DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

Release Stamp

DATE: Aug 12,2019 HANFORD RELEASE

1. **Doc No:** RPP-40149-VOL1 **Rev.** 05

2. **Title:**
Integrated Waste Feed Delivery Plan Volume 1-Process Approach

3. **Project Number:** ☒N/A

4. **Design Verification Required:** ☐Yes ☒No

5. **USQ Number:** ☒ N/A RPP-27195

6. **PrHA Number** **Rev.** ☒ N/A

Clearance Review Restriction Type: public

7. **Approvals**

Title	Name	Signature	Date
Clearance Review	Ayers, Lynn M	*Ayers, Lynn M*	08/12/2019
Document Control Approval	Hood, Evan	*Hood, Evan*	08/12/2019
Originator	Smith, Zabrina (Bree) B	*Smith, Zabrina (Bree) B*	07/31/2019
Responsible Manager	Wagnon, Todd J	*Wagnon, Todd J*	08/05/2019

8. **Description of Change and Justification**

Updated to bring into alignment with current long term and project planning for Direct Feed Low Activity Waste and reintroduce High Level Waste treatment elements. Minor revision to account for updates to planned first feed.

9. **TBDs or Holds** ☒N/A

10. **Related Structures, Systems, and Components**

a. **Related Building/Facilities** ☒N/A	b. **Related Systems** ☒N/A	c. **Related Equipment ID Nos. (EIN)** ☒N/A

11. **Impacted Documents – Engineering** ☐N/A

Document Number	Rev.	Title
RPP-40149-VOL2	05	Integrated Waste Feed Delivery Plan Volume 2-Campaign Plan
RPP-40149-VOL2	04A	Integrated Waste Feed Delivery Plan Volume 2-Campaign Plan
RPP-40149-VOL2	04	Integrated Waste Feed Delivery Plan Volume 2-Campaign Plan
RPP-40149-VOL2	03A	Integrated Waste Feed Delivery Plan Volume 2-Campaign Plan
RPP-40149-VOL3	05	Integrated Waste Feed Delivery Plan Volume 3-Project Plan
RPP-40149-VOL3	04	Integrated Waste Feed Delivery Plan Volume 3-Project Plan
RPP-RPT-57991	02	One System River Protection Project Integrated Flowsheet
RPP-RPT-57991	01	One System River Protection Project Integrated Flowsheet

12. **Impacted Documents (Outside SPF):**

ORP-11242
TFC-PLN-39

13. **Related Documents** ☐N/A

Document Number	Rev.	Title
HNF-3484	10	DOUBLE-SHELL TANK EMERGENCY PUMPING GUIDE
HNF-SD-WM-OCD-015	44	Tank Farms Waste Transfer Compatibility Program
OSD-T-151-00007	20	OPERATING SPECIFICATIONS FOR THE DOUBLE-SHELL STORAGE TANKS
RPP-17152	12	HANFORD TANK WASTE OPERATIONS SIMULATOR (HTWOS) VERSION 8.1 MODEL DESIGN DOCUMENT
RPP-47172	00	WASTE FEED DELIVERY SYSTEM DESCRIPTION
RPP-PLAN-40145	06	Single-Shell Tank Waste Retrieval Plan
RPP-PLAN-60093	01	One System Direct Feed Low Activity Waste Program Risk and Opportunity Management Plan
RPP-RPT-57991	01	One System River Protection Project Integrated Flowsheet
RPP-SPEC-56967	06	Project T5L01 Low Activity Waste Pretreatment System Specification

14. **Distribution**

Name	Organization
Arm, Stuart T	FLOWSHEET INTEGRATION
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RPP-40149-VOL1
Revision 5

Integrated Waste Feed Delivery Plan: Volume 1 – Process Approach

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Date Published
August 2019

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

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Printed in the United States of America

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TERMS

Abbreviations and Acronyms

BDGRE	buoyant displacement gas release event
CRV	condensate receipt vessel
DFLAW	direct feed low-activity waste
DOE	U.S. Department of Energy
DQO	data quality objectives
DSA	documented safety analysis
DST	double-shell tank
EMF	Effluent Management Facility
HLW	high-level waste
ICD	interface control document
IWFDP	Integrated Waste Feed Delivery Plan
JMN	Justification of Mission Need
LAW	low-activity waste
LERF	Liquid Effluent Retention Facility
MYOP	Multi-Year Operating Plan
ORP	Office of River Protection
PT	Pretreatment
RPP	River Protection Project
SST	single-shell tank
TFO	Tank Farm Operations
TFPT	Tank Farm Pretreatment
TSCR	Tank Side Cesium Removal
TOC	Tank Operations Contract, Tank Operations Contractor
TWCS	Tank Waste Characterization and Staging
WAC	waste acceptance criteria
WCA	waste compatibility assessment
WFD	waste feed delivery
WTP	Hanford Tank Waste Treatment and Immobilization Plant

Units

Ci	curie
g	gram
gal	gallon
gpm	gallons per minute
hr	hour
in.	inch
kg	kilogram
kgal	kilogallon
M	molar
Mgal	million gallons
mol	mole
wt%	weight percent

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Office of River Protection (ORP) manages the River Protection Project (RPP) at the Hanford Site. The RPP mission is to manage the nuclear waste stored in Hanford's 177 underground tanks safely and responsibly until it can be prepared for delivery and treated at the Hanford Tank Waste Treatment and Immobilization Plant (WTP) for final disposition. Specifically, the mission is to manage, prepare, and deliver the tank waste to the WTP, wherein the waste feed will be separated into low-activity waste (LAW) and high-level waste (HLW) fractions and immobilized prior to final disposal.

This Integrated Waste Feed Delivery Plan (IWFDP or the Plan) describes the commissioning, infrastructure upgrades, near-term, and long-term waste transfer/pre-process operations necessary to provide Hanford tank waste feed to the WTP. The Plan is based on a phased-approach for performing the RPP mission. The Plan focuses on the start-up, commissioning, and initial operating phase of WTP LAW Vitrification Facility as projected by a Tank Operations Contractor (TOC) life-cycle planning tool. The Plan also includes information on treatment of tank waste, including HLW at the WTP Pretreatment (PT) Facility as well as via a direct-feed mode.

WTP LAW vitrification will be performed in the direct-feed mode prior to commencement of HLW vitrification. The direct feed low-activity waste (DFLAW) approach involves the delivery of tank farm supernates to the Tank Side Cesium Removal (TSCR) system where solids and cesium are removed via filtration and ion-exchange, respectively. The pretreated waste is stored in a double-shell tank (DST) until it is delivered to the WTP LAW Vitrification Facility for conversion to borosilicate glass, followed by onsite disposal at the Integrated Disposal Facility. The solids removed by filtration are returned to DST storage and the spent ion exchange columns are transferred to an interim storage pad for eventual disposal. TSCR may eventually be replaced by (or supplemented with) additional supplemental pretreatment capacity to provide higher capacity pretreatment better matched to the capacity of the WTP LAW Vitrification Facility. As the specific design of the follow-on pretreatment system has not been determined, the term "Tank Farm Pretreatment" (TFPT) is being used to describe this additional pretreatment capacity.

Waste feed delivery (WFD) will be implemented through programs that coordinate and integrate across multiple Hanford Site prime contractor work scopes. The TOC Mission Integration and Waste Feed Delivery/Operations organization, which leads and performs planning, analysis, and integration activities, developed and will update this Plan, as required, and has responsibility for maintaining the Plan.

This Plan consists of three volumes. Volume 1 is organized into seven sections.

- Section 1.0, "Introduction," describes the purpose, objectives, evolution, and context of the Plan.
- Section 2.0, "Feed Delivery During Direct Feed Low-Activity Waste Operations" describes the phased approach to the waste feed delivery process for WTP facility and addresses the initial planning and process flow of the delivery of waste directly to the WTP LAW Vitrification Facility.

- Section 3.0, “Feed Delivery During Waste Treatment Plant Full Operations,” addresses the initial planning and process flow of the delivery of waste to the WTP facility for treatment after the WTP HLW Vitrification and WTP PT Facilities become operational.
- Section 4.0, “Special Topics,” describes special topics primarily related to storage of waste in the DSTs and delivery of DST supernate to TSCR and pretreated LAW to the WTP, including out-of-specification feed.
- Section 5.0, “Issues and Uncertainties,” addresses the process for the management of current and future challenges to successful waste feed delivery.
- Section 6.0, “Path Forward: Future Refinements,” discusses the waste feed delivery path forward with respect to near-term and long-term planning.
- Section 7.0, “References.”

1.1 PURPOSE

The purpose of the Plan is to describe how the TOC will prepare and deliver qualified Hanford tank waste to the WTP. Specific language in the *Tank Operations Contract* (Contract Number DE-AC27-08RV14800, Section C) describes the entire plan as a whole:

> The Contractor shall prepare, submit for DOE-ORP approval, and implement an *Integrated Waste Feed Delivery Plan* (Deliverable C.2.3.1-2) to provide optimum and reliable pretreatment (if needed), blending/mixing, retrieval and delivery of feed to DOE-ORP treatment facilities. This Plan shall include the needs of commissioning, near-term, and long-term operations; necessary studies, testing, and infrastructure installation; and projected waste transfer/pretreatment operations.

The Contract also states:

> The Contractor shall ensure that the *Integrated Waste Feed Delivery Plan* is integrated with the *RPP System Plan*.

The Plan is divided into three volumes:

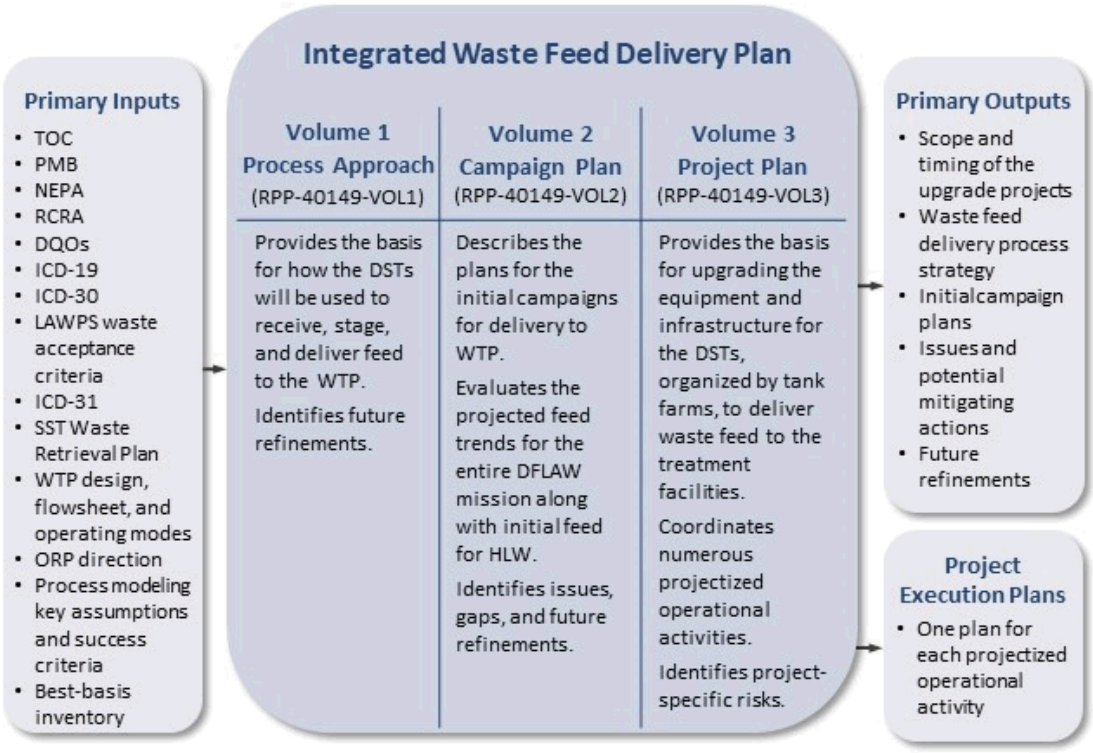
- Volume 1 – Process Approach (RPP-40149-VOL1),
- Volume 2 – Campaign Plan (RPP-40149-VOL2), and
- Volume 3 – Project Plan (RPP-40149-VOL3).

Volume 1 describes the process approach. Volume 2 describes the initial DFLAW and HLW campaigns based on the process approach per *One-System River Protection Project Integrated Flowsheet* (Integrated Flowsheet) (RPP-RPT-57991) and consistent with ORP mission guidance. Volume 3 identifies the scope and timing of the tank farm upgrade projects necessary to execute the process approach. Issues, potential mitigating actions, and future refinements regarding waste feed delivery are identified within each volume of the Plan. The purpose and scope of each volume, and the primary inputs to and outputs from the Plan as a whole, are likewise described in Figure 1-1.

This revision of the Plan documents the TOC approach to preparing and delivering appropriate feed to RPP treatment facilities, with emphasis on activities that support the startup and

operations of the WTP LAW Vitrification Facility in the DFLAW mode. Activities beyond DFLAW are addressed in less detail. The Plan draws from ORP direction, technical and programmatic assumptions, and requirements that relate to waste feed delivery and the interface between the tank farms and WTP.

Figure 1-1. Scope and Purpose of the Integrated Waste Feed Delivery Plan



DFLAW	direct-feed low activity waste
DQO	data quality objectives
DST	double-shell tank
HLW	high-level waste
ICD	interface control document
LAWPS	Low-Activity Waste Pretreatment Systems
NEPA	National Environmental Protection Act
ORP	Office of River Protection
PMB	performance measurement baseline
RCRA	Resource Conservation and Recovery Act
SST	single-shell tank
TOC	Tank Operations Contract
WTP	Hanford Tank Waste Pretreatment and Immobilization Plant

1.2 OBJECTIVES

This Plan develops the overall scheme for delivering compliant waste feed in a timely manner to the following processes and facilities to safely and efficiently accomplish the RPP mission:

- TSCR, TFPT, and subsequently WTP LAW Vitrification Facility for DFLAW treatment;
- Tank Waste Characterization and Staging (TWCS) Facility, WTP PT Facility, and WTP HLW Vitrification Facility, which come on line subsequent to DFLAW; and
- A Supplemental Treatment Facility for LAW if/when such a facility comes on line subsequent to the WTP PT Facility and WTP HLW Vitrification Facility.

"Timely," within the context of the Plan, refers to the ability of the tank farms to supply acceptable waste feed to the facilities and processes listed above at sufficient rate as to meet production goals. Likewise, adequate space will be maintained in the tank farms so as to receive effluent returns from TSCR/TFPT and WTP, thus supporting efficient operations throughout the treatment mission. Modifications to existing systems and installations of new systems will be coordinated in Volume 3 to meet startup, commissioning, and processing needs for these facilities and processes. Supporting objectives and concepts that aid in accomplishing the primary waste feed delivery objective include:

- Providing an integrated systems approach to waste retrieval, pretreatment, and delivery, which includes establishing the hardware baseline wherein existing DST farm conditions are evaluated to document the status of site infrastructure and storage/retrieval systems;
- Managing the dynamic between single-shell tank (SST) retrievals and waste feed delivery activities;
- Integrating DST system upgrades with other tank farms work scope;
- Relying on mature/proven technologies;
- Placing a high priority on operability and maintainability of systems;
- Assessing technical and programmatic risks and opportunities on a continuous basis;
- Providing flexibility to adapt to evolving requirements and process improvement opportunities;
- Assessing and responding to project performance risks; and
- Pursuing cost efficiency.

1.3 EVOLUTION OF THE INTEGRATED WASTE FEED DELIVERY PLAN

The Plan evolves and matures through an ongoing iterative process of successive refinements. This iterative approach builds from existing waste feed delivery infrastructure (tankage, evaporative capacity, etc.) configuration, upgrade plans and projects, and waste feed delivery process modeling requirements and assumptions.

Volume 1 of the Plan establishes the overall process approach required to meet the waste feed delivery goals. Volume 1 describes a baseline tank usage strategy (i.e., how the DSTs will be used to prepare and deliver feed) as per the life-cycle process model. The life-cycle process model output is also used to define the sequence of projected feed campaigns; thus forming the

basis for Volume 2. Volume 2 describes near term projected individual feed campaigns and trends for DFLAW. Volume 3 establishes the basis for the waste feed delivery system architecture - DSTs, waste transfer routing systems, and supporting infrastructure and utilities.

Risks and opportunities associated with successful execution of the Plan will be captured and addressed in accordance with the WRPS *Enterprise Risk and Opportunity Management (EROM) Framework* (WRPS-57232).

1.4 WASTE FEED DELIVERY PLANNING PROCESS

The waste feed delivery planning process is depicted graphically in Figure 1-2. The following text briefly describes the process. Items included in Figure 1-2 are identified with *italic font* at their first mention in the textual discussion that follows.

The waste feed delivery *Inputs* are built on a wide range of requirements, guidance, technical inputs, and assumptions documentation. The externally imposed requirements/regulatory documents are:

- *Hanford Federal Facility Agreement and Consent Order*, as stipulated by the Tri-Party Agreement;
- *Resource Conservation and Recovery Act of 1976* (hazardous waste management); and
- *National Environmental Policy Act of 1969* (environmental impact assessment and record of decision).

ORP inputs to the Plan include the Contract and ORP direction, which is provided by multiple means, e.g., verbal direction, letter, contract changes. Inputs from the TOC are Best Basis Inventory estimates for the tank waste, the Waste Compatibility Program, and waste acceptance criteria (WAC) for TSCR. The WTP (Bechtel National, Inc.) inputs to the Plan include interface control documents (ICDs), which include WTP WAC; and WTP design, flowsheet, operating modes, and availability.

The inputs are used to generate the *Integrated Waste Feed Delivery Plan, Volume 1, Process Approach*. The Process Approach and the *life-cycle process model* form a feedback loop, the output of which are the *WFD Campaign Plan (IWFDP Volume 2)* and the *WFD Project Plan (IWFDP Volume 3)*. The *IWFDP Volume 3* feeds into waste feed delivery specific *Upgrade Projects*.

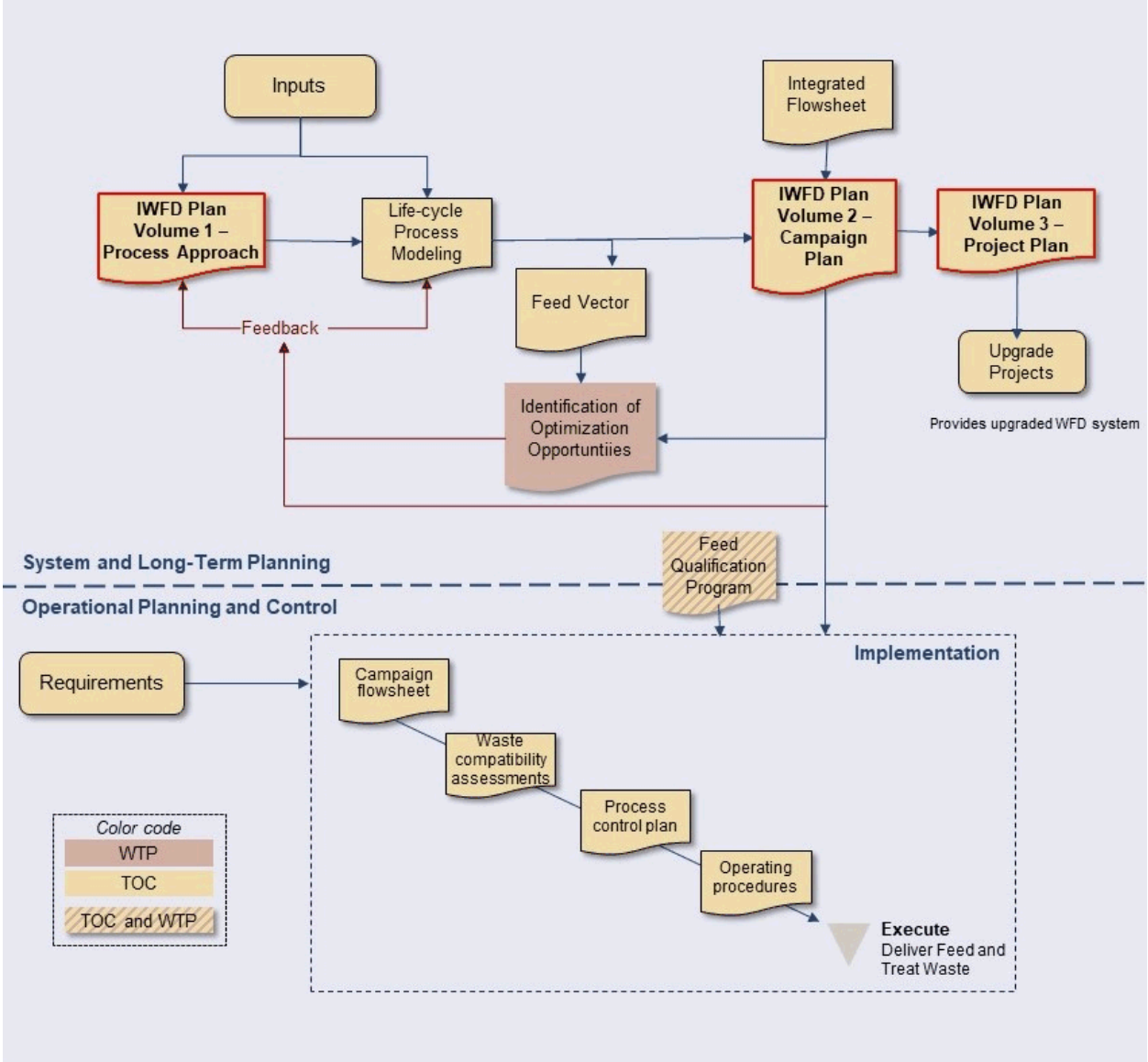
This revision of the IWFDP is being specifically developed in conjunction with other key planning documents, including the *Multi-Year Operating Plan* (MYOP) revision. Volume 1 will be utilized to form the technical underpinning for the remaining volumes of this Plan and the Integrated Flowsheet revision.

The dashed box entitled "*Implementation*" at the bottom center of Figure 1-2 contains four documents. These Implementation items are the *Campaign Flowsheet, Waste Compatibility Assessments*, *Process Control Plan*, and *Operating Procedures*.

The waste feed delivery planning process includes multiple feedback opportunities that support successive refinements via iteration. Feedback specifically supports the Integrated Flowsheet;

mission modeling; risk management; various processes identified in the Interface Management Plan; Integrated Project Teams; general decision making processes; and tradeoff studies.

Figure 1-2. Integrated Waste Feed Delivery Planning Process



Note: Documents are denoted by page-shaped objects with a wavy lower boundary, while processes and activities are shown as simple rectangular objects.

1.5 INTEGRATION WITH SYSTEM PLANNING

Contractually, the IWFDP is to be integrated with ORP-11242, *River Protection Project System Plan* (System Plan). Modeling for the IWFDP will be performed in conjunction with modeling for the revision to the MYOP and RPP-RPT-57991, Integrated Flowsheet to ensure a complete and accurate view of the DFLAW mission and follow on life-cycle activities are captured. The modeling uses key aspects of the Baseline Case, Scenario 1A from Revision 8 of the System Plan and updates technical and programmatic inputs to reflect more changes in near-term operations plans. Key updates included in the modeling for the MYOP, IWFDP, and Integrated Flowsheet are listed below:

- The use of the TSCR (and later, TFPT) system to pretreat DST supernate to meet the WTP LAW Vitrification Facility WAC
- Repurposing of tank AP-106[1] to store pretreated waste from TSCR/TFPT
- Changes to the AX and A Tank Farm retrieval schedules and flowsheets
- Impacts to 242-A Evaporator and other tank farm operations due to the need to replace the slurry lines
- Addition of a 2000-Gallon Test Bed Initiative using tank SY-101 waste.

The modeling performed for the MYOP may also serve as the starting point for Revision 9 of the System Plan.

[1] Throughout this document, individual tanks and tank farms are referred to without the "241-" tank/tank farm designator prefix (e.g., tank 241-AP-106 is referred to as tank AP-106 and 241-AP Tank Farm is referred to as AP Tank Farm).

2.0 FEED DELIVERY DURING DIRECT FEED LOW-ACTIVITY WASTE OPERATIONS

During full operations of the WTP Facilities, the WTP PT Facility separates tank waste into HLW and LAW fractions, which are vitrified at the WTP HLW and WTP LAW Vitrification Facilities, respectively. While HLW contains the vast majority of the radioactivity, the LAW consists of the bulk of the volume to be treated by WTP. Technical challenges have delayed the completion of the WTP PT Facility. In response, DOE-ORP has directed the treatment of LAW through a phased approach. The following sections present the processing approach and strategy for delivery of LAW directly to the WTP LAW Vitrification Facility via DFLAW.

2.1 FEED DELIVERY DURING TANK SIDE CESIUM REMOVAL OPERATIONS

The TSCR system provides for the early production of immobilized low-activity waste by preparing LAW that will be fed directly from Tank Farms to the WTP LAW Vitrification Facility. Prior to the transfer of feed to the WTP LAW Vitrification Facility, tank supernatant waste will be pretreated within the TSCR system to remove solids and cesium. The TSCR system will be deployed as a two-phased demonstration project. The first phase, which is a TSCR project deliverable, will demonstrate the ability to safely operate and maintain the TSCR system in support of WTP hot commissioning and early operations; a minimum of 170 kgal of waste from tank AP-107 will be treated and at least 100,000 Ci of ^{137}Cs will be removed in this phase. The second phase will demonstrate the ability to reliably and efficiently treat tank waste for an extended operating period; this phase will include up to 5 Mgal of waste feed processing. Figure 2-1 describes the process flow during this near-term mission.

The delivery and volume management of tank waste during DFLAW operations will require close coordination between the DST system, TSCR, and WTP operations. Figure 2-2 depicts the primary DFLAW liquid stream flows to and from the DSTs, TSCR, and WTP LAW Vitrification Facility. The existing DST system will be configured in such a way to support delivery of qualified supernatant feed to TSCR and pretreated feed to the WTP LAW Vitrification Facility on a semi-continuous, campaign (≈1 Mgal) basis.

As currently conceived, four DSTs in AP Tank Farm are dedicated to a DFLAW system that prepares, stages, characterizes, and pretreats tank waste supernates to ensure compliance with 24590-WTP-ICD-MG-01-030, *ICD-30 – Interface Control Document for Direct Feed Low-Activity Waste*, (ICD-30), as well as receiving process waste from TSCR. The system then provides interim storage of the pretreated waste and will deliver it to the WTP LAW Vitrification Facility. The system will utilize the DSTs for the following purposes:

- Staging and characterization tank (tank AP-105)
- DFLAW feed tank (tank AP-107)
- Interim pretreated LAW storage tank (tank AP-106)
- Wash liquids receipt tank (tank AP-108)

The primary prerequisites to preparation and delivery of waste feed to TSCR are (a) that the waste selected as the first feed for TSCR is diluted, mixed via recirculation, and sampled in the TSCR feed tank, qualifying the waste as being within the limits described in the WAC for TSCR (RPP-RPT-60636, *Waste Acceptance Criteria for Low Activity Waste Pretreatment Systems*) and WTP LAW (ICD-30) and (b) that necessary tank-specific upgrades and any associated transfer system and tank farm infrastructure upgrades have been completed.

Figure 2-3 shows a generic feed delivery logic for DFLAW campaigns. Key aspects of the logic are discussed in Sections 2.1.2 through 2.1.5. Engineering documents required to perform the campaigns are also discussed and are summarized in Appendix B.

Figure 2-1. Low-Activity Waste Feed Delivery Process During TSCR Operations

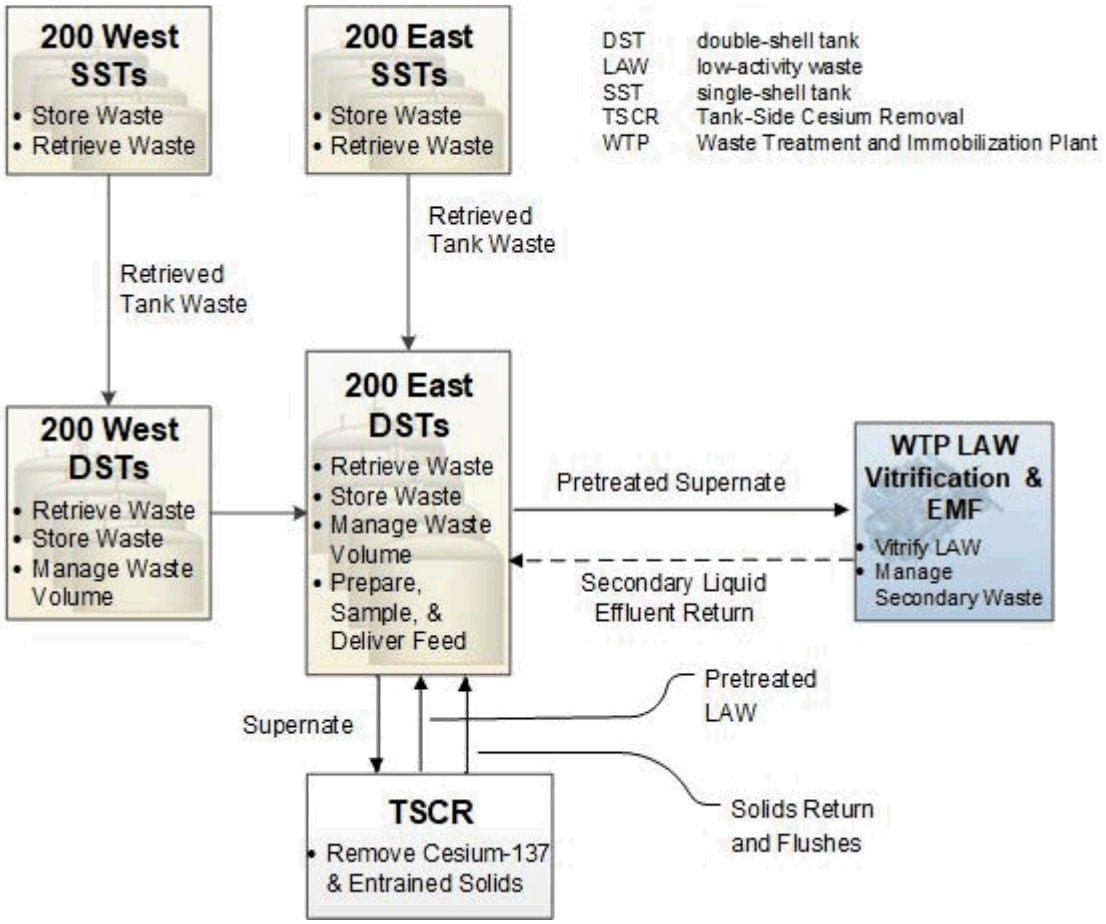


Figure 2-2. DFLAW Process Arrangement

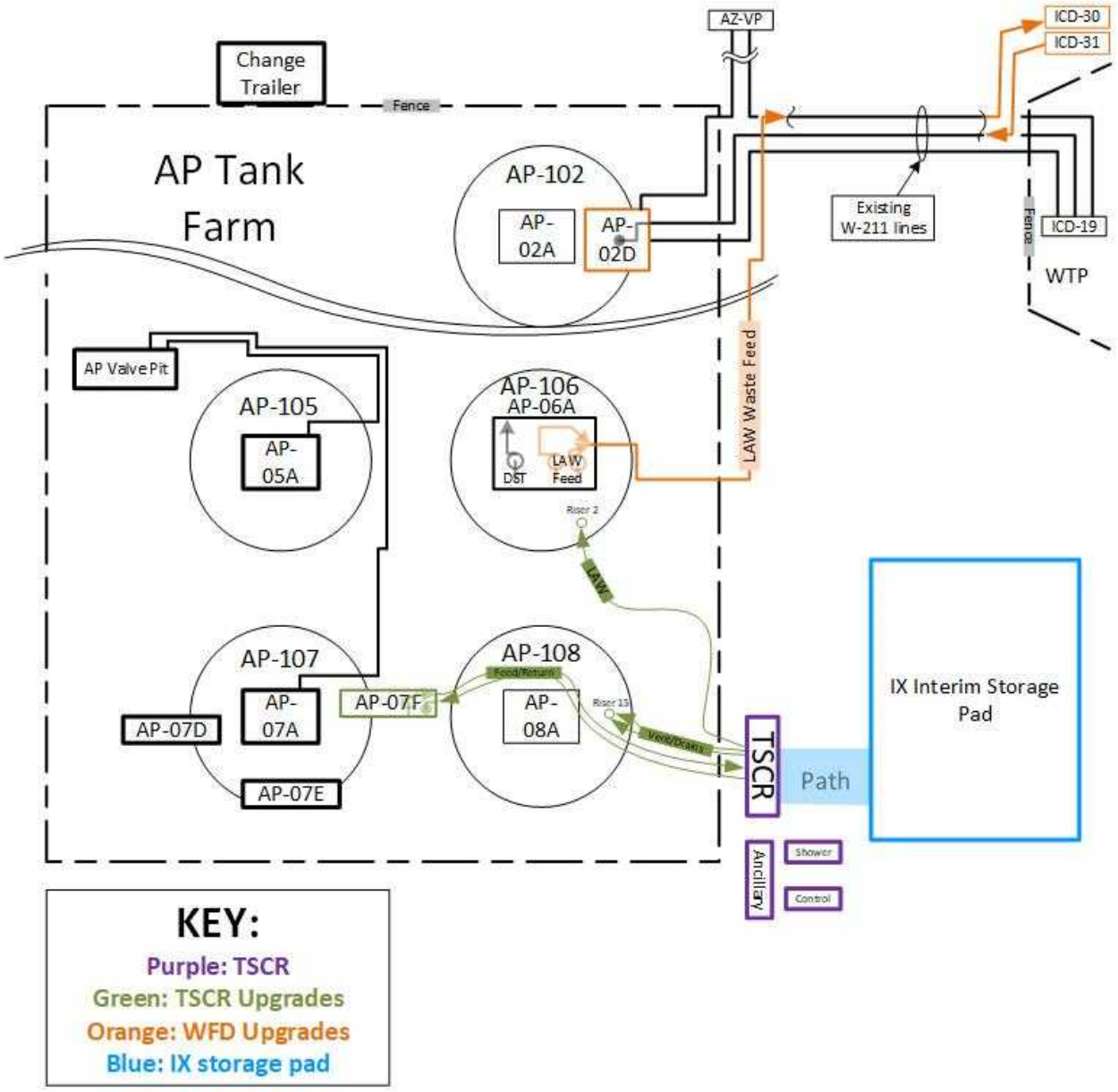


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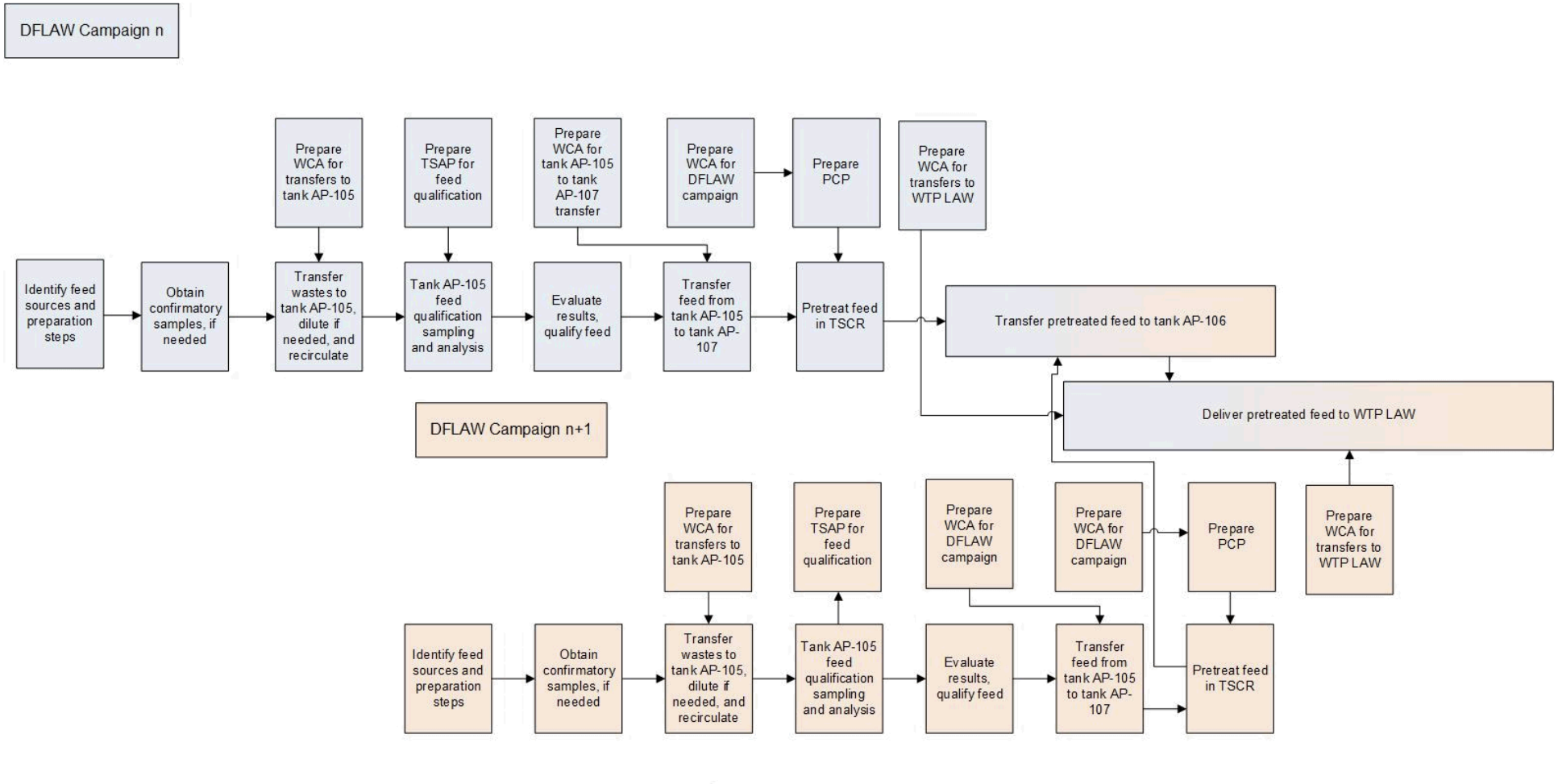
Figure 2-3. Feed Delivery Logic for Typical DFLAW Campaigns



2.1.1 Tank 241-AP-106 Repurposing

Waste currently stored in tank AP-106 does not meet the requirements of ICD-30 and therefore the tank is not currently suitable for interim storage of pretreated LAW. The ^{137}Cs to sodium ratio is several hundred times above the allowable 3.18×10^{-5} Ci ^{137}Cs/mol Na limit. Prior to the start of TSCR operations, waste will be transferred from tank AP-106 and a sequence of processing steps will be performed to repurpose the tank as the pretreated LAW storage tank.

The repurposing process will involve first pumping out as much of the supernate as possible from tank AP-106, then a number of bulk dilution and decant steps will be performed to reduce the ^{137}Cs in the tank. These steps will be followed by the injection of a caustic solution, and more water additions and dilution steps. In process samples will be obtained to determine the effectiveness of the process. Process steps will be adjusted based on the mixing behavior observed. The final steps planned for the process are a water addition and waste recirculation followed by sampling and analysis to confirm the waste, once mixed with pretreated waste from the first phase of the TSCR demonstration (the treatment of about 170 kgal of waste), will comply with ICD-30 requirements. Further information can be found within RPP-PLAN-62353, *Tank 241-AP-106 Cs-137 Removal for Repurposing Process Control Plan*.

2.1.2 Tank Side Cesium Removal Feed Source Identification

Each TSCR campaign will process a nominal 1 Mgal of waste. The feed for the first campaign has been prepared and is stored in tank AP-107. Following feed qualification sampling and analysis to ensure this waste meets WAC for processing in TSCR, the waste will be ready for processing in TSCR. Tank AP-105 contains waste that will become feed for the second campaign. A portion of the waste in tank AP-105 will be removed to another DST and the remaining waste will be diluted with water to bring the waste composition into compliance with the WAC. Feed qualification samples will be obtained from tank AP-105 to ensure that the feed composition meets the WAC for TSCR (RPP-RPT-60636) and the requirements of ICD-30 with the exception of ^{137}Cs, which will be removed in TSCR. Upon completion of the first TSCR campaign, the qualified feed in tank AP-105 will be transferred to tank AP-107, the feed tank for TSCR.

For subsequent campaigns, waste will be transferred from one or more DSTs to tank AP-105 and dilution material may be added to create a feed that complies with the TSCR WAC. Considerations for feed identification are discussed in RPP-RPT-61034, *Direct Feed Low-Activity Waste (DFLAW) Feed Delivery Process Strategy*. RPP-RPT-61034 provides the following source selection guidelines for Campaign 3 and beyond:

- Exclude supernates that are excluded for use by the Feed Control List (HNF-SD-WM-OCD-015, *Tank Farms Waste Compatibility Program*, Table A-1). Tank AN-102 and tank AN-107 are currently segregated from all other wastes due to their complexed TRU and strontium concentrations.
- Consult with Tank Farm Operations (TFO) so that source selection is not at odds with TFO's contemporary priorities. TFO may have preferred sources in mind as they juggle regular tank farm operations, SST retrieval, and waste feed delivery.

- Evaluate whether the supernate in tank AP-108 or dilute waste in another DST is (a) suitable for use as diluent for the next DFLAW campaign or (b) suitable for TSCR feed, thus avoiding water additions to the DST system and unnecessary evaporator campaigns.
- Select supernate only if treatability to ICD-30 compliance is a readily demonstrated based on inspection of the Best-Basis Inventory, process knowledge, and other characterization data. Consider blending possibilities for supernate that is not treatable to ICD-30 compliance.
- Give preference to supernates from Waste Group C and Waste Group B tanks over Waste Group A tanks. Waste Group A tanks are restricted from having waste transferred into or out of them until their flammable gas hazards are mitigated (see Section 4.2).
- Give preference to supernates that have sufficient volume to create a full campaign without having to supplement with a secondary source.
- Give consideration to supernates on the basis of proximity to the DFLAW system: AP Farm first, AW Farm second, AN Farm third.

In addition, it is desirable to avoid swings in the characteristics of successive campaigns to minimize process upsets.

For this Plan, feed selection focused first on wastes that currently exist in the DST system; these wastes are primarily in AP Farm and are treatable to ICD-30 compliance. Later campaigns include future dilute wastes. Tanks with feed identified for the subsequent campaigns are (in order):

- Tank AP-101 (contains primarily slurry from the 242-A Evaporator)
- Tank AP-104 (will contain primarily waste transferred to it from tank AP-105 during the preparation of the second DFLAW campaign and slurry from evaporator campaign EC 13)
- Tank AP-108 (will contain a mix of waste currently in tank AP-108, waste currently in tank AZ-102, and plant wash from TSCR operations)
- Tank AZ-102 (will contain primarily dilute waste from tank AX-101 retrieval)
- Tank AY-101 (contains primarily slurry from the 242-A Evaporator)

Waste from these feed tanks will be used beginning with Campaign 3. Waste will be blended to provide sufficient volume to feed forward to optimize the feed campaign batching and sampling process. The waste in tank AZ-102 is expected to be dilute and may serve to dilute tank AP-108 or tank AY-101 feeds.

In general, identification of potential feed sources should begin as soon as possible. If the uncertainty of the Best-Basis Inventory estimates of the composition of a potential feed(s) are considered to be unacceptably high, waste sampling to confirm the composition may be necessary.

A process flowsheet will be developed to evaluate the proposed feed composition. The flowsheet will provide added confidence that the proposed feed will meet the WAC and can be successfully pretreated in TSCR or will identify potential problems that may require changes to transfers to be made to tank AP-105, A waste compatibility assessment (WCA) will be performed for the transfers between the source tank and tank AP-105 and for any dilution material (dilute waste or water) added to the tank. Once blended in tank AP-105, feed qualification samples will be obtained from the tank and analyzed in accordance with 24590-LAW-RPT-PENG-16-003 / RPP-RPT-59494, *Integrated DFLAW Feed Qualification Data Quality Objectives*, (DFLAW DQO). A tank sampling and analysis plan (TSAP) will be prepared to provide direction to Sampling Operations and the analytical laboratory on the samples to be obtained, the analyses to be performed, and the requirements for reporting. Results will be evaluated to ensure the waste is compliant with the TSCR WAC and the waste can then be transferred to tank AP-107. A second WCA will be prepared to evaluate the transfer of the waste from tank AP-105 to tank AP-107. After waste has been transferred to tank AP-107, staging of waste for the next DFLAW campaign in tank AP-105 can begin.

2.1.3 Transfers Between Double-Shell Tanks and Tank Side Cesium Removal System

Feed will be provided to TSCR from tank AP-107 via hose-in-hose transfer lines in a continuous feed/return loop; a nominal 5 gpm will be diverted to TSCR and the rest of the stream will be returned to tank AP-107. ICD-30 compliant pretreated waste, from the TSCR pretreatment process, will be transferred to tank AP-106 at a nominal 5 gpm. Due to their low specific gravity (< 1.35) and low solids content, the feed and pretreated feed transfers are not subject to critical velocity requirements (TFC-ENG-STD-26, *Waste Transfer, Dilution, and Flushing Requirements*).

Waste streams generated at TSCR will be transferred to tank AP-108. This includes solids and liquids from the back flushing of the filter units, water and caustic solutions from the flushing of spent ion exchange columns, and exhaust from the filter and ion exchange vents.

After feed in tank AP-107 is processed through TSCR, qualified feed in tank AP-105 will be transferred to tank AP-107 for processing as the next TSCR campaign.

For all of these transfers, transfer line flushes will be performed in accordance with TFC-ENG-STD-26.

2.1.4 Tank Side Cesium Removal Operations

A system diagram for TSCR is shown in Figure 2-4. The TSCR unit operations are contained within a process skid that will be located adjacent to the AP Tank Farm. Feed is transferred from tank AP-107 to TSCR via a continuous feed/return loop, diverting a nominal 5 gpm to the TSCR process. The tank AP-107 pump provides all the motive force moving the waste through the TSCR process and to storage in tank AP-106. The TSCR process begins with the removal of suspended solids via filtration; the solids are removed to prevent fouling of the ion exchange columns. TSCR will contain two parallel filter units so that a clean filter is online at all times (with the offline filter being regenerated or on standby). The filtered supernate is then processed through an ion-exchange system for the removal of cesium, reducing the ^{137}Cs concentration to

less than 3.18×10^{-5} Ci/mol sodium to meet ICD-30 requirements. The ion exchange system is expected to consist of three columns with a non-elutable ion exchange medium (crystalline silicotitanate). The pretreated waste continues to tank AP-106 for storage prior to delivery to the WTP LAW Vitrification Facility. Continuous gamma monitoring of the ^{137}Cs concentration in the pretreated waste stream will be performed to ensure that the contents of tank AP-106 will meet the requirements of ICD-30. Other instrumentation to monitor operations include transfer and process line pressure and flow rates, waste temperatures, leak detection, and transfer pump interlocks.

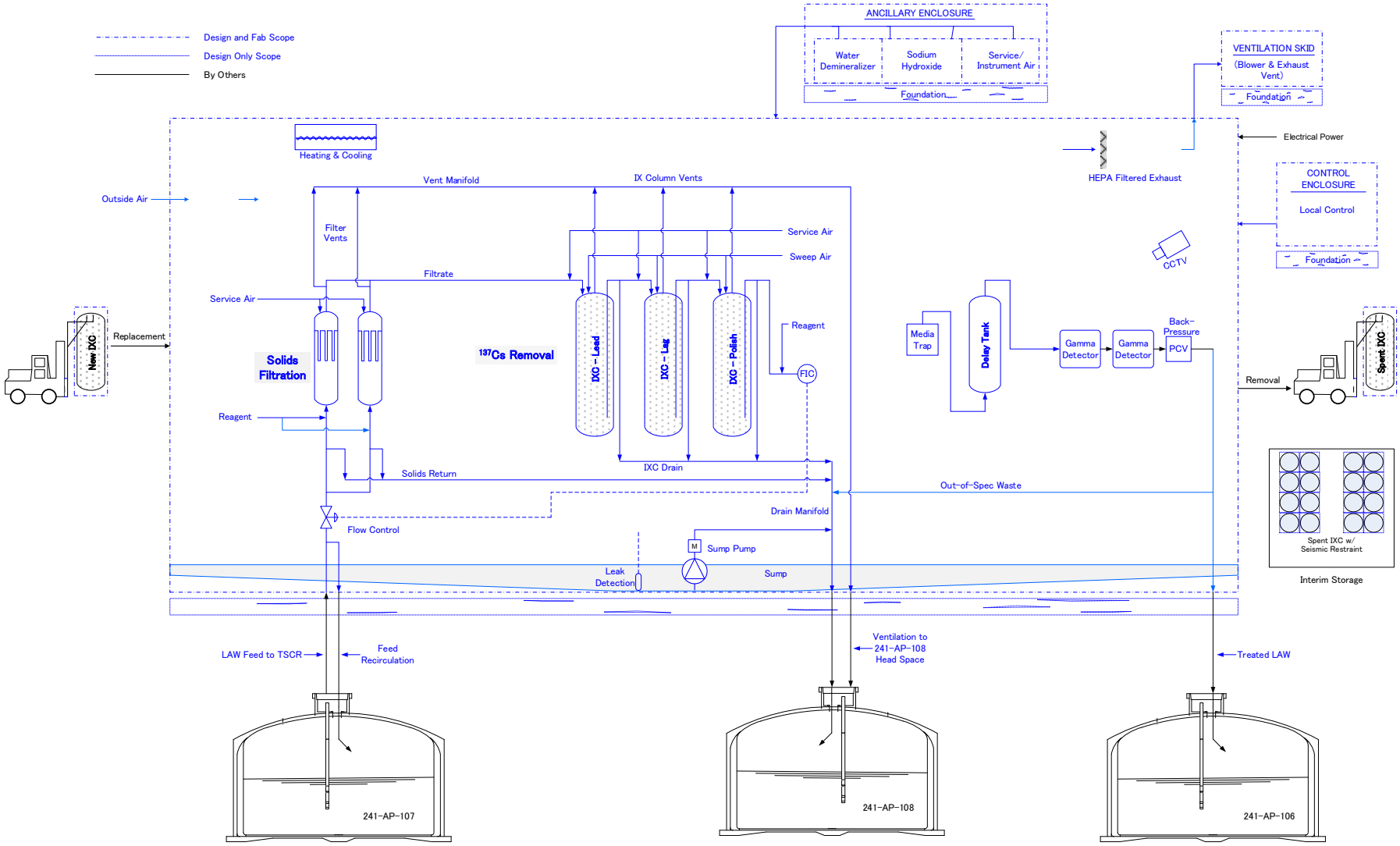
Spent ion exchange columns will be flushed with dilute caustic (0.1 M NaOH) and water, air-dried, and transferred to an interim storage pad. Waste streams generated by back flushing of the filters and caustic and water flushing of spent ion exchange columns will be transferred to tank AP-108, the wash liquids receipt tank. TSCR process vessel ventilation is provided by the AP Tank Farm ventilation system via tank AP-108 while a separate ventilation system will provide ventilation to the TSCR enclosure.

To minimize the impact on TSCR operations, the transfer of qualified feed from tank AP-105 to tank AP-107 to start a new campaign could be planned to coincide with TSCR outages for ion exchange column replacement.

A tank AP-106 tracking tool, with periodic benchmark sampling of tank AP-106, will be used to provide an approximation of the real-time tank inventory and composition of the tank. Inputs to the tracking tool include the feed qualification sample results and TSCR ^{137}Cs monitoring data as well as transfer information. The tracking tool will provide input to the WTP's Immobilized LAW Glass Formulation Algorithm.

It is expected that a single WCA will be prepared to cover transfers from tank AP-107 to TSCR and TSCR to tanks AP-106 and AP-108. A process control plan will be prepared for the TSCR operations and feed delivery, with process memos or an engineering controls checklist within the TSCR operating procedure expected to provide specific operating requirements and limits for each campaign.

Figure 2-4. Tank Side Cesium Removal System Diagram



2.1.5 Pretreated Feed to Waste Treatment and Immobilization Plant

The pretreated LAW is retained in tank AP-106 until it is transferred to the WTP LAW concentrate receipt vessels (CRV). Transfers will be made in batches, nominally 7,300 gal in volume, transferred daily. Transfer line flushes will be performed in accordance with TFC-ENG-STD-26. An assessment similar to a WCA will be prepared to evaluate the transfer of treated waste from tank AP-106 to the WTP LAW Vitrification Facility for each DFLAW campaign. A full WCA is not planned as the tank receiving the transfer is not within the tank farm system. The first assessment will be prepared before the first transfers to WTP begin. It is expected that the next assessment will be prepared before TSCR begins processing the next campaign and begins introducing new waste into tank AP-106.

Tank AP-106 will have a dynamic inventory as the tank will normally be receiving pretreated waste from TSCR at a rate of about 5 gpm at the same time it is transferring batches to the WTP LAW Vitrification Facility. However, with the large volume of waste initially in tank AP-106 at the start of WTP LAW operations, the rate of change in the composition of the pretreated waste will be very gradual. The assessment will need to be written in a manner that will allow the simultaneous transfers into and out of tank AP-106.

2.1.6 Effluent Returns to Tank Farms from Waste Treatment and Immobilization Plant

The WTP LAW Vitrification Facility generates two main liquid effluent streams that require treatment and disposition. These are melter off-gas condensates and contaminated plant wash liquids. Both are sent to the WTP Effluent Management Facility (EMF) for concentration by evaporation prior to recycle into WTP LAW and processed with a new batch of waste during routine operations. The concentrated waste is recycled to the WTP LAW CRVs. Overheads from the WTP EMF evaporator, sufficiently dilute in radionuclides, hazardous material and salts, are sent to the Liquid Effluent Retention Facility (LERF) for subsequent treatment in the Effluent Treatment Facility. One additional WTP LAW effluent stream, caustic scrubber waste, has sufficiently low radionuclide and chemical concentrations that it can be sent directly to the LERF via piping at the WTP EMF without further treatment.

To allow for continued melter operations during WTP EMF evaporator outages, melter off-gas condensates and plant wash liquids are managed within WTP EMF before being routed to tank farms. Prior to return to tank farms, chemicals (sodium nitrite and sodium hydroxide) are added to melter off-gas condensate to meet the corrosion control requirements for the DST system. Returns from the WTP are described along with the specific requirements for acceptance within 24590-WTP-ICD-MG-01-031, *ICD-31 – Interface Control Document for DFLAW Effluent Returns to Double-Shell Tanks* (ICD-31). A WCA will be prepared for any returns to tank farms.

2.2 ADDITIONAL WASTE FEED DELIVERY

Additional pretreatment capacity beyond the TSCR demonstration phases will be required to support DFLAW until the start-up of the WTP PT Facility and WTP HLW Vitrification Facility. This pretreatment capacity may be provided by continued TSCR operations or the replacement or supplementing of TSCR with a similar pretreatment system. As the pretreatment system has not been determined, the term “Tank Farm Pretreatment” (TFPT) is being used for this post-TSCR demonstration pretreatment capacity. For the modeling effort supporting this Plan, it is

assumed that the TFPT will start on February 25, 2024 and will be equivalent to a scaled-up version of TSCR with the capability of pretreating waste at an rate of 185 kg Na/hr, or a nominal rate of 6.4 gpm for a 5.5 M Na feed. If a TSCR campaign is in process at the start of TFPT, that campaign will continue to completion.

2.3 WASTE VOLUME MANAGEMENT

Effective and efficient management of DST space is essential to mission success during the DFLAW timeframe. The majority of DST space is used for waste storage or as operable space for waste transfers, SST retrievals, or 242-A Evaporator support. The total operating capacity of the 27 DSTs is 31.1 Mgal, however some headspace must be set aside to accommodate operating constraints. The two primary headspace constraints are:

- **Safety basis headspace:** The Authorization Agreement (29633-ESQ-AA-0001, *River Protection Project Authorization Agreement between the U.S. Department of Energy, Office of River Protection and Washington River Protection Solutions, LLC*) prohibits waste additions to existing Waste Group A tanks and prohibits the creation of new Waste Group A tanks, without prior approval from ORP, due to the potential for buoyant displacement gas release events (BDGREs) in Waste Group A tanks (tanks AN-103, AN-104, AN-105, AW-101, and SY-103). Therefore, the headspace in these tanks is not available for waste storage. This safety basis headspace comprises about 710 kgal of the total DST capacity.
- **DST emergency space:** In accordance with DOE M 435.1-1, *Radioactive Waste Management Manual*, tank farms is required to maintain 1.265 Mgal of available space that could be used to receive waste from another DST in the event that a DST leaks. The emergency space is distributed tank space that is available at all times. It is not practical to keep one entire tank empty for emergency space because that would inhibit DST utilization and waste feed delivery staging efforts. The maintenance of emergency space is managed through HNF-SD-WM-OCD-015 and is reviewed as part of the waste transfer evaluation process.

To achieve the DFLAW mission, the near-term goal of tank waste volume management is focused on tanks in the 200 East Area DSTs, which are instrumental during the DFLAW mission for preparing and delivering feed. The mission strategy is based on using the 242-A Evaporator to manage waste volume. However, the ability to run evaporator campaigns has been impacted by the need to replace the slurry lines. New slurry lines are expected to be ready for use in July 2021; aside from “no slurry” campaigns to maintain Evaporator operability, no evaporator campaigns can be performed until that time.

In the near term and during DFLAW, the MYOP is the tool used to monitor and plan the use of operational DST space.

2.4 WASTE FEED DELIVERY CONFIGURATION CONTROL

As part of the Waste Compatibility Program, a feed control suite has been developed to (a) ensure maintenance of DST space, (b) ensure timely characterization of adequate feed for the WTP hot commissioning and operating phases, and (c) support accelerated SST retrieval activities.

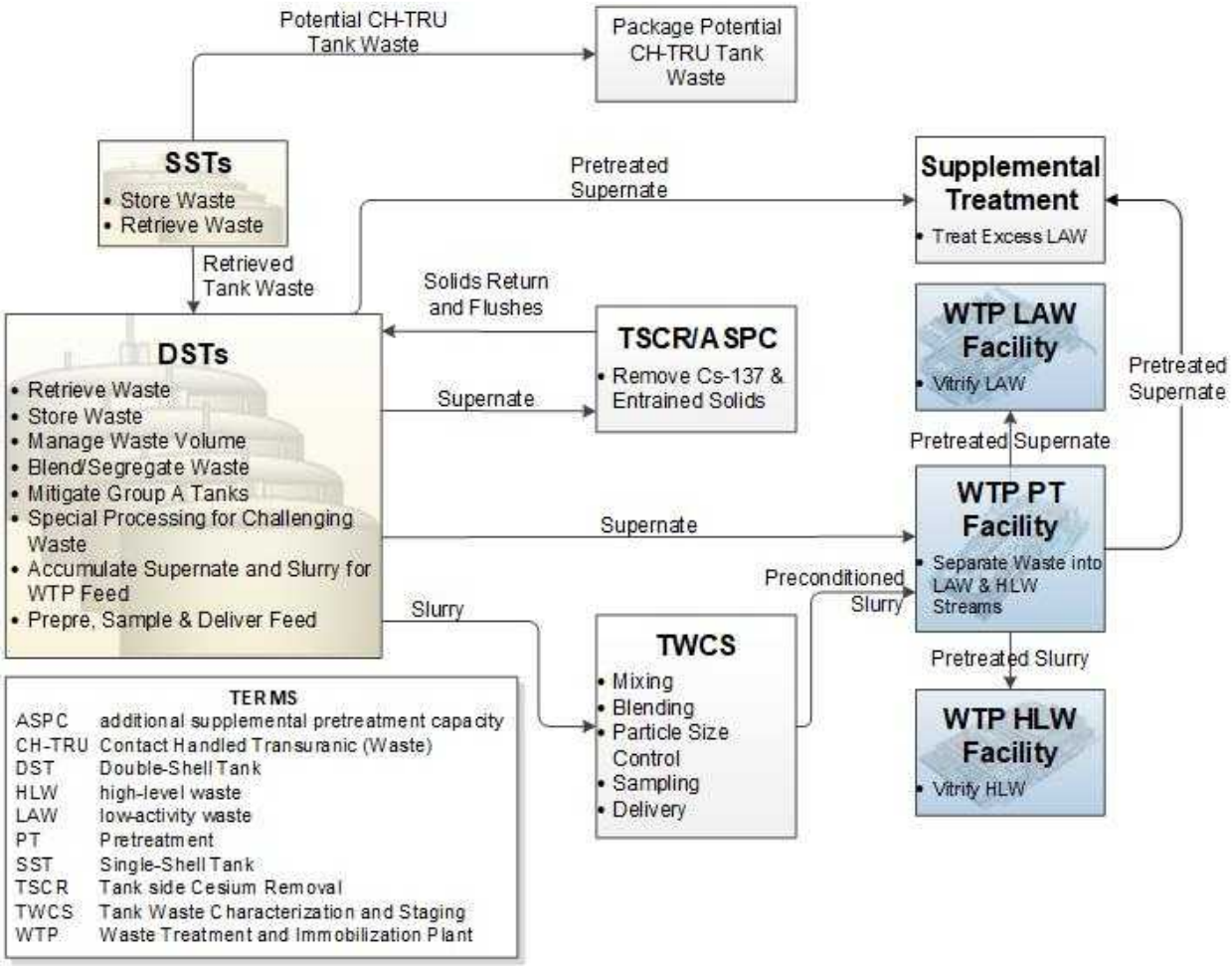
Waste feed delivery concerns are addressed in the Feed Control List (HNF-SD-WM-OCD-015, Table A-1). The objective of these controls include protecting the integrity of WTP hot commissioning feed and addressing processability of waste through the WTP. With respect to DFLAW, the primary goal is to ensure a DST accumulation and transfer sequence leading to feed staging and qualification tanks. Tanks AP-105 and AP-107 are currently on the Feed Control List, protecting the supernate in these tanks as feed for DFLAW operations. Other tanks may be added to the list as feed for subsequent DFLAW campaigns are confirmed.

Feed for TSCR is selected and prepared to meet the target compositions and key constituent concentrations identified in ICD-30 and the processing requirements for TSCR. TSCR feed requirements are defined the WAC (RPP-RPT-60636).

3.0 FEED DELIVERY DURING WASTE TREATMENT AND IMMOBILIZATION PLANT FULL OPERATIONS

Following DFLAW, during full operations of the WTP Facilities, the WTP PT Facility will separate tank waste into HLW and LAW fractions for vitrification at the WTP HLW and WTP LAW Vitrification Facilities, respectively. Figure 3-1 shows the waste feed delivery process after DFLAW. The following sections present the processing approach and strategy for delivery of waste to the WTP PT Facility, both via TWCS and directly and for delivery of waste to Supplemental Treatment. Figure 3-1 also shows that a potential contact-handled transuranic waste treatment process may be used for some SST waste; this process is outside the scope of this Plan and is not addressed further in this document.

Figure 3-1. Waste Feed Delivery Process Flow



3.1 LOW-ACTIVITY WASTE FEED DELIVERY TO THE WTP PT FACILITY

The general strategy for delivering LAW feed[2] to the WTP PT Facility is expected to proceed as follows: a DST operating as a WTP LAW feed tank is identified to receive staged waste, from one or more tanks operating as WTP LAW feed staging tanks, for delivery to the LAW feed receipt vessels in the WTP PT Facility. To ensure that the prepared feed will meet WAC, waste samples may be required before or after waste is transferred to the WTP LAW feed staging tanks. After the LAW campaign is fully prepared, the WTP LAW feed tank undergoes a prescribed hold time to allow for solids settling and sampling, and an additional time period for waste characterization to confirm the feed meets the requirements of 24590-WTP-ICD-MG-01-019, *ICD-19 – Interface Control Document for Waste Feed Delivery* (ICD-19). A pre-transfer flush of inhibited water precedes the designated waste transfer – this preheats the transfer line and helps prevent solids precipitation during the waste transfer. The LAW feed campaign is then transferred to the LAW feed receipt tanks, targeting a nominal 1 Mgal per campaign received. The delivery of a LAW feed campaign will be managed to fill multiple tanks in turn, and may involve multiple transfers, since each of the four WTP LAW feed receipt vessels in the WTP PT Facility has a maximum operating volume of 375 kgal. Once transfer of a LAW feed campaign to the WTP PT Facility is complete, the transfer line will be flushed to clear it of any remaining waste. This process is repeated for each LAW feed campaign, with a goal of ensuring that the steps required for the next LAW feed campaign to be transferred are completed prior to WTP requesting the feed.

The processing strategy for delivery to the WTP PT Facility was developed prior to the conceptualization of the DST support system necessary to support DFLAW. It may be necessary to repurpose the DFLAW feed tank or staging and characterization tank to support feed delivery to the WTP PT Facility. Given the current focus on DFLAW, this determination can be deferred until closer to WTP PT start-up. Re-evaluation must be scheduled with sufficient time to ensure that necessary upgrades to the existing tank farm infrastructure are complete in time to support WTP PT hot commissioning.

3.2 SUPPLEMENTAL TREATMENT OF LOW-ACTIVITY WASTE

The volume of LAW to be treated as part of the Hanford cleanup mission is significantly larger than the volume that can be immobilized in the WTP LAW Vitrification Facility over the duration of HLW treatment. No treatment technology has been selected to treat the additional LAW. As part of mission modeling, enabling assumptions have been made that excess LAW will be processed through the Supplemental Treatment Facility as a vitrification facility with WAC similar to those of the WTP LAW Vitrification Facility. Modeling results provide immobilized waste product quantities in terms of both glass and grouted waste forms for comparison based on total sodium processed. The capacity of Supplemental Treatment is assumed to be sufficient to ensure that it does not drive the RPP mission duration.

[2] During full operations, LAW feed is defined as the liquid stream (supernate plus a small amount of entrained solids) that is delivered to the WTP Pretreatment Facility. LAW feed is managed as HLW until it has been pretreated. After pretreatment to remove key radionuclides, this supernate will go to the WTP LAW Vitrification Facility.

It is assumed that Supplemental Treatment receives "excess" pretreated LAW from the WTP PT Facility as well as directly from a supplemental pretreatment source (TSCR or TFPT).

3.3 TANK WASTE CHARACTERIZATION AND STAGING

In September 2015, DOE formally approved the Justification of Mission Need (JMN) for the TWCS capability (Whitney 2015) to deliver HLW feed[3] to WTP. Numerous mixing studies have identified issues with the ability to deliver well-mixed waste and suspend high concentration solids (up to 20 wt%) using a single submersible mixer pump and transfer pump within a DST. A TWCS capability would allow for waste batches to be conditioned, blended, and delivered to the WTP PT Facility to meet throughput requirements.

TWCS, to be located in the 200 East Area, is envisioned to provide better slurry mixing, sampling, and feed staging than would otherwise be possible using DSTs. Current planning and assumptions are that TWCS will consist of six 500,000-gal tanks in a vault configuration and meet the functional requirements outlined in the JMN. The TWCS tanks are envisioned to accept waste transfers from DSTs, condition the waste (including performing particle size reduction), keep waste slurries adequately suspended to allow representative sampling of the waste, make transfers to each other for blending, and transfer batches of ICD-19 compliant feed to the WTP PT Facility. As additional design input is received, balance of mission operations will be redefined accordingly and incorporated within the Plan.

3.4 DIRECT FEED VERSUS PRETREATMENT

The timing of TWCS greatly depends on the operational start up strategy of the WTP HLW Vitrification Facility. The baseline plan as modeled in Revision 8 of the System Plan states that in order to meet commitments for treatment of waste identified within the Consent Decree, TWCS must be available to receive HLW by June 30, 2032. The formal request for approval of the JMN identified project costs up to $690M and schedule duration up to eight years.

Requirements for the function and design of TWCS will differ based on the intended destination of TWCS-characterized waste.

[3] During full operations, HLW feed is defined as the slurry stream (sludge plus supernate) that is delivered to the WTP Pretreatment Facility. Any solids remaining after pretreatment are routed to the WTP HLW Vitrification Facility along with separated radionuclides.

4.0 SPECIAL TOPICS

The following subsections present special topics primarily related to storage of waste in the DSTs and delivery of DST supernate to TSCR and pretreated LAW to the WTP LAW Vitrification Facility in support of DFLAW. Key uncertainties associated with delivery of waste to WTP HLW Vitrification/PT Facilities are also discussed as appropriate based on an update of information previously presented in earlier revisions of the Plan.

4.1 SOLIDS HANDLING WITHIN DFLAW

The WAC for TSCR (RPP-RPT-60636) imposes a limit on the concentration of solids within its feed. There are several risks to the DFLAW program associated with solids in the staging and feed tanks. RPP-RPT-59586, *Evaluation of Risks to the DFLAW Mission from Solids in East Area Double Shell Tanks*, addresses the primary concerns along with additional topics. Of primary concern is how the solids will affect the qualification sample, and whether changes to the solids in the staging tank during the qualification process will result in feed that is not represented by the qualification sample.

Initial modeling efforts indicate a gradual increase in the solids volume in tank AP-105 during DFLAW; the increase in settled solids volume is estimated to be about 70 kgal. The solids may be from solids entrained in the supernate transferred to tank AP-105 and solids precipitation from the mixing of the transferred waste with the existing tank heel. Solids precipitation will be evaluated in flowsheets developed for each DFLAW campaign; the flowsheets will identify any mitigating actions required.

4.2 WASTE GROUP A TANKS

Waste Group A tanks are DSTs with a potential spontaneous BDGRE flammable gas hazard in addition to a potential induced gas release event flammable gas hazard. These tanks are conservatively estimated to achieve a flammable gas concentration of 100 percent of the lower flammability limit in the tank headspace if all of the retained gas is released due to a spontaneous BDGRE.

There are five tanks identified as Waste Group A tanks: tanks AN-103, AN-104, AN-105, AW-101, and SY-103. These tanks are restricted from having waste transferred into or out of them until they are mitigated. An effort is underway to evaluate, recommend alternatives, and subsequently develop a standard flowsheet for Waste Group A tank mitigation. For this Plan, mitigation of Waste Group A tanks is assumed to begin immediately after the retrieval of the A Tank Farm.

The first Waste Group A tank mitigation (tank SY-101) resulted in large increases in tank waste volume in the DST system. While mitigation poses an initial challenge from a volume management perspective, when completed, restrictions and controls associated with waste transfers are will be relaxed to permit expanded use of the DST. Dissolution of the saltcake within Waste Group A tanks is anticipated to generate a large volume of supernate, which would provide additional dilute feed suitable for LAW feed.

4.3 A AND AX TANK FARM WASTE RETRIEVAL

The retrieval of waste from tanks in A and AX Tank Farm are scheduled to occur during DFLAW. About 90% of the waste volume in these tanks is classified as saltcake. Dissolution of the saltcake during retrieval will generate a large volume of supernate for the DST system. Depending on the composition of the retrieved waste, it may provide dilute feed suitable for LAW feed or may be suitable for diluting other LAW feed.

4.4 OUT-OF-SPECIFICATION FEED

Tank waste must meet waste acceptance feed criteria established by WTP contractual and interface requirements prior to delivery to WTP LAW feed receipt vessels. ICD-30 stipulates:

> If the pretreated LAW feed (prior to transfer to WTP) does not meet the feed acceptance criteria, alternative actions as described in the DFLAW DQO shall be taken. No transfers may take place until the WTP Contractor has reviewed the analytical results.
>
> 1. If the treated LAW feed does not comply with the feed acceptance criteria, the TOC, with support from the WTP Contractor, prepares an assessment and recommendation for the preferred method(s), if possible and practical, to correct any feed composition or property deficiencies for ORP review and approval.
> 2. If a batch of treated LAW feed is found to be non-compliant after transfer to LAW CRV, the WTP Contractor, with support from the TOC, prepares an assessment and recommendation to disposition the transferred feed and submits the assessment and recommendation to ORP for review and approval.

The waste feed delivery strategy involves a proactive approach to ensure that waste will meet contractual and interface requirements prior to WAC samples being taken. This includes taking feed qualification samples before treating waste in TSCR, monitoring ^{137}Cs concentrations in the pretreated waste stream, identifying any waste that may be out-of-specification, and taking action to adjust the waste to conform to requirements for waste acceptance.

Work is planned to develop a data management program for waste feed qualification samples which will include a discussion of the process used to address any non-conformances or defects within the qualification sample results.

4.5 HANDLING OF WTP RETURNS TO TANK FARMS DURING DFLAW

During normal operations of the WTP EMF melter off-gas condensates and contaminated plant wash liquids are directed to the WTP EMF where they are concentrated by evaporation. The evaporator concentrates are recycled to the WTP LAW CRVs. During outages of the WTP EMF evaporator and to allow melter operations to continue, the dilute melter off-gas condensates and contaminated plant wash liquids are managed in WTP EMF before being routed to the DST System. WRPS-1700288, *Calculation of EMF Returns*, estimated the anticipated return volume to be less than 300 kgal over the current DFLAW mission and no more than 70 kgal during any three-month outage window. DST space must be reserved within the DST system to accommodate the returns if necessary and will be part of the requirements for the individual feed campaigns.

4.6 BLENDING OF HIGH URANIUM-233 SOLIDS FOR HIGH-LEVEL WASTE FEED DELIVERY

Tank AN-101 contains solids from the retrieval of tanks C-101, C-102, C-104, C-111, and C-112. The waste initially in tank C-104 contained a fissile uranium to total uranium (^{F}U/U) ratio[4] that exceeded the 8.4 g/kg criticality prevention specification limit of the WTP. The tank C-104 sludge in tank AN-101 will be blended with the sludges from the other C Farm tanks to reduce the ^{F}U/U ratio to acceptable levels before being delivered to the WTP PT Facility; this waste is on the Feed Control List (HNF-SD-WM-OCD-015, Table A-1). Several other tanks – tanks AW-103, AW-104, A-105, and AZ-101 – have also been identified as having ^{F}U/U ratios exceeding the criticality prevention specification limit and will also require blending to reduce the ratios. A study is planned to review the ^{F}U/U ratios and mass quantities in all the tanks to document the extent and magnitude of the issue and inform blending or other strategies for delivering compliant feed to WTP.

4.7 SEPARABLE ORGANICS

Both ICD-30 and ICD-19 contain a separable organic requirement of "no visual immiscible layer." RPP-RPT-59624, *Separable Organic Evaluation: WFD Impact Assessment*, evaluates the potential for separable organic layers in feed to WTP, both during DFLAW and during full operations. Separable organics in the feed to WTP were not considered to be an issue during DFLAW potentially separable organics are generally associated with the waste solids (bound to solids or within the interstitial spaces). However, the HLW waste feed to WTP will contain solids and it is possible that separable organic layers will form in during waste feed delivery operations.RPP-RPT-59624 identifies additional testing that can provide additional information regarding the potential for separable organics in HLW feed and potential mitigating actions to be evaluated.

[4] Fissile uranium = ^{235}U mass + 1.25 x ^{233}U mass. Total uranium = ^{235}U mass + ^{233}U mass + ^{238}U mass.

5.0 ISSUES AND UNCERTAINTIES

Risks and opportunities associated with successful execution of the IWFDP will be captured and addressed in accordance with the WRPS *Enterprise Risk and Opportunity Management (EROM) Framework* (WRPS-57232). The DFLAW program addresses specific risks and opportunities associated with the execution of the overall program through a standalone *One System Direct Feed Low Activity Waste Program Risk and Opportunity Management Plan* (RPP-PLAN-60093). The IWFDP is critical to mitigation of risks associated with the DFLAW program, specifically those related to the availability of DST space and qualified feed.

6.0 PATH FORWARD: FUTURE REFINEMENTS

Future revisions of the Plan will include updates to planning assumptions for waste feed delivery for DFLAW, tasks completed to resolve existing issues and uncertainties, and emerging issues that arise during ongoing waste feed delivery planning activities. Long-term planning for the full-mission has been included within this Plan to the extent that information has been changed and updated.

Key activities that will mature the DFLAW process approach include the following.

1. Maintaining and updating the Feed Control List (HNF-SD-WM-OCD-015, Table A-1) as necessary to protect feed for DFLAW. This includes tanks AP-107 and AP-105, which are currently on the list, and other feeds as they are identified.
2. Finalize DFLAW waste feed qualification program. This includes the issuance of the revision to the DFLAW DQO and the 222-S Laboratory's implementation of the gas generation rate measurement apparatus and procedure.
3. Complete qualification sampling, analysis, and testing of feed for the first DFLAW campaign.
4. Update waste compatibility program (HNF-SD-WM-OCD-015) to incorporate waste compatibility decision rules associated with TSCR and update the feed control list.
5. Complete upgrades to tanks, transfer systems, and tank farm infrastructure.
6. Maintain alignment between waste feed delivery planning with ongoing DFLAW startup and commissioning planning.
7. Update process modeling specifications for TSCR, TFPT, and WTP EMF as design matures.
8. Continue to explore alternative SST retrieval and feed source strategies for potential improvements in meeting overall mission metrics.
9. Continue evaluation and implementation of DST tank waste management initiatives to increase useable operational space.

Key activities that support HLW feed delivery planning include:

1. Determine start up strategy for HLW treatment via PT versus direct feed approach.
2. Update waste feed requirements for waste acceptance of HLW to the WTP PT Facility (currently within ICD-19).
3. Develop comprehensive functions and requirements for TWCS.

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APPENDIX A

GLOSSARY

APPENDIX A

GLOSSARY

Term (abbreviation)	Definition or expansion
Buoyant Displacement Gas Release Event (BDGRE)	Tank waste generates flammable gases through the radiolysis of water and organic compounds, thermolytic decomposition of organic compounds, and corrosion of the carbon steel tank walls. Under certain conditions, this gas may accumulate in a settled solids layer until the waste becomes hydrodynamically unstable (less dense waste near the bottom of the tank). A BDGRE is the rapid release of this gas, partially restoring hydrodynamic equilibrium. The release may result in the temporary creation of a flammable mixture in the headspace of the tank, depending on the size of the release relative to the capacity of the ventilation system.
Disposal	Emplacement of waste in such a manner that ensures protection of the public, workers, and the environment with no intention of retrieval and that requires deliberate action to regain access to the waste (per DOE M 435.1-1[a]).
Direct feed LAW (DFLAW)	Direct transfer of Hanford tank farm treated low-activity waste (LAW) feed by the Tank Operations Contractor (TOC) to the Hanford Tank Waste Treatment and Immobilization Plant (WTP) LAW Vitrification Facility.
High-Level Waste (HLW)	The fraction of the tank waste containing most of the radioactivity that will be immobilized into glass and disposed at an off-site repository. HLW includes the solids remaining after pretreatment plus certain separated radionuclides.
High-Level Waste (HLW) Feed	The slurry stream (sludge plus supernate) that is delivered to the WTP Pretreatment Facility. Any solids remaining after pretreatment are routed to the WTP HLW Vitrification Facility along with separated radionuclides.
Hot Commissioning	The phase in which a treatment facility does production runs using actual tank waste.
Inhibited Water	Process water that contains at least 0.01 M sodium hydroxide and 0.01 M sodium nitrite.
Low-Activity Waste (LAW)	Waste that remains following pretreatment to separate as much radioactivity as is practicable from HLW. When solidified, Law may be disposed of as low-level waste in a near-surface facility.
Low-Activity Waste (LAW) Feed	During DFLAW operations, the liquid stream that is delivered to WTP LAW Vitrification Facility following pretreatment to remove entrained solids and cesium. For the balance of mission, the liquid stream (supernate plus a small amount of entrained solids) that is delivered to the WTP Pretreatment Facility. LAW feed is managed as HLW until it has been pretreated. After pretreatment to remove key radionuclides, this supernate will go to the WTP LAW Vitrification Facility.
LAW Pretreatment Systems (LAWPS)	The Low-Activity Waste Pretreatment System is a permanent facility that may supplant or run in conjunction with the Tank Side Cesium Removal (TSCR) system as part of the DFLAW process for treating sodium-bearing waste in the Hanford tank farm. The LAWPS Facility has the main objective to remove undissolved solids and radioactive cesium from the liquid LAW waste stream.
Pretreated LAW Feed	The stream produced by TSCR (or TFPT) to be delivered to the WTP LAW Vitrification Facility.

Term (abbreviation)	Definition or expansion
Retrieval	The process of removing, to the maximum extent practical, all of the waste from a given underground storage tank. The retrieval process is selected specific to each tank and accounts for the waste type stored and the access and support systems available and may involve the use of more than one retrieval technology. In accordance with OSD-T-151-00031,[d] a tank is officially in "retrieval status" if one of two conditions is met: (1) waste has been physically removed from the tank by retrieval operations, or (2) preparations for retrieval operations are directly responsible for rendering the leak or intrusion monitoring instrument out-of-service.
Saltcake	A mixture of crystalline sodium salts that originally precipitated when alkaline liquid waste from the various processing facilities was evaporated to reduce waste volume. Saltcakes are comprised primarily of the sodium salts of nitrate, nitrite, carbonate, phosphate, and sulfate. Concentrations of transition metals such as iron, manganese, and lanthanum and heavy metals (e.g., uranium and lead) are generally small. Saltcake typically contains some quantity of interstitial liquid. The bulk of the saltcake will dissolve if contacted with sufficient water.
Sludge	A mixture of metal hydroxides and oxyhydroxides that originally precipitated when acid liquid waste from the various reprocessing facilities was made alkaline with sodium hydroxide. Sludge is comprised primary of the hydroxides and oxyhydroxides of aluminum, iron, chromium, silicon, zirconium, and uranium, plus the majority of the insoluble radionuclides such as ^{90}Sr and the plutonium isotopes. Sludge typically contains a significant amount of interstitial liquid (up to nominal 40 wt% water). Sludge is mostly insoluble in water; however, a significant amount of aluminum and chromium will dissolve if leached with sufficient quantities of sodium hydroxide.
Slurry	The term slurry is used in several different contexts: • Slurry is a mixture of solids (e.g., sludge or undissolved saltcake) suspended in a liquid. For example, a slurry results when the sludge and supernate in a tank is mixed together. Slurries can be used to transfer solids by pumping though a pipeline. • Slurry can refer to the bottoms stream from the 242-A Evaporator or other evaporator streams. • Slurry also refers to a specific waste produced at Hanford that results from evaporating supernate originally removed from tanks containing saltcake so that aluminum salts begin to precipitate in addition to the sodium salts. This material, called "double-shell slurry" or "double-shell slurry feed" is present in the DSTs (specifically tanks AN-103, AN-104, AN-105, and AW-101). For simplicity, this document will use the term "settled salts" or "saltcake" instead of slurry in this context.
Supernate	Supernate is technically the liquid floating above a settled solids layer. At Hanford, it is typically used to refer to any non-interstitial liquid in the tanks, even if no solids are present. Supernate is similar to saltcake in composition and contains many of the soluble radionuclides such as ^{137}Cs and ^{99}Tc.
Tank Farm Pretreatment (TFPT)	TFPT refers to the additional pretreatment capacity beyond the TSCR demonstration phases that will be required to support DFLAW until the start-up of the WTP PT Facility and WTP HLW Vitrification Facility. This pretreatment capacity may be provided by continued TSCR operations, the replacement of TSCR with LAWPS, both TSCR and LAWPS, or other similar pretreatment system.
Tank Side Cesium Removal (TSCR)	The Tank Side Cesium Removal system is part of the DFLAW process for treating sodium-bearing waste in the Hanford tank farm. TSCR has the main objective to remove undissolved solids and radioactive cesium from the liquid LAW waste stream.

Term (abbreviation)	Definition or expansion
Tank Waste Characterization and Staging (TWCS)	Capability that will be designed to aid in the resolution of the technical issues associated with mixing and characterizing high-level tank waste. When constructed, the TWCS functions will include (but not limited to): adequate mixing, ability to sample, and ability to characterize high-level tank waste feed prior to delivery to the WTP PT Facility.
Waste Feed Delivery (WFD)	The overall program responsible for preparing, qualifying and delivering Hanford waste currently stored at the tank farms from the DSTs to WTP.
Waste Feed Delivery (WFD) System	RPP-47172[f] defines the WFD system as being composed of the DST system and the waste retrieval facilities; however, for the purposes of the Plan, WFD system is used to refer to those portions of the WFD system directly supporting preparation and delivery of waste feed to the WTP.
Waste Group A Tanks	Tanks that, due to their waste composition and quantities, have the potential for a spontaneous BDGRE and are conservatively estimated to contain enough flammable gas within the waste that if all were released into the tank headspace, the concentration of the flammable gas would be a flammable mixture.
Waste Group B Tanks	Tanks with a potential induced gas release event flammable gas hazard, but no potential spontaneous BDGRE flammable gas hazard. That is, tanks that are conservatively estimated to contain sufficient retained gas to achieve 100% of the LFL if all of the retained gas is released into the tank headspace, but are not Waste Group A tanks
Waste Group C Tanks	Tanks with no potential gas release event flammable gas hazard. These tanks are conservatively estimated to contain insufficient retained gas to achieve 100% of the LFL even if all of the retrained gas is released into the tank headspace.

[a] DOE M 435.1-1, 2011, *Radioactive Waste Management Manual*, Change 2, Office of Environmental Management, U.S. Department of Energy, Washington, D.C.

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

[c] ORP-11242, 2011, *River Protection Project System Plan*, Rev. 6, U.S. Department of Energy, Office of River Protection, Richland, Washington.

[d] OSD-T-151-00007, 2011, *Operating Specifications for the Double-Shell Storage Tanks*, Rev. 7, Washington River Protection Solutions, LLC, Richland, Washington.

[e] DE-AC27-01RV14136, 2010, *Design, Construction, and Commissioning of the Hanford Tank Waste Treatment and Immobilization Plant*, (as amended through A164), U.S. Department of Energy, Office of River Protection, Richland, Washington.

[f] RPP-47172, 2010, *Waste Feed Delivery System Description*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

APPENDIX B

PROCESS IMPLEMENTING DOCUMENTS

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PROCESS IMPLEMENTING DOCUMENTS

B1.0 INTRODUCTION

A number of documents are required to support the processing of a direct-feed low-activity waste (DFLAW) campaign through the Tank Side Cesium Removal (TSCR) system. This appendix lists the process engineering and operating documents to be prepared to support a typical campaign.

B2.0 PROCESS ENGINEERING DOCUMENTS

The documents to be prepared by Process Engineering include process flowsheets, waste compatibility assessments (WCAs), a tank sampling and analysis plan (TSAP), a process control plan (PCP), and direction to Operations via Engineering Transfer Controls checklists in transfer procedures.

Process flowsheets are prepared in accordance with TFC-ENG-CHEM-C-01, "Process Flowsheets." Process flowsheets are developed to assess the predicted outcome of a process on tank space, interfacing and downstream processes, and the overall tank farms mission.

WCAs are prepared in accordance with TFC-CHEM-P-13, "Tank Waste Compatibility Assessments." WCAs are prepared to ensure that the waste transfer will comply with specific administrative control, safety, regulatory, programmatic, and operational decision rules related to waste chemistry and waste properties. The waste compatibility program, described in HNF-SD-WM-OCD-015, *Tank Farms Waste Transfer Compatibility Program*, will be updated to incorporate new controls resulting from the amendment to the documented safety analysis (RPP-13033, *Tank Farm Documented Safety Analysis*) for TSCR operations and to modify the feed control list, which currently limits transfers involving tanks AP-105 and AP-107.

TSAPs are prepared in accordance with TFC-ENG-CHEM-D-23, "Preparation of Tank Sampling and Analysis Plans," and provide specific sampling, analysis, and reporting requirements to the Tank Farm Sampling and Analytical Laboratory organizations.

PCPs are prepared in accordance with TFC-ENG-CHEM-C-11, "Process Control Plans." A PCP coordinates the various technical operating control elements for a specific processing activity, and provides overall technical guidance for that activity. They describe and define the specific controls (e.g., safety basis controls, process controls, environmental controls) required for a planned process activity or project. The PCP provides a link between the process and equipment design and the technical operating procedures that control work in the field.

Procedures for tank transfers, which would also include the procedure for TSCR operations, contain an Engineering Transfer Controls checklist. This checklist is used by Engineering to provide direction to Operations such as transfer volumes, liquid level and temperature limits, flow rates, and flush volumes.

The following documents are expected to be prepared by process engineers for each direct feed low-activity waste (DFLAW) campaign. For the first campaign, the steps involving tank AP-105 are not applicable as the feed for TSCR is already in tank AP-107.

For feed source identification:

- Process flowsheet to evaluate the processing of proposed feed through TSCR and its ability to meet waste acceptance criteria.

For preparation of feed in tank AP-105:

- WCA for transfers into tank AP-105 from other double-shell tanks and any water additions to tank AP-105 needed to make up the feed for the DFLAW campaign.
- Directions to Operations regarding the transfer volumes, any water additions, and waste recirculation requirements will be provided in the Engineering Transfer Controls checklist contained in the transfer and recirculation procedures.

For qualification of feed:

- Tank sampling and analysis plan (TSAP) for sampling and analysis of prepared feed in accordance with RPP-RPT-59494 / 24590-LAW-RPT-PENG-16-003, *Integrated DFLAW Feed Qualification data Quality Objectives*. For the first campaign, the feed was prepared in tank AP-107 so tank AP-107 will be sampled. For subsequent campaigns, feed will be prepared in tank AP-105 and tank AP-105 will be sampled.
- A technical document that provides an evaluation of analytical results to ensure that the feed meets TCSR waste acceptance criteria and, with the exception of ^{137}Cs, Hanford Tank Waste Treatment and Immobilization Plan (WTP) low-activity waste (LAW) waste acceptance criteria.

For transfer of feed from tank AP-105 to tank AP-107:

- WCA for the transfer of prepared TSCR feed from tank AP-105 to tank AP-107; this WCA can normally be completed within four weeks of release of the feed qualification sample results.

For TSCR operations:

- WCA for TSCR operations; includes evaluation of the following transfers:
    a. transfer of feed from tank AP-107 to TSCR
    b. transfer of pretreated feed from TSCR to tank AP-106
    c. transfers of waste streams from TSCR to tank AP-108 (includes solids and liquid from backflushing of filters and water and caustic solutions from flushing of spent ion exchange columns).
- Process control plan for TSCR operations. Some of the key process control items currently identified are discussed in RPP-RPT-61034, *Direct Feed Low-Activity Waste (DFLAW) Feed Delivery Process Strategy*.

- An Engineering Transfer Controls checklist in the operating procedure will be filled out by Engineering to provide limits on parameters such as tank liquid levels, water usage, waste processing volume; the checklist can be updated as needed.

For tank AP-106 inventory and composition tracking:

- A tank AP-106 inventory tracking tool will be developed to provide an approximation of the real-time inventory in the tank. The tool is expected to be a spreadsheet, prepared in accordance with TFC-ENG-DESIGN-C-10, "Engineering Calculations," if designated a single-use spreadsheet or TFC-ENG-DESIGN-C-32, "Utility Calculation Software Management," if designated a multiple-use spreadsheet.
- TSAP for benchmark sampling and analysis of tank AP-106. The sampling and analysis will be performed in accordance with a DQO that will be developed to establish data needs. Sampling is expected to be more frequent during the first campaign and then be reduced to once per campaign.

For transfer of pretreated feed from tank AP-106 to WTP LAW Facility:

- WCA for the transfer of pretreated feed from tank AP-106 to the WTP Law Facility.

B3.0 OPERATING DOCUMENTS

All routine TSCR operations and maintenance activities will be performed using approved procedures. Non-routine work will be managed with work packages developed as needed for the tasks that arise.

Procedures are prepared in accordance with TFC-OPS-OPER-C-13, "Technical Procedure Control and Use," with additional requirements for procedures involving waste retrieval or transfers specified in TFC–OPS-OPER-C-49, "Development of Waste Retrieval and Transfer Operating Procedures (Including Water and Chemical Additions)."

Work packages are prepared in accordance with TFC-OPS-Maint-C-11, "Tank Operations Contractor Work Control." Non-routine work will be managed with specific maintenance work packages developed as needed for the tasks that arise. Tank sampling activities are also performed using work packages.

The following operational documents are expected to be required for DFLAW campaigns. Except as noted, new documentation is not required for each campaign. For the first campaign, the steps involving tank AP-105 are not applicable as the feed for TSCR is already in tank AP-107.

For preparation of feed in tank AP-105:

- Waste transfer procedures for transfers from other DSTs to tank AP-105. Each DST transferring to tank AP-105 will require a separate procedure.
- Procedure TO-270-951, "Recirculate 241-AP-105."

For qualification of feed in tank AP-105:

- Work package for sampling of tank AP-105 per the TSAP. A work package will be prepared for each sampling event.
- Existing grab sampling and sample transportation procedures (TO-080-075, "Sample Transfer Truck Operation;" TO-080-403, "Grab Sampling Using a Glovebag;" and TO-080-800,"Prepare and Load Hedgehog II Waste Sample Containers & Steel PIGs.")

For transfer of feed from tank AP-105 to tank AP-107:

- Waste transfer procedure for the transfer.

For TSCR operations:

- Procedure for TCSR operations (to include start up, operations, and shut down).
- Procedure for spent ion exchange column flushing and change out.
- Work package for change out of spent ion exchange columns. A work package will be prepared each time column change out is performed.

For benchmark sampling of tank AP-106:

- Work package for sampling of tank AP-106 per the TSAP. A work package will be prepared for each sampling event.
- Existing grab sampling and sample transportation procedures (TO-080-075, "Sample Transfer Truck Operation;" TO-080-403, "Grab Sampling Using a Glovebag;" and TO-080-800,"Prepare and Load Hedgehog II Waste Sample Containers & Steel PIGs.")

For transfer of pretreated feed from tank AP-106 to WTP LAW Facility:

- Waste transfer procedure for the transfer.

Supporting procedures that are required to perform this work are not listed. Supporting procedures may include surveillance, ventilation, environmental monitoring, industrial hygiene, alarm response, and abnormal operating procedures. Existing procedures may need to be revised and new procedures will need to be developed.

The 222-S Laboratory will receive feed qualification samples and perform the analyses in accordance with existing laboratory procedures and the TSAP requirements; results will be reported in a format specified by the TSAP.

B4.0 REFERENCES

RPP-13033, 2019, *Tank Farm Documented Safety Analysis*, Rev. 7L, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-PLAN-62353, *Tank 241-AP-106 Cs-137 Removal for Repurposing Process Control Plan,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

24590-LAW-RPT-PENG-16-003 / RPP-RPT-59494, 2019, *Integrated DFLAW Feed Qualification data Quality Objectives*, Rev. 1, Bechtel National, Inc. and Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-61034, 2018, *Direct Feed Low-Activity Waste (DFLAW) Feed Delivery Process Strategy*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-CHEM-C-01, "Process Flowsheets," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-CHEM-C-11, "Process Control Plans," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-CHEM-D-23, "Preparation of Tank Sampling and Analysis Plans," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-CHEM-P-13, "Tank Waste Compatibility Assessments," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-DESIGN-C-10, "Engineering Calculations," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-DESIGN-C-32, "Utility Calculation Software Management," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-FACSUP-C-04, "Tank Farms Process Memos," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-OPS-Maint-C-11, "Tank Operations Contractor Work Control," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-OPS-OPER-C-13, "Technical Procedure Control and Use," Washington River Protection Solutions, LLC, Richland, Washington.

TFC–OPS-OPER-C-49, "Development of Waste Retrieval and Transfer Operating Procedures (Including Water and Chemical Additions," Washington River Protection Solutions, LLC, Richland, Washington.

TO-080-075, "Sample Transfer Truck Operation," Washington River Protection Solutions, LLC, Richland, Washington.

TO-080-403, "Grab Sampling Using a Glovebag," Washington River Protection Solutions, LLC, Richland, Washington.

TO-080-800,"Prepare and Load Hedgehog II Waste Sample Containers & Steel PIGs," Washington River Protection Solutions, LLC, Richland, Washington.

TO-270-951, "Recirculate 241-AP-105," Washington River Protection Solutions, LLC, Richland, Washington.

TO-270-945, "Recirculate 241-AP-106," Washington River Protection Solutions, LLC, Richland, Washington.