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M-091-52 Alternative Evaluation

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
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Executive Summary

This evaluation provides a comparative analysis of alternatives to provide required capabilities for retrieval, designation, storage, and treatment/processing of Hanford Site remote-handled (RH)-transuranic mixed (TRUM) waste and TRUM waste in large containers. The information provided in this document is intended to provide the basis for development and submittal of a Tri-Party Agreement (TPA)[1] milestone change request to satisfy TPA Milestone M-091-52. It also considers the TPA Milestone M-091-48 constraint (complete off-shipment of M-091 TRUM waste to the Waste Isolation Pilot Plant (WIPP) by September 30, 2030) and the TPA Milestone M-091-49 constraint (complete retrieval and designation of retrievably stored waste [RSW] by September 30, 2028).

This evaluation was preceded by an alternative study completed in September 2016 to satisfy TPA Milestone M-091-51. The M-091-51 study[2] identified that capability gaps exist for retrieval, characterization, processing, certification, and shipping of wastes to satisfy requirements for disposing all the identified wastes and identified options for filling each capability gap. This evaluation further develops the options identified in the M-091-51 study and provides a comparative analysis to identify a preferred alternative that effectively integrates the options to fill the identified capability gaps. It results in cost and schedule estimates with identified risks for acquiring capabilities, acquiring new facilities, modifying existing facilities, and/or modifying planned facilities as required by M-091-52. The final concepts and siting for these capabilities are subject to the outcome of the DOE O 413.3B[3] critical decision process.

As part of the option development phase, consideration was given to existing on-site facilities that could potentially be retrofitted. Based on the gaps identified in the 2016

[1] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

[2] CHPRC-02916, 2016, *M-091 Engineering Alternatives Study*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland Washington.

[3] U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0413.3-BOrder-b/view.

alternative study and a team of subject-matter experts, the following options were selected for development:

- RSW Retrieval Options
  - Resume Next Generation Retrieval
  - Retrieval Using Heavy Equipment Capability
  - Retrieval Using Heavy Equipment and Box Size Reduction Capability
- Alpha Caissons Waste Retrieval and Processing Options
  - Apply 2010 Conceptual Design Retrieval Approach
  - Adapt 618-10/11 Caisson Retrieval Approach
  - Apply Mobile Hot Cell Approach
  - Apply 2010 Conceptual Design Processing Approach
- Contact-Handled (CH) Transuranic (TRU) Small Container Processing Options
  - Resume Repackaging of Noncompliant Waste in the 221-T Canyon
  - Repackaging of Noncompliant Waste in the 2706-T/TA Buildings
  - Repackaging of Noncompliant Waste at the Waste Receiving and Processing (WRAP)
  - Repackaging of Noncompliant Waste at the Maintenance and Storage Facility
- RH and Large Package Processing Options
  - Build New RH and Large Package Facility
  - Repurpose Existing Facility for RH and Large Package Processing
  - Build New Facility for Large Package Processing System
  - Build New Facility for RH-TRU Processing System
  - Repurpose WRAP for Large Package Processing System
  - Repurpose WRAP for RH-TRU Processing System
- Shipping Options
  - Build New RH-TRU 72B Loading/Shipping Facility
  - Build Weatherproof Enclosure for RH-TRU 72B Loading/Shipping Facility
  - Use Existing Facility for RH-TRU 72B Loading/Shipping Facility
  - Modify Existing Facility for TRUPACT-III
  - Establish a Movable Loading Facility for TRUPACT-III

  - Restart WRAP TRUPACT-II Loading
  - Modify WRAP for HalfPACT Loading
  - Build New HalfPACT Loading/Shipping Facility

The options were developed assuming implementation of monitored natural attenuation for high-dose waste containers. This approach maintains high-dose waste containers at the Hanford Site in a safe storage configuration to allow the high-energy radionuclides to naturally decay to a more manageable level prior to treatment and shipment of the waste for final disposition. Processing this waste at the lower dose rate in the future date will lessen the onsite and offsite impacts during final disposition by reducing the number of required RH shipments and reducing exposure to workers. Repacking the waste in its current state would significantly increase the required number of containers, would be highly time consuming and costly, and require an unrealistic number of shipments.

Options that evaluated use of existing facilities underwent a down-select process that screened candidate facilities against a set of evaluation criteria tailored to the specific need. Based on the comparison of several alternatives and the shipping evaluation, the recommended alternative must include parallel processing activities for both CH- and RH-TRU/TRUM waste to achieve the completion date for shipments of M-091 waste to WIPP by September 30, 2030. All options included certification, storage, and use of offsite commercial processing. The following options were selected:

- RSW Retrieval Option
  - Retrieval Using Heavy Equipment Capability
- Alpha Caissons Waste Retrieval and Processing Options
  - Apply Mobile Hot Cell Approach
  - Apply 2010 Conceptual Design Processing Approach
- CH-TRU Small Container Processing Option
  - Repackaging of Noncompliant Waste at WRAP
- RH and Large Package Processing Options
  - Build New Facility for Large Package Processing System
  - Build New Facility for RH-TRU Processing System

- Shipping Options
  - Establish a Movable Loading Facility for TRUPACT-III
  - Restart WRAP TRUPACT-II Loading
  - Modify WRAP for HalfPACT Loading

Under these options, completion of shipment of M-091 waste occurs by September 30, 2030.

The Rough Order of Magnitude Total Estimated Cost through completion of activities within the scope of the recommended alternative, including M-091 and non-M-091 activities, is ~$1.7 billion (burdened, un-escalated) or $2 billion (burdened, escalated). The cost estimate range is -50% to +100% based on the maturity of the technical input.

The cost estimates do not include potential costs associated with retrieval and disposition of collocated Classified Waste. The process to determine the scope, cost, and schedule for addressing these wastes are identified and should be expedited to avoid future impact to planning and execution of activities for retrieval, characterization, processing/treatment, certification, storage, and shipping of the M-091 waste within schedule.

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Terms

ACWPS	Alpha Caissons Waste Processing System
AMWTP	Advanced Mixed Waste Treatment Plant
CBFO	U.S. Department of Energy, Carlsbad Field Office
CCP	Central Characterization Program
CD	critical decision
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CH	contact-handled
CWC	Central Waste Complex
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operation Office
DOT	U.S. Department of Transportation
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FHGA	flammable head gas analysis
FY	fiscal year
INL	Idaho National Laboratory
LLBG	low-level burial ground
LLW	low-level waste
LPPS	Large Package Processing System
LSA	low-specific activity
MASF	Maintenance and Storage Facility
MDSA	master documented safety analysis
MHC	Mobile Hot Cell
MLLW	mixed low-level waste
MLU	mobile loading unit
MNA	monitored natural attenuation
MWDT	Mixed Waste Disposal Trench
NCW	nonconforming waste

NDA	nondestructive assay
NDE	nondestructive examination
NRC	U.S. Nuclear Regulatory Commission
PFNW	Perma-Fix Northwest
RCRA	*Resource Conservation and Recovery Act of 1976*
RH	remote-handled
RH-72B	RH-TRU 72B (cask)
RLC	removable lid canister
ROM	rough order of magnitude
RPS	RH-TRU Processing System
RSW	retrievably stored waste
SLB2	standard large box 2
SNM	special nuclear material
SPA	special packaging arrangement
STC	shielded transfer container
SWB	standard waste box
SWOC	Solid Waste Operations Complex
TPA	Tri-Party Agreement; *Hanford Federal Facility Agreement and Consent Order*
TRAMPAC	Authorized Methods for Payload Control
TRU	Transuranic
TRUM	transuranic mixed
TRUPACT-II	Transuranic Package Transporter-II
TRUPACT-III	Transuranic Package Transporter-III
WIPP	Waste Isolation Pilot Plant
WPS	waste processing system
WRAP	Waste Receiving and Processing (Facility)
WRS	waste retrieval system

1 Introduction

An alternative evaluation was completed to provide required capabilities for retrieval, designation, storage, and treatment/processing prior to disposal of Hanford Site remote-handled (RH)-transuranic mixed (TRUM) waste and TRUM waste in large containers (in aboveground storage as of June 30, 2009, and in retrievable storage). The purpose of the evaluation was to provide the basis for development and submittal of a Tri-Party Agreement (TPA) (Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*) milestone change request required to satisfy TPA Milestone M-091-52.

This document provides a description of the alternative evaluation. The results of the alternative evaluation are identified, including the estimated cost, schedule, and risks for the recommended alternative.

1.1 Background

The TPA is a legal agreement between the Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE). The TPA identifies cleanup actions and schedules, referred to as milestones.

In January 2016, an agreement finalized the realignment of several TPA M-091 milestones. The goal of this agreement was to align the M-091 milestones with anticipated funding for Hanford Site cleanup activities and the anticipated schedule for reopening the Waste Isolation Pilot Plant (WIPP). The agreement also recognized that DOE does not have the capabilities necessary to complete the M-091 milestones (to complete retrieval and eliminate the backlog of Hanford Site mixed low-level waste [MLLW] and TRUM waste in storage), and included a new set of milestones to provide DOE with the needed capabilities. These milestones are described below.

- M-091-51, due September 30, 2016: Submit to Ecology, as a secondary document, an engineering alternatives study for acquisition of capabilities and/or acquisition of new facilities, modifications of existing facilities, and/or modification of planned facilities necessary for retrieval, designation, storage, and treatment/processing prior to disposal of all Hanford Site RH-TRUM waste and TRUM waste in large containers (in aboveground storage as of June 30, 2009 and in retrievable storage).
- M-091-52, due September 30, 2017: Submit a milestone change request with target dates (including a completion date) for acquisition of capabilities and/or acquisition of new facilities, modification of existing facilities, and/or modification of planned facilities necessary for retrieval, designation, storage, and treatment/processing prior to disposal of all Hanford Site RH-TRUM waste and TRUM waste in large containers (in aboveground storage as of June 30, 2009 and in retrievable storage).
- M-091-53, due September 30, 2018: Submit a milestone change request to replace the target milestones established in M-091-52 with annual milestones (including a completion date) for acquisition of capabilities and/or acquisition of new facilities, modification of existing facilities, and/or modification of planned facilities necessary for retrieval, designation, storage, and treatment/processing prior to disposal of all Hanford Site RH-TRUM waste and TRUM waste in large containers (in aboveground storage as of June 30, 2009 and in retrievable storage).

An alternatives study was completed in September 2016 to satisfy the commitment for the first milestone in this new sequence, M-091-51. The study, which is documented in CHPRC-02916, *M-091 Engineering Alternatives Study*, identified that capability gaps exist for retrieval, characterization, processing, certification, and shipping of wastes to satisfy requirements for disposing all the identified wastes and identified options for filling each capability gap. The study did not develop or evaluate the options.

Additional evaluation was needed to provide an adequate basis for preparation and submittal of the change package required to satisfy the commitment for the second milestone in the new sequence, M-091-52. The evaluation was necessary to further develop the options identified in the M-091-51 study and provide a comparative analysis to identify a preferred alternative that effectively integrates the options to fill the capability gaps for retrieval, characterization, processing, certification, and shipping of the identified wastes. The evaluation resulted in cost and schedule estimates with identified risks for acquiring capabilities and/or acquiring new facilities, modifying existing facilities, and/or modifying planned facilities as required by M-091-52.

1.2 Purpose

The primary purpose of the alternative evaluation was to provide the basis for preparation and submittal of the change package required to satisfy TPA Milestone M-091-52. A secondary purpose for this evaluation was to provide technical scope, cost, and schedule information for update and maintenance of life-cycle planning for activities related to retrieval, characterization, processing, certification, storage, and shipment for disposal of wastes within the scope of the evaluation.

To satisfy this purpose, the recommended alternative was required to support the following TPA milestone commitments:

- M-091-48 by September 30, 2030
  - Complete the offsite shipment of all TRUM waste (in aboveground storage as of June 30, 2009 and in retrievable storage) by September 30, 2030.
- M-091-49 by September 30, 2028
  - Complete the retrieval and designation of RH retrievably stored waste (RSW) (includes the 200 Area caissons).
  - Complete the retrieval and designation of CH RSW in burial grounds 218-W-4B, 218-W-3A, and 218-E-12B.

The 200 Area caissons are defined by M-091-09-01, *Federal Facility Agreement and Consent Order Change Control Form, Modification of Hanford Federal Facility Agreement and Consent Order (HFFACO) M-091 Series Milestones*, as the alpha caissons.

The results of the evaluation were also intended to be used to support development of DOE O 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, Critical Decision (CD)-0, which is required to approve the mission need for acquisition of Capital Asset Projects identified within the evaluation. The range of integrated alternatives within the evaluation address the potential range of alternatives that are anticipated to be required to be evaluated during the CD-1 phase of DOE O 413.3B, except for a no action alternative, to minimize potential for future changes caused by formal alternative selection during CD-1 approval, where applicable. Formal alternative selection will be performed after CD-0 approval, where applicable, per the requirements of DOE O 413.3B.

1.3 Scope

The scope of the evaluation included development and comparison of integrated alternatives for filling capability gaps that exist for retrieval, characterization, processing, certification, and shipping of wastes to satisfy requirements for disposing all the identified wastes, based on options identified in the M-091-51 study (CHPRC-02916). The evaluation identified a preferred alternative, including cost and schedule

estimates with identified risks, from the results of the comparative analysis to provide the basis for preparation and submittal of the change package required to satisfy M-091-52.

The scope of the waste inventories addressed within the evaluation were limited to those identified from the results of the M-091-51 study, which evaluated the needed capabilities for all waste that is currently in or anticipated to be stored at the Hanford Site Solid Waste Operations Complex (SWOC). Some of the included waste inventories are not within the scope of the M-091 milestones. DOE had determined that the best path forward was to evaluate all needed capabilities within the M-091-51 study, rather than only those necessary to address the M-091 milestones to eliminate the need for separate or parallel studies. The results of the evaluation delineate scope, cost, and schedule for satisfying TPA commitments for the M-091-52 waste inventories.

The cost estimates provided in the evaluation included only Hanford Site costs for:

- Acquiring capabilities to retrieve, characterize, process, certify, store, and ship the waste inventories within the scope of this evaluation
- Activities to startup, demonstrate readiness, and perform operations and maintenance to provide WIPP certifiable contact-handled (CH)-transuranic (TRU)/TRUM and RH-TRU/TRUM waste packages from these waste inventories
- Disposition of low-level waste (LLW)/MLLW from these waste inventories; and decontamination and decommission of systems and facilities acquired to retrieve, characterize, process, certify, store, and ship these waste inventories

The estimates did not include costs to offsite programs, such as:

- Acquisition or maintenance of shipping casks
- Activities within the responsibility of the DOE Carlsbad Field Office (CBFO) Central Characterization Program (CCP) for providing WIPP certification equipment, performing certification, or providing mobile loading unit (MLU) support for cask shipping operations
- Transport of wastes to WIPP and disposal of the wastes

This evaluation, however, did identify the need dates for equipment and services provided by offsite programs.

1.4 Methodology

The evaluation was the second of a two-part process to develop and compare alternatives and provide the required cost and schedule information with identified risks. The initial phase was completed as part of the M-091-51 study (CHPRC-02916) and included identification of requirements, identification of existing and legacy capabilities to manage the waste within the scope of the study, identification of alternatives to address capability gaps, and strategies for acquisition of capabilities.

The following approach was then used to complete the evaluation required to support development of the M-091-52 Change Package:

- Options identified in the M-091-51 study were developed to satisfy capability gaps. Existing on-site facilities that could potentially be retrofitted for CH-TRU or RH-TRU waste processing or loading/unloading of RH-TRU shipping casks were identified and down-selected based on the

approach used in PRC-STP-00728, *K Basins Sludge Treatment Project Phase 2 — Preliminary STPF Siting Study*.

- Cost and schedule estimates were developed for acquisition and operation of the facility/capability and to provide information for comparative analysis of the options. A comparative analysis of options providing the same functional capabilities (e.g., RH-TRU unloading/loading capability) was then performed to down-select options for inclusion within integrated alternatives.
- A set of integrated alternatives were developed for comparative analysis. An "integrated alternative" is a combination of options necessary to fill all capability gaps as required to satisfy the requirements of M-091-52 for the waste inventories within the scope of this evaluation, including retrieval, characterization, processing, storage, certification, and shipping.
- A comparison of integrated alternatives was completed based on specific weighted selection criteria, including consideration of risks. Conclusions and recommendations were developed based on the comparative analysis.

1.5 Key Assumptions

The following key assumptions were made for development of alternatives in the evaluation:

- Annual funding is available consistent with the estimated costs in order to satisfy identified schedules.
- Monitored natural attenuation (MNA) will be approved for the waste packages containing >100 Ci of cesium-137 (Cs-137). These waste packages will not require retrieval, characterization, treatment, certification, relocation, or shipment to satisfy requirements for TPA Milestone M-091-52.
- The approved permitting strategy will include the following elements:
  - The *Resource Conservation and Recovery Act of 1976* (RCRA) permit application may be submitted to Ecology after preparation of preliminary (90%) design. Permitting approvals will occur within required schedules and will not delay start of construction and/or operation.
  - Low-level burial ground (LLBG) retrieval activities will be executed under *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) authority. Separate CERCLA actions will be prepared for alpha caissons retrieval and for retrieval of the other TRU/TRUM waste. No additional physical controls or requirements will be required than existed for Next Generation Phase 1 operations performed in 2010 and 2011.
- WIPP will be available to receive wastes within identified schedules and without restrictions from shipments by other sites. WIPP will be able to receive a total of 12 full shipments per week of Transuranic Package Transporter-IIs (TRUPACT-IIs) and HalfPACT casks from the Hanford Site for 40 weeks/year. Alternatively, WIPP will be able to receive up to 12 full shipments per week of TRUPACT-IIs and or RH-TRU 72B (RH 72B) casks (which includes a maximum of 6 RH 72B cask shipments/week) for 40 weeks/year. CBFO will provide the requisite number of casks (and supporting equipment) to satisfy the identified schedules and will perform WIPP shipments at no cost to the U.S. Department of Energy, Richland Operations Office (DOE-RL).
- The CBFO CCP will provide sufficient personnel and nondestructive assay (NDA) and nondestructive examination (NDE) equipment (except NDA/NDE equipment for RH-TRU/TRUM waste certification) to support identified schedules for certification. CCP will be responsible for sample analyses required to support waste certification. Certification of waste streams will be

completed within 1.5-yr durations by CCP. Certification activities will be completed in sufficient time to enable final shipments of M-091 CH-TRUM and RH-TRUM to WIPP to be completed within 3 months of completing final M-091 CH-TRUM and RH-TRUM processing, respectively. Costs for offsite activities (WIPP shipments and operations), CCP activities, and CCP-provided equipment will not be included in M-091-52 cost estimates. Sample analyses required to satisfy requirements for certification of wastes, including acceptable knowledge, basis of knowledge, chemical compatibility evaluation, and dose-to-curie are the responsibility of CCP.

- Existing WIPP certified/certifiable drums in storage at the Central Waste Complex (CWC) will not require repackaging.
- Identified existing/legacy facilities and infrastructure will be available to support the M-091-52 alternatives identified in this document. Current infrastructure (e.g., roads, utilities, and security) will be maintained by others.
- DOE approval of all safety basis documents will be obtained within 120 days of submittal. Reviews will be prioritized to achieve completion of the review and issuance of associated documentation (conceptual safety validation report, preliminary safety validation report, and safety evaluation reports) within 90 days where necessary to achieve schedules within this evaluation. Safety basis documents required to support CD-1, CD-2, and CD-3 (i.e., conceptual safety design reports, preliminary safety design reports, and preliminary documented safety analyses) do not require approval prior to submittal of the respective CD-1, CD-2, and CD-3 package to DOE.
- The DOE O 413.3B process will be implemented as follows:
  - Acquisition of capabilities for retrieval and treatment will be conducted under separate Capital Acquisition Projects, rather than a single Capital Acquisition Project, because of independent functionality and scope.
  - CD-0 approval will be received within 1 year after submittal.
  - CD-1, CD-2, and CD-3 approvals will be received within 3 months from DOE approval of the safety basis documents required for the respective CD phase (and no longer than a maximum of 5 months from submittal of CD package for approval) for projects with the Total Project Cost within the cost estimate range of >$10 million and <$100 million.
  - CD-1, CD-2, and CD-3 approvals will be received within 6 months from DOE approval of the safety basis documents required for the respective CD phase (and no longer than a maximum of 8 months from submittal of CD package for approval) for projects with the total project cost >$100 million.
  - CD-4 will be received within 2 months for approval after completion of a DOE Operational Readiness Review.
- Any new facility will be classified as a Hazard Category 2 facility with Performance Category 2 natural phenomena hazards criteria and Seismic Design Category 2 criteria unless analyses demonstrate that a lesser category applies.
- Perma-Fix Northwest (PFNW) will remain available to support processing at current throughput rates. Increased throughput rates may be achieved through implementation of additional work shifts and/or additional processing lines. A license amendment is achievable to increase the candidate packages for

processing at PFNW from a current limit of 200 g/package to up to 1,000 g/package, excluding limitations because of shipping requirements.

- Changes to the DOE exemption will be accepted as necessary to enable shipment of identified candidate packages to PFNW. The DOE exemption limits container types and destinations for shipments south of Horn Rapids Road.
- A sufficient number of federal drivers will be available to support PFNW processing schedules.
- The *Solid Waste Operations Complex Master Documented Safety Analysis* (HNF-14741) (MDSA) will remain in place. Current requirements for waste package transfers within the MDSA will remain in place.

1.6 Waste Inventories

The waste inventories within the scope of the M-091-52 alternative evaluation were based on those documented in CHPRC-02999, *M-091 Engineering Alternative Study: Basis for Waste Quantities and Volumes*. Changes from the waste volume and container counts documented in CHPRC-02999 resulted primarily from maturation of the options. These changes are summarized as follows:

- PFNW waste container counts and volumes were changed to reflect processing of large packages instead of drums and standard waste boxes (SWBs). The M-091-51 study (CHPRC-02916) assumed all TRUM/TRU retrievably stored waste would require processing. This resulted in nearly 4,750 drums being sent to PFNW. Additionally, the M-091-51 study assumed 900 drums and four SWBs in aboveground storage would be processed at PFNW. The M-091-52 alternative evaluation instead assumed processing of large packages at PFNW based on the results of a more detailed review of individual packages by PFNW subject-matter experts. The packages reviewed were from the "Resolve WAC Issues" and the "Requires additional processing capabilities" inventories identified in the M-091-51 study. This enabled better utilization of PFNW capability.
- The review of eligible containers for PFNW processing identified nine RH-TRUM large containers that could likely be processed at PFNW. The product from processing these containers is assumed to be CH-TRUM. These containers were removed from the feed to the RH-TRU Processing System (RPS).
- Processing at PFNW is on-going. M-091-52 values reflect changes based on processing subsequent to the M-091-51 study.
- Original options for CH small container processing involved restart of T Plant and Waste Receiving and Processing (WRAP) repackaging systems in addition to use of PFNW. A review of the status of the existing/legacy systems and project needs resulted in new small container options capable of processing all CH drums, SWBs, and certain other packages <1.8 m^3. None of the small containers are processed at PFNW in the M-091-52 alternative evaluation.
- The total amount of CH waste to be processed increased by 400 m^3 based on the need to repackage previous certifiable drums and SWBs from dropout during certification.
- To optimize utilization of the capabilities provided at each facility in order to meet the TPA M-091-48 milestone date, some waste containers were re-allocated to other facilities for processing. This included 140 drums (16 m^3) transferred from the RPS to the Alpha Caissons Waste Processing System (ACWPS). Because of the extra capacity, all CH small containers were re-allocated to the small container processing capability.

- The volume of non-M-91 waste processing decreased by ~200 m^3. This is attributed to removal of Trench 218-W-4C containers from the M-091-52 values, consistent with the CHPRC-02999 discussion, and addition of one container to the candidate MNA list that was inadvertently left out of the M-091-51 values.
- Waste product container counts and shipment values in the M-091-52 alternative evaluation are based on use of SWBs for CH-TRUM/TRU waste processing product.
- Waste product container counts and shipment values in the M-091-52 alternative evaluation for the recommended alternative are based on use of Half Transuranic Package Transporter Model (HalfPACT) casks only for RH-TRUM/TRU waste.

2 Development of Options

The results of the M-091-51 study were used as the starting point for identification of options for development within the evaluation. Adjustments to the M-091-51 study options were made based on review of existing/legacy facility capabilities and input received from WIPP and other DOE sites where TRUM waste is retrieved and prepared for shipment to WIPP. This section identifies the final options remaining in the M-091-52 alternative evaluation.

2.1 Identification of Options for Evaluation

Following are the final options considered for evaluation:

- RSW Retrieval Options
  - Resume Next Generation Retrieval
  - Retrieval Using Heavy Equipment Capability
  - Retrieval Using Heavy Equipment and Box Size Reduction Capability
- Alpha Caissons Waste Retrieval and Processing Options
  - Apply 2010 Conceptual Design Retrieval Approach
  - Adapt 618-10/11 Caisson Retrieval Approach
  - Apply Mobile Hot Cell Approach
  - Apply 2010 Conceptual Design Processing Approach
- CH-TRU Small Container Processing Options
  - Resume Repackaging of Noncompliant Waste in the 221-T Canyon
  - Repackaging of Noncompliant Waste in the 2706-T/TA Buildings
  - Repackaging of Noncompliant Waste at WRAP
  - Repackaging of Noncompliant Waste at the Maintenance and Storage Facility

- Commercial Repackaging Options
  - Continue Processing at PFNW under Existing License
  - Process at PFNW under Expanded License
- RH and Large Package Processing Options
  - Build New RH and Large Package Facility
  - Repurpose Existing Facility for RH and Large Package Processing
  - Build New Facility for Large Package Processing System
  - Build New Facility for RH-TRU Processing System
  - Repurpose WRAP for Large Package Processing System
  - Repurpose WRAP for RH-TRU Processing System
- Shipping Options
  - Build New RH-TRU 72B Loading/Shipping Facility
  - Build Weatherproof Enclosure for RH-TRU 72B Loading/Shipping Facility
  - Use Existing Facility for RH-TRU 72B Loading/Shipping Facility
  - Modify Existing Facility for TRUPACT-III
  - Establish a Movable Loading Facility for TRUPACT-III
  - Restart WRAP TRUPACT-II Loading
  - Modify WRAP for HalfPACT Loading
  - Build New HalfPACT Loading/Shipping Facility
- Storage Option
  - Develop Contingency Mixed-Waste Storage Area
- Certification Option
  - Certification

The logical ties between the options are depicted in the options flow path diagram shown in Figure 1. The diagram provides a basis for later option comparison and development of integrated alternatives.

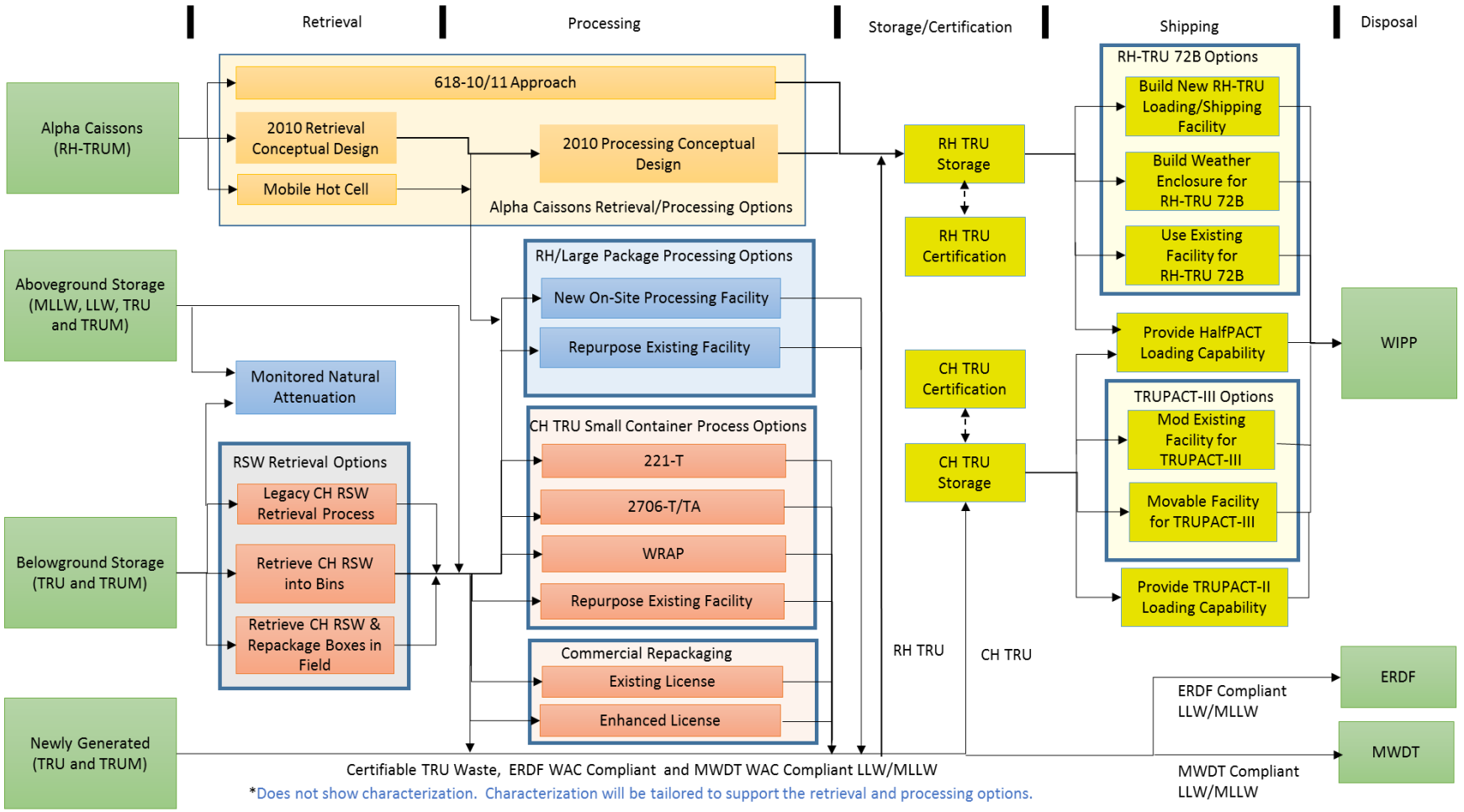

Figure 1. Options Flow Diagram

2.2 Down-Selection of Existing Facilities Options for Further Development

Several options included a review of existing facilities. A down-select process was used to identify which facilities should be considered for options to repurpose existing/legacy facilities at the Hanford Site specifically for use in CH Processing, RH and Large Package Processing, and RH-TRU 72-B Loading/Shipping Facility options. The following candidate facilities were screened and scored against a set of evaluation criteria tailored to the specific processing or shipping capability need to select the existing/legacy facility to use for CH Processing, RH and Large Package Processing, and RH-TRU 72-B Loading/Shipping Facility options:

- 221-B (B Plant)
- 212-H Canister Storage Building
- 222-S Laboratory
- 142-K Cold Vacuum Drying Facility
- 242-A Evaporator
- 242-S Evaporator
- 427 Fuels and Materials Examination Facility
- 224-B Facility
- 224-T Facility
- Plutonium Finishing Plant
- 231-Z Plutonium Metallurgy Laboratory
- 202-A Plutonium-Uranium Redox Extraction Plant
- 325 Building
- 204 AR Unloading Facility
- 202-S Reduction-Oxidation Plant
- 221-T (T Plant)
- 221-U Plant
- 225-B Waste Encapsulation and Storage Facility
- 2336-W WRAP Facility
- 6226 Waste Sampling and Characterization Facility
- 324 Building
- 437 Maintenance and Storage Facility (MASF)
- KW Basin Annex
- 405 Fast Flux Test Facility Reactor Containment Building/4717 Reactor Service Building
- 2706-T Equipment Decontamination Building/2706-TA Equipment Decontamination Annex

The outcome of the down-select process resulted in identification of the following existing/legacy facility options to be included within the alternative evaluation:

- Use MASF as an option for repackaging noncompliant waste in small containers, which is developed in the Repackaging of Noncompliant Waste at the Maintenance and Storage Facility option.
- Use WRAP as the existing facility option for RH and large package processing options, which is developed in the **Repurpose Existing Facility for RH and Large Package Processing**; **Repurpose**

WRAP for RH-TRU Processing System; and **Repurpose WRAP for RH-TRU Processing System** options.

- Use MASF for existing facility option for RH 72B cask loading facility, which is developed in the **Use Existing Facility for RH-TRU 72B Loading/Shipping Facility** option.

Note that other existing/legacy facilities were already included for processing CH-TRU/TRUM waste in small containers at 271-T, 2706-T/2706-TA, and the WRAP Facility.

2.3 Monitored Natural Attenuation

The options were developed assuming implementation of the MNA approach. This approach maintains high-dose waste containers at the Hanford Site in a safe storage configuration to allow the high-energy radionuclides to naturally decay to a more manageable level prior to treatment and shipment of the waste for final disposition. Processing this waste at the lower dose rate in the future date will lessen the impact to WIPP and the Hanford Site by reducing the number of required of RH shipments and reducing exposure to workers. Repacking the waste in its current state would significantly increase the required number of containers, would be highly time consuming and costly, and require an unrealistic number of shipments.

The options for processing RH-TRU waste were developed to handle up to 100 Ci of Cs-137. The highest radioactive MNA candidate contains up to 120,000 Ci of Cs-137. To sufficiently shield this amount of gamma radiation would require substantial additional shielding at increased cost to process <10% of the initial volume RH waste in the scope of this project.

As importantly, generated containers after repackaging at the elevated dose rate would require a significant number of containers (>500,000), which would be unachievable to produce or ship by 2030 for waste within the scope of M-091.

The needed space at WIPP would also be an issue for these waste packages. The repackage containers would require more than twice the remaining space at WIPP and would dramatically exceed the remaining amount of available borehole space if shipped in removable lid canisters (RLCs). RLCs are a WIPP waste container shipped in a RH 72B cask.

The cost, resources, and manpower required to achieve the processing, packaging, and shipping necessary would have a significant impact on the overall management of the project. Excluding these containers would increase the success of both M-091 and non-M-091.

2.4 Shipment to Advanced Mixed Waste Treatment Plant for Processing

The Advanced Mixed Waste Treatment Plant (AMWTP) at the Idaho National Laboratory (INL) has the capabilities to process CH-TRU and TRUM containers into a WIPP-certifiable form. The AMWTP is scheduled to complete its mission in 2019 and at that time would then be available to process Hanford Site waste.

Processing Hanford Site waste at the AMWTP would have some significant advantages. It would potentially reduce the need to provide new processing capabilities at the Hanford Site. The AMWTP is a capable facility with an experienced staff, and processing Hanford Site waste would use an existing capability within the DOE Complex.

The DOE has formed an Integrated Project Team to pursue the option of processing Hanford Site CH-TRU and TRUM waste at the AMWTP. The ability to process a significant amount of waste at the AMWTP is dependent upon DOE's ability to develop and implement packaging and transportation requirements that

support the shipment of waste from the Hanford Site to the AMWTP. These requirements will require regulatory agency approvals and input from the stakeholders.

All waste to be shipped to AMWTP must be fully U.S. Department of Transportation (DOT)-compliant unless an exemption from DOE O 460.1C, *Packaging and Transportation Safety*, is provided by the DOE-Headquarters Office of Packaging and Transportation based on demonstration of equivalent safety. The exemption would need to authorize out-of-commerce shipments of contaminated equipment and retrieved packages from the Hanford Site to AMWTP.

The U.S. Nuclear Regulatory Commission (NRC), under Title 10 of the *Code of Federal Regulations*, also governs shipments of TRU and TRUM waste. Currently, the only approved compliant method to ship TRU and TRUM waste from the Hanford Site to the AMWTP is in a Type B container. Requirements for Type B containers are identified in the certificates of compliance and in the applicable TRUPACT-II Authorized Methods for Payload Control (TRAMPAC) documents. Specific requirements for the waste package and waste form include the following: no liquids (unless residual after draining), pressurized containers, sealed containers >4 L, and pyrophoric materials. Compliance with these requirements would eliminate the ability to ship any significant amount of waste to the AMWTP under the currently approved compliant method.

In 2010 and 2011, ~950 drums (55 gal each) were shipped from the Hanford Site to AMWTP for treatment. These drums had been overpacked into 85 gal drums due to concerns regarding the structural integrity of the 55 gal drums. None of the 55 gal drums contained prohibited items (e.g., liquids, pressurized containers, and sealed containers >4 L).

Shipment of the drums to the AMWTP avoided the need to process these drums at the Hanford Site. The AMWTP placed the waste into a WIPP-certifiable configuration and ensured that the final waste package complied with transportation requirements and the WIPP waste acceptance criteria (DOE/WIPP-02-3122).

While the 2010/2011 shipment campaign to AMWTP was successful, there is a small number of containers that remain at the Hanford Site that could be shipped under a similar approach. Only CH drums or SWBs that do not contain any prohibited items could be considered.

DOE's Integrated Project Team are considering the following strategies to enable the shipment of a larger quantity of Hanford Site CH-TRU and TRUM waste to the AMWTP for processing:

- Revisions to certificates of compliance and TRAMPAC documents for TRUPACT-II, and Transuranic Package Transporter-III (TRUPACT-III), HalfPACT, and/or 10-160B Type B packaging to enable shipment of as many types of prohibited items (e.g., liquids and sealed containers >4 L) as possible.
- Easing the waste characterization requirements in the TRAMPAC documents. The rigor of the characterization performed on waste shipped to Idaho during the 2010/2011 campaign was almost as comprehensive as if the waste were to be shipped to WIPP. Protocols for shipping the waste would need to be reviewed and modified to reflect changes to the requirements.
- Relief from Clause 1.8.3.4 of the Agreed Order (Ecology, 2014), which requires nonconforming waste (NCW) to be characterized and dispositioned (i.e., opening drums and removing the NCW items).

In addition, the Integrated Project Team is assessing the value of pursuing approval of using non-NRC approved packaging for TRU and TRUM waste (e.g., Type A packaging) when consistent with DOT requirements. Only a small quantity of containers has been identified that meets the definition of DOT low-specific activity (LSA I or II) or surface-contaminated objects.

The alternative evaluation identified shipment of wastes to AMWTP as an opportunity. Implementation of this opportunity depends on the outcome of the DOE review and, therefore, is not currently considered an option.

3 Summary of Options

The options identified in Chapter 2 were further developed as summarized in this Chapter. Cost and schedule estimates were generated for each option and a comparative analysis was conducted to down-select options for further consideration within integrated alternatives.

The comparative analysis considered performance of each option against the following attributes: cost; schedule; regulatory; safety; reliability, operability, and maintainability; and uncertainty and/or risks. The preferred option is included in the evaluation of the integrated alternatives.

3.1 RSW Retrieval Options

The purpose of retrieval is to remove TRU and TRUM waste from its current belowground storage location so it can be characterized, processed as required, certified for acceptance at a disposal location, and shipped to its final disposal location. TRU and TRUM waste within the scope of this evaluation is currently located in the 218-W-3A, 218-W-4B, and 218-E-12B LLBGs.

The scope of the work is the retrieval and characterization of post 1970 suspect TRU retrievably stored in the 218-W-3A, 218-W-4B, and 218-E-12B LLBGs. RSW retrieval at the 218-W-4C LLBG has been completed. Areas where a few RSW containers are comingled with non-RSW located in the 218-W-3A LLBG will not be retrieved, reducing retrieval in that LLBG to trenches 4, 5, 6, 8, and S9. The retrieval of the remaining RSW containers will be completed during remediation of the rest of the LLBG.

The options evaluated for RSW retrieval are described below.

- **Resume Next Generation Retrieval**, which would have the capability to retrieve drums and boxes/other containers of waste using hands-on methods and characterize drums of waste consistent with the Next Generation process retrieval. Each RSW container would be removed then placed in an overpack. Drums are characterized using NDA and NDE. The waste is then packaged for delivery to an appropriate storage, processing, and disposal capability.

- **Retrieval Using Heavy Equipment Capability**, which would have the capability to retrieve waste using heavy equipment consistent with 618-10 remediation and characterize retrieved waste drums and small boxes/other containers consistent with Next Generation process. Large retrieved boxes would be managed consistent with Next Generation process methods. Each retrieved drum or small box will be placed in a bin or bag (bin/bag) sized to fit in an SWB. Each bin/bag is characterized using NDA and NDE. The waste is then packaged for delivery to an appropriate storage, processing, and disposal capability.

- **Retrieval Using Heavy Equipment and Box Size Reduction Capability**, which would be have capability to retrieve waste using heavy equipment consistent with 618-10 remediation, size reduce large boxes, and characterize all retrieved waste consistent with Next Generation process. Each RSW drum or box would be removed, large boxes size reduced, then retrieved waste placed in a bin/bag sized to fit in a SWB. Each bin/bag is characterized using NDA and NDE. The waste is then packaged for delivery to an appropriate storage, processing, and disposal capability.

The waste is in belowground storage in containers of various sizes. The waste consists primarily of debris material such as paper, plastic, tools, equipment, filters, and personal protective equipment with small

quantities of containerized liquids, aerosol cans, and lead shielding. Large equipment is often found in boxes. A small quantity of RH waste exists in the LLBGs.

About 1,000 drums of collocated waste are subject to the classified TRU waste disposition process. The process for determining the disposition requirements for these wastes is identified in 06-AMCP-0056, "Contract No. DE-AC06-96RL13200 – Process Guidance for Shipment of Classified Transuranic (TRU) Waste to the Waste Isolation Pilot Plant (WIPP)". The cost and schedule impacts for addressing these wastes and potential impacts to retrieval activities requires completion of a security analysis using the identified process.

Comparative analysis identified that the **Retrieval Using Heavy Equipment Capability** option had the best overall safety, schedule, and cost performance. Based on these results, this was identified for use in all integrated alternatives. The remaining RSW Retrieval options were not considered further in the evaluation.

3.2 Alpha Caissons Retrieval and Processing Options

Additional capability is needed to retrieve and process ~23 m^3 of RH waste currently in the alpha caissons located in Trench 14 of the 218-W-4B LLBG prior to shipment of the processed waste to WIPP. The alternative evaluation developed and compared the following three options to address retrieval of the alpha caissons waste.

- The **Apply 2010 Conceptual Design Approach** option was developed based on the concept developed in 2010 for alpha caissons retrieval that is documented in CHPRC-00492, *Conceptual Design Report – Alpha Caisson Waste Retrieval Project*, and the follow-on preliminary design work documented in G-100-001, *WRS 30% Review Drawings*. The conceptual design was the product of a value engineering study that examined technologies used in France for modular facility container retrieval and immediate processing at the retrieval site, as well as lessons learned from other sites such as INL and Oak Ridge National Laboratory. The earlier work was updated to reflect use of alternate retrieval equipment and adjustment of the retrieval cell size based on the new equipment requirements. This option builds a new mobile waste retrieval system for alpha caissons waste. The structure will support the retrieval of highly radioactive waste contained in the alpha caissons. A remotely operated telescopic manipulator arm will be used to extract waste items from the top of the alpha caisson and place them into a drum liner assembly. Once filled, the liner assembly will be loaded into a shielded transfer container (STC), if the dose rate is not too high based on the results of a gamma scan.

- The **Adapt 618-10/11 Caisson Retrieval Approach** option adapts the retrieval strategy developed for the 618-11 Burial Ground caissons (based on work performed at the 618-10 Burial Ground) for application to the alpha caissons. The overall process used here includes grouting the waste contents of the caisson, shortening the disposal chute of the caisson, installing an overcasing around the caisson, augering the waste until all the containers are breached and a mix has been made, and finally placing a retrieval enclosure over the caisson. The resulting mix would then be remotely retrieved from the caisson and placed into drums within the enclosure. The drums would be placed into STCs and moved to the STC staging area via forklift. Augering of the waste is meant to stabilize the waste within the alpha caisson to make it more readily handled. "Stabilize" in these terms means that the mixing process of the waste with surrounding dirt will result in all waste containers being breached and reduced in size, liquids mixed with the soil, and sufficient oxygen introduced to react with any strong reactants. Retrieval activities would conclude when the waste mix is completely retrieved from the caisson.

- The **Apply Mobile Hot Cell Approach** option uses Mobile Hot Cell (MHC) technology proven to perform retrieval, characterization, and processing of waste at the Marcoule Site in France to perform alpha caissons waste retrieval. The option is similar to the **Apply 2010 Conceptual Design Retrieval Approach**, but results in different configuration for the hot cell structure.

These options assume that the M-091 retrieval milestones and commitments will be satisfied for alpha caissons when all suspect TRU waste items and debris, to the extent possible using the available equipment, has been retrieved from each of the four caissons containing waste.

The alternative evaluation also developed an alpha caissons waste processing option, as described below.

- The **Apply 2010 Conceptual Design Processing Approach** option builds a new mobile waste processing system (WPS) for alpha caissons waste. The structure will support the processing of the highly radioactive waste contained in the four alpha caissons located in Trench 14 of 218-W-4B LLBG. The WPS provides characterization and repackaging capabilities with the purpose of producing 30 gal drums containing alpha caissons waste that can be certified for shipment and disposal at WIPP. The WPS uses design principles and equipment used in other RH hot cells, such as the MHCs at the Marcoule Site in France and lessons learned from RH processing operations conducted at other DOE sites. This facility would be receiving STCs filled with 30 gal drums loaded with retrieved waste items from the alpha caissons and processing them into WIPP certifiable RH 30 gal drums for interim storage and shipment to WIPP. This option was developed based on the 2010 conceptual design documented in CHPRC-00492, including changes to the design covered in WPS-ACWRP-3003474, *Engineering Report – Waste Processing System Status of Design Activities at Project Suspension*.

Alternatively, RPS options may process alpha caissons waste received as output from either the **Apply 2010 Conceptual Design Approach** option or the **Apply Mobile Hot Cell Approach** option in addition to other RH-TRU waste inventories.

The results of the comparative analysis down-selected the **Apply Mobile Hot Cell Approach** option for use in all integrated alternatives for alpha caissons retrieval, based on overall viability, cost, and operability. The **Adapt 618-10/11 Caisson Retrieval Approach** option was eliminated from further consideration as an alpha caisson retrieval option prior to the comparative analysis because of significant challenges related to nuclear and criticality safety; potential impacts to compliance with revised WIPP waste acceptance criteria (DOE/WIPP-02-3122); and additional complexity caused by differences between the alpha caissons and 618-11 caissons structures. The results of the analysis identified that integrated alternatives should be structured to provide a comparison of the **Apply 2010 Conceptual Design Processing Approach** with an option containing the RPS to potentially eliminate duplicate capabilities for RH processing.

3.3 CH-TRU Small Container Processing Options

The following options were developed for processing of the CH-TRU/TRUM small containers on the Hanford Site.

- The **Resume Repackaging of Noncompliant Waste in the 221-T Canyon** option replaces and restarts the repackaging capability used in past campaigns in the 221-T Canyon. This capability will support the repackaging of retrieved CH waste from LLBGs and waste that is currently in aboveground storage. A new glovebox enclosed inside of a new Perma-Con unit will be installed and used to sort through the waste material correcting noncompliant conditions then repackaging the waste into a disposal compliant container. The TRU-compliant containers would then be loaded in SWBs to

prepare them for certification and shipment to WIPP or the Environmental Restoration Disposal Facility, as applicable, for disposal.

- The **Repackaging of Noncompliant Waste in the 2706-T/TA Buildings** option would establish a new repackaging of TRU and LLW capability at the 2706-T and 2706-TA Buildings using Perma-Con structures. New Perma-Con and gloveboxes are installed capable of sorting and repackaging waste delivered in drums and boxes up to SWB in size and characterize and treat nonconforming items. Facility modifications would be completed at 2706-T/TA, including ventilation and stack upgrades, to support the new processing capability.
- The **Repackaging of Noncompliant Waste at WRAP** option would replace the gloveboxes in WRAP with a new repackaging of TRU and LLW capability using Perma-Con structures and provide access for entry of boxes into the process area. New Perma-Con and gloveboxes are installed capable of sorting and repackaging waste delivered in drums and boxes up to SWB in size and characterize and treat nonconforming items. Existing process equipment in either the process area or the NDA/NDE area would be removed to support installation and operation of the new process line.
- The **Repackaging of Noncompliant Waste at MASF** option would establish a new repackaging of TRU and LLW capability at the MASF building using Perma-Con structures. New Perma-Con and gloveboxes are installed capable of sorting and repackaging waste delivered in drums and boxes up to SWB in size and characterize and treat nonconforming items.

The comparative analysis of CH small container processing options resulted in selection of the **Repackaging of Noncompliant Waste at WRAP** option. The total life-cycle cost was about the same for each option so cost was not a discriminator, instead reliability and operability drove the decision. This option was selected for the following reasons:

- Repurposing the 221-T Canyon to perform repackaging was dismissed because it conflicted with the K Basins sludge storage mission and access of boxes into and out of the canyon is difficult.
- Use of MASF in the 400 Area to perform repackaging was dismissed because it required shipments on public roads, which is not possible for all the waste. Therefore, this option would not be able to process all the required waste.
- Use of 2706-T/TA to perform repackaging was dismissed because implementation has more risk than the selected option due to changes in the air permitting required and longer waste transfer distance between facilities.
- Repurposing WRAP exhibits less implementation risk because there are less significant permit changes required and it is collocated with waste storage at CWC making short transfer distances.

3.4 Commercial Repackaging Options

The commercial repackaging options continue the use of PFNW under an existing contract to provide size reduction and packaging of boxes containing TRU waste services. The waste is shipped via road closure using a federal driver to PFNW in Richland from Hanford SWOC facilities. The box contents are removed, size reduced (as necessary), then placed into SWBs packaged to be compliant with WIPP requirements. The box is size reduced and packaged for disposal as LLW if the surface contamination limit is satisfied, if not then it is packaged as TRU waste. The TRU waste is shipped back to SWOC facilities for eventual certification and disposal at WIPP. The LLW is sent to the Hanford Site for disposal.

The nuclear material license currently limits the amount of special nuclear material (SNM) to a total of 200 g in the facility, which prohibits the use of PFNW to size reduce high SNM loaded waste packages. The following two PFNW options were identified to support M-091 processing/treatment requirements:

- Continue Processing at PFNW under Existing License
- Process at PFNW under Expanded License

Both options were considered during development and evaluation of integrated alternatives in order to reduce the throughput requirements for any new or repurposed existing facility that would process large container waste in support of M-091 milestones. Therefore, comparative analysis of these options was not completed prior to development of integrated alternatives. Both options assumed the current characterization, packaging, and shipment practices and requirements for PFNW will be maintained.

The candidate packages are large containers, including M-091 waste boxes that have been retrieved from the burial grounds and non-M-091 waste (generally not retrieved from a burial ground). Most of the waste is in aboveground storage but a small portion of the boxes are yet to be retrieved from the burial grounds.

The boxes of waste will be characterized for radioactive content as needed prior to transportation to PFNW. Also, consistent with the Agreed Order (Ecology, 2014) all boxes prior to shipment will be approved by Ecology.

The maximum SNM content of waste that can be shipped based on current special packaging arrangement (SPA) is 450 g SNM. A revision to the SPA to increase shipping the SNM limits to up to 1,000 g SNM could be pursued; however, this option is not included in this evaluation because it would still not result in all waste boxes being sent to PFNW. The incremental benefit to shipping a small number of additional boxes to PFNW does not warrant additional cost to obtain a revision of the SPA. Fifteen boxes that constitute 172 m^3 (11 boxes that constitute 126 m^3 are M-091 waste) of waste are greater than this shipping limit and are not included in the feed stream described herein.

The waste feed stream that can be sent to PFNW for treatment differs between the two options due to the SNM content that can reside at PFNW. The **Continue Processing at PFNW under Existing License** option is limited to the current license limit of 200 g SNM. The **Process at PFNW under Expanded License** option is based on PFNW obtaining a nuclear materials license increase to 1,000 g SNM. The number and volume of TRU waste boxes that can be sent to PFNW under the 200 g SNM license are summarized in Table 1, which is based on containers that are ≤180 g SNM. The number and volume of TRU waste boxes that are ≤450 g SNM that can be sent to PFNW under the 1,000 g SNM license are summarized in Table 2.

Table 1. TRU Boxes Eligible for PFNW Packaging with 200 g SNM Limit

Box Information	M-091 TRU Waste	Non-M-091 TRU Waste
Count	195	3
Volume (m^3)	2,200	16

Table 2. TRU Boxes Eligible for PFNW Packaging with 1,000 g SNM Limit

Box Information	M-091 TRU Waste	Non-M-091 TRU Waste
Count	389	6
Volume (m^3)	4,200	33

The boxes summarized in Tables 1 and 2 reflect the waste expected to be present as of October 1, 2022. These aboveground stored boxes are being size reduced using PFNW now and will continue until the project starts in fiscal year (FY) 2022 when the expanded license may be available for use. An estimated 23 boxes comprising 1,600 m^3 of waste will have been sized reduced from now until 2022 (about half of the fiberglass boxes stored outside in aboveground storage). This amount aligns with plans to increase processing from the current 280 m^3/yr to be completed by September 1, 2018 to 400 m^3/yr.

3.5 RH and Large Package Processing Options

The following options were identified for processing of RH-TRU/TRUM waste and CH-TRU/TRUM waste in large packages, based on the results of the M-091-51 study:

- Build New RH and Large Package Facility
- Repurpose Existing Facility for RH and Large Package Processing

During development of the above options, the benefit of separating the RPS from the Large Package Processing System (LPPS) was identified to provide more flexibility in development and comparison of integrated alternatives. Therefore, the following set of options supersedes the initial two choices.

- The **Build New Facility for Large Package Processing System** option uses a large metal building to house the LPPS. The LPPS includes a large package receipt airlock/survey area, an unloading area, a size-reduction area, and a repackaging area. The repackaging area includes an additional metal confinement structure for contamination control. The LPPS is used to extract, size-reduce, and sort waste from CH-TRU/TRUM large packages for repackaging into WIPP certifiable packages.
- The **Build New Facility for RH-TRU Processing System** option would have capability for processing of RH wastes currently in 55 and 85 gal drums, SWBs, and large packages. The option will also be assessed for receipt and processing of retrieved alpha caissons waste to eliminate redundant RH-TRU/TRUM packaging lines. The RPS is a concrete and steel structure that provides shielding and contamination control and is used to remotely extract, size-reduce, and sort RH TRU/TRUM waste for repackaging into WIPP certifiable packages.
- The **Repurpose WRAP for Large Package Processing System** option would be sized to eliminate the need for a new standalone facility for onsite processing of CH-TRU/TRUM waste in large packages by modifying an existing facility to provide the New Onsite Large Package Processing Capability.
- The **Repurpose WRAP for RH-TRU Processing System** option would be sized to eliminate the need for a new standalone facility for RH-TRU/TRUM waste in 55 and 85 gal drums, SWBs, and large packages by modifying an existing facility to provide the New Onsite RH-TRU Processing Capability. The option will also be assessed for receipt and processing of retrieved alpha caissons waste to eliminate redundant RH-TRU/TRUM packaging lines.

These four options were included within the integrated alternatives; therefore, a comparative analysis was not performed to down-select the LPPS and RPS options for inclusion in the integrated alternatives.

The LPPS options are capable of extracting, size-reducing, and sorting waste from large packages having contents with low to moderate dose rates. The RPS options include shielding (16 in. concrete +2 in. steel for cask unloading, size-reduction and sorting; 8 in. of steel for hot cell and repackaging system) and is capable of receipt, size reduction, and sorting of waste from packages with <99 Ci of Cs-137.[4] The RPS options repackage RH-TRU/TRUM wastes into WIPP certifiable 30 gal drums. The LPPS options repackage CH-TRU/TRUM wastes into WIPP certifiable 55 gal drums or SWBs. The LPPS and RPS options all provide capability for treating NCW.

The LPPS and RPS options provide for visual inspection, and sampling of CH and RH-TRU waste, respectively, to support WIPP certification. The RPS options include NDA, and NDE capability sufficient to achieve later WIPP certification of each RH-TRU drum. NDA and NDE for CH-TRU waste for WIPP certification will be provided at CWC and is not included within the LPPS options. The RPS options include the capability to receive 30 or 55 gal drums containing treated sludge and to complete the NDA and NDE of those drums.

To support the LPPS and RPS options at WRAP, existing gloveboxes in the processing area and/or the NDA/NDE area will be removed to enable installation of the LPPS or RPS at WRAP. To accommodate existing WRAP Facility dimensions, the height of LPPS size reduction area will be lower than in the **Build New Facility for Large Package Processing System** option, requiring use of an alternate manipulator system that will breach large packages from the side rather than the top.

Because a decision on the need for new facilities or the use of WRAP will depend on throughput rates, both facilities were considered during evaluations of the integrated alternatives.

3.6 Shipping Options

Transportation of CH-TRU/TRUM and RH-TRU/TRUM waste to WIPP for disposal is conducted using NRC licensed cask systems with payloads authorized within NRC-approved certificates of compliance. There are currently four cask systems authorized for shipments of TRU/TRUM waste to WIPP:

- The RH 72-B and HalfPACT casks for shipment of RH waste
- The TRUPACT-II, TRUPACT-III, and HalfPACT casks for shipment of CH waste

The applicable payload requirements for the casks are identified in the CH-TRAMPAC (DOE, 2013a) and CH-TRU Payload Appendices (DOE, 2007a); RH-TRAMPAC (DOE, 2010) and RH-TRU Payload Appendices (DOE, 2013b); and TRUPACT-III TRAMPAC (DOE, 2007b).

The National TRU Program supplies all the conveyances and casks for TRU and TRUM waste. There are currently 84 TRUPACT-II casks, 6 TRUPACT-III, 15 HalfPACT casks, and 12 RH 72-B casks in the fleet. Each RH 72B cask is designed to ship three 30 gal or three 55 gal RH-TRU/TRUM drums within a payload canister called an RLC. Each HalfPACT is currently authorized to ship three 30 gal RH-TRU/TRUM drums, each in a shielded container (SC-30G1). Each HalfPACT is also authorized to ship a single SWB or seven 55 gal drums containing CH-TRU/TRUM waste per cask. The TRUPACT-II has the same general configuration as the HalfPACT but has a taller payload cavity that results in twice the payload capacity of the HalfPACT (fourteen 55 gal drums or two SWBs per cask). The TRUPACT-III is designed for shipment of a single standard large box 2 (SLB2) container of CH-TRU/TRUM waste. Three TRUPACT-II or HalfPACT casks may be included in a single shipment, as opposed to a single RH 72B or

[4] Highest Cs-137 content in a package in the RPS inventory was <97 Ci at time of receipt based on Solid Waste Information and Tracking System.

TRUPACT-III cask per shipment. The following options were developed to acquire shipping capabilities for loading/unloading of the RH 72B cask:

- The **Build New RH-TRU 72B Loading/Shipping Facility** option evaluates building a new standalone RH 72B loading and shipment facility. The facility will receive 30 gal drums of RH waste, shielded overpacks with RH waste drums inside, empty RH 72B casks, and empty payload canisters (RLCs). The RH drums will be loaded into the payload canister and the payload canister loaded into the cask. The cask is leak tested and ultimately shipped to WIPP. The facility concept in this option is derived from CHPRC-01291, *Alternative Evaluation for Hanford RH-TRU 72-B Cask Shipping Capability* (completed in September 2011). It evaluated several alternatives for a new shipping facility. These included the recommendations from Project W-593 (based on the INL facility), the system used by Argonne National Laboratory, and a more cost-effective, efficient version of each. The information presented below uses data from the recommended option in that study.

- The **Build Weatherproof Enclosure for RH-TRU 72B Loading/Shipping Facility** option provides a RH 72B loading/shipping facility that uses a weatherproof enclosure instead of a building. This option provides an RH 72B loading/shipping facility that uses a weatherproof enclosure instead of a building. The equipment and process operations inside the enclosure are similar to those identified for the **Build New RH-TRU 72B Loading/Shipping Facility** option.

- The **Use Existing Facility for RH-TRU 72B Loading/Shipping** option uses MASF as the location for the RH 72B loading and shipping facility. The overall process is the same as the **Build New RH-TRU 72B Loading/Shipping Facility** option; therefore, this option has the same throughput rate of up to six RH 72B cask loadings and shipments per week, assuming two shifts per day operations in a 5-day work week. The facility will provide capability for offsite shipment of RH-TRU waste in RH 72B casks. The existing facility selected for evaluation in this option was MASF.

A comparative analysis of the RH 72B options resulted in selection of the **Build New RH-TRU 72B Loading/Shipping Facility** option as the preferred option for the RH 72B cask loading/shipping facility primarily because it reduces schedule risk, collocates the operation that would allow easy resource sharing, and minimizes exposure in an accident scenario.

Because existing capability at WRAP for TRUPACT-II loading/shipping exists is sufficient, no new options to TRUPACT-II loading/shipping were considered.

The **Restart WRAP TRUPACT-II Loading** option evaluates restart of WRAP using existing systems to load and ship TRUPACT-II casks.

The following options were developed to provide shipping capability for the TRUPACT-III cask.

- The **Modify Existing Facility for TRUPACT-III** option evaluates use of an existing facility to load and ship TRUPACT-III casks. The facility will receive loaded SLB2s and empty TRUPACT-III casks. A gantry crane system with electric hoists on a trolley will be used to load and unload the TRUPACT-III from the transport trailer and remove/replace the inner and outer doors. The SLB2 will be loaded into the cask and the cask is leak tested and ultimately shipped to WIPP. Based on the experience of CCP, this option would be capable of supporting up to three SLB2 cask loadings and shipments per week, assuming one shift per day operations in a 5-day work week.

- The **Establish a Movable Loading Facility for TRUPACT-III** option evaluates use of a movable loading facility to load and ship TRUPACT-III casks. The facility will receive loaded SLB2s and empty TRUPACT-III casks. The SLB2 will be loaded into the cask and the cask leak tested and ultimately shipped to WIPP. This option would be accomplished by fully utilizing the MLU team and

their equipment. It is capable of supporting up to two SLB2 cask loadings and shipments per week, assuming one shift per day operations in a 5-day work week. In this option, no building is required. The cask will be loaded outdoors using a mobile crane and portable generator. In some locations power may be available from nearby buildings.

Because of the following considerations, the **Establish a Movable Loading Facility for TRUPACT-III** option was selected as the preferred option for TRUPACT-III loading. A formal comparative analysis was not completed.

- Shipment of TRUPACT-IIIs from the Hanford Site is not required for M-091 wastes. This consideration does not have the same schedule pressure; therefore, loading could be performed outdoors seasonally when weather allows.
- CCP personnel can provide all the necessary personnel and equipment needed to load SLB-2 into a TRUPACT-III; no special facility is required.
- The later shipment date for the TRUPACT-IIIs provides high confidence that the MLU equipment will be available for use at the Hanford Site.
- Similar outdoor operations have successfully been performed in the same area.

The following options were developed to provide shipping capability for the HalfPACT cask.

- The **Modify WRAP for HalfPACT Loading** option evaluates modification of existing systems at WRAP for loading and shipping TRUPACT-II casks to enable loading and shipping of HalfPACT casks.
- The **Build New HalfPACT Loading/Shipping Facility** option builds a new HalfPACT loading/shipping facility with loading capability similar to the WRAP Facility. The new facility includes a metal building with a crane to support loading. The facility will include an area to stage the HalfPACT inner and outer lids as well as space to assemble the SC and dunnage. To increase flexibility, a shrink-wrap system for CH containers and a platform that will accommodate the TRUPACT-II are included in the design.

Because a decision on the need for a new HalfPACT facility or use of WRAP will depend on throughput rates, both will be considered during evaluation of the integrated alternatives.

A comparative analysis of the RH 72B options resulted in selection of the **Build New RH-TRU 72B Loading/Shipping Facility** option as the preferred option for the RH 72B cask loading/shipping facility primarily because it reduced schedule risk, collocated the operation that would allow easy resource sharing, and minimizes exposure in an accident scenario.

3.7 Description of Storage and Certification Options

The following options were developed for Storage and Certification:

- The **Develop Contingency Mixed-Waste Storage Area** option acquires a fully RCRA-compliant waste storage area.
- The **Certification** option provides facilities and services required for CCP provided NDA and NDE equipment and for CCP flammable head space gas sampling and analysis. This option uses the 2404WC Building located at the CWC. The facility has required services and floor spaces to support this function and has been used for this function in the past.

Additional options were determined not to be warranted for the following reasons:

- The storage system is not complicated and the need is driven by other factors, namely the rate at which waste packages are placed into storage and the rate at which shipments occur. Storage capacity requirements will be addressed during evaluation of the integrated alternatives.
- Multiple acquisition approaches for acquiring equipment required for certification are identified in the M-091-51 study (CHPRC-02916). Contractually, the responsibility for providing the equipment is the responsibility of the CCP. Communications with CCP identified that this remained the correct approach for CH-TRU/TRUM waste and appropriate assumptions were identified. No benefit could be identified to implement an alternative approach.
- For equipment to support RH-TRU/TRUM certification, required systems (with the exception of those required to obtain samples for flammable head gas analysis [FHGA]), are appropriately included within the options for RH-TRU processing. Because the drums cannot be shielded during NDA/NDE, performing those functions prior to placing the drums into the shielded overpacks for storage or shipment is the only practical approach without adding handling steps that increase personnel exposure and the potential for accidents.

4 Description of Integrated Alternatives

This chapter identifies and describes the integrated alternatives for retrieval, processing, certification, storage, and shipping based on results of initial down-select of options. A schedule and cost estimate were developed for each integrated alternative. A comparative analysis of the integrated alternatives is provided in Chapter 5.

Based on the results of the down-select process, the following options are common to all integrated alternatives.

- Retrieval of alpha caissons waste will be accomplished by implementing the **Apply Mobile Hot Cell Approach** option.
- RSW will be retrieved from 218-W-3A, 218-W-4B, and 218-E-12B by implementing the **Retrieval Using Heavy Equipment Capability** option.
- CH-TRU/TRUM in small containers will be processed by implementing the **Repackaging Noncompliant Waste at WRAP** option.
- Characterization will use mobile equipment at the retrieval site and NDA/NDE equipment located at WRAP. PFNW processing under their current license will be maximized through the period of processing of M-091 wastes by implementing the **Continue Processing at PFNW under Existing License** option.
- CH-TRU/TRUM in 55 gal drums and SWBs will be shipped using the **Restart WRAP TRUPACT-II Loading** option.
- CH-TRU in SLB2s will be shipped using the **Establish a Movable Loading Facility for TRUPACT-III** option.
- CH-TRU certification will use equipment supplied by the Central Characterization Project at WRAP as described in the **Certification** option.
- RH-TRU certification (except FHGA) will use equipment provided as part of the respective RPS.

- Shipment of RH-TRU/TRUM in 30 gal drums to WIPP will use either the RH 72B, the HalfPACT with the currently certified SCA-30G1 containers, or a combination of the two. In all cases use of a new facility is assumed. The cost basis for this alternative assumes a new HalfPACT facility is built, as identified in the **Build New HalfPACT Loading/Shipping Facility** option.
- The cost bases assume a new contingency storage pad is built as identified in the **Develop Contingency Mixed-Waste Storage Area** option**.**

4.1 Description of Integrated Alternative 1

Integrated Alternative 1 includes acquisition of the alpha caissons processing capability identified in the alpha caissons 2010 conceptual design in addition to providing new facilities for the LPPS and RPS. Integrated Alternative 1 scope includes the following:

- All common options listed above.
- Process alpha caissons waste using the approach identified in the **Apply 2010 Conceptual Design Processing Approach** option.
- Acquire a new standalone RPS as identified in the **Build New Facility for RH-TRU Processing System** option.
- Acquire a new standalone LPPS as identified in the **Build New Facility for Large Package Processing System** option.

A logically tied schedule was developed for Integrated Alternative 1. The schedule reflects constraints caused to processing start and finish dates by retrieval start and finish dates, shipping start and finish dates by processing start and finish dates, and priority of M-091 processing and shipment at each facility over non-M-091 processing and shipment. The logic reflects a 3-month lag after final M-091 processing prior to final M-091 shipment to provide for final certification activities. Therefore, activities that do not include M-091 scope, such as SLB2 shipments, are logically driven out to after the completion of the M-091 shipments. This does not preclude the potential for later acceleration of certain activities on a non-interference basis with M-091.

The schedule reflects completion of M-091 shipments in March 2032, after the September 30, 2030 required completion date. Additional actions will be required to accelerate the schedule to achieve the required completion date.

The required resources for each activity were loaded into the Primavera P6® schedule. Cost reports, including escalation, were then developed using Cobra©. Level of effort resources, such as operating crews, were adjusted as necessary in P6 to ensure a constant staffing level was maintained for the required period when the schedule logic ties caused an activity to increase or decrease in duration.

The rough order of magnitude (ROM) total estimated cost for Integrated Alternative 1 is ~$1.8 billion (burdened, un-escalated). The cost estimate range is -50% to +100% based on the maturity of the technical input as a result of the individual options after modification of activity durations based on logic ties between the options.

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4.2 Description of Integrated Alternative 2

Integrated Alternative 2 includes acquisition of new facilities for the LPPS and RPS and uses the RPS for processing of alpha caissons waste. Integrated Alternative 2 scope includes the following:

- All common options listed in Section 4.0.
- Acquire a new standalone LPPS as identified in the **Build New Facility for Large Packaging Processing System** option.
- Acquire a new standalone RPS as identified in the **Build New Facility for RH-TRU Processing System** option.
- Process alpha caisson waste using the above RH-TRU processing option.

Shipment of RH-TRU/TRUM in 30 gal drums to WIPP under this alternative will use either the RH 72B, the HalfPACT with the currently certified SCA-30G1 containers, or a combination of the two. In both cases use of a new facility is assumed. The cost basis for this alternative assumes a new HalfPACT facility is built, as identified in the **Build New HalfPACT Loading/Shipping Facility** option. The cost basis also assumes a new contingency storage pad is built as identified in the **Develop Contingency Mixed-Waste Storage Area** option.

A logically tied schedule was developed for Integrated Alternative 2. The schedule reflects constraints caused to processing start and finish dates by retrieval start and finish dates, shipping start and finish dates by processing start and finish dates, and priority of M-091 processing and shipment at each facility over non-M-091 processing and shipment. The schedule reflects extension of the RPS operating duration for M-091 waste to accommodate processing of the alpha caissons waste. The logic reflects a 3-month lag after final M-091 processing prior to final M-091 shipment to provide for final certification activities. Therefore, activities that do not include M-091 scope, such as SLB2 shipments, are logically driven out to after finish of M-091 shipments. This does not preclude the potential for later acceleration of certain activities on a non-interference basis with M-091.

The schedule reflects completion of M-091 shipments in March 2035, far after the September 30, 2030 required completion date. Even with additional actions to accelerate the schedule, the ability to achieve the required completion date does not appear viable using a single processing system (without duplicate capabilities) to process all of the RH waste, including alpha caissons waste.

The required resources for each activity were loaded into the P6 schedule. Cost reports, including escalation, were then developed using Cobra. Level of effort resources, such as operating crews, were adjusted as necessary in P6 to ensure a constant staffing level was maintained for the required period when the schedule logic ties caused an activity to increase or decrease in duration.

The ROM total estimated cost for Integrated Alternative 2 is ~$1.8 billion (burdened, un-escalated). The cost estimate range is -50% to +100% based on the maturity of the technical input as a result of the individual options after modification of activity durations based on logic ties between the options.

4.3 Description of Integrated Alternative 3

Integrated Alternative 3 includes acquisition of the alpha caissons processing capability identified in the alpha caissons 2010 conceptual design in addition to repurposing WRAP for the LPPS and RPS. Integrated Alternative 3 scope includes the following:

- All common options listed in Section 4.0.
- Process alpha caissons waste using the approach identified in the **Apply 2010 Conceptual Design Processing Approach** option.
- Repurpose WRAP to provide capability for large package processing, as identified in the **Repurpose WRAP for Large Package Processing System** option.
- Repurpose WRAP to provide capability for RH-TRU processing as identified in the **Repurpose WRAP for RH-TRU Processing System** option.

A logically tied schedule was developed for Integrated Alternative 3. The schedule reflects constraints caused to processing start and finish dates by retrieval start and finish dates, shipping start and finish dates by processing start and finish dates, and priority of M-091 processing and shipment at each facility over non-M-091 processing and shipment. The logic reflects a 3-month lag after final M-091 processing prior to final M-091 shipment to provide for final certification activities. Therefore, activities that do not include M-091 scope, such as SLB2 shipments, are logically driven out to after finish of M-091 shipments. This does not preclude the potential for later acceleration of certain activities on a non-interference basis with M-091.

The schedule reflects completion of M-091 shipments in March 2032, after the September 30, 2030 required completion date. Additional actions will be required to accelerate the schedule to achieve the required completion date.

The required resources for each activity were loaded into the P6 schedule. Cost reports, including escalation, were then developed using Cobra. Level of effort resources, such as operating crews, were adjusted as necessary in P6 to ensure a constant staffing level was maintained for the required period when the schedule logic ties caused an activity to increase or decrease in duration.

The ROM total estimated cost for Integrated Alternative 3 is ~$1.8 billion (burdened, un-escalated). The cost estimate range is -50% to +100% based on the maturity of the technical input as a result of the individual options after modification of activity durations based on logic ties between the options.

4.4 Description of Integrated Alternative 4

Integrated Alternative 4 repurposes WRAP for the LPPS and RPS and uses the RPS for processing of alpha caissons waste. Integrated Alternative 4 scope includes the following:

- All common options listed in Section 4.0.
- Repurpose WRAP to provide capability for large package processing, as identified in the **Repurpose WRAP for Large Package Processing System** option.
- Repurpose WRAP to provide capability for RH-TRU processing as identified in the **Repurpose WRAP for RH-TRU Processing System** option.
- Process alpha caisson waste using the above RH-TRU processing option.

A logically tied schedule was developed for Integrated Alternative 4. The schedule reflects constraints caused to processing start and finish dates by retrieval start and finish dates, shipping start and finish dates by processing start and finish dates, and priority of M-091 processing and shipment at each facility over non-M-091 processing and shipment. The logic reflects a 3-month lag after final M-091 processing prior to final M-091 shipment to provide for final certification activities. Therefore, activities that do not include M-091 scope, such as SLB2 shipments, are logically driven out to after finish of M-091 shipments. This does not preclude the potential for later acceleration of certain activities on a non-interference basis with M-091.

The schedule reflects completion of M-091 shipments in March 2035, far after the September 30, 2030, required completion date. Even with additional actions to accelerate the schedule, the ability to achieve the required completion date does not appear viable using a single processing system (without duplicate capabilities) to process all the RH waste, including alpha caissons waste.

The required resources for each activity were loaded into the P6 schedule. Cost reports, including escalation, were then developed using Cobra. Level of effort resources, such as operating crews, were adjusted as necessary in P6 to ensure a constant staffing level was maintained for the required period when the schedule logic ties caused an activity to increase or decrease in duration.

The ROM total estimated cost for Integrated Alternative 4 is ~$1.8 billion (burdened, un-escalated). The cost estimate range is -50% to +100% based on the maturity of the technical input as a result of the individual options after modification of activity durations based on logic ties between the options.

5 Comparison of Integrated Alternatives

This chapter provides the results of the comparative analysis of integrated alternatives for retrieval, processing, certification, storage, and shipping.

A meeting was conducted with subject-matter experts from project, engineering, operations, environmental regulatory, and radiological safety organizations to compare alternatives for the purpose of selecting a preferred alternative.

Table 3 provides the criteria used to compare the alternatives. A weighting factor was applied to the various criteria by the team.

Based on the relative importance of cost and schedule to successful completion of M-091 waste inventories by September 30, 2030, performance measured against the cost and schedule criteria were weighted 30% each of the total score. Performance against the remaining criteria were weighted 10% each of the total score.

Table 3. Comparison of Alternatives

Criteria	Factors	Weighting Factor (%)
Cost	• Minimizes total project cost (capability acquisition, permitting, licensing, and startup) • Minimizes annual operations and maintenance cost	30
Schedule	• Facilitates early start of processing of wastes for shipment to WIPP • Maximizes throughput capability for processing wastes to enable shipment to WIPP • Compatible with Hanford Site cleanup schedules, including TPA (Ecology et al., 1989) commitments	30

Table 3. Comparison of Alternatives

Criteria	Factors	Weighting Factor (%)
Regulatory	• Achievable within normally used regulatory framework • Minimizes need for changes to existing regulatory decisions (e.g., records of decision) and the Central Plateau cleanup completion strategy • Best supports sustainable environmental stewardship goals	10
Safety	• Minimizes personnel exposure and contamination potential • Minimizes worker safety risks, including potential for near-misses and accidents	10
Reliability, operability, and maintainability	• Minimizes the number of operating systems and procedural steps • Minimizes the potential for single-point failures affecting overall throughput rate • Minimizes required maintenance; provides access and space for required maintenance • Maximizes use of available technologies; minimizes requirements for development of complex or first-of-kind systems	10
Uncertainty and/or risks	• Likely to result in successful M-091-52 waste retrieval/processing/ shipment within estimated cost and schedule • Minimizes environmental and public risks • Minimizes impacts and risks to other Hanford Site cleanup programs • Uses DOE O 413.3B implementation strategy that minimizes schedule risks	10

5.1 Summary of Comparison Results

Table 4 shows the results of the comparative evaluation. Note that the shipping options were compared separately and their comparison are not reflected in Table 4. Sections 5.1.1 through 5.1.6 provide details associated with each category. The results show Alternative 1 as the preferred option.

Table 4. Comparative Evaluation Results

Comparison of Alternatives						
Cost (30%)	Schedule (30%)	Regulatory (10%)	Safety (10%)	ROM (10%)	Uncertainty (10%)	Total Score
Alternative 1						
3	3	3	2	3	2	**28**
Alternative 2						
4	1	3	2	4	1	**25**
Alternative 3						
3	3	2	3	2	2	**27**
Alternative 4						
4	1	2	4	3	1	**25**

5.1.1 Comparison of Costs

Life-cycle costs, including annual operations and maintenance costs, are not distinguishable between the various alternatives. The estimated life-cycle costs for the alternatives are within 10% of each other from the highest cost alternative to the lowest cost alternative. Based on the phase of estimating, the difference in life-cycle cost, including annual operations and maintenance cost, estimates are sufficiently low to provide no difference in scoring against this element of cost.

Total Project Costs for Alternatives 1 and 3 have demonstrably higher costs than Alternatives 2 and 4 because of the acquisition of an additional facility for alpha caissons processing. Therefore, Alternatives 2 and 4 were given a slightly higher score against the cost criteria than Alternatives 1 and 3.

5.1.2 Comparison of Schedule

None of the alternatives scored high against the schedule criteria because of the identified durations to acquire capabilities either through modification of existing/legacy facilities or through construction of new facilities. No substantial difference was identified in schedule durations to provide facility capabilities. Additionally, all the alternatives relied on early start of processing using the PFNW capability.

The significant difference between alternatives was the additional throughput capability provided in Alternatives 1 and 3 to process alpha caissons waste. Without this capacity (or providing additional process systems and associated staffing), Alternatives 2 and 4 are estimated to require ~5 years longer to process M-091 waste. Alternatives 2 and 4 already are based on three operating shifts per week, so additional throughput could not be readily achieved through addition of more operating shifts or staff.

Additional measures will be required for Alternatives 1 and 3 to accelerate start of CH large package and RH-TRU processing sufficiently to achieve September 30, 2030 date to ship M-091 RH and CH large container waste. Alternatives 2 and 4 cannot realistically support the September 30, 2030 date without addition of more processing lines, which would increase cost and schedule durations to acquire the facilities and would result in comparable throughput as is currently achieved in Alternatives 1 and 3.

5.1.3 Comparison of Regulatory

Regulatory permitting for all alternatives will be challenging to achieve within the normally used regulatory framework and within required schedules. Each alternative includes multiple facilities requiring substantial regulatory permit modifications in parallel.

The ability to best satisfy regulatory requirements and avoid difficulties with retrofitting an existing facility to satisfy requirements for alternate missions is best achieved with Alternatives 1 and 2, because of the reliance on new facilities.

All alternatives are compatible with the Central Plateau cleanup completion strategy. No substantial difference exists between the alternatives to support sustainable environmental stewardship goals.

5.1.4 Comparison of Safety

Overall performance against safety criteria was deemed better for Alternatives 3 and 4, because operations were spread out in fewer facilities with fewer total systems to maintain, providing fewer worker safety risks. Alternative 4 had the best overall performance because of elimination of a facility, the ACWPS.

No discernable difference with noted between the ability of each alternative to minimize personnel exposure and contamination potential.

5.1.5 Comparison of Reliability, Operability, and Maintainability

Alternatives 2 and 4 provide fewer facilities to maintain and operate, resulting in a fewer number of operating systems and procedural steps and better performance in this regard than Alternatives 1 and 3.

Alternatives 1 and 2 provide new RPSs and LPPSs and eliminate difficulties associated with performing substantial construction in an existing facility where operations are ongoing. The new facilities also provide more flexibility in providing for required maintenance than if installed in an existing facility with space limitations.

Alternatives 1 and 3 have an additional processing system that reduces the potential for single-point failures affecting overall throughput rate. However, all facilities must achieve reasonably high total operating efficiencies to meet the September 30, 2030 commitment date for completion of M-091 waste shipments.

All alternatives maximize the use of available technologies and minimize the requirements for development of complex or first-of-kind systems. All alternatives, however, require the use of remotely operated equipment that traditionally present operability and maintainability challenges. For all alternatives, demonstration of the technologies and substantial operator/maintenance training will be required prior to placement of systems into service.

Based on a composite of the above considerations, Alternative 2 performs the best against the reliability, operability, and maintainability criteria. Alternatives 3 performs the worst.

5.1.6 Comparison of Uncertainty and/or Risks

Because of the number of parallel acquisition activities, startups, and operations to achieve the September 30, 2030 date for shipments, high schedule risk exists for all alternatives. The schedule risk for Alternatives 2 and 4 are highest due to lack of parallel RPSs because these alternatives do not include the ACWPS.

All alternatives minimize environmental and public risks.

No discernable difference is identified between alternatives in impacts and risks to other Hanford Site cleanup programs or in the use of a DOE O 413.3B implementation strategy that minimizes schedule risks.

Based on the above, Alternatives 1 and 3 perform the best against the uncertainty and/or risks criteria.

5.2 Shipping Review

For all alternatives, a review of potential strategies for shipment of both CH-TRU/TRUM and RH-TRU/TRUM waste to WIPP was performed that considered available casks systems, facility startup dates, and facility throughput rates.

The shipping review was conducted in parallel with the comparison of alternatives to ensure that the influence of shipping was considered in the final alternative recommendation and to ensure that the optimum shipping approach was recommended. The recommendation for shipping needs to address both the shipping cask system(s) to utilize and what facility to build or modify to support the shipping requirements. A sensitivity analysis was conducted to provide a basis for the recommendation.

5.2.1 CH-TRU/TRUM Shipping

All the integrated alternatives include the same processing throughput capabilities for CH-TRU/TRUM. The overall throughput rates for the CH-TRU/TRUM at the various facilities are identified in Table 5, based on the alternatives identified in the evaluation.

Table 5. CH-TRU/TRUM Production Durations

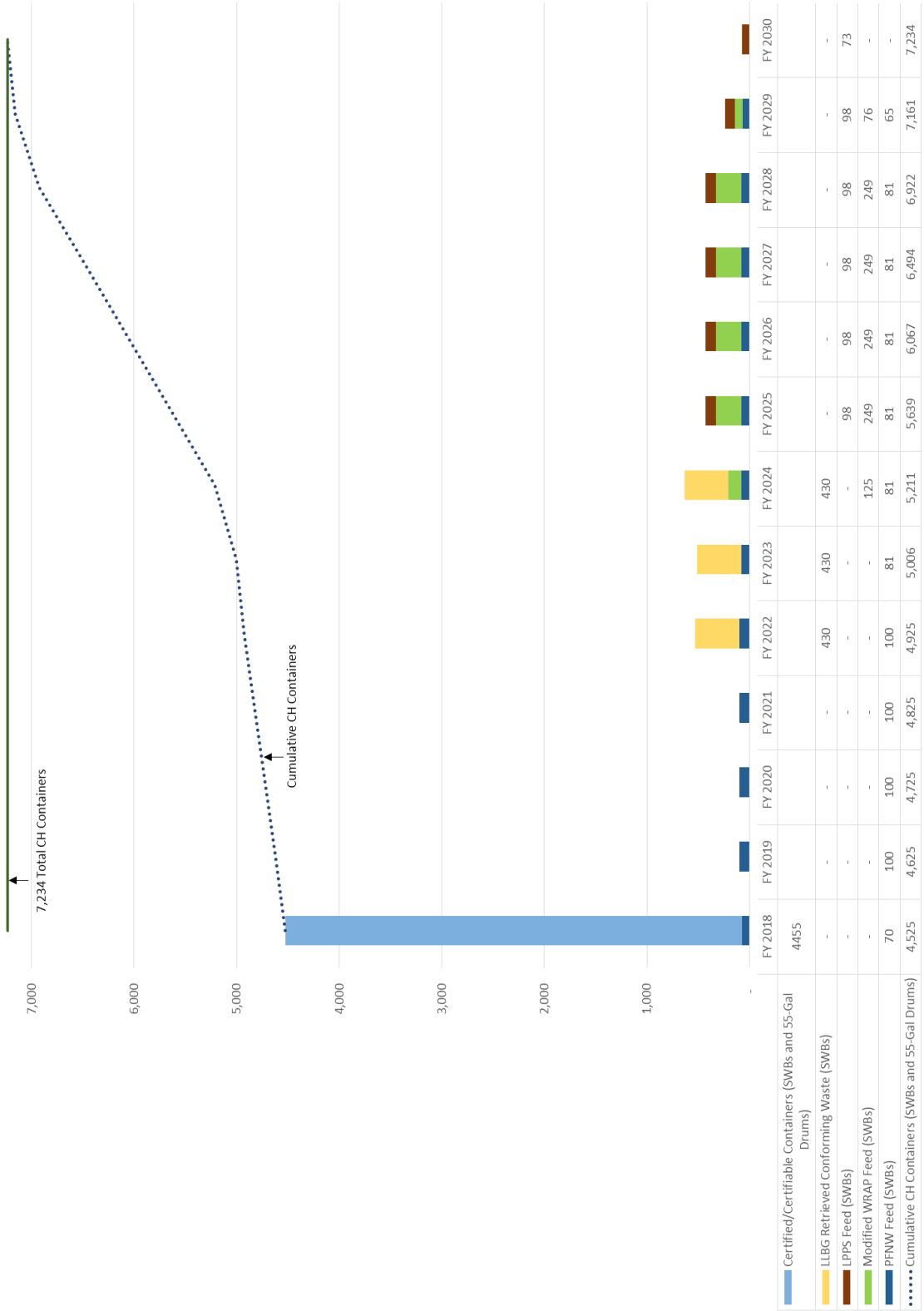
	Number of Shifts	Number of Lines	Efficiency to Achieve Operations Duration (%)	Days in Work Week	Operations Duration (yr)
PFNW (without Expanded License)	2	2	70	7	6.75
LLBG Retrieval	1	N/A	N/A	4	3
CH Small Containers Processing at WRAP	1	2	70	4	4.85
LPPS	3	1	85	5	5.75

N/A = not applicable

Based on a 3-month WIPP certification period after the final waste package is produced for shipment to WIPP, the final waste package must be produced by June 30, 2030. The production duration is achievable based on these identified shifts and efficiencies if adequate measures are taken to achieve startup of the onsite processing facilities by the start of FY 2025. Note that the efficiency for the LPPS assumes that certain small containers from the LPPS inventory are processed at WRAP, reducing the LPPS processing duration by 4 to 5 months.

Additional inventories requiring shipment include 4,455 WIPP certifiable packages (55 gal drums and SWBs) in storage, CH-TRU/TRUM produced from PFNW processing prior to FY 2023, and CH-TRU/TRUM that is conforming waste retrieved during RSW retrieval operations. Figure 2 shows the existing inventories and estimated new inventory production durations, based on the information in Table 5.

The demonstrated CH-TRU/TRUM shipping capability using the TRUPACT-II at WRAP (5 shipments per week using single shift operation; 42 drums or 6 SWBs per shipment) will be able to readily address the identified throughput, if not impacted by RH-TRU/TRUM shipments. The timing for when the capability re-start is needed is dependent on the timing and shipping rates required for the RH-TRU/TRUM shipments. A total of 12 combined RH and CH shipments to WIPP per week for 40 weeks each year is assumed to be the practical limit.



	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Certified/Certifiable Containers (SWBs and 55-Gal Drums)	4455												
LLBG Retrieved Conforming Waste (SWBs)	-	-	-	-	430	430	430	-	-	-	-	-	-
LPPS Feed (SWBs)	-	-	-	-	-	-	-	98	98	98	98	98	73
Modified WRAP Feed (SWBs)	-	-	-	-	-	-	125	249	249	249	249	76	-
PFNW Feed (SWBs)	70	100	100	100	100	81	81	81	81	81	81	65	-
Cumulative CH Containers (SWBs and 55-Gal Drums)	4,525	4,625	4,725	4,825	4,925	5,006	5,211	5,639	6,067	6,494	6,922	7,161	7,234

Figure 2. Processing Durations for M-091 CH-TRUM

5.2.2 RH-TRU/TRUM Shipping

The integrated alternatives included options to process the RH-TRU/TRUM waste at both the ACWPS and the RPS or to process the waste at both facilities. Based on the throughput rates identified in Table 6, and assuming processing at both facilities, the overall production rate supports completion of production at the beginning of July 30, 2030 to enable completion of WIPP certification of waste by September 30, 2030 if the RPS operations start by May 2025 and the ACWPS starts operation by June 2025 (Figure 3).

To achieve the July 30, 2030 date, 144 RH-TRUM drums from the RPS feed inventory are assumed to be processed at the ACWPS. Processing of these drums at the ACWPS is reflected in the durations shown in Table 6. To better integrate the operations, the ACWPS is recommended to be relocated to an area near the RPS. As shown in Figure 4, using the RPS without the ACWPS would extend the completion date for production of wastes to FY 2035.

Table 6. RH-TRU/TRUM Production Durations

	Number of Shifts	Number of Lines	Efficiency to Achieve Operations Duration (%)	Days in Work Week	Operations Duration (yr)
Alpha Caisson Retrieval	2	1	80	4	2.77
Alpha Caisson Processing	2	1	70	4	4.83
RPS	2	1	82	4	5.20

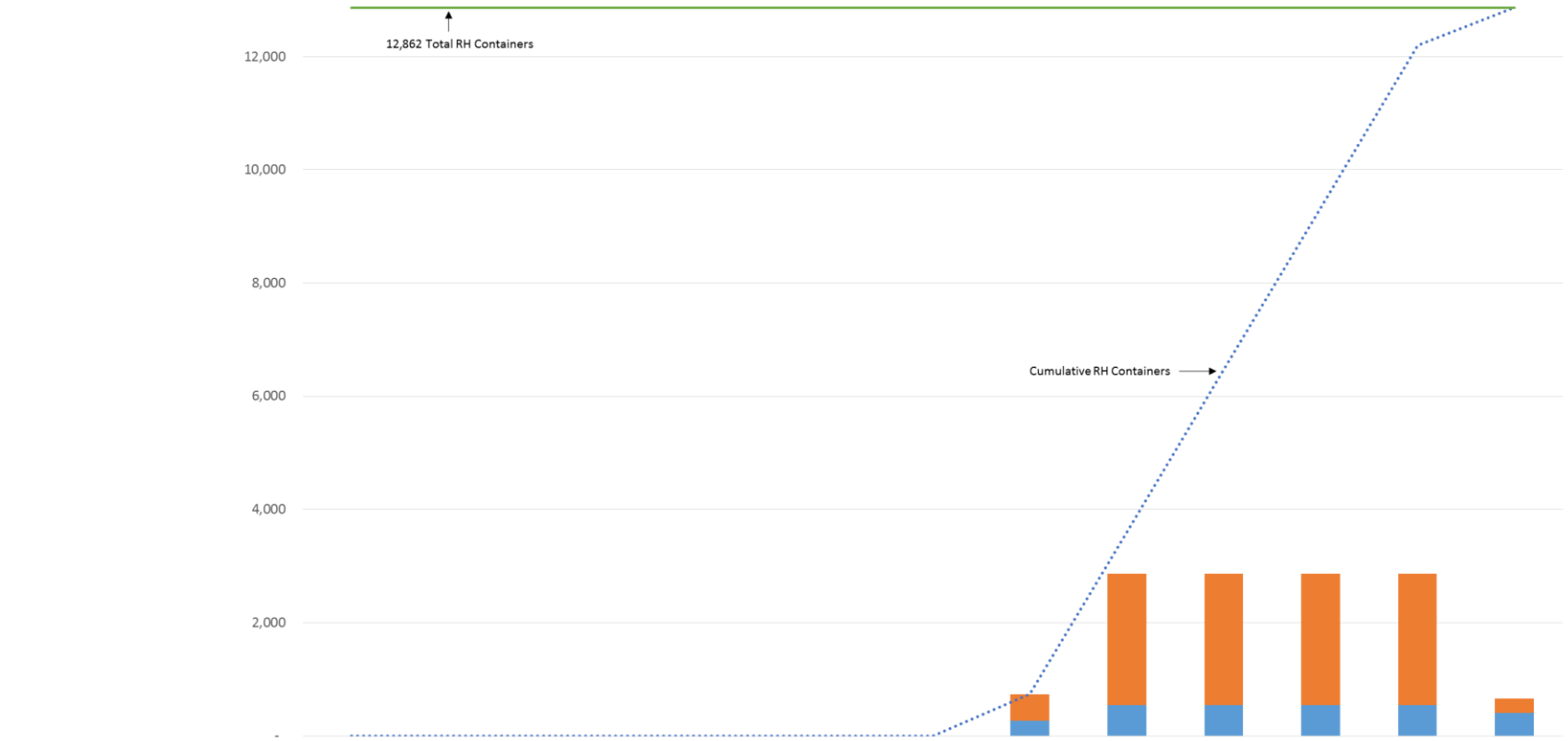
Two shipping casks options exist for RH-TRU/TRUM shipments to WIPP:

- Use of the RH 72B cask (with three drums per RLC and one RLC per RH 72B cask and one RH 72B cask per shipment)
- Use of the HalfPACT cask (with one drum per shielded canister and three shielded canisters per HalfPACT and three HalfPACTs per shipment).

As shown in Figure 5, shipments can be achieved by September 30, 2030 for the scenarios using both the RPS and ACWPS if the HalfPACT is used. This results in the need to ship nearly 6 HalfPACTs per week. Extrapolating from input provided by CBFO, this would likely result in the need to acquire an additional 47 HalfPACTs with associated conveyances to support the throughput rate. Each HalfPACT is estimated to cost ~$1.25 million based on the large quantity. As shown in Figure 6, if all the RH-TRU/TRUM is processed at the RPS, even six HalfPACT shipments per week cannot support completion of M-091 RH-TRUM to WIPP until 2036.

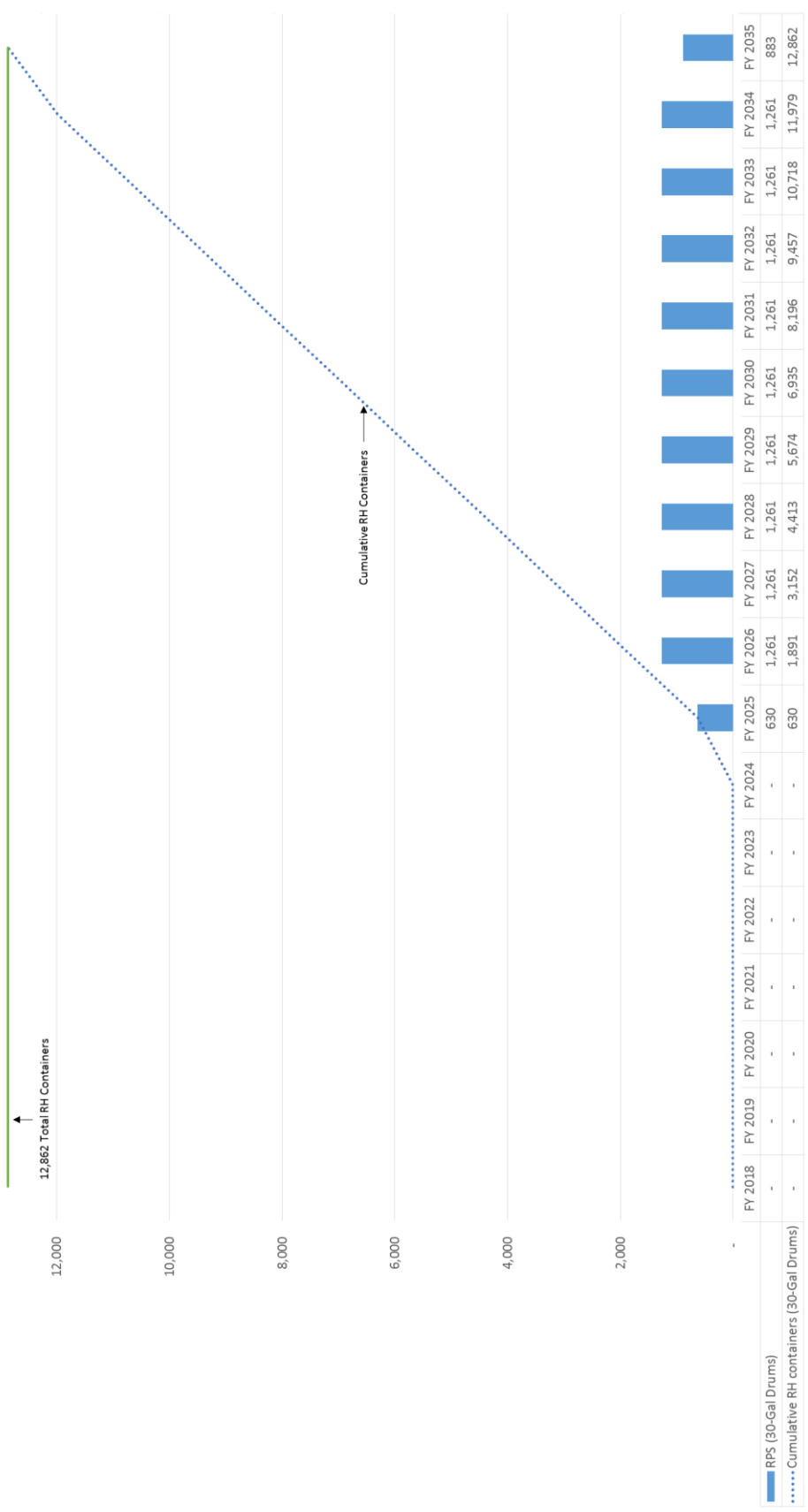
As shown in Figure 7, use of the RLC would enable earlier processing completion for alpha caissons waste due to the higher RLC curie limit as opposed to the SC-30G1. Use of the RH 72B cask would not result in completion of shipments until FY 2036 under any of the processing scenarios due to the limited turnaround rate of 6 RH 72B casks per week for WIPP, as Figure 8 depicts.

Based on the throughput requirements and capacity limitations of the RH 72B cask, use of the HalfPACT casks is recommended.



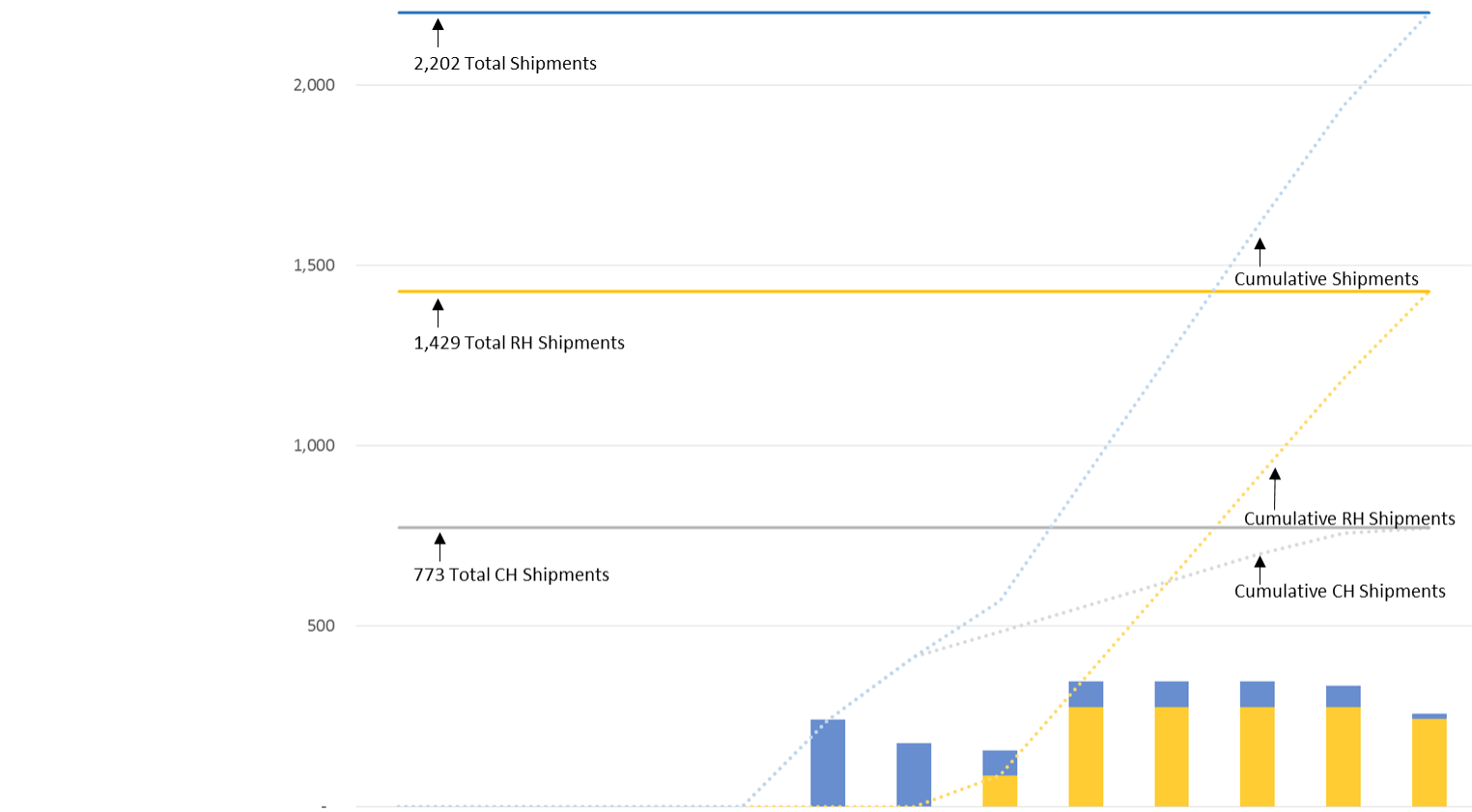
	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Alpha Caisson Capability (30-Gal Drums)	-	-	-	-	-	-	-	465	2,327	2,327	2,327	2,327	258
RPS (30-Gal Drums)	-	-	-	-	-	-	-	267	538	538	538	538	404
Cumulative RH containers (30-Gal Drums)	-	-	-	-	-	-	-	732	3,598	6,463	9,328	12,193	12,862

Figure 3. Processing Durations for M-091 RH-TRUM (with ACWPS and RPS)



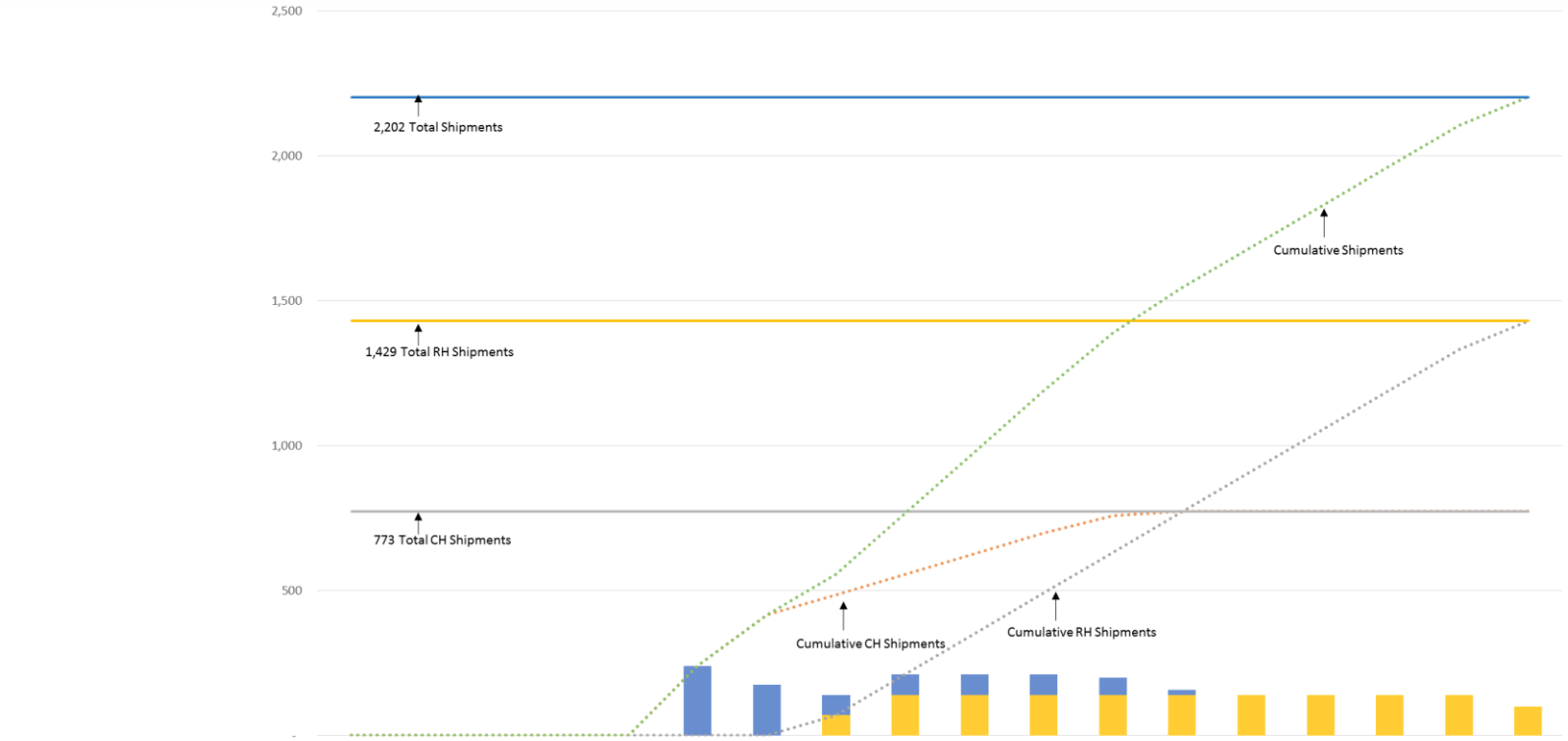
	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033	FY 2034	FY 2035
RPS (30-Gal Drums)	-	-	-	-	-	-	-	630	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	883
Cumulative RH containers (30-Gal Drums)	-	-	-	-	-	-	-	630	1,891	3,152	4,413	5,674	6,935	8,196	9,457	10,718	11,979	12,862

Figure 4. Processing Durations for M-091 RH-TRUM (Alpha Caisson Processed at RPS)



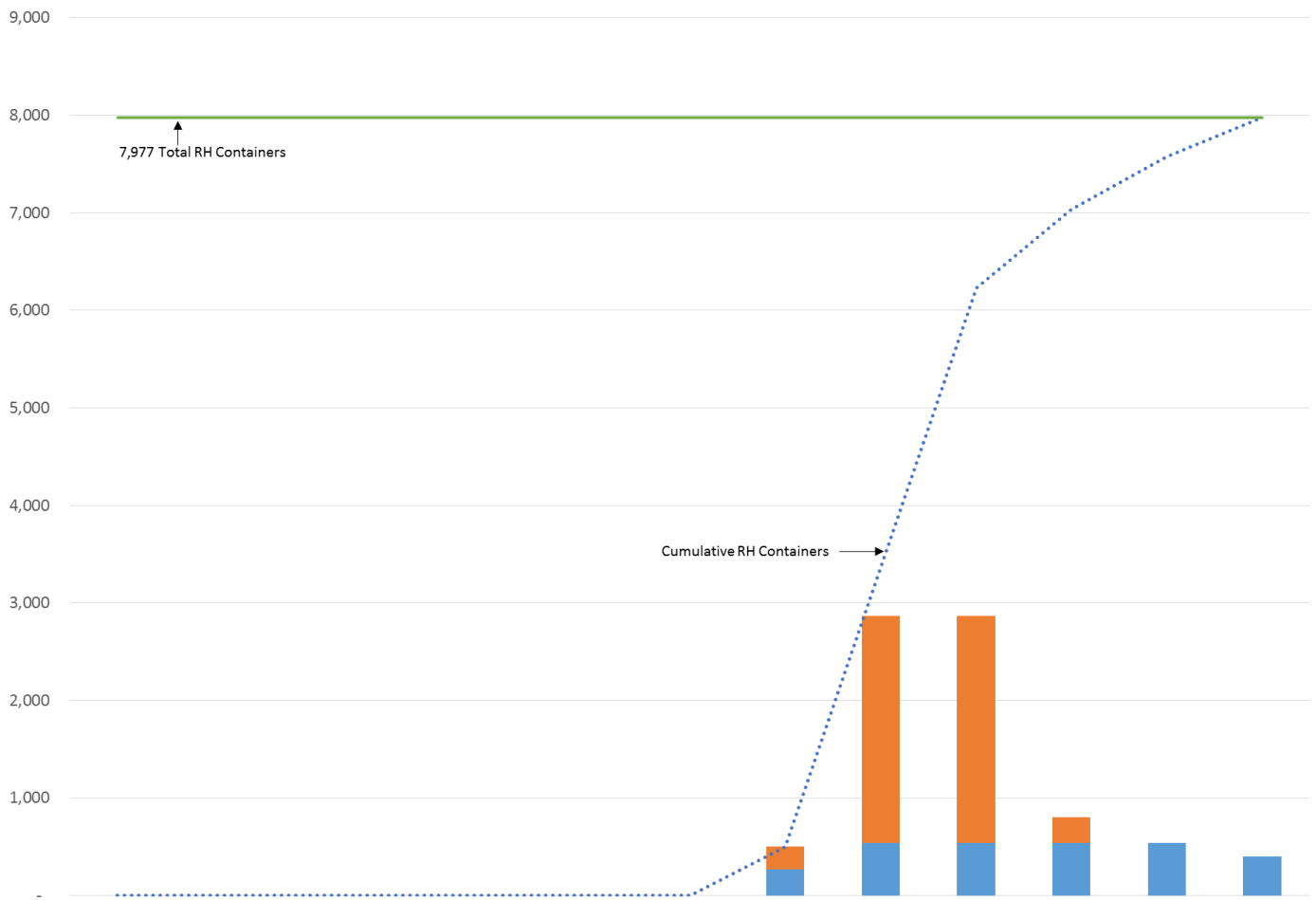
	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
CH shipments per year (TRUPACT-II)	-	-	-	-	-	240	175	70	71	71	71	60	16
RH shipments per year (HalfPACT)	-	-	-	-	-	-	-	86	275	275	275	275	242
Cumulative RH Shipments (HalfPACT)	-	-	-	-	-	-	-	86	361	636	911	1,186	1,429
Cumulative CH Shipments (TRUPACT-II)	0	0	0	0	0	240	415	485	556	627	698	758	773
Cumulative CH and RH Shipments	-	-	-	-	-	240	415	571	917	1,263	1,609	1,944	2,202

Figure 5. Shipping Durations for M-091 CH-TRU/TRUM and RH-TRUM (with ACWPS and RPS)



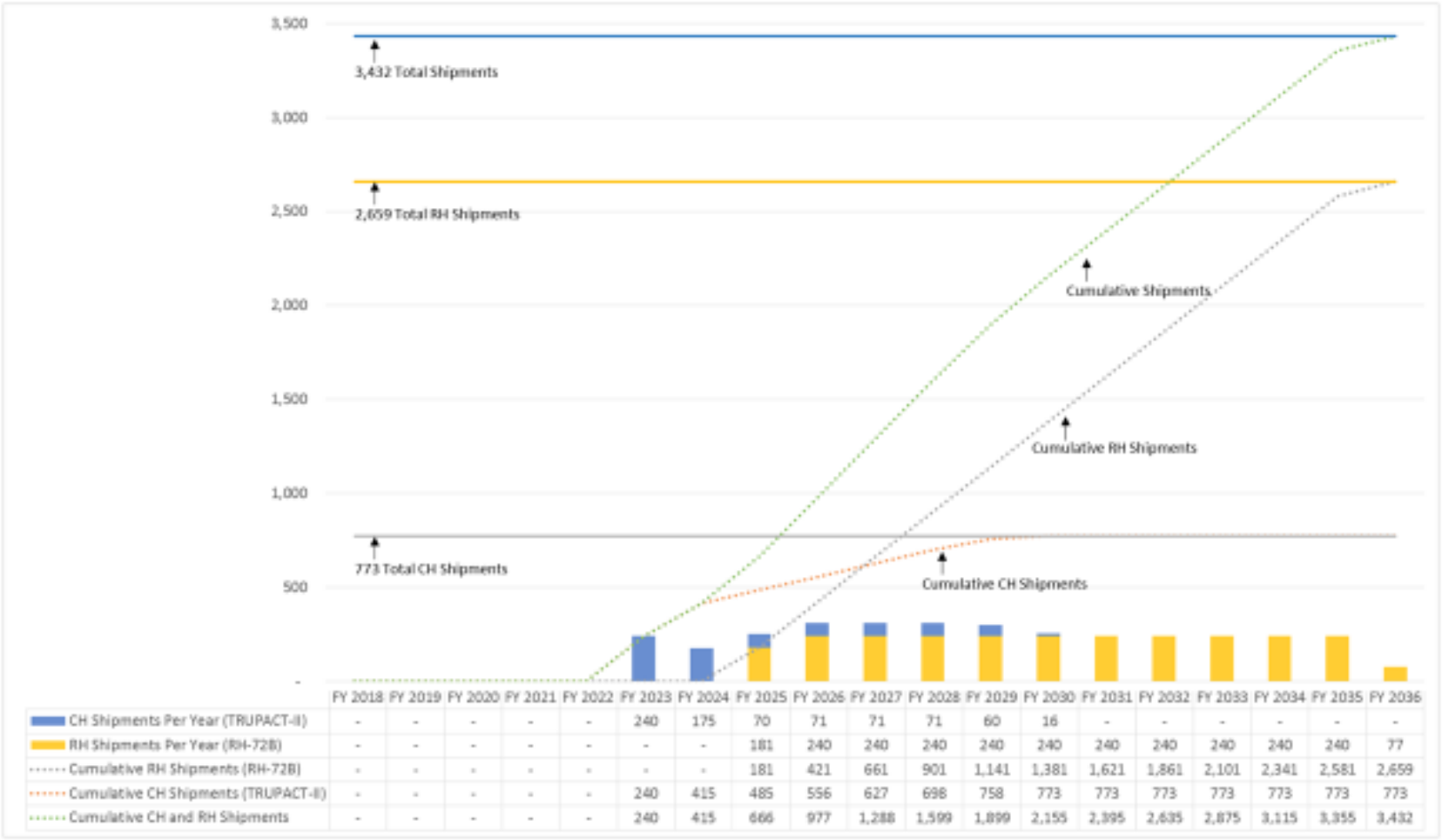
	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033	FY 2034	FY 2035
CH Shipments Per Year (TRUPACT-II)	-	-	-	-	-	240	175	70	71	71	71	60	16	-	-	-	-	-
RH Shipments Per Year (HalfPACT)	-	-	-	-	-	-	-	70	140	140	140	140	140	140	140	140	140	98
Cumulative RH Shipments (HalfPACT)	-	-	-	-	-	-	-	70	210	350	490	630	771	911	1,051	1,191	1,331	1,429
Cumulative CH Shipments (TRUPACT-II)	-	-	-	-	-	240	415	485	556	627	698	758	773	773	773	773	773	773
Cumulative CH and RH Shipments	-	-	-	-	-	240	415	555	766	977	1,188	1,388	1,545	1,685	1,825	1,965	2,105	2,202

Figure 6. Shipping Durations for M-091 Waste Using HalfPACTs and TRUPACT-IIs (Alpha Caisson Processed at RPS)



	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Alpha Caisson Capability (30-Gal Drums)	-	-	-	-	-	-	-	233	2,328	2,328	265	-	-
RPS (30-Gal Drums)	-	-	-	-	-	-	-	267	538	538	538	538	404
Cumulative RH Containers (30-Gal Drums)	-	-	-	-	-	-	-	500	3,366	6,232	7,035	7,573	7,977

Figure 7. Processing Durations for M-091 TRUM Waste for RLCs (with ACWPS and RPS)



	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033	FY 2034	FY 2035	FY 2036
CH Shipments Per Year (TRUPACT-II)	-	-	-	-	-	240	175	70	71	71	71	60	16	-	-	-	-	-	-
RH Shipments Per Year (RH-72B)	-	-	-	-	-	-	-	181	240	240	240	240	240	240	240	240	240	240	77
Cumulative RH Shipments (RH-72B)	-	-	-	-	-	-	-	181	421	661	901	1,141	1,381	1,621	1,861	2,101	2,341	2,581	2,659
Cumulative CH Shipments (TRUPACT-II)	-	-	-	-	-	240	415	485	556	627	698	758	773	773	773	773	773	773	773
Cumulative CH and RH Shipments	-	-	-	-	-	240	415	666	977	1,288	1,599	1,899	2,155	2,395	2,635	2,875	3,115	3,355	3,432

Figure 8. Shipping Durations for M-091 Waste Using RLCs and TRUPACT-IIs

5.2.3 Recommended Shipping Option

The recommended shipping option is the **Modify WRAP for HalfPACT Loading** option. Based on the combined shipments required for CH-TRU/TRUM and RH-TRU/TRUM wastes to WIPP, as reflected in Figure 5, the use of WRAP without construction of a new facility for HalfPACT shipments is feasible if a second shift is added. WRAP has capacity to support five shipments per week on a single shift. A second shift would support combined capacity requirements if shipments are made in campaigns to avoid constant changes in equipment configurations. Therefore, acquisition of a new standalone facility for HalfPACT loading/shipment is not recommended. Modifications to WRAP to support the HalfPACT loading/shipping capability will be sufficient to support the September 30, 2030 date without acquiring a new facility.

To further alleviate shipping schedules, early re-start of WRAP to ship current inventories of WIPP certifiable waste and any conforming waste identified during RSW retrieval operations is warranted. This would limit the number of CH-TRU/TRUM shipments from production activities to an average of fewer than two per week.

6 Conclusions and Recommendations

Based on the comparison of alternatives and the shipping evaluation, the recommended alternative must include parallel processing activities for both CH- and RH-TRU/TRUM waste to achieve the completion date for shipments of M-091 waste to WIPP by September 30, 2030.

The recommended alternative based on Alternative 1 and the selected shipping option includes the following work scope:

- Retrieve alpha caissons waste using the approach identified in the **Apply Mobile Hot Cell Approach** option.
- Process alpha caissons waste using the approach identified in the **Apply 2010 Conceptual Design Processing Approach** option.
- Acquire a new standalone RPS as identified in the **Build New Facility for RH-TRU Processing System** option.
- Acquire a new standalone LPPS as identified in the **Build New Facility for Large Package Processing System** option.
- Retrieve RSW from 218-W-3A, 218-W-4B, and 218-E-12B by implementing the **Retrieval Using Heavy Equipment Capability** option.
- Process CH-TRU/TRUM in small containers at WRAP by implementing the **Repackaging Noncompliant Waste at WRAP** option.
- Maximize PFNW processing under their current license through the period of processing of M-091 wastes by implementing the **Continue Processing at PFNW under Existing License** option.
- Ship 55 gal drums and SWBs containing CH-TRU/TRUM using existing capabilities at WRAP for TRUPACT-IIs, after restart of shipping operations, by implementing the **Restart WRAP TRUPACT-II Loading** option.
- Ship RH-TRU in 30 gal drums within shielded overpacks in HalfPACTs by modifying WRAP by implementing the **Modify WRAP for HalfPACT Loading** option, which makes minor modifications to WRAP TRUPACT-II equipment and systems.

- Ship SLB2s containing CH-TRU/TRUM using mobile capability provided by the MLU for TRUPACT-IIIs within CWC by implementing the **Establish a Movable Loading Facility for TRUPACT-III** option.
- Certify CH-TRU/TRUM using equipment supplied by the Central Characterization Project at the WRAP complex by implementing the **Certification** option.
- Expand storage capability by implementing the **Develop Contingency Mixed-Waste Storage Area** option.

Under this alternative, the processing and shipping operations would be performed per the summary schedules depicted in Figures 9 and 10 for M-091 and non-M-091 waste inventories. The required capabilities would be acquired per the schedule shown in Figure 11. The budget profile is depicted in Figure 12.

Final siting of new facilities will require a formal siting evaluation. Assumed siting of new facilities for this evaluation are centrally located (Figure 13). The final siting should consider relocation of the ACWPS to an area near the RPS or combining the ACWPS with the RPS for better integration of operations.

The ROM total estimated cost through completion of activities within the scope of the recommended alternative, including M-091 and non-M-091 activities, is ~$1.7 billion (burdened, un-escalated) or $2 billion (burdened, escalated). The budget profile (burdened, escalated) that aligns with the schedule is reflected in Figures 9 and 10. Based on maturity of the technical input, the cost estimate range is -50% to +100% of the estimated value. Note that Figures 9 and 10 do not show certification or storage costs.

The cost estimates do not include potential costs associated with retrieval and disposition of collocated Classified Waste. The process to determine the scope, cost, and schedule for addressing these wastes are identified in the document and should be expedited to avoid future impact to planning and execution of activities for retrieval, characterization, processing/treatment, certification, storage, and shipping of the M-091 waste within schedule.

The applicable capabilities and facilities in the recommended alternative that require inclusion in the TPA milestone change request to satisfy TPA Milestone M-091-52 are as follows:

- Acquire an alpha caissons retrieval system and an ACWPS.
- Acquire RSW retrieval capability for 218-W-3A, 218-W-4B, and 218-E-12B LLBGs that provides for retrieval using heavy equipment.
- Acquire a new standalone LPPS for processing CH waste in large containers.
- Acquire a new standalone RPS for processing RH waste in drums, SWBs, and large containers.
- Modify WRAP to enable HalfPACT shipments using the existing TRUPACT-II capability.

M-091 Volume & Cost Summary

(All numbers are approximate and based on CHPRC-03264-draft)

Based on project maturity, the expected accuracy range of estimated values is -50% to +100%

	Units	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total	
																Approx Volume	Approx Cost
TRUM/MLLW Repack																	
Offsite Commerical	(m^3)	280	280	* *M-091-47 Series 400	400	400	400	320	320	320	320	320	320	260		4,340	
Offsite Commericial Cost	($M)					$3	$3	$9	$9	$9	$9	$10	$10	$10			$72
CH Small Container	(m^3)								180	360	360	360	360	110		1,730	
CH Small Container Cost	($M)		$1	$2	$3	$5	$5	$34	$13	$14	$14	$14	$14	$15			$134
CH Large Package	(m^3)									390	390	390	390	390	290	2,240	
CH Large Package Cost	($M)		$1	$4	$4	$10	$16	$54	$43	$18	$18	$19	$19	$20	$20		$246
RH -Caisson	(m^3)									2	5	5	5	5	17	39	
RH- Caisson Cost	($M)		$1	$5	$4	$27	$20	$44	$51	$13	$10	$10	$11	$11	$10		$217
RH - Processing	(m^3)									30	65	65	65	65	50	340	
RH- Processing Cost	($M)		$1	$5	$4	$12	$17	$74	$89	$26	$35	$36	$37	$37	$38		$411
Approximate Cost	($M)		$4	$16	$15	$57	$61	$215	$205	$80	$86	$89	$91	$93	$68	8,689	$1,080
ROM Cost Range*	($M)		**$2-8**	**$8-32**	**$7-30**	**$28-114**	**$30-122**	**$107-430**	**$102-410**	**$40-160**	**$43-174**	**$44-178**	**$45-182**	**$46-186**	**$34-137**		**$540-2162**
*** M-091-47 Series costs not shown.*																	
Retrieval RSW (Trench and Caissons)																	
Trench RSW	(m^3)						850	850	850							2550	
Trench RSW Cost	($M)		$2	$2	$2	$36	$52	$62	$27								$183
Alpha Caissons	(m^3)									4	7	7	5			23	
Alpha Caissons Cost	($M)		$1	$4	$4	$7	$12	$31	$36	$13	$18	$18	$15	$13	$5		$177
Approximate Cost	($M)		$3	$6	$6	$43	$64	$93	$63	$13	$18	$18	$15	$13	$5	2573	$360
ROM Cost Range*	($M)		**$1-6**	**$3-12**	**$3-12**	**$21-86**	**$32-128**	**$46-186**	**$31-126**	**$6-26**	**$9-36**	**$9-36**	**$7-30**	**$6-26**	**$2-10**		**$180-720**
Shipments to WIPP																	
CH Shipments								240	170	70	70	70	70	60	20	770	
CH Shipment Cost	($M)					$1	$7	$7	$7	$8	$8	$8	$8	$14	$16		$84
RH Shipments										90	270	270	270	270	240	1410	
RH Shipment Cost	($M)							$1	$5	$8	$8	$8	$8	$8	$10		$56
Approximate Cost	($M)					**$1**	**$7**	**$8**	**$12**	**$16**	**$16**	**$16**	**$16**	**$22**	**$26**	**2180**	**$140**
ROM Cost Range*	($M)					**$1-2**	**$3-14**	**$4-16**	**$6-24**	**$8-32**	**$8-32**	**$8-32**	**$8-32**	**$11-44**	**$13-52**		**$70-280**

Note - Costs Certification, Storage not shown

Figure 9. Volumes and Costs for M-091 Waste Inventories

Non-M-091 Volume & Cost Summary

(All numbers are approximate and based on CHPRC-03264-draft)

Based on project maturity, the expected accuracy range of estimated values is -50% to +100%

	Units	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	Total	
																Approx Volume	Approx Cost
TRUM/MLLW Repack																	
Offsite Commerical	(m^3)	20														20	
Offsite Commericial Cost	($M)	$6															$6
CH Small Container	(m^3)	130	130													260	
CH Small Container Cost	($M)	$15	$13	$1													$29
CH Large Package	(m^3)		260	260	180											700	
CH Large Package Cost	($M)		$21	$21	$21	$10											$73
RH -Caisson	(m^3)															0	
RH- Caisson Cost	($M)		$8	$6													$14
RH - RSW	(m^3)		120	120	60											300	
RH- RSW Cost	($M)		$41	$41	$42	$13											$137
Approximate Cost	($M)	$21	$83	$69	$63	$23										1,280	$259
ROM Cost Range*	($M)	**$10-42**	**$41-166**	**$34-138**	**$32-126**	**$11-46**											**$129-518**

Notes - Costs include post processing demo

Shipments to WIPP																	
CH Shipments			110	90	90	80	80	80	80	80	80	80				850	
CH Shipment Cost**	($M)		$9	$9	$9	$10	$12	$18	$16	$12	$10	$10					$115
RH Shipments			180	180	180	180	180	180	180	180	180	180				1800	
RH Shipment Cost	($M)		$9	$9	$9	$9	$10	$10	$10	$10	$10	$10					$96
Approximate Cost	($M)		$18	$18	$18	$19	$22	$28	$26	$22	$20	$20				2650	$211
ROM Cost Range*	($M)		**$9-36**	**$9-36**	**$9-36**	**$9-38**	**$11-44**	**$14-56**	**$13-52**	**$11-44**	**$10-40**	**$10-40**					**$105-422**

Note - Costs Certification, Storage not shown

* *Includes TRUPACT-II and TRUPACT-III Costs*

Newly Generated Waste																	
CH TRU/TRUM	(m^3)		880	880	880	880	880	880	880	880	880	880				8800	
RH TRU/TRUM	(m^3)		90	90	90	90	90									450	
Total Volume m3																**9250**	

Figure 10. Volumes and Cost for Non-M-091 Waste Inventories

M-091 New Capability

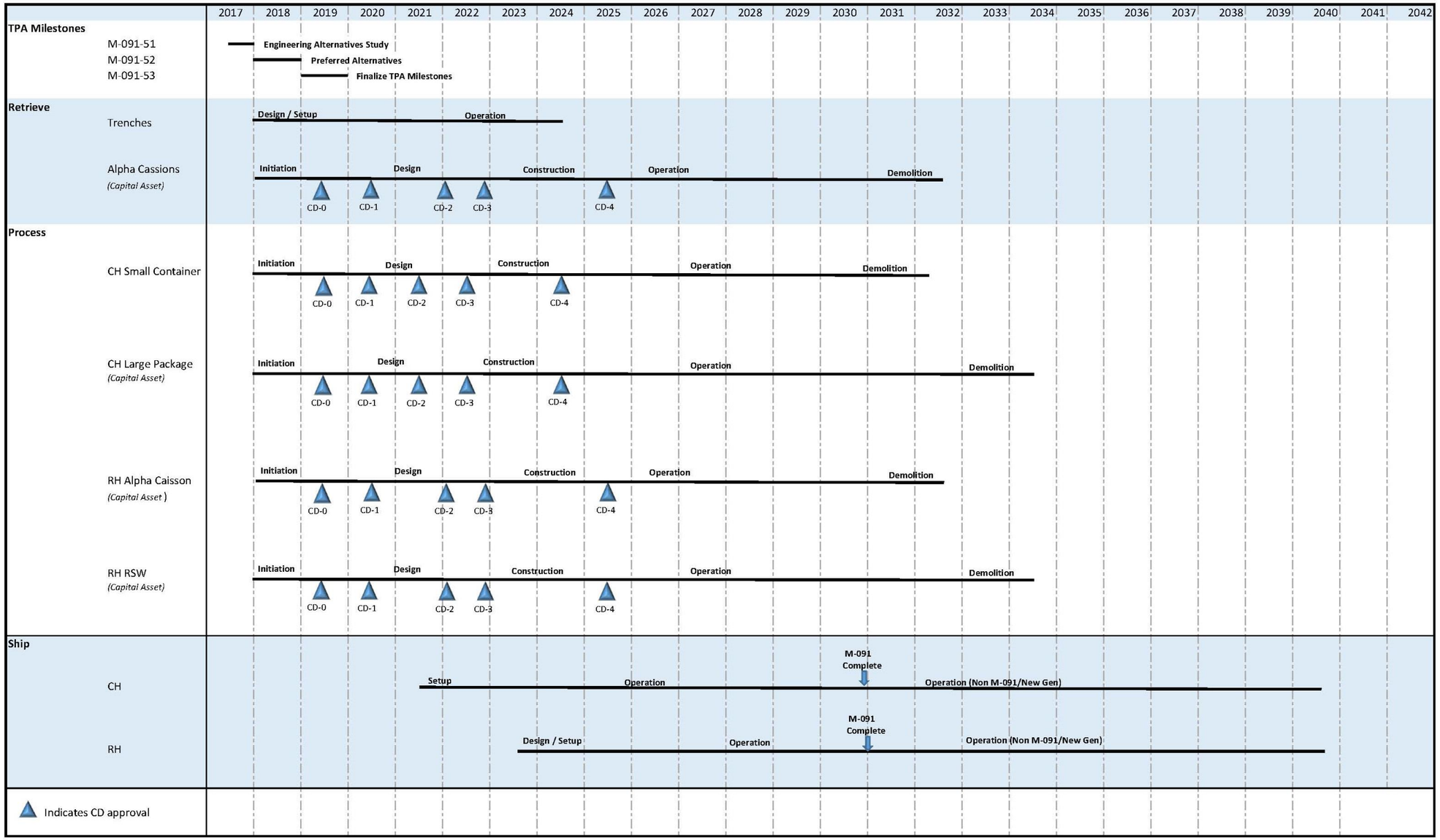


Figure 11. Capability Acquisition Schedule

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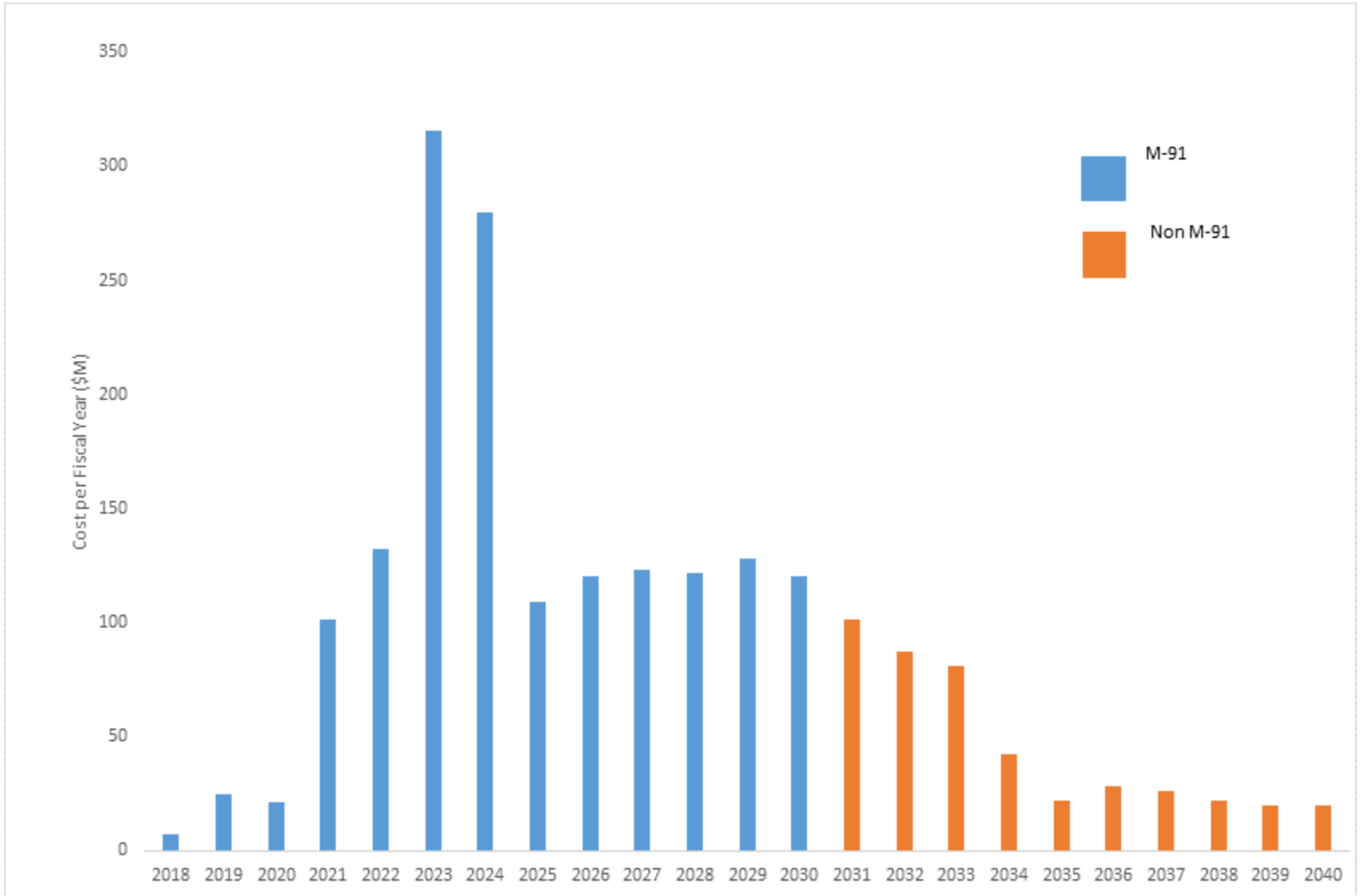

Figure 12. Budget Profile

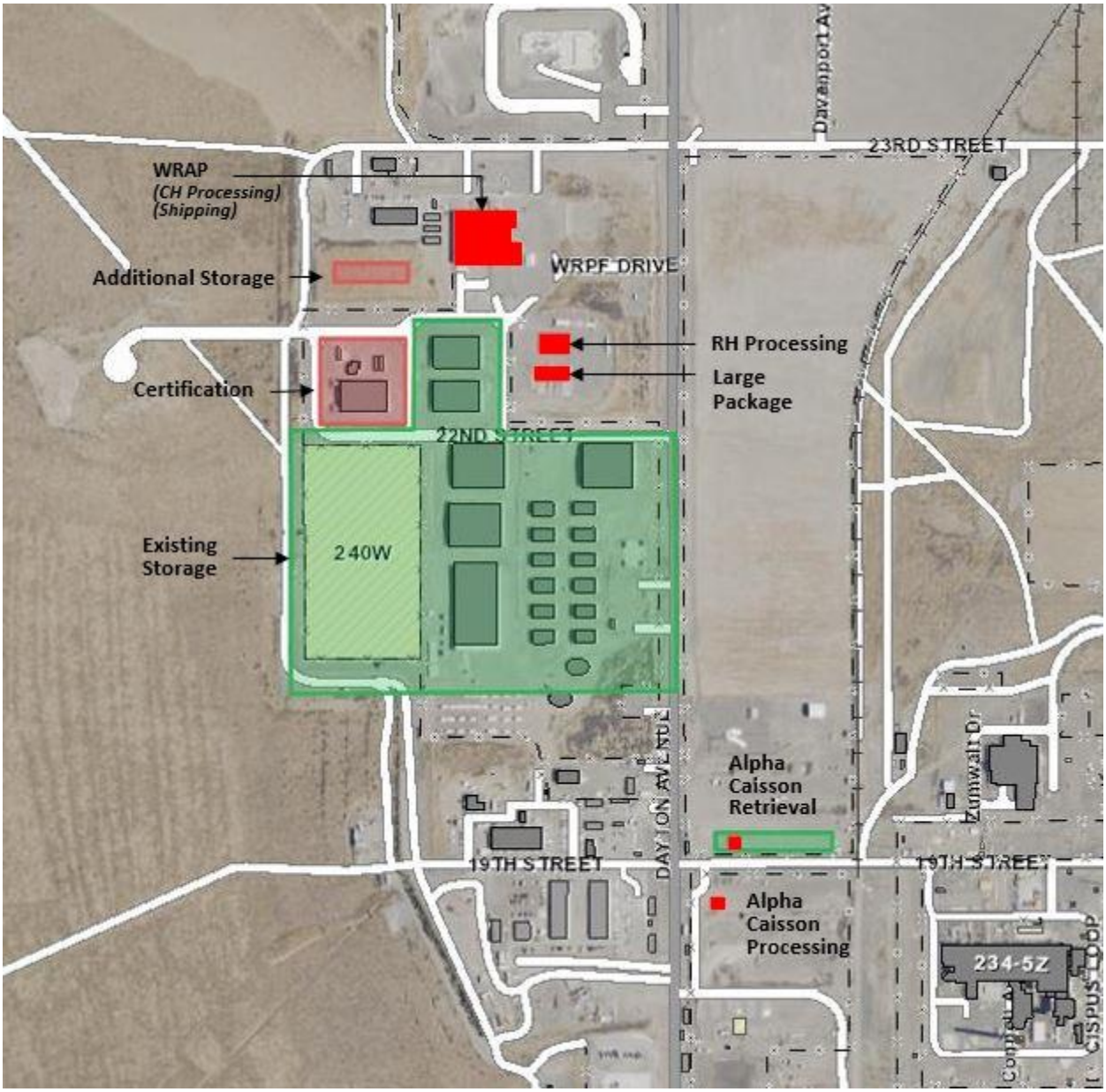

Figure 13. Recommended Alternative Facility Locations (Excluding Perma-Fix Northwest)

6.1 Additional Considerations

To complete off-shipment of all TRUM waste within the scope of M-091-52 by September 30, 2030, as required by TPA Milestone M-091-48, and to complete retrieval and designation of all RSW within the scope of M-091-52 by September 30, 2028, as required by TPA Milestone M-091-49, the alternative evaluation concluded the following additional actions will be required.

- PFNW processing under the existing license must be maximized through June 30, 2030 (including 1,600 m^3 total from FYs 2019 through 2022). The PFNW capacity and the LPPS capabilities are not sufficient to satisfy large container throughput requirements individually. Utilization of two processing lines with two shifts a day for 7 days a week at PFNW after 2022 and three shifts a day for 5 days a week at the LPPS is required to satisfy the September 30, 2030 date.

- The MNA approach must be accepted for the inventories specifically identified in this document. The conclusions and recommendations of this document are not valid if the MNA approach is not implemented for the identified waste packages.
- HalfPACTs must be used for shipment of RH-TRU/TRUM to WIPP using shielded containers. An additional 47 HalfPACT containers are estimated to be required to support the anticipated seven shipments/week needed to satisfy the September 30, 2030 date for completion of shipments. The additional HalfPACTs are assumed to be acquired by CBFO. RH 72B casks would not provide the required throughput capability to support completion of RH-TRU/TRUM shipments to WIPP by September 30, 2030.
- CH-TRU/TRUM shipments to WIPP must start at the beginning of FY 2023 to minimize overlap in CH-TRU/TRUM and RH-TRU/TRUM shipments. This will enable use of WRAP for HalfPACT shipments using an additional operating shift, but without building a standalone HalfPACT shipping facility and will free up storage capacity at SWOC, such that contingency storage capacity is not required.
- RSW retrieval must start in FY 2022 at the LLBGs to complete retrieval by September 30, 2028. Additionally, retrieval of conforming wastes prior to repackaging of RH-TRU/TRUM waste will enable earlier shipment of these waste and minimize overlap in shipment.

Other key assumptions that were identified that must be satisfied to achieve schedule include:

- WIPP CCP certification durations enable RH-TRU/TRUM shipments to start within 3 months after first certifiable package is produced from processing and complete within 3 months after final certifiable M-091 package is produced from processing.
- Authorizations for long-lead procurements will be received at time of CD-2 approval.
- Safety basis document reviews and approvals will be received from DOE within 90 calendar days of submittal rather than current contractual duration of 120 calendar days.
- RCRA permits will be approved within 1 year of submittal of initial draft to Ecology.

Risks were identified based on the recommended alternative scope, schedule, and cost. Key risks identified to satisfactory complete the TPA milestone include:

- WIPP waste acceptance criteria (DOE/WIPP-02-3122) requirements (or interpretation thereof) changes sufficiently to impact throughput rates for processing/treatment, characterization, certification, and/or shipment or results in the need to repackage existing inventory of WIPP certifiable containers.
- PFNW does not remain available.
- The considerable amount of parallel activities to permit, design, construct, staff, startup, and operate multiple nuclear facilities at the same time causes substantial delays because of complexity and logistics. Note that this may be exacerbated by limited availability of personnel with applicable experience.

Key risk reduction measures that were identified include:

- Support PFNW in obtaining an expanded license to increase the fissile gram equivalent limit to 1,000 g to provide increased flexibility in maximizing throughput rates and expanding inventory of waste packages eligible for processing.

- Continue to pursue authorization of alternate shielded containers with higher allowable curie content for use in HalfPACT cask to reduce the number of shipments required and the cost for the containers.
- Develop staffing strategy that addresses early personnel development and retention.

The key opportunity identified to execute this work scope more effectively is to extend the completion date for the shipments, pending WIPP approval to extend their closure schedule, as anticipated. This would likely enable elimination of the ACWPS and the CH-TRU small container processing system by providing sufficient duration to process the waste at the RPS and LPPS, respectively. This would also reduce the amount of staffing required to achieve the necessary throughput rates at each facility. The reduction in the number of facilities and staffing would reduce risks of delay caused by the amount of parallel activities to permit, design, construct, staff, startup, and operate the facilities. The approximate cost savings from extending the completion date for shipment of TRUM waste to WIPP are estimated at ~$300 million (burdened, un-escalated). Extending the completion date would also reduce the shipping efficiencies required to support shipment of RH-TRU/TRUM waste produced in a relatively short duration.

6.2 Other Opportunities and Conclusions

The following other opportunities were identified:

- LPPS and CH small container processing could be merged into a single facility to potentially reduce overall costs and minimize potential construction impacts within WRAP. Collocated systems could improve overall operations efficiencies.
- A larger percentage of wastes currently requiring retrieval could potentially be characterized as MLLW or LLW, reducing the amount of TRUM/TRU requiring processing and shipment to WIPP.

Other key conclusions related to non-M-091 inventories include the following:

- D-10 waste package processing/treatment should be formally reviewed for integration with K Basins Sludge Phase 2 rather than M-091 systems due to the nature and characteristics of the tank contents.
- The processing location for non-M-091 large containers should be reviewed in the future. Dependent on the cost and continued availability of PFNW versus the cost of the LPPS operations, the optimal location for these waste inventories may change.

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