OAK RIDGE MELTON VALLEY COMPLETION PROJECT

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ABSTRACT

Melton Valley was used between 1951 and 1986 for the disposal of solid and liquid radioactive waste and for the development of research reactors. The resulting waste units, contaminated media, and inactive research reactors now pose a risk to human health and the environment. The purpose of the Melton Valley Completion Project is to apply a results-oriented, accelerated approach that will reduce the risk to public health and to the environment from waste and contamination within the Melton Valley Watershed at the Oak Ridge National Laboratory (ORNL). The major issues identified in Melton Valley are the high inventories of short half-life radioactive waste and lesser quantities of long half-life radioactive waste, contaminant releases to surface water, and widespread contamination in soils and groundwater. The Melton Valley Completion Project addresses these conditions through a combination of remediation activities such as containment, stabilization, removal, treatment, monitoring, and land use controls.

Successful completion of the Melton Valley Completion Project will accomplish the following:

- Mitigate further impact to groundwater, reduce contaminant migration off-site by at least 90 percent, and remediate the large inventories of contaminated materials.
- Ensure that human receptors are protected from exposure to hazardous substances from the Melton Valley Watershed.
- Enhance overall protection of valley-wide ecological populations and sub-basin-level populations over most of the valley.
- Meet surface water remediation levels (Tennessee Ambient Water Quality Criteria and risk-based limits) to protect surface water in the Melton Valley Watershed within approximately 10 years after all closure elements are in place.
- Achieve progress toward meeting Maximum Contaminant Levels for radionuclides in the Clinch River, which the State of Tennessee has designated for domestic water supply.
- Continue progress in mitigating risk posed by selected waste units at the inactive research reactor facilities.

The Melton Valley Completion Project has been widely reviewed and accepted by the public through the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process, and the *Record of Decision for Interim Actions for the Melton Valley Watershed* (MV ROD) is in place. The project is already under way; a number of subprojects have been completed, while others are in progress. The U.S. Department of Energy (DOE), U. S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) are collaborating successfully on the implementation of this project. Plans are to expedite Melton Valley closure by 9 years and reduce closure costs by $85 million from the current baseline. All closure fieldwork is planned for completion in FY 2006, with a remedial action report (RAR) being completed in FY 2007.

Following are some of the major activities included in the Melton Valley Completion Project:

- closure of 2 million Ci (7.4×10^{16} Bq) of radioactivity in place under 130 acres (53 ha) of caps;
- removal of all spent nuclear fuel (SNF) from Melton Valley;
- selected removal of approximately 103,000 yd^3 (78,700 m^3) of contaminated soils and sediments;
- stabilization and selected removal of liquid waste pipelines;
- removal of 204 buried casks of transuranic (TRU) waste;
- in situ vitrification of two liquid waste seepage trenches;
- plugging and abandonment (P&A) of over 800 wells;
- demolition of 35 above-grade structures; and
- restoration of four acres (1.6 ha) of wetlands.

This paper will describe the substantial progress made to date and the planned work to successfully and safely complete these remediation activities.

INTRODUCTION

Melton Valley was used between 1951 and 1986 for disposal of approximately 2 million Ci (7.4×10^{16} Bq) of radioactive and mixed waste. The principal method for solid waste disposal was shallow land burial in unlined trenches. Deterioration of buried waste containers is ongoing, and contaminant discharges continue. Liquid radioactive wastes were disposed of initially by allowing them to seep into soils through shallow, unlined seepage pits and trenches. Later, the hydrofracture facilities were constructed to mix the wastes with cement grout and inject the grout-waste mixture deep underground.

The combination of high annual rainfall [55 in. (140 cm)], shallow groundwater conditions, and waste buried in or near the water table promotes the formation of contaminated leachate. The rate of water seepage through the uncapped burial trenches and through the shallow groundwater system to the nearby streams is rapid. Mobile contaminants can travel from source trenches to streams in hours when large storms occur.

Surface water is discharged from White Oak Creek (WOC) into the Clinch River. Based on risk assessment models, approximately 80% of the human health risk in surface water at the White Oak Dam originates in Melton Valley. Figure 1 shows the approximate contribution of risk to surface water from major contaminant source areas in Melton Valley.

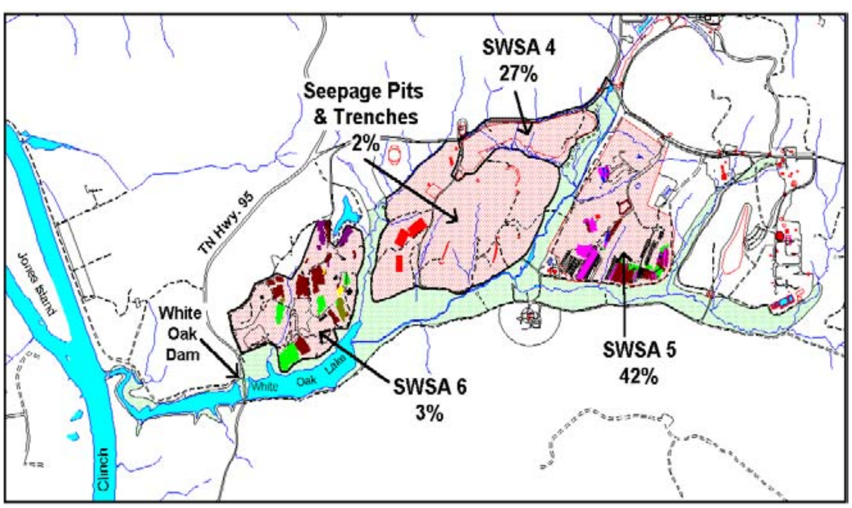

Fig. 1 Risk contribution of primary sources of off-site migration.

MELTON VALLEY COMPLETION ACTIONS

The Melton Valley Completion Project has been widely reviewed and accepted by the public through the CERCLA process, and the signed MV ROD is in place. Fieldwork is already under way. Collaboration with DOE, the EPA, and the TDEC for successful implementation is ongoing, and additional innovative work processes are being employed such as a streamlined decision-making process and subcontracting strategies designed to produce execution efficiencies.

Remedial actions are illustrated in Fig. 2 and discussed below.

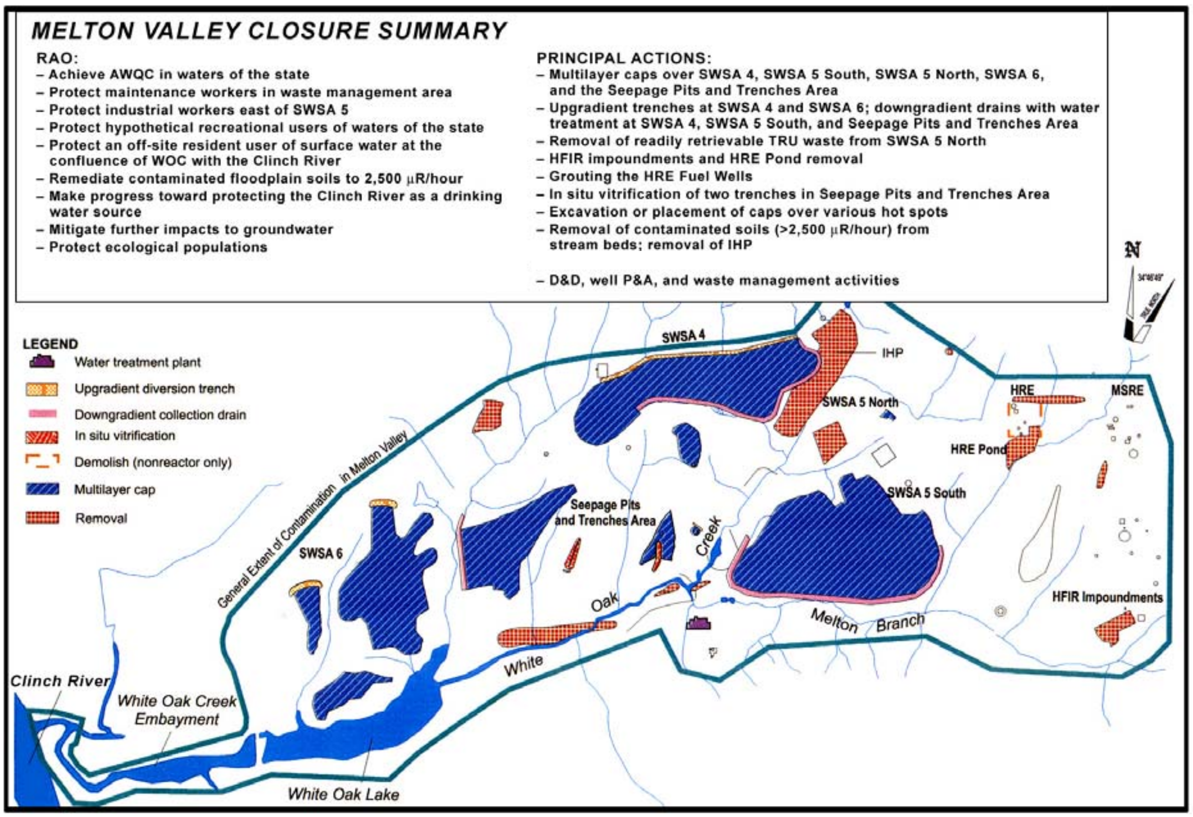

Fig. 2 Remedial actions for the Melton Valley Completion Project

Capping

Shallow land burial was used routinely for disposal of solid low-level radioactive waste (LLW) between the laboratory startup in 1943 through 1986, when improved disposal technology was implemented. ORNL has six LLW burial grounds designated as Solid Waste Storage Areas (SWSAs), three located in the main plant area and three in Melton Valley. The principal waste burial sites are SWSAs 4, 5, and 6 in Melton Valley. Early burial procedures involved the use of unlined trenches and auger holes covered by either soil from the trench excavation or by a combination of concrete caps and soil (i.e., minimal hydrologic control). Burial of LLW in unlined trenches and auger holes ceased in 1986 when ORNL began placing LLW in concrete-lined silos below grade in SWSA 6. Since 1988, this waste was placed in concrete boxes and placed on aboveground concrete storage pads, which will be covered with a multi-layer cap before final closure.

In the early 1950s, chemically treated liquid low-level waste (LLLW) began to be disposed of in large seepage pits and trenches excavated into relatively low permeability strata of the Conasauga Group in Melton Valley. As intended, the LLLW seeped into the surrounding soil that was primarily clay. This clay soil acted as a sorption agent for some radionuclides contained within the waste. Four seepage pits and three seepage trenches were used from 1951 to 1966, until the hydrofracture method of liquid waste disposal became operable. The pits and trenches area consists of Pits 1, 2, 3, and 4; Trenches 5, 6, and 7; and secondary source contamination from these units. Trenches 5 and 7 will be treated in place using in situ vitrification. The remaining pits and trenches will be hydrologically isolated.

Multi-layer caps [130 acres (53 ha)] will be installed in SWSAs 4, 5, and 6 and in portions of the seepage pits and trenches area. These caps will minimize infiltration during precipitation and protect ecological receptors and workers from exposure to the underlying soil and wastes. The caps are also expected to provide optimal site drainage and lower the water table (particularly the large caps in SWSAs 4, 5, and 6).

Upgradient diversion trenches will be installed in SWSAs 4 and 6 and in a portion of the seepage pits and trenches area to intercept upgradient storm flow and shallow groundwater before they flow through waste areas. Surface water will be routed around caps using perimeter ditches.

Collection drains will be installed downgradient of capped areas in SWSAs 4 and 5 South, and in the seepage pits and trenches area to increase the effectiveness of hydrologic isolation. These drains will collect contaminated leachate from the waste sites, preventing release to local surface water such as WOC and Melton Branch. The collected groundwater will be treated to meet discharge limits.

The SWSA 4 cap installation is in progress. Excavation of a contaminated intermediate holding pond and relocation of a major ORNL thoroughfare has been completed to facilitate SWSA 4 hydrologic isolation. The SWSA 5 remedial design has been approved, and site preparation is in progress. SWSA 6 and pits and trenches area remedial designs are being prepared. SWSA 4 remediation will be completed in FY 2004. Remediation of SWSAs 5 and 6 and the pits and trenches area will be completed in FY 2006.

Transuranic Waste Removal

Readily retrievable waste will be removed from the lower 22 TRU trenches in SWSA 5 North. The trenches contain 204 concrete casks, 18 boxes, and 12 drums of TRU waste. This waste was emplaced during the 1970s with the intent that it would be retrieved for ultimate disposal elsewhere. The removed waste will be segregated at the Transuranic Waste Treatment Facility, and the TRU waste will be sent to the Waste Isolation Pilot Plant in New Mexico for disposal.
Preparation of the remedial design for TRU waste removal is in progress. Removal will be completed in FY 2006.

Soil and Sediment

Radiological contamination of surface soil occurs in many areas of the Melton Valley watershed. Causes of surface soil contamination include:

- material spills on the ground surface,
- contaminated biological material including leaves and animal droppings,
- pipeline leaks that caused surface contamination,
- surface breakouts of contaminated seepage and groundwater originating in primary contaminant source areas such as waste burial trenches,
- surface breakouts of contaminated seepage during operation of the seepage pits and trenches, and
- contaminated sediment deposited in the floodplains of WOC and tributaries.

Surface contaminated areas range in size from small "hot spots" for material spills, to areas less than 1 acre (0.4 ha) for most pipeline leak sites, to areas as large as several acres for the contaminated floodplain soils and sediments associated with WOC and its tributaries.

Impoundments were constructed in Melton Valley to store wastewater and provide additional settling prior to treatment or discharge to surface water bodies. Five impoundments will be addressed in this action: four impoundments that serviced High Flux Isotope Reactor (HFIR) operations and one impoundment (currently filled in and capped) that serviced Homogeneous Reactor Experiment (HRE) operations.

The LLLW system is complex, requiring buried pipelines, valve boxes, and pumping stations to transport the aqueous radioactive waste solution from the generator facilities to storage tanks, and historically for disposal in seepage pits and trenches or hydrofracture injection. These pipelines are constructed of various materials including steel, black iron, and stainless steel. The pipelines not currently in use are potential pathways for contaminant transport and will be remediated in this action.

Sediment and soil from the HRE pond and HFIR impoundments will be excavated and disposed in the Environmental Management Waste Management Facility (EMWMF). Floodplain soil and sediment that exceed agreed-upon levels in the MV ROD will be excavated and either disposed in EMWMF or used as contour fill under the various multi-layer caps.

Hot spots in the waste management area (around SWSAs 4, 5, and 6 and the seepage pits and trenches area) generally will be capped. Hot spots in the industrial use area (east of SWSA 5) generally will be excavated and either disposed of in the EMWMF or used as contour fill under the various multi-layer caps. Inactive waste pipelines will be isolated, stabilized, or removed, as necessary, to address residual contamination.

Final verification surveys will be performed to confirm clean-up and post-remediation risk levels. Soil and sediments remedial design is in progress.

Small Facilities Demolition

The New Hydrofracture Facility (NHF) was constructed in 1980 to serve as the liquid waste disposal system for ORNL. It operated from 1982 to 1984 during which time nearly 3 million gal (11 million L) of waste/grout mixture containing over 750,000 Ci (2.8×10^{16} Bq) of activity was injected into deep shale formations. The facility consists of three hot cells (well cell, mixing cell, and a pump cell), injection pump rooms, office, control room, storage areas, change rooms, compressor room, penthouse (well pipe storage room), roof area, slotting waste pit, and equipment room. Additional outside facilities include the dry solids storage bins, utilities, and ancillary equipment. The HRE auxiliary facilities consist of a waste evaporator, a charcoal absorber, associated waste and valve pits, and a decontamination pad/shed. The NHF and the HRE auxiliary facilities will be demolished.

Waste storage facilities in SWSAs 5 and 6 will be demolished following waste removal to facilitate cap installation. Sodium and lithium shields from the Tower Shielding Facility currently stored in SWSA 5 will be removed to facilitate cap installation.

NHF demolition is in progress with completion scheduled for FY 2004. Preparation of the remedial design for the remaining small facilities is in progress. Demolition of the remaining small facilities will be completed in FY 2006.

Seepage Trenches 5 and 7 In Situ Vitrification

In situ vitrification will be used as a cost-effective treatment for Trenches 5 and 7 in the seepage pits and trenches area. In situ vitrification involves using electricity to generate extremely high temperatures that melt contaminated soil into a matrix that traps radionuclide inventories and hazardous inorganic elements for tens of thousands of years. The high processing temperature produced during melting also destroys organic contaminants.

Trench 5 was constructed in the 1960s to meet an increasing demand for LLLW disposal at ORNL. Trench 5 consists of a 300-ft-long (91 m) by 15-ft-deep (4.6 m) trench that contained horizontal piping installed for the distribution of LLLW throughout the trench. Pipes were also installed vertically for radiation monitoring, liquid sampling, and level measurement. Trench 5 reportedly received 9.5 million gal (36 million L) of liquid waste with an activity level of approximately 312,000 Ci (1.15×10^{16} Bq). Trench 7 contains two 100-ft-long (30 m) trench segments. The construction of Trench 7 was similar to that of Trench 5. Trench 7 also reportedly received approximately 9.5 million gal (36 million L) of liquid waste with an activity level of approximately 1 million Ci (3.7×10^{16} Bq). In situ vitrification is planned only for Trenches 5 and 7 because they hold most of the curie content. Completion of field in situ vitrification operations is scheduled for September 2006.

In Situ Grouting

In situ grouting will be used for stabilization of seven HRE fuel wells in the seepage pits and trenches area. The wells (auger holes) were used in 1964 for the disposal of residual fuel. Approximately 135 gal (511 L) of four molar sulfuric acid solution containing 10.3 lb (4.67 kg) of irradiated uranium sulfate were disposed of in the wells. An auger or similar method will be used to mix grout with soil in the wells to reduce groundwater contact with the waste.

Grouting of the HRE fuel wells is part of the pits and trenches area capping (hydrologic isolation) project due to their proximity to seepage Trench 5 and will be completed in FY 2006.

Hydrofracture Well Plugging and Abandonment

P&A will be used to isolate four hydrofracture injection wells and 107 associated observation and monitoring wells in Melton Valley that potentially are a pathway for contaminant transport and interfere with installation of multi-layer caps and other cleanup activities. The hydrofracture process involved injecting liquid waste and tank sludge mixed with grout and additives under pumping pressures of 2000 psi (1.4×10^7 Pa) or greater into a low-permeability shale formation at depths of between 800 ft (240 m) and 1000 ft (300 m). The injected slurry spread along induced fractures for several hundred feet from the injection wells, forming multiple thin grout sheets [e.g., often less than 1/8 in. (0.32 cm) thick]. The hydrofracture waste disposal process resulted in emplacement of approximately 10.1 million gal (38.2 million L) of radioactive wastes and grout containing an aggregate of approximately 1.4 million Ci (5.2×10^{16} Bq) of radioactivity over 25 years (1959-1984). The well bores are potential pathways for the migration of contaminants from deep geologic formations to the surface environment and freshwater zone. P&A seals the well in a way that maintains hydrologic separation among strata penetrated by the well bore. This remedial action consists of the P&A of injection and monitoring wells associated with two experimental and two operational waste injection sites, and re-completing (cleaning) of selected wells for future groundwater monitoring.

Due to the variations in the construction of the wells, combined with the presence of radiological contamination, a number of challenges were encountered during P&A activities. Adaptation of standard commercial P&A techniques and equipment was needed to successfully execute the P&A activities while minimizing personnel exposure. Well P&A will be completed in FY 2004.

Tank T-1, Tank T-2, and the HFIR Tank

The LLLW storage and collection tanks, T-1, T-2, and the HFIR tank, contain 5,500 gal (21,000 L) of waste sludge consisting mainly of ion exchange resin beads. Tank T-1 contains 2,000 gal (7,600 L) of TRU sludge. Waste will be removed from tanks T-1 and T-2, treated to destroy the organic resin, and transferred into the active LLLW system for disposition. Following waste removal, the tank shells will be grouted in-place. Due to the nature and reduced risk associated with the HFIR tank contents, the waste will be grouted in-place along with the tank shell. Remediation of T-1, T-2, and HFIR tanks will complete the tank closure program at ORNL. These actions are part of the Bethel Valley Record of Decision selected remedy.

Spent Nuclear Fuel Disposition

As part of ORNL's role in the research and development of nuclear fuels, many types of nuclear fuels were sent to ORNL following irradiation in reactors for post-irradiation examination. Following examination, the SNF was placed in below-grade storage in SWSAs 5 North and 6, primarily during the 1960s and 1970s.

The Programmatic Environmental Impact Statement Record of Decision (60 FR 28680) for SNF, issued in 1995, specified that sites with smaller inventories of SNF, like Oak Ridge, were to prepare and ship aluminum-clad SNF to the Savannah River Site (SRS) and non-aluminum-clad SNF to the Idaho National Engineering and Environmental Laboratory (INEEL). These two sites would serve as the regional storage and interim management sites for the DOE SNF until final disposition.

Oak Ridge SNF packages were retrieved from storage, transferred to a hot cell at ORNL for repackaging to meet acceptance criteria, and then transferred back to interim storage to await shipment. Three shipments of aluminum-clad SNF were made to the SRS in FY 1998. Five shipments of non-aluminum-clad SNF were made from Oak Ridge to the INEEL in 2003.

Remedial Action Report

Following completion of field activities associated with the above actions, an RAR will be prepared documenting completion of the MV ROD remedy implementation. The RAR will describe the activities completed; document the pre- and post-remediation conditions; summarize the results of field construction testing, monitoring, sampling, or other measurements; summarize any startup activities prior to long-term operation; and document the overall cost and schedule.

MELTON VALLEY CLOSURE SCHEDULING LOGIC

Melton Valley's schedule logic is shown in Fig. 3. This sequence of cleanup actions is based on several factors, including consideration of source unit contributions to off-site releases in the watershed (e.g., SWSAs 4 and 5 are larger contributors to watershed surface water risks than SWSA 6 and seepage pits and trenches area); construction sequencing requirements (i.e., some actions are logical precursors to other actions); combination of similar tasks to facilitate cost-efficient subcontracting; completion of work as on-site and off-site waste disposal facilities come online (i.e., EMWMF, Waste Isolation Pilot Plant); coordination of the actions with national programs (i.e., SNF shipped to an off-site disposal facility); and resource availability. As an example, before a cap can be installed on SWSA 6, SNF has to be retrieved from subsurface storage located within the cap footprint; legacy waste must be removed from storage located within the cap footprint; waste storage facilities, located within the cap footprint, must be demolished; and unneeded wells, located within the cap footprint, must be plugged and abandoned. The sequence of actions shown in the Melton Valley Completion schedule logic figure is intended only to show that some actions are precursors to others and to convey an overall logic for major activities.

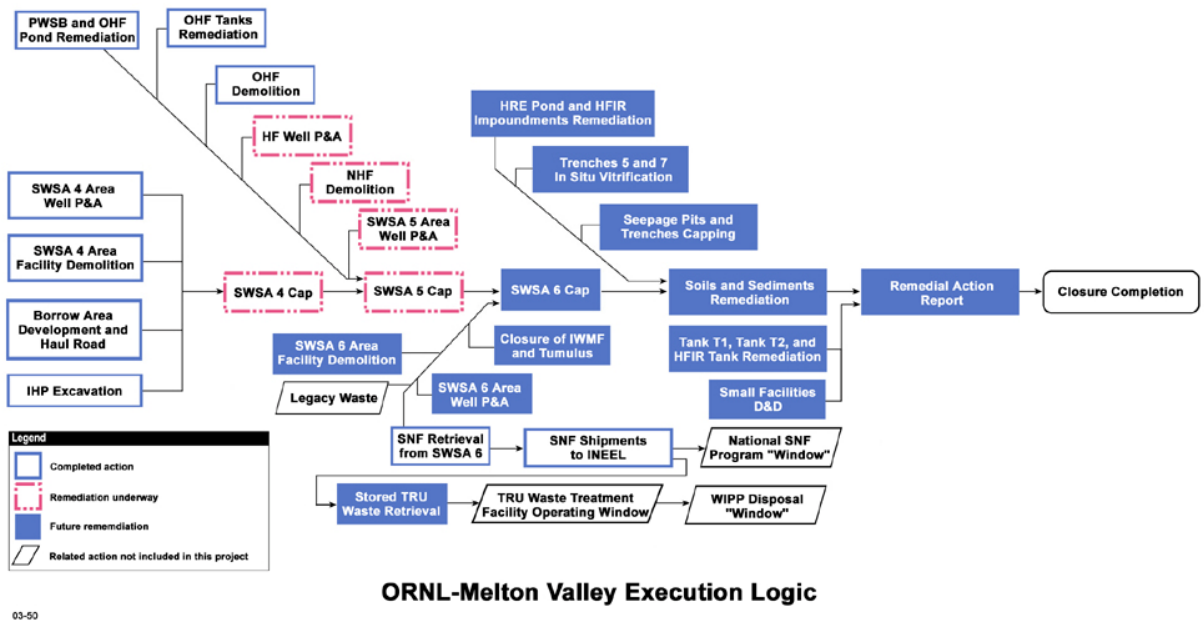

Fig. 3 Melton Valley Completion schedule logic

MELTON VALLEY COMPLETION SCHEDULE AND MILESTONES

As depicted in Fig. 4 below, all closure fieldwork will be completed by the end of FY 2006. Our accelerated plan expedites the existing plan by 9 years. The RAR will be completed in FY 2007.

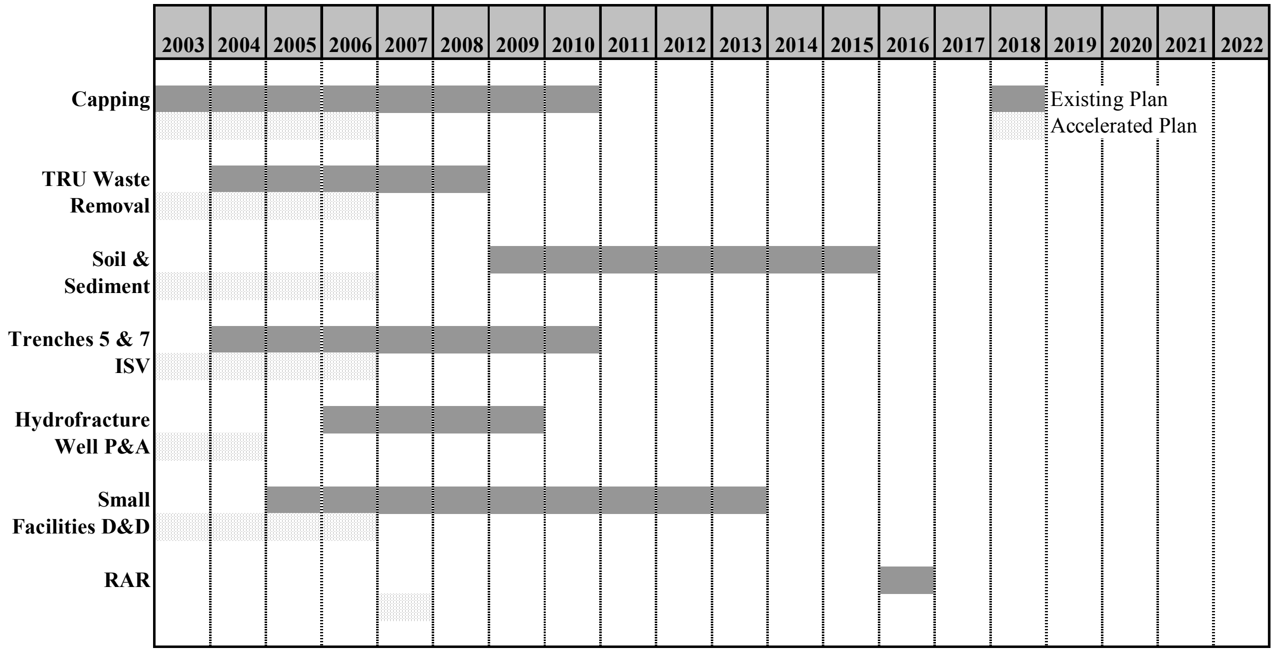

Fig. 4 Melton Valley Completion schedule

PREREQUISITES TO SUCCESS

The Melton Valley Completion Project is positioned for success: the watershed Record of Decision is signed, the scope of work is well understood, contractors are mobilized, waste disposal facilities are available for waste disposition, and remediation work has already been initiated.