PROPOSED HOLISTIC STRATEGY FOR THE CLOSURE OF F-AREA, A LARGE NUCLEAR INDUSTRIAL COMPLEX AT THE SAVANNAH RIVER SITE, SOUTH CAROLINA

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ABSTRACT

F-Area is a large nuclear complex located near the center of the Department of Energy's (DOEs) Savannah River Site in South Carolina. The present closure strategy for F-Area is based on established SRS protocol for a site-specific, graded approach to deactivation and decommissioning (D&D). Uncontaminated facilities will be closed under the National Environmental Policy Act (NEPA). Facilities requiring removal or *in-situ* disposition of residual chemical and/or radiological inventories will be decommissioned under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The F-Area Tank Farm, which is permitted under the Clean Water Act, will be closed in accordance with an industrial wastewater closure plan. F-Area closure will also involve the near- and long-term remediation of contaminated soil and groundwater resources under CERCLA.

The proposed holistic F-Area closure strategy would enhance the existing project-specific SRS closure protocol by incorporating a comprehensive area-wide groundwater modeling tool, or Composite Analysis. The use of this methodology would allow for the assessment of the relative impacts of individual projects, as well as the cumulative effect of all F-Area closure actions, on area groundwater resources. Other critical elements of the proposed strategy include (i) the consistent use of site-specific Risk Assessments (RAs) and Performance Assessments (PAs), (ii) the closer integration of selected soil and groundwater closure projects and near-term D&D projects, and (iii) the creation of an Area Core Team (ACT) consisting of DOE and selected regulator decision-makers to direct area D&D and environmental restoration activities. This holistic approach would facilitate the effective targeting of agency resources on high priority projects whose closure would have the greatest impact on achieving the desired area-wide risk-based end-state and accelerate delisting of F-Area from the National Priority List (NPL).

INTRODUCTION

F-Area is a large nuclear industrial complex located on the Department of Energy's (DOE) Savannah River Site (SRS) in southwestern South Carolina (see Figures 1 and 2). The primary mission of F-Area is to chemically process and purify special nuclear material from spent nuclear fuels, targets, and other legacy nuclear materials and to manage and store the liquid high-level waste generated by these operations. Major facilities in F-Area include F-Canyon, FB-Line, Naval Fuel Facility, Central Analytical Laboratory, Depleted Uranium Processing, and F-Area Tank Farm (see Figure 3). Chemical separation and purification processes are performed in the canyon facility, while high level liquid waste evaporation and storage take place in the tank farm. Approximately 13 percent of SRS employees work in F-Area.

As described within the *Savannah River Site Long Range Comprehensive Plan* [1], the projected end-state for F-Area is one of continued industrial land use. Over the next 20 years, F-Area will transition from its current mission of nuclear material processing and high level waste storage to one involving plutonium stabilization. The canyon, tank farm, and other excess facilities will be deactivated and decommissioned (D&D'd) and selected soil and groundwater (environmental restoration) projects will be closed. New facilities to support the plutonium stabilization mission (e.g., Mixed Oxide Fuel Fabrication and Pit

Disassembly and Conversion) may be constructed and operated [2]. This continuing industrial land use, along with the *in-situ* disposition of contamination associated with the closure and environmental restoration projects, will require long-term institutional control of F-Area.

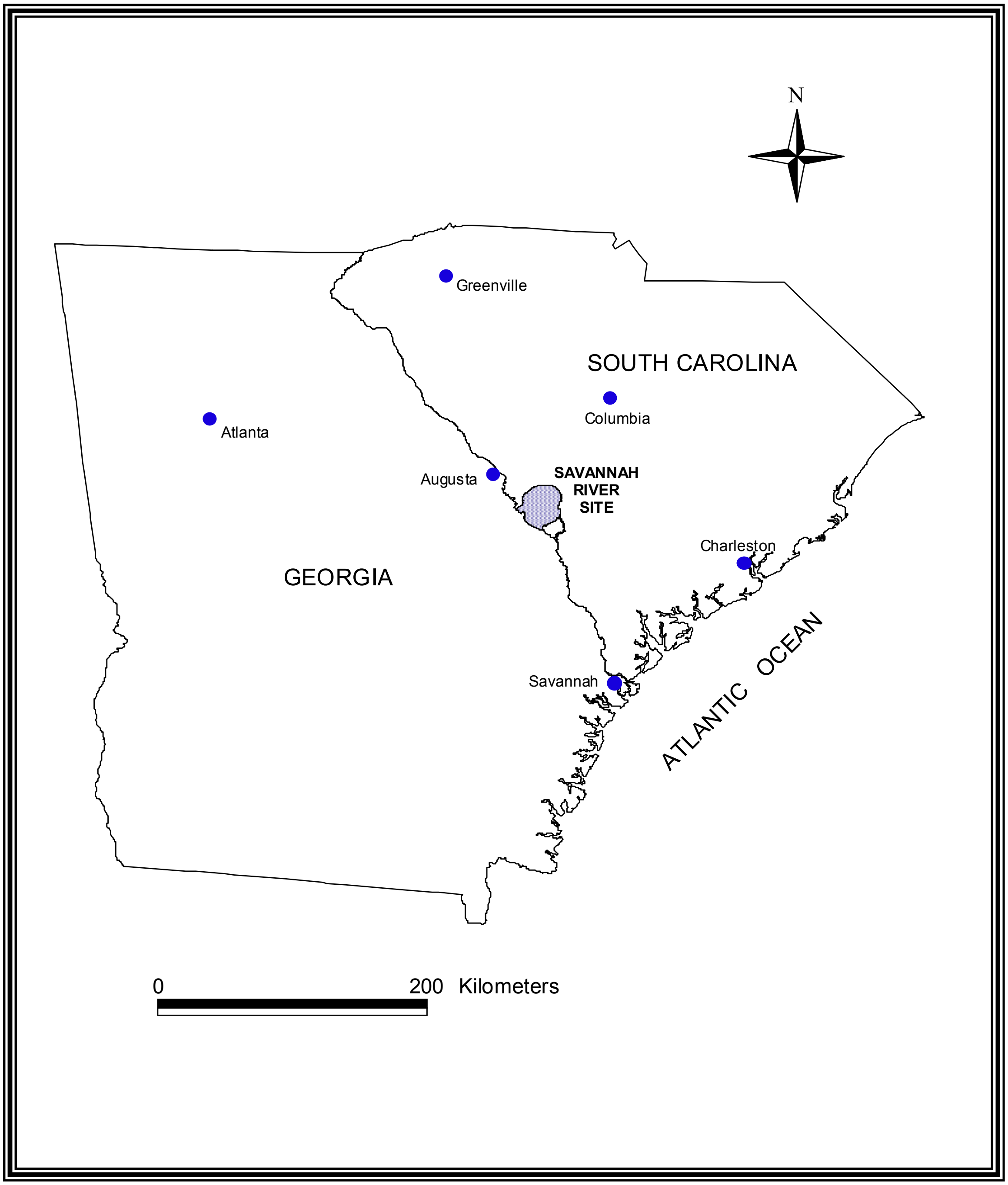

Fig. 1 Location of Savannah River Site (SRS) in South Carolina.

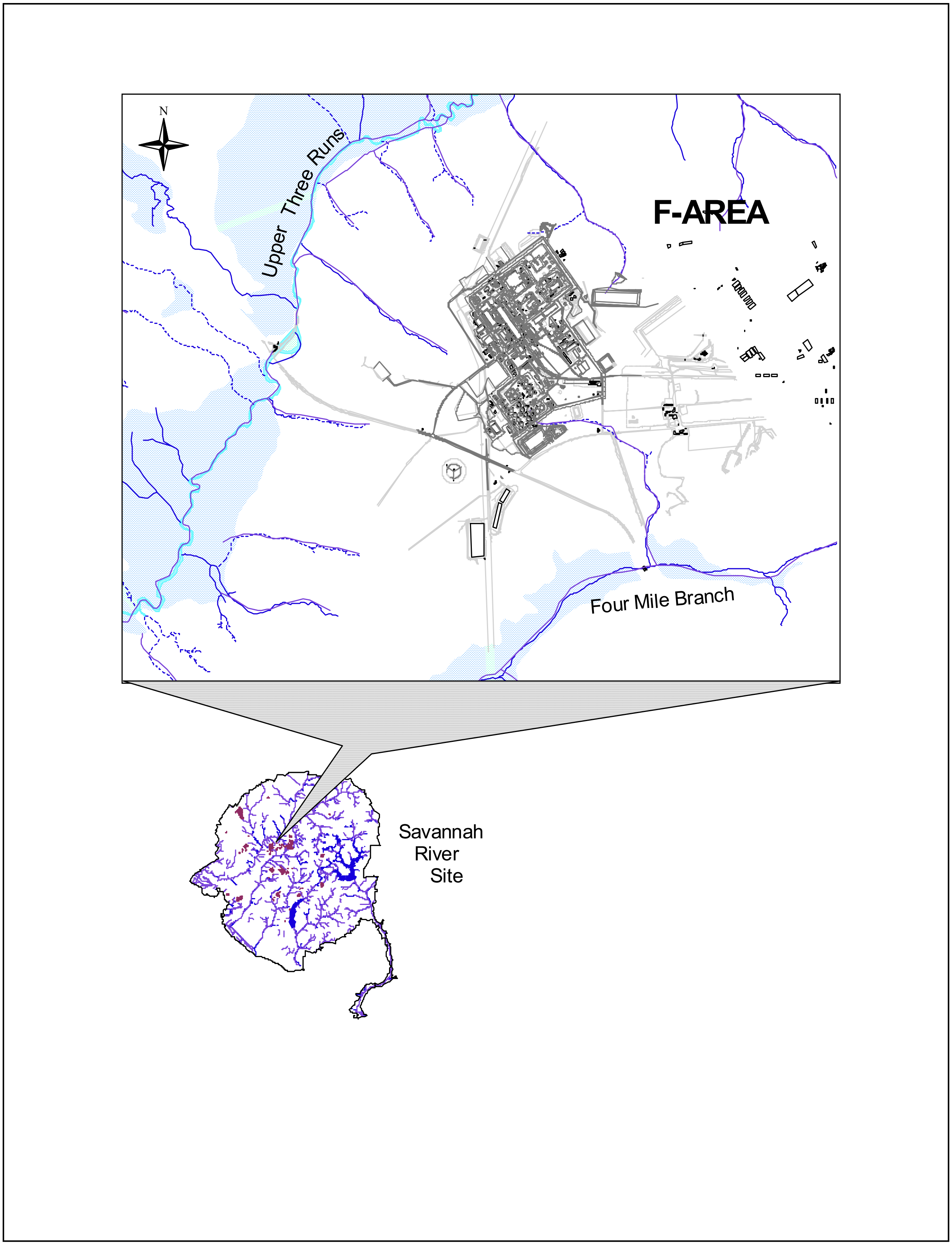

Fig. 2 Location of F-Area within the SRS.

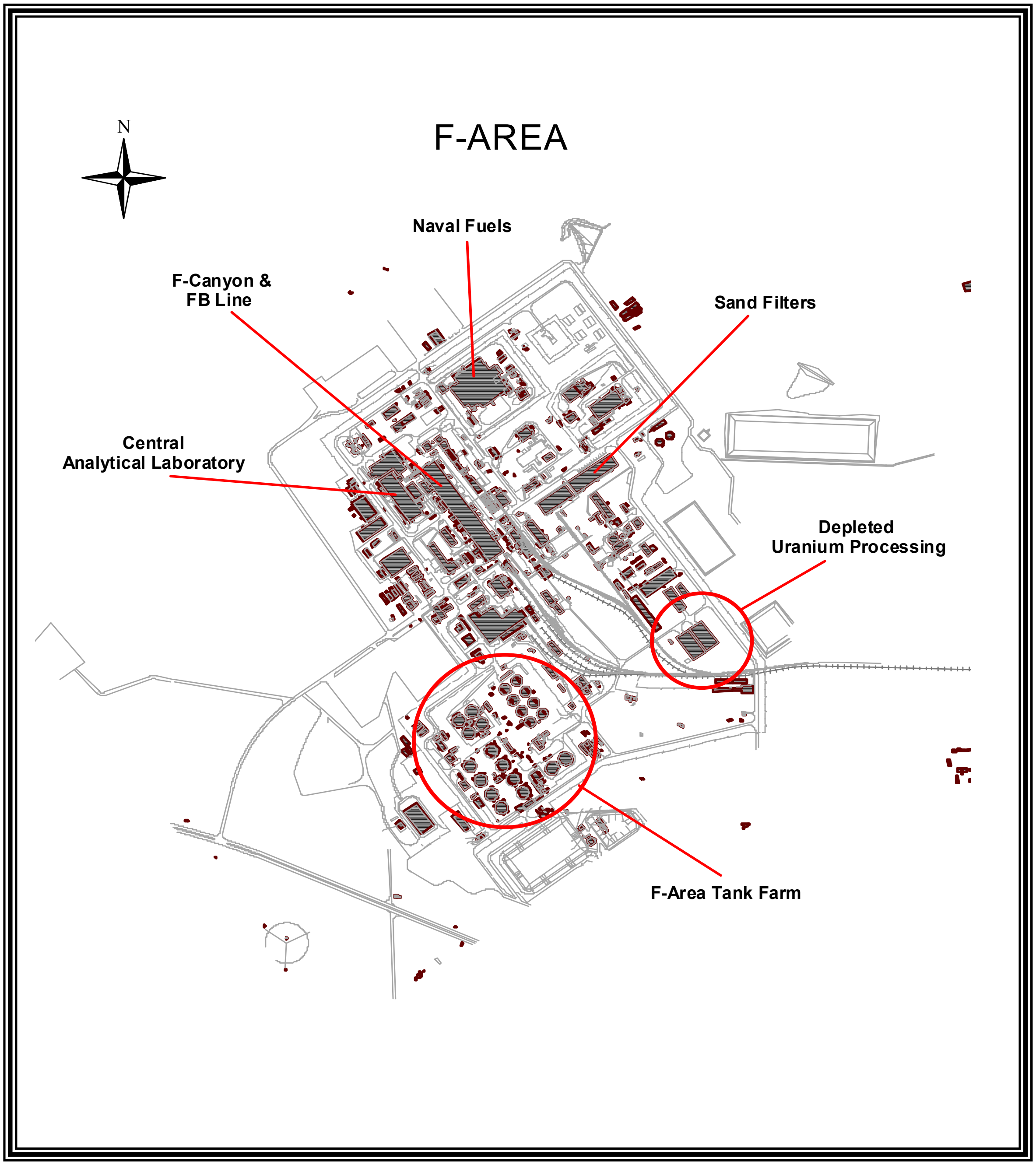

Fig. 3 Major Facilities within F-Area.

The present closure strategy for F-Area is based on the *Savannah River Site (SRS) Integrated Deactivation and Decommissioning Plan* [3]. With the exception of the F-Area Tank Farm, the closure of excess facilities in F-Area will follow the established SRS protocol for a site-specific, graded approach to deactivation and decommissioning (D&D) [4]. The level of characterization effort and magnitude of resource expenditure associated with each individual facility will be a function of that facility's direct and cumulative impact on the human environment [5]. Clean or uncontaminated facilities will be closed under the National Environmental Policy Act (NEPA). With the exception of F-Area Tank Farm, facilities requiring removal and/or *in-situ* disposition of residual inventory (chemical and/or radiological) will be decommissioned under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The F-Area Tank Farm (storage tanks and ancillary facilities), which is permitted under the Clean Water Act, will be closed in accordance with the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* [6]. The environmental impacts associated with the latter action were evaluated in the *SRS High-Level Waste Tank Closure FEIS* [7]. The near- and long-term remediation of contaminated soil and groundwater resources in F-Area will be conducted under CERCLA.

The proposed holistic F-Area closure strategy would enhance the existing project-specific SRS D&D or closure protocol by incorporating a comprehensive area-wide groundwater modeling tool, or Composite Analysis methodology. By utilizing this methodology, the relative impacts of individual projects, as well as the cumulative effect of all F-Area closure actions, could be assessed and tracked on an area-wide basis. This holistic approach would facilitate the effective targeting of agency resources on high priority projects whose remediation and closure would have the greatest relative impact on achieving an area-wide risk-based end state.

EXISTING SRS CLOSURE PROTOCOL

The D&D process currently being utilized for excess F-Area facilities involves the following sequential steps [5]:

(a) Transition from active operations

(b) Deactivation

(c) Safe storage (if applicable)

(d) Decommissioning

(e) Final end state and close out (EM completion)

(f) Long term stewardship

On a facility-specific basis, the safe storage phase may be omitted, with the facility transitioning directly to demolition and decommissioning from deactivation.

Deactivation

Following a facility's transition from active operations, it will be deactivated in accordance with Procedure *WSRC 1C, Facility Disposition Manual, Procedure 301 ["Deactivation of Facilities"]* [5]. Ideally, the objective of deactivation is to de-inventory or otherwise clean up a facility to a hazard risk level of $\leq 10^{-6}$ without adversely impacting human health or the environment. The facility could then be reused or demolished, negating the need for surveillance and monitoring for an indeterminate period and subsequent closure under CERCLA. If this is not a viable course-of-action, the desired end-state of deactivation is a passive, stable interim condition (e.g., cold, dark, and dry) that can be maintained and monitored for an extended period of time at minimal cost until decisions regarding facility decommissioning can be implemented. Toward this end, chemical, radiological, and other hazards remaining in the facility after cessation of operations are removed to the extent possible without causing a release to the environment or precluding future decommissioning actions or facility reuse. Representative facility deactivation activities include (i) removal of process material, (ii) stabilization of inventory, (iii) decontamination, and (iv) isolation of the facility and its systems from the environment. The removal of any hazardous materials will be conducted in accordance with established SRS protocols governing waste generation and disposition [8].

In the case of a Nuclear, Radiological, and Chemical hazard category facility, a Risk Assessment (RA) may be conducted prior to initiation of the deactivation process. The RA is useful in documenting the facility's risk/hazard status and evaluating deactivation alternatives for economically and safely achieving a selected risk-based end state. If insufficient data are available for purposes of conducting the RA, a characterization study of the facility may be required.

The deactivation of all excess facilities in F-Area (excluding the tank farm) will be reviewed and conducted under NEPA using classes of actions referred to as categorical exclusions (CXs). The NEPA process will be initiated by the preparation of an Environmental Evaluation Checklist (EEC). Upon completion of the deactivation process, any remaining structure, inclusive of residual chemical and/or radiological inventory, will be reclassified to reflect its current hazard category (e.g., Nuclear Hazard Category 2 or 3, Radiological, Chemical Hazard Category low or high, and "Other Industrial"). The facility's changed risk status will also be documented by an updated or new RA [3]. If required, facility deactivation can be re-entered into at any time prior to initiation of the decommissioning process.

Decommissioning

Facility decommissioning will be conducted in accordance with Procedure *WSRC 1C, Facility Disposition Manual, Procedure 501 ["Decommissioning of Facilities"]* [5]. During decommissioning, the facility structure and any residual radiological and/or chemical hazards are permanently removed or dispositioned. Facility decommissioning can follow one of two alternative pathways:

- Demolition – The facility structure and its contents are permanently removed. Any material and components that have residual value will be salvaged or recycled. Contaminants that are removed will be taken to an appropriate waste disposal site while clean rubble will be sent to a sanitary solid waste landfill.

- *In-situ* Disposition – When demolition is impractical due to a facility's robustness or level of contamination, some residual inventory (contamination) will be allowed to remain in place. After easily removed portions of the structure and its contents are recycled or appropriately dispositioned, the residual inventory will be permanently immobilized *in-situ* and site access controlled (e.g., institutional controls).

For each facility, the decommissioning process will be initiated by the preparation of a Facility Decommissioning Evaluation (FDE) and an EEC. The FDE process involves a review of the aforementioned RA, plus all available facility-specific historical data regarding operations, the storage and/or processing of radioactive or hazardous materials, and any known release to the environment. The decommissioning process encompasses a graded approach based on the results of the FDE process *WSRC 1C, Facility Disposition Manual, Procedure 502 ["Preparing Decommissioning Decision Documents"]* [5]. Facilities classified as "Other Industrial" after deactivation (hazard risk $\leq 10^{-6}$) will be decommissioned using the NEPA Categorical Exclusion (CX) process or Simple Model. It is anticipated that most excess facilities in F-Area will qualify for decommissioning using the Simple Model. Nuclear Hazard Category 2 and 3, Radiological, and Chemical facilities that pose a substantial threat of contaminant release to the environment following deactivation (hazard risk > 10^{-6}), as well as facilities and soil and groundwater (Environmental Restoration) projects listed on the Federal Facilities Agreement (FFA), will be decommissioned or closed under CERCLA as non-time critical removal actions. This closure pathway is referred to as the Engineering Evaluation/Cost Analysis (EE/CA) Model (ref: *WSRC 1C, Facility Disposition Manual, Procedure 504 ["Preparing an Analysis of Decommissioning Alternatives"]* [5]. It is anticipated that decommissioning of selected nuclear facilities within the F-Canyon Complex will follow the EE/CA model. Radiological and Chemical facilities which possess residual hazardous inventory following deactivation, but pose no substantial threat to the human environment (hazard risk ≤ 10^{-6}), will be decommissioned using a Nuclear Regulatory Commission (NRC) protocol originally developed for decommissioning commercial nuclear reactors. This closure pathway is referred to as the Streamlined Model. Following completion of the FDE decision-making process, the proposed action will be documented in an EEC prior to initiation of decommissioning activities. For those facilities closed under the EE/CA and Streamlined models, continued NEPA review and tracking beyond preparation of the EEC will not be required. However, the EEC will still be useful in identifying potential environment and regulatory issues (e.g., permitting requirements) that may need to be addressed.

A desired goal at SRS is that all decommissioning and closure actions be conducted in a manner that will not create any new waste sites. Confirmatory sampling and risk assessments of all closure sites will be conducted to ensure that desired risk-based end-states have been achieved. A Decommissioning Project Final Report will be prepared for each decommissioned facility (*WSRC 1C, Facility Disposition Manual, Procedure 506 [Preparing a Decommissioning Project Final Report"]* [5].

PROPOSED HOLISTIC CLOSURE STRATEGY

Determination of Risk-Based End-States

It is recommended that the determination of risk-based end-states for D&D activities in F-Area be based on the consistent utilization of site-specific RAs and Performance Assessments (PAs). Risk Assessments would be used to (i) document a facility's initial hazard/risk status and assist in identifying cost-effective, environmentally safe deactivation alternatives, (ii) validate a facility's updated risk/hazard status following deactivation and provide input to the FDE decision-making process, (iii) assess the levels of risk reduction that can be achieved through alternative remedial/removal actions (EE/CA Model), and (iv) ensure that the desired decommissioning end-state has been achieved. The suggested benchmark scenario for RAs in the F-Area complex is an industrial worker with an exposure duration and frequency of 25 years and 2000 hrs/yr, respectively.

The utilization of RAs prior to the initiation of deactivation would assist in defining the problem (or lack of one) up front and provide guidance regarding cost-effective and environmentally safe alternative actions that could be taken to possibly achieve the desired end state (≤ 10^{-6}) through deactivation rather than decommissioning. The savings in time and money gained by accelerating Environmental Management (EM) closure rather than having to maintain and monitor facilities until future decommissioning could be considerable (see Figure 4).

A PA similar to that used for evaluating radioactive waste disposal units would be used to model the fate and transport of radiological constituents of concern (COCs) from their source, through the environment, to selected points of compliance (e.g., 100 meter well or intruder homestead) over a specified time of compliance (e.g., 1000 years) [9]. The PA methodology would be applied on a facility-specific basis to

(i) assist in developing guidance regarding the amount of residual inventory that could be dispositioned *in-situ* without contravening risk-based performance objectives (POs) and (ii) evaluate the level of incremental risk reduction that could be achieved through alternative remedial/removal actions. PAs performed within F-Area would be based on an industrial land use scenario. For site-specific intruder-based scenarios, PAs would assume institutional control of at least 300 years. Chronic and acute exposure criteria for the intruder scenario would be 100 mrem (annual) and 500 mrem, respectively [9]. The source term data required to support both the RA and PA processes would be based on facility process knowledge, spill history, and site-specific characterization investigations (where required).

Areawide Composite Analysis

Groundwater is an excellent integrator of the impacts of D&D actions within a given area. The Composite Analysis methodology, which encompasses a comprehensive groundwater modeling tool, would be used to assess the cumulative effect of all F-Area closure actions area-wide, as well as the relative impacts of individual closure projects at selected points of compliance (POC). These POCs would be strategically located along the F-Area boundary (e.g. Four Mile Branch and Upper Three Runs) (Figure 2) to ensure that risk-based POs in contiguous land use areas are not exceeded and that waste disposal facilities located outside of F-Area are not adversely impacted. The CA methodology would also be used to identify those facilities and Soil and Groundwater Closure Projects (S&GCP) where the targeting of resources would result in the greatest return on investment with respect to achieving the desired F-Area risk-based end-state.

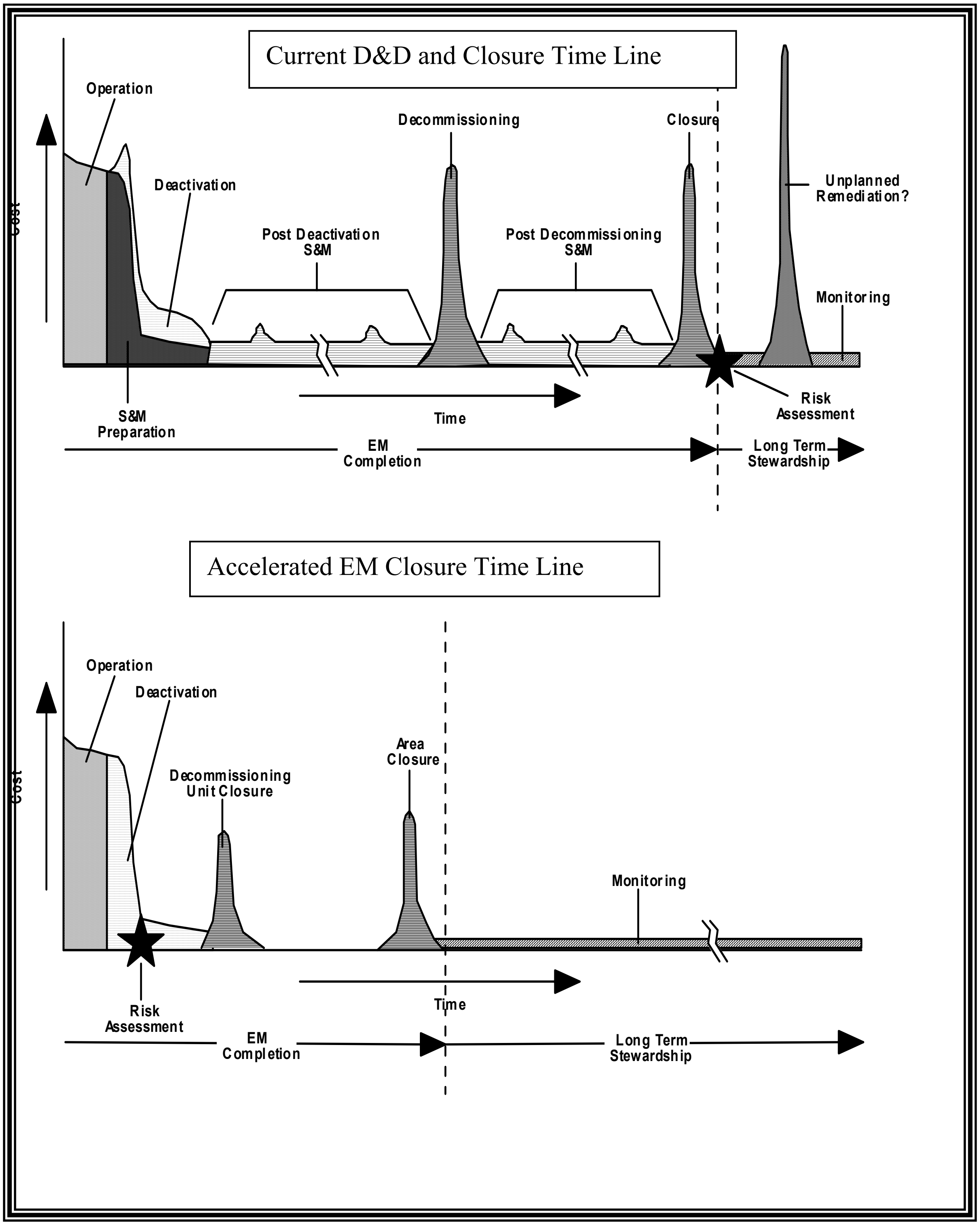

Fig. 4 Accelerated versus Current Closure Time Lines.

Implementation

It is proposed that the closure of F-Area be directed by an Area Core Team (ACT) consisting of DOE, Environmental Protection Agency (EPA), and South Carolina Department of Health and Environmental

Control (SCDHEC) decision-makers. The ACT, supported by site subject matter experts (SMEs), would advise the DOE with respect to deactivation-related activities and make all decisions regarding subsequent decommissioning and environmental restoration (S&GCP) activities (e.g., determining project-specific and area-wide POCs, defining industrial worker and intruder exposure scenarios).

It is further suggested that the closure of F-Area soil and groundwater projects be more closely integrated with near-term D&D projects. This would facilitate the more effective utilization of limited resources (e.g. site characterization and modeling services) and technical consistency between applied protocols and methodologies (e.g., performance objectives, exposure scenarios, modeling tools). Closer integration would also provide for a "clean" hand off from D&D to S&GCP (i.e., no creation of new waste sites) and accelerate the delisting of F-Area from the National Priority List (NPL).

CONCLUSION

The final closure of F-Area will involve actions related to (i) the near-term D&D of selected excess facilities (by 2006), (ii) the near- and long-term remediation of contaminated soil and groundwater projects and (iii) the long-term D&D of currently operating facilities and proposed new missions (circa 2020). The present closure strategy for F-Area follows the established SRS protocol for a site-specific, graded approach to D&D and environmental restoration. The proposed holistic F-Area closure strategy would enhance this existing closure strategy by incorporating a CA methodology to assess both the relative impact of individual projects as well as the cumulative effect of all F-Area closure actions on area groundwaters. This holistic groundwater modeling tool would assist DOE in identifying those facilities and environmental restoration projects where the application of resources would result in the greatest return on investment with respect to achieving area-wide performance objectives and risk-based end-states. Other critical elements of the proposed holistic closure strategy include (i) the consistent utilization of site-specific RAs and PAs, (ii) the creation of an ACT consisting of DOE, EPA, and SCDHEC decision-makers to direct F-Area decommissioning and environmental restoration (S&GCP) activities and (iii) the closer integration of selected S&GCP projects and near-term D&D projects to facilitate the more effective utilization of limited closure resources and accelerate the delisting of F-Area from the NPL.

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