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Engineering Evaluation/ Cost Analysis (EE/CA) for the C-Area Buildings at the Bettis Atomic Power Laboratory

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LIST OF ACRONYMS

ACM	Asbestos-Containing Material
ALARA	As Low as Reasonably Achievable
AMSL	Above Mean Sea Level
ARAR	Applicable or Relevant and Appropriate Requirement
CAA	Clean Air Act of 1970, as amended
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
Ci	Curie
CSCA	Controlled Surface Contamination Area
cy	Cubic Yard(s)
DEP	Department of Environmental Protection
DOE	U.S. Department of Energy
DOE-EM	DOE Office of Environmental Management
DOT	Department of Transportation
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
ft	Feet
HSA	Historical Site Assessment
HTTF	High Temperature Test Facility
in	Inch(es)
LFM	Legacy Facility Management
LLW	Low-Level Waste
M	Million
mrem/hr	Millirem per Hour
mrem/yr	Millirem per Year
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act of 1970
NHPA	National Historic Preservation Act of 1966
NPDES	National Pollutant Discharge Elimination System
NR	Naval Reactors
NTCRA	Non-Time-Critical Removal Action
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl
PNDI	Pennsylvania Natural Diversity Inventory
RA	Radiation Area
RCA	Radiologically Controlled Area
RCM	Radiological Controls required for Modification
RCRA	Resource Conservation and Recovery Act of 1976
RM	Radioactive Material
RmAO	Removal Action Objective

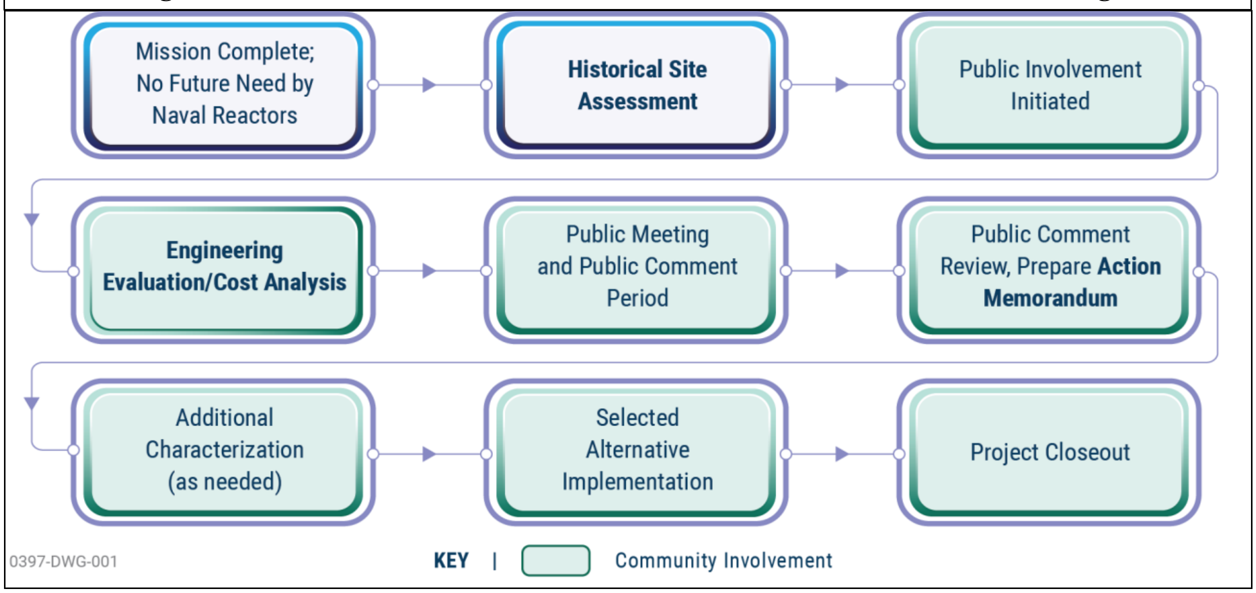
sf	Square Foot (feet)
SHPO	State Historic Preservation Office
SVTF	Shock and Vibration Test Facility
TBC	To Be Considered
U.S.	United States

EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared for the United States (U.S.) Department of Energy (DOE) Office of Environmental Management (DOE-EM) and Office of Naval Reactors (NR) to identify alternatives for disposition of the C-Area buildings at the Bettis Atomic Power Laboratory (Bettis Laboratory) in West Mifflin, Pennsylvania. As the C-Area buildings have reached the end of their mission and cannot be reused by the Bettis Laboratory in their present state, NR no longer has a need for the buildings and is working, in partnership with DOE-EM, to seek a disposition alternative that protects human health and the environment while balancing evaluation criteria of effectiveness, implementability, and cost.

Disposition of the C-Area buildings is being planned as a Non-Time-Critical Removal Action (NTCRA) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). In addition, National Environmental Policy Act of 1970 (NEPA) values are incorporated into the CERCLA process, in accordance with DOE NEPA policy (DOE 2002). Figure ES-1 delineates the phases of the CERCLA NTCRA process for the C-Area buildings and the position and timing of the EE/CA in the overall process.

Figure ES-1. Phases of the CERCLA NTCRA Process for the C-Area Buildings



The C-Area is located in the northeastern portion of the Bettis Laboratory site and consists of two buildings (referred to herein as “CX Building” and “CY Building”) (Figure ES-2). The buildings were constructed between 1953 and 1956 and supported the Bettis Laboratory mission throughout their lifetime. From the early 1950s to the 1980s, buildings CX and CY housed a variety of test reactors. At the end of the research phase for each reactor, the nuclear fuel was removed, leaving all or portions of the reactor vessels in place. The CX Building houses four small test reactor vessels, and the CY Building houses one large test reactor vessel. All test reactor vessels are inactive and defueled.

Figure ES-2. C-Area Layout

A Historical Site Assessment (HSA) has been prepared to document the presence of residual contamination within the C-Area buildings (DOE 2025a). Low levels of radioactive contamination are present in equipment, piping, and building surfaces. In addition, regulated and hazardous materials, such as friable and non-friable asbestos, are present in areas throughout the buildings. Chemical contamination includes lead in paint and shielding around reactor components and polychlorinated biphenyls (PCBs) in electrical equipment and light ballasts.

Over time, as the facilities age, costs to maintain conditions protective of human health and the environment increase, and the potential for a release to the environment increases. Therefore, DOE is evaluating the following alternatives for addressing the residual contamination and hazardous materials in the C-Area buildings:

- Alternative 1: Continued Legacy Facility Management (LFM), the “no action” alternative
- Alternative 2: Cleanout
- Alternative 3: Demolition

A qualitative risk evaluation is completed to identify potential risks to human health and the environment and to justify the need for a removal action. The goal of the C-Area buildings removal action is to address the facilities so that they are consistent with DOE’s continuing research mission at the Bettis Laboratory site. The three removal action alternatives that are being considered for disposition of the C-Area buildings are described in Table ES-1.

Table ES-1. Removal Action Alternatives

Alternative	Description
Alternative 1: Continued LFM ("No Action" alternative)	Under this alternative, the buildings, test reactor vessels, and associated equipment and piping would remain in their current state while LFM activities would continue.
Alternative 2: Cleanout	This alternative would involve removal of the test reactor vessels and their associated tanks, equipment, and piping along with decontamination/stabilization of the affected rooms. LFM activities would continue.
Alternative 3: Demolition	This alternative would involve removal of the test reactor vessels and all tanks, equipment, and piping; demolition of buildings CX and CY; and removal of floor slabs and contaminated soils beneath the buildings.

In this EE/CA, the three removal action alternatives are evaluated in terms of effectiveness, implementability, and cost. The advantages and disadvantages of each alternative are analyzed relative to one another so that key trade-offs that would affect the remedy selection can be identified.

DOE recommends that Alternative 3, Demolition, be selected as the preferred removal action. Demolition would be a permanent and effective remedy that is readily implemented with demonstrated technologies and would make the building footprint available for use by DOE in continuing its research mission at the Bettis Laboratory.

1.0 INTRODUCTION

DOE no longer has a need for the C-Area buildings, which were formerly used by NR to conduct research and testing of nuclear reactors for use in naval nuclear propulsion applications. Due to residual radiological and chemical contamination, the C-Area buildings cannot be reused by the Bettis Laboratory in their present state. While the C-Area buildings continue to be maintained in a safe condition, the potential for a release to the environment increases as the facilities age and deteriorate. Therefore, DOE is evaluating alternatives for the disposition of the C-Area buildings to address the residual contamination.

This EE/CA has been prepared for DOE-EM and NR to identify alternatives for disposition of the C-Area buildings. With the exception of a portion of the CX Building, NR no longer has a need for the buildings and is working in partnership with DOE-EM to seek a disposition alternative that protects human health and the environment while balancing evaluation criteria of effectiveness, implementability, and cost. Disposition of the C-Area buildings is being planned as a NTCRA under CERCLA consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan [NCP]).

A removal action is warranted in accordance with the U.S. Environmental Protection Agency (EPA) and DOE joint memorandum, *Policy on Decommissioning Department of Energy Facilities Under CERCLA*, dated May 22, 1995 (DOE & EPA 1995). The policy establishes the approach agreed upon by the EPA and DOE for decommissioning surplus DOE facilities that is consistent with the requirements of CERCLA. The approach ensures protection of worker and public health and the environment and achieves risk reduction without unnecessary delay. The policy establishes that decommissioning activities will be conducted as non-time-critical removal actions. The policy further establishes that DOE will utilize the CERCLA response authority whenever a hazardous substance is released, or there is a substantial threat of release, into the environment, and response is necessary to protect public health, welfare, or the environment in a manner consistent with CERCLA and the NCP.

In addition, NEPA values are incorporated into the CERCLA process in accordance with DOE NEPA policy (DOE 2002). DOE has lead agency authority for implementing CERCLA actions at the site, with input from the EPA, the Pennsylvania Department of Environmental Protection (DEP), and public stakeholders. DOE invites input from the public and community as a vital element of its CERCLA process. Details of these outreach efforts are described in the Community Involvement Plan for the C-Area buildings (DOE 2025b).

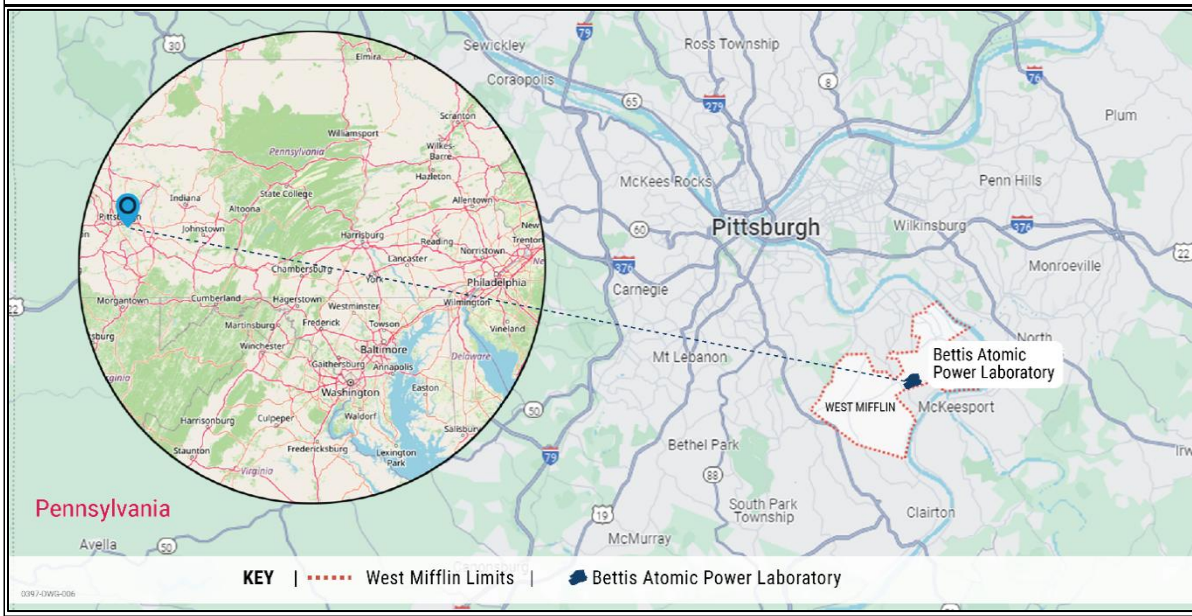
This EE/CA is being prepared in accordance with *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA 1993). The EE/CA describes the site background, nature and extent of contamination, potential risks to human health and the environment, and appropriate removal action objectives (RmAOs). It also describes various alternatives being considered for the disposition of the C-Area buildings and evaluates those alternatives with respect to their effectiveness, implementability, and cost.

1.1 Site Characterization

1.1.1 Site Description and Background

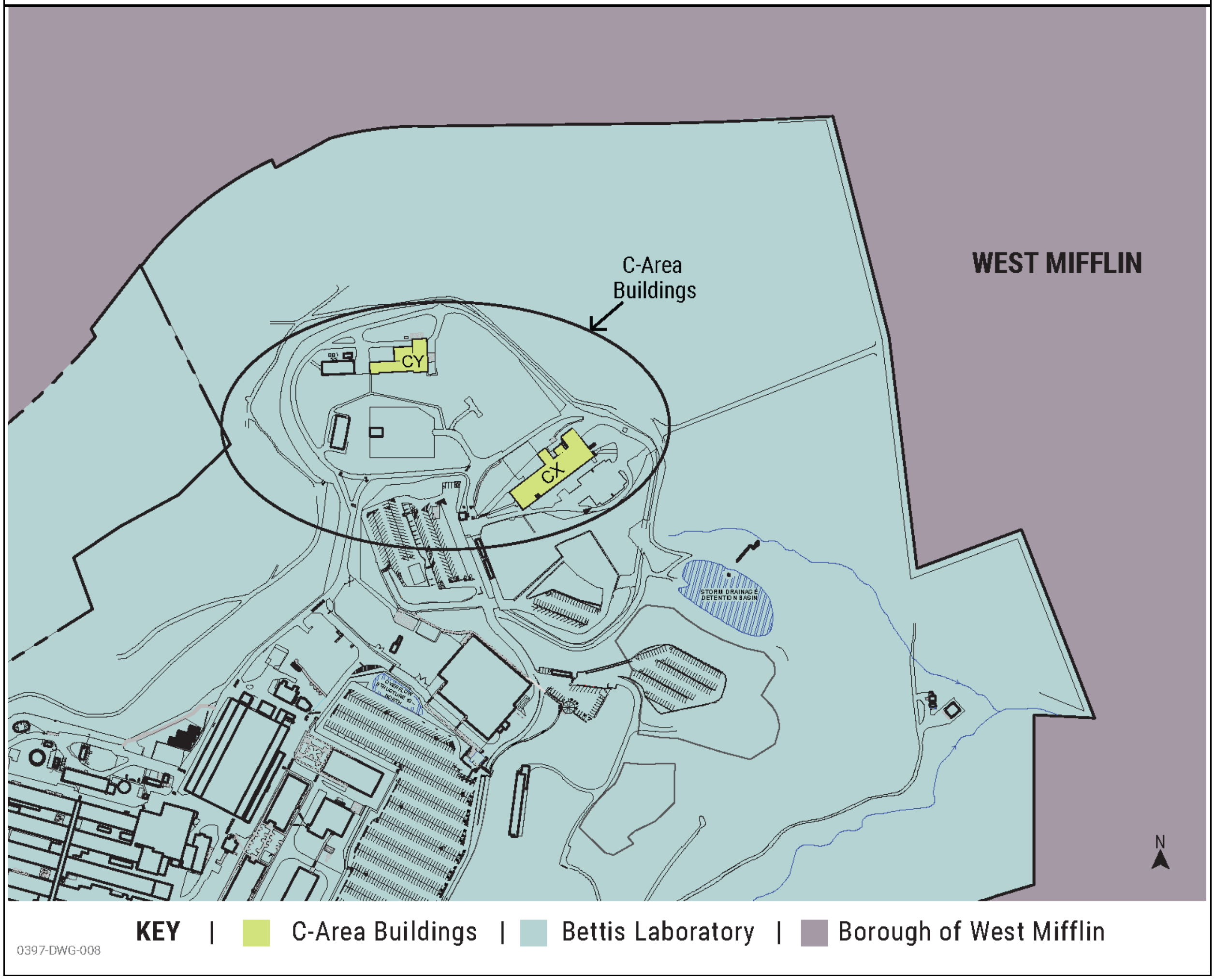
The Bettis Laboratory site is located in the Borough of West Mifflin, Allegheny County, Pennsylvania, approximately eight miles southeast of central Pittsburgh (Figure 1-1) and consists of approximately 229 acres of land. The Bettis Laboratory site is located approximately 6,000 feet (ft) west of the Monongahela River. The maximum elevation at the site is approximately 1,200 ft above mean sea level (amsl), while the minimum elevation is approximately 975 ft amsl on the northern site boundary. The land use of the region surrounding the site is largely industrial and residential.

Figure 1-1. Regional Location of the Bettis Laboratory



The Bettis Laboratory has evolved into a development, support engineering, and design facility for naval nuclear propulsion work. The developed portion of the Bettis Laboratory site consists of laboratories, offices, warehouses, workshops, and a boiler house for the centralized heating of several buildings. This developed portion covers approximately 60 acres. The C-Area buildings are located on a hilltop in the northeastern portion of the laboratory site (Figure 1-2).

Figure 1-2. Location of C-Area Buildings on the Bettis Laboratory Site



The C-Area facilities are comprised of two masonry and steel frame buildings (buildings CX and CY) (Figure 1-3). The C-Area buildings include a total building area of 54,701square feet (sf). The C-Area buildings were constructed between 1953 and 1956 and have been used for various missions throughout their lifetime (Bettis Laboratory 2022). From the early 1950s to the 1980s, buildings CX and CY housed a variety of test reactors. These reactors have been defueled and placed in a lay-up (inactive) condition designed to minimize the required level of attention. Five test reactor vessels remain in place.

Figure 1-3. C-Area Layout

1.1.2 Description of C-Area Buildings

The C-Area buildings have multi-height above-grade levels and some below-grade pits. Several rooms have a dense amount of residual equipment; other rooms have recently served as office space. The buildings are now mostly vacant, except for the five test reactor vessels and associated tanks, equipment, and piping.

1.1.2.1 CX Building

The CX Building, built in 1953 with several additions made in 1956 (called the CX Extension), originally served as the Aircraft Carrier, First Generation, Westinghouse test platform, and housed reactors used for low-power and unpressurized water-moderated critical experiments. This building is currently being used for office space and storage. One of the bays in the CX Building (High Bay 3) houses the Shock and Vibration Test Facility (SVTF). Layout of the CX Building is shown on Figures 1-4 and 1-5.

The CX Building is a 39,892-sf two-story building consisting of 8-inch (in.) concrete block with 4-in. speed tile façade, supported on a 6-in. concrete slab, although some areas have concrete and metal siding. The structure contains thick concrete shield walls (varying from 2 ft to 4 ft thick) around the high bays, control rooms, and inactive fuel storage vaults. The building also contains four 30-in. diameter oil-filled lead glass observation windows.

The CX Building contains four high bays with pits of varying depths and dimensions. High Bays 1, 2A, and 2B contain miscellaneous contaminated support equipment, tanks, and associated piping. High Bay 1 contains two test reactor vessels. High Bays 2A and 2B each contain one test reactor vessel. All test reactor vessels have been defueled. These test reactors operated at low power, so there is no appreciable activation of the vessels; however, the internal surfaces are contaminated. High Bay 3 currently houses the SVTF, which is to remain in operation and is not included in the scope of this NTCRA. Figures 1-6 through 1-8 provide views of the building exterior and the test reactor vessels in selected high bays.

There are three inactive fuel vaults in the CX Building. Vault 236 was decontaminated to support SVTF operations. Vaults 237 and 238 contain various storage devices. Underground drain piping remains beneath the building.

Figure 1-4. Building CX First Floor Plan

Figure 1-5. Building CX Second and Third Floor Plan

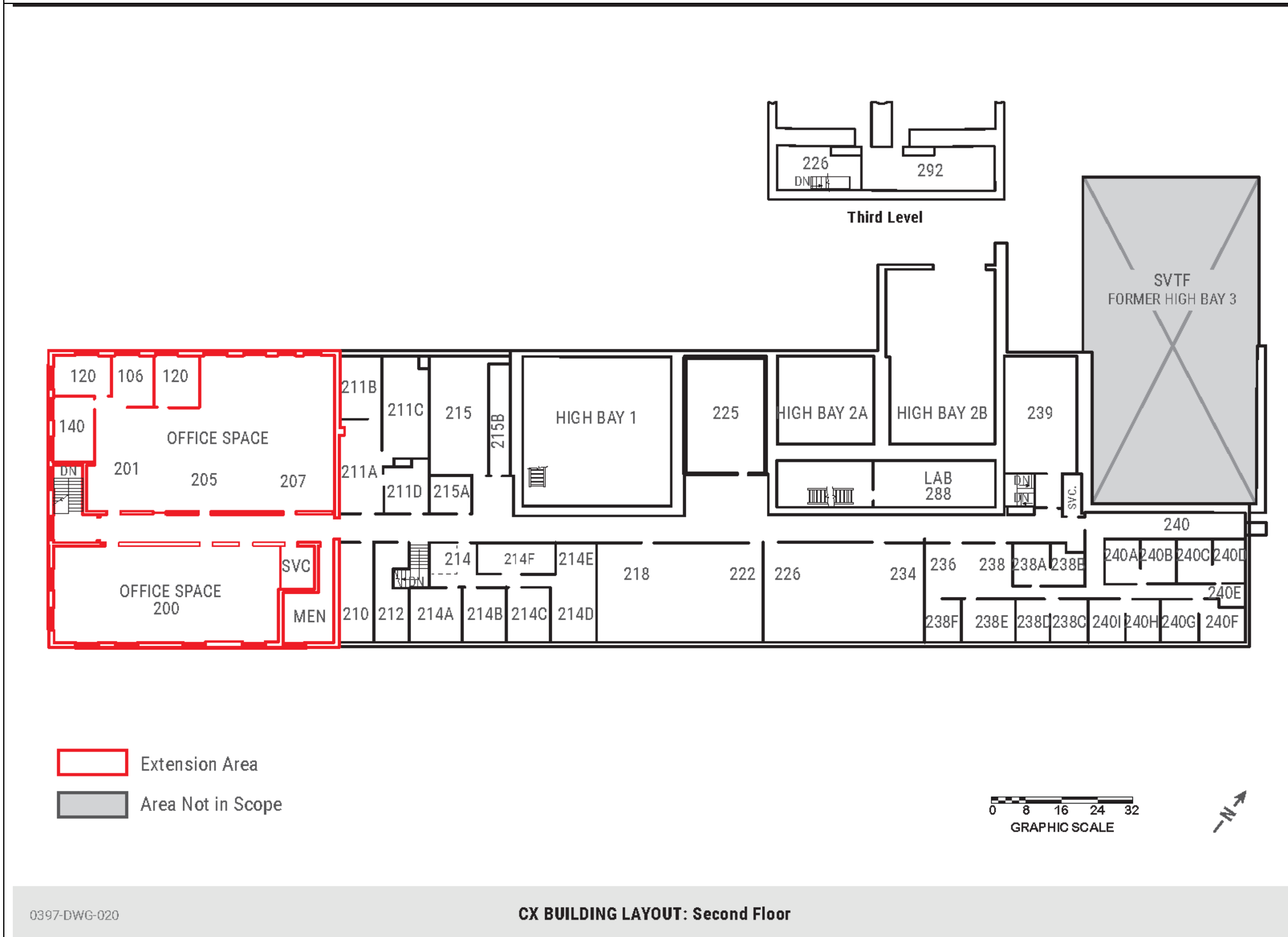
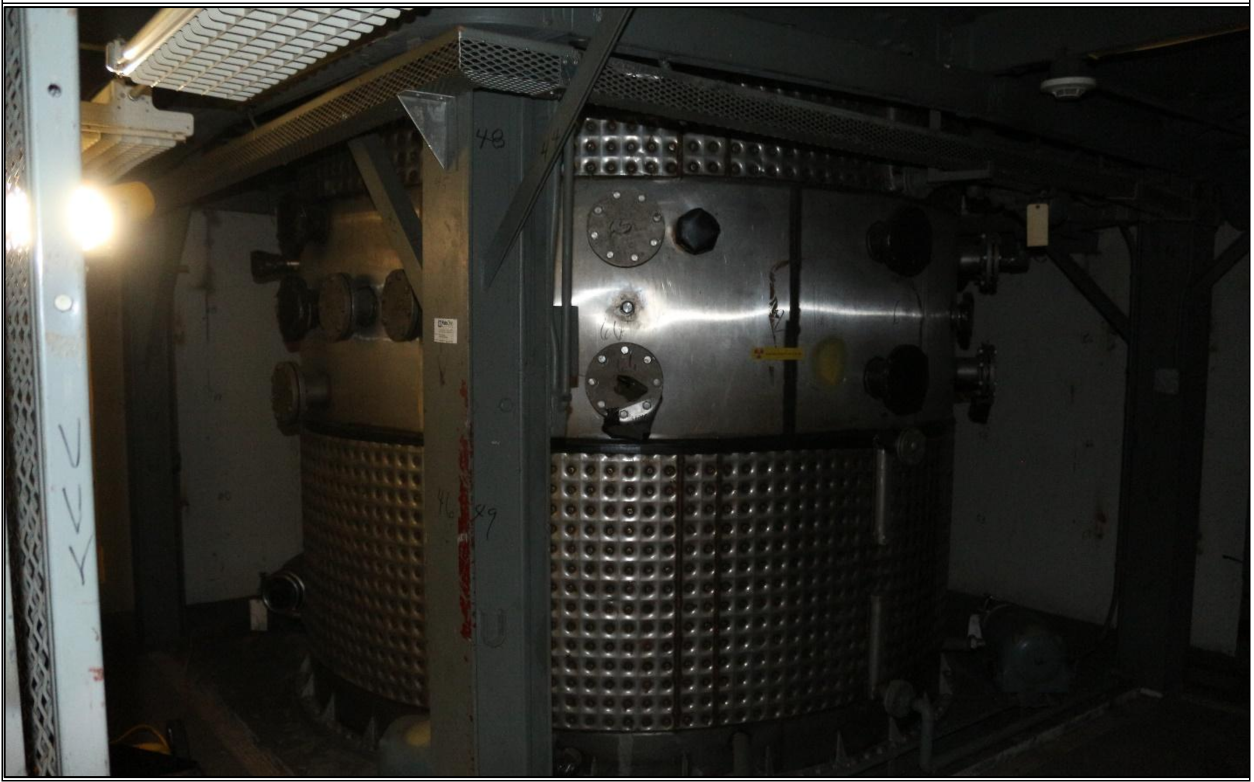


Figure 1-6. View of Building CX Exterior

Figure 1-7. View of Test Reactor Vessel in CX Building High Bay 1

Figure 1-8. View of Test Reactor Vessel in CX Building High Bay 2A



1.1.2.2 CY Building

The CY Building, built in 1956, originally operated as a core mock-up physics test facility using a pressurized water-moderated reactor under high temperature and pressure conditions, referred to as the High Temperature Test Facility (HTTF). The area was also used for core mock-up assembly and disassembly. Currently, the west wing of the building houses the Bettis Reactor Engineering School, while the remainder of the building is unused.

The CY Building is a 14,809-sf building consisting of 8-in. concrete block supported on 5- to 14-in. concrete slabs, with a high bay consisting of reinforced concrete, structural steel framing, and exterior corrugated sheeting (Figures 1-9 and 1-10). The structure contains 3- to 5-ft thick concrete shield walls. In addition, the former reactor room contains a 30-in. diameter oil-filled lead glass observation window.

The CY Building high bay houses a large 44-ton test reactor vessel, which was deactivated and defueled in 1984. The CY Building contains a significant amount of auxiliary equipment that supported operation of the former test reactor. This equipment is located on multiple levels of the high bay portion of the building (the CY Building High Bay has four deck levels of grated flooring). There are two reactor heads containing instrumentation and controls situated on support stands located on the operating mezzanine. There is currently a cover over the top of the test reactor vessel. The second level contains a Lexan® (a type of polycarbonate resin thermoplastic) and frame enclosure of the Controlled Surface Contamination Area (CSCA) portion of the high bay. Figures 1-11 and 1-12 provide views of the building exterior and the test reactor vessel in the high bay.

The reactor room portion of the high bay contains instrumentation and control systems. The former staging area of the high bay contains a large overhead crane previously used for core construction and loading and unloading of fuel into the test reactor. Currently, the staging area is used for loading steel components into containers for shipment to a metal melt facility. The process room portion of the high bay contains a water treatment system, water storage tanks, electrical switchgear and various other plant equipment. The process room pit on the east end of the process room contains various pump equipment and two storage tanks (HTTF Moderator Storage Tank and HTTF Monitor Drain Tank). The Moderator Storage Tank is constructed of ¼-in.-thick stainless steel with a storage capacity of 7,500 gallons. It was used to contain reactor-grade water when the facility was not in use. The Monitor Drain Tank is made of ¼-in.-thick carbon steel and has a storage capacity of 2,000 gallons. It was used to collect radioactive liquids from the floor and sink drains in the building. This pit may contain groundwater that has seeped into the pit; the groundwater is periodically monitored and pumped out as needed. Four high-efficiency particulate air ventilation systems are currently operational to prevent radon build-up in the high bay and Vault 244.

Figure 1-9. Building CY Lower Level Plan

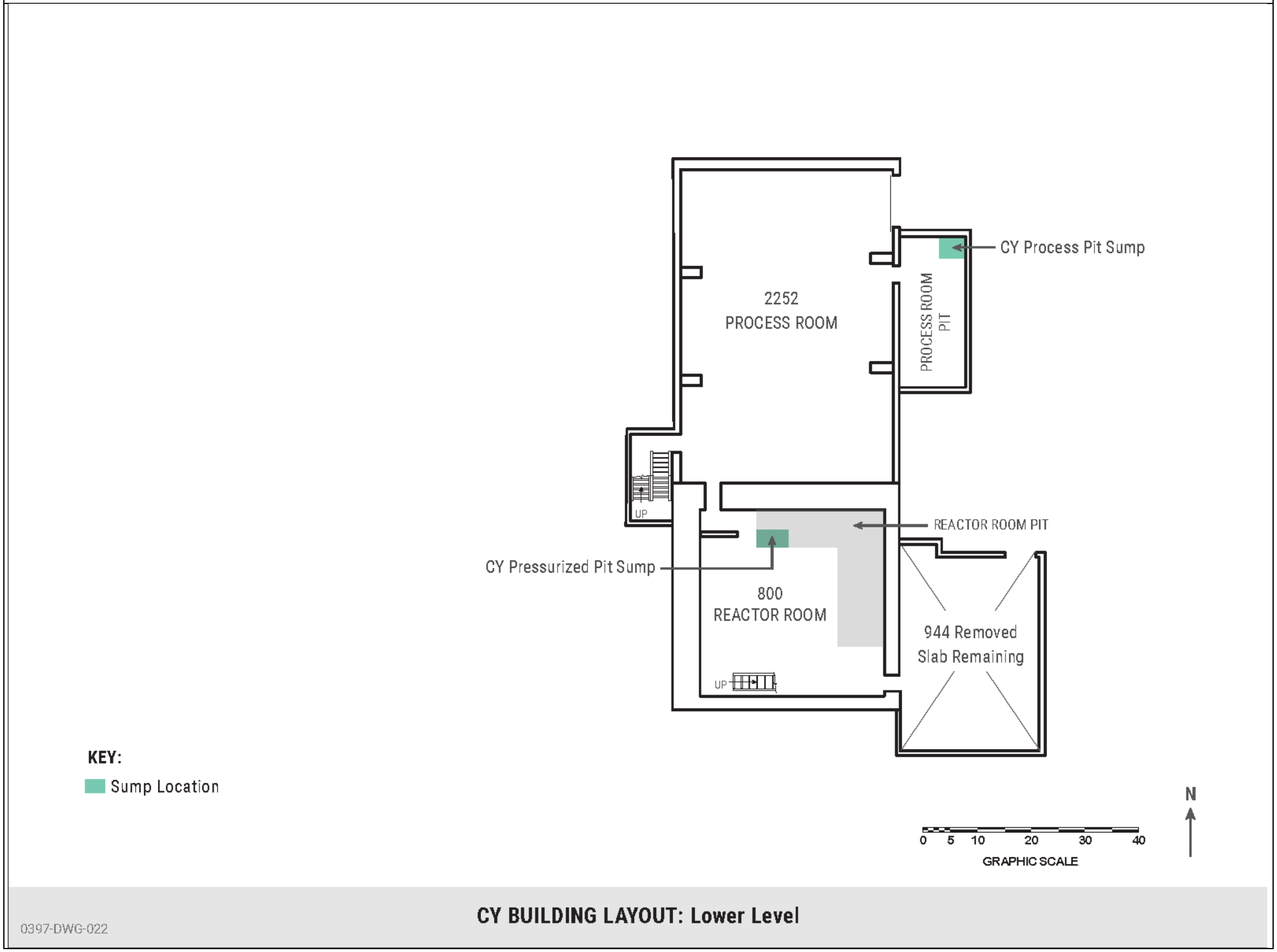
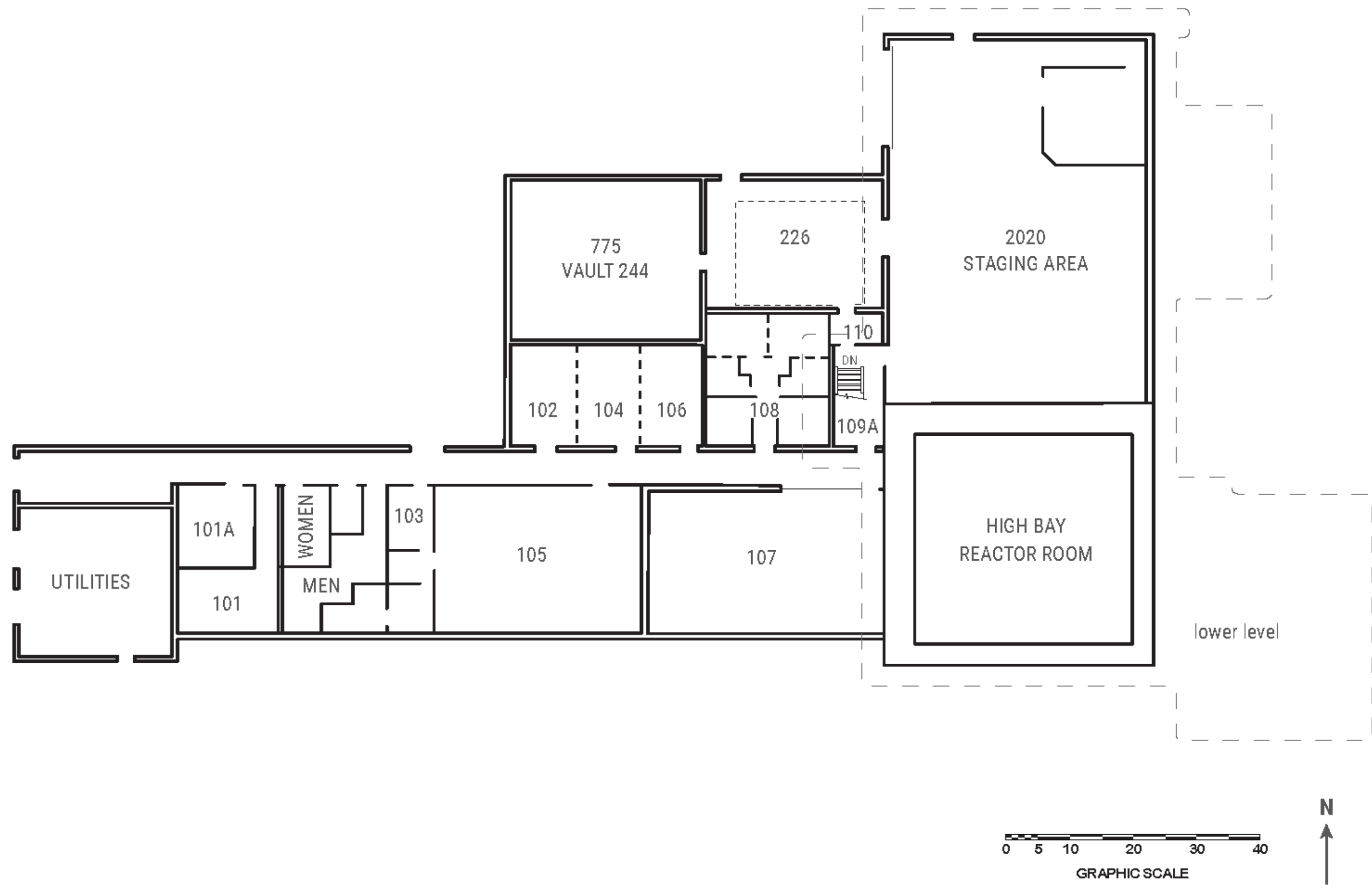


Figure 1-10. Building CY First Floor Plan



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CY BUILDING LAYOUT: First Floor

Figure 1-11. View of Building CY Exterior

Figure 1-12. View of Test Reactor Vessel in Building CY High Bay

1.1.3 Previous Actions (Deactivation After Shutdown)

All of the former test reactors in the C-Area buildings have been shut down, deactivated, and defueled, and the fluid systems have been drained. A previous test reactor in High Bay 3 of the CX Building was removed in 1985 prior to developing the current SVTF.

1.2 Sources, Nature, and Extent of Contamination

This section includes a summary of any known and potential radiological and chemical contamination associated with the C-Area buildings. The HSA for the C-Area buildings presents a detailed description of the nature and extent of hazardous substances within the buildings, including radiological contamination, chemical contamination, contaminated materials, and construction materials, such as asbestos-containing floor tile (DOE 2025a). The HSA also describes information on known and potential releases from and in the immediate vicinity of the buildings.

1.2.1 Known and Potential Radiological Contamination

It is estimated, based on historical information and operational experience, that approximately 1 Curie (Ci) of radioactivity is present within each of buildings CX and CY (total of approximately 2 Ci). The highest radioactivity levels are associated with the inactive test reactor assemblies, vaults, and piping housed within the buildings. There is potential for low, but detectable, levels of radioactive contamination on surfaces that may become newly exposed. Appropriate radiological controls are posted throughout the buildings to identify and effectively communicate potential hazards, which could include areas of radiological contamination or areas with radiation. These postings provide warning of specific hazards that may require individual protective action for safe entry and egress.

Radiological controls include the following types of posting:

- **Controlled Surface Contamination Area (CSCA)** indicates an area that has known or suspected loose contamination in excess of acceptable criteria including an area where equipment or materials with exposed parts exceeding those limits are handled. CSCA also indicates an area where surveys for surface contamination have not been made, but contamination is suspected.
- **Radioactive Material (RM)** indicates an area where radioactive materials that have been controlled (i.e., sealed or containerized) are stored.
- **Radiation Area (RA)** indicates an accessible area where a major portion of the body could be exposed to radiation levels greater than or equal to 1 millirem per hour (mrem/hr) but less than 100 mrem/hr.
- **Radiologically Controlled Area (RCA)** indicates an area that encompasses one or more CSCAs or an area that is established to allow personnel movement between CSCAs and the personnel monitoring area without removing all anticontamination clothing or immediately performing personnel monitoring.
- **Radiological Controls required for Modification (RCM)** indicates an area that has known or suspected total/fixed contamination in excess of acceptable criteria on surfaces that are not normally accessible. Examples of modifications include moving equipment, opening pipes, or removing floor or ceiling tiles.

The CX Building contains numerous radiologically contaminated areas (DOE 2025a). High Bays 1, 2A, and 2B are posted as either RCA or RCM. There is no known loose contamination in these areas; contamination that was accessible has been either covered or removed. There is, however, inaccessible contamination inside the reactor vessels and associated equipment and piping. Fuel Vaults 237 and 238 are posted as both RA and RCA, with portions of the vaults designated as CSCA or RM where radioactive equipment or materials are stored. Rooms 118 and 120 are posted as RCA to allow access to stored equipment or materials. The inactive drain and ventilation piping within the CX Building likely contain residual contamination. Soils surrounding the piping beneath the CX Building slab may also contain radiological contamination.

It is estimated that approximately 1 Ci of radioactivity is present within the CX Building. The highest radioactivity levels reside in High Bays 1, 2A, and 2B (48% contribution), Vaults 237 and 238 (33% contribution), and Rooms 118 and 120 (15% contribution). The uranium isotopes, Uranium-234, Uranium-235, and Uranium-238 (and their short-lived daughters, such as thorium isotopes), are the major contributors to the radioactivity (in curies). Strontium-90 and Cesium-137 are also present.

Several areas within the CY Building have known or suspected radiological contamination. The Reactor Room within the High Bay (including its pressurizer pit) is posted as RA and RCA and is not known to have any loose contamination. The Staging Area portion of the High Bay is also posted as RA and RCA, with portions of the Staging Area designated as CSCA or RM. The process room portion of the high bay is posted as RCM and is not known to have any loose contamination; however, internal contamination is expected in piping in the area and within the equipment, pumps, piping, and tanks in the process room pit. Vault 244 is posted as RA and RCA, with portions designated as CSCA or RM. The inactive ventilation and drain piping within and exterior to the CY Building likely contain residual contamination; soils surrounding the piping beneath the building slab may also contain radiological contamination.

It is estimated that approximately 1 Ci of radioactivity is present within the CY Building. The highest radioactivity levels reside in the High Bay, including the Reactor Room and Staging Area (62% contribution), and the CSCA areas found in the Staging Area and Vault 244 (30% contribution). Similar to the CX Building, the uranium isotopes, Uranium-234, Uranium-235, and Uranium-238 (and their short-lived daughters), are the major contributors to the radioactivity (in curies). Strontium-90 and Cesium-137 are also present.

1.2.2 Chemical Contamination

Hazardous substances (i.e., asbestos, lead, PCBs, mercury, and cadmium) are the primary chemical contaminants of concern. These substances were commonly used in building materials and equipment at the time the buildings were constructed and are therefore found to be ubiquitous throughout the buildings. Friable and non-friable asbestos is present in thermal pipe insulation, flooring, cove bases, ceiling tiles, transite, insulation, and caulk/sealant. Lead is present in reactor shielding components, masonry wall anchors, lead-based paint, and various equipment (e.g., switches, relays, wiring, piping, meters, fluorescent lamps, and batteries). PCBs are present in electrical equipment (e.g., switches, wiring, and light ballasts) and in machine oils. Mercury contamination is likely to be found in old utility switches and gauges. Structural steel may contain cadmium.

1.2.3 Known and Potential Releases to the Environment

As documented in the HSA (DOE 2025a), both buildings CX and CY have potential radiological and chemical contamination underneath and surrounding the buildings. Specifically, the monitoring drain lines underneath and extending beyond both buildings are sources for potential contamination. Potential soil contamination may also be present in areas surrounding both buildings where prior facilities have been removed, including a former CX Tank Farm and former underground waste oil tanks. In addition, the CY Spring near the CY Building has detectable chemical contamination; it is uncertain if this contamination came from the CY Building or another source. The HSA found no direct evidence of contaminant migration emanating from the C-Area.

1.3 Potential Release Mechanisms and Migration Pathways

Potential release mechanisms include the degradation of the C-Area building structures over time and/or damage to the structures caused by a catastrophic event (i.e., tornado, earthquake, etc.), thereby exposing radiological- and chemical-contaminated surfaces and asbestos-containing material (ACM) to the environment. Once exposed, contaminants may be released by water intruding into the damaged buildings, contacting existing contaminated areas, and exiting to the environment via cracks in the structures, sumps, or drain lines. Airborne contaminants may be released by wind intruding into the damaged buildings, contacting contaminated areas, and exiting to the environment through penetrations or openings in the walls or roof.

Potential migration pathways from the C-Area buildings include any cracks, penetrations, or openings in slabs, walls, and roofs leading outside the buildings that allow the movement of a contaminant into the environment. The most likely migration pathways are associated with the underground drain lines and sumps. Contaminants migrating from the buildings could enter the groundwater or stormwater system and subsequently make their way to Bull Run or Thompson Run streams, which ultimately discharge to the Monongahela River.

Under current conditions, contaminant migration outside of the C-Area buildings is unlikely due to the fixed nature of the contaminants and the intact structures. Known or potential releases outside or adjacent to the CX and CY buildings appear limited in scope and, based on site-wide environmental monitoring, do not provide evidence of any impacts outside the C-Area. In addition, current LFM activities reduce (through preventive maintenance) the likelihood of contaminant migration to surface water or groundwater via run-off or infiltration. The ongoing environmental monitoring program is also designed to identify any increases in contaminants present in liquid effluent or gaseous emissions from the Bettis Laboratory.

The HSA for the C-Area buildings evaluated historic information, including investigation reports and site-wide monitoring information, and found no direct evidence of contaminant migration emanating from the C-Area (DOE 2025a).

1.4 Risk Evaluation

This section evaluates the potential risks due to uncontrolled exposure to the contamination described in the HSA for the C-Area buildings. The potential risks are evaluated qualitatively to identify the relative levels of risk (“low,” “medium,” or “high”) that could be encountered. The risk evaluation uses available sampling and survey data from the site to identify the specific contaminants of concern, provides an estimate of how and to what extent people might be exposed to them, and provides an assessment of the health effects associated with them. The risk evaluation predicts the relative potential risk of health problems that may occur if no removal action is taken at the site.

The C-Area buildings contain levels of radiological and chemical contamination, hazardous substances and potentially hazardous materials that could cause adverse health effects to persons potentially exposed to them in the environment. Table 1-1 summarizes these contaminants of concern, their potential health effects, and the qualitative level of risk associated with them.

The potential risks are currently low as a result of shielding, access controls, and monitoring that are routinely performed within the C-Area buildings. However, the potential risks could become medium to high if these protections were to be removed and people were to become directly exposed to the contaminants in the future. Therefore, the potential future risks are unacceptable, and a removal action is warranted to minimize that potential exposure.

Table 1-1. Risk Evaluation

Contaminant	Potential Risk	Risk Level
Radionuclides – Radioactivity in process equipment or piping, and as loose or fixed contamination on building or equipment surfaces	• Chronic external radiation exposure can increase the rate of cancer in humans. • Internal exposure can cause cancer when radioactive materials enter the	• **Low** risk if shielding remains in place, if radionuclides are not disturbed, and if appropriate access controls and monitoring are maintained inside the buildings.

Table 1-1. Risk Evaluation

Contaminant	Potential Risk	Risk Level
	body through inhalation, ingestion, or absorption (dermal contact) routes.	• **Medium to high** risk if these protections are removed and the buildings were allowed to deteriorate.
Asbestos – Friable (easily crumbled) asbestos is present in insulation materials and flooring; non-friable asbestos may be present	• Known to cause lung cancer when fine asbestos fibers are inhaled.	• **Low** risk from non-friable asbestos if left undisturbed. • **High** risk if the ACM were to become crushed and the asbestos were to become friable.
Lead – present in shielding, wall anchors, paint, and equipment	• Known to cause neurological and developmental effects in children and in the fetus of pregnant women.	• **Low** risk if left undisturbed. • **Medium** risk if areas were to be disturbed and environmental releases were to occur.
PCBs – present in electrical equipment (e.g., light ballasts)	• Certain PCBs are known carcinogens, and others are associated with systemic toxic effects. • PCBs persist in the environment and bioaccumulate (increase in concentration) as they are passed up the food chain.	• **Low** risk if left undisturbed. • **Medium** risk if the paint or equipment were to be disturbed and environmental releases were to occur.
Mercury – present in utility switches and gauges	• Known to cause neurological, kidney, and reproductive damage.	• **Low** risk if equipment is left undisturbed. • **Medium** risk if the equipment were to be disturbed and environmental releases were to occur.
Cadmium – present in some structural steel	• Known to cause kidney damage, bone disease, and cancer.	• **Low** risk, as the cadmium is contained within the steel.

2.0 REMOVAL ACTION OBJECTIVES

This section identifies the scope, goals, and objectives of the C-Area buildings removal action. In addition, applicable or relevant and appropriate requirements (ARARs) are identified that govern implementation of the removal action.

> Identifying **ARARs** is a method to categorize regulatory or other requirements for cleanup activities under CERCLA. ARARs establish the regulatory compliance requirements for actions taken under CERCLA.

2.1 Removal Action Scope, Goals, and Objectives

The scope of the removal action is to address the residual contamination within the CX Building and the CY Building, which includes the four smaller test reactor vessels housed within the CX Building and the larger test reactor vessel housed within the CY Building. The scope includes the structural components of the buildings themselves (roofs, walls, slabs, and basements); the equipment and components within the buildings; utilities; and soil beneath or adjacent to the building foundations. Any potential soil contamination within the C-Area surrounding the buildings and any groundwater contamination will be addressed, if needed, after the removal action has been completed, in accordance with applicable regulatory authorities.

DOE's goal for the C-Area buildings is to select a removal action alternative that is consistent with the continuing research mission at Bettis Laboratory and protects human health and the environment. Any removal actions would include the buildings (and contaminated soil, if encountered) but would not involve the groundwater or soil not adjacent to the buildings.

Specific RmAOs developed for the C-Area buildings are as follows:

- Minimize direct exposure to contamination by onsite workers under future industrial use on a DOE continuing-mission site.
- Minimize potential releases to the environment and future migration of contaminants to soil, surface water, groundwater, or air from the source facilities.

2.2 Identification of Applicable or Relevant and Appropriate Requirements

CERCLA actions have unique methods to categorize regulatory or other requirements for cleanup activities, known as ARARs. ARARs establish the compliance requirements for actions taken under CERCLA. “Applicable” requirements specifically address a hazardous substance, pollutant, contaminant, action, location, or other circumstance found at a specific CERCLA site. “Relevant and appropriate” requirements are cleanup standards; standards of control; and other requirements, criteria, or limitations that have been publicized under federal or state environmental or facility siting laws. The relevant and appropriate requirements identified for a specific CERCLA site have historically addressed issues sufficiently similar to those encountered at the site.

In addition to ARARs, lead and support agencies may, as appropriate, identify other guidance sources to inform remedy selection. The “to be considered” (TBC) category consists of orders, advisories, criteria, or guidance that were developed by EPA, other federal agencies, or states that may be useful in developing CERCLA remedies. Table 2-1 contains the C-Area buildings ARARs and TBC list.

> The **TBC category** includes DOE Orders and practices that are mandatory for projects implemented by DOE. Therefore, the TBC guidance cited in Table 2-1 are not optional; rather, DOE requires its contractors to follow these Orders and practices.

Table 2-1. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Guidance for the C-Area Buildings Removal Action

Requirement	Citation	Description of Requirement	Type of Requirement	Reason for Inclusion
Chemical-Specific ARARs				
Radiation Protection of the Public and the Environment	DOE Order 458.1	Regulates exposure of members of the public. Radionuclide emissions must not exceed a total effective dose of 100 millirem per year (mrem/yr)	TBC	Establishes dose limit for members of the public
Location-Specific ARARs				
National Historic Preservation Act of 1966 (NHPA)	36 Code of Federal Regulations (CFR) 800	Regulates impacts to historic properties and provides requirements to avoid, minimize, or mitigate adverse effects to historic properties	Applicable	Applies to any archaeological resources onsite.
Pennsylvania State Historic Preservation Office (SHPO)	2006 Memorandum of Agreement	Establishes notification of the Pennsylvania SHPO if archaeological resources are discovered during excavations onsite	TBC	Applies to any archaeological resources discovered during excavations onsite.
Action-Specific ARARs				
Occupational Radiation Protection	10 CFR 835	Regulates radiation exposure to workers and provides radiation protection standards for controlling exposures to as low as reasonably achievable (ALARA); control and limitations on removal of material, labeling, posting, dosimetry, etc.	Applicable	Applies to general construction activities. Establishes dose limits for workers and members of the public during direct, onsite access
Radiation Protection of the Public and the Environment	DOE Order 458.1	Establishes requirements for management of DOE radiological material or property that can result in exposures to the public to radiation or radioactive materials	TBC	Applies to general construction activities, including decontamination of radiologically contaminated equipment and building structures
National Environmental Standards for Hazardous Air Pollutants	40 CFR 61, Subpart H	Regulates air emissions of radionuclides. Emissions of radionuclides (other than radon) to the ambient air must not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr	Applicable	Applies to general construction activities for control of hazardous air pollutants, including during demolition activities
Allegheny County Health Department Air Pollution Control Rules and Regulations	Article XXI	Regulates air emissions (including asbestos) and provides national primary and secondary ambient air quality standards for the protection of public health	Applicable	Applies to construction, excavation, asbestos abatement, demolition and other activities for management of exhaust and fugitive dust. Establishes

Table 2-1. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Guidance for the C-Area Buildings Removal Action

Requirement	Citation	Description of Requirement	Type of Requirement	Reason for Inclusion
				emission controls to maintain established air quality standards
Clean Water Act – Water Classification – National Pollutant Discharge Elimination System (NPDES)	40 CFR 122	Regulates water pollution control (substantive aspects of a NPDES permit)	Potentially Applicable	Applies to general construction activities to control run-off and avoid impacts to waters of the state, if land disturbance could cause run-off
National Pollutant Discharge Elimination System – Permitting, Monitoring, and Compliance	25 Pennsylvania Code Chapter 92a	Regulates water pollution control (substantive aspects of a NPDES permit)	Potentially Applicable	Applies to general construction activities to control run-off and avoid impacts to waters of the state, if land disturbance could cause run-off
Pennsylvania Erosion and Sediment Control Regulations	25 Pennsylvania Code Chapter 102	Establishes requirements to use Best Management Practices to minimize the potential for accelerated erosion and sedimentation and to manage post-construction stormwater	Potentially Applicable	Applies to activities that could accelerate erosion and sedimentation resulting from land disturbance
Radioactive Waste Management	DOE Order 435.1	Establishes requirements for management of DOE radioactive waste	TBC	Applies to waste management and disposal if radioactive waste is generated
Pennsylvania Municipal Waste Management Regulations	25 Pennsylvania Code Chapters 271-285	Regulates the storage, transportation, processing, and disposal of municipal waste.	Applicable	Applies to waste management and disposal if municipal waste is generated
Pennsylvania Residual Waste Management Regulations	25 Pennsylvania Code Chapters 287-289	Regulates the generation, storage, transportation, processing, and disposal of residual waste (non-hazardous industrial waste)	Applicable	Applies to waste management and disposal if residual waste is generated
Pennsylvania Hazardous Waste Management Regulations	25 Pennsylvania Code Chapters 260a - 270a	Regulates the generation, storage, transportation, treatment, and disposal of hazardous waste	Applicable	Applies to waste management and disposal if hazardous waste is generated
Spotted Lanternfly Order of Quarantine and Treatment	Pennsylvania Plant Pest Act of 1992, Public Law 1228, No. 162 §21 (3 P.S. §258.21 (a) and (c))	Vehicle and cargo inspections before moving within the quarantine zone and leaving the quarantine zone	Applicable	Applies to offsite transportation; Spotted Lanternflies are an invasive species found at Bettis

Table 2-1. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Guidance for the C-Area Buildings Removal Action

Requirement	Citation	Description of Requirement	Type of Requirement	Reason for Inclusion
Hazardous Waste Management System	40 CFR 260-264, 268	Regulates the characterization, storage, management, and disposal of solid and hazardous waste	Applicable	Applies to waste management of solid and hazardous waste
Toxic Substances Control Act – PCBs	40 CFR 761	Regulates toxic substances, and identifies cleanup levels and disposal requirements for PCBs and PCB-containing materials and management of PCB wastes	Applicable	Applies to waste management if PCB wastes are present
U.S. Department of Transportation (DOT) – Hazardous Materials Transport Regulations	49 CFR 171-180	Regulates packaging, labeling, placarding, and transportation of hazardous materials	Applicable	Applies to offsite waste transportation
Packaging and Transportation Safety	DOE Order 460.1	Establishes requirements for packaging and transportation of DOE hazardous materials, including radioactive materials	TBC	Applies to offsite waste transportation if hazardous or radioactive waste materials are generated and transported offsite for disposal
Radioactive Material Transportation Practices	DOE Manual 460.2-1	Establishes requirements for transportation of DOE radioactive materials	TBC	Applies to offsite waste transportation if radioactive waste materials are generated and transported offsite for disposal

Note: The DOE Orders and practices identified as “To Be Considered” are not optional on DOE projects and must be followed by all DOE contractors.

The ARARs are based on the following considerations:

- Removal actions must be conducted in a manner such that contamination will not reach Bull Run or Thompson Run streams or the surrounding community, either by air, water, or accidental release.
- Removal actions will involve the buildings and contaminated soil beneath or adjacent to the buildings but will not involve underlying groundwater or soil not adjacent to the buildings.
- The site does not contain or affect any sensitive areas, critical habitats, or endangered species. A Pennsylvania Natural Diversity Inventory (PNDI) screening has been completed and reviewed by the appropriate state agencies.
- The Bettis Laboratory will remain an industrial site with no residential land use.
- The Bettis Laboratory is eligible for the National Register of Historic Places; however, the C-Area buildings are not historic properties. Pursuant to the June 2006 Memorandum of Agreement with the Pennsylvania State Historic Preservation Office (SHPO), Section II, B, 2., "no additional notifications or submittals to the Pennsylvania SHPO are needed for modifications or demolition of existing structures at Bettis" (Pennsylvania SHPO 2006).
- There are no wetlands, floodplains, or archaeological sites that will be affected by the removal action.
- Potential removal actions for the C-Area buildings may include continued LFM activities; removal of defueled test reactor vessels, equipment, piping, and residual waste materials; decontamination of building surfaces; and/or demolition and removal of the structures and associated debris.

ARARs and TBC guidance are divided into three groups: chemical-specific, location-specific, and action-specific. The following summarizes each group:

- **Chemical-Specific:** This type of ARAR establishes an acceptable amount or concentration that may remain in or be discharged to the ambient environment. Chemical-specific ARARs provide health- or risk-based concentration limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, and air) for specific hazardous substances, pollutants, or contaminants. Chemicals that are inert, controlled, or stabilized do not have ARARs. When the chemicals are disturbed, such as with demolition activities, action-specific ARARs would be triggered. One chemical-specific TBC guidance that applies to C-Area buildings is DOE Order 458.1, *Radiation Protection of the Public and the Environment.*
- **Location-Specific:** This type of ARAR includes restrictions placed on conducting activities solely because they occur in special locations, such as wetlands, floodplains, historic properties, or critical habitat. Location-specific requirements may establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted, or mitigated, because they are in special locations. Although the C-Area buildings are not historic properties, the NHPA is an ARAR for the C-Area facilities if any archaeological evidence is discovered during soil excavation beneath the buildings.
- **Action-Specific:** This type of ARAR contains technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances or other particular circumstances at a site. Action-specific ARARs include operation, performance, and design requirements or limitations based on the waste types, media, and removal action activities. Action-specific ARARs identified for the C-Area buildings removal action include requirements related to general construction activities, building demolition, waste management, and waste material transportation.

General construction activities are regulated by ARARs governing radiation protection, air quality, and water quality. Radiation controls must be implemented to ensure radiation protection standards would be met in accordance with 10 CFR 835. Materials for unrestricted release must meet DOE Order 458.1 requirements for residual surface radioactive contamination. Removed building sites (footprints) with radioactively contaminated soil-like rubble must consider radiation protection requirements and use administrative procedures or engineering controls to reduce or achieve doses that are ALARA. Requirements under the Clean Air Act of 1970, as amended (CAA), must be met, including requirements for control of asbestos and radionuclide emissions (40 CFR 61) to meet specific air quality standards. Pennsylvania DEP requirements must be met for the control of fugitive dust and storm water run-off.

ALARA is the guiding principle of radiation safety. ALARA means avoiding exposure to radiation that does not have a direct benefit, even if the dose is small, by minimizing time spent near a radioactive source, maximizing distance from a radioactive source, and putting something between you and the radiation source (shielding).

Waste management activities may include characterization, waste storage, and treatment and disposal of materials generated during the C-Area buildings removal action. Potential waste streams may include solid or hazardous waste (e.g., mercury switches, lead paint, etc.) defined under the Resource Conservation and Recovery Act of 1976 (RCRA) and regulated under Pennsylvania municipal, residual, and hazardous waste regulations; low-level waste (LLW) for radioactively contaminated waste managed under requirements of DOE Order 435.1, *Radioactive Waste Management*; asbestos-containing waste materials regulated by 40 CFR 61; and PCB wastes in fluorescent light ballasts, capacitors, or drained equipment regulated under the Toxic Substances Control Act of 1976 (40 CFR 761). Primary waste (e.g., demolition debris, removed waste materials, etc.) and secondary waste (e.g., contaminated personal protective equipment or decontamination wastes) generated during building decontamination or demolition activities must be appropriately characterized and managed in accordance with requirements specific to the waste type (e.g., 40 CFR 761 for PCB wastes).

Nearby areas on the Bettis Laboratory site may be used for waste staging and temporary storage of materials removed from the C-Area buildings for implementation of the removal action. Those proximate facilities would be deemed "onsite" under CERCLA Section 121(e)(1) (see also 40 CFR 300.400[e][1]). In addition, CERCLA Section 121(d)(3) provides that any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that complies with applicable federal and state laws and has been approved by the EPA for acceptance of CERCLA waste.

Transportation activities may include offsite shipment of contaminated waste and debris for disposal. Wastes transported in commerce along public rights-of-way must meet the transportation requirements of various regulations, depending on the type of waste (e.g., RCRA or PCB). These include U.S. DOT packaging, labeling, marking, manifesting, and placarding requirements for hazardous materials at 49 CFR 171–180 et seq., and requirements of DOE Order 460.1, *Packaging and Transportation Safety*, and DOE Manual 460.2-1, *Radioactive Material Transportation Practices*.

3.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section presents a detailed analysis of removal action alternatives for the NTCRA for the C-Area buildings. The alternatives address potential release and short-term threats to worker safety and health during removal activities, as well as potential long-term threats to achieving site-specific RmAOs. The alternatives are evaluated in terms of effectiveness, implementability, and cost in accordance with the EPA *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA 1993). The detailed analysis complies with the nine criteria required in the NCP. For completeness, the detailed analysis also incorporates evaluation criteria from EPA's Feasibility Study guidance (EPA 1985).

The detailed effectiveness analysis also incorporates an evaluation of NEPA values, as found in the DOE NEPA policy (DOE 2002). Consistent with that guidance, cumulative effects considered for the C-Area buildings include air quality, water quality, and groundwater quality. Offsite impacts include noise, traffic, transportation, aesthetics, and waste disposal. Socioeconomic impacts are also evaluated. Impacts to historic properties are considered a NEPA value, which is discussed under the ARARs analysis for compliance with the NHPA. Waste management impacts are considered a NEPA value which is discussed under the ARARs analysis for compliance with waste management regulations. Impacts to visual/aesthetics, land use, and utilities are briefly discussed proportionately to their impacts.

The NEPA values discussion describes the potential impacts that could result if an alternative were to be implemented. The potential impacts of these actions are analyzed in qualitative rather than quantitative terms, using descriptors (e.g., negligible or minor) that provide a relative magnitude of the potential impact. The range of the impacts described, from negligible to major, provide a type of bounding analysis for the alternatives. The majority of impacts for the C-Area buildings removal action alternatives are negligible. Engineering and administrative controls and other mitigation measures are also highlighted to indicate how potential impacts could be avoided.

Qualitative Descriptors used in the NEPA values evaluation of alternatives:

Negligible: Potential impacts would not affect the environmental resource, or the effects would be at or below the level of detection and short in duration; the changes would be so slight that they would not be of any measurable or perceptible consequence.

Minor: Potential impacts would be detectable, although the effects would be localized, relatively small, and short in duration; changes would be so small that they would be difficult to measure and have barely perceptible consequences. Mitigation measures, if needed, would be simple and effective.

Moderate: Impacts would be readily detectable, longer in duration, and localized, with consequences to the immediate area surrounding the C-Area. Mitigation measures, if needed, would be more extensive and likely effective.

Major: Impacts would be readily detectable and longer in duration; changes could have substantial and permanent consequences. Mitigation measures would be more extensive, yet relatively effective.

A screening process was conducted to assess potentially viable and readily available technologies and approaches for removal actions implemented at the Bettis Laboratory. These technologies and approaches include the following categories:

- **Administrative and Engineering Controls:** Administrative and engineering controls include actions such as continued monitoring (personnel, radiation, or indoor air quality); access restrictions to radiological areas; shielding of contaminated facilities or equipment; and similar actions. These controls are currently utilized at the Bettis Laboratory as part of the LFM activities and are appropriate and effective in protecting the public, onsite workers, and the environment. This approach, while considered a temporary measure, was retained for development of alternatives due to its ease of implementation and relative success over the past few decades.
- **Containment or Entombment:** In-place containment or entombment of inactive reactor facilities has been implemented at other DOE sites. The test reactor vessels within the C-Area buildings are smaller and more accessible than the much-larger inactive reactor facilities at the other sites. Because contamination within the C-Area buildings can be safely removed in their current state, the containment or entombment approach was screened out. Temporary containment for dust control is retained as an ancillary technology.

- **Physical Treatment:** Physical treatment technologies (e.g., scabbling or pressure washing) are typical approaches used in radiological and chemical decontamination from building surfaces. Size reduction technologies (e.g., crushing or sorting) are incidental approaches typically used for waste disposal and waste minimization. Physical treatment of the more highly contaminated areas would be appropriate and effective in protecting the public, onsite workers, and the environment, especially if combined with other technologies such as administrative or engineering controls. This approach was therefore retained for development of alternatives.
- **Chemical Treatment:** Chemical treatment technologies involve using chemicals to reduce the amount, toxicity, or mobility of contaminants. Chemical treatment may be viable as an incidental agent during decontamination of building surfaces or equipment but is not considered viable as a stand-alone technology. Therefore, this approach was screened out.
- **Removal:** Removal technologies involve the physical dismantling, demolition, packaging, and offsite disposal of the contaminated building materials and equipment. The technology is effective and applicable in permanently eliminating the contamination present in the test reactor vessels and associated tanks, equipment, and piping. The technology has been successfully used in removing other facilities from the Bettis Laboratory. This approach was therefore retained for development of alternatives.

The technologies and approaches retained were then combined into removal action alternatives. The following sections describe the alternatives that were developed, the rationale for identifying each alternative, and a detailed analysis of each alternative (i.e., effectiveness, implementability, and cost).

The "no action" alternative for the C-Area buildings is Alternative 1, Continued LFM. Continued LFM provides a benchmark to enable decision makers and the public to compare the levels of environmental effects of the alternatives. Although the continued LFM alternative includes actions, it meets the regulatory definition and requirement for performing a no-action alternative analysis pursuant to NEPA.

3.1 Alternative 1: Continued Legacy Facility Management – "No Action"

Under Alternative 1, all structures and test reactor vessels would remain in their current state, and LFM activities would be continued. For this EE/CA, a 30-year duration was assumed for costing purposes. This alternative was developed because it is comparable to ongoing LFM activities at the Bettis Laboratory.

Routine surveillance activities would include access controls, radiation monitoring, air monitoring, and personnel monitoring. Maintenance activities would include necessary repairs, deferred maintenance activities, and routine maintenance activities, such as the following:

- Repair and/or replacement of roofing systems
- Repair of building structural elements and building shell maintenance
- Repair of internal and external doors and windows
- Repair of peeling paint on walls
- Repair and/or replacement of ceiling tiles and asbestos floor tiles
- Maintenance of electrical and mechanical equipment
- Maintenance of ductwork, piping, and water and sewer service
- Maintenance of lighting systems
- Maintenance of building fire protection systems
- Maintenance of weeds or vegetation threatening building integrity
- Maintenance of radiation shielding and containment systems

The following subsections provide a detailed analysis of the effectiveness, implementability, and cost for Alternative 1, which are summarized in Table 3-1.

Table 3-1. Summary of Alternative 1 Effectiveness, Implementability, and Cost	
Effectiveness	Effective for the assumed 30-year period, provided administrative and engineering controls remain in place. Risk to human health and the environment would be low.
Implementability	Readily implementable. Administrative and engineering controls already in place would continue.
Cost	$ 32.4 Million (M) (estimated)

3.1.1 Effectiveness

The Continued LFM alternative would be protective of human health and the environment for the assumed 30-year duration required by CERCLA. Current administrative and engineering controls (shielding, monitoring, and access controls) would continue, such that radiation and chemical exposure to workers would continue to meet applicable protective limits. Building maintenance would include routine repair of building systems, including roof, walls, windows, utilities, and service systems to prevent deterioration and thereby minimize the threat of an uncontrolled release.

Residual risks under this alternative would be low, similar to current conditions. The residual risk from potential exposure to radiation or radionuclides is considered low if shielding remains in place, if radionuclides in building components are not disturbed, and if appropriate access controls and monitoring are maintained inside the buildings. The residual risk from potential exposure to chemical contamination, hazardous substances, and potentially hazardous materials is considered low if the materials are left undisturbed. The alternative would not address any potentially contaminated soil associated with past or future releases from the CX and CY buildings, including any sub-slab soil contamination. Currently, there is no evidence that any such releases impact the areas outside the CX and CY buildings, so this would be a low residual risk.

Cumulative impacts (water quality, air quality, etc.) and offsite impacts (visual/aesthetic, noise, traffic, transportation, disposal, etc.) would be negligible since there would be no change from current conditions. Use of utilities and services would be unchanged; there would be no utility impacts. Land use impacts would not change; Bettis Laboratory is an industrial facility with an ongoing mission. However, due to the presence and arrangement of the test reactor vessels and associated tanks, equipment, and piping, as well as areas of residual contamination, the use of the C-Area buildings would be limited in meeting mission needs. There would be no socioeconomic or cultural resource impacts, since there would be no change from current conditions. There would also be no ecological/biological impacts since there would be no change from current conditions.

The Continued LFM alternative would comply with ARARs. The alternative would comply with radiation protection requirements in addition to controlling radiation exposures to ALARA. General construction requirements, including dust control, would be complied with during any construction activity. Routine waste management and waste transport activities would comply with existing waste management requirements.

The alternative would be effective in achieving RmAOs in the short term, although controls would need to remain in effect for the assumed 30-year duration. Shielding, monitoring, and access controls would minimize exposure to contamination by onsite workers. Building maintenance would minimize the threat of an uncontrolled release and thereby minimize potential future migration of contaminants to soil, surface water, groundwater, or air from the source facilities. Site environmental monitoring would reduce the risk of groundwater or soil releases from contamination associated with the buildings or potential contamination in below-ground areas.

However, the alternative does not provide a permanent remedy. There would be no reduction in the toxicity, mobility, or volume of contamination at the source areas, including from potential subsurface contamination. Those source areas would ultimately need to be removed to achieve permanent site closure.

3.1.2 Implementability

The Continued LFM alternative could be readily implemented, as the LFM program activities are already in place. The current LFM program activities have been ongoing successfully in recent years as the facilities reached inactive status. Prior to LFM, general maintenance was performed for decades in the active facilities following test reactor shutdown. These successful maintenance activities demonstrate that they are relatively easy to operate, perform effectively in protecting worker health and safety, and are applicable to the conditions within the high bays and the remainder of the C-Area buildings. Equipment, personnel, and resources are readily available to continue the LFM activities. Administrative and engineering controls (shielding, monitoring, and access controls) are in place and would continue uninterrupted.

3.1.3 Cost

Capital costs associated with Alternative 1, Continued LFM (No Action), include items currently needing repairs and are estimated at $1.0M. Operation and maintenance (O&M) costs would be similar to current LFM program costs for administrative and engineering controls and building maintenance and repair, including deferred maintenance activities. O&M costs were therefore estimated using DOE's Facility Information Management System report, which identifies typical maintenance activities for the C-Area buildings from 2023. The O&M costs were then escalated to 2025 dollars using an average inflation rate of 3%/year for that historical period. A present worth analysis approach was used to calculate the total present worth of the O&M costs over the assumed 30-year O&M period by applying a discount rate of 2.3%, per Office of Management and Budget Circular A-94, Appendix C (OMB 2024).

> **Present worth** (or present value) is the total current value of expected future costs that are discounted using an appropriate discount rate. It represents the amount of money to be set aside today to pay for future costs.

O&M costs of Alternative 1 are estimated at $1.46M/year for the assumed 30-year O&M period. Corresponding present worth O&M cost of Alternative 1 (assuming a 2.3% discount rate) is estimated at $31.4M. Total present worth cost of Alternative 1 is therefore estimated at $32.4M. The cost estimate is summarized in Appendix B.

3.2 Alternative 2: Cleanout

Alternative 2 would involve cleanout of the former test reactor cells within the high bays by removing the test reactor vessels and associated tanks, equipment, and piping. Following equipment removal, the high bays would be decontaminated to reduce potential future exposure to the residual radioactivity. This alternative was developed because it would eliminate the highest sources of radioactivity, resulting in a reduced level of LFM activities.

The following presents a conceptual approach for the cleanout of the high bays to provide a basis for developing the cost estimate. While these conceptual approaches are considered feasible and implementable, alternate approaches could be developed during final design.

3.2.1 Preparatory Planning

Planning and design would be required prior to implementation of the removal action. The isolation and/or rerouting of the utility and service systems is a critical preparatory activity, as most systems have not been air-gapped nor are they disconnected from the remainder of the CX Building and CY Building. Utility and service systems include electrical, communications, steam and condensate, potable water, sanitary sewer, storm drains, cooling water, sumps and drains, fire water, natural gas, and compressed air systems. The stabilization of building components may also be required to minimize risks to workers or contaminant release during implementation. Stabilization includes checking structural integrity and building isolation, removing liquids from pipes and equipment, and removing any stored gases, solids in bulk, radioactive materials, hazardous chemicals, trash, or other housecleaning items from the work areas.

Design of the removal action would proceed concurrently with these isolation and stabilization activities. The project team would be established to define the project, develop a statement of work, select a contractor, and issue the appropriate contract(s). Project planning would include design of the removal action, addressing regulatory requirements, and completing the necessary internal readiness reviews to receive authorization to proceed with construction. Additional building characterization surveys and sampling would be performed during the Preparatory Planning phase as needed to develop radiological and hazardous waste profiles for handling and disposal of the wastes.

3.2.2 Cleanout of CX Building High Bays

Cleanout of the CX Building high bays would involve removing the two test reactor vessels in High Bay 1, and each of the test reactor vessels in High Bays 2A and 2B, along with contaminated support equipment, tanks, and associated piping. While the high bays are not crowded with significant extraneous equipment, their removal would be a challenge since there are no operational cranes within this building and there is limited space for maneuverability.

Prior to equipment removal, the equipment showing higher levels of radiation would be stabilized or shielded in place to prevent the spread of contamination during removal of these items and to maintain worker exposure to ALARA levels. To prepare the room for removal of the equipment, temporary, localized ventilation would be installed, and the waste transfer path would be prepared by removing any obstructions and providing contamination control measures (i.e., Herculite® sheeting on floors and walls, absorbent booms, etc.). Facility surveys, sampling, and analysis to characterize the equipment in detail would be performed to support cleanout and waste disposition.

The four test reactor vessels would then be systematically disassembled and removed. Most of the disassembly would be “hands-on” work with the removed items being wrapped in Herculite® and/or plastic bags. The former high bays, waste management areas, and the waste transfer path would then be surveyed to determine the levels of any residual radioactivity and the extent of additional decontamination required. Areas identified as needing decontamination would be decontaminated using a graded approach from least invasive/destructive (e.g., wiping, washing, or fixing) to more invasive approaches (e.g., paint stripping, scrabbling, grinding, etc.) to reduce levels of both removable and fixed contamination and thereby achieve RmAOs.

3.2.3 Cleanout of CY Building High Bay

The CY Building houses the largest of the test reactor vessels within the C-Area facilities (44 tons), requiring greater planning and engineering during final design. Cleanout of the CY Building High Bay would involve removal of a significant amount of equipment that supported former operation of the reactor; this equipment is located on multiple levels of the high bay portion of the building. In addition, there are two reactor heads containing instrumentation and controls situated on support stands located on the operating mezzanine. There is currently a cover over the top of the reactor vessel.

The test reactor vessel would require size reduction to facilitate removal and subsequent transport for disposal. The bridge crane in the high bay is currently out of service and would need to be refurbished and certified to Occupational Safety and Health Administration (OSHA) standards and returned to service to support removal activities. If this is not possible, the work would be significantly more complex; there may be insufficient lay-down space/accessibility around the building exterior to facilitate use of a mobile crane. There is also some concern with the allowable floor loading for the high bay building slab; an engineering evaluation would be required to determine if the floor can accommodate equipment required for load-out of the test reactor vessel and associated components. Reinforcement of the floor from below may also be required.

Similar to the CX Building, prior to equipment removal, the equipment showing higher levels of radiation would be stabilized or shielded in place to prevent the spread of contamination during removal of these items and to maintain worker exposure to ALARA levels. To prepare the room for removal of the equipment, temporary, localized ventilation would be installed, and the waste transfer path as well as size reduction area would be prepared by removing any obstructions and providing contamination control measures (i.e., Herculite® sheeting on floors and walls, absorbent booms, etc.). Facility surveys, sampling, and analysis to characterize the equipment in detail would be performed to support cleanout and waste disposition.

The test reactor vessel would then be systematically disassembled and removed. Most of the disassembly would be "hands-on" work with the removed items being wrapped in Herculite® and/or plastic bags. Some equipment and piping would be removed initially to provide laydown and maneuvering space. Structural shoring of the high bay floor would be added if required. The miscellaneous equipment and piping would then be removed from the uppermost levels of the CY Building High Bay. The reactor vessel heads would be rigged and removed from the mezzanine level and placed in the temporary size reduction area where the remaining reactor internals would be removed, and the reactor head size-reduced and packaged for disposal. The reactor pressure vessel would be cut in-situ into manageable-sized rings for removal; the rings would be rigged and removed from the building and placed in the temporary size reduction area where they would be further size-reduced and packaged for disposal.

After the test reactor vessel and associated tanks, equipment, and piping have been removed, the former high bay, waste management areas, waste transfer path, and size reduction area would then be surveyed to determine the levels of any residual radioactivity and the extent of additional decontamination required; any identified areas would be decontaminated using a graded approach.

3.2.4 Waste Management

Wastes generated during this removal action alternative would be characterized and segregated by waste type (e.g., LLW, mixed LLW, hazardous, and nonhazardous). Contaminated equipment, piping, concrete, and demolition debris wastes would be transported offsite. All waste shipments would be containerized according to U.S. DOT requirements and transported using established commercial truck routes and rail lines.

Cleanout of the high bays would generate approximately 1,080 cubic yards (cy) of LLW. The cost estimate assumes that the LLW would be disposed at an existing, permitted disposal facility specifically authorized to accept the wastes generated. DOE is in the process of upgrading the rail line located at the northern edge of the site; therefore, it is expected that the LLW would be shipped from the project site by rail to the final disposal facility. In addition, cleanout would likely generate small amounts of non-radioactive debris (approximately 120 cy of RCRA regulated/hazardous), which would be shipped to a permitted disposal facility using containers or trucks appropriate for the waste type.

3.2.5 Continued LFM

LFM program activities would continue under this alternative, but potentially at a reduced level of effort because the highest sources of radioactivity would have been removed. For costing purposes in this EE/CA, it is assumed that LFM activities for Alternative 2 would cost approximately 10% less than those described for Alternative 1; a duration of 30 years for the LFM activities is also assumed. Demolition of the buildings would still be required in the future (beyond the assumed 30-year period), but those costs are not included here.

The following subsections provide a detailed analysis of the effectiveness, implementability, and cost for Alternative 2, which are summarized in Table 3-2.

Table 3-2. Summary of Alternative 2 Effectiveness, Implementability, and Cost	
Effectiveness	Effective to protect human health and the environment for the assumed 30-year duration provided engineering and administrative controls remain in place. Risk to human health and the environment would be low.
Implementability	Could be implemented within 2.5 years.
Cost	$45.3M

3.2.6 Effectiveness

The Cleanout Alternative would be protective of human health and the environment for the assumed 30-year duration. Dismantling of the test reactor vessels and associated tanks, equipment, and piping, followed by decontamination of the high bays and other areas affected by the removal action would remove the radiological contamination associated with them, which accounts for roughly half of the total radioactivity present in the C-Area buildings, and thereby reduce risk of occupational radiation exposure exceeding limits during subsequent LFM activities.

The alternative would reduce the volume (total mass) of radioactive materials. Chemical contamination and potentially hazardous materials present in the buildings would remain unchanged in areas outside the cleanout activities. Administrative and engineering controls (monitoring and access controls) would protect workers from exposure to the remaining residual radiation and/or chemical contamination on building surfaces and equipment. Building maintenance would include routine repair of building systems, including roof, walls, windows, utilities, and service systems to prevent deterioration and thereby minimize the threat of an uncontrolled release.

Residual risks under this alternative would be less than current conditions. The residual risk from potential exposure to the remaining radiation or radionuclides would be low if radionuclides in building components are not disturbed and appropriate access controls and monitoring are maintained inside the buildings. The residual risk from potential exposure to chemical contamination, hazardous substances, and potentially hazardous materials would be low if the areas are left undisturbed. The alternative would not address any potentially contaminated soil associated with past or future releases from the CX Building or CY Building, including any sub-slab soil contamination. Currently, there is no evidence that any such releases impact the areas outside the CX and CY buildings, so this would be a low residual risk.

While activities associated with Alternative 2 could result in minimal and temporary impacts to water resources, the impacts would be negligible. Any operations with the potential to affect water quality would be performed in compliance with local, state, and federal requirements. In addition, water quality impacts would be minimized by implementing sedimentation and erosion controls, protecting storm drains, preventing sheet flow run-off, and applying other appropriate controls needed to protect water quality.

Activities associated with Alternative 2 would result in some air emissions; those emissions would have a negligible effect on air quality. Air quality impacts during decontamination would be minimized through use of appropriate engineering controls. Air quality impacts during offsite waste transportation would be minimized by using proper packaging for containment of waste loads and by using vehicles with effective emission control systems and reducing idling times.

Offsite impacts (visual/aesthetic, noise, traffic, transportation, disposal, utilities) would be negligible or minor. There would be no visual or aesthetic impact since the buildings are not visible from offsite. Demolition activities and truck/rail haul traffic would have minor (minimal and temporary) impacts on noise levels in the community. Traffic impacts would be minor, and further minimized by scheduling truck trips in consideration of commuting peak times, school bus routes and schedules, road and street maintenance, etc. Offsite impacts due to waste transportation would be minor.

There would be no impacts from disposal as existing, permitted facilities would be used (whose impacts have already been evaluated); no new disposal facilities would be required. Existing commercial truck routes, rail lines, and waste disposal facilities would be used for the removed equipment and decontamination waste. Impacts from waste management activities would be minimal. Sound waste management practices are routinely incorporated into business management and operational practices and seek to minimize waste, prevent pollution, and encourage recycling.

There would be no impact to offsite utility systems; existing utilities would continue to be used. Land use would not change; the Bettis Laboratory is an industrial facility with an ongoing mission. However, due to the areas of residual contamination that would remain, the use of the C-Area buildings would be limited in meeting mission needs.

There would be no adverse socioeconomic impacts from decontamination, waste transportation, or disposal. Transportation routes would use established commercial rail and truck routes, including access to the Pennsylvania Turnpike via a new interchange that is under construction, and access to the upgraded rail system via a heavy haul road that is to be constructed under a separate project to support Bettis Laboratory's mission. Waste materials would be disposed at existing permitted facilities so that no new disposal facilities would be required. There may be a potential minor beneficial impact, since most construction equipment and labor would come from local vendors employing local labor. No negative impact has been identified to local population, neighborhoods, public facilities, or services.

A screening analysis was performed pursuant to the DOE NEPA Transportation Impact Screening Analysis (DOE 2022), to model probability of traffic accidents and fatalities for offsite shipment of wastes from Bettis Laboratory to potential permitted disposal facilities for each type of waste (e.g., LLW, regulated/ hazardous, and debris) and assumed transport method (truck or rail). Accident risks are independent of the type of cargo and reflect the national accident and fatality rate from truck and/or rail shipments as a function of miles traveled. The calculated probability of accidents (3E-8) is very small (less than one in a million probability). The calculated accident fatalities (5E-4) are significantly less than one.

The screening analysis also modeled the increased risk of developing a lethal cancer from radiation exposure associated with shipments of low-level radioactive waste under Alternative 2. The calculated increased cancer risk is very small, at 1E-5 latent cancer fatalities for the general population and 3E-6 for the trucking/rail crew, significantly less than one. Based on this screening analyses, impacts of the proposed action would be negligible, not resulting in significant transportation-related impacts.

No ecological/biological impacts are identified for the Cleanout Alternative. A PNDI screening was completed; results of the agency reviews indicated no impact.

The Cleanout Alternative would comply with ARARs and thereby minimize risks during implementation of the removal action. The alternative would comply with Federal and DOE radiation protection requirements for controlling radiation exposures to ALARA and would thereby minimize risks of exposure to radiation.

General construction ARARs, including dust and run-off control, would be complied with during any construction activity (e.g., equipment removal and decontamination operations), thereby further reducing risks of exposure to workers, the public, and the environment to radiological contamination, chemical contamination, hazardous substances, and potentially hazardous materials. Best management practices tailored to the project would be employed as a further measure of diligence. During decontamination, radiation protection measures would be provided to achieve doses that are ALARA.

The alternative would comply with waste management requirements for characterization of hazardous and/or radioactive wastes, waste packaging, labeling, manifesting, placarding, transport, and disposal at an approved disposal facility. Wastes generated during this alternative would be characterized and segregated by waste type (e.g., LLW, mixed LLW, hazardous, and nonhazardous). All waste shipments would be containerized according to U.S. DOT requirements.

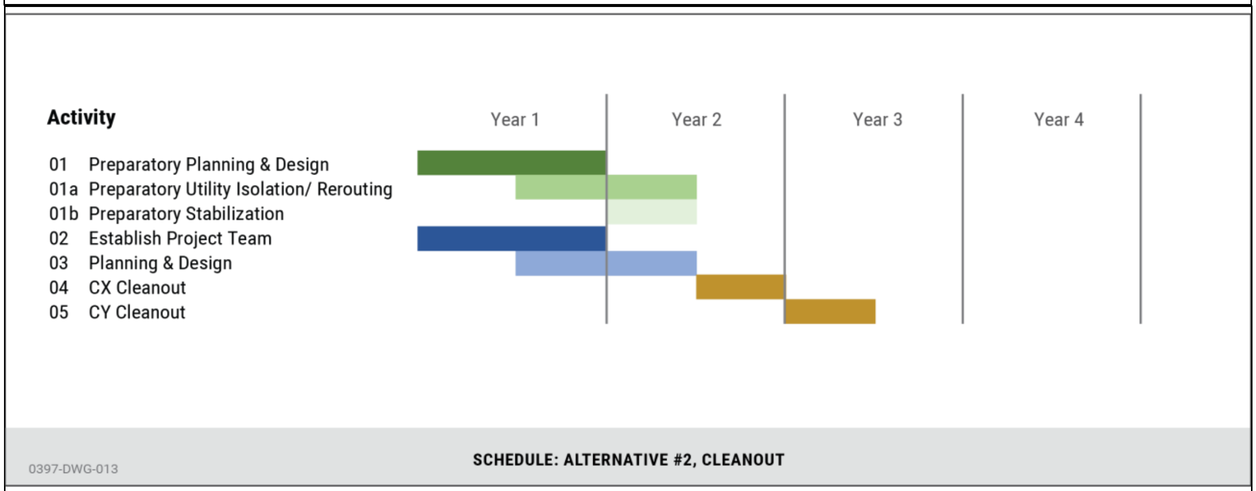
The alternative would be effective in achieving RmAOs in the short term, although some controls would need to remain in effect for the assumed 30-year duration. Monitoring and access controls would minimize direct exposure to residual contamination by onsite workers. Building maintenance would minimize the threat of an uncontrolled release, thereby minimizing potential future migration of contaminants to soil, surface water, groundwater, or air from the source facilities. Site environmental monitoring would reduce the risk of groundwater or soil releases from any residual contamination associated with the buildings or potential contamination in below-ground areas.

However, the alternative does not provide a permanent remedy. There would be residual radioactive and chemical contamination within areas of the buildings, including asbestos, PCBs in light ballasts, lead in paint, and potential miscellaneous contamination in drain piping systems. Potential subsurface contamination would also not be addressed by this alternative. This residual contamination would ultimately require removal to achieve permanent site closure.

3.2.7 Implementability

The Cleanout Alternative could be readily implemented. Construction activities would require an estimated duration of 2.5 years to complete (Figure 3-1). Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping within the high bays are well established and have been used in removing other facilities at the Bettis Laboratory. Because much of the radiological contamination is located inside pipes, tanks, and internal surfaces of the reactor assemblies, there would be potential short-term risk of contamination release during disassembly and decontamination of the high bays, potentially impacting workers. Therefore, the cleanout activities would require specialized expertise and protocols to operate and effectively protect worker health and safety. The specialized equipment, personnel, and resources needed for the work are readily available, though resource constraints may periodically occur.

Figure 3-1. Conceptual Schedule for Cleanout Alternative



Administrative and engineering controls to address the residual contamination (monitoring and access controls) are already in place and would be reduced as applicable for the reduced contamination levels. The current LFM program activities have been ongoing successfully for the past few decades following test reactor shut down, demonstrating that they are relatively easy to operate, perform effectively in protecting worker health and safety, and are applicable to the conditions within the high bays and the remainder of the C-Area buildings. Equipment, personnel, and resources are readily available to continue the LFM program activities for an assumed 30-year O&M period.

Contaminated equipment, piping, concrete, and demolition debris wastes would be transported offsite. Wastes would be disposed of at existing permitted facilities so that new permits would not be required for waste disposal.

3.2.8 Cost

Capital costs associated with Alternative 2 would include costs to (1) clean out the more highly contaminated test reactor vessels, tanks, equipment, and piping; (2) decontaminate the building surfaces within the high bays; (3) dispose of the associated wastes; and (4) implement needed building repairs. Capital costs are estimated at $17.1M. O&M costs of Alternative 2 are estimated at $1.31M/year for the assumed 30-year O&M period, for a corresponding present worth O&M cost (assuming a 2.3% discount rate) of $28.2M. The total present worth cost of Alternative 2, therefore, is estimated at $45.3M. The cost estimate is summarized in Appendix B.

3.3 Alternative 3: Demolition

Alternative 3 would involve demolishing the C-Area buildings, including removing the test reactor vessels and associated tanks, equipment, and piping. This alternative was developed because it would remove all hazardous substances, radiological and chemical contamination, and potentially hazardous materials from the buildings, provide a site suitable for use by DOE in continuing its mission, and eliminate the need for further LFM activities. DOE would retain ownership of the area and would control land use consistent with its continuing research mission at the Bettis Laboratory.

Alternative 3, similar to Alternative 2, would involve removing the test reactor vessels and associated tanks, equipment, and piping, as described in Section 3.2. Prior to demolition, the utilities within the area would be isolated and/or rerouted. Decontamination and stabilization would be conducted to clean the more highly contaminated areas and minimize the potential for hazardous material becoming airborne during demolition of the equipment and structures. The buildings would then be demolished. Slab and subgrade demolition would involve removal of utilities that have been isolated and/or rerouted. Small quantities of incidental soil would be removed in conjunction with the slab and subgrade demolition. Once demolition is complete, the soil beneath the building footprints would be characterized to determine if any residual contamination remains that requires removal. Following any additional contaminated soil removal, the excavation would be backfilled with clean backfill material and compacted. Backfill material could include imported soil, clean excavated onsite soil, or clean gravel.

> **Construction activities** under the Demolition Alternative include demolition, as well as several other types of construction, such as reactor removal, decontamination, utility relocation, soil excavation, and backfilling. The general term "construction" is used to encompass all the different types of construction activities.

The following presents a conceptual approach for the cleanout and demolition of the C-Area buildings to provide a basis for developing the cost estimate. While this conceptual approach is considered feasible and could be implemented, alternate approaches could be developed during final design by a demolition contractor.

3.3.1 Preparatory Planning

Planning and design would be required prior to implementation of the removal action. Planning and design would be more complex and extensive than Alternative 2 because this alternative includes not only cleanout of the high bay areas, but demolition of the two buildings as well.

The isolation and/or rerouting of the utility and service systems is a critical preparatory activity, as most systems have not been air-gapped nor are they disconnected from the remainder of the Bettis Laboratory site. In isolating a facility prior to demolition, consideration must be taken of the services source, destination, and affected buildings in between. This consideration would require significant lead time for comprehensive planning and system-wide engineering to reroute, and to partially replace components of the distribution systems. This planning would include locating the utility lines, design, and developing work plans for system rerouting and/or isolation. Utility and service systems include electrical, communications, steam and condensate, potable water, sanitary sewer, storm drains, cooling water, sumps and drains, fire water, natural gas, and compressed air systems. The stabilization of building components would also be required to minimize risks to worker or contaminant release during implementation. Stabilization includes checking structural integrity and building isolation, removing liquids from pipes and equipment, and removing any stored gases, solids in bulk, radioactive materials, hazardous chemicals, trash, or other housecleaning items from the work areas.

Design of the removal action would proceed concurrently with these isolation and stabilization activities. The project team would be established to define the project, develop a statement of work, select a contractor, and issue the appropriate contract(s). Project planning would include design of the removal action, addressing regulatory requirements, and completing the necessary readiness reviews to receive authorization to proceed with construction. Additional building characterization surveys and sampling would be performed during the Preparatory Planning phase as needed to develop radiological and hazardous waste profiles for handling and disposal of the wastes.

Design of the CX Building demolition represents a significant challenge associated with the need to surgically separate the bulk of the building from High Bay 3, which houses the SVTF. In-depth planning would be required to design the appropriate separation and sequencing of demolition activities so as not to interfere with the operation of the sensitive equipment associated with the SVTF.

3.3.2 Cleanout

The conceptual approach for the disassembly and removal of the test reactor vessels and stabilization/decontamination prior to demolition would be the same as described in Section 3.2. In addition, cleanout would include systematic dismantling and removing all utilities and service systems, and the removal of all piping, equipment, tanks, ductwork, and other removable systems throughout the C-Area buildings. Facility surveys, sampling, and analysis would be performed to characterize the buildings in detail to support demolition and waste disposition. Approximately 1,500 ft of contaminated subterranean monitor drain piping remains throughout the interior and exterior of the CX Building that has potential for retained radiological material that needs to be characterized. Asbestos abatement would be performed in accordance with requirements under the CAA for asbestos control to remove all friable or non-friable ACM prior to demolition. Any other potentially hazardous materials (e.g., PCB light ballasts) would also be removed.

3.3.3 Building Demolition

Building demolition would include demolition of the roofs and walls. For costing purposes, both the CX Building and the CY Building are identified as complex structures to be demolished. Robust building demolition would include demolition of the thick concrete walls surrounding the former high bays in the CX Building and CY Building.

The CX Building would require surgical separation of the building from the adjoining SVTF (High Bay 3). Surgical demolition is a precise method of dismantling a structure by removing specific parts (i.e., beams, walls, roofing, etc.) while leaving the walls of the SVTF intact and minimizing interference with SVTF operations. As such, surgical demolition would require greater use of hand tools, temporary cribbing or supports, and greater time to implement.

The CY Building High Bay would require a high-reach excavator for structure demolition. The building is built into a hillside, thereby limiting accessibility for demolition equipment.

3.3.4 Removal of Slabs and Soil

The building slabs would be removed, including basement structures and any shallow sumps and pits. Slab removal would include removal of incidental soil adjacent to the slabs or footings. Removal of below-grade basement structures and pits would involve OSHA-required benching and/or sloping to facilitate removal of the subgrade structure. Depending on final design details, a portion of the eastern CY Building high bay wall and footer may be left in place in order to minimize or prevent hillside erosion once the building is removed.

Once the building, rubble, and incidental soil are removed, the soil would be surveyed, sampled, and characterized to identify any areas of residual contamination. Further excavation of soil to remediate the building footprint areas to meet cleanup standards would be implemented, pending the soil characterization results. The extent of contaminated soil removal would depend on results of that soil characterization. For costing purposes, it has been assumed that the soil would be removed about 3 ft out in each direction from the building perimeter and 3 ft deep beneath all structures. For costing purposes, the building footprint to be excavated was estimated to be 125,000 sf for the CX Building and 35,000 sf for the CY Building. The building footprints would then be backfilled with compacted clean backfill material to support future development of the site by DOE.

3.3.5 Waste Management

Wastes generated during this removal action alternative would be characterized and segregated by waste type (e.g., LLW, mixed LLW, hazardous, and nonhazardous). The remaining contaminated equipment, piping, concrete, and demolition debris wastes would be transported offsite. All waste shipments would be containerized according to U.S. DOT requirements and would be transported using established commercial truck routes and rail lines.

Demolition of the buildings, including cleanout of the test reactor vessels and associated tanks, equipment, and piping, is anticipated to generate approximately 30,156 cy of LLW; 6,442 cy of RCRA regulated/hazardous waste; and 13,562 cy of non-hazardous solid waste and debris. The cost estimate assumes that the LLW would be disposed at a permitted DOE-approved disposal facility specifically authorized to accept the waste generated. The cost estimate assumes that the LLW would be shipped from the project site by rail to the disposal facility. RCRA-regulated/hazardous waste and/solid waste or debris would be shipped via truck or rail to their respective permitted disposal facilities.

The following subsections provide a detailed analysis of the effectiveness, implementability, and cost for Alternative 3, which are summarized in Table 3-3.

Table 3-3. Summary of Alternative 3 Effectiveness, Implementability, and Cost

Effectiveness	Most effective and protective alternative. Permanent and eliminates risks.
Implementability	Could be implemented within 4 years.
Cost	$79.0M

3.3.6 Effectiveness

The Demolition Alternative would be protective of human health and the environment and would permanently remove the test reactor vessels as well as any radiological contamination associated with the remainder of the C-Area buildings. This alternative would also permanently remove hazardous substances and potentially hazardous materials. The Demolition Alternative would be permanent and reliable, eliminating the need for further administrative and engineering controls.

There would be no residual risks associated with the C-Area buildings under this alternative, as all radiological and chemical contamination, hazardous substances, and potentially hazardous materials would be removed from the buildings.

Cumulative impacts to water quality and air quality would be negligible. Water quality impacts associated with Alternative 3 could result in minimal and temporary impacts to water resources, and operations with the potential to affect water quality would be performed in compliance with local, state, and federal requirements. In addition, water quality impacts would be minimized through the implementation of sedimentation and erosion controls, protection of storm drains, prevention of sheet flow run-off and other appropriate controls needed to protect water quality.

While activities associated with Alternative 3 would result in some air emissions, those emissions would have negligible impact on air quality. Air quality impacts during building demolition would be minimized by using appropriate engineering controls, such as misting to reduce dust emissions, asbestos abatement protocols, and personnel protection. Air monitoring would be conducted at the point of dust generation within the buildings and adjacent to the C-Area to verify that engineering controls are effective. Air quality impacts during waste transportation offsite would be minimized by using DOT-compliant waste packaging, vehicles with effective emissions control systems, and reduced idling time.

Offsite impacts (e.g., visual, noise, traffic, transportation, disposal, and utilities) would be negligible or minor. There would be no visual or aesthetic impacts, since the C-Area Buildings are not visible from offsite. Demolition activities and truck/rail haul traffic would have minor (minimal and temporary) impact on noise levels in the community. Traffic impacts would be minor, and further minimized by scheduling truck trips in consideration of commuting peak times, school bus routes and schedules, road and street maintenance, etc. Offsite impacts due to waste transportation would be minor. Transportation routes would use established commercial rail and truck routes, including access to the Pennsylvania Turnpike via a new interchange that is under construction and access to the upgraded rail system via a heavy haul road that is to be constructed under a separate project to support Bettis Laboratory's mission. There would be no impacts from disposal as existing, permitted facilities would be used (whose impacts have already been evaluated); no new disposal facilities would be required. Impacts from waste management activities would be minimal. Sound waste management practices are routinely incorporated into business management and operational practices and seek to minimize waste, prevent pollution, and encourage recycling.

There could be a minor, temporary increase in utilities (electricity, water) during demolition; however, long-term utility use would decrease because there would be no long-term LFM activities. Land use would not change. In the long term there could be positive impacts. The former site of the C-Area buildings would be suitable for use as part of DOE's continuing research mission at the Bettis Laboratory.

There would be no adverse socioeconomic impacts during decontamination, demolition, waste transport, or disposal. Transportation methods and routes would be evaluated and selected to minimize, to the extent practicable, the impacts on these communities and would use established commercial rail and truck routes. There may be potential minor beneficial impact, since most construction equipment and labor would come from local vendors employing local labor. There would be no impact to local population, neighborhoods, public facilities, or services.

A screening analysis was performed pursuant to the DOE NEPA Transportation Impact Screening Analysis (DOE 2022), to model the probability of traffic accidents and fatalities for offsite shipment of wastes from the Bettis Laboratory to potential permitted disposal facilities for each type of waste (e.g., LLW, regulated/hazardous, and debris) and assumed transport method (truck or rail). Accident risks are independent of the type of cargo and reflect the national accident and fatality rate from truck and/or rail shipments as a function of miles traveled. The calculated probability of accidents (2E-6) is small (two in a million probability). The calculated accident fatalities (1E-2) are significantly less than one.

The screening analysis also modeled the increased risk of developing a lethal cancer from radiation exposure associated with shipment of LLW under Alternative 3. The calculated increased cancer risk is very small, at 3E-4 latent cancer fatalities for the general population and 7E-5 for the trucking/rail crew. These risks are significantly less than one. Based on this screening analysis, impacts of the proposed action would be negligible, not resulting in significant transportation-related impacts.

No ecological/biological impact is identified for the Demolition Alternative. A PNDI screening has been completed; results of the agency reviews indicated no impact during implementation of the removal action. The alternative would comply with Federal and DOE radiation protection requirements for controlling radiation exposures to ALARA and would thereby minimize risks of exposure to radiation.

General construction ARARs, including dust and run-off control, would be complied with during any construction activity, equipment removal, and demolition, thereby further reducing the risks of exposure to workers, the public, and the environment to radiological and chemical contamination, hazardous substances, and potentially hazardous materials. Dust, asbestos, and radionuclide emissions would be controlled during building demolition so as to comply with all applicable air quality requirements. These controls would avoid the spread of radiological or chemical contamination outside of the C-Area and therefore be protective of the public and the environment.

The Demolition Alternative would comply with waste management requirements for characterization of hazardous and/or radioactive wastes, waste packaging, labeling, manifesting, placarding, transport, and disposal at an approved disposal facility. Wastes generated during this alternative would be characterized and segregated by waste type (e.g., LLW, mixed LLW, hazardous, and nonhazardous). All waste shipments would be containerized according to U.S. DOT requirements. Clean, reusable materials would meet DOE requirements for unrestricted release for residual surface radioactive contamination.

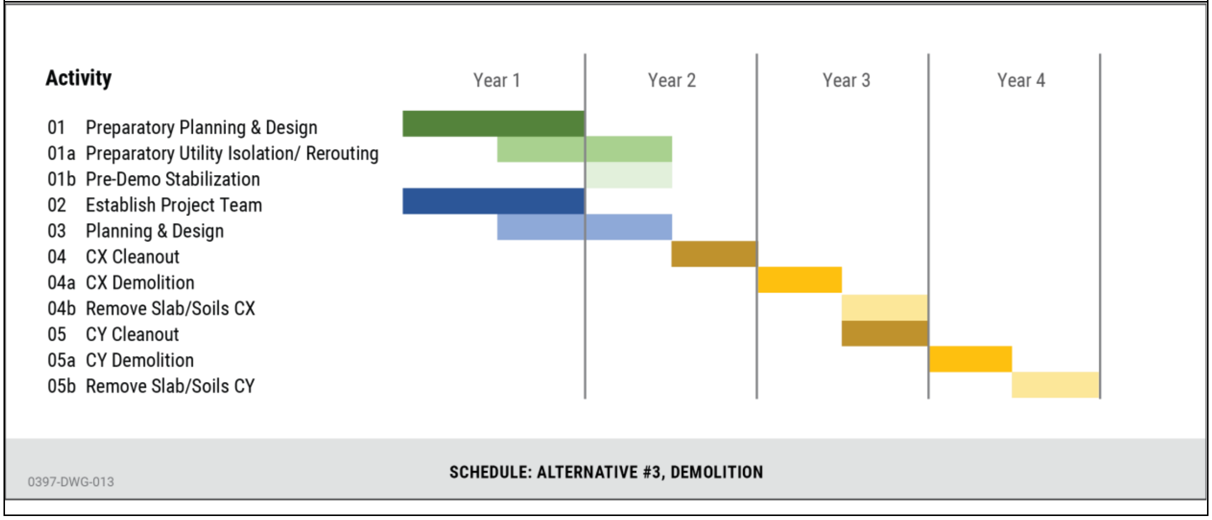
The alternative would be effective in achieving RmAOs by entirely removing the source facilities. Demolition of the C-Area buildings would eliminate potential exposure to radiological or chemical contamination, hazardous substances, or potentially hazardous materials, and eliminate potential future migration of contaminants to soil, surface water, groundwater, or air. The soil would be surveyed, sampled, and characterized to identify any areas of residual contamination, and any further excavation of soil to remediate the C-Area building areas to meet cleanup standards would be implemented, pending the soil characterization results.

Alternative 3 provides a permanent remedy by complete removal of the source facilities and removal of the residual radioactive or chemical contamination in soil to meet cleanup standards.

3.3.7 Implementability

The Demolition Alternative could be readily implemented. Construction activities, including cleanout of the test reactor vessels, tanks, equipment, and piping and building demolition would require an estimated 4 years to complete (Figure 3-2). Surgical demolition of the CX Building to separate it from the SVTF in High Bay 3 would involve greater complexity and time due to the intricate methods needed to implement the demolition.

Figure 3-2. Conceptual Schedule for Demolition Alternative



Technologies for safely dismantling, containerizing, and removing reactor components, accessory equipment, and piping within the high bays are well established and have been used previously to remove other facilities at the Bettis Laboratory and other DOE sites. Much of the radiological contamination is located inside pipes, tanks, and internal surfaces of the test reactor vessels. Therefore, during disassembly and decontamination of the test reactor vessels and associated tanks, equipment, and piping, and during subsequent building demolition, there would be potential short-term risk of airborne release of contamination potentially impacting demolition workers and the public. The removal activities would be planned and executed by professionals with specialized expertise to operate and effectively protect worker health and safety. The specialized equipment, personnel, and resources are readily available. Similarly, removal of hazardous substances, chemically contaminated building materials, and other potentially hazardous materials would also require specialized expertise, including training and certification and air circulation system operation, monitoring, and control. The specialized equipment, personnel, and resources needed for the work are readily available within the marketplace.

During demolition activities, there would also be potential for short-term risk of release of contaminants into underlying soils or drains due to rainfall into the partially demolished structure or during misting for dust control. Therefore, removal activities include plugging and capping sumps and drains and capturing any run-off water for characterization prior to release.

Waste would be disposed at existing permitted facilities so that no new permits would be required for waste disposal. Contaminated equipment, piping, concrete, and demolition debris wastes would be transported offsite.

3.3.8 Cost

Capital costs associated with Alternative 3 would include costs to clean out the radiologically contaminated test reactor vessels and associated tanks, equipment, and piping within the high bays and throughout the rest of the buildings; to remove the chemically-contaminated building materials, hazardous substances, and other potentially hazardous materials; to demolish the structures; to remove the slabs and contaminated soils; and to dispose of the associated wastes. Capital costs are estimated at $79.0M. There would be no O&M costs associated with Alternative 3. Correspondingly, the total present worth cost of Alternative 3 is estimated at $79.0M. The cost estimate is summarized in Appendix B.

4.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section presents a comparative analysis of the three removal action alternatives for the C-Area buildings that were discussed in Section 3. Similar to the individual analysis presented in Section 3, the alternatives are evaluated in terms of effectiveness, implementability, and cost. The comparative analysis evaluates the relative performance of each alternative in accordance with those criteria and identifies the advantages and disadvantages of each alternative relative to one another so that key tradeoffs that would affect the remedy selection can be identified. Appendix A summarizes the comparative analysis, listing key considerations for each evaluation criterion and for each removal action alternative.

NEPA values have been incorporated into this EE/CA for the C-Area buildings in accordance with DOE's NEPA policy (DOE 2002). Cumulative, offsite, ecological, and socioeconomic impacts are evaluated to the extent practicable in this comparative analysis of alternatives and are factors in DOE decision-making. Cumulative effects considered for the C-Area buildings include air, water, and groundwater quality. Offsite impacts include noise, traffic, transportation, aesthetics, and waste disposal. Socioeconomic impacts are also evaluated. Human health effects are included in the effectiveness evaluation. Impacts to visual/aesthetics, land use, and utilities are briefly discussed, proportionate to their impacts.

The No Action Alternative, Continued LFM, includes actions to continue to maintain the C-Area buildings, and provides a benchmark to enable decision-makers and the public to compare the levels of human health and environmental effects of the alternatives.

Table 4-1 highlights the results of the comparative analysis. State and community acceptance, both important to the CERCLA process, will be assessed as a part of the overall public and community involvement process, including the public comment period.

Table 4-1. Highlights of the Comparative Analysis

Criterion	Alternative 1: Continued LFM – No Action	Alternative 2: Cleanout	Alternative 3: Demolition
Effectiveness			
Overall Protection of Human Health and the Environment	Protective in the short term (30 years)	Protective in the short term (30 years)	Protective and permanent
NEPA Values	Negligible adverse impacts	Minor adverse impact due to noise, traffic, and transportation (mitigated); possible beneficial impacts (socioeconomics)	Minor adverse impact due to noise, traffic, and transportation (mitigated); possible beneficial impacts (socioeconomics and land use)
ARARs Compliance	Complies with ARARs	Complies with ARARs	Complies with ARARs
Ability to Achieve RmAOs	Effective in the short term	Effective in the short term	Effective and permanent
Implementability			
Technical Feasibility	Feasible	Feasible	Feasible
Administrative Feasibility	Feasible	Feasible	Feasible
Time to Implement	0 months (30-year O&M)	2.5 years (30-year O&M)	4 years
Cost			
Total Present Worth	$32.4M	$45.3M	$79.0M

4.1 Effectiveness

4.1.1 Overall Protectiveness of Human Health and the Environment

Alternative 1, Continued LFM (the No Action Alternative), would be protective in the short term. Administrative and engineering controls (e.g., shielding, monitoring, access controls) would continue to protect human health and the environment from exposure to radiation from reactor components and to chemical contamination on building surfaces and equipment, hazardous substances, and potentially hazardous materials. Building maintenance would prevent deterioration to minimize the threat of release to the environment. LFM would be effective for the assumed 30-year period, provided these controls remain in place. Residual risks to human health and the environment would be low, similar to current conditions.

Alternative 2, Cleanout, would be more protective than LFM alone because the test reactor components and associated radiological contamination representing approximately half of the radioactivity within the C-Area buildings would be removed. However, residual radiological contamination would remain, and chemical contamination, hazardous substances, and potentially hazardous materials would remain unchanged. Administrative and engineering controls would protect workers from this residual contamination. Alternative 2 would also be effective for the assumed 30-year period, provided these controls remain in place. Residual risks to human health and the environment would thereby be kept low.

Alternative 3, Demolition, offers the most protectiveness of any of the alternatives. The alternative would be effective and permanent, eliminating the risks associated with the chemical and radiological contamination, hazardous substances, and potentially hazardous materials associated with the structures. Residual soil associated with the structures would be surveyed, sampled, and characterized and residual contamination would be remediated, thereby addressing the risk of future environmental releases from soil sources. No long-term LFM controls would be required to protect human health or the environment.

4.1.2 Incorporation of NEPA Values

Cumulative Impacts:

- Water quality impacts would be limited. No impacts would occur under Alternative 1. Water discharges would be controlled per Bettis Laboratory permitted outfall requirements under Alternatives 2 and 3. There could be minor potential impacts under Alternative 3 during demolition, but with controls, such impacts would be negligible. The removal action would be performed in compliance with local, state, and federal requirements. Surface run-off impacts would be mitigated through engineering controls, such as sedimentation and erosion controls, protection of storm drains, prevention of sheet flow run-off and other appropriate controls needed to protect water quality and thereby meet permitted outfall requirements.
- Cumulative impacts to air quality due to air emissions would be negligible. While air emissions occur under Alternatives 2 and 3 during decontamination, asbestos abatement, and waste transportation, these air quality impacts would be minimized by using appropriate engineering controls and compliance with ARARs.
- Air quality impacts would be greater under Alternative 3 due to demolition of the two buildings and greater volumes of waste to be disposed offsite. Localized air impacts during building demolition would be minimized through use of engineering controls, such as misting to reduce dust emissions, asbestos abatement protocols, and personnel protection. Air monitoring would be performed in accordance with the Bettis Laboratory site air quality permit to verify controls are effective.
- Air quality impacts during waste transportation offsite would be negligible under all alternatives and would be minimized by using DOT-compliant waste packaging, vehicles with effective emissions control systems, and reduced idling time.

- There would be no impacts to soil or groundwater under any of the alternatives. Under Alternatives 1 and 2, LFM activities would maintain the buildings in an intact condition and on-going environmental monitoring programs at the Bettis Laboratory would mitigate any potential long-term impacts. Under Alternative 3, any contaminated soil encountered in the excavation would be excavated, thereby removing any contamination sources.

Offsite Impacts:

- There would be no visual/aesthetic impact for any of the alternatives, since the C-Area buildings are not visible from surrounding public areas.
- Because the C-Area is located a significant distance from the public, noise impacts due to demolition or other onsite activities would be minimal. While noise impacts due to traffic are minor under Alternatives 2 and 3, Alternative 3 would result in the greatest potential offsite noise impact due to the larger amount and duration of demolition activities and higher number of truck/rail haul traffic trips. However, impacts are expected to be minor and last only for the duration of demolition. Alternative 2 would pose less potential impact to noise levels due to the lower amount and shorter duration of demolition activities and lower number of truck/rail haul traffic trips. Alternative 1 would continue to have negligible noise impacts.
- Traffic impacts would be negligible for Alternative 1 because there would be no offsite waste shipments. Traffic impacts would be minor for Alternatives 2 or 3; in the short term, a temporary increase of truck traffic to and from the site would be expected during implementation of Alternative 2 or 3. Truck traffic may be minimized by use of rail for LLW shipments.
- Transportation impacts are negligible for Alternative 1, and minor for Alternatives 2 and 3. Analysis of transportation risks account for routes, distance, and mode of transport. To further reduce already low risks, haul routes would be planned to reduce traffic impacts to the local community during peak traffic hours and to consider factors such as road maintenance. The amounts of waste materials and of clean imported soil required would be minimized to the extent practicable. Alternative 3 would have greater impacts due to the greater volume of waste to be disposed and the greater number of trips. Alternative 3 would generate approximately 30 times more LLW and 50 times more regulated/hazardous waste than Alternative 2, plus an additional 13,562 cy of non-hazardous solid waste and debris. While the risk of a traffic accident is small under Alternatives 2 and 3 (about two in a million or less probability), the greater number of trips by rail and truck under Alternative 3 would pose a higher risk of a potential offsite traffic accident or injury.
- There would be no offsite disposal impacts from any of the alternatives. Waste materials would be disposed at existing, permitted disposal facilities (whose impacts have already been evaluated). No new disposal facilities would be required.
- There would be no potential impacts on utilities and service systems under Alternative 1 because ongoing LFM activities would continue to use existing facilities. Under Alternatives 2 and 3, a minor temporary increase in utilities such as electricity and water may be required for implementation of the selected removal action. In the long term, impacts to utilities and service systems would decrease under Alternative 3 because there would be no LFM activities. In consideration of both the long and short term, utility impacts would be negligible.

Land Use:

- There would be no change in land use under any of the alternatives; the Bettis Laboratory is an industrial facility with an ongoing mission. However, under Alternative 1 the presence of the test reactor vessels and associated tanks, equipment, and piping, and contamination within the buildings would significantly restrict the use of the buildings. Under Alternative 2, the residual contamination within the buildings would also restrict building use. For both Alternatives 1 and 2, the ability to meet the continuing research mission needs would be limited. Land use would be positively impacted under Alternative 3 as the site of the former buildings would be suitable for use as part of DOE's continuing research mission at the Bettis Laboratory.

Socioeconomics:

- There may be minor potential beneficial impacts under Alternatives 2 and 3 because most construction equipment and labor would come from local vendors employing local labor. The associated increase in business to vendors (including construction equipment rental vendors) who serve the construction trade would be in amounts typical of a construction project of an equivalent size. If specialized non-local labor forces were to be used, there would be associated local socioeconomic benefit from money spent on hotels, rental cars, and meals. In the long term, none of the alternatives would affect population, housing, lifestyles, neighborhood character or stability, property values, local tax base, employment, industry, or commerce. In addition, none of the alternatives would impact public services such as police, fire, schools, parks, or require the displacement of businesses or farms.

Ecological/Biological:

- A preliminary review of the project area and the individual buildings involved does not indicate the presence of threatened or endangered species or critical habitat that could be impacted by any of the alternatives. A PNDI screening has been completed and reviewed by the appropriate state agencies; results of the agency reviews indicated no impact would result from any of the alternatives.

4.1.3 Compliance with ARARs

In accordance with CERCLA, a removal action must comply with substantive technical requirements of an ARAR, but does not need to comply with administrative requirements, such as obtaining new permits. All three alternatives would comply with chemical-specific ARARs. Compliance with radiation protection requirements would control radiation exposures to ALARA and thereby minimize risks to workers, the public, and the environment.

All three alternatives would comply with Pennsylvania DEP general construction requirements, including dust control, during any construction activity to minimize short-term risks to workers or releases to the environment. Alternatives 2 and 3 would also comply with CAA requirements for control of asbestos and radionuclide emissions. Radiation protection measures would be implemented to reduce occupational radiation exposure to ALARA.

Alternative 3 may involve removal of contaminated soil beneath the building footprints. The alternative would comply with the 2006 Memorandum of Agreement with the Pennsylvania SHPO if any archaeological evidence is discovered during subsurface soil disturbance.

Alternative 1 would comply with waste management and waste transportation requirements during routine maintenance and repair. Alternatives 2 and 3, while involving greater volumes of waste, would comply with ARARs for characterization of hazardous and/or radioactive wastes, waste packaging, labeling, manifesting, placarding, and disposal at an approved disposal facility. Waste shipments would be containerized according to U.S. DOT requirements, complying with those respective ARARs.

4.1.4 Ability to Achieve RmAOs

All three alternatives would achieve RmAOs. Alternatives 1 and 2 would be effective for the assumed 30-year period, provided controls remain in place. Alternative 3 would be the most effective and would be permanent; risks to both workers and the environment would be eliminated by removing the contamination from the site. Following building demolition under Alternative 3, the soil would be characterized to identify any areas of residual contamination, and any further remediation would be implemented to meet cleanup standards, pending the soil characterization results.

Each of these action alternatives would achieve RmAOs at the completion of construction, which is estimated as immediately for Alternative 1, 2.5 years for Alternative 2, and 4 years for Alternative 3.

The three alternatives vary in the amount of residual contamination left onsite. There would be no reduction in radiological or chemical contamination, hazardous, or potentially hazardous materials under Alternative 1. Alternative 2 would remove approximately half of the radioactivity in the C-Area buildings by removing the radiologically-contaminated test reactor vessels and associated tanks, equipment, and piping, but would leave residual radiological and chemical contamination, hazardous substances, and potentially hazardous materials throughout the buildings. There would be virtually no residual contamination left onsite beneath the building footprints under Alternative 3.

4.2 Implementability

Each of the alternatives could be readily implemented. Alternative 1 could be readily implemented, as the administrative and engineering controls to be implemented are already in place. Current LFM activities have been ongoing successfully for the past few decades in the C-Area buildings, demonstrating that they are applicable to the conditions within the buildings.

Alternative 2 could be readily implemented within 2.5 years and Alternative 3 within 4 years, the longer time frame due to the greater volumes of demolition materials to be removed and disposed offsite. Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping are well established; specialized expertise would be required under both Alternatives 2 and 3 to protect construction worker health and safety. Technologies for building demolition under Alternative 3 are conventional and well-established technologies. These technologies have been used successfully in dismantling and demolishing other facilities at the Bettis Laboratory and other DOE sites and would be applicable to the C-Area facilities as well. Surgical demolition under Alternative 3 to separate the High Bay 3 from the rest of the CX Building would be more complex and would take greater time to implement than conventional demolition methods.

4.3 Cost

The cost estimates are summarized in Appendix B. Of the three alternatives, Alternative 1 would have the least cost, and Alternative 3 would have the greatest cost. Alternative 1 would have an estimated capital cost of $1.0M to implement building repairs, and an estimated operational cost of $1.46M/year for LFM over the assumed 30-year period, for an estimated total present worth cost of $32.4M. Alternative 2 would have an estimated capital cost of $17.1M to dismantle and remove the test reactor vessels and associated tanks, equipment, and piping, and to implement building repairs, as well as an estimated operational cost of $1.31M/year over the assumed 30-year period, for an estimated total present worth cost of $45.3M. Alternative 3 would have the highest estimated capital cost of $79.0M to demolish the two C-Area buildings, including the dismantling and removal of the test reactor vessels and associated tanks, equipment, and piping. However, Alternative 3 would have no long-term operational cost; therefore, its estimated total present worth cost would also be $79.0M.

5.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

DOE recommends that Alternative 3, Demolition, be selected as the preferred removal action. Although it would cost more than the other options and would take longer to complete the capital construction activities, it would be an effective and permanent remedy that is readily implemented with demonstrated technologies, would not require any post-construction long-term LFM, and would make the building footprints available for future use by DOE in continuing its research mission at the Bettis Laboratory. The Demolition Alternative fully satisfies RmAOs by eliminating the sources of contamination, both radiological and chemical. There would be no residual risk under Alternative 3.

This recommendation is based on the detailed comparative analysis provided in this EE/CA. The recommended alternative considers the tradeoffs between alternatives, with the goal of optimizing effectiveness in meeting the RmAOs and ease of implementation, while minimizing impacts and estimated cost.

While it is recognized that this alternative presents a greater potential for certain impacts than the other alternatives, the majority of the impacts are negligible or minor. Numerous best management practices would be employed to mitigate these impacts. For example, potential noise impacts during construction, particularly demolition, are expected to be minor due to the location of the C-Area at the northern end of the Bettis Laboratory site, away from any residential areas. These impacts would be managed by controlling noise-generating equipment and scheduling work during optimal hours to ease disturbance. Potential air quality impacts during asbestos removal and building demolition would be minimized through use of engineering controls and compliance with ARARs to protect against offsite release. Potential offsite impacts would be negligible, as the removed equipment, waste, and debris would be disposed of in existing, permitted, facilities authorized to accept such wastes. Potential transportation impacts and risks would be greater than other alternatives due to the greater volume of wastes to be disposed offsite and the greater number of trips. However, transportation risks would be minimized by using established haul routes and using rail for LLW transportation. Traffic impacts would be minimized by scheduling trips in consideration of commuting peak times, school bus routes and schedules, road and street maintenance, etc. Additional waste management optimization measures, such as segregating waste by waste type and reusing or recycling materials to the extent practicable, would also be implemented so as to minimize both traffic and transportation impacts.

The recommended alternative would be planned, designed, and implemented to achieve compliance with action-specific ARARs governing general construction practices, building demolition, waste management, and waste transportation. The alternative would comply with radiation protection requirements in controlling radiation exposures to ALARA.

This EE/CA will be made available for public review and comment in accordance with CERCLA requirements. EPA, State, and community acceptance of this recommended alternative will be assessed following the public comment period. Response to significant comments will be presented in a Responsiveness Summary, which will be included as part of a future CERCLA Action Memorandum for the C-Area buildings.

6.0 REFERENCES

Bettis Laboratory 2022 — *Bettis Laboratory Site Early Phase D&D Scope Facility Walkdown Assessment and Decommissioning Strategy.* Office of Infrastructure and Deactivation and Decommissioning, Bettis Atomic Power Laboratory, DOE Office of Environmental Management. 2022.

DOE 2002 — *DOE Policies on Applications of NEPA to CERCLA and RCRA Cleanup Actions*. Memorandum from B. Cook, Assistant Secretary, Environment, Safety and Health, to DOE Secretarial Officers and Heads of Field Organizations. July 11, 2002.

DOE 2022 — DOE NEPA Transportation Impact Screening Analysis. Office of Regulatory Compliance, Office of Environmental Management, version 3, June 22, 2022.

DOE 2025a — *Historical Site Assessment for the C-Area Buildings at the Bettis Atomic Power Laboratory*. DOE Environmental Management Consolidated Business Center. 2025.

DOE 2025b — *Community Involvement Plan for the C-Area Buildings*. DOE Environmental Management Consolidated Business Center. 2025.

DOE & EPA 1995	*Policy on Decommissioning Department of Energy Facilities Under CERCLA*, Joint Memorandum, May 22, 1995.
EPA 1985	*EPA/540/G-85/003 Guidance on Feasibility Studies Under CERCLA.* U.S. Environmental Protection Agency, Washington, D.C. June 1985.
EPA 1993	*EPA/540-R-93-057 Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*. U.S. Environmental Protection Agency, Washington, D.C. August 1993.
OMB 2024	OMB Circular A-94, Appendix C. *Discount Rates For Cost-Effectiveness, Lease Purchase, and Related Analyses*, Office of Management and Budget, Revised November 14, 2024.
Pennsylvania SHPO 2006	Memorandum of Agreement Between Pittsburgh Naval Reactors and the Pennsylvania State Historic Preservation Officer (SHPO) Regarding the Bettis Atomic Power Laboratory (Bettis), Located in Allegheny County, Pennsylvania. July 2006.

APPENDIX A
DETAILED SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Criterion	Alternative 1: Continued LFM – No Action Alternative	Alternative 2: Cleanout	Alternative 3: Demolition
Effectiveness			
Overall Protectiveness of Human Health and the Environment			
Protectiveness of Worker Health and Safety	Effective for assumed 30-year period. Administrative and engineering controls (shielding, monitoring, access controls) would protect workers and the environment from exposure to radiological and chemical contamination, hazardous substances and potentially hazardous materials above regulatory limits.	Effective for assumed 30-year period. Dismantling of the test reactor vessels and associated tanks, equipment, and piping, followed by decontamination of the high bays would remove approximately half of the radioactivity in the C-Area buildings and thereby reduce risk of exceeding occupational radiation exposure limits by workers during subsequent LFM activities. Administrative and engineering controls (monitoring and access controls) would protect workers from exposure to residual contamination.	Effective and permanent. Worker exposure eliminated by removing contaminated facilities.
Protectiveness of Human Health and Safety	Effective for assumed 30-year period. Building maintenance would prevent deterioration; access controls would prevent inadvertent access by onsite intruders.	Effective for assumed 30-year period. Approximately half of the radioactivity would be removed. Building maintenance would prevent deterioration; access controls would prevent inadvertent access by onsite intruders.	Effective and permanent. Human health and safety protected by removing contaminated facilities.
Protectiveness of the Environment	Effective for assumed 30-year period. Building maintenance would prevent deterioration to minimize threat of uncontrolled release to the environment. Any associated soil contamination would not be addressed.	Effective for assumed 30-year period. Approximately half of the radioactivity in C-Area buildings would be removed. Building maintenance would prevent deterioration to minimize threat of uncontrolled release to the environment. Any associated soil contamination would not be addressed.	Effective and permanent. Potential threat of release to environment eliminated by removing contaminated facilities and associated soil contamination.
Effectiveness in Reducing Inherent Risks	Moderately effective for 30-year period. Administrative and engineering controls would prevent exposure by workers and maintain risks at low levels. Inherent risks due to radiological and chemical contamination, hazardous substances, and potentially hazardous materials would be unchanged.	Moderately effective for assumed 30-year period. Inherent risks due to radioactivity would be reduced by removing approximately half of the radioactivity in the C-Area buildings. Administrative and engineering controls would prevent exposure by workers to residual radiological and chemical	Effective and permanent. Inherent risks eliminated by removing contaminated facilities and associated soil contamination.

Criterion	Alternative 1: Continued LFM – No Action Alternative	Alternative 2: Cleanout	Alternative 3: Demolition
		contamination, hazardous substances, and potentially hazardous materials.	
Reliability During Operation	Reliable as long as controls remain in effect.	Reliable as long as controls remain in effect.	Reliable and permanent with no long-term controls or operation required.
Level of Treatment/ Containment	Engineering controls (shielding) would protect against exposure to radiation related to test reactor components. There is no action to treat or otherwise contain contamination.	Approximately half of the radioactivity would be removed. Chemical contamination, hazardous substances, and potentially hazardous materials would remain unchanged. Treatment and/or containment would be implemented to meet requirements at the offsite disposal facility.	Contamination would be removed. Treatment and/or containment would be implemented to meet requirements at the offsite disposal facility.
Level of Residual Concern	Level of radiological and chemical contamination would remain unchanged. Administrative and engineering controls would prevent exposure by workers and maintain risks within allowable thresholds. Any associated soil contamination would not be addressed.	Approximately half of the radioactivity in C-Area buildings would remain as residual contamination. Chemical contamination, hazardous substances, and potentially hazardous materials would remain unchanged. Administrative and engineering controls would prevent exposure by workers and maintain risks within allowable thresholds. Any associated soil contamination would not be addressed.	Contamination would be removed. Contaminated soil would be remediated to meet soil cleanup standards. No residual contamination would remain.
Level of Control to Long-Term Remedy	Effective administrative and engineering controls for the assumed 30-year period. Long-term remedy would be implemented upon site closure.	Effective administrative and engineering controls for the assumed 30-year period. Long-term remedy would be implemented upon site closure.	Effective and permanent. No controls required during continued operation of Bettis Laboratory.
Long-Term Protectiveness and Permanence	Not effective over the long term; no permanent remedy implemented.	Not effective over the long term; no permanent remedy implemented. Residual chemical contamination, hazardous substances, and potentially hazardous materials would ultimately need to be removed to achieve permanent site closure.	Effective over the long term; permanent.
Reduction of Toxicity, Mobility, or Volume	No reduction in toxicity, mobility, or volume.	Onsite volume of radioactivity reduced by approximately one-half.	Onsite volume of contamination removed entirely.
Short-Term Effectiveness	Effective for the assumed 30-year period; administrative and engineering controls in place to protect workers.	Effective for the assumed 30-year period; administrative and engineering controls in place to protect workers.	Effective and permanent.
Performance over Useful Life	Effective for the assumed 30-year period; administrative and engineering controls would remain useful over that time period.	Effective for the assumed 30-year period; reduced levels of administrative and	Effective and permanent.

Criterion	Alternative 1: Continued LFM – No Action Alternative	Alternative 2: Cleanout	Alternative 3: Demolition
		engineering controls would remain useful over that time period.	
NEPA Values			
Cumulative Impact: Water Quality	No impact identified. No change from current conditions.	Negligible impact controlled through compliance with the Clean Water Act NPDES requirements.	Negligible impact controlled through compliance with the Clean Water Act NPDES requirements.
Cumulative Impact: Air Quality	No impact identified. No change from current conditions.	Negligible impact. Air quality impacts during decontamination would be minimized by using engineering controls. Air quality impacts during waste transportation would be minimized by using approved waste containers, vehicle emissions control systems, and reduced idling times.	Negligible impact. Air quality impacts during demolition would be minimized by using engineering controls. Air quality impacts during waste transportation offsite would be minimized by using approved waste containers, vehicle emissions control systems, and reduced idling times.
Offsite Impact: Aesthetics/Visual	No impact; buildings are not visible from offsite.	No impact; buildings are not visible from offsite.	No impact; buildings are not visible from offsite.
Offsite Impact: Noise	No impact identified. No change from current conditions.	Minor impact due to construction activities and truck/rail haul traffic.	Minor impact due to construction activities and truck/rail haul traffic.
Offsite Impact: Traffic	No impact identified. No change from current conditions.	Minor adverse impact. Mitigated through consideration of community traffic patterns, schedules, and coordinated planning to minimize the number of trucks.	Minor adverse impact. Mitigated through consideration of community traffic patterns, schedules, and coordinated planning to minimize the number of trucks.
Offsite Impact: Transportation	Negligible impact. No change from current conditions.	Minor impact. Mitigated through engineering measures and transportation planning. Low risk of vehicle accidents during offsite transportation of moderate quantities of waste materials. Waste transportation would comply with DOT requirements and haul routes would use established commercial truck routes and rail lines.	Minor impact. Mitigated through engineering measures and transportation planning. Low risk of vehicle accidents during offsite transportation of greater volumes of waste. Waste transportation would comply with DOT requirements and haul routes would use established commercial truck routes and rail lines.
Offsite Impact: Disposal	No impact identified. No change from current conditions.	No impact. Waste materials would be disposed at existing, permitted disposal facilities (whose impacts have already been evaluated). No new disposal facilities would be required.	No impact. Waste materials would be disposed at existing, permitted disposal facilities (whose impacts have already been evaluated). No new disposal facilities would be required.
Offsite Impact: Utilities	No impact identified. No change from current conditions.	No impact identified; existing utilities would continue to be used.	Minor temporary increase in utilities (electricity, water) during demolition. Long term utility use would decrease because there

Criterion	Alternative 1: Continued LFM – No Action Alternative	Alternative 2: Cleanout	Alternative 3: Demolition
			would be no long term LFM activities. Overall, impacts are negligible.
Offsite Impact: Waste Management	See analysis discussed under Compliance with action-specific ARARS: Waste Management		
Land Use Impact	No impact identified. No change in land use; the Bettis Laboratory is an industrial facility with an ongoing mission. However, due to the presence of the test reactor vessels, as well as areas of residual contamination, the use of C-Area buildings would be limited in meeting mission needs.	No impact identified. No change in land use; the Bettis Laboratory is an industrial facility with an ongoing mission. However, due to the areas of residual contamination, the use of C-Area buildings would be limited in meeting mission needs.	No impact identified. No change in land use; the Bettis Laboratory is an industrial facility with an ongoing mission. A future positive impact could occur; the site of the former buildings would be suitable for Bettis Laboratory mission uses.
Socioeconomic Impact	No impact identified. No change from current conditions.	No impact identified. Potential minor beneficial impact: most construction equipment and labor would come from local vendors employing local labor. No impact to local population, neighborhoods, public facilities, or services.	No impact identified. Potential minor beneficial impact: most construction equipment and labor would come from local vendors employing local labor. No impact to local population, neighborhoods, public facilities, or services.
Ecological / Biological Impact	No impact identified. No change from current conditions.	No impact identified. A PNDI screening has been completed; results of agency reviews indicates no impact.	No impact identified. A PNDI screening has been completed; results of agency reviews indicates no impact.
Compliance with ARARs			
Compliance with chemical-specific ARARs	Would continue to comply with radiation protection requirements in controlling exposures to ALARA.	Would comply with radiation protection requirements in controlling exposures to ALARA.	Would comply with radiation protection requirements in controlling exposures to ALARA.
Compliance with location-specific ARARs: NHPA	No impact.	No impact.	No impact. Any soil excavation below the buildings would be monitored for archaeological evidence in accordance with the Memorandum of Agreement with the Pennsylvania SHPO.
Compliance with action-specific ARARs: General Construction	Would continue to comply with general construction requirements, including dust and run-off control during any building repair.	Would comply with Pennsylvania DEP general construction requirements, including dust control and run-off during building repair and equipment removal and decontamination.	Would comply with Pennsylvania DEP general construction requirements, including dust and run-off control during equipment removal and decontamination and building demolition.

Criterion	Alternative 1: Continued LFM – No Action Alternative	Alternative 2: Cleanout	Alternative 3: Demolition
Compliance with action-specific ARARs: Building Demolition	Not applicable.	Not applicable.	Would comply with CAA requirements for control of asbestos and radionuclide emissions. Clean, reusable materials would meet DOE requirements for unrestricted release for residual surface radioactive contamination. Radiation protection measures would be implemented to keep occupational radiation exposures ALARA.
Compliance with action-specific ARARs: Waste Management	Would continue to comply with waste management and waste transportation requirements during routine LFM.	Would comply with waste management and waste transportation requirements for characterization of hazardous and/or radioactive wastes, waste packaging, labeling, and storage. Wastes would be characterized and segregated by waste type.	Would comply with waste management and waste transportation requirements for characterization of hazardous and/or radioactive wastes, waste packaging, labeling, and storage. Wastes would be characterized and segregated by waste type.
Compliance with action-specific ARARs: Waste Transportation	Would continue to comply with waste management and waste transportation requirements during routine LFM.	Would comply with waste manifesting, placarding, and disposal at an approved disposal facility. Waste shipments would meet U.S. DOT requirements.	Would comply with waste manifesting, placarding, and disposal at an approved disposal facility. Waste shipments would meet U.S. DOT requirements.
Ability to Achieve RmAOs			
Minimize Exposure by Workers	Effective for the assumed 30-year period. Administrative and engineering controls would protect workers from exposure to radiological and chemical contamination.	Effective for the assumed 30-year period. Removal of approximately half of the radioactivity in C-Area buildings and subsequent administrative and engineering controls (monitoring, and access controls) would protect workers from exposure to the residual levels of contamination.	Effective and permanent. Worker exposure eliminated by removing the contaminated facilities.
Minimize Migration to Environment	Effective for the assumed 30-year period. Building maintenance would prevent deterioration to minimize threat of uncontrolled release of contamination to the environment. Site environmental monitoring would minimize the threat of groundwater or soil releases from the buildings or potential contamination in below-ground areas.	Effective for the assumed 30-year period. Approximately half of the radioactivity would be removed. Building maintenance would prevent deterioration to minimize threat of uncontrolled release of contamination to the environment. Site environmental monitoring would minimize the threat of groundwater or soil releases from the buildings or potential contamination in below-ground areas.	Effective and permanent. Potential threat of release of hazardous substances to environment eliminated by removing contaminated facilities and contaminated soil.

Criterion	Alternative 1: Continued LFM – No Action Alternative	Alternative 2: Cleanout	Alternative 3: Demolition
Implementability			
Technical Feasibility			
Ease of Construction and/or Operation	Readily implemented; administrative and engineering controls already in place.	Readily implemented within 2.5 years. Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping are well established. Specialized expertise required to protect construction worker health and safety. Administrative and engineering controls to address residual contamination are already in place and would continue at a reduced level.	Readily implemented within 4 years. Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping are well established. Technologies for building decontamination and demolition are also well established. Specialized expertise required to protect construction worker health and safety.
Demonstrated Performance, Reliability	Current LFM program activities have been ongoing successfully for several years, demonstrating that they can perform effectively and can be reliably maintained.	Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping have been demonstrated previously in the removal of other facilities at Bettis Laboratory. Current LFM program activities have been ongoing successfully for several years, demonstrating that they can perform effectively and can be reliably maintained.	Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping have been demonstrated previously in the removal of other facilities at Bettis Laboratory. Technologies for building decontamination and demolition have also been demonstrated in the removal of facilities at other DOE sites.
Applicability to Site Conditions	Current LFM program activities have been ongoing successfully for several years, demonstrating that they are applicable to the conditions within the high bays and the remainder of the C-Area buildings.	Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping are applicable to this alternative. Current LFM program activities have been ongoing successfully for several years, demonstrating that they are applicable to the conditions within C-Area buildings.	Technologies for safely dismantling, containerizing, and removing reactor components and accessory equipment and piping are applicable to this alternative. Technologies for building decontamination and demolition are applicable to the C-Area buildings.
Time to Complete Removal	Readily implemented; administrative and engineering controls already in place and would be continued.	Readily implemented within 2.5 years.	Readily implemented within 4 years.
Time to Achieve RmAOs	RmAOs would be achieved immediately; but protectiveness relies on controls continuing uninterrupted for assumed 30-year period.	RmAOs would be achieved upon removal of the test reactor components, but protectiveness relies on controls continuing uninterrupted for assumed 30-year period.	RmAOs would be achieved upon completion of demolition and removal of any residual contaminated soil.

Criterion	Alternative 1: Continued LFM – No Action Alternative	Alternative 2: Cleanout	Alternative 3: Demolition
Availability of Resources			
Availability of Equipment, Personnel, or Services	Equipment, personnel, and resources are readily available to continue LFM program activities.	Specialized equipment, personnel, and resources are readily available for dismantling, containerizing, decontaminating, and disposal of wastes. Equipment, personnel, and resources are also readily available to continue LFM program activities at a reduced level.	Specialized equipment, personnel, and resources are readily available for dismantling, containerizing, decontaminating, and disposal of wastes. Conventional equipment, personnel and resources are readily available for building demolition.
Availability of Treatment or Disposal	No action or controls implemented that might require treatment or disposal.	Waste materials would be disposed at existing, permitted disposal facilities having sufficient capacity; no new disposal facilities required.	Waste materials would be disposed at existing, permitted disposal facilities having sufficient capacity; no new disposal facilities required.
Administrative Feasibility			
Feasibility of Institutional Controls	Feasible; current institutional controls have been successful for several years and would be continued.	Feasible; current institutional controls have been successful for several years and would be continued at a reduced level.	Feasible; no long-term institutional controls implemented.
Feasibility of Obtaining Permits	No additional permits required.	No additional permits required.	No additional permits required.
State Acceptance	State Acceptance to be assessed following the public comment period.		
Community Acceptance	Community Acceptance to be assessed following the public comment period.		
Cost			
Capital Cost	$1.0M	$17.1M	$79.0M
O&M Cost	$1.46M/year for 30 years	$1.31M/year for 30 years	$0
Present Worth Cost	$32.4M	$45.3M	$79.0M

APPENDIX B
SUMMARY OF ESTIMATED COSTS FOR THE REMOVAL ACTION ALTERNATIVES

Cost Category	Alternative 1: Continued LFM – No Action	Alternative 2: Cleanout	Alternative 3: Demolition
Capital Costs			
00 Building Repairs	$1,030	$1,030	$ -
01 Preparatory Planning & Design	$ -	$317	$634
01a Preparatory Utility Isolation/Rerouting	$ -	$950	$1,901
01b Preparatory Stabilization	$ -	$950	$1,901
02 Establish Project Team	$ -	$158	$277
03 Planning & Design	$ -	$422	$792
04 Cleanout CX	$ -	$5,045	$10,078
04a Demo CX	$ -	$ -	$33,997
04b Remove Slab/Soils CX	$ -	$ -	$2,550
05 Cleanout CY	$ -	$8,208	$10,920
05a Demo CY	$ -	$ -	$14,433
05b Remove Slab/Soils CY	$ -	$ -	$1,550
Total Capital Cost	$1,030	$17,080	$79,033
O&M Costs			
Annual O&M Cost	$1,460/year	$1,314/year	$ -
Present Worth O&M Cost	$31,389	$28,250	$ -
Total Present Worth Cost			
Total Present Worth Cost (Capital and O&M)	$32,419	$45,330	$79,033

Note: All costs are in $1,000s, shown as 2025 $. Present worth costs assume a 30-year O&M period and a discount rate of 2.3%.