# ALTERNATIVES EVALUATION REPORT FOR REMAINING COMMERCIAL AND FUSRAP RADIOLOGIAL AREAS

**CE WINDSOR SITE**

**2000 DAY HILL ROAD**

**WINDSOR, CONNECTICUT**

**Prepared for:**

**ABB, INC.**

**2000 Day Hill Road**

**Windsor, Connecticut 06095**

**SEPTEMBER 2007**

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CE WINDSOR SITE
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Prepared for:
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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ABB | Asea Brown Boveri |
| ACM | asbestos containing material |
| AEC | Atomic Energy Commission |
| ALARA | as low as reasonably achievable |
| AOC | area of concern |
| ARAR | applicable or relevant and appropriate requirement |
| | |
| C&D | construction and demolition |
| CE | Combustion Engineering, Inc. |
| CEAs | competing electron acceptors |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CE Windsor Site | 2000 Day Hill Road, Windsor, Connecticut |
| CFR | Code of Federal Regulations |
| $cm^2$ | square centimeters |
| Co-60 | cobalt isotope with atomic weight of 60 atomic mass units |
| COPC | constituent or chemical of potential concern |
| CTDEP | Connecticut Department of Environmental Protection |
| | |
| 1,2-DCE | 1,2-dichloroethene |
| D&D | decontamination and decommissioning |
| DCGL | Derived Concentration Guideline Level |
| DOE | U.S. Department of Energy |
| dpm | disintegrations per minute |
| | |
| ELUR | Environmental Land Use Restriction |
| . | |
| FR | Federal Register |
| FS | feasibility study |
| FSS | Final Status Survey |
| FUSRAP | Formerly Utilized Sites Remedial Action Program |
| | |
| GZA | GZA GeoEnvironmental, Inc. |
| | |
| HLA | Harding Lawson Associates |
| HRC | Hydrogen Release Compound™ |
| HRC-A | Hydrogen Release Compound Advanced™ |
| HRC-X® | Hydrogen Release Compound extend release formula™ |
| HSA | Historical Site Assessment |
| | |
| LTR | License Termination Rule |
| | |
| MACTEC | MACTEC Engineering and Consulting, Inc. |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MCL | maximum contaminant level |

## LIST OF ACRONYMS AND ABBREVIATIONS – Continued

| | |
|---|---|
| MCLG | maximum contaminant level goal |
| MDC | Metropolitan District Commission |
| MED | Manhattan Engineer District |
| mg/kg | milligrams per kilogram |
| mg/L | milligrams per liter |
| MOU | Memorandum of Understanding |
| mrem | milliRem |
| NAPL | nonaqueous phase liquid |
| NCP | National Oil and Hazardous Substance Pollution Contingency Plan |
| NRC | U.S. Nuclear Regulatory Commission |
| OSHA | Occupational Safety and Health Administration |
| PAH | polyaromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PCE | tetrachloroethene |
| pCi/g | picoCuries per gram |
| pCi/L | picoCuries per liter |
| POTW | publicly owned treatment works |
| PRG | preliminary remediation goal |
| RAO | remedial action objective |
| RCRA | Resource Conservation and Recovery Act |
| RCSA | Regulations of Connecticut State Agencies |
| RfD | reference dose |
| RFI | Resource Conservation and Recovery Act Facility Investigation |
| RI | remedial investigation |
| RSR | remediation standard regulations |
| SARA | Superfund Amendments and Reauthorization Act |
| Site | 2000 Day Hill Road, Windsor, Connecticut |
| TBC | to be considered |
| TCE | trichloroethene |
| TEDE | Total Effective Dose Equivalent |
| U-235 | uranium isotope with atomic weight of 235 atomic mass units |
| µg | microgram |
| µg/L | micrograms per liter |
| µg/kg | micrograms per kilogram |
| USACE | U.S. Army Corps of Engineers |
| USC | United States Code |
| USEPA | U.S. Environmental Protection Agency |
| VCA | Voluntary Corrective Action |
| VOC | volatile organic compound |

## EXECUTIVE SUMMARY

This Alternatives Evaluation Report evaluates alternatives for controlling potential human health and environmental risks posed by contamination associated with Formerly Utilized Sites Remedial Action Program (FUSRAP) materials and remaining NRC-licensed materials from past commercial operations commingled with FUSRAP materials (collectively "FUSRAP areas") at the Combustion Engineering, Inc. (CE) site ("Site") located at 2000 Day Hill Road, Windsor, Connecticut (CE Windsor Site).

The FUSRAP program was begun by the U.S. Department of Energy in the 1970s to clean up sites where radioactive contamination remained from the early years of the nation's atomic energy program. The FUSRAP Program was transferred to the US Army Corps of Engineers (USACE) in 1997. The USACE oversaw a remedial investigation (RI) of certain FUSRAP areas at the CE Windsor Site and preparation of a RI Report and draft Feasibility Study (FS) Report (ENSR, 2004; ENSR, 2005). As the result of an agreement between USACE and NRC, NRC has become the federal agency responsible for the oversight of the cleanup of the remaining commercial and FUSRAP radiological contamination. The clean up of all residual material is being undertaken in accordance with the NRC's License Termination Rule (LTR) (10 CFR 20 Subpart E), which is the controlling regulatory standard for cleanup under NRC authority and would be the controlling cleanup standard as an ARAR were the USACE handling the cleanup of the FUSRAP areas. This Alternatives Evaluation Report was prepared by MACTEC Engineering and Consulting, Inc., under the direction of ABB to complete the cleanup of FUSRAP areas in a timely manner that is protective of human health and the environment. The following areas are evaluated in this Alternatives Evaluation report:

| Environmental Study Areas | Building Study Areas |
|---|---|
| Groundwater (Areas of Concern [AOCs] 10, and 12) | Building 3 |
| Woods Area (AOCs 1 and 4) | Building 6 |
| Equipment Storage Yard (AOC 10) | |
| Industrial Waste Lines (AOC 12) | |
| Debris Piles (AOC 13) | |

| Environmental Study Areas | Building Study Areas |
|---|---|
| Site Brook (AOC 14) | |
| Drum Burial Pit (AOC 21) | |
| Clamshell Pile (AOC 27) | |

**Note:** AOC = RCRA VCA area of concern

This Alternatives Evaluation Report is based on a Human Health Risk Assessment and Baseline Ecological Risk assessment contained in the Resource Conservation and Recovery Act Facility Investigation Report prepared by Harding ESE (2003) and approved by USEPA Region 1, the Building 3/3A Complex and Building 6 Complex Remedial Investigations (Harding ESE, 2002a, 2002b), and the Remedial Investigation for FUSRAP Areas (ENSR, 2004). Attachment A to this report discusses the relevant information from each to soil, sediment, and radiologically contaminated building materials at the FUSRAP areas.

Based on the results of the risk assessments and taking into account the NRC's License Termination Rule requirements, the Alternatives Evaluation Report identified the following remedial action objectives:

- Decontaminate radiologically contaminated building materials and systems at Building 3 and Building 6 to prevent exposure to unacceptable levels of radiological contamination.
- Prevent human receptor exposure to groundwater with contaminants exceeding Preliminary Remediation Goals (PRGs) based on the Connecticut Remediation Standards Regulation (RSRs).
- Prevent contaminants in vadose zone soil at concentrations exceeding the Connecticut GA Mobility Criteria from contributing to groundwater contamination above concentrations of concern.
- Prevent human receptor exposure to radiologically contaminated soil and sediment at the identified FUSRAP areas at levels exceeding Derived Concentration Guideline Levels.
- Prevent human receptor exposure to chemically contaminated soil and sediment at the identified FUSRAP areas at concentrations exceeding PRGs based on Connecticut RSRs.

This report evaluates four groundwater and three building, soil, and sediment remedial alternatives:

- Alternative GW1: No Action

- Alternative GW2: Enhanced In-Situ Biodegradation
- Alternative GW3: Groundwater Extraction and Treatment
- Alternative GW4: Monitored Natural Attenuation
- Alternative SS1: No Action
- Alternative SS2: Excavation and Disposal in On-Site Landfill
- Alternative SS3: Excavation and Off-Site Disposal

**Alternative GW1: No Action.** The groundwater No Action alternative was evaluated to establish a baseline for comparison to other groundwater remedial alternatives. Alternative GW1 does not include remedial action components to reduce exposure to chemicals exceeding protective chemical-toxicity criteria based on Connecticut RSRs in groundwater. There are no capital or operation and maintenance costs associated with Alternative GW1.

**Alternative GW2: Enhanced In-Situ Biodegradation.** Alternative GW2 Alternative GW2 relies on enhanced in-situ bioremediation of groundwater to mitigate human receptor exposure to contaminants exceeding PRGs. Enhanced biodegradation would be accomplished by introducing nutrients and other compounds to stimulate biodegradation of contaminants and reduce the time required to achieve PRGs. The principal contaminants in groundwater at concentrations above RSR Criteria are the chlorinated volatile organic compounds (VOCs) tetrachloroethene and trichloroethene, as well as the daughter products 1,2-dichloroethene and vinyl chloride. The estimated groundwater cleanup time for Alternative GW2 is less than 10 years.

**Alternative GW3: Groundwater Extraction and Treatment.** Alternative GW3 relies on extraction and treatment of groundwater to mitigate human receptor exposure to contaminants exceeding PRGs. Groundwater extraction and treatment is a time-tested alternative for providing hydraulic containment of a contaminant plume, and, in cases where sorption is not a major factor, can significantly reduce contaminant mass within the plume. While extraction of contaminated groundwater is relatively straight-forward, there are a number of treatment options usually available, depending on the chemical constituents and discharge requirements. Treated water would be discharged to an off-site publicly owned treatment works. The estimated groundwater cleanup time for Alternative GW3 is approximately 45 years.

**Alternative GW4: Monitored Natural Attenuation.** Alternative GW4 relies on natural attenuation processes to reduce contaminant concentrations and mitigate human receptor exposure to contaminants exceeding PRGs. However, because of the relatively high concentrations of chlorinated VOCs in groundwater, the alternative is not anticipated to meet the remedial action objectives within a reasonable timeframe. Therefore this alternative was eliminated during the screening step and not evaluated in detail.

**Alternative SS1: No Action.** The building, soil, and sediment No Action alternative was evaluated to establish a baseline for comparison to other groundwater remedial alternatives. Alternative SS1 does not include remedial action components to reduce radiation dosages below Nuclear Regulatory Commission or Connecticut Department of Environmental Protection criteria resulting from exposure to soil, sediment, or building materials. In addition, no action would be taken to reduce exposure to chemicals exceeding protective chemical-toxicity criteria in soil or sediment. There are no capital or operation and maintenance costs associated with Alternative SS1.

**Alternative SS2: Excavation and Disposal in On-Site Landfill.** Alternative SS2 relies on institutional controls and excavation and disposal of FUSRAP area soil and sediment exceeding PRGs in a specially constructed on-site containment cell to mitigate human receptor exposure to contaminants. Radiologically contaminated building materials from building decontamination would also be placed in the on-site containment cell. Institutional controls in the form of an Environmental Land Use Restriction would be necessary to protect the long-term integrity of the containment cell and for protection of human health and the environment.

**Alternative SS3: Excavation and Off-Site Disposal.** Alternative SS3 relies on excavation and off-site disposal of FUSRAP area soil and sediment exceeding PRGs to mitigate human receptor exposure to contaminants. Building materials from building decontamination and dismantlement would also be disposed of off-site. The institutional controls and construction of an on-site containment cell that are a part of Alternative SS2 are not required as part of this alternative.

**Comparison of Groundwater Alternatives.** Comparison of the groundwater alternatives indicates that Alternative GW1 would not be protective of human health and the environment nor comply with applicable or relevant and appropriate requirements (ARARs), while both Alternatives

GW2 and GW3 would. The major differences between Alternatives GW2 and GW3 pertain to the time required to achieve cleanup and costs. It is estimated that Alternative GW2 will achieve cleanup within 10 years in comparison to 45 years for Alternative GW3. This accelerated time frame increases the short term effectiveness of Alterative GW2. In addition, Alternative GW2 will not generate treatment residuals requiring handling and disposal. Both alternatives will reduce the toxicity, mobility, and volume of contaminants through treatment. The estimated present worth cost of Alternative GW2 is $936,000, and the estimated present worth cost of Alternative GW3 is $1,493,566

**Comparison of Building, Soil, and Sediment Alternatives.** Comparison of the building, soil, and sediment alternatives indicates that Alternative SS1 would not be protective of human health and the environment or comply with ARARs, while both Alternatives SS2 and SS3 would. The major difference between Alternatives SS2 and SS3 is the approach to disposal of contaminated media. Alternative SS2 relies on an on-site containments cell while Alternative SS3 relies on off-site disposal of contaminated material. Utilization of an on-site containment cell will require the maintenance and monitoring of the cell for an indefinite period whereas this is not the case for Alternative SS3. There is, therefore, greater uncertainty associated with the short- and long-term effectiveness of Alternative SS2 compared to Alternative SS3. In addition, there may be strong community feelings against on-Site containment. The estimated present worth cost of Alternative SS2 is $48,482,357, and the estimated present worth cost of Alternative SS3 is $69,814,300.

# 1.0 INTRODUCTION

This Alternatives Evaluation Report evaluates alternatives for controlling potential human health and environmental risks posed by contamination at the Formerly Utilized Sites Remedial Action Program (FUSRAP) areas at the Combustion Engineering, Inc. (CE) Site located at 2000 Day Hill Road, Windsor, Connecticut (CE Windsor Site or Site). From the mid-1950s to 2000, the CE Windsor Site was involved in research, development, engineering, production, and servicing of nuclear fuels, systems, and services. It is the objective of Asea Brown Boveri (ABB) to decommission the Site, including associated buried piping and adjacent grounds, such that the areas will meet the criteria for unrestricted use as specified by 10 Code of Federal Regulations (CFR) 20.1402, and to terminate the U.S. Nuclear Regulatory Commission (NRC) licenses for the Site.

Certain of the areas at the Site are categorized as FUSRAP areas. The FUSRAP program was begun by the U.S. Department of Energy (DOE) in the 1970s to cleanup sites where radioactive contamination remained from the early years of the nation's atomic energy program. The FUSRAP program was transferred to the US Army Corps of Engineers (USACE) in 1997. The USACE conducted a remedial investigation (RI) of certain FUSRAP areas at the CE Windsor Site and prepared an RI Report and draft Feasibility Study (FS) Report (ENSR, 2004; ENSR, 2005). As the result of an agreement between USACE and NRC, NRC has become the federal agency responsible for the oversight of the cleanup of the remaining commercial and FUSRAP radiological contamination.

This Alternatives Evaluation Report was prepared by MACTEC Engineering and Consulting, Inc., (MACTEC) under the direction of ABB to complete the cleanup of FUSRAP areas in a timely manner that is protective of human health and the environment. This Alternatives Evaluation Report is based on a Human Health Risk assessment and Baseline Ecological Risk assessment contained in the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report prepared by Harding ESE (2003) and approved by USEPA Region 1, the Building 3/3A Complex and Building 6 Complex Remedial Investigations (Harding ESE, 2002a, 2002b), and the Remedial Investigation for FUSRAP Areas (ENSR, 2004). Attachment A to this report discusses the relevant information from each to soil, sediment, and radiologically contaminated building materials at the FUSRAP areas.

This Alternatives Evaluation Report was prepared generally consistent with requirements contained in the following statutes, regulations, and guidance:

- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) (note that references made to CERCLA in this report should be interpreted as "CERCLA, as amended by SARA");
- The National Oil and Hazardous Substance Pollution Contingency Plan (NCP) (U.S. Environmental Protection Agency [USEPA], 1990);
- NRC regulations and guidance that pertain to decontamination and decommissioning (applicable portions of 10 CFR 20); and
- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988b).

## 1.1 PURPOSE AND SCOPE

The purpose of this Alternatives Evaluation Report is to develop, screen, and evaluate remedial alternatives to reduce potential human-health and environmental risks posed by exposure to contaminated groundwater, soil, sediments, debris, and building materials at the designated FUSRAP areas at the CE Windsor Site for integration into the Site Decommissioning Plan amendments which must be approved by the NRC. The Alternatives Evaluation Report addresses both radiological and chemical contaminants.

This Alternatives Evaluation Report does not select a preferred alternative. This will be done in the Remedy Selection Plan (similar to a Proposed Plan under CERCLA).

## 1.2 REPORT ORGANIZATION

This report is divided into five sections as follows:

<u>Section 1.0 – Introduction</u>

Provides an overview of the Site, the reasons and objectives for this investigation, and a summary of previous investigations and actions.

Section 2.0 – Identification and Screening of Remedial Technologies

Identifies remedial action objectives (RAOs), describes applicable or relevant and appropriate requirements (ARARs), and identifies remedial technologies and processes to be screened.

Section 3.0 – Development and Screening of Alternatives

Summarizes remedial action alternatives and the screening process and evaluates cleanup times.

Section 4.0 – Detailed Analysis of Alternatives

Evaluates the following aspects of each remedial action alternative presented in Section 3: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

Section 5.0 – Comparative Analysis of Alternatives

Compares the alternatives to highlight advantages and disadvantage and aid in the selection of a preferred alternative.

Attachment 1 presents the Risk Assessment that assesses risk to human health and the environment for the FUSRAP areas.

## 1.3 SITE HISTORY AND BACKGROUND

This section provides a brief overview of the history, environmental setting, regulatory context, and other aspects of the CE Windsor Site and its designated FUSRAP areas. Additional details about the site characterization are presented in the RI Report (ENSR, 2004).

### 1.3.1 Site Location and Description

The CE Windsor Site is located at 2000 Day Hill Road (previously 1000 Prospect Hill Road) in Windsor, Connecticut, approximately 2 miles northwest of Windsor center, 8 miles north of Hartford, and within 3 miles of the Bradley International Airport (Figure 1-1). The Site occupies approximately 600 acres and is located south of the Farmington River, within the Connecticut River Valley. A mixture of residential, agricultural, commercial, and industrial land uses surround the Site. The nearest residential areas are located within ¼ to ½ mile of the Site. The Site also includes various wooded areas and three ponds – Goodwin Pond, Small Pond, and Great Pond. Site Brook transects the northern portion of the property, flowing northwest into the Farmington River.

The CE Windsor Site is classified as an I-2 Industrial Zone by the Town of Windsor (ENSR, 2004). The I-2 Industrial Zone category designates general, higher-intensity industrial uses. There were historically more than 30 buildings on the Site that have been used for nuclear and/or fossil fuel research and development, nuclear fuel production, nuclear power plant support, engineering and designing activities, administration, materials storage, and general property and equipment maintenance.

### 1.3.2 Site History

CE acquired ownership of the property in the 1950s, and maintains the property title. In 1989, CE was purchased by ABB.

Over the history of its operation, the 600-acre CE Windsor Site was used primarily for nuclear and fossil power research and development, nuclear fuel production, and repair of nuclear power plant equipment. Operations began at the Site in the late 1950s. Nuclear fuel production ceased in 1993, and all other commercial nuclear activities ceased in 2001, with the exception of decontamination and decommissioning (D&D) activities of the areas used exclusively for commercial operations.

From the late 1950s and through the early 1960s, nuclear fuel fabrication was conducted for the Atomic Energy Commission (AEC), which is now the DOE. After the early 1960s, CE performed similar operations for the commercial nuclear industry.

In 1960, an area of approximately 11 acres was segregated from the CE Windsor Site for exclusive federal government use (S1C Facility), and ownership was transferred to the U.S. Government. CE and subsequently ABB used the remaining 589 acres for various nuclear operations and activities, until those operations subsequently ceased. FUSRAP areas of the CE Windsor Site are located on the 589-acre parcel that ABB continues to own; the S1C Facility, which incorporates the other 11 acres, is not a part of this Alternative Evaluation Report.

### 1.3.3 Selection of Areas Subject to Alternatives Evaluation

As described in the RI Report (ENSR, 2004) and summarized earlier in this Alternatives Evaluation Report, the selection of areas subject to FUSRAP evaluation was based on the initial Site designation (DOE, June 20, 1994). Combining the Determination Letter with subsequent Site reconnaissance for all areas containing FUSRAP materials and commingled radiological materials and collocated chemical contamination, and performing the Risk Assessment (Attachment 1) yielded the areas in the following table for further investigation.

| Environmental Study Areas | Building Study Areas |
|---|---|
| Groundwater (Areas of Concern [AOCs] 10, and 12) | Building 3 |
| Woods Area (AOCs 1 and 4) | Building 6 |
| Equipment Storage Yard (AOC 10) | |
| Industrial Waste Line (AOC 12) | |
| Debris Piles (AOC 13) | |
| Site Brook (AOC 14) | |
| Drum Burial Pit (AOC 21) | |
| Clamshell Pile (AOC 27) | |

**Note:** AOC = RCRA VCA area of concern

Figure 1-2 shows the locations of these areas within the CE Windsor Site boundaries.

## 1.4 INDIVIDUAL CONCEPTUAL SITE MODELS FOR SELECTED AREAS

The following subsections describe the general characteristics of the areas evaluated in this Alternatives Evaluation Report.

Available data indicate that radiological contamination of groundwater and surface water does not pose a risk at the FUSRAP areas. Groundwater samples were collected by USACE in August 2000 and in April 2001. For both sampling events, groundwater samples were collected from a total of 25 existing Site monitoring wells to provide water quality data associated with the FUSRAP areas. The August 2000 data revealed that total uranium was detected in only one location (MW-E1), at a relatively low activity of 0.45 picocuries per liter (pCi/L). The April 2001 data revealed the presence of total uranium activity up to 3.4 pCi/L (MW-S02) with a mean of 0.93 pCi/L for detected values. These results are significantly less than USEPA drinking water maximum contaminant levels (MCLs) and are not a concern from a risk perspective.

Surface water samples from Site Brook were also collected by USACE in November 2000. Results indicated that uranium was present at activities up to 0.42 pCi/L, with a mean of 0.33 pCi/L for detected values. For Site Brook, cobalt-60 (Co-60) was an additional chemical of potential concern (COPC), but was not detected in any of the surface water samples analyzed (ENSR, 2004). These results are significantly less than USEPA ambient water quality criteria and are not a concern from a risk perspective.

### 1.4.1 Building 3

Building 3 is a one-story structure constructed of concrete block, concrete floors, and steel framing with transite (asbestos) siding, and a steel roof deck. Building 3 was used for nuclear research and fabrication of nuclear fuel from uranium fuel stock, and houses multiple process control systems. These systems include multiple ventilation units for heating and isolating contaminated areas, and a water supply and drainage system for controlling process waters, industrial waste, sanitary waste, and radiological waste.

The building occupies 56,000 square-feet and is divided into three sections: the North Bay (hot fabrication area, "Hot Shop"), Main Bay (Cold Fabrication Shop), and the 70-feet tall High Bay (Core Assembly Building). Metal melting and grinding were performed in the North Bay, rolling and cutting operations were performed in the Main Bay, and assembly and shipping of uranium fuel were performed in the High Bay.

The Core Assembly Building was located on the south end of the building and was intended to remain radiologically clean. However, there were times when final assemblies contained residual uranium and had to be cleaned before release from the building (Interview Log, 2001). Products that left the Core Assembly Building went into the field (S1C, US Navy). The footprint of the High Bay was doubled in the early 1970s to support the commercial [fossil] power plant safety valve testing program. The soil under this addition was surveyed prior to construction and was clean of radiological contamination from the plant operations.

A one-story office space addition (Building 3A) was added to Building 3 in 1962. Building 3A occupied approximately 18,000 square feet and was used exclusively as office space. The building was dismantled in 2002, and only the concrete floor slab remains.

Please refer to the Limited Radiological Characterization Work Plan (Harding ESE, 2002a) and the Final Historical Site Assessment (HSA) (Harding ESE, 2002b) for comprehensive operational and investigative background information on the Building 3 Complex.

The results of the Limited Radiological Characterization are discussed briefly in the following paragraphs.

**Building 3 North Bay Walls.** A total of nineteen survey locations were measured for fixed and removable alpha and beta activity. The maximum direct alpha and beta measurements are 251 disintegrations per minute per 100 square centimeters (dpm/100 $cm^2$) and 697 dpm/100 $cm^2$, respectively. Smear samples results indicate maximum removable alpha and beta activities of 17 and 8 dpm/100 $cm^2$, respectively.

**Building 3 Inaccessible Areas.** A total of ten survey locations were measured for fixed and removable alpha and beta activity. The maximum reported alpha and beta direct measurements are 131 and 1,004 dpm/100 $cm^2$, respectively. The maximum alpha and beta removable contamination estimated on these surfaces are 4 and 18 dpm/100 $cm^2$, respectively.

**Soil and Structures Beneath Building 3.** Uranium may be present in the soil beneath the building slab and may be present in the drain lines under and adjacent to the building. Consistent with the License Termination Rule (LTR), these areas cannot be fully investigated and potential risks evaluated without removal of the building.

### 1.4.2 Building 6

Building 6 was constructed in 1956 as a liquid radiological waste collection and dilution facility for Buildings 3, 5, and 17 (ENSR, 2004). Building 6 is a reinforced concrete building (approximately 40 by 60 feet) with a steel roof deck and a deep basement extending approximately 20 feet below ground surface. The building houses four 5,000-gallon steel dilution tanks and ten 2,000-gallon steel storage tanks, and there is a shallow sump located in the southwest corner. The building is also equipped with a roof mounted ventilation system. Please refer to the Limited Radiological Characterization Work Plan (Harding ESE, 2002a) and the Final HSA (Harding ESE, 2002b) for comprehensive operational and investigative background information on the Building 6.

The results of the Limited Radiological Characterization are discussed briefly in the following paragraphs. In general, removable and fixed radiological measurements were below the NRC Regulatory Guide 1.86 release criteria; however, volumetrically contaminated materials exist in the building materials.

Direct surface measurements indicate that all but one beta measurement are less than the NRC Regulatory Guide 1.86 release criterion. The maximum beta measurement of 6,054 dpm/100 $cm^2$ (B6F1) was the only measurement to exceed the NRC release criterion of 5,000 dpm/100 $cm^2$ in this sampling event. This measurement was made on the floor in the northwest corner of the basement. The maximum alpha measurement was 4,400 dpm/100 $cm^2$ (B6S1). This measurement was made on the south wall in the lower east corner.

Removable surface activity measurements (smear results) indicate that all alpha and beta smear sample results collected during the Limited Radiological Characterization are less than the NRC Regulatory Guide 1.86 release criterion of 1,000 dpm/100 $cm^2$. The maximum alpha and beta measurements are 319 dpm/100 $cm^2$ and 156 dpm/100 $cm^2$, respectively.

**Soil and Structures Beneath Building 6.** Uranium and other contaminants may be present in the soil beneath the building slab and may be present in the drain lines under and adjacent to the building. Consistent with the LTR, these areas cannot be fully investigated without removal of the building.

### 1.4.3 Areas Surrounding Building 3 and 6

The topography of the area surrounding the buildings is generally flat, with surface flow toward the east. The geology of the area consists of fill overlying fine, inter-bedded layers of sand and silt, with trace to small amounts of cobble. Till (prevalent within other areas with the CE Windsor Site) was not encountered in the area (Harding Lawson Associates (HLA), 2000). Groundwater is reported at a depth of approximately 20 feet below ground surface, and interpreted to flow easterly (HLA, 2000).

This area was studied in 1993 as part of the Designation Survey (ORISE, 1994). Subsequent studies were performed in 1998 (SAIC, 1999) and in 2000/2001 (ENSR, 2004). In addition, the property owner (CE) conducted its own studies throughout this period. During the RI phase, gamma walkover survey measurements and analytical data compiled by both USACE and ABB were reviewed and interpreted. Total uranium was identified as posing potential risks to human health based on its chemical toxicity and radioactivity. Total uranium was not considered to pose unacceptable risks to ecological receptors (ENSR, 2004).

There are three distinct areas where uranium is present: (1) a small area just west of Building 3, and adjacent to the old "High Bay" area, (2) a small area just north of Building 6, and (3) a larger area to the east and south of Building 6. The total uranium activity within these three areas ranged from non-detect to 939 picoCuries per gram (pCi/g), with an average of 59 pCi/g for the detected values. The highest total uranium activity (939 pCi/g) was detected in the surface of the northern portion of the study area, immediately adjacent to the east side of Building 6. In general, the highest total uranium activities are in the northern portion of the study area, between Buildings 3 and 6.

### 1.4.4 Woods Area

The Woods Area consists of an asphalt waste storage pad, as well as an adjacent roadway and woodland. The pad is adjacent to a dirt access road, and was historically used for materials storage. The pad itself is located in a lightly wooded area with mildly sloping terrain. The area was historically used to store and process low-level radioactive waste. There has also been evidence of machinery from Building 3 being stored in the area for extended periods prior to disposition.

The Woods Area is approximately 7 acres (HLA, 2000). This area is located within one of the topographically higher areas of the CE Windsor Site. The ground surface generally slopes to the west and north, which is the inferred direction of surface water runoff. The geology of this area consists of stratified sand and till. The till is present at or near the ground surface immediately east of the area, and dips steeply toward the east with a wedge of stratified sand overlapping and thickening toward the west and north. The depth to groundwater is controlled by the presence and depth of the dense till, and ranges generally from 30 to 45 feet below ground surface, with a northwesterly flow (HLA, 2000).

The area was studied in 1993 (ORISE, 1994), 1998 (SAIC, 1999), and 2000/2001 (ENSR, 2004), and studied by ABB throughout this period. Total uranium was identified as posing potential risks to human health and ecological receptors, based on its chemical toxicity and radioactivity. In addition, the RFI Report and Human Health Risk Assessment identified tetrachloroethene (PCE) as being present at concentrations exceeding Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSR) criteria (Harding ESE, 2003).

Uranium activity has been detected ranging from nondetect to 110,236 pCi/g, with a mean of 1,645 pCi/g for the detected values. The highest total uranium activity (110,236 pCi/g) was detected in the surface of the northern portion of the study area, immediately west of the access road and waste storage pad. Several samples within the study area were analyzed for chemical parameters. In general, higher concentrations of chemical parameters were correlated with higher total uranium activity.

### 1.4.5 Equipment Storage Yard

AOC 10 occupies approximately one acre along the southwestern shore of Small Pond. The area was originally used in the mid-1950s to store fill and construction debris. In 1968, Building 20 was constructed and used as a test facility for trash incineration. The Facility and Engineering Services Department subsequently used Building 20 for their daily maintenance operations. In fall 2001, Building 20 was dismantled.

AOC 10 has been studied extensively under the RCRA Voluntary Corrective Action (VCA) Program. Soil samples have been collected for off-Site chemical analyses, as well as on-Site radiological screening using gamma spectroscopy. Two interim corrective measures have been completed as well. The first interim corrective measure was performed to remove polyaromatic hydrocarbon (PAH)-contaminated soils and crushed drums. The second interim corrective measure consisted of the installation of a fence to limit/control human exposure to elevated concentrations of PAHs in surface soils.

PAHs have been detected in soil in the former Equipment Storage Yard at concentrations above CTDEP RSR Criteria. The highest concentrations of PAHs were reported from test pit TP-1002, where concentrations of several PAHs were above the CTDEP Imminent Hazard Threshold, which is 30 times the Direct Exposure Criteria. This area of contaminated soil with PAH concentrations above the CTDEP Imminent Hazard Threshold was excavated and the material was disposed of off-Site as part of an interim corrective measure completed in February 1999. PAHs are still present at concentrations above Direct Exposure Criteria. Some soil samples also had PAHs at concentrations above Connecticut groundwater GA Pollutant Mobility Criteria. However, when these locations were re-sampled and analyzed for PAHs by synthetic precipitation leaching procedure, PAHs were not detected. Mercury was the only inorganic detected by synthetic precipitation leaching procedure in test pit samples at concentrations slightly above the laboratory reporting limit. However, mercury was not detected by mass analysis. Therefore, the reported synthetic precipitation leaching procedure mercury results are considered suspect.

Previous sampling has identified two areas within the former Equipment Storage Yard with elevated total uranium activity. These are: (1) a partially buried drum containing uranium which remains on the fill bank above the edge of Small Pond, and (2) fill soils discovered during excavation of test pit TP-1012. Anecdotal information indicates a drum containing byproduct material was removed from the vicinity of TP-1012 in the past.

Total uranium in year 2002 characterization samples analyzed by alpha spectroscopy ranged from 0.74 pCi/g to 841.95 pCi/g. This range agrees with historical results (including both alpha and gamma results) that range from non-detect to 458.10 pCi/g. The maximum result was collected at DP-1032 from a depth of three feet below ground surface. This boring location is adjacent to RCRA VCA test pit TP-1012, where a sample from three feet below ground surface had earlier provided a total uranium activity of 458.10 pCi/g. These two results are bounded by surrounding explorations (DP-1030, DP-1031, and DP-1033) and are bounded at depth (samples collected at 7 feet below ground surface). The maximum reported result in these surrounding samples was approximately 2 pCi/g.

Sample 36ARSB008, obtained from soil collected from within the partially buried drum along the fill bank contained 174.54 pCi/g total uranium. Surrounding soil samples (SS-1023, SS-1024, SS-1025, and SS-1026) showed a maximum result of 37.03 pCi/g at SS-1023.

With the exception of the two areas just discussed, radioactivity at sampled AOC 10 locations is within the range of activities (0.57 to 3.15 pCi/g) observed at the Background Reference Area.

Finally, a walkover gamma scanning survey at the Equipment Storage Yard found only one area with activity detected slightly above general background levels. The sample collected from this area (SS-1022) contained total uranium at less than 2 pCi/g, a concentration consistent with background conditions.

### 1.4.6 Industrial Waste Lines

The Industrial Waste Lines area consists of three parallel subsurface pipelines and the surrounding soil. The pipelines are known to have transported radioactive and chemical materials. The RI evaluated the residual radioactivity within the lines, as well as potential evidence of radioactivity in soil borings near the lines, which could have resulted from leakage. Uranium activity exceeding preliminary remediation goals (PRGs) has not been detected in soil borings near the lines; however, there is evidence of leakage from the lines, based on chemical concentrations in soil and groundwater in the vicinity of the lines and anecdotal evidence of a significant leak that required replacement of the old industrial waste line. ORISE found uranium activities as high as 97,000 pCi/g in the Industrial Waste Lines sediments.

### 1.4.7 Debris Piles

The area contains one pile of wood debris and one of concrete debris. Both piles also contain miscellaneous other materials, including metal scraps. In addition to the debris, soil in the vicinity of the debris was assessed during the RI phase to determine if there were environmental impacts. The area consists of two distinct piles, one of concrete debris and one of wood debris. Some metallic debris is located within both of the piles, and is most prevalent within the northern edge of the wood debris pile. Each pile is approximately 15 feet in diameter at the base, and 3 feet tall in the center.

The topography in the area is gently sloping towards Site Brook, approximately 30 feet away. The soil within the area consists of light brown silty fine sands. Till, common in many subsurface areas of the CE Windsor Site, was not encountered in the area of the Debris Piles. Groundwater was encountered at approximately six feet below ground surface, and trends northerly in the direction of Site Brook. The area was studied in 1993 (ORISE, 1994), 1996 (ORISE, 1996), 1998 (SAIC, 1999), and 2000/2001 (ENSR, 2004). Total uranium poses potential risks to human health based on its chemical toxicity and radioactivity; ecological risks were not identified.

This Alternatives Evaluation Report evaluates potential response actions for debris at this study area, as well as residual total uranium in soil surrounding the debris pile.

#### 1.4.8 Site Brook

Site Brook was included as part of the RI based on the potential impacts that could have occurred through the discharge of liquid wastes to surface water in the brook. Discharges to the brook have included treated sanitary wastewater, industrial wastewater, and diluted radioactive wastewater from Building 6, and low-level radioactive wastes from the S1C facility. Site Brook flows northwest from Goodwin Pond, for approximately ½ mile through the CE Windsor Site, prior to recharging the Farmington River.

The floodplain topography is well defined along most of the northern and southern banks of the brook, with a 100-foot difference in elevation between the top of the bank and the streambed. The brook sediment is dominated by coarse material, with little silt or clay. The surface organic materials are underlain by fine washed sands at approximately 6 inches below ground surface (HLA, 1999). Surface water depths are generally less than 1 foot, and the flow rate within the brook has been estimated at 1.5 feet per second or less (HLA, 1999). The brook has been studied though several investigations, including studies in 1991 (DOE, 1991), 1993 (ORISE, 1994), 1996 (ORISE, 1996), 1998 (SAIC, 1999), and 2000/2001 (ENSR, 2004). The brook was also studied throughout this timeframe by CE, including the collection of sediment samples along multiple transects. Based on an evaluation of this data, and prior Manhattan Engineer District (MED)/AEC activities (ENSR, 2004), Co-60 and total uranium in brook sediments were the only chemicals detected that are potentially associated with prior MED/AEC activities, and which pose a potential risk. Total uranium was identified as posing potential risks to both human health and ecological receptors based on its chemical toxicity. Co-60 and total uranium were identified as posing potential risks to human health based on their radioactivity.

This Alternatives Evaluation Report evaluates potential response actions for residual total uranium and Co-60 in soil and sediment within these areas of Site Brook.

#### 1.4.9 Drum Burial Pit

The Drum Burial Pit study area consists of a manmade pit, in which drums and other materials have been disposed. In addition to the contents of the pit, soil around the pit was assessed during the RI phase to determine if there were environmental impacts. The pit was originally a sand and gravel pit, which was filled with miscellaneous waste material from 1955 to 1960. During an excavation conducted in 1990, 26 drums/barrels were discovered and removed (Moulton, 1994). Material found included electrical wiring, plastics, paint cans, personnel protective clothing and asbestos (Weston, 1992). In addition to buried drums and containers, miscellaneous debris, including bottles, pails, and machine parts, have been historically visible and reported at the ground surface. Many buried drums/containers currently exist within the pit, and extend to a depth of 15 feet below ground surface (HLA, 2000).

The geology of the area is described as red silty sand, with gravel and tan very fine sands. Groundwater was encountered at approximately 35 feet below ground surface, and reportedly flows north to northwest towards Site Brook and the Farmington River, with minor westerly components in the topographic low areas (HLA, 1999).

This area was studied in 1990 (GZA GeoEnvironmental, Inc [GZA], 1991; Moulton, 1994), 1993 (ORISE, 1994), 1998 (SAIC, 1999), and 2000/2001 (ENSR, 2004), as well through various studies conducted by CE. Beryllium, total uranium, and polychlorinated biphenyls (PCBs) pose potential risks to human health based on their chemical toxicity. Total uranium was also identified as posing potential risks to human health based on its radioactivity. Ecological risks were not identified.

### 1.4.10 Clamshell Pile

The Clamshell Pile contains a pile of clamshells that were removed from Site Brook. The clamshells were placed into Site Brook to buffer the pH as wastewater passed through them during discharge because wastewater discharged to Site Brook exhibited a low pH value (i.e., acidic condition), which did not comply with water quality requirements. The addition of clamshells as a buffer was reportedly successful as a passive neutralization technique; however, their high absorptive properties retained low-level radioactive and other materials (ENSR, 2004). The uranium-rich clamshells were subsequently removed from Site Brook, and placed in their current location, 600 feet north of the brook. The previous location where the clamshells were located has not been identified; however, the entire length of Site Brook that transects the CE Windsor Site is a separate study area.

The topography in the vicinity of the current clamshell pile is characterized by a drainage swale in an upland area, approximately 600 feet upgradient of the brook. Soil underlying the clamshells consists of light brown silty fine sands. Well-shaded, dense brush growth is present in the area, with emergent plant species between the clamshell pile and the brook. Groundwater and surface water flow is reported to be southerly towards the direction of Site Brook (HLA, 2000; ENSR, 2004).

This area was studied only in 1999 (HLA, 2000). Zirconium and PCBs were identified as posing potential risks to human health based on their chemical toxicity. Total uranium was identified as posing potential risks to human health based on its radioactivity. Ecological risks were not associated with these chemicals.

### 1.4.11 Groundwater

There are two groundwater plumes in the southern portion of the Site as shown on Figure 1-3 that have groundwater contamination associated with FUSRAP areas. The Western Plume is located east of Great Pond, in the vicinity of former Building 6A and the former Industrial Waste Lines. The Eastern Plume is located in the vicinity of the Equipment Storage Yard, along the southwestern shoreline of Small Pond. Groundwater contaminants exceeding PRGs consist of PCE, trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), and vinyl chloride.

## 2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLGIES

This section identifies and screens remedial technologies using the process outlined in USEPA RI/FS guidance, Principal Threats Guidance, and the NCP (USEPA, 1988b, 1990, 1991, and 1993). The process begins with the identification of remedial response objectives which establish general cleanup goals and identification of ARARs. Next, chemical-specific numerical cleanup goals are established and, in conjunction with remedial response objectives and ARARs, used to identify remedial action objectives. Once these tasks are completed, estimates are made of the areas and volumes of media which exceed numerical cleanup goals, and potential cleanup technologies are identified and screened to produce an inventory of suitable technologies that can be assembled into candidate remedial alternatives capable of mitigating actual or potential risks at the Site.

The national goal of the Superfund program as stated in the NCP at 40 CFR 300.430(a)(1)(i) is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. To reach this goal, the NCP enumerates several expectations at 40 CFR 300.430(a)(1)(iii)(A-F):

- to use treatment to address principal threats posed by a site wherever possible;
- to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable;
- to use a combination of methods, as appropriate, to achieve protection of human health and the environment;
- to use institutional controls, such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants;
- to consider innovative technology where such technology offers the potential for comparable or superior performance or implementability, fewer or less adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies; and
- to return usable groundwater to beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site.

## 2.1 IDENTIFICATION OF PRINCIPAL AND LOW-LEVEL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats at a site wherever practical, whereas engineering controls, such as containment, may be used for wastes that pose a relatively low long-term threat or where treatment is impractical. The concept of principal threat and low-level threat wastes is applied on a site-specific basis when characterizing source material. Source material is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be source material, although nonaqueous phase liquids (NAPLs) may be.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile which cannot be reliably contained or that would present a significant risk to human health or the environment should exposure occur. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied. Although USEPA has not established a threshold level of toxicity/risk to identify a principal threat waste; toxicity and mobility must combine to pose a potential risk several orders of magnitude greater than is acceptable under current or reasonably expected future land use, given realistic exposure scenarios. Further, characterizing a waste as a principal threat does not necessarily mean that the waste poses the primary risk at a site. Examples of source materials that generally constitute principal threats include liquid wastes in drums, lagoons, or tanks; NAPLs floating on or under groundwater; soil, sediment, sludge, or debris containing high concentrations of mobile or potentially mobile contaminants; buried non-liquid wastes; and soil containing significant concentrations of highly toxic material.

Low-level threat wastes are those source materials that generally can be readily contained and that would present only a low risk in the event of a release or exposure. Examples of wastes generally considered to constitute low-level threats include soil containing contaminants that are relatively immobile in air or groundwater (i.e., non-liquid, low volatility, low leachability) in the specific environmental setting and soil containing contaminants not greatly above reference dose (RfD) levels or presenting an excess cancer risk near the acceptable risk range.

Investigations at the FUSRAP areas have not identified liquid waste in drums, tanks, or impoundments. Free-phase NAPLs or significant concentrations of highly toxic or mobile contaminants in soil or other source material have not been identified. Therefore, principal threat wastes have not been identified at the FUSRAP areas.

## 2.2 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

Remedial action objectives are general statements of cleanup goals along with medium- or operable unit-specific, quantitative goals defining the extent of cleanup required to achieve response objectives. They specify contaminants of concern, exposure routes and receptors, and PRGs. In the case of groundwater, they also include a restoration time frame. Remedial action objectives are used as the framework for developing remedial alternatives. The remedial action objectives are formulated to achieve the overall goal of USEPA of protecting human health and the environment. To develop Remedial Action Objectives, it is first necessary to identify the following:

- remedial response objectives
- ARARs
- PRGs.

### 2.2.1 Identification of Remedial Response Objectives

Remedial response objectives are site-specific qualitative cleanup objectives used for defining remedial action objectives and for developing appropriate remedial alternatives. They are developed based on the nature and distribution of contamination, the resources currently or potentially threatened, and the potential for human and environmental exposure. At the FUSRAP areas, remedial response objectives are based on potential human-health risks from exposure to soil and sediment. Remedial response objectives for the FUSRAP areas are listed below.

- Prevent exposure to radiologically contaminated materials and chemical contamination at Buildings 3 and 6 at levels exceeding those allowing unrestrictive use and unlimited exposure
- Prevent human receptor exposure to radiologically contaminated soil and sediment at the identified FUSRAP areas at levels exceeding those allowing unrestrictive use and unlimited exposure

- Prevent human receptor exposure to chemically contaminated soil and sediment at the identified FUSRAP areas at concentrations exceeding those allowing unrestrictive use and unlimited exposure
- Prevent contaminants in vadose zone soil from contributing to groundwater contamination above concentrations allowing for unrestricted use and unlimited exposure
- Prevent human receptor exposure to groundwater with contaminants exceeding concentrations allowing for unrestricted use and unlimited exposure

### 2.2.2 Applicable or Relevant and Appropriate Requirements

CERCLA and the NCP require that on-site CERCLA remedial actions must attain federal standards, requirements, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. ARARs are federal and state environmental and facility siting requirements and guidelines used to: (1) evaluate the appropriate extent of site cleanup; (2) define and formulate remedial action alternatives; and (3) govern implementation and operation of the selected action. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured. Because of the need to address residual radiological material from Government-directed Site activities, the NRC Radiological Criteria for License Termination (10 CFR Part 20, Subpart E) is one of the most important ARARs to cleanup of the FUSRAP areas.

#### 2.2.2.1 Definition of ARAR Categories

To properly consider ARARs and to clarify their function in the remedy selection process, the NCP defines two ARAR components: (1) applicable requirements, and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs:

**Applicable Requirements.** Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (52 Federal Register [FR] 32496, August 27, 1987). Basically, to be applicable, a requirement must directly and fully address a CERCLA activity. For example, RCRA regulations governing the operation and design of a hazardous waste incinerator (40 CFR Part 264, Subpart 0) apply to hazardous waste incinerators used at Superfund sites.

**Relevant and Appropriate Requirements.** Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site (52 FR 32496). For example, RCRA landfill design standards could be relevant and appropriate to a landfill at a Superfund site, if the wastes being disposed or were sufficiently similar to RCRA hazardous wastes.

Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be both relevant and appropriate for compliance to be necessary. In the case where both a federal and a state ARAR are available, or where two potential ARARs address the same issue, the more stringent regulation must be selected. The final NCP states that a state standard must be legally enforceable and more stringent than a corresponding federal standard to be relevant and appropriate (55 FR 8756, March 8, 1990).

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, and guidance values that are not legally binding, but may serve as useful guidance for response actions. These are not potential ARARs, but are "to-be-considered" (TBC) guidance. These guidelines or advisory criteria should be identified if used to develop clean-up goals or if they provide important information needed to properly design or perform a remedial action. Three categories of TBC information are: (1) health effects information with a high degree of certainty (e.g., RfDs); (2) technical information on how to perform or evaluate site investigations or response actions; and (3) regulatory policy or proposed regulations.

ARARs are divided into the three categories listed below.

**Location-specific** ARARs "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 FR 51394). In determining the use of location-specific ARARs for selected remedial actions at CERCLA sites, one must investigate the jurisdictional prerequisites of each of the regulations. Basic definitions and exemptions must be analyzed on a site-specific basis to confirm the correct application of the requirements.

**Chemical specific** ARARs are usually health or risk based standards that limit the concentration of a chemical found in or discharged to the environment. They govern the extent of site remediation by providing either actual cleanup levels, or the basis for calculating such levels. For example, drinking water MCLs may provide the necessary cleanup goals for sites with contaminated groundwater. Chemical-specific ARARs may also be used to indicate acceptable levels of discharge in determining treatment and disposal requirements, and to assess the effectiveness of future remedial alternatives.

**Action-specific** ARARs set controls or restrictions on particular kinds of activities related to the management of hazardous waste (53 FR 51437). Selection of a particular response action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals.

Many regulations can fall into more than one category. For example, many location-specific ARARs are also action-specific because they are triggered if response activities affect site features. Likewise, many chemical-specific ARARs are also location-specific.

The Occupational Safety and Health Administration (OSHA) has promulgated standards for protection of workers who may be exposed to hazardous substances at RCRA or CERCLA sites (29 CFR Part 1910.120 and 1926.65). USEPA requires compliance with the OSHA standards in the NCP (40 CFR 300.150), not through the ARAR process. Therefore, the OSHA standards are not considered as ARARs. Although the requirements, standards, and regulations of OSHA are not ARARs, they will be complied with during response activities.

#### 2.2.2.2 Location-Specific Applicable or Relevant and Appropriate Requirements

Location-specific ARARs are triggered by the presence of specific natural or manmade features or potentially affected resources at a disposal or cleanup site. Features and resources that can trigger location-specific ARARs include the following:

- seismic faults
- caves, salt domes, salt beds, and underground mines
- floodplains, wetlands, and water bodies
- sensitive ecosystems
- wilderness areas, wildlife refuges, wildlife resources, and scenic rivers
- rare, threatened, or endangered species
- archaeological resources and historic sites

Of these, floodplains, wetlands, and water bodies may affect candidate response actions at Site Brook and at AOC 10, located adjacent to Small Pond.

There are no known extant populations of Federal or State Endangered or Threatened Species that occur at the Site. This was confirmed by letter from the U.S. Department of the Interior, Fish and Wildlife Service to the NRC, Region I, dated August 21, 2002.

Based on information received from the CTDEP there is one freshwater mussel species of special concern, *Ligumia nastuta*, Eastern pond mussel, which occurs in close proximity to the Site.

Also, based on information obtained from the CTDEP, the Farmington River has been stocked with Atlantic salmon (*Salmo salar*) as part of the State and Federal Atlantic salmon restoration effort.

Location-specific ARARs and TBCs for each evaluated remedial alternative are identified in Section 4.0.

2.2.2.3 Chemical-Specific Applicable or Relevant and Appropriate Requirements

This subsection discusses chemical-specific ARARs that are key to determining preliminary remediation goals and RAOs. These ARARs are:

- NRC Radiological Criteria for License Termination, 10 CFR Part 20 Subpart E
- Safe Drinking Water Act, 40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53
- Regulations of Connecticut State Agencies (RCSA) RSRs (RCSA §§ 22a-133k-1 et seq.)

**Nuclear Regulatory Commission Radiological Criteria for License Termination, 10 CFR Part 20 Subpart E.** This rule provides consistent standards to NRC licensees for determining the extent to which cleanup may be required before decontaminating and decommissioning can be considered complete, and the license terminated. Under this rule, "...a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 milliRem (mrem) per year and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)."

**Safe Drinking Water Act National Primary Drinking Water Regulations (40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53).** These regulations establish MCLs and maximum contaminant level goals (MCLGs) for several common organic and inorganic contaminants in drinking water. MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques.

MCLGs specify the maximum concentration at which no known or anticipated adverse effect on humans will occur. MCLGs are non-enforceable health-based goals which are always set equal to or lower than MCLs.

**Regulations of Connecticut State Agencies Remediation Standard Regulation (RCSA §§ 22a-133k-1 through 22a-133k-3).** Connecticut's RSRs list numeric standards for the remediation of chemical contaminants in soil and groundwater. Two remediation criteria must be met when remediating soil:

> **Direct Exposure Criteria** are established to protect human health from exposure to contaminants in soil. With some exceptions, these criteria apply to soil located within fifteen feet of the ground surface. Polluted soil must be remediated to a concentration that is consistent with the Residential Direct Exposure Criteria, unless the site is used exclusively for industrial or commercial purposes. The residential direct exposure criteria are established at a target excess lifetime cancer risk of 1 in 1 million ($1x10^{-6}$) and a target hazard index of 1. These target risk levels comply with the NCP risk management criteria of an excess lifetime cancer risk between 1 in 1 million ($1x10^{-6}$) and 1 in ten-thousand ($1x10^{-4}$).

> **Pollutant Mobility Criteria** are established to prevent the pollution of groundwater caused by soil contamination that is available to migrate into groundwater. With some exceptions, these criteria apply to soil located above the seasonal low water table.

The RSRs also stipulate that additional polluting substances not listed in the RSRs shall be remediated to a level consistent with a $1x10^{-5}$ lifetime cancer risk. Pursuant to this authority, CTDEP has established a 19 mrem per year dose standard as the cleanup target for radioactive material at the Site (CTDEP, 2002; CTAG, 2003). Therefore, the 19 mrem per year dose standard corresponds to excess lifetime cancer risks are that are within the NCP risk management criteria of an excess lifetime cancer risk between 1 in 1 million ($1x10^{-6}$) and 1 in ten-thousand ($1x10^{-4}$).

Three criteria apply to the remediation of groundwater:

> **Groundwater Protection Criteria** require that groundwater in high quality groundwater areas be remediated to background quality, or, in certain instances, to levels that adequately protect existing and future uses of groundwater as public or private drinking water supplies.

> **Surface Water Protection Criteria** apply to groundwater at the point where the plume discharges to a surface water body.

> **Volatilization Criteria** are established to protect human health from volatile substances in shallow groundwater that may migrate from groundwater and enter overlying buildings.

Compliance of each remedial alternative with chemical-specific ARARs and TBCs is discussed in Section 4.0.

#### 2.2.2.4 Action-Specific Applicable or Relevant and Appropriate Requirements

A number of regulations, including RCRA regulations pertaining to handling, treatment, storage, and disposition of hazardous wastes, may need to be considered depending on the response actions selected.

Action-specific ARARs and TBCs for each remedial alternative are identified in Section 4.0.

### 2.2.3 Development of Preliminary Remediation Goals

PRGs are long-term numerical goals used during analysis and selection of remedial alternatives. PRGs should comply with ARARs and result in residual risks consistent with NCP requirements for protection of human health and the environment. Therefore, PRGs are based both on risk-based concentrations and on ARARs. Eventually, PRGs become the final remediation goals or cleanup levels for the selected remedy.

To select PRGS for the FUSRAP areas, it is necessary to consider two types of candidate PRGs:

- PRGs based on radioactivity (i.e., Derived Concentration Guideline Levels)
- PRGs based on chemical toxicity

#### 2.2.3.1 Derived Concentration Guideline Levels

Derived Concentration Guideline Levels (DCGLs) are radionuclide-specific surface or volume residual radioactivity levels that correspond to a concentration or exposure dose or risk criterion. As discussed in Subsection 2.2.2.3, NRC criteria for license termination require demonstration that a member of the public potentially exposed to residual activity at the Site will not receive an annual dose in excess of 25 mrem in any one year, having considered all credible sources and pathways for exposure. In addition, the State of Connecticut has established an acceptable annual public dose limit of 19 mrem per year (CTDEP, 2002; CTAG, 2003). The more restrictive of the two applicable limits (i.e., 19 mrem per year) was used to derive site-specific DCGLs for the Site.

DCGLs were calculated using the RESRAD 6.0 modeling code for six different potential future exposure scenarios:

- an occupational worker employed at a facility located at the Site
- a commercial truck farmer
- a construction worker participating in a construction or excavation project at the Site
- a recreational visitor using park-like space (jogging, biking, etc.)
- a residential occupant in a suburban residential setting
- a residential occupant in a resident farm setting

The limiting land-use scenario (i.e., the one yielding the lowest concentration yielding 19 mrem per year) was the residential farm scenario. DCGLs based on this scenario are:

| | |
|---|---|
| Total Uranium | 557 pCi/g |
| Cobalt-60 | 5.0 pCi/g |

A detailed description of the calculation of the DCGLs is contained in *Derivation of the Site-Specific DCGLs* (MACTEC, 2003). As discussed in the Remedial Investigation Report (ENSR, 2004), protection of human receptors will be protective of ecological receptors. Table 2-1 summarizes identified PRGs for FUSRAP soil and sediment.

2.2.3.2 Preliminary Remediation Goals for Other Chemicals

Chemical-specific PRGs for cancer and noncancer toxicity associated with direct contact exposure to soil were based on Connecticut RSRs found at RCSA §§ 22a-133k-1 through 22a-133k-3. Chemicals in soil for which chemical-toxicity PRGs were identified include the inorganics beryllium and zirconium; PCBs; and several PAHs (see Table 2-1).

Chemical-specific PRGs for cancer and noncancer toxicity associated with exposure to groundwater were based on federal drinking water MCLs and on Connecticut RSRs found at

RCSA §§ 22a-133k-1 through 22a-133k-3. Chemicals in groundwater for which chemical-toxicity PRGs were identified include PCE, TCE, total 1,2-DCE, vinyl chloride, and manganese (Table 2-2).

### 2.2.4 Identification of Remedial Action Objectives

Remedial action objectives are general statements of cleanup goals along with medium- or operable unit-specific, quantitative goals defining the extent of cleanup required to achieve response objectives. They specify contaminants of concern, exposure routes and receptors, and PRGs. In the case of groundwater, they also include a restoration time frame. Remedial action objectives are used as the framework for developing remedial alternatives. The remedial action objectives are formulated to achieve the overall goal of protecting human health and the environment. Remedial Action Objectives for the FUSRAP areas are listed below.

- Decontaminate and dismantle radiologically contaminated buildings and systems at Building 3 and Building 6 to prevent exposure to unacceptable levels of radiological contamination.
- Dismantle Buildings 3 and 6 to allow complete evaluation of contamination conditions in soil and drain lines beneath and next to the buildings
- Prevent contaminants in vadose zone soil at concentrations exceeding the CTDEP GA Mobility Criteria (Table 2-1) from contributing to groundwater contamination above concentrations of concern.
- Prevent human receptor exposure to radiologically contaminated soil and sediment at the identified FUSRAP areas at levels exceeding DCGLs listed in Table 2-1.
- Prevent human receptor exposure to chemically contaminated soil and sediment at the identified FUSRAP areas at concentrations exceeding PRGs based on Connecticut RSRs (see Table 2-1).
- Prevent human receptor exposure to groundwater with contaminants exceeding the PRGs in Table 2-2.

## 2.3 GENERAL RESPONSE ACTIONS

General response actions are categories of remedial actions that may be used to satisfy remedial action objectives by either reducing the contaminant concentration in each medium below the PRG or by preventing receptor exposure to the contaminated medium. General response actions provide the basis for identifying specific remedial technologies.

The particular characteristics of radionuclides limit the number of available response actions that apply. Chemical (non-radioactive) constituents in soil and sediment can typically be altered or destroyed to reduce their toxicity through physical, chemical, or biological processes. However, radionuclides are typically not altered or destroyed by applying those processes. Instead, radionuclides are typically addressed by applying considerations (or concepts) of "time, distance, and shielding" (USEPA, 1996). Time allows for the natural decay of the radionuclide to occur, which reduces the potential risks to human health and the environment, while distance and shielding from the radionuclide reduce risks by reducing the intensity of the emitted energy. Response actions for residual radioactivity can involve either (1) reducing radiological exposure by applying the principles of time, distance, and shielding to materials left onsite, or (2) eliminating potential exposure from radioactivity by transporting the materials off-site.

Potential general response actions for the FUSRAP areas at the CE Windsor Site include the following:

| **General Response Actions for FUSRAP Areas** | | | |
|---|---|---|---|
| | | **Applicability** | |
| **General Response Action** | **Buildings** | **Soil and Sediment** | **Groundwater** |
| No Action * | ✓ | ✓ | ✓ |
| Institutional Controls | | ✓ | ✓ |
| Decontamination | ✓ | | |
| Dismantlement | ✓ | | |
| Containment | ✓ (of debris) | ✓ | ✓ |
| Immobilization | | ✓ | |
| Excavation/Extraction | | ✓ | ✓ |
| Separation | | ✓ | |
| Treatment | | | ✓ |
| Disposal | ✓ (of debris) | ✓ | ✓ |

* = No action required for baseline comparison under CERCLA

## 2.4 VOLUMES AND AREAS OF MEDIA EXCEEDING PRELIMINARY REMEDIATION GOALS

Figures 2-1 through 2-6 depict the estimated areas and volumes of soil and sediment exceeding PRGs and requiring cleanup for the following FUSRAP areas: Buildings 3 and 6, Woods Area, Equipment Storage Yard, Site Brook, Debris Piles, Drum Burial Pit, and Clamshell Pile. The following table summarizes the volumes by area.

| FUSRAP Area | Estimated Volume Exceeding PRGs (cubic feet) |
|---|---|
| Buildings 3 (Rad. - structure and soil) | 5,000 |
| Building 6 (Rad. - structure and soil) | 6,000 |
| Woods Area | 33,105 |
| Equipment Storage Yard | 59,400 |
| Industrial Waste Lines | 14,000 |
| Site Brook | 49,148 |
| Debris Piles | Included in Site Brook volume |
| Drum Burial Pit | 12,712 |
| Clamshell Pile | 1,350 |
| Total Volume | 180,715 (6,693 cubic yards) |

## 2.5 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This subsection identifies and screens remedial technologies using the process outlined in USEPA RI/FS guidance and the NCP (USEPA, 1988b, 1990, and 1993). First, technologies are identified to attain the remedial action objectives established in Subsection 2.2 and to correspond to the categories of general response actions described in Subsection 2.3. Demonstrated performance of each technology for site contaminants and conditions is considered during technology identification. The result is a list of potential remedial technologies that are then screened based on their applicability to site- and waste-limiting characteristics. The purpose of the screening is to produce an inventory of suitable technologies that can be assembled into candidate remedial alternatives capable of mitigating actual or potential risks at the Site. An extensive list of potential technologies representing a range of general response actions (i.e., no action, institutional controls, containment, collection, treatment, and disposal) was considered to develop the candidate remedial alternatives. This process is consistent with USEPA guidance.

### 2.5.1 Technology Identification

Categories of remedial technologies and specific process options were identified based on a review of literature, vendor information, and performance data. Process options considered potentially applicable to attaining the remedial response objectives were selected for screening. Tables 2-3 and 2-4 identify applicable remedial technologies and associated process options for each general response action for groundwater; soil, and sediments; and buildings. Information contained in USEPA's guidance manual *Technology Screening Guide for Radioactively Contaminate Sites* (USEPA, 1996) was considered during preparation of Table 2-4.

### 2.5.2 Technology Screening

The technology screening process reduces the number of potentially applicable technologies and process options by evaluating factors that may influence process-option effectiveness and implementability. This overall screening is generally consistent with guidance for performing feasibility studies under CERCLA (USEPA, 1988b).

The screening process assesses each technology or process option for its probable effectiveness and implementability with regard to site-specific conditions, known and suspected contaminants, and affected environmental media. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the contaminant reduction goals identified in the remedial action objectives; (2) the effectiveness of the technology in protecting human health and the environment during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to contaminants and conditions at the site. Implementability encompasses both the technical and administrative feasibility of implementing a technology.

In Tables 2-3 and 2-4, technologies and process options judged ineffective or not implementable are eliminated from further consideration. The technologies retained following screening represent an inventory of technologies considered most suitable for treatment of soil at the Site.

Technologies/process options retained in this subsection may be used either alone or integrated with other technologies to develop remedial alternatives. Treatability studies may be required prior to final technology selection to confirm effectiveness of the given technology.

# 3.0 DEVELPOMENT AND SCREENING OF ALTERNATIVES

In this section, technically feasible technologies retained following the screening outlined in Section 2.0 are combined to form remedial action alternatives that may be applicable for cleanup of groundwater, buildings, soil, and sediment at the CE Windsor Site FUSRAP areas.

The alternatives are developed to meet the remedial action objectives presented in Subsection 2.2, using the general response actions identified in Subsection 2.3 either singly or in combination. Developed remedial alternatives are then screened with respect to the criteria of effectiveness, implementability, and cost to meet the requirements of CERCLA and the NCP. Cost is not formally evaluated in this subsection. Rather, based on knowledge of relative costs, professional judgment is used to identify the relative cost-effectiveness of each alternative. Cost estimates are presented in Section 4.0 as part of the detailed evaluation of alternatives passing this section's screening.

The objective of the alternative screening step is to eliminate impractical alternatives or higher cost alternatives (i.e., order of magnitude cost differences) that provide little or no increase in effectiveness or implementability over their lower-cost counterparts. The effectiveness and implementability criteria used for screening the alternatives are defined below.

**Effectiveness.** Each alternative is evaluated for its ability to protect human health and the environment, including the extent to which toxicity, mobility, or volume of contaminants is reduced. Both short- and long-term effectiveness are considered. Short-term effectiveness involves the extent to which existing risks to receptors during the construction and implementation period are reduced, identifying and mitigating expected effects to the environment during construction and implementation, the alternative's ability to meet remedial action objectives, and the relative time frame required to achieve remedial action objectives. Long-term effectiveness, which applies after remedial action objectives have been attained, considers the magnitude of the remaining residual risk because of residual contaminant sources, and the adequacy and reliability of specific technical components and control measures to maintain compliance with remedial action objectives over the life of the remediation.

**Implementability.** Each alternative is also evaluated in terms of technical and administrative feasibility. In the assessment of short-term technical feasibility, availability of a technology for construction or mobilization and operation, as well as compliance with action-specific ARARs during the remedial action, are considered. Long-term technical feasibility considers the ease of operation and maintenance, technical reliability, the ease of undertaking additional remedial actions, and the degree of monitoring of technical controls for residuals and untreated wastes. Administrative feasibility for implementing a given technology addresses coordination with other agencies, public acceptance, and the commercial availability of required services and trained specialists or operators.

The No Action Alternative is not evaluated according to the screening criteria; it will pass through screening to be evaluated during the detailed analysis as a baseline for other retained alternatives (USEPA, 1988b).

## 3.1 DEVELOPMENT OF GROUNDWATER ALTERNATIVES

Four remedial alternatives (including No Action) are identified in this subsection to address remedial action objectives for groundwater associated with two specific areas in the southern portion of the Site as shown on Figure 1-3. The Western Plume is located east of Great Pond, in the vicinity of former Building 6A and the former Industrial Waste Lines. The Eastern Plume is located in the vicinity of the Equipment Storage Yard, along the southwestern shoreline of Small Pond. The groundwater alternatives are listed below.

- Alternative GW1: No Action
- Alternative GW2: Enhanced In-Situ Biodegradation
- Alternative GW3: Groundwater Extraction and Treatment
- Alternative GW4: Monitored Natural Attenuation

### 3.1.1 Alternative GW1: No Action

CERCLA requires that the No Action alternative be evaluated to establish a baseline for comparison to other remedial alternatives. Alternative GW1 will not be evaluated according to screening criteria, and will pass through screening to be evaluated during detailed analysis (USEPA, 1988b).

### 3.1.2 Alternative GW2: Enhanced In-Situ Biodegradation

Alternative GW2 relies on enhanced in-situ bioremediation of groundwater to mitigate human receptor exposure to contaminants exceeding PRGs. This alternative would consist of the following key components:

- Injection of nutrients and other compounds to stimulate biodegradation of chlorinated volatile organic compounds (VOCs) in groundwater
- Performance monitoring to evaluate the effectiveness of the remedial action

**Effectiveness.** Alternative GW2 will provide short- and long-term effectiveness for the following reasons:

- Installation of monitoring wells, injection of nutrients and other compounds to enhance biodegradation, and groundwater performance monitoring can be performed in accordance with a site-specific Work Plan and Health and Safety Plan to protect workers.
- The alternative is anticipated to meet the remedial action objectives in a relatively short timeframe (e.g., less than 10 years)
- Groundwater performance monitoring will evaluate the effectiveness of the remedy.
- Groundwater performance monitoring will identify the need to modify the remedy if the remedial action objectives are not met.

**Implementability.** Alternative GW2 is considered implementable for the following reasons:

- Technical resources are readily available to implement the remedy.
- Construction materials and equipment are readily available to implement the remedy.
- The technology has been proven to be successful for remediation of chlorinated VOCs in groundwater.
- Groundwater performance monitoring is easily implemented.
- Obtaining the necessary regulatory approvals, permits, and licenses should not present obstacles.

**Costs:** Costs for this alternative are expected to be proportional to its benefits.

**Screening Decision.** Alternative GW2 is retained for detailed analysis.

### 3.1.3 Alternative GW3: Groundwater Extraction and Treatment

Alternative GW3 relies on extraction and treatment of groundwater to mitigate human receptor exposure to contaminants exceeding PRGs. This alternative would consist of the following key components:

- Installation of groundwater extraction wells
- Construction of the groundwater treatment system
- Discharge of treated groundwater to the local publicly-owned treatment works (POTW)
- Performance monitoring to evaluate the effectiveness of the remedial action

**Effectiveness.** Alternative GW3 will provide short- and long-term effectiveness for the following reasons:

- Installation of monitoring wells, construction of the groundwater treatment plant, and groundwater performance monitoring can be performed in accordance with a site-specific Work Plan and Health and Safety Plan to protect workers.
- The alternative is anticipated to meet the remedial action objectives within a reasonable timeframe (e.g., less than 50 years)
- Groundwater performance monitoring will evaluate the effectiveness of the remedy.
- Groundwater performance monitoring will identify the need to modify the remedy if the remedial action objectives are not met.

**Implementability.** Alternative GW3 is considered implementable for the following reasons:

- Technical resources are readily available to implement the remedy.
- Construction materials and equipment are readily available to implement the remedy.
- The technology has been proven to be successful for remediation of chlorinated VOCs in groundwater.

- Groundwater performance monitoring is easily implemented.
- Obtaining the necessary regulatory approvals, permits, and licenses should not present obstacles.

**Costs:** Costs for this alternative are expected to be proportional to its benefits.

**Screening Decision.** Alternative GW3 is retained for detailed analysis.

### 3.1.4 Alternative GW4: Monitored Natural Attenuation

Alternative GW4 relies on natural attenuation processes to mitigate human receptor exposure to contaminants exceeding PRGs. This alternative would consist of the following key components:

- Installation of groundwater monitoring wells
- Performance monitoring to evaluate the effectiveness of the remedial action

**Effectiveness.** Alternative GW4 will provide short- and long-term effectiveness for the following reasons:

- Installation of monitoring wells and groundwater performance monitoring can be performed in accordance with a site-specific Work Plan and Health and Safety Plan to protect workers.
- Groundwater performance monitoring will evaluate the effectiveness of the remedy.
- Groundwater performance monitoring will identify the need to modify the remedy if the remedial action objectives are not met.

However, •because of the relatively high concentrations of chlorinated VOCs (e.g., concentrations of 1,2-DCE up to 1,550 micrograms per liter (µg/L) and vinyl chloride up to 1,250 µg/L, which are three to four orders of magnitude above the respective MCLs and CTDEP RSR GWPC, the alternative is not anticipated to meet the remedial action objectives within a reasonable timeframe (e.g., remedy will take longer than 50 years)

**Implementability.** Alternative GW4 is considered implementable for the following reasons:

- Technical resources are readily available to implement the remedy.
- Construction materials and equipment are readily available to implement the remedy.
- The technology has been proven to be successful for remediation of chlorinated VOCs in groundwater.
- Groundwater performance monitoring is easily implemented.
- Obtaining the necessary regulatory approvals, permits, and licenses should not present obstacles.

**Costs:** Costs for this alternative are expected to be proportional to its benefits.

**Screening Decision.** Alternative GW4 is not retained for detailed analysis due to the relatively long anticipated timeframe to achieve the remedial action objectives.

## 3.2 DEVELOPMENT OF BUILDING, SOIL AND SEDIMENT ALTERNATIVES

Three remedial alternatives (including No Action) are identified in this subsection to address remedial action objectives for buildings, soil and sediment. These alternatives are listed below.

- Alternative SS1: No Action
- Alternative SS2: Excavation and Disposal in On-Site Landfill
- Alternative SS3: Excavation and Off-Site Disposal

The following subsections describe the alternatives developed for buildings, soil and sediment at the CE Windsor Site FUSRAP areas.

### 3.2.1 Alternative SS1: No Action

CERCLA requires that the No Action alternative be evaluated to establish a baseline for comparison to other remedial alternatives. Alternative SS1 will not be evaluated according to screening criteria, and will pass through screening to be evaluated during detailed analysis (USEPA, 1988b).

### 3.2.2 Alternative SS2: Excavation and Disposal in On-Site Landfill

Alternative SS2 relies on institutional controls and excavation and on-site disposal of FUSRAP area soil exceeding PRGs to mitigate human receptor exposure to contaminants exceeding PRGs. This alternative would consist of the following key components:

- Institutional controls
  - Signs
  - Fencing
  - Environmental Land Use Restriction
- Construction of an on-site containment cell
- Building decontamination and dismantlement
- Excavation and on-site disposal of FUSRAP area media exceeding PRGs and consolidation in on-site containment cell
- Wetland restoration and monitoring
- Maintenance of the containment system
- Monitoring and management of leachate
- Post-remediation groundwater monitoring for compliance with CTDEP RSRs

**Effectiveness.** Alternative SS2 will provide short- and long-term effectiveness for the following reasons:

- Excavation, building dismantlement and disposal can be performed in accordance with a Work Plan and Health and Safety Plan to protect workers
- On-site disposal will eliminate the need for off-site transportation of radioactive materials along highways and railways and through populated areas, thereby minimizing potential for the public to be exposed as a result of accidental releases.
- Material will be excavated to the extent necessary to allow unrestricted use and exposure at the individual FUSRAP areas; however, the disposal area would be a restricted access area and would not meet the NRC/USACE Memorandum of Understanding (MOU) requirements for unrestricted access.
- Institutional controls in the form of signage and fences will be used to identify the containment area and restrict access.
- Implementation of an Environmental Land Use Restriction (restrictive deed covenant) in the event of property title transfer to restrict development and potential disruption of the on-site containment cell.

- Long-term maintenance will be provided to maintain the integrity and protectiveness of the containment system.
- Long-term monitoring will identify the need for remedy modification if unacceptable exposure risk is indicated.

**Implementability.** Alternative SS2 is considered implementable for the following reasons:

- Technical resources are readily available to implement the remedy.
- Long-term monitoring, operation, and maintenance are expected to be low. Leachate generation is expected to be low, and maintenance is expected to consist principally of mowing the grass on the landfill cover.

**Costs:** Costs for this alternative are expected to be proportional to its benefits.

**Screening Decision.** Alternative SS2 is retained for detailed analysis.

### 3.2.3 Alternative SS3: Excavation and Off-Site Disposal

Alternative SS3 relies on excavation and off-site disposal of FUSRAP area soil exceeding PRGs to mitigate human receptor exposure to contaminants exceeding PRGs. This alternative would consist of the following key components:

- Excavation of FUSRAP area soil and sediment exceeding PRGs
- Building decontamination and dismantlement
- Disposal of excavated material and building materials at an off-site disposal facility licensed to receive those wastes
- Wetland restoration and monitoring
- Post-remediation groundwater monitoring for compliance with CTDEP RSRs

**Effectiveness.** Alternative SS3 will provide short- and long-term effectiveness for the following reasons:

- Excavation, building dismantlement and disposal can be performed in accordance with a Work Plan and Health and Safety Plan to protect workers.

- Material will be excavated to the extent necessary to allow unrestricted use and exposure at the individual FUSRAP areas.
- Long-term maintenance will be provided to maintain the integrity and protectiveness of the containment system.
- Long-term monitoring will identify the need for remedy modification if unacceptable exposure risk is indicated.

**Implementability.** Alternative SS3 is considered implementable for the following reasons:

- Technical resources are readily available to implement the remedy.
- Off-site disposal will eliminate the need for construction and long-term management and monitoring of an on-site containment/disposal facility.
- The need to obtain regulatory approvals, permits, and licenses is minimized, and obtaining the necessary approvals, permits, and licenses should not present obstacles.

**Costs:** Costs for this alternative are expected to be proportional to its benefits.

**Screening Decision.** Alternative SS3 is retained for detailed analysis.

# 4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the detailed analyses of remedial action alternatives for FUSRAP areas at the CE Windsor Site. The detailed analysis is intended to provide decision-makers with information to aid in selection of a remedial alternative that best meets the following CERCLA requirements:

- protects human health and the environment
- attains ARARs (or provides grounds for invoking a waiver)
- utilizes permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable
- satisfies the preference for treatment that reduces toxicity, mobility, or volume of hazardous substances as a principal element
- is cost-effective

The detailed analysis was performed in general accordance with CERCLA Section 121, the NCP (USEPA, 1990), and USEPA RI/FS guidance (USEPA, 1988b). The detailed analysis contains the following:

- a detailed description of each candidate remedial alternative, emphasizing the application of various component technologies
- an assessment of each alternative compared to the first seven of the nine evaluation criteria described in the NCP (USEPA, 1990)

The detailed description of technologies or processes used for each alternative includes, as appropriate, discussion of limitations, assumptions, and uncertainties for each component. The descriptions provide a conceptual design of each alternative and are intended for alternative-comparison and cost-estimation purposes only.

Remedial alternatives are evaluated according to the first seven of nine NCP evaluation criteria. The nine NCP evaluation criteria are defined in the following paragraphs as they pertain to this Alternatives Evaluation Report.

**Overall Protection of Human Health and the Environment.** This criterion assesses how well an alternative, as a whole, achieves and maintains protection of human health and the environment.

**Compliance with ARARs.** This criterion assesses how the alternative complies with location-, chemical-, and action-specific ARARs, and whether a waiver is required or justified.

**Long-term Effectiveness and Permanence.** This criterion evaluates the effectiveness of the alternative in protecting human health and the environment after response objectives have been met. This criterion includes consideration of the magnitude of residual risks and the adequacy and reliability of controls.

**Reduction of Toxicity, Mobility, and Volume through Treatment.** This criterion evaluates the effectiveness of treatment processes used to reduce toxicity, mobility, and volume of hazardous substances. It also considers the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

**Short-term Effectiveness.** This criterion examines the effectiveness of the alternative in protecting human health and the environment during the construction and implementation of a remedy until response objectives have been met. It also considers the protection of the community, workers, and the environment during implementation of remedial actions.

**Implementability.** This criterion assesses the technical and administrative feasibility of an alternative and availability of required goods and services. Technical feasibility considers the ability to construct and operate a technology and its reliability, the ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of a remedy. Administrative feasibility considers the ability to obtain approvals from other parties or agencies and the extent of required coordination with other parties or agencies.

**Cost.** This criterion evaluates the capital, and operation and maintenance costs of each alternative. Present worth costs are typically presented to help compare costs among alternatives. This Alternatives Evaluation Report includes cost summaries to aid the decision making process.

**State Acceptance.** This criterion considers the state's preferences among or concerns about the alternatives, including comments on ARARs or the proposed use of waivers. This criterion will be addressed following state inputs on this Alternatives Evaluation Report and the Proposed Remedy Plan (analogous to a CERCLA Proposed Plan).

**Community Acceptance.** This criterion considers the community's preferences or concerns about the alternatives. This criterion will be addressed following community inputs on this Alternatives Evaluation Report and the Proposed Remedy Plan.

## 4.1 DETAILED EVALUATION OF GROUNDWATER ALTERNATIVES

This subsection contains a detailed evaluation of the following remedial alternatives for groundwater that were retained in Subsection 3.1:

- Alternative GW1: No Action
- Alternative GW2: Enhanced In-Situ Biodegradation
- Alternative GW3: Groundwater Extraction and Treatment

### 4.1.1 Alternative GW1: No Action

Alternative GW1, the No Action Alternative, was retained as a baseline with which to compare the other alternatives. This alternative does not include remedial action components to eliminate, reduce, or control actual or potential risks to human or ecological receptors. The alternative would not allow for unrestricted Site use. The following assessment of the No Action Alternative is based on the first seven NCP evaluation criteria.

#### 4.1.1.1 Overall Protection of Human Health and the Environment

Alternative GW1 would not take any actions to prevent human exposure to groundwater with contaminant concentrations exceeding PRGs. The alternative would not be protective of human health or the environment.

#### 4.1.1.2 Compliance with ARARs

Chemical-specific ARARs triggered by Alternative GW-1 are presented in Table 4-1. The No Action Alternative does not include any actions to reduce contaminant concentrations to achieve PRGs or attain ARARs. Because no action is proposed, location- and action-specific ARARs are not triggered by this alternative. This alternative would not comply with ARARs.

#### 4.1.1.3 Long-Term Effectiveness and Permanence

This alternative does not include any action to stimulate or promote the reduction of contaminants, or provide containment of or exposure to chemical constituents in groundwater. Therefore, the No Action Alternative will not provide long-term effectiveness and permanence for protecting human health and the environment from exposure or potential exposure to contaminants.

#### 4.1.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The No Action Alternative does not reduce the toxicity, mobility, and volume of contaminants through treatment.

#### 4.1.1.5 Short-Term Effectiveness

The No Action Alternative would not provide protection from exposure to chemical constituents at concentrations exceeding PRGs. The alternative does not protect human health and the environment in the short-term.

#### 4.1.1.6 Implementability

Because this alternative does not propose any remedial action, there would be no technical difficulties associated with implementation. The alternative would not limit or interfere with the ability to perform future remedial actions. The no action approach would be considered unacceptable to the regulatory community; however, and would not be implementable administratively.

#### 4.1.1.7 Cost

Because no remedial actions would be preformed, there are no costs associated with the No Action Alternative.

### 4.1.2 Alternative GW2: Enhanced In-Situ Biodegradation

Alternative GW2 relies on enhanced in-situ bioremediation of groundwater to mitigate human receptor exposure to contaminants exceeding PRGs. Enhanced biodegradation can be accomplished by introducing nutrients and other compounds to stimulate biodegradation of contaminants and reduce the time required to achieve PRGs. The principal contaminants in groundwater at concentrations above CTDEP RSR Criteria are chlorinated VOCs: PCE and TCE, as well as the daughter products 1,2-DCE and vinyl chloride.

PCE and TCE have degraded mainly anaerobically and likely biologically through successive dechlorination reactions (reactive dechlorination) to daughter products such as 1,2-DCE and vinyl chloride. Eventually, 1,2-DCE and vinyl chloride may be mineralized to carbon dioxide, especially under aerobic conditions within the aquifer or at the point of discharge to surface water. During reductive dechlorination, the chlorinated solvents serve as terminal electron acceptors (utilizing hydrogen) during the microbiological metabolism of organic carbon. The microorganisms preferentially use several other competing electron acceptors (CEAs) before the chlorinated solvents degrade, so there must be a relatively large carbon (electron donor) source available to the microorganisms if the process is to occur. CEAs include dissolved oxygen, nitrate/nitrite, and sulfate. If there is sufficient organic carbon in the groundwater naturally, the process may proceed on its own. If sufficient carbon is not available naturally, adding it by injection or other means may initiate and sustain the biodegradation process. Adding a carbon source with the intent of stimulating or maintaining the biodegradation process is the basis of enhanced biodegradation.

Potential carbon sources include lactic acid, propionic acid, acetate, ethanol, and even molasses, all of which could be injected into the subsurface to promote biodegradation. Regenesis, Inc., of San Clemente, California (www.regenesis.com), markets a product know as Hydrogen Release Compound™ (HRC), which is a polylactate ester specially formulated for slow release of lactic acid upon hydration. Regenesis markets several HRC formulations, including standard HRC®, HRC-X® [extend release formula], HRC Advanced™ (HRC-A), and HRC Primer®.

HRC works through a series of chemical and biological reactions to produce the hydrogen required for reductive dechlorination. Initially, when in contact with subsurface moisture, the HRC slowly releases lactic acid. Indigenous anaerobic microbes (such as acetogens) metabolize the lactic acid producing consistent low concentrations of dissolved hydrogen. The resulting hydrogen is then used by other subsurface microbes (reductive dehalogenators) to strip the solvent molecules of their chlorine atoms and allow for further biological degradation. The key to the effectiveness of HRC is the distribution of the resulting hydrogen. Other options include a slow controlled injection of hydrogen directly into the subsurface through injection wells.

There are two basic approaches for design of an HRC injection system. One is a grid-based approach in which HRC is injected in a grid pattern across the length and width of the contaminant plume. This approach achieves cleanup in a relatively short period of time, but requires a large number of injection points and may not be cost-effective for large areas. The other approach is injection along a row of delivery points oriented perpendicular to groundwater flow to create a treatment barrier. This approach may require multiple injections and take longer than the grid-based approach, but be more cost effective for large areas. Because groundwater contamination is associated with distinct source areas, and to decrease the time required to achieve remediation goals, a grid approach is proposed.

This alternative would consist of the following key components:

- Injection of nutrients and other compounds to stimulate biodegradation of chlorinated VOCs in groundwater
- Performance monitoring to evaluate the effectiveness of the remedial action

**Injection of nutrients.** It is proposed that enhanced biodegradation utilizing the HRC formulation known as HRC-A be implemented to address contamination at MW-0610R (Western Plume) and at MW-1004, MW-1005, and MW-1016 (Eastern Plume). HRC-A is a concentrated HRC formulation which is applied as microemulsion, offering the most cost-effective approach for HRC implementation over relatively large areas.

The Site-specific data have been entered into the Regenesis HRC Advanced Design Software, which is available from Regenesis for use in estimating costs and conceptual design. This software calculates the recommended HRC dosage based upon chemistry and hydrogeological data for the Site.

The proposed injection layout for the Western and Eastern Plumes consists of 10-foot by 10-foot injection grids. The injection would utilize the direct-push drilling technology, and would be conducted in accordance with the HRC-A Installation Instructions. In lieu of pilot-scale testing, the first year following the injection program would include an intensive performance monitoring program, as described in the following paragraphs.

**Performance Monitoring.** Subsequent to the initial injection, performance monitoring would be conducted. Performance monitoring would consist of the collection, analysis, and evaluation of groundwater samples from existing and proposed future monitoring wells.

At the estimated velocity of 0.133 feet per day (ft/day), it would take an estimated 1,353 days (3.7 years) for the Eastern Plume to reach Small Pond. At the estimated velocity of 0.147 ft/day, it would take an estimated 2,176 days (6 years) for the Western Plume to reach MW-1203.

The HRC-A formulation is estimated to remain viable in the subsurface for up to two years following injection, after which, based upon performance monitoring, a subsequent injection could be conducted to address residual contamination.

A baseline-monitoring event would occur prior to injection of HRC. The samples would be submitted for VOCs, field parameters, nitrate/nitrite, sulfate, dissolved manganese, dissolved iron, and total organic carbon (full list). Subsequent sampling would be conducted at 2, 3, 4, 5, 6, 8, 10, and 12 months following injection. The timeline is based on estimated travel times between monitoring wells, and the analytical parameters are based on those likely to provide useful results based on site conditions and historical knowledge of pilot-scale implementation.

Subsequent performance monitoring would be conducted as part of a long-term monitoring program. A groundwater monitoring plan will be prepared and implemented in accordance with Connecticut's RSR at 22a-133k-3(g) to evaluate remedy effectiveness. This Alternatives Evaluation Report assumes sampling and analysis on a quarterly basis for an additional year, followed by semi-annual monitoring until PRGs are achieved. Discontinuation of the monitoring program would be based on the requirements presented in the Connecticut RSRs.

#### 4.1.2.1 Overall Protection of Human Health and the Environment

Alternative GW2 would achieve the RAOs and would be protective of human health and the environment by reducing contaminant concentrations to achieve PRGs.

#### 4.1.2.2 Compliance with ARARs

Alternative GW2 would comply with the ARARs identified in Tables 4-2 through 4-4. Performance monitoring and additional injection of HRC-A, as necessary, would be conducted until contaminant concentrations in groundwater have been reduced to achieve the PRGs. The alternative would be designed and implemented to attain ARARs.

#### 4.1.2.3 Long-Term Effectiveness and Permanence

Alternative GW2 would provide long-term effectiveness and permanence at protecting human health and the environment. Current data suggest that natural attenuation is occurring. Enhancement of naturally occurring processes by injection of HRC would increase degradation rates and provide for stable microbial and chemical conditions necessary to achieve PRGs. Biodegradation processes are irreversible.

#### 4.1.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Enhanced biodegradation is a treatment technology that provides a reduction in toxicity, mobility, and volume of contaminants by reducing contaminant concentrations to achieve PRGs.

#### 4.1.2.5 Short-Term Effectiveness

The activities associated with Alternative GW2 would be conducted in areas of the Site where access is limited to trained workers. This alternative has potential short-term risks to site workers; however, these risks would be minimized by effectively implementing an approved site-specific health and safety plan.

4.1.2.6 Implementability

Alternative GW2 would be easily implemented. The equipment, materials, and services required for implementation of this alternative are readily available. Obtaining the necessary regulatory approvals and permits associated with this alternative should not present obstacles.

4.1.2.7 Cost

Table 4-5 presents a summary of the estimated cost to implement Alternative GW2. The present worth for Alternative GW2 is estimated to be approximately $936,000. The cost estimate assumes that groundwater monitoring will be performed for 5 years. Table 4-5 also contains a total non-discounted cost estimate based on cash outlays for 5 years. The estimated non-discounted cost is approximately $992,588.

### 4.1.3 Alternative GW3: Groundwater Extraction and Treatment

Alternative GW3 relies on extraction and treatment of groundwater to mitigate human receptor exposure to contaminants exceeding PRGs. Groundwater extraction and treatment is a time-tested alternative for providing hydraulic containment of a contaminant plume, and, in cases where sorption is not a major factor, can significantly reduce contaminant mass within the plume. While extraction of contaminated groundwater is relatively straight-forward, there are a number of treatment options usually available, depending on the chemical constituents and discharge requirements. Treated water would be discharged to an off-site POTW. This alternative would consist of the following key components:

- Installation of groundwater extraction wells
- Construction of the groundwater treatment system
- Discharge of treated groundwater to the local POTW
- Performance monitoring to evaluate the effectiveness of the remedial action

**Installation of groundwater extraction wells.** This alternative proposes the installation of five extraction wells: two wells for the Western Plume and three wells for the Eastern Plume. The extraction wells would be located at the interpreted or assumed extent (or leading edge) of the plumes. Additionally, an extraction wells would be installed within each plume near the area of highest contaminant concentrations in order to reduce flushing path lengths and overall remediation time.

**Construction of the groundwater treatment system.** Based on estimates of plume size/width, aquifer thickness, and groundwater flow rates or recharge rates, groundwater extraction estimates are a combined total of 6 gallons per minute (gpm) for the two wells at the Western Plume and a combined total of 14 gpm for the three wells at the Eastern Plume.

Groundwater would be pumped from the extraction wells to a treatment facility that would be constructed on-site. The treatment facility is proposed to be constructed at a central location, in the vicinity of former Building 17, which is in close proximity of both plumes.

The proposed treatment system would consist of an equalization tank followed by a diffused aeration treatment unit. Air stripping is a time-tested technology for treatment of chlorinated VOCs in groundwater that can achieve greater than 99 percent removal rates for VOCs. A diffused aeration treatment unit was selected over a packed tower or low-profile air stripper because it is much less prone to fouling due to elevated concentrations of naturally occurring iron and manganese in the groundwater associated with the two plumes.

**Discharge of treated groundwater.** This alternative proposes to discharge the treated effluent through the existing Metropolitan District Commission (MDC) sewer system to a local POTW. Discharge to the POTW would be permitted under the General Permit for the Discharge of Groundwater Remediation Wastewater to a Sanitary Sewer. With an estimated influent to the treatment plant of approximately 6 milligrams per liter (mg/L) of total VOCs, the treatment system would only need to remove approximately 85 percent of the VOC concentrations to meet the discharge permit requirements of 1 mg/L total VOCs.

**Performance monitoring.** A groundwater monitoring plan will be prepared and implemented in accordance with Connecticut's RSR at 22a-133k-3(g) to evaluate the effectiveness of the extraction and treatment system at reducing VOC concentrations to achieve PRGs. This Alternatives Evaluation Report assumes sampling and analysis on a quarterly basis for one year, followed by semi-annual monitoring until PRGs are achieved. Discontinuation of the monitoring program would be based on the requirements presented in the Connecticut RSRs. The estimated duration for this alternative to achieve PRGs is approximately 45 years for the Western Plume and approximately 20 years for the Eastern Plume.

#### 4.1.3.1 Overall Protection of Human Health and the Environment

Alternative GW3 would achieve the RAOs and would be protective of human health and the environment by reducing contaminant concentrations to achieve PRGs.

#### 4.1.3.2 Compliance with ARARs

Alternative GW3 would comply with the ARARs identified in Table 4-6 through 4-8. Performance monitoring would be conducted until contaminant concentrations in groundwater have been reduced to achieve the PRGs. The alternative would be designed and implemented to attain ARARs.

#### 4.1.3.3 Long-Term Effectiveness and Permanence

Alternative GW3 would provide long-term effectiveness and permanence at protecting human health and the environment. Extraction and treatment systems are very reliable and effective at reducing VOC concentrations. Once PRGs are achieved, this alternative offers a permanent solution to groundwater contamination.

#### 4.1.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternative GW3 provides a reduction in toxicity, mobility, and volume by treating the contaminated groundwater to reduce contaminants concentrations to achieve PRGs.

#### 4.1.3.5 Short-Term Effectiveness

The activities associated with Alternative GW3 would be conducted in areas of the Site where access is limited to trained workers. This alternative has potential short-term risks to site workers;

however, these risks would be minimized by effectively implementing an approved site-specific health and safety plan.

#### 4.1.3.6 Implementability

Alternative GW3 would be easily implemented. The equipment, materials, and services required for implementation of this alternative are readily available. Obtaining the necessary regulatory approvals and permits associated with this alternative should not present obstacles.

#### 4.1.3.7 Cost

Table 4-9 presents a summary of the estimated cost to implement Alternative GW3. The present worth for Alternative GW3 is estimated to be approximately $1,493,566. The cost estimate assumes that groundwater monitoring will be performed for 30 years. Table 4-9 also contains a total non-discounted cost estimate based on cash outlays for 30 years. The estimated non-discounted cost is approximately $2,810,954.

## 4.2 DETAILED EVALUATION OF SOIL, SEDIMENT AND BUILDING ALTERNATIVES

This subsection contains a detailed evaluation of the following remedial alternatives for buildings, soil, and sediment which were retained in Subsection 3.2:

- Alternative SS1: No Action
- Alternative SS2: Excavation and Disposal in On-Site Landfill
- Alternative SS3: Excavation and Off-Site Disposal

### 4.2.1 ALTERNATIVE SS1: NO ACTION

Alternative SS1, the No Action Alternative, was retained as a baseline with which to compare the other alternatives. This alternative does not include remedial action components to eliminate, reduce, or control actual or potential risks to human or ecological receptors. The alternative would not allow for unrestricted Site use according to NRC rules. The following assessment of the No Action Alternative is based on the first seven NCP evaluation criteria.

#### 4.2.1.1 Overall Protection of Human Health and the Environment

Alternative SS1 would not take any actions to prevent human exposure to FUSRAP area media exceeding PRGs or to reduce ecological exposure to contaminants. The alternative would not be protective of human health or the environment.

#### 4.2.1.2 Compliance with ARARs

Chemical-specific ARARs triggered by Alternative SS-1 are presented in Table 4-10. The No Action Alternative does not include any actions to reduce contaminant concentrations to achieve PRGs or attain ARARs. Because no action is proposed, location- and action-specific ARARs are not triggered by this alternative. This alternative would not comply with ARARs.

#### 4.2.1.3 Long-Term Effectiveness and Permanence

This alternative does not include any action to stimulate or promote the reduction of contaminants, or provide containment of or exposure to residual radioactivity and chemical contaminants. The current access control provided by the chain-link perimeter fences surrounding the Drum Burial Pit and Clamshell Pile, partially surrounding the Equipment Storage Yard, and the snow fence surrounding the Woods Area, are not considered to provide long-term protection. Therefore, the No Action Alternative will not provide long-term effectiveness and permanence for protecting human health and the environment from exposure or potential exposure to contaminants.

#### 4.2.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The No Action Alternative does not reduce the toxicity, mobility, and volume of contaminants through treatment.

4.2.1.5 Short-Term Effectiveness

The No Action Alternative would not provide protection from exposure to residual radioactivity or chemical contaminants exceeding PRGs during the time period during which PRGS are being attained. The alternative does not protect human health and the environment in the short-term.

4.2.1.6 Implementability

Because this alternative does not propose any remedial action, there would be no technical difficulties associated with implementation. The alternative would not limit or interfere with the ability to perform future remedial actions. The no action approach would be considered unacceptable to the regulatory community; however, and would not be implementable administratively.

4.2.1.7 Cost

Because no remedial actions would be preformed, there are no costs associated with the No Action Alternative.

### 4.2.2 ALTERNATIVE SS2: EXCAVATION AND DISPOSAL IN ON-SITE LANDFILL

Alternative SS2 relies on institutional controls and excavation and on-Site disposal of FUSRAP area soil and sediment exceeding PRGs to mitigate human receptor exposure to contaminants. An on-Site containment cell would be constructed specifically to contain the contaminated material.

This alternative would consist of the following key components:

- Institutional controls
  - Signs
  - Fencing
  - Environmental Land Use Restriction
- Construction of an on-site containment cell
- Building decontamination and dismantlement

- Excavation and on-site disposal of FUSRAP area media (including both soil and building debris) exceeding PRGs and consolidation in on-site containment cell
- Wetland restoration and monitoring
- Maintenance of the containment system
- Monitoring and management of leachate
- Post-remediation groundwater monitoring for compliance with CTSEP RSRs

**Institutional Controls.** Institutional controls in the form of signage and fences will be used to identify the containment area and restrict access. An Environmental Land Use Restriction (ELUR) pursuant to Connecticut RSRs would be implemented to restrict development and potential disruption of the on-Site containment cell.

**Construction of On-Site Containment Cell.** An on-Site containment cell, tentatively to be located at or near the Woods Area, will be constructed to contain, isolate, and shield contaminated soil and sediment exceeding PRGs. Because excavated material may also contain chemical constituents of concern at concentrations exceeding PRGs, the containment cell will be constructed with a low-permeability multi-layer liner with primary and secondary leachate collection. A multi-layer capping system will be constructed to cover the containment cell. The containment cell will be designed to hold approximately 9,000 cubic yards which is sufficient for the estimated volume of radiologically contaminated soil and sediment exceeding PRGs (see Subsection 2.4) plus a swell factor of approximately one-third. This volume also includes radiologically contaminated materials from building decontamination. Conceptual design indicates that a containment cell with 10 feet of contained material would be approximately 220 by 220 feet square (including cap system) and occupy approximately 1.1 acres. A security fence would be located 100 feet from the active portion of the containment cell, resulting in an enclosed area approximately 420 by 420 feet and occupying approximately 4.1 acres. Other aspects of the containment cell design would be developed in accordance with Connecticut Low-Level Radioactive Waste Facility Siting Regulations. Although a two-foot soil thickness is expected to adequately shield gamma radiation in contained materials (USEPA, 1996), the conceptual buildup sequence and component thicknesses shown in the following table are based on more conservative requirements for hazardous waste landfills.

| **Cap and Liner Buildup Sequence and Thicknesses for On-Site Containment Cell** | | | |
|---|---|---|---|
| Containment Cap | | Containment Liner | |
| Topsoil | 0.5 foot | Sand | 1.0 foot |
| Protective layer | 3.0 feet | Geomembrane | 80 mil |
| Geocomposite mat | Approx. 350 mil | Geocomposite mat | Approx. 350 mil |
| Geomembrane | 80 mil | Geomembrane | 80 mil |
| Geosynthethic clay liner | Approx. 250 mil | Clay | 3.0 feet |

The primary leachate collection system will drain by gravity to a holding tank. Generated leachate generation is expected to be minimal and not to exhibit significant radioactivity, therefore, treatment will be limited to settling and a filter/strainer to remove suspended matter when the tank is pumped out. It is anticipated that the filtered water would be trucked off-Site for disposal.

**Building Decontamination and Dismantlement.** Alternative SS2 includes decontamination of radiologically contaminated areas of Buildings 3 and 6 followed by dismantlement of the buildings. D&D activities include identification and removal of chemically and radiologically contaminated soil and structures (i.e., drain lines and surrounding soil) exceeding PRGs beneath the buildings.

Decontamination of radiologically contaminated areas will include the following major activities:

- Perform detailed surveys on non-load bearing walls that need to be removed.
- Perform spot decontamination as necessary to minimize radioactive waste volumes.
- Remove all fixtures and building system components.
- Contain radiological contaminated materials in on-site containment cell
- Segregate all materials as necessary and containerize for transportation to appropriate off-Site licensed disposal facilities.
- Abate all asbestos containing material (ACM) in accordance with applicable federal, state, and local regulations.
- Manage PCB and mercury containing materials and equipment, and surfaces contaminated with lead-based paint in accordance with applicable federal, state, and local regulations. PCB containing ballasts and mercury containing lamps, gauges, thermometers, gauges, and switches will segregated for off-Site disposal.
- Perform radiological surveys in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) to obtain necessary data to support the Final Status Survey (FSS).

Following decontamination, above ground portion of Buildings 3 and 6 would be dismantled. Site preparation activities associated with this alternative include obtaining a Building Permit from the Town of Windsor for the demolition of Buildings 3 and 6. Other activities associated with Site preparation include mobilization of equipment and personnel to the Site, as well as development of necessary project plans, including a Decommissioning Plan, Health and Safety Plan, Quality Assurance Project Plan, and Waste Management and Transportation Plan.

Following dismantlement of the above ground portions of Buildings 3 and 6, D&D of below ground structures will commence. This will include pavement, foundations, floor slabs, floor drains and associated contaminated soil, and removal of identified underground utilities (e.g., sanitary sewer lines and Industrial Waste Lines) and associated contaminated soil. The sanitary sewer lines will be removed from Building 3 to the main line. The industrial waste lines that connect Building 3 to Building 6 and that connect the buildings to Manhole No. 1 (just northeast of Building 6), will be removed.

Decontamination and radiological surveys of below grade structures will be performed similar to the above grade portions of the buildings. Contaminated soil associated with the floor drains of Building 3, the sanitary sewer lines, and the industrial waste lines will be excavated to achieve the Site-specific soil PRGs (i.e., radiological DCGLs and applicable CTDEP RSR Criteria). Material exceeding PRGS would be placed in the on-site containment cell. Clean (i.e., no contamination exceeding PRGs) construction and demolition (C&D) debris from building dismantlement would be segregated in accordance with the Waste Management Plan and sent off-Site to a C&D debris disposal facility. After completion of the FSS, clean soil would be returned to the Site.

**Excavation and Disposal of Soil and Sediment.** To prepare for excavation at the FUSRAP areas, woody vegetation would be cleared, grubbed, and stockpiled temporarily adjacent to the excavation areas. Following excavation, the grubbed material will be chipped and blown back into the excavation prior to backfilling the excavation with clean fill. Erosion control measures such as straw bales and silt fencing would be installed to control erosion and migration of contaminated materials to uncontaminated areas. Following site preparation, FUSRAP area soils exceeding PRGS would be excavated and transported to the containment cell for disposal. After the initial excavation, confirmation screening/sampling would take place, and additional soil removed until all soil/sediment exceeding PRGs is removed.

To complete excavation of targeted areas of Site Brook, surface water within the brook would need to be temporarily redirected and contained. Therefore, this alternative includes the construction of temporary containment structures to contain surface water and facilitate pumping of surface water around excavation areas during excavation. Upon completion of excavation and backfilling, any contained water would be released slowly back into the brook (i.e., at a rate that would not promote scouring of the brook) and the containment structures removed.

Even with surface water being redirected, excavation of sediment from Site Brook would most likely consist of wet material. Therefore, localized dewatering would be necessary at each excavation area. This Alternatives Evaluation Report assumes that excavated sediment would be placed on a lined pad, where water would be allowed to drain. Settleable material would be allowed to separate, and the water returned to the brook. Once the sediment is sufficiently dewatered, it would be placed in the appropriate containers for transport.

Excavated upland areas would be backfilled with clean fill, covered with a topsoil/vegetative support layer, and seeded and mulched to prevent erosion. Excavations in Site Brook would be backfilled with material to match native substrate.

Estimated excavation volumes for each FUSRAP area are presented in Subsection 2.4.

**Wetland Restoration.** Delineated wetland areas adjacent to where earthwork (clearing, grubbing, and grading) and sediment removal from Site Brook are performed would require restoration. Restoration efforts would include, at a minimum:

- Coordination with Town of Windsor Inland Wetland and Watercourses Commission and the CTDEP
- Replacement of excavated soils with a mixture of loam and organic materials
- Stabilization of the restored wetlands through the introduction of a seed mixture including native wetland herbaceous species
- Development of a planting plan which includes the planting of woody species similar to what exists in adjacent undisturbed wetlands
- Monitoring of the site for three to five years to ensure that the area would be restored to wetlands

**Maintenance of the Containment System.** Post-closure monitoring/maintenance activities associated with this alternative would consist of inspection of the containment cap; repairing the cap as necessary; maintenance of the vegetative cover, including mowing, fertilizing and liming (as needed); and maintenance of site fencing and signs.

**Monitoring and Management of Leachate.** Monitoring and management of leachate would consist of removal of leachate from the leachate collection system, treating it as required; and discharging it to Site Brook or to the Metropolitan District Commission in accordance with required permits.

**Post-Remediation Groundwater Monitoring.** A groundwater monitoring plan will be prepared and implemented in accordance with Connecticut's RSR at 22a-133k-3(g) to assess the effectiveness of this alternative at preventing groundwater pollution and at minimizing health and safety risks. This Alternatives Evaluation Report assumes sampling and analysis on a quarterly basis for one year, followed by semi-annual monitoring until PRGs are achieved. Discontinuation of the monitoring program would be based on the requirements presented in the Connecticut RSRs. The estimated duration of monitoring at individual FUSRAP areas as part of this alternative is four years. Monitoring at the containment cell proposed as alternative SS2 would continue for an indefinite period.

#### 4.2.2.1 Overall Protection of Human Health and the Environment

Alternative SS2 would achieve RAOs for the FUSRAP areas and would be protective of human health and the environment. Chemical and radiologically contaminated material exceeding PRGs would be excavated and placed in an on-Site containment cell that would isolate, contain, and shield. This would prevent direct human exposure, prevent leaching and erosion of contaminated material, and shield potential receptors from radiation exposure exceeding 19 mrem per year.

#### 4.2.2.2 Compliance with ARARs

Assuming proper long-term management, Alternative SS2 could comply with the ARARs identified in Tables 4-11 through 4-13. While the FUSRAP areas would be suitable for unlimited use and exposure under NRC regulations and Connecticut RSRs, the containment cell would not be suitable for unlimited use, and would not meet the requirements of the NRC/USACE MOU requiring that cleanups at NRC licensed facilities meet the LTR unrestricted release criteria. In addition long-term active management for an indefinite period would be required. An ELUR would be implemented in accordance with Connecticut RSRs.

#### 4.2.2.3 Long-Term Effectiveness and Permanence

Alternative SS2 would provide long-term effectiveness and permanence at protecting human health and the environment. Excavation of soil/sediment exceeding PRGs at the FUSRAP areas would effectively reduce potential risks posed by current Site conditions to levels within or below USEPA's target risk range and threshold.

The on-Site containment cell, with proper maintenance, will provide long-term isolation, containment, and shielding.

#### 4.2.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This alternative does not satisfy the CERCLA preference for reduction of toxicity, mobility, or volume of contaminants through treatment. Placing excavated material in the on-Site containment cell will, however, reduce potential mobility of radiological and chemical contaminants and prevent direct contact exposure to radiological and chemical contaminants. The shielding provided by the containment cover system will reduce potential toxicity from exposure to radiation.

#### 4.2.2.5 Short-Term Effectiveness

In addition to direct contact exposure, on-Site construction workers performing excavation and containment activities may be exposed to radiation, noise, and dust. Potential risks can be minimized, however, by development of and adherence to a comprehensive health and safety plan, utilization of personnel protective equipment and monitoring devices, and following safe work practices. There is also short-term risk to on-Site construction works from construction equipment and activities. Because nearly all construction activities will be confined to the CE Windsor Site, short-term risks to the general public are expected to be minimal.

#### 4.2.2.6 Implementability

Alternative SS2 has good technical implementability. The excavation and consolidation activities can be completed with common construction equipment and procedures. The effectiveness of these activities can be easily monitored, and implementation of Alternative SS2 will not interfere or prevent implementation of additional remedial actions.

Administrative implementability refers to the ability to obtain necessary permits, licenses, and approvals from other parties and agencies necessary to implement the remedy, and to the extent of required coordination with other parties or agencies. A potential obstacle to administrative implementability will be the ability to obtain the necessary approvals to construct an on-Site containment cell at the Site.

#### 4.2.2.7 Cost

Table 4-14 presents a summary of the estimated cost to implement Alternative SS2. The present worth for Alternative SS2 is estimated to be approximately $48,482,357. The cost estimate assumes that operation and maintenance and groundwater monitoring will be performed for 100 years. Table 4-14 also contains a total non-discounted cost estimate based on cash outlays for 100 years. The estimated nondiscounted cost is approximately $76,055,303.

### 4.2.3 ALTERNATIVE SS3: EXCAVATION AND OFF-SITE DISPOSAL

Alternative SS3 relies on excavation and off-Site disposal of FUSRAP area soil and sediment exceeding PRGs and building D&D to mitigate human receptor exposure to contaminants. The institutional controls and construction of an on-Site containment cell that are a part of Alternative SS2 are not required as part of this alternative. This alternative would consist of the following key components:

- Building decontamination and dismantlement
- Excavation and off-site disposal of FUSRAP area media exceeding PRGs
- Wetland restoration and monitoring
- Post-remediation groundwater monitoring for compliance with CTDEP RSRs

**Building Decontamination and Dismantlement.** Building decontamination and dismantlement would be performed as described for Alternative SS2 in Subsection 4.2.2 with the exception that all D&D debris would be transported off-Site to permitted facilities. The transportation process could consist of the following steps:

- placement of wastes into 25 cubic yard intermodal containers
- placement of these containers onto trucks for transport from Windsor, Connecticut to a rail siding
- removal of containers from trucks and placement on flatbed railcars for rail transport to the disposal location

Clean (i.e., no contamination exceeding PRGs) C&D debris from building dismantlement would be sent off-Site to a C&D debris disposal facility.

**Excavation and Disposal of Soil and Sediment.** Soil and sediment would proceed as described in Subsection 4.2.2 for Alternative SS2 with the exception that excavated materials would be shipped off-Site to a commercial facility for disposal. The transportation process would consist of the following steps:

- placement of wastes into 25 cubic yard intermodal containers
- placement of these containers onto trucks for transport from Windsor, Connecticut to a rail siding
- removal of containers from trucks and placement on flatbed railcars for rail transport to the disposal facility

**Wetland Restoration.** Wetland restoration would be performed as described for Alternative SS2 in Subsection 4.2.2.

**Post-Remediation Groundwater Monitoring.** A groundwater monitoring plan will be prepared and implemented in accordance with Connecticut's RSR at 22a-133k-3(g) to assess the effectiveness of this alternative at preventing groundwater pollution and at minimizing health and safety risks. This Alternatives Evaluation Report assumes sampling and analysis on a quarterly basis for one year, followed by semi-annual monitoring until PRGs are achieved. Discontinuation of the monitoring program would be based on the requirements presented in the Connecticut RSRs. The estimated duration of monitoring at individual FUSRAP areas as part of this alternative is four years.

#### 4.2.3.1 Overall Protection of Human Health and the Environment

Alternative SS3 would achieve RAOs for the FUSRAP areas and would be protective of human health and the environment. Contaminated material exceeding chemical and radiological PRGs would be excavated and disposed of off-Site in a permitted facility. This would prevent direct human exposure, prevent leaching and erosion of contaminated material, and prevent potential receptors from radiation exposure exceeding 19 mrem per year.

#### 4.2.3.2 Compliance with ARARs

Alternative SS3 would comply with the ARARs identified in Tables 4-15 through 4-17. The FUSRAP areas would be suitable for unlimited use and exposure under NRC regulations and Connecticut RSRs.

#### 4.2.3.3 Long-Term Effectiveness and Permanence

Alternative SS3 would provide good long-term effectiveness and permanence at protecting human health and the environment. Excavation of soil/sediment exceeding PRGs at the FUSRAP areas would effectively reduce potential risks posed by current site conditions to levels within or below USEPA's target risk range and threshold.

The off-Site disposal facility is expected to provide long-term isolation, containment, and shielding.

#### 4.2.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

It is expected that excavated material will be landfilled at off-Site disposal facilities; therefore, this alternative does not satisfy the CERCLA preference for reduction of toxicity, mobility, or volume of contaminants through treatment. Disposing of excavated material at off-Site facilities will, however, reduce on-Site toxicity, mobility, or volume of contaminants.

4.2.3.5 Short-Term Effectiveness

In addition to direct contact exposure, on-Site construction workers performing excavation activities may be exposed to radiation, noise, and dust. Potential risks can be minimized, however, by development of and adherence to a comprehensive health and safety plan, utilization of personnel protective equipment and monitoring devices, and following safe work practices. There is also short-term risk to on-Site construction works from construction equipment and activities.

Because excavated material will be shipped to an off-Site location, there is a potential exposure risk to members of the public in the event of a truck or rail accident resulting in the release of contaminated material. The risk of such an event is considered relatively low, however. In addition, the activity levels of the excavated material would not pose an acute risk. Trucking and rail transportation firms would be made aware of the type of material being transported and appropriate precautions taken to minimize potential risk.

4.2.3.6 Implementability

Alternative SS3 has good technical implementability. The excavation and off-Site transportation activities can be completed with common construction and transportation equipment and procedures. The effectiveness of Alternative SS3 can be easily monitored, and implementation of Alternative SS3 will not interfere or prevent implementation of additional remedial actions.

No obstacles are foreseen in obtaining necessary permits, licenses, and approvals from other parties and agencies necessary to implement the remedy, or in required coordination with other parties or agencies. Alternative SS3 has good administrative implementability

4.2.3.7 Cost

Table 4-18 presents a summary of the estimated cost to implement Alternative SS3. The present worth for Alternative SS3 is estimated to be approximately $69,814,300. The cost estimate assumes that groundwater monitoring will be performed for 3 years. Table 4-18 also contains a total non-discounted cost estimate based on cash outlays for 3 years. The estimated nondiscounted cost is approximately $69,816,179.

# 5.0 COMPARATIVE ANALYSIS OF ALTERATIVES

The comparative analysis compares the candidate remedial alternatives with respect to the evaluation criteria used during the detailed analysis of alternatives. The purposes of the comparative analysis are to identify the advantages and disadvantages of alternatives relative to one another, and to aid in the eventual selection of a preferred remedial alternative that will be identified in the Proposed Remedy Plan for the FUSRAP areas. The evaluation criteria are divided into three specific categories during remedy selection: Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria. Subsection 5.1 presents the approach of the comparative analysis based on the NCP with respect to these three categories. Subsection 5.2 presents the comparison of groundwater remedial alternatives, and Subsection 5.3 presents the comparison of buildings, soil, and sediment remedial alternatives.

## 5.1 APPROACH TO THE COMPARATIVE ANALYSIS

The NCP outlines the approach for performing the comparative analysis of site alternatives. The remedy proposed must reflect the scope and purpose of the actions being undertaken and how these actions relate to other remedial actions and the long-term response at the site. Identification of the preferred alternative and final remedy selection are based on an evaluation of the major tradeoffs among alternatives in terms of the nine evaluation criteria. USEPA categorizes the evaluation criteria into three groups: threshold, balancing, and modifying. Each criteria group is discussed in the following subsections.

### 5.1.1 Threshold Criteria

USEPA designated (1) overall protection of human health and the environment, and (2) compliance with ARARs as the two threshold criteria. An alternative must meet both criteria to be eligible for selection as the preferred site remedy.

### 5.1.2 Primary Balancing Criteria

The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These balancing criteria provide a preliminary assessment of the extent to which permanent solutions and treatment can be used practicably and in a cost-effective manner.

An alternative that is protective of human health and the environment, is ARAR-compliant, and affords the best balance among these criteria is identified as the preferred alternative in the Proposed Remedy Plan. The balancing emphasizes long-term effectiveness and reduction of toxicity, mobility, or volume through treatment.

### 5.1.3 Modifying Criteria

State and community acceptance is factored into a final balancing that determines the preferred remedy and the extent of permanent solutions and treatment practicable for the Site. Formal state-regulatory-agency comments will not be received until after the agencies have reviewed the FS Report. Community concerns will be factored into the remedy selection process following the public comment period on the Proposed Remedy Plan.

## 5.2 COMPARATIVE ANALYSIS OF GROUNDWATER ALTERNATIVES

This subsection contains a comparative analysis of groundwater alternatives associated with the CE Windsor Site FUSRAP areas. The groundwater remedial alternatives that are the focus of this comparative analysis are:

- Alternative GW1: No Action
- Alternative GW2: Enhanced In-Situ Biodegradation
- Alternative GW3: Groundwater Extraction and Treatment

### 5.2.1 Overall Protection of Human Health and the Environment

According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final site remedy. Alternative GW1 is the No Action Alternative, which was developed as a baseline with which to compare the other alternatives. It would not eliminate, reduce, or control potential future exposure to contaminants exceeding PRGs and would not meet RAOs. Therefore, it is not protective of human health and the environment and cannot be chosen as a final remedy.

Alternative GW2 consists of enhanced in-situ bioremediation of groundwater to eliminate, reduce, or control potential future exposure to contaminants exceeding PRGs and would meet RAOs. Alternative GW2 is considered protective of human health and the environment.

Alternative GW3 consists of extraction and treatment of groundwater to eliminate, reduce, or control potential future exposure to contaminants exceeding PRGs and would meet RAOs. Alternative GW3 is considered protective of human health and the environment.

### 5.2.2 Compliance with ARARs

CERCLA requires that a selected alternative must also meet a second threshold criterion of compliance with ARARs, or a waiver must be obtained if the criterion can not be met. According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final remedy.

**Location-specific ARARs.** Alternative GW1 is the No Action Alternative, which was developed as a baseline with which to compare the other alternatives. Because this alternative does not include any actions, the alternative does not trigger location-specific ARARs. Alternatives GW2 and GW3 would be designed and implemented to comply with regulations pertaining to floodplains, wetlands, and endangered species. Other location-specific ARARs are not expected to be triggered.

**Chemical-specific ARARs.** Alternative GW1 proposes no action, and would not meet chemical-specific ARARs. Implementation of Alternatives GW2 and GW3 would continue until contaminant concentrations in groundwater have been reduced to achieve PRGs. Alternatives GW2 and GW3 are considered compliant with ARARs.

**Action-specific ARARs.** Alternative GW1 does not include any actions and, therefore, action-specific ARARs are not triggered. Alternatives GW2 and GW3 can be designed and implemented to attain action-specific ARARs.

The degree to which action-specific ARARs are triggered and the difficulties in attaining compliance correspond to the complexity of the proposed actions. Alternative GW2 consists of enhanced in-situ bioremediation, which includes injection of nutrients and other compounds into the subsurface, followed by groundwater performance monitoring. Alternative GW3 consists of installation of extraction wells, construction of a groundwater treatment plant, discharge of the treated effluent to a local off-site POTW, and groundwater performance monitoring.

The relative ranking of the alternatives according to overall ability to attain ARARs is probably most dependent on compliance with action-specific ARARs. Because Alternative GW3 involves more construction and remedial components than Alternative GW2, it would likely require the greatest effort to meet action-specific ARARs. The relative ranking is, therefore, GW2 > GW3 > GW1.

### 5.2.3 Long-term Effectiveness and Permanence

This criterion evaluates the magnitude of residual risk and the reliability of controls after response objectives have been met. Alternative GW1 consists of no action and, therefore, does not offer long-term effectiveness and permanence for protection of human health and the environment. Alternatives GW2 and GW3 both offer good long-term effectiveness and permanence; however, Alternative GW3 would require a much longer timeframe to achieve PRGs than Alternative GW2; the estimated cleanup time for Alternative GW3 is approximately 45 years as compared to 6 years for Alternative GW2. The relative ranking of long-term effectiveness is GW2 > GW3 > GW1.

### 5.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This criterion evaluates whether the alternatives meet the statutory preference for treatment under CERCLA. The criterion evaluates the reduction of toxicity, mobility, or volume of contaminants, and the type and quantity of treatment residuals.

Alternative GW1 proposes no action, and would therefore not provide any reduction in toxicity, mobility, or volume of contaminants, nor does it include any treatment of contaminants.

Alternatives GW2 and GW3 both provide a reduction in toxicity, mobility, and volume of contaminants by treating contaminated groundwater to reduce contaminant concentrations to achieve. Alternative GW2 consists of enhanced in-situ bioremediation, which would not result in any treatment residuals. Alternative GW3 consists of extraction and treatment of contaminated groundwater prior to discharge to a local off-site POTW. The treatment system would generate treatment residual associated with metals precipitation and sludge processing that would require off-site disposal. The relative ranking is GW2 > GW3 > GW1.

### 5.2.5 Short-term Effectiveness

CERCLA requires that potential adverse short-term effects to workers, the surrounding community, and the environment be considered during implementation of a remedial action and until response objectives have been met. Alternative GW1 does not eliminate, reduce, or control potential exposure risks and, therefore, provides poor short-term effectiveness.

The short-term risks for Alternatives GW2 and GW3 are similar; however, Alternative GW3 would require more time to construct and a significantly longer time to achieve PRGs than Alternative GW2. Therefore, the relative ranking is GW2 > GW3 > GW1.

### 5.2.6 Implementability

This criterion evaluates each alternative's ease of construction and operation, and availability of services, equipment, and materials to construct and operate the alternative. Also evaluated is the ease of undertaking additional remedial actions and administrative feasibility.

Alternative GW1 does not include any actions and, therefore, would be technically easy to implement. However, administratively, obtaining regulatory and/or public approval would be difficult.

Services, equipment, and materials are available to implement either Alternative GW2 or GW3, and neither alternative would interfere with the ability to undertake additional remedial actions.

The administrative feasibility of obtaining regulatory approvals and the necessary permits is considered good for both Alternatives GW2 and GW3.

The relative ranking of technical implementability is GW1 > GW2 = GW3. The relative ranking of administrative implementability is GW2 = GW3 > GW1.

### 5.2.7 Cost

The estimated present worth costs for the alternatives are summarized as follows:

| | |
|---|---|
| Alternative GW1 | $0 |
| Alternative GW2 | $936,000 |
| Alternative GW3 | $1,493,566 |

## 5.3 COMPARATIVE ANALYSIS OF SOIL, SEDIMENT AND BUILDING ALTERNATIVES

This subsection contains a comparative analysis of building, soil, and sediment alternatives for the CE Windsor Site FUSRAP areas. The soil and sediment remedial alternatives that are the focus of this comparative analysis are:

- Alternative SS1: No Action
- Alternative SS2: Excavation and Disposal in On-Site Landfill
- Alternative SS3: Excavation and Off-Site Disposal

### 5.3.1 Overall Protection of Human Health and the Environment

According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final site remedy. Alternative SS1 was developed as a baseline with which to compare the other alternatives, and proposes no action. It would not eliminate, reduce, or control potential future exposure to contaminants exceeding PRGs and would not meet RAOs. Therefore, it is considered not protective of human health and the environment and cannot be chosen as final remedy.

Alternative SS2 includes actions in the form of institutional controls, building decontamination, and soil and sediment excavation and containment in an on-site containment cell to eliminate, reduce, or control potential future exposure to contaminants exceeding PRGs and would meet RAOs. The proposed containment cell would require long-term maintenance and monitoring, but would provide good protection of human health and the environment. Alternative SS2 is considered protective of human health and the environment.

Alternative SS3 includes actions in the form of building decontamination, excavation of soil and sediment exceeding PRGS, and disposal of excavated material in a permitted off-site facility to eliminate, reduce, or control potential future exposure to contaminants exceeding PRGs and would meet RAOs. Alternative SS3 is considered protective of human health and the environment.

### 5.3.2 Compliance with ARARs

CERCLA requires that the selected alternatives also meet a second threshold criterion of compliance with ARARs, or a waiver must be obtained if the criterion can not be met. This criterion, according to CERCLA, must be met for a remedial alternative to be chosen as a final site remedy.

**Location-specific ARARs.** Alternative SS1 was developed as a baseline with which to compare the other alternatives, and proposes no action. Therefore, Alternative SS1 does not trigger location-specific ARARs. Alternatives SS2 and SS3 can be designed and implemented to comply with regulations pertaining to floodplains, wetlands, and endangered species. Other location-specific ARARs are not expected to be triggered.

**Chemical-specific ARARs.** Alternative SS1 proposes no action and would not meet chemical-specific ARARs. Alternative SS2 would meet chemical-specific ARARs for building decontamination and for cleanup of the FUSRAP areas for unlimited use and exposure. The on-site containment cell would not meet unlimited use and exposure criteria as required under the NRC/USACE MOU, but it would be designed, constructed, and managed in accordance with other applicable and relevant and appropriate requirements to be protective of human health and the environment. Alternative SS2 is not considered compliant with ARARs.

Alternative SS3 would meet chemical-specific ARARs for building decontamination and for cleanup of the FUSRAP areas for unlimited use and exposure. Alternative SS3 is considered compliant with ARARs.

**Action-specific ARARs.** The degree to which action-specific ARARs are triggered and the difficulties in attaining compliance correspond to the complexity of proposed actions. Both Alternatives SS2 and SS3 can be designed and implemented, however, to attain action-specific ARARs.

Alternative SS1 entails no action and, therefore, triggers no action-specific ARARs. Actions associated with Alternative SS2 consist primarily of decontaminating and dismantling Buildings 3 and 6, excavating contaminated soil and sediment, and constructing an on-site containment cell. ARARs pertaining to the identification and handling of hazardous wastes, control of dust, noise, and erosion would apply.

Alternative SS3 consists primarily of decontaminating and dismantling Buildings 3 and 6, excavating contaminated soil and sediment, and transporting excavated material to an off-Site facility. ARARs pertaining to the identification and handling of hazardous wastes, control of dust, noise, and erosion would apply.

The relative ranking of the alternatives according to overall ability to attain ARARs is probably most dependent on compliance with action-specific ARARs. Because Alternative SS2 involves the most on-site handling and management of contaminated material it would likely require the greatest effort to meet ARARs. The relative ranking is, therefore, SS3 > SS2 > SS1.

### 5.3.3 Long-term Effectiveness and Permanence

This criterion evaluates the magnitude of residual risk and the reliability of controls after response objectives have been met. Alternative SS1 does not offer long-term effectiveness and permanence for protection of human health and the environment. Alternatives SS2 and SS3 both offer good long-term effectiveness and permanence, but because wastes remain on site in Alternative SS2, the long-term effectiveness and permanence of Alternative SS3 is considered greater. The relative ranking of long-term effectiveness is SS3 > SS2 > SS1.

### 5.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This criterion evaluates whether the alternatives meet the statutory preference for treatment under CERCLA. The criterion evaluates the reduction of toxicity, mobility, or volume of contaminants, and the type and quantity of treatment residuals.

None of Alternatives SS1, SS2, or SS3 provides reduction of toxicity, mobility, or volume of contaminants through treatment. None of these alternatives would satisfy CERCLA's statutory preference for treatment as a principal component of remedial action.

### 5.3.5 Short-term Effectiveness

CERCLA requires that potential adverse short-term effects to workers, the surrounding community, and the environment be considered during implementation of a remedial action and until response objectives have been met. Alternative SS1 does nothing to eliminate, reduce, or control potential exposure risks and, therefore, provides poor short-term effectiveness. Alternatives SS2 and SS3 are considered sufficiently similar that their short-term risks are equal. The short-term risks associated with construction of a containment cell in Alternative SS2 are considered approximately equal to the short-term risks associated with transportation of excavated material to an off-site disposal facility. The relative ranking of short-term effectiveness is SS3 = SS2 >SS1.

### 5.3.6 Implementability

This criterion evaluates each alternative's ease of construction and operation, and availability of services, equipment, and materials to construct and operate the alternative. Also evaluated is the ease of undertaking additional remedial actions and administrative feasibility.

Alternative SS1 requires no action and, therefore, would be technically easy to implement. However, administratively, obtaining regulatory and/or public approval would be difficult.

Services, equipment, and materials are available to implement either Alternative SS2 or SS3, and neither alternative would interfere with the ability to undertake additional remedial actions.

The administrative feasibility of obtaining necessary permits, licenses, and regulatory approvals is considered good for Alternative SS3, but may be difficult for Alternative SS2.

The relative ranking of technical implementability is SS1 > SS2 = SS3. The relative ranking of administrative implementability is SS3 > SS2 > SS1.

### 5.3.7 Costs

The estimated present worth costs for the alternatives are summarized as follows:

| | |
|---|---|
| Alternative SS1 | $0 |
| Alternative SS2 | $48,482,357 |
| Alternative SS3 | $69,814,300 |

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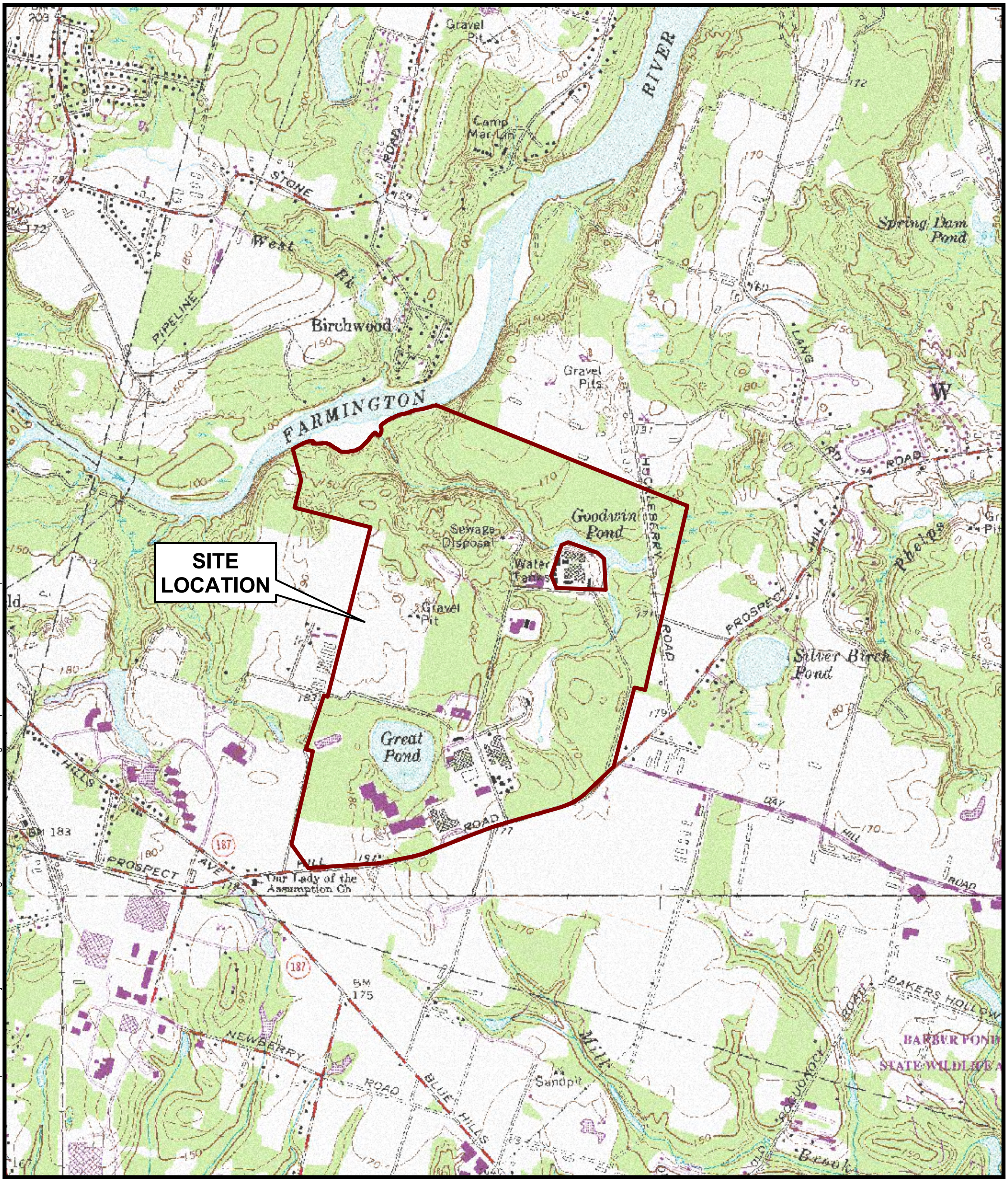
**FIGURES**

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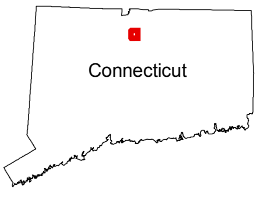


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| Prepared by BRP | Checked by ESS |
|---|---|

Figure 1-1
Site Location Map
Alternatives Evaluation Report for
Remaining Commercial and
FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

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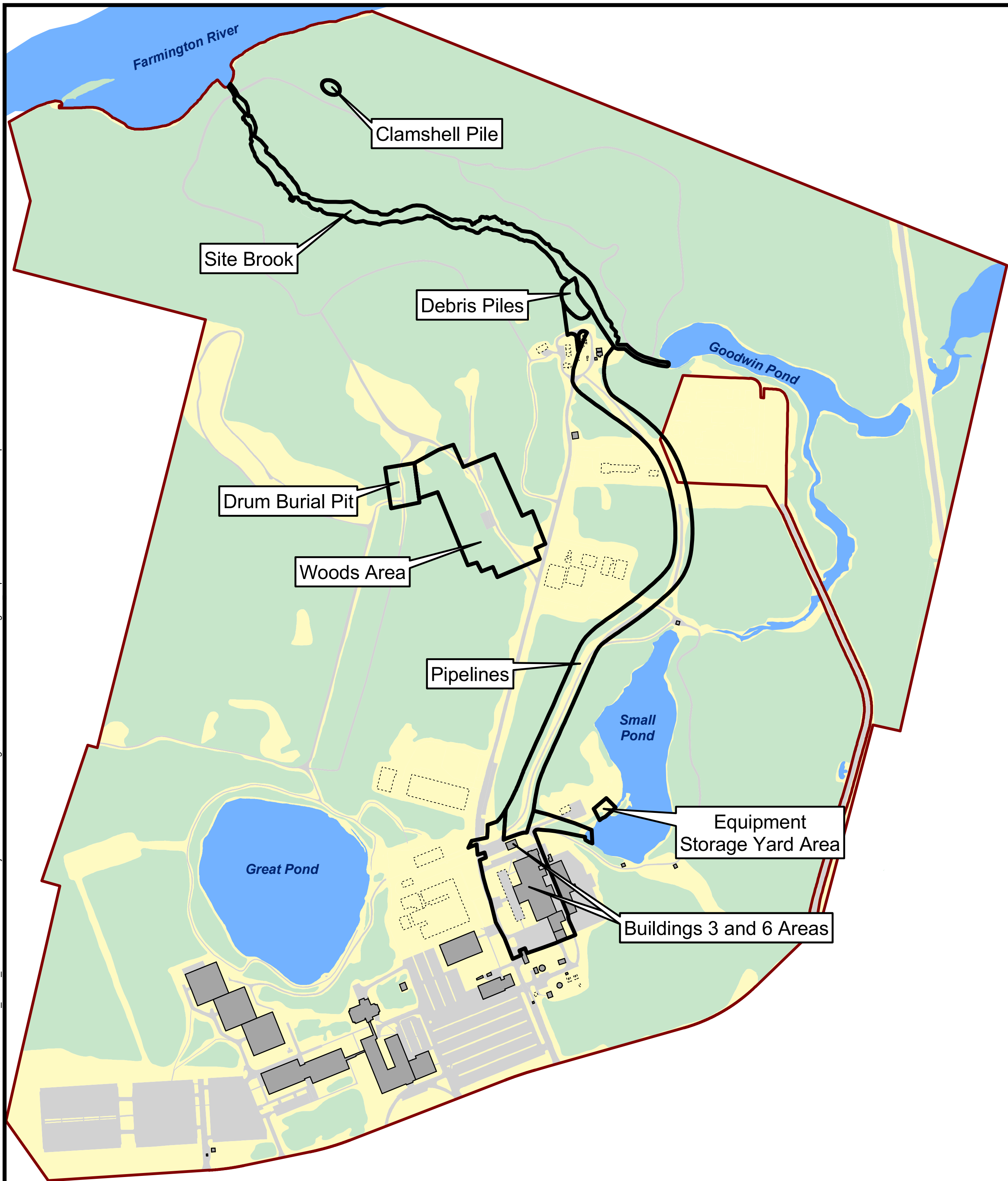


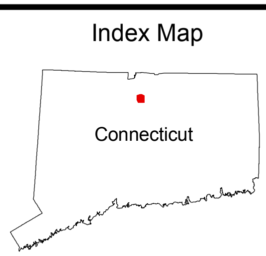


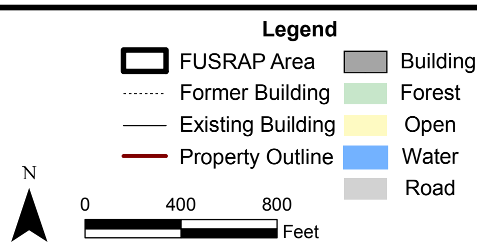


Prepared by BRP | Checked by ESS

Figure 1-2
Location of FUSRAP Study Areas
Alternatives Evaluation Report for
Remaining Commercial and
FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

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0 100 200 Feet

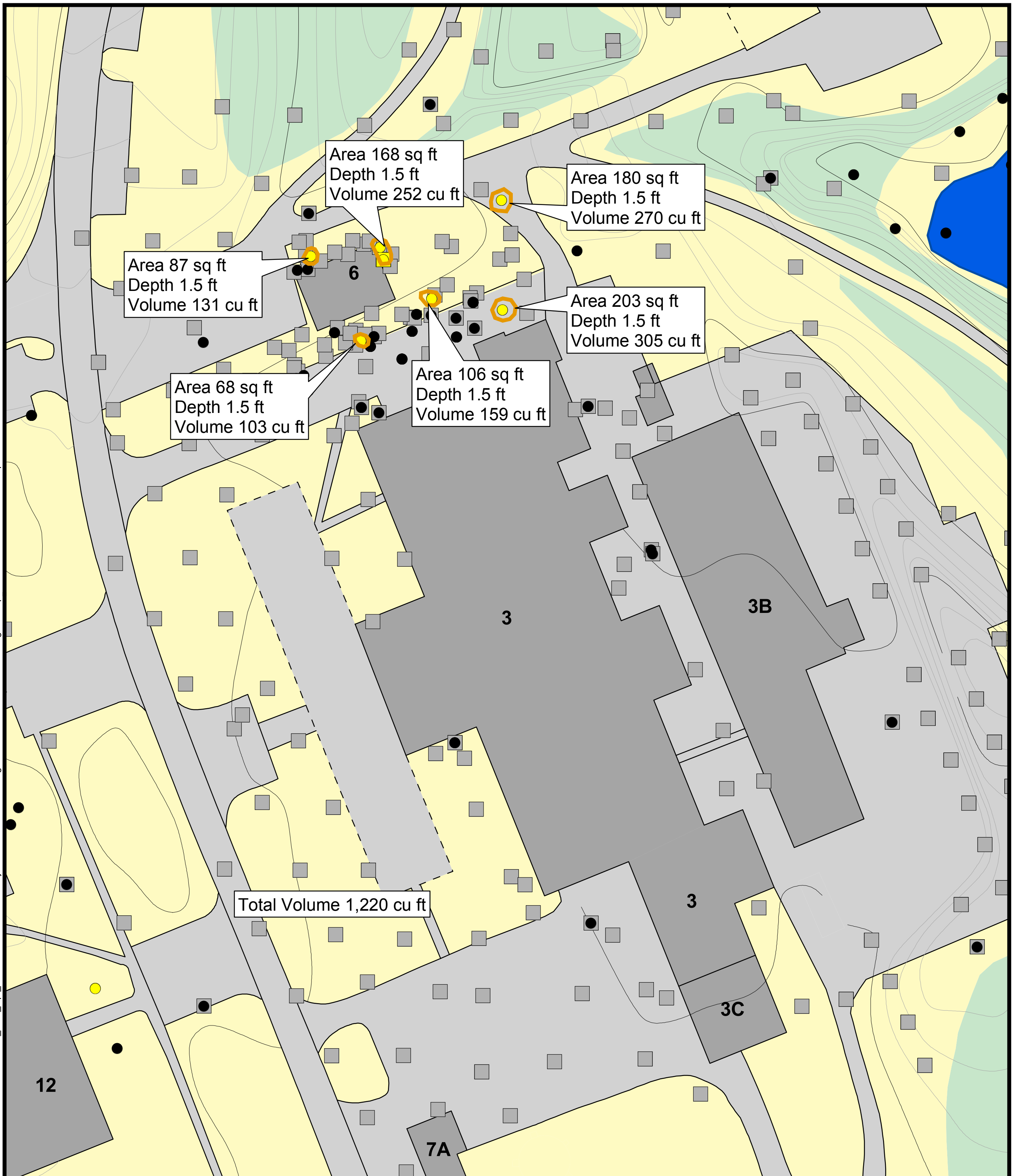
Prepared by BRP | Checked by ESS

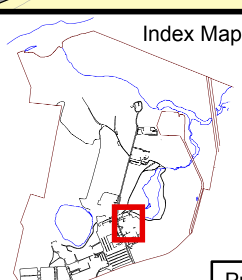
**Legend**

- Monitoring Well
- Approximate Extent of Chlorinated VOCs in Groundwater at Concentrations Above CTDEP RSR Criteria
- Former Building
- Existing Building
- Water
- Road
- Property Outline
- Building
- Forest
- Open
- Water
- Road

Figure 1-3
Groundwater Contaminant Plumes

Alternatives Evaluation Report for
Remaining Commercial and FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.




**Legend**

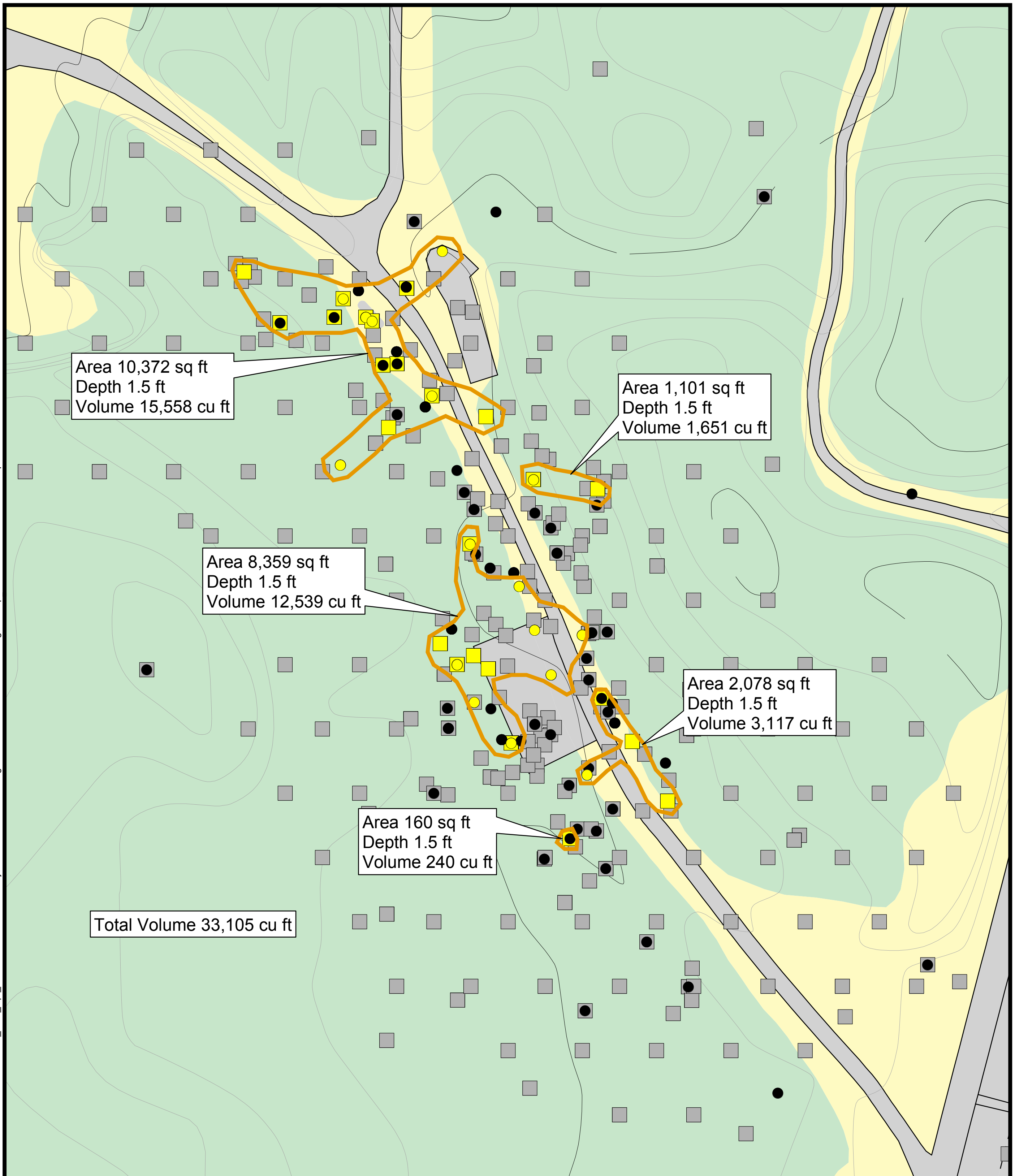
- Remediation Area
- Total Uranium Alpha >= 500
- Total Uranium Alpha < 500 pCi/gm
- Total Uranium Gamma >= 500
- Total Uranium Gamma < 500 pCi/gm

0 50 100 Feet

N

Prepared by BRP | Checked by ESS

Figure 2-1
Buildings 3 and 6 Areas
Alternatives Evaluation Report for
Remaining Commercial and
FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

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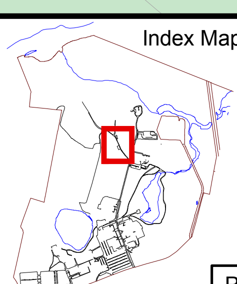

**Legend**

- Remediation Area
- Total Uranium Alpha >= 500
- Total Uranium Alpha < 500 pCi/gm
- Total Uranium Gamma >= 500
- Total Uranium Gamma < 500 pCi/gm

Prepared by BRP | Checked by ESS

0 50 100 Feet

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Figure 2-2
Woods Area
Alternatives Evaluation Report for
Remaining Commercial and
FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

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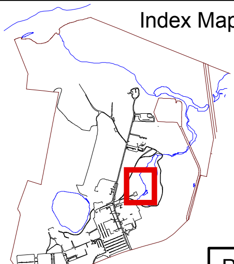
Index Map



**Legend**

- Remediation Area
- Soil Sample
- Soil Sample Exceeding Residential DEC for PAHs

| Prepared by BRP | Checked by ESS |
|---|---|

0 50 100 Feet

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Figure 2-3
Equipment Storage Yard Area
Alternatives Evaluation Report for
Remaining Commercial and
FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

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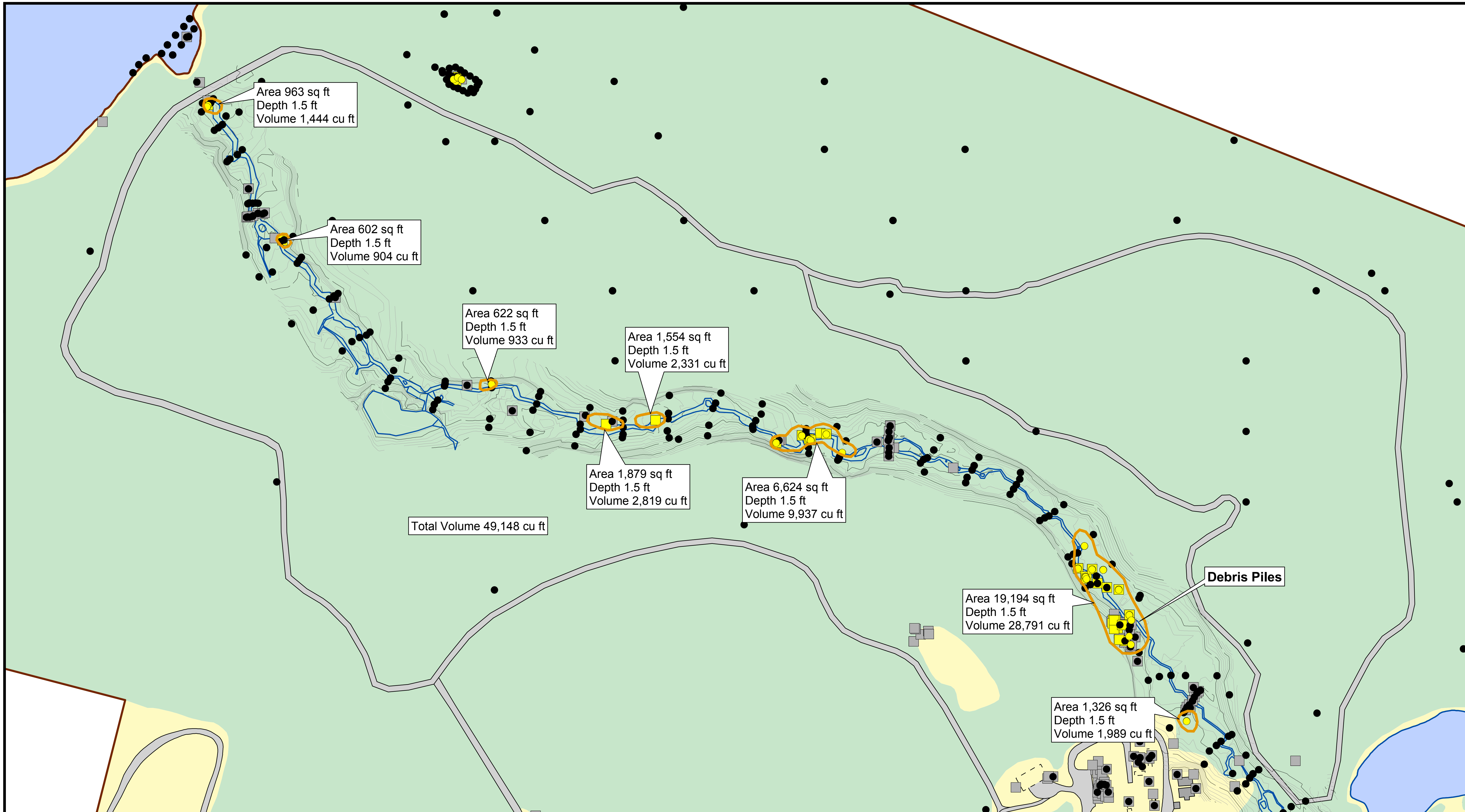


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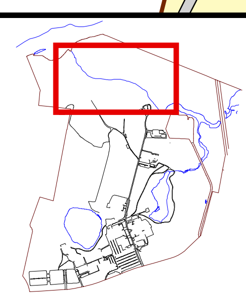

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0 100 200 Feet

| Prepared by BRP | Checked by ESS |
|---|---|

**Legend**

- Remediation Area
- Total Uranium Alpha >= 500
- Total Uranium Alpha < 500 pCi/gm
- Total Uranium Gamma >= 500
- Total Uranium Gamma < 500 pCi/gm

Figure 2-4
Site Brook and Debris Piles

Alternatives Evaluation Report for
Remaining Commercial and FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

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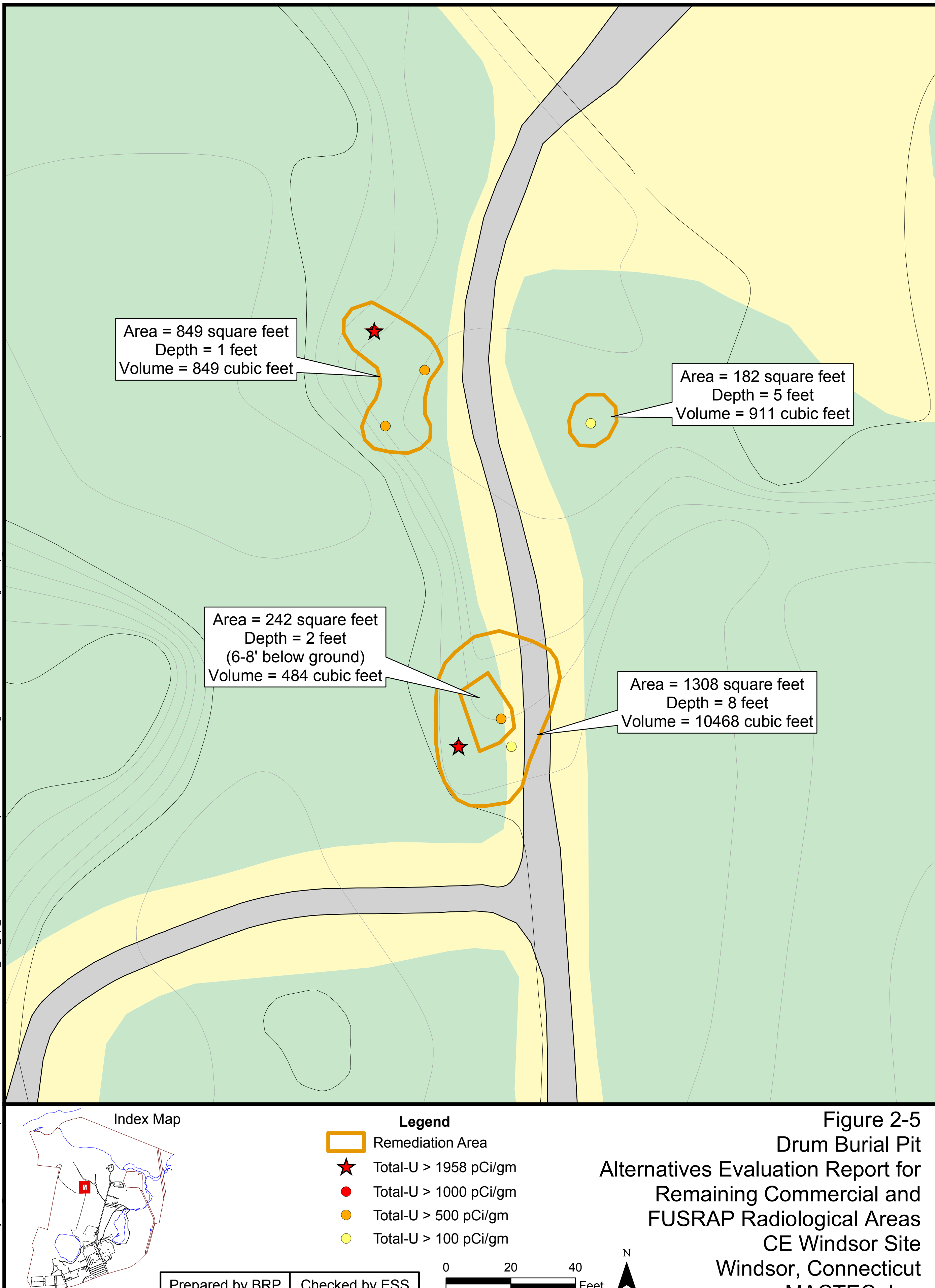


Prepared by BRP | Checked by ESS

Figure 2-5
Drum Burial Pit
Alternatives Evaluation Report for
Remaining Commercial and
FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

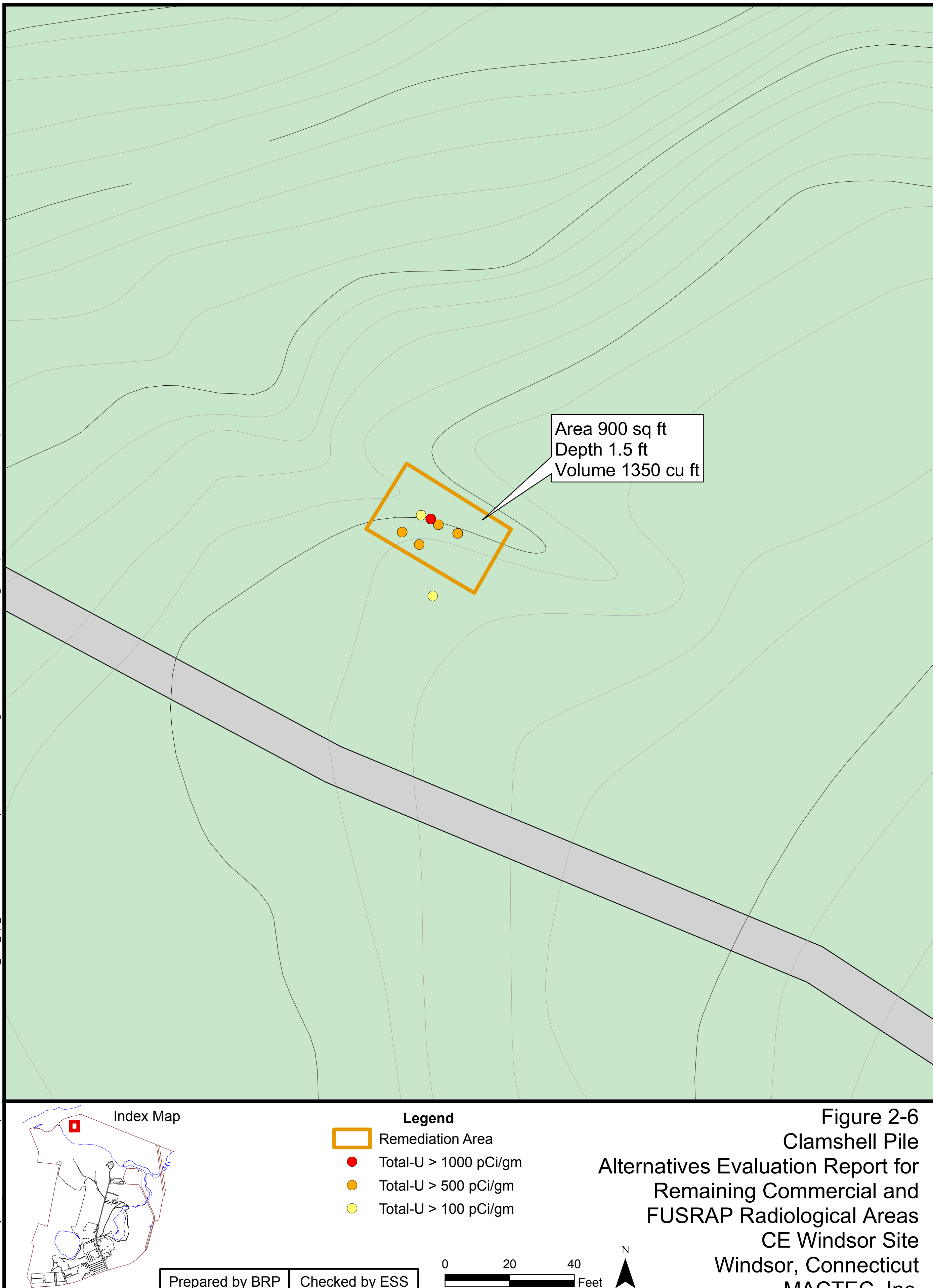


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Figure 2-6
Clamshell Pile
Alternatives Evaluation Report for
Remaining Commercial and
FUSRAP Radiological Areas
CE Windsor Site
Windsor, Connecticut
MACTEC, Inc.

# TABLES

**Table 2-1**
**Preliminary Remediation Goals for Soil and Sediment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Chemical | DCGL pCi/g | RSR Direct Exposure Criteria mg/kg | RSR GA Pollutant Mobility Criteria mg/kg | RSR GA Pollutant Mobility Criteria by TCLP/SPLP mg/L | Preliminary Remediation Goal (PRG) ** |
|---|---|---|---|---|---|
| Beryllium | Not applicable | 2 | Not applicable | 0.004 * | 0.004 mg/L in TCLP/SPLP extract |
| Cobalt-60 | 5 | Not applicable | Not applicable | Not applicable | 5 pCi/g |
| Total Uranium | 557 | Not applicable | Not applicable | Not applicable | 557 pCi/g |
| Zirconium | Not applicable | 68 | Not applicable | 0.007 * | 0.007 mg/L in TCLP/SPLP extract |
| Tetrachloroethene | Not applicable | 12 | 0.1 | Not applicable | 0.1 mg/kg |
| Benzo(a)anthracene | Not applicable | 1 | 1 | Not applicable | 1 mg/kg |
| Benzo(a)pyrene | Not applicable | 1 | 1 | Not applicable | 1 mg/kg |
| Benzo(b)fluoranthene | Not applicable | 1 | 1 | Not applicable | 1 mg/kg |
| Benzo(k)fluoranthene | Not applicable | 8.4 | 1 | Not applicable | 1 mg/kg |
| Chyrsene | Not applicable | 84 | 1 | Not applicable | 1 mg/kg |
| Dibenzo(a,h)anthracene | Not applicable | 1 | 1 | Not applicable | 1 mg/kg |
| Indeno(1,2,3-c,d)pyrene | Not applicable | 1 | 1 | Not applicable | 1 mg/kg |
| Polychlorinated Biphenyls | Not applicable | 1 | 0.0005 | Not applicable | 0.005 mg/kg |

Prepared/Date: SWR 09/04/07
Checked/Date: NW 09/06/07

**Notes**:
* Based on the 20 times rule, samples containing less than the following total concentrations of metals could not exceed the TCLP/SPLP criteria for those metals: beryllium, 0.080 mg/kg; zirconium, 0.140 mg/kg.
** = PRG is the lowest value listed for that constituent.
The Direct Exposure Criteria applies to soil from 0 to 15 feet below ground surface.
The Pollutant Mobility Criteria only applies to vadose zone soils.
DCGL = derived concentration guideline level
RSR = Remediation Standard Regulations
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
pCi/g = picoCuries per gram
SPLP = synthetic precipitation leaching procedure
TCLP = toxicity characteristic leaching procedure

**Table 2-2**
**Preliminary Remediation Goals for Groundwater**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Chemical | MCL µg/L | RSR Groundwater Protection Criteria µg/L | RSR Surface Water Protection Criteria µg/L | RSR Residential Volatilization Criteria µg/L | Preliminary Remediation Goal (PRG) *** µg/L |
|---|---|---|---|---|---|
| Tetrachloroethene | 5 | 5 | 88 | 1500 | 5 |
| Trichloroethene | 5 | 5 | 2340 | 219 | 5 |
| 1,2-Dichloroethene (total) | 70 | 70 | 830 | 5900 | 70 |
| Vinyl Chloride | 2 | 2 | 15750 | 1.6 | 1.6 |
| Manganese | 50* | 329** | 1200** | Not applicable | 329 |

Prepared/Date: SWR 09/04/07
Checked/Date: NW 09/06/07

**Notes**:
* = Secondary MCL (Non-enforceable guidelines regulating contaminants in drinking water that may cause cosmetic effects (e.g., skin or tooth discoloration) or aesthetic effects (e.g., taste, odor, or color).
** = Proposed RSR Criteria
*** = PRG is the lowest value listed for that constituent.
MCL = maximum contaminant level
RSR = Remediation Standard Regulations
µg/L = micrograms per liter

**Table 2-3**
**Screening of Groundwater Technologies**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| General Response Action | Remediation Technology | Process Option | Screening Comments | Effectiveness | Implementability | Cost | Retained |
|---|---|---|---|---|---|---|---|
| No Action | None | None | Baseline for comparison | Not effective | Implementable | No Cost | Yes |
| Institutional Controls | Access and Use Restrictions | Environmental land use restriction | Through administrative controls, restrict activity at the CE Windsor Site to limit use of the Site and exposure risk. Place deed restrictions to prohibit use of groundwater beneath the Site. | Effective. Applicable in combination with other technologies to control access and exposure if material exceeding preliminary remediation goals (PRGs) remains on site and property title is transferred | Implementable | Low | Yes |
| | Environmental Monitoring | Groundwater monitoring | Collect groundwater samples to monitor contaminant concentrations and assess future environmental impacts. | Effective. Applicable in combination with other technologies to control access and exposure if material exceeding PRGs remains on site | Implementable | Low | Yes |
| Containment | Barriers | Grout curtain | Boreholes are drilled in overburden and bedrock at a designed spacing and a high-pressure grout is injected to provide a low-permeability cutoff wall. | To be effective, would need to be combined with other technologies such as capping or groundwater extraction. | Based on groundwater contaminant concentrations and Site-specific geologic conditions, depth of the cutoff wall would be significant (i.e., greater than 40 feet). Installation could be difficult because of cobbles and boulders in dense glacial till at the Site. | Medium | No |
| | | Slurry wall | A trench is excavated in the overburden and then backfilled with a slurry, usually consisting of a soil-bentonite or cement-bentonite mixture, to provide a low-permeability cutoff wall. | To be effective, would need to be combined with other technologies such as capping or groundwater extraction. | Based on groundwater contaminant concentrations and Site-specific geologic conditions, depth of the cutoff wall would be significant (i.e., greater than 40 feet). Installation could be difficult because of cobbles and boulders in dense glacial till at the Site. | Medium | No |
| | | Sheet piling | Sheet piles are installed in the overburden to provide a low-permeability cutoff wall. The sheeting joints are typically grouted to reduce leakage in the joints. | To be effective, would need to be combined with other technologies such as capping or groundwater extraction. | Based on groundwater contaminant concentrations and Site-specific geologic conditions, depth of the cutoff wall would be significant (i.e., greater than 40 feet). Installation could be difficult because of cobbles and boulders in dense glacial till at the Site. | High | No |
| Extraction | Groundwater Pumping | Groundwater pumping | Extraction wells are installed across the flow path of a contaminated groundwater plume. Contaminated groundwater is extracted and treated to reduce contaminant concentrations. The treated groundwater is then either reinjected using infiltration trenches or reinjection wells, or discharged to a publicly owned treatment works (POTW )or nearby surface water body. | Effective. Groundwater extraction is a demonstrated technology. Would require on-Site groundwater treatment system or discharge to POTW. | Implementable. Equipment, materials, and suppliers are readily available. Would require long-term monitoring and maintenance. | Medium | Yes |

**Table 2-3**
**Screening of Groundwater Technologies**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| General Response Action | Remediation Technology | Process Option | Screening Comments | Effectiveness | Implementability | Cost | Retained |
|---|---|---|---|---|---|---|---|
| Treatment | In-Situ Treatment | Air sparging | Air is injected into the subsurface saturated zone creating an underground air stripper that removes contaminants in groundwater through volatilization. Air sparging is typically combined with soil vapor extraction (SVE) to collect contaminated vapors prior to reaching the ground surface. | Based on the lateral extent of the contaminated groundwater plume, numerous wells would be required due to the relatively small radius of influence of the air injection wells. Depth of groundwater contamination may limit the effectiveness of this technology. | Technically implementable. Would require monitoring and maintenance. | Medium | No |
| | | Passive treatment walls | A permeable reactive wall is installed across the flow path of a contaminated groundwater plume, allowing the plume to passively move through the wall. The halogenated compounds are degraded by reactions with a mixture of porous media and a metal catalyst. | Effective. | Based on groundwater contaminant concentrations and Site-specific geologic conditions, depth of the cutoff wall would be significant (i.e., greater than 40 feet). Installation could be difficult because of cobbles and boulders in dense glacial till at the Site. | Medium | No |
| | | Chemical oxidation | A liquid oxidant solution is injected into the subsurface. The solution breaks down organic contaminants into carbon dioxide and chloride ions. | Effective. Technology is well demonstrated at destroying chlorinated volatile organic compounds (VOCs) in groundwater; however, a groundwater circulation system must be created by installing extraction and injection wells. | Distribution of oxidants may be difficult in dense glacial till at the Site. Requires sophisticated equipment, proper safety controls to protect workers from injury by contact with reactants | High | No |
| | | Steam/hot air injection | Steam/hot air is injected into the subsurface to vaporize VOCs. The vaporized contaminants rise to the unsaturated zone where they can be removed with an off-gas collection system and treated, if necessary. | Effective | Implementable, but requires a substantial amount of power, as well as vapor/condensate extraction and treatment systems. More efficient, cost-effective technologies exist for groundwater. | High | No |
| | | Electric resistive heating | Conventional electricity is used for resistive heating of soil and groundwater. A voltage causes an electrical current to flow through soil and groundwater between electrodes. The aquifer temperature rises to the boiling point of water, thereby vaporizing the VOCs. Vapors are then recovered with vapor extraction systems. | Effective | Implementable, but requires a substantial amount of power, as well as vapor/condensate extraction and treatment systems. More efficient, cost-effective technologies exist for groundwater. | High | No |

**Table 2-3**
**Screening of Groundwater Technologies**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| General Response Action | Remediation Technology | Process Option | Screening Comments | Effectiveness | Implementability | Cost | Retained |
|---|---|---|---|---|---|---|---|
| | | Enhanced bioremediation | Reagents and/or nutrients (e.g., oxygen and nitrogen) are injected into the subsurface to enhance the ability of naturally occurring microorganisms to degrade organic contaminants into less toxic and non-toxic byproducts through aerobic and anaerobic degradation processes. | Technology is well demonstrated at destroying chlorinated VOCs in groundwater. Hydrogen Release Compound (HRC®) is an innovative and unique product that has been shown to achieve rapid in-situ degradation of chlorinated VOCs in groundwater. | Implementable | Medium | Yes |
| | | Monitored natural attenuation | Natural subsurface processes (e.g., biodegradation, volatilization, dilution, dispersion, sorption, and precipitation) are allowed to reduce contaminant concentrations to acceptable levels. Reduction in contaminant concentrations in groundwater is monitored by routine sampling and analysis. | Groundwater analytical data indicate that chlorinated VOCs groundwater are attenuating. Natural attenuation may be evaluated as a stand-alone remedial alternative, or in conjunction active treatment of areas of contaminated groundwater that exhibit higher concentrations of chlorinated VOCs. | Implementable | High | Yes |
| | Ex-Situ Treatment | Activated carbon | Groundwater is pumped through canisters containing granular activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required. | Effective at removing most volatile organic compounds from groundwater, but may have difficulty with vinyl chloride. Spent carbon would require special disposal, destruction, or regeneration. High concentrations of contaminants may foul the system, requiring frequent replacement or regeneration. | Implementable. | High | No |
| | | Air stripping | VOCs are removed from extracted groundwater by contacting contaminated water with large volumes of air. Contaminants are transferred from a liquid phase to a gas phase. Off-gas may require treatment to meet air regulations. | Effective. Pretreatment for inorganics in groundwater may be required to minimize fouling of the system. Air stripping is well-demonstrated and reliable technology for treatment of chlorinated VOCs. | Implementable | Medium | Yes |
| | | Ultraviolet (UV) oxidation | The simultaneous application of UV light and chemical oxidants are used to degrade (through oxidation) concentrations of organic compounds in extracted groundwater. Ozone and hydrogen peroxide have been used as chemical oxidants. | Technology provides permanent destruction of VOCs; however, presence of inorganics can adversely affect system performance. Costs generally high due to energy requirements. | Implementable | High | No |
| Disposal/Discharge | On-site Disposal | Groundwater reinjection | Treated groundwater, meeting required discharge limits, is reinjected into the subsurface using infiltration trenches or reinjection wells. | Issues with fouling of injection wells due to high inorganic concentrations. | May be difficult to obtain underground injection permit for disposal of treated groundwater. | Medium-High | No |

**Table 2-3**
**Screening of Groundwater Technologies**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| General Response Action | Remediation Technology | Process Option | Screening Comments | Effectiveness | Implementability | Cost | Retained |
|---|---|---|---|---|---|---|---|
| | | Surface water discharge | Treated groundwater, meeting required discharge limits, is discharged to a nearby surface water body. | Treated groundwater must meet applicable federal, state, and local discharge requirements. Would require significant treatment. | Would require obtaining permits for surface water discharge | Low | No |
| | Off-Site Disposal | Discharge to POTW | Contaminated groundwater is transported via pipeline to an off-Site POTW. Pretreatment may be required to meet POTW pretreatment regulations. | Effective. Groundwater must meet POTW requirements. Would require pre-treatment. | Implementable. | Low | Yes |

**Notes:**
POTW= publicly owned treatment works
PRGs = preliminary remediation goals
SVE = soil vapor extraction
UV = ultraviolet
VOCs = volatile organic compounds

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**Table 2-4**
**Screening of Soil, Sediment and Buildings Technologies**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| General Response Action | Remediation Technology | Process Option | Screening Comments | Effectiveness | Implementability | Cost | Retained |
|---|---|---|---|---|---|---|---|
| No Action | None | None | Baseline for comparison | Not effective | Implementable | No Cost | Yes |
| Institutional Controls | Access and Use Restrictions | Environmental land use restriction (Deed restrictions) | Applicable in combination with other technologies to control access and exposure if material exceeding PRGs remains on site and property title is transferred | Effective | Implementable | Low | Yes |
| | | Signs | Applicable in combination with other technologies to control access and exposure if material exceeding PRGs remains on site | Effective | Implementable | Low | Yes |
| | | Fencing | Applicable in combination with other technologies to control access and exposure if material exceeding PRGs remains on site | Effective | Implementable | Low | Yes |
| Containment | | In-place capping | A soil or composite cap would be constructed over areas with soil exceeding PRGs. Soil would be left in place, not excavated. | Effective for most areas, but not for Site Brook. | Technically implementable, but would create a patchwork of containment areas across Site. Result would be incompatible with site reuse. | Medium | No |
| | | In-place soil mixing | Soil would be imported to mix with and dilute site soils, thereby reducing potential exposure dosages. | Could not be used for Site Brook. | Technically implementable, but would create a patchwork of containment areas across Site. Result would be incompatible with site reuse. | Medium | No |
| | | Land encapsulation (on-site landfill) | Material exceeding PRGs would be consolidated in a specially constructed on-site landfill. | Effective | Potential to implement. Would require long-term monitoring and maintenance. Containment areas would require long-term monitoring and maintenance. | High | Yes |
| | | Cryogenic barrier | Refrigeration equipment used to create an ice barrier around area(s) of contamination. Requires on-going cooling. Highly energy intensive. | Not effective, would not provide shielding. | Technically implementable, but would create a patchwork of containment areas across Site. Result would be incompatible with site reuse. Would require long-term monitoring and maintenance. | High | No |
| Immobilization | Solidification/stabilization | In-situ solidification/stabilization | A solidifying agent (e.g., portland cement, asphalt, etc.) would be used to solidify material in-place. | Capping would be needed to provide shielding, therefore, no advantage over capping. | Technically implementable, but would create a patchwork of disposal areas across Site. Result would be incompatible with site reuse. Would require long-term monitoring and maintenance. | Medium | No |
| | | Ex-situ solidification/stabilization | Excavated material would be mixed with a solidifying agent (e.g., Portland cement, asphalt, etc.). Solidified/stabilized material would then require disposal. | Does not provide shielding unless combined with capping or landfilling. No advantage over capping or landfilling. | Technically implementable. Would require long-term monitoring and maintenance. | High | No |

**Table 2-4**
**Screening of Soil, Sediment and Buildings Technologies**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| General Response Action | Remediation Technology | Process Option | Screening Comments | Effectiveness | Implementability | Cost | Retained |
|---|---|---|---|---|---|---|---|
| | Vitrification | In-situ vitrification | Potential to reduce volume of contaminated media exceeding PRGs and to reduce and mobility of radionuclides. | Does not provide shielding unless combined with capping. | Technically difficult to implement. Would create a patchwork of disposal areas across Site. Result would be incompatible with site reuse. Would require long-term monitoring and maintenance. | Very high | No |
| | | Ex-situ vitrification | Potential to reduce volume of contaminated media exceeding PRGs and reduce and mobility of radionuclides. | Vitrified mass must be disposed of in landfill to provide shielding. No advantage over landfilling. | Technically difficult to implement. Would require long-term monitoring and maintenance. | Very high | No |
| Excavation | Mechanical Excavation | Mechanical excavation | Applicable in combination with other technologies. | Effective. Removes contaminated material exceeding PRGs. | Implementable. Need to protect workers with a Health and Safety Plan (HASP). | Low | Yes |
| | Dredging | Sediment removal with a dredge | Could be applicable as an alternative to excavation of sediments | Effective, although can resuspend sediments | Implementable | High | No |
| Separation | Chemical separation | Acid washing | Effectiveness and feasibility of applying to Site soils is unknown. | Effectiveness and feasibility of applying to Site soils is unknown. | Implementable, but requires sophisticated equipment, proper safety controls to protect workers from injury by contact with acid reactants | High | No |
| | Physical separation | Dry soil separation<br>Soil washing<br>Flotation | Physical separation techniques would be used to separate the soil fraction containing radioactive material from the non-radioactive fraction. Contaminated material must be disposed of. Cleaned material would be returned to site. | Effectiveness highly dependent on percentage of fines and organic content of soil. Effectiveness on Site soils and for attaining PRGs is not known | Implementable. | High | No |
| Disposal | On-site Disposal | Consolidate and cap | Place excavated soil material in a on-site landfill cell with low permeability cap and a leachate collection system. Landfill cell would function as a containment system and shield. | Effective. Would require appropriate design to prevent infiltration and leachate generation. Would prevent direct exposure and dermal contact. | Implementable, but requires administrative controls and deed restrictions on future land use of containment cell. Requires long-term monitoring and maintenance. | Medium-High | Yes |
| | Off-Site Disposal | Permitted landfill | Transport excavated material to an off-site disposal area such as EnergySolutions in Clive Utah. | Effective. | Implementable. | High | Yes |
| Buildings | Decontamination | Wiping, washing, scabbling, grit blasing, removals of systems and structures | Various decontamination techniques can be used to remove contamination from a building | Effective. | Implementable. | Medium | Yes |
| | Dismantlement | Removal of building structure | Removal of entire structure | Effective. | Implementable. | Medium | Yes |

**Notes:**
HASP = Health and Safety Plan
PRGs = preliminary remediation goals

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## Table 4-1
## Chemical-Specific ARARS for
## Alternative GW1: No Action

## Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas
## CE Windsor Site, Windsor, Connecticut

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Groundwater | Safe Drinking Water Act (SDWA) – Maximum Contaminant Levels (MCLs) (40 CFR 141.11 – 141.16) | Relevant and Appropriate | MCLs have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water. | MCLs in groundwater associated with AOCs 6, 10, and 12 will not be attained. |
| Federal | Groundwater | SDWA – Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 – 141.51) | To be Considered | MCLGs are health-based criteria to be considered for drinking water sources. MCLGs are available for several organic and inorganic contaminants. Non-zero MCLGs are to be used as goals when MCLs have not been established. | MCLs in groundwater associated with AOCs 6, 10, and 12 will not be attained. |
| State | Groundwater | Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulation (RSR) (CGS §§ 22a-133k; RCSA §§ 22a-133k-1 through 22a-133k-3) | Applicable | Remediation standards have been promulgated for several common organic and inorganic contaminants. These standards regulate the concentration of contaminants in soil and groundwater. | RSR Criteria for groundwater will not be attained. |

**Table 4-1**
**Chemical-Specific ARARS for**
**Alternative GW1: No Action**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

**Notes:**

CFR = Code of Federal Regulations

CTDEP = Connecticut Department of Environmental Protection

MCL = maximum contaminant level

MCLG = maximum contaminant level goal

RCSA = Regulations of Connecticut State Agencies

RSR = Remediation Standard Regulation

SDWA = Safe Drinking Water Act

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**Table 4-2**
**Location-Specific ARARS for**
**Alternative GW2: Enhanced In-Situ Biodegradation**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Floodplains | Floodplain Management Executive Order No. 11988 [40 Code of Federal Regulations (CFR) Part 6, App. A] | Relevant and Appropriate | Requires federal agencies to evaluate potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain. | Corrective action activities at AOC 10 will be conducted to minimize impacts on natural resources including the potential impact of flooding and erosion, and damage to and destruction of life and property. Corrective action activities at AOC 10 will also be conducted to comply with the floodplain management standards established by this regulation. |
| Federal | Wetlands | Protection of Wetlands Executive Order No. 11990 [40 CFR Part 6, App. A] | Relevant and Appropriate | Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetlands areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values. | Corrective action activities at AOC 10 will be conducted to minimize impacts on natural resources including the potential impact of flooding and erosion, and damage to and destruction of life and property. Corrective action activities at AOC 10 will also be conducted to comply with the floodplain management standards established by this regulation. |

**Table 4-2**
**Location-Specific ARARS for**
**Alternative GW2: Enhanced In-Situ Biodegradation**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Endangered Species | Endangered Species Act [16 United States Code (USC) 1531 et seq.; 40 CFR 6.302(h); 50 CFR Part 200, 50 CFR Part 402] | Applicable, if such species are encountered | This statute requires that activities be avoided that jeopardize threatened or endangered species or adversely modify habitats essential to their survival. Mitigation measures should be considered if a listed species or habitat may be jeopardized. | Although no currently listed endangered or threatened species or their nests have been identified at the site, their presence has been noted in the area. As part of the remedial action, pertinent lists will be reviewed to assess whether federally listed species may be present. During the remedial action, measures such as relocation or seasonal work limits for specific actions would be implemented to protect listed species, if any are identified. |
| State | Floodplains | Flood Management (CGS §§ 25-68b through 25-68h; RCSA §§25-68h-1 through 25-68h-3) | Applicable | This requirement regulates activities in floodplains to minimize flood risk and prevent flood hazards. RCSA § 25-68h-2 provides standards for floodplain management, including restrictions pertaining to filling, dumping, construction, excavating, and other activities that change the topography within a floodplain. | Corrective action activities at AOC 10 will be conducted to minimize impacts on natural resources including the potential impact of flooding and erosion, and damage to and destruction of life and property. Corrective action activities at AOC 10 will also be conducted to comply with the floodplain management standards established by this regulation. |
| State | Wetlands | Inland Wetlands and Watercourses Act (CGS §§ 22a-36 through 22a-45a; RCSA §§ 22a-39-1 through 22a-39-15) | Applicable | This act requires that actions be taken to protect, preserve, and maintain inland wetlands and watercourses, including protecting the quality of the wetlands and watercourses for their conservation, economic, aesthetic, recreational, and other public and private uses and values. | Corrective action activities at AOC 10 will be conducted to minimize disturbance of wetlands and watercourses, prevent loss of beneficial aquatic organisms, wildlife, and vegetation, and prevent destruction of natural habitats. |

**Table 4-2**
**Location-Specific ARARS for**
**Alternative GW2: Enhanced In-Situ Biodegradation**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

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**Notes:**

CGS = Connecticut General Statute

CFR = Code of Federal Regulations

USC = United States Code

RCSA = Regulations of Connecticut State Agencies

## Table 4-3
## Chemical-Specific ARARS for
## Alternative GW2: Enhanced In-Situ Biodegradation

## Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas
## CE Windsor Site, Windsor, Connecticut

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Groundwater | Safe Drinking Water Act (SDWA) – Maximum Contaminant Levels (MCLs) (40 CFR 141.11 – 141.16) | Relevant and Appropriate | MCLs have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water. | MCLs in groundwater associated with AOCs 6, 10, and 12 will be attained within the area designated by the CTDEP as a GA groundwater area. |
| Federal | Groundwater | SDWA – Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 – 141.51) | To be Considered | MCLGs are health-based criteria to be considered for drinking water sources. MCLGs are available for several organic and inorganic contaminants. Non-zero MCLGs are to be used as goals when MCLs have not been established. | When MCLs have not been established, non-zero MCLGs in groundwater associated with AOCs 6, 10, and 12 will be attained within the area designated by the CTDEP as a GA groundwater area. |
| State | Groundwater | Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulation (RSR) (CGS §§ 22a-133k; RCSA §§ 22a-133k-1 through 22a-133k-3) | Applicable | Remediation standards have been promulgated for several common organic and inorganic contaminants. These standards regulate the concentration of contaminants in soil and groundwater. | The corrective action alternative will be designed and implemented to provide a reduction in groundwater contaminant concentrations to achieve applicable RSR Criteria. |

**Table 4-3**
**Chemical-Specific ARARS for**
**Alternative GW2: Enhanced In-Situ Biodegradation**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

**Notes:**

CFR = Code of Federal Regulations

CTDEP = Connecticut Department of Environmental Protection

MCL = maximum contaminant level

MCLG = maximum contaminant level goal

RCSA = Regulations of Connecticut State Agencies

RSR = Remediation Standard Regulation

SDWA = Safe Drinking Water Act

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# Table 4-4
# Action-Specific ARARS for
# Alternative GW2: Enhanced In-Situ Biodegradation

## Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas
## CE Windsor Site, Windsor, Connecticut

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Underground injection of liquids | SDWA Underground Injection Control (UIC) Program (40 CFR Parts 144, 146, and 147 Subpart H) | Applicable | These regulations outline minimum program and performance standards for underground injection programs. Technical criteria and standards for siting, operation, and maintenance, closure, and reporting and recordkeeping as required for permitting are set forth in Part 146. | Corrective action alternatives involving injection wells will be implemented in accordance with the criteria and standards set forth in these regulations. |
| State | Discharge to surface water | Water Pollution Control Act (CGS §§ 22a-416 through 22a-438; RCSA §§ 22a-430-1 through 22a-430-7) | Applicable | This act requires permits for any discharge of water, substance, or material into the waters of the state. | Contaminated surface water, groundwater, or dewatering fluids encountered during corrective action activities will be containerized and either treated on-Site prior to discharge to surface water, or routed through an off-Site POTW. These activities will be conducted in accordance with the requirements of this act (e.g., monitoring requirements and discharge limitations). |
| State | Installation and abandonment of nonwater supply wells | Regulations for the Well Drilling Industry (CGS §§ 25-126 through 131; RCSA §§ 25-126 through 25-131) | Applicable | These regulations specify that non-water supply wells must be constructed so that they are not a source or cause of groundwater contamination. These regulations also include procedures for abandonment of both water wells and other types or wells. | The installation and abandonment of any injection, extraction, or monitoring wells associated with corrective action activities will be conducted in accordance with these regulations. |

**Table 4-4**
**Action-Specific ARARS for**
**Alternative GW2: Enhanced In-Situ Biodegradation**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Spill incident | Report of Discharge, Spill, Loss, Seepage, or Filtration [CGS 22a-450] | Applicable | This statute requires that discharge, spillage, uncontrolled loss, seepage or filtration of oil or petroleum or chemical liquids or solid, liquid or gaseous products or hazardous wastes be immediately reported to the CTDEP | The discharge, spill, loss, seepage, or filtration of material will be reported as required by this statute. |
| State | Performing activities with potential to cause erosion and sedimentation | Guidelines for Soil Erosion and Sediment Control; The Connecticut Council on Soil and Water Conservation | To be Considered | These guidelines provide technical and administrative guidance for the development, adoption, and implementation of erosion and sediment control program. | These guidelines will be incorporated into any remedial action activities. Erosion and sediment control measures will be implemented during remedial action activities. |

**Notes:**

CAA = Clean Air Act

CFR = Code of Federal Regulations

CGS = Connecticut General Statute

CTDEP = Connecticut Department of Environmental Protection

CWA = Clean Water Act

NESHAP = National Emission Standards for Hazardous Air Pollutants

POTW = Publicly Owned Treatment Works

RCRA = Resource Conservation and Recovery Act

RCSA = Regulations of Connecticut State Agencies

UIC = Underground Injection Control

USC = United States Code

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**Table 4-5**
**Cost Summary for Alternative GW2**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| ITEM | | COST |
|---|---|---|
| DIRECT CAPITAL COSTS | | |
| 1 | Pre-Design Investigations | $25,000 |
| 2 | Full Scale System | $268,000 |
| 3 | Adminstrative Costs | $110,000 |
| | Direct Cost Subtotal | $403,000 |
| INDIRECT CAPITAL COSTS | | |
| 1 | Heath and Safety | $5,000 |
| 2 | Legal, Admin, Permitting | $5,000 |
| 3 | Engineering | $24,000 |
| | Indirect Cost Subtotal | $34,000 |
| **TOTAL CAPITAL COSTS** | | **$437,000** |
| ANNUAL OPERATION AND MAINTENANCE COSTS | | |
| 1 | Performance Monitoring Year 1 | $95,000 |
| 2 | Performance Monitoring Year 2 | $49,000 |
| 3 | HRC Implementation and Performance Monitoring Year 3 | $363,000 |
| 4 | Long-Term Monitoring Years 4-5 | $48,588 |
| **PRESENT WORTH OF ANNUAL AND PERIODIC COSTS (5 yrs) *** | | **$499,000** |
| **TOTAL PRESENT WORTH OF ALTERNATIVE GW2 (5 yrs) *** | | **$936,000** |
| **TOTAL NON-DISCOUNTED COST OF ALTERNATIVE GW2 (5 yrs) *** | | **$992,588** |

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**Table 4-6**
**Location-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Floodplains | Floodplain Management Executive Order No. 11988 [40 Code of Federal Regulations (CFR) Part 6, App. A] | Relevant and Appropriate | Requires federal agencies to evaluate potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain. | Corrective action activities at AOC 10 will be conducted to minimize impacts on natural resources including the potential impact of flooding and erosion, and damage to and destruction of life and property. Corrective action activities at AOC 10 will also be conducted to comply with the floodplain management standards established by this regulation. |
| Federal | Wetlands | Protection of Wetlands Executive Order No. 11990 [40 CFR Part 6, App. A] | Relevant and Appropriate | Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetlands areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values. | Corrective action activities at AOC 10 will be conducted to minimize impacts on natural resources including the potential impact of flooding and erosion, and damage to and destruction of life and property. Corrective action activities at AOC 10 will also be conducted to comply with the floodplain management standards established by this regulation. |

**Table 4-6**
**Location-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Endangered Species | Endangered Species Act [16 United States Code (USC) 1531 et seq.; 40 CFR 6.302(h); 50 CFR Part 200, 50 CFR Part 402] | Applicable, if such species are encountered | This statute requires that activities be avoided that jeopardize threatened or endangered species or adversely modify habitats essential to their survival. Mitigation measures should be considered if a listed species or habitat may be jeopardized. | Although no currently listed endangered or threatened species or their nests have been identified at the site, their presence has been noted in the area. As part of the remedial action, pertinent lists will be reviewed to assess whether federally listed species may be present. During the remedial action, measures such as relocation or seasonal work limits for specific actions would be implemented to protect listed species, if any are identified. |
| State | Floodplains | Flood Management (CGS §§ 25-68b through 25-68h; RCSA §§25-68h-1 through 25-68h-3) | Applicable | This requirement regulates activities in floodplains to minimize flood risk and prevent flood hazards. RCSA § 25-68h-2 provides standards for floodplain management, including restrictions pertaining to filling, dumping, construction, excavating, and other activities that change the topography within a floodplain. | Corrective action activities at AOC 10 will be conducted to minimize impacts on natural resources including the potential impact of flooding and erosion, and damage to and destruction of life and property. Corrective action activities at AOC 10 will also be conducted to comply with the floodplain management standards established by this regulation. |
| State | Wetlands | Inland Wetlands and Watercourses Act (CGS §§ 22a-36 through 22a-45a; RCSA §§ 22a-39-1 through 22a-39-15) | Applicable | This act requires that actions be taken to protect, preserve, and maintain inland wetlands and watercourses, including protecting the quality of the wetlands and watercourses for their conservation, economic, aesthetic, recreational, and other public and private uses and values. | Corrective action activities at AOC 10 will be conducted to minimize disturbance of wetlands and watercourses, prevent loss of beneficial aquatic organisms, wildlife, and vegetation, and prevent destruction of natural habitats. |

**Table 4-6**
**Location-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

**Notes:**

CGS = Connecticut General Statute

CFR = Code of Federal Regulations

USC = United States Code

RCSA = Regulations of Connecticut State Agencies

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**Table 4-7**
**Chemical-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Groundwater | Safe Drinking Water Act (SDWA) – Maximum Contaminant Levels (MCLs) (40 CFR 141.11 – 141.16) | Relevant and Appropriate | MCLs have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water. | MCLs in groundwater associated with AOCs 6, 10, and 12 will be attained within the area designated by the CTDEP as a GA groundwater area. |
| Federal | Groundwater | SDWA – Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 – 141.51) | To be Considered | MCLGs are health-based criteria to be considered for drinking water sources. MCLGs are available for several organic and inorganic contaminants. Non-zero MCLGs are to be used as goals when MCLs have not been established. | When MCLs have not been established, non-zero MCLGs in groundwater associated with AOCs 6, 10, and 12 will be attained within the area designated by the CTDEP as a GA groundwater area. |
| State | Groundwater | Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulation (RSR) (CGS §§ 22a-133k; RCSA §§ 22a-133k-1 through 22a-133k-3) | Applicable | Remediation standards have been promulgated for several common organic and inorganic contaminants. These standards regulate the concentration of contaminants in soil and groundwater. | The corrective action alternative will be designed and implemented to provide a reduction in groundwater contaminant concentrations to achieve applicable RSR Criteria. |

**Table 4-7**
**Chemical-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

**Notes:**

CFR = Code of Federal Regulations

CTDEP = Connecticut Department of Environmental Protection

MCL = maximum contaminant level

MCLG = maximum contaminant level goal

RCSA = Regulations of Connecticut State Agencies

RSR = Remediation Standard Regulation

SDWA = Safe Drinking Water Act

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**Table 4-8**
**Action-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Generating emissions from process vents | Resource Conservation and Recovery Act (RCRA) Air Emissions Standards for Process Vents (40 Code of Federal Regulations (CFR) 264, Subpart AA) | Applicable | This rule contains pollution emission standards for process vents associated with distillation, fractionation, thin film extraction, or air or steam stripping. This rule is applicable to operations that manage hazardous wastes with organic concentrations of at least 10 parts per million by weight. | If air stripping is selected as a treatment method and it involves management of hazardous waste with organic concentrations of at least 10 parts per million by weight in off-gases, equipment used in corrective action activities will meet these standards and be monitored for compliance. |
| Federal | Discharge to a Publicly Owned Treatment Works (POTW) | Clean Water Act (CWA) National Pretreatment Standards (40 CFR Part 403) | Applicable | This regulation sets pretreatment standards for the introduction of pollutants from non-domestic sources into POTWs. These regulations are designed to control pollutants that pass through, cause interference, or are otherwise incompatible with treatment processes at a POTW. | Any discharge of treated surface water, groundwater, or dewatering fluids that goes to an off-Site POTW will meet discharge limitations and pretreatment requirements imposed on POTWs. |
| State | Discharge to surface water | Water Pollution Control Act (CGS §§ 22a-416 through 22a-438; RCSA §§ 22a-430-1 through 22a-430-7) | Applicable | This act requires permits for any discharge of water, substance, or material into the waters of the state. | Contaminated surface water, groundwater, or dewatering fluids encountered during corrective action activities will be containerized and either treated on-Site prior to discharge to surface water, or routed through an off-Site POTW. These activities will be conducted in accordance with the requirements of this act (e.g., monitoring requirements and discharge limitations). |

**Table 4-8**
**Action-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Installation and abandonment of nonwater supply wells | Regulations for the Well Drilling Industry (CGS §§ 25-126 through 131; RCSA §§ 25-126 through 25-131) | Applicable | These regulations specify that non-water supply wells must be constructed so that they are not a source or cause of groundwater contamination. These regulations also include procedures for abandonment of both water wells and other types or wells. | The installation and abandonment of any injection, extraction, or monitoring wells associated with corrective action activities will be conducted in accordance with these regulations. |
| State | Spill incident | Report of Discharge, Spill, Loss, Seepage, or Filtration [CGS 22a-450] | Applicable | This statute requires that discharge, spillage, uncontrolled loss, seepage or filtration of oil or petroleum or chemical liquids or solid, liquid or gaseous products or hazardous wastes be immediately reported to the CTDEP | The discharge, spill, loss, seepage, or filtration of material will be reported as required by this statute. |
| State | Performing activities with potential to cause erosion and sedimentation | Guidelines for Soil Erosion and Sediment Control; The Connecticut Council on Soil and Water Conservation | To be Considered | These guidelines provide technical and administrative guidance for the development, adoption, and implementation of erosion and sediment control program. | These guidelines will be incorporated into any remedial action activities. Erosion and sediment control measures will be implemented during remedial action activities. |

**Table 4-8**
**Action-Specific ARARS for**
**Alternative GW3: Groundwater Extraction and Treatment**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

**Notes:**

CAA = Clean Air Act

CFR = Code of Federal Regulations

CGS = Connecticut General Statute

CTDEP = Connecticut Department of Environmental Protection

CWA = Clean Water Act

NESHAP = National Emission Standards for Hazardous Air Pollutants

POTW = Publicly Owned Treatment Works

RCRA = Resource Conservation and Recovery Act

RCSA = Regulations of Connecticut State Agencies

UIC = Underground Injection Control

USC = United States Code

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**Table 4-9**
**Cost Summary for Alternative GW3**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| ITEM | COST |
|---|---|
| DIRECT CAPITAL COSTS | |
| 1 Mobilization | $13,338 |
| 2 Pre-Design Investigations | $12,099 |
| 3 System Construction | $452,558 |
| 4 Adminstrative Costs | $10,831 |
| Direct Cost Subtotal | $488,826 |
| INDIRECT CAPITAL COSTS | |
| 1 Heath and Safety | $1,610 |
| 2 Legal, Admin, Permitting | $1,610 |
| 3 Engineering | $20,608 |
| 4 Services During Construcation | $13,685 |
| 5 Contractor Mark-up | $48,883 |
| Indirect Cost Subtotal | $86,396 |
| **TOTAL CAPITAL COSTS** | **$575,222** |
| ANNUAL OPERATION AND MAINTENANCE COSTS | |
| 1 Treatment System Operation: 30 Years | $1,940,520 |
| 2 System Effectiveness Monitoring: 30 Years | $213,795 |
| 3 Well Repair/Replacement | $81,417 |
| **PRESENT WORTH OF ANNUAL AND PERIODIC COSTS (30 yrs)** | **$918,344** |
| **TOTAL PRESENT WORTH OF ALTERNATIVE GW3 (30 yrs)** | **$1,493,566** |
| **TOTAL NON-DISCOUNTED COST OF ALTERNATIVE GW3 (30 yrs)** | **$2,810,954** |

Prepared/Date ESS 09/05/07
Check/Date NW 09/06/07

## Table 4-10
## Chemical-Specific ARARS for
## Alternative SS1: No Action

## Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas
## CE Windsor Site, Windsor, Connecticut

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Various | Nuclear Regulatory Commission (NRC) Radiological Criteria for License Termination [10 Code of Federal regulations (CFR) Part 20, Subpart E] | Applicable | Under this rule, a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mRem per year and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). | No action will be taken to prevent dosages exceeding 25 mRem per year. |
| State | Soil, Goundwater, Surface water, and Soil vapor. | Regulations of Connecticut State Agencies (RCSA) Remediation Standard Regulations (RSRs) [RCSA §§ 22a-133k-1 et seq.] | Applicable | These regulations provide numeric standards for remediation of a wide variety of contaminants in soil, groundwater, surface water, and soil vapor.<br>The State of Connecticut has established a 19 mRem per year dose standard as a cleanup target for radiologically contaminated sites. | No action will be taken to attain the 19 mRem per year dose standard or chemical toxicity criteria. |

**Notes:**

ALARA = as low as reasonably achievable

CFR = Code of Federal Regulations

FR = Federal Register

NRC = Nuclear Regulatory Commission

RCSA = Regulations of Connecticut State Agencies

RSR = Remediation Standard Regulations

TEDE = total effective dose equivalent

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**Table 4-11**
**Location-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Floodplains | Floodplain Management Executive Order No. 11988 [40 Code of Federal Regulations (CFR) Part 6, App. A] | Relevant and Appropriate | Requires federal agencies to evaluate potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain. | There is no practicable alternative that would have a less adverse impact on floodplains. Appropriate federal and state agencies would be contacted and allowed to review the proposed work plan for the response action within Site Brook prior to implementation of the action. Response actions would be scheduled and designed to minimize harm to floodplains to the extent practicable, and any adverse impacts would be mitigated through floodplain restoration. |
| Federal | Wetlands | Protection of Wetlands Executive Order No. 11990 [40 CFR Part 6, App. A] | Relevant and Appropriate | Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetlands areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values. | There is no practicable alternative that would have a less adverse impact on wetlands. Appropriate federal and state agencies would be contacted and allowed to review the proposed work plan for the response action within Site Brook prior to implementation of the action. Response actions would be scheduled and designed to minimize harm to wetlands to the extent practicable, and any adverse impacts would be mitigated through wetland restoration. |

**Table 4-11**
**Location-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Navigable Waters | Rivers and Harbors Act of 1899 [33 United States Code (USC) 403 et seq.; 33 CFR Parts 320-323] | Relevant and Appropriate | Section 10 of the Rivers and Harbors Act of 1899 requires that the construction of any structure in or over any "navigable water of the U.S." including the excavation from or deposition of material in such waters, or any obstruction of alteration in such waters, obtain authorization from the Secretary of the Army acting through the U.S. Army Corps of Engineers. | Site activities will be designed and implemented to avoid obstruction and minimize alteration of navigable waters. Disturbed areas will be restored. |
| Federal | Endangered Species | Endangered Species Act [16 (USC) 1531 et seq.; 40 CFR 6.302(h); 50 CFR Part 200, 50 CFR Part 402] | Applicable, if such species are encountered | This statute requires that activities be avoided that jeopardize threatened or endangered species or adversely modify habitats essential to their survival. Mitigation measures should be considered if a listed species or habitat may be jeopardized. | Although no currently listed endangered or threatened species or their nests have been identified at the site, their presence has been noted in the area. As part of the remedial action, pertinent lists will be reviewed to assess whether federally listed species may be present. During the remedial action, measures such as relocation or seasonal work limits for specific actions would be implemented to protect listed species, if any are identified. |
| Federal | Surface Waters | Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Section 6.302(g); 33 CFR Part 320] | Applicable | Requires that the U.S. Fish and Wildlife Service and National Marine Fisheries Service be consulted prior to structural modification of any stream or other water body (i.e., wetland). It also requires adequate protection of fish and wildlife resources. Requires consultation with state agencies to develop measures to prevent, mitigate, or compensate for project-related | This alternative would include excavation within Site Brook. No practicable alternative to this action exists. Actions taken would minimize adverse impacts to fish and wildlife. Relevant federal and state agencies would be contacted and allowed to review the proposed work plan for the response action prior to implementation of the action. |

# Table 4-11
# Location-Specific ARARS for
# Alternative SS2: Excavation and Disposal in On-Site Landfill

## Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas
## CE Windsor Site, Windsor, Connecticut

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| | | | | losses to fish and wildlife. | |
| State | Floodplains | Regulations of Connecticut State Agencies (RCSA) Floodplain Management Standards [RCSA 25-68h-2] | Applicable to Site Brook excavation | These rules address restrictions for structures within floodplains, restrictions for filling or excavating within floodplains, and storage of materials and equipment within floodplains. | This alternative would include excavation within Site Brook. No practicable alternative to this action exists. Actions taken would minimize adverse impacts to floodplains of the brook. Relevant state agencies would be contacted and allowed to review the proposed work plan for the response action prior to implementation of the action |
| State | Wetlands | Wetland Requirements [RCSA 22a-39] | Applicable to Site Brook excavation | These rules regulate the following activities within a wetland: removal of materials, deposition of materials, and construction or alteration within such areas. Under these rules, wetlands are defined to include soil types designated as floodplains. | This alternative would include excavation within Site Brook. No practicable alternative to this action exists. Actions taken would minimize adverse impacts to wetlands and floodplains of the brook. Relevant state agencies would be contacted and allowed to review the proposed work plan for the response action prior to implementation of the action. |

**Notes:**

CFR = Code of Federal Regulations

USC = United States Code

RCSA = Regulations of Connecticut State Agencies

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**Table 4-12**
**Chemical-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Various | Nuclear Regulatory Commission (NRC) Radiological Criteria for License Termination [10 Code of Federal regulations (CFR) Part 20, Subpart E] | Applicable | Under this rule, a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mRem per year and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). | This alternative includes excavation of soil and sediment at FUSRAP areas that exceed Preliminary Remediation Goals based on a 19 mRem per year dosage, a level considered ALARA. Excavated material will be consolidated in an on-site containment cell designed and constructed to prevent dosages exceeding 25 mRem per year. |
| Federal | Soils, Sediments and Building Materials | Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) [NUREG 1575] | To be considered | Provides guidance on the performance of Final Status Surveys. | Final Status Surveys will be conducted at the Site in accordance with MARSSIM. |
| State | Soil, Goundwater, Surface water, and Soil vapor. | Regulations of Connecticut State Agencies (RCSA) Remediation Standard Regulations (RSRs) [RCSA §§ 22a-133k-1 et seq.] | Applicable | These regulations provide numeric standards for remediation of a wide variety of contaminants in soil, groundwater, surface water, and soil vapor.<br>The State of Connecticut has established a 19 mRem per year dose standard as a cleanup target for radiologically contaminated sites. | This alternative will be designed and implemented to provide a reduction in soil contaminant concentrations to achieve the RSRs criteria.<br>This alternative will be designed and implemented to attain the 19 mRem per year dose standard. |

**Table 4-12**
**Chemical-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

**Notes:**

ALARA = as low as reasonably achievable

CFR = Code of Federal Regulations

FR = Federal Register

NRC = Nuclear Regulatory Commission

RCSA = Regulations of Connecticut State Agencies

RSR = Remediation Standard Regulations

TEDE = total effective dose equivalent

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**Table 4-13**
**Action-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Identification of hazardous waste | Resource Conservation and Recovery Act (RCRA) Identification and Listing of Hazardous Waste [40 Code of Federal Regulations (CFR) Part 260/261; incorporated by reference at RCSA 22a-449c-101] | Applicable | These requirements identify the conditions under which a waste would be considered hazardous (i.e., an F-, P-, K-, U-, or D- listed waste). These requirements also provide the maximum concentrations of contaminants for which the waste would be a RCRA characteristic waste because of its toxicity. The analytical test set out in Appendix II of 40 CFR Part 261 is referred to as the Toxicity Characteristic Leaching Procedure. | Removed material will be assessed to determine whether it should be handled as hazardous waste |
| Federal | Generation of hazardous waste | RCRA Standards Applicable to Generators of Hazardous Waste [40 CFR Part 262] | Applicable | Connecticut has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. The relevant and appropriate provisions of 40 CFR Part 262 are incorporated by reference. | Because this alternative involves the excavation of material potentially classified as RCRA-listed or RCRA-characteristic wastes, such materials would need to be handled in compliance with the substantive requirements of these standards. |
| Federal | Storage of hazardous waste in containers. | RCRA Container Storage Requirements [40 CFR Part 264, Subpart I] | Applicable | These regulations apply to owners and operators who store hazardous wastes in containers. | If containers are used to store materials that are hazardous wastes, the containers will be managed according to these rules. |
| Federal | Transport and disposal of hazardous waste | RCRA Manifest System, Record keeping, and Reporting [40 CFR Part 264, Subpart E] | Applicable | This regulation outlines the requirements to track hazardous waste activities, including the manifest system, operating records, and reporting. | Remedial action activities will be conducted to comply with the facility's requirements in accordance with this regulation. |

**Table 4-13**
**Action-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Transportation of hazardous waste | RCRA Standards Applicable to Transporters Of Hazardous Waste [40 CFR Part 263] | Applicable | These regulations establish procedures to be followed when transporting manifested hazardous waste within the United States. | Transporters of hazardous waste for off-Site treatment and/or disposal will comply with these requirements. |
| Federal | Generation of air emissions at NRC licensed facilities | Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) [40 CFR Part 61, Subpart I] | Applicable | Subpart I provides emission standards for NRC-licensed facilities. 40 CFR § 61.102 specifies that a member of the general public shall not be exposed to emissions of radionuclides to ambient air in excess of an effective dose equivalent of 10 mRem per year. | Remedial actions will be conducted in accordance with these requirements. |
| Federal | Demolition of structures with asbestos containing material | CAA National Emission Standards for Hazardous Air Pollutants [40 CFR Part 61, Subpart M] | Applicable | This requirement provides emission standards for specific pollutants for which no ambient air quality standard exists. NESHAPs have been promulgated for specific source types emitting certain pollutants, including asbestos. Subpart M establishes standards for inactive waste disposal sites and disposal of asbestos-containing material from demolition and renovation operations (40 CFR § 61.145). | Demolition activities involving asbestos-containing material will be conducted in accordance with these requirements. |
| Federal | Cleanup and disposal of PCB remediation waste | Toxic Substances Control Act (TSCA) Polychlorinated Biphenyl (PCB) Remediation Waste [40 CFR Part 761.61] | Applicable | Provides cleanup and disposal options for PCB remediation waste. | Cleanup and disposal of PCB remediation waste resulting from the remedial action will be conducted in accordance with these requirements. |

# Table 4-13
# Action-Specific ARARS for
# Alternative SS2: Excavation and Disposal in On-Site Landfill

## Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas
## CE Windsor Site, Windsor, Connecticut

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Decontamination and Decommissioning | NMSS Consolidated Decommissioning Guidance [NUREG 1757] | To Be Considered | Provides guidance to licensees, identifies techniques and criteria to be used in decommissioning, and provides acceptable methods for implementing specific parts of the NRC's regulations. | NUREG 1757 is not a regulation and therefore compliance with the NuReg is not required. However, this guidance will be considered in design and implementation of the remedial action. |
| Federal | Radiological remediation | U.S. Nuclear Regulatory Commission (NRC)/U.S. Army Corps of Engineers (USACE) Memorandum of Understanding (MOU) | To Be Considered | The MOU addresses unrestricted releases under 10 CFR 20.1402 to ensure that the criteria of the License Termination Rule or a more stringent requirement will be met. The MOU assists to reduce unnecessary burden on stakeholders and avoid duplication of regulatory requirements and effort by setting cooperative conditions, consistent with the protection of public health and safety. | The agencies cooperate and share data and reports in order to meet statutory requirements. Site remediation must be conducted to achieve radiological criteria for unrestricted use of the NRC's License termination Rule. |
| Federal | Discharge to surface water | Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) (40 CFR Parts 122, 125, 131, and 136) | Applicable | This rule requires permits for the discharge of pollutants from any point source into U.S. waters. | Contaminated surface water, groundwater, or dewatering fluids encountered during corrective action activities will be containerized and either treated on-Site prior to discharge to surface water, or routed through an off-Site POTW. Effluent will meet the POTW discharge limitations, monitoring requirements, and best management practices. |
| State | Disposal of demolition waste | CTDEP Solid Waste Management [CGS Title 22a Chapter 446d § 208x; RCSA § 22a-209] | Relevant and Appropriate | This regulation specifies that demolition waste may be disposed of at any solid waste disposal facility that has a permit for bulky waste, or at a municipal solid waste facility. | Demolition waste not contaminated with hazardous substances will be disposed in accordance with these requirements. |

**Table 4-13**
**Action-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Management of hazardous waste | CTDEP Hazardous Waste Management [CGS §§ 22a-454 and 22a-449(c); RCSA §§ 22a-449(c)-100 through 110 and 22a-449(c)-11] | Relevant and Appropriate | This regulation specifies requirements for the design, operation, and closure of hazardous waste disposal facilities. This regulation incorporates by reference the RCRA requirements for hazardous waste facilities. | Remedial action activities will meet the minimum standards of this regulation. |
| State | Land-disposal of hazardous wastes | RCRA Land Disposal Restrictions [40 CFR Part 268.7 incorporated by reference at RCSA 22a-449c-108] | Applicable | Certain restricted wastes are prohibited from land disposal unless treated to specified standards. These regulations state that a generator must determine whether or not a waste is one that is restricted from land disposal, and whether or not the waste meet the treatment standard. The generator must notify the disposal facility of these findings. | The potential exists for wastes removed from Drum Burial Pit, Clamshell Area, and Site Brook study areas to be RCRA-characteristic wastes. Some wastes, if classified, may be prohibited from land disposal without prior treatment. If so, appropriate treatment would need to be applied in accordance with these regulations prior to ultimate disposal of these materials. |
| State | Soil remediation | RCSA Remediation Standard Regulations [RCSA 22a-1 33k-2] | Applicable | The state standards for soil remediation regulate the remediation of polluted soil at release area. The standards specify the criteria that must be met in terms of direct exposure and pollutant mobility, including engineered controls. | Components of this alternative relating to construction of a containment cell will be performed in accordance with the regulations. As such, any soil exceeding these criteria will be physically isolated. |

**Table 4-13**
**Action-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Excavation within Site Brook | RCSA Water Quality Standards [CGS 22a-426, et seq.] | Applicable | These state water quality standards prohibit discharge of radioactive materials in concentrations that would be harmful to human health or the environment. These standards also specify that sediments are to be free of pollutants that unduly affect the bottom of a stream or that interfere with propagation and habitats of fish and wildlife. | Components of this alternative relating to excavation of sediment within Site Brook will be carried out in compliance with these regulations, such that surface water and sediments remain in compliance with water quality standards. |
| State | Discharge to surface water | Water Pollution Control Act (CGS §§ 22a-416 through 22a-438; RCSA §§ 22a-430-1 through 22a-430-7) | Applicable | This act requires permits for any discharge of water, substance, or material into the waters of the state. | Contaminated surface water, groundwater, or dewatering fluids encountered during corrective action activities will be containerized and either treated on-Site prior to discharge to surface water, or routed through an off-Site POTW. These activities will be conducted in accordance with the requirements of this act (e.g., monitoring requirements and discharge limitations). |
| State | Generation of fugitive dust air emissions | Abatement of Air Pollution [CGS Title 22a, Chapter 446c; RCSA §§ 22a-174-1, et seq.] | Applicable | These regulations require permits to construct and to operate specified types of emission sources and contain emission standards that must be met prior to issuance of a permit. Pollutant abatement controls may be required. Specific standards pertain to fugitive dust (RCSA § 22a-174-18(b)) and control of odors (RCSA § 22a-174-23) | Emission standards for fugitive dust will be met with dust control measures during the remedial actions to comply with substantive requirements. |

**Table 4-13**
**Action-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Asbestos removal | CT Standards for Asbestos Abatement [CGS Title 19a Chapter 368L; RCSA §§ 19a-332a-5 and 19a-332a-7] | Applicable | RCSA § 19a-332a-5 establishes general requirements for asbestos abatement projects, such as posted signs, shutdown of HVAC systems, isolation from non-work areas, and other measures.<br>RCSA § 19a-332a-7 establishes specific requirements for asbestos removal, such as wetting, removing components intact where possible, decontaminating equipment, and other measures. | Asbestos abatement will be conducted in accordance with the requirements of these regulations. |
| State | Generation of noise | Noise Pollution Control Act [CGS § 22a-69; RCSA §§ 22a-69-1 through 69-7.4] | Applicable | These regulations establish allowable noise levels. | Remedial actions will be conducted to comply with these regulations. |
| State | Encountering significant environmental hazards while sampling | Reporting of Certain Significant Environmental Hazards by Owners of Contaminated Real Property [CGS 22a-6u] | Applicable | Requires reporting to the property owner, the client, the Commissioner, and, in some case, the local fire department when certain conditions are encountered by a technician collecting soil, water, vapor, or air samples for the purpose of remediating sources of pollution to waters of the state. | If significant environmental hazards are encountered during collection of samples, the will be reported to the Connecticut department of Environmental protection s required by this regulation. |
| State | Spill incident | Report of Discharge, Spill, Loss, Seepage, or Filtration [CGS 22a-450] | Applicable | This statute requires that discharge, spillage, uncontrolled loss, seepage or filtration of oil or petroleum or chemical liquids or solid, liquid or gaseous products or hazardous wastes be immediately reported to the CTDEP | The discharge, spill, loss, seepage, or filtration of material will be reported as required by this statute. |

**Table 4-13**
**Action-Specific ARARS for**
**Alternative SS2: Excavation and Disposal in On-Site Landfill**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Performing activities with potential to cause erosion and sedimentation | Guidelines for Soil Erosion and Sediment Control; The Connecticut Council on Soil and Water Conservation | To be Considered | These guidelines provide technical and administrative guidance for the development, adoption, and implementation of erosion and sediment control program. | These guidelines will be incorporated into any remedial action activities. Erosion and sediment control measures will be implemented during remedial action activities. |

**Notes:**

CAA = Clean Air Act

CFR = Code of Federal Regulations

CGS = Connecticut General Statute

CTDEP = Connecticut Department of Environmental Protection

CWA = Clean Water Act

DCGL = Derived Concentration Guidance Levels

NESHAP = National Emission Standards for Hazardous Air Pollutants

NPDES = National Pollutant Discharge Elimination System

POTW = Publicly Owned Treatment Works

RCRA = Resource Conservation and Recovery Act

RCSA = Regulations of Connecticut State Agencies

TSCA = Toxic Substances Control Act

USC = United States Code

Prepared/Date: SWR 09/04/07
Checked/Date: NW 09/06/07

**Table 4-14**
**Cost Summary for Alternative SS2**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| ITEM | | COST |
|---|---|---|
| DIRECT CAPITAL COSTS | | |
| 1 Building 3 and 6 Building Demolition and Surrounding Soil Remediation | | |
| | Project Execution Costs | $7,356,477 |
| 2 Waste Storage Pad | | |
| | Project Execution Costs | $3,964,703 |
| 3 Equipment Storage Yard | | |
| | Project Execution Costs | $250,000 |
| 4 Industrial Drain Lines | | |
| | Project Execution Costs | $5,175,284 |
| 5 Site Brook and Debris Piles | | |
| | Project Execution Costs | $9,135,464 |
| 6 Drum Burial Pit | | |
| | Project Execution Costs | $1,469,019 |
| 7 Clamshell Area | | |
| | Project Execution Costs | $325,753 |
| 8 On-Site Landfill Cell Construction | | |
| | Project Execution Costs | $10,340,830 |
| Direct Cost Subtotal | | $38,017,530 |
| Contingency Cost (@10 Percent) | | $3,801,753 |
| Direct and Contingency Cost Subtotal | | $41,819,283 |
| INDIRECT CAPITAL COSTS | | |
| Oversight/Radiological Support (@ 10 Percent of Direct Cost Subtotal) | | $3,801,753 |
| Indirect Cost Subtotal | | $3,801,753 |
| **TOTAL CAPITAL COSTS** | | **$45,621,035** |
| ANNUAL OPERATION AND MAINTENANCE COSTS | | |
| Landfill Cell O&M | | $176,252 |
| PERIODIC COSTS | | |
| 5-Year Reviews | | $15,600 |
| **PRESENT WORTH OF ANNUAL AND PERIODIC COSTS (100 yrs) *** | | **$2,861,321** |
| **TOTAL PRESENT WORTH OF ALTERNATIVE SS2 (100 yrs) *** | | **$48,482,357** |
| **TOTAL NON-DISCOUNTED COST OF ALTERNATIVE SS2 (100 yrs) *** | | **$76,055,303** |

Prepared/Date ESS 09/05/07
Check/Date NW 09/06/07

**Table 4-15**
**Location-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Floodplains | Floodplain Management Executive Order No. 11988 [40 Code of Federal Regulations (CFR) Part 6, App. A] | Relevant and Appropriate | Requires federal agencies to evaluate potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain. | There is no practicable alternative that would have a less adverse impact on floodplains. Appropriate federal and state agencies would be contacted and allowed to review the proposed work plan for the response action within Site Brook prior to implementation of the action. Response actions would be scheduled and designed to minimize harm to floodplains to the extent practicable, and any adverse impacts would be mitigated through floodplain restoration. |
| Federal | Wetlands | Protection of Wetlands Executive Order No. 11990 [40 CFR Part 6, App. A] | Relevant and Appropriate | Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetlands areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values. | There is no practicable alternative that would have a less adverse impact on wetlands. Appropriate federal and state agencies would be contacted and allowed to review the proposed work plan for the response action within Site Brook prior to implementation of the action. Response actions would be scheduled and designed to minimize harm to wetlands to the extent practicable, and any adverse impacts would be mitigated through wetland restoration. |

**Table 4-15**
**Location-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Navigable Waters | Rivers and Harbors Act of 1899 [33 United States Code (USC) 403 et seq.; 33 CFR Parts 320-323] | Relevant and Appropriate | Section 10 of the Rivers and Harbors Act of 1899 requires that the construction of any structure in or over any "navigable water of the U.S." including the excavation from or deposition of material in such waters, or any obstruction of alteration in such waters, obtain authorization from the Secretary of the Army acting through the U.S. Army Corps of Engineers. | Site activities will be designed and implemented to avoid obstruction and minimize alteration of navigable waters. Disturbed areas will be restored. |
| Federal | Endangered Species | Endangered Species Act [16 (USC) 1531 et seq.; 40 CFR 6.302(h); 50 CFR Part 200, 50 CFR Part 402] | Applicable, if such species are encountered | This statute requires that activities be avoided that jeopardize threatened or endangered species or adversely modify habitats essential to their survival. Mitigation measures should be considered if a listed species or habitat may be jeopardized. | Although no currently listed endangered or threatened species or their nests have been identified at the site, their presence has been noted in the area. As part of the remedial action, pertinent lists will be reviewed to assess whether federally listed species may be present. During the remedial action, measures such as relocation or seasonal work limits for specific actions would be implemented to protect listed species, if any are identified. |
| Federal | Surface Waters | Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Section 6.302(g); 33 CFR Part 320] | Applicable | Requires that the U.S. Fish and Wildlife Service and National Marine Fisheries Service be consulted prior to structural modification of any stream or other water body (i.e., wetland). It also requires adequate protection of fish and wildlife resources. Requires consultation with state agencies to develop measures to prevent, mitigate, or compensate for project-related | This alternative would include excavation within Site Brook. No practicable alternative to this action exists. Actions taken would minimize adverse impacts to fish and wildlife. Relevant federal and state agencies would be contacted and allowed to review the proposed work plan for the response action prior to implementation of the action. |

**Table 4-15**
**Location-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Location Characteristic | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| | | | | losses to fish and wildlife. | |
| State | Floodplains | Regulations of Connecticut State Agencies (RCSA) Floodplain Management Standards [RCSA 25-68h-2] | Applicable to Site Brook excavation | These rules address restrictions for structures within floodplains, restrictions for filling or excavating within floodplains, and storage of materials and equipment within floodplains. | This alternative would include excavation within Site Brook. No practicable alternative to this action exists. Actions taken would minimize adverse impacts to floodplains of the brook. Relevant state agencies would be contacted and allowed to review the proposed work plan for the response action prior to implementation of the action |
| State | Wetlands | Wetland Requirements [RCSA 22a-39] | Applicable to Site Brook excavation | These rules regulate the following activities within a wetland: removal of materials, deposition of materials, and construction or alteration within such areas. Under these rules, wetlands are defined to include soil types designated as floodplains. | This alternative would include excavation within Site Brook. No practicable alternative to this action exists. Actions taken would minimize adverse impacts to wetlands and floodplains of the brook. Relevant state agencies would be contacted and allowed to review the proposed work plan for the response action prior to implementation of the action. |

**Notes:**

CFR = Code of Federal Regulations

USC = United States Code

RCSA = Regulations of Connecticut State Agencies

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**Table 4-16**
**Chemical-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Various | Nuclear Regulatory Commission (NRC) Radiological Criteria for License Termination [10 Code of Federal regulations (CFR) Part 20, Subpart E] | Applicable | Under this rule, a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mRem per year and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). | This alternative includes excavation of soil and sediment at FUSRAP areas that exceed Preliminary Remediation Goals based on a 19 mRem per year dosage, a level considered ALARA. Excavated material will be consolidated in an on-site containment cell designed and constructed to prevent dosages exceeding 25 mRem per year. |
| Federal | Soils, Sediments and Building Materials | Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) [NUREG 1575] | To be considered | Provides guidance on the performance of Final Status Surveys. | Final Status Surveys will be conducted at the Site in accordance with MARSSIM. |
| State | Soil, Goundwater, Surface water, and Soil vapor. | Regulations of Connecticut State Agencies (RCSA) Remediation Standard Regulations (RSRs) [RCSA §§ 22a-133k-1 et seq.] | Applicable | These regulations provide numeric standards for remediation of a wide variety of contaminants in soil, groundwater, surface water, and soil vapor.<br>The State of Connecticut has established a 19 mRem per year dose standard as a cleanup target for radiologically contaminated sites. | This alternative will be designed and implemented to provide a reduction in soil contaminant concentrations to achieve the RSRs criteria.<br>This alternative will be designed and implemented to attain the 19 mRem per year dose standard. |

**Table 4-16**
**Chemical-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Chemical Medium | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|

**Notes:**

ALARA = as low as reasonably achievable

CFR = Code of Federal Regulations

FR = Federal Register

NRC = Nuclear Regulatory Commission

RCSA = Regulations of Connecticut State Agencies

RSR = Remediation Standard Regulations

TEDE = total effective dose equivalent

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**Table 4-17**
**Action-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Identification of hazardous waste | Resource Conservation and Recovery Act (RCRA) Identification and Listing of Hazardous Waste [40 Code of Federal Regulations (CFR) Part 260/261; incorporated by reference at RCSA 22a-449c-101] | Applicable | These requirements identify the conditions under which a waste would be considered hazardous (i.e., an F-, P-, K-, U-, or D- listed waste). These requirements also provide the maximum concentrations of contaminants for which the waste would be a RCRA characteristic waste because of its toxicity. The analytical test set out in Appendix II of 40 CFR Part 261 is referred to as the Toxicity Characteristic Leaching Procedure. | Removed material will be assessed to determine whether it should be handled as hazardous waste |
| Federal | Generation of hazardous waste | RCRA Standards Applicable to Generators of Hazardous Waste [40 CFR Part 262] | Applicable | Connecticut has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. The relevant and appropriate provisions of 40 CFR Part 262 are incorporated by reference. | Because this alternative involves the excavation of material potentially classified as RCRA-listed or RCRA-characteristic wastes, such materials would need to be handled in compliance with the substantive requirements of these standards. |
| Federal | Storage of hazardous waste in containers. | RCRA Container Storage Requirements [40 CFR Part 264, Subpart I] | Applicable | These regulations apply to owners and operators who store hazardous wastes in containers. | If containers are used to store materials that are hazardous wastes, the containers will be managed according to these rules. |
| Federal | Transport and disposal of hazardous waste | RCRA Manifest System, Record keeping, and Reporting [40 CFR Part 264, Subpart E] | Applicable | This regulation outlines the requirements to track hazardous waste activities, including the manifest system, operating records, and reporting. | Remedial action activities will be conducted to comply with the facility's requirements in accordance with this regulation. |

**Table 4-17**
**Action-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Transportation of hazardous waste | RCRA Standards Applicable to Transporters Of Hazardous Waste [40 CFR Part 263] | Applicable | These regulations establish procedures to be followed when transporting manifested hazardous waste within the United States. | Transporters of hazardous waste for off-Site treatment and/or disposal will comply with these requirements. |
| Federal | Generation of air emissions at NRC licensed facilities | Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) [40 CFR Part 61, Subpart I] | Applicable | Subpart I provides emission standards for NRC-licensed facilities. 40 CFR § 61.102 specifies that a member of the general public shall not be exposed to emissions of radionuclides to ambient air in excess of an effective dose equivalent of 10 mRem per year. | Remedial actions will be conducted in accordance with these requirements. |
| Federal | Demolition of structures with asbestos containing material | CAA National Emission Standards for Hazardous Air Pollutants [40 CFR Part 61, Subpart M] | Applicable | This requirement provides emission standards for specific pollutants for which no ambient air quality standard exists. NESHAPs have been promulgated for specific source types emitting certain pollutants, including asbestos. Subpart M establishes standards for inactive waste disposal sites and disposal of asbestos-containing material from demolition and renovation operations (40 CFR § 61.145). | Demolition activities involving asbestos-containing material will be conducted in accordance with these requirements. |
| Federal | Cleanup and disposal of PCB remediation waste | Toxic Substances Control Act (TSCA) Polychlorinated Biphenyl (PCB) Remediation Waste [40 CFR Part 761.61] | Applicable | Provides cleanup and disposal options for PCB remediation waste. | Cleanup and disposal of PCB remediation waste resulting from the remedial action will be conducted in accordance with these requirements. |

**Table 4-17**
**Action-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| Federal | Decontamination and Decommissioning | NMSS Consolidated Decommissioning Guidance [NUREG 1757] | To Be Considered | Provides guidance to licensees, identifies techniques and criteria to be used in decommissioning, and provides acceptable methods for implementing specific parts of the NRC's regulations. | NUREG 1757 is not a regulation and therefore compliance with the NuReg is not required. However, this guidance will be considered in design and implementation of the remedial action. |
| Federal | Radiological remediation | U.S. Nuclear Regulatory Commission (NRC)/U.S. Army Corps of Engineers (USACE) Memorandum of Understanding (MOU) | To Be Considered | The MOU addresses unrestricted releases under 10 CFR 20.1402 to ensure that the criteria of the License Termination Rule or a more stringent requirement will be met. The MOU assists to reduce unnecessary burden on stakeholders and avoid duplication of regulatory requirements and effort by setting cooperative conditions, consistent with the protection of public health and safety. | The agencies cooperate and share data and reports in order to meet statutory requirements. Site remediation must be conducted to achieve radiological criteria for unrestricted use of the NRC's License termination Rule. |
| Federal | Discharge to surface water | Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) (40 CFR Parts 122, 125, 131, and 136) | Applicable | This rule requires permits for the discharge of pollutants from any point source into U.S. waters. | Contaminated surface water, groundwater, or dewatering fluids encountered during corrective action activities will be containerized and either treated on-Site prior to discharge to surface water, or routed through an off-Site POTW. Effluent will meet the POTW discharge limitations, monitoring requirements, and best management practices. |
| Federal | Discharge to Publicly Owned Treatment Works | CWA National Pretreatment Standards (40 CFR Part 403) | Applicable | This regulation sets pretreatment standards for the introduction of pollutants from non-domestic sources into POTWs. These | Any discharge of treated surface water, groundwater, or dewatering fluids that goes to an off-Site POTW will meet discharge limitations and |

**Table 4-17**
**Action-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| | | | | regulations are designed to control pollutants that pass through, cause interference, or are otherwise incompatible with treatment processes at a POTW. | pretreatment requirements imposed on POTWs. |
| State | Disposal of demolition waste | CTDEP Solid Waste Management [CGS Title 22a Chapter 446d § 208x; RCSA § 22a-209] | Relevant and Appropriate | This regulation specifies that demolition waste may be disposed of at any solid waste disposal facility that has a permit for bulky waste, or at a municipal solid waste facility. | Demolition waste not contaminated with hazardous substances will be disposed in accordance with these requirements. |
| State | Management of hazardous waste | CTDEP Hazardous Waste Management [CGS §§ 22a-454 and 22a-449(c); RCSA §§ 22a-449(c)-100 through 110 and 22a-449(c)-11] | Relevant and Appropriate | This regulation specifies requirements for the design, operation, and closure of hazardous waste disposal facilities. This regulation incorporates by reference the RCRA requirements for hazardous waste facilities. | Remedial action activities will meet the minimum standards of this regulation. |
| State | Land-disposal of hazardous wastes | RCRA Land Disposal Restrictions [40 CFR Part 268.7 incorporated by reference at RCSA 22a-449c-108] | Applicable | Certain restricted wastes are prohibited from land disposal unless treated to specified standards. These regulations state that a generator must determine whether or not a waste is one that is restricted from land disposal, and whether or not the waste meet the treatment standard. The generator must notify the disposal facility of these findings. | The potential exists for wastes removed from Drum Burial Pit, Clamshell Area, and Site Brook study areas to be RCRA-characteristic wastes. Some wastes, if classified, may be prohibited from land disposal without prior treatment. If so, appropriate treatment would need to be applied in accordance with these regulations prior to ultimate disposal of these materials. |

**Table 4-17**
**Action-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Soil remediation | RCSA Remediation Standard Regulations [RCSA 22a-1 33k-2] | Applicable | The state standards for soil remediation regulate the remediation of polluted soil at release area. The standards specify the criteria that must be met in terms of direct exposure and pollutant mobility, including engineered controls. | Soils and sediments exceeding these criteria will be excavated and disposed off-site. |
| State | Excavation within Site Brook | RCSA Water Quality Standards [CGS 22a-426, et seq.] | Applicable | These state water quality standards prohibit discharge of radioactive materials in concentrations that would be harmful to human health or the environment. These standards also specify that sediments are to be free of pollutants that unduly affect the bottom of a stream or that interfere with propagation and habitats of fish and wildlife. | Components of this alternative relating to excavation of sediment within Site Brook will be carried out in compliance with these regulations, such that surface water and sediments remain in compliance with water quality standards. |
| State | Discharge to surface water | Water Pollution Control Act (CGS §§ 22a-416 through 22a-438; RCSA §§ 22a-430-1 through 22a-430-7) | Applicable | This act requires permits for any discharge of water, substance, or material into the waters of the state. | Contaminated surface water, groundwater, or dewatering fluids encountered during corrective action activities will be containerized and either treated on-Site prior to discharge to surface water, or routed through an off-Site POTW. These activities will be conducted in accordance with the requirements of this act (e.g., monitoring requirements and discharge limitations). |
| State | Generation of fugitive dust air emissions | Abatement of Air Pollution [CGS Title 22a, Chapter 446c; RCSA §§ 22a-174-1, et seq.] | Applicable | These regulations require permits to construct and to operate specified types of emission sources and contain emission standards that must | Emission standards for fugitive dust will be met with dust control measures during the remedial actions to comply with substantive requirements. |

**Table 4-17**
**Action-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| | | | | be met prior to issuance of a permit. Pollutant abatement controls may be required. Specific standards pertain to fugitive dust (RCSA § 22a-174-18(b)) and control of odors (RCSA § 22a-174-23) | |
| State | Asbestos removal | CT Standards for Asbestos Abatement [CGS Title 19a Chapter 368L; RCSA §§ 19a-332a-5 and 19a-332a-7] | Applicable | RCSA § 19a-332a-5 establishes general requirements for asbestos abatement projects, such as posted signs, shutdown of HVAC systems, isolation from non-work areas, and other measures.<br>RCSA § 19a-332a-7 establishes specific requirements for asbestos removal, such as wetting, removing components intact where possible, decontaminating equipment, and other measures. | Asbestos abatement will be conducted in accordance with the requirements of these regulations. |
| State | Generation of noise | Noise Pollution Control Act [CGS § 22a-69; RCSA §§ 22a-69-1 through 69-7.4] | Applicable | These regulations establish allowable noise levels. | Remedial actions will be conducted to comply with these regulations. |
| State | Encountering significant environmental hazards while sampling | Reporting of Certain Significant Environmental Hazards by Owners of Contaminated Real Property [CGS 22a-6u] | Applicable | Requires reporting to the property owner, the client, the Commissioner, and, in some case, the local fire department when certain conditions are encountered by a technician collecting soil, water, vapor, or air samples for the purpose of remediating sources of pollution to waters of the state. | If significant environmental hazards are encountered during collection of samples, the will be reported to the Connecticut department of Environmental protection s required by this regulation. |

**Table 4-17**
**Action-Specific ARARS for**
**Alternative SS3: Off-Site Disposal**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| Regulatory Authority | Action | Requirement | Status | Requirement Synopsis | Action to be Taken to Attain ARAR |
|---|---|---|---|---|---|
| State | Spill incident | Report of Discharge, Spill, Loss, Seepage, or Filtration [CGS 22a-450] | Applicable | This statute requires that discharge, spillage, uncontrolled loss, seepage or filtration of oil or petroleum or chemical liquids or solid, liquid or gaseous products or hazardous wastes be immediately reported to the CTDEP | The discharge, spill, loss, seepage, or filtration of material will be reported as required by this statute. |
| State | Performing activities with potential to cause erosion and sedimentation | Guidelines for Soil Erosion and Sediment Control; The Connecticut Council on Soil and Water Conservation | To be Considered | These guidelines provide technical and administrative guidance for the development, adoption, and implementation of erosion and sediment control program. | These guidelines will be incorporated into any remedial action activities. Erosion and sediment control measures will be implemented during remedial action activities. |

**Notes:**

CAA = Clean Air Act

CFR = Code of Federal Regulations

CGS = Connecticut General Statute

CTDEP = Connecticut Department of Environmental Protection

CWA = Clean Water Act

DCGL = Derived Concentration Guidance Levels

NESHAP = National Emission Standards for Hazardous Air Pollutants

NPDES = National Pollutant Discharge Elimination System

POTW = Publicly Owned Treatment Works

RCRA = Resource Conservation and Recovery Act

RCSA = Regulations of Connecticut State Agencies

TSCA = Toxic Substances Control Act

USC = United States Code

Prepared/Date: SWR 09/04/07
Checked/Date: NW 09/06/07

**Table 4-18**
**Cost Summary for Alternative SS3**

**Alternatives Evaluation Report for Remaining Commercial and FUSRAP Radiological Areas**
**CE Windsor Site, Windsor, Connecticut**

| ITEM | | COST |
|---|---|---|
| DIRECT CAPITAL COSTS | | |
| 1 Building 3 and 6 Building Demolition and Surrounding Soil Remediation | | |
| | Project Execution Costs | $7,356,477 |
| | Waste Disposal | $1,819,035 |
| 2 Waste Storage Pad | | |
| | Project Execution Costs | $3,964,703 |
| | Waste Disposal | $9,068,480 |
| 3 Equipment Storage Yard | | |
| | Project Execution Costs | $250,000 |
| | Waste Disposal | $750,000 |
| 4 Industrial Drain Lines | | |
| | Project Execution Costs | $5,175,284 |
| | Waste Disposal | $1,974,724 |
| 5 Site Brook and Debris Piles | | |
| | Project Execution Costs | $9,135,464 |
| | Waste Disposal | $12,745,457 |
| 6 Drum Burial Pit | | |
| | Project Execution Costs | $1,469,019 |
| | Waste Disposal | $3,269,588 |
| 7 Clamshell Area | | |
| | Project Execution Costs | $325,753 |
| | Waste Disposal | $863,665 |
| Direct Cost Subtotal | | $58,167,649 |
| Contingency Cost (@10 Percent) | | $5,816,765 |
| Direct and Contingency Cost Subtotal | | $63,984,414 |
| INDIRECT CAPITAL COSTS | | |
| Oversight/Radiological Support (@ 10 Percent of Direct Cost Subtotal) | | $5,816,765 |
| Indirect Cost Subtotal | | $5,816,765 |
| **TOTAL CAPITAL COSTS** | | **$69,801,179** |
| ANNUAL OPERATION AND MAINTENANCE COSTS | | |
| Groundwater Monitoring | | $13,122 |
| PERIODIC COSTS | | |
| | | $0 |
| **PRESENT WORTH OF ANNUAL AND PERIODIC COSTS (3 yrs)** | | **$13,122** |
| **TOTAL PRESENT WORTH OF ALTERNATIVE SS3 (3 yrs)** | | **$69,814,300** |
| **TOTAL NON-DISCOUNTED COST OF ALTERNATIVE SS3 (3 yrs)** | | **$69,816,179** |

Prepared/Date ESS 09/05/07
Check/Date NW 09/06/07

# ATTACHMENT 1

## Risk Assessment

# CE WINDSOR SITE
# FUSRAP AREAS RISK ASSESSMENT

This attachment presents the human health baseline risk assessment (BRA) for the FUSRAP areas of the CE Windsor Site. Specifically, this memorandum describes how previous risk assessments completed for the CE Windsor Site fulfill the requirements for conducting Site-specific risk assessments for the FUSRAP areas.

## 1.0 Regulatory Requirements

The National Contingency Plan (NCP) stipulates that site-specific BRAs should be conducted as part of the remedial investigation (RI) to "characterize the current and potential future threats to human health and the environment posed by contaminants migrating to ground water or surface water, releasing to air, leaching through the soil, remaining in the soil, and bioaccumulating in the food chain" (55 Fed. Reg. 8665-8865 (Mar. 8, 1990)). The NCP further stipulates that alternatives must be developed to protect human health such that for known or suspected carcinogens, media concentrations are associated with excess upper bound lifetime cancer risk to an individual of between $10^{-4}$ and $10^{-6}$, and for systemic toxicants media concentrations are associated with levels to which the human population, including sensitive sub groups, may be exposed without adverse effect during a lifetime or part of a lifetime.

To implement the requirements of the NCP, the United States Environmental Protection Agency (USEPA) has developed guidance and policy for conducting BRAs (USEPA, 1989; 1991). As a matter of policy, USEPA stipulates that where the BRA indicates that a cumulative site risk to an individual using reasonable maximum exposure assumptions for either current or future land use exceeds the $10^{-4}$ lifetime excess cancer risk end of the risk range, or if there are non-carcinogenic hazards in excess of a hazard index of 1, action under CERCLA is generally warranted. USEPA further states that the cumulative site baseline risks should not assume that institutional controls or fences will account for risk reduction. Consequently, the results of the BRA, and specifically the results for future unrestricted land uses (i.e., land uses that assume no institutional controls), are used to establish the basis for taking a remedial action (USEPA, 1991).

If remedial action is warranted, the NCP states that remediation goals should establish acceptable exposure levels that are protective of human health and the environment. The NCP indicates that remediation goals should be developed by considering applicable or relevant and appropriate requirements (ARARs) under federal or state environmental laws, and should factor in attaining a level of protection commensurate with the NCP cancer risk range of $10^{-6}$ to $10^{-4}$ and a hazard index of 1.

## 2.0 Identification of FUSRAP Areas

FUSRAP areas were originally designated by ORISE in 1994 as Buildings 3 and 6, and areas of the Site that contained uranium enriched at 20% or greater in U235. On May 6, 2004, the USACE expanded the designation to include all uranium enrichments, natural uranium and depleted uranium within the CE Windsor Site and any chemicals used in CE government contract work. Due to commingling of radiological contamination resulting from both government and commercial activities, and the collocation of chemical contamination from government and commercial activities, the "FUSRAP areas" include all remaining radiological contamination at the CE Windsor Site.

The original designation surveys and subsequent investigation by ABB and the USACE identified the following FUSRAP Areas:

- Building 3
- Building 6
- Woods Area
- Drum Burial Pit
- Site Brook
- Debris Piles
- Clamshell Pile
- Equipment Storage Yard (AOC 10)
- Industrial Waste Lines

Media affected by chemicals, uranium, and/or cobalt-60 at these areas include soil, interior building surfaces (Building 3 and Building 6 only), and groundwater (Equipment Storage Yard and Industrial Waste Lines only).

## 3.0 Risk Assessments Previously Completed for the CE Windsor Site

Baseline risk assessments have been performed for the CE Windsor Site as part of the Resource Conservation and Recovery Act (RCRA) Voluntary Correction Action (VCA), Building 3 Complex and Building 6 Remedial Investigations, and the Remedial Investigation for FUSRAP Areas. This section provides a summary of the results of the risk assessments that are applicable to the designated FUSRAP areas.

### 3.1 RCRA VCA

ABB completed a BRA as a component of the RCRA Facility Investigation (RFI) under the RCRA VCA program (Harding ESE, 2003). The BRA was conducted in accordance with USEPA performance standards for performing risk characterization, as described in the *Risk Assessment Guidance for Superfund (RAGS)* document series (USEPA, 1989; 1991) and associated USEPA Office of Solid Waste and Remedial Response directives concerning risk characterization. The BRA was reviewed and approved by USEPA in 2003.

The RCRA VCA BRA characterized health risks associated with current land use conditions, as well as future land use conditions that considered unrestricted residential land use, and restricted commercial/industrial and recreational land uses of the Site property. The BRA characterized health risks for FUSRAP-designated areas, as well as areas associated strictly with non-AEC operations (i.e., non-FUSRAP areas).

RCRA only regulates chemical substances and does not regulate radionuclides. In mixed chemical/radionuclide wastes, RCRA only regulates the chemical aspects of the waste. Therefore, cancer risks associated with the radiotoxicity of uranium and cobalt were not evaluated in the RCRA VCA BRA, but the chemical toxicity (non-cancer hazard) associated with uranium and cobalt was evaluated in the BRA. Consequently, the RCRA VCA BRA quantified cancer risks to chemicals, and non-cancer hazards to chemicals and radionuclides.

The results of the RCRA VCA BRA indicated that health risks exceeded the NCP risk limits of an excess lifetime cancer risk of $10^{-4}$ and/or a hazard index of 1 at the following FUSRAP areas:

- Clamshell Pile: Non-cancer hazard index above 1 due to zirconium
- Equipment Storage Yard: Cancer risk above $10^{-4}$ due to polynuclear aromatic hydrocarbons
- Groundwater adjacent to Building 6 due to tetrachloroethene, trichloroethene, 1,2-dichloroethene, vinyl chloride, and manganese.
- Groundwater at the Equipment Storage Yard due to trichloroethene, 1,2-dichloroethene, vinyl chloride, and manganese.

The results of the RCRA VCA BRA indicate that response actions are required at these two areas.

## 3.2 Building 3 /3A Complex and Building 6 Complex Remedial Investigations

ABB completed BRAs for the Building 3/3A Complex (Harding ESE, 2002a) and the Building 6 Complex (Harding ESE, 2002b) as a component of the Remedial Investigations for these building complexes. The risk assessments were completed in accordance with applicable USEPA risk characterization guidance (USEPA, 1989; 1991; 2000).

The risk assessments evaluated potential exposures to radionuclides that were detected on interior building materials and surfaces under future restricted (commercial/industrial) and unrestricted (residential) uses. The excess lifetime cancer risks for both restricted (commercial/industrial) and unrestricted (residential) land uses exceeded the NCP risk limits of an excess lifetime cancer risk of $10^{-4}$ due to uranium The results of the Building 3/3A Complex and Building 6 Complex RI risk assessments indicate that response actions are required at these two building complexes.

In addition, drain lines and soils beneath the buildings have not been adequately investigated and consistent with the LTR, cannot be fully investigated without removal of Buildings 3 and 6.

## 3.3 FUSRAP Areas

The USACE completed a risk assessment for all of the FUSRAP areas identified in Section 2.0 except the Industrial Waste Lines and Equipment Storage Yard (ENSR, 2004). The risk assessment characterized cancer risks and non-cancer hazards associated with uranium, cobalt-60, and chemicals that were detected in soil and Site Brook sediment within the FUSRAP boundaries as defined in the FUSRAP RI. The FUSRAP risk assessment characterized health risks associated with current land use conditions, as well as future land use conditions that considered unrestricted residential land use, and restricted commercial/industrial and recreational land uses of the FUSRAP areas.

The results of the FUSRAP risk assessment indicated that health risks exceeded the NCP risk limits of an excess lifetime cancer risk of $10^{-4}$ and/or a hazard index of 1 at all of the soil and sediment FUSRAP areas evaluated in the risk assessment.

The FUSRAP risk assessment was not reviewed nor approved by USEPA. However, ABB submitted comments on the FUSRAP risk assessment on October 12, 2004 which noted that some of the risk characterization methods used in the FUSRAP risk assessment did not comply with the generally accepted performance standards for performing risk assessments in accordance with CERCLA.

Although ABB does not concur with some of the methodologies that were used to characterize risks in the FUSRAP risk assessment, ABB does concur that, with respect to cancer risk estimates for radionuclides in soil and sediment, the conclusions reached in the FUSRAP risk assessment are accurate, and concurs that radionuclide cancer risks for all of the FUSRAP areas evaluated in the FUSRAP risk assessment are in excess of the upper bound of the NCP risk range.

## 4.0 Risk Evaluation for Equipment Storage Yard and Industrial Waste Lines

The RI for the FUSRAP Areas (ENSR, 2004) did not include the Equipment Storage Yard. Comments submitted on the FUSRAP RI noted that the Equipment Storage Yard had met the criteria as a FUSRAP area and, consequently, should have been characterized in the RI and BRA.

The BRA for the FUSRAP Areas excluded soil surrounding the Industrial Waste Lines as well as sediment from within the waste lines and associated manholes. The rationale for exclusion of soil surrounding the Industrial Waste Lines was that analytical data for the soil samples exhibited uranium isotope with atomic weight of 235 atomic mass units (U-235) enrichments of less than 20%. The FUSRAP RI report did not provide rationale for the exclusion of the sediments within the Industrial Waste Lines. Comments submitted on the FUSRAP RI indicated that soils surrounding the waste lines, as well as material from within the waste lines, should have been evaluated in the RI and BRA. Specifically, comments noted that:

- FUSRAP designation is based on area of the property and not U-235 enrichment; hence U-235 enrichment of 20% or greater should not have been used to limit the FUSRAP boundary;
- material from within the waste lines exhibited U-235 enrichments in excess of 50%, and therefore by USACE's own definition of FUSRAP material, should have been evaluated in the BRA;
- the RI field investigation was not adequate to fully characterize the soil surrounding the industrial waste lines; several lines of evidence were presented to validate that the Industrial Waste Lines had leaked into the surrounding soils, and in doing so could have also leaked uranium with enrichments greater than 20% into the surrounding soils.

Since health risk assessments for radionuclides associated with soil at the Equipment Storage Yard and material within the Industrial Waste Lines have not been completed as a component of previous risk assessments, this section provides risk characterizations for those two areas.

USEPA guidance for conducting risk characterizations describes a four part process for completing a BRA (hazard identification, exposure assessment, toxicity assessment, and risk characterization) (USEPA, 1989). The previous risk characterizations completed for the CE Windsor Site have established the methodology and Site-specific information necessary to complete these components of the risk characterizations for these two areas. Therefore, the risk characterizations for these two areas are completed using a streamlined approach that integrates relevant area-specific information into the assessments that have already been completed, in order to derive conclusions concerning risk assessment outcomes.

### 4.1 Equipment Storage Yard

The radiological characterization for the Equipment Storage Yard was performed by ABB and was presented in "Radiological Characterization Report for Five Potential FUSRAP Areas" (MACTEC, 2003). The report concluded that uranium was detected in excess of background activities in soil, with activities of 458 pCi/g and 842 pCi/g reported in two adjacent soil samples. With the exception of uranium activities associated with samples collected from a partially buried drum, uranium activities reported in the remainder of soil samples were generally below the analytical reporting limit or consistent with background.

In accordance with USEPA guidance for evaluating exposures and determining exposure point concentrations (USEPA, 2002), the exposure point should not include clean (non-contaminated) perimeter soil samples. Therefore, in accordance with USEPA guidance, the potential exposures to uranium in soil at the Equipment Storage Yard are based on the detected activities of uranium (458 pCi/g to 842 pCi/g; average 650 pCi/g).

The FUSRAP RI risk assessment presented risk estimates for potential exposures to uranium in soil under current and potential future land uses. The exposure scenarios evaluated in the FUSRAP RI risk assessment would be applicable at the Equipment Storage Yard. A review of the FUSRAP RI risk assessment results for radionuclides, shown in Table 7-1 of the FUSRAP RI report, indicates that excess lifetime cancer risks in excess of $10^{-4}$ (the upper bound of the NCP cancer risk range) were associated with one or more land use exposure scenarios at each of the FUSRAP areas evaluated. A comparison of the total uranium concentrations in soil at the Equipment Storage Yard (average of 650 pCi/g) to the total uranium exposure point concentrations that were used to calculate the excess lifetime cancer risks at the FUSRAP areas, as shown in Table R-1 of the FUSRAP RI Report, indicates that the concentrations at the Equipment Storage Yard are higher than the concentrations at three of the FUSRAP Areas for which excess lifetime cancer risks greater than $10^{-4}$ were calculated (Areas Surrounding Building 3/3A, Clamshell Pile, Drum Burial Pit). Therefore, by analogy, excess lifetime cancer risks for potential exposures to uranium in Equipment Storage Yard soils would also be in excess of $10^{-4}$, thereby representing a risk that requires a response action.

### 4.2 Industrial Waste Lines

The radiological characterization for the Industrial Waste Lines was performed by ORISE and was presented in "Designation Survey, Combustion Engineering Site, Windsor Connecticut" (ORISE, 1996). The report presented the results of sediment samples collected from 16 different manhole locations along the Industrial Waste Lines. Total uranium activities reported in the sediment samples ranged from 3.1 pCi/g to 97,000 pCi/g, as reported in Tables 4 and 6 of the ORISE report.

Conceptually, human exposures to Waste Lines sediments could potentially occur through two mechanisms:

1. A utility worker who cleans out the manholes and/or who performs maintenance, repairs, or upgrades to the line, could be exposed to sediments in the manholes and line while working in the manhole or accessing the line.

2. The utility line and associated manhole structures, approximately half of which are located at depths less than 10 feet below ground surface, could be excavated in the future; the contamination within the lines could be mixed into the soil, or spread on the

ground surface. Under these circumstances, future owners and occupants of the property, which could include workers associated with commercial/industrial land uses, or residents associated with unrestricted (residential) land uses, could be exposed to the sediment in the same manner as those receptors would be exposed to soil.

In accordance with USEPA guidance for conducting radiological risk assessments (USEPA, 2000), the potential routes of exposure to radionuclides in soil or sediment include:

- Incidental ingestion of soil or sediment via hand-mouth contact;
- Inhalation of dust that may be liberated from soil;
- External exposure to ionizing radiation;
- Ingestion of produce that may uptake radionuclides from soil.

### 4.2.1 Utility Worker Risk Evaluation

For a utility worker potentially exposed to sediments in a manhole or waste line, only the incidental ingestion and external exposure routes are potentially complete. It is unlikely that the dust inhalation pathway would be complete, as the sediments are likely to be wet and, therefore, not available for particulate emission into the air.

Since utility work is typically performed at a single location (e.g., repairs or maintenance to one part of utility line), the utility worker exposure scenario is evaluated as a worker who spends a short period of time (i.e., two days) performing utility work at a single area. Therefore, the uranium activities reported at each manhole sampling location are used to represent the uranium in sediment to which a utility worker would be exposed while performing utility repairs or maintenance. However, rather than calculate risks for each manhole location separately, the risk characterization can be streamlined by evaluating the manhole location with the highest reported activity. If the health risks for the exposure point with the highest activity do not exceed the NCP risk range, then, by analogy, no other exposure points would be associated with risks in excess of the risk range. If, however, risks for any one of the exposure points exceeds the NCP risk range, then a response action is warranted.

Exposures to a utility worker are modeled using parameters established by USEPA for evaluating worker exposures (USEPA, 2002). The parameters assume that a utility worker contacts sediment two eight-hour work days per year over the duration of employment (25 years). The daily ingestion rate for sediment is based on the USEPA default value for outdoor workers. Exposures are quantified using algorithms developed by USEPA for quantifying radiation exposures (USEPA, 2000) and are presented in Table 1.

In accordance with USEPA guidance (USEPA, 1989; 2000), cancer risks are calculated by multiplying the quantified intakes to radionuclides by each exposure route by an exposure route-specific cancer slope factor. USEPA guidance (USEPA, 2003) indicates that cancer slope factors for radionuclides should be obtained from the Health Effects Assessment Summary Tables (HEAST, 2001). Table 1 presents the applicable cancer slope factors for the uranium isotopes reported in Industrial Waste Lines sediment.

Non-cancer hazard index values are calculated by dividing the chemical intake by a chemical-specific reference dose that is obtained from the USEPA Integrated Risk Information System (IRIS). Since hazard index characterizes the chemical toxicity, it is necessary to characterize exposure based on uranium mass rather than activity. The uranium mass associated with the total uranium activity used to calculate cancer risk estimates is 2,430 milligrams per kilogram (mg/kg). Hazard index calculations are documented in Table 2.

The excess lifetime cancer risk for a utility worker exposed to uranium in Industrial Waste Line sediments (Table 1) is $2x10^{-4}$, which exceeds the upper-bound of the NCP cancer risk range of $10^{-4}$. The hazard index for a utility worker exposed to uranium in Industrial Waste Line sediments (Table 2) is 0.4, which is below the USEPA threshold HI value of 1. Based on cancer risks in excess of $10^{-4}$, remedial responses are warranted.

#### 4.2.2 Future Land Uses Risk Evaluation

Under the assumption that radionuclides in Industrial Waste Lines sediment get incorporated into soil or spread onto soil if the pipeline is excavated, future occupants of the Site may be exposed to the radionuclides in the Waste Lines sediment while contacting the soil. The future land use exposure scenarios that characterize risks associated with soil exposures are described in the FUSRAP RI Report.

Under this scenario, it is assumed that a large section or all of the waste lines would be excavated. Therefore, the appropriate uranium concentration for evaluating potential exposures to sediment from the Industrial Waste Lines is the average concentration among the waste lines manhole locations sampled. The average uranium activity among manhole locations sampled at the Industrial Waste Lines is 10,430 pCi/g.

A review of the FUSRAP RI risk assessment results for radionuclides, shown in Table 7-1 of the FUSRAP RI report, indicates that excess lifetime cancer risks in excess of $10^{-4}$ (the upper bound of the NCP cancer risk range) were associated with one or more land use exposure scenarios at each of the FUSRAP areas evaluated. A comparison of the average total uranium concentration in Industrial Waste Lines sediment (10,430 pCi/g) to the total uranium exposure point concentrations that were used to calculate the excess lifetime cancer risks at the FUSRAP areas, as shown in Table R-1 of the FUSRAP RI Report, indicates that the Industrial Waste Lines sediment average is higher than the concentrations at all of the FUSRAP Areas for which excess lifetime cancer risks greater than $10^{-4}$ were calculated. Therefore, by analogy, excess lifetime cancer risks for potential exposures to uranium in Industrial Waste Lines sediments that may be mixed with soils would also be in excess of $10^{-4}$, thereby representing a risk that requires a response action.

## 5.0 Conclusions and Recommendations

The risk assessments completed for the CE Windsor Site demonstrate that health risks at all of the FUSRAP areas exceed risk limits established in the NCP. Specifically,

- cancer risks associated with radionuclides at all of the FUSRAP areas exceed the upper bound of the NCP cancer risk range;
- cancer risks associated with chemicals at one of the FUSRAP areas (Equipment Storage Yard) exceed the upper bound of the NCP risk range; and
- non-cancer hazard index values associated with chemicals at the Clamshell Pile exceed the threshold hazard index value of 1.

As stipulated by USEPA, when risk to an individual or either current or future land use exceeds the $10^{-4}$ lifetime excess cancer risk end of the risk range, or if there are non-carcinogenic hazards in excess of a hazard index of 1, action under CERCLA is generally warranted. Therefore, based on the results of the risk assessments completed at the CE Windsor Site, response actions are required at each of the FUSRAP areas.

## 6.0 References

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