JOINT BASE MYER HENDERSON HALL

PROPOSED PLAN FOR FMY-01

FORT MYER, VIRGINIA

MAY 2024

*Text in **bold italics** (at first use) indicates that a word/phrase is included in the glossary at the end of this Proposed Plan.*

MARK YOUR CALENDAR!

The Army will accept written comments on the Proposed Plan during the public comment period. Comments should be emailed or postmarked by August 9, 2024. Mailed comments should be sent to the following location at JBM-HH, where a copy of the Proposed Plan is available for public review as part of the **Administrative Record** file:

Department of Public Works (DPW)
Environmental Division
111 Stewart Road, Building 321
Fort Myer, VA 22211-1199

Email: usarmy.jbmhh.asa.mbx.fort-myer-fort-mcnair-stormwater-program@army.mil

Public Review of Proposed Plan

The Proposed Plan will be available for review here - Plan Proposal

Public Meeting

The Army will hold a public meeting to explain the Proposed Plan if sufficient interest is received to warrant a meeting.

1.0 INTRODUCTION

This ***Proposed Plan*** identifies the Preferred Remedy Alternative for FMY-01 within Joint Base Myer-Henderson Hall (JBM-HH) FMY-01, located in Fort Myer, Virginia (Figures 1-1 and 1-2). This cleanup plan is being proposed in accordance with the ***Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)***, as amended by the ***Superfund Amendments and Reauthorization Act (SARA)*** of 1986. The preferred alternative for FMY-01 is **Alternative 7, *Fracture-enhanced (FE) Soil Vapor Extraction (SVE)*, FE *Air Sparging*, FE *In Situ Chemical Reduction (ISCR)*, *Monitored Natural Attenuation (MNA)*, and *Land Use Controls (LUCs)*.**

The Army is the lead agency for conducting investigations and remediation at this site, and the Virginia Department of Environmental Quality (VADEQ) is the support agency. The site is not managed through the CERCLA National Priorities List (NPL). Activities conducted at the site must comply with the ***Defense Environmental Restoration Program (DERP)*** statute, Title 10 United States (U.S.) Code Section 2701 (10 USC 2701) et seq.; CERCLA, 42 USC § 9601 et seq.; Executive Orders 12580 and 13016; and the ***National Oil and Hazardous Substances Pollution Contingency Plan (NCP)***, Title 40 Code of Federal Regulations (40 CFR) Part 300.

This Proposed Plan is being issued by the Army as part of its public participation responsibilities under NCP Section 300.430(f)(2) and CERCLA Section 117(a) (42 USC § 9617). The Proposed Plan summarizes seven cleanup alternatives evaluated for FMY-01 and identifies the preferred cleanup method selected by the Army with agreement from VADEQ. This information can be found in greater detail in the ***Feasibility Study (FS)*** report for FMY-01 Former Dry-Cleaning Facility and FMY-02 Former Sanitary Landfill (SIA-TPMC 2024). Information on the five-year reviews, site investigations, and cleanup efforts can be found at the ***information repository*** at Arlington Public Library (Central Branch), 1015 N Quincy St, Arlington, VA 22201. The public is encouraged to review this Proposed Plan and supporting documents in the information repository to gain a more complete understanding of the activities previously conducted at FMY-01 and FMY-02. See the above information box for details on the information repository and to find out how your opinion can be heard. The official ***Administrative Record file*** is maintained and located at 111 Stewart Road, Building 321, Fort Myer, VA 22211-1199. The FS addressed FMY-01 and FMY-02 and proposed remediation alternatives for FMY-01; No Action is proposed for FMY-02. The public has until **August 9, 2024** to comment on the Proposed Plan.

The Army, in consultation with VADEQ, will select the final remedy for the site after reviewing and considering all information submitted during the public comment period. The input the public provides may result in the selection of a final ***remedial action*** that differs from the Preferred Alternative. The final decision on contaminated groundwater at FMY-01 will be presented in a ***Decision Document***. This document will include a Responsiveness Summary containing any regulator comments on the Proposed Plan and any new relevant information submitted during the public comment period, along with the Army's response. A notice will be placed in the local newspaper when the Decision Document is finished and can be read at the information repository.

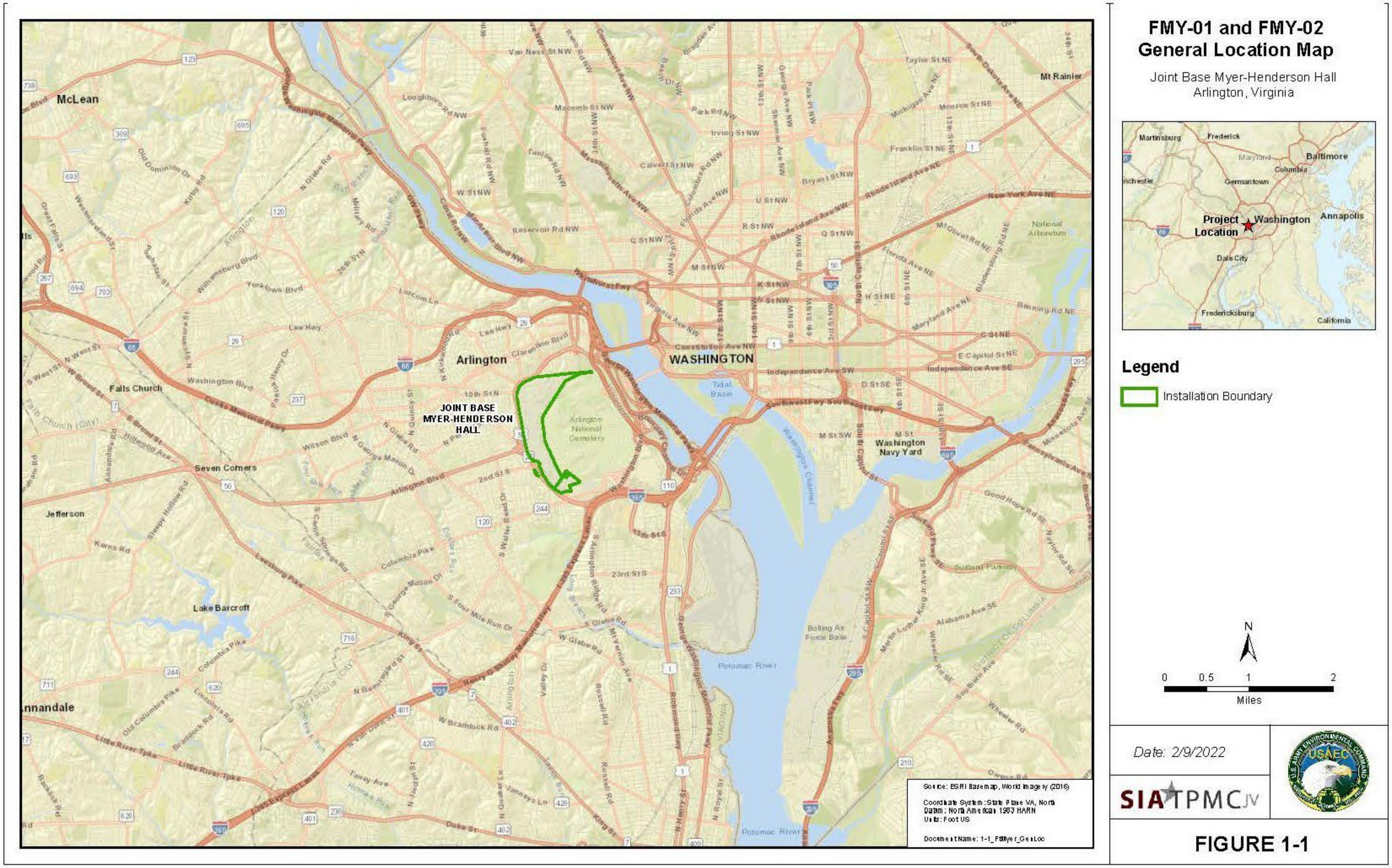

Figure 1-1. FMY-01 and FMY-02 General Location Map

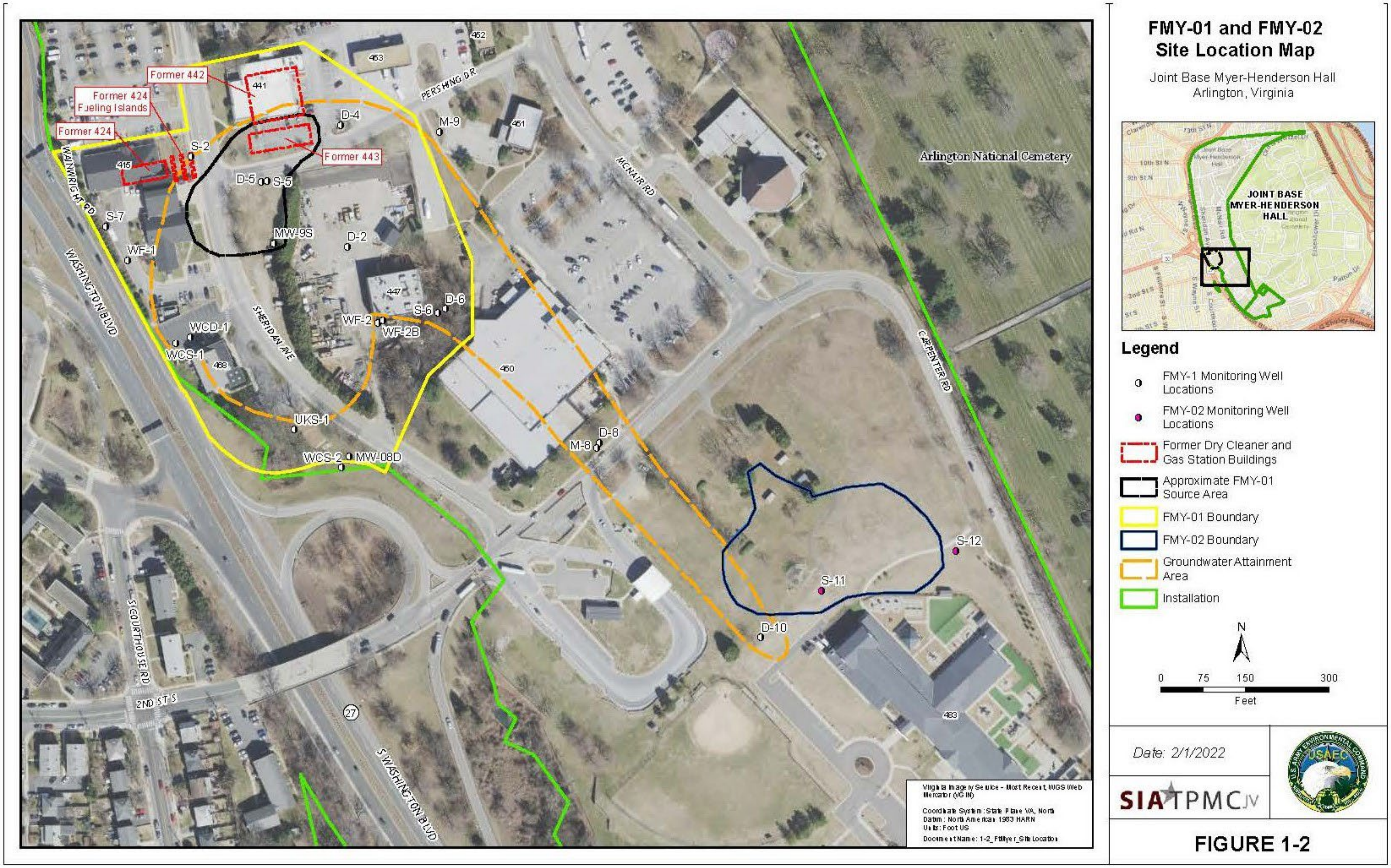

Figure 1-2. FMY-01 and FMY-02 Site Location Map

2.0 SITE BACKGROUND

2.1 JBM-HH Description

JBM-HH consists of approximately 380 acres located in the east portion of Arlington County, Virginia, adjacent to Arlington National Cemetery. JBM-HH provides installation services and support to both active and retired military, their families, and civilians. Additionally, JBM-HH provides Base Support to the Military District of Washington/Joint Forces Headquarters-National Capital Region facilitating deployment of forces for Homeland Defense and Defense Support to Civil Authorities in the National Capital Region. JBM-HH is also used for official ceremonies and public events (Atkins 2013).

2.2 Site Description

Cleanup site designations at FMY-01 (Former PX [post exchange] Gas Station and Former Dry-Cleaning Facility) and FMY-02 (Former Sanitary Landfill) are located within the southern portion of JBM-HH in an area of current and historic commercial use (Figure 1-2).

The Area of Interest, FMY-01, for this Proposed Plan was a former dry-cleaning plant (former Building 443) that was located on Pershing Drive and was combined with the former U.S. Army and U.S. Air Force Exchange Service PX service station (former Building 424) located on Sheridan Avenue to the west of former Building 443.

FMY-01 is characterized by soil and groundwater impacted with chlorinated solvents south of former Building 443 and petroleum hydrocarbons impacted soil and groundwater southeast of former Building 424. Based on previous soil and groundwater assessment the contaminant plumes merge (comingle) at the southeast corner of Sheridan Avenue and Pershing Drive.

The former dry-cleaning facility was demolished in 1991, and the former gas station was demolished in 1984. The site now contains a Physical Fitness Center (current Building 415) and Shopette, with parking lots, which were constructed in the area of FMY-01 following the 1992 site characterization.

The FMY-02 site is a former sanitary landfill that was used for the disposal of sanitary waste and construction debris. No further action is proposed for FMY-02 because no groundwater exceedances were reported in the previous investigations. Therefore, no risk to human health or the environment that warranted a remedial response was identified.

2.3 FMY-01 Site Characterization

2.3.1 1992 FYM-01 Site Characterization Investigation

A 1992 site characterization investigation identified subsurface soil and groundwater contamination with perchloroethene (PCE) and benzene, toluene, ethylbenzene, and total xylene (BTEX). Chlorinated solvents, including PCE and its degradation products, are associated with dry cleaning activities, whereas BTEX compounds are fuel related (USACE 1992).

2.3.2 1993–1997 FMY-01 Soil Vapor Extraction Remediation

A soil vapor extraction (SVE) system was installed in June 1993 to remediate soil contamination at the Former Dry-Cleaning Facility and Former PX Gas Station. JBM-HH installed the remediation system to minimize soil disposal costs and avoid worker exposure to contaminants during future development. During SVE remediation, the system removed more than 4,400 pounds of PCE, 110 pounds of benzene, and 14,500 pounds of fuel-related organic compounds and appeared to have remediated soil in a 1.75-acre area. In July 1997, the system was shut down and subsequently dismantled after reaching ***asymptotic*** conditions, indicated by a plateau in the rate of contaminant removal. During construction of the Shopette in 1995–1996, approximately 2,200 tons of PCE-impacted soil was excavated and disposed of appropriately, and the sub-slab impermeable membrane was installed to limit migration of subsurface vapors (Woodward-Clyde 1997).

2.3.3 1998–2001 URS Quarterly Groundwater Sampling Events and 2001 Comprehensive Report at FMY-01

A comprehensive report presented the results of the groundwater monitoring, a groundwater model, a ***human health risk assessment (HHRA),*** and an evaluation of remedial alternatives. It concluded that no immediate remedial action was recommended based upon the results of the risk assessment. MNA with long-term monitoring was recommended as the most effective remedial alternative. MNA uses naturally occurring processes in soil and groundwater to reduce the mass and concentration of contaminants over time (URS 2001).

2.3.4 2001–2007 FMY-01 Routine Groundwater Sampling and the 2007 U.S. Army Center for Health Promotion and Preventive Medicine Groundwater Monitoring

Nine rounds of groundwater monitoring were performed between March 2001 and January 2005 to monitor the effectiveness of the selected remedy. These results were documented in quarterly reports and subsequently summarized and documented in the 2012 Final Phase II Pilot Study Summary Report (CDM 2012).

In June 2007, the U.S. Army Center for Health Promotion and Preventive Medicine conducted a groundwater sampling event to identify fuel-related ***volatile organic compounds (VOCs)*** and ***chlorinated volatile organic compounds (CVOCs)*** at concentrations greater than ***maximum contaminant levels*** (***MCLs)*** in 12 site monitoring wells. PCE and BTEX concentrations were reported lower than the previous findings but still exceeding the MCLs.

2.3.5 2010 Phase I Confirmation Study Memorandum for FMY-01

In 2010, a Phase I confirmation study was conducted to verify the magnitude and extent of the remaining contamination and to evaluate the biological remediation progress and potential. The presence of trichloroethane (TCE) and cis-1,2-dichloroethene (cis-DCE), products of the biological degradation of PCE, indicated that reductive ***dechlorination*** processes were occurring or had occurred in the past. However, this naturally occurring bioremediation was limited by environmental conditions, including acidic groundwater. The availability of ***electron donors***, compounds which are required by microbes for reductive dechlorination to occur, was also found to be limited.

The study recommended the installation of additional monitoring wells, injection of an electron donor, and monitoring of VOC concentrations to determine the effectiveness of the injection program (CDM 2010, 2012)

2.3.6 2012 – Phase II Pilot Study Report for FMY-01

From 2010 through 2013, a two-phase Treatability Study was conducted at the Former Dry-Cleaning Facility to assess the site potential for ***enhanced in situ bioremediation (EISB)***, which involves the direct injection of microbes into the groundwater contaminant plume. EISB methods use a combination of ***biostimulation***, supplementing the carbon source to increase microbial growth, and ***bioaugmentation***, adding cultured bacteria with known dechlorination capabilities. These bacteria are obligate anaerobes that can chemically reduce chlorinated solvents, such as PCE, in the absence of oxygen. Anaerobic conditions were established at wells S-5 and MW-9S, along with the first detection of vinyl chloride (VC) at FMY-01. VC is the last toxic product in the process of PCE degradation to ethylene. However, groundwater monitoring results indicated that appropriate reducing conditions were not achieved during the pilot study. The inability to distribute emulsion oil was a disadvantage of selecting EISB for the site due to the low injection volume, low pH, relatively unknown lithology, and limited monitoring network. EISB remedies also typically employ multiple injection events with high-volume injections, optimized over time.

The report recommended immediate actions to address challenges presented during the study and are addressed in the Extended Phase II Treatability Study (see section 2.3.7). Long-term actions were recommended, including further characterization of soil chemistry, installation of additional groundwater monitoring wells to understand site lithology and further delineation of dissolved-phase plume distributions, and monitoring of electron donor/***pH buffer*** injection rates and distributions to estimate spacing of future injection points (CDM 2012).

2.3.7 Extended Phase II Treatability Study Addendum for FMY-01

The Treatability Study was extended to better evaluate the ability of enhanced anaerobic bioremediation to treat chlorinated solvents in groundwater at JBM-HH.

Soil sampling was conducted to delineate the nature and extent of CVOCs near the contamination source area and to better characterize the subsurface lithology. In addition, a total of six injection wells were installed upgradient; aquifer pH buffering and monitoring was performed to achieve conditions conducive to reductive dechlorination; injection amendments and volumes were optimized for site-specific geology and geochemical conditions and injected with a reduced distribution target; and reductive dechlorination was monitored. Increased dechlorination efficiency was found to occur with higher pH and higher methane concentrations, which served as a general indicator of geochemical conditions conducive to reductive dechlorinating bacteria. Subsequently, reducing conditions within the treatment zone area was achieved and considered to be conducive to bioaugmentation.

Because of high concentrations of TCE in the soil samples as deep as 45 feet below ground surface (bgs), it was recommended that a ***remedial investigation (RI)***/feasibility study be conducted to further delineate their interaction with groundwater. Direct groundwater treatment would likely not be enough to address the dissolved groundwater plume because much of the contaminant mass still resides in the soil, and surface water infiltration provides a long-term continuous source of groundwater contamination.

2.3.8 2013 Vapor Intrusion Assessment at FMY-01

Vapor intrusion (VI) sampling was conducted in February 2013 to better define the nature and extent of the FMY-01 PCE plume and to determine whether human health is potentially affected by CVOC vapors.

The VI sampling results determined that PCE was detected in five of the six sub-slab (soil gas) sample locations, but based on results screening, no risks were identified for employees who inhabit the building for 8 hours a day. Based on these findings, VADEQ concurred that there were no imminent risks to receptors from vapors. VADEQ requested to include a warm-weather sampling event to assess seasonal variations in soil gas. The warm weather VI sampling event was performed in May 2015 as part of the RI effort discussed in section 2.3.9.

2.3.9 FMY-01 Remedial Investigation

An RI was conducted starting in 2015, which included VI sampling for soil gas at the six existing sub-slab monitoring points; groundwater sampling of the existing wells; installation of four additional intermediate and deep groundwater monitoring wells; and soil borings in the ***vadose zone***, above 50 feet bgs (EA 2018).

The RI concluded:

- Subsurface soil contamination is in exceedance of protection of groundwater criteria and will continue to be a source to groundwater. The generally steady-state groundwater PCE concentrations in the source area, and observations of ***light non-aqueous phase liquids (LNAPL)*** and elevated concentrations of BTEX in adjacent borings support this finding.
- Based upon sampling results, the FMY-01 groundwater contaminant plume is thought to have reached a steady state and is retracting in some areas. Reductive dechlorination is ongoing but appears to be mostly stalled at intermediate byproducts. The FMY-01 PCE plume (and resultant daughter products such as TCE and *cis*-DCE) is expected to last for decades due to ongoing leaching of contaminant mass from soils underlying FMY-01 to the groundwater below.
- The weight of evidence (i.e., clean water lens, deep CVOC impacts, VI sampling results for Buildings 468 and 447, and vapor barriers installed) and the conceptual risk models indicate that there are no unacceptable risks from VI.
- Potential ***exposure pathways*** include surface and subsurface soil, groundwater, and VI exposure to current and projected future construction workers and future hypothetical residents.

Figure 1-2 shows the former buildings and RI sampling locations.

2.4 FMY-02 Site Characterization

2.4.1 2016–2017 Former Sanitary Landfill (FMY-02) Shallow Groundwater Investigation

A groundwater investigation was conducted from October 2016 through February 2017 to assess shallow groundwater conditions underlying FMY-02 and the surrounding area. Four shallow wells and an existing deep aquifer monitoring well were sampled. The sample results included three exceedances above the EPA MCLs. These exceedances (lead, TCE, benzene) were observed in monitoring wells S-10 and D-10, which are associated with the FMY-01 plume (EA 2017a).

2.4.2 2016–2017 Former Sanitary Landfill (FMY-02) Shallow Vapor Intrusion Investigation

EA conducted a VI sampling study in Building 483 (Child Development Center), adjacent to the FMY-02. Two sampling rounds were conducted: one during the heating season (November 2016) and the other during the cooling season (July 2017). The study included six sub-slab sampling points distributed throughout the building.

The results of this study did not show any exceedances of the Project Action Limits (PALs) specified in the VI Work Plan, except for acrolein, a byproduct of cooking fatty foods. The maximum detected concentration of acrolein (0.81 micrograms per cubic meter [$\mu g/m^3$]) was less than average residential indoor concentrations (greater than 1 $\mu g/m^3$) and therefore not considered a risk (EA 2017b).

3.0 SCOPE AND ROLE OF RESPONSE ACTION

This Proposed Plan is intended to address potential risks to human health and the environment associated with contaminated soil and groundwater at FMY-01, as described in Section 4.0.

4.0 SUMMARY OF SITE RISKS

An HHRA was performed as a part of the 2018 RI to determine the potential risks to human health and the environment from exposure to chemical contamination present in FMY-01. The HHRA does not include FMY-02 because no exceedances were identified at FMY-02 during the groundwater and VI studies; hence no risk was identified. It is the Army's current judgment that the Preferred Alternative identified in this Proposed Plan, or one of the other cleanup alternatives considered in the Proposed Plan, is necessary to protect public health and the environment from actual or threatened releases of hazardous substances into the environment.

4.1 *Human Health Risk Assessment*

The objective of the HHRA was to derive site-specific estimates of exposures and risks to potential ***receptors*** comprising hypothetical child residents, hypothetical adult residents, and construction workers at FMY-01, although residents are not expected to be present due to the current and anticipated future commercial-industrial land use. Receptors face hazards if there is a pathway (ingestion, dermal contact, or inhalation) for their exposure to contamination.

NCP §300.430(e)(2)(i)(A)(1) provides guidance for exposure to systemic toxicants; these shall be reduced to concentrations not having an adverse effect on the human population, including sensitive subgroups, and incorporating a margin of safety. NCP §300.430(e)(2)(i)(A)(2) provides an acceptable range for excess lifetime ***cancer risk*** resulting from site exposure, or carcinogenic risk (CR), of 10^{-6} (1 in 1,000,000) to 10^{-4} (1 in 10,000). The upper bound of this risk level shall be used to determine remediation goals when ***applicable or relevant and appropriate requirements (ARARs)*** are not available, or when additional protection is required due to the presence of multiple contaminants or multiple exposure pathways.

The HHRA identified potentially complete exposure pathways for the resident exposure to soil (via the migration to groundwater pathway) and groundwater via ingestion of and dermal contact with groundwater as a potable water supply; inhalation of CVOCs while showering and other household activities; and inhalation of CVOCs due to VI from groundwater. A potentially complete exposure pathway for the construction worker was identified as inhalation of CVOCs in a trench.

Both carcinogenic risks and non-carcinogenic hazards were estimated for the construction worker and the hypothetical child and adult residential receptors. The construction worker risk assessment indicated that carcinogenic risk is within or below the acceptable risk range. However, the residential risk assessment showed that carcinogenic risks are above this range for several ***contaminants of concern (COCs)***: ethylbenzene ($3x10^{-4}$) (3 in 10,000), PCE ($6x10^{-3}$) (6 in 1,000), TCE ($2x10^{-2}$) (2 in 100), and VC ($2x10^{-4}$) (2 in 10,000) have a CR greater than 10^{-4} at FMY-01 and benzene (3×10^{-5}) (3 in 100,000) had a risk at the upper end of the acceptable carcinogenic risk range. There were three COCs that were only noncarcinogenic: cis-1,2-dichloroethene, trans-1,2-dichloroethene and xylenes, all of which had target hazard quotients above 1.

Table 1 presents a summary of the HHRA results for the carcinogenic and noncarcinogenic risks. For further details, the HHRA is available as part of the 2018 Remedial Investigation report, which can be found in the Administrative Record file (EA 2018).

4.2 Ecological Risk Evaluation

Current and probable future land use, in addition to physical features such as extensive pavement, reduce the potential for animals to come into contact with contaminated soils. FMY-01, which is characterized by buildings, paved areas, and roadways in an urban environment, has limited presence of ***ecological receptors*** (such as animals). Surface VOC impacts at FMY-01, observed at 0–2 feet bgs, are confined to an area of less than 0.2 acres that is situated centrally in a highly developed zone with an absence of significant ecological habitats. Analysis of groundwater data collected from 1993 to 2016 suggests that the groundwater contaminant plume lacks a hydrologic connection to neighboring surface water bodies and does not pose an ecological risk to the surrounding area. Due to the absence of significant ecological receptors, an ecological risk assessment was judged to be unnecessary at FMY-01.

Table 1: Summary of HHRA Results for FMY-01

Receptor	Carcinogenic Risk	Non-Carcinogenic Risk	Chemicals of Concern
Hypothetical Child Resident (Cumulative)	2.0E-2	1,087	PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, VC, benzene, ethylbenzene, toluene, xylenes
Hypothetical Adult Resident (Cumulative)	2.0E-2	2,847	PCE, TCE, cis-1,2, DCE, trans-1,2-DCE, VC, benzene, ethylbenzene, toluene, xylenes
Construction Worker (Trench)	3.0E-7	2	TCE

Notes:
Carcinogenic risk results for the child and adult residents are combined to represent a cumulative lifetime carcinogenic risk.
DCE = dichloroethene
PCE = perchloroethene
TCE = trichloroethene
VC = vinyl chloride

5.0 REMEDIAL ACTION OBJECTIVES

To develop cleanup alternatives to address contaminated soil at FMY-01, ***Remedial Action Objectives (RAOs)*** were developed to provide goals for protecting human health and the environment. The current and planned future use of FMY-01 is for industrial/military activity; however, RAOs are based on the remediation required to achieve ***unlimited use/unrestricted exposure (UU/UE)***. The NCP (40 CFR Part 300) specifies procedures, techniques, materials, equipment, and methods to be employed in identifying, removing, or remedying releases of hazardous substances. The RAOs for the FMY-01 soil and groundwater are to:

- Reduce risk to on-site workers' (commercial) and future hypothetical residents' exposure to COCs in groundwater at concentrations above applicable risk-based ***preliminary remediation goals (PRGs)***.
- Reduction or isolation of residual sources of TCE and PCE and BTEX in soil and groundwater to minimize potential plume migration and to enhance reductions of COCs to below the PRGs.
- Reduce the volume/mass of LNAPL in soils within the source area to the maximum extent practicable (MEP).

No RAOs were established for FMY-02 because no groundwater exceedances were reported in the investigations associated with the former landfill. Therefore, no risk to human health or the environment that warranted a remedial response was identified.

5.1 Preliminary Remediation Goals

PRGs are contaminant concentrations based on cleanup goals that are protective of human health and the environment. These goals also comply with any ARARs that have been established by state and federal regulations for the protection of human health and the environment. The PRGs for FMY-01 are risk-based goals and are calculated from toxicity values under site-specific exposure conditions. The PRG calculation uses exposure equations and parameters based on reasonable expected current and future use scenarios. The PRG target cleanup levels that were selected would reduce the risk associated with contaminant exposure to an acceptable level.

Based on the HHRA's analysis of hypothetical resident receptors, PRGs were developed for all COCs present in groundwater at FMY-01. PRGs were also developed for PCE, TCE, and LNAPL present in soils to address the soil to groundwater migration exposure pathways for these contaminants.

Based on the RAOs, the following PRGs were developed for FMY-01:

- PCE and TCE in vadose zone (unsaturated) soil are considered COCs at concentrations in unsaturated soil that exceed 59.8 micrograms per kilogram (µg/kg).
- For LNAPL in the source area at the interface between the vadose zone and groundwater, the PRG should include the

goal of removing LNAPL from FMY-01 to the MEP.
- For groundwater, the EPA MCLs for COCs provides the basis for the groundwater PRG.

The PRGs for FMY-01 were not developed for ecological receptors because there is no significant ecological habitat at the site.

6.0 SUMMARY OF REMEDIAL ALTERNATIVES

The following remedial alternatives for soil and groundwater at FMY-01 were developed and evaluated in the FS (SIA-TPMC 2024):

- Alternative 1: No Action
- Alternative 2: MNA and land use controls (LUCs)
- Alternative 3: Fracture-Enhanced (FE) SVE for Source, FE EISB for Groundwater and Curtain 1, FE (In Situ Chemical Reduction*)* ISCR for ***Groundwater Curtain*** 2, FE Air Sparging for LNAPL, MNA, and LUCs
- Alternative 4: FE SVE for Source, FE ISCR for Groundwater and curtains, FE Air Sparging, MNA, and LUCs
- Alternative 5: FE SVE for Source, FE Air Sparging for Groundwater and LNAPL, FE ISCR for Groundwater Curtains, MNA, and LUCs
- Alternative 6: ***Thermal Remediation*** for Source and Groundwater, FE ISCR for Groundwater Curtains, MNA, and LUCs
- Alternative 7: FE SVE for Source, FE Air Sparging for LNAPL, FE ISCR for Groundwater Curtains, MNA, and LUCs

Alternatives 2 through 7 satisfy the first RAO, reducing exposure risk for on-site workers and hypothetical future residents, through protection of human health and the environment via LUCs. Alternatives 3 through 7 are expected to satisfy all RAOs, with any groundwater plume expansion estimated to be minimal and within the planned area of LUCs.

No technologies were identified or screened for FMY-02 because no groundwater exceedances were reported in the investigations. Therefore, no risk to human health or the environment that warranted a remedial response was identified.

6.1 Alternative No. 1: No Action

Under this alternative, no action or LUCs are taken or implemented on the site. Potential risks and COCs present above PRGs would not be addressed and therefore the No Action alternative would not be protective of human health or the environment.

Evaluation of the No Action alternative is required pursuant to NCP §300.430(e)(6) to provide a baseline against which other alternatives are compared.

6.2 Alternative No. 2: MNA and LUCs

MNA relies on the natural attenuation or the naturally occurring processes in soil and groundwater to reduce the mass and concentration of contaminants and collection and analysis of soil and groundwater samples to assess the progress of MNA. LUCs such as deed restrictions are established methods to limit the potential exposure to contamination.

Alternative 2 partially achieves the RAOs through the implementation of LUCs to protect human health and the environment by limiting exposure to soil and groundwater. The existing groundwater monitoring network would be expanded and utilized to assess the effectiveness of MNA, ensure that contaminant migration does not affect other receptors, and monitor COC concentrations.

Alternative 2 would not be effective in providing long-term protection because MNA alone is unlikely to achieve RAOs and COCs would remain present above PRGs in the short term. This would leave FMY-01 in a condition that does not allow for UU/UE, therefore 5-year reviews will be conducted until UU/UE is achieved.

Alternative 2 is technically and administratively feasible to implement because MNA and LUCs are widely used options, maintenance and monitoring requires minimal effort, and the resources to carry out this alternative are readily available and easily accessible.

Capital Cost: $137,000
Total Operation and Maintenance (O&M) Cost: $1,119,000
Total Present-Worth Cost: $651,000

6.3 Alternative No. 3: FE SVE for Source; FE EISB for Groundwater and Curtain 1; FE ISCR for Groundwater Curtain 2; FE Air Sparging for LNAPL; MNA, and LUCs

Alternative 3 addresses the RAOs and is protective of human health through LUCs and the reduction of COC concentrations in source material and groundwater through the following remedial components:

- FE SVE of the vadose zone source area
  - Extraction and treatment of recovered vapors from the subsurface with SVE system
- In situ reduction of contaminants into less-hazardous compounds via:
  - FE EISB of the groundwater at FMY-01
  - FE EISB and FE ISCR installation at curtains one and two, respectively, within downgradient groundwater
- FE air sparging the LNAPL within FMY-01
- Implementation of LUCs to limit exposure to soil and groundwater
- Use of the existing groundwater monitoring network and additional monitoring wells to monitor COC concentrations, assess the effectiveness of natural attenuation processes and in situ remediation of contaminants, and ensure no further off-site migration could affect other receptors beyond the current limits of the COC groundwater plume

Alternative 3 will remediate VOCs and LNAPLs in the source by applying a vacuum to soils, introducing a controlled airflow that also stimulates aerobic ***biodegradation***. Fracture enhancement increases this airflow, improving both SVE and in situ bioremediation with the injection of EISB amendments composed of site-specific groundwater and microbes combined with an additional organic substrate to enhance microbial activity.

FE ISCR involves the addition of a chemical-reducing agent to groundwater, resulting in the reduction of contaminant mobility or toxicity through biotic or abiotic processes. The implementation of FE ISCR is feasible due to the depth of contamination, which is within the range for plausible treatment with a direct injection curtain or continuous barrier. However, additional treatability studies may be required to evaluate reducing amendments that are suitable to treat COCs in groundwater based on site geochemistry. New injection wells also would be installed in the shallow saturated soil directly below the water table for the implementation of FE air sparging for the treatment of LNAPL.

Following the implementation of FE SVE, FE EISB, FE ISCR, and air sparging (LNAPL only), long-term groundwater monitoring would be performed to confirm that COC concentrations exceeding PRGs are decreasing through natural attenuation.

Alternative 3 would be effective in the long term for reducing COC concentrations through ex situ and in situ treatment of the source and groundwater contaminants. FE SVE would reduce the area of the highest concentrations of COCs and LNAPL in the vadose source area. FE EISB would reduce the area of the highest concentrations of COCs in groundwater. FE ISCR with ***zero-valent iron (ZVI)*** would serve as a polishing treatment for groundwater. FE air sparging would reduce the area of LNAPL in shallow groundwater.

It is expected that once the areas of the highest PCE and TCE concentrations have been reduced, COC concentrations would decrease below the PRGs over time due to natural attenuation. A monitoring program for FMY-01 would be effective in the long term for evaluating the effectiveness of the remedial action and the nature and extent of COCs. LUCs would be implemented to limit exposure to soil and groundwater.

This alternative has a moderate likelihood of success.

Alternative 3 would have a low effectiveness in the short term for decreasing COC concentrations in the FMY-01 source area. FE SVE would reduce the area of the highest concentrations of COCs and LNAPL in the vadose source area. However, FE EISB would take more time and applications within the source area groundwater. Additionally, EISB has the potential to break down COCs and stall intermediate degradation products.

Alternative 3 is implementable because the installation and injection components are readily available. Post treatment groundwater sampling and LUCs also would be easily implemented.

Capital Cost: $13,515,000
Total O&M Cost: $8,594,000
Total Present-Worth Cost: $19,240,000

6.4 Alternative No. 4: FE SVE, FE ISCR, FE Air Sparging, MNA, and LUCs

Alternative 4 addresses the RAOs and is protective of human health through LUCs and the reduction of COC concentrations in source material and groundwater through the following remedial components:

- FE SVE of the vadose source area
- Extraction and treatment of recovered vapors from the subsurface with SVE system
- In situ reduction of contaminants into less-hazardous compounds via:
  - FE ISCR of the groundwater at FMY-01
  - FE ISCR installation at curtains within downgradient groundwater
- FE air sparging the LNAPL within FMY-01
- Implementation of LUCs to limit exposure to soil and groundwater
- Use of the existing groundwater monitoring network and additional monitoring wells to monitor COC concentrations, assess the effectiveness of natural attenuation processes and in situ remediation of contaminants, and ensure no further off-site migration that could affect other receptors beyond the current limits of the COC groundwater plume

Alternative 4 would reduce the concentrations of COCs in source material and groundwater in FMY-01, thereby protecting human health. Additionally, this alternative would be protective of human health through LUCs that limit the potential of human and COC interaction. Following the implementation of FE SVE, FE ISCR, and FE air sparging, long-term groundwater monitoring would be performed to confirm that COC concentrations exceeding PRGs are decreasing through natural attenuation.

Alternative 4 would be effective in the long term for reducing COC concentrations through ex situ and in situ treatment of the source and groundwater contaminants. FE SVE would reduce the area of the highest concentrations of COCs and LNAPL in the vadose and saturated source area. FE ISCR would reduce the area of the highest concentrations of COCs in groundwater. FE air sparging would reduce the area of LNAPL in shallow groundwater.

It is expected that once the areas of the highest PCE and TCE concentrations have been reduced, COC concentrations would decrease below the PRGs over time due to natural attenuation. A monitoring program for FMY-01 would be effective in the long term for evaluating the effectiveness of the remedial action and the nature and extent of COCs. Additional LUCs would be implemented to limit exposure to soil and groundwater.

This alternative has a high likelihood of success.

Alternative 4 would be effective in the short term for decreasing COC concentrations in the FMY-01 source area for both vadose and groundwater zones. Groundwater monitoring would be conducted to verify changes to the toxicity, mobility, or volume of COCs.

Alternative 4 is implementable because the installation and injection components are readily available. Post-treatment groundwater sampling and LUCs also would be easily implemented.

Capital Cost: $11,709,000
Total O&M Cost: $2,534,000
Total Present-Worth Cost: $13,502,000

6.5 Alternative No. 5: FE SVE, FE Air Sparging, FE ISCR, MNA, and LUCs

Alternative 5 addresses the RAOs and is protective of human health through LUCs and the reduction of COC concentrations in source material and groundwater through the following remedial components:

- FE SVE of the vadose source area
- Extraction and treatment of recovered vapors from the subsurface with SVE system
- In situ reduction of contaminants into less-hazardous compounds via FE ISCR installation at curtains within downgradient groundwater
- FE air sparging the LNAPL with FMY-01
- Implementation of LUCs to limit exposure to soil and groundwater
- Use of the existing groundwater monitoring network and additional monitoring wells to monitor COC concentrations, assess the effectiveness of natural attenuation processes and in situ remediation of contaminants, and ensure no further offsite migration that could affect other receptors beyond the current limits of the COC groundwater plume

Alternative 5 would reduce the concentrations of COCs in source material in FMY-01, thereby protecting human health. Additionally, this alternative would be protective of human health through LUCs that limit the potential of human and

COC interaction. Following the implementation of FE SVE, FE air sparging, and FE ISCR, long-term groundwater monitoring would be performed to confirm that COC concentrations exceeding PRGs are decreasing through natural attenuation.

Alternative 5 would be effective in the long term for reducing COC concentrations through ex situ and in situ treatment of the source and groundwater contaminants. FE SVE would reduce the area of the highest concentrations of COCs and LNAPL in the vadose source area. FE air sparging would reduce the area of the highest concentrations of COCs and LNAPL in groundwater. FE ZVI would be used as a polishing material downgradient of the groundwater to further convert certain contaminants into less-hazardous compounds.

It is expected that once the areas of the highest PCE and TCE concentrations have been reduced, COC concentrations would decrease below the PRGs over time due to natural attenuation. A monitoring program for FMY-01 would be effective in the long term for evaluating the effectiveness of the remedial action and the nature and extent of COCs. Additional LUCs would be implemented to limit exposure to soil and groundwater.

This alternative has a high likelihood of success.

Alternative 5 would be effective in the short term for decreasing COC concentrations in the FMY-01 source area. It is likely that the combination of FE SVE and FE air sparging would reduce concentrations of COCs to PRGs within the source area in two years. As a result, Alternative 5 would not generate additional on-site and off-site adverse environmental impacts originating from the source area. Groundwater monitoring would be conducted to verify changes to the toxicity, mobility, or volume of COCs.

Alternative 5 is implementable because the installation and injection components are readily available. Post-treatment groundwater sampling and LUCs also would be easily implemented.

Capital Cost: $8,737,000
Total O&M Cost: $2,915,000
Total Present-Worth Cost: $10,875,000

6.6 Alternative No. 6: Thermal for Source, FE ISCR for Groundwater Curtains, MNA, and LUCs

Alternative 6 addresses the RAOs and is protective of human health through LUCs and the reduction of COC concentrations in source material and groundwater through the following remedial components:

- ***Electrical Resistivity Heating (ERH)*** and extraction of vapors
- Extraction and treatment of recovered vapors from the subsurface with SVE system
    - VI mitigation system of Building 441 (shopette) for potential fugitive emissions from SVE treatment system
- In situ reduction of contaminants into less-hazardous compounds via FE ISCR with ZVI installation at two curtains within downgradient groundwater
- Implementation of LUCs to limit exposure to soil and groundwater
- Use of the existing groundwater monitoring network and additional monitoring wells to monitor COC concentrations, assess the effectiveness of natural attenuation processes and in situ remediation of contaminants, and ensure no further offsite migration that could affect other receptors beyond the current limits of the COC groundwater plume.

Thermal remediation involves the heating of source material within the contaminated medium, volatilizing target compounds to allow for their removal and treatment. Alternative 6 includes thermal remediation via ERH to address the areas of the highest COC concentrations in FMY-01. ERH would facilitate in situ degradation of PCE and TCE via hydrolysis and degradation and/or volatilization of secondary COCs and their degradation byproducts. Volatilized contaminants would be captured by SVE with ex situ treatment of the off-gas.

Approximately 200 electrodes would be installed throughout the treatment area. This remedy would require the installation of treatment infrastructure at the site, including heater and vacuum wells, drip tubes for water injection, power distribution system, heat exchanger, and water and vapor treatment. A VI mitigation system also would be installed in Building 441 (shopette) to capture any fugitive emissions not collected by the extraction well system to prevent an indoor inhalation risk for occupants. FE ISCR with ZVI would be installed as a polishing treatment at two groundwater curtains downgradient to further reduce COCs into less-hazardous compounds.

Alternative 6 would reduce the concentrations of COCs in Source Material in FMY-01, thereby protecting human health. Following the implementation of ERH, long-term groundwater monitoring would be performed to confirm that COC concentrations exceeding PRGs are decreasing through natural attenuation.

Alternative 6 would be effective in the long-term for reducing COC concentrations in groundwater through in situ treatment of the Source contaminants. ERH would reduce the area of the highest concentrations of COCs in groundwater. It is expected that once the areas of the highest PCE and TCE concentrations have been reduced, COC concentrations would decrease below the PRGs over time due to natural attenuation. A monitoring program for FMY-01 would be effective in the long term for evaluating the effectiveness of the remedial action as well as the nature and extent of COCs. Additional LUCs would also be implemented to limit exposure to groundwater.

This alternative has a high likelihood of success.

Alternative 6 would be effective in the short term for decreasing COC concentrations in the FMY-01 source area through the implementation of subsurface heating using ERH. Further, there would be minimal increased risks to human health or the environment from implementation of this alternative since the increased quantities of volatile contaminants would be collected and treated. Similarly, Alternative 6 would not generate additional on-site and off-site adverse environmental impacts. Beneficial effects of Alternative 6 would be realized immediately through high-impact reductions in COC concentrations. Some COC concentrations would remain above PRGs in the short term. However, LUCs would be effective in preventing exposure to groundwater.

Alternative 6 is implementable because thermal remediation via ERH and extraction technology components are readily available and have proven successful at similar sites. The time required for treatment using the ERH system is estimated at up to 385 days including system installation and the ERH operating period. Post-treatment groundwater sampling and LUCs also would be easily implemented.

Capital Cost: $44,518,000
Total O&M Cost: $1,166,000
Total Present-Worth Cost: $45,075,000

6.7 Alternative No. 7 – FE SVE, FE Air Sparging, FE ISCR, MNA, and LUCs

Alternative 7 addresses the RAOs and is protective of human health through LUCs and the reduction of COC concentrations in source material and groundwater through the following remedial components:

- FE SVE of the vadose source area.
- Extraction and treatment of recovered vapors from the subsurface with SVE system.
- In situ reduction of contaminants into less-hazardous compounds via: FE ISCR installation at curtains within downgradient groundwater.
- FE air sparging the LNAPL within FMY-01.
- Implementation of LUCs to limit exposure to soil and groundwater.
- Use of the existing groundwater monitoring network and additional monitoring wells to monitor COC concentrations, to assess the effectiveness of natural attenuation processes and in situ remediation of contaminants, to ensure no further offsite migration that could affect other receptors beyond the current limits of the COC groundwater plume.

Alternative 7 is comparable to Alternative 5; however, Alternative 7 does not actively remediate the deep groundwater at the FMY-01 source area. Rather, Alternative 7 passively remediates the deep groundwater from the FMY-01 source area and the plume through two groundwater treatment curtains. This is acceptable because, despite the elongated remediation timeline, this alternative is the least expensive remediation plan while achieving remediation goals and is likely to prevent off-site mobility of COCs in groundwater.

Alternative 7 would reduce the concentrations of COCs in the vadose zone Source Material in FMY-01, thereby protecting human health. Additionally, this alternative would be protective of human health through LUCs that limit the potential of human and COC interaction. Following the implementation of FE SVE, FE air sparging, and FE ISCR, long-term groundwater monitoring would be performed to confirm that COC concentrations exceeding PRGs are decreasing through natural attenuation.

Alternative 7 would be effective in the long-term for reducing COC concentrations through ex situ and in situ treatment of the source contaminants. FE SVE would reduce the area of the highest concentrations of COCs and LNAPL in the vadose source area, and FE air sparging would reduce the area of the highest concentrations of LNAPL in shallow groundwater. FE ISCR via ZVI would be used as a barrier and polishing material downgradient of the groundwater to further convert certain contaminants into less-hazardous compounds. It is expected that once the areas of the highest PCE and TCE concentrations have been reduced within the vadose zone, COC concentrations would decrease below the PRGs over time due to natural attenuation and the ZVI groundwater curtains. A monitoring program for FMY-01 would be effective in the long term for evaluating the effectiveness of the remedial action as well as the nature and extent of COCs. Additional LUCs would also be implemented to limit exposure to soil and groundwater.

This alternative has a high likelihood of success.

Alternative 7 would be effective in the short term for decreasing COC concentrations in the FMY-01 vadose source area. It is likely that the combination of FE SVE and FE air sparging would reduce concentrations of COCs to PRGs within the vadose source area in two years. However, it would not be effective in reducing COC concentrations within the source groundwater area in a timely manner because it depends on groundwater migration from the source area through the FE ISCR groundwater curtains to decrease the COC concentrations. Groundwater monitoring would be conducted to verify changes to the toxicity, mobility, or volume of COCs.

Alternative 7 is implementable because the installation and injection components are readily available. Post-treatment groundwater sampling and LUCs would also be easily implemented.

Capital Cost: $7,187,000
Total O&M Cost: $2,589,000
Total Present-Worth Cost: $9,031,000

7.0 EVALUATION OF ALTERNATIVES

Nine criteria are used to evaluate the different remediation alternatives individually and against each other to select a remedy; NCP Section 300.430(e)(9)(iii). The nine criteria are further divided into three categories, as presented in Table 2. A comparative analysis of remedial alternatives is provided in Table 3.

Table 2: Overview of Evaluation Criteria

Threshold Criteria: Two of the evaluation criteria relate directly to statutory findings that must ultimately be made in the Decision Document. Therefore, these criteria are categorized as threshold criteria in that each alternative must meet them.

1. **OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT:** Each alternative is assessed to determine whether they can adequately protect human health and the environment from exposure to risks above acceptable threshold levels.
2. **COMPLIANCE WITH *APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs*):** Each alternative is assessed to determine whether they meet federal and state environmental statutes, regulations, and other requirements that pertain to the site.

Primary Balancing Criteria: The five criteria listed below are grouped together because they represent the primary criteria upon which the analysis is based.

1. **Long-Term Effectiveness:** Considers the ability of an alternative to maintain protection of human health and the environment over time.
2. **Reduction of Toxicity, Mobility or Volume through treatment:** Evaluates an alternative's use of treatment to reduce the toxicity, mobility, and volume of the contaminants.
3. **Short-Term Effectiveness:** Considers the risks the alternative poses to the community, workers, and the environment during implementation.
4. **Implementability:** Considers the technical and administrative feasibility of implementing the alternative.
5. **Cost:** Includes the estimated capital and annual operations and maintenance costs and ***present-worth*** cost. Present-worth cost is the total cost of an alternative over time in terms of today's dollar value.

Modifying Criteria: The final two criteria will be evaluated based on state or support agency review of the FS report, input from the public meeting, and public comments.

1. **State Acceptance:** Considers the acceptance of the state or support agency of the preferred alternative.
2. **Community Acceptance:** Considers the acceptance of the community of the preferred alternative.

7.1 Overall Protectiveness of Human Health and Environment

All the alternatives, except for Alternative 1 (No Action), are protective of human health and the environment by reducing or controlling risks posed by site soils and groundwater through LUCs and either active or passive treatment. Additionally, Alternatives 3 through 7 provide active source removal with extraction/treatment to reduce the concentrations of COCs in source soils.

FMY-01 site data indicates the plume is stable, and there is no current risk for indoor inhalation for base population, but future hypothetical risk of exposure can be mitigated.

Regarding the first RAO (reduce risk), alternatives 2 through 7 are protective of human health and the environment. For Alternatives 3 through 7, FMY-01 plume expansion, if any, is estimated to be minimal and to be within the planned area of LUCs. Alternatives 3 through 7 are technologies that can complete a removal of ***LNAPLs*** to the MEP in the source area. Alternatives 3 through 7 comply with the second and third RAO (removal or isolation of residual sources of TCE and PCE and BTEX in soil and reduce the volume/mass of LNAPL) and seek to reduce concentrations of the source material in soils and reduce groundwater concentrations of COCs.

Monitoring and LUCs will provide protection until RAOs are achieved for Alternatives 3 through 7; therefore, meeting this threshold criterion.

7.2 Compliance with ARARs

ARARs were considered for the remedial alternatives for FMY-01. Alternative 1 consists of taking no action, to serve as a baseline for evaluating the other proposed alternatives as required by the NCP Section 300.430(e)(6).). Alternative 1 does not comply with ARARs because groundwater monitoring would not be conducted to ensure groundwater quality regulations that require groundwater restoration are achieved. Because Alternative 1: No Action is not protective of human health and the environment, it is eliminated from consideration under the remaining evaluation criteria.

Alternative 2 implements LUCs to limit exposure to soil and groundwater; however, it does not actively remediate the COCs in the source or groundwater. As a result, it is unlikely that this alternative will comply with ARARs in a reasonable time frame.

Alternatives 3 through 7 comply with location-, action-, and chemical-specific ARARs as removal of source material in soils will be achieved; restrictions to groundwater use are in place; PRGs comply with ARARs and state and federal requirements.

7.3 Long-Term Effectiveness and Permanence

COCs will remain for many decades and may continue to migrate if no action is taken. Alternatives 3 through 7 are likely to reduce contamination and achieve the RAOs. However, Alternatives 5 and 6 excel in short-term effectiveness by achieving source removal in a shorter time with a higher likelihood of success, while also exhibiting excellent long-term effectiveness and permanence at FMY-01. Alternatives 2 through 7 ensure that LUCs are maintained, and natural attenuation is monitored. Alternative 6 has the potential to achieve the RAOs the most quickly, within one year once installed, and protect the base population from any long-term residual contamination in groundwater by effectively reducing the source COCs below the PRGs. As a result, these alternatives are "excellent" in long-term effectiveness and permanence.

Alternatives 4 and 7 are likely to achieve RAOs; however, they require more time than Alternatives 5 and 6. As a result, these alternatives are "good" in long-term effectiveness and permanence.

Alternative 3 requires more time than Alternatives 5 and 6 (potentially 10–15 years due to requirement for multiple injections of reagent and pH adjustments to the treatment area). Additionally, this alternative has a moderate likelihood of success. As a result, this alternative is "moderate" in long-term effectiveness and permanence.

Within Alternative 2, some natural attenuation of the COCs would occur; however, RAOs would not be achieved. As a result, this alternative is "poor" in long-term effectiveness and permanence.

7.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 3 through 7 would reduce toxicity, mobility, or volume through treatment at FMY-01. Alternatives 3 through 7 provide active treatment to reduce the mass of COCs and inhibit ongoing migration from source area soils to groundwater. Remaining COCs in groundwater would be addressed by implementing LUCs and continuing long-term groundwater monitoring to verify no further off-site mobility of COCs in groundwater.

However, Alternatives 5, 6, and 7 are the most effective in reducing toxicity, mobility, or volume through treatment at the source and depend less on the groundwater curtains. As a result, these alternatives are "good" in reduction of toxicity, mobility, or volume through treatment while Alternatives 3 and 4 are "moderate" in reduction of toxicity, mobility, or volume through treatment.

Within Alternative 2, some natural attenuation of the COCs would occur; however, RAOs would not be achieved. As a result, this alternative is "poor" in reduction of toxicity, mobility, or volume through treatment.

7.5 Short-Term Effectiveness

Alternatives 3 through 7 present potential short-term impacts to workers, which include risk associated with drilling and heater/extraction point installations, power and treatment system installations, and treatment of extracted vapor and liquids during system operation; working in proximity to a through road and near base buildings; and waste handling during treatment.

Another potential short-term risk associated with Alternatives 3 through 7 is vapor and off-gassing from the construction and heating process. These risks would be monitored near the treatment area with stack monitoring and sampling and perimeter air monitoring as required to be compliant with ARARs. These risks may be controlled but not eliminated by following standard health and safety practices and proper construction safety measures and by implementing appropriate traffic plans.

Alternative 3 is the most likely to have short-term impacts to overall protection of human health and the environment because EISB has the potential to break down COCs and stall intermediate degradation products *cis*-1,2-DCE, *trans*-1,2-DCE, and VC. These risks can be effectively managed and controlled with the use of proper air testing and personal protective equipment usage and a series of subsurface injection curtains positioned within the groundwater's downgradient area. Additionally, Alternative 2 does not actively reduce COCs within the source area via treatment. As a result, these alternatives are "low" in short-term effectiveness.

Alternatives 3, 4, and 7 do not achieve RAOs as quickly as Alternatives 5 and 6. However, Alternatives 3, 4, and 7 are protective of both human health and the environment. Alternative 3's short-term effectiveness is rated as low. The primary factor contributing to this effectiveness rating is the extended timeline associated with bio-enhanced MNA, which is anticipated to take significantly longer than the corresponding timelines for Alternatives 4 and 7.

Alternative 4 degrades COCs to be protective of human health and the environment. Alternative 7 removes source area COCs through active remediation of vadose zone soils in a timely manner and remediates the deep groundwater from the FMY-01 source area and the plume through two groundwater treatment curtains. As a result, these alternatives are "moderate" in short-term effectiveness.

Alternative 6 has the potential to achieve the RAOs the most quickly, within one year once installed, and Alternative 5 is likely to reduce concentrations of COCs to RAOs within the source area in two years. As a result, these alternatives are "good" in short-term effectiveness.

7.6 Implementability

Alternatives 3 through 7 are implementable. For these alternatives, treating under the roadway with angled points and dealing with buffers around current utilities are challenges to implementability.

For Alternatives 3 through 7, fracturing through the site soil types may prove challenging to implement as homogeneous soils are optimal for installation. However, the pre-design investigation/remedial design characterization can determine fracture intervals with more certainty so the heterogenous soils would be less of a concern for fracture enhancement.

For Alternative 6 there are challenges associated with power generation/distribution and installing heating points in developed areas. Additionally, the disadvantage of ERH probes is that they are affected by subsurface conditions (such as debris and changes in soil moisture in vadose zone soils), which may lead to inconsistent heating due to variable soil resistivity. If more water is required to be introduced into the treatment area, this could prolong the overall treatment time. As a result, these alternatives are "moderate" in implementability.

7.7 Cost

There are no costs associated with Alternative 1. Estimated ***capital costs***, ***Operation and Maintenance (O&M) costs***, and total costs (as adjusted for ***present worth*** over the specified time periods) are summarized in Table 3.

There are no costs for Alternative 1 because no action is taken. The net present worth for Alternative 2 that does not actively require remediation is approximately $651,000. With the relatively rapid treatment of the source material soil included as part of Alternatives 3 and 6, there is a much higher capital cost in comparison to O&M costs due to the intensive construction, working around the roadways and utilities; net remediation costs for these alternatives total approximately $19.0 million and $45.0 million in present worth, respectively.

Alternative 5 and 7 are the most balanced between time to achieve remedial goals, short- and long-term effectiveness, and total cost of remediation at approximately $10.9 and $9.0 million in present value, respectively. The difference between Alternative 5 and 7 is that Alternative 5 actively remediates the groundwater at the FMY-01 source area and polishes the remaining COCs with two groundwater curtains. Alternative 7 does not actively treat the groundwater source area but passively remediates the groundwater at the FMY-01 source area, and it actively remediates the downgradient groundwater plume with two groundwater curtains. This is acceptable because, despite the elongated remediation timeline, this alternative maintains overall protection of human health and the environment, as well as likely achieving no off-site mobility of COCs in groundwater.

7.8 State or Support Agency Acceptance

VADEQ is the state regulatory agency. The Army has coordinated with VADEQ during the RI/FS process and during identification of remedial action alternatives, including the preferred alternative, for the site. State acceptance will be fully addressed in the Decision Document after all public comments are received.

7.9 Community Acceptance

Community acceptance of the preferred alternative will be evaluated based on comments received during the public comment period and the public meeting (conducted if sufficient interest is received). All comments will be considered, and significant comments will be described and addressed in the responsiveness summary. Considering the comments received, USACE may change a component of the preferred alternative, select another alternative, or select a “new” alternative. If the basic features of the new cleanup alternative are significantly different from what could have been reasonably anticipated from this Proposed Plan, USACE will seek additional public comment on a revised Proposed Plan.

8.0 PREFERRED ALTERNATIVE

It has been concluded that the previous investigation results support the conclusion that there is an unacceptable health risk at FMY-01. Based on the criteria and evaluation conducted under Section 7.0, Alternative 7 is being proposed as the Preferred Alternative at FMY-01 that meets regulatory requirements and satisfies the statutory requirements under CERCLA §121(b).

Alternative 7 includes FE SVE for the source, FE air sparging for LNAPL, FE ISCR via groundwater curtains, MNA, and LUCs. FE soil vapor extraction relies on installation of extraction wells to collect gaseous VOCs and treat vapors. Fracture-enhanced air sparging involves injection of air to saturated soils in the source area to volatilize LNAPL for collection via extraction wells. Fractured-enhanced ISCR injection would be used at downgradient curtains as a polishing amendment.

Alternative 7 meets the evaluation criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The preferred alternative is expected to satisfy the following statutory requirements of CERCLA §121(d):

1. Be protective of human health and the environment.
2. Comply with ARARs.
3. Be cost effective.
4. Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.
5. Satisfy the preference for treatment as a principal element or explain why the preference for treatment would not be met.

No Action is required for FMY-02 because no groundwater exceedances were reported in the investigations associated with the landfill. Therefore, no risk to human health or the environment was identified that warrants an action.

Table 3 Comparative Analysis of Remedial Activities

Criterion	Alternative 1: No Action	Alternative 2: MNA and LUCs	Alternative 3 FE SVE, FE EISB, FE ISCR, FE Air Sparging, MNA, and LUCs	Alternative 4 FE SVE, FE ISCR, FE Air Sparging, MNA, and LUCs	Alternative 5 FE SVE, FE Air Sparging, FE ISCR, MNA, and LUCs	Alternative 6 Thermal, FE ISCR, MNA, and LUCs	Alternative 7 FE SVE, FE Air Sparging, FE ISCR, MNA, and LUCs
Overall Protection of Human Health and the Environment	Not protective	Protective	Protective	Protective	Protective	Protective	Protective
Compliance with ARARs	Not compliant	Not compliant	Compliant	Compliant	Compliant	Compliant	Compliant
Long-Term Effectiveness and Permanence	Not evaluated	Poor	Moderate	Good	Excellent	Excellent	Good
Reduction of Toxicity, Mobility, or Volume	Not evaluated	Poor	Moderate	Moderate	Good	Good	Good
Short-Term Effectiveness	Not evaluated	Low	Low	Moderate	Good	Good	Moderate
Implementability	Not evaluated	Good	Moderate	Moderate	Moderate	Moderate	Moderate
Total 30-Year Present Value Cost							
Capital	$0	$137,000	$13,515,000	$11,709,000	$8,737,000	$44,518,000	$7,187,000
O&M (PV)	$0	$514,000	$5,725,000	$1,794,000	$2,139,000	$557,000	$1,844,000
Present Value Cost	$0	$651,000	$19,240,000	$13,502,000	$10,875,000	$45,075,000	$9,031,000
Remedial Timeframe	50-100 years	50-100 years; 30 years monitoring	365 days for PDI, design, bidding, and procurement; 202 days construction, 116 days treatment; 30 years monitoring	365 days for PDI, design, bidding, and procurement; 467 days construction and treatment; 30 years monitoring	365 days for PDI, design, bidding, and procurement; 375 days construction and treatment; 30 years monitoring	365 days for PDI, design, bidding, and procurement 45-60 days construction, 325 days treatment; 30 years monitoring	365 days for PDI, design, bidding, and procurement 45-60 days construction, 297 days treatment; 30 years Monitoring

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
O&M = Operation and Maintenance

COMMUNITY PARTICIPATION

Public input is important to the decision-making process. Your comments on the Army's ***preferred remedial alternative*** of Alternative 7 are encouraged during the public comment period before a decision is made on the final remedy. You are encouraged to review the reports listed in the reference section that the Army used to arrive at its proposed decision and use the comment period for questions and concerns about the proposed decision.

AVAILABLE INFORMATION

Technical details on the proposed Alternative 7 decision are available in the documents provided for the public in the information repository at the following location:

Local Information Repository:

Arlington Public Library (Central Branch)

1015 N Quincy St.

Arlington, VA 2201

The public is invited to participate in the decision process and the resulting proposed decision. If there is sufficient interest, a public meeting may be held during the public comment period. Through receiving comments and a potential public meeting, the Army seeks to provide an opportunity for the public to ask questions and make comments.

Based on any new information or public comments that are received, the Army may modify its proposed decision of Alternative 7. The Army will summarize and respond to significant public comments in a responsiveness summary, which will become part of the final Decision Document. Once finalized, the Army will announce its final decision in a local newspaper advertisement and place a copy of the final Decision Document in the project information repository.

HOW TO SUBMIT PUBLIC COMMENTS

To submit written comments during the Public Comment Period or to obtain further information, please contact the following office:

JBM-HH DPW Environmental Division

111 Stewart Road, Building 321
Fort Myer, VA 22211-1199
Email: usarmy.jbmhh.asa.mbx.fort-myer-fort-mcnair-stormwater-program@army.mil

Written comments on JBM-HH Proposed Plan must be postmarked no later than August 9, 2024.

LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-DCE	cis-1,2-Dichloroethene
CR	carcinogenic risk
COC	contaminant of concern
CVOC	chlorinated volatile organic compound
DERP	Defense Environmental Restoration Program
EISB	enhanced in situ bioremediation
ERH	electrical resistivity heating
FE	fracture enhanced
FS	feasibility study
HHRA	human health risk assessment
ISCR	in situ chemical reduction
JBM-HH	Joint Base Myer-Henderson Hall
LNAPL	light non-aqueous phase liquid
LUC	land use control
MCL	maximum contaminant level
MEP	maximum extent practicable
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
PAL	Project Action Limit
PCE	perchloroethene
PRG	preliminary remediation goal
PX	post exchange
RAO	remedial action objective
RI	remedial investigation
SVE	soil vapor extraction
trans-DCE	trans-1,2-Dicloroethene
TCE	trichloroethene
THQ	target hazard quotient
µg/kg	micrograms per kilogram
$\mu g/m^3$	micrograms per cubic meter
USACE	United States Army Corps of Engineers
UU/UE	unlimited use/unrestricted exposure
VADEQ	Virginia Department of Environmental Quality
VC	vinyl chloride
VI	vapor intrusion
VOC	volatile organic compound
ZVI	zerovalent iron

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Administrative Record File — The body of documents that "forms the basis" for the selection of a particular response at a site in accordance with ***CERCLA***. This file is to be available for public review and a copy maintained near the site. The official ***Administrative Record File*** is maintained by the JBM-HH DPW Environmental Division and is located at 111 Stewart Road, Building 321, Fort Myer, VA 22211-1199. The point of contact for the file can be reached via email at usarmy.jbmhh.asa.mbx.fort-myer-fort-mcnair-stormwater-program@army.mil

Air Sparging — ***Air sparging*** removes contaminant vapors from belowground for treatment aboveground. Air sparging pumps air underground to make chemicals evaporate faster. ***Air sparging*** involves drilling one or more injection wells into the groundwater-soaked (saturated) soil. An air compressor at the surface pumps air underground through the wells. As air bubbles through the groundwater, it carries contaminant vapors upward to the surface where they are recovered and treated.

Applicable or Relevant and Appropriate Requirements (ARARs) — Applicable requirements mean those cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at the subject site. Relevant and appropriate requirements mean those cleanup standards that address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. These requirements may vary among sites and alternatives.

Asymptotic — The behavior of a function which approaches, but does not reach, a theoretical limit can be described as asymptotic.

Bioaugmentation — Addition of microbes, possibly with a carbon substrate or other amendments, to augment (increase) the rate of biological degradation (biodegradation) of contaminants.

Biodegradation — Process by which contaminants are broken down through naturally occurring biotic processes, such as microbial action.

Biostimulation — Technology that treats soil or groundwater contamination through the addition of specific nutrients to induce naturally occurring microbes to break down the chemical contaminants.

Cancer Risk — The probability that an individual will develop cancer over a 70-year lifetime as a direct result of exposure to contaminants.

Capital Costs — One-time expenses, as incurred during construction or excavation activities.

GLOSSARY FOR SPECIALIZED TERMS
PROPOSED PLAN
JBM-HH IN FORT MEYER, VIRGINIA

Contaminants of Concern (COCs)	Contaminants that are identified through the risk assessment process as being the primary chemicals of concern that may cause unacceptable human health and/or ecological risk.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Commonly known as Superfund, the CERCLA was enacted by Congress on December 11, 1980, and modified in 1986 by the ***Superfund Amendments and Reauthorization Act***. CERCLA addresses the investigation and cleanup of hazardous substances.
Chlorinated volatile organic compound (CVOC)	Chlorinated organic compounds, such as the chlorinated solvents TCE and PCE, that are sufficiently volatile to partition into the gaseous phase at ambient temperatures.
Decision Document	A public document that describes the cleanup plan selected for a site. The ***Decision Document*** provides the reasons behind selecting the cleanup plan and includes comments received on the ***Proposed Plan*** and how these comments were addressed. The ***Decision Document*** will be maintained in the ***Administrative Record File.***
Dechlorination	The partial or complete reduction of a compound containing chlorine by any chemical or physical process
Defense Environmental Restoration Program (DERP)	This program manages the Department of Defense's cleanup program for active installations, closed or closing installations, and ***Formerly Used Defense Sites***. It provides for the identification, investigation, and cleanup of contamination and military munitions associated with past activities at Department of Defense facilities to ensure that potential threats to public health and the environment are appropriately assessed and addressed.
Ecological Receptors	Any living organisms, other than humans, that could be negatively affected by constituents of potential concern or constituents of concern. ***Ecological Receptors*** include both plants and animals.
Electrical Resistivity Heating (ERH)	In situ environmental remediation method that uses the flow of alternating current electricity to heat soil and groundwater and remediate contaminants.
Electron donor	A compound that provides electrons in a chemical reaction, thereby becoming oxidized while reducing another reactant.
Enhanced In Situ Bioremediation (EISB)	EISB methods use a combination of ***biostimulation***, supplementing the carbon source to increase microbial growth, and ***bioaugmentation***, the addition of cultured bacteria with known ***dechlorination*** capabilities.
Exposure pathway	The ways that humans, animals, and plants may come in contact with a chemical, such as by touching, breathing, or ingesting it.

Feasibility Study (FS)	A comprehensive evaluation of potential alternatives for remediating contamination. The FS identifies general response actions, screens potentially available technologies and process options, assembles alternatives, and evaluates alternatives in detail. Preparation of the ***Feasibility Study*** usually starts after the ***Remedial Investigation*** is completed.
Fracture-enhanced (FE)	An environmental technique to enhance or create openings in bedrock or soil, thereby increasing the effective porosity of the contaminated medium to improve remediation efficiency.
Groundwater curtain	An in-situ remediation method utilizing a zone of injection wells through which contaminated groundwater passes for treatment.
Human Health Risk Assessment (HHRA)	A ***Human Health Risk Assessment*** estimates the likelihood of health problems occurring due to the presence of constituents of concern if no cleanup action is taken at a site.
Information Repository (IR)	A file containing current information, technical reports, and reference documents duplicated from the ***Administrative Record File*** maintained for a site.
In situ	Latin term for "in place." When used in discussions of groundwater remediation, in situ means that contaminants are destroyed or transformed into a less-toxic form in the subsurface instead of being removed to the surface for treatment.
In Situ Chemical Reduction (ISCR)	ISCR involves the injection of a chemical agent in the subsurface to stimulate reactions that degrade chlorinated ethenes to simpler compounds and eventually to non-toxic products.
Land Use Controls (LUCs)	Any type of physical, legal, or administrative mechanism that restricts the use of or limits access to real property to prevent or reduce risks to human health and the environment.
Maximum Contaminant Levels (MCLs)	The maximum concentrations of a chemical, established by the Safe Drinking Water Act, that are allowed in public drinking water systems. Currently, there are fewer than 100 chemicals for which a maximum contaminant level has been established; however, these represent chemicals that are thought to pose the most serious risk.
Monitored Natural Attenuation (MNA)	The monitoring of the reduction in contaminant mass, toxicity, mobility, volume, and/or concentration due to naturally occurring biological, chemical, and physical processes. No actively engineered remediation techniques are necessary for natural attenuation to occur.
Light Non-Aqueous Phase Liquid (LNAPL)	Organic compounds or mixtures of such compounds that do not mix with water are called Non-Aqueous Phase Liquids (NAPLs). Light non-aqueous phase liquid (***LNAPL)*** is a type of NAPL that is less dense than water and typically floats.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP)	The National Contingency Plan (40 Code of Federal Regulations [CFR] Part 300) — Provides the organizational structure and procedures for preparing for and responding to spills or other releases of oil and hazardous substances, pollutants, and contaminants into the environment.
Operation and Maintenance (O&M) Costs	Costs associated with operating and/or maintaining a cleanup action in the long term. Typically, annual costs covering one year of ***O&M*** are presented.
pH buffer	pH is a measure of the concentration of hydrogen ion in solution and is used to determine the acidity (pH less than 7) or alkalinity (pH greater than 7) of a solution. Groundwater with pH between 5 and 9 is optimal for biodegradation of contaminants; bioactivity is usually limited outside this pH range. A pH buffer is a solution that helps to maintain a balance in alkaline (base)/acidity levels and to keep the pH of a solution constant.
Preferred Remedial Alternative	The remedial alternative selected by the USACE and USEPA, based on a comparison of various remedial alternatives using specific evaluation criteria.
Preliminary Remediation Goal (PRG)	A site-specific chemical concentration determined to protect human health and the environment that must be met by a cleanup plan. The final remediation goal is presented in the Decision Document.
Present Worth	The total cost of an alternative over time in terms of today's dollar value.
Proposed Plan	A public document that summarizes the findings of the ***Remedial Investigation*** and ***Feasibility Study*** and identifies the preferred cleanup plan for a site. The purpose of the proposed plan is to provide the public with a reasonable opportunity to comment on the preferred cleanup plan, as well as alternative plans under consideration, and to participate in the selection of the cleanup plan at a site.
Receptor	Includes both humans and biota (plants or animals) that may come into contact with a hazardous substance, either directly by picking an item up or indirectly by breathing in contaminated air.
Remedial Action	An action taken to clean up munitions or chemicals in the environment that may pose a risk to humans, animals, or other potential ***receptors*** or to prevent these munitions or chemicals from entering the environment and causing risk. Remedial actions include, but are not limited to, fencing off, covering, excavating, disposing, or treating munitions or chemical contamination.

Remedial Action Objective (RAO)	Site-specific goal for protecting human health and the environment. ***Remedial Action Objectives*** guide the development of cleanup options and must be met by any cleanup plan selected for a site. ***Remedial action objectives*** also assist in achieving an acceptable level of protection for human health and the environment.
Remedial Investigation (RI)	A remedial investigation involves data collection and site characterization activities intended to identify the type and magnitude of contamination present at a site. The remedial investigation includes sampling, monitoring, and gathering sufficient information to evaluate potential risk to human health and the environment and determine the necessity for remedial action
Superfund Amendments and Reauthorization Act (SARA)	Passed in 1986, this legislation established standards for cleanup activities, required federal facility compliance with the ***Comprehensive Environmental Response, Compensation, and Liability Act*** and clarified public involvement requirements.
Soil Vapor Extraction (SVE)	An in-place process for soil remediation where contamination is removed from soil under a vacuum. SVE is suitable for removing a variety of VOCs that have a high vapor pressure or a low boiling point compared with water.
Thermal Remediation	Thermal remediation is the use of heat to volatilize contaminants in situ, allowing them to be subsequently removed through vapor extraction methods.
Unlimited Use/Unrestricted Exposure (UU/UE)	A term used to describe when contamination at a site has been reduced to a level that is safe for any land use, including residential land use.
Vadose zone	Unsaturated subsurface soils extending from the soil surface to the capillary fringe above the groundwater table.
Vapor intrusion (VI)	Migration of volatile chemical vapors from contaminated groundwater or soil into an overlying building.
Volatile Organic Compounds (VOC)	Organic chemical compounds whose composition allows them to evaporate at or below room temperature. ***Volatile organic compounds*** include both man-made and naturally occurring chemicals such as benzene and trichloroethene (TCE).
Zero-valent iron	The elemental form of iron in a very fine powdered form. The powdered iron reacts with contaminants in groundwater and converts the contaminants into harmless substances. Zero-valent iron is iron particles that can be mixed with soil and groundwater to chemically treat specific contaminants. The iron particles are typically installed in a permeable reactive barrier or injected into groundwater to treat chlorinated solvents. Through a process known as reductive dehalogenation, the iron degrades the chlorinated solvents to innocuous by-products.

PUBLIC COMMENT FORM
PROPOSED PLAN – ALTERNATIVE 7
FMY-01 AT JBM-HH
IN FORT MYER, VIRGINIA

USE THIS SPACE TO WRITE YOUR COMMENTS

Your comments on the Proposed Plan are important to the Army. Comments provided by the public are valuable in helping us select a final remedy for the site. You may use the space below to write your comments for the Army to consider. Please use additional paper if needed.

Your comments must be postmarked or e-mailed by midnight on Friday, August 9, 2024.

Mail or e-mail your comments to:

JBM-HH DPW Environmental Division
111 Stewart Road, Building 321
Fort Myer, VA 22211-1199

Email: usarmy.jbmhh.asa.mbx.fort-myer-fort-mcnair-stormwater-program@army.mil

If you have any questions about the public comment process, please contact the JBM-HH DPW Environmental Division.

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Name____

Affiliation____

Address____

City, State, Zip____