FINAL

United States Army Corps of Engineers
New England District

Focused Feasibility Study Report

Shepley's Hill Landfill (Area of Contamination 5)

Former Fort Devens Army Installation

Devens, Massachusetts

March 2024

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CERTIFICATION
I hereby certify that the enclosed Report, shown and marked in this submittal, is that proposed to be incorporated with Contract Number W912WJ-19-D-0014. This document was prepared in accordance with the United States Army Corps of Engineers Scope of Work and is hereby submitted for Government approval.

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Acronyms and Abbreviations

µg/L	microgram per liter
AOC	area of contamination
ARAR	applicable or relevant and appropriate requirement
Army	United States Army
ATP	arsenic treatment plant
bgs	below ground surface
BOD	biochemical oxygen demand
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CH2M	CH2M HILL, Inc.
CMR	Code of Massachusetts Regulations
COC	chemical of concern
CSM	conceptual site model
Devens	former Fort Devens Army Installation
DO	dissolved oxygen
DOC	dissolved organic carbon
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FFS	focused feasibility study
FFS Report	Focused Feasibility Study Report
FYR	5-year review
FYR Report	Five-Year Review Report
ft/yr.	feet per year
GW-1	Massachusetts drinking water standard
gpm	gallon per minute
IAS	in-situ air sparge
JV	Joint Venture
KGS	KOMAN Government Solutions, LLC
L	liter

lbs./yr.	pounds per year
LLC	Limited Liability Company
LOQ	limit of quantification
LTM	long-term monitoring
LUC	land use control
MassDEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Bureau of Geographic Information
MCL	maximum contaminant level
mg/kg	milligram per kilogram
mg/L	milligram per liter
MNA	monitored natural attenuation
MSW	municipal solid waste
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIA	North Impact Area
NPDWSA	non-potential drinking water source area
O&M	operation and maintenance
ORP	oxidation-reduction potential
PFAS	per- and polyfluoroalkyl substances
POTW	publicly owned treatment works
PRB	permeable reactive barrier
psig	pounds-per-square-inch gauge
PVC	polyvinyl chloride
RAO	remedial action objective
RI	remedial investigation
ROD	Record of Decision
S-A JV	SERES-Arcadis Joint Venture
SDWA	Safe Drinking Water Act
SHL	Shepley's Hill Landfill
Sovereign	Sovereign Consulting, Inc.
SOW	Scope of Work
SSSL	site-specific screening level
TBC	to be considered
TOC	total organic carbon

U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

Executive Summary

This Focused Feasibility Study Report (FFS Report) has been prepared to evaluate current site conditions and whether additional or alternative remedies could enhance the remedies in place, allowing for more efficient remedy implementation. This FFS Report provides the technical basis for implementing the alternative(s) for Shepley's Hill Landfill (SHL) at the former Fort Devens Army Installation (Devens), located in Devens, Massachusetts. This FFS Report was prepared by the SERES-Arcadis Joint Venture (S-A JV), Limited Liability Company on behalf of the United States Army Corps of Engineers (USACE) under Contract Number W912WJ-19-D-0014.

The focus of this FFS Report is to identify and evaluate remedial alternatives appropriate to address groundwater quality at SHL. This FFS Report provides a summary of relevant site conditions, including the current remedies, identifies alternatives that may improve the effectiveness and sustainability of groundwater remediation, and provides a detailed analysis of potential remedial alternatives. Although there are no completed exposure pathways or unacceptable risks presented at the site, the United States Environmental Protection Agency (USEPA) requested this post-Record of Decision (ROD; USACE 1995) investigation and assessment of the remedies, as part of a Federal Facility Agreement (FFA) dispute. The FFS work is described and set forth in the USEPA's SHL Scope of Work (SOW), Phase 3 (USEPA 2016). Devens was placed on the National Priorities List in December 1989, and an FFA was signed in 1991. The work is conducted under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, 42 United States Code §9601 et. seq.), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 Code of Federal Regulations [CFR] Part 300), and USEPA, Department of Defense, and United States Army (Army) policies and guidance.

United States Environmental Protection Agency Scope of Work

The fourth Five-Year Review (FYR) report was finalized by the Army in September 2015 (H&S Environmental, Inc. 2015). The USEPA concurred with the Army's determinations of the short-term protectiveness of remedies at Devens included in the fourth FYR but set forth recommendations and requirements to be met by Army before they would issue a determination regarding long-term protectiveness. The Army finalized the fourth FYR before these requirements were addressed to the satisfaction of the USEPA. In response, USEPA invoked the dispute resolution provision of the Federal Facility Agreement on November 3, 2015 (USEPA 2015).

Under the dispute resolution process, USEPA provided the Army with additional work to evaluate whether the remedy at SHL was protective of human health and the environment over the long term. The additional SOW provided by USEPA to Army on February 24, 2016 included three phases (USEPA 2016):

- Phase 1 – Demonstrate Plume Capture. The SOW included tasks to demonstrate if the current remedy, groundwater extraction and treatment by the arsenic treatment plant (ATP), was achieving capture. The requirements of Phase 1 were noted to be complete by USEPA in correspondence to Army on October 29, 2021 (USEPA 2021). The Army's analyses (S-A JV 2021) indicated that the ATP is operating as designed: capturing approximately 87% of the overburden groundwater flow from the landfill, and approximately 97% of the associated arsenic mass flux – with an estimated capture zone that corresponds to the design capture zone presented in the Remedial Design and Remedial Action Workplan (CH2M Hill, Inc. [CH2M] 2005a). However, the USEPA disagreed and determined the current remedy to be insufficient.

- Phase 2 – Evaluate Remedy Performance. The SOW included tasks to evaluate performance of the ATP, coupled with monitored natural attenuation (MNA) over a period of five years. This work included calculating cleanup timeframes for groundwater and performing a study to evaluate the background concentration of arsenic at SHL. In their letter of October 29, 2021 USEPA indicated, following completion of Phase 1, that Phase 2 work was not necessary. The Army did not agree that all portions of Phase 2 were not necessary and has, therefore, included the calculation of cleanup timeframes in this FFS Report, and recently completed a background study for arsenic in groundwater (S-A JV 2022a, 2023).
- Phase 3 – Document Remedy in a Decision Document. Groundwater treatment by the ATP was initiated as a contingency remedy and is documented in an Explanation of Significant Differences (ESD) that was issued in 2005 (CH2M 2005b). Phase 3 of the dispute would be implemented if USEPA determined that operation of the groundwater extraction system and the ATP, plus MNA, would not result in restoration of the aquifer (USEPA 2016). Accordingly, in their letter dated October 29, 2021, the USEPA instructed the Army to proceed with Phase 3 and develop a remedy and issue a proposed plan for that remedy for USEPA concurrence (USEPA 2021). Though the Army did not agree with the USEPA's reasoning, the Army agreed to proceed with Phase 3 activities. This FFS Report is the first primary document under the Phase 3 SOW.

The USEPA's SOW document is included in Appendix A.

This FFS Report includes information from the Phase 1 SOW deliverables, which were prepared to evaluate performance of the current remedy to support the conceptual site model (CSM) and evaluation of alternative remedial strategies for groundwater at SHL. To evaluate the response of the SHL groundwater flow system to the various FFS alternatives, the calibrated SHL groundwater flow model (Geosyntec 2020) was used.

Site Description

SHL is a capped landfill that encompasses approximately 84 acres in the northeast corner of the Main Post of Devens. SHL includes three areas of contamination (AOCs) investigated under CERCLA and the NCP, as follows:

- AOC 4: sanitary landfill incinerator;
- AOC 5: sanitary landfill No. 1; and
- AOC 18: asbestos cell.

These three AOCs are located within SHL. SHL contains various waste materials, including incinerator ash, demolition debris, asbestos, sanitary wastes, paper, wood waste, spent shell casings, glass, and other wastes (Sovereign Consulting, Inc. [Sovereign] 2011).

Risk Assessment

A risk assessment, pursuant to 40 CFR 400.430(d)(1), was performed as part of the original CERCLA investigation activities for the SHL Operable Unit (USACE 1995). The risk assessment evaluated the probability and magnitude of the potential for unacceptable risks to human health and environmental associated with exposure to contaminated media at the site. Forty chemicals of concern (COCs) were selected for evaluation in the human health risk assessment (USACE 1995). Potential human health effects associated with exposure to the COCs were estimated quantitatively or qualitatively through the development of several potential exposure pathways. Based on excess lifetime cancer risk and hazard index calculations, the following potential unacceptable risks to human health were identified (USACE 1995):

- Long-term consumption of fish from Plow Shop Pond;

- Long-term contact with Plow Shop Pond sediment; and
- Future residential use of unfiltered groundwater.

In addition, the ecological risk assessment predicted that Plow Shop Pond surface water and sediments presented potential adverse risks to aquatic receptors. The Army concluded that actual or potential releases of hazardous substances to groundwater from SHL, if not addressed by implementing an appropriate response action, may present an imminent and substantial endangerment to public health, welfare, and the environment (USACE 1995).

In 2009, USACE again evaluated risk as part of the Supplemental Groundwater and Landfill Cap Assessment for Long-Term Monitoring and Maintenance (AMEC 2009). Exposure pathways assessed during this risk evaluation included the following:

- Drinking water use;
- Recreational use of Nonacoicus Brook; and
- Landfill gas exposures from
  - Direct venting from the landfill,
  - Lateral migration from the landfill through shallow soil, and
  - Migration from groundwater containing dissolved gas.

This report concluded that no significant risk to human health was present, but such a risk could exist if groundwater were to be used as a source of drinking water.

Conceptual Site Model

The source of arsenic to groundwater at SHL includes anthropogenic and geogenic sources. Specifically, the release and mobility of arsenic in groundwater at SHL is believed to include the following three sources and mechanisms:

- Mechanism 1 – anthropogenic sources: Arsenic present within landfill waste, which dissolves into landfill leachate and is (or was historically) transported into the underlying aquifer (Mechanism 1 was thought to be the primary source/mechanism when the ROD was written in 1995).
- Mechanism 2 – geogenic/naturally released sources: Naturally occurring arsenic present in bedrock, glacial till, and overburden sands, which is released into solution via ambient (i.e., non-landfill-influenced) processes, including sulfide mineral oxidation within the bedrock and iron mineral reduction in the glacial till/overburden due to naturally oxidizing and reducing conditions (i.e., natural peat deposits of former swamps located under SHL), respectively.
- Mechanism 3 – geogenic/anthropogenic influenced sources: This includes arsenic with a geogenic source (i.e., naturally occurring arsenic in the glacial till/overburden) that may be released into groundwater due to reducing conditions caused or exacerbated by the landfill.

Following release into groundwater, dissolved arsenic is anticipated to be present primarily in the oxyanion forms of arsenite and arsenate. Both of these forms are highly mobile in solution, with transport governed by adsorption. The primary processes governing arsenic attenuation will include dilution and oxidative precipitation of iron and manganese. As iron and manganese oxidize and precipitate, coprecipitation or sorption of arsenic within metal oxyhydroxides will remove arsenic from solution, but in environments where reduced iron and manganese are stable in solution, limited arsenic attenuation may be expected and arsenic remains dissolved in groundwater. Key components of the arsenic fate conceptual site model are summarized below:

- SHL acts as a source of anthropogenic arsenic (and likely organic carbon) to groundwater, while also contributing to reducing conditions. Estimates suggest that only about 11% of the waste in the landfill is thought to be saturated (Sovereign 2011). With the landfill cap in place, little recharge to groundwater is occurring; this is largely beneficial as it limits further leaching of arsenic and organic carbon from the unsaturated landfill into the aquifer, but it also limits the inflow of oxygenated water, exacerbating reducing conditions beneath SHL.
- Within the saturated overburden immediately beneath SHL, arsenic, iron, and manganese are present as a result of all three mechanisms described above. This zone receives arsenic and reducing groundwater from the landfill, with limited recharge of oxygenated water. It also contains some organic carbon from buried former swamp and peat deposits, which are likely contributing to the reducing conditions.
- The North Impact Area overburden receives a combination of reducing groundwater (containing dissolved arsenic, iron, and manganese) from the landfill overburden, lateral inflow of groundwater (primarily from the east and west) within the overburden and bedrock, and recharge from precipitation. As with the landfill overburden, the presence of naturally occurring organic carbon from former swamp and peat deposits within the North Impact Area (NIA), the area south and north of West Main Street in Ayer, likely contributes to reducing capacity in the NIA aquifer. These inputs have created a vertical redox gradient, with more oxidizing conditions (and lower arsenic) in shallow zones and more reducing conditions (and higher arsenic) at depth.
- Across SHL, groundwater flows between overburden and bedrock zones, with flow direction (bedrock to overburden versus overburden to bedrock) varying spatially and seasonally. For example, groundwater flow from the bedrock aquifer is evident in the groundwater elevations measured at well cluster SHP-2016-06 (on the western edge of the landfill near Shepley's Hill), which shows a consistent upward gradient from the deeper wells (SHP-2016-06B/C) to the shallow well (SHP-2016-06A). Groundwater elevations at other locations show upward gradients from deeper wells seasonally, with upward gradients occurring most often in the spring when recharge is higher (e.g., SHP-2016-3A/B). Bedrock groundwater flowing into the overburden can contribute arsenic (with relatively low iron and manganese) due to oxidation of arsenic-containing sulfides.
- As water flows downgradient, arsenic attenuation occurs through dilution, sorption to aquifer solids and reoxidation of iron and manganese. Prior to groundwater discharge into Nonacoicus Brook, reoxidation of iron and manganese and precipitation occurs in the hyporheic zone where oxygen present in surface water mixes with more reducing groundwater. In this way, iron, manganese, and arsenic are removed from solution before discharge to the brook.

Aquifer Restoration Potential

The groundwater redox conditions play a central role in both the release and attenuation of arsenic at SHL. Therefore, the restoration of the aquifer at SHL will rely on creating stable and sustainable redox conditions in which arsenic is less mobile, less prone to release, and can attenuate via the available geochemical mechanisms.

Specifically, achieving long-term arsenic removal and stabilization would best be accomplished if the alluvial aquifer is an oxygenated environment. Introduction of oxygen into the aquifer will result in oxidation and precipitation of iron and manganese oxyhydroxides, which removes arsenic from solution. However, ensuring long-term arsenic removal will require not only near-term oxygen introduction to oxidize dissolved metals, but also long-term oxygenation of the aquifer which requires that the active reducing capacity of the aquifer is overcome, either through continual flow of oxygenated water or through sufficient oxygenation over a long enough period of time to consume readily available reducing capacity (both natural and anthropogenic) present within the aquifer. These geochemical factors were considered when identifying and evaluating alternatives for the site.

Remedial Action Objectives and Identified Remedial Alternatives

As described in the ROD (USACE 1995) and subsequent ESDs (CH2M 2005b; Sovereign 2013), the remedial action objectives (RAOs) for SHL are to:

- Protect potential residential receptors from exposure to impacted groundwater migrating from the landfill having chemicals in excess of applicable or relevant and appropriate requirements (ARARs); and,
- Prevent impacted groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations.

Consistent with the first RAO, the conceptual design of remedial alternatives that include an active treatment component positions them at the downgradient / northern end of SHL to affect groundwater migrating from beneath the landfill.

The following remedial alternatives have been identified for evaluation in this FFS Report:

- Alternative 1: No Action;
- Alternative 2: Groundwater Extraction and Treatment (current remedy);
- Alternative 3: In-Situ Air Sparging;
- Alternative 4: Modified Groundwater Extraction and Treatment
  - Alternative 4A: Groundwater Extraction and Treatment with Three Extraction Wells, and
  - Alternative 4B: Groundwater Extraction and Treatment with Three Extraction Wells and Injection;
- Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging; and
- Alternative 6: Partial Landfill Removal with Active Aquifer Treatment.

Evaluation Criteria

Nine evaluation criteria have been developed to address the CERCLA requirements and additional technical and policy considerations that have proven to be important for selecting among remedial alternatives. The evaluation criteria are divided into three categories: threshold criteria, balancing criteria, and modifying criteria (40 CFR 300.430(e)). In addition to the nine criteria, additional factors have been evaluated. The evaluation criteria and additional factors are:

- Threshold criteria
  - Overall protection of human health and the environment, and
  - Compliance with applicable or relevant and appropriate requirements.
- Balancing criteria
  - Long-term effectiveness and permanence,
  - Reduction of toxicity, mobility, and volume through treatment,
  - Short-term effectiveness,
  - Implementability, and
  - Cost.
- Modifying criteria
  - State acceptance, and
  - Community acceptance.
- Additional factors

- Environmental footprint, and
- Impact on per- and polyfluoroalkyl substances in groundwater.

Comparative Analysis

Each alternative was evaluated against the above criteria and assigned a rating of high, moderate, or low based on the evaluation, as shown in Table 5.

References:

AMEC. 2009. Draft Final Supplemental Groundwater and Landfill Cap Assessment for Long-Term Monitoring and Maintenance, Shepley's Hill Landfill, Devens MA. Prepared for USACE-NAE. June.

CH2M. 2005a. Remedial Design and Remedial Action Workplan Final 100% Submittal. Groundwater Extraction, Treatment, and Discharge Contingency Remedy for Shepley's Hill Landfill. Fort Devens, MA. May.

CH2M. 2005b. Explanation of Significant Differences. Groundwater Extraction, Treatment, and Discharge Contingency Remedy for Shepley's Hill Landfill, Fort Devens, Massachusetts. April.

H&S Environmental, Inc. 2015. 2015 Five-Year Review Report for Former Fort Devens Army Installation. BRAC Legacy Sites, Devens, Massachusetts. September.

S-A JV. 2021. Final Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 5.e, Validate the Extent of Capture by Evaluating Concentration Trends in NIA Monitoring Locations as Compared to Flow Paths Developed from the Updated Groundwater Flow Model. Area of Contamination 5 – Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. December 9.

S-A JV. 2022. Work Plan to Evaluate Site-Specific Arsenic Background Concentrations in Groundwater. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. January 28.

Sovereign. 2011. Final Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-Term Monitoring and Maintenance – Addendum Report. August.

Sovereign. 2013. Explanation of Significant Differences. Shepley's Hill Landfill Superfund Site, Former Fort Devens Installation. Land Use Controls to Restrict Groundwater Use. December.

USACE. 1995. Record of Decision, Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts. September.

USEPA. 2015. Letter from Lynne Jennings to Robert Simeone Re: 2015 Five Year Review Report for Former Fort Devens Army Installation Devens, Massachusetts. November 3.

USEPA. 2016. Letter from Lynne A. Jennings to William J. O'Donnell Re: Former Fort Devens Installation – Dispute Resolution 2015 Devens Five Year Review Report. February 24.

USEPA. 2021. Letter from Carol A. Keating to Robert J. Simeone Re: EPA Comments on the Draft Phase 1 Task 5 Subtask 5.e Technical Memorandum, Army's Completion of SHL SOW Phase 1 Tasks, and EPA's Determination Regarding the Existing Extraction and Treatment System's Ability to Effectively Contain/Capture the Contamination Migrating from the SHL. October 29.

1 Introduction

The former Fort Devens Army Installation (Devens), located in Devens, Massachusetts, is a federal facility on the National Priorities List (NPL) and has been undergoing environmental investigations and remedy implementation activities under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA; 42 United States Code [U.S.C.] §9601 et. seq.) since the late 1990s. In 2016, the United States Environmental Protection Agency (USEPA) determined that the original remedy was insufficient to protect human health and the environment, and that additional phased work was needed at Shepley's Hill Landfill (SHL), located at Devens. Phase 3 of the 2016 USEPA Scope of Work (SOW; USEPA 2016a) is the requirement to complete a focused feasibility study (FFS). The SOW document is included in Appendix A.

The SERES-Arcadis Joint Venture (S-A JV), Limited Liability Company (LLC)[1] (hereafter referred to as the S-A JV) has prepared this Focused Feasibility Study Report (FFS Report) on behalf of the United States Army Base Realignment and Closure (BRAC) Office to conduct an evaluation of current site conditions and potential additional remedial alternatives, then compare them to the current remedies in place, and provide the technical basis for implementing the alternative(s) for SHL at Devens, located in Devens, Massachusetts. This FFS Report has been developed under Contract Number W912WJ-19-D-0014. The work has been completed in accordance with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 Code of Federal Regulations [CFR] Part 300), the Defense Environmental Restoration Program (10 U.S.C. §2701 et. seq.), and Department of Defense, Army, and USEPA policy and guidance documents for implementing CERCLA at Federal Facilities.

1.1 Focus and Scope

The focus of this FFS Report is to identify and evaluate remedial alternatives appropriate to address groundwater quality at SHL. This FFS Report provides a summary of relevant site conditions, including the current remedies, identifies alternatives that may improve the effectiveness and sustainability to the current groundwater remediation remedy, and provides a detailed analysis of potential remedial alternatives (40 CFR 300.430(e)(1)).

SHL operated as a landfill from at least the 1940s to late 1980s, at which point closure activities began and potential impacts to environmental media were evaluated. The investigations and CERCLA process led to USACE establishing a Record of Decision (ROD), including a selected remedy, for the SHL Operable Unit in 1995 (USACE 1995). Information on the landfill operational history, remedial investigations and decision documents, and remedial action in response to documented onsite contamination are provided in Sections 1.2.2 and 1.2.3. As discussed herein, the evaluations concluded that arsenic impacted soil and groundwater were present at SHL, which resulted in the installation of a groundwater extraction and treatment system for arsenic in 2006 that remains in operation today.

The fourth Five-Year Review (FYR) report was finalized by Army on September 30, 2015 (H&S Environmental, Inc. 2015). The USEPA concurred with the Army's determinations of short-term protectiveness of remedies at Devens included in the fourth FYR but set forth recommendations and requirements to be met by Army before they would issue a determination regarding long-term protectiveness. The Army finalized the FYR before these

[1] The SERES-Arcadis JV is composed of protégé firm SERES Engineering & Services, LLC and its mentor, Arcadis U.S., Inc.

requirements were addressed to the satisfaction of the USEPA. In response, USEPA invoked the dispute resolution provision of the Federal Facility Agreement on November 3, 2015 (USEPA 2015).

Under the dispute resolution process, USEPA provided the Army with additional work to evaluate whether the remedy at SHL was protective of human health and the environment over the long term. The SOW document is included in Appendix A. The additional SOW provided by USEPA to Army on February 24, 2016 included three phases (USEPA 2016a):

- Phase 1 – Demonstrate Plume Capture. The SOW included tasks to demonstrate if the current remedy, groundwater extraction and treatment by the arsenic treatment plant (ATP), was achieving capture. The requirements of Phase 1 were noted by USEPA to be complete in correspondence to Army on October 29, 2021 (USEPA 2021). The Army's analyses (S-A JV 2021) indicated that the ATP is operating as designed: capturing approximately 87% of the overburden groundwater flow from the landfill, and approximately 97% of the associated arsenic mass flux – with an estimated capture zone that corresponds to the design capture zone presented in the Remedial Design and Remedial Action Workplan (CH2M Hill, Inc. [CH2M] 2005a). However, the USEPA disagreed and determined the current remedy was insufficient.
- Phase 2 – Evaluate Remedy Performance. The SOW included tasks to evaluate performance of the ATP, coupled with monitored natural attenuation (MNA) over a period of five years. This work included calculation of cleanup timeframes for groundwater and performing a study to evaluate the background concentration of arsenic at SHL. In their letter of October 29, 2021 USEPA indicated, following completion of Phase 1, that Phase 2 work was not necessary. The Army did not agree that all portions of Phase 2 were not necessary and has, therefore, included the calculation of cleanup timeframes in this FFS Report, and recently completed a background study for arsenic in groundwater (S-A JV 2022a, 2023).
- Phase 3 – Document Remedy in a Decision Document. Groundwater treatment by the ATP was initiated as a contingency remedy and is documented in an Explanation of Significant Differences (ESD) that was issued in 2005 (CH2M Hill, Inc. [CH2M] 2005b). Phase 3 of the dispute would be implemented if USEPA determined that operation of the groundwater extraction system and the ATP, plus MNA, would not result in restoration of the aquifer (USEPA 2016a). Accordingly, in its letter dated October 29, 2021, the USEPA instructed the Army to proceed with Phase 3 and develop a remedy and issue a proposed plan for that remedy for USEPA concurrence (USEPA 2021). Though the Army did not agree with the USEPA's reasoning, the Army agreed to proceed with Phase 3 activities. This FFS Report is the first primary document deliverable under the Phase 3 SOW.

The USEPA's SOW document is included in Appendix A. This FFS Report includes information from Phase 1 SOW deliverables prepared to evaluate performance of the current remedy to support the conceptual site model (CSM) and evaluation of alternative remedial strategies for groundwater at SHL. To evaluate the response of the SHL groundwater flow system to the various FFS alternatives, the calibrated SHL groundwater flow model (Geosyntec 2020) was used. The FFS scope includes an evaluation of the nature and extent of contamination, a risk evaluation, a description of the CSM, identification of remedial action objectives and alternatives, and a detailed analysis of the remedial alternatives.

1.2 Site Background

1.2.1 Site Setting

Devens is located approximately 35 miles northwest of the city of Boston, Massachusetts, within the towns of Ayer and Shirley in Middlesex County, and within the towns of Harvard and Lancaster in Worcester County (Figure 1). Devens was established in 1917 for military training and logistical support during World War I and operated as a permanent base from 1931 until the BRAC Committee recommended closure under the 1991 BRAC round. Closure activities were completed by 1996.

SHL encompasses approximately 84 acres in the northeast corner of the Main Post of Devens (Figure 2). SHL is bordered to the east by Plow Shop Pond and land that formerly contained a railroad roundhouse, to the west by Shepley's Hill, to the south by recent commercial development, and to the north by wooded and residential areas. Plow Shop Pond to the east drains to Nonacoicus Brook to the north, which flows north/northwest and discharges to the Nashua River. Nonacoicus Brook is located north of SHL in the North Impact Area (NIA), the area south and north of West Main Street in Ayer.

1.2.1.1 Areas of Contamination

SHL is a capped landfill that includes three areas of contamination (AOCs) investigated under CERCLA and the NCP. These AOCs include the following:

- AOC 4: sanitary landfill incinerator;
- AOC 5: sanitary landfill No. 1; and
- AOC 18: asbestos cell.

These three AOCs are located within SHL. AOC 4 was included in Phase I of the sanitary landfill closure and AOC 18 was included in Phase IV of the sanitary landfill closure (United States Army Corps of Engineers [USACE] 1995). Additional details regarding the landfill closure are provided in Section 1.2.2. SHL contains various waste materials, including incinerator ash, demolition debris, asbestos, sanitary wastes, paper, wood waste, spent shell casings, glass, and other wastes (Sovereign Consulting, Inc. [Sovereign] 2011). Investigations conducted at SHL have not identified waste hot spots or hazardous waste disposal areas (USACE 1995).

Plow Shop Pond, identified as AOC 72 for potential groundwater impacts emanating from SHL, is managed under CERCLA as a separate operable unit for surface water and sediment.

1.2.1.2 Physical Setting

Topography at SHL includes a 70-foot elevation change on the western side of the landfill, known as Shepley's Hill. The landfill area is in the local topographic low and is generally flat, with slight sloping to the east/northeast along the edge of Plow Shop Pond. An excerpt of the 2021 Ayer, Massachusetts 7.5-minute quadrangle topographic map is included as Figure 3A, and an excerpt of the 1939 Ayer, Massachusetts 7.5-minute quadrangle topographic map is included as Figure 3B.

The overburden deposits beneath SHL consist of glacially deposited, well-graded to poorly graded sands with silts and gravel. The saturated soil is predominantly medium and fine to medium sands with little variability. A discontinuous layer of glacial till is present at the base of the sands directly overlying bedrock. The overburden ranges from 65 to 95 feet thick. To the west of the landfill lies Shepley's Hill which consists almost entirely of bedrock with little to no overburden. The surficial materials at SHL are shown on Figure 4.

The bedrock formations beneath SHL and Nonacoicus Brook are the Ayer Granite (also referred to as the Ayer Granodiorite) and the Chelmsford Granite. The Ayer Granite, which is part of a larger assemblage of intrusive rocks in eastern Massachusetts, is characterized as gneissic-biotite granite and granodiorite, approximately late Silurian to early Devonian in age, and has been significantly deformed by subsequent metamorphism and intrusion (Wones and Goldsmith 1991; Kopera 2008). Analyses of core samples indicate that silicate minerals (primarily quartz, feldspars, and mica group minerals), iron and manganese oxides/oxyhydroxides, clay minerals, and carbonates are present in the bedrock, which is consistent with Ayer Granite mineralogy (Gannett Fleming 2012). Though less prevalent than the Ayer Granite, the Chelmsford Granite is also present in parts of SHL. This formation is a well foliated quartz-microcline-plagioclase monzonite that intrudes the Ayer Granite. The bedrock layers at SHL are shown on Figure 5.

Groundwater beneath SHL originates from two primary recharge areas:

- Precipitation on the west side of Shepley's Hill (to the west of SHL) recharges bedrock groundwater, which flows east and up into overburden (seasonally, when the hydraulic gradient between bedrock and overlying overburden is upward); and precipitation on the north end of Shepley's Hill flows north/northeast and up into the overburden.
- Groundwater within the overburden flows from south to north under SHL, receiving additional recharge from an area of stormwater retention located along the southern boundary of SHL.

Groundwater at SHL consistently flows northwest from Plow Shop Pond toward the NIA, north of the extraction wells (S-A JV 2021b). This is likely driven by direct recharge along the northwest shore of Plow Shop Pond. The Plow Shop Pond dam is located approximately 800 feet east of the ATP and is approximately 4 feet above the surface of Nonacoicus Brook. The difference in surface water elevation created by the dam is approximately 4 feet, as indicated by historical measurements from staff gages SWEL-107 (below the dam) and SWEL-106 at the dam. A review of the potentiometric maps shows that the groundwater contours wrap around the active extraction wells EW-01 and EW-04 (located on the north end of SHL) and are driven by recharge from Shepley's Hill and Plow Shop Pond. In the absence of groundwater pumping at the extraction wells, groundwater flows generally from the southwest to the north toward Nonacoicus Brook (Figure 6).

An analysis of groundwater gradients based on potentiometric maps and three-point estimation analysis indicates that the groundwater flow direction varies in the northern portion of SHL (S-A JV 2021b). The influence of Shepley's Hill and its underlying bedrock aquifer creates a northeasterly flow along the western edge of SHL southwest of the ATP, while Plow Shop Pond creates an elevated hydraulic head that induces a flow to the northwest. These two hydraulic gradients create a funnel-like flow system in the northern portion and area north of SHL. Groundwater flow from the western and eastern portions of SHL migrate toward the extraction wells north of the toe of SHL (S-A JV 2021b). Groundwater from areas east of the Landfill footprint flows toward the area north of SHL, with some flow toward the extraction wells and some to the north or northwest toward Nonacoicus Brook and the NIA (Figure 6).

Seasonal changes in the direction of vertical groundwater flow between the bedrock and overburden have been observed at SHL. During periods of high recharge and low evapotranspiration (generally winter and spring), the direction of groundwater flow is upward from the bedrock to the overburden beneath SHL, primarily due to precipitation recharge on Shepley's Hill. During periods of low recharge and high evapotranspiration (generally summer and fall), the direction of groundwater flow is downward from the overburden sands to the underlying bedrock, but with a lower gradient than the upward gradient observed in the winter and spring (Gannett Fleming 2012). For example, groundwater flow from the bedrock aquifer at Shepley's Hill is evident in the groundwater elevations measured at well cluster SHP-2016-06 (on the western side of the landfill), which shows a consistent upward gradient from the deeper wells (SHP-2016-06B/C) to the shallow well (SHP-2016-06A). Other locations show upward gradients from deeper wells seasonally, with upward gradients occurring most often in the spring when recharge is higher (e.g., SHP-2016-3A/B).

1.2.1.3 Groundwater Classification and Use

Based on the Groundwater Use and Value Determination for the Devens area (Massachusetts Department of Environmental Protection [MassDEP] 2003), the groundwater across most of Devens is considered to be of high use and value. A small southeastern portion of SHL is within a Zone II wellhead protection area. The overburden groundwater at SHL is noted to be medium yield. The groundwater classification is shown on Figure 7 and the groundwater classification and the extent of dissolved metals in groundwater is shown on Figure 8.

1.2.2 Landfill Operational History and Closure

The Army reportedly began operating SHL by the early 1940s; however, evidence from test pits within SHL suggests earlier usage, possibly as early as the mid-19th century. SHL contains a variety of waste materials (more than 1.5 million cubic yards), which extend to a depth of up to 40 feet below ground surface (bgs) in the central portion of the former landfill. The landfill cap is at the ground surface. Approximately 160,000 cubic yards (11% of the total waste mass) appear to have been emplaced below the current water table in a former swamp, and peat deposits have been identified below the waste (Harding ESE 2003; Sovereign 2011).

MassDEP approved the Fort Devens Sanitary Landfill Closure Plan for SHL in 1985[2]. SHL was closed in four phases between 1986 and 1993 in accordance with 310 Code of Massachusetts Regulations (CMR) 19.000, as follows:

- Phase I: 50 acres were capped in October 1986;
- Phase II: 15 acres were capped in November 1987;
- Phase III: 9.2 acres were capped in March 1989; and
- Phase IV: The last 10 acres were capped in two phases:
  - Phase IV-A: completed in 1991, and
  - Phase IV-B: completed in 1993.

Closure of Phases I through IV-A consisted of capping the landfill with a 30-mil polyvinyl chloride (PVC) membrane, overlain with a 12-inch drainage layer and 6-inch topsoil layer. Closure of Phase IV-B consisted of capping the landfill with a 40-mil PVC membrane overlain with a 6-inch drainage layer and a 12-inch topsoil layer.

A passive landfill gas collection system consisting of 3-inch gas collection pipes bedded in a minimum 6-inch gas venting layer was installed every 400 feet beneath the PVC membrane. In addition, a minimum 6-inch protection

[2] SERES-Arcadis JV was unable to locate a copy of the 1984 Fort Devens Sanitary Landfill Closure Plan or the 1985 MassDEP Approval Letter for citation, and prior reports do not have citations for these documents.

layer was maintained between the PVC membrane and underlying waste. MassDEP issued a Landfill Capping Compliance Letter approving the closure in February 1996[3].

1.2.3 Decision Documents and Remedial Actions

After closure of SHL was completed in 1993, remedial investigations (RIs) under CERCLA evaluated soil, sediment, surface water, and groundwater conditions at and in its immediate vicinity (40 CFR 300.430(d)). These RIs documented the presence of various contaminants, particularly certain inorganic analytes and volatile organic compounds (VOCs) in groundwater, sediment, and surface water at or adjacent to SHL (Ecology and Environment, Inc. 1993; ABB Environmental Services, Inc. 1993). The environmental reports (decision documents) that were prepared after the initial RIs and the remedial actions completed at SHL are discussed below and included in Appendix B.

1995: Record of Decision

Using the results of the RIs, USACE prepared a ROD for the SHL Operable Unit, which presented the selected remedial action for SHL (USACE 1995) (see Appendix B) (40 CFR 300.430(f)). The remedial action selected (Alternative SHL-2) was a source control action that was intended to address long-term residential exposure to contaminated groundwater. The remedial action included the following elements:

- Completing closure of SHL in accordance with 310 CMR 19.000 (completed in 1993 and documented in the 1996 Close-Out Report [Stone & Webster Environmental Technology & Services 1996]);
- Landfill cover maintenance;
- Landfill gas collection system maintenance;
- Long-term groundwater monitoring;
- Long-term landfill gas monitoring; and
- Annual reporting to the MassDEP and USEPA.

The selected remedy also included a contingency remedy if the selected remedy proved ineffective at reducing concentrations of chemicals of concern (COCs) present in downgradient groundwater. The contingency remedy (Alternative SHL-9) was identified as groundwater extraction and treatment with discharge to the Town of Ayer publicly owned treatment works (POTW).

While SHL is in a condition that does not allow for unlimited use and unrestricted exposure, 5-year review (FYRs) are required by statute. Cleanup goals for COCs established in the ROD (USACE 1995) are provided in Table 1, below.

Table 1 - Cleanup Goals

Chemical of Concern	Cleanup goal (µg/L)	Selection Basis
Arsenic	50	ARARs (SDWA MCL)

[3] SERES-Arcadis JV was unable to locate a copy of the 1996 Landfill Capping Compliance Letter for citation, and prior reports do not have a citation for this document.

Chemical of Concern	Cleanup goal (µg/L)	Selection Basis
Chromium	100	ARARs (SDWA MCL)
1,2-Dichlorobenzene	600	ARARs (SDWA MCL)
1,4-Dichlorobenzene	5	Massachusetts MCL
1,2-Dichloroethane	5	ARARs (SDWA MCL)
Lead	15	Action level
Manganese	291	Background
Nickel	100	ARARs (SDWA MCL)
Sodium	20,000	Health advisory
Aluminum	6,870	Background
Iron	9,100	Background

Notes:
1. At the time of the ROD (USACE 1995), the cleanup goal for arsenic was 50 µg/L, but the SDWA MCL for arsenic has since been revised to 10 µg/L.
2. At the time of the ROD (USACE 1995), the cleanup goal for manganese was 291 µg/L, but it has been revised since to 1,715 µg/L based on a change in the risk-based reference dose.
µg/L = micrograms per liter
MCL = maximum contaminant level

The CSM at the time of the 1995 ROD was such that the remedial action was meant to be a "source control action" that "control[ed] the release of contaminants from wastes buried in Shepley's Hill Landfill" (USACE 1995). Additional characterization of the sources and nature of the arsenic in groundwater has been performed since 1995 and show there are a mix of anthropogenic (landfill waste) and geogenic (native) sources of arsenic. A description of the CSM is included as Section 4.

During the first FYR in 2000, monitoring wells sampled at SHL showed little to no reduction in arsenic concentrations, as well as some increases in concentrations. Therefore, it was concluded that these wells may not meet the 2003 incremental goal of 75% reduction in risk between baseline concentration and the cleanup goals specified in the ROD (USACE 1995). This resulted in the recommendation to implement the contingency remedy.

2005: Explanation of Significant Differences

CH2M prepared an ESD (CH2M 2005b) for USACE, which detailed the rationale for the changes to the contingency remedy (Alternative SHL-9) specified in the ROD (USACE 1995) (see Appendix B) (40 CFR 300.435(c)(2)). The required modifications to implement the contingency remedy outlined in the ROD (USACE 1995) included the following:

- Changing the POTW from Ayer to Devens; and
- Providing pre-treatment to meet Devens POTW discharge limitations (coagulation and filtration treatment).

As specified in the ROD (USACE 1995), the Army implemented the contingency remedy by installing and operating a groundwater extraction and treatment system (generally referred to as the ATP) in March 2006.

2005 to Present: Arsenic Treatment Plant

Due to continued elevated contaminant concentrations, beginning in September 2005, the Army installed and started full-time operation of the contingency remedy groundwater extraction and treatment system to address groundwater contamination emanating from the northern portion of the landfill.

The groundwater extraction and treatment system consists of two groundwater extraction wells (EW-01 and EW-04) located in the northwest portion of the landfill cap and an ATP. The ATP was designed to remove arsenic from extracted groundwater through co-precipitation with iron followed by filtration. The extraction wells can achieve the required combined target extraction rate of 50 gallons per minute (gpm) by either operating simultaneously or independently of one another to maximize plant influent flow, with an average annual removal rate of 428 pounds of arsenic per year (Geosyntec 2020). The ATP effluent is discharged to the Devens POTW collection system, and the precipitated solids produced by the system are taken from the plant at least once a month for disposal at a permitted landfill. The ATP currently remains in operation in this configuration.

The USACE is authorized to discharge treated groundwater from the ATP to the Devens municipal sewerage system in accordance with Landfill Discharge Permit Number 020. The permit was last renewed on June 28, 2022, and is in effect until June 28, 2025 (MassDevelopment 2022). The current permit mandates a maximum daily flow of 93,600 gallons per day (65 gpm) and for specific analytes to be sampled for in the effluent. Arsenic is analyzed monthly; select metals (barium, manganese, and magnesium) and other parameters (chloride, nitrate, and sulfate) are sampled quarterly; and select metals along with total toxic organics and total petroleum hydrocarbons are required to be sampled annually. Total toxic organics includes volatile organic compounds, semi-volatile organic compounds, pesticides, and polychlorinated biphenyls. Analysis of the effluent for per- and polyfluoroalkyl substances (PFAS) is not required by the permit.

2012: Slurry Barrier Wall

Following several years of operation of the ATP and monitoring of the SHL cap, it was determined that neither remedy was preventing the flow of impacted groundwater to the Red Cove area of Plow Shop Pond. To mitigate the arsenic flux in groundwater from SHL to Red Cove area of Plow Shop Pond and reduce risk to environmental receptors consistent with local conditions in Plow Shop Pond, a low-permeability barrier wall was installed along the eastern limit of SHL and to the west of Red Cove in 2012 as part of a non-time critical removal action. The slurry barrier wall consisted of an 850-foot-long in-situ barrier designed to intercept and divert groundwater flowing in the overburden soils away from Red Cove. The barrier wall extended from the ground surface through the SHL cap, a thin mantling of waste, and the underlying native sandy glacial deposits and glacial till to the bedrock surface. Installation of the slurry barrier wall also addressed the second remedial action objective (RAO) stated in the ROD (i.e., prevent contaminated groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations). As such, the slurry barrier wall is now considered a component of the existing SHL remedy in place. This FFS Report does not include evaluation of performance of the barrier wall.

2013: Second Explanation of Significant Differences

Sovereign prepared a second ESD (Sovereign 2013a) for USACE, which detailed a supplemental action to the selected remedy outlined in the ROD (USACE 1995) (see Appendix B). The supplemental action included the incorporation of land use controls (LUCs) as an enforceable component of the selected remedy to further protect potential receptors from exposure to groundwater containing COCs at concentrations that exceed ARARs migrating from SHL. The conclusions outlined in the 2013 ESD (Sovereign 2013a) include the following:

- Post-ROD investigations documented impacted groundwater within the area north of SHL (referred to as the NIA).
- The ROD (USACE 1995) did not specifically address LUCs for non-Army properties located north of SHL (i.e., the NIA) because the extent of the impact was not defined at the time.
- Groundwater in the NIA poses an unacceptable human health risk if used as drinking water, and potentially poses an unacceptable risk if used for irrigation.
- An area of LUCs was established in this ESD where the use of groundwater will be restricted based on the defined limits of groundwater contamination as documented during previous site investigations. The area of LUCs is shown on Figure 9.

The 2013 ESD noted that (Sovereign 2013a):

> "Since the time of the ROD, a more comprehensive understanding of the remedy Conceptual Site Model (CSM), groundwater chemistry in particular, has developed which indicates that a large amount of arsenic is being mobilized by natural as well as landfill-induced conditions. This CSM and the complex groundwater contamination problems have increased the uncertainty that the remedy will meet the aquifer restoration goals."

The CSM provided in Section 4 takes these conditions into consideration.

2014: Land Use Control Implementation Plan

Sovereign prepared a Land Use Control Implementation Plan (Sovereign 2014) for USACE, which described the plan to implement LUCs to restrict groundwater use in the NIA (see Appendix B). The performance objectives of the LUCs included the following:

- Restrict access to groundwater so the potential exposure pathway to the contaminants or COCs remains incomplete;
- Prohibit the withdrawal and/or future use of water, except for monitoring, from the aquifer within the identified groundwater LUC boundary; and
- Maintain the integrity of any current or future monitoring programs.

SHL and surrounding Army-controlled property are not addressed under these additional LUCs because these properties are addressed in the ROD (USACE 1995).

2 Nature and Extent of Contamination

This section provides a summary of contaminant data in groundwater compared to ROD-specified cleanup goals (USACE 1995).

After closure of SHL began in 1986, RIs confirmed the presence of various contaminants or COCs, including arsenic, in groundwater and soil. The ROD was completed in 1995 (USACE 1995), and FYRs were completed in 2000, 2005, 2010, 2015, and 2020 (USACE 2000, 2005; HydroGeoLogic, Inc. 2010; H&S Environmental, Inc. 2015; and KOMAN Government Solutions, LLC [KGS] 2020a).

A supplemental groundwater investigation was completed in 2003 (Harding ESE 2003). A supplemental groundwater investigation and landfill cap assessments were also performed in 2005 (AMEC 2009), followed by a supplemental groundwater and landfill cap assessment in 2010 (Sovereign 2011).

In 2016 and 2017, KGS performed additional field investigation activities, as required by the SOW (USEPA 2016a). Phase 1 of the SOW (USEPA 2016a) identified five tasks and associated subtasks necessary to assess whether the ATP provides sufficient containment/capture of the arsenic contamination migrating from SHL. The field investigation activities were conducted to determine whether the selected remedial action is protective of human health and the environment and whether the remedy is operating as intended (Geosyntec/KGS 2016 and KGS 2017). Field investigation activities included groundwater profile sampling at piezometers near extraction wells EW-01 and EW-04, bedrock well installation and sampling, groundwater profiling at transect borings located upgradient and downgradient from the extraction wells, and groundwater profiling in the NIA (Geosyntec/KGS 2016 and KGS 2017).

The Army monitors the groundwater within and around SHL semi-annually. The S-A JV sampled the monitoring well network at SHL in October and November 2021 as part of the semi-annual long-term monitoring (LTM) program (S-A JV 2022b). The extent of dissolved metals in groundwater based on the October and November 2021 sampling is shown on Figure 10. The locations of two cross sections are also shown on this figure, one north to south and one west to east. The extent of dissolved metals in groundwater is shown on Figure 11 for the north to south cross section and Figure 12 for the west to east cross section.

In addition to the routine LTM activities at SHL, the Army sampled groundwater at SHL for PFAS as part of an installation-wide RI for these chemicals. As part of this effort, KGS sampled selected SHL monitoring locations for PFAS in 2020 and subsequently prepared a Preliminary Site Characterization Summary for USACE (KGS 2020b). The RI field investigation at SHL included sampling existing monitoring wells (both overburden and bedrock) and collecting surface water and sediment samples from Plow Shop Pond and Nonacoicus Brook (KGS 2020b). The nature and extent of PFAS in groundwater adjacent to SHL is briefly summarized below.

2.1 Source Characteristics

Arsenic in groundwater beneath and adjacent to SHL is derived from geogenic sources in the bedrock, glacial till, and overburden sands, as well as from anthropogenic sources in the landfill waste. The mechanisms behind arsenic release and transport are discussed in Section 4. Data and investigations supporting anthropogenic and geogenic sources of arsenic present in groundwater at SHL are described below.

2.1.1 Anthropogenic Arsenic

Waste materials emplaced within SHL primarily consist of municipal solid waste (MSW) with some demolition debris and MSW incinerator ash. In 2010, the Army collected 37 samples from five borings within the landfill waste. Arsenic concentrations in these 37 soil samples ranged from 3.8 to 31 milligrams per kilogram (mg/kg), with an average of 10.9 mg/kg. Ash was observed in five of the 37 samples (14%), and the average arsenic concentration in these five samples was 15.1 mg/kg (Sovereign 2011). These concentrations in solids may have reduced slightly over time due to infiltration of water through the waste material before landfill capping and closure activities in 1993, but arsenic concentrations in soils and solids sampled to date from landfill solids are relatively low compared to arsenic concentrations observed in bedrock and overburden soil, particularly at the bedrock-till interface (discussed below). Low levels of arsenic may have migrated downward through the overburden into groundwater from MSW and demolition debris.

2.1.2 Geogenic Arsenic

Site data indicate that geogenic arsenic is most likely the predominant source of arsenic to groundwater at SHL. Arsenic in vertical profile groundwater samples does not exhibit the distributional pattern of dissolved arsenic expected if leachate from the landfill waste was the dominant contributing source. The highest concentrations of arsenic in both groundwater and soils have been detected in soils at, and immediately above, the overburden/bedrock interface, rather than shallower within and adjacent to soils where landfill wastes are or may be located.

Naturally occurring arsenic is present in the bedrock at SHL. SHL overlies the Devens Gneiss Complex, known to contain arsenic-bearing minerals such as arsenopyrite and scorodite. Analysis of arsenic mineralogy performed in 2011 associated with fractures in bedrock cores indicated that borings from SHP-99-29X and N5-P1 both contained arsenic, primarily in the form of arsenopyrite and scorodite (Gannett Fleming 2012).

In groundwater samples collected from bedrock well CH-1D, which is located hydraulically upgradient from SHL, arsenic was detected at concentrations up to 570 µg/L in 2016 (KGS 2017); these results indicate that arsenic associated with the mineralized fracture zones identified during the bedrock investigations are likely contributing to the dissolved arsenic load observed in groundwater at SHL. Similar observations were noted in profile sampling conducted in 2010 (Sovereign 2011). In bedrock below the Landfill footprint, arsenic was detected at concentrations as high as 4,700 µg/L (monitoring well N5-P1). Monitoring wells SHP-2016-06A and -06B located adjacent to the bedrock slope near Shepley's Hill have historically exhibited arsenic concentrations above 1,000 µg/L, indicating that groundwater originating from Shepley's Hill bedrock is likely to be a contributing source of arsenic beneath and downgradient of SHL. Concentrations of arsenic more than 1,000 µg/L are also observed in wells north of SHL that are screened in the overburden downgradient from the north toe of Shepley's Hill bedrock. The background concentration of arsenic in groundwater under reducing conditions at SHL is likely greater than the cleanup goal included in Table 1.

Arsenic is also present in the glacial till and overburden sands at SHL. Arsenic concentrations at the bedrock-till interface range from 9.4 mg/kg up to 1,319 mg/kg, with an observed median value of 23 mg/kg (Sovereign 2011; KGS 2017). Although less data are available, arsenic concentrations reported for bedrock in the later study ranged from 5.2 to 107.8 mg/kg, with an observed median value of 8.8 mg/kg (KGS 2017). The arsenic at the bedrock-till interface has accumulated through coprecipitation and/or adsorption over time, having originated from the geogenic arsenic in the bedrock described above, during seasonal periods of upward groundwater flow from the bedrock into the till matrix, which has a higher surface area. Arsenic derived from geogenic sources in the bedrock and/or glacial till has also accumulated in the overburden through coprecipitation and/or adsorption onto iron oxide coatings present on sand grains.

2.2 Arsenic Distribution in Groundwater

Arsenic concentrations within groundwater have been characterized beginning in 1987 during the SHL closure and continue to be monitored as part of the LTM program. The mobilization, fate, and transport of arsenic in site groundwater is primarily dependent on the highly reducing conditions present in groundwater at SHL. The fate and transport of contaminants in groundwater is further discussed in Section 4.1. Conditions in groundwater are consistent with reductive dissolution of iron and manganese, with the concomitant release of arsenic. Hydraulically downgradient (to the north) of SHL, redox conditions become more variable as oxic meteoric inputs provide recharge to groundwater.

Downgradient of SHL, higher concentrations of dissolved metals and arsenic are observed in deeper groundwater relative to shallow groundwater, and overall concentrations of dissolved metals are less than within the SHL footprint. Near Nonacoicus Brook, dissolved oxygen (DO) concentrations indicate at least seasonally oxic groundwater and decreasing dissolved arsenic concentrations relative to concentrations detected hydraulically upgradient.

In the following subsections, contaminant concentrations measured during the fall 2021 monitoring event are presented by site area (the boundaries of these areas are shown on Figure 2), including comparisons with the cleanup goals established in the ROD (USACE 1995), which are listed in Table 1, above. The current cleanup goal referenced for arsenic is the updated MCL of 10 µg/L. The cleanup goal for manganese was revised to be the background value of 1,715 µg/L since the time of the ROD (USACE 1995).

2.2.1 Bedrock Groundwater

Seven bedrock groundwater monitoring wells were sampled in fall 2021 corresponding to locations in the upgradient area, landfill area, barrier wall, and nearfield area (SHM-11-02, N5-P1, SHP-2016-06B, SHP-2016-06C, SHP-2016-07B, SHM-93-22C, and SHM-93-10D). Concentrations of arsenic in bedrock in fall 2021 ranged from non-detect (limit of quantification [LOQ] of 3.0 µg/L) to 540 µg/L (Figure 10, Table 2).

DO concentrations in bedrock groundwater ranged from 0.01 to 2.54 milligrams per liter (mg/L; Figure 13, Table 2); concentrations were 1.25 mg/L or less in all but one of the four areas, indicating low oxygen conditions. Iron and manganese concentrations were relatively low (i.e., below the cleanup goals) in all areas, as shown on Figure 10. The presence of arsenic with low iron and manganese concentrations is consistent with the potential release of geogenic arsenic through oxidative dissolution of sulfide minerals; this sulfide oxidation contributes to groundwater oxygen consumption and reduces oxidation-reduction potential (ORP; S-A JV 2022b).

2.2.2 Upgradient Area

Upgradient groundwater was sampled in fall 2021 from six monitoring wells located to the south/southeast of SHL and screened in overburden or glacial till (SHM-93-24A, SHM-93-18B, SHL-7, SHL-12, SHL-15, and SHL-24). Concentrations of arsenic in groundwater ranged from non-detect (LOQ of 3.0 µg/L) to 22 µg/L (Figure 10; Table 2). Only one of the six wells, SHL-15, which is installed adjacent to the landfill cap in the southwest portion of the site, exceeded the cleanup goal for arsenic (i.e., 10 µg/L), at 22 µg/L. This location is also the only upgradient well with a dissolved iron concentration above 1,000 µg/L (7,000 µg/L) (Figure 10). Upgradient groundwater conditions are generally oxic and exhibit low dissolved metals concentrations.

2.2.3 Landfill Area

Overburden groundwater beneath SHL was sampled in 2021 at seven monitoring wells (SHM-10-07, SHM-10-11, SHM-10-12, SHM-10-13, SHM-10-14, SHM-10-15, and SHP-99-29X). Each of the seven monitoring wells exceeded the cleanup goal for arsenic of 10 µg/L and concentrations ranged from 410 µg/L at SHM-10-13 to 6,300 µg/L at SHM-10-15 (Figure 10; Table 2). Three of the highest detected concentrations of arsenic in groundwater in fall 2021 were in samples collected from landfill area overburden wells SHM-10-12, SHM-10-14, and SHM-10-15. Landfill area locations exhibited low DO (DO concentrations were less than 1 mg/L at all seven wells) and ORP (ORP measurements were less than 0 millivolts at all seven wells), and higher concentrations of dissolved iron (40,000 to 76,000 µg/L) and manganese (1,500 to 7,700 µg/L) (Figure 10; Table 2). These results are consistent with what would be expected beneath a landfill with an impermeable cap and indicative of active reductive dissolution of arsenic, iron, and manganese.

2.2.4 Barrier Wall Area

The barrier wall was installed between SHL and Plow Shop Pond in an area of groundwater exceeding the cleanup goal for arsenic to mitigate the migration of arsenic-contaminated groundwater to Red Cove area of Plow Shop Pond. Since the wall was installed in an existing area of groundwater exceeding the arsenic cleanup goal, there are exceedances of the cleanup goal in groundwater on both sides of the wall. In the fall 2021 monitoring data, monitoring wells directly adjacent (east or west) to the barrier wall along the northern third of the wall (e.g., PZ-12-01, PZ-12-02, PZ-12-03, PZ-12-04, SHL-11, and SHL-20) contained the highest concentrations of arsenic in groundwater in the Barrier Wall Area, ranging from 270 to 990 µg/L (Figure 10; Table 2). Elevated dissolved iron and manganese concentrations (up to 67,000 and 3,700 µg/L for iron and manganese, respectively) are indicative of active reducing conditions (Figure 10; Table 2). These wells are within the footprint of SHL or are immediately adjacent.

Far northeast and southeast of the Landfill footprint and barrier wall (e.g., in the areas adjacent to monitoring wells SHL-3, SHL-10, SHP-01-36X, and SHP-01-37X), conditions are oxidizing and arsenic concentrations are lower, below detection (LOQ of 3 µg/L) at wells SHL-3 and SHL-10 and detected at 13 µg/L at wells SHP-01-36X and SHP-01-37X, slightly above the cleanup goal for arsenic (Figure 10; Table 2). These wells (e.g., SHL-3, SHL-10, SHP-01-36X, and SHP-01-37X) are located outside of the area of groundwater influenced by both the landfill and bedrock at Shepley's Hill (S-A JV 2022b).

2.2.5 Nearfield Area

As groundwater moves north from beneath SHL, vertical variability in arsenic distribution and redox conditions is apparent. Downgradient (north) of the SHL, arsenic concentrations in shallow groundwater at well SHP-2016-1A, -2A, -3A, -4A, and -5A exhibited generally oxic conditions with low concentrations of arsenic (non-detect to 8.9 µg/L; Figure 10, Table 2). These wells have a maximum bottom screen depth of 30 feet bgs. In contrast, monitoring wells screened in deeper groundwater in this area (e.g., SHP-2016-1B, -2B, -3B, -4B, and -5B) contained detected concentrations of arsenic in groundwater ranging from 110 to 1,100 µg/L in fall 2021 (Figure 10; Table 2). These wells are screened to a maximum depth of 90 feet bgs. Arsenic concentrations in groundwater were higher in this area in the deep overburden and were below the cleanup goal in shallow overburden, reflecting oxic meteoric water recharge to groundwater downgradient of SHL (S-A JV 2022b).

2.2.6 North Impact Area

North of the nearfield area in the NIA, concentrations of all dissolved metals, including arsenic, iron, and manganese, generally decreased from the levels observed both at the toe of Shepley's Hill and within SHL, where reductive dissolution of metals is evident. As in the Nearfield Area, shallower groundwater (e.g., wells SHM-05-39A, SHM-99-31A, and SHM-99-31B) generally exhibited lower concentrations of all dissolved metals (arsenic, iron, and manganese) than deeper groundwater in the same area (e.g., wells SHM-05-39B and SHM-99-31C). As groundwater flows to the northwest toward Nonacoicus Brook, the portion of the aquifer where arsenic exceeds the cleanup goal narrows (Figure 10). Arsenic at well SHM-13-03, just upgradient of Nonacoicus Brook, was detected at a concentration of 39 µg/L in fall 2021 compared to concentrations at the wells located approximately 300 feet hydraulically upgradient to the southeast, where concentrations of arsenic detected in groundwater in fall 2021 ranged from 290 to 1,800 µg/L (Figure 10; Table 2). DO concentrations were variable in this area (Figure 13, Table 2), and more oxic groundwater conditions support attenuation of dissolved metals (S-A JV 2022b).

2.3 PFAS Distribution in Groundwater in the Vicinity of SHL

KGS performed a PFAS RI at Devens and subsequently prepared a Preliminary Site Characterization Summary for USACE (KGS 2020b). SHL was investigated as part of field activities, along with other AOCs at Devens. The RI field investigation at SHL included sampling existing monitoring wells (both overburden and bedrock) and collecting surface water and sediment samples from Plow Shop Pond and Nonacoicus Brook (KGS 2020b).

Results of the RI field investigation indicated that PFAS in groundwater adjacent to SHL are present in the sampled wells at concentrations exceeding the June 2022 Devens site-specific screening levels (SSSLs) for PFAS (USEPA 2022). The highest concentration of PFAS in groundwater adjacent to SHL were detected at vertical profile 32VP-19-01, an investigation location hydraulically upgradient (to the south) of SHL and associated with AOC 32, the Former Defense Reuse and Marketing Office Yard (KGS 2020b). Perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorohexanesulfonic (PFHxS) acid are the primary PFAS detected in groundwater, typically at concentrations less than 100 nanograms per liter per compound. Figure 14 shows the area of PFAS in groundwater exceeding the Devens SSSLs. PFAS investigations will continue site-wide and will be addressed separately from the FFS.

3 Risk Evaluation

USEPA's guidance "Role of Background in the CERCLA Cleanup Program" (USEPA 2002) notes that under CERCLA, cleanup levels are generally not set at concentrations below natural background levels. This approach is taken due to "cost-effectiveness, technical practicability, and the potential for recontamination of remediate areas by surrounding areas with elevated background concentrations" (USEPA 2002). At SHL, a background value for arsenic in groundwater has not yet been determined. Though the USEPA communicated that Phase 2 of the SOW is no longer necessary (USEPA 2021), the Army recently completed a background study for arsenic in groundwater (S-A JV 2022a, 2023) as outlined by the USEPA SOW (Appendix A). The ROD (USACE 1995) did not include consideration of a background value for arsenic, but it will be important to establish an acceptable background concentration as the site CSM continues to be updated and the potential efficacy of available technologies to remediate arsenic contamination in groundwater caused by SHL are evaluated.

A risk assessment, pursuant to 40 CFR 400.430(d)(1), was performed as part of the original CERCLA investigation activities for the SHL Operable Unit (USACE 1995). The risk assessment evaluated the probability and magnitude of potential unacceptable risks to human health and the environment associated with exposure to contaminated media at SHL. A four-step process was followed for the human health risk assessment (USACE 1995):

1. Contaminant identification;
2. Exposure assessment;
3. Toxicity assessment; and
4. Risk characterization.

Forty COCs were selected for evaluation in the human health risk assessment (USACE 1995). Potential human health effects associated with exposure to the COCs were estimated quantitatively or qualitatively through the development of several potential exposure pathways, which included the following:

- Incidental ingestion of Plow Shop Pond surface water, and long-term consumption of Plow Shop Pond fish by recreational anglers and their families;
- Contact (dermal and incidental ingestion) with Plow Shop Pond sediment by site visitors;
- Contact (dermal and incidental ingestion) with surface water by swimmers in Plow Shop Pond; and
- Future residential use of groundwater.

Details on excess lifetime cancer risk and hazard index calculations are included in the ROD (USACE 1995). Based on those calculations, the following potential unacceptable risks to human health were identified (USACE 1995):

- Long-term consumption of fish from Plow Shop Pond;
- Long-term contact with Plow Shop Pond sediment; and
- Future residential use of unfiltered groundwater.

The ROD (USACE 1995) stated that the:

> "[f]future residential use of unfiltered groundwater interpreted to be under the influence of the landfill and contaminated with several inorganics (arsenic, manganese, chromium, lead, nickel, and sodium) and 1,2-dichloroethane and dichlorobenzenes was estimated to present potential cancer risks of $4x10^{-4}$ to $8x10^{-3}$. Most of the risk was due to the presence of arsenic."

The ROD (USACE 1995) also stated that:

> "It should be noted that when present at the federal MCL for drinking water, arsenic presents an estimated cancer risk of $1x10^{-3}$, which exceeds the target risk range."

In addition, the ecological risk assessment predicted that Plow Shop Pond surface water and sediment presented potential adverse risks to aquatic receptors. The Army concluded that actual or potential releases of hazardous substances to groundwater from SHL, if not addressed by implementing an appropriate response action, may present an imminent and substantial endangerment to public health, welfare, and the environment (USACE 1995). Details on relevant decision documents and remedial actions performed in response to this risk evaluation is summarized in Section 1.2.3.

USACE again evaluated risk as part of the Supplemental Groundwater and Landfill Cap Assessment for Long-Term Monitoring and Maintenance (AMEC 2009). Exposure pathways assessed during this risk evaluation included the following:

- Drinking water use;
- Recreational use of Nonacoicus Brook; and
- Landfill gas exposures from
  - Direct venting from the landfill,
  - Lateral migration from the landfill through shallow soil, and
  - Migration from groundwater containing dissolved gas.

This report (AMEC 2009) concluded that no significant unacceptable risk to human health is present, but such a risk could exist if groundwater were to be used as a source of drinking water.

4 Conceptual Site Model

The section utilizes the cumulative data for SHL to update the CSM. The subsections below describe the fate and transport conditions of contaminants in groundwater and the theoretical conditions that would be conducive to aquifer restoration potential. The nature and extent of contamination is described in Section 2.

4.1 Fate and Transport of Contaminants in Groundwater

Numerous factors affect the release and attenuation of arsenic in groundwater, including system pH, the presence of competing anions, and oxidation-reduction (redox) conditions. Groundwater at SHL generally has circumneutral pH and relatively low concentrations of typical competing anions, such as phosphate. Therefore, changes in the mobilization, fate, and transport behavior of arsenic in SHL groundwater is primarily dependent on redox conditions. The following subsections start with a discussion of the site-specific release mechanisms for arsenic based on the arsenic source information and data provided in Section 2.1, followed by a summary of the geochemical mechanisms controlling arsenic mobility and attenuation.

4.1.1 Arsenic Release Mechanisms

As described in Section 2.1, the source of arsenic to groundwater at SHL includes anthropogenic and geogenic sources. Specifically, the release and mobility of arsenic in groundwater at SHL is believed to include the following three sources and mechanisms:

- Mechanism 1 – anthropogenic sources: Arsenic present within landfill waste, which dissolves into landfill leachate and is (or was historically) transported into the underlying aquifer. (Mechanism 1 was thought to be the primary source/mechanism when the ROD was written in 1995).
- Mechanism 2 – geogenic/naturally released sources: Naturally occurring arsenic present in bedrock, glacial till, and overburden sands, which is released into solution via ambient (i.e., non-landfill-influenced) processes, including sulfide mineral oxidation within the bedrock and iron mineral reduction in the till and overburden due to naturally oxidizing and reducing conditions (i.e., natural peat deposits of former swamps located under SHL), respectively.
- Mechanism 3 – geogenic/anthropogenic influenced sources: Arsenic with a geogenic source (i.e., naturally occurring arsenic in the glacial till and overburden) that may be released into groundwater due to reducing conditions caused or exacerbated by the landfill.

Naturally occurring arsenic is present in the bedrock at SHL as arsenic sulfide minerals, including arsenopyrite, as well as the ferric arsenate mineral scorodite (a common weathering product of arsenopyrite; Gannett Fleming 2012). Under equilibrium conditions, dissolution of scorodite can produce aqueous arsenic concentrations on the order of 1,000 to more than 10,000 µg/L (Magalhaes 2002; Bluteau and Demopoulos 2007 [as referenced in Gannett Fleming 2012]). Arsenopyrite can also be oxidized in the presence of oxygen, releasing arsenic into groundwater. Within the bedrock, oxidative dissolution of arsenopyrite and dissolution of scorodite with recharge from precipitation on Shepley's Hill provides a source of arsenic to bedrock groundwater. Seasonal upward groundwater flow within SHL subsequently flows into the overburden beneath the landfill. On the western side of the landfill close to Shepley's Hill, groundwater elevations measured at well cluster SHP-2016-06 showed a consistent upward gradient, regardless of season, from the deeper wells (SHP-2016-06B/C) to the shallow well

(SHP-2016-06A). This mechanism represents one source of geogenic arsenic released under natural conditions (Mechanism 2 above).

Whereas a significant quantity of naturally occurring arsenic in the bedrock is present in sulfide minerals, naturally occurring arsenic in the glacial till and overburden sands is associated with iron oxyhydroxides. In contrast to the oxidative dissolution mechanism releasing arsenic from arsenopyrite in bedrock, the naturally occurring arsenic present in glacial till and overburden sands may be released through reductive dissolution processes, which reduce and solubilize iron, releasing the co-occurring arsenic. Beneath and hydraulically downgradient of SHL, variably reducing redox conditions have developed due to the presence of both natural organic carbon (associated with the buried former swamp and associated peat deposits) and potentially landfill-derived organic carbon, resulting in the release of arsenic from iron oxyhydroxide-coated sand. As such, both Mechanisms 2 and 3 above can contribute to the release and sustained mobility of arsenic in groundwater at SHL.

4.1.2 Arsenic Mobility and Attenuation

Following release into groundwater, arsenic is anticipated to be present primarily in the oxyanion forms of arsenite and arsenate. Both of these forms are highly mobile in water, with transport governed by adsorption. Both arsenate and arsenite will adsorb to soil mineral surfaces, with adsorption affinity dependent on pH, alkalinity, and the presence of other ions in the water (Dixit and Hering 2003; Campbell and Nordstrom 2014). In mildly reducing to oxic environments (i.e., redox potential above sulfate reducing conditions; discussed below), the predominance of arsenate versus arsenite may vary depending on the specific redox conditions, which to some extent will affect transport via sorption. However, the primary processes governing arsenic attenuation include dilution and oxidative precipitation of iron and manganese. As iron and manganese oxidize and precipitate, coprecipitation or sorption of arsenic within metal oxyhydroxides will remove arsenic from groundwater, but in environments where dissolved reduced iron and manganese are stable, limited arsenic attenuation may be expected.

In natural systems, oxidation-reduction reactions typically proceed in order of "preference" based on the energy released per mole of reactant. This can be quantified as the redox potential ("Eh") of the reaction expressed in units of volts. Figure 15 illustrates the redox potential of several redox reactions relevant to the groundwater system at SHL on a "redox ladder" diagram. The redox status of a system (whether it is "reducing" or "oxidizing" and to what extent) is governed by the reactions controlling the redox poise. Specifically, at SHL, arsenic-containing groundwater tends to exhibit low oxygen, with coexistence of dissolved Fe(II) and Mn(II) in solution and with solid-phase Fe(III) and Mn(III/IV) in the soil. The dissolved Fe(II) and Mn(II) is the result of reductive dissolution of the more oxidized Fe and Mn oxyhydroxide phases, with the redox poise set in this range by these reactions.[4] This redox potential is above the range in which significant sulfate reduction is anticipated to occur, and as noted above, arsenic may be present as either arsenate or arsenite (Figure 15).

The importance of the redox environment on arsenic release and mobility at SHL is evident based on the overlap between arsenic concentrations and redox parameters, including dissolved iron and manganese, DO, and ORP. These co-occurrences are discussed in Section 2.2 and are evident from the metal distributions shown on Figures 10, 11, 12, and 16, and they are explored further in scatter plots discussed below. Areas of elevated dissolved

[4] Importantly, the redox reactions on the ladder do not necessarily run to completion in natural systems before other redox reactions with different redox potentials may proceed. Therefore, it is possible for multiple redox species to coexist out of equilibrium in groundwater. In this way, it is common for dissolved reduced iron and manganese to both coexist in the presence of oxidized iron and manganese within oxyhydroxides, along with a combination of arsenate or arsenite, as achieving equilibrium among all redox-active species may be kinetically limited.

arsenic in groundwater include the overburden immediately beneath SHL and hydraulically downgradient to the north, extending into the NIA. Beneath SHL, spatial overlap is observed between arsenic, iron, and manganese (Figure 10). Extending to the north, iron and manganese concentrations become more variable, but generally still overlap with the extent of dissolved arsenic. Variability in iron and manganese concentrations (with some areas showing elevated iron with relatively low manganese and vice versa) may be indicative of redox dynamics between these two metals as they are transported in groundwater. This spatial overlap between arsenic and redox conditions is also observable in the distribution of DO and ORP in groundwater, where strong overlap is observed between dissolved arsenic and negative ORP (i.e., ORP less than 0 millivolts; Figure 13).

A similar spatial overlap between arsenic, iron, and manganese is also observed vertically (Figures 11 and 12); as noted in Section 2, water quality is uniformly reducing beneath SHL, and downgradient (to the north), groundwater at depth is both more reducing (with higher iron and manganese) and exhibits greater arsenic concentrations than shallow groundwater, which is oxic (containing greater DO and lower dissolved iron and manganese). The more oxic condition in shallow groundwater may be driven by oxic recharge with precipitation; this recharge contributes to dilution as well as reoxidation and precipitation of iron and manganese, with both mechanisms resulting in lower arsenic concentrations in shallow groundwater.

The correlation at SHL between dissolved arsenic and iron is observed more directly on Figure 16a, which provides scatter plots of arsenic versus dissolved iron, dissolved manganese, DO, ORP, and pH using the fall 2021 data for the same wells shown on Figures 10 and 13. A strong positive correlation is observed between dissolved arsenic and dissolved iron, particularly for dissolved iron values above 1,000 µg/L. To evaluate this further, the combined iron and arsenic dataset (i.e., overburden and bedrock wells within and outside of the landfill footprint) for iron values above 1,000 µg/L were evaluated with a correlation analysis. The logarithms of the iron and arsenic concentrations exhibit a linear trend with a correlation coefficient of 0.81 (R^2 value of 0.66), with a p value substantially less than 0.01 (6.2×10^{-18}). Figure 16b also provides the 95-percent prediction intervals on the fitted line. The results also show a slightly weaker but positive correlation between arsenic and dissolved manganese. A negative correlation is also evident between arsenic and ORP, with increasing dissolved arsenic at lower ORP values. A correlation analysis was also conducted for the arsenic and ORP results (corresponding to the same iron greater-than-1,000 µg/L dataset); these results are provided on Figure 16b. This plot shows a linear correlation between ORP and log-arsenic with a correlation coefficient of 0.57 (R^2 value of 0.32) and a calculated p value substantially lower than 0.01 (2.0×10^{-7}). 95-percent prediction intervals are also provided on the plot. With DO, arsenic does not appear to follow a simple linear trend, though it is apparent that arsenic concentrations greater than 10 µg/L coincide with low DO (approximately 1 mg/L or lower), whereas arsenic tends to be less than 10 µg/L for DO greater than 2 mg/L (Figure 16a).

The arsenic versus iron plot on Figure 16a illustrates that bedrock wells tend to exhibit higher arsenic, but with lower iron concentrations compared to overburden wells; this trend is also observed to a lesser extent with manganese. As noted previously, this observation is consistent with the arsenic release mechanism in the bedrock, which is driven more by the oxidative dissolution of arsenopyrite rather than the reductive dissolution of arsenic-containing metal oxyhydroxides. Notably, despite the lower iron and manganese concentrations in the bedrock wells, the ORP remains as low or lower compared to overburden wells with the same arsenic concentration. This may partly be due to the pH (ORP decreases with increasing pH, and groundwater in the bedrock wells tend to be 1 pH unit or more greater than in the overburden wells; Figure 16a), or it may be due to additional reduced chemical species in bedrock groundwater, such as dissolved sulfide. Otherwise, no correlation is observed between arsenic and pH. Overall, these results further demonstrate the connection between the presence of arsenic in groundwater and reducing conditions at SHL.

The primary geochemical factors governing arsenic release, transport, and attenuation in different portions of SHL are summarized on Figure 17. The gray arrows represent the flow of water and dissolved constituents between different portions of the aquifer. Key components of the arsenic transport conceptual site model are summarized below:

- SHL acts as a source of anthropogenic arsenic (and likely organic carbon) to groundwater, while also contributing to reducing conditions. Estimates suggest that only about 11% of the waste in the landfill is thought to be saturated (Sovereign 2011). This condition was much more prevalent before the landfill was capped. With the landfill cap in place, little recharge to groundwater is occurring; this is largely beneficial (as it limits further leaching of arsenic and organic carbon from the unsaturated landfill into the aquifer), but it also limits the inflow of oxygenated water, exacerbating reducing conditions beneath SHL.
- Within the overburden immediately beneath SHL, arsenic, iron, and manganese are present because of all three mechanisms described in Section 4.1.1. This overburden receives arsenic and reducing groundwater from the landfill, with limited recharge of oxygenated water. The overburden also contains some organic carbon from buried former swamp and peat deposits (Figure 3B), which are likely contributing to the reducing conditions.
- The NIA overburden receives a combination of reducing groundwater (containing dissolved arsenic, iron, and manganese) from the landfill overburden, lateral inflow of groundwater (primarily from the east and west) within the overburden and bedrock, and recharge from precipitation. As with the landfill overburden, the presence of naturally occurring organic carbon from former swamp and peat deposits likely contributes to reducing capacity in the NIA aquifer. As noted above, these inputs have created a vertical redox gradient, with more oxidizing conditions (and lower arsenic) in the shallow overburden and more reducing conditions (and higher arsenic) at deeper groundwater depth.
- Across SHL, groundwater flows between overburden and bedrock zones, with flow direction (bedrock to overburden versus overburden to bedrock) varying spatially and seasonally. As described above, bedrock groundwater flowing into the overburden can contribute arsenic (with relatively low iron and manganese) due to oxidation of arsenic containing sulfides.
- As water flows downgradient, arsenic attenuation occurs through dilution, sorption to aquifer solids and reoxidation of iron and manganese. Prior to groundwater discharge into Nonacoicus Brook, reoxidation of iron and manganese and precipitation occurs in the hyporheic zone where oxygen present in surface water mixes with more reducing groundwater. In this way, iron, manganese, and arsenic are removed from solution before discharge to the brook.

4.2 Aquifer Restoration Potential

As described in Section 4.1, the groundwater redox conditions play a central role in both the release and attenuation of arsenic at SHL. Therefore, potential restoration of the aquifer at SHL relies on creating stable and sustainable redox conditions in which arsenic is less mobile, less prone to release, and can attenuate via the available geochemical mechanisms.

Specifically, achieving long-term arsenic removal and stabilization would best be accomplished by creating a sustained oxygenated environment within the alluvial aquifer. Introduction of oxygen into the aquifer will result in oxidation and precipitation of dissolved iron and manganese as oxyhydroxides, which remove arsenic from groundwater. However, ensuring long-term arsenic removal will require not only near-term oxygen introduction to oxidize dissolved metals, but also some assurance that the active reducing capacity of the aquifer is overcome, either through continual flow of oxygenated water or through sufficient oxygenation over a long enough period to consume readily available reducing capacity (both natural and anthropogenic) present within the aquifer. Even in these conditions, an active system that provides oxygen to groundwater would need to run in perpetuity to overcome the active reducing capacity at SHL.

These geochemical factors were considered when identifying and evaluating alternatives for SHL, as described in Sections 5 and 6. Alternatives that result in direct oxidation of short-term and long-term oxygen demand (e.g., air sparge) and result in the influx of oxygenated water (e.g., partial landfill removal) will most directly achieve this result, contingent on the feasibility of implementation (Section 6).

Although introduction of oxygen and/or oxygenated water are feasible in principle, the long-term sustainability of strategies to consume residual reducing capacity and maintain a more oxic condition are uncertain. The results of work conducted to date to evaluate long-term reducing capacity and performance of remedial alternatives as they relate to aquifer restoration potential are summarized in Section 4.2.

4.2.1 Potential Residual Reducing Capacity

With the goal of creating a more oxic long-term condition in the alluvial aquifer, the aquifer restoration potential must consider both the current aqueous redox conditions (primarily represented by concentrations of DO, iron, and manganese), as well as the residual reducing capacity present upgradient and within the overburden. Residual reducing capacity in the overburden likely takes the form of solid-phase organic matter (including natural buried former swamp and peat deposits, as well as organic carbon and biomass associated with biodegradation of landfill leachate transported into the overburden) and sulfide minerals, if present. However, little is known regarding the extent and distribution of this type of residual reducing capacity throughout the alluvial aquifer.

To evaluate the presence of residual reducing capacity in aquifer solids, soil samples were collected and analyzed during installation of air sparge points and groundwater monitoring wells as part of the in-situ air sparge (IAS) pilot test conducted in 2021 (S-A JV 2022c), which is described further in Section 4.2.4. The pilot test and associated sampling were conducted outside of the footprint of SHL. Soil samples were collected across the saturated zone during installation of air sparge point AS-21-1D, with discrete samples collected at depth intervals between 24 and 72 feet bgs (from 24 to 28, 34 to 38, 48 to 54, 60 to 64, and 70 to 72 feet bgs). In addition to total metals (arsenic, iron, and manganese), samples were analyzed for biochemical oxygen demand (BOD), acid-base accounting including sulfur forms, and total organic carbon (TOC). The results indicated no sulfur minerals (pyritic/sulfide or otherwise) above the detection limit of 0.04% by mass and no detectable TOC above 900 milligrams (mg) organic carbon per kilogram (kg) soil. Similarly, BOD was not detected above the laboratory sample quantitation limits of between 850 and 980 mg oxygen/kg soil.

Overall, these results are promising in that they indicate minimal presence of solid-phase residual reducing capacity in the immediate vicinity of the IAS pilot test, suggesting a high potential for aquifer restoration with minimal local rebound from soil/overburden materials following air sparging. However, significant uncertainty still remains in this area and other areas of the alluvial aquifer. The high reporting limits for TOC and BOD for these samples do not eliminate the possibility of significant reducing capacity below 900 mg organic carbon/kg soil associated with the soil. In addition, based on soil boring logs, the pilot test was conducted in an area with minimal presence of former swamp and peat deposits. These deposits are believed to be more significant toward the centerline of the arsenic plume; mapped areas of former swamp are shown on Figure 3B.

Residual reducing capacity, which may complicate the establishment of long-term oxidizing conditions, may also derive from dissolved constituents entering from hydraulically upgradient areas. The influx of reduced groundwater (i.e., groundwater with low DO and iron) may not in itself pose a risk for arsenic re-release; however, the greater risk is associated with reducing groundwater containing electron donors (e.g., dissolved organic carbon [DOC]). DOC was also collected along with metals during the fall 2021 sampling event. To evaluate the potential importance of DOC on sustaining reducing conditions, the current DOC concentration distribution was compared to concentrations of arsenic and iron in groundwater on Figure 18 for the fall 2021 data collected at the same wells shown on Figures 10 and 13. In these graphs, bedrock and overburden data are each plotted separately for wells occurring within and outside the landfill footprint. Overall, arsenic does not appear to be well correlated with DOC in groundwater when viewed on either a log or linear scale; several wells within the landfill footprint (which tend to be highly reducing) exhibited elevated arsenic concentrations under a range of DOC conditions, while several wells exhibited DOC between 2 and 10 mg organic carbon/liter (L) groundwater but with low arsenic concentrations. Other factors can be surmised from these trends (such as specific locations and dissolved oxygen content), the results indicate that organic carbon alone is not a reliable predictor of arsenic concentration. In contrast, iron exhibits a more strongly visible bimodal clustering with DOC, with a qualitative positive correlation observed in both clusters. For very high iron concentrations between 20,000 and 80,000 µg/L (linear scale; Figure 18), iron appears positively correlated with DOC values between 1 and 7 mg organic carbon/L groundwater, particularly for the overburden bedrock wells within the landfill footprint. For the overburden landfill wells, a linear trendline was fit to the data, which yielded a correlation coefficient (R value) of 0.681, based on the fitted R^2 of 0.464. At lower iron concentrations below 15,000 µg/L, a second grouping also suggests a positive correlation with DOC values between 1 and 9 mg organic carbon/L groundwater (log scale; Figure 18). As with arsenic, the higher concentration iron cluster includes wells immediately beneath SHL. In the case of iron, although organic carbon alone is not necessarily a predictor of iron content, the results indicate that elevated iron is associated with higher organic carbon concentrations within the landfill footprint. Although these results may be indicative of an organic carbon electron donor control on dissolved iron concentrations, they should not be used to infer causation. Regardless, the results suggest the possibility that long-term influx of organic carbon may complicate attempts to establish a stable oxic condition.

4.2.2 Arsenic Treatment Plant Performance

In accordance with the Phase I USEPA SOW, the S-A JV prepared a Technical Memo titled *Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 5.e, Validate the Extent of Capture by Evaluating Concentration Trends in NIA Monitoring Locations as Compared to Flow Paths Developed in the Updated Groundwater Flow Model* (Technical Memo 5) on behalf of USACE in 2021 (S-A JV 2021a). The purpose of Technical Memo 5 was to evaluate performance of the ATP by evaluating the capture zones estimated by the groundwater model developed for SHL using MODFLOW (Geosyntec 2020). Technical Memo 5 also included analyses of groundwater flow potential, recharge, and pumping influence using three-point estimation analysis and the groundwater flow model to estimate the capture zone created by the two extraction wells (EW-01 and EW-04) used by the ATP to recover arsenic-impacted groundwater.

Three-point estimation analyses (presented and discussed Technical Memo 5 and Technical Memos 1, 2, and 4 [S-A JV 2021b, 2021c, 2021d]) indicate there could be areas between wells SHM-10-06 and SHL-21 where groundwater containing arsenic may not be captured by the extraction wells at all times.[5] A mass flux analysis

[5] The key design criteria for the ATP extraction wells, as specified in the 100% design (CH2M 2005b) were to "provide containment of the groundwater plume in the vicinity of the base boundary," seek to reduce the design rate of 50 gpm as appropriate, and to focus groundwater extraction in the deeper part of the glacial aquifer. The modeling results presented in

was performed to quantify the potential arsenic mass not captured by the ATP extraction wells. The groundwater model developed for the SHL area (Geosyntec 2020) indicates that approximately 39 gpm flows naturally through the overburden from beneath the landfill. The ATP currently extracts approximately 50 gpm, or more than 125% of the water that naturally flows northward from beneath the landfill.

Approximately 13% (5.1 gpm) of the overburden groundwater migrating northward from the landfill (under non-pumping conditions) migrates though the area between monitoring wells SHM-10-06 and SHL-21 (i.e., the hypothetical bypass area).The mass of arsenic present in the 5.1 gpm of overburden groundwater that may bypass the extraction system is estimated to be 0.7 to 3.9 pounds per year (lbs./yr.) based on the geometric and arithmetic mean arsenic concentrations measured in this area. This is approximately 0.3 to 1.4% of the approximately 220 to 280 lbs./year of arsenic that migrates through the overburden across the entire transect between profile borings/wells SB-2017-06 and SHL-21. Using 95% upper confidence limit arsenic concentrations, the upper-bound estimate of arsenic mass present in the 5.1 gpm of overburden groundwater that may bypass the ATP is approximately 16.9 lbs./yr., or 3.4% of the total arsenic mass flux that migrates through the entire transect. These mass flux calculations indicate if the capture zone was improved to consistently always capture the mass that may be bypassing the ATP to the east, the pumping system would only achieve 0.7 to 16.9 lbs./yr. more of arsenic removal. The mass flux calculations are presented in Appendix C.

Improvements in groundwater quality at several locations in the Nearfield Area and NIA over time are demonstrated in the Mann-Kendall trend analysis performed as part of the 2021 Operations, Maintenance, and Monitoring Report (S-A JV 2022b); however, the data indicate that continued ATP operation will not result in the achievement of the current groundwater cleanup goals in these areas. As evidenced in the technical memoranda provided to date and referenced above, the ATP is capturing approximately 87% of the overburden groundwater flow from the landfill, and approximately 97% of the associated arsenic mass flux, with an estimated capture zone that corresponds to the design capture zone presented in the Remedial Design and Remedial Action Workplan (CH2M 2005a). The discrepancy between system performance and remedy effectiveness is attributed to geogenic sources of arsenic that are present, and will persist, downgradient of the ATP regardless of the ATP's operational status. Downgradient of the ATP in the NIA, discharge of groundwater from mineralized bedrock zones will continue to contribute dissolved arsenic to overburden, while arsenic in the overburden may exhibit limited attenuation and/or may continue to be mobilized due to naturally reducing conditions associated with the presence of swamps in that area. These conditions are likely to result in extended or even unachievable cleanup timeframes for the NIA and Nearfield Area. An evaluation of cleanup timeframes under these conditions (capture of 87% of the overburden groundwater flow from SHL and approximately 97% of the associated arsenic mass flux) is presented in Section 4.2.3.

As discussed in the USEPA SOW Phase I Subtask 2.d (Appendix A) technical memo (S-A JV 2021c), the vertical capture zone extent of the ATP was based on a review of the vertical hydraulic gradients near extraction wells EW-01 and EW-04, which indicate that the predominant vertical direction of flow is downward within the glacial aquifer, with slight temporal variations when an upward gradient may be present. Many of the calculated vertical gradients presented in the USEPA SOW Phase I Subtask 5.e (Appendix A) technical memo are relatively low, with greater than 25% of the vertical gradients less than or equal to 0.001 foot per foot (S-A JV 2021b). The gradients are likely influenced by a relatively high hydraulic conductivity of the glacial aquifer, with little to no impediment to downward flow between shallow and deep zones within the aquifer. Therefore, the estimated

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the final design of the ATP extraction system did not include full capture east of the landfill boundary (between wells SHM-10-06 and SHM-21; Figures A-8 and A-9 of CH2M 2005b).

vertical capture zone likely extends to at least the top of bedrock. The extent of the capture zone into the bedrock is somewhat uncertain as there are seasonal differences in vertical hydraulic gradients between the bedrock and glacial aquifer (the gradient is sometimes upward). The gradient from monitoring well SHP-2016-06A to monitoring well SHP-2016-6B is typically downward and the gradient from monitoring well SHP-2016-6C to monitoring well SHP-2016-6B is typically upward, therefore the estimated vertical extent of the capture zone in the bedrock was set to the bottom of the screen for monitoring well SHP-2016-6B.

4.2.3 Cleanup Timeframe Estimate

As mentioned in Section 3, USEPA's guidance "Role of Background in the CERCLA Cleanup Program" (USEPA 2002) notes that under CERCLA, cleanup levels are generally not set at concentrations below natural background levels. At SHL, a background value for arsenic in groundwater has not yet been approved. The Army recently completed a voluntary background study for arsenic in groundwater (S-A JV 2022a, 2023). The background study field sampling included collection of groundwater samples at 27 overburden wells and 16 bedrock well locations upgradient and side-gradient of SHL. Field parameters (turbidity, DO, temperature, pH, specific conductivity, and ORP) were recorded at each sampling location. In addition, laboratory samples were analyzed for dissolved arsenic, redox-active constituents (dissolved iron and manganese, ammonia-nitrogen, nitrate/nitrite nitrogen, and DOC), major cations (dissolved calcium, magnesium, potassium, and sodium), and major anions (sulfate, total alkalinity, and chloride). As part of the total alkalinity measurement, calculation of the carbonate, bicarbonate, and hydroxide components were requested from the laboratory. The *Report on the Evaluation of Site-Specific Arsenic Background Concentrations in Groundwater* estimated a background value of 198 µg/L for groundwater in overburden under reducing geochemical conditions and a background value of 7,839 µg/L for arsenic in bedrock groundwater (S-A JV 2023). These values exceed the current cleanup goal.

Mann-Kendall trend analysis was performed on arsenic data spanning from 2014 to 2020 at 79 SHL monitoring wells using an Access/Excel based tool. Results of the trend analysis are included in Appendix D. A total of 68 of the 79 monitoring wells had a frequency of detection of arsenic great enough for Mann-Kendall analysis to be performed (at least four samples are available, and the frequency of detection was greater than or equal to 20%). Results indicate that arsenic concentrations at most SHL monitoring wells analyzed have no significant trend. Of the 68 monitoring wells, 18 wells (26%) had decreasing trends over time and 48 wells (71%) had no significant trend (Table D-1 in Appendix D). Two locations, SHM-05-41A and SHP-2016-5A, were noted to have a statistically significant increasing trend, but the arsenic concentration in groundwater at each location in 2020 was only 18 and 3.9 µg/L, respectively.

A quantitative estimate of cleanup timeframe predictions was conducted using exponential decay model analysis (Theil-Sen estimator). Cleanup timeframe estimates are also included in Table D-1 in Appendix D. Confidence intervals for Theil-Sen lines were constructed by bootstrapping (USEPA 2009b). The data for each well/analyte pair were randomly resampled with 500 bootstrap replicates, and a Theil-Sen line was calculated for each replicate. The time interval between the first sample date and the original predicted compliance date was divided into 100 equally spaced dates. For each date, the upper and lower 95th percentile of Theil-Sen predictions from the 500 bootstrap replicates was calculated. These predictions were graphed to create the lower confidence limit and upper confidence limit. Predicted compliance dates were only calculated when a decreasing trend was identified using Theil-Sen estimator. The predicted compliance date was estimated using the following equations:

Linear interpretation:

$$Compliance\ Date = \frac{Screening\ Level\ - Intercept}{Slope} + Excel\ Origin\ Date\ (January\ 1,\ 1970)$$

Loglinear interpretation:

$$Compliance\ Date = \frac{LN(Screening\ Level)\ - LN(Intercept)}{LN(Slope)} + Excel\ Origin\ Date\ (January\ 1,\ 1970)$$

Cleanup timeframe estimates were then calculated using R programming language (R Core Team 2022).

Cleanup timeframe estimates were able to be calculated at 13 monitoring wells with decreasing trends identified using Mann-Kendall and Theil-Sen estimator. Arsenic concentrations in two of the 13 monitoring wells (SHL-22 and SHP-2016-2A) have been below the screening level since November 2016 and May 2020, respectively, resulting in predicted dates which occur in the past. Cleanup timeframe estimates in the remaining 11 monitoring wells range between September 2025 and September 2044 using the linear interpretation and October 2029 and February 2169 using the loglinear interpretation. Although cleanup timeframes could not be estimated in 31 of the remaining monitoring wells, arsenic concentrations in these wells either are entirely non-detect and less than the screening level (seven wells) or are currently less than the screening level (24 wells). Arsenic concentrations in 34 of the remaining 35 wells are relatively stable, with an increasing trend identified in one well (SHM-05-41A).

The calculation of cleanup timeframes was not possible for these 34 locations because current trends do not indicate that cleanup could ever be achieved. As stated above, cleanup timeframes can be calculated for a total of 13 of 68 monitoring wells, with timing ranging from predicted dates occurring in the past (those currently below the cleanup goal) to February 2169. Most of the monitoring wells have had arsenic concentrations over time that have no significant trend (Table D-1 of Appendix D). The lack of trends in these wells is true following a decade of active remediation by the ATP, which is capturing approximately 87% of the overburden groundwater flow from SHL and approximately 97% of the associated arsenic mass flux (Section 4.2.2). Based on these performance results to date, as well as the presence of geogenic arsenic in groundwater under strongly reducing conditions (background arsenic concentrations in groundwater greater than the cleanup goals), it is expected that none of the remedial alternatives that are being evaluated in this FFS Report would be able to achieve restoration of the aquifer to the current cleanup goals within 30 years. LUCs already in place and administrated by Army are protective of human health.

4.2.4 In-Situ Air Sparge Pilot Test

The S-A JV prepared an IAS Pilot Test Implementation Report for USACE to document the activities performed and the results observed in the execution of the IAS pilot test at SHL (S-A JV 2022c). The objective of the pilot test was to determine the efficacy of IAS to immobilize arsenic in groundwater to the current cleanup goal of 10 µg/L (the current MCL for arsenic) and to collect necessary data for comparison and evaluation of IAS to other remedial technologies.

Based on the work performed and data collected as part of the IAS pilot test, S-A JV concluded the following:

- From a geochemical standpoint, SHL appears to be well suited for immobilization of arsenic through an IAS treatment system.
- The efficacy of arsenic removal is dependent on the aqueous iron to arsenic ratio in solution. The pilot test was highly effective in the area where the pilot test was conducted (adjacent to monitoring well SHM-10-06 on

the northeast corner of the landfill), where dissolved iron to arsenic mass ratios range from 40 to more than 1,000 (S-A JV 2022c). Preliminary bucket tests conducted on groundwater obtained from the northwest corner of the landfill (exhibiting influence from bedrock groundwater with lower dissolved iron to arsenic ratios) were less effective (S-A JV 2021e).

- SHL contains suitable material for air sparging: permeable sands with a low degree of heterogeneity to minimize channeling and/or short-circuiting of injected air.
- The pilot test was less effective in distributing DO to the deepest part of the overburden (low-permeability glacial till), making it uncertain if IAS can target treatment of dissolved arsenic at depth near bedrock (where the highest concentrations of arsenic in soils and groundwater have been detected) and/or requiring closely spaced deep sparge points.
- IAS is a technology that can effectively reduce dissolved arsenic flux flowing within alluvium downgradient of SHL and is a valid remedial option to evaluate and include as part of a feasibility study.

5 Identification of Remedial Objectives and Alternatives

This section describes the RAOs for SHL, the ARARs (40 CFR 300.400(g)), and the remedial alternatives selected for evaluation.

5.1 Remedial Action Objectives

As described in the ROD (USACE 1995) and subsequent ESDs (CH2M 2005b; Sovereign 2013a) the RAOs for SHL are to:

- Protect potential residential receptors from exposure to impacted groundwater migrating from the landfill having chemicals in excess of ARARs; and
- Prevent impacted groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations.

Consistent with the first RAO, the conceptual design of remedial alternatives that have an active treatment component position them at the downgradient / northern end of SHL to affect groundwater migrating from beneath the landfill.

In 1995, AOC-72 was established by the Army as the Plow Shop Pond Operable Unit. The second RAO was addressed through installation of a barrier wall upgradient of Plow Shop Pond, between the pond and SHL. Performance monitoring for this remedial action continues. More detailed information can be found in the Final Removal Action Completion Report for Shepley's Hill Landfill Barrier Wall (Sovereign 2013b).

5.2 Applicable or Relevant and Appropriate Requirements

Applicable requirements are those substantive provisions of any promulgated federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable as they specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (BLR 2014).

Relevant and appropriate requirements are those substantive provisions of any promulgated federal or more stringent state environmental standards, requirements, criteria, or limitations that, while not legally 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 CERCLA site that their use is well suited to the particular site (BLR 2014).

USEPA has identified three categories of ARARs for CERCLA remedial actions (USEPA 1987):

- Chemical-specific ARARs are typically health-based numerical criteria, which are used to establish acceptable concentrations or amounts of a chemical that may be discharged to or present in the environment.
- Action-specific ARARs are requirements that pertain to the particular remedial actions that are proposed at the site (e.g., monitored natural attenuation, landfill gas control)
- Location-specific ARARs are restrictions placed on the concentration of hazardous substances, pollutants or contaminants or the conduct of activities because they are in a specific location.

In addition to ARARs, many federal and state environmental and public health programs also develop criteria, guidance, and proposed standards that are not legally binding, but that may provide useful information or recommendation procedures. These are referred to as "to be considered" (TBC) requirements that are non-promulgated advisories or guidance that are not legally binding and do not have the status of potential ARARs.

5.3 Identification of Remedial Alternatives

The remedial alternatives identified for evaluation in this FFS Report are listed below and described in detail in the following subsections:

- Alternative 1: No Action;
- Alternative 2: Groundwater Extraction and Treatment (current remedy);
- Alternative 3: In-Situ Air Sparging;
- Alternative 4: Modified Groundwater Extraction and Treatment
  - Alternative 4A: Groundwater Extraction and Treatment with Three Extraction Wells, and
  - Alternative 4B: Groundwater Extraction and Treatment with Three Extraction Wells and Injection;
- Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging; and
- Alternative 6: Partial Landfill Removal with Active Aquifer Treatment.

Although they do not appear in the name of the alternative, LUCs and LTM are included in Alternatives 2 through 6.

The reclassification of SHL as a NPDWSA under MassDEP Policy WSC-97-701 as a LUC was considered in formulation of the above remedial alternatives. Additional information regarding the potential reclassification of SHL to a NPDWSA is included as Appendix E. However, based on subsequent discussions with MassDEP and USEPA, this approach was not retained as a Remedial Alternative in the Final FFS.

The use of several other technologies was considered in formulation of the above remedial alternatives. A permeable reactive barrier (PRB) was considered but was not retained for evaluation for the following reasons:

1. The depth to which the PRB would need to be installed (80 to 100+ feet bgs);
2. The cost of installation;
3. The frequency at which the active material would need to be replaced once spent;
4. The high likelihood of clogging due to calcium carbonate precipitation; and
5. The likelihood that the PRB would promote reducing conditions downgradient of the wall, which would promote additional or continued dissolution of geogenic arsenic.

In-well addition of oxygenated water and circulating wells were not considered because of the potential of in-well fouling in the iron-rich groundwater in the area of SHL, and because addition of oxygen to groundwater via air injection (sparging) would more effectively deliver oxygen to the subsurface.

As part of development of the 1995 ROD, ion exchange treatment, chemical precipitation, construction of wetlands, and in situ oxidation were considered as potential technologies. Following screening, "Limited Action" was selected as the remedy, with "Collection/Discharge to POTW" as a contingency (USACE 1995).

As discussed in Section 4.2.3, none of the remedial alternatives evaluated in this FFS Report would be able to achieve restoration of the aquifer to the current cleanup goals within 30 years.

5.3.1 Alternative 1: No Action

The No Action alternative is required by 40 CFR 300.430(e)(6) to serve as a baseline for comparison with other remedial alternatives. Operation of the ATP and LTM associated with groundwater would be terminated. LUCs put into place and maintained by the Army that restrict access to groundwater in the NIA would cease. LUC activities the Army performs to ensure the performance objectives outlined in the 2013 ESD are being met (public education and outreach and meeting with the Ayer Board of Health on an annual basis to discuss implementation) would be discontinued. Administratively under MassDEP, much of the NIA would continue to be classified as a NPDWSA, limiting access to groundwater for use as drinking water, but areas outside of the NPDWSA would not have this protection.

Alternative 1 takes no action to further minimize the potential for human exposure to COCs. COC reduction is achieved only through natural attenuation processes. The No Action alternative would rely on the existing landfill cap to isolate landfill waste from the environment and infiltration during precipitation events. The barrier wall would continue to direct groundwater flow from the landfill area away from Plow Shop Pond. Groundwater would continue to contact landfill waste and peat layers, continuing reducing conditions in groundwater. As the mobilization and fate and transport of dissolved metals is largely dependent upon redox conditions, arsenic would continue to be mobilized. Dissolved arsenic would continue to be detected in reduced groundwater downgradient of the landfill. Downgradient (to the north) of the landfill, near Nonacoicus Brook, oxic groundwater conditions and decreasing dissolved arsenic concentrations would continue to reduce arsenic mobility.

Appendix F presents the groundwater modeling used to evaluate this alternative. For the No Action alternative, forward particle tracking from a transect south of the SHL barrier wall showed that groundwater will migrate into the NIA, which is located just north of the Devens boundary, because the extraction wells would be turned off. The pathway of the particles in general mimics the shape of the interpreted area of arsenic greater than 10 µg/L. The groundwater velocity at the northern end of SHL, just south of the extraction wells is between 200 and 300 feet per year (ft/yr.). As groundwater enters the NIA, groundwater velocities slightly decline to between 100 and 200 ft/yr. This indicates that groundwater velocities are faster within the landfill than within the NIA under No Action conditions. When compared to the current remedy (Alternative 2), the groundwater velocity in the NIA under non-pumping/steady state conditions is faster and the groundwater velocity in the landfill is slower. These groundwater velocity comparisons are most relevant when considering active remedial alternative technologies that may provide oxygenated groundwater that will travel through specific areas for treatment at a greater or lesser rate.

5.3.2 Alternative 2: Groundwater Extraction and Treatment

Groundwater extraction and treatment was identified as the contingency remedy in the ROD (Alternative SHL-9 [USACE 1995]) and is currently in place at SHL. Under this alternative, two extraction wells (EW-01 and EW-04) are used to extract groundwater for treatment at the ATP at a rate of 50 to 55 gpm, with an average annual removal rate of 428 pounds of arsenic per year (Geosyntec 2020), which is almost twice the amount of arsenic mass that flows northward under non-pumping conditions. Solids are removed from the ATP monthly for disposal. Using this annual removal rate, Alternative 2 was estimated by Geosyntec as potentially taking 340 years for complete arsenic removal from SHL (Geosyntec 2020). This calculation assumes both that there is a finite source of arsenic in groundwater and that arsenic migrates from SHL as an "advective plume"; however, these assumptions are an oversimplification, as they do not account for ongoing arsenic release from the solid phase or the low mobility of the arsenic plume due to sorptive retardation.

As discussed in Section 4.2.3, most of the monitoring wells at SHL do not have a statistically significant decreasing trend for arsenic concentrations in groundwater over time and it is not possible to reliably estimate a timeframe to achieve the current cleanup goals (Appendix D). As stated in Section 4.2, reducing conditions and the presence of geogenic arsenic in groundwater make treatment of groundwater to meet the current cleanup goals impractical.

Appendix F presents the groundwater modeling used to evaluate this alternative. For Alternative 2, forward particle tracking from a transect south of the SHL barrier wall showed that all particles were captured by the two ATP extraction wells. Groundwater velocity was also evaluated. Relative to Alternative 1 (No Action), the groundwater velocity is faster upgradient of extraction wells, increasing from 200 ft/yr. under Alternative 1 (No Action), to greater than 400 ft/yr. under Alternative 2 (Groundwater Extraction and Treatment). North of the extraction wells in the NIA, an area of lower groundwater velocity (less than 100 ft./yr.) develops. Groundwater flow and arsenic mass extracted by the ATP is greater than the amounts flowing northward under non-pumping conditions, indicating that the additional flow of groundwater and additional arsenic mass includes water and arsenic from the bedrock and from north of the pumping wells (as described in Section 4.2.2). Based on the groundwater modeling results, approximately 15% of the extracted groundwater is from bedrock (19% of the groundwater extracted by EW-1 and 11% of the groundwater extracted by EW-4). Appendix F includes the methodology used to develop this estimate.

LUCs under this alternative include restricting access to groundwater and prohibiting the withdrawal and/or future use of water, except for monitoring, from the aquifer within the identified groundwater LUC boundary. An area of LUCs was established in the 2013 ESD (Sovereign 2013a) where the use of groundwater is restricted. These LUCs are already in place as part of the contingency remedy (Alternative SHL-9 [USACE 1995]). LUC activities the Army performs to ensure the performance objectives outlined in the 2013 ESD are being met include public education and outreach and meeting with the Ayer Board of Health on an annual basis to discuss implementation of the LUCs.

LTM under this alternative includes landfill monitoring and maintenance and monitoring of the ATP and barrier wall remedies. The current LTM program is documented in the 2015 Long-Term Monitoring and Maintenance Plan Update and the 2018 Addendum to the Long-Term Monitoring and Maintenance Plan (Sovereign 2015; KGS 2018). The LTM program consists of annual groundwater quality and chemistry monitoring, sampling, and analysis to evaluate performance and effectiveness of the existing remedy (i.e., ability of the ATP extraction system, as designed, constructed, and operated, to achieve the ROD-specified RAOs [USACE 1995]). LTM is in place as part of the original selected remedy (Alternative SHL-2 [USACE 1995]), and LTM activities and results are summarized in the annual operations, maintenance, and monitoring reports.

5.3.3 Alternative 3: In-Situ Air Sparging

Air sparging for the in-situ remediation of arsenic in groundwater is performed by supplying oxygen into the saturated subsurface through the injection of air using an aboveground compressor and subsurface injection points. Some oxygen present in the injected air is dissolved in groundwater. Dissolved iron and manganese in chemically reduced groundwater is oxidized by DO, and arsenic is immobilized through adsorption and coprecipitation of arsenic with the oxidized amorphous iron. Oxidation of manganese may also yield arsenic removal via adsorption/coprecipitation with manganese oxyhydroxides over longer durations.

Successful IAS requires development of air-filled porosity in the aquifer to cause sufficient dissolution of oxygen in the groundwater to reverse the chemical-reducing conditions and then promote iron precipitation. The most suitable soil for air sparging is permeable sand with a low degree of heterogeneity to minimize channeling and/or short-circuiting of injected air (USACE 2013). The effectiveness of air sparging for arsenic "removal" also depends on dissolved iron and/or manganese concentrations in groundwater being high enough, relative to concentrations of arsenic, to provide sufficient arsenic uptake capacity.

The conceptual design parameters for this alternative evaluation were determined through the implementation of an IAS pilot study at SHL in 2021 (S-A JV 2022c). Figure G-2 in Appendix G shows the layout of the conceptual implementation and identifies key design assumptions. As shown on the figure, an air sparge transect would be installed along the toe of the landfill and span the width of the area where arsenic concentrations exceed ARARs. An IAS system comprising compressors, a programmable logic controller, and a manifold connecting each sparge well (to manifolds connected to the compressors) would be installed and operated. Both shallow and deep sparge points would be installed in overburden groundwater along this transect to distribute DO within the aquifer. ATP operation would cease. Dissolved oxygen where distributed in groundwater would oxidize iron and co-precipitate arsenic where present.

The IAS system is expected to have a negligible effect on overall groundwater hydraulics. While there may be a local reduction in the permeability in soils adjacent to the sparge points due to metals precipitation, effects on the aquifer permeability are expected to be minimal, as discussed in the Final In-Situ Air Sparge Pilot Test Implementation Report (S-A JV 2022c).

Operation of the IAS system is anticipated to result in a decrease of dissolved arsenic concentrations in groundwater to concentrations at or below the ARARs where DO is able to be successfully distributed. The pilot test demonstrated that DO distribution was easier to achieve in shallow overburden groundwater than in the deep overburden groundwater. Implementation of IAS at the SHL boundary would result in reducing the total arsenic mass flux from SHL as well as reversing the chemical reducing potential of the migrating landfill groundwater and would also result in improvements in groundwater quality in the NIA. Specifically, reduction in mass flux at the SHL boundary would begin immediately upon initiation of the remedy; however, improvements in downgradient water quality would depend on sustained transport of oxygen downgradient, slowly consuming the reducing capacity of the downgradient aquifer. The timeframe for this process is difficult to predict but is likely to require at least several decades under ambient flow conditions.

LUCs under this alternative are consistent with those described in Section 5.3.2, which are the LUCs outlined in the contingency remedy (Alternative SHL-9 [USACE 1995]).

LTM under this alternative is consistent with the LTM described in Section 5.3.2, which is the LTM outlined in the original selected remedy (Alternative SHL-2 [USACE 1995]). Instead of conducting LTM to evaluate the effectiveness of the ATP, LTM would be conducted to evaluate the effectiveness of the IAS.

5.3.4 Alternative 4: Modified Groundwater Extraction and Treatment

Alternative 4 has been divided into two sub-alternatives to evaluate two modifications to the existing groundwater extraction and treatment system: the addition of a third extraction well (Alternative 4A), and the addition of a third extraction well coupled with injection of treated groundwater effluent to the subsurface (Alternative 4B).

<u>Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells</u>

Under this alternative, the groundwater extraction and treatment currently in place would be expanded to include a third extraction well (EW-03). The third extraction well would not increase the rate of groundwater extraction for treatment at the ATP but rather is intended to decrease the flow of landfill impacted groundwater northward by installing an extraction well east of extraction wells EW-01 and EW-04 to improve the capture zone. By widening the capture zone to the east, the landfill impacted groundwater and dissolved arsenic that may be bypassing the current capture zone east of monitoring well SHM-10-06 could no longer impact the NIA. Figure G-2 in Appendix G shows the conceptual layout of the modified groundwater extraction and treatment alternative showing the proposed location of the third extraction well and identifies key design assumptions.

Appendix F presents the groundwater modeling used to evaluate this alternative. For Alternative 4A, forward particle tracking from a transect south of the SHL barrier wall showed that all particles were captured by the three ATP extraction wells. Groundwater velocity was also evaluated. The groundwater velocity at the northern end of the landfill is greater than 300 ft/yr. approaching the three extraction wells. The groundwater velocity near extraction wells EW-01 and EW-04 is slightly slower under this Alternative than Alternative 2 (Groundwater Extraction and Treatment, current remedy), primarily because of the reduction in the groundwater extraction flowrate at extraction well EW-04 relative to Alternative 2. The groundwater velocity is much faster under this alternative in the area of extraction well EW-03. Two areas of lower groundwater velocity (less than 100 ft/yr.) develop north of the extraction wells, one area in the NIA north of extraction wells EW-01 and EW-04 and another area northwest of extraction well EW-03.

LUCs under this alternative are consistent with those described in Section 5.3.2, which are the LUCs outlined in the contingency remedy (Alternative SHL-9 [USACE 1995]).

LTM under this alternative is consistent with the LTM described in Section 5.3.2, which is the LTM outlined in the original selected remedy (Alternative SHL-2 [USACE 1995]). Instead of conducting LTM to evaluate the effectiveness of the existing ATP, LTM would be conducted to evaluate the effectiveness of the modified groundwater extraction and treatment system.

<u>Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection</u>

Under this alternative, the groundwater extraction and treatment currently in place would be expanded to include a third extraction well (EW-03) consistent with Alternative 4A, with the addition of injection of treated groundwater effluent to the subsurface.

The ATP would continue to operate and remove arsenic from influent groundwater. Injected water would be required to meet the standards of the substantive provisions of an otherwise applicable injection program. The treated effluent would be rerouted from the current discharge to the Devens POTW to injection wells or trenches. Injection of the treated groundwater effluent would utilize six injection wells (or trenches extending across the same transect), spaced evenly along an injection transect located to the north of the extraction wells, as shown on Figure G-3 in Appendix G. Treatment of water by the ATP results in the addition of DO to the effluent due to oxidant addition and mixing to promote oxic conditions within the aquifer. A jet pump ejector or other suitable method could be used if needed to supplement the effluent with additional DO. Figure G-3 lists the key design assumptions used to develop this alternative. Figure G-4 in Appendix G includes a cross-section that shows the approximate location of the proposed third extraction well.

Injection of oxic treated groundwater will enhance attenuation of arsenic in groundwater through the oxidative precipitation of iron and manganese and aerobic consumption of residual reducing capacity (e.g., labile organic carbon). It is expected that DO concentrations in the overburden aquifer would increase, resulting in the immobilization of dissolved arsenic through coprecipitation with oxidized dissolved iron. Over time, this in-situ treatment would result in the distribution of DO and reduction of arsenic and iron concentrations in groundwater downgradient of the ATP.

Three different potential treated effluent injection locations were evaluated using the SHL groundwater flow model (Geosyntec 2020). One location was to the northeast of the SHL boundary, one was upgradient of the extraction wells in the footprint of SHL, and one was downgradient of SHL, just south of the property boundary. The first option (northeast of the SHL boundary) resulted in modeled particles in the area where arsenic exceeds the current cleanup goal being "pushed" further to the northeast, outside of the current footprint. Modeling results of injection of groundwater upgradient of the extraction wells within SHL resulted in some particles bypassing the extraction wells and some migrating further to the northeast, outside of the area where arsenic in groundwater exceeds the current cleanup goal. When the injection wells were modeled as being positioned hydraulically downgradient of the extraction wells, just south along the northern property boundary, there was no observed negative effect on capture, and the injected treated water resulted in an increased groundwater velocity through the downgradient NIA, which would be anticipated to increase dissolved oxygen loading in this area.

Appendix F presents the groundwater modeling used to evaluate this alternative. For Alternative 4B, forward particle tracking from a transect perpendicular to the northern end of the SHL barrier wall through SHL showed that all particles were captured by the three ATP extraction wells. Groundwater velocity was also evaluated. The area of groundwater velocities greater than 300 ft/yr. is smaller than for Alternative 4A (Groundwater Extraction and Treatment with Three Extraction Wells). However, the groundwater velocity north of the injection wells is faster than under Alternative 4A, indicating there is increased groundwater recirculation and dissolved oxygen inflow that may facilitate more expeditious arsenic attenuation. The injection wells will also add more oxygenated water at the downgradient boundary of Devens.

LUCs under this alternative are consistent with those described in Section 5.3.2, which are the LUCs outlined in the contingency remedy (Alternative SHL-9 [USACE 1995]).

LTM under this alternative is consistent with the LTM described in Section 5.3.2, which is the LTM outlined in the original selected remedy (Alternative SHL-2 [USACE 1995]). LTM would be used to evaluate the effectiveness of the modified groundwater extraction, treatment, and injection system.

5.3.5 Alternative 5: Groundwater Extraction and Treatment with In-Situ Air Sparging

Under this alternative, the ATP would be expanded to include a third extraction well (EW-03) and would be coupled with IAS. The expanded groundwater extraction would be consistent with that described for Alternative 4A (Section 5.3.4), and IAS would be consistent with that described for Alternative 3 (Section 5.3.3), except for the location of the air sparge transect and number of sparge points. IAS is used as a combination technology in this alternative because allows for a much greater amount of oxygen to be delivered to the aquifer than injection of oxygenated water.

Figure G-3 in Appendix G shows the layout of the conceptual implementation of Alternative 5 and identifies key design assumptions. As shown on the figure, an air sparge transect would be installed downgradient of the ATP, beyond the capture zone of the ATP, across the area where arsenic concentrations exceed ARARs. An IAS system comprising compressors, a programmable logic controller, and a manifold connecting each individual sparge well to manifolds connected to the compressors would be installed and operated.

Although Alternative 5 was not evaluated using the groundwater flow model (Appendix F), hydraulically, the results would be similar to those for Alternative 4A. As described in Section 5.3.4, while there may be a local reduction in the permeability adjacent to the sparge points due to metals precipitation, effects on the aquifer are likely to be minimal, as shown in the IAS Pilot Test Implementation Report (S-A JV 2022c).

LUCs under this alternative are consistent with those described in Section 5.3.2, which are the LUCs outlined in the contingency remedy (Alternative SHL-9 [USACE 1995]).

LTM under this alternative is consistent with the LTM described in Section 5.3.2, which is the LTM outlined in the original selected remedy (Alternative SHL-2 [USACE 1995]). LTM would be performed to evaluate the effectiveness of the ATP with a third extraction well and the addition of IAS.

5.3.6 Alternative 6: Partial Landfill Removal with Active Aquifer Treatment

Under this alternative, landfill waste material located within and above the groundwater table in the northern half of the landfill (approximately 29 acres) would be excavated; the estimated total volume of material that would be excavated is approximately 1,080,000 cubic yards. The waste material would be transported to and disposed of at an offsite lined waste management facility. The excavated northern portion of the landfill would be backfilled with clean fill materials to 1 foot above the groundwater table at a minimum and regraded as necessary to maintain general site topography and facilitate future use. This alternative was initially envisioned to involve relocation/reconsolidation of the waste material in the northern half of the landfill into a new engineered landfill to be located on top the southern portion of the current SHL footprint. However, the reconsolidation alternative was considered to not be feasible since this alternative would essentially require excavation and reconstruction of the entire landfill, including the southern portion, to ensure that the resulting structure was geotechnically stable. Such reconstruction would be prohibited by BRAC regulations.

The reconfigured landfill is shown on Figure G-5 in Appendix G. Cross sections detailing the conceptual design are included as Figures G-6 and G-7. An air sparge system would be installed along the Devens boundary downgradient of the landfill as the active aquifer treatment component to this alternative.

Appendix F describes the groundwater modeling used to evaluate this alternative. To simulate the northern landfill area, the recharge in the northern portion of the landfill (where waste material would be removed, and clean fill material would be placed) was set to match that of the recharge of the NIA and most of the active model domain (recharge in the northern portion of the landfill was increased from 2.47 to 17.3 inches per year). The recharge in the southern end of the landfill was retained as the calibrated model (2.47 inches per year) given the reconsolidated portion would be placed above the existing cap. The forward particle tracks are similar to Alternative 1 – No Action; however, some of the pathlines migrate farther to the east towards Plow Shop Pond (as described in Section 5.3.4, air sparging has a minimal effect on overall groundwater hydraulics). The groundwater elevations are approximately 1 foot higher at the toe of the landfill than under Alternative 1 due to the enhanced recharge in the northern portion of the landfill. The groundwater velocity at the northern end of the landfill, just south of the extraction wells, is 300 ft/yr., which is approximately one to two times faster than for Alternative 1. As groundwater enters the NIA, velocities decline to between 100 and 200 ft/yr., similar to Alternative 1 (No Action). As there will be increased recharge within the northern end of the landfill because the landfill cover will be removed in that area, and with increased groundwater flow rates in this area, there will be an increase in the mass load of dissolved oxygen flowing to the north.

LUCs under this alternative are consistent with those described in Section 5.3.2, which are the LUCs outlined in the contingency remedy (Alternative SHL-9 [USACE 1995]).

LTM under this alternative is consistent with the LTM described in Section 5.3.2, which is the LTM outlined in the original selected remedy (Alternative SHL-2 [USACE 1995]). Instead of conducting LTM to evaluate the effectiveness of the ATP, LTM would be conducted to evaluate the effectiveness of the partial landfill removal with active aquifer treatment.

6 Detailed Analysis of Remedial Alternatives

6.1 Overview of Evaluation Criteria

Nine evaluation criteria have been developed to address the CERCLA requirements, as well as technical and policy considerations that are important to consider at SHL when evaluating remedial alternatives (40 CFR 300.430(e)). These evaluation criteria serve as the basis for conducting the detailed analysis during the feasibility study and for subsequently selecting an appropriate remedial action. The evaluation criteria are divided into three categories: threshold criteria, balancing criteria, and modifying criteria, as detailed in Section 6.1. In addition to the nine criteria under these three categories, additional factors have been evaluated, as detailed in Section 6.3.

6.1.1 Threshold Criteria

Threshold criteria include 1) overall protection of human health and the environment; and 2) compliance with ARARs, as described below.

Overall Protection of Human Health and the Environment

This evaluation criterion addresses whether the remedial action can adequately protect human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established by remediation cleanup goals. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, specifically compliance with ARARs, long-term effectiveness and permanence, and short-term effectiveness.

Compliance with ARARs

The identification and evaluation of ARARs (40 CFR 300.400(g) and 300.430(e)(2)(i)) is a key component in the FFS process and compliance with CERCLA and the NCP. CERCLA §9621 specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental or facility siting laws that are ARARs to the hazardous substances or circumstances at the site. Location-specific, chemical-specific, and action-specific ARARs are included in Table 3.

CERCLA onsite remedial response actions must comply with the substantive requirements of a regulation and not the administrative or procedural requirements (CERCLA §9621(e)). Substantive requirements pertain directly to the actions or conditions at the site and administrative or procedural requirements facilitate their implementation.

Circumstances exist in which several ARAR waiver options may be invoked, provided that the basic premise of protection of human health and the environment is evaluated. The situations eligible for waivers include the following:

- The selected remedial action is only part of a total remedial action that will attain the ARARs (interim remedy).
- Compliance with the ARAR would pose a greater risk to human health or the environment than would nonattainment.
- Attainment of the ARAR is not practicable from an engineering perspective.
- The ARAR is a state requirement and is inconsistently applied or enforced.
- Under Section 104 of CERCLA responses, compliance with the ARAR for the protection of human health and the environment will be too expensive relative to benefits that could be attained at other sites.

- Equivalent performance or standard of control can be obtained without the ARAR (40 CFR § 300.430(f)).

This evaluation criterion addresses whether the ARARs can be met, and if not, whether a waiver is appropriate.

6.1.2 Balancing Criteria

Balancing criteria include 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility, and volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost, as described below (40 CFR 300.430(e)(9)(iii)(C)-(G)).

Long-Term Effectiveness and Permanence

This evaluation criterion addresses the results of a remedial action in terms of the risk remaining at the site after RAOs have been met, along with the degree of certainty that the alternative will prove successful. The primary focus of this evaluation criterion is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. Components that will be considered for each alternative under this criterion include the following:

- Magnitude of residual risk: the residual risk remaining from untreated waste or treatment residuals at the conclusion of remedial activities; and
- Adequacy and reliability of controls: the adequacy and suitability of controls, if any, that are used to manage treatment residuals or untreated wastes that remain at the site.

Reduction of Toxicity, Mobility, and Volume through Treatment

This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. Components that will be considered for each alternative under this criterion include the following:

- The treatment processes the remedy will employ and the materials they will treat.
- The amount of hazardous materials that will be destroyed or treated, including how the principal threat(s) will be addressed.
- The degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude).
- The degree to which the treatment will be irreversible.
- The type and quantity of treatment residuals that will remain following treatment.
- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

Short-Term Effectiveness

This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until RAOs are met. Under this criterion, alternatives should be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. Components that are considered for each alternative under this criterion include the following:

- Protection of the community during remedial action.
- Protection of workers during remedial action.

- Environmental impacts that may result from implementation and construction of the remedial action.
- Time until remedial RAOs are achieved.

Implementability

This evaluation criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials during its implementation. Components of technical feasibility that are considered for each alternative under this criterion include the following:

- Technical difficulties and unknowns associated with construction and operation of the remedial action.
- The likelihood that technical problems associated with implementation will lead to schedule delays.
- The ability to monitor the effectiveness of the remedy and the evaluation of risks of exposure should monitoring be insufficient to detect a system failure.

Administrative feasibility includes evaluation of the activities needed to coordinate with other offices and agencies for implementation of the remedial action.

Institutional feasibility is considered, which refers to the ability of the technology used in the remedial action to obtain necessary approvals; the availability of treatment, storage, and disposal services and capacity; and the availability of specific equipment, technical specialists, and other related components.

Cost

This evaluation criterion addresses the anticipated costs to implement and maintain the remedial action. Cost can be divided into two categories, as follows:

- Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Costs that must be incurred in the future as part of the remedial action alternative should be identified and noted for the year in which they will occur.
- Annual operation and maintenance (O&M) costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. Consistent with USEPA guidance, the cost estimate assumes that LUCs and LTM would be maintained for 30 years. USEPA allows the use of 30 years for estimation purposes if the actual length of the remedial activity cannot be determined (USEPA 2000).

The estimated cost for each alternative was developed based on prior project and contractor experience, and current estimates received from contractors. Cost for each alternative is summarized in Table 4 and detailed in Appendix H.

6.1.3 Modifying Criteria

Modifying criteria include 1) state acceptance; and 2) community acceptance, as described below (40 CFR 300.430(e)(9)(iii)(H)-(I)).

State Acceptance

This assessment evaluates the technical and administrative issues and concerns that the state may have regarding each alternative. State acceptance has not been given a rating as this step is addressed as part of the Proposed Plan process.

Community Acceptance

This assessment evaluates the issues and concerns the public may have regarding each alternative. Community acceptance modifying criteria have not been given a rating; these will be reflected during the Proposed Plan process.

6.2 Detailed Analysis of Alternatives

This section details the evaluation of the seven identified alternatives described in Section 5.3 using the criteria described in Section 6.1.

6.2.1 Alternative 1: No Action

The No Action alternative is required by 40 CFR 300.430(e)(6) to serve as a baseline for comparison with other remedial alternatives.

6.2.1.1 Overall Protection of Human Health and the Environment

Alternative 1 does not provide groundwater treatment or monitoring. The Moratorium on Groundwater Wells in the Town of Ayer, dated May 6, 2013 and amended May 20, 2013, does not have a specified active period or expiration date (Town of Ayer Board of Health [BOH] 2013). However, landowners and residents within the area of the LUCs would no longer be contacted annually by the Army to ensure awareness, compliance, and enforcement of the LUCs. Contaminant concentrations would not be monitored, reported, or evaluated to ensure adequate protection of human health through LUCs. Therefore, if there are changes in groundwater use by landowners and residents, No Action could result in potential exposure and unacceptable risk to human health. The MassDEP classification of much of the NIA as a NPDWSA may provide protection within that area, but areas outside of the NPDWSA would not have LUCs for protectiveness in place.

6.2.1.2 Compliance with ARARs

Alternative 1 does not comply with ARARs. Dissolved arsenic would continue to exceed ARARs, with no further action taken towards addressing risk associated with these exceedances.

6.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 would not meet the RAOs established for the site and therefore is not an effective or permanent solution. Dissolved arsenic would continue to exceed ARARs, and LUCs would not be adequately communicated, enforced, or evaluated periodically to ensure adequacy of protection, presenting an unacceptable risk.

6.2.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Buried landfill waste and/or naturally occurring peat would continue to provide an ongoing source of dissolved carbon to groundwater resulting in the reductive dissolution and mobility of arsenic. Dissolved arsenic would continue to be detected in reduced groundwater located at the toe of the landfill. The "toxicity, mobility, and volume" or potential hazards associated with arsenic would not be reduced because no action would be taken. Appendix F contains the results of forward particle tracking modeling from a transect south *of* the SHL barrier wall. This analysis indicates that under Alternative 1, groundwater will migrate into the NIA located just north of the Devens boundary. Further downgradient near Nonacoicus Brook, more oxic groundwater conditions would reduce arsenic concentration and mobility.

6.2.1.5 Short-Term Effectiveness

Alternative 1 does not include any groundwater treatment, monitoring activities, or enforcement of LUCs. Limited protections would be provided to the community, the workers, or the environment as no actions would be taken under this alternative.

6.2.1.6 Implementability

Alternative 1 poses no technical difficulties as no actions would be taken. However, no action would have significant administrative difficulties due to regulatory non-compliance and community concerns.

6.2.1.7 Cost

The cost of Alternative 1 is $0.

6.2.2 Alternative 2: Groundwater Extraction and Treatment

Alternative 2, groundwater extraction and treatment along with LUCs, is currently in place at SHL. Under this alternative, the two current extraction wells (EW-01 and EW-04) would continue to operate and extract groundwater for arsenic removal at the ATP at a rate of 50 to 55 gpm. LUCs under this alternative include restricting access to groundwater and prohibiting the withdrawal and/or future use of water from the aquifer, except for monitoring, within the identified groundwater LUC boundary.

6.2.2.1 Overall Protection of Human Health and the Environment

Alternative 2 adequately protects human health by controlling exposure to arsenic above ARARs through LUCs restricting access to groundwater and prohibiting the withdrawal and/or future use of groundwater, except for monitoring, from the aquifer. The LUCs effectively control the exposure pathway and achieve the RAOs. Groundwater extraction and treatment remove arsenic mass from the toe of the landfill to control and/or limit arsenic flux from the landfill to the NIA. Long-term groundwater monitoring tracks and documents arsenic concentration trends, remedial progress, and ensures the arsenic footprint is not expanding or migrating beyond the area with LUCs. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.

6.2.2.2 Compliance with ARARs

Groundwater use is restricted through LUCs controlling potential exposure to contaminated groundwater in the NIA. These LUCs are protective of human health and meet the RAO. Alternative 2, the current groundwater extraction and treatment system is operated, maintained, and monitored in compliance with ARARs (Table 3). System and groundwater monitoring, performance tracking, and reporting is conducted in compliance with federal and state requirements.

6.2.2.3 Long-Term Effectiveness and Permanence

The RAOs identified in Section 5.1 are currently being met through implementation of Alternative 2. The permanence and long-term effectiveness of this alternative is dependent upon maintaining and enforcing the LUCs within the NIA for the foreseeable future. LTM reduces the potential for exposure by periodically assessing the extent of contamination and the remedial effectiveness. Alternative 2 has been in operation at SHL since March 2006 when the Army installed two extraction wells (EW-01 and EW-04) and constructed a groundwater extraction and treatment system. While improvements in groundwater quality at several locations in the Nearfield Area and NIA have been observed since startup of the system, the data trends established indicate that continued groundwater extraction and treatment will not result in the achievement of the current groundwater cleanup goals within the NIA (Section 4.2.3). Downgradient of the ATP within the NIA, discharge of groundwater from mineralized bedrock zones will continue to contribute dissolved arsenic to overburden, while arsenic in the overburden may exhibit limited attenuation and/or may continue to be mobilized due to naturally reducing conditions associated with the presence of wetlands in that area.

6.2.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Treatment processes to reduce toxicity and mobility of arsenic under Alternative 2 involve the ex-situ treatment of extracted groundwater through operation of the recovery wells. The groundwater recovery system is operated to limit the mobility of groundwater from SHL to the NIA while dissolved arsenic in groundwater further downgradient of the NIA outside of the capture zone is reduced through natural attenuation as the aquifer is recharged with DO through precipitation, infiltration, and other natural processes.

The ATP removes dissolved arsenic ex-situ from extracted groundwater through the addition of an oxidant to the influent groundwater to oxidize iron present in the extracted groundwater, the co-precipitation and settling of arsenic with the oxidized iron, and filtration. The removed arsenic from groundwater is transferred to the sludge generated from operation of the ATP. The treated groundwater is discharged to the Devens POTW for further processing and ultimate discharge. In 2021, a total of 262.5 tons of sludge containing co-precipitated arsenic was generated, removed, and disposed of off-site. The ATP treated and discharged approximately 24.8 million gallons of groundwater to the Devens POTW in 2021. The annual arsenic removal rate of Alternative 2 is estimated to be 428 pounds of arsenic per year (Geosyntec 2020).

As previously discussed, operation of Alternative 2 since March 2006 has resulted in the reduction of arsenic concentrations at several monitoring wells located in the Nearfield Area and NIA. The ATP is capturing approximately 87% of the overburden groundwater flow from the landfill and approximately 97% of the associated arsenic mass flux (Section 4.2.2). The mobility of arsenic emitting from the landfill footprint has been limited through operation of the extraction wells.

Alternative 2 would not result in a significant reduction of arsenic concentrations within the NIA for the foreseeable future due to the expected longevity of reducing conditions in groundwater caused by buried peat/wetlands and geogenic arsenic. This alternative would satisfy the statutory preference for treatment as a principal element.

6.2.2.5 Short-Term Effectiveness

During implementation of the remedial actions of Alternative 2, protection of the community is achieved through restriction of access to the site and maintenance and enforcement of LUCs. Potential risks to workers and the environment during the implementation of Alternative 2 include those related to:

- The handling and disposal of 262.5 tons of sludge waste per year;
- The handling and disposal of 24.8 million gallons of wastewater per year;
- The use of heavy equipment;
- The handling, storage, and use of chemicals in operation of the ATP; and

- Physical demands of the job.

These risks would be managed through training of staff, development and following of standard operating procedures, and administrative controls. These risks would be carried for the foreseeable future, as the implementation of Alternative 2 would result in the long-term operation of the ATP with no defined achievable endpoint.

6.2.2.6 Implementability

Alternative 2 is currently being implemented on site with limited technical difficulties related to its ongoing operation. Additional remedial actions are not expected to be necessary. Monitoring the effectiveness of the remedy will be conducted using monitoring wells that are in place or will be installed with no expected difficulties. There are no known or expected administrative or institutional limitations or challenges that would prevent the ongoing operation and implementation of Alternative 2.

6.2.2.7 Cost

The cost estimate for Alternative 2 is summarized on Table 4 and detailed in Appendix H. The total estimated cost of Alternative 2 is $26.8 million. No capital costs have been carried for implementation of Alternative 2 as it is already in place. Major assumptions of the costs developed are included in Appendix H and summarized as follows:

- 30 years of O&M of the ATP
- 30 years of O&M of the landfill
  - Annual inspection, and
  - Mowing, repair, and maintenance.
- 30 years of LTM and reporting
  - 10 years of semi-annual groundwater monitoring,
  - 20 years of annual groundwater monitoring and
  - Annual reporting.

6.2.3 Alternative 3: In-Situ Air Sparging and LUCs

Alternative 3 consists of the implementation of IAS for treatment of arsenic in groundwater with LUCs to restrict drinking water use of groundwater within the NIA. LTM would be conducted to evaluate the effectiveness of the IAS. As shown on Figure G-2 in Appendix G, an air sparge transect spanning approximately 600 feet would be installed along the toe of the landfill where arsenic concentrations exceed ARARs.

An enclosed IAS treatment system would be installed on site. It has been assumed that the IAS system enclosure would be positioned in the vicinity of the ATP building. The main components of an IAS system consist of compressors and injection manifolds. The IAS system would be operated in pulsed mode, and the compressor would be sized to provide enough airflow at the required pressure for up to 10 injection wells at one time. DR17 high-density polyethylene piping would be trenched from the treatment system to each sparge point. Wellhead completions would consist of the subsurface connection of air sparge line and air sparge well, and associated fittings set in a flush-mount vault.

Pulsed operation is a best practice used in air sparging systems and has many benefits over continuous operation (USACE 2013). It minimizes the potential for formation of large air channels, the presence of which can impact the ability of an IAS to effectively distribute dissolved oxygen. Many small air channels are much more effective than a few large air channels. The practice also reduces the amount of electricity required for operation. The amount of dissolved oxygen necessary to promote and maintain oxic conditions in the aquifer is easily provided with the amount of oxygen injected through pulsed operation.

The conceptual design parameters for this alternative were determined through the implementation of an IAS pilot study at SHL in 2021 (S-A JV 2022c) and are summarized as follows:

- 30 deep sparge wells spaced evenly across the IAS transect
  - Spaced every 20 feet,
  - Installed in the overburden to the top of bedrock (approximately 75 feet),
  - 2-foot screened interval positioned at the bottom of the sand aquifer,
  - Injection flow rates up to 8 cubic feet per minute (cfm) per sparge well, and
  - Injection pressure up to 30 pounds per square inch gauge (psig).
- 15 shallow sparge wells spaced evenly across the IAS transect
  - Spaced every 30 feet,
  - Effective zone of influence of 30 feet,
  - Installed in the overburden to 15 feet above top of bedrock (approximately 60 feet),
  - 2-foot screened interval,
  - Injection flow rates up to 4 cfm per sparge well, and
  - Injection pressure up to 25 psig.
- IAS system
  - Two compressors to deliver air separately to the deep and shallow intervals,
  - PLC and controls with solenoid values on each leg,
  - Each compressor sized to allow for operation of up to 10 wells at one time (deep zone = 80 cfm at 30 psig; shallow zone = 40 cfm at 25 psig),
  - Separate 10 leg minimum manifold for each compressor,
  - Valves, gauges, and instrumentation to control and remotely monitor system operational parameters (e.g., flowrates, temperature, pressure), and
  - Pulsed mode with on/off periods adjusted as determined through monitoring results.

6.2.3.1 Overall Protection of Human Health and the Environment

Alternative 3 protects human health by controlling exposure to arsenic above ARARs through implementation of the IAS and enforcement of LUCs restricting access to groundwater and prohibiting the withdrawal and/or future use of groundwater, except for monitoring, from the aquifer. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.

It is expected that through operation of the IAS system, dissolved arsenic concentrations in groundwater would decrease to concentrations at or below the current cleanup goal where DO is successfully distributed. Over time, it would be expected that implementation of IAS would result in reducing the total arsenic mass flux from SHL as well as reversing the chemical reducing potential of the migrating landfill groundwater and increasing the flux of dissolved oxygen downgradient and improving groundwater quality downgradient.

Alternative 3 includes long-term groundwater monitoring to track and document remedial progress through evaluation of arsenic concentration trends and ensure the arsenic footprint is not expanding or migrating beyond the area with LUCs.

6.2.3.2 Compliance with ARARs

Alternative 3 complies with all ARARs (Table 3). It controls potential exposure to contaminated groundwater in the NIA through existing LUCs. These LUCs are protective of human health and meet the RAO. IAS results in the co-precipitation of dissolved arsenic from groundwater and is expected to reduce the migration of arsenic flux over time and result in improvements in groundwater quality within and downgradient of its area of application. Long-term groundwater monitoring would be conducted to evaluate the effectiveness of the remedy by documenting arsenic trends and concentrations, and ensuring the arsenic footprint is not expanding or migrating beyond the area with LUCs.

6.2.3.3 Long-Term Effectiveness and Permanence

The RAOs identified in Section 5.1 will be met by implementation of Alternative 3. Potential residential receptors are protected from exposure to impacted groundwater through the implementation and enforcement of LUCs. IAS would provide the benefit of providing dissolved phase oxygen to groundwater and may be able to shift redox conditions downgradient of SHL over time. The permanence and long-term effectiveness of Alternative 4 is dependent upon establishing and maintaining oxic groundwater conditions. The effectiveness of IAS also depends on the dissolved iron concentration in groundwater being high enough, relative to concentrations of arsenic, to provide sufficient arsenic uptake capacity. Further downgradient of the ATP within the NIA, naturally reducing conditions associated with the presence of wetlands in the area may result in limited improvement in existing arsenic concentrations from the operation of the IAS system upgradient. In areas where treatment is observed from operation of the IAS system, co-precipitated arsenic and/or arsenic present otherwise in soils may undergo reductive dissolution and become mobile in groundwater if reducing conditions are reestablished. An ongoing source of dissolved carbon is present in landfill waste buried below the groundwater table and buried peat layers from historical wetlands. Therefore, it is expected that IAS would require indefinite operation to maintain oxic conditions and to prevent remobilization of arsenic through reductive dissolution.

6.2.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Treatment processes to reduce arsenic concentrations and/or mobility under Alternative 3 involve the in-situ treatment of dissolved arsenic in groundwater through co-precipitation with iron. The introduction of air to the aquifer through air-sparging transfers DO to the aquifer. Some of the DO transferred will react with dissolved iron present and promote precipitation of the oxidized iron. Dissolved arsenic present will co-precipitated with the iron and be bound up in the saturated soil.

Alternative 3 is expected to reduce the mobility of arsenic in groundwater where DO can be distributed, and enough dissolved iron is present. It is expected that through long-term operation of Alternative 3, DO would be distributed downgradient of the air sparge transect following natural flow patterns resulting in treatment. Naturally reducing conditions within the NIA due to the presence of historical wetlands located beneath the water table may not be able to be fully overcome through operation of the IAS system. Treatment of dissolved arsenic present in the deeper overburden further downgradient is less certain due to challenges with distribution of DO in the deeper saturated soils. As discussed in the previous section, treatment is reversible if reducing conditions are reestablished. This alternative would satisfy the statutory preference for treatment as a principal element.

6.2.3.5 Short-Term Effectiveness

During implementation of Alternative 3, protection of the community is through restriction of access to the site, monitoring of conditions, and maintenance and enforcement of LUCs. Potential risks to workers and the environment during the implementation of Alternative 3 include those related to:

- Clearing of land and subsurface disturbance;
- Use of heavy equipment during trenching and well installation;
- Operation and maintenance of the IAS system; and
- Physical demands of the job.

These risks would be managed through training of staff, development and following of standard operating procedures, and administrative controls. Risks related to the operation and maintenance of the system would be carried for the foreseeable future, as the implementation of Alterative 3 would result in long-term operation of the system.

6.2.3.6 Implementability

There are limited technical difficulties associated with the construction and operation of Alternative 3. IAS is an established remedial measure and has been successfully pilot tested at the Site. Schedule delays are unlikely due to technical problems arising during construction. Additional remedial actions beyond IAS or MNA are not expected to be necessary. Monitoring the effectiveness of the remedy will be conducted using monitoring wells that are in place or will be installed with no expected difficulties. While expected to be manageable, potential operational issues may occur due to clogging of injection well screens and/or the surrounding soil due to iron precipitation. Some administrative challenges related to regulatory and community acceptance of the shutdown of the ATP are expected. There are no expected institutional difficulties.

6.2.3.7 Cost

The cost estimate for Alternative 3 is summarized on Table 4 and detailed in Appendix H. The total estimated cost of Alternative 3 is $14.2 million. Capital costs carried related to implementation of Alternative 3 are estimated at $2.4 million and include well installation, trenching, system procurement, and system connection and startup. Major assumptions of the costs developed are included in Appendix H and summarized as follows:

- Installation of 30 deep sparge wells,15 shallow sparge wells, and 10 performance monitoring wells;
- Trenching and connection of subsurface piping from system to each sparge well;
- 2 years of O&M of the ATP;
- 28 years of IAS system O&M;
- 30 years of O&M of the landfill
  - Annual inspection,
  - Mowing, repair, and maintenance;
- 30 years of LTM and reporting
  - 10 years of semi-annual groundwater monitoring,
  - 20 years of annual groundwater monitoring, and

- Annual reporting.

6.2.4 Alternative 4A: Modified Groundwater Extraction and Treatment (Three Extraction Wells) and LUCs

Under this alternative, the groundwater extraction and treatment currently in place would be expanded to include a third extraction well (EW-03). The third extraction well would improve the capture zone to the east of extraction wells EW-01 and EW-04. LUCs under this alternative include restricting access to groundwater and prohibiting the withdrawal and/or future use of water, except for monitoring, from the aquifer within the identified groundwater LUC boundary.

Figure G-2 in Appendix G shows the conceptual layout of the modified groundwater extraction and treatment alternative showing the proposed location of the third extraction well (EW-03). The trench connecting the ATP to EW-03 would be approximately 100-feet in length and installed to a depth of at least 3 feet below grade. The trench would contain subsurface piping and electrical conduit to allow for the installation and operation of a new submersible pump in EW-03. Wellhead completion would consist of the subsurface connection of the piping and electrical connections to the submersible pump and associated fittings set in a flush-mount vault.

6.2.4.1 Overall Protection of Human Health and the Environment

Alternative 4A protects human health by controlling exposure to arsenic above ARARs through LUCs restricting access to groundwater and prohibiting the withdrawal and/or future use of groundwater, except for monitoring, from the aquifer. Groundwater extraction and treatment remove arsenic mass from the toe of the landfill to control and/or limit arsenic flux from the landfill to the NIA. Long-term groundwater monitoring tracks and documents arsenic concentration trends and ensure the arsenic footprint is not expanding or migrating beyond the area with LUCs. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.

6.2.4.2 Compliance with ARARs

Alternative 4A complies with all ARARs (Table 3). It controls potential exposure to contaminated groundwater in the NIA through existing LUCs. These LUCs are protective of human health and meet the RAO. Groundwater extraction and treatment removes arsenic mass from the groundwater and controls and/or minimizes any off-site migration of arsenic flux from the landfill to the NIA. Long-term groundwater monitoring evaluates performance and effectiveness of the existing remedy by documenting arsenic trends and concentrations, and ensuring the arsenic footprint is not expanding or migrating beyond the area with LUCs.

6.2.4.3 Long-Term Effectiveness and Permanence

The RAOs identified in Section 5.1 would be met by implementation of Alternative 4A. Potential residential receptors are protected from exposure to impacted groundwater through the implementation and enforcement of LUCs. The permanence and long-term effectiveness of this alternative is dependent upon maintaining and enforcement of LUCs within the NIA for the foreseeable future. Alternative 4A would expand upon the current groundwater extraction and treatment system that has been in operation at SHL since March 2006. The system would be expanded to include a third extraction well located to the east of the two existing extraction wells as detailed on Figures G-2 and G-4 in Appendix G. Appendix F presents the groundwater modeling used to evaluate this alternative. For Alternative 4A, forward particle tracking from a transect south of the SHL barrier wall showed that all particles were captured by the three ATP extraction wells.

Alternative 4A would not be expected to achieve the current groundwater cleanup goals within the NIA within a reasonable period of time. Alternative 4A will increase the certainty of capture on the east side of the toe of SHL and control arsenic flux to the NIA. However, discharge of groundwater from mineralized bedrock zones beneath the NIA will continue to contribute dissolved arsenic to overburden, while arsenic in the overburden groundwater or tied up in the soil matrix may exhibit limited attenuation and/or may continue to be mobilized due to naturally reducing conditions associated with the presence of historical buried wetlands in that area.

6.2.4.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Treatment processes to reduce toxicity and mobility of arsenic under Alternative 4A involve the ex-situ treatment of extracted groundwater through operation of the recovery wells. The groundwater recovery system is operated to limit the mobility of groundwater from SHL to the NIA while dissolved arsenic in groundwater further downgradient of the NIA outside of the capture zone is reduced through natural attenuation as the aquifer is recharged with DO through precipitation, infiltration, and other natural processes.

The ATP removes dissolved arsenic ex-situ from extracted groundwater through the addition of an oxidant to the influent groundwater to oxidize iron present in the extracted groundwater, the co-precipitation and settling of arsenic with the oxidized iron, and filtration. The removed arsenic from groundwater is transferred to the sludge generated from operation of the ATP. The treated groundwater is discharged to the Devens POTW for further processing and ultimate discharge.

Alternative 4A differs from Alternative 2 in that the capture zone will be expanded to the east through the addition of a third extraction well. The overall groundwater recovery will be kept at approximately the same volumetric rate. Alternative 4A is expected to process approximately the same amount of groundwater and dissolved iron and generate the same amount of sludge as Alternative 2 (i.e., approximately 262.5 tons of sludge containing co-precipitated arsenic and 24.8 million gallons of groundwater discharged to the Devens POTW).

Alternative 4A is not expected to result in a significant reduction of arsenic concentration within the Nearfield Area and NIA. Dissolved arsenic concentrations are expected to exceed the current cleanup goals within the NIA for the foreseeable future due to ongoing reducing conditions in groundwater due to the presence of buried peat and geogenic arsenic in the subsurface. This alternative would satisfy the statutory preference for treatment as a principal element.

6.2.4.5 Short-Term Effectiveness

During implementation of Alternative 4A, protection of the community is through restriction of access to the site, monitoring, and maintenance/enforcement of LUCs. Potential risks to workers and the environment during the implementation of Alternative 4A include those related to:

- Subsurface disturbance during trenching and well installation;
- The handling and disposal of 262.5 tons of sludge waste per year;
- The handling and disposal of 24.8 million gallons of wastewater per year;
- The use of heavy equipment;
- The handling, storage, and use of chemicals in operation of the ATP; and
- Physical demands of the job.

These risks would be managed through training of staff, development and following of standard operating procedures, and administrative controls. The system operational risks would be carried for the foreseeable future, as the implementation of Alterative 4A would result in the long-term operation of the ATP with no defined achievable endpoint.

6.2.4.6 Implementability

Alternative 4A would reconfigure the current remedy being implemented on site through the addition of an extraction well, installation of trenches, and slight modifications to the existing system piping with little technical difficulties related to its implementation or ongoing operation. Additional remedial actions are not expected to be necessary. Monitoring the effectiveness of the remedy will be conducted using monitoring wells that are in place or will be installed with no expected difficulties. There are no known or expected administrative or institutional limitations or challenges that would prevent the expansion and/or operation and implementation of Alternative 4A.

6.2.4.7 Cost

The cost estimate for Alternative 4A is summarized on Table 4 and detailed in Appendix H. The total estimated cost is $29.1 million. A total of $500K in capital costs has been carried for system expansion including the installation, trenching, and connection of a new extraction well. Major assumptions of the costs developed are included in Appendix H and summarized as follows:

- Installation of third extraction well, 10 performance monitoring wells, and testing/optimization of system;
- Trenching and connection of subsurface piping from system to extraction well;
- 30 years of O&M of the ATP;
- 30 years of O&M of the landfill
  - Annual inspection,
  - Mowing, repair, and maintenance;
- 30 years of LTM and reporting
  - 10 years of semi-annual groundwater monitoring,
  - 20 years of annual groundwater monitoring, and
  - Annual reporting.

6.2.5 Alternative 4B: Modified Groundwater Extraction and Treatment (Three Extraction Wells), Injection, and LUCs

Under Alternative 4B, the groundwater extraction and treatment currently in place would be expanded to include a third extraction well (EW-03) consistent with Alternative 4A, with the addition of injection of treated groundwater effluent to the subsurface. LUCs under this alternative include restricting access to groundwater and prohibiting the withdrawal and/or future use of water, except for monitoring, from the aquifer within the identified groundwater LUC boundary.

The treated effluent from the ATP would be rerouted from discharge to the Devens POTW to six injection wells (or an infiltration trench) spaced evenly along the injection transect to the north of the extraction wells, as shown on Figure G-3 in Appendix G. The injection transect would be approximately 500 feet in length and span the extent of the area where groundwater exceeds ARARs along the downgradient property boundary. Wellhead completion would consist of a flush-mount vault containing the subsurface connection of piping running from the ATP to each injection well. The trench connecting the subsurface piping to the ATP would be installed to a depth of at least 3 feet. A manifold at the ATP would be constructed and installed to allow for the distribution and monitoring of flow and pressure to each individual injection well. Treatment of water by the ATP results in the addition of DO to the effluent due to oxidant addition and mixing. A simple jet pump ejector or other suitable method could be used if needed to supplement the effluent from the ATP with additional DO to achieve oxygen saturation in the injected water (i.e., ~ 9 mg/L) and thereby help promote oxic conditions within the aquifer.

6.2.5.1 Overall Protection of Human Health and the Environment

Alternative 4B protects human health by controlling exposure to arsenic above ARARs through LUCs restricting access to groundwater and prohibiting the withdrawal and/or future use of groundwater, except for monitoring, from the aquifer. Groundwater extraction and treatment remove arsenic mass from the toe of the landfill to control and/or limit arsenic flux from the landfill to the NIA. Injection of the treated groundwater downgradient of the ATP directs recharge of treated oxic groundwater to add to aquifer restoration. Long-term groundwater monitoring tracks and documents arsenic concentration trends and ensure the arsenic footprint is not expanding or migrating beyond the area with LUCs. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.

6.2.5.2 Compliance with ARARs

Alternative 4B complies with all ARARs (Table 3). It controls potential exposure to contaminated groundwater in the NIA through existing LUCs. These LUCs are protective of human health and meet the RAO. Groundwater extraction and treatment removes arsenic mass from the groundwater and controls and/or minimizes any off-site migration of arsenic flux from the landfill to the NIA. Long-term groundwater monitoring evaluates performance and effectiveness of the existing remedy by documenting arsenic trends and concentrations, and ensuring the arsenic footprint is not expanding or migrating beyond the area with LUCs.

6.2.5.3 Long-Term Effectiveness and Permanence

The RAOs identified in Section 5.1 would be met by implementation of Alternative 4B. Potential residential receptors are protected from exposure to impacted groundwater through the implementation and enforcement of LUCs. The permanence and long-term effectiveness of this alternative is dependent upon maintaining and enforcement of LUCs within the NIA for the foreseeable future. Alternative 4B would expand upon the current groundwater extraction and treatment system that has been in operation at SHL since March 2006. The system would be expanded to include a third extraction well located to the east of the two existing extraction wells as well as to reroute treated effluent from the ATP amended with DO into the downgradient NIA aquifer to promote aquifer restoration and oxic conditions.

Arsenic flux from SHL to the NIA would be controlled and minimized through the expansion of the current groundwater extraction and treatment system. Over time, aquifer restoration downgradient within the NIA will be enhanced through the injection of treated groundwater containing DO. It is anticipated that discharge of groundwater from mineralized bedrock zones will continue to contribute dissolved arsenic to the overburden within the NIA and naturally occurring arsenic present in overburden soils will continue to be mobilized due to naturally reducing conditions associated with the presence of wetlands in that area. Because of these naturally reducing conditions and an ongoing source of arsenic from bedrock and soils within the NIA, it is likely that Alternative 4B will not achieve the current arsenic groundwater cleanup goals at all locations within the NIA.

Regardless of its ability to achieve cleanup goals, continued long-term operation of the groundwater extraction and treatment system would be required to control arsenic flux from SHL to the NIA and provide infiltration of oxygen rich groundwater downgradient to counter natural reducing conditions.

6.2.5.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Treatment processes to reduce toxicity and mobility of arsenic under Alternative 4B involve the ex-situ treatment of extracted groundwater through operation of the ATP and the in-situ remediation of groundwater downgradient of SHL through groundwater injection and aquifer recharge. The groundwater recovery system is operated to limit the mobility of dissolved arsenic flux in groundwater from SHL to the NIA while dissolved arsenic in groundwater further downgradient of the NIA outside of the capture zone is reduced through the infiltration of oxygen-rich treated effluent from the system in addition to natural attenuation as the aquifer is recharged with DO through precipitation, infiltration, and other natural processes.

The ATP removes dissolved arsenic ex-situ from extracted groundwater through the addition of an oxidant to the influent groundwater to oxidize iron present in the extracted groundwater, the co-precipitation and settling of arsenic with the oxidized iron, and filtration. The removed arsenic from groundwater is transferred to the sludge generated from operation of the ATP. Injected water would be required to meet the standards of the substantive provisions of an otherwise applicable injection program. The treated groundwater with increased DO concentration would be injected downgradient of the ATP.

Alternative 4B is expected to process approximately the same amount of groundwater and generate the same amount of sludge as Alternative 4A (262.5 tons) containing co-precipitated arsenic. Additional treatment of arsenic would occur through in-situ co-precipitation of arsenic downgradient of the ATP.

The exceedance of ARARs in the NIA would be expected for the foreseeable future due to ongoing reducing conditions caused by the presence of buried peat and geogenic arsenic in the subsurface. This alternative would satisfy the statutory preference for treatment as a principal element.

6.2.5.5 Short-Term Effectiveness

During implementation of Alternative 4B, protection of the community is through restriction of access to the site, monitoring, and maintenance/enforcement of LUCs. Potential risks to workers and the environment during the implementation of Alternative 4B include those related to:

- Subsurface disturbance during trenching and well installation;
- System modification, connection, startup, and operation of injection wells;
- The handling and disposal of 262.5 tons of sludge waste per year;
- The use of heavy equipment;
- The handling, storage, and use of chemicals in operation of the ATP; and
- Physical demands of the job.

These risks would be managed through training of staff, development and following of standard operating procedures, and administrative controls. The system operational risks would be carried for the foreseeable future, as the implementation of Alterative 4B would result in the long-term operation of the ATP with no defined achievable endpoint.

6.2.5.6 Implementability

Alternative 4B would expand upon the current remedy being implemented on site through the addition of an extraction well, injection wells, and system modifications with little technical difficulties related to its installation. Additional remedial actions are not expected to be necessary. Monitoring the effectiveness of the remedy will be conducted using monitoring wells that are in place or will be installed with no expected difficulties. Manageable technical difficulties associated with startup of the modified system may be encountered due to balancing of influent and effluent flow rates and controlling injection pressures. Ongoing long-term technical difficulties of the system may be encountered related to iron fouling of the injection wells which may result in build-up of injection pressures and/or decreased injection rates requiring well redevelopment or possibly periodic replacement. Aboveground oxidation may not create a significant dissolved oxygen level in the groundwater to be injected without use of an oxygen generator. Injection of oxygenated water in the reduced geochemical environment at SHL will lead to fouling in injection wells or points that may be very difficult to maintain. Administrative difficulties of Alternative 4B may be related to obtaining regulatory approval for the downgradient injection of treated effluent from the ATP containing arsenic at concentrations above the ARARs. There are no known institutional limitations or challenges that would prevent the expansion, operation, or implementation of Alternative 4B.

6.2.5.7 Cost

The cost estimate for Alternative 4B is summarized on Table 4 and detailed in Appendix H. The total estimated cost is $24.7 million. A total of $800K in capital costs has been estimated for system expansion including the installation, trenching, and connection of a new extraction well and the installation, trenching, and connection of six injection wells. Major assumptions of the costs developed are included in Appendix H and summarized as follows:

- Installation of third extraction well, 10 performance monitoring wells, 6 injection wells, and testing/optimization of system;
- Trenching and connection of subsurface piping from system to extraction/injection wells;
- 30 years of O&M of the ATP;
- 30 years of O&M of the landfill
  - Annual inspection, and
  - Mowing, repair, and maintenance;
- 30 years of LTM and reporting
  - 10 years of semi-annual groundwater monitoring,
  - 20 years of annual groundwater monitoring, and
  - Annual reporting.

6.2.6 Alternative 5: Groundwater Extraction and Treatment, In-Situ Air Sparging, and LUCs

Under this alternative, the ATP would be expanded to include a third extraction well (EW-03) and would be coupled with IAS. LUCs under this alternative include restricting access to groundwater and prohibiting the withdrawal and/or future use of water, except for monitoring, from the aquifer within the identified groundwater LUC boundary. The expanded groundwater extraction would be consistent with that described for Alternative 4A

(Section 5.3.4), and IAS would be consistent with that described for Alternative 3 (Section 5.3.3), except for the location of the air sparge transect and number of sparge points.

Figure G-3 in Appendix G shows the layout of the conceptual implementation of Alternative 6 and identifies key design assumptions. A trench connecting the ATP to the third extraction well EW-03 would be approximately 100 feet in length and installed to a depth of at least 3 feet below grade. The trench would contain subsurface piping and electrical conduit to allow for the installation and operation of a new submersible pump in EW-03. Wellhead completion would consist of the subsurface connection of the piping and electrical connections to the submersible pump and associated fittings set in a flush-mount vault.

An air sparge transect approximately 500 feet in length would be installed downgradient of the ATP along the northern property boundary and span the extent where arsenic concentrations exceed the ARARs in groundwater. An enclosed treatment system would be installed containing the IAS system. It has been assumed that the IAS system enclosure would be positioned in the vicinity of the ATP building. The main components of the IAS system would consist of a compressor and injection manifold. The IAS system would be operated in pulsed mode, and the compressor would be sized to provide enough airflow at the required pressure for up to 10 wells at one time. DR17 high-density polyethylene piping would be trenched from the treatment system to each sparge point. Wellhead completions would consist of the subsurface connection of air sparge line and air sparge well, and associated fittings set in a flush-mount vault.

The conceptual design parameters for this alternative were determined through the implementation of an IAS pilot study at SHL in 2021 (S-A JV 2022c) and are summarized as follows:

- 25 deep sparge wells spaced evenly across the IAS transect
  - Spaced every 20 feet,
  - Installed in the overburden to the top of bedrock (approximately 95 feet),
  - 2-foot screened interval positioned at the bottom of the sand aquifer,
  - Injection flow rates up to 8 cfm per sparge well, and
  - Injection pressure up to 30 psig;
- 13 shallow sparge wells spaced evenly across the IAS transect
  - Spaced every 30 feet,
  - Installed in the overburden to 15 feet above top of bedrock (approximately 80 feet),
  - 2-foot screened interval,
  - Injection flow rates up to 4 cfm per sparge well, and
  - Injection pressure up to 25 psig;
- IAS system
  - 2 compressors to deliver air separately to the deep and shallow intervals,
  - PLC and controls with solenoid values on each leg,
  - Each compressor sized to allow for operation of up to 10 wells at one time (deep zone = 80 cfm at 30 psig; shallow zone = 40 cfm at 25 psig),
  - Separate 10 leg minimum manifold for each compressor,
  - Valves, gauges, and instrumentation to control and remotely monitor system operational parameters (e.g., flowrates, temperature, pressure), and
  - Pulsed mode with on/off periods adjusted as determined through monitoring results.

6.2.6.1 Overall Protection of Human Health and the Environment

Alternative 5 protects human health by controlling exposure to arsenic above ARARs through LUCs restricting access to groundwater and prohibiting the withdrawal and/or future use of groundwater, except for monitoring, from the aquifer. Groundwater extraction and treatment remove arsenic mass from the toe of the landfill to control and/or limit arsenic flux from the landfill to the NIA. It is expected that through operation of the IAS system and over time, dissolved arsenic concentrations in groundwater would decrease where DO is successfully distributed and results in improvements in groundwater quality downgradient. Alternative 5 includes long-term groundwater monitoring to track and document remedial progress through evaluation of arsenic concentration trends and ensures the arsenic footprint is not expanding or migrating beyond the area with LUCs. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.

6.2.6.2 Compliance with ARARs

Alternative 5 would comply with all ARARs (Table 3). It would control potential exposure to contaminated groundwater in the NIA through existing LUCs. These LUCs are protective of human health and meet the RAO. Groundwater extraction and treatment would remove arsenic mass from the groundwater and control/minimize arsenic flux from the landfill to the NIA. The IAS system would add DO to the aquifer downgradient within the NIA and reduce dissolved arsenic concentrations. Long term groundwater monitoring would evaluate performance and effectiveness of the existing remedy by documenting arsenic trends and concentrations, and ensuring the arsenic footprint is not expanding or migrating beyond the area with LUCs.

6.2.6.3 Long-Term Effectiveness and Permanence

The RAOs identified in Section 5.1 would be met by Alternative 5. Potential residential receptors are protected from exposure to impacted groundwater through the implementation and enforcement of LUCs. The permanence and long-term effectiveness of this alternative is dependent upon maintaining and enforcement of LUCs within the NIA for the foreseeable future. Alternative 5 would expand upon the current groundwater extraction and treatment system that has been in operation at SHL since March 2006. The system would be expanded to include a third extraction well located to the east of the two existing extraction wells to improve capture and installation and operation of an IAS system targeting treatment and restoration of the aquifer downgradient of SHL.

Arsenic flux from SHL to the NIA would be controlled and minimized through the expansion of the current groundwater extraction and treatment system. Over time, aquifer restoration downgradient within the NIA will be enhanced through the addition of DO to the aquifer through operation of the IAS system. Discharge of groundwater from mineralized bedrock zones would continue to contribute dissolved arsenic to the overburden within the NIA, and naturally occurring arsenic present in overburden soils will continue to be mobilized due to reducing conditions associated with the presence of wetlands in that area. Because of these naturally reducing conditions and an ongoing source of arsenic from bedrock and soils within the NIA, Alternative 5 is not likely to achieve the current arsenic groundwater cleanup goals at all locations within the NIA. Regardless of its ability to achieve cleanup goals, continued long-term operation of the groundwater extraction and treatment system and the IAS system would be required to control arsenic flux from SHL to the NIA and to add DO downgradient via IAS to counter the natural reducing conditions present.

6.2.6.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Treatment processes to reduce toxicity and mobility of arsenic under Alternative 5 involve the ex-situ treatment of extracted groundwater through operation of the recovery wells and the in-situ treatment of dissolved arsenic in groundwater through co-precipitation with iron. The groundwater recovery system is operated to limit the mobility of dissolved arsenic from SHL to the NIA.

The ATP removes dissolved arsenic ex-situ from extracted groundwater through the addition of an oxidant to the influent groundwater to oxidize iron present in the extracted groundwater, the co-precipitation and settling of arsenic with the oxidized iron, and filtration. The removed arsenic from groundwater is transferred to the sludge generated from operation of the ATP.

The IAS system delivers air to the subsurface resulting in the transfer of DO to the aquifer and the co-precipitation of iron and arsenic. Further downgradient in the NIA, the mobility of dissolved arsenic is also controlled through the addition of DO to the aquifer through precipitation and other natural aquifer recharge processes.

Alternative 5 would expand the capture zone of the existing system to the east through the addition of a third extraction well. Similar to Alternatives 4A and 4B, the overall groundwater recovery will be kept at approximately the same rate resulting in the generation of an estimated 262.5 tons of sludge containing co-precipitated arsenic and the annual removal of approximately 429 to 446 pounds of arsenic from the aquifer . The immobilization of arsenic downgradient of the SHL via operation of the IAS system will result in additional removal of dissolved arsenic from the aquifer. Co-precipitated arsenic will remain tied up in the soil matrix post treatment and remain immobile as long as reducing conditions are not reestablished. Alternative 6 satisfies the statutory preference for treatment as a principal element of a remedial alternative.

6.2.6.5 Short-Term Effectiveness

During implementation of the remedial actions of Alternative 5, protection of the community is through restriction of access to the site, monitoring, and maintenance/enforcement of LUCs. Potential risks to workers and the environment during the implementation of Alternative 5 include those related to:

- Subsurface disturbance during trenching and well installation;
- System mobilization, installation, connection, startup, and operation of IAS system;
- The handling and disposal of 262.5 tons of sludge waste per year;
- The use of heavy equipment;
- The handling, storage, and use of chemicals in operation of the ATP; and
- Physical demands of the job.

These risks would be managed through training of staff, development and following of standard operating procedures, and administrative controls. The system operational risks would be carried for the foreseeable future, as the implementation of Alterative 6 would result in the long-term operation of the ATP with no defined achievable endpoint.

6.2.6.6 Implementability

Alternative 5 would expand upon the current remedy being implemented on site through the addition of an extraction well, addition of an IAS system and IAS transect, and system modifications with little technical difficulties related to its installation. Groundwater extraction and treatment is currently being implemented on site.

IAS is an established remedial measure and has been successfully pilot tested at SHL. Schedule delays are unlikely due to technical problems arising during construction. Additional remedial actions beyond groundwater extraction and treatment, IAS and MNA are not expected to be necessary. Monitoring the effectiveness of the remedy will be conducted using monitoring wells that are in place or will be installed with no expected difficulties. There are no expected administrative or institutional difficulties to implement Alternative 5.

6.2.6.7 Cost

The cost estimate for Alternative 5 is summarized on Table 4 and detailed in Appendix H. The total estimated cost is $33.3 million. A total of $1.8 million in capital costs has estimated for Alternative 5 including installation and trenching in a third well for system expansion, installation and trenching in of the IAS wells, and procurement and installation of an IAS system. Major assumptions of the costs developed are included in Appendix H and summarized as follows:

- Installation of an extraction well and10 performance monitoring wells;
- Trenching and connection of subsurface piping from system to extraction well;
- Installation of 25 deep sparge wells and13 shallow sparge wells;
- Trenching and connection of subsurface piping from IAS system to each sparge well;
- 30 years of O&M of the ATP;
- 28 years of O&M of the IAS system;
- 30 years of O&M of the landfill
  - Annual inspection, and
  - Mowing, repair, and maintenance;
- 30 years of LTM and reporting
  - 10 years of semi-annual groundwater monitoring,
  - 20 years of annual groundwater monitoring, and
  - Annual reporting.

6.2.7 Alternative 6: Partial Landfill Removal, In-Situ Air Sparging, and LUCs

Under Alternative 6, landfill waste material located within and above the groundwater table in the northern half of the landfill would be excavated, and the waste material would be transported to and disposed of at an offsite waste management facility. The excavated landfill waste material would be moved to a lined landfill with the available capacity to accept the large volume associated with this alternative. Due to capacity limitations in Massachusetts, it is likely that one or several out of state lined landfill would need to be identified and selected for use in disposal. Excavated cover material could be potentially segregated from the landfill waste for reuse. The excavated northern portion of the landfill would be backfilled with clean fill materials to one foot above the groundwater table at a minimum and regraded. The reconfigured landfill is shown on Figure G-5 in Appendix G. Cross sections detailing the conceptual design are included as Figures G-6 and G-7 in Appendix G.

An IAS system would be installed as the active aquifer treatment component to this alternative. An air sparge transect approximately 500 feet in length would be installed downgradient of the ATP along the northern property boundary and span the extent where arsenic concentrations exceed the ARARs in groundwater. The location of the air sparge transect and construction and operation of the IAS system is consistent with the IAS component outlined in Alternative 6.

LUCs under this alternative are consistent with those described in Section 5.3.2, which are the LUCs outlined in the contingency remedy (Alternative SHL-9 [USACE 1995]).

6.2.7.1 Overall Protection of Human Health and the Environment

Alternative 6 protects human health by controlling exposure to arsenic above ARARs through LUCs restricting access to groundwater and prohibiting the withdrawal and/or future use of groundwater, except for monitoring, from the aquifer. Landfill waste buried on approximately 29 acres in the northern portion of the landfill including a portion currently in contact with groundwater would be removed and transported to and disposed of at an out of state lined waste management facility. This would result in the removal of a direct source of carbon and landfill wastes that may contain arsenic from contacting groundwater. Removal of the cap in the northern portion of the landfill would allow for infiltration to occur directly into the aquifer which would aid in the long-term restoration of the aquifer. Further downgradient, the IAS would provide treatment along the northern boundary. It is expected that through operation of the IAS system and infiltration over time, dissolved arsenic concentrations in groundwater would decrease where DO is successfully distributed resulting in improvements in groundwater quality downgradient. Alternative 6 includes long-term groundwater monitoring to track and document remedial progress through evaluation of arsenic concentration trends and ensure the arsenic footprint is not expanding or migrating beyond the area with LUCs. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.

6.2.7.2 Compliance with ARARs

Alternative 6 would comply with all ARARs (Table 3). Potential exposure to contaminated groundwater in the NIA would be controlled and managed through implementation and enforcement of existing LUCs. These LUCs are protective of human health and meet the RAO. Removal of buried waste in the northern portion of the landfill located beneath the water table may lower arsenic flux from the landfill to the NIA. Removal of the cap located on approximately 29 acres in the northern portion of the landfill would allow for the direct infiltration of precipitation into the groundwater resulting in the addition of DO to the aquifer over time. The IAS system would add DO to the aquifer downgradient within the NIA and reduce dissolved arsenic concentrations.

Management of wastes from SHL would require approval by many stakeholders, and the scale of the associated construction activity would trigger potential concerns with respect to solid waste management, endangered species protection, and activities conducted in floodplains. The waste that would be removed from the northern portion of SHL would be transported to and disposed of at an offsite lined waste management facility. Depending on the future use of the northern portion of SHL, additional LUCs may need to be put into place for protection of human health.

The IAS system would be operated, maintained, and monitored in compliance with ARARs. Long-term groundwater monitoring would evaluate performance and effectiveness of the existing remedy by documenting arsenic trends and concentrations, and ensure the arsenic footprint is not expanding or migrating beyond the area with LUCs.

6.2.7.3 Long-Term Effectiveness and Permanence

The RAOs identified in Section 5.1 will be met by implementation of Alternative 6. Potential residential receptors are protected from exposure to impacted groundwater through the implementation and enforcement of LUCs. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall. The permanence and long-term effectiveness of this alternative is dependent upon maintaining and enforcement of LUCs within the NIA for the foreseeable future. Alternative 6 would limit the contact of landfill wastes with groundwater removing a source of carbon. It would also result in the addition of DO to the underlying aquifer and downgradient of the landfill through removal of the cap and the operation of an IAS system.

While these measures would result in the improvement of groundwater quality exiting the landfill, groundwater from mineralized bedrock zones within the NIA would continue to contribute dissolved arsenic to the overburden, and naturally occurring arsenic present in overburden soils will continue to be mobilized due to reducing conditions associated with the presence of wetlands in that area. Because of these naturally reducing conditions and an ongoing source of arsenic from bedrock and soils within the NIA, Alternative 6 is not likely to achieve the current arsenic groundwater cleanup goals at all locations within the NIA within a reasonable period of time. Continued long-term operation of the IAS system is expected to be required for the foreseeable future to add DO to the aquifer downgradient and overcome the natural reducing conditions present.

6.2.7.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Treatment processes employed by Alternative 6 include both source removal and the in-situ treatment of dissolved arsenic in groundwater through co-precipitation with iron. A source of reducing potential and arsenic would be removed from the aquifer through excavation and backfill with clean soils. Removal of the cap and grading related to the excavation and backfill of materials would enhance infiltration of rain and surface water runoff to the aquifer promoting oxic conditions.

The IAS system would deliver air to the subsurface at the boundary of the landfill and result in the transfer of DO to the aquifer and the co-precipitation of iron and arsenic. Further downgradient in the NIA, the mobility of dissolved arsenic would be controlled through the addition of DO to the aquifer by natural aquifer recharge processes. Co-precipitated arsenic will remain tied up in the soil matrix post treatment and remain immobile as long as reducing conditions are not reestablished. Alternative 6 would satisfy the statutory preference for treatment as a principal element.

6.2.7.5 Short-Term Effectiveness

During implementation of the remedial actions of Alternative 6, protection of the community is through restriction of access to the site, monitoring, and maintenance/enforcement of LUCs. Potential risks to workers and the environment during the implementation of Alternative 6 are substantial and include those related to:

- The disturbance and excavation of buried landfill waste of unknown composition;
- The staging, loading, transport, and placement of excavated landfill waste;
- Air quality impacts during excavation and post excavation handling of buried wastes;
- Transport of a large quantity of excavated landfill waste (potentially 50,000 truckloads) and soil cap over an extended period of time from the site through the surrounding communities and states to disposal facilities;
- Trucking of construction materials and clean soils to the site through the community;

- The use of heavy equipment on site;
- Subsurface disturbance during trenching and well installation;
- System mobilization, installation, connection, startup, and operation of IAS system; and
- Physical demands of the job.

These risks particularly associated with the loading and offsite transport of excavated landfill wastes would be significant and difficult to fully control. Risks would be managed to the extent possible through training of staff, development and following of standard operating procedures, and administrative controls. The system operational risks would be carried for the foreseeable future, as the implementation of Alterative 6 would result in the long-term operation of the IAS system.

6.2.7.6 Implementability

Alternative 6 has both significant technical and administrative challenges. Technical challenges are related to the excavation and disposal of buried landfill waste of unknown composition beneath the water table. These include but are not limited to:

- Potential exposure to unknown waste types associated with former military operations;
- Composition of waste materials and ability for excavation, loading, transporting, and off-site disposal of the excavated waste material;
- Proper characterization of unknown and variable waste types;
- Identification of disposal facilities with the capacity to accept the quantity of landfill waste and soil generated;
- Extents of waste material requiring excavation (i.e., depth and plan area);
- Logistics and on-site space constraints associated with sequencing of earthwork activities (i.e., stripping of cover soils, excavation, staging, loading, and restoring using stripped cover soils);
- Management of groundwater within excavation areas (where excavation is below groundwater table);
- Stability of excavations relating to waste composition and groundwater conditions;
- Stormwater management within and external to waste excavation areas;
- Health and Safety;
- Large quantity of material;
- Odor; and
- Monitoring and controls for air quality within waste excavation/placement areas.

Administrative challenges are related to the potential inability to reach consensus with regulators as to the compliance of this alternative with ARARs (removing waste from a closed landfill in an area subject to federal and state ARARs as outlined in Table 3).

Identification of off-site facilities with the capacity to accept over one million cubic yards of excavated historical landfill waste and cover materials would be challenging to implement. Proper characterization of the wastes for off-site disposal would also present challenges due to uncertainty associated with the historic disposal practices and composition of waste materials requiring potential on site sorting of encountered materials in the landfill.

6.2.7.7 Cost

The cost estimate for Alternative 6 is summarized on Table 4 and detailed in Appendix H. The total estimated cost is $204 million. A total of $193 million in capital costs has estimated for Alternative 6. Major assumptions of the costs developed are included in Appendix H and summarized as follows:

- Removal of existing cap in north landfill;
- Excavation of 900,000 cubic yards of soils above water table;
- Excavation of 180,000 cubic yards of soil below water table;
- Staging, transport, and disposal of 1,080,000 cubic yards of soil;
- Import of 270,000 cubic yards of general backfill;
- Installation of 10 performance monitoring wells;
- Installation of 25 deep sparge wells and 13 shallow sparge wells;
- Trenching and connection of subsurface piping from IAS system to each sparge well;
- Three years of O&M of the ATP;
- 28 years of O&M of the IAS system;
- 30 years of O&M of the landfill
  - Annual inspection, and
  - Mowing, repair, and maintenance;
- 30 years of LTM and reporting
  - 10 years of semi-annual groundwater monitoring,
  - 20 years of annual groundwater monitoring, and
  - Annual reporting.

6.2.8 Comparative Analysis of Alternatives

This section details the comparative analysis and ratings of Alternatives 1 through 6 for the two threshold and five balancing criteria. The Pass / Fail and relative ratings (Low, Moderate, High) for each criterion are included in Table 5, along with a brief description of why each rating was selected. Table 6 provides a summary of the ratings only, for ease of reference. It is important to note that none of the remedies result in aquifer restoration in the foreseeable future, but all remedies but No Action have been given high ratings for long-term effectiveness and permanence due to the implementation and maintenance of land use controls to prevent exposures.

Table 6 – Summary of Alternative Ratings

Threshold and Balancing Criteria	Alternative 1: No Action	Alternative 2: Groundwater Extraction and Treatment (Current Remedy)	Alternative 3: In-Situ Air Sparging	Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells	Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection	Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging	Alternative 6: Partial Landfill Removal with Active Aquifer Treatment
Overall protection of human health and the environment	No	Yes	Yes	Yes	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes	Yes	Yes	Yes
Long-term effectiveness and permanence	Low	High	High	High	High	High	High
Reduction of mobility, toxicity, or volume through treatment	Low	Low to Moderate	Moderate	Low to Moderate	Moderate	Moderate	Moderate
Short-term effectiveness	Low	Low	Moderate	Low	Moderate	Low	Low
Implementability	Low	High	Moderate	High	Low to Moderate	Moderate	Low
Cost	Low	High	Moderate	High	High	High	High

Color Code:
Threshold criteria are Pass / Fail
More desirable
Neutral
Less desirable

6.2.8.1 Overall Protection of Human Health and the Environment

Alternative 1 (no action) is not protective of human health and the environment as it does not provide groundwater monitoring or adequate long-term control of exposure pathways. While LUCs would remain to administratively protect against the installation of drinking water wells within the NIA, the LUCs would not be adequately monitored or enforced. Changes in site conditions including contaminant concentrations/distributions would not be monitored, reported, or evaluated to ensure adequate protection of human health through LUCs.

Alternatives 2 through 6 are protective of human health and the environment. LUCs prevent installation of drinking water wells within the NIA. LTM and the adherence to the LUC implementation plan ensures adequate monitoring, reporting, and protection from LUCs. Human health and environmental risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall (see Section 1.2.3).

6.2.8.2 Compliance with ARARs

Alternative 1 (no action) does not meet the threshold criteria of compliance with ARARs. Dissolved arsenic and other metals would continue to exceed ARARs, with no further action or regulatory monitoring/reporting to address risk associated with these exceedances.

Alternatives 2 through 6 meet this threshold criterion. Long-term groundwater monitoring is included in all these alternatives to evaluate performance and effectiveness of the selected remedy by documenting arsenic trends and concentrations, and to ensure the arsenic footprint is not expanding or migrating. Discussions with regulators and stakeholders would be required to reach consensus and approval for implementation of Alternative 4B (Groundwater Extraction and Treatment with Three Extraction Wells and Injection) and Alternative 6 (Partial Landfill Removal with Active Aquifer Treatment). This has been further discussed and rated/evaluated under the implementability criterion.

6.2.8.3 Long-Term Effectiveness and Permanence

Alternative 1 (no action) rates Low for long-term effectiveness and permanence. Dissolved arsenic would continue to exceed ARARs . LUCs would not be adequately enforced or monitored, presenting a potentially unacceptable risk to residents.

Alternatives 2 through 6 rate High for long-term effectiveness and permanence. RAOs would be met through implementation of any one of these alternatives. Long-term protection from risk is achieved through LTM and enforcement of LUCs preventing residential use of groundwater.

All alternatives screened with active remedial systems are incapable of attaining and sustaining ARARs thus requiring long-term operation for an indefinite timeframe. A continual source of arsenic is present in soils and bedrock both beneath SHL and in the NIA which will be mobilized under reducing conditions. Alternatives 2, 3, 4A, 4B, 5, and 6 require long-term operation due to the site reducing conditions related to naturally present carbon from buried wetlands/peat and/or an anthropogenic source of carbon from the landfill waste beneath the water table. Alternatives 3, 4B, 5, and 6 that rely on DO addition to the aquifer will require long-term operation to continually overcome reducing conditions present and prevent remobilization of arsenic. Alternatives 2 and 4A that rely only on containment of arsenic through pump and treat will control arsenic flux to the NIA but does not result in achievement of ARARs within the NIA due to the presence of sources of carbon and arsenic within the NIA.

6.2.8.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element.

Alternative 1 relies solely on natural attenuation for reduction of toxicity, mobility, and volume and have been given a Low rating. Alternatives 2 and 4A rely on containment of arsenic flux in groundwater from SHL to the NIA and removal of arsenic in extracted groundwater and have been given a Low to Moderate rating. While both Alternatives 2 and 4A result in removal of arsenic in groundwater at the toe of SHL, they will not have a significant impact on removal of arsenic in groundwater within the NIA, the compliance point, as demonstrated from the results achieved to date from operation of the ATP and modeling results.

As discussed in Section 4.2, alternatives that result in direct oxidation of short-term and long-term oxygen demand (e.g., air sparge) and result in the influx of oxygenated water (e.g., partial landfill removal) and will most directly achieve the goal of providing continual flow of oxygenated water or through sufficient oxygenation over a long enough timeframe to consume readily available reducing capacity present within the aquifer are rated Moderate for this criterion (Alternatives 3, 4B, 5, and 6). The degree to which any active treatment method will be irreversible is not known. It is anticipated that each will need to run in perpetuity if a sustained reduction in concentrations of COCs within the NIA to the ARARs is required.

6.2.8.5 Short-Term Effectiveness

This criterion provides an assessment of how protective each alternative would be to the community, workers, and to the environment during implementation. Alternative 1 is rated Low as it is not protective of human health and the environment. Alternatives that present a risk to the community or workers and generate a high volume of waste to be disposed offsite (i.e., Alternatives 2, 4A, 5, and 6) are rated Low. Alternatives where O&M and/or waste volumes are greatly reduced (i.e., Alternative 3 and Alternative 4B) are rated as Moderate.

6.2.8.6 Implementability

Alternatives 1 has a Low rating as it is administratively infeasible due to regulatory noncompliance. Alternatives 2 and 4A which involve continued operation of the ATP as is or with a limited change to site infrastructure are readily implementable and have been given a High rating. Alternatives 3 and 5 include IAS and have been given a Moderate rating: IAS treatment of groundwater in low-permeability soils and in bedrock is not feasible. Alternative 4B includes injection of treated water and was given a Low rating: injection of treated and oxygenated water may require additional infrastructure for DO addition prior to injection, and there will likely be operational difficult in sustaining injection rates due to well and formation fouling. Alternative 6 is rated Low because of the scale and arduous nature of performing the alternative, increased health and safety risks associated with excavation/handling/transport/and off-site disposal of landfill waste material, and the low likelihood of administrative feasibility.

6.2.8.7 Cost

Costs are included in Table 4, with detailed cost estimates included in Appendix H. The estimated cost for 30 years of each alternative ranges from $0 under Alternative 1 to $204 million for Alternative 7.

- Alternative 2 has a High rating for costs with an estimated cost of $26.8 million. The bulk of the costs is related to 30 years of O&M of the ATP system ($22.4 million).
- Alternative 3 has a Moderate rating for costs with an estimated cost of $14.2 million, the lowest cost alternative that meets both Threshold Criterion (Overall Protection of Human Health and the Environment and Compliance with ARARs). Most costs are related to the IAS remedy ($2.4 million for IAS implementation, $7.4 million for 30 years of O&M).
- Alternative 4A has a High rating for costs with an estimate cost of $29.1 million. This includes an estimated cost of $500K for expansion of the existing ATP and $24.2 million for 30 years of O&M.
- Alternative 4B has a High rating for cost with an estimated cost of $24.7 million. This includes $800K in implementation costs related to installation of injection wells and modification of the ATP and $19.5 million for 30 years of O&M. The reduction in O&M costs of Alternative 4B over Alternatives 3 and 4A are largely due to removal of costs associated with the discharge of treated effluent to the POTW.
- Alternative 5 has a High rating for an estimated cost of $33.3 million with $1.8 million in implementation costs largely related to the installation of IAS system and $27.1 million for 30 years of O&M of the ATP/IAS systems.
- Alternative 6 is by far the highest cost alternative with an estimated cost of $204 million. An estimated cost of $193 million has been carried for implementation costs. The magnitude of the cost is due to the scale of the

project and high overall costs associated with the excavation, staging, loading, transport, and off-site disposal of a large volume of soils/wastes.

6.3 Additional Factors for Evaluation of Alternatives

As part of this FFS, the following additional factors to evaluate the criteria were considered: 1) environmental footprint; and 2) impact on PFAS in groundwater, as described below.

Environmental Footprint

This assessment evaluates the effect that the remedial alternative has on the environment. The environmental footprint, also referred to as an ecological footprint, considers the amount of natural resources the alternative requires and the amount of harmful waste that is produced. The environmental footprint has been calculated using the USEPA Spreadsheets for Environmental Footprint Analysis. The USEPA's Consideration of Greener Cleanup Activities in the Superfund Process Memorandum (USEPA 2016b) recommends approaches for regional remedial Superfund programs to consider throughout the remedy selection process and encourages regions to consider conducting a footprint analysis throughout the CERCLA cleanup process.

Impact on PFAS in Groundwater

This assessment evaluates the impact of the remedial alternative on the presence and distribution of PFAS in groundwater at and adjacent to SHL (refer to Section 2.3 and Figure 14). The potential for changes in concentrations of PFAS in groundwater has been evaluated.

6.3.1 Individual Evaluation of the Additional Factors

Table 7 below provides a succinct summary of ratings and detailed descriptions of how each of the alternatives compare when the potential environmental footprint and the effect of each alternative on PFAS in groundwater are taken into consideration.

Table 7 – Summary of Additional Factors

Additional Considerations	Alternative 1: No Action	Alternative 2: Groundwater Extraction and Treatment (Current Remedy)	Alternative 3: In-Situ Air Sparging	Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells	Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection	Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging	Alternative 6: Partial Landfill Removal with Active Aquifer Treatment
Environmental footprint	Low	High	Moderate	High	High	High	High
Impact on PFAS in groundwater	Low	Moderate	Low	Moderate	Moderate	Moderate	Low

Color Code:
More desirable
Neutral
Less desirable

6.3.1.1 Environmental Footprint

A summary of the environmental footprint results and analysis is included in Appendix I.

Alternative 1: No Action

As detailed in Appendix I, Alternative 1 has low material use and waste, low water use, low energy use, and low total greenhouse gas emissions.

Alternative 2: Groundwater Extraction and Treatment (Current Remedy)

Alternative 2 has a high overall environmental footprint with the following ratings for each individual element:

- Materials and Waste - Sludge generation and disposal: Moderate;
- Water – Wastewater generation and disposal: High;
- Energy – Both on and off-site energy use: High; and
- Air – Total greenhouse gas emissions: High.

Alternative 3: In-Situ Air Sparging

Alternative 3 has a moderate overall environmental footprint with the following ratings for each individual element:

- Materials and Waste - Sludge generation and disposal: Low;
- Water – Wastewater generation and disposal: Low;
- Energy – Both on and off-site energy use: Moderate; and
- Air – Total greenhouse gas emissions: Moderate.

Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells

Alternative 4A has a high overall environmental footprint with the following ratings for each individual element:

- Materials and Waste - Sludge generation and disposal: Moderate;
- Water – Wastewater generation and disposal: High;
- Energy – Both on and off-site energy use: High; and
- Air – Total greenhouse gas emissions: High.

Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection

Alternative 4B has a high overall environmental footprint with the following ratings for each individual element:

- Materials and Waste – Sludge generation and disposal: Moderate;
- Water – Wastewater generation and disposal: Moderate;
- Energy – Both on and off-site energy use: High; and
- Air – Total greenhouse gas emissions: High.

Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

Alternative 5 has a high overall environmental footprint with the following ratings for each individual element:

- Materials and Waste - Sludge generation and disposal: Moderate;
- Water – Wastewater generation and disposal: High;
- Energy – Both on and off-site energy use: High; and
- Air – Total greenhouse gas emissions: High.

Alternative 6: Partial Landfill Removal with Active Aquifer Treatment

Alternative 6 has a high overall environmental footprint with the following ratings for each individual element:

- Materials and Waste - Sludge generation and disposal: High;
- Water – Wastewater generation and disposal: Low;
- Energy – Both on and off-site energy use: High; and
- Air – Total greenhouse gas emissions: High.

6.3.1.2 Impact on PFAS in Groundwater

As shown on Figure 14, PFAS are present in groundwater both upgradient and downgradient of SHL at concentrations exceeding SSSL. The following sections detail the likely impact the implementation of each alternative would have on PFAS concentration and distribution.

Alternative 1: No Action

Alternative 1 would have no effect on the distribution of PFAS in groundwater, as no physical remedy would be implemented.

Alternative 2: Groundwater Extraction and Treatment (Current Remedy)

PFAS in groundwater in the overburden beneath SHL and some groundwater containing PFAS in the overburden beyond SHL to the northeast are captured by the extraction wells. Groundwater recovered from the extraction wells containing PFAS above the SSSL is sent through the ATP. The ATP is not designed to treat and remove PFAS from the influent. PFAS recovered in the extracted groundwater are sent through the ATP and discharged to the Devens POTW. The permit to discharge effluent water from the ATP to the Devens POTW does not have a PFAS limit or monitoring requirement.

Alternative 3: In-Situ Air Sparging

The IAS system is expected to have a negligible effect on overall groundwater hydraulics. While there may be a local reduction in the permeability adjacent to the sparge points due to in-situ metals precipitation, effects on the aquifer permeability are expected to be negligible, as discussed in the Final In-Situ Air Sparge Pilot Test Implementation Report (S-A JV 2022c). The concentrations of PFAS in groundwater are not expected to be impacted by IAS. Alternative 3 would have little to no effect on the distribution or concentration of PFAS in groundwater.

Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells

The third extraction well would capture PFAS in overburden groundwater to the northeast of SHL. Groundwater recovered from the extraction wells containing PFAS above the SSSL is sent through the ATP. The ATP is not designed to treat and remove PFAS from the influent. PFAS recovered in the extracted groundwater sent through the ATP is then discharged to the Devens POTW. The permit to discharge effluent water from the ATP to the Devens POTW does not have a PFAS monitoring requirement.

Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection

The third extraction well would capture PFAS in overburden groundwater to the northeast of the Landfill footprint. Groundwater recovered from the extraction wells containing PFAS above the SSSL would be sent through the ATP. The ATP is not designed to treat and remove PFAS from the influent. PFAS recovered in the extracted groundwater would be sent through the ATP with limited removal and be discharged downgradient of the ATP at the injection wells into groundwater containing similar concentrations of PFAS. Injection of water would increase groundwater velocity downgradient.

Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

The third extraction well would capture PFAS in overburden groundwater to the northeast of the Landfill footprint. Groundwater recovered from the extraction wells containing PFAS above the SSSL would be sent through the ATP. The ATP is not designed to treat and remove PFAS from the influent. PFAS recovered in the extracted groundwater would be sent through the ATP with limited removal and be discharged downgradient of the ATP at the injection wells into groundwater with similar concentrations of PFAS. The addition of air to overburden groundwater would have little effect.

Alternative 6: Partial Landfill Removal with Active Aquifer Treatment

Alternative 6 would result in the removal of landfill waste in the northern half of SHL. The concentration and composition of PFAS in groundwater upgradient and downgradient of the landfill are similar, based on the data collected to date (KGS 2020b). Alternative 7 would result in the direct infiltration of rain and surface water run-off into the northern part of SHL due to the removal of the existing cap. This would result in a change in the groundwater hydrology at SHL as detailed in the groundwater modeling results in Appendix F but not direct treatment of PFAS. The addition of air to the overburden groundwater via IAS would have little effect on PFAS.

6.3.2 Comparison of Additional Factors

6.3.2.1 Environmental Footprint

The primary categories included in the environmental footprint analysis are materials and waste, water use, energy use, and air emissions. Alternative 1 relies primarily on administrative changes and therefore has a low environmental footprint. Alternative 3 is the only alternative to receive a Moderate rating because it would produce little waste, use little water and moderate energy, and have low air emissions when compared to alternatives that include groundwater extraction and treatment in any configuration (Alternatives 2, 4A, 4B, and 5), or partial landfill removal (Alternative 6). All these alternatives would have a High environmental footprint over a 30-year timespan. A summary of the environmental footprint results and analysis is included in Appendix I.

6.3.2.2 Impact on PFAS in Groundwater

The predicted effect that each alternative would have on the distribution of PFAS in overburden groundwater both within and adjacent to SHL was considered for this evaluation. Generally, alternatives that include installation and operation of a third extraction well (Alternatives 4A, 4B, and 5) are anticipated to have a greater, but limited, effect on the distribution of PFAS in groundwater in and adjacent to SHL, based on the groundwater modeling performed as part of this evaluation (Appendix F) and the PFAS data collected to date (KGS 2020b). The RI data indicate that there is more PFAS in groundwater in the overburden to the east and northeast of SHL than there may be within the footprint of SHL (Figure 14). Extraction of groundwater at a third well to be located to the northeast of SHL would influence groundwater in this area.

7 References

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Tables

Table 2
Fall 2021 LTM Analytical Results and Field Parameters
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Location	Well ID	Formation Type at Screen Interval	Screened Interval (feet bgs)	Sample ID	Analytical Method	Metals			General Chemistry				Field Parameters					
					Analyte	Arsenic	Iron	Manganese	Alkalinity	Chloride	DOC	Sulfate	DO	ORP	pH	SPC	Temp	Turbidity
					Unit	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mv	Units	µS/cm	°C	NTU
					Screening Limit[a]	10	9,100	1,715	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					Date													
Barrier Wall	SHM-11-02	Bedrock	39.0 - 49.0	SHM-11-02-FAL21	10/26/2021	3.00 U	100	38.0	78.0	44.0	1.70	1.00 U	1.1	-207.9	9.34	344	8.5	24.05
Barrier Wall	SHM-93-10D	Bedrock	46.0 - 56.0	SHM-93-10D-FAL21	11/10/2021	3.00 U	140	3.60 J	42.0	30.0	0.470 J	19.0	0.01	-4.6	11.00	212	12	14
Landfill Area	N5-P1	Bedrock	95.5 - 97.5*	N5-P1-FAL21	11/04/2021	540	280	980	140	18.0	0.800 U	17.0	1.25	-23.4	7.19	428	4.20	4.11
Landfill Area	SHP-2016-07A	Bedrock	22.0 - 32.0	SHL-DUP11-FAL21	10/27/2021	120	6,700	3,600	38.0 J	1.70	1.10	3.30	--	--	--	--	--	--
Landfill Area	SHP-2016-07A	Bedrock	22.0 - 32.0	SHP-2016-07A-FAL21	10/27/2021	130	7,100	3,700	37.0 J	1.70	1.00	3.30	0.110	-20.8	6.02	53	11.4	0.1 U
Landfill Area	SHP-2016-07B	Bedrock	70.0 - 80.0	SHP-2016-07B-FAL21	10/27/2021	130	270	340	150 J	2.90	3.50	36.0	0.210	-91.5	7.29	263	11.5	2.19
Nearfield Area	SHM-93-22C	Bedrock	124.3 - 134.3	SHM-93-22C-FAL21	11/04/2021	5.00	50.0 U	1.50 J	140	20.0	3.10	5.60	2.54	-33.1	7.60	241	11.4	0.1 U
Nearfield Area	SHP-2016-06A	Bedrock	81.0 - 86.0	SHP-2016-06A-FAL21	11/09/2021	1,000	820	1,100 J	210	5.60	8.80	85.0	1.70	-99.6	7.76	636	5.90	15.7
Nearfield Area	SHP-2016-06B	Bedrock	102.0 -112.0	SHP-2016-06B-FAL21	11/09/2021	510	56.0	130	220	2.50	6.60	60.0	0.810	-118	8.07	605	7.80	26.4
Nearfield Area	SHP-2016-06C	Bedrock	123.0 - 133.0	SHP-2016-06C-FAL21	11/09/2021	290	130	180	130	1.40	0.660 J	8.50	0.810	-124	8.15	371	8.80	17.3
Barrier Wall	PZ-12-01	Overburden	24.0 - 34.0	PZ-12-01-FAL21	10/21/2021	580	62,000	2,400	140	75.0	2.50	14.0	1.03	-73.8	6.50	894	14.5	7.46
Barrier Wall	PZ-12-02	Overburden	24.0 - 34.0	PZ-12-02-FAL21	10/21/2021	270	67,000	1,400	180	63.0	3.70	1.00 U	1.14	-69.3	6.46	954	15.6	0.480
Barrier Wall	PZ-12-03	Overburden	22.0 - 32.0	PZ-12-03-FAL21	10/26/2021	740	45,000	3,500	160	65.0	2.00	3.80	0.9	-80.7	6.70	590	7.2	4.73
Barrier Wall	PZ-12-04	Overburden	22.0 - 32.0	PZ-12-04-FAL21	10/26/2021	720	64,000	1,700	130	43.0	2.30	0.810 J	0.83	-75.6	6.58	541	7.5	0.83
Barrier Wall	PZ-12-05	Overburden	26.0 - 36.0	PZ-12-05-FAL21	10/26/2021	49.0	12,000	1,200	50.0	0.730	1.20	2.70	1.22	13.1	6.06	201	8.70	7.47
Barrier Wall	PZ-12-06	Overburden	26.0 - 36.0	PZ-12-06-FAL21	10/26/2021	1.80 J	490	170	35.0	0.380 J	0.980 J	11.0	0.98	115.1	5.91	153	8.1	3.51
Barrier Wall	PZ-12-06	Overburden	26.0 - 36.0	SHL-DUP03-FAL21	10/26/2021	1.80 J	510	170	36.0	0.380 J	0.970 J	11.0	--	--	--	--	--	--
Barrier Wall	PZ-12-07	Overburden	18.0 - 28.0	PZ-12-07-FAL21	10/27/2021	140	4,600	1,600	120 J	1.40	1.80	42.0	1.65	-57.1	6.92	488	7.1	47.26
Barrier Wall	PZ-12-08	Overburden	18.0 - 28.0	PZ-12-08-FAL21	10/27/2021	3.00 U	6,100	1,300	52.0 J	0.510	1.20	15.0	1.35	32.9	6.13	261	8	49.94
Barrier Wall	PZ-12-09	Overburden	22.0 - 32.0	PZ-12-09-FAL21	11/01/2021	3.00 U	50.0 U	7.20 J	90.0	2.30	0.740 J	2.30	6.03	115.3	6.88	333	9.2	0.52
Barrier Wall	PZ-12-10	Overburden	22.0 - 32.0	PZ-12-10-FAL21	10/27/2021	3.00 U	50.0 U	3.00 U	53.0 J	0.420 J	0.850 J	2.40	8.01	158.3	6.24	208	8.2	0.47
Barrier Wall	SHL-10	Overburden	24.0 - 39.0	SHL-10-FAL21	11/02/2021	3.00 U	50.0 U	3.00 U	6.40 UJ	0.610	0.800 U	1.60	2.15	100	6.46	89	8.80	1.11
Barrier Wall	SHL-11	Overburden	12.0 - 27.0	SHL-11-FAL21	10/25/2021	990	66,000	2,000	130	81.0	2.10	2.90	1.05	-95.2	6.75	659	7.40	3.74
Barrier Wall	SHL-19	Overburden	20.0 - 30.0	SHL-19-FAL21	10/27/2021	3.00 U	50.0 U	3.00 U	62.0 J	0.680	0.910 J	9.50	7.55	114	6.69	278	9.50	6.51
Barrier Wall	SHL-20	Overburden	39.0 - 49.0	SHL-20-FAL21	10/21/2021	840	57,000	3,600	120	75.0	2.00	43.0	0.960	-93.1	6.69	851	11.6	16.0
Barrier Wall	SHL-20	Overburden	39.0 - 49.0	SHL-DUP04-FAL21	10/21/2021	850	58,000	3,700	120	75.0	2.00	43.0	--	--	--	--	--	--
Barrier Wall	SHL-3	Overburden	24.0 - 34.0	SHL-3-FAL21	11/03/2021	3.00 U	17.0 J	1.60 J	150 J	0.790	0.800 U	8.40	8.52	84.1	6.99	219	13.1	1.46
Barrier Wall	SHL-4	Overburden	3.0 - 13.0	SHL-4-FAL21	11/01/2021	220	14,000	1,400	71.0	0.760	1.10	16.0	0.0100	-37.2	7.10	175	13.8	6.10
Barrier Wall	SHM-11-06	Overburden	25.0 - 35.0	SHL-DUP08-FAL21	11/09/2021	840	75,000	2,400	190	57.0	1.80	5.40	--	--	--	--	--	--
Barrier Wall	SHM-11-06	Overburden	25.0 - 35.0	SHM-11-06-FAL21	11/09/2021	870	74,000	2,400	200	58.0	1.50	5.50	1.10	-67.8	6.52	890	12.4	6.58
Barrier Wall	SHP-01-36X	Overburden	3.0 - 8.0	SHP-01-36X-FAL21	11/01/2021	13.0	1,300	46.0	35.0	47.0	3.60	3.00	0.850	13.5	6.18	212	16.3	1.04
Barrier Wall	SHP-01-37X	Overburden	1.0 - 6.0	SHP-01-37X-FAL21	11/01/2021	13.0	1,200	98.0	41.0	71.0	4.20	6.50	0.740	3.70	6.29	296	14.8	1.59
Barrier Wall	SHP-01-38A	Overburden	1.5 - 6.5	SHL-DUP10-FAL21	11/01/2021	110	16,000	1,400	71.0	0.640	1.50	6.70	--	--	--	--	--	--
Barrier Wall	SHP-01-38A	Overburden	1.5 - 6.5	SHP-01-38A-FAL21	11/01/2021	110	16,000	1,400	67.0	0.650	1.40	6.80	0.740	-2.30	5.92	146	13.0	1.27
Landfill Area	SHM-10-07	Overburden	40.0 - 50.0	SHM-10-07-FAL21	11/01/2021	980	40,000	1,700	120	75.0	1.80	9.80	0.970	-97.1	6.57	507	12.4	2.87
Landfill Area	SHM-10-11	Overburden	50.0 - 60.0	SHM-10-11-FAL21	11/05/2021	680	50,000	2,900	96.0 J	34.0	3.80	68.0	0.700	-45.0	6.38	682	9.40	12.0
Landfill Area	SHM-10-12	Overburden	45.0 - 55.0	SHM-10-12-FAL21	11/04/2021	2,900	66,000	5,100	180	3.30	7.00	3.20	0.780	-16.8	6.03	535	8.20	42.9
Landfill Area	SHM-10-13	Overburden	60.0 - 70.0	SHM-10-13-FAL21	11/04/2021	410	58,000	1,500	250	29.0	5.00	1.00 U	0.790	-80.5	6.59	849	9.10	4.31
Landfill Area	SHM-10-14	Overburden	60.0 - 80.0	SHM-10-14-FAL21	11/02/2021	4,100	76,000	2,000	200 J	3.90	3.70	1.00 U	0.800	-59.5	5.94	419	11.3	3.69
Landfill Area	SHM-10-15	Overburden	45.0 - 55.0	SHM-10-15-FAL21	11/04/2021	6,300	43,000	7,700	190	7.80	2.80	8.60	0.890	-46.2	6.40	611	7.20	5.11
Landfill Area	SHP-99-29X	Overburden	19.0 - 29.0	SHP-99-29X-FAL21	11/02/2021	1,600	40,000	2,800	92.0 J	2.70	2.20	2.20	0.760	-16.4	5.92	176	11.1	6.60
Nearfield Area	EPA-PZ-2012-1A	Overburden	20.0 - 25.0	EPA-PZ-2012-1A-FAL21	11/01/2021	3.00 U	180	180	47.0	0.860	2.10	12.0	0.91	88.2	6.20	194	7.9	4.6
Nearfield Area	EPA-PZ-2012-1B	Overburden	70.0 - 75.0	EPA-PZ-2012-1B-FAL21	11/01/2021	140	8,600	7,900	170	41.0	1.40	17.0	0.97	-33.2	6.57	638	7.8	3.79
Nearfield Area	EPA-PZ-2012-2A	Overburden	20.0 - 25.0	EPA-PZ-2012-2A-FAL21	11/01/2021	3.00 U	50.0 U	1.20 J	17.0	2.90	0.640 J	6.20	4.63	195.1	5.84	132	7.8	5.17
Nearfield Area	EPA-PZ-2012-2B	Overburden	75.0 - 80.0	EPA-PZ-2012-2B-FAL21	11/01/2021	1.50 J	5,500	5,400	140 J	39.0	0.800 U	7.40	0.88	41.9	6.12	550	7.7	4.68
Nearfield Area	EPA-PZ-2012-3A	Overburden	20.0 - 25.0	EPA-PZ-2012-3A-FAL21	11/03/2021	16.0	14,000	920	96.0 J	20.0	8.40	1.00 U	0.71	-5.2	5.81	204	11.8	9.22
Nearfield Area	EPA-PZ-2012-3B	Overburden	70.0 - 75.0	EPA-PZ-2012-3B-FAL21	11/03/2021	2,500	38,000	5,500	160 J	33.0	0.800 U	18.0	0.75	-94.4	6.52	398	11.2	1.06
Nearfield Area	EPA-PZ-2012-4A	Overburden	20.0 - 25.0	EPA-PZ-2012-4A-FAL21	11/05/2021	4.20	4,100	560	94.0 J	25.0	9.40	6.30	1.11	-4.4	6.39	419	8.5	6.75
Nearfield Area	EPA-PZ-2012-4B	Overburden	70.0 - 75.0	EPA-PZ-2012-4B-FAL21	11/05/2021	2,000	49,000	740	120 J	29.0	2.10	20.0	1.14	-76.9	6.71	588	6.8	5.97
Nearfield Area	EPA-PZ-2012-4B	Overburden	70.0 - 75.0	SHL-DUP01-FAL21	11/05/2021	1,800	45,000	690	110 J	29.0	2.20	20.0	--	--	--	--	--	--

Table 2
Fall 2021 LTM Analytical Results and Field Parameters
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Location	Well ID	Formation Type at Screen Interval	Screened Interval (feet bgs)	Sample ID	Analytical Method	Metals			General Chemistry				Field Parameters					
					Analyte	Arsenic	Iron	Manganese	Alkalinity	Chloride	DOC	Sulfate	DO	ORP	pH	SPC	Temp	Turbidity
					Unit	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mv	Units	µS/cm	°C	NTU
					Screening Limit[a]	10	9,100	1,715	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					Date													
Nearfield Area	EPA-PZ-2012-5A	Overburden	20.0 - 25.0	EPA-PZ-2012-5A-FAL21	10/26/2021	3.00 U	6,200	90.0	33.0	15.0	7.40	4.20	0.27	36.7	5.51	85	11.6	1.03
Nearfield Area	EPA-PZ-2012-5B	Overburden	80.0 - 85.0	EPA-PZ-2012-5B-FAL21	10/26/2021	3.60	140	9,800	180	45.0	1.30	12.0	0.26	-14	6.41	356	11.4	0.1 U
Nearfield Area	EPA-PZ-2012-6A	Overburden	25.0 - 30.0	EPA-PZ-2012-6A-FAL21	11/03/2021	3.00 U	50.0 U	3.00 U	62.0 J	0.930	0.800 U	3.70	9.2	95.2	6.64	206	6.5	4.68
Nearfield Area	EPA-PZ-2012-6B	Overburden	75.0 - 80.0	EPA-PZ-2012-6B-FAL21	11/03/2021	250	21,000	990	39.0 J	8.50	0.800 U	4.40	1.16	-83.8	6.98	260	6.5	7.17
Nearfield Area	EPA-PZ-2012-6B	Overburden	75.0 - 80.0	SHL-DUP02-FAL21	11/03/2021	240	20,000	990	38.0 J	8.50	0.800 U	4.40	--	--	--	--	--	--
Nearfield Area	EPA-PZ-2012-7A	Overburden	25.0 - 30.0	EPA-PZ-2012-7A-FAL21	11/02/2021	3.00 U	50.0 U	3.00 J	31.0 J	67.0	0.800 U	2.10	7.12	135.3	6.06	439	8.3	2.78
Nearfield Area	EPA-PZ-2012-7B	Overburden	60.0 - 65.0	EPA-PZ-2012-7B-FAL21	11/02/2021	1,200	24,000	3,400	56.0 J	1.30	0.800 U	3.30	1.18	-81.8	6.75	307	8.6	4.25
Nearfield Area	EW-01	Overburden	60.0 - 85.0	EW-01-FAL21	11/05/2021	1,600	63,000	2,100	210 J	19.0	4.60	4.30	2.93	-38.7	6.41	622	5.40	5.45
Nearfield Area	EW-04	Overburden	70.0 - 95.0	EW-04-FAL21	11/05/2021	3,400	39,000	2,500	120 J	6.90	2.10	4.70	3.04	-25.3	6.60	440	6.60	7.13
Nearfield Area	SHL-5	Overburden	3.0 - 13.0	SHL-5-FAL21	11/02/2021	8.00	2,100	280	43.0 J	4.30	5.30	1.00 U	1.77	80.8	6.34	82	13.3	4.90
Nearfield Area	SHL-8D	Overburden	68.0 - 70.0	SHL-8D-FAL21	11/02/2021	3.00 U	89.0	15.0	33.0 J	38.0	0.800 U	8.30	0.0100	37.7	6.70	166	11.4	0.1 U
Nearfield Area	SHL-8S	Overburden	52.0 - 54.0	SHL-8S-FAL21	11/02/2021	3.00 U	50.0 U	3.00 U	35.0 J	7.40	0.800 U	5.40	3.47	128	6.90	75	11.3	0.280
Nearfield Area	SHL-9	Overburden	15.0 - 25.0	SHL-9-FAL21	11/02/2021	35.0	4,100	260	76.0 J	8.80	7.00	4.10	0.850	-16.6	6.39	140	13.0	3.47
Nearfield Area	SHL-22	Overburden	105.0 - 115.0	SHL-22-FAL21	11/04/2021	5.00	51.0	8,000	320	31.0	0.800 U	12.0	0.890	120	6.53	478	10.3	0.960
Nearfield Area	SHL-22	Overburden	105.0 - 115.0	SHL-DUP05-FAL21	11/04/2021	4.70	49.0 J	8,100	320	31.0	0.800 U	12.0	--	--	--	--	--	--
Nearfield Area	SHL-23	Overburden	23.0 - 33.0	SHL-23-FAL21	11/09/2021	3.00 U	50.0 U	18.0	6.40 U	2.30	0.800 U	5.10	12.0	216	5.46	88	7.10	3.34
Nearfield Area	SHM-05-41A	Overburden	42.0 - 44.0	SHM-05-41A-FAL21	11/05/2021	20.0	2,900	150	6.40 UJ	4.30	2.20	0.470 J	7.24	107	6.30	86	6.60	21.2
Nearfield Area	SHM-05-41B	Overburden	62.0 - 64.0	SHM-05-41B-FAL21	11/08/2021	440	34,000	1,200	96.0	11.0	1.50	3.00	1.20	-62.7	6.65	451	9.70	3.11
Nearfield Area	SHM-05-41C	Overburden	88.0 - 93.0	SHM-05-41C-FAL21	11/04/2021	280 J	8,800	1,100 J	130	24.0	3.40	4.30	1.33	-75.0	6.93	428	6.50	12.0
Nearfield Area	SHM-05-42A	Overburden	40.0 - 42.0	SHM-05-42A-FAL21	10/25/2021	3.00 U	560	310	31.0	4.10	1.10	7.20	0.860	83.1	5.94	63	10.8	0.1 U
Nearfield Area	SHM-05-42B	Overburden	70.0 - 72.0	SHM-05-42B-FAL21	10/25/2021	150	29,000	6,600	160	45.0	2.10	13.0	0.830	-57.8	6.25	439	10.9	0.300
Nearfield Area	SHM-10-06	Overburden	69.5 - 79.5	SHM-10-06-FAL21	11/02/2021	990	78,000	2,800	150 J	30.0	2.40	6.90	0.12	-96.2	7.40	546	14.1	0.1 U
Nearfield Area	SHM-10-06A	Overburden	77.0 - 87.0	SHM-10-06A-FAL21	11/03/2021	76.0	14,000	1,400	85.0 J	12.0	0.800 U	5.10	0.130	68.3	6.27	150	9.30	0.6
Nearfield Area	SHM-10-16	Overburden	75.0 - 85.0	SHM-10-16-FAL21	10/22/2021	1,100	33,000	2,100	280 J	31.0	2.10	5.90	0.780	-91.2	6.48	560	12.1	20.9
Nearfield Area	SHM-93-22B	Overburden	82.3 - 92.3	SHM-93-22B-FAL21	11/04/2021	440	13,000	9,500	200	37.0	0.800 U	11.0	0.73	-65.5	6.59	423	11.9	3.63
Nearfield Area	SHM-96-5B	Overburden	80.0 - 90.0	SHM-96-5B-FAL21	11/09/2021	1,200	15,000	7,500	190	36.0	0.740 J	20.0	0.0200	-65.4	6.43	458	11.9	0.1 U
Nearfield Area	SHM-96-5B	Overburden	80.0 - 90.0	SHL-DUP09-FAL21	11/09/2021	1,100	15,000	7,600	190	36.0	0.680 J	20.0	--	--	--	--	--	--
Nearfield Area	SHM-96-5C	Overburden	50.0 - 60.0	SHM-96-5C-FAL21	11/08/2021	45.0	17,000	5,700	160	29.0	1.20	5.40	0.900	-73.2	6.25	382	11.2	1.00
Nearfield Area	SHP-2016-1A	Overburden	13.9 - 23.0	SHP-2016-1A-FAL21	11/02/2021	3.00 U	50.0 U	1.40 J	33.0 J	0.510	0.800 U	3.20	7.57	136	5.97	51	14.6	4.45
Nearfield Area	SHP-2016-1B	Overburden	75.0 - 85.0	SHP-2016-1B-FAL21	11/02/2021	110	15,000	860	60.0 J	3.90	1.90	2.50	0.810	-68.9	6.49	123	12.4	5.45
Nearfield Area	SHP-2016-2A	Overburden	20.0 - 25.0	SHP-2016-2A-FAL21	11/09/2021	8.90	50.0 U	170	62.0	2.70	1.60	3.80	3.45	70.6	9.29	100	12.8	1.95
Nearfield Area	SHP-2016-2B	Overburden	80.0 - 85.0	SHP-2016-2B-FAL21	11/09/2021	380	35,000	2,200	130	13.0	1.80	2.70	0.0700	-83.5	6.54	320	12.5	10.8
Nearfield Area	SHP-2016-3A	Overburden	20.0 - 25.0	SHP-2016-3A-FAL21	11/04/2021	5.80	13,000	490	75.0	2.40	0.800 U	1.20	0.980	-61.8	6.64	113	11.9	0.1 U
Nearfield Area	SHP-2016-3B	Overburden	80.0 - 85.0	SHP-2016-3B-FAL21	11/04/2021	200	44,000	3,000	120	18.0	2.10	4.30	0.940	-67.5	6.38	291	11.3	0.320
Nearfield Area	SHP-2016-4A	Overburden	25.0 - 30.0	SHP-2016-4A-FAL21	11/04/2021	3.00 U	50.0 U	69.0	6.40 U	2.20	0.800 U	4.50	8.97	114	6.13	30	9.30	1.71
Nearfield Area	SHP-2016-4B	Overburden	85.0 - 90.0	SHP-2016-4B-FAL21	11/04/2021	1,100	36,000	2,300	120	14.0	0.800 U	6.30	0.810	-95.9	6.60	252	9.10	0.940
Nearfield Area	SHP-2016-5A	Overburden	25.0 - 30.0	SHP-2016-5A-FAL21	11/09/2021	3.40	2,000	220	67.0	24.0	6.10	2.60	0.100	-33.3	6.31	184	11.7	0.560
Nearfield Area	SHP-2016-5B	Overburden	85.0 - 90.0	SHP-2016-5B-FAL21	11/10/2021	550	58,000	3,000	150	28.0	2.50	9.80	0.0200	-65.9	6.40	377	12.0	0.1 U
Northern Impact Area	SHM-05-39A[c]	Overburden	37.0 - 39.0	SHM-05-39A-FAL21	11/10/2021	2.00 J	50.0 U	180	58.0	25.0	0.880 J	5.60	1.45	83.0	6.62	317	10.3	8.82
Northern Impact Area	SHM-05-39B[c]	Overburden	66.0 - 68.0	SHM-05-39B-FAL21	11/10/2021	250	19,000	980	36.0	220	0.970 J	5.00 U	1.26	55.2	6.31	557	9.90	58.2
Northern Impact Area	SHM-05-40X	Overburden	32.0 - 34.0	SHL-DUP07-FAL21	11/08/2021	2,200	28,000	850	140	20.0	1.20	3.50	--	--	--	--	--	--
Northern Impact Area	SHM-05-40X	Overburden	32.0 - 34.0	SHM-05-40X-FAL21	11/08/2021	2,100	27,000	830	140	19.0	1.50	3.40	1.25	-77.1	6.84	538	9.00	4.81
Northern Impact Area	SHM-07-03	Overburden	25.0 - 35.0	SHM-07-03-FAL21	11/10/2021	3.00 U	120	2.10 J	35.0	110	0.600 J	7.50	7.29	159	6.12	552	8.20	9.34
Northern Impact Area	SHM-07-05X	Overburden	56.0 - 66.0	SHM-07-05X-FAL21	11/08/2021	24.0	560	53.0	6.40 U	22.0	1.70	5.00 U	1.65	86.6	6.08	207	10.6	5.27
Northern Impact Area	SHM-10-02	Overburden	53.0 - 63.0	SHM-10-02-FAL21	11/01/2021	3.00 U	50.0 U	1.20 J	90.0	110	1.10	6.50	4.54	93.1	7.15	488	13.8	0.1 U
Northern Impact Area	SHM-10-03	Overburden	58.5 - 68.5	SHM-10-03-FAL21	10/28/2021	3.00 U	32.0 J	4.20 J	140 J	88.0	1.10	5.40	0.160	36.0	7.61	483	11.4	0.110
Northern Impact Area	SHM-10-04	Overburden	55.0 - 65.0	SHM-10-04-FAL21	10/28/2021	3.00 U	50.0 U	390	81.0 J	81.0	1.20	21.0	0.100	97.1	6.62	371	11.9	0.170
Northern Impact Area	SHM-10-05A	Overburden	50.0 - 60.0	SHM-10-05A-FAL21	10/27/2021	3.00 U	50.0 U	2.00 J	39.0 J	49.0	1.60	6.10	1.03	89.8	6.16	187	13.6	0.1 U
Northern Impact Area	SHM-10-08	Overburden	46.0 - 56.0	SHM-10-08-FAL21	11/01/2021	3.00 U	50.0 U	540	160	110	1.30	5.50	0.600	84.1	7.19	574	13.6	0.1 U
Northern Impact Area	SHM-10-10	Overburden	56.0 - 66.0	SHM-10-10-FAL21	11/08/2021	3.00 U	18.0 J	3,300	230	34.0	1.60	2.80	0.153	132	6.42	403	13.6	1.29

Table 2
Fall 2021 LTM Analytical Results and Field Parameters
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Location	Well ID	Formation Type at Screen Interval	Screened Interval (feet bgs)	Sample ID	Analytical Method	Metals			General Chemistry				Field Parameters					
					Analyte	Arsenic	Iron	Manganese	Alkalinity	Chloride	DOC	Sulfate	DO	ORP	pH	SPC	Temp	Turbidity
					Unit	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mv	Units	µS/cm	°C	NTU
					Screening Limit[a]	10	9,100	1,715	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
					Date													
Northern Impact Area	SHM-13-01	Overburden	39.0 - 49.0	SHM-13-01-FAL21	11/08/2021	1.70 J	50.0 U	2.40 J	32.0	110	0.800 U	7.80	0.125	174	6.03	300	12.1	0.710
Northern Impact Area	SHM-13-02	Overburden	60.0 - 70.0	SHM-13-02-FAL21	11/08/2021	3.00 U	50.0 U	69.0	120	43.0	0.990 J	4.20	0.0490	150	6.45	263	13.7	10.3
Northern Impact Area	SHM-13-03	Overburden	42.0 - 52.0	SHM-13-03-FAL21	11/05/2021	**39.0**	3,900	**11,000**	260 J	90.0	3.10	3.30	0.0200	44.8	7.25	605	11.0	5.81
Northern Impact Area	SHM-13-04	Overburden	20.0 - 30.0	SHM-13-04-FAL21	10/26/2021	**31.0**	60.0	18.0	41.0	170	1.00	9.30	5.86	130	6.18	595	13.3	60.3
Northern Impact Area	SHM-13-05	Overburden	75.0 - 85.0	SHM-13-05-FAL21	10/26/2021	**18.0**	3,500	**2,900**	410	42.0	2.70	11.0	1.08	-122	6.92	730	12.5	0.560
Northern Impact Area	SHM-13-06	Overburden	36.0 - 46.0	SHM-13-06-FAL21	11/04/2021	**1,800**	**18,000**	1,500	68.0	99.0	0.800 U	8.30	0.450	-65.2	7.57	407	14.1	3.82
Northern Impact Area	SHM-13-07	Overburden	27.0 - 37.0	SHM-13-07-FAL21	11/04/2021	**290 J**	**18,000 J**	**2,400**	56.0	210	0.800 U	4.00 J	0.190	5.10	7.10	692	14.0	0.710
Northern Impact Area	SHM-13-08	Overburden	55.0 - 65.0	SHM-13-08-FAL21	11/04/2021	**820**	**38,000**	920	120	25.0	2.10	3.80	0.0100	-109	7.66	354	12.6	4.10
Northern Impact Area	SHM-13-14D	Overburden	45.0 - 55.0	SHM-13-14D-FAL21	11/05/2021	3.30	3,800	720	71.0 J	34.0	0.800 U	4.90	0.950	-21.6	6.54	202	11.1	5.68
Northern Impact Area	SHM-13-14S	Overburden	5.0 - 15.0	SHM-13-14S-FAL21	11/05/2021	3.00 U	18.0 J	39.0	6.40 UJ	100	0.800 U	16.0	0.510	147	6.34	344	9.80	10.3
Northern Impact Area	SHM-13-15	Overburden	50.0 - 60.0	SHM-13-15-FAL21	11/05/2021	1.80 J	110	**2,300**	260 J	66.0	3.10	6.30	0.01	61.3	7.79	530	10.7	6.41
Northern Impact Area	SHM-99-31A[c]	Overburden	4.0 - 14.0	SHM-99-31A-FAL21	10/25/2021	25.0	5,000	270	47.0	26.0	6.70	1.20	0.840	48.4	5.67	158	13.7	2.61
Northern Impact Area	SHM-99-31B[c]	Overburden	50.0 - 60.0	SHM-99-31B-FAL21	10/25/2021	1.60 J	50.0 U	3.00 U	39.0	8.80	2.50	5.00	4.53	50.1	6.45	102	11.9	2.61
Northern Impact Area	SHM-99-31C	Overburden	68.0 - 78.0	SHM-99-31C-FAL21	10/25/2021	**150**	**12,000**	**4,900**	260	59.0	2.70	9.50	0.850	-75.6	6.40	467	10.7	1.01
Northern Impact Area	SHM-99-32X	Overburden	72.0 - 82.0	SHM-99-32X-FAL21	10/25/2021	**27.0**	4,500	**3,100**	47.0	79.0	1.50	8.10	0.920	-88.8	6.79	313	11.3	5.61
Upgradient Area	SHL-7	Overburden	11.0 - 21.0	SHL-7-FAL21	11/04/2021	3.00 U	320	5.80 J	62.0	4.40	0.800 U	2.50	0.190	105	6.93	110	13.1	21.7
Upgradient Area	SHL-12	Overburden	15.0 - 30.0	SHL-12-FAL21	11/09/2021	2.80 J	110	440	110	47.0	1.50	66.0	1.40	88.7	6.16	411	13.0	13.1
Upgradient Area	SHL-15	Overburden	14.5 - 24.5	SHL-15-FAL21	11/02/2021	**22.0**	7,000	250	110 J	19.0	2.80	4.70	1.01	-28.7	5.99	431	6.9	4.66
Upgradient Area	SHL-24	Overburden	110.0 - 120.0[b]	SHL-24-FAL21	11/04/2021	3.80	50.0 U	3.00 U	60.0	42.0	0.800 U	24.0	1.90	82.2	8.08	247	10.6	0.880
Upgradient Area	SHL-24	Overburden	110.0 - 120.0[b]	SHL-DUP06-FAL21	11/04/2021	3.80	40.0 J	3.00 U	59.0	42.0	0.800 U	24.0	--	--	--	--	--	--
Upgradient Area	SHM-93-18B	Overburden	78.5 - 88.5	SHM-93-18B-FAL21	11/08/2021	3.00 U	50.0 U	520	56.0	170	0.800 U	35.0	0.980	204	6.08	661	12.6	0.1 U
Upgradient Area	SHM-93-24A	Overburden	13.2 - 23.2	SHM-93-24A-FAL21	11/05/2021	3.00 U	50.0 U	20.0	6.40 UJ	180	0.800 U	94.0	7.01	152.5	6.12	745	13.4	1.68

Notes:

[a] Screening Limits: Shepley's Hill Landfill cleanup goals (USACE 1995).

[b] Estimated value derived from Supplemental Groundwater Investigation (Harding ESE 2003).

[c] Location added to LTMMP list in response to United States Environmental Protection Agency (USEPA) informal dispute resolution letter dated (USEPA 2016).

Acronyms and Abbreviations:

--	no data available
°C	degree Celsius
µg/L	microgram per liter
µS/cm	microSiemen per centimeter
DO	dissolved oxygen
DOC	dissolved organic carbon
LTM	long-term monitoring
mg/L	milligram per liter
mV	millivolt
NA	not applicable
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
SPC	specific conductivity
Temp	temperature

Analytical Parameters:

2,000 = above cleanup goal

Qualifiers:

J	The analyte was positively identified, the quantitation is an estimation (i.e., estimated result).
U	The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

References:

Harding ESE. 2003. Shepley's Hill Landfill Supplemental Groundwater Investigation, Devens, Massachusetts. February.

United States Army Corps of Engineers. 1995. Record of Decision, Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts. September.

USEPA. 2016. Former Fort Devens Installation – Dispute Resolution 2015 Devens Five Year Review (FYR) Report. February 24.

Table 3
Applicable or Relevant and Appropriate Requirements
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Type	Standard, Requirement Criteria, or Limitation	Citation	Requirement Synopsis	Considered	Pertains to Alternative #						
					1	2	3	4	5A	5B	6
Location-Specific	Massachusetts Wetlands Protection Act and Regulations	MGL Chapter 131, Section 40 310 CMR 10.55-56	Regulation and protection of wetlands and lands subject to flooding under this Act. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. Activities that disturb wetland and buffer areas are subject to regulation. Applicants must file a Notice of Intent (to disturb) to the local municipal agency Conservation Commission prior to proceeding. The local authority may place construction-related restrictions, requirements, or restoration plans in place as part of permitting. Local or State permits are not required for onsite CERCLA actions, only substantive provisions may apply.	Relevant & Appropriate			X	X	X	X	X
Chemical-Specific	Safe Drinking Water Act, National Primary Drinking Water Standards	40 CFR 141.11(a) and 141.50-191.51	The National Primary Drinking Water Regulation establishes MCLs and non-zero MCL Goals for several common organic and inorganic contaminants. These MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies.	Relevant & Appropriate	X	X	X	X	X	X	X
Action-Specific	Non-Potential Drinking Water Source Areas Guidance and Regulations	MassDEP WSC-97-701	This policy outlines guidance for determining areas that are non-potential drinking water source areas based on land use and acreage, and how NPDWSAs are not considered to be potential drinking water source areas and do not need to be Massachusetts Drinking Water Standards.	To Be Considered		X	X	X	X	X	X
	Massachusetts Standard References for Monitoring Wells	MassDEP WSC-310-91 Section 4	Guidance document for siting and installation piezometers, observation wells, and monitoring wells in Massachusetts.	To Be Considered		X	X	X	X	X	X
	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403.5-403.6	Includes pretreatment standards to prevent introduction of pollutants into POTWs which will interfere with the operation of the POTW, or that will pass through or be incompatible with POTWs. Discharges must be non-prohibited and meet categorical standards.	Applicable		X		X		X	X
	Massachusetts Remedial Wastewater Discharges to Publicly Owned Treatment Works	310 CMR 40.0043(2)	Allows for discharge of Remedial Wastewater to a sewer system and/or POTW, provided that the discharge complies with the terms and conditions of the public entity controlling the POTW.	Relevant & Appropriate		X		X		X	X

Type	Standard, Requirement Criteria, or Limitation	Citation	Requirement Synopsis	Considered	Pertains to Alternative #						
					1	2	3	4	5A	5B	6
Action-Specific	Underground Injection Control Program	40 CFR 144.13(c), 144.23(c)	Wells used to inject contaminated groundwater that has been treated and is being reinjected into the same formation from which it was withdrawn are not prohibited if activity is approved by EPA or a State and part of CERCLA or RCRA actions.	Applicable					X		
	Massachusetts Remedial Wastewater Discharges to the Ground Surface of Subsurface and/or Groundwater	310 CMR 40.0045(1) and (7)	Includes regulations for discharge of Remedial Wastewater to the subsurface and/or groundwater.	Relevant & Appropriate					X		

Alternatives:
Alternative 1: No Action
Alternative 2: Groundwater Extraction and Treatment
Alternative 3: In-Situ Air Sparging
Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells
Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection
Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging
Alternative 6: Landfill Footprint Reduction with Active Aquifer Treatment

Acronyms and Abbreviations:
CFR = Code of Federal Regulations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CMR = Code of Massachusetts Regulations
EPA = Environmental Protection Agency
MassDEP = Massachusetts Department of Environmental Protection
MCL = maximum contaminant level
MGL = Massachusetts General Laws
NPDWSA = Non-Potential Drinking Water Source Area
POTW = Publicly Owned Treatment Works
RCRA = Resource Conservation and Recovery Act

Table 4
Estimated Cost of Alternatives
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Alternative	Remedial Alternative				Long Term Maintenance & Monitoring				Total Cost for 30 Yrs.
	Implementation		Operation & Maintenance		Landfill Inspection & Maintenance		Monitoring & Reporting		
	Scoped Tasks Included	Subtotal	Scoped Tasks Included	30 Yr. Subtotal	Scoped Tasks Included	30 Yr. Subtotal	Scoped Tasks Included	30 Yr. Subtotal	
Alternative 1: No Action	--	$0	--	$0	--	$0	--	$0	**$0**
Alternative 2: Groundwater Extraction and Treatment	--	$0	1. Annual ATP System O&M (Yrs. 1-30)	$22,400,000	2. Annual LF Inspection and Maintenance (Yrs. 1-30)	$1,800,000	3. Semi-Annual GWM (Yrs. 1-10) 4. Annual GWM (Yrs. 11-30)	$2,600,000	**$26,800,000**
Alternative 3: In-Situ Air Sparging	1. RD Optimization and Testing (Yr. 1) 2. ROD Amendment Preparation and Submittal (Yr. 1) 5. RD (Yr. 2) 6. RD Impl. - IAS System, Trenching, Well Install. (Yr. 2)	$2,400,000	4. Annual ATP System O&M (Yrs. 1-2) 7. Annual IAS System O&M (Yrs. 3-30) 8. Quarterly IAS Performance Monitoring (Yrs. 3-4)	$7,400,000	3. Annual LF Inspection and Maintenance (Yrs. 1-30)	$1,800,000	9. Semi-Annual GWM (Yrs. 1-10) 10. Annual GWM (Yrs. 11-30)	$2,600,000	**$14,200,000**
Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells	1. RD Optimization and Testing (Yr. 1) 2. ESD Preparation and Submittal (Yr. 1) 3. RD (Yr. 2) 4. RD Impl. - Install. and Testing of Third EW (Yr. 3)	$500,000	5. Annual ATP System O&M (2 EWs; Yrs. 1-3) 7. Annual ATP System O&M (3 EWs; Yrs. 3-30)	$24,200,000	6. Annual LF Inspection and Maintenance (Yrs. 1-30)	$1,800,000	8. Semi-Annual GWM (Yrs. 1-10) 9. Annual GWM (Yrs. 11-30)	$2,600,000	**$29,100,000**
Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection	1. RD Optimization and Testing (Yr. 1) 2. ESD Preparation and Submittal (Yr. 1) 3. RD (Yr. 2) 4. RD Impl. - Install. of Third EW and Injection (Yr. 3)	$800,000	5. Annual ATP System O&M (2 EWs; Yrs. 1-3) 7. Annual ATP System O&M (3 EWs and injection; Yrs. 3-30) 8. Quarterly Performance Monitoring (Yrs. 3-4)	$19,500,000	6. Annual LF Inspection and Maintenance (Yrs. 1-30)	$1,800,000	9. Semi-Annual GWM (Yrs. 1-10) 10. Annual GWM (Yrs. 11-30)	$2,600,000	**$24,700,000**
Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging	1. RD Optimization and Testing (Yr. 1) 2. ROD Modification Preparation and Submittal (Yr. 1) 3. RD (Yr. 2) 4. RD Impl. - Install. of Third EW and IAS System (Yr. 2)	$1,800,000	5. Annual ATP System O&M (2 EWs; Yrs. 1-3) 7. Annual ATP System O&M (3 EWs and IAS; Yrs. 3-30) 8. Quarterly Performance Monitoring (Yrs. 3-4)	$27,100,000	6. Annual LF Inspection and Maintenance (Yrs. 1-30)	$1,800,000	9. Semi-Annual GWM (Yrs. 1-10) 10. Annual GWM (Yrs. 11-30)	$2,600,000	**$33,300,000**
Alternative 6: Partial Landfill Removal with Active Aquifer Treatment	1. RD Optimization and Testing (Yr. 1) 2. ROD Amendment Preparation and Submittal (Yr. 1) 3. RD - IAS System (Yr. 2) 4. RD Impl. - Install. of IAS System (Yr. 3) 5. Design Documents (Yr. 1) 6. Partial Landfill Removal (Yr. 2)	$192,700,000	7. Annual ATP System O&M (2 EWs; Yrs. 1-3) 9. Annual IAS System O&M (Yrs. 3-30)	$7,900,000	8. Annual LF Inspection and Maintenance (Yrs. 1-30)	$1,800,000	10. Semi-Annual GWM (Yrs. 1-10) 11. Annual GWM (Yrs. 11-30)	$1,900,000	**$204,300,000**

Notes:
1. Detailed cost estimates for each alternative (except Alternative 1: No Action) are included in Appendix H. The tasks referred to above are included in the detailed cost estimates.
2. Costs above are rounded to the nearest $100,000.

Acronyms and Abbreviations:
-- = none, not applicable
ATP = Arsenic Treatment Plant
ESD = Explanation of Significant Differences
EW = extraction well
GWM = groundwater monitoring
IAS = in situ air sparge
Impl. = implementation
Install. = installation
LF = landfill
O&M = operation and maintenance
RD = remedial design
ROD = Record of Decision
Yr. = year
Yrs. = years

Table 5
Comparative Analysis of Alternatives
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Threshold and Balancing Criteria	Alternative 1: No Action	Alternative 2: Groundwater Extraction and Treatment (Current Remedy)	Alternative 3: In-Situ Air Sparging
Overall protection of human health and the environment	No. The NPDWSA designation would remain to administratively protect against the installation of drinking water wells within the NIA. LUC activities performed by the Army would cease. Changes in site conditions including contaminant concentrations/distributions would not be monitored, reported, or evaluated to ensure protection of human health.	Yes. LUCs and the NPDWSA designation prevent installation of drinking water wells within the NIA. Human health risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.	Yes. LUCs and the NPDWSA designation prevent installation of drinking water wells within the NIA. Human health risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.
Compliance with ARARs	No. Dissolved arsenic and other metals would persist in groundwater with no further action to address potential risk.	Yes. Groundwater use is restricted through LUCs controlling potential exposure to contaminated groundwater in the NIA. System and groundwater monitoring, performance tracking, and reporting is conducted in compliance with federal and state requirements.	Yes. Groundwater use is restricted through LUCs controlling potential exposure to contaminated groundwater in the NIA. System and groundwater monitoring, performance tracking, and reporting is conducted in compliance with federal and state requirements.
Long-term effectiveness and permanence	Low. Not an effective permanent solution. The NPDWSA designation across much of the NIA would persist, but areas outside of the NPDWSA would no longer have LUCs maintained by Army, presenting a potentially unacceptable risk to residents.	High. RAOs are currently being met by LUCs in place, administered by the Army. Concentrations of arsenic in groundwater will remain relatively stable over time, even with extraction, but risk is controlled both by the NPDWSA designation and by LUCs preventing residential use of groundwater as drinking water.	High. RAOs are currently being met by LUCs in place, administered by the Army. Arsenic in groundwater will persist, even with active treatment, but risk is controlled both by the NPDWSA designation and by LUCs preventing residential use of groundwater.
Reduction of mobility, toxicity, or volume through treatment	Low. Limited reduction in mobility, toxicity, or volume due to natural attenuation.	Low to Moderate. The effect of groundwater extraction and treatment at reducing arsenic concentrations in groundwater has not been significant, despite a high degree of capture (over 90%), and removal of arsenic mass from treated groundwater. Concentrations of arsenic in groundwater in the NIA are expected to remain relatively stable due to ongoing reducing conditions in groundwater and the presence of geogenic arsenic in the subsurface.	Moderate. Alternative would establish more oxic redox conditions in groundwater, precipitating arsenic with iron and preventing redissolution. The depth to which treatment can occur is limited to the overburden and the ability to inject air into permeable soils. Concentrations of arsenic in groundwater exceeding the drinking water standards in the NIA would likely continue due to the presence of geogenic arsenic in the subsurface, which may be present in part due to oxidative release in bedrock, but addition of oxygen to groundwater has the best chance of reducing overall concentrations downgradient. The importance of this source component in the long-term is not well understood.
Short-term effectiveness	Low. Not protective of human health and the environment.	Low. Risk to workers who run the treatment system due to the use of heavy equipment, chemicals, and physical demands of the job. A high volume of sludge waste and treated effluent are disposed offsite.	Moderate. Some risk to workers installing the treatment system, and to workers who would continue to operate and maintain the operation. Limited environmental impact in the short term. Could be implemented within 2 to 3 years, depending on acceptance and approval timing.
Implementability	Low. Poses no technical difficulties, but would face significant administrative difficulties due to regulatory noncompliance and community concerns.	High. Alternative is in place.	Moderate. Pilot test demonstrated the ability to implement at the site with limited technical challenges While expected to be manageable, potential long-term operation may require periodic redevelopment and/or replacement of injection wells due to fouling of well screens. Some administrative challenges related to regulatory and/or community acceptance of shutdown of the ATP is expected.
Cost	Low. $0.	High. $26.8 million.	Moderate. $14.2 million.

Note:
1. State acceptance and community acceptance modifying criteria will not be given a rating; these will be reflected during the Proposed Plan process.

Color Code:

Color Code
Threshold criteria are Pass / Fail
More desirable
Neutral
Less desirable

Acronyms and Abbreviations:
ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
LUC = land use control
MassDEP = Massachusetts Department of Environmental Protection
NIA = North Impact Area
NPDWSA = non-potential drinking water source area
PFAS = per- and polyfluoroalkyl substances
RAOs = Remedial Action Objectives
RCRA = Resource Conservation and Recovery Act
redox = oxidation-reduction
SHL = Shepley's Hill Landfill

Table 5
Comparative Analysis of Alternatives
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Threshold and Balancing Criteria	Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells	Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection	Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging
Overall protection of human health and the environment	Yes. LUCs and the NPDWSA designation prevent installation of drinking water wells within the NIA. Human health risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.	Yes. LUCs and the NPDWSA designation prevent installation of drinking water wells within the NIA. Human health risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.	Yes. LUCs and the NPDWSA designation prevent installation of drinking water wells within the NIA. Human health risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.
Compliance with ARARs	Yes. Groundwater use is restricted through LUCs controlling potential exposure to contaminated groundwater in the NIA. System and groundwater monitoring, performance tracking, and reporting is conducted in compliance with federal and state requirements.	Yes. Groundwater use is restricted through LUCs controlling potential exposure to contaminated groundwater in the NIA. System and groundwater monitoring, performance tracking, and reporting is conducted in compliance with federal and state requirements.	Yes. Groundwater use is restricted through LUCs controlling potential exposure to contaminated groundwater in the NIA. System and groundwater monitoring, performance tracking, and reporting is conducted in compliance with federal and state requirements.
Long-term effectiveness and permanence	High. RAOs are currently being met by LUCs in place, administered by the Army. Arsenic in groundwater will persist, even with active treatment, but risk is controlled both by the NPDWSA designation and by LUCs preventing residential use of groundwater.	High. RAOs are currently being met by LUCs in place, administered by the Army. Arsenic in groundwater will persist, even with active treatment, but risk is controlled both by the NPDWSA designation and by LUCs preventing residential use of groundwater.	High. RAOs are currently being met by LUCs in place, administered by the Army. Arsenic in groundwater will persist, even with active treatment, but risk is controlled both by the NPDWSA designation and by LUCs preventing residential use of groundwater.
Reduction of mobility, toxicity, or volume through treatment	Low to Moderate. Effect of groundwater extraction and treatment at reducing arsenic concentrations in groundwater has not been significant, despite a high degree of capture (over 90%) and removal of arsenic mass from treated groundwater. Additional capture of groundwater north of SHL is not anticipated to greatly improve the concentrations of arsenic in groundwater downgradient. Arsenic in groundwater concentrations in the NIA are expected to remain above drinking water standards due to ongoing reducing conditions in groundwater and the presence of geogenic arsenic in the subsurface.	Moderate. Effect of groundwater extraction and treatment at reducing arsenic concentrations in groundwater has not been significant, despite a high degree of capture (over 90%). Injection of clean water would enhance flushing by increasing groundwater flow rates and would introduce dissolved oxygen into the aquifer. The effectiveness of this additional flushing and groundwater oxygenation on decreasing concentrations of arsenic in groundwater downgradient is not well understood.	Moderate. Effect of groundwater extraction and treatment at reducing arsenic concentrations in groundwater has not been significant, despite a high degree of capture (over 90%). The addition of the air sparge component would establish more oxic redox conditions in groundwater. The depth to which treatment can occur with this technology is limited to the overburden and the ability to inject air into permeable soils. Arsenic in groundwater concentrations in the NIA are expected to remain above drinking water standards due to the presence of geogenic arsenic in the subsurface, which may be present in part due to oxidative release in bedrock. The importance of this source component in the long-term is not well understood.
Short-term effectiveness	Low. Risk to workers who run the treatment system due to the use of heavy equipment, chemicals, and physical demands of the job. A high volume of sludge waste and treated effluent are disposed of offsite.	Moderate. Risk to workers who run the treatment system due to the use of heavy equipment, chemicals, and physical demands of the job. A high volume of sludge waste would continue to be disposed of offsite. Effluent would be discharged to the subsurface rather than to the publicly owned treatment works.	Low. Risk to workers who run the treatment system due to the use of heavy equipment, chemicals, and physical demands of the job. A high volume of sludge waste and treated effluent are disposed of offsite.
Implementability	High. Alternative is largely in place. Installation of a third extraction well is readily implementable.	Low to Moderate. System can be constructed readily, but injection of treated water into either injection wells or trenches may eventually foul injection well screens and/or pore spaces within the overburden requiring frequent injection well redevelopment and/or replacement.	Moderate. The groundwater extraction component of this alternative is largely in place. Installation of a third extraction well is readily implementable. While expected to be manageable, potential long-term operation may require periodic redevelopment and/or replacement of injection wells due to fouling of well screens.
Cost	High. $29.1 million.	High. $24.7 million.	High. $33.3 million.

Note:
1. State acceptance and community acceptance modifying criteria will not be given a rating; these will be reflected during the Proposed Plan process.

Color Code:
- Threshold criteria are Pass / Fail
- More desirable
- Neutral
- Less desirable

Acronyms and Abbreviations:
ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
LUC = land use control
MassDEP = Massachusetts Department of Environmental Protection
NIA = North Impact Area
NPDWSA = non-potential drinking water source area
PFAS = per- and polyfluoroalkyl substances
RAOs = Remedial Action Objectives
RCRA = Resource Conservation and Recovery Act
redox = oxidation-reduction
SHL = Shepley's Hill Landfill

Table 5
Comparative Analysis of Alternatives
Focused Feasibility Study Report
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

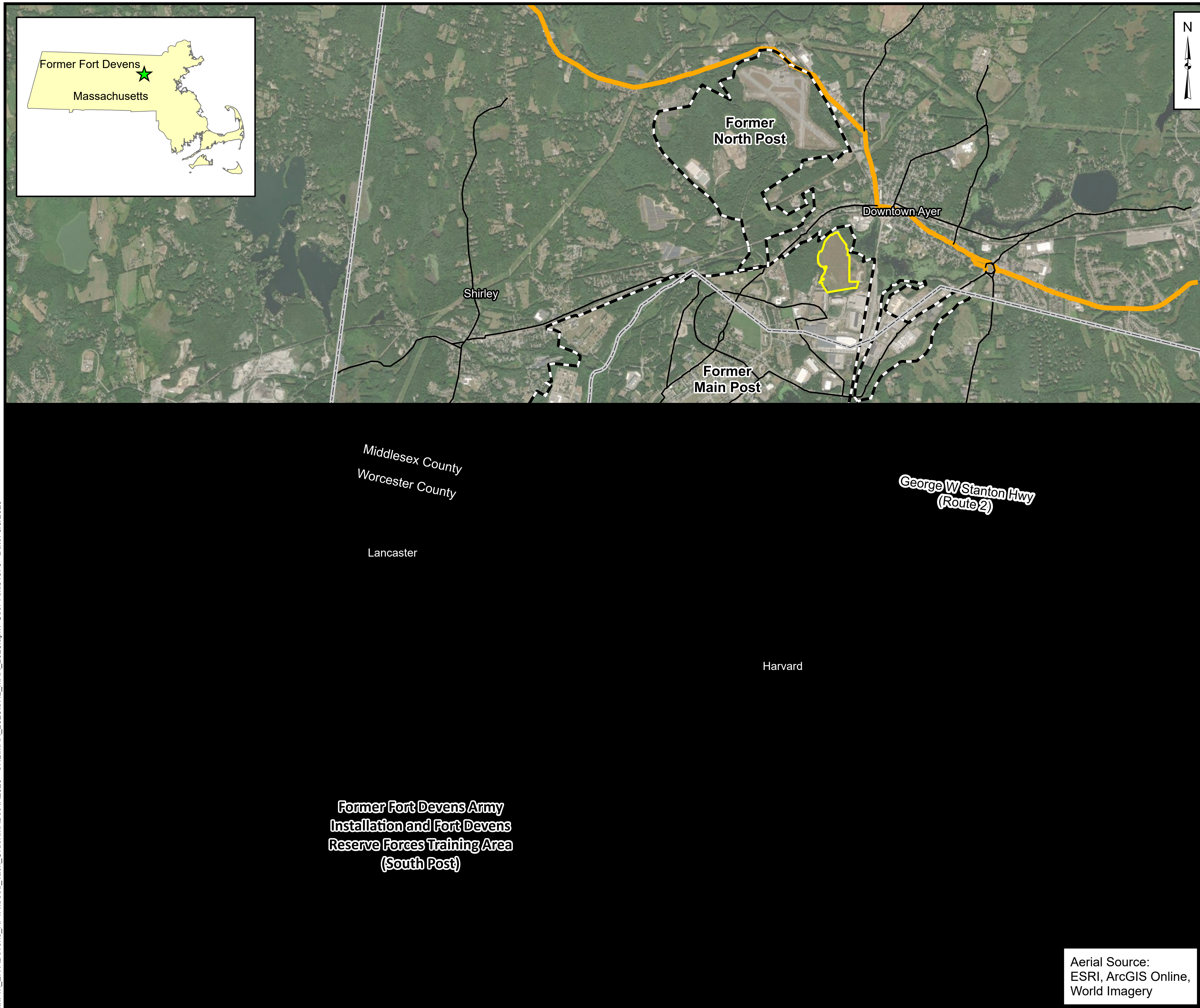
Threshold and Balancing Criteria	Alternative 6: Partial Landfill Removal with Active Aquifer Treatment
Overall protection of human health and the environment	Yes. LUCs and the NPDWSA designation prevent installation of drinking water wells within the NIA. Human health risks associated with Plow Shop Pond have been mitigated by remedial actions including sediment removal and installation of the barrier wall.
Compliance with ARARs	Yes. Groundwater use is restricted through LUCs controlling potential exposure to contaminated groundwater in the NIA. This alternative includes excavation of waste from SHL and ARARs would be met, but management of these wastes would require approval by many stakeholders, and the scale of the associated construction activity would trigger concerns with respect to solid waste management and activities conducted in floodplains. The waste that would be removed from the northern portion of SHL would require approximately 50,000 trucks to dispose of it. Depending on the future use of the northern portion of SHL, additional LUCs may need to be put into place for protection of human health.
Long-term effectiveness and permanence	High. RAOs are currently being met by LUCs in place, administered by the Army. Arsenic in groundwater will persist, even with active treatment, but risk is controlled both by the NPDWSA designation and by LUCs preventing residential use of groundwater.
Reduction of mobility, toxicity, or volume through treatment	Moderate. Alternative would establish more oxic redox conditions in groundwater, precipitating arsenic with iron and preventing redissolution. The depth to which treatment can occur is limited to the overburden and the ability to inject air into permeable soils. Exceedances of ARARs in the NIA would likely continue due to the presence of geogenic arsenic in the subsurface, which may be present in part due to oxidative release in bedrock. The importance of this source component in the long-term is not well understood. Removal of the northern part of the landfill cap would allow oxygenated groundwater to infiltrate across the former landfill footprint and flow northward into the NIA. Additional recharge would enhance flushing of groundwater and support more oxic conditions in the overburden; however, continued exceedances of ARARs in the NIA may be expected if geogenic arsenic source components remain. The long-term effect of the removal of a portion of the landfill cap from the area is not well understood.
Short-term effectiveness	Low. Significant risks related to the scale of the action, including excavation, dewatering, transporting, and grading of waste.
Implementability	Low. May be difficult to get approval from the required stakeholders to implement this alternative and difficult to identify waste disposal facilities that would accept the volume of waste required to be disposed of. More arduous to implement than the other alternatives.
Cost	High. $204 million.

Note:
1. State acceptance and community acceptance modifying criteria will not be given a rating; these will be reflected during the Proposed Plan process.

Color Code:
Threshold criteria are Pass / Fail
More desirable
Neutral
Less desirable

Acronyms and Abbreviations:
ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
LUC = land use control
MassDEP = Massachusetts Department of Environmental Protection
NIA = North Impact Area
NPDWSA = non-potential drinking water source area
PFAS = per- and polyfluoroalkyl substances
RAOs = Remedial Action Objectives
RCRA = Resource Conservation and Recovery Act
redox = oxidation-reduction
SHL = Shepley's Hill Landfill

Figures



Legend

- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- County Line
- Highway
- Major Road

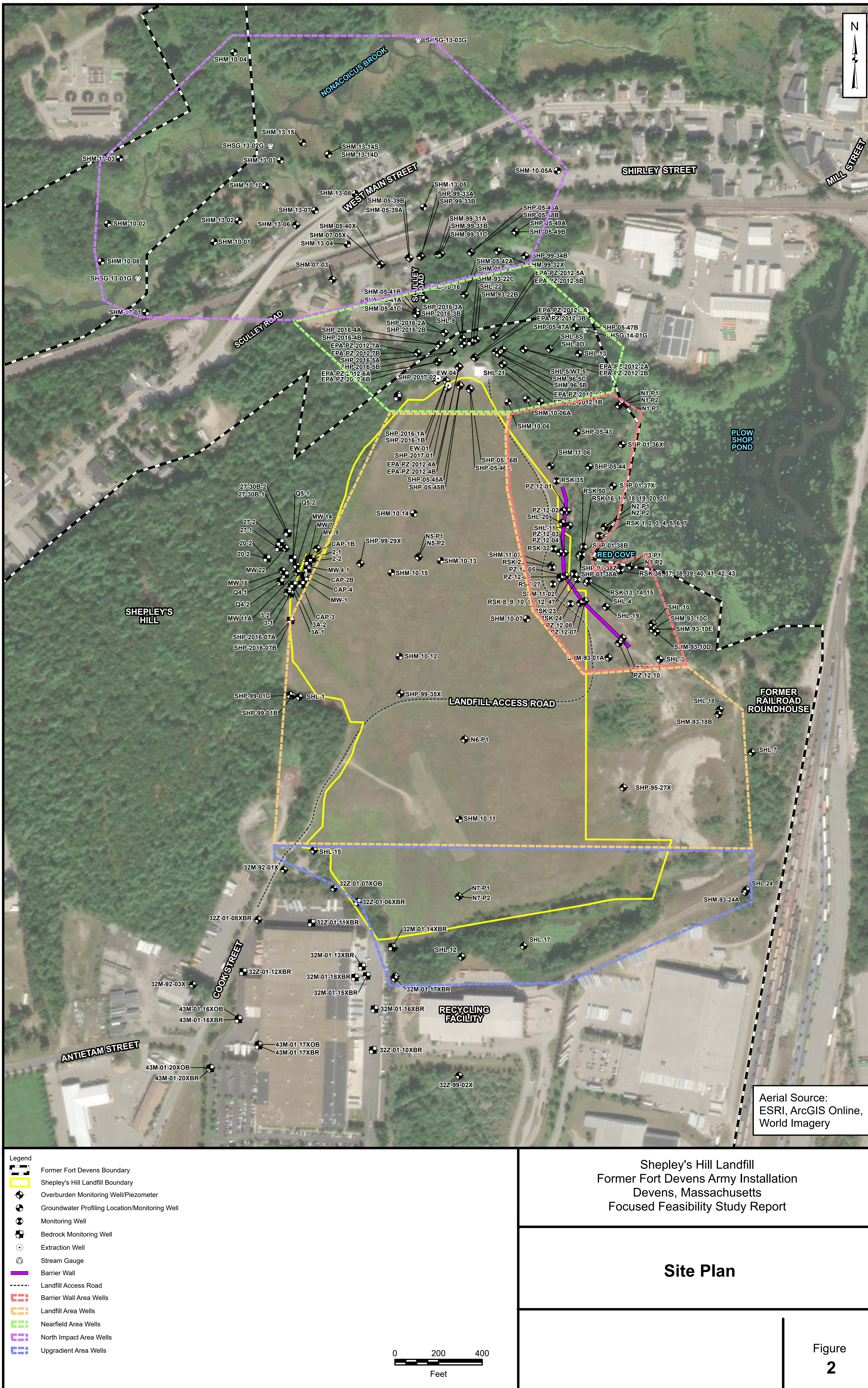
0 1 2
Miles

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Study Report

Site Location

Figure 1

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\SHL_MAR_2023.aprx User : ski01076 Date: 3/3/2023



Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
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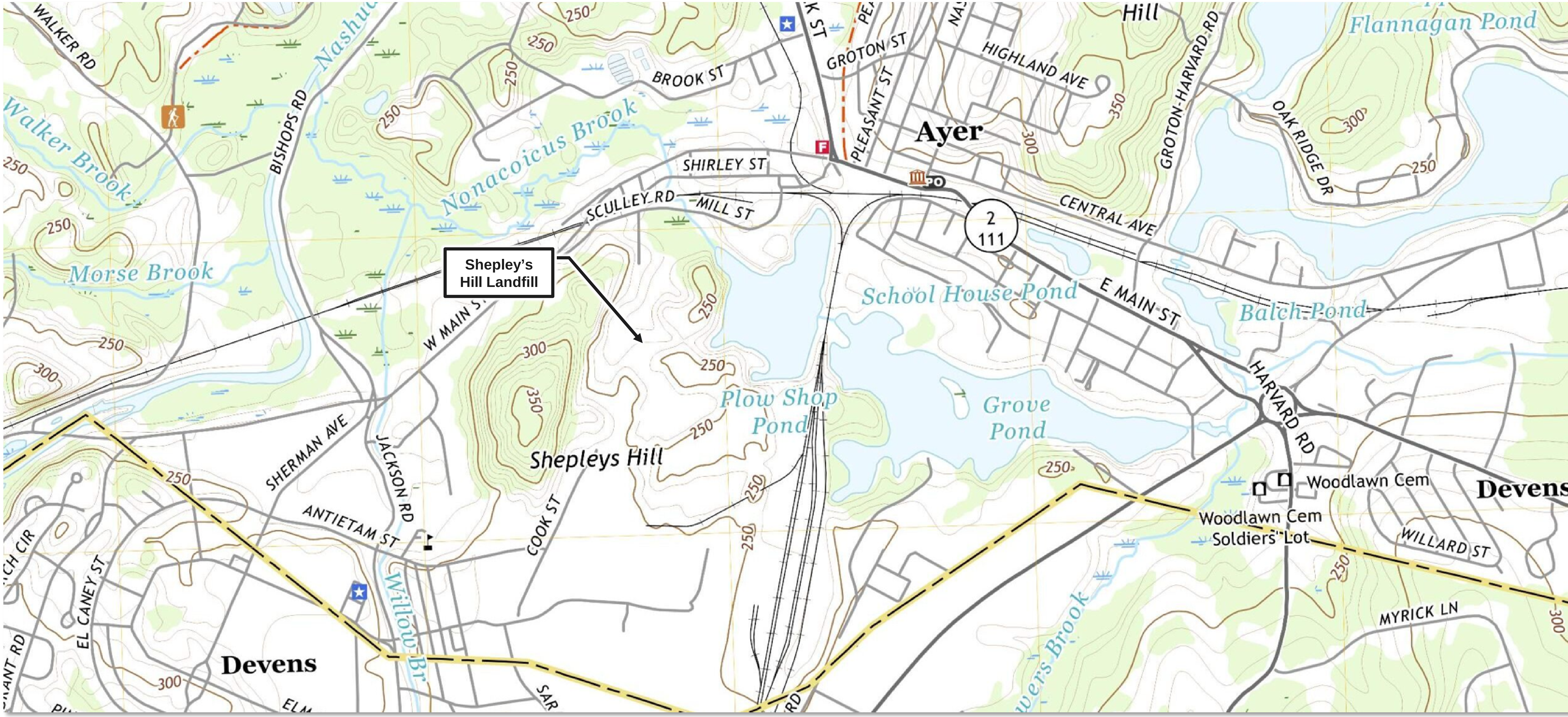
Site Plan

Figure 2

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\SHL_MAR_2023.aprx User : ski01076 Date: 3/3/2023

File: SHL_MAR_2023.mxd



0 1,075 ft

N

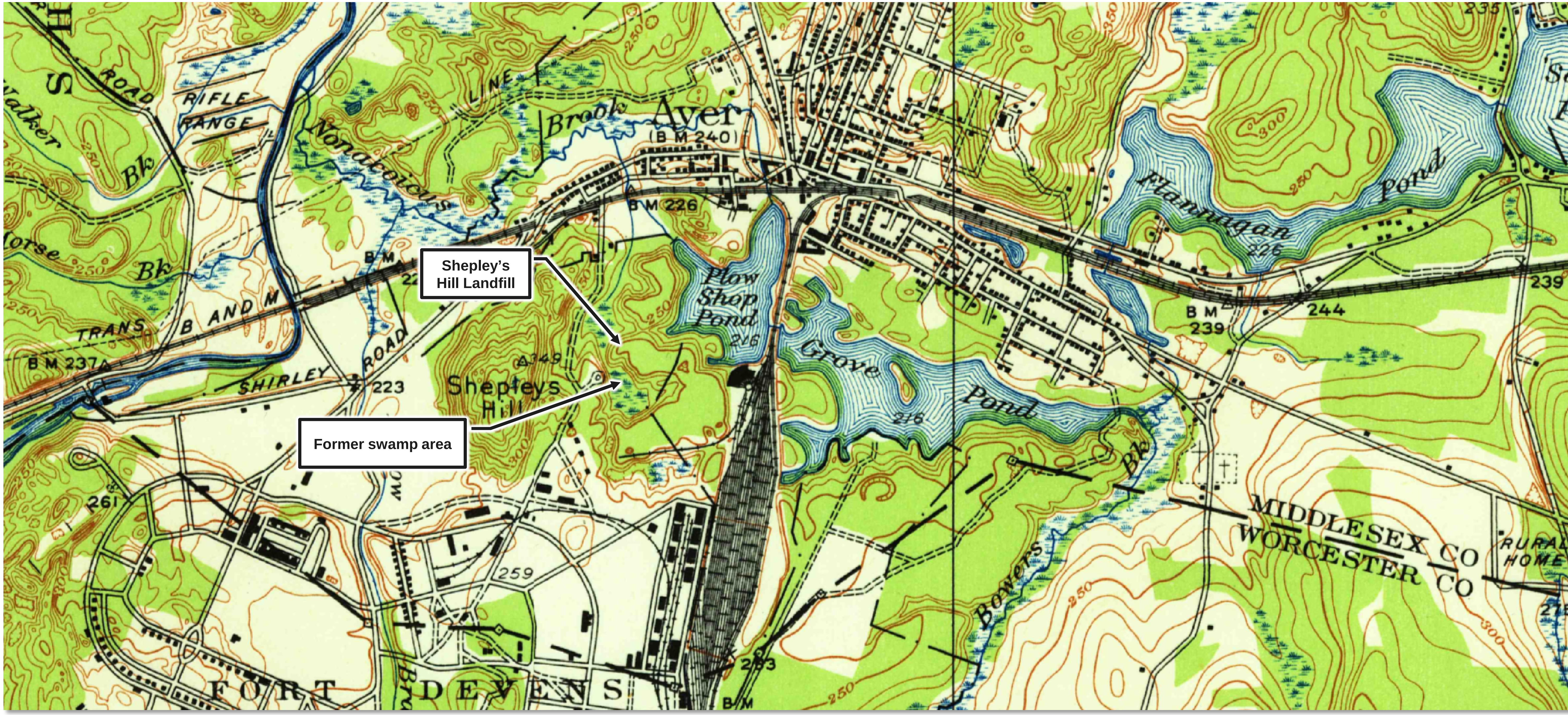
Notes

1. Map source: United States Department of the Interior U.S. Geological Survey 2021 Topographic Map of the Ayer Quadrangle, Massachusetts.
2. Scale is approximate.

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
FOCUSED FEASIBILITY STUDY REPORT

CURRENT TOPOGRAPHIC MAP

FIGURE
3A



0 1,125 ft

N

Notes

1. Map source: United States Department of the Interior Geological Survey 1939 Topographic Map of the Ayer Quadrangle, Massachusetts.
2. Scale is approximate.

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
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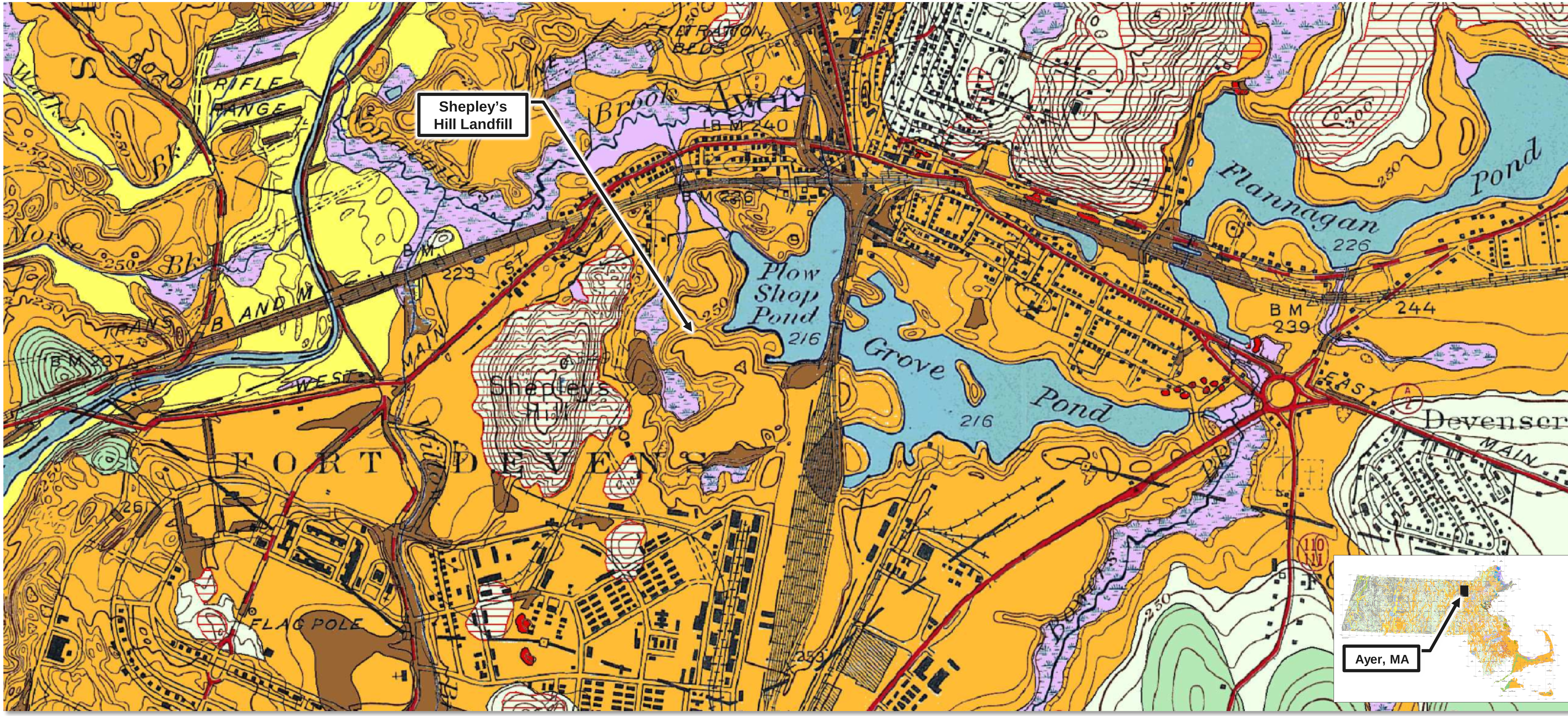
HISTORICAL TOPOGRAPHIC MAP

FIGURE
3B



0 1,130 feet

N

Notes

1. Map source: United States Department of the Interior, United States Geological Survey Surficial Materials Map of the Ayer Quadrangle, Massachusetts 2018.
2. Scale is approximate.

Legend

- Course Deposits
- Flood Plain Alluvium
- Thin Till / Thick Till
- Shallow Bedrock
- Artificial Fill
- Swamp Deposits

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
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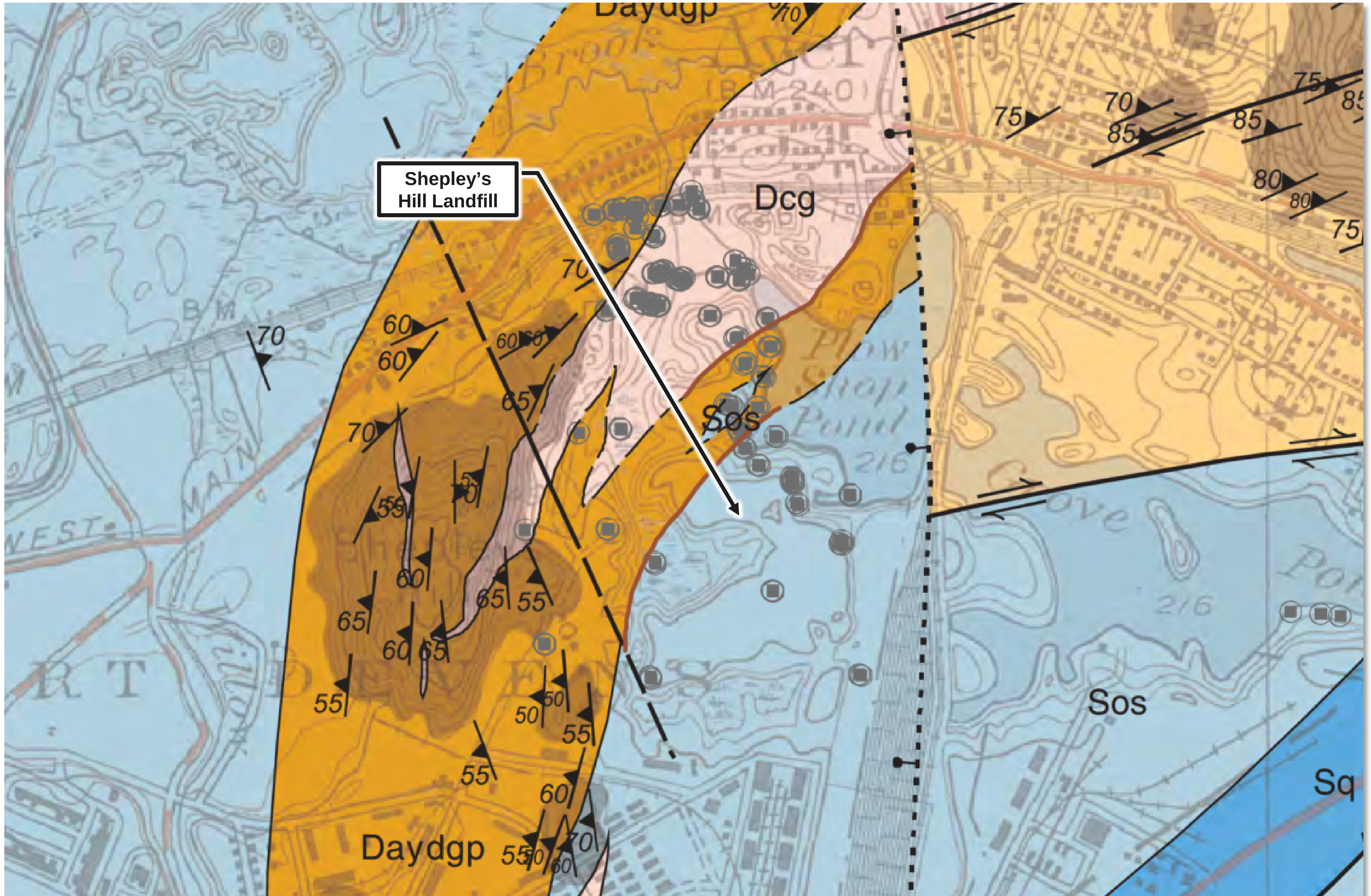
SURFICIAL MATERIALS MAP

FIGURE
4



EXPLANATION OF MAP SYMBOLS

map symbols adapted from the FDGC Digital Cartographic Standard for Geologic Map Symbolization (FDGC, 2006)

FAULTS

Solid where location certain, long dash where location approximate, short dash where location inferred.

Normal fault. All normal faults in quadrangle have brittle motion overprinting ductile fabrics. Teeth on downthrown side. Dotted where location inferred.

Right lateral shear zone / ductile fault as determined by mylonitic fabrics in outcrop.

Left lateral shear zone / ductile fault as determined by mylonitic fabrics in outcrop.

Early thrust fault. Teeth on overriding plate.

FOLDS

Axial trace of overturned synform

LITHOLOGIC CONTACTS

Solid where location certain, long dash where location approximate, dotted where location inferred.

Approximate location of Jurassic diabase dike via aeromagnetic data.

RELIABILITY

Areas of shallow bedrock and multiple outcrops (<10ft from surface)

Location of boring used to constrain lithology in vicinity of Shepley's Hill.

STRUCTURAL SYMBOLS

Strike and dip of inclined bedding.

Strike and dip of inclined foliation, generally parallel to compositional layering.

Strike and dip of compositional layering and parallel foliation in plutonic rocks, and bedding-parallel foliation in metasediments, where observed.

Trend and plunge of lineation

Trend and plunge of minor fold axis

0 1,000 feet

Notes

1. Map source: Massachusetts Geological Survey Bedrock Geologic Map of the Ayer 7.5' Quadrangle 2015.
2. Scale is approximate.

Legend

Dayd	Ayer granodiorite, Long Pond facies (early Devonian) - biotite granodiorite. Locally porphyritic.
Daydgp	Ayer granodiorite, Long Pond facies, porphyritic member (early Devonian) - biotite granodiorite with k-feldspar megacrysts up to 3 cm in diameter. Interpreted to be transitional phase between Long Pond and Clinton facies.
Dcg	Chelmsford granite (Devonian) - Biotite-muscovite granite
Sb	Berwick Formation (Silurian) - Biotite-garnet bearing thick-bedded calc-silicate rich granofels. Interpreted to be equivalent to Sg but at higher-metamorphic grade.

N

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
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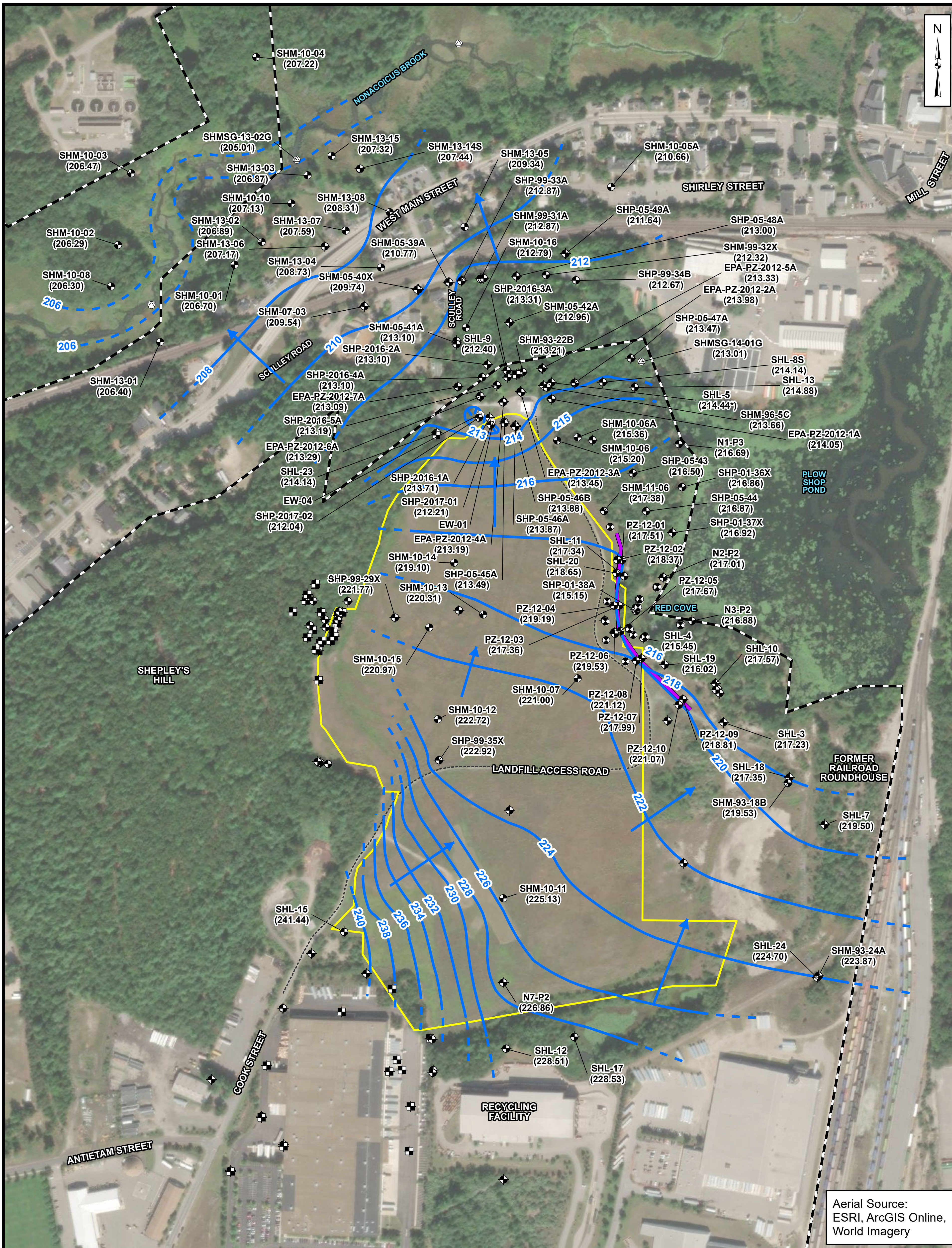
BEDROCK MAP

FIGURE
5



Legend

- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Monitoring Well
- Bedrock Monitoring Well
- Extraction Well
- Stream Gauge
- Barrier Wall
- Landfill Access Road
- Groundwater Contour (ft NAVD88) (Interval = 2 ft) (dashed where inferred)
- Groundwater Extraction Zone

Notes:
1. Well SHL-5 not used for contouring.
2. NAVD88 = North American Vertical Datum of 1988
3. 2-ft interval used for drafting contour lines, with the exception of near the EW-1 and EW-4 extraction well area (1-ft interval) 2021
4. ft = feet

0 200 400
Feet

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Study Report

Groundwater Elevation Contour Map - Fall 2021

Figure
6

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\Figure 6 - Groundwater Elevation Contour Map - Fall 2021.mxd User: ski01076 Date: 3/6/2023

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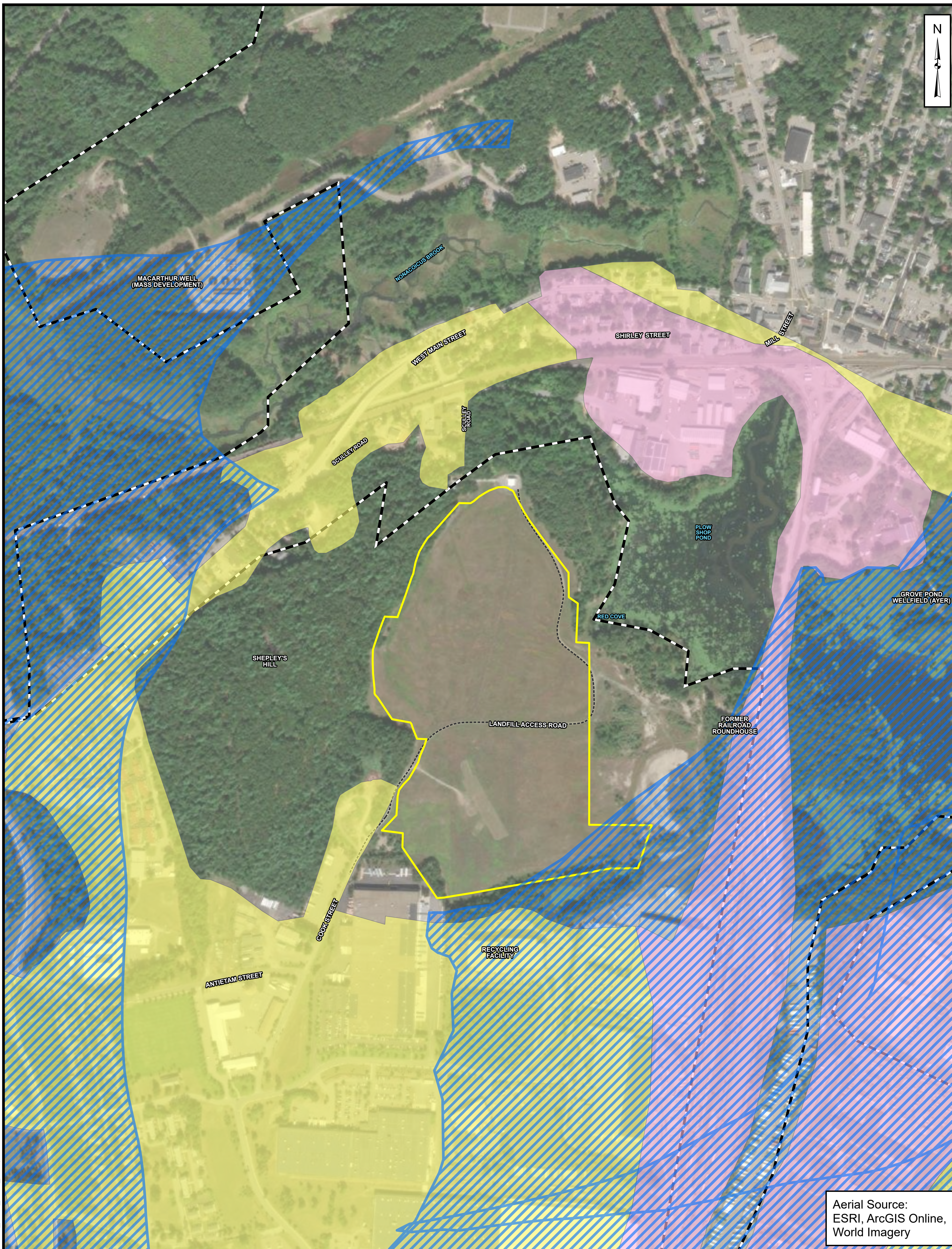

Legend
- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Landfill Access Road

Non Potential Drinking Water Source Areas
- High
- Medium

Wellhead Protection Areas
- Zone II

Notes:
1. A Zone II is that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation).
2. Non Potential Drinking Water Source Area and Wellhead Protection Area boundaries are provided by the MassGIS (Bureau of Geographic Information).

0 300 600
Feet

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Devens, Massachusetts
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Groundwater Classification

Figure
7

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\SHL_MAR_2023_V1.aprx User : vmn1306 Date: 3/7/2023

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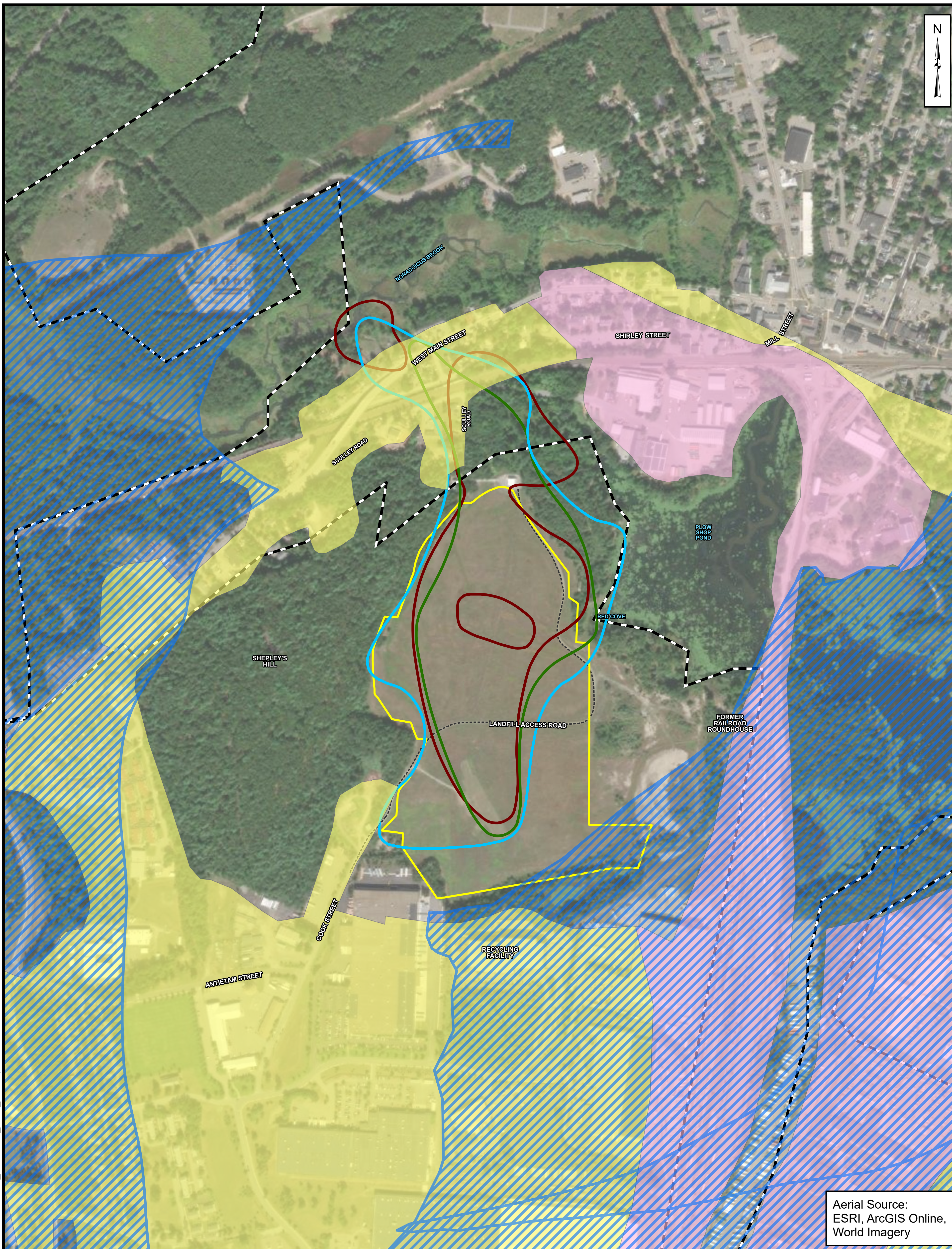

Legend

- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Interpreted Area of Arsenic > CL of 10 µg/L
- Interpreted Area of Iron > CL of 9,100 µg/L
- Interpreted Area of Manganese > CL of 1,715 µg/L
- Landfill Access Road

Non Potential Drinking Water Source Areas

- High
- Medium

Wellhead Protection Areas

- Zone II

Notes:
1. A Zone II is that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation).
2. Non Potential Drinking Water Source Area and Wellhead Protection Area boundaries are provided by the MassGIS (Bureau of Geographic Information).
3. µg/L = microgram per liter
4. > = greater than
5. CL = cleanup level

0 300 600
Feet

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
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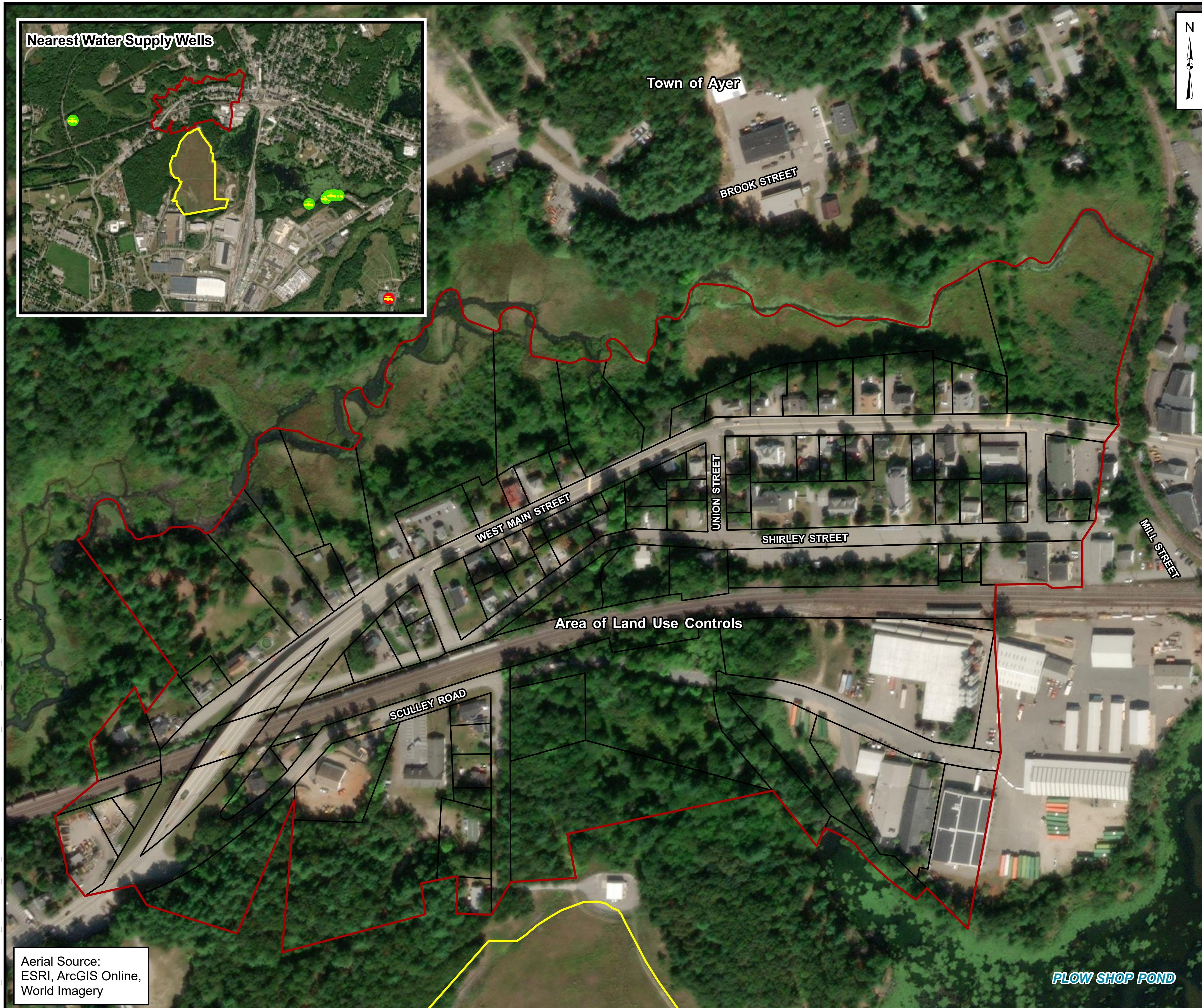
Groundwater Classification and Extent of Dissolved Metals in Groundwater

Figure
8

Document Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\SHL_MAR_2023.aprx

File: SHL_MAR_2023.mxd



Legend

- Shepley's Hill Landfill Boundary
- Area of Land Use Controls
- Property Boundary
- Community Groundwater Source
- Non-Community Groundwater Source

Parcel Source: Level 3 Assessors' Parcel Mapping

Public Water Supply Source: Massachusetts Department of Environmental Protection

0 200 400

Feet

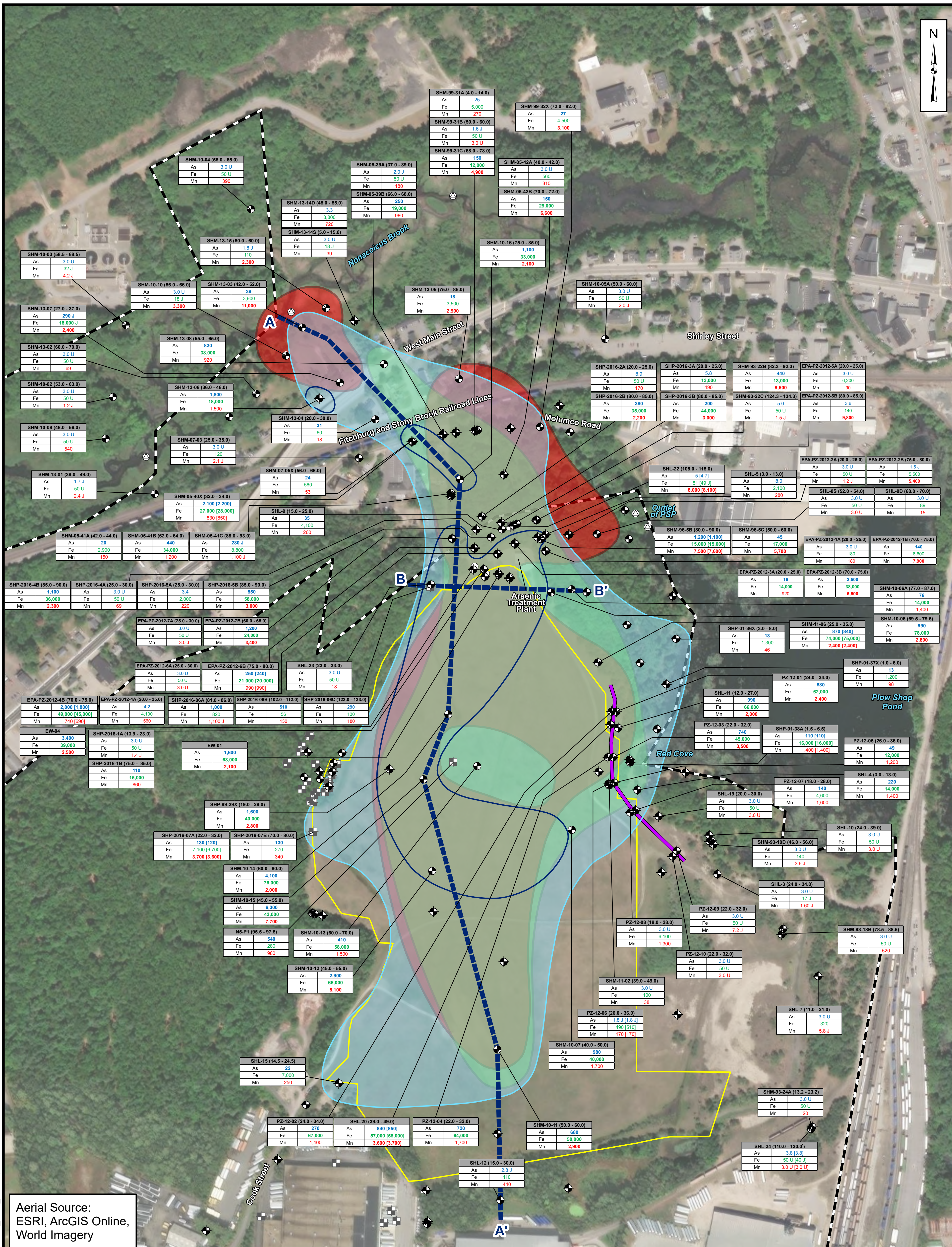
Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Study Report

Area of LUCs from 2021 Annual Report

Figure 9

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\SHL_MAR_2023_V1.aprx User : vmn1306 Date: 3/9/2023

File: SHL_MAR_2023_V1.mxd



Legend

- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Bedrock Monitoring Well
- Extraction Well
- Stream Gauge
- Barrier Wall
- Interpreted Area of Arsenic >10 ug/L
- Interpreted Area of Arsenic > 1,000 µg/L
- Interpreted Area of Arsenic > CL of 10 µg/L
- Interpreted Area of Iron > CL of 9,100 µg/L
- Interpreted Area of Manganese > CL of 1,715 µg/L
- Cross-Section Location

Notes:
1. All concentrations are in µg/L
2. As = arsenic
3. Fe = iron
4. Mn = manganese
5. J = Estimated result
6. U = Analyte was below detection limit
7. As concentrations are presented in blue
8. Fe concentrations are presented in green
9. Mn concentrations are presented in red
10. Duplicate results are presented in brackets following the sample results
11. **Bold** values indicate an exceedance of the CLs
12. µg/L = micrograms per liter
13. CL = Cleanup Level
14. > = greater than

0 200 400
Feet

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Former Fort Devens Army Installation
Devens, Massachusetts
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Extent of Dissolved Metals in Groundwater October/November 2021

Figure
10

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2024\SHL_MAR_2024.aprx User: msi01059 Date: 3/14/2024

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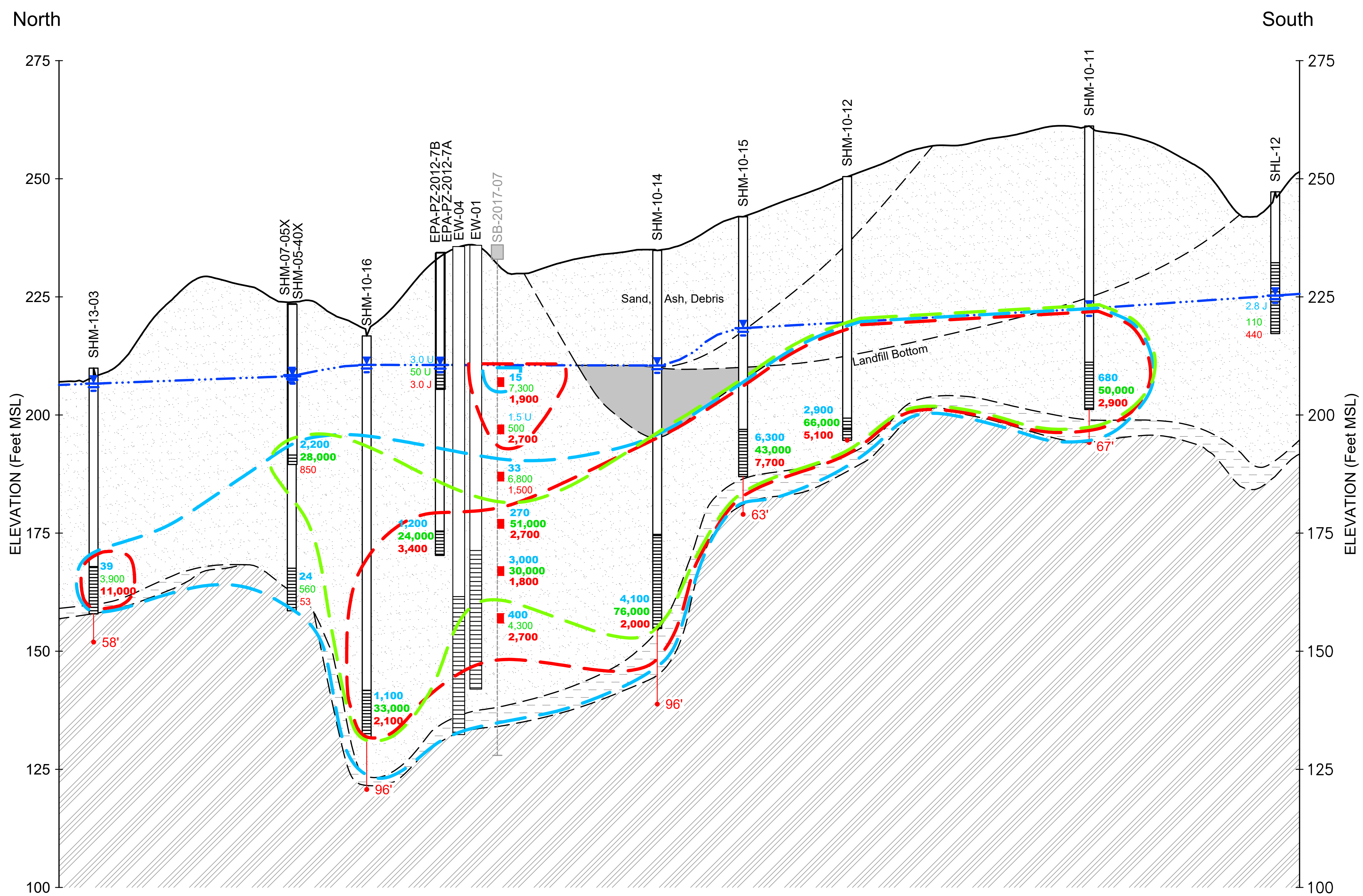

Legend

- EPA-PZ-2012-7A — Monitoring Well
  - **430** Arsenic Concentration (µg/L)
  - **47,000** Iron Concentration (µg/L)
  - **1,900** Manganese Concentration (µg/L)
  - U, J = Laboratory Qualifiers
  - Results shown for monitoring wells are from October/November 2021 or most recent sampling event for that well as specified.
- Well Casing
- Screened Interval
- 90' Depth to Bottom of Boring (feet)
- SB-16-09 — 2017 Soil Boring
  - **430** Arsenic Concentration (µg/L)
  - **47,000** Iron Concentration (µg/L)
  - **1,900** Manganese Concentration (µg/L)
  - U, J = Laboratory Qualifiers
- Sample Interval (1 Foot)
- Boring to Refusal
- Interpreted Area of Arsenic > CL of 10 µg/L
- Interpreted Area of Iron > CL of 9,100 µg/L
- Interpreted Area of Manganese > CL of 1,715 µg/L
- Water Table Elevations for Monitoring Wells are from October 2021 Well Hydraulic Gauging Event
- Sand
- Peat
- Till
- Bedrock

Notes:

1. MSL = mean seal level
2. µg/L = microgram per liter
3. J = Estimated result 2023
4. U = Analyte was below detection limit
5. CL = cleanup levels
6. > = greater than
5. **Bold** values indicate an exceedance of the CLs
8. Cross sections and data included in the August 2011 Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-Term Monitoring anda Maintenance - Addendum Report by Sovereign Consulting, Inc. were referenced in development of this cross section.
9. Geologic and depth to bottom information shown for SB-2017-07 is based on notes during installation of SB-16-07.
10. Depth to bottom of boring not available for SHM-05-40X, SHM-07-05X, EPA-PZ-2012-7A, EPA-PZ-2012-7B, and SHL-12.

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Report

DISSOLVED METALS IN GROUNDWATER - NORTH TO SOUTH CROSS SECTION

Figure
11

CITY: SYRACUSE, NY DIV/GROUP: IMDV DB: M.WASILEWSKI K.DAVIS R.ALLEN LD: M.WASILEWSKI PIC: K.ABBOTT PM: J.GRAVENMIER TM: A.BAIRD LYR: ON=*;OFF=*REF*
C:\Users\cd\0112\ACCDocs\Arcadis\AUS-USACE-FORT DEVENS-SHEPLEY'S HILL-DEVENS Massachusetts\Project Files\2023\01-In Progress\01-DWG\GEN-F11-CROSS SECTION.dwg LAYOUT: 11 SAVED: 3/9/2023 12:02 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
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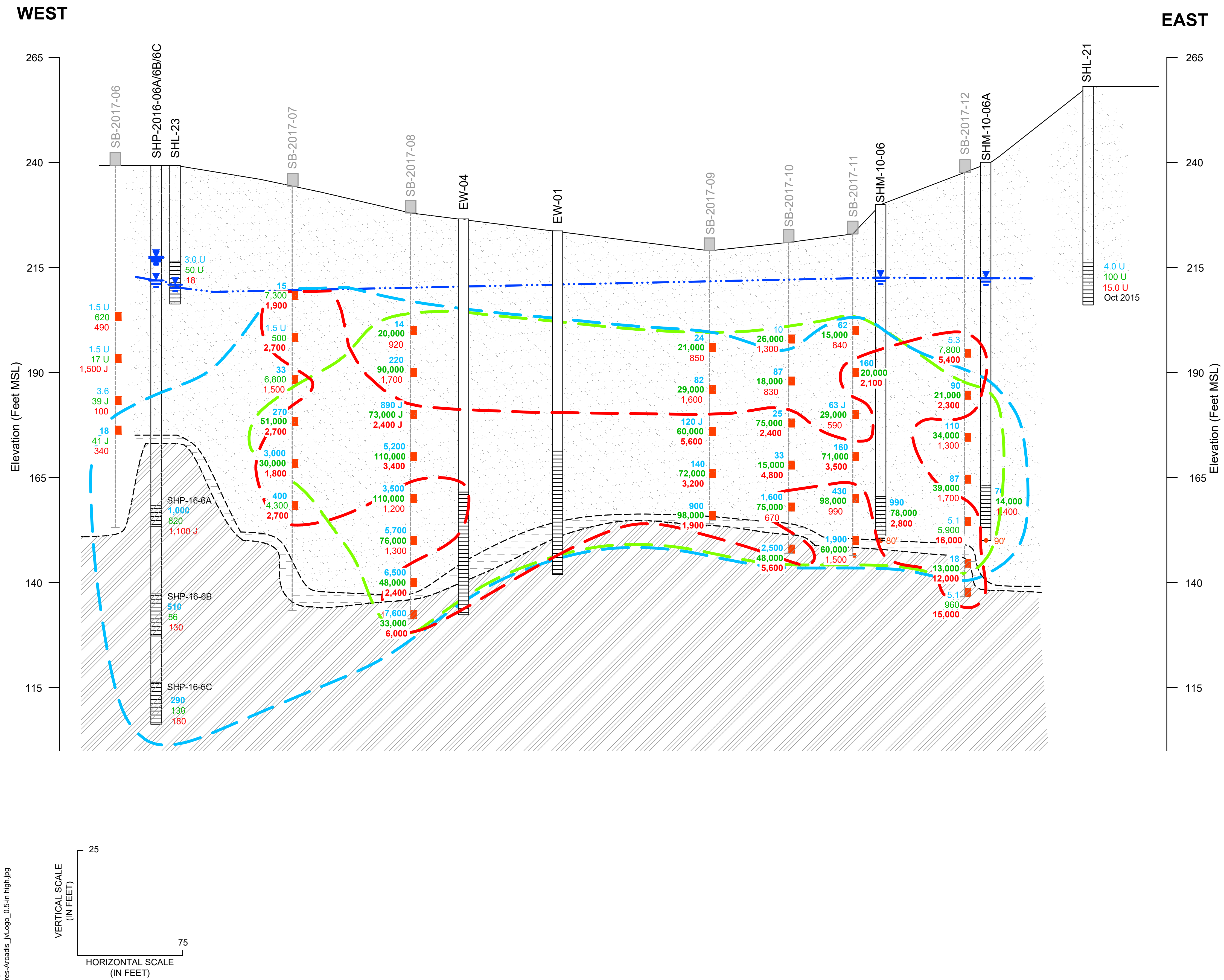


Legend

Monitoring Well

- 4.0 U Arsenic Concentration (µg/L)
- 100 U Iron Concentration (µg/L)
- 15.0 U Manganese Concentration (µg/L)
- U, J = Laboratory Qualifiers

Results shown for monitoring wells are from October/November 2021 or most recent sampling event for that well as specified.

Well Casing

Screened Interval

90' Depth to Refusal (feet)

2017 Soil Boring

- 25 Arsenic Concentration (µg/L)
- 75,000 Iron Concentration (µg/L)
- 2,400 Manganese Concentration (µg/L)
- U, J = Laboratory Qualifiers

Sample Interval (1 Foot)

Boring to Refusal

Interpreted Area of Arsenic > CL of 10 µg/L

Interpreted Area of Iron > CL of 9,100 µg/L

Interpreted Area of Manganese > CL of 1,715 µg/L

Water Table Elevations for Monitoring Wells are from October 2021 Well Hydraulic Gauging Event

Sand

Bedrock

Till

Notes:

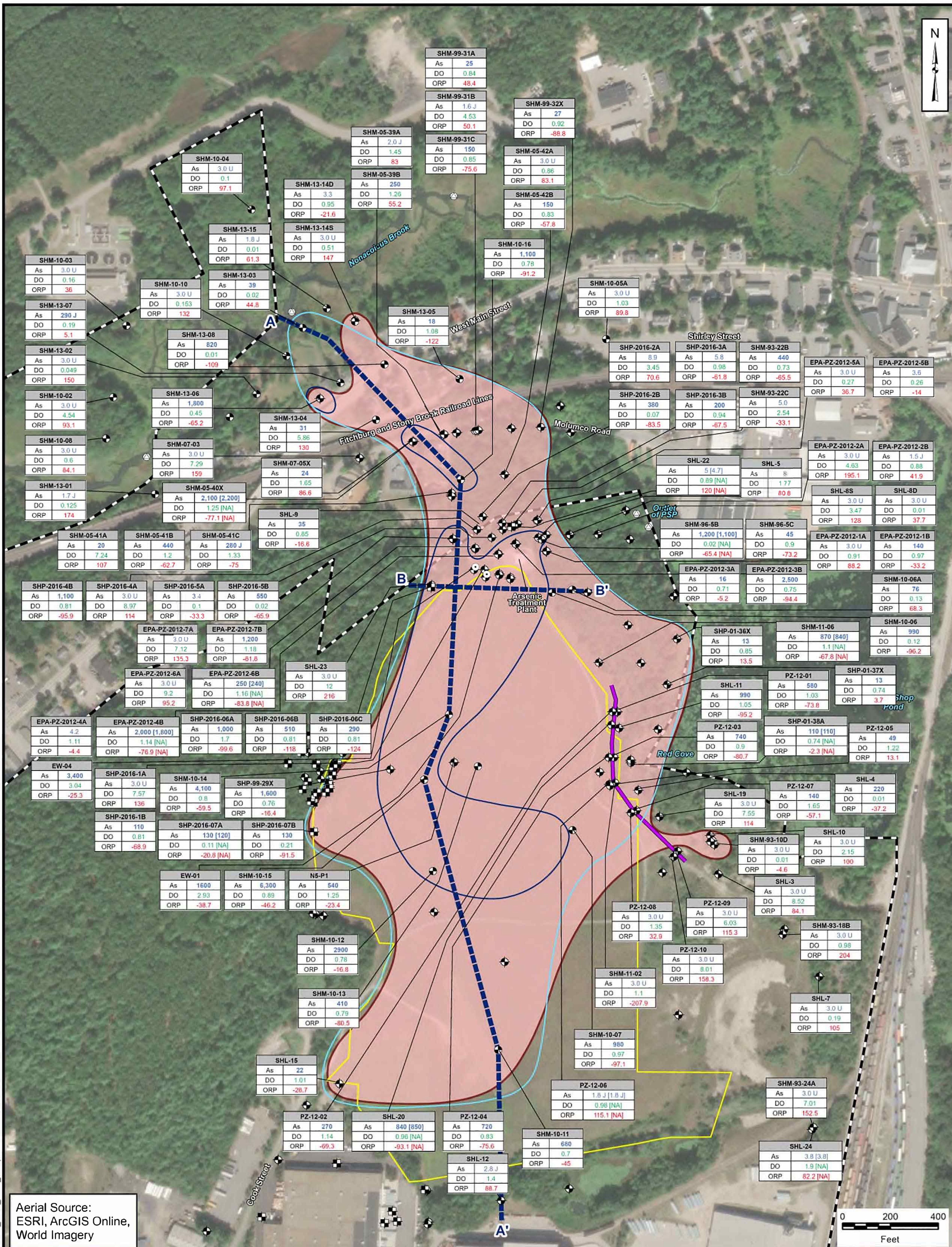
1. MSL = mean seal level
2. µg/L = microgram per liter
3. J = Estimated result 2023
4. U = Analyte was below detection limit
5. CL = cleanup levels
6. > = greater than
7. **Bold** values indicate an exceedance of the CLs
8. Depth to bottom of boring not available for SHL-21 and SHL-23.
9. Strata data shown on Figure 5-8 of the September 2020 Area 2 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation by KOMAN Government Solutions, LLC were used to develop this figure.

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Report

DISSOLVED METALS IN GROUNDWATER - WEST TO EAST CROSS SECTION

Figure

12



Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\SHL_MAR_2023_V1.aprx User: vmn1306 Date: 3/9/2023

Legend
- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Bedrock Monitoring Well
- Extraction Well
- Stream Gauge
- Barrier Wall
- Interpreted Area of Arsenic >10 ug/L
- Interpreted Area of Arsenic > 1,000 µg/L
- Interpreted Area of Arsenic > CL of 10 µg/L
- Interpretated Area of ORP <0 mV
- Cross-Section Location

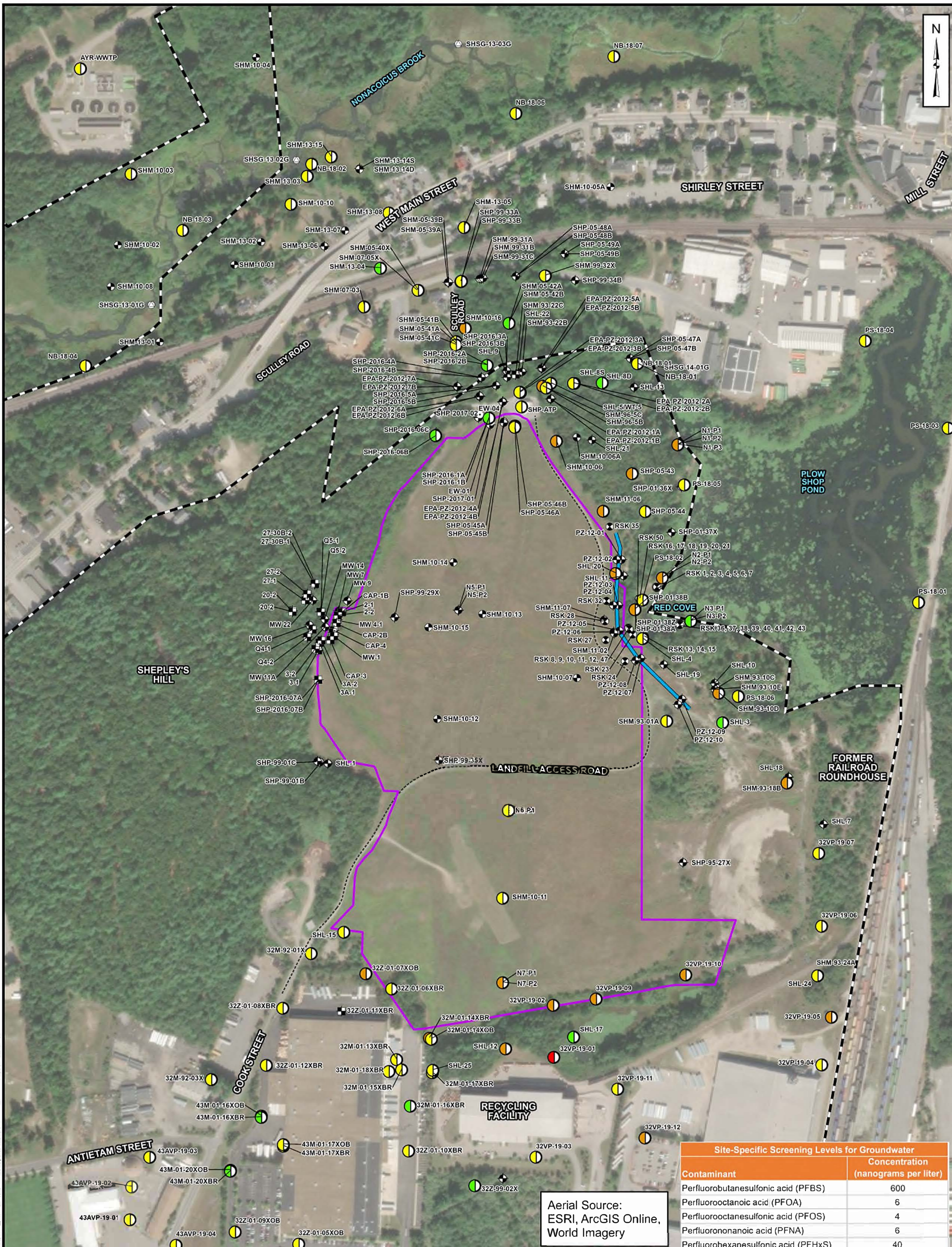
Notes:
1. As = Arsenic.
2. DO = Dissolved Oxygen.
3. ORP = Oxidation Reduction Potential.
4. Arsenic concentration are in micrograms per liter (µg/L).
5. DO concentrations are in milligrams per liter (mg/L).
6. ORP concentrations are in millivolts (mV).
7. J = Estimated result.
8. U = Analyte was below detection limit.
9. As concentrations are presented in blue.
10. DO concentrations are presented in green.
11. ORP concentrations are presented in red.
12. Duplicate results are presented in brackets following the sample results.
13. **Bold** values indicate an exceedance of the Cleanup Levels (CLs).
14. > = greater than
15. PFAS = per- and polyfluoroalkyl substances
16. SSSL = site-specific screening level
17. ng/L = nanograms per liter

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Study Report

Overview of the Redox State of the Aquifer at Shepley's Hill Landfill October/November 2021

Figure
13

File: SHL_MAR_2023_V1.mxd



Site-Specific Screening Levels for Groundwater	
Contaminant	Concentration (nanograms per liter)
Perfluorobutanesulfonic acid (PFBS)	600
Perfluorooctanoic acid (PFOA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorononanoic acid (PFNA)	6
Perfluorohexanesulfonic acid (PFHxS)	40

Legend

- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Overburden Monitoring Well/Piezometer
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- Extraction Well
- Stream Gauge
- Barrier Wall
- Landfill Access Road

PFAS Results in Groundwater

- < SSSLs
- > SSSLs
- > 10X SSSLs
- > 100X SSSLs

Notes :
< = less than
> = greater than
PFAS = per- and polyfluoroalkyl substances

0 200 400
Feet

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Study Report

PFAS Detections

Figure
14

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2023\SHL_MAR_2023_V1.aprx User: vmn1306 Date: 3/9/2023

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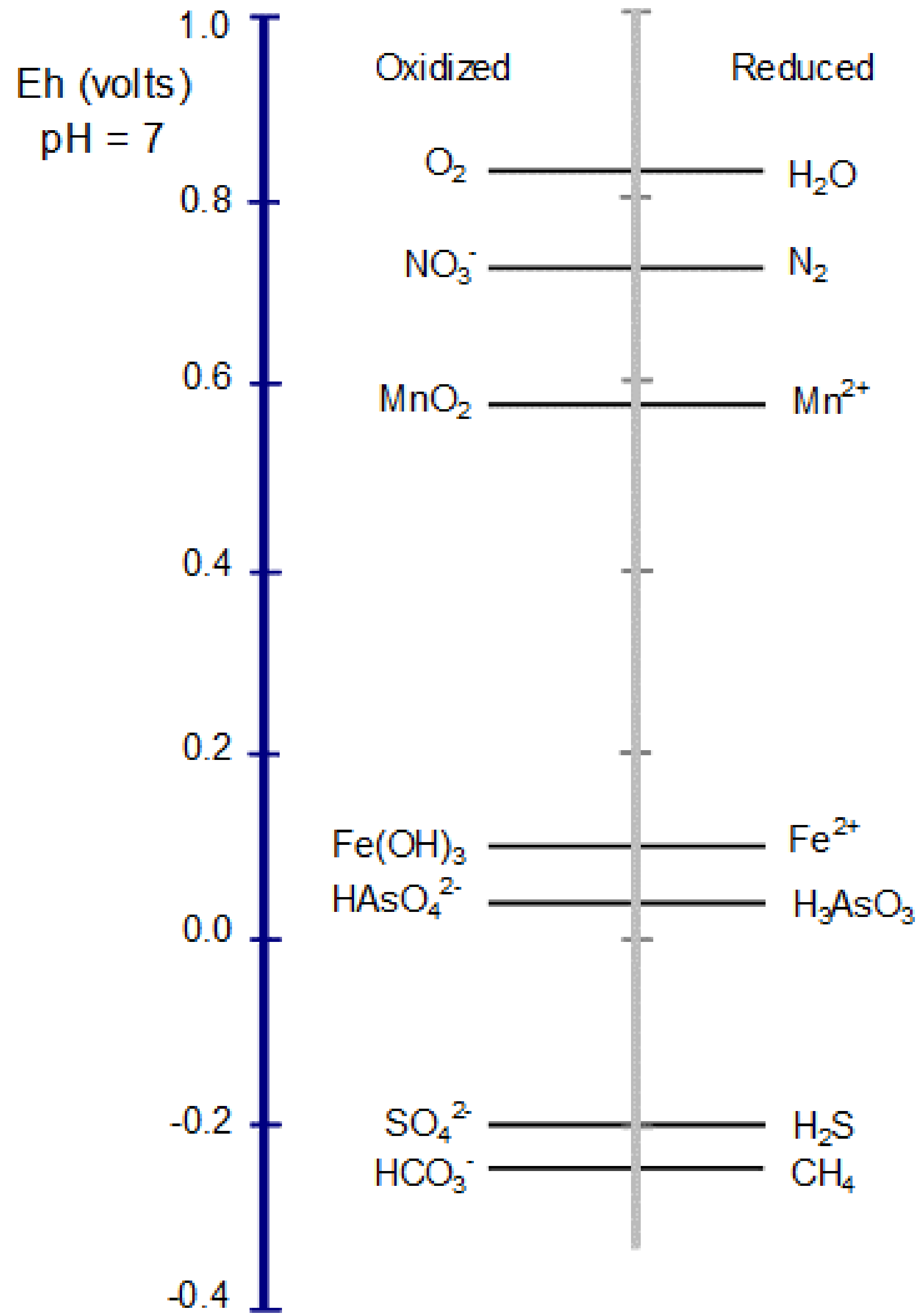

SHEPLEY'S HILL LANDFILL
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DEVENS, MASSACHUSETTS
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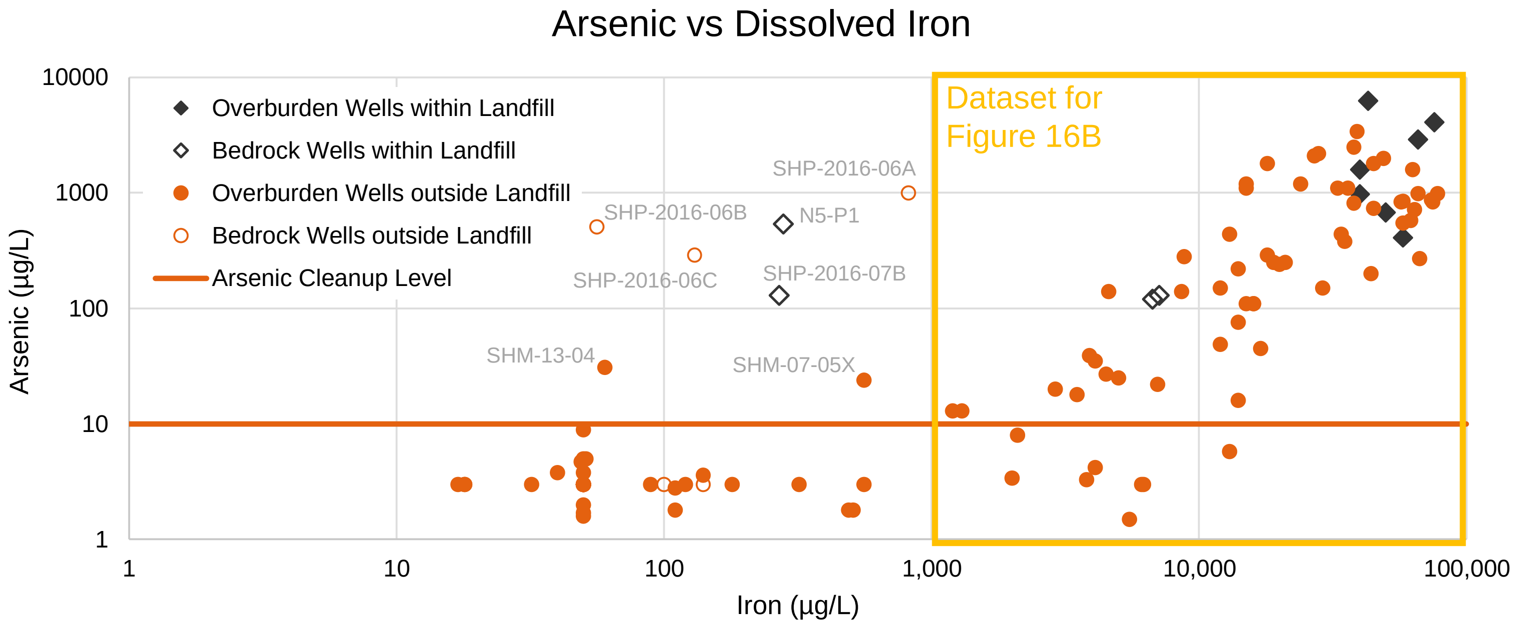
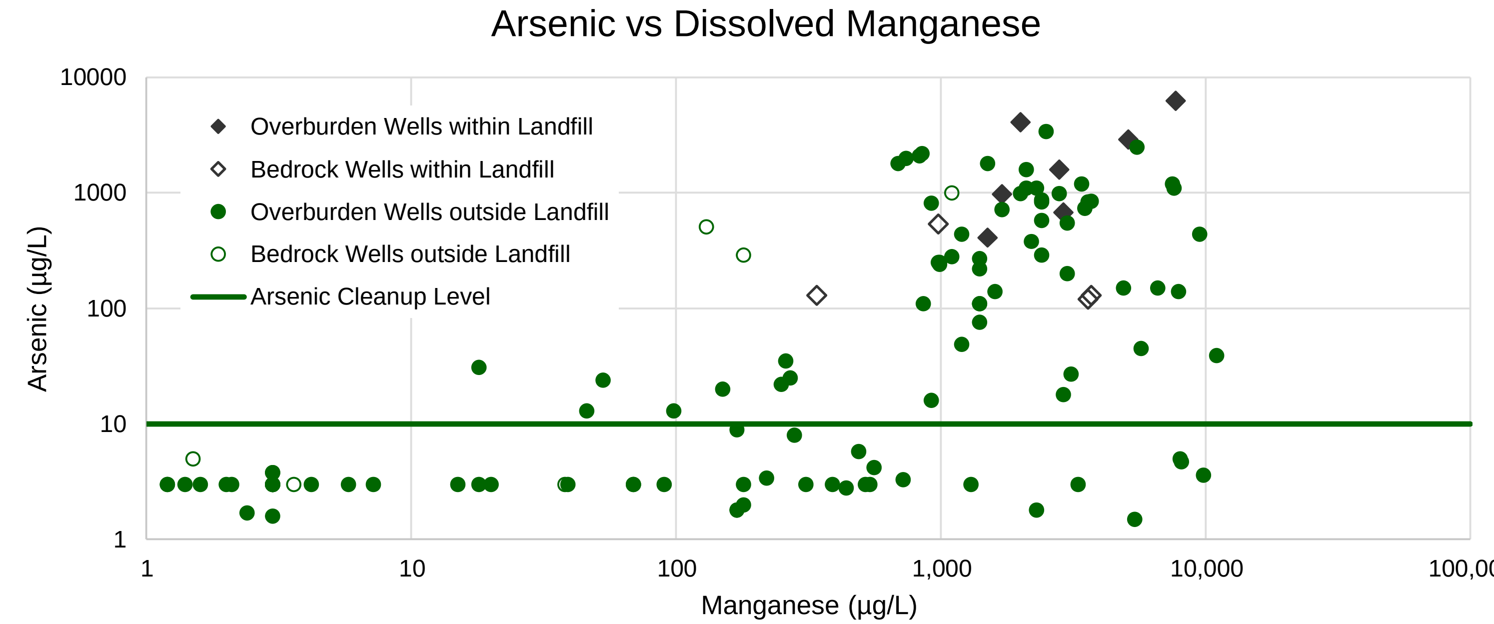
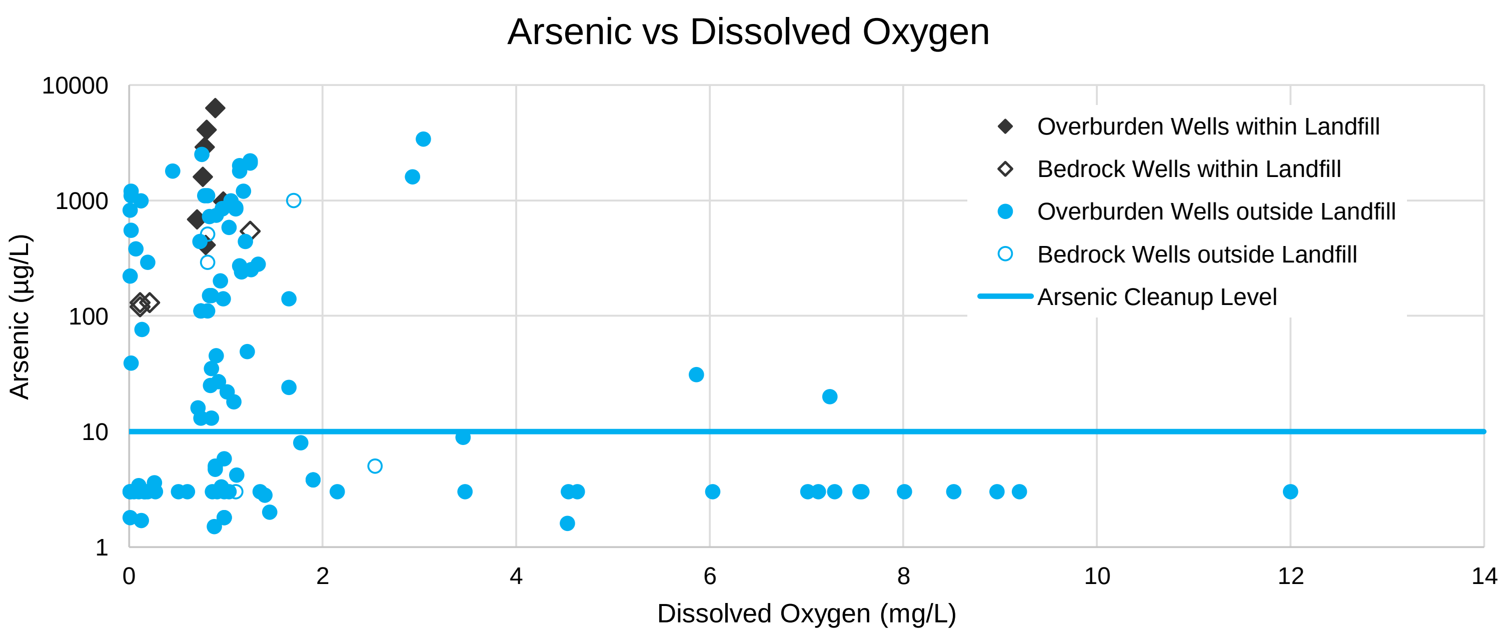
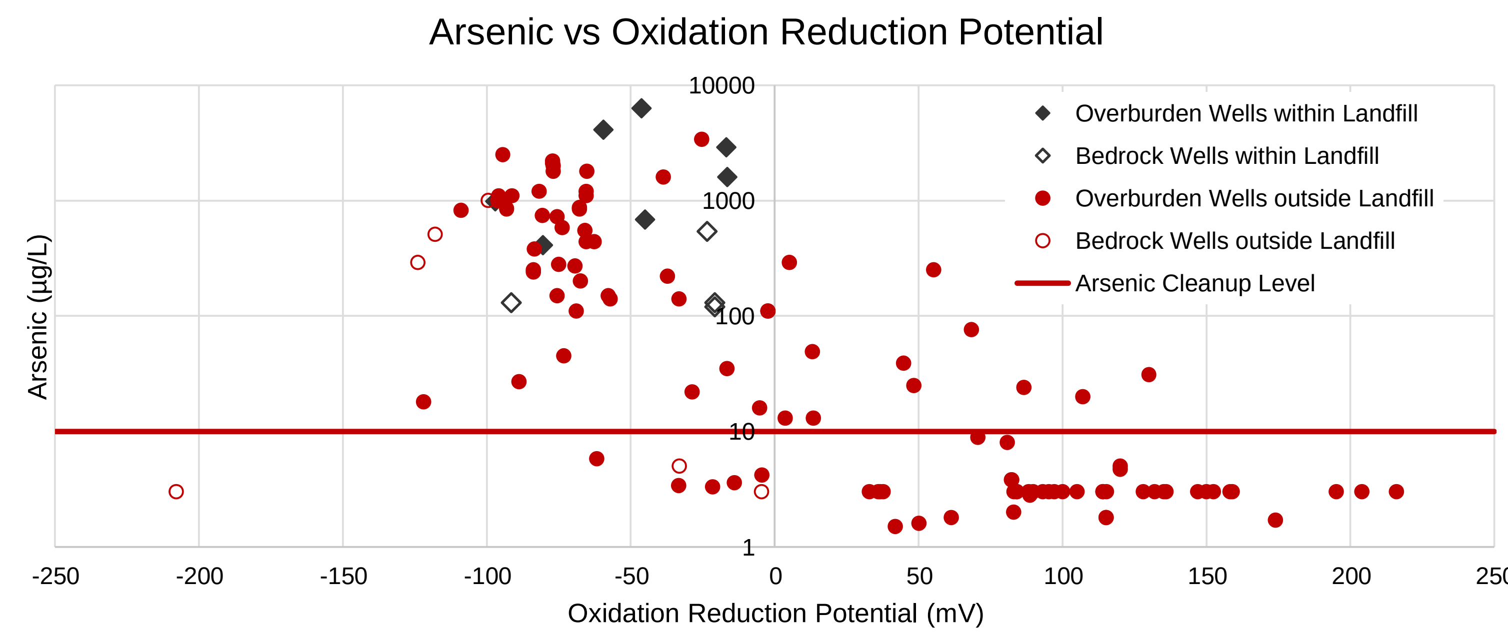
REDOX LADDER

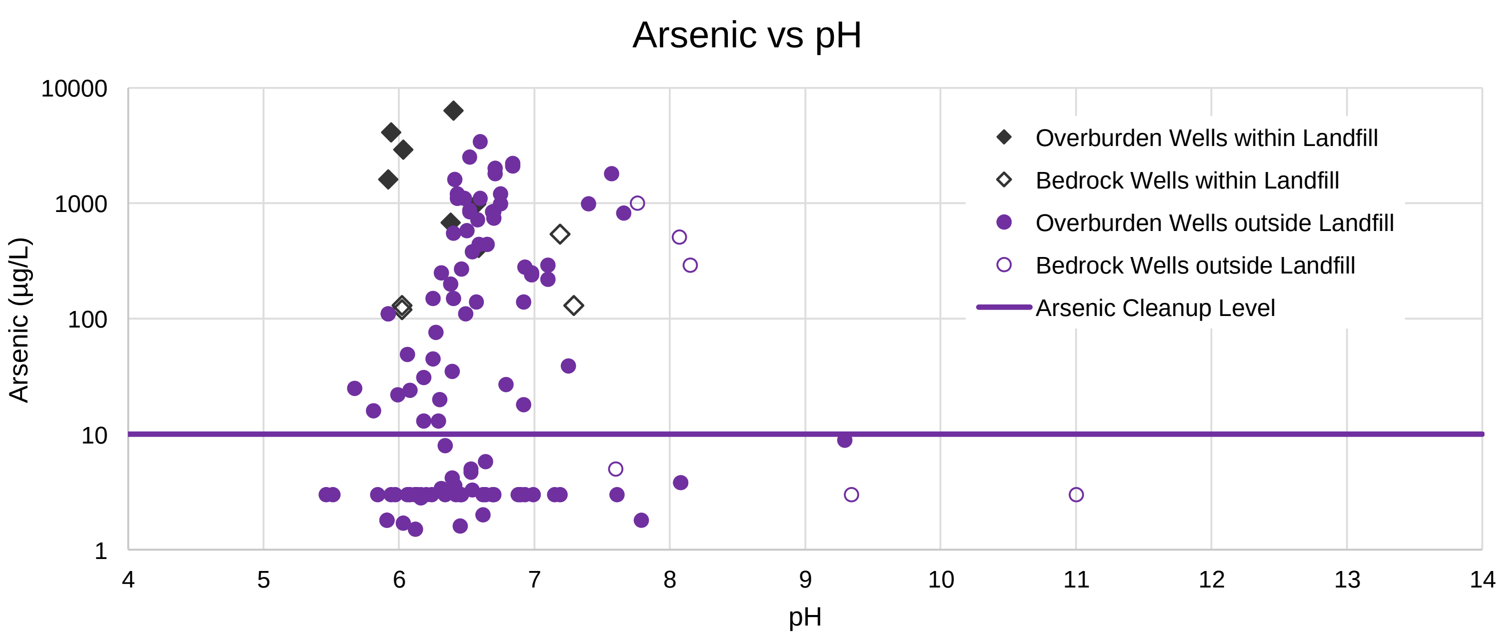
FIGURE
15











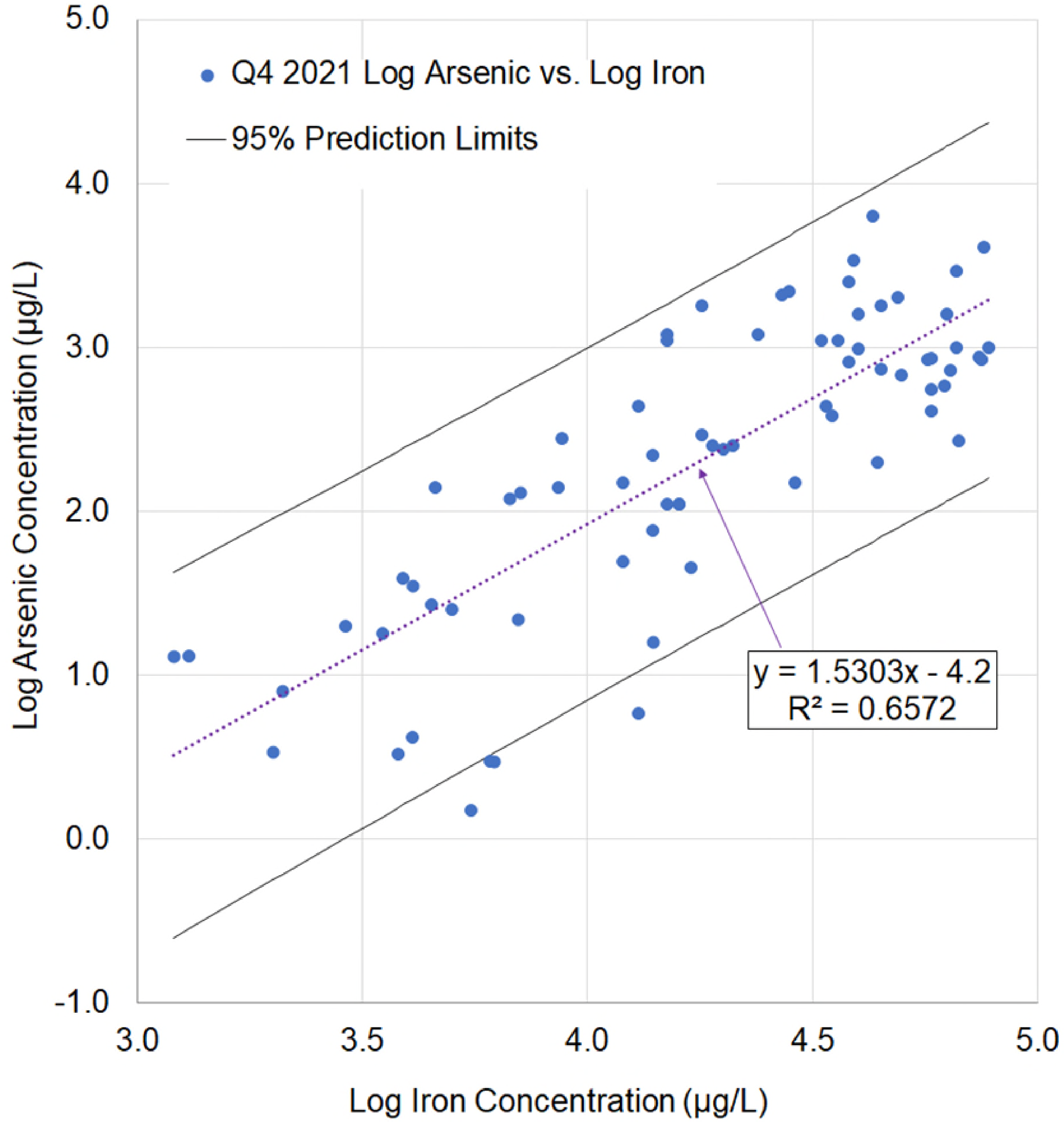
Acronyms and Abbreviations:
µg/L = microgram per liter
mg/L = milligram per liter
mV = millivolt

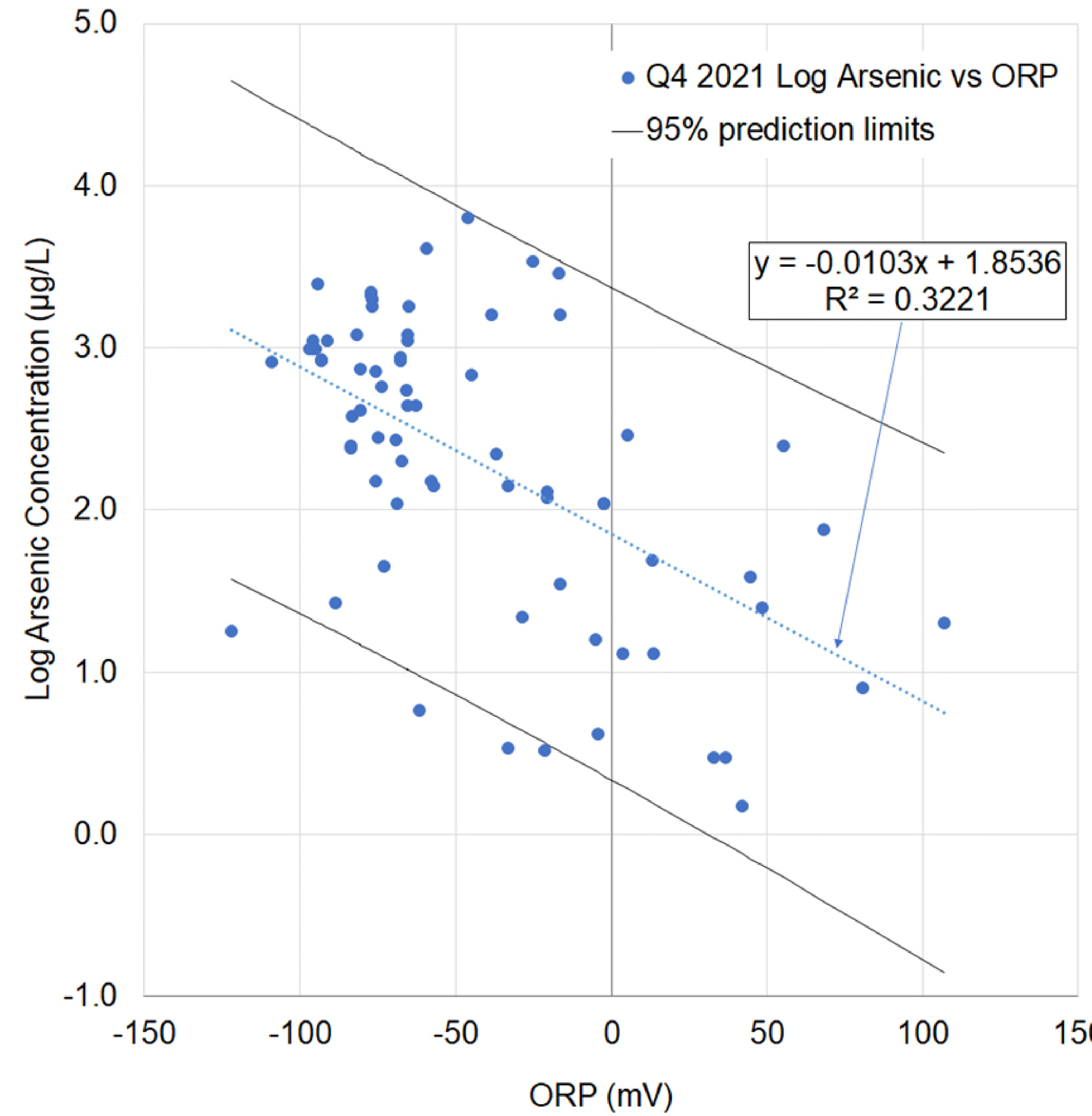
Note:
Data include Shepley's Hill Landfill overburden and bedrock monitoring well data collected in 2021.

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
FOCUSED FEASIBILITY STUDY REPORT

ARSENIC COMPARISON WITH REDOX SENSITIVE CONSTITUENTS

FIGURE
16a





Acronyms and Abbreviations:
µg/L = microgram per liter
mV = millivolt

Note:
Data include Shepley's Hill Landfill overburden and bedrock monitoring well data collected in 2021.

SHEPLEY'S HILL LANDFILL
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DEVENS, MASSACHUSETTS
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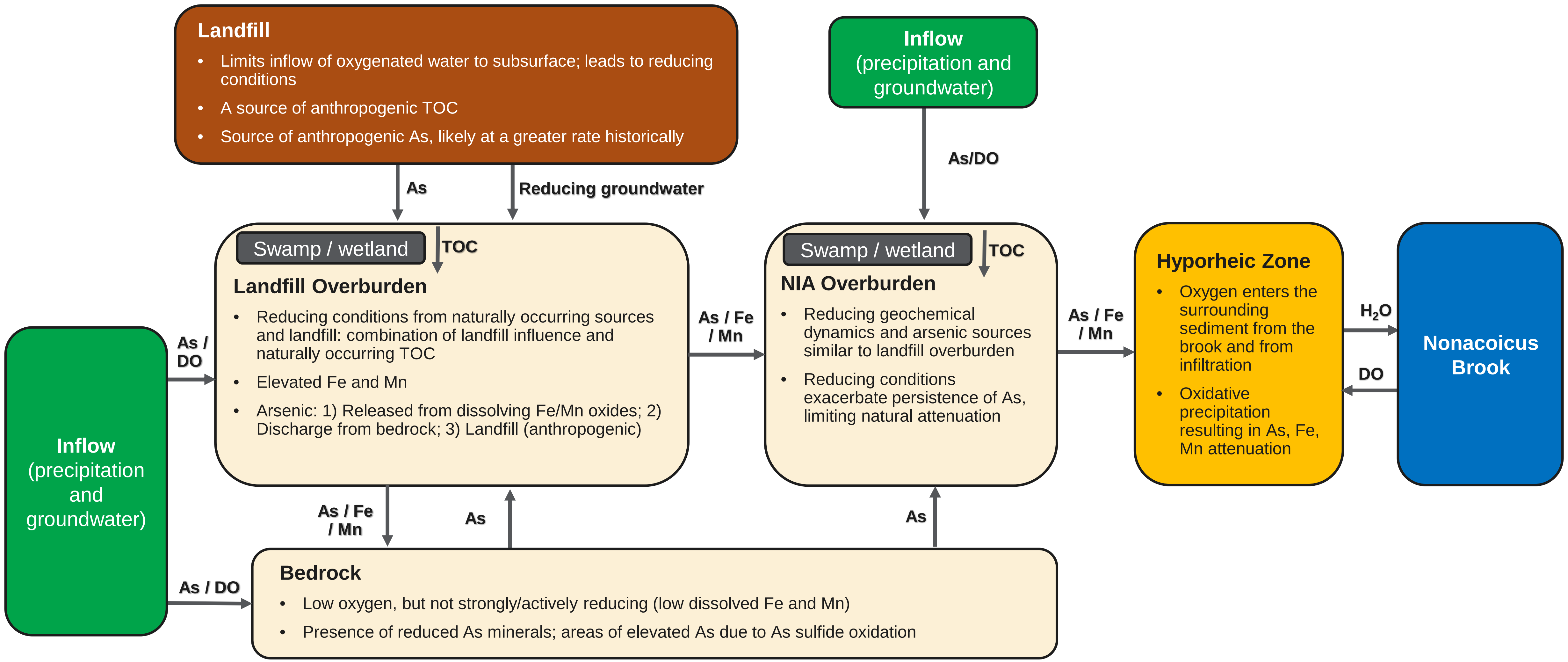
ARSENIC COMPARISON WITH IRON AND ORP: TRENDLINE AND CONFIDENCE INTERVALS

FIGURE
16b



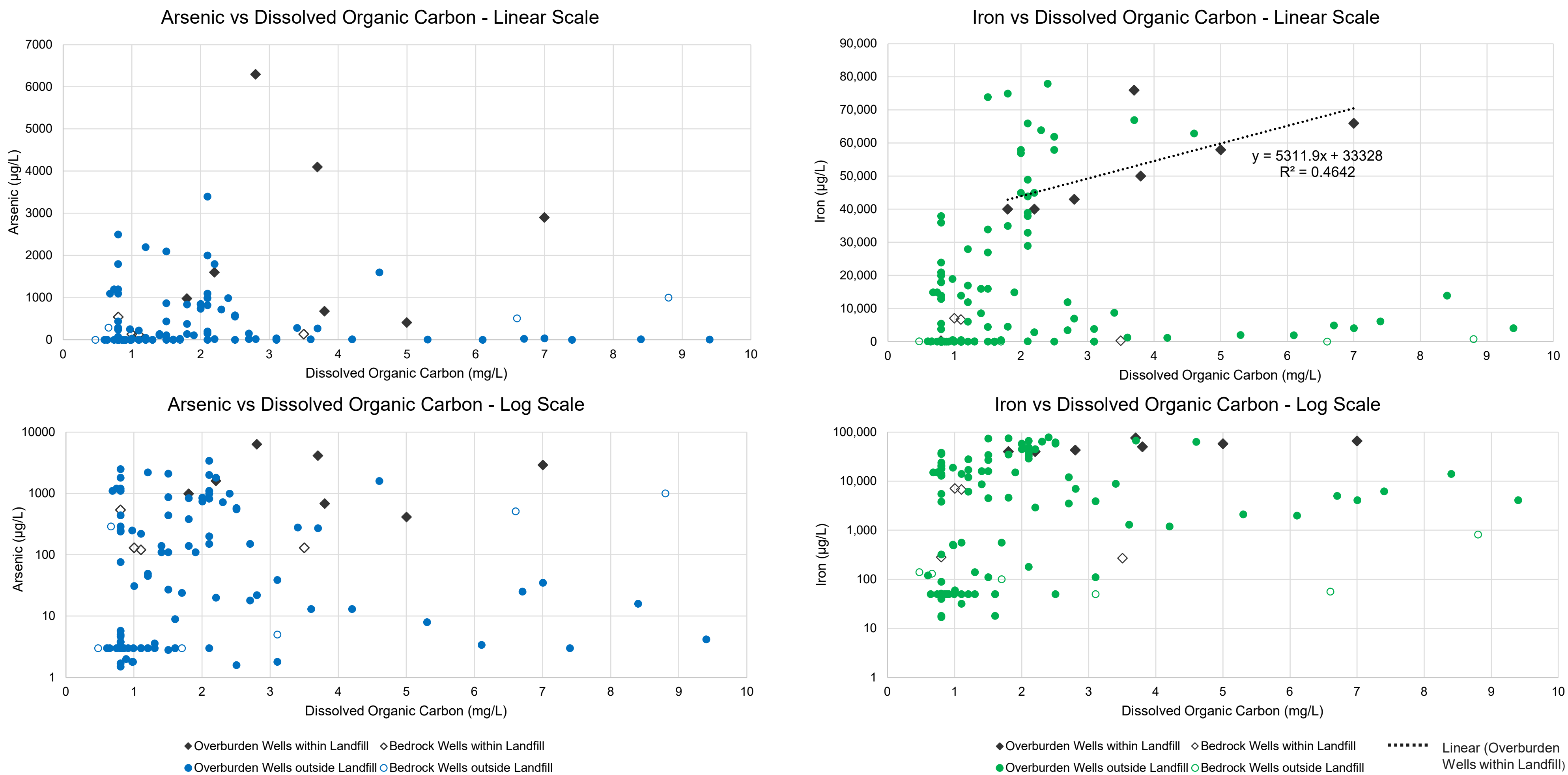
Acronyms and Abbreviations:

As = arsenic
DO = dissolved oxygen
Fe = iron
H_2O = water
Mn = manganese
NIA = North Impact Area
TOC = total organic carbon

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
FOCUSED FEASIBILITY STUDY REPORT

GEOCHEMICAL MECHANISMS

FIGURE
17



Acronyms and Abbreviations:
µg/L = microgram per liter
mg/L = milligram per liter

Note:
Data include Shepley's Hill Landfill overburden and bedrock monitoring well data collected in 2021.

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
FOCUSED FEASIBILITY STUDY REPORT

IRON AND ARSENIC COMPARISON WITH DISSOLVED ORGANIC CARBON

FIGURE
18

Appendix A

United States Environmental Protection Agency Scope of Work

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

February 24, 2016

William J. O'Donnell, II, Chief Reserve
Department of the Army Industrial and Medical Branch
Assistant Chief of Staff for Installation Management (DAIM-ODB)
600 Army Pentagon
Washington, D.C., 20310-0600

Re: Former Fort Devens Installation – Dispute Resolution
2015 Devens Five Year Review (FYR) Report

Dear Mr. O'Donnell:

The purpose of this letter is to follow up on a conversation between Lynne Jennings and William Walsh-Rogalski of the U.S. Environmental Protection Agency (EPA) and Andrew Van Dyke and David Minvielle of the Department of Army (Army) on February 4, 2015 regarding the Former Fort Devens Installation (Devens). During that call, EPA committed to providing the Army with a Scope of Work (SOW) for the Additional Work necessary to determine whether the remedy at the Shepley's Hill Landfill (SHL) is protective of human health and environment over the long term and to satisfy the requirements of a Five Year Review (FYR) under CERCLA, the National Contingency Plan (NCP) and relevant guidance.

As you know, on July 20, 2015, pursuant to the Federal Facilities Agreement (FFA) between the Army and EPA Region 1 for the Fort Devens Installation (Devens), the Army issued its draft, fourth Comprehensive FYR report. Subsequently, on September 9, 2015, EPA issued comments on the draft FYR report, identifying a significant number of deficiencies and data gaps that needed to be addressed before issuance of a final report. Recognizing that the issues raised by EPA could not be resolved before the relevant deadline, on September 22, 2015, EPA concurred with Army findings regarding short term protectiveness of some remedies, but deferred any decisions regarding long term protectiveness of other remedies addressed in the draft FYR report until the issues, recommendations and requirements set out in the September 22 EPA letter were addressed. Despite our request to resolve the remaining issues, recommendations and requirements, the Army moved forward on September 30, 2015 and issued its final FYR report. As a result of the number of unresolved issues and the need for additional work, EPA invoked the dispute resolution provision of the FFA on November 3 2015.

Consistent with Paragraph 19.3 of the FFA, on November 11, 2015, EPA supplemented its November 3, 2015 letter with an outline of Additional Work including specific data and analyses that were not addressed in the Army's FYR report regarding the SHL remedy. On the following day, EPA and Army conversed as the preliminary step in the dispute resolution process.

Subsequently, on December 4, 2015, the Army wrote to EPA stating that it did not intend to conduct a significant portion of the Additional Work.

In response, on December 31, 2015, EPA sent an email to the Army condensing the Additional Work into eight key issues and recommendations. The parties held conference calls on January 12, 2016, January 19, 2016, January 26, 2016 and February 4, 2016 and exchanged additional information on the issues. During the call on February 4, 2016, the Army indicated a willingness to perform additional work to resolve the issues associated with the long term protectiveness issues of the remedy at the SHL and requested that EPA provide a scope of work for the Additional Work. In summary, since EPA's invocation of dispute resolution on November 3, 2015, the Army and EPA have held numerous meetings and telephone calls and have also exchanged numerous emails and letters in an attempt to narrow their differences on the most critical issues in contention, the effectiveness and protectiveness of the SHL remedy. During the most recent telephone conversation between the Army and EPA on February 4, 2015, the Army agreed to conduct specific tasks to be identified by EPA and provided to the Army. Attachment 1 to this letter is a Scope of Work for the Additional Work needed to determine whether the remedy at the SHL is protective over the long term and to satisfy the requirements of a FYR under CERCLA, the National Contingency Plan (NCP) and relevant guidance. Please note that this Attachment only pertains to issues number 1-5 (work needed to determine the long term protectiveness of the remedy) in EPA's December 31, 2015 summary. Discussion on issues 6-8 (regarding the sites that were eliminated from the FYR Report and the need for PFC sampling) are still ongoing and will be addressed separately.

While EPA appreciates the Army's willingness to review EPA's request for Additional Work, the above history of communications indicates that the informal dispute resolution step has not been successful. EPA believes its responsibilities under CERCLA and the FFA compel it to bring this ongoing dispute to a conclusion. Toward that end, EPA intends to elevate this disagreement to the Dispute Resolution Committee (DRC) if the Army does not unconditionally commit to conduct the Additional Work provided in Attachment 1 to this letter.

Please note, EPA will not accept a response from the Army that indicates that all or portions of the work requested by EPA are already planned as part of the Long Term Maintenance and Monitoring Plan (LTMMP) and will be implemented pursuant to that plan. EPA has provided numerous comments on the LTMMP, which were never resolved to EPA's satisfaction and are now the subject of the additional work needed for the FYR. We expect the tasks in the SOW to proceed separate from and in addition to the work under the LTMMP.

In addition, EPA will not accept a response from the Army indicating that the work will proceed after review and agreement is reached on the groundwater flow model or conceptual site model (CSM). It is EPA's position that the data from this Additional Work is needed to evaluate and validate the accuracy of the groundwater flow model as a tool to assist in decision making at the site and to validate with sufficient data the CSM.

Simply stated, EPA cannot and will not determine that the SHL remedy is protective of human health and the environment unless the information requested in the SOW is provided without conditions attached.

Please provide a written response to this letter within twenty one (21) days of receipt. If you have any questions, please feel free to contact me at 617-918-1210 or Carol Keating at 617-918-1393.

Sincerely,

Lynne A. Jennings

Lynne A. Jennings, Chief
Superfund Federal Facility Section

Cc: Andrew Van Dyke, U.S. Army
Robert Simeone, U.S. Army, Devens
David Chaffin, MassDEP
Bryan Olson, US EPA
William Walsh-Rogalski, US EPA
Carol Keating, US EPA
Laurie O'Connor, US EPA

ATTACHMENT 1 - SCOPE OF WORK

Former Fort Devens Installation
Pursuant to Section 19.3 and 33.2 of the Federal Facility Agreement

Introduction and Purpose:

Pursuant to Sections XIX and XXX of the Federal Facility Agreement (FFA) between EPA and the Army at the Former Fort Devens Site, EPA is requiring that the following Additional Work be performed by the Army at the Shepley's Hill Landfill (SHL) Area of Contamination to assure that the selected remedial action is protective of human health and the environment over the long-term as required by CERCLA Section 121(c), applicable CERCLA guidance and the NCP. In the Army's October 2, 2015 Fourth Comprehensive Five Year Review Report, the Army failed to demonstrate that the existing extraction and treatment system is sufficiently containing/capturing contamination migrating from the landfill so as to assure that human health and the environment are protected by the remedial action. Additional Work is necessary to determine whether the SHL remedial action is protective of human health and the environment. As required by Paragraph 19.3 of the FFA the Army shall complete the following Additional Work in accordance with the standards, specifications, and schedules described below:

Phase 1 – Demonstrate Plume Capture – The Army shall collect and submit to EPA data sufficient to demonstrate to EPA's satisfaction that the existing extraction and treatment system as designed, constructed and operated provides sufficient containment/capture of the contamination migrating from SHL. If EPA determines that plume capture is not sufficient, the Army shall, as described below, modify the extraction and treatment system so achieve sufficient capture.

Phase 2 – Evaluate Remedy Performance - After EPA determines that sufficient containment has been achieved, the Army shall collect and submit to EPA sufficient monitoring data collected on a quarterly basis for five (5) years to adequately evaluate whether the operation of the containment system, coupled with Monitored Natural Attenuation (MNA), will result in restoration of groundwater in the downgradient impacted area (i.e. North Impacted Area (NIA) in a time frame that is reasonable. EPA may modify this long term monitoring program as necessary to assure the protectiveness of the remedy.

Phase 3 – Document Remedy in a Decision Document - If EPA determines based on the data collected that the containment system (as it currently exists or as modified), coupled with MNA, can achieve restoration of the aquifer to drinking water standards within a reasonable period of time, the Army shall, consistent with the NCP and applicable guidance, issue the appropriate Decision Document (Explanation of Significant Difference or Amended ROD). If EPA determines that the containment system, coupled with MNA does not result in restoration of the aquifer, the Army shall develop a remedy that complies with CERCLA, the NCP, relevant guidance and the FFA and shall issue a proposed plan for that remedy for EPA concurrence. Upon issuance of a final ROD, the Army shall construct, operate and maintain the remedy consistent with all requirements of the FFA.

Modification of this Scope of Work:

The Additional Work described in Phase 1 above relates to a Demonstration of Plume Capture. If upon review of the data and Technical Memorandums submitted as part of Phase 1, EPA determines that the treatment system is not adequately capturing the plume so as to be protective of human health and the environment or that the Army has not submitted to EPA sufficient data to determine that the plume is being adequately captured, EPA will provide a supplemental SOW that the Army shall implement to collect sufficient data for that determination. The supplemental SOW may describe additional data needs or may describe changes to the existing treatment system sufficient to achieve plume capture adequate to protect public health and the environment.

The Additional Work described in Phase 2 above relates to the Evaluation of Remedy Performance. If EPA, after review of the data and Technical Memorandums submitted as part of Phase 2, or at a later time, determines that a supplemental SOW is necessary to evaluate the performance of the remedy, the Army shall implement the supplemental SOW provided by EPA.

I. DEMONSTRATE PLUME CAPTURE

1. Delineate the capture zone based on hydraulic and geochemical data.

a. Within 30 days of receipt of this Scope of Work (SOW), the Army shall submit a written assurance stating that the Army will conduct the Additional Work required by this SOW. The written assurance shall contain a memorandum proving that funds have been obligated and shall include copies of the task orders provided to contractors or other agents that will complete the tasks specified in the SOW.

b. Within 180 days of receipt of this SOW, the Army shall define the lateral and vertical extent of the capture zone of the two extraction wells based on hydraulic data collected with the system operating at 50 gallons per minute. The assessment shall build upon the data and methodology developed by EPA in its 2013 capture zone assessment.

c. The assessment shall expand the current piezometer /monitoring well network to address data gaps near the extraction wells by installing five (5) paired piezometers as shown on **Figure 1**. The construction of the piezometers shall be consistent with the EPA piezometers installed in 2012 and include a shallow screen installed near the water table and a deep screen installed at a depth interval of approximately 130-160 AMSL.

d. Prior to installation of the piezometers, the Army shall advance a geoprobe profile to refusal and shall collect groundwater samples at intervals of ten feet. Sample acquisition and analysis shall be consistent with methods identified in Section 4.0 of the September 2015, Revised Final SHL LTMMP Update.

e. Within 45 days of completing the profile sample collection, the Army shall submit a Technical Memorandum to EPA with the analytical results from the profile sampling.

f. Within 15 days after completion of the construction of the piezometers, the Army shall collect a round of water level data from the newly installed piezometers as well as the existing network of piezometers and monitoring wells that are subject to semi-annual sampling of water level measurements pursuant to the September 2015 Revised Final LTMMP. Thereafter, the Army shall include the newly installed piezometers in the semi-annual sampling of water level measurements performed pursuant to paragraph 4.a.iii below.

g. Within 30 days of completing the water level measurements and no later than 180 days of receipt of this SOW, the Army shall submit a Technical Memorandum with the results of this assessment. The Technical Memorandum shall include the hydraulic data collected, a comparison of observed and predicted flow vectors, and a map showing the horizontal and vertical extent of the plume capture zone (i.e. items b. - f. above) for the extraction wells based on the hydraulic data collected.

2. **Delineate the lateral and vertical extent of the contaminant plume upgradient of extraction system.**

   a. Within 240 days of receipt of this SOW, the Army shall delineate the lateral and vertical extent of the plume upgradient of the extraction system and compare this delineated plume to the mapped capture zone determined in Section I, Task 1 above.
   b. The Army shall perform geoprobe vertical profile sampling along the transect SHL-23 to SHL-21 as shown on **Figure 2**. The Army shall install three equally-spaced geoprobes at locations between SHL-23 and EW-04 and four equally-spaced geoprobes at locations between SHP-05-46 and SHM-10-06A.
   c. The Army shall advance the geoprobes to refusal and shall collect groundwater samples at ten foot intervals. Sample acquisition and analysis shall be consistent with methods identified in Section 4.0 of the September 2015 Revised Final SHL LTMMP Update.
   d. Within 240 days of receipt of this SOW, the Army shall submit a Technical Memorandum to EPA. The Technical Memorandum shall include the data from the profile investigation and a map of the vertical and horizontal extent of the plume upgradient of the extraction wells based on the data collected during this task and any other relevant data including previously collected data.
   e. Based on the results of this work, EPA will determine the location of permanent monitoring wells that should be installed by the Army to monitor the performance of the remedy and will supplement this SOW to require the installation of those wells.

3. **Delineate the lateral and vertical extent of the contamination down gradient of extraction system along Scully Road.**

   a. Within 240 days of receipt of this Scope of Work, the Army shall delineate the lateral and vertical extent of contamination downgradient of the extraction system along Scully Road
   b. Army shall perform geoprobe vertical profile sampling at six, equally –spaced locations along the transect SHM-07-03 and SHM-99-31A/B/C as shown on **Figure 3**.
   c. The Army shall advance geoprobes to refusal and shall collect groundwater samples at ten foot intervals. Sample acquisition and analysis shall be consistent with methods identified in Section 4.0 of the September 2015 Revised Final SHL LTMMP Update
   d. Within 240 days of receipt of this SOW, the Army shall submit a Technical Memorandum to EPA. The Technical Memorandum shall include the data from the profile investigation and a map of the vertical and horizontal extent of the plume along Scully Road. The map shall be generated using the data from this investigation and any other relevant data from previous investigations.
   e. Based on the results of this work, EPA will determine the location of permanent monitoring wells that shall be installed by the Army to monitor the performance of the remedy and will supplement this SOW to require the Army to install permanent monitoring wells.

4. **Validate the updated groundwater flow model with sufficient field measured hydraulic data to confirm the conclusions.**

   a. As agreed previously, the Army shall submit the updated groundwater flow model and documentation to EPA no later than March 18, 2016. The model shall be updated in accordance with the changes noted in Attachment A of the Army's December 4, 2015 Letter.
   b. Within 240 days of receipt of this SOW, the Army shall submit field measured hydraulic head data and water level measurements to demonstrate that the data support and validate the projections of groundwater flow predicted by the updated flow model.
   c. The Army shall evaluate hydraulic gradient vectors near the extraction wells as follows:
      i. Use the well network presented in Figure 2 of EPA ORDs February 4, 2014, "Revised Hydraulic Gradient Analysis of Pump and Treat System Performance" and groundwater elevation data obtained since the ATP upgrade in 2015 to estimate hydraulic gradient vectors and compare those vectors with vectors predicted by the updated groundwater flow model, to validate modeling results.
      ii. Using the same methodology as in I.4.b.i and the technical guidance provided in USEPA (2014), perform an analysis of hydraulic gradient vectors using wells/piezometers screened near the water table and compare those vectors with vectors predicted by the updated groundwater flow model.
   d. The Army shall evaluate upgradient flow lines through plume cross-section as follows:
      i. Assess upgradient flow lines captured by the extraction system using forward particle-track projections starting at a vertical, west-to-east cross-section through monitoring locations SHM-11-06 and SHP-05-44 throughout the entire modeled overburden across the transect shown on Figure 2.
      ii. Analysis should include release of particles from each model layer spaced at regular west-to-east distances across the modeled overburden cross-section
   e. Within 240 days of receipt of this SOW, the Army shall submit a Technical Memorandum summarizing the results of this task. The Technical Memorandum shall include the data collected and the results of the evaluations requested.

5. Validate the extent of capture by evaluating concentration trends in NIA monitoring locations as compared to flow paths developed from the updated groundwater flow model.

a. Within 120 days from receipt of this SOW, the Army shall validate the extent of plume capture by conducting trend analysis of monitoring locations in the NIA. The trend analysis shall evaluate whether concentrations are decreasing, increasing or stabilizing at locations where capture is predicted to occur based on the updated flow model.
b. The Army shall conduct the trend analysis using data from the available period of record and prepare time-trend plots of groundwater chemistry parameters for the following monitoring locations: SHM-93-22B, SHM-96-5B, SHM-05-41A/B/C, EPA-PZ-2012-1A/B, EPA-PZ-2012-2A/B, EPA-PZ-2012-3A/B, EPA-PZ-2012-4A/B, EPA-PZ-2012-5A/B, EPA-PZ-2012-6A/B, and EPA-PZ-2012-7A/B, SHL-5, SHL-8S/D, SHL-9, SHL-22, SHL-23, SHM-93-22C, SHM-96-5C, SHM-05-42A/B, SHM-10-16, SHM-05-40X, SHM-07-03, SHM-07-05, SHM-05-39A/B, SHM-99-31A/B/C, SHM-99-32X, SHM-13-03, SHM-13-04, SHM-13-06, SHM-13-07, SHM-13-08, SHM-10-02, SHM-10-03, SHM-10-04, SHM-10-05A, SHM-10-08, SHM-10-10, SHM-13-01, SHM-13-02, SHM-13-05, SHM-13-14S/D, and SHM-13-15.
c. For the period 2010-2015, the Army shall identify if concentration trends are decreasing, increasing or stable.
d. For each monitoring location, the Army shall identify the upgradient model flow path for the groundwater extraction system operation during 2010-2016.
e. Within 120 days from receipt of this SOW, the Army shall submit a technical memorandum summarizing the results of this task. The technical memorandum shall include for each well the time trend plots, a statement as to whether the concentrations are increasing, decreasing or stable, and a summary as to whether the data validates the extent of capture.

II. COLLECT SUFFICIENT DATA TO EVALUATE REMEDY PERFORMANCE

1. Collect and analyze geochemical (wells) and hydrologic (piezometers) data for a minimum of five (5) years, to evaluate remedy's ability to achieve cleanup goals and ensure long-term protectiveness:

a. Upon receipt of this SOW and for a period of at least 5 years, the Army shall collect samples and analyze the samples for the parameters as defined in the September 2015 Revised Final SHL LTMMP Update from each of the monitoring locations as grouped according to the following key sub-areas and at the sample frequency specified below:
   i) Extraction Wells – (Semi-Annual) EW-1 and EW-4
   ii) Landfill Area Wells – (Annual) N5-P1, SHL-99-29X, SHM-10-07, SHL-10-11, SHM-10-12, SHM-10-13, SHM-10-14, and SHM-10-15
   iii) Nearfield Area Wells – (Semi-Annual) SHM-93-22B, SHM-96-5B, SHM-05-41B, SHM-05-41C, EPA-PZ-2012-1A/B, EPA-PZ-2012-2A/B, EPA-PZ-2012-3A/B, , EPA-PZ-2012-4A/B, EPA-PZ-2012-5A/B, EPA-PZ-2012-6A/B, and EPA-PZ-2012-7A/B; (Annual) SHL-5, SHL-8S, SHL-8D, SHL-9, SHL-22, SHL-23, SHM-93-22C, SHM-96-5C, SHM-05-

41A, SHM-05-42A,, SHM-05-42B, SHM-10-06, SHM-10-06A, SHM-10-16,

iv) North Impact Area Wells – (Semi-Annual) SHM-05-40X, SHM-07-03, SHM-0705, SHM-13-03, SHM-13-04, SHM-13-06, SHM-13-07, SHM-13-08; (Annual) SHM-99-31C, SHM-99-32X, SHM-10-02, SHM-10-03, SHM-10-04, SHM-10-05A, SHM-10-08, SHM-10-10, SHM-13-01, SHM-13-02, SHM-13-05, SHM-13-14S/D, and SHM-13-15

v) Upgradient Area Wells – (Annual) SHL-3, SHL-7, SHL-12, SHL-15, SHL-24, SHM-93-10D, SHM-93-18B, and SHM-93-24A

vi) Barrier Wall Area Wells and Piezometers - SHL-11 SHL-4, SHL-20, SHL-10, SHM-11-02, SHL-19, SHM-11-06, SHP-01-36X, SHP-01-37X, SHP-01-38A, and PZ-12-01 through PZ-12-10

b. Within forty-five days of completion of each monitoring event, the Army shall submit a Technical Memorandum to EPA with the un-validated (i.e. raw) groundwater monitoring data.

c. No later than February 1 of each year following receipt of this SOW, the Army shall submit a draft Annual Report containing a summary of the sampling results and an analysis of arsenic trends (95% confidence level) for each of the key sub-areas identified above. The draft report shall include:

   i) updated estimates of the time to achieve the cleanup goal of MCLs in the "Nearfield Area" and the "North Impacted Area" based on the trend analysis conducted using the data collected from the wells in each of these areas;

   ii) updated estimates of the time it will take the landfill source to be depleted based on the trend analysis conducted using the data collected from the wells in landfill area; and

   iii) analysis of the concentration trend for arsenic based on the inlet data collected from the individual extraction wells, EW-04 and EW-01.

d. EPA will review the Annual Monitoring Report and determine if modifications to the monitoring network are needed. If changes are needed, EPA will supplement this SOW with additional work to modify the monitoring network.

2. Perform a study to determine the site specific background level of arsenic in groundwater.

a. Within 240 days of receipt of this SOW, the Army shall perform a statistical analysis of analytical data from monitoring locations that lie outside the influence of the plume as identified in Table 1 (and illustrated on Figure 4).

b. The Army shall collect two rounds of samples (fall and spring) using low-stress, low-flow procedures (USEPA, 2010)*.

c. Parameters analyzed in the groundwater samples should include field parameters monitored to establish stability prior to sampling, as well as laboratory-based determination of arsenic, calcium, sulfate, total alkalinity, magnesium, manganese, iron, sodium, ammonia-nitrogen, nitrate/nitrite-nitrogen, dissolved organic carbon, potassium, and chloride. It is recommended that parameters in addition to arsenic be measured in order to allow secondary, qualitative comparisons of background and (historic) plume groundwater chemistry and to allow for charge balance calculations to assess overall data quality for each sample.

d. Within forty five (45) days of completion of each monitoring event, the Army shall submit the unvalidated (i.e. raw) groundwater monitoring data to EPA.
e. Within 240 days of receipt of this SOW, the Army shall submit a Technical Memorandum with the results of this study. The study shall include a statistical analysis of the arsenic data to establish a relevant upper tolerance limit for the background data distribution, consistent with USEPA (2009) guidance**, employing the Agency-supported ProUCL software (http://www.epa.gov/osp/hstl/tsc/software.htm#Documentation).

* USEPA, 2010. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, SOP #: GW 0001, Revision 3. July.

** USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530-R-09-007.

*** USEPA, 2014. 3PE: A Tool for Estimating Groundwater Flow Vectors. EPA 600-R-14-273.

Figure 1 – Locations for Additional Paired Piezometers

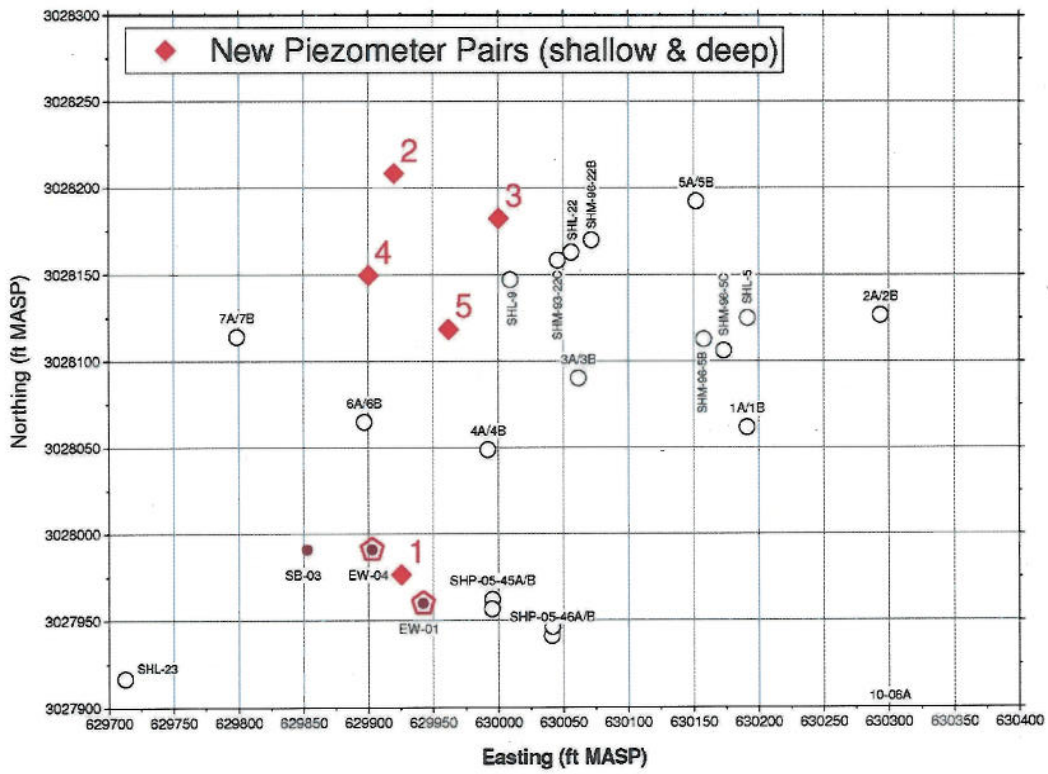


Figure 2 – Geoprobe Profile Transect SHL-23 and SHL-21 (top line) and Forward-Particle Transect SHM-11-06 and SHP-05-44 (bottom line)

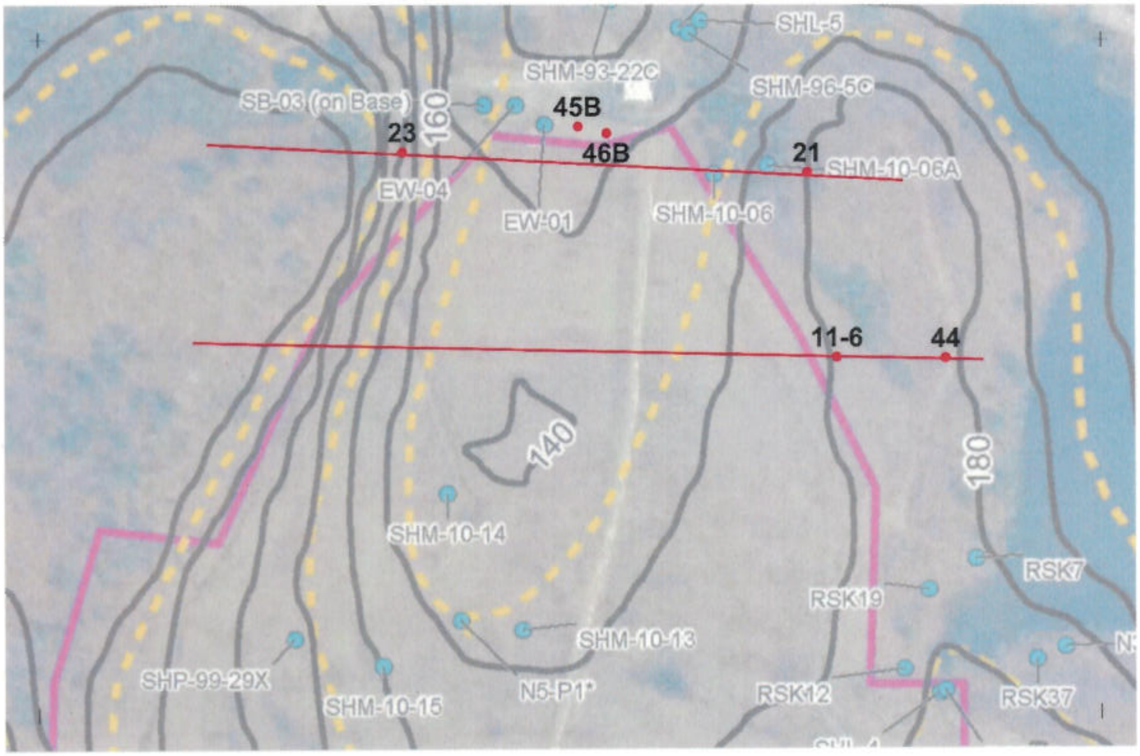


Figure 3 - Geoprobe vertical profile sampling locations along transect SHM-07-03 and SHM-99-31A/B/C

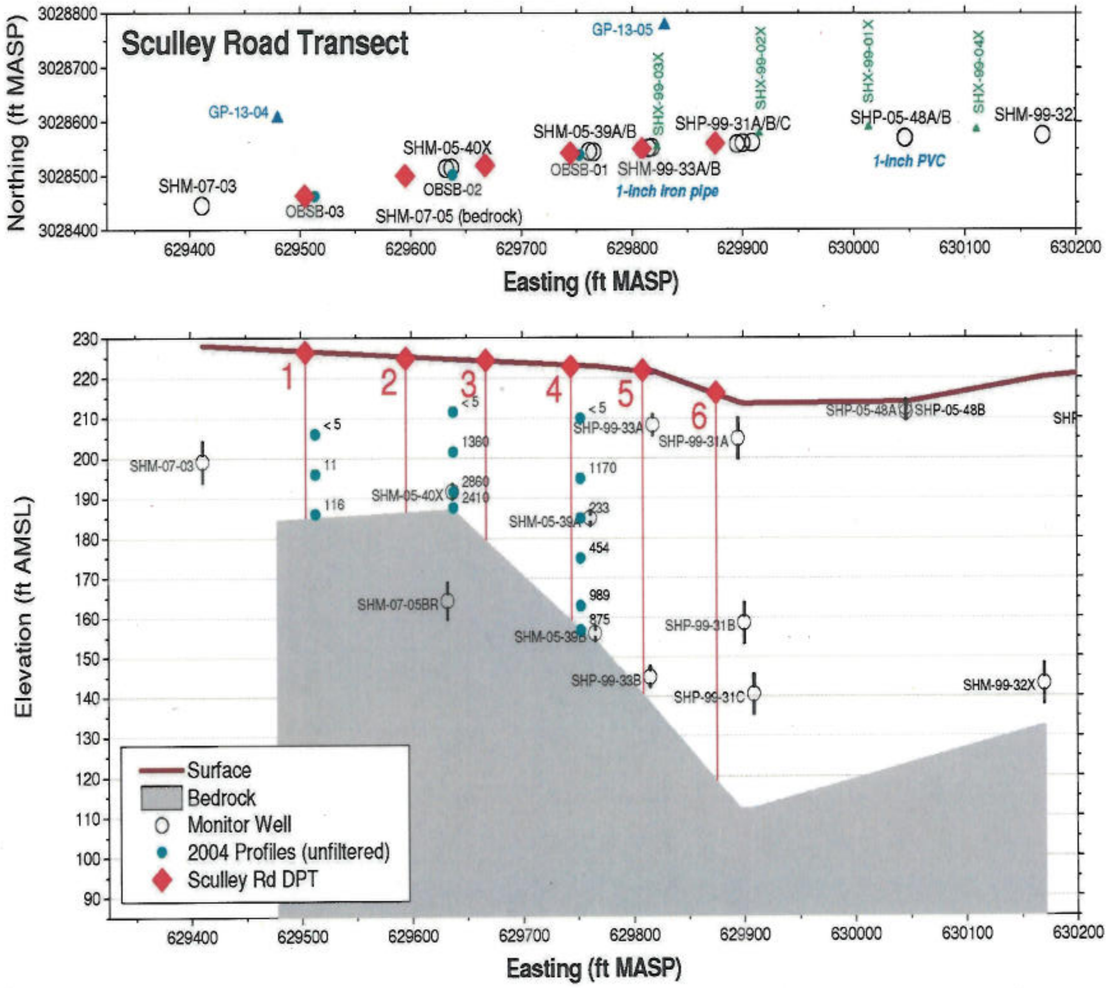


Table 1. List of well/piezometer locations proposed for sampling to support analysis of background groundwater chemistry for Shepley's Hill Landfill. Location ID listed with italics are for locations for which data are currently not available or data have not been incorporated into the SHL database.

Location ID	Screen Depth (ft bgs)	Formation Type	Location Type and Well Status
SHL-23	23-33	Overburden	Outside of SHL cap; Shepley's Hill soil
SHL-1	2-7	Overburden	Outside of SHL cap; Shepley's Hill soil
SHP-99-1B	4-8	Overburden	Outside of SHL cap; Shepley's Hill soil
SHP-99-1C	19.7-29.7	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
SHL-15	14.5-24.5	Overburden	Outside of SHL cap; borders AOC32
32M-92-01X	13.7-23.7	Overburden	Outside of SHL cap; borders AOC32
32Z-01-07XOB	12.7-22.7	Overburden	Outside of SHL cap; borders AOC32
32M-01-14XOB	17.3-27.3	Overburden	Outside of SHL cap; borders AOC32
SHL-25	23.5-33.5	Overburden	Outside of SHL cap; borders AOC32
SHL-12	15-30	Overburden	Outside of SHL cap; historical & current wetland area
N7-P1	65-69	Bedrock	Under southern edge of SHL cap; immediately downgradient of historical wetland area
N7-P2	29-35	Overburden	Under southern edge of SHL cap; immediately downgradient of historical wetland area
SHL-17	6-16	Overburden	Outside of SHL cap; historical & current wetland area
SHM-93-24A	13.2-23.2	Overburden	Outside of SHL cap; adjacent to rail spur
SHL-24	110-120	Overburden/Till/Bedrock	Outside of SHL cap; adjacent to rail spur
SHP-95-27X	Unknown	Overburden	Outside of SHL cap at edge of historical landfill footprint Boring log and/or piezometer construction information needed; measured well bottom 42.8 ft below casing top

SHL-7	11-21	Overburden	Outside of SHL cap; adjacent to rail spur Listed as abandoned; yields water with Waterra inertial pump; measured well bottom 23.3 ft below casing top
SHL-18	16-26	Overburden	Outside of SHL cap; adjacent to Railroad Roundhouse
SHM-93-18B	78.5-88.5	Overburden	Outside of SHL cap; adjacent to Railroad Roundhouse
N4-P1	77.5-82.5	Overburden	Outside of SHL cap; adjacent to Railroad Roundhouse
N4-P2	39.5-44.5	Overburden	Outside of SHL cap; adjacent to Railroad Roundhouse
N4-P3	3-8	Overburden	Outside of SHL cap; adjacent to Railroad Roundhouse
N1-P1	65-75	Overburden	Outside of SHL cap; adjacent to Plow Shop Pond
N1-P2	45-50	Overburden	Outside of SHL cap; adjacent to Plow Shop Pond
N1-P3	12-17	Overburden	Outside of SHL cap; adjacent to Plow Shop Pond
CH-1D	85-95	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
CH-1S	36-41	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
3-2	54-59	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
Q4-1	30-40	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
20-1	40-55	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
27-1	58.25-63.25	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
27-2	58-68	Bedrock	Outside of SHL cap; Shepley's Hill bedrock

Q5-1	47-52	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
CAP-2B	52-57	Bedrock	Outside of SHL cap; Shepley's Hill bedrock
MW-1	6.58-8.58	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown
MW-4-1	3.72-5.72	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown
MW-7	6.98-8.98	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown
MW-9	7.65-9.65	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown
MW-11A	4.18-6.18	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown
MW-14	5.14-7.14	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown
MW-16	5.18-7.18	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown
MW-22	4.70-6.70	Overburden	Outside of SHL cap; Shepley's Hill soil – water yield unknown

Figure 4. Approximate locations of wells/piezometers (yellow triangles) proposed for sampling to support analysis of background groundwater chemistry for Shepley's Hill Landfill.

1. Aerial Photograph derived from EPIC 1991 Vol 2; Figure 16, Photo Area C – April 6, 1965.
2. Approximate boundary of landfill cap designated with white line; yellow line shows approximate boundary of Shepley's Hill Bedrock Investigation (July 2012).
3. Approximate location of Seismic Refraction Line 1 designated with red line connecting open, red triangles (1993 RI Addendum Report).

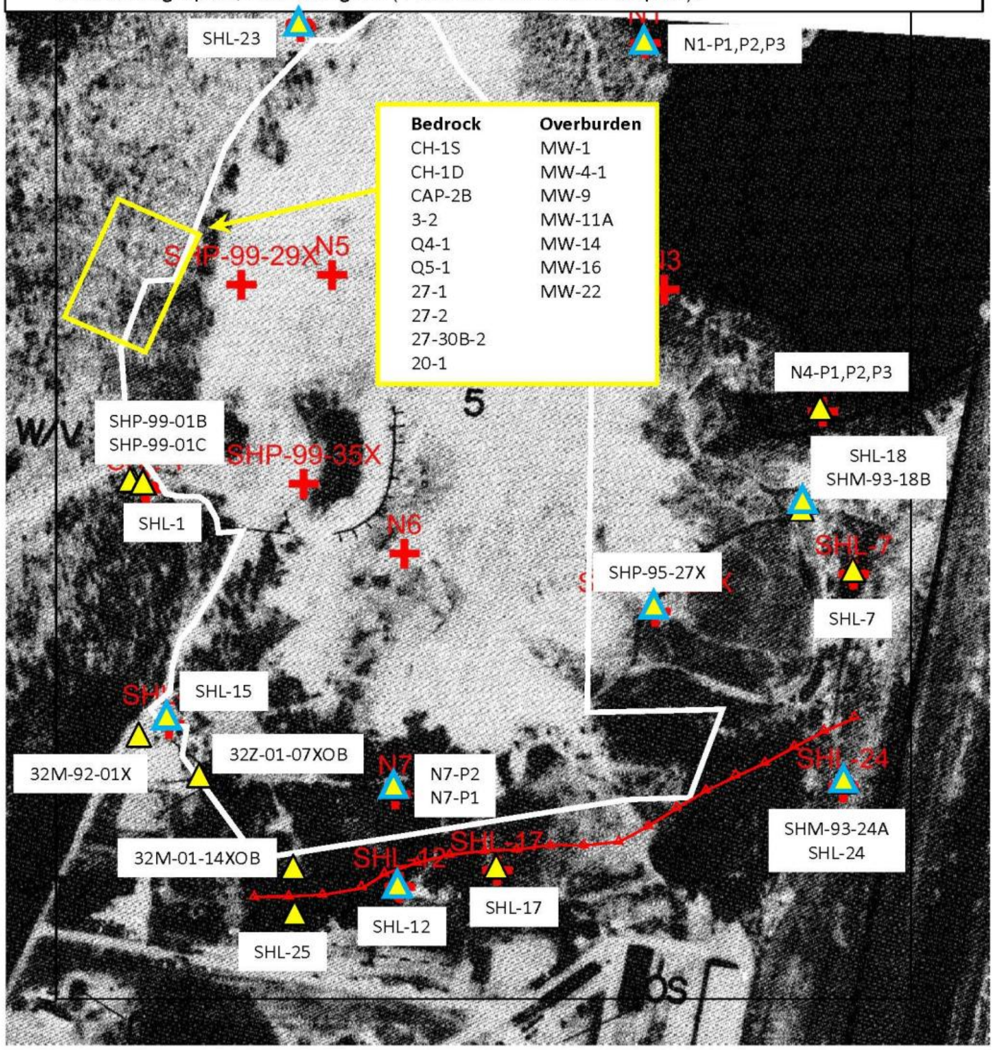
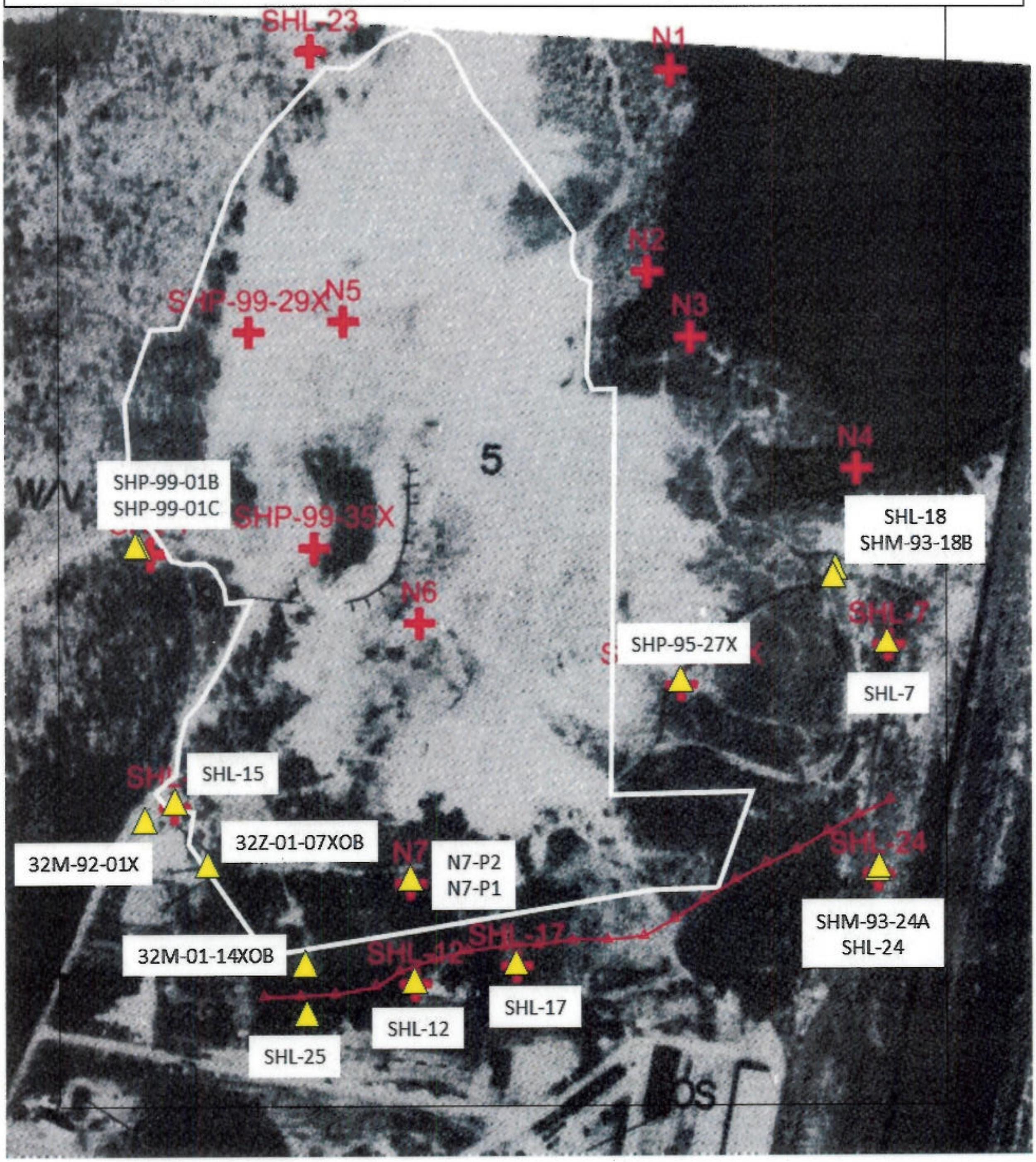


Figure 4. Approximate locations of wells/piezometers (yellow triangles) proposed for sampling to support analysis of background groundwater chemistry for Shepley's Hill Landfill.

1. Aerial Photograph derived from EPIC 1991 Vol 2; Figure 16, Photo Area C – April 6, 1965.
2. Approximate boundary of landfill cap designated with white line.
3. Approximate location of Seismic Refraction Line 1 designated with red line connecting open, red triangles (1993 RI Addendum Report).



Appendix B

Decision Documents

5/6 ?

FORT DEVENS
FEASIBILITY STUDY
FOR GROUP 1A SITES

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MASSACHUSETTS

IN ACCORDANCE WITH U.S. ARMY REGULATION 200-2, THIS DOCUMENT IS INTENDED BY THE U.S. ARMY TO COMPLY WITH THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969.

SEPTEMBER 1995

PRINTED ON RECYCLED PAPER

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
AREAS OF CONTAMINATION 4, 5, AND 18
FORT DEVENS, MASSACHUSETTS

SEPTEMBER 1995

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MASSACHUSETTS

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DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Shepley's Hill Landfill Operable Unit
Fort Devens, Massachusetts

STATEMENT OF PURPOSE AND BASIS

This decision document presents the U.S. Army's selected remedial action for the Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts. It was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended, 42 USC §§ 9601 et seq. and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as amended, 40 CFR Part 300, to the extent practicable. The Fort Devens Base Realignment and Closure (BRAC) Environmental Coordinator; the Installation Commander; the U.S. Army Deputy Chief of Staff for Personnel and Installation Management; and the Director of the Waste Management Division, U.S. Environmental Protection Agency New England have been delegated the authority to approve this Record of Decision.

This decision is based on the Administrative Record that has been developed in accordance with Section 113(k) of CERCLA. The Administrative Record is available for public review at the Fort Devens BRAC Environmental Office, Building P12, Fort Devens, Massachusetts, and at the Ayer Town Hall, Main Street, Ayer, Massachusetts. The Administrative Record Index (Appendix D of this Record of Decision) identifies each of the items considered during selection of the remedial action.

ASSESSMENT OF THE SITE

Actual or potential releases of hazardous substances from the Shepley's Hill Landfill Operable Unit, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to the public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This remedial action is a source control action that addresses long-term residential exposure to contaminated groundwater, the principal known threat at the Shepley's Hill Landfill Operable Unit. It consists of completing closure of Shepley's Hill Landfill in accordance with applicable Massachusetts requirements at 310 CMR 19.000, and monitoring and evaluating the effectiveness of the landfill cover system completed in 1993 at controlling groundwater contamination and site risk. The remedy controls the release of contaminants from wastes buried in Shepley's Hill Landfill and reduces the potential risk of future residential exposure to contaminated groundwater. The major components of the selected remedy include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- 60 percent design of a groundwater extraction system;
- annual reporting to the Massachusetts Department of Environmental Protection and the U.S. Environmental Protection Agency; and
- five-year site reviews.

The selected remedy includes a contingency remedy if the selected remedy proves ineffective at controlling site risk. The contingency remedy is groundwater extraction and discharge to the Town of Ayer publicly owned treatment works.

STATE CONCURRENCE

The Commonwealth of Massachusetts has concurred with the selected remedy. Appendix E of this Record of Decision contains a copy of the declaration of concurrence.

DECLARATION

The selected remedy is consistent with CERCLA, and to the extent practicable, the NCP, is protective of human health and the environment, complies with federal and Commonwealth requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. The remedy utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable for the Shepley's Hill Landfill Operable Unit. However, because treatment of the principal source of contamination was found not to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element.

The contingency remedy, if implemented, would also be consistent with CERCLA, and to the extent practicable, the NCP, be protective of human health and the environment, comply with federal and Commonwealth requirements that are legally applicable or relevant and appropriate to the remedial action, and be cost effective. The remedy utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable for the Shepley's Hill Landfill Operable Unit. The contingency remedy, if implemented, would satisfy the statutory preference for treatment as a principal element.

Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

DECLARATION FOR THE RECORD OF DECISION
Shepley's Hill Landfill Operable Unit
Fort Devens, Massachusetts

The foregoing represents the selection of a remedial action by the U.S. Department of the Army and the U. S. Environmental Protection Agency, with the concurrence of the Commonwealth of Massachusetts Department of Environmental Protection.

Concur and recommend for immediate implementation:

U.S. DEPARTMENT OF THE ARMY

James C. Chambers
Fort Devens BRAC Environmental Coordinator

19 Sep 95
Date

DECLARATION FOR THE RECORD OF DECISION
Shepley's Hill Landfill Operable Unit
Fort Devens, Massachusetts

The foregoing represents the selection of a remedial action by the U.S. Department of the Army and the U. S. Environmental Protection Agency, with the concurrence of the Commonwealth of Massachusetts Department of Environmental Protection.

Concur and recommend for immediate implementation:

U.S. DEPARTMENT OF THE ARMY

Colonel Edward R. Nuttall
Installation Commander, Fort Devens

21 Sep 95
Date

W0099518.080

DECLARATION FOR THE RECORD OF DECISION
Shepley's Hill Landfill Operable Unit
Fort Devens, Massachusetts

The foregoing represents the selection of a remedial action by the U.S. Department of the Army and the U. S. Environmental Protection Agency, with the concurrence of the Commonwealth of Massachusetts Department of Environmental Protection.

Concur and recommend for immediate implementation:

U.S. DEPARTMENT OF THE ARMY

Arthur T. Dean
ARTHUR T. DEAN
Major General, USA
Deputy Chief of Staff for
Personnel and Installation
Management

28 Sep 95
Date

W0099518.080

DECLARATION FOR THE RECORD OF DECISION
Shepley's Hill Landfill Operable Unit
Fort Devens, Massachusetts

The foregoing represents the selection of a remedial action by the U.S. Department of the Army and the U. S. Environmental Protection Agency, with the concurrence of the Commonwealth of Massachusetts Department of Environmental Protection.

Concur and recommend for immediate implementation:

U.S. ENVIRONMENTAL PROTECTION AGENCY

Linda M. Murphy
Director, Waste Management Division
U.S. Environmental Protection Agency, New England

Sept. 26, 1995
Date

DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

Fort Devens is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) site located in the Towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts. The installation occupies approximately 9,600 acres and is divided into the North Post, Main Post, and South Post (Figure 1 in Appendix A). Seventy-three Study Areas (SAs) and Areas of Contamination (AOCs) have been identified at Fort Devens.

This Record of Decision addresses groundwater contamination at the Shepley's Hill Landfill at Fort Devens. The Shepley's Hill Landfill includes three AOCs: AOC 4, the sanitary landfill incinerator; AOC 5, sanitary landfill No. 1 or Shepley's Hill Landfill; and AOC 18, the asbestos cell. AOCs 5 and 18 are located within the capped area at Shepley's Hill Landfill. The three AOCs are collectively referred to as Shepley's Hill Landfill.

Shepley's Hill Landfill encompasses approximately 84 acres in the northeast corner of the Main Post at Fort Devens. It is situated between the bedrock outcrop of Shepley's Hill on the west and Plow Shop Pond on the east (Figure 2 in Appendix A). Nonacoicus Brook, which drains Plow Shop Pond, flows through a wooded wetland at the north end of the landfill. The southern end of the landfill borders the Defense Reutilization and Marketing Office (DRMO) yard and a warehouse area. An area east of the landfill and south of Plow Shop Pond is the site of a former railroad roundhouse.

Review of the surficial geology map of the Ayer Quadrangle shows that in the early 1940s, the active portion of the landfill consisted of approximately 5 acres near the end of Cook Street, near where monitoring well SHL-1 is located. The fill was elongated north-south along a pre-existing small valley marked by at least two swamps (probably kettle holes) and lying between the bedrock outcrop of Shepley's Hill to the west and a flat-topped kame terrace with an elevation of approximately 250 feet to the east, next to Plow Shop Pond. During the landfilling operation, the valley was filled-in, and much of the kame terrace, which may have been used as cover material, disappeared. Background information indicates the landfill once operated as an open burning site.

Landfill operations at Shepley's Hill Landfill began at least as early as 1917, and stopped as of July 1, 1992. During its last few years of use, the landfill received about 6,500 tons per year of household refuse and construction debris, and operated using the modified trench method. There is evidence that trenches in the northwest portion cut into previously used areas containing glass and spent shell casings. The glass dated from the mid-nineteenth century to as late as the 1920s. The approximate elevation of the bottom of the waste is estimated to be 214 feet above sea level at the north end and in the central portion of the landfill, and 230 feet above sea level in the southeast portion of the landfill. The maximum depth of the refuse is about 30 feet. The average thickness of waste is not documented; however, if the average thickness were 10 feet, the landfill volume would be over 1,300,000 cubic yards. Reports of flammable fluid disposal in the southeastern portion of the landfill have not been substantiated by observations in test pits or other research. The Army has no evidence that hazardous wastes were disposed of in the landfill after November 19, 1980. No waste hot spots or hazardous waste disposal areas were identified during remedial investigation (RI) or supplemental RI activities.

In an effort to mitigate the potential for off-site contaminant migration, Fort Devens initiated the Fort Devens Sanitary Landfill Closure Plan in 1984 in accordance with Massachusetts regulations entitled "The Disposal of Solid Wastes by Sanitary Landfill" (310 CMR 19.00, April 21, 1971). The Massachusetts Department of Environmental Protection (MADEP) approved the plan in 1985. Closure plan approval was consistent with 310 CMR 19.00 and contained the following requirements:

- grading the landfill surface to a minimum 2 percent slope in non-operational areas of the landfill and 3 percent in operational areas;
- removing waste from selected areas within 100 feet of the 100-year floodplain;
- installing a gas venting system;
- installing a low permeability cap and covering the cap with sand, gravel, and loam, and seeding to provide cover vegetation and prevent erosion; and

- implementing a groundwater monitoring program based on sampling five existing monitoring wells every four months.

The capping was completed in four phases (see Figure 2 in Appendix A). In Phase I, 50 acres were capped in October 1986; in Phase II, 15 acres were capped in November 1987; and in Phase III, 9.2 acres were capped in March 1989. The Phase IV closure of the last 10 acres was accomplished in two steps: Phase IV-A was closed in 1991, and Phase IV-B was closed as of July 1, 1992, although the geomembrane cap was not installed over Phase IV-B until May 1993.

Because of the large area and shallow surface slope of the existing landfill, early phases of the landfill closure were completed with a 2 or 3 percent surface slope. Slopes were increased to 5 percent in Phase IV-B. Phases I through IV-A were capped with a 30-mil polyvinyl chloride (PVC) geomembrane overlain with a 12-inch drainage layer and 6-inch topsoil layer. At the request of MADEP, the Phase IV-B cap design was modified to include a 40-mil PVC geomembrane, a 6-inch drainage layer, and a 12-inch topsoil layer. A landfill gas collection system consisting of 3-inch diameter gas-collection pipes bedded in a minimum 6-inch thick gas-venting layer was installed beneath the PVC geomembrane in all closure phases. Gas vents were installed through the PVC geomembrane at 400-foot centers. A minimum 6-inch cushion/protection layer was maintained between the geomembrane and underlying waste. As requested by the U.S. Environmental Protection Agency (USEPA) and MADEP, four additional groundwater monitoring wells were installed in 1986 to supplement the five in the original groundwater program. The Army submitted a draft closure plan to MADEP on July 21, 1995 pursuant to 310 CMR 19.000 to document that Shepley's Hill Landfill was closed in accordance with plans and applicable MADEP requirements. Closure in accordance with applicable requirements of Commonwealth regulations is a component of the selected and contingent remedy.

AOC 4, the sanitary landfill incinerator was located in former Building 38 near the end of Cook Street within the area included in Phase I of the sanitary landfill closure. The incinerator was constructed in 1941, burned household refuse, and operated until the late 1940s. Ash from the incinerator was buried in the landfill. The incinerator was demolished and buried in the landfill in September 1967. The building foundation was removed and buried on-site in 1976.

AOC 18, the asbestos cell, is located in the section of the landfill closed during Phase IV. Between March 1982 and November 1985, an estimated 6.6 tons of asbestos construction debris were placed in the section of the landfill closed during Phase IV-A. In 1990, a new asbestos cell was opened in the section closed during Phase IV-B, and was used until July 1992 for disposal of small volumes of asbestos-containing material.

A more complete description of the Shepley's Hill Landfill Operable Unit can be found in the RI Addendum report, December 1993, Section 3, and the Feasibility Study (FS) report, February 1995, Subsection 1.2.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

A. Land Use and Response History

Fort Devens was established in 1917 as Camp Devens, a temporary training camp for soldiers from the New England area. In 1931, the camp became a permanent installation and was redesignated as Fort Devens. Throughout its history, Fort Devens has served as a training and induction center for military personnel, and as a unit mobilization and demobilization site. All or portions of this function occurred during World Wars I and II, the Korean and Vietnam conflicts, and operations Desert Shield and Desert Storm. During World War II, more than 614,000 inductees were processed and Fort Devens reached a peak population of 65,000.

The primary mission of Fort Devens is to command, train, and provide logistical support for non-divisional troop units and to support and execute Base Realignment and Closure (BRAC) activities. The installation also supports the Army Readiness Region and National Guard units in the New England area.

Fort Devens was selected for cessation of operations and closure under the Defense BRAC Act of 1990 (Public Law 101-510).

A more complete description of the Shepley's Hill Landfill Operable Unit can be found in the RI Addendum report, December 1993, Section 3, and the FS report, February 1995, Subsection 1.2.

B. Enforcement History

In conjunction with the Army's Installation Restoration Program (IRP), Fort Devens and the U.S. Army Environmental Center (USAEC; formerly the U.S. Army Toxic and Hazardous Materials Agency) initiated a Master Environmental Plan (MEP) in 1988. The MEP assessed the environmental status of SAs, discussed necessary investigations, and recommended potential responses to environmental contamination. Priorities for environmental restoration at Fort Devens were also assigned. The MEP identified Shepley's Hill Landfill as a source of groundwater contamination and recommended additional groundwater sampling and a full RI to determine the extent of contamination.

On December 21, 1989, Fort Devens was placed on the NPL under CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA) as a result of volatile organic compound (VOC) contamination in groundwater at Shepley's Hill Landfill, metal contamination in groundwater at the Cold Spring Brook Landfill (AOC 40), and the proximity of both locations to public drinking water supplies. A Federal Facilities Agreement (Interagency Agreement [IAG]) was developed and signed by the Army and USEPA Region I on May 13, 1991, and finalized on November 15, 1991. The IAG provides the framework for the implementation of the CERCLA/SARA process at Fort Devens.

In 1991, the U.S. Department of Defense, through USAEC, initiated an RI for the Group 1A sites (AOCs 4, 5, 18, and 40) at Fort Devens. The RI report was issued in April 1993, and an RI Addendum report was issued in December 1993. The purpose of the RI and RI Addendum was to determine the nature and extent of contamination at the AOCs, assess human health and ecological risks, and provide a basis for conducting an FS.

An FS that evaluates remedial action alternatives for cleanup of groundwater at Shepley's Hill Landfill was issued in February 1995. The FS identifies and screens 10 remedial alternatives and provides a detailed analysis of five of these remedial alternatives to allow decision-makers to select a remedy for cleanup of groundwater at the Shepley's Hill Landfill Operable Unit.

The proposed plan detailing the Army's preferred remedial alternative was issued in May 1995 for public comment. Technical comments presented during the public comment period are included in the Administrative Record. Appendix C, the Responsiveness

Summary, contains a summary of these comments and the Army's responses, and describes how these comments affected the remedy selection.

III. COMMUNITY PARTICIPATION

The Army has held regular and frequent informational meetings, issued fact sheets and press releases, and held public meetings to keep the community and other interested parties informed of activities at Shepley's Hill Landfill.

In February 1992, the Army released, following public review, a community relations plan that outlined a program to address community concerns and keep citizens informed about and involved in remedial activities at Fort Devens. As part of this plan, the Army established a Technical Review Committee (TRC) in early 1992. The TRC, as required by SARA Section 211 and Army Regulation 200-1, included representatives from USEPA, USAEC, Fort Devens, MADEP, local officials, and the community. Until January 1994, when it was replaced by the Restoration Advisory Board (RAB), the committee generally met quarterly to review and provide technical comments on schedules, work plans, work products, and proposed activities for the SAs at Fort Devens. The RI, RI Addendum, and FS reports, proposed plan, and other related support documents were all submitted to the TRC or RAB for their review and comment.

The Army, as part of its commitment to involve the affected communities, forms a RAB when an installation closure involves transfer of property to the community. The Fort Devens RAB was formed in February 1994 to add members of the Citizen's Advisory Committee (CAC) to the TRC. The CAC had been established previously to address Massachusetts Environmental Policy Act/Environmental Assessment issues concerning the reuse of property at Fort Devens. The RAB consists of 28 members (15 original TRC members plus 13 new members) who are representatives from the Army, USEPA Region I, MADEP, local governments and citizens of the local communities. It meets monthly and provides advice to the installation and regulatory agencies on Fort Devens cleanup programs. Specific responsibilities include: addressing cleanup issues such as land use and cleanup goals; reviewing plans and documents; identifying proposed requirements and priorities; and conducting regular meetings that are open to the public. The Army presented the proposed plan for the Shepley's Hill Landfill Operable Unit at the May 4, 1995 RAB meeting.

On May 31, 1995, the Army issued a fact sheet to citizens and organizations, to provide the public with a brief explanation of the Army's preferred remedy for cleanup of groundwater at the Shepley's Hill Landfill Operable Unit. The fact sheet also described the opportunities for public participation and provided details on the upcoming public comment period and public meetings.

During the week of May 22, 1995, the Army published a public notice announcing the proposed plan, public informational meeting, and public hearing in the Times Free Press and the Lowell Sun. A public notice announcing the public hearing was published the week of June 12, 1995 in the Times Free Press and the week of June 19, 1995 in the Lowell Sun. The Army also made the proposed plan available to the public at the information repositories at the libraries in Ayer, Shirley, Lancaster, and Harvard, and at Fort Devens.

From June 1 to June 30, 1995, the Army held a 30-day public comment period to accept public comments on the alternatives presented in the FS and the proposed plan and on other documents released to the public. On June 6, 1995, the Army held an informal informational meeting at Fort Devens to present the Army's proposed plan to the public and discuss the cleanup alternatives evaluated in the FS. This meeting also provided the opportunity for open discussion concerning the proposed cleanup. On June 27, 1995, the Army held an informal public hearing at Fort Devens to discuss the proposed plan and to accept verbal or written comments from the public. A transcript of this meeting, public comments, and the Army's response to comments are included in the attached Responsiveness Summary (Appendix C).

All supporting documentation for the decision regarding the Shepley's Hill Landfill Operable Unit is contained in the Administrative Record for review. The Administrative Record is a collection of all the documents considered by the Army in choosing the remedy for the Shepley's Hill Landfill Operable Unit. On June 2, 1995, the Army made the Administrative Record available for public review at the Fort Devens BRAC Environmental Office, and at the Ayer Town Hall, Ayer, Massachusetts. An index to the Administrative Record is available at the USEPA Records Center, 90 Canal Street, Boston, Massachusetts and is provided as Appendix D.

IV. SCOPE AND ROLE OF THE RESPONSE ACTION

The Army developed the selected remedy by combining components of different source control and management of migration alternatives. The selected remedy for the Shepley's Hill Landfill Operable Unit controls the release of contaminants to groundwater and controls potential groundwater use. The selected remedy also provides environmental monitoring of groundwater for a period of thirty years. The implementation of the selected alternative will not adversely affect any future response actions at the Shepley's Hill Landfill Operable Unit should they be required.

This remedial action will address the principal threat to human health at the Shepley's Hill Landfill Operable Unit posed by long-term residential exposure to contaminated groundwater. Potential threats to human and ecological receptors resulting from exposure to contaminated sediments and surface water in Plow Shop Pond will be addressed as part of the Plow Shop Pond Operable Unit. Potential remedial actions for Plow Shop Pond sediment contamination will be evaluated in a separate engineering report anticipated to be issued September 1, 1996. Environmental monitoring to assess any continuing affect of the landfill on the pond will take place as part of the Plow Shop Pond Operable Unit.

V. SUMMARY OF SITE CHARACTERISTICS

Section 1 of the FS report contains an overview of RI and supplemental RI investigations at Shepley's Hill Landfill. A complete discussion of site characteristics can be found in Sections 3, 5, and 6 of the RI report, April 1993, and Sections 3, 4, and 5 of the RI Addendum report, December 1993. Significant findings of the RI and supplemental RI are summarized in the following subsections.

A. Soils

The RI at Shepley's Hill Landfill included collecting three surface soil samples from suspected seep areas and analyzing them for Target Compound List (TCL) organic compounds, Target Analyte List (TAL) metals, and total organic carbon (TOC). Low concentrations of acetone and methylene chloride were reported in the samples; however, they were attributed to laboratory contamination. No other organics were detected. Concentrations of TAL metals were within the estimated background range, except for calcium, which was elevated slightly. This was not considered significant. Because soil contamination was not identified during the RI, soils were not sampled during the supplemental RI.

B. Groundwater

Assessment of groundwater quality included two rounds of sampling at 22 monitoring wells during the RI, and one confirming round of sampling at 27 monitoring wells plus a second round at five monitoring wells during the supplemental RI. Target analyte groups for the RI and supplemental RI field programs included VOCs, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), explosives, and inorganics.

The RI report concluded that groundwater downgradient of the landfill was contaminated with VOCs and inorganics as well as low concentrations of explosives, pesticides, and PCBs in scattered monitoring wells. The presence of pesticides was not certain, however, because of apparent laboratory contamination of several method blanks. The PCB Aroclor-1260 was reported at a low concentration in only one of 22 samples in one sampling round. The SVOC di-ethylphthalate was reported at 12 and 32 parts per billion (ppb) in samples from two separate monitoring wells, and was considered a sampling artifact.

The RI Addendum report also concluded that downgradient monitoring wells were contaminated with several VOCs and inorganics. A total of nine VOCs was reported at low concentrations in seven of the monitoring wells. Organic compounds were reported most frequently and at the highest concentrations in the downgradient monitoring wells SHL-11, SHL-19, SHL-20, and SHM-93-10C along the eastern edge of the landfill. In two instances, concentrations exceeded federal Maximum Contaminant Levels (MCLs) or Massachusetts Maximum Contaminant Levels (MMCLs) for drinking water: total dichlorobenzenes were reported at 11 ppb (the MMCL for 1,4-dichlorobenzene = 5 ppb) in monitoring well SHL-20, and the VOC 1,2-dichloroethane was reported at 9.9 ppb (MCL = 5 ppb) in monitoring well SHM-93-10C.

Inorganics were also reported at their highest concentrations in downgradient monitoring wells, especially SHL-10, SHL-11, SHL-19, SHL-20, and SHM-93-22C. Unfiltered groundwater samples from downgradient monitoring wells typically exceeded background concentrations for arsenic, calcium, iron, magnesium, manganese, and potassium. In addition, there were scattered exceedances of background concentrations for barium, lead, vanadium, and zinc. The concentrations of arsenic ranged from 69 to 390 ppb (MCL = 50 ppb) in unfiltered samples from these monitoring wells. A significant portion of the total concentration of the inorganics was often associated with suspended material in the samples. An exception to this was the presence of dissolved arsenic in monitoring wells SHL-11, SHL-19, and SHL-20, all of which had high concentrations of arsenic in both filtered and unfiltered samples. Low oxidation potential in the samples with high dissolved arsenic concentrations was consistent with expected conditions downgradient of the landfill.

No pesticides or PCBs were reported in the supplemental RI groundwater samples. This led the RI Addendum report to reinterpret groundwater data presented in the RI report. Although pesticides were reported at low concentrations in several RI samples, no monitoring well had pesticides detected in both RI sampling rounds. In addition, the RI report states that several pesticides including heptachlor, endrin, alpha- and beta-benzenehexachloride, 2,2-bis(para-chlorophenyl)-1,1,1-trichloroethane (DDT), and endosulfan sulfate were detected in method blank samples, and that low concentrations of those compounds should be considered laboratory contamination. The RI report also noted difficulties with the pesticide and PCB analyses. These considerations and the supplemental RI data support the conclusion that the landfill is not a source of pesticides or PCBs in groundwater.

Supplemental RI data included the reported presence of the explosive nitroglycerine in one monitoring well, the water table monitoring well SHM-93-24A, at 80.8 ppb. This monitoring well is considered cross-gradient of the landfill and the source of the nitroglycerine is not known. The landfill is not considered a source of nitroglycerine. Although the explosives 1,3,5-trinitrobenzene, 1,3-dinitrobenzene and tetryl were reported inconsistently and at low concentrations in RI samples, they were not detected in the supplemental RI samples. SVOCs were not identified as groundwater contaminants in the RI report or targeted as analytes during the supplemental RI field program. They are not considered groundwater contaminants at Shepley's Hill Landfill.

C. Plow Shop Pond Surface Water

During the RI, samples were collected from 13 locations along the Plow Shop Pond shoreline to characterize surface water quality. Target analytes included TCL organics and TAL metals. The VOCs chloroform and methylene chloride were reported in several samples, and the pesticide endrin was reported at a low concentration in one sample. Methylene chloride was considered a laboratory contaminant and the detection of endrin was not considered significant in the RI report. The presence of chloroform, considered an improbable surface water contaminant in the RI report, could not be explained. The inorganics copper, silver, and zinc exceeded Ambient Water Quality Criteria (AWQC) for the protection of aquatic life throughout the pond, and iron and zinc exceeded AWQC in the wetlands area north of the pond.

D. Plow Shop Pond Sediments

Plow Shop Pond is believed to have been a historical discharge area for groundwater passing beneath Shepley's Hill Landfill and to have received contamination from the landfill. Areas of iron staining have been observed in Plow Shop Pond adjacent to the landfill. The characterization of Plow Shop Pond sediments was accomplished during both the RI and supplemental RI. The RI report concluded that pond sediments were contaminated with high concentrations of TAL metals and low concentrations of several polynuclear aromatic hydrocarbons. The VOCs acetone, methylene chloride, and 2-butanone were reported in several samples, as were low concentrations of 2,2-bis(para-chlorophenyl)-1,1-dichloroethene (DDE) and heptachlor. The presence of acetone, methylene chloride, and heptachlor is attributed to laboratory contamination.

Additional sediment samples were collected during the supplemental RI. The RI Addendum report concluded that sediments were contaminated with arsenic, barium, copper, chromium, iron, lead, manganese, mercury, nickel, and zinc. Based on available data, manufacturing process chemicals, waste disposal practices, and chemical distribution patterns in Plow Shop and Grove ponds, the RI Addendum report identified a former tannery located on Grove Pond as the major source of arsenic, chromium, lead, and mercury. Shepley's Hill Landfill was identified as a primary source of barium, iron, manganese, and nickel and a secondary source of arsenic, chromium, and lead. Data available at the time of the RI Addendum report were insufficient to define the source of copper. Subsequently available data from the Grove Pond and Railroad Roundhouse investigations suggest that activities at the tannery may have been a source of barium and copper and activities at the roundhouse may have been a source of copper and lead.

The supplemental RI sampling confirmed the presence of 2,2-bis(para-chlorophenyl)-1,1-dichloroethane (DDD), DDE, and DDT at low concentrations in Plow Shop Pond sediments. Several chemicals exceeded sediment quality guidelines. The RI Addendum report did not identify the landfill as a source of the pesticides.

VI. SUMMARY OF SITE RISKS

The risk assessment contained in the RI Addendum report evaluates the probability and magnitude of potential human health and environmental effects associated with exposure to contaminated media at the site and updates the risk assessment of the RI report. The human health risk assessment followed a four step process: (1) contaminant identification, which identified those hazardous substances that, given the specifics of the site, were of significant concern; (2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; (3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and (4) risk characterization, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the site, including carcinogenic and non-carcinogenic risks. A detailed discussion of the human health risk assessment approach and results is presented in Section 6 of the RI Addendum report and summarized in Subsection 1.4 of the FS report.

Forty contaminants of potential concern, listed in Tables 1 through 7 in Appendix B of this Record of Decision were selected for evaluation in the human health risk assessment of the RI Addendum report. These contaminants of concern were selected to represent potential site-related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment. A summary of the health effects of each of the contaminants of concern can be found in the risk assessment detailed in Section 6 of the RI Addendum Report and associated appendices.

Potential human health effects associated with exposure to the contaminants of concern were estimated quantitatively or qualitatively through the development of several hypothetical exposure pathways. These pathways were developed to reflect the potential for exposure to hazardous substances based on the present uses, potential future uses, and location of the site. The following is a brief summary of the exposure pathways evaluated; a more thorough description can be found in Subsection 6.1.2.2 of the risk assessment:

- incidental ingestion of Plow Shop Pond surface water, and long-term consumption of Plow Shop Pond fish by recreational fishermen and their families;
- contact (dermal contact and incidental ingestion) with Plow Shop Pond sediment by site visitors;
- contact (dermal contact and incidental ingestion) with surface water by swimmers in Plow Shop Pond; and
- future residential use of groundwater (there is no current identified use).

Because the RI report did not identify human health or ecological risks for soils exceeding the target risk values, soils were not re-evaluated in the RI Addendum report.

Excess lifetime cancer risks were determined for each exposure pathway by multiplying the exposure level with the chemical-specific cancer slope factor. Cancer slope factors have been developed by USEPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds. That is, the true risk is unlikely to be greater than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g. $1x10^{-6}$ for 1/1,000,000) and indicate (using this example), that an average individual is not likely to have greater that a one in a million chance of developing cancer over 70 years as a result of site-related exposure to the compound at the stated concentration. Current USEPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances.

The hazard index was also calculated for each pathway as a measure of the potential for non-carcinogenic health effects. A hazard quotient is calculated by dividing the exposure level by the reference dose (RfD) or other suitable benchmark for non-carcinogenic health effects for an individual compound. RfDs have been developed by USEPA to protect sensitive individuals over the course of a lifetime and they reflect a daily exposure level that is likely to be without an appreciable risk of an adverse health effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. The hazard quotient is often expressed as a single value (e.g., 0.3) indicating the ratio of the stated exposure as defined to the RfD value (in this example, the exposure as characterized is approximately one third of an acceptable exposure level for the given compound). The hazard quotient is only considered additive for compounds that have the same or similar toxic endpoint and the sum is referred to as the hazard index (HI). (For example: the hazard quotient for a compound known to produce liver damage should not be added to a second whose toxic endpoint is kidney damage).

The human health risk assessment of the RI Addendum report identifies the following potential human health risks:

- Future residential use of unfiltered groundwater interpreted to be under the influence of the landfill and contaminated with several inorganics (arsenic, manganese, chromium, lead, nickel, and sodium) and 1,2-dichloroethane and dichlorobenzenes was estimated to present potential cancer risks of $4x10^{-4}$ to $8x10^{-3}$. Most of the risk was due to the presence of arsenic. If a downward modifying factor of 10 is applied to this estimate to account for the uncertainty associated with arsenic risks, the modified risk estimate is $4x10^{-5}$ to $8x10^{-4}$, still within or exceeding the Superfund target risk range. Manganese presented average and maximum noncancer HI values of 12 to 55.

  It should be noted that when present at the federal MCL for drinking water, arsenic presents an estimated cancer risk of $1x10^{-3}$, which exceeds the target risk range, and an HI of 5.

- Long-term consumption of fish from Plow Shop Pond presented cancer risks that ranged from $3x10^{-6}$ to $4x10^{-4}$, within or exceeding the Superfund target risk range. Arsenic accounted for approximately 96 to 99 percent of the risk, while DDE contributed approximately 4 to 0.4 percent. Mercury presented noncancer risks that exceeded the target value of 1 (HIs ranged from 2 to 7). If a downward modifying factor of 10 is applied to the cancer risk estimate to account for the uncertainty associated with arsenic risks, the modified risk estimate is $3x10^{-7}$ to $4x10^{-5}$, which is within or below the Superfund target risk range. Thus it appears that the major human health risk associated with Plow Shop Pond fish is due to mercury contamination.

- Long-term contact with Plow Shop Pond sediment presented cancer risks of $2x10^{-5}$ to $2x10^{-4}$ and $9x10^{-5}$ to $6x10^{-4}$ under current and future exposure scenarios, respectively. Only under the maximum exposure assumptions did the estimates exceed the target risk range. Arsenic was responsible for essentially 100 percent of the risk. If a downward modifying factor of 10 is applied to the cancer risk estimate to account for the uncertainty associated with arsenic risks, the modified risk estimates are $2x10^{-6}$ to $2x10^{5}$ (current exposure scenario) and $9x10^{-6}$ to $6x10^{-5}$ (future exposure scenario), which are within or below the Superfund target risk range.

The ecological risk assessment evaluates risks to aquatic and semi-aquatic receptors from exposure to Plow Shop Pond surface water and sediments. Because the RI report did not identify ecological risks for soils exceeding the target risk values, soils were not re-evaluated in the RI Addendum report. Exposure of ecological receptors to groundwater was not evaluated because this was not considered a likely or significant exposure pathway.

The ecological risk assessment predicted, based on comparison to reference criteria, that Plow Shop Pond surface water and sediments present potential adverse risks to aquatic receptors. Average and maximum HI values for aquatic receptor exposure to surface water were 7.7 and 12.8, respectively. Primary contributors to potential risk were copper, silver, and zinc. For aquatic receptor exposure to sediments, average and maximum HI values were 182 and 1,300, respectively. Primary contributors to estimated risk were arsenic, chromium, manganese, and mercury. Other data, including fish and macroinvertebrate community studies, suggest that adverse effects may be less severe than predicted by the risk assessment.

For semi-aquatic wildlife, in both the average and maximum exposure scenarios, HIs were greater than 1 for five of the eight receptor species evaluated, including the mallard duck, painted turtle, green frog, mink, and muskrat. For the great blue heron, the HI for the maximum exposure scenario but not the average exposure scenario exceeded 1. HIs for the osprey and raccoon were well below 1. Sediments were predicted most likely to present potential risks to species with small home ranges and direct contact with sediment, such as the green frog or painted turtle. Primary contributors to predicted risk were arsenic, chromium, manganese, and mercury.

A detailed discussion of the ecological risk assessment approach and results is presented in Section 7 of the RI Addendum report and summarized in Subsection 1.5 of the FS report.

Actual or potential releases of hazardous substances to groundwater from Shepley's Hill Landfill, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to public health, welfare, and the environment.

VII. DEVELOPMENT AND SCREENING OF ALTERNATIVES

A. Statutory Requirements/Response Objectives

Under its legal authorities, the Army's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: a requirement that the remedial action, when complete, must comply with all federal and more stringent state environmental standards, requirements, criteria, or limitations, unless a waiver is invoked; a requirement that a remedial action be cost-effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment permanently and significantly reduces the toxicity, mobility, or volume of hazardous substances as a principal element. Response alternatives were developed to be consistent with these Congressional mandates.

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, remedial response objectives were developed to aid in the development and screening of alternatives. These remedial response objectives were developed to mitigate existing and future potential threats to public health and the environment. The response objectives are:

- Protect potential residential receptors from exposure to contaminated groundwater migrating from the landfill having chemicals in excess of MCLs.

- Prevent contaminated groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations.

Response objectives were not identified for surface soil, landfill gas, or leachate. The risk assessments did not identify potential risks from exposure to surface soil, and ambient air monitoring during the RI did not identify airborne contaminants. Liquid leachate was not identified during either RI or supplemental RI activities. Additional actions to manage risk from exposure to Plow Shop Pond surface water and sediment will be evaluated separately for the Plow Shop Pond Operable Unit.

B. Technology and Alternative Development and Screening

CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a range of alternatives was developed for the Shepley's Hill Landfill Operable Unit. The NCP reaffirms CERCLA's preference for permanent solutions that use treatment technologies to reduce the toxicity, mobility, and volume of hazardous substances to the maximum extent practical. With respect to source control, the in-situ treatment, or alternately the excavation and treatment, of such a large, heterogeneous landfill as Shepley's Hill Landfill is considered impractical and not cost effective. Therefore, the FS for the Shepley's Hill Landfill Operable Unit developed a range of alternatives in which containment of wastes was the principal element. This approach is consistent with guidance contained in the USEPA document *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, which states that the most practical remedial alternative for landfills is generally containment by capping. All of the alternatives (including the no action alternative) considered in the FS included containment of landfill waste by the existing cover system. One alternative was based on installing a Resource Conservation and Recovery Act (RCRA) composite cover system on top of the existing geomembrane cover system.

With respect to groundwater, the FS developed several remedial alternatives that attain site-specific cleanup levels using different technologies and a no action alternative. Three candidate alternatives included slurry wall containment of groundwater, two included in-situ treatment of groundwater, five included groundwater extraction and on-site treatment, and one included groundwater extraction and discharge to the local publicly owned treatment works (POTW). Except for the no action alternative, all the alternatives also included institutional controls, long-term maintenance, and environmental monitoring programs.

Section 3 of the FS identified, assessed, and screened technologies and process options based on implementability, effectiveness, and cost. In Section 4 of the FS, these technologies and process options were combined into the ten candidate alternatives listed below.

Alternative SHL-1: No Action
Alternative SHL-2: Limited Action
Alternative SHL-3: Containment/Collection/Short-term Ex Situ Treatment/Surface Water Discharge
Alternative SHL-4: Containment/In Situ Treatment
Alternative SHL-5: Collection/Ion Exchange Treatment/Surface Water Discharge
Alternative SHL-6: Collection/Chemical Precipitation Treatment/Surface Water Discharge
Alternative SHL-7: Collection/Constructed Wetland Treatment/Surface Water Discharge
Alternative SHL-8: Groundwater Barrier/In Situ Oxidation
Alternative SHL-9: Collection/Discharge to POTW
Alternative SHL-10: Installation of RCRA Cap

Each alternative was then evaluated and screened in Section 4 of the FS based on implementability, effectiveness, and cost, as described in Section 300.430(e)(4) of the NCP, to narrow the number of potential remedial alternatives for detailed analysis. From this screening process, five remedial alternatives were retained for detailed analysis.

VIII. DESCRIPTION OF ALTERNATIVES

Of the 10 alternatives identified in the FS, five were discarded during the FS screening step, and the remaining five were evaluated in detail. A detailed assessment of each alternative can be found in Section 5 of the FS report. This section provides a narrative summary of each of the following five alternatives evaluated in detail in the FS:

Alternative SHL-1: No Action
Alternative SHL-2: Limited Action
Alternative SHL-5: Collection/Ion Exchange Treatment/Surface Water Discharge
Alternative SHL-9: Collection/Discharge to POTW
Alternative SHL-10: Installation of RCRA Cap

A. Alternative SHL-1: No-Action

The No Action alternative does not contain any remedial action components beyond the existing landfill cover system to reduce or control potential risks. No institutional controls would be implemented to prevent future human exposure, and existing activities to maintain existing systems and monitor for potential future releases would be stopped. Alternative SHL-1 is developed to provide a baseline for comparison with the other remedial alternatives.

Estimated Time for Restoration: not applicable	
Estimated Capital Cost:	$0
Estimated Operation and Maintenance Cost: (net present worth)	$0
Estimated Total Cost: (net present worth, assuming 5% discount rate)	$0

B. Alternative SHL-2: Limited Action

Alternative SHL-2 contains components to maintain and potentially improve the effectiveness of the existing landfill cover system and to satisfy the Landfill Post-Closure Requirements of 310 CMR 19.142 to reduce potential future exposure to contaminated groundwater. Key components of this alternative include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;

- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- 60 percent design of a groundwater extraction system;
- annual reporting to MADEP and USEPA; and
- five-year site reviews.

Estimated Time for Restoration: Approximately 12 months for engineering evaluations, design, and construction.

Estimated Capital Cost:	$ 928,000
Estimated Operation and Maintenance Cost: (net present worth)	$1,291,000
Estimated Total Cost: (net present worth, assuming 5% discount rate)	$2,219,000

C. Alternative SHL-5: Collection/Ion Exchange Treatment/Surface Water Discharge

Alternative SHL-5 consists of components that, together with the components of Alternative SHL-2, would provide additional controls to prevent off-site migration of contaminated groundwater. Key components of Alternative SHL-5 include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- design, construction, operation, and maintenance of groundwater extraction, treatment, and discharge facilities;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- annual reporting to MADEP and USEPA; and
- five-year site reviews.

The major difference between Alternative SHL-5 and Alternative SHL-2 is the construction and operation of groundwater extraction, treatment, and discharge facilities. Data collected during predesign studies would be used to optimize the size and location of groundwater extraction wells at Shepley's Hill Landfill. Contaminated groundwater would be treated in an on-site groundwater treatment facility that (subject to treatability studies) includes carbon adsorption, sand filtration, and ion exchange treatment units and discharges through an effluent pipeline to Nonacoicus Brook.

Estimated Time for Restoration: Approximately 18 months for predesign studies, design, and construction. Groundwater extraction and treatment assumed to continue for a minimum of 30-years.

Estimated Capital Cost:	$2,577,000
Estimated Operation and Maintenance Cost: (net present worth)	$6,549,000
Estimated Total Costs: (net present worth, assuming 5% discount rate)	$9,126,000

D. Alternative SHL-9: Collection/Discharge to POTW

Alternative SHL-9 adds the components of groundwater extraction and discharge to the Town of Ayer POTW to Alternative SHL-2 to provide additional control to prevent off-site migration of contaminated groundwater. Key components of Alternative SHL-9 include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- design, construction, operation, and maintenance of groundwater extraction and discharge facilities;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;

- annual reporting to MADEP and USEPA; and
- five-year site reviews.

The major difference between Alternative SHL-9 and Alternative SHL-2 is the construction and operation of groundwater extraction and discharge facilities. Data collected during predesign studies would be used to optimize the size and location of groundwater extraction wells at Shepley's Hill Landfill. Following construction of the groundwater extraction facilities, contaminated groundwater would be pumped to a discharge manhole anticipated to be located on Scully Road near the north end of the landfill. There, the groundwater would combine with domestic wastewater and flow to the Town of Ayer POTW for treatment and subsequent discharge. The Ayer POTW, with a capacity of 1.79 million gallons per day (MGD), would be able to handle the additional anticipated volume of 20 to 30 gallons per minute (0.029 to 0.043 MGD).

Review of available groundwater monitoring data suggests that pretreatment of the groundwater will not be needed to meet existing pretreatment standards established by the Town of Ayer. The Army would monitor the groundwater discharge to the POTW, however, and if necessary install pretreatment facilities to meet pretreatment standards. The Army would pay a sewer user fee to the town based on the volume of water discharged to the POTW.

Estimated Time for Restoration: Approximately 15 months for predesign studies, design, and construction. Groundwater extraction and discharge to POTW assumed to continue for a minimum of 30-years.

Estimated Capital Cost:	$1,184,000
Estimated Operation and Maintenance Cost: (net present worth)	$2,690,000
Estimated Total Cost: (net present worth, assuming 5% discount rate)	$3,874,000

E. Alternative SHL-10: Installation of RCRA Cap

Alternative SHL-10 consists of building a new landfill cover system on top of the existing cover system at Shepley's Hill Landfill. The new cover system would be designed to meet RCRA performance criteria and design guidance for hazardous waste landfills. The principal component of the new cover system would be a 24-inch layer of low permeability soil in intimate contact with a geomembrane. Maintenance activities, monitoring and reporting requirements, and institutional controls would be similar to those of Alternative SHL-2.

Estimated Time for Restoration: Approximately three years required for design and construction.

Estimated Capital Cost:	$19,645,000
Estimated Operation and Maintenance Cost: (net present worth)	$ 1,291,000
Estimated Total Cost: (net present worth, assuming 5% discount rate)	$20,936,000

IX. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that at a minimum the Army is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives. The nine criteria are used to select a remedy that meets the goals of protecting human health and the environment, maintaining protection over time, and minimizing untreated waste.
A detailed analysis was performed on the alternatives using the nine evaluation criteria to select a site remedy. Specific discussion regarding this analysis is provided in Section 5 of the FS report. Definitions of the nine criteria are provided below:

Threshold Criteria

The two threshold criteria described below must be met in order for an alternative to be eligible for selection in accordance with the NCP.

- Overall Protection of Human Health and the Environment - Assesses how well an alternative, as a whole, achieves and maintains protection of human health and the environment.

- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) - Assesses how the alternative complies with location-, chemical-, and action-specific ARARs, and whether a waiver is required or justified.

Primary Balancing Criteria

The following five criteria are used to compare and evaluate the elements of alternatives that meet the threshold criteria.

- Long-Term Effectiveness and Permanence - 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 - Evaluates the effectiveness of treatment processes used to reduce toxicity, mobility, and volume of hazardous substances. This criterion considers the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

- Short-Term Effectiveness - 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. Considers the protection of the community, workers, and the environment during implementation of remedial actions.

- Implementability - 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 extent of required coordination with other parties or agencies.

- Cost - Evaluates the capital, and operation and maintenance costs of each alternative.

Modifying Criteria

The modifying criteria are used on the final evaluation of remedial alternatives generally after the Army has received public comments on the FS and proposed plan.

- 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.
- Community Acceptance - This criterion considers the communities preferences among or concerns about the alternatives.

Following the detailed analysis of each individual alternative, the Army conducted a comparative analysis, focusing on the relative performance of each alternative against the nine criteria. This comparative analysis of the five alternatives is presented in Table 6-1 of the FS report and summarized below.

A. Overall Protection of Human Health and the Environment

This criterion addresses how an alternative as a whole will protect human health and the environment. This includes an assessment of how public health and environmental risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls. According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final site remedy.

At Shepley's Hill Landfill, the existing cover system isolates landfill materials from the environment, blocks infiltration, and based on computer modeling, diverts groundwater that would otherwise discharge to Plow Shop Pond. Historical groundwater monitoring between the landfill and Plow Shop Pond has shown analyte concentrations in excess of cleanup levels; however, no current residential exposure to groundwater has been identified, and the existing cap prevents infiltration of contaminants into groundwater downgradient of the landfill. Alternatives SHL-1, SHL-2, SHL-5, and SHL-9, all of which rely on the existing cover to isolate waste, prevent infiltration, and reduce groundwater discharge to the pond, are considered equally protective of human health under current exposure scenarios. Alternative SHL-10, which proposes to replace the existing geomembrane cover with a composite cover, would not afford significantly greater protection under current conditions.

Differences in protectiveness may exist under future exposure conditions. Alternative SHL-1 proposes no action to prevent future residential exposure to groundwater or to maintain and monitor the long-term performance of the existing cover. The remaining alternatives all propose to implement zoning and deed restrictions to prevent future residential exposure to groundwater and to maintain and monitor long-term cover performance. Once installed, the composite cover system proposed for Alternative SHL-10 would be newer and therefore potentially provide protection longer than the existing cover. However, its protectiveness at any given time would not be significantly greater than the anticipated performance of the existing cover. In addition, the five-year site reviews proposed for all alternatives provide the opportunity to implement additional remedial actions if they are needed. The installation of a composite cover system could be considered in the future if the existing cover system does not perform as anticipated. Alternatives SHL-5 and SHL-9, in addition to their reliance on the existing cover system, propose to extract contaminated groundwater for subsequent treatment and discharge. They therefore provide some redundancy or backup to achieve cleanup levels if the existing cover system does not perform as anticipated.

There is no ecological exposure to groundwater. Reductions in infiltration and leaching coupled with the diversion of groundwater that would otherwise discharge to Plow Shop Pond will provide protection of the environment. The potential differences in effectiveness of the evaluated alternatives at protecting the environment are similar to the differences discussed for future protection of human health.

B. Compliance with Applicable or Relevant and Appropriate Requirements

This criterion addresses whether a remedy complies with all state and federal environmental and public health laws and requirements that apply or are relevant and appropriate to the conditions and cleanup options at a specific site. If an alternative cannot meet an ARAR, the analysis of the alternative must provide the rationale for invoking a statutory waiver.

Location-specific ARARs identified for the Shepley's Hill Landfill Operable Unit include regulations that protect wetlands, floodplains, and endangered species (i.e., the Grasshopper Sparrow, a state listed species of special concern). Alternatives SHL-1, SHL-2, and SHL-9 would not involve any activities anticipated to trigger wetlands or floodplain ARARs. Alternative SHL-5 would require construction of a discharge pipeline to Nonacoicus Brook and may trigger wetland and floodplain ARARs. Activities for all alternatives would be conducted or altered to comply with wetlands and floodplain ARARs. All of the alternatives would be subject to ARARs protecting endangered species. Activities performed for any of the alternatives would be planned to prevent or minimize adverse effects on the Grasshopper Sparrow and its habitat. In spite of this, implementation of Alternative SHL-10 would result in destruction of any nesting areas of the Grasshopper Sparrow that might exist at the landfill.

Alternatives SHL-1, SHL-2, and SHL-10 rely on cover system performance to comply with chemical-specific ARARs and cleanup levels. Currently groundwater at the northern end of the landfill meets cleanup levels, and landfill capping is expected to reduce leaching of landfill materials and the resulting groundwater contamination, thereby achieving cleanup levels along the eastern edge of the landfill. Alternatives SHL-5 and SHL-9 would comply with chemical-specific ARARs and cleanup levels with a combination of landfill capping and groundwater extraction. Groundwater exceeding cleanup levels would be extracted and treated or disposed of before exiting the site.

Several action-specific ARARs have been identified for the Shepley's Hill Landfill Operable Unit; the most important are the ones relating to landfill cover systems and landfill closure. The Massachusetts Solid Waste Management Regulations at 310 CMR 19.000 have been identified as applicable. USEPA Regulations for Owners and Operators of Permitted Hazardous Waste Facilities at 40 CFR 264 (RCRA Subtitle C), and USEPA Criteria for Municipal Solid Waste Landfills at 40 CFR 258 (RCRA Subtitle D), and Massachusetts Hazardous Waste Management Rules at 310 CMR 30.000 have all been identified as relevant and appropriate.

The design of the existing cover system at Shepley's Hill Landfill was approved by MADEP in 1985 pursuant to the Massachusetts Sanitary Landfill regulations of 1971 (310 CMR 19.00). Provisions in the Massachusetts Solid Waste Management Regulations of 1990 (310 CMR 19.000) indicate that the conditions of the 1985 approval satisfy 310 CMR 19.000; therefore the existing cover is considered to comply with the applicable cover system requirements of 310 CMR 19.000. In addition, the existing cover meets the general performance standards of 310 CMR 19.000. The existing cover system also meets the performance standards of RCRA Subtitle C at 40 CFR 264.310, RCRA Subtitle D at 40 CFR 258, and Massachusetts Hazardous Waste Regulations at 310 CMR 30.000. The existing cover varies from USEPA guidance for RCRA final covers primarily in that it has a geomembrane hydraulic barrier rather than a composite hydraulic barrier. Table 8 in Appendix B describes how the existing cover complies with these performance standards. Alternatives SHL-1, SHL-2, SHL-5, and SHL-9, which rely on the existing cover, will therefore comply with ARARs for cover systems. The cover system of Alternative SHL-10 would be designed to meet ARARs for cover systems as well as RCRA design guidance. The long-term monitoring and maintenance programs of all alternatives except Alternative SHL-1 would be designed to comply with the applicable requirements of 310 CMR 19.000.

Action-specific ARARs for landfill post-closure requirements would be met by all of the alternatives except Alternative SHL-1. Alternative SHL-5 would be required to meet the substantive requirements of a federal National Pollutant Discharge Elimination System (NPDES) permit to discharge treated groundwater to Nonacoicus Brook. These alternatives would also be required to meet ARARs for disposal of filter cake and resin regeneration concentrate from groundwater treatment and to meet substantive requirements of a U.S. Army Corps of Engineers permit, a MADEP license, and a Massachusetts water quality certification to construct a discharge pipeline to Nonacoicus Brook. Alternative SHL-9 would be required to meet the federal Clean Water Act General Pretreatment Requirements to discharge to the Town of Ayer POTW. Federal and state air quality regulations would be met by all the alternatives. Dust suppression techniques would be used, when necessary, for Alternatives SHL-5, SHL-9, and SHL-10 intrusive activities to meet air quality regulations.

C. Long-term Effectiveness and Permanence

This refers to the ability of an alternative to maintain reliable protection of human health and the environment over time once the cleanup levels have been met.

Alternative SHL-1 provides no controls or treatment beyond the existing cover system to protect human health and the environment. Alternatives SHL-2 and SHL-10 rely on the effectiveness of a landfill cover system to achieve the remedial action objectives. The other alternatives use groundwater extraction and treatment in addition to the cover system to achieve remedial action objectives. All of the alternatives except SHL-1 include landfill post-closure and long-term groundwater monitoring to evaluate their long-term effectiveness. All the alternatives except SHL-1 include institutional controls. Institutional controls require cooperation by private parties and government agencies to be reliable and effective.

Alternatives SHL-5 and SHL-9 would use data obtained from the pre-design hydrogeological investigation to design a groundwater extraction system. This would allow design of an extraction system that is effective in capturing contaminated groundwater. However, groundwater extraction would not prevent landfill waste and/or its leachate from potentially contaminating the underlying aquifer; these alternatives rely on the cover system as discussed earlier.

D. Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion is a principal measure of the overall performance of an alternative. The 1986 amendments to the Superfund statute emphasize that, whenever possible, a remedy should be selected that uses a treatment process to reduce permanently the toxicity of contaminants at the site, the spread of contaminants away from the source of contamination, and the volume or amount of contamination at the site.

Alternatives SHL-1, SHL-2, and SHL-10 do not meet the statutory preference for treatment under CERCLA since these alternatives do not treat contaminants contained in groundwater or wastes at the site. Landfill capping which is a part of each of all the alternatives will reduce infiltration and the resulting leaching of contaminants, thus reducing contaminant mobility.

Alternatives SHL-5 and SHL-9 meet the CERCLA statutory preference for treatment. These alternatives would reduce the mobility of contaminants by extracting the groundwater for treatment or disposal. The removal of contaminants from groundwater in Alternative SHL-5 would generate concentrated waste streams that would require disposal. Alternative SHL-9 would discharge extracted groundwater to the Town of Ayer POTW. The POTW generates sludge from treating influent water which would require disposal.

E. Short-term Effectiveness

This refers to the likelihood of adverse effects on human health or the environment that may be posed during the construction and implementation of an alternative until cleanup goals are achieved.

Alternatives SHL-1 and SHL-2 would have the least likelihood for adverse effects during implementation because no intrusive activities would be required. Alternative SHL-1 would have the least effect during implementation because it would not involve construction or operation. Alternatives SHL-5 and SHL-9 involve installation of extraction wells and underground piping. A Health and Safety Plan would be followed during performance of these activities and during environmental monitoring to minimize the risk of site hazards to workers. Alternative SHL-5 would require transportation of treatment residuals and adherence to RCRA and U.S. Department of Transportation regulations to minimize potential risks to workers.

Site activities would be performed to minimize effects on the Grasshopper Sparrow and its habitat. Maintenance schedules for Alternatives SHL-2, SHL-5, and SHL-9 would be prepared to limit activities during the nesting season. Construction schedules for Alternatives SHL-5 and SHL-9 would be prepared to limit activities during nesting season to avoid direct effects on the bird. Alternative SHL-10 would destroy any nesting areas of the Grasshopper Sparrow that might exist at the landfill.

F. Implementability

Implementability refers to the technical and administrative feasibility of an alternative, including the ease of construction and operation; administrative feasibility; and availability of services, equipment, and materials to construct and operate the technology. Also evaluated is the ease of undertaking additional remedial actions.

Post-closure requirements included in all of the alternatives present no implementation problems. Equipment and services required for monitoring and maintenance are readily available. Zoning and deed restriction (i.e., institutional controls) included in all alternatives, except SHL-1, could be easily implemented by the Army. Enforcement by the Town of Ayer would be required.

Groundwater extraction systems used in Alternatives SHL-5 and SHL-9 would be easily designed and constructed. Many engineering companies are qualified to design and install extraction systems. The treatment system proposed for Alternative SHL-5 uses sand filtration, carbon adsorption, and ion exchange, all of which are proven technologies with vendors available. Alternative SHL-9 would require a long-term discharge agreement between the Army and the Town of Ayer POTW as part of its implementation. Initial discussions with representatives from the Town of Ayer POTW indicate a willingness to consider accepting the discharge. Many engineering and construction companies are qualified to design and install the cover system of Alternative SHL-10.

Alternative SHL-1 would be the easiest alternative to implement at the site, and would have the least effect on future remedial actions.

G. Cost

Cost includes the capital (up-front) cost of implementing an alternative and the cost of operating and maintaining the alternative over the long term, and net present worth of both capital and operation and maintenance costs.

A comparison of the estimated total present worth costs (based on a 5 percent discount rate) for each alternative evaluated in detail is presented in the following table:

Alternative	Total Capital	Total O&M (net present worth)	Total Costs (net present worth)
SHL-1	$ 0	$ 0	$ 0
SHL-2	$ 928,000	$ 1,291,000	$ 2,219,000
SHL-5	$ 2,577,000	$ 6,549,000	$ 9,126,000
SHL-9	$ 1,184,000	$ 2,690,000	$ 3,874,000
SHL-10	$ 19,645,000	$ 1,291,000	$ 20,936,000

Capital, operation and maintenance, and present worth costs for each alternative were calculated with an estimated accuracy of -30 percent to +50 percent. The alternatives with the lowest capital costs are those that include the least amount of construction, such as Alternatives SHL-1, SHL-2, and SHL-9. Alternatives SHL-5 and SHL-10, which involve greater amounts of construction, require larger capital investment.

Operation and maintenance costs are estimated on an annual basis, and are lowest for Alternative SHL-1, which does not provide any long-term maintenance or monitoring. Operation and maintenance costs for Alternatives SHL-2, SHL-5, SHL-9, and SHL-10 include environmental monitoring for 30 years. Alternative SHL-5 includes operation of the groundwater extraction, treatment and discharge systems, while Alternative SHL-9 includes operation of groundwater extraction and discharge systems and groundwater monitoring for the estimated duration of treatment.

H. State Acceptance

This criterion addresses whether, based on its review of the RI, RI Addendum, FS, and proposed plan, the state concurs with, opposes, or has no comment on the alternative the Army is proposing as the remedy for the AOCs. The Commonwealth of Massachusetts has reviewed the RI, RI Addendum, FS, proposed plan, and this Record of Decision and concurs with the selected remedy.

I. Community Acceptance

This criterion addresses whether the public concurs with the Army's proposed plan. No comments were received from the community during the public comment period. The Army believes this shows community acceptance of the proposed plan and selected remedy.

X. THE SELECTED REMEDY

The selected remedy to address groundwater contamination at the Shepley's Hill Landfill Operable Unit is Alternative SHL-2: Limited Action, with Alternative SHL-9 as the contingency remedy if Alternative SHL-2 proves not to be protective. Each of these alternatives includes components for the containment of landfill wastes and management of contaminant migration. The remedial components of the selected remedy are described in detail below.

A. Groundwater Cleanup Levels

Groundwater cleanup levels for the Shepley's Hill Landfill Operable Unit were developed following the USEPA guidance documents entitled, *Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part B, Development of Risk Based Preliminary Remediation Goals)*, Interim, December 1991, and OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*. The first step in developing cleanup levels for protection of human health was to identify those environmental media that in the baseline risk assessment presented either a cumulative current or future cancer risk greater than $1x10^{-4}$ or a cumulative noncarcinogenic HI greater than 1, based on reasonable maximum exposure assumptions. The next step was to identify chemicals of concern within the media presenting cancer risks greater than $1x10^{-6}$ or a hazard quotient greater than 1. This approach identified dichlorobenzenes, 1,2-dichloroethane, arsenic, and manganese as chemicals of concern in groundwater. In addition, the baseline risk assessment identified the following chemicals of concern as exceeding MCLs or MMCLs: dichlorobenzenes, 1,2-dichloroethane, arsenic, chromium, and nickel. Concentrations of lead in groundwater exceeded the federal drinking water action level. Concentrations of aluminum and iron exceeded non-risk based federal and Massachusetts Secondary MCLs, while sodium exceeded the federal and Massachusetts guidelines for individuals on a sodium restricted diet.

With the exception of manganese, groundwater cleanup levels for chemicals of concern were established based on MCLs and MMCLs. No MCL or MMCL has been established for manganese. The cleanup level for manganese was based on background concentrations because background concentrations exceed the risk-based concentration derived from the available RfD value ($5x10^{-3}$ milligrams/kilograms/day). Because background concentrations for aluminum and iron exceed their respective guideline value, cleanup levels for them were set at the background value. The cleanup level for sodium was set equal to the federal health advisory. The following table summarizes cleanup levels for Shepley's Hill Landfill Operable Unit groundwater.

Chemical of Concern	Cleanup Level, $\mu g/L$	Selection Basis
Arsenic	50	MCL
Chromium	100	MCL
1,2-Dichlorobenzene	600	MCL
1,4-Dichlorobenzene	5	MMCL
1,2-Dichloroethane	5	MCL
Lead	15	Action Level
Manganese	291	Background
Nickel	100	MCL
Sodium	20,000	Health Advisory
Aluminum	6,870	Background
Iron	9,100	Background

Attainment of cleanup levels in groundwater will result in an approximate eight-fold reduction in potential human health risk, reflecting the approximate eight-fold reduction in arsenic concentrations needed to attain the arsenic cleanup level. Recent studies indicate that many skin tumors arising from oral exposure to arsenic are non-lethal and that the dose-response curve for the skin cancers may be sublinear (in which case the cancer slope factor used to generate risk estimates may be overestimated). It has been USEPA policy to manage these risks downward by as much as a factor of ten. As a result, the carcinogenic risk for arsenic at Shepley's Hill Landfill Operable Unit has been managed as if it were one order or magnitude lower than the calculated risk. The residual human health risk from residential exposure to groundwater after attainment of cleanup levels is estimated to be approximately $1x10^{-3}$ (unmodified to account for the uncertainty associated with arsenic) and $1x10^{-4}$ if modified to account for the uncertainty associated with exposure to arsenic.

B. Description of Remedial Components

Alternative SHL-2 contains components to maintain and potentially improve the effectiveness of the existing landfill cover system and to satisfy the Landfill Post-Closure Requirements of 310 CMR 19.142 to reduce potential future exposure to contaminated groundwater. Key components of this alternative include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- 60 percent design of a groundwater extraction system;
- annual reporting to MADEP and USEPA; and
- five-year site reviews.

Each of these components is described in the following paragraphs.

<u>Landfill Closure in Accordance with Applicable Requirements of 310 CMR 19.000.</u> Commonwealth of Massachusetts regulations at 310 CMR 19.000 contain requirements for the submittal to, and approval by, MADEP of plans and supporting materials to document that landfill closure occurs according to approved plans and applicable MADEP requirements. The Army submitted a draft closure plan for Shepley's Hill Landfill to MADEP on July 21, 1995 pursuant to 310 CMR 19.000; however, the landfill will not be officially closed until MADEP approves the documents. Review of the plan and official closure of the landfill by MADEP was anticipated prior to signature of this Record of Decision. The Army will coordinate the finalization and submittal of plans and support materials to MADEP to achieve official landfill closure.

<u>Survey of Shepley's Hill Landfill</u>. Prior to design and implementation of remedial actions at Shepley's Hill Landfill, an accurate topographic survey of the landfill surface is required. No survey has been done since completion of the last phase of landfill capping. The estimated cost of this alternative includes an aerial survey of Shepley's Hill Landfill. It also includes the costs to survey the elevation and horizontal location of

monitoring wells or piezometers installed as part of remedial alternative implementation, and to prepare record drawings.

Evaluation/Improvement of Stormwater Diversion and Drainage. Stormwater diversion and drainage systems at and adjacent to Shepley's Hill Landfill will be evaluated as part of this alternative. Modifications for improvement will be implemented if the evaluation shows they would be practical and cost-effective. The evaluation will focus on the following items of concern:

- landfill cap runoff patterns and drainage ditch flow capacities;
- potential run-under along the western edge of the landfill, particularly where the existing geomembrane cap may not have a good seal with the underlying bedrock; and
- the effectiveness of stormwater drainage systems upgradient of the landfill (i.e., at the transfer station, tire recycling station, DRMO yards, and along Market Street) at diverting run-off from potential infiltration areas upgradient of the landfill.

Detailed plans for evaluating stormwater diversion and drainage would be developed during the alternative's design phase and submitted for regulatory agency review and concurrence.

Landfill Cover Maintenance. A small area of ponded water in the northwestern section of the landfill would be drained and regraded to minimize stress on the cover system and prevent future ponding and potential for leakage through the PVC geomembrane. The area is approximately 100 feet in diameter and is estimated to be about 1 foot deep. The water would be pumped out and the ponded area backfilled with common borrow to bring the area up to the desired grade. A new section of PVC geomembrane would be installed on top of the fill and seamed to the existing geomembrane cap to provide a low permeability surface in this area.

At the northern end of the landfill, erosion of cover soil in sections of the drainage swales has occurred in the past, exposing PVC geomembrane. This erosion has been repaired, but may require additional repair in the future.

Annual inspections are proposed to monitor the condition of the landfill cover at Shepley's Hill Landfill, including monitoring wells, cover surface, and drainage swales to decide if maintenance is needed. Grass will be mowed annually and the cover repaired as required. Landfill maintenance and mowing would be scheduled to minimize potential adverse effects to the Grasshopper Sparrow, a state-listed species of special concern that may nest on the cover.

Detailed plans for landfill cover maintenance would be developed during the alternative's design phase and submitted for regulatory agency review and concurrence.

Landfill Gas Collection System Maintenance. Annual inspections are proposed to monitor the Shepley's Hill Landfill gas collection system and provide any necessary repairs.

Long-term Groundwater Monitoring. Groundwater monitoring is proposed to monitor groundwater quality at Shepley's Hill Landfill and to assess future environmental effects. Based on the hydrogeologic interpretation and analytical data presented in the RI Addendum report, the FS report presents proposed monitoring locations and analytical parameters for a conceptual long-term groundwater monitoring program. The conceptual plan includes installation of three new monitoring wells at the north end of the landfill to create nested triplets of shallow/water table, mid-depth, and deep overburden monitoring wells at SHL-9/SHL-22 and SHL-5. The monitoring wells that are included in the conceptual program would be sampled semi-annually for a minimum of 30 years, consistent with 310 CMR 19.142. Table 5-3 of the FS report presents proposed monitoring locations and analytical parameters for a conceptual long-term groundwater monitoring program.

Detailed plans for long-term groundwater monitoring would be developed during the alternative's design phase and submitted for regulatory agency review and concurrence.

Long-term Landfill Gas Monitoring. As part of post-closure monitoring activities, landfill gas will be monitored quarterly at landfill gas vents and analyzed in the field by direct-reading instruments for lower explosive limit and total organic gases. Semiannual samples will be collected from the two vents with the highest field measurements and analyzed for TCL VOCs. These samples will be collected and analyzed in accordance with USEPA Method TO 14. Detailed plans for landfill gas monitoring would be developed during the alternative's design phase and submitted for regulatory agency review and concurrence.

Institutional Controls. Institutional controls are proposed in the form of zoning and deed restrictions for any property released by the Army at Shepley's Hill Landfill during Fort Devens base-closure activities. The Fort Devens Preliminary Reuse Plan, Main and North Posts has proposed that Army land bordering Plow Shop Pond be zoned for open space and rail-related uses. By pre-empting residential use, these controls would help limit human exposure. In addition, the Army would place deed restrictions on landfill area property to prohibit installation of drinking water wells. This, in combination with landfill capping and long-term groundwater monitoring, would protect potential human receptors from risks resulting from exposure to contaminated groundwater. There are no current human receptors for groundwater exposure. Institutional controls would be drafted, implemented, and enforced in cooperation with state and local governments.

Educational Programs. Periodic public meetings and presentations would be conducted to increase public awareness. This would help keep the public informed of the site status, including both its general condition and remaining contaminant levels. This could be accomplished by conducting public meetings every five years coincident with the five-year site reviews for Shepley's Hill Landfill. The presentation would summarize site activities and the results of monitoring programs.

60 Percent Design of a Groundwater Extraction System. The Army will conduct predesign hydrogeologic studies and prepare a 60 percent complete engineering design for groundwater extraction and discharge to the Town of Ayer POTW. Predesign studies may include installation of several additional piezometers in and around the landfill, collection of additional groundwater elevation data, and updating/refining the groundwater model. Detailed plans for monitoring the piezometers will be developed as part of the long-term groundwater monitoring plan. The 60 percent complete engineering design will begin in 1996 and be completed before the first five-year site review, scheduled for 1998.

Annual Reporting to MADEP and USEPA. Reports which would include a description of site activities and a summary of results of environmental monitoring would be submitted annually to MADEP and USEPA. This reporting would satisfy the requirements of 310 CMR 19.132 and 19.142.

Five-year Site Reviews. Under CERCLA 121c, any remedial action (or lack thereof) that results in contaminants remaining on-site must be reviewed at least every five years. During five-year reviews, an assessment is made of whether the implemented remedy is protective of human health and the environment and whether the implementation of additional remedial action is appropriate.

The five-year site reviews for Alternative SHL-2 will evaluate the alternative's effectiveness at reducing potential human health risk from exposure to groundwater and at preventing groundwater from contributing to Plow Shop Pond sediment contamination in excess of human health and ecological risk-based values. These evaluations will be based on how successful the alternative is at attaining cleanup levels at individual wells in two distinct monitoring well groups. Well Group 1 consists of wells, primarily at the north end of the landfill, where cleanup levels have been attained historically. Well Group 2 consists of wells where historically cleanup levels have not been attained.

The goal of Alternative SHL-2 is to maintain groundwater quality below cleanup levels at Group 1 wells, and to attain cleanup levels at Group 2 wells. Since groundwater quality historically attains cleanup levels in Group 1 wells, Alternative SHL-2 will be considered effective with regard to these wells if five-year site reviews show that this condition is maintained.

Evaluating effectiveness at Group 2 wells is less straightforward. Installation of the geomembrane cap over the most upgradient areas at Shepley's Hill Landfill (i.e., areas in the Phase IV-B closure) was not completed until May 1993. Based on groundwater modeling, it is estimated that the average time needed for groundwater to travel from these upgradient areas to downgradient wells SHL-11 and SHL-20 may be 10 to 14 years or longer. An equal or greater number of years may be needed for downgradient groundwater quality at these wells to attain cleanup levels. Overall groundwater quality is expected to improve and potential risk is expected to decrease during this period, although at some wells, certain chemicals may show small short-term increases in concentration while other chemicals show decreases in concentrations and overall risk is reduced.

The Army proposes to use reduction of risk rather than reduction of concentration as a measure of progress toward attainment of cleanup levels because this approach focuses on the cleanup of arsenic, which is the primary contributor to risk in the Group 2 wells. This approach prevents a situation in which failure to attain a concentration reduction goal for a minor contributor to risk (e.g., 1,2-dichloroethane where a reduction of 2.5 ppb represents a 50 percent reduction in concentration exceeding the cleanup level) overshadows the achievement of 50 percent or greater reduction in the concentration of arsenic. In the Group 2 wells, a 50 percent reduction in the concentration of arsenic approximates a 50 percent reduction in groundwater risk, while a 50 percent reduction in the concentration of 1,2-dichloroethane represents less than a 1 percent reduction in groundwater risk. Alternative SHL-2 will be considered effective with regard to these wells if five-year reviews show an ongoing reduction of potential human health risk at Group 2 wells and the ultimate attainment of cleanup levels by January 2008.

The specific criteria for evaluating the effectiveness of Alternative SHL-2 are stated below. The criteria for both groups of wells must be met for the alternative to be considered effective.

> Group 1 Wells. For Group 1 wells where analyte concentrations have historically attained cleanup levels, Alternative SHL-2 will be considered effective if concentrations of individual chemicals within individual wells do not show statistically significant cleanup level exceedances. To determine statistical significance, the Army will apply methods consistent with the regulations at 40 CFR 264.97, 40 CFR 258.53, and 310 CMR 30.663.

> Group 2 Wells. For Group 2 wells where chemical concentrations have exceeded cleanup levels in the past, Alternative SHL-2 will be considered effective if a 50 percent reduction in the increment of risk between cleanup levels and baseline concentrations for chemicals of concern within individual wells is achieved by January 1998, if an additional 25 percent (75 percent cumulative) is achieved by January 2003, and if cleanup levels are attained by January 2008.

The Army will apply methods consistent with the regulations at 40 CFR 264.97, 40 CFR 258.53, and 310 CMR 30.663 to estimate chemical concentrations at baseline conditions. Analytical data collected during RI (August and December 1991) and supplemental RI (March and June 1993) activities will be used to estimate the baseline conditions. The detailed approach would be developed during the design phase and submitted for regulatory agency review and concurrence.

A major consideration in assessing the protectiveness of Alternative SHL-2 and whether additional remedial actions may be appropriate will be the basis on which individual cleanup levels were set. The Army will implement the contingency remedy if the above criteria are not met for any chemicals for which cleanup levels were based on MCLs (40 CFR 141) and for manganese. No MCL has been established for manganese. The cleanup level for manganese was based on background concentrations because background concentrations exceed the risk-based concentration derived from the available RfD value ($5x10^{-3}$ milligrams/kilograms/day). This approach for setting cleanup levels and for evaluating the effectiveness of landfill closure is consistent with USEPA guidance contained in *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim*, December 1991, and with 40 CFR 258.55.

The Army will not implement additional remedial actions under CERCLA if cleanup levels are not attained for aluminum and iron. The cleanup levels for aluminum and iron were based on background concentrations because dose/response values were not available.

Similarly, the Army will not implement additional remedial actions if the cleanup level is not attained for sodium. The cleanup level for sodium was based on the health advisory for individuals on a reduced sodium diet.

Estimated Time for Restoration: Approximately 12 months for engineering evaluations, design, and construction.	
Estimated Capital Cost:	$ 928,000
Estimated Operation and Maintenance Cost: (net present worth)	$1,291,000
Estimated Total Cost: (net present worth, assuming 5% discount rate)	$2,219,000

XI. STATUTORY DETERMINATIONS

The selected remedy for the Shepley's Hill Landfill Operable Unit, Alternative SHL-2, is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, attains ARARs, and is cost-effective. The remedy utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable for this site. However, because treatment of the principal source of contamination at the site was found not to be practicable, Alternative SHL-2 does not satisfy the statutory preference for treatment as a principal element.

A. The Selected Remedy is Protective of Human Health and the Environment.

Alternative SHL-2 will permanently reduce the risks to human health and environment by eliminating, reducing, or controlling exposures to human and environmental receptors through engineering and institutional controls. The principal threat at the Shepley's Hill Landfill Operable Unit is potential residential use of contaminated groundwater. The landfill closure plan, approved in 1985 and implemented in 1986 through 1993, relies on landfill capping and stormwater controls to reduce leaching of landfill materials and contamination of groundwater, thereby reducing potential risk associated with groundwater use. Institutional controls included in this alternative would prevent the use of groundwater from the contaminated aquifer, resulting in reduced potential for human exposure to contaminated groundwater. The landfill cover maintenance activities will help ensure protection of human health and the environment by maintaining the integrity and effectiveness of the cover.

The effectiveness of the selected alternative will be evaluated by comparing groundwater monitoring data to cleanup levels tabulated in Subsection X.A. Attainment of cleanup levels along the eastern edge of the landfill will result in potential human health risk levels within the Superfund target risk range of $1x10^{-4}$ to $1x10^{-6}$ for carcinogenic chemicals. Groundwater at the north end of the landfill currently meets cleanup levels.

Groundwater modeling done during the FS suggests that capping of the landfill has significantly reduced the amount of water in the landfill area, resulting in a more northerly groundwater flow and reducing potential adverse effects on Plow Shop Pond. Groundwater at the north end of the landfill currently meets cleanup levels. No ecological receptor exposure to contaminated groundwater was identified.

Alternative SHL-9, the contingency remedy for the Shepley's Hill Landfill Operable Unit, is also protective of human health and the environment. Alternative SHL-9 will permanently reduce the risks to human health and environment by eliminating, reducing, or controlling exposures to human and environmental receptors through engineering and institutional controls. The principal threat at the Shepley's Hill Landfill Operable Unit is potential residential use of contaminated groundwater. The landfill closure plan, approved in 1985 and implemented in 1986 through 1993, relies on landfill capping and stormwater controls to reduce leaching of landfill materials and contamination of groundwater, thereby reducing potential risk associated with groundwater use. In addition, as part of Alternative SHL-9 groundwater would be pumped from the contaminated aquifer and discharged to the Town of Ayer POTW for treatment and discharge, preventing contaminant migration and potential exposure. Institutional controls included in this alternative would further prevent the use of groundwater from the contaminated aquifer, resulting in reduced potential for human exposure to contaminated groundwater. The landfill cover maintenance activities will help ensure protection of human health and the environment by maintaining the integrity and effectiveness of the cover.

The effectiveness of the contingency alternative will be evaluated by comparing groundwater monitoring data to cleanup levels tabulated in Subsection X.A. Attainment of cleanup levels along the eastern edge of the landfill will result in potential human health risk levels within the Superfund target risk range of $1x10^{-4}$ to $1x10^{-6}$ for carcinogenic chemicals. Groundwater at the north end of the landfill currently meets cleanup levels.

Groundwater modeling done during the FS suggests that capping of the landfill has significantly reduced the amount of water in the landfill area, resulting in a more northerly groundwater flow and reducing potential adverse effects on Plow Shop Pond. Groundwater at the north end of the landfill currently meets cleanup levels. No ecological receptor exposure to contaminated groundwater was identified.

B. The Selected Remedy Attains ARARs.

The selected remedy will attain all applicable or relevant and appropriate federal and State requirements. No waivers are required. ARARs for the Shepley's Hill Landfill Operable Unit were identified and discussed in the FS (Sections 2 and 5). Table 9 in Appendix B summarizes the ARARs for the selected remedy, including the regulatory citation, a brief summary of the requirement, and how it will be attained. Environmental laws from which ARARs for the selected remedial action are derived, and specific ARARs include:

Location-specific Federal Requirements

Floodplain Management Executive Order No. 11988, (40 CFR Part 6, App. A)(Applicable)

Protection of Wetlands Executive Order No. 11990 (Applicable)

Fish and Wildlife Coordination Act, (16 USC 661 et seq.; 40 CFR Part 302)(Applicable)

Endangered Species Act, (16 USC 1531 et seq.; 50 CFR Part 402)(Applicable)

Location-specific State Requirements

Massachusetts Wetland Protection Act and Regulations, (MGL c. 131 s. 40; 310 CMR 10.00)(Applicable)

Massachusetts Endangered Species Act and implementing regulations, (MGL c. 131A, s. 1 et seq.; 321 CMR 8.00)(Applicable)

Areas of Critical Environmental Concern, (301 CMR 12.00)(Relevant and Appropriate)

Chemical-specific Federal Requirements

Safe Drinking Water Act, National Primary Drinking Water Standards, MCLs, (40 CFR Parts 141.11-141.16 and 141.50-191.51)(Relevant and Appropriate)

Chemical-specific State Requirements

Massachusetts Surface Water Quality Standards, (314 CMR 4.00)(Applicable)

Massachusetts Groundwater Quality Standards, (314 CMR 6.00)(Applicable)

Massachusetts Drinking Water Standards and Guidelines, (310 CMR 22.00)(Relevant and Appropriate)

Massachusetts Ambient Air Quality Standards, (310 CMR 6.00)(Relevant and Appropriate)

Massachusetts Air Pollution Control Regulations, (310 CMR 7.00)(Relevant and Appropriate)

Action-specific Federal Requirements

Resource Conservation and Recovery Act (RCRA), (Subtitle D, 40 CFR 258)(Relevant and Appropriate)

Resource Conservation and Recovery Act (RCRA), (Subtitle C, 40 CFR 260, 264)(Relevant and Appropriate)

Action-specific State Requirements

Massachusetts Solid Waste Management Regulations, (310 CMR 19.100)(Applicable)

Massachusetts Hazardous Waste Regulations, (310 CMR 30.00)(Relevant and Appropriate)

The contingency remedy, Alternative SHL-9, will also attain all applicable or relevant and appropriate federal and State requirements. No waivers are required. ARARs for the Shepley's Hill Landfill Operable Unit were identified and discussed in the FS (Sections 2 and 5). ARARs for the Alternative SHL-9 are the same as for Alternative SHL-2 with the addition of the General Pretreatment Program regulations (40 CFR 403) promulgated pursuant to the Clean Water Act. These regulations require that nondomestic wastewater discharges to a POTW must comply with the general prohibitions of the regulation, any categorical pretreatment standards, and local pretreatment standards. The discharge of groundwater to the POTW would be sampled to evaluate compliance with the regulation.

C. The Selected Remedial Action is Cost-Effective.

In the Army's judgment, the selected remedy is cost effective (i.e., the remedy affords overall effectiveness proportional to its costs). In selecting this remedy, once the Army identified alternatives that are protective of human health and the environment and attain, or, as appropriate, waive ARARs, the Army evaluated the overall effectiveness of each alternative according to the relevant three criteria -- long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs.

Review of the discussion of "Overall Protection of Human Health and the Environment" in Subsection IX.A. and of "Cost" in Subsection IX.G. suggests that Alternatives SHL-2, SHL-5, SHL-9, and SHL-10 all provide a similar level of protectiveness. However, Alternative SHL-2 does so at the lowest cost and is considered the most cost-effective of those four alternatives. The cost of Alternative SHL-9, although approximately 1.75 times as much as Alternative SHL-2, is still considered proportional to the benefits, and Alternative SHL-9 is also considered cost-effective. Alternative SHL-5 is very similar to Alternative SHL-9, but costs over twice as much as Alternative SHL-9 and over four times as much as Alternative SHL-2: it is not considered cost-effective. Alternative SHL-10, which costs nearly ten times as much as Alternative SHL-2, is not considered cost-effective. The costs of the selected remedy, Alternative SHL-2, in 1994 dollars are:

Estimated Capital Cost:	$ 928,000
Estimated Operation and Maintenance Cost (net present worth):	$ 1,291,000
Estimated Total Cost (net present worth):	$ 2,219,000

Should the selected remedy fail to be protective, the contingency remedy, Alternative SHL-9, will be implemented, the overall effectiveness of which is proportional to its costs. The costs of the contingency remedy are presented below:

Estimated Capital Cost:	$ 1,184,000
Estimated Operation and Maintenance Cost (net present worth):	$ 2,690,000
Estimated Total Cost (net present worth):	$ 3,874,000

D. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable.

Once the Army identified those alternatives that attain or, as appropriate, waive ARARs and that are protective of human health and the environment, the Army determined which alternative made use of permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of trade-offs among alternatives in terms of: (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility or volume through treatment; (3) short-term effectiveness; (4) implementability; and (5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility, and volume through treatment; and considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The selected remedy provides the best balance of trade-offs among the alternatives.

As described in Section IX, Summary of The Comparative Analysis of Alternatives, Alternative SHL-1 does not provide long-term effectiveness and permanence, while Alternatives SHL-2, SHL-5, SHL-9, and SHL-10 provide similar long-term effectiveness and permanence.

Alternatives SHL-1, SHL-2, and SHL-10 do not meet the statutory preference for treatment under CERCLA since these alternatives do not treat contaminants contained in groundwater or wastes at the site. Landfill capping which is a part of each alternative will reduce infiltration and the resulting leaching of contaminants, thus reducing contaminant mobility. Alternatives SHL-5 and SHL-9 meet the CERCLA statutory preference for treatment. These alternatives would reduce the mobility of contaminants by extracting the groundwater for treatment or disposal.

Among the five alternatives, Alternatives SHL-1 and SHL-2 have the least potential for adverse short-term effects while Alternative SHL-10 has the greatest potential. Alternatives SHL-5 and SHL-9 share a similar intermediate potential for adverse short-term effects.

Although Alternative SHL-1 is seen to have the easiest technical implementability, significant obstacles to current implementation or implementation of future remedial actions are not foreseen for any of the alternatives. Implementation of Alternative SHL-9 does require a long-term discharge agreement between the Army and the Town of Ayer POTW.

Alternative SHL-1, the No Action alternative, does not require any capital commitment or any ongoing expenditure for operation and maintenance. Of the remaining alternatives, Alternative SHL-2 has the lowest estimated cost. Alternative SHL-5 costs approximately four times more than Alternative SHL-2, while Alternative SHL-9 costs approximately two times more than Alternative SHL-2. The estimated cost of Alternative SHL-10 is approximately ten times greater than the cost of Alternative SHL-2.

The Army believes Alternative SHL-2 provides the best balance among the alternatives that are protective and attain ARARs. Alternative SHL-2 offers potential long-term effectiveness with little potential for short-term risks. The alternative is readily implementable at a moderate cost. Although named Limited Action, Alternative SHL-2 is based on the presence of an existing landfill cover system designed to comply with applicable MADEP criteria. Installation of the cover system was only completed in 1993, and Alternative SHL-2 provides an opportunity to monitor and evaluate the effectiveness of the cover system at controlling groundwater contamination. The selection of Alternative SHL-2 is cost-effective and consistent with USEPA guidance contained in the USEPA document *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, which states that the most practical remedial alternative for landfills is generally containment by capping.

The Army believes the contingency remedy, Alternative SHL-9, provides the next best balance among the alternatives that are protective and attain ARARs. Alternative SHL-9 offers potential long-term effectiveness, but compared to Alternative SHL-2 has a somewhat greater potential for short-term risks. The alternative is readily implementable at approximately twice the cost of Alternative SHL-2. Similar to Alternative SHL-2, Alternative SHL-9 is based on the presence of an existing landfill cover system designed to comply with applicable MADEP criteria. Alternative SHL-9 has groundwater extraction and treatment/disposal components to further control contaminant migration and potential exposure.

E. The Selected Remedy Does Not Satisfy the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility, and Volume of Hazardous Substances as a Principal Element

The principal element of the selected remedy is source control by containment of landfill materials. This element addresses the primary threat at the Shepley's Hill Landfill Operable Unit, which is potential residential use of contaminated groundwater, by controlling the leaching of landfill materials and the release of contaminants to groundwater. Therefore, the selected remedy does reduce contaminant mobility, but not by treatment. In-situ treatment, or alternately the excavation and treatment, of such a large, heterogeneous landfill as Shepley's Hill Landfill is considered impractical and not cost effective. If the selected remedy proves not to be protective, the contingency alternative (Alternative SHL-9), which includes groundwater extraction and treatment, will be implemented to attain cleanup levels.

XII. DOCUMENTATION OF NO SIGNIFICANT CHANGES

The Army presented a proposed plan (preferred alternative) for remediation of Shepley's Hill Landfill Operable Unit on June 6, 1995. The components of the preferred alternative (Alternative SHL-2: Limited Action) included:

- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- 60 percent design of a groundwater extraction system
- annual reporting to MADEP and USEPA; and
- five-year site reviews.

New information obtained prior to the final selection of the remedy for Shepley's Hill Landfill Operable Unit resulted in a modification of the preferred alternative discussed in the proposed plan. The preferred alternative, Alternative SHL-2, was selected in part because approval of landfill closure documents and official closure of the landfill by MADEP under applicable requirements of 310 CMR 19.000 were expected prior to Record of Decision signature. However, although construction of the cap on the landfill is complete, and the Army has submitted supporting documentation to MADEP, the landfill closure will not be officially complete until MADEP approves the documents.

Consequently, the selected remedy has been modified to include achievement by the Army of the official closure of the landfill by MADEP. The ARARs table has been modified to reflect this additional remedial requirement. This change to the remedy, though significant, has little or no effect on the scope, performance, or cost of the proposed remedy, and does not require additional public comment.

The contingency remedy, Alternative SHL-9, has also been modified from the proposed plan to include achievement by the Army of official closure of the landfill by MADEP pursuant to applicable requirements of 310 CMR 19.000.

XIII. STATE ROLE

The Commonwealth of Massachusetts has reviewed the alternatives presented in the FS and proposed plan and concurs with the selected remedy for the Shepley's Hill Landfill Operable Unit. The Commonwealth has also reviewed the RI, RI Addendum, and FS to determine if the selected remedy complies with applicable or relevant and appropriate laws and regulations of the Commonwealth. A copy of the declaration of concurrence is attached as Appendix E.

APPENDIX A

APPENDIX A - FIGURES

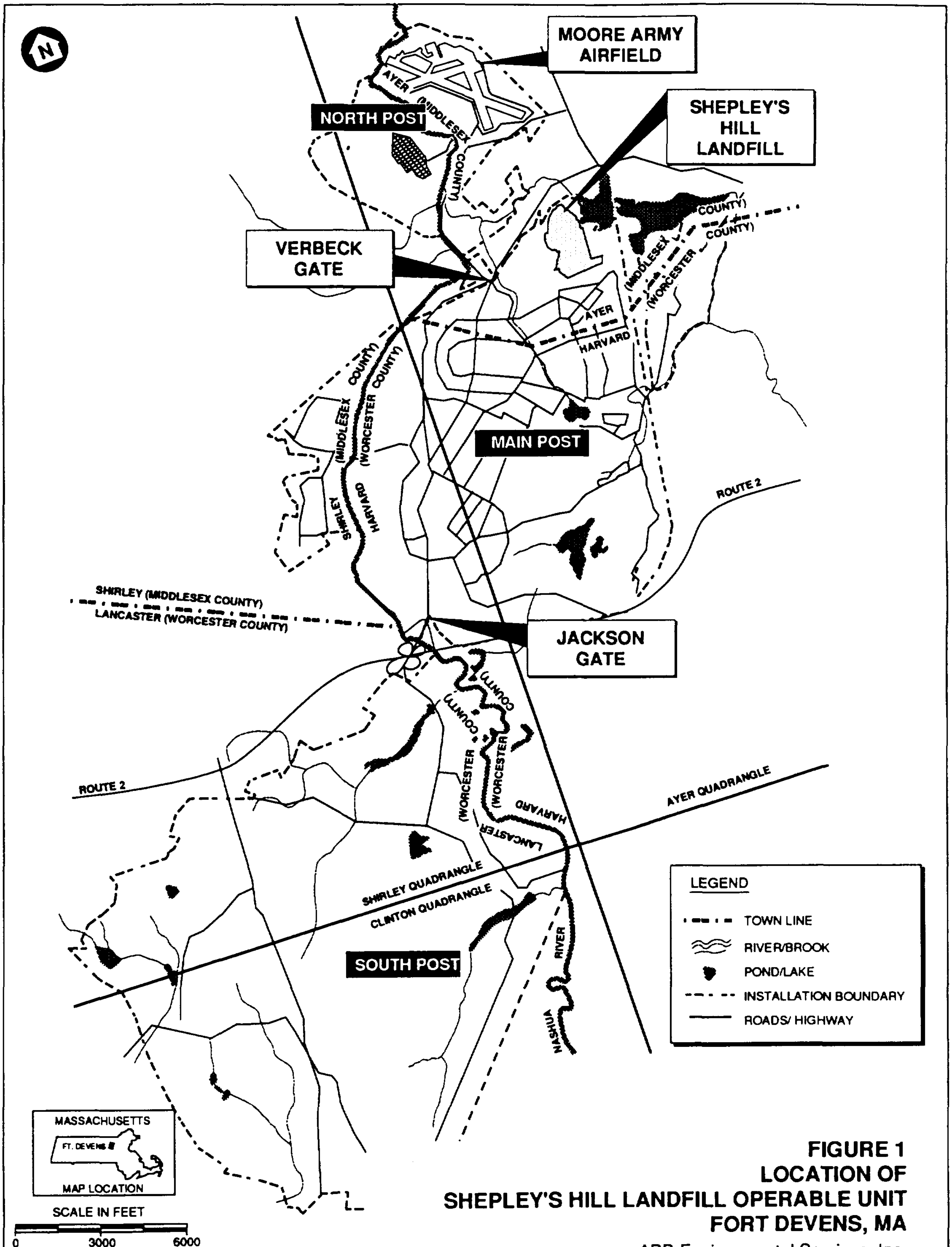

FIGURE 1
LOCATION OF
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

ABB Environmental Services, Inc.

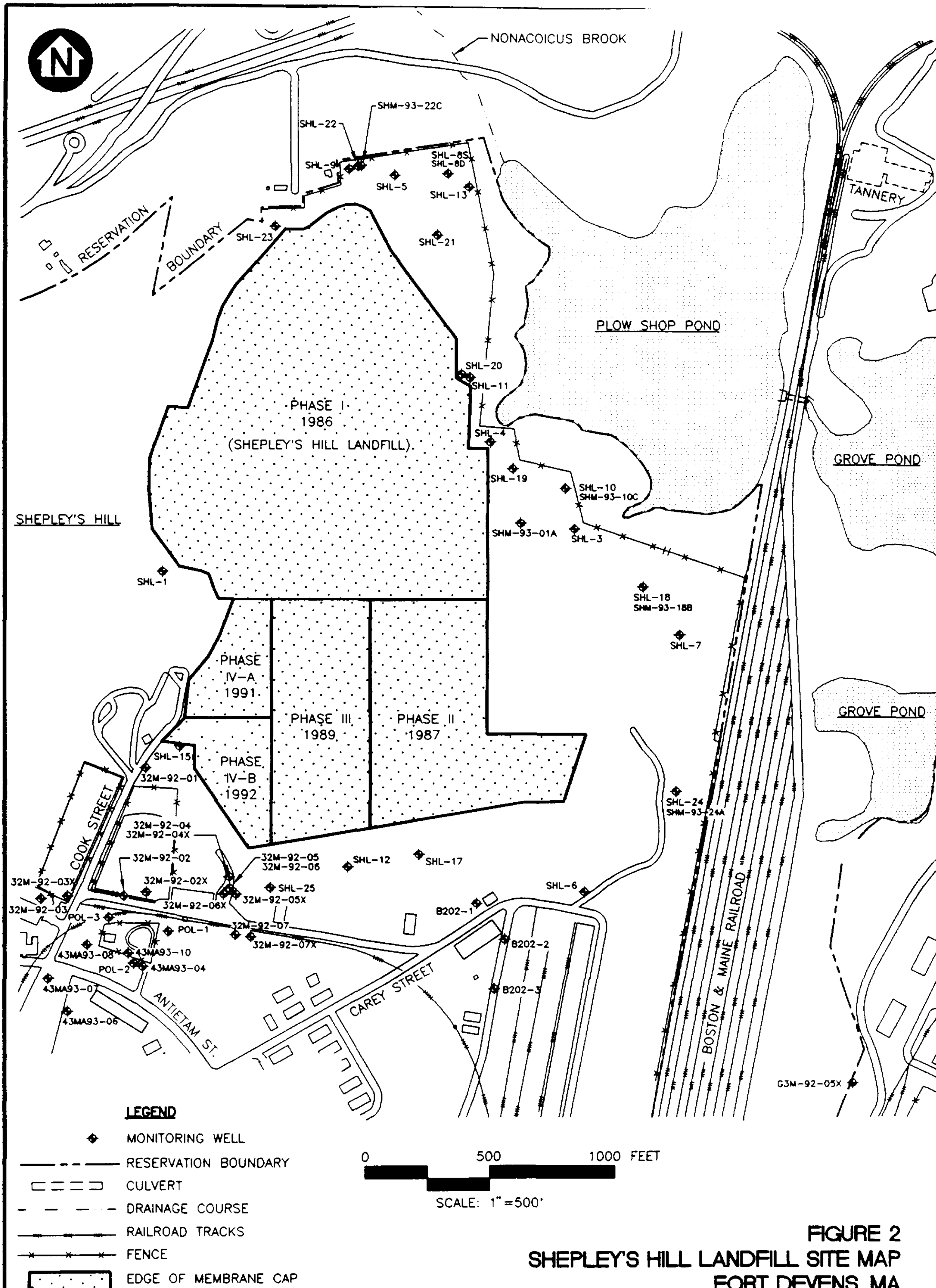

FIGURE 2
SHEPLEY'S HILL LANDFILL SITE MAP
FORT DEVENS, MA
ABB Environmental Services, Inc.

APPENDIX B

APPENDIX B - TABLES

TABLE 1
SUMMARY STATISTICS FOR SHEPLEY'S HILL LANDFILL GROUNDWATER WELL GROUP[1]

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	MAXIMUM DETECTED CONCENTRATION (µg/L)	ARITHMETIC MEAN (µg/L)	COPC (Y/N)
UNFILTERED SAMPLES [2]				
1,1-Dichloroethane	4 / 14	4.4	0.86	Y
1,2-Dichloroethane	5 / 14	9.9	0.97	Y
1,2-Dichloroethene (cis & trans)	6 / 14	7	1.4	Y
1,2-Dichloropropane	1 / 14	0.52	0.27	Y
Acetone	1 / 14	15	7	N
Benzene	3 / 14	1.7	0.51	Y
Chloroethane	1 / 14	5.5	1.3	Y
Chloroform	3 / 14	0.87	0.33	N
Dichlorobenzenes (total)	1 / 14	11	5.4	Y
Toluene	1 / 14	0.56	0.26	N
Aluminum	13 / 14	75500	4259	Y
Antimony	2 / 14	3.3	1.7	Y
Arsenic	12 / 14	390	101	Y
Barium	13 / 14	350	47.6	Y
Calcium	14 / 14	219000	54280	Y
Chromium	5 / 14	115	9	Y
Cobalt	1 / 14	54.6	14	Y
Copper	4 / 14	92.2	8.6	Y
Iron	14 / 14	97400	17608	Y
Lead	10 / 14	66.8	5.2	Y
Magnesium	14 / 14	24000	7603	Y
Manganese	14 / 14	9650	2045	Y
Nickel	1 / 14	177	22.9	Y
Potassium	13 / 14	31800	7119	Y
Sodium	14 / 14	67300	20749	Y
Vanadium	3 / 14	79.1	9.4	Y
Zinc	3 / 14	220	29.4	Y
FILTERED SAMPLES [3]				
Aluminum	1 / 10	236 BB	NA	N
Antimony	1 / 10	3.12	2	Y
Arsenic	6 / 10	270	71	Y
Barium	10 / 10	117	30	Y
Calcium	10 / 10	175000	37402	Y
Iron	7 / 10	91600	14427	Y
Lead	2 / 10	1.52 BB	NA	N
Magnesium	9 / 10	19900	4679	Y
Manganese	10 / 10	9540	1812	Y
Potassium	9 / 10	10600	4127	Y
Sodium	10 / 10	64600	16934	Y
Zinc	1 / 10	25.5	11	Y

Notes:
NA = Not applicable
µg/L = Micrograms per liter
BB = Less than background concentration
1 From March and June 1993 sampling rounds
2 Unfiltered samples from monitoring wells SHL-3, SHL-4, SHL-5, SHL-9, SHL-10, SHL-11, SHL-18, SHL-19, SHL-20, SHL-22, SHM-93-01A, SHM-93-10C, SHM-93-18B, SHM-93-22C
3 Filtered samples from monitoring wells SHL-3, SHL-4, SHL-5, SHL-9, SHL-10, SHL-11, SHL-19 SHL-20, SHM-93-01A, SHM-93-18B

TABLE 2
SUMMARY STATISTICS FOR SHEPLEY'S HILL LANDFILL GROUNDWATER
WELL GROUP 3[1]

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	MAXIMUM DETECTED CONCENTRATION (µg/L)	ARITHMETIC MEAN (µg/L)	COPC (Y/N)
UNFILTERED SAMPLES[2]				
Aluminum	2 / 4	4030 BB	1800	N
Arsenic	2 / 4	17	8.4	Y
Barium	4 / 4	28 BB	14	N
Calcium	4 / 4	15400	1100	Y
Chromium	2 / 4	7.38 BB	5.1	N
Iron	4 / 4	5350 BB	2500	N
Lead	2 / 4	7.38	3.4	Y
Magnesium	4 / 4	2850 BB	1900	N
Manganese	4 / 4	1590	680	Y
Potassium	4 / 4	2080 BB	1900	N
Sodium	4 / 4	17300	7600	Y
FILTERED SAMPLES[3]				
Barium	1 / 1	8.71 BB	NA	N
Calcium	1 / 1	11000 BB	NA	N
Magnesium	1 / 1	1840 BB	NA	N
Manganese	1 / 1	114 BB	NA	N
Potassium	1 / 1	829 BB	NA	N
Sodium	1 / 1	16400	NA	Y

Notes:
µg/L = Micrograms per liter
NA = Not applicable
BB = Less than background concentration
1 From March 1993 sampling round.
2 Unfiltered samples from monitoring wells SHL-8D, SHL-8S, SHL-13, SHL-21.
3 Filtered samples from monitoring well SHL-13.

TABLE 3
SUMMARY STATISTICS FOR SHEPLEY'S HILL LANDFILL GROUNDWATER
WELL GROUP 4[1]

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	MAXIMUM DETECTED CONCENTRATION (µg/L)		ARITHMETIC MEAN (µg/L)	COPC (Y/N)
UNFILTERED SAMPLES[2]					
Trichlorofluoromethane	1 / 1	2.1		NA	Y
Aluminum	1 / 1	1330	BB	NA	N
Arsenic	1 / 1	24		NA	Y
Barium	1 / 1	39.4	BB	NA	N
Calcium	1 / 1	15600		NA	Y
Iron	1 / 1	1840	BB	NA	N
Lead	1 / 1	3.69	BB	NA	N
Magnesium	1 / 1	1900	BB	NA	N
Manganese	1 / 1	1430		NA	Y
Potassium	1 / 1	3260		NA	Y
Sodium	1 / 1	7370	BB	NA	N
Zinc	1 / 1	35.8		NA	Y
FILTERED SAMPLES[3]					
Barium	1 / 1	26.2	BB	NA	N
Calcium	1 / 1	16900		NA	Y
Chromium	1 / 1	6.95	BB	NA	N
Iron	1 / 1	42.5	BB	NA	N
Lead	1 / 1	1.63	BB	NA	N
Magnesium	1 / 1	1860	BB	NA	N
Manganese	1 / 1	1850		NA	Y
Potassium	1 / 1	1870	BB	NA	N
Sodium	1 / 1	7630	BB	NA	N
Zinc	1 / 1	28.8		NA	Y

Notes:
µg/L = Micrograms per liter
NA = Not applicable
BB = Less than background concentration
1 From March 1993 sampling record
2 Unfiltered samples from monitoring well SHL-15
3 Filtered samples from monitoring well SHL-15

TABLE 4
SUMMARY STATISTICS FOR ANALYTE CONCENTRATIONS
IN PLOW SHOP POND BLUEGILLS (WHOLE FISH)[1]

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

ANALTYE	FREQUENCY OF DETECTION	MINIMUM CONCENTRATION	MAXIMUM CONCENTRATION	ARITHMETIC MEAN
Pesticides (µg/kg)				
DDE	2/5	21	29	12.92
Inorganics (mg/kg)				
Aluminum	5/5	1.6	4.5	2.58
Arsenic	1/5	1.3	1.3	0.331
Barium	5/5	1.3	4.4	2.76
Calcium	5/5	23300	48800	31940
Chromium	5/5	0.48	0.93	0.656
Cobalt	4/5	0.1	0.16	0.108
Copper	5/5	0.44	0.6	0.506
Iron	5/5	42.4	130	79.72
Lead	1/5	0.16	0.16	0.072
Magnesium	5/5	496	754	568
Manganese	5/5	39.1	94.7	63.2
Mercury	5/5	0.19	0.54	0.368
Selenium	5/5	0.42	0.67	0.55
Sodium	5/5	1480	2290	1794
Thallium	1/5	0.1	0.1	0.06
Zinc	5/5	22.2	29.6	25.02

Notes:
µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
1 Table inlcudes detected analytes only.
All detected analytes were included as COPCs.

TABLE 5
SUMMARY STATISTICS FOR ANALYTE CONCENTRATIONS IN PLOW SHOP POND BULLHEAD AND BASS (FILLETS)[1]

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	MINIMUM CONCENTRATION	MAXIMUM CONCENTRATION	ARITHMETIC MEAN
Pesticides (µg/kg)				
DDE	2/10	15	31	9.6675
Inorganics (mg/kg)				
Arsenic	2/10	0.09	0.15	0.0497
Calcium	10/10	82.8	627	170.615
Chromium	2/10	0.19	0.24	0.123
Cobalt	2/10	0.11	0.11	0.056
Copper	10/10	0.08	0.24	0.174
Iron	10/10	1.7	27	8.195
Magnesium	10/10	252	344	279.15
Manganese	1/10	0.3	0.3	0.163
Mercury	9/10	0.12	4	1.144
Selenium	8/10	0.11	0.2	0.125
Sodium	10/10	283	509	420.85
Zinc	10/10	3.4	6.1	4.48

Notes:
µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
1 Table includes detected analytes only.
All detected analytes were included as COPCs.

TABLE 6

SUMMARY STATISTICS FOR PLOW SHOP POND SHALLOW SEDIMENT[1]

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	CONCENTRATION MEAN (µg/g)	CONCENTRATION MAXIMUM (µg/g)	COPC (Y/N)
ORGANICS				
Acetone	9/13	0.19	0.55	N
Mmethylene chloride	11/13	0.05	0.12	N
2-butanone	5/13	0.04	0.13	N
Benzo(a)anthracene	1/13	0.22	1.1	Y
Chrysene	1/13	0.32	1.5	Y
Fluoranthene	1/13	0.5	3.4	Y
Naphthalene	1/13	0.32	1.6	Y
Phenanthrene	1/13	0.38	2.5	Y
Pyrene	3/13	0.97	4.35	Y
DDE	6/41	0.05	1.3	Y
DDD	4//41	0.07	1.8	Y
DDT	1/41	0.03	0.13	Y
Heptachlor	2/41	0.006	0.092	N
INORGANICS				
Aluminum	41/41	7,938	24,000	Y
Arsenic	41/41	467	3,200	Y
Barium	38/41	108	344	Y
Beryllium	8/41	0.53	2.72	Y
Cadmium	13/41	9.8	60	Y
Calcium	39/41	8,074	20,100	Y
Cobalt	8/41	5.8	58.7	Y
Chromium	38/41	1,987	10,000	Y
Copper	30/41	39.7	132	Y
Iron	41/41	36,314	330,000	Y
Lead	40/41	125	632	Y
Magnesium	36/41	1,629	6,900	Y
Manganese	37/41	2,639	54,800	Y
Mercury	37/41	18.2	130	Y
Nickel	25/41	23	79.3	Y
Potassium	17/41	435	2,350	Y
Selenium	12/41	1.95	6.6	Y
Sodium	35/41	1,113	2,870	Y
Vanadium	15/41	24.6	166	Y
Zinc	17/41	88.6	403	Y

Notes:
µg/g = micrograms per gram
1. Based on sediment samples SE-SHL-01 through SE-SHL-13 (April 1993 RI) and SHD-92-01 through SHD-92-28 at depths of less than 1 foot.

TABLE 7
CHEMICALS OF POTENTIAL CONCERN[1] IN HUMAN HEALTH RISK ASSESSMENT
SHEPLEY'S HILL LANDFILL

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

CHEMICAL OF POTENTIAL CONCERN	FISH TISSUE	SEDIMENT	GROUNDWATER		
			WELL GROUP 1	WELL GROUP 3	WELL GROUP 4
Inorganics					
Aluminum	X	X	X		
Antimony			X		
Arsenic	X	X	X	X	X
Barium	X	X	X		
Beryllium		X			
Calcium	X	X	X	X	X
Cadmium		X			
Chromium	X	X	X		
Cobalt	X	X	X		
Copper	X	X	X		
Iron	X	X	X		
Lead	X	X	X	X	
Magnesium	X	X	X		
Manganese	X	X	X	X	X
Mercury	X	X			
Nickel		X	X		
Potassium		X	X		X
Selenium	X	X			
Sodium	X	X	X	X	
Thallium	X				
Vanadium		X	X		
Zinc	X	X	X		X

TABLE 7
CHEMICALS OF POTENTIAL CONCERN[1] IN HUMAN HEALTH RISK ASSESSMENT
SHEPLEY'S HILL LANDFILL

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

CHEMICAL OF POTENTIAL CONCERN	FISH TISSUE	SEDIMENT	GROUNDWATER		
			WELL GROUP 1	WELL GROUP 3	WELL GROUP 4
VOCs					
Benzene			X		
Chloroethane			X		
Chloroform			X		
1,1-Dichloroethane			X		
1,2-Dichloroethane			X		
1,2-Dichloroethene (cis & trans)			X		
1,2-Dichloropropane			X		
Trichlorofluoromethane					X
SVOCs					
Dichlorobenzenes (total)			X		
Benzo(a)anthracene		X			
Chrysene		X			
Fluoranthene		X			
Naphthalene		X			
Phenanthrene		X			
Pyrene		X			
Pesticides/PCBs					
DDD		X			
DDE	X	X			
DDT		X			

TABLE 8
SUMMARY OF COVER SYSTEM PERFORMANCE STANDARDS

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

MASSACHUSETTS SOLID WASTE REGULATIONS 310 CMR 19.000	RCRA SUBTITLE C 40 CFR 264	RCRA SUBTITLE D 40 CFR 258	MASSACHUSETTS HAZARDOUS WASTE REGULATIONS 310 CMR 30.000	HOW COMPLIANCE IS ACHIEVED BY EXISTING COVER
Minimize percolation of water into landfill.	Minimize migration of liquids through landfill.	Minimize infiltration through landfill.	Minimize migration of liquids through landfill.	Geomembrane installations such as the existing one at Shepley's Hill Landfill have a permeability of 10 E -7 centimeters per second or less that minimizes infiltration and migration of liquid into landfilled waste. Sloped surface promotes runoff and minimizes infiltration. Vegetation promotes evapotranspiration.
	Have a permeability less than or equal to bottom liner or subsoils.	Have a permeability less than or equal to bottom liner or subsoils or less than 10 E-5 centimeters per second, whichever is less.	Have a permeability less than or equal to bottom liner.	Existing geomembrane permeability is less than that of sands underlying landfill. There is no bottom liner.
Promote drainage of precipitation.	Promote drainage and minimize erosion.		Promote drainage and minimize erosion of cover.	The existing cover is sloped to promote drainage and vegetated to prevent erosion.
Minimize erosion of final cover.		Minimize erosion of final cover.		The existing cover is sloped and vegetated to minimize erosion.
	Function with minimum maintenance.		Function with minimum maintenance.	The existing cover was constructed in a manner to minimize maintenance. Monitoring and maintenance of cover systems to maintain integrity is normal practice.
Facilitate gas venting.				The existing collection piping and riser system facilitate gas venting. Analysis of gas samples from vents confirms that they function.

(continued)

TABLE 8
SUMMARY OF COVER SYSTEM PERFORMANCE STANDARDS

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

MASSACHUSETTS SOLID WASTE REGULATIONS 310 CMR 19.000	RCRA SUBTITLE C 40 CFR 264	RCRA SUBTITLE D 40 CFR 258	MASSACHUSETTS HAZARDOUS WASTE REGULATIONS 310 CMR 30.000	HOW COMPLIANCE IS ACHIEVED BY EXISTING COVER
Minimize percolation of water into landfill.	Minimize migration of liquids through landfill.	Minimize infiltration through landfill.	Minimize migration of liquids through landfill.	Geomembrane installations such as the existing one at Shepley's Hill Landfill have a permeability of 10 E -7 centimeters per second or less that minimizes infiltration and migration of liquid into landfilled waste. Sloped surface promotes runoff and minimizes infiltration. Vegetation promotes evapotranspiration.
Accommodate settling and subsidence to continue to meet performance standards.	Accommodate settling and subsidence to maintain cover integrity.		Accommodate settling and subsidence to maintain cover integrity.	Landfill materials were compacted and graded during construction of the existing cap to accommodate settling. Maintenance actions are possible to maintain cover integrity if or when settling occurs.
Ensure isolate of wastes from environment.				The existing cover isolates wastes from potential terrestrial receptors by covering them with soil and lowers groundwater to elevations interpreted to be below waste.

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARs FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Floodplains	Floodplain Management Executive Order No. 11988, [40 CFR Part 6, App. A]	Applicable	Requires federal agencies to evaluate the 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.	To the extent that any activity associated with this alternative takes place in the floodplain, the activity will be altered to comply with the law.
	Wetlands	Protection of Wetlands Executive Order No. 11990	Applicable	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 wetland areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values.	To the extent that any activity associated with this alternative takes place in wetlands, the activity will be altered to comply with the law.

(continued)

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Surface Waters Endangered Species	Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Part 302]	Applicable	Actions which affect species/habitat require consultation with U.S. Department of the Interior, U.S. Fish and Wildlife Service, and National Marine Fisheries Service, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. The effects of water-related projects on fish and wildlife resources must be considered. Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. Consultation with the responsible agency is also strongly recommended for on-site actions. Under 40 CFR Part 300.38, these requirements apply to all response activities under the NCP.	No off-site remedial actions performed for this alternative. On-site actions would be minimal and would include agency consultation prior to implementation.
	Endangered Species	Endangered Species Act [16 USC 1531 et seq.; 50 CFR Part 402]	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	To minimize impact, landfill cover maintenance would be performed after nesting areas of the Grasshopper Sparrow have been identified.

(continued)

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
State Regulatory Authority	Floodplains Wetlands	Massachusetts Wetland Protection Act and Regulations [MGL c. 131 s. 40; 310 CMR 10.00]	Applicable	Wetlands and land subject to flooding are protected under this Act and these regulations. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. A Determination of Applicability or Notice of Intent must be filed for activities such as excavation within a 100 foot buffer zone. The regulations specifically prohibit loss of over 5,000 square feet of bordering vegetated wetland. Loss may be permitted with replication of any lost area within two growing seasons.	If remedial activities alter more than 5,000 square feet of protected area, the affected area will be restored within two growing seasons.
	Endangered Species	Massachusetts Endangered Species Act and implementing regulations [MGL c. 131A, s. 1 et seq.; 321 CMR 8.00]	Applicable	Actions must be conducted in a manner which minimizes the impact to Massachusetts listed endangered species and species listed by the Massachusetts Natural Heritage Program.	To minimize impacts, landfill cover maintenance would be performed after nesting areas of the Grasshopper Sparrow have been identified.

(continued)

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Area of Critical Environmental Concern	Areas of Critical Environmental Concern [301 CMR 12.00]	Relevant and Appropriate	An Area of Critical Environmental Concern is of regional, state, or national importance or contains significant ecological systems with critical inter-relationships among a number-of-components. An eligible area must contain features from four or more of the following groups: (1) fishery habitats; (2) coastal feature; (3) estuarine wetland; (4) inland wetland; (5) inland surface water; (6) water supply area (i.e., aquifer recharge area); (7) natural hazard area (i.e., floodplain); (8) agricultural area; (9) historical/archeological resources; (10) habitat resource (i.e., for endangered wildlife; or (11) special use areas.	Activities must be controlled to minimize impacts to nesting areas of the Grasshopper Sparrow.

(continued)

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Groundwater	Safe Drinking Water Act, National Primary Drinking Water Standards, MCLs [40 CFR Parts 141.11 - 141.16 and 141.50-191.51]	Relevant and Appropriate	The National Primary Drinking Water Regulation establishes MCLs and non-zero Maximum Contaminant Level Goals for several common organic and inorganic contaminants. These 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.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the remedy will be re-evaluated.
State Regulatory Authority	Surface water	Massachusetts Surface Water Quality Standards [314 CMR 4.00]	Applicable	Massachusetts Surface Water Quality Standards designate the most sensitive uses for which surface waters of the Commonwealth are to be enhanced, maintained and protected and designate minimum water quality criteria for sustaining the designated uses. Surface waters at Fort Devens are classified as Class B. Surface waters assigned to this class are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.	Discharges associated with remedial actions will be controlled/monitored to ensure that surface waters meet standards.

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Groundwater	Massachusetts Groundwater Quality Standards [314 CMR 6.00]	Applicable	Massachusetts Groundwater Quality Standards designate and assign uses for which groundwaters of the Commonwealth shall be maintained and protected and set forth water quality criteria necessary to maintain the designated uses. Groundwater at Fort Devens is classified as Class I. Groundwaters assigned to this class are fresh groundwaters designated as a source of potable water supply.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the remedy will be re-evaluated.
	Groundwater	Massachusetts Drinking Water Standards and Guidelines [310 CMR 22.00]	Relevant and Appropriate	The Massachusetts Drinking Water Standards and Guidelines list MMCLs which apply to water delivered to any user of a public water supply system as defined in 310 CMR 22.00. Private residential wells are not subject to the requirements of 310 CMR 22.00; however, the standards are often used to evaluate private residential contamination especially in CERCLA activities.	MMCLs will be used to evaluate the performance of this alternative. If MMCLs are exceeded, the remedy will be re-evaluated.

(continued)

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Air	Massachusetts Ambient Air Quality Standards [310 CMR 6.00]	Relevant and Appropriate	Regulations specify primary and secondary ambient air quality standards to protect public health and welfare for certain pollutants	Ambient Air Quality Standards will be used to evaluate the performance of this alternative. If standards are exceeded, the remedy will be re-evaluated.
	Air	Massachusetts Air Pollution Control Regulations [310 CMR 7.00]	Relevant and Appropriate	Regulations pertain to the prevention of emissions in excess of Massachusetts or national ambient air quality standards or in excess of emission limitations in those regulations.	Ambient Air Quality Standards will be used to evaluate the performance of this alternative. If standards are exceeded, the remedy will be re-evaluated.

(continued)

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle D, 40 CFR 258]	Relevant and Appropriate	RCRA Subtitle D regulates the generation, transport, storage, treatment, and disposal of solid wastes. Regulations at 40 CFR 258 govern preparedness and prevention, closure, and post-closure at municipal solid waste landfills.	Performance of this alternative will be evaluated to determine compliance with the substantive requirements of federal solid waste regulations. If the substantive requirements are not met at the appropriate time, the remedy will be re-evaluated.
	Hazardous waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle C, 40 CFR 260,264]	Relevant and Appropriate	RCRA Subtitle C regulates the generation, transport, storage, treatment, and disposal of hazardous wastes. Regulations at 40 CFR 264 govern preparedness and prevention, closure, and post-closure at landfills.	Performance of this alternative will be evaluated to determine compliance with the substantive requirements of federal hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the remedy will be re-evaluated.
State Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure.	Massachusetts Solid Waste Management Regulations [310 CMR 19.000]	Applicable	These regulations outline the requirements for construction, operation, closure, and post-closure at solid waste management facilities in the Commonwealth of Massachusetts.	This alternative includes components to meet closure and post-closure requirements at Shepley's Hill Landfill.

(continued)

TABLE 9
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

RECORD OF DECISION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Hazardous waste landfill construction, operation, closure, and post-closure	Massachusetts Hazardous Waste Regulations [310 CMR 30.00]	Relevant and Appropriate	Regulates handling, storage, treatment, disposal, and record keeping at hazardous waste facilities.	Performance of this alternative will be evaluated to determine compliance with the substantive requirements of Massachusetts hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the remedy will be re-evaluated.

APPENDIX C

APPENDIX C - RESPONSIVENESS SUMMARY

This Responsiveness Summary has been prepared to meet the requirements of Sections 113(k)(2)(B)(iv) and 117(b) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), which requires response to "... significant comments, criticisms, and new data submitted in written or oral presentations" on a proposed plan for remedial action. The purpose of this Responsiveness Summary is to document Army responses to questions and comments expressed during the public comment period by the public, potentially responsible parties, and governmental bodies in written and oral comments regarding the proposed plan for the Shepley's Hill Landfill Operable Unit.

The Army held a 30-day public comment period from June 1 to June 30, 1995 to provide an opportunity for interested parties to comment on the Feasibility Study (FS), proposed plan, and other documents developed to address the cleanup of contaminated groundwater at the Shepley's Hill Landfill Operable Unit at Fort Devens, Massachusetts. The FS developed and evaluated various options (referred to as remedial alternatives) to address human health and ecological risk from exposure to contaminated groundwater and potential migration of substances present in groundwater at the Shepley's Hill Landfill Operable Unit. The Army identified its preferred alternative for cleanup of groundwater in the proposed plan issued on May 31, 1995.

All documents on which the preferred alternative were based were placed in the Administrative Record for review. The Administrative Record contains all supporting documentation considered by the Army in choosing the remedy for Shepley's Hill Landfill Operable Unit. The Administrative Record is available to the public at the Fort Devens Base Realignment and Closure (BRAC) Environmental Office, Building P12, Fort Devens, and at the Ayer Town Hall, Main Street, Ayer. An index to the Administrative Record is available at the U.S. Environmental Protection Agency (USEPA) Records Center, 90 Canal Street, Boston, Massachusetts and is provided as Appendix D to the Record of Decision.

This Responsiveness Summary is organized into the following sections:

I. **<u>Overview of Remedial Alternatives Considered in the FS Including the Selected Remedy</u>**-This section briefly outlines the remedial alternatives evaluated in detail in the FS and presented in the proposed plan, including the Army's selected remedy.

II. **Background on Community Involvement**-This section provides a brief history of community involvement and Army initiatives in informing the community of site activities.

III. **Summary of Comments Received During the Public Comment Period and Army Responses**-This section provides Army responses to oral and written comments received from the public and not formally responded to during the public comment period. A transcript of the public meeting consisting of all comments received during this meeting and the Army's responses to these comments is provided in Attachment A of this Responsiveness Summary.

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I. OVERVIEW OF REMEDIAL ALTERNATIVES CONSIDERED IN THE FS INCLUDING THE SELECTED REMEDY

Ten remedial alternatives were developed in the FS report and screened based on implementability, effectiveness, and cost to narrow the number of remedial alternatives for detailed analysis. Of the initial ten, five were retained for detailed evaluation. The five retained alternatives are:

A. Alternative SHL-1: No-Action

The No Action alternative does not contain any remedial action components beyond the existing landfill cover system to reduce or control potential risks. No institutional controls would be implemented to prevent future human exposure, and existing activities to maintain existing systems and monitor for potential future releases would be stopped. Alternative SHL-1 is developed to provide a baseline for comparison with the other remedial alternatives.

B. Alternative SHL-2: Limited Action

Alternative SHL-2 contains components to maintain and potentially improve the effectiveness of the existing landfill cover system and to satisfy the Landfill Post-Closure Requirements of 310 CMR 19.142 to reduce potential future exposure to contaminated groundwater. Key components of this alternative include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- 60 percent design of a groundwater extraction system;
- annual reporting to Massachusetts Department of Environmental Protection (MADEP) and USEPA; and
- five-year site reviews.

The Army's selected remedy is Alternative SHL-2, with Alternative SHL-9 as the contingency remedy.

C. Alternative SHL-5: Collection/Ion Exchange Treatment/Surface Water Discharge

Alternative SHL-5 consists of components that, together with the components of Alternative SHL-2, would provide additional controls to prevent off-site migration of contaminated groundwater. Key components of Alternative SHL-5 include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- design, construction, operation, and maintenance of groundwater extraction, treatment, and discharge facilities;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- annual reporting to MADEP and USEPA; and
- five-year site reviews.

The major difference between Alternative SHL-5 and Alternative SHL-2 is the construction and operation of groundwater extraction, treatment, and discharge facilities. Data collected during predesign studies would be used to optimize the size and location of groundwater extraction wells at Shepley's Hill Landfill. Contaminated groundwater would be treated in an on-site groundwater treatment facility that (subject to treatability studies) includes carbon adsorption, sand filtration, and ion exchange treatment units and discharges through an effluent pipeline to Nonacoicus Brook.

D. Alternative SHL-9: Collection/Discharge to POTW

Alternative SHL-9 adds the components of groundwater extraction and discharge to the Town of Ayer publicly owned treatment works (POTW) to Alternative SHL-2 to provide additional control to prevent off-site migration of contaminated groundwater. Key components of Alternative SHL-9 include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- design, construction, operation, and maintenance of groundwater extraction and discharge facilities;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of stormwater diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- annual reporting to MADEP and USEPA; and
- five-year site reviews.

The major difference between Alternative SHL-9 and Alternative SHL-2 is the construction and operation of groundwater extraction and discharge facilities. Data collected during predesign studies would be used to optimize the size and location of groundwater extraction wells at Shepley's Hill Landfill. Following construction of the groundwater extraction facilities, contaminated groundwater would be pumped to a discharge manhole anticipated to be located on Scully Road near the north end of the landfill. There, the groundwater would combine with domestic wastewater and flow to the Town of Ayer POTW for treatment and subsequent discharge. The Ayer POTW, with a capacity of 1.79 million gallons per day (MGD), would be able to handle the additional anticipated volume of 20 to 30 gallons per minute (0.029 to 0.043 MGD).

Review of available groundwater monitoring data suggests that pretreatment of the groundwater will not be needed to meet existing pretreatment standards established by the Town of Ayer. The Army would monitor the groundwater discharge to the POTW, however, and if necessary install pretreatment facilities to meet pretreatment standards. The Army would pay a sewer user fee to the town based on the volume of water discharged to the POTW.

E. Alternative SHL-10: Installation of RCRA Cap

Alternative SHL-10 consists of building a new landfill cover system on top of the existing cover system at Shepley's Hill Landfill. The new cover system would be designed to meet Resource Conservation and Recovery Act (RCRA) performance criteria and design guidance for hazardous waste landfills. The principal component of the new cover system would be a 24-inch layer of low permeability soil in intimate contact with a geomembrane. Maintenance activities, monitoring and reporting requirements, and institutional controls would be similar to those of Alternative SHL-2.

II. BACKGROUND ON COMMUNITY INVOLVEMENT

Community concern and involvement have been low throughout the history of Shepley's Hill Landfill. Although the Army has kept the community and other interested parties informed of site activities through regular and frequent informational meetings, fact sheets, press releases, and public meetings, no members of the public attended the public informational meeting on the proposed plan or the public hearing.

In February 1992 the Army released, following public review, a community relations plan that outlined a program to address community concerns and keep citizens informed about and involved in remedial activities at Fort Devens. As part of this plan, the Army established a Technical Review Committee (TRC) in early 1992. The TRC, as required by SARA Section 211 and Army Regulation 200-1, included representatives from USEPA, U.S. Army Environmental Center (USAEC), Fort Devens, MADEP, local officials and the community. Until January 1994, when it was replaced by the Restoration Advisory Board (RAB), the committee generally met quarterly to review and provide technical comments on schedules, work plans, work products, and proposed activities for the Study Areas at Fort Devens. The Remedial Investigation (RI), RI Addendum, and FS reports, proposed plan, and other related support documents were all submitted to the TRC or RAB for their review and comment.

The Army, as part of its commitment to involve the affected communities, forms a RAB when an installation closure involves transfer of property to the community. The Fort Devens RAB was formed in February 1994 to add members of the Citizen's Advisory Committee (CAC) to the TRC. The CAC had been established previously to address Massachusetts Environmental Policy Act/Environmental Assessment issues concerning the reuse of property at Fort Devens. The RAB consists of 28 members (15 original TRC members plus 13 new members) who are representatives from the Army, USEPA Region I, MADEP, local governments and citizens of the local communities. It meets monthly and provides advice to the installation and regulatory agencies on Fort Devens cleanup programs. Specific responsibilities include: addressing cleanup issues such as land use and cleanup goals; reviewing plans and documents; identifying proposed requirements and priorities; and conducting regular meetings that are open to the public. The Army presented the proposed plan for the Shepley's Hill Landfill Operable Unit at the May 4, 1995 RAB meeting.

On May 31, 1995, the Army issued a fact sheet to citizens and organizations, to provide the public with a brief explanation of the Army's preferred remedy for cleanup of groundwater at the Shepley's Hill Landfill Operable Unit. The fact sheet also described the opportunities for public participation and provided details on the upcoming public comment period and public meetings.

During the week of May 22, the Army published a public notice announcing the proposed plan, public informational meeting, and public hearing in the Times Free Press and the Lowell Sun. A public notice announcing the public hearing was published the week of June 12, 1995 in the Times Free Press and the week of June 19, 1995 in the Lowell Sun. The Army also made the proposed plan available to the public at the information repositories at the libraries in Ayer, Shirley, Lancaster, Harvard and at Fort Devens.

From June 1 to June 30, 1995, the Army held a 30-day public comment period to accept public comments on the alternatives presented in the FS and the proposed plan and on other documents released to the public. On June 6, 1995, the Army held an informal informational meeting at Fort Devens to present the Army's proposed plan to the public and discuss the cleanup alternatives evaluated in the FS. This meeting also provided the opportunity for open discussion concerning the proposed cleanup. On June 27, 1995, the

Army held an informal public hearing at Fort Devens to discuss the proposed plan and to accept verbal or written comments from the public.

All supporting documentation for the decision regarding the Shepley's Hill Landfill Operable Unit is contained in the Administrative Record for review. The Administrative Record is a collection of all the documents considered by the Army in choosing the remedy for the Shepley's Hill Landfill Operable Unit. On June 2, 1995, the Army made the Administrative Record available for public review at the Fort Devens BRAC Environmental Office, and at the Ayer Town Hall, Ayer, Massachusetts. An index to the Administrative Record is available at the USEPA Records Center, 90 Canal Street, Boston, Massachusetts and is provided as Appendix D.

III. SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND ARMY RESPONSES

No comments were received during the public comment period.

ATTACHMENT A - PUBLIC HEARING TRANSCRIPT

ABB ENVIRONMENTAL SERVICES, INC.

PROPOSED PLAN
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FORT DEVENS, MASSACHUSETTS

PUBLIC HEARING

HELD AT:
FORT DEVENS, MASSACHUSETTS
TUESDAY, JUNE 27, 1995
7:00 P.M.

(Robin Gross, Registered Professional Reporter)

Attorneys Notes

Doris O. Wong Associates

P R O C E E D I N G S

MR. CHAMBERS: Welcome, everybody, to Fort Devens. My name is James Chambers. I'm the BRAC environmental coordinator for the U.S. Army here at Fort Devens.

Tonight's hearing is in regards to the remedial action proposed plan for Shepley's Hill Landfill, and I'd like to open up the floor to comments. We do have a court stenographer here tonight to officially record your comments.

I'd like to recognize Ms. Lynn Welsh from the Massachusetts Department of Environmental Protection; Mr. James Byrne of the U.S. Environmental Protection Agency; Mr. Gerry Keefe from the U.S. Environmental Protection Agency; Mr. Charles George from the U.S. Army Environmental Center; and Mr. Paul Exner and Mr. Stan Reed representing ABB Environmental Services.

(Recess taken)

MR. CHAMBERS: It's now 7:30. Let the record show that we were prepared to make a presentation this evening and no members of the public showed.

The 30th of June is the last day for

submitting written comments. Thank you.

(Whereupon, the hearing was adjourned at 7:30 p.m.)

C E R T I F I C A T E

I, Robin Gross, Registered Professional Reporter, do hereby certify that the foregoing transcript, Volume I, is a true and accurate transcription of my stenographic notes taken on June 27, 1995.

Robin Gross
Registered Professional Reporter

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APPENDIX D

APPENDIX D - ADMINISTRATIVE RECORD INDEX

Fort Devens

Group 1A Sites
Shepley's Hill Landfill Operable Unit
Administrative Record File

Index

Prepared for
New England Division
Corps of Engineers

by
ABB ENVIRONMENTAL SERVICES, INC.
107 Audubon Road, Wakefield, Massachusetts 01880 (617) 245-6606

Introduction

This document is the Index to the Administrative Record File for Fort Devens Group 1A Shepley's Hill Landfill Operable Unit. Section I of the Index cites site-specific documents and Section II cites guidance documents used by U.S. Army staff in selecting a response action at the site. Some documents in this Administrative Record File Index have been cited but not physically included. If a document has been cross-referenced to another Administrative Record File Index, the available corresponding comments and responses have been cross-referenced as well.

The Administrative Record File is available for public review at EPA Region I's Office in Boston, Massachusetts, at the Fort Devens Environmental Management Office, Fort Devens, Massachusetts, and at the Ayer Town Hall, 1 Main Street, Ayer, Massachusetts. Supplemental/Addendum volumes may be added to this Administrative Record File. Questions concerning the Administrative Record should be addressed to the Fort Devens Base Realignment and Closure Office (BRAC).

The Administrative Record is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

Section I

Site-Specific Documents

ADMINISTRATIVE RECORD FILE INDEX

for
Fort Devens Group 1A Site
Shepley's Hill Landfill Operable Unit

Compiled: September 29, 1995

1.0 Pre-Remedial

1.2 Preliminary Assessment

Cross Reference: The following Reports, Comments, and Responses to Comments (entries 1 through 6) are filed and cited as entries 1 through 6 in minor break 1.2 Preliminary Assessment of the Fort Devens Group 1A Administrative Record File Index.

Reports

1. "Final Master Environmental Plan for Fort Devens," Argonne National Laboratory (April 1992).
2. "Preliminary Zone II Analysis for the Production Wells at Fort Devens, MA, Draft Report", ETA Inc. (January 1994).

Comments

3. Comments Dated May 1, 1992 from Walter Rolf, Montachusett Regional Planning Commission on the April 1992 "Final Master Environmental Plan for Fort Devens," Argonne National Laboratory.
4. Comments Dated May 7, 1992 from James P. Byrne, EPA Region I on the April 1992 "Final Master Environmental Plan for Fort Devens," Argonne National Laboratory.
5. Comments Dated May 23, 1994 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the January 1994 "Preliminary Zone II Analysis for the Production Wells at Fort Devens, MA, Draft Report", ETA Inc.

Responses to Comments

6. Response Dated June 29, 1992 from Carrol J. Howard, Fort Devens to the May 7, 1992 Comments from James P. Byrne, EPA Region I.

3.0 Remedial Investigation (RI)

3.2 Sampling and Analysis Data

Reports

1. Cross Reference: "Method for Determining Background Concentrations - Inorganic Analytes in Soil and Groundwater - Fort Devens," ABB Environmental Services, Inc. (January 20, 1993) [Filed and cited as entry number 1 in minor break 3.2 Sampling and Analysis Data of the Fort Devens Group 1A Sites Administrative Record Index].

3.4 Interim Deliverables

The following Reports and Comments (entries 1 through 2) are filed and cited as entries 1 and 2 in minor break 3.4 of the Group 1A Administrative Record Index File.

Reports

1. "Final Ground Water Flow Model at Fort Devens," Engineering Technologies Associates, Inc. (May 24, 1993).

Comments

2. Comments Dated February 1, 1993 from James P. Byrne, EPA Region I and D. Lynne Chappell, Commonwealth of Massachusetts Department of Environmental Protection on the October 30, 1992 "Draft Final Ground Water Flow Model at Fort Devens," Engineering Technologies Associates, Inc.

3.5 Applicable or Relevant and Appropriate Requirements (ARARs)

Cross Reference: The following report (entries 2 and 3) are filed and cited as entries 1 and 2 in minor break 3.5 Applicable or Relevant and Appropriate Requirements (ARARs) of the Fort Devens Groups 3, 5, & 6 Sites Administrative Record Index unless otherwise noted below.

Reports

1. Cross Reference: "Draft Assessment of Chemical-Specific Applicable or Relevant and Appropriate Requirements (ARARs) for Shepley's Hill Landfill and Cold Spring Brook Landfill, Fort Devens, Massachusetts," U.S. Army Toxic and Hazardous Materials Agency (May 21, 1992). [Filed and cited as entry number 1 in

minor break 3.5 Applicable or Relevant and Appropriate Requirements (ARARs) of the Fort Devens Group 1A Sites Administrative Record File Index].

2. "Draft Applicable or Relevant and Appropriate Requirements (ARARs) for CERCLA Remedial Actions," U.S. Army Toxic and Hazardous Materials Agency (May 21, 1992).
3. "Draft Assessment of Location-Specific Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Devens, Massachusetts," U. S. Army Toxic and Hazardous Materials Agency (September 1992).

3.6 Remedial Investigation (RI) Reports

Cross Reference: The following Reports, Comments, and Responses to Comments (entries 1 through 15) are filed and cited in minor break 3.6 Remedial Investigation (RI) Reports of the Group 1A Administrative Record Index unless otherwise noted below.

Reports

1. "Final Remedial Investigation Report, Group 1A - Volume I," Ecology and Environment, Inc. (April 1993).
2. "Final Remedial Investigation Report, Group 1A - Volume II," Ecology and Environment, Inc. (April 1993).
3. "Final Remedial Investigation Addendum Report - Volume I, "ABB Environmental Services, Inc. (December 1993)
4. "Final Remedial Investigation Addendum Report - Volume II, "ABB Environmental Services, Inc. (December 1993)
5. "Final Remedial Investigation Addendum Report - Volume III, "ABB Environmental Services, Inc. (December 1993)
6. "Final Remedial Investigation Addendum Report - Volume IV, "ABB Environmental Services, Inc. (December 1993)

Comments

7. Comments Dated February 8, 1993 from James P. Byrne, EPA Region I on the December 1992 "Draft Final Remedial Investigations Report," Ecology and Environment, Inc.
8. Comments Dated February 11, 1993 from D. Lynne Chappell, Commonwealth of Massachusetts Department of Environmental Protection on the December 1992 "Draft Final Remedial Investigations Report," Ecology and Environment, Inc.
9. Comments Dated June 1, 1993 from James P. Byrne, EPA Region I on the April 1993 "Final Remedial Investigation Report, Group 1A - Volume I-II," Ecology and Environment, Inc.

10. Comments Dated June 18, 1993 from D. Lynne Chappell, Commonwealth of Massachusetts Department of Environmental Protection on the April 1993 "Final Remedial Investigation Report, Group 1A - Volume I-II," Ecology and Environment, Inc.
11. Comments Dated September 2, 1993 from James P. Byrne, EPA Region I on the July 26, 1993 "Draft Remedial Investigation Addendum Report," ABB Environmental Services, Inc.
12. Comments Dated September 9, 1993 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the July 26, 1993 "Draft Remedial Investigation Addendum Report," ABB Environmental Services, Inc.
13. Comments Dated January 21, 1994 from Molly Elder, Commonwealth of Massachusetts Department of Environmental Protection on the December 21, 1993 "Final Remedial Investigation Addendum Report'" ABB Environmental Services, Inc.
14. Comments Dated February 15, 1994 from James P. Byrne, EPA Region I on the December 21, 1993 "Final Remedial Investigation Addendum Report," ABB Environmental Services, Inc.

Responses to Comments

15. Responses Dated December 21, 1994 from U.S. Army Environmental Center on the following document: "Draft Remedial Investigation Addendum Report," ABB Environmental Services, Inc.

3.7 Work Plans and Progress Reports

Cross Reference: The following Reports, Comments, and Responses to Comments (entries 1 through 3) are filed and cited in minor break 3.7 Work Plans and Progress Reports of the Group 1A Administrative Record Index unless otherwise noted below.

Reports

1. "Final Work Plan and Field Sampling Plan - Remedial Investigation," Ecology and Environment, Inc. (February 1992).

Comments

2. Letter from Carrol J. Howard, Fort Devens to D. Lynne Chappell, Commonwealth of Massachusetts Department of Environmental Protection (March 3, 1992). Concerning confirmation that the state is waiving its right to comment on the February 1992 "Final Work Plan and Field Sampling Plan - Remedial Investigation," Ecology and Environment, Inc.

3. Letter from James P. Byrne, EPA Region I to F. Timothy Prior, Fort Devens (March 19, 1992). Concerning approval of the February 1992 "Final Work Plan and Field Sampling Plan - Remedial Investigation," Ecology and Environment, Inc.

4.0 Feasibility Study (FS)

4.1 Correspondence

Cross Reference: The following Letters and Comments (entries 1 and 2) are filed and cited as entries 1 and 2 in minor break 4.1 Correspondence of the Fort Devens Group 1A Sites Administrative Record Index.

Letters

1. Letter Dated July 25, 1994 from James C. Chambers, Department of the Army, Headquarters Fort Devens, Brac Environmental Coordinator, on the Army's proposed triggers for implementing contingency remedial actions at the Shepley's Hill Landfill Operable Unit at Fort Devens.

Comments

2. Comments Dated August 16, 1994 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the Letter Dated July 25, 1994 from James C. Chambers on the Contingency Thresholds for Alternative SHL-2 at Shepley's Hill Landfill.

4.4 Interim Deliverables

Cross Reference: The following documents (entries 1 through 4) are filed and cited as entries 1 through 4 in minor break 4.4 Interim Deliverables of the Group 1A Sites Administrative Record File Index.

Reports

1. "Draft Alternatives Screening Report," ABB Environmental Services, Inc. (July 26, 1993).

Comments

2. Comments Dated September 2, 1993 from James P. Byrne, EPA Region I on the July 26, 1993 "Draft Alternatives Screening Report." ABB Environmental Services, Inc.

3. Comments Dated September 9, 1993 and September 20, 1993 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the July 26, 1993 "Draft Alternatives Screening Report." ABB Environmental Services, Inc.

Responses to Comments

4. Responses Dated March 18, 1994 from U.S. Army Environmental Center on the following document: Draft Alternatives Screening Report, dated July 26, 1993.

4.6 Feasibility Study (FS) Reports

Cross Reference: The following Letters, Reports, Comments, Responses to Comments and Responses to Responses to Comments (entries 1 through 16) are filed and cited in minor break 4.6 Feasibility Study (FS) Reports of the Fort Devens Group 1A Sites Administrative Record Index.

Reports

1. "Draft Feasibility Study Shepley's Hill Landfill Operable Unit," ABB Environmental Services, Inc. (March 18, 1994).
2. "Revised Draft Feasibility Study, Shepley's Hill Landfill Operable Unit, Fort Devens Feasibility Study for Group 1A Sites," ABB Environmental Services, Inc. (September 1994).
3. "Revised Draft Shepley's Hill Groundwater Operable Unit Feasibility Study and Contingency Triggers," (Letter Dated November 30, 1994 from Major Pease).
4. "Final Feasibility Study Shepley's Hill Landfill Operable Unit, Fort Devens Feasibility Study for Group 1A Sites," ABB Environmental Services, Inc. (February 1995).

Comments

5. Comments Dated April 28, 1994 form James P. Byrne, EPA Region I on the March 18, 1994 "Draft Feasibility Study Shepley's Hill Landfill Operable Unit," (ABB Environmental Services, Inc.).
6. Comments Dated May 5, 1994 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the March 18, 1994 "Draft Feasibility Study Shepley's Hill Landfill Operable Unit," (ABB Environmental Services, Inc.).
7. Comments Dated November 10, 1994 from James P. Byrne, USEPA, on the "Revised Draft Feasibility Study for Shepley's Hill Landfill Operable Unit," (ABB Environmental Services, Inc.).

8. Comments Dated November 15, 1994 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the September 1994 "Revised Draft Feasibility Study. Shepley's Hill Landfill Operable Unit," (ABB Environmental Services, Inc.).
9. Comments Dated January 11, 1995 from James P. Byrne, USEPA, on the "Revised Draft Feasibility Study for Shepley's Hill Landfill Operable Unit," ABB Environmental Services, Inc.
10. Comments Dated January 11, 1995 from James P. Byrne, USEPA, on the Proposed Feasibility Study Language For Alternative SHL-2, Shepley's Hill Landfill Source Control Operable Unit.
11. Comments Dated January 23, 1995 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the November 30, 1994 "Revised Draft Shepley's Hill Groundwater Operable Unit Feasibility Study and Contingency Triggers".
12. Comments Dated March 27, 1995 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the "Final Feasibility Study, Shepley's Hill Landfill Operable Unit," (ABB Environmental Services, Inc.).

Responses to Comments

13. Responses Dated September 1994 from U.S. Army Environmental Center on the following document: Draft Feasibility Study Shepley's Hill Landfill Operable Unit, Feasibility Study For Group 1A Sites, Fort Devens, Massachusetts.
14. Responses Dated February 1995 from U.S. Army Environmental Center on the following document: revised Draft Feasibility Study Shepley's Hill Landfill Operable Unit, Feasibility Study for Group 1A Sites, Fort Devens, Massachusetts.

Responses to Responses to Comments

15. Rebuttal Dated November 15, 1994 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the Responses to Comments on the Draft Feasibility Study, Shepley's Hill Landfill Operable Unit.
16. Responses Dated June 1995 from U.S. Army Environmental Center on the following documents: Final Feasibility Study, Draft Proposed Plan and Draft Fact Sheet Shepley's Hill Landfill Operable Unit.

4.7 Work Plans and Progress Reports

Cross Reference: The following Reports, Comments, and Responses to Comments (entries 1 through 10) are filed and cited in minor break 4.7 Work Plans and Progress Reports of the Fort Devens Group 1A Sites Administrative Record Index unless otherwise noted below.

Reports

1. "Final Feasibility Study Work Plan," ABB Environmental Services, Inc. (August 1992).
2. "Final Data Gap Activity Work Plan," ABB Environmental Services, Inc. (March 31, 1993).

Comments

3. Comments Dated September 14, 1992 from James P. Byrne, EPA Region I on the August 1992 "Final Feasibility Study Work Plan," ABB Environmental Services, Inc.
4. Comments Dated September 21, 1992 from D. Lynne Chappell, Commonwealth of Massachusetts Department of Environmental Protection on the August 1992 "Final Feasibility Study Work Plan," ABB Environmental Services, Inc.
5. Comments Dated January 11, 1993 from James P. Byrne, EPA Region I on the December 1992 "Draft Final Data Gap Activities Work Plan," ABB Environmental Services, Inc.
6. Comments Dated January 20, 1993 from D. Lynne Chappell, Commonwealth of Massachusetts Department of Environmental Protection on the December 1992 "Draft Final Data Gap Activities Work Plan," ABB Environmental Services, Inc.
7. Comments Dated February 17, 1993 from James P. Byrne, EPA Region I and D. Lynne Chappell, Commonwealth of Massachusetts Department of Environmental Protection on the December 1992 "Draft Final Data Gap Activities Work Plan," ABB Environmental Services, Inc.
8. Comments Dated April 21, 1993 and April 26, 1993 from James P. Byrne, EPA Region I on the March 31, 1993 "Final Data Gap Activity Work Plan," ABB Environmental Services, Inc.
9. Comments Dated May 13, 1993 from D. Lynne Chappell on the March 31, 1993 "Final Data Gap Activity Work Plan," ABB Environmental Services, Inc.

Responses to Comments

10. Responses Dated May 1993 from U.S. Army Environmental Center on the following document: Final Data Gap Activity Work Plan, dated March 31, 1993.

4.9 Proposed Plan for Selected Remedial Action

1. Cross Reference: "Draft Proposed Plan, Shepley's Hill Landfill AOCs 4,5, & 18, Fort Devens, Massachusetts," ABB Environmental Services, Inc. (February 1995). [Filed and cited as entry number 1 in minor break 4.9 Proposed Plan for Selected Remedial Action in the Fort Devens Group 1A Sites Administrative Record File Index.]
2. Cross Reference: "Proposed Plan, Shepley's Hill Landfill AOCs 4, 5, & 18, Fort Devens, Massachusetts," ABB Environmental Services, Inc. (May 1995). [Filed and cited as entry number 2 in minor break 4.9 Proposed Plan for Selected Remedial Action in the Fort Devens Group 1A Sites Administrative Record File Index.]

Comments

3. Cross Reference: Comments Dated March 30, 1995 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the February 1995 "Draft Proposed Plan, Shepley's Hill Landfill," (ABB Environmental Services, Inc.). [Filed and cited as entry number 3 in minor break 4.9 Proposed Plan for Selected Remedial Action in the Fort Devens Group 1A Sites Administrative Record File Index.]
4. Cross Reference: Comments Dated July 17, 1995 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the May 1995 Proposed Plan for Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts (ABB Environmental Services, Inc.).

Responses to Comments

5. Cross Reference: Responses Dated June 1995 from U.S. Army Environmental Center on the following documents: Final Feasibility Study, Draft Proposed Plan and Draft Fact Sheet Shepley's Hill Landfill Operable Unit. [Filed and cited as entry number 19 in minor break 4.6 Proposed Plan for Selected Remedial Action in the Fort Devens Group 1A Sites Administrative Record File Index.]

5.0 Record of Decision

Cross Reference: The following Reports, Comments, and Responses to Comments (entries 1 through 6) are filed and cited in minor break 5.4 Record of Decision of the Fort Devens Group 1A Sites Administrative Record Index unless otherwise noted below.

5.4 Record of Decision

Reports

1. "Draft Record of Decision Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts", ABB Environmental Services, Inc. (July 1995).
2. "Revised Draft Record of Decision Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts", ABB Environmental Services, Inc. (August 1995).
3. "Final Record of Decision Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts", ABB Environmental Services, Inc. (September 1995).

Comments

4. Comments Dated August 17, 1995 from James P. Byrne, USEPA Region I on the July 1995 Draft Record of Decision for Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts (ABB Environmental Services, Inc.).
5. Comments Dated August 18, 1995 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the July 1995 Draft Record of Decision, Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts (ABB Environmental Services, Inc.).
6. Comments Dated September 13, 1995 from James P. Byrne, USEPA Region I on the August 1995 Revised Draft Record of Decision Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts (ABB Environmental Services, Inc.).

6.0 Remedial Design (RD)

6.6 Work Plans and Progress Reports

Cross Reference: The following Reports and Comments (entries 1 through 3) are filed and cited in minor break 6.6 Remedial Design (RD) Work Plans and Progress Reports of the Fort Devens Group 1A Sites Administrative Record Index unless otherwise noted below.

Reports

1. "Final Delivery Order Work Plan for Predesign Investigations, Areas of Contamination (AOCs) 4, 5, & 18 Shepley's Hill Landfill, Fort Devens, Massachusetts," Stone & Webster Environmental Technology & Services (June 1995).

Comments

2. Comments Dated July 11, 1995 from James P. Byrne, USEPA Region I on the June 1995 Final Delivery Order Work Plan for Predesign Investigations Shepley's Hill Landfill, Fort Devens, Massachusetts" (Stone & Webster Environmental Technology & Services).
3. Comments Dated July 26, 1995 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the June 1995 Final Delivery Order Work Plan, Areas of Contamination (AOCs) 4, 5, & 8, Shepley's Hill Landfill

10.0 Enforcement

10.16 Federal Facility Agreements

1. Cross Reference: "Final Federal Facility Agreement Under CERCLA Section 120," EPA Region I and U.S. Department of the Army (November 15, 1991) with attached map [Filed and cited as entry number 1 in minor break 10.16 Federal Facility Agreements of the Fort Devens Group 1A Sites Administrative Record Index].

13.0 Community Relations

13.2 Community Relations Plans

Reports

1. Cross Reference: "Final Community Relations Plan," Ecology and Environment, Inc. (February 1992) [Filed and cited as entry number 1 in minor break 13.2 Community Relations Plans of the Fort Devens Group 1A Sites Administrative Record Index].
2. Cross Reference: "Fort Devens Community Relations Plan for Environmental Restoration, 1995 Update," ABB Environmental Services, Inc. (May 1995). [Filed and cited as entry number 2 in minor break 13.2 Community Relations Plans of the Fort Devens Group 1A Sites Administrative Record Index].

Comments

3. Cross Reference: Letter from James P. Byrne, EPA Region I to F. Timothy Prior, Fort Devens (March 19, 1992). Concerning approval of the February 1992 "Final Community Relations Plan," Ecology and Environment, Inc. [Filed and cited as entry number 2 in minor break 13.2 Community Relations Plans of the Fort Devens Group 1A Sites Administrative Record Index].
4. Cross Reference: Comments Dated July 17, 1995 from James P. Byrne, USEPA, Region I, on the May 1995 Fort Devens Community Relations Plan for Environmental Restoration, 1995 Update (ABB Environmental Services, Inc.). [Filed and cited as entry number 4 in minor break 13.2 Community Relations Plans of the Fort Devens Group 1A Sites Administrative Record Index].

13.5 Fact Sheets

1. Cross Reference: "Shepley's Hill Landfill Draft Fact Sheet, Fort Devens, Massachusetts," ABB Environmental Services, Inc. (February 1995). [Filed and cited as entry number 1 in minor break 13.5 Fact Sheets of the Group 1A Sites Administrative Record File Index.]
2. Cross Reference: "Fact Sheet 2, Shepley's Hill Landfill Proposed Plan, Fort Devens, Massachusetts Environmental Restoration Program," ABB Environmental Services, Inc. (May 1995). [Filed and cited as entry number 2 in minor break 13.5 Fact Sheets of the Group 1A Sites Administrative Record File Index.]

Comments

3. Cross Reference: Comments Dated March 30, 1995 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the February 1995 "Shepley's Hill Landfill Draft Fact Sheet, Fort Devens, Massachusetts," (ABB Environmental Services, Inc.). [Filed and cited as entry number 3 in minor break 13.5 Fact Sheets of the Group 1A Sites Administrative Record File Index.]

Responses to Comments

4. Cross Reference: Responses Dated June 1995 from U.S. Army Environmental Center on the Final Feasibility Study, Draft Proposed Plan and the Draft Fact Sheet, Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts. [Filed and cited as entry number 19 in minor break 4.6 Feasibility Study Reports of the Group 1A Sites Administrative Record File Index.]

13.11 Technical Review Committee Documents

Cross Reference: The following Reports, Comments, and Responses to Comments (entries 1 through 8) are filed and cited in minor break 13.11 Technical Review Committee Documents of the Group 1A Administrative Record Index unless otherwise noted below.

1. Technical Review Committee Meeting Agenda and Summary (March 21, 1991).
2. Technical Review Committee Meeting Agenda and Summary (June 27, 1991).
3. Technical Review Committee Meeting Agenda and Summary (September 17, 1991).
4. Technical Review Committee Meeting Agenda and Summary (December 11, 1991).
5. Technical Review Committee Meeting Agenda and Summary (March 24, 1992).
6. Technical Review Committee Meeting Agenda and Summary (June 23, 1992).
7. Technical Review Committee Meeting Agenda and Summary (September 29, 1992).
8. Technical Review Committee Meeting Agenda and Summary (January 5, 1993).

17.0 Site Management Records

17.6 Site Management Plans

Cross-Reference: The following Reports, Comments, and Responses to Comments (entries 1 through 9) are filed and cited in minor break 17.6 Site Management Records of the Groups 3, 5, & 6 Administrative Record Index unless otherwise noted below.

Reports

1. "Final Quality Assurance Project Plan," Ecology and Environment, Inc. (November 1991).
2. "General Management Procedures, Excavated Waste Site Soils, Fort Devens, Massachusetts," ABB Environmental Services, Inc. (January 1994).
3. "Final Project Operations Plan, Fort Devens, Massachusetts", ABB Environmental Services, Inc. (May 1995).
4. "Project Operations Plan, Fort Devens, Massachusetts," ABB Environmental Services, Inc. (June 1995).

Comments

5. Cross Reference: Comments from James P. Byrne, EPA Region I on the November 1991 "Final Quality Assurance Project Plan," Ecology and Environment, Inc. [These Comments are filed and cited as a part of entry number 8 in the Responses to Comments section of this minor break].
6. Comments Dated December 16, 1993 from Molly J. Elder, Commonwealth of Massachusetts Department of Environmental Protection on the November 1993 "Draft General Management Procedures, Excavated Waste Site Soils, Fort Devens, Massachusetts," ABB Environmental Services, Inc.
7. Comments Dated December 27, 1993 from James P. Byrne, EPA Region I on the November 1993 "Draft General Management Procedures, Excavated Waste Site Soils, Fort Devens, Massachusetts," ABB Environmental Services, Inc. [Filed and cited as entry number 4 in minor break 4.4 Interim Deliverables of the AOCs 44/52 Administrative Record Index.]
8. Comments Dated March 11, 1994 from D. Lynne Welsh, Commonwealth of Massachusetts Department of Environmental Protection on the January 1994 "General Management Procedures, Excavated Waste Site Soils, Fort Devens, Massachusetts," ABB Environmental Services, Inc.

Responses to Comments

9. Cross-Reference: U. S. Army Environmental Center Responses to Comments on the following documents: Feasibility Study Report; Biological Treatability Study Report; Feasibility Study Report - New Alternative 9; Draft General Management Procedures Excavated Waste Site Soils; and Draft Siting Study Report, dated January 25, 1994. [These Responses to Comments are filed and cited as a part of entry number 7 in the Responses to Comments section of minor break 4.4 Interim Deliverables of the AOCs 44/52 Administrative Record Index.]

Responses to Comments

10. Response from Fort Devens to Comments from James P. Byrne, EPA Region I on the November 1991 "Final Quality Assurance Project Plan," Ecology and Environment, Inc.
11. Cross-Reference: U.S. Army Environmental Center Responses to Comments for the following documents: Final Feasibility Study Report; Draft Proposed Plan; Revised Draft Proposed Plan; Draft Excavated Soils Management Plan; Final General Management Procedures Excavated Waste Site Soils; and Biological Treatability Study Report, dated May 1994. [These Responses to Comments are filed and cited as entry number 8 in the Responses to Comments section of minor break 4.4 Interim Deliverables of the AOCs 44/52 Administrative Record Index.]

17.9 Site Safety Plans

Cross Reference: The following Reports and Comments (entries 1 through 3) are filed and cited as entries 1 through 3 in minor break 17.9 Site Safety Plans of the Group 1A Sites Administrative Record File Index unless otherwise noted below.]

Reports

1. "Final Health and Safety Plan," Ecology and Environment, Inc. (November 1991).

Comments

2. Cross Reference: Comments from James P. Byrne, EPA Region I on the November 1991 "Final Health and Safety Plan," Ecology and Environment, Inc. [These Comments are filed and cited as a part of entry number 8 in minor break 17.6 Site Management Plans of the Group 1A Sites Administrative Record File Index].

3. Response from Fort Devens to Comments from James P. Byrne, EPA Region I on the November 1991 "Final Health and Safety Plan," Ecology and Environment, Inc.
   Reports

Section II

Guidance Documents

GUIDANCE DOCUMENTS

The following guidance documents were relied upon during the Fort Devens cleanup. These documents may be reviewed, by appointment only, at the Environmental Management Office at Fort Devens, Massachusetts.

1. Occupational Safety and Health Administration (OSHA). Hazardous Waste Operation and Emergency Response (Final Rule, 29 CFR Part 1910, Federal Register. Volume 54, Number 42) March 6, 1989.
2. USATHAMA. Geotechnical Requirements for Drilling Monitoring Well, Data Acquisition, and Reports, March 1987.
3. USATHAMA. IRDMIS User's Manual, Version 4.2, April 1991.
4. USATHAMA. USATHAMA Quality Assurance Program: PAM-41, January 1990.
5. USATHAMA. Draft Underground Storage Tank Removal Protocol - Fort Devens, Massachusetts, December 4, 1992.
6. U.S. Environmental Protection Agency. Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring: OWRS QA-1, May 1984.
7. U.S. Environmental Protection Agency. Office of Research and Development Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans: QAMS-005/80, 1983.
8. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, (OSWER Directive 9355.3-01, EPA/540/3-89/004, 1986.
9. U.S. Environmental Protection Agency. Test Methods for Evaluating Solid Waste: EPA SW-846 Third Edition, September 1986.
10. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), (EPA/540/1-89/002), 1989.
11. U.S. Environmental Protection Agency. Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristic Revisions, (Final Rule, 40 CFR Part 261 et al., Federal Register Part V), June 29, 1990.

APPENDIX E

APPENDIX E - DECLARATION OF STATE CONCURRENCE

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection
Central Regional Office

William F. Weld
Governor
Trudy Coxe
Secretary, EOEA
David B. Struhs
Commissioner

September 18, 1995

Mr. John De Villars
Regional Administrator
U.S. Environmental Protection Agency
Region I
JFK Federal Building
Boston, MA 02203

RE: ROD Concurrence, Shepley's Hill Landfill, AOCs 4, 5 and 18, Fort Devens, MA

Dear Mr. De Villars:

The Massachusetts Department of Environmental Protection (MADEP) has reviewed the preferred remedial alternative recommended by the Army and the EPA for the final cleanup of the Shepley's Hill Landfill, the core provisions of which are summarized below. The MADEP has worked closely with the Army and EPA in the development of the preferred alternative and is pleased to concur with the Army's choice of the remedial alternative.

The MADEP has evaluated the preferred alternative for consistency with M.G.L. c. 21E (21E) and the Massachusetts Contingency Plan (MCP). The remedial alternative addresses the entire landfill as one operable unit and includes the following components:

- Completion of any outstanding closure requirements identified under 310 CMR 19.000;
- Survey of Shepley's Hill Landfill;
- Evaluation/improvement of stormwater diversion and drainage;
- Landfill cover maintenance;
- Long-term groundwater and landfill gas monitoring;
- Institutional controls;
- Educational programs;

- Design of groundwater extraction system;
- Annual reporting to MADEP and USEPA; and
- Five-year site reviews.

The MADEP's concurrence with the preferred remedial alternative is based upon the expectation that it will result in a permanent solution as defined in 21E and the MCP and that contaminant concentrations achieved during the implementation of the remedial alternative will meet the MCP standards.

The MADEP would like to thank EPA, in particular the Fort Devens Remedial Project Manager, Jim Byrne, for their efforts to ensure that the Massachusetts environmental requirements were met in the selection of the remedial alternative. We look forward to continuing to work with EPA in the implementation of the remedial alternative. If you have any questions, please contact Lynne Welsh at (508) 792-7653, ext. 3851.

Sincerely,

Cornelius J. O'Leary

Cornelius O'Leary
Regional Director
MADEP, CERO

cc: Fort Devens Mailing List (cover letter only)
Edward Kunce, MADEP
Jay Naparstek, MADEP
Informational Repositories
Jim Byrne, EPA
Charles George, AEC
Mark Applebee, ACOE
Judy Kohn, Mass Land Bank

APPENDIX F

APPENDIX F - GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Contamination
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
BRAC	Base Realignment and Closure Act
CAC	Citizen's Advisory Committee
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMR	Code of Massachusetts Regulations
DDD	2,2-bis(para-chlorophenyl)-1,1-dichloroethane
DDE	2,2-bis(para-chlorophenyl)-1,1-dichloroethene
DDT	2,2-bis(para-chlorophenyl)-1,1,1-trichloroethane
DRMO	Defense Reutilization and Marketing Office
FS	Feasibility Study
HI	Hazard Index
IAG	Interagency Agreement
IRP	Installation Restoration Program
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MEP	Master Environmental Plan
MGD	million gallons per day
MMCL	Massachusetts Maximum Contaminant Level
NPL	National Priorities List
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
POTW	publicly owned treatment works
ppb	parts per billion
PVC	polyvinyl chloride

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	remedial investigation
SA	Study Area
SARA	Superfund Amendments and Reauthorization Act of 1986
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound list
TOC	total organic carbon
TRC	Technical Review Committee
$\mu g/L$	micrograms per liter
USAEC	U.S. Army Environmental Center
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

EXPLANATION OF SIGNIFICANT DIFFERENCES

GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE CONTINGENCY REMEDY

For
SHEPLEY'S HILL LANDFILL
FORT DEVENS, MA

Prepared for:

Department of the Army
Atlanta Field Office
BRAC-AFO
1347 Thorne Street SW, Bldg 243
Ft. McPherson, GA 30330-1062

April, 2005

Prepared by:

CH2M HILL, Inc.

25 New Chardon Street, Suite 500
Boston, MA 02114

Contents

FIGURES

1.0 Introduction

This document presents an Explanation of Significant Differences (ESD) for the Shepley's Hill Landfill Operable Unit, inclusive of Areas of Contamination (AOC) 4, 5, and 18, at the former Fort Devens. The ESD represents a significant change in remediation approach subsequent to the issuance of the Shepley's Hill Landfill Operable Unit Record of Decision (ROD), dated September, 1995[1].

Site Name and Location	
Site Name:	Shepley's Hill Landfill Operable Unit. The Shepley's Hill Landfill includes three AOCs: AOC 4, the sanitary landfill incinerator, AOC 5, sanitary landfill No. 1, and AOC 18, the asbestos cell.
Location:	Fort Devens is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) site located in the Towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts.
Lead and Support Agencies	
Lead Agency: Contacts:	Headquarters Dept. of the Army, Base Realignment and Closure, Atlanta Field Office Robert Simeone, BRAC Environmental Coordinator (978) 796-2205
Support Agencies Contacts:	United States Environmental Protection Agency and Massachusetts Department of Environmental Protection Ginny Lombardo, Remedial Project Manager, EPA New England, (617) 918-1754 Lynne Welsh, Remedial Project Manager, MA DEP, Central Region (508) 792-7650

Under Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and promulgated in 40 CFR Sections 300.435(c)(2)(i) and 300.825(a)(2), if the Army determines that the remedial action at the Shepley's Hill Landfill Operable Unit (site) differs significantly in scope, performance, or cost from the Record of Decision for the site, the Army shall publish an explanation of significant differences between the remedial action being undertaken and the remedial action set forth in the ROD and the reasons such changes are being made. This ESD includes a brief history of the site, a description of the remedy selected in the ROD, and a description of the rationale for the changes to the contingency remedy specified in the ROD.

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[1] US Army Environmental Center (USAEC), 1995. Record of Decision, Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts. September. Signed by EPA New England (Region 1) on September 26, 1995.

Among other alternatives, the ROD describes two remedial alternatives: Alternative SHL-2, Limited Action, and Alternative SHL-9, Groundwater Pump and Discharge to the Ayer Publicly-Owned Treatment Works (POTW). These alternatives became the primary and contingency elements of the selected remedy for the Shepley's Hill Landfill remedial action, respectively. Alternative SHL-2 generally involves landfill closure with capping and monitoring. Alternative SHL-9, involving active extraction of groundwater, was selected as a contingency element of the selected remedy in order to supplement SHL-2, should SHL-2 not prove to be effective at controlling site risk.

This ESD documents decisions and provides notification relating to 1) implementation of the contingency remedy and 2) needed modifications of the contingency remedy. The needed modifications involve changing the POTW from Ayer to Devens, and providing pretreatment to meet Devens POTW discharge limitations. The change in POTW is a result of a MA DEP consent order issued to the Ayer POTW and subsequent planning, decisions and commitments by the Ayer POTW made to increase the utility's effective capacity, which did not consider a contribution of flow from the Devens SHL Extraction, Treatment and Discharge System. Increases in flow in Ayer will be diverted to the Devens POTW. Therefore, the decision was made to connect directly to the Devens POTW pursuant to the Utility Agreement between the U.S. Army and MassDevelopment.

In addition, the Army has added treatment prior to POTW discharge to ensure that discharge limitations specified in the Devens POTW Industrial Wastewater Discharge Permit #20, dated July, 2003[2], are met. The ESD has been prepared concurrently with the design of the contingency remedy, in accordance with the *Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (USEPA, July 30, 1999)[3].

In accordance with the National Contingency Plan (NCP), Section 300.825(a)(2), the ESD will become part of the Administrative Record for the Shepley's Hill Landfill Operable Unit. The Administrative Record contains the ESD and other supporting documents considered by the Army and the regulatory agencies in developing the ROD for the Shepley's Hill Landfill Operable Unit. The Administrative Record may be viewed at the Ft. Devens BRAC Environmental Office (Building 666, 30 Quebec St., Devens, MA 01432) between the hours of 8:30 AM and 5:00 PM, Monday through Friday. Additional repositories for the Administrative Record are housed in surrounding Town Libraries, including Ayer, Harvard, Lancaster (Executive Summaries only), and Shirley.

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[2] MassDevelopment, 2003. Shepley's Hill Landfill, Industrial Wastewater Discharge Permit #20, July 14.

[3] USEPA, 1999. A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, July, EPA 540-R-98-031.

2.0 Summary of Site History and Selected Remedy

The following sections present a brief history relating to the Shepley's Hill Landfill Operable Unit and the selected remedy identified in the 1995 Record of Decision.

2.1 SITE HISTORY

General

The former Fort Devens is located 35 miles west of Boston in north-central Massachusetts within the towns of Ayer and Shirley in Middlesex County, and the towns of Harvard and Lancaster in Worcester County. Prior to realignment and closure in 1996, Fort Devens included 9,280 acres divided into North Post, Main Post, and South Post. Figure 1-1 depicts the location of the various areas of the former base. The North and Main Posts are separated from the South Post by Massachusetts Route 2. The Nashua River runs through the North, Main and South Posts and the area around the former Fort Devens is primarily rural/residential. Currently, the Devens Reserve Forces Training Area (RFTA) consists of 5,196 acres primarily on South Post.

Camp Devens was created as a temporary cantonment in 1917 for training soldiers from the New England area. In 1932, the camp was formerly dedicated as Fort Devens and trained active duty personnel for World War II, the Korean and Vietnam Wars. In July of 1991, the North and Main Posts of Fort Devens were slated for closure and the South Post for realignment, for tactical training of Army Reserves, under the Defense Base Realignment and Closure Act (BRAC) of 1990. The installation ceased to be Fort Devens on March 31, 1996 at which time the remaining Army mission was assimilated by the Devens Reserve Forces Training Area (DRFTA).

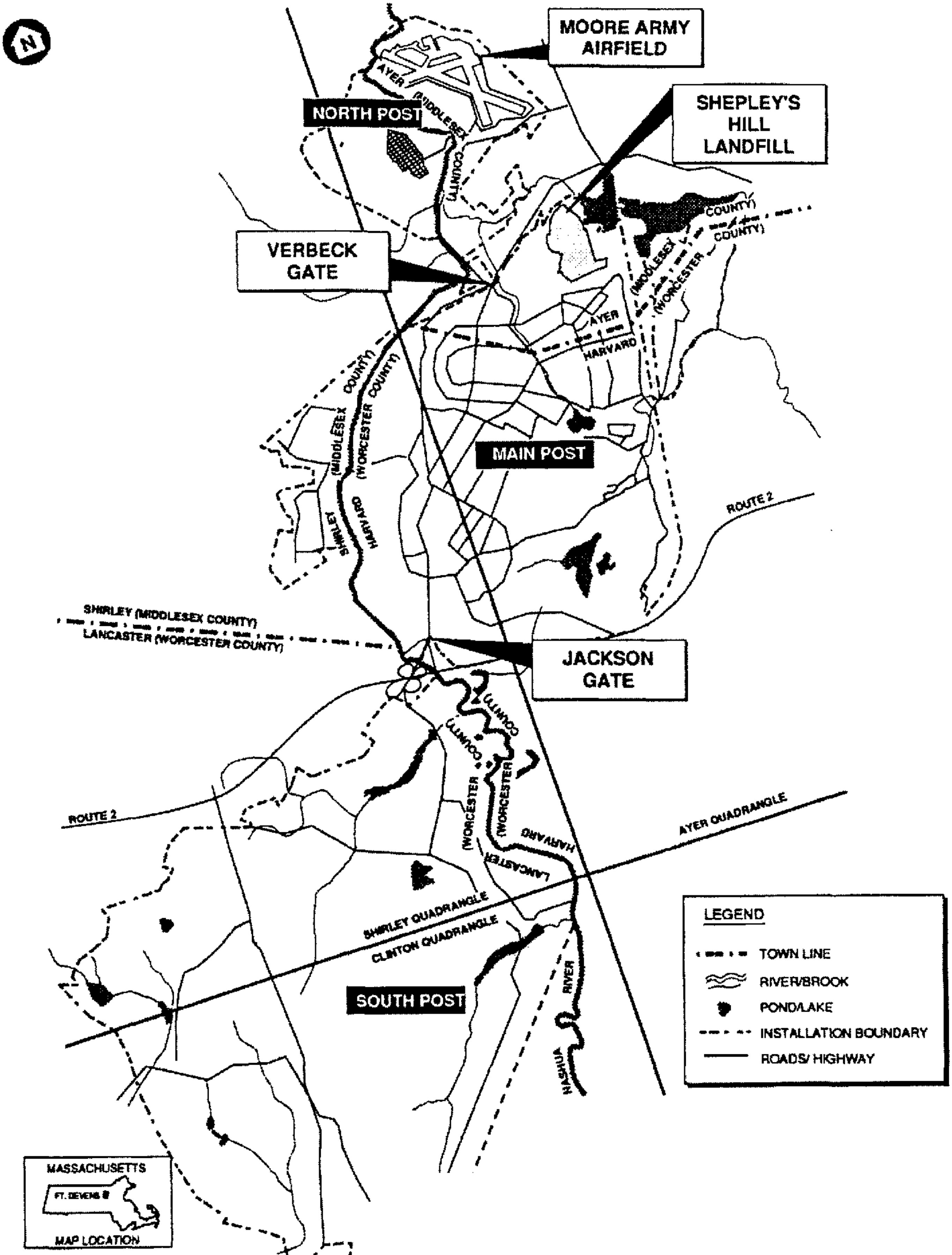
The US Environmental Protection Agency placed the former Fort Devens on its National Priorities List on November 21, 1989. Since listing, investigation and cleanup activities have been occurring to protect human health and the environment and facilitate property redevelopment.

Shepley's Hill Landfill Operable Unit

Shepley's Hill Landfill encompasses approximately 84 acres in the northeast corner of the former Main Post at Fort Devens (see Figure 1-2). It is situated between the bedrock outcrop of Shepley's Hill on the west and Plow Shop Pond on the east. Nonacoicus Brook drains Plow Shop Pond and flows through a low-lying wooded area at the north end of the landfill. The southern end of the landfill borders an area formerly occupied by the Defense Reutilization and Marketing Office (DRMO) yard, motor repair shops, and a warehouse.

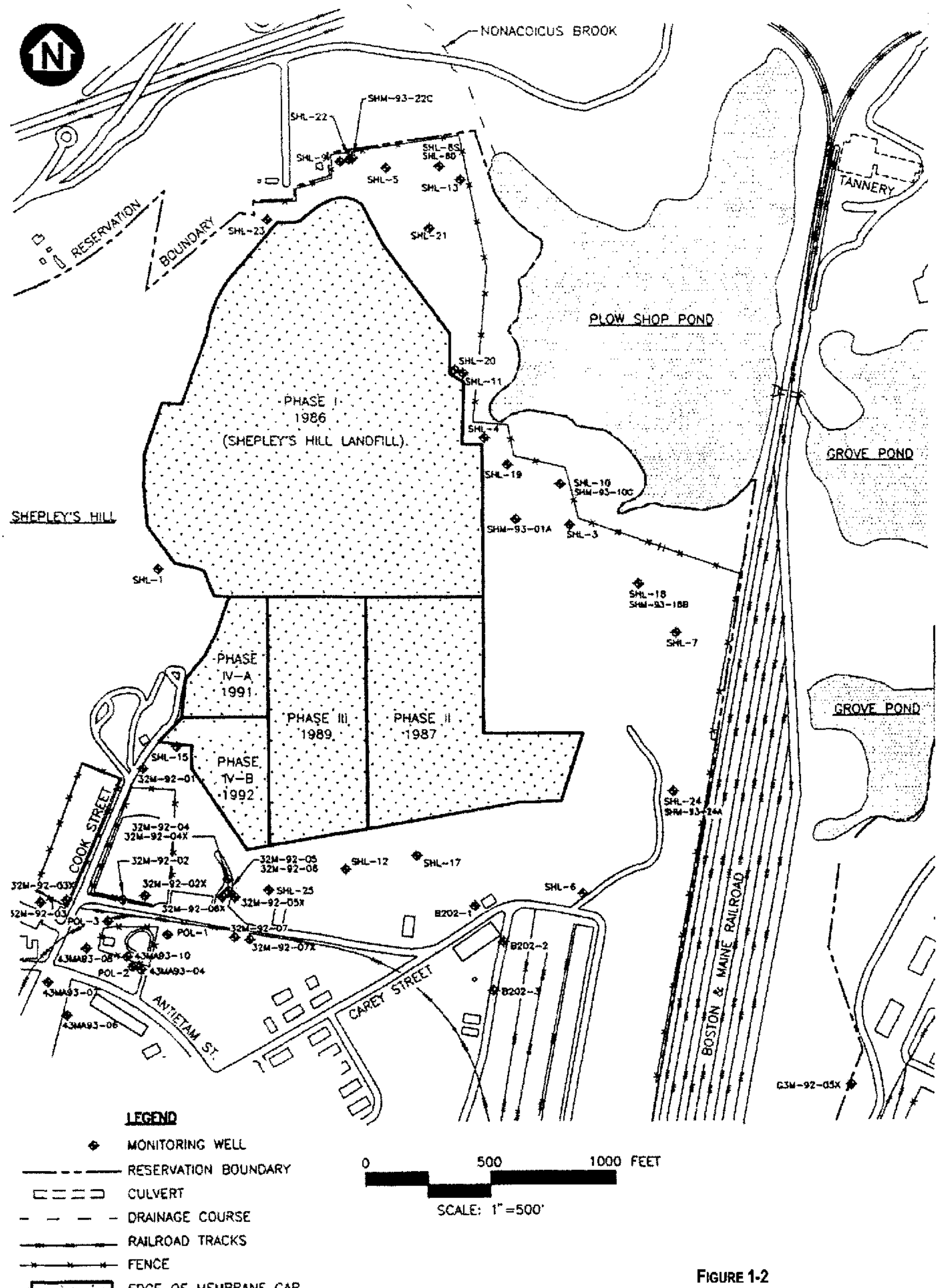
Shepley's Hill Landfill includes three Areas of Contamination (AOCs): AOC 4, the sanitary landfill incinerator; AOC 5, sanitary landfill No. 1 or Shepley's Hill Landfill; and AOC 18, the asbestos cell. AOCs 4, 5, and 18 are all located within the capped area at Shepley's Hill Landfill. The three AOCs are collectively referred to as Shepley's Hill Landfill. In an effort to mitigate the potential for off-site contaminant migration, Fort Devens initiated the Fort Devens Sanitary Landfill Closure Plan in 1984 in accordance with Massachusetts regulations (310CMR 19.00, April 21, 1971). The MADEP (then the Department of Environmental Quality Engineering) approved the plan in 1985. Closure plan approval was consistent with 310 CMR 19.00. The capping was completed in four phases (Figure 1-2). In Phase I, 50 acres were capped in October 1986; in Phase II, 15 acres were capped in November 1987; and in Phase III, 9.2 acres were capped in March 1989. The Phase IV closure of the last 10 acres was accomplished in two steps: Phase IV-A was closed in 1991, and Phase IV-B was closed as of July 1, 1992, although the geomembrane cap was not installed over Phase IV-B until May 1993.

Because of the large area and shallow surface slope of the existing landfill, early phases of the landfill closure were completed with a 2 or 3 percent surface slope. Slopes were increased to 5 percent in Phase IV-B. Phases I through IV-A were capped with a 30-mil polyvinyl chloride (PVC) geomembrane overlain with a 12-inch drainage layer and 6-inch topsoil layer. At the request of MADEP, the Phase IV-B cap design was modified to include a 40-mil PVC geomembrane, a 6-inch drainage layer, and a 12-inch topsoil layer. A landfill-gas collection system consisting of 3-inch diameter gas-collection pipes bedded in a minimum 6-inch thick gas-venting layer was installed beneath the PVC geomembrane in all closure phases. Gas vents were installed through the PVC geomembrane at 400-foot centers. A minimum 6-inch cushion/protection layer was maintained between the geomembrane and underlying waste. The Army submitted a draft closure plan to MADEP on July 21, 1995 to document that SHL was closed in accordance with plans and applicable MADEP requirements. A Record of Decision for the Shepley's Hill Landfill Operable Unit was signed in September, 1995. The MADEP issued a Capping Compliance Letter on February 8, 1996, concurring in the closure and establishing conditions for Monitoring and Maintenance of the Landfill Post Closure.



CH2MHILL

FIGURE 1-1
Former Fort Devens Vicinity Map and Shepley's Hill Landfill (adapted from Harding ESE, 2003)



CH2MHILL

FIGURE 1-2
Shepley's Hill Landfill Site Location Map
(Adapted from USAEC, 1995)

2.2 SELECTED REMEDY (INCLUDING CONTINGENCY REMEDY)

Summary

Among other alternatives, the ROD describes two alternatives, Alternative SHL-2 (Limited Action) and Alternative SHL-9 (Groundwater Pump and Discharge to the Ayer POTW), which became the primary and contingency elements of the selected remedy for the Shepley's Hill Landfill remedial action. Alternative SHL-2 involves landfill closure with capping and monitoring. Alternative SHL-9, involving active extraction of groundwater, was selected as a contingency or supplement to SHL-2, should it not prove to be effective at controlling site risk.

Shepley's Hill Landfill (SHL) ceased landfilling operations in July 1992 and the final phase of capping (Phase IV-B) was completed in May 1993. The Army performed a remedial investigation (RI) and supplemental RI at SHL in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) between 1991 and 1993. The RI and RI Addendum reports identified potential human exposure to arsenic in groundwater as the primary risk at SHL. A Feasibility Study was performed in 1995 to evaluate alternatives to reduce potential exposure risks, and in September 1995, a Record of Decision (ROD) was finalized.

The ROD requires the Army to perform groundwater monitoring and five-year reviews to evaluate the effectiveness of the selected remedial action (Alternative SHL-2), which relies heavily on the previously installed landfill cap, to attain groundwater cleanup goals by 2008 and to reduce potential exposure risks. The ROD and the Long Term Monitoring and Maintenance Plan established incremental reduction of risk rather than incremental reduction in concentration of individual contaminants as a measure of progress toward attainment of cleanup levels to focus on the cleanup of arsenic, which was the primary contributor to risk. The required incremental reduction in risk was not achieved and the Army and the regulatory agencies decided to implement the contingent element of the selected remedy.

Record of Decision, Five Year Review, and Contingency Remedy

As described in the Record of Decision for Shepley's Hill landfill, the remedial response objectives are to:

- *Protect potential residential receptors from exposure to contaminated groundwater migrating from the landfill having chemicals in excess of MCLs.*
- *Prevent contaminated groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations.*

Alternative SHL-2 contains components to maintain and potentially improve the effectiveness of the existing landfill cover systems to satisfy the Landfill Post-Closure Requirement of 310 CMR 19.142 and to reduce potential future exposure to contaminated groundwater. The key components of this Alternative SHL-2 are summarized as follows:

- Landfill closure in accordance with requirements of 310 CMR 19.000;
- Survey of Shepley's Hill Landfill;
- Evaluation/improvement of stormwater diversion and drainage;
- Landfill cover maintenance;
- Landfill gas collection system maintenance;
- Long-term monitoring;
- Long-term landfill gas monitoring;
- Institutional controls;
- Educational programs;
- 60 percent design of a groundwater extraction system;
- Annual reporting to MADEP and USEPA; and
- Five year site reviews.

With the exception of the first two items listed above, activities involving each of these components have been occurring since signing of the ROD in September 1995 and these activities are reported in annual monitoring reports and two separate five year review reports. The original five year review, focused solely on Shepley's Hill Landfill, was completed in August, 1998 (Stone & Webster, 1998)[4]. Another five year review, intended to be comprehensive for all sites at the former Fort Devens undergoing investigation and remediation, was completed in September, 2000 (HLA, 2000)[5], being triggered by the initiation of soil remediation activities of AOC 44 and 52 on August 11, 1995.

The five year review is intended to evaluate the effectiveness of SHL-2 in reducing potential human health risk from exposure to groundwater and at preventing groundwater from contributing to Plow Shop Pond sediment contamination in excess of human health and ecological risk-based values.

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[4] Stone and Webster Environmental Technology & Services (SWET), 1998. Final Five Year Review, Shepley's Hill Landfill Long Term Monitoring, Devens, Massachusetts. Prepared for the US Army Corps of Engineers, New England District, August.

[5] Harding Lawson Associates (HLA). 2000. Final First Five-Year Review Report for Devens Reserve Forces Training Area, Devens, Massachusetts. Prepared for the US Army Corps of Engineers, New England District, September.

The following are the specific criteria, as stated in the ROD, for evaluating the effectiveness of Alternative SHL-2 relative to groundwater data from Group 1 and Group 2 wells:

Group 1 Wells. *For Group 1 wells where analyte concentrations have historically attained cleanup levels, Alternative SHL-2 will be considered effective if concentrations of individual chemicals within individual wells do not show statistically significant cleanup level exceedances. To determine statistical significance, the Army will apply methods consistent with the regulations at 40 CFR 264.97, 40 CFR 258.53, and 310 CMR 30.663.*

Group 2 Wells. *For Group 2 wells where chemical concentrations have exceeded cleanup levels in the past, Alternative SHL-2 will be considered effective if a 50 percent reduction in the increment of risk between cleanup levels and baseline concentrations for chemicals of concern within individual wells is achieved by January 1998, if an additional 25 percent (75 percent cumulative) is achieved by January 2003, and if cleanup levels are attained by January 2008.*

In general, the ROD states that "Alternative SHL-2 will be considered effective with regard to these wells if five-year reviews show an ongoing reduction of potential human health risk at Group 2 wells and the ultimate attainment of cleanup levels by January 2008." The ROD further states that "the Army will implement the contingency remedy if the above criteria are not met for any chemical for which cleanup levels were based on MCLs (40 CFR 141) and for manganese. No MCL has been established for manganese. The cleanup level for manganese was based on background concentrations because background concentrations exceed the risk-based concentration derived from the available RfD value (5×10^{-3} milligrams/kilogram/day)." The current cleanup level for manganese was updated in the Long Term Monitoring and Maintenance Plan to 1715 μg/l based on the risk-based concentrations derived from the revised/updated RfD value (4.7×10^{-2} milligrams/kilogram/day).

The data collected over the past several years at Group 1 and 2 wells as part of the long-term groundwater monitoring plan for Shepley's Hill Landfill, as well as those data collected as part of the *Supplemental Groundwater Investigation* (Harding ESE 2003)[6] led to the following conclusion in the *Final First Five-Year Review Report* (HLA 2000):

Review of available data suggests that the remedy may have difficulty meeting 2003 interim groundwater cleanup goals. Because of this, the Army should re-evaluate the contingency

[6] Harding ESE, 2003. Revised Draft Shepley's Hill Landfill Supplemental Groundwater Investigation, Devens Reserve Forces Training Area, Devens, MA. Volume 1 and 2. Prepared for the US Army Corps of Engineers, New England District, May.

remedy of groundwater extraction with subsequent discharge to the Town of Ayer publicly owned treatment works (POTW). Although groundwater extraction has the potential to contain groundwater contaminants, it will not prevent the release of arsenic from aquifer materials and would need to be performed for an indeterminate length of time. Also, it appears that the POTW would no longer be suitable for receipt of extracted groundwater. These studies should be completed prior to the 2003 assessment of risk at Shepley's Hill Landfill.

During the First Devens Five Year Review four wells; SHL-11, SHL-20, SHM-96-05B and SHM-96-22B had shown little or no reduction in arsenic level between 1997 and 1999 and three of the wells showed an increase. Therefore, it was concluded that these wells may not meet the ROD 2003 incremental goal calling for a 75 % reduction in risk between baseline concentration and the cleanup goals and additional time would be required to determine if the 2008 goal of attaining cleanup goals will be met. These trends continue to be seen in the monitoring data. Subsequent analysis provided in the Supplemental Groundwater Investigation (Harding ESE, 2003) and work of the Army and BRAC Cleanup Team (BCT) have resulted in a recommendation to implement the contingency remedy with changes to further control contamination migration and potential exposure. The Army developed and the BCT reviewed a draft Remedial Action Work Plan in the Spring of 2003 for implementing the contingency remedy identified in the 1995 ROD. The contingency remedy directly addresses the first remedial response objective.

The second remedial response objective involves preventing contaminated groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations. The capping of the landfill, associated with Alternative SHL-2, has reduced groundwater flow in the direction of Plow Shop Pond by diverting groundwater flow to the north as indicated by both groundwater monitoring data for a number of wells along the east side of the landfill and groundwater modeling work conducted during the FS for both uncapped and capped landfill scenarios. Groundwater extraction near the north end of the landfill, associated with the contingency remedy is expected to induce additional groundwater flow to the north in the vicinity of Plow Shop Pond, which would further limit or reduce any discharge of landfill-related groundwater to Plow Shop Pond.

The comprehensive *First Five-Year Review Report for Devens Reserve Forces Training Area* (HLA, 2000), identifies the issue of potential changes in the arsenic standard from 50 to 5 ug/l based on the June 22, 2000 USEPA proposed changes. Since that time, a new arsenic standard of 10 ug/l was promulgated (on January 22, 2001) and public water systems must comply with this new standard by

January 23, 2006. Although ROD clean-up goals have not changed, to date, it is anticipated that they will change to be responsive to this new standard while incorporating knowledge of the known ranges of background arsenic concentration in groundwater at the Devens RFTA.

3.0 Significant Differences and the Basis for those Differences

This ESD documents decisions and provides notification relating to:

1) Implementation of the contingency remedy;

2) Modification of the contingency remedy to
   a) change the POTW from Ayer to Devens and
   b) provide pretreatment to meet Devens POTW discharge limitations;. and

3) The Army's plan to conduct a Comprehensive Site Assessment (CSA) and Corrective Action Alternatives Analysis (CAAA) in accordance with Massachusetts Solid Waste Management Facility regulations (310 CMR 19.000). The CSA/CAA process will provide the technical framework for evaluating all impacts associated with the landfill and shall propose changes to the selected remedy (SHL-2 and SHL-9), if necessary.

Since the signing of the ROD, monitoring work, a groundwater pump test, groundwater modeling, knowledge of capacity constraints of the Ayer POTW, and discharge limitations of the Devens POTW Industrial Wastewater Discharge Permit #20 (MassDevelopment, 2003) have all been factors considered by the Army and the BCT in developing changes to the contingency remedy. Implementation of the contingency remedy, as well as the associated changes, which are considered "significant," require, in accordance with Section 117(c) of CERCLA, that an ESD be developed.

Changes and further definition of the Contingency Remedy may be summarized as follows:

- <u>Receiving POTW Changed from Ayer to Devens</u>: This requires that a discharge pipeline contained within a protective berm will be placed across the Shepley's Hill Landfill to connect with the Devens sewer at a manhole near Antietam and Cook Streets. The Army received an Industrial Wastewater Discharge Permit #20 from MassDevelopment, the owner of the Devens POTW in July 2003. It grants a one year permit term with extensions to the Army for release of up to 50 gallons per minute (gpm) of groundwater with a discharge limitation for arsenic of 150 μg/l and no greater than a maximum daily loading to the plant of 0.07 pounds per day. A one-year renewal Permit was issued in March 2005.

- Addition of Arsenic Treatment Prior to Discharge: This will involve coagulation and microfiltration treatment of extracted groundwater to meet a treatment goal of 10 μg/l. The Army decided to add permanent pretreatment to the Shepley's Hill project with a treatment goal of 10 μg/l to ensure that the concentration and loading discharge limitations for arsenic provided in the Devens POTW permit would be met.

4.0 Support Agency Comments

The United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (DEP) have expressed their support for implementation of the contingency remedy as modified by this ESD. Both agencies have provided comments to a draft of this document, they were discussed, and responses have been incorporated.

5.0 Affirmation of the Statutory Determinations

The revised remedy complies with the NCP and the statutory requirements of CERCLA. Considering the decision to implement the contingency remedy (Alternative SHL-9) to supplement the original remedy and new information that has been developed and the changes that have been made to the contingency remedy, the Army, EPA, and DEP believe that the remedy remains protective of human health and the environment, complies with federal and state requirements that were identified in the ROD as applicable or relevant and appropriate to this remedial action at the time the original and this ESD were signed, and is cost-effective. In addition, local POTW pre-treatment system discharge limitations and monitoring requirements will be met. The revised remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for this site.

6.0 Public Participation Activities

The Army meets regularly with stakeholders through BRAC clean-up team (BCT) meetings and monthly Restoration Advisory Board (RAB) meetings to discuss clean up status at the former Fort Devens and, more specifically, monitoring and other data relating to the Shepley's Hill Landfill Operable Unit. These meetings have involved discussions of monitoring data relating to groundwater compliance monitoring, annual reports, and five year reviews evaluating performance of the selected alternative (SHL-2, Limited Action involving closure capping and monitoring) for Shepley's Hill Landfill. Discussions relating to implementation of the contingency remedy (Alternative SHL-9 involving installation of a groundwater extraction and discharge system), and its modification to involve treatment following groundwater extraction and discharge at a new POTW location (Devens rather than Ayer), have also been presented and discussed. At the RAB meeting on November 13, 2003, the plans to implement the contingency remedy and details about treatment process design and discharge to the Devens POTW were presented and discussed.

In accordance with 40 CFR Section 300.435(c)(2)(i) of the National Contingency Plan, this ESD and other supporting documents are available in the Administrative Record maintained by the Army. The Administrative Record may be viewed at the Ft. Devens BRAC Environmental Office (Building 666, 30 Quebec St., Devens, MA 01434) between the hours of 8:30 AM and 5:00 PM, Monday through Friday, by calling (978) 796-3835. Additional repositories for the Administrative Record are housed in surrounding Town Libraries, including Ayer, Harvard, Lancaster (Executive Summaries only), and Shirley.

Public notice relating to the availability of the ESD for review was made in the Nashoba Publishing papers, Lowell Sun, and Fitchburg Sentinel on April 22, 2005. A voluntary 30 day public comment period beginning April 29th, 2005 and ending May 31, 2005 will be held by the Army to solicit public comment on this Explanation of Significant Differences.

AUTHORIZING SIGNATURES

The forgoing Explanation of Significant Differences has been prepared to document changes in the contingency remedy from the Record of Decision as required by Section 117(a) of CERCLA. The forgoing represents the selection of a remedial action by the U. S. Department of the Army and U. S. Environmental Protection Agency, with the concurrence of the Massachusetts Department of Environmental Protection.

Concur and recommend for immediate implementation.

U.S. DEPARTMENT OF THE ARMY

Glynn D. Ryan
Chief, Atlanta Field Office
Department of the Army
Base Realignment and Closure

11-29-05
Date

U.S. ENVIRONMENTAL PROTECTION AGENCY

Susan Studien
Division Director
Office of Site Remediation and Restoration
Region 1

11-2-05
Date

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

Memorandum

To: Devens Federal Facility CERCLA File

From: Ginny Lombardo, Devens RPM

Subj: OU1, Shepley's Hill Landfill, Explanation of Significant Difference (ESD), April 2005

Date: March 30, 2006

The purpose of this memo is to reconcile the ESD CERCLIS completion date of April 2005 to the ESD EPA and Army signature date of November 2005.

The actual Final ESD document, as prepared by CH2MHill on behalf of the Army, is dated April 2005. This addressed all of EPA's prior comments and the Army issued the public notice on the ESD on April 22, 2005. At that time, the RPM entered the ESD completion date of April 2005 into CERCLIS.

In July 2005, the RPM was informed by Patti Ludwig that a signature page was needed for the ESD. At that time, the RPM emailed the Army to let them know this oversight and on July 27, 2005, the RPM sent the Army a signature page signed by the OSRR Division Director and requested that the page be signed by the appropriate Army official and then a copy sent to EPA for our files.

After not receiving the Army-signed final signature page for several months, the RPM inquired and learned that the July EPA-signed ESD signature page had been lost at the Army's Atlanta office. Therefore, in November 2005, the RPM sent the Army a new ESD signature page signed by the OSRR Division Director on 11/2/05. This signature page was then signed on 11/29/05 by the Army official.

Therefore, although the date of the Final ESD document is April 2005, the final signature page was signed in November 2005.

cc: Brenda Haslett, EPA

EXPLANATION OF SIGNIFICANT DIFFERENCES

SHEPLEY'S HILL LANDFILL SUPERFUND SITE
FORMER FORT DEVENS ARMY INSTALLATION

LAND USE CONTROLS TO RESTRICT GROUNDWATER USE

DEVENS, MASSACHUSETTS
DECEMBER 2013

Prepared for:
DEPARTMENT OF THE ARMY

U.S. Army Corps of Engineers
New England District

Base Realignment and Closure Division
Fort Devens, Massachusetts

Prepared by:
Sovereign Consulting Inc.
4 Open Square Way
Holyoke, MA 01040

SOVEREIGN CONSULTING INC.

Table of Contents

FIGURES

APPENDICES

LIST OF ACRONYMS

AOC	Area of Contamination
ATP	Arsenic Treatment Plant
BOH	Board of Health
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	Conceptual Site Model
DRMO	Defense Reutilization and Marketing Office
ESD	Explanation of Significant Differences
ESI	Expanded Site Investigation
FOST	Finding of Suitability to Transfer
LIFOC	Lease in Furtherance of Conveyance
LRA	Land Redevelopment Authority
LUCs	Land Use Controls
LUCIP	Land Use Controls Implementation Plan
MassDEP	Massachusetts Department of Environmental Protection
NCP	National Contingency Plan
NIA	Northern Impact Area
NPL	National Priorities List
OPS	Operating Properly and Successfully
OU	Operable Unit
POTW	Public Operated Treatment Works
RAOs	Remedial Action Objectives
RAB	Restoration Advisory Board

RI	Remedial Investigation
ROD	Record of Decision
SHL	Shepley's Hill Landfill Operable Unit
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

This document presents the second Explanation of Significant Differences (ESD) for the Shepley's Hill Landfill Operable Unit, inclusive of Areas of Contamination (AOC) 4, 5, and 18, at the former Fort Devens. The ESD represents a significant change in remediation approach subsequent to the issuance of the Shepley's Hill Landfill Operable Unit Record of Decision (ROD), dated September, 1995[1] and the first ESD dated April 2005.[2]

Site Name and Location	
Site Name:	Shepley's Hill Landfill Operable Unit. The Shepley's Hill Landfill includes three AOCs: AOC 4, the sanitary landfill incinerator, AOC 5, sanitary landfill No. 1, and AOC 18, the asbestos cell.
Location:	Fort Devens is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) site located in the towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts.
Lead and Support Agencies	
Lead Agency: Contacts:	Department of the Army Office of the Assistant Chief of Staff for Installation Management Base Realignment and Closure (BRAC) Division Robert Simeone, BRAC Environmental Coordinator, Fort Devens, MA, (978) 796-2205
Support Agencies: Contacts:	United States Environmental Protection Agency (USEPA) and Massachusetts Department of Environmental Protection (MassDEP) Carol Keating, Remedial Project Manager, USEPA Region One, (617) 918-1393 David Chaffin, Remedial Project Manager, MassDEP Boston HQ Office (617)-348-4005

[1] US Army Environmental Center (USAEC), 1995. Record of Decision, Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts. September. Signed by EPA New England (Region 1) and by Department of the Army BRAC Division on September 26th 1995 and September 28th 1995, respectively.

[2] US Army Base Realignment and Closure (BRAC) Atlanta Field Office (AFO), 2005. Explanation of Significant Differences, Groundwater Extraction, Treatment, and Discharge Contingency Remedy, Shepley's Hill Landfill, Fort Devens, Massachusetts. April. Signed by USEPA New England (Region 1) and by Department of the Army BRAC Division on November 2nd , 2005 and November 29th 2005, respectively.

Under Section 117(c) of CERCLA, and promulgated in 40 CFR Sections 300.435(c)(2)(i) and 300.825(a)(2), if the Army determines that the remedial action at the Shepley's Hill Landfill Operable Unit (SHL) differs significantly in scope, performance, or cost from the ROD for the site, the Army shall publish an ESD between the remedial action being undertaken and the remedial action set forth in the ROD and the reasons such changes are being made. This ESD includes a brief history of the site, a description of the remedy selected in the ROD, the contingency remedy specified in the ROD as implemented in the first ESD, and the remedy changes being implemented under this ESD. Specifically, the Lead and Support agencies have decided to enhance remedy Land Use Controls[3] (LUCs) by modifying the LUCs in the decision record for SHL via this ESD in order to further ensure protection of human health and the environment.

In accordance with the National Contingency Plan (NCP), Section 300.825(a)(2), the ESD will become part of the Administrative Record for the Shepley's Hill Landfill Operable Unit. The Administrative Record contains the ESD and other supporting documents considered by the Army and the regulatory agencies in developing the ROD for the Shepley's Hill Landfill Operable Unit. The Administrative Record may be viewed at the Ft. Devens BRAC Environmental Office (Building 666, 30 Quebec St., Devens, MA 01432) between the hours of 8:30 AM and 5:00 PM, Monday through Friday.

[3] Land Use Controls as defined by EPA guidance document (Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites, EPA-540-R-09-001, December 2012):

> *EPA defines (Institutional Controls) ICs as non-engineered instruments, such as administrative and legal controls, that help to minimize the potential for exposure to contamination and/or protect the integrity of a response action. ICs typically are designed to work by limiting land and/or resource use or by providing information that helps modify or guide human behavior at a site. ICs are a subset of Land Use Controls (LUCs). LUCs include engineering and physical barriers, such as fences and security guards, as well as ICs.*

2. SUMMARY OF SITE HISTORY AND SELECTED REMEDY

The following sections contain a brief history of the site, an overview of site contamination and risks, a description of the remedy selected in the ROD, and the contingency remedy specified in the ROD as implemented in the first ESD.

2.1 SITE HISTORY

2.1.1. General

The former Fort Devens is located 35 miles west of Boston in north-central Massachusetts within the towns of Ayer and Shirley in Middlesex County, and the towns of Harvard and Lancaster in Worcester County. Prior to realignment and closure in 1996, Fort Devens included 9,280 acres divided into North Post, Main Post, and South Post. Figure 1 depicts the location of the various areas of the former base. The North and Main Posts are separated from the South Post by Massachusetts Route 2. The Nashua River runs through the North, Main and South Posts and the area around the former Fort Devens is primarily rural/residential. Currently, the U.S. Army Garrison Fort Devens (formerly the Devens Reserve Forces Training Area) consists of 5,196 acres primarily on South Post.

Camp Devens was created as a temporary cantonment in 1917 for training soldiers from the New England area. In 1932, the camp was formerly dedicated as Fort Devens and trained active duty personnel for World War II, the Korean and Vietnam Wars. In July of 1991, the North and Main Posts of Fort Devens were slated for closure and the South Post for realignment, for tactical training of Army Reserves, under the Defense Base Realignment and Closure Act of 1990. The installation ceased to be Fort Devens on March 31, 1996 at which time the remaining Army mission was assimilated as the Devens Reserve Forces Training Area.

The EPA placed the former Fort Devens on its NPL on November 21, 1989. Since listing, investigation and cleanup activities have been occurring to protect human health and the environment and facilitate property redevelopment.

2.1.2. Shepley's Hill Landfill Operable Unit

SHL encompasses approximately 84 acres in the northeast corner of the former Main Post at Fort Devens (Figure 2). It is situated between the bedrock outcrop of Shepley's Hill on the west and Plow Shop Pond on the east. Nonacoicus Brook drains Plow Shop Pond and flows through a low-lying wooded area at the north end of the landfill. The southern end of the landfill borders an area formerly occupied by the Defense Reutilization and Marketing Office (DRMO) yard, motor repair shops, and a warehouse. Areas previously mapped as wetlands have been filled by waste materials. The landfill waste material was placed over peat deposits and a sandy aquifer that overlie bedrock and/or till[4].

SHL includes three AOCs: AOC 4, the sanitary landfill incinerator; AOC 5, sanitary landfill No. 1 or Shepley's Hill Landfill; and AOC 18, the asbestos cell. AOCs 4, 5, and 18 are all located within the capped area at SHL. The three AOCs are collectively referred to as Shepley's Hill Landfill Operable Unit. In an effort to mitigate the potential for off-site contaminant migration, Fort Devens initiated the Fort Devens Sanitary Landfill Closure Plan in 1984 in accordance with Massachusetts regulations (310CMR 19.00, April 21, 1971). The MassDEP (then the Department of Environmental Quality Engineering) approved the plan in 1985. Closure plan approval was consistent with 310 CMR 19.00. The capping was completed in four phases. In Phase I, 50 acres were capped in October 1986; in Phase II, 15 acres were capped in November 1987; and in Phase III, 9.2 acres were capped in March 1989. The Phase IV closure of the last 10 acres was accomplished in two steps: Phase IV-A was closed in 1991, and Phase IV-B was closed as of July 1, 1992, although the geomembrane cap was not installed over Phase IV-B until May 1993.

Because of the large area and shallow surface slope of the existing landfill, early phases of the landfill closure were completed with a 2 or 3 percent surface slope. Slopes were increased to 5 percent in Phase IV-B. Phases I through IV-A were capped with a 30-mil polyvinyl chloride (PVC) geomembrane overlain with a 12-inch drainage layer and 6-inch topsoil layer. At the request of MassDEP, the Phase IV-B cap design was modified to include a 40-mil PVC geomembrane, a 6-inch drainage layer, and a 12-inch topsoil layer. A landfill-gas collection system consisting of 3-inch diameter gas-collection pipes bedded in a minimum 6-inch thick gas-venting layer was installed beneath the PVC geomembrane in all closure phases. Gas vents were installed through the PVC geomembrane at 400-foot centers. A minimum 6-inch cushion/protection layer was maintained between the geomembrane and underlying waste. The Army submitted a draft closure plan to MassDEP on July 21, 1995 to document that SHL was closed in accordance with plans and applicable MassDEP requirements. The MassDEP issued a Capping Compliance Letter on February 8, 1996, concurring in the closure and establishing conditions for Monitoring and Maintenance of the Landfill Post Closure.

The Army performed a remedial investigation (RI) and a supplemental RI at SHL in accordance with CERCLA between 1991 and 1993. The RI and RI Addendum reports identified potential human exposure to arsenic in groundwater as the primary risk at SHL. Currently, based on available survey records, there is no significant risk to human health, but such a risk would exist if groundwater was a source of drinking water. Arsenic levels are above acceptable human health risk levels for potential future exposure pathways that include drinking water. A

[4] Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-term Monitoring and Maintenance – Addendum Report, August 2011.

Feasibility Study was performed in 1995 to evaluate alternatives to reduce potential exposure risks, and in September 1995, the ROD was finalized.

2.2 SELECTED REMEDY (INCLUDING CONTINGENCY REMEDY)

2.2.1. Remedial Action Objectives

Remedial action objectives (RAOs) are project objectives identified to ensure the protection of public health or welfare and the environment. The following RAOs were stipulated in the 1995 ROD:

1) Protect potential residential receptors from exposure to contaminated groundwater migrating from the landfill having chemicals in excess of Maximum Contaminant Levels (MCLs).

2) Prevent contaminated groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations.

The ROD did not identify remedial objectives for surface soil, landfill gas, or leachate because the risk assessments did not identify potential risks from exposure to surface soil and ambient air. Leachate was not identified during the RI or supplemental RI activities.

The Plow Shop Pond Operable Unit (OU) was established under AOC 72 to evaluate additional actions that may be necessary to manage potential risks from exposure to Plow Shop Pond surface water and sediment. The Army and USEPA performed surface water and sediment characterization as well as sediment toxicity characterization in Plow Shop Pond and Grove Pond from 1992 through 2010. Results of these studies were reported in the RI Addendum Report (ABB-ES, 1993); the Draft Plow Shop Pond and Grove Pond Sediment Evaluation (ABB-ED, 1995c); the Final Expanded Site Investigation (ESI): Remedial Oversight of Activities at Fort Devens, Plow Shop Pond and Grove Pond (USEPA, 2006); Final SA 71 Sediment Risk Characterization (MACTEC, 2008); and the Draft Final Remedial Investigation for AOC 72, Plow Shop Pond (AMEC, 2011).

2.2.2. Summary of Existing Remedy

The ROD describes two alternatives, Alternative SHL-2 (Limited Action) and Alternative SHL-9 (Groundwater Pump and Discharge to the Ayer Public Operated Treatment Works (POTW)), which became the primary and contingency elements of the selected remedy for the SHL remedial action. The ROD required the Army to perform groundwater monitoring and five-year reviews to evaluate the effectiveness of the selected remedial action (Alternative SHL-2), which relied on the previously installed landfill cap to attain groundwater cleanup goals by 2008 and to reduce potential exposure risks. The ROD and the Long Term Monitoring and Maintenance Plan established incremental reduction of risk rather than incremental reduction in concentration of individual contaminants as a measure of progress toward attainment of cleanup levels to focus on the cleanup of arsenic, which is the primary contributor to potential risk. The required incremental reduction in risk was not achieved and the Army decided to implement the contingent element of the selected remedy as documented in the first ROD ESD.

Alternative SHL-2 contains components to maintain and potentially improve the effectiveness of the existing landfill cover system and to satisfy the Landfill Post-Closure Requirements of 310 CMR 19.142 to reduce potential future exposure to contaminated groundwater. Key components of this alternative include:

- landfill closure in accordance with applicable requirements of 310 CMR 19.000;
- survey of Shepley's Hill Landfill;
- evaluation/improvement of storm water diversion and drainage;
- landfill cover maintenance;
- landfill gas collection system maintenance;
- long-term groundwater monitoring;
- long-term landfill gas monitoring;
- institutional controls;
- educational programs;
- 60 percent design of a groundwater extraction system;
- annual reporting to MassDEP and USEPA; and
- five-year site reviews

Alternative SHL-9, involving active extraction of groundwater, was selected as a contingency or supplement to SHL-2, should it not prove to be effective at controlling site risk.

The following selected remedy components related to this ESD and how they were implemented are described in greater detail below.

Existing SHL Remedy Institutional Controls (ICs):

From the SHL ROD;

> *Institutional controls are proposed in the form of zoning and deed restrictions for any property released by the Army at Shepley's Hill Landfill during Fort Devens base-closure activities. The Fort Devens Preliminary Reuse Plan, Main and North*

Posts has proposed that Army land bordering Plow Shop Pond be zoned for open space and rail-related uses. By pre-empting residential use, these controls would help limit human exposure. In addition, the Army would place deed restrictions on landfill area property to prohibit installation of drinking water wells. This, in combination with landfill capping and long-term groundwater monitoring, would protect potential human receptors from risks resulting from exposure to contaminated groundwater. There are no current human receptors for groundwater exposure. Institutional controls would be drafted, implemented, and enforced in cooperation with state and local governments.

These ROD remedy requirements were implemented by Army as follows:

Land Use Zoning:

Land use for the SHL and surrounding Army property is governed by the Devens Reuse Plan[5]which was approved by the towns of Ayer, Harvard and Shirley on December 7, 1994. The zoning or permitted land use for SHL and surrounding Army property per this plan is Open Space/Recreation which is further defined in the Devens Open Space and Recreation Plan[6] . As stated in the SHL ROD, this IC component restricts residential use of the SHL and surrounding Army property, and therefore limits human exposure. The Army's long-term monitoring and periodic inspections of the SHL and surrounding Army property ensure that this zoning layer is being enforced by MassDevelopment, the Land Redevelopment Authority (LRA).

Deed Restrictions:

The SHL property remains in Army ownership and is under a Lease in Furtherance of Conveyance (LIFOC) Agreement[7] with the LRA, pursuant to BRAC policy requirements. A Finding of Suitability to Transfer (FOST) has not been executed by the Army for this lease premise known as Parcel A.1 (SHL) (See Figure 3) since the SHL remedy has not been determined to be Operating Properly and Successfully (OPS). The SHL ROD requirement for the ICs to "*protect potential human receptors from risks resulting from exposure to contaminated groundwater*" is implemented and enforced by the Army through the LIFOC agreement. Specifically, Article 16.05 states "*No groundwater will be extracted for any purpose*." The Army long-term monitoring and periodic inspections of the SHL and surrounding Army property ensure that this use restriction is in compliance per the LIFOC agreement. Once the SHL remedy is determined to be OPS, the Army will execute a FOST and the property will

[5] *Devens Reuse Plan.* Prepared by VHB 1994.
[6] *Devens Open Space and Recreation Plan.* Prepared for Massachusetts Development by Cicil and Rizvi, Inc. 1996.
[7] Department of the Army Lease in Furtherance of Conveyance of Real Property and Facilities on the Fort Devens, Massachusetts, Military Reservation, dated May 9, 1996.

be transferred by deed to the LRA. This deed will include similar provisions as the LIFOC agreement to ensure the SHL remedy remains protective of human health and environment.

Alternative SHL-9, (active extraction of groundwater) or the Contingency Remedy:

Post-ROD groundwater monitoring results indicated that the selected remedy, Alternative SHL-2, would not meet risk-based arsenic performance standards. Therefore, the Army issued an ESD, Groundwater Extraction, Treatment, and Discharge Contingency Remedy for SHL (CH2M Hill, 2005), and implemented the contingency remedy, Alternative SHL-9. The Army installed and started full time operation of a groundwater extraction and treatment system, generally referred to as the Arsenic Treatment Plant (ATP), in March 2006 to address groundwater contamination emanating from beneath the northern portion of the landfill. As anticipated in the ROD and ESD, the objective of the ATP was to provide for aquifer restoration in the area down gradient of the landfill, now generally referred to as the northern impacted area or NIA. In July 2007 the ATP flow rate was increased from 25 to 50 gpm. The ATP system treated and discharged approximately 22 million gallons of groundwater during 2011, bringing the cumulative treatment total to approximately 101 million gallons and 2,696 pounds of arsenic removed through 2011[8].

Since the time of the ROD, a more comprehensive understanding of the remedy Conceptual Site Model (CSM), groundwater chemistry in particular, has developed which indicates that a large amount of arsenic is being mobilized by natural as well as landfill-induced conditions. This CSM and the complex groundwater contamination problems have increased the uncertainty that the remedy will meet the aquifer restoration goals.

3. SIGNIFICANT DIFFERENCES AND THE BASIS FOR THOSE DIFFERENCES

This ESD documents a modification to the SHL ROD for a remedy component that significantly changes, but does not fundamentally alter, the selected remedy. The only significant differences in the remedy as detailed in the ROD are the incorporation of additional LUC language as an enforceable component of the ROD that will further protect potential receptors from exposure to contaminated groundwater migrating from the landfill having chemicals in excess of MCLs. A summary of the LUCs to be implemented at the Site are specified below.

3.1 LAND USE CONTROLS TO RESTRICT GROUNDWATER USE OFF-SITE

The current ROD does not specifically address LUCs for any non-Army property located north of the landfill (i.e., the groundwater impacted off-site that includes properties in Ayer along West

[8] *Shepley's Hill Landfill and Treatment Plant Long Term Monitoring and O&M, 2011 Annual Report.*

Main Street, north of the landfill, or the "north impacted area" or NIA), because the extent of the impact was not defined at the time (See Figure 3). Post-ROD investigations have established that the SHL has impacted groundwater within the NIA as documented in the *Supplemental Groundwater Investigation Report*[9]*;* the *Supplemental Groundwater & Landfill Cap Assessment for Long-Term Monitoring & Maintenance*[10] and the *Supplemental Groundwater & Landfill Cap Assessment for Long-Term Monitoring & Maintenance Addendum Report*[11].

The LUCs implemented pursuant to this ESD address the RAO to protect potential residential receptors from exposure to contaminated groundwater in excess of MCLs, until remedial goals have been met, as stipulated in the ROD. In addition, the LUCs will also protect any commercial receptors from exposure to contaminated groundwater.

3.1.1. Land Use Control Performance Objectives

Groundwater in the NIA would pose an unacceptable risk to human health if used for drinking water and may cause unacceptable risk to human health if used for irrigation purposes. Therefore, administrative and/or legal land use controls known as "LUCs" are being incorporated as a component of the selected groundwater remedy for the Site.

The performance objectives of the LUCs shall be to:

- Restrict access to groundwater so the potential exposure pathway to the contaminants would remain incomplete.
- Prohibit the withdrawal and/or future use of water, except for monitoring, from the aquifer within the identified groundwater LUC boundary (Figure 3).
- Maintain the integrity of any current or future monitoring system.

To meet these objectives, the Army has established the Area of Land Use Controls where the use of groundwater will be restricted via this ESD (See Figure 3). This area is based on the defined limits of groundwater contamination as documented by the site investigations referenced in Section 3.1. The LUC boundary limits were then set approximately 400 feet from the horizontal limits of groundwater contamination in order to conservatively establish the restricted area.

[9] *Revised Draft Shepley's Hill Landfill Supplemental Groundwater Investigation, Devens Reserve Forces Training Area. Devens, MA*. Harding ESE, 2002.
[10] *Draft final Supplemental Groundwater and Landfill Cap Assessment for Long-Term Monitoring and Maintenance, Shepley's Hill Landfill, Devens, MA.* AMEC, 2009.
[11] *Final Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-term Monitoring and Maintenance - Addendum Report*. Sovereign, August 2011.

The SHL and surrounding Army controlled property, also shown on Figure 3, are ***not*** addressed under these additional LUCs since this property is addressed in the initial ROD as described in Section 2.2.2. Also, it is noted that the Army property is within the Devens Regional Enterprise Zone (under jurisdiction of Devens) and the NIA is within the Town of Ayer jurisdiction.

This ESD documents decisions and provides notification relating to implementation of the LUCs restricting use of groundwater within the area defined herein – the area potentially impacted by SHL.

3.1.2 Land Use Controls

To meet the LUC performance objectives, the following institutional controls in the form of governmental permitting, zoning, public advisories, prohibitive directives (e.g., no drilling of drinking water wells) and other 'legal' restrictions will be utilized within the NIA.

- The Zoning By-Laws of the Town of Ayer, Town of Ayer Subdivision Control Regulations and Town of Ayer Building Department Permitting Requirements[12]. Town of Ayer zoning, permitting and building requirements to which the use of all new or existing buildings, other structures or land must comply.

  This LUC layer ensures that any new building or structure and any land use comply with town regulations, by-laws and requirements. Site Plan Review requires that new developments have approved site plans that comply with the Ayer Zoning By-laws and the Subdivision Control Regulations including a Utility Plan that identifies all municipal water and sewer and the requirement to connect to the public utilities when located within 400 feet of the property. This requirement is also specified in the Ayer Building Department's minimum documentation and drawings required for Residential Building Permits.

- Moratorium on Groundwater Use within the Area of Land Use Controls - The Ayer BOH has issued a Moratorium on Groundwater Use (Attached as Appendix A).

[12] Town of Ayer Zoning By-law:
http://www.ayer.ma.us/pages/AyerMA_About/zoningbylaws/zoning_bylaws_2009.pdf
Article 10 – Site Plan Review and Article 7 – Special Development Regulations
Town of Ayer Subdivision Control Regulations:
http://www.ayer.ma.us/Pages/AyerMA_Bcomm/Planning/Subdivision%20Regulations.pdf
Section IV. Design Standards, Town of Ayer Building Department – New House Permit Requirements:
http://www.ayer.ma.us/Pages/AyerMA_Building/house

This LUC will provide additional controls or restrictions on access to groundwater for the purpose of potable use or irrigation within documented or anticipated areas of groundwater contamination as defined by the Ayer Board of Health in consultation with the Army. This measure prohibits any and all uses of groundwater use in the defined area.

- The Ayer Board of Health (BOH) Well Regulations (Adopted January 10, 2001) – Town of Ayer permitting requirements for the installation and use of new drinking water wells (Attached as Appendix B).

  The Area of Land Use Controls has been serviced by public water since approximately the 1930s and therefore, the installation of new private wells is not allowed per town zoning by-laws and building permitting requirements. In the unlikely event that an application for a private well construction permit were submitted to the Ayer BOH for approval, this LUC layer would ensure that a private well would not be permitted within the Area of Land Use Controls. Specifically, the requirement to identify any and all sources of potential contamination within 400 feet of the proposed well site as part of the permitting process would prevent the installation of any new private wells in this area.

- The Massachusetts Drinking Water Regulation 310 CMR 22.00 – the state regulatory permitting and approval process for any new drinking water supply wells in Massachusetts that propose to service more than 25 customers or exceed a withdrawal rate of 100,000 gallons per day.

  This LUC layer ensures that the locating of a new or expanding source of public water supply will follow a rigorous screening, evaluation and approval process. For example, the screening process requires the identification of potential environmental threats within one-half mile of the proposed site. Based on this process, the Area of Land Use Controls would likely not meet the criteria for locating a public water supply. It is also noted that areas along West Main Street are already defined as a Non-Potential Drinking Water Source Area per MassDEP.

In addition, the Army will implement the following affirmative measures to further ensure that the LUC performance objectives are being met.

- Public education and outreach via ongoing periodic distribution of educational materials and groundwater use surveys to be distributed to all property owners and residents with the stated goal of confirming that no groundwater wells are in use within the entire Area of LUCs.

The Army will contact land owners and residents in the Area of LUCs to explain the groundwater contamination distribution in the aquifer and the health impacts that may result from drinking contaminated groundwater, using contaminated groundwater for irrigation or otherwise contacting contaminated groundwater and that installation of wells that draw groundwater from the contaminated aquifer is prohibited. Private property owners have an independent obligation to comply with the applicable statutes, regulations, and zoning requirements. In the unlikely event that these affirmative measures discover an existing private well (active or abandoned), the Army, with permission of the landowner, will properly decommission the well to ensure remedy integrity.

- Meet with the Ayer BOH on an annual basis, or more frequently if needed, to discuss the implementation of LUCs and provide an updated Area of Land Use Control map(s) that document the current and projected location of groundwater contamination within the Town of Ayer. While Figure 3 shows the current area of the NIA where the LUCs apply, the Ayer BOH or the Army may modify the areas based on new information, and all LUCs will apply to such areas based on revisions to Figure 3.

All LUCs will be maintained until the concentrations of contaminants of concerns in the groundwater are at such levels as to allow unrestricted use and exposure.

The Army is responsible for ensuring that adequate LUCs are established and maintained through monitoring and reporting on the implementation, maintenance, and enforcement of land use controls, and coordination with federal, state, and local governments and owners and occupants of properties subject to land use controls. Although the Army may later transfer these procedural responsibilities to another party by contract or through other means, the Army shall retain ultimate responsibility for remedy integrity. The Army will provide notice of the groundwater contamination and any land use restrictions referenced in the ESD. The Army will send these notices to the federal, state and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and land use controls. The Army shall provide the initial notice within 3 months of ESD signature. The frequency of subsequent notifications will be described in the LUCIP for the ESD. The Army remains responsible for ensuring that the remedy remains protective of human health and the environment. The Army will fulfill its responsibility and obligations under CERCLA and the NCP as it implements, maintains, and reviews the selected remedy.

A Land Use Control Implementation Plan (LUCIP) will be prepared to describe the actions for all LUCs described in this ESD, including implementation, maintenance and periodic inspections. The Army shall prepare a draft LUCIP within 3 months of ESD signature.

4. SUPPORT AGENCY COMMENTS

The USEPA and the MassDEP have worked with the U.S. Army in developing the SHL remedy changes described in this ESD document. All comments received on the draft ESD have been addressed by the Army and incorporated into this document.

5. AFFIRMATION OF THE STATUTORY DETERMINATIONS

The proposed change to the selected remedy described in the ROD continues to satisfy all of the statutory requirements of CERCLA and the NCP. Considering the new information that has been developed and the proposed change to the selected remedy, the Army believes that the remedy remains protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to this remedial action, and is cost effective

6. PUBLIC PARTICIPATION ACTIVITIES

The Army meets regularly with stakeholders through BRAC clean-up team (BCT) meetings and quarterly Restoration Advisory Board (RAB) meetings to discuss clean up status at the former Fort Devens and, more specifically, monitoring and other data relating to the Shepley's Hill Landfill Operable Unit. These meetings have involved discussions of monitoring data relating to groundwater investigations and compliance monitoring, annual reports, and five year reviews evaluating performance of the selected alternative. At the RAB meeting on November 15, 2012, the ESD remedy component (LUCs to restrict access to groundwater) were presented and discussed.

In accordance with 40 CFR Section 300.435(c)(2)(i) of the National Contingency Plan, this ESD and other supporting documents are available in the Administrative Record maintained by the Army. The Administrative Record may be viewed at the Ft. Devens BRAC Environmental Office (Building 666, 30 Quebec St., Devens, MA 01434) between the hours of 8:30 AM and 5:00 PM, Monday through Friday, by calling (978) 796-2205.

Public notice relating to the availability of the ESD for review was made in the Nashoba Publishing papers, Lowell Sun, and Fitchburg Sentinel on November 15, 2012. A voluntary 30 day public comment period beginning November 16, 2012 and ending December 17, 2012 was held by the Army to solicit public comment on this Explanation of Significant Differences. At the request of the Town of Ayer the public comment period was extended to April 4, 2013 and a Public Hearing held in Ayer on March 20, 2013.

AUTHORIZING SIGNATURES

The forgoing Explanation of Significant Differences has been prepared to document changes in the selected and contingency remedies from the Record of Decision as required by Section 117(a) of CERCLA. The forgoing represents the selection of a remedial action by the U.S. Department of the Army and U. S. Environmental Protection Agency, with review and comment by the Massachusetts Department of Environmental Protection.

Concur and recommend for immediate implementation.

U.S. DEPARTMENT OF THE ARMY

3 DEC 13

William J. O'Donnell, II
Chief, Reserve, Industrial and Medical Branch
Department of the Army Assistant Chief of Staff for Installation Management

Date

U.S. ENVIRONMENTAL PROTECTION AGENCY

1/15/14

James T. Owens III
Chief, Office of Site Remediation and Restoration
U.S. EPA Region I

Date

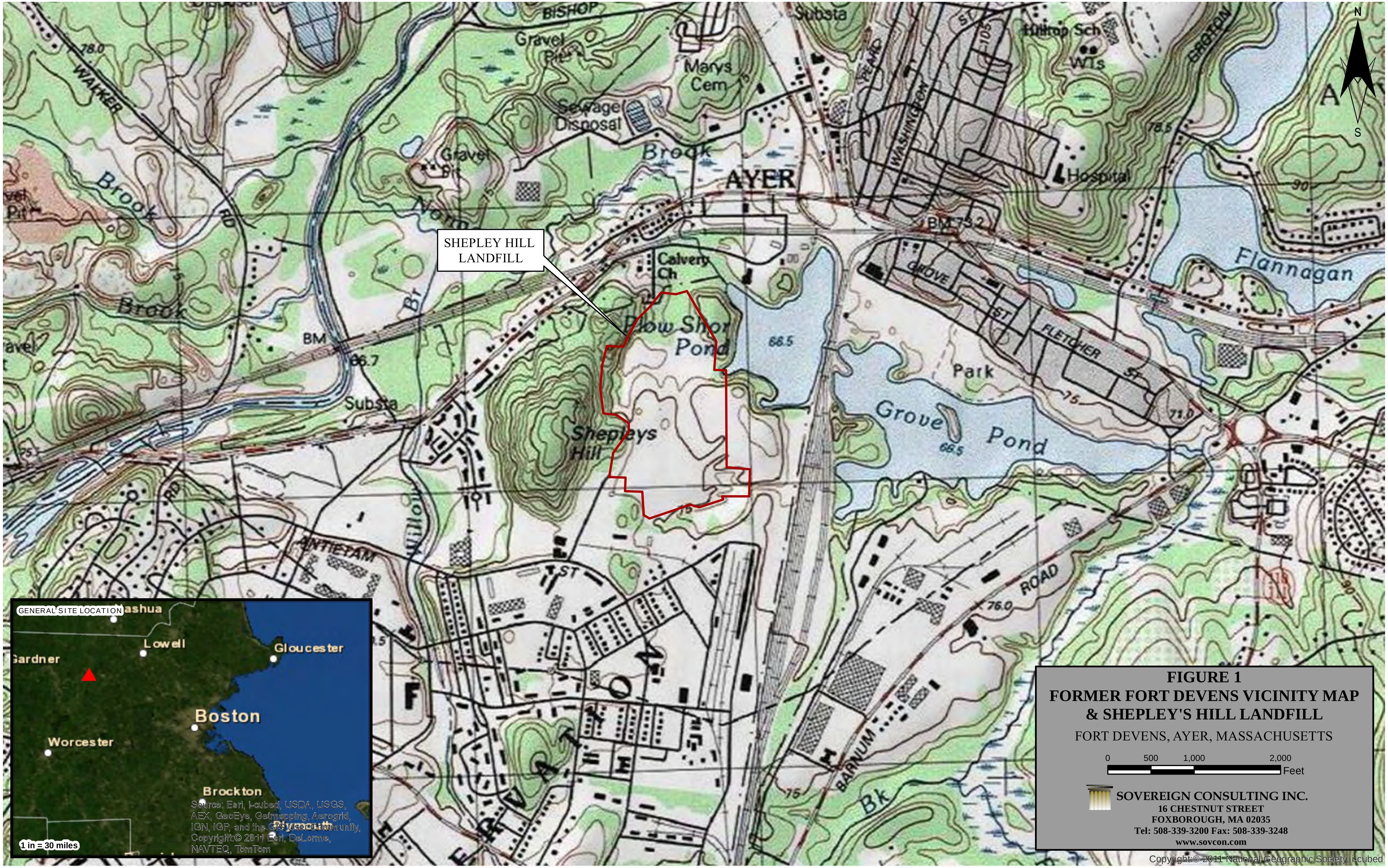

FIGURE 1
FORMER FORT DEVENS VICINITY MAP & SHEPLEY'S HILL LANDFILL
FORT DEVENS, AYER, MASSACHUSETTS

0 500 1,000 2,000 Feet

SOVEREIGN CONSULTING INC.
16 CHESTNUT STREET
FOXBOROUGH, MA 02035
Tel: 508-339-3200 Fax: 508-339-3248
www.sovcon.com

Dec 2010 ROV Updated Aug 6, 2012 ROV

FIGURE 2
SHEPLEY'S HILL LANDFILL
SITE LOCATION MAP

SHEPLEY'S LANDFILL
FORT DEVENS, AYER, MASSACHUSETTS

07/27/2012 ROV

Source: 2000 TIGER Towns. US Census and Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs.
2001 Devens Regional Enterprise Zone: Devens Zoning District Key Map. Accessed August 1, 2010. www.devensec.com.
2010 Public Water Supplies. Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs.
2010 Legacy Level 0 and Level 2 Assessor's Parcels. Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs.

06/01/2012 ROV Updated 08/03/2012 ROV

APPENDIX A

Ayer Board of Health Groundwater Use Moratorium

TOWN OF AYER
BOARD OF HEALTH
TOWN HALL – 1 MAIN STREET – AYER, MASSACHUSETTS 01432 – (978) 772-8213

MORATORIUM ON GROUNDWATER WELLS IN THE TOWN OF AYER

Under the authority of Massachusetts General Laws Chapter 111, Section 31, the Ayer Board of Health adopts the following regulation in an effort to better protect the public health and welfare of the citizens of Ayer:

Purpose

This regulation seeks to prevent any exposure to contaminated groundwater from the Shepley's Hill Landfill on the former Fort Devens military base, which may present a potential health risk to the residents of the Town of Ayer. Any well waters in documented or potentially affected areas of groundwater pollution pose a possibility of exposure pathways to humans. Ingestion, inhalation, and dermal exposure are potential pathways. This potential risk necessitates this regulation.

Regulation

Existing and future residential and commercial wells located in documented or anticipated areas of groundwater contamination as defined by the Ayer Board of Health are herewith restricted from use for any purpose, including drinking; any agricultural use (lawn watering, gardening, livestock watering, irrigation of crop land, etc.); washing vehicles; pool filling; etc. This moratorium includes groundwater wells owned by the residents currently connected to a public water supply.

A Massachusetts Licensed Well Driller must decommission the affected wells, and written evidence thereof must be submitted to the Ayer Board of Health, 1 Main Street, Ayer, MA 01432.

Adoption

This Moratorium on Groundwater Wells in the Town of Ayer approved and adopted by the Ayer Board of Health on the 6th day of May, 2013. This regulation will become effective upon the date of publication in the press.

Ayer Board of Health

Mary Spinner, Chair	Heather Hasz, Member	Pamela Papineau, Member

AMENDED

TOWN OF AYER
BOARD OF HEALTH
TOWN HALL – 1 MAIN STREET – AYER, MASSACHUSETTS 01432 – (978) 772-8213

MORATORIUM ON GROUNDWATER WELLS IN THE TOWN OF AYER

Under the authority of Massachusetts General Laws Chapter 111, Section 31, the Ayer Board of Health adopts the following regulation in an effort to better protect the public health and welfare of the citizens of Ayer:

Purpose

This regulation is intended to prevent any exposure to contaminated groundwater from the Shepley's Hill Landfill, located on the property of the former Fort Devens military base, which may present a potential health risk. Any well waters in documented or potentially affected areas of groundwater pollution constitute possible exposure pathways to humans. Ingestion, inhalation, and dermal exposure are potential pathways. This potential risk necessitates this regulation.

Regulation

Existing and future residential and commercial wells located in documented or anticipated areas of groundwater contamination as defined by the Ayer Board of Health are hereby prohibited from use for any purpose, including but not limited to drinking; agricultural (lawn watering, gardening, livestock watering, irrigation of crop land, etc.); washing vehicles; pool filling; etc. This moratorium includes groundwater wells located on properties currently connected to a public water supply.

A Massachusetts Licensed Well Driller must decommission the affected wells, and written evidence thereof must be submitted to the Ayer Board of Health, 1 Main Street, Ayer, MA 01432.

Please refer to the Ayer Board of Health Private Well Regulations for further information.

Adoption

This Moratorium on Groundwater Wells in the Town of Ayer approved and adopted on May 6, 2013, is amended by the Ayer Board of Health this 20 day of May, 2013. This amendment will become effective upon the date of publication.

Ayer Board of Health

Mary Spinner, Chair   Heather Hasz, Member   Pamela Papineau, Member

APPENDIX B

Ayer Board of Health Private Well Regulations

Ayer Board of Health
Well Regulations

1.0 Purpose and Authority

The regulations are intended to promote the public health and general welfare by ensuring that private wells are constructed in a manner which will protect the quality of the groundwater derived from private wells. These regulations are adopted by the authority of Chapter 111, Section 31, M. G. L.

1.1 Definitions

As used in these regulations, the following terms shall be defined and interpreted as follows:

(1) Abandoned water well. A private well that has not been used for a water supply for a period of one (1) year or more and which the owner does not intend to use again.

(2) Agent. The Nashoba Associated Boards of Health (hereinafter referred to as Nashoba) serving as the agent for the Ayer Board of Health, as provided by Chapter 111, Section 27A.

(3) Aquifer. A water bearing geologic formation that contains water in sufficient quantites to potentially supply a well for drinking water or other purposes.

(4) Person. An individual, corporation, company, association, trust, or partnership.

(5) Portable water. Water that is satisfactory for drinking and for culinary and domestic purposes.

(6) Private well. A water supply well which will not serve either a number of service connections or a number of individuals sufficient to qualify as a public water system as defined in 310CMR22.02.

(7) Pumps and pumping equipment. Any equipment or materials used or intended for use in withdrawing or obtaining groundwater. Including, without limitation, seals and tanks, together with fittings and controls.

(8) Regulating agency. The Ayer Board of Health through its agent, the Nashoba Associated Board of Health.

(9) Well. An excavation or opening into the ground made by digging, boring, drilling, driving, or other methods, for the purpose of providing a potable drinking water supply.

(10) Well driller and/or digger. Any person who is licensed by the Water Resources Commission (as defined by Chapter 620 of the Acts of 1956, as amended) to construct wells.

(11) Well Seal. An approved arrangement or device used to cap a well or to establish and maintain a junction between the casing or curbing of a well and the piping or equipment installed therein, the purpose or function of which is to prevent pollutants from entering the well at the upper terminal.

2.0 Requirements for Private Wells

(1) No private well shall be deemed a source of potable water unless it is constructed in accordance with these regulations. No well shall be constructed or destroyed except in accordance with these regulations.

(2) For each private well constructed after the effective dates of these regulations, there shall be:
- (a.) a well construction permit application;
- (b.) a well construction permit;
- (c.) a water quality analysis;
- (d.) a certificate of compliance with the terms of the permit;
- (e.) a well driller's or digger's report

(3) For each private well destroyed after the effective date of these regulations, there shall be:
- (a.) a well destruction permit application;
- (b.) a statement of well abandonment from the owner;
- (c.) a well destruction permit;
- (d.) a well driller's or digger's, or contractor's report of destruction.

(4) The Ayer Board of Health or its agent shall investigate violations of these regulations or of any permit issued and may take such actions as it may deem necessary for the protection of the public health and to restrain violations of these regulations.

(5) Whosoever violates these regulations shall be punished by a fine of not more than $500.00 dollars to, and for the use of, the Town in which the well is located.

3.0 Well Construction or Destruction Permits

(1) No person shall engage in the business of constructing or destroying private wells within the Town under these regulations unless registered as a well driller/digger with the Water Resources Commission, pursuant to 313CMR3.00.

(2) An application for a well construction or destruction permit shall be submitted by the property owner, the well driller/digger or his agent to Nashoba on a form furnished by Nashoba.

(3) A well construction or destruction permit shall be obtained from Nashoba prior to the construction or destruction of any private well. Nashoba shall charge a fee for each well construction or destruction permit and said fee shall be paid to the Nashoba Associated Boards of Health prior to the permits issue.

4.0 Well Construction Permit Requirements

The following information shall be submitted by the property owner or the well driller/digger or their agent with the well construction application, prior to the issuance of a permit:

(a.) general location of the proposed well to include the location of at least one road intersection for reference;
(b.) a sketch of the expected construction of the well to include an approximation of the expected well depth;
(c.) a description of any possible source(s) of contamination within 400 feet of the proposed well location (see sect. 4.1(1);
(d.) The well driller's/digger's name and certification number as it appears on the Water Resources commission certificate;
(e.) description of the prior/current land use in the vicinity of the proposed well location (i.e. agricultural, industrial, etc.).

For emergency repair, alteration, or replacement of an existing well the Ayer Board of Health or Nashoba may waive the requirements of these regulations for dwellings which were in existence prior to the effective date of this regulation.

4.1 Well Location Requirements

(1) In establishing the location of a well, the well owner and/or the driller/digger, shall identify any and all sources of potential contamination (agricultural fields, animal feed lots, beauty salon, dry cleaner, funeral home, furniture stripper/refinisher, gasoline/service station, fuel depot, automotive junk yard, railroad line or yard, etc.) which exist within 400 feet of the proposed well site.

The following minimum lateral distances from contamination shall apply with the granting of a variance under special conditions:

Source of Contamination	Minimum Distance (feet)
Leaching facility (310CMR15.00)	100
Leaching facility (in soils with percolation rates 2 minutes per inch or less)	150
Cesspool	100
Septic tank	50
Sewer line	50
Property line	50
Public or private way, common drive, easement	50
Active or closed landfill	400
Hazardous waste spill site	400
Any type of surface water	100

(2) Where, in the opinion of the Ayer Board of Health or Nashoba, adverse conditions exist, the above minimum distances may be increased or special means of protection may be required.

These special requirements shall be added to the well construction permit by Nashoba.

(3) The well shall be up gradient of sources of contamination when ever possible. The top of the well shall be higher than any surface of contamination and above any conditions of flooding by drainage or runoff from the surrounding land, unless otherwise adequately protected.

4.2 Well Construction Standards

(1) Wells shall be constructed in compliance with the recommendations of the latest edition of the Manual of Individual Water Supply, U. S. Environmental Protection Agency (U.S. EPA), Water Supply Division (exception: springs shall not be used for the purpose of a potable water supply).

(2) The annular space between the protective well casing and the wall of the drilled hole or surface casing shall be effectively sealed. The seal is to protect against contamination by surface and/or shallow, subsurface waters.

(3) The well casing shall be capped or covered with a sanitary well seal. Casings shall extend a minimum of 24 inches above the highest known flood levels or 18 inches above the ground surface in areas which are not subject to flooding. In addition all non-vent openings shall be sealed to exclude the intrusion of contaminants. Vent openings shall be of an approved type, complete with screening.

(4) Any well that is finished in bedrock or penetrates any confining layers (impervious formations) and therefore a potentially different aquifer(s) shall require the sealing off of each aquifer from the other(s). A minimum of ten feet of an appropriate sealing material shall be used to seal one aquifer or formation from another.

(5) When well screens are used, the screen length and opening size should be selected to ensure that the water supply will be free from silts and sands and other suspended solids.

(6) Well pumps and water storage equipment shall be selected to ensure that the water supply is to be adequate (a minimum of five gallons per minute (GPM) is recommended) over a sustained period of pumping. NOTE: The proper selection of the pump is important to protect against unnecessary wear on the equipment and to maintain a safe and adequate supply of water.

(7) Pump suction lines (if used) shall not be closer than 100 feet from underground sewage leaching facilities or 50 feet from a septic system (310CMR15.03).

(8) Well pits to house the pumping equipment or to permit accessibility to the top of a well shall not be permitted.

4.3 Disinfection and Other Sanitary Requirements

All private wells shall be disinfected following construction, rehabilitation, and well or pump repair, before the well is placed into service. The well shall be pumped to waste (not to the septic system) until the water is as clear as possible. Thereafter the well and the pumping equipment (and plumbing, if installed) shall be disinfected with a solution containing at least 50 parts per million (ppm) of chlorine. The well shall remain in contact with the chlorine solution for a minimum of 24 hours before the well is pumped to waste (not the septic system) and the water found to be free of chlorine. (Information and instructions for the disinfection procedure is available from Nashoba)

4.4 Water Sampling Procedure

(1) Water sample(s) shall be collected by Nashoba. All water sample(s) shall be collected in an appropriate manner as to maintain the integrity of the sample collected. Collection of the sample(s) shall occur following the well development and the disinfection process for the well (see section 4.3). The water sample may be taken to a laboratory of Nashoba's choice unless the owner selects a specific laboratory, at which time the sample container may be sealed with the custody tag and delivered to the owner selected testing laboratory by him/herself. The laboratory shall be required to notify Nashoba should the sample be received with a broken custody seal.

(2) A representative water sample for laboratory analysis shall be collected at the pump discharge or from a tap in the pump discharge line. A representative sample shall constitute a sample collected after the removal of at least three standing volumes of water from the well or a minimum of 10-15 minutes of pumping from the well.

(3) The sample(s) shall be analyzed for the following parameters at a minimum: coliform bacteria, arsenic, lead, sodium, iron, manganese, copper, magnesium, color, sulfate, turbidity, alkalinity, chlorine, chloride, hardness, ammonia, nitrite, nitrate, pH, conductivity, odor and potassium. All analyses shall be performed in accordance with U. S. EPA methods or other approved methods for drinking water analysis.

(4) Analytical tests such as volatile organics (VOCs), pesticides, PCBs and inorganics (metals) other than those specified in 4.4(3), can be added or deleted, as public knowledge increases or at the request of the Ayer Board of Health or Nashoba, when conditions may indicate the need (i.e. prior land use) for such testing. Samples which are to be analyzed for volatile organic compounds shall not contain air bubbles of any size.

4.5 Water Quality

(1) All analytical results shall be reviewed by Nashoba and an assessment of the suitability of that well for drinking water will be made. Nashoba will adhere to the current and applicable drinking water standards as detailed by the U. S. EPA and the State of Massachusetts Department of Environmental Quality Engineering (DEQE). Approval of the results, by Nashoba, must be obtained in writing before the well shall be placed into service as a drinking water supply.

(2) The water sample(s) shall be analyzed by a laboratory certified to perform drinking water analysis by the DEQE for each parameter analyzed. A copy of the results shall be sent to both the Ayer Board of Health and Nashoba. All fees for the water testing are the responsibility of the applicant and all fees shall be paid in full prior to the approval of the well permit.

(3) As stated in section 4.4, Nashoba or the Ayer Board of Health may require that additional chemical analysis be performed on the well water. Any such additional requirement shall specify which chemical constituents or chemical fractions (pesticide/PCB, extractables, etc.) shall be tested for.

(4) No result shall exceed the current and applicable drinking water standards for a public water supply, as detailed by the U. S. EPA and/or DEQE (40CFR141 and 310CMR32). Nashoba may also use professional judgement when assessing the results of the water well prior to approval of that well. When the results indicate a potential health hazard (i.e. possible gasoline contamination) Nashoba may at its discretion disapprove the well for use as a water supply.

4.6 Well Completion Requirements

(1) Within 30 days after the completion of the construction of any well, the well driller/digger shall submit to Nashoba a report containing the following information:

(a.) The name of the owner of the well;
(b.) The address of the property served and/or the lot number as assigned by the Assessor's office;
(c.) The depth, size and method of construction of the well;
(d.) The location of the well which shall show the distance from two permanent landmarks;
(e.) The static water level;
(f.) The yield of the well after eight hours of pumping;
(g.) The recovery after draw down and yield tests (for at least a 24 hour period);
(h.) The well driller's/digger's log information.

The well driller's/digger's report shall be signed by an authorized representative and shall constitute a statement of compliance with all requirements of these regulations. This will satisfy the requirement of the certificate of compliance.

5.0 Well Destruction

A well that is abandoned shall be destroyed to protect the groundwater supply and to eliminate potential physical hazards. Wells shall be sealed with non-hazardous, impervious materials which shall be permanently in place. All exposed casing materials, pumping equipment, and distribution lines shall be removed. The excavation shall be returned the existing grade of the surrounding land. A record of abandonment shall be kept in accordance with Section 2.01(5).

5.1 Well Destruction Requirements

The following information shall be submitted with each well destruction application, prior to the issuance of a permit:

(a.) The specific location of the well to be destroyed;
(b.) The design and construction of the well to be destroyed;
(c.) A written statement from the owner that the well is abandoned.

Within 30 days after the destruction of any well, the well driller/digger, or contractor shall submit to Nashoba a report containing the following:

(a.) The name of the owner of the well;
(b.) The address of the property served;
(c.) Method of sealing, including materials used;
(d.) Person or persons sealing the well and date of the sealing of the well.

The well driller's/digger's report shall be signed by an authorized representative and shall constitute a statement of compliance with all requirements of these regulations. This will satisfy the requirement of the certificate of compliance.

6.0 Variances

(1) Variances may be granted only as follows: The Ayer Board of Health may vary the application of these regulations with respect to any particular case when, in its opinion, the enforcement thereof would do manifest injustice, and the applicant has proven that the same degree of public health and environmental protection required under these regulations can be achieved without strict application of a particular provision(s).

(2) Variance requests shall be in writing to the Ayer Board of Health and include all the information/reasons and proposed measures necessary to assure the protection of the public health and environment. The Ayer Board of Health shall grant, modify, or deny a variance in writing, and state the reasons for any denial.

7.0 Substantive Procedures

Substantive Procedures shall be performed as specified in 105CMR400.1

The above **Well Regulation** approved and adopted by the Ayer Board of Health on the 10 day of January, 2001.

Margaret Kidder
Margaret Kidder, Chairman

C. Jane Witherow
C. Jane Witherow, Clerk

Laurie Rosas
Laurie Rosas, Member

APPENDIX C

Response to Comments

MassDEP COMMENTS ON
EXPLANATION OF SIGNIFICANT DIFFERENCES
SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION (RTN 2-0000662)
JANUARY 7, 2013

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1. Section 2.2.2: The final paragraph, an apparent reference to the Army's controversial position on the performance of the groundwater extraction system, should be deleted from the ESD because the regulatory agencies have not accepted the Army's position on the performance of the extraction system, and the subsequently described rationale (incomplete delineation at time ROD was signed, Section 3.l) has been accepted and is sufficient to justify the ESD.

   The text has been revised as follows: "Since the time of the ROD, a more comprehensive understanding of the remedy Conceptual Site Model (CSM) has been developed which indicates a more complex groundwater contamination problem with greater uncertainty that the remedy will meet the aquifer restoration goals."

2. Section 3.l: LUCs cannot be used as a surrogate for necessary groundwater remediation. Consequently, the ESD should be clarified to indicate that the LUCs are intended to provide interim control of exposure to contaminated groundwater until unacceptable risks are eliminated by other remedial action that will be implemented as a component of the coming remedy update.

   The intent of this statement was not to imply that LUCs can be used as a surrogate for necessary groundwater remediation, but rather that LUCs are required to protect potential residential receptors from exposure to contaminated groundwater. Therefore lines 325-327 will be replaced with the following text: "The LUCs implemented pursuant to this ESD address the *RAO to protect potential residential receptors from exposure to contaminated groundwater in excess of MCLs, until remedial goals have been met, as stipulated in the ROD."*

3. Section 3.l.2: Copies of the cited BOH well regulations and zoning by-laws should be attached to the ESD for current review and future reference.

   This information will be provided as an appendix to the Draft Final ESD.

4. Section 3.1.2: The second and third affirmative measures will not be effective if the BOH is not able or willing to participate; consequently, these measures should not be included in the ESD until the Army has confirmed the board's ability and willingness to participate.

   The Town Of Ayer's Well Regulations and Zoning By-laws are already in-place. Without amendment, these existing regulations and standard practices will prevent any future groundwater use in the area of proposed Land Use Controls. The roles and responsibilities of how the LUCs will be *implemented will be specified in the LUCIP. The Army will work with the Town of Ayer under the LUCIP to specify how the LUCs will be implemented maintained and enforced.*

5. Section 4: To document that all comments received on the draft ESD were addressed, copies of the comment letters received should be attached to the ESD and cited here.

   All Response to Comments will be included in the Draft Final ESD.

6. Section "AUTHORIZING SIGNATURES": The ESD should not indicate that MassDEP concurred with the ESD. Instead, the ESD should indicate that MassDEP reviewed and commented on the ESD, in accordance with CERCLA, and a copy of MassDEP's comment letter should be attached to the ESD.

   The suggested change will be made in the text on Page 15, line 526.

EPA Comments on
Draft Explanation of Significant Differences
Land Use Controls to Restrict Use of Groundwater
For Shepley's Hill Landfill Superfund Site
Former Fort Devens, MA
October 2012

General Comment:

1. If the local Board of Health (BOH) regulations will be the primary land use control (LUC) as presented in the Draft ESD, the Army must ensure that the Town's well regulations provide clear requirements to prevent the use and installation of groundwater wells in the NIA. Army and EPA have had initial discussions with the Town of Ayer regarding the Draft ESD and particularly the request for a moratorium on groundwater wells in the LUC area. Town representatives have indicated that they are willing to enact a moratorium, but further discussions and coordination are required to ensure that the Town will agree to partner with the Army and EPA to implement and enforce the proposed moratorium.

   As an example, the Town of Mashpee, MA BOH, as a result of off-site groundwater contamination from the Mass Military Reservation, adopted a moratorium on residential wells, restricting any and all uses of groundwater, and defining the areas where well use is prohibited based on the documented groundwater plume areas. The moratorium applies to existing and potential future wells. As another example, the Town of North Smithfield, RI enacted a similar ordinance to prohibit groundwater use within the area impacted by the Stamina Mill Superfund Site. Copies of these moratoriums are attached. This type of moratorium provides for a strong LUC, since the groundwater plume map and specific restrictions for the area are incorporated directly into the well regulations, and as it applies to both existing and new wells. EPA believes that this type of LUC is necessary to address potential gaps in the existing local regulatory controls cited by the Army as LUC layers in the Draft ESD.

   If a moratorium is not enacted by the Town, or if the Town's by-laws remain inadequate to prevent exposure to contaminated groundwater from existing or potential future groundwater wells, the ESD as proposed will not meet statutory requirements for protectiveness. Other alternatives, including proprietary controls (for example, easements that restrict groundwater use for each of the affected properties) must then be considered.

   Please see response to MassDEP Comment No. 4. With respect to the need for a moratorium on the use of groundwater within the impacted area, the use of LUCs/ICs are effective given the existing town regulations, the well documented site conditions and local BOH legal responsibilities, it is difficult to envision a scenario whereby a private well construction permit application for property along West Main Street would ever be submitted let alone be approved.

However, if the Town and EPA consider issuing a moratorium on groundwater use is necessary, then the Army will work with both agencies to ensure it is implemented under the LUCIP.

2. In order to support the reliance on governmental controls, such as a groundwater use moratorium implemented through the local BOH well regulations, the Army will need to demonstrate that the Town has the ability and capacity to assist with IC implementation, maintenance, and enforcement. A "common understanding" regarding the respective IC roles, responsibilities, and legal authorities of the parties should be memorialized through mechanisms available under state law (e.g., an MOU, Administrative Order on Consent, contract, or enforceable agreement). Refer to Sections 3.8, 6.0, 8.4, and 9.3 of "A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites" for further guidance on establishing a "common understanding" and the use of governmental controls as ICs. A discussion of the "common understanding" arrangements will need to be discussed in the ESD and detailed in the LUCIP.

   Please see response to MassDEP Comment No. 4 and EPA General Comment No. 1.

   The roles and responsibilities of how the LUCs will be implemented will be specified in the LUCIP. The Army will work with the Town of Ayer under the LUCIP to specify how the LUCs will be implemented, maintained and enforced.

   The Army should add language to the ESD to address the disposition of any groundwater wells found within the LUC area (e.g., if a property owner in the LUC area reports an existing well). The ESD should identify actions that the Army will take to ensure that the well is not used (e.g., Army should provide for the safe and permanent decommissioning of any wells found to exist within the LUC area).

   The Army will incorporate the abandonment and/or decommissioning of any groundwater wells that are identified within the area of Land Use Controls into the LUCIP, for any wells installed prior to implementation of the ESD. The LUCIP will provide details on this task including that there is not a time limit on the Army's responsibility for this.

Specific Comments:

1. Page 2, line 69: The CERCLA citation is in error. The correct citation for "Explanation of Significant Differences" is CERCLA § 117(c).

   The reference will be corrected.

2. Page 2, line 78 and footnote 3: Replace the LUC definition footnote with the most recent EPA Guidance reference for the definition of ICs and LUCs. See Section 2 of EPA's "A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites."

   The reference will be updated.

3. Page 3, line 93: Revise to read: "The following sections contain a brief history of the site, *an overview of site contamination and risks,* a description of the remedy selected in the ROD, and..."

   The text will be added as noted above.

4. Page 4, line 165: Additional discussion regarding the levels of arsenic found at the site driving the risk of human exposure should be included in this summary.

   Additional language will be added to this line as indicated below.

   "The RI and RI Addendum reports identified potential human exposure to arsenic in groundwater as the primary risk at SHL. *Currently, there is no significant risk to human health, but such a risk could exist if groundwater was a source of drinking water. Arsenic levels are above acceptable human health risk levels for potential future exposure pathways that include drinking water."*

5. Page 8, line 311: Revise to read: "...enforceable component of the ROD *to address the migration of arsenic contamination from Shepley's Hill Landfill groundwater to groundwater under public, residential and commercial areas of Ayer and the potential risk of human exposure to that contamination.*"

   The above text will be added as noted with the following addition.

   "...enforceable component of the ROD *that will further protect potential receptors from exposure to contaminated groundwater migrating from the landfill having chemicals in excess of MCLs.*"

6. Page 9, line 331: "Groundwater in the NIA pose*s* an unacceptable risk to human health if used for drinking water..."

   The above sentence will be corrected as shown below.

   "Groundwater in the NIA *would pose* an unacceptable risk to human health if used for drinking water..."

7. Page 9, lines 359-361: Omit this sentence: "Since natural sources of arsenic and natural conditions resulting in arsenic mobilization are prevalent throughout the region surrounding SHL, this ESD nor the LUC's implemented, are not by any means intended to infer groundwater outside the restricted area is suitable for any use." This does not relate to the objectives of this ESD.

   The subject text will be deleted.

8. Page 10, lines 368-373: The ESD does not clearly address how the regulatory citation supports the LUC performance objectives identified in Section 3.1.1 of prohibiting use of

groundwater. How does the well application procedure of requiring the applicant to "identify any and all sources of potential contamination within 400 feet of the proposed well site" support prohibiting groundwater wells in the NIA? Where does the applicant obtain the information on potential sources of contamination? Would the applicant obtain information on the location of SHL and the SHL plume through the process of gathering the information on sources of potential contamination? Would all areas of the plume be considered within the 400 foot designation? Does Ayer BOH prohibit installation of groundwater wells if the location is proposed within 400 feet of a potential source of contamination and, if so, where is that stated? Copies of the regulations should be provided as an Appendix to the ESD. If the regulations only apply to certain areas of the LUC Area, this should be depicted on a figure. The LUC Area depicted in Figure 3 shows that this area extends up to approximately 2000 feet beyond the Fort Devens property boundary.

The comment and questions posed all presuppose that private wells in this area of town could be allowed pending the processing of a well permit application. However, based on the Town of Ayer zoning, building and permitting requirements referenced in the ESD, a well permitting process would never be implemented for a property in this area because it is serviced by public water. In fact, private well permits in Ayer are rare (95% of Ayer is serviced by Town water) given these requirements and the fact that most areas have access to public water. A review of the MassDEP "search well" database indicates only 25 new well records from 1971-2009 all of which are located in more rural areas outside the town center not serviced by public water. Finally, in the unlikely event that a private well permit application is submitted for review by the BOH, it is the duty of the local BOH to monitor local conditions and create necessary regulations which address those conditions in order to protect public health (per MGL CH. 111, Section 31). Therefore, under the existing town regulations, the well documented site conditions and local BOH legal responsibilities, it is difficult to envision a scenario whereby a private well construction permit application for property along West Main Street would ever be submitted let alone be approved.

The LUC boundary is approximately 400 feet from the edge of the northern impact area, not the Fort Devens' property boundary. Any institutional controls will refer to the LUC boundary on a map (Figure 3) not distances from property boundaries. Therefore this extended boundary will create an additional buffer from the impacted groundwater. Figure 3 of the ESD depicts the area to be restricted under the LUCs and will be included in the moratorium developed with the Town of Ayer.

9. Page 10, lines 375-384: To support the relevance of the cited by-laws, a copy of the Town of Ayer utility plan showing the location of municipal water supply pipelines in the LUC Area should be provided. Further, consistent with Section 6.2 of "A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites," the Army should have discussions with the Town to address whether any anticipated changes to the ordinance are likely, whether zoning variances are allowed that could compromise the value of these requirements as an IC layer, and whether procedures are in place to assure compliance with the zoning requirements.

As part of the preparation of the LUCIP the Army will work with the Town of Ayer to define and develop what procedures are required to assure compliance with the zoning requirements. A Town Utility Map will included as an Appendix to the LUCIP.

10. Page 11, lines 410-412: As noted in the General Comment above, EPA believes a groundwater use moratorium must be implemented for the LUC discussed here. EPA has determined that the existing regulations and proposed education and outreach in the Draft ESD are not capable of meeting the LUC performance objective of prohibiting the withdrawal and/or use of groundwater from the LUC Area without a moratorium.

    Please refer to the response to EPA General Comment No.1 and 2.

11. Page 11, lines 421-423: Please revise. Because the LUCs identified on page 10 are governmental controls under State and local authority, Army would not modify or terminate them. Rather, Army should indicate that they will coordinate with local and State authorities, as appropriate, when LUCs are no longer required for protectiveness of the Shepley's Hill Remedy. At that time, the Town of Ayer may choose to terminate the groundwater use moratorium.

    *The following language will be added to line 423 "*coordination/concurrence of the *Town of Ayer,* EPA and MassDEP, *that the LUCs are no longer required or the LUCs should be modified.*

Follow-up to Army's Draft RTCs
March 26, 2013

EPA has the following follow-up comments on the Army's RTCs:

- During our telephone discussion on March 15th, we discussed the response to General Comment 2 and EPA's request for a document to memorialize a "common understanding" between Army and the Town of Ayer. During the call, you indicated that Army believed that the planned Land Use Control Implementation Plan (LUCIP) should satisfy the requirements for Army's documentation of its roles, responsibilities and legal authorities related to the implementation of the proposed LUCs and that Army did not agree that a separate document was necessary. EPA is willing to consider using the LUCIP as the document to support the Army and Town's "common understanding", since the Army intends to retain responsibility for much of the long-term responsibility for LUC oversight. Possibly, Army could ensure that the LUCIP adequately documents the Town's roles and responsibilities for LUC implementation and enforcement and Army/Town coordination efforts going forward. The Town could then issue a letter following review of the draft LUCIP acknowledging the LUCIP requirements and agreeing to work with the Army to ensure implementation and enforcement of the

LUCs. EPA would also want the Town's letter to state that the Town would notify Army, EPA and DEP if there was any change in their ability to maintain and enforce the LUCs relied upon in the ESD and LUCIP. This letter could be incorporated into the Final LUCIP. Let's discuss this option further with the Town as we move forward with finalizing the ESD and drafting the LUCIP.

The Army will work with the Town of Ayer and the EPA to incorporate the above points into the LUCIP.

- With respect to RTC to Specific Comment 4, EPA recommends the revised text be updated to state: "*Currently, **based on available survey records,** there is no significant risk to human health, but such a risk could exist if groundwater was a source of drinking water.*"

  The text will be revised to reflect the above recommendation.

Ayer BOH Comments on
Draft Explanation of Significant Differences
Land Use Controls to Restrict Use of Groundwater
For Shepley's Hill Landfill Superfund Site
Former Fort Devens, MA
April 5, 2013

The Ayer Board of Health offers the following comments on the Draft ESD:

1. The Ayer Board of Health would like to go on record that the Army will be responsible and provide for any abandonment and/or decommissioning of wells that may be identified within the plume of contamination Area of Land Use Controls, including covering the costs of doing so. This should be noted as being open ended, meaning that should a well be found, for example, five years from now, the Army will still be responsible for taking care of it.

   Please refer to the response to EPA General Comment No.2.

2. The report is very difficult for the average person to understand. It would be helpful in the future if information produced by you was put forth in less technical language.

   Although we understand your frustration, the documents that are produced under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) are technical in nature, in order to meet the requirements of the EPA's regulations. The Explanation of Significant Differences (ESDs) is a legal document that is intended to spell out the changes to the site remedial action objectives (RAOs) from the current of the Record of Decision (ROD) for the site. Therefore this document requires a concise technical summary of the differences noted and changes required.

   As part of the LUCIP there will be newsletters and public forums to provided, written in less technical language that will be distributed to the public.

3. We wish to reiterate that all costs associated with any implementation of land use controls by Ayer Board of Health must be borne by the Army.

   The Army's responsibility with respect to implementation of LUCs and the Town of Ayer's responsibility related to the enforcement of the LUCs will be specified in the LUCIP. The Army will work with the BOH to ensure effective implementation and enforcement of the LUCs. The Army believes that these LUCs will have a minimal financial impact on the Ayer BOH or the town in general.

4. We feel it would be helpful if the Army maintained a database of all landowners in the affected area and continued to update it annually. Contents of this database should be worked out in consultation with the Town of Ayer.

   In the LUCIP, the Army will outline the tasks that will be completed as part of the plans execution. The Army will be updating its database of landowners with the area of LUCs.

5. Public education and outreach is important and must be defined clearly.

   The Army will include the details of "public education and outreach" *in the LUCIP. Public education and outreach will likely include but limited to the following:*

   i. *Updated survey of affected landowners and residents*

   ii. *Distribution is literature regarding the restriction of ground water use in the area of Land Use Controls*

   iii. *Participation in annual or as needed meetings with the Board of Health to update them on any changes in the groundwater use restrictions or to the area of LUCs*

6. Please define how the Army will contact landowners and residents to ensure the greatest outreach to impacted residents' areas. We would suggest using a combination of certified mail, inclusion of notices in water bills, and door-to-door outreach if necessary.

   The Army will contact the landowners and residents of properties located within the LUCs via certified mail, door to door survey or other means agreed to by the Town Ayer. The LUCIP will include the details of these notifications.

7. Please consider posting the land with signs indicating the Ayer Board of Health does not allow wells in this area.

   The Army will work with the Town of Ayer to determine the best means of continuing to inform the public that groundwater should not be accessed or used in the area of LUCs. The installation of groundwater wells in any part of Ayer requires approval by the BOH. The administrative controls on groundwater use implemented in the LUCs and that are currently in place under the Town of Ayer's by-laws may be the best means to protect the public.

Laurie Nehring Comments on
Draft Explanation of Significant Differences
Land Use Controls to Restrict Use of Groundwater
For Shepley's Hill Landfill Superfund Site
Former Fort Devens, MA
April 5, 2013

General Comments:

I am concerned that this report is very difficult for the average person to understand, and to grasp the potential impact on his/her property if they reside in the designated areas along West Main Street in Ayer. The town of Ayer is not even mentioned in this report, as it relates to the need for LUCs until we get to page 9 (out of 14 pages).

The report appears to me to be cryptic in avoiding language that makes it clear why the ESD is important, and how the LUCs may impact the residents in the affected area and burden town officials. I ask that Army to remove acronyms that have little meaning to residents (such as NIA), and replace them with words that have meaning, such as "town of Ayer".

Specifically, I suggest:

-The title of this report should be reworded as: "Explanation of Significant Differences Land Use Controls to Restrict Use of Groundwater in portion of the town of Ayer as a result of the for Shepley's Hill Landfill Superfund Site"

-Remove the acronym NIA and replace it with "the properties in Ayer along W. Main Street that is north of the landfill."

-Include a clear statement about the problem and need for the LUC in the introduction that clearly defines the location of the impact area.

Please see the answer to the BOH's comment No. 2. In addition the requested revisions would cause confusion with other documents that refer to the area as the NIA as well as the previous ROD, and therefore is not recommended, however we can define the NIA acronym to state that this area includes properties in Ayer along W. Main Street that is north of the landfill.

Specific Comments:

1. I agree with the comment from EPA, that the LUC defined in the footnote 3 should be replaced with the updated regulation.

   The reference will be updated. Please see the response to EPA's Specific Comment No 2.

2. Line 131. Please provide evidence that the landfill waste was placed over peat deposits and how much of it is "sandy aquifer that overlie bedrock or till. "

   The characterization of the landfill's geology can be found in the several historic SHL site investigation reports but is most recently summarized in the Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-term Monitoring and maintenance – Addendum Report, dated August 2011. A reference to this report will be added to the document.

3. Line 178. In the RAO, please include "Protect potential residential receptors <u>in Ayer and possibly Devens</u> from exposure..

   The RAO is a direct quote from the ROD and cannot be changed in this document.

4. Line 244-250. A question: Do the deed restrictions described here which border Plow Shop Pond also apply to Grove Pond drinking water wells, owned by the Army or by Mass Development? It is my understanding that these wells are shallow wells, and still used sporadically to keep them from rusting. Please explain.

   The Grove Pond drinking water wells are owned and operated by the Devens Enterprise Commission (DEC) and are located outside the area proposed to be under the LUCs.

5. Line 251. Suggest rewording "There <u>currently are no known human receptors</u> for groundwater exposure.

   The language in line 251 will be updated to reflect the above suggested change.

6. Line 300-304. The statement that "large amount of arsenic is being mobilized by natural as well as landfill-induced conditions" has not been proven. While it is a complex problem, this statement should be removed unless is it supported with scientific evidence.

   The Army believes that this statement is supported by scientific evidence as summarized in the SAR, 2011 and other investigative reports and those data and conclusions are also supported by similar peer-reviewed scientific studies at sites with similar conditions/history therefore the Army will retain the text in lines 300-304.

7. Line 309. Please remove the word "only". It diminishes the importance of the impact of property owners, and I find it belittling.

   The word "only" here is used in a specific reference to the existing ROD, not the SHL project as a whole. The addition of the LUC language as an enforceable component of the ROD is the only significant change; therefore keeping the word "only" in line 309 appropriate. There is no other intention of the use of the word.

8. Line 317 – 319. I adamantly request the Army NOT use the vague term "NIA" to mean, "Properties in Ayer impacted by the north plume." Please replace NIA throughout this document with a clear statement that defines the location.

   The term NIA has been used in several of the previous documents as an abbreviation to define the area where elevated arsenic levels have been detected in groundwater beyond the SHL boundary. The term NIA has come to define the area in earlier submittals and has become a term that defines this area for the regulatory groups involved. The Army will try to minimize its use where it's appropriate; especially in the LUCIP. As per our response to the General Comment, the Army will use the phrase "the properties in Ayer along W. Main Street that is north of the landfill" as suggested.

9. Line 331. Rewording suggested to state "Groundwater in the areas in Ayer impacted by the north plume poses an unacceptable risk.. (remove the work 'would').

   The language in line 331 is being updated at with additional language at the EPA's request. Please refer to the response to EPA's comment No. 5.

10. Line 359-362. Please remove the final sentence in this paragraph.

    The Army believes that this statement is supported by scientific evidence and will retain the text in lines 359-362.

11. All costs associated with the implementation of these LUC's by the Ayer Board of Health, Building Commissioner, legal fees and any other town official or individual responsible for this implementation should be fully funded by the Army. This would include but not be limited to clerical time, technology support, management, hiring of any experts, materials & supplies needed, postage, costs for public hearings, etc.

    Please see the response to the BOH's comment No. 3.

12. A database of the impacted properties in Ayer should be maintained and updated at least annually, along with a map overlay, clearly showing the impacted properties. The contents of the database should be worked out in consultation with the Town of Ayer.

    Please see the response to the BOH's comment No. 4.

13. Line 399. The Public Education and outreach is important, and must be defined clearly. "Periodic distribution" should be replaced with "annual" or "biannual" as per the Board of Health requirements.

    Please see the response to the BOH's comment No. 5.

14. Line 403. Please define how the Army will contact landowners and residents to ensure the greatest outreach to impacted residents possible, as close to 100% as possible. I

suggest using a combination of certified mail, inclusion of notices in water bills, and if necessary, door to door outreach for those who have not been reached via certified mail.

Please see the response to the BOH's comment No. 6.

15. Consider posting the land with signs indicating, "The Ayer Board of Health does not allow wells in this area" or something like that, with contact information on the sign.

Please see the response to the BOH's comment No. 7.

16. Line 460. While it is helpful to have meetings with 'stakeholders' through the BRAC cleanup team & the RAB, as stated here, it should also be stated that these are not adequate in reaching out and educating the general public. RABs are offered only quarterly, and are not well attended, nor understood by the average person. In addition, the public (including the Technical Advisor for PACE & PACE representatives) is not generally allowed to attend the BRAC Cleanup Team meetings, which is the best way stay updated on current events and activities.
I believe that the RAB meetings, by themselves, barely function in serving the purpose of keeping citizens involved and informed.

In accordance with the CERCLA process, the Army is fulfilling its requirement to provide a forum through the RAB meetings to involve and inform the public in the site remedial investigations and actions taking place at Fort Devens. If additional outreach is required we suggest that this be discussed with PACE.

TOWN OF AYER BOARD OF SELECTMEN COMMENTS ON
EXPLANATION OF SIGNIFICANT DIFFERENCES
SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION (RTN 2-0000662)
APRIL 2, 2013

Of specific comment and concern, the Ayer Board of Selectmen offers the following with respect to the DRAFT ESD

1. The Town of Ayer would like the U.S. Army to conduct additional testing to accurately delineated the extent of the arsenic plume with respect to its apparent north-west expansion toward the Nonacoicus Brook (Similar requests have been stated by PACE in their comments to you on the DRAFT ESD).

   The Army is in the middle of additional delineation drilling in this area. Please refer to the "Draft Final Work Plan for Long-Term Monitoring and Maintenance Plan Update," dated April 2013 for the details of this additional investigation. This investigation is being conducted with input from the EPA and MassDEP. The data will be available in the Annual Long Term Maintenance and Monitoring Plan in September 2013 which will also be submitted in draft form for public review and comment.

2. The Town of Ayer through its Board of Health will implement the mandatory drinking and irrigation water well moratorium and other local regulatory controls, but the Town remains concerned over the level of technical support for the monitoring and enforcement of these controls. As you are aware, the Town of Ayer has a three-member, elected, all-volunteer Board of Health and we share a Health Inspector through the Nashoba Valley Board of Health with 16 other communities. Hence, the Town of Ayer is requesting that the U.S. Army provide the Town of Ayer's Board of Health with **permanent,** dedicated technical support for the monitoring and enforcement of the land use controls with all costs (including employment and post-employment benefits) to be incurred by the U.S. Army.

   The Army is responsible for implementation all LUCs to be specified in the LUCIP. The BOH currently has a technical grant from the EPA for a third party consultant to assist them in writing the requested moratorium on groundwater use in the area of proposed LUCs. Once the moratorium is in place there will not be any extra duties the BOH is required to perform that is outside their routine review and enforcement duties which the board already performs. Under the Town's current zoning by-laws, building and permitting requirements, the use of private wells along West Main Street is already prohibited given the availability of public water. Therefore, an application for a private well construction permit submitted through the Board of Health is very unlikely. For this reason, the Army believes that a groundwater moratorium is not necessary to meet the stated LUC objectives.

   However, if the Town and EPA consider issuing a moratorium on groundwater use is necessary, then the Army will work with both agencies to ensure it is implemented under the LUCIP.

3. On March 20, 2013, through the support of a TASC Grant from the EPA, the Town of Ayer held a successful Public Hearing in Ayer on the issue(s) of Shepley's Hill Landfill Superfund Site and its impact(s) to the Town of Ayer. Part of this Public Hearing included the direct mailing to all known addresses in the affected arsenic plume. However, the Town remains concerned as to the level of public awareness of this issue at the affected properties because there is a high level of transient residents in this area in addition to non-resident property owners. We would respectfully request a dedicated public outreach and public education program initiated by the U.S. Army in cooperation with the Town of Ayer, EPA, and DEP.

   Please see the response to the BOH's comment No. 5.

4. As stated by our Town Administrator at the November 2012 RAB Meeting as well as by other Town officials at the March 20, 2013 Public Hearing, the Town has incurred and will continue to incur legal costs with respect to the drafting, implementation, administration, and periodic update/revision of the Town's land-use controls. Therefore, the Town of Ayer respectfully requests a meeting with the U.S. Army to negotiate a fair and equitable financial amount for Town incurred legal costs to effectively address this problem which was created by the U.S Army and not the Town of Ayer.

   Please see the response to Board of Selectmen Comment No. 2.

5. The Town of Ayer as well as PACE (people of Ayer Concerned about the Environment) believes that there is significant value to improving the ongoing operation of the arsenic pumping station on the Shepley's Hill Landfill. It is our opinion, that the pumping station has and is slowing the expansion of the arsenic plume across the north western portion of the Town of Ayer. However, we are concerned that the area of influence of the system is not sufficient. We are respectfully requesting written reassurance from the U.S. Army that the arsenic pumping station will remain operational on the Shepley's Hill Landfill for the foreseeable future and that every effort will be made to evaluate and upgrade the system as needed to prevent further migration of arsenic form the landfill and further contamination of ground water under the properties within the Town of Ayer. Furthermore, we request that the Army periodically look for and evaluate any emerging technologies that could possibly resolve the arsenic contamination of groundwater more quickly than the pumping station is able to do.

   The Army respectfully disagrees with the Town of Ayer's assessment of the SHL remedy effectiveness and refers to the Army's position stated in Memorandum by Mr. William J. O'Donnell II, BRAC Division to Mr. Bryan Olson, USEPA Region I, dated August 9, 2012.

6. With respect to the public participation activities as outlined in the U. S. Army's DRAFT "Explanation of Significant Differences" (ESD), the Town of Ayer requests that the U.S. Army at its cost in conjunction with the Town of Ayer, PACE, EPA, and DEP hold an annual public forum in Ayer regarding the ongoing status of the Shepley's Hill Landfill Superfund

Site with specific emphasis on an update pertaining to the arsenic plume in the Town of Ayer until the arsenic contamination in the ground water under the Town is below EPA's Maximum Contaminant Levels for drinking water and the Town can lift the moratorium on private water wells.

As part of the LUCIP, the Army will include providing an annual public meeting to update the Town and its residents on the status of the arsenic plume and the area of proposed LUCs.

TOWN OF AYER DPW's COMMENTS ON
EXPLANATION OF SIGNIFICANT DIFFERENCES
SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION (RTN 2-0000662)
APRIL 4, 2013

I have reviewed the Draft Explanation of Significant Differences- Land Use Controls to Restrict the Use of Groundwater, dated October 2012 Prepared by Sovereign Consulting Inc. My review and comments are based on my engineering education and experience and are beyond comments directly related to the Department of Public Works. These comments should be reviewed and if the Town feels they are valid, should be forwarded to the Department of Army.

1. Line 410 - " Request that the Ayer BOH consider implementing additional controls or restrictions....". The existing controls are related to drinking water wells. Provide more guidance on how to monitor or restrict the installation of irrigation and geothermal wells.

   The BOH currently has a technical grant from the EPA for a third party consultant to assist them in writing the requested moratorium on groundwater use in the area of proposed LUCs. An example of a moratorium (a one page letter) from the Town of Mashpee was provided to the Board of Health by the EPA.

2. Line 422 - refers to "such levels". Levels or basis for establishing acceptable levels should be detailed.

   "Such levels" will be defined as below Massachusetts DEP Maximum Contaminant Levels (MCLs).

3. The LUCIP should detail the specific responsibilities, level of effort and related costs to the Town to implement and oversee the controls.

   Please see the Response to the Board of Health's Comment Nos.3, 4 and 5.

4. All costs to the Town for monitoring and enforcing the local controls should be paid by the Army.

   The Army will be responsible for the implementation of the LUCIP. The Army cannot enforce local regulations. The Army does not believe that there are any additional expenses that the town will bare as a result of the LUC implementation or the enforcement of any new or existing local regulations that restrict groundwater use within the area of LUCs.

5. The Ayer DPW will need to repair, replace and extend buried utilities in the impacted area. Other utility companies (gas & electric) also have buried utilities in the area that will need excavation. This may impact the contaminated groundwater. The ESD needs to address in detail and specific requirements for material, excavation, dewatering, disposal of excavated

material and groundwater and worker protection. In addition, the additional costs related to these requirements need to be paid for by the Army.

The depths of arsenic impacts is greater than 20 feet below grade and are not at the typical depths where utility lines are lain.

MassDEP COMMENTS ON
REVISED EXPLANATION OF SIGNIFICANT DIFFERENCES
SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION (RTN 2-0000662)
JULY 3, 2013

Specific Comments:

1) Section 2.2.2: The final paragraph, an apparent reference to the Army's controversial position on the performance of the groundwater extraction system, should be deleted from' the ESD because the regulatory agencies have not accepted the Army's position on the performance of the extraction system, and the subsequently described rationale (incomplete delineation at time ROD was signed, Section 3.1) has been accepted and is sufficient to justify the ESD.

   Comment Noted. The Army intends to keep this text in the document as it appropriate to document the concern that that remedy cannot achieve the RAO.

2) Section 3.1.2, First Bullet: Please identify the page number, subsection, and paragraph where the requirement to connect to public utilities located within 400 feet of a property can be found.

   A foot note has been added to this section of text to provide a more specific reference.

3) Section 3.1.2, Second Bullet: The ESD should include a copy of the cited Moratorium on Groundwater Use.

   Now that the Moratorium has been issued by the Ayer Board of Health, it will be included as Appendix A.

4) Section 3.1.2, Fourth Bullet: New text concerning conditions that meet public water supply criteria and consequences of a non-potential drinking water source area should be deleted; the outcome from the source approval process cannot be known without a case-specific determination by MassDEP.

   The text is prefixed as an example, based on observed site characteristics and not making a determination of behalf of the DEP. The Army intends to keep this text in the document as it relates to the definition of the Land Use Controls for the restricted area. The word "likely" has been inserted in line 475 of the attached redline version to help clarify an example is being made.

EPA Comments on
Draft Final Explanation of Significant Differences
Land Use Controls to Restrict Use of Groundwater
For Shepley's Hill Landfill Superfund Site
Former Fort Devens, MA
18 July 2013

General Comment:

The Draft Final ESD was submitted in order to amend the Shepley's Hill Landfill (SHL) Record of Decision (ROD) to incorporate institutional controls (ICs) prohibiting the use of groundwater in the area within the Town of Ayer where the groundwater plume from SHL has traveled beyond the former Fort Devens boundaries (referred to as the "impacted area," "North Impact Area," or "NIA"). As EPA has stated in past correspondence, robust and reliable institutional controls are necessary because of the extremely high levels of arsenic under SHL and private properties in the North Impact Area.

Through the Draft Final ESD, Army has proposed reliance on governmental controls, in the form of local land use control (LUC) ordinances, along with informational devices, including regular surveys and communications with property owners in the impacted area, to meet the LUC objectives of restricting access to groundwater and prohibiting use of groundwater within the NIA.

EPA reiterates its position that a groundwater moratorium specifically prohibiting use of groundwater within the impacted area is a critical component of the Army's LUC layers. EPA believes that this type of LUC is necessary to address potential gaps in the existing local regulatory controls cited by the Army as LUC layers in the Draft ESD. A moratorium provides for a strong LUC, since the groundwater plume map and specific restrictions for the area are incorporated directly into the Town's well regulations and as it applies to both existing and new wells.

As noted in the Draft Final ESD, the Ayer Board of Health issued a Moratorium of Groundwater Use within the Army designated 'Area of Land Use Controls' in May 2013, and that is now incorporated into the ESD as an additional LUC layer. EPA provided technical support to the Town of Ayer, through its Technical Assistance for Superfund Communities (TASC) grant program, which facilitated the Town's evaluation of the ESD and the issuance of this Moratorium. EPA greatly appreciates the Town's cooperation and willingness to issue the moratorium, in support of the LUC performance objectives detailed in the ESD.

Although EPA continues to disagree with the Army on the adequacy of the other governmental controls included in the ESD in meeting the LUC performance objectives alone, it is a moot point since the Town has now issued the groundwater moratorium and Army has incorporated the moratorium as an additional LUC layer.

EPA requests that Army address any outstanding comments from stakeholders and proceed with preparing a Final ESD for Army and EPA signature. EPA requests that Section 6.0 be revised to reference the extended public comment period and the Town of Ayer's March 20, 2013 public meeting.

Within 3 months of signature of the ESD, Army must submit the Draft Land Use Control Implementation Plan (LUCIP). Consistent with the Army's response to EPA's comments on the Draft ESD, the LUCIP should document the Army and Town of Ayer's roles, responsibilities and legal authorities related to the implementation of the governmental controls relied upon pursuant to the ESD and should also include procedures to assure compliance with the zoning requirements and a Town utility map. In addition, in preparation of the Draft LUCIP, Army should consider the recently released EPA guidance documents related to Institutional Controls entitled, "A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites" and "A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites," both issued in December 2012 and available at

http://www.epa.gov/superfund/policy/ic/guide/index.htm.

The Army will address comments from stakeholders that have been submitted regarding the Draft Final ESD. Section 6 will be revised to include a reference the extended public comment period and the Town of Ayer's March 20, 2013 public meeting.

The Army will submit a draft LUCIP to the stakeholders within 90 days of finalization of the ESD as stated in Section 3.1.1, line 502 of the attached redline version.

As included in footnote No. 3 of the Draft Final ESD, the Army is utilizing the above suggested reference in the preparation of these documents.

Ayer BOH Comments on
Draft Final Explanation of Significant Differences
Land Use Controls to Restrict Use of Groundwater
For Shepley's Hill Landfill Superfund Site
Former Fort Devens, MA
July, 8 2013

The Ayer Board of Health (BOH) offers the following comments on the Draft Final ESD:

1) To make the document easier to review by those new to the project, please consider adding a glossary of abbreviations and acronyms prior to the first section of the document content.

   A list of acronyms will be provided following the table of contents.

2) Please replace the words "increased the uncertainty" with "decreased the likelihood" in the final paragraph in Section 2.2.2, which currently states:

   i) This CSM and the complex groundwater contamination problems have increased the uncertainty that this remedy will meet the aquifer restoration goals.

   The BOH understands that the wording of this paragraph has been the subject of much debate between the Army and regulatory agencies due to disagreement over the performance of the extraction system. The BOH's request is intended to clarify the present situation, based on monitoring well data, which clearly demonstrate unacceptable levels of mobilized arsenic in the groundwater; therefore, it is unlikely that the arsenic treatment plant (ATP) will be capable of adequately restoring the aquifer.

   Comment noted. The draft final language will be kept as the term "uncertainty" is tied to standard risk evaluation language used when evaluating a remedy. The Army intends to keep this text in the document as it appropriate to document the concern that that remedy cannot achieve the RAO.

3) Please replace the word "could" with "would" in the following sentence in the last paragraph of Section 2.1.2:

   i) Currently, based on available survey records, there is no significant risk to human health, but such a risk could exist if groundwater was a source of drinking water.

   It has been well established in the scientific literature that human ingestion of arsenic at levels in excess of the 10 ppb MCL (Maximum Contaminant Level) upper limit set by the Federal EPA constitute a risk to human health. Because groundwater arsenic levels have consistently exceeded this limit over a long period of time as measured via sampling wells, with some values in excess of 3,000 ppb measured earlier this year at SHM-13-04 (which is believed by the EPS to be within the core of the plume), there should be no remaining uncertainty as to whether exposure to these levels of arsenic in drinking water "could" pose a significant risk to public health.

The text will be revised as suggested.

4) The BOH requests that the Army include a statement in the ESD to clarify that it will bear financial responsibility for any well decommissioning or any other costs necessary to ensure the effectiveness of existing and future Land Use Controls.

   In a letter dated April 5, 2013 the BOH made the following comments:

   i) The Ayer Board of Health would like to go on record that the Army will be responsible and provide for any abandonment and/or decommissioning of wells that may be identified within the plume of contamination Area of Land Use Controls, including covering the costs of doing so. This should be noted as being open ended, meaning that should a well be found, for example, five years from now, the Army will still be responsible for taking care of it.

   ii) We wish to reiterate that all costs associated with any implementation of land use controls by Ayer Board of Health must be borne by the Army.

   As stated in the Response to Comments to the Draft ESD, it is the Army's responsibility to implement the Land Use Controls (LUCs). As part of the LUCIP, the Army will detail the procedures to be followed if a groundwater well is discovered with the area of LUCs. If it is determined that a groundwater well was installed prior to the implementation of the LUCs, the Army will take financial responsibility for the decommissioning of that well and filing of the appropriate paperwork with the Ayer BOH and the State of Massachusetts.

   The Army will be administratively and financial responsible for the implementation of the LUCIP. The Town of Ayer will be responsible for the enforcement of the related LUCs.

5) The Army's response to these comments, which were provided in Appendix D to the Draft Final ESD, is as follows:

   i) The Army's responsibility with respect to the implementation of LUCs (Land Use Controls) and the Town of Ayer 's responsibility related to the enforcement of the LUCs will be specified in the LUCIP (Land Use Control Implementation Plan). The Army will work with the BOH to ensure effective implementation and enforcement of the LUCs. The Army believes that these LUCs will have a minimal financial impact on the Ayer BOH or the town in general.

   Section 3.1.2 of the Draft Final ESD defines the LUCs applied to Shepley's Hill Site as: the current Town of Ayer Zoning Bylaws, the recent BOH Moratorium on Groundwater Use within the Area of Land Use Controls, the January 2001 Ayer BOH Well Regulations, and the Massachusetts Drinking Water Regulation 310 CMR 22.00, in addition to the following affirmative measures to be taken by the Army in support of these LUCs: public education and outreach, meetings with the Ayer BOH, and updates to the LUC maps defining the current and projected areas affected by the LUCs.

In light of the reasonably detailed information describing the Army's steps to ensure that LUC performance objectives are met, the BOH requests that the Army add a statement confirming its current and ongoing financial responsibility for the costs of any decommissioning of any well found to be within the area of current and future LUC's. The Army's comment that "these LUCs will have a minimal financial impact on the Ayer BOH or on the town in general" is not substantiated and does not address potential expansion of the affected LUC area. While the BOH agrees that information currently available indicates there are no affected wells in the affected area, this may not be true in the future if the affected area is expanded due to further migration of the existing arsenic contamination. In the event that any wells are discovered to be present in the current LUC area, or if the LUC area is expanded to include properties where wells are present, neither the cost nor the responsibility for decommissioning is clearly defined. Because the Army, not the residents of Ayer, is responsible for the full cost of the entire Shepley's Hill contamination cleanup, we believe it is appropriate to include the cost of well decommissioning in the lists of the Army's "affirmative measures to further ensure that the LUC performance objectives are met" (Draft Final ESD, Section 3.1.2).

See response to BOH Comment No. 4 above.

6) The BOH finds the Army's description of public education and outreach relative to ensuring that LUC performance objectives are being met to be vague and non-specific and requests that the description of these actions be changed to describe the Army's plans for the type, method, and frequency of public education and outreach activities in terms that are quantifiable and measurable. If the Army does not feel it is appropriate to go into this level of detail in the ESD, the BOH requests that the Army modify the final paragraph of Section 3.1.2 to specify that the LUCIP will include the Army's plans for specific, quantifiable public education and outreach activities, which will be evaluated and monitored by the Town of Ayer.

   Please note that this request mirrors similar requests made in the BOH's April 5, 2013 letter in reference to the previous ESD draft, specifically:

   i) Public education and outreach is important and must be defined clearly.

   ii) Please define how the Army will contact landowners and residents to ensure the greatest outreach to impacted residents' areas. We would suggest using a combination of certified mail, inclusion of notices in water bills, and door-to-door outreach if necessary.

In response to these comments the Army indicated that the details of these activities will be defined in the LUCIP and will "likely include but limited to the following" (should this state "not limited to"?):

i) Updated survey of affected landowners and residents.

ii) Distribution of literature regarding the restriction of groundwater use in the area of Land Use Controls.

iii) Participation in annual or as needed meetings with the Board of Health to update them on any changes in the groundwater use restrictions or to the area of LUCs.

The requested information and detail will be included in the LUCIP and not in the ESD. The Army will describe the tasks listed above, and the implementation of those tasks in LUCIP. The Army can meet with BOH, at the board's request, prior to the finalization of the draft LUCIP to review the plans contents. The BOH will have the opportunity to review and comment on the Draft and Draft Final LUCIP.

MassDEP Comment No. 1

First Paragraph of 3.1.2: Replace entire paragraph with the following:

"To meet the LUC performance objectives, the Army is responsible for ensuring that the following four LUCs are established, monitored, maintained, and reported on as part of this final remedy to ensure protection of human health and the environment in accordance with CERCLA and the NCP. In the event that the Town of Ayer fails promptly to enforce the any of the first three LUCs or the Commonwealth of Massachusetts fails to promptly enforce the fourth LUC, the Army will act in accordance with subparagraph (b) of this section 3.2.1, below, regarding the decommissioning of wells, issuing health warnings and installing treatment systems. For purposes of the preceding sentence, "promptly enforce" means if the violation or potential violation is imminent or on-going, enforce to prevent or terminate the violation within 10 days from the enforcing agency's (i.e., the Town or the Commonwealth) discovery of the violation or potential violation; otherwise, enforce as soon as possible."

Army Response:

These changes are not necessary to include as a replacement to referenced text. The Army's responsibilities are already specified in the ESD with respect to LUC monitoring, maintenance and reporting. These responsibilities will be further specified in the LUCIP.

MassDEP Comment No. 2

First bulleted paragraph of 3.1.2: This bulleted paragraph overstates the scope of Ayer's zoning code, and the degree to which it can serve as an effective control on groundwater use. The referenced "Article 10 – Site Plan Review" in Ayer's zoning code, which the Army appears to be relying on principally, does not apply to all "new building or structure and any land use," as the bulleted paragraph states, but only the developments and uses described in 10.2(a) through (d) of Article 10. This is typical of zoning codes: site plan review applies to some, but not all development. Furthermore, although the site plan must show compliance with "environmental performance standards" (which is undefined), as well various provisions cited in the Zoning By-Law, none of those provisions appear to address groundwater use specifically. See 10.6(g) and (h) of the Zoning By-Law. Replace second paragraph in this bullet in its entirety with the following language:

"Article 10 – Site Plan Review of the Town of Ayer's Zoning By-Laws provide that developments and uses above certain minimum thresholds specified in Section 10.2 of said Article may not be permitted unless a site plan has been endorsed by the Town of Ayer Planning Board. Such site plan must show the location of, and describe, how water is being supplied to such developments."

Army Response:

The text has been revised to better reflect how the zoning by-laws apply. However, this LUC layer does in fact address all new building and structures since it includes both the Town of Ayer Zoning By-Laws and the Town of Ayer Building Department Permitting Requirements. The site plans required for both subdivision and cluster development under the Subdivision Control Regulations and the Zoning By-Laws requires, "A Utility Plan showing the location, size and engineering detail of the existing municipal water distribution lines, sanitary sewer collection lines, storm-water management systems, fire hydrants, pumping stations and other system features. The Utilities Plan also shall include design of all proposed utilities to be constructed on site and their connections to the municipal systems; also refer to Town of Ayer Subdivision Control Regulations, Section IV, Design Standards." The design standards state, "Where public water system is located within four hundred feet of the subdivision, the sub-divider shall connect to the public water system. Where a public water system is not located within four hundred feet, the sub-divider may install private on-lot water systems and such systems shall be designed in conformity with the standards of the Board of Health."

The site plan review of other types of development not addressed above i.e., new single residence house construction, is addressed under the Town of Ayer Building Department Permitting process which states, " If your lot has public utilities, you are required to obtain connection permits from the DPW."

MassDEP Comment No. 3

Second bulleted paragraph of 3.1.2: The Town of Ayer's Moratorium restricts the use of groundwater in "documented or anticipated areas of groundwater contamination as defined by the Ayer Board of Health." These areas are not necessarily identical to the "Area of Land Use Controls" described in Figure 3 of the ESD, which extends 400 feet from the limits of groundwater contamination. Delete "within the Area of Land Use Controls" after "(Attached as Appendix B)". Delete "within the Area of Land Use Controls as defined by Figure 3 (including any future revisions)" and replace with "within documented or anticipated areas of groundwater contamination as defined by the Ayer Board of Health." Add the following sentence: "The Army will be responsible for ensuring that the Town of Ayer applies the Moratorium to an area that is at least as extensive as the Area of Land Use Controls established pursuant to this ESD, as the Area of Land Use Controls may be adjusted from time to time to reflect the actual location of the contamination."

Army Response:

Since the Town of Ayer Moratorium did not reference Figure 3 - Area of Land Use Control, the text has been revised accordingly as follows:

- ***Moratorium on Groundwater Use within the Area of Land Use Controls - The Ayer BOH has issued a Moratorium on Groundwater Use (Attached as Appendix A).***

  This LUC will provide additional controls or restrictions on access to groundwater for the purpose of potable use or irrigation within documented or anticipated areas of groundwater contamination as defined by the Ayer Board of Health in consultation with the Army. This measure prohibits any and all uses of groundwater use in the defined area.

The final suggested text change is not necessary since the Army's responsibilities to consult with the Ayer BOH for updating the Area of LUCs are already stated under the affirmative measure LUC.

MassDEP Comment No. 4

Third bulleted paragraph of 3.1.2: Delete the sentence beginning with "The Area of Land Use Controls has been serviced." The language of the zoning by-laws and building permitting requirements cited in that statement does not support the broad statement that the "installation of new private wells is not allowed." Delete "unlikely" before "event." We aware of no reliable basis for predicting far into the future the likelihood that a landowner in the affected area may apply for a groundwater permit. Replace "ensure that a private well would not be permitted" with "help ensure that a private well would not be permitted." Replace "Specifically, the requirement" with "The requirement". Replace "would prevent the installation of any new private wells in this area" with "would require the permit applicant to identify any possible sources of contamination within 400 feet of the proposed well."

Army Response:

As discussed above, the installation of new private wells is not allowed per zoning and permitting regulations. The purpose of this paragraph was to explain and interpret how this LUC *(the well regulations) would meet the LUC objective to restrict access to groundwater. The interpretation is accurate and the suggested changes to this paragraph are not warranted.*

MassDEP Comment No. 4

Fourth bulleted paragraphs of 3.1.2: Replace these paragraphs in their entirety with the following:

"The Massachusetts Drinking Water Regulations at 310 CMR 22.00 – the state regulatory permitting and approval process for public water systems.

Any new Public Water Supply or any expansion of an existing Public Water Supply will be required to conform with the requirements of 310 CMR 22.00, which includes a screening, evaluation and approval process. The screening process is designed to identify potential threats to any Public Water Supply, including threats posed by contamination within the protective zones and areas around Public Water Supplies identified in 310 CMR 22.00."

Army Response:

The text as written provides an accurate description of the LUC layer and why it is consistent with the overall LUC objective to restrict access to groundwater. The suggested changes to this paragraph are not warranted.

MassDEP Comment No. 4

After the paragraph in 3.1.2 beginning with "In addition, the Army will implement the following affirmative measures," add the following new bulleted paragraph:

"Within two years of the signing of the ESD, the Army shall:

(a) Document all private wells (i.e. non-decommissioned wells, including wells not currently in use) that are above or within the Area of Land Use Controls;

(b) If, pursuant to paragraph (a) above, the Army identifies any private wells (i.e. non-decommissioned wells, including wells not currently in use) that are above or within the Area of Land Use Controls, the Army will offer the owner to decommission the well. If accepted, the Army will document such action with the BOH. If the decommissioning is not accepted, the Army will take other steps to ensure protectiveness, including, but not be limited to, requesting assistance from the BOH to issue health warnings to the property owner and any other person with access to the well (such as a lessee or licensee), offering bottled water (if well is used for drinking), or installing treatment systems on affected wells. In each instance, the Army shall submit a schedule subject to EPA approval, outlining and including time limitations for the completion of steps sufficient to prevent exposure to concentrations of contaminated groundwater."

Army Response:

The suggested text additions are not appropriate for an ESD. The implementation of these LUCs, specifically groundwater use surveys and results, will be defined in the LUCIP.

MassDEP Comment No. 4

Third to Last Paragraph of 3.1.2: Replace "with the prior coordination/concurrence of the Town of Ayer, EPA and MassDEP" with "with approval of EPA and MassDEP, and after coordination with the Town of Ayer"

Army Response:

The referenced concurrence language has been deleted. This paragraph will now state that "All LUCs will be maintained until the concentrations of contaminants of concerns in the groundwater are at such levels as to allow unrestricted use and exposure." The concurrence language to modify LUCs will be added to the LUCIP.

MassDEP Comment No. 5

Second to Last Paragraph of 3.1.2: After the first sentence, add:

"Such monitoring shall be conducted at least annually. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the EPA and MassDEP. The monitoring reports will be used in preparation of the five-year review to evaluate the effectiveness of the final remedy. The monitoring report, submitted to the regulatory agencies by the Army, will evaluate the status of the LUCs and how any LUC deficiencies or inconsistent uses have been addressed. The annual evaluation will address (i) whether the use restrictions and controls referenced above were effectively communicated, (ii) whether the operator, owner, and state and local agencies were notified of the use restrictions and controls affecting the property, and (iii) whether use of the property has conformed with such restrictions and controls and, in the event of any violations, summarize what actions have been taken to address the violations."

Army Response:

The suggested text additions are not appropriate for an ESD. The monitoring and reporting elements of each LUC will be specified in the LUCIP.

MassDEP Comment No. 6

Second to Last Paragraph of 3.1.2: At the end of the paragraph, add:

"The Army will provide EPA and MassDEP 30 days' notice of any changes to its or its contractors' or agents' procedures for monitoring, maintaining, and reporting on the LUCs established under this ESD."

Army Response:

The suggested text additions are not appropriate for an ESD. The monitoring and reporting elements of each LUC will be specified in the LUCIP.

FINAL

LAND USE CONTROL IMPLEMENTATION PLAN

RESTRICTION OF GROUNDWATER USE

SHEPLEY'S HILL LANDFILL

FORMER FORT DEVENS ARMY INSTALLATION, DEVENS, MA

AUGUST 2014

Prepared for:
US Army Corp of Engineers
New England District
Concord, Massachusetts

Prepared by:
Sovereign Consulting Inc.
Contract No.: W912WJ-10-D-0003
Delivery Order: 0002

SOVEREIGN CONSULTING INC.

NOTICE

The United States Department of Defense, Department of Army, funded wholly or in part the preparation of this document and work described herein under Contract No. W912WJ-10-D-0003 and Delivery Order 0002. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Land Use Control Implementation Plan

FINAL

Devens, Massachusetts

August 2014

CERTIFICATION:

I hereby certify that the enclosed Plan, shown and marked in this submittal, is that proposed to be incorporated with Contract Number W912WJ-10-D-0003 DO#0002. This Document has been prepared in accordance with USACE Scope of Work and is hereby submitted for Government Approval.

Reviewed By:

27 August 2014

Sovereign Project Manager **Date**

27 August 2014

Sovereign Quality Control Manager **Date**

Received By:

Digitally signed by ANDERSON.MARK.J.JR.1241441683
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27 August 2014

USACE Project Manager **Date**

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AOC	Area of Contamination
BOH	Board of Health
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	Conceptual Site Model
DPW	Department of Public Works
DRMO	Defense Reutilization and Marketing Office
ESD	Explanation of Significant Differences
FS	Feasibility Study
ICs	Institutional Controls
LUC	Land Use Control
LUCIP	Land Use Control Implementation Plan
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
NAE	New England District
NCP	National Contingency Plan
NIA	North Impact Area
NTCRA	Non-Time Critical Removal Action
PVC	Polyvinyl Chloride
RAO	Remedial Action Objectives
RI	Remedial Investigation
ROD	Record of Decision
SHL	Shepley's Hill Landfill
Sovereign	Sovereign Consulting Inc.
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION AND PURPOSE

Pursuant to the Contract Modification for #W912WJ-10-D-0003 Task Order 0002, Sovereign Consulting Inc. (Sovereign), on behalf of the US Army Corps of Engineers New England District (USACE-NAE) and the Army Base Realignment and Closure (BRAC) Environmental Office at Devens, Massachusetts, hereafter referred to as the Army, has completed this Land Use Control Implementation Plan (LUCIP) for the restriction of groundwater use north of Shepley's Hill Landfill (SHL) in the Town of Ayer Massachusetts (**Figure 1**). This document describes the procedures for implementing the institutional controls required by the SHL Operable Unit Record of Decision (ROD), dated September, 1995 (USAEC, 1995) as amended by the Explanation of Significant Differences (ESD) dated December 2013 (Sovereign, 2013b). The ESD introduced additional Land Use Controls (LUCs) on non-Army owned properties to restrict the use of groundwater from a portion of the Town of Ayer, located north of SHL, referred to as the Northern Impact Area (NIA) **(Figure 2**). The NIA includes properties in Ayer along West Main Street and is presented in **Figure 3**.

1.1 Objectives and Plan Organization

The objectives of this LUCIP is to:

- Summarize the site description and historical background; and
- Summarize how the Army will implement Land Use Controls (LUCs) and supporting requirements specified in the ESD.

This plan has been divided into the following sections:

- **Section 2.0** of this plan summarizes site details, including a description and the history of the site.
- **Section 3.0** of this plan presents the LUCs with the definition of LUCs, land affected, Institutional Controls (ICs) in place for the NIA and performance objectives of the ICs and Affirmative Measures.
- **Section 4.0** summarizes the implementation of LUCs, which entails public outreach and communication with local government departments.
- **Section 5.0** summarizes the LUCIP maintenance and reporting requirements.
- **Section 6.0** describes the responsibilities encompassed by the LUC; including ICs and Affirmative Measures.
- **Section 7.0** provides information regarding any modifications or the termination of the LUC. **Section 8.0** provides enforcement requirements.
- **Section 9.0** summarizes the approval and notification process. And,
- **Section 10.0** provides a list of references.

2.0 SITE BACKGROUND

The former Fort Devens is located 35 miles west of Boston in north-central Massachusetts within the towns of Ayer and Shirley in Middlesex County, and the towns of Harvard and

Lancaster in Worcester County. Prior to realignment and closure in 1996, Fort Devens included 9,280 acres divided into North Post, Main Post, and South Post. **Figure 1** depicts the location of the various areas of the former base. The North and Main Posts are separated from the South Post by Massachusetts Route 2. The area around the former Fort Devens is primarily rural/residential with the Nashua River running through the North, Main and South Posts. Currently, the U.S. Army Garrison Fort Devens (formerly the Devens Reserve Forces Training Area) consists of 5,196 acres primarily on South Post.

SHL encompasses approximately 84 acres in the northeast corner of the former Main Post at Fort Devens (**Figure 1**). It is situated between the bedrock outcrop of Shepley's Hill on the west and Plow Shop Pond on the east. Nonacoicus Brook drains Plow Shop Pond and flows through a low-lying wooded area at the north end of the landfill. The southern end of the landfill borders an area formerly occupied by the Defense Reutilization and Marketing Office (DRMO) yard, motor repair shops, and a warehouse. Areas previously mapped as wetlands have been filled by waste materials. The landfill waste material was placed over peat deposits and a sandy aquifer that overlies bedrock and/or till. SHL includes three Areas of Contamination (AOCs): AOC 4, the sanitary landfill incinerator; AOC 5, sanitary landfill No. 1 or SHL; and AOC 18, the asbestos cell. AOCs 4, 5, and 18 are all located within the capped area at SHL. The three AOCs are collectively referred to as Shepley's Hill Landfill Operable Unit (**Figure 4)**.

The landfill was closed in five phases between 1987 and 1992-93 in accordance with Massachusetts Regulations at 310 CMR 19.000. The Massachusetts Department of Environmental Protection (MassDEP) approved the closure plan in 1985. Closure consisted of installing a 30 to 40-mil polyvinyl chloride (PVC) membrane cap, covered with soil and vegetation and incorporating gas vents. Closure also included installation of wells to monitor groundwater quality around the landfill, and construction of drainage swales to control surface water runoff. MassDEP issued a Landfill Capping Compliance Letter approving the closure in February 1996.

Subsequent to closure of the landfill, remedial investigations (RIs) completed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) evaluated soil, sediment, surface water, and groundwater conditions at and in the immediate vicinity of the landfill. The results confirmed the presence of various contaminants, particularly certain inorganics including arsenic and volatile organic compounds (VOCs), in groundwater, sediment, and surface water at or adjacent to SHL. A Feasibility Study (FS) and ROD resulted in a remedial action that required long term monitoring and maintenance of the existing landfill cap and groundwater monitoring.

The ROD (USAEC, 1995) required the Army to perform groundwater monitoring and five-year reviews to evaluate the effectiveness of the selected remedial action, which relied heavily on the previously installed landfill cap, to attain groundwater cleanup goals by 2008 and to reduce potential exposure risks. If groundwater contaminant concentrations, primarily arsenic, met risk-based performance standards (cleanup goals) over time, the ROD did not require further action; however, if cleanup goals were not met, the ROD required implementation of a groundwater extraction contingency remedy. Due to continued elevated contaminant concentrations, the Army installed and operated a groundwater extraction and treatment system in March 2006 as a contingency remedy to address groundwater contamination emanating from the northern portion of the landfill (Sovereign, 2011).

The AOC 72 RI (AMEC, 2011) results suggested that groundwater discharge contributes concentrations of arsenic in sediments of Plow Shop Pond that may accumulate to levels resulting in conditions that pose unacceptable risks to ecological receptors. Therefore, remedies that minimize such arsenic-in-groundwater flux to Red Cove were deemed to be most protective. All available data indicate that the current remedies (landfill capping and groundwater extraction) have not eliminated groundwater flow and arsenic migration from SHL into Red Cove / Plow Shop Pond, identified as AOC 72. Consequently, in 2012 a low-permeability groundwater barrier wall was installed between the SHL and AOC 72 as part of a Non-Time Critical Removal Action (NTCRA) to mitigate arsenic flux from groundwater flow from the SHL to Red Cove/Plow Shop Pond. Documentation of the barrier wall installation was provided in the Removal Action Completion Report (Sovereign, 2013a).

Since the time of the ROD, a more comprehensive understanding of the remedy Conceptual Site Model (CSM) (Draft LTMMP (Sovereign, 2013c), groundwater chemistry in particular, has developed which indicates that a large amount of arsenic is being mobilized by both natural as well as landfill-induced conditions. Groundwater in the NIA would pose an unacceptable risk to human health if used for drinking water or irrigation purposes. Therefore, the Army has established the area of Land Use Controls to restrict the extraction and use of groundwater through the implementation of the ESD. The LUC objectives (to restrict access to groundwater, prohibit withdrawal and/or future use of water, and maintain the integrity of any current or future monitoring system), and the established area of LUC are detailed below.

Although the majority of the Town of Ayer is connected to a public water supply whose source is outside the NIA and therefore is not at risk of impact from groundwater discharge from under SHL, additional protective measures have been implemented to protect any future potential groundwater users. The NIA ESD for the ROD presented the following conclusions:

- Post-ROD investigations documented impacted groundwater within the NIA.
- The ROD did not specifically address LUCs for any non-Army properties located north of the landfill (i.e. NIA) because the extent of the impact was not defined at the time.
- Groundwater in the NIA poses an unacceptable human health risk if used as drinking water, and potentially poses an unacceptable risk if used for irrigation purposes.
- An Area of Land Use Controls was established via the ESD where the use of groundwater will be restricted based on the defined limits of groundwater contamination as documented during previous site investigations (**Figure 3**).

As prescribed in the ESD, a LUCIP would be developed to ensure the proper implementation of the Land Use controls to meet the performance objectives. The following sections will detail these controls and the plan to communicate them to the public.

3.0 LAND USE CONTROL

3.1 Definition of Land Use Controls

Land Use Controls in regard to real property are broadly interpreted to mean:

> *any restriction or control, arising from the need to protect human health and the environment, that limits use of and/or exposure to any portion of that property, including water resources. This*

term encompasses 'institutional controls,' such as those involving real estate interests, governmental permitting, zoning, public advisories, deed notices, and other 'legal' restrictions. The term may also include restrictions on access, whether achieved by means of engineered barriers such as a fence or concrete pad, or by 'human' means, such as the presence of security guards. Additionally, the term may involve both affirmative measures to achieve the desired restriction (e.g., night lighting of an area) and prohibitive directives (e.g., no drilling of drinking water wells).

The LUCs for a property will provide a blueprint for how the property should be used in order to maintain the level of protection intended by the remedial alternative.

3.2 Land Affected

The boundary of the LUCs was determined by taking the defined limits of groundwater contamination as documented by the site investigations included in the ESD and then set approximately 400 feet from the horizontal limits of groundwater contamination in order to conservatively establish the restricted area. These properties are not owned by the Army and are located with the Town of Ayer. The Area of LUCs affected under this LUCIP is shown on **Figures 3 and 4.** The SHL and surrounding Army controlled properties (**Figure 2**) are not addressed under these additional LUCs since these properties are addressed in the initial ROD**.**

A narrative description of the NIA is included as **Appendix A**. An aerial plan of the Impact Area is included as **Figures 3,** and a figure with property information for each parcel within the NIA is included as **Figure 4**.

3.3 Land Use Control Performance Objectives

Groundwater in the NIA would pose an unacceptable risk to human health if used for drinking water and may cause unacceptable risk to human health if used for irrigation purposes. Therefore, administrative and/or legal land use controls known as "LUCs" have been incorporated as a component of the selected groundwater remedy for the Site.

The performance objectives of the LUCs are to:

- Restrict access to groundwater so the potential exposure pathway to the contaminants remain incomplete.
- Prohibit the withdrawal and/or future use of water, except for monitoring, from the aquifer within the identified groundwater LUC boundary (**Figure 3**).
- Maintain the integrity of any current or future monitoring programs.

To meet these objectives, the Army has established the Area of Land Use Controls where the use of groundwater will be restricted (See **Appendix A** and **Figure 3**). This area is based on the defined limits of groundwater contamination as documented by the site investigations referenced in Section 3.1. The LUC boundary limits were then set an additional approximately 400 feet from the horizontal limits of groundwater contamination in order to include an additional buffer zone thereby conservatively establishing the restricted area. The SHL and surrounding Army controlled property, also shown on **Figure 2**, are ***not*** addressed under these additional LUCs since this property is addressed in the initial ROD (USAEC, 1995). Also, it is noted that the Army property is within the Devens Regional Enterprise Zone (under jurisdiction of Devens) and the NIA is within the Town of Ayer jurisdiction.

3.4 Land Use Controls – Institutional Controls

To meet the LUC performance objectives, the following Institutional Controls in the form of governmental permitting, zoning, public advisories, prohibitive directives (e.g., no drilling of drinking water or irrigation wells) and other 'legal' restrictions are currently established within the NIA. A more detailed description of each institutional control is included in the Section 3.1.2 of the ESD, which is included in **Appendix B** of this plan.

- *The Zoning By-Laws of the Town of Ayer* - Town of Ayer Subdivision Control Regulations and Town of Ayer Building Department Permitting Requirements. Town of Ayer zoning, permitting and building requirements to which the use of all new or existing buildings, other structures or land must comply.
- *Moratorium on Groundwater Use within the Area of Land Use Controls* - The Ayer Board of Health (BOH) has issued a Moratorium on Groundwater Use (Attached as **Appendix B**).
- *The Ayer Board of Health (BOH) Well Regulations (Adopted January 10, 2001)* – Town of Ayer permitting requirements for the installation and use of new drinking water wells.
- *The Massachusetts Drinking Water Regulation 310 CMR 22.00* – the state regulatory permitting and approval process for any new drinking water supply wells in Massachusetts that propose to service more than 25 customers or exceed a withdrawal rate of 100,000 gallons per day.

The Army will notify the USEPA and MassDEP of any changes in LUC management responsibilities. An implementation schedule has been included as **Appendix D**. All LUCs will be maintained until the concentrations of contaminants of concerns in the groundwater are at such levels as to allow unrestricted use and exposure.

3.5 Land Use Controls - Affirmative Measures

In addition to the land use controls described above, the Army will implement the following affirmative measures, under this LUCIP to further ensure that the LUC performance objectives are being met.

- Public education and outreach via ongoing periodic distribution of educational materials and groundwater use surveys to be distributed to all property owners and residents with the stated goal of confirming that no groundwater wells are in use within the entire Area of LUCs.
- Meet with town officials (Ayer BOH, Department of Public Works (DPW), etc.) annually, or more frequently if necessary.
- Distribution of the LUCIP to local and federal parties.

The following sections are a more detailed description of the affirmative measures presented above.

4.0 LUC IMPLEMENTATION

4.1 Public Education and Outreach

The Army will contact land owners and residents in the Area of LUCs to explain the groundwater contamination distribution in the aquifer. A list of land owners and residents within the Area of the LUCs will be generated using public town records obtained from the Town of Ayer (BOH, DPW, Assessor's Office, etc.). Land owners and residents will be informed of the health impacts that may result from drinking contaminated groundwater, using contaminated groundwater for irrigation or otherwise contacting contaminated groundwater. It will be made clear that the installation of wells that draw groundwater from the contaminated aquifer is prohibited. Use of any existing wells must be discontinued and the Army, with permission of the landowner, will be responsible for properly decommissioning any identified wells still in use. Private property owners have an independent obligation to comply with the applicable statutes, regulations, and zoning requirements.

The Army will conduct a door to door survey of land owners and residents in the Area of LUCs to verify that all properties have water meters (i.e. are connected to municipal water), to ensure that no undocumented private/irrigation wells are present, and to document a property ownership list to certify that both owners and renters are informed of the ICs. For example, if a property owner is not the primary resident, they would be contacted by mail, where as the renter would be contacted at the Ayer address, during the door to door survey and by mailings to the home/residence. The Army, with permission of the landowner, will properly decommission any wells discovered during the survey to ensure remedy integrity. In addition to the door to door survey, the Army will provide a pamphlet (**Appendix C**) with supplemental educational materials and contact information. Following the initial door to door survey a survey will be conducted every five years or sooner if required by changes to the LUCIP. Reminder mailings will be sent out annually to account for changes in ownership/occupancy.

If the Army identifies any private wells (i.e. decommissioned wells, including wells not currently in use) that are within the Area of Land Use Controls, and the landowner refuses the Army's offer to decommission the well, then the Army bring the instance of the Groundwater Moratorium to the attention of the Ayer BOH to issue warnings to the property owner and any other person with access to the well (such as a lessee or licensee). The Army will decommission any private well and if none exists, provide a connection to the public water system in Ayer, at the Army's expense. In each instance, the Army will monitor the implementation of the enforcement action by the BOH as described in Section 8 of this LUCIP.

4.2 Coordination with the Ayer Board of Health

In 2013, the Army worked with the Town of Ayer Board of Health to implement the Moratorium on Groundwater Use within the Area of Land Use Controls that was signed in May 2013. Through an EPA Technical Assistance Grant and meetings with the Army, the Town of Ayer was able draft language to restrict use of groundwater in the Town of Ayer without the boards review and approval.

The Army will meet with the Town of Ayer BOH, to discuss the implementation of LUCs and provide an updated Area of Land Use Control map(s) that document the current and projected location of groundwater contamination within the Town of Ayer. While **Figures 3 and 4** show the current area of the NIA where the LUCs apply, the Ayer BOH or the Army may modify the areas based on new information, and all LUCs will apply to such areas based on revisions. The Army will meet with the BOH annually, or if a change in the groundwater contamination distribution in the aquifer occurs (i.e. plume area change). Upon request, the Army will coordinate with the BOH to provide information to post on the BOH website regarding the LUCs.

4.3 Coordination with the Ayer Department of Public Works and Building Department

The Army will periodically meet with the Town of Ayer DPW and Building Department to discuss the implementation of LUCs, ensure that the installation of any wells that draw groundwater from the contaminated aquifer is prohibited, and to verify that all properties within the Area of LUCs are connected to municipal water and do not contain private/irrigation wells. The Army will properly decommission any wells that draw groundwater from the contaminated aquifer to ensure remedy integrity.

4.4 Distribution of LUCIP

Within 30 days of receiving USEPA approval and MassDEP concurrence of this LUCIP, in accordance with their respective legal authorities, the Army will undertake the following specific actions:

- Send a copy of this LUCIP to the following Agencies of the Town of Ayer, Massachusetts for their records:
    - Board of Health
    - Department of Public Works
    - Building Department
- Place a copy of this LUCIP in the central Army repository and the public libraries for the Town of Ayer, Massachusetts.
- Include a copy of this LUCIP with the initial survey of land owners and educational pamphlet distribution to all property owners within the Area of LUCs affected under this LUCIP.

5.0 LUCIP MAINTENANCE AND REPORTING

The Army is responsible for ensuring that LUCs are maintained through monitoring and reporting. In the case of LUCs in the form of Institutional Controls (ICs), the Army will work with the Town of Ayer to monitor and implement their enforcement. Following the initial implementation of the LUC, all LUCs will be maintained until the concentrations of contaminants of concerns in the groundwater are at such levels as to allow unrestricted use and exposure. Maintenance and reporting of the LUCs, in the form of Affirmative Measures the Army is implementing, shall occur on an annual basis, or every five years as specified below, or if a change in the land use or groundwater contamination distribution in the aquifer occurs.

5.1 Monitoring and Maintenance of Plan

The following Monitoring and Maintenance activities will occur annually to ensure the performance objectives of the LUCs are met:

- Intuitional Controls
  - The Area of LUCs is actively monitored in accordance with the SHL Long Term Monitoring & Maintenance Plan (LTMMP) and any required changes to the area of LUCs will be made to the plan and **Figure 3**; and
  - Monitor and report on the implementation and enforcement of the ICs by the Town of Ayer and MA DEP, including the restriction of groundwater extraction and use within the NIA; record any instances where the groundwater use was identified and corrective actions taken.
- Affirmative Measures
  - Reminder mailings of the pamphlet (**Appendix C**) with supplemental educational materials and contact information will be distributed annually;
  - A list of all property owners and resident addresses within the Area of LUCs will be generated for implementation of the LUCIP actions noted;
  - Distribution of the LUCIP to appropriate parties; and
  - The Army will meet with the BOH annually, or if a change in the groundwater contamination distribution in the aquifer occurs.

The following Monitoring and Maintenance activities will occur every five (5) years:

- Intuitional Controls
  - In accordance with CERCLA, Section 121(c), a five-year review will be conducted to assure that human health and the environment are being protected by the remedy and to document maintenance of the LUCs.
- Affirmative Measures
  - With information from the Department of Public Works, the Army will verify that all residents within the area of LUCs are connected to town water: and
  - Following the initial door to door survey of land owners and residents, a survey will be conducted every five (5) years, or sooner if required by changes to the LUCIP. The purpose of the survey is to confirm that all properties are connected to municipal water, to ensure that no undocumented private/irrigation wells are present, and to document a property ownership list to certify that both owners and renters are informed of the LUCs. The Army will provide a pamphlet (**Appendix C**) with supplemental educational materials and contact information, which will be handed out during each survey.

Any corrective actions noted, will be reported in accordance with Section 5.2 below. If for any reason the Town of Ayer is unable to enforce or maintain the LUCs that fall under their jurisdiction, the Army will ensure that the LUCs are enforced and maintained, to protect public health. The implementation and maintenance of Affirmative Measures are the responsibility of the Army. A summary of the implementation schedule is included as **Appendix D**.

5.2 LUCs Reporting

Institutional Controls

An annual LUC compliance review, utilizing the Annual Checklist presented in Appendix E, will be documented in the SHL annual report and will be provided by the Army to the USEPA, MassDEP, MassDevelopment, and the Town of Ayer, Massachusetts. The annual review will include a summary of the items reviewed from the checklist, identification of deviations from this LUCIP, corrective actions necessary due to implementation issues or as a result of changes in site conditions or land use, and proposed changes to the plan and reporting frequency. If any deficiency(ies), including any violations of the ICs, should be found during the annual review, a written explanation will be prepared indicating the deficiency and what efforts or measures have or will be undertaken to correct the deficiency. The correction and enforcement of such deficiencies shall follow the requirements under **Section 8.0 Enforcement**. If there is to be a delegation of performance of duties by the Army, the Army will promptly notify USEPA, MassDEP, MassDevelopment, and the Town of Ayer, Massachusetts.

Affirmative Measures

The annual review will include items identified on the attached Annual Review Checklist in **Appendix E**. This checklist will be followed as a guideline to review required tasks and any updates that may be necessary due to changing circumstances over that year. The annual report will also address whether the use restrictions and controls referenced in this LUCIP were communicated appropriately via public outreach and education, whether the owners and state and local agencies were notified of the restrictions and controls affecting SHL and the NIA, and whether use of the area has conformed to such restrictions and controls.

The annual reports will also be placed in the central Army document repository at Fort Devens and the public library for the Town of Ayer, Massachusetts. Property owners and resident addresses within the Area of LUCs will receive notification of the availability of the annual reports, to be included with the annual reminder mailings and supplemental educational materials.

6.0 LUCS AND AFFIRMATIVE MEASURES RESPONSIBILITIES

The Army is responsible for ensuring that LUCs are established and maintained through monitoring and reporting on the implementation, maintenance, and enforcement of land use controls, and coordination with federal, state, and local governments and owners and occupants of properties subject to land use controls.

The Army will provide notice of the groundwater contamination and any land use restrictions referenced in the ESD. The Army will send these notices to the federal, state and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and land use controls. The Army remains responsible for ensuring that the remedy remains protective of human health and the environment. The Army will fulfill its responsibility and obligations under CERCLA and the National Contingency Plan (NCP) as it implements, maintains, and reviews the selected remedy.

The Army is responsible for the implementation of the Affirmative Measures presented in Section 4.0. The Army will complete the public education and outreach to the affected citizens of Ayer, and coordinate with appropriate town officials of Ayer to ensure the effective implementation of the ICs.

7.0 LUC MODIFICATIONS AND TERMINATION

The LUCs reflected in this LUCIP are expected to remain in place until the concentrations of contaminants of concern in the groundwater are at such levels as to allow unrestricted use and exposure. If groundwater conditions change, land use objectives change, or remedial goals are met, the Army shall propose modifications through an ESD or a ROD amendment. The Army will decide whether to modify or discontinue a LUC with the review and approval of USEPA and MassDEP. If LUCs are no longer needed, as determined in an ESD or a ROD amendment, the owners of Areas of LUCs, including the Town of Ayer, Massachusetts, will be notified and LUCs will be discontinued.

8.0 ENFORCEMENT

If the Army determines that LUCs are not being complied with, its actions may range from informal resolutions with the owner/renter or violator, to the institution of judicial action. Any activity that is inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs will be addressed by the Army as soon as practicable, but in no case will the process be initiated later than ten (10) days after the Army becomes aware of the breach. The Army will notify USEPA and MassDEP as soon as practicable but no longer than ten (10) days after discovery of any activity that is inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs. The Army will notify USEPA and MassDEP regarding how the Army has or will address the breach within ten (10) days of sending USEPA and MassDEP notification of the breach. Should the Army become aware that a user of the Areas of LUCs or Impact Area has violated any LUC requirement where a local agency may have independent jurisdiction (local regulations and permits), the Army will also notify the agencies of such violations and work cooperatively with them to re-establish owner/user compliance with the LUC.

9.0 APPROVALS AND NOTICES

9.1 Approvals

Changes to the LUCIP can only be approved through the process set forth in **Section 7.0**. Where the approval of a party (hereafter, the “approval party”) is required under this LUCIP for non-substantive changes that may be made without amending of this LUCIP as provided herein, the Army (or its designee) shall give the approval party notice thereof, along with any information to be included in such notice pursuant to the terms of this LUCIP. If the approval party fails to respond to the request for approval within thirty (30) days after said request is made, the Army (or its designee) will send the approval party a second request. If the approval party fails to respond to such second request within ten (10) days after said second request is made, the approval party will be deemed to have approved such request.

9.2 Notices

All notices, responses, requests, approvals and other communications required or permitted under this LUCIP between or among MassDevelopment, USEPA, MassDEP, the Town of Ayer, Massachusetts, and/or the Army shall be in writing and shall be sent by postage pre-paid certified or registered mail (return receipt requested) or by recognized overnight courier (such as DHL, Federal Express, UPS), with delivery charges prepaid, to the following respective address:

If to the Army:

Department of the Army, Fort Devens, BRAC Division, 30 Quebec Street, Room 100, Devens, MA 01432-4479, Attn: BRAC Environmental Coordinator

If to USEPA:

U.S. Environmental Protection Agency, Region I, 5 Post Office Square, Federal Facilities Superfund Section, Suite 100 (HBT), Mail Code OSRR07-3, Boston, MA 02019, Attn: Remedial Project Manager

If to MassDEP:

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, One Winter Street, Boston, MA 02108, Attn: Superfund Federal Facilities, Section Chief

If to the Town of Ayer, Massachusetts:

- Board of Health, Town of Ayer, 1 Main Street, Ayer, MA 01432, Attn: Chairperson
- Department of Public Works, Town of Ayer, 25 Brook Street, Ayer, MA 01432, Attn: Superintendant
- Building Department, Town of Ayer, Town of Ayer, 1 Main Street, Ayer, MA 01432, Attn: Building Commissioner

A party may change its address for notice by notice to the other parties in accordance with this Section.

10.0 REFERENCES

AMEC 2011. *Draft Final Remedial Investigation for AOC 72*. Prepared for USACE-NAE. March.

Sovereign, 2013a. *Final Removal Action Completion Report for Shepley's Hill Landfill Barrier Wall, Former Fort Devens Army Installation, Devens, Massachusetts*. Prepared for USACE-NAE. July.

Sovereign, 2013b. *Explanation of Significant Differences*, *Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts*. . December.

Sovereign, 2013c. Draft *Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-term Monitoring and Maintenance*. Prepared for USACE-NAE. December.

Sovereign, 2011. Final *Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-term Monitoring and Maintenance - Addendum Report*. Prepared for USACE-NAE. August.

USAEC, 1995. *Record of Decision, Shepley's Hill Landfill Operable Unit, Fort Devens, Massachusetts*. Signed by USEPA Region I on September 26, 1995.

FIGURES

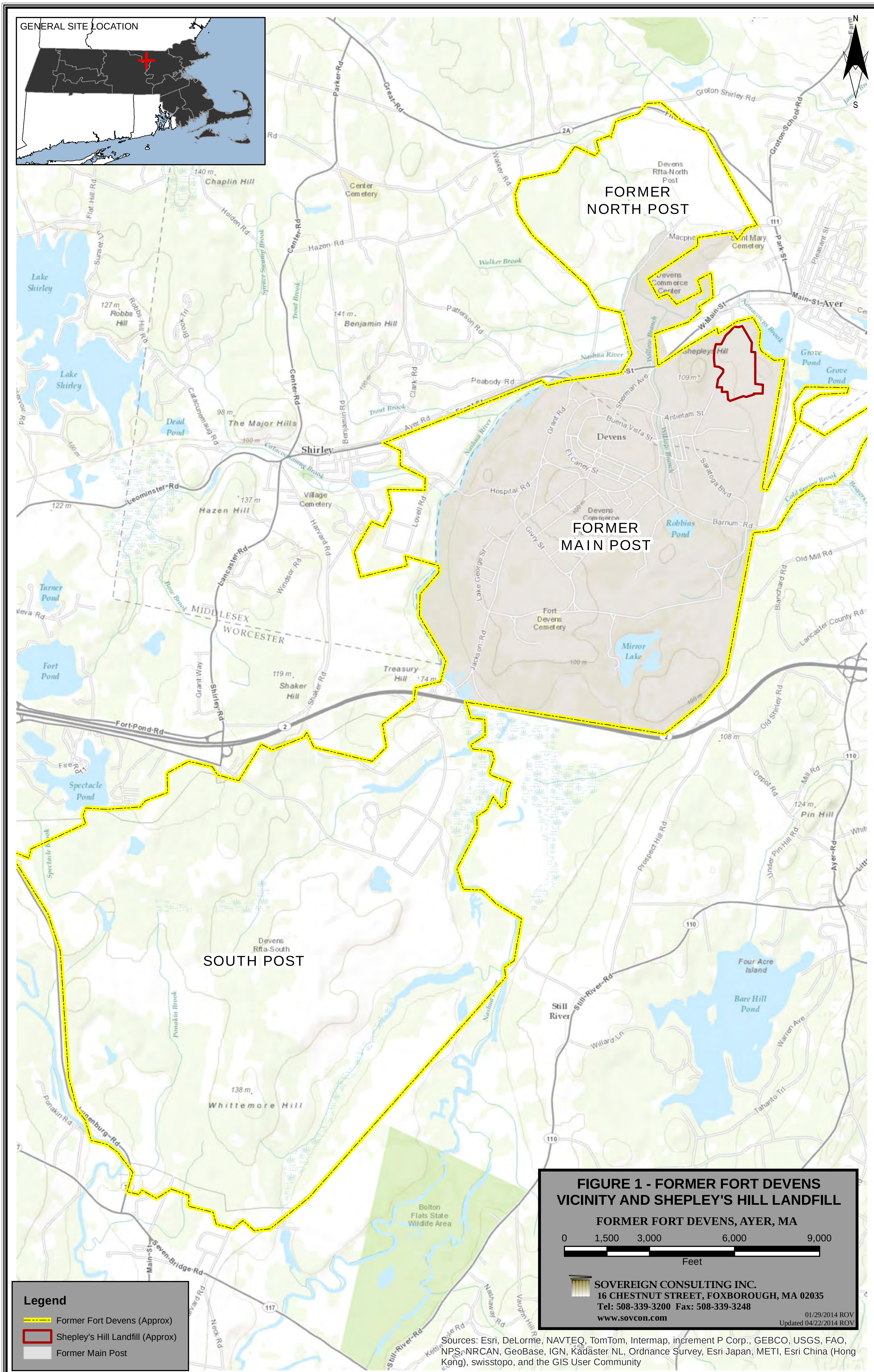

FIGURE 1 - FORMER FORT DEVENS VICINITY AND SHEPLEY'S HILL LANDFILL

FORMER FORT DEVENS, AYER, MA

SOVEREIGN CONSULTING INC.
16 CHESTNUT STREET, FOXBOROUGH, MA 02035
Tel: 508-339-3200 Fax: 508-339-3248
www.sovcon.com

01/29/2014 ROV
Updated 04/22/2014 ROV

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

FIGURE 2 - SHEPLEY'S HILL LANDFILL OVERALL SITE PLAN WITH NORTH IMPACTED AREA

FORMER FORT DEVENS, AYER, MA

SOVEREIGN CONSULTING INC.
16 CHESTNUT STREET, FOXBOROUGH, MA 02035
Tel: 508-339-3200 Fax: 508-339-3248
www.sovcon.com

01/29/2014 ROV
Updated 02/19/2014 ROV

FIGURE 3 - AREA OF LAND USE CONTROLS

FORMER FORT DEVENS, AYER, MA

SOVEREIGN CONSULTING INC.
16 CHESTNUT STREET, FOXBOROUGH, MA 02035
Tel: 508-339-3200 Fax: 508-339-3248
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01/29/2014 ROV
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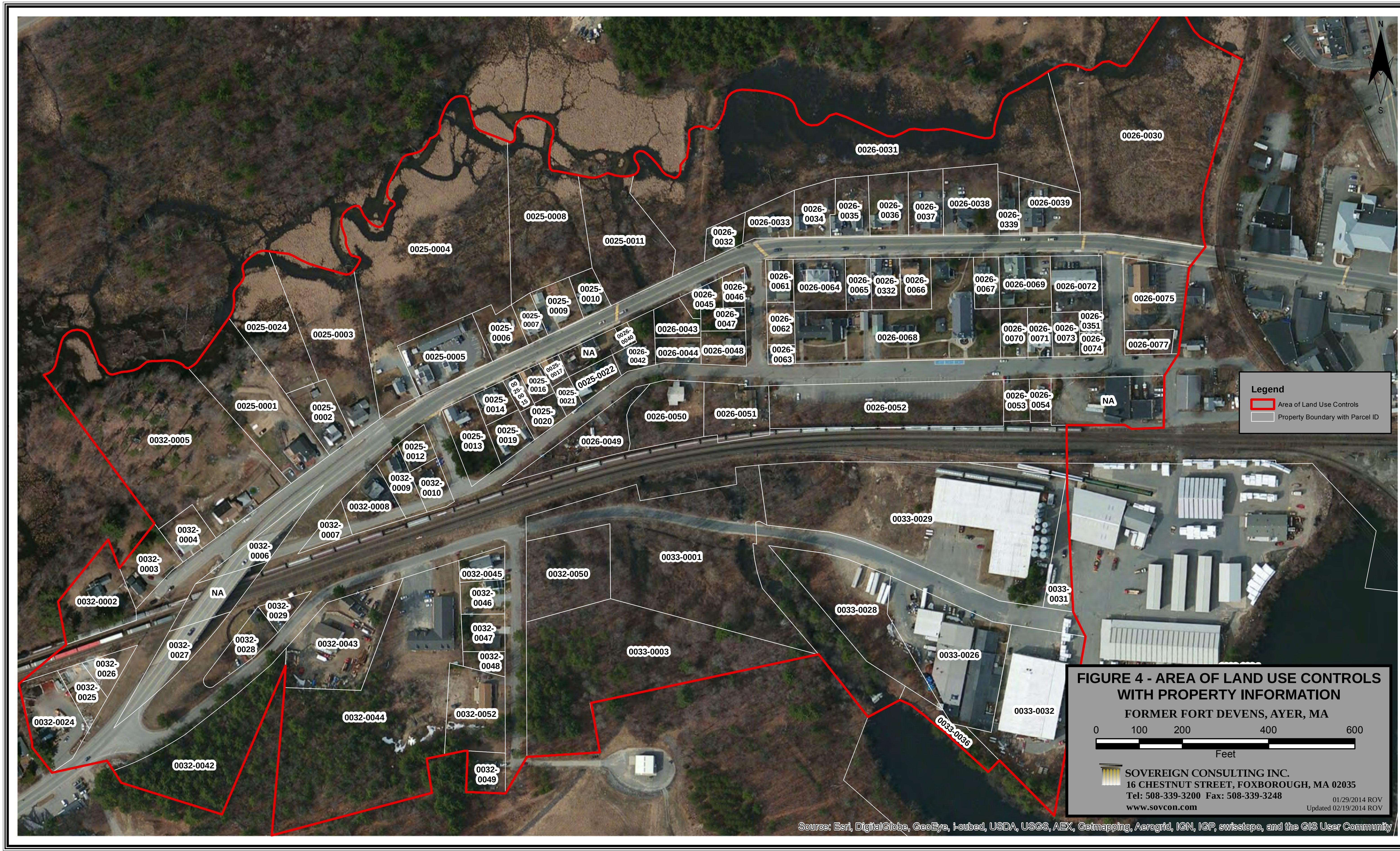


Data Source: 2013. MassGIS Data - Level 3 Assessors' Parcel Mapping for the Town of Ayer. Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Appendix C

Mass Flux Estimate

Table 1. Arsenic Flux in the Overburden Across East to West Section from SHL-23 to SHL-21

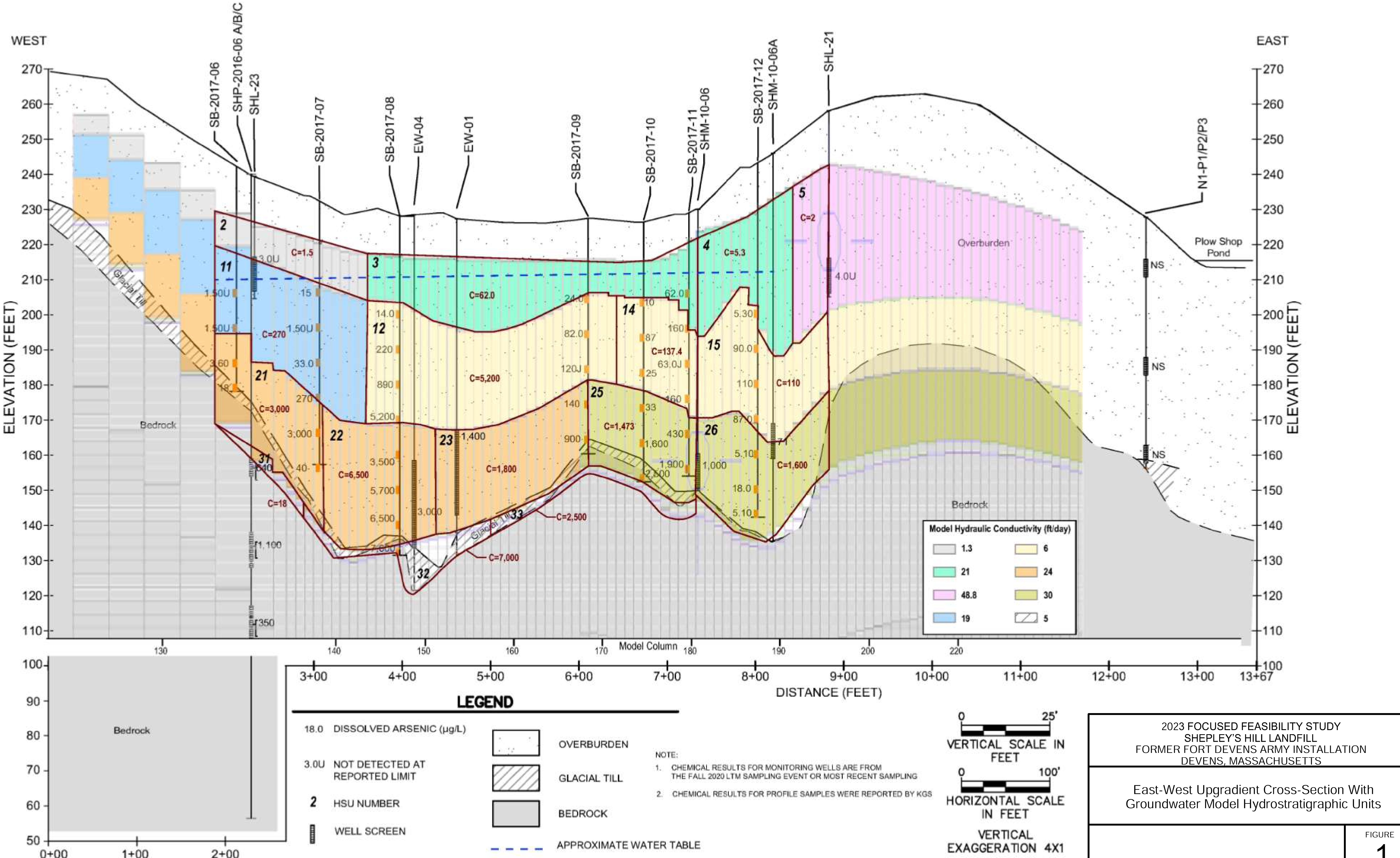
HSU Number	Model Hydraulic Conductivity (ft/d)	Geometric Mean Arsenic Conc. (µg/L)	Mean Arsenic Conc. (µg/L)	Sensitivity (95% UCL) Arsenic Conc. (µg/L)	Darcy Flux Under Pumping Conditions (gpm)	Darcy Flux Under Ambient Conditions (gpm)	Mass Flux Under Pumping Conditions			Mass Flux Under Ambient (Non-Pumping) Conditions		
							Based on Geometric Mean (lb/yr)	Based on Mean (lb/yr)	Based on 95% UCL (lb/yr)	Based on Geometric Mean (lb/yr)	Based on Mean (lb/yr)	Based on 95% UCL (lb/yr)
2[5]	1.3	1.5	1.5	1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	21	62	62	62	0.80	0.69	0.22	0.22	0.22	0.19	0.19	0.19
4	21	5.3	5.3	5.3	0.37	0.33	0.01	0.01	0.01	0.01	0.01	0.01
5	48.8	2	2	2	0.28	0.25	0.00	0.00	0.00	0.00	0.00	0.00
11	19	51	106	270	3.15	2.73	0.71	1.46	3.73	0.61	1.27	3.24
12	6	165	936	5,200	2.98	2.57	2.16	12.2	68.0	1.86	10.6	58.7
14	6	57	84.2	137	0.55	0.51	0.14	0.20	0.33	0.13	0.19	0.31
15	6	50	72.7	110	0.73	0.70	0.16	0.23	0.35	0.15	0.22	0.34
21	24	163	1,135	3,000	3.98	3.51	2.85	19.8	52.5	2.51	17.5	46.2
22	24	4,441	4,675	6,500	9.14	7.38	178	188	261	144	151	211
23	24	561	813	1,400	9.66	7.76	23.8	34.5	59.4	19.1	27.7	47.7
25	30	419	834	1,473	3.54	3.28	6.51	13.0	22.9	6.04	12.0	21.2
26	30	32	220	1,000	3.76	3.59	0.53	3.64	16.5	0.51	3.48	15.8
31	5	18	18	18	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00
32	5	7,000	7,000	7,000	0.17	0.14	5.22	5.22	5.22	4.21	4.21	4.21
33	5	2,500	2,500	2,500	0.14	0.12	1.51	1.51	1.51	1.34	1.34	1.34
Total Across East-West Cross Section					*39.3*	*33.6*	*222*	*280*	*491*	*181*	*230*	*410*
Total Across Area Where Arsenic in Groundwater Exceeding the CL May Not be Captured at All Times					*5.1*	*4.9*	*0.7*	*3.9*	*16.9*	*0.7*	*3.7*	*16.1*
Total Across Hypothetical Area Where Arsenic in Groundwater Exceeding the CL May Not be Captured at All Times as a % of Total Across East-West Cross Section					**13.1%**	**14.5%**	**0.3%**	**1.4%**	**3.4%**	**0.4%**	**1.6%**	**3.9%**
Total Across East-West Cross Section as a % of Total ATP Pumping Rate or Mass Removal					**78%**	--	**48%**	**60%**	**85%**	--	--	--
Total Flow Rate Across East-West Cross Section Less the Total Across Hypothetical Area Where Arsenic in Groundwater Exceeding the CL May Not be Captured at All Times as a % of Total ATP Pumping Rate					**68%**	--	--	--	--	--	--	--

ATP Data

ATP Extraction Well	Average 2016-2020 Pumping Rate (gpm)	Average 2016-2020 Dissolved Arsenic Conc. (µg/L)	Average 2016-2020 Arsenic Removed (lb/yr)	Maximum 2016-2020 Dissolved Arsenic Conc. (µg/L)	Maximum 2016-2020 Arsenic Removed (lb/yr)
EW-01	32.5	1,610	229.9	1,900	271.4
EW-04	17.5	3,066	235.8	4,000	307.6
Total	**50.1**	--	**466**	--	**579**

Notes:

1. The East-West Cross Section spans from monitoring well SHL-23 to SHL-21.
2. The hypothetical bypass area spans from monitoring well SHM-10-06 to SHL-21.
3. The hydrostratigraphic units (HSUs) were assigned to row 76 in the calibrated model.
4. Darcy flux is calculated in model Stress Period 18 which simulates long term average conditions.
5. Arsenic concentrations assigned to each hydrostratigraphic unit were calculated using dissolved arsenic concentrations in groundwater samples collected from profile borings in 2017 and the most recent time (Fall 2020) for monitoring wells. The HSU5 arsenic concentration for SHL-21 is from the most recent sample collected on 21 October 2015.
6. Pumping flux represents darcy flux with the Arsenic Treatment Plant (ATP) wells EW-01 and EW-04 operating at an average extraction rate of 50.1 gpm for 2016-2020. The same extraction rates are used to evaluate the ATP arsenic output.
7. Non-pumping flux represents groundwater flux calculated with extraction wells EW-01 and EW-04 not pumping.
8. Gray shaded cells include data for HSUs in the hypothetical bypass area between wells SHM-10-06 and SHL-21, which include HSUs 4, 5, 15, and 26.



2023 FOCUSED FEASIBILITY STUDY
SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

East-West Upgradient Cross-Section With Groundwater Model Hydrostratigraphic Units

FIGURE 1

Appendix D

Trend Analyses

Table D-1
Summary Statistics and Trend Results for Arsenic Concentrations
Focused Feasibility Study Report, Appendix C Trend Analyses
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Well ID	Date Range	Figure	FOD	Detected Results Summary[1]					Mann-Kendall Test[2,3]			Sen's Estimator of Slope[2,4,5]						Note
				Range	Mean	Median	SD	Most Recent Result	Result[6]	P Value	S Value	Result[6]	Slope (µg/L per Day)	95% CI (µg/L per Day)	Intercept[7]	Linear Predicted Compliance Date[7,8]	Exponential Predicted Compliance Date[7,9]	
EPA-PZ-2012-1A	10/14 - 10/20	--	0 / 12	--	--	--	--	<3	--	--	--	--	--	--	--	--	--	All ND and BSL
EPA-PZ-2012-1B	10/14 - 10/20	D-1	12 / 12	3.6 - 290	170	170	86.1	3.6	DEC	0.042	-26	NST	-0.0737	-0.131 to 0.00695	--	--	--	BSL 10/2020
EPA-PZ-2012-2A	10/14 - 11/20	--	2 / 12	1.6 - 1.9	1.8	1.8	0.212	<3	--	--	--	--	--	--	--	--	--	All BSL
EPA-PZ-2012-2B	10/14 - 11/20	--	1 / 12	3.3 - 3.3	3.3	3.3	--	<3	--	--	--	--	--	--	--	--	--	All BSL
EPA-PZ-2012-3A	10/14 - 11/20	D-2	12 / 12	12 - 23	16.1	15.5	3.5	12.0	NST	0.167	-15	NST	-0.00189	-0.00561 to 0.00264	--	--	--	
EPA-PZ-2012-3B	10/14 - 11/20	D-3	12 / 12	2700 - 4100	3,340	3,300	476	2,700	DEC	0.004	-40	DEC	-0.55	-0.95 to -0.217	12954	6/20/2034	1/23/2116	
EPA-PZ-2012-4A	10/14 - 10/20	D-4	12 / 12	2.5 - 210	20.9	3.5	59.6	210	NST	0.340	-7	NST	-0.000239	-0.00175 to 0.00187	--	--	--	
EPA-PZ-2012-4B	10/14 - 10/20	D-5	12 / 12	1800 - 3500	2,290	2,150	476	2,000	DEC	0.003	-41	DEC	-0.437	-0.805 to -0.216	9817	6/28/2031	11/2/2093	
EPA-PZ-2012-5A	10/14 - 11/20	D-6	5 / 12	1.5 - 3	1.9	1.5	0.666	<3	NST	0.156	14	--	--	--	--	--	--	All BSL
EPA-PZ-2012-5B	10/14 - 11/20	D-7	9 / 12	1.6 - 14	4.9	2.7	4.6	2.5	NST	0.364	6	NST	0.000206	-0.0017 to 0.004	--	--	--	BSL 05/2020
EPA-PZ-2012-6A	10/14 - 11/20	--	2 / 11	1.6 - 1.6	1.6	1.6	0	<3	--	--	--	--	--	--	--	--	--	All BSL
EPA-PZ-2012-6B	10/14 - 11/20	D-8	12 / 12	96 - 520	345	360	109	300	DEC	0.006	-37	DEC	-0.0909	-0.152 to -0.029	1956	8/13/2028	1/9/2059	
EPA-PZ-2012-7A	10/14 - 11/20	--	2 / 12	1.8 - 2.3	2.1	2.1	0.354	<3	--	--	--	--	--	--	--	--	--	All BSL
EPA-PZ-2012-7B	10/14 - 11/20	D-9	12 / 12	1000 - 1500	1,270	1,300	167	1,300	NST	0.175	14	NST	0.0544	-0.0904 to 0.278	--	--	--	
EW-01	03/14 - 10/20	D-10	19 / 19	1400 - 2100	1,790	1,800	184	1,400	DEC	<0.001	-88	DEC	-0.175	-0.27 to -0.0618	4781	9/18/2044	2/21/2169	
EW-04	03/14 - 10/20	D-11	19 / 19	2900 - 4000	3,320	3,300	280	3,000	NST	0.285	-17	NST	0	-0.233 to 0.145	--	--	--	
N5-P1	10/14 - 10/20	D-12	10 / 10	35 - 4700	2,150	1,950	1,790	520	NST	0.242	9	NST	0.699	-1.57 to 3.95	--	--	--	
SHL-5	04/14 - 11/20	D-13	6 / 8	2.8 - 13	7.0	4.9	4.7	4.6	NST	0.452	2	NST	0.000411	-0.00653 to 0.00279	--	--	--	BSL 11/2016
SHL-8D	04/14 - 11/20	--	0 / 8	--	--	--	--	<3	--	--	--	--	--	--	--	--	--	All ND and BSL
SHL-8S	04/14 - 11/20	--	0 / 8	--	--	--	--	<3	--	--	--	--	--	--	--	--	--	All ND and BSL
SHL-9	04/14 - 11/20	D-14	8 / 8	19 - 38	28.6	28.5	6.5	35.0	NST	0.089	12	NST	0.00545	-0.00342 to 0.0111	--	--	--	
SHL-22	04/14 - 11/20	D-15	8 / 8	2.4 - 49	17.4	7.8	18.7	2.4	DEC	<0.001	-24	DEC	-0.0151	-0.0325 to -0.0037	269	12/21/2016	9/20/2016	BSL 11/2016
SHL-23	06/15 - 11/20	--	0 / 10	--	--	--	--	<3	--	--	--	--	--	--	--	--	--	All ND and BSL
SHM-05-40X	10/14 - 11/20	D-16	12 / 12	25 - 3100	2,100	2,150	743	2,100	NST	0.072	-22	NST	-0.334	-0.607 to 0.0723	--	--	--	
SHM-05-41A	04/14 - 11/20	D-17	8 / 8	9.7 - 31	17.6	17.0	6.2	18.0	INC	0.024	17	INC	0.00365	0.000125 to 0.0105	--	--	--	
SHM-05-41B	04/14 - 11/20	D-18	14 / 14	330 - 730	566	615	122	570	DEC	0.007	-46	DEC	-0.0955	-0.179 to -0.0202	2277	1/3/2035	1/5/2088	
SHM-05-41C	04/14 - 11/20	D-19	13 / 13	29 - 1500	702	800	379	610	DEC	<0.001	-58	DEC	-0.216	-0.577 to -0.125	4544	6/9/2027	5/13/2062	
SHM-05-42A	04/14 - 11/20	--	0 / 8	--	--	--	--	<3	--	--	--	--	--	--	--	--	--	All ND and BSL
SHM-05-42B	04/14 - 11/20	D-20	8 / 8	160 - 230	186	175	29.2	160	DEC	0.005	-21	DEC	-0.0284	-0.0529 to -0.0106	666	4/22/2033	5/6/2067	
SHM-07-03	06/15 - 11/20	D-21	2 / 10	3.1 - 3.2	3.2	3.2	0.0707	<3	NST	0.242	-9	--	--	--	--	--	--	All BSL
SHM-07-05_X	06/16 - 11/20	D-22	9 / 9	11 - 950	337	100.0	375	83.0	NST	0.381	4	NST	0.0341	-1.03 to 0.75	--	--	--	
SHM-10-02	06/15 - 11/20	D-23	1 / 5	3.2 - 3.2	3.2	3.2	--	<3	NST	0.242	-4	--	--	--	--	--	--	All BSL
SHM-10-03	06/15 - 11/20	D-24	3 / 5	1.9 - 8.5	4.9	4.2	3.4	1.9	NST	0.500	1	--	--	--	--	--	--	All BSL
SHM-10-04	06/15 - 11/20	--	0 / 5	--	--	--	--	<3	--	--	--	--	--	--	--	--	--	All ND and BSL
SHM-10-05A	06/15 - 11/20	D-25	4 / 5	2 - 3	2.3	2.1	0.486	2.0	NST	0.180	-5	--	--	--	--	--	--	All BSL
SHM-10-06	10/14 - 10/20	D-26	7 / 7	1000 - 2200	1,560	1,600	420	1,000	DEC	0.005	-17	DEC	-0.468	-0.826 to -0.264	9782	3/7/2027	2/10/2063	
SHM-10-06A	10/14 - 11/20	D-27	6 / 7	63 - 96	74.0	72.5	12.0	71.0	NST	0.191	-7	NST	-0.00551	-0.0215 to 0.0416	--	--	--	
SHM-10-07	10/14 - 11/20	D-28	7 / 7	750 - 1000	916	930	89.6	1,000	NST	0.052	12	NST	0.0535	-0.0256 to 0.211	--	--	--	
SHM-10-08	06/15 - 11/20	D-29	2 / 5	2 - 3.6	2.8	2.8	1.1	<3	NST	0.180	-5	--	--	--	--	--	--	All BSL
SHM-10-10	10/14 - 11/20	D-30	3 / 7	2.6 - 3.5	3.0	2.9	0.458	<3	NST	0.119	-9	--	--	--	--	--	--	All BSL
SHM-10-11	10/15 - 11/20	D-31	6 / 6	430 - 620	528	530	63.4	430	NST	0.360	3	NST	0.0373	-0.232 to 0.132	--	--	--	
SHM-10-12	10/14 - 11/20	D-32	7 / 7	2900 - 3500	3,240	3,300	244	3,400	NST	0.236	6	NST	0.136	-0.118 to 0.443	--	--	--	
SHM-10-13	10/14 - 10/20	D-33	7 / 7	4.5 - 570	425	460	192	430	NST	0.443	-2	NST	-0.0184	-0.19 to 0.324	--	--	--	

Table D-1
Summary Statistics and Trend Results for Arsenic Concentrations
Focused Feasibility Study Report, Appendix C Trend Analyses
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Well ID	Date Range	Figure	FOD	Detected Results Summary[1]					Mann-Kendall Test[2,3]			Sen's Estimator of Slope[2,4,5]						Note
				Range	Mean	Median	SD	Most Recent Result	Result[6]	P Value	S Value	Result[6]	Slope (µg/L per Day)	95% CI (µg/L per Day)	Intercept[7]	Linear Predicted Compliance Date[7,8]	Exponential Predicted Compliance Date[7,9]	
SHM-10-14	10/14 - 11/20	D-34	7 / 7	2300 - 5400	4,490	4,900	1,100	5,000	NST	0.563	0	NST	0	-1.23 to 1.5	--	--	--	
SHM-10-15	10/14 - 11/20	D-35	7 / 7	5100 - 6800	5,870	5,800	571	6,800	NST	0.281	5	NST	0.367	-1.03 to 1.21	--	--	--	
SHM-10-16	10/15 - 11/20	D-36	9 / 9	1100 - 1900	1,420	1,200	346	1,100	DEC	0.005	-25	DEC	-0.415	-0.674 to -0.082	8457	9/23/2025	1/3/2062	
SHM-13-01	10/15 - 11/20	D-37	4 / 5	1.5 - 2.1	1.8	1.7	0.3	<3	NST	0.180	-5	--	--	--	--	--	--	All BSL
SHM-13-02	10/14 - 11/20	D-38	3 / 7	1.8 - 2.6	2.3	2.6	0.462	<3	DEC	0.025	-14	--	--	--	--	--	--	All BSL
SHM-13-03	04/14 - 10/20	D-39	14 / 14	26 - 150	78.5	72.5	38.2	83.0	NST	0.435	-4	NST	-0.0055	-0.0371 to 0.0401	--	--	--	
SHM-13-04	04/14 - 11/20	D-40	14 / 14	21 - 690	305	235	211	260	NST	0.331	9	NST	0.057	-0.183 to 0.217	--	--	--	
SHM-13-05	10/14 - 11/20	D-41	7 / 7	6.4 - 16	11.0	11.0	3.0	6.4	NST	0.500	-1	NST	0	-0.0046 to 0.0044	--	--	--	BSL 10/2020
SHM-13-06	04/14 - 11/20	D-42	15 / 15	1900 - 3100	2,530	2,500	313	2,200	NST	0.460	-3	NST	0	-0.288 to 0.28	--	--	--	
SHM-13-07	04/14 - 11/20	D-43	14 / 14	140 - 1300	575	480	317	420	NST	0.056	-30	NST	-0.174	-0.39 to 0.102	--	--	--	
SHM-13-08	04/14 - 11/20	D-44	14 / 14	310 - 1000	840	885	186	1,000	DEC	0.039	-33	NST	-0.109	-0.188 to 0.00938	--	--	--	
SHM-13-14D	02/14 - 10/20	D-45	6 / 7	6.1 - 12	9.3	9.4	2.1	<3	NST	0.500	-1	NST	-0.000638	-0.0065 to 0.00276	--	--	--	BSL and ND 10/2020
SHM-13-14S	02/14 - 10/20	D-46	3 / 7	1.5 - 4	2.5	1.9	1.3	1.5	NST	0.281	5	--	--	--	--	--	--	All BSL
SHM-13-15	02/14 - 10/20	D-47	8 / 8	1.6 - 36	9.1	5.6	11.0	7.1	NST	0.274	-6	NST	-0.00106	-0.0144 to 0.00138	--	--	--	BSL 2/2014
SHM-93-22B	04/14 - 11/20	D-48	14 / 14	83 - 1100	472	365	309	300	DEC	<0.001	-64	DEC	-0.369	-0.509 to -0.198	6776	4/7/2020	10/13/2029	
SHM-93-22C	04/14 - 11/20	D-49	9 / 9	3.8 - 140	39.9	4.5	53.5	4.4	NST	0.209	-9	NST	-0.0153	-0.081 to 0.000922	--	--	--	BSL 11/2017
SHM-96-5B	04/14 - 11/20	D-50	14 / 14	41 - 1300	901	990	383	720	DEC	0.034	-34	NST	-0.18	-0.505 to 0	--	--	--	
SHM-96-5C	04/14 - 11/20	D-51	8 / 8	11 - 42	27.2	30.0	11.9	29.0	NST	0.548	0	NST	-0.000854	-0.0145 to 0.0301	--	--	--	
SHM-99-31C	10/14 - 10/20	D-52	8 / 8	140 - 200	174	180	24.5	140	NST	0.114	-11	NST	-0.0198	-0.0554 to 0.0164	--	--	--	
SHM-99-32X	10/14 - 10/20	D-53	8 / 8	6.3 - 94	49.8	57.0	29.5	26.0	DEC	0.016	-18	DEC	-0.0303	-0.0578 to -0.00394	592	8/22/2022	7/18/2026	
SHP-2016-1A	05/17 - 11/20	--	0 / 8	--	--	--	--	<3	--	--	--	--	--	--	--	--	--	All ND and BSL
SHP-2016-1B	05/17 - 11/20	D-54	8 / 8	110 - 180	138	130	24.9	140	NST	0.548	0	NST	0	-0.0648 to 0.0605	--	--	--	
SHP-2016-2A	05/17 - 11/20	D-55	8 / 8	8.5 - 58	25.4	16.5	19.5	8.5	DEC	<0.001	-28	DEC	-0.0391	-0.0674 to -0.0133	717	7/16/2019	11/29/2019	BSL 05/2020
SHP-2016-2B	05/17 - 11/20	D-56	8 / 8	260 - 560	442	440	103	520	NST	0.274	6	NST	0.0954	-0.3 to 0.236	--	--	--	
SHP-2016-3A	05/17 - 11/20	D-57	7 / 7	3.1 - 7	4.6	4.5	1.4	5.3	NST	0.281	-5	NST	-0.00115	-0.00479 to 0.00241	--	--	--	All BSL
SHP-2016-3B	05/17 - 11/20	D-58	7 / 7	160 - 270	223	240	38.6	180	DEC	0.025	-14	NST	-0.0732	-0.116 to 0	--	--	--	
SHP-2016-4A	05/17 - 11/20	D-59	5 / 8	1.5 - 1700	344	4.6	758	1,700	NST	0.114	-11	NST	-0.00447	-0.0098 to 1.49	--	--	--	
SHP-2016-4B	05/17 - 11/20	D-60	7 / 8	650 - 1800	1,310	1,400	359	<3	NST	0.237	-7	NST	-0.814	-1.92 to 0.445	--	--	--	BSL and ND 10/2020
SHP-2016-5A	05/17 - 11/20	D-61	8 / 8	2.2 - 3.9	3.0	2.9	0.663	3.9	INC	0.012	19	INC	0.00126	0.000394 to 0.00189	--	--	--	All BSL
SHP-2016-5B	05/17 - 11/20	D-62	8 / 8	470 - 730	624	620	93.3	730	NST	0.500	1	NST	0.0135	-0.244 to 0.278	--	--	--	
SHP-2016-06A	06/17 - 11/20	D-63	8 / 8	280 - 2800	868	620	800	640	NST	0.199	8	NST	0.221	-0.678 to 1.02	--	--	--	
SHP-2016-06B	06/17 - 11/20	D-64	8 / 8	830 - 1300	1,180	1,250	166	1,100	NST	0.237	-7	NST	-0.0707	-0.273 to 0.228	--	--	--	
SHP-2016-06C	11/17 - 11/20	D-65	7 / 7	210 - 350	281	280	44.9	350	NST	0.068	11	NST	0.099	-0.06 to 0.202	--	--	--	
SHP-2016-07A	11/17 - 05/20	D-66	5 / 5	12 - 200	77.8	74.0	75.5	74.0	NST	0.408	2	--	--	--	--	--	--	
SHP-2016-07B	11/17 - 11/20	D-67	7 / 7	11 - 200	85.4	65.0	66.6	65.0	NST	0.386	-3	NST	-0.0587	-0.292 to 0.116	--	--	--	
SHP-99-29X	10/14 - 11/20	D-68	7 / 7	1200 - 3900	2,560	2,300	1,050	2,300	NST	0.191	-7	NST	-0.797	-2.34 to 1.17	--	--	--	

Table D-1
Summary Statistics and Trend Results for Arsenic Concentrations
Focused Feasibility Study Report, Appendix C Trend Analyses
Shepley's Hill Landfill
Former Fort Devens Army Installation, Devens, Massachusetts

Notes:

Highlight — Result is greater than the screening level (10 µg/L).

[1] All analytical results are in µg/L.

[2] Trend results are presented when the following conditions are met:
- Mann-Kendall: at least four samples are available and the FOD is greater than or equal to 20%.
- Sen's Estimator of Slope: at least six samples are available and the FOD is greater than 50%.

[3] Non-detects were assigned a common value less than the minimum detected value, equal to half the minimum RL in the dataset (USEPA 2009). If half the minimum RL was greater than the minimum detected value, then half the minimum detect was assigned.

[4] The Sen's slope null hypothesis is no significant trend is present (slope = 0) and the alternative hypothesis is a significant trend is present (slope ≠ 0).

[5] Sen's slope is considered significant if: a) the slope is negative and each number in the 95% CI is not zero and negative, or b) the slope is positive and each number in the 95% CI is not zero and positive.

[6] Statistically significant trend defined as having p-value less than or equal to 0.05, or 95% confidence.

[7] Predicted compliance dates are presented when a decreasing trend is identified using Sen's Estimator of Slope.

[8] The predicated compliance date is calculated using the following equation:

$$Compliance\ Date = \frac{Screening\ Level\ - Intercept}{Slope} + Excel\ Origin\ Date\ (January\ 1, 1970)$$

[9] The exponential predicated compliance date is calculated using the following equation:

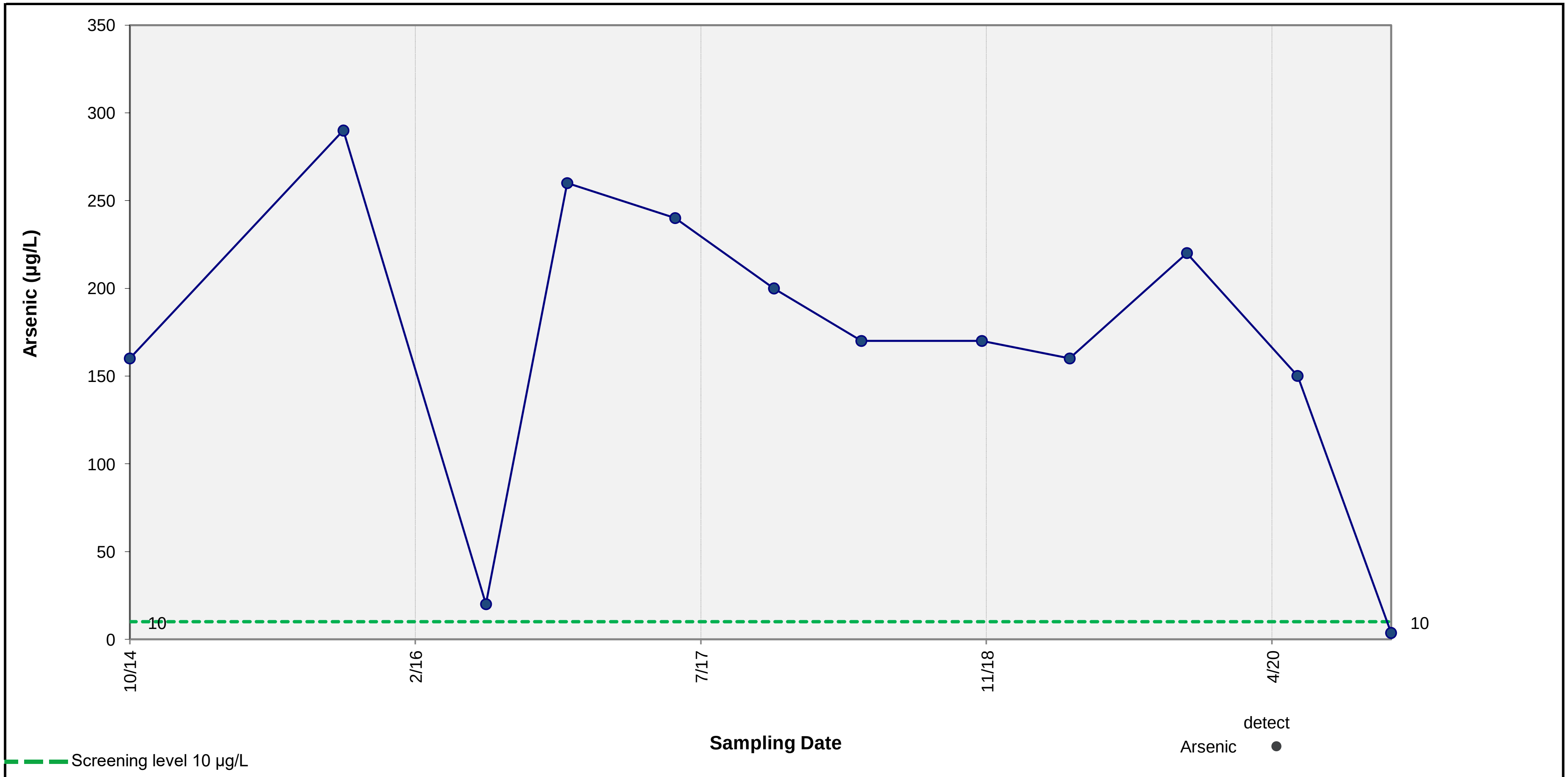
$$Compliance\ Date = \frac{Natural\ Log(Screening\ Level) - Natural\ Log(Intercept)}{Natural\ Log(Slope)} + Excel\ Origin\ Date\ (January\ 1, 1970)$$

Acronyms and Abbreviations:

-- = insufficient data for calculating statistics (n < 4) or not available
< = less than
µg/L = microgram per liter
BSL = below screening level
CI = confidence interval
DEC = decreasing trend
FOD = frequency of detection (# detects / # samples)
INC = increasing trend
mean = arithmetic mean
ND = non-detect
NST = no significant trend
NT = no trend
p value = how likely you are to have found a particular set of observations if the null hypothesis were true
RL = reporting limit
s value = sum of the differences between sequential sampling events
SD = standard deviation
USEPA = United States Environmental Protection Agency

Reference:

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Unified Guidance. EPA/530/R-09/007, 2009.



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.042 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

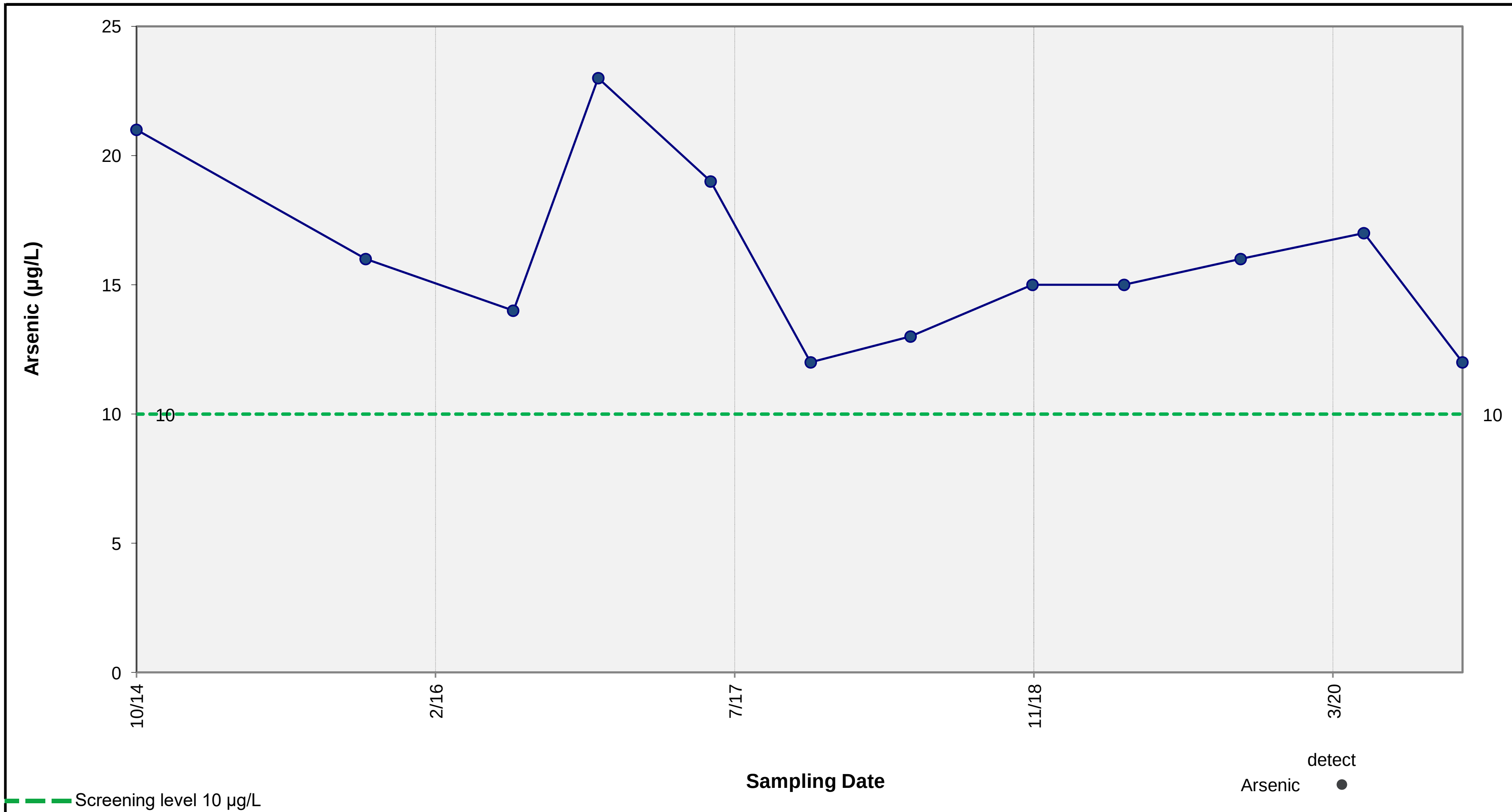
Median Slope Estimate = -7.4E-02 µg/L Per Day

95% Confidence Interval = -1.3E-01 to 1.5E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-1B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-1



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.167 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

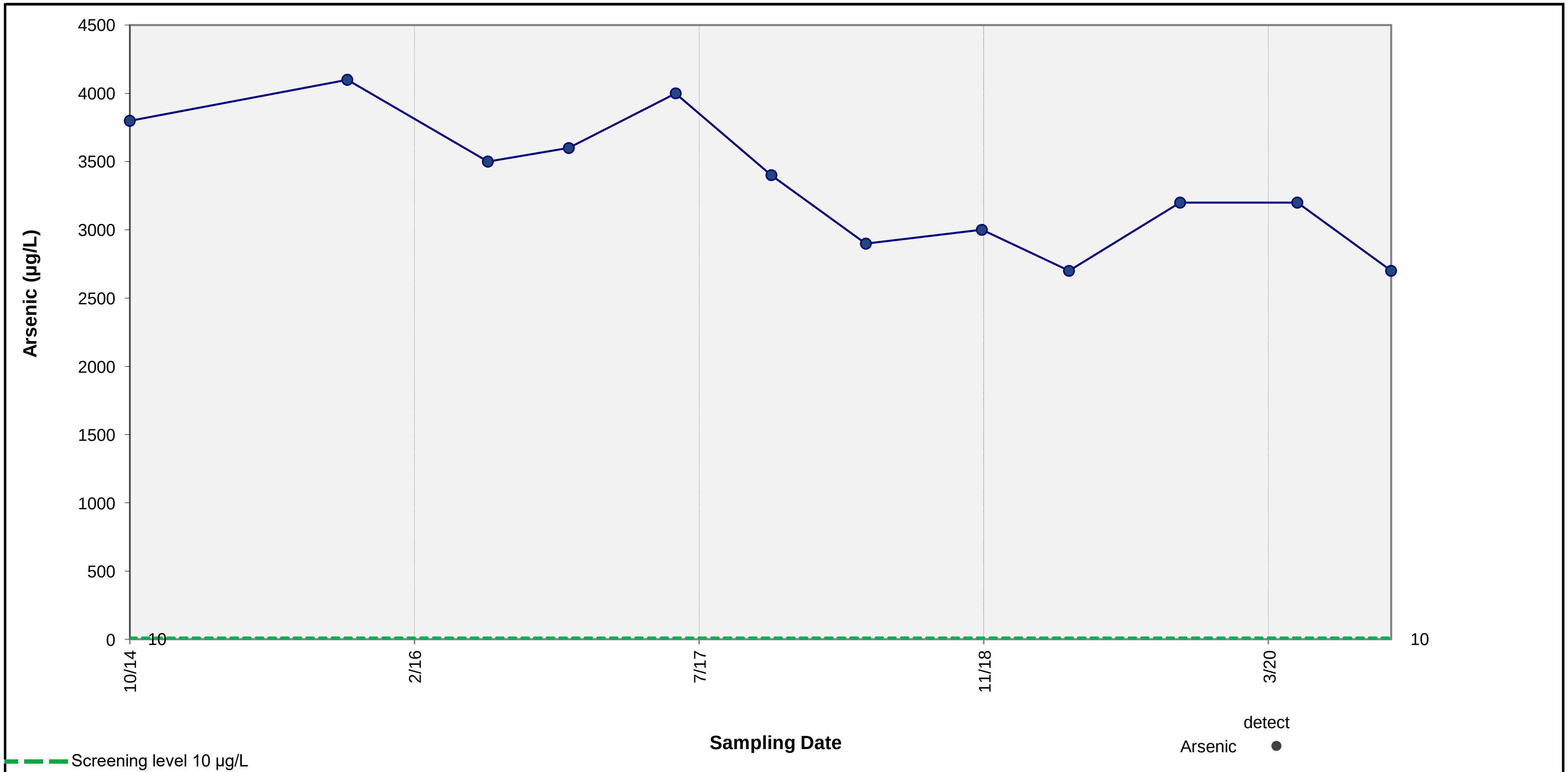
Median Slope Estimate = -1.9E-03 µg/L Per Day

95% Confidence Interval = -5.6E-03 to 2.2E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-3A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-2



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.004 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

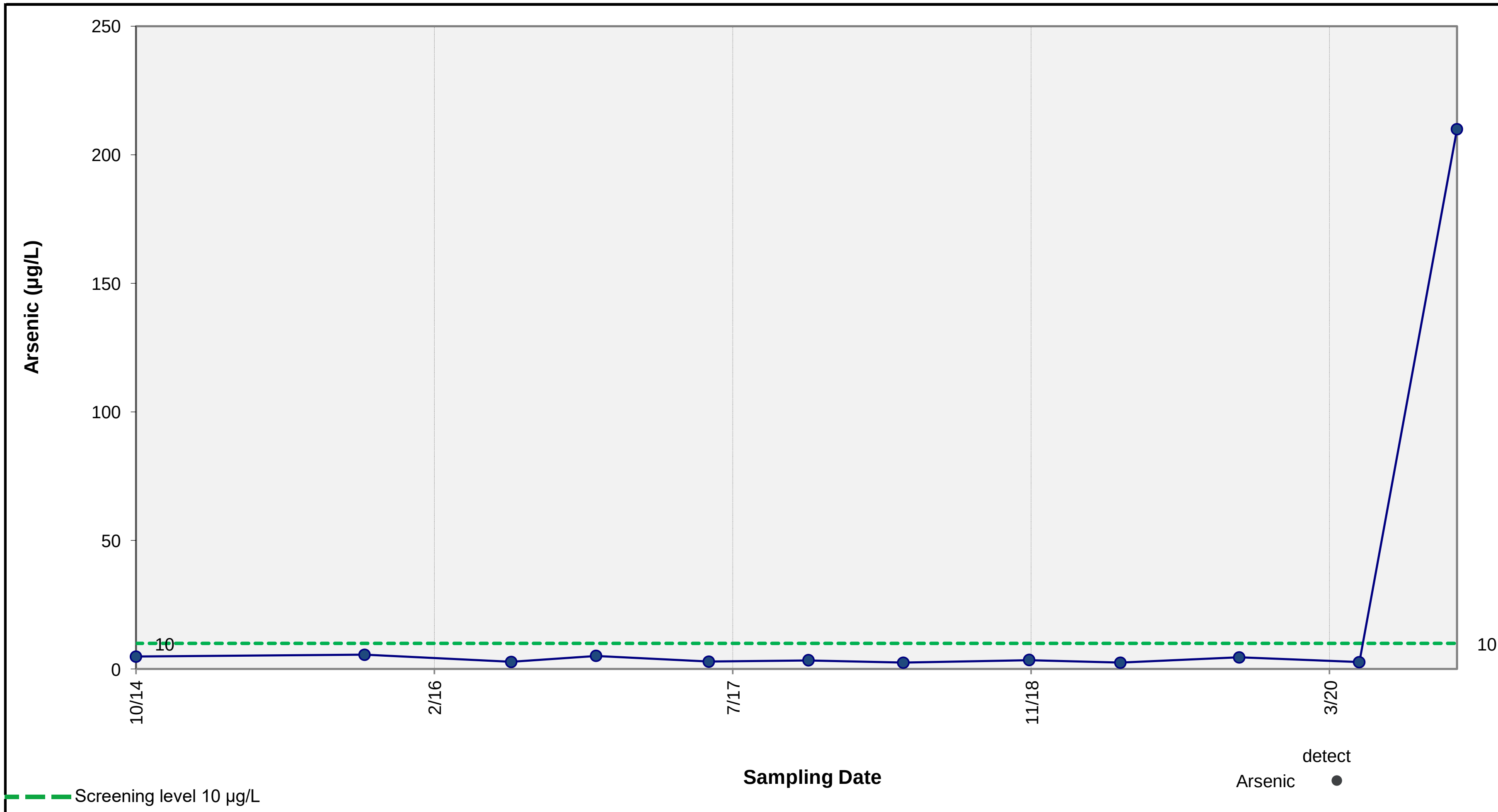
Median Slope Estimate = -5.5E-01 µg/L Per Day

95% Confidence Interval = -9.5E-01 to -2.4E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-3B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-3



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.340 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

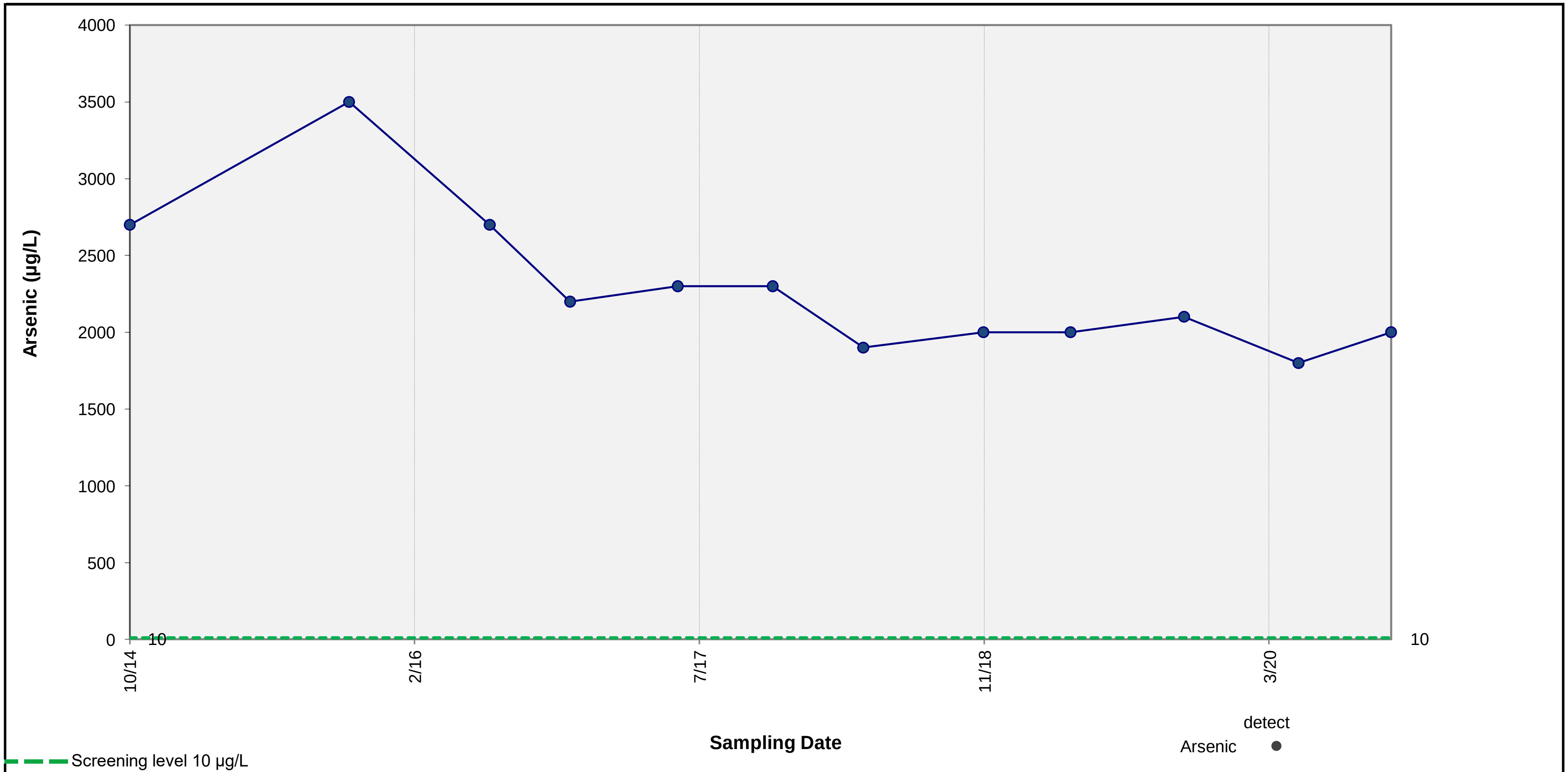
Median Slope Estimate = -2.4E-04 µg/L Per Day

95% Confidence Interval = -1.8E-03 to 1.6E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-4A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-4



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.003 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

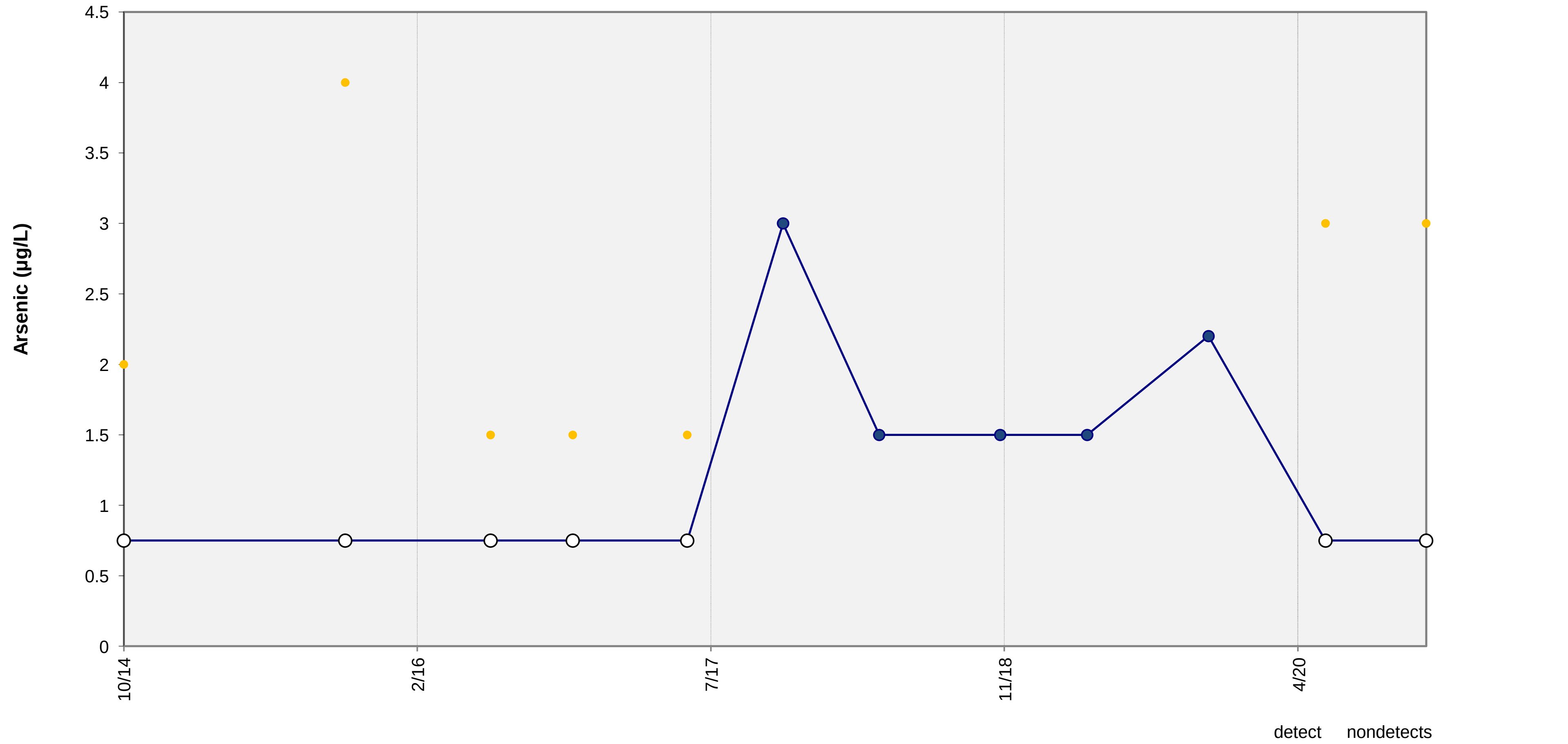
Median Slope Estimate = -4.4E-01 µg/L Per Day

95% Confidence Interval = -8.1E-01 to -2.3E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-4B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-5



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.156 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Frequency of Detection < 50%)**

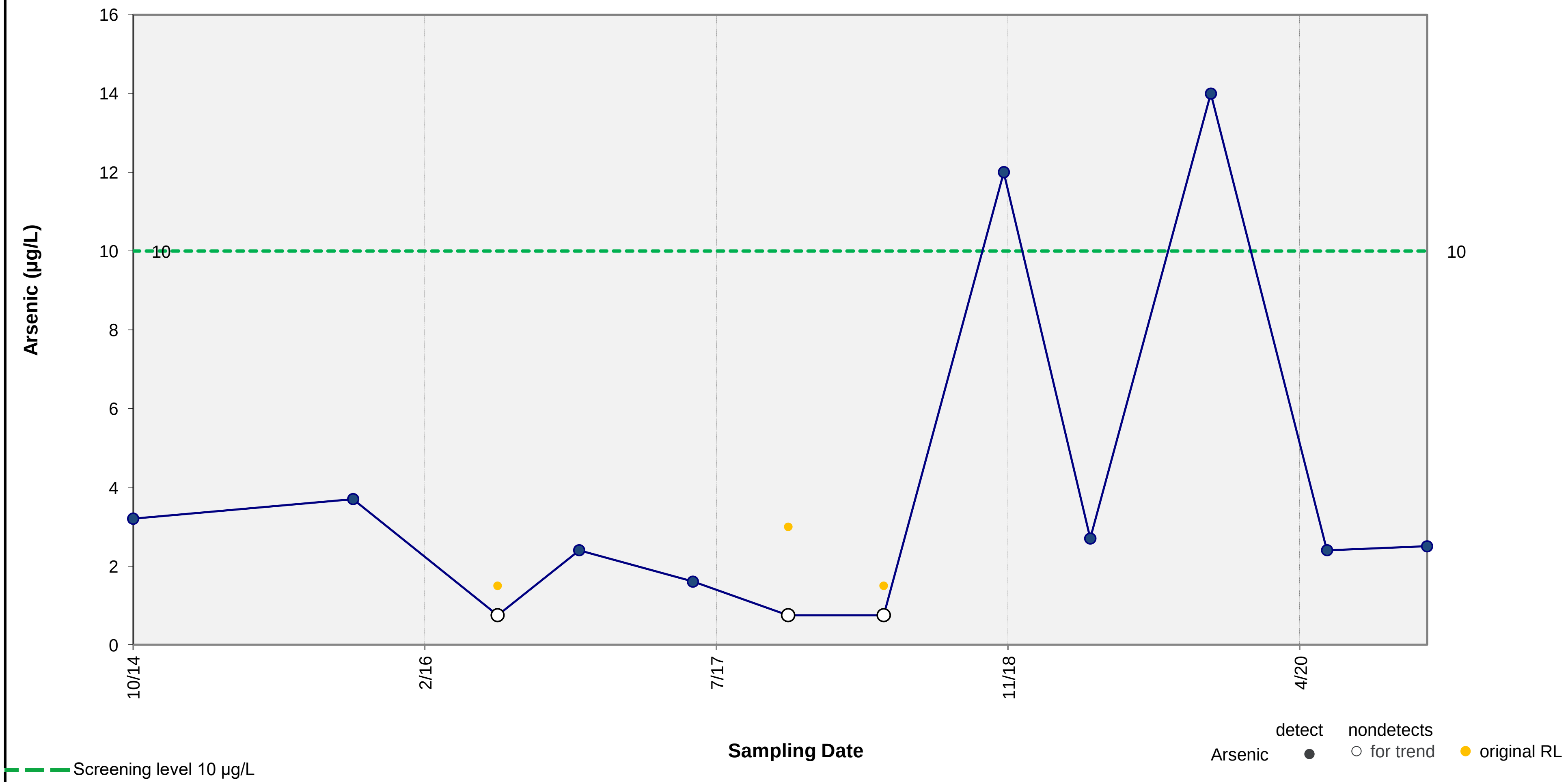
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-5A

Shepleys Hill Landfill, Devens, Massachusetts

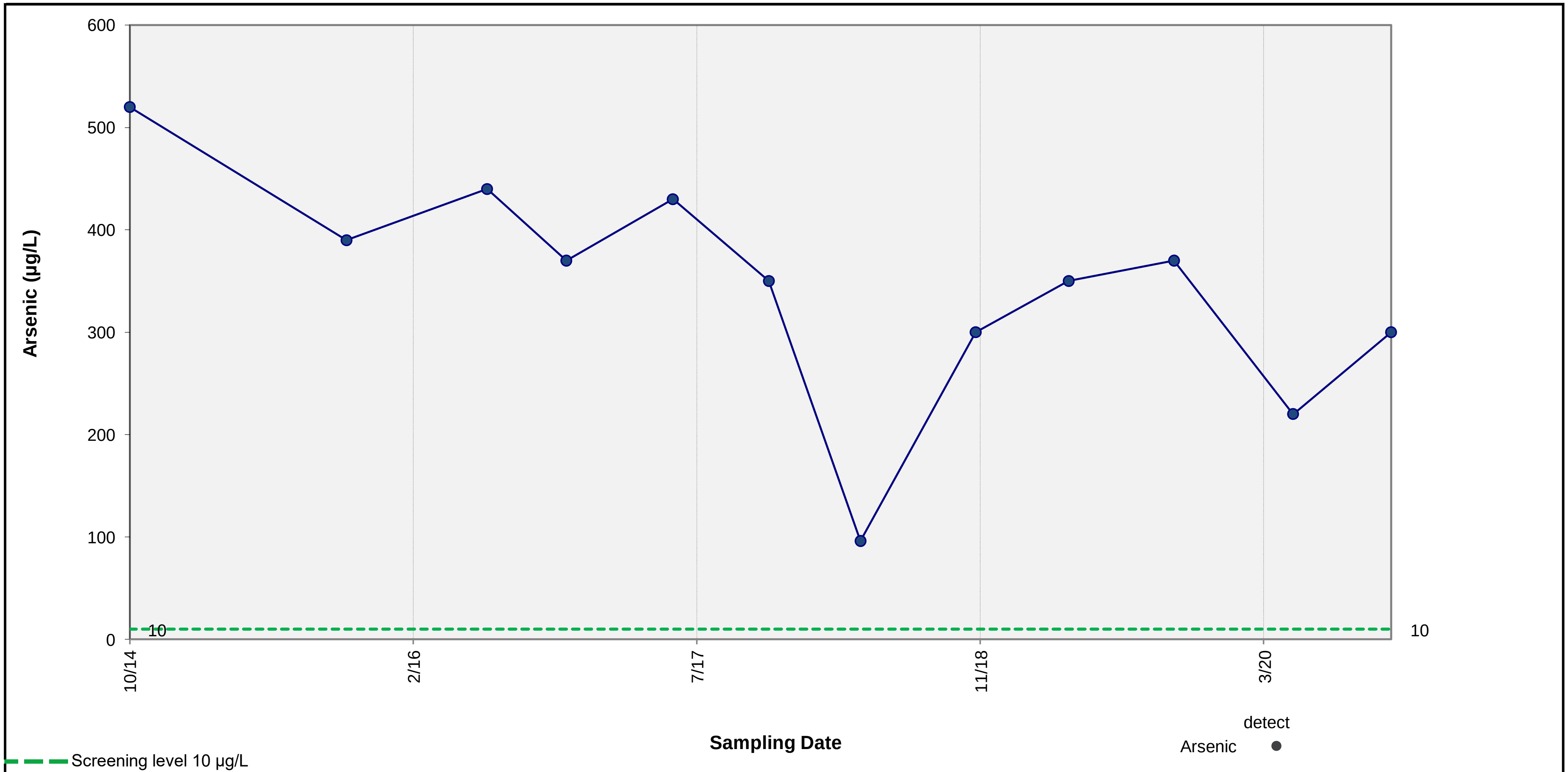
FIGURE D-6



Results of Mann-Kendall Test for Trend:	**No Significant Trend**				
	p value =	0.364	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).		
Results of Sen's Estimator of Slope:	**No Significant Trend**				
	Median Slope Estimate =	2.1E-04	µg/L Per Day		
	95% Confidence Interval =	-1.7E-03	to	2.7E-03	µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-5B
Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-7



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.006 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

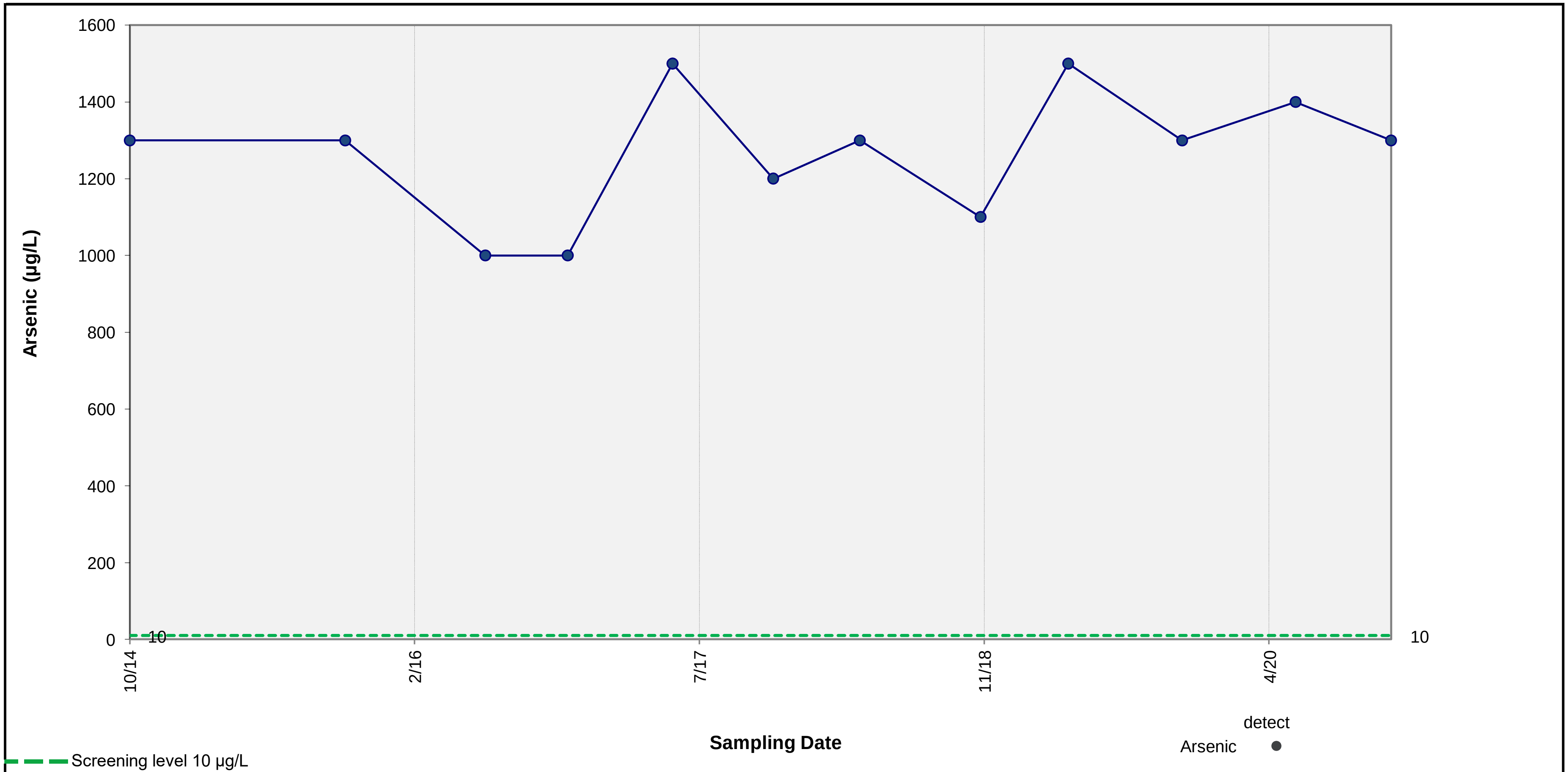
Median Slope Estimate = -9.1E-02 µg/L Per Day

95% Confidence Interval = -1.5E-01 to -3.1E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-6B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-8



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.175 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

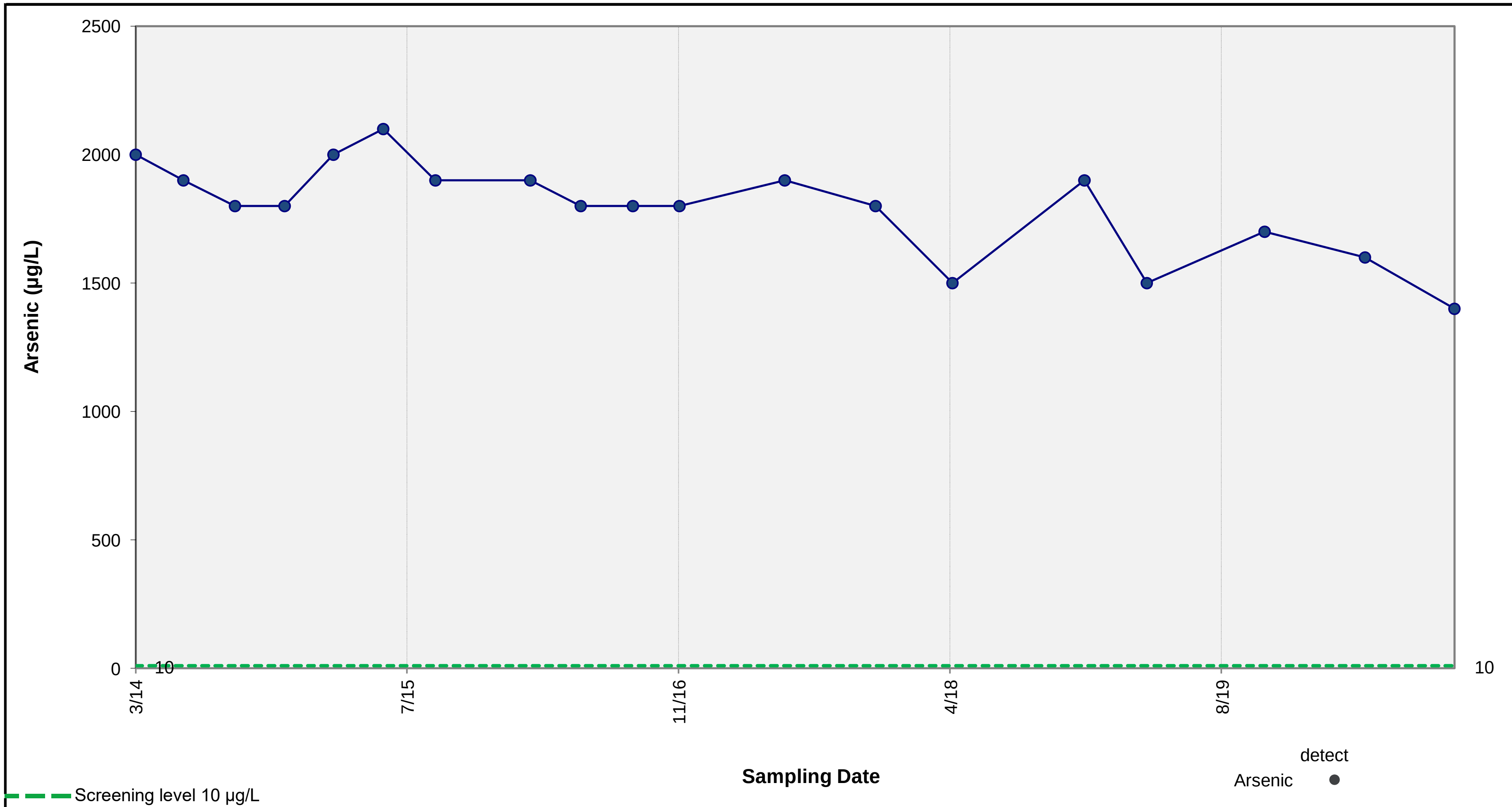
Median Slope Estimate = 5.4E-02 µg/L Per Day

95% Confidence Interval = -9.0E-02 to 2.7E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EPA-PZ-2012-7B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-9



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = <0.001 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

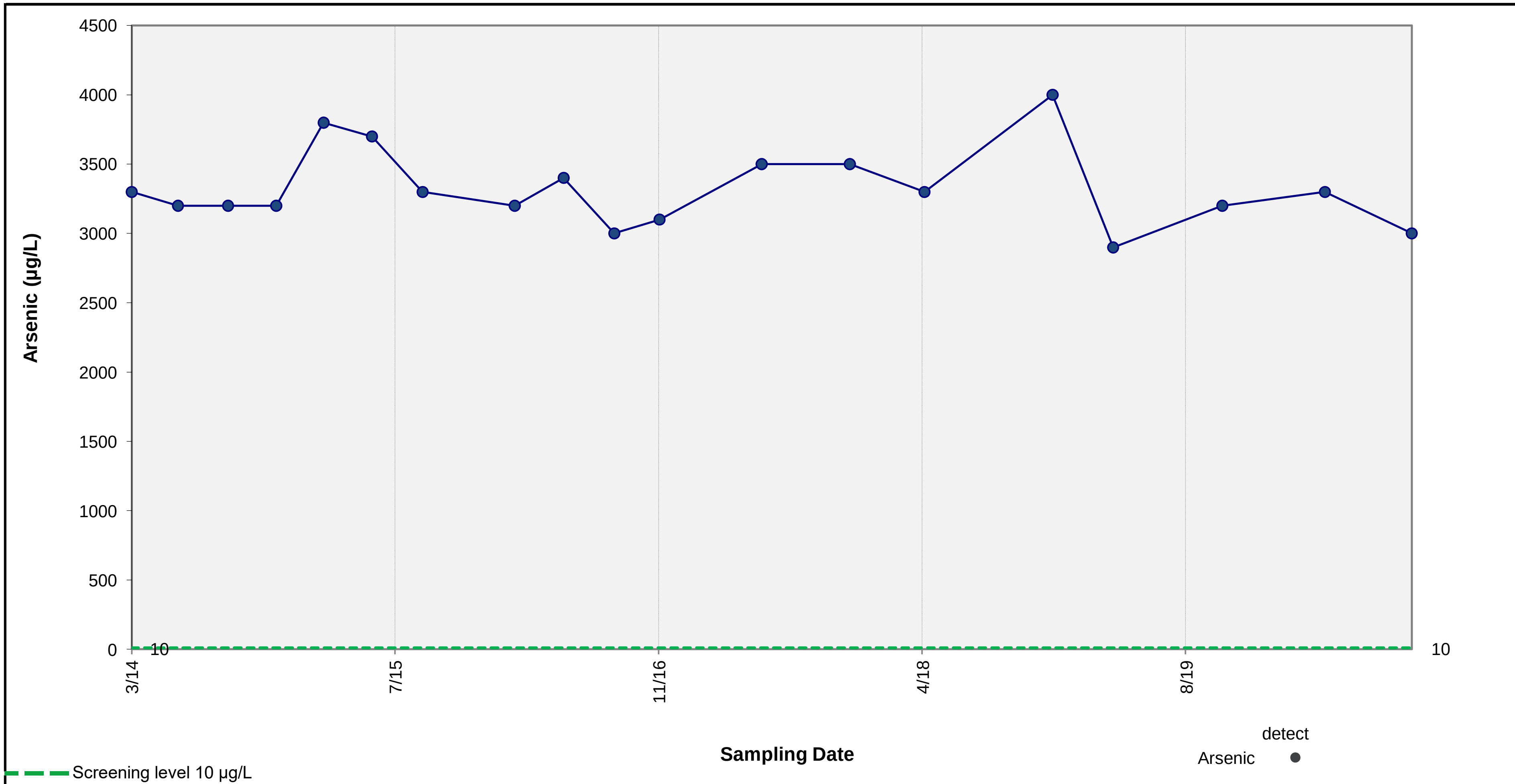
Median Slope Estimate = -1.7E-01 µg/L Per Day

95% Confidence Interval = -2.7E-01 to -7.4E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EW-01

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-10



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.285 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

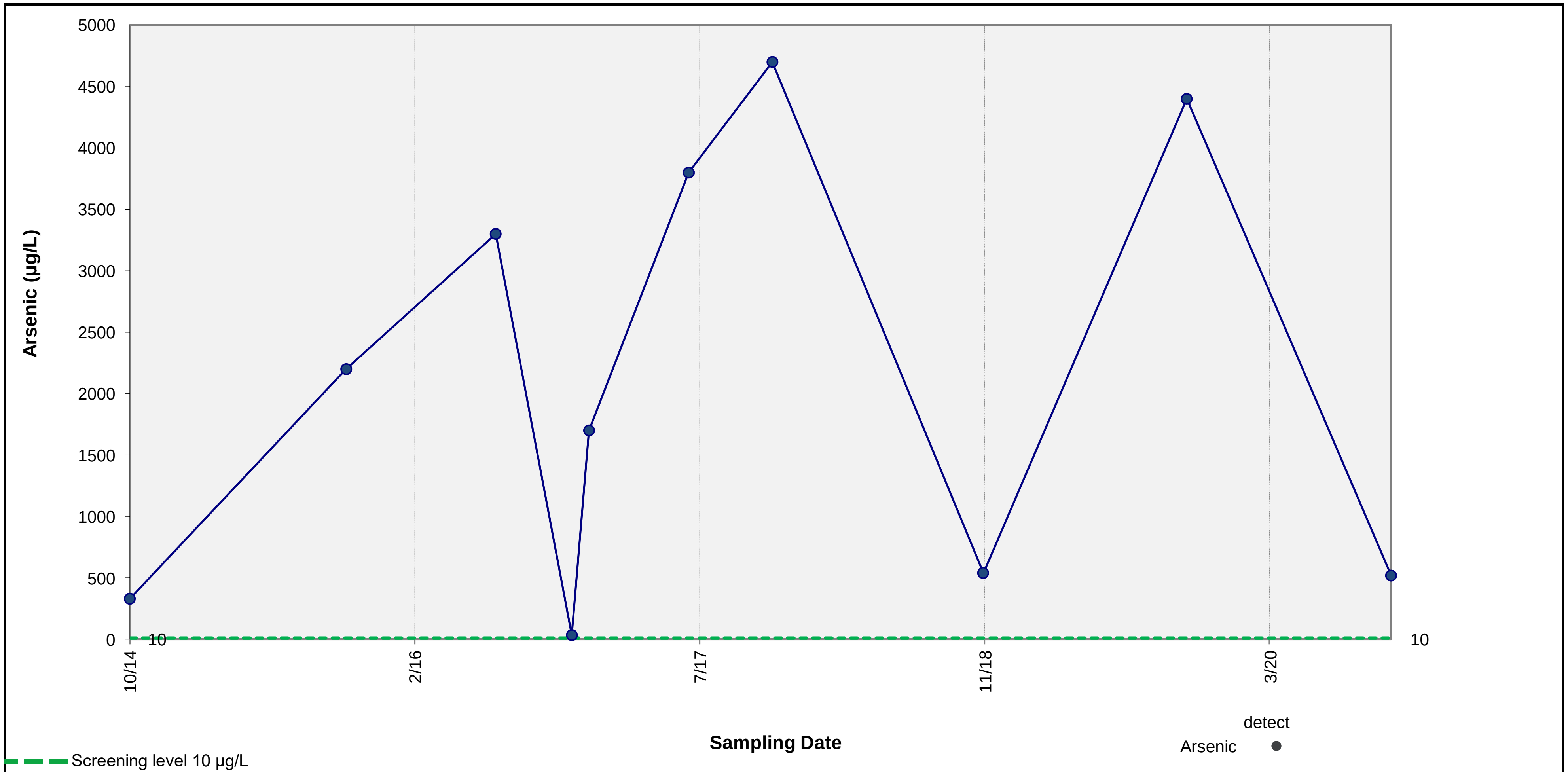
Median Slope Estimate = 0.0E+00 µg/L Per Day

95% Confidence Interval = -2.3E-01 to 1.3E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well EW-04

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-11



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.242 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

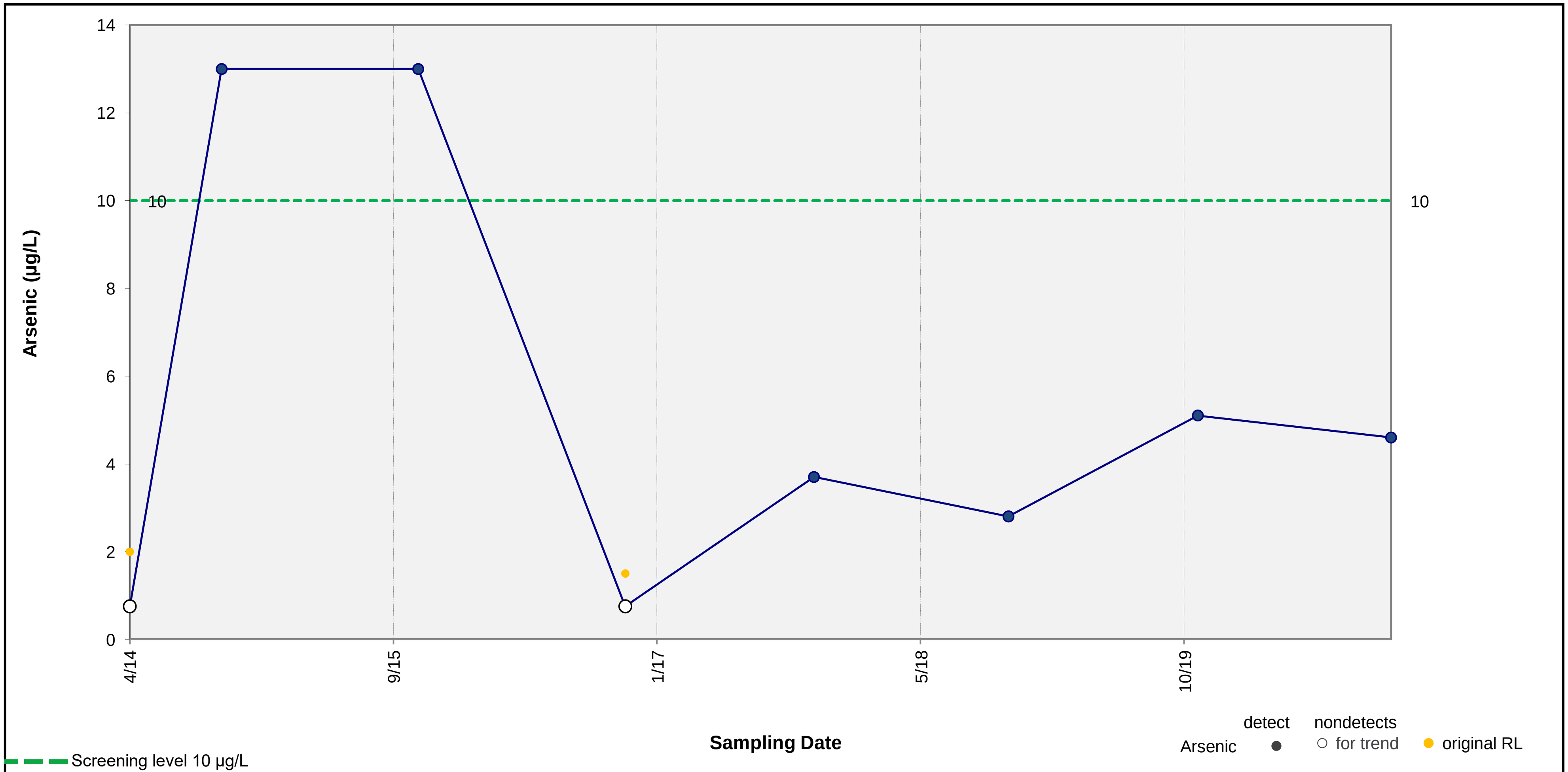
Median Slope Estimate = 7.0E-01 µg/L Per Day

95% Confidence Interval = -1.6E+00 to 3.7E+00 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well N5-P1

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-12



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.452 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

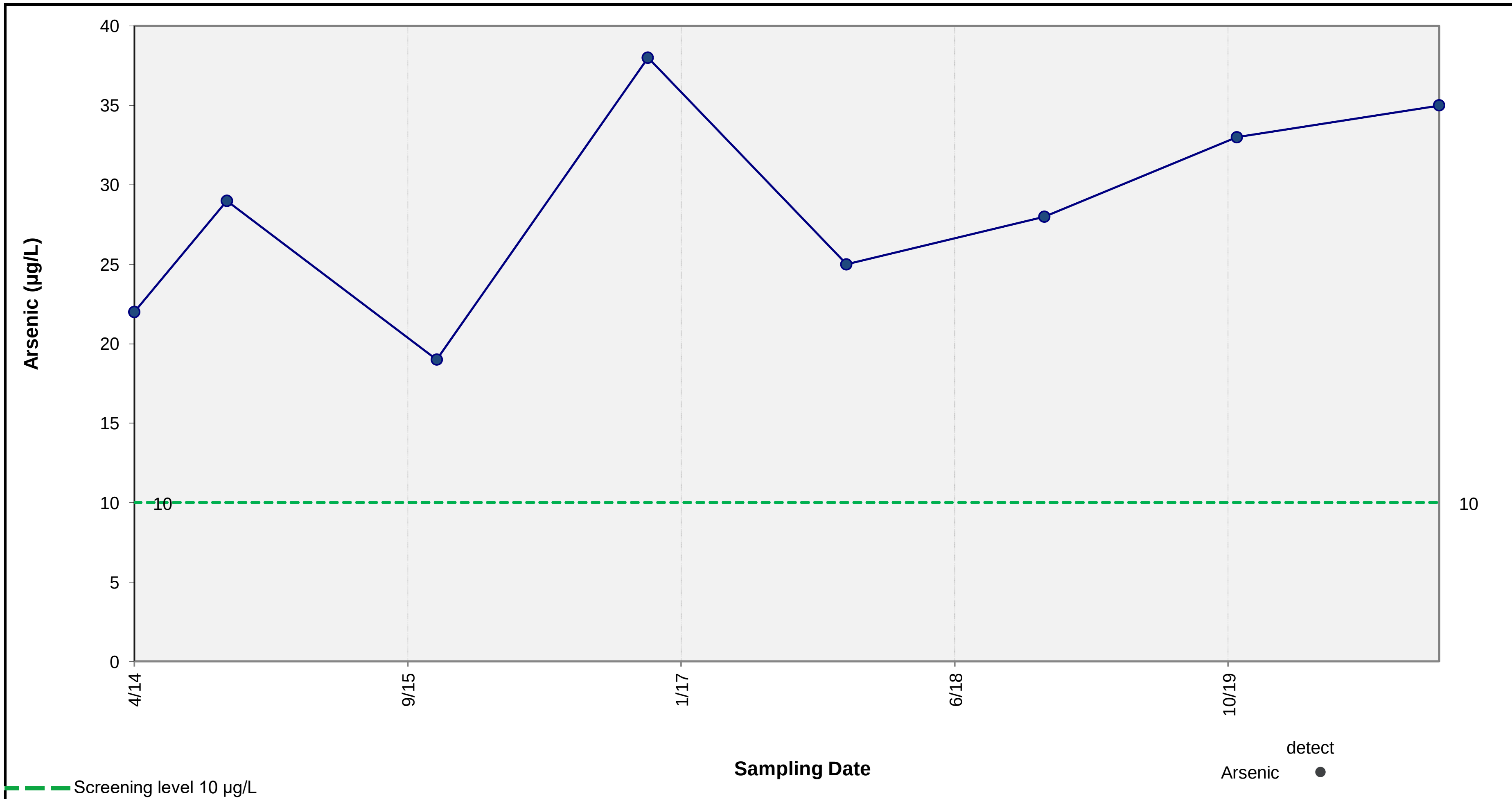
Median Slope Estimate = 4.1E-04 µg/L Per Day

95% Confidence Interval = -6.5E-03 to 2.6E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHL-5

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-13



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.089 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

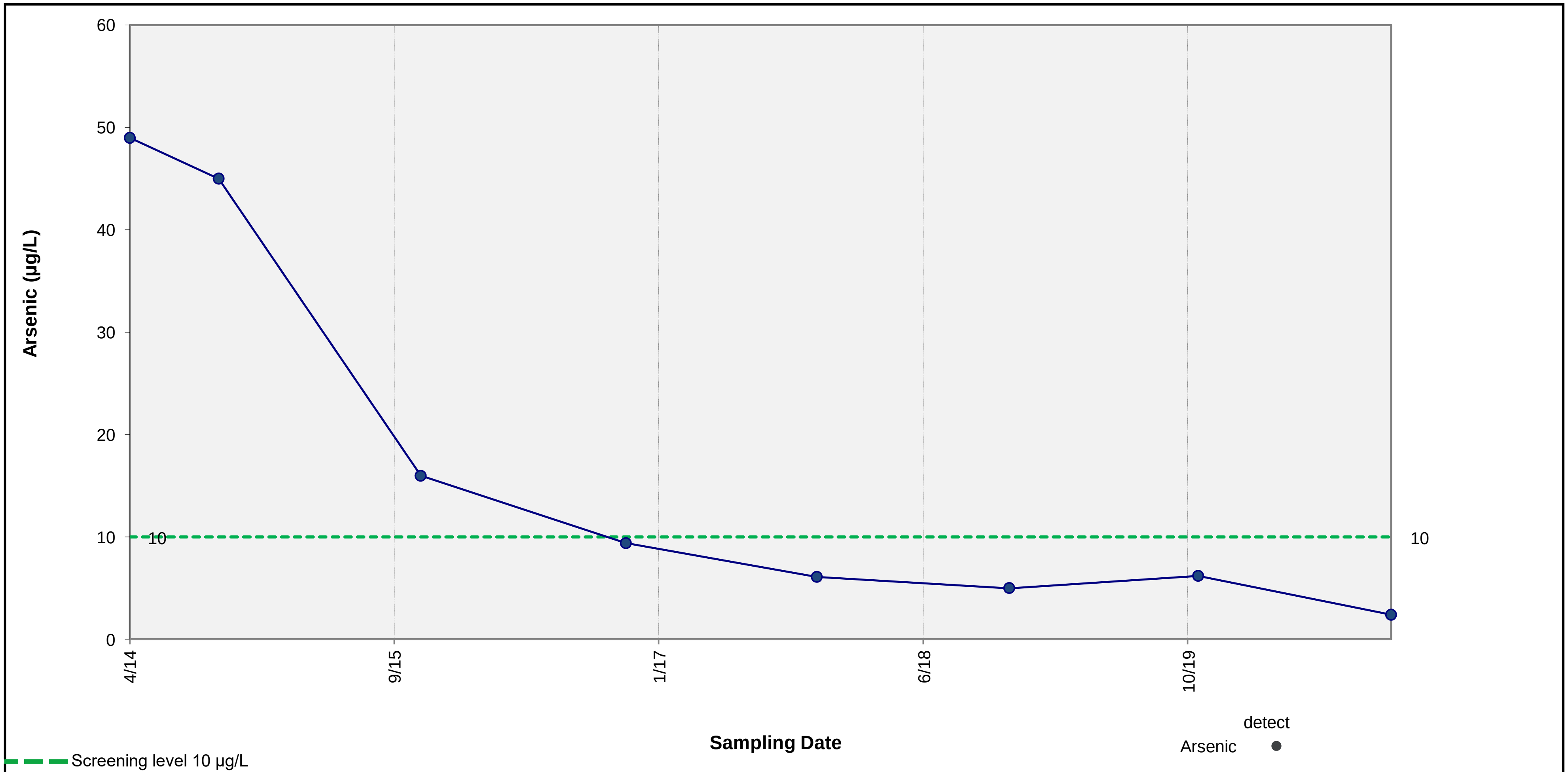
Median Slope Estimate = 5.5E-03 µg/L Per Day

95% Confidence Interval = -3.4E-03 to 9.7E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHL-9

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-14

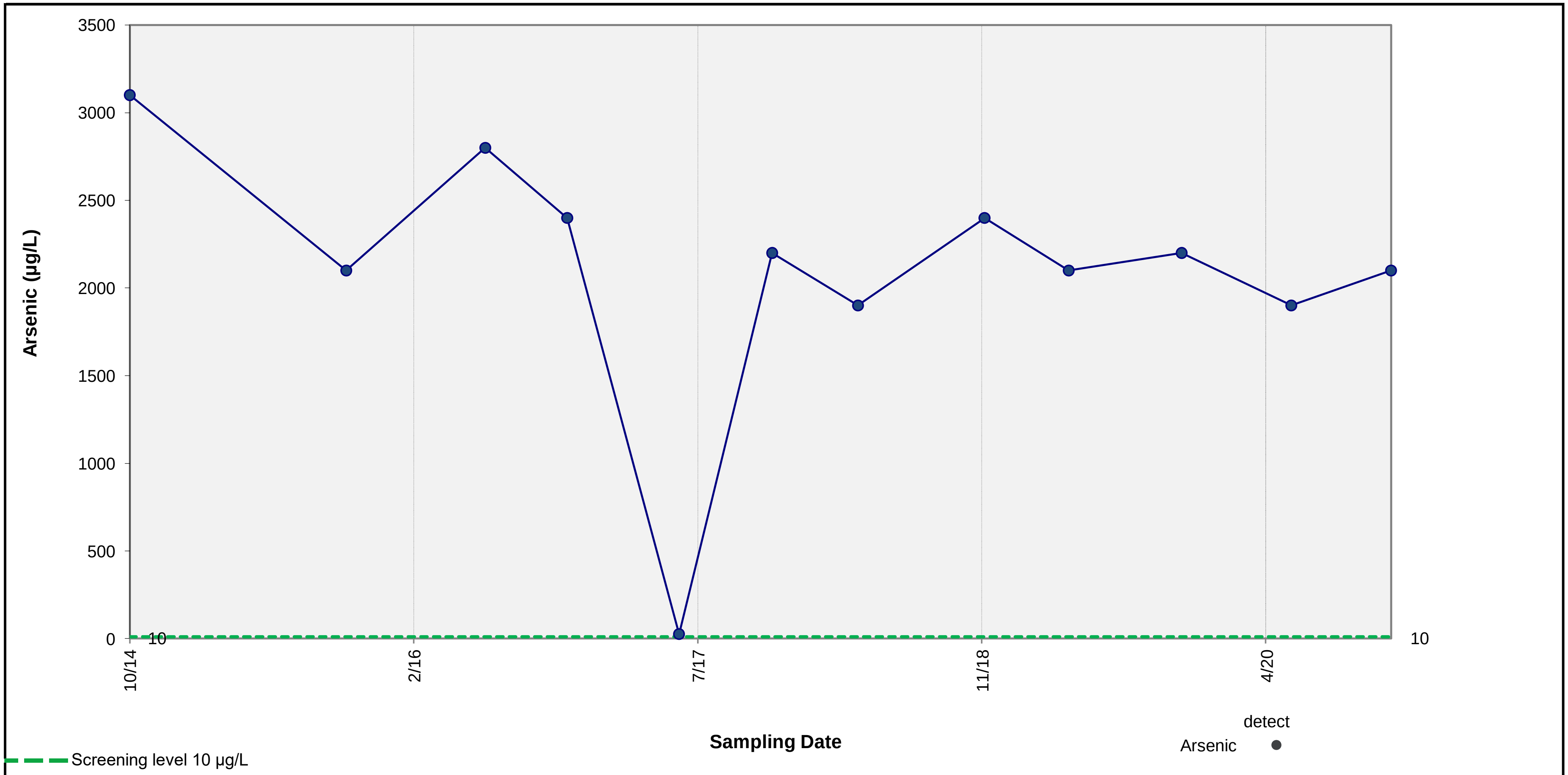


Results of Mann-Kendall Test for Trend:	**DECREASING TREND**			
	p value =	<0.001	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).	
Results of Sen's Estimator of Slope:	**DECREASING TREND**			
	Median Slope Estimate =	-1.5E-02	µg/L Per Day	
	95% Confidence Interval =	-3.3E-02	to -4.9E-03	µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHL-22

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-15

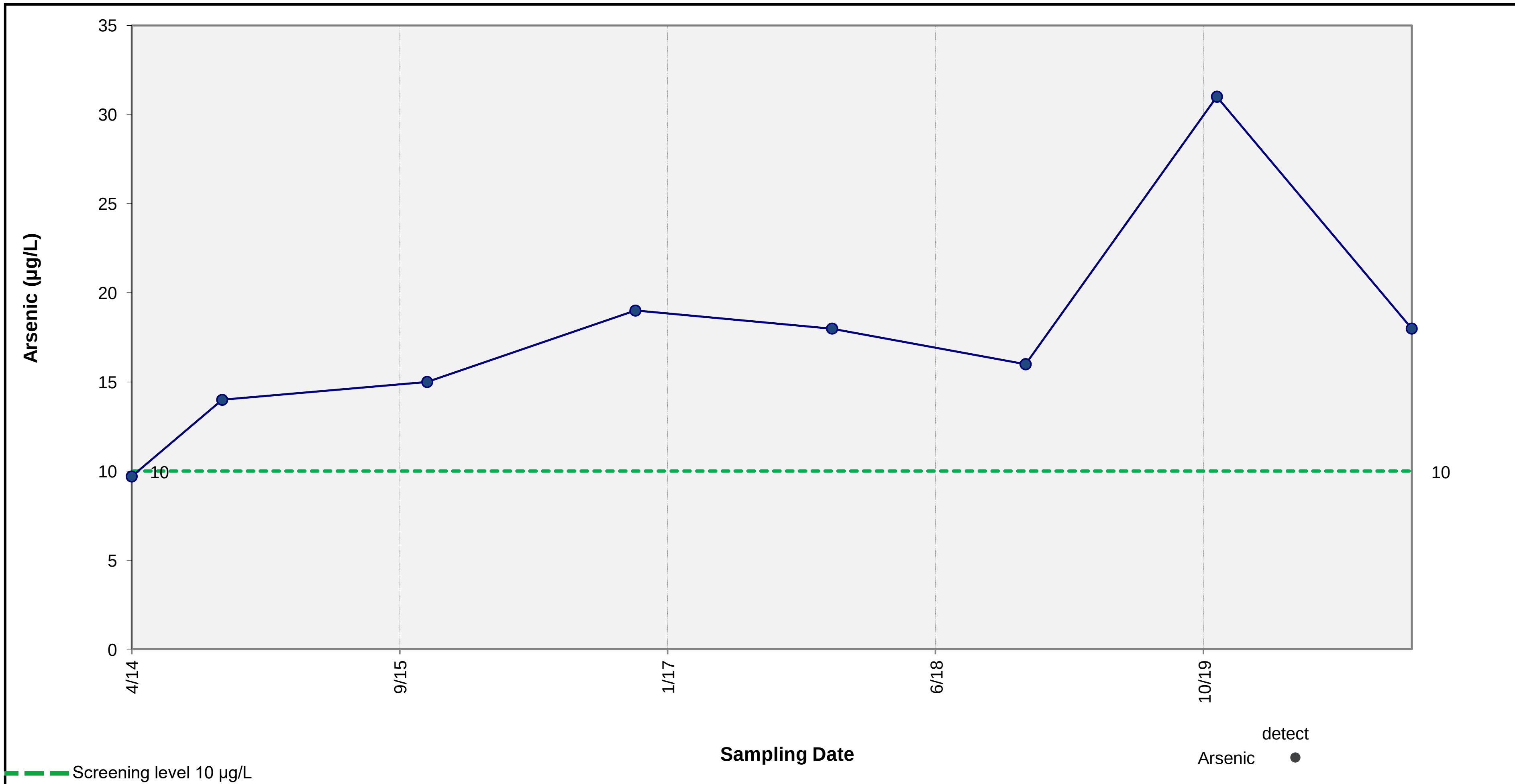


Results of Mann-Kendall Test for Trend:	**No Significant Trend**				
	p value =	0.072	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).		
Results of Sen's Estimator of Slope:	**No Significant Trend**				
	Median Slope Estimate =	-3.3E-01	µg/L Per Day		
	95% Confidence Interval =	-6.1E-01	to	4.4E-03	µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-05-40X

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-16



Results of Mann-Kendall Test for Trend: **INCREASING TREND**

p value = 0.024 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **INCREASING TREND**

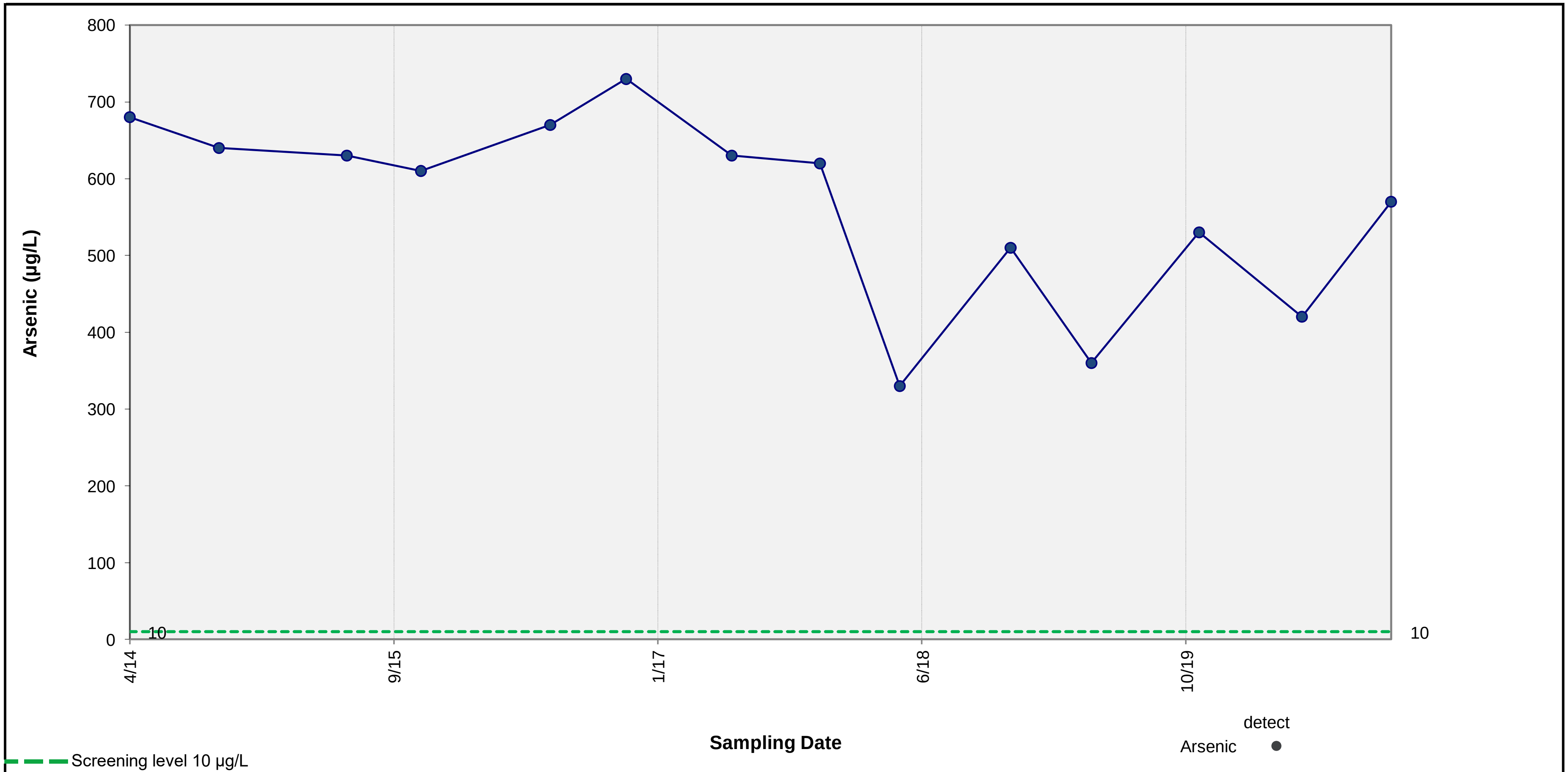
Median Slope Estimate = 3.6E-03 µg/L Per Day

95% Confidence Interval = 1.3E-04 to 1.0E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-05-41A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-17



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.007 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

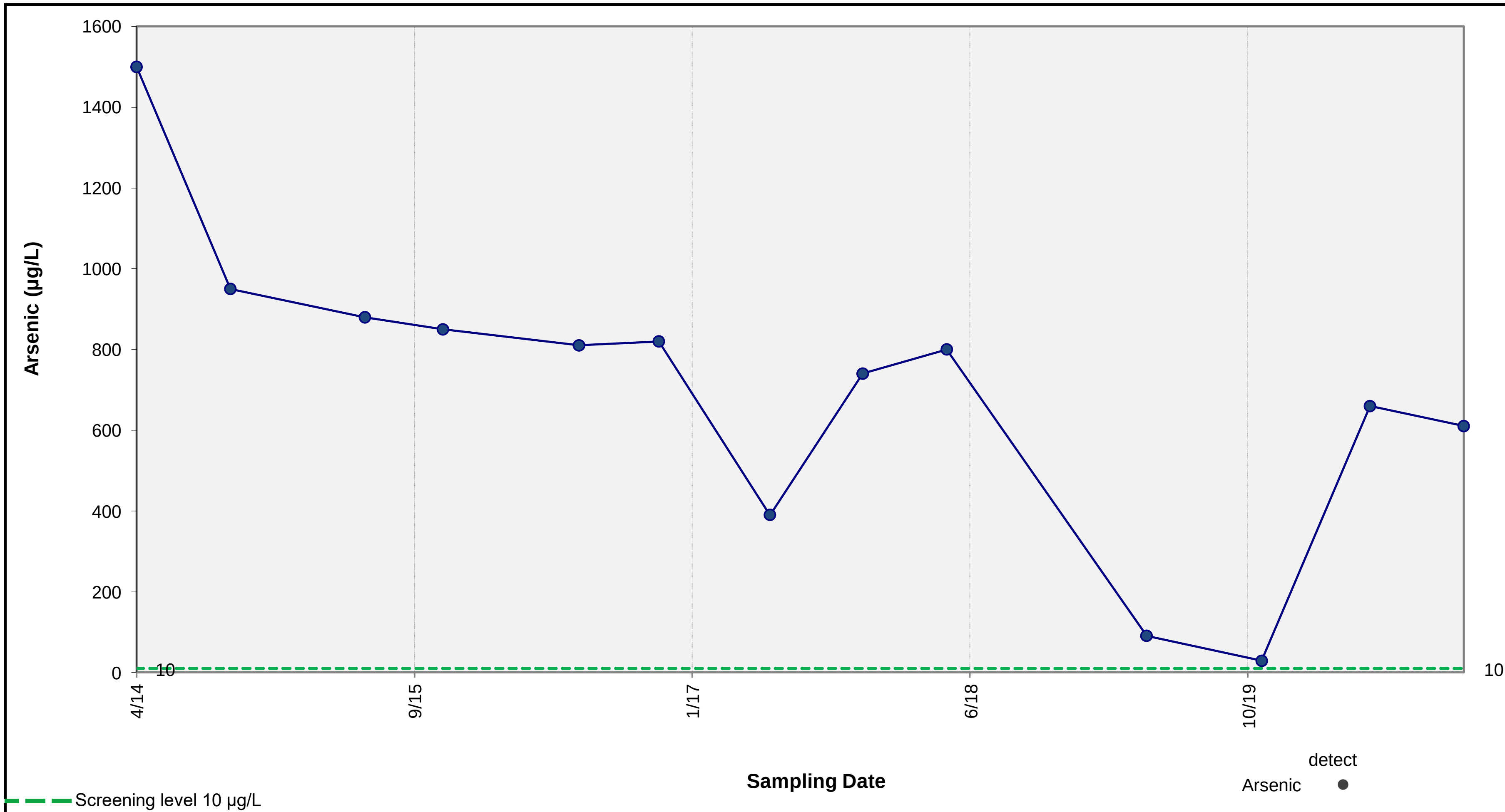
Median Slope Estimate = -9.5E-02 µg/L Per Day

95% Confidence Interval = -1.8E-01 to -2.7E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-05-41B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-18



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = <0.001 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

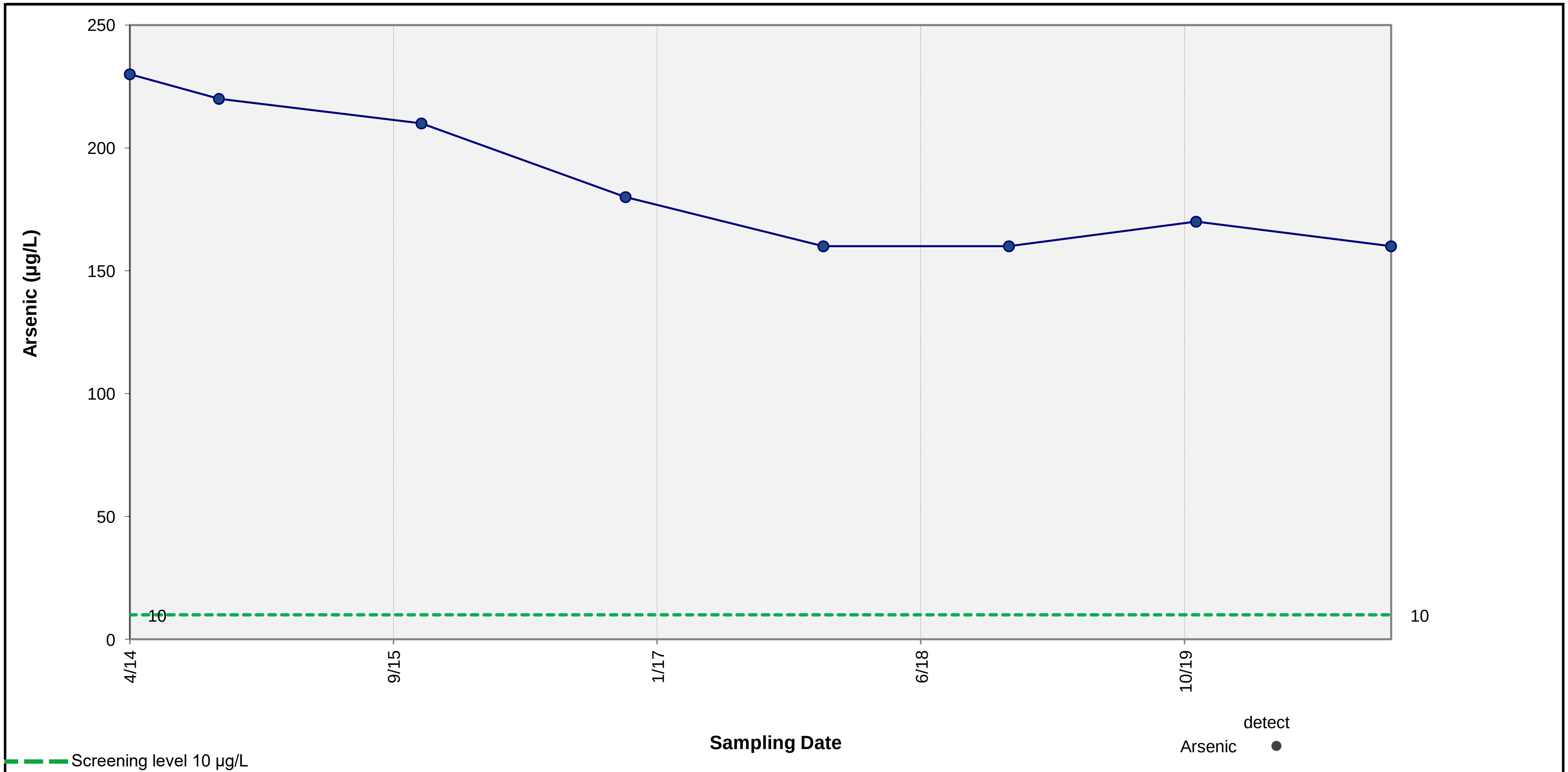
Median Slope Estimate = -2.2E-01 µg/L Per Day

95% Confidence Interval = -5.8E-01 to -1.3E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-05-41C

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-19

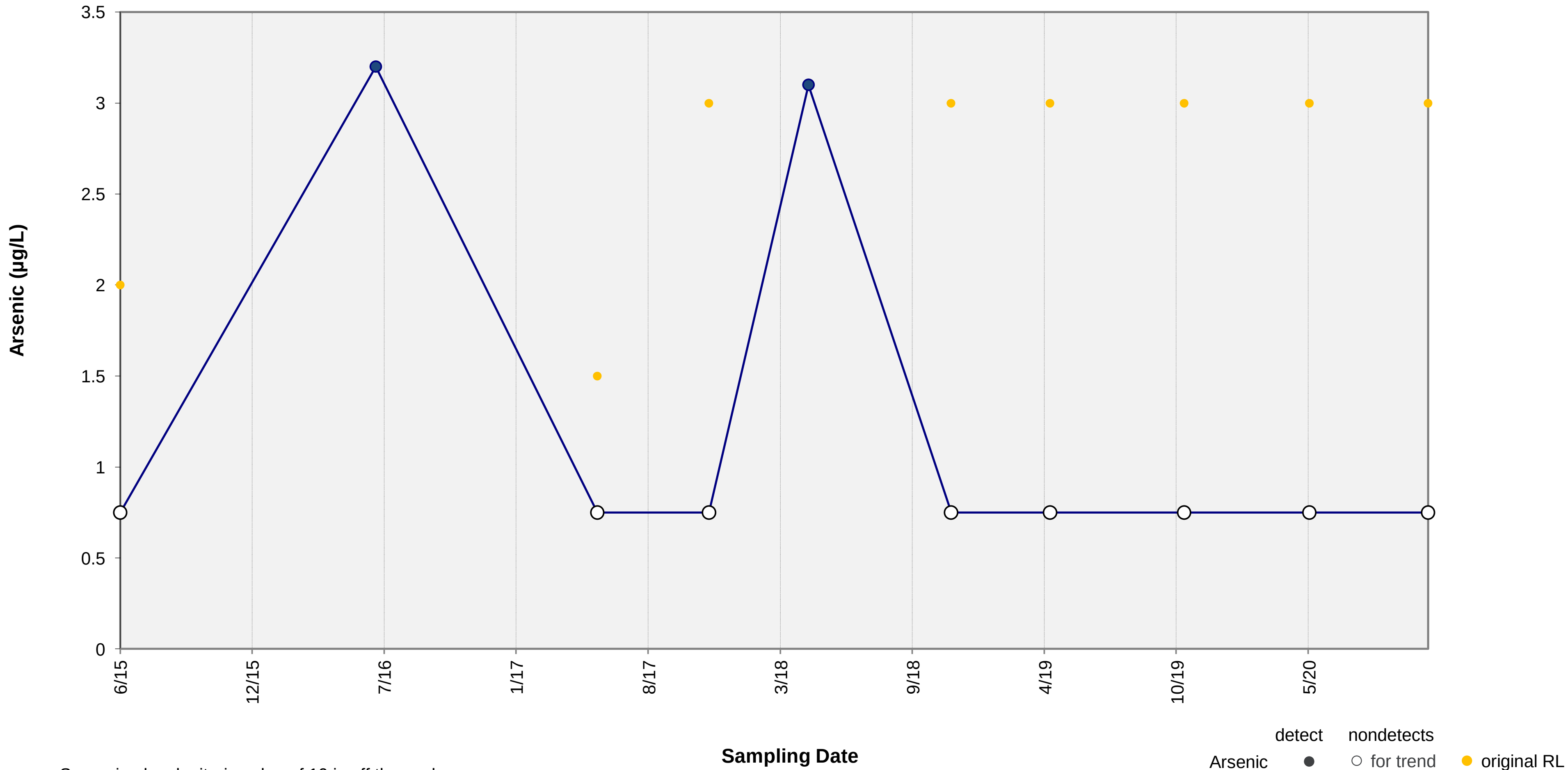


Results of Mann-Kendall Test for Trend:	**DECREASING TREND**			
	p value =	0.005	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).	
Results of Sen's Estimator of Slope:	**DECREASING TREND**			
	Median Slope Estimate =	-2.8E-02	µg/L Per Day	
	95% Confidence Interval =	-5.3E-02	to	-1.8E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-05-42B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-20



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.242 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Frequency of Detection < 50%)**

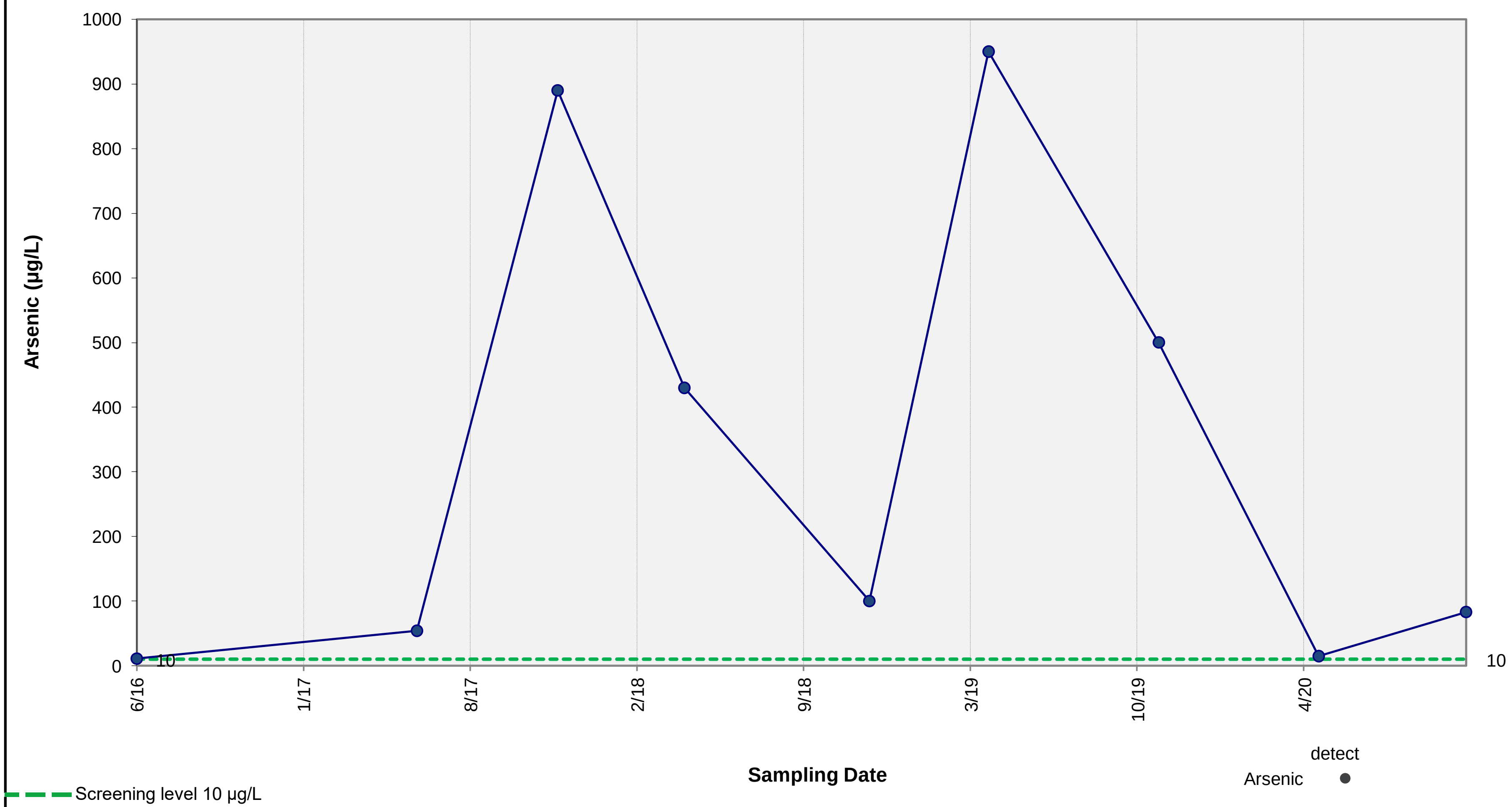
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-07-03

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-21



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.381 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

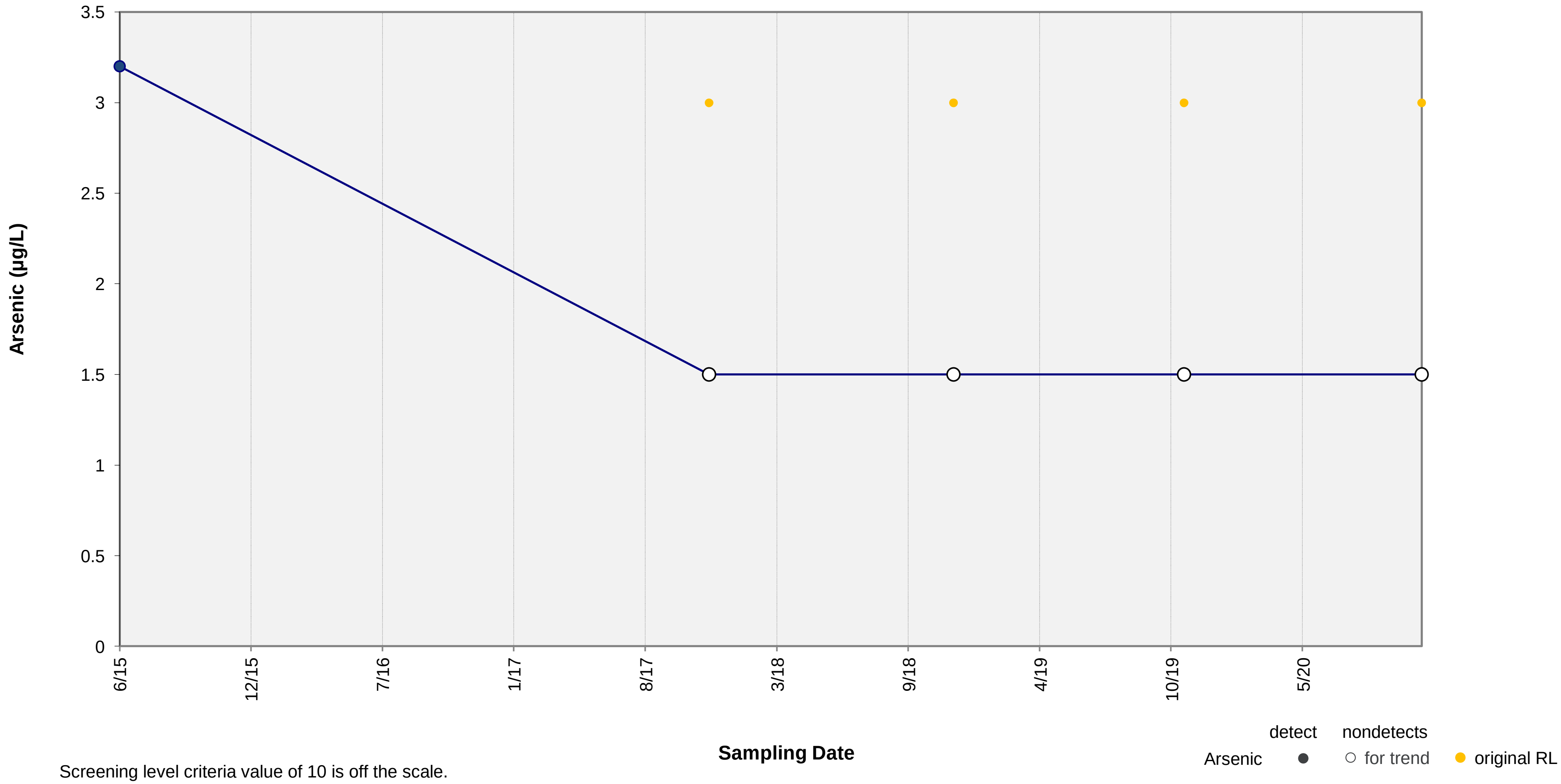
Median Slope Estimate = 3.4E-02 µg/L Per Day

95% Confidence Interval = -1.0E+00 to 5.6E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-07-05_X

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-22



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.242 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Sample Size < 6)**

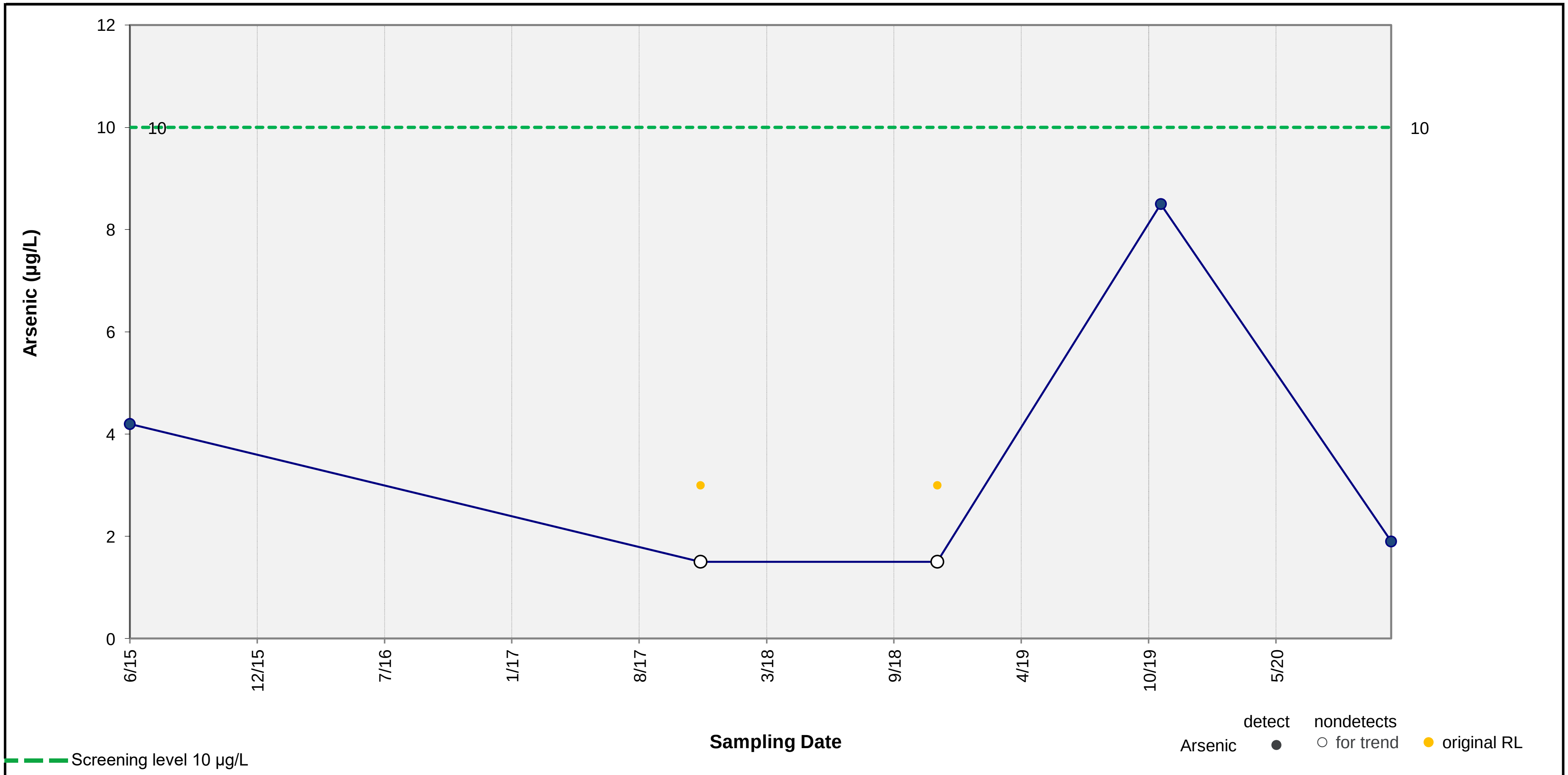
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-02

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-23



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.500 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Sample Size < 6)**

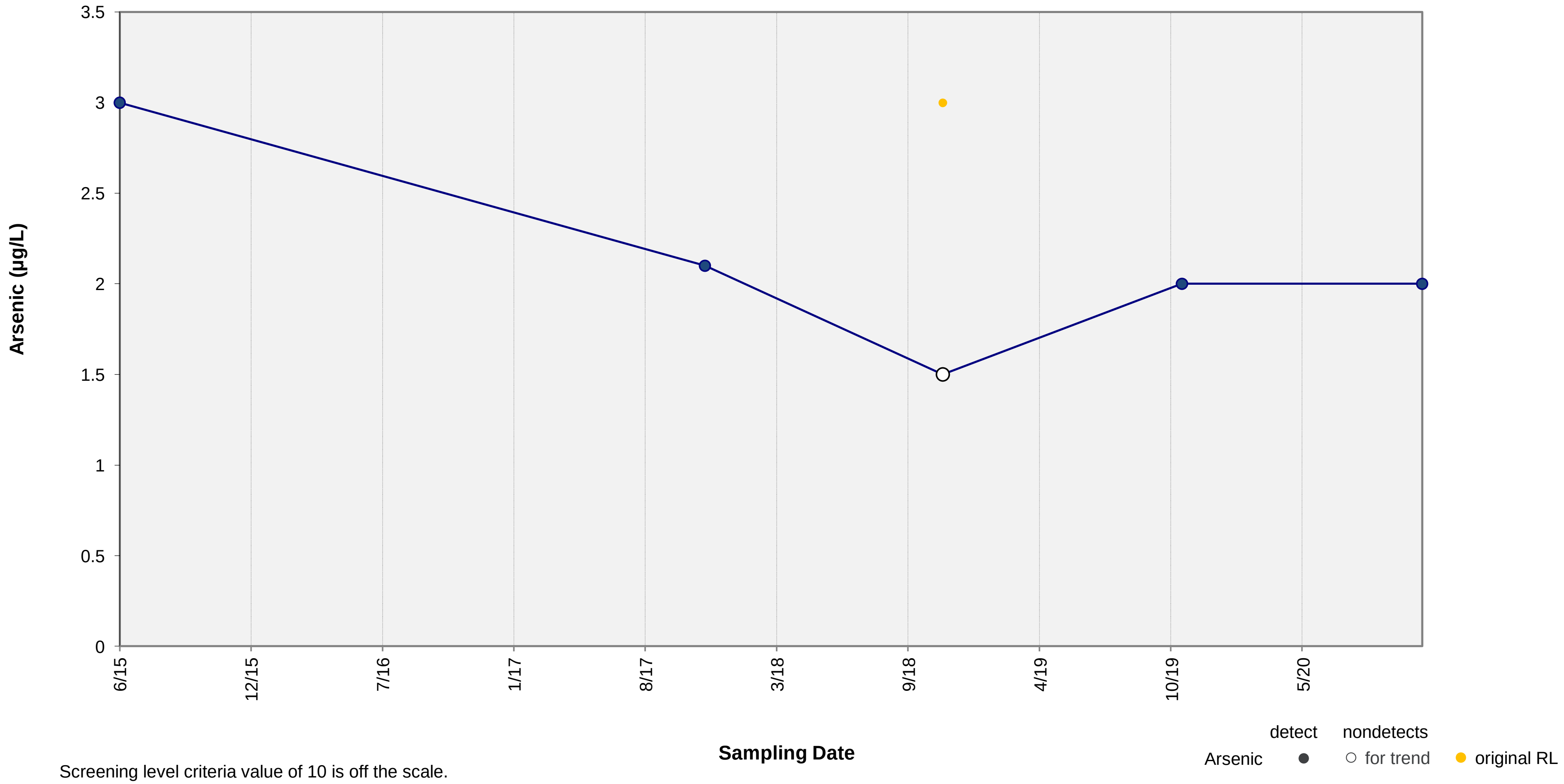
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-03

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-24



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.180 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Sample Size < 6)**

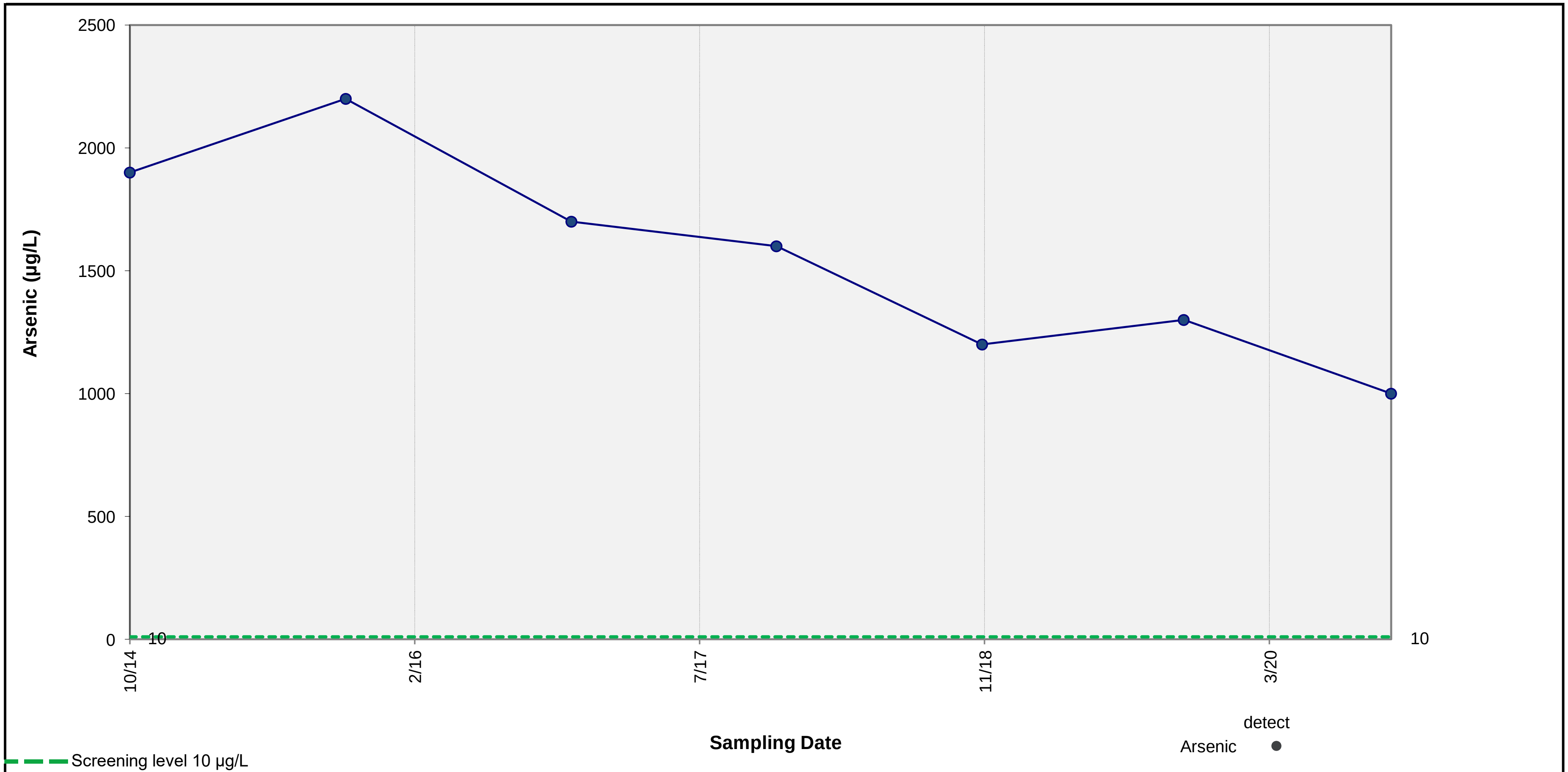
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-05A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-25



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.005 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

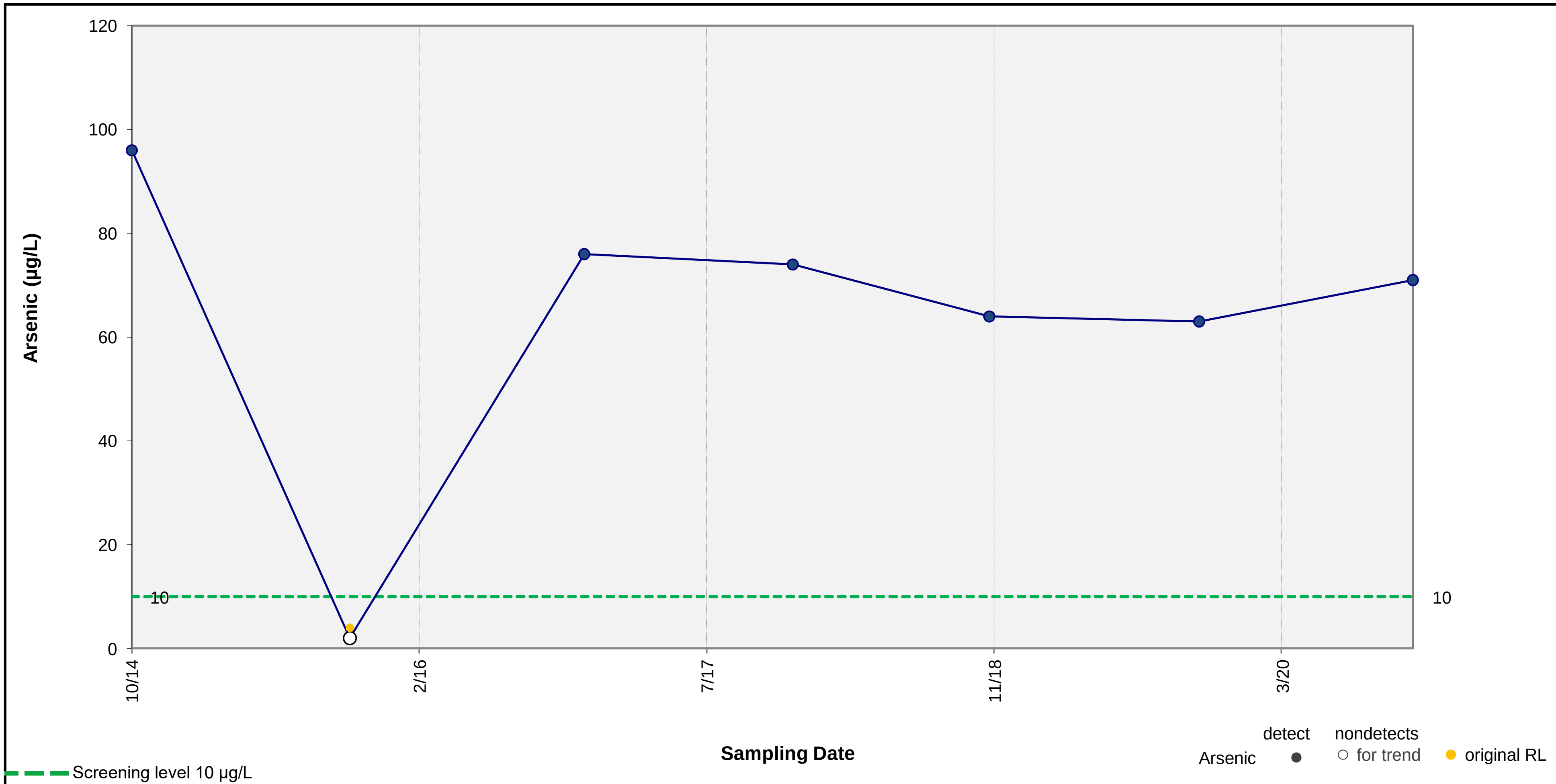
Median Slope Estimate = -4.7E-01 µg/L Per Day

95% Confidence Interval = -8.3E-01 to -2.8E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-06

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-26



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.191 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

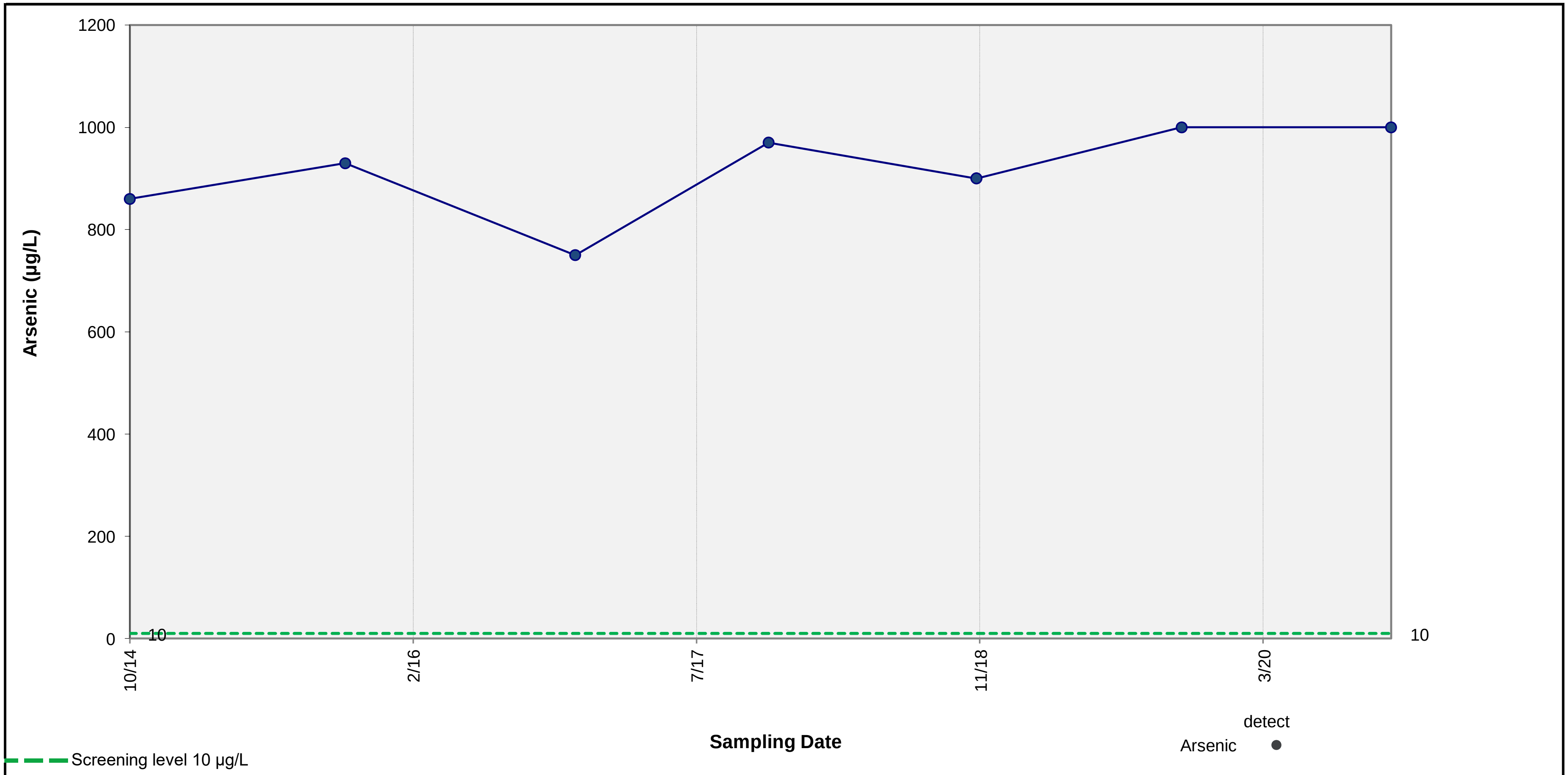
Median Slope Estimate = -5.5E-03 µg/L Per Day

95% Confidence Interval = -2.2E-02 to 3.7E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-06A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-27

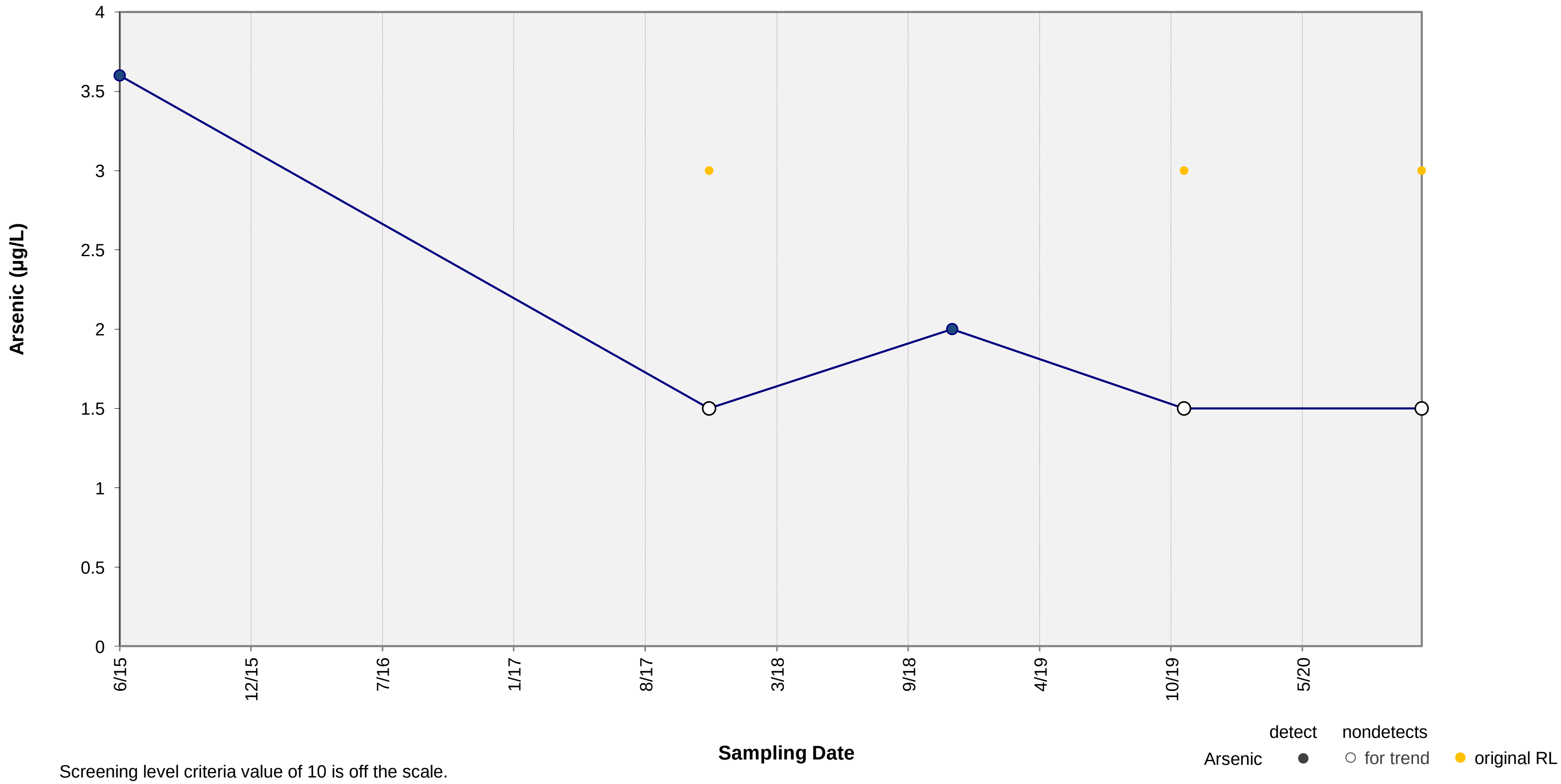


Results of Mann-Kendall Test for Trend:	**No Significant Trend**			
	p value =	0.052	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).	
Results of Sen's Estimator of Slope:	**No Significant Trend**			
	Median Slope Estimate =	5.4E-02	µg/L Per Day	
	95% Confidence Interval =	-2.6E-02	to 1.8E-01	µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-07

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-28



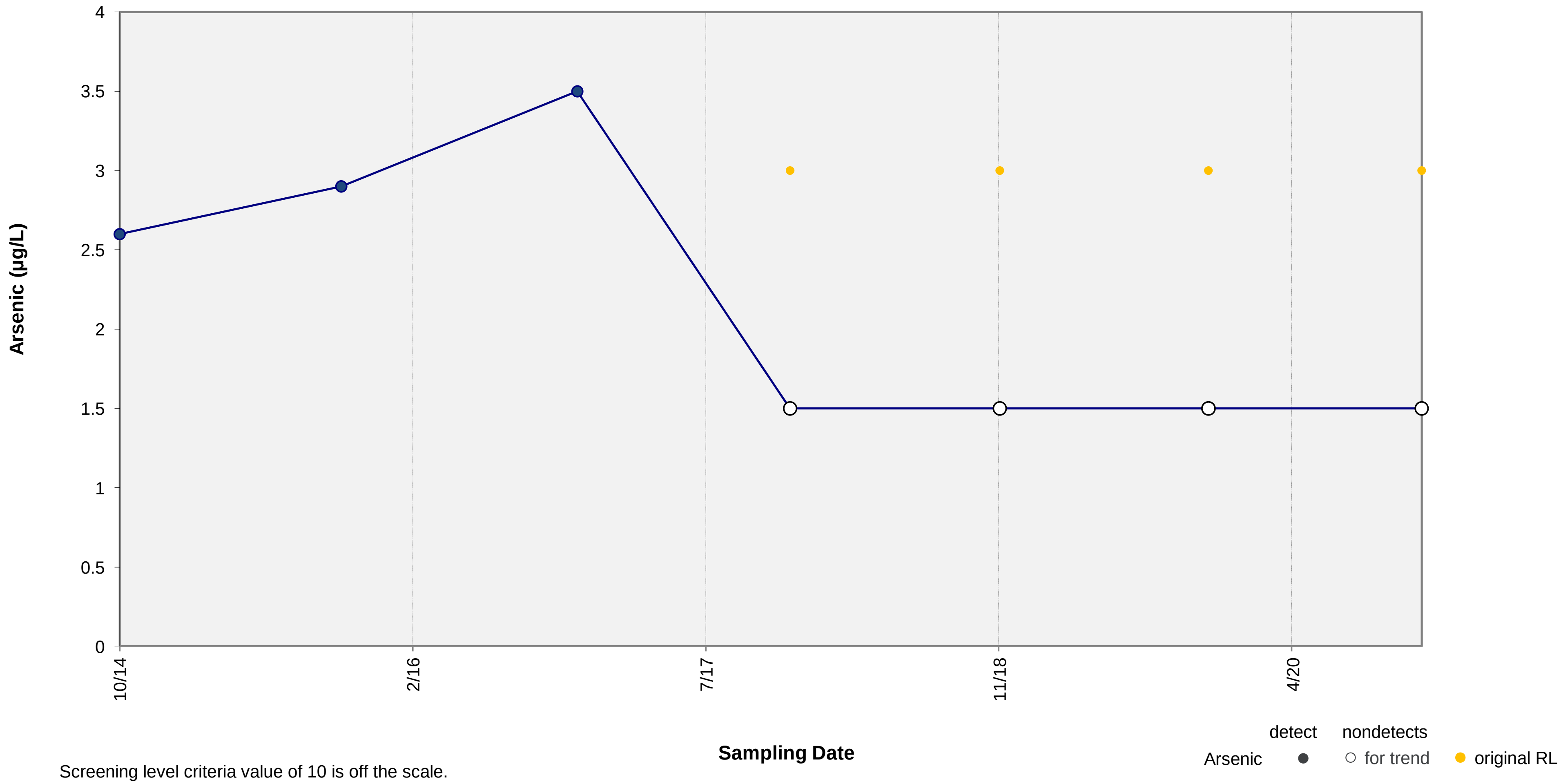
Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend:	**No Significant Trend**	
	p value = 0.180	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).
Results of Sen's Estimator of Slope:	**Not Analyzed (Sample Size < 6)**	
	Median Slope Estimate = NA µg/L Per Day	
	95% Confidence Interval = NA to NA µg/L Per Day	

Concentration vs. Time Plot – Arsenic in Well SHM-10-08

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-29



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.119 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Frequency of Detection < 50%)**

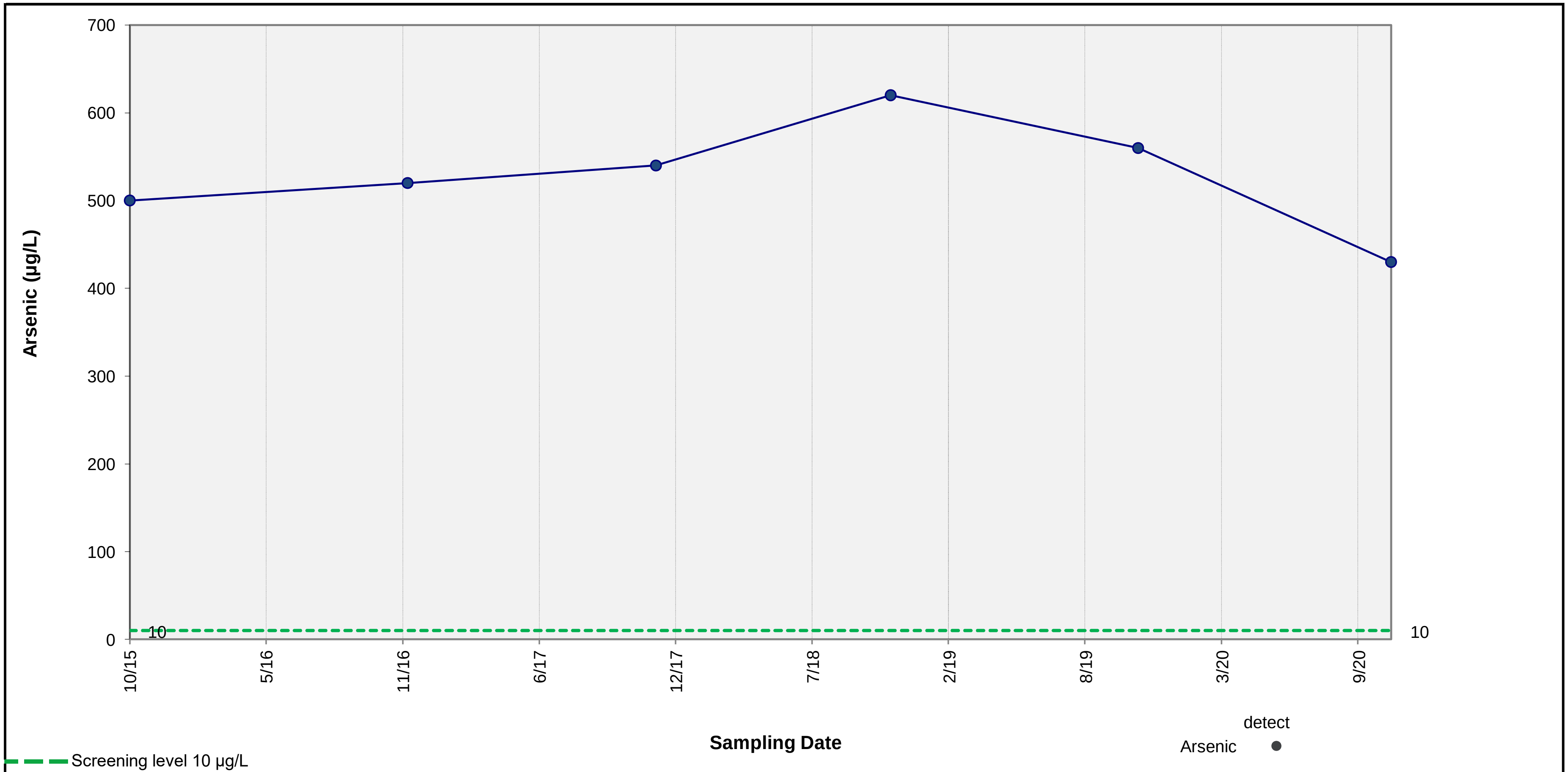
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-10

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-30



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.360 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

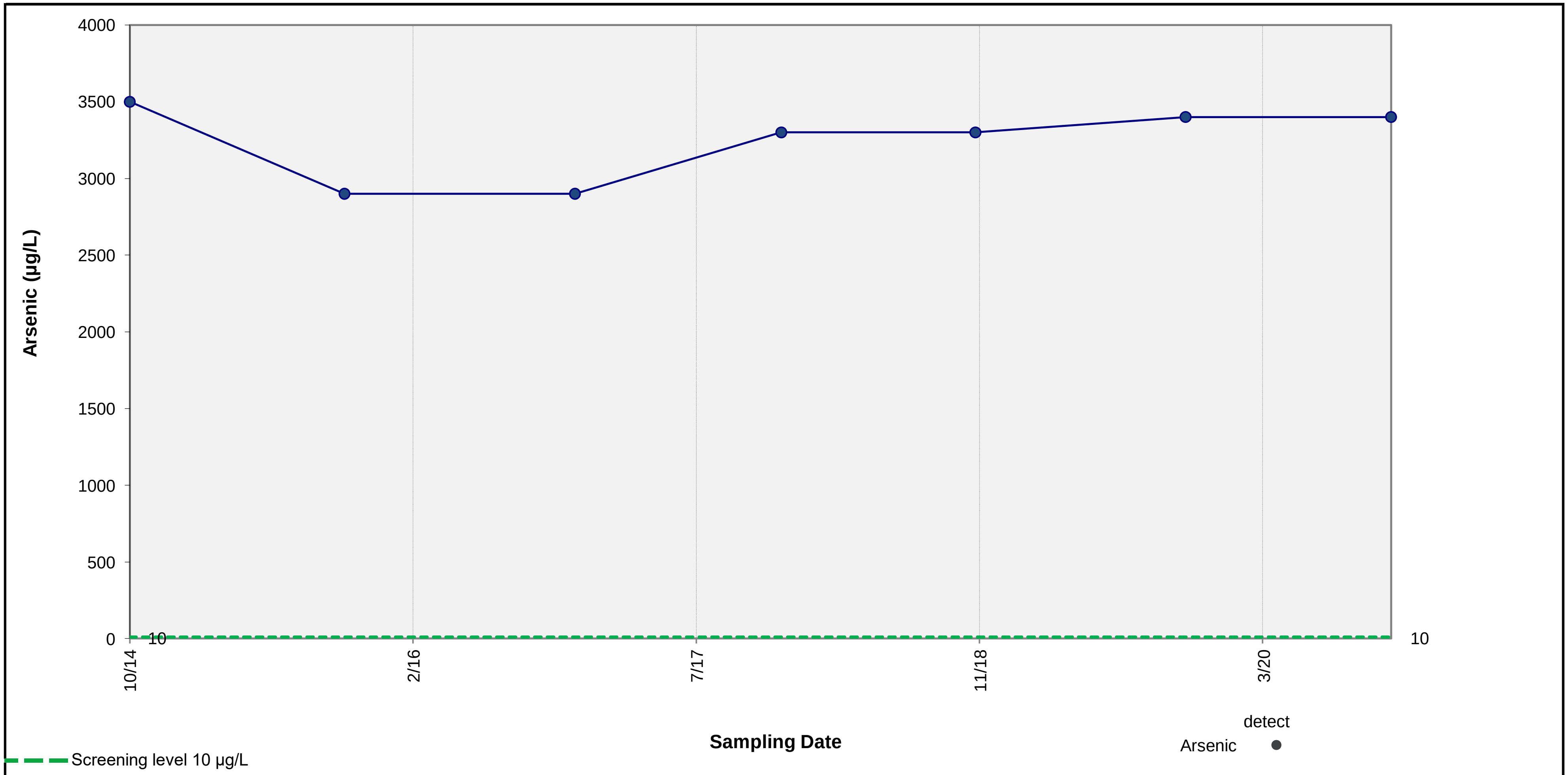
Median Slope Estimate = 3.7E-02 µg/L Per Day

95% Confidence Interval = -2.3E-01 to 9.3E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-11

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-31



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.236 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

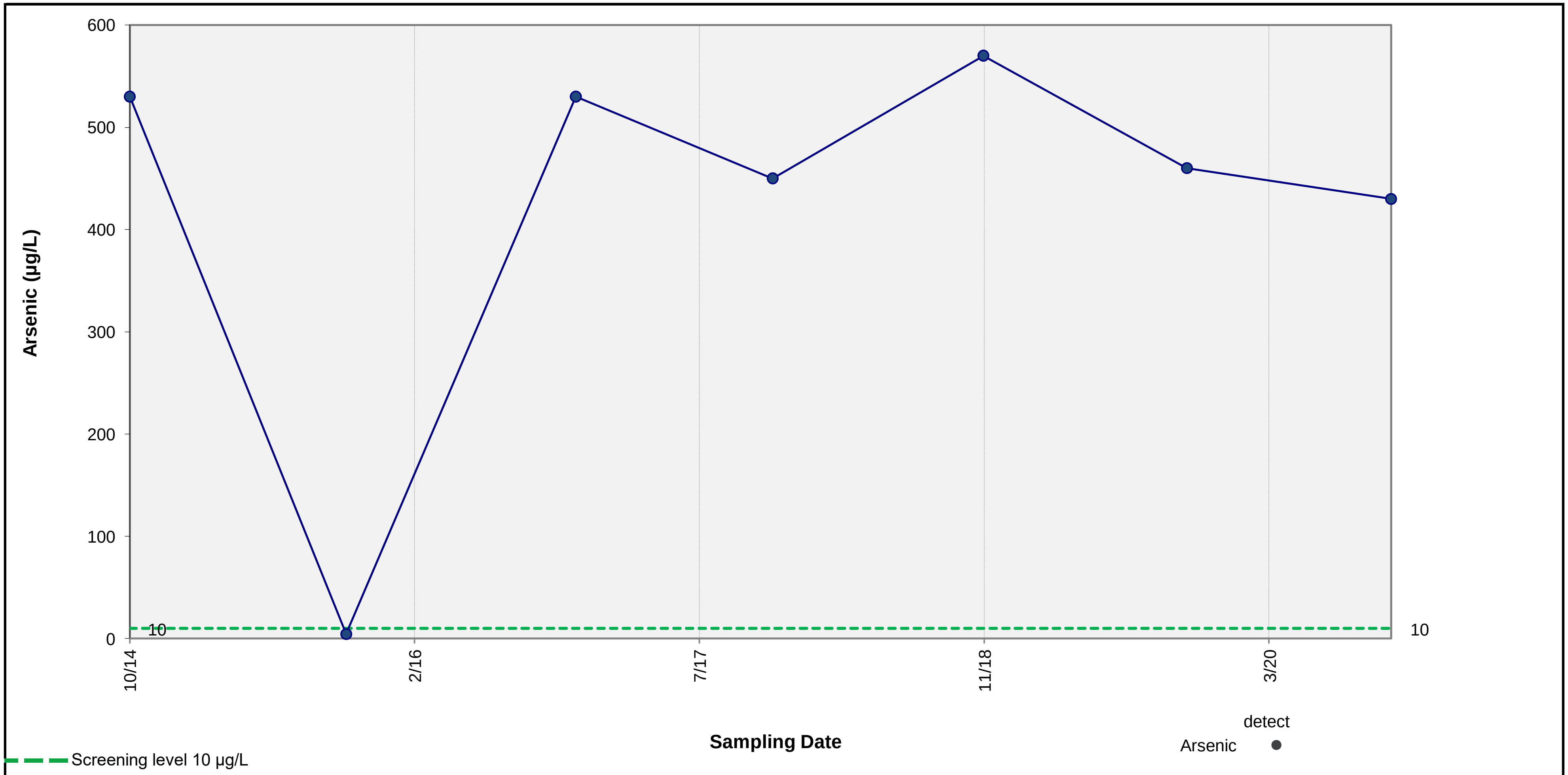
Median Slope Estimate = 1.4E-01 µg/L Per Day

95% Confidence Interval = -1.2E-01 to 3.6E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-12

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-32



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.443 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

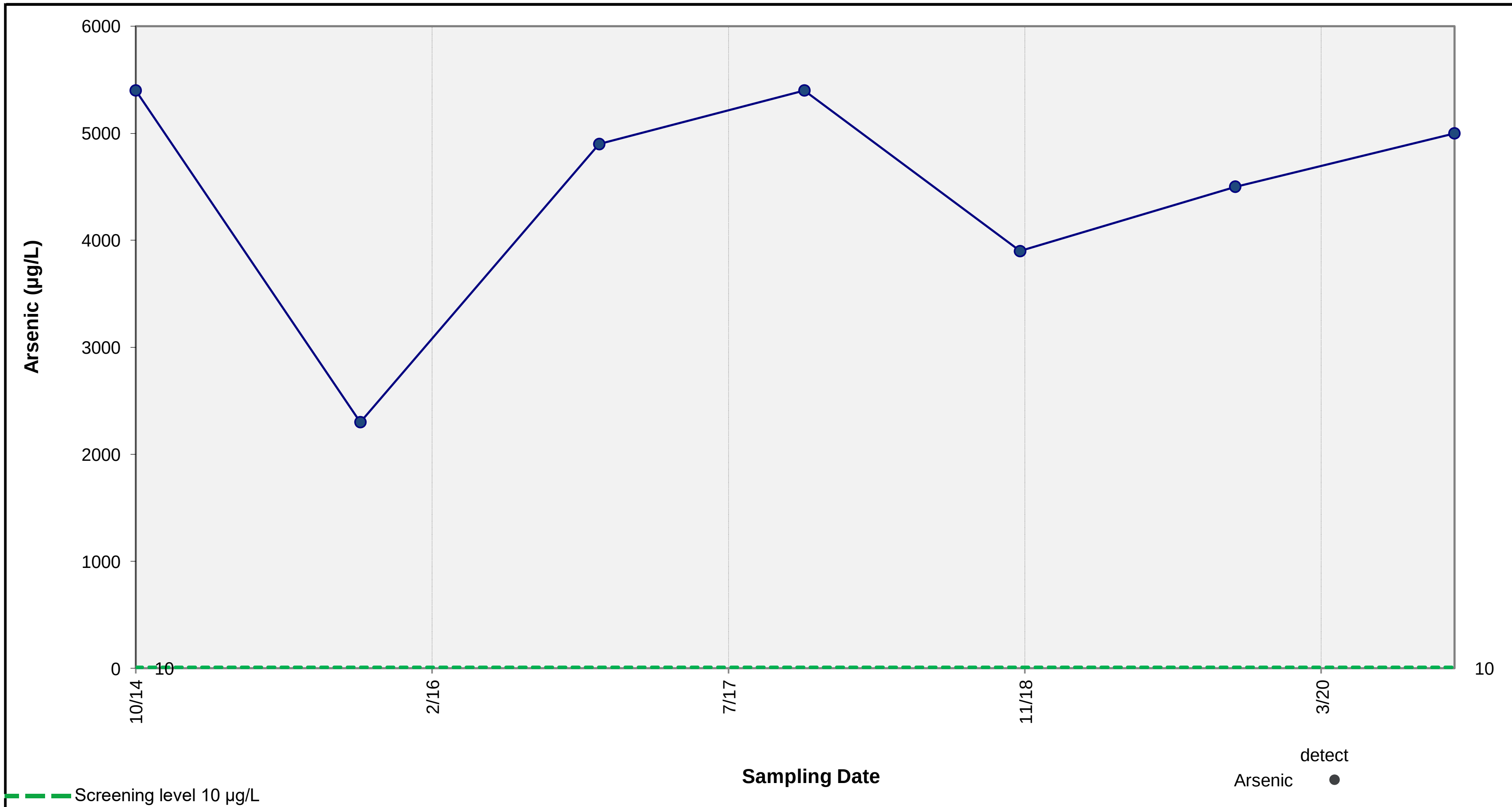
Median Slope Estimate = -1.8E-02 µg/L Per Day

95% Confidence Interval = -1.9E-01 to 3.0E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-13

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-33

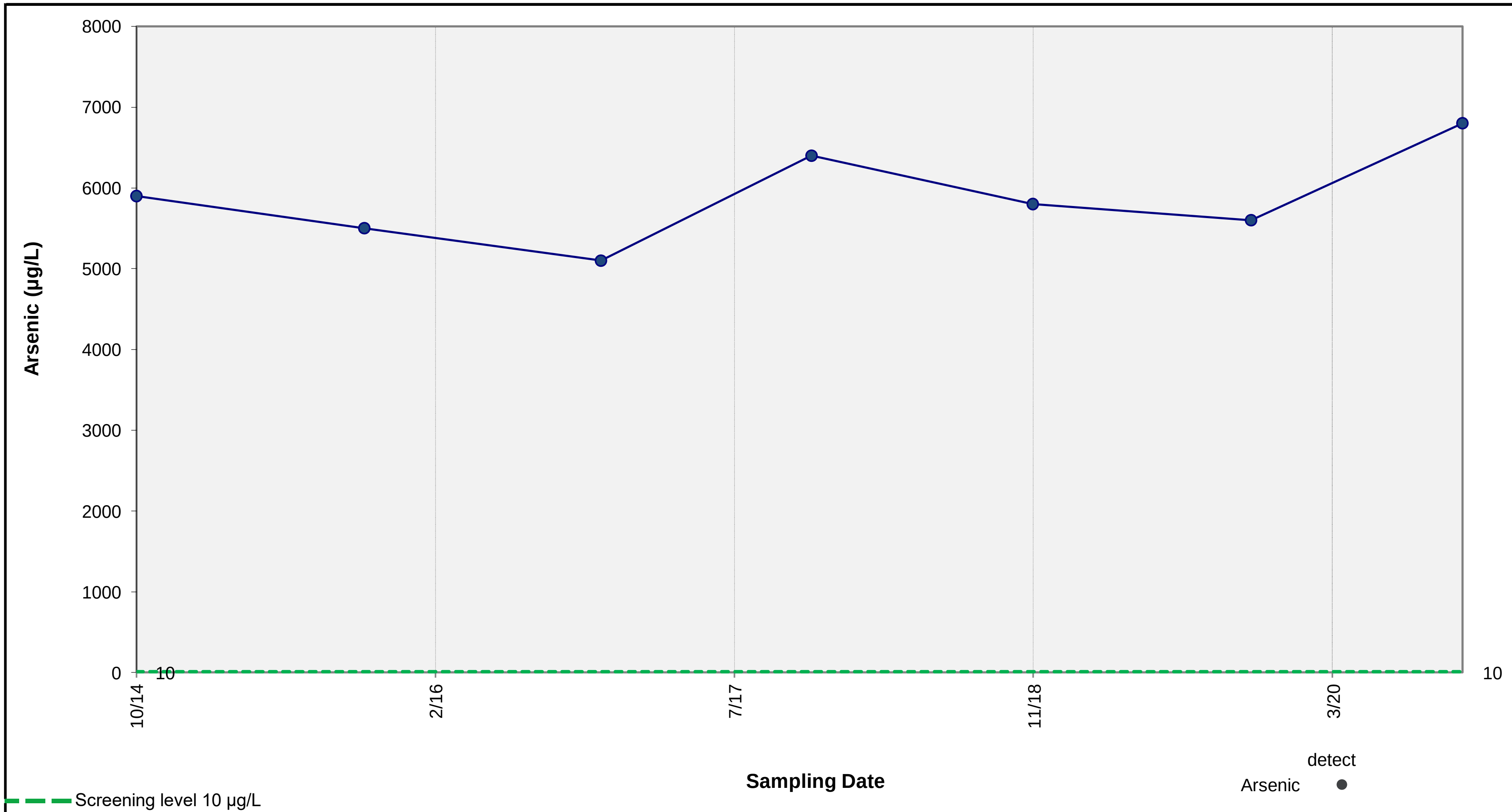


Results of Mann-Kendall Test for Trend:	**No Significant Trend**			
	p value =	0.563	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).	
Results of Sen's Estimator of Slope:	**No Significant Trend**			
	Median Slope Estimate =	0.0E+00	µg/L Per Day	
	95% Confidence Interval =	-1.2E+00	to 1.5E+00	µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-14

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-34



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.281 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

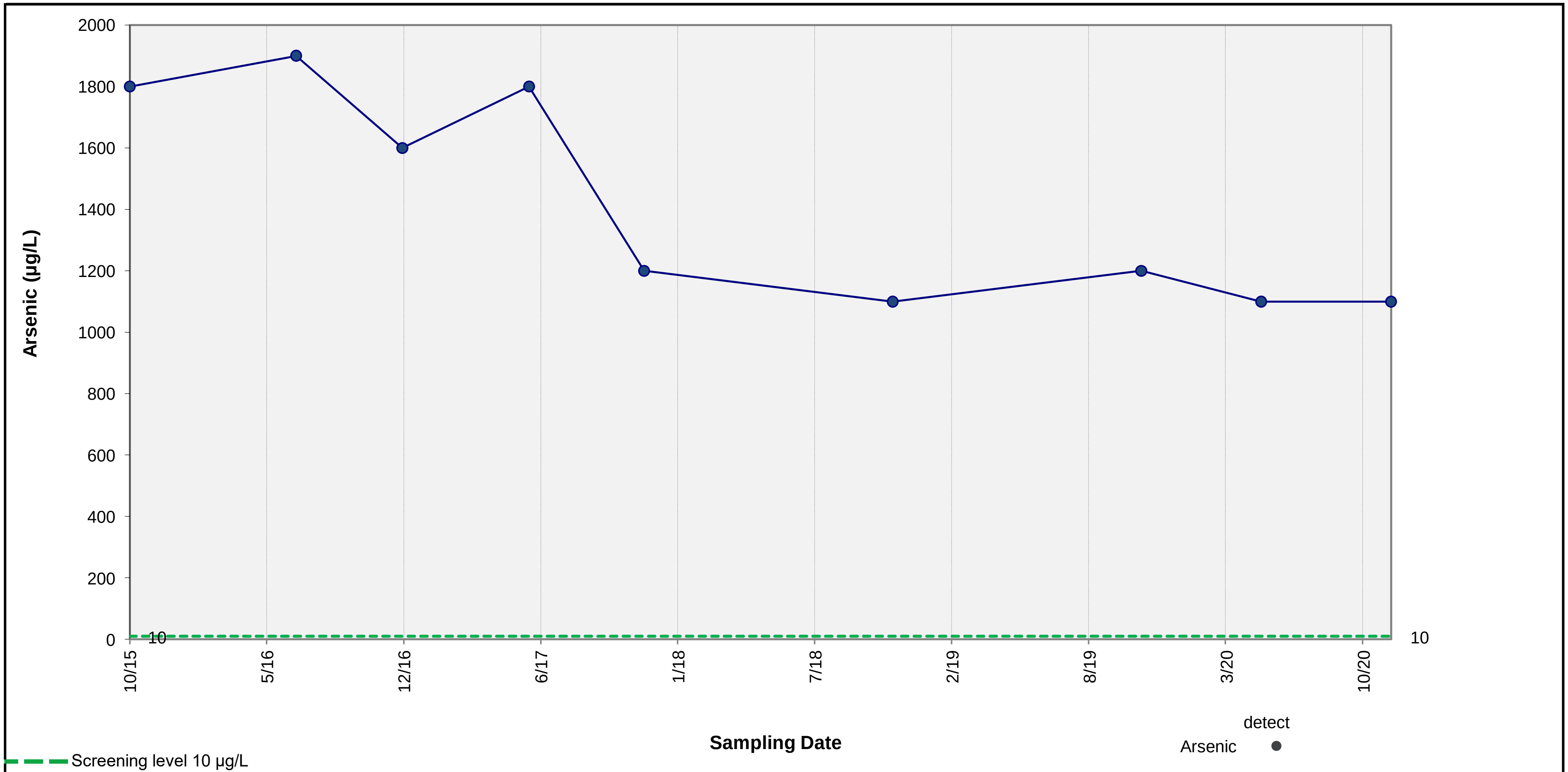
Median Slope Estimate = 3.7E-01 µg/L Per Day

95% Confidence Interval = -1.0E+00 to 1.2E+00 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-15

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-35



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.005 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

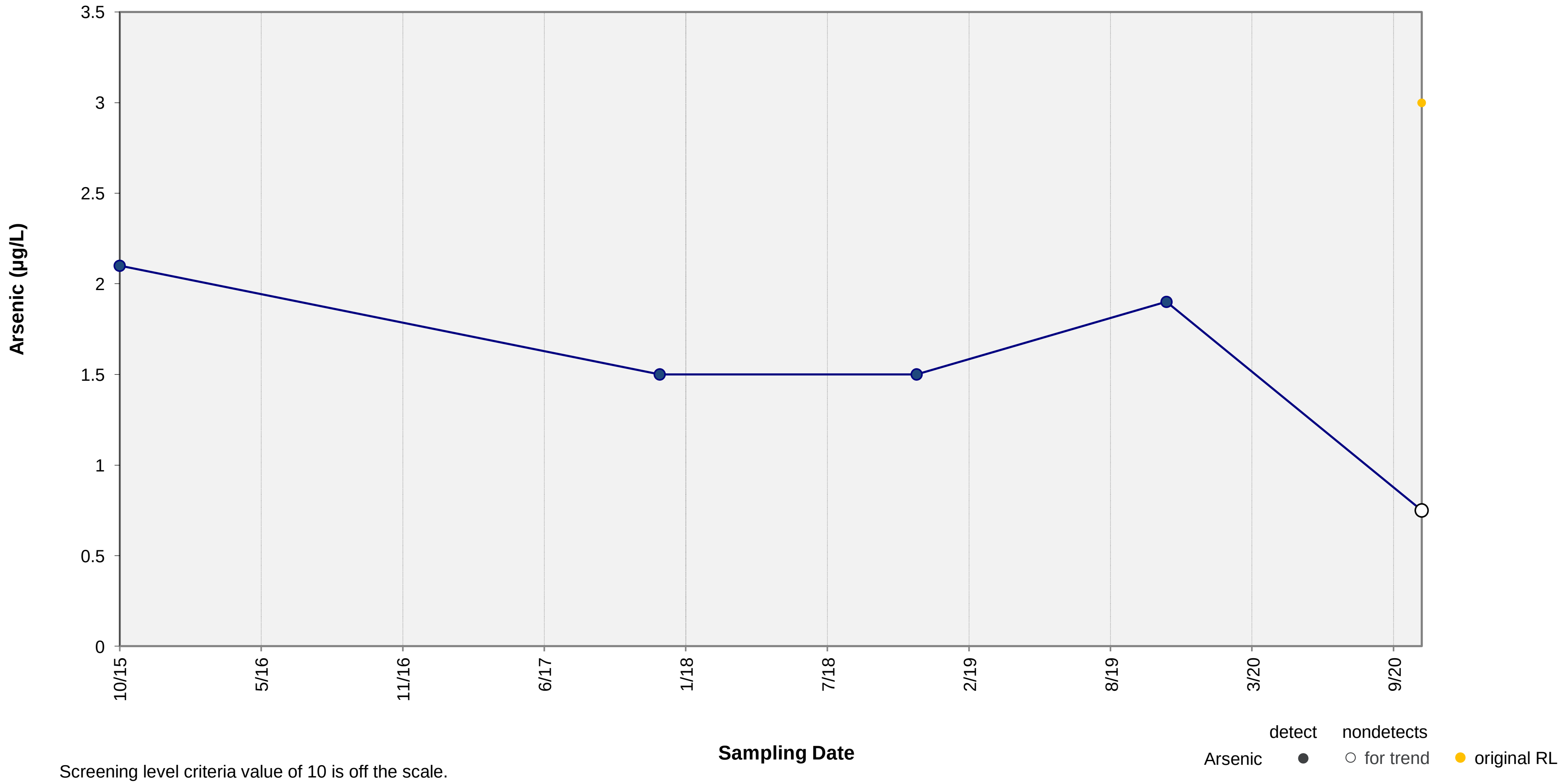
Median Slope Estimate = -4.1E-01 µg/L Per Day

95% Confidence Interval = -6.7E-01 to -1.1E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-10-16

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-36



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.180 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Sample Size < 6)**

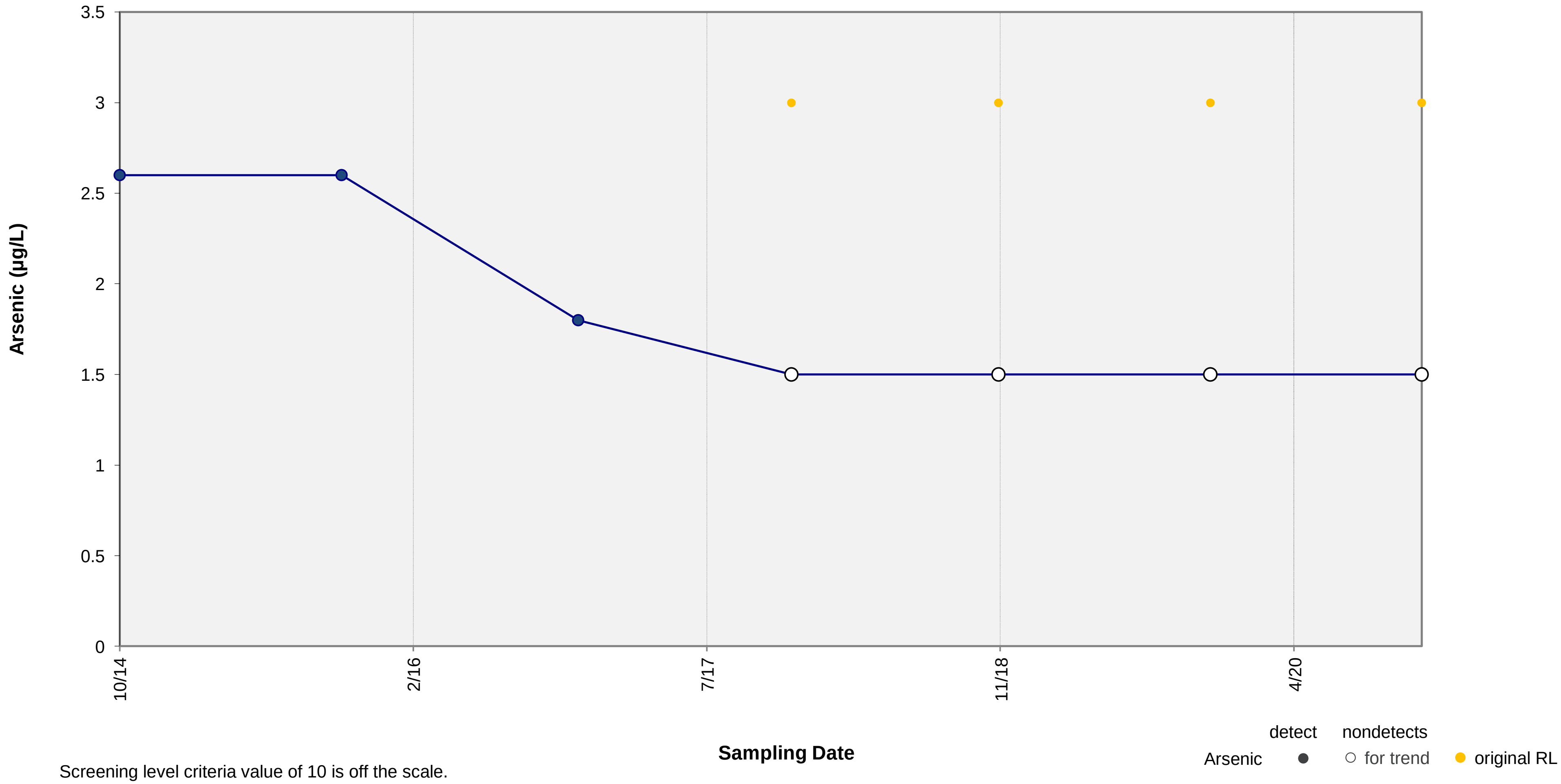
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-01

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-37



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.025 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Frequency of Detection < 50%)**

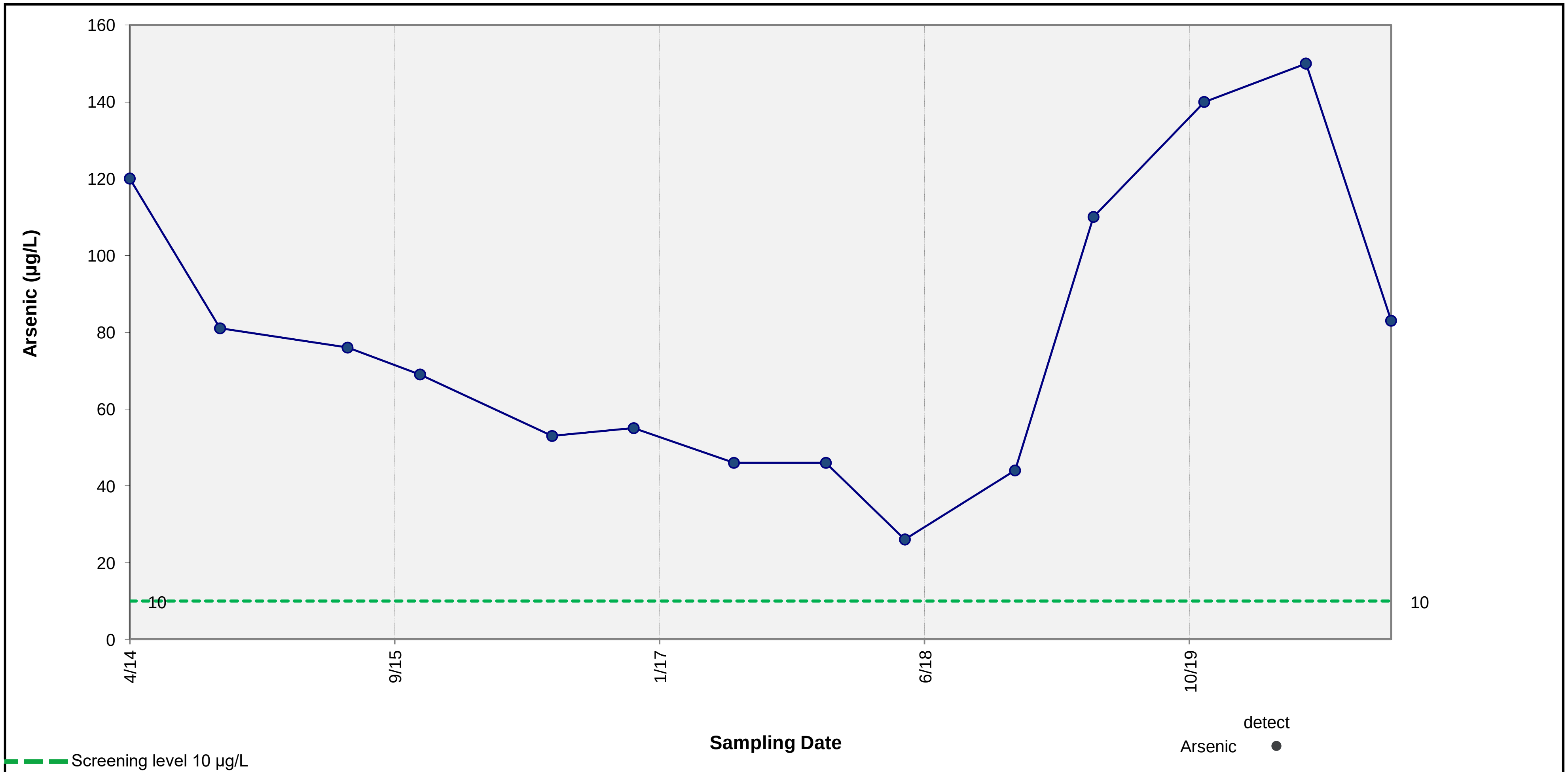
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-02

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-38



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.435 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

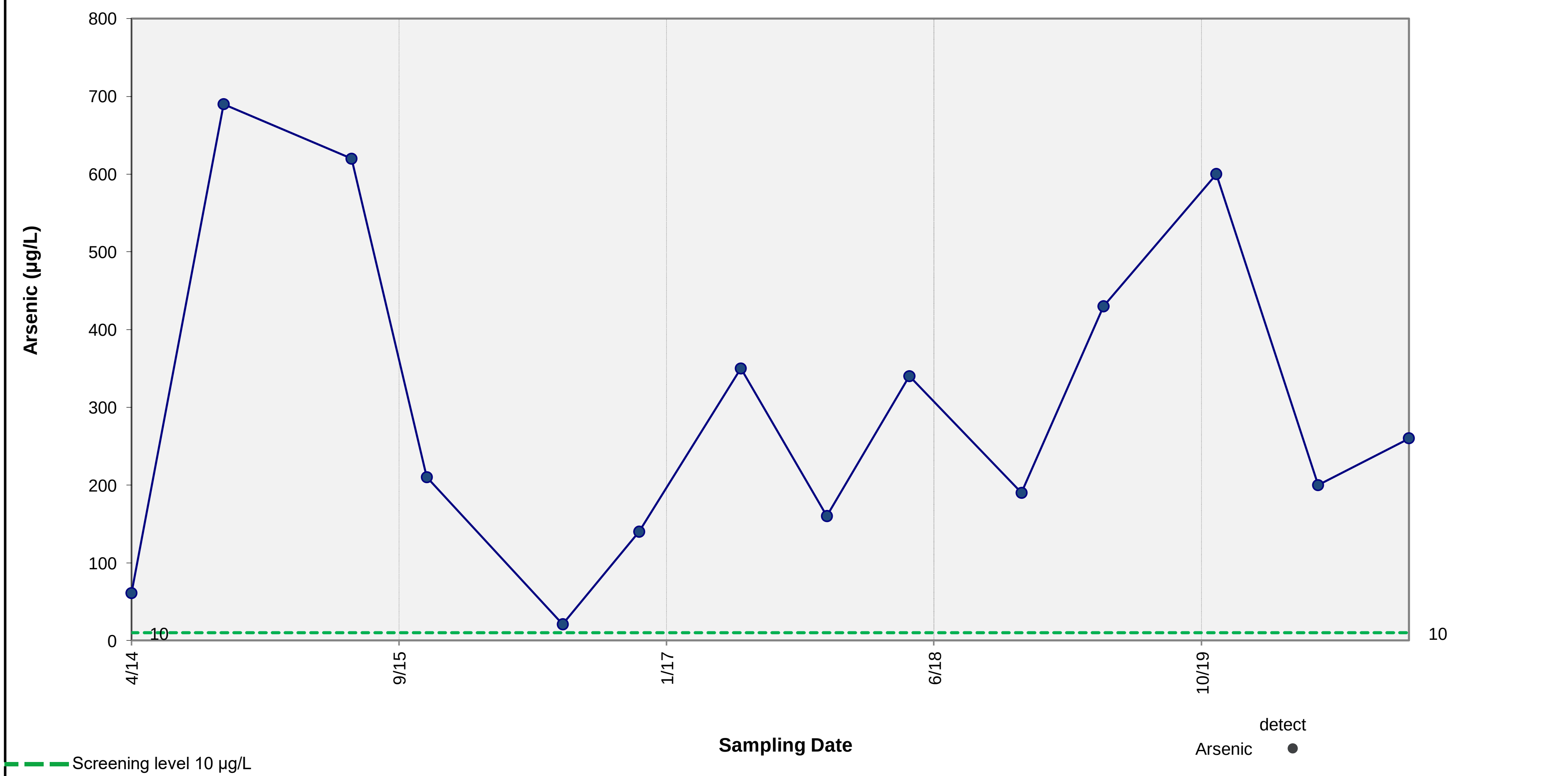
Median Slope Estimate = -5.5E-03 µg/L Per Day

95% Confidence Interval = -3.7E-02 to 3.7E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-03

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-39



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.331 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

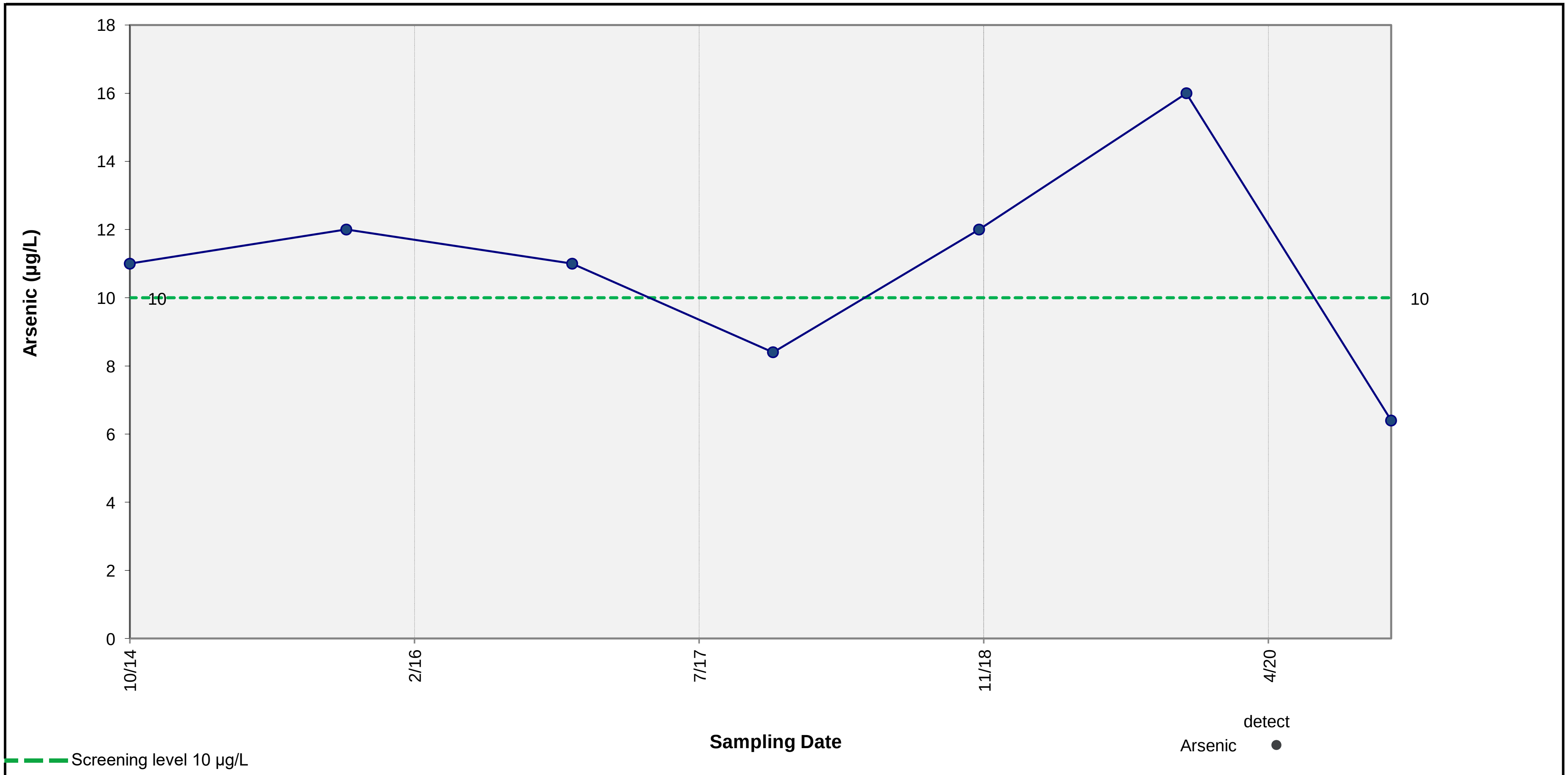
Median Slope Estimate = 5.7E-02 µg/L Per Day

95% Confidence Interval = -1.8E-01 to 2.0E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-04

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-40



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.500 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

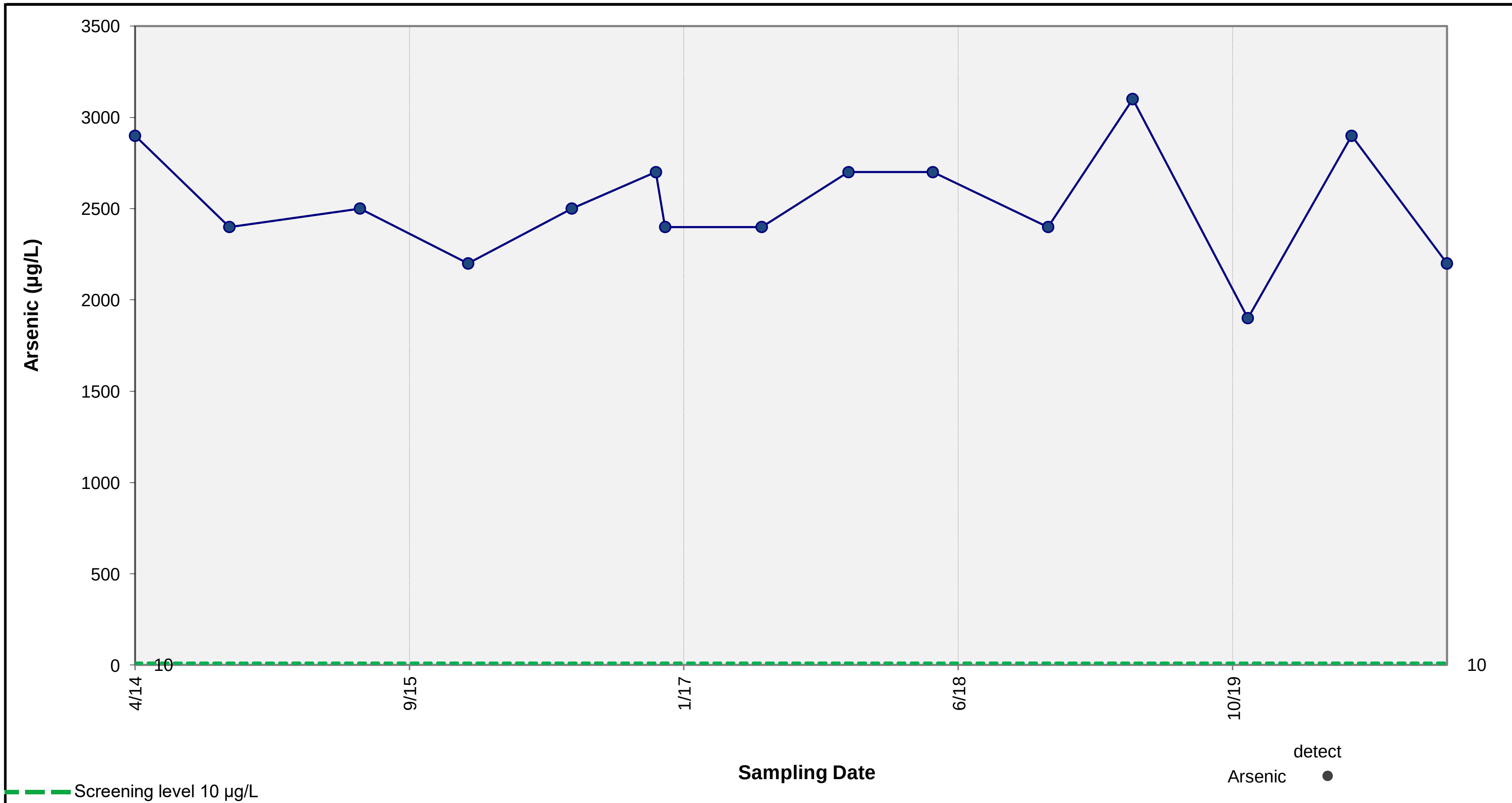
Median Slope Estimate = 0.0E+00 µg/L Per Day

95% Confidence Interval = -4.6E-03 to 2.7E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-05

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-41



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.460 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

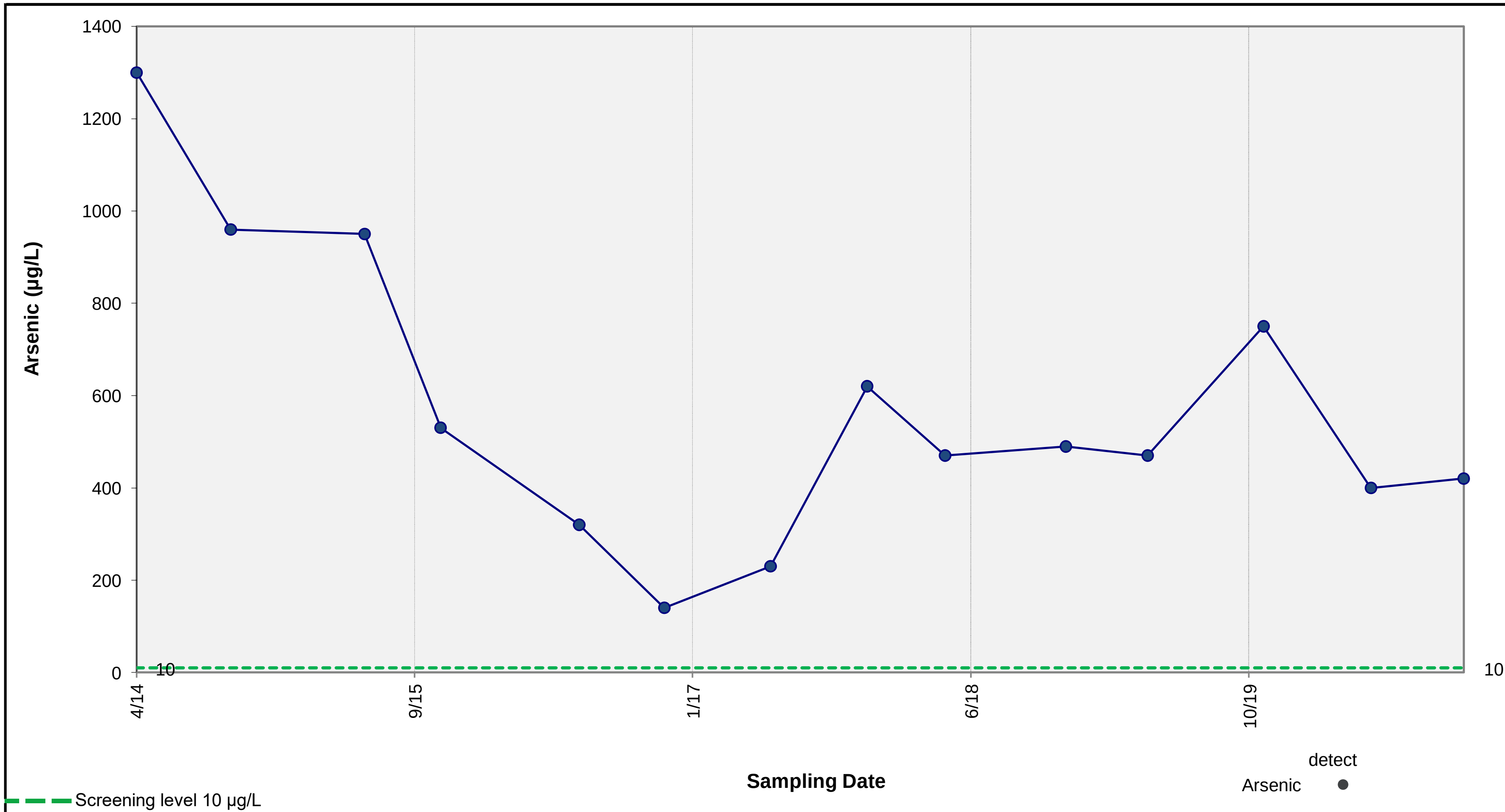
Median Slope Estimate = 0.0E+00 µg/L Per Day

95% Confidence Interval = -2.9E-01 to 2.7E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-06

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-42



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.056 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

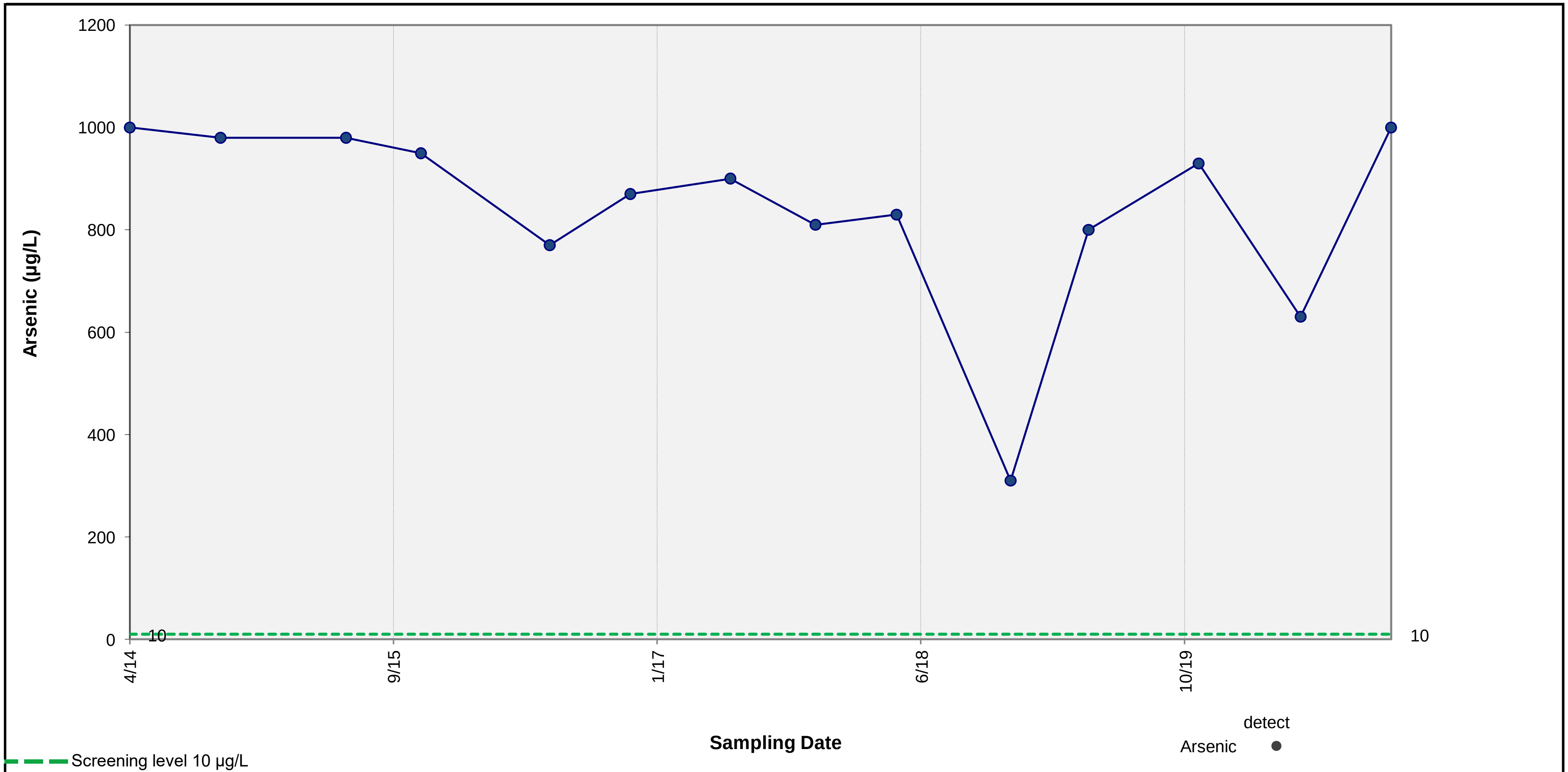
Median Slope Estimate = -1.7E-01 µg/L Per Day

95% Confidence Interval = -3.9E-01 to 7.4E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-07

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-43



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.039 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

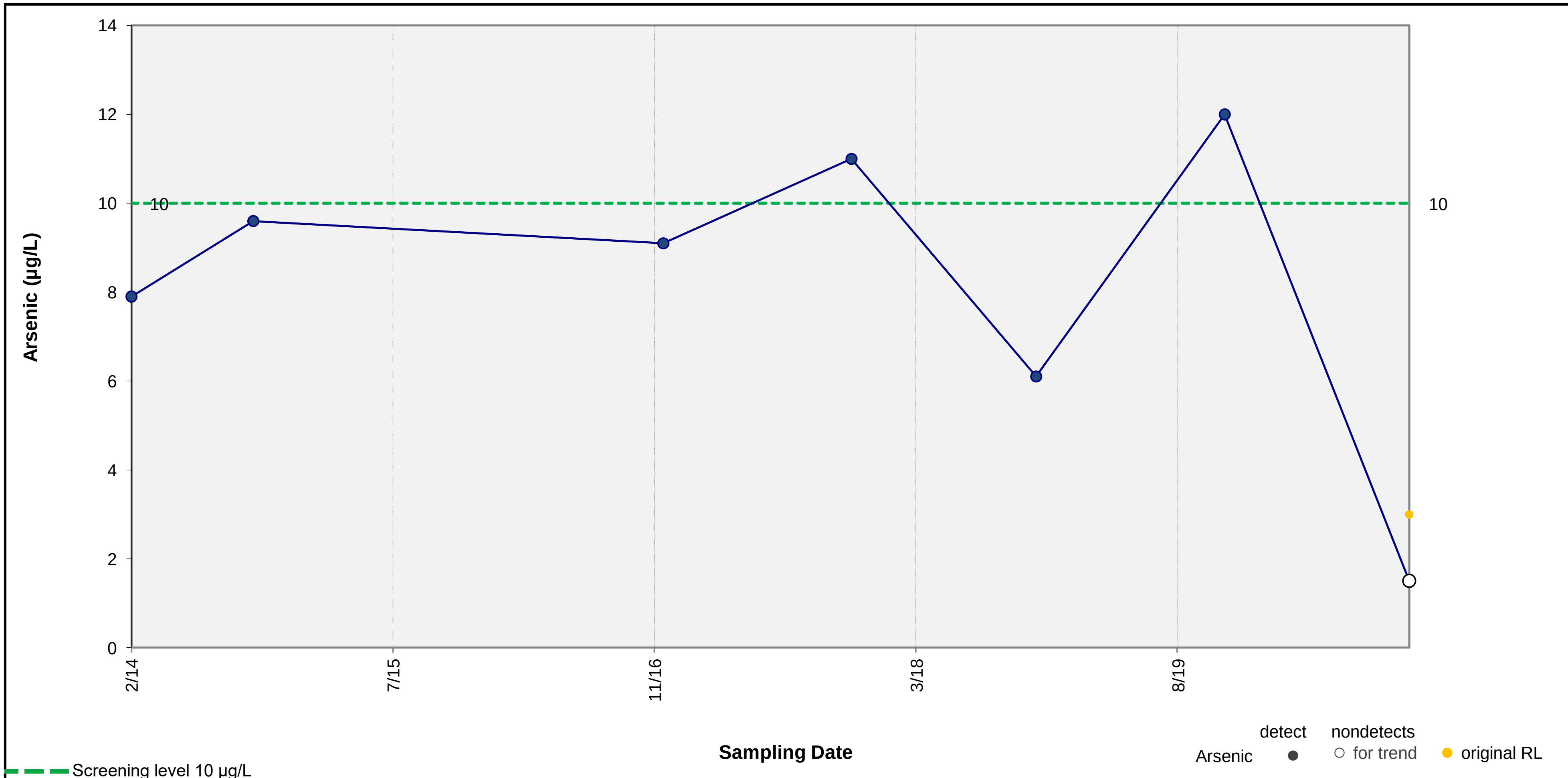
Median Slope Estimate = -1.1E-01 µg/L Per Day

95% Confidence Interval = -1.9E-01 to 3.1E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-08

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-44



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.500 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

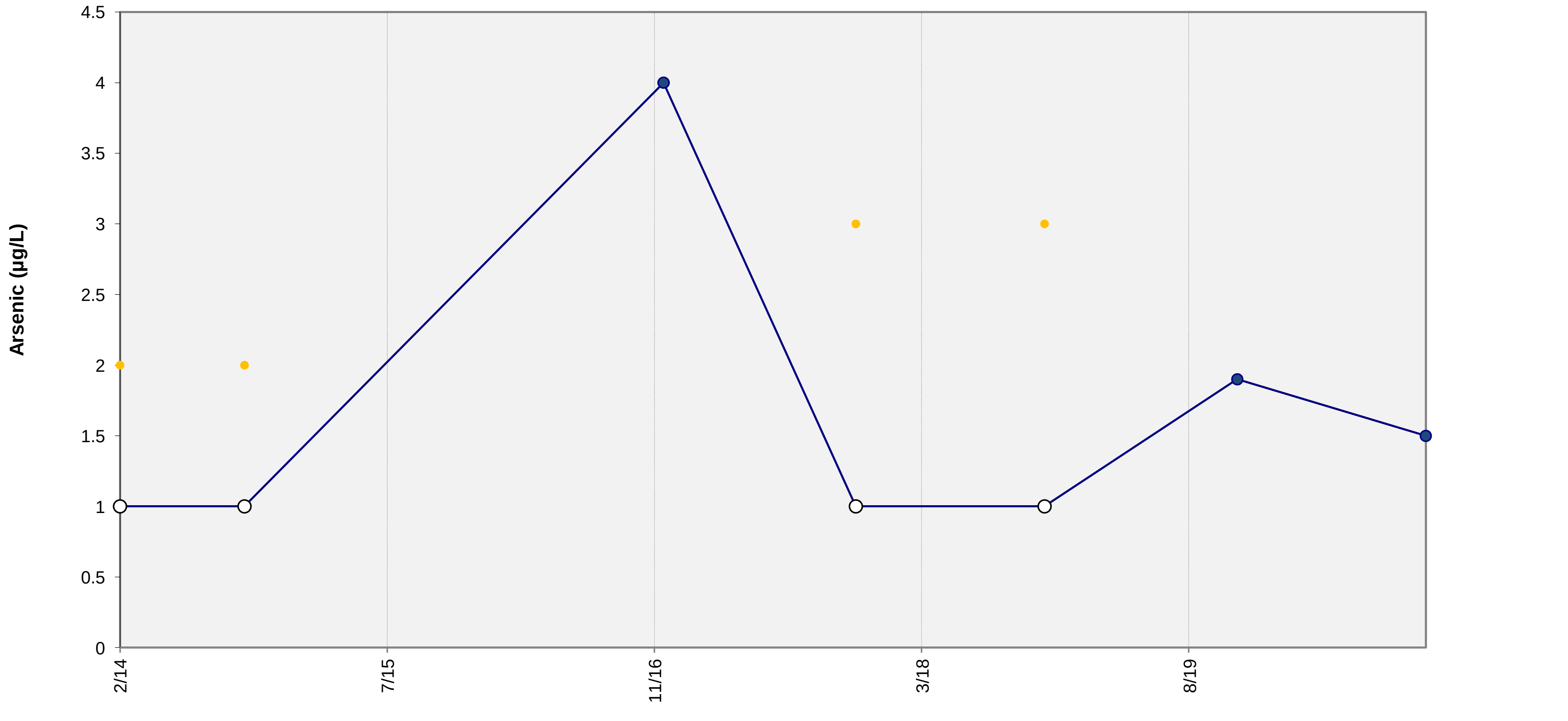
Median Slope Estimate = -6.4E-04 µg/L Per Day

95% Confidence Interval = -6.5E-03 to 2.3E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-14D

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-45



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.281 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Frequency of Detection < 50%)**

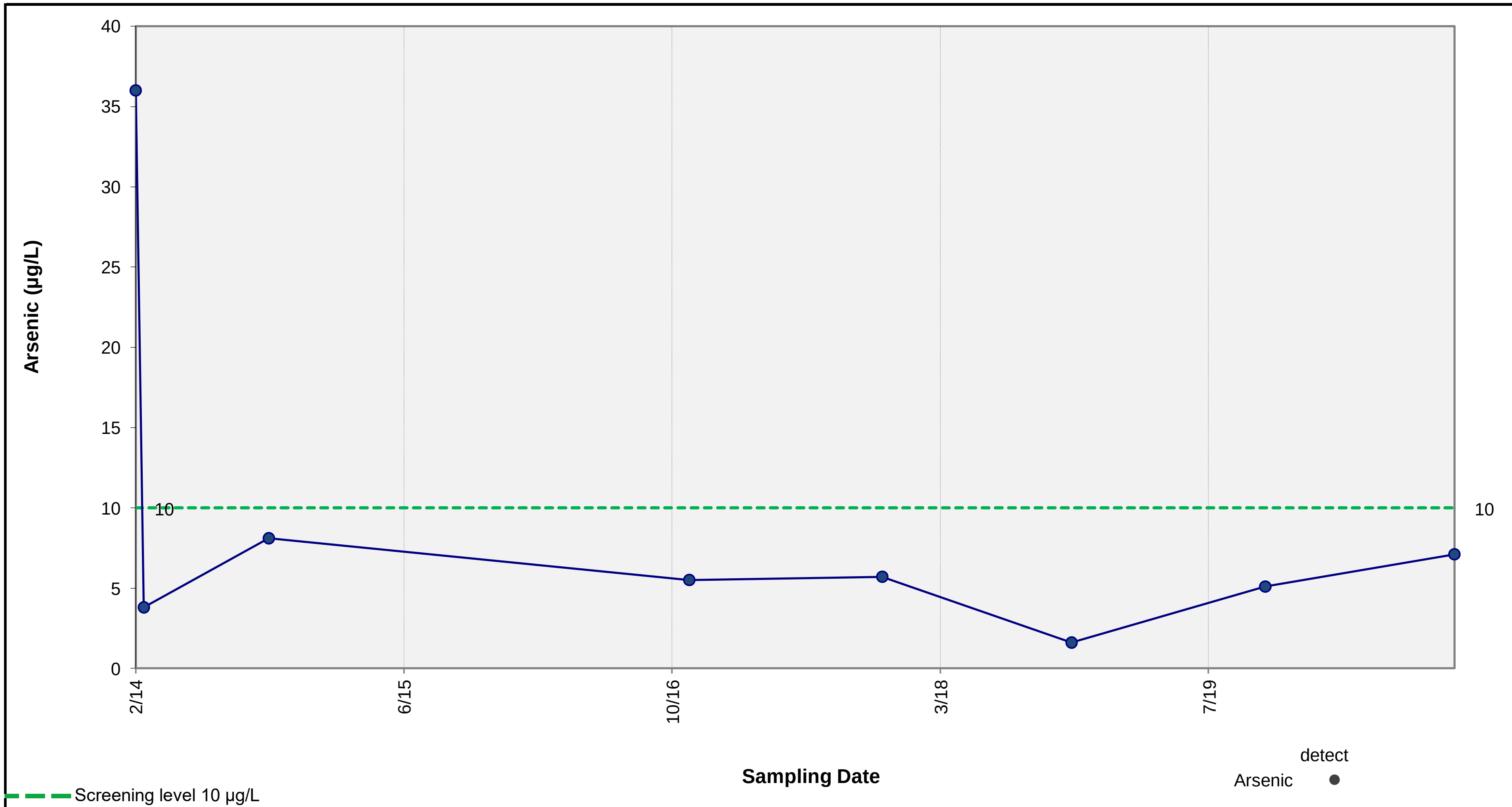
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-14S

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-46



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.274 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

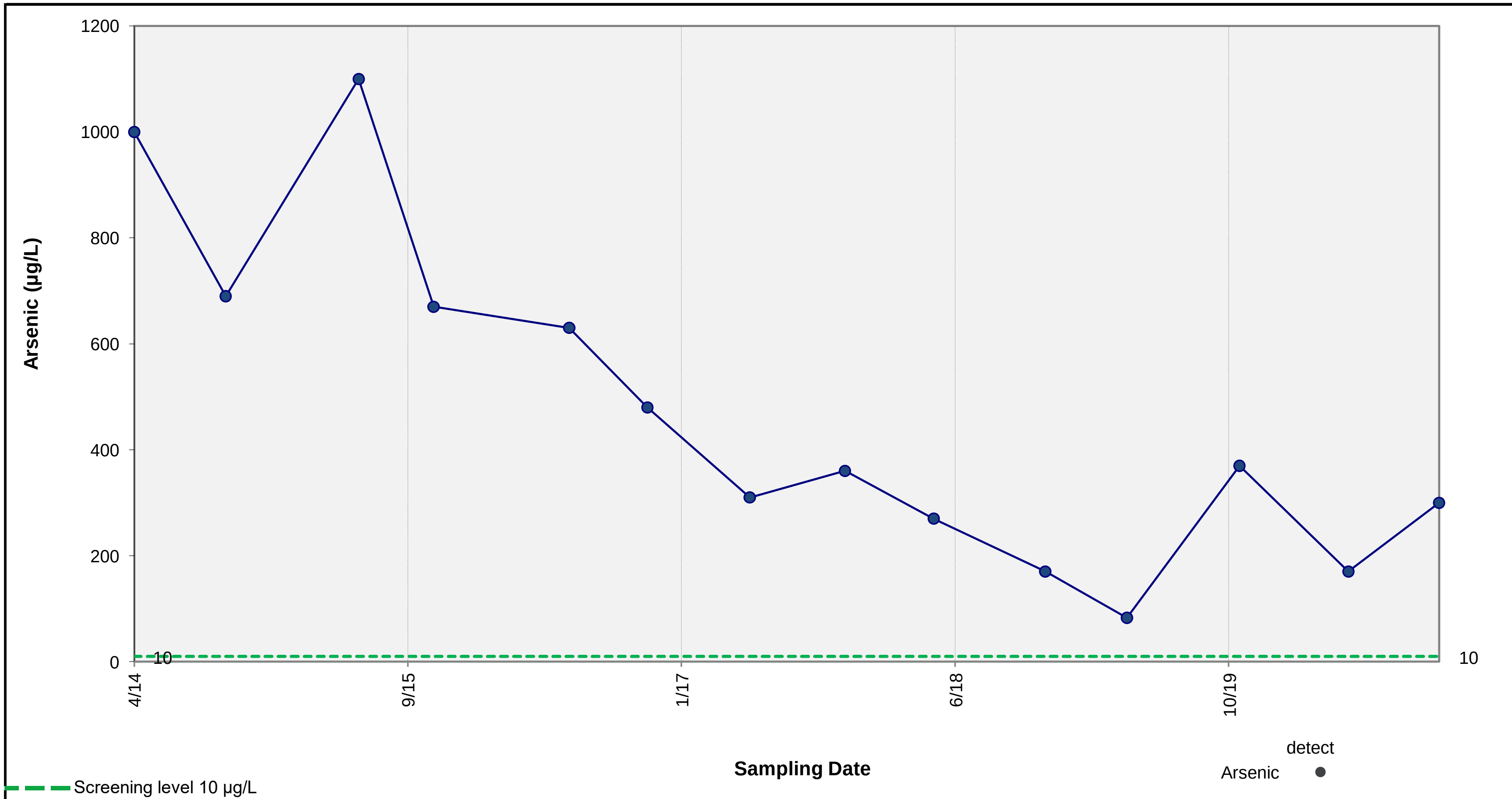
Median Slope Estimate = -1.1E-03 µg/L Per Day

95% Confidence Interval = -1.4E-02 to 1.3E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-13-15

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-47



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = <0.001 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

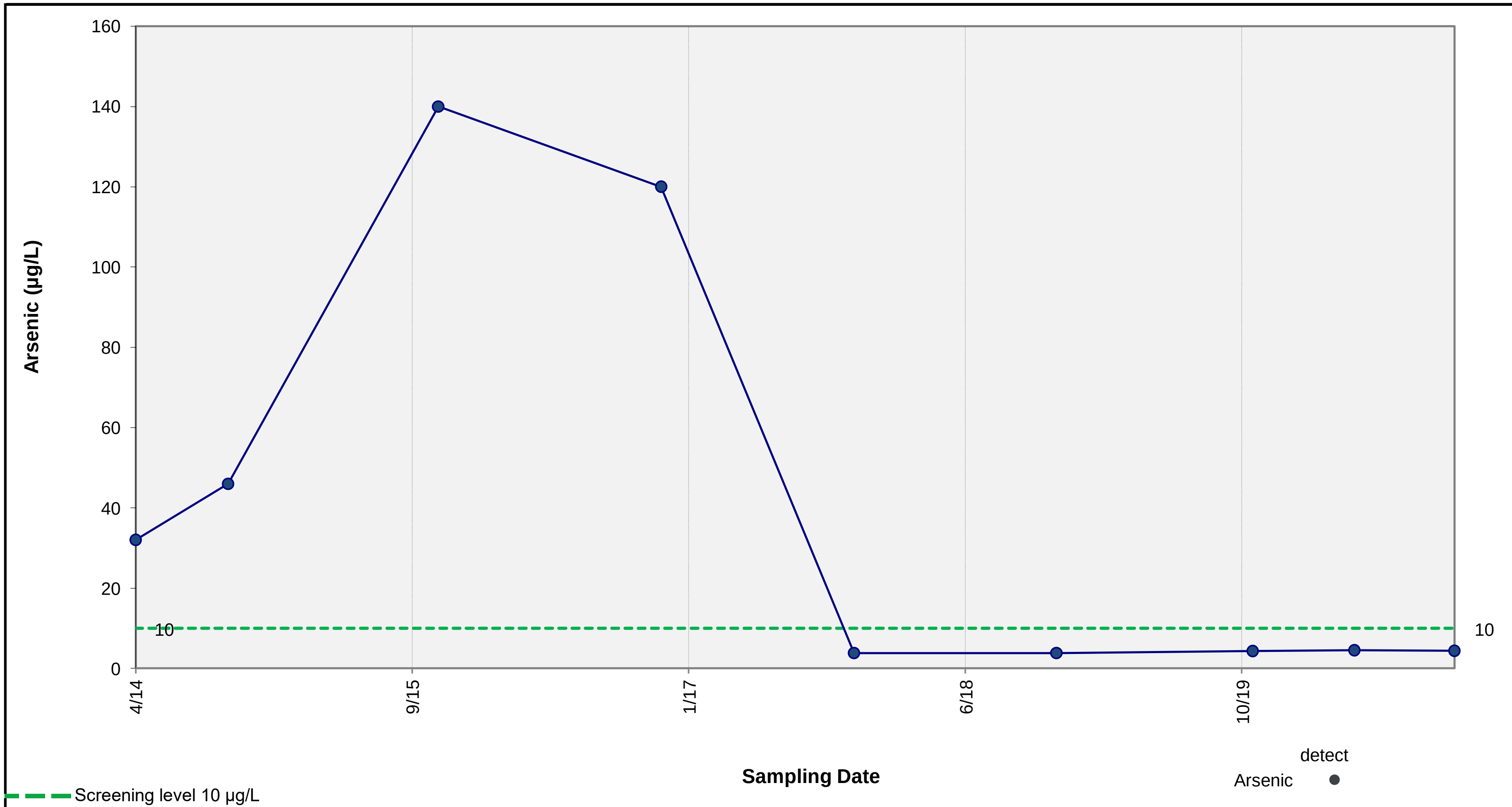
Median Slope Estimate = -3.7E-01 µg/L Per Day

95% Confidence Interval = -5.1E-01 to -2.0E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-93-22B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-48



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.209 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

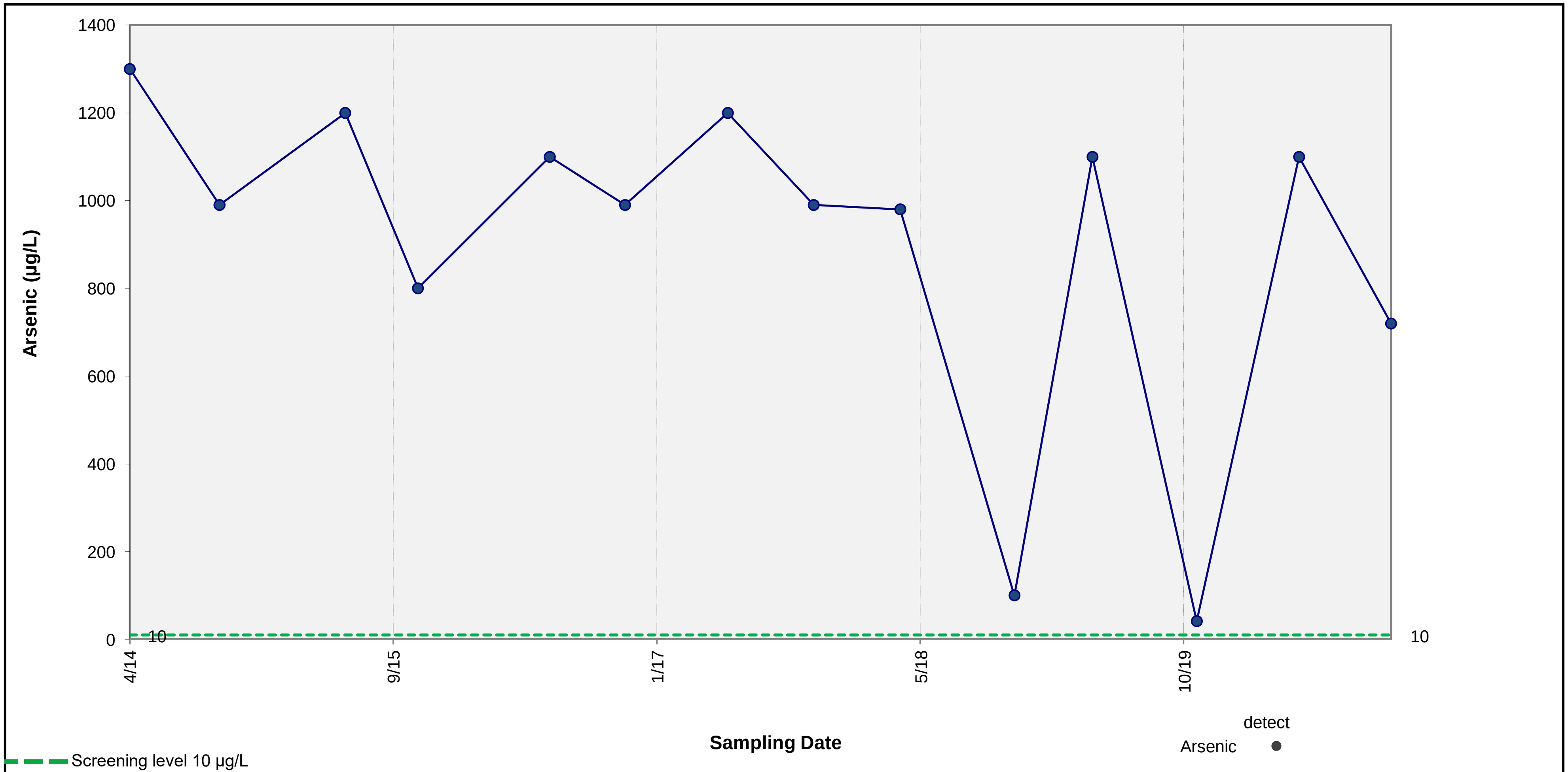
Median Slope Estimate = -1.5E-02 µg/L Per Day

95% Confidence Interval = -8.1E-02 to 7.9E-04 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-93-22C

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-49



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.034 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No trend**

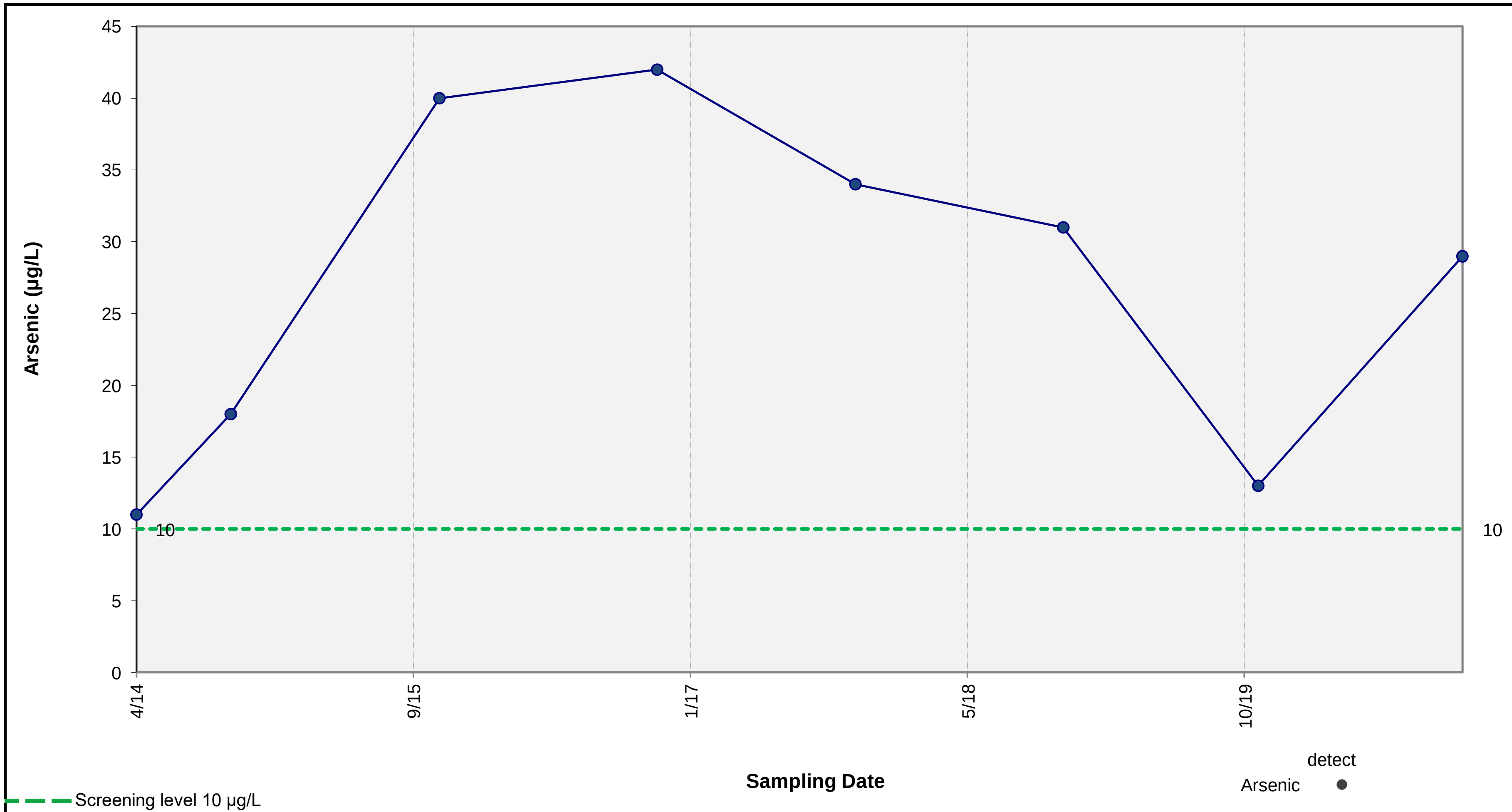
Median Slope Estimate = -1.8E-01 µg/L Per Day

95% Confidence Interval = -5.1E-01 to 0.0E+00 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-96-5B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-50



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.548 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

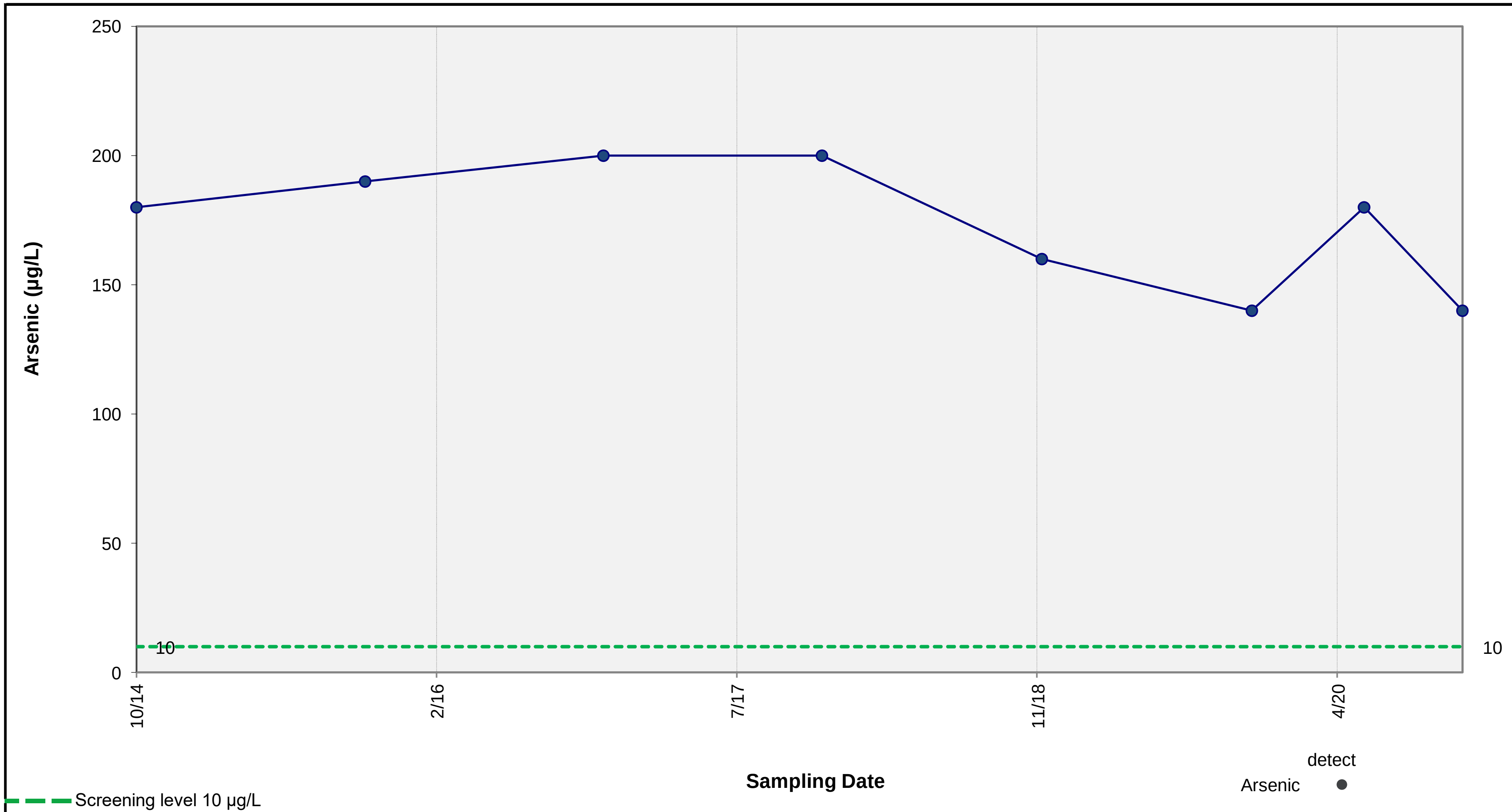
Median Slope Estimate = -8.5E-04 µg/L Per Day

95% Confidence Interval = -1.5E-02 to 1.7E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-96-5C

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-51



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.114 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

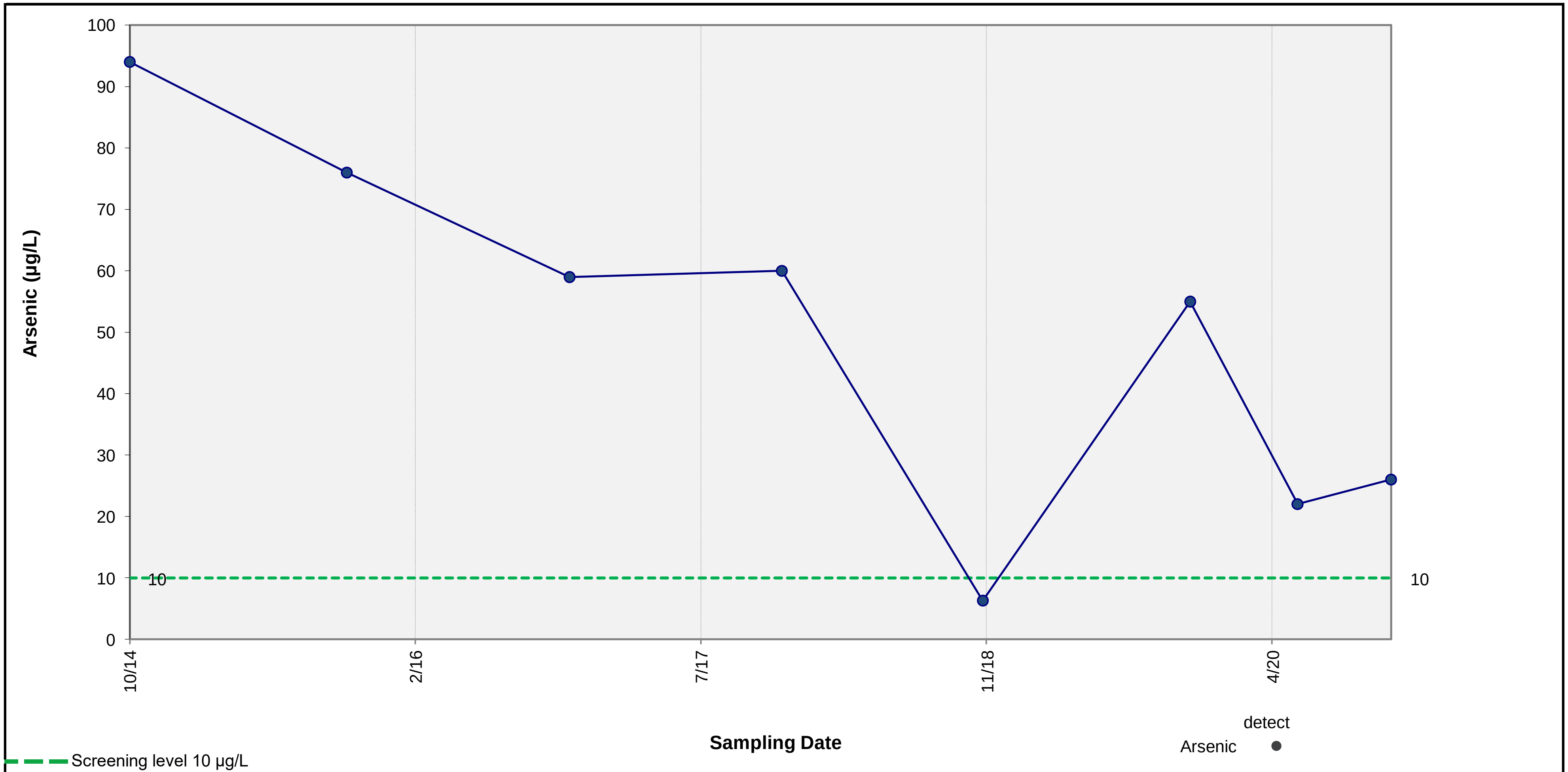
Median Slope Estimate = -2.0E-02 µg/L Per Day

95% Confidence Interval = -5.5E-02 to 9.7E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-99-31C

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-52



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.016 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

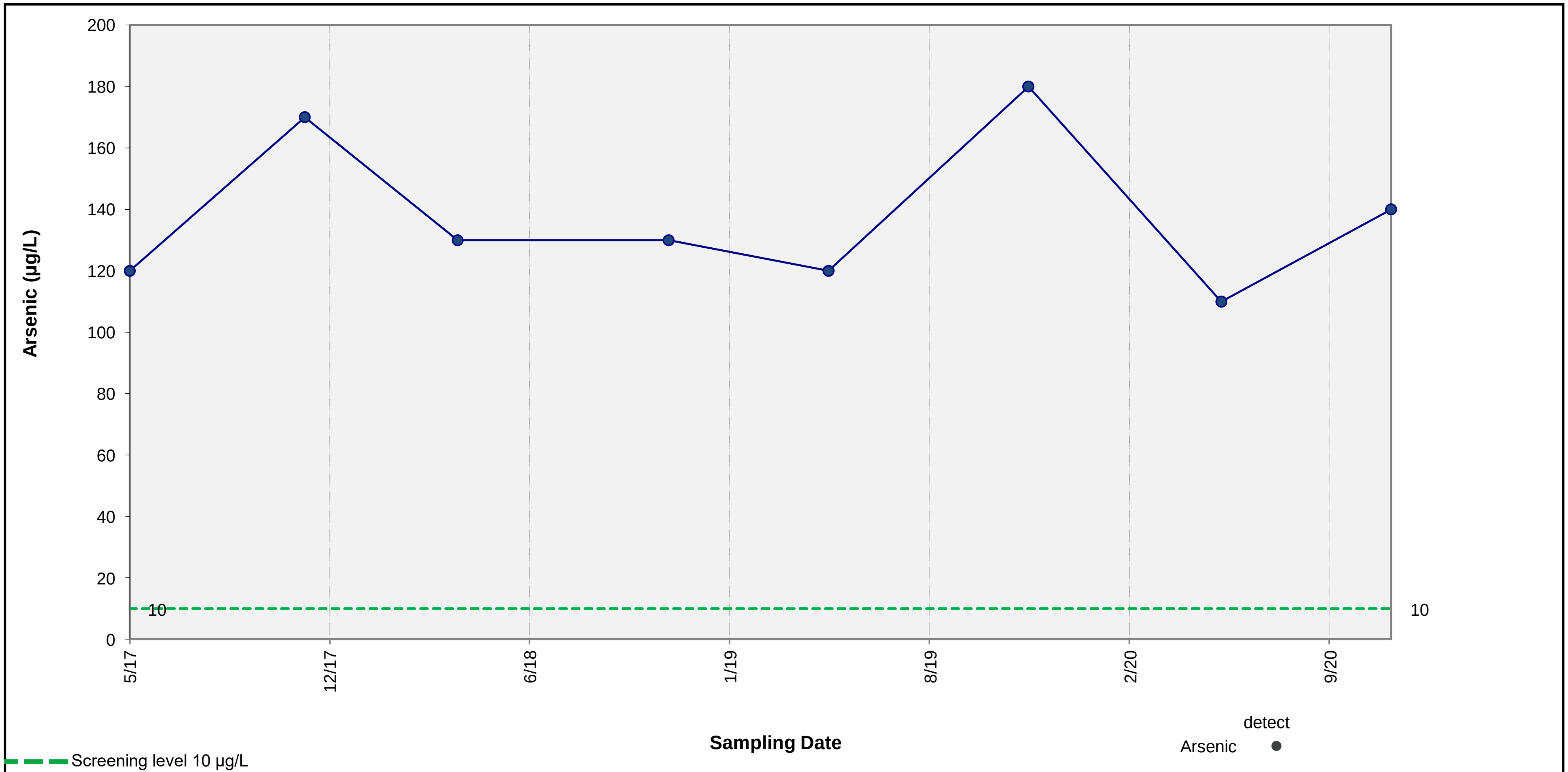
Median Slope Estimate = -3.0E-02 µg/L Per Day

95% Confidence Interval = -5.8E-02 to -7.6E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHM-99-32X

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-53



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.548 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

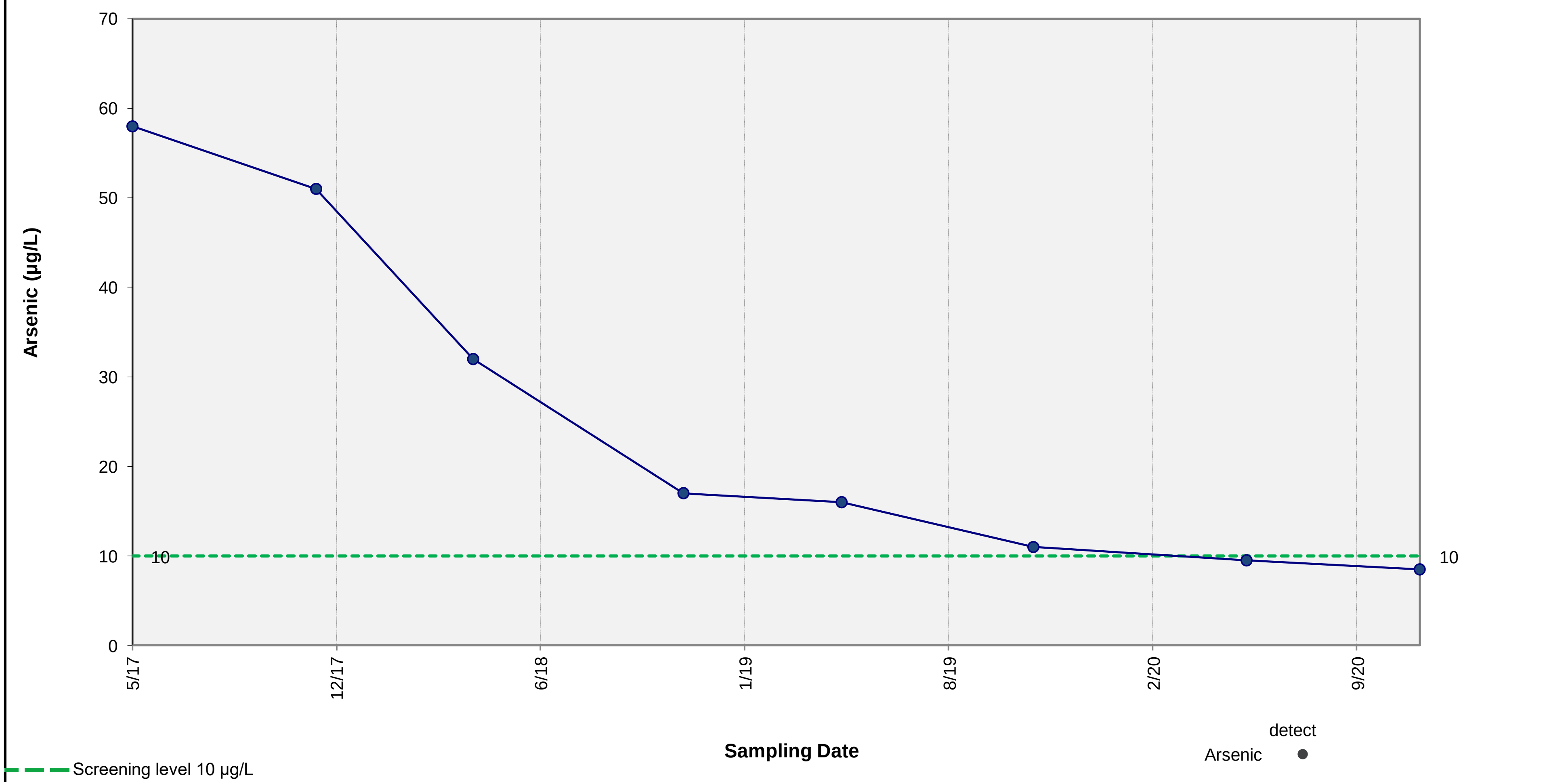
Median Slope Estimate = 0.0E+00 µg/L Per Day

95% Confidence Interval = -6.5E-02 to 3.5E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-1B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-54

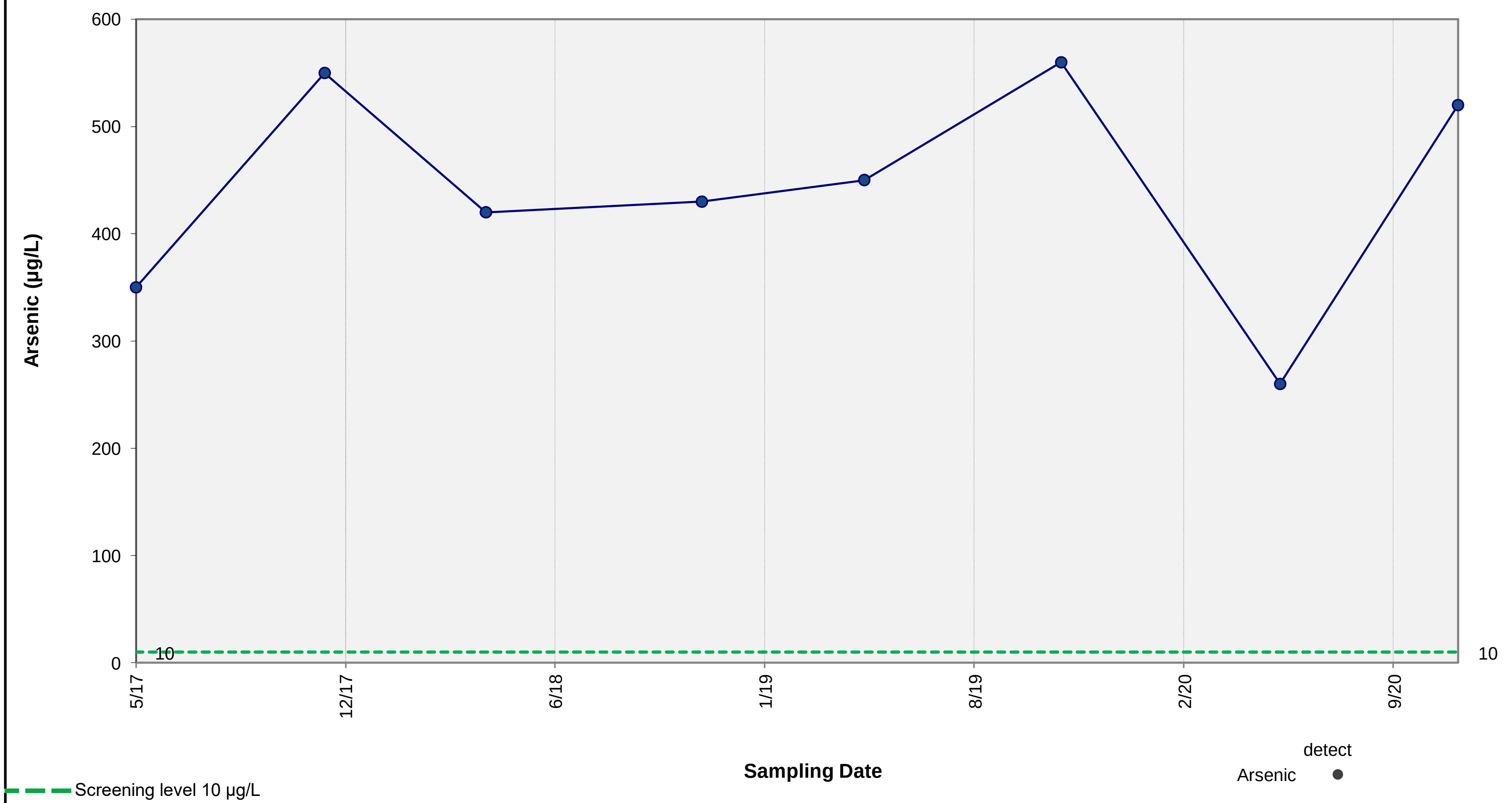


Results of Mann-Kendall Test for Trend:	**DECREASING TREND**			
	p value =	<0.001	Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).	
Results of Sen's Estimator of Slope:	**DECREASING TREND**			
	Median Slope Estimate =	-3.9E-02	µg/L Per Day	
	95% Confidence Interval =	-6.7E-02	to	-1.4E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-2A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-55



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.274 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

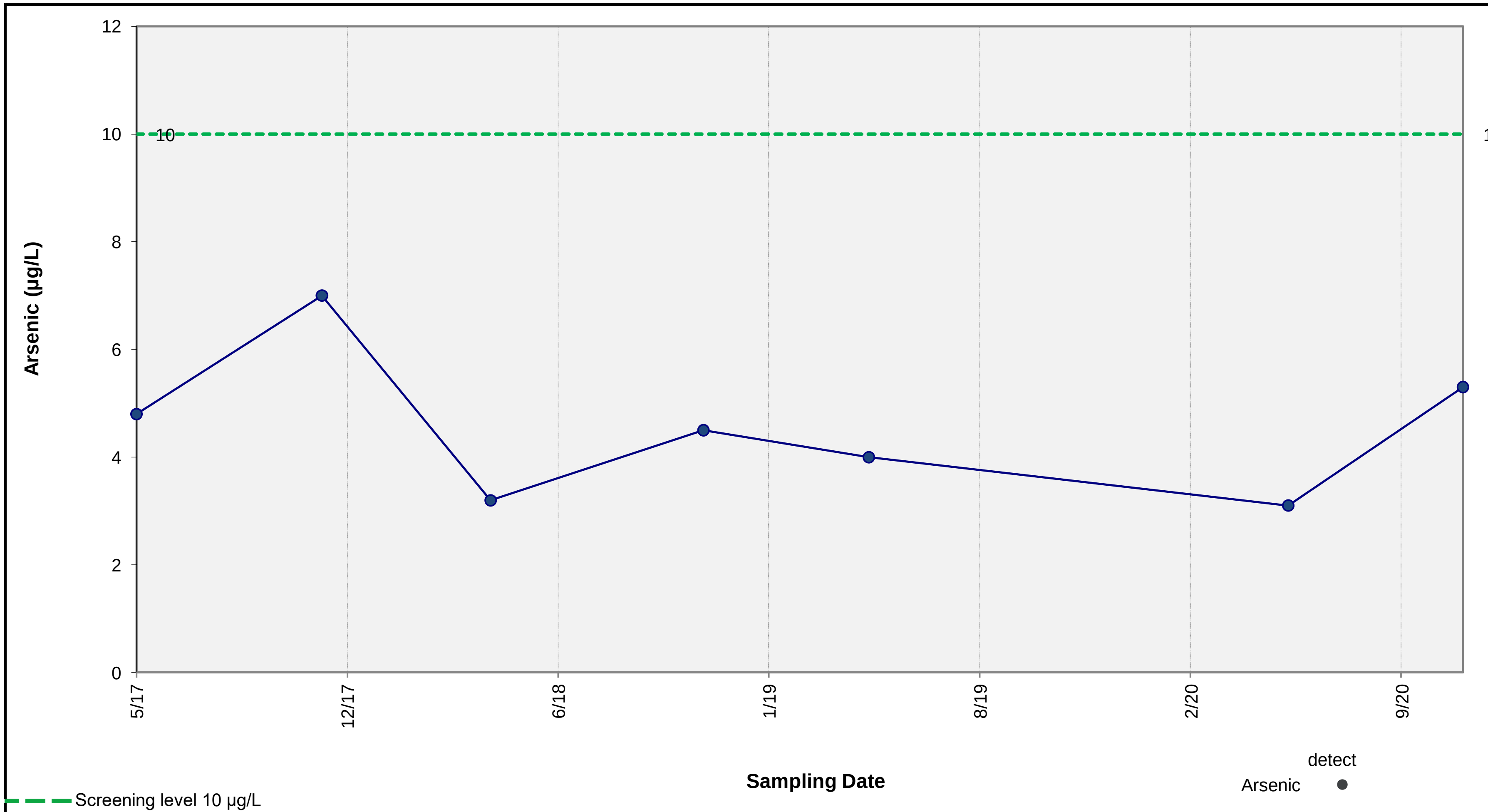
Median Slope Estimate = 9.5E-02 µg/L Per Day

95% Confidence Interval = -3.0E-01 to 2.0E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-2B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-56



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.281 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

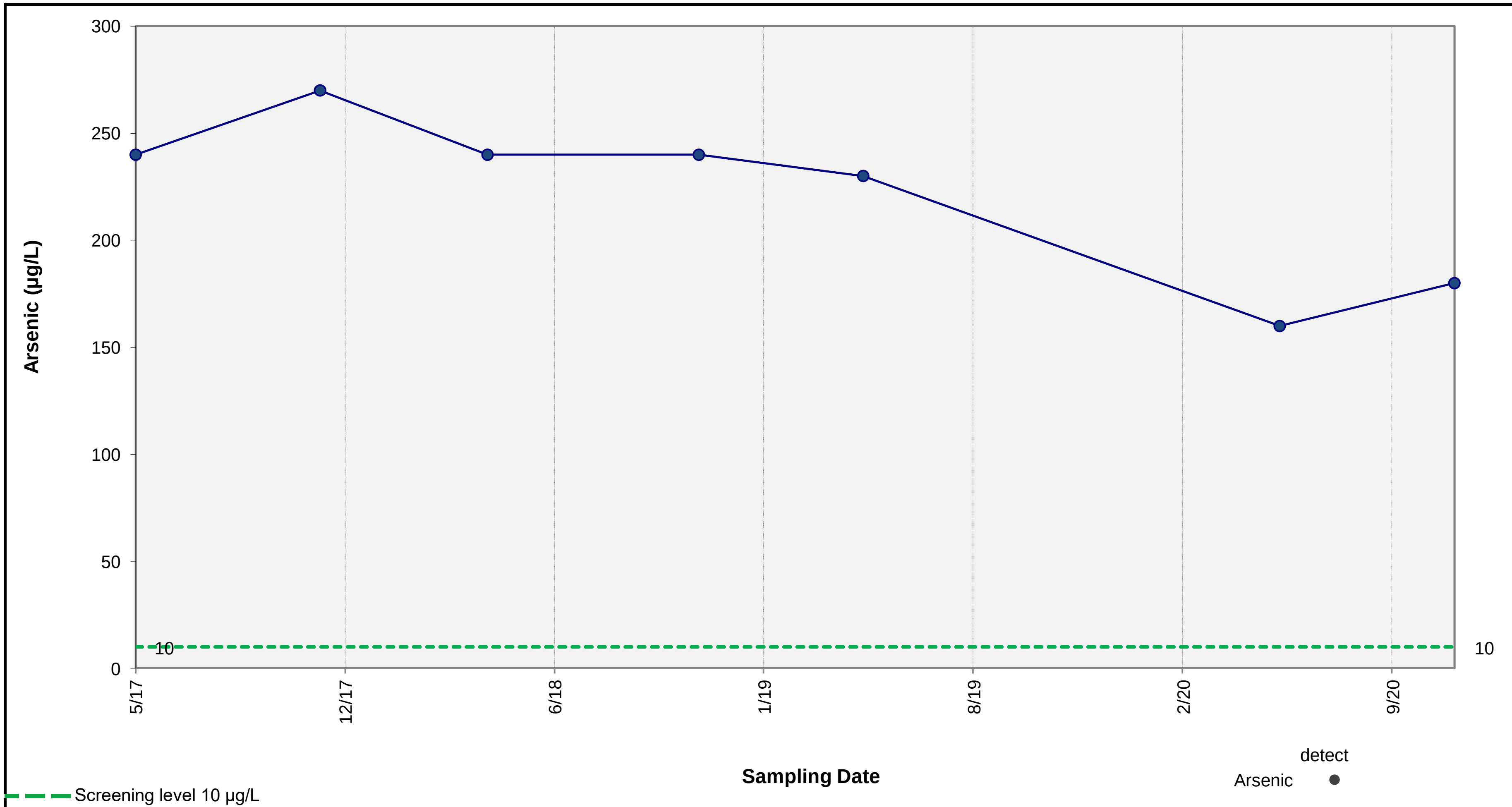
Median Slope Estimate = -1.2E-03 µg/L Per Day

95% Confidence Interval = -4.8E-03 to 2.3E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-3A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-57



Results of Mann-Kendall Test for Trend: **DECREASING TREND**

p value = 0.025 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **DECREASING TREND**

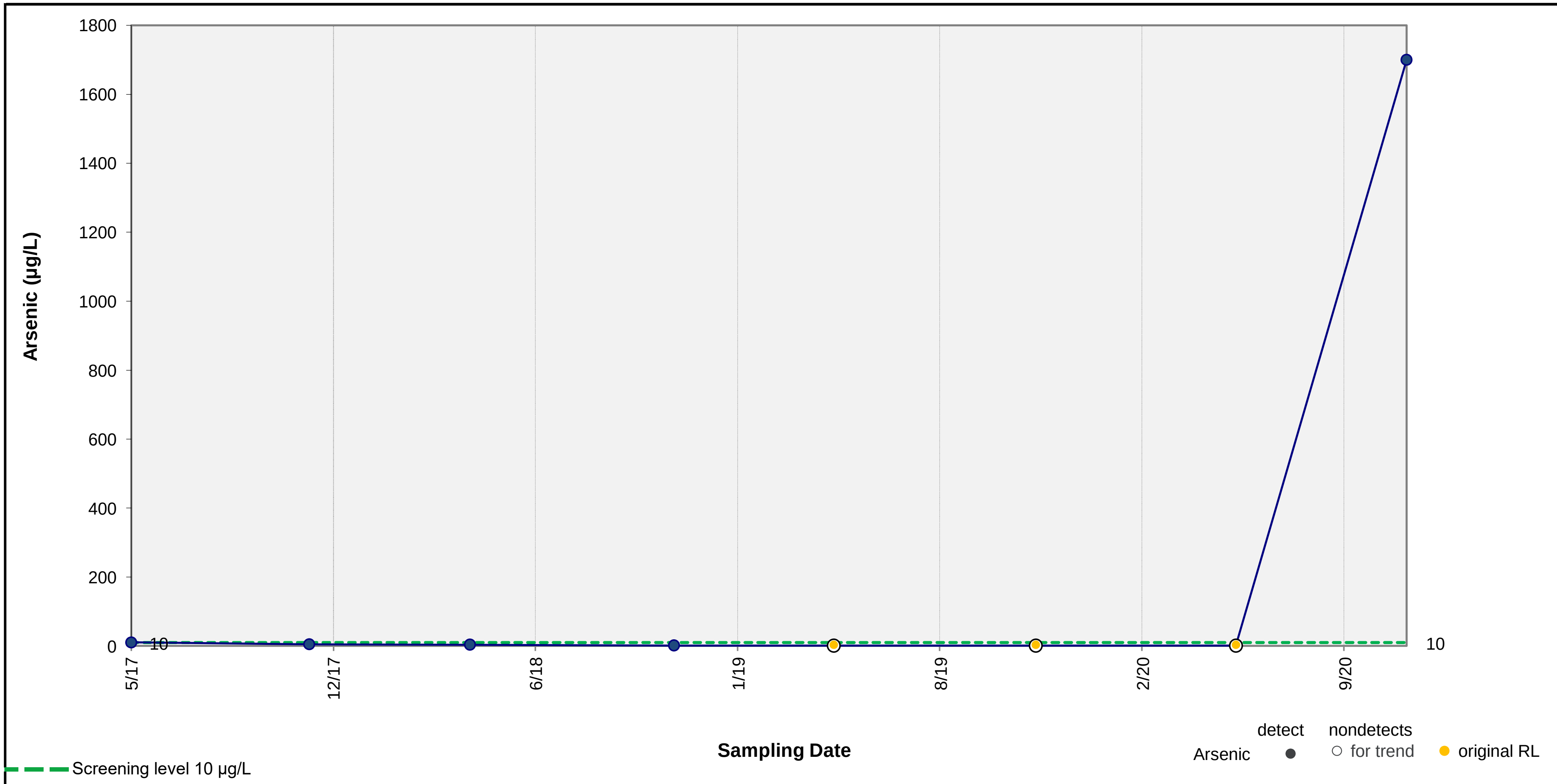
Median Slope Estimate = -7.3E-02 µg/L Per Day

95% Confidence Interval = -1.2E-01 to -3.6E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-3B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-58



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.114 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

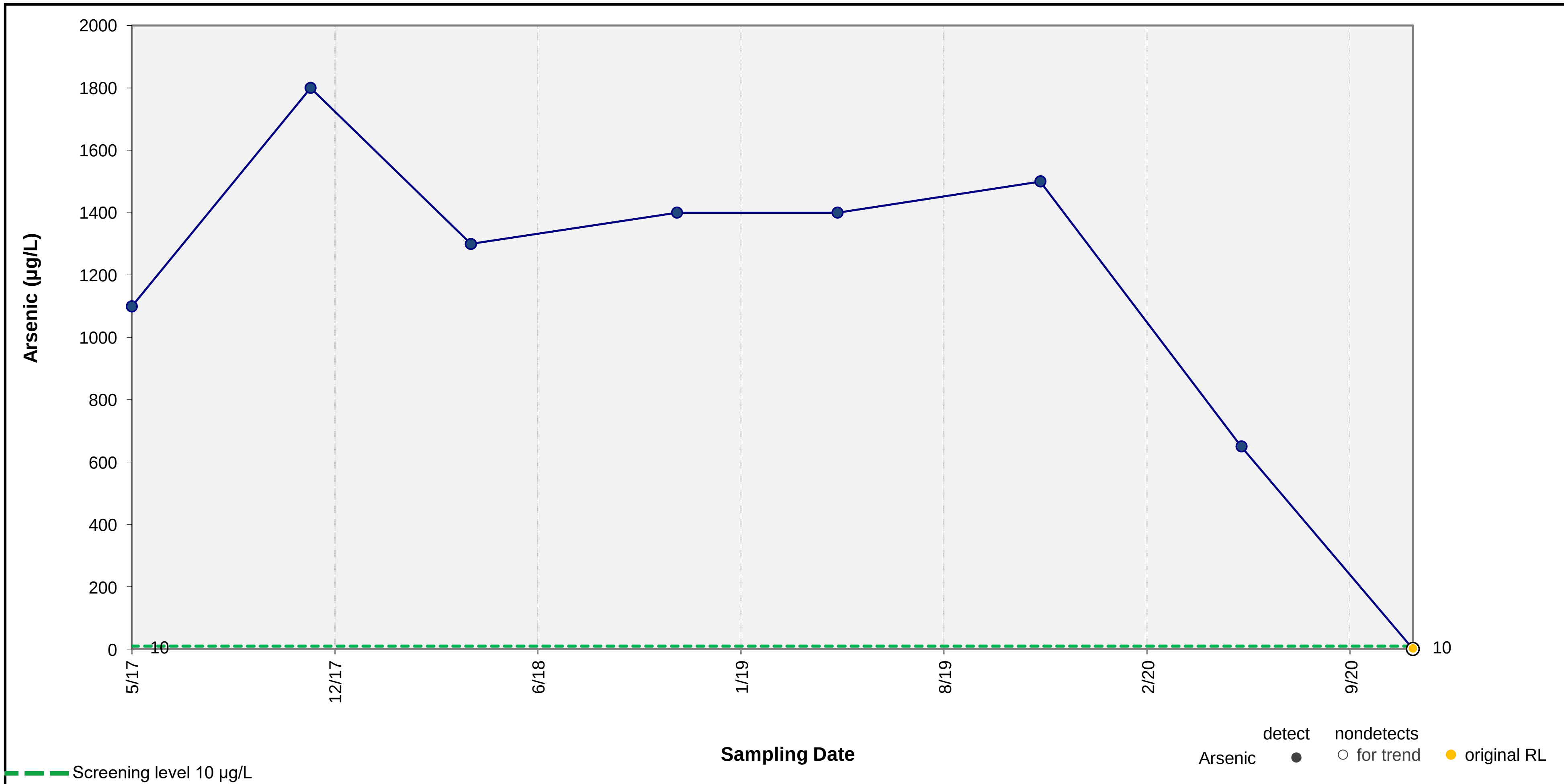
Median Slope Estimate = -4.5E-03 µg/L Per Day

95% Confidence Interval = -9.8E-03 to 9.3E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-4A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-59



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.237 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

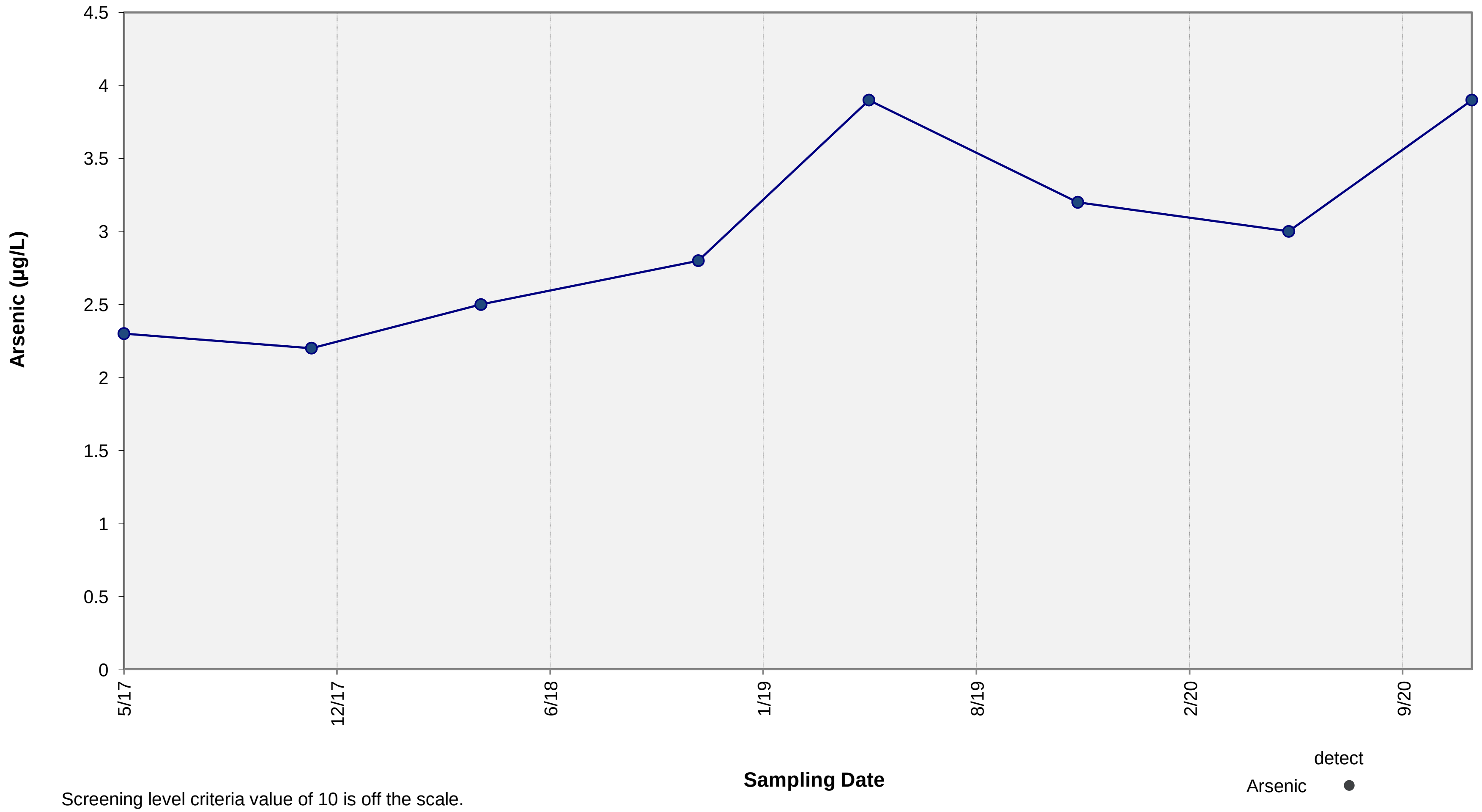
Median Slope Estimate = -8.1E-01 µg/L Per Day

95% Confidence Interval = -1.9E+00 to 4.2E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-4B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-60



Screening level criteria value of 10 is off the scale.

Results of Mann-Kendall Test for Trend: **INCREASING TREND**

p value = 0.012 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **INCREASING TREND**

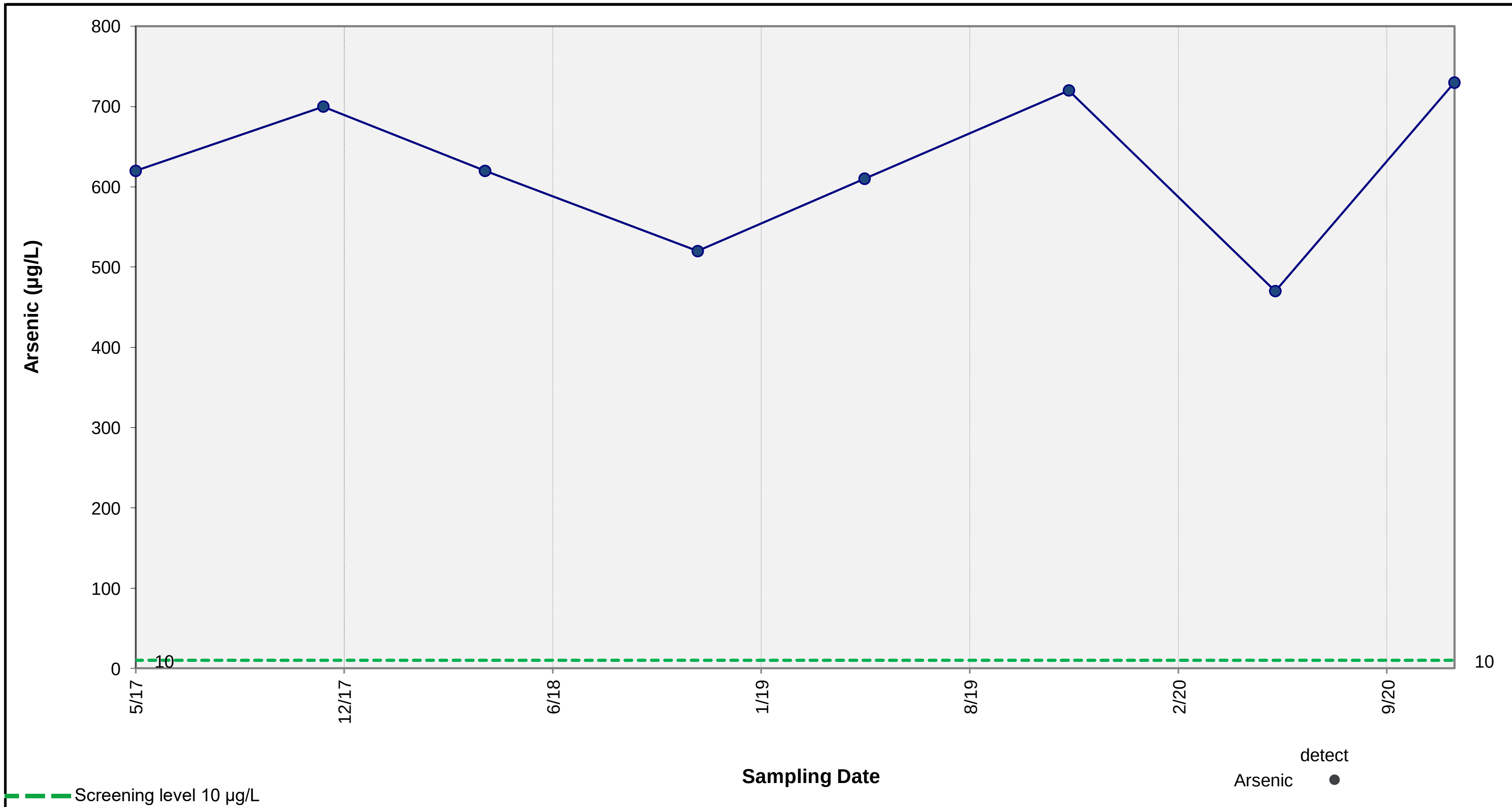
Median Slope Estimate = 1.3E-03 µg/L Per Day

95% Confidence Interval = 3.9E-04 to 1.9E-03 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-5A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-61



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.500 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

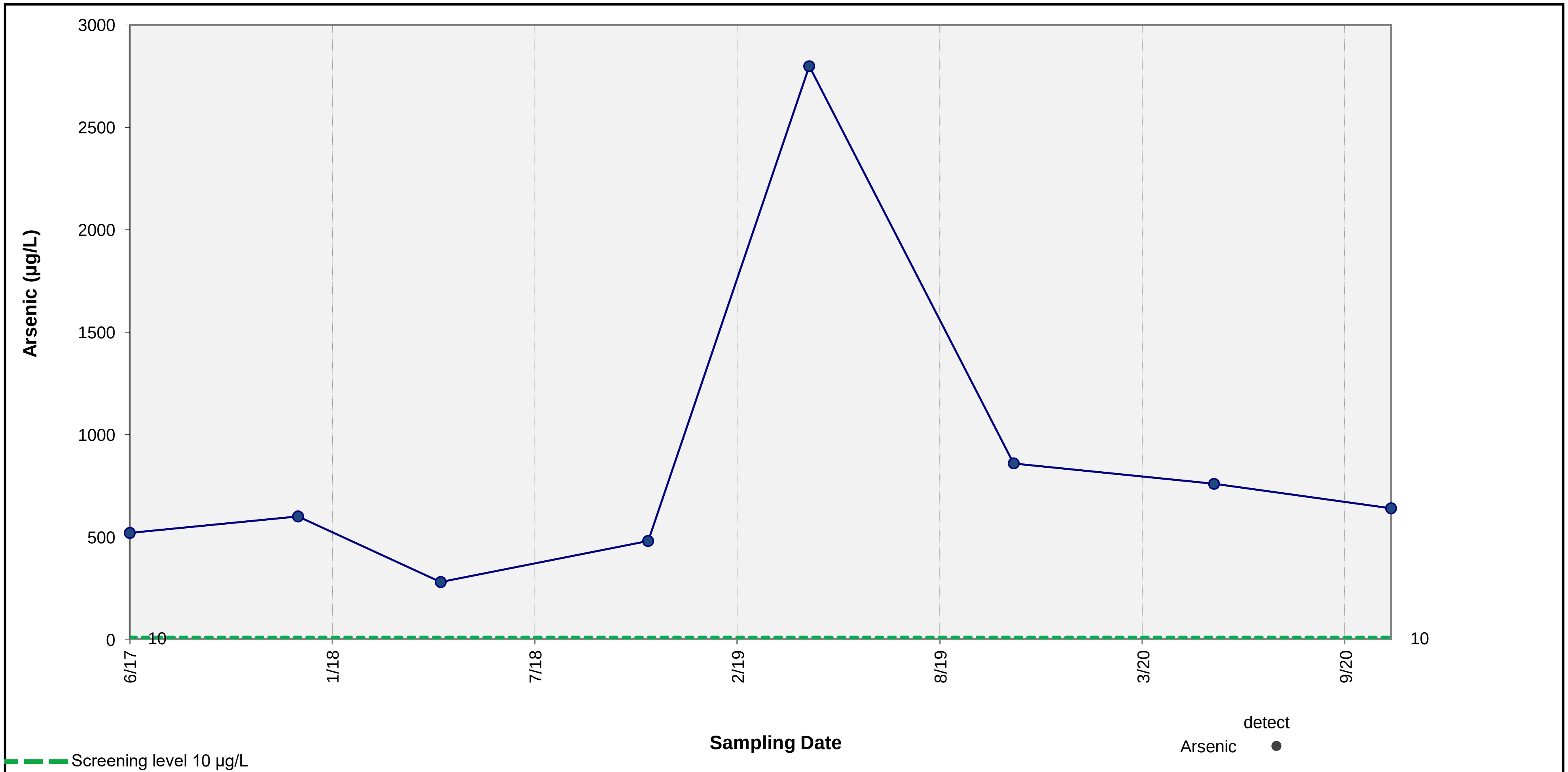
Median Slope Estimate = 1.4E-02 µg/L Per Day

95% Confidence Interval = -2.4E-01 to 2.1E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-5B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-62



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.199 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

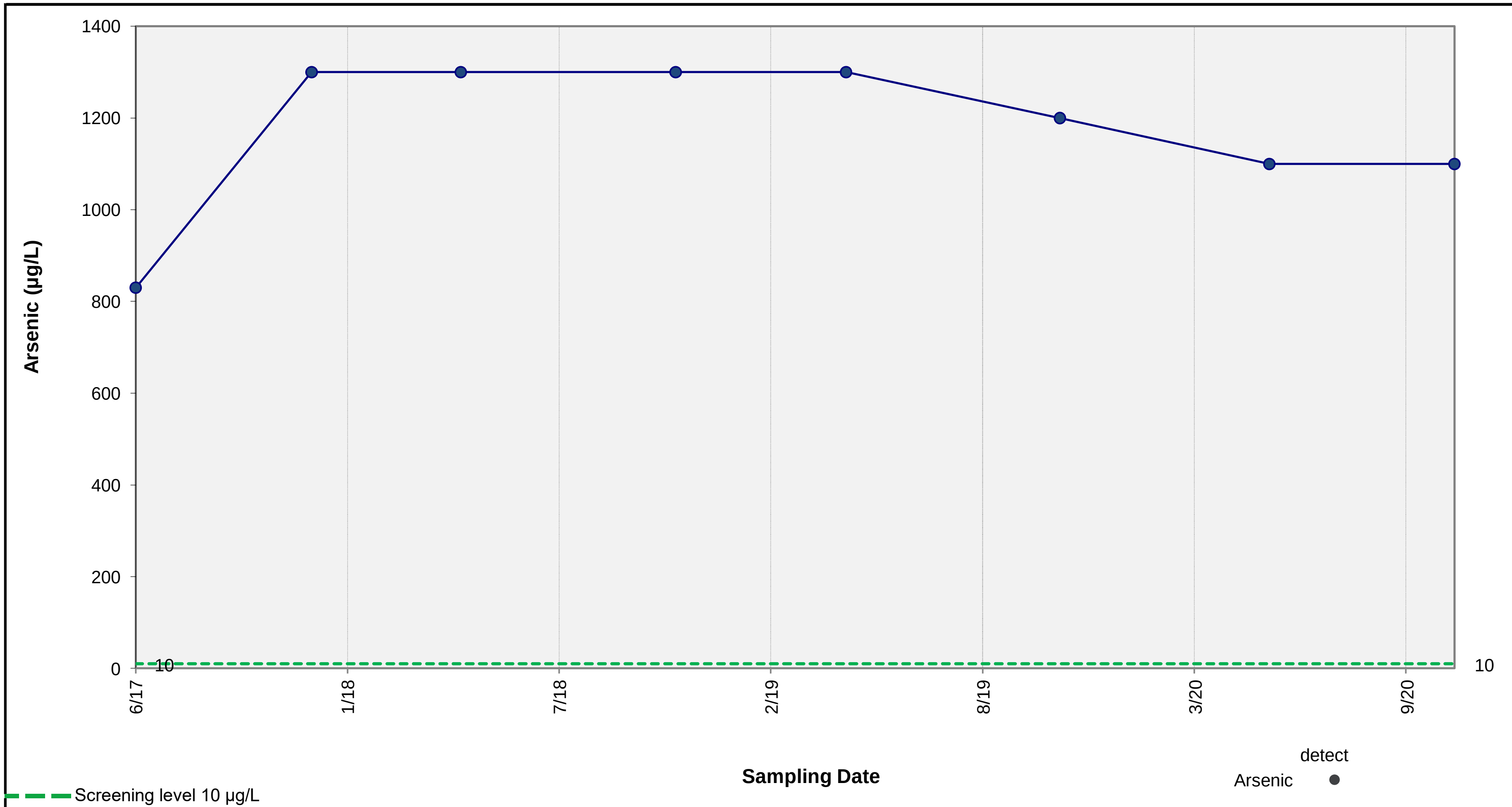
Median Slope Estimate = 2.2E-01 µg/L Per Day

95% Confidence Interval = -6.8E-01 to 9.5E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-06A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-63



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.237 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

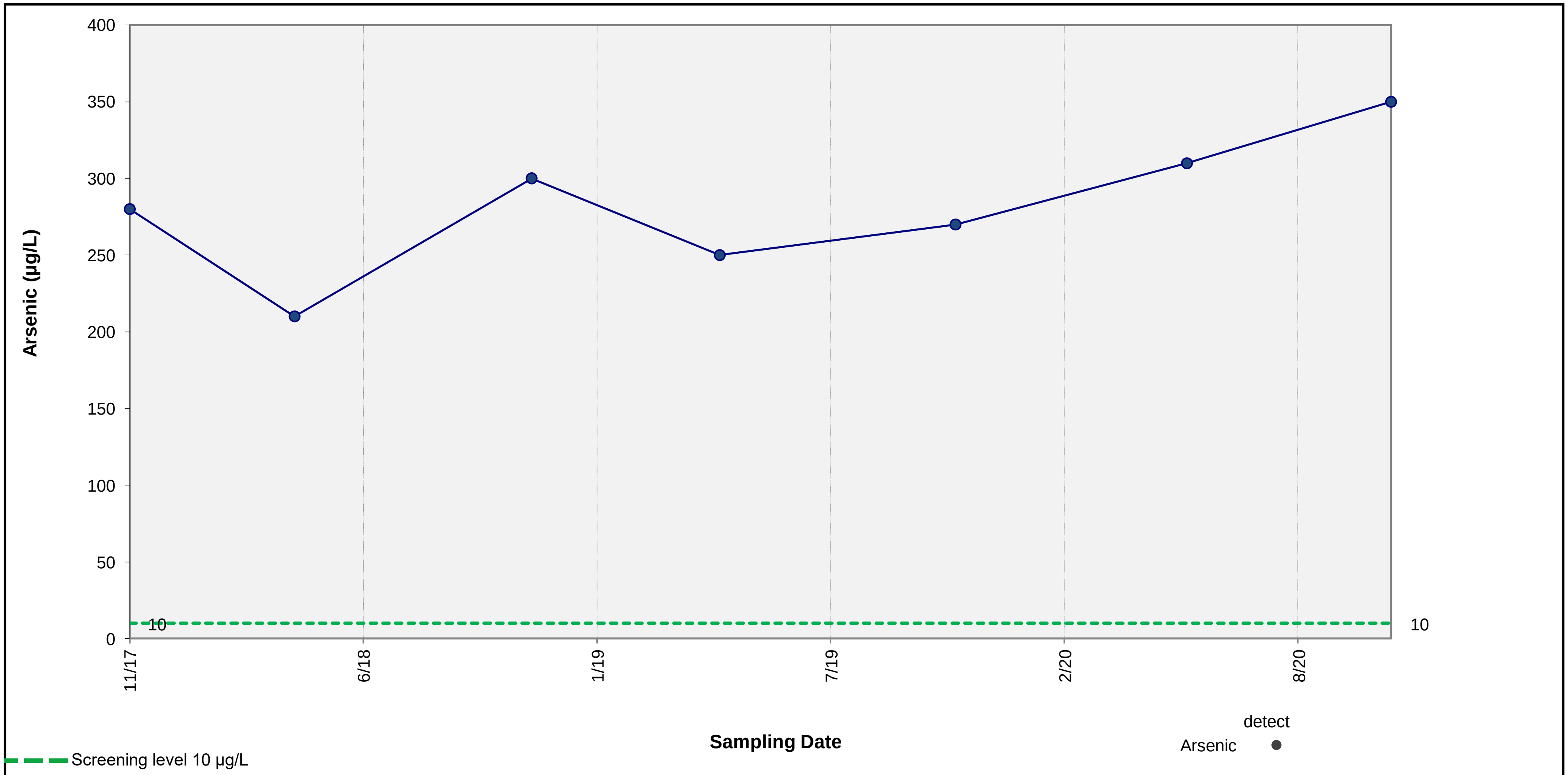
Median Slope Estimate = -7.1E-02 µg/L Per Day

95% Confidence Interval = -2.7E-01 to 6.8E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-06B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-64



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.068 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

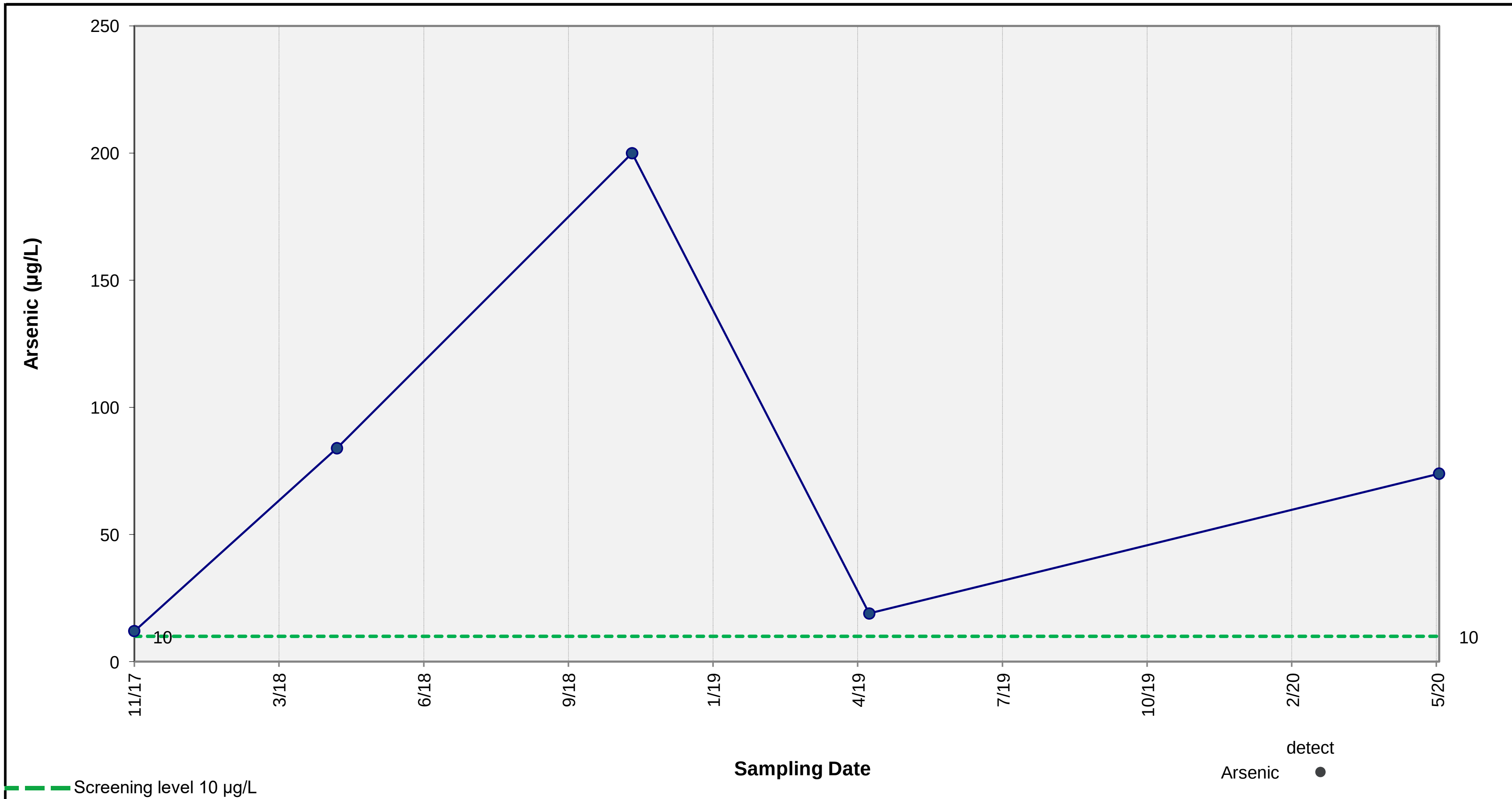
Median Slope Estimate = 9.9E-02 µg/L Per Day

95% Confidence Interval = -6.0E-02 to 1.7E-01 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-06C

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-65



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.408 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **Not Analyzed (Sample Size < 6)**

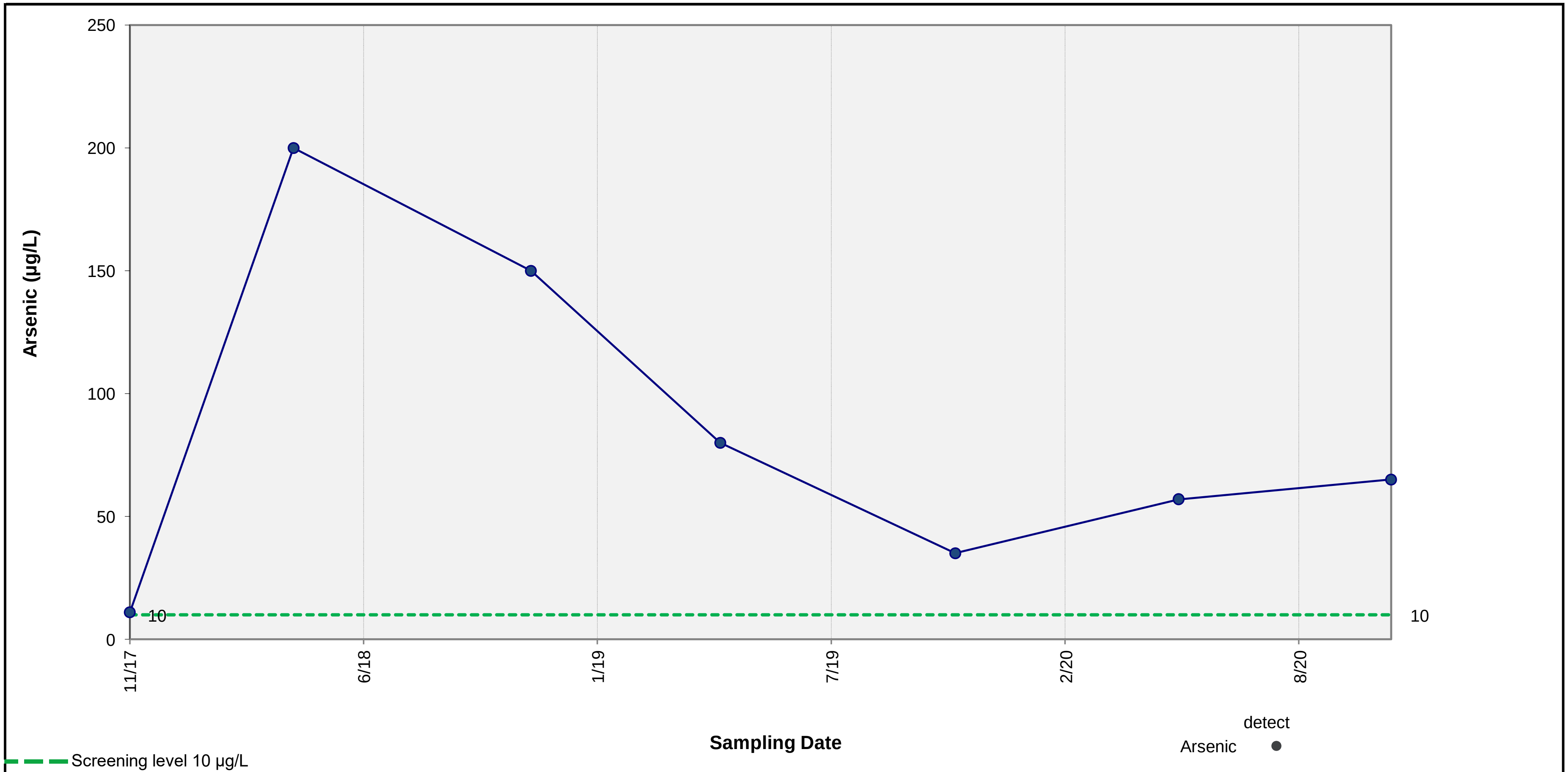
Median Slope Estimate = NA µg/L Per Day

95% Confidence Interval = NA to NA µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-07A

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-66



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.386 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

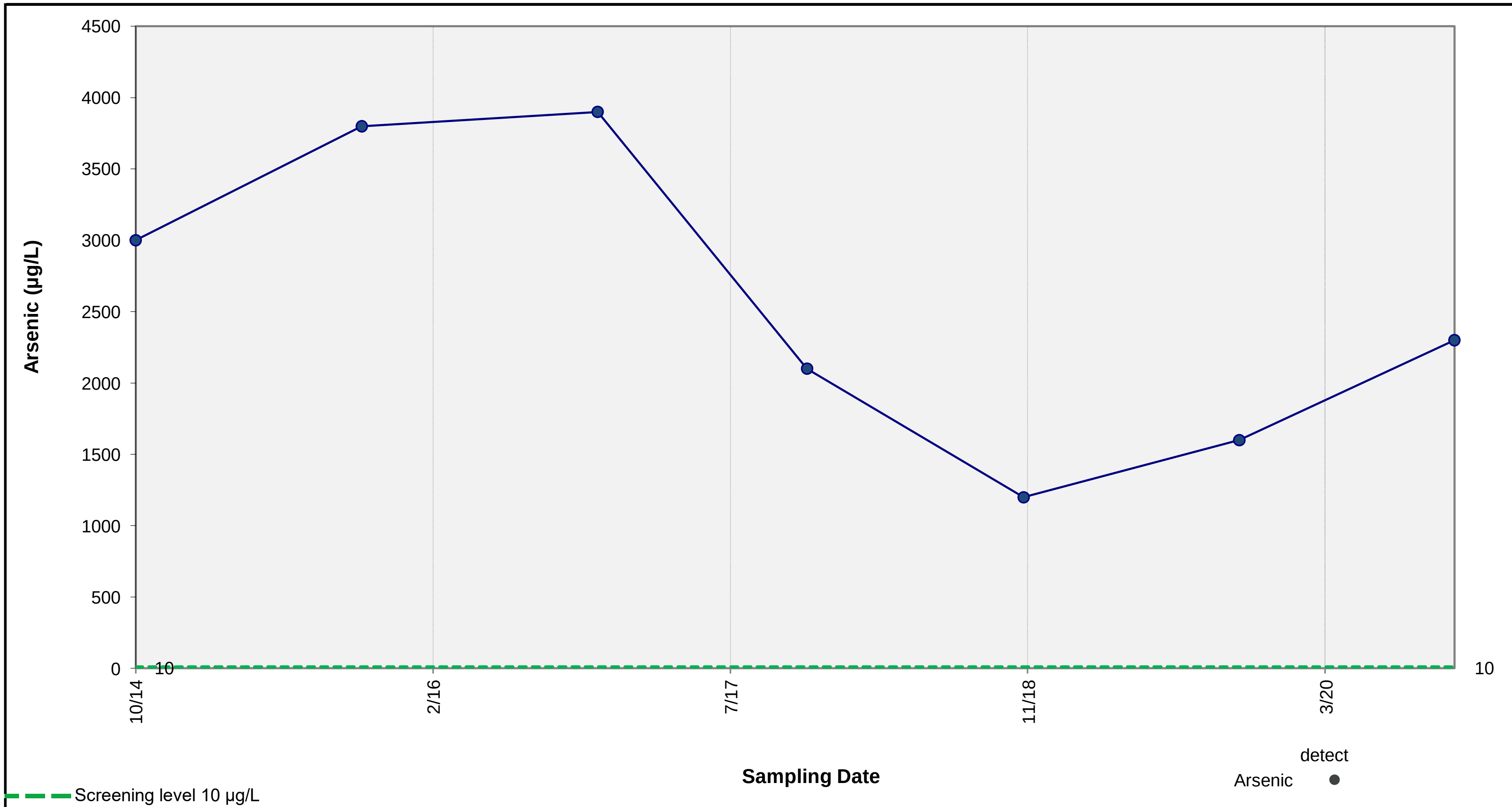
Median Slope Estimate = -5.9E-02 µg/L Per Day

95% Confidence Interval = -2.9E-01 to 8.1E-02 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-2016-07B

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-67



Results of Mann-Kendall Test for Trend: **No Significant Trend**

p value = 0.191 Note: p value < 0.05 indicates a statistically significant trend (95% confidence level).

Results of Sen's Estimator of Slope: **No Significant Trend**

Median Slope Estimate = -8.0E-01 µg/L Per Day

95% Confidence Interval = -2.3E+00 to 1.1E+00 µg/L Per Day

Concentration vs. Time Plot – Arsenic in Well SHP-99-29X

Shepleys Hill Landfill, Devens, Massachusetts

FIGURE D-68

Appendix E

Non-Potential Drinking Water Source Area Reclassification Rationale

Appendix E
Non-Potential Drinking Water Source Area Reclassification Rationale

The former Fort Devens Army Installation (Devens), located in Devens, Massachusetts, is listed on the National Priorities List (NPL) and has been undergoing environmental investigations and remedy implementation activities under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA; 42 United States Code [U.S.C.] §9601 et. seq.) since the 1990s. Shepley's Hill Landfill (SHL), located at Devens, encompasses approximately 84 acres in the northeast corner of the Main Post of Devens. SHL is bordered to the east by Plow Shop Pond and land that formerly contained a railroad roundhouse, to the west by Shepley's Hill, to the south by recent commercial development, and to the north by wooded and residential areas. Plow Shop Pond drains north to Nonacoicus Brook , which flows north/northwest and discharges to the Nashua River. Nonacoicus Brook is located north of SHL.

Based on the Groundwater Use and Value Determination for the Devens area (Massachusetts Department of Environmental Protection [MassDEP] 2003), the groundwater across most of Devens is considered to be of high use and value, though many areas of Devens have been categorized as being Non-Potential Drinking Water Source Areas (NPDWSA) by the Massachusetts Department of Environmental Protection (MassDEP), per MassDEP Policy WSC-91-701 (MassDEP 1997). A small southeastern portion of SHL is within a Zone II wellhead protection area. The overburden groundwater at SHL is noted to be medium yield (MassGIS 2023).

MassDEP Policy WSC-91-701 applies to land encompassing at least 100 acres and overlying a potentially productive aquifer or a portion thereof. Furthermore, the land above the potentially productive aquifer must have an urbanized land use and/or a population density equal to or more than 4,400 people per square mile. Urbanized land use includes the following categories: industrial lands, commercial lands, dense residential lands, transportation lands, and urban open lands. Landfills and sewage lagoons are grouped under the waste disposal land use, which is not an urbanized land use.

Landfills and sewage lagoons that are less than 100 acres and are surrounded by other land uses that meet one or more of the NPDWSA criteria are automatically included in the exemption from meeting GW-1 standards. As SHL is a landfill encompassing approximately 84 acres, it meets the size requirement of the policy. However, current MassGIS data identify SHL as grassland. SHL should be reclassified as a landfill under the waste disposal land use in the MassGIS system.

MassGIS data indicate SHL is encircled by NPDWSAs. These include two separate NPDWSAs, as shown on Figures 7 and 8 of the Focused Feasibility Study and Figure F-1 in Appendix F. The medium yield NPDWSA located to the north, west, and south of SHL comes within approximately 30 feet of the boundary of SHL at its most proximal location. The high yield NPDWSA located to the east of SHL comes within 350 feet of the boundary of SHL. Though there are spatial gaps between the boundary of SHL and these NPDWSAs, these areas are not technically feasible drinking water sources.

One such gap, located between the medium yield NPDWSA to the west and SHL, is Shepley's Hill. Shepley's Hill is an area classified in the MassGIS system as being an "Area of abundant outcrop of shallow bedrock" under Surficial Geology 24k Overlay. Unconsolidated aquifer materials are not present in this area for use. Investigation into the minerology of Shepley's Hill bedrock performed by the United States Environmental Protection Agency (USEPA) Region 1 and Gannett Fleming, Inc. identified in 2012 both arsenic-containing pyrite and arsenopyrite in the Chelmsford Granite of the hill (Gannett Fleming, Inc. 2012). Groundwater in a number of the bedrock monitoring wells installed in the bedrock of the hill during the same effort exceed the GW-1 standards for arsenic due to the local minerology.

The second gap, located east of SHL, is the area of Plow Shop Pond and land adjacent to the pond. Plow Shop Pond receives water from Grove Pond, which used to be named “Tannery Pond”, as a tannery located on the northwest corner of Grove Pond that operated intermittently from 1854 to 1963 discharged untreated waste directly to the pond. Contaminants that have been detected in Plow Shop Pond include arsenic, polycyclic aromatic hydrocarbons, chromium, and mercury. Some amount of the arsenic in Plow Shop Pond, as well as the chromium and mercury concentrations have been attributed to the Hartnett Tannery (AMEC 2011).

Though a portion of SHL intersects a Zone II Wellhead Protection Area (WPAs), large portions of all adjacent NPDWSAs also intersect with Zone II WPAs in the area for both the Grove Pond Wellfield and MacPherson Well. Establishing the area of SHL as a NPDWSA would provide additional assurance that groundwater there would not be used as a drinking water resource.

AMEC. 2011. BCT Draft Final Remedial Investigation for AOC 72, Plow Shop Pond, Devens, Massachusetts. March.

Gannett Fleming, Inc. and USEPA Region 1. 2012. Final Shepley’s Hill Bedrock Investigation. July.

MassDEP. 1997. Determining Non-Potential Drinking Water Source Areas. Policy: WSC-97-701. Accessed 02 October 2023 at https://www.mass.gov/files/documents/2016/08/tk/gispol_0.pdf. April 30.

MassDEP. 2003. Revised Draft Groundwater Use and Value Determination. Devens, Massachusetts. March.

MassGIS. 2023. MassMapper. Accessed 02 October 2023 at https://maps.massgis.digital.mass.gov/MassMapper/MassMapper.html.

Appendix F

Groundwater Model Technical Memorandum

Memo – Final

SUBJECT
Final – Evaluation of Focused Feasibility Study Alternatives Using the Shepley's Hill Landfill Groundwater Flow Model

TO
United States Army Corps of Engineers New England District

DATE
March 2024

DEPARTMENT
Resilience

PROJECT NUMBER
30048392.07G

Introduction

The SERES-Arcadis Joint Venture (JV), Limited Liability Company (LLC)[1] has prepared this technical memorandum describing the groundwater modeling used to evaluate Focused Feasibility Study (FFS) alternatives on behalf of the United States Army Corps of Engineers (USACE) for Shepley's Hill Landfill (SHL) at the former Fort Devens Army Installation (Devens) located in Devens, Massachusetts. The following alternatives were evaluated using the calibrated SHL groundwater flow model (Geosyntec 2020):

- Alternative 1 – No Action;
- Alternative 2 – Groundwater Extraction and Treatment – Current Remedy;
- Alternative 4A– Groundwater Extraction and Treatment with Three Extraction Wells;
- Alternative 4B – Groundwater Extraction and Treatment with Three Extraction Wells and Injection; and
- Alternative 6 – Landfill Reconsolidation with Active Aquifer Treatment.

The in-situ air sparging (IAS) alternatives (Alternatives 3 and 5) were not evaluated using the groundwater flow model since the IAS system is expected to have a negligible effect on overall groundwater hydraulics.

The methods of analysis and the results of each alternative are described in the sections below.

Methods of Analysis

To evaluate the response of the SHL groundwater flow system to the various FFS alternatives, the calibrated SHL groundwater flow model (Geosyntec 2020) was modified, and particle tracking analyses and groundwater velocity calculations were conducted, to illustrate the predicted pathway of upgradient groundwater. The results for the final model stress period (stress period 18), which represents current average annual conditions, were used to predict the steady-state pathlines under several FFS alternatives. Stress periods 1 through 17 (representing each annual quarter from fourth quarter 2012 to fourth quarter 2016) are unchanged from the calibrated SHL groundwater flow model.

For each alternative, forward particle tracking was conducted using MODPATH to evaluate the migration of particles starting along a transect located at the southern end of the SHL barrier wall (Figure 1). Fifty particles were distributed vertically at the top, middle, and bottom of layers 1, 2, and 3 (overburden sand; total of 150 particles per layer), and 50 particles were distributed at the bottom of layer 4 (till), for a total of 500 particles.

[1] The SERES-Arcadis JV is composed of protégé firm SERES Engineering & Services, LLC (SERES) and its mentor, Arcadis U.S., Inc. (Arcadis).

Particles were tracked using the flow field for stress period 18 and released at the start of stress period 18. Migration was evaluated by mapping the flow lines to determine the discharge locations. For alternatives with pumping at the toe of the landfill (either with or without reinjection), emphasis was placed on capturing all of the particles in the extraction wells (e.g., EW-01, EW-03, or EW-04) such that there was no offsite migration.

The groundwater velocity (Darcy flux) matrix was used to evaluate the relative velocities between each alternative. To complete this evaluation, the cell-by-cell files for stress period 18 for each alternative were loaded into Groundwater Vistas, and a groundwater velocity grid was output for model layer 3 (where the extraction wells are screened). The velocity maps clearly indicate areas of higher and lower velocity, e.g., areas of lower groundwater velocities could develop downgradient of the extraction wells. The groundwater velocity results were particularly useful in evaluating reinjection scenarios given that one of the benefits of strategic reinjection is the enhancement of groundwater velocities. The groundwater velocity results were also used to draw conclusions about what the relative increase or decrease in groundwater velocities mean, such as an increase or decrease in groundwater flushing and thus an increase or decrease in clean-up times.

Results

Alternative 1 – No Action

Alternative 1 – No Action was simulated by turning off the extraction wells (EW-01 and EW-04) in stress period 18. The forward particle tracking and groundwater velocity results are shown on Figure 1. With the extraction wells turned off, the forward particle pathlines migrate into the North Impact Area (NIA), which is located just north of the Devens boundary. The pathway of the particles in general mimics the shape of the interpreted area of arsenic greater than 10 micrograms per liter (µg/L). The groundwater velocity at the northern end of the landfill, just south of the extraction wells, is between 200 and 300 feet per year (ft/yr). As groundwater enters the NIA, groundwater velocities slightly decline to between 100 and 200 ft/yr. This indicates that groundwater velocities (and thus groundwater flushing) are faster within the landfill than in the NIA under No Action conditions.

Alternative 2 – Groundwater Extraction and Treatment – Current Remedy

Alternative 2 – Groundwater Extraction and Treatment (Current Remedy) was simulated by running the extraction wells at 33.4 gallons per minute (gpm) for EW-01 and 19.6 gpm for EW-04 (total extraction of 53.1 gpm) during stress period 18. These rates represent the average annual pumping rates.

The forward particle tracking and groundwater velocity results are shown on Figure 2. The forward particle pathlines are fully captured by the two extraction wells (EW-01 and EW-04). Relative to Alternative 1 (No Action), the groundwater velocity is faster upgradient of extraction wells, increasing from 200 ft/yr under Alternative 1 (No Action), to greater than 400 ft/yr under Alternative 2 (Groundwater Extraction and Treatment). Since there is an increase in groundwater velocity just upgradient of the extraction wells, the amount of groundwater flushing (and thus the clean-up time) is greater for the locations upgradient of the extraction wells. North of the extraction wells in the NIA, an area of lower groundwater velocity (less than 100 ft/yr) develops that was absent in Alternative 1 (No Action). This area has less groundwater flushing and slower clean-up time than for the same area in Alternative 1.

To estimate the amount of bedrock groundwater captured by extraction wells, an endpoint analysis using MODPATH was conducted with reverse particle tracks from the extraction wells. The particles were initialized within the well screen of each extraction well with particles starting at the extraction wells in Layer 3. Twenty particles were evenly spaced along a five-feet diameter ring around each extraction well with ten vertical release points for a total of 400 starting particles. If the endpoint analysis showed that the particle endpoints were in model layers 5 or 6 (bedrock layers), then flow for those particles was considered to be from bedrock. Since there were different extraction rates for each well, the flow from bedrock was obtained using flow rate averaging. For example, 38 of the 200 initialized particles for EW-01 were from bedrock (19%). To obtain the estimated flow from bedrock the extraction rate (33.4 gpm) was multiplied by 19% which yielded 6.3 gpm from bedrock for EW-01. Table 1 summarizes the flow from bedrock for each extraction well.

Table 1. Summary of Extraction Well Bedrock Flow for Alternative 2

Location	Extraction Rate (gpm)	Number of Particles from Bedrock	Total Particles	Percentage of Particles from Bedrock per Well	Flow from Bedrock (gpm)
EW-01	33.4	38	200	19%	6.3
EW-04	19.6	22	200	11%	2.2
Total	53	60	400	--	8.5

Alternative 4A – Groundwater Extraction and Treatment with Three Extraction Wells

Alternative 4A – Groundwater Extraction and Treatment with Three Extraction Wells was simulated by running the extraction wells at 21.25 gpm for EW-01, 10.6 gpm for EW-04, and 21.25 gpm for EW-03 (total extraction of 53.1 gpm) during stress period 18. The location of the projected third extraction well (EW-03) is approximately 250 feet east of EW-01 and was selected to target groundwater capture in the inferred bypass area on the east side of the landfill (Figure 3). Vertically, the well was simulated in the deep overburden sand to target the higher arsenic concentrations observed in SHM-10-06 (model layer 3, row 68, column 174). The effective well screen length is 34 feet, which is equal to the thickness of model layer 3 at the well location.

The forward particle tracking and groundwater velocity results are shown on Figure 3. The forward particle pathlines are fully captured by the three extraction wells (EW-01, EW-03, and EW-04). The groundwater velocity at the northern end of the landfill is greater than 300 ft/yr approaching the extraction wells. The groundwater velocity in the area of extraction wells EW-01 and EW-04 is slightly slower under this Alternative than Alternative 2 (Groundwater Extraction and Treatment, current remedy), primarily because of the reduction in pumping at EW-04 relative to Alternative 2. The groundwater velocity is much faster under this Alternative in the area of EW-03. Two areas of lower groundwater velocity (less than 100 ft/yr) develop north of the extraction wells: one area in the NIA north of EW-01 and EW-04 and another northwest of EW-03. These areas have slower groundwater velocities than in Alternative 2, indicating these areas have less groundwater flushing and slower clean-up time than for the same area in Alternative 2.

To estimate the amount of bedrock groundwater captured by extraction wells, an endpoint analysis using MODPATH was conducted with reverse particle tracks from the extraction wells. The particles were initialized within the well screen of each extraction well with particles starting at the extraction wells in Layer 3. Twenty particles were evenly spaced along a five-feet diameter ring around each extraction well with ten vertical release points for a total of 600 starting particles. If the endpoint analysis showed that the particle endpoints were in model layers 5 or 6 (bedrock layers), then flow for those particles was considered to be from bedrock. Since there were different extraction rates for each well, the flow from bedrock was obtained using flow rate averaging. Table 2 summarizes the flow from bedrock for each extraction well. Compared with Alternative 2, Alternative 4A has more groundwater originating from bedrock (11.9 gpm for Alternative 4A versus 8.5 gpm for Alterative 2).

Table 2. Summary of Extraction Well Bedrock Flow for Alternative 4A

Location	Extraction Rate (gpm)	Number of Particles from Bedrock	Total Particles	Percentage of Particles from Bedrock per Well	Flow from Bedrock (gpm)
EW-01	21.25	62	200	31%	6.6
EW-04	10.6	59	200	29.5%	3.1
EW-03	21.25	21	200	10.5%	2.2
Total	53.1	142	600	--	11.9

Alternative 4B – Groundwater Extraction and Treatment with Three Extraction Wells and Onsite Injection

Alternative 4B – Groundwater Extraction and Treatment with Three Extraction Wells and Onsite Injection was simulated by running the extraction wells at 21.25 gpm for EW-01, 10.6 gpm for EW-04, and 21.25 gpm for EW-03 (total extraction of 53.1 gpm) during stress period 18. Treated groundwater was then simulated to be reinjected in six injection wells screened in model layer 1 at a rate of 8.85 gpm per well (total injection of 53.1 gpm) during stress period 18. The reinjection wells are located at the downgradient boundary of Devens (Figure 4). Upgradient and cross-gradient reinjection locations were also simulated; however, downgradient reinjection was more successful because it did not interfere with groundwater capture at the extraction wells.

The forward particle tracking and groundwater velocity results are shown on Figure 4. The forward particle pathlines are fully captured by the three extraction wells (EW-01, EW-03, and EW-04). The groundwater velocity at the northern end of the landfill increases to greater than 300 ft/yr approaching the extraction wells. The area of greater than 300 ft/yr is smaller than for Alternative 4A (Groundwater Extraction and Treatment with Three Extraction Wells). The groundwater velocity north of the injection wells is faster than under Alternative 4A, indicating there is increased groundwater flushing and faster clean-up time. The injection wells will also add more oxygenated water at the upgradient boundary of Devens. As needed, treated groundwater would be amended with dissolved oxygen (DO) before injection to promote oxic conditions within the aquifer. Injection of oxic treated groundwater will enhance attenuation of arsenic in groundwater through the oxidative precipitation of iron and manganese and aerobic consumption of residual reducing capacity (e.g., labile organic carbon). It is expected that DO concentrations in the overburden aquifer would increase, resulting in the immobilization of dissolved arsenic through coprecipitation with oxidized dissolved iron. Over time, this in-situ treatment would result in the distribution of DO and reduction of arsenic and iron concentrations in groundwater downgradient of the ATP.

Forward pathline analysis were conducted from the six reinjection wells to assess where the injected water travels. The particles were initialized for each of the reinjection wells in model layer 1 (where the reinjection wells are screened). Twenty particles were evenly spaced along a five-feet diameter ring around each extraction well with ten vertical release points for a total of 600 starting particles. The results of the forward pathline analyses are shown on Figure 5. The pathlines from the reinjection wells indicate the reinjected water either travels to EW-04 or Nonacoicus Brook.

To estimate the amount of bedrock groundwater captured by extraction wells, an endpoint analysis using MODPATH was conducted with reverse particle tracks from the extraction wells. The particles were initialized within the well screen of each extraction well with particles starting at the extraction wells in Layer 3. Twenty particles were evenly spaced along a five-feet diameter ring around each extraction well with ten vertical release points for a total of 600 starting particles. If the endpoint analysis showed that the particle endpoints were in model layers 5 or 6 (bedrock layers), then flow for those particles was considered to be from bedrock. Since there were different extraction rates for each well, the flow from bedrock was obtained using flow rate averaging. Table 3 summarizes the flow from bedrock for each extraction well. Compared with Alternative 2, Alternative 4B has more groundwater originating from bedrock (11.6 gpm for Alternative 4B versus 8.5 gpm for Alterative 2). Alternatives 4A and 4B have similar amounts of groundwater originating from bedrock (11.9 gpm for Alternative 4A and 11.6 gpm for Alternative 4B).

Table 3. Summary of Extraction Well Bedrock Flow for Alternative 4B

Location	Extraction Rate (gpm)	Number of Particles from Bedrock	Total Particles	Percentage of Particles from Bedrock per Well	Flow from Bedrock (gpm)
EW-01	21.25	78	200	39%	8.3
EW-04	10.6	2	200	1%	0.1
EW-03	21.25	30	200	15%	3.2
Total	53.1	110	600	--	11.6

Alternative 6 – Landfill Reconsolidation with Active Aquifer Treatment

Alternative 6 – Landfill Reconsolidation with Active Aquifer Treatment uses IAS as the active aquifer treatment and includes landfill reconsolidation. Under the landfill reconsolidation portion of this alternative, all landfill waste material within and above the groundwater table in the northern half of the landfill would be excavated and reconsolidated in the southern portion of the landfill above the existing cap. The southern reconsolidated area would then be capped with a geomembrane liner and soil cover. The excavated northern portion of the landfill would be backfilled with clean fill materials to the top of the groundwater table. To simulate the northern landfill area, recharge in the northern portion of the landfill (where waste would be removed and clean fill materials would be backfilled) was set in stress period 18 to be the same as for the NIA and most of the active model domain (recharge was increased from 2.47 inches per year [in/yr] to 17.3 in/yr). Recharge in the southern end of the landfill was kept the same as the calibrated model (2.47 in/yr) because the reconsolidated portion is above the existing cap.

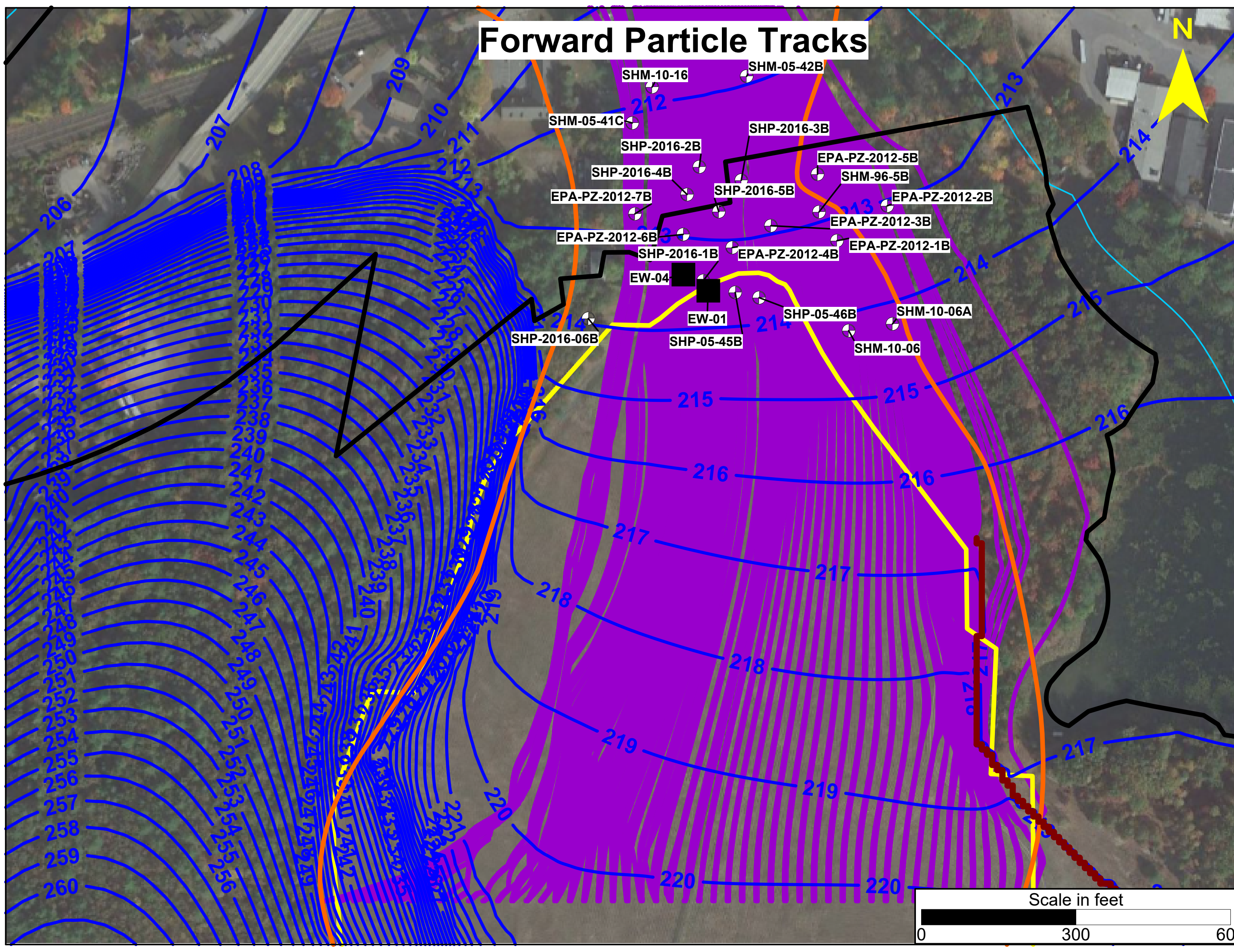
The forward particle tracking and groundwater velocity results are shown on Figure 6. The forward particle tracks are similar to Alternative 1 – No Action; however, some of the particle pathlines migrate farther to the east toward Plow Shop Pond. Groundwater elevations are approximately 1 foot higher at the toe of the landfill than under Alternative 1 due to the enhanced recharge in the northern portion of the landfill. The groundwater velocity at the northern end of the landfill, just south of the extraction wells, is between 300 and 400 ft/yr, which is approximately 1 to 2 times faster than for Alternative 1. As groundwater enters the NIA, velocities decline to between 100 and 200 ft/yr, similar to Alternative 1. Since the groundwater velocity is faster for this alternative than for Alternative 1, there is more groundwater flushing within the north end of the landfill and consequently faster clean-up times. As there will be increased recharge within the northern end of the landfill since the landfill cover will be removed in that area, there will be an increase in oxygenated water flowing to the north. The IAS at the Devens boundary will also add more oxygen to the groundwater system. Dissolved iron and manganese in chemically reduced groundwater is oxidized by DO, and arsenic is immobilized through adsorption and coprecipitation of arsenic with the oxidized amorphous iron. Oxidation of manganese may also yield arsenic removal via adsorption/coprecipitation with manganese oxyhydroxides over longer durations.

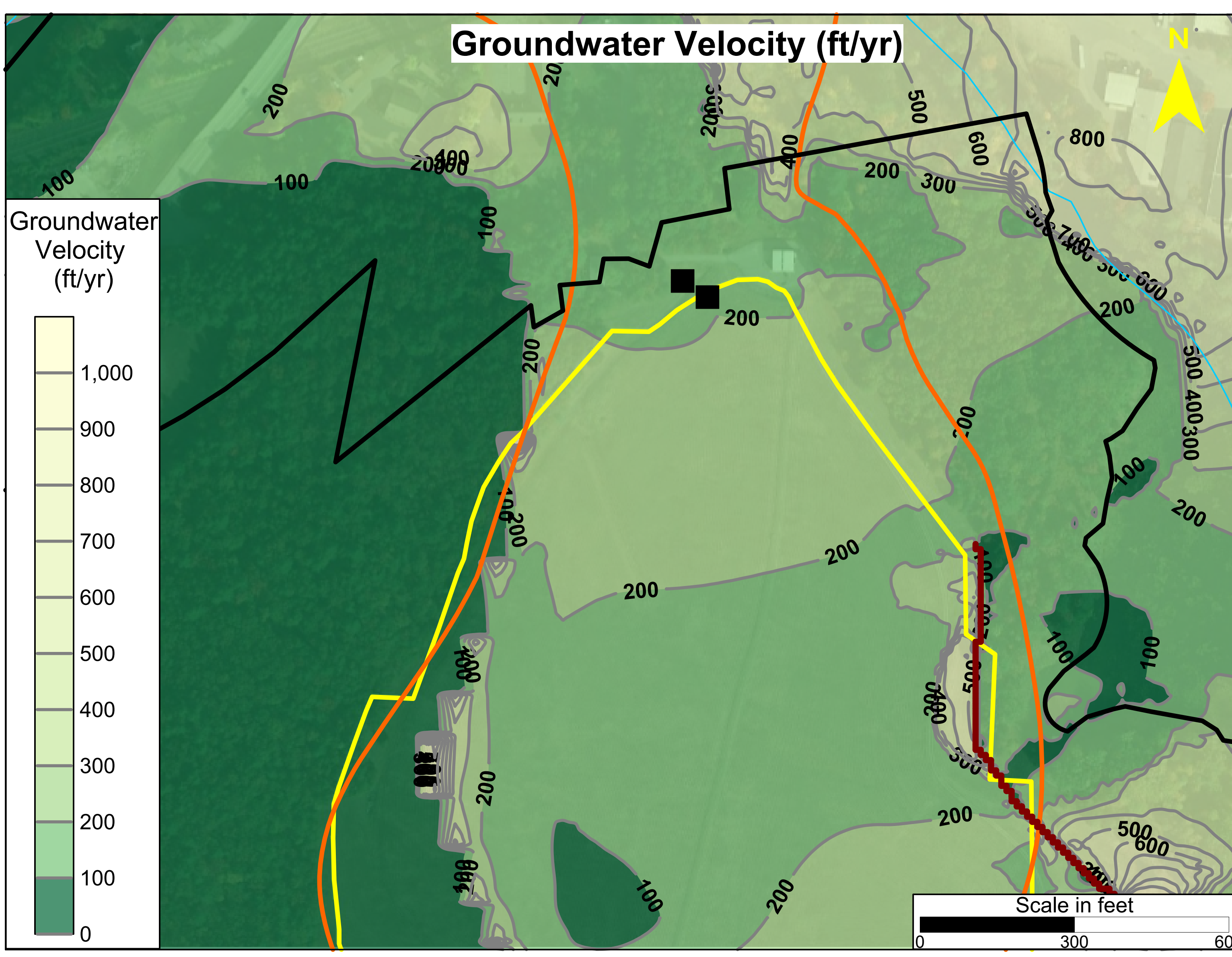
References

Geosyntec. 2020. SHL Groundwater Flow Model Revision Report. Shepley's Hill Landfill, Fort Devens, Massachusetts. December.

Enclosures:

Figures





Legend

- ■ Extraction Wells
- Monitoring Wells
- Interpreted Area of Arsenic greater than 10 μg/L
- Barrier Wall
- Former Ft Devens Boundary
- Forward Groundwater Pathlines from Transect
- Simulated Groundwater Elevation Contour (ft NAVD 88)
- Shepley's Hill Landfill Boundary

Notes:

1. Monitoring wells used as part of the Phase I Environmental Protection Agency Scope of Work: Demonstrate Plume Capture Technical Memorandums are shown.
2. ft/yr = feet per year
3. ft NAVD 88 = feet North American Vertical Datum of 1988
4. μg/L = micrograms per liter
5. Extraction well locations shown for reference.
6. Groundwater elevation contours and groundwater velocities are shown for model layer 3.

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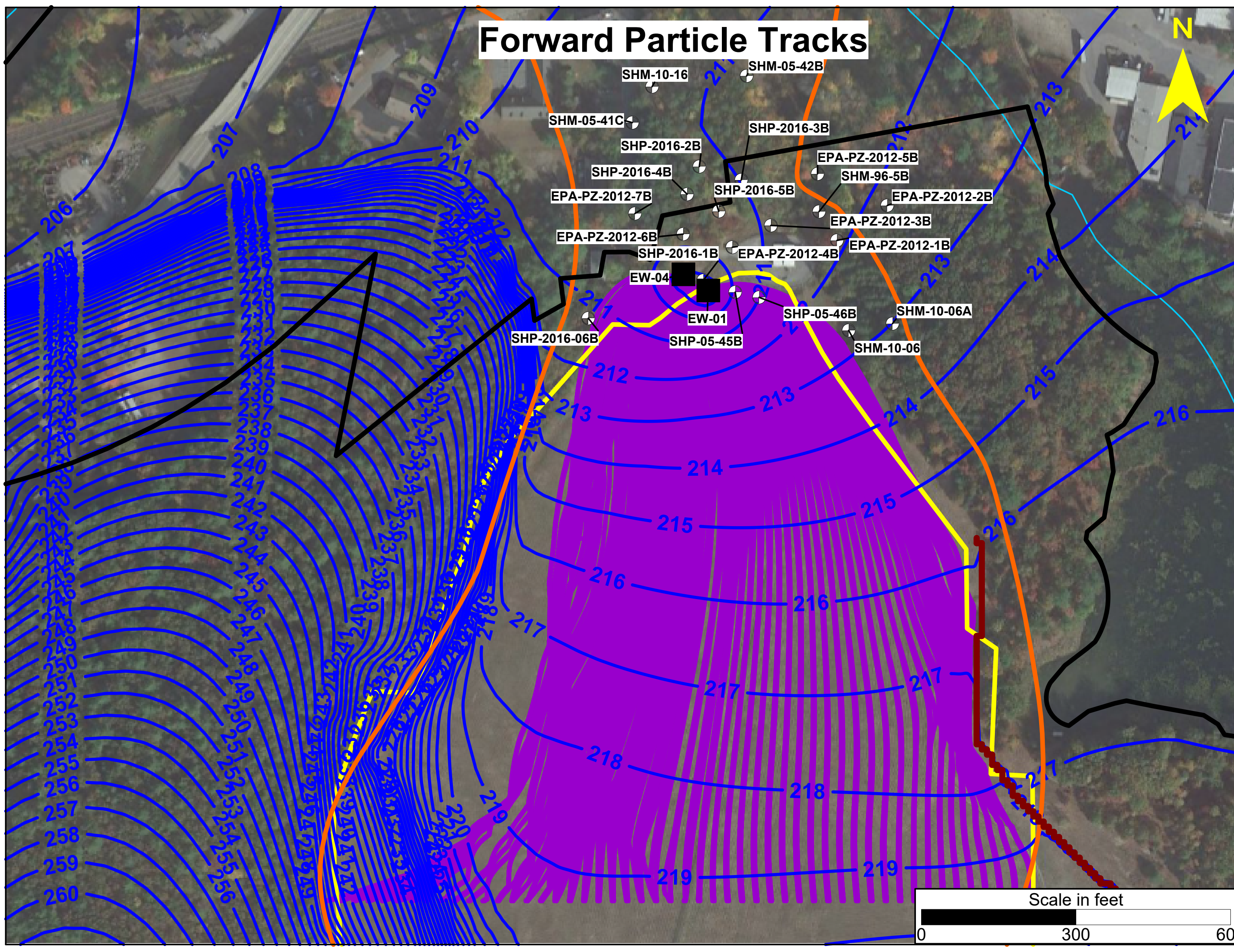
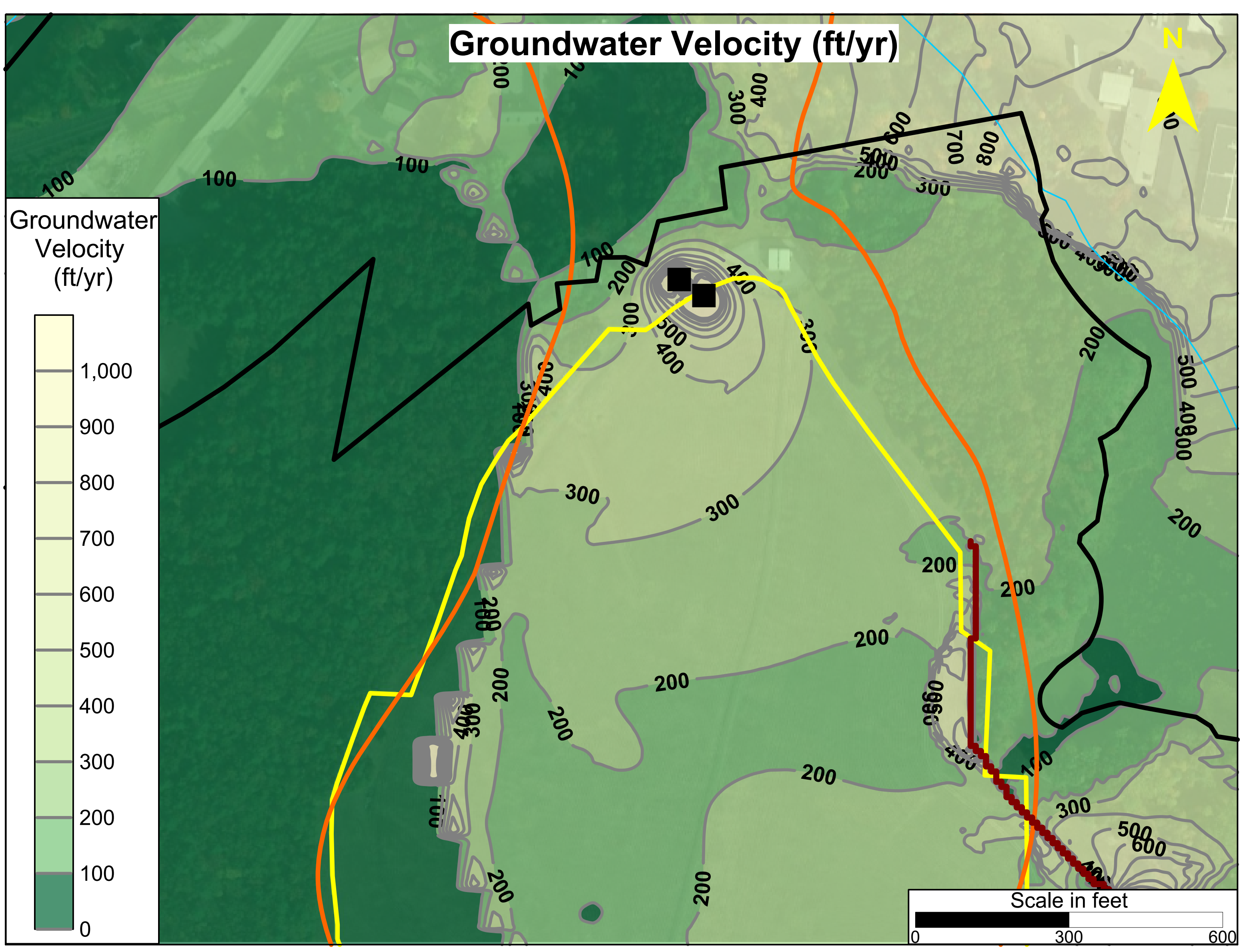
APPENDIX F GROUNDWATER MODEL TECHNICAL MEMORANDUM

Alternative 1 No Action: Simulated Groundwater Pathlines and Groundwater Velocity

FIGURE
1





Legend

- Extraction Wells
- Monitoring Wells
- Interpreted Area of Arsenic greater than 10 µg/L
- Barrier Wall
- Former Ft Devens Boundary
- Forward Groundwater Pathlines from Transect
- Simulated Groundwater Elevation Contour (ft NAVD 88)
- Shepley's Hill Landfill Boundary

Notes:

1. Monitoring wells used as part of the Phase I Environmental Protection Agency Scope of Work: Demonstrate Plume Capture Technical Memorandums are shown.
2. ft/yr = feet per year
3. ft NAVD 88 = feet North American Vertical Datum of 1988
4. µg/L = micrograms per liter
5. Groundwater elevation contours and groundwater velocities are shown for model layer 3.

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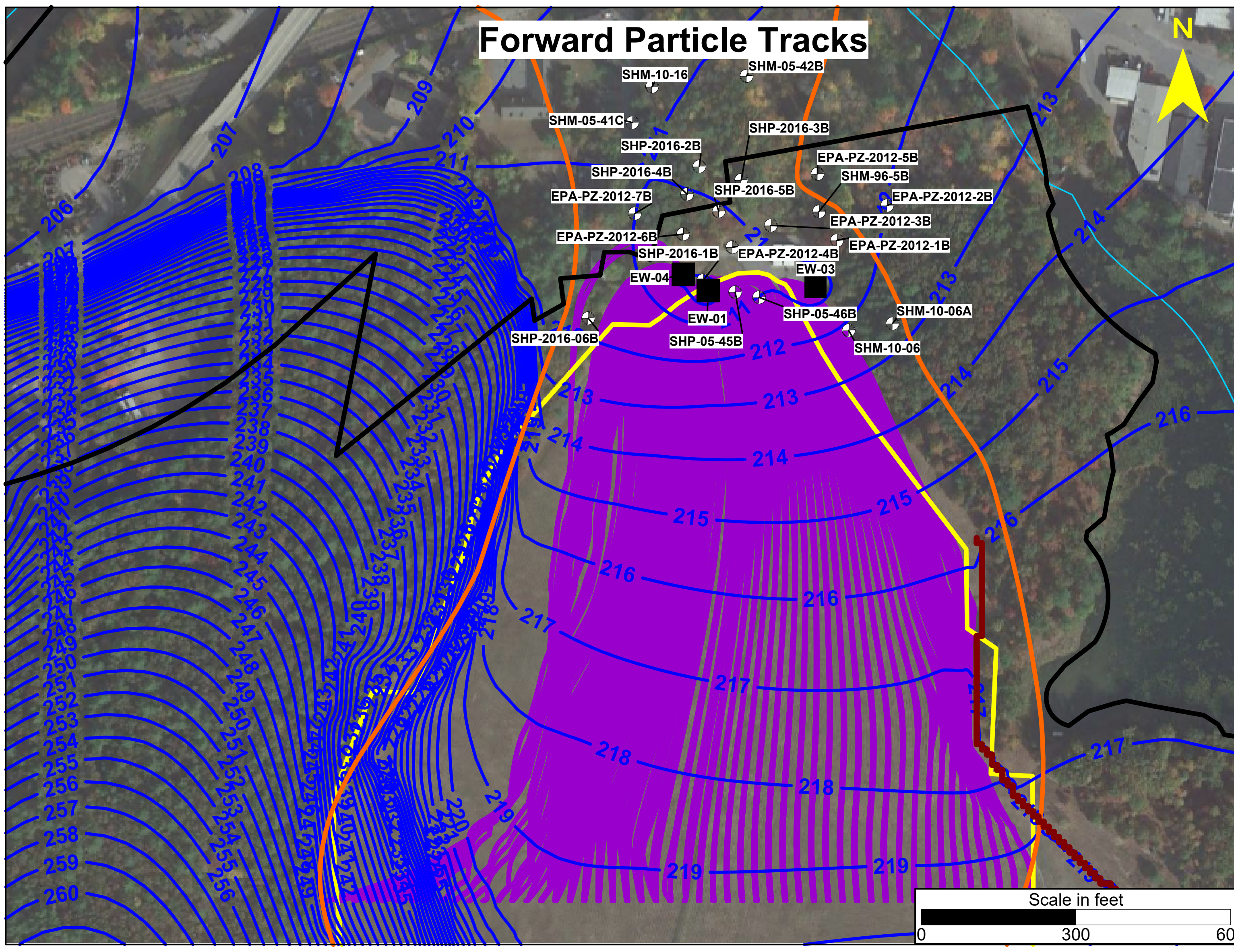
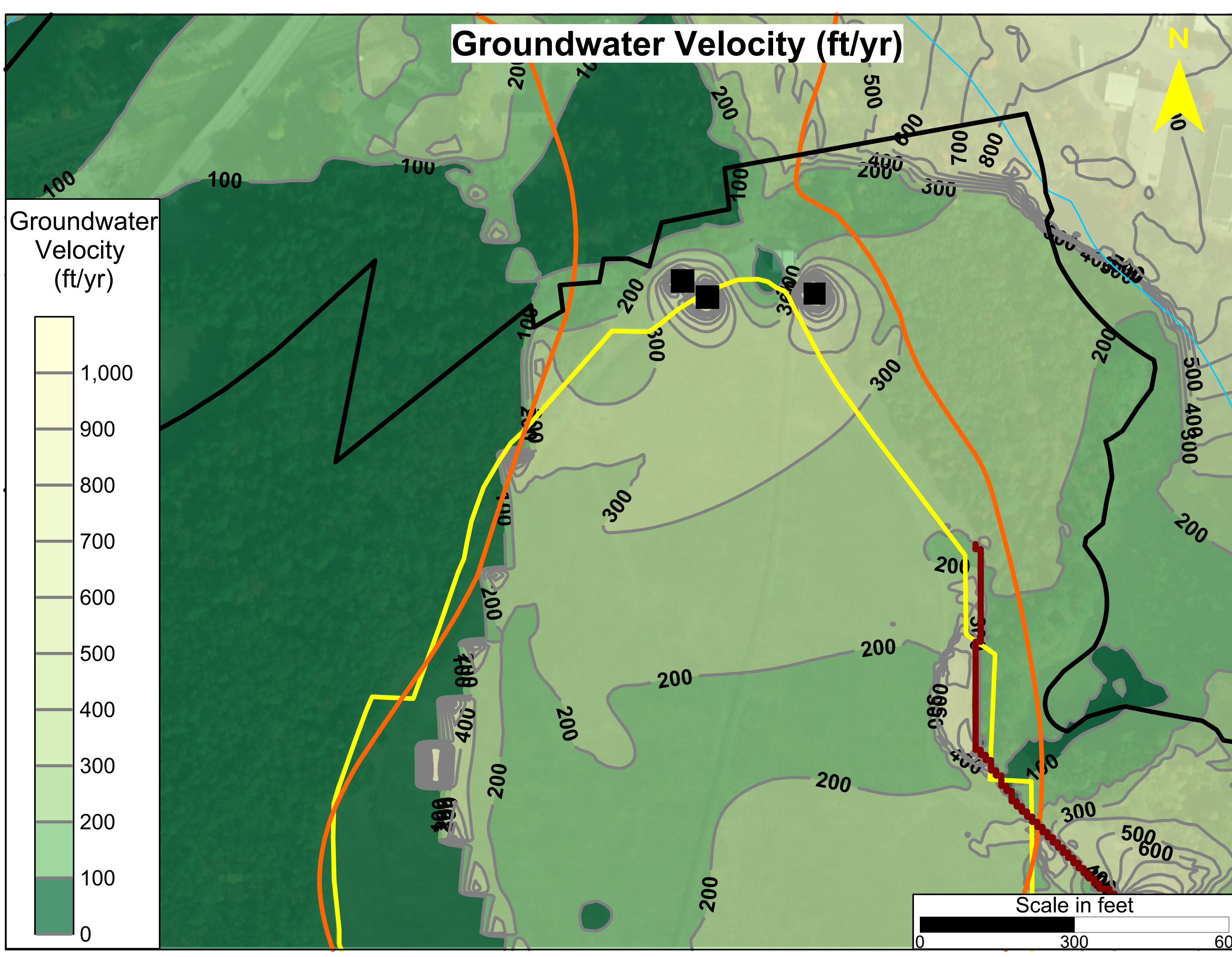
APPENDIX F GROUNDWATER MODEL TECHNICAL MEMORANDUM

Alternative 2 Groundwater Extraction and Treatment (Current Remedy): Simulated Groundwater Pathlines and Groundwater Velocity

FIGURE
2





Legend

- Extraction Wells
- Monitoring Wells
- Interpreted Area of Arsenic greater than 10 µg/L
- Barrier Wall
- Former Ft Devens Boundary
- Forward Groundwater Pathlines from Transect
- Simulated Groundwater Elevation Contour (ft NAVD 88)
- Shepley's Hill Landfill Boundary

Notes:

1. Monitoring wells used as part of the Phase I Environmental Protection Agency Scope of Work: Demonstrate Plume Capture Technical Memorandums are shown.
2. ft/yr = feet per year
3. ft NAVD 88 = feet North American Vertical Datum of 1988
4. µg/L = micrograms per liter
5. Groundwater elevation contours and groundwater velocities are shown for model layer 3.

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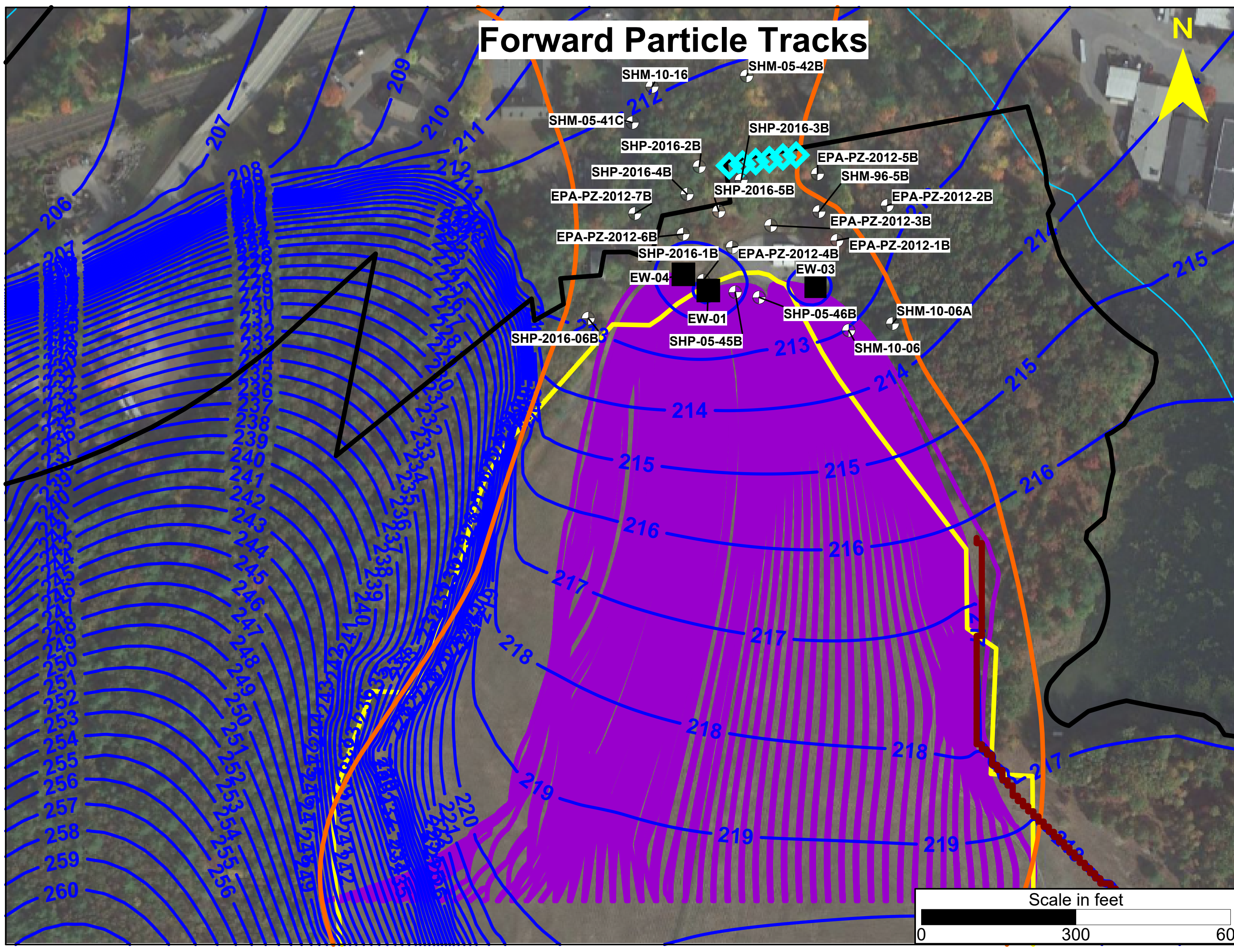
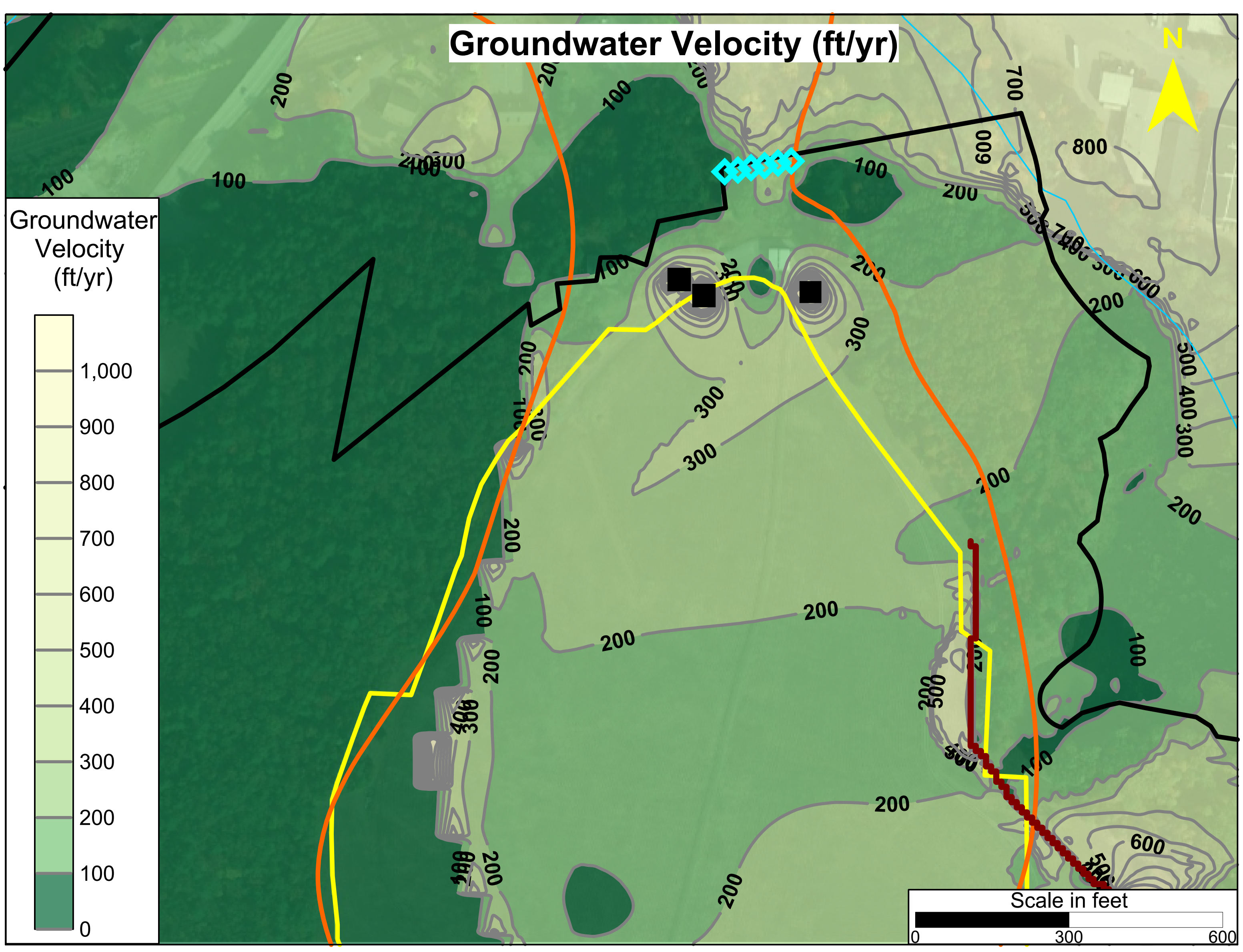
APPENDIX F GROUNDWATER MODEL TECHNICAL MEMORANDUM

Alternative 4A Groundwater Extraction and Treatment with Three Extraction Wells: Simulated Groundwater Pathlines and Groundwater Velocity

FIGURE
3





Legend

- Extraction Wells
- Monitoring Wells
- Injection Wells
- Interpreted Area of Arsenic greater than 10 µg/L
- Barrier Wall
- Former Ft Devens Boundary
- Forward Groundwater Pathlines from Transect
- Simulated Groundwater Elevation Contour (ft NAVD 88)
- Shepley's Hill Landfill Boundary

Notes:

1. Monitoring wells used as part of the Phase I Environmental Protection Agency Scope of Work: Demonstrate Plume Capture Technical Memorandums are shown.
2. ft/yr = feet per year
3. ft NAVD 88 = feet North American Vertical Datum of 1988
4. µg/L = micrograms per liter
5. Groundwater elevation contours and groundwater velocities are shown for model layer 3.

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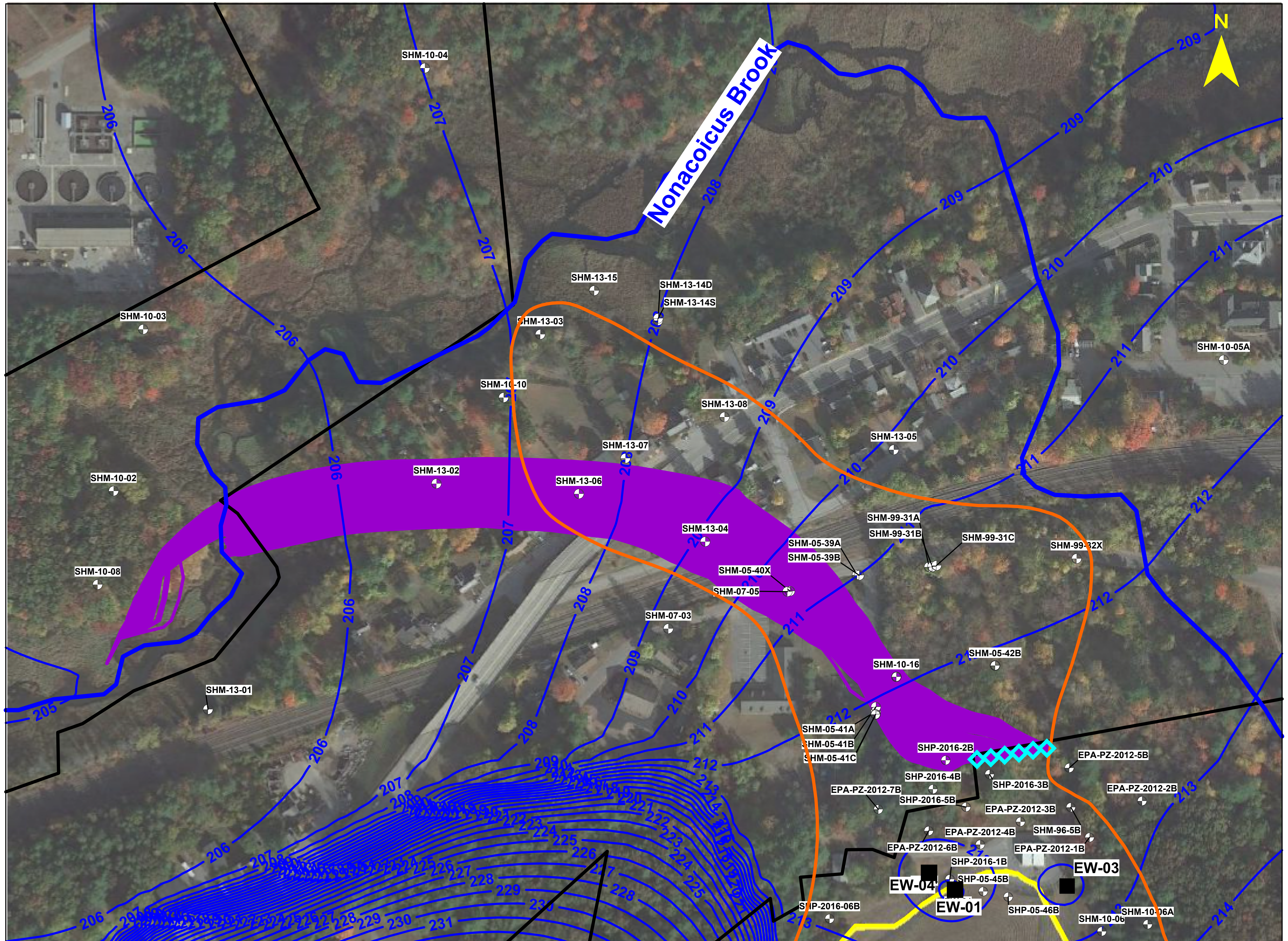
APPENDIX F GROUNDWATER MODEL TECHNICAL MEMORANDUM

Alternative 4B Groundwater Extraction and Treatment with Three Extraction Wells and Injection: Simulated Groundwater Pathlines and Groundwater Velocity

FIGURE
4



Legend

- Extraction Wells
- Monitoring Wells
- Injection Wells
- Interpreted Area of Arsenic greater than 10 μg/L
- Shepley's Hill Landfill Boundary
- Former Ft Devens Boundary
- Forward Groundwater Pathlines from Reinjection Wells
- Simulated Groundwater Elevation Contour (ft NAVD 88)

Scale in feet

0 200 400

Notes:

1. Monitoring wells used as part of the Phase I Environmental Protection Agency Scope of Work: Demonstrate Plume Capture Technical Memorandums are shown.
2. ft/yr = feet per year
3. ft NAVD 88 = feet North American Vertical Datum of 1988
4. μg/L = micrograms per liter
5. Groundwater elevation contours are shown for model layer 3.

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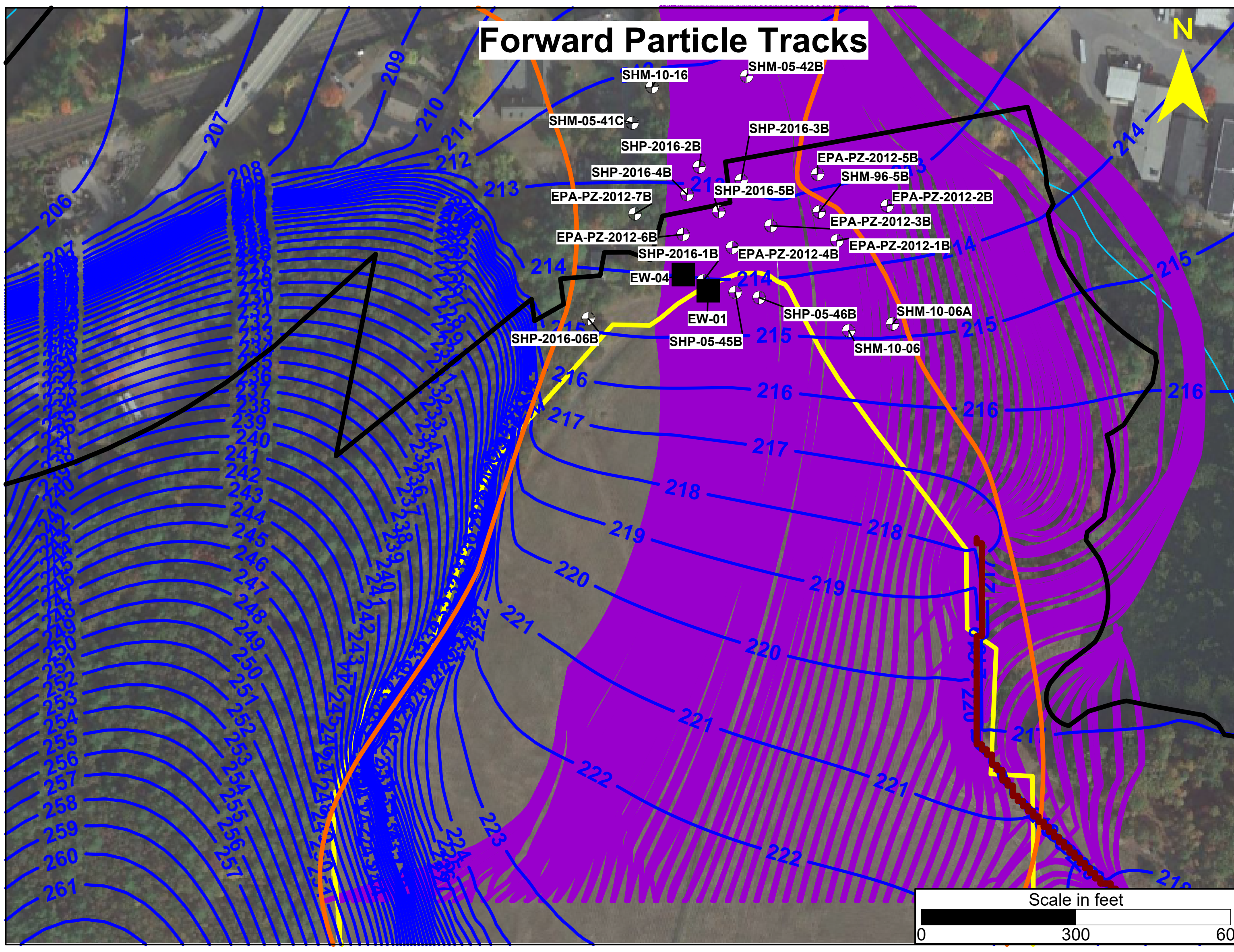
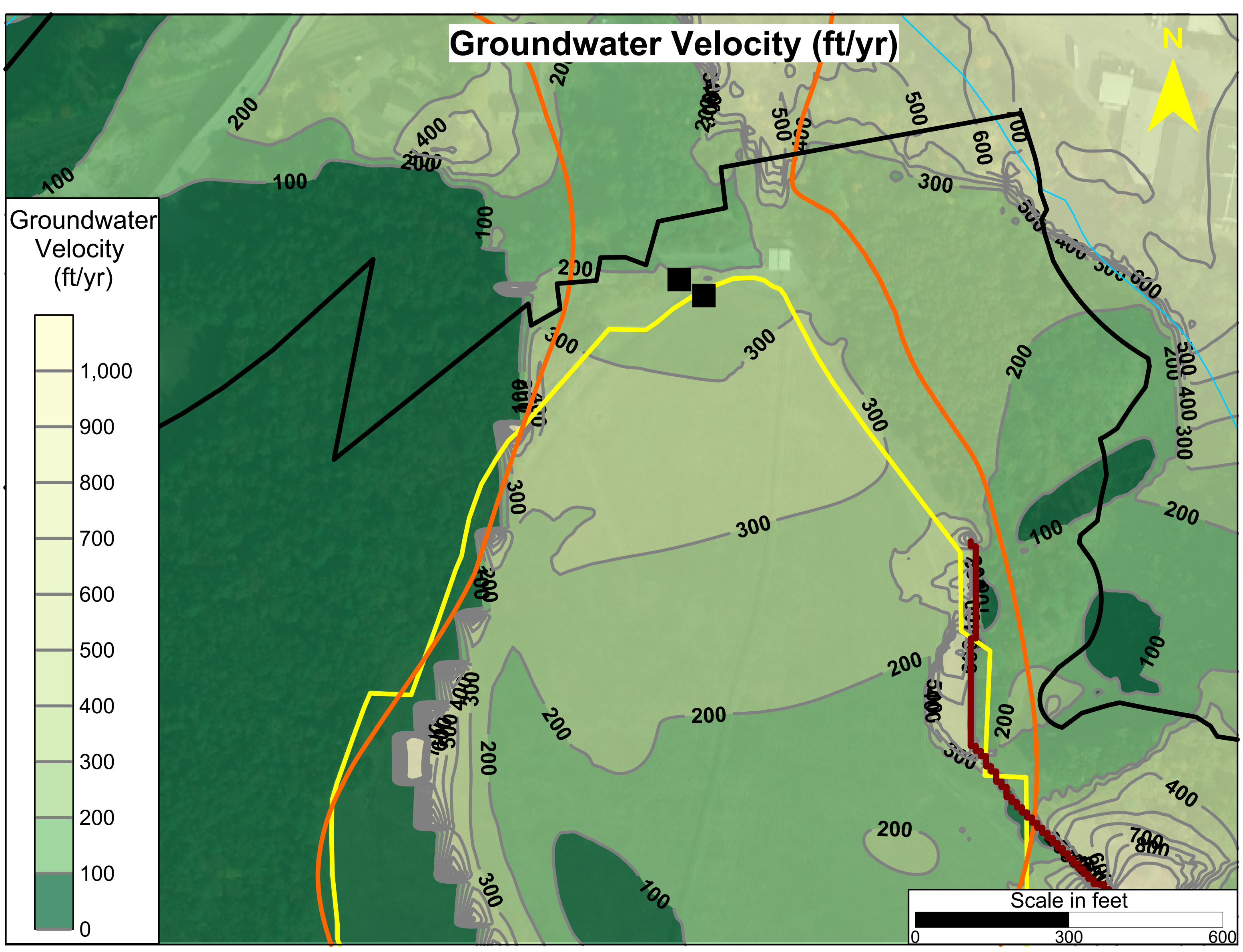
APPENDIX F GROUNDWATER MODEL TECHNICAL MEMORANDUM

Alternative 4b Groundwater Extraction and Treatment with Three Extraction Wells and Injection: Simulated Pathlines from Reinjection Wells

FIGURE 5





Legend

- Extraction Wells
- Monitoring Wells
- Interpreted Area of Arsenic greater than 10 μg/L
- Barrier Wall
- Former Ft Devens Boundary
- Forward Groundwater Pathlines from Transect
- Simulated Groundwater Elevation Contour (ft NAVD 88)
- Shepley's Hill Landfill Boundary

Notes:

1. Monitoring wells used as part of the Phase I Environmental Protection Agency Scope of Work: Demonstrate Plume Capture Technical Memorandum are shown.
2. ft/yr = feet per year
3. ft NAVD 88 = feet North American Vertical Datum of 1988
4. μg/L = micrograms per liter
5. Active aquifer treatment was assumed to be in-situ air sparge.
6. Extraction wells shown for reference.
7. Groundwater elevation contours and groundwater velocities are shown for model layer 3.

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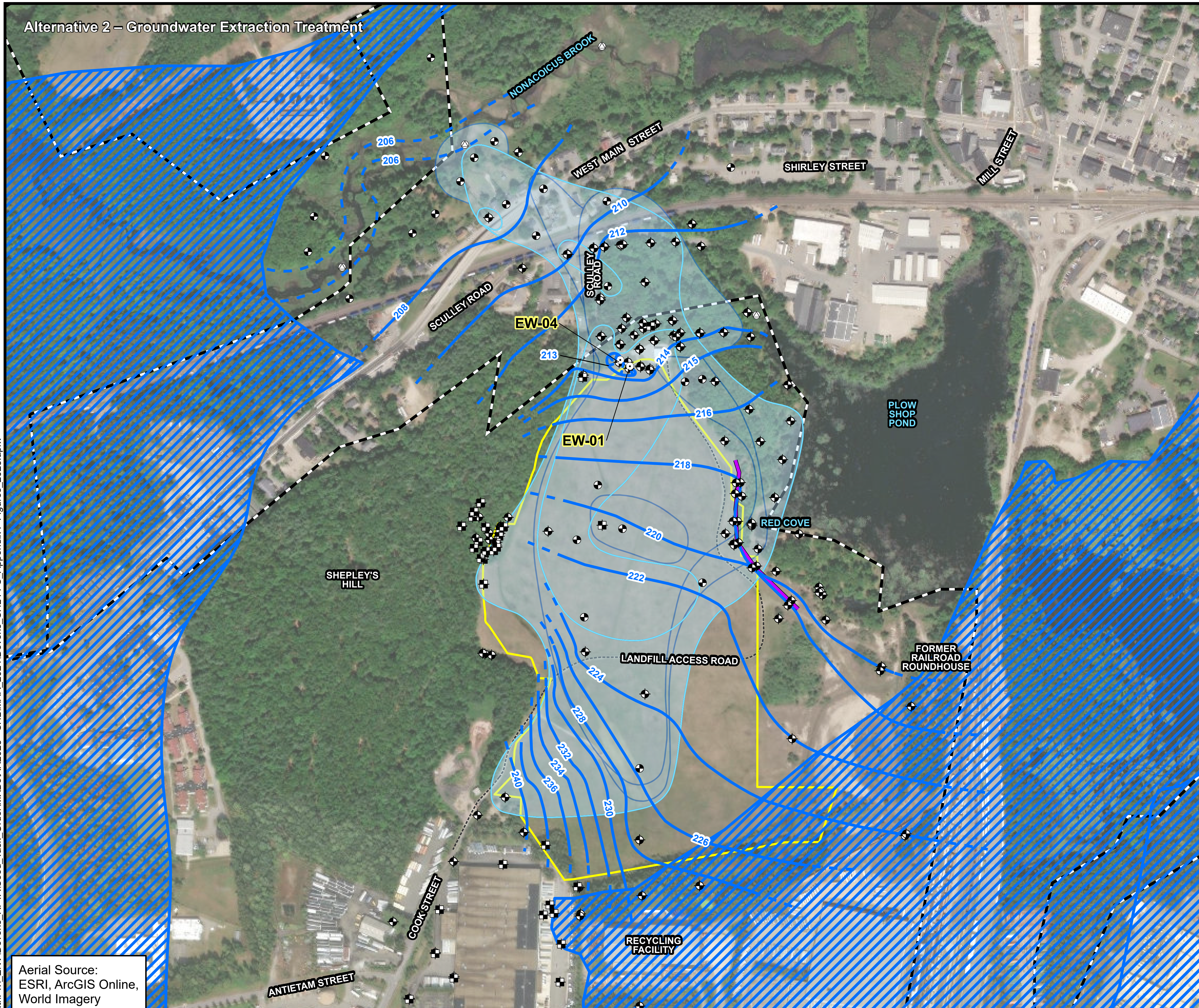
APPENDIX F GROUNDWATER MODEL TECHNICAL MEMORANDUM

Alternative 6 Landfill Reconsolidation with Active Aquifer Treatment: Simulated Groundwater Pathlines and Groundwater Velocity

FIGURE
6

Appendix G

Remedial Alternative Figures



Legend

- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Bedrock Monitoring Well
- Extraction Well
- Stream Gauge
- Barrier Wall
- Interpreted Area of Arsenic >10 µg/L
- Interpreted Area of Arsenic > 1,000 µg/L
- Interpreted Area of Arsenic > CL of 10 µg/L
- Groundwater Contour (ft NAVD88) (Interval = 2 ft) (dashed where inferred)
- Groundwater Extraction Zone

Wellhead Protection Areas

- Zone II

Notes:

1. A Zone II is that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation).
2. µg/L = micrograms per liter
3. CL = Cleanup Level
4. > = greater than
5. NAVD88 = North American Vertical Datum of 1988

N

0 500 1,000

Feet

Shepley's Hill Landfill
Former Fort Devens Army Installation
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Appendix G Remedial Alternative Figures

Alternative 2

Figure
G-1

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2024\Devens_SHL FFS_Appendix F Figures_2023.aprx

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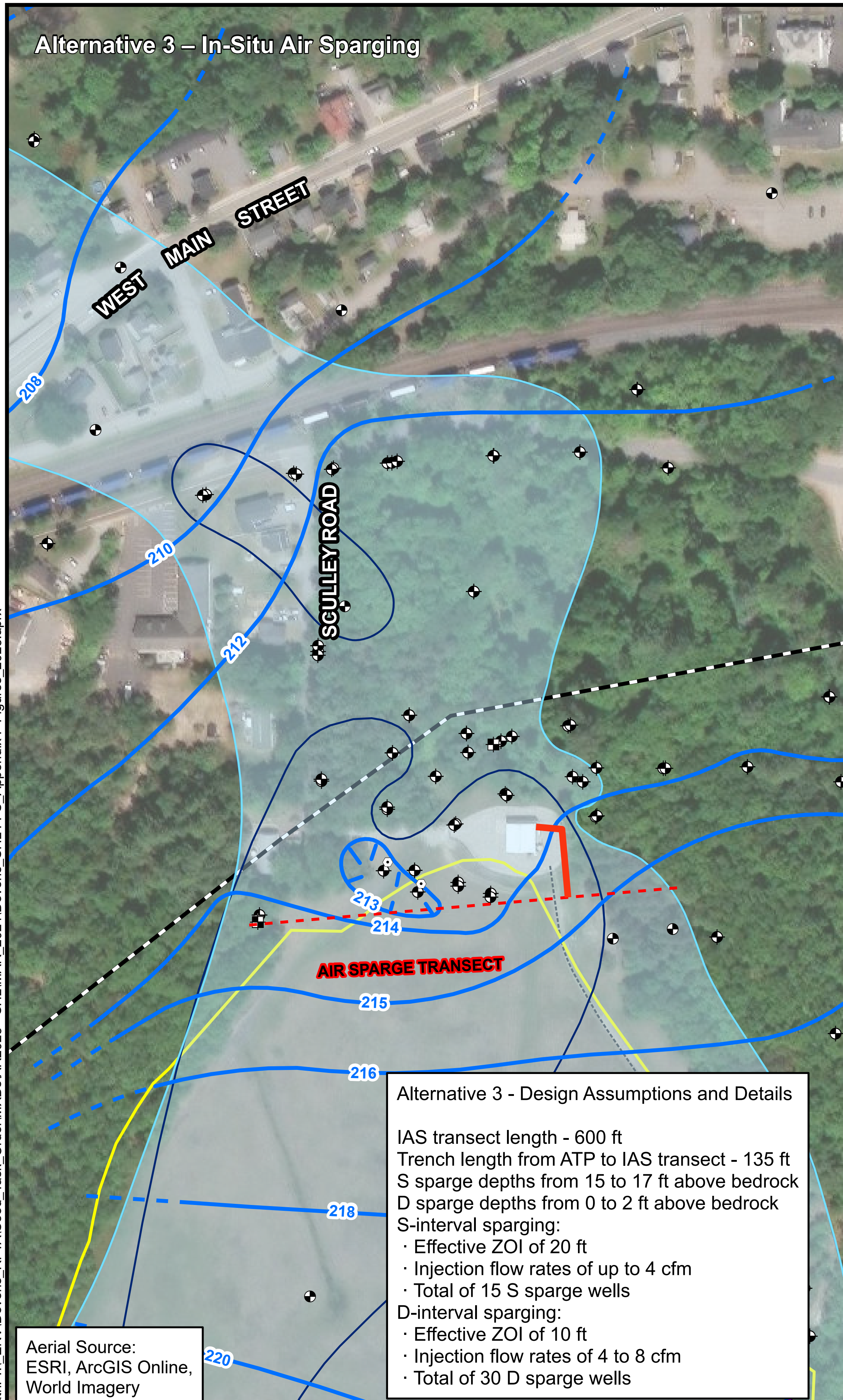

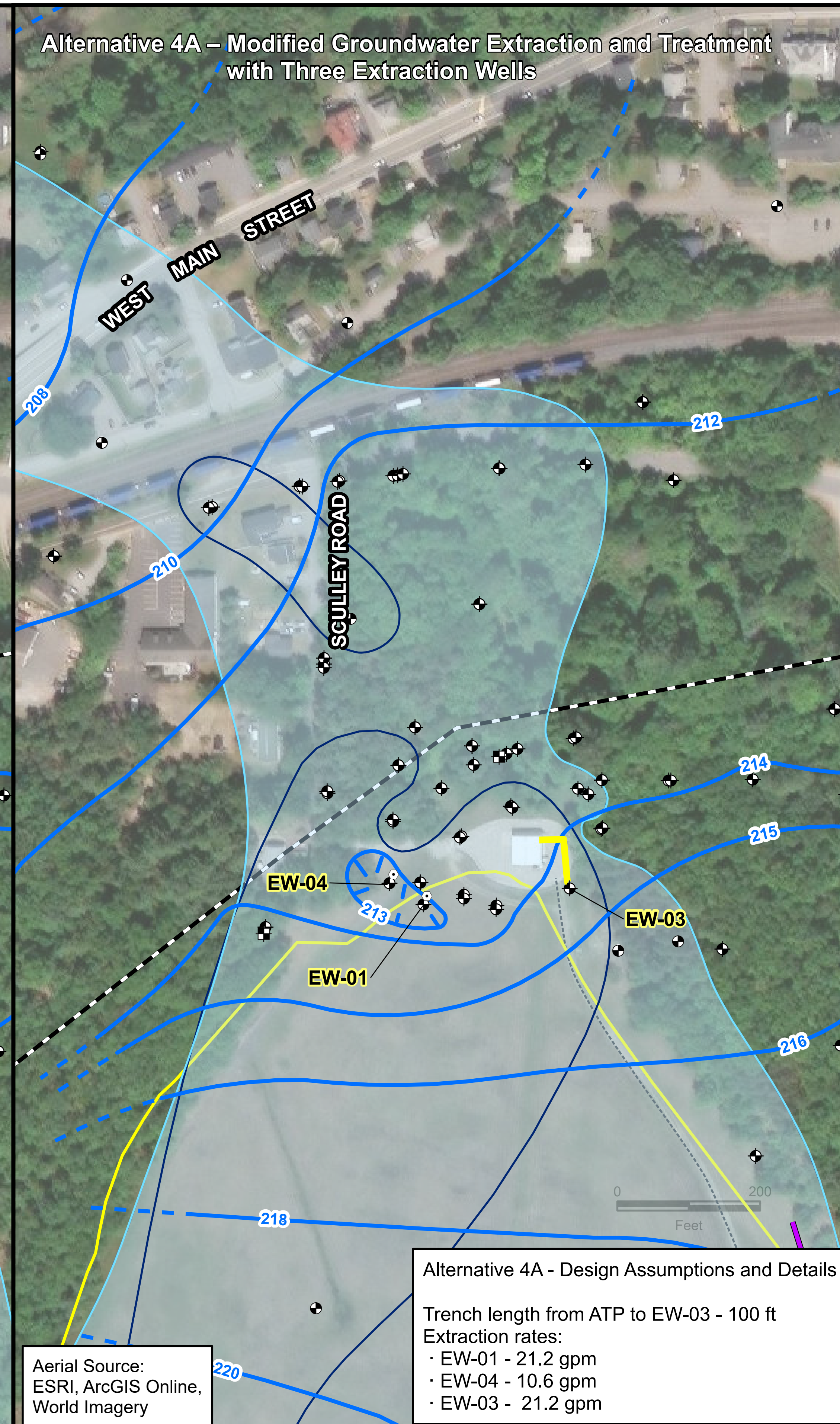

Legend

- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Bedrock Monitoring Well
- Extraction Well
- Stream Gauge
- Barrier Wall
- Interpreted Area of Arsenic >10 µg/L
- Interpreted Area of Arsenic > 1,000 µg/L
- Interpreted Area of Arsenic > CL of 10 µg/L
- Groundwater Contour (ft NAVD88) (Interval = 2 ft) (dashed where inferred)
- Groundwater Extraction Zone
- Air Sparge Transect
- Trench Connecting ATP to Air Sparge Transect
- Trench Connecting ATP to EW-03

N

Shepley's Hill Landfill
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Appendix G Remedial Alternative Figures

Alternative 3 and Alternative 4A

Figure
G-2

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\AR2023 - SHL\MAR_2024\Devens_SHL FFS_Appendix F Figures_2023.aprx

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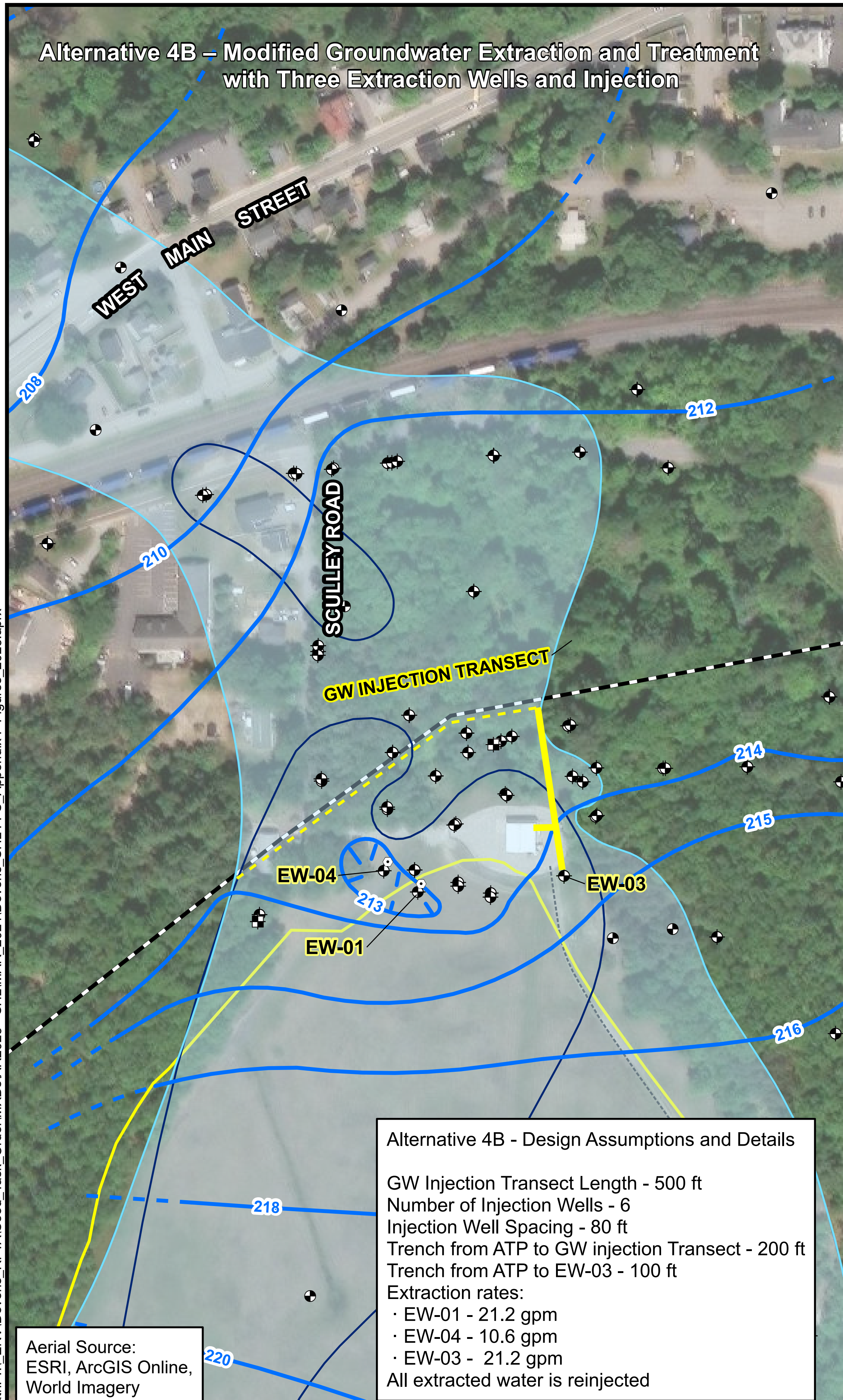

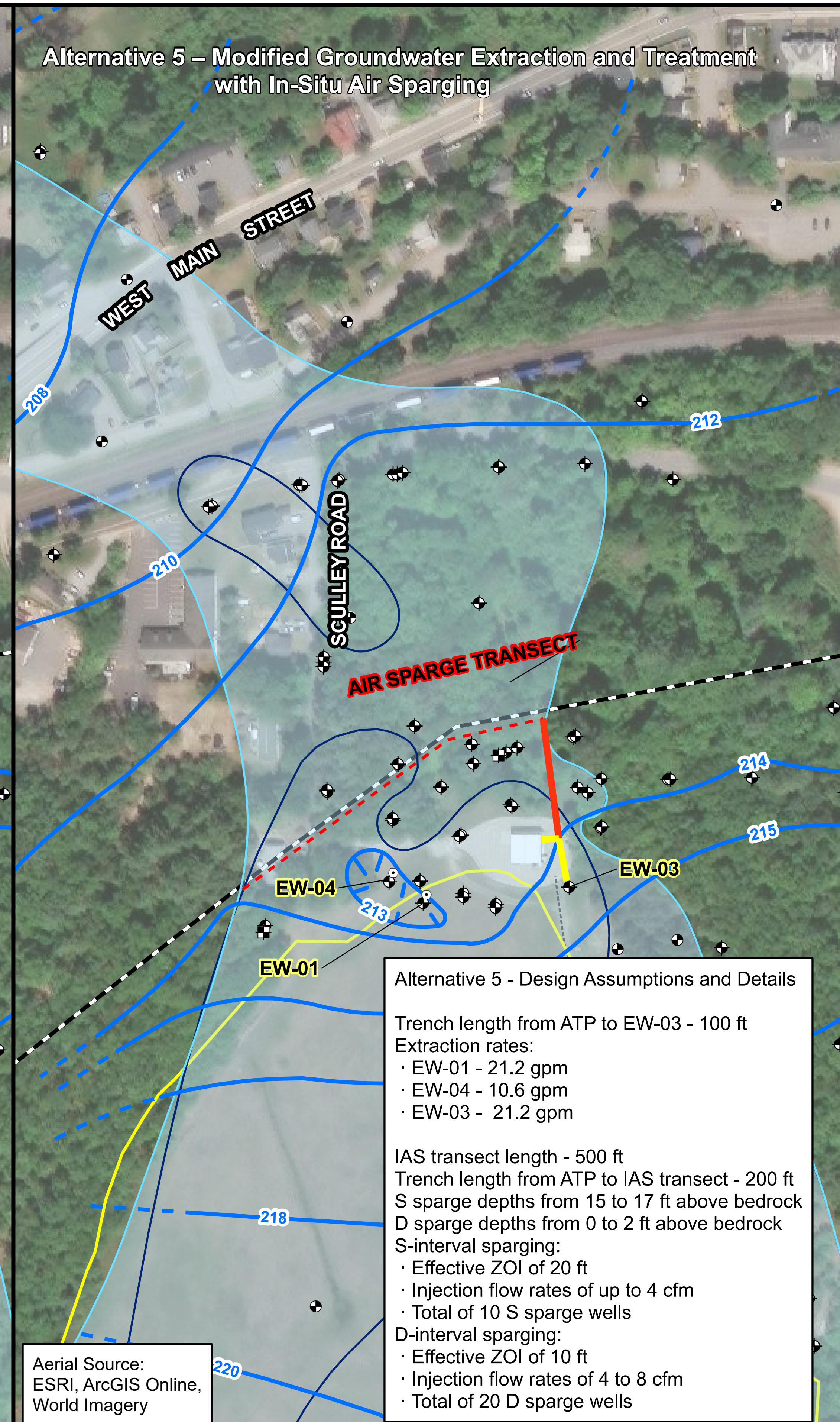

Legend
- Former Fort Devens Boundary
- Shepley's Hill Landfill Boundary
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Bedrock Monitoring Well
- Extraction Well
- Stream Gauge
- Barrier Wall
- Interpreted Area of Arsenic >10 µg/L
- Interpreted Area of Arsenic > 1,000 µg/L
- Interpreted Area of Arsenic > CL of 10 µg/L
- Groundwater Contour (ft NAVD88) (Interval = 2 ft) (dashed where inferred)
- Groundwater Extraction Zone
- Air Sparge Transect
- Trench Connecting ATP to Air Sparge Transect
- Groundwater Injection Transect
- Trench Connecting ATP to EW-03 and Groundwater Injection Transect

N

0 200
Feet

Shepley's Hill Landfill
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Alternative 4B and Alternative 5

Figure
G-3

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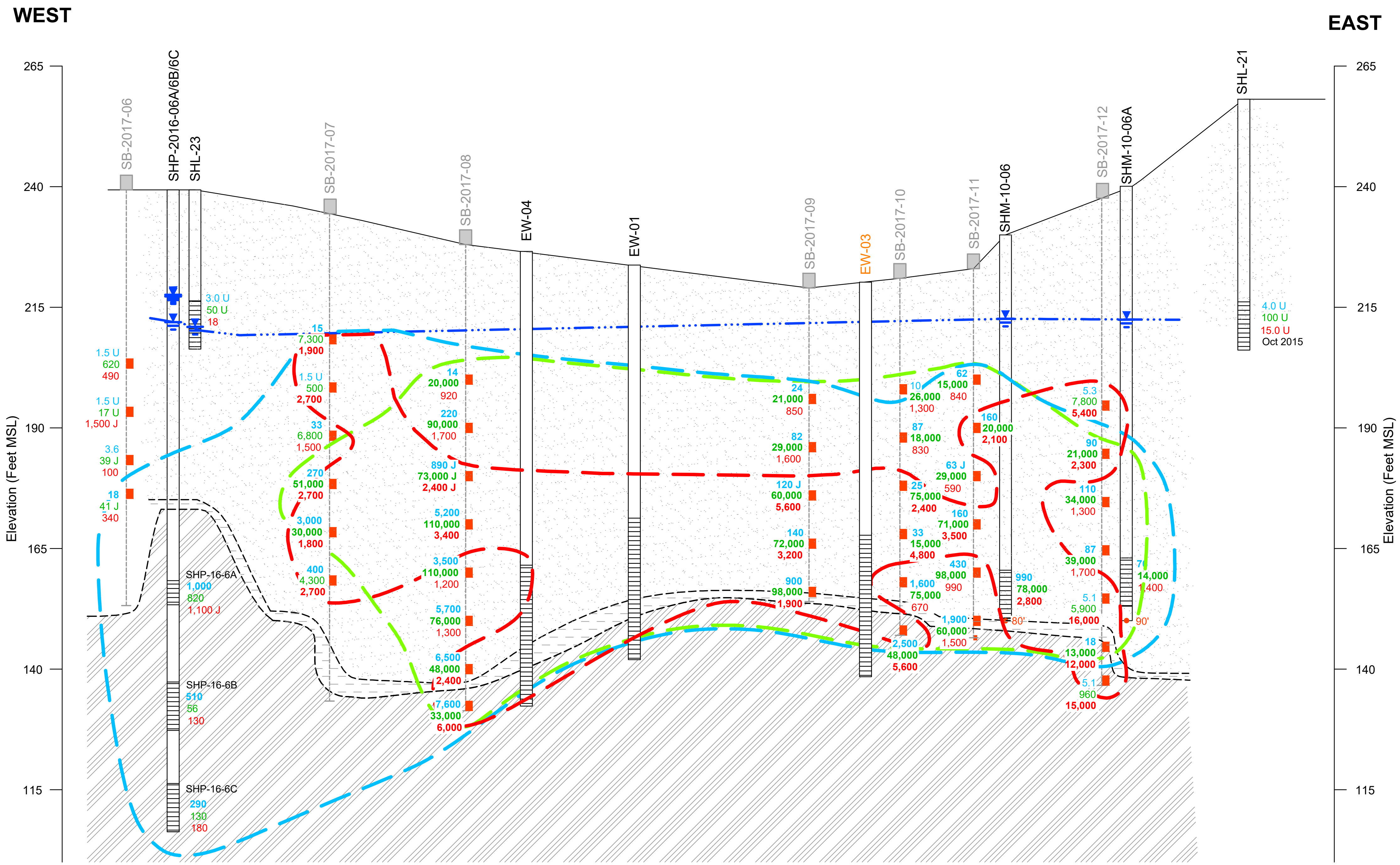

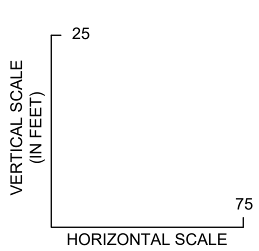

Legend

EW-03 — PROPOSED EXTRACTION WELL LOCATION
- 4.0 U — Arsenic Concentration (µg/L)
- 100 U — Iron Concentration (µg/L)
- 15.0 U — Manganese Concentration (µg/L)
- U, J = Laboratory Qualifiers

Results shown for monitoring wells are from October/November 2021 or most recent sampling event for that well as specified.

Well Casing

Screened Interval

90' Depth to Refusal (feet)

SHL-21 — Monitoring Well
- 4.0 U — Arsenic Concentration (µg/L)
- 100 U — Iron Concentration (µg/L)
- 15.0 U — Manganese Concentration (µg/L)
- U, J = Laboratory Qualifiers

Results shown for monitoring wells are from October/November 2021 or most recent sampling event for that well as specified.

Well Casing

Screened Interval

90' Depth to Refusal (feet)

SB-16-09 — 2017 Soil Boring
- 25 — Arsenic Concentration (µg/L)
- 75,000 — Iron Concentration (µg/L)
- 2,400 — Manganese Concentration (µg/L)
- U, J = Laboratory Qualifiers

Sample Interval (1 Foot)

Boring to Refusal

Interpreted Area of Arsenic > CL of 10 µg/L

Interpreted Area of Iron > CL of 9,100 µg/L

Interpreted Area of Manganese > CL of 1,715 µg/L

Water Table Elevations for Monitoring Wells are from October 2021 Well Hydraulic Gauging Event

Sand

Bedrock

Till

Shepley's Hill Landfill
Former Fort Devens Army Installation
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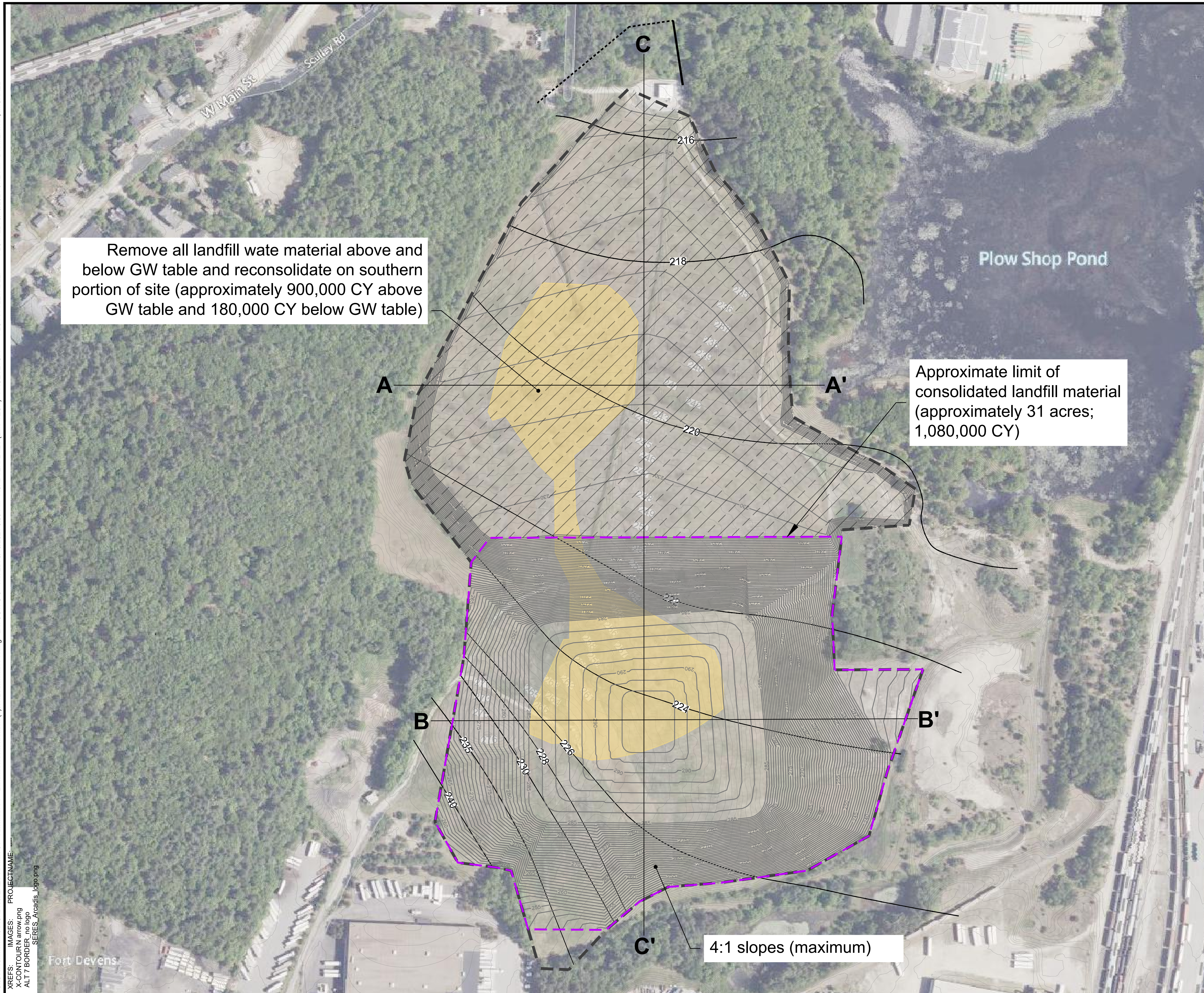
Focused Feasibility Report
Appendix G Remedial Alternative Figures

THREE EXTRACTION WELL CROSS SECTION

Figure G-4

Notes:
1. MSL = mean seal level
2. µg/L = microgram per liter
3. J = Estimated result 2023
4. U = Analyte was below detection limit
5. CL = cleanup levels
6. > = greater than
7. **Bold** values indicate an exceedance of the CLs
8. Depth to bottom of boring not available for SHL-21 and SHL-23.
9. Strata data shown on Figure 5-8 of the September 2020 Area 2 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation by KOMAN Government Solutions, LLC were used to develop this figure.



Legend

- Estimated Limit of Landfill Waste and Peat Below Water Table
- 235 — Existing Topographic Contours (2016 Lidar survey)
- 290 — Proposed Final Grade Contour (1–ft Interval)
- 220 — Groundwater Elevation Contour (approximate)
- Approximate Limit of Existing Landfill
- Approximate Limit of Reconsolidated Landfill Material
- Approximate Waste Removal Limits
- Approximate Location of Air Sparge Transect
- Approximate Location of Trench Connecting ATP to Air Sparge Transect

Notes

1. Existing waste 40 feet below existing grade, 20 feet below water table (Supplemental Groundwater and Landfill Cap Assessment for Long–Term Monitoring and Maintenance, AMEC, June 2009)
2. Lidar = Light Detection and Ranging
   GW = groundwater
   CY = cubic yards
   ATP = arsenic treatment plant

N

0 300' 600'
GRAPHIC SCALE

Shepley's Hill Landfill
Former Fort Devens Army Installation
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Appendix G Remedial Action Alternatives

Alternative 6

FIGURE
G-5

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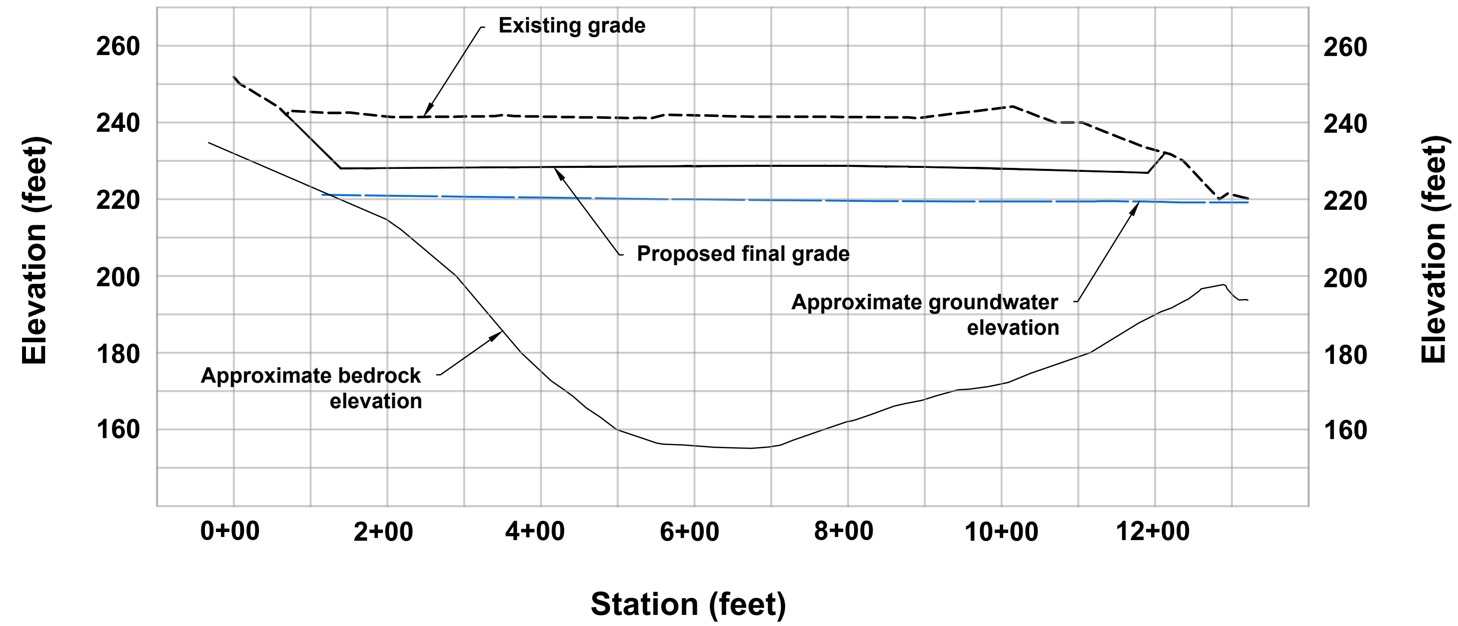
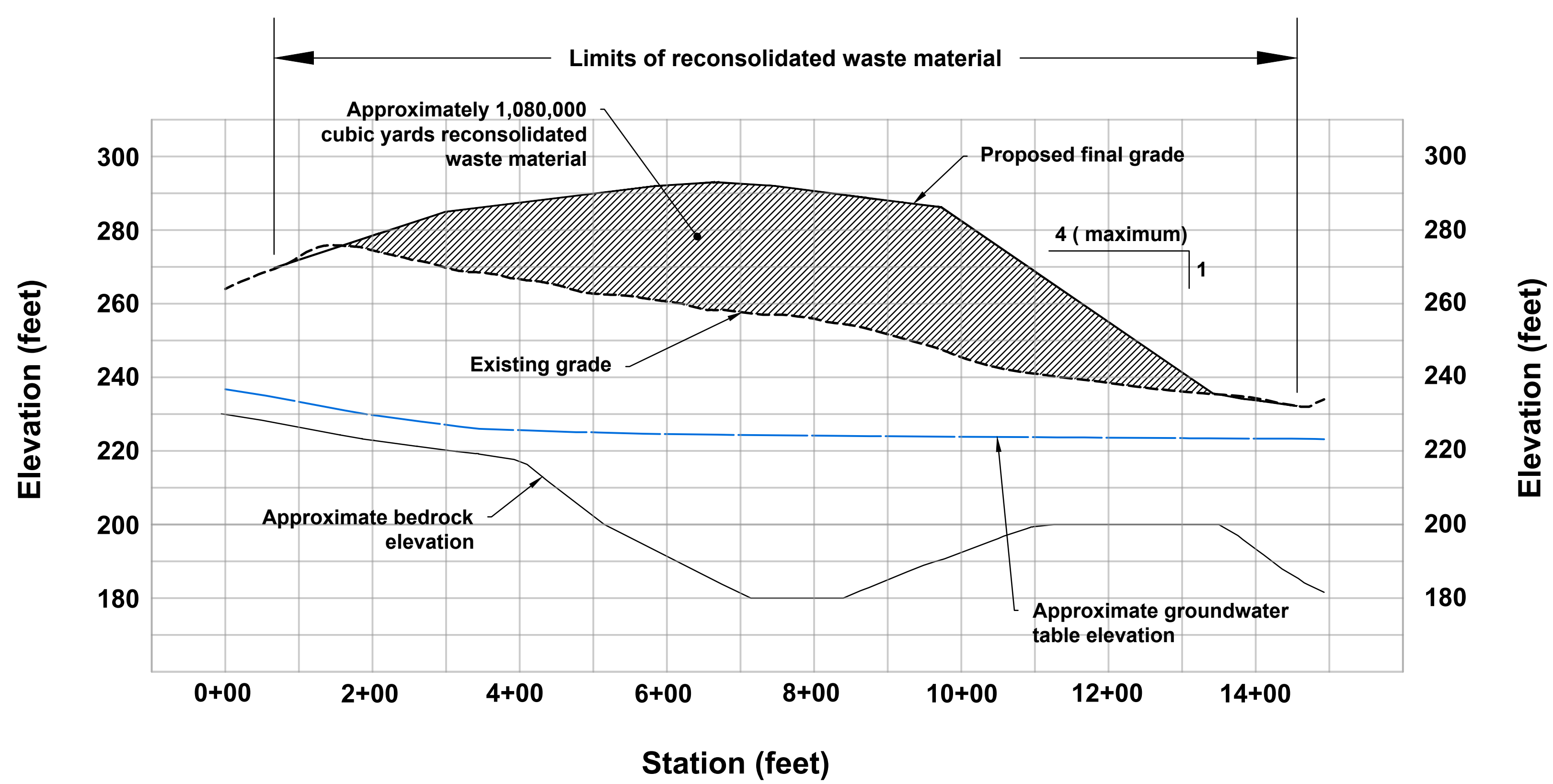


Cross-Section A-A'

SCALE: 1 inch = 250 feet
VERTICAL EXAGGERATION = 5X



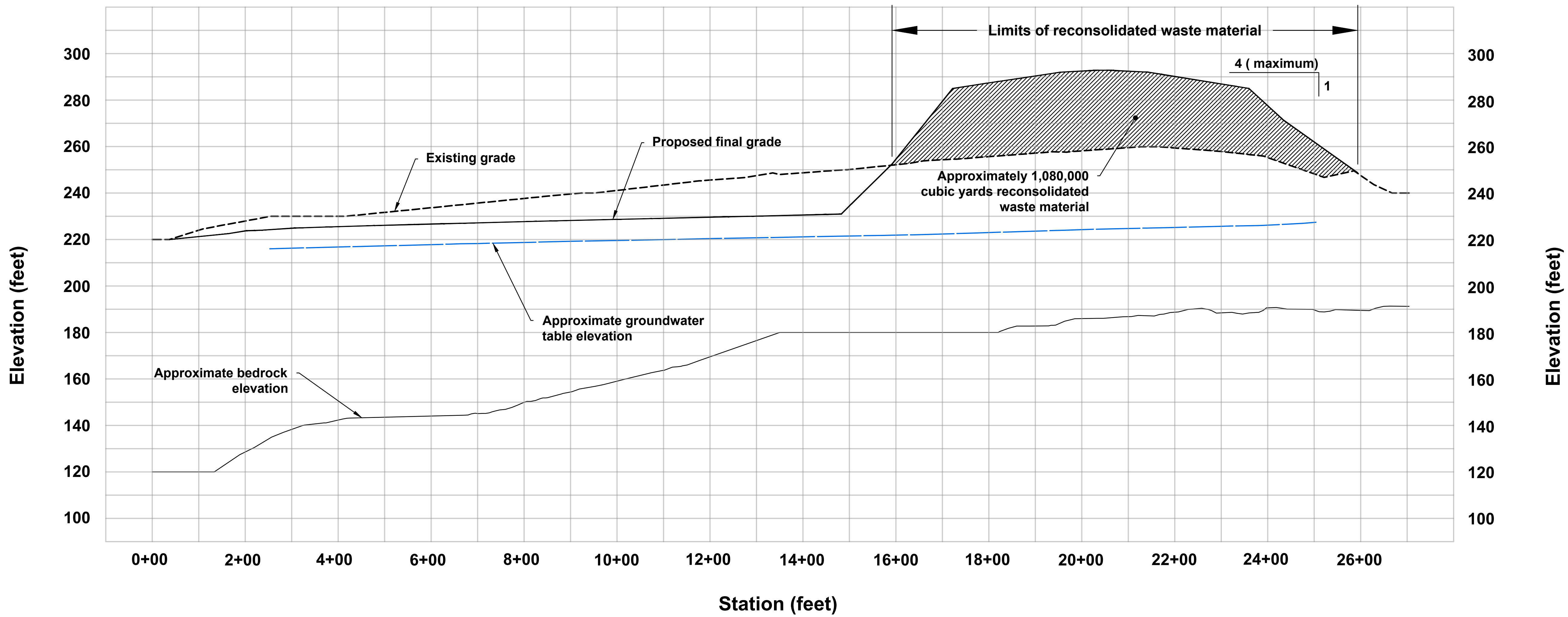
Cross-Section B-B'

SCALE: 1 inch = 250 feet
VERTICAL EXAGGERATION = 5X

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Study Report
Appendix G Remedial Action Alternatives

Alternative 6
Cross-Sections A-A' and B-B'

FIGURE
G-6



Cross-Section C-C'

Scale: 1 inch = 250 feet
Vertical exaggeration = 5X

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts
Focused Feasibility Study Report
Appendix G Remedial Action Alternatives

Alternative 6
Cross-Section C-C'

FIGURE
G-7

Appendix H

Remedial Alternative Cost Tables

TABLE A-1
Cost Estimate for Shepley's Hill Landfill, Alternative 2

Alternative 2
Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

Site: Shepley's Hill Landfill
Location: Former Fort Devens, Massachusetts
Phase: Focused Feasibility Study (-30% to +50%)
Base Year: 2023
Date: March 2023

Description: Alternative 2 for Shepley's Hill Landfill consists of continuing the existing groundwater extraction and treatment system currently in place at the site.

SCOPED TASKS:
1. **Annual Arsenic Treatment Plant (ATP) Operation and Maintenance (O&M) (Years 1-30)**
2. **Annual Landfill Inspection and Maintenance (Years 1-30)**
3. **Semi-Annual Groundwater Monitoring (Years 1-10)**
4. **Annual Groundwater Monitoring (Years 11-30)**

1. Annual Arsenic Treatment Plant (ATP) Operation and Maintenance (O&M) (Years 1-30)

Includes:
1. ATP O&M for years 1-30
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site chemicals of concern (COCs) (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:

1.	Staff per weekly routine maintenance event	1	people
2.	Days per weekly routine maintenance event	1	days/event
3.	Number of routine maintenance events per week	3	events/week
4.	Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1.	Staff per monthly routine maintenance event	2	people
2.	Days per monthly routine maintenance	2	days/event
3.	Number of routine maintenance events per month	1	events/month
4.	Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1.	Staff per non-routine maintenance event	2	people
2.	Days per non-routine maintenance	1	day/event
3.	Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1.	Labor included in weekly routine maintenance		
2.	Number of samples per sampling event	3	samples
3.	Number of sampling events	12	events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	

TABLE A-1
Cost Estimate for Shepley's Hill Landfill, Alternative 2

Alternative 2
Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

Labor - Monthly Routine Maintenance				
Program Manager	12	hour	$200	$2,400
Project Manager	24	hour	$150	$3,600
Environmental Engineer - Mid	96	hour	$120	$11,520
Environmental Engineer - Junior	192	hour	$90	$17,280
GIS Specialist - Mid	24	hour	$100	$2,400
CADD Technician - Mid	24	hour	$75	$1,800
Administrative Assistant - Mid	12	hour	$70	$840
Labor - Non-Routine Maintenance				
Program Manager	40	hour	$200	$8,000
Project Manager	60	hour	$150	$9,000
Environmental Engineer - Mid	160	hour	$120	$19,200
Environmental Engineer - Junior	160	hour	$90	$14,400
GIS Specialist - Mid	40	hour	$100	$4,000
CADD Technician - Mid	40	hour	$75	$3,000
Administrative Assistant - Mid	20	hour	$70	$1,400
Labor - O&M Reporting				
Program Manager	8	hour	$200	$1,600
Project Manager	16	hour	$150	$2,400
Environmental Engineer - Mid	20	hour	$120	$2,400
Environmental Engineer - Junior	40	hour	$90	$3,600
GIS Specialist - Mid	8	hour	$100	$800
CADD Technician - Mid	8	hour	$75	$600
Administrative Assistant - Mid	4	hour	$70	$280
Laboratory Analyses				
Site COCs (including duplicates)	36	samples	$135	$4,860
Trip blanks	12	samples	$80	$960
Sample shipping	12	coolers	$100	$1,200
Supplies and Expenses				
Electrical	145,000	kilowatts per hour (kW-h)	$0.21	$30,450
ATP sampling equipment	12	day	$251	$3,012
Field supplies	12	event	$500	$6,000
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000
Disposal				
Sludge disposal	1	lump sum	$80,000	$80,000
Investigation-derived waste (IDW) disposal	1	lump sum	$10,000	$10,000
Water disposal (publicly owned treatment works)	23,652	gallons	$7.50	$177,390
Travel				
Per diem (food)	244	day	$69	$16,836
Pick-up truck	244	day	$50	$12,200
SUBTOTAL				**$745,068**
SUBTOTAL (YEARS 1-30)				**$22,352,040**

TABLE A-1
Cost Estimate for Shepley's Hill Landfill, Alternative 2

Alternative 2
Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

2. Annual Landfill Inspection and Maintenance (Years 1-30)

Includes:

1. Annual landfill inspection and maintenance for years 1-30
2. One week of mowing performed by subcontractors, followed by annual landfill inspection
3. Landfill repair and maintenance
4. Landfill inspection report (Final version only, no response to comments)

Major Assumptions:

Landfill Inspection:

1. Staff per event	1	people
2. Days per event	1	days/event

Landfill Repair and Maintenance:

1. Staff per event	2	people
2. Days per event	2	days/event

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Landfill Inspection					
Program Manager	1	hour	$200	$200	
Project Manager	2	hour	$150	$300	
Environmental Engineer- Mid	6	hour	$120	$720	
Environmental Engineer - Junior	12	hour	$90	$1,080	
GIS Specialist - Mid	2	hour	$100	$200	
CADD Technician - Mid	2	hour	$75	$150	
Administrative Assistant - Mid	1	hour	$70	$70	
Labor - Landfill Repair and Maintenance					
Program Manager	4	hour	$200	$800	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	4	hour	$100	$400	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	2	hour	$70	$140	
Labor - Inspection Report					
Program Manager	2	hour	$200	$400	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	4	hour	$70	$280	
Subcontractors					
Landfill mowing	5	day	$6,000	$30,000	
Landfill repair	2	day	$5,000	$10,000	
Supplies					
Landfill inspection equipment	5	day	$250	$1,250	
Field supplies	3	day	$500	$1,500	
Reproduction costs	1	lump sum	$500	$500	
Travel					
Per diem (food)	5	day	$69	$345	
Per diem (lodging)	2	day	$175	$350	
Pick-up truck	5	day	$50	$250	
SUBTOTAL				**$60,295**	
SUBTOTAL (YEARS 1-30)				**$1,808,850**	

TABLE A-1
Cost Estimate for Shepley's Hill Landfill, Alternative 2

Alternative 2
Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

3. Semi-Annual Groundwater Monitoring (Years 1-10)

Includes:
1. Semi-annual groundwater monitoring for years 1-10
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 85 wells during each event; 9 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 85 wells during each event; 9 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1. Staff per monitoring event	2	people
2. Days per monitoring event	15	days
3. Number of monitoring events	2	events
4. Number of wells sampled per event	85	wells
5. Duplicate samples (COCs)	9	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer/Geologist - Mid	300	hour	$120	$36,000	
Environmental Engineer/Geologist - Junior	300	hour	$90	$27,000	
GIS Specialist - Mid	16	hour	$100	$1,600	
Administrative Assistant - Mid	8	hour	$70	$560	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	100	hour	$90	$9,000	
GIS Specialist - Mid	40	hour	$100	$4,000	
Administrative Assistant - Mid	12	hour	$70	$840	
Laboratory Analyses					
Site COCs (including duplicates)	188	samples	$45	$8,460	
General chemistry (including duplicates)	188	samples	$110	$20,680	
Sample shipping	38	coolers	$100	$3,800	
IDW disposal	2	lump sum	$2,000	$4,000	
Supplies					
Sampling equipment	60	day	$200	$12,000	
Field supplies	2	event	$500	$1,000	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	60	day	$69	$4,140	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	60	day	$50	$3,000	
SUBTOTAL				**$153,780**	
SUBTOTAL (YEARS 1-10)				**$1,537,800**	

TABLE A-1
Cost Estimate for Shepley's Hill Landfill, Alternative 2

Alternative 2
Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

4. Annual Groundwater Monitoring (Years 11-30)

Includes:

1. Annual groundwater monitoring for years 11-30
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 45 wells during each event; 5 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 45 wells during each event; 5 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1.	Staff per sampling event	2	people
2.	Days per sampling event	8	days
3.	Number of sampling events	1	event
4.	Number of wells per sampling event	45	wells
5.	Duplicate samples (COCs)	5	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	8	hour	$100	$800	
Administrative Assistant - Mid	4	hour	$70	$280	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	36	hour	$120	$4,320	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	24	hour	$100	$2,400	
Administrative Assistant - Mid	8	hour	$70	$560	
Laboratory Analyses					
Site COCs (including duplicates)	50	samples	$45	$2,250	
General chemistry (including duplicates)	50	samples	$110	$5,500	
Sample shipping	10	coolers	$100	$1,000	
IDW disposal	1	lump sum	$2,000	$2,000	
Supplies					
Sampling equipment	16	day	$200	$3,200	
Field supplies	1	event	$500	$500	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	16	day	$69	$1,104	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	16	day	$50	$800	
SUBTOTAL				**$54,414**	
SUBTOTAL (YEARS 11-30)				**$1,088,280**	

TOTAL COSTS

COSTS	**$26,786,970**

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

Site: Shepley's Hill Landfill
Location: Former Fort Devens, Massachusetts
Phase: Focused Feasibility Study (-30% to +50%)
Base Year: 2023
Date: March 2023

Description: Alternative 3 for Shepley's Hill Landfill consists of termination of the existing groundwater extraction and treatment system and implementation of in-situ air sparging.

SCOPED TASKS:
1. **Remedial Design Optimization and Testing (Year 1)**
2. **Record of Decision (ROD) Amendment Preparation and Submittal (Year 1)**
3. **Annual Landfill Inspection and Maintenance (Years 1-30)**
4. **Annual Arsenic Treatment Plant (ATP) Operation and Maintenance (O&M) (Years 1-2)**
5. **Remedial Design (Year 2)**
6. **Remedial Design Implementation - In-Situ Air Sparge (IAS) System, Trenching, Well Installation (Year 2)**
7. **Annual IAS System O&M (Years 3-30)**
8. **Quarterly IAS Performance Monitoring (Years 3-4)**
9. **Semi-Annual Groundwater Monitoring (Years 1-10)**
10. **Annual Groundwater Monitoring (Years 11-30)**

1. Remedial Design Optimization and Testing (Year 1)

Includes:
1. Remedial design optimization and testing in year 1
2. Work plan (Rev 0 Draft Army, Rev 0 Draft Regulators, and Rev 1 Versions with Responses to Comments)
3. Additional field testing and data collection. Deep sparge wells only, specific capacity testing
4. Three rounds of groundwater sampling data on 12 wells, sampling for metals, alkalinity, dissolved organic carbon, sulfate, nitrate
5. Data compilation and evaluation

Major Assumptions:

1.	Staff for pre-design investigation	2	person
2.	Days of pilot testing	5	days
3.	Days of specific capacity testing	3	days
4.	Existing wells to sample	12	wells
5.	Number of groundwater sampling rounds	3	rounds
6.	Total sampling days	9	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Work Plan					
Program Manager	10	hour	$200	$2,000	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Senior	40	hour	$145	$5,800	
Environmental Engineer - Mid	220	hour	$120	$26,400	
Environmental Engineer - Junior	340	hour	$90	$30,600	
GIS Specialist - Mid	20	hour	$100	$2,000	
CADD Technician - Mid	10	hour	$75	$750	
Labor - Pre-Design Investigation					
Program Manager	10	hour	$200	$2,000	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Senior	60	hour	$145	$8,700	
Environmental Engineer - Mid	170	hour	$120	$20,400	
Environmental Engineer - Junior	170	hour	$90	$15,300	
Subcontractors					
Equipment rental - sparging	5	days	$3,000	$15,000	
Equipment rental - specific capacity testing	3	days	$1,500	$4,500	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Laboratory Analyses					
Site chemicals of concern (COCs)	12	well	$155	$1,860	
Trip blanks	2	samples	$8	$16	
Sample shipping	2	coolers	$100	$200	
Supplies					
Field supplies	1	lump sum	$7,500	$7,500	
Travel					
Per diem (food)	25	day	$69	$1,725	
Per diem (lodging)	25	day	$175	$4,375	
Pick-up truck	25	day	$50	$1,250	
SUBTOTAL				**$156,376**	
SUBTOTAL W/ CONTIGENCY (30%)				**$203,289**	
SUBTOTAL (YEAR 1)				**$203,289**	

2. Record of Decision (ROD) Amendment Preparation and Submittal (Year 1)

Includes:

1. ROD amendment preparation and submittal in year 1
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	24	hour	$200	$4,800	
Project Manager	40	hour	$150	$6,000	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$38,100**	
SUBTOTAL (YEAR 1)				**$38,100**	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

3. Annual Landfill Inspection and Maintenance (Years 1-30)

Includes:

1. Annual landfill inspection and maintenance for years 1-30
2. One week of mowing performed by subcontractors, followed by annual landfill inspection
3. Landfill repair and maintenance
4. Landfill inspection report (Final version only, no response to comments)

Major Assumptions:

Landfill Inspection:

1. Staff per event	1	people
2. Days per event	1	days/event

Landfill Repair and Maintenance:

1. Staff per event	2	people
2. Days per event	2	day/event

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Landfill Inspection					
Program Manager	1	hour	$200	$200	
Project Manager	2	hour	$150	$300	
Environmental Engineer - Mid	6	hour	$120	$720	
Environmental Engineer - Junior	12	hour	$90	$1,080	
GIS Specialist - Mid	2	hour	$100	$200	
CADD Technician - Mid	2	hour	$75	$150	
Administrative Assistant - Mid	1	hour	$70	$70	
Labor - Landfill Repair and Maintenance					
Program Manager	4	hour	$200	$800	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	4	hour	$100	$400	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	2	hour	$70	$140	
Labor - Inspection Report					
Program Manager	2	hour	$200	$400	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	4	hour	$70	$280	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

Subcontractors				
Landfill mowing	5	day	$6,000	$30,000
Landfill repair	2	day	$5,000	$10,000
Supplies				
Landfill inspection equipment	5	day	$250	$1,250
Field supplies	3	event	$500	$1,500
Reproduction costs	1	lump sum	$500	$500
Travel				
Per diem (food)	5	day	$69	$345
Per diem (lodging)	2	day	$175	$350
Pick-up truck	5	day	$50	$250
SUBTOTAL				**$60,295**
SUBTOTAL (YEARS 1-30)				**$1,808,850**

4. Annual Arsenic Treatment Plant (ATP) Operation and Maintenance (O&M) (Years 1-2)

Includes:
1. ATP O&M for years 1-30
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site chemicals of concern (COCs) (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:

1. Staff per weekly routine maintenance event	1	people
2. Days per weekly routine maintenance event	1	days/event
3. Number of routine maintenance events per week	3	events/week
4. Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1. Staff per monthly routine maintenance event	2	people
2. Days per monthly routine maintenance	2	days/event
3. Number of routine maintenance events per month	1	events/month
4. Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1. Staff per non-routine maintenance event	2	people
2. Days per non-routine maintenance	1	day/event
3. Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1. Labor included in weekly routine maintenance		
2. Number of samples per sampling event	3	samples
3. Number of sampling events	12	events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	
Labor - Non-Routine Maintenance					
Program Manager	40	hour	$200	$8,000	
Project Manager	60	hour	$150	$9,000	
Environmental Engineer - Mid	160	hour	$120	$19,200	
Environmental Engineer - Junior	160	hour	$90	$14,400	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	
Labor - O&M Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Mid	20	hour	$120	$2,400	
Environmental Engineer - Junior	40	hour	$90	$3,600	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	8	hour	$75	$600	
Administrative Assistant - Mid	4	hour	$70	$280	
Laboratory Analyses					
Site COCs (including duplicates)	36	samples	$135	$4,860	
Trip blanks	12	samples	$80	$960	
Sample shipping	12	coolers	$100	$1,200	
Supplies and Expenses					
Electrical	145,000	kilowatts per hour (kW-h)	$0.21	$30,450	
ATP sampling equipment	12	day	$251	$3,012	
Field supplies	12	event	$500	$6,000	
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000	
Disposal					
Sludge disposal	1	lump sum	$80,000	$80,000	
Investigation-derived waste (IDW) disposal	1	lump sum	$10,000	$10,000	
Water disposal (publicly owned treatment works)	23,652	gallons	$7.50	$177,390	
Travel					
Per diem (food)	244	day	$69	$16,836	
Pick-up truck	244	day	$50	$12,200	
SUBTOTAL				**$745,068**	
SUBTOTAL (YEARS 1-30)				**$1,490,136**	

5. Remedial Design (Year 2)

Includes:
1. Remedial design in year 2
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	36	hour	$200	$7,200	
Project Manager	72	hour	$150	$10,800	
Hydrogeologist - Senior	90	hour	$160	$14,400	
Environmental Engineer - Senior	120	hour	$150	$18,000	
Environmental Engineer - Mid	180	hour	$120	$21,600	
Environmental Engineer - Junior	300	hour	$90	$27,000	
Modeling Specialist - Mid	72	hour	$145	$10,440	
GIS Specialist - Mid	72	hour	$100	$7,200	
CADD Technician - Mid	72	hour	$75	$5,400	
Administrative Assistant - Mid	36	hour	$70	$2,520	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
SUBTOTAL				**$126,060**	

TABLE A-2 **Cost Estimate for Shepley's Hill Landfill, Alternative 3**	
Alternative 3 **In-Situ Air Sparging**	**OPINION OF PROBABLE COST**
SUBTOTAL (YEAR 2)	**$126,060**

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

6. Remedial Design Implementation - In-Situ Air Sparge (IAS) System, Trenching, Well Installation (Year 2)

Includes:

1. Remedial design implementation of the IAS system, trenching, and well installation in year 2
2. Installation of 30 deep sparge wells (~75-foot depth) and 15 shallow sparge wells (~60-foot depth) across landfill footprint
3. Installation of 10 performance monitoring wells
4. Trenching 1-inch high-density polyethylene lines from arsenic treatment plant (ATP) building to each sparge well
5. Delivery of IAS system to the site and connection to piping

Major Assumptions:

1. Field days for well installation/development	30	days
2. Field days for trenching/pipe installation	19	days
3. System connection and startup	10	days
4. Total days	59	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	30	hour	$200	$5,900	
Project Manager	59	hour	$150	$8,850	
Environmental Engineer - Senior	118	hour	$160	$18,880	
Site Safety Officer	590	hour	$120	$70,800	
Geologist - Mid	300	hour	$120	$36,000	
Environmental Engineer - Mid	290	hour	$120	$34,800	
Geologist - Junior	300	hour	$90	$27,000	
Environmental Engineer - Junior	290	hour	$90	$26,100	
Subcontractors					
Utility clearance	1	lump sum	$5,000	$5,000	
Site clearing	1	lump sum	$10,000	$10,000	
Driller	1	lump sum	$574,000	$574,000	
Site work contractor	1	lump sum	$367,000	$367,000	
Surveyor	1	lump sum	$10,000	$10,000	
Electrician	1	lump sum	$20,000	$20,000	
System capital cost	1	lump sum	$250,000	$250,000	
Decommissioning of ATP	1	lump sum	$50,000	$50,000	
Supplies					
Field supplies/expenses	3	event	$5,000	$15,000	
Travel					
Per diem (food)	177	day	$69	$12,213	
Pick-up truck	177	day	$50	$8,850	
SUBTOTAL				**$1,550,393**	
SUBTOTAL W/ CONTIGENCY (30%)				**$2,020,000**	
SUBTOTAL (YEAR 2)				**$2,020,000**	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

7. Annual IAS System O&M (Years 3-30)

Includes:
1. IAS system O&M for years 3-30
2. One event per week and six contingency visits per year for IAS system O&M
3. Data compilation, tracking, and reporting

Major Assumptions:
1. Staff per O&M event — 1 people
2. Number of O&M visits per year — 64 days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Senior	60	hour	$145	$8,700	
Environmental Engineer - Mid	120	hour	$120	$14,400	
Environmental Engineer - Junior	640	hour	$90	$57,600	
Labor - O&M Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Senior	30	hour	$145	$4,350	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	8	hour	$75	$600	
Administrative Assistant - Mid	4	hour	$70	$280	
Other Expenses					
Annual compressor service	1	lump sum	$3,000	$3,000	
System electricity	12	months	$1,700	$20,400	
Annual well redevelopment	1	lump sum	$30,000	$30,000	
Field supplies/expenses	64	days	$100	$6,400	
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000	
Travel					
Per diem (food)	64	day	$69	$4,416	
Per diem (lodging)	64	day	$175	$11,200	
Pick-up truck	64	day	$50	$3,200	
SUBTOTAL				**$202,946**	
SUBTOTAL (YEARS 3-30)				**$5,682,488**	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

8. Quarterly IAS Performance Monitoring (Years 3-4)

Includes:

1. Quarterly performance monitoring at a subset of monitoring wells adjacent to the sparge points for years 3 and 4
2. Site COCs (arsenic, iron, and manganese) sampled at 15 wells during each event; 2 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 15 wells during each event; 2 duplicates per event
4. Data-focused monitoring report completed following each sampling event (2 total versions per report)

Major Assumptions:

1. Staff per sampling event	2	people
2. Days per sampling event	3	days
3. Number of sampling events	4	events
4. Number of wells per sampling event	15	wells
5. Duplicate samples (COCs)	2	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	16	hour	$200	$3,200	
Project Manager	48	hour	$150	$7,200	
Environmental Engineer - Mid	120	hour	$120	$14,400	
Environmental Engineer - Junior	120	hour	$90	$10,800	
GIS Specialist - Mid	32	hour	$100	$3,200	
Administrative Assistant - Mid	16	hour	$70	$1,120	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	120	hour	$90	$10,800	
GIS Specialist - Mid	20	hour	$100	$2,000	
Administrative Assistant - Mid	4	hour	$70	$280	
Laboratory Analysis					
Site COCs (including duplicates)	68	samples	$45	$3,060	
General chemistry (including duplicates)	68	samples	$110	$7,480	
Sample shipping	16	coolers	$100	$1,600	
Investigation-derived waste (IDW) disposal	4	lump sum	$2,000	$8,000	
Supplies					
Sampling equipment	24	day	$200	$4,800	
Field supplies	4	event	$500	$2,000	
Reproduction costs	4	lump sum	$500	$2,000	
Travel					
Per diem (food)	24	day	$69	$1,656	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	24	day	$50	$1,200	
SUBTOTAL				**$95,996**	
SUBTOTAL (YEARS 3-4)				**$191,992**	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

9. Semi-Annual Groundwater Monitoring (Years 1-10)

Includes:
1. Semi-annual groundwater monitoring for years 1-10
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 85 wells during each event; 9 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 85 wells during each event; 9 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1. Staff per monitoring event	2	people
2. Days per monitoring event	15	days
3. Number of monitoring events	2	events
4. Number of wells sampled per event	85	wells
5. Duplicate samples (COCs)	9	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	300	hour	$120	$36,000	
Environmental Engineer - Junior	300	hour	$90	$27,000	
GIS Specialist - Mid	16	hour	$100	$1,600	
Administrative Assistant - Mid	8	hour	$70	$560	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	100	hour	$90	$9,000	
GIS Specialist - Mid	40	hour	$100	$4,000	
Administrative Assistant - Mid	12	hour	$70	$840	
Laboratory Analyses					
Site COCs (including duplicates)	188	samples	$45	$8,460	
General chemistry (including duplicates)	188	samples	$110	$20,680	
Sample shipping	38	coolers	$100	$3,800	
IDW disposal	2	lump sum	$2,000	$4,000	
Supplies					
Sampling equipment	60	day	$200	$12,000	
Field supplies	2	event	$500	$1,000	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	60	day	$69	$4,140	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	60	day	$50	$3,000	
SUBTOTAL				**$153,780**	
SUBTOTAL (YEARS 1-10)				**$1,537,800**	

TABLE A-2
Cost Estimate for Shepley's Hill Landfill, Alternative 3

Alternative 3
In-Situ Air Sparging

OPINION OF PROBABLE COST

10. Annual Groundwater Monitoring (Years 11-30)

Includes:

1. Annual groundwater monitoring for years 11-30
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 45 wells during each event; 5 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 45 wells during each event; 5 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1. Staff per sampling event	2	people
2. Days per sampling event	8	days
3. Number of sampling events	1	event
4. Number of wells per sampling event	45	wells
5. Duplicate samples (COCs)	5	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	8	hour	$100	$800	
Administrative Assistant - Mid	4	hour	$70	$280	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	36	hour	$120	$4,320	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	24	hour	$100	$2,400	
Administrative Assistant - Mid	8	hour	$70	$560	
Laboratory Analyses					
Site COCs (incl. duplicates)	50	samples	$45	$2,250	
General chemistry (incl. duplicates)	50	samples	$110	$5,500	
Sample shipping	10	coolers	$100	$1,000	
IDW disposal	1	lump sum	$2,000	$2,000	
Supplies					
Sampling equipment	16	day	$200	$3,200	
Field supplies	1	event	$500	$500	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	16	day	$69	$1,104	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	16	day	$50	$800	
SUBTOTAL				**$54,414**	
SUBTOTAL (YEARS 11-30)				**$1,088,280**	

TOTAL COSTS

COSTS	**$14,186,995**

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

Site:	Shepley's Hill Landfill
Location:	Former Fort Devens, Massachusetts
Phase:	Focused Feasibility Study (-30% to +50%)
Base Year:	2023
Date:	March 2023

Description: Alternative 4A for Shepley's Hill Landfill consists of continuing the existing groundwater extraction and treatment system currently in place at the site with the addition of a third groundwater extraction well.

SCOPED TASKS:
1. **Remedial Design Optimization and Testing (Year 1)**
2. **Explanation of Significant Differences Preparation and Submittal (Year 1)**
3. **Remedial Design (Year 2)**
4. **Remedial Design Implementation - Installation and Testing of Third Extraction Well (Year 3)**
5. **Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)**
6. **Annual Landfill Inspection and Maintenance (Years 1-30)**
7. **Annual ATP System Operation and Maintenance (3 extraction wells; Years 3-30)**
8. **Semi-Annual Groundwater Monitoring (Years 1-10)**
9. **Annual Groundwater Monitoring (Years 11-30)**

1. Remedial Design Optimization and Testing (Year 1)

Includes:
1. Remedial design optimization work plan preparation and minor reporting in year 1
2. Install soil boring to collect soil sieve analysis for well screen design and log soils throughout, as well as auger refusal

Major Assumptions:

1. Staff for drilling	2	person
2. Days of direct push technology drilling operation	2	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field Work					
Program Manager	4	hour	$200	$800	
Project Manager	8	hour	$150	$1,200	
Site Safety Officer	20	hour	$120	$2,400	
Geologist - Junior	20	hour	$90	$1,800	
Labor - Work Plan and Reporting					
Program Manager	2	hour	$200	$400	
Project Manager	2	hour	$150	$300	
Environmental Engineer - Mid	6	hour	$120	$720	
Environmental Engineer - Junior	16	hour	$90	$1,440	
GIS Specialist - Mid	4	hour	$100	$400	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	2	hour	$70	$140	
Subcontractors					
Driller	2	days	$7,500	$15,000	
Laboratory Analyses					
Soil analysis	1	well	$200	$200	
Trip blanks	1	samples	$8	$8	
Sample shipping	1	coolers	$100	$100	
Supplies					
Field supplies and equipment rental	1	lump sum	$500	$500	
Travel					
Per diem (food)	4	day	$69	$276	
Per diem (lodging)	4	day	$175	$700	
Pick-up truck	4	day	$50	$200	
SUBTOTAL				**$26,884**	
SUBTOTAL (YEAR 1)				**$26,884**	

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

2. Explanation of Significant Differences Preparation and Submittal (Year 1)

Includes:
1. Explanation of Significant Differences preparation and submittal in year 1
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	18	hour	$200	$3,600	
Project Manager	30	hour	$150	$4,500	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	30	hour	$100	$3,000	
CADD Technician - Mid	30	hour	$75	$2,250	
Administrative Assistant - Mid	15	hour	$70	$1,050	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$29,100**	
SUBTOTAL (YEAR 1)				**$29,100**	

3. Remedial Design (Year 2)

Includes:
1. Remedial design in year 2
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	16	hour	$200	$3,120	
Project Manager	31	hour	$150	$4,680	
Hydrogeologist - Senior	39	hour	$160	$6,240	
Environmental Engineer - Senior	52	hour	$150	$7,800	
Environmental Engineer - Mid	78	hour	$120	$9,360	
Environmental Engineer - Junior	130	hour	$90	$11,700	
Modeling Specialist - Mid	31	hour	$145	$4,524	
GIS Specialist - Mid	31	hour	$100	$3,120	
CADD Technician - Mid	31	hour	$75	$2,340	
Administrative Assistant - Mid	16	hour	$70	$1,092	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
SUBTOTAL				**$55,476**	
SUBTOTAL (YEAR 2)				**$55,476**	

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

4. Remedial Design Implementation - Installation and Testing of Third Extraction Well (Year 3)

Includes:

1. Remedial design implementation in year 3
2. Installation of third extraction well and trenching 2-inch polyvinyl chloride pipe from ATP building to third extraction well
3. Installation of 10 performance monitoring wells
4. 5 days of performance testing

Major Assumptions:

1. Staff for installation of third extraction well	2	person
2. Days of utility clearance and well installation	13	days
3. Days of well development	3	days
4. Staff for trenching/pipe installation and plumbing	2	people
5. Days trenching/pipe installation and plumbing	4	days
6. Staff for performance testing	2	people
7. Days of performance testing	5	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	4	hour	$200	$800	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Senior	25	hour	$150	$3,750	
Environmental Engineer - Mid	250	hour	$120	$30,000	
Environmental Engineer - Junior	250	hour	$90	$22,500	
GIS Specialist - Mid	16	hour	$100	$1,600	
CADD Technician - Mid	8	hour	$75	$600	
Subcontractors					
Utility clearance	1	lump sum	$3,000	$3,000	
Driller	1	lump sum	$141,600	$141,600	
Site work contractor	1	lump sum	$43,000	$43,000	
Surveyor	1	lump sum	$3,000	$3,000	
Electrician	1	lump sum	$10,000	$10,000	
Supplies and Field Expenses					
Field supplies	1	lump sum	$3,000	$3,000	
Travel					
Per diem (food)	50	day	$69.00	$3,450	
Per diem (lodging)	50	day	$175.00	$8,750	
Pick-up truck	50	day	$50.00	$2,500	
SUBTOTAL				**$279,350**	
SUBTOTAL W/ CONTIGENCY (30%)				**$363,155**	
SUBTOTAL (YEAR 3)				**$363,155**	

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

5. Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)

Includes:

1. ATP O&M for years 1-3
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site chemicals of concern (COCs) (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:

1.	Staff per weekly routine maintenance event	1	people
2.	Days per weekly routine maintenance event	1	days/event
3.	Number of routine maintenance events per week	3	events/week
4.	Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1.	Staff per monthly routine maintenance event	2	people
2.	Days per monthly routine maintenance	2	days/event
3.	Number of routine maintenance events per month	1	events/month
4.	Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1.	Staff per non-routine maintenance event	2	people
2.	Days per non-routine maintenance	1	day/event
3.	Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1.	Labor included in weekly routine maintenance		
2.	Number of samples per sampling event	3	samples
3.	Number of sampling events	12	events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	
GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	
Labor - Non-Routine Maintenance					
Program Manager	40	hour	$200	$8,000	
Project Manager	60	hour	$150	$9,000	
Environmental Engineer - Mid	160	hour	$120	$19,200	
Environmental Engineer - Junior	160	hour	$90	$14,400	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

Labor - O&M Reporting				
Program Manager	8	hour	$200	$1,600
Project Manager	16	hour	$150	$2,400
Environmental Engineer - Mid	20	hour	$120	$2,400
Environmental Engineer - Junior	40	hour	$90	$3,600
GIS Specialist - Mid	8	hour	$100	$800
CADD Technician - Mid	8	hour	$75	$600
Administrative Assistant - Mid	4	hour	$70	$280
Laboratory Analyses				
Site COCs (including duplicates)	36	samples	$135	$4,860
Trip blanks	12	samples	$80	$960
Sample shipping	12	coolers	$100	$1,200
Supplies and Expenses				
Electricity	145,000	kilowatts per hour (kW-h)	$0.21	$30,450
ATP sampling equipment	12	day	$251	$3,012
Field supplies	12	event	$500	$6,000
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000
Disposal				
Sludge disposal	1	lump sum	$80,000	$80,000
Investigation-derived waste (IDW) disposal	1	lump sum	$10,000	$10,000
Water disposal (publicly owned treatment works)	23,652	gallons	$7.50	$177,390
Travel				
Per diem (food)	244	day	$69	$16,836
Pick-up truck	244	day	$50	$12,200
SUBTOTAL				**$745,068**
SUBTOTAL (YEARS 1-3)				**$2,235,204**

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

6. Annual Landfill Inspection and Maintenance (Years 1-30)

Includes:
1. Annual landfill inspection and maintenance for years 1-30
2. One week of mowing performed by subcontractors, followed by annual landfill inspection
3. Landfill repair and maintenance
4. Landfill inspection report (Final version only, no response to comments)

Major Assumptions:

Landfill Inspection:

1. Staff per event	1	people
2. Days per event	1	days/event

Landfill Repair and Maintenance:

1. Staff per event	2	people
2. Days per event	2	day/event

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Landfill Inspection					
Program Manager	1	hour	$200	$200	
Project Manager	2	hour	$150	$300	
Environmental Engineer - Mid	6	hour	$120	$720	
Environmental Engineer - Junior	12	hour	$90	$1,080	
GIS Specialist - Mid	2	hour	$100	$200	
CADD Technician - Mid	2	hour	$75	$150	
Administrative Assistant - Mid	1	hour	$70	$70	
Labor - Landfill Repair and Maintenance					
Program Manager	4	hour	$200	$800	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	4	hour	$100	$400	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	2	hour	$70	$140	
Labor - Inspection Report					
Program Manager	2	hour	$200	$400	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	4	hour	$70	$280	
Subcontractors					
Landfill mowing	5	day	$6,000	$30,000	
Landfill repair	2	day	$5,000	$10,000	
Supplies					
Landfill inspection equipment	5	day	$250	$1,250	
Field supplies	3	event	$500	$1,500	
Reproduction costs	1	lump sum	$500	$500	
Travel					
Per diem (food)	5	day	$69	$345	
Per diem (lodging)	2	day	$175	$350	
Pick-up truck	5	day	$50	$250	
SUBTOTAL				**$60,295**	
SUBTOTAL (YEARS 1-30)				**$1,808,850**	

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

7. Annual ATP System Operation and Maintenance (3 extraction wells; Years 3-30)

Includes:
1. ATP O&M for years 3-30
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site COCs (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:

1.	Staff per weekly routine maintenance event	1	people
2.	Days per weekly routine maintenance event	1	days/event
3.	Number of routine maintenance events per week	3	events/week
4.	Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1.	Staff per monthly routine maintenance event	2	people
2.	Days per monthly routine maintenance	2	days/event
3.	Number of routine maintenance events per month	1	events/month
4.	Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1.	Staff per non-routine maintenance event	2	people
2.	Days per non-routine maintenance	1	day/event
3.	Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1.	Labor included in weekly routine maintenance		
2.	Number of samples per sampling event	3	samples
3.	Number of sampling events	12	events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	
GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	
Labor - Non-Routine Maintenance					
Program Manager	40	hour	$200	$8,000	
Project Manager	60	hour	$150	$9,000	
Environmental Engineer - Mid	160	hour	$120	$19,200	
Environmental Engineer - Junior	160	hour	$90	$14,400	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

Labor - O&M Reporting				
Program Manager	8	hour	$200	$1,600
Project Manager	16	hour	$150	$2,400
Environmental Engineer - Mid	20	hour	$120	$2,400
Environmental Engineer - Junior	40	hour	$90	$3,600
GIS Specialist - Mid	8	hour	$100	$800
CADD Technician - Mid	8	hour	$75	$600
Administrative Assistant - Mid	4	hour	$70	$280
Laboratory Analyses				
Site COCs (including duplicates)	36	samples	$135	$4,860
Trip blanks	12	samples	$80	$960
Sample shipping	12	coolers	$100	$1,200
Supplies and Expenses				
Electricity	194,000	kW-h	$0.21	$40,740
ATP sampling equipment	12	day	$251	$3,012
Field supplies	12	event	$500	$6,000
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000
Disposal				
Sludge disposal	1	lump sum	$110,000	$110,000
IDW disposal	1	lump sum	$10,000	$10,000
Water disposal (publicly owned treatment works)	23,652	gallons	$7.50	$177,390
Travel				
Per diem (food)	244	day	$69	$16,836
Pick-up truck	244	day	$50	$12,200
SUBTOTAL				**$785,358**
SUBTOTAL (YEARS 3-30)				**$21,990,024**

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

8. Semi-Annual Groundwater Monitoring (Years 1-10)

Includes:

1. Semi-annual groundwater monitoring for years 1-10
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 85 wells during each event; 9 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 85 wells during each event; 9 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1. Staff per monitoring event	2	people
2. Days per monitoring event	15	days
3. Number of monitoring events	2	events
4. Number of wells sampled per event	85	wells
5. Duplicate samples (COCs)	9	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	300	hour	$120	$36,000	
Environmental Engineer - Junior	300	hour	$90	$27,000	
GIS Specialist - Mid	16	hour	$100	$1,600	
Administrative Assistant - Mid	8	hour	$70	$560	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	100	hour	$90	$9,000	
GIS Specialist - Mid	40	hour	$100	$4,000	
Administrative Assistant - Mid	12	hour	$70	$840	
Laboratory Analyses					
Site COCs (including duplicates)	188	samples	$45	$8,460	
General chemistry (including duplicates)	188	samples	$110	$20,680	
Sample shipping	38	coolers	$100	$3,800	
IDW disposal	2	lump sum	$2,000	$4,000	
Supplies					
Sampling equipment	60	day	$200	$12,000	
Field supplies	2	event	$500	$1,000	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	60	day	$69	$4,140	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	60	day	$50	$3,000	
SUBTOTAL				**$153,780**	
SUBTOTAL (YEARS 1-10)				**$1,537,800**	

TABLE A-3
Cost Estimate for Shepley's Hill Landfill, Alternative 4A

Alternative 4A
Modified Groundwater Extraction and Treatment

OPINION OF PROBABLE COST

9. Annual Groundwater Monitoring (Years 11-30)

Includes:

1. Annual groundwater monitoring for years 11-30
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 45 wells during each event; 5 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 45 wells during each event; 5 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1. Staff per sampling event	2	people
2. Days per sampling event	8	days
3. Number of sampling events	1	event
4. Number of wells per sampling event	45	wells
5. Duplicate samples (COCs)	5	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	8	hour	$100	$800	
Administrative Assistant - Mid	4	hour	$70	$280	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	36	hour	$120	$4,320	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	24	hour	$100	$2,400	
Administrative Assistant - Mid	8	hour	$70	$560	
Laboratory Analyses					
Site COCs (including duplicates)	50	samples	$45	$2,250	
General chemistry (including duplicates)	50	samples	$110	$5,500	
Sample shipping	10	coolers	$100	$1,000	
IDW disposal	1	lump sum	$2,000	$2,000	
Supplies					
Sampling equipment	16	day	$200	$3,200	
Field supplies	1	event	$500	$500	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	16	day	$69	$1,104	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	16	day	$50	$800	
SUBTOTAL				**$54,414**	
SUBTOTAL (YEARS 11-30)				**$1,088,280**	

TOTAL COSTS

COSTS	**$29,134,773**

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

Site: Shepley's Hill Landfill
Location: Former Fort Devens, Massachusetts
Phase: Focused Feasibility Study (-30% to +50%)
Base Year: 2023
Date: March 2023

Description: Alternative 4B for Shepley's Hill Landfill consists of continuing the existing groundwater extraction and treatment system currently in place at the site with the addition of a third groundwater extraction well and injection.

SCOPED TASKS:
1. **Remedial Design Optimization and Testing (Year 1)**
2. **Explanation of Significant Differences Preparation and Submittal (Year 1)**
3. **Remedial Design (Year 2)**
4. **Remedial Design Implementation - Installation of Third Extraction Well and Injection (Year 3)**
5. **Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)**
6. **Annual Landfill Inspection and Maintenance (Years 1-30)**
7. **Annual ATP System O&M (3 extraction wells and injection; Years 3-30)**
8. **Quarterly Performance Monitoring (Years 3-4)**
9. **Semi-Annual Groundwater Monitoring (Years 1-10)**
10. **Annual Groundwater Monitoring (Years 11-30)**

1. Remedial Design Optimization and Testing (Year 1)

Includes:
1. Remedial design optimization and testing in year 1
2. Work plan (Rev 0 Draft Army, Rev 0 Draft Regulators, and Rev 1 Versions with Responses to Comments)
3. Two days of field testing (falling head injection)
4. Install soil boring to collect soil sieve analysis for well screen design

Major Assumptions:

1. Staff per event	2	person
2. Days direct push technology drilling operation	1	days
3. Days of field testing	2	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Workplan					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Senior	20	hour	$145	$2,900	
Environmental Engineer/Geologist - Mid	40	hour	$120	$4,800	
Environmental Engineer/Geologist - Junior	40	hour	$90	$3,600	
Labor - Field Testing					
Program Manager	3	hour	$200	$600	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Senior	9	hour	$145	$1,305	
Environmental Engineer/Geologist - Mid	30	hour	$120	$3,600	
Environmental Engineer/Geologist - Junior	30	hour	$90	$2,700	
Subcontractors					
Driller	1	lump sum	$7,500	$7,500	
Utility clearance	1	lump sum	$3,000	$3,000	
Laboratory Analyses					
Soil analysis	1	well	$200	$200	
Trip blanks	1	samples	$8	$8	
Sample shipping	1	coolers	$100	$100	
Supplies					
Field supplies & equipment rental	1	lump sum	$1,000	$1,000	
Travel					
Per diem (food)	6	day	$69	$414	
Pick-up truck	6	day	$50	$300	
SUBTOTAL				**$21,627**	
SUBTOTAL (YEAR 1)				**$21,627**	

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B — **OPINION OF PROBABLE COST**
Modified Groundwater Extraction and Treatment with Injection

2. Explanation of Significant Differences Preparation and Submittal (Year 1)

Includes:
1. Explanation of Significant Differences preparation and submittal in Year 1
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	18	hour	$200	$3,600	
Project Manager	30	hour	$150	$4,500	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	30	hour	$100	$3,000	
CADD Technician - Mid	30	hour	$75	$2,250	
Administrative Assistant - Mid	15	hour	$70	$1,050	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$29,100**	
SUBTOTAL (YEAR 1)				**$29,100**	

3. Remedial Design (Year 2)

Includes:
1. Remedial design in year 2
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	36	hour	$200	$7,200	
Project Manager	72	hour	$150	$10,800	
Hydrogeologist - Senior	90	hour	$160	$14,400	
Environmental Engineer - Senior	120	hour	$150	$18,000	
Environmental Engineer - Mid	180	hour	$120	$21,600	
Environmental Engineer - Junior	300	hour	$90	$27,000	
Modeling Specialist - Mid	72	hour	$145	$10,440	
GIS Specialist - Mid	72	hour	$100	$7,200	
CADD Technician - Mid	72	hour	$75	$5,400	
Administrative Assistant - Mid	36	hour	$70	$2,520	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$126,660**	
SUBTOTAL (YEAR 2)				**$126,660**	

TABLE A-4

Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

4. Remedial Design Implementation - Installation of Third Extraction Well and Injection (Year 3)

Includes:

1. Remedial design implementation in year 3
2. Installation of third extraction well
3. Installation of 6 groundwater injection wells at property boundary
4. Installation of 4 performance monitoring wells
5. Trenching 1-inch high-density polyethylene lines from ATP building to each groundwater injection well
6. Trenching 2-inch polyvinyl chloride pipe from ATP building to third extraction well
7. Installation, connection, and integration of piping manifold to ATP

Major Assumptions:

1.	Field days for well installation/development	24	days
2.	Field days for trenching/pipe installation	15	days
3.	System connection and startup	5	days
4.	Total days	44	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	22	hour	$200	$4,400	
Project Manager	44	hour	$150	$6,600	
Environmental Engineer - Senior	88	hour	$150	$13,200	
Site Safety Officer	440	hour	$120	$52,800	
Geologist - Mid	240	hour	$120	$28,800	
Environmental Engineer - Mid	200	hour	$120	$24,000	
Geologist - Junior	240	hour	$90	$21,600	
Environmental Engineer - Junior	200	hour	$90	$18,000	
Subcontractors					
Utility clearance	1	lump sum	$5,000	$5,000	
Site clearing	1	lump sum	$10,000	$10,000	
Driller	1	lump sum	$262,000	$262,000	
Site work contractor	1	lump sum	$146,000	$146,000	
Surveyor	1	lump sum	$5,000	$5,000	
Electrician	1	lump sum	$10,000	$10,000	
Supplies					
Field supplies	1	lump sum	$7,500	$7,500	
Travel					
Per diem (food)	44	day	$70.00	$3,080	
Pick-up truck	44	day	$160.00	$7,040	
SUBTOTAL				**$455,620**	
SUBTOTAL W/ CONTIGENCY (30%)				**$592,306**	
SUBTOTAL (YEAR 3)				**$592,306**	

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B **OPINION OF PROBABLE COST**
Modified Groundwater Extraction and Treatment with Injection

5. Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)

Includes:
1. ATP O&M for years 1-3
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site chemicals of concern (COCs) (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:

1. Staff per weekly routine maintenance event	1	people
2. Days per weekly routine maintenance event	1	days/event
3. Number of routine maintenance events per week	3	events/week
4. Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1. Staff per monthly routine maintenance event	2	people
2. Days per monthly routine maintenance	2	days/event
3. Number of routine maintenance events per month	1	events/month
4. Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1. Staff per non-routine maintenance event	2	people
2. Days per non-routine maintenance	1	day/event
3. Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1. Labor included in weekly routine maintenance		
2. Number of samples per sampling event	3	samples
3. Number of sampling events	12	events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	
GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

Labor - Non-Routine Maintenance				
Program Manager	40	hour	$200	$8,000
Project Manager	60	hour	$150	$9,000
Environmental Engineer - Mid	160	hour	$120	$19,200
Environmental Engineer - Junior	160	hour	$90	$14,400
GIS Specialist - Mid	40	hour	$100	$4,000
CADD Technician - Mid	40	hour	$75	$3,000
Administrative Assistant - Mid	20	hour	$70	$1,400
Labor - O&M Reporting				
Program Manager	8	hour	$200	$1,600
Project Manager	16	hour	$150	$2,400
Environmental Engineer - Mid	20	hour	$120	$2,400
Environmental Engineer - Junior	40	hour	$90	$3,600
GIS Specialist - Mid	8	hour	$100	$800
CADD Technician - Mid	8	hour	$75	$600
Administrative Assistant - Mid	4	hour	$70	$280
Laboratory Analyses				
Site COCs (including duplicates)	36	samples	$135	$4,860
Trip blanks	12	samples	$80	$960
Sample shipping	12	coolers	$100	$1,200
Supplies and Expenses				
Electrical	145,000	kilowatts per hour (kW-h)	$0.21	$30,450
ATP sampling equipment	12	day	$251	$3,012
Field supplies	12	event	$500	$6,000
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000
Disposal				
Sludge disposal	1	lump sum	$80,000	$80,000
Investigation-derived waste (IDW) disposal	1	lump sum	$10,000	$10,000
Water disposal (publicly owned treatment works)	23,652	gallons	$7.50	$177,390
Travel				
Per diem (food)	244	day	$69	$16,836
Pick-up truck	244	day	$50	$12,200
SUBTOTAL				**$745,068**
SUBTOTAL (YEARS 1-3)				**$2,235,204**

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

6. Annual Landfill Inspection and Maintenance (Years 1-30)

Includes:

1. Annual landfill inpsection and maintenance for years 1-30
2. One week of mowing performed by subcontractors, followed by annual landfill inspection
3. Landfill repair and maintenance
4. Landfill inspection report (Final version only, no response to comments)

Major Assumptions:

Monthly routine maintenance:

1. Staff per event	1	people
2. Days per event	1	days/event

Landfill Repair and Maintenance:

1. Staff per event	2	people
2. Days per event	2	day/event

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Landfill Inspection					
Program Manager	1	hour	$200	$200	
Project Manager	2	hour	$150	$300	
Environmental Engineer - Mid	6	hour	$120	$720	
Environmental Engineer - Junior	12	hour	$90	$1,080	
GIS Specialist - Mid	2	hour	$100	$200	
CADD Technician - Mid	2	hour	$75	$150	
Administrative Assistant - Mid	1	hour	$70	$70	
Labor - Landfill Repair and Maintenance					
Program Manager	4	hour	$200	$800	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	4	hour	$100	$400	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	2	hour	$70	$140	
Labor - Inspection Report					
Program Manager	2	hour	$200	$400	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	4	hour	$70	$280	
Subcontractors					
Landfill mowing	5	day	$6,000	$30,000	
Landfill repair	2	day	$5,000	$10,000	
Supplies					
Landfill inspection equipment	5	day	$250	$1,250	
Field supplies	3	event	$500	$1,500	
Reproduction costs	1	lump sum	$500	$500	
Travel					
Per diem (food)	5	day	$69	$345	
Per diem (lodging)	2	day	$175	$350	
Pick-up truck	5	day	$50	$250	
SUBTOTAL				**$60,295**	
SUBTOTAL (YEARS 1-30)				**$1,808,850**	

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

7. Annual ATP System O&M (3 extraction wells and injection; Years 3-30)

Includes:
1. ATP O&M for years 3-30
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site COCs (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:

1.	Staff per weekly routine maintenance event	1	people
2.	Days per weekly routine maintenance event	1	days/event
3.	Number of routine maintenance events per week	3	events/week
4.	Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1.	Staff per monthly routine maintenance event	2	people
2.	Days per monthly routine maintenance	2	days/event
3.	Number of routine maintenance events per month	1	events/month
4.	Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1.	Staff per non-routine maintenance event	2	people
2.	Days per non-routine maintenance	1	day/event
3.	Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1.	Labor included in weekly routine maintenance		
2.	Number of samples per sampling event	3	samples
3.	Number of sampling events	12	events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	
GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	
Labor - Non-Routine Maintenance					
Program Manager	40	hour	$200	$8,000	
Project Manager	60	hour	$150	$9,000	
Environmental Engineer - Mid	160	hour	$120	$19,200	
Environmental Engineer - Junior	160	hour	$90	$14,400	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

Labor - O&M Reporting				
Program Manager	8	hour	$200	$1,600
Project Manager	16	hour	$150	$2,400
Environmental Engineer - Mid	20	hour	$120	$2,400
Environmental Engineer - Junior	40	hour	$90	$3,600
GIS Specialist - Mid	8	hour	$100	$800
CADD Technician - Mid	8	hour	$75	$600
Administrative Assistant - Mid	4	hour	$70	$280
Laboratory Analyses				
Site COCs (including duplicates)	36	samples	$135	$4,860
Trip blanks	12	samples	$80	$960
Sample shipping	12	coolers	$100	$1,200
Supplies and Expenses				
Electricity	194,000	kW-h	$0.21	$40,740
ATP sampling equipment	12	day	$251	$3,012
Field supplies	12	event	$500	$6,000
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000
Disposal				
Sludge disposal	1	lump sum	$110,000	$110,000
IDW disposal	1	lump sum	$10,000	$10,000
Travel				
Per diem (food)	244	day	$69	$16,836
Pick-up truck	244	day	$50	$12,200
SUBTOTAL				**$607,968**
SUBTOTAL (YEARS 3-30)				**$17,023,104**

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

8. Quarterly Performance Monitoring (Years 3-4)

Includes:

1. Quarterly performance monitoring at a subset of monitoring wells for years 3 and 4
2. Site COCs (arsenic, iron, and manganese) sampled at 15 wells during each event; 2 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 15 wells during each event; 2 duplicates per event
4. Data-focused monitoring report completed following each sampling event (2 total versions per report)

Major Assumptions:

1. Staff per sampling event	2	people
2. Days per sampling event	3	days
3. Number of sampling events	4	event
4. Number of wells per sampling event	15	wells
5. Duplicate samples (COCs)	2	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	16	hour	$200	$3,200	
Project Manager	48	hour	$150	$7,200	
Environmental Engineer - Mid	120	hour	$120	$14,400	
Environmental Engineer - Junior	120	hour	$90	$10,800	
GIS Specialist - Mid	32	hour	$100	$3,200	
Administrative Assistant - Mid	16	hour	$70	$1,120	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	120	hour	$90	$10,800	
GIS Specialist - Mid	20	hour	$100	$2,000	
Administrative Assistant - Mid	4	hour	$70	$280	
Laboratory Analysis					
Site COCs (including duplicates)	68	samples	$45	$3,060	
General chemistry (including duplicates)	68	samples	$110	$7,480	
Sample shipping	16	coolers	$100	$1,600	
IDW disposal	4	lump sum	$2,000	$8,000	
Supplies					
Sampling equipment	24	day	$200	$4,800	
Field supplies	4	event	$500	$2,000	
Reproduction costs	4	lump sum	$500	$2,000	
Travel					
Per diem (food)	24	day	$69	$1,656	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	24	day	$50	$1,200	
SUBTOTAL				**$95,996**	
SUBTOTAL (YEARS 3-4)				**$191,992**	

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

9. Semi-Annual Groundwater Monitoring (Years 1-10)

Includes:

1. Semi-annual groundwater monitoring for years 1-10
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 85 wells during each event; 9 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 85 wells during each event; 9 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1.	Staff per monitoring event	2	people
2.	Days per monitoring event	15	days
3.	Number of monitoring events	2	events
4.	Number of wells sampled per event	85	wells
5.	Duplicate samples (COCs)	9	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	300	hour	$120	$36,000	
Environmental Engineer - Junior	300	hour	$90	$27,000	
GIS Specialist - Mid	16	hour	$100	$1,600	
Administrative Assistant - Mid	8	hour	$70	$560	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	100	hour	$90	$9,000	
GIS Specialist - Mid	40	hour	$100	$4,000	
Administrative Assistant - Mid	12	hour	$70	$840	
Laboratory Analyses					
Site COCs (including duplicates)	188	samples	$45	$8,460	
General chemistry (including duplicates)	188	samples	$110	$20,680	
Sample shipping	38	coolers	$100	$3,800	
IDW disposal	2	lump sum	$2,000	$4,000	
Supplies					
Sampling equipment	60	day	$200	$12,000	
Field supplies	2	event	$500	$1,000	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	60	day	$69	$4,140	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	60	day	$50	$3,000	
SUBTOTAL				**$153,780**	
SUBTOTAL (YEARS 1-10)				**$1,537,800**	

TABLE A-4
Cost Estimate for Shepley's Hill Landfill, Alternative 4B

Alternative 4B
Modified Groundwater Extraction and Treatment with Injection

OPINION OF PROBABLE COST

10. Annual Groundwater Monitoring (Years 11-30)

Includes:

1. Annual groundwater monitoring for years 11-30
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 45 wells during each event; 5 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 45 wells during each event; 5 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1. Staff per sampling event	2	people
2. Days per sampling event	8	days
3. Number of sampling events	1	event
4. Number of wells per sampling event	45	wells
5. Duplicate samples (COCs)	5	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	8	hour	$100	$800	
Administrative Assistant - Mid	4	hour	$70	$280	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	36	hour	$120	$4,320	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	24	hour	$100	$2,400	
Administrative Assistant - Mid	8	hour	$70	$560	
Laboratory Analyses					
Site COCs (including duplicates)	50	samples	$45	$2,250	
General chemistry (including duplicates)	50	samples	$110	$5,500	
Sample shipping	10	coolers	$100	$1,000	
IDW disposal	1	lump sum	$2,000	$2,000	
Supplies					
Sampling equipment	16	day	$200	$3,200	
Field supplies	1	event	$500	$500	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	16	day	$69	$1,104	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	16	day	$50	$800	
SUBTOTAL				**$54,414**	
SUBTOTAL (YEARS 11-30)				**$1,088,280**	

TOTAL COSTS

COSTS **$24,654,923**

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

Site:	Shepley's Hill Landfill
Location:	Former Fort Devens, Massachusetts
Phase:	Focused Feasibility Study (-30% to +50%)
Base Year:	2023
Date:	March 2023

Description: Alternative 5 for Shepley's Hill Landfill consists of continuing the existing groundwater extraction and treatment system currently in place at the site with the addition of a third groundwater extraction well and in-situ air sparging.

SCOPED TASKS:
1. **Remedial Design Optimization and Testing (Year 1)**
2. **Record of Decision (ROD) Modification Preparation and Submittal (Year 1)**
3. **Remedial Design (Year 2)**
4. **Remedial Design Implementation - Installation of Third Extraction Well and In-Situ Air Sparge (IAS) System (Year 2)**
5. **Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)**
6. **Annual Landfill Inspection and Maintenance (Years 1-30)**
7. **Annual ATP System O&M (3 extraction wells and IAS; Years 3-30)**
8. **Quarterly Performance Monitoring (Years 3-4)**
9. **Semi-Annual Groundwater Monitoring (Years 1-10)**
10. **Annual Groundwater Monitoring (Years 11-30)**

1. Remedial Design Optimization and Testing (Year 1)

Includes:
1. Remedial design optimization and testing in year 1
2. Work plan (Rev 0 Draft Army, Rev 0 Draft Regulators, and Rev 1 Versions with Responses to Comments)
3. Additional field testing and data collection. Deep sparge wells only, specific capacity testing
4. Three rounds of groundwater sampling data on 12 wells, sampling for metals, alkalinity, dissolved organic carbon, sulfate, nitrate
5. Data compilation and evaluation

Major Assumptions:

1.	Staff for pre-design investigation	2	person
2.	Days of pilot testing	5	days
3.	Days of specific capacity testing	3	days
4.	Existing wells to sample	12	wells
5.	Number of groundwater sampling rounds	3	rounds
6.	Total sampling days	9	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	48	hour	$200	$9,600	
Project Manager	60	hour	$150	$9,000	
Environmental Engineer - Senior	80	hour	$145	$11,600	
Environmental Engineer - Mid	94	hour	$120	$11,280	
Environmental Engineer - Junior	440	hour	$90	$39,600	
GIS Specialist - Mid	20	hour	$100	$2,000	
CADD Technician - Mid	10	hour	$75	$750	
Subcontractors					
Equipment rental - sparging	5	days	$3,000	$15,000	
Equipment rental - specific capacity testing	3	days	$1,500	$4,500	
Laboratory Analyses					
Site chemicals of concern (COCs)	12	well	$220	$2,640	
Trip blanks	2	samples	$8	$16	
Sample shipping	2	coolers	$100	$200	
Supplies					
Field supplies	1	lump sum	$7,500	$7,500	
Travel					
Per diem (food)	25	day	$69	$1,725	
Per diem (lodging)	25	day	$175	$4,375	
Pick-up truck	25	day	$50	$1,250	
SUBTOTAL				**$121,036**	
SUBTOTAL (YEAR 1)				**$121,036**	

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

2. Record of Decision (ROD) Modification Preparation and Submittal (Year 1)

Includes:
1. ROD modification preparation and submittal in year 1
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	24	hour	$200	$4,800	
Project Manager	40	hour	$150	$6,000	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$38,100**	
SUBTOTAL (YEAR 1)				**$38,100**	

3. Remedial Design (Year 2)

Includes:
1. Remedial design in year 2
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	36	hour	$200	$7,200	
Project Manager	72	hour	$150	$10,800	
Hydrogeologist - Senior	90	hour	$160	$14,400	
Environmental Engineer - Senior	120	hour	$150	$18,000	
Environmental Engineer - Mid	180	hour	$120	$21,600	
Environmental Engineer - Junior	300	hour	$90	$27,000	
Modeling Specialist - Mid	72	hour	$145	$10,440	
GIS Specialist - Mid	72	hour	$100	$7,200	
CADD Technician - Mid	72	hour	$75	$5,400	
Administrative Assistant - Mid	36	hour	$70	$2,520	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$126,660**	
SUBTOTAL (YEAR 2)				**$126,660**	

TABLE A-5

Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

4. Remedial Design Implementation - Installation of Third Extraction Well and In-Situ Air Sparge (IAS) System (Year 2)

Includes:

1. Remedial design implementation in year 2
2. Installation of third extraction well
3. Trenching 2-inch polyvinyl chloride pipe from ATP building to third extraction well
4. Installation of 25 deep sparge wells (~95-foot depth) and 13 shallow sparge wells (~80-foot depth) at property boundary
5. Installation of 10 performance monitoring wells
6. Trenching 1-inch high-density polyethylene lines from ATP building to each sparge well
7. Delivery of IAS system to the site and connection to piping

Major Assumptions:

1.	Field days for well installation/development	33	days
2.	Field days for trenching/pipe installation	21	days
3.	System connection and startup	10	days
4.	Total days	64	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	32	hour	$200	$6,400	
Project Manager	64	hour	$150	$9,600	
Environmental Engineer - Senior	128	hour	$160	$20,480	
Site Safety Officer	640	hour	$120	$76,800	
Geologist - Mid	330	hour	$120	$39,600	
Environmental Engineer - Mid	310	hour	$120	$37,200	
Geologist - Junior	330	hour	$90	$29,700	
Environmental Engineer - Junior	310	hour	$90	$27,900	
Subcontractors					
Utility clearance	1	lump sum	$5,000	$5,000	
Driller	1	lump sum	$146,000	$146,000	
Site work contractor	1	lump sum	$414,000	$414,000	
Surveyor	1	lump sum	$10,000	$10,000	
Electrician	1	lump sum	$25,000	$25,000	
System capital cost	1	lump sum	$250,000	$250,000	
Supplies					
Field supplies	3	event	$5,000	$15,000	
Travel					
Per diem (food)	192	day	$69	$13,248	
Pick-up truck	192	day	$50	$9,600	
SUBTOTAL				**$1,135,528**	
SUBTOTAL W/ CONTIGENCY (30%)				**$1,476,186**	
SUBTOTAL (YEAR 2)				**$1,476,186**	

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

5. Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)

Includes:

1. ATP O&M for years 1-3
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site COCs (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:

1.	Staff per weekly routine maintenance event	1	people
2.	Days per weekly routine maintenance event	1	days/event
3.	Number of routine maintenance events per week	3	events/week
4.	Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1.	Staff per monthly routine maintenance event	2	people
2.	Days per monthly routine maintenance	2	days/event
3.	Number of routine maintenance events per month	1	events/month
4.	Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1.	Staff per non-routine maintenance event	2	people
2.	Days per non-routine maintenance	1	day/event
3.	Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1.	Labor included in weekly routine maintenance		
2.	Number of samples per sampling event	3	samples
3.	Number of sampling events	12	events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	
GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	
Labor - Non-Routine Maintenance					
Program Manager	40	hour	$200	$8,000	
Project Manager	60	hour	$150	$9,000	
Environmental Engineer - Mid	160	hour	$120	$19,200	
Environmental Engineer - Junior	160	hour	$90	$14,400	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

Labor - O&M Reporting				
Program Manager	8	hour	$200	$1,600
Project Manager	16	hour	$150	$2,400
Environmental Engineer - Mid	20	hour	$120	$2,400
Environmental Engineer - Junior	40	hour	$90	$3,600
GIS Specialist - Mid	8	hour	$100	$800
CADD Technician - Mid	8	hour	$75	$600
Administrative Assistant - Mid	4	hour	$70	$280
Laboratory Analyses				
Site COCs (including duplicates)	36	samples	$135	$4,860
Trip blanks	12	samples	$80	$960
Sample shipping	12	coolers	$100	$1,200
Supplies and Expenses				
Electricity	145,000	kilowatts per hour (kW-h)	$0.21	$30,450
ATP sampling equipment	12	day	$251	$3,012
Field supplies	12	event	$500	$6,000
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000
Disposal				
Sludge disposal	1	lump sum	$80,000	$80,000
Investigation-derived waste (IDW) disposal	1	lump sum	$10,000	$10,000
Water disposal (publicly owned treatment works)	23,652	gallons	$7.50	$177,390
Travel				
Per diem (food)	244	day	$69	$16,836
Pick-up truck	244	day	$50	$12,200
SUBTOTAL				**$745,068**
SUBTOTAL (YEARS 1-3)				**$2,235,204**

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

6. Annual Landfill Inspection and Maintenance (Years 1-30)

Includes:

1. Annual landfill inspection and maintenance for years 1-30
2. One week of mowing performed by subcontractors, followed by annual landfill inspection
3. Landfill repair and maintenance
4. Landfill inspection report (Final version only, no response to comments)

Major Assumptions:

Landfill Inspection:

1. Staff per event	1	people
2. Days per event	1	days/event

Landfill Repair and Maintenance:

1. Staff per event	2	people
2. Days per event	2	day/event

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Landfill Inspection					
Program Manager	1	hour	$200	$200	
Project Manager	2	hour	$150	$300	
Environmental Engineer - Mid	6	hour	$120	$720	
Environmental Engineer - Junior	12	hour	$90	$1,080	
GIS Specialist - Mid	2	hour	$100	$200	
CADD Technician - Mid	2	hour	$75	$150	
Administrative Assistant - Mid	1	hour	$70	$70	
Labor - Landfill Repair and Maintenance					
Program Manager	4	hour	$200	$800	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	4	hour	$100	$400	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	2	hour	$70	$140	
Labor - Inspection Report					
Program Manager	2	hour	$200	$400	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	4	hour	$70	$280	
Subcontractors					
Landfill mowing	5	day	$6,000	$30,000	
Landfill repair	2	day	$5,000	$10,000	
Supplies					
Landfill inspection equipment	5	day	$250	$1,250	
Field supplies	3	event	$500	$1,500	
Reproduction costs	1	lump sum	$500	$500	
Travel					
Per diem (food)	5	day	$69	$345	
Per diem (lodging)	2	day	$175	$350	
Pick-up truck	5	day	$50	$250	
SUBTOTAL				**$60,295**	
SUBTOTAL (YEARS 1-30)				**$1,808,850**	

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

7. Annual ATP System O&M (3 extraction wells and IAS; Years 3-30)

Includes:

1. ATP O&M for years 3-30
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site COCs (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. One event per week and six contingency visits per year for IAS system O&M conducted in conjunction with ATP O&M
7. O&M reporting

Major Assumptions ATP O&M:

Weekly routine maintenance:

1.	Staff per weekly routine maintenance event	1	people
2.	Days per weekly routine maintenance event	1	days/event
3.	Number of routine maintenance events per week	3	events/week
4.	Total weekly routine maintenance events	52	weeks/year

Monthly routine maintenance:

1.	Staff per monthly routine maintenance event	2	people
2.	Days per monthly routine maintenance	2	days/event
3.	Number of routine maintenance events per month	1	events/month
4.	Total monthly routine maintenance events	12	months/year

Non-routine maintenance:

1.	Staff per non-routine maintenance event	2	people
2.	Days per non-routine maintenance	1	day/event
3.	Total number of non-routine maintenance events	20	events/year

Influent and effluent sampling:

1.	Labor included in weekly routine maintenance		
2.	Number of samples per sampling event	3	samples
3.	Number of sampling events	12	events/year

Major Assumptions IAS System O&M:

1.	Staff per O&M event	1	people	
2.	Number of routine O&M events per year	52	events	
3.	Number of non-routine O&M events per year	6	events	
4.	Hours for IAS O&M per event	4	hours/event	(assume IAS O&M done in conjunction with ATP O&M)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	780	hour	$120	$93,600	
Environmental Engineer - Junior	1,352	hour	$90	$121,680	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	
GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

Labor - Non-Routine Maintenance				
Program Manager	40	hour	$200	$8,000
Project Manager	60	hour	$150	$9,000
Environmental Engineer - Mid	172	hour	$120	$20,640
Environmental Engineer - Junior	172	hour	$90	$15,480
GIS Specialist - Mid	40	hour	$100	$4,000
CADD Technician - Mid	40	hour	$75	$3,000
Administrative Assistant - Mid	20	hour	$70	$1,400
Labor - O&M Reporting				
Program Manager	16	hour	$200	$3,200
Project Manager	32	hour	$150	$4,800
Environmental Engineer - Mid	40	hour	$120	$4,800
Environmental Engineer - Junior	80	hour	$90	$7,200
GIS Specialist - Mid	16	hour	$100	$1,600
CADD Technician - Mid	16	hour	$75	$1,200
Administrative Assistant - Mid	8	hour	$70	$560
Laboratory Analyses				
Site COCs (including duplicates)	36	samples	$0	$0
Trip blanks	12	samples	$0	$0
Sample shipping	12	coolers	$100	$1,200
Supplies and Expenses				
Electricity - ATP	194,000	kW-h	$0.21	$40,740
Electricity - IAS	12	month	$1,700	$20,400
Annual well redevelopment	1	lump sum	$30,000	$30,000
ATP sampling equipment	12	day	$251	$3,012
Field supplies	12	event	$500	$6,000
Annual equipment replacement/upgrade	1	LS	$25,000	$25,000
Disposal				
Sludge disposal	1	lump sum	$110,000	$110,000
IDW disposal	1	lump sum	$10,000	$10,000
Water disposal (publicly owned treatment works)	23,652	1,000 gallons	$7.50	$177,390
Travel				
Per diem (food)	244	day	$69	$16,836
Pick-up truck	244	day	$50	$12,200
SUBTOTAL				**$882,218**
SUBTOTAL (YEARS 3-30)				**$24,702,104**

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

8. Quarterly Performance Monitoring (Years 3-4)

Includes:

1. Quarterly performance monitoring at a subset of monitoring wells for years 3 and 4
2. Site COCs (arsenic, iron, and manganese) sampled at 15 wells during each event; 2 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 15 wells during each event; 2 duplicates per event
4. Data-focused monitoring report completed following each sampling event (2 total versions per report)

Major Assumptions:

1. Staff per sampling event	2	people
2. Days per sampling event	3	days
3. Number of sampling events	4	event
4. Number of wells per sampling event	15	wells
5. Duplicate samples (COCs)	2	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	16	hour	$200	$3,200	
Project Manager	48	hour	$150	$7,200	
Environmental Engineer - Mid	120	hour	$120	$14,400	
Environmental Engineer - Junior	120	hour	$90	$10,800	
GIS Specialist - Mid	32	hour	$100	$3,200	
Administrative Assistant - Mid	16	hour	$70	$1,120	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	120	hour	$90	$10,800	
GIS Specialist - Mid	20	hour	$100	$2,000	
Administrative Assistant - Mid	4	hour	$70	$280	
Laboratory Analysis					
Site COCs (including duplicates)	68	samples	$45	$3,060	
General chemistry (including duplicates)	68	samples	$110	$7,480	
Sample shipping	16	coolers	$100	$1,600	
IDW disposal	4	lump sum	$2,000	$8,000	
Supplies					
Sampling equipment	24	day	$200	$4,800	
Field supplies	4	event	$500	$2,000	
Reproduction costs	4	lump sum	$500	$2,000	
Travel					
Per diem (food)	24	day	$69	$1,656	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	24	day	$50	$1,200	
SUBTOTAL				**$95,996**	
SUBTOTAL (YEARS 3-4)				**$191,992**	

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5 **OPINION OF PROBABLE COST**

Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

9. Semi-Annual Groundwater Monitoring (Years 1-10)

Includes:

1. Semi-annual groundwater monitoring for years 1-10
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 85 wells during each event; 9 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 85 wells during each event; 9 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1.	Staff per monitoring event	2	people
2.	Days per monitoring event	15	days
3.	Number of monitoring events	2	events
4.	Number of wells sampled per event	85	wells
5.	Duplicate samples (COCs)	9	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	300	hour	$120	$36,000	
Environmental Engineer - Junior	300	hour	$90	$27,000	
GIS Specialist - Mid	16	hour	$100	$1,600	
Administrative Assistant - Mid	8	hour	$70	$560	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	100	hour	$90	$9,000	
GIS Specialist - Mid	40	hour	$100	$4,000	
Administrative Assistant - Mid	12	hour	$70	$840	
Laboratory Analyses					
Site COCs (including duplicates)	188	samples	$45	$8,460	
General chemistry (including duplicates)	188	samples	$110	$20,680	
Sample shipping	38	coolers	$100	$3,800	
IDW disposal	2	lump sum	$2,000	$4,000	
Supplies					
Sampling equipment	60	day	$200	$12,000	
Field supplies	2	event	$500	$1,000	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	60	day	$69	$4,140	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	60	day	$50	$3,000	
SUBTOTAL				**$153,780**	
SUBTOTAL (YEARS 1-10)				**$1,537,800**	

TABLE A-5
Cost Estimate for Shepley's Hill Landfill, Alternative 5

Alternative 5
Modified Groundwater Extraction and Treatment with In-Situ Air Sparging

OPINION OF PROBABLE COST

10. Annual Groundwater Monitoring (Years 11-30)

Includes:

1. Annual groundwater monitoring for years 11-30
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 45 wells during each event; 5 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 45 wells during each event; 5 duplicates per event
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)

Major Assumptions:

1.	Staff per sampling event	2	people
2.	Days per sampling event	8	days
3.	Number of sampling events	1	event
4.	Number of wells per sampling event	45	wells
5.	Duplicate samples (COCs)	5	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	8	hour	$100	$800	
Administrative Assistant - Mid	4	hour	$70	$280	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	36	hour	$120	$4,320	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	24	hour	$100	$2,400	
Administrative Assistant - Mid	8	hour	$70	$560	
Laboratory Analyses					
Site COCs (including duplicates)	50	samples	$45	$2,250	
General chemistry (including duplicates)	50	samples	$110	$5,500	
Sample shipping	10	coolers	$100	$1,000	
IDW disposal	1	lump sum	$2,000	$2,000	
Supplies					
Sampling equipment	16	day	$200	$3,200	
Field supplies	1	event	$500	$500	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	16	day	$69	$1,104	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	16	day	$50	$800	
SUBTOTAL				**$54,414**	
SUBTOTAL (YEARS 11-30)				**$1,088,280**	

TOTAL COSTS

COSTS **$33,326,212**

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

Site:	Shepley's Hill Landfill
Location:	Former Fort Devens, Massachusetts
Phase:	Focused Feasibility Study (-30% to +50%)
Base Year:	2023
Date:	March 2023

Description: Alternative 6 for Shepley's Hill Landfill consists of removal the landfill waste in the northern portion of the landfill, restoration, and active aquifer treatment via air sparging.

SCOPED TASKS:
1. **Remedial Design Optimization and Testing (Year 1)**
2. **Record of Decision (ROD) Amendment Preparation and Submittal (Year 1)**
3. **Remedial Design - In-Situ Air Sparge (IAS) System (Year 2)**
4. **Remedial Design Implementation - Installation of IAS System (Year 3)**
5. **Design Documents for Partial Landfill Waste Removal and Restoration (Year 1)**
6. **Partial Landfill Waste Removal, Transportation, and Off-Site Disposal (Year 2)**
7. **Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)**
8. **Annual Landfill Inspection and Maintenance (Years 1-30)**
9. **Annual IAS System O&M (Years 3-30)**
10. **Semi-Annual Groundwater Monitoring (Years 1-10)**
11. **Annual Groundwater Monitoring (Years 11-30)**

1. Remedial Design Optimization and Testing (Year 1)

Includes:
1. Remedial design optimization and testing in year 1
2. Work plan (Rev 0 Draft Army, Rev 0 Draft Regulators, and Rev 1 Versions with Responses to Comments)
3. Additional field testing and data collection. Deep sparge wells only, specific capacity testing
4. Three rounds of groundwater sampling data on 12 wells, sampling for metals, alkalinity, dissolved organic carbon, sulfate, nitrate
5. Data compilation and evaluation

Major Assumptions:

1.	Staff for pre-design investigation	2	person
2.	Days of pilot testing	5	days
3.	Days of specific capacity testing	3	days
4.	Existing wells to sample	12	wells
5.	Number of groundwater sampling rounds	3	rounds
6.	Total sampling days	9	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Workplan					
Program Manager	10	hour	$200	$2,000	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Senior	40	hour	$145	$5,800	
Environmental Engineer - Mid	220	hour	$120	$26,400	
Environmental Engineer - Junior	340	hour	$90	$30,600	
GIS Specialist - Mid	20	hour	$100	$2,000	
CADD Technician - Mid	10	hour	$75	$750	
Labor - Pre-design Investigation					
Program Manager	10	hour	$200	$2,000	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Senior	60	hour	$145	$8,700	
Environmental Engineer - Mid	170	hour	$120	$20,400	
Environmental Engineer - Junior	170	hour	$90	$15,300	
Subcontractors					
Equipment rental - sparging	5	days	$3,000	$15,000	
Equipment rental - specific capacity testing	3	days	$1,500	$4,500	
Laboratory Analyses					
Site chemicals of concern (COCs)	12	well	$205	$2,460	
Trip blanks	2	samples	$8	$16	
Sample shipping	2	coolers	$100	$200	
Supplies					
Field supplies	1	lump sum	$7,500	$7,500	
Travel					
Per diem (food)	25	day	$69	$1,725	
Per diem (lodging)	25	day	$175	$4,375	
Pick-up truck	25	day	$50	$1,250	
SUBTOTAL				**$156,976**	
SUBTOTAL W/ CONTIGENCY (30%)				**$204,069**	

TABLE A-6 **Cost Estimate for Shepley's Hill Landfill, Alternative 6**	
Alternative 6 **Partial Landfill Removal with Active Aquifer Treatment**	**OPINION OF PROBABLE COST**
SUBTOTAL (YEAR 1)	**$204,069**

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

2. Record of Decision (ROD) Amendment Preparation and Submittal (Year 1)

Includes:

1. ROD amendment preparation and submittal in year 1
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	24	hour	$200	$4,800	
Project Manager	40	hour	$150	$6,000	
Environmental Engineer - Mid	80	hour	$120	$9,600	
Environmental Engineer - Junior	80	hour	$90	$7,200	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	
Supplies					
Reproduction Costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$38,100**	
SUBTOTAL (YEAR 1)				**$38,100**	

3. Remedial Design - In-Situ Air Sparge (IAS) System (Year 2)

Includes:

1. Remedial design in year 2
2. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	36	hour	$200	$7,200	
Project Manager	72	hour	$150	$10,800	
Hydrogeologist - Senior	90	hour	$160	$14,400	
Environmental Engineer - Senior	120	hour	$150	$18,000	
Environmental Engineer - Mid	180	hour	$120	$21,600	
Environmental Engineer - Junior	300	hour	$90	$27,000	
Modeling Specialist - Mid	72	hour	$145	$10,440	
GIS Specialist - Mid	72	hour	$100	$7,200	
CADD Technician - Mid	72	hour	$75	$5,400	
Administrative Assistant - Mid	36	hour	$70	$2,520	
Supplies					
Reproduction costs	3	lump sum	$500	$1,500	
Shipping	3	lump sum	$200	$600	
SUBTOTAL				**$126,660**	
SUBTOTAL (YEAR 2)				**$126,660**	

TABLE A-6

Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6

Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

4. Remedial Design Implementation - Installation of IAS System (Year 3)

Includes:

1. Remedial design implementation in year 3
2. Installation of 25 deep sparge wells (~95-foot depth) and 13 shallow sparge wells (~80-foot depth) at property boundary
3. Installation of 10 performance monitoring wells
4. Trenching 1-inch high-density polyethylene lines from ATP building to each sparge well
5. Delivery of IAS system to the site and connection to piping

Major Assumptions:

1. Field days for well installation/development	33	days
2. Field days for trenching/pipe installation	18	days
3. System connection and startup	10	days
4. Total days	61	days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	31	hour	$200	$6,100	
Project Manager	61	hour	$150	$9,150	
Environmental Engineer - Senior	122	hour	$200	$24,400	
Site Safety Officer	610	hour	$120	$73,200	
Geologist - Mid	330	hour	$120	$39,600	
Environmental Engineer - Mid	280	hour	$120	$33,600	
Geologist - Junior	330	hour	$90	$29,700	
Environmental Engineer - Junior	280	hour	$90	$25,200	
Subcontractors					
Utility clearance	1	lump sum	$5,000	$5,000	
Driller	1	lump sum	$10,917	$10,917	
Site work contractor	1	lump sum	$11,867	$11,867	
Surveyor	1	lump sum	$10,000	$10,000	
Electrician	1	lump sum	$25,000	$25,000	
System capital cost	1	lump sum	$250,000	$250,000	
Supplies					
Field supplies	3	event	$5,000	$15,000	
Travel					
Per diem (food)	183	day	$69	$12,627	
Pick-up truck	183	day	$50	$9,150	
SUBTOTAL				**$590,510**	
SUBTOTAL W/ CONTIGENCY (30%)				**$767,663**	
SUBTOTAL (YEAR 3)				**$767,663**	

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

5. Design Documents for Partial Landfill Waste Removal and Restoration (Year 1)

Includes:
1. Design documents for partial landfill waste removal and restoration in year 1
2. Meetings with United States Army Corps of Engineers
3. Preparation of Bid Documents and selection of subcontractors
4. Preparation of submittals (including but not limited to accident prevention plan and work plan)

Major Assumptions:
1. Preparation of Rev 0 Draft Army, Rev 0 Draft Regulators and Rev 1 Versions with Responses to Comments for each submittal

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Meetings with United States Army Corps of Engineers					
Program Manager	20	hour	$200	$4,000	
Project Manager	20	hour	$150	$3,000	
Hydrogeologist - Senior	20	hour	$160	$3,200	
Environmental Engineer - Senior	30	hour	$150	$4,500	
Environmental Engineer - Mid	30	hour	$120	$3,600	
Environmental Engineer - Junior	20	hour	$90	$1,800	
Labor - Bid Specifications					
Program Manager	24	hour	$200	$4,800	
Project Manager	48	hour	$150	$7,200	
Hydrogeologist - Senior	60	hour	$160	$9,600	
Environmental Engineer - Senior	60	hour	$150	$9,000	
Environmental Engineer - Mid	120	hour	$120	$14,400	
Environmental Engineer - Junior	60	hour	$90	$5,400	
Modeling Specialist - Mid	48	hour	$145	$6,960	
GIS Specialist - Mid	48	hour	$100	$4,800	
CADD Technician - Mid	48	hour	$75	$3,600	
Administrative Assistant - Mid	24	hour	$70	$1,680	
Labor - Submittals					
Program Manager	72	hour	$200	$14,400	
Project Manager	144	hour	$150	$21,600	
Hydrogeologist - Senior	180	hour	$160	$28,800	
Environmental Engineer - Senior	180	hour	$150	$27,000	
Environmental Engineer - Mid	360	hour	$120	$43,200	
Environmental Engineer - Junior	180	hour	$90	$16,200	
Modeling Specialist - Mid	144	hour	$145	$20,880	
GIS Specialist - Mid	144	hour	$100	$14,400	
CADD Technician - Mid	144	hour	$75	$10,800	
Administrative Assistant - Mid	72	hour	$70	$5,040	
SUBTOTAL				**$202,320**	
SUBTOTAL (YEAR 1)				**$202,320**	

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

6. Partial Landfill Waste Removal, Transportation, and Off-Site Disposal (Year 2)

Includes:

1. Partial landfill waste removal in year 2
2. General construction activities (including but not limited to mobilization/demobilization, project management, documentation)
3. Site preparation
4. Landfill waste excavation, staging, loading, transportation, and off-site disposal of existing landfill material from the northern portion of the landfill.
5. Site restoration
6. Team meetings

Major Assumptions:

1. Oversight staff	3	people
2. Days for site preparation	30	days
3. Days for excavation and off-site disposal	550	days (spread across two years)
4. Days for site restoration	180	days
5. Team meetings	1	week

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Team Meetings					
Program Manager	152	hour	$200	$30,400	
Project Manager	152	hour	$150	$22,800	
Hydrogeologist - Senior	152	hour	$160	$24,320	
Environmental Engineer - Senior	152	hour	$150	$22,800	
Environmental Engineer - Mid	152	hour	$120	$18,240	
Environmental Engineer - Junior	152	hour	$90	$13,680	
Labor - Oversight					
Program Manager	304	hour	$200	$60,800	
Project Manager	608	hour	$150	$91,200	
Environmental Engineer - Senior	7,600	hour	$150	$1,140,000	
Environmental Engineer - Mid	7,600	hour	$120	$912,000	
Site Safety and Health Officer	7,600	hour	$90	$684,000	
Subcontractors - General					
Mobilization/demobilization	1	lump sum	$500,000	$500,000	
Project management and health and safety	1	lump sum	$1,000,000	$1,000,000	
Construction support (staging area, access, utility locate)	1	lump sum	$500,000	$500,000	
Pre/post construction survey and documentati	1	lump sum	$250,000	$250,000	
Subcontractors - Site Preparation					
Temporary erosion and sedimentation controls	1	lump sum	$100,000	$100,000	
Temporary construction entrance and material	1	lump sum	$100,000	$100,000	
Temporary fencing	1	lump sum	$100,000	$100,000	
Temporary access/haul roads	1	lump sum	$500,000	$500,000	
Onsite water handling/management	1	lump sum	$250,000	$250,000	
Subcontractors - Partial Excavation, Transportation, and Off-Site Disposal of Existing Landfill Material					
Cap removal - stripping and stockpiling of	125,000	cubic yard	$7	$875,000	
Removal and off-site disposal of cap	1	lump sum	$300,000	$300,000	
Excavation, transportation, and off-site disposal of waste material above	900,000	cubic yard	$105	$94,500,000	
disposal of waste material below groundwater table	180,000	cubic yard	$115	$20,700,000	
Excavation, transportation, and off-site disposal of waste material contingency	100,000	cubic yard	$105	$10,500,000	
Treatment/management of waste material and leachate below groundwater table	1	lump sum	$250,000	$250,000	
Dust/debris/odor control	1	lump sum	$350,000	$350,000	
Perimeter air monitoring	1	lump sum	$400,000	$400,000	

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

Subcontractors - Site Restoration - North Landfill Area				
Onsite reuse general fill backfill	70,000	cubic yard	$12	$840,000
Imported general fill backfill	270,000	cubic yard	$40	$10,800,000
Onsite reuse topsoil (6-inch layer)	25,000	cubic yard	$12	$300,000
Stormwater management features	1	lump sum	$250,000	$250,000
Seeding and mulching	33	acres	$4,000	$132,000
Travel				
Per diem (food)	2,280	day	$69	$157,320
Per diem (lodging)	2,280	day	$175	$399,000
Pick-up truck	2,280	day	$50	$114,000
SUBTOTAL				**$147,187,560**
SUBTOTAL W/ CONTIGENCY (30%)				**$191,343,828**
SUBTOTAL (YEAR 2)				**$191,343,828**

7. Annual Arsenic Treatment Plant (ATP) System Operation and Maintenance (O&M) (2 extraction wells; Years 1-3)

Includes:

1. ATP O&M for years 1-3
2. ATP weekly routine maintenance
3. ATP monthly routine maintenance (clean in place)
4. Influent and effluent samples analyzed for site COCs (arsenic, volatile organic compounds, dissolved gasses)
5. ATP non-routine maintenance
6. O&M reporting

Major Assumptions:

Weekly routine maintenance:		
1. Staff per weekly routine maintenance event	1	people
2. Days per weekly routine maintenance event	1	days/event
3. Number of routine maintenance events per we	3	events/week
4. Total weekly routine maintenance events	52	weeks/year
Monthly routine maintenance:		
1. Staff per monthly routine maintenance event	2	people
2. Days per monthly routine maintenance	2	days/event
3. Number of routine maintenance events per mc	1	events/month
4. Total monthly routine maintenance events	12	months/year
Non-routine maintenance:		
1. Staff per non-routine maintenance event	2	people
2. Days per non-routine maintenance	1	day/event
3. Total number of non-routine maintenance evei	20	events/year

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

Influent and effluent sampling:
1. Labor included in weekly routine maintenance
2. Number of samples per sampling event — 3 samples
3. Number of sampling events — 12 events/year

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Weekly Routine Maintenance					
Program Manager	104	hour	$200	$20,800	
Project Manager	312	hour	$150	$46,800	
Environmental Engineer - Mid	624	hour	$120	$74,880	
Environmental Engineer - Junior	1,248	hour	$90	$112,320	
GIS Specialist - Mid	104	hour	$100	$10,400	
CADD Technician - Mid	104	hour	$75	$7,800	
Administrative Assistant - Mid	52	hour	$70	$3,640	
Labor - Monthly Routine Maintenance					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	96	hour	$120	$11,520	
Environmental Engineer - Junior	192	hour	$90	$17,280	
GIS Specialist - Mid	24	hour	$100	$2,400	
CADD Technician - Mid	24	hour	$75	$1,800	
Administrative Assistant - Mid	12	hour	$70	$840	
Labor - Non-Routine Maintenance					
Program Manager	40	hour	$200	$8,000	
Project Manager	60	hour	$150	$9,000	
Environmental Engineer - Mid	160	hour	$120	$19,200	
Environmental Engineer - Junior	160	hour	$90	$14,400	
GIS Specialist - Mid	40	hour	$100	$4,000	
CADD Technician - Mid	40	hour	$75	$3,000	
Administrative Assistant - Mid	20	hour	$70	$1,400	
Labor - O&M Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Mid	20	hour	$120	$2,400	
Environmental Engineer - Junior	40	hour	$90	$3,600	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	8	hour	$75	$600	
Administrative Assistant - Mid	4	hour	$70	$280	
Laboratory Analyses					
Site COCs (including duplicates)	36	samples	$135	$4,860	
Trip blanks	12	samples	$80	$960	
Sample shipping	12	coolers	$100	$1,200	
Supplies and Expenses					
Electricity	145,000	kilowatts per hour (kW-h)	$0.21	$30,450	
ATP sampling equipment	12	day	$251	$3,012	
Field supplies	12	event	$500	$6,000	
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000	
Disposal					
Sludge disposal	1	lump sum	$80,000	$80,000	
Investigation-derived waste (IDW) disposal	1	lump sum	$10,000	$10,000	
Water disposal (publicly owned treatment worl	23,652	gallons	$7.50	$177,390	
Travel					
Per diem (food)	244	day	$69	$16,836	
Pick-up truck	244	day	$50	$12,200	
SUBTOTAL				**$745,068**	
SUBTOTAL (YEARS 1-3)				**$2,235,204**	

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

8. Annual Landfill Inspection and Maintenance (Years 1-30)

Includes:
1. Annual landfill inspection and maintenance for years 1-30
2. One week of mowing performed by subcontractors, followed by annual landfill inspection
3. Landfill repair and maintenance
4. Landfill inspection report (Final version only, no response to comments)

Major Assumptions:

Landfill Inspection:

1. Staff per event	1	people
2. Days per event	1	days/event

Landfill Repair and Maintenance:

1. Staff per event	2	people
2. Days per event	2	day/event

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Landfill Inspection					
Program Manager	1	hour	$200	$200	
Project Manager	2	hour	$150	$300	
Environmental Engineer - Mid	6	hour	$120	$720	
Environmental Engineer - Junior	12	hour	$90	$1,080	
GIS Specialist - Mid	2	hour	$100	$200	
CADD Technician - Mid	2	hour	$75	$150	
Administrative Assistant - Mid	1	hour	$70	$70	
Labor - Landfill Repair and Maintenance					
Program Manager	4	hour	$200	$800	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	4	hour	$100	$400	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	2	hour	$70	$140	
Labor - Inspection Report					
Program Manager	2	hour	$200	$400	
Project Manager	6	hour	$150	$900	
Environmental Engineer - Mid	16	hour	$120	$1,920	
Environmental Engineer - Junior	24	hour	$90	$2,160	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	4	hour	$75	$300	
Administrative Assistant - Mid	4	hour	$70	$280	
Subcontractors					
Landfill mowing	5	day	$6,000	$30,000	
Landfill repair	2	day	$5,000	$10,000	
Supplies					
Landfill inspection equipment	5	day	$250	$1,250	
Field supplies	3	event	$500	$1,500	
Reproduction costs	1	lump sum	$500	$500	
Travel					
Per diem (food)	5	day	$69	$345	
Per diem (lodging)	2	day	$175	$350	
Pick-up truck	5	day	$50	$250	
SUBTOTAL				**$60,295**	
SUBTOTAL (YEARS 1-30)				**$1,808,850**	

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

9. Annual IAS System O&M (Years 3-30)

Includes:

1. Annual IAS System O&M for years 3-30
2. One event per week and six contingency visits per year for IAS system O&M
3. Data compilation, tracking, and reporting

Major Assumptions:

1. Staff per O&M event 1 people
2. Number of O&M visits per year 64 days

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor					
Program Manager	12	hour	$200	$2,400	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Senior	60	hour	$145	$8,700	
Environmental Engineer - Mid	120	hour	$120	$14,400	
Environmental Engineer - Junior	640	hour	$90	$57,600	
Labor - O&M Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	16	hour	$150	$2,400	
Environmental Engineer - Senior	30	hour	$145	$4,350	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	8	hour	$100	$800	
CADD Technician - Mid	8	hour	$75	$600	
Administrative Assistant - Mid	4	hour	$70	$280	
Other Expenses					
Annual compressor service	1	lump sum	$3,000	$3,000	
System electricity	12	months	$1,700	$20,400	
Annual well redevelopment	1	lump sum	$30,000	$30,000	
Field supplies/expenses	64	days	$100	$6,400	
Annual equipment replacement/upgrade	1	LS	$15,000	$15,000	
Travel					
Per diem (food)	64	day	$69	$4,416	
Per diem (lodging)	64	day	$175	$11,200	
Pick-up truck	64	day	$50	$3,200	
SUBTOTAL				**$202,946**	
SUBTOTAL (YEARS 3-30)				**$5,682,488**	

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

10. Semi-Annual Groundwater Monitoring (Years 1-10)

Includes:
1. Semi-annual groundwater monitoring for years 1-10
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 50 wells during each event; 5 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 50 wells during each event; 5 duplicates per
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)
5. calculated using a discount rate of 0.5% for real interest rates (OMB Circular A-94, May 2022)

Major Assumptions:

1.	Staff per monitoring event	2	people
2.	Days per monitoring event	9	days
3.	Number of monitoring events	2	events
4.	Number of wells sampled per event	50	wells
5.	Duplicate samples (COCs)	5	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	24	hour	$150	$3,600	
Environmental Engineer - Mid	180	hour	$120	$21,600	
Environmental Engineer - Junior	180	hour	$90	$16,200	
GIS Specialist - Mid	16	hour	$100	$1,600	
Administrative Assistant - Mid	8	hour	$70	$560	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	20	hour	$150	$3,000	
Environmental Engineer - Mid	60	hour	$120	$7,200	
Environmental Engineer - Junior	100	hour	$90	$9,000	
GIS Specialist - Mid	40	hour	$100	$4,000	
Administrative Assistant - Mid	12	hour	$70	$840	
Laboratory Analyses					
Site COCs (including duplicates)	110	samples	$45	$4,950	
General chemistry (including duplicates)	110	samples	$110	$12,100	
Sample shipping	22	coolers	$100	$2,200	
IDW disposal	2	lump sum	$2,000	$4,000	
Supplies					
Sampling equipment	36	day	$200	$7,200	
Field supplies	2	event	$500	$1,000	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	36	day	$69	$2,484	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	36	day	$50	$1,800	
SUBTOTAL				**$107,234**	
SUBTOTAL (YEARS 1-10)				**$1,072,340**	

TABLE A-6
Cost Estimate for Shepley's Hill Landfill, Alternative 6

Alternative 6
Partial Landfill Removal with Active Aquifer Treatment

OPINION OF PROBABLE COST

11. Annual Groundwater Monitoring (Years 11-30)

Includes:

1. Annual groundwater monitoring for years 11-30
2. Site COCs (arsenic, iron, and manganese) sampled at an average of 25 wells during each event; 3 duplicates per event
3. General chemistry parameters (alkalinity, chloride, dissolved organic carbon, and sulfate) sampled at 25 wells during each event; 3 duplicates per
4. Annual monitoring report (Draft Army, Draft Regulators, Final Version with Responses to Comments)
5. calculated using a discount rate of 0.5% for real interest rates (OMB Circular A-94, May 2022)

Major Assumptions:

1. Staff per sampling event	2	people
2. Days per sampling event	5	days
3. Number of sampling events	1	event
4. Number of wells per sampling event	25	wells
5. Duplicate samples (COCs)	3	samples

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES:
Labor - Field					
Program Manager	4	hour	$200	$800	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	50	hour	$120	$6,000	
Environmental Engineer - Junior	50	hour	$90	$4,500	
GIS Specialist - Mid	8	hour	$100	$800	
Administrative Assistant - Mid	4	hour	$70	$280	
Labor - Reporting					
Program Manager	8	hour	$200	$1,600	
Project Manager	12	hour	$150	$1,800	
Environmental Engineer - Mid	36	hour	$120	$4,320	
Environmental Engineer - Junior	60	hour	$90	$5,400	
GIS Specialist - Mid	24	hour	$100	$2,400	
Administrative Assistant - Mid	8	hour	$70	$560	
Laboratory Analyses					
Site COCs (including duplicates)	28	samples	$45	$1,260	
General chemistry (including duplicates)	28	samples	$110	$3,080	
Sample shipping	6	coolers	$100	$600	
IDW disposal	1	lump sum	$2,000	$2,000	
Supplies					
Sampling equipment	10	day	$200	$2,000	
Field supplies	1	event	$500	$500	
Reproduction costs	3	lump sum	$500	$1,500	
Travel					
Per diem (food)	10	day	$69	$690	
Per diem (lodging)	0	day	$175	$0	
Pick-up truck	10	day	$50	$500	
SUBTOTAL				**$42,390**	
SUBTOTAL (YEARS 11-30)				**$847,800**	

TOTAL COSTS

COSTS	**$204,329,322**

Appendix I

Environmental Footprint Analysis

Core Element	Metric		Unit	Footprint						
				Alternative 1: No Action	Alternative 2: Groundwater Extraction and Treatment	Alternative 3: In-Situ Air Sparging	Alternative 4A: Modified Groundwater Extraction and Treatment with Three Extraction Wells	Alternative 4B: Modified Groundwater Extraction and Treatment with Three Extraction Wells and Injection	Alternative 5: Modified Groundwater Extraction and Treatment with In-Situ Air Sparging	Alternative 6: Partial Landfill Removal and Active Aquifer Treatment
Materials and Waste	M&W-1	Refined materials used on site	Tons	33	297	32	366	372	392	507,746
	M&W-2	% of refined materials from recycled or reused material	%	0	0	0	0	0	0	100
	M&W-6	On-site non-hazardous waste disposed of off site	Tons	0	7,800	49	7,817	7,826	7,855	1,815,835
			Element Rating	Low	Moderate	Low	Moderate	Moderate	Moderate	High
Water	W-1	Public water use	MG	0	3	0	4	4	4	0
	W-8	Wastewater generated	MG	0	662	0	795	0	795	0
			Element Rating	Low	High	Low	High	Moderate	High	Low
Energy	E-1	Total energy used (on-site and off-site)	MMBtu	60	80,019	37,884	99,808	88,048	130,128	930,528
	E-4	On-site grid electricity use	MWh	0	4,500	2,860	5,828	5,828	8,243	2,867
			Element Rating	Low	High	Moderate	High	High	High	High
Air	A-1	On-site NOx, SOx, and PM emissions	Pounds	0	0	661	149	313	700	96,233
	A-3	Total NOx, SOx, and PM emissions	Pounds	52	79,611	30,827	94,747	70,674	114,129	159,493
	A-3A	Total NOx emissions	Pounds	46	24,690	5,464	28,340	15,874	30,883	110,590
	A-3B	Total SOx emissions	Pounds	3	50,035	24,390	61,377	49,724	78,017	39,569
	A-3C	Total PM emissions	Pounds	2	4,886	972	5,029	5,076	5,229	9,334
	A-4	Total HAP emissions	Pounds	1	1,056	644	1,098	1,123	1,168	1,782
	A-5	Total greenhouse gas emissions	Tons CO2	245	4,826	1,689	5,795	4,059	6,902	10,638
			Element Rating	Low	High	Moderate	High	High	High	High
			Overall Rating	**Low**	**High**	**Moderate**	**High**	**High**	**High**	**High**

Note: Only metrics of the analysis that included a non-zero result for at least one alternative are shown above.

Acronyms and Abbreviations:

CO2 = carbon dioxide
GW = groundwater
HAP = hazardous air pollutants
MG = million gallons
MMBtu = Million British thermal units
MWh = mega-watt hour
NOx = nitrogen oxides
PM = particulate matter
SOx = sulfur oxides

Appendix J

Responses to Regulatory Comments

Comments on the Draft Final Focused Feasibility Study, Shepley's Hill Landfill (SHL), Former Fort Devens Army Installation, Devens, Massachusetts, December 2023							
Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification N = Comment noted							
Comment Number	Commenter	Page(s)	Section	Line(s)	Comment	Response Code	Response
1	M. Daly / USEPA		Section 5.3.3		MassDEP provided the Army a letter dated 30 January 2024 transmitting comments on the draft final SHL FFS, including Appendix G of the document - Non-Potential Drinking Water Source Area (NPDWSA) Reclassification Rationale. MassDEP has made the determination that SHL does not meet the criteria as described in Massachusetts regulation (310 CMR 40.0006) or MassDEP Policy WSC-97-701 Determining Non-Potential Drinking Water Source Areas, to be classified as a NPDWSA. Therefore, ground water at, and immediately down-gradient of SHL cannot be reclassified from a Current or Potential Drinking Water Source Area to a NPDWSA. Based on the MassDEP determination, FFS Alternative 3 would not meet the NCP threshold criteria for compliance with ARARs. EPA concurs with MassDEP that this remedial alternative should no longer be considered in the SHL FFS.	A	This alternative has been removed from the FFS.
2	M. Daly / USEPA		Section 5.3.6		Alternative 7 has substantively changed from the Alternative 7 presented in the draft SHL FFS. This alternative initially considered reconsolidation of landfill waste within the existing SHL waste management unit to achieve the goal of removing landfill waste that is acting as a direct source of carbon and arsenic to site ground water. The landfill material removed from the northern half of SHL would be recontoured within the southern portion of SHL followed by reestablishment of the existing cover system. Alternative 7 presented in the draft final document proposes the same excavated volume to now be transported and disposed at an off-site licensed disposal facility. This change to Alternative 7 results in the estimated cost to almost double from $113 million to $204 million. EPA requests that the revised draft final SHL FFS discuss basis for this change to Alternative 7 as originally presented in the draft document.	A	A description of the basis for this change has been added to Section 5.3.6.
3	D. Baxter / MassDEP	p. 5	Section 1.2.1.3		The Groundwater Classification and Use in Section 1.2.1.3 of the Draft Final FFS should be revised as this section incorrectly states that SHL "meets the requirements to be exempt from meeting GW-1 Standards". As discussed in the letter above, this section incorrectly interprets MassDEP Policy WSC-97-701 as it pertains to Shepley's Hill Landfill.	A	This alternative has been removed from the FFS. Note that Army's opinion regarding the applicability of the NPDWSA regulations to SHL remains in the document as part of Appendix E (formerly Appendix G).
4	D. Baxter / MassDEP	p. 7	Table 1		Please add a footnote regarding the current cleanup goal for arsenic as discussed in Section 2.2.	A	A footnote has been added to Table 1.
5	D. Baxter / MassDEP	p. 30	Section 5.3.3		As discussed in the letter above, SHL does not meet the criteria, as outlined in the MassDEP Policy WSC-97-701 Determining Non-Potential Drinking Water Source Areas, to be classified as a NPDWSA. Therefore, Alternative 3: Land Use Controls should be removed from the FFS.	A	The Army disagrees with the MassDEP's assertion that reclassification is not applicable to Shepley's Hill Landfill, and with the idea that inclusion and evaluation of an alternative on it's own merits in an FS indicates regulatory acceptance of the alternative. However, at MassDEP's request and in the spirit of collaboration, the Army has removed Alterative 3 from the FFS. Note that the Army's opinion regarding the applicability of the NPDWSA regulations to SHL presented in Appendix E (formerly Appendix G) will remain in the document. Army requests that MassDEP revise the following features in MassGIS/MassMapper, as the current designations are incorrect and available to the public and decision-making officials: 1) The Land Cover Land Use designation for the landfill should be revised from "Grassland" to "Landfill" and; 2) The "Medium Yield" designation of Shepley's Hill should be compared to the documented Bedrock Depth and revised, as the hill and surrounding areas of bedrock outcrops should be classified as a Non-Aquifer Area.
6	D. Baxter / MassDEP	p. 38	Section 6.1.3		Please delete the third and fourth sentences under the header State Acceptance. This sentence is inaccurate as MassDEP did not "chose to provide feedback on Alternative 3 ahead of the Proposed Plan process". MassDEP provided comments on the Draft FFS and Draft version of Appendix G both of which were submitted by the Army to MassDEP for review and comment. MassDEP has repeatedly stated to the Army that the Army has incorrectly interpreted MassDEP Policy WSC-97-701 Determining Non-Potential Drinking Water Source Areas and that reclassifying the groundwater from GW-1 to GW-3 would not be considered.	A	This alternative has been removed from the FFS.
7	D. Baxter / MassDEP	p. 42	Section 6.2.3		Please delete this section. As discussed in the letter above, SHL does not meet the criteria, as outlined in the MassDEP Policy WSC-97-701 Determining Non-Potential Drinking Water Source Areas, to be classified as a NPDWSA. Therefore, Alternative 3: Land Use Controls should be removed from the FFS.	A	This alternative has been removed from the FFS.
8	D. Baxter / MassDEP	p. 61	Section 6.2.9		Please remove all refences to Alternative 3: Land Use Controls as presented in this version of the Draft Final FFS and remove Alternative 3 from Tables 5 and 6.	A	This alternative has been removed from the FFS.
9	D. Baxter / MassDEP	p. 65	Section 6.3		Please remove Alternative 3: Land Use Controls from this section and Table 7.	A	This alternative has been removed from the FFS.
10	D. Baxter / MassDEP		Table 3		Please revise Table 3. As discussed in the letter above, SHL does not meet the criteria, as outlined in the MassDEP Policy WSC-97-701 Determining Non-Potential Drinking Water Source Areas, to be classified as a NPDWSA.	A	This alternative has been removed from the FFS.
11	D. Baxter / MassDEP		Table 4		Please remove Alternative 3: Land Use Controls from the table.	A	This alternative has been removed from the FFS.
12	L. Nehring / RAB		General		Please explain how a remedy will be selected (by whom) and provide a timeline.	N	Following finalization of the Focused Feasibility Study, a Proposed Plan (PP) that identifies the preferred remedial alternative, based on the analysis performed in the FFS, will be prepared. The PP is provided to the public for review and comment before it is finalized. The selected remedy is documented in a Record of Decision (ROD) or modification to a ROD prior to implementation. The document at the bottom of this USEPA webpage includes much more detail regarding the process: https://www.epa.gov/superfund/record-decision-rod-guidance
13	L. Nehring / RAB		General		Re: Use of "NIA" for North Impact Area. We believe this is misleading to the public. Please consistently replace this term with something that includes the word "Ayer" with a more clear term, such as "West Main Street area in Ayer" or Ayer-WMS or Ayer-NIA.	N	The description of the North Impact Area at first use in the document has been revised to describe its location with respect to West Main Street and its location in Ayer. This area has been referred to as the NIA in finalized documents for over 10 years.

Comments on the
Draft Final Focused Feasibility Study, Shepley's Hill Landfill (SHL), Former Fort Devens Army Installation, Devens, Massachusetts, December 2023

Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification N = Comment noted

Comment Number	Commenter	Page(s)	Section	Line(s)	Comment	Response Code	Response
14	L. Nehring / RAB		General		Army has (again) proposed to reclassify the groundwater surrounding SHL from GW-1 (potential drinking water source area, as defined in the MCP: 310 CMR 40.0006) to nonpotential drinking water source area. PACE strongly opposes this reclassification. We concur fully with the objections made the town of Ayer an by Ms. Diane M. Baxter, MassDEP Bureau of Waste Site Cleanup in her Jan. 30, 2024 letter to Thomas Lineer, BRAC Program Manger.	N	The alternative under which SHL would be reclassified as a NPDWSA has been removed from the FFS.
15	L. Nehring / RAB		General		The Army's rationalization, to exempt the SHL from meeting GW-1 standards, appears to be based on their own determination of arsenic background levels. This FFS mentions a cleanup level of arsenic to 198 ug/L rather than drinking water standard of 10 ug/L. This would clearly not meet the ARAR or RAO established by the MaDEP, as detailed in Baxter's letter. We note that Army made this same argument in 2011, and MaDEP objected then, as stated in a letter written by Mr. David Chaffin, Federal Facilities Project Manager, Bureau of Waste Site Cleanup to Mr. Robert Simeone, BRAC Environmental Coordinator at the time, (Feb. 24, 2011). Mr. Chaffin states, "The concern that it may not be feasible to meet the applicable groundwater standards should not be addressed by changing the groundwater classification to justify less conservative cleanup standards." (p. 1).	N	Though the results of the recent arsenic background study are mentioned in the FFS, the document does not include a proposal for an alternate cleanup level to that which is included in the 1995 ROD. Changes to cleanup values must be documented in RODs.
16	L. Nehring / RAB		General		Further consideration regarding these levels of arsenic should be given to the long-term impacts in Ayer. These extremely high levels of arsenic that have been moving in groundwater, offsite, beneath private homes in Ayer are not simply disappearing. To date, we know there are at least 25+ years of high levels of arsenic precipitating out as it mixes with oxygenated groundwater in a relatively small area, north of the landfill, in Ayer. Common sense suggests that the wetland areas leading to Nonacoicus Brook must be impacted by the accumulation of arsenic- being absorbed or consumed by small organisms (i.e. bacteria, benthos) at the bottom of the food chain, and thus passed on to local wildlife. Since treatment will likely need to continue over a very long time, it seems likely that, over time, arsenic has been traveling, perhaps pulled toward the MacPherson Wells and other potential drinking water sources.	N	Studies performed to date to identify if arsenic is impacting downgradient wetlands, Nonacoicus Brook, and potable water supply wells indicate that this is not occurring. In particular, the Final Shepley's Hill Landfill Supplemental Groundwater and Cap Assessment Addendum for Long-Term Monitoring and Maintenance -Addendum Report dated August 2011 includes cross sections with data collected east of the Zone II for MacPherson well that show arsenic is not migrating to the MacPherson Well.
17	L. Nehring / RAB		General		Please explain why high arsenic levels in groundwater north of the Arsenic Treatment plant (ATP), but outside of the area you identify as NIA (North Impact Area), has traveled north, into Ayer, missing the ATP. With the cleanup goal for arsenic of10ug/L., we are concerned that some wells north of West Main Street, are showing levels of arsenic from 39ug/L **to 1800ug/L**. Also, just a bit further south of the RR Tracks, closer to the ATP, well SHM-05-40x shows arsenic at **2200ug/L-far** exceeding the cleanup goals. Please explain why.	N	Arsenic concentrations downgradient of the ATP are not decreasing due to the geochemical conditions of the aquifer (highly reducing) and the availability of geogenic arsenic. This is described in detail in Section 4.1.
18	L. Nehring / RAB		General		Please provide historic background, and explain why and how such high levels of arsenic in groundwater beneath the cap of the central area of the landfill still exist. How long will they be expected to last? Additional Background: In 2021, seven overburden wells within the landfill sampled all exceeded the arsenic cleanup goal with concentrations ranging from **410 µg/L to 6,300 µg/L**. Monitoring wells suggest that arsenic levels in groundwater significantly increase under the landfill footprint. Specifically: • There is a noted increase of arsenic under the landfill cap, including: SHM-10-12=2900ug/L, SHM-10-15=**6300ug/L**, SHP-99-29X=1,600ug/L, SHM-10-14=4,100ug/L, EW-04=3,400ug/L, EPA-PZ-2012-3B=2,500ug/L. • These levels strongly suggest that much of the high levels of arsenic contamination is from the landfill debris placed there and is NOT naturally occurring. (The FFS notes that 14% of the landfill samples contain ash, which was reported to have a higher arsenic concentration than other samples.)	N	There are two arsenic sources presented in Section 2.1; one is geogenic (from local rocks and minerals) and one is anthropogenic (attributed to the landfill). As noted in Section 4.1, arsenic concentrations are not anticipated to decrease due to the geochemical conditions of the aquifer (highly reducing), which keeps arsenic in solution and present in groundwater at these concentrations.
19	L. Nehring / RAB		General		In addition to arsenic, are there other contaminants of concern in the groundwater or landfill that should be addressed in the FFS Report, particularly PFAS? We note that a PFAS study is ongoing, and a separate (but related) report will be issued at a future date.	N	Per Section 2.3, PFAS in groundwater will be addressed under a forthcoming remedial investigation effort for Area 2.
20	L. Nehring / RAB		General		Plow Shop Pond Dam is privately owned by CTC Holdings, Inc.- which is part of Ayer parcel number 33-4. This is the Moore Lumber Company. The dam is known to be in poor condition. PACE is aware of conversations with the Nashua River Watershed Association (NRWA) about the owner's concerns about the cost of maintaining this dam, and what would be involved in removing it, through various the Dam Removal funding programs. • Please explain possible ramifications of dam removal. Could the responsibilities for this dam be taken over by the Army or Devens, considering that CTC may be willing to donate it? We suggest Army contact "CTC Holdings Inc." to discuss this.	N	The Army cannot take ownership of a dam. The dam's status would not be expected to affect the effectiveness of the current remedies.

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21	L. Nehring / RAB		General		Background Discussion for consideration of the Remedial Alternatives. 1. General Discussion (as summarized from our TASC technical advisor, Skeo): Dissolved oxygen level is the key factor determining arsenic concentrations in groundwater. Increasing dissolved oxygen causes iron to precipitate out of the groundwater. Arsenic adsorbs to the iron oxide and co-precipitates with iron. The FFS Report notes that achieving long-term arsenic removal and stabilization would best be accomplished by creating a sustained oxygenated environment within the overburden aquifer. As groundwater moves downgradient and beyond SHL, arsenic attenuation occurs. Oxygenated surface water infiltration increases dissolved oxygen and precipitates out iron and arsenic. The FFS Report also mentions groundwater dilution via contributions from surrounding oxygenated inflows with low arsenic concentrations. Army states that high dissolved oxygen levels near Nonacoicus Brook remove remaining arsenic, iron and manganese from the groundwater before it flows into the brook. Only one of the series of wells adjacent to Nonacoicus Brook (SHM-13-03) detects arsenic above the MCL. Short-term treatment is possible via active sparging or reintroduction of water with high dissolved oxygen (the objective would be to actively increase dissolved oxygen in groundwater). Skeo suggests that long-term treatment requires identifying passive, non-active remedies to keep dissolved oxygen levels elevated. Long-term effectiveness is determined by providing sufficient inflows of oxygen- rich groundwater to offset the oxygen depletion from biochemical processes in the subsurface. Organic carbon sources reduce dissolved oxygen through decay. Carbon sources include historic peat swamp material, landfill waste and upgradient inflows.	N	Comment noted. If passive remedies that would allow for groundwater oxygen levels to remain elevated were available, the Army would have included them in this FFS.
22	L. Nehring / RAB		Section 5.1		2. Remedial Action Objectives (RAOs) for SHL Section 5.1 of the FFS Report. The selected remedy must: Protect potential residential receptors from exposure to impacted groundwater migrating from the landfill having chemicals in excess of "applicable or relevant and appropriate requirements" (ARARs). Prevent impacted groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations. (The FFS states that this was addressed through installation of the barrier wall between the pond and SHL.) As part of the evaluation process for remedy alternatives the options must meet local, state and federal requirement (ARARs), including the Safe Drinking Water Act, Wetland protection, pretreatment standards for the use of Devens publicly owned treatment works (POTW), regulations for reinjection of groundwater into an aquifer and for discharge of remedial wastewater to subsurface and/or groundwater.	N	Comment noted.
23	L. Nehring / RAB		Section 5.1		3. Selected Remedy must meet these Evaluation Criteria. The selected remedy must meet: A. Threshold Criteria: • Overall protection of human health and the environment and • Compliance with ARARs B. Balancing Criteria: • Long-term effectiveness and performance • Reduction of toxicity, mobility and volume through treatment • Short-term effectiveness • Implementability • Cost – (This is NOT the primary driver.) C. Modifying Criteria: • State/federal acceptance • Community acceptance* Please explain how Community Acceptance will be determined, particularly the community of Ayer, who is most impacted by this contamination problem.	N	Community Acceptance is determined during the Proposed Plan process following the Feasibility Study. This guidance is available at https://www.epa.gov/superfund/record-decision-rod-guidance and states: "The lead agency is charged with making the relevant documents, such as the Proposed Plan and the RI/FS Report, available to the public at the time the newspaper notification is made. In addition, the lead agency must ensure that any information that forms the basis for selecting the response action is included as part of the Administrative Record file and is available to the public during the public comment period. CERCLA §117(a)(2) also requires the lead agency to provide the public with a reasonable opportunity to submit written and oral comments on the Proposed Plan. NCP §300.430(f)(3)(i) requires the lead agency to allow the public a minimum of 30 days to comment on the information contained in the RI/FS Report and Proposed Plan (including any proposed waivers relating to ARARs). In addition, the lead agency must extend the comment period by a minimum of 30 additional days, upon timely request. The lead agency must provide an opportunity for a public meeting to be held at or near the site during the comment period. A transcript of the meeting conducted during the public comment period must be made available to the public and should be included as part of the Administrative Record file (pursuant to NCP §300.430(f)(3)(i)(E)). The lead agency should also place the transcript in the information repository. Although the lead agency may respond to oral or written comments received during the RI/FS process and before the public comment period, it has no legal obligation to do so. To ensure that their comments are addressed, commenters may wish to resubmit their comments during the formal public comment period as well."

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24	L. Nehring / RAB		Section 5.1		We believe that **Alternatives 1, 2 and 3** cannot be accepted because they do not meet ARAR's and/or cleanup standards. They do not meet the Community Acceptance criteria. • For Consideration: combining remediation for both Arsenic and PFAS: In an effort to "think outside of the box," a PACE Board Member, who is also a chemist, suggested the following concept be investigated and considered for incorporation into the proposed remedies for SHL.	N	Comment noted.
25	L. Nehring / RAB		Section 5.1		• We are all well aware of the ongoing investigations and research regarding PFAS contamination at the former Ft. Devens, and expect that SHL also has PFAS in groundwater. As arsenic passes in groundwater through SHL, would it be possible to use a vertical permeable barrier at the north end of the landfill to remove arsenic in groundwater, along with the removal of PFASs? Here are our thoughts:	N	Section 5.3 discusses why a permeable reactive barrier was not included as an alternative for evaluation.
26	L. Nehring / RAB		Section 5.1		• Consider: at the Feb. 8, 2024, RAB meeting a presentation was given that explained a pilot project to be conducted at AOC 31 to sequester PFASs during which a "modified clay" barrier will be installed around and below an area of substantial PFAS contamination in the soil above the groundwater level. The horizontal component of this barrier will be tested to prove that it can sequester all PFAS that is carried downward by rainwater that passes through the contaminated soil, while passing the thus-filtered rainwater. This sequestration is likely the result of PFAS anion adsorption onto the clay material. • <u>The dissolved arsenic in groundwater is essentially all in anionic form and might therefore be amenable to capture by this same modified clay.</u> Presumably, a vertical barrier at the north end of SHL could effectively remove dissolved arsenic, as well as any PFAS contamination at this site. • We point out that the AOC 31 test involves a relatively slow percolation of rainwater, whereas a vertical barrier suggested for SHL may impact the flow of groundwater, even if the clay is permeable. We recognize this may be a problem, but it seems worth discussing with the investigator who is piloting this for AOC 31.	N	Comment noted.
27	L. Nehring / RAB		Alternative 3		Alternative 3: Land use controls. Environmental Justice Issue? LUCs were imposed on homeowners and people who rent homes in a low-income area of Ayer, along West Main Street. LUCs depend entirely on homeowners and the town of Ayer being responsible to regularly educate and ensure people who live at these properties do not inadvertently expose themselves to highly contaminated groundwater by installing private wells for drinking water or irrigation of lawns or gardens. We believe this is an unfair burden to the people, with no compensation for property value losses to homeowners or for the Town's administrative burden. This problem was created by the Army and it should not be 'dumped on Ayer.' Some PACE members question if the dependency on LUC's to manage the contamination would be considered in a wealthier town, and wonder: Is this an Environmental Justice issue?	N	The alternative under which SHL would be reclassified as a NPDWSA has been removed. The majority of the NIA is already classified as a Non-Potential Drinking Water Source Area (please refer to Figure 8). The Army was not responsible for this classification.
28	L. Nehring / RAB		Alternative 4		In Situ Air Sparging can be successful, given the right conditions. However, over time, could it become less effective because of decreased porosity in the vicinity of the sparge sites, due to build up of iron oxide precipitate. How will this be monitored over time? Will Army plan to install new sparge sites when such decreases in effectiveness are observed?	N	Correct, decreased porosity could be a concern with long-term air sparging. Performance would be monitored as part of implementation. Should this remedy be selected for implementation, the performance monitoring to be conducted would be included in a work plan. As mentioned in Section 4.2.4, distributing oxygen to deeper parts of the aquifer may also be a challenge and would need to be tested if this alternative were selected for implementation.
29	L. Nehring / RAB		Alternative 4		A PACE Board member who is a chemist commented on the chemistry: the removal of arsenic from groundwater by oxygen/air sparging is attributed to its tendency to absorb on iron oxide which precipitates from groundwater in the presence of dissolved oxygen. While the formation of iron oxide is essentially irreversible, it is not clear that the adsorbed arsenic is permanently sequestered. Could the adsorption equilibrium be altered by changes in groundwater conditions, such as pH or hardness (within the natural range of such parameters)? How will this be monitored over time? What adjustments would be made, if it occurs?	N	Correct, arsenic may solubilize into groundwater if air sparging is stopped and redox conditions in groundwater are again reducing. Air sparging would likely need to run in perpetuity to avoid this.
30	L. Nehring / RAB		Alternative 4		Please explain why the ATP would cease operation and how the continuing use of existing land use controls and long-term monitoring would impact the town of Ayer and affected properties? What would be the long-term impacts? How will arsenic be managed, considering the above concerns about impacts on the food chain and future water sources?	N	If selected for implementation, air sparging would replace the function of the ATP as the remedy.
31	L. Nehring / RAB		Alternative 4		What is the long-term expectation if the air sparge wells are eventually turned off? What conditions would allow this to occur? If this is a realistic possibility in the future, please provide a summary of the environmental impacts, along with a timeline.	N	The Army anticipates that any active remedial technology would operate in perpetuity.
32	L. Nehring / RAB		Alternative 4		**Technical Advisor Suggestion ** (which PACE supports): Air sparging is a proven remediation approach in the right circumstances. Please <u>**evaluate the possibility of installing air sparge wells UPGADIENT of SHL**</u>. An upgradient location closer to the southern end of the LF would increase dissolved oxygen levels under the landfill cap and potentially reduce the amount of arsenic that dissolves into the groundwater.	N	Oxygen provided via air sparge at the upgradient edge of SHL would be readily consumed before having a chance to have a notable affect on arsenic concentrations beneath the landfill and downgradient. Note that the distance this groundwater travels before reaching the downgradient edge of SHL is approximately 2,500 feet and it takes approximately five or more years for groundwater at the upgradient edge of the landfill to reach the northern edge / ATP.
33	L. Nehring / RAB		Alternative 5A		The ongoing pilot will help provide critical data to determine the viability of this alternative. We prefer option 6, which combines this with air sparging in transects.	N	Comment noted.
34	L. Nehring / RAB		Alternative 5A		We suggest the consideration of adding air-sparging <u>upgradient</u> of SHL to reduce the arsenic being released into groundwater, as described above.	N	Please refer to the response to Comment #32 above.
35	L. Nehring / RAB		Alternative 5A		How will PFAS (and any other contaminants found) in the groundwater be removed prior to being sent to the Devens POTW?	N	Should this alternative be selected for implementation, the treatment system will be designed so the effluent meets the Ayer POTW permit requirements.
36	L. Nehring / RAB		Alternative 5B		The FFS Report stated that reinjection of oxygenated water would not provide enough dissolved oxygen to significantly increase the dissolved oxygen levels in the groundwater (Section 5.3, p. 28 of the FFS Report). How will the effectiveness be evaluated, especially long-term?	N	Should this alternative be selected for implementation, the performance monitoring to be conducted would be included in a work plan.

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37	L. Nehring / RAB		Alternative 5B		Also, the re-injection would require careful modeling and pilot studies since it would impact groundwater flow patterns and extraction wells' zone of influence. How will the site for reinjection be evaluated and selected?	N	Should this alternative be selected for implementation, the approved groundwater model will be used to select the optimal location(s) for injection. Injection at these areas would be tested prior to full-scale implementation.
38	L. Nehring / RAB		Alternative 5B		This would also require approval from state and/or federal agencies. What concerns do MaDEP, EPA and the town of Ayer have? How will the town of Ayer officials, such as the Ayer Conservation Commission, be clearly included in this discussion?	N	Please see the response to above Comments #12 and 23 regarding the Proposed Plan process.
39	L. Nehring / RAB		Alternative 5B		How will PFAS (and any other contaminants found) in the groundwater be removed prior to reinjection?	N	If this alternative is selected for implementation, the treatment system will be designed so the effluent meets requirements for injection.
40	L. Nehring / RAB		Alternative 6		**We like this alternative.** It appears it will combine reasonably successful technologies that will both increase dissolved oxygen in groundwater and also remove arsenic more effectively. As stated above, In Situ Air Sparging can be successful, given the right conditions. However, over time, could it become less effective because of decreased porosity in the vicinity of the sparge sites, due to build up of iron oxide precipitate. How will this be monitored over time? Will Army plan to install new sparge sites when such decreases in effectiveness are observed?	N	Please see the response to above Comment #28.
41	L. Nehring / RAB		Alternative 6		As we suggested above, in Alternative 4, **please consider the additional installation of air sparging transects UPGRADIENT of SHL to** increase dissolved oxygen levels under the landfill cap and potentially reduce the amount of arsenic that dissolves into the groundwater that flows through the arsenic contaminated areas.	N	Please see the response to above Comment #32.
42	L. Nehring / RAB		Alternative 6		How will Army determine how effective will air sparging be in both the fine glacial till (silts and clay) and in the deeper bedrock aquifer, where arsenic levels are highest? How can this be improved or modified over time, if proven ineffective?	N	Should this alternative be selected for implementation, additional in-field testing would be performed to assist in answering these questions.
43	L. Nehring / RAB		Alternative 6		How effective will air sparging in both shallow and deep points prove to be over time? With all of the expected precipitation of arsenic/iron/manganese, what will prevent channels from forming and/or clogging up of the soils or air spaces between the soils?	N	Should this alternative be selected for implementation, additional in-field testing would be performed to assist in answering these questions. Per above Comment #40, reductions in aquifer permeability as a result of metals precipitation would be monitored for as part of performance.
44	L. Nehring / RAB		Alternative 6		How will PFAS (and any other contaminants found) in the groundwater be removed prior to sending to the Devens POTW?	N	Should this alternative be selected for implementation, the treatment system will be designed so the effluent meets the Ayer POTW permit requirements.
45	L. Nehring / RAB		Alternative 7		Why is the landfill debris being shipped offsite? Where would it go? How much would be considered hazardous waste vs. degraded soils that are easier to relocate?	N	Under this alternative, landfill debris is being shipped offsite to reduce the surface area of the landfill cover. Should this alternative be selected for implementation, material to be removed would be characterized for disposal.
46	L. Nehring / RAB		Alternative 7		Have UXO considerations been included in this study?	N	Should this alternative be selected for implementation, the need for consideration of UXO would be evaluated and accounted for in the work plan.
47	L. Nehring / RAB		Alternative 7		Our first reaction to this alternative was 'well, no way. Too costly.' But in looking over the other alternatives, it appears that most will require 340+ years to reach cleanup goals – or more! This adds up in energy requirements, management costs, monitoring and oversight. The majority of the environmental impact and costs for alternative 7 appears to be the transportation costs and fees to the receiving landfill. Under this light, we ask: • Has the Army considered this partial landfill removal, with air sparging, as described, but rather than shipping the debris all offsite to a lined waste management facility, most if it stays ONSITE with major reshaping of the southern portion of the landfill, making the footprint smaller but taller?	N	Yes, the Army considered partial landfill removal with consolidation on-site, but this is not compatible with Army BRAC policy. This is described in Section 5.3.6.
48	L. Nehring / RAB		Alternative 7		• Could this result in similar benefits to increase the recharge and groundwater flow rates in the northern portion of the landfill, where waste material is removed, and clean fill added, and thus increasing the mass load of dissolved oxygen flowing to the north to remove arsenic? (as described on p. 35).	N	Yes, this would likely increase dissolved oxygen loading, as described in Section 5.3.6.
49	L. Nehring / RAB		Alternative 7		• We recall that the endangered grasshopper sparrow found habitat on the current landfill, (which more resembles an open field than a traditional landfill) and is under legal protection. Certainly, the landfill habitat will be disturbed with either scenario. PACE would support Army seeking a waiver from the Commonwealth to pursue consideration the reshaping option, which, overall, we believe has far fewer environmental impacts in balancing the criteria compared to the original Alternative 7.	N	Comment noted. Though there is a grass atop the landfill cover, it has been a landfill since 1917.
50	L. Nehring / RAB	p. 7	Table 1		The cleanup goal for Arsenic of 50 is the former standard and is misleading. Pls. make this clear with a footnote, or better yet, include the current standard of 10mg/L.	N	Per Comment #4, a footnote has been added to Table 1.
51	L. Nehring / RAB	p. 8			Description of the ATP states that during analysis of discharge sent to the Devens POTW, that PFAS is not sampled for. If this is still the case, please be sure to add it to the sampling protocol, with at least quarterly sampling.	N	ATP discharge to the POTW is in compliance with permit requirements.
52	L. Nehring / RAB		Section 2		These calculations are important contributions to the understanding of arsenic fate & transport and level of contamination; however, they are also just a snapshot in time. What does the analysis of data over time show? This should be a significant part of this analysis. Also, in this section, Pls. discuss the context of other monitoring wells with high values, such as SHM-13-06, SHM-05-40x, SHM-96-5B, and all of the EPA-PZ samples. Were these done by EPA? If so, why? What were the findings?	N	An analysis of arsenic concentrations over time is included in Section 4.2.3. The analysis shows that trends do not indicate that cleanup could ever be achieved. Results of sampling performed at piezometers installed by USEPA are included in Sections 2.2.4 (monitoring wells with the ID prefix of PZ-12) and 2.2.5 (monitoring wells with the ID prefix of SHP-2016). Trend graphs showing arsenic concentrations over time at monitoring wells SHM-13-06, SHM-05-40X, and SHM-96-5B are included in Appendix D as Figures D-42, D-16, and D-50. The first two have no significant trend (both look relatively stable), but the concentration at SHM-96-5B is most likely decreasing (Appendix Table D-1).

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53	L. Nehring / RAB	p. 12	Section 2.2.1		Bedrock GW. I do not see 540ug/L listed in table 2. It would be helpful to have a map showing just these wells, as I cannot find them on the map 10. Likewise, it would be helpful to sort Table 2 by general locations, as described in this section, so that all of the Bedrock data is together, for example.	N	The 540 ug/L arsenic result is associated with bedrock monitoring well N5-P1 (sample ID N5-P1-FAL21 in Table 2), located between landfill overburden monitoring wells SHM-10-15 and SHM-10-13 on Figure 10. This figure incorrectly showed that location as an overburden monitoring well, and has been updated so it is clear which wells are overburden wells and which are bedrock wells on Figure 10. Table 2 has also been sorted into overburden and bedrock monitoring well groups.
54	L. Nehring / RAB		Tables 1 & 2		For Tables 1 and 2, please include a column for the depth of these measurements to elucidate the reader on the location and significance.	N	A column that notes what depth of the aquifer is screened by the wells has been added to Table 2. Table 1 does not include monitoring well measurements or data.
55	L. Nehring / RAB		Section 2.2.2		As above, pls. add info on depth and suggest creating a separate map for this wells.	N	Table 2 has been revised as suggested. The areas and wells associated with each of these sections are shown on Figures 2 and 10.
56	L. Nehring / RAB		Section 2.2.3		As above. The conditions of low DO & ORP are described as 'consistent/expected for a capped landfill.' Are these levels of arsenic (6300 Ug/L) also consistent and expected?	N	Per the Conceptual Site Model presented in Section 4, elevated arsenic concentrations in this area may be associated with both geogenic and anthropogenic sources, and remain in solution in areas of low dissolved oxygen and negative ORP.
57	L. Nehring / RAB		Section 2.2.4		Barrier Wall. Area. Again, the wells listed in this section do not appear to be included in Table 10 Also, there should be a discussion of why arsenic levels are so high on both sides of the barrier wall, as indicated by SHL-11 and SHL 20 included in the redox conditions discussion here.	N	The monitoring wells discussed in Section 2.2.4 do appear in Table 2 and on Figure 10. The barrier wall was installed within the area of arsenic exceeding the cleanup goal. A sentence has been added to Section 2.2.4 noting that, for this reason, there are exceedances of the cleanup goals in groundwater on both sides.
58	L. Nehring / RAB		Section 2.2.6		North Impact Area. Again, please re-label this to be make the location clear to Stakeholders in Ayer. Also, many of the well sites do not appear to be included in Table 2. Please state the depths of each well on the table.	N	Table 2 has been revised as suggested. Please see the response above to Comment #13. The monitoring wells described in this section are present in Table 2 and on Figure 10.
59	L. Nehring / RAB		Section 2.3		PFAS Distribution. Please state the levels of PFAS found, not the general SSSLs. The highest and median levels should be stated in this section.	N	PFAS in groundwater is being addressed separately as part of the Area 2 PFAS remedial investigation. The Preliminary Site Characterization Summary referenced in this section includes all of the data collected to date in this area.
60	A. & D. McCoy / RAB				What is the groundwater cleanup goal for arsenic at this site?	N	The groundwater cleanup goal is shown in Table 1. The goal listed in the 1995 for arsenic was 50 ug/L. This has yet to be formally revised in a Record of Decision modification, but the "current cleanup goal" referred to throughout the FFS text is 10 ug/L.
61	A. & D. McCoy / RAB				The FFS report states, "it is expected that none of the remedial alternatives that are evaluated in this FFS Report would be able to achieve restoration of the aquifer to the current cleanup goals with 30 years" (p. 25). Is a 30-year cleanup timeframe crucial in the remedy selection?	N	USEPA guidance for estimating costs of remedial alternatives in feasibility studies recommends using 30 years as the basis for cost development. At SHL, 30 years was selected as the minimum period to consider for discussion.
62	A. & D. McCoy / RAB				Many of the alternatives include groundwater extraction and/or injection to reduce arsenic in groundwater. Must these systems run for perpetuity? What would happen if these systems were ever shut down? Would arsenic levels return to pretreatment levels?	N	The Army anticipates that any active remedial technology would operate in perpetuity.
63	A. & D. McCoy / RAB				Several of the alternatives include injections to increase dissolved oxygen in the groundwater (reinjection of oxygenated water or air sparging). Currently these alternatives would place oxygen injections in the Nearfield area (near the ATP). Modelling suggests this will reduce arsenic concentrations in the Nearfield area and downgradient into the North Impact Area. The community may want to ask if the Army has considered injecting oxygen upgradient of the landfill. By injecting oxygen upgradient of the landfill, less arsenic may be dissolved into the groundwater from the landfill area. The report also notes that the organic matter in the landfill (peat material and landfill waste) consumes oxygen in the decay process. Adding oxygen upgradient may offset this oxygen depletion and keep dissolved oxygen levels higher under the landfill.	N	Please see response to above Comment #32.

COMMENTS PROVIDED BY

Date	Name	Department/ Organization	Email Address	Phone Number
02/13/24	Michael Daly	USEPA	Daly.Mike@epa.gov	(617) 918-1386
01/30/24	Diane Baxter	MassDEP	Diane.Baxter@mass.gov	(617) 292-5500
02/29/24	Laurie Nehring	PACE / RAB	lnehring100@gmail.com	
02/29/24	Amy and David McCoy	RAB	mccoy4@verizon.net	

The Commonwealth of Massachusetts
MASSACHUSETTS SENATE

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Joint Committee on Environment and Natural Resources

District Office
225 Main Street, Room 219A
Marlborough, MA 01752

Mr. Thomas Lineer, BRAC Program Manager
Army Environmental Division
Installation Service Directorate

Dear Mr. Lineer,

I would like to express my support for PACE's concerns regarding the Army's proposed reclassification of the groundwater surrounding SHL from GW-1 to non-potential drinking water source area. Along with the members of PACE, I oppose this reclassification. I also concur with the objections made by Ms. Diane M. Baxter, MassDEP Bureau of Waste Site Cleanup in her Jan. 30, 2024 letter to Mr. Thomas Lineer, BRAC Program Manger.

The Army's rationalization to exempt the SHL from meeting GW-1 standards appears to be based on their own determination of arsenic background levels. This FFS mentions a cleanup level of arsenic of 198 ug/L rather than drinking water standard of 10 ug/L. This would clearly not meet the ARAR or RAO established by the MaDEP, as detailed in Ms. Baxter's letter.

The long-term impacts regarding these high levels of arsenic must be considered. To date, there are at least 25+ years of high levels of arsenic precipitating out as it mixes with oxygenated groundwater in a relatively small area, north of the landfill, in Ayer. The wetland areas leading to Nonacoicus Brook are most likely impacted by the accumulation of arsenic that is being absorbed by small organisms, and thus passed on to local wildlife. Treatment will likely need to continue over a very long time. As a result, it seems likely that the arsenic will travel towards the MacPherson Wells and other potential drinking sources.

I implore you to take these considerations into account and prioritize access to safe drinking water for Ayer residents. Thank you for your time.

Sincerely,

Jamie Eldridge
State Senator
Middlesex & Worcester

Office of the Select Board
Office of the Town Manager

Town of Ayer| Ayer Town Hall| 1 Main Street| Ayer, MA 01432|978-772-8220| www.ayer.ma.us

Via E-mail to thomas.a.lineer.civ@army.mil and U.S. Mail

February 28, 2024

Dr. Thomas Lineer
BRAC Program Manager
Army Environmental Division
Installation Services Directorate

**Re: Shepley's Hill Landfill Draft Final Focus Feasibility Study
Former Fort Devens Army Installation, Devens, MA**

Dear Dr. Lineer:

The Town of Ayer (Town) has reviewed the *Draft Final Focused Feasibility Study Report for the Shepley's Hill Landfill (Area of Contamination 5), Former Fort Devens Army Installation* dated December 2023. On behalf of the Town, please receive the comments below related to the Report.

General:
Impacts of the Shepley's Hill Landfill (SHL) in the Town of Ayer are in the North Impact Area. This area includes land use restrictions on properties in the area, which can adversely affect property owners, values, future growth, and utility work. The Town strongly supports the approval of an alternative that will most likely reduce or eliminate the impacts in the North Impact Area.

Alternative 3: Land Use Controls
The Town does not agree with reclassifying the areas immediately downgradient of the SHL as Non-Potential Drinking Water Source Areas. The area encompasses a medium and high yield aquifer, which has potential to be suitable for public water supply. The Town of Ayer has historically performed public water supply source investigations for its water system, which was originally installed in 1898. The public water supply sources currently in use are in the vicinity of the southeast side of Grove Pond and western side of Spectacle Pond. Aside from the two areas currently used for public water supply, there have been several other areas investigated but deemed not viable as public water supply sources. Notably, areas immediately north of the SHL, i.e., downgradient, have yet to be investigated. Furthermore, the Town's future needs projections in its Water System Master Plan identify the need for an additional water source sometime between 2035 and 2040.

Additional Comments Related to Alternatives
Has in-situ air sparging been considered upgradient of the SHL?

Is Alternative 5A, the installation of a third extraction well, already being implemented? It's understood a third well was installed in 2023 and is in the process of coming online.

The groundwater extraction alternatives may carry other pollutants (e.g. PFAS) in the groundwater to their end discharge at Devens POTW. The selected alternative should consider any potential future restrictions of a permit to discharge to the Devens POTW.

It appears the air sparging alternative(s) would have the most benefit for the North Impact Area. Would these be required in perpetuity and what happens if they were shut down?

The Town looks forward to receiving your responses to our questions and concerns. If you have any questions or require any additional information, please do not hesitate to contact us directly.

Thank you for your time and consideration

Sincerely,

Robert A. Pontbriand
Town Manager
Town of Ayer

Dan Van Schalkwyk, P.E.
Director of Public Works
Town of Ayer

Cc: Ayer Select Board
State Senator James B. Eldridge
State Representative Danillo Sena
Ms. Laurie Nehring, P.A.C.E.

Tom

-----Original Message-----
From: Marion Stoddart <marionstoddartov40@gmail.com>
Sent: Thursday, February 29, 2024 3:28 PM
To: Lineer, Thomas A CIV USARMY HQDA DCS G-9 (USA) <thomas.a.lineer.civ@army.mil>
Cc: Laurie Nehring <lnehring100@gmail.com>
Subject: Comments on Army's shepley's Hill Landfill Focused Feasibility Study of Arsenic in groundwater

Dear Mr. Leneer-

I am a member of PACE and am writing you to add my support to the comments that Laurie Nehring, our President, has sent you regarding our concerns about the Army Feasibility Study of Arsenic in the Town of Ayer's groundwater. Our comments include recommendations, if followed, that would help provide safe drinking water for Ayer and downstream communities. I believe that the Army has the responsibility for restoring the resources that hey have damaged.

Sincerely,

Marion Stoddart
204 Autumn Ridge Drive
Ayer, MA 01432

Comments on the Focused Feasibility Study Report, January 26, 2023							
Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification							
Comment Number	**Commenter**	**Page(s)**	**Section**	**Line(s)**	**Comment**	**Response Code**	**Response**
1	Michael Daly		Section 4.2.2 – Arsenic Treatment Plant (ATP) Performance		The section discusses the performance of the current ground water extraction/treatment system. As part of this discussion, temporal trends in arsenic concentrations in monitoring wells are analyzed. Given that the current extraction system is not fully capturing the plume of landfill-impacted ground water, interpretation of these trends with respect to the possible influence of geogenic arsenic or potential remedial timeframes is speculative. The Army will be implementing modifications to the ATP treatment process this summer. Specifically, chlorine dioxide generation and addition to the ATP influent to oxidize and precipitate iron will be replaced with $KMnO_4$. As part of the development and comparative analysis of alternatives that includes continued ground water extraction and treatment, has the Army considered additional ATP modifications to reduce the significant volume of waste currently being generated and requiring off-site disposal? The Army should consider completing an engineering and cost evaluation for the addition of a sludge thickening and dewatering system. Significantly reducing the volume of waste requiring offsite transport and disposal could further reduce annual ATP O&M costs.	D	Temporal trends of arsenic concentrations were evaluated at locations selected by the USEPA in the *USEPA Scope of Work (SOW) Phase 2, Task 1 – Evaluate Remedy Performance, Task 1.a. Data Evaluation* , selected to evaluate performance of the ATP following 8+ years of active treatment. While Army agrees that there may be a portion of the arsenic plume not captured by the current two extraction well network, many of the locations at which trends were evaluated are located in areas where capture is occurring. These trends are worth considering when evaluating the suitability and potential success of future remedial alternatives on water quality. The Army has considered the addition of a sludge thickening and dewatering system, but is not able to install one at this time because the treatment system building is not large enough. This option will be considered as the remedy continues to be optimized.
2	Michael Daly		Section 4.2.3 – Cleanup Timeframe Estimate		Background chemical concentrations in ground water and the role of geogenic arsenic are not fully defined. Given the uncertainty of distinguishing ground water in the Northern Impact Area (NIA) that is impacted by the landfill versus potential geogenic sources, it is recommended that investigation of background include detailed characterization of water chemistry to facilitate multivariate statistical analysis that relies on objective, data-driven analysis.	A	The text will be updated to include additional details on the background study water chemistry analysis. As discussed, Army will share the results of the background study with regulators once the report is complete. The background study data collection has already occurred; the results will be based on the data collected during the study and supported by previously collected data at the same sampling locations.
3	Michael Daly		Section 4.2.3 – Cleanup Timeframe Estimate		On page 25, the following statement is made: "*Based on these performance results to date, as well as the presence of geogenic arsenic in groundwater under strongly reducing conditions (background arsenic concentrations in groundwater greater than the cleanup goals), it is expected that none of the remedial alternatives that are being evaluated in this FFS Report would be able to achieve restoration of the aquifer to the cleanup goals within 30 years.*" Please revise the statement to change "cleanup goals" to "current cleanup goals". Remedial timeframes for ground water beneath a waste management unit that represents a continuing source for down-gradient ground water contamination, such as a landfill, will often be significantly different than timeframes for remediation of ground water hydraulically down-gradient of the waste management unit. At many cleanup sites, this ultimately means that some form of containment may be necessary for greatly extended periods of time to allow effective remediation of down-gradient ground water due to limitations in technologies suitable for treatment of ongoing sources such as a landfill. Future discussions amongst the Army & regulators may benefit from this shift in SHL conceptual model.	A	The text will be revised to state "current cleanup goals". Army agrees that the remedial timeframe at SHL will be longer than for a typical remediation site, given the location of the landfill, the presence of the required landfill cap, and their effect on the redox state of the underlying aquifer. This condition and the limitations of available treatment technologies in this environment inhibit the efficacy of active treatment.
4	Michael Daly		Section 5.3 – Identification of Remedial Alternatives		The development of media-specific general response actions responsive to remedy RAOs (i.e., excavation, in-situ/ex-situ treatment, containment), along with the identification of technically practicable technologies applicable to these general response actions, precedes the development, screening, and comparative analysis of remedial alternatives in an FS. Did the Army consider other in-situ technologies that could be used alone or in combination with other approaches to accomplish site RAOs? For instance, passive in-situ oxygen diffusion technology, which relies on the installation of diffusers in wells to supersaturate ground water, have been used to enhance biodegradation of petroleum hydrocarbon-impacted contamination. This technology could be similarly deployed as presented for the conceptual in-situ air sparging (IAS) system but does not have some of the capital and O&M costs associated with IAS. Another potential in-situ technology that may have applicability in controlling the migration of SHL-impacted ground water are circulating wells (CW). CWs have been historically used to treat VOC-impacted ground water (e.g., AOC50 remedy). Air lift pumping of contaminated ground water drawn within a CW results in the mass transfer of VOCs from water to air via air stripping but also results in the oxygenation of this same ground water. The treated water is then reintroduced back into the aquifer through the CW creating a 3-dimension circulation pattern. It is requested that the revised FFS present this earlier alternative development step prior to Section 5.3. If this screening step has already been completed as part of an earlier Army document, a summary of this step should be included in the FFS text or added as an appendix to the document. On the last paragraph of this section, the following statement is made: "As discussed in Section 4.2.3, none of the remedial alternatives evaluated in this FFS Report would be able to achieve restoration of the aquifer to the cleanup goals within 30 years." Please revise the statement to change "cleanup goals" to "current cleanup goals".	A	The text will be updated to include a brief discussion of additional in-situ technologies that were considered but ultimately not retained for evaluation. The text will be revised to state "current cleanup goals".

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5	Michael Daly		Section 5.3.2 – Alternative 2 (Current SHL Remedy)		In the 1st paragraph of this section, the following statement is made: "This calculation assumes both that there is a finite source of arsenic in groundwater and that arsenic migrates from SHL as an advective plume, neither of which is true." Please reference the document in which technical analysis of site data was conducted and presented to support the statement that arsenic migrating within the overburden under the landfill cap is not an advective plume. In the 2nd paragraph of this section, the following statement is made: "As stated in Section 4.2, reducing conditions and the presence of geogenic arsenic in groundwater make treatment of groundwater to meet the cleanup goals impractical." Please revise the statement to change "cleanup goals" to "current cleanup goals". In the 3rd paragraph of this section, the following statement is made: "Groundwater flow and arsenic mass extracted by the ATP is greater than the amounts flowing northward under non-pumping conditions, indicating that the additional flow of groundwater and additional arsenic mass includes water and arsenic from the bedrock and from north of the pumping wells (as described in Section 4.2.2)." Please include in the revised FFS the results from the ground water flow model to document the volume of bedrock-derived ground water that is captured by extraction wells EW-04 and EW-01. Subsequently, please also evaluate and present in the revised FFS calculations to assess whether the concentrations of chemical constituents measured during the Fall 2021 LTM sampling event for extraction wells EW-04 and EW-01 align with the concentrations predicted by volumetric mixture of model-estimated volumes of overburden and bedrock ground water chemistry for monitoring wells within the model-estimated capture zone of the extraction wells. In the 5th paragraph of this section, the establishment of LUCs as required by the 2013 ESD is briefly discussed. It is suggested this paragraph be very briefly expanded to describe actions the Army takes to ensure the continued integrity and performance of LUCs as part of SHL remedy implementation and monitoring.	A	The first paragraph will be revised; rather than implying that the groundwater arsenic is "not an advective plume" and stating "neither of which is true," the point will be clarified that arsenic mobility is complicated by the anticipated sorptive retardation, as well as potential ongoing arsenic release from soils under reducing conditions. The text will be revised to state "current cleanup goals". As described in Technical Memo 5, if 5.1 gpm bypasses the ATP through the hypothetical bypass area, then only 34.2 gpm extracted by ATP system is from the landfill, and 15.9 gpm of the groundwater captured by the ATP originates from areas located downgradient of the extraction wells, cross-gradient (e.g., Shepley's Hill), or from bedrock beneath the system. The groundwater flow from the bedrock has not been specifically quantified. This explanation and reference will be added to the text. The estimated amount of bedrock groundwater captured by extraction wells for Alternatives 2 and 5 will be quantified using the approved groundwater model and described in Appendix E. The 2nd paragraph of Section 5.3.1 and the 4th paragraph of Section 5.3.2 will be expanded to include LUC activities the Army performs in accordance with the 2013 ESD.
6	Michael Daly		Section 5.3.3 – Alternative 3: Land Use Controls		The September 1995 SHL ROD established compliance boundary wells for the SHL waste management unit (i.e., Group 1 & Group 2 monitoring wells) at and beyond which SHL drinking water-based RGs are to be attained. The Army established LUCs to prevent uncontrolled human consumption and exposure to SHL-impacted ground water within the NIA. This alternative proposes the permanent re-classification of ground water at and beyond the SHL ground water RG compliance boundary, including residential- and commercial-owned properties within the NIA. Re-classifying this ground water would effectively exempt the Army from meeting drinking water-based (GW-1) standards. However, Figure F-1 in Appendix F identifies the SHL Ground Water LUC Area abutting a Zone 2 Wellhead Protection Area. Is there any reasonable likelihood for MassDEP to reclassify this ground water, so it does not need to meet GW-1 standards, given the nearby Zone 2 wellhead protection area? If this ground water reclassification is unlikely to be considered and approved by regulatory agencies, it is recommended this alternative be eliminated for consideration in the revised FFS.	C	Per the discussion with USEPA and MassDEP on August 31, 2023, Alternative 3 will remain a part of the FFS. The Army will include a technical rationale for the change in designation of SHL as a NPDWSA as an attachment to the Draft Final FFS.
7	Michael Daly		Section 5.3.4 – Alternative 4: In-Situ Air Sparging		EPA conceptually concurs with the Army that passive and/or active efforts to positively affect the SHL-impacted overburden geochemistry from anoxic, reducing conditions to more oxic conditions will result in the precipitation of redox-sensitive metals, and reduction of arsenic flux beyond the SHL boundary. The Army's IAS pilot test demonstrated the technology's ability to create favorable geochemical conditions within the aquifer where DO can be successfully distributed and sustained. These favorable conditions were pronounced within the shallower portions of the aquifer while distribution of DO deeper within the aquifer was less pronounced. Given the added uncertainty in distributing sufficient DO in the deeper portion of the aquifer during the pilot test, a more robust sparging well field would likely be needed in other areas where arsenic concentrations and reducing conditions are significantly greater than encountered within the pilot test area. Instead of or in addition to IAS beyond the northern toe of SHL, did the Army consider or evaluate "source" treatment of the aquifer withing the footprint of SHL? The proposed IAS array manages the migration of metals to the NIA but does not fundamentally address anoxic conditions beneath SHL that is solubilizing redox-sensitive metals.	A, C	The conceptual full scale IAS system presented in the FFS included tighter spacing of the deep sparge points in order to assist with distribution of dissolved oxygen in the deep overburden. Additional testing is warranted to refine the spacing required for the deep sparge points if air sparging is selected as an alternative. It is the Army's position that in-situ source treatment of the landfill mass via air-sparging is impractical given the amount of carbon present both in the deposited waste and in the buried swamp deposits, as well as the presence of the cap that creates an environment where reducing conditions are expected to be present indefinitely. In-situ source treatment of landfills is not in line with the USEPA Presumptive Remedy for CERCLA Municipal Landfill Sites guidance (1993), which establishes containment as the presumptive remedy. Source treatment of the landfill through reconsolidation and regrading has been examined as Alternative 7 in the FFS.
8	Michael Daly		Section 5.3.5 – Alternative 5A: Modified Ground Water Treatment		This alternative includes the addition of a third extraction well (EW-3) east of existing extraction well EW-1. SHL-impacted ground water in the vicinity of SHM-10-06 is not effectively controlled by the current extraction well network resulting in continued impacts down-gradient within the NIA. In addition to Appendix F Figure F-2 (conceptual plan view of 3rd extraction well location), it is suggested that EW-3 be presented in cross-section view by use of existing Figure 12 of the FFS. The design, development, and hydraulic testing of EW-3 will need to be completed to validate modeled assumptions and the associated performance/LTM/O&M plans will need to be revised to confirm the model-predicted expanded capture zone for the three-well array has been established and is maintained over seasonally variable hydrological conditions. EPA requests that the Army collaborate with the regulatory agencies on the design, construction, and hydraulic testing plans for EW-3.	A	The existing Figure 12 will be used as the basis for a new figure to be included in Appendix F that will show the location of EW-03. USEPA will be provided a copy of the work plan for the performance monitoring of the modified ATP for review. The performance monitoring will include analyses confirming the capture zone of the expanded system (3PE, vertical gradient calculation, groundwater flow maps, etc.).

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9	Michael Daly		Section 5.3.5 – Alternative 5B: Modified Ground Water Treatment		This alternative is identical to Alternative to 5A but reinjects ATP effluent back to the aquifer and down-gradient of the extraction wells with the goal of promoting more oxic aquifer conditions thereby improving precipitation and attenuation of arsenic-impacted ground water influenced by SHL. Effluent generated to date as part of ATP operations has been directed to a POTW for disposal. The proposed potential addition of jet pump injector or other method to further increase DO concentrations in the effluent would be a very simple but technically advantageous element to this alternative and would only result in minor additional capital and operational costs. The reinjection/recharge of treated water ground water back to the aquifer would potentially need to consider the concentrations of other comingled contaminants. Specifically, PFAS concentrations above MMCLs are present in ground water in the vicinity of SHL and has also been measured in ATP influent at concentrations approximately 2x the MMCL standard of 20 ng/l for six PFAS. Pre-treatment by liquid phase GAC or ion exchange resin filtration would be necessary to reduce concentrations down to MMCLs prior to aquifer re-infiltration down-gradient of the extraction well system. While technically practicable to reduce elevated PFAS concentrations, capital and O&M costs would make this alternative more expensive. In remedial alternatives 5A/5B, EW-03 may draw "cleaner" ground water from areas east of SHM-10-06A based on its proposed location and flow rate. Has the Army considered the installation of a five-well extraction network using wells EW-01, EW-03, EW-04, a well between EW-01 & EW-03, and a well west of EW-04? This would potentially provide a more flexible system for optimizing hydraulic capture seasonally, possibly allowing reduction of flow rates during dry periods, preventing the loss of capture between wells EW-01 and EW-03 during wet periods, and ensuring capture across the entire plume without unnecessarily treating large volumes of clean water.	A, C	The Army agrees any re-injection of water will be required to meet the treatability standards of the substantive provisions of an otherwise applicable permitting program. The three well extraction network was proposed as modeling predicts that a three well network will generate a capture zone that covers the entire area of interest. The two well system has been successfully operated over time and has only shown a minor change in capture zone between wet and dry seasons (see *Final Phase I EPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data* [a.k.a. Technical Memo 1; S-A JV June 2021], *Final Phase I USEPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 2.d Delineate Lateral and Vertical Extent Upgradient* [a.k.a. Technical Memo 2; S-A JV August 2021], and *Final Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 5.e, Validate the Extent of Capture by Evaluating Concentration Trends in NIA Monitoring Locations as Compared to Flow Paths Developed from the Updated Groundwater Flow Model* [a.k.a. Technical Memo 5; S-A JV December 2021]). Based on the previously submitted Technical Memorandums, a five well system would not be necessary in order to facilitate plume capture.
9 (cont'd)					Alternative 5B uses reinjection of treated water to enhance both capture and down-gradient remediation. To allow better evaluation of this system, forward particle tracking from the injection wells should be included in Figure 4 of Appendix E. Has the Army considered other areas of the SHL site where aquifer re-injection could be hydraulically and/or geochemically beneficial in meeting SHL RAOs? If this has not been considered but could be a feasible remedial component to one or more of the alternatives evaluated in the draft FFS, this could be discussed in greater detail amongst the Army, MassDEP, and EPA.	A	A figure showing forward particle tracking from the injection wells will be added to the document as Figure 5 (Figure 5 in the current version will be renumbered to Figure 6). Additional injection locations were modeled (both upgradient and cross-gradient locations), however those locations reduced groundwater capture at the extraction wells. A brief summary of the additional injection locations that were modeled will be added to the text. A figure showing the simulations can be shared as well.
10	Michael Daly		Section 5.3.6 – Alternative 6: Ground Water Extraction / Treatment & IAS		Did the Army consider the incorporation the re-infiltration of treated ground water as part of Alternative 6 development? Please explain in the revised text.	A	Alternative 6 includes IAS in lieu of groundwater infiltration to add dissolved oxygen to the aquifer and promote restoration. IAS allows for a much greater amount of oxygen to be delivered to the aquifer than injection of treated water. This note will be added to the text.
11	Michael Daly		Section 5.3.7 – Alternative 7: Landfill Consolidation and IAS along Devens Boundary		1.1 million cubic yards, making up approximately the northern half of SHL would be excavated, reconsolidated on top of the southern half of SHL and covered with a geomembrane liner and soil cover. This reconsolidated volume would have 4:1 side slopes and cover approximately 31 acres. The northern excavated area would then be backfilled up to one foot above the water table. Did the Army consider a more limited reconsolidation of regularly & seasonally saturated waste beneath the current cover system? This approach could achieve the same result as Alternative 7 but with potentially lower cost. This alternative could be divided into "part A" with saturated material reconsolidation and "part B" with reconsolidation of the complete 1.1 million yd3 making up the northern half of SHL. Has the Army evaluated the potential advantages and disadvantages of altering portions of the existing SHL cover system to allow for the infiltration of precipitation thereby creating more oxic ground water conditions within SHL to reduce the mobilization of redox-sensitive metals? If this approach has potential technical merit, a dialogue amongst Devens BCT should be convened to discuss this in greater detail.	D	Solids samples collected within the landfill footprint and analyzed for arsenic in 2010 generally had the greatest arsenic concentrations 10s of feet lower than the anticipated bottom of the landfill waste, in deep overburden and/or glacial till above bedrock (see the August 2011 report *Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-Term Monitoring and Maintenance - Addendum Report* by Sovereign Consulting Inc.). The landfill waste does not appear to be a primary continuing source of arsenic to groundwater. Consolidation efforts were considered with the objective of reducing the size of the landfill cap, rather than to remove saturated waste. Alternative 7 would greatly reduce the size of the landfill cap and includes proper management of the waste solids that would be removed under that scenario. This would create more oxic groundwater conditions over time and reduce mobilization of redox-sensitive metals over a period of many years.
12	Michael Daly		Section 6.1.1 – Threshold Criteria & Table 3 – ARARs Table		To fully assess an alternative's compliance with ARARs, the FFS should be revised to include the identification of action-, location-, and chemical-specific ARARs for each of the six "active" alternatives presented in the draft FFS. Alternative 2 (current SHL remedy) would not require the creation of new tables but it is recommended that the tables from SHL decision documents be included in the FFS for completeness.	A	The Army will comply with the NCP in identifying ARARs as part of the feasibility study process (40 CFR 300.430(e)(1)(i)(A)) and evaluating the alternatives against the potential ARARs (40 CFR 300.430(e)(9)(iii)(B)). Additionally, the ARAR guidance provided in the 1991 EPA document "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" will be utilized.
13	Michael Daly		Section 6.2.1.1 – No Action, Long-Term Effectiveness & Permanence		Town ordinances, such as moratoriums on ground water well installations can be allowed to lapse, be vacated, or no longer enforced by a municipality. This should be noted in this section.	A	The text will be updated to include details on active periods/expiration dates for the Moratorium on Groundwater Wells in the Town of Ayer, dated May 6, 2013 and amended May 20, 2013.
14	Michael Daly		Section 6.2.2.2 – Compliance with ARARs		Please see comment #12 above.	A	Please see the response to Comment #12 above.

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15	Michael Daly		Section 6.2.3 – Alternative 3		Please see comment #6 above.	A	Please see the response to Comment #6 above.
16	Michael Daly		Section 6.2.4 – Alternative 4, ¶2		Please briefly explain the technical basis for pulsed operation of the conceptual IAS system instead of continuous operation, at least in the start-up and early operational phases of IAS implementation and associated performance monitoring.	A	Pulsed operation is a best practice used in air sparging systems and has many benefits over continuous operation. It minimizes the potential for formation of air channels to form impacting the ability of an IAS to effectively distribute dissolved oxygen, while reducing the amount of electricity required for operation. Chapters 2 and 6 of the USACE In-Situ Air Sparging Engineer Manual describe the value of pulsed operation (https://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_200-1-19.pdf?ver=eJhb4sOF0lsD_T47TxjGBA%3d%3d). The amount of dissolved oxygen necessary to promote and maintain oxic conditions in the aquifer is easily provided with the amount of oxygen injected through pulsed operation. This information will be added to the text.
17	Michael Daly		Section 6.2.4.2 – Alternative 4 Compliance with ARARs		Please see comment #12 above.	A	Please see the response to Comment #12 above.
18	Michael Daly		Section 6.2.5.2 – Alternative 5A Compliance with ARARs		Please see comment #12 above.	A	Please see the response to Comment #12 above.
19	Michael Daly		Section 6.6 – Alternative 5B		As identified in comment #9 above, pre-treatment to address PFAS concentrations above MMCLs would be necessary before reinjecting/reinfiltrating ATP-treated ground water down-gradient of the extraction well system.	A	Please see the response to Comment #9 above.
20	Michael Daly		Section 6.2.6.2 – Alternative 5b Compliance with ARARs		Please see comment #12 above.	A	Please see the response to Comment #12 above.
21	Michael Daly		Section 6.2.6.3 – Long-term Protectiveness & Performance of Alternative 5A		The following statement is made: "*Discharge of groundwater from mineralized bedrock zones will continue to contribute dissolved arsenic to the overburden within the NIA and naturally occurring arsenic present in overburden soils will continue to be mobilized due to naturally reducing conditions associated with the presence of wetlands in that area.*" To support assessment of the potential source of elevated arsenic in overburden within the NIA, it is recommended that a thorough analysis of ground water data collected during profile sampling be undertaken. The lateral and vertical density of data from the various investigation efforts conducted since 2010 should be sufficient to map out potential correlations (or not) with chemical signatures of ground water underneath the landfill and/or bedrock. Presently, there are several monitor wells within the nearfield NIA that are positioned within an area of low ground water flow gradients due to the influence of the extraction system. This portion of the aquifer likely experiences minimal flushing and limited influx of oxygen at depth. In the absence of a more detailed forensic analysis that can help differentiate SHL versus geogenic impact, statements concerning long-term effectiveness and permanence are speculative.	A	The language in this section has been revised to state that it is "anticipated" or "likely" that mineralized bedrock zones and naturally reducing overburden zones will continue to contribute dissolved arsenic, rather than stating that this "will" occur. These will be revisited as suggested; however, correlations with chemical signatures have been made and are discussed in Section 4.1.2. The results clearly demonstrate that arsenic concentrations in overburden are correlated to elevated iron and manganese and decreased dissolved oxygen; however, this is not sufficient to quantitatively differentiate geogenic vs. SHL arsenic, particularly since landfill impacts also exhibit a reducing signature. The data analyses presented also demonstrate that bedrock groundwater itself exhibits high arsenic with relatively low iron and manganese (due to the differing geochemical release mechanisms), but it is complicated as this water migrates into the reducing zone of the overburden; since arsenic, iron, and manganese are not anticipated to be conservative, we do not necessarily expect that a simple mixing model (for example) can be used to quantify the percentage of bedrock arsenic present in overburden groundwater at a given location.
22	Michael Daly		Section 6.2.7.2 – Alternative 6 Compliance with ARARs		Please see comment #12 above.	A	Please see the response to Comment #12 above.
23	Michael Daly		Section 6.2.8.2 – Alternative 6 Compliance with ARARs		Please see comment #12 above.	A	Please see the response to Comment #12 above.
24	Michael Daly		Section 6.2.9 – Comparison of Alternatives & Table 6		Alternatives 2 and 5A as "Low" for Reduction of Mobility, Toxicity, or Volume through Treatment. This rating understates the value that the containment of the contaminant plume has in reducing contaminant concentrations down-gradient of the system based on historical data. As stated in the FFS, much of the arsenic in groundwater impacted by the landfill is captured and treated by the existing system even though the system currently does not appear to provide complete containment. It is recommended that the rating of these alternatives be increased to a "Moderate" ranking.	C	Per the discussion with the USEPA on August 31, 2023, the ratings for these two alternatives for "Reduction of Mobility, Toxicity, or Volume through Treatment" will be revised to be Low to Moderate.
25	Joanne Dearden	5, 29	Section 1.2.1.3, Section 5.3.3		While MassDEP agrees that Shepley's Hill Landfill (SHL) could be reclassified from a "grassland" to a "landfill", MassDEP disagrees that the area surrounding SHL meets the criteria allowed for the exemption in the Non-Potential Drinking Water Source Areas Policy WSC-97-701. The area mapped as NPDWSA does not abut SHL, as SHL is bordered by areas mapped as forest. A portion of SHL is also mapped as a Zone II Wellhead Protection Area. Given that a portion of the Zone II extends onto SHL and that the NPDWSA does not border or completely surround SHL, SHL does not meet the requirements to be exempt from meeting GW-1 standards.	C	Per the discussion with USEPA and MassDEP on August 31, 2023, Alternative 3 will remain a part of the FFS. The Army will include a technical rationale for the change in designation of SHL as a NPDWSA as an attachment to the Draft Final FFS.

Comments on the							
Focused Feasibility Study Report, January 26, 2023							
Response Code: A = Agree with comment D = Disagree with comment C = Comment requires clarification							
Comment Number	**Commenter**	**Page(s)**	**Section**	**Line(s)**	**Comment**	**Response Code**	**Response**
26	MassDevelopment				Discussion of contaminant fate and transport in the FFS report appears to be focused on potential discharge of arsenic into Nonacoicus Brook. Given the Brook is a shallow water body within a deep aquifer, and the NIA is upgradient of the McPherson Well Zone II (the well's predicted capture zone under long term operating conditions), MassDevelopment requests additional information on the potential for arsenic to migrate from the NIA beyond Nonacoicus Brook and toward McPherson Well. Of particular interest would be groundwater quality data from discrete intervals at depths within the aquifer that are below the estimated zone of discharge contributing to Nonacoicus Brook.	A	In response to discussions regarding this comment at the June 28, 2023 technical meeting, the Army provided the Final Shepley's Hill Landfill Supplemental Groundwater and Cap Assessment Addendum for Long-Term Monitoring and Maintenance -Addendum Report dated August 2011 via email on August 25, 2023, to MassDevelopment and the agencies. This report includes cross sections with data collected east of the Zone II for MacPherson well, which suggests arsenic is not migrating to the MacPherson Well.

COMMENTS PROVIDED BY

Date	Name	Department/ Organization	Email Address	Phone Number
6/2/2023	Michael Daly	USEPA		(617) 918-1386
5/12/2023		MassDevelopment		
6/26/2023	Joanne Dearden	MassDEP		

Subject: RE: Shepley's Hill Landfill FFS Appendix G Rationale

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From: Dearden, Joanne (DEP) <joanne.dearden@mass.gov>
Sent: Thursday, December 7, 2023 3:21 PM
To: Lineer, Thomas A CIV USARMY HQDA DCS G-9 (USA) <thomas.a.lineer.civ@army.mil>; Reddy, Penelope W CIV USARMY CENAE (USA) <PENELOPE.W.REDDY@usace.army.mil>
Cc: Baxter, Diane (DEP) <Diane.Baxter@mass.gov>; Daly, Michael <Daly.Mike@epa.gov>; Lowry, Shawn (he/him/his) <Lowry.Shawn@epa.gov>
Subject: [Non-DoD Source] RE: Shepley's Hill Landfill FFS Appendix G Rationale

Tom,

As stated in my previous emails and during our meeting on August 31, 2023, the Massachusetts Department of Environmental Protection has made the determination that the Shepley's Hill Landfill (SHL) does not meet the criteria, as outlined in the MassDEP Policy WSC-97-701 *Determining Non-Potential Drinking Water Source Areas*, to be classified as a Non-Potential Drinking Water Source Area (NPDWSA). Therefore, the groundwater at SHL cannot be reclassified from a Current or Potential Drinking Water Source Area to a Non-Potential Drinking Water Source Area. Since this reclassification of groundwater cannot occur under existing state regulations and policy, *Remedial Alternative 3*, in the SHL Draft Focused Feasibility Study (FFS) is not a viable alternative to consider in the FFS, as it cannot be implemented and wouldn't meet the Remedial Action Objects (RAO) identified in the 1995 Record of Decision (ROD) and subsequent Explanation of Significant Differences (ESDs). *Alternative 3* relies on the reclassification of groundwater at and immediately downgradient from SHL to GW-3 in order to fully implement the alternative and achieve the RAO. Therefore, *Alternative 3* should be removed from the FFS.

In regards to the information presented in both the *Draft Focused Feasibility Study* and *Appendix G Draft Non-Potential Drinking Water Source Area Reclassification Rationale* MassDEP has determined that the Army has incorrectly interpreted MassDEP's Policy WSC-97-701 *Determining Non-Potential Drinking Water Source Areas*. MassDEP has provided the basis for our determination in emails dated June 26, 2023 and December 5, 2023 as well as during the August 31, 2023 meeting. MassDEP will again be providing the Army our determination in a letter, which is forthcoming.

Thank you,

Joanne

Joanne Dearden
Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup
100 Cambridge Street, Suite 900

Boston, MA 02114

Cell: 781-407-1595

From: Lineer, Thomas A CIV USARMY HQDA DCS G-9 (USA) <thomas.a.lineer.civ@army.mil>
Sent: Thursday, December 7, 2023 7:26 AM
To: Dearden, Joanne (DEP) <joanne.dearden@mass.gov>; Reddy, Penelope W CIV USARMY CENAE (USA) <PENELOPE.W.REDDY@usace.army.mil>
Cc: Baxter, Diane (DEP) <Diane.Baxter@mass.gov>; Daly, Michael <Daly.Mike@epa.gov>; Lowry, Shawn (he/him/his) <Lowry.Shawn@epa.gov>
Subject: RE: Shepley's Hill Landfill FFS Appendix G Rationale

Joanne:

Thank you for MassDEP comments on *Alternative 3: Land Use Controls* from consideration in the *Draft Focused Feasibility Study Report*.

The Army and MassDEP disagree on whether Shepley's Hill Landfill meets the criteria allowed for the exemption in the Non-Potential Drinking Water Source Areas Policy WSC-97-701 due to it being a landfill, meeting the size requirement, and being encircled by other NPDWSAs that are in closer proximity to supply wells than SHL. These details were discussed at the meeting on August 31, 2023, and were summarized in the technical rationale provided in Appendix G.

The Army does not have a basis to remove *Alternative 3* from the FFS as recommended by MassDEP. The inclusion criteria for alternatives is to assess potential remedies. *Alternative 3* is a potential remedy regardless of the foregoing Army and MassDEP disagreement. Thus, *Alternative 3* should be included and documented in the FFS.

If you would like to discuss further, please let us know.

v/r

Tom

Thomas Lineer

BRAC Program Manager

HQDA/ODCS G-9

From: Dearden, Joanne (DEP) <joanne.dearden@mass.gov>
Sent: Tuesday, December 5, 2023 3:15 PM
To: Lineer, Thomas A CIV USARMY HQDA DCS G-9 (USA) <thomas.a.lineer.civ@army.mil>; Reddy, Penelope W CIV USARMY CENAE (USA) <PENELOPE.W.REDDY@usace.army.mil>
Cc: Baxter, Diane (DEP) <Diane.Baxter@mass.gov>; Daly, Michael <Daly.Mike@epa.gov>; Lowry, Shawn (he/him/his) <Lowry.Shawn@epa.gov>
Subject: [Non-DoD Source] Shepley's Hill Landfill FFS Appendix G Rationale

Tom,

MassDEP has reviewed the Army's *Appendix G Draft Non-Potential Drinking Water Source Area Reclassification Rationale*. MassDEP reiterates that it does not concur with the Army's conclusion that Shepley's Hill Landfill meets the criteria allowed for the exemption in the Non-Potential Drinking Water Source Areas Policy WSC-97-701. As stated in Section 2.0 of WSC-97-701 "the NPDWSA criteria and this policy are not applicable within a Current or Potential Drinking Water Source Area as defined in the MCP (310 CMR 4.0006)". Therefore the portions of SHL and the areas surrounding SHL to the west and south/southeast mapped as Zone II Wellhead Protection Areas are not classified as a NPDWSA. While the MassGIS MassMapper may identify both GIS layers (i.e. both the Zone II and the Medium and High Yield NPDWSAs), the areas in which the Zone II overlays the NPDWSA would not be classified as a NPDWSA. As stated in Section 5.0 of the WSC-97-701 Policy the resource maps are only intended to be used as a guide and that actual site specific information should be the basis for determining if the area actually meets the NPDWSA definition.

Taking into consideration the Zone II Wellhead Protection Areas, SHL is not "encircled" by NPDWSAs.

Also, while the Army mentions groundwater exceedances of GW-1 standards for naturally occurring arsenic at Shepley's Hill and contaminants in the area of Plow Shop Pond, the WSC-97-701 does not take into consideration the groundwater quality of the underlying aquifer in classifying an area as a NPDWSA. The policy uses current land use activities as the criteria to establish NPDWSA status.

Given the above information, MassDEP requests that the Army remove *Alternative 3: Land Use Controls* from consideration in the *Draft Focused Feasibility Study Report*.

If you have any questions, or would like to discus please let me know.

Thank you,

Joanne

Joanne Dearden
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