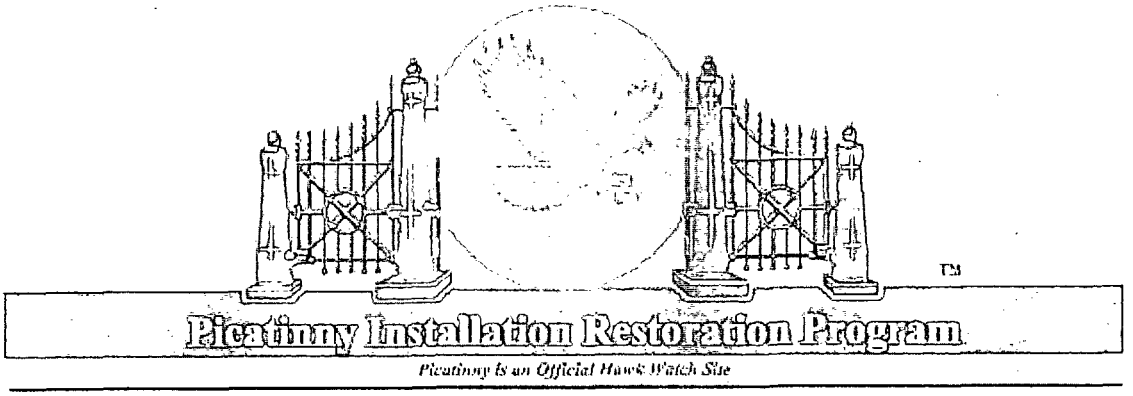

RECORD OF DECISION
AREA E GROUNDWATER AND SITE 22
(BUILDING 95 IMPOUNDMENT AREA)
FINAL

PICATINNY ARSENAL
NEW JERSEY

FINAL

JULY 2007

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LIST OF ACRONYMS

µg/L .....micrograms per liter
1,1-DCA ...1,1-dichloroethane
1,1-DCE ...1,1-dichloroethene
1,1,1-TCA.1,1,1-trichloroethane
1,2-DCE ...1,2-dichloroethene
AEDB-R....Army Environmental Data Base-Restoration
AOC.....area of concern
AR .....Army Regulation
ARAR .....Applicable or Relevant and Appropriate Requirement
ARDEC.....Armament Research Development and Engineering Center
Army.....United States Department of the Army
AUF .....area use factor
AWQC .....Ambient Water Quality Criteria

bgs.....below ground surface
BSB .....Bear Swamp Brook

CDI .....chronic daily intake
CEA.....Classification Exception Area
CERCLA...Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS..Comprehensive Environmental Response, Compensation, and Liability Information System
COC .....Contaminant of Concern
COPC.....Constituent of Potential Concern
COPEC.....Constituent of Potential Ecological Concern
CR .....cancer risk

DCSCC ....Direct Contact Soil Cleanup Criteria
DDT.....dichlorodiphenyltrichloroethane
DGI.....Data Gap Investigation
DNAPL .....dense non-aqueous phase liquid
DSERTS...Defense Site Environmental Restoration Tracking System

ER,A.....Environmental Restoration, Army
ERA.....ecological risk assessment

FSAC.....Fire Support Armament Center
FS.....Feasibility Study

ft.....feet
ft/day .....feet per day
ft/ft.....feet per foot

GAC .....granular activated carbon
GIS.....geographic information system
GPB .....Green Pond Brook

HEAST.....Health Effects Assessment Summary Tables
HHRA.....human health risk assessment
HI .....Hazard Index
HQ.....Hazard Quotient

IAG.....Interagency Agreement
ICFKE .....ICF Kaiser Engineers
IRIS.....Integrated Risk Information System
IRP.....Installation Restoration Program
ISCO .....In-Situ Chemical Oxidation

LOC.....level of concern
LUC.....Land Use Control

MADEP ....Massachusetts Department of Environmental Protection
MCL .....maximum contaminant level
mg/kg .....milligrams per kilogram
MNA.....monitored natural attenuation
msl .....mean sea level

NCEA.....National Center for Environmental Assessment
NCP .....National Oil and Hazardous Substances Contingency Plan
NJ.....New Jersey
NJDEP .....New Jersey Department of Environmental Protection
NOAEL.....no observed adverse effect level
NPL .....National Priorities List

O&M.....Operation and Maintenance
OSHA.....Occupational Safety and Health Administration

PADEP.....Pennsylvania Department of Environmental Protection
PCB.....polychlorinated biphenyl
PCE.....tetrachloroethene
PEL .....potential effects level
PMW.....performance monitoring well
PQL.....practical quantitation limit

RAB.....Restoration Advisory Board
RAGS.....Risk Assessment Guidance for Superfund
RAO.....Remedial Action Objective
RBCL.....risk-based cleanup level
RCRA.....Resource Conservation and Recovery Act
RfD.....reference dose
RI.....Remedial Investigation
RME.....reasonable maximum exposure
RMP.....Risk Management Plan
ROD.....Record of Decision

SARA.....Superfund Amendments and Reauthorization Act of 1986
SCL.....site cleanup level
SF.....slope factor
SVE.....soil vapor extraction
SWML.....surface water monitoring location
SWQC.....Surface Water Quality Criteria

TAPP.....Technical Assistance for Public Participation
TCE.....trichloroethene

USACE.....United States Army Corps of Engineers
USEPA.....United States Environmental Protection Agency
USGS.....United States Geological Survey
UST.....underground storage tank

VC.....vinyl chloride
VOC.....volatile organic compound

WAC.....Washington Administrative Code
WES.....Waterways Experiment Station
WRA.....Well Restriction Area

1.0 PART 1: DECLARATION

1.1 SITE NAME AND LOCATION

Picatinny Arsenal is formally designated as U.S. Department of the Army (Army) Installation Management Agency Northeast Regional Garrison Office. It is located in North Central New Jersey (NJ) in Morris County near the city of Dover. The facility was included on the National Priorities List (NPL) in March of 1990 and assigned a Comprehensive Environmental Response, Compensation and Liability Identification System (CERCLIS) number of NJ3210020704.

This Record of Decision (ROD) specifically addresses groundwater contamination at Area E, and soil, sediment, and surface water at Site 22 - Building 95 Impoundment Area (Site 22). The Army maintains a comprehensive database of sites that are being addressed within its Installation Restoration Program (IRP) called Army Environmental Data Base-Restoration (AEDB-R). Area E groundwater and Site 22 are designated in the AEDB-R as PICA-077 and PICA-010, respectively. The remaining areas in Picatinny Arsenal are being addressed as separate actions.

1.2 STATEMENT OF BASIS AND PURPOSE

This ROD presents the selected remedies for Area E groundwater and Site 22 located in Picatinny Arsenal in Rockaway Township, NJ. The remedial actions are selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and to the greatest extent possible, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The information supporting the decisions on the selected remedial actions is contained in the administrative record file for the site. These decisions have been made by the Army and the U.S. Environmental Protection Agency (USEPA). Comments received from the NJ Department of Environmental Protection (NJDEP) were evaluated and considered in selecting the final remedies. NJDEP concurs with the selected remedy. The remedial action for Area E groundwater is being undertaken to protect human health and the environment from contaminant concentrations in excess of groundwater standards. The remedial action for Site 22 is being undertaken based on subsurface soil exceedances of NJDEP non-residential standards.

1.3 ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect public health and welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The remediation of Area E groundwater and Site 22 is part of a comprehensive environmental investigation and remediation process currently being performed at Picatinny Arsenal. The remaining sites in Picatinny Arsenal are being considered separately and remedies for these areas are presented in separate documents.

The Feasibility Study (FS) identified chlorinated volatile organic compounds (VOCs) as the contaminants of concern (COCs) targeted for remediation in Area E groundwater. The extent of groundwater contamination at Area E that exceeds the remediation goals covers an area of approximately 33 acres within Area E which is 38 acres in size. No COCs were identified for surface and subsurface soil at Site 22. Metals were identified as COCs in sediment and surface water at Site 22. The remedial alternatives selected to protect human health for Area E groundwater and Site 22 consist of the following components:

- Demonstration of monitored natural attenuation (MNA) through the implementation of long-term groundwater and surface water monitoring, primarily for natural attenuation parameters to verify the progress of natural attenuation.

- Use of the existing Classification Exception Area (CEA) / Well Restriction Area (WRA). The CEA mandates that any proposed groundwater use within the WRA will require review and approval to implement modifications that would be protective of any impacts from identified contaminants for the duration of the CEA.
- Implementation of land use controls (LUCs) to ensure protectiveness that include land use and access restrictions, public education, and emergency provisions throughout the entire duration of MNA implementation.
- Ensuring that no land use of Site 22 occurs which is inconsistent with the land use control objectives until such time as the site conditions are protective.
- Performance of five-year reviews in accordance with CERCLA and the NCP.
- Development of a remediation exit strategy to determine when monitoring efforts should be reevaluated, modified, or discontinued.

The objective of the actions described in this ROD is to ensure site conditions are protective of human health and the environment. The response actions will accomplish the objective. Soils at Site 22 are not a principal threat waste or primary/secondary source to groundwater. Subsurface soils at Site 22 with residual contamination are buried beneath seven feet of clean fill material and there has been regulatory closure for soils under the RCRA program. No principal threat wastes remain at Site 22/Area E in any environmental media. Principal threat wastes from these sites were removed as part of Resource Conservation and Recovery Act (RCRA) closure activities completed in the early 1990s. The remedial action will be considered complete upon agreement with the USEPA Region 2 and Picatinny Arsenal. Upon agreement that remediation is complete, long-term monitoring will be discontinued per an agreed-upon exit strategy and documented in the next 5-year review. LUCs will be continued and 5-year reviews will be performed for Area E and Site 22 until contaminant levels are shown to allow unrestricted use and exposure.

1.5 STATUTORY DETERMINATIONS

The selected remedies are protective of human health and the environment, comply with Federal and State laws and regulations that are applicable or relevant and appropriate to the remedial actions, and are cost effective.

The Selected Remedy for Area E groundwater uses passive treatment to address the remaining mobilized contamination. The Selected Remedy provides an optimal implementation time frame commensurate with an effective use of funding; therefore, it is much more cost effective than the technologies that utilize active treatment.

NJDEP and USEPA representatives concluded that active remediation was not warranted for sediment and surface water at Site 22. However, a passive response action involving the use of institutional controls is necessary to maintain protectiveness under potential future use scenarios. Residential land use of the site is not anticipated, so potential risk to residential receptors has not been evaluated for Site 22. The Selected Remedy for Site 22 (LUCs) is capable of meeting the remedial goals for the site.

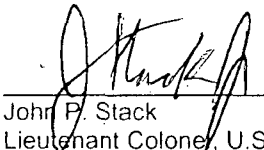
Because these remedies will result in hazardous substances remaining on site for a period of time above levels that allow for unlimited use and unrestricted exposure, five-year reviews will be conducted in compliance with CERCLA and the NCP to ensure that the remedy is and will be protective of human health and the environment.

1.6 RECORD OF DECISION DATA CERTIFICATION CHECK LIST

The following information is included in the Decision Summary (Section 2.0) of this ROD. Additional information can be found in the Administrative Record for this site.

Criterion	Section	Page Number
Chemicals of Concern and Their Respective Concentrations	2.8.1.1	2-22
Cleanup Levels Established for Chemicals of Concern and the Basis for These Levels	2.8.1.1	2-22
Current and Reasonably Anticipated Future Land Use Assumptions and Current and Potential Future Beneficial Uses of Groundwater Used in Baseline Risk Assessment and ROD	2.7	2-21
Baseline Risk Represented by the Chemicals of Concern	2.8.1.4	2-25
How Source Materials Constituting Principal Threats will be Addressed	2.12	2-43
Selected Remedy: Description, Estimated Capital, Annual Operation and Maintenance (O&M) and Total Present Worth Costs, Discount Rate, and the Number of Years Over Which the Remedy Cost Estimates are Projected	2.13.3	2-47
Key Factors Leading to Selection of Selected Remedy	2.13.1	2-43

1.7 AUTHORIZING SIGNATURE



24 Jul 07

John P. Stack
Lieutenant Colonel, U.S. Army
Garrison Commander

Date

9/28/07

George Pavlou, Director
Emergency and Remedial Response Division
United States Environmental Protection Agency, Region 2

Date

2.0 PART 2: DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

Picatinny Arsenal, located in Rockaway Township, NJ is listed on USEPA's Superfund NPL. The CERCLIS identification number is NJ3210020704. The Army is the lead agency for the remedial actions at Area E and Site 22 portions of Picatinny Arsenal and USEPA Region 2 is the support agency with oversight responsibilities. Plans and activities are also being coordinated with the appropriate NJ State agencies, including the NJDEP. The funding for this action will be provided from the Environmental Restoration, Army (ER,A) account.

Picatinny Arsenal is located approximately four miles north of the City of Dover in Rockaway Township, Morris County, NJ. The location of Picatinny Arsenal is presented on **Figure 1**. Some of the nearby populous areas are Morristown, Morris Plains, Parsippany, Troy Hills, Randolph Township, and Sparta Township. The Picatinny Arsenal land area consists of 6,491 acres of improved and unimproved land. Picatinny Arsenal is situated in an elongated classic U-shaped glacial valley, trending northeast-southwest between Green Pond Mountain and Copperas Mountain on the northwest and an unnamed hill on the southeast. Most of the buildings and other facilities at Picatinny Arsenal are located on the narrow valley floor or on the slopes along the southeast side.

This ROD describes the preferred remedies to address elevated concentrations of chlorinated VOCs that are present in groundwater at Area E and with elevated concentrations of metals that are present in surface water and sediment at Site 22. Soils at Site 22 are not a principal threat waste or primary/secondary source to groundwater. Subsurface soils at Site 22 with residual contamination are buried beneath seven feet of clean fill material and there has been regulatory closure for soils under the RCRA program. Area E is approximately 38 acres in size and is located in the south-central portion of Picatinny Arsenal. Area E borders Third Avenue to the northwest, Bear Swamp Brook (BSB) to the northeast, and Green Pond Brook (GPB) to the southeast. Area E consists of four study sites: Site 22 (Building 95 Impoundment Area), Defense Site Environmental Restoration Tracking System (DSERTS) site PICA-010; Site 28 (Sewage Treatment Plant Sludge Beds), DSERTS site PICA-070; Site 38 (Building 95, Printed Circuit Board Manufacturing Operations Treatment Facility), DSERTS site PICA-077; and Site 44 (Building 39, Golf Course Maintenance Shop), DSERTS site PICA-083. This ROD addresses groundwater in all of Area E. Therefore all groundwater concerns associated with these sites are addressed in this ROD. However, Area E groundwater is predominantly impacted by waste disposal practices associated with Site 38 and Site 22.

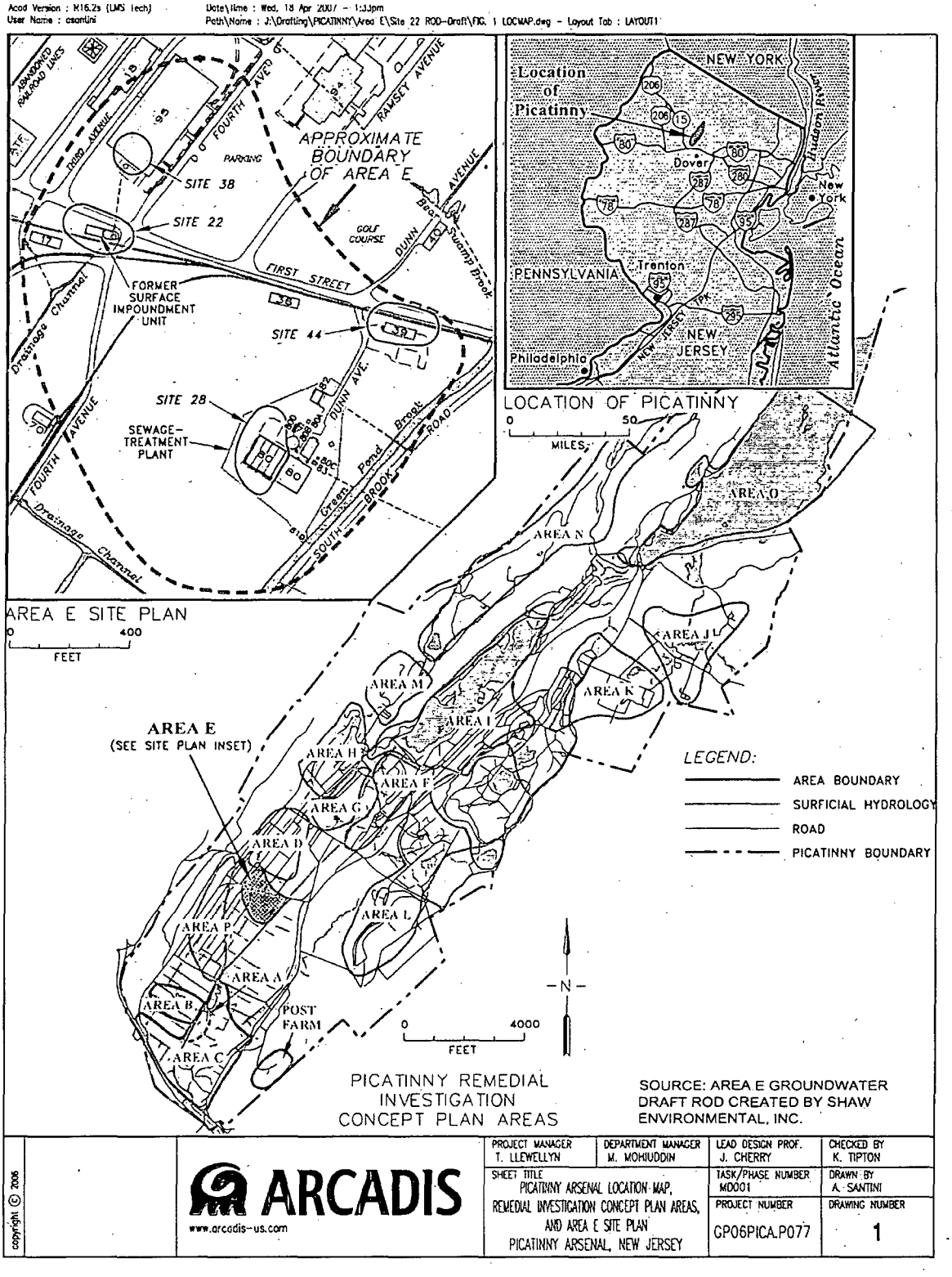
Site 22 is located in the western portion of Area E at Picatinny Arsenal. Site 22 consists of an area, less than one acre in size, where two unlined sand filter lagoons and one unlined sludge drying bed (jointly referred to as the surface impoundment unit) were formerly located. The surface impoundment unit is located 250 feet (ft) southwest of Building 95 between First Street and Third Avenue at Fourth Avenue. **Figure 1** presents the location and site plan of Area E, including Site 22.

The remedial actions presented in this ROD were selected by the Army, in partnership with USEPA Region 2 in accordance with CERCLA, as amended by the SARA, and to the greatest extent possible, the NCP. NJDEP concurs with the selected remedies. The remedial action is funded by the Army and was selected in accordance with Army Regulation (AR) 200-1, Environmental Protection and Enhancement, as applicable.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.2.1 Operational History

Building 95 was constructed in April 1961 as a two-story, concrete block building resting on a reinforced concrete foundation. Building 95 was initially constructed to replace the metal plating operations at Building 24; however, due to the demand for weapons systems, printed circuit board operations were initiated instead. The printed circuit board manufacturing operations continued until 1988. The Armament Engineering Division has occupied the southern portion of Building 95 since the completion of its construction. This division has housed multi-faceted operations that included research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ABANDONED RAILROAD LINES
THIRD AVENUE
FOURTH AVENUE
RAMSEY AVENUE
PARKING
APPROXIMATE BOUNDARY OF AREA E
SITE 38
SITE 22
GOLF COURSE
DUNN AVENUE
Brook
Swamp Brook
FIRST STREET
FORMER SURFACE IMPOUNDMENT UNIT
Drainage Channel
SITE 44
SITE 28
SEWAGE-TREATMENT PLANT
DUNN AVE.
Brook
ROAD
Pond
GREEN BROOK
SOUTH
FOURTH AVENUE
Drainage Channel
AREA E SITE PLAN
0
400
FEET
Location of Picatinny
NEW YORK
Dover
New York
Hudson River
PENNSYLVANIA
Trenton
NEW JERSEY
Philadelphia
Atlantic Ocean
LOCATION OF PICATINNY
0
50
MILES
AREA O
AREA N
AREA J
AREA K
AREA M
AREA I
AREA H
AREA F
AREA G
AREA D
AREA E
(SEE SITE PLAN INSET)
AREA L
AREA P
AREA A
AREA B
AREA C
POST FARM
LEGEND:
AREA BOUNDARY
SURFICIAL HYDROLOGY
ROAD
PICATINNY BOUNDARY
-N-
0
4000
FEET
PICATINNY REMEDIAL INVESTIGATION CONCEPT PLAN AREAS
SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.
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ARCADIS
www.arcadis-us.com
PROJECT MANAGER T. LLEWELLYN
DEPARTMENT MANAGER M. MOHIUDDIN
LEAD DESIGN PROF. J. CHERRY
CHECKED BY K. TIPTON
SHEET TITLE PICATINNY ARSENAL LOCATION MAP, REMEDIAL INVESTIGATION CONCEPT PLAN AREAS, AND AREA E SITE PLAN PICATINNY ARSENAL, NEW JERSEY
TASK/PHASE NUMBER M0001
DRAWN BY A. SANTINI
PROJECT NUMBER GP06PICA.P077
DRAWING NUMBER 1

and development, plotting, lamination, photo engraving, painting, plating, and machining. Since 1977, the northern portion of Building 95 has been occupied by the headquarters of the Fire Support Armament Center (FSAC) division. The FSAC maintains and operates physics laboratories.

Degreasing and cleaning with chlorinated solvents (part of metal plating operations for printed circuit board manufacturing) was conducted at Building 95. These activities produced contaminated wastewater that contained VOCs and other chemicals. This activity no longer takes place in Building 95. This wastewater was stored and treated in nine underground storage tanks (USTs) that were installed beneath Building 95 in 1961.

After treatment in the USTs, wastewater and sludge were transported via pipelines from the Site 38 USTs to the surface impoundment unit (Site 22). Wastewater from the surface impoundment unit was discharged to GPB via a drainage ditch through the sand filter lagoon, in accordance with the facility's water discharge permit issued by NJDEP. It is estimated that up to 9,000 gallons of treated wastewater effluent and 140 pounds of precipitated sludge were generated daily, although the amounts varied over time.

2.2.2 RCRA Closures

The surface impoundment unit was cleaned annually and the sludge was removed for off-site disposal. The sludge was last removed in December 1979. As of 1980, both lagoons and the sludge bed were registered with NJDEP as a RCRA hazardous waste surface impoundment unit. Consistent with RCRA regulations, groundwater underlying the impoundments was monitored with four wells. Analysis of groundwater from these wells during the early 1980s indicated the presence of VOCs. As a result, the surface impoundment unit was decommissioned in October 1981. Following the decommissioning of the surface impoundment unit, all wastewater and sludge generated from metal plating operations between 1981 and 1988 (approximately 40,000 gallons per year) was stored in the Site 38 USTs and then transported off-site for disposal. Integrity (leak) testing performed on the USTs by Picatinny Arsenal between 1988 and 1991 determined that the USTs may have leaked. The USTs were then closed and filled with concrete in accordance with NJDEP-approved RCRA closure plans.

As part of the decommissioning in 1981, an interim closure of the units was conducted by the Army. As part of this interim closure, 315 cubic yards of sand and sludge material from the impoundment units were excavated and shipped offsite for disposal. This excavation was conducted to a maximum depth of 8 feet. No post excavation samples were collected as a part of this interim closure. After excavation, the impoundment area was backfilled with clean soil. The area was then graded and capped with a layer of bentonite. The two underground pipes from the Building 95 treatment tanks and the piping extending from the surface impoundments to the drainage ditch were abandoned in place at this time.

In the autumn of 1990, the Armament Research Development and Engineering Center (ARDEC) removed 30 ft of piping exiting the Building 95 USTs that extended into the adjacent parking lot. The piping was removed to allow the construction of aboveground wastewater tanks on the south side of Building 95 to support continuing wastewater operations.

Because the removal action in 1981 was performed as an interim action, a final action was planned and implemented for the RCRA closure of the surface impoundments. A closure plan for the surface impoundment unit was submitted to NJDEP in 1987 and approved in 1990. Excavation and removal of soil and underground piping associated with the surface impoundment unit began in February 1992. Excavation began outside Building 95 at the point that pipe removal ceased in 1990 and extended past the surface impoundment unit. After the piping was removed, excavation of the impoundment area was initiated. The surface impoundment unit was excavated to the bottom of the vadose zone. The excavated soil was disposed off-site as hazardous waste. Approximately 684 cubic yards of soil was excavated and disposed of off-site. Post excavation samples were taken from the sidewalls of the impoundment excavation and bottom of the piping excavations. The sides of the excavation were lined with geotextile fabric. The excavation was then backfilled with riprap stone, a second layer of geotextile fabric, and certified clean fill to bring the excavation back to grade. The trench for the influent pipe was backfilled with soil and then covered with a layer of asphalt. Although the drainage ditch that formerly

received waste-water discharge from the lagoons was not part of the RCRA action, sediment samples were collected from the drainage ditch when the RCRA closure activities were conducted.

In summary, following the NJDEP approvals for the RCRA closure actions, the surface impoundment unit and its associated piping system and the USTs are considered closed. While the NJDEP approved the RCRA closures, they indicated that additional action would be required at the discharge ditch and Area E groundwater under the CERCLA program.

2.2.3 Previous Investigations

Groundwater studies within Area E have primarily been concerned with the extent of contamination in the shallow unconfined groundwater aquifer. However, other studies have also focused on surface water in GPB, subsurface soil, and soil gas to define the total extent of the contamination associated with the Area E groundwater plume. Studies have also been directed at the detection of potential dense non-aqueous phase liquids (DNAPLs) though none have been identified. In addition, bioattenuation/ natural attenuation studies have been performed to predict how the contaminant plume will behave and how long it will take the plume to degrade.

Some investigation of groundwater resources was initiated at Picatinny Arsenal as early as 1958. However, the majority of investigations were conducted within the last twenty years. The locations of groundwater samples collected during these various studies are depicted on **Figure 2**. Also, it should be noted that several wells from Area P are also included in the Area E groundwater assessment to establish the upgradient delineation for the contamination plume at Area E. Sample results from Area P are presented in the Picatinny Arsenal Phase III-1A Remedial Investigation (Remedial Investigation) Report-Draft Final (Shaw, 2002). Groundwater investigations indicate that Area E groundwater, primarily from within the unconfined shallow aquifer, was contaminated with chlorinated VOCs, including tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA) and their breakdown products. Additionally, metals including arsenic, beryllium, iron and manganese have been detected in both the shallow unconfined and the semi-confined aquifers in Area E. However, these metal contaminants may be attributable to aquifer properties and underlying bedrock, rather than anthropogenic (man-made) sources.

The groundwater associated with Sites 22 and 38 have been combined as Area E groundwater. Site 28 (Sewage Treatment Plant Sludge Beds) and Site 44 (Golf Course Maintenance Facility) have been adequately characterized. The chlorinated VOCs that dominate the groundwater contamination at Area E were not historically used at these sites.

Soil, sediment and surface water within Area E have been addressed in a number of site investigations. The Army has performed closure, cleanup and/or sampling at all of these sites. Sites within Area E other than 22 and 38 are addressed under other CERCLA documents. The majority of soil sampling within Sites 22 and 38 was performed during the Phase I RI and RCRA Closure activities. The preponderance of contamination in soil was removed during the RCRA closure activities. The NJDEP has approved these closure activities for Sites 22 and 38. Site 38 and 22 RCRA closure activities were considered complete. However, Area E groundwater and the drainage ditch at Site 22 are being addressed under the CERCLA program. To that end, cleanup for the remaining contamination in Area E groundwater and at Site 22 is being addressed in this ROD.

The Army has performed groundwater sampling of the Area E plume for the past 14 years as part of the requirements of the post closure permit. From 1990 until 2001 the Army monitored seven wells at Area E on a quarterly basis. The Army currently monitors eight wells within the Area E plume on a semiannual basis. This sampling will continue until the ROD is signed. After signature of the ROD, the sampling to be completed as part of the remedial action will be finalized in the remedial design and reviewed by the NJDEP and USEPA. Additional information regarding the background of Area E and Site 22 can be found in greater detail in the Administrative Record file for Picatinny Arsenal.

No formalized enforcement activities have occurred at Area E. Picatinny Arsenal is working in cooperation with the USEPA and NJDEP to apply appropriate remedies that will preclude the necessity of formalized enforcement actions, such as Notices of Violation.

2.3 COMMUNITY PARTICIPATION

Area E groundwater and Site 22 have been the topic of presentations to the Picatinny Arsenal Environmental Restoration Advisory Board (RAB). The Army briefed the RAB on May 7, 2003 on the proposed remedial approach for Area E groundwater. RAB members have provided comments regarding the proposed remedial alternative. A courtesy copy of the Proposed Plan was given to the RAB's co-chair and a complimentary copy was offered to any RAB member who requested it. The final Proposed Plans for Area E groundwater and Site 22 were completed and released to the public in December 2004 at the information repositories listed below:

Installation Restoration Program Office
Building 319
Picatinny, NJ 07806

Rockaway Township Library
61 Mount Hope Road
Rockaway Township, NJ 07866

Morris County Library
30 East Hanover Ave
Whippany, NJ 07981

Multiple newspaper notifications were made to inform the public of the start of the Proposed Plan comment period, solicit comments from the public, and announce the public meeting. The notification was run in the *New Jersey-Star Ledger* and the *Daily Record* on November 24, 2004. A public comment period was held from December 8, 2004 to January 8, 2005 during which comments from the public were received. A public meeting was held on December 8, 2004 to inform the public about the Selected Remedies for Area E groundwater and Site 22 and to seek public comments. At this meeting, representatives from the Army, NJDEP, USEPA, and the U.S. Army Corps of Engineers (USACE) were present to answer questions about the site and alternatives under consideration. Written comments were received from Subsurface Solutions on behalf of the Picatinny Arsenal RAB. Subsurface Solutions is under contract to the Army under the Technical Assistance for Public Participation (TAPP) program. Written comments were also received from the Law Offices of Schwartz, Tobia, Stanziale, Sedita and Campisano on behalf of Pondview Estates, Inc., a large residential development being constructed across Route 15 from the southern boundary of Picatinny Arsenal. The Army's responses to comments made at the public meeting are included in the Responsiveness Summary (Section 3.0) of this ROD.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

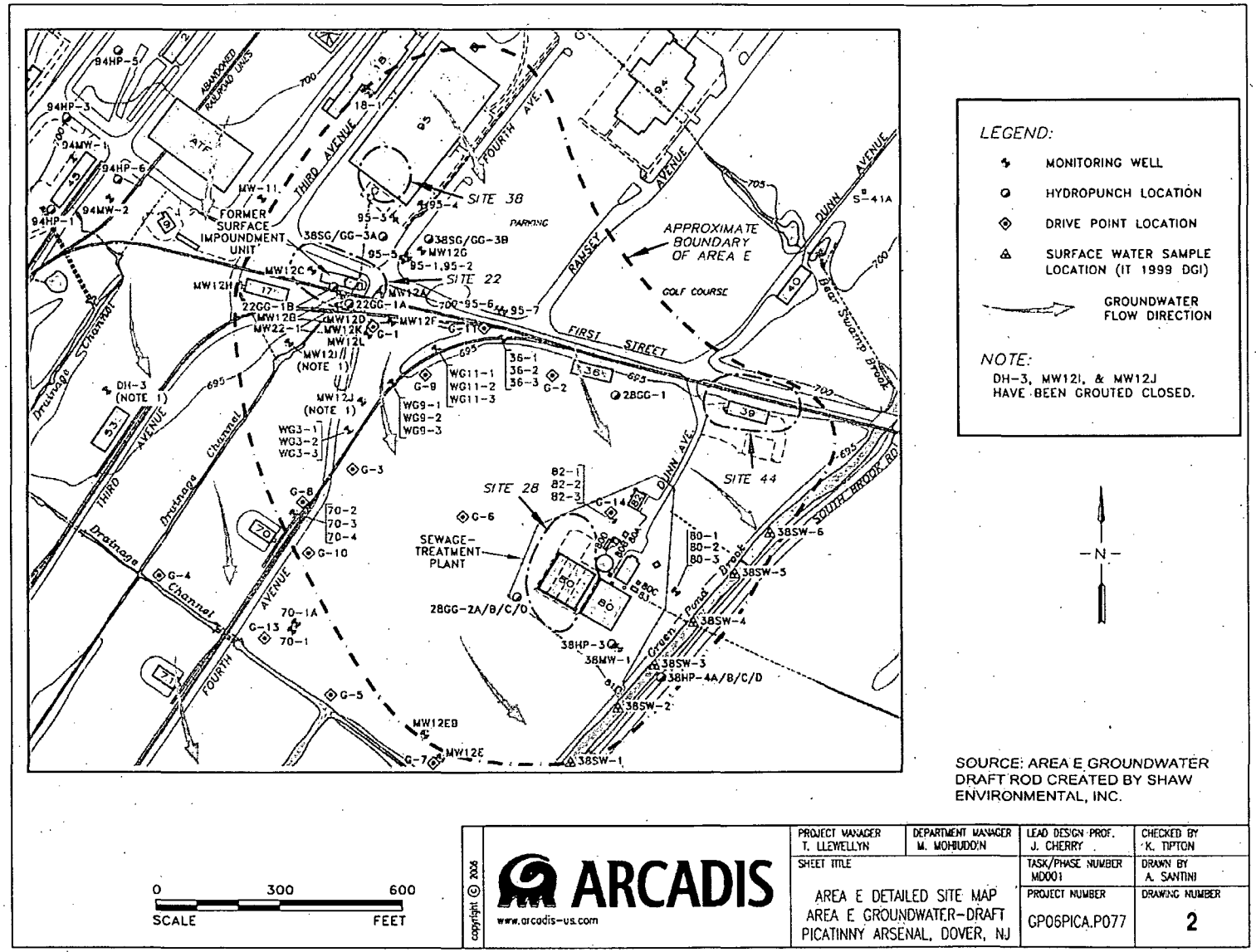
As outlined in the IRP at Picatinny Arsenal, the overall environmental cleanup goal is to protect human health and the environment by eliminating or reducing to prescribed, safe levels any potential risks caused by past installation activities. The remediation of Area E groundwater and Site 22 is part of a comprehensive environmental investigation and remediation process currently underway to meet the IRP goals at Picatinny Arsenal.

The proposed remedial action for Area E groundwater is primarily targeted at the unconfined aquifer, which is affected by chlorinated VOCs. Preliminary natural attenuation modeling conducted during the FS suggested that the remedial goals for the contaminants in groundwater would be achieved within approximately 45 years of the implementation of the Selected Remedy. The actual implementation time frame may vary based on the results of the groundwater and surface water monitoring.

The proposed remedial action for Site 22 targets soil, sediment, and surface water, which are affected by metals. The Army will act to ensure that future land use of Site 22 is consistent with the LUC objectives. Five-year reviews will be conducted in compliance with CERCLA and the NCP to ensure that the remedy is and will be protective of human health and the environment.

2.5 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plans for Area E groundwater and Site 22 present the selected remedial actions as the preferred alternatives. No significant changes have been made.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94HP-5
94HP-3
94MW-1
94HP-6
94HP-1
94MW-2
ABANDONED RAILROAD LINES
THIRD AVENUE
FOURTH AVE.
FORMER SURFACE IMPOUNDMENT UNIT
MW-11
SITE 38
PARKING
95-3
95-4
38SG/GG-3A
38SG/GG-3B
MW12G
95-1,95-2
MW12C
MW12H
SITE 22
MW12A
22GG-1B
22GG-1A
95-6
95-7
MW12B
MW22-1
MW12D
MW12F
MW12K
G-1
MW12L
MW12I (NOTE 1)
RAMSEY AVENUE
APPROXIMATE BOUNDARY OF AREA E
GOLF COURSE
DUNN AVENUE
S-41A
Bear Swamp Brook
FIRST STREET
DH-3 (NOTE 1)
Drainage Channel
WG11-1
WG11-2
WG11-3
36-1
36-2
36-3
G-2
2BGG-1
MW12J (NOTE 1)
WG9-1
WG9-2
WG9-3
WG3-1
WG3-2
WG3-3
G-3
G-8
SITE 28
82-1
82-2
82-3
G-14
DUNN AVE.
SITE 44
SOUTH BROOK RD
70-2
70-3
70-4
G-10
G-6
SEWAGE-TREATMENT PLANT
80-1
80-2
80-3
38SW-6
38SW-5
G-4
70-1A
G-13
70-1
28GG-2A/B/C/D
38HP-3
38MW-1
38SW-4
Green Pond Brook
38SW-3
38HP-4A/B/C/D
38SW-2
G-5
MW12E9
MW12E
G-7
38SW-1
LEGEND:
MONITORING WELL
HYDROPUNCH LOCATION
DRIVE POINT LOCATION
SURFACE WATER SAMPLE LOCATION (IT 1999 DGI)
GROUNDWATER FLOW DIRECTION
NOTE:
DH-3, MW12I, & MW12J HAVE BEEN GROUTED CLOSED.
N
SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.
0
300
600
SCALE
FEET
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DEPARTMENT MANAGER M. MOHIUDDIN
LEAD DESIGN PROF. J. CHERRY
CHECKED BY K. TIPTON
SHEET TITLE
AREA E DETAILED SITE MAP
AREA E GROUNDWATER-DRAFT
PICATINNY ARSENAL, DOVER, NJ
TASK/PHASE NUMBER M0001
DRAWN BY A. SANTINI
PROJECT NUMBER GP06PICA.P077
DRAWING NUMBER 2

2.6 SITE CHARACTERISTICS

2.6.1 Conceptual Site Model

A conceptual site model has been developed for Site 22 and the Area E groundwater plume in order to convey the salient processes affecting the introduction, movement, and distribution of contaminant mass at the site.

Chlorinated solvents were introduced to the subsurface via leaking USTs, pipes, and sludge lagoons. These solvents were introduced into the groundwater via infiltration of waste water containing relatively low levels of TCE. This discharge of wastewater resulted in a groundwater plume with relatively low aqueous concentrations and limited amounts of solvents in the subsurface soil beneath the lagoons. RCRA actions conducted in 1981 and the early 1990s removed most of the contaminant source in the soil. As a result, the contaminant mass transported to the groundwater has been tremendously reduced, as supported by the results of the Data Gap Investigation (DGI; IT Corporation, 1999) that suggested that contamination in the subsurface soil is minimal in the areas immediately downgradient of the two suspected source areas and does not appear to be continuously impacting groundwater. Through infiltration and percolation mechanisms, contaminants were gradually transported to groundwater. Mobilization of contaminants in groundwater is suggested primarily through advection, dispersion, and diffusion mechanisms. Analyses of subsurface soil samples from Area E indicate that no significant secondary source of chlorinated solvents exists. Further, analysis of soils for total organic carbon show limited amounts in the soil column. Correspondingly, sorption/desorption will not be the primary determining factor for transport of solvents in this plume.

Area E groundwater in the unconfined aquifer moves in a south-southeasterly direction to the area of Building 80, where ultimately it discharges to GPB. All shallow groundwater discharges to GPB and does not cross the brook. Levels of chlorinated solvents adjacent to GPB are low. Chlorinated solvents do not discharge to GPB at concentrations in excess of remedial goals nor do they impact groundwater on the other side of GPB. **Figure 3** presents the Conceptual Site Model for Site 22 and Area E groundwater.

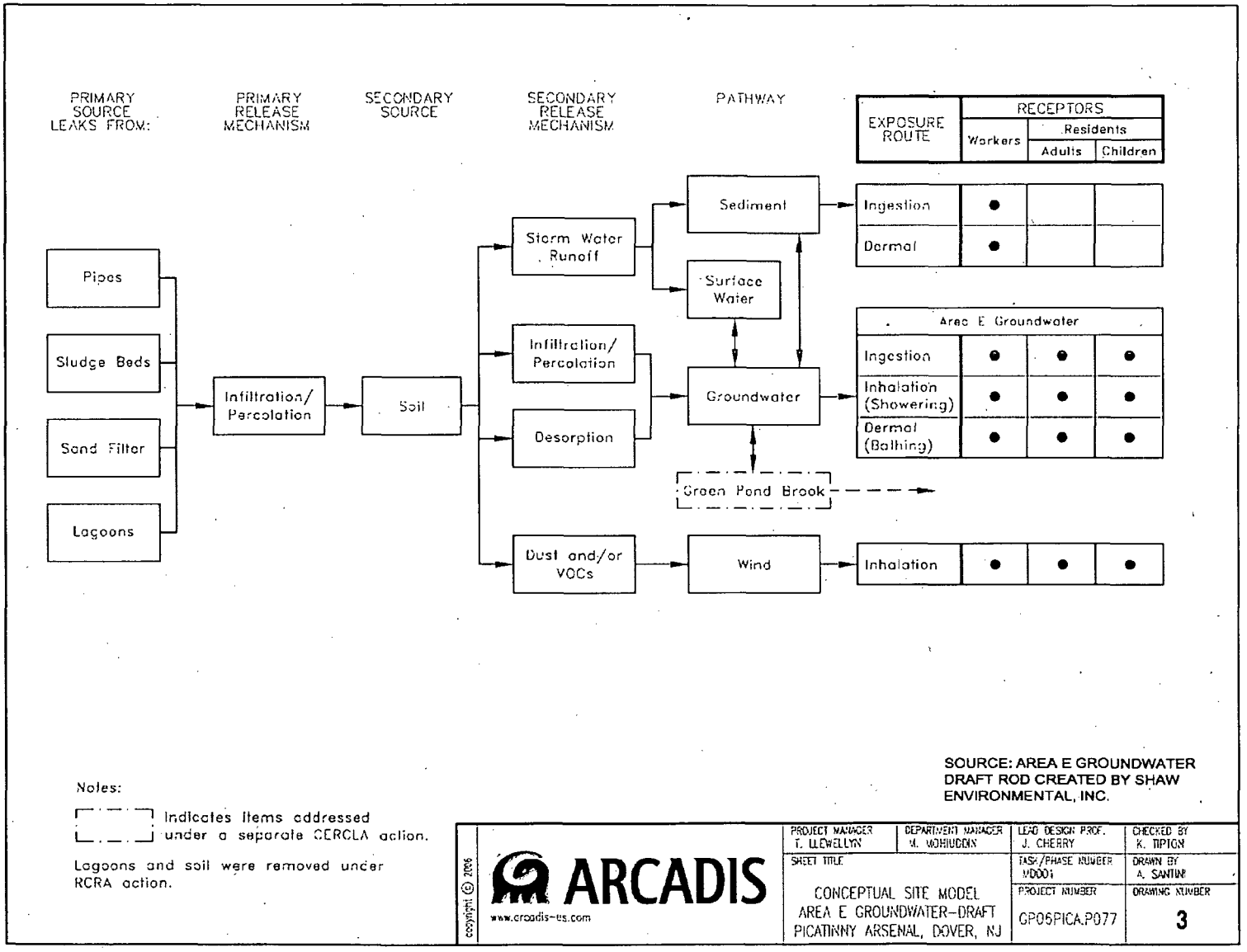
2.6.2 Surface and Subsurface Features

The surface and subsurface features of Area E, including Site 22, such as topography, surface water hydrology, geology, and hydrogeology are described in Sections 2.6.3 through 2.6.5 below.

According to data contained in the Picatinny Arsenal geographic information system (GIS), there are no archeologically sensitive or potentially archeologically sensitive areas within the boundaries of Area E. Cultural and historic data contained in the Picatinny Arsenal GIS was primarily obtained from *Architectural Assessment of Historic Structures at Picatinny Arsenal, Morris County, New Jersey,* August 1999.

2.6.3 Topography/Surface Water Hydrology

As a result of moderate land development, the topography of Area E is essentially flat, with an approximate elevation of 695 ft above mean sea level (msl). Surface water runoff is significant along the paved parking areas and roads in the northern portion of Area E, which is more developed than the southern portion. Infiltration is predominant in the western and southern portions, which contain more grassy and unpaved areas. Storm sewer lines that primarily serve Building 95 and its immediate vicinity collect the runoff in the northern portion of Area E. The storm sewer lines discharge to open drainage channels that eventually join GPB. Surface runoff from the southern portion of Area E tends to follow natural drainage paths and flows into GPB. All of Site 22 and the majority of Area E are outside of the 100-year and 500-year flood plains. A portion of the plume footprint on the southern and southwestern end is within the 10-year floodplain. The area formerly containing wastewater USTs, piping and lagoons is outside of the adjacent wetlands. The land south of First Street is almost entirely wetlands. Therefore, the majority of the plume footprint lies within wetland areas. Floodplain and wetland information was obtained from the Picatinny Arsenal GIS. Source data for the GIS was obtained from wetland and


PRIMARY SOURCE LEAKS FROM:
PRIMARY RELEASE MECHANISM
SECONDARY SOURCE
SECONDARY RELEASE MECHANISM
PATHWAY
RECEPTORS
EXPOSURE ROUTE
Workers
Residents
Adults
Children
Pipes
Sludge Beds
Sand Filter
Lagoons
Infiltration/ Percolation
Soil
Storm Water Runoff
Infiltration/ Percolation
Desorption
Dust and/or VOCs
Sediment
Surface Water
Groundwater
Green Pond Brook
Wind
Ingestion
Dermal
Area E Groundwater
Ingestion
Inhalation (Showering)
Dermal (Bathing)
Inhalation
Notes:
Indicates items addressed under a separate CERCLA action.
Lagoons and soil were removed under RCRA action.
SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.
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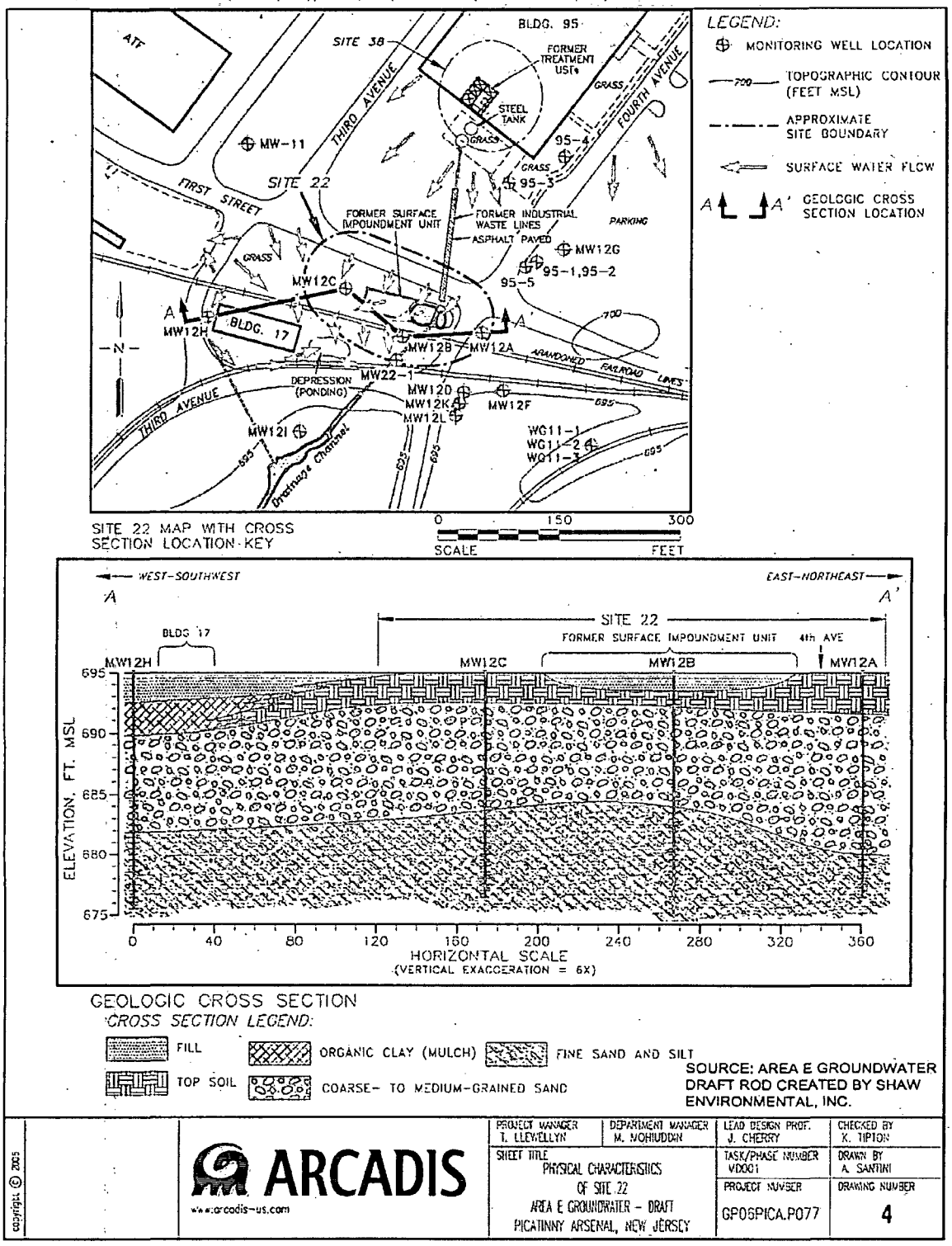
DEPARTMENT MANAGER M. WOHLUDON
LEAD DESIGN PROF. J. CHERRY
CHECKED BY K. TIPTON
SHEET TITLE
CONCEPTUAL SITE MODEL AREA E GROUNDWATER–DRAFT PICATINNY ARSENAL, DOVER, NJ
TASK/PHASE NUMBER M0001
DRAWN BY A. SANTIAM
PROJECT NUMBER GP06PICA.P077
DRAWING NUMBER 3


LEGEND:
MONITORING WELL LOCATION
TOPOGRAPHIC CONTOUR (FEET MSL)
APPROXIMATE SITE BOUNDARY
SURFACE WATER FLOW
GEOLOGIC CROSS SECTION LOCATION
BLDG. 95
SITE 38
FORMER TREATMENT UNIT
STEEL TANK
THIRD AVENUE
FOURTH AVENUE
FIRST STREET
SITE 22
MW-11
95-4
95-3
FORMER SURFACE IMPOUNDMENT UNIT
FORMER INDUSTRIAL WASTE LINES
ASPHALT PAVED
PARKING
MW12G
95-1,95-2
95-5
MW12C
MW12H
BLDG. 17
MW12B
MW12A
ABANDONED RAILROAD LINES
DEPRESSION (PONDING)
MW22-1
MW12D
MW12K
MW12L
MW12F
MW12I
WG11-1
WG11-2
WG11-3
Drainage Channel
SITE 22 MAP WITH CROSS SECTION LOCATION KEY
SCALE
FEET
WEST-SOUTHWEST
EAST-NORTHEAST
FORMER SURFACE IMPOUNDMENT UNIT
4th AVE
ELEVATION, FT. MSL
HORIZONTAL SCALE
(VERTICAL EXAGGERATION = 6X)
GEOLOGIC CROSS SECTION
CROSS SECTION LEGEND:
FILL
TOP SOIL
ORGANIC CLAY (MULCH)
COARSE- TO MEDIUM-GRAINED SAND
FINE SAND AND SILT
SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.
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PROJECT MANAGER T. LLEWELLYN
DEPARTMENT MANAGER M. MOHIUDDIN
LEAD DESIGN PROF. J. CHERRY
CHECKED BY K. TIPTON
SHEET TITLE PHYSICAL CHARACTERISTICS OF SITE 22 AREA E GROUNDWATER – DRAFT PICATINNY ARSENAL, NEW JERSEY
TASK/PHASE NUMBER V0001
DRAWN BY A. SANTINI
PROJECT NUMBER GP05PICA.P077
DRAWING NUMBER 4
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floodplain analysis performed by the USACE Waterways Experiment Station (WES, 1994). **Figure 4** shows the general direction of surface water flow.

2.6.4 Geology and Soil

The geology of Area E consists of the Leithsville Dolomite and overlying glacial sediments. The thickness of the glacial sediments ranges from 195 to 205 feet (ft). **Figure 2** presents the locations of monitoring wells in Area E. These locations have been used in various environmental investigations at Area E, including U.S. Geological Survey (USGS) Sampling (1981- 1993), RI (1993 -1994), DGI (1999 – 2000), and Periodic Groundwater Monitoring (1990 – present). **Figure 4** provides geologic cross-section A–A'. Cross-section A–A' is a west to east trending cross-section.

In Area E, the Leithsville Dolomite is represented in well boring logs only by its weathered remnants, consisting of clay and fine silt with inclusions of iron nodules, fine-grained sandstone, and quartz. The deepest boring in Area E (95-1) was advanced to a depth of 352 ft below ground surface (bgs), but did not encounter competent, unweathered bedrock. However, weathered quartzitic dolomite was encountered approximately 195 to 205 ft bgs. Based on data collected at Picatinny Arsenal outside of Area E, the Leithsville Dolomite consists of light gray, micritic dolomite, weathered to a yellow silty clay and fine silt with inclusions of fine-grained sandstone and quartz. Less weathered intervals of quartzitic dolomite, dolomitic limestone, and quartzite alternate with layers of weathered bedrock. Some solution cavities typical of weathered carbonate rock were encountered.

The glacial sediments overlying bedrock range in thickness from approximately 195 ft along the southeast boundary of Area E to 205 ft along the northwest boundary. Based on sediment grain size, lower, middle, and upper sequences have been identified in the glacial sediments. The top of the lower glacial sequence is encountered at depths ranging from 179 to 185 ft bgs. The lower sequence is poorly sorted and consists of a heterogeneous mix of clayey till with sand, gravel, and boulders. Occasional layers of reworked till consisting of poorly sorted sand, gravel, and silt are encountered towards the top of the lower sequence. Stratification in the lower glacial sequence of sediments follows the gentle slope of the bedrock surface. The thickness of the lower glacial sequence increases from 16 ft along the southeastern boundary to 20 ft at the northwestern boundary. The lower sequence of glacial sediments is overlain by the fine-grained middle sequence consisting predominantly of silt, laminated with very fine to fine sand and clay. Lenses of coarse sand, cobbles, and boulders occur in the lower and middle portions of this fine-grained sequence. Thicknesses of the coarse-grained lenses range from approximately 12 to 20 ft. The top of the middle glacial sequence is encountered at depths ranging from 44 to 50 ft bgs. The bottom of the fine-grained middle sequence is bowl-shaped, indicative of a lacustrine environment of deposition. The thickness of the middle sequence decreases from 135 ft in the northeast to 110 ft to the southeast. The thickest section of the middle sequence is to the southwest and ranges up to 140 ft. The upper sequence is more horizontally stratified and has a fairly uniform thickness that ranges from 44 to 50 ft. This upper sequence displays an overall coarsening upward lithology, beginning with fine sand and silt at the base (40 to 50 ft bgs), grading to medium sand and silt with gravel (20 to 30 ft bgs), and finally to medium sand and gravel at the top (10 to 15 ft bgs). The sands exhibit variable degrees of sorting and rounding and the middle portion of the sequence shows cyclical coarsening upward sequences that vary from fine sand to fine gravel.

Swamp deposits occur sporadically in low-lying areas and are represented by organic clays and muck that are encountered at the surface. Thicknesses of the swamp deposits range from 0 to 3 ft. However, it is possible that the swamp deposits have a greater areal extent than presently observed, since a significant part of these deposits in the culturally developed areas of Area E may have been excavated and replaced by artificial fill material.

2.6.5 Hydrogeology

A total of 48 monitoring wells have been installed in Area E as part of investigations (monitoring wells DH-3, MW-12I, and MW-12J have been grouted closed). **Figure 2** shows the approximate location of the monitoring wells in Area E.

Based on the geology of Area E and aquifer slug test data collected during the Phase I RI, the DGI, and previous investigations, three separate aquifers have been identified. The aquifers include an unconfined glacial aquifer, an upper semi-confined glacial aquifer, and a lower semi-confined glacial aquifer. None of the wells located in Area E were screened in bedrock.

The unconfined glacial aquifer corresponds to the coarse-grained upper sequence of glacial sediments, which consist of silt and sand at the base, grading upward to sand and gravel. The thickness of the upper sequence of glacial sediment ranges from 44 to 50 ft. Dames and Moore performed a slug test on monitoring well 22MW-1 during the Phase I RI. Based on the result of this single test, the hydraulic conductivity of the unconfined aquifer was estimated to be 22 feet per day (ft/day).

The hydrogeology of Area E was further defined during the DGI. Slug tests were conducted on wells 36-3, 95-3, MW-11, MW-12A, WG11-2, WG3-3, and WG9-3 that are screened between 9 to 20.5 ft bgs. The average conductivity in these wells was 124 ft/day. Slug tests were also conducted on several wells screened between 22.2 and 36.8 ft bgs (80-1, 82-2, WG3-1, and WG9-2). Conductivity in these wells was significantly less than in the shallow wells, except for WG9-2, with an average conductivity of 24.9 ft/day. The overall average conductivity of wells in the unconfined aquifer was 98 ft/day with a hydraulic gradient of 0.004 feet per foot (ft/ft).

The upper semi-confined glacial aquifer corresponds to the intermediate fine-grained sequence of glacial sediments that consists of silt laminated with sand and clay. The top of the upper semi-confined glacial aquifer is encountered at depths ranging from 44 to 50 ft bgs and is approximately 135 ft thick. Due to its fine grained nature relative to the unconfined and lower semi-confined glacial aquifers, the upper semi-confined glacial aquifer behaves as a low permeability aquifer and retards groundwater flow to the lower semi-confined aquifer.

The lower semi-confined glacial aquifer corresponds to the lower sequence of glacial sediments, which is encountered at a depth of approximately 180 ft bgs. This aquifer consists of till, occasionally inter-bedded with reworked till, and has a thickness ranging from 16 to 20 ft. A downward vertical hydraulic gradient was estimated at 0.006 ft/ft between the unconfined and lower semi-confined glacial aquifers.

Localized groundwater mounding is occurring around Building 95. The groundwater mounding may be related to the hydraulic connection between shallow groundwater and local surface water bodies. The swampy area and drainage ditches located south of Building 95 tend to store water that backs up from GPB, which is regulated by a weir approximately one mile downstream. As a result of the groundwater mounding, the groundwater flow in the northern portion of Area E fans out in the south and southwest directions. The hydraulic gradient associated with this feature is gentle and averages 0.002 ft/ft. Farther south, the flow changes to a southeast direction and flows perpendicular to GPB, with a hydraulic gradient of 0.004 ft/ft. The direction of groundwater flow in Area E is shown on **Figure 2**.

2.6.6 Sampling Strategy

Once it was determined that Site 38 and Site 22 were the primary cause of contaminated groundwater in Area E, most of the environmental investigations at Area E were conducted in the vicinity of Building 95 (Site 38), the associated lagoons to the south/southwest of Building 95 (Site 22), and areas downgradient of these two sites extending to GPB. The contamination originating from Sites 22 and 38 was identified and investigated by several agencies during the 1980s and early 1990s.

The DGI was specifically designed to gather data necessary to evaluate potentially applicable remedial alternatives. In this investigation, samples of groundwater, surface water, and subsurface soil were collected and analyzed to aid in the evaluation of remedial technologies. Sampling was performed to determine the following:

- Vertical variation of VOCs near Building 95, the surface impoundments, and GPB
- Current distribution of VOCs within Area E groundwater and natural attenuation characteristics
- Extent and reach of VOC plume as it intersects GPB

Soil, sediment, and surface water sampling has been conducted at Site 22 to define the nature and extent of contamination at Site 22 due to past waste disposal activities and to further characterize the drainage ditch area leading to GPB that was a potential contaminant pathway to GPB.

2.6.7 Nature and Extent of Contamination

This summary of the nature and extent of contamination is based on studies performed by USGS, the RI and additional DGI performed for the Army to focus on the nature and extent of contamination present in Area E groundwater and at Site 22. This section focuses on the extent and history of the contamination in Area E groundwater and Site 22. The potential excess cancer risk and health hazard estimates associated with this contamination are presented in Section 2.8 of this ROD. The Army is conducting separate studies which focus on contamination known or suspected to be present at other sites in Picatinny Arsenal. The administrative record file for the site includes detailed information about individual investigations and sampling results summarized herein.

2.6.7.1 Area E Groundwater

The three most comprehensive data sets (1989 USGS [USGS, 1994]; 1994 Phase I RI [Dames and Moore, 1998]; and, 1999 DGI [IT Corporation, 1999]) were used to spatially evaluate changes in the VOC plumes of highest concentration. Each round of data represents a time-referenced "snap-shot" of the plume. **Figure 2** presents locations of groundwater monitoring wells sampled during the previous investigations. Information about the previous investigations is summarized in **Table 2** and **Figures 5 through 7** and additional detail is available in the administrative record. As shown on these figures, the highest concentrations of chlorinated VOCs were detected in the vicinity of the former wastewater USTs or the surface impoundment unit, suggesting that these were the most likely sources of groundwater contamination in Area E.

Table 1 presents a summary of the maximum concentrations of chlorinated VOCs detected in Area E groundwater that exceeded groundwater standards during the 1989 sampling event and the DGI. These constituents are identified as contaminants of concern (COCs) in Section 2.8.1.1. **Figures 5 through 7** present the migration and attenuation of VOC contamination in Area E groundwater over time. As shown on these figures, VOC concentrations in groundwater at Area E have decreased tremendously over time through natural attenuation processes. As described in the FS, the 1989 groundwater data were based on sampling results from 39 wells. In 1994, Dames and Moore sampled 27 monitoring wells. Several of the wells with high concentrations in 1989 were not sampled in 1994 (cluster WG11 and WG3, and MW12-H). The 1999 isopleth was developed based on the sample results from 37 wells, including the locations where high concentrations were detected in 1989. Because the sampling points used in the 1989 and 1999 sampling rounds correlated well with one another, these are the rounds depicted on **Figures 5 through 7**. Comparison of the 1989 and 1999 plume maps clearly shows a decreasing trend.

Table 1: Comparison of Groundwater Standards and Maximum Concentrations of COCs in Area E Groundwater

Contaminant	Federal and State Groundwater Standards (µg/L)				Maximum Concentration Observed (µg/L)	
	Federal MCL	New Jersey MCL	NJDEP GWQS (PQL)*	Chosen Standard	1989	1999
1,1-Dichloroethene (1,1-DCE)	7	2	1 (1)	1	215.4	21
cis-1,2-Dichloroethene (cis-1,2-DCE)	70	70	70 (1)	70	27.9	13
Tetrachloroethene (PCE)	5	1	0.4 (1)	1	168	55
Trichloroethene (TCE)	5	1	1 (1)	1	52.7	35
Vinyl Chloride (VC)	2	2	0.08 (1)	1	1.5	3.5

* Column lists NJDEP Groundwater Quality Standard with the corresponding Practical Quantitation Limit (PQL) in parenthesis. The NJDEP PQL values take the place of NJDEP Groundwater Quality Criteria where the Groundwater Quality Criteria are below the ability of chemical analysis to reliably detect/quantify the subject analyte. For analytes with a higher PQL than Groundwater Quality Criterion, the NJDEP directs the selection of the PQL as the standard.
MCL – Maximum Contaminant Level (value listed is the lowest of the State and Federal MCLs)
µg/L – micrograms per liter

Monitoring well 80-3 was the farthest downgradient well originally intended to be sampled during the DGI. Additional well installation and sampling was completed to determine the vertical extent of VOC contamination and to assess the potential for impact to GPB from VOCs in groundwater. Samples collected on the west side of GPB indicated that PCE, 1,1,1-TCA, and TCE are not migrating to this downgradient location, as these constituents were not detected in any sample from this location. 1,1-Dichloroethane (1,1-DCA) was detected on the west side of GPB at a maximum concentration of 4.1 µg/L, which is well below the level of concern (LOC; see Table 4-2 of the FS) of 50 µg/L, at a depth of 60 ft bgs to 63 ft bgs. No VOCs associated with Area E were detected on the east side of GPB at sample location 38HP-4, shown on **Figure 2**. These results provide evidence that the Area E plume is not impacting groundwater on the east side of GPB. Well 38MW-1 was installed to a depth of 69 to 79 ft bgs. No VOCs were detected above LOCs in this well. This monitoring well bounds the VOC plume vertically on the downgradient extent of the plume.

2.6.7.2 Natural Attenuation Assessment

Natural attenuation is passive remediation that relies on intrinsic processes and groundwater chemistry to reduce levels of contaminants and control plume migration. MNA is a USEPA-approved remedy that has proven to be an effective remedy at many Superfund sites. Studies and remediation at other sites have confirmed that all primary contaminants at Area E are amenable to natural attenuation processes, including biodegradation, advection, dispersion, dilution, chemical reaction, and volatilization. The Army conducted an evaluation of MNA to determine if it is a viable remedy for groundwater at Area E. Results of this study, presented in the Final FS for Area E groundwater and approved by the USEPA and NJDEP, indicate that intrinsic degradation and attenuation of COCs is occurring in the groundwater. The contribution of natural attenuation processes in the reduction of VOC concentrations in groundwater at Area E was further supported by the results of the natural attenuation parameters analysis conducted during the DGI. Natural attenuation is advantageous at Area E because it is non-invasive and cost effective.

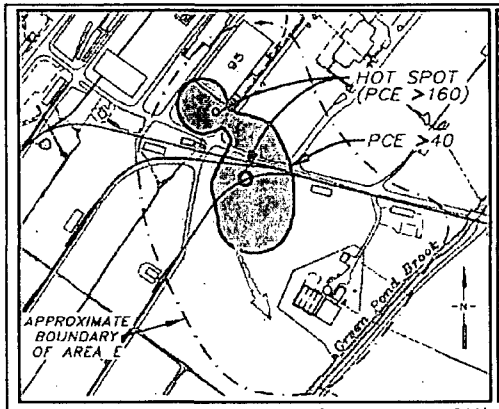
At Area E, the data suggested that the dominant natural attenuation processes for the reduction of VOCs mass are: degradation through chemical reactions, dilution, dispersion, and advection. Other processes, including biodegradation and volatilization, are also occurring. These processes, synergistically, have contributed to the 50 percent overall reduction of PCE and TCE concentrations. In addition, the 1,1,1-TCA concentrations have decreased to below the LOCs.

The initial growth of the VOC plume was likely attributable to advection (movement through groundwater flow) evident from the downgradient extent of contamination. Effects of dispersion/diffusion are also apparent from the lateral extent of the plume. Over the past 10 years, sampling results have suggested that the overall size of the plume has remained the same, but the overall plume concentrations are decreasing. This observation is due to the fact that the plume is approaching or has reached steady-state conditions.

Evaluation of results from the common wells between 1989 and 1999 indicate that VOC concentrations have consistently decreased. As is the case with many naturally attenuating plumes, the plume's periphery degrades more rapidly than the plume's center. As presented on **Figures 5 through 7**, the contaminant plume has not migrated to Green Pond Brook, indicating plume stability and the effectiveness of natural attenuation processes at controlling plume migration. Additionally, the trend analysis shows decreasing concentration trends in the plume, further indicative of intrinsic degradation and attenuation processes. Analysis of the migration and attenuation of the daughter products show similar decreasing concentration trends and plume stability.

Natural processes occurring in the Area E groundwater promote degradation and attenuation of the COCs. There is no continuing source of contamination, and periodic monitoring of the groundwater constituent levels and groundwater geochemistry support this conclusion.

User Name : esantini Path\Name : J:\Drafting\PICATINNY\Area E\Site 22 ROD-Draft\EGW-S22 ROD.dwg – Layout Tab : FIG 5



JULY 1989

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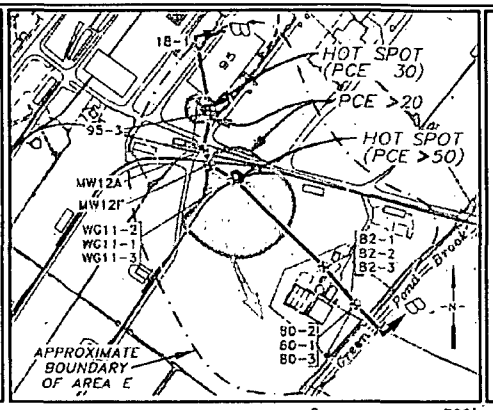

NOVEMBER 1999

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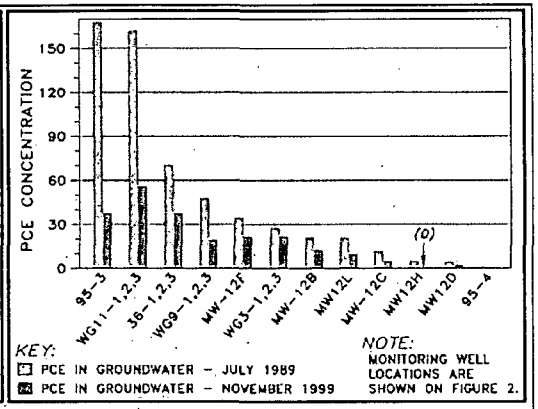
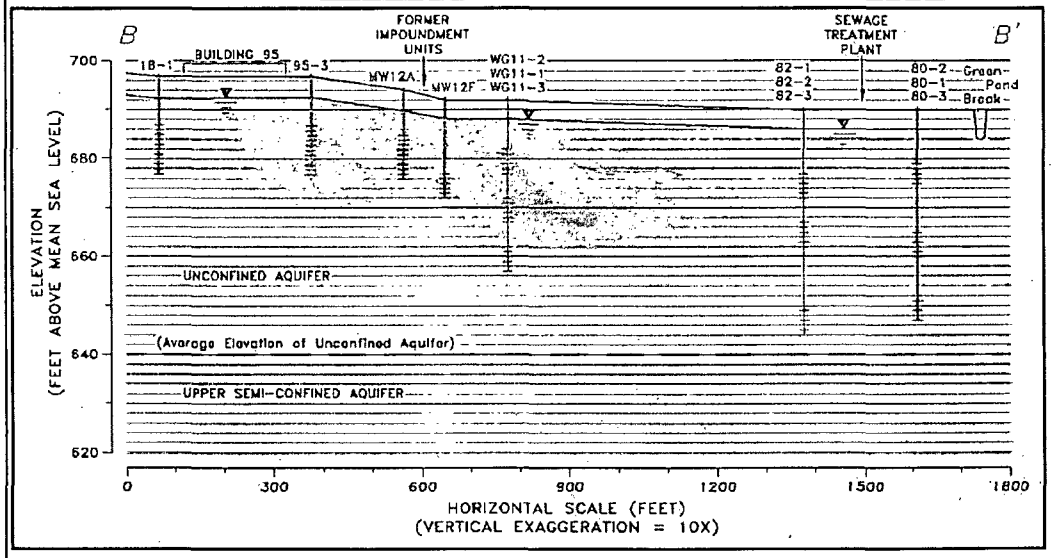


PCE ATTENUATION TREND GRAPH



NOTES:
1. OUTERMOST BOUNDARIES OF PLUMES REPRESENT THE ARAR LEVEL FOR PCE IN GROUNDWATER (1 μg/L).
2. ALL PCE CONCENTRATIONS ARE SHOWN IN μg/L.

LEGEND:
- MONITORING WELL LOCATION
- POTENTIOMETRIC SURFACE
- GENERAL DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER MONITORING LOCATION
- SCREENED INTERVAL

PCE CONCENTRATIONS IN GROUNDWATER (μg/L):
- 1
- > 10
- > 20
- > 30
- > 40
- > 50

SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.

CROSS SECTION OF NOVEMBER 1999 PLUME

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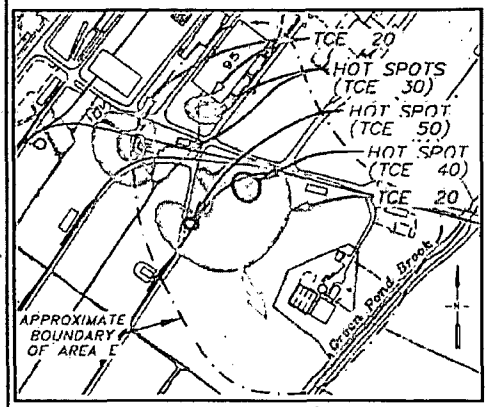
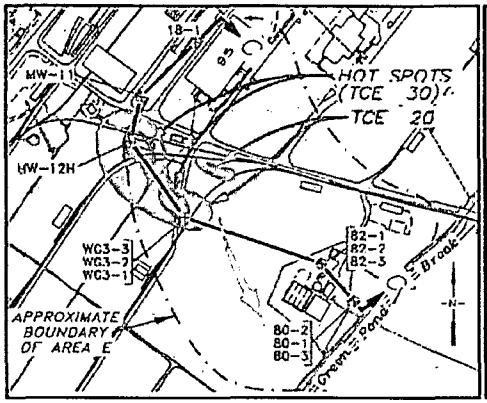
PROJECT MANAGER	DEPARTMENT MANAGER	LEAD DESIGN PROF.	CHECKED BY
T. LLEWELLYN	M. MOHIUDDIN	J. CHERRY	K. TIPTON
SHEET TITLE: MIGRATION & ATTENUATION OF PCE GROUNDWATER PLUME OVER TIME AREA E GROUNDWATER–DRAFT PICATINNY ARSENAL, DOVER, NJ		TASK/PHASE NUMBER: MD001	DRAWN BY: A. SANTINI
		PROJECT NUMBER: GP06PICA.P077	DRAWING NUMBER: 5

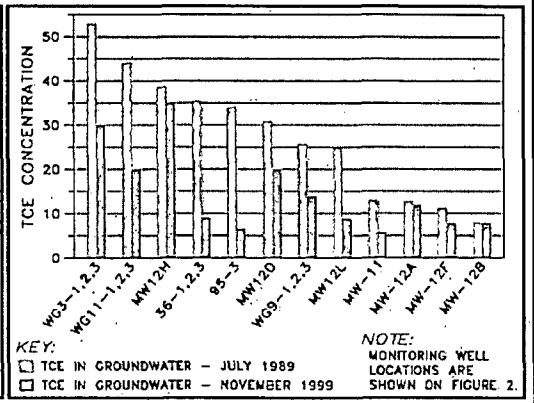
User Name : csantini Path\Name : J:\Drafting\PICATINNY\Area E\Site 22 ROD-Draft\EDW-S22 ROD.dwg – Layout Tab : FIG 6



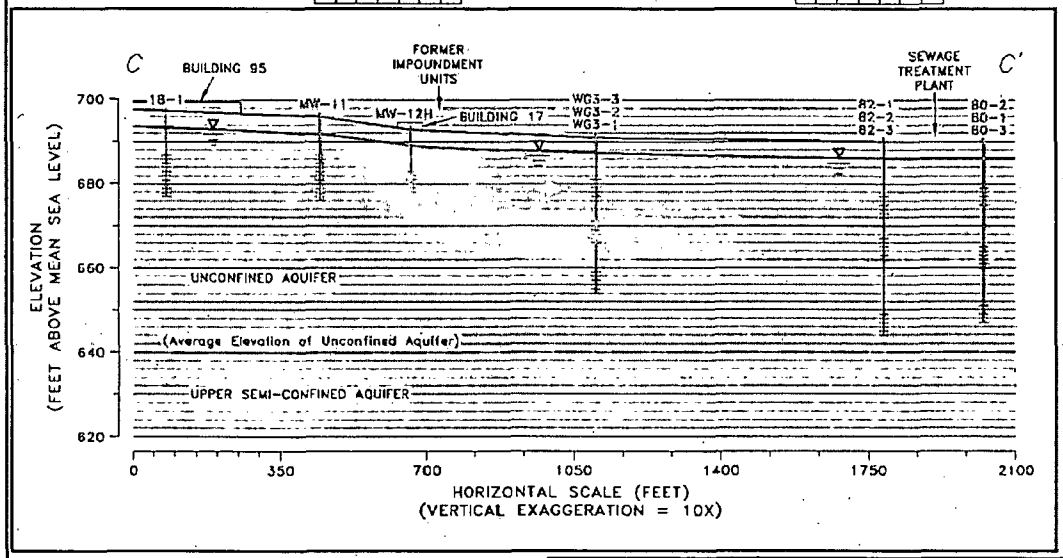
JULY 1989



NOVEMBER 1999



TCE ATTENUATION TREND GRAPH



NOTES:
1. OUTERMOST BOUNDARIES OF PLUMES REPRESENT THE ARAR LEVEL FOR TCE IN GROUNDWATER (1 µg/L).
2. ALL TCE CONCENTRATIONS ARE SHOWN IN µg/L.

LEGEND:
- MONITORING WELL LOCATION
- POTENTIOMETRIC SURFACE
- GENERAL DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER MONITORING LOCATION
- SCREENED INTERVAL

TCE CONCENTRATIONS IN GROUNDWATER (µg/L):
1 | > 10 | > 20 | > 30

SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.

CROSS SECTION OF NOVEMBER 1999 PLUME

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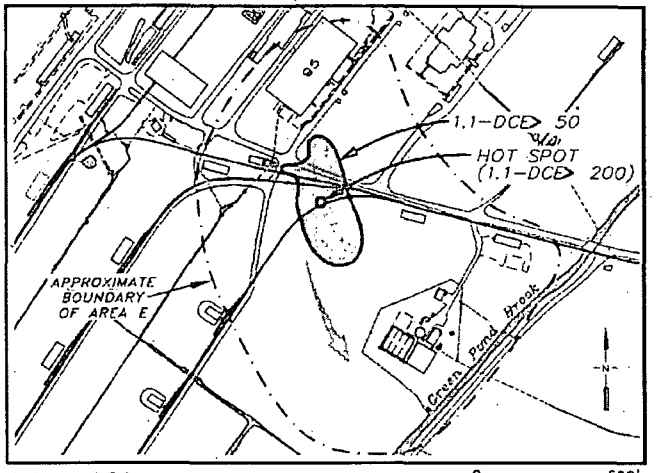
PROJECT MANAGER	DEPARTMENT MANAGER	LEAD DESIGN PROF.	CHECKED BY
T. LLEWELLYN	M. MOHIUDDIN	J. CHERRY	K. TIPTON
SHEET TITLE		TASK/PHASE NUMBER	DRAWN BY
MIGRATION & ATTENUATION OF TCE GROUNDWATER PLUME OVER TIME AREA E GROUNDWATER–DRAFT PICATINNY ARSENAL, DOVER, NJ		MD001	A. SANTINI
		PROJECT NUMBER	DRAWING NUMBER
		GP06PICA.P077	6

User Name : asantini
Path\Name : J:\Drafting\PICATINNY\Area E\Site 22 ROD-Draft\EGW-S22 ROD.dwg – Layout Tab : FIG 7



JULY 1989

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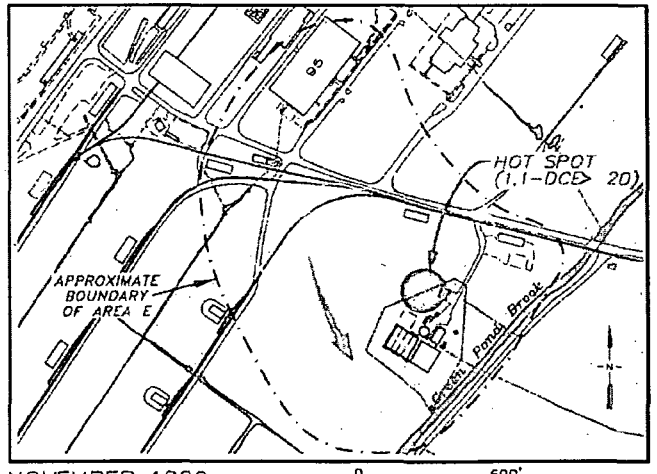

NOVEMBER 1999

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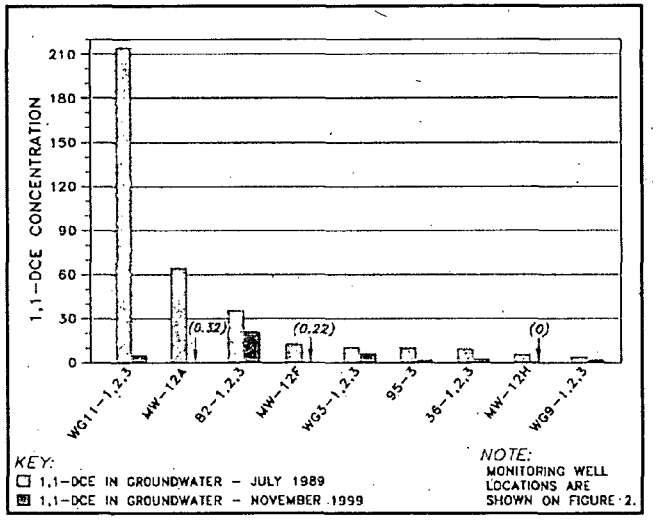

1,1-DCE ATTENUATION TREND GRAPH

LEGEND:

GENERAL DIRECTION OF GROUNDWATER FLOW

NOTES:

1. OUTERMOST BOUNDARIES OF PLUMES REPRESENT THE ARAR LEVEL FOR 1,1-DCE IN GROUNDWATER (2 µg/L).
2. ALL 1,1-DCE CONCENTRATIONS ARE SHOWN IN µg/L

SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.

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PROJECT MANAGER	DEPARTMENT MANAGER	LEAD DESIGN PROF.	CHECKED BY
T. LLEWELLYN	M. MOHIUDDIN	J. CHERRY	K. TIPTON
SHEET TITLE: MIGRATION & ATTENUATION OF 1,1-DCE GROUNDWATER PLUME OVER TIME AREA E GROUNDWATER-DRAFT PICATINNY ARSENAL, DOVER, NJ		TASK/PHASE NUMBER: MD001	DRAWN BY: A. SANTINI
		PROJECT NUMBER: GP06PICA.P077	DRAWING NUMBER: 7

2.6.7.3 Surface Water Downgradient of Area E

Studies within Area E surface water have been primarily conducted on a region-wide basis with the goal of identifying region-wide areas of contamination. Surface water samples were collected from GPB in the vicinity of Area E groundwater plume to determine if the Area E groundwater contamination was impacting GPB.

Surface water samples collected upstream of Area E (northeast of First Street) indicated the presence of TCE, 1,2-DCE, chloroform, and PCE. The contamination is likely a result of groundwater discharge from the Area D VOC plume. Surface water samples collected adjacent to Area E indicated similar results. Because these concentrations are of the same magnitude as concentrations upstream of Area E (within Area D) and did not include detections of 1,1,1–TCA, the VOCs are believed to have originated from the Area D plume. This discharge is being remediated by a separate action specific to Area D groundwater.

To characterize the potential for groundwater discharge from the unconfined aquifer to GPB, six additional surface water samples were collected within GPB downgradient from Area E. These sample results indicated that no chlorinated VOCs other than vinyl chloride were detected at concentrations greater than the surface water LOCs identified in the FS. Based on these results, detections of these compounds in the surface water are likely to be attributed to sources upstream originating in the Area D groundwater plume.

2.6.7.4 Site 22

NJDEP-approved RCRA closure was completed for Site 22 in 1992. Closure activities included excavation and disposal of soil and underground piping associated with the surface impoundment unit and restoration including backfill with clean material. The trench for the influent piping was backfilled and covered with asphalt.

Post-excavation samples were collected from the bottom of the piping trenches and from the sidewalls of the impoundment trench excavation. Influent and effluent piping was encountered between four and five feet below ground surface. Post-excavation soil samples were analyzed for metals, cyanide, total base/neutral extractables, and total acid extractables. Post-excavation soil sampling results indicated no cyanide, base/neutral or acid extractables. However, sporadic metals exceedances, when compared to current NJDEP non-residential Direct Contact Soil Cleanup Criteria (DCSCC), were seen. Out of a total of 39 samples collected, three samples contained concentrations of copper in excess of the non-residential DCSCC of 600 milligrams per kilogram (mg/kg) and six samples contained concentrations of beryllium in excess of the non-residential DCSCC of 2 mg/kg. Because post-excavation samples from the influent and effluent piping trenches were collected deeper than four feet below ground surface, this residual contamination is buried beneath a minimum of four feet of clean fill material. Additionally, in the case of the influent piping trench, the ground surface is paved (Building 95 parking lot). Post-excavation samples from the impoundment location were collected one foot above the bottom of the excavation. The excavation was advanced to a maximum depth of eight feet below ground surface. Therefore the residual contamination is buried beneath as much as seven feet of clean fill material. Sampling of the drainage ditch was also conducted at this time. These samples indicated concentrations of chromium and copper exceeded their respective sediment action levels. However, surface water in the ditch is intermittent and therefore copper and chromium concentrations in sediment were compared to the NJDEP non-residential direct contact soil cleanup criterion. The maximum concentration of copper exceeded the NJDEP cleanup criterion while the maximum concentration of chromium did not. The drainage ditch was not included in the RCRA closure. Although the NJDEP approved the RCRA closure, they indicated that further response would be necessary for the residual contamination in the drainage ditch. **Table 2** presents a comparison of the maximum concentrations of metals in subsurface soil and drainage ditch sediment to current NJDEP non-residential DCSCC. **Figure 8** presents the locations of post excavation samples and indicates which samples exhibited concentrations of copper or beryllium in excess of current NJDEP non-residential DCSCC.

The 1999 Phase I Additional RI was conducted to further characterize the drainage ditch area leading to GPB that was a potential contaminant pathway to GPB. As a result, three surface water and three sediment samples were collected from the drainage ditch area. Chromium exceeded the LOC (identified in the Site 22 FS) in both surface water and sediments at all three sampling locations. These locations were resampled and analyzed for chromium speciation. Results of the chromium speciation indicated that trivalent chromium exceeded the LOC in two downgradient surface water samples and in all of the sediment samples. No hexavalent chromium was detected in the surface water samples; however, it was detected below the LOC in all sediment samples. **Figure 9** presents the concentrations of constituents exceeding LOCs in surface water and sediment.

Table 2: Comparison of Site 22 Maximum Subsurface Soil and Sediment Concentrations from the 1991 RCRA Closure to Current NJDEP Non-Residential Direct Contact Soil Cleanup Criteria

Contaminant	NJDEP Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)	Maximum Concentration Observed (mg/kg)	Location of Maximum Concentration
Subsurface Soil			
Beryllium	2	7.7	S-1
Copper	600	1049.5	S-10A
Sediment			
Copper	600*	823.1	ST4

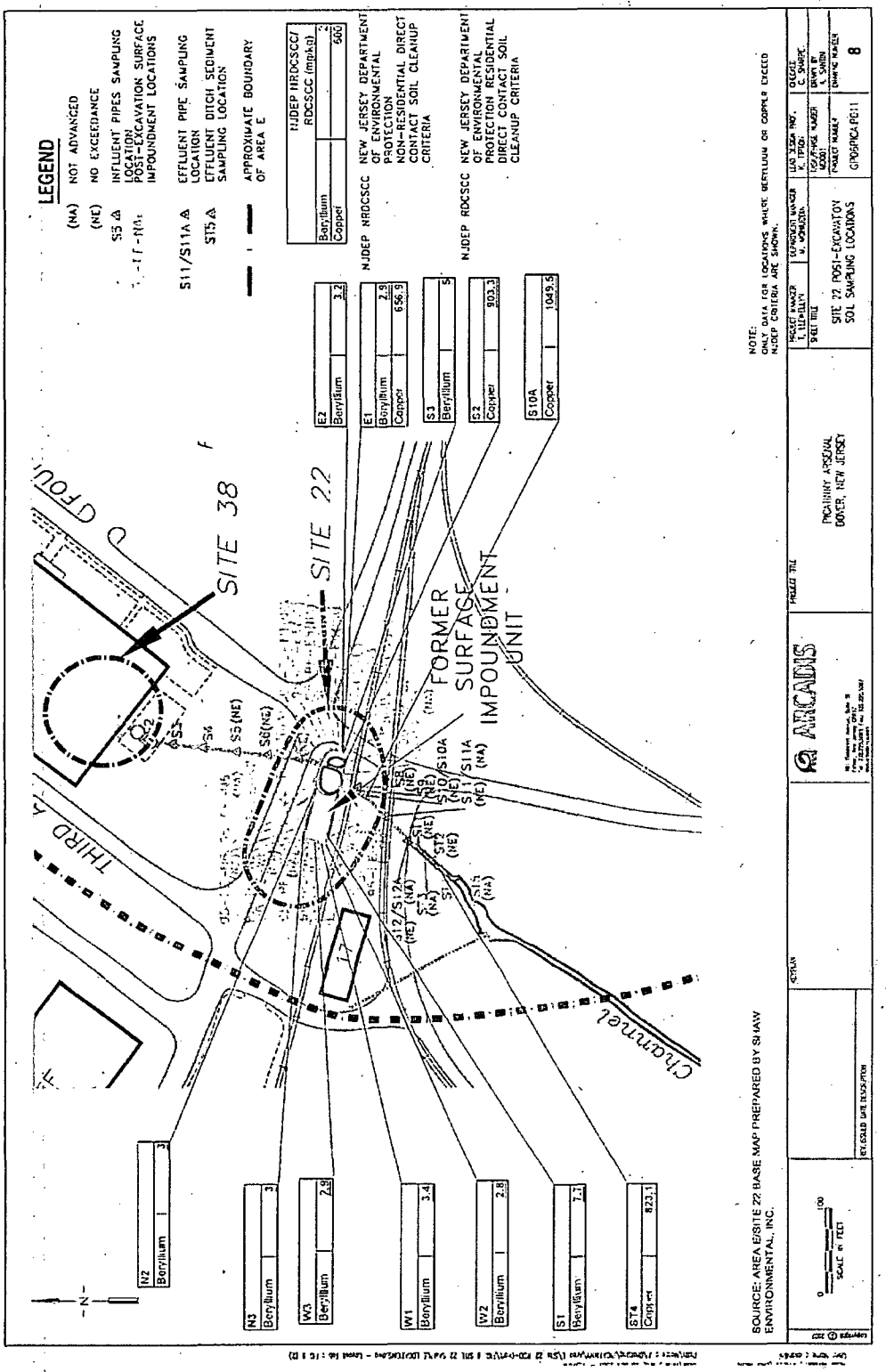
* Note that surface water in the ditch is intermittent. Therefore the copper concentration is compared to the NJDEP non-residential direct contact soil cleanup criterion

2.6.8 Area E Groundwater Plume Characteristics

The most prominent feature of Area E groundwater is a chlorinated solvent plume. This plume was created when solvents were introduced into subsurface materials through leaks from the wastewater treatment tanks, pipes, sludge drying beds, and sand filter lagoons formerly located at Site 22 and Site 38 within Area E, where PCE, 1,1,1-TCA, and TCE were historically used.

The Army has identified five chemicals as those which pose the greatest potential risk to human health in Area E groundwater (COCs, see Section 2.8.1.1). The characteristics of the five COCs that have been identified in Area E groundwater are presented below:

- **Trichloroethene (TCE)** is a halogenated organic compound historically used as a solvent and degreaser in many industries. Exposure to this compound has been associated with deleterious health effects in humans. Based on laboratory studies, TCE is considered a probable human carcinogen.
- **1,1-Dichloroethene (1,1,-DCE)** is a halogenated organic compound formed through the breakdown of TCE. Exposure to this compound has been associated with deleterious health effects in humans.
- **cis-1,2-Dichloroethene (cis-1,2-DCE)** is a halogenated organic compound formed through the breakdown of TCE by microorganisms. Exposure to this compound has been associated with deleterious health effects in humans.
- **Tetrachloroethene (PCE)** is a halogenated organic compound historically used as a solvent and degreaser in many industries. Exposure to this compound has been associated with deleterious health effects in humans.


LEGEND
(NA) NOT ADVANCED
(NE) NO EXCEEDANCE
S5 INFLUENT PIPES SAMPLING LOCATION
POST-EXCAVATION SURFACE IMPOUNDMENT LOCATIONS
S11/S11A EFFLUENT PIPE SAMPLING LOCATION
ST5 EFFLUENT DITCH SEDIMENT SAMPLING LOCATION
APPROXIMATE BOUNDARY OF AREA E
NJDEP NRDCSCC/ RDCSCC (mg/kg)
Beryllium 2
Copper 600
NJDEP NRDCSCC NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION NON-RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA
NJDEP RDCSCC NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA
NOTE: ONLY DATA FOR LOCATIONS WHERE BERYLLIUM OR COPPER EXCEED NJDEP CRITERIA ARE SHOWN.
SITE 38
SITE 22
FORMER SURFACE IMPOUNDMENT UNIT
THIRD AVENUE
Channel
E2 Beryllium 3.2
E1 Beryllium 2.9 Copper 656.9
S3 Beryllium 5
S2 Copper 903.3
S10A Copper 1049.5
N2 Beryllium 3
N3 Beryllium 3
W3 Beryllium 2.8
W1 Beryllium 3.4
W2 Beryllium 2.8
S1 Beryllium 7.1
ST4 Copper 823.1
SOURCE: AREA E/SITE 22 BASE MAP PREPARED BY SHAW ENVIRONMENTAL, INC.
MCGINNY ARSENAL DOVER, NEW JERSEY
SITE 22 POST-EXCAVATION SOIL SAMPLING LOCATIONS
8

User Name : escalini Path\Name : J:\Drafting\PICATINNY\Area E\Site 22 ROD-Draft\FIG. 4 & 9 SITE 22.dwg – Layout Tab : FIG. 5

SITE 22 ARARs:

Surface Water ARARs (µg/L) [NJDEP SWQC (FW-2)]	
Aluminum	37,000
Arsenic	0.017*
Chromium, Total	110
Copper	1,500
Iron	11,000
Lead	5
Manganese	730*
Zinc	NA

* Values are based on a potential human health risk that is not considered a viable pathway at Site 22.

Sediment PELs (mg/kg)	
Arsenic	22
Chromium	247
Lead	2,500
Zinc	436

38SW-1		
Analyte	Sampling Results (µg/L)	
	April 1997	April 2003
Aluminum	NS	121 J
Arsenic	NS	<10.0
Chromium, Total	NS	4.0 J
Copper	NS	37.9
Iron	NS	1,680
Lead	NS	2.5 J
Manganese	NS	38 J
Zinc	NS	48.0

38SD-1	
Analyte	April 1997 Sampling Results (mg/kg)
Arsenic	7.67
Chromium, Total	166.0
Lead	25.5
Zinc	93.1

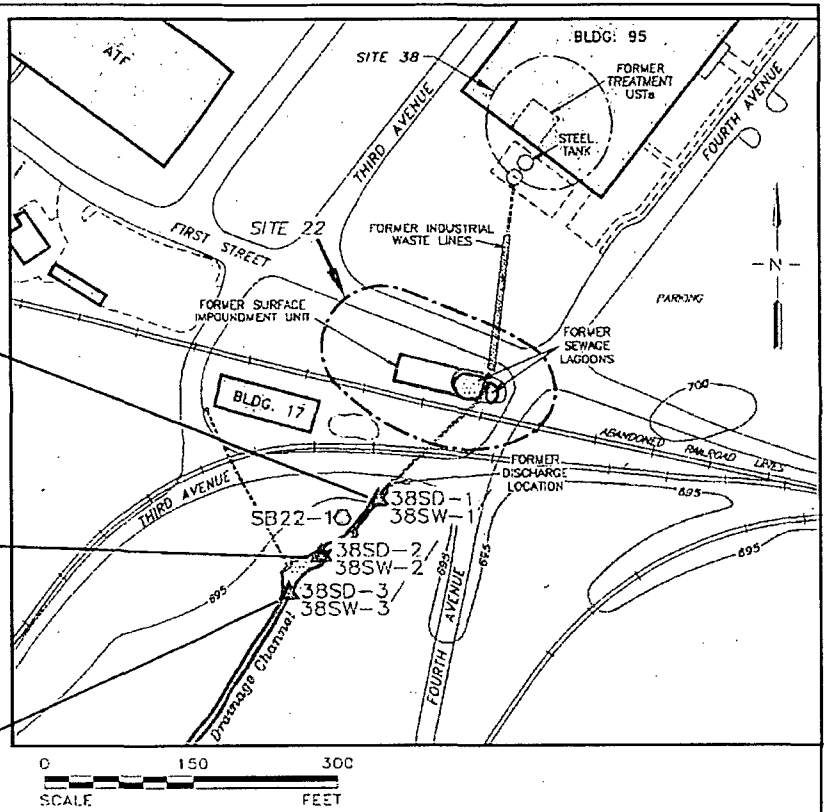
38SW-2		
Analyte	Sampling Results (µg/L)	
	April 1997	April 2003
Aluminum	190.0	87.6 J
Arsenic	2.10	<10.0
Chromium, Total	58.3	3.0 J
Copper	16.5	9.2 J
Iron	1,040.0	933
Lead	2.5	<3.0
Manganese	525.0	401
Zinc	32.7	31.7

38SD-2	
Analyte	April 1997 Sampling Results (mg/kg)
Arsenic	11.90
Chromium, Total	76.0
Lead	104.0
Zinc	87

38SW-3		
Analyte	Sampling Results (µg/L)	
	April 1997	April 2003
Aluminum	4,320.0	<200
Arsenic	11.60	<10.0
Chromium, Total	74.8	5.6
Copper	124.0	10.9
Iron	39,200.0	686
Lead	111.0	<3.0
Manganese	836.0	473
Zinc	264.0	41.3

38SD-3	
Analyte	April 1997 Sampling Results (mg/kg)
Arsenic	2.06
Chromium, Total	62.20
Lead	68.90
Zinc	59.5

J Estimated Result. Result is less than reporting limit.
NS = Not sampled
NA = Not available



SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.

LEGEND:
- SURFACE WATER/SEDIMENT SAMPLING LOCATION
- SURFACE SOIL SAMPLING LOCATION

NOTES:
1. SAMPLING RESULTS SHOWN IN RED REPRESENT CONCENTRATIONS ABOVE ARARs.
2. 1997 DATA WERE INCLUDED IN FINAL PHASE I ADDITIONAL SAMPLING RI REPORT SUBMITTED BY IT CORPORATION IN SEPTEMBER 1999.

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PROJECT MANAGER T. LLEWELLYN	DEPARTMENT MANAGER M. MOHIUDDIN	LEAD DESIGN PROF. J. CHERRY	CHECKED BY K. TIPTON
SHEET TITLE: ARAR EXCEEDANCES IN SITE 22 SURFACE WATER & SEDIMENT SAMPLES AREA E GROUNDWATER–DRAFT PICATINNY ARSENAL, DOVER, NJ		TASK/PHASE NUMBER M0001	DRAWN BY A. SANTINI
		PROJECT NUMBER GP05PICA.P077	DRAWING NUMBER 9

Vinyl Chloride (VC) is a halogenated organic compound formed through breakdown of both cis-1,2-DCE and 1,1-DCE. Exposure to this compound has been associated with deleterious health effects in humans. Vinyl chloride is a known human carcinogen.

2.6.9 Fate and Transport of PCE and TCE

The fate and transport characteristics of the contaminants that reside in the plume are vital aspects of the chemical compounds that affect their behavior, ability to mobilize, rate of degradation, and probability of human, biotic, or ecological exposure. The important processes that may influence the fate of TCE and PCE include physical transport processes, such as advection, diffusion, volatilization, and adsorption, natural degradation processes, such as chemical reactions and biodegradation, and discharge to GPB. As previously discussed in Section 2.6.7.2 "Natural Attenuation Assessment", these processes, synergistically, have contributed to the 50 percent overall reductions of PCE and TCE concentrations within a 10-year time frame. Further details on the fate and transport of COCs in Area E groundwater are discussed in the Final Area E Groundwater Feasibility Study (IT, 2002).

2.7 CURRENT AND POTENTIAL FUTURE LAND USES AND DESIGNATION OF AREA E

The Picatinny Arsenal master planning land use designation for the land within Area E is administrative and laboratory operations. Numerous uses and activities are conducted in this area of Picatinny Arsenal including:

- Base golf course maintenance facility (Site 44)
- Sewage Treatment facility (Site 28)
- Administrative office space in Building 95 (Site 38)
- Public relations activities, e.g. Veterans Day, in parking lot south of Building 95 (Site 38)
- Area D Groundwater Treatment Plant (adjacent to Site 44)

No VOCs originated from these activities other than the contaminants identified at Sites 22 and 38.

The future land use of Area E is anticipated to remain unchanged from current land use designation. Area E will continue to be used for industrial activities by the Army. Currently Area E is within a NJDEP-approved CEA, described in the letter dated July 29, 2002 to the NJDEP, for the bedrock and unconsolidated aquifers. The terminology "unconsolidated aquifers" in the CEA encompasses the unconfined, upper semi confined, and lower semi confined aquifers which underlie Area E. The CEA was established for many compounds previously detected within the confines of Picatinny. This includes the COCs established for Area E Groundwater (see section 2.8.1.1). The Picatinny Arsenal CEA mandates that any proposed groundwater use within the CEA will require NJDEP review and approval to ensure that modifications would be protective of any impacts from identified contaminants for the duration of the CEA. The Selected Remedy for the site will include updating the existing CEA. Area E is entirely within Picatinny Arsenal's property boundary. Picatinny Arsenal is an active military installation with a potable water system that currently meets all of its needs. There are currently no plans for increasing the capacity of that system.

2.8 SUMMARY OF SITE RISKS

This section presents the results of the Area E human health and ecological risk assessments that were conducted for the Phase I RI by Dames and Moore. The risk assessments were designed to evaluate the potential impact to human health and the environment. It should be noted that the data collected during the DGI are not included in this assessment.

All of the risk assessments summarized below were performed at the request of the USEPA. It should be noted that currently Area E is within a NJDEP-approved CEA, described in the letter dated July 29, 2002 to the NJDEP, for the bedrock and unconsolidated aquifers. The NJDEP has identified the CEA as a WRA that functions as an institutional control to restrict potable use within the boundaries of the CEA. The Picatinny CEA mandates that any proposed groundwater use within the CEA will require

review and approval to ensure that modifications would be protective of any impacts from identified contaminants for the duration of the CEA. Therefore, direct residential human exposures to untreated groundwater are unlikely. A summary of the results of the human health and environmental risk assessments are presented in the following sections.

The response action selected in this ROD is necessary to protect human health and the environment from actual or threatened releases of hazardous substances into the environment.

2.8.1 Human Health Risk Assessment

To determine whether risk-based remedial action is warranted, USEPA requires a baseline human health risk assessment (HHRA) be conducted for each site. The baseline risk assessment is an evaluation of cancer risks and non-cancer hazards of constituents of potential concern (COPCs) associated with a site if no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section summarizes the results of the baseline risk assessment for this site. As part of the baseline HHRA, estimates of exceeded cancer risks and non-cancer health hazards are quantified for potential receptor populations and exposure scenarios.

Currently, USEPA guidelines for cumulative carcinogenic site risk to an individual, based on reasonable maximum exposure for both current and future land use, use a risk range of $1x10^{-6}$ (one in one million) to $1x10^{-4}$ (one in ten thousand) as a target range within which the USEPA strives to manage risks as part of a Superfund Cleanup. Exceedances of this target range may trigger remedial action.

Potential non-carcinogenic effects are evaluated by comparing the calculated exposure intake of the COPCs to the chemical-specific reference dose. This ratio of exposure to toxicity is called the hazard quotient (HQ). HQs greater than 1 are indicative of potential adverse health effects. The hazard index (HI) is the sum of all HQs for all COPCs that affect the same target organ, or act through the same mechanism of action within a media or across all media, of a reasonably maximum exposed individual. In general, HIs that are less than 1 are not likely to be associated with non-cancer hazards.

The Phase I RI HHRA was prepared to evaluate the probability and magnitude of adverse effects on human health associated with actual or potential exposure to COPCs that were selected for evaluation. The HHRA was based on groundwater, surface soil, subsurface soil, sediment, and surface water data collected during the Phase I RI. Additionally, risk assessment results were scaled after the collection of additional data in the 1999 Additional RI (ICF, 1999). Those risks to humans based on fish consumption were not included in this risk summary since there are no game fish that are consumed in the drainage ditches or reach of GPB in Area E. Throughout the RI/FS process, Area E groundwater and Site 22 were treated as separate sites. Therefore, the risk assessments were performed independently. The following sections present risk assessment results for Area E groundwater followed by Site 22.

2.8.1.1 Identification of Contaminants of Concern

This section presents a summary of the COC selection that was performed as part of the Area E groundwater FS (IT, 2002) and Site 22 FS (Shaw, 2004). A determination of COCs was also performed for the Phase I HHRA (Dames and Moore, 1998) in accordance with the Risk Assessment Guidance for Superfund (RAGS). The COC selection performed for the FS included an evaluation of the HHRA COCs.

COCs were identified for Area E groundwater based on exceedance of groundwater standards and contaminant distribution indicative of a contaminant plume. Inorganic contaminants exhibiting random distribution were removed from COC consideration. Organic contaminants that were sporadically detected and not confirmed in adjacent or subsequent samples were also eliminated via this criterion. The five COCs identified in the unconfined aquifer were 1,1-DCE, cis-1,2-DCE, PCE, TCE, and vinyl chloride. **Table 1** presents the maximum concentrations of Area E groundwater COCs compared to the groundwater standards.

COCs were selected for Site 22 based on contribution to the majority of site-specific human health or ecological risk and exceedance of the NJDEP DCSCC, USEPA Ambient Water Quality Criteria

(AWQC), and/or NJDEP Surface Water Quality Criteria (SWQC). No COCs were identified for surface or subsurface soil at Site 22.

Arsenic, chromium, lead, selenium, and zinc were retained as COCs in Site 22 sediment. Sediment concentrations of the COCs were compared further with the site-specific potential effect levels (PELs) developed for the focused FS for GPB at Picatinny Arsenal in May 2001 (IT, 2001). PEL is defined as a level at which one might expect to be able to observe ecological effects. **Table 3** presents the comparison of the maximum detected concentrations of COCs in sediment with estimated risk-based cleanup levels (RBCLs) and PELs. The RBCL values were calculated specifically for the Site 22 FS. As shown, the maximum detected concentrations of the COCs in sediment were all below their corresponding RBCLs and/or PELs. Therefore, no site cleanup levels (SCLs) were developed for sediment. **Figure 9** shows the sample locations and the associated analytical results of the COCs.

Table 3: Comparison of RBCL, PEL, and Maximum Sediment Concentrations at Site 22

COC	Human Health RBCL	Ecological RBCL	PEL	Max. Detected Concentration
Arsenic (mg/kg)	20 (3)	23,500	22	11.9
Chromium (mg/kg)	NA	520	247	223
Lead (mg/kg)	NA	5,500	2,500	104
Selenium(mg/kg	NA	900	NA	2.33
Zinc (mg/kg)	NA	16,000	456	97

Notes:
The risk-based value for arsenic is 3 mg/kg; however, NJDEP DCSCC of 20 mg/kg is used since this is a background-based concentration.
NA not applicable, as the constituent was not identified as a risk or hazard driver.
NJDEP New Jersey Department of Environmental Protection
NR SCL not relevant, as the maximum detected concentration was lower than the RBCLs and the PEL.
RBCL Risk-Based Cleanup Level
SCL Site Cleanup Level
PEL Potential Effect Level

Aluminum, chromium, copper, iron, lead, and zinc were identified as COCs in Site 22 surface water based on exceedance of either the acute or chronic standards. Because of the intermittent nature of the surface water, it is likely that sediment contamination contributes to contamination of surface water.

As a result of an agreement reached at the program meeting on January 15, 2003, three samples of surface water were obtained from the drainage ditch on April 21, 2003 and analyzed for metals so that analytical results could be compared with those from the 1999 study. Additionally, it was concluded that Site 22 could be a candidate for LUCs as a remedial alternative, if surface water contamination remained the same or decreased since 1999. **Table 4** presents the comparison between maximum concentrations detected during the 1999 Phase I Additional RI and the additional sampling in 2003 with the NJDEP SWQC. **Figure 9** shows the surface water sampling locations. As shown, sampling results from April 2003 indicated that surface water concentrations of the COCs have decreased since they were last sampled in 1999. All results were below NJDEP SWQC except for arsenic; however, the SWQC level for arsenic was derived based on a potential human health risk that is not considered a viable pathway at Site 22. These data were presented at the program meeting on May 15, 2003. At this meeting, both NJDEP and USEPA representatives agreed that active remediation was not warranted for sediment and surface water at Site 22. However, LUCs would be necessary to maintain protectiveness under potential future use scenarios.

Table 4: Comparison of SWQC and Maximum Surface Water Concentrations at Site 22

Constituent	Max. Concentration Phase I Additional RI (1999)	Max. Concentration April 2003	NJDEP SWQC (FW-2)
Aluminum (µg/L)	4,320	123	37,000
Arsenic (µg/L)	11.6	<10	0.017[1]
Chromium, Total (µg/L)	74.8	5.6	92
Copper (µg/L)	124	37.9	1,300
Iron (µg/L)	39,200	2,250	11,000
Lead (µg/L)	111	2.5	5
Zinc (µg/L)	264	48	NA

[1] Value is based on potential human health risk that is not considered a viable pathway at Site 22.

2.8.1.2 Exposure Assessment

Figure 3 presents a conceptual site model of environmental transport media and principal exposure routes for Area E groundwater and Site 22.

The potential pathways through which individuals may be exposed to COPCs were discussed in detail within the Phase I RI HHRA. Probable exposure pathways were then selected for quantitative evaluation in the HHRA. Using the site-specific data obtained from the field samples, chemical concentrations were computed for the points of potential exposure associated with each pathway selected for quantitative evaluation. Assumptions were made for the magnitude, frequency, and duration of exposure for each pathway, and potential exposures (intakes) were then quantified. Ingestion, dermal absorption, and inhalation of VOCs were evaluated for groundwater, and dermal absorption was evaluated for surface water. Detailed evaluations for the incidental ingestion and dermal absorption of sediment can be found in the Phase I RI HHRA.

For Area E groundwater, hypothetical future exposure to groundwater for workers, combined adults/children, and children were evaluated for ingestion, inhalation, and skin contact risks. The risks were calculated for the unconfined aquifer and semi-confined aquifers separately. The potential receptors and pathways through which individuals could be exposed to groundwater contamination included the following:

- Future ingestion of groundwater used for drinking water by Picatinny Arsenal workers;
- Future ingestion of groundwater used for drinking water by combined child/adult residents;
- Future ingestion of groundwater used for drinking water by adult residents;
- Future dermal absorption of chemicals in groundwater while bathing by combined child/adult residents;
- Future dermal absorption of chemicals in groundwater while bathing by adult residents;
- Future inhalation of VOCs in groundwater while showering by combined child/adult residents; and,
- Future inhalation of VOCs in groundwater while showering by adult residents.

It should be noted that residential exposures to chemicals in groundwater are not expected to occur as the expected future use of the site is industrial by the Army. Nevertheless, these pathways were evaluated for informational purposes.

It was decided as part of the DGI that the vapor intrusion exposure pathway would not be evaluated specifically for Area E, based on results of a similar evaluation at Area D, which indicated that there are no unacceptable risks from vapor intrusion. Area D has a higher concentration of VOCs in groundwater (IT, 2003) and there are more buildings located over the Area D plume, several of them with

basements. There are only three buildings located within the Area E plume footprint, Buildings 80, 82, and 95. Building 95 has a basement and is the only building that is regularly occupied. The depth to groundwater under Building 95 is approximately 4 ft bgs. Building 80 is the wastewater treatment plant that is occupied intermittently. Building 82 is currently unoccupied.

Additionally, the detected groundwater concentrations of COCs in the DGI were compared to the screening criteria in the draft *Vapor Intrusion Guidance* (USEPA, 2002). Results of the screening indicate that the maximum concentrations of 1,1-DCE, cis 1,2-DCE, PCE, and vinyl chloride detected in the groundwater do not exceed the screening criteria, indicating that no further evaluation of the vapor intrusion pathway is required. Additionally, TCE was not detected beneath Building 80, and was well below the screening criteria beneath Building 82. The TCE concentration beneath Building 95 (6.5 µg/L) slightly exceeded the screening concentration, which is based on residential occupancy, not occupational, and therefore conservative. The maximum detected concentration of TCE (35 µg/L in MW12H) exceeded the screening concentration of 5.3 µg/L, but was detected cross-gradient from Building 95, and therefore does not present potential for vapor intrusion into the building. Based on these determinations, it is concluded that no further evaluation of the vapor intrusion pathway is required.

For Site 22, the three exposure scenarios evaluated were current outdoor maintenance worker, future industrial research worker, and future construction worker. A future residential scenario was not examined for Site 22 because the Army does not anticipate that type of land use. The recommended remedial alternative will preclude residential land use of the site.

Surface water was not evaluated as a potential human health risk since exposure to surface water is not considered a complete pathway. Because of the intermittent nature of the drainage ditch, it would not serve as a potential drinking water source. Additionally, the ditch does not support organisms that are used for human consumption.

2.8.1.3 Toxicity Assessment

The potential toxicity of chemicals to humans was presented and the chemical-specific toxicity criteria were compiled for each COPC within the Phase I risk assessment. Specifically, the toxicity criteria used in the quantitative assessment were obtained from USEPA's Integrated Risk Information System (IRIS), the Health Effects Assessment Summary Tables (HEAST), and the National Center for Environmental Assessment (NCEA).

2.8.1.4 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

$$Risk = CDI \times SF$$

where:
- risk = a unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer
- CDI = chronic daily intake averaged over 70 years (mg/kg-day)
- SF = slope factor, expressed as $(mg/kg\text{-}day)^{-1}$.

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the RME estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. USEPA identifies cancer risks of 10^{-6} to 10^{-4} as a target range within which USEPA strives to manage risks for site-related exposures for Superfund sites.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An

RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called an HQ. An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all chemicals of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI>1 indicates that site-related exposures may present a risk to human health. The HQ is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI/RfD}$$

where: CDI = Chronic daily intake
RfD = reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

2.8.1.4.1 Area E Groundwater

The unconfined and semi-confined groundwater strata were evaluated independently. All samples collected during the Phase I RI for Area E groundwater (all three sampling rounds) were used in the HHRA to assess risks associated with groundwater exposures.

The contaminants shown in **Table 5 through Table 7** are either the five COCs for the Area E groundwater plume or those chemicals that are significant contributors to the overall risk (cancer risk higher than 1×10^{-6} or HI greater than 1.0). It should also be noted that the constituents absent from these tables were not selected for consideration during the performance of the Phase I RI HHRA due to the lack of detections of these compounds or they did not exceed risk-based criteria (human health) used for screening the media in question. Furthermore, the total risks presented in these tables only represent the total for the contaminants that significantly contributed to the overall risk (presented in the tables) and do not represent the total risk for each receptor for each medium exposure.

Exposures to COPCs in groundwater from the unconfined aquifer were associated with total cancer risks of 7×10^{-5} for workers, 3×10^{-4} for combined adult/child residents, and 1×10^{-4} for child residents. Although six VOCs were selected as COPCs in this groundwater aquifer, the risk drivers (i.e., chemicals that contributed most significantly to the elevated risks for each of the receptors) were arsenic, beryllium, and 1,1-DCE. Arsenic makes up 59.6% of the risk (2×10^{-4}) for future adult and children residents; 59.8% (7×10^{-5}) for future children residents; and 54.5% (4×10^{-5}) for workers. Beryllium makes up 20.9% of the risk (7×10^{-5}) for future adult and children residents; 17.1% (2×10^{-5}) for future children residents; and 27.2% (2×10^{-5}) for workers. 1,1-DCE makes up 8.9% of the risk (4×10^{-5}) for future adult and children residents; 13.7% (1.6×10^{-5}) for future children residents; and 9.5% (7×10^{-6}) for workers.

Groundwater in the semi-confined aquifer was associated with total cancer risks of 4×10^{-4} for workers, 2×10^{-3} for combined future adult/child residents, and 7×10^{-4} for future child residents. Risk drivers were arsenic and beryllium. Two VOCs were selected as COPCs in the semi-confined aquifer groundwater grouping, but neither contributed as significantly to overall risks as arsenic and beryllium. Arsenic makes up 41.2% of the risk (7×10^{-4}) for combined future adult/child residents; 42.9% (3×10^{-4}) for future child residents; and, 50% (2×10^{-4}) for workers. Beryllium makes up 58.8% of the risk (1×10^{-3}) for combined future adult/child residents; 57.1% (4×10^{-4}) for future child residents; and, 50% (2×10^{-4}) for workers.

The risk assessment evaluations performed for groundwater sampled in Area E indicated that risks due to the VOC contamination were within the CERCLA risk range. The VOC that primarily contributed to the elevated cancer risks for the ingestion pathway (the pathway with the greatest risks) was 1,1-DCE in the unconfined aquifer. All other risk is attributable to compounds not associated with the

VOC plume. There were no VOCs that contributed significantly to HIs exceeding the threshold value of 1.0 for the groundwater ingestion pathway.

Table 5: Area E Future Site Worker Groundwater Risk Characterization Summary - Carcinogens

Scenario Time Frame: Future
Receptor Population: Picatinny Arsenal Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Constituent	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Surficial Aquifer Use	1,1-DCE	7.0×10^{-6}	NA	NA	7.0×10^{-6}
			cis-1,2-DCE	NA	NA	NA	0.00
			PCE	3.0×10^{-6}	NA	NA	3.0×10^{-6}
			TCE	4.0×10^{-7}	NA	NA	4.0×10^{-7}
			VC	NA	NA	NA	0.00
			Arsenic	4.0×10^{-5}	NA	NA	4.0×10^{-5}
			Beryllium	2.0×10^{-5}	NA	NA	2.0×10^{-5}
			Total PCBs	3.0×10^{-6}	NA	NA	3.0×10^{-6}
						TOTAL RISK	**7.0×10^{-5}**
Groundwater	Groundwater	Semiconfined Aquifer Use	Arsenic	2.0×10^{-4}	NA	NA	2.0×10^{-4}
			Beryllium	2.0×10^{-4}	NA	NA	2.0×10^{-4}
						TOTAL RISK	**4.0×10^{-4}**

Table 6: Area E Future Adult/Child Groundwater Risk Characterization Summary - Carcinogens

Scenario Time Frame: Future
Receptor Population: Residents
Receptor Age: Adult/Child

Medium	Exposure Medium	Exposure Point	Constituent	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Surficial Aquifer Use	1,1-DCE	3.0×10^{-5}	1.0×10^{-5}	1.0×10^{-10}	4.0×10^{-5}
			cis-1,2-DCE	NA	NA	NA	0.00
			PCE	1.0×10^{-5}	8.0×10^{-7}	9.0×10^{-10}	1.08×10^{-5}
			TCE	2.0×10^{-6}	1.0×10^{-6}	2.0×10^{-10}	3.0×10^{-6}
			VC	NA	NA	NA	0.00
			Arsenic	2.0×10^{-4}	NA	1.0×10^{-10}	2.0×10^{-4}
			Beryllium	7.0×10^{-5}	NA	2.0×10^{-9}	7.0×10^{-5}
			Total PCBs	1.0×10^{-5}	NA	NA	1.0×10^{-5}
						TOTAL RISK	**3.0×10^{-4}**
Groundwater	Groundwater	Semiconfined Aquifer Use	Arsenic	7.0×10^{-4}	NA	5.0×10^{-10}	7.0×10^{-4}
			Beryllium	1.0×10^{-3}	NA	3.0×10^{-8}	1.0×10^{-3}
						TOTAL RISK	**2.0×10^{-3}**

Note: Total risk is rounded up.

Table 7: Area E Future Child Groundwater Risk Characterization Summary - Carcinogens

Scenario Time Frame: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Constituent	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Surficial Aquifer Use	1,1-DCE	1.0×10^{-5}	6.0×10^{-6}	3.0×10^{-11}	1.6×10^{-5}
			cis-1,2-DCE	NA	NA	NA	0.00
			PCE	5.0×10^{-6}	3.0×10^{-7}	2.0×10^{-10}	5.3×10^{-6}
			TCE	6.0×10^{-7}	6.0×10^{-7}	3.0×10^{-11}	1.2×10^{-6}
			VC	NA	NA	NA	0.00
			Arsenic	7.0×10^{-5}	NA	4.0×10^{-11}	7.0×10^{-5}
			Beryllium	2.0×10^{-5}	NA	7.0×10^{-10}	2.0×10^{-5}
			Total PCBs	4.0×10^{-6}	NA	5×10^{-15}	4.0×10^{-6}
						TOTAL RISK	**1.0×10^{-4}**
Groundwater	Groundwater	Semiconfined Aquifer Use	Arsenic	3.0×10^{-4}	NA	2.0×10^{-10}	3.0×10^{-4}
			Beryllium	4.0×10^{-4}	NA	1.0×10^{-8}	4.0×10^{-4}
						TOTAL RISK	**7.0×10^{-4}**

Groundwater in the unconfined aquifer was associated with elevated HIs for all pathways combined. The calculated HIs were 3 for workers, 12 for adult/child residents, and 23 for child residents. The chemicals that accounted for the most elevated HIs were manganese, iron, and antimony, of which none are associated with the Area E groundwater plume. Manganese makes up 33.4 percent of the HI (4) for adult and children residents; 34.9 percent (8) for children residents; and 31.3 percent (1) for workers. Iron makes up 25.1 percent of the HI (3) for adult and children residents; 26.2 percent (6) for children residents; and, 25.1 percent ($8x10^{-1}$) for workers. Antimony makes up 25.1 percent of the HI (3) for adult and children residents; 21.8 percent (5) for children residents; and, 25.1 percent ($8x10^{-1}$) for workers.

Groundwater in the semi-confined aquifer was associated with elevated HIs for all pathways combined. The HIs were 136 for workers, 449 for adult/child residents, and 937 for child residents. The chemicals that accounted for the elevated HIs included iron, manganese, and thallium; none of these were associated with the Area E groundwater plume. Manganese makes up 11.1 percent of the HI (50) for adult and children residents; 10.7 percent (100) for children residents; and, 14.8 percent (20) for workers. Iron makes up 17.8 percent of the HI (80) for adult and children residents; 21.4 percent (200) for children residents; and, 14.8 percent (20) for workers. Thallium makes up 66.8 percent of the HI (300) for adult and children residents; 64.1 percent (600) for children residents; and 66.4 percent (90) for workers.

Due to the inconsistencies of the metal data between sampling rounds and the lack of specific patterns evident in the data it has been concluded that the concentrations in groundwater are not site related. The conclusion was made in the final FS, which has been approved by the NJDEP and USEPA.

2.8.1.4.2 Site 22

The baseline HHRA for Site 22 was performed as part of the Phase I RI. The results of this HHRA indicated that non-carcinogenic hazards did not exceed the HI criterion of 1 for any of the receptors, and no constituents with carcinogenic endpoints were detected. The HIs calculated for the current outdoor maintenance worker and future industrial research worker are based on one sample

collected during one event. The future construction worker HI was calculated using one shallow soil sample and one subsurface soil sample collected during one event.

Additional surface water and sediment data were collected in April 1997 from the drainage ditches as part of the Phase I Additional RI. These data were used to reevaluate the human health and ecological risks first estimated for the Phase I RI. The results of the risk re-evaluation were presented in a Risk Management Plan (RMP) (IT, 2000). For purposes of the RMP evaluation, it was assumed that the sediments are similar to surface soil, and, therefore, potential risks to current outdoor maintenance workers and future industry/research workers could be scaled from results in the Phase I RI.

In the case of Site 22, Dames and Moore did not perform an evaluation of the dermal surface water uptake pathway because potential risks from dermal exposure to impacted surface water were considered insignificant. The suggested reasons are primarily because surface water is intermittent, inorganics do not readily cross the dermal layer (compared with organics), and workers are not expected to be exposed to drainage ditch surface water on a routine basis.

Table 8 presents estimated human health risks from sediment exposure at Site 22.

Table 8: Risk and Hazard Characterization Summary – Site 22 Sediment

Sediment Inorganics Above ARARs	Site Surface Soil Concentration Used in Risk Assessment (mg/kg)	Site Cancer Risk (CR) or Noncancer Hazard Quotient (HQ)	Range of Detected Concentrations in Site 22 Sediment (mg/kg)	Estimated Site 22 Risk or Hazard (based on max. conc. In fourth column)
Receptor: Outdoor Maintenance Worker				
Arsenic	10.1 (Site 24)	$2.3x10^{-7}$ (CR)	2.1-11.9	$2.7x10^{-7}$ (CR)
Arsenic	10.1 (Site 24)	0.001 (HQ)	2.1-11.9	0.001 (HQ)
Cadmium	5.57 (Site 25)	0.02 (HQ)	0.28-0.91	0.003 (HQ)
Chromium (total)	25.7 (Site 25)	0.000001 (HQ)	8.6-223	0.000009 (HQ)
Copper	1,560 (Site 24)	0.002 (HQ)	7.6-106	0.0001 (HQ)
Lead	1,270 (Site 24)	NA	25.8-104	NA
Mercury	5.7 (Site 117)	0.0007 (HQ)	0.08 ND-0.204	0.00003 (HQ)
Nickel	158 (Site 24)	0.0003 (HQ)	5.5-30.2	0.00006 (HQ)
			Total Risk	**$2.7x10^{-7}$**
			Total Hazard	**0.004**
Receptor: Industrial/Research Worker				
Arsenic	10.1 (Site 24)	$3.4x10^{-6}$ (CR)	2.1-11.9	$4x10^{-6}$
Arsenic	10.1 (Site 24)	0.02 (HQ)	2.1-11.9	0.02 (HQ)
Cadmium	5.57 (Site 25)	0.013 (HQ)	0.28-0.91	0.002 (HQ)
Chromium (total)	25.7 (Site 25)	0.00001 (HQ)	8.6-223	0.00009 (HQ)
Copper	1,560 (Site 24)	0.02 (HQ)	7.6-106	0.001 (HQ)
Lead	1,270 (Site 24)	NA	25.8-104	NA
Mercury	5.7 (Site 117)	0.0095 (HQ)	0.08 ND-0.204	0.0003 (HQ)
Nickel	158 (Site 24)	0.004 (HQ)	5.5-30.2	0.0008 (HQ)
			Total Risk	**$4x10^{-6}$**
			Total Hazard	**0.024**

2.8.2 Ecological Risk Assessment

The Phase I RI Ecological Risk Assessment (ERA) was prepared to evaluate ecological effects from contaminant residues in surface soil, sediment, and surface water. The Phase I RI ERA did not specifically evaluate Area E. The Phase I RI ERA evaluated the entire stretch of GPB in Phase I (from the Picatinny Lake spillway to the southern boundary of the installation) using benthic macroinvertebrate and fish community surveys, sediment bioassays, chemical data collected from fish tissue, surface water, and sediment. However, limited biological sampling was conducted where the Area E groundwater plume discharges, as habitat degradation is greatest in this reach of GPB. The entire reach of GPB south of Farley Avenue to the point where it exits Picatinny Arsenal is channelized. Much of the channelized portions can be characterized as steep-banked and lined with herbaceous and small woody plants that provide little shading. The channelization of GPB on Picatinny Arsenal and the bordering golf course in Area E have degraded the aquatic habitat. Sediment toxicity tests using sediment from trap and grab samples were conducted at two locations in this reach. The results of the test deemed most appropriate (48-hour LC50 on grab samples) in the screening stage indicated that these locations were not toxic. As a result, no further toxicity testing was conducted in this stream reach.

VOCs were not evaluated or selected as constituents of potential ecological concern (COPECs) in the Phase I RI ERA because they are not persistent in surface water or surface soils within the vadose zone and are unlikely to bioaccumulate. In addition, there are no areas of concern (AOC) in the reach between Farley Avenue and First Street in the GPB/BSB ROD, which is currently evaluating risks along the entire portion of GPB in Phase I (along with upstream portions of GPB in Phase II and Phase III areas). Ecological risk is the main driver in the GPB/BSB ROD. As a result, decisions for choosing a remedial alternative in Area E were not based on ecological risk.

The ERA did not specifically evaluate Site 22. Ecological hazards, however, were calculated from nearby Site 28 (also in Area E) for three representative terrestrial receptor wildlife species: the veery, the barred owl, and the American woodcock. Site 22 (Building 95) is about 1,000 ft northwest of Site 28. The ERA also performed additional studies in Drainage Area 3 near Site 28, including terrestrial earthworm bioassays, terrestrial plant community assessments, small mammal trapping and small mammal community assessments, as well as earthworm, plant, and small mammal tissue chemical analyses. The Phase I RI ERA concluded the following for Site 28:

- There is no significant bioaccumulation in plant tissue.
- There is limited bioaccumulation of copper, magnesium, and dichlorodiphenyltrichloroethane (DDT) in small mammal tissue.
- Modeled hazards to woodcock from arsenic and chromium in soils were considered conservative.

Based on these conclusions, the Phase I ERA classified Site 28 as a Group 3 site. This group included those sites within a drainage basin that, based on the overall weight-of-evidence and professional judgment, posed potential ecological risks that were of such low order that they did not appear to warrant immediate risk management attention.

As mentioned previously, additional surface water and sediment samples were collected in April 1997 from drainage ditches downgradient of the surface impoundment unit. For purposes of the RMP evaluation, it was assumed that the sediments were similar to surface soil and potential risks to the most sensitive ecological receptor (e.g., the American woodcock) could be scaled from other sites with similar constituents of concern using the results from the Phase I RI ERA. However, ecological hazards from Site 28 could not be used to estimate the hazards at Site 22 because Site 28 was much larger in size than Site 22. Therefore, Site 22 hazards were scaled from soil hazards estimated for Sites 61 and 180, as these had comparable area to Site 22 and had COPECs found in Site 22 sediment. This scaling approach is technically defensible because the important ERA variables between Site 22 and Site 61 and between Site 22 and Site 180 are assumed to be similar, except for chemical concentration (e.g., woodcocks are assumed to experience similar exposure conditions and each chemical's toxicity is

assumed to be the same). These differences in chemical concentrations are taken into consideration in the scaling approach.

Contaminant migration potential from the drainage ditch to downstream aquatic receptors was also considered. All of the sampling conducted in the drainage ditch leads to the conclusion that the sediment with the higher levels of metals is closest to the former wastewater outfall. As the topography is essentially flat and the drainage ditch exhibits very little flow, the potential for migration is minimal.

Ecological no observed adverse effect level (NOAEL)-based hazards for potential impacts to the American woodcock were estimated for inorganic COPECs at Site 22. The COPECs (and their corresponding hazard indices) were: arsenic (4.6), lead (8.0), selenium (6.5), zinc (2.8), and chromium (9). It should be noted that the chromium hazard of 9 includes a reduction of 11-fold to account for the use of a chromium^{3+} NOAEL of 1 mg/kg-day (Sample et al., 1996) compared with the chromium^{6+} NOAEL of 0.093 mg/kg-day (Dames and Moore, 1998). It should also be noted that the area use factor (AUF) for Site 22 was expected to be smaller than Site 61's AUF due to the smaller size of Site 22. Thus, Site 22 ecological hazards were likely overestimated, and the small size of the site is likely below the minimum size requirement for conducting ERAs, as further described below.

In summary, contamination in sediment and surface water associated with the drainage ditch at Site 22 does not pose unacceptable hazards to the ecological receptors, despite some estimated ecological hazards above 1. This conclusion is further supported by the fact that there is no significant habitat at Site 22, outside of the drainage ditch. This site is located in an industrial area, which is primarily surrounded by paved parking lots, streets, and other buildings. The drainage ditches located downgradient of the surface impoundment unit are expected to provide some limited habitat, although the significance of this habitat is likely minor due to their relative small size and intermittent nature. It should also be noted that at least three states Pennsylvania – Pennsylvania Department of Environmental Protection (PADEP), Massachusetts – Massachusetts Department of Environmental Protection (MADEP), and Washington – Washington Administrative Code (WAC), recommend that no ERA is even required for small sites, such as Site 22, less than 1 acre (PADEP, 1997; WAC, 2001; and MADEP, 1996). For example, PADEP states that no ERA is required for sites less than 2 acres in size. As the drainage ditch is only wet on an intermittent basis, only seasonal aquatic habitat is likely and aquatic life may be essentially absent. Secondly, since no site-specific ERA was performed at this site, greater uncertainties are inherent in the scaled risks; however, conservatisms in the ERA process (e.g., use of NOAEL-based toxicity data) compensate for some of these uncertainties. Finally, as the estimated scaled ecological hazards are all less than 10, and an AUF adjustment of at least 100 could be factored in to the scaling approach (reducing the hazards by two orders of magnitude), hazards at the site are acceptable.

2.8.3 Risk Assessment Conclusions

For Area E groundwater, the VOC that primarily contributed to the elevated carcinogenic risks for the ingestion pathway (the pathway with the greatest risks) was 1,1-DCE in the unconfined aquifer. All other risk is attributable to compounds not associated with the VOC plume. Currently Area E is within a NJDEP-approved CEA, described in the letter dated July 29, 2002 to the NJDEP, for the bedrock and unconsolidated aquifers. The terminology "unconsolidated aquifers" in the CEA encompasses the unconfined, upper semi-confined, and lower semi-confined aquifers which underlie Area E. The CEA was established for many compounds previously detected within the confines of Picatinny. This includes the COCs established for Area E Groundwater (see section 2.8.1.1). The NJDEP has identified the CEA as a WRA that functions as an institutional control to restrict potable use within the boundaries of the CEA. The CEA mandates that any proposed groundwater use within the CEA will require review and approval by NJDEP to ensure that modifications would be protective of any impacts from identified contaminants for the duration of the CEA. Area E is entirely within Picatinny Arsenal's property boundary. Picatinny Arsenal is an active military installation with a potable water system that currently meets all of its needs. There are currently no plans for increasing the capacity of that system. Therefore, direct residential human exposures to untreated groundwater are unlikely.

There were no VOCs that contributed significantly to HIs exceeding the threshold value of 1.0 for the groundwater ingestion pathway. The chemicals that accounted for the most elevated HIs were metals, of which none are associated with the Area E groundwater plume. Due to the inconsistencies of

the metal data between sampling rounds and the lack of specific patterns evident in the data it has been concluded that the metals concentrations in groundwater are not site related. The conclusion was made in the final FS, which has been approved by the NJDEP and USEPA. The basis for taking action for groundwater at Area E is exceedance of VOC groundwater standards, as presented in Section 2.6.7 of this ROD. There are several compounds that have emanated from industrial activities within Area E that exceed chemical-specific criteria for groundwater.

As stated above, there is no unacceptable estimated excess cancer risk or health hazards to human receptor populations at Site 22. Additionally, contamination in sediment and surface water associated with the drainage ditch at Site 22 does not pose unacceptable hazards to the ecological receptors.

2.9 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are based on human health and environmental factors that must be considered in the evaluation of response actions. Such objectives are developed based on criteria outlined in Section 121 of CERCLA and the NCP.

The RAOs for Area E groundwater and Site 22 have been developed in such a way that attainment of these goals will result in the protection of human health, ecological receptors, and the environment. RAOs for Area E groundwater are specific to groundwater contamination identified within Area E. The RAOs for Area E groundwater are:

- Prevent human consumption of, and contact with, contaminated Area E groundwater.
- Prevent contamination of uncontaminated Area E groundwater and surface water with COCs.
- Restore contaminated Area E groundwater to comply with its use designation. The designated use of groundwater underlying Area E is Class IIA groundwater, whose primary use is potable water and/or conversion to potable water through conventional treatment, mixing, or similar techniques.

As an additional safeguard, the RAO to prevent human consumption of Area E groundwater will be met by the Picatinny Arsenal CEA until such time that attainment of the third RAO above, aquifer restoration, is met. The risks identified in the previous section will be mitigated by attainment of these RAOs, as the only unacceptable human health risk is due to ingestion of the Area E groundwater. By preventing consumption of the groundwater, the human ingestion risk is mitigated.

RAOs for Site 22 address soil, sediment, surface water. Although there are sporadic exceedances of NJDEP non-residential DCSCC for subsurface soil at Site 22, no exposure to this material is anticipated because it is buried beneath as much as seven feet of clean-fill material. Therefore no COCs were developed for soil at Site 22 for industrial land use. Because Picatinny is an active military installation with no plans to use Site 22 for residential purposes, no evaluation of residential land use was performed as part of the risk assessment. Additionally, no comparison of site soils to residential LOCs was performed. The RAOs for Site 22 are:

- Prevent residential exposure to contaminated soil, surface water and sediment remaining at Site 22.

Attainment of this RAO will eliminate potential risks associated with Site 22.

2.10 DESCRIPTION OF ALTERNATIVES

Area E and Site 22 have undergone an RI/FS in accordance with the CERCLA process. The RI phase is the mechanism for collecting data to characterize the site and assess potential human health and ecological risk. The RI phase is followed by the FS phase, which involves the development, screening, and detailed evaluation of remedial alternatives.

Four general response actions for Area E groundwater were identified and included in the FS: No Action, Limited Action and MNA, Ex-Situ Active Restoration, and In-Situ Active Restoration. Numerous remedial technologies were identified for each general response action and process options of each remedial technology were screened based on effectiveness, implementability, and cost. This information

is provided in detail in the Final Area E groundwater FS (IT, 2002). **Table 9** presents the Remedial Alternatives retained and estimated completion times for Area E groundwater remediation.

In the Draft FS for Site 22, the Army considered five other alternatives for the preferred remedy at Site 22. However, after examining these alternatives in a Draft FS, the Army in consultation with USEPA and NJDEP concluded that the preferred alternative was implementation of LUCs. To expedite the CERCLA process at this site, the Army decided to concurrently submit the final FS reflecting the changes and the Proposed Plan to the USEPA and NJDEP for review and approval. The final FS evaluated two remedial alternatives: No Action and Implementation of LUCs, as shown in **Table 9**.

Table 9: Estimated Completion Times for the Area E Groundwater and Site 22 Alternatives

NUMBER	ALTERNATIVE	CLEANUP TIME (YRS)
AREA E GROUNDWATER		
1	No Action	NA
2	Limited Action with MNA and LUCs	45
3	Mass Extraction Pump and Treat with MNA and LUCs	41.5
4	In-Situ Chemical Oxidation with MNA and LUCs	38
5	Air Sparging with SVE with MNA and LUCs	38
SITE 22		
1	No Action	NA
2	Implementation of LUCs	30

Because each alternative for Area E groundwater will leave levels of groundwater contaminants in place for an extended period of time, LUCs and implementation of a CEA are proposed for each remedial alternative. Furthermore, MNA as a polishing step is included with all active groundwater restoration alternatives, as they are designed to achieve "hot spot" removal and not treatment to below ARARs. The full description of the LUC and MNA portions of the Area E groundwater alternatives are described only once, under Alternative 2. For all other Alternatives, please refer to that discussion.

2.10.1 Alternative 1: No Action for Area E Groundwater and Site 22.

CERCLA and the NCP require that a No Action alternative be evaluated at every site to establish a baseline for the comparison of other remedial alternatives. Under this alternative, no remedial action would take place. Five-year reviews in accordance with CERCLA and the NCP would be performed. These reviews are required by CERCLA regulations whenever a selected remedial action results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use of the property and unrestricted exposure. The purpose of the five-year review is to ensure human health and the environment are being protected.

2.10.2 Area E Groundwater Alternative 2: Limited Action with MNA and LUCs

Alternative 2, combination of MNA and LUCs, includes institutional and access restrictions, public education, emergency provisions, and the implementation of a CEA, as well as long-term monitoring of the groundwater and surface water. No active treatment would be implemented to remove contaminants from groundwater at the site. Rather, monitoring of groundwater and surface water for natural attenuation parameters would verify that contaminants are being attenuated. It was estimated, using the site-specific groundwater calculations, that it could take up to 45 years to achieve groundwater standards.

The MNA program will be designed to: 1) evaluate long-term behavior of the plume; 2) verify that exposure to contaminants and their breakdown products do not pose additional risks; and, 3) assess when it is necessary to implement a contingency remedy. Performance monitoring wells (PMWs),

surface water monitoring locations (SWMLs), and contingency wells will be used to demonstrate the MNA's performance. Contingency wells are intended to monitor unexpected plume migration and to trigger implementation of a contingency plan. These wells will be located on the upgradient side of GPB (northwest side) to monitor the potential migration of contamination into GPB. The locations of the contingency wells were determined based on the estimated groundwater velocity of 95 ft/year at Area E. An evaluation of a contingency remedy will be triggered when the level of contamination in GPB resulting from Area E discharge is equivalent to or exceeds a surface water cleanup level, or when the level of contamination in the contingency wells is equivalent to or exceeds a groundwater cleanup level. The data will be examined to account for seasonal variation and statistical significance.

The effectiveness of MNA would be evaluated by continuing groundwater sampling programs. Samples of groundwater would be collected at a regular frequency. Monitoring of the rate of natural attenuation would be conducted by analyzing groundwater samples for VOCs, dissolved oxygen, nitrate, iron (II), and sulfate.

For each of the first two years of sampling and once every five years until the end of remediation, formal natural attenuation reports would be written. The formal reports would include a spatial analysis and display of COCs and natural attenuation parameters. During all other years of remediation, summary reports would be generated. During the performance of the yearly reporting, the chemical analytical data would be reviewed to determine if the conceptual site model is correct and the rates of attenuation are within the expected range. There would be one closeout report and statistical proof of compliance submitted to the regulatory agency at the end of the remediation period. In order to comply with CERCLA, five-year reviews would be conducted at the site, included in the Interagency Agreement (IAG), to ensure that the remedy is and will be protective of human health and the environment. Reports detailing the findings of the reviews would also be generated. **Figure 10** depicts the area of attainment and locations of wells that could be used for long-term monitoring of natural attenuation. Note that *specific details of the MNA program are included here for cost purposes only. Final details of the MNA* program, including number of wells, sampling and reporting frequencies, and the exit strategy will be included in the remedial design and submitted to USEPA and NJDEP for approval after the ROD is signed.

Since contamination would remain on site while MNA is taking place, LUCs would be required as part of this alternative. LUCs are administrative measures put in place to restrict human activity in order to preclude undesirable land use. In the case of Area E, LUCs would be established to preclude activities that could lead to unacceptable human exposure to environmental contaminants. The specific provisions and requirements of the LUC portion of this remedy necessary to ensure land use remains safe and appropriate for the level of protection afforded by the remedial action will be detailed as part of the *remedial design after the ROD is signed.*

The Army is responsible for implementing, maintaining, reporting on, and enforcing the LUCs. LUCs will be maintained until the concentrations of hazardous substances in the groundwater are at such *levels to allow for unrestricted use and exposure. A LUC remedial design will be prepared as the land* use component of the remedial design. Within 90 days of ROD signature, the Army will prepare and submit to the USEPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections. The following LUC objectives will be met by implementation of LUCs:

- Prevent access or use of the groundwater until cleanup levels are met.
- Maintain the integrity of any current or future remedial monitoring system such as monitoring wells.
- Implement a CEA (continuation of the existing CEA)
- Prohibit excavation without safeguards in all areas below the water table in the plume footprint

These LUC objectives will be met through the implementation of LUCs as part of all remedial alternatives, LUCs will be continued and 5-year reviews will be performed for Area E until contaminant levels are

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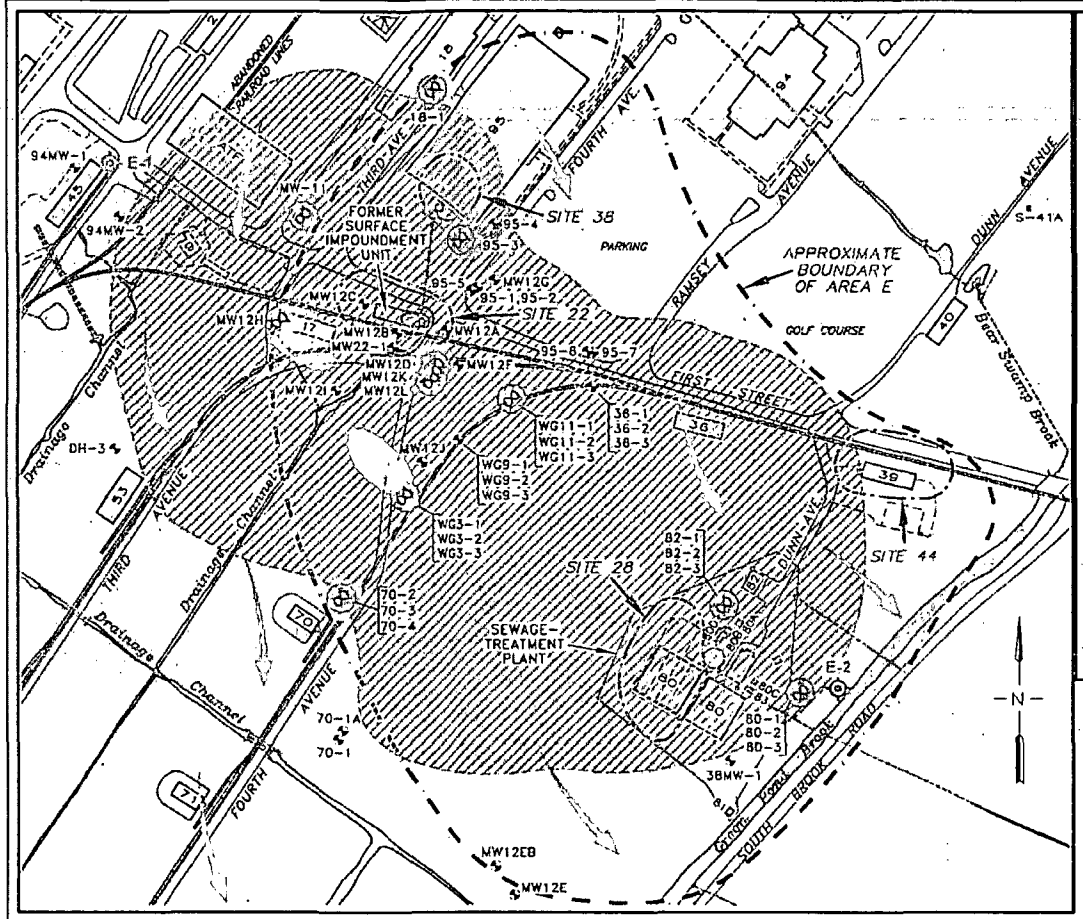


LEGEND:

- GROUNDWATER FLOW DIRECTION
- AREA OF ATTAINMENT FOR NATURAL ATTENUATION, BASED ON EXCEEDENCES OF ARAR LEVELS OF PCE, TCE, AND 1,1-DCE IN NOVEMBER 1999
- TCE HOT SPOTS (TCE IN GROUNDWATER >30 µg/L)
- EXISTING MONITORING WELL NOT TO BE USED FOR LONG TERM MONITORING
- EXISTING MONITORING WELL TO BE USED FOR LONG TERM MONITORING
- INDICATES EXISTING WELLS TO BE MAINTAINED AS PEFORMANCE WELLS
- INDICATES EXISTING WELLS TO BE ABANDONED AFTER 8 QUARTERS OF MNA DEMONSTRATION

WELLS TO BE INSTALLED:

- UPGRADIENT WELL/BACKGROUND
- CONTINGENCY WELL

NOTE:

1. LOCATIONS OF PROPOSED WELLS ARE APPROXIMATE AND WILL BE FINALIZED DURING DEVELOPMENT OF THE SAMPLING PLAN.

SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.

0 300 600
SCALE FEET

ARCADIS
www.arcadis-us.com

PROJECT MANAGER	DEPARTMENT MANAGER	LEAD DESIGN PROF.	CHECKED BY
T. LLEWELLYN	M. MOHIUDDIN	J. CHERRY	K. TIPTON
SHEET TITLE		TASK/PHASE NUMBER	DRAWN BY
AREA OF ATTAINMENT & PRELIMINARY LOCATIONS OF WELLS FOR LONG-TERM MONITORING OF NATURAL ATTENUATION AREA E GROUNDWATER-DRAFT PICATINNY ARSENAL, DOVER, NJ		M0001	A. SANTINI
		PROJECT NUMBER	DRAWING NUMBER
		GP06PICA.P077	10

shown to allow unrestricted use and exposure. When the concentrations of COCs fall below the remedial goals, groundwater monitoring will be terminated in accordance with an approved exit strategy and documented in the next 5-year review. In the interest of streamlining this text, these details will not be repeated in the discussion of each groundwater alternative.

2.10.3 Area E Groundwater Alternative 3: Mass Removal Configured Extraction Wells with MNA and LUCs

The mass removal configured extraction wells would reduce groundwater contamination by extracting the groundwater from the two targeted areas (hot spots) of remediation and piping it to a treatment plant, which is currently operating as a hydraulic barrier at neighboring Area D. The system would be comprised of extraction pumps, a collection tank, air stripper, and carbon adsorption system. The existing treatment plant at Area D would be used for this alternative; thus, new construction would not be required.

Modifications to the current design of the Area D plant could be required if this additional flow rate of groundwater for Area E is combined with the existing hydraulic barrier arrangement at Area D. These modifications were not included in this cost because the Area D hydraulic barrier is scheduled to be shit down after construction of permeable reactive barrier..

This alternative was designed to bring Area E groundwater into compliance within 41.5 years (4.5 years of active pumping and 37 years of MNA).

Under this alternative, a total of three extraction wells located in the vicinity of the hot spots would pump contaminated groundwater to the Area D treatment system. Once at the treatment plant, contaminated groundwater would pass through a filter before entering an air stripper, where most of the VOCs would be removed. Any remaining contaminants in vapors from the air stripper or in the groundwater would be passed through vapor- or liquid-phase carbon treatment units, where it would bond with the carbon molecules while allowing water or air to pass through.

The pump and treat system would require operation and maintenance (O&M) for the 4.5 years of operation. One full-time and one part-time operator would be needed. System maintenance would include cleaning of the air strippers, influent and effluent sampling, provision of electrical power, and equipment maintenance and repair.

Maintenance reports would be generated as applicable. Replacement of the vapor- and liquid-phase carbon for polishing would be required periodically. Vapor phase carbon emissions would be tested periodically to ensure compliance with air permit conditions and to determine when the carbon must be replaced.

The remainder of the plume would be treated by MNA as described under Alternative 2. Since contamination would remain on site while MNA is taking place, LUCs as described in Alternative 2 would be required as part of this alternative.

The effectiveness of this alternative would be evaluated by implementing groundwater and surface water sampling programs. Samples of groundwater and surface water would be collected at a regular frequency. Periodic reports of sampling and analytical results would be completed as well as a close-out report and statistical demonstration of compliance with regulatory criteria in accordance with the NJDEP *Technical Requirements for Site Remediation*.

2.10.4 Area E Groundwater Alternative 4: In-Situ Chemical Oxidation with MNA and LUCs

Alternative 4 involves the implementation of In-Situ Chemical Oxidation (ISCO) to actively oxidize contaminant mass from the hot spot areas with the approximate volume of 115,000 cubic yards to 20 µg/L, with MNA for the remaining areas of the plume. The 20 µg/L target level for TCE was selected as the boundary area for active treatment, such that MNA could be used to treat the remaining portion of the plume to within ARARs in a reasonable amount of time.

The combination of ISCO and MNA is believed to be more cost effective than the implementation of ISCO alone for treating the contaminated groundwater to ARARs. The alternative was designed to achieve compliance with the RAOs in the groundwater in approximately 38 years (one year of ISCO and 37 years of MNA). It should be noted that the time to treat the targeted areas is likely to be two months; however, for comparison purposes, costs are estimated for one year. Additional costs for the ISCO system would include the performance of a pilot-scale test to determine design parameters, such as potassium permanganate requirements and injection duration.

The ISCO process would reduce groundwater contamination through injection of potassium permanganate into the subsurface to oxidize the contaminants. The system would be comprised of injection points, monitoring wells, transfer pumps, and potassium permanganate. Permanganate is a strong oxidant with a long history of safe use in drinking water, wastewater, and chemical manufacturing industries. Permanganate is applied to oxidize chemicals to carbon dioxide and chloride ions. Chemical oxidation using permanganate in soil and groundwater can be achieved by the passive addition of the oxidant into the treatment zone. The permanganate reacts with all reduced species in the aquifer, including chlorinated compounds.

Implementation of ISCO would require the installation of 72 injection points, injection of potassium permanganate into the subsurface, and installation of transfer pumps near the hot spots of the Area E groundwater plume. Additionally, six wells would be installed to monitor the groundwater concentrations downgradient of the injection points, as well as within the areas of remediation. Some of these areas would have to be cleared and/or excavated. Some of the excavated material would be transported and disposed in a non-hazardous waste landfill. The ISCO system would require an injection permit equivalent to inject potassium permanganate into the subsurface. The ISCO system also would require an engineering design to maximize the efficiency of the potassium permanganate delivery.

Technical and construction oversight would be required prior to and during the installation of the ISCO system. Typically, a more comprehensive data review and a site visit and meeting would be conducted by the design group. In addition, while the ISCO system is being installed (approximately one month), a field engineer and construction supervisor would be required on site. Other than groundwater sampling during MNA, there are no O&M costs associated with the chemical oxidation system.

The remainder of the plume would be treated by MNA as described under Alternative 2. Since contamination would remain on site while MNA is taking place, LUCs as described in Alternative 2 would be required as part of this alternative.

2.10.5 Area E Groundwater Alternative 5: In-Situ Air Sparging with SVE and MNA and LUCs

Alternative 5 proposes in-situ air sparging combined with soil vapor extraction (SVE). This technology would reduce groundwater contamination by stripping the VOCs from the groundwater and transferring them to the vadose zone, where the resulting contaminated vapors will be extracted and treated. Off-gas from the SVE system would be treated with granular activated carbon (GAC). The system would be comprised of air sparging and SVE wells, blowers, and groundwater monitoring wells to monitor effectiveness. Air sparging and SVE would be used to remediate contamination in the targeted hot spots, where contamination is greatest.

SVE is a well-demonstrated, cost-effective way to remove contaminants from the vadose zone. A vacuum pump is used in conjunction with air sparge blowers to recover the vapors volatilized in the sparging process. Similar to air sparging, the success of SVE is dependent on the permeability of the sediments.

Because the groundwater at Area E is shallow, the potential complication of groundwater mounding is greater. Therefore, the air sparging and SVE points would be designed as a network of horizontal wells. Compared to the conventional vertical well system, horizontal wells also present additional benefits of a larger area of influence per well and the feasibility for construction under buildings or other structures. The volatilization of sorbed and trapped contaminants is also enhanced with the injection of air into and subsequent extraction of vapors from the subsurface. The vapor pressure of chlorinated VOCs, such as those found in Area E, enable the contaminants to volatilize.

Technical and construction oversight would be required prior to and during the installation of the in-situ air sparging and the SVE system. Typically, a more comprehensive data review and site visit and meeting would be conducted by the design group. In addition, while the in-situ air sparging and SVE system is being installed (approximately one month), a field engineer and construction supervisor would be required on site.

It is estimated that 11 horizontal air sparging wells (total) and 9 horizontal SVE wells would be needed within the targeted hot spot areas. Some of these areas would have to be cleared and/or excavated. Two MD-Pneumatic 50-horsepower blowers should meet the operational requirements. No wells would be installed within 25 ft of Building 17, based on the potential for concerns such as vapor accumulation. Blowers would deliver air to the groundwater via the injection wells through a 2-inch-diameter galvanized steel pipe. In order to prevent short-circuiting of the SVE system, a surface liner could be installed over the remediation areas.

A vapor-phase treatment system using GAC would be required to treat off-gas from the SVE system. It is estimated that no more than four pounds per day would be required throughout the duration of treatment.

The specific capacity of the system would be determined in a pilot-scale test. Five additional monitoring wells would be installed to monitor the performance of the air sparging and SVE system at Area E. A temporary building would be constructed to house the blowers and the SVE vapor treatment system. Additional costs for the in-situ air sparging and SVE system would include the performance of a pilot-scale test to determine the required injection pressure, radius of influence, and estimated mass removal efficiency. Also included in the cost of this alternative were insurance, bonds, and a contingency factor.

Following the in-situ air sparging and SVE duration, not to exceed one year, the total duration for remediation is estimated to be 38 years.

The remainder of the plume would be treated by MNA as described under Alternative 2. Since contamination would remain on site while MNA is taking place, LUCs as described in Alternative 2 would be required as part of this alternative.

2.10.6 Site 22 Alternative 2: Implementation of LUCs

Property access restrictions, such as site security, and restrictions on future site activities, are already in place at Site 22. Enforcement of these restrictions will ensure the protection of human health. Some restrictions are already in place at Picatinny Arsenal by virtue of it being an active military installation. However, in the event that Picatinny Arsenal would be closed and declared excess property, the land use restrictions would be legally recorded (e.g., in zoning ordinances, property deeds, etc.) and incorporated into the provisions for the new land use. A change in land use would include the re-evaluation of clean-up requirements and a notification requirement to USEPA and NJDEP.

It should be noted that there is a potential for risk to residential receptors based on subsurface soil exceedance of DCSCC, should the site be used in that capacity. The potential for risk to residential receptors has never been quantified in a risk assessment. NJDEP DCSCC were considered for Site 22. Exceedances of both residential and non-residential DCSCC were a factor in remedy selection for this site. These exceedance conditions necessitate the implementation of LUCs for this site. Because this low-level contamination would remain in place as part of this alternative, implementation of LUCs would be required as part of this alternative. LUCs are also required because risks were not calculated for the unrestricted land use scenario.

The Army is responsible for implementing, maintaining, reporting on, and enforcing the LUCs. LUCs will be maintained until the concentrations of hazardous substances in the groundwater are at such levels to allow for unrestricted use and exposure. A LUC remedial design will be prepared as the land use component of the remedial design. Within 90 days of ROD signature, the Army will prepare and submit to the USEPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections. The requirements of the LUC portion of the remedy for Site 22 are similar to those described above for Area E groundwater, however the LUC

objectives are specific to Site 22. The following LUC objectives for Site 22 will be met by implementation of LUCs:

- Prevent access to the site by continued implementation of existing access restrictions.
- Maintain existing cover materials including grass, pavement, and building foundations.
- Prevent exposure to contaminants in subsurface soil by prohibiting excavation without proper safeguards in accordance with approved procedures.
- Prevent the development and use of property for residential housing, elementary schools, child-care facilities and playgrounds.

All proposed engineering and institutional controls must comply with the requirements in N.J.A.C. 7:26E-8.1. This includes the monitoring, maintenance, and biennial certification of the protectiveness of the remedial action.

Industrial land use and intermittent recreational land use (e.g., hunting) of Site 22 are acceptable. This remedy prohibits any land use that could result in prolonged exposure to the site.

Under this alternative, the Army will act to ensure that only appropriate land use takes place until such time as site conditions are protective for unrestricted use and exposure. LUCs will be continued and 5-year reviews will be performed for Site 22 until contaminant levels are shown to allow unrestricted use and exposure.

2.11 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Army and USEPA selected the preferred alternatives by evaluating each of the alternatives against the nine criteria established by USEPA. These criteria are described below.

The advantages and disadvantages of each of the alternatives were compared using the nine CERCLA evaluation criteria established by USEPA in Section 300.430(e) of the NCP. The detailed comparative analysis of all the alternatives is provided in the FSs for Area E and Site 22; a summary of this comparison is provided in the following text.

2.11.1 Threshold Criteria (must be met)

2.11.1.1 Overall Protection of Human Health and the Environment

This criterion addresses whether each alternative provides adequate protection of human health and the environment by eliminating, reducing, or controlling exposure to human or environmental receptors.

Except for Alternative 1, No Action, each of the other alternatives for Area E groundwater is protective of human health. Alternative 1 is not considered protective. Alternative 4, ISCO, and Alternative 5, In-Situ Air Sparging with SVE, are the most protective of human health and the environment due to the aggressive, one-year treatment of the targeted areas of remediation. However, they are followed by 37 and 38 years of MNA polishing respectively. Alternative 3, Mass Extraction Pump and Treat, addresses the targeted areas with an active remediation system which is required to run for a longer time and an MNA component estimated to last 41.5 years. Alternative 2, Limited Action with MNA, does not include any active treatment of the plume which results in the remediation timeframe being extended to approximately 45 years. The longer remediation timeframe is counter-balanced by the passive nature of MNA which would not require the extensive clearing of the forested wetland overlying the plume that the more aggressive alternatives would.

For Site 22, under Alternative 2, Implementation of LUCs, active control measures would be imposed on the affected area; therefore, a greater human health protection would be afforded. However, due to the minimal nature of human health and ecological risks posed by sediment and surface water contamination at Site 22, active mitigation measures would not be necessary. Protection of the environment would be at the same level as with Alternative 1.

2.11.1.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

This criterion addresses if a remedy would meet all of the ARARs related to the hazardous substances at the site and the circumstances of their release. ARARs are Federal and State environmental laws and promulgated regulations identified for the cleanup.

With the exception of the no action alternative, Alternative 1, all groundwater alternatives comply with ARARs as discussed in detail in the Area E Groundwater FS and the Site 22 FS. All groundwater alternatives, with the exception of Alternative 1, include LUCs and implementation of the NJDEP-approved CEA for the duration of the remedial action to ensure protection of the environmental receptors. Additional permitting documentation (permit equivalency) would be necessary for alternatives 3, 4, and 5 due to the active nature of these alternatives. These systems would have the potential to impact the wetland, streams and wildlife habitat present within Area E.

For Site 22, all detected sediment and surface water concentrations fall below the PELs for sediment and the NJDEP SWQC for surface water. Therefore, both alternatives would adequately comply with ARARs.

2.11.2 Primary Balancing Criteria (identifies major trade-offs among alternatives)

2.11.2.1 Long-term Effectiveness and Permanence

This criterion addresses the remaining risk and the ability to protect human health and the environment over time, once cleanup levels have been met.

Alternative 1 provides no long-term effectiveness or permanence. For Area E groundwater, Alternatives 2, 3, 4, and 5 would all provide permanent reduction in risk and achieve the RAOs. Alternative 2 will achieve long-term effectiveness after 45 years. Alternatives 3, 4, and 5 will remove over half of the contaminant mass actively in combination with Alternative 2 to remediate the site slightly more quickly than Alternative 2 alone. Alternatives 4 and 5 achieve the long-term, permanent remedy in the shortest amount of time.

For Site 22, both Alternative 1 and Alternative 2 satisfy the long-term effectiveness and permanence criterion. As previously discussed, it is very likely that contaminated sediment primarily contributes to the surface water contamination at Site 22. Because discharges of COCs at Site 22 no longer occur, cleaner, non-contaminated sediments will gradually cover the impacted sediments identified in the AOC. Additionally, it is anticipated that natural processes, including chelation, complexation, and binding reactions of contaminants at levels non-toxic to aquatic receptors, will continue to reduce existing contaminant levels. These natural processes would indirectly provide mitigation measures for the surface water contamination.

2.11.2.2 Short-term Effectiveness

This criterion addresses impacts to the community and site workers during cleanup including the amount of time it takes to complete the action.

Alternatives 1 and 2 do not pose any hazards to workers in the short-term. For Area E groundwater, of the engineered remedial alternatives, Alternatives 4 and 5 pose the greatest safety hazards when compared to the other technologies. Alternative 4, ISCO, poses hazards due to the potential contact with contaminated soils and groundwater while injection is taking place.

A concern with Alternative 4 is the release of unreacted potassium permanganate to surface water. However, due to the high background metal concentrations in soil at Picatinny Arsenal and the contaminants found within the Area E plume, it would be unlikely that permanganate will reach a discharge point in GPB. If permanganate did reach GPB, organic material in the sediment would likely react with the permanganate immediately, preventing any transport downstream. If this alternative were implemented, the possibility of non-point source discharge would be investigated, and compliance with any substantive requirement for surface water discharge would be ensured. Loading of permanganate to the groundwater would be adjusted such that breakthrough to the surface water would be prevented.

In addition, contact with the permanganate solution is a worker hazard. Alternative 5, air sparging with SVE, utilizes high-powered blowers to sparge air and recover vapors. Installation of the large number of wells required for this technology poses a hazard with respect to soil contact for workers. All hazards associated with the implementation and O&M of active remediation systems are minimal if the health and safety plan is followed correctly. Alternatives 4 and 5 achieve the largest mass reduction in the plume in the shortest amount of time, but have greater short-term impacts during remediation.

For Site 22, because neither alternative would involve any active remediation activities, no short-term impacts are anticipated from implementation.

2.11.2.3 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the anticipated performance of treatment systems that permanently and significantly reduce toxicity, mobility, or volume of hazardous substances as a principal threat at the site.

Alternative 1 does not include treatment. For Area E groundwater, Alternative 2 provides reduction on toxicity with passive treatment through natural attenuation.. All other alternatives for Area E groundwater provide reduction in toxicity, mobility and volume through active treatment or removal (either in-situ or ex-situ) of the plume hot spots.

For Site 22, natural attenuation processes (i.e., adsorption, complexation, or chelation) may reduce contaminant concentrations in sediment over the long term.

2.11.2.4 Implementability

This criterion addresses the technical and administrative feasibility of an alternative, including the availability of materials and services required for cleanup.

Alternative 1 would require no resources to implement. Alternative 2 requires minimal resources and only a limited effort (due to monitoring requirements). For Area E groundwater, mass removal at the source of the contamination by Alternative 3, Pump and Treat, and Alternative 4, ISCO, are the easiest of the engineered alternatives to implement. Minimal construction is required for Alternative 3 since the treatment plant is already built. Alternative 4 requires no construction since injections of permanganate occur once and are accomplished using gravity-fed injection methods. Alternative 5 is the most difficult to implement due to the large number of in-situ air sparging wells and SVE wells required for installation. In addition, dewatering may be required as part of Alternative 5.

2.11.2.5 Cost

This criterion compares the differences in cost, including capital, operation, and maintenance costs.

Present worth costs were calculated with a discount rate of 7 percent for each alternative. **Table 10** shows the estimated present worth and capital cost for each alternative for Area E groundwater.

For Site 22, costs associated with the implementation of Alternative 2 include the capital cost to develop plans, estimated at $16,000 and a lifetime (present worth) O&M cost to perform periodic inspections and five-year reviews, estimated at $41,000. The lifetime O&M cost was calculated with a 7 percent discount rate. Although a time period of 30 years was selected for developing a cost estimate, LUCs will be exercised by the Army until such time as the site is determined to be safe for unrestricted use.

Table 10: Summary of Costs of Groundwater Remedial Alternatives

Alternative 1	Present Worth $0 Capital Cost $0
Alternative 2	Present Worth $668,500 Capital Cost $102,050
Alternative 3	Present Worth $3,156,400 Capital Cost $497,710
Alternative 4	Present Worth $2,314,600 Capital Cost $1,673,200
Alternative 5	Present Worth $2,405,700 Capital Cost $1,580,860

2.11.3 Modifying Criteria (formally evaluated after the comment period)

2.11.3.1 State Acceptance

This criterion evaluates whether the State agrees with, opposes, or has no comment on the preferred alternative. This criterion is evaluated formally when comments on the Proposed Plan are reviewed.

State acceptance was evaluated formally after the public comment period on the Proposed Plan. The Proposed Plan and this ROD were prepared in partnership with USEPA and NJDEP representatives. Although NJDEP has not provided any formal letter approving the Proposed Plan for Area E groundwater, NJDEP provided an implicit acceptance based on their approval of the Feasibility Study for Area E, various meeting minutes and the IAG schedules. The NJDEP approved the Proposed Plan for Site 22 on June 8, 2004. Based on the April 2003 Picatinny Arsenal meeting, in which representatives of the NJDEP were present, it is anticipated that the NJDEP will concur with the selection of the preferred remedial alternative for Site 22.

The NJDEP accepts Alternative 2 (Limited Action with MNA and LUCs) for Area E groundwater and Alternative 2 (Implementation of LUCs) for Site 22.

2.11.3.2 Community Acceptance

This criterion addresses the issues and concerns the public may have regarding each of the alternatives. This criterion is evaluated formally when comments on the Proposed Plan are reviewed.

A final Proposed Plan for Area E groundwater was completed and released to the public in November 2004 at the information repositories listed in Section 2.3. A final Proposed Plan for Site 22 was also completed and released to the public in December 2004 at the information repositories listed in Section 2.3. The notice of availability of these documents was published on November 24, 2004 in the New Jersey-Star Ledger and the Daily Record. A public meeting was held on December 8, 2004 to inform the public about the Selected Remedy for Area E groundwater and for Site 22 and to seek public comments. A public comment period was held from December 8, 2004 to January 8, 2005 during which comments from the public were received. Written comments were received from Subsurface Solutions on behalf of the RAB. Subsurface Solutions is under contract to the Army under the TAPP program. Written comments were also received from the Law Offices of Schwartz, Tobia, Stanziale, Sedita and Campisano on behalf of Pondview Estates, Inc. (Pondview). Pondview is a large residential development being constructed across Route 15 from the southern boundary of Picatinny Arsenal. The Army's responses to comments made at the public meeting and received during the public comment period are included in the Responsiveness Summary (Section 3.0) of this ROD. A community relations program has been established and is maintained for Picatinny Arsenal.

Community acceptance was evaluated formally after the public comment period on the Proposed Plan. Community acceptance is addressed in the Responsiveness Summary, Section 3.0, of this ROD.

2.12 PRINCIPAL THREAT WASTE

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a)][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

No principal threat wastes remain at Site 22/Area E. Principal threat waste from these sites were removed as part of RCRA closure activities completed in the early 1990s. The source of the contaminants has been removed and the media being dealt with under the scope of this ROD is the mobilized contaminants (rather than a mobile source). However, discharge of the plume to the water of GPB could potentially constitute a threat to human health and ecological receptors.

With the exception of Alternative 1, No Action, all of the remedial alternatives for Area E groundwater address remaining mobilized contaminants through treatment.

2.13 SELECTED REMEDIES

The Selected Remedy for Area E groundwater is **Alternative 2: Limited Action with MNA and LUCs**. The Selected Remedy for Site 22 is **Alternative 2: Implementation of LUCs**. This decision is based on the administrative record for the site. This section provides detailed descriptions of the Selected Remedies.

2.13.1 Summary of the Rationale for the Selected Remedies

The remedy for Area E groundwater was chosen by the RI/FS process. The primary factors in the selection of Alternative 2 for Area E were based on comparison to chemical specific ARARs. There is currently no use of groundwater in Area E and the reasonably anticipated future land use also does not include use of Area E groundwater. Alternative 2 complies with chemical specific ARARs at a significantly lower cost and with only a slightly longer remedial timeframe. Also because Alternative 2 is passive it achieves site cleanup without destruction of any of the forested wetland overlying the groundwater plume.

The remedy for Site 22 was also chosen by the RI/FS process. The primary factors in the selection of Alternative 2 were the NJDEP soil cleanup criteria and the results of the human health risk assessment. Based on the site-specific risk assessment, risk to industrial receptors is within the USEPA range. However, the potential risk to residential receptors in Site 22 was not quantitatively evaluated in the human health risk assessment. NJDEP DCSCC were utilized for Site 22. Exceedances of both residential and non-residential DCSCC were a factor in remedy selection for this site.

The selected remedies meet the threshold criteria and provide the best overall balance of tradeoffs in terms of the five balancing criteria:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost.

The selected remedies address State and community concerns by passively treating the groundwater contamination and implementing LUCs to ensure protectiveness.

2.13.2 Description of the Selected Remedies

2.13.2.1 Area E Groundwater

The major MNA components of the selected remedy (Alternative 2) include:

- Prepare and execute plans to direct MNA activities. The MNA program designed to: 1) evaluate long-term behavior of the plume; 2) verify that exposure to contaminants and their breakdown products do not pose additional risks; and, 3) assess when it is necessary to implement a contingency remedy. Planned elements will include the monitoring program requirements, well maintenance, well replacement, additional groundwater modeling, data requirements, and reporting requirements.
  - The project work plan will address all aspects of the program and direct the work to be performed. One key aspect of the work plan will be the identification of funding and responsibility to assure the completion of the program.
  - The Field Sampling Plan will direct the technical requirements of the field sampling, including field sampling techniques, sampling locations, sampling frequency, proposed data use, sampling analytical programs, and use of site screening equipment.
  - The project quality assurance plan will detail the requirements of the chemical analytical program (method), data quality objectives, data quality, and include all applicable standard operating procedures required.

- Collect groundwater samples at a regular frequency to evaluate the effectiveness of MNA. Analyze groundwater samples for VOCs, dissolved oxygen, nitrate, iron (II), sulfate, and methane to monitor the attenuation of COCs and the changing redox state of the aquifer. The redox state of the aquifer needs to be monitored to infer the health and activity of the microbial population. As electron donors and terminal electron donors are consumed in the aquifer, the rate of attenuation may change. These changes can be used as a predictor of actual changes to the rate of attenuation of COCs. These parameters ensure monitoring of the plume for regulatory compliance as well as monitoring for changing geochemical and oxidation-reduction state. Groundwater samples will be collected in accordance with the site-wide MNA program at the following frequency:
  - Quarterly for the first two years;
  - Semi-annually for the next five years; and,
  - Annually for the remainder of remediation.

- Use PMWs, SWMLs, and contingency wells to demonstrate the MNA's performance. Contingency wells are intended to monitor unexpected plume migration and to trigger implementation of a contingency plan. These wells will be located on the upgradient side of GPB (northwest side) to monitor the potential migration of contamination into GPB. The locations of the contingency wells were determined based on the estimated groundwater velocity of 95 ft/year at Area E. An evaluation of a contingency remedy will be triggered when the level of contamination in GPB is equivalent to or exceeds a surface water cleanup level, or when the level of contamination in the contingency wells is equivalent to or exceeds a groundwater cleanup level. The data will be examined to account for seasonal variation and statistical significance.

- Prepare and submit formal natural attenuation reports and summary reports. The formal reports would include a spatial analysis and display of COCs and natural attenuation parameters. The summary reports will include a review of the chemical analytical data to determine if the conceptual site model is correct and the rates of attenuation are within the expected range. Reports will be prepared at the following frequency:
  - Annually for each of the first two years (formal)
  - Once every five years for the remainder of remediation (formal)
  - Annually for all other years of remediation (summary)

- Maintain each groundwater monitoring well over the entire duration of remediation and replace as necessary to provide continuous service.

- Prepare and submit one closeout report and statistical proof of compliance to the regulatory agency at the end of the remediation period.

The major LUC components of the selected remedy (Alternative 2) include:

- Implement LUCs to preclude activities that could lead to unacceptable human exposure to environmental contaminants. LUCs will be enforced throughout the area depicted on **Figure 11**. The following LUC objectives will be met by implementation of LUCs:
  - Prevent access or use of the groundwater until cleanup levels are met.
  - Maintain the integrity of any current or future remedial monitoring system such as monitoring wells.
  - Continue implementation of a CEA. Because the implementation of MNA will require an extended period of time for completion, the groundwater will be out of compliance with groundwater standards for that time period. The CEA allows for the exemption of compliance with NJDEP regulations for the amount of time required for remediation.
  - Prohibit excavation without safeguards in all areas below the water table in the plume footprint

- Prepare a LUC remedial design as the land use component of the remedial design. Within 90 days of ROD signature, the Army will prepare and submit to the USEPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections.

- Conduct 5-year reviews in accordance with CERCLA 121 and the NCP to ensure that the remedy is and will be protective of human health and the environment. Reports detailing the findings of the reviews would also be generated. When the concentrations of COCs fall below the remedial goals, the groundwater monitoring program will be discontinued upon an agreed-upon exit strategy and documented in the next five-year review.

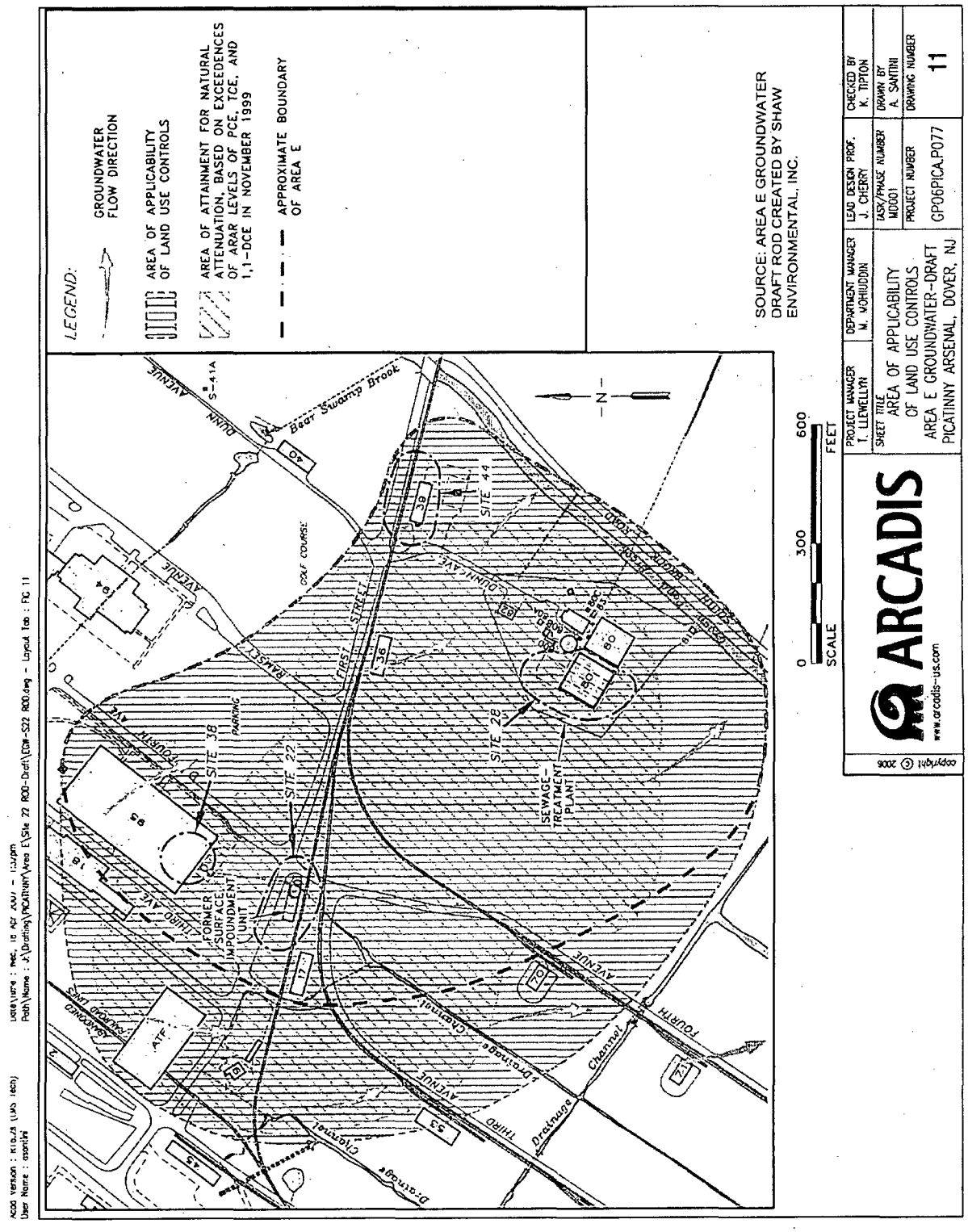
2.13.2.2 Site 22 Alternative 2: Implementation of LUCs

The major components of the selected remedy (Alternative 2) include:

- Enforce property access restrictions, such as site security, and restrictions on future site activities already in place at Site 22.

- Implement LUCs because low-level contamination would remain in place in the subsurface soil. The requirements of the LUC portion of the remedy for Site 22 are similar to those described above for Area E groundwater, however the LUC objectives are specific to Site 22. LUCs will be continued until contaminant levels are shown to allow unrestricted use. The following LUC objectives for Site 22 will be met by implementation of LUCs:
  - Prevent access to the site by continued implementation of existing access restrictions.
  - Maintain existing cover materials including grass, pavement, and building foundations.
  - Prevent exposure to contaminants in subsurface soil by prohibiting excavation without proper safeguards.
  - Prohibit the development and use of property for residential housing, elementary schools, child-care facilities and playgrounds.

- Legally record the LUCs (e.g., in zoning ordinances, property deeds, etc.) in the event that Picatinny Arsenal would be closed and declared excess property. Additionally, the LUCs would be incorporated into the provisions for the new land use. A change in land use would include the re-evaluation of clean-up requirements and a notification to and concurrence by USEPA and NJDEP.


LEGEND:
GROUNDWATER FLOW DIRECTION
AREA OF APPLICABILITY OF LAND USE CONTROLS
AREA OF ATTAINMENT FOR NATURAL ATTENUATION, BASED ON EXCEEDENCES OF ARAR LEVELS OF PCE, TCE, AND 1,1-DCE IN NOVEMBER 1999
APPROXIMATE BOUNDARY OF AREA E
SOURCE: AREA E GROUNDWATER DRAFT ROD CREATED BY SHAW ENVIRONMENTAL, INC.
Bear Swamp Brook
SITE 44
SITE 28
SITE 22
SITE 38
FORMER SURFACE IMPOUNDMENT UNIT
SEWAGE TREATMENT PLANT
ATF
GOLF COURSE
DUNN AVENUE
RAMSEY AVENUE
FIRST STREET
QUINN AVENUE
THIRD AVENUE
FOURTH AVENUE
Drainage Channel
N
0
300
600
SCALE
FEET
ARCADIS
www.arcadis-us.com
PROJECT MANAGER T. LLEWELLYN
DEPARTMENT MANAGER M. MOHIUDDIN
LEAD DESIGN PROF. J. CHERRY
CHECKED BY K. TIPTON
SHEET TITLE AREA OF APPLICABILITY OF LAND USE CONTROLS AREA E GROUNDWATER-DRAFT PICATINNY ARSENAL, DOVER, NJ
TASK/PHASE NUMBER M00001
DRAWN BY A. SANTINI
PROJECT NUMBER GP06PICA.P077
DRAWING NUMBER 11
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- Ensure that no inconsistent land use of Site 22 occurs until such time as the site conditions are protective.
- Conduct 5-year reviews in accordance with CERCLA and the NCP to ensure the remedy is and will be protective of human health and the environment.

2.13.3 Summary of the Estimated Remedy Costs

The total project estimated present worth cost, if approved, is $668,500 for Area E groundwater, and $57,000 for Site 22, the sum total of which will be paid by the Army. The costs associated with the preferred alternative for Area E groundwater are outlined in **Table 11**.

The costing information in this section is based on the best available information regarding the anticipated scope of the remedial alternatives. Details on the cost items are presented in the *Final FS for Area E groundwater* (IT, 2002) and the *FS for Site 22* (Shaw, 2004). Changes in the cost elements are likely to occur as a result of new information and data collected during the work plan phase and the five-year review(s). Major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 of the actual project cost.

Costs associated with the implementation of Alternative 2 for Site 22 include the capital cost to develop plans, estimated at $16,000 and a lifetime (present worth) O&M cost to perform periodic inspections and five-year reviews, estimated at $41,000.

Although a time period of 30 years was selected for developing a cost estimate, LUCs will be exercised by the Army until such time as the site is determined to be safe for unrestricted use. The lifetime O&M cost was calculated with a 7% discount rate.

Table 11: Summary of Estimated Lifetime Costs of the Selected Remedies

	Area E Groundwater
CAPITAL COST (TOTAL)	**$102,050**
LUCs and Planning	$55,000
Immediate and Future Well Abandonment (20 wells)	$11,500
Well Installation (2 wells)	$12,000
Subtotal Capital Costs	***$78,500***
Scope Contingency (20 percent)	$15,700
Legal Contingency (10 percent)	$7,850
O&M AND PERIODIC COSTS[1] (TOTAL)	**$566,400**
Demonstration of MNA (Subtotal)	**$325,000**
Groundwater Sampling (Year 0 – 48)	$115,400
Groundwater Analysis (Year 0 – 48)	$163,500
Annual Well Maintenance (48 years)	$27,500
Periodic Well Replacement (every 5 years)	$11,800
Future Well Abandonment (7 wells)	$7,000
Reporting (Subtotal)	**$147,000**
Natural Attenuation Reports – Formal (8 quarters)	$36,200
Natural Attenuation Reports – Informal (46 years)	$74,500
Five-Year Review Reports - (45 years)	$35,500
Closeout Report	$480
Subtotal O&M Cost	***$472,000***
Scope Contingency (20 percent)	$94,400
TOTAL PRESENT WORTH COST	**$668,500**

[1] Include 3-year post-remediation monitoring.

2.13.4 Expected Outcomes of the Selected Remedies

The RAOs for Area E groundwater and Site 22 would be achieved through implementation of the selected remedies. The estimated outcome would also include compliance with ARARs. However, as contaminants will remain in the aquifer, uncontrolled use of groundwater at the site is not permitted until MNA objectives are met.

For Site 22, enforcement of LUCs will ensure the protection of human health. Some restrictions are already in place at Picatinny Arsenal by virtue of it being an active military installation. However, in the event that Picatinny Arsenal would be closed and declared excess property, the land use restrictions would be legally recorded (e.g., in zoning ordinances, property deeds, etc.) and incorporated into the provisions for the new land use. A change in land use would include the re-evaluation of clean-up requirements and a notification requirement to USEPA and NJDEP.

2.14 STATUTORY DETERMINATIONS

The selected remedies satisfy the statutory requirements of CERCLA §121 and the NCP, as described below.

2.14.1 Protection of Human Health and the Environment

Because the preferred alternative for Area E groundwater relies on passive treatment (natural attenuation) processes to reduce concentrations of contaminants in groundwater to ARAR levels, the environment is still being exposed to the COCs. However, implementation of LUCs, such as access restriction and CEA would tremendously reduce the potential human health exposure pathways. Furthermore, the analytical results of surface water samples also indicated that contaminants discharged to the surface water at GPB were well below the surface water LOCs, minimizing the impact to ecological receptors from surface water exposures. An added benefit of the preferred alternative is its passive nature. Monitored natural attenuation will not require any clearing or destruction of the mature forested wetland overlying much of the plume.

Due to the minimal nature of human health and ecological risks posed by sediment and surface water contamination at Site 22, active mitigation measures are not necessary to ensure protectiveness. Furthermore, existing LUCs currently in place at Picatinny Arsenal serve to limit access to the site, thereby reducing the potential for human exposure to the contaminated sediment. Under the preferred alternative for Site 22, additional land use controls would be imposed on the affected area; therefore, a greater human health protection would be afforded.

Protection of the environment may be achieved as a result of the following: 1) discharges of COCs at these sites no longer occur; therefore, it is very likely that cleaner, non-contaminated sediments will gradually cover the impacted sediments identified in the AOC; 2) the drainage ditches are only wet on an intermittent basis and the sediments are likely dry for a significant portion of the year; 3) the distance to GPB and the relative low flow of the drainage ditches suggest that contamination would not migrate to GPB where significant ecological receptors are present; and, 4) it is anticipated that natural processes, including chelation, complexation, and binding reactions of contaminants at levels non-toxic to aquatic receptors, will continue to reduce existing contaminant levels.

2.14.2 Compliance with Applicable or Relevant and Appropriate Requirements

The preferred alternative for Area E groundwater is expected to comply with the chemical-specific ARARs for groundwater presented in **Tables 2 and 12** within 45 years. Because historical data suggested that discharge of contaminated groundwater into the surface water at GPB were below LOCs, surface water discharge criteria are expected to be met as well.

Location-specific ARARs presented in **Table 13** will be satisfied because none of the wetlands or stream encroachment areas will be affected by implementation of the LUCs or by natural attenuation processes in the groundwater and surface water.

Action-specific ARARs presented in **Table 14** will be met by obtaining appropriate permits for installation and abandonment of the monitoring wells. All personnel will be properly trained to handle

Table 12: Chemical-Specific ARARs for Area E Groundwater

Authority	Law/Regulation	Requirement (s)
Federal	SDWA – Non-zero Maximum Contaminant Level Goals (MCLGs)	Health-based criteria for drinking water sources.
State	SDWA – State MCLs, NJAC 7:10-1 et. Seq.	MCLs have been promulgated by the State and regulate contaminants in public drinking water.
	GWQS, NJAC 7:9-6.1 et. Seq.	Contaminated groundwater may have to be remediated.

Table 13: Location-Specific ARARs for Area E Groundwater

Characteristic	Requirement(s)	Impacted Areas
Wetlands Presence of wetlands as defined in Executive Order 11990 section 7(c) and 40 CFR 6, Appendix A section 4 (j)	Whenever possible, Federal agency actions must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. Agencies should particularly avoid new construction in wetland areas unless there are no practicable alternatives. Federal agencies shall incorporate wetlands protection consideration into planning, regulating, and decision-making processes.	Substantive permit requirements for stream, wetlands, and/or transition area encroachments during implementation of the specific remedial alternatives.
Flood Plains Within 100-year flood plain as defined in 40 CFR 264.18(b) and NJAC 7:13 (New Jersey Flood Hazard Area Control Regulations).	Facility must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by flooding.	A portion of Area E, along GPB, is within the 100-year flood plain. Flood plain restrictions are specified in the cited law.
Within "lowland and relatively flat area adjoining inland and coastal waters and other flood-prone areas such as offshore islands, including at a minimum that area subject to a 1 percent or greater chance of flooding in any given year." [Executive Order 11988 section 6 (c) and 40 CFR 6, Appendix A and section 4(d)].	Federal agencies shall take action to reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values of flood plains. Federal agencies shall evaluate the potential effects of actions in flood plains and ensure consideration of flood hazards and flood plain management. If action is taken in flood plains, Federal agencies shall consider alternatives to avoid adverse impacts and potential harm.	
Aquifer Recharge Protection Federal Water Pollution Control Act, Section 309 (c) [Fed. Reg. 2946-2948, Jan. 24, 1984).	Restricted activities, such as landfill, surface impoundment, waste pile, injection well, or land treatment, over the Unconsolidated Quarternary Aquifer or recharge zone or streamflow source zone of such aquifer in the Rockaway River Basin, NJ.	Remedial activities are limited to prevent any impact to the Rockaway River Basin.
Classification Exemption Area (CEA) Presence of an area that is out of compliance with NJ groundwater chemical-specific ARARs (NJAC 7:9-6.6).	Establishes an administrative control on an area that does not comply with GWQS. The CEA administratively prohibits construction of drinking water production wells by circumventing the issuing of a well construction permit in areas where a CEA has been placed.	ARAR for the Area E groundwater AOC.

Table 14: Action-Specific ARARs for Area E Groundwater

Action	Law/Regulation	Requirement (s)
Sampling and Analysis	Remediation Technical Requirements, NJAC 7:26E-3	Requirements of quality assurance for sampling and analysis at remediation sites.
	Regulations Governing the Certification of Laboratories and Environmental Measurements, NJAC 7-18:1-3, 5 and 9	Establishes the procedures for obtaining and maintaining certifications and the criteria and procedures that certified laboratories shall follow in handling, preserving, and analyzing regulatory samples.
LUC implementation	Institutional Controls – 40 CFR 300.430(a)(iii)(D)	USEPA expects to use institutional controls such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Institutional controls may be used during implementation of the remedial action and, where necessary, as a component of the completed remedy. "[t]he use of institutional controls shall not substitute for active response measures as the sole remedy unless such active measures are determined not to be practicable, based on the balancing trade-offs among alternatives that is conducted during the selection of the remedy."
General Remediation	Technical Requirements for Site Remediation, NJAC. 7:26E 1, 4-7	Specifies the minimum technical requirements to investigate and remediate contamination on any site.
	USEPA Office of Solid Waste and Emergency Response (OSWER) Publication 9345.3-03FS, January 1992	Investigation-derived wastes generated from remedial activities (e.g., drilling mud, purged water, etc.) are required to be properly stored, managed and disposed. Guidance given in the publication includes waste material containment, collection, labeling, etc.
Labeling and Transportation	NJDEP – Division of Waste Management: NJAC. 7:26 Subchapter 3; NJAC. 7:26-3.2(c), -3.2(b), -3.2(a), -3.2(a)2, -3.2(a)6; NJAC. 7:26-16.4; and NJAC. 7:26-3.4 and 7:26-3.5	Solid waste (IDW) for off-site transportation must obtain proper written approval from the State prior to transporting the waste. Once approved, the transporting vehicle has to be properly registered to handle the waste with appropriate placard.
Installation of Wells	Field Sampling Procedures Manual, May 1992	State guidance and general industry procedures for installation of extraction wells/monitoring wells.

hazardous materials in accordance with Occupational Safety and Health Administration (OSHA) Act 29 CFR 1910. Any contaminated excavated soil will be properly stored and disposed off site to comply with the NJDEP Hazardous Waste Management, RCRA, USEPA, and OSHA regulations for waste storage/disposal/handling and transport work at CERCLA sites.

For Site 22, all detected sediment and surface water concentrations fall below the PELs for sediment and the NJDEP SWQC for surface water. No active remedial action is required to comply with ARARs, therefore, the preferred alternative would adequately comply with ARARs and RAOs.

2.14.3 Cost Effectiveness

In the lead agency's judgment, the Selected Remedies are cost-effective and represent a reasonable value in the money to be spent. In making this determination, the following definition was used: *"A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430(f)(1)(ii)(D))*. This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility and volume through treatment; short-term effectiveness; regulatory acceptance; and, community acceptance). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the Selected Remedy for Area E groundwater is approximately **$668,500**. The estimated present worth cost of the Selected Remedy for Site 22 is

approximately **$57,000**. This cost estimate was based upon periodic inspections and five-year reviews for up to 30 years.

The Army believes that the Selected Remedies are cost effective and the additional cost compared to Alternative 1 (No Action) provides a significant increase in protection to human health and the environment.

2.14.4 Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

The Army has determined that the Selected Remedy for Area E groundwater represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. The Army has determined that the Selected Remedy Area E groundwater provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal and considering regulatory and community acceptance.

The Selected Remedy for Area E groundwater employs passive treatment to eliminate contaminants present at the site by relying on natural attenuation processes. COC concentrations in groundwater will be reduced over time. The Selected Remedy for Area E groundwater satisfies the criteria for long-term effectiveness by plume degradation through MNA. In addition, further reduction of risks could be accomplished through proper enforcement of LUCs. The Selected Remedy for Area E groundwater does not present short-term risks that cannot be effectively controlled through safe work practices. There are no special implementability issues that set the Selected Remedy for Area E groundwater apart from any of the other alternatives evaluated.

NJDEP and USEPA representatives concluded that active remediation was not warranted for sediment and surface water at Site 22. However, the Selected Remedy of LUCs for Site 22 would be implemented based on subsurface soil exceedances of NJDEP residential standards.

2.14.5 Preference for Treatment as a Principal Element

The Selected Remedy for Area E groundwater uses passive treatment to address the remaining mobilized contamination. The Selected Remedy provides an optimal implementation time frame commensurate with an effective use of funding; therefore, it is much more cost effective than the technologies that utilize active treatment.

2.14.6 Five-year Review Requirements

Five-year reviews will be conducted in compliance with CERCLA and the NCP, and in accordance with the IAG, to ensure that the remedy is and will be protective of human health and the environment.

3.0 PART 3: RESPONSIVENESS SUMMARY

The final component of the ROD is the Responsiveness Summary. The purpose of the Responsiveness Summary is to provide a summary of the stakeholders' comments, concerns, and questions about the Selected Remedies for Area E groundwater and Site 22 and the Army's responses to these concerns.

Some community concern has been expressed because groundwater treatment will rely on passive attenuation rather than active treatment. The Army, USEPA, and NJDEP have considered all comments and concerns, summarized below, in selecting the final cleanup methods for Area E groundwater and Site 22 at Picatinny Arsenal.

3.1 PUBLIC ISSUES AND LEAD AGENCY RESPONSES

As of the date of this ROD, the Army endorses the preferred alternative for Area E groundwater of Limited Action with MNA and LUCs and the preferred alternative for Site 22 of Implementation of LUCs. The USEPA and the NJDEP support the Army's plan. Comments received during the Area E groundwater and Site 22 public comment period on the Proposed Plans are summarized below. Written comments were received from Subsurface Solutions on behalf of the Picatinny Arsenal Restoration Advisory Board. Subsurface Solutions is under contract to the Army under the Technical Assistance for Public Participation (TAPP) program. Written comments were also received from the Law Offices of Schwartz, Tobia, Stanziale, Sedita and Campisano on Behalf of Pondview Estates, Inc. (Pondview). Pondview is a large residential development being constructed across Route 15 from the southern boundary of Picatinny Arsenal. The comments are categorized by source.

3.1.1 Summary of Comments Received during the Public Meeting on the Proposed Plan and Agency Responses

The following summarize the Army responses to the comments received during the public meeting on December 8, 2004.

3.1.1.1 Area E Groundwater

COMMENT FROM WILLIAM BAKER

Comment 1: William Baker is a resident of Parsippany and an employee of Schwartz, Tobia, Stanziale, Sedita & Campisano, a law firm working on behalf of Pondview Estates. He is asking for the direction of the Area E groundwater flow, and if any deep aquifers are affected.

Response: The groundwater flow direction is basically due east. There is a deep aquifer, but it is not affected by the groundwater plume.

Comment 2: Where are the monitoring wells that are going to monitor the area, where are those located, and how many are there? Would some or all of the same monitoring wells that are going to be employed for the Area C monitoring remedy will also be used in the same sense for Area E?

Response: From 1990 until 2001, the Army monitored seven wells quarterly. The Army currently monitors eight wells within the Area E plume on a semiannual basis. This sampling will continue until the ROD is signed. After signature of the ROD, the location of wells, number of wells, and the frequency of sampling to be completed as part of the remedial action will all be finalized in the remedial design and reviewed by the NJDEP and USEPA. However, the feasibility study does make assumptions on this. The Army assumed that there would be eight consecutive rounds of quarterly monitoring followed by semi-annual monitoring for five years and then annual monitoring for a period of time.

Sampling would be reduced based upon the levels of contamination found in those samples. As stated, that is open to change in the remedial design. Regarding the second question, Area C and E wells are geographically fairly far apart (approximately one mile); therefore, there are different monitoring wells for Area C than for Area E.

COMMENT FROM MICHAEL GLAAB

Comment 3: Michael Glaab is a resident of Jefferson Township and the community co-chair of the Picatinny Arsenal Environmental Restoration Advisory Board (RAB). Mr. Glaab asked - What is the closest distance that the contaminated area approaches Green Pond Brook, and do any such areas indicate a higher than acceptable level of any COC?

Response: There are measurable levels of solvents in wells 80-1, 80-2, and 80-3. They are approximately 150 feet from Green Pond Brook. There are also measurable levels of solvents in Green Pond Brook, but below the surface water standards, which are very low. None of these sample points collected as part of the FS (three monitoring wells and six surface water samples in GPB itself) contained exceedances of solvents coming from the Area E plume. It should be noted that this section of Green Pond Brook is downstream from the Area D plume which is discharging to Green Pond Brook. Because of this Area D discharge, low levels of vinyl chloride were detected in excess of surface water criteria. The vinyl chloride exceedances in surface water that were detected downgradient of the Area E plum are attributable to the Area D plume discharge.

Comment 4: What are PELs and are they site specific to Picatinny Arsenal? Also, was this data accepted by the NJDEP and EPA?

Response: The PELs are Potential Effect Levels. The PELs were used throughout Green Pond Brook and elsewhere at Picatinny Arsenal to determine when sediment concentrations might be toxic to aquatic organisms. They are a measure of the potential eco-toxicity to aquatic organisms. They were calculated specifically for use at Picatinny Arsenal, based on Green Pond Brook data. They were accepted by the NJDEP and EPA.

3.1.1.2 Site 22

Comment 5: Why were arsenic and manganese not retained as COCs in surface water? (page 12 of Proposed Plan, paragraph 2)

Response: Arsenic and manganese were not retained as COCs because there is no human consumption of the surface water in that drainage ditch; human ingestion is not a complete exposure pathway. The drainage ditch typically has little to no water in it and it is not used for human consumption. Therefore, it was considered inappropriate to carry those compounds forward based on potential human health risk when no one was drinking the water.

Comment 6: For the record and for consideration, if the level of arsenic and manganese could be so high in surface water that it would exceed human health values, where is it coming from? Also, has signage warning about consumption of the surface water been considered?

Response: Signage has not been considered for the drainage ditch because the possibility of someone wanting to drink the water from the Site 22 ditch is extremely unlikely. The ditch is dry a significant portion of the year. When there is water in the ditch it is shallow and stagnant. Picatinny Arsenal has a centralized potable water system that obtains 100% of its water supply from groundwater so none of the ditch water will enter the

potable water system. The remedial alternative for Site 22 includes implementation of land use controls to ensure protectiveness of human health and the environment. The provisions and requirements of the land use controls will be detailed in the remedial design after the ROD is signed.

3.1.2 Summary of Comments Received during the Public Comment Period and Agency Responses

COMMENT FROM SUBSURFACE SOLUTIONS

The following summarizes comments received from Subsurface Solutions, LLC on behalf of the (RAB). These comments were received through a letter dated January 6, 2005 to the Environmental Affairs Office of Picatinny Arsenal.

Comment 1: U.S. Environmental Protection Agency (USEPA) guidance states that "in general, the period of performance for costing purposes should not exceed 30 years for the purpose of the detailed analysis." The qualifier "in general" would seem to indicate that there may be situations where the period of performance exceeds 30 years. In some cases, a longer time period of performance may provide more realistic estimates for comparing alternatives. As an example, the alternatives considered for Area E groundwater have timeframes ranging from 38 to 45 years for the attainment of groundwater quality standards. Despite the timeframes exceeding 30 years, the horizon for costing of operation and maintenance (O&M) expenses was only 30 years. It is unrealistic to suppose that 30 years is an adequate time period for these alternatives. The RAB would like to review the total estimated cost (capital plus O&M) for the various alternatives based on the actual estimated duration to attain to compliance and requests that these costs be put forth in the responsiveness summary.

Response: The total estimated costs for each remedial alternative included O&M for the actual estimated duration for the remedial activity (from 38 to 45 years). Appendix D of the Final FS, which is part of the administrative record file for the site, includes the detailed cost estimates for each alternative, including O&M costs and duration.

Comment 2: The assumptions for calculation of costs are summarized in the Proposed Plan. For Alternative 5, the Proposed Plan states that "also included in the cost of this alternative were insurance, bonds, and a contingency factor." Other alternatives do not include a similar statement leading one to believe that these costs have not been factored in. However, such costs should be factored into all alternatives (other than the no-action alternative). If in fact such costs have not been included in other alternatives then the estimated costs for Alternative 5 are unduly inflated in comparison to the other alternatives and therefore, the comparison of alternatives based on cost is skewed.

Response: The cost estimated for each alternative (other than the no action alternative) included contingency for capital and O&M costs. The referenced statement was inadvertently omitted from the description of the other alternatives. The cost estimate for Alternative 5 is not unduly inflated in comparison to the other alternatives. The detailed cost estimates for each remedial alternative are presented in the Final FS, and are available as part of the administrative record file for the site.

Comment 3: Concern has been expressed amongst the RAB members about the possibility of TCE migrating towards Green Pond Brook. Indeed, one member of the RAB refers to the version of the Proposed Plan for Area E Groundwater Picatinny New Jersey that is designated Final – Revision 1, November 2004 when he expresses the following:

"The maps on pages 13 and 15 graphically display a very noticeable south-easterly migration of the TCE groundwater contamination towards Green Pond Brook. Maps on pages 13, 15 and 22 make self-evident the relative proximity of the south-eastern portion of the TCE contaminated groundwater plume to Green Pond Brook. Therefore, the rate of flow of the TCE from the plume of contaminated groundwater towards the brook is a factor deserving consideration.

In paragraph 5 of page 20 of the final Proposed Plan for Area E Groundwater Picatinny New Jersey, dated November of 2004, the groundwater velocity (actually speed - since velocity is a vector that includes a directional vector component) is estimated to be 95 ft./year at Area E.

Apparently it is anticipated that several currently existing monitoring wells will probably not be utilized for long term monitoring and that therefore many of these will be abandoned. It is understandable that some of the wells that were initially installed primarily to identify and assess the onsite groundwater contamination may no longer be necessary and that therefore it may not be cost effective to maintain them.

Nevertheless, the relatively close proximity of the TCE groundwater contamination to Green Pond Brook and the possibility that these contaminants may eventually migrate to Green Pond Brook logically imply that it would be prudent to have sufficient monitoring wells properly placed to assure that monitoring of the movement of the groundwater contaminants will be both accurate and timely.

Enough monitoring wells should be appropriately sited over the long term to prevent significant contamination of Green Pond Brook by the aforementioned contaminants to both safe guard the environment and the health of individuals utilizing Picatinny's governmental facilities, its private commercial facilities, and the residences of those families living on the base".

A number of wells are included in the plan for long-term monitoring whereas some wells will be abandoned after eight quarters of monitoring. Wells 70-2, 70-3, and 70-4 are located at the perimeter of the plume and are side gradient of a trichloroethene hot spot. Given the close proximity of the area to Green Pond Brook and the potential for plume migration to the brook, it would seem prudent to maintain the aforementioned well cluster for a longer period of time. Sampling might be discontinued after eight quarters but the wells left intact in the event of unforeseen circumstances.

Response: The comment is correct is stating that historically the plume **moved** in a southeasterly direction prior to reaching steady state and beginning to recede. Groundwater in the shallow unconfined aquifer **flows** in that direction and ultimately discharges into Green Pond Brook. However, as stated on page 16 of the Proposed Plan, none of the Area E contaminants are discharging to the brook at levels above surface water criteria. The number and locations of wells will be detailed in the remedial design after the ROD is signed. Sufficient wells will be used to achieve RAOs, which include preventing contamination of surface water.

Comment 4: Arsenic and manganese concentrations (in surface water at Site 22) exceeded human health values but were not retained as COCs because there was supposedly not a complete pathway, this being due to the intermittent nature of the drainage ditch. However, during periods of precipitation and storm runoff, the ditch most likely does have flowing water. Given the potential presence of water in the ditch at times, the RAB requests that appropriate signs warning of the potential hazards be installed in this area.

Response: Yes, during rain events, the ditch would have flowing water. However, the intersection with Green Pond Brook is approximately 2,000 feet distant. It should also be noted that Green Pond Brook is not used as a source of drinking water. Signage has not been considered for the drainage ditch because the possibility of someone wanting to drink the water from the Site 22 ditch is extremely unlikely. The ditch is dry a significant portion of the year. When there is water in the ditch, it is shallow and stagnant. Picatinny has a centralized potable water system that obtains 100% of its water supply from groundwater so none of the ditch water will enter the potable water system. The remedial alternative for Site 22 includes implementation of land use controls to ensure protectiveness. The provisions and requirements of the land use controls will be detailed in the remedial design after the ROD is signed.

The following summarizes comments received from The Law Offices of Schwartz, Tobia, Stanziale, Sedita & Campisano, on behalf of Pondview Estates, Inc. These comments were received through a letter dated January 7, 2005 to the Environmental Affairs Office of Picatinny. It should be noted that the Army is responding to these comments despite the fact that the comments were not received until January 10th, two days after the close of the public comment period.

Subject Comment 1: Area E Groundwater, Future Potable Use of Area Groundwater at Pondview

As the Army is well aware (and has been for some time), Pondview and Rockaway Township have had a joint application pending with NJDEP since 2000 for a Water Allocation Permit. This NJDEP permit would allow supply wells at Pondview (located approximately 0.8 miles from the southern boundary of Picatinny Arsenal) to withdraw for potable use up to 1.1 million gallons per day of groundwater from the same source aquifer as located beneath the Site. Recent well testing shows that the tapped aquifer is capable of supporting a minimum pumping rate of 1,110 gpm. Additionally, in August 2001, Pondview was issued a Water Use Registration by NJDEP that currently allows Pondview to use up to 100,000 gallons per day from the existing wells. Accordingly, the Army has certainly been on notice for some time of the planned groundwater use in the area adjacent to the Picatinny facility.

Response: The Army has been aware that Pondview has discussed their application to the NJDEP when the remedial alternatives for Site 22 and Area E groundwater were selected. However, the Army has no first hand knowledge of the application or its status as we have received no correspondence on this matter. It should be noted that while the proposed Pondview supply wells are approximately 0.8 miles from Picatinny's southern boundary, Area E is over one mile inside the southern boundary. Therefore Area E groundwater is approximately two miles from the proposed Pondview wells and not flowing toward the Pondveiw wells but flowing toward Green Pond Brook.

Subject Comment 2: Area E Groundwater, History and Proposed Remediation Plan

The Army's preferred remedial alternative for Area E Groundwater is monitored natural attenuation ("MNA") and land use controls. The Army cites the significant reductions in the levels of the chlorinated COCs as justification for MNA as opposed to some remediation component that would include active treatment. However, while the most recent sampling results for several chlorinated compounds do reflect decreased levels, these COCs still remain substantially above NJDEP drinking water standards. Moreover, the Proposed Plan for Area E Groundwater prepared by Shaw Environmental and Infrastructure, Inc., dated November 2004 (hereinafter "Proposed Plan") (at p. 11) specifically states that "(s)ampling results from 1999 indicated that the concentrations [of COCs] in several wells within the center region of the plume have not substantially changed since 1994." (Emphasis added.) Thus, by its own contractor's acknowledgment, the Army's contention that the groundwater data demonstrates support for a natural attenuation remedy is not completely accurate and, in fact, directly contradicts that assertion.

Response: It is acknowledged that some concentrations of COCs in Area E groundwater exceed NJDEP drinking water standards. The statement is referenced out of context. The primary point made in the subject paragraph is that the concentrations of solvents in Area E have gone down considerably. As stated in the introductory sentence to paragraph no. 4 on page 11 of the Proposed Plan: "Evaluation of results from the common wells between 1989 and 1999 indicate that VOC concentrations have consistently decreased." As is the case with many naturally attenuating plumes, the plumes periphery degrades more rapidly than the plumes center. As presented on Figure 6 - Migration and Attenuation of TCE Groundwater Plume over Time, page 14 of the Proposed Plan, the contaminant plume has not migrated to Green Pond Brook, indicating plume stability and the effectiveness of natural attenuation processes at controlling plume migration. Additionally, the trend analysis shows decreasing concentration trends in the plume, further indicative of intrinsic degradation and attenuation processes. Analysis of the migration and attenuation of the daughter products show similar decreasing concentration trends and plume stability.

Subject Comment 3: Area E Groundwater, Remedial Action Objectives for the Site
The Army's proposed remediation plan is purportedly intended, among other things, but presumably first and foremost, to "prevent human consumption of ... contaminated Area E groundwater." Proposed Plan (at p. 17). However, the Remedial Action Objectives did not include preventing human consumption resulting from off-site migration of chlorinated VOCs at concentrations in excess of primary drinking water standards. Without extending the RAOs to include protecting potable off-site receptors and preventing off-site migration, it cannot be categorically stated that such COCs as PCE and TCE, currently present in Area E groundwater in concentrations exceeding MCLs, for which the ARARs/LOCs (e.g., NJDEP drinking water standards) are one part per billion, will not eventually reach off-site sources of potable use. As a result, absent inclusion of this critical RAO in the Army's remedy selection analysis; there is inadequate basis from which to definitively conclude that the remedial alternative chosen will in all foreseeable circumstances effectively protect human health. Thus, it is clear that had the appropriate considerations for formulating RAOs been utilized in selection of the Army's Proposed Plan, clearly Remedial Alternative No. 2 (MNA) would not adequately address and/or satisfy the above contemplated RAO.

Response: The RAO on Page 17 of the proposed plan reads "Prevent human consumption of and contact with contaminated Area E groundwater". Attainment of this RAO is not limited to the geographic confines of Area E. The RAO on page 17 is more protective than the RAO described in the comment.

Contaminated groundwater at Area E is not flowing toward the base boundary. It is flowing toward Green Pond Brook and COCs have not reached the brook. Further, because the plume is stable, it is currently predicted that the plume will never reach the brook or the base boundary. As an additional safeguard the RAO to prevent human consumption of Area E groundwater will be met by implementation of land use controls and the CEA. Further, the remedy includes the performance of 5-year reviews. The effectiveness of the remedy is evaluated during the 5-year review to ensure continued protectiveness. If, during the course of that review, it is determined that the remedy is no longer protective of human health and the environment, the need for additional action will be examined and any modifications to the remedy will require regulatory approval.

Subject Comment 4: The Shortcomings of the Army's Selected Remedy
In perhaps the most glaring and crucial omission, the Proposed Plan (at p. 8) states that "(t)here are no potable supply wells . . . to be considered in the selection of the remedy for Area E groundwater." Thus, the Army's remediation contractor make it clear that

despite the knowledge of future supply wells at Pondview, located less than a mile from Picatinny Arsenal's closest boundary along Route 15, this crucial fact was given absolutely no consideration whatsoever in the formulation or selection of the Army's proposed remedy for Area E. Consequently, the Health Hazard Risk Assessment (HHRA) for groundwater, utilized to determine whether (and to what extent) remedial action is warranted, failed to evaluate the risk of off-site receptors' potential exposure to chlorinated VOC contaminants from potable use of groundwater drawn from the unconfined aquifer beneath Area E. Notwithstanding that the Army completely ignored this risk in conducting the requisite HHRA, NJDEP has nevertheless previously communicated its position to Pondview (as early as August 2001) that there is a potential risk of off-site migration of contaminants in the unconfined aquifer beneath the Site that would pose a theoretical threat to future supply wells located at Pondview. The Army is plainly aware of this position taken by NJDEP. Accordingly, the Army should, at a minimum, be required to reassess the health hazard risk for its presumptive remediation plan, factoring in the future potable supply wells at Pondview.

The Army's preferred Remedial Alternative for Area E groundwater is the implementation of land use controls, and groundwater monitoring. One of the primary land use controls that the Army would implement includes the establishment of a Classification Exception Area ("CEA") for groundwater at this Site. A CEA may be established by NJDEP based on its conclusion that groundwater impacts at the Site have made groundwater use limited or unsafe for human consumption. A CEA designation institutionally restricts the installation of groundwater wells until groundwater beneath the site meets applicable NJDEP standards. It is Pondview's understanding that, in July 2002, the Army received approval from NJDEP for a groundwater CEA coextensive with the boundaries of the entire Picatinny Arsenal facility, which covers approximately 6,500 acres.

However, upon information and belief, the Army may not have fully disclosed to NJDEP all relevant information specifically in regard to future area groundwater use as required by NJDEP regulations in order to obtain this CEA approval. For certain, when it applied to NJDEP, the Army failed to notify Pondview, as an affected property owner, of the proposed CEA, in violation of NJDEP requirements found at N.J.A.C. 7:26E-8.3(b)5vii. If, indeed, the Army's CEA application failed to comply with NJDEP regulations, then it is arguable whether this CEA for the Site, which is inextricably part of the remedial action plan proposed for Area E groundwater, was validly issued. If the CEA was obtained based on the absence of information required to be disclosed, then the CEA may potentially be invalid, which would effectively vitiate the necessary State authorization and approval for the Army's proposed remedy for this Site.

Moreover, the following statutory cleanup standards for Superfund Site remediations under CERCLA § 121(b) are not obviously satisfied by the Army's choice of monitored natural attenuation:
(1) protectiveness of human health; ...
(2) utilization of permanent solutions and alternative technologies to the maximum extent possible; and
(3) satisfaction of the preference for treatment as-a principal element of the remedial action.

None of the above statutory requirements are even close to be met by the Army's selected remedy.

Response: The referenced statement, "(t)here are no potable supply wells . . . to be considered in the selection of the remedy for Area E groundwater.", was not presented accurately in

the above comment. The text of the Proposed Plan reads "There are no potable supply wells, or areas of major historic importance in Area E to be considered...".. This is a true statement. The Army acknowledges the presence of supply wells in proximity to Area E, on page 7 of the Proposed Plan. The proposed Pondview wells were not mentioned because they are screened in a different aquifer than the Area E plume and based upon all existing site data, too distant to be impacted by chlorinated solvents from Area E. Furthermore, the HHRA evaluated risks to residents for ingestion of groundwater from the unconfined aquifer. A summary of these risks is presented on pages 17-19 of the Proposed Plan. Additional details of the risk assessments are available in the Administrative Record file for the site. As part of the 5-year review process, the remedy is evaluated to determine continued protectiveness, and may be re-evaluated if it is determined that the remedy in place is no longer protective of human health based on new conditions.

It should be noted that while the Picatinny Arsenal CEA is part of the land use controls, the primary facet of the remedy is monitored natural attenuation. EPA guidance on the use of Monitored Natural Attenuation states:

"Natural attenuation processes (biodegradation, dispersion sorption, volatilization) affect the fate and transport of chlorinated solvents in all hydrologic systems. When these processes are shown to be capable of attaining site-specific remediation objectives in a time period that is reasonable compared to other alternatives, they may be selected alone or in combination with other more active remedies as the preferred alternative." USEPA Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater EPA/600/R-98/128

The Area E groundwater plume meets this description.

In regard to the Picatinny Arsenal CEA, the New Jersey Administrative Code lists all parties that must be copied by certified letter return receipt requested. The requirement from the administrative code reads as follows:

"Copies of certified letters, return receipt requested, notifying the following persons of the need to establish the groundwater classification exception area:"

The list includes local and State officials. Off-site property owners are not included on this list. The specific subsection cited in the comment reads as follows:

"If the groundwater classification exception area is located in a groundwater use area, each owner of any real property within the groundwater classification exception area."(Must receive a letter)

The subsection indicates that owners of property within the CEA should be notified. The CEA was established for Picatinny Arsenal's property only.

The remedy is protective of human health as there is no unacceptable risk to human health from the ingestion of the COCs in the Area E groundwater. The statutory preference for treatment applies to principal threat wastes (source materials), which have already been removed from the site.

The statutory preference for treatment of Area E groundwater is not applicable because source materials constituting principal threats have already been removed. The selected remedy does passively treat the site contaminants through monitored natural attenuation.

The selected remedy for Area E groundwater is expected to be capable of meeting the remediation goals within a reasonable time frame and more cost-effectively than the technologies that utilize active treatment. Because the selected remedy will result in hazardous substances remaining on site for a period of time above levels that allow for unlimited use and unrestricted exposure, five-year reviews will be conducted in compliance with CERCLA and the NCP to ensure that the remedy is and will be protective of human health and the environment. Because the preferred alternative for Area E groundwater relies on passive treatment (natural attenuation) processes to reduce concentrations of contaminants in groundwater to ARAR levels, the environment is still being exposed to the COCs. However, implementation of LUCs, such as access restrictions and a CEA designation would tremendously reduce the potential human health exposure pathways.

Subject Comment 5: Evaluation of Remedial Alternatives Considered by the Army

In selecting its preferred remedial alternative of monitored natural attenuation, the Army eschewed other alternatives that not only address, but effectively, comprehensively and permanently eliminate or neutralize contaminants impacting groundwater. These other Remedial Alternatives accomplish the RAOs through in situ treatment, extraction and/or air sparging of the COCs found in Area E groundwater. (See Remedial Alternatives Nos. 3-5 at pp. 21, 23-24 of Proposed Plan.) The abovementioned, more aggressive technologies associated with these Remedial Alternatives are notably absent from the Army's selected remedy.

In comparison to active remediation alternatives (Nos. 3-5), *the Army's preferred* remedy of MNA appears to fall far short in terms of overall protection of human health and the environment, which is the threshold criteria to be used to evaluate the effectiveness of remediation options. Nor does the Army's selected remedy stack up to the other alternatives insofar as criteria such as long-term effectiveness and *permanence or reduction of toxicity, mobility, or volume through treatment.* In appropriately evaluating the various remedial alternatives based upon the essential criteria referred to above, it would hardly be an overstatement to suggest that MNA does not appear to provide any greater tangible benefits than would "No Action."

In actuality, the only criteria under which the Army's selected remedial alternatives can be deemed preferable or advantageous are implementability and cost. Clearly, the remedial alternative evaluation process has improperly given too much weight to implementability and cost factors over far more important criteria, such as protection of human health and the environment, long-term effectiveness and permanence, as well as reduction of toxicity, mobility and volume. The result of this transparently biased selection process is that the Army seeks to implement a Remedial Alternative which is neither comprehensive nor most effective. Further, the resultant cost savings to the Army would unfairly and impermissibly shift costs onto area resident groundwater users and developers of residential property that must rely on area groundwater as a water supply source for future potable use. Both current and future groundwater users may likely find it advisable or be compelled to needlessly take costly measures of their own to ensure that any contaminants which may migrate off-site through the groundwater do not reach nearby potable water sources. As a condition of the water allocation permit for the aforementioned supply wells to be located at Pondview, NJDEP is requiring Pondview, as a wellhead protection measure, to install a hydraulic barrier system at very substantial cost.

Response: The preferred remedy meets statutory requirements as noted in the Evaluation of Alternative Section and in the Feasibility Study for Area that is part of the administrative record. The Feasibility Study for Area E Groundwater was approved by both the EPA and NJDEP.

Natural processes occurring in the Area E groundwater promote degradation and attenuation of the COCs. There is no continuing source of contamination, and periodic monitoring of the groundwater constituent levels and groundwater geochemistry support this conclusion. This attenuation process, in conjunction with implementation of LUCs is protective of human health and the environment. It is a common misconception that MNA is not a viable remedy because it is passive remediation that relies on intrinsic processes and groundwater chemistry to reduce levels of contaminants and control plume migration. However, MNA is an EPA-approved remedy that has proven to be an effective remedy at many Superfund sites. The Army conducted an evaluation of MNA to determine if it is a viable remedy for groundwater at Area E. Results of this study, presented in the Final FS for Area E groundwater and approved by the USEPA and NJDEP, indicate that intrinsic degradation and attenuation of COCs is occurring in the groundwater. The remedial timeframe for MNA at Area E is comparable to the other alternatives evaluated in the Area E Feasibility Study and reasonable based upon the review by the NJDEP and EPA of the Area E FS. Further, implementation of LUCs during this timeframe will ensure human health and the environment are protected.

The comments state that the Army is unfairly transferring cost onto area groundwater users. This is incorrect. The Area E groundwater plume is in the shallow aquifer and does not flow toward the base boundary. The Army has demonstrated that the plume is not spreading. Therefore, based on all available site data, the plume will not reach the southern boundary of Picatinny Arsenal.

Subject Comment 6: Monitored Natural Attenuation Is Not an Appropriate Remedy for this Site

The aquifer which underlies the Picatinny Arsenal facility is a major source of drinking water for Morris County as well as outlying communities. The Army's preferred remedial action alternative spurns active, aggressive forms of remediating contaminated groundwater beneath the Site. Left incompletely addressed, such groundwater contamination could adversely impact groundwater resources, including potential impact to off-site groundwater, which (in addition to other critical issues) the Army did not even give consideration to in conducting its remedial action selection process. The potential inability of the Army's selected remedy to prevent such impacts would threaten to write off for many decades to come the future potable use of groundwater located beneath the Site, preventing such use by generations of existing and future Morris County residents. Both the State and local governments in Morris County and other parts of Northern New Jersey have been grappling to adequately address growing concerns about the potential future shortages in the potable water supply in the region, as well as protecting and preserving the valuable Highlands region in this area of the State. Given (among numerous other concerns) the potential for long-term loss of significant groundwater resources that could result under the Army's Proposed Plan for Area E groundwater, this remedial alternative should not be deemed acceptable.

The groundwater is a natural resource which is held in public trust by the State for the people of New Jersey. The Army's Proposed Plan could result in impermissibly and unjustifiably usurping from the current and future residents of Rockaway Township and surrounding communities the right to enjoy unrestricted use of this valuable natural resource. As the polluter responsible for the contamination, the Army must aggressively step up to the plate in terms of remediation and do the utmost to ultimately restore the condition of the groundwater to unrestricted use, in order to ensure that contaminants do not further migrate to potentially threaten to permanently restrict or condition potable use of additional area groundwater. The Proposed Plan fails to satisfy these threshold concerns and requirements.

The primary factor underlying the Army's selection of monitored natural attenuation as the preferred remedy was the incorrect assumption of no reasonably anticipated use of groundwater that could potentially be impacted by contaminants found in Area E groundwater. Rockaway Township and Pondview jointly submitted a water allocation permit for its proposed potable supply wells to NJDEP in 2000, public hearings were held and that application still remains pending, with a reasonable likelihood of ultimately being approved. Since 2001, NJDEP's position has been that groundwater contamination beneath Picatinny Arsenal presents a potential risk to Pondview's proposed wells. Clearly, the linchpin rationale for the Army's MNA remedy is founded on an erroneous basis that was already known (or should have known) by the Army long in advance of this remedy's selection.

Furthermore, as discussed above, the human health risk assessment for the Army's Proposed Plan also appears to have completely overlooked a significant, future off-site receptor in the Pondview supply wells and does not even attempt to address any such related concerns. These concerns ought to be seriously considered in assessing whether the Army's preferred Remedial Alternative is sufficiently protective of human health and satisfies the applicable federal and state regulatory requirements. Given the proposed Pondview potable wells' location and the planned groundwater use, the detected presence of chlorinated VOCs in Area E groundwater at concentrations substantially exceeding drinking water standards, and the potential risk they present to human health, cannot and should not be ignored or dismissed.

In sum, the Army's selected Remedial Alternative does not satisfy fundamental regulatory requirements and criteria relating to either long-term effectiveness, permanence or reduction of toxicity, mobility or volume. Nor, as set forth above, does this proposed remedy adequately address potential concerns relating to possible off-site impacts to groundwater from existing contamination in the Area E groundwater, to which the remedial action plan selection process undertaken to date has not given the required consideration. Accordingly, the Army's chosen remedy does not meet mandatory regulatory requirements and should be rejected.

Response: As previously stated, the Area E groundwater plume is in a shallow aquifer that is not flowing toward the Pondveiw wells but flowing toward Green Pond Brook. The comment is incorrect or somewhat of an exaggeration in its assertion that the selected remedial alternative for Area E groundwater impacts the use of groundwater in Morris County. The land use restrictions disallow or limit the use of Area E groundwater for the period of time it will take monitored natural attenuation to degrade the plume. However Area E groundwater is not available to be developed in Morris County. Area E is entirely within Picatinny Arsenal's property boundary. Picatinny Arsenal is an active military installation with a potable water system that currently meets all of its needs. There are currently no plans for increasing the capacity of that system.

The Army has borne the cost of remedial action. The Army has been aggressive in cleanup of the principle threat waste responsible for this plume. The Army completed multiple removal actions to address the source of this plume and these actions have shown real impact in the cleanup of the environment. The removal of the waste lagoons has resulted in contaminant concentrations consistently degrading since the early 1990s. The Army has also monitored this plume on a consistent basis for the last 14 years. This monitoring has shown that the plume has not reached Green Pond Brook and is at steady state (not moving). It should also be noted that it is the responsibility of the Army to ensure that funding for CERCLA cleanup is expended appropriately and efficiently. Using funds to perform additional remediation not warranted by the degree of contamination at this site would be a waste of taxpayer dollars.

The comment states that the Army's future groundwater use assumption is incorrect. As discussed in the responses above, the Army has determined the potential hypothetical receptors for the Area E plume. The Army has performed a risk assessment to evaluate the potential impact to these hypothetical receptors. Potential impact to the Pondview wells from the Area E plume is not a realistic scenario.

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4.0 PART 4: REFERENCES

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