DEPARTMENT OF THE ARMY
INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, UNITED STATES ARMY GARRISON, PICATINNY
PICATINNY ARSENAL, NEW JERSEY 07806-5000

SUBJECT: Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)/Interagency Agreement (IAG) Administrative Docket No. II-CERCLA-FFA-001-04: **Record of Decision Group 3 Sites**: Review is ER,A-eligible

23 August 2010

Mr. William Roach
U.S. Environmental Protection Agency
Region 2
290 Broadway, 18th Floor
New York, NY 10007-1866

Mr. Gregory Zalaskus
New Jersey Department of Environmental Protection
Emergency Management Program
East State Street, Floor 5, P.O. Box 028
Trenton, New Jersey 08625-0028

Dear Sirs:

Enclosed for your records are copies of the **Record of Decision Group 3 Sites** signed by Picatinny Arsenal's Deputy Garrison Commander, Herb Koehler, on July 8th, and Mr. Walter Mugdan for Region 2 USEPA on August 2nd, 2010.

The document will be public noticed and placed within the administrative repositories within the next few weeks. I will keep you informed of that notification. ARCADIS is already moving forward on the action based on the submitted remedial design workplan.

Sincerely,

Project Manager for Environmental Restoration

Enclosure

Copies Furnished w/o enclosure:
NJDEP, Greg Zalaskus
Mike Glaab, RAB Co-Chair

Picatinny Installation Restoration Program

Picatinny is an Official Hawk Watch Site

RECORD OF DECISION FOR GROUNDWATER AND SURFACE WATER AT GROUP 3 SITES (PICA 008)

PICATINNY ARSENAL NEW JERSEY

FINAL **JUNE 2010**

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LIST OF ACRONYMS AND ABBREVIATIONS

1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
ARAR	Applicable or Relevant and Appropriate Requirement
Army	U.S. Department of the Army
AS	Air Sparging
AST	Aboveground Storage Tank
bgs	Below Ground Surface
BRG	Ballistic Rail Gun
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CF	Chloroform
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CT	Carbon Tetrachloride
DGI	Data Gap Investigation
EEQ	Ecological Effect Quotient
ELCR	Excess Lifetime Cancer Risk
ERA	Ecological Risk Assessment
EVO	Emulsified Vegetable Oil
FS	Feasibility Study
ft	Feet
GAC	Granulated Activated Carbon
gpm	gallons per minute
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
ICFKE	ICF Kaiser Engineers
IT	IT Corporation
LOC	Level of Concern
LUC	Land Use Control
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
µg/L	microgram per liter
mg/kg	Milligrams per kilogram
MMRP	Military Munitions Response Program
MNA	Monitored Natural Attenuation
msl	mean sea level
NARTS	Naval Air Rocket Test Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NJGWQS	New Jersey Groundwater Quality Standards
NJMCL	New Jersey Maximum Contaminant Level
NJSWQC	New Jersey Surface Water Quality Criteria
NPL	National Priorities List
O&M	Operation and Maintenance
PAERAB	Picatinny Arsenal Environmental Restoration Advisory Board
PCE	Tetrachloroethylene
PP	Proposed Plan
PQL	Practical Quantitation Limit
PRG	Preliminary Remedial Goal
RA	Response Action
RAO	Remedial Action Objective
RBC	Risk-Based Concentration
RD	Remedial Design
RDX	Cyclotrimethylenetrinitramine
RI	Remedial Investigation
RMD	Reaction Motors Division
ROD	Record of Decision
ROI	Radius of Influence
SARA	Superfund Amendments and Reauthorization Act
SCL	Site Cleanup Level
SDWA	Safe Drinking Water Act
SVE	Soil Vapor Extraction
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TBC	To-Be-Considered
TCE	Trichloroethene
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UXO	Unexploded Ordnance
VOCs	Volatile Organic Compounds
WRA	Well Restriction Area
WWI	World War I
WWII	World War II
ZVI	Zero-Valent Iron

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 Command, Northeast Region, 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.

The Group 3 Sites (PICA 008) are located in Area J at Picatinny (see **Figure 1**) and encompass approximately 40 acres. Site 2 is centrally located in Area J, south of Site 1 (located in the northeast corner) and north of Site 4 (located in the southern portion of Area J). This Record of Decision (ROD) addresses groundwater and surface water at the Group 3 Sites (PICA 008) at Picatinny Arsenal (Picatinny), located in Rockaway Township, Morris County, New Jersey (**Figure 1**).

1.2 STATEMENT OF BASIS AND PURPOSE

This *Record of Decision for Groundwater and Surface Water at Group 3 Sites (PICA 008)* presents the Response Action (RA) selected for the sites. The response action is selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, 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 RA 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 New Jersey Department of Environmental Protection (NJDEP) were evaluated and considered in selecting the final RA as well. NJDEP concurs with the Selected RA.

1.3 ASSESSMENT OF THE SITE

The Response Action selected in this ROD is necessary to protect public health and welfare and the environment from actual or threatened releases of hazardous substances into the environment at the Group 3 Sites (PICA 008).

1.4 DESCRIPTION OF THE SELECTED RESPONSE ACTION – *IN-SITU* ENHANCED BIOREMEDIATION AT SITE 2, WITH LONG-TERM GROUNDWATER MONITORING AND LAND USE CONTROLS

The Response Action for the Group 3 Sites (PICA 008), pursuant to this ROD, is part of a comprehensive environmental investigation and remediation process currently being performed at Picatinny. The remaining areas in Picatinny are being considered separately and remedies for these areas are presented in separate documents.

Studies conducted at the Group 3 Sites (PICA 008), presented in **Table 1**, have shown various constituents present in groundwater at concentrations above the levels of concern (LOCs). **Table 2** summarizes the constituents that exceeded LOCs in groundwater samples collected beneath the Group 3 Sites. **Table 3** summarizes the constituents that exceeded LOCs in surface water samples collected at the Group 3 Sites (PICA 008). These samples were collected to characterize surface water impacts as a result of existing groundwater contamination.

The Selected RA for groundwater at the Group 3 Sites (PICA 008) consists of the implementation of *in-situ* enhanced bioremediation at Site 2; long-term groundwater monitoring; and land use controls (LUCs). Surface water monitoring will be conducted at Site 2 in conjunction with the long-term groundwater monitoring program until concentrations fall below New Jersey Surface Water Quality Criteria (NJSWQC). A response action is not required at Sites 1 and 4 to address groundwater or surface water.

The Selected RA was chosen based on protection of human health and the environment and effectively addresses the risk posed by groundwater. In addition, the Selected RA is the most implementable and cost-effective, while satisfying the remaining selection criteria.

1.5 STATUTORY DETERMINATIONS

The Selected RA satisfies the chemical-specific cleanup levels and complies with the chemical-, action- and location-specific applicable or relevant and appropriate requirements (ARARs) presented in **Tables 4**, **5** and **6**. Site Cleanup Levels (SCLs) were selected for groundwater in the Feasibility Study (FS) (Shaw, 1995a) and in the Pre-Design Technical Memorandum (ARCADIS, 2009a) for Group 3 Sites (PICA 008) based on the lower of the following values: Federal Maximum Contaminant Levels (MCLs); New Jersey State MCLs (NJMCLs); New Jersey Groundwater Quality Standards (NJGWQS) or New Jersey Practical Quantitation Limits (PQLs) (whichever is lower); and, any non-zero Federal Maximum Contaminant Level Goals (MCLGs). The Federal Standards are established in 40 CFR Part 141 while the New Jersey Standards are established in N.J.A.C. 7:9C and 7:10.

The Selected RA addresses Group 3 Sites (PICA 008) through the use of an active treatment technology. As concluded in the Risk Assessment, none of the contaminants that exceeded LOCs at Group 3 Sites (PICA 008) meet the criteria of principal threat waste. The Selected RA provides an optimal balance of controlling human health and ecological risks, and incorporating active groundwater treatments with minimal intrusive activities.

Because the Selected RA will result in contaminants remaining on site above levels that do not allow for unlimited use and unrestricted exposure, five-year reviews will be conducted in compliance with CERCLA and NCP to ensure that the Selected RA is, and will be, protective of human health and the environment.

1.6 DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary (Part 2) of this ROD. Additional information can be found in the Administrative Record for this site.

Criterion	Section	Page No.
Contaminants of concern and their respective concentrations	Table 8 2.8.4	2-13
Baseline risk represented by the contaminants of concern	2.8	2-7
Cleanup levels established for contaminants of concern and the basis for these levels	Table 8 2.8.4	2-13
How source materials constituting principal threats will be addressed	2.13	2-22
Current and reasonably anticipated future land use assumptions used in baseline risk assessment and ROD	2.7	2-7
Potential land and groundwater use available as a result of the Selected RA	2.14.5	2-25
Estimated capital, annual operation and maintenance (O&M) and total present worth costs, discount rate, and the number of years over which the Response Action cost estimates are projected	2.14.4	2-24
Key factors leading to selection of Selected RA	2.14.1	2-23

1.7 AUTHORIZING SIGNATURE

Herb Koehler

Herb Koehler
Lieutenant Colonel, U.S. Army
Garrison Commander

7-8-10
Date

Walter E. Mugdan, Director
Emergency and Remedial Response Division
United States Environmental Protection Agency, Region 2

August 2, 2010
Date

2.0 PART 2: DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

This ROD describes the Selected RA at the Group 3 Sites (PICA 008) located at Picatinny Arsenal in Rockaway Township, Morris County, New Jersey. Picatinny is a NPL site and is registered under the CERLIS number NJ3210020704. The Army is the lead agency for CERCLA actions at these sites and USEPA Region 2 is the support agency with oversight responsibilities. In addition, plans and activities are also being coordinated with appropriate state agencies, including NJDEP.

Picatinny Arsenal is a 5,900-acre government-operated munitions research and development facility located in Morris County, New Jersey, approximately 40 miles west of New York City and 4 miles northeast of Dover, New Jersey. The Arsenal sits in the Highlands of the state of New Jersey (**Figure 1**).

The Group 3 Sites (PICA 008) are located in Area J at Picatinny (see **Figure 1**). Area J is approximately 40 acres in size and encompasses 3 sites (Sites 1, 2 and 4). Located south of Lake Denmark in the northeastern portion of Picatinny, Site 1 encompasses the northeast corner of Area J, Site 2 is centrally located, and Site 4 (Test Areas D and E) encompasses the southern portion of Area J. The G-2 Pond and Stillwell Pond are both located within Site 2 (southwest of Site 1). Sites 1 and 4 were formerly used as a Naval Air Rocket Test Station (NARTS) area; and, Site 2 was a test area for rocket engines, a photographic lab, a passivation house, and a sewage treatment facility.

The remedial action presented in this ROD was 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 remedy. 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 Picatinny Arsenal Background

Picatinny Arsenal was established in 1880 by the U.S. War Department as a storage and powder depot. Later it was expanded to assemble powder charges for cannons and to fill projectiles with maximite (a propellant). During World War I (WWI), Picatinny Arsenal produced all sizes of projectiles. In the years following WWI, Picatinny Arsenal began projectile melt-loading operations and began to manufacture pyrotechnic signals and flares on a production basis. During World War II (WWII), Picatinny Arsenal produced artillery ammunition, bombs, high explosives, pyrotechnics, and other ordnance. After WWII, Picatinny Arsenal's primary role became the research and engineering of new ordnance. However, during the Korean and Vietnam conflicts, Picatinny Arsenal resumed the production and development of explosives, ammunition, and mine systems.

In recent years, Picatinny Arsenal's mission has shifted to conducting and managing research and development, life-cycle engineering, and support of other military weapons and weapon systems. The facility has responsibility for the research and development of armament items. The Base Realignment and Closure process in 2005 resulted in Picatinny being designated to remain open and to expand in mission.

2.2.2 Group 3 Sites (PICA 008) Background

Currently, Site 1 is inactive and only contains former building structures, roadways, and rubble and debris from past demolition activities. Originally the Site was operated by the NARTS division of the Navy for rocket testing, but was also used for flare testing and for training activities. Many of the existing buildings and former structures, such as the reported dump area behind Building 3576 and the transformers, were investigated during the Phase II Remedial Investigation (RI) (Round 1) (ICFKE, 1994). The G-2 Range is being constructed at Site 1, in the 3500 Building Area, and involves the refurbishment of Buildings 3500, 3504 and 3518.

Current homeland security training at Site 2 exists in buildings located in the northwest portion of the Site and has resulted in the construction of a new building southeast of Building 3518. Site 2 was originally

owned by the Reaction Motors Division (RMD) of Thiokol Chemical Company for rocket testing and development. Other relevant features at Site 2 include explosive test sheds, explosive magazines, a photographic lab, a garage, a maintenance shop and instrument lab, a heavy-equipment storage compound, a passivation house (which used solvents to clean rocket components), and a sewage treatment facility.

Currently at Site 4 a Ballistic Rail Gun (BRG) operates within Building 3620. A minimum of four additional buildings are devoted to ordnance disassembly, and Building 3611 is a photography lab where pictures of disassembled ordnance from Building 3612 are developed. Test Area E of Site 4 currently has five inactive structures (including Building 3627) and two inactive test stands. Site 4 was originally operated by the NARTS division for rocket fuel and engine development similar to Site 1.

Aboveground storage tanks (ASTs) for both rocket fuels and oxidizers were located at the ends of each testing bay located within Sites 2 and 4.

Previous environmental investigations conducted at the Group 3 Sites (PICA 008) are listed below:

- Site Investigation conducted by Dames and Moore in 1989;
- Discharge Investigation for the removal of underground storage tanks (USTs) conducted by Carpenter Environmental Associates from 1991 to 1992;
- Phase II Remedial Investigation (RI), Round 1 conducted by ICF Kaiser Engineers (ICFKE) from 1995 to 1998 (ICFKE, 1999);
- Phase II Group 3 Sites RI conducted by IT Corporation (IT) in 1998 (Final Report submitted in October 2001);
- Data Gap Investigation (DGI) conducted by IT from July 2001 to August 2002;
- Nanoscale Zero-Valent Iron (ZVI) Groundwater Treatment Pilot Study conducted by Shaw Environmental, Inc. (Shaw) from September 2004 to January 2005 (Shaw, 2005b);
- Facility-Wide Sump Investigation (Shaw, 2005c) conducted by Shaw in 2005;
- Group 3 Sites (PICA 008) FS conducted by Shaw in August 2005; and
- Emulsified Vegetable Oil (EVO) Injection Test conducted by ARCADIS, Inc. (ARCADIS) in August 2007.

Although previous reports indicated that the source of the detected contamination was believed to be past practices at Building 3526 and/or the construction rubble used as fill following the demolition and regrading of the Building 3526 area, no major source has been identified at the Group 3 Sites (PICA 008) and there are no known continuing sources.

2.2.3 Enforcement Activities

No formal enforcement activities have occurred at the Group 3 Sites (PICA 008). Picatinny 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

The Group 3 Sites (PICA 008) have been the topic of presentations at the Picatinny Arsenal Environmental Restoration Advisory Board (PAERAB). PAERAB members have provided comments regarding the Selected RA. A copy of the Proposed Plan (PP) (ARCADIS, 2009b) was given to the PAERAB's co-chair and a copy was offered to all PAERAB members. A final PP for the Group 3 Sites (PICA 008) was completed and released to the public on October 29, 2009 at the information repositories listed below:

Installation Restoration Program Office
Building 319
Picatinny Arsenal, New Jersey 07806

Rockaway Township Library
61 Mount Hope Road
Rockaway Township, New Jersey 07866

Morris County Library
30 East Hanover Avenue
Whippany, New Jersey 07981

Multiple newspaper notifications were made to inform the public of the start of the PP comment period, to solicit comments from the public, and to announce the public meeting. The notification was run in the Daily Record on October 16, 2009 and in the Star Ledger on October 16, 2009. Copies of the certificates of publication are provided in **Appendix A**. A public meeting was held on October 29, 2009 to inform the public about all of the remedial alternatives considered and the Selected RA for the Group 3 Sites (PICA 008) and to seek public comments. At this meeting, representatives from the U.S. Army, NJDEP, USEPA, and the Army's contractor, ARCADIS U.S., Inc., were present to answer questions about the site and response actions under consideration. Following the public meeting, a public comment period was held from October 29, 2009 to November 28, 2009 during which no written comments were received from the public. Public comments and prepared responses from the public meeting are presented in Section 3.0 of this ROD.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

This ROD addresses a selection of the Response Action for groundwater at the Group 3 Sites (PICA 008). The Selected RA will address the contaminants of concern (COCs) identified in groundwater during previous investigations at the Group 3 Sites. The COCs are discussed in further detail in Section 2.8.4. The Selected RA for the Group 3 Sites (PICA 008) is designed to provide protection to human health and the environment.

The Selected RA for remediation of groundwater at the Group 3 Sites (PICA 008) consists of *in-situ* enhanced bioremediation at Site 2, with the implementation of long-term groundwater and surface water monitoring and LUCs. Injections of emulsified vegetable oil, a carbon substrate, would occur in the surficial (unconfined) aquifer at Site 2. Surface water at the Group 3 Sites will be monitored throughout the duration of groundwater monitoring and will continue until groundwater response actions result in COC concentrations within the G-2 pond which are below the NJSWQC. LUCs will be implemented to control current and future activities that could cause exposure to environmental contaminants resulting in unacceptable risk to human health. No response action is required at Sites 1 and 4. Soils will be addressed in a separate ROD, and there are no actions required for sediments at the Group 3 sites.

The Selected RA also involves performing any site maintenance required to maintain the protectiveness of the RA. The LUCs and any maintenance that will be implemented by the Army will be detailed in the Remedial Design (RD). LUCs for groundwater will be maintained until such time as contaminant levels are sufficiently reduced to allow beneficial use.

2.5 DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED RESPONSE ACTION FROM PROPOSED PLAN

The PP presented the same Selected RA as this ROD. No significant changes have been made.

2.6 SITE CHARACTERISTICS

2.6.1 Physical Characteristics

Size, Topography, and Surface Water Hydrology

The Group 3 Sites (PICA 008) are located in Area J at Picatinny (see **Figure 1**). Area J is approximately 40 acres in size and encompasses 3 sites (Sites 1, 2 and 4).

The Group 3 Sites (PICA 008) are located along the unnamed ridge that trends from the northeast to the southwest along the southeast side of the installation. The area is transected by a small valley that trends from northwest to southeast, perpendicular to the direction of the axis of the ridge on which it is located. Site 2 is located in this valley, with Site 1 on the ridge to the northeast, and Site 4 on the ridge to the southwest. Elevations within this valley range from 800 to 900 feet (ft) above mean sea level (msl).

The surface topography consists of woodlands present on the elevated ridges of the valley while low-lying swampy marshes dominate the valley floor. However, the various industrial structures, activities, and roadways present in the valley floor and on the ridges have altered the topography and the natural pattern of surface water flow and drainage.

Surface water bodies within the Group 3 Sites include several small unnamed streams and drainage ditches that transect the valley floor, low-lying swampy marshes, the 1500 Run, Stillwell Pond (0.3 acres located in the center of Site 2), G-2 Pond (4.5-acres located within Site 2), a small gunnite-lined rocket exhaust pond located within Site 4 and Pre-Ames Brook (entering from the north). Stillwell Pond discharges to the marshy area associated with the G-2 Pond via Stillwell Run. Beaver activity in the G-2 Pond has created a wetland area surrounding most of Pre-Ames Brook. Surface water draining from the Group 3 Sites eventually flows off of Picatinny property via Pre-Ames Brook.

A site map showing existing site limits for the three sites is provided as **Figure 1**.

Conceptual Site Model

The geology of the Group 3 Sites has been investigated with a total of 37 groundwater monitoring wells and five additional soil borings to characterize the subsurface environment. The bedrock geology of Area J consists almost entirely of Precambrian Gneiss, comprised of alternating bands of varying mineralogical composition and texture. Bedrock elevations range from 955-ft msl at Test Area E in Site 4, where bedrock was encountered at five feet below ground surface (bgs), to 792-ft msl in the central portion of Site 2. The unconfined soil at the Group 3 Sites consists of two sequences, post-glacial alluvium and glacial till, that overlie the bedrock units. The thickest section of glacial sediments (58-ft) was identified near the center of the valley at sample location 2SB-3, located within Site 2. The unconsolidated unit in Area J is thinnest (overburden logged to 5 ft bgs) at well 4MW-3 located on a hill to the southeast within Site 4.

Two aquifers, an unconsolidated aquifer and a bedrock aquifer, have been identified based on boring logs obtained from the Group 3 Sites. A total of 25 monitoring wells have been installed in the unconsolidated aquifer and twelve monitoring wells have been installed into the bedrock aquifer. The unconsolidated aquifer (essentially water-bearing shallow soil) was identified only at Site 2 and Test Area D in Site 4. Groundwater elevations associated with wells set in the unconsolidated aquifer indicate that groundwater flows toward G-2 Pond and Stillwell Pond, located in the low-lying areas of the valley floor. Similarly, based on groundwater elevations in bedrock monitoring wells, groundwater appears to follow bedrock topography and flows toward the G-2 Pond. A comparison of water levels measured in well pairings at Site 2 indicated that the two aquifers are hydraulically connected (Shaw, 2005a). The vertical hydraulic gradients are downward from the unconfined unit into the bedrock unit within the southwestern portion of Site 2 and upward from the bedrock aquifer into the unconfined unit in the northeastern portion of Site 2.

Climate

Northern New Jersey has a continental temperate climate controlled by weather patterns from the continental interior. Prevailing winds blow from the northwest from October to April and from the southwest from May to September. The average monthly temperature ranges from a high of about 72°F in July to a low of about 27°F in January and February. The average date of the last freeze is May 2, and the first freeze is October 8. Average annual precipitation at the Boonton monitoring station located approximately 5 miles east of Picatinny is 48 inches and is evenly distributed throughout the year.

2.6.2 Summary and Findings of Site Investigations

Table 1 summarizes environmental investigations and reporting that have been conducted at the Group 3 Sites (PICA 008). The extent of contamination in groundwater and surface water is summarized below. In addition to the LOCs described below, all surface water samples were compared to the Picatinny background thresholds, when available.

Extent of Groundwater Contamination

Studies have shown various contaminants present in groundwater at the site above LOCs. The LOCs are based on the lower of the following values: Safe Drinking Water Act (SDWA) Federal MCLs; SDWA NJMCLs; NJGWQS or New Jersey PQLs (whichever is lower); and any non-zero SDWA Federal MCLG. In cases where none of the above criteria were available, the lower of the following To-Be-Considered (TBC) criteria were selected as LOCs: Federal Drinking Water Standards and Health Advisories, or USEPA Region 3 Tap Water Risk-Based Concentration (RBC).

Groundwater samples were collected at the Group 3 Sites (PICA 008) during four rounds of monitoring well sampling, HydroPunch® sampling, sampling from bedrock borings (completed as wells), and a supplemental ammonia investigation in 2005. Groundwater samples were collected during the Phase II Round 1 sampling event (September to October 1996), the Group 3 Additional Investigation (two rounds of sampling conducted in December 1997 and in April 1998), and the FS DGI conducted in 2001 and 2002. Groundwater samples collected from the Group 3 Sites (PICA 008) were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), explosives, Target Analyte List (TAL) metals, and anions.

Based on the analytical results, the primary groundwater COCs of VOCs, SVOCs and explosives were reported above LOCs in less than three wells each; ammonia was detected above its LOC in one well. The common naturally occurring metals--aluminum, iron, and manganese--were identified at concentrations above LOCs in numerous wells. The only other metal concentrations reported above LOCs were arsenic and lead, which were each identified in only one well at an elevated level. **Table 2** summarizes the constituents that exceeded LOCs in groundwater samples collected from the Group 3 Sites (PICA 008).

Volatile Organic Compounds

The VOC compounds carbon tetrachloride (CT), trichloroethene (TCE), and 1,1-dichloroethene (1,1-DCE) were the parameters most frequently detected above LOCs in groundwater beneath the Group 3 Sites. TCE exhibited a maximum concentration of 110 micrograms per liter (μg/L), CT was detected at concentrations up to 480 μg/L, and 1,1-DCE was detected at concentrations up to 47 μg/L. Although there are no continuing sources of contamination to groundwater in soil or sediments at Group 3 Sites, the groundwater data indicate that a plume consisting principally of TCE and CT is present beneath Site 2, with a center of mass in the vicinity of Building 3515 and former Building 3516. Groundwater plume maps for TCE and carbon tetrachloride (including cross-sectional depictions) are presented on **Figures 2 through 4**, respectively.

VOCs were detected only sporadically in Site 4 groundwater, with CT, TCE and methylene chloride exceeding their respective LOCs in 2, 3, and 1 sample(s), respectively, out of the 19 that were collected. VOCs were not detected in groundwater samples collected from beneath Site 1.

Methylene chloride was detected above its LOC in a total of three samples collected from Sites 2 and 4; however, methylene chloride was also detected in associated laboratory blanks (though at lower levels). Methylene chloride exceedances were included on **Table 2** because this compound may be related to the elevated levels of chloroform detected at Site 2. Methylene chloride is an anaerobic reductive dechlorination product of chloroform, which is in turn an anaerobic reductive dechlorination product of carbon tetrachloride.

Semi-Volatile Organic Compounds

Three SVOCs exceeded their LOCs in Site 2 groundwater, each in only one of 23 samples. All SVOC exceedances were in the sample collected from well 2MW-5. One SVOC was detected in Site 4 groundwater [bis(2-ethylhexyl)phthalate] in two wells at concentrations of 47 μg/L and 200 μg/L, which are above the LOC of 6 μg/L.

Explosives

In samples collected from the groundwater beneath Site 2 nitroglycerine and cyclotrimethylenetrinitramine (RDX) exceeded their respective LOCs of 4.8 μg/L and 2.0 μg/L in 2 of 17 and 1 of 20 samples, respectively. It is recognized that New Jersey has an Interim Guidance standard for RDX of 0.5 ug/L. The

exceedances for nitroglycerin occurred in samples from wells MW40-104 and 2MW-5, and for RDX the exceedance was detected in a sample from 2MW-5. Both hydrazine and perchlorate have been sampled at the Group 3 Sites, per EPA's request, and were not detected.

Target Analyte List Metals

Aluminum, arsenic, iron, lead, manganese and sodium were detected above their respective LOCs in several samples of groundwater located beneath the Group 3 Sites. As aluminum, iron, manganese and sodium are naturally occurring minerals, the concentrations of those metals are believed to be representative of background conditions. Lead was detected above its LOC of 10 μg/L in one sample collected from monitoring well 2MW-2 at a concentration of 12.6 μg/L. Arsenic was identified at a concentration of 9.92 μg/L in MW-N at Site 4, exceeding the LOC of 8.0 μg/L.

Anions

Ammonia was detected above its LOC of 3,000 μg/L in one sample collected from monitoring well 4MW-3 (Site 4) at a concentration of 4,700 μg/L; however, in subsequent sampling of the well in February 2005 the concentration was detected an order of magnitude below the LOC (330 μg/L). The attenuation, or breakdown, of ammonia in Group 3 groundwater is shown on **Figure 5**. Total nitrate/nitrite concentrations exceeded the LOC for nitrite of 1,000 μg/L in seven groundwater samples collected from beneath the Group 3 Sites. The nitrate/nitrite concentrations did not exceed the nitrate LOC of 10,000 μg/L.

Extent of Surface Water Contamination

A total of thirty-nine surface water samples were collected at Site 2 from the G-2 Pond, Stillwell Pond, their tributaries and surrounding wetlands. Seven surface water samples were collected at Site 4 from the 1500 Run, the rocket exhaust pond and from standing water at a steel pipe outfall in the BRG Pond. No surface water samples were collected from Site 1 as minimal surface water exists. Surface water samples collected at Sites 2 and 4 were analyzed for VOCs, SVOCs, TAL metals, explosives, and anions. These samples were collected to characterize potential surface water impacts from the flow of contaminated groundwater. **Table 3** summarizes the constituents that exceeded LOCs in surface water collected from the Group 3 Sites. The LOCs are the lower of the USEPA Water Quality Criteria (USEPA, 2009b) and the NJSWQC. In the absence of these criteria, the USEPA Tap Water RBC (USEPA, 2009a) was selected as the LOC. If the applicable surface water LOC was lower than the natural background level, the background value was selected as the LOC.

Surface water samples collected from Sites 2 and 4 that exceeded LOCs are shown on **Figures 6** and **7**, respectively.

Volatile Organic Compounds

At Site 2, six surface water samples collected from the G-2 Pond were identified above LOCs for the VOCs carbon tetrachloride (2 samples), chloroform (1 sample), 1,1-dichloroethane (1,1-DCA) (1 sample), methylene chloride (4 samples) and TCE (3 samples). Sample 2SW-2, collected from a drainage ditch near Building 3520 and nearby rocket test stands, contained levels of 1,1-DCA (1.25 μg/L) and TCE (1.65 μg/L) exceeding their respective LOCs. Three samples from Stillwell Pond exhibited methylene chloride concentrations above its 2.49 μg/L LOC. Finally, one sample located in the wetland west of G-2 Pond contained TCE above its LOC of 1.00 μg/L.

The only VOCs detected at Site 4 were bromodichloromethane and dibromochloromethane, which were found in one sample from 1500 Run in excess of their respective LOCs.

Semi-Volatile Organic Compounds

A single sample was identified at both Site 2 and Site 4 for exceeding the LOC for the SVOC bis(2-ethylhexyl)phthalate. These samples were collected from the G-2 Pond and the rocket exhaust pond (4SW-7), respectively.

Explosives

Two samples analyzed for explosives were identified above LOCs in the G-2 Pond. Nitroglycerin was identified in two surface water samples (2SW-21 and 2SW-22) from the G-2 Pond as exceeding its LOC of 4.8 μg/L.

Target Analyte List Metals

Various metals were detected throughout all of the surface water bodies in the Group 3 Sites. Specifically, aluminum, iron and manganese were commonly detected above their LOCs (background threshold values) at Site 2. Samples 2SW-30 to 2SW-37, collected from the wetland areas surrounding the G-2 Pond and samples 2SW-21 and 2SW-22 collected near the southern boundary of the G-2 Pond contained numerous metals above LOC values, including arsenic, beryllium, cadmium, chromium, copper, iron, lead, mercury, silver, and zinc. One sample exceeded the Picatinny background threshold concentration for sulfide of 2,200 μg/L, with a concentration of 11,000 μg/L.

At Site 4, surface water sample 4SW-2 from the 1500 Run reported elevated levels of the following five common metals: aluminum (3,220 μg/L), iron (5,280 μg/L) and manganese (961 μg/L), as well as arsenic (1.71 μg/L) and lead (8.76 μg/L). Additional surface water samples collected from the 1500 Run and the BRG Pond contained elevated metals concentrations. Some metals were detected within the sump area and the rocket exhaust pond as well. Details regarding the detections of metals within surface water at the Group 3 Sites are provided in **Table 3**.

2.7 CURRENT AND POTENTIAL FUTURE LAND USE

Current land use within the Group 3 Sites (PICA 008) is industrial. Historical and current uses include various forms of rocket testing at all three Sites, rocket fuel development and engine re-design, small mine testing, Ballistic Rail Gun operations, and ordnance disassembly. Site 1 is currently inactive, as is Test Area E located in Site 4. Test Area D of Site 4 is active, although all of the rocket test pads and stands are currently inactive. A BRG, Building 3620, constructed in 1975 in the southern part of Test Area D, is still in operation. At least four buildings in Test Area D are devoted to operations, storage, and support. Three buildings are devoted to ordnance disassembly. The future land uses planned at the Group 3 Sites (PICA 008) will ultimately remain as industrial and are anticipated to consist of training activities and research and development, as specified in the most recent Master Plan for Picatinny Arsenal. Future activities at Sites 1 and 2 involve the development of the Homeland Defense Technology Center, a multi-use facility supporting the Department of Defense mission. Additional proposed projects include the refurbishment and reutilization of a former research and development facility, the construction of two new Buildings (3501 and 3510), and the renovation of a third (3515). These facilities will be occupied by the Armament Research Development and Engineering Center's Homeland Defense Program and the Rangesafe Technology Demonstration Initiative. It should be noted that future residential land use at Group 3 Sites will be restricted by the Land Use Control Plan that will be detailed in the Group 3 RD. In addition, the Group 3 RD will include a contingency for vapor intrusion sampling should any building located above the plume become occupied during the remedial action for groundwater.

Relative to use of groundwater beneath the Group 3 Sites (PICA 008), the State of New Jersey has designated all groundwater within the state as a drinking water source. However, Picatinny has a centralized water distribution system, and it has no current or future plans for the use of Group 3 groundwater for any purpose. Moreover, the Group 3 Sites are within a NJDEP-approved Classification Exception Area (CEA). As described in a letter dated July 29, 2002 to the NJDEP, the CEA was established for all groundwater beneath Picatinny in both the bedrock and unconfined aquifers. Thus, the CEA addresses all aquifers and COCs for Group 3 (PICA 008) groundwater. Upon establishment of a CEA, NJDEP identifies the region within the CEA as a well restriction area (WRA). The WRA functions as the institutional control by which potable use restrictions can be effected. As long as the CEA is in place, NJDEP may prohibit the installation and pumping of wells within this area.

2.8 SUMMARY OF SITE RISKS

As part of the RI/FS (IT, 2000), baseline risk assessments were conducted for the Group 3 Sites (PICA 008) to evaluate the potential risks to human health and the environment associated with exposure to

site-related chemicals. As previously discussed, these sites are currently used for industrial purposes, and it is anticipated that this will not change in the future.

The baseline risk assessments estimate the potential risks and hazards associated with exposure to chemicals at the Group 3 Sites (PICA 008) under current conditions—i.e., assuming no response action is taken to address on-site contamination. Through the work conducted at this site under CERCLA, it has been determined that a response action is necessary for the groundwater at Site 2.

Unacceptable risks to human health and the environment, under the current and reasonably anticipated future use, were identified in groundwater at the Group 3 Sites (PICA 008) as a result of the potential exposure to contaminants within groundwater via ingestion and inhalation of VOCs. The results of the human health risk assessment (HHRA) and ecological risk assessment (ERA) are discussed below.

2.8.1 Human Health Risk Assessment

A human health risk assessment was conducted for the Group 3 Sites (PICA 008) as part of the Phase II RI. Potential risks associated with exposure to chemicals in soil, sediment, groundwater and surface water were quantified for current/future outdoor maintenance workers, future industrial/research workers, and future construction workers. Risks associated with exposure to soil and sediments were included in the evaluation conducted during the HHRA in order to completely assess the risk to human health at the Group 3 Sites. However, this ROD only addresses groundwater and surface water. Soil impacts will be discussed in a separate ROD.

In addition to the HHRA, a supplemental assessment (IT, 2001b) was performed to address potential risks to on-site youth visitors. However, the exposure scenarios identified for these visitors related to contact with liquids and solids contained in Site sumps. Since the sumps and their contents have since been removed from Picatinny, there are no potential risks associated with exposure to chemicals in the sumps and this will not be further discussed. Two supplemental risk assessments were also performed to evaluate exposure to chemicals via ingestion of fish (IT, 2004) and ingestion of potable groundwater at Site 2. Finally, a separate risk assessment was performed for lead, using the Adult Lead Model, as lead is assessed differently than other chemicals that have published cancer slope factors and/or non-cancer reference doses. The following section summarizes the risk assessment process and results.

2.8.1.1 Contaminants of Potential Concern

Contaminants of Potential Concern (COPCs) were identified by comparing the maximum detected concentration of an individual contaminant to its LOC value. For the purposes of the screening evaluation, groundwater concentrations were compared to Federal MCLs, NJMCLs, NJGWQS or PQLs (whichever is lower), and any non-zero Federal MCLG. In the absence of these criteria one of the following TBC criteria were selected as the LOC: Federal Drinking Water Standards and Health Advisories, or USEPA Tap Water RBC. Surface water concentrations were compared to USEPA Water Quality Criteria and NJSWQC. In the absence of these criteria, the USEPA Tap Water RBC or background threshold levels were selected as the LOC. Chemicals detected at concentrations greater than their respective screening levels were identified as COPCs and were further evaluated in the risk assessment.

The identification of COPCs is conservatively biased to ensure that the screening process retains all contaminants that might pose an unacceptable risk. However, the identification of a contaminant as a COPC does not indicate that an unacceptable risk actually exists, but only that further analysis is required. Whether or not the COPCs are addressed qualitatively or quantitatively in the risk assessment is dependent on the result of the comparison to background values and the availability of contaminant-specific toxicity information.

COPCs selected for groundwater at the Group 3 Sites (PICA 008) include twelve VOCs (benzene, bromodichloromethane, CT, chloroethane, chloroform [CF], 1,2-dichloroethane, 1,1-DCE, cis-1,2-dichloroethene, methylene chloride, tetrachloroethylene [PCE], 1,1,1-trichloroethane and TCE), four SVOCs (carbazole, dibenzofuran, bis[2-ethylhexyl]phthalate and phenanthrene), two explosives (nitroglycerin and RDX), six inorganics (aluminum, arsenic, iron, lead, manganese and sodium) and two anions (ammonia and nitrite/nitrate).

COPCs selected for surface water at the Group 3 Sites (PICA 008) included ten VOCs (bromodichloromethane, CT, chloroethane, CF, chloromethane, dibromochloromethane, 1,1-DCA, 1,1-DCE, methylene chloride and TCE), one SVOC (bis[2-ethylhexyl]phthalate), one explosive (nitroglycerin), thirteen inorganics (aluminum, arsenic, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, selenium, silver and zinc), and two anions (ammonia and sulfide).

2.8.1.2 Exposure Assessment

Exposure pathways were identified based on the site characterization information, the fate and transport properties of the COPCs, and likely points where human receptors may come in contact with affected media under current or potential future conditions at the site. An exposure pathway is defined by the following four elements:

1) a source and mechanism of contaminant release to the environment;
2) an environmental transport medium for the released contaminant;
3) a point of potential contact with the contaminated medium (the exposure point); and,
4) an exposure route at the exposure point.

Exposure can occur only when the potential exists for a receptor to contact released contaminants directly, or when there is a mechanism for released contaminants to be transported to a receptor. Without exposure there is no risk; therefore, the exposure assessment is a critical component of the risk assessment. Based on these criteria, the human health risk assessment focused on several current and hypothetical future exposure scenarios.

Estimated risks and hazards were calculated for the following receptor populations for the Group 3 Sites (PICA 008):

- Current exposed populations: outdoor maintenance worker; industrial/research worker
- Future exposed populations: outdoor maintenance worker; industrial/research worker; construction worker; on-site youth visitor

For purposes of the screening evaluation, soil and sediment concentrations were compared to USEPA Region 3 RBCs for soil at industrial sites, since the current and future site uses in the Group 3 Sites (PICA 008) are likely to be industrial, while groundwater and surface water concentrations were compared to USEPA Region 3 RBCs for tap water. Essential human nutrients that did not have RBCs were compared to dietary allowable daily intakes and lead was compared to USEPA screening- and action-levels. A discussion of the methodology used in the screening-level risk assessment is provided in Section 7 of the RI (IT, 2001a).

Groundwater beneath the site is not currently used, nor are there any future plans for its use. In addition, Picatinny Arsenal has a potable water system that is not hydraulically connected to this site. However, although exposure to groundwater used as a potable water supply is a hypothetical exposure scenario, the exposure route via ingestion and inhalation was assessed in a supplemental risk assessment conducted by ARCADIS. During this investigation, it was determined that the potential exposure to COPCs in groundwater does pose an unacceptable risk to human health.

2.8.1.3 Risk Characterization

Potential risks to human health are evaluated quantitatively by combining calculated exposure levels and toxicity data. A distinction is made between noncarcinogenic and carcinogenic endpoints, and two general criteria are used to describe risk: the hazard quotient (HQ) for noncarcinogenic effects and excess lifetime cancer risk (ELCR) for contaminants evaluated as human carcinogens. The HQs are summed to calculate the hazard index (HI). The regulatory benchmark for noncancer health effects is 1. An HI less than or equal to 1 indicates that health effects should not likely occur; an HQ or HI that exceeds 1 does not imply that health effects will occur, but that health effects are possible. The USEPA considers an ELCR within the target risk range of 1×10^{-4} to 1×10^{-6} as generally acceptable cancer risk

(USEPA, 1994). If the ELCR exceeds the 1 x 10^{-4} target risk level, site-specific remedial goal options will be derived for the relevant contaminants and exposure scenarios.

Health effects were evaluated for current and future maintenance workers, current industrial/research workers, future construction workers, future on-site youth visitors and future industrial/research workers. The HI is the sum of all the HQs for all COPCs that affect the same target organ, or that act through the same mechanism of action within a medium, to which a given individual may reasonably be exposed. An HI of less than 1 indicates that toxic noncarcinogenic effects from all COPCs are unlikely. **Table 7** summarizes the results of the HHRA for the Group 3 Sites (PICA 008).

Site 1

The cumulative cancer risks for all receptors at Site 1 are within USEPA target risk range of 1 x 10^{-4} to 1 x 10^{-6}, and the cumulative HI is below the target hazard level of 1.

The average lead concentration in surface soil was less than the lead preliminary remedial goal (PRG) for industrial workers calculated using the Adult Lead Model. However, the average lead concentrations in subsurface soil exceeded the PRGs for the construction worker. As noted in the FS, the exposure parameters used in the RI to calculate the lead PRG for construction workers have been updated by USEPA since that time. Thus, the lead PRG was recalculated in the FS using current regulatory guidance. The average lead concentration in subsurface soil was less than the revised PRG, indicating that lead does not pose an unacceptable risk to construction workers.

In summary, the results of the risk assessment indicate that under the current conditions at Site 1, constituents in soil and groundwater do not pose an unacceptable risk to human health under the exposure scenarios evaluated in the HHRA.

Site 2

The initial risk assessment conducted at Site 2 concluded that cumulative cancer risks for all receptors at Site 2 are within USEPA target risk range of 1 x 10^{-4} to 1 x 10^{-6}, and the cumulative HI for an outdoor maintenance worker and industrial/research worker is less than the target hazard level of 1. However, the HI for a construction worker is greater than 1 (1.9). The primary chemical driving the non-cancer hazard is carbon tetrachloride in groundwater through the dermal absorption route. Following USEPA (1989) guidance, the HI was segregated by target organ/effect. When recalculated, the HIs for each target organ/effect was less than or equal to one, indicating adverse non-cancer effects would not occur under the conditions evaluated. It is noted that the industrial/research worker cancer risk is associated with exposure to soil; risks associated with exposure to surface water and sediment were *de minimis* (i.e., ≤ 1 x 10^{-6}).

While the results of the HHRA indicate that chemicals in soil, sediment, surface water, and groundwater do not pose an unacceptable risk under the conditions and exposure scenarios evaluated in the risk assessment, this initial assessment did not evaluate future industrial/research worker exposure to COPCs in the groundwater beneath Site 2, assuming ingestion and inhalation of VOCs during workday use. While it is highly unlikely that groundwater beneath the Group 3 Sites will ever be ingested, the risks associated with industrial/research worker exposure to groundwater were evaluated. Consistent with the evaluation methodology presented in the Phase II RI (IT, 2001a), the potential cancer risk and non-cancer hazard associated with future industrial worker exposure to COPCs in groundwater via ingestion and inhalation of VOCs during the workday are as follows: the potential cancer risk is 3 x 10^{-4}, which is greater than the USEPA target risk range of 1 x 10^{-4} to 1 x 10^{-6}, and the HI is greater than 1 (HI = 8). Therefore, following USEPA guidance, the HI was segregated by target organ/effect. When recalculated, the only HI for target organ/effects greater than one was for liver effects (HI = 7). Carbon tetrachloride and trichloroethene are the risk drivers for the cancer risks. Carbon tetrachloride and tetrachloroethene are the risk drivers for the non-cancer hazards.

Subsequent assessments that identified the average concentration of lead in sediment did not exceed site-specific lead PRGs for the industrial research worker; the cancer risks associated with fish consumption for the combined G-2 Pond and 1500 Pond assessment were within the USEPA target risk range of 1 x 10^{-4} to 1 x 10^{-6}; however, the HI for a child consuming largemouth bass from these water bodies was greater than 1 (HI = 11). As a result, fish advisories were enacted at the site in response to

mercury in fish tissue, as discussed in the FS. It is noted that New Jersey, as well as 39 other states, have fish advisories in effect due to mercury.

The results of the HHRA and the supplemental groundwater evaluation indicate that under the current conditions at Site 2 of PICA 008, constituents in groundwater do pose an unacceptable risk to human health based on existing cancer risks and exceed applicable drinking water standards.

Site 4

The results of the site-specific HHRA for the industrial/research worker indicated that the cumulative risk from exposure to impacted site media (including surface soil, sediment, and surface water) was 2.0×10^{-5}, with arsenic in soil being the primary risk driver. The cumulative risk for the construction worker was 1.4×10^{-6} for exposure to total soil and groundwater; however, no one COPC had an estimated cancer risk greater than 1×10^{-6}. The other receptor evaluated (i.e., maintenance worker) had estimated cancer risks that were lower than either the industrial/research worker or the construction worker. The cumulative hazard index was below the target hazard level of 1 for the maintenance worker, industrial/research worker, and construction worker receptors.

The average concentrations of lead in sediment or sump sediment, evaluated during the Adult Lead Model, did not exceed site specific lead PRGs for the industrial research worker or the outdoor maintenance worker. [Note: lead in soil was not assessed using the Adult Lead Model, as the maximum lead concentrations did not exceed the lead LOC of 600 milligrams per kilogram (mg/kg).]

For the groundwater at Site 4, the transmissivity of the overburden and bedrock aquifers was determined to be too low to provide sufficient yield for potable wells; therefore, groundwater as a drinking water source was not evaluated as an exposure pathway in the risk assessment (IT, 2001b). However, dermal absorption of chemicals in groundwater was quantitatively evaluated in the site-specific risk assessment (and risks from exposure to surface water and sediment at Site 4 were also assessed). The results of the risk assessment (IT, 2001b) indicated that the cumulative risk and cumulative hazard index from exposure to impacted media were below the target risk level of 1×10^{-4} and below the target hazard index of 1.

In summary, the results of the risk assessment indicate that under the current conditions at Site 4, constituents in all media do not pose an unacceptable risk to human health under the exposure scenarios evaluated in the HHRA (although arsenic levels contributed to a cancer risk of 2×10^{-5}).

2.8.2 Ecological Risk Assessment

A baseline ecological risk assessment was conducted at Sites 1, 2, and 4 as part of the Phase II RI (IT, 2000). The purpose of the baseline ERA was to evaluate the potential risk to aquatic and terrestrial receptors associated with exposure to chemicals in environmental media under current conditions at each site. The ERA evaluated the following exposure pathways and representative receptors for aquatic biota: direct exposure to surface water for fish, direct exposure to sediment for benthic invertebrates, and food chain exposures for birds and mammals. For terrestrial biota, the ERA evaluated direct exposure to surface soil for soil invertebrates (e.g., earthworms) and plants, and food chain exposures for birds and mammals. Similar to the HHRA, soil and sediment samples were included in the evaluation conducted during the ERA in order to completely assess the ecological risk at Group 3 Sites. However, as discussed previously, soil impacts will be discussed and addressed in subsequent documents. The results of the ERA are presented below.

2.8.2.1 Summary of Findings for Soil and Terrestrial Food Chain Exposures

The results of the Phase II ERA indicate that soils were not toxic in bioassay results, the plant community does not show evidence of impacts and modeled food-chain risks to Group 3 ecological receptors are not significant.

Site 1

The surface soil bioassay performed for Site 1, using the earthworm toxicity test, was actually termed a reference sample in the ERA (IT, 2000) and represents a non-impacted soil location. Results of this earthworm bioassay showed that survival was an acceptable 95%. Wildlife ecological effects quotients (EEQs) for Site 1 for the white-footed mouse were less than 1 for all chemicals of potential ecological concern (COPECs) except for arsenic that had an EEQ of 2.6. EEQs for the American woodcock and

barred owl were less than 1 for all COPECs. Given the many conservative assumptions used in the food-chain model (e.g., 100% bioavailability of COPECs), an EEQ of 2.6 is not deemed ecologically significant. In addition, the arsenic soil exposure point concentration used was 3.93 mg/kg, which is lower than the site-specific background value of 9.23 mg/kg for surface soil (IT, 2001d).

In summary, for terrestrial receptors at Site 1, no significant adverse effects were observed in the earthworm bioassay and no unacceptable risks to terrestrial species were estimated. Therefore, no significant ecological risks were identified for terrestrial receptors exposed to soil at Site 1.

Site 2

The results of the earthworm bioassay indicate the potential for reduced survival; however, these results were mainly attributed to the physical characteristics of the soil and poor habitat quality rather than exposure to the elevated chemicals at Site 2. Wildlife EEQs for Site 2 for the white-footed mouse were less than 1 for all COPECs except for arsenic and aluminum that had EEQs of 4.8 and 2.1, respectively. EEQs for the American woodcock and barred owl were less than 1 for all COPECs. Based on concentrations measured in fish tissue samples, great blue heron and mink EEQs were less than 1 for all COPECs in Drainage Area 6 (that includes Site 2). For the muskrat, all EEQs were less than 1 except for selenium and mercury that had EEQs in Drainage Area 6 of 2.5 and 1.8, respectively. Given the many conservative assumptions used in the food-chain model (e.g., 100% bioavailability of COPECs), EEQs up to 4.8 are not deemed ecologically significant. In addition, the arsenic and aluminum soil exposure point concentrations used were 6.29 and 18,300 mg/kg that are lower than the site-specific background values of 9.23 and 20,500 mg/kg for surface soil (IT, 2001d). Therefore, modeled food-chain risks to terrestrial species were determined to be not ecologically significant.

In summary, no significant ecological risks were identified for terrestrial receptors from direct or indirect exposures to soil at Site 2.

Site 4

No surface soil bioassay assessments were performed at Site 4. However, wildlife food chain models were conducted and the results are as follows.

EEQs for Site 4 for the white-footed mouse were less than 1 for all COPECs except for arsenic and aluminum that had EEQs of 6.4 and 1.7, respectively. EEQs for the American woodcock and barred owl were less than 1 for all COPECs. Based on concentrations measured in fish tissue samples, great blue heron and mink EEQs were less than 1 for all COPECs in Drainage Area 6 (that includes Site 4). For the muskrat, all EEQs were less than 1 except for selenium and mercury that had EEQs in Drainage Area 6 of 2.5 and 1.8, respectively. Given the many conservative assumptions used in the food-chain model (e.g., 100% bioavailability of COPECs), EEQs up to 6.4 are not deemed ecologically significant. In addition, the arsenic and aluminum soil exposure point concentrations used were 9.17 and 14,400 mg/kg, which are lower than the Picatinny-specific background values of 9.23 and 20,500 mg/kg for surface soil (IT, 2001d).

In summary, the results of the ERA indicate that no unacceptable ecological risks were identified from potential exposures to soil at Site 4.

2.8.2.2 Summary of Findings for Surface Water

Surface water and sediment within the Group 3 Sites were assessed by IT Corporation, Inc. during the Phase II Sites ERA (IT, 2000).

No significant surface water exists at Site 1; therefore, no aquatic biological programs or food chain models for aquatic wildlife were performed for this site. Surface water bioassays conducted on surface water samples collected from Site 2 showed some decreased survival of test organisms. However, these results were determined to be reflective of natural conditions based on the occurrence of comparable effects in background samples (IT, 2000b). The results of the Site 4 surface water bioassays showed limited toxicity. However, these results were determined to be reflective of natural conditions based on comparisons with the background samples. In summary, it was determined that exposure to surface water at the Group 3 Sites does not appear to pose a significant risk to ecological receptors.

2.8.2.3 Ammonia

Ammonia in surface water and in groundwater discharging to surface water at various Group 3 (PICA 008) sites was initially estimated in the ERA to pose a potential risk to aquatic organisms. However, the results of further evaluation in the FS suggest that the conservative exposure assumptions used in the ERA over estimated potential risks to aquatic biota. Further, ammonia concentrations decreased below LOC's in the 2005 data set. Based on data presented within the FS from the 1996 and 2005 sampling events, ammonia is not expected to pose unacceptable ecological risks to aquatic biota at the Group 3 Sites (PICA 008).

2.8.2.4 Indiana Bats

Area J, which includes the Group 3 Sites (PICA 008), contains a documented summer roost for the Indiana bat (*Myotis sodalis*), which is a federally-listed endangered species. A baseline risk assessment was performed at the request of the U.S. Fish and Wildlife Service to estimate potential risks to the Indiana bat associated with exposure to site-related chemicals in the Phase II assessment areas (Shaw, 2003). Based on food-chain modeling results using site-specific analytical results for common prey species, the risk assessment concluded that adverse effects to the Indiana bat are not expected to occur.

2.8.3 Unexploded Ordnance

Unexploded Ordnance (UXO) has previously been discovered at Site 1 and is known or suspected to exist at Site 4 as well. Currently, consistent with Army and Picatinny regulations, UXO hazards are controlled by the Picatinny Safety Program. This program includes coordination with the Picatinny Safety Office, land-use restrictions, and UXO clearance procedures. These controls are in place to protect construction workers.

2.8.4 Contaminants of Concern and Site Cleanup Levels

COCs in groundwater were identified in the *Final Group 3 Sites Feasibility Study* (Shaw, 2005). As part of the Group 3 Sites (PICA 008) FS, the contaminants detected in groundwater were screened to identify COCs. COCs are defined as contaminants that:

1) Contribute to the majority of site-specific human health or ecological risk based on the HHRA or ecological risk assessments; and,
2) Exceed NJGWQC, or the NJSWQC.

Site cleanup levels were developed for contaminants identified in groundwater at the Group 3 Sites (PICA 008) if the concentrations were a major contributor to human health risks or exceeded NJGWQC. SCLs were determined based on the more stringent of the SDWA (USEPA, 1996) Federal MCLs, the SDWA State MCLs (NJMCL), or the NJGWQC. Surface water will be monitored for the duration of the groundwater response action to ensure groundwater remediation mitigates potential surface water impacts. SCLs for surface water at the Group 3 Sites (PICA 008) were determined based on the USEPA Water Quality Criteria, the NJSWQC or site-specific background threshold levels if greater than the NJSWQC.

Five groundwater contaminants (CT, CF, 1,1-DCE, PCE, and TCE) were initially identified during the FS as risk-drivers or were found to exceed the applicable standards. Since completion of the Remedial Investigation and Risk Assessment, a new CF standard of 70 μg/L has been promulgated. Chloroform was detected at a maximum concentration of 54.54 μg/L and therefore, is no longer considered a groundwater COC. The final COCs, SCLs, and respective concentrations are presented in **Table 8.**

Impacts were identified in groundwater beneath Site 2. Three contaminant plumes, a north plume, a south plume, and a bedrock plume, are presented on **Figure 8**. The north and south plumes are both primarily located in the overburden aquifer. There were no groundwater plumes identified at Site 1 or Site 4. The estimated area and volume of each contaminant plume is presented in **Table 9**.

2.9 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are based on human health and environmental factors, which are considered in the formulation and development of Response Actions. Such objectives are developed based on the criteria outlined in Section 300.430(e)(2) of the NCP and Section 121 of SARA.

The RAOs for the Group 3 Sites (PICA 008) have been developed in such a way that attainment of these goals will result in the continued protection of human health, ecological receptors, and the environment. The RAOs are specific to groundwater contamination and incidental surface water impacts originating from the Group 3 Sites (PICA 008). The RAOs are as follows:

- To prevent human exposure to contaminated groundwater that would cause unacceptable risk over the duration of the response action;
- To achieve the more stringent of the Federal MCLs or NJGWQS for the identified contaminants of concern in a reasonable timeframe, thereby restoring groundwater to its beneficial use as a drinking water source;
- To achieve NJSWQC through remediation of groundwater for the identified contaminants of concern to ensure that groundwater remediation mitigates potential surface water impacts; and,
- To maintain current land-use (industrial) and current institutional controls at the Group 3 Sites (PICA 008).

2.10 DESCRIPTION OF RESPONSE ACTIONS

The Group 3 Sites (PICA 008) 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 response actions.

Technology types and process options appropriate for the COCs were identified and screened based on effectiveness, implementability, and cost. The retained technologies and process options were developed into response actions. The RAs for groundwater and incidental surface water impacts at the Group 3 Sites (PICA 008) are:

- Response Action GW-1: No Action;
- Response Action GW-2: Implementation and Maintenance of Land Use Controls Including Existing Groundwater-Use Restrictions, Emergency Provisions, and Long-Term Groundwater Monitoring;
- Response Action GW-3: Air Sparging/Soil Vapor Extraction (AS/SVE), Land Use Controls, and Long-Term Groundwater Monitoring;
- Response Action GW-4: Pump and Treat Using Air Stripping, Land Use Controls, and Long-Term Groundwater Monitoring;
- Response Action GW-5: Nanoscale Zero-Valent Iron Injection, Land Use Controls, and Long-Term Groundwater Monitoring; and
- Response Action GW-6: *In-Situ* Enhanced Bioremediation, Land Use Controls and Long-Term Groundwater Monitoring.

2.10.1 Response Action GW-1: No Action

Estimated Capital Cost: *$0*
Estimated O&M (Cost over 30 years): *$0*
Estimated Present Worth Cost: *$0*

CERCLA and the NCP require that a No Action response action be evaluated at every site to establish a baseline for comparison of other response actions. Under this RA no response action would take place.

2.10.2 Response Action GW-2: Implementation of LUCs and Long-Term Groundwater Monitoring

Estimated Capital Cost: *$142,000*
Estimated O&M (Cost over 30 years): *$405,000*
Estimated Present Worth Cost: *$547,000*

(Present worth of the O&M and long-term replacement cost is calculated using a 7% discount rate.)

Response Action GW-2 would involve implementation and maintenance of LUCs, with particular restrictions on groundwater use and implementation of a long-term groundwater monitoring program. As summarized in the FS (Shaw, 2005a), using the Total Mass Reduction over Time method, it was estimated that non-accelerated natural attenuation processes at Site 2 would require 129 years to reduce the initial carbon tetrachloride concentration of 370 μg/L to the SCL of 2 μg/L. Because the NJGWQS (and, hence, the SCL) for carbon tetrachloride has since been reduced to 1 μg/L, the natural attenuation timeframe will likely be longer than originally anticipated.

Land Use Controls

The LUC objectives for Group 3 groundwater are to ensure no contact with groundwater occurs by industrial users that could result in unacceptable risk. Additionally, they control possible changes in groundwater use at the site. These LUCs objectives will be met until such time as contaminant levels are sufficiently reduced to allow beneficial use. Currently Picatinny is under an installation-wide CEA. This CEA requires the NJDEP to restrict or require the restriction of potable groundwater uses within the CEA by implementing a WRA. The LUC objectives as stated herein will be further detailed within the Remedial Design document outlining the implementation and maintenance actions that will be taken by the Army to augment the existing LUCs of the CEA and WRA, currently controlled by the NJDEP.

Long-Term Groundwater Monitoring

The primary objectives of the long-term groundwater monitoring program under Response Action GW-2 are 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) provide data to assess whether a contingency remedy is warranted.

Implementation of the long-term groundwater monitoring program under Response Action GW-2 would involve submittals of plans, field sampling activities, and reporting requirements. The submittal of plans would include the health and safety plan, the project work plan, the field sampling plan, the data quality objectives, the quality assurance project plan that will detail elements such as sampling locations, parameters, and frequency, as well as the exit strategy and the general evaluation criteria to evaluate the necessity of a contingency remedy. The reporting requirements would involve, at a minimum, submittal of the monitoring results and five-year review reports.

Long-Term Monitoring of Surface Water

The objective of a long-term monitoring program for surface water is to evaluate the potential for surface water impairment due to impacted groundwater discharging to surface water. Surface water monitoring will be conducted at sample locations that have previously exceeded the surface water quality criteria. Surface water monitoring will be conducted in conjunction with the long-term groundwater monitoring until concentrations fall below NJSWQC.

2.10.3 Response Action GW-3: Air Sparging/Soil Vapor Extraction, LUCs and Long-Term Groundwater Monitoring

Estimated Capital Cost: *$3,067,000*
Estimated O&M (Cost over 30 years): *$1,045,000*
Estimated Present Worth Cost: *$4,112,000*

(Present worth of the O&M and long-term replacement cost is calculated using a 7% discount rate.)

Response Action GW-3 would involve: 1) implementation of Air Sparging/Soil Vapor Extraction for *in-situ* treatment of the chlorinated solvent plumes in the surficial aquifer at Site 2; 2) long-term groundwater monitoring for all plumes including monitoring of natural attenuation parameters; and, 3) implementation and maintenance of LUCs.

The system would be comprised of AS and SVE wells, blowers, and groundwater monitoring wells. Due to the shallow groundwater depths at the Group 3 Sites, the SVE points would be designed as a network of horizontal wells to reduce complications due to groundwater mounding. A pilot test would be performed in order to facilitate the final system design. Groundwater monitoring would be performed during and after AS/SVE operation. The estimated active remediation timeframe for Response Action GW-3 was estimated during the FS to be 12 months. It was assumed that groundwater monitoring at Site 2 would be performed for four years following termination of the remedial system.

As detailed in the Pre-Design Technical Memorandum (ARCADIS, 2009), the remedial costs and the timeframe required for active remediation were reevaluated subsequent to approval of the FS for RAs GW-3 through GW-6. The revised costs are presented herein. In the case of RA GW-3, the reevaluation took into account a more achievable contaminant mass transfer efficiency and radius of influence (ROI). The results indicate that the timeframe for active AS/SVE remediation is likely to be 5 years and the estimated time it will take for contaminant concentrations to reach below site cleanup levels is approximately 10 years.

The following text details the planning and implementation components of Response Action GW-3.

Land Use Controls

The LUC objectives for Group 3 groundwater are to ensure no contact with groundwater occurs by industrial users that could result in unacceptable risk. Additionally, they control possible changes in groundwater use at the site. These LUCs objectives will be met until such time as contaminant levels are sufficiently reduced to allow beneficial use. Currently Picatinny is under an installation wide CEA. This CEA requires the NJDEP to restrict or require the restriction of potable groundwater uses within the CEA by implementing a WRA. The LUC objectives as stated herein will be further detailed within the Remedial Design document outlining the implementation and maintenance actions that will be taken by the Army to augment the existing LUCs of the CEA and WRA, currently controlled by the NJDEP.

Site Preparations

In order to implement the *in-situ* AS/SVE RA, modifications to the site will include installation of wells; temporary construction of a building to house the treatment system; and clearing, grubbing, and excavation of areas where wells, piping, and equipment would be constructed. Some of the excavated material will be transported and disposed in a non-hazardous waste construction debris landfill. The well and subsurface piping network would be extensive and would significantly limit site redevelopment potential for the proposed Homeland Security National Training Center.

Planning, Permitting, and Reporting

Because the response action at Group 3 is being conducted under CERCLA, obtaining permits is not required. Permit-equivalent approvals may be required to sparge air into the aquifer and release vapors from the SVE system. The AS/SVE system would require pre-construction submittals, including an engineering design and specifications, a work plan, health and safety plan, and a closure report.

Installation of AS/SVE System

Technical and construction oversight would be required prior to and during the installation of the system.

The following list describes the construction components of the AS/SVE system at Site 2. For cost estimating purposes, the specifications of these components are simplified.

- Construction of 51 AS wells – 27 wells at the south plume and 24 wells at the north plume.
- Construction of 18 horizontal 60-foot SVE wells – 10 wells at the south plume and 8 wells at the north plume.
- Construction of approximately 3,000 ft and 1,300 ft of piping, associated fittings and manifolds for the AS and SVE units, respectively.
- Installation of the AS and SVE blowers and granular activated carbon (GAC) SVE off-gas treatment system.
- Construction of treatment pads and buildings to house the treatment system.

- Installation of a surface liner over the remediation areas to prevent short circuiting of the SVE system.
- Installation of seven additional monitoring wells to monitor the performance of the AS/SVE system.

Additional costs for the AS/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 Response Action are insurance, bonds, and a contingency factor.

O&M of the AS/SVE System

It is estimated that the AS/SVE system would require regular maintenance. Off-gas treatment of the extracted vapors will be conducted using GAC.

Long-Term Monitoring

Details of the long-term monitoring program are included in the FS (Shaw, 2005a), and would include monthly off-gas air monitoring and quarterly groundwater monitoring of the surficial aquifer plumes during system operation. Monitoring of the surficial aquifer would continue following termination of the AS/SVE system until such time as conditions in the exit strategy are met. Surface water monitoring will be conducted at sample locations that have previously exceeded the surface water quality criteria. Surface water monitoring will be conducted in conjunction with the long-term groundwater monitoring until concentrations fall below NJSWQC.

Reporting

One of the requirements of the NJDEP Technical Requirements for Site Remediation is submittal of periodic reports of sampling and analytical results, as well as closeout reports and statistical demonstration of compliance with regulatory criteria.

2.10.4 Response Action GW-4: Pump and Treat Using Air Stripping, LUCs, and Long-Term Groundwater Monitoring

Estimated Capital Cost:	*$1,067,000*
Estimated O&M (Cost over 30 years):	*$2,714,000*
Estimated Present Worth Cost:	*$3,781,000*

(Present worth of the O&M and long-term replacement cost is calculated using a 7% discount rate.)

Response Action GW-4 would involve: 1) extraction of groundwater (via pumping) and treatment using air stripping technology for ex-situ treatment of the chlorinated solvent plumes in the surficial aquifer at Site 2; 2) long-term groundwater monitoring; and, 3) implementation and maintenance of LUCs. Treated water from the pump and treat system would be discharged to the surface water body within immediate vicinity of the treatment plants. It is estimated that a total of two extraction wells would be required, one at each of the targeted overburden groundwater plumes.

The FS estimated that the pump and treat system would be operated for a period of approximately ten years at a total groundwater extraction rate of approximately 13 gallons per minute (gpm). A reevaluation of site-specific pumping test data indicates that an achievable pumping rate is likely to be only approximately 4 gpm (based upon hydraulic conductivity data from well 2-MW-3, located in the center of the plume). Use of this pumping rate results in an approximate three-fold increase in the time required to treat the plume (30 years).

In this timeframe, the plume volume and aqueous chlorinated VOC concentrations would be reduced to within SCLs. The extracted groundwater would be treated using air stripping technology. The long-term monitoring program would be performed for the entire duration of the operation of the system plus an additional three years during the post-remediation period.

The following details the planning and implementation components of Response Action GW-4.

Land Use Controls

The same LUC components would be implemented under this Response Action as for RA GW-3, which are fully discussed in the FS.

Site Preparations

Site preparations would involve the same components as described for RA GW-3 and would likewise limit site redevelopment potential.

Installation of Pump and Treat System

Technical and construction oversight would be required prior to and during the installation of the pump and treat system at Site 2. The following list describes the construction components of the system. For cost estimating purposes, the specifications of these components are simplified.

- Construction of two groundwater extraction wells — one each at the south and north plumes.
- Construction of approximately 500 feet of piping and associated fittings and manifolds.
- Construction of an ex-situ air stripping treatment system.
- Construction of treatment pads and buildings to house the ex-situ treatment system.
- Installation of six additional monitoring wells to monitor the performance of the pump and treat system.

Additional costs for the pump and treat system would include the performance of a pump test to determine the required extraction rates, radiuses of influence, and optimum operating conditions for the ex-situ treatment system. Also included in the cost of this RA are insurance, bonds, and a contingency factor.

O&M of the Pump and Treat System

The pump and treat system would be operated and maintained for thirty years.

Long-Term Monitoring

Long-term monitoring would consist of monthly system influent and effluent water sampling, plus quarterly air stripper off-gas sampling for VOCs. Groundwater monitoring would consist of sampling sufficient to demonstrate that the plume treatment is effective. Groundwater sampling would continue until such time as the conditions in the exit strategy are met. Surface water monitoring will be conducted at sample locations that have previously exceeded the surface water quality criteria. Surface water monitoring will be conducted in conjunction with the long-term groundwater monitoring until concentrations fall below NJSWQC.

Reporting

Response Action GW-4 would entail similar reporting requirements as RA GW-3.

2.10.5 Response Action GW-5: Zero-Valent Iron Injection, LUCs, and Long-Term Groundwater Monitoring

Estimated Capital Cost:	*$1,458,000*
Estimated O&M (Cost over 30 years):	*$900,000*
Estimated Present Worth Cost:	*$2,359,000*

(Present worth of the O&M and long-term replacement cost is calculated using a 7% discount rate.)

Response Action GW-5 would involve: 1) ZVI injection for the *in-situ* treatment of the chlorinated solvent plumes in the surficial aquifer at Site 2 (north and south plumes); 2) long-term groundwater monitoring; and, 3) implementation and maintenance of LUCs for all plumes.

Under RA GW-5, it was estimated during the FS that the concentrations of COCs in groundwater at Site 2 would be reduced to SCLs levels within six months, after a single injection of ZVI. However, based upon the pilot test results and 2007 data it can be assumed that, at a minimum, one additional ZVI injection followed by a substantially greater period of long-term monitoring, would be required to achieve SCLs. The revised costs incorporate a second injection of ZVI and 30 years of ongoing groundwater monitoring.

A detailed description of the processes involved in using ZVI for Site 2 groundwater is presented in Section 8.4.1.5.1 of the FS (Shaw, 2005a).

Pilot Test

Pilot-scale testing of *in-situ* treatment using nanoscale ZVI injection was performed at Site 2 from July 2004 to January 2005. The test was conducted to ascertain the effectiveness of this technology in reducing contaminant concentrations, primarily CT, in Site 2 groundwater to SCLs through abiotic reductive dechlorination. Although initial results demonstrated the effectiveness of the ZVI injection at reducing contaminant concentrations in Site 2 groundwater, post pilot test sampling conducted in early 2007 indicated that, while the observed decreases in TCE and its degradation products due to the injection of ZVI had been sustained, the levels of carbon tetrachloride in a number of locations within the plume had rebounded to near historical levels. Additionally, although a ROI of approximately 6 feet was observed, the ability to effect a second or third injection of ZVI into an injection well at a later date (which would be required due to the inability of a single injection to achieve SCLs) was precluded as it was found that clogging of the injection well screen by the ZVI product had occurred.

Response Action GW-5 was thus re-evaluated assuming the following scope of remedial activities at Site 2:

- Two injections of supported nanoscale ZVI into the subsurface through 66 points at the south plume and 46 points at the north plume; and
- On-going groundwater monitoring as discussed below.

Long-Term Monitoring

The FS-stated objectives for the long-term monitoring program under RA GW-5 were three-fold: 1) monitoring of the remediation performance at Site 2 (planned to be quarterly for six months); 2) post-remediation monitoring to ensure a permanent reduction in the groundwater COC concentrations; and, 3) monitoring of the groundwater contamination in the bedrock aquifer at Site 2. Groundwater sampling was to continue until such time as the conditions in the exit strategy were met. The results of the pilot test and post-test groundwater quality data indicate that a one-time injection of ZVI will not achieve SCLs in the timeframes indicated. Long-term monitoring assumptions have therefore been revised to reflect a significantly longer timeframe.

The revised cost estimate assumes monitoring of groundwater would be performed quarterly for the first year, biannually for the subsequent two years, and annually for the remaining years until the thirtieth year to ensure a permanent reduction in COC concentrations. However, the final frequency of monitoring will initially be determined based on results obtained during near-term monitoring activities. The duration of monitoring activities is subject to change based upon evaluation of the data collected and agreement by EPA and NJDEP. Surface water monitoring will be conducted at sample locations that have previously exceeded the surface water quality criteria. Surface water monitoring will be conducted in conjunction with the long-term groundwater monitoring until concentrations fall below NJSWQC.

Operations and Maintenance

COC concentrations in groundwater at Site 2 were initially expected to decrease to within SCLs under RA GW-5 within one round of ZVI injections. The results of the 2007 sampling suggest that additional ZVI injections, or additional injection wells (or both) would be required and, unless rehabilitation (maintenance) of the injection wells could be conducted, new wells would be needed to effect multiple injections. The FS projected that under this RA, no O&M activities would be necessary, with the exception of the long-term monitoring of groundwater. This conclusion has not been supported by post-FS studies as reported in the Pre-Design Technical Memorandum (ARCADIS, 2009a).

LUCs, Planning, and Permitting

The implementation and maintenance of LUCs, planning, and permitting for Response Action GW-5 would involve similar requirements as for RA GW-3.

Site Preparation

Site preparation for RA GW-5 would involve similar components as described for RA GW-3. Additionally, site redevelopment potential would be further limited under the alternative due to the relatively large number of injection wells to be installed.

Reporting

RA GW-5 would entail similar reporting requirements as RA GW-3.

2.10.6 Response Action GW-6: *In-Situ* Enhanced Bioremediation, LUCs, and Long-Term Groundwater Monitoring

Estimated Capital Cost:	*$284,000*
Estimated O&M (Cost over 30 years):	*$900,000*
Estimated Present Worth Cost:	*$1,196,000*

(Present worth of the O&M and long-term replacement cost is calculated using a 7% discount rate.)

Response Action GW-6 would involve: 1) injections of a carbon substrate, EVO, for the *in-situ* treatment of chlorinated solvents in both the southern and northern portions of the surficial (unconfined) aquifer at Site 2; 2) long-term groundwater monitoring for all impacted groundwater; and, 3) implementation and maintenance of LUCs for all components of the groundwater plume.

For GW-6, an alternate mechanism for carbon substrate delivery is the installation of injection well lines oriented perpendicular to the groundwater flow direction. Each injection well line would include several wells spaced appropriately to provide coverage over the design ROI. This alternate delivery system will provide flexibility in treatment by allowing multiple injections of substrate, if required. Updated costs for implementing Alternative GW-6 have been developed based upon the results of the EVO injection test performed at Site 2 in 2007, and are based on the assumption that three injections of EVO will be required. The results of this test and results from modeling activities also determined that the estimated time it will take for contaminant concentrations to reach below site cleanup levels will decrease from that timeframe proposed within the FS to approximately 30 years.

Long-Term Monitoring

The objectives under the long-term monitoring program under Alternative GW-6 are three-fold: 1) monitoring of the remediation performance at Site 2; 2) post-remediation monitoring to ensure a permanent reduction in the groundwater COC concentrations; and, 3) monitoring of the groundwater contamination in the bedrock aquifer at Site 2. Groundwater sampling was to continue until such time as the conditions in the exit strategy were met.

The cost estimate assumes monitoring of groundwater would be performed quarterly for the first year, biannually for the subsequent two years, and annually for the remaining years until the thirtieth year to ensure a permanent reduction in COC concentrations. However, the final frequency of monitoring will initially be determined based on results obtained during near-term monitoring activities. The duration of monitoring activities is subject to change based upon evaluation of the data collected and agreement by EPA and NJDEP. Surface water monitoring will be conducted at sample locations that have previously exceeded the surface water quality criteria. Surface water monitoring will be conducted in conjunction with the long-term groundwater monitoring until concentrations fall below NJSWQC.

Operations and Maintenance

A total of ten new injection wells will be installed to create the line system. The two existing pilot test wells (2IW-1A and 2IW-1B) will also be utilized. The EVO solution injection volume will be such that overlapping ROI is created between injection wells. A second injection may occur approximately two years after the first. The need for a third injection will be considered upon evaluation of groundwater data.

LUCs, Planning and Permitting

The implementation and maintenance of LUCs, planning and permitting for Alternative GW-6 would involve similar requirements as for Alternative GW-3.

Site Preparations

Site preparations for Alternative GW-6 would involve similar components as described for Alternative GW-3; however, site redevelopment potential would not be significantly affected under this alternative.

Reporting

Alternative GW-6 would entail similar reporting requirements as Alternative GW-3.

2.11 COMPARATIVE ANALYSIS OF RESPONSE ACTIONS

The advantages and disadvantages of each of the Response Actions were compared using the nine CERCLA evaluation criteria in Section 300.430(e) of the NCP. The detailed comparative analysis of all the Response Actions is provided in the FS for Group 3 Sites (PICA 008); a summary of this comparison is provided in the following text.

2.11.1 Protection of Human Health and the Environment

Alternatives GW-3 through GW-6 would provide comparable protection to human health and the environment because contaminant concentrations would be reduced to SCLs through treatment. Alternative GW-2 affords the human health protection through the implementation of LUCs, primarily the groundwater use restrictions.

2.11.2 Compliance with Applicable or Relevant and Appropriate Requirements

Over time, the NJGWQS (which serve as chemical-specific ARARs and therefore, SCLs) will be met by all response action alternatives, with the exception of Alternative GW-1. However, it is anticipated that alternatives GW-3 through GW-6 will attain SCLs substantially faster than alternative GW-2 as a result of the active treatment remedies provided by alternatives GW-3 through GW-6. Action- and location-specific ARAR compliance would be satisfied by Alternatives GW-2 through GW-6.

2.11.3 Long-term Effectiveness and Permanence

The remediation timeframe to assess whether Alternative GW-1 would satisfy the long-term effectiveness and permanence criterion is unknown because there would be no monitoring of the plume to determine whether the magnitude of the residual risks decrease over time due to natural attenuation. Alternative GW-2 does not reduce concentrations in the short term using an active remedy, but will reduce concentrations over a longer time period through natural attenuation as demonstrated with a Monitored Natural Attenuation (MNA) sampling program. Alternatives GW-3 and GW-4 provide hydraulic control in addition to treatment of contaminants; however, the treatment effectiveness would likely be less than Alternatives GW-5 and GW-6 because of the heterogeneity of the subsurface and low groundwater yield. Post pilot test results associated with Alternative GW-5 indicate that ZVI will not likely be able to achieve reduction in carbon tetrachloride concentrations in the timeframe predicted during the FS, rather, long-term effectiveness would be reached by Alternatives GW-5 and GW-6 in similar timeframes.

2.11.4 Reduction in Toxicity, Mobility, or Volume through Treatment

Alternatives GW-3 through GW-6 all provide active treatment of groundwater to reduce contaminant concentrations in groundwater. Alternatives GW-5 and GW-6 achieve the reduced concentrations through complete contaminant destruction/degradation, rather than contaminant transfer from the groundwater medium onto a treatment medium. Therefore, these alternatives provide the highest treatment efficiency for the groundwater contamination at the Group 3 sites.

2.11.5 Short-term Effectiveness

None of the groundwater alternatives will provide short-term effectiveness due to the time required to restore the aquifer to SCLs under MNA or any form of active treatment. Alternative GW-1 offers unchanged risk to the community. In addition, the RAOs, and thus the SCLs, would not be achieved. In contrast, GW-2 does offer a lower risk to the community; although not a significant decrease, this response action would be able to determine when SCLs would be achieved and restrict exposure to groundwater. Elevated short-term risks to the community and construction workers would be experienced under the implementation of Alternatives GW-3 through GW-6; however, risks are considered manageable. During the FS, it was calculated that GW-3 through GW-6 would achieve SCLs within 5 to 13 years. Reassessment of historical data and evaluation of recently collected data suggests that none of the alternatives are likely to reach SCLs in less than 10 years in the surficial aquifer. Specifically,

timeframes for each Response Action to reach the SCLs were estimated at approximately 10 years under GW-3 and approximately 30 years under GW-4, GW-5, and GW-6.

2.11.6 Implementability

All of the alternatives are implementable; however, remedy approval from other agencies would be difficult to obtain for Alternative GW-1. Of the active remedies, Alternative GW-6 is the most readily implementable. Alternative GW-6 would require the least clearing, excavation and infrastructure installation. This alternative would also not limit site redevelopment potential.

2.11.7 Cost

Alternatives GW-1 and GW-2 are the least costly options. Of the active remedial strategies, Alternative GW-6 is the most cost effective. Alternatives GW-5, GW-4 and GW-3 exceed the $1.2 million estimated cost of GW-6 by $1.2, $2.6 and $2.9 million, respectively.

2.12 MODIFYING CRITERIA

2.12.1 State/Support Agency Acceptance

This document was prepared in partnership with USEPA and NJDEP representatives. EPA approval and NJDEP concurrence of the Selected RA is anticipated. NJDEP concurrence of the Group 3 Sites FS has been documented. Prior to finalization, the NJDEP commented on the Draft Final Feasibility Study for Group 3 Sites. Comments included concern over the discovery of UXO at Site 1. This comment was addressed by informing the NJDEP that areas such as these would be evaluated under the Military Munitions Response Program (MMRP). The NJDEP hydrologist approved the document without comment. In addition to the FS, the State has concurred with the Proposed Plan for Group 3 Sites (PICA 008).

Permit equivalency approvals are being documented and will be obtained through the CERCLA process for all work that would require a State of New Jersey permit, if being done under State authority.

2.12.2 Community Acceptance

Community acceptance is addressed in the Responsiveness Summary (Section 3) of this ROD.

2.13 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 threat wastes are those source materials that generally can be reliably contained and would present only a low risk in the event of exposure. In addition, principal threat wastes are identified based upon the results of the quantitative risk assessment, with those compounds that have a value of 1×10^{-3} or higher being considered as principal threat waste. As concluded in the Risk Assessment, none of the contaminants that exceeded LOCs in groundwater at the Group 3 Sites (PICA 008) meet the criteria to be considered a principal threat waste. In addition, groundwater itself is not a principal threat because it is considered a non-source material.

2.14 SELECTED RESPONSE ACTION

This ROD represents the Selected RA for the Group 3 Sites (PICA 008) at Picatinny, Rockaway Township, Morris County, New Jersey, developed in accordance with CERCLA as amended and consistent with the NCP. Based on the results of the comparative analysis and comments received from the USEPA and NJDEP, the Selected RA includes the following:

- Groundwater: Response Action GW-6: *In-Situ* Enhanced Bioremediation, Land Use Controls and Long-Term Groundwater Monitoring.

2.14.1 Summary of the Rationale for the Selected Response Action

The Selected RA achieves the RAOs, meets the threshold criteria, and provides the best balance of tradeoffs with respect to the balancing and modifying criteria. The Selected RA addresses the limited risk posed by groundwater effectively, is the most implementable active remediation, and is cost effective.

The Selected RA is consistent with CERCLA. The implementation of *in-situ* enhanced bioremediation at Site 2 was considered appropriate based on contaminant concentrations within groundwater beneath the Site and the results of the pilot study.

2.14.2 Detailed Description of the Selected Response Action

The Selected RA for remediation of groundwater at the Group 3 Sites (PICA 008) includes the injection of carbon substrate into the unconsolidated aquifer at both the southern and northern surficial plumes at Site 2 to create an *in-situ* reactive treatment zone. The proposed injection locations are depicted on **Figures 9a** and **9b** for the South and North surficial plumes, respectively. No injections will occur within the bedrock aquifer. The bedrock plume will be addressed by treating the South plume which flows downward to the bedrock aquifer. Any discharge from the bedrock aquifer will be treated through injections at the North plume. Following EVO injections, MNA would be implemented to address the portions of the plume remaining in the unconsolidated and bedrock aquifers subsequent to injections. LUCs and long-term groundwater monitoring would be implemented at the Group 3 Sites (PICA 008) as a result of contamination remaining in groundwater above NJGWQC.

In order to implement the Selected RA, the following actions will be required:

- Preparation of the following documents:
  - Remedial Design and Construction Work Plans
  - Remedial Action Report
- Construction surveys;
- Construction of a decontamination area;
- Erosion and sediment controls as needed;
- Clearing of vegetation, as needed;
- Construction of monitoring and injection wells;
- Injections of the EVO substrate;
- Implementation of a long-term monitoring program; and,
- Implementation of LUCs.

2.14.3 Land Use Controls

LUCs will be required at the Group 3 Sites (PICA 008) due to the residual contamination exceeding residential standards that will remain on-site during implementation of the Selected RA. The Army is responsible for implementing, enforcing, maintaining, and reporting on the LUCs. The area of LUC applicability for Group 3 Sites is depicted on **Figure 8**. A change in land use would include notifying the regulators.

A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections. Residential land use at Group 3 Sites will be restricted by the Land Use Control Plan. In addition, the LUC objectives will include a contingency for vapor intrusion sampling should any building located above the plume become occupied during the remedial action for groundwater.

The LUC objectives for Group 3 groundwater and surface water are as follows:

- Prevent access or use of the groundwater and surface water until cleanup levels are met.

- Maintain the integrity of any current or future remedial monitoring system, such as monitoring wells.
- Maintain the integrity of any components of the remedy, such as injection wells.
- Maintain the existing CEA.
- Prohibit excavation without safeguards in all areas below the water table where groundwater contaminants exceed SCLs.

LUCs will be maintained until the concentration of hazardous substances in groundwater and incidental surface water are at such levels to allow for unrestricted use and unlimited exposure. Requirements of NJDEP Deed Restriction policies will be included in the LUC Remedial Design. Many of the exhibits required (maps, engineering drawings, location maps) are already incorporated into the Army's plans. It should be noted that in the event that Picatinny is closed and the land ownership transferred, the LUCs would need to be documented through an appropriate mechanism for privately owned property (i.e., deed notice). Although the Army may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Army shall retain ultimate responsibility for remedy integrity. Upon implementation of the remedy, the following activities will be completed to fully implement LUCs:

- Install and maintain engineering controls (typically signs) per the LUC Remedial Design;
- Amend the Picatinny GIS to document the area of applicability, engineering controls, and sign locations;
- Prepare an announcement for all Picatinny employees and residents informing them of the LUCs at the Group 3 Sites (PICA 008); and,
- Conduct annual inspections of the Sites and complete an Annual Certification of LUCs.

2.14.4 Summary of Expected Response Action Costs

The costs associated with the implementation of *in-situ* bioremediation, LUCs and long-term monitoring for groundwater are provided in **Table 10** and summarized in the following list:

Capital Costs

- *In-Situ* Enhanced Bioremediation with MNA

- Land Use Restrictions & Institutional Controls	$ 10,000
- Permits and Report Writing	$ 126,000
- Site Preparation	$ 34,231
- Installation of Injection Points	$ 33,000
- Construction Oversight	$ 43,500
- Contingency of Scope (10%)	$ 24,673
- Contingency of Bid (5%)	$ 12,336
Total Capital Costs	**$ 283,740**

O&M Costs (30 Years)

7-Year Injection Cost (3 events)	$ 397,680
30-Year MNA Sampling Cost	$ 281,585
Well Abandonment, Replacement, and Maintenance	$ 81,535
5-Year Reviews	$ 32,367
Total Present Worth O&M Costs (7% Dis., 30 years)	**$ 793,167**
TOTAL PRESENT WORTH	**$1,195,882**

The costing information in this section is based on the estimates created in support of the Pre-Design Technical Memorandum (ARCADIS, 2009a).

2.14.5 Expected Outcomes of the Selected Response Action

It is anticipated that current land use will continue unchanged after implementation of the Selected RA. Implementation of the RA will reduce groundwater contamination to concentrations below the NJGWQC, thus reducing risks to human and ecological receptors. Furthermore, the enforcement of LUCs will ensure that risks to human receptors remain within acceptable levels.

2.15 STATUTORY DETERMINATIONS

Under CERCLA § 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, and comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and response action treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment and permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected RA meets these statutory requirements.

2.15.1 Protection of Human Health and the Environment

The Selected RA will protect human health and the environment by reducing existing on-site contamination and maintaining LUCs that limit exposure. In addition, by conducting remedial activities *in-situ*, exposure risks to sites workers are limited even further.

2.15.2 Compliance with Applicable or Relevant and Appropriate Requirements

The Selected Remedy of *in-situ* enhanced bioremediation and the implementation of LUCs to limit the exposure to existing groundwater contaminants complies with all ARARs. The ARARs and other criteria, advisories, and guidance to-be-considered are presented in **Tables 4**, **5**, and **6**.

2.15.3 Cost Effectiveness

In the lead agency's judgment, the Selected RA is cost-effective and represents 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 determination was accomplished by evaluating the "overall effectiveness" of those response actions 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, implementability, and costs). A comparison of the costs to the overall effectiveness was conducted to determine cost effectiveness. The relationship of the overall effectiveness of the Selected RA was determined to be proportional to its costs, and hence the Selected RA represents a reasonable value for the money to be spent.

The Army believes that the Selected RA is cost-effective and is protective of human health and the environment.

2.15.4 Utilization of Permanent Solutions and Response Action Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Possible

The Selected RA employs permanent solutions to treat and reduce the volume of contaminants present at the Group 3 Sites. The Selected RA satisfies the criteria for long-term effectiveness by eliminating, as well as preventing, unacceptable exposures to groundwater. The Selected RA reduces the toxicity, mobility and volume of contamination though treatment; is minimally intrusive; and will have reduced short-term risks by implementing an *in-situ* treatment technology. Additionally, there are no significant implementability issues associated with the Selected RA as the remedial activities have become commonly applied construction practices.

2.15.5 Preference for Treatment as a Principal Element

The Selected RA addresses groundwater contamination at the Group 3 Sites (PICA 008) through the use of an active treatment technology. The Selected RA is the most cost effective alternative in comparison to the other active technologies being evaluated.

2.15.6 Five-Year Review Requirements

Because this RA will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, statutory reviews will be conducted every five years after response action initiation. Five-year reviews will ensure that the Selected RA is, or will be, protective of human health and the environment.

3.0 PART 3: RESPONSIVENESS SUMMARY

The final component of this 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 RA for the Group 3 Sites (PICA 008) and the Army's responses to these concerns.

The Group 3 Sites (PICA 008) have been the topic of presentations at the PAERAB. PAERAB members have provided comments regarding the proposed Response Action. A copy of the PP was given to the PAERAB's co-chair and a copy was offered to all PAERAB members. A final PP for the Group 3 Sites (PICA 008) was completed and released to the public on October 29, 2009 at the information repositories listed in Section 2.3.

Multiple newspaper notifications were made to inform the public of the start of the PP comment period, solicit comments from the public, and announce the public meeting. The notification was run in the Daily Record on October 16, 2009 and in the Star Ledger on October 16, 2009. Copies of the certificates of publication are provided in **Appendix A**. A public meeting was held on October 29, 2009 to inform the public about the Selected RA for the Group 3 Sites (PICA 008) and to seek public comments. At this meeting, representatives from the U.S. Army, NJDEP, USEPA, and the Army's contractor, ARCADIS U.S., Inc., were present to answer questions about the site and response actions under consideration. A public comment period was held from October 29, 2009 to November 28, 2009 during which no comments from the public were received.

In general, the community is accepting of the Selected RA and is in favor of eliminating groundwater contamination from beneath the Group 3 Sites. All comments and concerns summarized below have been considered by the Army, USEPA, and NJDEP in selecting the final cleanup methods for the Group 3 Sites (PICA 008) at Picatinny.

3.1 PUBLIC ISSUES AND LEAD AGENCY RESPONSES

As of the date of this ROD, the Army endorses the Selected RA for the Group 3 Sites (PICA 008). The USEPA and the NJDEP support the Army's plan. Comments received during the Group 3 Sites (PICA 008) public comment period on the PP are summarized below. The comments are categorized by source.

3.1.1 Summary of Written Comments Received during the Public Comment Period

No written comments were received during the public comment period.

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

Five verbal comments specific to the Selected RA were received during the public meeting held on October 29, 2009. Transcripts from the public meeting have been submitted to the Administrative Record (located at the information repositories listed in Section 2.3) for the site.

The comments received on the Selected RA are summarized as follows:

Comment 1: Mr. Pat Matarazzo, a member of the PAERAB: Has Lake Ames been studied? Due to the steep gradient, once the remediation begins, contamination may travel further south to Lake Ames.

Response: Mr. Gabel: Ames Brook and the G-2 Pond have been looked at, both of which would be potentially impacted before Lake Ames. A full ecological risk assessment has been performed of the G-2 Pond and the nearby streams, and no impacts have been found. Mr. Llewellyn: I will review the data again and take Mr. Matarazzo's comment into consideration during the Remedial Design stage.

Comment 2: Mr. Michael Glaab, a member of the PAERAB: I encourage the Army to take a conservative approach with the surface water and sediment sampling program.

Response: Mr. Gabel: Since the initial sampling did not find any impact to the sediment, additional sediment sampling would have to be discussed with the regulators.

Comment 3: Mr. Ted Hussa, Mayor of Denville: Has historical information been sought from long-time installation employees?

Response: Mr. Gabel: Information has been sought from employees as far back as the 1990s during the site investigation. Information has also been requested more recently through the web site.
Mr. Rowland: Efforts have been made to allow information to be submitted anonymously.

Comment 4: Mr. Glaab: Will the EVO be effective with the carbon tetrachloride as well as the TCE?

Response: Mr. Llewellyn: The pilot test showed the EVO would be equally effective with both compounds.

Comment 5: Mr. Glaab: Why is EVO being used instead of molasses?

Response: Mr. Llewellyn: Different carbon sources are used at different locations depending on the site environment. At this location groundwater flow is fairly rapid so the molasses would flush through very quickly and then be gone, compared to the EVO which would remain in the ground longer.

3.2 TECHNICAL AND LEGAL ISSUES

No technical or legal issues were raised on the Selected RA.

4.0 PART 4: REFERENCES

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USEPA. 2009a. Mid-Atlantic Risk Assessment Risk-Based Concentration Tables. Regional Screening Level (RSL) Master Table. December 10, 2009.

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Tables

Table 1
Chronological Order of Investigations Conducted at the Group 3 Sites (PICA 008)
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Event	Date
1. Submittal of Final Phase II Work Plan, Sampling and Analysis Plan, Quality Assurance Plan and Health and Safety Plan.	Dec-94
2. Performance of Round 1 of RI Field Investigation at 55 sites	May 1995 to November 1996
3. Performance of RI field activities at the Group 3 Sites	December 1997 to April 1998
4. Regulatory Submittal of Final Work Plan for Additional RI Investigation at Phase II Group 3 Sites	Feb-98
5. Regulatory Submittal of the Draft Final Phase II RI Report, Round 1	Apr-99
6. Preparation/Regulatory Submittal of the Phase II Ecological Risk Assessment	Feb-00
7. Misc. delineation of contamination in soil as part of H,I,J,K Investigation	2000
8. Submittal of Final Group 3 RI Report (including Data Gap Field Investigation Work Plan)	Oct-01
9. Summary Letter Report for 3500 Area Groundwater Feasibility Study, referred to as the NA Letter	Jul-99
10. Performance of the Data Gap Field Investigation	July 2001 to August 2002
11. Regulatory Submission of Group 3 Groundwater Summary	Apr-03
12. Facility-Wide Sump Investigation (Removal of Sumps at Site 1 and Site 4)	September 2003 to November 2004
13. Supplemental sampling of ammonia in groundwater	Feb-05
14. Performance of nano-scale ZVI groundwater treatment pilot study	September 2004 to January 2005
15. Submittal of Final Group 3 Sites Feasibility Study	Aug-05
16. Regulatory Submittal of the Draft Final Site 2 Nanoscale ZVI Pilot Study Report	Aug-05
17. Emulsified Vegetable Oil Injection Test	Aug-07
18. Submittal of Final Pre-Design Technical Memorandum for Groundwater and Sediment	Jul-09
19. Submittal of Final Proposed Plan for Group 3 Sites	Oct-09

Table 2
Contaminants Detected in Groundwater Samples that Exceed LOCs
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Constituent	Range of Concentrations (µg/L)		LOC (µg/L)	Source of LOC Value	Frequency of Detection	No. of Samples Exceeding LOC
	Minimum	Maximum				
SITE 1						
Nitrite/Nitrate	200	1,600	1,000	MCL, NJGWQS, MCLG	3/3	1
SITE 2						
Benzene	0.39	1.6	1	NJMCL, PQL	10/113	7
Bromodichloromethane	0.77	1.8	1	PQL	3/113	1
Carbon Tetrachloride	0.13	480	1 (2)*	NJGWQS (NJMCL, PQL)	37/113	26
Chloroethane	4.9	4.9	3.6	RBC	1/113	1
Chloroform	0.35	54.54	6	NJGWQS	37/113	12
1,2-Dichloroethane	0.29	7.392	2	NJMCL, PQL	19/113	7
1,1-Dichloroethene	0.62	50	1 (2)*	NJGWQS (NJMCL, PQL)	29/113	24
cis-1,2-Dichloroethene	0.53	12.51	10	NJGWQS	32/96	1
Methylene Chloride	0.976	3.5	2	NJGWQS, PQL	3/113	2
Tetrachloroethene	0.63	4.2	1	NJMCL, PQL	12/113	9
1,1,1-Trichloroethane	0.8	90.77	30	NJMCL, NJGWQS	36/113	4
Trichloroethene	0.49	110	1	NJMCL, NJGWQS, PQL	56/113	47
Carbazole	5.9	5.9	3.3	RBC	1/23	1
Dibenzofuran	3.3	35	24	RBC	3/23	1
Phenanthrene	71	71	10	PQL	1/23	1
Nitroglycerin	38.1	53	4.8	RBC	2/17	2
RDX	8.12	8.12	2	HA	1/20	1
Aluminum	27.3	5,750	200	NJGWQS, PQL	6/17	5
Iron	40.6	12,600	300	NJGWQS	14/17	5
Lead	1.35	12.6	10	PQL	9/17	1
Manganese	8.85	3,000	50	NJGWQS	17/17	11
Sodium	4,350	56,500	50,000	NJGWQS	17/17	1
Nitrate/Nitrite	40.4	2,000	1,000	MCL, NJGWQS, MCLG	15/17	4
SITE 4						
Carbon Tetrachloride	1.516	6.7	1 (2)*	NJGWQS (NJMCL, PQL)	4/19	2
Methylene Chloride	0.694	2.3	2	NJGWQS, PQL	4/19	1
Trichloroethene	0.854	2	1	NJMCL, NJGWQS, PQL	5/19	3
bis(2-Ethylhexyl)-phthalate	47	200	6	MCL	2/9	2
Aluminum	95.2	276	200	NJGWQS, PQL	3/9	2
Arsenic	5.11	9.92	8	PQL	2/9	1
Iron	50.8	38,100	300	NJGWQS	7/9	5
Manganese	2.89	2,800	50	NJGWQS	9/9	8

Notes:

1. LOC - Level of Concern
2. MCL – Federal Maximum Contaminant Level
3. MCLG – Federal Maximum Contaminant Level Goal
4. NJMCL – New Jersey State Maximum Contaminant Level
5. NJGWQS – New Jersey Groundwater Quality Standards
6. PQL – New Jersey State Practical Quantitation Limit
7. RBC – USEPA Region 3 Tap Water Risk Based Concentration
8. HA – Federal Drinking Water Health Advisory
9. µg/L - microgram per Liter
10. * Reflects amendments to the NJDEP Groundwater Quality Standards (including numeric criteria) adopted on November 7, 2005 - the LOC used in the FS is provided in parentheses. The data discussions provided herein reflect comparisons to the LOCs in effect at the time the FS was prepared. The reduction in the LOC by 1 µg/L does not substantively change the conclusions presented, except as noted in the text.

Table 3
Contaminants Detected in Surface Water Samples that Exceed LOCs
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Constituent	Range of Concentrations (µg/L)		LOC (µg/L)	Source of LOC Value	Frequency of Detection	No. of Samples Exceeding LOC
	Minimum	Maximum				
Site 2						
Carbon Tetrachloride (CT)	0.25	8.8	0.23 (0.25)*	AWQC	3/39	2
Chloroform (CF)	0.17	11	5.67	NJSWQC	6/39	1
Chloromethane	5	5	2.1	RBC	1/39	1
1,1-Dichloroethane (DCA)	0.24	1.4	0.291	NJSWQC	4/39	3
Methylene Chloride	2.5	6.3	2.49	NJSWQC	7/39	7
Trichloroethene (TCE)	0.5	5.9	1	NJSWQC	8/39	6
bis(2-Ethylhexyl)phthalate	8	8	1.76	NJSWQC	1/22	1
Nitroglycerin	13.7	32	4.8	RBC	2/15	2
Aluminum	29	29,900	190	BG Threshold	29/29	14
Arsenic	1	14	1.38	BG Threshold	22/29	13
Cadmium	0.8	8.2	2.4	AWQC	6/29	4
Chromium	9.06	40.1	11.4	AWQC	9/29	5
Copper	5.56	98.8	9.4	AWQC	11/29	10
Cyanide	9.49	9.57	5.2	AWQC	2/18	2
Iron	269	162,000	1,790	BG Threshold	29/29	17
Lead	0.6	462	3.2	AWQC	16/29	12
Manganese	16.7	6,950	383	BG Threshold	29/29	16
Mercury	0.239	0.468	0.05	AWQC	4/29	4
Selenium	3.52	6.55	5	AWQC	2/18	1
Silver	0.1	6.64	4	AWQC	7/29	2
Zinc	57.3	485	122	AWQC	11/29	6
Ammonia	64.3	4,500	210	RBC	15/18	6
Sulfide	434	11,000	2,200	AWQC	3/18	1
Site 4						
Bromodichloromethane	0.66	0.66	0.266	NJSWQC	1/7	1
Dibromochloromethane	1.2	1.2	0.41	AWQC	1/7	1
bis(2-Ethylhexyl)phthalate	50	50	1.76	NJSWQC	1/7	1
Aluminum	77.7	3,220	190	BG Threshold	7/7	4
Arsenic	1.71	1.71	1.38	BG Threshold	1/7	1
Copper	5	28.9	9.4	AWQC	2/7	1
Iron	178	11,500	1,790	BG Threshold	7/7	4
Lead	8.76	18.3	3.2	AWQC	4/7	4
Manganese	32.7	961	383	BG Threshold	7/7	3
Zinc	53.1	245	122	AWQC	4/7	2
Ammonia	148	21,000	210	RBC	4/7	2

Notes:

1. AWQC – USEPA Water Quality Criteria
2. BG Threshold – Surface Water Background Threshold Value
3. LOC - Level of Concern
4. NJSWQC – New Jersey Surface Water Quality Criteria
5. RBC – USEPA Region 3 Tap Water Risk Based Concentration
6. µg/L - microgram per Liter
7. No surface water samples were collected from Site 1 as minimal surface water exists.
8. * Reflects amendments to the USEPA Water Quality Criteria (including numeric criteria) adopted in 2009 - the LOC used in the FS is provided in parentheses. The data discussions provided herein reflect comparisons to the LOCs in effect at the time the FS was prepared. The reduction in the LOC by 0.02 µg/L does not substantively change the conclusions presented.

Table 4
Chemical-Specific ARARs
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Contaminant of Concern	Groundwater SCLs (µg/L)	Surface Water SCLs (µg/L)
Carbon Tetrachloride (CT)	1 (2)[a]	0.33
1,1-Dichloroethene (1,1-DCE)	1 (2)[a]	0.47
Tetrachloroethene (PCE)	1	0.34
Trichloroethene (TCE)	1	1.00

Notes:

1. SCL = site cleanup level
2. µg/L = microgram per liter
3. a. - Reflects amendments to the NJDEP Groundwater Quality Standards adopted on November 7, 2005 - the SCL used in the FS is provided in parentheses.

Table 5
Action-Specific ARARs and TBCs
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Action	Law/Regulation	Requirements of Law/Regulation	ARAR/TBC Status
Sampling and Analysis	Remediation Technical Requirements NJAC 7:26E-3	Requirements of quality assurance for sampling and analysis at remediation sites.	ARAR Applicable to sampling and analytical activities at the site.
	Regulations Governing the Certification of Laboratories and Environmental Measurements NJAC 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.	ARAR Applicable when selecting a laboratory for sampling activities during remediation.
	Notice of Intent to implement a Performance-Based Measurement System 62 FR 52098, Oct. 6, 1997 (FRL-5903-2)	Give the public an opinion on selecting any appropriate analytical test method to use in complying with USEPA regulations.	TBC Applicable to analytical methods in regards to waste generation.
Installation Of Wells	A Field Sampling Procedures Manual, May 1992	State guidance and general industry procedures for installation of extraction wells/monitoring wells are identified.	TBC Guidelines for installation for monitoring and extraction wells.
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.	ARAR Relevant and appropriate for on-site remediation activities.
	USEPA OSWER Publication 9345.3-03FS, January 1992	Investigation-derived wastes generated from remedial activities (e.g., drilling muds, purged water, etc.) are required to be properly stored, managed and disposed. Guidance given in the publication includes waste material containment, collection, labeling, etc.	TBC For wastes generated during monitoring and sampling activities.
Stream/Wetland Encroachment	33 CFR 320.4 Flood Hazard Area Control (NJAC 7:13-1.1 et seq.) Freshwater Wetland Protection Act Rule (NJAC 7:7A-9, NJSA 13:9A-1) All the regulations require equivalency permit and correlate with location-specific requirements.	Equivalency permit required for the following activities: • Development or disturbances in floodplain and wetland area • Stream encroachment • Soil erosion and sediment control	ARAR Applicable to the substantive requirements of the permit program for monitoring and sampling activities that occur in the floodplain or vicinity of any surface water bodies (G-2 Pond, Ames Brook, 1500 Run) at the Group 3 Sites.

Table 6
Location-Specific ARARs and TBCs
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Location	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
Wetlands	Presence of wetlands as defined in Executive Order 11990- § 7 (c) and 40 CFR 6, Appendix A § 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.	ARAR Applicable to the substantive requirements as monitoring and sampling activities will occur in areas that encroach upon stream, wetlands, and/or transition areas. No construction or other intrusive activities are planned to occur.
	Presence of wetlands as defined in the Clean Water Action (CWA) Section 402 33 CFR 320.4 and NJAC 7:7A (the Freshwater Wetlands Protection Act, P.L. 1987)	To the extent possible, action must be taken to avoid degradation or destruction of wetlands. Discharges for which there are practicable alternatives with less adverse impacts or those that would cause or contribute to significant degradation are prohibited. If adverse impacts are unavoidable, action must be taken to enhance, restore, or create alternative wetlands.	ARAR Applicable to the substantive requirements as monitoring and sampling activities will occur in areas that encroach upon stream, wetlands, and/or transition areas.
Floodplains	Protection of floodplains as defined in Executive Order 11988 § 6 (c) and 40CFR 6, Appendix A § 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.	ARAR Applicable to the substantive requirements as monitoring and sampling activities will occur in areas that encroach upon stream, wetlands, and/or transition areas. No construction or other intrusive activities are planned to occur.

Table 7
Human Health Risk Assessment Results
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Receptor	Cumulative Cancer Risk	Hazard Index
Site 1		
Future Industrial/Research Worker	1.2×10^{-5}	0.07
Future Construction Worker	1.1×10^{-6}	0.2
Site 2		
Current/Future Outdoor Maintenance Worker	5.8×10^{-6}	0.2
Current Industrial/Research Worker	1.3×10^{-5}	0.4
Future Construction Worker	2.3×10^{-6}	>1*
Future Industrial/Research Worker	3.0×10^{-4}	>1**
Site 4		
Current Outdoor Maintenance Worker	6.6×10^{-6}	0.04
Future Outdoor Maintenance Worker	6.6×10^{-6}	0.05
Current/Future Industrial/Research Worker	2.0×10^{-5}	0.1
Future Construction Worker	1.4×10^{-6}	0.4

Notes:

1. * The originally calculated Hazard Index was 1.9. However, the Hazard Indexes for each target organ/effect were less than or equal to one, indicating adverse non-cancer effects are unlikely.

2. ** The cumulative calculated Hazard Index calculated for the supplemental risk assessment for future exposure to ingestion and inhalation of groundwater is 8. When broken down for each target organ/effect, some Hazard Indexes were still greater than one, indicating adverse non-cancer effects existed.

Table 8
Final Site Cleanup Levels (SCLs) and Detected Concentrations
for the Group 3 Sites Contaminants of Concern
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

Contaminant of Concern	Groundwater		Surface Water	
	SCL (µg/L)	Maximum Detected Concentration (µg/L)	SCL (µg/L)	Maximum Detected Concentration (µg/L)
Carbon Tetrachloride (CT)	1 (2)[a]	480	0.23 (0.25)[b]	8.8
1,1-Dichloroethene (1,1-DCE)	1 (2)[a]	50	4.7	0.52
Tetrachloroethene (PCE)	1	4.2	0.34	--
Trichloroethene (TCE)	1	110	1	5.9

Notes:

1. SCL = site cleanup level
2. µg/L = microgram per Liter
3. -- = Constituent has not been detected.
4. a. - Reflects amendments to the NJDEP Groundwater Quality Standards adopted on November 7, 2005, the SCL used in the FS is provided in parentheses.
5. b. - Reflects amendments to the USEPA Water Quality Criteria adopted in 2009, the SCL used in the FS is provided in parentheses.

Table 9
Groundwater Plume Description
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

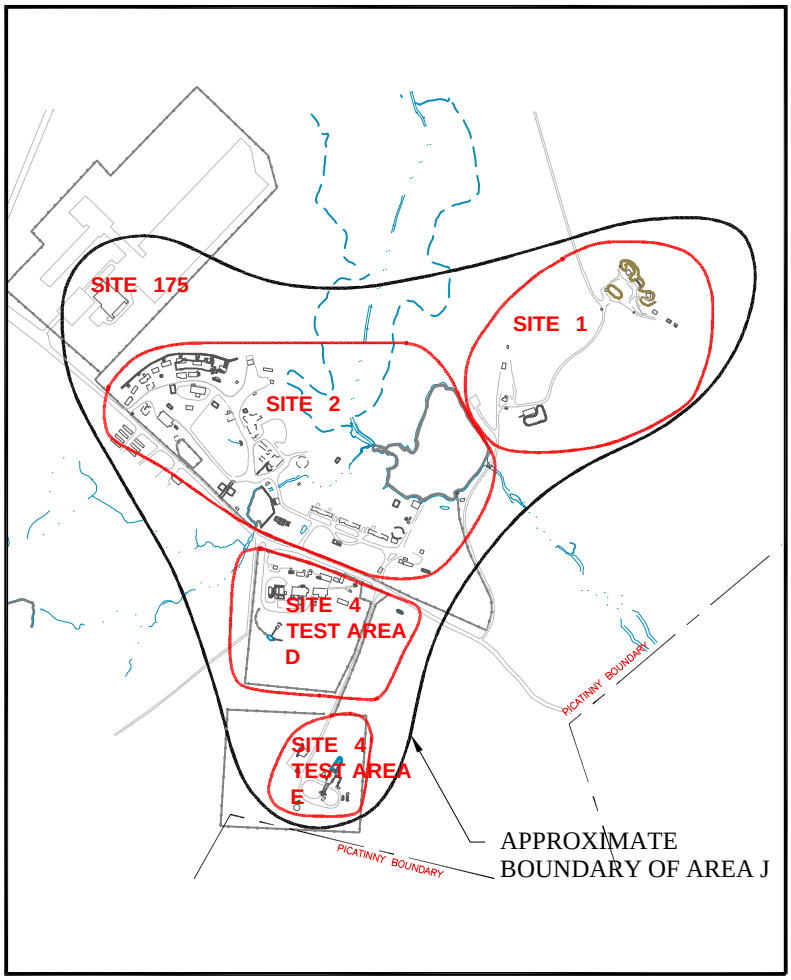
Plume	Approximate Area (square feet)	Porosity	Approximate Thickness (feet)	Volume (gallons)
Site 2				
South	85,546	30%	56	10,751,490
North	61,238	30%	30	4,123,093
Bedrock	130,239	1%	80	779,454

Table 10
Costs for Response Action GW-6 - *In-Situ* Enhanced Bioremediation,
LUCs and Long-Term Groundwater Monitoring
Group 3 Sites (PICA 008)
Picatinny Arsenal, New Jersey

	Description	Costs
Capital Costs		
	Land Use Restrictions and Institutional Controls	$ 10,000.00
	Permits and Reports Writing	$ 126,000.00
	Site Preparation	$ 34,230.70
	Installation of Injection Points	$ 33,000.00
	Construction Oversight	$ 43,500.00
	Total Capital Cost	**$ 246,730.70**
O&M Costs		
	Injection to Treat Plume Hot Spot (7-year, 3 events)	$ 397,679.51
	30-Year MNA Sampling	$ 281,585.03
	Well Abandonment, Replacement, and Maintenance	$ 81,535.04
	5-Year Reviews	$ 32,367.25
Discounted O&M Costs (7% Interest) *		**$ 793,166.83**
Contingency (15%)		**$ 155,984.63**
	Total Remediation Cost	**$ 1,195,882.16**

Notes:
1. O&M - Operation and Maintenance
* O&M Costs are totaled as a present worth cost based on a 7% net investment rate for a 30-year period.

Figures



AREA J SITE PLAN

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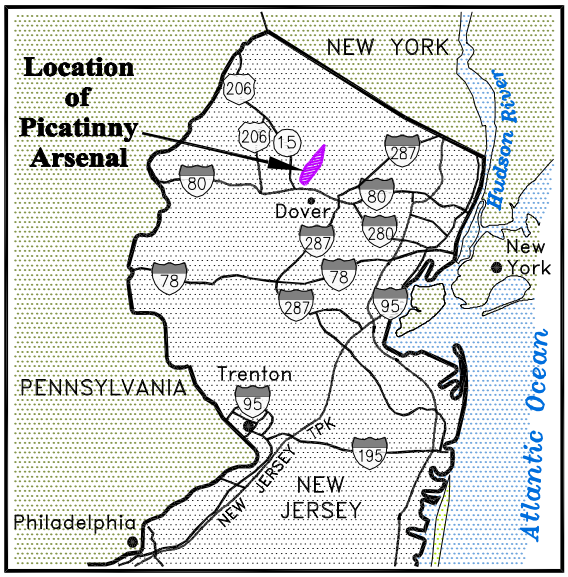
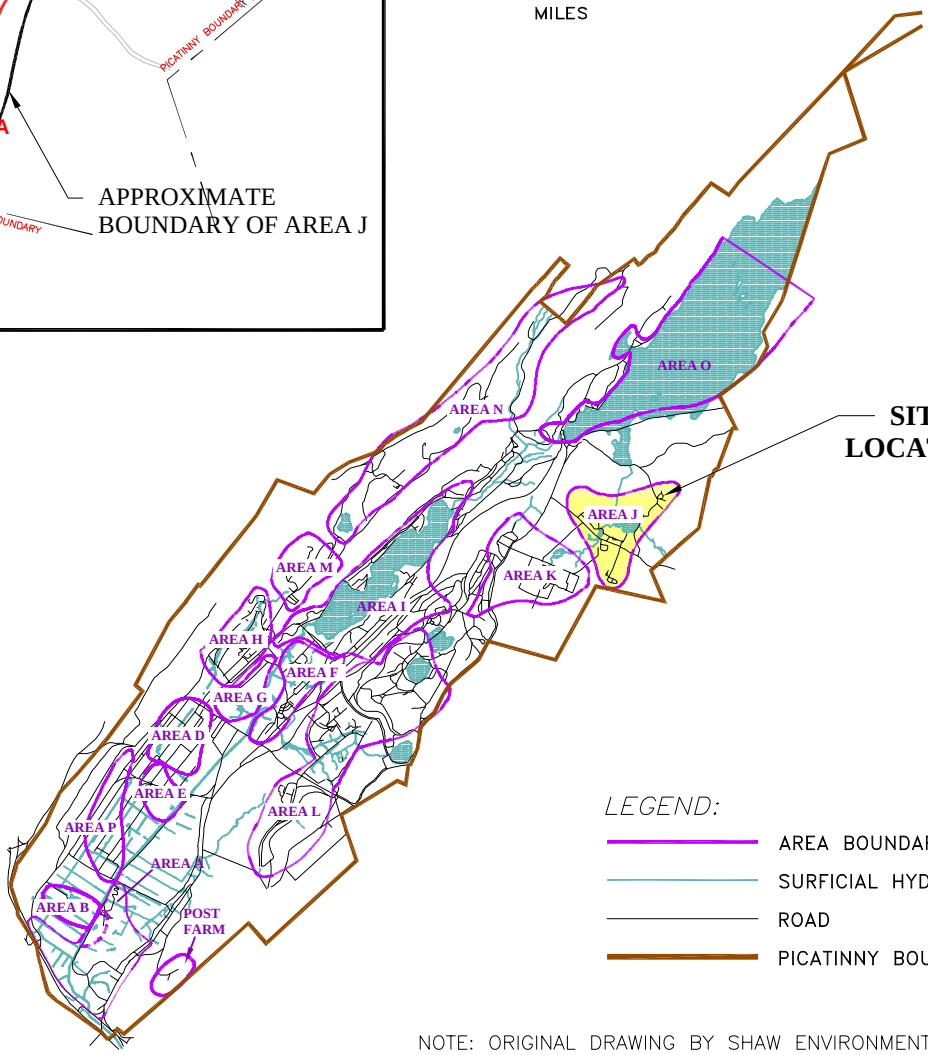
SCALE: 1"=1,000'



LOCATION OF PICATINNY

0 50

MILES



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SCALE: 1"=6,000'

N

NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

PICATINNY ARSENAL LOCATION MAP REMEDIAL INVESTIGATION CONCEPT PLAN AREAS

PICATINNY ARSENAL, NEW JERSEY

Project Number
GP06PICA.P008

Drawing Date
22 OCTOBER, 2007

Figure
1

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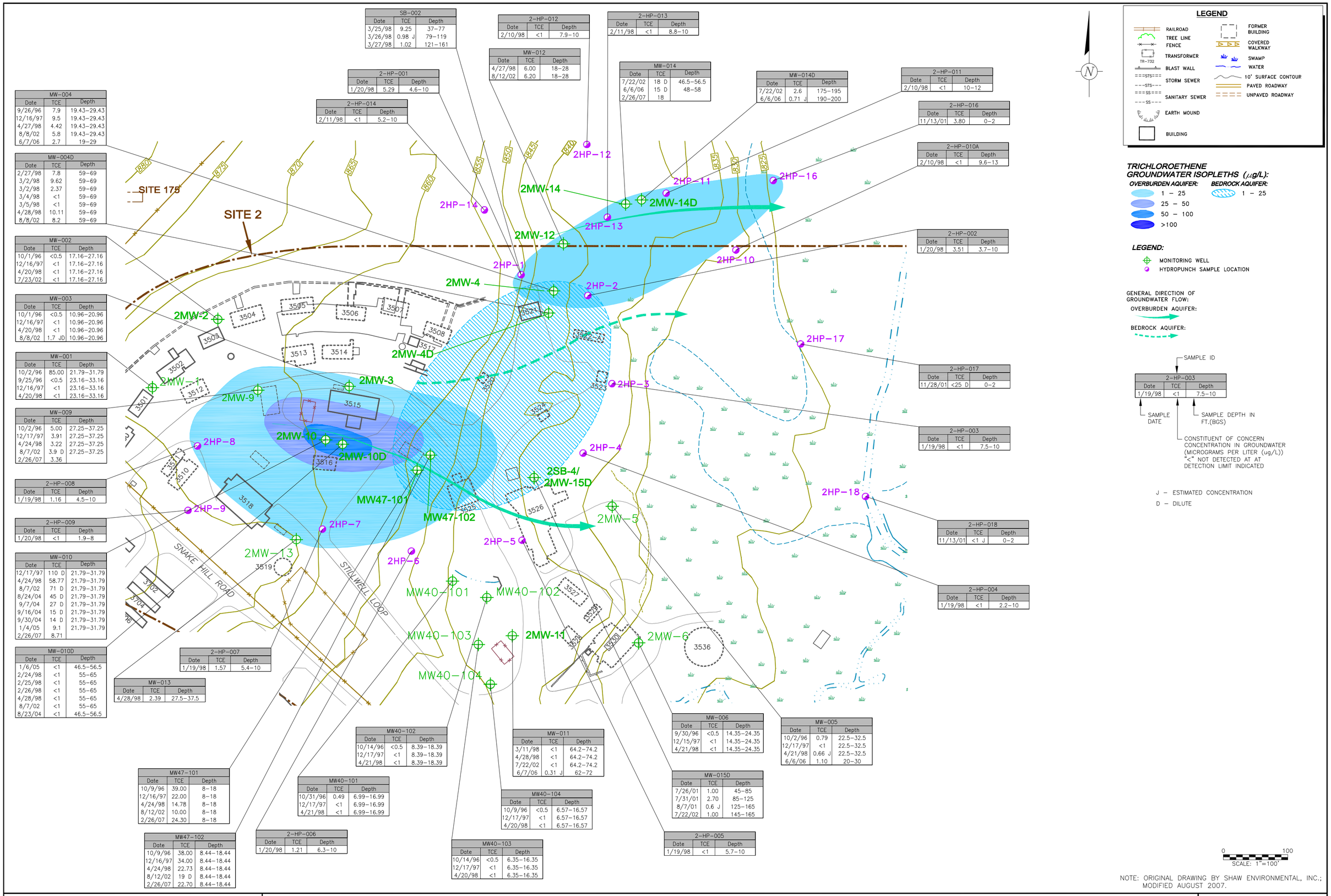

SB-002		
Date	TCE	Depth
3/25/98	9.25	37–77
3/26/98	0.98 J	79–119
3/27/98	1.02	121–161

2-HP-012		
Date	TCE	Depth
2/10/98	<1	7.9–10

2-HP-013		
Date	TCE	Depth
2/11/98	<1	8.8–10

MW-012		
Date	TCE	Depth
4/27/98	6.00	18–28
8/12/02	6.20	18–28

2-HP-001		
Date	TCE	Depth
1/20/98	5.29	4.6–10

2-HP-014		
Date	TCE	Depth
2/11/98	<1	5.2–10

MW-014		
Date	TCE	Depth
7/22/02	18 D	46.5–56.5
6/6/06	15 D	48–58
2/26/07	18	

MW-014D		
Date	TCE	Depth
7/22/02	2.6	175–195
6/6/06	0.71 J	190–200

2-HP-011		
Date	TCE	Depth
2/10/98	<1	10–12

2-HP-016		
Date	TCE	Depth
11/13/01	3.80	0–2

2-HP-010A		
Date	TCE	Depth
2/10/98	<1	9.6–13

2-HP-002		
Date	TCE	Depth
1/20/98	3.51	3.7–10

2-HP-017		
Date	TCE	Depth
11/28/01	<25 D	0–2

2-HP-003		
Date	TCE	Depth
1/19/98	<1	7.5–10

2-HP-018		
Date	TCE	Depth
11/13/01	<1 J	0–2

2-HP-004		
Date	TCE	Depth
1/19/98	<1	2.2–10

MW-004		
Date	TCE	Depth
9/26/96	7.9	19.43–29.43
12/16/97	9.5	19.43–29.43
4/27/98	4.42	19.43–29.43
8/8/02	5.8	19.43–29.43
6/7/06	2.7	19–29

MW-004D		
Date	TCE	Depth
2/27/98	7.8	59–69
3/2/98	9.62	59–69
3/2/98	2.37	59–69
3/4/98	<1	59–69
3/5/98	<1	59–69
4/28/98	10.11	59–69
8/8/02	8.2	59–69

MW-002		
Date	TCE	Depth
10/1/96	<0.5	17.16–27.16
12/16/97	<1	17.16–27.16
4/20/98	<1	17.16–27.16
7/23/02	<1	17.16–27.16

MW-003		
Date	TCE	Depth
10/1/96	<0.5	10.96–20.96
12/16/97	<1	10.96–20.96
4/20/98	<1	10.96–20.96
8/8/02	1.7 JD	10.96–20.96

MW-001		
Date	TCE	Depth
10/2/96	85.00	21.79–31.79
9/25/96	<0.5	23.16–33.16
12/16/97	<1	23.16–33.16
4/20/98	<1	23.16–33.16

MW-009		
Date	TCE	Depth
10/2/96	5.00	27.25–37.25
12/17/97	3.91	27.25–37.25
4/24/98	3.22	27.25–37.25
8/7/02	3.9 D	27.25–37.25
2/26/07	3.36	

2-HP-008		
Date	TCE	Depth
1/19/98	1.16	4.5–10

2-HP-009		
Date	TCE	Depth
1/20/98	<1	1.9–8

MW-010		
Date	TCE	Depth
12/17/97	110 D	21.79–31.79
4/24/98	58.77	21.79–31.79
8/7/02	71 D	21.79–31.79
8/24/04	45 D	21.79–31.79
9/7/04	27 D	21.79–31.79
9/16/04	15 D	21.79–31.79
9/30/04	14 D	21.79–31.79
1/4/05	9.1	21.79–31.79
2/26/07	8.71	

MW-010D		
Date	TCE	Depth
1/6/05	<1	46.5–56.5
2/24/98	<1	55–65
2/25/98	<1	55–65
2/26/98	<1	55–65
4/28/98	<1	55–65
8/7/02	<1	55–65
8/23/04	<1	46.5–56.5

2-HP-007		
Date	TCE	Depth
1/19/98	1.57	5.4–10

MW-013		
Date	TCE	Depth
4/28/98	2.39	27.5–37.5

MW40-102		
Date	TCE	Depth
10/14/96	<0.5	8.39–18.39
12/17/97	<1	8.39–18.39
4/21/98	<1	8.39–18.39

MW-011		
Date	TCE	Depth
3/11/98	<1	64.2–74.2
4/28/98	<1	64.2–74.2
7/22/02	<1	64.2–74.2
6/7/06	0.31 J	62–72

MW-006		
Date	TCE	Depth
9/30/96	<0.5	14.35–24.35
12/15/97	<1	14.35–24.35
4/21/98	<1	14.35–24.35

MW-005		
Date	TCE	Depth
10/2/96	0.79	22.5–32.5
12/17/97	<1	22.5–32.5
4/21/98	0.66 J	22.5–32.5
6/6/06	1.10	20–30

MW47-101		
Date	TCE	Depth
10/9/96	39.00	8–18
12/16/97	22.00	8–18
4/24/98	14.78	8–18
8/12/02	10.00	8–18
2/26/07	24.30	8–18

MW40-101		
Date	TCE	Depth
10/31/96	0.49	6.99–16.99
12/17/97	<1	6.99–16.99
4/21/98	<1	6.99–16.99

MW40-104		
Date	TCE	Depth
10/9/96	<0.5	6.57–16.57
12/17/97	<1	6.57–16.57
4/20/98	<1	6.57–16.57

MW-015D		
Date	TCE	Depth
7/26/01	1.00	45–85
7/31/01	2.70	85–125
8/7/01	0.6 J	125–165
7/22/02	1.00	145–165

MW47-102		
Date	TCE	Depth
10/9/96	38.00	8.44–18.44
12/16/97	34.00	8.44–18.44
4/24/98	22.73	8.44–18.44
8/12/02	19 D	8.44–18.44
2/26/07	22.70	8.44–18.44

2-HP-006		
Date	TCE	Depth
1/20/98	1.21	6.3–10

MW40-103		
Date	TCE	Depth
10/14/96	<0.5	6.35–16.35
12/17/97	<1	6.35–16.35
4/20/98	<1	6.35–16.35

2-HP-005		
Date	TCE	Depth
1/19/98	<1	5.7–10

LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER
- SANITARY SEWER
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER
- 10' SURFACE CONTOUR
- PAVED ROADWAY
- UNPAVED ROADWAY

TRICHLOROETHENE GROUNDWATER ISOPLETHS (µg/L):

OVERBURDEN AQUIFER:	BEDROCK AQUIFER:
1 – 25	1 – 25
25 – 50	
50 – 100	
>100	

LEGEND:

- MONITORING WELL
- HYDROPUNCH SAMPLE LOCATION

GENERAL DIRECTION OF GROUNDWATER FLOW:

OVERBURDEN AQUIFER:

BEDROCK AQUIFER:

SAMPLE ID

2-HP-003		
Date	TCE	Depth
1/19/98	<1	7.5–10

SAMPLE DATE — SAMPLE DEPTH IN FT.(BGS)

CONSTITUENT OF CONCERN CONCENTRATION IN GROUNDWATER (MICROGRAMS PER LITER (ug/L)) "<" NOT DETECTED AT AT DETECTION LIMIT INDICATED

J – ESTIMATED CONCENTRATION

D – DILUTE

0 100
SCALE: 1"=100'

NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.; MODIFIED AUGUST 2007.

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

TRICHLOROETHENE CONCENTRATIONS IN GROUNDWATER AT SITE 2

PICATINNY ARSENAL, NEW JERSEY

Project Number
GP06PICA.P008
Date
22 AUGUST, 2007
Figure
2

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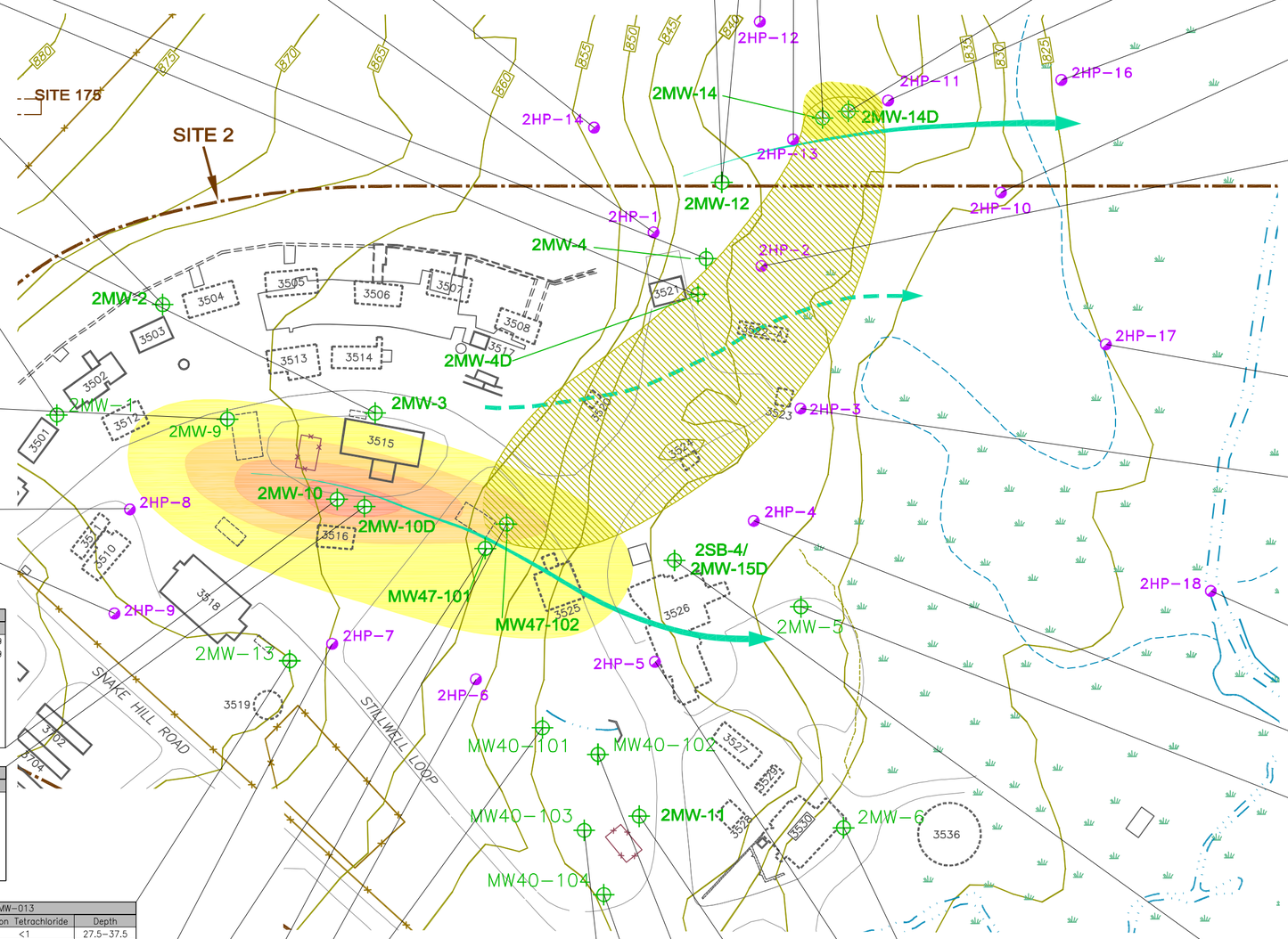

MW-004		
Date	Carbon Tetrachloride	Depth
9/26/96	<1	19.43–29.43
12/16/97	1.3	19.43–29.43
4/27/98	<1	19.43
8/8/02	0.77 J	19.43
6/7/06	<1	19–29

MW-004D		
Date	Carbon Tetrachloride	Depth
2/27/98	6.49	59–69
3/2/98	5.7	59–69
3/2/98	3.84	59
3/4/98	<1	59
3/5/98	<1	59
4/28/98	14.59	59
8/8/02	9.9	59

MW-002		
Date	Carbon Tetrachloride	Depth
10/1/1996	<0.58	17.16–27.16
12/16/1997	<1	17.16–27.16
4/20/1998	<1	17.16–27.16
7/23/2002	<1	17.16–27.16

MW-003		
Date	Carbon Tetrachloride	Depth
10/1/1996	<0.58	10.96–20.96
12/16/1997	<1	10.96–20.96
4/20/1998	1.67	10.96–20.96
8/8/2002	<3.3 D	10.96–20.96

MW-001		
Date	Carbon Tetrachloride	Depth
9/25/1996	0.74	23.16–33.16
10/2/1996	300	21.79–31.79
12/16/1997	<1	23.16–33.16
4/20/1998	<1	23.16–33.16

MW-009		
Date	Carbon Tetrachloride	Depth
10/2/1996	72	27.25–37.25
12/17/1997	50.24	27.25–37.25
4/24/1998	43.67	27.25–37.25
8/7/2002	67 D	27.25–37.25
2/26/2007	48.5	

2-HP-008		
Date	Carbon Tetrachloride	Depth
1/19/1998	<1	4.5–10

2-HP-009		
Date	Carbon Tetrachloride	Depth
1/20/1998	<1	1.9–8

MW-010		
Date	Carbon Tetrachloride	Depth
12/17/97	480 D	21.79–31.79
4/24/98	302 D	21.79–31.79
8/7/02	370 D	21.79
8/24/04	210 D	21.79
9/7/04	88 JD	21.79
9/16/04	47 D	21.79
9/30/04	35 D	21.79
1/4/05	36 D	21.79
2/26/07	81.4	

MW-010D		
Date	Carbon Tetrachloride	Depth
1/6/05	<1	46.5–56.5
2/24/98	<1	55–65
2/25/98	<1	55–65
2/26/98	<1	55
4/28/98	1.13	55
8/7/02	<1	55
8/23/04	<2	46.5–56.5

MW-013		
Date	Carbon Tetrachloride	Depth
4/28/1998	<1	27.5–37.5

2-HP-007		
Date	Carbon Tetrachloride	Depth
1/19/1998	<1	5.4–10

MW47-101		
Date	Carbon Tetrachloride	Depth
10/9/1996	70	8–18
12/16/1997	52	8–18
4/24/1998	44.9	8–18
8/12/2002	35	8–18
2/26/2007	131	

MW47-102		
Date	Carbon Tetrachloride	Depth
10/9/1996	93	8.44–18.44
12/16/1997	64	8.44–18.44
4/24/1998	85.98	8.44–18.44
8/12/2002	58 D	8.44–18.44
2/26/2007	100	

2-HP-014		
Date	Carbon Tetrachloride	Depth
2/11/1998	<1	5.2–10

2-HP-001		
Date	Carbon Tetrachloride	Depth
1/20/1998	3.33	4.6–10

2-HP-012		
Date	Carbon Tetrachloride	Depth
2/10/1998	<1	7.9–10

MW-012		
Date	Carbon Tetrachloride	Depth
4/27/1998	<1	18–28
8/12/2002	<1	18–28

2-SB-002		
Date	Carbon Tetrachloride	Depth
3/25/1998	0.58	37–77
3/26/1998	<1	79–119
3/27/1998	2.75	121–161

2-HP-013		
Date	Carbon Tetrachloride	Depth
2/11/1998	<1	8.8–10

MW-014		
Date	Carbon Tetrachloride	Depth
7/22/02	43 D	46.5–56.5
6/6/06	31 D	48–58
2/26/07	59	

MW-014D		
Date	Carbon Tetrachloride	Depth
7/22/02	6.5	175–195
6/6/06	1	190–200

2-HP-011		
Date	Carbon Tetrachloride	Depth
2/10/1998	<1	10–12

2-HP-016		
Date	Carbon Tetrachloride	Depth
11/13/2001	1.7 J	0–2

2-HP-010A		
Date	Carbon Tetrachloride	Depth
2/10/1998	<1	9.6–13

2-HP-002		
Date	Carbon Tetrachloride	Depth
1/20/1998	<1	3.7–10

2-HP-017		
Date	Carbon Tetrachloride	Depth
11/28/2001	<25 D	0–2

2-HP-003		
Date	Carbon Tetrachloride	Depth
1/19/1998	<1	7.5–10

2-HP-018		
Date	Carbon Tetrachloride	Depth
11/13/2001	<1 J	0–2

2-HP-004		
Date	Carbon Tetrachloride	Depth
1/19/1998	<1	2.2–10

MW-005		
Date	Carbon Tetrachloride	Depth
6/6/2006	<1	20–30
10/2/1996	<0.58	22.5–32.5
12/17/1997	<1	22.5–32.5
4/21/1998	<1	22.5–32.5

MW-006		
Date	Carbon Tetrachloride	Depth
9/30/1996	<0.58	14.35–24.35
12/15/1997	<1	14.35–24.35
4/21/1998	<1	14.35–24.35

MW-015D		
Date	Carbon Tetrachloride	Depth
7/26/2001	0.13 J	45–85
7/31/2001	0.44 J	85–125
8/7/2001	<1	125–165
7/22/2002	<1	145–165

2-HP-005		
Date	Carbon Tetrachloride	Depth
1/19/1998	<1	5.7–10

MW-011		
Date	Carbon Tetrachloride	Depth
3/11/1998	<1	64.2–74.2
4/28/1998	<1	64.2–74.2
7/22/2002	<1	64.2–74.2
6/7/2006	<1	62–72

MW40-101		
Date	Carbon Tetrachloride	Depth
10/31/1996	<0.58	6.99–16.99
12/17/1997	<1	6.99–16.99
4/21/1998	<1	6.99–16.99

MW40-103		
Date	Carbon Tetrachloride	Depth
10/14/1996	<0.58	6.35–16.35
12/17/1997	<1	6.35–16.35
4/20/1998	<1	6.35–16.35

2-HP-006		
Date	Carbon Tetrachloride	Depth
1/20/1998	<1	6.3–10

MW40-104		
Date	Carbon Tetrachloride	Depth
10/9/1996	<0.58	6.57–16.57
12/17/1997	<1	6.57–16.57
4/20/1998	<1	6.57–16.57

MW40-102		
Date	Carbon Tetrachloride	Depth
10/14/1996	<0.58	8.39–18.39
12/17/1997	<1	8.39–18.39
4/21/1998	<1	8.39–18.39

LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER
- SANITARY SEWER
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER
- 10' SURFACE CONTOUR
- PAVED ROADWAY
- UNPAVED ROADWAY

CARBON TETRACHLORIDE GROUNDWATER ISOPLETHS (µg/L):

OVERBURDEN AQUIFER:
- 2 – 50
- 50 – 100
- 100 – 200
- >200

BEDROCK AQUIFER:
- 2 – 50

LEGEND:

- MONITORING WELL
- HYDROPUNCH SAMPLE LOCATION

GENERAL DIRECTION OF GROUNDWATER FLOW:

OVERBURDEN AQUIFER:

BEDROCK AQUIFER:

SAMPLE ID

2-HP-014		
Date	Carbon Tetrachloride	Depth
2/11/1998	<1	5.2–10

SAMPLE DATE

CONSTITUENT OF CONCERN CONCENTRATION IN GROUNDWATER (MICROGRAMS PER LITER (ug/L)) "<" NOT DETECTED AT AT DETECTION LIMIT INDICATED

SAMPLE DEPTH IN FT.(BGS)

J – ESTIMATED CONCENTRATION

D – DILUTE

0 100
SCALE: 1"=100'

NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.; MODIFIED AUGUST 2007.

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

CARBON TETRACHLORIDE CONCENTRATIONS IN GROUNDWATER AT SITE 2

PICATINNY ARSENAL, NEW JERSEY

Project Number: GP06PICA.P008

Date: 22 OCTOBER, 2009

Figure: 3

Path\Name: G:\Projects\Picatinny\Site Technical\PICA 008 Inactive Rocket Test Area\RDD\Draft - 10_2009\Figures\VTC-03 - RDD.dwg
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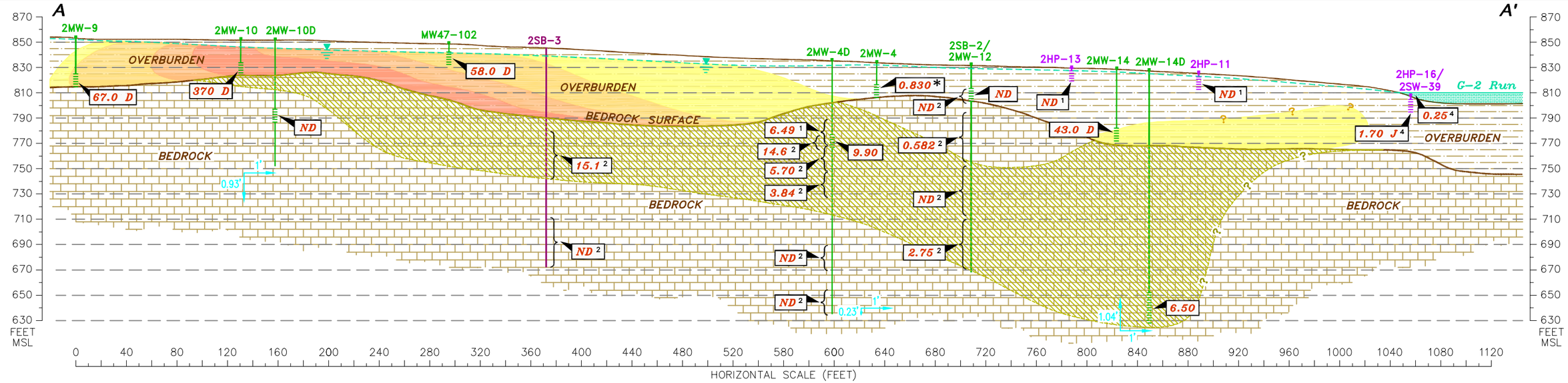
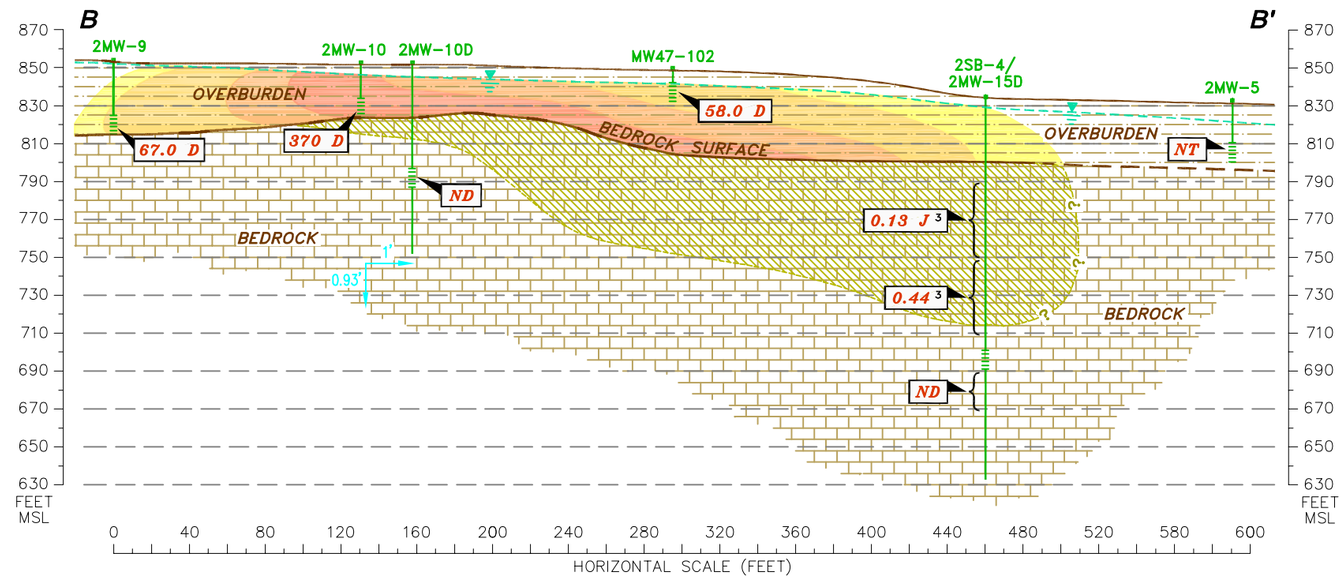
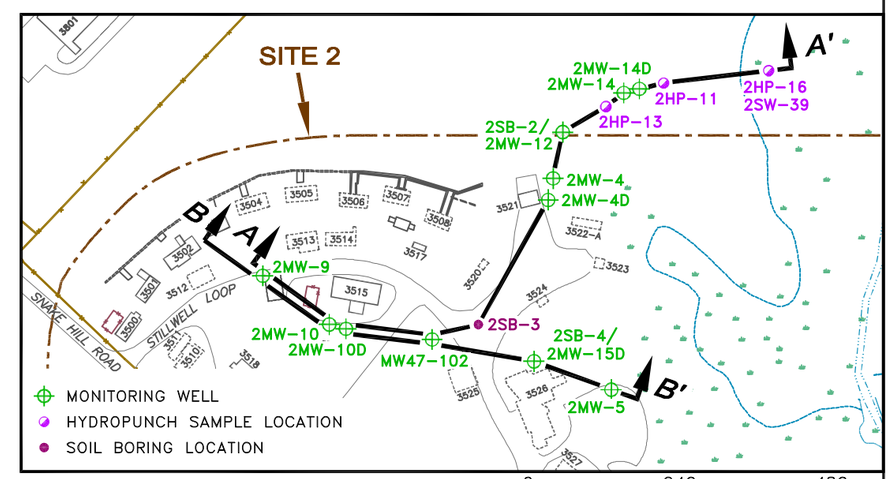


GEOLOGIC CROSS SECTION A-A' WITH CARBON TETRACHLORIDE PLUME - SUMMER 2002



GEOLOGIC CROSS SECTION B-B' WITH CARBON TETRACHLORIDE PLUME - SUMMER 2002



KEY PLAN

LEGEND:

GROUNDWATER MONITORING LOCATION

SCREEN INTERVAL

J = ESTIMATED CONCENTRATION

D = DILUTE

XXX CARBON TETRACHLORIDE CONCENTRATION IN GROUNDWATER (ug/L)

ND = NOT DETECTED

NT = NOT TESTED FOR ANALYTE

* RESULT SHOWN IS THE AVERAGE OF ORIGINAL AND DUPLICATE SAMPLES

1' 0.93' GROUNDWATER FLOW VECTORS RESOLVED INTO VERTICAL AND HORIZONTAL HYDRAULIC COMPONENTS. VECTORS COMPUTED BASED ON MEASUREMENTS TAKEN FROM THE BEDROCK/OVERBURDER MONITORING WELL PAIRS UNDER WHICH THEY APPEAR.

CARBON TETRACHLORIDE GROUNDWATER ISOPLETHS (µg/L):

OVERBURDEN AQUIFER:

- 2 – 50
- 50 – 100
- 100 – 200
- >200

BEDROCK AQUIFER:

- 2 – 50

NOTES:

1. CARBON TETRACHLORIDE CONCENTRATIONS SHOWN ARE FROM SUMMER 2002 SAMPLING SEASON EXCEPT WHERE OTHERWISE NOTED.
   - 1 WINTER 1997/1998 SAMPLING EVENT
   - 2 SPRING 1998 SAMPLING EVENT
   - 3 SUMMER 2001 SAMPLING EVENT
   - 4 FALL 2001 SAMPLING EVENT

NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

A-A' & B-B' GEOLOGIC CROSS SECTIONS WITH CARBON TETRACHLORIDE PLUME AT SITE 2 SUMMER 2002

PICATINNY ARSENAL, NEW JERSEY

Project Number	GP06PICA.P008
Drawing Date	22 OCTOBER, 2007
Figure	4

Path\Name: G:\Projects\Picatinny\Site Technical\PICA 008 Inactive Rocket Test Area\ROD\Draft - 10_2009\Figures\FIG-04 - ROD.dwg
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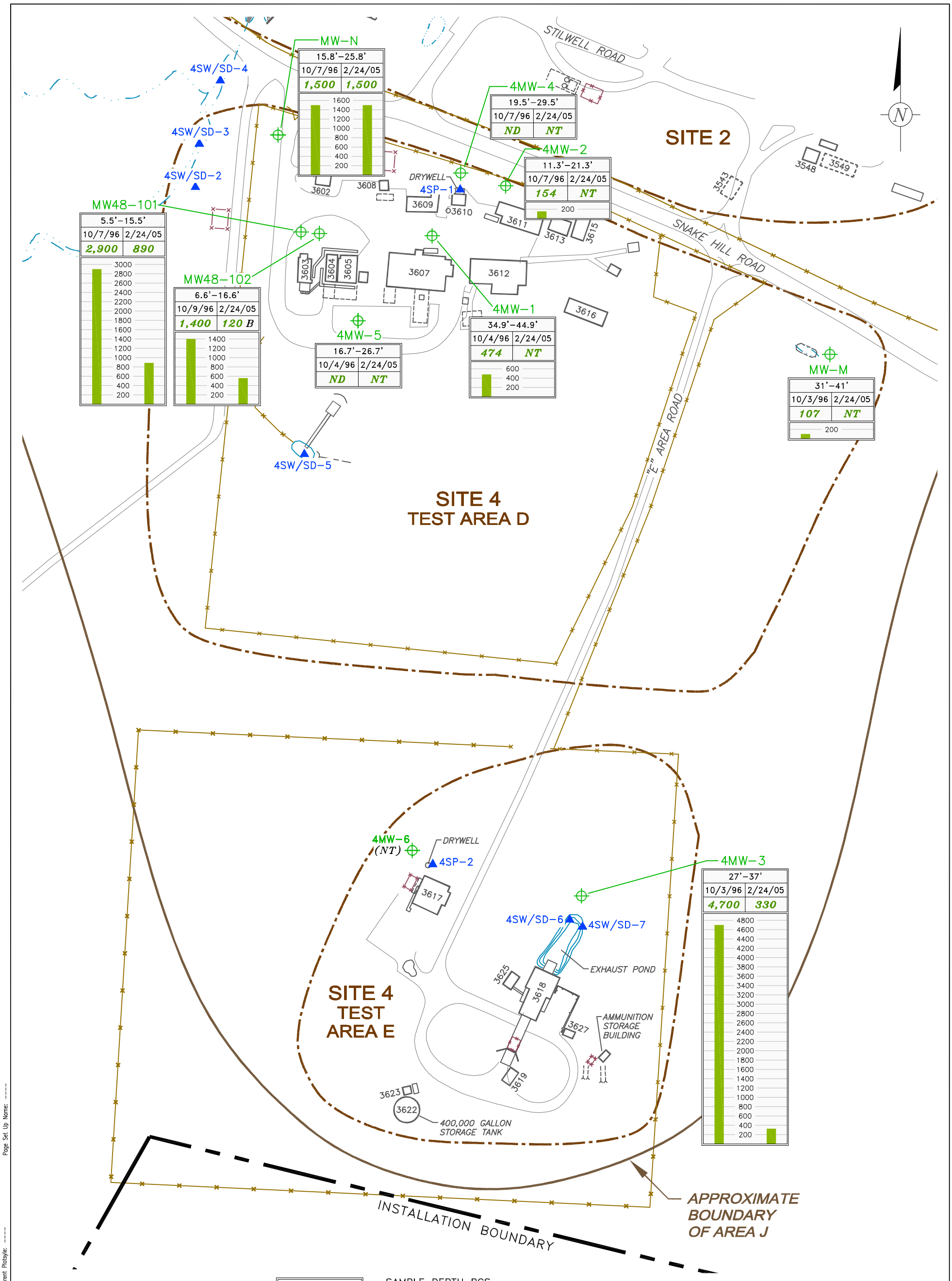

LEGEND:

- MONITORING WELL
- SURFACE WATER / SEDIMENT SAMPLE LOCATION

6.6'-16.6' — SAMPLE DEPTH BGS
10/7/96 2/24/05 — SAMPLE DATE
1,400 570 — AMMONIA CONCENTRATION IN GROUNDWATER (µg/L)
(ND = NOT DETECTED)
(B = ESTIMATED RESULT, RESULT IS LESS THAN REPORTING LIMIT)
(NT = NOT TESTED FOR ANALYTE)

0 125
SCALE: 1"=125'

NOTES:
1. LOC FOR AMMONIA IS 3,000 µg/L. (NJDEP N.J.A.C. 7:9C, SEPTEMBER 2004)

NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

SITE 4 AMMONIA ATTENUATION IN GROUNDWATER

PICATINNY ARSENAL, NEW JERSEY

Project Number: GP06PICA.P008
Drawing Date: 22 OCTOBER, 2009
Figure: 5

Path\Name: G:\Projcts\Picatinny\Site Technical\PICA 008 Inactive Rocket Test Area\ROD\Draft - 10_2009\Figures\FIG-05 - ROD.dwg
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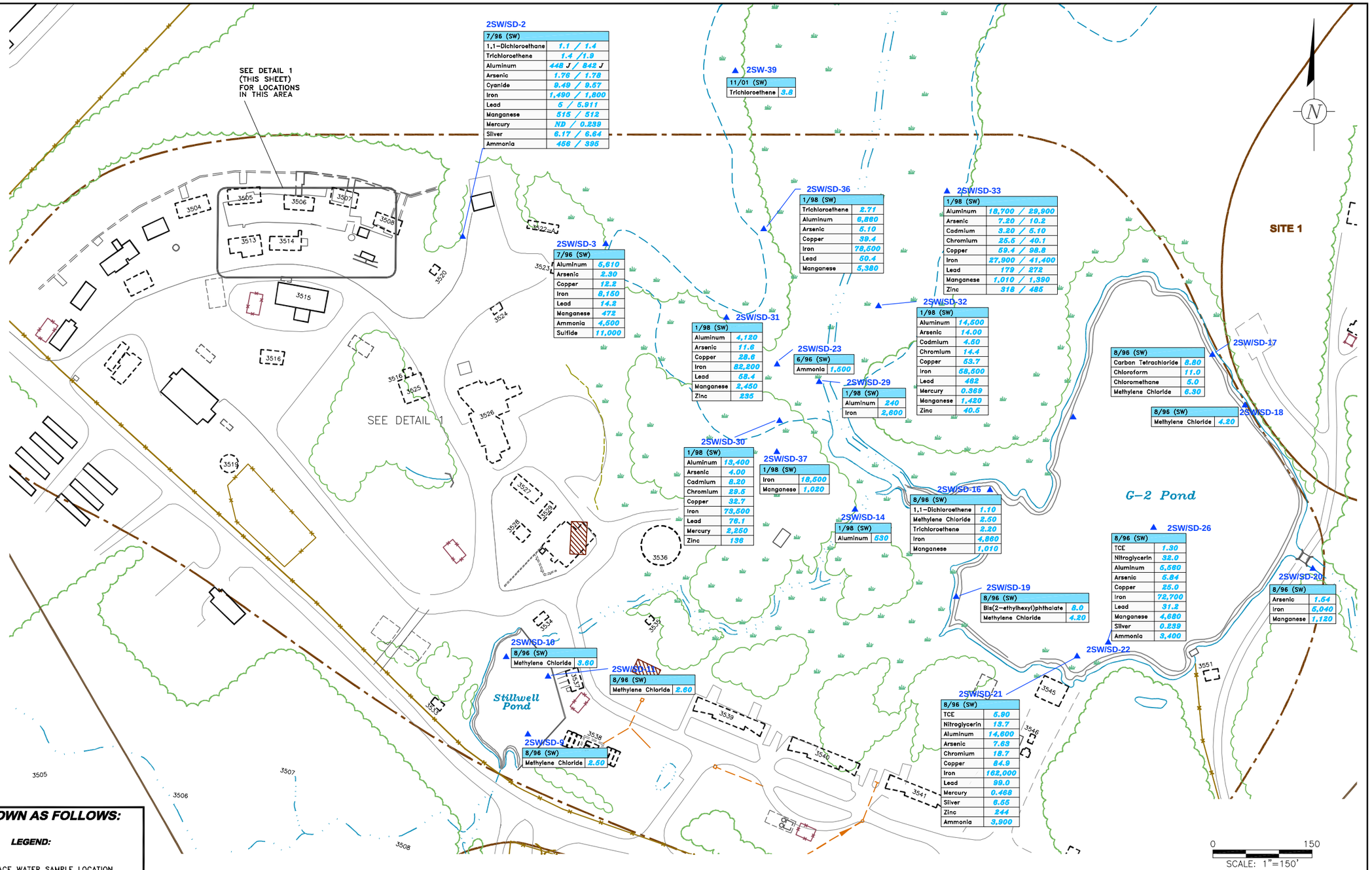
User Name: Goforth, John

SUMMARY OF CONSTITUENTS DETECTED ABOVE LOC IN SURFACE WATER

SURFACE WATER (μg/L)	
Chemical	**LOC**
Volatiles	
Carbon tetrachloride	0.25
Chloroform	5.67
Chloromethane	2.1
Methylene Chloride	2.49
Trichloroethene	1.09
Semivolatiles	
bis(2-ethylhexyl)phthalate	1.76
Inorganics	
Arsenic	1.38
Cadmium	2.4
Chromium	11.4
Copper	9.4
Cyanide	5.2
Iron	1,790
Lead	3.2
Manganese	383
Murcury	0.05
Selenium	5
Silver	4
Zinc	122
Anions	
Ammonia	88
Sulfide	2,200
Explosives	
Nitroglycerin	4.8



NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.

LOC EXCEEDANCES ARE SHOWN AS FOLLOWS:

SURFACE WATER:

SAMPLE DATE	
Potential Concern	*Sample Result (μg/L)*

LEGEND:

▲ SURFACE WATER SAMPLE LOCATION

J ESTIMATED CONCENTRATION

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

SITE 2 - BUILDINGS 3500-3551, REACTION MOTORS, ROCKET TEST AREAS A, B, AND C
LOC EXCEEDANCES IN SURFACE WATER

PICATINNY ARSENAL, NEW JERSEY

Project Number: GP06PICA.P008

Drawing Date: 22 OCTOBER, 2009

Figure: 6

Path\Name: G:\Projs\Picatinny\Site Technical\PICA 008 Inactive Rocket Test Area\R00\Draft - 10_2009\Figures\F6-06 - R00.dwg
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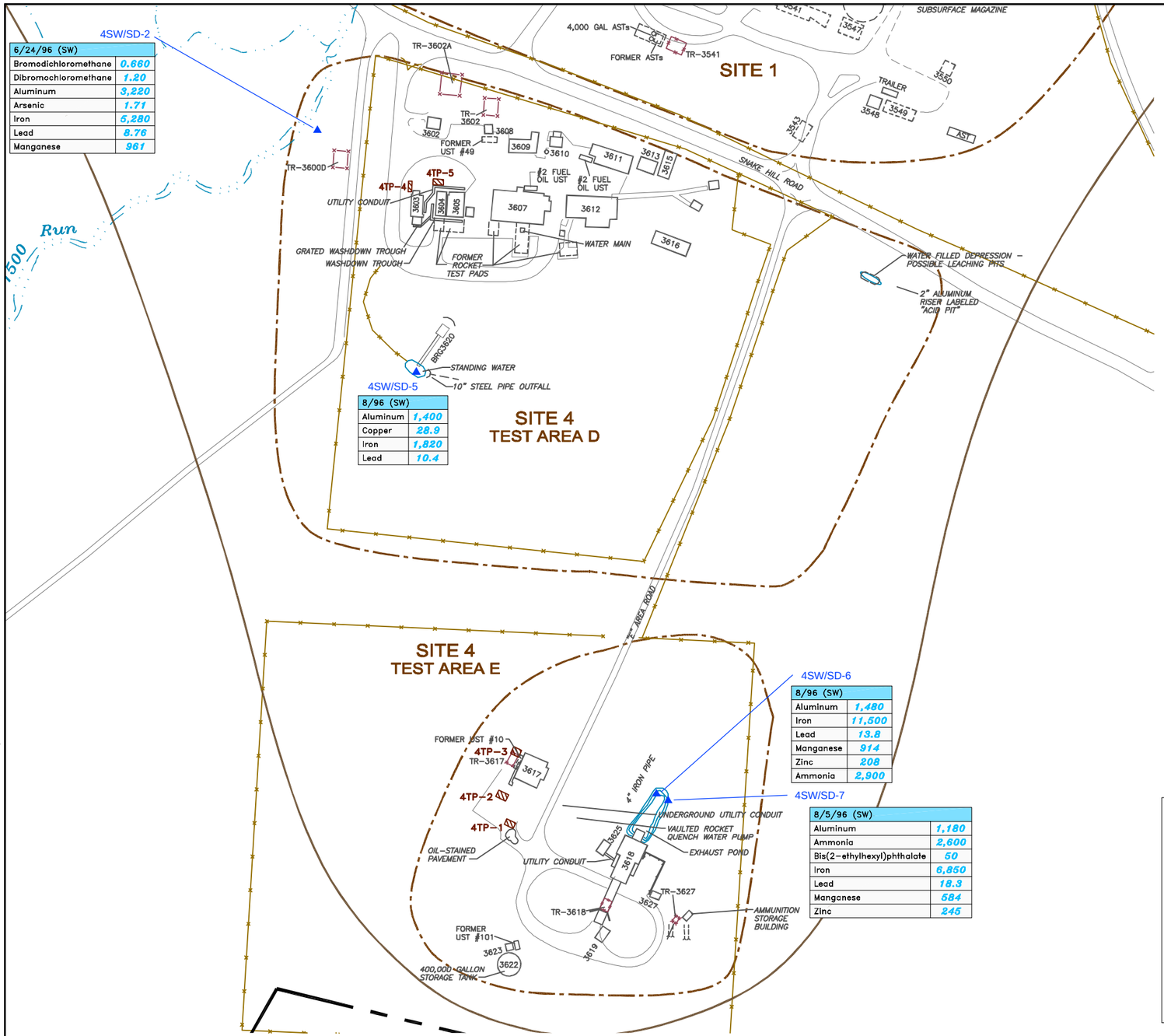

SUMMARY OF CONSTITUENTS DETECTED ABOVE LOC IN SURFACE WATER

SURFACE WATER (µg/L)	
Chemical	LOC
Semivolatiles	
bis(2-ethylhexyl)phthalate	1.76
Inorganics	
Aluminum	190
Arsenic	1.38
Copper	9.4
Iron	1,790
Lead	3.2
Manganese	383
Zinc	122
Anions	
Ammonia	88

LOC EXCEEDANCES ARE SHOWN AS FOLLOWS:

SURFACE WATER:

SAMPLE DATE	
Constituent	Sample Result (µg/L)

LEGEND

RAILROAD
TREE LINE
FENCE
TRANSFORMER (TR-732)
BLAST WALL
STORM SEWER (STS)
SANITARY SEWER (SS)
EARTH MOUND
BUILDING
FORMER BUILDING
COVERED WALKWAY
SWAMP
WATER
10' SURFACE CONTOUR
PAVED ROADWAY
UNPAVED ROADWAY
SURFACE WATER SAMPLE LOCATION
TEST PIT

0 175
SCALE: 1"=175'

NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

SITE 4 - BUILDING 3600 SERIES TEST AREAS D & E LOC EXCEEDANCES IN SURFACE WATER

PICATINNY ARSENAL, NEW JERSEY

Project Number: GP06PICA.P008
Drawing Date: 22 OCTOBER, 2009
Figure: 7

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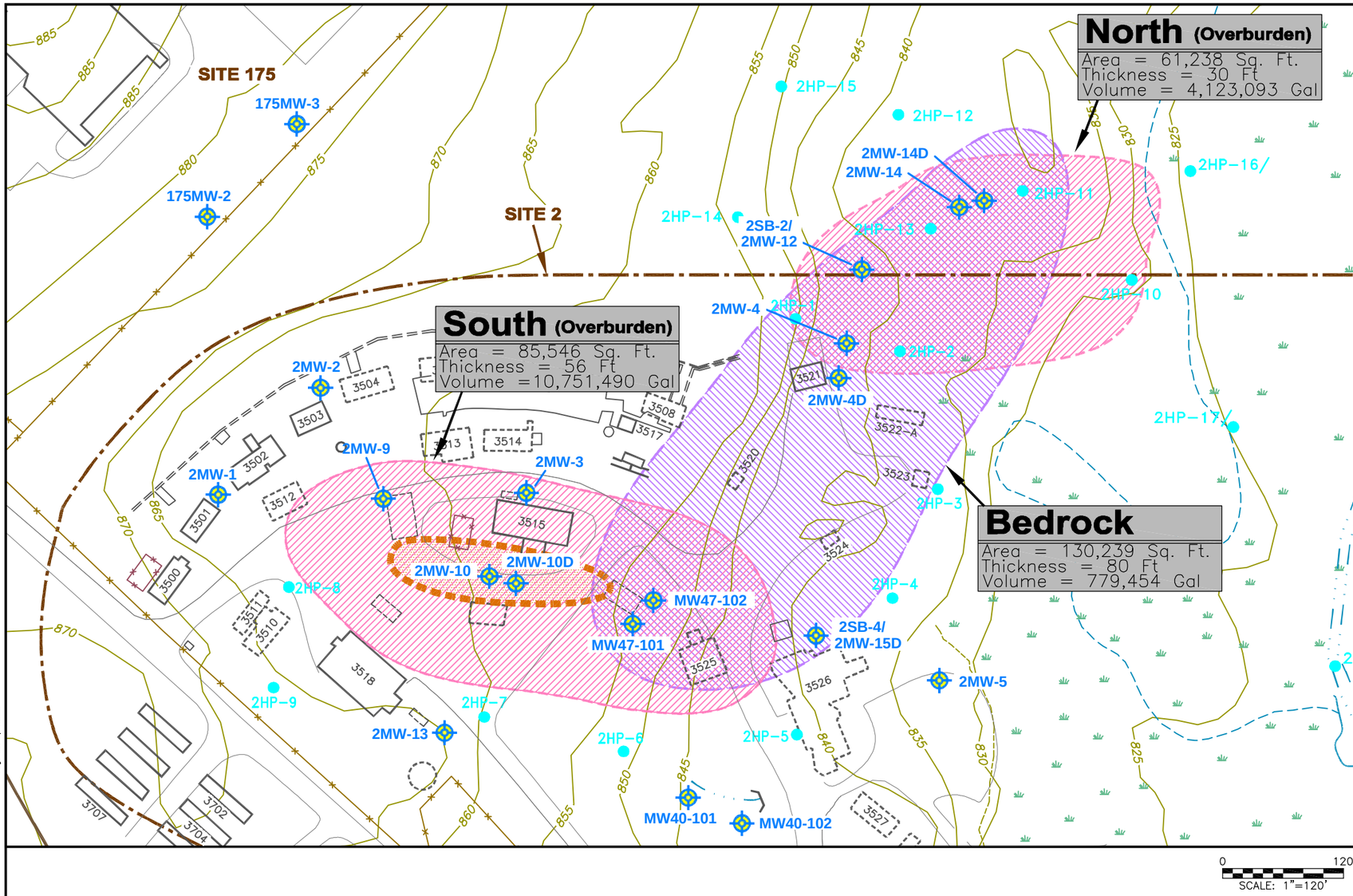

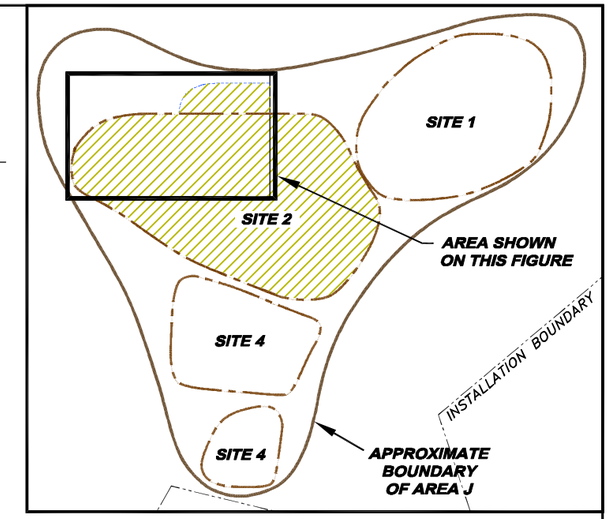

KEY PLAN

0 1000 2000
SCALE FEET

LEGEND:

- EXISTING MONITORING WELL
- Hydropunch Locations
- GROUNDWATER CONTAMINATION IN THE OVERBURDEN
- GROUNDWATER CONTAMINATION IN THE BEDROCK AQUIFER
- CARBON TETRACHLORIDE IN GROUNDWATER HOT SPOT (CONCENTRATION EXCEEDING 100 $\mu g/L$)
- AREA OF LUC APPLICABILITY (SHOWN IN KEY PLAN VIEW ONLY)

NOTES:

1. FOR THIS ALTERNATIVE, PROPOSED REMEDIAL ACTION FOR ALL OVERBURDEN AND BEDROCK PLUMES INCLUDES IMPLEMENTATION OF LUCs.

NOTE: ORIGINAL DRAWING BY SHAW ENVIRONMENTAL, INC.

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

GROUNDWATER PLUME MAP

PICATINNY ARSENAL, NEW JERSEY

Project Number
GP06PICA.P008

Drawing Date
16 MAY, 2007

Figure
8

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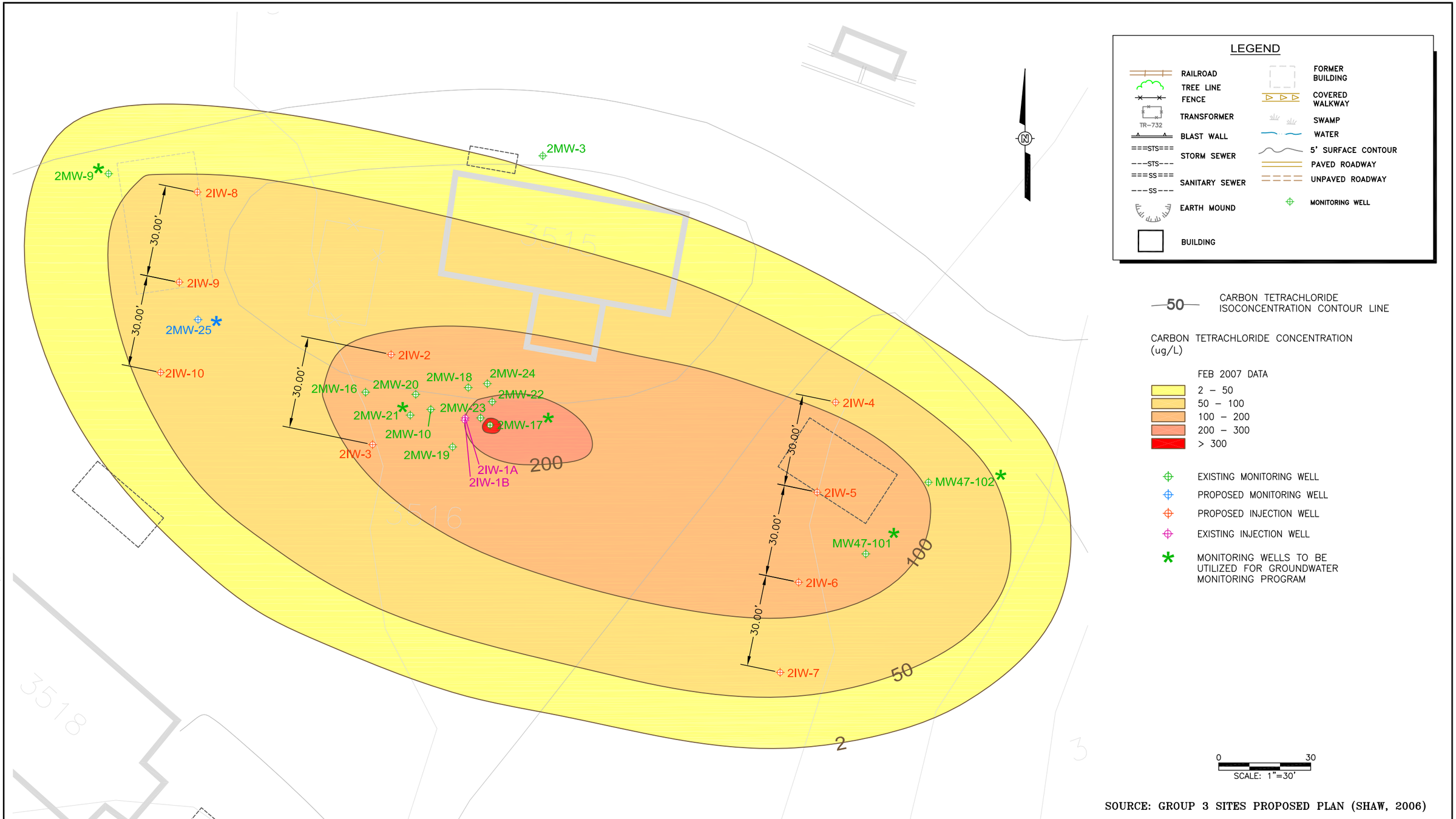

SOURCE: GROUP 3 SITES PROPOSED PLAN (SHAW, 2006)

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

SOUTHERN EVO-IRZ BARRIER AND INJECTION WELL LAYOUT

PICATINNY ARSENAL, NEW JERSEY

Project Number	GP06PICA.P008
Drawing Date	7 JUNE, 2010
Figure	9A

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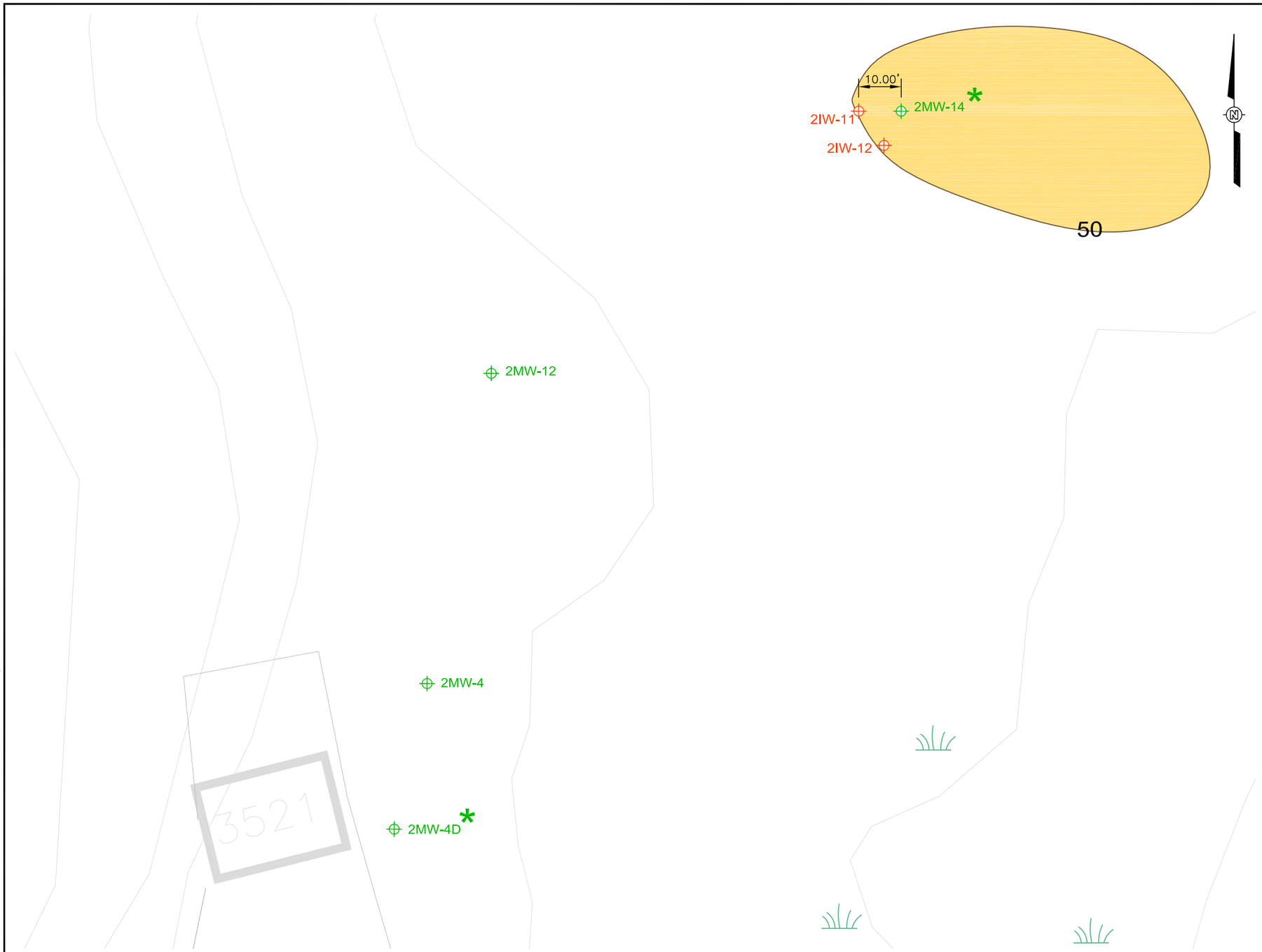

LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER (===STS===, ---STS---)
- SANITARY SEWER (===SS===, ---SS---)
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER
- 5' SURFACE CONTOUR
- PAVED ROADWAY
- UNPAVED ROADWAY
- MONITORING WELL

—50— CARBON TETRACHLORIDE ISOCONCENTRATION CONTOUR LINE

CARBON TETRACHLORIDE CONCENTRATION (ug/L)

FEB 2007 DATA

2 – 50

EXISTING MONITORING WELL

PROPOSED INJECTION WELL

* MONITORING WELLS TO BE UTILIZED FOR GROUNDWATER MONITORING PROGRAM

0 25
SCALE: 1"=25'

SOURCE: GROUP 3 SITES PROPOSED PLAN (SHAW, 2006)

RECORD OF DECISION FOR GROUP 3 SITES
(PICA 008)

NORTHERN EVO-IRZ BARRIER AND INJECTION WELL LAYOUT

PICATINNY ARSENAL, NEW JERSEY

Project Number	GP06PICA.P008
Drawing Date	7 JUNE, 2010
Figure	9B

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Appendix A

Certificate of Publication for
Public Notices

PUBLIC NOTICE

U.S. ARMY INVITES PUBLIC COMMENT ON PROPOSED PLANS FOR GROUP 3 SITES (PICA 008) AND GROUP 1 SITES (PICA 079) & PUBLIC INVITED TO RESTORATION ADVISORY BOARD MEETING

The U.S. Army at Picatinny Arsenal (Picatinny) invites the public to comment on the Proposed Plans addressing contaminated groundwater at the Picatinny Arsenal Group 3 Sites (PICA 008) and contaminated soil and groundwater at Group 1 Sites (PICA 079). The Group 3 Sites are located in the northeastern portion of Picatinny, and the Group 1 Sites are located in the central portion. The Proposed Plans are summarized below.

PROPOSED PLAN FOR GROUP 3 SITES (PICA 008)

GROUP 3 SITES (PICA 008) Proposed Action

The Group 3 Sites (Sites 1, 2, and 4) encompass approximately 40 acres on the northeastern boundary of Picatinny Arsenal. The sites have been used for a variety of activities since the 1950s. These uses mainly include various forms of rocket testing at all three sites, rocket fuel development and engine re-design, small mine testing, Ballistic Rail Gun operations, and ordnance disassembly. Today, Site 1 is inactive and contains debris from past demolition activities. Test areas within Site 2 are inactive and the buildings are used for homeland security training. Test Area D located at Site 4 is still active, while Test Area E has remained inactive for over 30 years. The Army has conducted comprehensive environmental investigations at the Sites. Low to moderate levels of chemical contamination have been identified in soil, surface water, sediment and groundwater. The Proposed Plan for Group 3 Sites only addresses groundwater contamination and subsequent surface water contamination. Sediment and soil will be addressed in subsequent documents for Picatinny. Human health and ecological risk assessments indicated that a Response Action will be required to protect both human and ecological receptors at Group 3 Sites.

GROUP 3 SITES (PICA 008) Alternatives Evaluated

The Army, the U.S. Environmental Protection Agency, and the New Jersey Department of Environmental Protection evaluated the following alternatives for groundwater at the Group 3 Sites:

Alternative GW-1: No Action.
Alternative GW-2: Implementation and maintenance of land use controls (LUCs) including existing groundwater-use restrictions, emergency provisions, and long-term groundwater monitoring.
Alternative GW-3: Air sparging/soil vapor extraction (AS/SVE), LUCs, and long-term groundwater monitoring.
Alternative GW-4: Pump and treat using air stripping and long-term groundwater monitoring.
Alternative GW-5: Nano-scale Zero Valent Iron (ZVI) Injection, LUCs, and long-term groundwater monitoring.
Alternative GW-6: In-Situ Enhanced Bioremediation, LUCs, and long-term groundwater monitoring.

GROUP 3 SITES (PICA 008) Preferred Response Action

Alternative GW-6 is the Preferred Response Action for groundwater at Group 3 Sites. This Alternative provides an optimum balance between the selection criteria and is protective of human health and the environment. The Preferred Response Action may be modified or a new Alternative may be developed based on public input. The final Response Action selected will be documented in a Record of Decision that summarizes the decision-making process. The Army will summarize and respond to comments received during the comment period as part of the Record of Decision.

PROPOSED PLAN FOR GROUP 1 SITES (PICA 079)

GROUP 1 SITES (PICA 079) Proposed Action

The Group 1 Sites consist of approximately 4 acres on the western side of Picatinny Lake in the center of Picatinny Arsenal. The sites have been used for a variety of activities since 1930. These uses included assembly and production of explosives during WWI and WWII; ammunitions tear-down, stability testing, inspection and storage; and wastewater treatment. Today, these ten buildings, known as the melt load line or completed rounds division, still make up the Group 1 Sites and are currently used for explosives-contaminated wastewater treatment, melt-pour research, remote automated controls, ammunition repack and surveillance, and light industrial storage. Most of the Group 1 Sites are paved or covered in gravel. The Army conducted comprehensive environmental investigations at the site. Various chemicals, explosives, and metals have been detected at elevated levels in the surface soils, sub-surface soils, and groundwater within Group 1 Sites. Human health and ecological risk assessments showed potential impacts to human health, soil invertebrates, and terrestrial plants. Sediments and surface water are being addressed as part of Picatinny Lake (PICA 057).

GROUP 1 SITES (PICA 079) Alternatives Evaluated

The Army, the U.S. Environmental Protection Agency, and the New Jersey Department of Environmental Protection evaluated the following alternatives:

Explosives in Soil

Alternative S1-1: No Action.
Alternative S1-2: Excavation and on-site treatment by composting.
Alternative S1-3: Excavation and on-site treatment by slurry-bioreactor.
Alternative S1-4: Excavation and on-site treatment by enhanced bioremediation (Daramend®).
Alternative S1-5: Excavation and off-site disposal.

Arsenic and PAHs in Soil

Alternative S2-1: No Action.
Alternative S2-2: Institutional Controls.
Alternative S2-3: Installation of a soil cover and revegetation.
Alternative S2-4: Installation of an asphalt cover.
Alternative S2-5: Excavation and off-site disposal.

PCBs in Soil

Alternative S3-1: No Action.
Alternative S3-2: Institutional Controls.
Alternative S3-3: Excavation and off-site disposal.

Groundwater

Alternative GW-1: No Action.
Alternative GW-2: Continued implementation of Institutional Controls and Monitored Natural Attenuation (MNA).
Alternative GW-3: Pump and treat using carbon treatment, MNA, and continued implementation of Institutional Controls.
Alternative GW-4: Pump and treat using ultraviolet/chemical oxidation, MNA, and continued implementation of Institutional Controls.
Alternative GW-5: Pump and treat using bioreactor treatment, MNA, and continued implementation of Institutional Controls.
Alternative GW-6: Pneumatic fracturing and liquid atomized injection of zero valent iron, MNA, and continued implementation of Institutional Controls.
Alternative GW-7: Nano-scale zero valent iron injection, MNA, and continued implementation of Institutional Controls.
Alternative GW-8: Enhanced anaerobic bioremediation by injection of microbial growth substrate (i.e., hydrogen release compound [HRC®], emulsified oil substrate [EOS®], sodium lactate), MNA, and continued implementation of Institutional Controls.

GROUP 1 SITES (PICA 079) Preferred Response Action

A combination of Alternatives S1-5, S2-2, S3-2, and GW-2, is the Preferred Response Action. This combination of Alternatives provides an optimum balance between the selection criteria and is protective of human health and the environment. The Preferred Response Action may be modified or a new Alternative may be developed based on public input. The final Response Action selected will be documented in a Record of Decision that summarizes the decision-making process. The Army will summarize and respond to comments received during the comment period as part of the Record of Decision.

PUBLIC MEETING

The Army invites the public to attend a meeting on **Thursday, October 29, 2009, 6 p.m., Hilton Garden Inn** (near the Rockaway Townsquare Mall), 375 Mt. Hope Avenue, Rockaway, NJ 07866. The meeting location is wheelchair accessible. A meeting of Picatinny's Environmental Restoration Advisory Board will follow the Proposed Plan meeting, and the public is also invited to attend the Board meeting.

WRITTEN COMMENTS

Copies of the Remedial Investigations, the Feasibility Studies, and the Pre-Design Technical Memoranda are available for public review at the Environmental Affairs Directorate at Picatinny by contacting Mr. Ted Gabel at (973) 724-6748 in advance. Starting October 29, 2009, a copy of the Proposed Plans for Group 3 and Group 1 Sites are available for review at the Rockaway Township Library (61 Mount Hope Road) and Morris County Library (30 East Hanover Avenue, Whippany). The public may submit written comments during the 30-day comment period (October 29 to November 28, 2009). Comments must be postmarked by November 28 and sent to Mr. Ted Gabel, Environmental Affairs Office, U.S. Army Installation Management Agency, Northeast Regional Garrison Office, Building 319, Picatinny, NJ, 07806.

$1,827.36

STATE OF NEW JERSEY } SS
COUNTY OF ESSEX

Lauren Kincaid

Being duly sworn, according to law, on his/her oath sayeth that he/she is CLERK of the Star-Ledger, in said County of Essex, and that the notice, of which the attached is a copy, was published in said paper on the 16th day of October 2009 and continued therein for _____ successively, at least once in each _____ for 1 day

Lauren Kincaid

Sworn to and subscribed before me this 5th day of January, 2010

Patricia D Holley
NOTARY PUBLIC of NEW JERSEY

Affidavit of Publication

Publisher's Fee $135.27 Affidavit $35.00

State of New Jersey } SS.

Morris County

Personally appeared **Dayna Carlo**

Of the **Daily Record,** a newspaper printed in Secaucus, New Jersey and published in Parsippany, in said County and State, and of general circulation in said county, who being duly sworn, deposeth and saith that the advertisement of which the annexed is a true copy, has been published in the said newspaper 1 times, once in each issue as follows:

10/16/09

SHARON L. BECKETT
NOTARY PUBLIC OF NEW JERSEY
MY COMMISSION EXPIRES APRIL 14, 2013

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Sworn and subscribed before me, this **16** day of **October, 2009**

Notary Public of New Jersey

UNITED STATES

PUBLIC NOTICE

U.S. ARMY INVITES PUBLIC COMMENT ON PROPOSED PLANS FOR GROUP 3 SITES (PICA 008) AND GROUP 1 SITES (PICA 079) & PUBLIC INVITED TO RESTORATION ADVISORY BOARD MEETING

The U.S. Army at Picatinny Arsenal (Picatinny) invites the public to comment on the Proposed Plans addressing contaminated groundwater at the Picatinny Arsenal Group 3 Sites (PICA 008) and contaminated soil and groundwater at Group 1 Sites (PICA 079). The Group 3 Sites are located in the northeastern portion of Picatinny, and the Group 1 Sites are located in the central portion. The Proposed Plans are summarized below.

PROPOSED PLAN FOR GROUP 3 SITES (PICA 008)

GROUP 3 SITES (PICA 008) Proposed Action

The Group 3 Sites (Sites 1, 2, and 4) encompass approximately 40 acres on the northeastern boundary of Picatinny Arsenal. The sites have been used for a variety of activities since the 1950s. These uses mainly include various forms of rocket testing at all three sites, rocket fuel development and engine re-design, small mine testing, Ballistic Rail Gun operations, and ordnance disassembly. Today, Site 1 is inactive and contains debris from past demolition activities. Test areas within Site 2 are inactive and the buildings are used for homeland security training. Test Area D located at Site 4 is still active, while Test Area E has remained inactive for over 30 years. The Army has conducted comprehensive environmental investigations at the Sites. Low to moderate levels of chemical contamination have been identified in soil, surface water, sediment and groundwater. The Proposed Plan for Group 3 Sites only addresses groundwater contamination and subsequent surface water contamination. Sediment and soil will be addressed in subsequent documents for Picatinny. Human health and ecological risk assessments indicated that a Response Action will be required to protect both human and ecological receptors at Group 3 Sites.

GROUP 3 SITES (PICA 008) Alternatives Evaluated

The Army, the U.S. Environmental Protection Agency, and the New Jersey Department of Environmental Protection evaluated the following alternatives for groundwater at the Group 3 Sites: Alternative GW-1: No Action.

Alternative GW-2: Implementation and maintenance of land use controls (LUCs) including existing groundwater-use restrictions, emergency provisions, and long-term groundwater monitoring.

Alternative GW-3: Air sparging/soil vapor extraction (AS/SVE), LUCs, and long-term groundwater monitoring.

Alternative GW-4: Pump and treat using air stripping and long-term groundwater monitoring.

Alternative GW-5: Nano-scale Zero Valent Iron (ZVI) Injection, LUCs, and long-term groundwater monitoring.

Alternative GW-6: In-Situ Enhanced Bioremediation, LUCs, and long-term groundwater monitoring.

GROUP 3 SITES (PICA 008) Preferred Response Action

Alternative GW-6 is the Preferred Response Action for groundwater at Group 3 Sites. This Alternative provides an optimum balance between the selection criteria and is protective of human health and the environment. The Preferred Response Action may be modified or a new Alternative may be developed based on public input. The final Response Action selected will be documented in a Record of Decision that summarizes the decision-making process. The Army will summa-

rize and respond to comments received during the comment period as part of the Record of Decision.

PROPOSED PLAN FOR GROUP 1 SITES (PICA 079)

GROUP 1 SITES (PICA 079) Proposed Action

The Group 1 Sites consist of approximately 4 acres on the western side of Picatinny Lake in the center of Picatinny Arsenal. The sites have been used for a variety of activities since 1930. These uses included assembly and production of explosives during WWI and WWII; ammunitions tear-down; stability testing, inspection and storage; and wastewater treatment. Today, these ten buildings, known as the melt load line or completed rounds division, still make up the Group 1 Sites and are currently used for explosives-contaminated wastewater treatment, melt-pour research, remote automated controls, ammunition repack and surveillance, and light industrial storage. Most of the Group 1 Sites are paved or covered in gravel. The Army conducted comprehensive environmental investigations at the site. Various chemicals, explosives, and metals have been detected at elevated levels in the surface soils, sub-surface soils, and groundwater within Group 1 Sites. Human health and ecological risk assessments showed potential impacts to human health, soil invertebrates, and terrestrial plants. Sediments and surface water are being addressed as part of Picatinny Lake (PICA 057).

GROUP 1 SITES (PICA 079) Alternatives Evaluated

The Army, the U.S. Environmental Protection Agency, and the New Jersey Department of Environmental Protection evaluated the following alternatives:

Explosives in Soil

Alternative S1-1: No Action.
Alternative S1-2: Excavation and on-site treatment by composting.
Alternative S1-3: Excavation and on-site treatment by slurry-bioreactor.
Alternative S1-4: Excavation and on-site treatment by enhanced bioremediation (Daramend®).
Alternative S1-5: Excavation and off-site disposal.

Arsenic and PAHs in Soil

Alternative S2-1: No Action.
Alternative S2-2: Institutional Controls.
Alternative S2-3: Installation of a soil cover and revegetation.
Alternative S2-4: Installation of an asphalt cover.
Alternative S2-5: Excavation and off-site disposal.

PCBs in Soil

Alternative S3-1: No Action.
Alternative S3-2: Institutional Controls
Alternative S3-3: Excavation and off-site disposal.

Groundwater

Alternative GW-1: No Action.
Alternative GW-2: Continued implementation of Institutional Controls and Monitored Natural Attenuation (MNA).
Alternative GW-3: Pump and treat using carbon treatment, MNA, and continued implementation of Institutional Controls.
Alternative GW-4: Pump and treat using ultraviolet/chemical oxidation, MNA, and continued implementation of Institutional Controls.
Alternative GW-5: Pump and treat using bioreactor treatment, MNA, and continued implementation of Institutional Controls.
Alternative GW-6: Pneumatic fracturing and liquid atomized injection of zero valent iron, MNA, and continued implementation of Institutional Controls.
Alternative GW-7: Nano-scale zero valent iron injection, MNA, and continued implementation of Institutional Controls.
Alternative GW-8: Enhanced anaerobic bioremediation by injection of microbial growth substrate (i.e., hydrogen release compound [HRC®], emulsified oil substrate [EOS®], sodium lactate), MNA, and continued implementation of Institutional Controls.

GROUP 1 SITES (PICA 079) Preferred Response Action

A combination of Alternatives S1-5, S2-2, S3-2, and GW-2, is the Preferred Response Action. This combination of Alternatives provides an optimum balance between the selection criteria and is protective of human health and the environment. The Preferred Response Action may be modified or a new Alternative may be developed based on public input. The final Response Action selected will be documented in a Record of Decision that summarizes the decision-making process. The Army will summarize and respond to comments received during the comment period as part of the Record of Decision.

PUBLIC MEETING

The Army invites the public to attend a meeting on Thursday, October 29, 2009, 6 p.m., Hilton Garden Inn (near the Rockaway Townsquare Mall), 375 Mt. Hope Avenue, Rockaway, NJ 07866. The meeting location is wheelchair accessible. A meeting of Picatinny's Environmental Restoration Advisory Board will follow the Proposed Plan meeting, and the public is also invited to attend the Board meeting.

WRITTEN COMMENTS

Copies of the Remedial Investigations, the Feasibility Studies, and the Pre-Design Technical Memoranda are available for public review at the Environmental Affairs Directorate at Picatinny by contacting Mr. Ted Gabel at (973) 724-6748 in advance. Starting October 29, 2009, a copy of the Proposed Plans for Group 3 and Group 1 Sites are available for review at the Rockaway Township Library (61 Mount Hope Road) and Morris County Library (30 East Hanover Avenue, Whippany). The public may submit written comments during the 30-day comment period (October 29 to November 28, 2009). Comments must be postmarked by November 28 and sent to Mr. Ted Gabel, Environmental Affairs Office, U.S. Army Installation Management Agency, Northeast Regional Garrison Office, Building 319, Picatinny, NJ, 07806.

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