Picatinny Arsenal Installation Restoration Program

Picatinny Arsenal is an Official Hawk Watch Site

FEASIBILITY STUDY FOR PICA-111 (SITES 109, 125, 142, 144, 146 & PICA-203) PICATINNY ARSENAL, NEW JERSEY

VOLUME 1
REPORT

Prepared By:

APRIL 2010

Shaw Environmental, Inc.
111 Howard Boulevard, Suite 110
Mt. Arlington, NJ 07856

U.S. Army Corps of Engineers
Baltimore District

FINAL REVISION #1

Architect Engineering Contract (AE) Number W912DR-04-R-0025

TABLE OF CONTENTS

Section ***Page***

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION AND PURPOSE 1-1

1.1 PURPOSE OF THE FEASIBILITY STUDY 1-1
1.2 ORGANIZATION OF REPORT 1-1

2.0 SITE BACKGROUND 2-1

2.1 REGIONAL AND LOCAL FEATURES 2-1
2.1.1 Location and Physiography 2-1
2.1.2 Topography/Surface Water Hydrology 2-1
2.1.3 Geology 2-2
2.1.4 Hydrogeology 2-3
2.2 SITE 109 – FORMER BUILDINGS 445 AND 445-D, PYROTECHNIC PLANT 2-4
2.2.1 Site History 2-4
2.2.2 Previous Investigations 2-5
2.2.3 Nature and Extent of Contamination 2-6
2.2.4 Summary of Risk Assessments 2-7
2.3 SITE 125 – BUILDINGS 172 AND 183, OFFICE BUILDING AND LUBRICANT TESTING AREA 2-10
2.3.1 Site History 2-10
2.3.2 Previous Investigations 2-10
2.3.3 Nature and Extent of Contamination 2-10
2.3.4 Summary of Risk Assessments 2-11
2.4 SITE 142, FORMER BUILDING 435, PROPELLANT PROCESSING PLANT 2-12
2.4.1 Site History 2-12
2.4.2 Previous Studies 2-12
2.4.3 Nature and Extent of Contamination 2-13
2.4.4 Summary of Risk Assessments 2-16
2.5 SITE 144, BUILDING 462, PROPELLANT FINISHING 2-20
2.5.1 Site History 2-20
2.5.2 Previous Studies 2-20
2.5.3 Nature and Extent of Contamination 2-20
2.5.4 Summary of Risk Assessments 2-22
2.6 SITE 146, FORMER BUILDING 497, POWDER PRESSING 2-23
2.6.1 Site History 2-23
2.6.2 Previous Investigations 2-23
2.6.3 Nature and Extent of Contamination 2-23
2.6.4 Summary of Risk Assessments 2-25
2.7 SITE PICA-203 2-28
2.7.1 Site History 2-28
2.7.2 Previous Studies 2-28
2.7.3 Nature and Extent of Contamination 2-29
2.7.4 Summary of Risk Assessments 2-30
2.8 HUMAN HEALTH RISK ASSESSMENT SUMMARY FOR PICATINNY PICA-111 GROUNDWATER 2-31

3.0 REMEDIAL ACTION OBJECTIVES AND IDENTIFICATION OF ARARs 3-1

3.1 ALLOWABLE EXPOSURE BASED ON RISK ASSESSMENT (INCLUDING ARARS) 3-1
3.1.1 ARAR Classification Requirements 3-1
3.1.2 Types of ARARs 3-1
3.1.3 Chemical-Specific ARARs and TBC Guidance 3-2
3.1.4 Location-Specific ARARs and TBC Guidance 3-7

3.1.5 Action-Specific ARARs and TBC Guidance 3-7
3.1.6 Non-Applicable ARARs 3-7
3.2 IDENTIFICATION OF CONTAMINANTS OF CONCERN, SITE CLEANUP LEVELS, AND AREAS OF ATTAINMENT 3-16
3.2.1 Identification of COCs and SCLs 3-16
3.2.2 Areas of Attainment 3-24
3.2.3 Area of Attainment Summary 3-25
3.3 REMEDIAL ACTION OBJECTIVES 3-25
3.3.1 Soils 3-25
3.3.2 Groundwater 3-26

4.0 SCREENING AND ANALYSIS OF REMEDIAL ALTERNATIVES 4-1

4.1 GENERAL RESPONSE ACTIONS 4-1
4.2 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS 4-2
4.2.1 Identification and Screening of Technologies 4-2
4.2.2 Evaluation of Technologies and Selection of Representative Technologies for Soil 4-2
4.2.3 Preliminary Screening of Groundwater Process Options 4-6
4.3 REMEDIAL ALTERNATIVE SCREENING CRITERIA 4-12
4.4 REMEDIAL ALTERNATIVES 4-15
4.4.1 No Action 4-15
4.4.2 Land Use Controls and Existing Engineering Controls for Soils 4-15
4.4.3 Excavation and Off-Site Disposal of Soil with COC Concentrations above SCLs 4-19
4.4.4 Long-Term Monitoring and Land Use Controls for Groundwater 4-22
4.4.5 Mass Removal Pump and Treat Long-Term Groundwater Monitoring, and ICs .. 4-24
4.4.6 Comparative Analysis of RAs 4-27

5.0 References 5-1

LIST OF FIGURES

Figure

Figure 2-1	Picatinny Site Location Map
Figure 2-2	Physiographic Provinces of New Jersey
Figure 2-3	Site Location Map
Figure 2-4	Picatinny Drainage Patterns
Figure 2-5	Picatinny Bedrock Geology Map
Figure 2-6	Site 109 – LOC Exceedences in Soil
Figure 2-7	Site 109 – Former Bldgs. 445 and 445-D, Groundwater LOC Exceedences
Figure 2-8	Site 125 – Buildings 172 and 183, Sample Location Map
Figure 2-9	Site 142 – Former Building 435, LOC Exceedences in Surface Soil
Figure 2-10	Site 142 – LOC Exceedences in Groundwater
Figure 2-11	Site 144 – Building 462, Sample Locations
Figure 2-12	Site 146 – LOC Exceedences
Figure 2-13	Site PICA-203 – Former Buildings 333 and 347, LOC Exceedences
Figure 3-1	Site 109 Areas of Attainment
Figure 3-2	Site 142 Soil Areas of Attainment
Figure 3-3	Site 146 Areas of Attainment
Figure 4-1	Criteria for Detailed Analysis of Alternatives
Figure 4-2	LUCs and Existing ECs Implementation Areas
Figure 4-3	Excavations and Disposal Implementation Area
Figure 4-4	Groundwater Monitoring Wells Proposed for LTM
Figure 4-5	Groundwater Pump and Treat Remedial Alternative

LIST OF TABLES

Table		*Page*
Table ES-1	Cost Summary for Remedial Alternatives	ES-4
Table 2-1	Site 109, Constituents Detected that Exceed LOCs	2-7
Table 2-2	Summary of Site 109 COPCs	2-8
Table 2-3	Summary of Site 109 Estimated Risks and Hazards	2-8
Table 2-4	Site 142, Constituents Detected that Exceed LOCs	2-14
Table 2-5	Summary of Site 142 COPCs from the HHRA	2-17
Table 2-6	Summary of Site 142 Estimated Risks and Hazards	2-17
Table 2-7	Summary of Site 142 Adult Lead Model Results	2-18
Table 2-8	Site 144, Constituents Detected that Exceed LOCs	2-21
Table 3-1	Surface and Subsurface Soil Chemical-Specific TBCs and Promulgated Criteria	3-3
Table 3-2	Promulgated Criteria for Soil (mg/kg)	3-3
Table 3-3	Chemical Specific Groundwater Criteria	3-4
Table 3-4	ARARs and Other Guidance To Be Considered for PICA-111 Groundwater	3-6
Table 3-5	Location-Specific ARARs and TBCs	3-8
Table 3-6	Action-Specific ARARs and TBCs	3-10
Table 3-7	Human Health Risk-Driver COCs in Surface Soil	3-18
Table 3-8	Surface Soil COCs and SCLs	3-18
Table 3-9	Groundwater Constituents above LOCs	3-19
Table 3-10	Distribution of COPCs in Groundwater	3-20
Table 3-11	Frequency of Detection for Potential Impact to Groundwater Constituents	3-21
Table 3-12	Subsurface Soil Cleanup Levels	3-22
Table 3-13	COC Groundwater Screening	3-23
Table 3-14	Summary of AAs for the Sites 109, 125, 142, 146 & PICA-203	3-25
Table 4-1	GRAs and Technologies Applicable to RAOs for PICA-111	4-1
Table 4-2	Identification and Screening of Technology Types and Process Options for Soils Areas of Attainment	4-3
Table 4-3	Identification and Screening of Technology Types and Process Options	4-7
Table 4-4	Cost Summary for Remedial Alternatives, PICA-111	4-14
Table 4-5	Comparative Analysis of Remedial Alternatives	4-29

LIST OF CHARTS

Chart		*Page*
Chart 3-1	Schematic Representation of Surface Soil COC Development	3-17

LIST OF APPENDICES

Appendix	
Appendix A	Groundwater Human Health Risk Assessment for PICA-111
Appendix B	Vapor Intrusion Pathway for Human Health Risk Assessment
Appendix C	Picatinny LOC Tables
Appendix D	Historical Data Including Analytical Results Summary Tables
Appendix E	Detailed Remedial Alternative Cost Analyses

LIST OF ACRONYMS AND ABBREVIATIONS

μg/g .....micrograms per gram
μg/L .....micrograms per liter
AA.....Area of Attainment
ANL .....Argonne National Laboratory
AOC.....Area of Concern
ARAR .....Applicable or Relevant and Appropriate Requirement
BERA.....Baseline Ecological Risk Assessment
bgs.....below ground surface
BNA.....Base Neutral/Acid Extractable
CEA.....Classification Exception Area
CERCLA.....Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR.....Code of Federal Regulations
COC .....Contaminant of Concern
COPC.....Constituent of Potential Concern
COPEC.....Constituent of Potential Ecological Concern
CT.....Central Tendency
CY .....cubic yards
DEH.....Division of Engineering and Housing
DNT.....Dinitrotoluene
DOD .....Department of Defense
DQO .....Data Quality Objective
EC .....Engineering Control
EEQ.....Environmental Effects Quotient
EQL .....Estimated Quantitation Limit
ERA.....Ecological Risk Assessment
FOD.....Frequency of Detection
FS.....Feasibility Study
ft .....feet
ft/day.....feet per day
ft/ft .....feet per foot
ft/year .....feet per year
GIS .....Geographic Information System
GPB.....Green Pond Brook
GRA.....General Response Action
GSD.....Geometric Standard Deviation
GWQS.....Groundwater Quality Standards
HAZCOM.....Hazard Communication
HHCOPC.....Human Health Constituent of Potential Concern
HHRA .....Human Health Risk Assessment
HI.....Hazard Index
HMIS .....Hazardous Materials Information System
HMX .....Cyclotetramethylenetetranitramine
IC.....Institutional Control
IGW .....Impact to Groundwater
INRMP.....Integrated Natural Resource Management Plan
IRP .....Installation Restoration Program
IRSL .....Industrial Regional Screening Level
ISRS.....Industrial Soil Remediation Standards
IT .....IT Corporation
LOC.....Level of Concern
LTM .....Long-Term Monitoring
LUC .....Land Use Control
LUCRD.....Land Use Control Remedial Design

MCL.....Maximum Contaminant Level
MCLG.....Maximum Contaminant Level Goal
MDI.....Mean Dietary Intake
MEC .....Munitions and Explosives of Concern
mg/kg.....milligrams per kilogram
MSDS.....Material Safety Data Sheets
msl.....mean sea level
NC .....Nitrocellulose
NCP.....National Oil and Hazardous Substances Pollution Contingency Plan
NFA .....No Further Action
NJAC.....New Jersey Administrative Code
NJDEP.....New Jersey Department of Environmental Protection
NJPDES .....New Jersey Pollutant Discharge Elimination System
NPDES.....National Pollutant Discharge Elimination System
OSWER.....Office of Solid Waste and Emergency Response
PAH.....Polycyclic Aromatic Hydrocarbon
PCB.....Polychlorinated Biphenyl
PETN.....Pentaerythritol tetranitrate
PQL .....Practical Quantitation Limit
PRG.....Preliminary Remediation Goal
QAPP .....Quality Assurance Project Plan
RA .....Remedial Alternative
RAGS .....Risk Assessment Guidance for Superfund
RAO.....Remedial Action Objective
RBC.....Risk-Based Concentration
RCRA .....Resource Conservation and Recovery Act
RDX.....Cyclonite (hexahydro-1,3,5-trinitro-syn-triazine)
RI.....Remedial Investigation
RME .....Reasonable Maximum Exposure
ROD .....Record of Decision
RPM .....Remedial Project Manager
RRSE .....Relative Risk Site Evaluation
RSL .....Regional Screening Level
SARA.....Superfund Amendments and Reauthorization Act of 1986
SCL .....Site Cleanup Level
SDWA.....Safe Drinking Water Act
SF.....square feet
Shaw .....Shaw Environmental, Inc.
SLERA.....Screening Level Ecological Risk Assessment
SOP.....Standard Operating Procedure
SVOC .....Semivolatile Organic Compound
TACOM .....Tactical Army Command
TBC .....To-Be-Considered
TCL.....Target Compound List
TCLP .....Toxicity Characteristic Leachate Procedure
TECUP .....Toxic and Energetic Cleanup Program
TSC .....Toxic Substances Control Act
USACE.....U.S. Army Corps of Engineers
USACHPPM.....U.S. Army Center for Health Promotion and Preventive Medicine
USEPA .....U.S. Environmental Protection Agency
USGS .....U.S. Geological Survey
UXO.....Unexploded Ordnance
VOC.....Volatile Organic Compound
WRA.....Well Restriction Area

EXECUTIVE SUMMARY

This report presents the methodology and results of the Feasibility Study (FS) conducted to address contamination in soil, sediment, surface water, and groundwater at Sites 109, 125, 142, 144, 146, and PICA-203 at Picatinny Arsenal, Rockaway Township, New Jersey. Shaw Environmental, Inc. (Shaw) was tasked by the U.S. Army Corps of Engineers (USACE), Baltimore District, to conduct this FS under the Architect Engineering Contract; contract number W912DR-04-R-0025, Delivery Order Number 04. The scope of this FS is the evaluation of alternatives for remediation of surface soil, subsurface soil, sediment, and groundwater at Sites 109, 125, 142, 144, 146, and PICA-203. As further explained in this FS, the preferred remedial alternatives (RAs) are selected based on the best balance between the selection criteria for remediation of contamination at these sites. These alternatives are: **Alternative 109-S2 [Land Use Controls (LUCs) and Maintenance of Existing Engineering Controls (ECs)], Alternative 142-S2 (LUCs and Maintenance of Existing ECs), and Alternative 109/203-GW-2 [LUCs and Long-Term Monitoring (LTM) of Groundwater]**. No RAs are required for Sites 125 or 144. However, because none of the six sites included in PICA-111 are suitable for unrestricted use, LUCs will be maintained at all six sites to ensure that the currently-protective land use continues.

The subject sites are located within the "mid-valley" portion of the installation, southwest of Picatinny Lake. Site 109 is located directly southwest of Green Pond Brook (GPB) and approximately 250 feet (ft) south of the southern shore of Picatinny Lake. Site 109, which covers 1.6 acres, consists of former Buildings 445 and 445-D. Both buildings were used for the mixing, manufacturing, and storage of pyrotechnics to include single-, double-, and triple-base propellants.

Site 125 is approximately 1.5 acres in area including Buildings 172 and 183. Building 172 is a two-story brick office building with a basement constructed in 1942 as an ordnance administration building. Building 183 is a lubricant testing facility originally constructed in 1945. A two-story addition was completed in 1963. The building has brick walls and a concrete foundation. According to Picatinny records, two polychlorinated biphenyl (PCB)-containing transformers were located at Building 183. One of the transformers caught fire in March 1989 and subsequently spilled PCB-contaminated oil. This spill was reportedly cleaned up; however, specific information regarding this action was unavailable (Dames and Moore, 1998).

Site 142 consists of former Building 435 and the surrounding area, which encompasses approximately 0.18 acres. Former Building 435 was a one-story, 432 square foot (SF) brick and concrete structure that was constructed in 1918. Information regarding the use of Building 435 was unavailable for the years between 1918 and 1950. The building has been used for pulverizing operations in the preparation of experimental propellants, and subsequently for the mixing of solvents for propellant production.

Site 144 encompasses approximately 0.7 acres and includes a two-story concrete structure (Building 462), which was constructed in 1942 as a tracer loading facility and has been used for various munitions manufacturing processes. In the 1940s, finished gun bags were transported from Building 462 via a railroad line, located approximately 40 ft west of the building. In 1947, Building 462 was temporarily converted to a rocket facility. During the Vietnam War, the building was used as a solvent-less propellant finishing facility. According to Picatinny safety files, Building 462 was used for explosive chemical manufacturing in November 1993.

Site 146 includes a former propellant plant (Building 497) and the surrounding area, including a former dumping and debris area located to the southwest, encompassing an area of approximately 0.27 acres. The building was a 45-ft x 28-ft structure, constructed in 1956 as a mix house, with concrete bays, wood-framed control rooms and cement asbestos siding.

Site PICA-203, located adjacent to (to the northwest of) Site 109, is an open field which covers approximately 1.0 acre. From about 1922 until 1926, former Buildings 333 and 347 were used as a poisonous gas laboratory and sample handling house, respectively. Work at these facilities included laboratory testing using normal poisonous gases in experiments for propellants. Following the 1926 Lake Denmark Disaster, the buildings were never rebuilt. Former Building 445-B was built within the footprint of former Building 347. In 1918, a 10-ft x 12-ft concrete solvent vault was located in the vicinity of nearby

Building 332. No information is available on the depth or volume of the vault. Field reconnaissance could not locate the structure and it is suspected that the vault no longer exists.

As part of the remedial investigation (RI) for each site, a human health risk assessment (HHRA) was completed for exposure to site soil, sediment, and groundwater (in the case of the construction excavation worker). These scenarios did not evaluate use of groundwater. Groundwater use was evaluated in a separate HHRA. Industrial scenarios were run for all of the PICA-111 sites. Additionally, future residential scenarios were run for Site 142. The following summaries of the associated HHRA for each site presents the results of the risk assessment at the subject sites:

- Site 109: Based on the Phase II HHRA, the excess cancer risk level for the industrial research worker receptor is equal to the upper bound of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) target range of 1E-4 to 1E-6. The noncancer hazard is above 1 for the construction excavation worker.
- Site 125: The excess cancer risk for the industrial research worker and construction excavation worker were both below the target risk range of 1E-4 to 1E-6. Additionally, the noncancer hazard was below 1 for both scenarios.
- Site 142: Based on the Phase I 2A/3A HHRA, the excess cancer risk was within the target risk range for the industrial research worker, adult resident, and child resident. The estimated noncancer hazard to child residents is greater than the target threshold of 1 and the estimated noncancer hazard is equal to one for the adult resident. However, the current and future use of the site is highly industrial so noncancer hazard to the adult and child resident is hypothetical.
- Site 144: Based upon the Phase I 2A/3A HHRA, the excess cancer risks to the outdoor maintenance workers, industrial research workers, and construction excavation workers were all below the target risk range and noncancer hazard index (HI) of 1.
- Site 146: Based on the Phase I 2A/3A HHRA, the noncancer risk was below the target range for the industrial research worker and construction excavation worker. The estimated total hazard for the construction worker receptor is greater than the target threshold of 1. The adult lead model results indicate lead concentrations in total soil may be a concern for construction workers.
- PICA-203: Based on the Phase I 2A/3A HHRA, excess cancer risk to the industrial research worker was within the target risk range. Noncancer hazards were below 1 for both scenarios.

As part of this FS, an additional groundwater risk assessment was performed. This risk assessment calculated potential risk and hazard to the following receptors: on-site adult military resident, on-site child military resident, industrial research worker and construction worker. This risk assessment utilized the combined groundwater data set for all PICA-111 sites at which groundwater samples were collected. The following constituents of potential concern (COPCs) were selected in the risk assessment: aluminum, arsenic, iron, manganese, chloroform, and perchlorate. Excess cancer risk was within the target risk range for all scenarios except the construction worker scenario which fell below the range. The primary risk driver for all scenarios was arsenic. The noncancer hazard was above the HI of 1 for all scenarios except the construction worker which was below 1. Primary noncancer hazard drivers were perchlorate, manganese, iron, and arsenic.

The ecological risk assessment (ERA) performed during the Phase I RI (Dames and Moore, 1998) identified modeled ecological risks to indicator species (woodcock and veery) at Site 146; although, these modeled risks were not considered significant considering the small home range for the receptor relative to the site. No ERA was performed at Sites 125, 142 or 144 during the Phase I RI. A screening level ERA (SLERA) determined that no further investigation was necessary at Sites 125, 142, and 144; and recommended a baseline ERA (BERA) to address potential receptor exposure to contaminants in Site 146 soil. Site 146 was included in the Phase III and Phase I 2A/3A BERA. The BERA concluded that it is unlikely that ecological communities within Site 146, as well as other Area F sites at Picatinny, are not at any significant risk from contaminants present at these sites. The BERA recommended that no further ERA investigations or remedial actions based on ecological risks were warranted at these sites.

Site 109 was evaluated for terrestrial species in the Phase II ERA despite poor habitat quality, because the area may revert to a more natural state. Results of the food-chain modeling indicate potential risk to terrestrial feeding wildlife is minimal. Since PICA Site 203 had not been identified as an RI site prior to the Phase II ERA, it was not evaluated in the Phase II ERA. The site is a small field with low habitat quality, but it is adjacent to GPB and Site 109.

Remedial action objectives (RAOs) were developed for Sites 109, 142, and 203. Based on the geographic proximity of Site 109 to 203, the areas of attainment (AAs) for these two sites were combined for both soil and groundwater. The RAOs for these sites have been developed in such a way that attainment of the goals will result in the elimination of exposure pathways thereby mitigating documented risks to human health. There are no RAOs regarding ecological receptors as no unacceptable ecological risks were identified at the subject sites.

In this FS, a list of contaminants of concern (COCs) were developed for each media type based on the results of the human health and ecological risk assessments, as well as comparison to New Jersey Industrial Soil Remediation Standards (ISRS).

Based on the list of COCs and RAOs, AAs were identified at the subject sites. Remedial goals should be achieved throughout the AAs. For soil, four AAs were identified at three of the six subject sites (no COCs were identified at Sites 125, 144, or 146). Due to the geographic proximity of Site 109 and PICA-203, the AA for these sites were combined. For groundwater, one AA was identified at Site 109 and 203 combined. In order to address the identified contamination, RAs were established for each site. The following RAs have been developed for soil contamination within Sites 109, 142, and PICA-203.

Soil (Sites 109, 142, and 203)

Alternative S-1: No action.

Alternative S-2: Maintenance and enforcement of LUCs and maintenance of existing ECs.

Alternative S-3: Excavation of soil with concentrations of COCs that exceed site cleanup levels (SCLs), off-site disposal, and maintenance and enforcement of LUCs.

Groundwater (Sites 109 and 203)

Alternative GW-1: No action.

Alternative GW-2: LUCs and LTM of Groundwater.

Alternative GW-3: Mass Removal Pump and Treat, Groundwater Monitoring and ICs.

The alternatives were screened against seven of the nine NCP criteria, in which each RA must be assessed. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified. The detailed criteria are: protection of human health and the environment, compliance with Applicable or Relevant and Appropriate Requirement (ARARs), long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost. The final two criteria, State and community acceptance, are "modifying criteria" which are evaluated at later stages of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process. The costs for each alternative are provided in **Table ES-1**.

The following RAs were selected as the preferred remedial alternative:

Soil - Alternative S-2: Maintenance and enforcement of LUCs and maintenance of existing ECs.

Groundwater - Alternative GW-2: LUCs and LTM of Groundwater.

Table ES-1
Cost Summary For Remedial Alternatives, PICA-111
Picatinny Arsenal, New Jersey

Remedial Alternative	Description	Capital Cost	Discounted O&M [2]	Total Present Worth	Duration (Construction and O&M)
BASELINE COST OF LAND USE CONTROLS FOR SOIL AT PICA-111		$32,200	$37,222	**$69,422**	30 years
Site 109					
		Soil			
Alternative 109S-1	NO ACTION	$0	$0	**$0**	None
Alternative 109S-2[1]	LUCs AND MAINTENANCE OF EXISTING ECs		$25,721	**$25,721**	30 years
Alternative 109S-3	EXCAVATION OF SOIL WITH CONCENTRATIONS ABOVE SCLs AND OFF-SITE DISPOSAL	$1,506,128	$25,721	**$1,531,849**	42 days (30 years ICs)
Site 142					
		Soil			
Alternative 142S-1	NO ACTION	$0	$0	**$0**	None
Alternative 142S-2[1]	LUCs AND MAINTENANCE OF EXISTING ECs		$25,721	**$25,721**	30 years
Alternative 142S-3	EXCAVATION OF SOIL WITH CONCENTRATIONS ABOVE SCLs AND OFF-SITE DISPOSAL	$58,989	$25,721	**$84,711**	3 days (30 years ICs)
Site 109 and PICA-203 Groundwater					
		Groundwater			
Alternative 109/203GW-1	NO ACTION	$0	$0	**$0**	None
Alternative 109/203GW-2	LUCs AND LONG TERM MONITORING OF GROUNDWATER		$62,151	**$62,151**	30 years
Alternative 109/203GW-3	MASS REMOVAL GROUNDWATER PUMP AND TREAT	$922,958	$1,281,162	**$2,204,120**	15 years

[1] Baseline costs for the implementation of LUCs are evaluated for the subject sites combined. As SCLs are based on a non-residential use scenario, the costs for LUCs must be added to the costs presented for the site specific remedial alternatives with the exception of the No Action alternative.
[2] Present worth O&M with discount rate of 7%.

1.0 INTRODUCTION AND PURPOSE

The U.S. Army Corps of Engineers (USACE), Baltimore District, has tasked Shaw Environmental, Inc. (Shaw) to perform a Feasibility Study (FS) for Sites 109, 125, 142, 144, 146, and PICA-203 (former propellant processing and finishing and powder pressing facilities) at Picatinny, located in Rockaway Township, New Jersey. This FS addresses contamination in soil, sediment, surface water, and groundwater at these sites within Area F. In addition, potential impact to groundwater from contaminants in soil is also assessed in this FS.

This FS was prepared based upon the compilation of data from previous investigations conducted at each site, including the *Phase I Remedial Investigation (RI)* (Dames and Moore, 1998) and the *Phase I 2A/3A Sites RI Report* (Shaw, 2005a). This work is being performed under the Architect Engineering Contract; Contract Number W912DR-04-R-0025, Delivery Order Number 04.

1.1 PURPOSE OF THE FEASIBILITY STUDY

The purpose of the FS is to develop and evaluate remedial options such that appropriate response actions may be selected for the sites. To ensure selection of appropriate response actions, this FS has been conducted in accordance with U.S. Environmental Protection Agency (USEPA) guidance documents (USEPA, 1985; 1988a,b) developed for activities performed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and implemented by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 Code of Federal Regulations (CFR) 300]; the National Environmental Policy Act of 1969; and the President's Council on Environmental Quality regulations (40 CFR 1500 - 1508); and New Jersey Department of Environmental Protection (NJDEP) guidance documents (NJDEP, 2006 and 2009a).

The FS presents the results of previous investigations conducted at each site, documents the risk assessment findings, identifies areas of concern (AOCs), describes contaminant fate and transport, identifies the remedial action objectives (RAOs) for specific media types and contaminants, and identifies and screens potential remedial alternatives (RAs). The methodology used in this FS employs a step-by-step evaluation of technologies and alternatives and selects a preferred response action:

- Remedial technologies that, alone or in combination, can treat, contain, or dispose of contaminated media are identified.
- The remedial technologies are screened to eliminate those that are technically infeasible or otherwise unacceptable, either based on attainment of chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) or the volume or type of media to be treated.
- The remedial technologies are assembled into RAs which, to the maximum extent practicable, utilize permanent solutions and alternative technologies.
- The RAs are evaluated with respect to seven of the nine NCP criteria. The remaining criteria, state and community acceptance, will be evaluated at later stages of the CERCLA process.

NCP methodology provides a systematic procedure for: (1) identifying and evaluating RAs; (2) specifying criteria for determining the magnitude and importance of effects resulting from the implementation of an action; and, (3) considering measures to mitigate the adverse effects of the response actions.

1.2 ORGANIZATION OF REPORT

The FS is organized into five sections:

Section 1.0 – Introduction and Purpose: The purpose of the FS and the report organization are presented in this section.

Section 2.0 – Site Background: This section provides a regional environmental setting as well as a summary for each site. Each summary addresses the site history, previous investigations, nature and extent of contamination, results of human health and ecological risk assessments, data tables, and pertinent site figures and photographs.

Section 3.0 – Remedial Action Objectives and Identification of ARARs: This section provides a statement of RAOs, identifies potential ARARs, To-Be-Considered (TBC) guidance, contaminants of concern (COCs), areas of attainment (AAs), and site cleanup levels (SCLs).

Section 4.0 – Screening and Analysis of Remedial Alternatives: This section identifies general response actions (GRAs) applicable to the RAOs presented in Section 3.0. The GRAs are broken down into technologies and process options screened according to implementability, effectiveness, and relative cost. A detailed evaluation of the alternatives retained from the initial screening process is presented utilizing the nine NCP evaluation criteria [40 CFR 300.430(e)].

Section 5.0 – References: This section lists the reference materials utilized to develop this FS.

2.0 SITE BACKGROUND

2.1 REGIONAL AND LOCAL FEATURES

2.1.1 Location and Physiography

Picatinny is located in north central New Jersey approximately 4 miles north of the city of Dover in Rockaway Township, Morris County (**Figure 2-1**). Major roadways adjacent to the site include State Route 15, which skirts the southern boundary of the installation, and Interstate 80, which is located one mile to the southeast of the main gate.

Picatinny is located in the New Jersey Highlands physiographic province, which ranges from 12 to 18 miles wide and is located between the Appalachian Piedmont physiographic province to the southeast and the Valley and Ridge province to the northwest (**Figure 2-2**). The New Jersey Highlands is the southernmost extension of the New England sub-province (Reading Prong) of the Appalachian Highland physiographic province (Gill and Vecchioli, 1985). The area is characterized by broad, rounded, or flat-topped northeast-southwest trending ridges, and deep and generally narrow valleys that are controlled by the northeast-trending folds and faults of the underlying bedrock.

The valley in which Picatinny resides has a broad and relatively flat floor, which slopes gently to the southwest. Elevations within the valley floor range from approximately 800 feet (ft) mean sea level (msl) at the northeastern boundary to approximately 700 ft msl at the southwestern boundary. The valley varies from 1,000 to 4,000 ft in width. The main valley of Picatinny is bounded to the northwest by Green Pond and Copperas Mountains and to the southeast by an unnamed ridge. Green Pond and Copperas Mountains are rugged and steeply sloped with a maximum elevation of about 1,250 ft msl. The southeastern ridge is less steep with a maximum elevation of about 1,150 ft msl and contains small elevated plateaus. Marshy areas at the southern end of Picatinny and north of Lake Denmark are very flat with minor relief.

The sites included in this FS are located within Area F and the southernmost portion of Area I in the central valley of the installation, as shown on **Figure 2-3**. Area F consists of approximately 77 acres and is located in the central portion of Picatinny, southwest of Picatinny Lake. PICA-111 groundwater is also evaluated on a site by site basis in this FS. The two Area I sites are approximately 2.6 acres and are located south of the southern shore of Picatinny Lake. Area F and the two sites in Area I are bounded by Green Pond Brook (GPB) to the northwest, the unnamed ridge to the southeast, Picatinny Lake to the northeast, and Farley Avenue to the southwest.

2.1.2 Topography/Surface Water Hydrology

Picatinny is located in the upper part of the Passaic River drainage basin. GPB, which is the primary drainage feature of Picatinny, joins the Rockaway River approximately 1 mile south of Picatinny. Surface water at Picatinny generally flows down to the valley axis via a number of small unnamed streams and ditches, and then to the southwest by Burnt Meadow Brook and GPB. A map presenting surface water drainage features and directions at Picatinny is provided on **Figure 2-4**. The northeast portion of Picatinny is drained by Burnt Meadow Brook, which has an average width of 3 to 4 ft and a maximum depth of 1 foot. Burnt Meadow Brook discharges into Lake Denmark in the northeastern portion of the installation (USATHAMA, 1976). Lake Denmark discharges by a continuation of Burnt Meadow Brook into GPB. GPB then flows southwestward into Picatinny Lake. Located in the geographic center of Picatinny, Picatinny Lake is approximately 5,300 ft long, with an average width of 1,000 ft, and a maximum depth of 20 ft. The lake covers an estimated 108 acres with an approximate volume of 165 million gallons (USATHAMA, 1976). GPB, with a width of 10 to 30 ft and a maximum depth of 5 ft, continues southwestward from Picatinny Lake through the center of the valley, and discharges into the Rockaway River about one mile southeast of Picatinny.

The northwestern and central portions of Area F as well as the southern portion of Area I are relatively flat and lie in the valley region of Picatinny, approximately 690 to 700 ft above msl. Topographic elevations increase to approximately 725 to 735 ft above msl to the east and 730 to 755 ft above msl to the north, near Picatinny Lake at the secondary terminal moraine.

Areas F and I are moderately developed with paved, grassy, and marshy areas. Area I encircles Picatinny Lake. Picatinny Lake and GPB act as storm water collection basins for the Installation. Surface water flows from higher elevations in the northeast and east to the valley regions in the west along GPB. In developed areas, surface water runoff is partially controlled by storm drains that direct surface water flow toward GPB or its tributaries. Surface water in the grassy portions of Area F is expected to infiltrate the ground. Lowland marshy areas near GPB exhibit poor surface water drainage and contain pools of standing water.

2.1.3 Geology

Four bedrock formations underlie Picatinny: Precambrian Basement and three lower Paleozoic sedimentary formations – the Hardyston Quartzite, the Leithsville Formation, and the Green Pond Conglomerate (**Figure 2-5**). The overlying valley fill is composed of Pleistocene glacial deposits and minor amounts of recent alluvium. The bedrock in the northwestern portion of the valley is composed of lower Paleozoic sedimentary rocks, which unconformably overlie the Middle Proterozoic basement rocks, and are faulted by a series of northeast trending faults (i.e., Tanners Brook-Green Pond Fault, Picatinny Fault, Berkshire Valley Fault, and the Gorge Fault – which splays off of the Tanners Brook-Green Pond Fault).

Unconsolidated sediments overlie the Precambrian and lower Paleozoic age bedrock at Picatinny. The unconsolidated glacial materials consist mostly of till and stratified drift deposited during the Wisconsin glacial event. There are also minor amounts of recent alluvium. Following deglaciation, Holocene deposits of silt, clay and finally peat formed in floodplains and ice-blocked depressions along GPB [U.S. Geological Survey (USGS), 1993].

The bedrock geology underlying Area F, from oldest to youngest, consists of the Precambrian Gneiss, Hardyston Quartzite, and Leithsville Dolomite. As a result of folding and faulting, bedrock dips steeply to the northwest. Glacial sediments overlie the bedrock geology throughout Areas F and I. Beneath Area F, bedrock occurs at depths ranging from 40 ft below ground surface (bgs) along the slopes of the southeastern ridge to 120 ft bgs in the central portion along GPB. The bedrock erosional surface slopes down valley, and the thickest section of glacial sediments was encountered in the central portion of Area F, near Building 176, where the thickness is approximately 120 ft.

The Precambrian Gneiss is found beneath the slopes of the southeastern ridge in Areas F and I. The formation consists of a fine to very coarse, highly fractured granitic gneiss. The Hardyston Quartzite unconformably overlies the Precambrian Gneiss and ranges up to 200 ft in thickness (USGS, 1993). In Area F, the Hardyston Quartzite was not encountered in any of the monitoring wells but is projected and mapped through this area by USGS. The Hardyston Quartzite and the Leithsville Formation were only identified in Area I along the northwestern shore of Picatinny Lake. The Leithsville Formation overlies the Hardyston Quartzite and consists of a light gray, micritic dolomite, weathered to a yellow silty clay, with less weathered quartzitic dolomite intervals. As is typical of carbonate rock, solution cavities are common and filled with silty fine sand and clay derived from weathering of the dolomite. Wells 176D and 176DB in Area F are the only wells completed in the Leithsville Dolomite. The bedrock formation was encountered at a depth of 120 ft bgs in wells 176D and 176DB, which are completed at depths of approximately 310 and 350 ft bgs, respectively. Weathered bedrock was encountered between 120 to 248 ft bgs, turning to fractured and less weathered bedrock between 248 and 310 ft bgs in well 176D. Specific lithological data is not available for well 176DB.

Reportedly, large solution cavities in the Leithsville Dolomite up to 20 ft in vertical thickness are common. These cavities are filled with silty fine sand and clay derived from weathering of the dolomite. Less weathered intervals of the dolomite are highly fractured and exhibit stylolitic features (i.e., columnar structure perpendicular to bedding common to limestone rocks). The dominant fracture set observed in rock core samples is oriented vertically; secondary fractures do not show any pattern in orientation.

The unconsolidated surficial geology is difficult to separate into distinct units. Current interpretation identifies the following two units in Areas F and I, as described below:

- The uppermost and youngest, Holocene swamp and alluvial deposits.
- A lower semi-confined glacial sequence.

Holocene swamp deposits occur at the surface along the flood plains of GPB and its tributaries. The Holocene deposits consist of organic silt and clay and range in thickness from approximately 20 to 35 ft. The swamp deposits have been extensively modified by artificial fill as a result of land development and construction activities.

The lower semi-confined glacial sequence is poorly sorted and consists of a heterogeneous mix of sand, gravel, and boulders. The top of the lower semi-confined glacial sequence occurs at a depth of approximately 20 to 35 ft bgs, beneath Holocene swamp deposits. Thickness ranges from 5 to 95 ft, moving from the slopes of the southeastern ridge to the central portions of Area F, respectively. Large boulders and discontinuous clayey till horizons are commonly encountered, and stratification appears to follow the slope of the bedrock surface.

2.1.4 Hydrogeology

Three aquifers were identified in this study area based on the geology and aquifer slug test data collected during the 1998 Phase I RI and the Phase II RI. They are as follows: an unconfined glacial aquifer (also referred to as the water table aquifer), a lower semi-confined glacial aquifer, and a bedrock aquifer. The interpretation of groundwater flow patterns in Area F is based primarily on the information provided in the 1998 Phase I RI and information obtained during the Phase I 2A/3A RI. The Phase I RI hydrogeologic data was supplemented by data from four additional wells installed during the Phase I 2A/3A RI.

2.1.4.1 Unconfined Glacial Aquifer

Thirteen wells in Area F and three wells in Area I (Site 109) were used to study groundwater conditions in the unconfined glacial aquifer in the Phase I and Phase II RIs. Four additional monitoring wells (including 142MW-1) were installed in the unconfined glacial aquifer during the Phase I 2A/3A RI. The unconfined glacial aquifer has a thickness of 20 to 35 ft. Groundwater in the unconfined glacial aquifer flows towards GPB. The hydraulic gradient in the unconfined glacial aquifer across Area F averages 0.028 ft/ft, but is steeper in the northeastern portion of Area F (approximately 0.11 ft/ft). Groundwater flow velocity in the unconfined glacial aquifer is estimated to average 2.24 ft/day (818 ft/yr) based on an average hydraulic conductivity estimate of 20 ft/day (with a range of 0.7 to 86 ft/day) and an assumed porosity value of 0.25.

During the Phase I RI, it was reported that the pumping of water supply wells 410 and 430A influenced groundwater flow in the Area F unconfined aquifer. However, within the last several years both water supply wells have not been utilized. Water supply well 410 is still connected to Picatinny's water treatment system, but the valves are currently closed. This well has not been in use since the year 2000. Water supply well 430A is slated for abandonment, and has not been in use since 1996.

2.1.4.2 Lower Semi-Confined Glacial Aquifer

Eight wells in Area F were used to study groundwater conditions in the lower semi-confined glacial aquifer. The top of the lower semi-confined glacial aquifer occurs at depths ranging from 20 to 35 ft bgs in Area F.

Groundwater flow in the lower semi-confined aquifer in Area F is in a westerly direction under GPB, towards Area G, due to pumping from water supply well 302D. Well 302D is screened in the dolomitic bedrock at an interval of 110 to 417 ft bgs. During the Phase I 2A/3A RI, pumping rates for well 302D averaged approximately 700 gallons per minute. The average daily pumping time of the water supply well was approximately 14.5 hours per day. The water withdrawal causes a cone of depression centered on well 302D, inducing a radial flow pattern towards the well. Groundwater flow in the lower semi-confined glacial aquifer indicates a hydraulic connection between the lower semi-confined glacial aquifer and the underlying bedrock, although a similar influence on the direction of groundwater flow between the lower semi-confined and shallow unconfined glacial aquifer was not reported in the 1998 Phase I RI.

Slug test estimates of the hydraulic conductivity for the Area F lower semi-confined aquifer average 53 ft/day, with a range of 6 to 200 ft/day. The hydraulic gradient across Area F is estimated to be 0.02 ft/ft. These estimates are higher than those for the unconfined aquifer.

2.1.4.3 Bedrock Aquifer

Only two monitoring wells located in Area F are screened in the bedrock aquifer. No wells are screened in bedrock in the southern portion of Area I. Groundwater in the bedrock aquifer occurs under confined conditions and is often separated from the deep glacial aquifer by a clayey, weathered bedrock zone. Upward flow, artesian conditions are encountered in both Area F wells; 176D, screened in the bedrock aquifer from 275 to 305 ft, and well 176DB, completed in bedrock at a depth of 350 ft. Because there are only two wells screened within the bedrock aquifer, it is not possible to accurately estimate hydraulic gradients. Based on facility-wide groundwater contour maps, groundwater in the bedrock aquifer flows southwest, down the valley center.

2.1.4.4 Vertical Hydraulic Gradients

Area F vertical hydraulic gradients presented in the 1998 Phase I RI between the unconfined and lower semi-confined glacial aquifers are all upward with the exception of well cluster MWF-4A and MWF-4B, which changed from downward to upward between data collection dates. Due to the proximity of the specified well cluster to GPB, groundwater elevation in the shallow monitoring well would be expected to be greatly affected by transient events including precipitation and spring thaw. The lower semi-confined aquifer would not be directly influenced by such events, and could result in the apparent reversal of vertical flow. Groundwater data in Area F indicate that recharge is from the lower semi-confined aquifer to the unconfined glacial aquifer, both along the ridge slopes and the valley region. Near GPB, flow is both upward into the stream and westward under GPB and towards water supply well 302D in adjacent Area G.

2.2 SITE 109 – FORMER BUILDINGS 445 AND 445-D, PYROTECHNIC PLANT

2.2.1 Site History

Site 109 is located directly southwest of GPB and approximately 250 ft south of the southern shore of Picatinny Lake (**Figure 2-6**). Site 109, which covers 1.6 acres, consists of Buildings 445 and 445-D. Both buildings were used for the mixing, manufacturing, and storage of pyrotechnics to include single-, double-, and triple-base propellants.

Building 445 was originally constructed as a gun-bag loading facility where single-, double-, and triple-base propellants were loaded into gun-bags. From 1957 to the mid-1970s, the building operated as a pyrotechnic plant. Building 445 was placed on inactive status in 1975, and was closed under the Fabrication Capacity Program in the late 1970s. In 1997, Building 445 was demolished as part of the Toxic and Energetic Cleanup Program (TECUP).

According to Picatinny personnel, all waste chemicals and cleaning rags generated at Building 445 were placed in drums and sent to the Picatinny Burning Ground. In addition, Picatinny personnel indicated that the conductive floors were pressure-washed following propellant operations to remove residual explosives. A sump, which formerly received wash down water, ran along the northeast side of Building 445. The soil around the sump was placarded to indicate that the area was potentially contaminated. Washdown water was also discharged to an evaporation bed. Solid residuals from the evaporation bed were removed and sent to the Picatinny Burning Ground for disposal.

Three 50-KVA pad-mounted transformers (TR-445) were located southeast of Building 445. According to the Picatinny transformer database, all three transformers were in good condition and were not contaminated with polychlorinated biphenyls (PCBs). The three transformers were removed in the late 1990s.

Building 445-D was used to store chemicals, possibly in support of operations in Building 94. Aluminum, magnesium, lithium, and pyrotechnic substances including zirconium powder, potassium sulfate chlorides, toluene, potassium perchlorate, sodium nitrate, and barium chromate were known to have been stored at Building 445-D. Explosive and propellant materials including nitrocellulose (NC), nitroglycerine, nitroguanidine, and dinitrotoluene (DNT) were also stored here. Building 445-D was declared hazardous in 1987 because of structural decay and has since been demolished.

2.2.2 Previous Investigations

The field investigation of Site 109 was performed under the purview of the U.S. Army, USEPA Region II, and NJDEP as part of the Phase II RI initially conducted by ICF Kaiser between March 1996 and October 1996. The Phase II Round 1 RI sampling program for Site 109 included:

1. Collecting 13 surface soil samples and six subsurface soil samples from six locations.
2. Collecting two sump samples.
3. Installing three monitoring wells and collecting 18 subsurface soil samples.
4. Sampling, performing aquifer testing, and surveying the newly installed wells.

Follow-up investigations (Round 2) were conducted in May and June 2001 based on the results of the previous sampling and regulatory comments, and included:

1. Collecting four surface soil samples.
2. Collecting two subsurface soil samples from two soil borings.

Metals concentrations were detected in the sediment and water samples collected from the sumps located at Buildings 445 and 445-F. Explosives were also identified in the samples, in addition to concentrations of semivolatile organic compounds (SVOCs) and the pesticide Mirex. However, sump samples were compared to surface water and sediment criteria which are overly conservative since the exposure scenario at a sump bears little resemblance to exposure from a surface water body for which the criteria are developed.

Sump 109SP-2, which ran along the northeast side of Building 445, formerly received wash down water from facility operations. The soil around the sump was placarded to indicate that the area was potentially contaminated. Sump 109SP-1 was located adjacent to Building 445-F. It is believed that this sump received wastewater discharges from the building. No sediment was found in this sump during the sampling event. Thus, only a water sample was collected at this location. The discharge point of the sumps is unknown, but based on the close proximity to GPB and similar known discharges to GPB, the sump water probably discharged to GPB north of the site.

Based on regulatory comments related to these sumps at Site 109, soil borings were drilled adjacent to each sump as part of the Round 2 investigation in accordance with NJDEP's *Technical Requirements for Site Remediation* (NJDEP, 2009a). Subsurface soil samples were collected in each boring at depths corresponding to the bottom of each sump. The samples were analyzed for metals and explosives including the nitroesters. No explosives or inorganic compounds were detected above their respective levels of concern (LOCs), which indicate the contents of the sumps did not impact the surrounding environment.

Following the Round 1 sampling at Site 109, Building 445 and its auxiliary buildings were demolished under TECUP. Sump 109SP-2 is believed to have also been removed as part of the demolition and regrading of the site. In 2002, cement sump 109SP-1 was removed as part of a facility-wide investigation of sumps and dry wells. Sidewall and bottom samples collected from the excavation were analyzed for SVOCs, explosives, herbicides, pesticides, Mirex, metals, and cyanide. The samples did not contain any elevated levels. During this sump investigation, a test pit was excavated in the location of former sump 109SP-2. The test pit contained bricks and wooden debris, which could have been the remains of the sump or building rubble. No exceedences were identified in the subsurface soil samples collected from the test pit and the excavation was backfilled. With the removal of both sumps from the site and receipt of "clean" post-excavation samples, these potential sources have been eliminated. Thus, the sumps should no longer be considered an AOC.

In addition to the Round 2 investigation at Site 109, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) performed a Relative Risk Site Evaluation (RRSE) of adjacent Site PICA-203 in 1997 (USACHPPM, 1998). Three surface soil samples were collected along with three Geoprobe groundwater samples from the surface soil locations. The CHPPM report does not indicate that the Geoprobe groundwater samples were filtered prior to analysis. Groundwater samples were also collected from two monitoring wells installed for Site 109. For continuity, all PICA-203 groundwater sampling results will be included in the assessment for Site 109. Arsenic and lead were detected in

excess of their respective LOCs in the groundwater samples. Arsenic concentrations above the LOC of 3 micrograms per liter (μg/L) were reported in Geoprobe samples PGL-1W (11 μg/L), PGL-2W (11 μg/L), PGL-3W (4.7 μg/L); and monitoring wells 109MW-1 (4.8 μg/L) and 109MW-3 (9.8 μg/L). Lead exceedences were detected in PGL-1W (6.5 μg/L), PGL-2W (23 μg/L), 109MW-1 (20 μg/L), and 109MW-3 (6.7 μg/L). The LOC for lead in groundwater is 5 μg/L. The RRSE scored the site a high risk due to the groundwater hazard. The score was based on groundwater samples collected from the Geoprobe borings and from the two monitoring wells at Site 109.

Section 2.2.3 of this FS summarizes all results pertaining to Site 109.

2.2.3 Nature and Extent of Contamination

Based on the analytical results from samples collected at Site 109 during the Phase II RI, the following AOC was identified at the site and subsequently investigated in the follow-on RI effort:

- AOC 1: Explosives contamination of surface soil near Buildings 445 and 445-D.

As defined in the subsequent RI, the AOCs do not include every single exceedence of an LOC at a site but rather were areas upon which the additional investigation was focused. Factors considered during the determination of the AOCs included the following: number and magnitude of the exceedences related to the LOCs, whether the results could be attributable to natural background levels (e.g., metals and radiological parameters), mobility of the contaminants (e.g., low mobility of PCBs), toxicity based on existing toxicological data [e.g., low toxicity of NC and pentaerythritol tetranitrate (PETN)], and evidence of site-related anthropogenic contamination (e.g., explosives). Summaries of chemicals detected above LOCs in surface soil, subsurface soil, and groundwater are presented in **Table 2-1** and on **Figures 2-6 and 2-7**. Following identification of the AOCs, contamination at each site was evaluated in a human health risk assessment (HHRA).

2.2.3.1 AOC 1: Explosives Contamination of Surface Soil near Buildings 445 and 445-D

Explosives were detected in two surface soil samples collected near Buildings 445 and 445-D. The 2,4-DNT concentration of 17.9 milligrams per kilogram (mg/kg), identified in sample 109SS-2A, exceeds the LOC of 3.0 mg/kg (**Figure 2-6**). NC was also detected in this sample at a concentration of 33.9 mg/kg. In addition, PETN was identified in sample 109SS-4A at a concentration of 5.89 mg/kg. LOCs have not been established for NC or PETN.

Buildings 445 and 445-D were used for the mixing, manufacturing, and storage of pyrotechnics including single, double, and triple base propellants. Explosive and propellant materials including NC, nitroguanidine, nitroglycerin, and DNT were known to have been stored at Building 445-D.

Following the Round 1 sampling at Site 109, Building 445 and its auxiliary buildings were demolished under TECUP. Regulators commented that additional samples were required to re-characterize the extent of this AOC due to the regrading of the site. During the Round 2 investigation, four surface soil samples (109SS-5 to 109SS-8) were collected at the site and analyzed for explosives. One sample was collected within the footprint of the former building and the other three samples were collected on the southeast, southwest, and northwest sides of the former building. Explosives were not identified in excess of LOCs in the four samples. DNT was not detected above the reporting limit (RL = 0.250 mg/kg). The elevated DNT level reported in Round 1 sample 109SS-2A may have been re-located to the subsurface during the site regrading or consumed in the demolition by fire under TECUP. As a result, explosives contamination at Site 109 should no longer be considered an AOC.

As part of the completion of this FS, the complete set of Site 109 soils data was compared to NJDEP Soil Remediation Standards and USEPA Industrial Regional Screening Levels (IRSLs). Soils at Site 109 exceeded the NJDEP criteria for 2,4-DNT, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene in surface soil and arsenic and benzo(a)pyrene in subsurface soil. The USEPA Regional Screening Levels (RSLs) were exceeded for 2,4-DNT, arsenic, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and mirex in surface soil and arsenic and benzo(a)pyrene in subsurface soil. **Table 2-1** presents a summary of compounds which exceed LOCs. **Figure 2-6** presents all exceedences of either criteria.

Table 2-1
Site 109, Constituents Detected that Exceed LOCs

Constituents	Range of Detected Concentrations		LOC		Number of Exceedences/ Number of Samples[3]	
	min	max	NJ SRS	EPA RSL	NJ SRS	EPA RSL
Surface Soil (mg/kg)						
Benz(a)anthracene	0.28	5	2	2.1	2/6	2/6
Benzo(a)pyrene	0.47	5	0.2	0.21	5/6	5/6
Benzo(b)fluoranthene	0.36	6	2	2.1	2/6	2/6
Dibenz(a,h)anthracene	0.7	0.7	0.2	0.21	1/6	1/6
Indeno(1,2,3-c,d)pyrene	3	3	2	2.1	1/6	1/6
2,4-Dinitrotoluene	17.9	17.9	3	5.5	1/11	1/11
Mirex	0.42	0.42	none	0.096	0/6	1/6
Arsenic	7.12	16.1	19	1.6	0/6	3/6
Mercury	0.199	40	65	24	0/6	1/6
Subsurface Soil (mg/kg)						
Benzo(a)pyrene	0.052	4	0.2	0.21	3/12	3/12
Arsenic	2.78	51	19	1.6	1/15	1/15

Constituents	Range of Detected Concentrations		LOC		Number of Exceedences/ Number of Samples
	min	max	Value	Source	
Groundwater [(1)] (µg/L)					
Arsenic	1.58	12.0	3	NJPQL	5/9
Iron	5410	11800	300	Quality Criteria	3/3
Lead	3.5	23	5	Quality Criteria	8/9
Manganese	881	1190	50	Quality Criteria	3/3

Note: (1) U.S. Army Center for Health Promotion and Preventive Medicine relative risk site evaluation groundwater sampling results for Site PICA-203 are included in the Site 109 data set. Elevated arsenic and lead concentrations in Geoprobe samples may not be representative of aquifer conditions due to high turbidity associated with the sampling technique.
(2) Table 2-1 does not include results of Onsite Laboratories analyses as these results were unconfirmed. Tabulated results for all Onsite chemical detections are included in **Appendix D**. Onsite analytical results are included in the evaluation of Areas of Attainment in Section 3.0.
(3) Detections below Picatinny background levels were removed from the count.
EPA RSL = EPA Regional Screening Levels, Industrial Soil
LOC = Level of Concern
NJ SRS = Non-Residential Direct Contact Health Based Criteria and Soil Remediation Standards
NJPQL = New Jersey Practical Quantitation Limit
Quality Criteria = New Jersey Groundwater Quality Criteria

2.2.4 Summary of Risk Assessments

In the Phase II RI HHRA (Shaw, 2005b), estimated cancer risks and noncancer hazards were quantified for Site 109. Risk assessment details, including procedures used for the selection of constituents of potential concern (COPCs), chemical-specific factors and soil emission equations for COPCs, Site 109 risk tables, and risk assessment uncertainty analysis, are presented in the RI (Shaw, 2006a). The results of the Phase II HHRA for Site 109 are summarized in Section 2.2.4.1.

Soil samples collected at Site 109 were evaluated during the Phase II ecological risk assessment (ERA) (IT, 2000) to determine the potential ecological risk to terrestrial species using the site. The results of the Phase II ERA are summarized in Section 2.2.4.2.

As part of this FS, an additional risk assessment has been completed to evaluate groundwater ingestion pathways for both military resident and non-residential receptors. This risk assessment evaluated groundwater data throughout all of the subject sites in this FS, collectively designated the PICA-111 Sites, rather than on a site-specific basis. Risk assessment details are presented in

Appendix A and results from the Johnson and Ettinger Vapor Intrusion Model are presented in **Appendix B**. Results are summarized in Section 2.8.

2.2.4.1 Summary of HHRA Findings

As stated above, this section summarizes the results for the risk assessment performed for Site 109. For the results of the groundwater risk assessment performed for the PICA-111 group, please refer to Section 2.8. Estimated cancer risks and noncancer hazards quantified for realistic exposure scenarios are summarized as follows for current/future industrial research workers and current/future construction excavation workers. For the current/future industrial research worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, and volatilization of constituents in soil to ambient air followed by inhalation. For the current/future construction excavation worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, volatilization of constituents in soil to ambient air followed by inhalation, and dermal contact with constituents in groundwater. COPCs identified for each media are listed in **Table 2-2**.

These COPCs were generally selected based on risk-based concentrations (RBCs for target cancer risk of 10^{-6} and target noncancer hazard of 0.1) and potential ARARs (see Section 8.0 and risk summary Table 2s in the Phase II RI). A summary of estimated risks and hazards for the realistic exposure scenarios is presented in **Table 2-3**.

Table 2-2
Summary of Site 109 COPCs

COPCs by Media	Surface Soil	Subsurface Soil	Groundwater
Ammonia	X	X	X
Arsenic	X	X	X
Benz(a)anthracene	X		
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene	X		
Dibenz(a,h)anthracene	X		
Iron		X	X
Manganese	X	X	X
Mercury	X	X	

Table 2-3
Summary of Site 109 Estimated Risks and Hazards

Receptor (Current and Future)	Estimated Total Cancer Risk (RME unless noted)	Cancer Risk Driver(s) (contributing most to total risk)	Media Contributing Most to Cancer Risk
Industrial Research Worker	1.0E-4	Benzo(a)pyrene, Arsenic, Dibenz(a,h)anthracene, Benzo(b)fluoranthene, Benz(a)anthracene	Surface Soil
Construction Excavation Worker	4.5E-6	Arsenic, Benzo(a)pyrene	Subsurface Soil
Receptor (Current and Future)	**Estimated Total Noncancer Hazard (RME unless noted)**	**Noncancer Hazard Driver (contributing most to total hazard)**	**Media Contributing Most to Noncancer Hazard**
Industrial Research Worker	0.41	NR - hazards acceptable	NR - hazards acceptable
Construction Excavation Worker	1.9 (CT = 0.4)	Iron, Manganese, Arsenic	Subsurface Soil

RME = Reasonable Maximum Exposure
NR = Not Relevant. Cancer risk drivers and/or noncancer hazard drivers not presented because risks and/or hazards acceptable.
CT = Central Tendency

The estimated total cancer risk of 1.0E-4 for the industrial research worker scenario is based upon the following risks associated with the three exposure pathways evaluated and totaled: 1.3E-5 for ingestion, 5.6E-9 for inhalation, and 8.8E-5 for dermal contact. This estimated total risk is equal to the upper end of USEPA's target risk range of 10^{-4} to 10^{-6}.

The estimated total cancer risk of 4.5E-6 for the construction excavation worker scenario is based upon the following risks associated with the three exposure pathways evaluated and totaled: 3.1E-6 for ingestion, 2.7E-10 for inhalation, and 1.4E-6 for dermal contact. This estimated total risk is within USEPA's target risk range of 10^{-4} to 10^{-6}.

The estimated total hazards for industrial research worker are below USEPA's target noncancer hazard threshold of 1; however, the estimated total hazards for the construction excavation receptor are above the target noncancer hazard threshold of 1. The estimated total hazard for the construction excavation worker is below 1 when hazards are segregated by target organ. If the central tendency (CT) approach is used, based on average exposure point concentrations for the COPCs; the estimated total noncancer hazard for the construction excavation worker drops from 1.9 to 0.4.

A summary of the findings from the HHRA is presented as follows:

Based on the current use of Picatinny, HHRAs were conducted for an industrial research worker exposure to surface soil and a construction excavation worker exposure to subsurface soil. The results of the HHRA for the soil exposures indicate the estimated total cancer risk for the industrial research worker is equal to the upper end of USEPA's target risk range of 10^{-4} to 10^{-6}. The primary risk drivers identified in the surface soil are polycyclic aromatic hydrocarbons and arsenic. However, arsenic concentrations detected in the surface soil did not exceed the NJDEP Soil Remediation Standard of 19 mg/kg. The estimated total hazards for surface soil exposure are below USEPA's target noncancer hazard threshold of 1. The estimated total risk for the construction excavation worker is within USEPA's target risk range. However, the total hazard for subsurface soil exposure is below the threshold of 1 after accounting for the separation of hazards by target organ. The primary hazard drivers identified in the subsurface soil are arsenic, iron, and manganese. However, iron and manganese were not reported above their respective LOCs in the subsurface soil samples. Explosives were not identified as risk or hazard drivers in the soil.

2.2.4.2 Ecological Risk Assessment

Soil samples collected at Site 109 during the Round 1 investigation were evaluated during the Phase II ERA (IT, 2000) to determine the potential ecological risk to terrestrial species using the site. Results of the food-chain modeling indicate potential risk to terrestrial feeding wildlife is minimal. Ecological Effects Quotients (EEQs), the ratio of the measured concentration to the LOC, representing a type of "normalization" of the data, were calculated for the constituents of potential ecological concern (COPECs). EEQs for the COPECs were less than 1 for all chemicals except for arsenic (EEQ of 10) and mercury (EEQ of 5.9) in the white-footed mouse. Thus, the levels of chemicals in the soil samples most likely present minimal risk to populations of terrestrial species.

2.2.4.3 Site 109 Risk Assessments Conclusions

Based on the HHRA results, the excess cancer risk level for the industrial research worker scenario is equal to the upper bound of the USEPA target risk range. Therefore, RAOs will be established to address this risk level. Excess cancer risk for the construction excavation worker scenario was within the USEPA target risk range. Estimated total noncancer hazards were below the target threshold of 1, when the hazards are segregated by target organ or when the CT approach is used in favor of the reasonable maximum exposure (RME). In addition to the identified risk for the industrial research worker scenario, there are exceedences of NJDEP Soil Remediation Standards.

The establishment of RAOs for the protection of human health will be determined based on these risk assessment results and a comparison of soils data from this site to NJDEP Soil Remediation Standards. Comparison of soils data to the USEPA IRSLs will also be factored into the remedy. This process is addressed in Section 3 of this document.

There is no unacceptable risk to ecological receptors at Site 109. Therefore, no RAOs will be established for the protection of ecological receptors.

2.3 SITE 125 – BUILDINGS 172 AND 183, OFFICE BUILDING AND LUBRICANT TESTING AREA

2.3.1 Site History

Site 125 is approximately 1.5 acres in area and consists of Buildings 172 and 183. Building 172 is an office building, while Building 183 is a lubricant testing area. Site 125 is presented on **Figure 2-8**.

Building 172 is a two-story rectangular building with a basement. The building was constructed in 1942 as an ordnance administration building and is still used for administrative purposes. Building 172 has brick walls and a concrete foundation.

The original one-story portion of Building 183 was constructed in 1945. A two-story addition was completed in 1963. The building has brick walls and a concrete foundation.

Several different waste streams have been produced at Building 183 as a result of lubricant testing operations. These waste streams included: petroleum oil and lubricants, oily rags, speedi-dry contaminated with solvents, mixed solvents, mixed acid and base solutions, resins, cooling water, salt water, and sulfur-based cutting fluid. Only small quantities (less than 15 gallons) of each waste type have been generated yearly. The waste streams are containerized and stored on the floor inside the building.

According to Picatinny documentation, two PCB-containing transformers were located at Building 183. One of the transformers caught fire in March 1989 and subsequently spilled PCB-contaminated oil. This spill was reportedly cleaned up. Dames and Moore noted in a 1991 site reconnaissance that the two transformers had been removed. Dames and Moore also noted that a trench was located along the west side of Building 183 in the area of the two former PCB-containing transformers. Six 55-gallon drums labeled “PCB soils” were observed next to the trench. According to the Phase I RI Report, it appeared that the trench and drums were associated with a PCB removal action at Building 183; however, specific information regarding this action was unavailable (Dames and Moore, 1998). These drums have since been removed.

In the 1991 Water Discharge Investigation Report, Foster Wheeler noted several large corrugated pipes that discharged liquid material to a stream northwest of Building 183. The pipes were located on the east, southeast, northwest, and southwest sides of Building 183 and were connected to three sinks and four floor drains inside the building.

2.3.2 Previous Investigations

The initial field investigation of Site 125 was performed under the purview of the U.S. Army, USEPA Region II, and NJDEP from 1993 through 1994 as part of the Phase I RI conducted by Dames and Moore (Dames and Moore, 1998). Six surface soil samples were collected during the Phase I RI and analyzed for volatile organic compounds (VOCs), SVOCs, metals, and cyanide. Two samples were also analyzed for pesticides and PCBs.

Additional field activities were conducted at Site 125 in October and November 2000 and included the collection of four subsurface soil samples from four locations.

Section 2.3.3 of this FS summarizes all results pertaining to Site 125.

2.3.3 Nature and Extent of Contamination

Based on the NJDEP’s recommendation that subsurface soil samples be collected at Site 125 during the Phase I 2A/3A RI, the following AOC was identified for the site at that time:

1. Potential PCB contamination on the western side of Building 183.

AOCs represent those areas within each site that required additional investigation to complete the characterization of the extent of contamination associated with the AOC. The AOCs do not include every single exceedence of LOCs at a site. Factors considered during the determination of the AOCs included the following: number and magnitude of the exceedences relative to the LOCs, whether the results could be attributable to natural background levels (e.g., metals and radiological parameters), mobility of contaminants (e.g., low mobility of PCBs), toxicity based on existing toxicological data (e.g., low toxicity of NC and PETN), and evidence of site-related anthropogenic contamination (e.g. explosives). Following investigation of the AOCs, contamination at each site was evaluated in an HHRA.

2.3.3.1 AOC 1: Potential PCB Contamination on the Western Side of Building 183

Site 125 was included as part of the Phase I RI conducted by Dames and Moore in 1995. Soil samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and cyanide. The analytical results indicated that no analytes were detected at concentrations above comparison criteria. Although no analytes were detected above their respective comparison criteria, the NJDEP recommended that subsurface soil samples be collected during the Phase I 2A/3A RI from the location of the former trench on the western side of Building 183 (at the location of the two transformers that burned in 1989).

Four subsurface soil samples were collected from the western side of Building 183 during the Phase I 2A/3A RI field investigation and analyzed for PCBs (**Figure 2-8**). The former trench was estimated to be approximately 3 ft bgs. Sample depths ranged from 3.7 to 7 ft bgs. The analytical results indicated that no PCBs were detected within any of the samples collected at the site. Based on the results of the RIs conducted by Dames and Moore and IT Corporation (IT), Site 125 has not been impacted by previous site activities.

Investigation of this site included the collection of numerous surface and subsurface soil samples from all areas of potential contamination established based upon the site history. As a part of the completion of this FS, the complete set of Site 125 soils data was compared to NJDEP Soil Remediation Standards and USEPA IRSLs. This comparison identified that there were no exceedences for either surface or subsurface soil at Site 125. Because there were no exceedences of either the NJDEP Industrial Soil Remediation Standards (ISRS) or the USEPA IRSLs, the site data was further screened against the USEPA Residential RSLs. This screening identified exceedences of the residential level for benzo(a)anthracene (0.15 mg/kg) in five samples and benzo(b)fluoranthene (0.15 mg/kg) in two samples.

2.3.4 Summary of Risk Assessments

2.3.4.1 Summary of HHRA Findings

Based on the HHRA approach (Shaw, 2005a), estimated cancer risks and noncancer hazards were re-calculated for the site using data from both the Phase I RI investigation (Dames and Moore, 1998) and the Phase I 2A/3A data. Chemicals were selected if the constituent was a risk or hazard driver identified in the Dames and Moore (1998) risk assessment (i.e., it contributed a majority of the total estimated cancer risk or total noncancer hazard). However, constituents that had a cancer risk less than or equal to 1E-06 or a noncancer hazard less than or equal to 1 were not selected as COPCs. Results of the HHRA performed during the Phase I RI (Dames and Moore, 1998) indicate that the carcinogenic risk is below the target cancer risk range of 1E-06 to 1E-04 for future industrial/research workers, current outdoor maintenance workers, and future construction workers at 4E-07, 3E-08, and 1E-07, respectively. The non-carcinogenic hazard falls below the target value of 1.0 for all three populations. The results of the Phase I 2A/3A field investigation indicated that all subsurface soil samples were non-detect. Therefore, no COPCs were selected for Site 125 and the estimated cancer risks for the industrial/research worker, outdoor maintenance worker, and construction worker are acceptable.

2.3.4.2 Ecological Risk Assessment

No ERA was performed at Site 125. The screening level ERA (SLERA) (Shaw, 2005c) concluded that there is a potential for risk to terrestrial wildlife, if exposures were significant; however, the majority of the area is paved and is located within a high human-use part of Picatinny. Building 183 is surrounded on two sides by roads and very little suitable habitat exists for most species. In addition, there is no migration pathway to Robinson Run, because Robinson Run travels via an underground pipe beneath the site.

2.3.4.3 Site 125 Risk Assessment Conclusions

Based on the HHRA results, all excess cancer risk levels are below $1x10^{-6}$, and estimated total noncancer hazards are below 1. Based on the results of the HHRA and lack of exceedences of comparison criteria, no RAOs will be necessary for Site 125. However, there were exceedences of residential USEPA RSLs. Therefore, LUCs will be maintained at the site to ensure that the current-protective land use continues.

There is no unacceptable risk to ecological receptors at Site 125. Therefore, no RAOs will be established for the protection of ecological receptors.

2.4 SITE 142, FORMER BUILDING 435, PROPELLANT PROCESSING PLANT

2.4.1 Site History

Site 142 (**Figures 2-9 and 2-10**) consists of former Building 435 and the surrounding area, which encompasses approximately 0.18 acres. Former Building 435 was a one-story, 432 SF brick and concrete structure that was constructed in 1918. Information regarding the use of Building 435 was unavailable for the years between 1918 and 1950. In the early 1950s, the building was used for pulverizing operations in the preparation of experimental propellants. The activities involved the mixing of potassium nitrate with sulfur and charcoal to form black powder. Potassium perchlorate was then mixed with the black powder to make a detonating agent. Pulverizing operations at Building 435 ceased in 1976. According to Picatinny personnel, the building was subsequently used to mix solvents for propellant production. The 1991 Argonne National Laboratory (ANL) RI Concept Plan indicated that ethyl acetate and acetone were potentially used in Building 435. No information was available on when solvent mixing operations were discontinued. Building 435 was inactive when it was demolished in September 2000.

A deteriorated wooden trough extended to an open “seep” pit located approximately 30 ft west of Former Building 435. The pit was 4-ft x 4-ft and was 3 ft in depth. Wash water from Building 435 was directed to the seep pit via the trough. The seep vat may have been an infiltration gallery through which water was discharged to the subsurface soil and groundwater. No information was available regarding the use of the trough or the open pit. The seep vat and trough were demolished and removed from Site 142 by Picatinny Public Works in September 2000.

A Resource Conservation and Recovery Act (RCRA) closure was performed at Former Building 435 in 1991. However, in a December 1992 letter, NJDEP stated that the closure was incomplete due to a soil concentration that was greater than the proposed NJDEP cleanup standard for copper. NJDEP indicated that Former Building 435 would require further investigation under CERCLA.

2.4.2 Previous Studies

RCRA Closure Weston, 1991

In 1991, Weston Environmental performed closure activities at Former Building 435 according to the approved closure plan. Two wipe samples were analyzed for priority pollutant metals (except thallium), and two surface soil samples were analyzed for VOCs and priority pollutant metals (except silver and thallium) plus barium. Two surface soil samples were collected outside Former Building 435. The samples were analyzed for target and non-target VOCs and metals. In addition, one surface soil sample was analyzed for target compound list (TCL) and non-TCL base neutrals/acid extractables (BNAs) and PCBs. Chromium, copper, lead, and zinc were detected in both wipe samples. Antimony, arsenic, cadmium, and silver were detected in one of the two wipe samples. The analytical results indicated that copper, detected at 2,100 mg/kg in sample SS-2, was the only COC detected above comparison criteria in the surface soil samples. The NJDEP criterion for total organic contaminants was also exceeded in sample SS1, primarily due to the contribution from Non-TCL BNAs.

Phase I 2A/3A RI

Phase I 2A/3A RI sampling activities at Site 142 were conducted from August 2000 through February 2004. Limited groundwater monitoring of the site has been ongoing since 2004. The sampling program for Site 142 included:

1. Collecting 15 surface soil samples.
2. Collecting 10 subsurface soil samples.
3. Collecting 5 surface water samples.
4. Installing, developing, surveying, and sampling 3 monitoring wells.

5. Collecting 19 groundwater samples from 11 piezometers, 2 Geoprobe points, 1 hydropunch, and the 3 installed monitoring wells.
6. Ongoing monitoring of well 142MW-1 has been carried out since its installation. Samples have been collected from this well and analyzed for perchlorate in 2004, 2006, 2008, and 2009.

Section 2.4.3 of this FS summarizes all results pertaining to Site 142.

2.4.3 Nature and Extent of Contamination

Based on the analytical results of the surface and subsurface soil, surface water, and groundwater samples collected from Site 142 during the Phase I 2A/3A RI, the following AOCs (**Figure 2-9**) have been identified at the site:

1. Copper contaminated surface soil.
2. Potential contamination associated with the seep vat and trough.
3. Perchlorate contamination in soil and groundwater.

AOCs were identified in the RI as those areas within each site that required additional investigation to complete the characterization of the extent of contamination. The AOCs do not include every single exceedence of LOCs at a site. Factors considered during the determination of the AOCs included the following: number and magnitude of the exceedences relative to the LOCs, whether the results could be attributable to natural background levels (e.g., metals and radiological parameters), mobility of contaminants (e.g., low mobility of PCBs), toxicity based on existing toxicological data (e.g., low toxicity of NC and PETN), and evidence of site-related anthropogenic contamination (e.g. explosives). Following investigation of the AOCs, contamination at each site was evaluated in an HHRA. Summaries of chemicals detected above LOCs in surface soil and groundwater are presented in **Table 2-4**. There were no LOC exceedences identified in the subsurface soil and surface water samples.

2.4.3.1 AOC 1: Copper Contaminated Surface Soil

Copper was the only compound detected above soil comparison criteria in use at that time (sample SS-2, 2,100 mg/kg) during the 1991 RCRA closure. The current NJDEP ISRS for copper is 45,000 mg/kg. In order to delineate the extent of copper contamination at Site 142, additional soil samples were collected as part of the Phase I 2A/3A RI field investigation.

Former sample SS-2 was recollected during the Phase I 2A/3A RI along with two surface soil samples (142SS-3A and 142SS-4A) around former sample location SS-2 (**Figure 2-9**). Soil sample 142SS-5B was also collected from 1-2 ft bgs beneath SS-2 to determine the vertical extent of contamination. In addition to the copper analysis, the samples were analyzed for silver and thallium, because these compounds were not evaluated during the previous investigation.

The analytical results indicated that copper was detected below the LOC in the four soil samples collected as part of the Site 142 investigation. Additionally, silver was not identified at concentrations greater than the LOC in surface soil. Thallium was also not detected in any of the surface soil samples. Therefore, it appears that the copper concentration observed in 1991 was an isolated occurrence. The copper contamination may have been removed or relocated during the demolition of the building and subsequent regrading of the site in 2000. Additionally, it should be noted that the original level of copper detected in 1991 does not exceed the current NJDEP ISRS.

Table 2-4
Site 142, Constituents Detected that Exceed LOCs

Constituents	Range of Detected Concentrations		LOC		Number of Exceedences/ Number of Samples[2]	
	min	max	NJ SRS	EPA RSL	NJ SRS	EPA RSL
Surface Soil (mg/kg)						
Lead	6.5	103000	800	800	1/8	1/8
Benzo(a)pyrene	0.48	0.48	0.2	0.21	1/2	1/2
Constituents	**Range of Detected Concentrations**		**LOC**		**Number of Exceedences/ Number of Samples**	
	min	**max**	**Value**	**Source**		
Groundwater (µg/L)						
Aluminum	210	240	200	Quality Criteria	2/2	
Iron	270	310	300	Quality Criteria	1/2	
Manganese	48	55	50	Quality Criteria	1/2	
Perchlorate	10.8	627	5	Quality Criteria[1]	7/34	

Note: (1) NJDEP DRAFT perchlorate standard
(2) Exceedences below Picatinny background levels were removed from the count.
EPA RSL = EPA Regional Screening Levels, Industrial Soil
LOC = Level of Concern
NJ SRS = Non-Residential Direct Contact Health Based Criteria and Soil Remediation Standards
NJPQL = New Jersey Practical Quantitation Limit
Quality Criteria = New Jersey Groundwater Quality Criteria

2.4.3.2 AOC 2: Potential Contamination Associated with the Seep Vat and Trough

The seep pit and trough, which extended westward from Building 435, were used to discharge wash water from building operations. The seep pit is believed to have been an infiltration gallery or dry well through which the wash water discharged directly to the subsurface soil and groundwater. Materials used in Building 435, which may have been discharged to the pit, include VOCs such as acetone, and propellants such as the nitroesters and potassium perchlorate.

The seep vat and trough were never inspected as part of any investigation conducted at Site 142. However, one hydropunch groundwater sample (FHP-4) was collected downgradient of the seep vat during the field investigation of Areas F&G. Preliminary results from the sample indicated concentrations of aluminum (27,000 µg/L), arsenic (8.8 µg/L), lead (25 µg/L), iron (32,400 µg/L), and manganese (280 µg/L) in excess of their respective LOCs. Therefore, the NJDEP requested that the former seep vat be inspected during the Phase I 2A/3A RI field investigation to determine its construction and present condition.

One surface soil sample was collected from both the seep vat (142SD-1A) and trough (142SD-2A), and one shallow monitoring well (142MW-1) was installed downgradient of the vat to a depth of 13 ft bgs during the Phase I 2A/3A RI. One subsurface soil sample was collected from the boring for monitoring well 142MW-1 at a depth of 2-3 ft bgs. One of the two soil samples and the groundwater sample collected from the well were analyzed for VOCs, SVOCs, metals, explosives, PETN, nitroglycerine, nitroguanidine, and NC. VOCs were not collected from sample location 142SD-1A, as the seep vat had been demolished when IT personnel returned to the site to collect the VOC samples. Additionally, the groundwater sample was analyzed for perchlorate, as potassium perchlorate was used at former Building 435.

The analytical results indicated that lead was the only parameter with a LOC exceedence in soil (**Figure 2-9**). Lead (103,000 mg/kg) exceeded soil comparison criteria in sample 142SD-1A. NC was detected at concentrations of 121 mg/kg and 8.50 mg/kg in samples 142SD-1A and 142SD-2A, respectively. No LOC has been established for this compound. SVOCs, explosives, and the nitroesters

were not detected above LOCs in samples collected from the seep vat, trough, and monitoring well boring. The extent of lead contamination was confined to the seep vat as evidenced by the low lead levels detected in downgradient soil borings 142MW-1B (60.9 mg/kg), 142SB-1A (173 mg/kg), and 142SB-1B (11.6 mg/kg). The groundwater sample collected from monitoring well 142MW-1 had concentrations of aluminum (225 μg/L) and manganese (51.5 μg/L) that exceeded groundwater comparison criteria. Analytical results exceeding LOCs in groundwater are presented on **Figure 2-10**. Additionally, perchlorate was detected at a concentration of 616 μg/L, which exceeds the LOC of 5 μg/L by two orders of magnitude. Perchlorate contamination at Site 142 is discussed below in detail (AOC 3).

The seep vat and trough were demolished and removed from Site 142 by Picatinny Public Works in September 2000. Any soil-like material within the seep vat (142SD-1A) was also removed from the site with the seep vat and trough. No chemical exceedences were identified in the sample collected under the trough (142SD-2A). In order to investigate the concentrations of lead that may have migrated into the soil below the wooden seep vat and trough, a removal action was conducted at AOC 2 between May and June 2004. Approximately 15 cubic yards (CY) of soil were removed from under the former structure and transported to former Building 1033 at Picatinny. The soil was staged in this area until it was disposed off-site as non-hazardous waste at the Edgeboro landfill. A total of five post-excavation samples were collected from the sidewalls of the excavation as well as the excavation bottom. Based on a review of historical data, all samples were analyzed for lead and perchlorate. The analytical results indicated that lead was identified well below the LOC of 600 mg/kg in all five samples. Perchlorate concentrations ranged from non-detect (EQL=0.0124 mg/kg) to 0.102 mg/kg. No LOC has been established for perchlorate in soil. Based on the analytical results, the excavation was backfilled with clean soil and no additional excavation activities were conducted at Site 142.

2.4.3.3 AOC 3: Perchlorate Contamination in Soil and Groundwater

Since potassium perchlorate was used in site operations and could have been discharged to the seep vat, monitoring well 142MW-1 was installed downgradient of the seep vat and analyzed for perchlorate in addition to other compounds. The groundwater sample from 142MW-1 contained a perchlorate concentration of 616 μg/L, which exceeds the LOC of 5 μg/L. Based on the elevated perchlorate concentration detected in 142MW-1, several additional surface soil, subsurface soil, surface water, and groundwater samples were collected at Site 142 in order to characterize the nature and extent of perchlorate in all media types.

Additional samples were collected at Site 142 from April 2001 through July 2009 in order to further characterize the potential perchlorate contamination at the site. Eight surface soil samples were collected from a depth of 0-1 ft bgs; eight subsurface soil samples were collected from depths of 3-4 ft bgs; one soil boring was installed to a depth of 2-3 ft bgs and sampled at two depths; two monitoring wells were installed upgradient and vertically downgradient of 142MW-1; a soil removal action was conducted at the site of the former wooden seep vat and trough; five surface water samples were collected from GPB; and groundwater samples were collected from three monitoring wells (142MW-1, 142MW-2, and 142MW-3), two Geoprobe points, one hydropunch location, and eleven piezometers. All samples were analyzed solely for perchlorate.

Following identification of perchlorate in groundwater at 142MW-1, a soil boring (142SB-1) was drilled approximately 5 ft downgradient from the well. Perchlorate was detected in both samples collected from the soil boring. Perchlorate was detected in sample 142SB-1A (0-1 ft bgs) at a concentration of 0.516 mg/kg, and in sample 142SB-1B (2-3 ft bgs) at a concentration of 0.459 mg/kg. No LOC has been established for this compound in soil. In response to the detection of perchlorate in the surface and subsurface soil sample from 142SB-1, soil samples were collected from a small grid around 142MW-1. Eight soil borings were advanced on 40-foot centers around 142MW-1. Surface soil (0-1 ft bgs) and subsurface soil (3-4 ft bgs) samples were collected from each boring and analyzed for perchlorate. The analytical results indicated perchlorate was not detected in surface soil samples 142SS-101 through 142SS-108 and subsurface soil samples 142SB-101 through 142SB-108.

During the 2004 removal action conducted in support of AOC 2, impacted soil was removed to a depth of 5.0 ft bgs at the location of the former wooden seep vat and trough. Post-excavation samples were collected from the four sidewalls of the excavation as well the excavation bottom and analyzed for perchlorate. Sidewall samples were collected at depths ranging from 2.0 to 2.5 bgs. Perchlorate was

identified in the sidewall samples at concentrations ranging from non-detect (EQL=0.0124 mg/kg) to 0.102 mg/kg. The bottom sample had a perchlorate concentration of 0.0714 mg/kg.

Delineation of the extent of groundwater contamination involved the installation/sampling of three monitoring wells, three well points, and eleven piezometers. Two monitoring wells (142MW-2 and 142MW-3) were installed vertically downgradient and upgradient of monitoring well 142MW-1, respectively, and sampled for perchlorate. In addition, monitoring well 142MW-1 was resampled for perchlorate. Two well points (142HP-1 and 142GP-3) were installed upgradient of the site. The third well point (142GP-2) was installed downgradient of the site, approximately half way between former Building 435 and GPB. The 11 piezometers were installed downgradient of the site along the shore and floodplain of GPB. Perchlorate was identified in three groundwater samples. Sample 142GP-2 had a perchlorate level of 76.1 μg/L and perchlorate was detected in monitoring well 142MW-1 at concentrations of 56.65 μg/L during the May 2001 sampling event and 10.8 μg/L during the February 2004 sampling event. Subsequent sampling rounds were conducted in August 2006, November 2008, and July 2009. All samples were analyzed for perchlorate. Perchlorate results were ND, 7.1 micrograms per kilogram (μg/kg), and 1.6 μg/kg in these three subsequent sampling rounds. Therefore, only one of the past three rounds exhibited concentrations of perchlorate in excess of the LOC of 5 μg/kg. Perchlorate was not detected in samples 142HP-1 or 142GP-3 located upgradient of the site or the 11 piezometers installed adjacent to GPB. Additionally, no detections of perchlorate were identified in surface water samples 142SW-1 through 142SW-5 collected from GPB (downgradient of Site 142). GPB is the discharge point for shallow groundwater in this area.

Based on the sampling conducted at Site 142, the horizontal extent of this AOC has been delineated to the area immediately downgradient of the former seep vat. Perchlorate has not impacted GPB. The perchlorate is believed to be site-related (i.e., use of potassium perchlorate), and based on the results of the post-excavation samples, it is probable that the contamination originated from former Building 435.

As part of the completion of this FS, the complete set of Site 142 soils data was compared to NJDEP Soil Remediation Standards and USEPA IRSLs. Soils at Site 142 exceeded the NJDEP criteria for lead and benzo(a)pyrene, in surface soil. However, the lone lead exceedence was at location 142SD-1A which was subsequently remediated. There were no exceedences in subsurface soil. **Table 2-4** presents a summary of compounds which exceed LOCs. **Figure 2-9** presents all exceedences of the NJDEP criteria.

2.4.4 Summary of Risk Assessments

During the Phase I 2A/3A RI (Shaw, 2005a), estimated cancer risks, noncancer hazards, and lead hazards were quantified for the site. Risk assessment details, including procedures used for the selection of site COPCs (**Table 2-5**), chemical-specific factors and soil emission equations for COPCs, lead exposure assessment, Phase I 2A/3A RAGS-D tables, summary of future hypothetical risk scenarios, and RA uncertainty analysis, are presented in the RI (Shaw, 2005a). The results of the Phase I 2A/3A HHRA for Site 142 are summarized in Section 2.4.4.1.

No ERA was performed at Site 142; however, Section 2.4.4.2 presents the results of a SLERA performed at Site 142, which determined that no further ERA was necessary for the site.

An additional risk assessment has been completed to evaluate groundwater ingestion pathways for both military resident and non-residential receptors. This risk assessment evaluated groundwater data throughout the PICA-111 Sites, rather than on a site-specific basis. Results are presented in Section 2.8.

2.4.4.1 Summary of HHRA Findings

As stated above this section summarizes the results for the risk assessment performed for Site 142. For the results of the groundwater risk assessment performed for PICA-111 group of sites, please refer to Section 8. Estimated cancer risks, noncancer hazards, and lead hazards quantified for realistic exposure scenarios are summarized as follows for current/future industrial research workers and current/future construction excavation workers. For the current/future industrial research worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, and volatilization of constituents in soil to ambient air followed by inhalation. For the

current/future construction excavation worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, volatilization of constituents in soil to ambient air followed by inhalation and dermal contact with constituents in groundwater. Hypothetical future scenario risks and hazards are presented in the RI for future adult and child residents. COPCs identified for each media at Site 142 are presented in **Table 2-5**.

These COPCs were generally selected based on RBCs, for target cancer risk of 1E-06 and target noncancer hazard of 0.1, and potential ARARs (see Section Q.2 and RAGS-D Table 2s in Section Q.5 of the Phase I 2A/3A RI). A summary of estimated risks and hazards for the realistic worker exposure scenarios (current and future) as well as future hypothetical residential exposure scenarios is presented in **Table 2-6**.

Table 2-5
Summary of Site 142 COPCs from the HHRA

COPCs by Media*	Surface Soil	Subsurface Soil	Surface Water (Not Applicable)	Sediment (Not Applicable)	Groundwater
Aluminum					X
Arsenic	X	X			
Chloroform					X
Lead	X				
Manganese					X

*COPC selection based on industrial use.

Table 2-6
Summary of Site 142 Estimated Risks and Hazards

Receptor (Current and Future)	Estimated Total Cancer Risk (RME unless noted)	Cancer Risk Driver(s) (contributing most to total risk)	Media Contributing Most to Cancer Risk
Industrial Research Worker	7.7E-06	Arsenic	Surface Soil
Construction Excavation Worker	2.5E-07	NR – risks acceptable	NR – risks acceptable
Adult Resident	6.1E-05	Benzo(a)pyrene, Arsenic	Soil
Child Resident	3.9E-05	Benzo(a)pyrene, Arsenic	Soil
Receptor (Current and Future)	**Estimated Total Noncancer Hazard (RME unless noted)**	**Noncancer Hazard Driver (contributing most to total hazard)**	**Media Contributing Most to Noncancer Hazard**
Industrial Research Worker	0.048	NR – hazards acceptable	NR – hazards acceptable
Construction Excavation Worker	0.041	NR – hazards acceptable	NR – hazards acceptable
Adult Resident	1	NR – hazards acceptable	NR – hazards acceptable
Child Resident	4.8	Antimony, Cadmium	Soil

RME = Reasonable Maximum Exposure
NR = Not Relevant. Cancer risk drivers and/or noncancer hazard drivers not presented because risks and/or hazards acceptable.

The estimated total cancer risk of 7.7E-06 for industrial research worker scenario is based upon the following risks associated with the three exposure pathways evaluated and totaled: 1.3E-06 for ingestion, 1.5E-09 for inhalation, and 6.4E-06 for dermal contact. The estimated total cancer risk of 2.5E-07 for construction excavation worker scenario is based upon the following risks associated with the three exposure pathways: 1.6E-07 for ingestion, 2.0E-11 for inhalation, and 9.8E-08 for dermal contact with subsurface soil and groundwater. The estimated total hazards for industrial research worker and construction excavation worker scenarios are below USEPA's target noncancer hazard threshold of 1. The estimated RME risks and hazards for the realistic exposure scenarios are within or below USEPA's target cancer risk range of 1E-04 to 1E-06 and USEPA's target noncancer hazard threshold of 1 for the evaluated receptors.

The estimated risks for the hypothetical future residential scenarios are within or below USEPA's target cancer risk range of 1E-04 to 1E-06. The estimated hazards are above USEPA's target noncancer hazard threshold of 1 for child residential exposure to antimony and cadmium in soil. However, current and reasonably anticipated land use is expected to remain industrial.

The adult lead model results listed in **Table 2-7** indicated lead concentrations in surface soil were a concern for the industrial research worker and lead concentrations in surface and subsurface soil were a concern for the future residential adult. The average lead concentration exceeded the lead model-derived preliminary remediation goals (PRGs) for heterogeneous and homogeneous receptor populations.

Table 2-7
Summary of Site 142 Adult Lead Model Results

Receptor	Media	Media Lead Concentration (Avg. mg/kg)	Lead Model PRGs (mg/kg) (GSDs = 2.1-1.8)	Exceedence?
Industrial Research Worker	Surface Soil	34,560(1)	778 – 1,354	Yes
Construction Excavation Worker	Subsurface Soil	Lead not selected as COPC in this medium.	162 – 282	--
Future Adult Resident	Mixed Surface and Subsurface Soil	20,800(1)	278-483	Yes

(1) Elevated lead concentrations were primarily due to sample 109SD-1A (103,000 mg/kg), collected from within the seep vat located west of former Building 435, prior to its removal.

There are site-specific uncertainties associated with the HHRA for Site 142. One of the uncertainties is related to the fact that although groundwater data collected using both Geoprobe hydropunch sampling and monitoring well sampling were available, only the monitoring well data were used, because the Geoprobe data were deemed inappropriate for RA purposes. This may have resulted in an underestimation of groundwater risks and hazards; however, as Geoprobe sampling is thought to result in unrealistically elevated COPC concentrations in groundwater samples, due to increased turbidity, this potential underestimation of risk and hazard is deemed insignificant. Another uncertainty is related to the assessment of VOCs (e.g., chloroform) in groundwater at the Site. The off-gassing of VOCs from groundwater to air was not quantified for industrial research workers or construction excavation workers; therefore, this exposure pathway was potentially underestimated. Finally, perchlorate was not selected as a COPC in either soil or groundwater because no toxicity data were available for this constituent and this represents an uncertainty. A summary of the findings from the HHRA, by AOC, is presented as follows.

AOC 1: Copper Contaminated Surface Soil. Based on the current uses of Picatinny, an HHRA was conducted for an industrial research worker and a construction excavation worker. The HHRA results indicated that the carcinogenic risk falls within or below the target range (1E-04 to 1E-06) for both receptors. Arsenic is identified as the primary risk driver in surface soil. Arsenic was not detected in excess of NJDEP comparison criteria in samples collected during the Phase I RI and was not analyzed for during the Phase I 2A/3A RI. The non-carcinogenic hazard does not exceed the hazard index (HI) criterion of 1 for any population.

AOC 2: Potential Contamination Associated with the Seep Vat and Trough. Based on the current uses of Picatinny, an HHRA was conducted for an industrial research worker and a construction excavation worker. The HHRA results indicated that the carcinogenic risk falls within or below the target range (1E-04 to 1E-06) for both receptors. Arsenic is identified as the primary risk driver in surface soil. Arsenic was not detected above LOCs in samples collected at this AOC. The non-carcinogenic hazard does not exceed the HI criterion of 1 for any population. The adult lead model results indicate lead concentrations in surface soil were a concern for an industrial research worker.

The seep vat and trough were demolished and removed from Site 142 by Picatinny Public Works in September 2000. Any soil-like material within the seep vat (i.e., 142SD-1) also was removed from the site with the wooden seep vat and trough. Additionally, the soil from underneath these structures was removed as part of the Facility-Wide Lead Removal Action in May 2004. Approximately 15 CY of soil were removed from the site of the former wooden seep vat and trough. Removal of lead contaminated soil was confirmed by the analysis of post-excavation samples collected from the four sidewalls of the excavation and excavation bottom. Post-excavation results did not identify lead concentrations above the LOC. The results of the soil removal (including analytical results) were included in the *Lead Removal Action Data Report* (Shaw, 2005d).

AOC 3: Perchlorate Contamination in Soil and Groundwater. Based on the current uses of Picatinny, an HHRA was conducted for an industrial research worker and a construction excavation worker. However, perchlorate was not selected as a COPC for the HHRA because no toxicity information was available for this compound at that time. (Please refer to **Section 2.8** for the results of the subsequent HHRA for exposure to PICA-111 groundwater, which includes evaluation of perchlorate as a COPC based on current toxicological information.)

2.4.4.2 Ecological Risk Assessment

No ERA was performed at Site 142. Site 142 lies between GPB and a paved road. The area was once located within a high human-use, highly industrialized part of Picatinny. However, since Building 435 was demolished in September 2000, the site has reverted to a more natural state and has become more suitable for terrestrial species. A SLERA was performed at Site 142 to determine whether a baseline ERA (BERA) is necessary for the site. The maximum detected chemical concentrations in each media were compared to ecological LOCs for the applicable media. Several inorganic constituents were found at concentrations above their ecologically based screening values.

Though copper had been previously detected in surface soils near the southwest side of Building 435, subsequent sampling did not confirm these results. Any contamination may have been removed during demolition. Soil samples from the seep vat showed elevated levels of lead as well as the presence of NC. Soil contamination was limited to the seep vat. The seep vat and trough were demolished and removed from Site 142 in 2000 and any soil-like material within the seep vat was also removed from the site. This area was backfilled and regraded once the seep vat and trough were removed. Though Building 435 has been demolished, the Site lies within a high human use, industrialized part of Picatinny. However, there is some wooded and shrubby habitat that may be used by ecological receptors. The only apparent contamination at Site 142 is perchlorate in groundwater. Samples from GPB, a potential discharge point for shallow surface water, did not contain detectable levels of perchlorate. As there are no complete exposure pathways for ecological receptors from groundwater or at GPB and the area of potential exposure to wildlife is extremely limited, an ERA was not warranted (Shaw, 2005c).

2.4.4.3 Site 142 Risk Assessments Conclusions

Based on the HHRA results, all excess cancer risk levels are within or below the USEPA target risk range. Therefore, RAOs will be established based on these risk levels. Estimated noncancer hazards indicated that the hazard to child residents is greater than the target threshold of 1. However, the current and future use of the site is expected to remain industrial for the foreseeable future. In addition to the identified hazard for the child resident receptor, there are exceedences of NJDEP ISRS and USEPA IRSLs.

RAOs will be established based on the HHRA and for the exceedence of NJDEP Soil Remediation Standards for benzo(a)pyrene. Comparison of soil data to the USEPA IRSLs will also be factored into the site remedy. This process is addressed in Section 3 of this document.

There is no unacceptable risk to ecological receptors at Site 142. Therefore, no RAOs will be established for the protection of ecological receptors.

2.5 SITE 144, BUILDING 462, PROPELLANT FINISHING

2.5.1 Site History

Building 462 is a two-story concrete structure, which was constructed in 1942 as a tracer loading facility (**Figure 2-11**). Building 462 has been used for various munitions manufacturing processes since its construction. In the 1940s, finished gun bags were transported from Building 462 via a railroad line, located approximately 40 ft west of the building, to various storehouses, packing, and shipping buildings for final preparations before shipment off post. In 1947, Building 462 was temporarily converted to a rocket facility. During the Vietnam War, the building was used as a solvent-less propellant finishing facility. According to Picatinny safety files, Building 462 was used for explosive chemical manufacturing in November 1993. The building is divided into nine rooms, which are used in the research and development of energetic materials. The rooms include a load and machine room, an x-ray development room, a lab examination room, a pressroom, a control room, a reactor room, a coating and mixing room, a blending and pressing room, and a drying and conditioning room. A small basement is located beneath Room 1. No sumps or tanks are present in the basement, but there is a 6-inch PVC pipe which is used to vent radon gas. Research and development activities at Building 462 have generated the following wastes: about 200 lbs/month of explosives-contaminated paper towels, rubber gloves, and plastic hardware; 15 lbs/year of scrap propellant and explosives; and 15 gallons/year of solvents contaminated with explosives. These wastes are stored in red cans at Building 462 prior to disposal at the Picatinny Burning Ground. According to a November 1993 Picatinny Hazards Inventory, ethyl alcohol, acetone, ethyl ether, and NC were stored in a room at the northern end of Building 462.

2.5.2 Previous Studies

During the Dames and Moore Phase I RI, four surface soil samples were collected and analyzed for VOCs, SVOCs, explosives, metals, and cyanide. One sample was also analyzed for pesticides and PCBs. The analytical results indicated that no analytes were detected above comparison criteria. The HHRA conducted as part of the Phase I RI concluded that the non-carcinogenic hazard does not exceed the HI criterion of 1 for any population. Likewise, the carcinogenic risk does not exceed 1E-06 for any population.

Based on NJDEP's recommendation for additional characterization of the site, further sampling activities at Site 144 were conducted as part of the Phase I 2A/3A RI in September and October 2000. The sampling program for Site 144 included:

1. Collecting one surface soil sample.
2. Collecting two subsurface soil samples from one soil boring and one surface soil location.

Section 2.5.3 of this FS summarizes all results pertaining to Site 144.

2.5.3 Nature and Extent of Contamination

Based on the NJDEP's recommendation that additional soil and sediment samples be collected from Site 144 during the Phase I 2A/3A RI, the following AOCs (**Figure 2-11**) were identified at the site:

1. Potential contamination within the drainage ditch east of Building 462.
2. Potential subsurface soil contamination near the catch basin southwest of Building 462.

AOCs were identified in the RI as those areas within each site that required additional investigation to complete the characterization of the extent of contamination. The AOCs do not include every single exceedence of LOCs at a site. Factors considered during the determination of the AOCs included the following: number and magnitude of the exceedences relative to the LOCs, whether the results could be attributable to natural background levels (e.g., metals and radiological parameters),

mobility of contaminants (e.g., low mobility of PCBs), toxicity based on existing toxicological data (e.g., low toxicity of NC and PETN), and evidence of site-related anthropogenic contamination (e.g., explosives). Constituents detected that exceed LOCs are presented in **Table 2-8**. Following investigation of the AOCs, contamination at each site was evaluated in an HHRA.

Table 2-8
Site 144, Constituents Detected that Exceed LOCs

Constituents	Range of Detected Concentrations		LOC		Number of Exceedences/ Number of Samples(1)	
	min	max	NJ SRS	EPA RSL	NJ SRS	EPA RSL
Surface Soil (mg/kg)						
Arsenic	3.55	11.4	19	1.6	0/5	2/5

(1) Exceedences below Picatinny background levels were removed from the count
EPA RSL = EPA Regional Screening Levels, Industrial Soil
LOC = Level of Concern
NJ SRS = Non-Residential Direct Contact Health Based Criteria and Soil Remediation Standards
NJPQL = New Jersey Practical Quantitation Limit
Quality Criteria = New Jersey Groundwater Quality Criteria

2.5.3.1 AOC 1: Potential Contamination within the Drainage Ditch East of Building 462

As part of the Phase I RI, four surface soil samples were collected. The analytical results indicated that no analytes were detected in soil above comparison criteria. Even though no compounds were detected above soil comparison criteria, the NJDEP requested that the drainage ditch, catch basin, and manholes on the east and west side of Building 462 be further investigated during the Phase I 2A/3A RI field investigation.

The investigation conducted at Site 144 included the sampling of the drainage ditch next to the rectangular structure on the east side of Building 462. The NJDEP requested that one sediment sample be collected from the drainage ditch and one soil sample be collected beneath the rocks in the drainage ditch. No standing water was observed in the drainage ditch at the time of sampling. The sediment sample (144SD-1A) was collected first from a depth of 0-1 ft bgs and then the rocks were removed from the sample location. Following removal of the rocks, a subsurface soil sample (144SS-5C) was collected from a depth of 2-3 ft bgs beneath 144SD-1A.

The analytical results from samples 144SD-1A and 144SS-5C were compared to soil LOCs and no compounds were detected at concentrations exceeding comparison criteria. Therefore, the drainage ditch has not been impacted by site activities that may have occurred at Site 144.

2.5.3.2 AOC 2: Potential Subsurface Soil Contamination near the Catch Basin Southwest of Building 462

NJDEP requested that the catch basin and manholes southwest of Building 462 be investigated during the Phase I 2A/3A RI. In order to further investigate the catch basin, one soil boring (144SB-2) was installed downgradient of the existing catch basin and alleged 8-inch drain line. The structures did not contain water or sediment. The outfall of the drainage lines could not be located during the field investigation. One subsurface soil sample was collected from the soil boring at a depth of 5-7 ft bgs. A second soil boring (144SB-1) was proposed for installation near the existing manhole and catch basin on the west side of the building, but could not be installed due to the proximity of the overhead utility lines and underground sewer pipes downgradient of the manhole.

Although no LOC exceedences were identified at this AOC during the RI field investigation, the catch basin southwest of Building 462 was further investigated in December 2003 as part of the Facility-Wide Sump and Dry Well Investigation. Because Building 462 is currently an active building at Picatinny, the catch basin and associated piping could not be removed. Therefore, in order to confirm the catch basin had not leaked over time, an excavation was completed around the basin to a depth of 6 ft bgs and one post-excavation sample was collected from the excavation bottom. The subsurface soil sample was

analyzed for VOCs, metals, baseline explosives, and NC. The analytical results indicated that no analytes were identified above soil comparison criteria. Because no contamination was identified during the removal action or RI field investigation, the excavation was backfilled with the excavated soil. No additional excavation activities were conducted at the site.

Based on the analytical results of the soil samples collected from Site 144, no compounds exceeded NJDEP industrial remediation standards. Therefore, it appears that previous activities that may have involved the catch basin and manholes southwest of Building 462 have not impacted the area downgradient of the building.

As part of the completion of this FS, the complete set of Site 144 soils data was compared to NJDEP Soil Remediation Standards and USEPA IRSLs. Soils at Site 144 exhibited no exceedences of the NJDEP ISRS. The USEPA RSLs were exceeded for arsenic in surface soil. **Table 2-8** presents a summary of compounds which exceed LOCs. **Figure 2-11** presents all exceedences of USEPA criteria.

2.5.4 Summary of Risk Assessments

Based on the HHRA approach (Shaw, 2005a), estimated cancer risks and noncancer hazards were re-calculated for the site using data from both the Phase I RI (Dames and Moore, 1998) and the Phase I 2A/3A RI (Shaw, 2005a). Chemicals were selected if the constituent was a risk or hazard driver identified in the Dames and Moore (1998) risk assessment (i.e., it contributed a majority of the total estimated cancer risk or total noncancer hazard). However, constituents that had a cancer risk less than or equal to 1E-06 or a noncancer hazard less than or equal to 1 were not selected as COPCs. Results of the HHRA performed during the Phase I RI (Dames and Moore, 1998) indicate that the non-carcinogenic hazard does not exceed the HI criterion of 1 for any population (current outdoor maintenance workers, future industrial/research workers, and future construction workers with estimated noncancer hazards of 2E-03, 3E-02, and 2E-01, respectively). Carcinogenic risks fall below the NCP target range of concern (1E-04 to 1E-06) for all three populations (future industrial/research workers, current outdoor maintenance workers and future construction workers with estimated cancer risks of 4E-07, 4E-08, and 1E-07, respectively). No COPCs were selected for Site 144 (Appendix R Section R.2, Phase I 2A/3A RI) because only low levels of select compounds were identified in soil during the Phase I 2A/3A field investigation, and estimated cancer risks for the industrial/research worker, outdoor maintenance worker, and construction worker are acceptable.

The catch basin southwest of Building 462 was further investigated in December 2003 as part of the Facility-Wide Sump and Dry Well Investigation. One (1) CY of soil was excavated from around the basin and one post-excavation sample was collected from the excavation bottom to confirm that the catch basin had not leaked over time. The analytical results indicated that all analytes were below soil comparison criteria. Thus, the excavated soil was used to backfill the excavation (Shaw, 2005e).

2.5.4.1 Ecological Risk Assessment

No ERA was performed at Site 144 during the Phase I RI (Dames and Moore, 1998). The SLERA performed for Site 144 identified several metals as COPECs. However, the majority of the area is paved, with the exception of a grassy area behind Building 462. A former railroad line runs in front of Building 462. Site 144, which is approximately 0.7 acres in size, is located within a high human-use, highly industrialized part of Picatinny. Thus, the high level of activity would discourage most ecological receptors. Though a potential risk to wildlife may exist if there were sufficient exposures to COPECs, based on the lack of habitat and the lack of significant contamination, exposures are expected to be significantly limited; the SLERA concluded that a BERA was not required for Site 144.

2.5.4.2 Site 144 Risk Assessment Conclusions

Based on the HHRA results all excess cancer risk levels are below $1x10^{-6}$, and estimated total noncancer hazards are below 1. There are exceedences of the USEPA IRSLs but no exceedences of the NJDEP ISRS.

Based on the results of the HHRA and lack of exceedences of NJDEP ISRS, no RAOs will be necessary of Site 144. However, there were exceedences of USEPA IRSLs. Therefore, LUCs will be maintained to ensure that the current-protective land use continues.

There is no unacceptable risk to ecological receptors at Site 144. Therefore, no RAOs will be established for the protection of ecological receptors.

2.6 SITE 146, FORMER BUILDING 497, POWDER PRESSING

2.6.1 Site History

Former Building 497 was demolished by personnel from Picatinny's Public Works Department in September 2000 (**Figure 2-12**). The building was a 45-ft x 28-ft structure, which was constructed in 1956 as a mix house. Former Building 497 had six bays and two control rooms. Based on a 1953 Picatinny property record, the bays were constructed of concrete, while the control rooms were wooden framed with cement asbestos board siding. In 1971, Former Building 497 was used as a propellant plant. According to the 1991 ANL RI Concept Plan, powder-pressing operations were conducted at Former Building 497. DEH engineering drawings from 1965 indicated that a wastewater gutter and catch tank were installed along the north side of former Building 497. A gutter and settling tank also were installed on the west side of the building in 1976. No information was available regarding the use of the gutter and settling/catch tank. A former dumping and debris area is located in the wooded area southwest of former Building 497. During the Phase I 2A/3A field investigation, the field crew noticed signs of stressed vegetation and debris in this area. The dimensions of the dumping and debris area were estimated to be 36-ft by 27-ft. No other information could be obtained about this area.

2.6.2 Previous Investigations

During the Dames and Moore Phase I RI, four surface soil samples were collected and analyzed for VOCs, SVOCs, explosives, metals, and cyanide. One sample was also analyzed for pesticides and PCBs. The analytical results indicated that the concentration of lead in sample SS146-2A (758 mg/kg) exceeded the comparison criterion in use at the time. Currently, the NJDEP ISRS for lead is 800 mg/kg. The antimony concentration in sample SS146-1 was equal to the comparison criterion of 340 mg/kg in use at that time. The current NJDEP ISRS for antimony is 450 mg/kg. The explosive compounds cyclonite (RDX), HMX, NC, and nitroguanidine were detected in all surface soil samples. The RDX concentration in sample SS146-2A (69.6 mg/kg) exceeded the NJDEP non-residential soil criteria in use at that time. No NJDEP Soil Remediation Standard has been established for RDX. Currently, there is no NJDEP ISRS and the USEPA IRSL for RDX is 24 mg/kg. The detected levels of HMX and nitroguanidine did not exceed applicable criteria. No comparison criterion is available for NC. No groundwater samples were collected at the site.

One additional surface soil sample was collected at Site 146 during the Phase I 2A/3A RI. Section 2.6.3 of this FS summarizes all results pertaining to Site 146.

2.6.3 Nature and Extent of Contamination

Based on the analytical results of the surface soil samples collected from Site 146 during the Phase I RI and NJDEP recommendations for the site, the following AOCs (**Figure 2-12**) were identified at the site:

1. Lead contaminated surface soil.
2. Potential contamination in the dumping and debris area southwest of Former Building 497.

AOCs represent those areas within each site that may require additional investigation to complete the characterization of the extent of contamination associated with the AOC. The AOCs do not include every single exceedence of LOCs at a site. Factors considered during the determination of the AOCs included the following: number and magnitude of the exceedences relative to the LOCs, whether the results could be attributable to natural background levels (e.g., metals and radiological parameters), mobility of contaminants (e.g., low mobility of PCBs), toxicity based on existing toxicological data (e.g., low toxicity of NC and PETN), and evidence of site-related anthropogenic contamination (e.g., explosives). Summaries of chemicals detected above their LOC in surface soil are presented in **Table 2-9**. Following investigation of the AOCs, contamination at each site was evaluated in an HHRA.

Table 2-9
Site 146, Constituents Detected that Exceed LOCs

Constituents	Range of Detected Concentrations		LOC		Number of Exceedences/ Number of Samples(1)	
	min	max	NJ SRS	EPA RSL	NJ SRS	EPA RSL
Surface Soil (mg/kg)						
RDX	3.95	69.6	None	24	0/7	1/7

(1) Exceedences below Picatinny background levels were removed from the count
EPA RSL = EPA Regional Screening Levels, Industrial Soil
LOC = Level of Concern
NJ SRS = Non-Residential Direct Contact Health Based Criteria and Soil Remediation Standards
NJPQL = New Jersey Practical Quantitation Limit
Quality Criteria = New Jersey Groundwater Quality Criteria

Comments received from the USEPA have raised concern regarding the site's proximity to GPB and the maximum detected surface soil concentrations of antimony (340 mg/kg), copper (473 mg/kg), lead (758 mg/kg), zinc (509 mg/kg), HMX (768 mg/kg), NC (13,000 mg/kg), RDX (69 mg/kg), and nitroglycerin (47 mg/kg). The site is located approximately 150 ft from GPB. However, results of surface water and sediment samples collected from GPB compiled in the Green Pond and Bear Swamp Brooks Focused FS (IT, 2001) do not indicate that Site 146 is a source of contamination to GPB. Concentrations of antimony (not detected), copper (24.5 mg/kg), lead (5.32 mg/kg), and zinc (25.9 mg/kg) in sediment sample GPBSD-20 (sampled in March 1999 and located in the region of GPB closest to Site 146) were all below Picatinny sediment LOCs. Explosive compounds analyses were not performed for GPBSD-20; however, upgradient and downgradient samples (SW/SDGP-1 and SW/SDGP-2, respectively) were analyzed for explosives during the Phase I investigation. HMX, RDX, and nitroglycerine were not detected in either surface water or sediment samples at either location. NC was detected in both sediment samples at concentrations of 178 mg/kg (SDGP-1) and 223 mg/kg (SDGP-2). Although the downgradient sediment concentration is slightly higher than that for the upgradient location, surface water concentrations suggest that the nominal increase is not due to loading from Site 146 surface soil. NC was detected at a concentration of 545 μg/L in upgradient surface water sample SWGP- 1, but was not detected at the downgradient location. Please note, there is no LOC for NC in surface water or sediment.

2.6.3.1 AOC 1: Lead Contaminated Surface Soil

Four surface soil samples were collected at Site 146 as part of the Phase I RI conducted by Dames and Moore in 1995. The samples were analyzed for VOCs, SVOCs, explosives, metals, and cyanide. One sample was also analyzed for pesticides and PCBs. The analytical results indicated that the concentrations of lead (758 mg/kg) and RDX (69.6 mg/kg) in sample SS146-2 exceeded LOCs in use at that time of 600 mg/kg and 26 mg/kg, respectively. Currently, the NJDEP does not have a soil remediation standard for RDX and the lead standard is 800 mg/kg. In order to delineate the horizontal and vertical extent of lead contamination in the area northwest of Former Building 497, additional surface soil samples were proposed for collection during the Phase I 2A/3A RI field investigation.

Building 497 was demolished by the Picatinny Public Works Department approximately 2 days before the Phase I 2A/3A RI field investigation began. The sample locations proposed at Site 146 were covered by construction debris, lumber, and concrete. Personnel from Public Works were in the process of removing the debris, backfilling the site, and regrading the area as the field investigation was being initiated. Therefore, the area around former sample location SS146-2 was regraded and the original sampling points could not be recreated. No documentation was available indicating if additional soil was brought in or if the site was simply regraded. As a result, no additional samples were collected at this AOC.

2.6.3.2 AOC 2: Potential Contamination in the Dumping and Debris Area Southwest of Former Building 497

It was determined through employee interviews that the area southwest of former Building 497 was previously used as a dumping and debris area. This area was inspected for visible signs of dumping and debris during the Phase I 2A/3A RI field investigation. The field crew observed visible signs of

dumping and debris (e.g., stressed vegetation) in the area. The dimensions of the dumping and debris area were estimated to be 36-ft by 27-ft. A surface soil sample was collected from a depth of 0-1 ft bgs and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, baseline explosives, PETN, nitroglycerine, nitroguanidine, and NC.

No VOCs, SVOCs, baseline explosives, PETN, nitroglycerine, or nitroguanidine were detected within the sample. Pesticide 4,4'-DDT and PCB Aroclor 1260 were detected in sample 146SS-9A at concentrations below LOCs. Eighteen (18) metals were detected at concentrations below soil comparison criteria. NC was detected in sample 146SS-9A at a concentration of 6.9 mg/kg. No comparison criterion exists for this explosive. Based on the analytical results, this AOC has not been impacted by the dumping activities that have occurred in the area southwest of former Building 497.

As part of the completion of this FS, the complete set of Site 146 soils data was compared to NJDEP Soil Remediation Standards and USEPA IRSLs. The results of the screening indicate that there were no exceedences of NJDEP Criteria. The only exceedence of industrial USEPA criteria was for RDX in surface soil.

2.6.4 Summary of Risk Assessments

The HHRA results from the Phase I RI (Dames and Moore, 1998) indicated non-carcinogenic hazard exceeds the HI criterion of 1 for future construction/excavation workers at 3. The hazard driver is identified as antimony in surface soil. Carcinogenic risk falls within the NCP target range of concern (1E-04 to 1E-06) for all three populations. RDX and nitroglycerine are identified as the primary risk drivers in surface soil. Because the hazard exceeds the noncancer threshold, the hazards at Site 146 were re-evaluated using data from the Phase I RI and the Phase I 2A/3A RI.

Based on the HHRA approach (Shaw, 2005a), estimated noncancer hazards and lead hazards were quantified for the site. Risk assessment details, including procedures used for the selection of site COPCs, chemical-specific factors, lead exposure assessment, Phase I 2A/3A data tables, and risk assessment uncertainty analysis, are presented in the RI.

Estimated noncancer hazards and lead hazards quantified for realistic exposure scenarios are summarized as follows for current/future industrial research workers and current/future construction workers. For the current/future industrial research worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, and volatilization of constituents in soil to ambient air followed by inhalation. For the current/future construction worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, and volatilization of constituents in soil to ambient air followed by inhalation.

COPCs selected for Site 146 included two COPCs in surface soil and two COPCs in total soil. COPCs are listed by media in **Table 2-10**.

Table 2-10
Summary of Site 146 COPCs from the HHRA

COPCs by Media	Surface Soil	Total Soil	Surface Water (Not Applicable)	Sediment (Not Applicable)	Groundwater (Not Applicable)
Antimony	X	X			
Lead	X	X			

A summary of estimated risks and hazards for the realistic exposure scenarios is presented in **Table 2-11**. Although risks and hazards for the outdoor maintenance worker are also presented in Appendix R.5 of the Phase I 2A/3A RI, the risks and hazards are lower than either the industrial research worker or construction worker, and are therefore not summarized herein.

Table 2-11
Summary of Site 146 Estimated Risks and Hazards

Receptor (Current and Future)	Estimated Total Cancer Risk (RME unless noted)	Cancer Risk Driver(s) (contributing most to total risk)	Media Contributing Most to Cancer Risk
Industrial Research Worker	(no carcinogenic COPCs selected)	NR	NR
Construction Worker		NR	NR
Receptor (Current and Future)	**Estimated Total Noncancer Hazard (RME unless noted)**	**Noncancer Hazard Driver (contributing most to total hazard)**	**Media Contributing Most to Noncancer Hazard**
Industrial Research Worker	0.4	NR - hazards acceptable	NR - hazards acceptable
Construction Worker	3	Antimony	Total Soil

RME = reasonable maximum exposure.
NR = not relevant. Cancer risk drivers and/or noncancer hazard drivers not presented because risks and/or hazards acceptable.

No carcinogenic COPCs were selected for the site, as the estimated RME risks for the realistic exposure scenarios are below USEPA's target cancer risk range of 1E-04 to 1E-06. The estimated total hazards for the industrial research worker is less than or equal to USEPA's target noncancer hazard threshold of 1, while the estimated total hazards for the construction worker are above USEPA's target noncancer hazard threshold of 1, with the hazard driver being antimony. It should be noted that antimony was not detected in the Phase I 2A/3A RI sample.

The adult lead model results (**Table 2-12**) indicate lead concentrations in total soil may be a concern for construction workers, as the average lead concentration exceeds the lead model-derived PRG for heterogeneous receptor populations.

Table 2-12
Summary of Site 146 Adult Lead Model Results

Receptor	Media	Media Lead Concentration (Avg. mg/kg)	Lead Model PRGs (mg/kg) (GSDs = 2.1-1.8)	Exceedence?
Industrial Research Worker	Surface Soil	254	778 - 1,354	No
Construction Worker	Total Soil	254	162 - 282	Yes, for GSD = 2.1

GSD = Geometric Standard Deviation

There are site-specific uncertainties associated with the HHRA for Site 146. The primary uncertainty is related to the scaling approach used to estimate the risks and hazards, as COPC toxicity noncancer reference doses and cancer slope factors may have changed since the Dames and Moore (1998) RI was completed. However, as discussed in Appendix R Section R.7.4 Phase I 2A/3A RI, toxicity values for the Site 146 COPCs antimony and lead have not changed since 1998.

2.6.4.1 Summary of HHRA Findings

A summary of the findings from the HHRA, by AOC, is presented as follows.

AOC 1: Lead Contaminated Surface Soil. The adult lead model results indicate lead concentrations in soil are a concern at Site 146.

AOC 2: Potential Contamination in the Dumping and Debris Area Southwest of Former Building 497. Based on the current uses of Picatinny, HHRAs were conducted for the industrial research worker and the construction excavation worker. The carcinogenic risks fall within the target range of concern (10^{-04} to 10^{-06}) for both populations. However, no individual constituent exhibited an excess cancer risk greater than $1x10^{-6}$; therefore, no human health constituents of potential concern (HHCOPCs) were selected I the Phase I 2A/3A risk assessment. The estimated noncancer HI exceeds the hazard threshold of 1 for the construction excavation worker, with the hazard driver identified as antimony in soil (HI=3). Additionally, the adult lead model results indicate lead concentrations in soil are a concern for the

construction excavation worker. However, antimony and lead were not detected above LOCs in the surface soil sample collected at this AOC. Lead contamination in the soil was evaluated as AOC 1.

2.6.4.2 Ecological Risk Assessment

An ERA was conducted at Site 146 in the area surrounding former Building 497 (Dames and Moore, 1998). At the time this risk evaluation was performed, the Army considered the risk implications associated with contamination at Site 146 as a stand-alone site. Risk implications for sites as small as Site 146 (approximately 0.7 acres) are typically not independently evaluated. Had the risk assessment been performed at a later date, this evaluation would not have been performed. However, the risk results presented in the Phase I RI are presented here for consistency with earlier documents. Results indicated modeled ecological risk to some bird species with small foraging areas (i.e. the veery and woodcock). Modeled risk to the veery was high (Hazard Quotient > 10) and risk to the woodcock was elevated. While there are modeled risks to the barred owl, these risks are not significant considering the small home range for the receptor relative to the site. Earthworm, plant, and small mammal studies were not performed for Site 146.

Based on the results of the Phase I RI ERA, a SLERA was performed at Site 146. The SLERA concluded that although there are relatively few contaminants at the dumping area and exposure near former Building 497 has been reduced due to the backfilling with new soil after demolition, an ERA was recommended only to address potential exposures and risks to terrestrial receptors, particularly birds, with relatively small foraging areas, from contaminants in soil at Site 146 as identified in the Phase I RI (Shaw, 2005c).

As part of the Phase III and Phase 1 2A/3A Sites BERA (Shaw, 2006b), risks were assessed on an area-wide basis rather than by individual site to address ecological receptors with larger foraging areas which may be exposed to contaminants at multiple sites. A total of five sites within Area F, which is approximately 77 acres, were specifically included in the BERA for Area F, although all five of the sites recommended for further evaluation by the SLERA are contained within the 40 to 50 acres of the northwest portion of Area F. Additional sites located in Area F were not included in the BERA based on the results of the SLERA which did not warrant further evaluation of these sites.

For the Area F (including Site 146) BERA, a breeding bird survey and wildlife exposure modeling were conducted to assess this potential risk. The assessment endpoint selected for evaluation in the BERA for Site 146 was the reduced survival, growth, reproduction, or reproductive capability of breeding birds due to exposures to COPECs in soil and food items. COPECs for the Area F BERA were identified as any COPECs previously identified for the individual sites included in the BERA. Target species for the terrestrial food web exposure models in the BERA were the American Robin and the Red-Tailed Hawk (as well as the white-footed mouse included based on potential risk identified at other sites). The two bird species represent invertivorous birds, which are expected to have the highest potential exposure due to consumption of soil and leaf litter invertebrates which could bioaccumulate COPECs; and carnivorous birds, which have the potential for higher exposure due to bioaccumulation of COPECs through the food chain. In addition, carnivores have larger home ranges; the Red-Tailed Hawk has a home range of approximately 1,700 acres compared to the 2-acre home range of the American Robin (which is between the home range reported for the Veery and Woodcock evaluated in the Phase I ERA). The results of the terrestrial food web exposure models indicated it is possible that American Robin reproduction could be affected if sufficient exposures were to occur. Results indicated no adverse impact to the Red-Tailed Hawk.

In addition to the food web models, a breeding bird nesting success survey was conducted as part of the BERA. The target species for the breeding bird surveys were the invertivorous species American Robin and Eastern Phoebe. Nesting bird surveys were conducted within Area F (including Site 146) as well as Area L of Picatinny and a variety of reference locations to determine whether adverse effects were observable in the actual populations there. While breeding success of the American Robin in Area F was complicated due to raiding or abandoning of the nests, results for the Eastern Phoebe (for which the food web exposure models are equally applicable) showed no statistically significant difference compared to the reference areas. Though the food web exposure models indicated that adverse effects on reproduction in birds could occur given sufficient exposure to site COPECs in Area F (Site 146), the

bird survey results indicated that effects, if any, were not adversely impacting the local populations of birds.

The BERA concluded that it is unlikely that ecological communities within Site 146, as well as other Area F sites at Picatinny, are at any significant risk from site contaminants present in environmental media at these sites. The BERA recommended that no further ERA investigations or response actions based on ecological risks are warranted at these sites (Shaw, 2006b).

2.6.4.3 Site 146 Risk Assessment Conclusions

Based on the HHRA results, all excess cancer risk levels are below USEPAs target risk range. Estimated total noncancer hazard for the construction worker scenario is greater than 1; therefore, RAOs may be established to address this hazard. RAOs may also be established based on lead concentrations above the Adult Lead Model-derived PRGs, which indicate a concern for the construction worker receptor. There are exceedences of USEPA IRSLs.

Comparison of soils data to the USEPA screening levels will be factored into the remedy. There was one exceedence of USEPA criteria for RDX in surface soil. This process is addressed in Section 3 of this document.

There is no unacceptable risk to ecological receptors at Site 146. Therefore, no RAOs will be established for the protection of ecological receptors.

2.7 SITE PICA-203

Site PICA-203 is located in the west-southwest portion of Area I along GPB approximately 500 ft downstream of the outfall from Picatinny Lake. The site, which covers approximately 1.0 acre, is an open field.

2.7.1 Site History

From about 1922 until 1926, former Buildings 333 and 347 (**Figure 2-13**) were used as a poison gas laboratory and sample handling house, respectively. Work at these facilities included laboratory testing using normal poisonous gases in experiments for propellants. Following an explosion in 1926, the buildings were never rebuilt. Former Building 445-B was built within the footprint of former Building 347.

In 1918, a 10-ft x 12-ft concrete solvent vault was located near Building 332. No information is available on the depth or volume of the vault. Field reconnaissance could not locate the structure and it is suspected that the vault no longer exists.

2.7.2 Previous Studies

In 1997, USACHPPM performed an RRSE of Site PICA-203 (USACHPPM, 1998). Three surface soil samples were collected along with three Geoprobe groundwater samples from the surface soil locations. Groundwater samples were also collected from two monitoring wells installed for Site 109. Arsenic and lead were detected in excess of their respective LOCs in the groundwater samples. Arsenic concentrations above the LOC of 3 μg/L were reported in Geoprobe samples PGL-1W (11 μg/L), PGL-2W (11 μg/L), PGL-3W (4.7 μg/L); and monitoring wells 109MW-1 (4.8 μg/L) and 109MW-3 (9.8 μg/L). Lead exceedences were detected in PGL-1W (6.5 μg/L), PGL-2W (23 μg/L), 109MW-1 (20 μg/L), and 109MW-3 (6.7 μg/L). The LOC for lead in groundwater is 5 μg/L. Further discussion of the PICA-203 groundwater sampling results was included in the assessment of Site 109 for continuity with the results from the Site 109 monitoring wells. No exceedences using the LOCs at that time were reported for the soil samples. The RRSE scored the site a high risk. The groundwater hazard was high and the surface soil hazard was low.

Phase II RI sampling activities at Site PICA-203 were conducted by IT between May and June 2001 and included:

1. Collecting three surface soil samples from three soil borings.
2. Collecting three subsurface soil samples from three soil borings.

2.7.3 Nature and Extent of Contamination

Based on the USACHPPM investigation, the following AOC has been identified at Site PICA-203:

- AOC 1: Potential contamination from the former solvent vault and former Buildings 333 and 347.

AOCs represent those areas within each site that required additional investigation during follow-on RI activity. The AOCs do not include every single exceedence of LOCs at a site. Factors considered during the determination of the AOCs included the following: number and magnitude of the exceedences related to the LOCs, whether the results could be attributable to natural background levels (e.g., metals and radiological parameters), mobility of the contaminants (e.g., low mobility of PCBs), toxicity based on existing toxicological data (e.g., low toxicity of NC and PETN), and evidence of site-related anthropogenic contamination (e.g., explosives). Summaries of chemicals detected above their LOC in surface soil are presented in **Table 2-13**. Following identification of the AOCs, contamination at each site was evaluated in an HHRA.

Table 2-13
Site 203, Constituents Detected that Exceed LOCs

Constituents	Range of Detected Concentrations		LOC		Number of Exceedences/ Number of Samples(1)	
	min	max	NJ SRS	EPA RSL	NJ SRS	EPA RSL
Surface Soil (mg/kg)						
Benzo(a)pyrene	0.075	0.53	0.2	0.21	4/9	4/9
Arsenic	6.7	18.9	19	1.6	0/9	4/9
Subsurface Soil (mg/kg)						
Benzo(a)pyrene	0.46	0.46	0.2	0.21	1/3	1/3
Mercury	0.021	189	65	24	1/3	1/3

(1) Exceedences below Picatinny background levels were removed from the count
EPA RSL = EPA Regional Screening Levels, Industrial Soil
LOC = Level of Concern
NJ SRS = Non-Residential Direct Contact Health Based Criteria and Soil Remediation Standards
NJPQL = New Jersey Practical Quantitation Limit
Quality Criteria = New Jersey Groundwater Quality Criteria

2.7.3.1 AOC 1: Potential Contamination from the Former Solvent Vault and Former Buildings 333 and 347

From 1922 to 1926, former Buildings 333 and 347 were used as a poison gas laboratory and sample handling house, respectively. Work at these facilities included laboratory testing using normal poisonous gases in experiments for propellants. In 1918, a 10-ft x 12-ft concrete solvent vault was located near Building 332. No information is available on the depth or volume of the vault. According to USACHPPM, potential site contaminants include VOCs, SVOCs, explosives, cyanide, and arsenic. USACHPPM's investigation did not identify any chemicals above LOCs in the surface soil. Arsenic and lead were detected in excess of their respective LOCs in the groundwater samples. The elevated arsenic and lead levels may be the result of the high turbidity associated with Geoprobe samples and collection of monitoring well samples without using the low-flow sampling technique.

Based on the results of USACHPPM's RRSE, additional samples were collected at Site PICA-203 as part of the Phase II RI. A soil boring was drilled at the suspected location of the former vault and within the footprints of the two former buildings. A surface soil and a subsurface soil sample were collected from each boring. The subsurface soil samples were collected from the two-foot interval directly above the water table (i.e., 4-6 ft bgs or 5-7 ft bgs). Analytical results did not indicate any chemical concentrations in excess of LOCs in the samples. These results suggest that past operations at the former solvent vault and former Buildings 333 and 347 have not impacted the soil.

As part of the completion of this FS, the complete set of PICA-203 soils data was compared to NJDEP Soil Remediation Standards and USEPA IRSLs. The results of the screening indicate that the NJDEP Criteria was exceeded in two surface soil samples (each surface soil sample included a duplicate). Mercury and benzo(a)pyrene exceeded the NJDEP criteria in one subsurface soil sample each. The industrial USEPA criteria was exceeded for arsenic and benzo(a)pyrene in surface soil and mercury and benzo(a)pyrene in subsurface soil.

2.7.4 Summary of Risk Assessments

2.7.4.1 Summary of HHRA Findings

Based on the HHRA approach (Shaw, 2005b), estimated cancer risks and noncancer hazards were quantified for Site 203. Risk assessment details, including procedures used for the selection of site COPCs, chemical-specific factors and soil emission equations for COPCs, Site 203 risk tables, and risk assessment uncertainty analysis, are presented in the RI (Shaw, 2006a).

Estimated cancer risks and noncancer hazards quantified for realistic exposure scenarios are summarized as follows for current/future industrial research workers and current/future construction excavation workers. For the current/future industrial research worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, and volatilization of constituents in soil to ambient air followed by inhalation. For the current/future construction excavation worker, routes of exposure evaluated included: incidental ingestion and dermal contact with soil, inhalation of dust particles, and volatilization of constituents in soil to ambient air followed by inhalation. COPCs identified by media are listed in **Table 2-14**.

Table 2-14
Summary of Site 203 COPCs

COPCs by Media	Surface Soil	Subsurface Soil	Surface Water (Not Applicable)	Sediment (Not Applicable)	Groundwater (Not Applicable*)
Arsenic	X	X			
Benzo(a)pyrene	X	X			
Iron	X				
Mercury	X	X			

USACHPPM RRSE groundwater sampling results were included in the assessment of adjacent Site 109 groundwater.

These COPCs were generally selected based on RBCs (for target cancer risk of 10^{-6} and target noncancer hazard of 0.1) and available ARARs (see Section 8.0 and risk summary Table 2s in the Phase II RI). A summary of estimated risks and hazards for the realistic exposure scenarios is presented in **Table 2-15**.

Table 2-15
Summary of Site 203 Estimated Risks and Hazards

Receptor (Current and Future)	Estimated Total Cancer Risk (RME unless noted)	Cancer Risk Driver(s) (contributing most to total risk)	Media Contributing Most to Cancer Risk
Industrial Research Worker	1.7E-5	Arsenic, Benzo(a)pyrene	Surface Soil
Construction Excavation Worker	6.2E-7	NR - risks acceptable	NR - risks acceptable
Receptor (Current and Future)	**Estimated Total Noncancer Hazard (RME unless noted)**	**Noncancer Hazard Driver (contributing most to total hazard)**	**Media Contributing Most to Noncancer Hazard**
Industrial Research Worker	0.13	NR - hazards acceptable	NR - hazards acceptable
Construction Excavation Worker	0.21	NR - hazards acceptable	NR - hazards acceptable

NR = not relevant. Cancer risk drivers and/or noncancer hazard drivers not presented because risks and/or hazards acceptable.

The estimated total cancer risk of 1.7E-5 for the industrial/research worker RME scenario is based upon the following risks associated with the three exposure pathways evaluated and totaled: 4.1E-6 for ingestion, 4.2E-9 for inhalation, and 1.3E-5 for dermal contact. This estimated total cancer risk is within USEPA's target risk range of 10^{-4} to 10^{-6}. The estimated total hazard for the industrial/research worker RME scenario is 0.13, which is below USEPA's target noncancer hazard threshold of 1.

The estimated RME risk for the realistic exposure scenario for the construction excavation receptor is below USEPA's target cancer risk range of 10^{-4} to 10^{-6}. In addition, the estimated total hazard for the construction excavation worker scenario is below USEPA's target noncancer hazard threshold of 1.

2.7.4.2 Ecological Risk Assessment

Since PICA Site 203 had not been identified as an RI site prior to the Phase II ERA, it was not evaluated in the Phase II ERA. The site is a small field with low habitat quality, but it is adjacent to GPB and Site 109, a larger open field. Site 109 was evaluated for terrestrial species in the Phase II ERA despite poor habitat quality, because the area may revert to a more natural state. EEQs for the COPECs detected in soil samples were less than 1 for all chemicals except arsenic (EEQ of 10) and mercury (EEQ of 5.9) for the white-footed mouse. Thus, the levels of chemicals in the soil samples most likely present minimal risk to populations of terrestrial species.

2.7.4.3 Site PICA-203 Risk Assessment Conclusions

Based on the HHRA results, all excess cancer risk levels are within or below the USEPA target risk range, and estimated total noncancer hazards are below 1. There are exceedences of USEPA IRSLs and NJDEP Soil Remediation Standards.

The establishment of RAOs for the protection of human health will be determined based on these risk assessment results and a comparison of soil data from this site to NJDEP ISRS. Comparison of soil data to USEPA IRSL will also be factored into the remedy. This process is addressed in Section 3 of this document.

There is no unacceptable risk to ecological receptors at Site PIC-203. Therefore, no RAOs will be established for the protection of ecological receptors.

2.8 HUMAN HEALTH RISK ASSESSMENT SUMMARY FOR PICATINNY PICA-111 GROUNDWATER

Estimated cancer risks, noncancer hazards, and lead hazards were quantified for PICA-111. Risk assessment details, including procedures used for the selection of site COPCs, chemical-specific factors and vapor emission equations for COPCs, PICA-111 risk tables, and the risk assessment uncertainty analysis, are presented in **Appendix A**. Results from the Johnson and Ettinger Vapor Intrusion Model are presented in **Appendix B**.

Estimated cancer risks and noncancer hazards were quantified for exposure scenarios for on-site industrial research workers, on-site military residents (adult and child), and on-site constructions workers. For these receptors, routes of exposure evaluated included: ingestion and dermal contact with groundwater, inhalation of VOCs during washroom use or showering, and volatilization of constituents from *in situ* groundwater to indoor air followed by inhalation. All of these exposure scenarios should be considered future scenarios, except for the inhalation of VOCs from *in situ* groundwater by on-site workers, because no residential receptors currently reside in the PICA-111 area, and no workers currently use untreated PICA-111 groundwater.

COPCs selected for the Site included six COPCs in groundwater, listed below (**Table 2-16**) (see **Appendix A** for details):

Table 2-16
Summary of PICA-111 Groundwater COPCs

COPCs by Media	Groundwater
Aluminum	X
Arsenic	X
Iron	X
Manganese	X
Chloroform	X
Perchlorate	X

These COPCs were generally selected based on risk-based RSLs (for target cancer risk of 1E-6 and target noncancer hazard of 0.1) and available ARARs (see Occurrence, Distribution, and Selection of COPC Table 2 in **Appendix A**). It should be noted that surface water data were available for the Site, but only perchlorate was analyzed and it was nondetect in all samples.

A summary of estimated risks and hazards for the future exposure scenarios is as follows (**Table 2-17**) (from **Appendix A**, Risk Summary Tables 9 and 10):

Table 2-17
Summary of PICA-111 Groundwater Estimated Future Risks and Hazards

Receptor (Future)	Estimated Total Cancer Risk (RME)	Cancer Risk Driver(s) (contributing most to total risk)	Groundwater Pathway Contributing Most to Cancer Risk
On-Site Military Resident - Adult	1.2E-05	Arsenic	Ingestion
On-Site Military Resident - Child	2.8E-05	Arsenic	Ingestion
Industrial Research Worker	2.7E-5	Arsenic	Ingestion
Construction Worker	4.4E-9	None (CR < 1E-6)	--
Receptor (Future)	**Estimated Total Noncancer Hazard (RME)**	**Noncancer Hazard Driver (contributing most to total hazard)**	**Groundwater Pathway Contributing Most to Noncancer Hazard**
On-Site Military Resident - Adult	5.1	Perchlorate, Manganese, Iron, Arsenic	Ingestion
On-Site Military Resident - Child	12	Perchlorate, Manganese, Iron, Arsenic	Ingestion
Industrial Research Worker	2.0	Perchlorate, Manganese, Iron *	Ingestion
Construction Worker	0.055	None (HI < 1)	--

* Individual COPC, including COPCs that affect similar target organs, had HI less than 1.

The estimated total RME cancer risk of 1.2E-05 for the adult on-site military resident scenario is based upon the following risks associated with the three exposure pathways evaluated and totaled: 1.2E-05 for ingestion, 1.0E-08 for inhalation, and 4.1E-08 for dermal contact. The estimated total RME cancer risk of 2.8E-05 for the child on-site military resident scenario is based upon the following risks associated with the three exposure pathways evaluated and totaled: 2.8E-05 for ingestion, 2.2E-08 for inhalation, and 6.6E-08 for dermal contact. The estimated total RME cancer risk of 2.7E-05 for the industrial research worker scenario is based upon the following risks associated with the three exposure

pathways evaluated and totaled: 2.7E-05 for ingestion, 4.5E-08 for inhalation, and 3.7E-08 for dermal contact. The estimated total RME cancer risk of 4.5E-09 for the construction worker scenario is based entirely on the dermal exposure pathway evaluated. The estimated RME risks for the on-site military residents (with both adult and child risks totaling 4.0E-05) and the industrial research worker are within USEPA's target cancer risk range of 1E-4 to 1E-6, and the estimated risks are below the target risk range for the construction worker receptor.

The estimated total RME noncancer hazard of 5.1 for the adult on-site military resident scenario is based upon the following hazards associated with the three exposure pathways evaluated and totaled: 5.0 for ingestion, 0.000077 for inhalation, and 0.12 for dermal contact. The estimated total RME noncancer hazard of 12 for the child on-site military resident scenario is based upon the following hazards associated with the three exposure pathways evaluated and totaled: 12 for ingestion, 0.00017 for inhalation, and 0.2 for dermal contact. The estimated total RME noncancer hazard of 1.8 for the industrial research worker scenario is based upon the following hazards associated with the three exposure pathways evaluated and totaled: 1.8 for ingestion, 0.000055 for inhalation, and 0.018 for dermal contact. The estimated total RME noncancer hazard of 0.055 for the construction worker scenario is based entirely on the dermal exposure pathway evaluated. The estimated RME hazards for the future on-site military residents and industrial research worker receptors are above USEPA's target noncancer HI of 1, but are below USEPA's target noncancer HI of 1 for the construction worker. It should be noted, however, that for the industrial research worker, the individual COPC HIs, when segregated by target organ, are all less than 1 (see **Appendix A**, Table 9.1).

For the consideration of risks and hazards from the inhalation of VOCs that may migrate from *in situ* groundwater to indoor air, the Johnson and Ettinger Vapor Intrusion Model was used. These risks and hazards were estimated separately from the RAGS-D assessment presented in **Appendix A**. This is because the RAGS-D format is not amenable to the Johnson and Ettinger Vapor Intrusion Model risk and hazard output because the J&E Model uses unit risk factors (URFs) and reference concentrations (RfCs) to assess exposure to VOCs in air, not estimated doses and the J&E Model calculates risks and hazards.

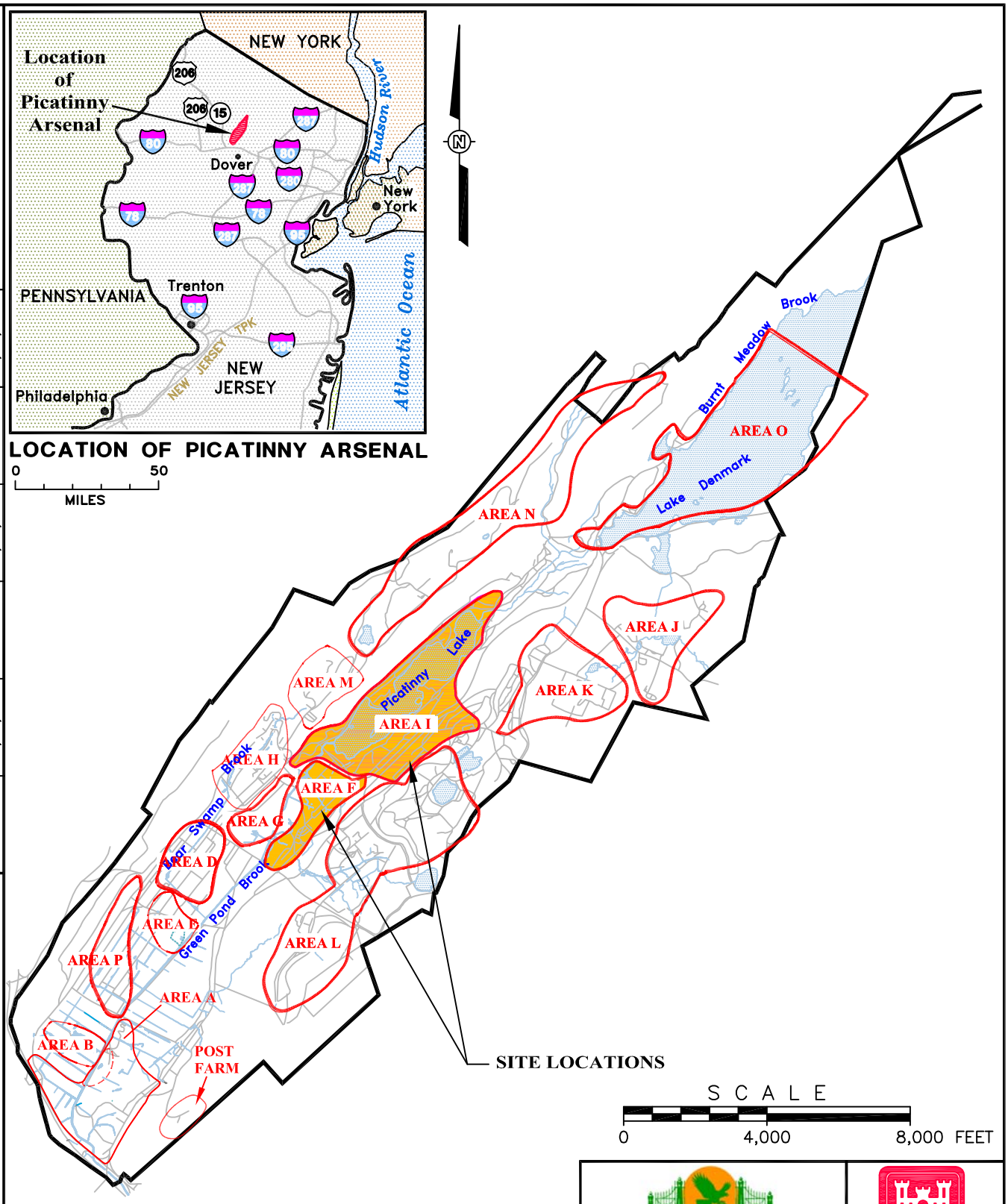
A summary of estimated risks and hazards for the current and future inhalation of VOCs off-gassing from *in situ* groundwater to indoor air is as follows (**Table 2-18**) (from **Appendix B**, Johnson and Ettinger Model input and output files):

Table 2-18
Summary of PICA-111 Groundwater Estimated Current and Future Risks and Hazards from Vapor Intrusion of VOC from *In Situ* Groundwater

Receptor (Future)	Estimated Total Cancer Risk (RME)	Cancer Risk Driver(s) (contributing most to total risk)
Industrial Research Worker	8.9E-7	None (CR < 1E-6)
Receptor (Future)	**Estimated Total Noncancer Hazard (RME)**	**Noncancer Hazard Driver (contributing most to total hazard)**
Industrial Research	0.002	None (HI < 1)

These results show that the estimated cancer risk from the off-gassing of VOCs (chloroform) from *in situ* groundwater to indoor air for the current and future industrial research worker is acceptable, as the risk is below USEPA's target cancer risk range of 1E-4 to 1E-6. The estimated hazard is also acceptable, as it is below USEPA's target noncancer HI of 1. It should be noted that the worker risks and hazards are overestimated due to the fact that the J&E Model assumes 24 hours per day exposure, whereas workers would actually only be exposed 8 hours per day. Due to this overestimation, a correction factor of 3 could be applied (24 hours divided by 8 hours); however, as estimated risks and hazards are acceptable, this correction factor is not needed.

These *in situ* groundwater risks and hazards may be added to the risks and hazards presented in **Table 2-17**. The summation of risks and hazards from **Tables 2-17 and 2-18** results in a total estimated industrial research worker cancer risk of 2.7E-5 and a total estimated HI of 2.0. The summed risks are within USEPA's target risk range and the summed hazards, when segregated by target organ, are below USEPA's target HI of 1.



LEGEND

- AREA BOUNDARY
- ROAD
- PICATINNY ARSENAL BOUNDARY
- WATER BODIES

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

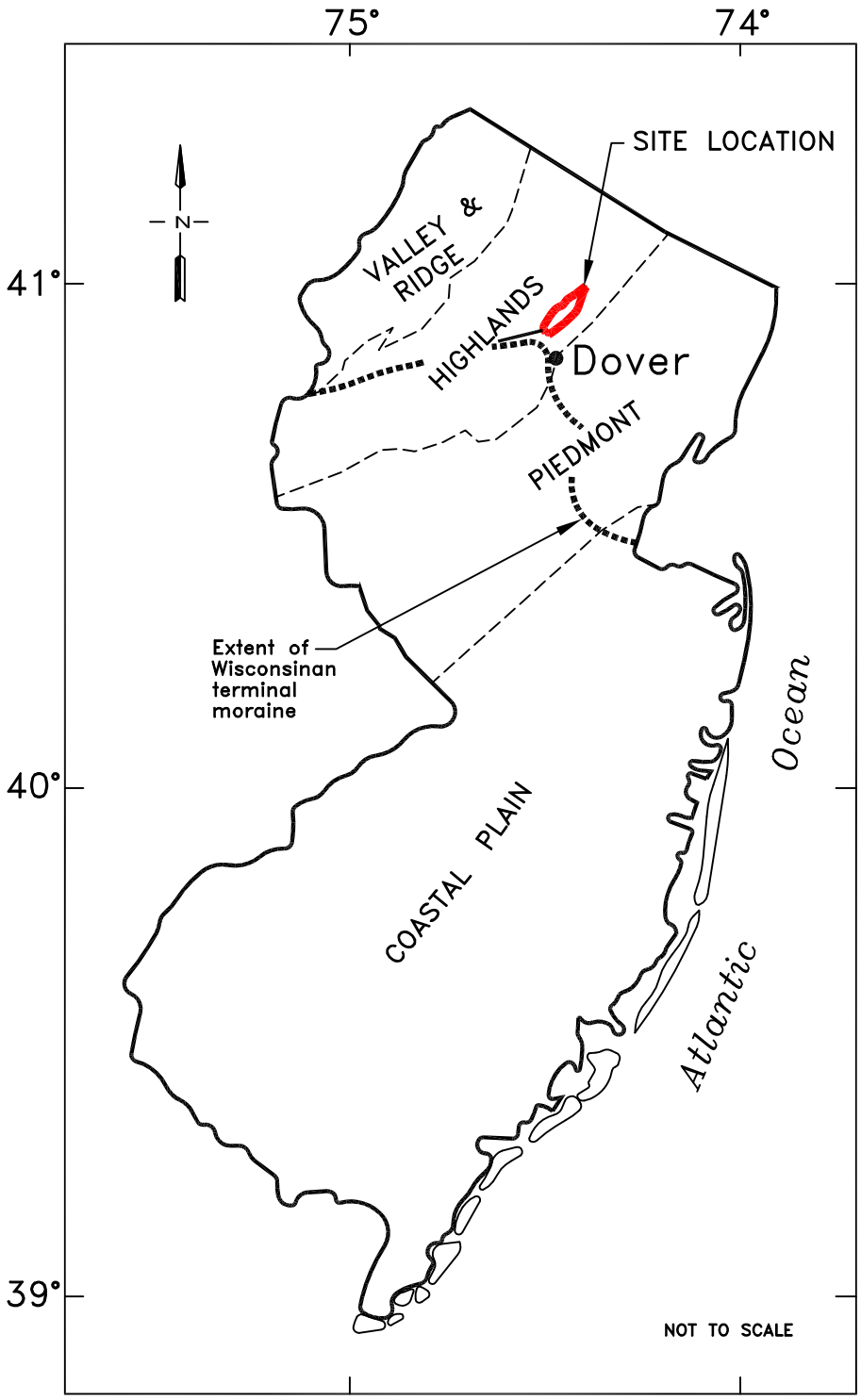
FIGURE 2-1

PICATINNY ARSENAL LOCATION MAP
REMEDIAL INVESTIGATION CONCEPT PLAN AREAS

FS FOR SITES 109, 125, 142, 144, 146 AND PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	04/11/06	K. Gerdes	04/11/06	K. Gerdes	04/11/06	sitemap041106.dwg

File: N:\cad\CAD drawings\Picatinny\Area-F\site61\Sites 61&104\sitemap041106.dwg
Plot Date/Time: Feb 03, 2010 - 2:39pm
Plotted By: stephen.Wiafe



Base from U.S. Geological Survey 1:24,000 topographic quadrangles.

After Harte et al, 1986.

From U.S.G.S., 1986a as modified from Sims, 1958; and Bayley and others, 1914.

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE 2-2

PHYSIOGRAPHIC PROVINCES OF NEW JERSEY

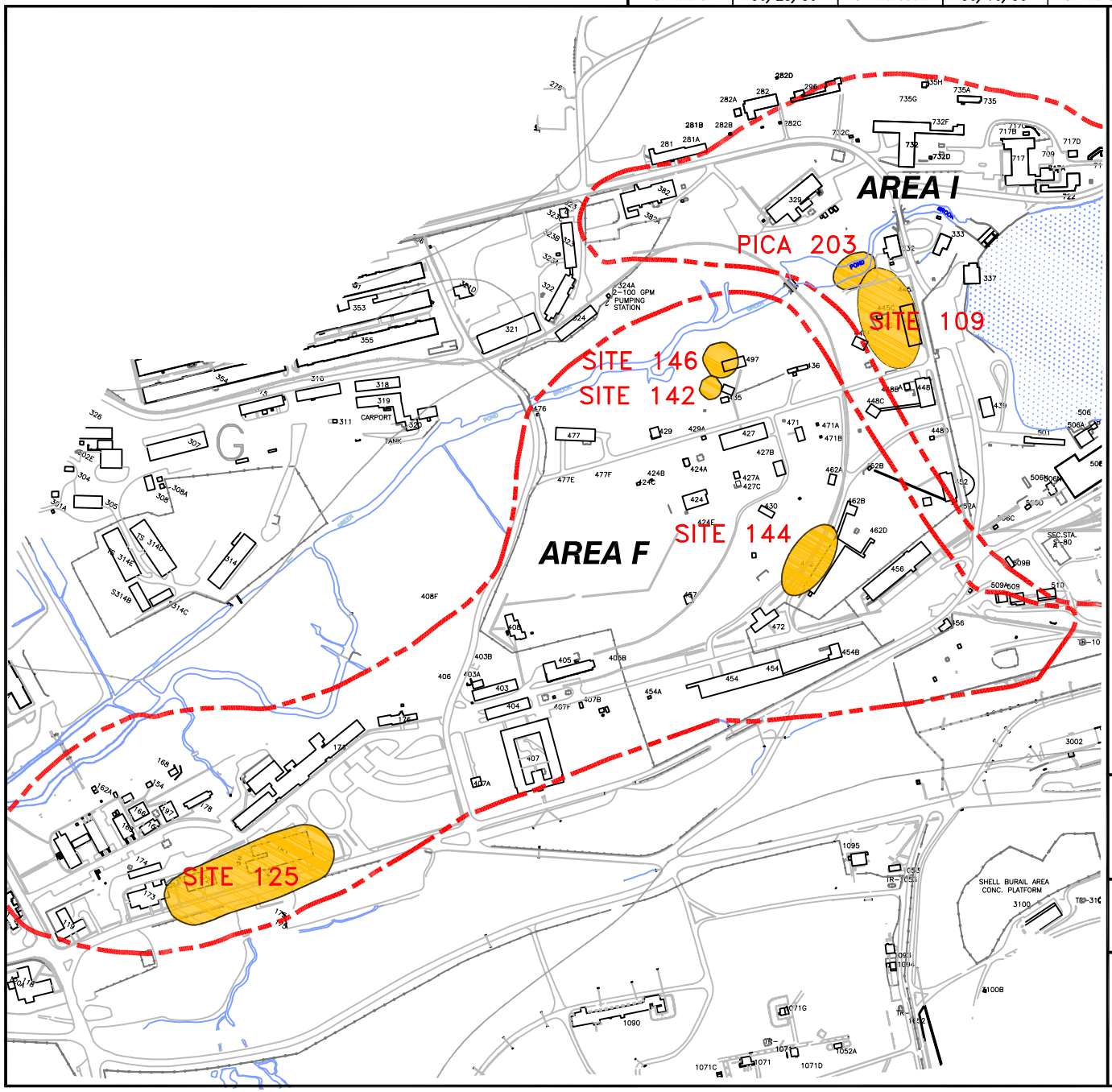
FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NJ

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	06/23/06	K. Gerdes	06/23/06	G.Maresca	06/23/06	PROVINCES.dwg

File: N:\cad\CAD drawings\Picatinny\Basewide\provinces.dwg
Plot Date/Time: Feb 03, 2010 – 2:50pm
Plotted By: stephen.Wiafe

File: N:\cad\CAD drawings\Picatinny\Area-F\F061606.dwg
Plot Date/Time: Feb 03, 2010 – 2:29pm
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	06/23/06	G. Maresca	06/16/06	G. Maresca	06/23/06	F061606.dwg



LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER
- SANITARY SEWER
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER/POND
- PAVED ROADWAY
- UNPAVED ROADWAY
- SITE ADDRESSED IN FEASIBILITY STUDY

SCALE

0 500 1,000 Ft.

Picatinny Arsenal Installation Restoration Program

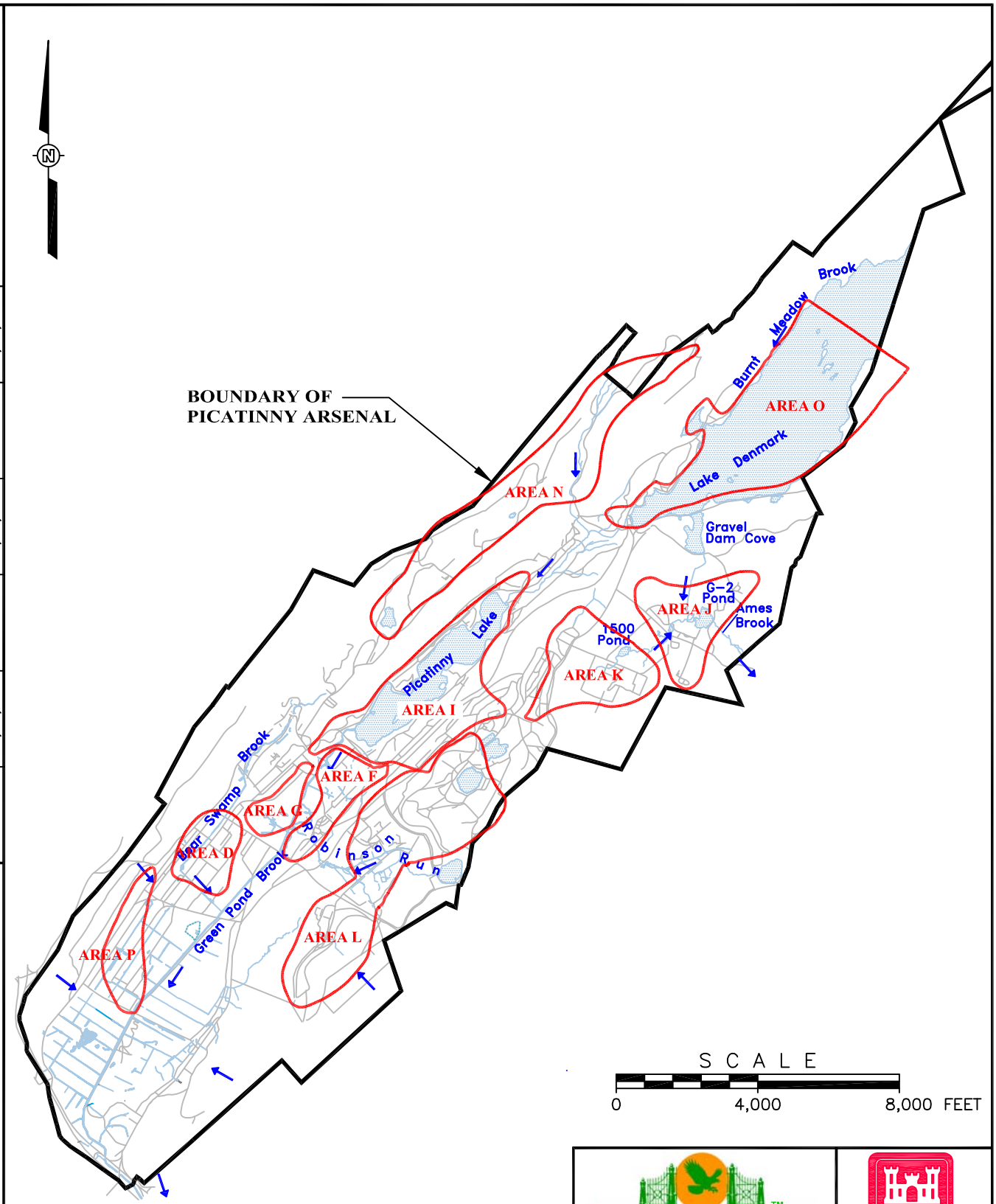
U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-3

SITE LOCATION MAP

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY



DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	06/15/06	K. Gerdes	06/15/06	G. Maresca	06/15/06	Drainage061506.dwg

LEGEND

- SURFACE WATER FLOW DIRECTION
- ROAD
- PICATINNY ARSENAL BOUNDARY
- WATER BODIES

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

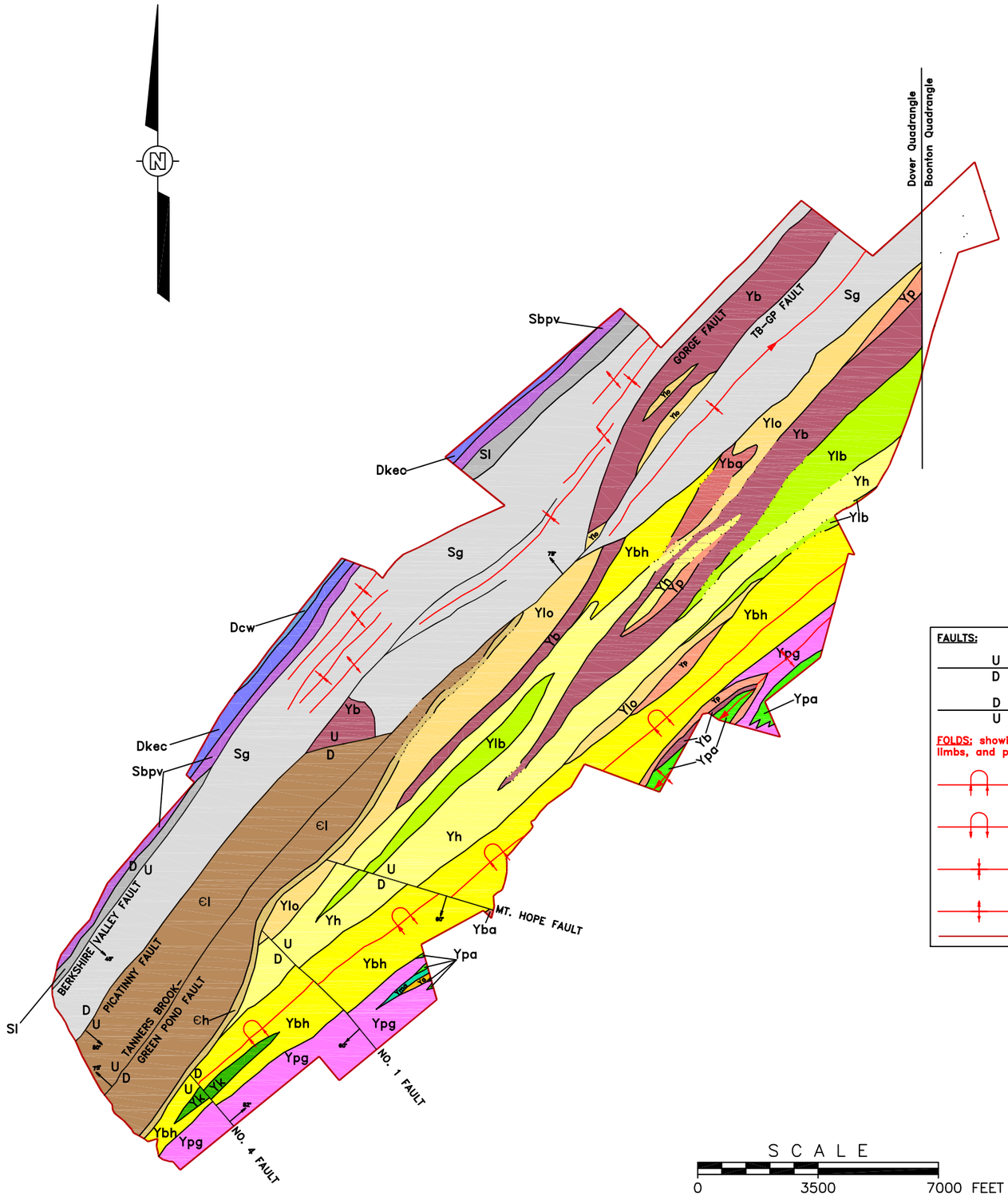
FIGURE No. 2-4

PICATINNY DRAINAGE PATTERNS

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

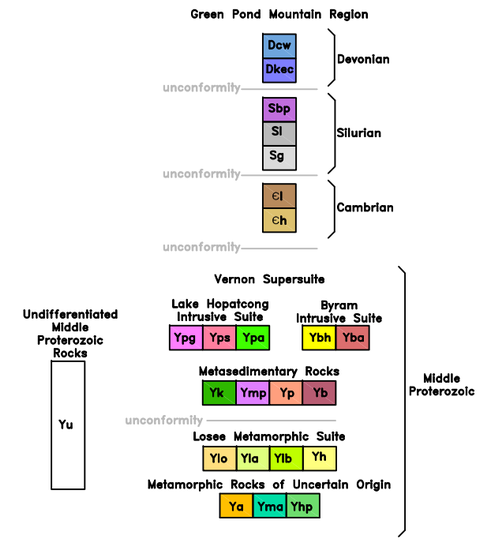
File: N:\cad\CAD drawings\Picatinny\Area-F\site61\Sites 61&104\sitemap041106.dwg
Plot Date/Time: Feb 03, 2010 - 2:48pm
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
A. Smith	06/23/06	G. Maresca	06/23/06	G. Maresca	06/23/06	GEO1_091003.dwg



DESCRIPTION OF MAP UNITS

- Dcw — Cornwall Shale
- Dkec — Kanouse Sandstone, and Connelly Conglomerate, undivided
- Sbp — Berkshire Valley and Poxino Island Formations, undivided
- Sl — Longwood Shale
- Sg — Green Pond Conglomerate
- Ꞓl — Leithsville Formation
- Ꞓh — Hardyston Quartzite
- Ybh — Hornblende granite
- Yba — Microperthite alaskite
- Ypg — Pyroxene granite
- Ypa — Pyroxene alaskite
- Yk — Potassic feldspar gneiss
- Yb — Biotite–quartz–feldspar gneiss
- Yp — Pyroxene gneiss
- Ylo — Quartz–oligoclase gneiss
- Yla — Albite–oligoclase alaskite
- Ylb — Biotite–quartz–oligoclase gneiss
- Yh — Hypersthene–quartz–plagioclase gneiss
- Ya — Amphibolite
- Yma — Microantiperthite



FAULTS:

Normal Fault – U=upthrown side, D=downthrown side. Arrow shows attitude of fault plane, if known.

Reverse Fault – U=upthrown side, D=downthrown side. Arrow shows attitude of fault plane, if known.

FOLDS: showing trace of axial surface, dip direction of limbs, and plunge direction

- Overturned Synform
- Overturned Antiform
- Synform
- Antiform
- Icatinny Boundary

SCALE

0 3500 7000 FEET

GEOLOGICAL MAP BASED ON:
BEDROCK GEOLOGIC MAP OF THE DOVER QUADRANGLE
MORRIS COUNTY, NEW JERSEY BY RICHARD A. VOLKERT, 2002, IN REVIEW.
NEW JERSEY GEOLOGICAL SURVEY OPEN FILE.

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-5

PICATINNY
BEDROCK GEOLOGY MAP

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

03/03/03

PLOT DATE: 07/10/05

109MW-3A	06/04/96		(2-4')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.57

109MW-3B	06/04/96		(5-7')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	51

PICA-PGL-2S	1997		
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	12/12
Benzo(a)pyrene	0.2	0.21	0.34J/0.25J

109MW-1A	05/01/96		(0-2')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	15.3
Benz(a)anthracene	2	2.1	5.0
Benzo(a)pyrene	0.2	0.21	5.0
Benzo(b)fluoranthene	2	2.1	6.0
Dibenz(a,h)anthracene	0.2	0.21	0.7
Indeno(1,2,3-c,d)pyrene	2	2.1	3.0

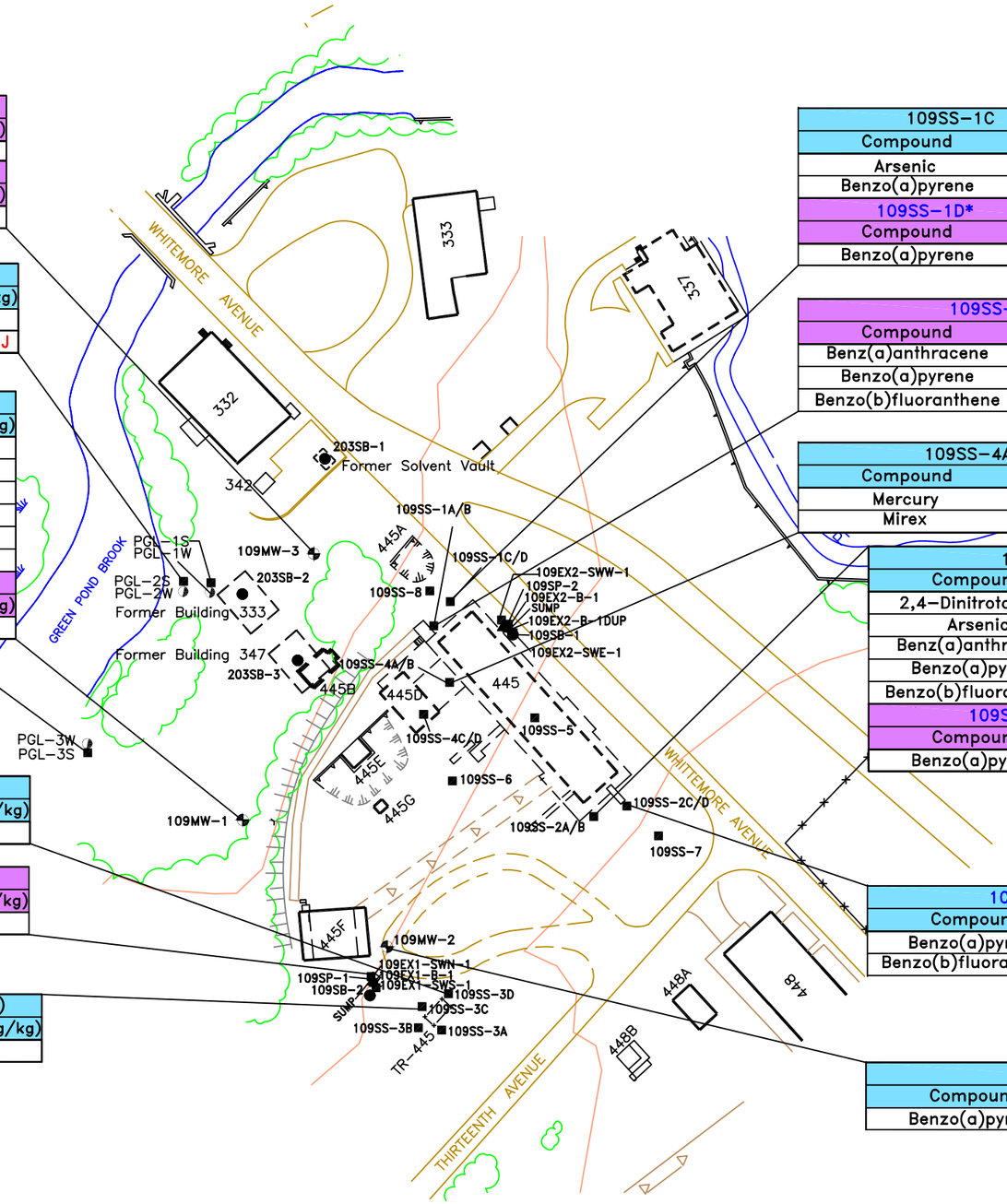
109MW-1C	05/01/96		(10-12')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	4.0

PICA-PGL-3S	1997		
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	10

109SS-3D*	03/28/96		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	1.6

109EX1-SWN-1	08/06/03		(3-3')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.62

109SS-3C*	03/28/96		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.39



109SS-1C	04/15/96		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	16.1
Benzo(a)pyrene	0.2	0.21	1.0

109SS-1D*	04/15/96		(2-4')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.68

109SS-1B*	04/15/96		(2-4')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benz(a)anthracene	2	2.1	7.0
Benzo(a)pyrene	0.2	0.21	5.9
Benzo(b)fluoranthene	2	2.1	6.6

109SS-4A	04/16/96		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Mercury	65	24	40
Mirex	–	0.096	0.42

109SS-2A	04/16/96		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
2,4-Dinitrotoluene	3	5.5	17.9
Arsenic	19	1.6	9.89
Benz(a)anthracene	2	2.1	4.0
Benzo(a)pyrene	0.2	0.21	5.0
Benzo(b)fluoranthene	2	2.1	5.0

109SS-2B*	04/16/96		(2-4')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.64

109SS-2C*	04/16/96		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	3.5
Benzo(b)fluoranthene	2	2.1	3.8

109MW-2A	05/01/96		(0-2')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.47/0.61

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
- UNDERGROUND LINES

EXISTING SAMPLING LOCATIONS
MONITORING WELL
SURFACE WATER/SEDIMENT
SURFACE SOIL
SOIL BORING

NOTE: (*) DENOTES ON-SITE SCREENING SAMPLING

SCALE
0 100 200 FEET

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-6

SITE 109 -
LOC EXCEEDENCES IN SOIL

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

DRAWING NUMBER 109082301.dwg
APPROVED BY -- --
CHECKED BY M. Lobsiger 01/06/10
DRAWN BY S. Wiafe 01/06/10

File: N:\cad\CAD drawings\Picatinny\Area-1\site109\PHASE2RISITEMAPS\109082301.dwg
Plot Date/Time: Jan 14, 2010 - 12:10pm
Plotted By: stephen.Wiafe

File: N:\cad\CAD drawings\Picatinny\Area-I\site109\PHASE2RISITEMAPS\109080404.dwg
Plot Date/Time: Jan 08, 2010 – 2:11pm
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	01/07/10	M. Lobsiger	01/07/10	--	--	109080404.dwg

109MW-3	10/21/96	8/13/97 (27-37')	
Compound	LOC (ug/L)	Conc. (ug/L)	Conc. (ug/L)
Arsenic	3	1.58	9.8
Iron	300	11,600	NA
Manganese	50	1,190	NA
Lead	5	ND	6.7

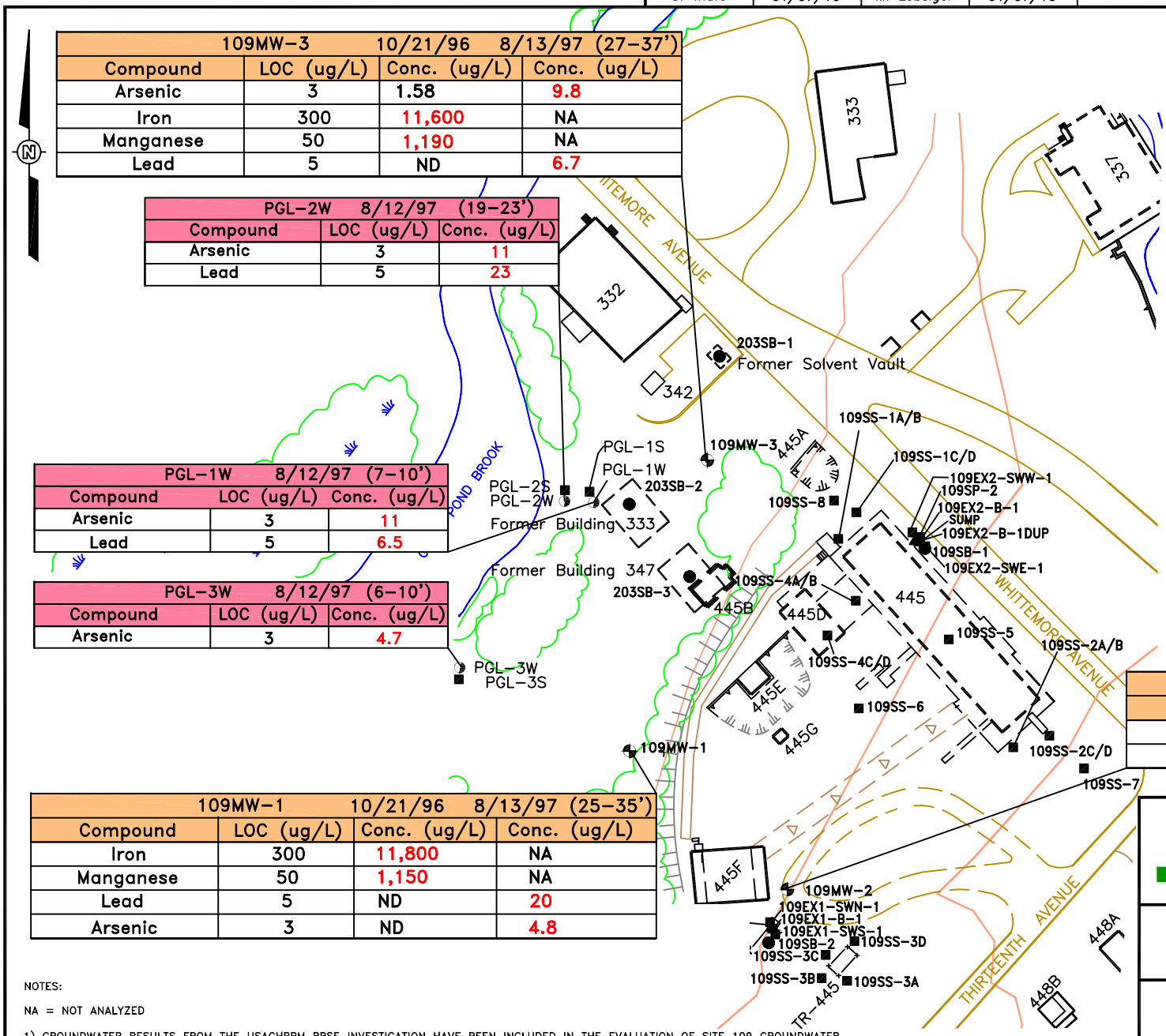
PGL-2W	8/12/97	(19-23')
Compound	LOC (ug/L)	Conc. (ug/L)
Arsenic	3	11
Lead	5	23

PGL-1W	8/12/97	(7-10')
Compound	LOC (ug/L)	Conc. (ug/L)
Arsenic	3	11
Lead	5	6.5

PGL-3W	8/12/97	(6-10')
Compound	LOC (ug/L)	Conc. (ug/L)
Arsenic	3	4.7

109MW-1	10/21/96	8/13/97 (25-35')	
Compound	LOC (ug/L)	Conc. (ug/L)	Conc. (ug/L)
Iron	300	11,800	NA
Manganese	50	1,150	NA
Lead	5	ND	20
Arsenic	3	ND	4.8

109MW-2	10/18/96	(28-38')
Compound	LOC (ug/L)	Conc. (ug/L)
Iron	300	5,410
Manganese	50	881



LEGEND

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

EXISTING SAMPLING LOCATIONS

- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- GEOPROBE GROUNDWATER SAMPLING LOCATION

SCALE
0 100 200 FEET

NOTES:

NA = NOT ANALYZED

1) GROUNDWATER RESULTS FROM THE USACHPPM RRSE INVESTIGATION HAVE BEEN INCLUDED IN THE EVALUATION OF SITE 109 GROUNDWATER.

2) TOPOGRAPHIC CONTOUR SOURCE IS THE IDENTIFICATION AND ANALYSIS OF WETLANDS, FLOODPLAINS, THREATENED AND ENDANGERED SPECIES AND ARCHAEOLOGICAL GEOMORPHOLOGY AT PICATINNY, NJ (WES, 1994), WHICH USED TOPOGRAPHIC CONTOURS DERIVED FROM 1948 SURVEY MAPS. THESE SURVEY MAPS WERE SCANNED TO CREATE ELECTRONIC FILES AND WERE MANUALLY REFINED. WHILE THESE CONTOURS DEPICT GENERAL TOPOGRAPHY WELL, THEY ARE NOT PRECISE IN SOME LOCATIONS.

Picatinny Installation Restoration Program

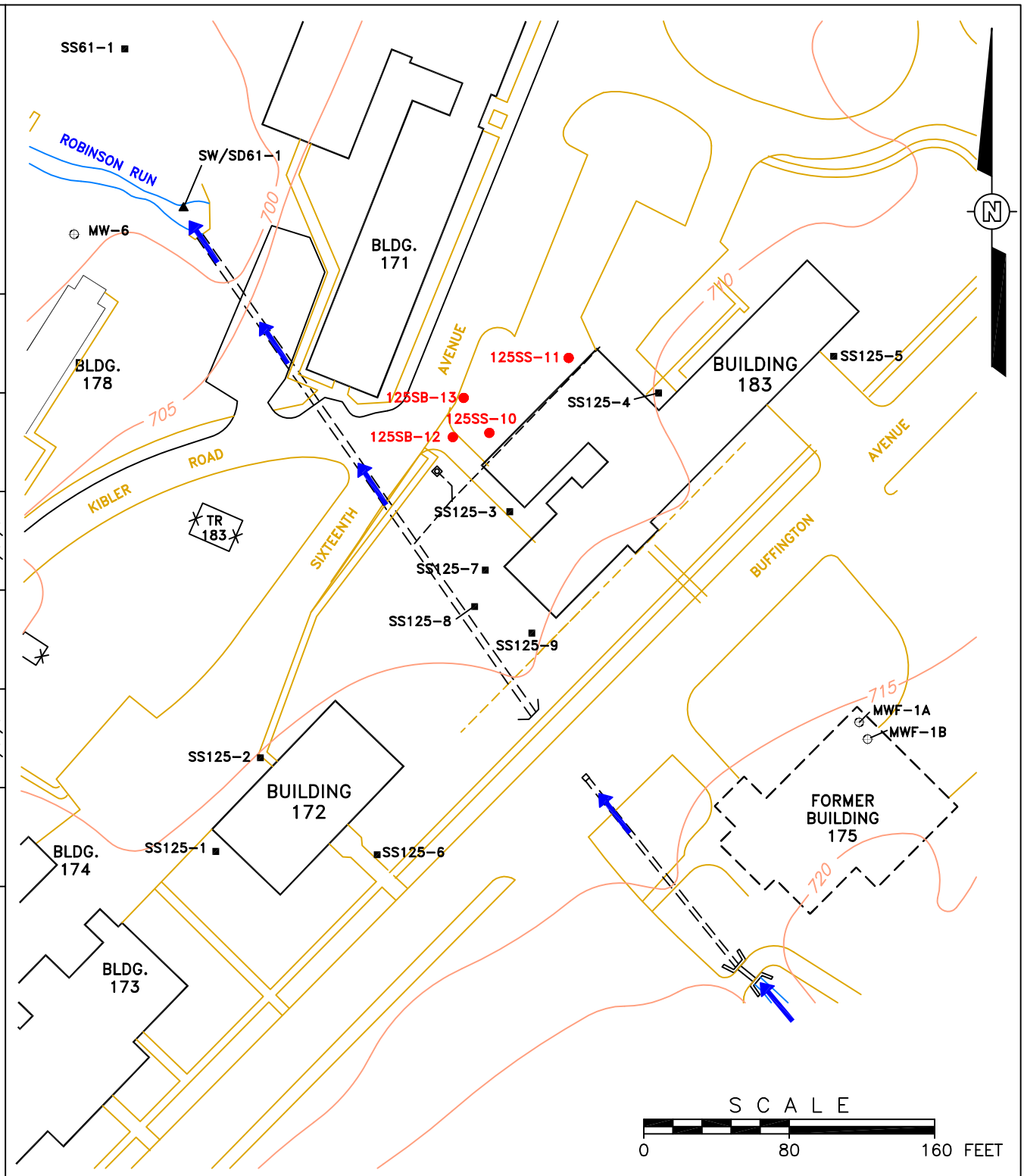
U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-7

SITE 109 AND PICA-203
GROUNDWATER LOC EXCEEDENCES

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY



DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	11/04/04	K. Gerdes	11/04/04	K. Gerdes	--	125110404.dwg

LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER (STS OR STS)
- SANITARY SEWER (SS OR SS)
- SURFACE WATER FLOW DIRECTION
- EARTH MOUND
- BUILDING (BLDG. NO.)
- FORMER BUILDING (BLDG. NO.)
- COVERED WALKWAY
- SWAMP
- WATER

EXISTING SAMPLING LOCATIONS

- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH

PHASE I 2A/3A SAMPLING LOCATIONS

- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

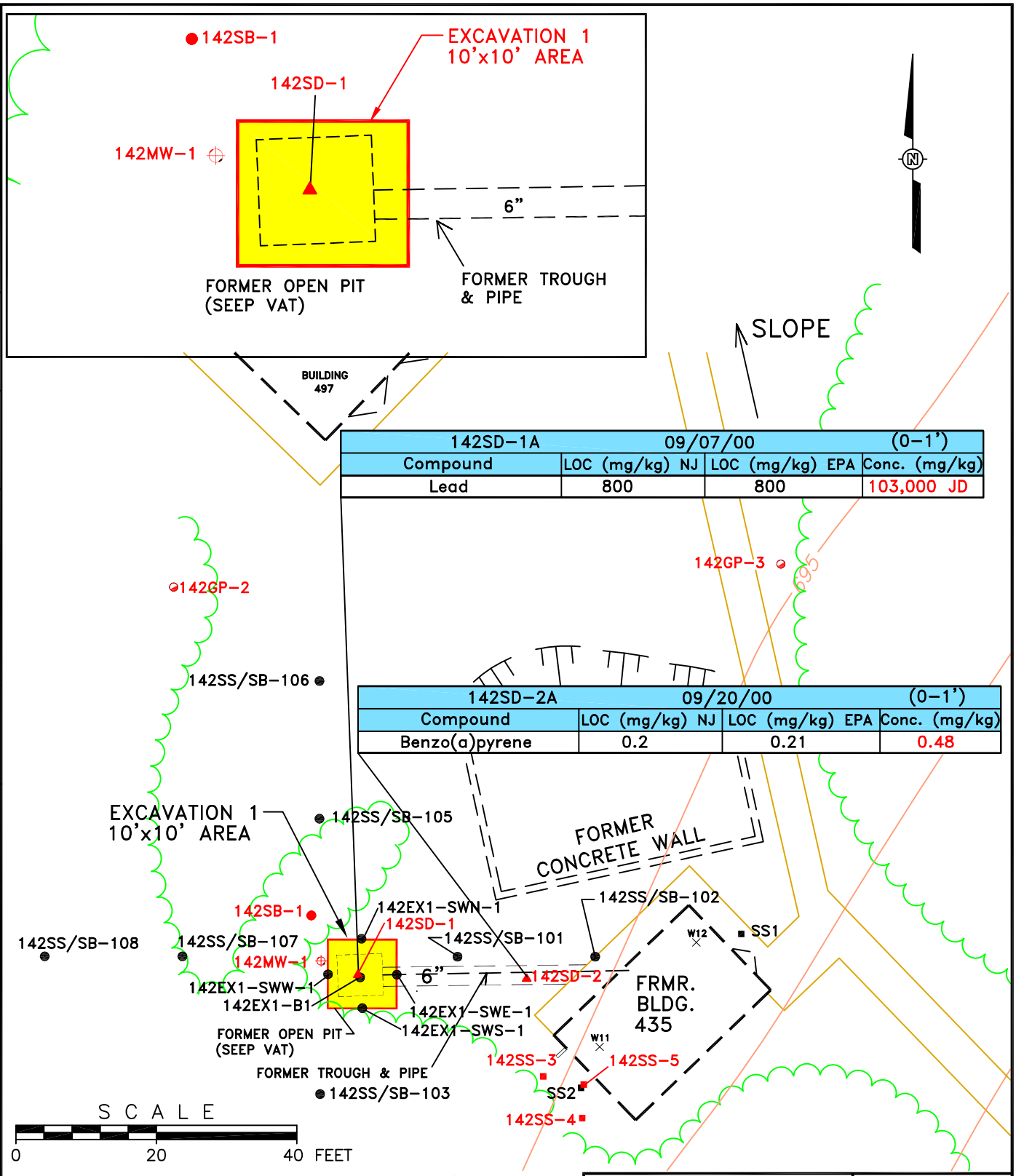
Shaw Environmental, Inc.

FIGURE NO. 2-8

SITE 125 - BUILDINGS 172 & 183
SAMPLE LOCATION MAP

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

File: N:\cad\CAD drawings\Picatinny\Area-F\site125\125110404.dwg
Plot Date/Time: Jan 06, 2010 - 5:46pm
Plotted By: stephen.Wiafe



142SD-1A	09/07/00		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Lead	800	800	103,000 JD

142SD-2A	09/20/00		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.48

LEGEND:

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER (STS OR STS)
- SANITARY SEWER (SS OR SS)
- SOIL REMOVAL AREA
- EARTH MOUND
- BUILDING (BLDG. NO.)
- FORMER BUILDING (BLDG. NO.)
- COVERED WALKWAY
- SWAMP
- WATER

EXISTING SAMPLING LOCATIONS

- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH
- WASTEWATER AND SLUDGE GRAB SAMPLE

PHASE I 2A/3A SAMPLING LOCATIONS

- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH

* NOTE: LOC IS FOR TOTAL ORGANIC CONTAMINANTS

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-9

SITE 142- FORMER BUILDING 435
LOC EXCEEDENCES IN SURFACE SOIL

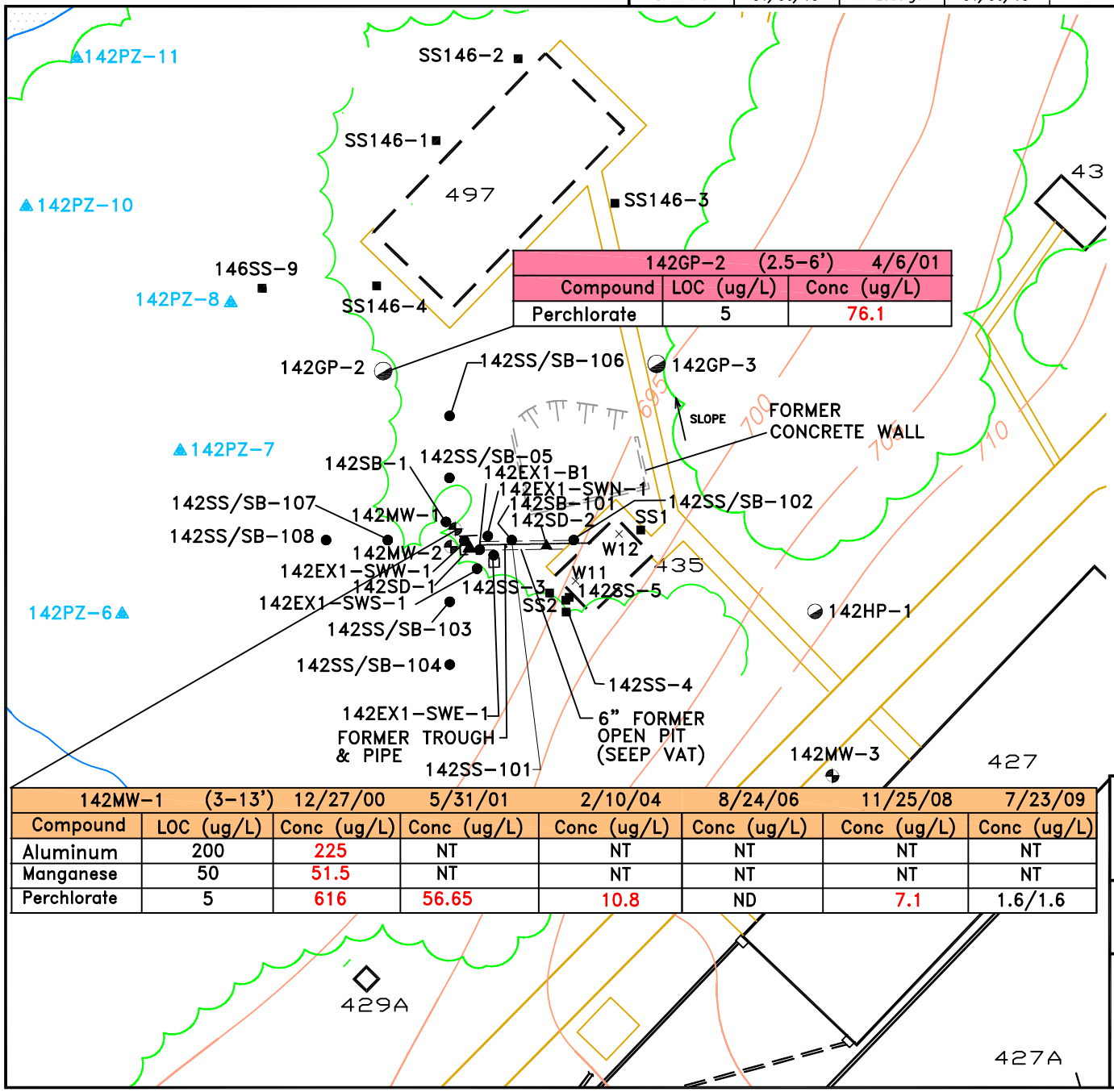
FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

DRAWING NUMBER	APPROVED BY		CHECKED BY		DRAWN BY	
F142010610.dwg	M. Lobsiger	01/06/10	M. Lobsiger	01/06/10	S. Wiafe	01/06/10

File: N:\cad\CAD drawings\Picatinny\Area-F\site142\F142010610.dwg
Plot Date/Time: Jan 08, 2010 - 1:29pm
Plotted By: stephen.Wiafe

File: N:\cad\CAD drawings\Picatinny\Area-F\site142\F142010710.dwg
Plot Date/Time: Jan 08, 2010 – 12:39pm
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER	F142010710.dwg
S. Wiafe	01/06/10	M. Lobsiger	01/06/10	--	--		



142GP-2 (2.5-6') 4/6/01		
Compound	LOC (ug/L)	Conc (ug/L)
Perchlorate	5	76.1

142MW-1 (3-13')		12/27/00	5/31/01	2/10/04	8/24/06	11/25/08	7/23/09
Compound	LOC (ug/L)	Conc (ug/L)	Conc (ug/L)	Conc (ug/L)	Conc (ug/L)	Conc (ug/L)	Conc (ug/L)
Aluminum	200	225	NT	NT	NT	NT	NT
Manganese	50	51.5	NT	NT	NT	NT	NT
Perchlorate	5	616	56.65	10.8	ND	7.1	1.6/1.6

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
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- PIEZOMETER
- GEOPROBE/HYDROPUNCH
- SOIL BORING

ND – NOT DETECTED
NT – NOT TESTED

SCALE
0 50 100 FEET

Picatinny Arsenal Installation Restoration Program

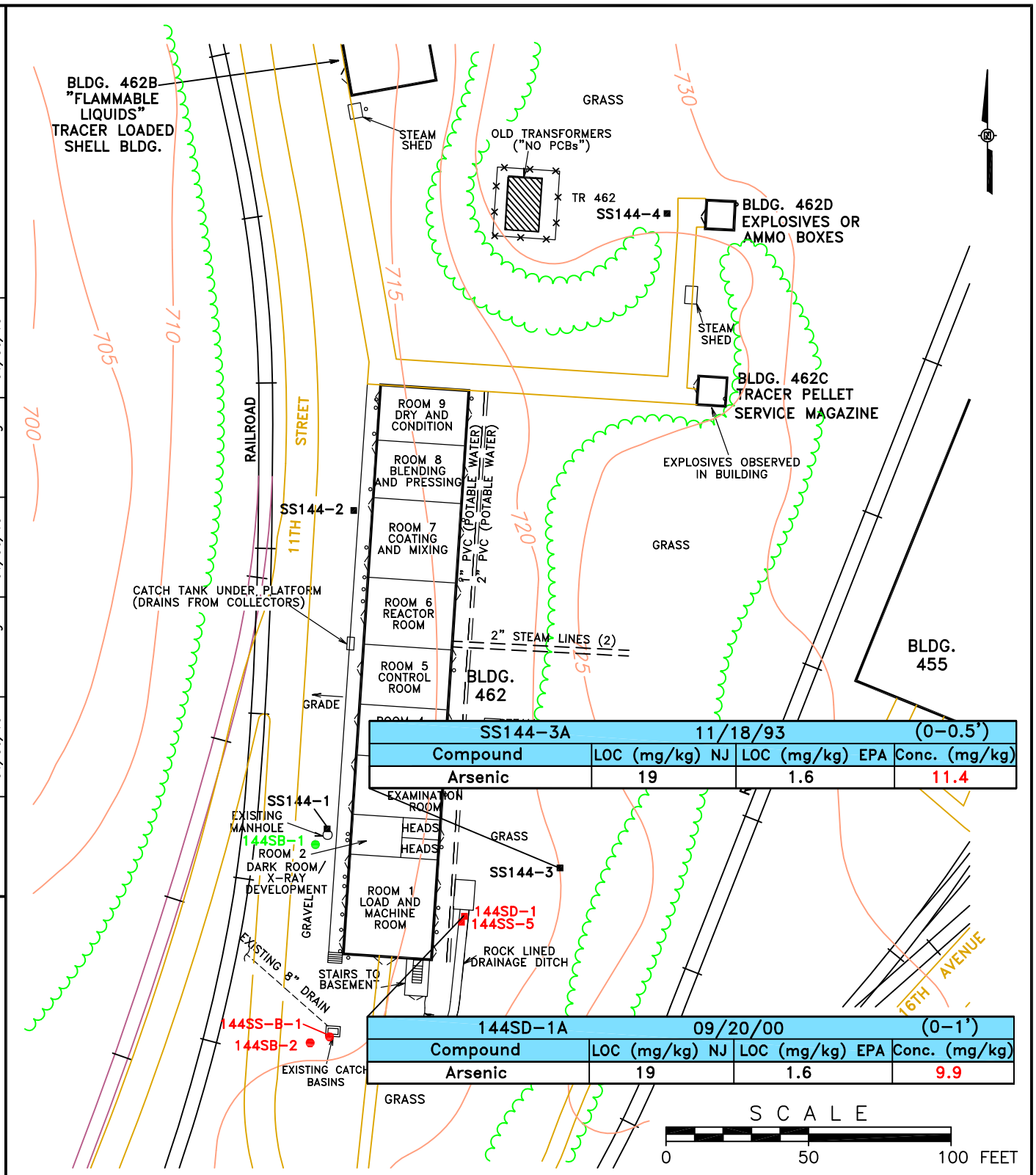
U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-10

SITE 142 - FORMER BUILDING 435
LOC EXCEEDENCES IN GROUNDWATER

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY



SS144-3A	11/18/93		(0-0.5')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	11.4

144SD-1A	09/20/00		(0-1')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	9.9

NOTE: Sample could not be collected due to space limitations.

RAILROAD
TREE LINE
FENCE
TRANSFORMER TR-732
BLAST WALL
STORM OR SEWER
SANITARY OR SEWER
EARTH MOUND
BUILDING
FORMER BUILDING
COVERED WALKWAY
SWAMP
WATER

EXISTING SAMPLING LOCATIONS
MONITORING WELL
SURFACE WATER/SEDIMENT
SURFACE SOIL
SOIL BORING
TEST PIT
HYDROPUNCH

PHASE I 2A/3A SAMPLING LOCATIONS
MONITORING WELL
SURFACE WATER/SEDIMENT
SURFACE SOIL
SOIL BORING
TEST PIT
HYDROPUNCH

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

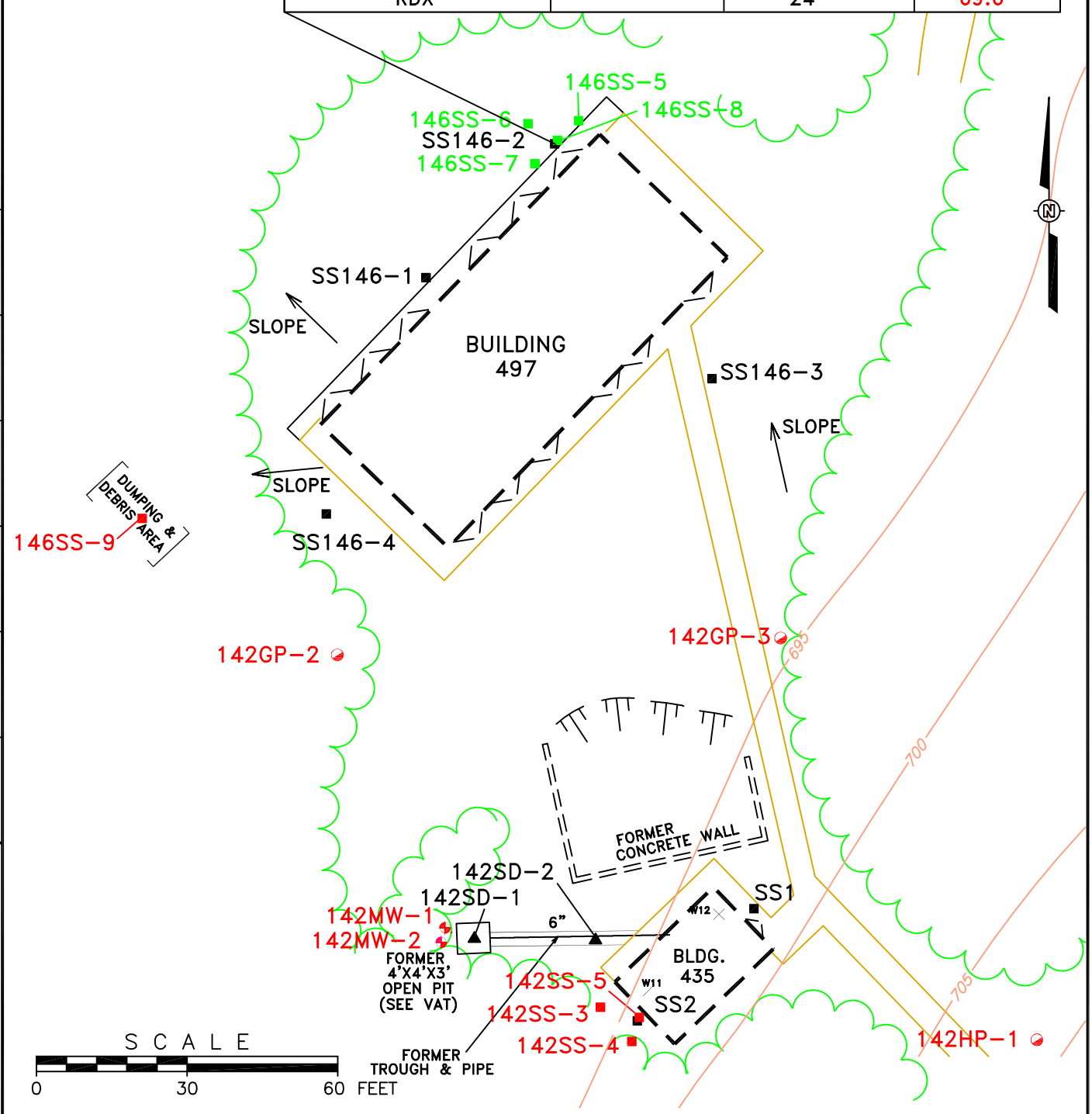
FIGURE NO. 2-11

SITE 144 - BUILDING 462
LOC EXCEEDENCES IN SOIL

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
S. Wiafe 01/06/10	M. Lobsiger 01/06/10	M. Lobsiger 01/06/10	F144092302.dwg

SS146-2A	11/17/93		(0-0.5')
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
RDX	--	24	69.6



NOTE: These samples could not be collected due to demolition activities.

RAILROAD
TREE LINE
FENCE
TR-732 TRANSFORMER
BLAST WALL
STS OR STS STORM SEWER
SS OR SS SANITARY SEWER
EARTH MOUND
BLDG. NO. BUILDING
BLDG. NO. FORMER BUILDING
COVERED WALKWAY
SWAMP
WATER

EXISTING SAMPLING LOCATIONS
- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH

PHASE I 2A/3A SAMPLING LOCATIONS
- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-12

SITE 146 - FORMER BUILDING 497
LOC EXCEEDENCES IN SURFACE SOIL

FS FOR SITES 109, 125, 142, 144, 146 & PICA-203
PICATINNY ARSENAL, DOVER, NEW JERSEY

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	01/06/10	M. Lobsiger	01/06/10	M. Lobsiger	01/06/10	F146010610.dwg

File: N:\cad\CAD drawings\Picatinny\Area-F\site146\F146010610.dwg
Plot Date/Time: Jan 06, 2010 - 5:44pm
Plotted By: stephen.Wiafe

File: N:\cad\CAD drawings\Picatinny\Area-I\site109\PHASE2RISITEMAPS\109-203-010710.dwg
Plot Date/Time: Jan 14, 2010 - 12:25pm
Plotted By: stephen.Wiafe

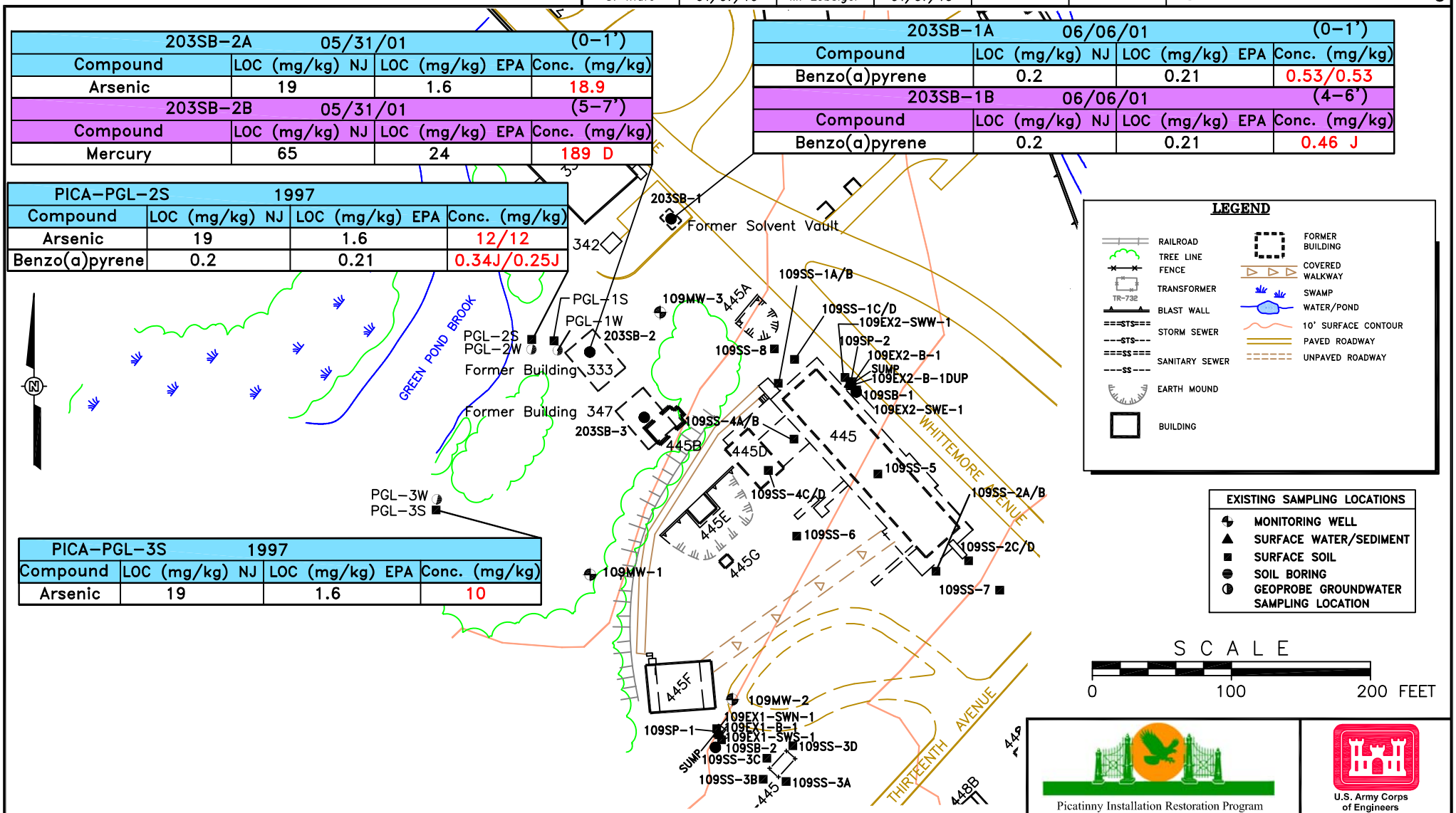
DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	01/07/10	M. Lobsiger	01/07/10	--	--	109-203-010710.dwg

203SB-2A 05/31/01 (0-1')			
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	18.9
203SB-2B 05/31/01 (5-7')			
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Mercury	65	24	189 D

203SB-1A 06/06/01 (0-1')			
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.53/0.53
203SB-1B 06/06/01 (4-6')			
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.21	0.46 J

PICA-PGL-2S 1997			
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	12/12
Benzo(a)pyrene	0.2	0.21	0.34J/0.25J

PICA-PGL-3S 1997			
Compound	LOC (mg/kg) NJ	LOC (mg/kg) EPA	Conc. (mg/kg)
Arsenic	19	1.6	10



NOTES:

NA = NOT ANALYZED

1) GROUNDWATER RESULTS FROM THE USACHPPM RRSE INVESTIGATION HAVE BEEN INCLUDED IN THE EVALUATION OF SITE 109 GROUNDWATER.

2) TOPOGRAPHIC CONTOUR SOURCE IS THE IDENTIFICATION AND ANALYSIS OF WETLANDS, FLOODPLAINS, THREATENED AND ENDANGERED SPECIES AND ARCHAEOLOGICAL GEOMORPHOLOGY AT PICATINNY, NJ (WES, 1994), WHICH USED TOPOGRAPHIC CONTOURS DERIVED FROM 1948 SURVEY MAPS. THESE SURVEY MAPS WERE SCANNED TO CREATE ELECTRONIC FILES AND WERE MANUALLY REFINED. WHILE THESE CONTOURS DEPICT GENERAL TOPOGRAPHY WELL, THEY ARE NOT PRECISE IN SOME LOCATIONS.

Picatinny Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 2-13

SITE PICA 203 - FORMER BLDGS. 333 AND 347
LOC EXCEEDENCES IN SOIL

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

3.0 REMEDIAL ACTION OBJECTIVES AND IDENTIFICATION OF ARARS

3.1 ALLOWABLE EXPOSURE BASED ON RISK ASSESSMENT (INCLUDING ARARS)

Potential ARARs that address the sites' surface soils, subsurface soils, and groundwater are identified in this section. ARAR identification is an integral part of the remediation process mandated under Section 121(d) of CERCLA, as amended by SARA. ARARs are used to develop remedial action cleanup levels, determine the appropriate extent of site cleanup, and govern implementation and operation of the selected remedial action. Specifically, the preamble of CERCLA states, the purpose of the law is "to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites." Response actions that "clean up" hazardous substances at CERLCA sites must comply with standards and criteria that are legally applicable to the substance, pollutant, or contaminant; or that are relevant and appropriate under the circumstances [42 U.S.C. 9621(d)(2)(A)]. These ARARs include federal requirements and more stringent state requirements. Furthermore, the most stringent ARAR identified must be complied with [40 C.F.R. 300.400]. "More stringent" also include those state laws or programs that have no federal counterpart as "they add to the Federal law requirements that are specific to the environmental conditions in the State" (USEPA, 1988b). State requirements, however, must be adopted by formal means (i.e., promulgated) and applied universally throughout the state (i.e., not just to Superfund sites, but to all circumstances addressed in the requirement) [42 U.S.C. 9621(d)(2)(C)(iii)(I)].

3.1.1 ARAR Classification Requirements

In order to be classified as an ARAR, the NCP states that federal and/or state laws must meet one of the following two requirements: (1) applicability or (2) relevance and appropriateness. "Applicable" requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" [40 C.F.R. ' 300.5]. "Relevant and appropriate" requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" [40 C.F.R. ' 300.5].

Once a federal or state law has been classified as applicable or relevant and appropriate, its requirements must be distinguished between substantive and administrative. "Substantive" requirements are "those requirements that pertain directly to actions or conditions in the environment. "Administrative" requirements are "those mechanisms that facilitate the implementation of the substantive requirements of a statute or regulation." Compliance with administrative requirements is not mandated for on-site actions (USEPA, 1988b). For example, CERCLA specifically exempts on-site actions from federal, state, and local permitting requirements [42 U.S.C. ' 9621(e)(1)].

In addition, the NCP identifies a third category, termed "information to-be-considered," or TBC. TBCs are guidelines or advisories that are issued by the federal or state government, but which are neither legally binding nor promulgated (USEPA, 1990). However, these guidelines may be used when they are necessary to ensure protection of public health and the environment (USEPA, 1990). If ARARs do not address a particular circumstance at a CERCLA site, then TBCs can be used to establish remedial guidelines or targets. Even when TBCs are used, the requirements imposed on the remedy, including cost-effectiveness, still apply (55 Fed. Reg. 8745, March 8, 1990).

3.1.2 Types of ARARs

Selection of ARARs is dependent on the hazardous substances present at the site, site characteristics, site location, and the actions selected to remediate the site. Thus, requirements may be chemical-, location-, or action-specific. These categories are not always mutually exclusive and there may be some conceptual overlapping.

Chemical-specific ARARs are generally health- or risk-based concentration values set for specific hazardous substances or other contaminants potentially found in environmental media. Chemical-

specific ARARs provide protective SCLs or a basis for calculating cleanup levels for COCs in the designated media. Chemical-specific ARARs are also used to determine treatment and disposal requirements for a particular remedial activity and to assess the effectiveness of an RA. In the event that a chemical has more than one ARAR, the most stringent is applied.

Location-specific ARARs are made up of restrictions or requirements for substances or activities based primarily on their specific physical location (USEPA, 1988b). An RA may be restricted or precluded based on federal, state, or facility siting laws that address things such as proximity to wetlands, flood plains, or man-made features (such as existing landfills, disposal areas, and local historic buildings). Location-specific ARARs provide a basis for assessing restrictions during the formulation and evaluation of potential site-specific response actions.

Action-specific ARARs are generally technology or activity-based requirements for actions taken with respect to cleanup of hazardous substances at a site. These requirements are triggered by the particular activities that are selected to accomplish a remedy. Thus, action-specific requirements do not in themselves determine the RA; rather, they indicate how a selected alternative must be achieved.

3.1.3 Chemical-Specific ARARs and TBC Guidance

Findings from the RIs have identified contaminated surface soils, subsurface soils, and groundwater. Potential chemical-specific ARARs and TBCs for surface soils, subsurface soils, and groundwater are identified for COPCs within this section. ARARs are only identified based on the scope of the remedial action and alternatives proposed. As there are no drivers for the development of RAOs for surface water or sediment at the subject sites, no ARARs are identified for these media.

Two jurisdictions, federal and state, can enact laws to protect human health and the environment. Localities (such as municipal governments) do not enact laws but usually govern by ordinances. The same holds true for facilities. CERCLA 121(d)(2)(A)(ii) discusses the consideration of environmental law or facility siting law; however, both are in the context of state laws which are more stringent. CERCLA, the mechanism under which remediation at this site is conducted, defines the role and importance of federal and state laws. Section 121 of CERCLA specifies that response actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to hazardous substances or particular circumstances at the site.

3.1.3.1 Surface and Subsurface Soil Criteria

The Federal government has not promulgated chemical-specific standards, requirements, criteria or limitations that are applicable or relevant and appropriate for remediation of surface or subsurface soils at PICA-111. As described throughout Section 2, the promulgated NJDEP ISRS were utilized to create screening levels for surface and subsurface soils. These standards will also be considered for the selection of SCLs for PICA-111.

<u>Federal and State Surface and Subsurface Soil TBCs</u>

TBC guidance includes advisories that have not been promulgated and thus are not enforceable. When compiling chemical specific criteria, TBCs are useful where ARARs do not exist for a specific chemical, or where such ARARs are not sufficient to be protective. In the absence of federal or state-promulgated ARARs, TBC guidance will be considered to provide a list of comparison criteria. Surface and subsurface soil TBCs for PICA-111 include the USEPA IRSLs and USEPA Residential RSLs. Please refer to **Table 3-1** for a listing of promulgated criteria and TBCs.

Table 3-1
Surface and Subsurface Soil Chemical-Specific TBCs and Promulgated Criteria

Chemical	Law/Regulation	Requirement of Law/Regulation
See **Table 3-2** for specific chemicals	NJDEP Soil Remediation Standards NJAC 7:26D Appendix 1	Promulgated Health Base Direct Contact Soil Remediation Standards for Residential and Non-Residential Direct Contact Exposure
See **Appendix C** for specific constituent values	USEPA Regional Screening Levels	These non-promulgated values are concentrations corresponding to fixed levels of risk (i.e., a hazard quotient of 1 or a lifetime excess cancer risk of $1x10^{-6}$) whichever occurs at a lower concentration. Values are calculated for both industrial and residential exposure scenarios.

A comparison of COPCs in surface and subsurface soil identified in Section 2.0 with the New Jersey criteria indicated that both inorganic and organic constituents exceed the NJDEP ISRS. Surface and subsurface soil COPCs are those constituents which exceeded NJDEP ISRS (including natural background thresholds determined in the Background Study Report) or which were identified as a potential risk in either the HHRA or ERA. These constituents are provided in **Table 3-2**. No ecological risk drivers were identified for any of the subject sites.

Table 3-2
Promulgated Criteria for Soil (mg/kg)

Constituent of Potential Concern	NJ Soil Cleanup Criteria (1)	Applicable Site (Risk/Hazard Site(2) in Bold)
• Antimony	450	**146(3)**
• Arsenic	19	**109, 142(3), PICA-203(3)**
• Copper	45,000	142(3)
• Lead	800	**142(3),** 146(3)
• Mercury	65	PICA 203
• Benz(a)anthracene	2	**109**
• Benzo(a)pyrene	0.2	**109, PICA 203, 142**
• Benzo(b)fluoranthene	2	**109**
• Dibenz(a,h)anthracene	0.2	**109**
• Indeno(1,2,3-c,d)pyrene	2	109
• 2,4-DNT	3.0	109
• RDX	NA	**146**

Notes:
(1) Nonresidential Direct Contact Soil Remediation Standards (NJDEP, 2009b).
(2) Risk and Hazard drivers presented are defined as exceeding the lower bound (10^{-6}) of the USEPA target risk range or a HI of >1.
(3) Identified as a risk driver (as defined above); but did not exceed NJ Soil Remediation Standards.
.

3.1.3.2 Federal Groundwater ARARs

The federal Safe Drinking Water Act (SDWA) contains several lists of criteria including maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs). MCLs are enforceable standards that take into consideration human health effects, available treatment technologies, and costs of treatment. Generally, MCLGs are health-based criteria that are lower than the corresponding constituent's MCL criteria.

Pursuant to SDWA, MCLs are applicable "at the tap" for public water systems that have at least 15 service connections or that serve an average of at least 25 people daily for at least 60 days a year.

MCLGs, though not enforceable under the SDWA, are specifically referenced within Section 121 of CERCLA. Section 121 specifically states that remedial actions shall attain MCLGs where such goals or criteria are relevant and appropriate. Section 121 goes on to state that in determining whether or not any water quality criteria under the SDWA are relevant and appropriate, designated or potential use of the groundwater must be considered. Because the designated use of Class IIA groundwater includes drinking water which will affect human health, MCLGs are ARARs. However, Section 300.430e(2)(i)(B) and (C) of the CFR states that MCLGs, established under the SDWA, that are set at levels above zero shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water. Therefore, only MCLs and non-zero MCLGs will be considered ARARs. Federal and State chemical-specific criteria are presented in **Table 3-3**.

Table 3-3
Chemical Specific Groundwater Criteria

Chemical	Laws/Regulations	Requirement(s)
See **Table 3-4** for specific chemicals	SDWA--MCLs, 40 CFR 141.60 through 141.62	MCLs have been promulgated and regulate contaminants in public drinking water.
	New Jersey SDWA--State MCLs, NJAC 7:10-5.0 through 5.4	MCLs have been promulgated by the state and regulate contaminants in public drinking water.
	New Jersey Groundwater Quality Standards (GWQS), NJAC 7:9C-1.5 through 1.9 and Table 1	Groundwater quality standards have been promulgated and regulate contaminants in groundwater.
	SDWA--MCLGs, 40CFR 141.50 through 141.51	Promulgated health-based criteria for drinking water sources.
	EPA Office of Drinking Water Health Advisories	Non promulgated advisories that estimate risk due to consumption of contaminated drinking water/groundwater.
	USEPA Tap Water RSLs	Non-promulgated concentrations that estimate risk due to standard lifetime exposure scenarios.

3.1.3.3 State Groundwater ARARs

New Jersey has incorporated by reference the federal MCLs [NJAC 7:10-5.0 through 5.4]. The New Jersey MCLs apply to public water systems and are identical to the SDWA MCLs except for more stringent MCLs for VOCs [NJAC 7:10-5.2(a)(4)]. Like the federal MCLs, New Jersey MCLs are relevant and appropriate for a Class IIA water source.

Additionally, the state has promulgated GWQS [NJAC 7:9C]. The purpose of GWQS is to protect groundwater quality through the establishment of constituent standards [NJAC 7:9C]. GWQS consist of two lists of criteria. The first list, referred to within this FS as “quality criteria,” is generally composed of contaminant concentrations that are protective of human health and the environment. The second list is composed of practical quantitation limits (PQLs). New Jersey PQLs are the lowest levels of a specified substance that can be reliably measured within specified limits of precision and accuracy during routine laboratory operations. The overall standard for any contaminant is the higher of that contaminant’s quality criterion or PQL. GWQS are applicable for the development of groundwater protection standards pursuant to the National Pollutant Discharge Elimination System; groundwater cleanup standards and compliance levels beyond the boundaries of a contaminated site pursuant to applicable regulatory programs; and other requirements and regulatory actions applicable to discharges.

The New Jersey Technical Requirements for Site Remediation provide substantive cleanup levels or levels of control by requiring that remedial actions shall “comply with all applicable remediation standards in effect at the time the remedial action work plan is approved by the Department . . .”

[NJAC 7:26E-6.1(b)(2)]. "Applicable remediation standards" are defined to include the GWQS at NJAC 7:9C. These standards are promulgated and enforceable, thus qualify as ARARs.

Table 3-4 provides the MCL, MCLG, NJMCL, NJGWQC, NJPQL, Federal Drinking Water Health Advisory, and USEPA Tap Water RSLs for comparison.

Table 3-4
ARARs and Other Guidance to Be Considered for PICA 111 Groundwater

Chemical	Promulgated Standards (µg/L)			ARAR (µg/L)		Non-Promulgated Standards (µg/L)			
	Federal Drinking Water Standards (b)		New Jersey Drinking Water	New Jersey Groundwater (c)		Federal Drinking Water Health Advisories (b)	USEPA Regional Screening Levels (d)		
	MCL	MCLG	NJMCL	Quality Criteria	NJPQL	HA	Tapwater	C/N	MCL
Volatiles									
Chloroform (f)	80	70	---	70	1	70	0.19	c	---
Metals									
Aluminum	---	---	---	200	30	---	37000	n	---
Arsenic	10	0	5	0.02	3	---	0.045	c	---
Iron	---	---	---	300	20	---	26000	n	---
Lead	15	0	---	5	5	---	---	---	15
Manganese	---	---	---	50	0.4	300	880	n	---
Anions									
Perchlorate (aq)	---	---	---	5	2.7	---	26	n	15 (g)

ARAR = Applicable or Relevant and Appropriate Requirement
C/N = Carcinogenic or noncarcinogenic according to USEPA (2009).
HA = Health Advisory
MCL = Maximum Contaminant Level
--- = No value available.
(b) USEPA Drinking Water Standards and Health Advisories (Winter 2004) Publication #EPA 822-R-04-005.
(c) NJDEP (2005).
(f) MCL value is based on trihalomethanes.
(g) http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/faq.htm#FAQ29
(aq) The NJ Groundwater Quality Criteria values are Interim Specific Criterion

MCLG = Maximum Contaminant Level Goal
NJMCL = New Jersey Maximum Contaminant Level (2002)
PQL = Practical Quantitation Limit

3.1.4 Location-Specific ARARs and TBC Guidance

Remedial action alternatives may be restricted or precluded by federal, state, and U.S. Army regulations based on its location within a site or its immediate environment. Location-specific ARARs are designed to protect the local area from potentially damaging response actions. For example, altering habitat of an endangered species to construct a treatment facility may jeopardize the survivability of the species. The converse is also true; location-specific ARARs also protect RAs from the environment. For example, locating a treatment facility within a flood plain without proper engineering precautions may result in structural damage during a flood. **Table 3-5** identifies the federal, state, and U.S. Army regulations that contain promulgated standards, requirements, criteria, or limitations that will be considered ARARs for this FS. Within the table, location-specific ARAR "requirements" are grouped by site characteristics that have been observed within the subject sites or characteristics that are likely to be encountered at the site. The promulgated standards and requirements and the impact each location-specific ARAR will have if encountered is also identified within **Table 3-5**.

3.1.5 Action-Specific ARARs and TBC Guidance

Action-specific ARARs are promulgated state or federal laws that set controls or restrictions on activities related to the management of hazardous materials. Within Section 4.0 of this FS, several RAs for the subject sites are developed. Each of the RAs, except No Action, will require several "actions" to transpire in the course of successfully instituting the alternative and may be controlled or restricted by action-specific ARARs. The action-specific ARARs and TBCs are organized by the associated actions and presented in **Table 3-6**. ARARs listed in **Table 3-6** generally apply to RAs involving excavation of COCs, with the exception of the specified requirements in the NJ Technical Requirements for Site Remediation N.J.A.C. 7:26E Subchapter 8, Engineering and Institutional Controls.

By definition, ARARs pertain to on-site actions subject to promulgated state or federal laws. Legal requirements governing off-site actions, such as those pertaining to labeling and transportation of solid and/or hazardous waste do not qualify as ARARs; however, they are applicable requirements outside of the CERCLA ARARs process that must be met. Such requirements would be applicable to the transporter but would apply outside of the ARARs context. Off-site actions must comply with all applicable requirements. Such requirements would include:

- NJDEP – Division of Waste Management: NJAC 7:26 Subchapter 3, which requires that solid waste (investigation derived waste) for off-site transportation must obtain proper written approval from the state prior to transporting the waste. Once approved, the transporting vehicle has to be properly registered to handle the waste with appropriate placard.
- RCRA – Solid/Hazardous Waste Regulations: 40 CFR, Subparts A, B, C, and D and 40 CFR 263, Subparts A, B, and C; Directive #9330.2-07,49; and NJAC 7:26G-7 require vehicles transporting hazardous waste to be properly registered to handle and transport the waste to a regulated facility. In addition, waste must be properly packed and accompanied by proper emergency response spill procedures and manifests.
- U.S. Department of Transportation Hazardous Materials Transportation Regulations, 49 CFR 171-180 establishes classification, packaging, and labeling requirements for shipments of hazardous materials.

3.1.6 Non-Applicable ARARs

The following location-specific ARARs were considered, but found to be not applicable or relevant and appropriate for this FS:

- Faults
- Wilderness Areas
- Wildlife Resources and Refuges
- Scenic Rivers
- Farmlands
- Coastal Zones

These potential areas are required to be reviewed as potential ARARs by CERCLA guidance documents.

Table 3-5
Location-Specific ARARs and TBCs

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 permit requirements if clearing and/or excavation activities encroach upon wetlands and/or transition areas identified in the Picatinny Facility-wide Geographic Information System (GIS) at Sites 109, 142, 144, 146 and PICA-203. Applicable or potentially applicable to sites within or adjacent to: Encroachment/Transition Areas: Sites 109, 142, 144, 146 & PICA-203 Wetlands: Sites 142, 144, 146 & PICA-203
	Presence of wetlands as defined in the Clean Water Act 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.	
Floodplains	Protection of flood plains as defined in Executive Order 11988 § 6(c) and 40CFR 6, Appendix A §4 (d)	Federal agencies shall take action to reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values of flood plains. Federal agencies shall evaluate the potential effects of actions in flood plains and ensure consideration of flood hazards and flood plain management. If action is taken in flood plains, federal agencies shall consider alternatives to avoid adverse affects, and potential.	ARAR Based upon the Picatinny Facility-wide GIS, three of the sites have been identified within or adjacent to: 100-yr floodplain: Sites 144 & 146 1-yr floodplain: Site 146
	Within 100-year flood plain as defined in 40 CFR 6, Appendix A §4 (d)	Facility must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by flooding.	

Table 3-5 (Continued)
Location-Specific ARARs and TBCs

Location	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
Integrated Natural Resource Management Plan (INRMP)	Interagency agreement with the United States Army Environmental Center, as required by: - Sikes Act (16 U.S.C. 670a *et seq*) - Army Regulation 200-3 - Department of Defense Instruction 4715.3	The purpose of the INRMP is to ensure that natural resources conservation measures and Army mission activities are integrated and are consistent with federal stewardship requirements. Stated goals of the INRMP include minimizing habitat fragmentation and protecting unique or sensitive habitat; and protecting native species, rare and ecologically important species, and genetic diversity.	TBC Applicable to clearing and/or excavation activities which could affect the multipurpose uses of natural resources at Picatinny. Remedial activities at Sites 109, 125, 142, 144, 146 and PICA-203 will be conducted in accordance with the INRMP.
Endangered Species Act (Rare, Threatened, or Endangered Species)	Presence of those species listed in the following acts and regulations: - Endangered Species Act (16 U.S.C. 1531 *et seq*) - Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq*) - 40 CFR 6.302(h) - 50 CFR 402 - CWA § 404 - 50 CFR 17.11-17.12 - NJAS 23:2A - NJAC 7:25-4 as being rare, threatened, or endangered species.	Whenever possible, federal agency actions must avoid or minimize adverse impacts on rare, threatened, or endangered species and act to preserve and enhance their natural and beneficial values. Agencies should particularly avoid new construction in those areas containing these species unless there are no practicable alternatives. Federal agencies shall incorporate rare, threatened, or endangered species protection consideration into planning, regulating, and decision-making processes.	ARAR Applicable to sites located within the habitats identified in the Picatinny Facility-wide GIS. Sites 109 and 144 are located within the safety distance around Indiana Bat siting locations.

Table 3-6
Action-Specific ARARs and TBCs

Action	Law/Regulation	Requirement of Law/ Regulation	ARAR/TBC Status
Generation of Hazardous Wastes and Testing of Excavated Materials	RCRA methods for identification and evaluation of solid and hazardous wastes - 40 CFR 261, Subparts A, B, C, and D - 40 CFR 136, App. A (SW-846 including method 608, 8082 by gas chromatography for PCB wastes). - NJAC 26G-5.1 (incorporated by reference 40 CFR 261)	Specific requirements for identifying hazardous wastes. Establishes analytical requirements for testing and evaluating solid, hazardous, and water wastes	ARAR Applicable. Toxicity Characteristic Leachate Procedure (TCLP) analysis and testing results indicative of hazardous wastes.
Sampling and Analysis	Remediation Technical Requirements NJAC 7:26E-6.4(a)	Requirements for post remedial action sampling and analysis at remediation sites.	ARAR Applicable to the performance of sampling and analysis at excavation sites.
Soil Erosion and Sediment Control during Excavation	New Jersey Soil Erosion and Sediment Control Act, NJAC 7:13-3 and NJAC 2:90	Requirements for soil erosion and sediment controls.	ARAR Applicable to excavation, and clearing activities.
Military Munitions Identification, Treatment, and Disposal	40 CFR 266.200 – 266.206, Subpart M [reference 40 CFR 260-270]	Regulations which identify when military munitions become a solid waste and if hazardous.	ARAR Potentially applicable if unexploded ordnance (UXO) is discovered during excavation and/or clearing activities at the site.
	40 CFR 300.120	The Department of Defense (DOD) will have removal response authority and Remedial Project Manager (RPM) will be the prime contact for incidents involving military weapons and munitions under control of DOD.	ARAR Potentially applicable if UXO is discovered during excavation and/or clearing activities at the site. DOD and RPM will be contacted.
	ER-1110-1-8153	Defines response actions and roles and responsibilities for UXO removal Adapts criterion of 10% explosive content as a measure of contaminated soil reactivity to differentiate between hazardous and explosive waste.	TBC Potentially applicable if UXO is discovered during excavation and/or any other access of personnel at site TBC Applies to explosive content in soil. Not applicable to UXO directly.

Table 3-6 (Continued)
Action-Specific ARARs and TBCs

Action	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
Military Munitions Identification, Treatment, and Disposal (continued)	EP-1110-1-18	Provides the procedures to implement an UXO removal action.	TBC Potentially applicable if UXO is discovered during excavation and/or any other access of personnel at site
	TM-9-1375-213-12	Defines the minimum safe distance between emitters of electromagnetic radiation in the radio frequency range and UXO clearance/demolition activities.	TBC Potentially applicable if UXO is discovered during excavation and/or any other access of personnel at site
	TM-5-855-1	Defines protective measures to be taken to reduce blast shock and fragmentation damage.	TBC Potentially applicable if UXO is discovered during excavation and/or any other access of personnel at site.
	DA PAM 385-61 DA PAM 385-64	Defines procedures for emergency decontamination of site workers and minimum safe distance for UXO removal.	TBC Potentially applicable if UXO is discovered during excavation and/or any other access of personnel at site
	TM-60-A-1-1-31	Provides UXO disposal requirements	TBC Potentially applicable if UXO is discovered during excavation and/or any other access of personnel at site
	DOD 6055.9-STD	Requires specialized personnel in detection, removal, and disposal of ordnance and explosives; stipulates required safety precautions and procedures for detonation/ disposal; establishes depth of remediation based on land use.	TBC Potentially applicable if UXO is discovered during excavation and/or any other access of personnel at site

Table 3-6 (Continued)
Action-Specific ARARs and TBCs

Action	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
General Remediation and Institutional Controls	Technical Requirements for Site Remediation NJAC 7:26E-6.1(b)2,4	Specifies that revised applicable numerical remediation standards must be achieved if they decrease by an order of magnitude or more prior to issuance of a No Further Action (NFA) and that remedial action must not cause an uncontrolled or unpermitted discharge or transfer of contaminants to another media.	ARAR Relevant and appropriate for on-site remediation activities.
	NJAC 7:26E-6.1(e)	Requires institutional controls (ICs) whenever a restricted/limited use remedy is used at a site.	ARAR Relevant and appropriate for on-site remedial activities.
	NJAC 7:26E-6.4(b)	Specifies post-remedial site restoration requirements.	ARAR Applicable to on-site remedial activities involving excavation.
	NJAC 7:26E-6.4(d)1	Provides requirements for reuse of excavated soil at the site.	ARAR Potentially applicable to on-site remedial activities if excavated soil is to be reused.
	NJAC 7:26E-8.1(b)3 NJAC 7:26E-8.5(a)1,2,3 NJAC 7:26E-8.7(a)1,2,3	Specifies monitoring of engineering and institutional controls.	ARAR Relevant and appropriate for on-site remedial activities.
	New Jersey Soil Erosion and Sediment Control Act 40 CFR 122.26(c) NJAC 7:13-3 and 2:90. 40 CFR 122.26 (c)	Requires the implementation of soil and erosion and sediment control measures for activities disturbing over 5,000 SF of surface area of land.	ARAR Applicable for site activities involving excavation, grading, or other soil disturbance activities exceeding 1 acre.
	USEPA OSWER Publication 9345.3-03FS, January 1992	Investigation-derived wastes generated from remedial activities (e.g., drilling mud, purged water, etc.) are required to be properly stored, managed and disposed. Guidance given in the publication includes waste material containment, collection, labeling, etc.	TBC for wastes generated during excavation activities and groundwater monitoring.

Table 3-6 (Continued)
Action-Specific ARARs and TBCs

Action	Law/Regulation	Requirement of Law/ Regulation	ARAR/TBC Status
Discharge of Aqueous Waste to Surface Water	CWA Effluent Guidelines – National Pollutant Discharge Elimination System 40 CFR 401 40 CFR 122 and 125 40 CFR 136.1 – 136.4	Provides requirements for point source discharges of pollutants.	ARAR Applicable for discharge of storm water that may result from on-site *in situ* and/or excavation and clearing activities and the discharge of treated wash water to the drainage ditch, wetlands or surface water.
	New Jersey Water Pollution Control Act – New Jersey Pollutant Discharge Elimination System (NJPDES) (NJAC 7:14A)	Discharge of pollutants to surface water and groundwater from remediation sites is regulated via NJPDES requirements. NJPDES requirements include obtaining a discharge to surface water or groundwater permit equivalent and meeting substantive requirements of the permit. Requirements include effluent limitations, water quality based limitations, monitoring, and monitoring techniques.	ARAR Applicable to the substantive requirements of the permit program for storm water and treated wash water discharges to surface water.
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 remediation activities.

Table 3-6 (Continued)
Action-Specific ARARs and TBCs

Action	Law/Regulation	Requirement of Law/ Regulation	ARAR/TBC Status
On-Site Treatment, Storage, and Disposal	RCRA Treatment, Storage and Disposal of Hazardous Waste 40 CFR 264, Subparts A, B, C, D, E, G, and I. 265, Subparts A, B, C, D, E, G and I NJAC 26G-8 and 9 (incorporation by reference)	Standards and requirements for facilities that treat, store, and dispose of hazardous waste. Requirements include: - General Facility Standards - Emergency Preparedness and Prevention - Contingency Plan and Emergency Procedures - Manifest System - Use and Management of Containers - Closure and Post Closure	ARAR Applicable to the substantive requirements if hazardous waste is treated or stored on site.
	RCRA Treatment, Storage and Disposal of Hazardous Waste 40 CFR 264, Subparts J, L, and X 40 CFR 265 Subparts J, L, and Q RCRA – New Jersey Hazardous Waste Regulations Incorporates the above regulations (NJAC 7:26G-8 and 9)	Provides requirements for handling waste at the following facility types: - Tank systems - Waste piles - Chemical, physical and biological treatment - Miscellaneous units	ARAR Potentially applicable to the substantive requirements for storage and treatment of wash water and soils from remediation activities. This would be applicable if wash water and/or excavated soils were identified as hazardous waste and treated on site.
	Air Quality Regulations New Jersey NJAC 7:27-13	Provides requirements applicable to ambient air pollution sources.	ARAR Potentially applicable to the on-site generation and emission of ambient air pollutants. Air monitoring will be performed and if the following air quality standards are exceeded, then requirements are applicable. Primary air quality standard is 75 micrograms per cubic meter ($\mu g/m^3$) (not to exceed 260 $\mu g/m^3$ more than once) and secondary standard of 60 $\mu g/m^3$ (not to exceed 150 $\mu g/m^3$ more than once), both for geometric mean value of all 24-hour average concentration standard over 12 consecutive months.

Table 3-6 (Continued)
Action-Specific ARARs and TBCs

Action	Law/Regulation	Requirement of Law/ Regulation	ARAR/TBC Status
Disposal Off Site	RCRA Land Disposal Restrictions 40 CFR 268, Subparts A, B, C, D, and E NJAC 7:26-11 *et seq.*	Identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise restricted waste may continue to be land disposed.	ARAR Applicable if hazardous waste is disposed of on site or transported off site to a landfill.
	Toxic Substances Control Act (TSCA) Identification of alternate disposal methods, traditional (performance based) and risk-based methods for disposal. 40 CFR 761.50 (alternate disposal method) 40 CFR 761.75 (chemical waste landfill) 40 CFR 761.61 (self-implementing, traditional and risk based options) 40 CFR 761.77 (approval)	Applicable to disposal of material: 1) containing < 50 mg/kg PCBs; 2) managed under a 404 CWA or equivalent permit USACE under 33 CFR 320; 3) getting prior approval from USEPA based on risk assessment and site specifics.	ARAR Potentially applicable to disposal of < 50 mg/kg PCBs may be sent to a RCRA approved landfill.
	Procedures for Planning and Implementing Off-Site Response Actions 40 CFR 300.440(a)(4)	Requires the receiving facility meet acceptability requirements (as determined by the EPA Regional Office) prior to the facility's initial receipt of CERCLA waste.	ARAR Applicable if site contaminants are excavated and disposed off site.
Packaging, Labeling and Storage	RCRA Hazardous Waste Generation 40 CFR 262, Subparts A, B, C, D, and E NJAC 7:26G-6	Specifies requirements for hazardous waste packaging, labeling, manifesting, and storage.	ARAR Potentially applicable for the off-site transportation of hazardous waste.
	TSCA 40 CFR 761.40 and 40 CFR 761.45	Specifies requirements for labeling and shipping of PCBs.	ARAR Potentially applicable for labeling and transportation of PCBs off site.

3.2 IDENTIFICATION OF CONTAMINANTS OF CONCERN, SITE CLEANUP LEVELS, AND AREAS OF ATTAINMENT

This section describes the determination of COCs, SCLs, and AAs for each media at Sites 109, 125, 142, 144, 146, and PICA-203. Previous sections of this report have identified lists of potential COCs, as follows:

COPCs – identified by screening versus LOCs. Results of this screening process are included in Section 2.0 (Nature and Extent of Contamination).

HHCOPCs – identified as potential risks in HHRAs.

COPECs – identified as potential risks in ERAs.

In the following sections, these contaminants are further evaluated with respect to the potential chemical-specific ARARs and TBCs presented in Section 3.2 and to refine the potential associated risks.

A COC is defined as a contaminant that poses significant human health and/or ecological risks at a particular site. The SCL is a level, determined based on the evaluation of potential ARARs and the potential risks posed to human health and ecological receptors, which is used to achieve the RAOs for a particular site. Lastly, an AA is defined as the area over which RAOs, thus the SCLs, are to be obtained.

The USEPA uses the general 10^{-4} to 10^{-6} risk range as a "target range" within which the Agency strives to manage risks as part of a Superfund Cleanup. Generally, a response action is implemented following NCP guidance when site-specific excess carcinogenic risk to human health exceeds one in ten thousand (10^{-4}). For the purpose of this FS the AAs are areas of low-level soil contamination with excess human health carcinogenic risk within the $1x10^{-4}$ and $1x10^{-6}$ range or HI>1 with exceedences of NJDEP ISRS. AAs for groundwater are areas of low-level groundwater contamination in excess of NJDEP GWQS or compounds identified as risk drivers in the HHRA after being further screened by site-specific concentrations.

3.2.1 Identification of COCs and SCLs

COCs are addressed within this section for each media covered within this FS (i.e., surface soil and subsurface soil, sediment, surface water and groundwater). The starting point for the development of the list of COCs is the entire list of contaminants that were detected in samples collected from the sites. For soils, the entire list of detected chemicals was compared with the current NJDEP ISRS. In cases where a site exhibited no exceedences of the ISRS, the site data was compared to the USEPA RSL (both Industrial and Residential) to determine if a recommendation of NFA was appropriate for the site. For groundwater, the entire list of detected constituents were compared to Picatinny LOCs for groundwater. All exceedences of Picatinny LOCs were then further screened by site-specific considerations. All available chemical concentrations detected at Sites 109, 125, 142, 144, 146, and PICA 203 are presented in **Appendix D** in order to allow the reader to get a complete look at the data. These lists of compounds were also screened using the results of the HHRA and ERA.

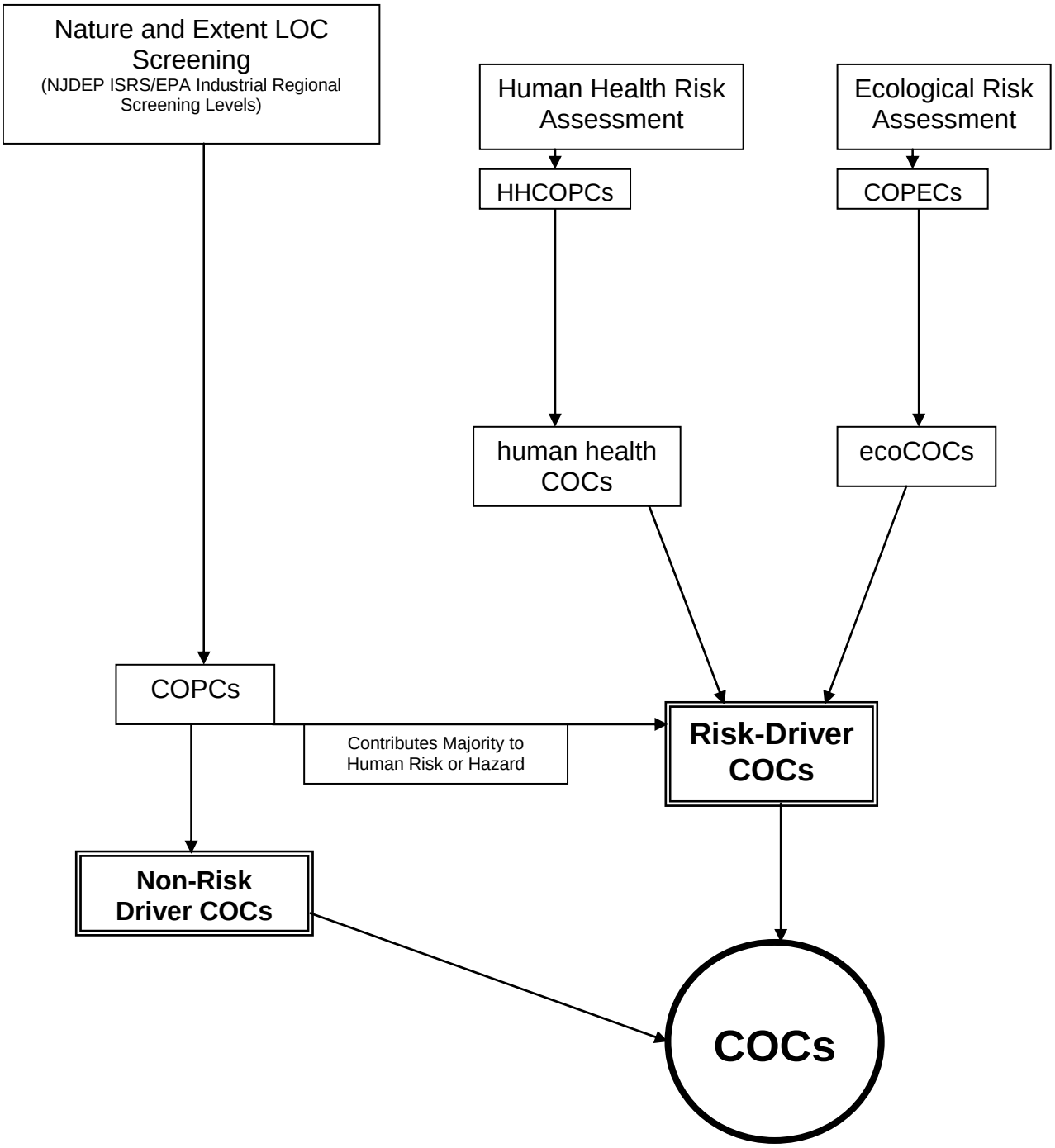
3.2.1.1 Surface Soil

Based on comments from the NJDEP, COCs are defined as compounds that: 1) contributed to the majority of site-specific human health or ecological risk, which are referred to as "Risk-Driver COCs"; and, 2) exceeded the NJDEP ISRS, which are referred to as "Non Risk-Driver COCs."

Below is a summary of the screening process used to identify COCs in surface soil (also depicted graphically in **Chart 3-1**).

- If the highest concentration detected was above the NJDEP ISRS listed in **Appendix C** then the detected constituent was included as a COPC. The HHRA was examined to determine which COPCs contributed to the majority of carcinogenic risk of 1E-06 or the majority of the noncarcinogenic hazard of 1; these compounds were considered Risk-Driver COCs.
- Compounds identified as human health COCs in the HHRA and ecological COCs were included as Risk-Driver COCs.

Chart 3-1. Schematic Representation of Surface Soil COC Development



- Any compound included as a COPC because it exceeded the NJDEP criteria, but did not contribute to a major portion of the risk identified in the site-specific risk assessment were included as Non Risk-Driver COCs. These compounds were addressed as part of the AOCs.

In this FS, HHRAs and ERAs were also used to develop the list of COCs to assure the protectiveness of the remedy. The results of this screening process for surface soil are presented in the following sections.

Surface Soil Human Health Risk Drivers

Surface Soil human health risk drivers were developed based on the human health COCs identified in Section 2 for surface soils (from the HHRA). Human health risk driver constituents are presented in **Table 3-7**.

Table 3-7
Human Health Risk-Driver COCs in Surface Soil

Surface Soil Constituent	NJDEP Soil Remediation Goal (1) (mg/kg)	Risk-Driver? (Applicable Site)
Benz(a)anthracene	2	**Yes (109)**
Benzo(a)pyrene	0.2	**Yes (109, PICA-203)**
Benzo(b)fluoranthene	2	**Yes (109)**
Dibenz(a,h)anthracene	0.2	**Yes (109)**
Antimony	450	**Yes (146)(2)**
Arsenic	19	**Yes (109, 142, PICA-203)**
Lead	800	**Yes (146)**

(1) Nonresidential NJDEP ISRS (NJDEP, 2009).
(2) Identified as a risk-driver; however, all surface soil concentrations were below the NJDEP soil criteria (based on New Jersey background) and the total risks/hazards for the site were at or below USEPA target levels.

Surface Soil Ecological Risk Drivers

Results of available ERAs, SLERAs, and evaluation of habit potential are provided for each site in Section 2.0. Based on the results of these assessments, no significant ecological risks have been identified for surface soil at the six sites evaluated in this FS. Any ecological hazards that may be associated with surface soils are expected to be addressed by attainment of the cleanup levels recommended in **Table 3-8**.

Surface Soil Constituents above LOCs

Three additional constituents were included as COCs because they exceeded NJDEP ISRS. These 2,4-DNT, indeno(1,2,3-c,d)pyrene, and mercury. These constituents are considered Non Risk-Driver COCs.

Final List of COCs and SCLs

The final list of COCs for surface soils for this FS includes those which 1) exceed the NJDEP ISRS and 2) pose a human health risk based on the site-specific risk assessment. The COCs are:

Table 3-8
Surface Soil COCs and SCLs

COC	SCL(1) (mg/kg)	Applicable Site
Benz(a)anthracene	2	109
Benzo(a)pyrene	0.2	109, 142, 203
Benzo(b)fluoranthene	2	109
Dibenz(a,h)anthracene	0.2	109

Table 3-8 (Continued)
Surface Soil COCs and SCLs

COC	SCL[(1)] (mg/kg)	Applicable Site
Indeno(1,2,3-c,d)pyrene	2	109
2,4-DNT	3	109
Arsenic	19	109
Antimony	450	146
Lead	800	146
Mercury	65	203

(1) in all cases the NJDEP ISRS was selected as the SCL.

Impact to Groundwater (IGW) COCs

Additionally, for subsurface soil, the detected concentrations were examined in light of compounds detected in groundwater. Compounds detected in subsurface soil that could potentially prove harmful to groundwater were identified to evaluate the potential for data gaps associated with groundwater protection. These IGW COPCs were developed utilizing soils and groundwater data on a site by site basis. Compounds were selected based on results that indicated that groundwater was already impacted. The starting point for this list was the entire groundwater data set for each of the six sites evaluated in this FS. The groundwater data set was screened against relevant criteria such as NJDEP MCLs and Quality Criteria that are included as Picatinny LOCs for groundwater. Due to the large amount of time since the release of contamination at these sites, it was assumed that if groundwater impact from a specific compound were to occur, it would already be evident in the groundwater analytical results. Therefore, if groundwater had not been impacted to date, future impacts are improbable.

Some compounds were eliminated as COPCs based on three additional considerations. The first consideration was the presence of a plume distribution. Contaminants that were not distributed as a plume were eliminated as a COPC. The second was the frequency of detection (FOD) of these compounds in subsurface soil. Compounds detected infrequently were removed from consideration (e.g., less than 5 percent FOD). The third was background soil concentrations. Inorganics detected in soil at concentrations below Picatinny-specific background soil concentrations (IT, 2002) were removed from consideration. Once the list was narrowed to this point, it was then determined if existing concentrations of groundwater COPCs (developed in this section) in soil posed a continued threat to groundwater. This determination was made through a comparison to NJDEP IGW criteria, where these values existed, or IGW criteria obtained from other available sources if New Jersey values were unavailable. If a compound was a COPC for groundwater and was above these soil screening values, it was considered a COPC for IGW. Conversely, if no soil concentrations were found above these screening values, the compound was excluded.

Based on a comparison of maximum detected groundwater concentrations and relevant human health based criteria (as discussed previously), the following constituents were initially selected at the respective sites, as the maximum detected concentration exceeded a groundwater LOC (**Table 3-9**).

Table 3-9
Groundwater Constituents above LOCs

Site 109	Arsenic, Iron, Lead, Manganese
Site 125	None
Site 142	Perchlorate, Aluminum, Manganese
Site 144	None
Site 146	None
Site PICA-203	None (PICA-203 groundwater is addressed under Site 109

These constituents were evaluated for potential plume distribution at each site (**Table 3-10**). Constituents were eliminated based on a low FOD (detected in only one or two groundwater samples in a sufficiently large data set). The remaining constituents were evaluated to determine whether their LOC exceedence pattern exhibited a potential plume distribution, as discussed in **Table 3-10**.

Table 3-10
Distribution of COPCs in Groundwater

Constituent	FOD	Number of LOC Exceedences	Exhibit Potential Plume Distribution?	Comment
Site 109				
Arsenic	8/8	6	Yes	The pattern of exceedences was somewhat localized suggesting the existence of a plume
Iron	3/3	3	Yes	The pattern of exceedences was somewhat localized suggesting the existence of a plume
Lead	5/5	4	Yes	The pattern of exceedences was somewhat localized suggesting the existence of a plume
Manganese	3/3	3	Yes	The pattern of exceedences was somewhat localized suggesting the existence of a plume
Site 142				
Perchlorate	6/23	5	Yes	The pattern of exceedences was somewhat localized suggesting the existence of a plume
Aluminum	2/2	2	Yes	Due to limited groundwater data its distribution in a plume could not be ruled out.
Manganese	2/2	1	Yes	Due to limited groundwater data its distribution in a plume could not be ruled out.

Based on this evaluation, six constituents (perchlorate, aluminum, arsenic, iron, lead, and manganese) were determined to be potentially distributed in a groundwater plume and were retained for further evaluation. However; a review of groundwater sampling results shows that arsenic and lead detected above groundwater LOCs at Site 109 were collected from temporary Geoprobe sampling points or simultaneous monitoring well samples collected during the USACHPPM RRSE investigation (USACHPPM, 1998). Due to the high turbidity associated with temporary sampling points, concentrations of naturally-occurring minerals are not representative of groundwater in the aquifer. Similar to samples collected from temporary groundwater sampling points, samples collected from monitoring wells without using low-flow sampling methodology yield inorganic sample concentrations that are not representative of groundwater in the aquifer. The USACHPPM RRSE reports only that a submersible pump was used to collect the monitoring well samples. Conversely, groundwater samples collected from the Site 109 monitoring wells during the Phase II RI (Shaw, 2006a), in which the low-flow sampling methodology was employed, did not contain any exceedences of arsenic or lead LOCs. As a result, arsenic and lead have been removed from further impact to groundwater analysis.

Next, the FOD in subsurface soil samples of the remaining four constituents was evaluated, as infrequently detected constituents would not be a significant concern for leaching to groundwater. Detection frequency information is summarized in **Table 3-11**. Based on the evaluation of FOD (**Table 3-11**), three subsurface soil constituents (aluminum, iron, and manganese) are a potential concern for leaching to groundwater.

Table 3-11
Frequency of Detection for Potential Impact to Groundwater Constituents

Constituent	Subsurface Soil FOD at Site:	
	109	142
Perchlorate	---	1/9
Aluminum	---	1/1
Iron	7/7	---
Manganese	7/7	1/1

There are no criteria for groundwater protectiveness for any of these three constituents published or promulgated in the State of New Jersey. Therefore, USEPA guidance for groundwater protectiveness (based on partition theory associated with leaching from soil) was employed for these inorganic constituents, following the method presented in USEPA (1996). However, it should be noted that partition theory for inorganics is much more complicated than for organics. Unlike organic compounds, for which Kd values are largely controlled by a single parameter (e.g., soil organic carbon), Kd values for metals are significantly affected by a variety of soil conditions. The most significant parameters are pH, oxidation-reduction conditions, iron oxide content, soil organic matter content, cation exchange capacity, and major ion chemistry. The number of significant influencing parameters, their variability in the field, and differences in experimental methods result in a wide range of Kd values for individual metals, reported in the literature to range over five orders of magnitude.

USEPA (1996) does not present migration to groundwater SSLs for aluminum, iron, or manganese; nor does the NJDEP establish IGW values for these inorganics. Thus, there is no readily available method to assess whether or not concentrations of the three inorganic constituents in soils are a continuing concern for groundwater protectiveness. It should be noted that many measured sample concentrations of these inorganics in subsurface soil at the subject sites are above the Picatinny site-specific background soil concentrations. To be conservative, the following Picatinny LOCs may be used to protect groundwater resources from future leaching from soil:

- Aluminum: 1,000,000 mg/kg
- Iron: 310,000 mg/kg
- Manganese: 20,000 mg/kg

As the maximum detected concentrations of aluminum, manganese, and sodium in subsurface soil do not exceed these recommended surrogate groundwater-protective LOCs at any of the sites, there are no COCs recommended based on the impact to groundwater evaluation. In addition, aluminum, iron, and manganese are naturally-occurring minerals detected frequently in soil and groundwater throughout Picatinny. Concentrations of these inorganics are likely due to site geology.

Final COCs and SCLs

Based on human health risks and IGW concerns, the final list of COCs for subsurface soils is presented on **Table 3-12**. For the subsurface soil COCs, the NJDEP ISRS values were used as cleanup levels.

Table 3-12
Subsurface Soil Cleanup Levels

Subsurface Soil Constituent	NJDEP Industrial Soil Remediation Standard (mg/kg) (1)	Leaching to Groundwater Level (mg/kg)	Site Cleanup Level (mg/kg)	Applicable Site
Benzo(a)pyrene	0.2	100	0.2	109
Arsenic	19		19	109

3.2.1.2 Sediment

There are no COCs in sediment at Sites 109, 125, 142, 144, 146, and PICA-203.

3.2.1.3 Surface Water

There are no COCs in surface water at Sites 109, 125, 142, 144, 146, and PICA-203.

3.2.1.4 Groundwater

This section identifies groundwater COC(s) at PICA-111. The screening method used in this FS to determine the COC(s) is as follows:

1. Contaminants that exceed their corresponding LOCs are considered as COPCs. Section 2 presents the comprehensive lists of COPCs developed for PICA-111.
2. The list of COPCs was enhanced by the addition of all compounds which were identified as HHCOPCs. Section 2.8 presents the comprehensive list of HHCOPCs developed for PICA-111 groundwater.
3. The list of groundwater COPCs and HHCOPCs is then used in ARAR determinations. **Table 3-3** presents the determination of ARAR levels for the COPCs in the groundwater for PICA-111.
4. If the maximum concentration of the COPC exceeds the ARAR level, the COPC is evaluated further.
5. The next step is to determine whether contaminant distribution is indicative of a contaminant plume. Contaminants that were sporadically detected and not confirmed in adjacent or subsequent samples were also eliminated via this criterion.
6. The final step is to screen the remaining compounds versus those which were identified as risk drivers as a result of the HHRA. All COPCs passing this step are considered as COCs.

Table 3-13 details the implementation of this refinement process.

<u>SCLs for Groundwater</u>

The NJDEP GWQS ARAR concentration will be used as a SCL within each AA.

Table 3-13
COC Groundwater Screening

Criteria Based Compounds of Potential Concern (COPC) and Human Health Compounds of Potential Concern (HHCOPC) (See Table 4-10)	Maximum Observed Concentration (µg/L)	ARAR (µg/L)	Frequency of ARAR Exceedances	COC Screening Criteria ("No" indicates elimination as a COC, only a "yes" will be evaluated by next criterion)			COC
	PICA-111			Above ARAR?	Plume Distribution?	Risk Driver?[f]	
Metals							
Aluminum (COPC)	240	200	2/5	Yes	No[1]		
Arsenic (COPC & HHCOPC)	5.09	5	5/11	Yes	Yes	Yes	Yes
Iron (COPC & HHCOPC)	11,800	300	4/5	Yes	No[1]		
Lead (COPC)	23	5	8/11	Yes	Yes	Yes	Yes
Manganese (COPC & HHCOPC)	1190	50	4/5	Yes	No[1]		
Anions							
Perchlorate (HHCOPC)	627	5	7/34	Yes	No		

1 - These metals are ubiquitous in Picatinny Groundwater. The concentrations at PICA-111 are likely the result background due to the regional geology.

3.2.2 Areas of Attainment

The complete list of COCs identified for Sites 109, 125, 142, 144, 146, and PICA-203 are presented in **Tables 3-5 and 3-9** for surface soil and subsurface soil, respectively. Sites 125, 144, and 146 did not exceed SCLs in any of the evaluated media.

AAs for the remaining sites are presented in the following sections. AAs for each of the remaining sites are as follows:

3.2.2.1 Site 109 and PICA-203

The AAs for Site 109 and PICA-203 have been established together. Because the sample locations with exceedences on the west side of former Building 445 are immediately adjacent to sample locations with exceedences within PICA-203, the most efficient way of establishing the AA was to have it span the sample boundary between the two sites.

- AA_{109S-1} is defined for SCL exceedences in samples 203SB-1A, 203SB-1B, 109MW-3A, 109MW-3B, PICA-PGL-2S, 109MW-1A, 109MW-1C, 109SS-1B, 109SS-1C, and 109SS-1D. This AA encompasses all exceedences of SCLs for surface and subsurface soil within the western area of Site 109 and the area of PICA-203. AA_{109S-1} is assumed to encompass an area 42,742 SF and a depth interval of 2-13 ft bgs, yielding a volume of approximately **3,394 CY**. AA_{109S-1} is shown on **Figure 3-1**.
- AA_{109S-2} (**Figure 3-1**) is defined for benzo(a)pyrene detected above the SCL on the southern end of Site 109. The AA encompasses sample locations 109SS-3D, 109EX1-SWN-1, 109SS-3C, and 109MW-2A. AA_{109S-2} encompasses an area of approximately **3,914 SF** and a depth of 4 ft bgs, yielding a volume of approximately **579 CY**.
- AA_{109S-3} (**Figure 3-1**) is defined for benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, and 2,4-DNT detected above the SCLs on the southeastern end of former Building 445. The AA encompasses sample locations 109SS-2A, 109SS-2B, and 109SS-2C. AA_{109S-3} encompasses an area of approximately **2,991 SF** and a depth of 5 ft bgs, yielding a volume of approximately **553 CY**.

3.2.2.2 Site 125

As discussed in Section 2, Site 125 had no exceedences of NJDEP ISRS or USEPA IRSL nor did the risk assessment indicate unacceptable levels of risk at the site. Therefore, no AAs have been established for Site 125. However, because the site does exhibit exceedences of USEPA Residential RSLs, LUCs will be maintained at the site.

3.2.2.3 Site 142

- AA_{142S-1} is defined for a single exceedence of the SCL for benzo(a)pyrene. Copper detected above the SCL during the RCRA closure investigation is not included in the AA since delineation sampling (including sampling of the original sample location) conducted during the Phase I 2A/3A RI (Shaw, 2005a) did not yield any constituents above LOCs. As previously described, the AOC has been covered with several feet of clean fill as part of the demolition and regrading activities for Building 435. The AA is assumed to encompass an area of 42 SF with a depth interval of 0-2 ft bgs, yielding a volume of approximately **3 CY**. AA_{142S-1} is shown on **Figure 3-2**.

3.2.2.4 Site 144

As discussed in Section 2, Site 144 had no exceedences of NJDEP ISRS nor did the risk assessment indicate unacceptable levels of risk at the site. Therefore, no AAs have been established for Site 144. However, because the site does exhibit exceedences of USEPA IRSLs, LUCs will be maintained at the site.

3.2.2.5 Site 146

As discussed in Section 2, Site 146 had no exceedences of NJDEP ISRS. The sole exceedence of the USEPA IRSL was for RDX. The risk assessment calculated an HI of 3 for the construction

excavation worker due to antimony. However, comparison to NJDEP ISRS (450 mg/kg) and USEPA IRSL (410 mg/kg) shows the level of antimony 340 mg/kg is well below both of these industrial standards. Similarly, the risk assessment indicated an unacceptable risk from lead detected in one sample at the site (758 mg/kg). This level of lead is below the current NJDEP ISRS and USEPA IRSL for lead both of which are 800 mg/kg. All of the soil sampling locations at Site 146 were disturbed during the regrading that took place at the site during the demolition of Building 497. This regrading has made locating the previous sampling points impossible, therefore no AAs have been established for Site 146. However, because the site does exhibit exceedences of USEPA IRSLs and Residential RSLs, LUCs will be maintained at the site.

3.2.2.6 Groundwater AAs

An AA is defined as the area over which RAOs are to be obtained. Cleanup levels should be achieved throughout the AA. The AA for groundwater is depicted on **Figure 3-3**. The only AA, $AA_{109GW-1}$ addresses arsenic and lead in groundwater at Site 109.

3.2.3 Area of Attainment Summary

The AAs identified in the preceding sections are summarized in **Table 3-14**. The COCs comprising each AA and an approximation of the dimensions are also presented.

Table 3-14
Summary of AAs for the Sites 109, 125, 142, 146 & PICA-203

AA	COCs	Area (SF)	Depth Interval (ft)	Volume (CY)
Site 109				
AA_{109S-1}	Arsenic, benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene,	42,742	2-13	3,394
AA_{109S-2}	Benzo(a)pyrene	3,914	0-4	579
AA_{109S-3}	Benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, 2,4-DNT	2,991	0-5	553
Site 142				
AA_{142S-1}	Benzo(a)pyrene	42	0-2	23
Site 109/PICA-203 Groundwater				
$AA_{109GW-1}$	Lead, arsenic	42,365	7-37	na

N/A = Not Applicable
(1) Recent sampling indicates current concentrations are below SCLs.

3.3 REMEDIAL ACTION OBJECTIVES

The soils RAOs for the sites in this FS area based on the continued management of human health risk that drive the formulation and development of response actions. This RAO has been developed based on the criteria outlined in Section 300.430(ee)(2) of the NCP and Section 12 of SARA with the objective to protect human health and the environment.

3.3.1 Soils

Surface and subsurface soils at these sites have risks and hazards that are within the target range under current and reasonably anticipated future land-use scenarios. Because risks or hazards identified for surface and subsurface soils, do not allow for unrestricted use, a response action will be implemented following NCP guidance.

The proposed RAO for the sites included in this FS is the following:

- Maintain a use consistent with the assumptions and results of the risk assessments which identified risk within the CERCLA generally accepted risk range for the current and reasonably anticipate future use (military/industrial) following NCP guidance.

The 5-year review process and the annual land use certifications will be used to document continuing land use is industrial and the remedy remains protective. Additionally, the remedial design will specify notification requirement to the USEPA should land use change occur, or be planned, in accordance with the department of the Navy Principles.

3.3.2 Groundwater

The groundwater RAOs for PICA-111 have been developed to be protective of human health and to meet identified ARARs. As discussed in the previous sections, there is no unacceptable risk to ecological receptors associated with PICA-111 groundwater. The RAOs will be specific to groundwater contaminated by sources originating from Site 109.

The RAOs for each COC for PICA-111 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 MCLs or NJGWQS for the identified COCs in a reasonable timeframe, thereby restoring groundwater to its beneficial use as a drinking water source.

109MW-3A	06/04/96	(2-4')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.57
109MW-3B	06/04/96	(5-7')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Arsenic	19	51

PICA-PGL-2S	1997	
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.34J/0.25J

109MW-1A	05/01/96	(0-2')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benz(a)anthracene	2	5.0
Benzo(a)pyrene	0.2	5.0
Benzo(b)fluoranthene	2	6.0
Dibenz(a,h)anthracene	0.2	0.7
Indeno(1,2,3-c,d)pyrene	2	3.0
109MW-1C	05/01/96	(10-12')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	4.0

203SB-1A	06/06/01	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.53/0.53
203SB-1B	06/06/01	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.46 J

109SS-1C	04/15/96	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	1.0
109SS-1D*	04/15/96	(2-4')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.68

109SS-1B*	04/15/96	(2-4')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benz(a)anthracene	2	7.0
Benzo(a)pyrene	0.2	5.9
Benzo(b)fluoranthene	2	6.6

109SS-2A	04/16/96	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
2,4-Dinitrotoluene	3	17.9
Benz(a)anthracene	2	4.0
Benzo(a)pyrene	0.2	5.0
Benzo(b)fluoranthene	2	5.0
109SS-2B*	04/16/96	(2-4')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.64

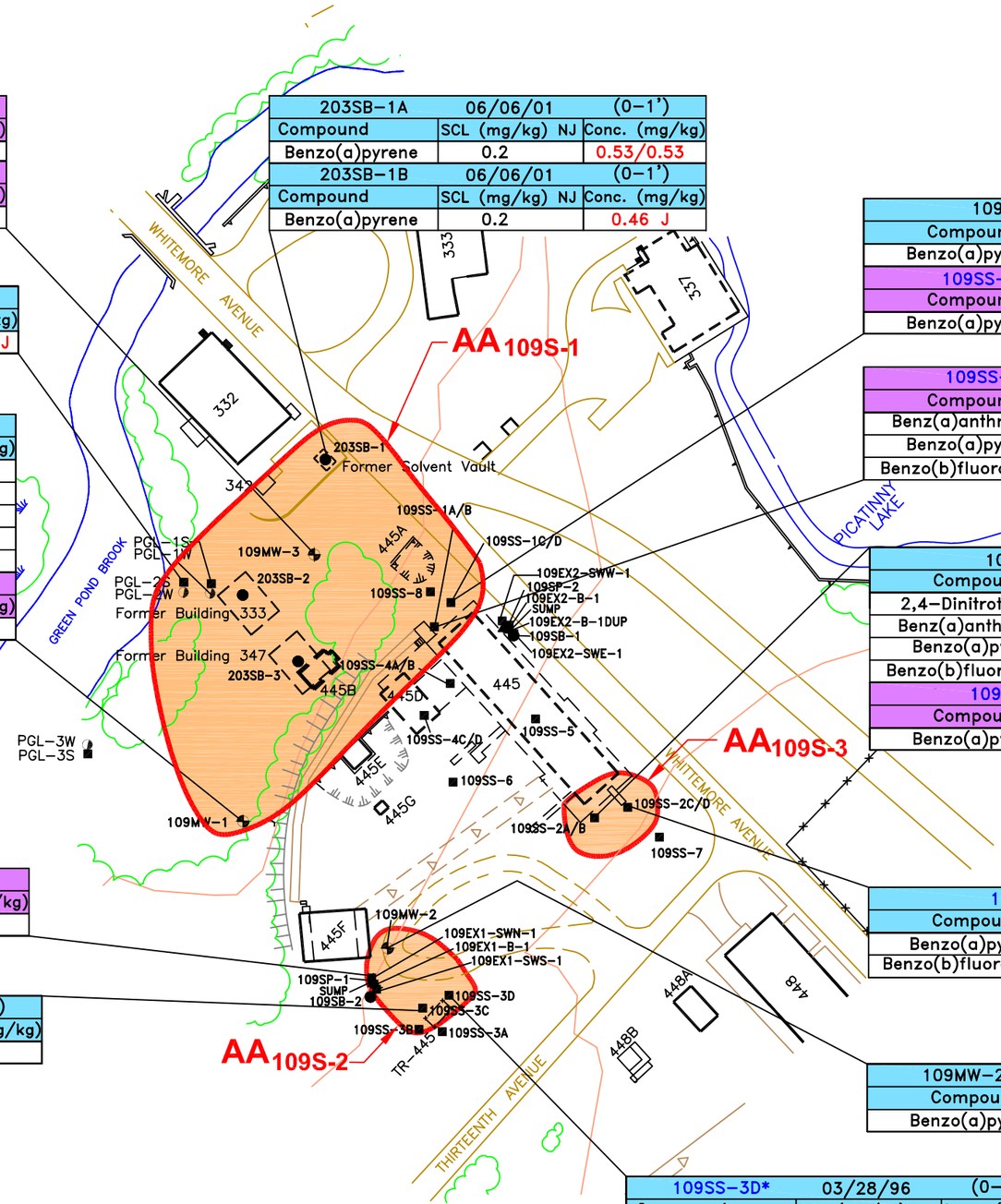
109EX1-SWN-1	08/06/03	(3-3')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.62

109SS-2C*	04/16/96	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	3.5
Benzo(b)fluoranthene	2	3.8

109SS-3C*	03/28/96	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.39

109MW-2A	05/01/96	(0-2')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.47/0.61

109SS-3D*	03/28/96	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	1.6



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
- UNDERGROUND LINES
- AREA OF ATTAINMENT

EXISTING SAMPLING LOCATIONS
MONITORING WELL
SURFACE WATER/SEDIMENT
SURFACE SOIL
SOIL BORING

NOTE: (*) DENOTES ON-SITE SCREENING SAMPLING

SCALE

0 100 200 FEET

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 3-1

SITE 109 & PICA 203
AREAS OF ATTAINMENT IN SOIL

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

DRAWING NUMBER 109011010.dwg

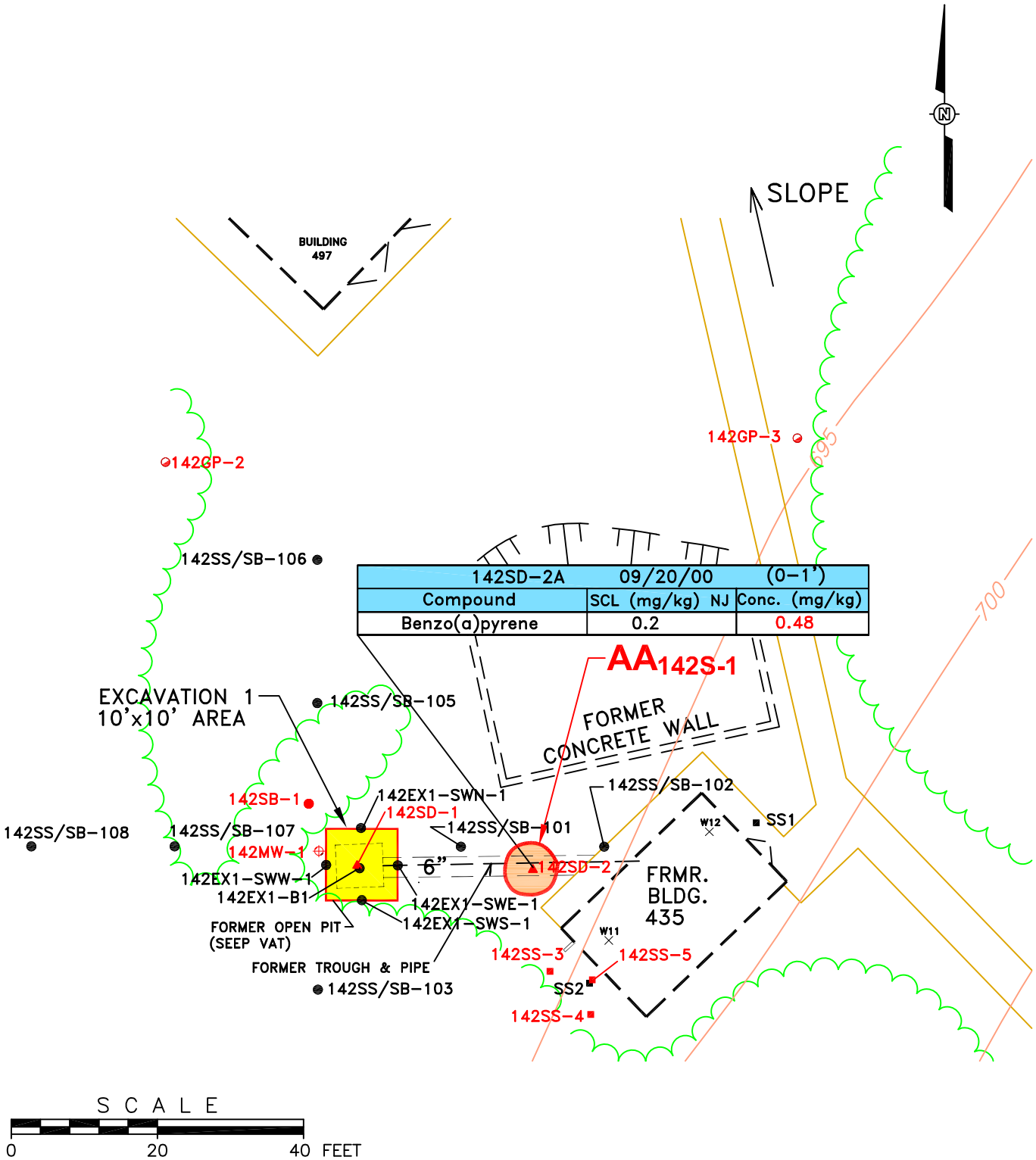
APPROVED BY -- --

CHECKED BY M. Lobsiger 01/06/10

DRAWN BY S. Wiafe 01/06/10

File: N:\cad\CAD drawings\Picatinny\Area-I\site109\PHASE2RI\SITEMAPS\109011010.dwg
Plot Date/Time: Jan 14, 2010 - 12:19pm
Plotted By: stephen.Wiafe

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
S. Wiafe 01/06/10	M. Lobsiger 01/06/10	M. Lobsiger 01/06/10	F142011010.dwg



142SD-2A	09/20/00	(0-1')
Compound	SCL (mg/kg) NJ	Conc. (mg/kg)
Benzo(a)pyrene	0.2	0.48

LEGEND:

RAILROAD
TREE LINE
FENCE
TRANSFORMER TR-732
BLAST WALL
STORM SEWER
SANITARY SEWER
SOIL REMOVAL AREA
EARTH MOUND
BUILDING
FORMER BUILDING
COVERED WALKWAY
SWAMP
WATER
AREA OF ATTAINMENT

EXISTING SAMPLING LOCATIONS
- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH
- WASTEWATER AND SLUDGE GRAB SAMPLE

PHASE I 2A/3A SAMPLING LOCATIONS
- MONITORING WELL
- SURFACE WATER/SEDIMENT
- SURFACE SOIL
- SOIL BORING
- TEST PIT
- HYDROPUNCH

* NOTE: LOC IS FOR TOTAL ORGANIC CONTAMINANTS

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 3-2

SITE 142- FORMER BUILDING 435
AREA OF ATTAINMENT IN SOIL

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

File: N:\cad\CAD drawings\Picatinny\Area-F\site142\F142011010.dwg
Plot Date/Time: Jan 11, 2010 - 11:56am
Plotted By: stephen.Wiafe

File: N:\cad\CAD drawings\Picatinny\Area-I\site109\PHASE2RISITEMAPS\1090011010.dwg
Plot Date/Time: Jan 11, 2010 – 11:44am
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	01/07/10	M. Lobsiger	01/07/10	--	--	1090011010.dwg

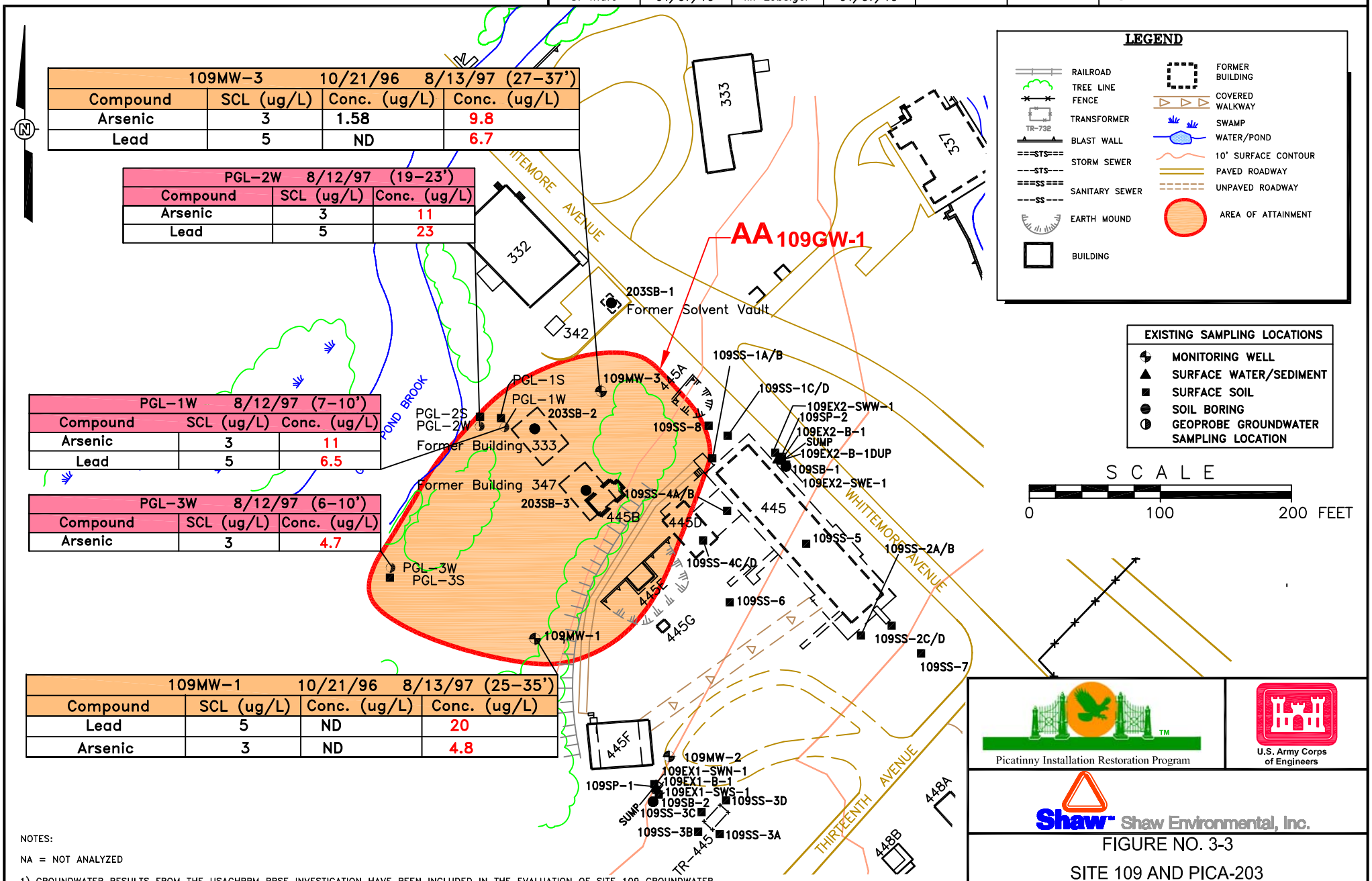
109MW-3	10/21/96	8/13/97 (27-37')	
Compound	SCL (ug/L)	Conc. (ug/L)	Conc. (ug/L)
Arsenic	3	1.58	9.8
Lead	5	ND	6.7

PGL-2W	8/12/97 (19-23')	
Compound	SCL (ug/L)	Conc. (ug/L)
Arsenic	3	11
Lead	5	23

PGL-1W	8/12/97 (7-10')	
Compound	SCL (ug/L)	Conc. (ug/L)
Arsenic	3	11
Lead	5	6.5

PGL-3W	8/12/97 (6-10')	
Compound	SCL (ug/L)	Conc. (ug/L)
Arsenic	3	4.7

109MW-1	10/21/96	8/13/97 (25-35')	
Compound	SCL (ug/L)	Conc. (ug/L)	Conc. (ug/L)
Lead	5	ND	20
Arsenic	3	ND	4.8



NOTES:

NA = NOT ANALYZED

1) GROUNDWATER RESULTS FROM THE USACHPPM RRSE INVESTIGATION HAVE BEEN INCLUDED IN THE EVALUATION OF SITE 109 GROUNDWATER.

2) TOPOGRAPHIC CONTOUR SOURCE IS THE IDENTIFICATION AND ANALYSIS OF WETLANDS, FLOODPLAINS, THREATENED AND ENDANGERED SPECIES AND ARCHAEOLOGICAL GEOMORPHOLOGY AT PICATINNY, NJ (WES, 1994), WHICH USED TOPOGRAPHIC CONTOURS DERIVED FROM 1948 SURVEY MAPS. THESE SURVEY MAPS WERE SCANNED TO CREATE ELECTRONIC FILES AND WERE MANUALLY REFINED. WHILE THESE CONTOURS DEPICT GENERAL TOPOGRAPHY WELL, THEY ARE NOT PRECISE IN SOME LOCATIONS.

Picatinny Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 3-3

SITE 109 AND PICA-203
AREAS OF ATTAINMENT IN GROUNDWATER

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

4.0 SCREENING AND ANALYSIS OF REMEDIAL ALTERNATIVES

This section describes the identification and screening of applicable technologies and assembly of these technologies into RAs for Sites 109, 125, 142, 144, 146, and PICA-203. This discussion has been grouped by matrix type, specifically surface and subsurface soil are discussed first, followed by groundwater. As no COCs or AAs were identified in sediment or surface water technology screening was not performed for these environmental media.

Discussions include: identification of general response actions, or GRAs, and technologies associated with the GRAs; a brief description of each technology; and, an initial screening of technologies based on effectiveness, implementability, and cost. GRAs are broad classes of responses or remedial actions that can potentially achieve the RAOs. GRAs may encompass many remedial technologies and remedial technology process options. For example, *in situ* active restoration is a GRA, *in situ* biological treatment is a remedial technology, and methane sparging is a remedial technology process option. Technologies that pass the preliminary screening process are then used in the development of RAs as discussed at the end of this section.

In this FS, similar to other sites at Picatinny, all RAs would be implemented in conjunction with LUCs, if a non-restricted land use scenario is not achieved.

4.1 GENERAL RESPONSE ACTIONS

GRAs are broad categories of response actions that could be selected to achieve the RAOs for the media and COCs at the site. Some response actions are sufficiently broad in effect that they are capable of meeting the RAOs alone. However, in most cases, combinations of response actions are required to be effective in meeting all of the RAOs. The RAOs for Sites 109, 125, 142, 144, 146 and PICA-203 involve preventing the exposure of potential human receptors to contaminated soil and/or groundwater at each site. The GRAs that can potentially be used to achieve the RAOs are summarized in **Table 4-1**.

Key factors in evaluating the applicability of GRAs and associated technologies include the type and form of wastes, surficial geologic characteristics, and location-specific characteristics.

Table 4-1
GRAs and Technologies Applicable to RAOs for PICA-111

General Response Action/ Technology Type	Applicability to Remedial Action Objectives
No Action	Action must be evaluated as the baseline for comparison of other response actions and alternatives as required by the NCP.
Land Use Controls	Application of administrative actions such as land-use and deed restrictions, which protect public health and the environment through management of potential risk. May incorporate existing engineering controls (ECs).
Containment	Isolation of contaminated media from the environment and potential receptors by blocking the exposure/transport mechanism.
Removal	Removal of the contaminant source from the site. Refers to the methods used to excavate and handle soils, sediments, wastes, and other solid materials. Required prior to implementation of *ex situ* treatment or disposal options.
Treatment	Treatment of contaminated soil or groundwater may reduce the toxicity, mobility, or volume of contaminants, thereby eliminating the risks. Treatment of contaminated materials may be performed *in situ* or *ex situ*, either on-site or off-site following a removal action.
Disposal	Disposal of treated or untreated soil or groundwater on site or at an off-site location would reduce the potential for exposure. Disposal involves placement of waste materials in designated facilities that have been designed and are operated for such purpose.

Table 4-1 (Continued)
GRAs and Technologies Applicable to RAOs for PICA-111

General Response Action/ Technology Type	Applicability to Remedial Action Objectives
Monitoring	Monitoring of levels of contamination to evaluate trends and determine if levels of contamination are acceptable or if concentrations are increasing or becoming mobile
Ex Situ Active Restoration	Groundwater extraction, treatment and discharge technologies. The main advantage of *ex situ* treatment is that the treatment process is controlled and the effectiveness can be verified through monitoring of pre- and post-treatment samples.
In Situ Active Restoration	Technologies that remove or destroy contaminant mass without being brought to the surface. *In situ* treatment usually results in significant savings as compared to *ex situ* technologies.

4.2 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Presented below are general descriptions of potentially applicable technologies and process options for the sites addressed in this FS. Remedial technologies are described generally and may be applicable to more than one response action. The term "process option" refers to specific processes within each technology type. Several broad technology types may be identified for each GRA, and numerous process options may exist for each technology. Even within process options there are additional levels of choice. For purposes of alternative development, this level of detail is left to the detailed remedial design phase as it makes minimal difference on the overall cost.

The technology identification and screening process was performed in accordance with the CERCLA FS guidance document (USEPA, 1988a), as specified by the NCP (40 CFR Part 300, Subpart F).

4.2.1 Identification and Screening of Technologies

A master list of potentially applicable technologies was developed and organized in terms of the GRA categories (**Table 4-1**). These GRA were developed separately for soil and groundwater. The technology screening for soil is presented in **Table 4-2**. The technology screening for groundwater is presented in **Table 4-3**. Initial screening of the identified technologies was based primarily on technical implementability considerations. Specific criteria employed in the screening process were as follows:

- Compatibility with Site and Constituent Characteristics – A technology must be compatible with the specific site and constituent characteristics.
- Ability to Achieve RAOs – A technology must be capable of achieving the RAOs, either alone or as a component of a technology train.
- Cost – A technology should not be an order of magnitude more costly than other technologies providing comparable performance.

4.2.2 Evaluation of Technologies and Selection of Representative Technologies for Soil

Table 4-2 summarizes the technologies identified and considered for soil under each GRA category. The evaluation of technology for groundwater is presented in the following section. Because sediment and surface water are not a concern at the sites, only technologies specific to soil and groundwater were evaluated. Based on the criteria listed above, some remedial technologies listed in **Table 4-2** were eliminated from further consideration. Those technologies considered potentially applicable and relevant to meeting site RAOs and GRAs are described in detail below, and will be used in the development of RAs presented in Section 4.4.

No Action – Under the No Action alternative, no remedial activities will be conducted at the sites. Nevertheless, the No Action alternative has passed the technology screen in accordance with the

Table 4-2
Identification and Screening of Technology Types and Process Options for Soils Areas of Attainment

General Response Action/Technology	Description	Pass/Fail (Applicable Site)	Comments
A. NO ACTION			
No Action	No remedial measures to be taken.	Pass	The No Action alternative must be fully evaluated according to 40 CFR 300.430(e)(6). No Action would be the lowest cost alternative. However, this would not ensure the protection of the environment.
B. LIMITED ACTION			
Land Use and Access Restrictions	Land use restrictions will limit future use and access to prevent exposure to the contaminated soil.	Pass	If properly enforced, land use restrictions are an effective means of preventing exposure to on-site contaminated soil. Because the site is a controlled military base, access is restricted to authorized personnel only.
Maintenance of Existing Engineering Controls	Maintenance of existing engineering controls (such as covers of vegetation or clean soil) will prevent exposure to contaminated soils.	Pass	Through regular maintenance and inspections, existing vegetation and/or clean soil covers offer straightforward and effective means to prevent exposure to contaminated soil.
C. CONTAINMENT			
Soil Cover Installation	A cover of clean soil that is stabilized by vegetation and graded to promote appropriate drainage. The soil cover isolates contaminated soil, prevents direct contact with the soil, and prevents erosion of contaminated soil via wind and surface water runoff.	Pass	Well suited for isolation of contaminated soil, although this alternative will not decrease or eliminate the contaminants. This alternative will restrict further site use and is less effective at preventing infiltration of water from precipitation than other capping alternatives. May include existing soil cover.
Asphalt Cap Installation	A rigid cover of asphalt to isolate and prevent direct contact with contaminated soil, reduce infiltration of precipitation, and prevent erosion of contaminated soil via wind and surface water runoff.	Fail	Asphalt capping is a well demonstrated technology that has proven to be very effective at preventing direct contact with, and mobility of contaminants. However it would not provide any benefit over soil capping, and would serve no additional function due to the limited areas to be capped.

Table 4-2 (Continued)
Identification and Screening of Technology Types and Process Options for Soils Areas of Attainment

General Response Action/Technology	Description	Pass/Fail	Comments
Multi-Layer (RCRA C) Cap Installation	A low permeability, non-rigid cover of clay and/or synthetic material, in conjunction with vegetative and drainage layers, to isolate contaminated soil, prevent direct contact with the soil, eliminate infiltration of precipitation, and prevent erosion of contaminated soil via wind and surface water runoff	Fail	The RCRA C multi-layered cap is a baseline design for hazardous waste applications. However, contamination identified at the sites has not been identified at levels indicating characteristics of hazardous waste. Additionally, infiltration of water and leaching of COCs into groundwater is not of particular concern at any of the subject sites.
D. REMOVAL			
Excavation (Soil)	Physical removal of contaminated soil and/or sediment, performed mechanically with standard earthmoving equipment, such as a backhoe or excavator.	Pass	A routine operation performed in the remediation of contaminated soil or sediment. Required for remedial alternatives that use *ex situ* treatment or disposal. Highly effective and protective of human health and the environment. This alternative will completely eliminate contaminants from the site. Excellent for “hot spot” remediation.
Soil Washing	The process of transferring contaminants within soil or sediment to an aqueous stream, followed by collection and treatment of the wash water and any suspended media.	Fail	Requires large capital investment in relative to the volumes of contaminated media identified.
Fixation (Solidification/Stabilization)	Use of cement-, silicate-, or plastic-based materials and other suitable additives to physically or chemically bind a waste material in a solid matrix to reduce the mobility of contaminants.	Fail	Proven effective for treatment of inorganics in soil and sediment that would otherwise require disposal as hazardous waste. Provides no benefit over untreated disposal given the low level contaminant concentrations, at a substantially greater cost.
Thermal Desorption	The thermal desorption process is used to thermally strip volatile and semi-volatile organic compounds from contaminated soil and sediment. May be performed on-site or off-site.	Fail	The more costly High Temperature Thermal Desorption (HTTD) would be required to strip PCBs and PAHs, which is generally not effective for inorganic contaminated sediments.
Incineration	High-temperature combustion of organic contaminants in soil/sediment in stationary or mobile (transportable) equipment designed to maximize waste destruction. May be performed on-site or off-site.	Fail	Although a proven and reliable technology for destroying PAHs and other organic contaminants, this technology is not applicable to inorganic COCs and entails high cost.

Table 4-2 (Continued)
Identification and Screening of Technology Types and Process Options for Soils Areas of Attainment

General Response Action/Technology	Description	Pass/Fail	Comments
Chemical Oxidation	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Chemical oxidation can be applied in-situ or ex-situ.	Fail	Although a proven and reliable technology for some inorganics and applicable (with lesser effectiveness) to nonhalogenated SVOCs, additional components for a treatment train would be required in addition to the large capital investment to set up this single component of the treatment system.
Bioremediation	The use of microorganisms to biodegrade contaminants in soil and sediment. May be performed *in situ* or *ex situ*.	Fail	Although a proven technology for treatment of selected hydrocarbons and PAHs, it is not effective for highly chlorinated PCBs and metals. Highly dependent on site conditions and sediment characteristics. Bioremediation is limited in its demonstrated ability to reduce COCs in soil/sediment within a reasonable timeframe.
A. DISPOSAL			
Off-Site Disposal - Subtitle D Landfill	Shipment to and disposal of excavated soil (including dredged sediment) in a Subtitle D landfill.	Pass	Appropriate for disposal of wastes that are non-hazardous as demonstrated by TCLP analysis. This alternative is associated with lower costs than other alternatives, and will immediately remove the risk to human health and the environment.
Off-Site Disposal - Subtitle C Landfill	Shipment to and disposal of excavated soil in a Subtitle C landfill.	Fail	Appropriate for disposal of wastes that are classified as hazardous as demonstrated by waste classification analysis. Any soil disposal would include appropriate waste class sampling; however, it is unlikely based on available sample results that hazardous waste disposal would be required.
On-Site Disposal - Picatinny	Disposal of excavated material in an appropriate landfill at Picatinny.	Fail	No suitable landfill exists on-site for disposal of excavated soil.

requirements of Subpart F of the NCP, which specifies that it be fully evaluated as a basis for comparison with other RAs.

Land Use Controls – LUCs, which may include maintenance of existing ECs, would prevent or limit the use of, and access to, the contaminated media at the sites. These restrictions could include property access restrictions prohibiting fishing and swimming, restrictions on future construction activities, and/or a deed notification. Restrictions can be implemented that would limit property usage and specify any special considerations such as personal protective equipment required for future site activities. Land use restrictions and development controls can be an effective means of protecting public health by decreasing risk of exposure to contamination at a site. They do not, however, protect potential ecological receptors; however, no unacceptable ecological risk was identified at any of the sites. A description of the existing LUCs in place at Picatinny is provided in Section 4.4.2.1.

Soil/Vegetative Cover – A soil cover can be used to physically cover and isolate the contaminated soil material, thus limiting the potential for direct contact by humans, airborne transport, and surface water runoff. A soil cover typically consists of a layer of clean soil that is placed over the contaminated soil in engineered compacted lifts. The surface layer of the soil cover is usually composed of topsoil that is suitable for vegetation. To minimize ponding of water on the soil cover, infiltration of precipitation through the cover and contaminated soil, and erosion of the cover; the soil cover would be graded and vegetated with an appropriate type of grass. In some cases, existing clean soil and/or vegetation which serve to isolate underlying contamination may provide protection of human and ecological receptors. The cover would be inspected periodically to confirm that it has not been damaged and to ensure that it is properly maintained.

Excavation – Excavation is defined as the mechanical process of physically removing material from the ground. Dredging is the removal or excavation of contaminated sediments specifically from a water body. Excavation can be accomplished by digging up contaminated media with a backhoe, excavator, or other suitable type of earth-moving equipment.

The backhoe and excavator are types of hydraulically powered equipment suitable for excavation and dredging operations. They may be mounted on tracked or wheeled vehicles, or even on pontoons. A backhoe enables relatively accurate removal and placement of sediments, reducing the amount of excess material removed.

Off-Site Disposal – Contaminated soil and sediment present at the sites may be excavated and transported for off-site disposal in a RCRA Subtitle D landfill (if the material is not classified as a hazardous waste). It is assumed, based on detected sample concentrations, that none of the media to be disposed would require disposal in a hazardous waste landfill (Subtitle C). Placement of the excavated material in a landfill would minimize the potential for leakage of contaminants and minimize threats to public health and the environment by permanently removing the contaminants from the sites.

4.2.3 Preliminary Screening of Groundwater Process Options

Table 4-3 describes the preliminary screening process for the groundwater process options for PICA-111. Based on this screening, the following process options were either retained or eliminated from further consideration:

Retained Technologies or Process Options	Eliminated Technologies or Process Options
No Action	
Institutional Restrictions	Air Stripping
Access/Land-Use Restrictions	
Public Education	UV Oxidation
Emergency Provisions	Bioreactor
LTM of Groundwater	Discharge to Surface Water
Pumping – Mass Removal	Aquifer Reinjection
Carbon Absorption	Discharge to POTW
Ex-Situ Chemical Oxidation	Cometabolism
Coagulation/Flocculation/Filtration	MNA
	In Situ Chemical Oxidation
	Zero-Valent Iron (ZVI) Injection
	Accelerated Anaerobic Bioremediation

Table 4-3
Identification and Screening of Technology Types and Process Options

GRA/Technology	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING RESULTS
A. NO ACTION				
NO ACTION	Not Applicable	Not Applicable	"No Action" is not a category of technologies but provides a risk baseline to which all other alternatives may be compared. The NCP requires that "No Action" be included among the general response actions evaluated [40 CFR 300.43(e)(6)].	Retain
B. LIMITED ACTION				
INSTITUTIONAL CONTROLS	Institutional Controls	Institutional Restrictions	Institutional restrictions involve controlling access to contaminated areas by implementing administrative policies. Administrative policies of interest include restricting future property uses within contaminated areas and restricting the installation of new drinking water wells. One such institutional restriction is the classification exemption area (CEA). The CEA is a state of New Jersey administrated designation of areas that are not potable due to contamination. The State exercises its authority by utilizing a statute that requires permits prior to the construction of any groundwater well. Thus, the drinking water well exposure pathway is administratively controlled by the State for those areas classified as a CEA.	Retain
		Access Restrictions	Access restrictions involve controlling access to contaminated areas by installing physical boundaries and/or signs.	Retain
		Public Education	An increased public awareness of the hazards present at the site would be achieved through public meetings, presentations at local schools, press releases, and posting of signs.	Retain
		Emergency Provisions	In the event of an unexpected deterioration of site conditions resulting in an increased threat to public health and the environment, emergency measures are outlined to allow prompt attention to the problem. Existing emergency provisions, if any, should be identified and updated.	Retain
	Long-Term Monitoring	Groundwater Monitoring	The primary objectives of long term monitoring include: (1) evaluation of long term behavior of the plume, (2) verify that exposure to contaminants and their breakdown products do not pose additional risks, and (3) assess when it is necessary to implement a contingent remedy.	Retain

Table 4-3
Identification and Screening of Technology Types and Process Options

GRA/Technology	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING RESULTS
MONITORED NATURAL ATTENUATION	Monitored Natural Attenuation	Natural Attenuation	Natural attenuation includes a variety of natural processes which work together to reduce the concentration of contaminants and their impact on the environment. Natural attenuation includes intrinsic bioremediation of contaminants, and reduction of contaminant concentrations through sorption/dispersion in the aquifer. Monitored Natural Attenuation or "MNA" is a formal and systemic approach of monitoring and measuring the rate at which the natural attenuation of contaminants occur, so as to demonstrate that RAOs are achieved. Based on the types of contamination (arsenic and lead) and limited extent of contamination; the advantages of MNA over LTM do not justify the additional cost.	Do not retain
C. CONTAINMENT				
BARRIERS	Impermeable/Low Permeability Barriers	Vertical Impermeable Barriers - Sheet piling, slurry wall and liner	Installation of vertical sheet piling, slurry walls or impermeable liners in the aquifer to prevent further migration of groundwater contaminants. The COCs are bounded by Green Pond Brook which does not appear to be affected by the contamination at Site 109.	Do not retain
		Capping and other impermeable covers	Installation of an impermeable or low permeability cap (for example clay and/or concrete) or cover (liner) to prevent infiltration of rain and leaching of contaminated soils. This technology would have limited utility since source areas are remediated or otherwise inactive. The COCs are bounded by Green Pond Brook which does not appear to be affected by the contamination at Site 109.	Do not retain
	Permeable Barriers	Drains, Interceptor Trenches	Drains and interceptor trenches are installed across the flow path of a contaminated plume to intercept shallow groundwater and prevent further migration. Water is then treated via an ex-situ technology. The COCs are bounded by Green Pond Brook which does not appear to be affected by the contamination at Site 109.	Do not retain
		Permeable Reactive Barrier (PRB)	A PRB composed of zero valent iron filings or other material is installed across the flow path of a contaminated plume, allowing the water portion of the plume to passively move through while reacting/precipitating with chlorinated solvents and other contaminants. The COCs are bounded by Green Pond Brook which does not appear to be affected by the contamination at Site 109.	Do not retain
D. TREATMENT				
EX SITU ACTIVE RESTORATION	Extraction	Pumping/Extraction Wells for Mass Removal	Mass removal extraction wells consist of a series of pumping wells installed into highly contaminated areas of the plume to remove contaminated groundwater. Specifically, the well field configuration is optimized to remove groundwater from the highest contaminant concentration areas of the plume. The technology is most useful in formations with high transmissivity. Pumping will have limited effectiveness on the COCs (arsenic and lead) at this site.	Do not retain

Table 4-3
Identification and Screening of Technology Types and Process Options

GRA/Technology	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING RESULTS
EX SITU ACTIVE RESTORATION (CONTINUED)	Physical/Chemical Treatment	Air Stripping	Air stripping is a full-scale technology in which volatile organics are separated from groundwater by increasing the surface area of the contaminated water that is exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Air stripping involves the mass transfer of volatile contaminants from water to air. For groundwater remediation, this process is typically conducted in a packed tower or an aeration tank. Pumping will have limited effectiveness on the COCs (arsenic and lead) at this site.	Do not retain
		Carbon Adsorption	Liquid phase carbon adsorption is a full-scale technology in which groundwater is pumped through a vessel or series of vessels containing granular activated carbon (GAC) to which dissolved contaminants adsorb. When the concentration of contaminants in the effluent from the bed exceeds a certain level, the carbon can be regenerated in place, removed and regenerated at an off-site facility, or discarded and replaced. Adsorption by activated carbon has a long history of use in treating municipal, industrial, and hazardous waste. Carbon adsorption is most efficient for removing organic compounds with a high boiling point, high molecular weight, and low solubility in water. Pumping will have limited effectiveness on the COCs (arsenic and lead) at this site.	Do not retain
		UV Oxidation	UV oxidation is a destruction process that oxidizes organic, inorganics, and explosive constituents present in water by the addition of strong oxidizers and irradiation with UV light. The oxidation reaction is achieved through the synergistic action of UV light, in combination with ozone and or hydrogen peroxide. If complete mineralization is achieved, the final products of oxidation are CO_2, water, and salts. The main advantage of UV oxidation is that it is a destruction process, as opposed to air stripping or carbon adsorption, for which contaminants are extracted and concentrated in a separate phase. UV oxidation processes can be configured in batch or continuous flow modes, depending on the throughput under consideration. However, UV oxidation is considerably more complex and expensive in comparison to carbon adsorption and air stripping. Given the low contaminant concentrations in site groundwater UV oxidation is not a cost effective alternative.	Do not retain
		Zero-Valent Iron	This technology has been demonstrated to be capable of treating a wide range of contaminants, including halogenated organics and heavy metals. The COCs are bounded by Green Pond Brook which does not appear to be affected by the contamination at Site 109.	Do not retain
	Biological Treatment	Bioreactor	Extracted groundwater is amended with nutrients, microbial cultures, and pH adjustment to facilitate biodegradation of contaminants. Granular activated carbon (GAC) is typically added as a microbial growth substrate. GAC provides a secondary benefit of adsorbing contaminants, limiting aqueous concentrations and potential toxicity to the microbes, and desorbing as aqueous concentrations are reduced though degradation. Pumping will have limited effectiveness on the COCs (arsenic and lead) at this site.	Do not retain
	Discharge	Surface Water	Treated groundwater is discharged into an on-site surface water channel. Discharge to surface water after treatment is feasible however, pumping will have limited effectiveness on the COCs (arsenic and lead) at this site.	Do not retain
		Reinjection	Treated groundwater is reinjected back to the aquifer through a series of reinjection wells. Reinjection after treatment is feasible however, pumping will have limited effectiveness on the COCs (arsenic and lead) at this site.	Do not retain

Table 4-3
Identification and Screening of Technology Types and Process Options

GRA/Technology	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING RESULTS
EX SITU ACTIVE RESTORATION (CONTINUED)	Discharge	Publicly Owned Treatment Works	Discharge of treated or untreated water to a POTW facility. Pretreatment may be required if the untreated water has high content of heavy metals that could be toxic to the microorganisms used in the treatment system. Discharge to a POTW after treatment is feasible however, pumping will have limited effectiveness on the COCs (arsenic and lead) at this site.	Do not retain
IN SITU ACTIVE RESTORATION	Physical and Chemical	Air Sparging and SVE	Air sparging is the process of injecting air into the saturated subsurface to remove contaminants. Air travels through the soil column and creates an *in situ* stripping mechanism in which the volatile contaminants partition from the solution phase into the vapor phase. The contaminated vapors travel upwards to the unsaturated zone where they can be extracted via SVE wells. Treatment of the contaminated vapors is then required. Contaminant displacement has not been observed in previous field applications of the process. Aerobic, microbial growth is observed within and around the subsurface of an air sparging system. Not viable for removal/treatment of arsenic and lead.	Do not retain
		Injection of Zero-Valent Iron (ZVI)	This technology has been demonstrated to be capable of treating a wide range of contaminants, including halogenated organics and heavy metals. ZVI may be dispersed into one or more aquifers as a nanoscale liquid suspension or through pneumatic fracturing followed by liquid atomized injection (LAI). The added expense of this technology would not be justified.	Do not retain
		Chemical Oxidation	In Situ Chemical Oxidation (ISCO) involves the addition of oxidizing agents, such as hydrogen peroxide, permanganate, ozone, or Fenton's reagent in order to facilitate direct oxidation of contaminants. Chemical oxidants are injected into the subsurface through injection wells. The added expense of this technology would not be justified.	Do not retain
		Steam Injection with Dual Phase Recovery	This alternative involves the injection of steam into the subsurface. This technology serves to remove contaminated groundwater via three mechanisms. First, steam displaces groundwater and causes a cold water flush. Second, steam that has condensed to warm water is also displaced by continued steam injection causing a warm water flush. This technology is not feasible for the COCs at this site.	Do not retain
	Biological	Cometabolism	Cometabolism is when microorganisms degrade contaminants without getting any benefits. This occurs by the activity of non specific enzymes which are generated during the degradation of another compound. Cometabolic processes can occur under a variety of electron accepting conditions, including aerobic and anaerobic. This technology is not feasible for the COCs at this site.	Do not retain

Table 4-3
Identification and Screening of Technology Types and Process Options

GRA/Technology	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING RESULTS
IN SITU ACTIVE RESTORATION (CONTINUED)	Biological	Accelerated Anaerobic Bioremediation	This alternative stimulates the growth of microbial populations to consume available dissolved oxygen to generate anaerobic conditions, through the addition of an organic substrate (electron donor). Under anaerobic conditions, microbes utilize terminal electron accepting reactants that yield the greatest free energy. his technology is not feasible for the COCs at this site.	Do not retain

4.3 REMEDIAL ALTERNATIVE SCREENING CRITERIA

Section 300.430(e) of the NCP lists nine criteria against which each RA must be assessed. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified. The detailed criteria are as follows:

- Protection of human health and the environment.
- Compliance with ARARs.
- Long-term effectiveness and permanence.
- Reduction of toxicity, mobility, or volume through treatment.
- Short-term effectiveness.
- Implementability.
- Cost.
- State acceptance.
- Community acceptance.

The NCP [Section 300.430(f)] states that the first two criteria, protection of human health and the environment and compliance with ARARs, are "threshold criteria" which must be met by the selected response action unless a waiver can be granted under Section 121(d)(4) of CERCLA. Criteria three through seven are "primary balancing criteria," and the trade-offs within this group must be balanced. The preferred alternative will be the alternative which is protective of human health and the environment, is ARAR-compliant, and provides the best combination of primary balancing attributes. Only the first seven criteria are evaluated in this report. The final two criteria, state and community acceptance, are "modifying criteria" which are evaluated following the comment period on the RI/FS reports and the proposed remedial plan. The nine NCP criteria are described in further detail in the following sections and summarized on **Figure 4-1**.

Overall Protection of Human Health and the Environment

This criterion involves an assessment based on a composite of factors addressed under other evaluation criteria, including long-term effectiveness, short-term effectiveness, and compliance with ARARs.

This criterion provides an evaluation of how the RA, as a whole, achieves RAOs and maintains protection of human health and the environment. A determination and declaration that this criterion will be met by the proposed response action must be made in the Decision Document; therefore, this is a threshold criterion, which must be met by the selected remedy. Ordinarily this criterion is satisfied if the potential risks posed at the sites are eliminated, reduced, or controlled through treatment, engineering controls, or ICs. According to the CERCLA definition, the site itself is protective of human health, even without remedial action. However, overall protection of the environment will be addressed individually for the RAs.

Compliance with ARARs

This criterion assesses the compliance of an alternative with all contaminant-specific, action-specific, and location-specific ARARs. Any TBCs are also taken into consideration including appropriate state or federal criteria, advisories, and guidance as they apply.

Long-Term Effectiveness and Permanence

This criterion examines the protection of human health and the environment after construction and implementation of the RA. This criterion addresses the long-term adequacy, reliability, and permanence of the RA. Components of this analysis include the following:

- The expected long-term reduction in risk posed by the sites.

- The level of effort needed to maintain the remedy and monitor the area for changes in site conditions.
- The compatibility of the remedy with the planned future use of the site.

Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion examines the effectiveness of the RA in reducing the toxicity, mobility, and volume of contaminants through treatment. The statutory preference for remedial technologies that significantly and permanently reduce the toxicity, mobility, or volume of the waste is addressed by this criterion. The following factors will be considered:

- The amount of hazardous materials that will be destroyed or treated.
- The degree of expected reduction in toxicity, mobility, or volume.
- The degree to which the treatment will be irreversible.
- The type and quantity of treatment residuals that will remain following treatment.

Short-Term Effectiveness

The effects of the remedial action alternative from construction and implementation to completion of the remedial action alternative are addressed under this criterion. The following factors will be addressed:

- Protection of the community during the remedial action, including the effects of dust from excavation, transportation of contaminated materials, and air-quality impacts from on-site treatment.
- Protection of workers during the remedial action.
- Environmental impacts of the remedial action.
- Time required to achieve RAOs.

Implementability

This criterion considers the technical and administrative feasibility of each alternative, as well as availability of required resources. Factors considered in assessing this criterion include construction, operation, and maintenance of the RA; required approvals and permits from regulatory agencies; availability of required off-site treatment or disposal services; and availability of necessary equipment, materials, and personnel for implementation.

Cost

This criterion involves development and evaluation of the capital cost of construction, equipment, land, buildings, engineering services, and project administration, and operation and maintenance costs for labor, spare parts, materials, and administration. In addition, the present worth of each alternative is calculated using a discount rate of 7%. Costs are then compared on a common, present-worth basis in terms of 2010 dollars. The level of detail employed in developing these estimates is considered appropriate for making choices between alternatives, but the estimates are not intended for use in detailed budgetary planning. Detailed cost calculations are presented in Appendix E, and are summarized in **Table 4-4**.

Table 4-4
Cost Summary For Remedial Alternatives, PICA-111
Picatinny Arsenal, New Jersey

Remedial Alternative	Description	Capital Cost	Discounted O&M [2]	Total Present Worth	Duration (Construction and O&M)
BASELINE COST FOR LAND USE CONTROLS (LUCs) FOR SOIL AT PICA-111		$32,200	$37,222	**$69,422**	30 years
Site 109 & PICA-203					
Soil					
Alternative 109S-1	NO ACTION	$0	$0	**$0**	None
Alternative 109S-2[1]	LUCs AND MAINTENANCE OF EXISTING ECs		$25,721	**$25,721**	30 years
Alternative 109S-3	EXCAVATION OF SOIL WITH CONCENTRATIONS ABOVE SCLs AND OFF-SITE DISPOSAL	$1,506,128	$25,721	**$1,531,849**	9 weeks, (30 years ICs)
Site 142					
Soil					
Alternative 142S-1	NO ACTION	$0	$0	**$0**	None
Alternative 142S-2[1]	LUCs AND MAINTENANCE OF EXISTING ECs		$25,721	**$25,721**	30 years
Alternative 142S-3	EXCAVATION OF SOIL WITH CONCENTRATIONS ABOVE SCLs AND OFF-SITE DISPOSAL	$58,989	$25,721	**$84,711**	3 days, (30 years ICs)
Site 109 & PICA-203 Groundwater					
Soil					
Alternative 109/203GW-1	NO ACTION	$0	$0	**$0**	None
Alternative 109/203GW-2	LUCs AND LONG TERM GROUNDWATER MONITORING		$62,151	**$62,151**	30 years
Alternative 109/203GW-3	MASS REMOVAL GROUNDWATER PUMP AND TREAT	$922,958	$1,281,162	**$2,204,120**	15 years

(1) Baseline costs for the implementation of LUCs are evaluated for the all subject sites combined. As SCLs are based on a non-residential use scenario, the costs for LUCs must be added to the costs presented for the site specific remedial alternatives with the exception of the No Action alternative.
[2] Present worth O&M with discount rate of 7%.

4.4 REMEDIAL ALTERNATIVES

The following section provides a detailed description of each soil RA for the sites evaluated in this FS, and analysis of each alternative with respect to the NCP criteria. The RAs for groundwater are developed in Section 4.5. The RAs evaluated for each site are listed in **Table 4-4** along with a summary of estimated costs and remedial timeframes. Each of the soil RAs, with the exception of the "no action" alternative, involves the maintenance and enforcement of LUCs. As such, LUCs are considered supplemental to each of the remaining alternatives. A single LUC plan would be prepared encompassing all sites at PICA-111. A comparison of the alternatives for each site, based on the evaluation criteria, follows the analysis such that the most appropriate alternative can be selected.

4.4.1 No Action

According to the NCP, the level of protectiveness achieved must be compared to the required expenditure of time and materials as an integral portion of the remedy selection process. The No Action alternative is intended to serve as a baseline by which to compare the risk reduction effectiveness of other potential alternatives. In this alternative, no response actions would be performed. No efforts would be undertaken to contain, remove, monitor, or treat the contaminated soil at the sites. The sites would remain without any additional actions.

4.4.1.1 Evaluation of Screening Criteria

A summary of the screening criteria evaluation with respect to each of the applicable sites is presented in **Table 4-5**.

Overall Protection of Human Health and the Environment

The No Action alternative provides no control of exposure to the contaminated media and no reduction in risk to human health or the environment.

Compliance with ARARs

Since no remedial activities are associated with this alternative, chemical-specific ARARs/TBCs will not be met. Action-specific and location-specific ARARs are not applicable since no remediation would be implemented.

Long-Term Effectiveness and Permanence

The No Action alternative does not provide any controls for reduction of exposure or long-term management measures. All current and potential future risks would remain the same under this alternative.

Reduction of Toxicity, Mobility, and Volume through Treatment

This alternative does not employ any treatment that would reduce the toxicity, mobility, or volume of COCs; therefore, it does not meet this criterion.

Short-Term Effectiveness

Implementation of this alternative does not pose any additional risks to the community, the workers, or the environment since there are no remedial activities associated with it.

Implementation

There are no implementability concerns posed by this option.

Cost

The present worth cost and capital cost of the No Action alternative are estimated to be **$0.00** since there would be no action taken at the site.

4.4.2 Land Use Controls and Existing Engineering Controls for Soils

The LUCs and existing ECs alternative involves the application of land use and access restrictions and also includes maintenance of existing ECs, such as existing surface soil cover, vegetative cover, pavement, gravel cover, or site fence at applicable AAs. LUCs have been evaluated on a basis

which encompasses contaminated media at each of the sites evaluated in this FS. Additional site-specific measures (such as site inspections and maintenance of existing ECs) and associated costs would be added for each site included in the LUC plan. For the purpose of this FS, a 30-year timeframe is assumed in the cost estimate.

4.4.2.1 Description of Alternative

As part of this RA, existing ECs (vegetative cover) will be maintained throughout the AAs. LUCs will be maintained across all of the PICA-111 sites. **Figure 4-2** depicts the coverage of existing ECs and LUCs. Property access restrictions as a component of LUCs, such as site security, and restrictions on future site activities, are already in place. Some restrictions are in place at Picatinny by virtue of it being an active military installation. Enforcement of these restrictions will ensure the protection of human health. However, in the event that Picatinny would be closed and declared excess property, the land use restrictions would be legally recorded (e.g., in zoning ordinances, property deeds, etc.) and incorporated into the provisions for the new land use. A change in land use would include the re-evaluation of clean-up requirements.

Because contamination would remain in place that either exceeds New Jersey ISRS or which poses a potential human health risk, as part of this alternative, land use and access restrictions would be required. The USEPA requires LUCs when site contaminant levels do not allow unrestricted use and unlimited exposure. As such, LUCs would be established to preclude activities that could lead to human exposure to environmental contaminants, by eliminating exposure pathways and/or restricting access by potential receptors. LUCs are administrative measures put in place to effect human activity, in order to preclude land use which could result in unacceptable risk. They can also serve to notify current and future users about the environmental conditions of the property. The Record of Decision (ROD) will detail the provisions and requirements of the LUC portion of this remedy necessary to assure that land use remains consistent with the level of protection afforded by the remedial action to protect human health. To properly enforce and maintain LUCs for this site, a Land Use Control Remedial Design (LUCRD) will be written and submitted as a primary document during the design stage of the project. The LUCRD will also detail the existing ECs (required by the NJDEP to address any exceedence of the NJDEP ISRS) and maintenance procedures required to ensure the existing ECs remain effective. This plan will contain sufficient detail such that adherence to the plan will ensure the protectiveness of the remedy. Annual or biennial land use certification reports documenting that land use continues to be consistent with the assumptions in the risk assessment will be signed by the installation commander and provided to the NJDEP and USEPA.

According to the NCP, LUCs may be used during the conduct of the RI/FS and implementation of the remedial action and, where necessary, as a component of the completed remedy [40 CFR 300.430 (a) (1)(iii)(D)]. The use of LUCs shall not substitute for active response measures as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of the trade-offs among alternatives that is conducted during the selection of the remedy [40 CFR 300.430 (a)(1)(iii)(D)]. The NCP regulation specifies the conditions under which LUCs can be incorporated into a remedy, but it does not provide specific guidance on how to incorporate them into the remedy selection process. The USEPA direction entitled Land Use in CERCLA Remedy Selection Process provides insight into USEPAs position on LUCs (USEPA, 1995). USEPA specified that LUCs should be evaluated and implemented with the same degree of care as is given to other elements of the remedy. The directive states that in evaluating a remedy that includes an IC, USEPA should determine the type of IC to be used; the existence of the authority to implement the IC; and the appropriate entities' resolve and ability to implement the IC.

The four general categories of ICs screened for or already in use at Picatinny, and which provide layers of protection, are as follows: government controls, proprietary controls, enforcement and permitting and informational devices which assist with the management and implementation of LUCs. Most of these measures have been addressed in seven elements of the Land Use Restriction policy for Picatinny. The seven elements are Site Clearance and Soil Management Procedures; UXO Clearance Procedures; Master Plan Regulations; Picatinny GIS Database; Picatinny Base Access Restriction; Picatinny Safety Program; and Army Military Construction Program. All of these elements of Land Use Restriction are explained below. These controls have been developed with a consideration of all reasonably anticipate

land uses at Picatinny; these include administrative and industrial military operations, and outdoor recreation/golf course. LUCs will be implemented using the Department of Navy Guidance as agreed between the Army and the USEPA.

ECs, including signage (warning signs) describing restrictions of site use at the major access points of sites included in this FS, to augment the existing perimeter fence surrounding Picatinny would be installed. Annual inspections will be performed to establish that all on-site LUCs are in good condition and to confirm that the land use of the site has not changed. The 5-year review process and the annual land use certifications/inspections will be used to document continuing land use is industrial and the remedy remains protective. Additionally, the remedial design will specify notification requirements to the EPA should land use change occur, or be planned, in accordance with the Department of Navy Principles.

Site Clearance/Soil Management Procedures

Picatinny initially established a Site Clearance/Soil Management Procedure on 2 August 1991. The procedure has been continually updated as requirements change. Currently, the Site Clearance Soil Management Procedure is specified in the Standard Operating Procedure (SOP) for Soil Management Procedures During Construction Activities, Picatinny Arsenal, July 2003 (Prepared by Johnson Controls, Inc., Risk Management Group Environmental Office). The SOP applies to all construction projects affecting soil movement at Picatinny and requires the approval by the Environmental Affairs Office. The SOP and the attached Soil Management Checklist are for use at all sites where activities will disturb the soils. This includes grubbing, grading, excavation, and significant heavy equipment traffic over unprotected soils. The procedure provides safeguards against inadvertent, unplanned exposure of potentially contaminated soils. The procedures include completion and submittal of an Environmental Work Request for Site Clearance/Soil Management Checklist prior to implementing the proposed work, no excavation of soil without approval of the Picatinny Installation Restoration Program (IRP) Project Manager, and no transportation of excavated soils off any site in this study without written approval from the USEPA Project Manager. This restriction does not include soil samples taken from the site for investigations.

Munitions and Explosives of Concern (MEC) Clearance Procedures

A series of explosions destroyed many of the structures at Picatinny on 10 July 1926. Unexploded ordnance and explosives were scattered over approximately one-third of Picatinny as a result of the explosions. Historical and current explosives testing and firing have resulted in the need to exercise care while conducting activities in many Picatinny areas. Picatinny, together with additional Army commands, has established procedures for the clearing of all Army property suspected of containing any potential MEC. Requirements for MEC work are outlined in the 30 July 1996 update for Personnel and Work Standards for Ordnance Response. The Picatinny Office of Chief of Safety, Public Safety and Environmental Affairs Directorate, is responsible for maintaining this procedure.

Master Plan Regulations, Army Regulation 210-20

The Army issued a new regulation, Master Planning for Army Installations, AR 21 0-20, on 13 July 1987 updating an earlier regulation dated 27 January 1976. AR 21 0-20 "establishes the requirement for an installation master plan and planning board and specifies procedures for developing, submitting for approval, updating, and implementing the installation master plan." This regulation provides for comprehensive planning at Army installations and not only allows, but requires incorporation of existing land-use and conditions into the master plan. The master plan regulations provide a framework for comprehensive planning through the use of component plans, which include, but are not limited to, the following:

- Natural Resources Plan
- Environmental Protection Plan
- Installation Layout Vicinity Plan
- Land-use Plan
- Future Development Plan

The overall objective is to provide each installation with a master plan through the integration of each component plan into the installation master plan. The component plans form a series of narrative, tabular and graphic plans. Their integration into an installation master plan provides many benefits as outlined in AR 210-20, including "the mechanism for ensuring that installation projects are sited to meet operational, safety, physical security, and environmental requirements."

Picatinny Office of the Chief Engineer in the Public Works Directorate is in charge of the master plan. A key component of the Picatinny master plan is the Arsenal Land Use map.

Picatinny GIS Database

Picatinny maintains a comprehensive base-wide GIS database. The database includes descriptions of existing land and environmental restrictions and locations of known contamination on base. This information will be made useable for rapid response and will permit rapid inquiries regarding sites within Picatinny. Existing wells, chemical contamination, building restrictions, MEC concerns, and many other lines of inquiry, will quickly be available to support the decision making process. Picatinny Office of the IRP Manager, Public Safety and Environmental Affairs Division, is responsible for maintaining this database, which has been delegated to ARCADIS until 2016.

Picatinny Base Access Regulations

Access regulations are in place at Picatinny. Picatinny is not closed to the public but access to the Arsenal is controlled. Trespassing and unauthorized activities on Picatinny are illegal. Picatinny Office of the Chief of Security Division, Public Safety and Environmental Affairs Division, is in charge of enforcing these regulations.

Picatinny Safety Program

Army regulation AR 385-10 outlines safety requirements for Army installations. Tactical Army Command (TACOM) Supplement 1 to AR385-10 provides Picatinny specific requirements for the Safety Program, IC6. AR 385-10 establishes an occupational safety and health program, and integrates "Hazard Risk Management into all command business processes." The Safety Program establishes the Hazard Communication (HAZCOM) Program and Hazardous Materials Information System (HMIS), maintains a central Material Safety Data Sheets (MSDS) file in the Installation Safety Office, and provides a safety review of all construction projects. The Safety Program also establishes "the appropriate medical surveillance program" for personnel working with hazardous materials or otherwise performing hazardous operations. The Installation Safety Office is the point of contact for the Safety Program, and has the authority to stop work where unsafe work conditions are present. Picatinny Office of the Chief of Safety, Public Safety and Environmental Affairs Division, is responsible for this program.

Army Military Construction Program Development and Execution

Army regulation AR 41 5-1 5 outlines pre-construction environmental survey procedures. Prior to construction activities, the Army categorizes the proposed construction site based on an environmental survey. Under this regulation, the Army must determine wetland status of the site, historical significance, and endangered species habitat identification. Picatinny Office of the Resident Engineer, USACE, New York District, coordinating with the Chief Engineer in the Public Works Directorate is responsible for maintaining this program.

4.4.2.2 Evaluation of Screening Criteria

A summary of the screening criteria evaluation with respect to each of the applicable sites is presented in **Table 4-5**.

Overall Protection of Human Health and the Environment

Potential human health and ecological exposures to COCs at the subject sites are considered minimal. Land use and access restrictions are effective means to reduce human health exposure to contaminated soil, but will not address ecological risk. Existing ECs may inhibit exposure to some ecological receptors; however, no significant ecological risks were identified during ERAs or SLERAs (Some sites were not assessed due to the evaluation that the site offered insufficient habitat to warrant additional investigation). Since the contamination would remain on site and undergo no treatment to

reduce toxicity, mobility or volume, the LUCs and Existing ECs alternative would not inhibit the potential migration of contaminants.

Compliance with ARARs

There are chemical-specific criteria for soil promulgated by the state of New Jersey relevant to PICA-111. Chemical-specific criteria would be addressed under this alternative by limiting exposure to COCs above SCL levels through existing ECs. Action-specific and location-specific ARARs are not applicable since no active remediation would be implemented.

Long-Term Effectiveness and Permanence

LUCs and Maintenance of Existing ECs provides long-term effectiveness and permanence for the reduction of human health exposure to COCs, as long as the LUCs and ECs remain in place.

Reduction of Toxicity, Mobility, and Volume through Treatment

This alternative does not employ any treatment that would reduce the toxicity, mobility, or volume of the COCs.

Short-Term Effectiveness

Implementation of this alternative does not pose any additional risks to the community, the workers, or the environment since there are no remedial activities associated with it.

Implementation

LUCs and Maintenance of Existing ECs is readily implementable.

Cost

Implementation costs of this alternative are provided for each site in **Table 4-4**. This baseline cost is supplementary to each of the RAs evaluated in this FS, since SCLs are based on nonresidential criteria. A LUCRD will be prepared for the combined PICA-111 sites at an estimated present worth cost of **$69,000**. Site-specific costs, such as site inspections and maintenance of ECs, are evaluated separately by site and media.

4.4.3 Excavation and Off-Site Disposal of Soil with COC Concentrations above SCLs

The excavation and off-site disposal alternative involves the excavation of contaminated soil with concentrations greater SCLs, and confirmatory sampling of the limits of excavation. Excavated soil would be transported off post for disposal in a RCRA D landfill (waste characterization sampling would be required to confirm waste class). The excavation would then be backfilled with soil from an approved off-post source and revegetated. In addition, the property will be subject to LUCs to prevent exposure to COCs remaining at the sites at concentrations in excess of residential criteria.

4.4.3.1 Description of Alternative

This RA would involve excavation of soil contamination identified in the AAs presented in Section 3.2.2. The AAs which will be excavated are presented on **Figure 4-3**. The timeframes for the completion of site activities are presented in **Table 4-4** for the sites where excavation and disposal is evaluated. The major elements of this alternative are discussed in further detail below:

Design and Permitting

Once an RA has been selected and the Proposed Plan and ROD have been completed, a remedial design would be prepared. This would include, at a minimum, a site-specific work plan describing the remedial activities, quality assurance/control procedures, technical specifications, a soil erosion and sedimentation control plan, and a site health and safety plan. The design documents would be submitted for review and approval by the appropriate agencies prior to initiation of remedial activities.

The initial phases of the work would consist of the arrangement of the relevant permit equivalencies and preparation of a site-specific health and safety plan. Because the remedial action would be conducted under CERCLA, the substantive requirements of the permits, and permitting agencies, would be followed in lieu of obtaining formal permits for required activities. The health and

safety plan would outline the physical and chemical hazards associated with the work to be performed at the site and would serve as the instrument of control for ensuring the health and safety of personnel at the site. The health and safety plan would also outline the air monitoring program that would be implemented during the excavation activities to ensure that a safe working environment is maintained. The health and safety plan will provide the action levels that will dictate the need for implementation of dust controls at the site.

Critical design elements and considerations would include work plan preparation, development of waste excavation and handling procedures, and design of erosion and sedimentation controls. Because this action would be performed under CERCLA, Picatinny is only required to file State and local permit equivalents. Permit equivalents will be filed for a storm water permit. Preparation of a Soil Erosion and Sedimentation Control Plan will also be required.

Contractor and Material Procurement

This would include preparation of bid packages for the remedial activities, solicitation of bids, bid review, and contractor selection. Materials and equipment required to complete the remedial activities would also be selected and procured.

Mobilization and Site Preparation

The first phase of this alternative would include mobilization of the required personnel, equipment, and facilities. Following mobilization, site preparation would occur. During the site preparation task, a small equipment decontamination area would be constructed to allow for the decontamination of equipment used on site during construction activities. Liquids generated during decontamination activities will be collected, sampled, analyzed, and disposed of at an appropriate permitted facility.

Material and waste staging areas would also be constructed during the site preparation phase to provide an area for storage of soils, materials, and miscellaneous equipment used during site activities. A “clean” access road may also be required to allow trucks hauling clean backfill and waste materials to enter and exit without requiring decontamination.

Prior to the commencement of site clearing activities, the soil and sediment and erosion controls that are required to meet applicable local, State, and Federal guidelines will be installed. These soil and sediment controls will be properly maintained during contaminated soil and sediment excavation, and will be removed once the disturbed areas have been restabilized. As required, the controls would consist of installation of silt fence, straw bale barriers, and diversion berms, as well as construction of a stabilized entrance through which vehicles will enter and exit the site. Erosion and sedimentation controls will be detailed in the site-specific Soil Erosion and Sedimentation Control Plan. Clearing and grubbing will consist of the removal of trees, shrubs, brush, and debris from the proposed excavation areas, as well as from the areas where support facilities will be located.

UXO Screening Survey

The Picatinny Safety Office has indicated that an UXO safety survey for intrusive activities will be required. Based on the existing site use and the determination by the Picatinny Safety Office, there may be explosive ordnance disposal activities associated with this RA. A 40% markup will be added to account for the UXO construction support for certain construction activities, such as clearing and grubbing, excavation, and sampling for any site at which UXO avoidance is required. Safety distances may have to be established, implemented, and enforced during intrusive activities. The size of the safety zone “push back” would be determined by the size and type of the ordnance potentially expected at the site. “Push back” distances could potentially encompass on-post facilities, including roads and buildings, which could result in the restriction of some activities and workspace at Picatinny during implementation of this RA.

Contaminated Soil Excavation and Confirmatory Sampling

Soil would be excavated using a backhoe or excavator and loaded directly into dump trucks to be transported to a non-hazardous waste landfill. Prior to commencing excavation activities, waste characterization samples would be collected and analyzed to ensure proper disposal. Standard dust

control techniques would be used during the excavation activities to mitigate the potential for release of contaminated dust. Visual observations and confirmatory sampling will be used to determine the limits of the excavation.

Confirmatory samples will be collected for every 30 ft of each excavation sidewall and 900 SF of each excavation bottom. For larger excavations, the sampling frequency can be reduced after consultation with the NJDEP. For excavations less than 20 ft in perimeter, one sidewall and one bottom sample will be collected in accordance with NJDEP Requirements for Site Remediation. Sample locations will be biased toward locations and depths of the highest expected contamination, utilizing both the results of prior sampling and field indicators (including surface water flow). Samples will be analyzed for all COCs identified in the AA. The excavation of contaminated soil and sediment will comply with the NJDEP Technical Requirements for Site Remediation set forth in NJAC 7:26E.

Backfill and Restoration

The excavated areas would be backfilled as soon as practicable with clean fill from an approved off-post source. The excavated areas would be restored to the original contours. Run-off collection and retention would be considered during the design phase to comply with all location- and action-specific ARARs.

Site Cleanup and Demobilization

The final phase of the work would involve site cleanup and demobilization of all personnel, facilities, and equipment.

Continued Implementation of ICs

The excavation and off-post disposal alternative would be implemented in conjunction with the LUCs (assumed to be a 30-year period for the purpose of cost analysis). Those constituents meeting unrestricted use requirements following remediation would not be required to be included in the LUCRD. Refer to Section 4.4.2.1 for the detailed description of LUCs.

4.4.3.2 Evaluation of Screening Criteria

A summary of the screening criteria evaluation with respect to each of the applicable sites is presented in **Table 4-5**.

Overall Protection of Human Health and the Environment

The excavation and off-site disposal alternative provides protection of human health and the environment through removal of contaminated soil from the sites. Thus, this alternative prevents further degradation of the site and eliminates the potential for exposure to contaminated soil.

Compliance with ARARs

There are chemical-specific ARARs for soil promulgated by the State of New Jersey relevant to PICA-111. This alternative would comply with the chemical-specific criteria for soil as well as all action- and location-specific ARARs.

Long-Term Effectiveness and Permanence

The Excavation and Off-Site Disposal alternative provides a permanent remedy for contaminated soil above SCLs which would be permanently removed from the site. However, potential long-term liability might exist because contaminated media would be disposed off-site untreated.

Reduction of Toxicity, Mobility, and Volume through Treatment

The Excavation and Off-Site Disposal alternative provides the greatest reduction of COC mobility. Both toxicity and volume would be removed from the site. However, the toxicity and volume removed from the site would be transferred to the disposal facility rather than eliminated.

Short-Term Effectiveness

Site clearing and excavation activities would result in significant material handling and some dust generation, resulting in minimal short-term risks. The potential for exposure would be addressed through

the use of suitable protective clothing and equipment, good construction practices, and standard dust suppression techniques.

Implementation

The Excavation and Off-Site Disposal alternative is readily implementable, involving standard construction techniques and equipment. Due to the reliance of this alternative on intrusive site work, the potential for UXO discovery poses the greatest potential implementability concern.

Cost

Implementation costs for this alternative would be primarily attributed to activities directly associated with the removal and disposal of the contaminated material (such as site preparation, excavation, transportation, disposal, and site restoration). The costs specific to each site at which excavation has been evaluated are presented in **Table 4-4**. The application of ICs is supplementary to each of the RAs. The costs specific to excavation and off-site disposal for each site are in addition to the baseline cost of ICs, which is evaluated to address all of the sites considered in the evaluation of RAs.

4.4.4 Long-Term Monitoring and Land Use Controls for Groundwater

The LTM and LUCs for Groundwater alternative involves the application of land use and access restrictions at applicable AAs. Groundwater will also be periodically monitored to determine when it is permissible to cease LUCs. For the purpose of this FS, a 30-year timeframe is assumed in the cost estimate.

4.4.4.1 Description of Alternative

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

Because contamination would remain in place that exceeds groundwater SCLs, land use and access restrictions would be required. The USEPA requires LUCs when site contaminant levels do not allow unrestricted use and unlimited exposure. As such, LUCs would be established to preclude activities that could lead to human exposure to environmental contaminants, by eliminating exposure pathways and/or restricting access by potential receptors. LUCs are administrative measures put in place to effect human activity, in order to preclude land use which could result in unacceptable risk. They can also serve to notify current and future users about the environmental conditions of the property. The ROD will detail the provisions and requirements of the LUC portion of this remedy necessary to assure that land use remains consistent with the level of protection afforded by the remedial action to protect human health. To properly enforce and maintain LUCs for this site, a LUCRD will be written and submitted as a primary document during the design stage of the project. The LUCRD will also detail the existing ECs (required by the NJDEP to address any exceedence of the NJDEP ISRS) and maintenance procedures required to ensure the existing ECs remain effective. This plan will contain sufficient detail such that adherence to the plan will ensure the protectiveness of the remedy. Annual or biennial land use certification reports documenting that land use continues to be consistent with the assumptions in the risk assessment will be signed by the installation commander and provided to the NJDEP and USEPA.

According to the NCP, LUCs may be used during the conduct of the RI/FS and implementation of the remedial action and, where necessary, as a component of the completed remedy [40 CFR 300.430 (a) (1)(iii)(D)]. The use of LUCs shall not substitute for active response measures as the sole remedy unless such active measures are determined not to be practicable, base on the balancing of the trade-offs among alternatives that is conducted during the selection of the remedy [40 CFR 300.430 (a)(1)(iii)(D)]. The NCP regulation specifies the conditions under which LUCs can be incorporated into a remedy, but it does not provide specific guidance on how to incorporate them into the remedy selection process. The USEPA direction entitled Land Use in CERCLA Remedy Selection Process provides insight into USEPA's

position on LUCs (USEPA, 1995). USEPA specified that LUCs should be evaluated and implemented with the same degree of care as is given to other elements of the remedy. The directive states that in evaluating a remedy that includes an IC, USEPA should determine the type of IC to be used; the existence of the authority to implement the IC; and the appropriate entities' resolve and ability to implement the IC.

The four general categories of ICs screened for or already in use at Picatinny, and which provide layers of protection, are as follows: government controls, proprietary controls, enforcement and permitting and informational devices which assist with the management and implementation of LUCs. Most of these measures have been addressed in seven elements of the Land use Restriction policy for Picatinny. The seven elements are Site Clearance and Soil Management Procedures; UXO Clearance Procedures; Master Plan Regulations; Picatinny GIS Database; Picatinny Base Access Restriction; Picatinny Safety Program; and Army Military Construction Program. All of these elements of Land Use Restriction are explained below. These controls have been developed with a consideration of all reasonably anticipated land uses at Picatinny; these include administrative and industrial military operations, and outdoor recreation/golf course. LUCs will be implemented using the Department of Navy Guidance as agreed between the Army and the USEPA. A description of all of these seven elements is contained in Section 4.4.2.1 and will not be repeated here. In addition to these seven elements of LUC, groundwater at Picatinny is covered by a site-wide CEA, which comprises a component of the LUCs. The Picatinny CEA mandates that any proposed groundwater use within the CEA will require NJDEP review and approval to ensure that modifications would be protective of any impacts from the identified contaminants for the duration of the CEA.

A facility-wide CEA is currently in place, in which PICA-111 groundwater is included. The CEA, which includes both unconsolidated and consolidated aquifers to a depth of 380 ft bgs, was approved by the NJDEP in November 2002 and recertified in 2008. The CEA identifies contaminant concentrations within the CEA boundary (which is coincident with the Picatinny property boundary) above drinking water standards; therefore, the CEA establishes a Well Restriction Area (WRA). The WRA functions as the IC by which potable use restriction can be affected.

Well Head Protection

PTA currently has a well head treatment program in place for its production wells. As part of this program, well head treatment, sampling, and reporting are conducted. As part of this RA, this will be continued and the treatment, monitoring and notification program will be formalized.

Long-Term Monitoring of Groundwater

The primary objectives of LTM under this RA is to ensure that concentrations of arsenic and lead do not increase and/or spread to uncontaminated areas/media, assess if it is necessary to implement a contingency remedy and to determine when monitoring and LUCs can cease.

Implementation of the LTM program under this alternative 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 (DQOs), the quality assurance project plan (QAPP) that would 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 contingent remedy. The exit strategy will include a provision for the cessation of sampling and LUCs if concentrations of lead and arsenic at the site stabilize at levels near the SCL. The reporting requirements would involve, at a minimum, submittal of the monitoring results and 5-year review reports.

The project work plan would address all aspects of the program and direct the work to be performed. The field sampling plan would direct the technical requirements of the sampling program, including field sampling techniques, sampling locations, sampling frequency, proposed data use, sampling analytical programs, and use of site screening equipment. The QAPP would detail the requirements of the chemical analytical program (i.e., analytical methods), DQOs, data quality, and SOPs.

To monitor the site, two groundwater monitoring wells 109MW-1 and 109MW-3 will be included in the LTM program. Monitoring will take place once every 5 years to coincide with the 5-year review for the site. All groundwater samples would be analyzed for arsenic and lead, with the collection of field

parameters such as dissolved oxygen, temperature, oxidation-reduction potential, and pH during sampling. The wells selected for the LTM sampling program are shown in red type on **Figure 4-4**.

Should COC concentrations fall below the chemical-specific ARARs, groundwater monitoring would cease. Each groundwater monitoring well would be maintained over the entire duration of the remedy and replaced as necessary to provide continuous service.

4.4.4.2 Evaluation of Screening Criteria

A summary of the screening criteria evaluation with respect to each of the applicable sites is presented in **Table 4-5**.

Overall Protection of Human Health and the Environment

This alternative provides protection of the human health through the implementation of groundwater ICs, primarily through groundwater use restrictions. Metals concentrations are expected to decrease during the LTM period, and will achieve groundwater and surface water SCLs during that period.

Compliance with ARARs

The response action of LTM and ICs will remain in place until the ARAR is achieved. LTM data is expected to show continued decreases of COC concentrations, and sampling will cease once concentrations reduce below LOCs or stabilize near the SCL. Action-specific ARARs associated with groundwater sampling and analysis will be complied with during the remedial action.

Long-Term Effectiveness and Permanence

The long-term effectiveness of this alternative is poor because the magnitude of the residual groundwater risk would remain unchanged. The long-term effectiveness and permanence of this alternative GW-2 would be afforded through continuous implementation and enforcement of ICs, particularly the groundwater use restrictions.

Reduction of Toxicity, Mobility, and Volume through Treatment

This alternative does not employ any treatment that would reduce the toxicity, mobility, or volume of COCs in groundwater.

Short-Term Effectiveness

Implementation of this alternative does not pose any additional risks to the community, the workers, or the environment since there are no active remedial actions.

Implementation

There are no implementability concerns posed by this remedy.

Cost

The total present worth cost for Alternative GW-2 is approximately $62,100, including $0 in capital costs and $62,100 in operation and maintenance during the assumed 30-year monitoring timeframe. Detailed costs are provided in **Appendix E** of this volume.

4.4.5 Mass Removal Pump and Treat Long-Term Groundwater Monitoring, and ICs

Removal of metals through pump and treat is not commonly practiced due to the affinity of metals for soil particles. Pumping tends to be a costly method and in the case of lead and arsenic it is likely that the removal efficiency will be low and rebound is likely after pumping is stopped. Once the groundwater is removed treatment can be performed in a number of different ways. Arsenic can be removed through use of an iron oxide bed, coagulation/flocculation, and anion exchange. Lead can be removed though coagulation/flocculation, oxidation/filtration and ion exchange. The treatment train would have to be chosen based on treatability testing on water collected from the site. For costing purposes in this FS oxidation/filtration is the methodology selected.

Alternative 109/203GW-3 would involve: 1) implementation of pump and treat (P&T) using chemical oxidation, filtration and granular activated carbon for ex-situ treatment of the lead and arsenic contaminated groundwater at PICA-111; 2) long-term groundwater monitoring would be implemented to assess the effectiveness of the mass removal; and, 3) continued implementation of ICs would be implemented to ensure the remedial action objectives are met while the treatment is being performed. Treated water from the P&T system would be discharged to Green Pond Brook.

4.4.5.1 Description of Alternative

The extraction system was designed to capture the flow of all shallow groundwater within the Site 109 and PICA-203 Area of Attainment. The groundwater model TWO-DAN was utilized to simulate various pumping scenarios in the AA shallow aquifer, and to determine an extraction rate. Since no pump tests have been conducted for the groundwater at the PICA-111 sites, site slug test hydraulic conductivity data was used in the model. Other key groundwater model inputs included average groundwater flow direction and horizontal gradient data. Green Pond Brook lies adjacent the NW corner of the AA, and was set up as a constant head boundary in the model.

A number of extraction scenarios were simulated in order to optimize groundwater capture and pumping rate. A two extraction well configuration demonstrated the most efficient capture of the AA groundwater at 56 GPM, and targeted concentrations of lead and arsenic in nearby monitoring wells 109MW-1 and 109MW-3. **Figure 4-5** shows the projected aquifer drawdown in relation to the AA and impacted monitoring wells. System extraction wells would capture all AA and adjacent groundwater, including those areas lying adjacent to Green Pond Brook. System extraction wells would lower the local water table and induce recharge from adjacent Green Pond Brook, ensuring the capture of impacted groundwater in those areas.

A conceptual layout of the extraction wells, piping, and treatment facility are presented on **Figure 4-5**. Two-inch PVC piping at a depth of 18 to 24 inches bgs, below the frost zone, will connect the wells to the treatment areas. If this alternative is chosen, a pump test will be conducted to determine the achievable pumping rates, ROIs, and drawdown levels. The pump and treat system would be operated for a period of approximately fifteen years at a total groundwater extraction rate of 56 GPM. This would result in the extraction and treatment of over 441 million gallons of contaminated groundwater over the duration of the system operation. The 15 year timeframe has been established as a budgetary benchmark. It is likely, due to the low concentrations of lead and arsenic at the site levels would attenuate in a shorter time period. There is currently insufficient data to calculate an attenuation timeframe. Groundwater concentrations of lead and arsenic are likely to be reduced through pumping however; because groundwater pump and treat is inefficient in removing metals it is likely that rebound would occur when pumping is ceased and the overall remedial timeframe will likely be the same as through attenuation alone.

The following details the planning and implementation components of Alternative GW-3.

<u>ICs, Planning, and Permitting</u>

Refer to the descriptions of ICs for the Alternative GW-2 in the previous section (Section 4.4.4.1), since the same IC components would be implemented under this alternative.

<u>Site Preparations</u>

In order to implement the pump and treat alternative, some modifications to the site will be required. Wells will be installed and a temporary building will be constructed to house the treatment system. Clearing, grubbing, and excavation would be conducted to prepare areas where wells, piping, and equipment would be constructed. A total cost for clearing this area is presented in **Appendix E**. Excavated material generated during the drilling of extraction and monitoring wells will be sampled, analyzed, and reused on base or transported and disposed in a non-hazardous waste construction debris landfill pending analytical results. Excavated material generated during trenching for piping installation will be backfilled or reused on-base following appropriate sampling and analysis.

<u>Installation of P&T System</u>

The system would be of prefabricated design and could be housed in a prefabricated structure on a pad to be constructed at the site. Technical and construction oversight would be required prior to and during the installation of the P&T system. In addition, while the P&T system is being installed, a field engineer and a construction supervisor would be required on site.

The following list describes the construction components of the P&T system. For cost estimating purposes, the specifications of these components are simplified.

- Construction of a total of two groundwater extraction wells to be located at PICA-111. These wells would be constructed of 6-inch diameter PVC pipes to a depth of approximately 40 ft. Construction of approximately 500 ft of piping and manifold. These piping networks would be constructed underground using 2-inch diameter PVC and associated fittings.
- Construction of treatment pads and buildings to house the ex-situ treatment system.
- Construction of an ex-situ treatment system consisting of mixing tank for the addition of oxidant (e.g. hydrogen peroxide), settling tanks, bag filter and liquid granular activated carbon (LGAC) filtration units to act as a final groundwater polishing step after treatment for metals.

Additional costs for the P&T system would include the performance of a pump test to determine the required extraction rates, ROIs, and optimum operating conditions for the ex-situ treatment system. Also included in the cost of this alternative are insurance, bonds, and a contingency factor. A treatability test would also be required to select the treatment processes.

O&M of the Pump and Treat System

The P&T system would be operated for approximately fifteen years. The O&M activities for the P&T system would be carried out by a plant operator 8 hours per week, 52 weeks per year. A second operator will be at the plant for 5 hours per month to assist with the sampling and intrusive repairs. The O&M activities would include replenishing the chemical feed system, changing filter media, periodic back flushing of the carbon units and spent carbon change out, and maintenance of pumps and instruments. Treatment system operation will include monthly discharge monitoring of the effluent to GPB as well as the submission of monthly discharge monitoring reports to be submitted to the NJDEP. Sampling and off-site disposal of sludge generated as part of the treatment system will also be required.

Long-Term Monitoring

The long-term groundwater monitoring would be designed to monitor the system performance and ensure that the plume characteristics are not changing, no new source areas are apparent, regulatory levels are being met, and the plume as a whole is acting as predicted. A total of two monitoring wells would be included in the long term monitoring program. All groundwater samples will be analyzed for lead and arsenic. Dissolved oxygen and other field parameters, such as temperature, ORP, and pH would also be included in the groundwater analysis. These parameters ensure monitoring of the plume for regulatory compliance. All quality control sample analysis (field duplicates, rinse blanks, trip blanks) are assumed to be 20% of the total number of samples collection.

Additional parameters may be required for the treated water samples as specified in the NJPDES permit to determine compliance with the discharge criteria.

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.

For the first 2 years of sampling and once every 5 years until the end of remediation, formal sampling and analysis reports would be written. There will be one closeout report and Statistical Proof of Compliance submitted to the regulatory agency at the end of the remediation period. In order to comply with CERCLA, 5-year reviews will be conducted at the site. Reports detailing the findings of the reviews will be generated.

4.4.5.2 Evaluation of Screening Criteria

Overall Protection of Human Health and the Environment

The treatment proposed under Alternative GW-3 will temporarily reduce contaminant concentrations to SCLs. However it is expected that groundwater concentrations will rebound and the overall treatment timeframe for mass extraction pump and treat is believed to be similar to long term monitoring. Thus, the risk to human health and the environment for this alternative will be minimized mainly by land use controls and institutional controls.

Compliance with ARARs

The remediation components of Alternative GW-3 would involve standard construction practices; therefore, compliance with action-, location-, and chemical-specific ARARs is expected.

Long-Term Effectiveness and Permanence

The long-term effectiveness of this alternative is poor because the magnitude of the residual groundwater risk would remain largely unchanged. The long-term effectiveness and permanence of this alternative GW-3 would be afforded through continuous implementation and enforcement of ICs, particularly the groundwater use restrictions.

Reduction in Toxicity, Mobility, and Volume through Treatment

All three components of this criterion will be satisfied by this alternative. Treating the areas of maximum groundwater contamination will reduce lead and arsenic concentrations in groundwater, therefore reducing toxicity, mobility, and volume. However, it is likely that groundwater rebound will be a factor after pumping ceases.

Short-Term Effectiveness

As previously discussed, under Alternative GW-3, concentrations of COCs in groundwater would remain above the SCLs for an extended period of time. Furthermore, implementation of this alternative would involve potential exposure risks of contaminated soil and vapor to the workers during the construction of the P&T systems, such as the treatment area, the extraction wells, and the piping system. However, these risks could be significantly reduced through the use of proper personal protection and field techniques.

Implementability

All of the additional equipment for this option, such as extraction pumps, drilling equipment for additional wells, etc., is industry standard. Installation of extraction wells is standard in the groundwater remediation field as well. Continuous O&M is required for the time period during which the P&T system would be operated.

Cost

Capital costs for this alternative include ICs, site preparation, planning, permitting, and reporting, construction of the piping and treatment systems, and well installation. The O&M costs are based on operating the P&T system for 30 years, sampling, analysis, and monitoring at the plant and in the groundwater. **Appendix E** presents the detailed cost calculations for Alternative GW-3. The total estimated present worth cost for Alternative GW-3 is $2,204M, including $922K in capital costs and $1.281M in O&M costs over the 15-year treatment and monitoring timeframe.

4.4.6 Comparative Analysis of RAs

4.4.6.1 Site 109

All of the alternatives except no action meet the threshold criteria of overall protection of human health and the environment and compliance with ARARs. Excavation and off-site disposal of COCs above SCLs in soil provides marginally better long-term effectiveness and permanence and reduction of mobility through transfer of contaminated soil to a disposal facility, while short-term effectiveness, implementability, and cost favor maintenance of existing ECs and ICs. Based on the comparative

analysis of RAs, the preferred RA for Site 109 is **Alternative 109-2 (LUCs and Maintenance of Existing ECs)**.

4.4.6.2 Site 125

There is no unacceptable risk associated with Site 125 nor are there any exceedences of NJDEP ISRS. Therefore, no RAOs were necessary for the site and no AAs were established. No RAs were assembled, so therefore no comparative analysis of RAs is necessary. However, based on comparison to USEPA Residential RSLs, there are exceedences of residential standards. Based on these exceedences, use of the site should be restricted to ensure that the currently-protective land use continues.

4.4.6.3 Site 142

All of the alternatives except no action meet the threshold criteria of overall protection of human health and the environment and compliance with ARARs. Excavation and off-site disposal of COCs above SCLs in soil provides marginally better long-term effectiveness and permanence and reduction of mobility through transfer of contaminated soil to a disposal facility, while short-term effectiveness, implementability, and cost favor maintenance of existing ECs and ICs. Based on the comparative analysis of RAs, the preferred RA for Site 142 is **Alternative 142-2 (LUCs and Maintenance of Existing ECs)**.

4.4.6.4 Site 144

There is no unacceptable risk associated with Site 144 nor are there any exceedences of NJDEP ISRS. Therefore, no RAOs were necessary for the site and no AAs were established. No RAs were assembled, so therefore no comparative analysis of RAs is necessary. However, based on comparison to USEPA IRSLs, there are exceedences of industrial standards. Based on these exceedences, use of the site should be restricted to ensure that the currently-protective land use continues.

4.4.6.5 Site 146

There is no unacceptable risk associated with Site 146 nor are there any exceedences of NJDEP ISRS. Therefore, no RAOs were necessary for the site and no AAs were established. No RAs were assembled, so therefore no comparative analysis of RAs is necessary. However, based on comparison to USEPA IRSLs, there are exceedences of industrial standards. Based on these exceedences, use of the site should be restricted to ensure that the currently-protective land use continues.

4.4.6.6 PICA-203

The AAs for soil at PICA-203 were combined with Site 109.

4.4.6.7 Site 109/PICA-203 Groundwater Area of Attainment

The RAs evaluated for the groundwater AA were no action, LTM/LUCs, and Mass Extraction Groundwater Pump and Treat. No action did not meet the threshold criteria for overall protection of human health and the environment and compliance with ARARs. LTM/LUCs did meet the threshold criteria primarily through LUCs. The implementation of LUCs will ensure that human contact with groundwater from Site 109/PICA-203 will not occur. The combination of the CEA and interlocking LUC measures in place at Picatinny will ensure that no groundwater use takes place at the site. Mass Extraction Groundwater Pump and Treat will remove mass from the soluble portion of the plume. However since lead and arsenic preferentially adhere to soil particles the efficiency of this alternative is poor. Protection of human health attained as part of this remedial alternative will be primarily derived from LUCs. Based on a comparative analysis of RAs, the preferred RA for Site 109/PICA-203 Groundwater AA is **Alternative 109/203GW-2 (LTM and LUCs for Groundwater)**.

Table 4-5
Comparative Analysis of Remedial Alternatives

Site ID	Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-Term Effectiveness	Implementability	Cost
BASELINE COST FOR MAINTENANCE AND ENFORCEMENT OF LAND USE CONTROLS AT SITES 109, 125, 142, 144, 146 & PICA-203								**$69K**
Site 109	Alternative 109S-1: No Action	Limited – Existing ECs	Does Not Address RAOs or SCLs	Poor	No Reduction	RAOs Would Not Be Achieved	Readily Implemented	$0.00
	Alternative 109S-2: LUCs and Maintenance of Existing ECs	**Effective for Human Health by Ensuring ECs Are Maintained; No Unacceptable Ecological Risk Identified.**	**Addresses RAOs for Potential Exposure to COCs above SCLs**	**Risks Are Manageable with ECs and LUCs**	**No Reduction; Toxicity, Mobility, and Volume Are Minimal**	**No Additional Risk to Community; RAOs Achieved**	**Readily Implemented**	**$26K**
	Alternative 109S-3: Excavation of Soil with Concentrations above SCLs and Off-Site Disposal	Protective of Human Health Receptors; No Unacceptable Ecological Risk Identified	Meets RAOs through Removal of COCs above SCLs	Effective and Reliable	Complete Reduction at the Site; However Transferred to Disposal Facility.	Elevated Risk Easily Mitigated; RAOs Achieved in Short Term	Standard Practices	$1,532K
Site 142	Alternative 142S-1: No Action	Limited – Existing ECs	Does Not Address RAOs or SCLs	Poor	No Reduction	RAOs Would Not Be Achieved	Readily Implemented	$0.00
	Alternative 142S-2: LUCs and Maintenance of Existing ECs	**Effective for Human Health by Ensuring ECs Are Maintained; No Unacceptable Ecological Risk Identified.**	**Addresses RAOs for Potential Exposure to COCs above SCLs**	**Risks Are Manageable with ECs and LUCs**	**No Reduction; Toxicity, Mobility, and Volume Are Minimal**	**No Additional Risk to Community; RAOs Achieved**	**Readily Implemented**	**$26K**
	Alternative 142S-3: Excavation of Soil with Concentrations above SCLs and Off-Site Disposal	Protective of Human Health Receptors; No Unacceptable Ecological Risk Identified	Meets RAOs through Removal of COCs above SCLs	Effective and Reliable	Complete Reduction at the Site; However Transferred to Disposal Facility.	Elevated Risk Easily Mitigated; RAOs Achieved in Short Term	Standard Practices	$85K

Table 4-5 (Continued)
Comparative Analysis of Remedial Alternatives

Site ID	Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-Term Effectiveness	Implementability	Cost
Site 109 and PICA-203 Groundwater	Alternative 109/209GW-1: No Action	Limited – Existing Institutional Controls	Does Not Address RAOs or SCLs	Poor	No Reduction	RAOs Would Not Be Achieved	Readily Implemented	$0.00
	Alternative 109/203GW-2: LUCs and LTM of Groundwater	**Effective for Human Health by Ensuring ICs Are Maintained; No Unacceptable Ecological Risk Identified.**	**Addresses RAOs for Potential Exposure to COCs above SCLs**	**Risks Are Manageable with ICs and LUCs**	**No Reduction; Toxicity, Mobility, and Volume Are Minimal**	**No Additional Risk to Community; RAOs Achieved**	**Readily Implemented**	**$62K**
	Alternative 109/203GW-3: Mass Removal Groundwater Pump and Treat	**Effective for Human Health by Ensuring ICs Are Maintained; No Unacceptable Ecological Risk Identified.**	**Addresses RAOs for Potential Exposure to COCs above SCLs**	**Risks Are Manageable with ICs and LUCs**	**Limited Reduction; Toxicity, Mobility, and Volume**	**Additional risk to on site workers during construction and operation; RAOs Achieved**	**Readily Implemented**	**$2,204K**

Figure 4-1: Nine Criteria for Detailed Analysis of Remedial Alternatives

THRESHOLD CRITERIA

1 Overall Protection of Human Health and the Environment

- How the Alternative Provides Human Health and Environmental Protection

2 Compliance with ARARs (or justification of a Waiver)

- Compliance with Chemical-Specific ARARs
- Compliance with Location-Specific ARARs
- Compliance with Action-Specific ARARs
- Compliance with Other Criteria, Advisories, and Guidance (TBC Guidance)

PRIMARY BALANCING CRITERIA

3 Long-Term Effectiveness and Permanence

- Magnitude of Residual Risk
- Adequacy and Reliability of Controls

4 Reduction of Toxicity, Mobility, or Volume through Treatment

- Treatment Process used and Materials Treated
- Amount of Hazardous Materials Destroyed or Treated
- Degree of Expected Reductions in Toxicity, Mobility or Volume
- Degree to which Treatment is Irreversible
- Type and Quantity of Residuals Remaining after Treatment

5 Short-Term Effectiveness

- Protection of Community during Remedial Actions
- Protection of Workers during Remedial Actions
- Environmental Impacts
- Time Unit Remedial Action Objectives are Achieved

6 Implementability

- Ability to Construct and Operate the Technology
- Reliability of the Technology
- Ease of Undertaking Additional Remedial Actions, if necessary
- Ability to Monitor Effectiveness of Remedy
- Coordination with Other Agencies
- Availability of Off-Site Treatment, Storage and Disposal Services, and Capacity
- Availability of Necessary Equipment, Materials, and Specialists
- Availability of Prospective Technologies

7 Cost

- Estimated Capital Costs
- Estimated Annual Operation and Maintenance Costs
- Estimated Present Worth Costs

MODIFYING CRITERIA[1]

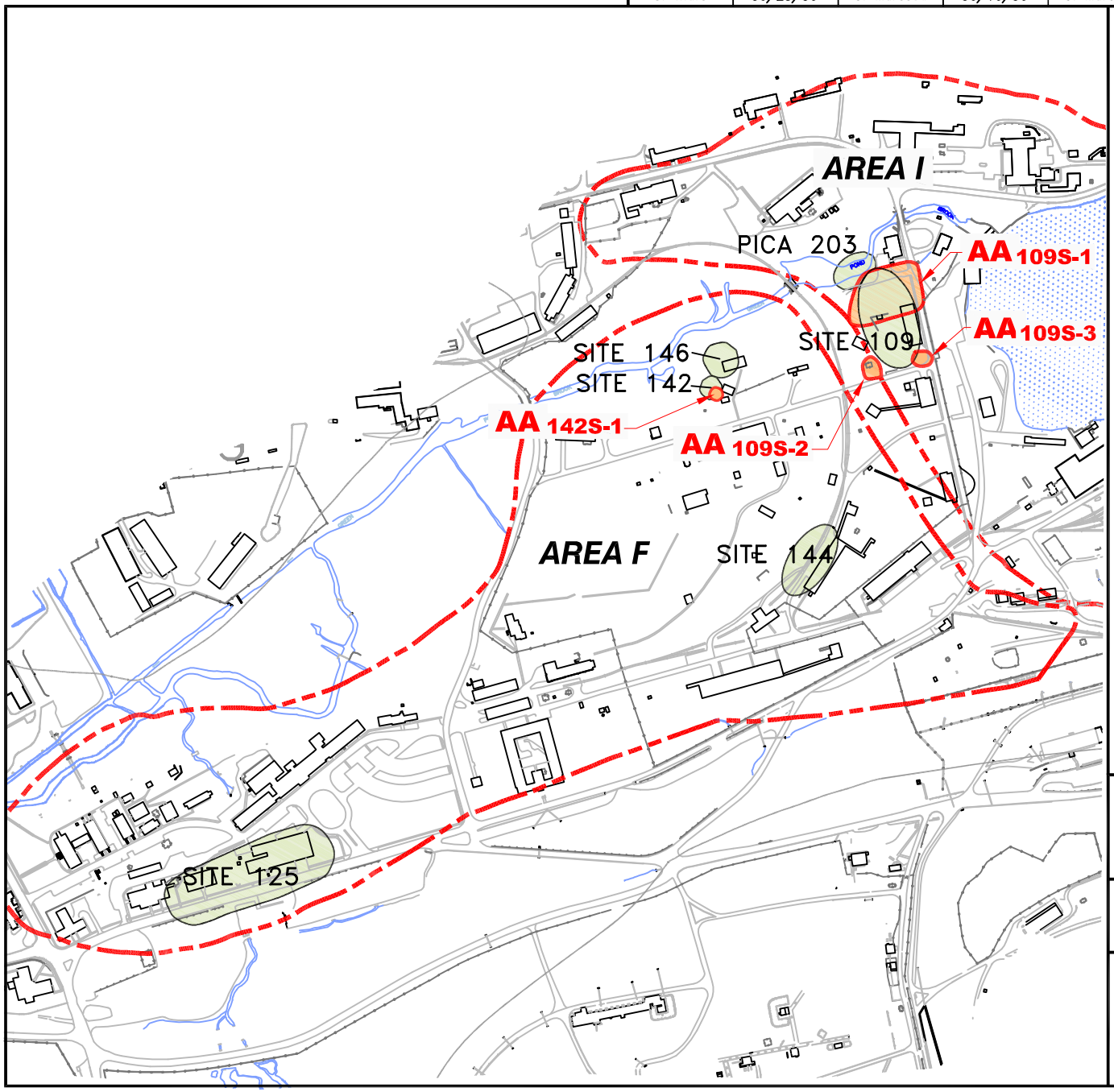
8 State Acceptance

9 Community Acceptance

[1]These criteria are fully assessed following comment on the RI/FS Report and the Proposed Plan, and will be fully addressed in the ROD.

File: N:\cad\CAD drawings\Picatinny\Area-F\F011410.dwg
Plot Date/Time: Jan 15, 2010 - 10:37am
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER	F011410.dwg
S. Wiafe	06/23/06	G. Maresca	06/16/06	G. Maresca	06/23/06		



LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER
- SANITARY SEWER
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER/POND
- PAVED ROADWAY
- UNPAVED ROADWAY
- SITE ADDRESSED IN FEASIBILITY STUDY
- AREAS OF ATTAINMENT

SCALE

0 500 1,000 Ft.

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

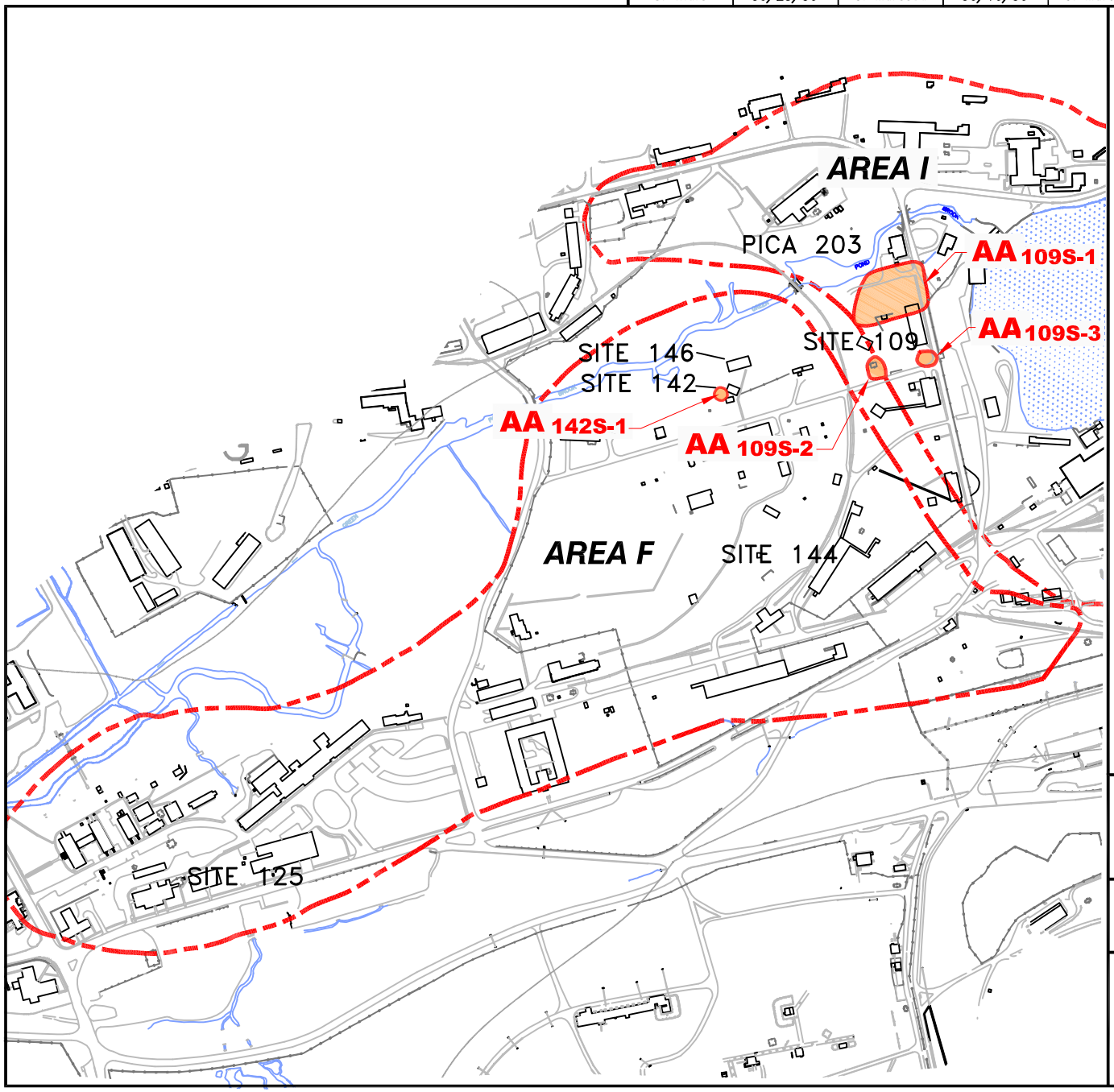
FIGURE NO. 4-2

LUCs AND EXISTING EC's IMPLEMENTATION AREAS

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

File: N:\cad\CAD drawings\Picatinny\Area-F\F011410.dwg
Plot Date/Time: Jan 15, 2010 - 10:33am
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
S. Wiafe	06/23/06	G. Maresca	06/16/06	G. Maresca	06/23/06	F011410.dwg



LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER
- SANITARY SEWER
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER/POND
- PAVED ROADWAY
- UNPAVED ROADWAY
- AREAS OF ATTAINMENT

SCALE

0 500 1,000 Ft.

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

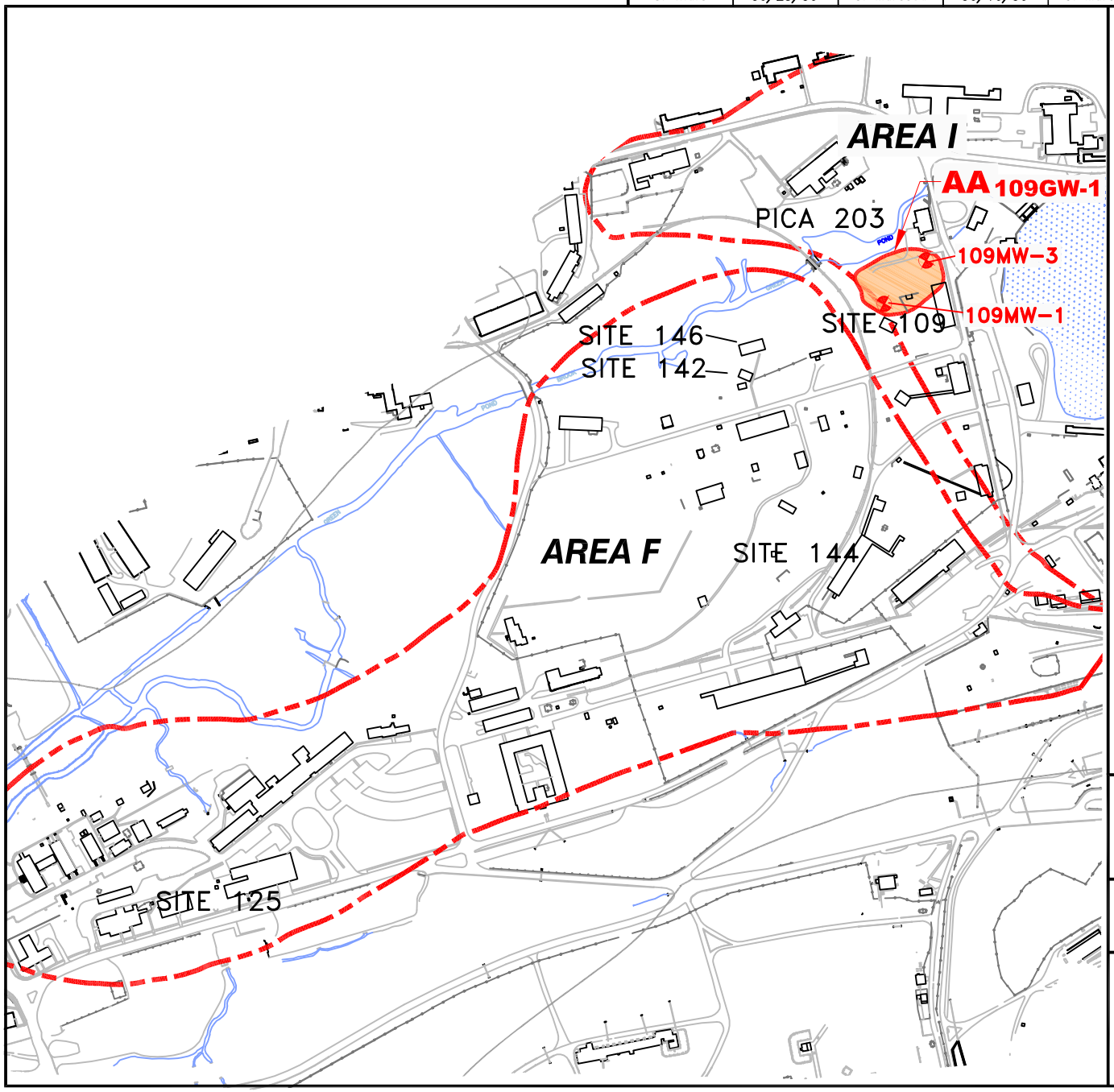
FIGURE NO. 4-3

EXCAVATIONS AND DISPOSAL IMPLEMENTATION AREAS

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY

File: N:\cad\CAD drawings\Picatinny\Area-F\F011410.dwg
Plot Date/Time: Jan 15, 2010 - 10:39am
Plotted By: stephen.Wiafe

DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER	F011410.dwg
S. Wiafe	06/23/06	G. Maresca	06/16/06	G. Maresca	06/23/06		



LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER (TR-732)
- BLAST WALL
- STORM SEWER
- SANITARY SEWER
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER/POND
- PAVED ROADWAY
- UNPAVED ROADWAY
- GROUNDWATER MONITORING WELLS PROPOSED FOR LTM
- AREAS OF ATTAINMENT

SCALE

0 500 1,000 Ft.

Picatinny Arsenal Installation Restoration Program

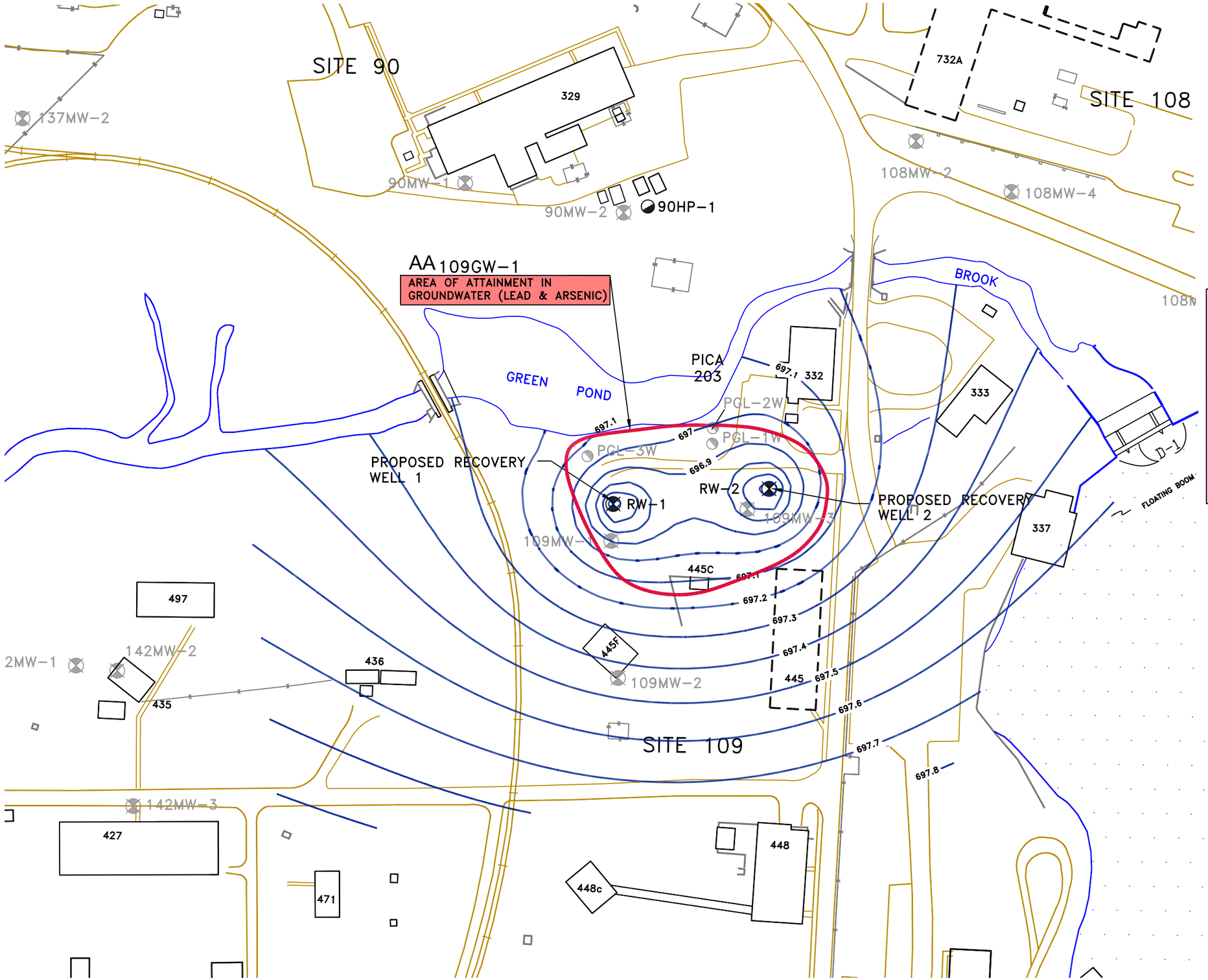
U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE NO. 4-4

GROUNDWATER MONITORING WELLS PROPOSED FOR LTM

FS FOR SITES 109, 125, 142, 144, 146 & PICA 203
PICATINNY ARSENAL, DOVER, NEW JERSEY



LEGEND

- RAILROAD
- TREE LINE
- FENCE
- TRANSFORMER
- BLAST WALL
- STORM SEWER
- SANITARY SEWER
- EARTH MOUND
- BUILDING
- FORMER BUILDING
- COVERED WALKWAY
- SWAMP
- WATER
- 10' SURFACE CONTOUR
- GROUNDWATER CONTOURS
- PAVED ROADWAY
- UNPAVED ROADWAY
- MONITORING WELL
- HYDROPUNCH
- AREA OF ATTAINMENT

SCALE

0 100 200 FEET

Picatinny Arsenal Installation Restoration Program

U.S. Army Corps of Engineers

Shaw Environmental, Inc.

FIGURE 4-5

GROUNDWATER PUMP AND TREAT REMEDIAL ALTERNATIVE

PICA-111 SITES
PICATINNY ARSENAL, DOVER, NEW JERSEY

DRAWING NUMBER	53041510-BobDemoth.dwg
APPROVED BY	-- --
CHECKED BY	B. Demott 04/19/10
DRAWN BY	S. Wiafe 04/19/10

File: N:\cad\CAD drawings\Picatinny\Area-1\site53\PHASE2RISITEMAP\53041510-BobDemoth.dwg
Plot Date/Time: Apr 23, 2010 - 3:28pm
Plotted By: stephen.Wiafe

5.0 REFERENCES

Argonne National Laboratory (ANL), 1991. *Remedial Investigation Concept Plan for Picatinny Arsenal.* Prepared for U.S. Army Toxic and Hazardous Material Agency (2 volumes).

Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISQGs) as presented in the Canadian Environmental Quality Guidelines. 2002.

Dames and Moore, 1989. *Site Investigation Report – Picatinny Arsenal, New Jersey.* Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland.

Dames and Moore, 1995. *Draft Preliminary Assessments for Non-RI Buildings in Phase I Study Areas.* Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland.

Dames and Moore, 1998. *Draft Final Phase I Remedial Investigation Report – Picatinny Arsenal, New Jersey.* Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland.

Eby, C.F., 1976. *Soil Survey of Morris County, New Jersey*, U.S. Department of Agriculture, Soil Conservation Services.

Foster Wheeler, 1991. *ARDEC Discharge Investigation Project Report, Volumes I – IV*. U.S. Army Armament Research, Development, and Engineering Center (ARDEC).

Gill, H.E. and J. Vecchioli, 1985. *Availability of Groundwater in Morris County, New Jersey*, New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply Special Report 25.

IT Corporation (IT), 2000. *Phase II Ecological Risk Assessment, Remedial Investigation/Feasibility Study, Picatinny Arsenal, New Jersey.* Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. February 2000. Draft Final.

IT, 2001a. *Picatinny Arsenal Phase III-1A Human Health Risk Assessment Approach*. Prepared for the U.S. Army Corps of Engineers, Baltimore District, TERC Number DACA31-95-D-0083, April 2001.

IT, 2001. *Green Pond Brook and Bear Swamp Brook Focused Feasibility Study*. Prepared for U.S. Army Corps of Engineers – Baltimore District. Contract No. DACA-31-95-D-0083. May 2001. Final.

IT, 2002. *Picatinny Arsenal Facility-Wide Background Investigation*. Prepared for U.S. Army Corps of Engineers – Baltimore District. Contract No. DACA-31-95-D-0083. May 2002. Final.

Jones, D.S. and Suter, G.W., 1997. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects of Sediment-Associated Biota*: 1997 Revision. Prepared for the U.S. Department of Energy by Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-95/R4.

Lacombe, P. et al., 1986. *Determination of Geohydrologic Framework and Extent of Ground-Water Contamination Using Surface Geophysical Techniques at Picatinny Arsenal, New Jersey*, U.S. Geological Survey Water Resources Investigation Report 86-4051.

Long, E.R. and Morgan, L.G., 1990. *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program.* National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Seattle, Washington.

Long, E.R., MacDonald, D.D., Smith, S.L., and Calder, F.D., 1995. *Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments.* Environmental Management 19(1): 81-97.

National Oceanic and Atmospheric Administration (NOAA), 1982. *Monthly Normals of Temperature, Precipitation, and Heating and Cooling Days, 1951-80, New Jersey*, in Climatography of the United States, No. 81.

New Jersey Department of Environmental Protection (NJDEP), 1998. *Guidance for Sediment Quality Evaluations*, November 1998.

New Jersey Department of Environmental Protection (NJDEP), 2006. *Field Sampling Procedures Manual*. Bureau of Environmental Measurements and Quality Assurance.

New Jersey Department of Environmental Protection (NJDEP), 2009a. *Technical Requirements for Site Remediation.* Site Restoration Program. Updated November 4, 2009.

NJDEP, 2009b. *Soil Remediation Standards*. N.J.A.C. 7:26D, Date last amended November 4, 2009.

New York State Department of Environmental Conservation (NYSDEC), 1999. *Technical Guidance for Screening Contaminated Sediments.* Division of Fish and Wildlife.

Office of the Deputy under Secretary of Defense (ODUSD), 1995. *Revised Draft Relative Risk Site Evaluation Primer.* November 1995.

Persaud, D., R. Jaagumagi, and A. Hayton, 1993. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.* Ontario Ministry of the Environment, Ottawa, Ontario. ISBN 0-7729-9248-7.

Shaw, 2005a. *Phase I 2A/3A Sites Remedial Investigation Report.* Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. January 2005. Final.

Shaw, 2005b. *Phase II Remedial Investigation Report, Rounds 1 and 2, Volume 1.* Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. November 2005. Final.

Shaw, 2005c. *Phase III & Phase I 2A/3A Sites Screening Level Ecological Risk Assessment.* Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. June 2005. Final.

Shaw, 2005d. *Lead Removal Action Data Report*. Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. October 2005. Draft Final.

Shaw, 2005e. *Report on the Investigation of Sumps and Dry Wells with Previously Identified COCs at Various Sites*. Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. June 2005. Draft Final.

Shaw, 2005f. *Mid-Valley Groundwater Feasibility Study.* Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. September 2005. Draft.

Shaw, 2006a. *Phase II Remedial Investigation Report, Rounds 1 and 2, Volume 3 – Area I Remaining Sites.* Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. May 2006. Final.

Shaw, 2006b. *Phase III & Phase I 2A/3A Sites Baseline Ecological Risk Assessment.* Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. March 2006. Draft Final.

Sims, P.K., 1958. *Geology and Magnetite Deposits of the Dover District, Morris County, New Jersey*, U.S. Geological Survey Professional Paper 287.

U.S. Army Armament, Munitions, and Chemical Command (USAAMC), 1993. *Environmental Baseline Study for Picatinny Arsenal.*

U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), 1998. Relative Risk Site Evaluation No. 38-EH-569097, Picatinny Arsenal, New Jersey, June, August, and December 1997. Prepared for U.S. Army Armament, Research, Development, and Engineering Center, Picatinny Arsenal.

U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), 1976. *Installation Assessment of Picatinny Arsenal*, Report No. 102 (2 vols.).

U.S. Environmental Protection Agency (USEPA), 1985. *Handbook – Remedial Action at Waste Disposal Sites. EPA/625/G-85/005.* Hazardous Waste Engineering Research Laboratory, Office of Research and Development, Cincinnati, OH, 1985.

U.S. Environmental Protection Agency (USEPA), 1988a. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.* Interim Final. EPA/540/G-89/004.

U.S. Environmental Protection Agency (USEPA), 1988b. CERCLA Compliance with Other Laws Manual. Interim Guide. Part I, OSWER Directive 9234.1001. Office of Emergency and Remedial Response, Washington, D.C.

USEPA, 1989a. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual*. Part A. Interim Final. USEPA/540/1-89/002. December 1989.

USEPA, 1990. *National Oil and Hazardous Substances Pollution Contingency Plan*. Fed. Reg. 55:8666-

USEPA, 1995. *Land Use in CERCLA Remedy Selection Process*. OSWER Directive 9355.7-04. May.

USEPA, 1996. *Soil Screening Guidance: Technical Background Document.* Prepared by the Office of Emergency and Remedial Response. EPA/540/R-95/128. May.

U.S. Geological Survey (USGS), 1993. *Hydrogeology and Simulation of Groundwater Flow at Picatinny Arsenal and Vicinity, Morris County, New Jersey*. Water-Investigations Report 93.

Vowinkel, E.F. et al., 1985. *Preliminary Evaluation of Groundwater Contamination at Two Wastewater Treatment Facilities at Picatinny Arsenal, Morris County, New Jersey*, NJ, U.S. Geological Survey, Water Resources Investigation 85.

Weston, 1991. *Technical Reports/Closure Certifications/Environmental Remedial Actions at Picatinny Arsenal.*