Record of Decision (ROD) for Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU)

Prepared for:
U.S. Army Corps of Engineers
Omaha, Nebraska

Prepared by:
Environmental Science & Engineering, Inc.
St. Louis, Missouri

ESE Project No. 592-1139-4300

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DECLARATION

Selected Remedial Alternative for the Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Areas Operable Unit

Site Name and Location

This Record of Decision (ROD) has been prepared for the Crab Orchard National Wildlife Refuge (NWR) Explosives/Munitions Manufacturing Areas (EMMA) Operable Unit (OU). The Crab Orchard NWR is located approximately 5 miles west of Marion, Illinois. The EMMA OU consists of 15 individual sites. These sites are grouped into three discrete areas: ten sites are located in the Crab Orchard Cemetery (COC) area, so named due to the proximity of Hampton Cemetery; four of the sites are located in the Crab Orchard Plant (COP) area, near the Group II load line and the former Ammonium Nitrate Plant; and one site is located in the explosives compounds storage bunker area.

Statement of Basis and Purpose

This ROD presents the selected response actions for the EMMA OU that were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This ROD explains the factual and legal basis for selecting the response actions for the EMMA OU. The information supporting this remedial action decision is contained in the Administrative Record (AR) for the EMMA OU, an index to that AR is included as Appendix B.

The content of this ROD is in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and other U.S. Environmental Protection Agency (USEPA) guidance listed in the AR index (Appendix B).

Assessment of the Sites

Based on the findings of the Remedial Investigation (RI) Report (1994) for the EMMA OU prepared by Environmental Science & Engineering, Inc. (ESE), soil, sediment, surface water, and groundwater have been affected at 13 of the 15 sites (Sites COC-1 through COC-10, COP-1 through COP-4, and Bunker 1-3) in the EMMA OU. The sites contain metals and nitroaromatic compounds in various media above background concentrations.

The results of the Baseline Risk Assessment (BRA) concluded that conditions at Sites COC-1, COC-2, COC-5, COC-7, COC-8, COC-9, COC-10, COP-1, COP-2, COP-3, and Bunker 1-3 do not pose an unacceptable potential risk to human health and the environment. A potential for

unacceptable risk was indicated at Site COC-6. However, this potential unacceptable risk at Site COC-6 is based on an exposure scenario that is extremely unlikely. Therefore, no further action is recommended at these sites.

The BRA indicated that Sites COC-3 and COP-4 pose a potential unacceptable risk to human health due to elevated levels of nitroaromatic compounds and metals in the soils. Additionally, potential ecological risks are associated with these two sites. From the receptors evaluated, potential ecological risks to the white-tailed deer, small mammal, and bobwhite quail are identified. Actual or threatened releases of hazardous substances from Sites COC-3 and COP-4, if not addressed by implementing the response action selected in this ROD, may present potential current or future risks to public health, welfare, and the environment.

The BRA indicated that Site COC-4 poses a potential ecological risk to the bobwhite quail, while not posing any unacceptable risk to human health. Ecological risks associated with Site COC-4 are several orders of magnitude lower than the estimated potential risks at Sites COC-3 and COP-4, and will be further evaluated in order to avoid the application of order-of-magnitude uncertainty factors that result in risks being overestimated. Therefore, this ROD does not include a selected remedy (either remediation or no further action) for Site COC-4.

Description of the Selected Remedy

The refuge is currently divided into five separate OUs, managed by different lead agencies. The OUs are the Polychlorinated Biphenyls Area (PCB) OU, the Metals Area (MA) OU, the EMMA OU, the Miscellaneous Area (MISCA) OU, and the Water Towers OU. This ROD addresses the final remedy for EMMA OU Sites COC-3 and COP-4. The remedial actions determined to be necessary at Sites COC-3 and COP-4 are:

- Excavation and offsite treatment (offsite incineration) and disposal of soils containing levels of nitroaromatic compounds greater than 100,000 milligrams per kilogram (mg/kg), and lead greater than 450 mg/kg;
- Additional removal of RDX/HMX contaminated soil at Site COP-4 to a depth of two feet below grade within the existing fenced area. Excavated soils will be disposed of at an offsite permitted special waste landfill;
- Sampling to ensure that remaining affected soils (i.e., soils with contaminants above remediation goals) at Sites COC-3 and COP-4 do not exhibit the characteristics of a RCRA hazardous waste for lead and 2,4-DNT;
- Backfill excavated areas to shape the base of the covers;
- Placing 24-inch clean soil covers over the remaining affected soils at Sites COC-3 and COP-4;
- Long-term maintenance of the soil covers for a period of up to 30 years;

- Implementation of land use controls at Sites COC-3 and COP-4; and
- Groundwater monitoring.

The land use controls to be implemented at Sites COC-3 and COP-4 include restriction of the following activities: groundwater well installation; subgrade activities; and pond creation within the perimeter of the soil covers on Sites COC-3 and COP-4.

Statutory Determinations

The selected remedy for Sites COC-3 and COP-4 is protective of human health and the environment, complies with federal and state environmental requirements that are legally applicable or relevant and appropriate to the remedial action, and is the least costly among alternatives providing equal levels of protection. This remedy uses permanent solutions to the maximum extent practicable for Sites COC-3 and COP-4. Since the soils containing nitroaromatic compounds greater than 100,000 mg/kg will be sent offsite for treatment, the statutory preference for treatment as a principal element of the remedy will be met. Because the remedy will result in hazardous substances remaining on-site, a review will be conducted within 5 years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

01/16/97

Date

Kisuk Cheung
Acting Chief, Environmental Division
Directorate of Military Programs
U.S. Army Corps of Engineers

2/19/97

Date

William E. Muno, Director
Superfund Division
U.S. Environmental Protection Agency Region V

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

List of Tables

Table of Contents (continued)

List of Figures

Table of Contents (continued)

List of Appendices

Table of Contents (continued)

List of Acronyms and Abbreviations

ARARs	Applicable or relevant and appropriate requirements
AWQC	Ambient Water Quality Criteria
BNAs	Base neutral acids
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	Centimeters per second
COC	Crab Orchard Cemetery
COP	Crab Orchard Plant
CSF	Carcinogenic slope factor
CTV	Critical toxicity value
cy	Cubic yard
DNB	Dinitrobenzene
DNT	4-amino-2,6-dinitrotoluene
EMMA OU	Explosives/Munitions Manufacturing Areas Operable Unit
ERI	Ecological Risk Index
ESE	Environmental Science & Engineering, Inc.
FFA	Federal Facility Agreement
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
HI	Hazard index
HMX	High Melting Explosives, cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IAC	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
IOP	Illinois Ordnance Plant
LOEL	Lowest-observed-effect level
MA OU	Metals Area Operable Unit
mg/kg	Milligrams per kilogram
mg/kg/day	Milligram per kilogram day
mg/L	Milligrams per liter
MISCA OU	Miscellaneous Area Operable Unit
mm	Millimeter
msl	Mean sea level

Table of Contents (continued)

List of Acronyms and Abbreviations (cont.)

MTV	Mobility, toxicity, and volume
NCP	National Contingency Plan
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NOAEL	No observable adverse effect level
NPL	National Priorities List
NWR	National Wildlife Refuge
NWRSA	National Wildlife Refuge System Act
NOEL	No-observed-effect level
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PCB	Polychlorinated biphenyls
PCB OU	Polychlorinated Biphenyls Area Operable Unit
PP	Proposed Remedial Action Plan
PQL	Practical Quantitation Limit
RAE	Reasonable average exposure
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosives, Hexahydro-1,3,5-trinitro-1,3,5-triazine
RfD	Reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RME	Reasonable maximum exposure
SARA	Superfund Amendments and Reauthorization Act
sq ft	Square foot
TBC	To be considered
TCLP	Toxicity characteristic leaching procedure
TNB	Trinitrobenzene
TNT	Trinitrotoluene
TSD	Treatment, storage, disposal
USACE	U.S. Army Corps of Engineers
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOCs	Volatile organic compounds

Table of Contents (continued)

List of Acronyms and Abbreviations (cont.)

WAA	War Assets Administration
WCC	Woodward Clyde Consultants
UXO	Unexploded Ordnance

1.0 Site Name, Location, and Description

The Crab Orchard National Wildlife Refuge (NWR) is located approximately 5 miles west of Marion, Illinois in Williamson County (Figure 1-1). It is near the center of the southern tip of the state, with the Mississippi River approximately 25 miles to the west and the Ohio River approximately 55 miles to the east. The Crab Orchard NWR (the refuge) currently comprises an area of approximately 43,500 acres of forested land, pine plantations, and cultivated lands. A portion of the refuge is set aside for industrial purposes. Three lakes are located within the refuge, including Crab Orchard Lake, a 7,000-acre man-made reservoir.

The Crab Orchard NWR was included into the National Priorities List (NPL) in 1987. The U.S. Fish and Wildlife Service (USFWS), an agency of the U.S. Department of the Interior (USDOI), administers the refuge. Affected areas within the refuge are currently divided into five separate operable units (OUs) that are managed by different lead agencies. These operable units are the Polychlorinated Biphenyls Area (PCB) OU, the Metals Area (MA) OUs, the Explosives/Munitions Manufacturing Areas (EMMA) OU, the Miscellaneous Area (MISCA) OU, and the Water Towers OU. Pursuant to the Federal Facility Agreement (FFA) in effect for the Crab Orchard NWR, the Department of the Army (DA) is the Lead Department for the EMMA OU. The United States Army Corps of Engineers (USACE) is the executive agent of DA for work at the EMMA OU. This ROD addresses the final remedy selected for the EMMA OU sites.

Fifteen individual sites were investigated within the EMMA OU. Munitions disposal and storage activities were historically performed at these sites. These sites are grouped into three discrete areas: ten sites (Sites COC-1 through COC-10) are located in the Crab Orchard Cemetery (COC) area, so named due to the proximity of Hampton Cemetery (Figures 1-2 and 1-3); four of the sites (Sites COP-1 through COP-4) are in the Crab Orchard Plant (COP) area, near the Group II load line and former Ammonium Nitrate Plant (Figure 1-4); and one site (Site Bunker 1-3) is in the explosives storage bunker area. The COC and COP sites are located within a portion of the refuge closed to the public. Historic land use in and around the COP sites has been largely associated with ordnance manufacturing, while the COC sites have been associated with a variety of cultivation practices coupled with ordnance testing and disposal practices.

Population centers in the vicinity of Crab Orchard NWR include the cities of Marion 5 miles to the east (population 14,545), Herrin 8 miles to the north (population 10,857), and Carbondale 6 miles to the west (population 27,033) [U.S. Department of Commerce (Bureau of Census 1990)]. In addition, several smaller towns and communities are scattered in the vicinity of the refuge.

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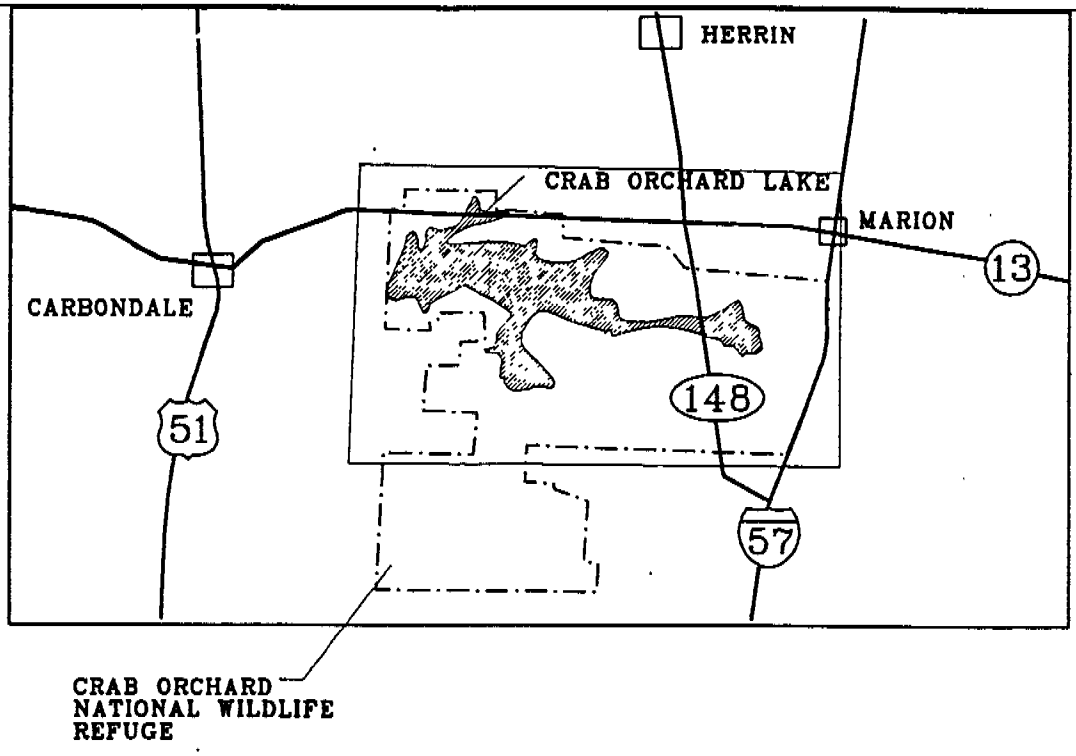


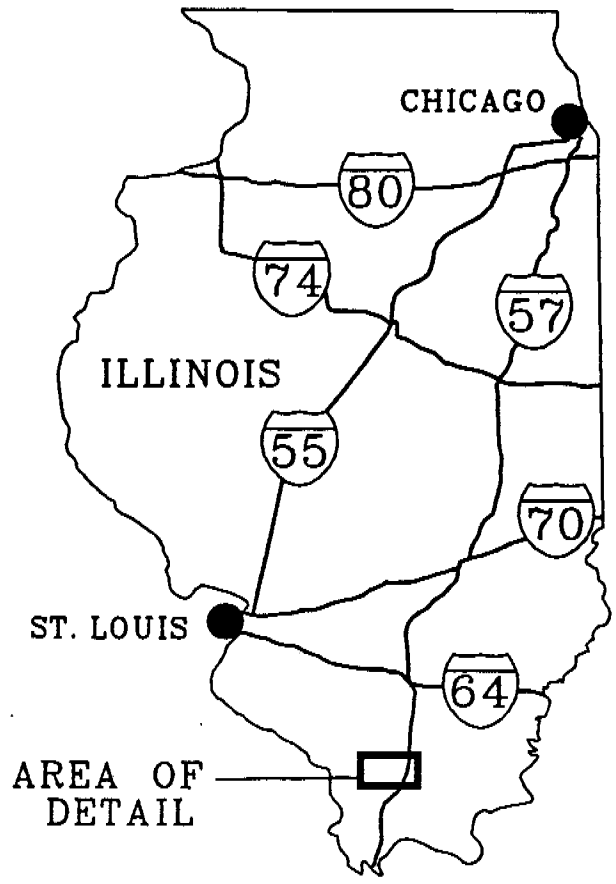
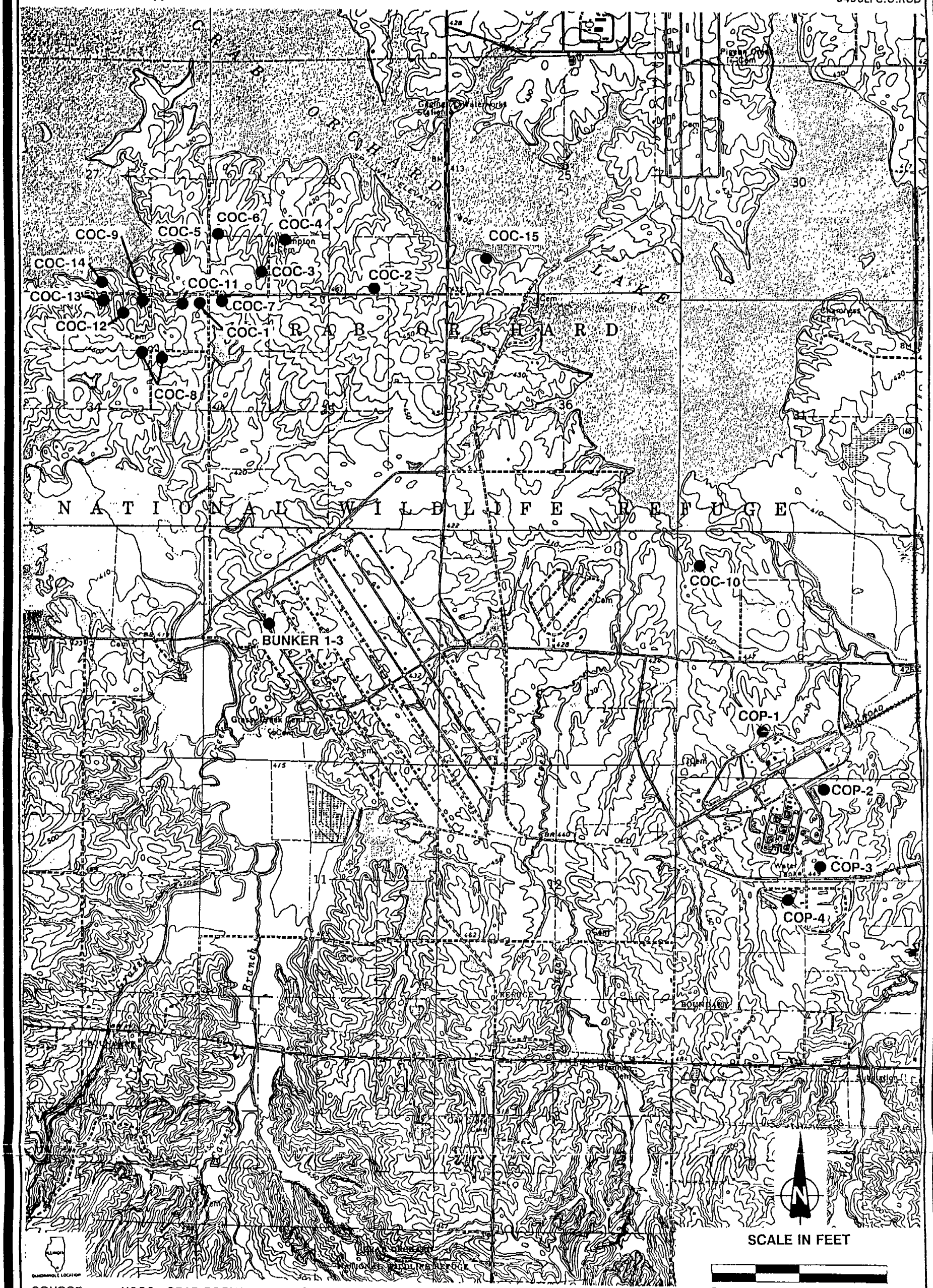


Figure 1-1
VICINITY MAP
CRAB ORCHARD NWR
MARION, ILLINOIS

ESE
A CILCORP Company
Environmental
Science &
Engineering, Inc.

3496LFC.O.ROD



SOURCE: USGS - CRAB ORCHARD LAKE QUADRANGLE
1966 PHOTOREVISED 1978

Figure 1-2
EMMA OU SITES
CRAB ORCHARD NWR
MARION, ILLINOIS

ESE Environmental Science & Engineering, Inc.
A CH2MHILL Company

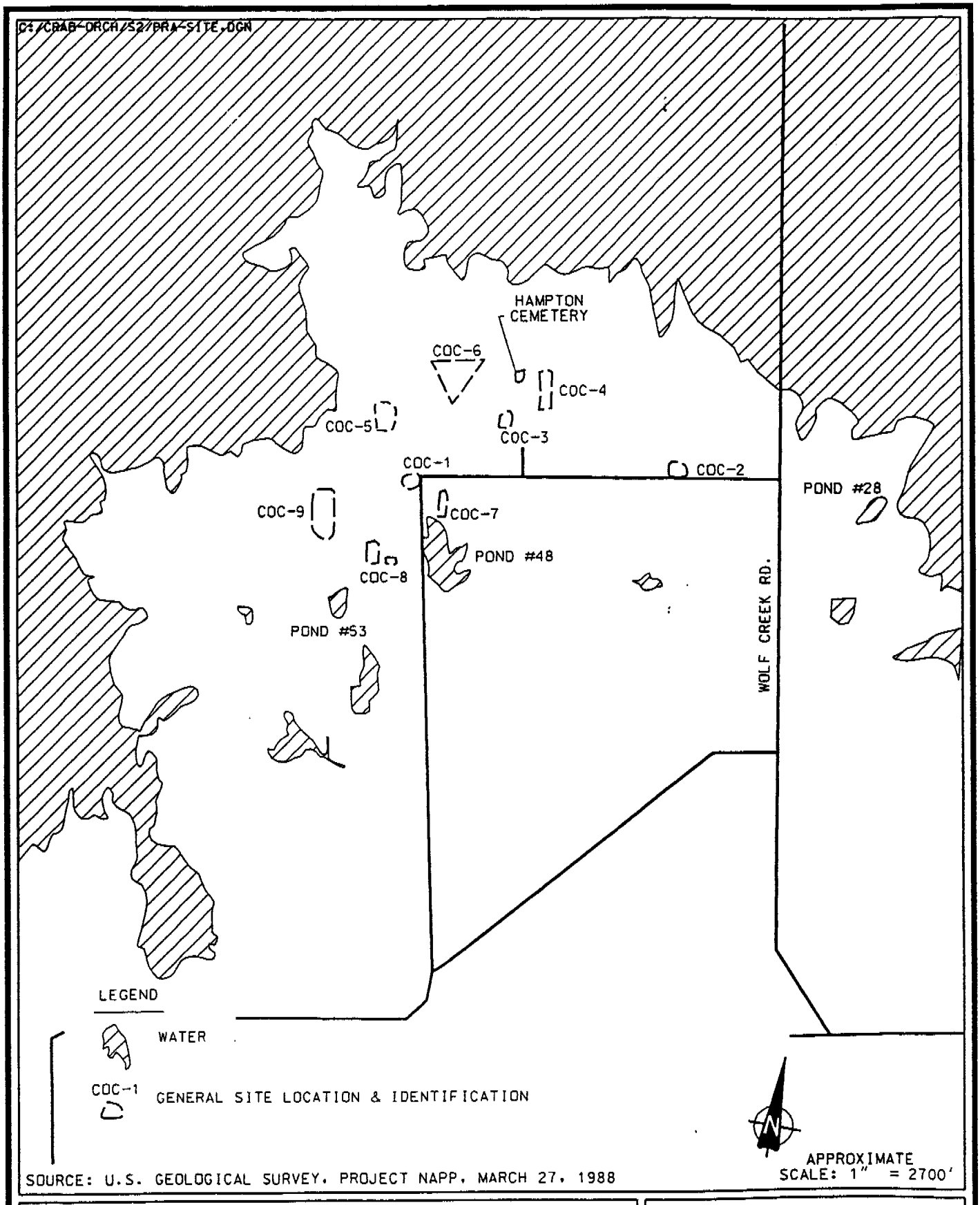


Figure 1-3
COC SITE LOCATIONS
CRAB ORCHARD NWR
MARION, ILLINOIS

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A CILCORP Company
Environmental Science & Engineering, Inc.

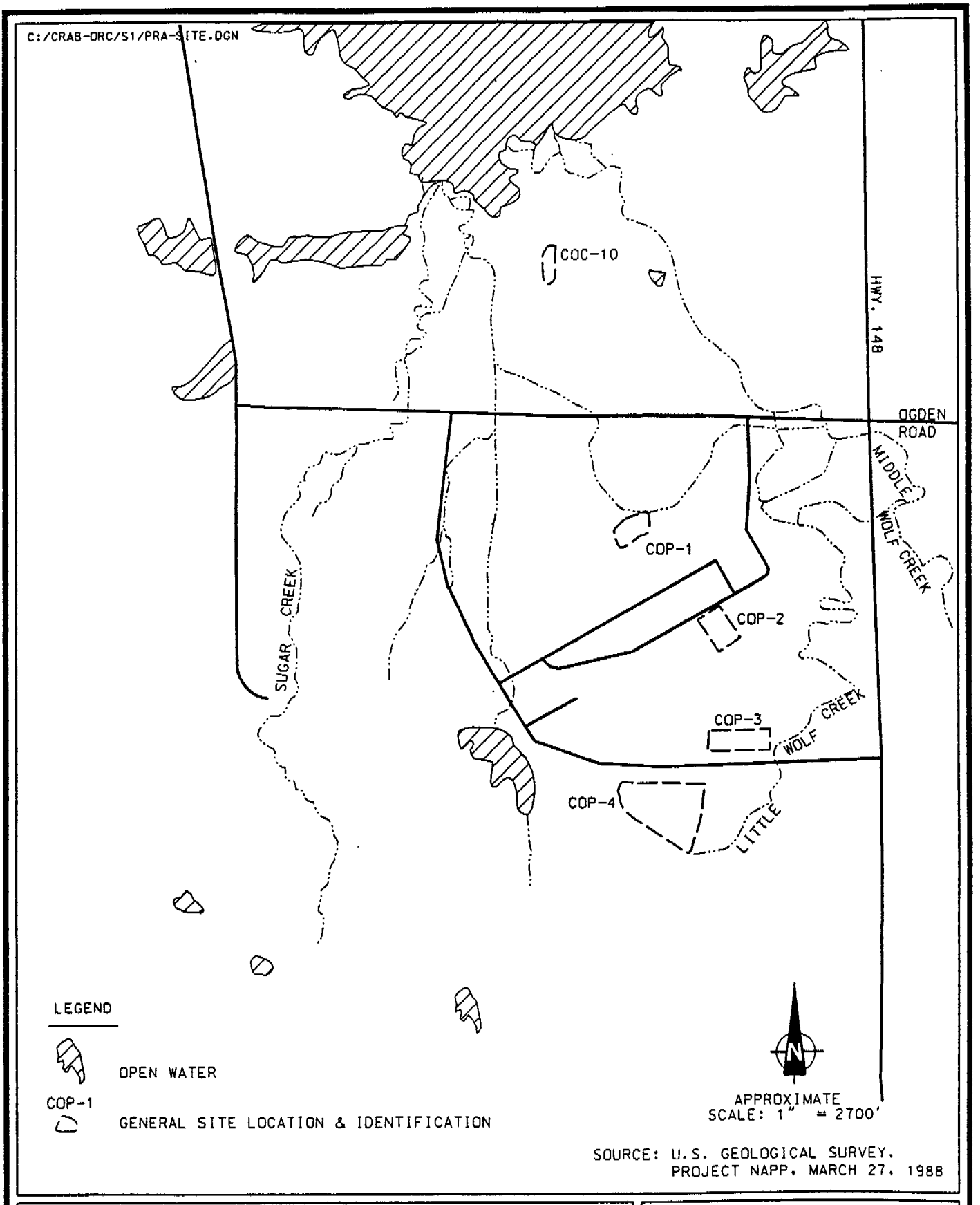

Figure 1-4
COC-10 AND COP SITE LOCATIONS
CRAB ORCHARD NWR
MARION, ILLINOIS

ESE Environmental Science & Engineering, Inc.
A CH2M HILL Company

1.1 Topography

The topography of the area is relatively uniform, characterized by flat to moderately sloping areas. Generally, the relatively flat to gently rolling parcels are utilized for cultivation purposes. Elevations across the area range from 420 to 455 feet above mean sea level (msl). Numerous streams, drainageways, and drainage courses dissect the COC and COP areas. In the vicinity of the COC sites, these drainageways are largely limited to narrow intermittent streams. In contrast, Sugar Creek, Little Wolf Creek, and Middle Wolf Creek are perennial streams located in the general area of the COP sites. Surface water from the EMMA OU sites eventually drains to Crab Orchard Lake.

1.2 Geology/Hydrology

The major structural feature of southern Illinois is the Illinois Basin. This is a broad, gentle, structural depression that contains more than 10,000 feet of sedimentary rocks. The basin is oval, elongated on the northwest to southeast axis. Williamson County is situated near the southwestern limit of the basin, so the regional dip of the bedrock is generally toward the center of the basin to the north and east.

Pennsylvanian-age bedrock underlies Williamson County, Illinois. The bedrock at the COC sites consists of the shales, sandstones, and thin limestones of the Carbondale formation. The bedrock in the COP area is the Pottsville formation, which consists of interbedded shales and sandstones. These formations also include a number of coal beds. Sandstones of the Carbondale formation are generally medium- and thin-bedded; limestone beds are rarely over 4 feet in thickness. The total thickness of this formation within the Carbondale Quadrangle is believed to be between 275 and 350 feet. The formation lies conformably on the underlying Pottsville formation. The uppermost member of the Pottsville is the Makanda Sandstone. In the eastern portion of the quadrangle, in the vicinity of the COP sites, the Makanda is believed to be very similar to the Carbondale formation, consisting of interbedded sandstone and shale, with some local coal beds. The maximum thickness of the Makanda is reported at about 300 feet. A geological map of the EMMA OU areas is shown on Figures 1-5 and 1-6.

A thin layer of Illinoisan glacial till sits on the bedrock. Overlying this till unit is a loess sheet from the Wisconsin glacial age. In the COC area, loess materials range in thickness from 12 to 120 inches, averaging about 57 inches thick. Loess thickness in the COP area range from 0 to 30 inches. A number of wells and borings in the COP area were sited in areas where construction and fill activities occurred (Sites COP-2 and COP-3). Due to their disturbed nature, loess thicknesses encountered in these areas may not reflect undisturbed conditions in the surrounding areas.

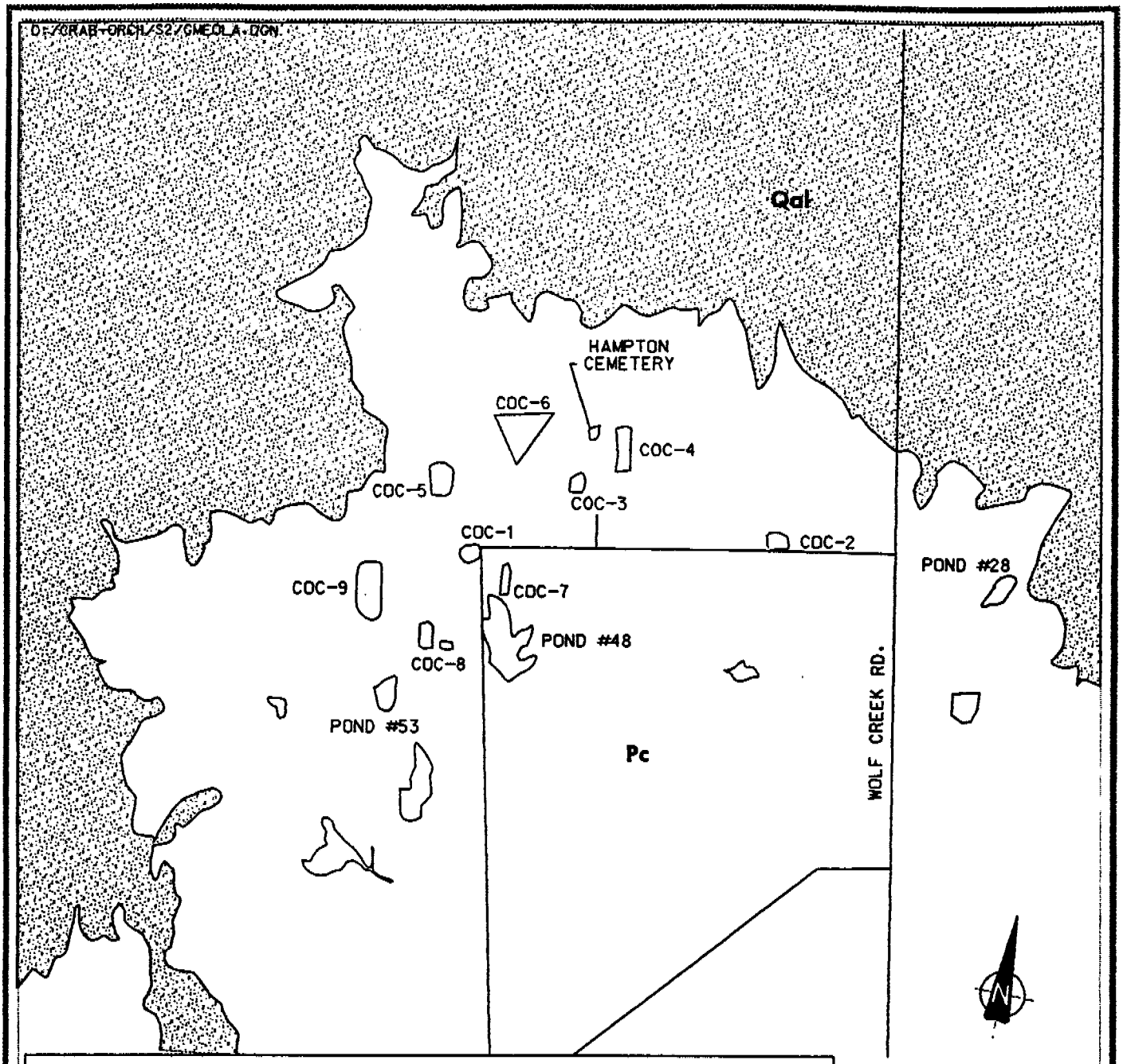

Figure 1-5
GEOLOGICAL MAP OF EMMA OU COC SITE LOCATIONS
CRAB ORCHARD NWR
MARION, ILLINOIS

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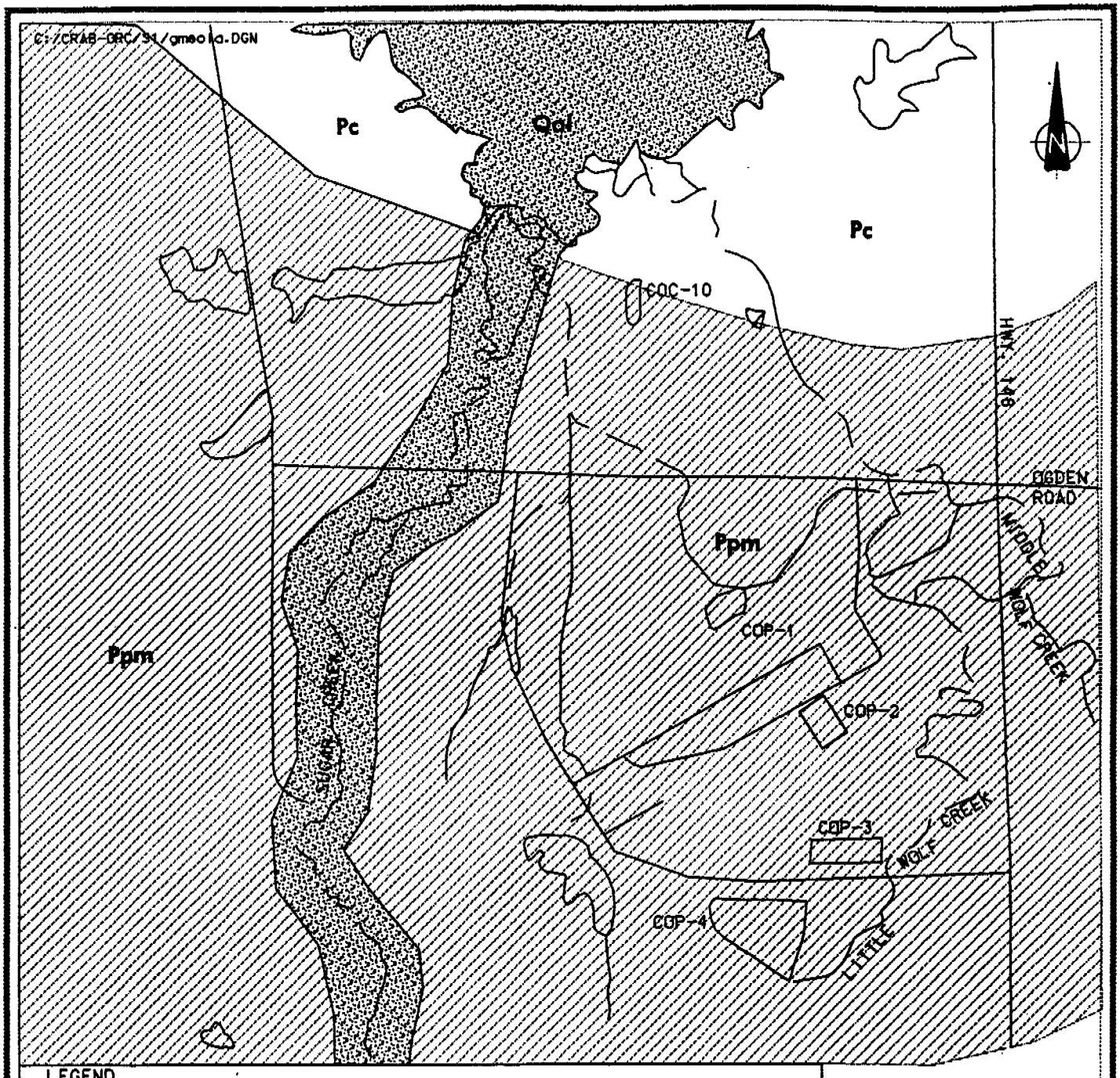

LEGEND

Pc — CARBONDALE FORMATION
(shale, sandstone and thin limestone; includes one to six coal beds; Murphysboro (No. 2) coal at the base and Herrin (No. 6) coal at the top of the formation)

Qal — ALLUVIUM
(silt, sand and gravel comprising the flood plains of present streams)

Ppm — POTTSVILLE FORMATION
(sandstone and shale interbedded; locally contains coal and limestone)
Makanda sandstone member
(lower portion massive sandstone, locally conglomeratic; upper portion sandstone and shale, locally containing coal and limestone)

COP-1 — GENERAL SITE LOCATION & IDENTIFICATION

BASE MAP SOURCE:
U.S. GEOLOGICAL SURVEY.
PROJECT NAPP,
MARCH 27, 1988

GEOLOGICAL FORMATION SOURCE:
USGS -GEOLOGY OF THE CARBONDALE QUADRANGLE BULLETIN NO. 48 1925

APPROXIMATE SCALE: 1" = 2700'

Figure 1-6
GEOLOGICAL MAP OF EMMA OU COP AND COC-10 SITE LOCATIONS
CRAB ORCHARD NWR
MARION, ILLINOIS

ESE Environmental Science & Engineering, Inc.

Sandstone and shale bedrock was encountered in the COC area at depths of 6 to 23 feet. Thin coal seams were noted within this bedrock unit. Sandstone bedrock was encountered at about 25 feet in the COP area. The sandstones encountered were poorly sorted, consisting of coarse to fine sands with silt and clay fines.

Groundwater resources in Williamson County are relatively poor. Shallow drift wells and cisterns have been utilized by farmers in this area; however, surface water is the principal source for industries and towns. Deep wells are generally not a good source of water due to high mineral content (SCS, 1959). In general, groundwater flow at the EMMA OU sites is toward Crab Orchard Lake. During Phase I well installations in the COP and Bunker areas, groundwater was generally encountered at about 18 to 20 feet in the glacial materials that overlie the bedrock. Groundwater was somewhat more elusive in the COC area, and was generally encountered below the unconsolidated glacial materials in the sandstone/shale bedrock. Therefore, monitor wells in the COC area were installed to varying depths in the sandstone/shale bedrock.

The highest groundwater elevations are noted in the vicinity of Sites COC-3 and COC-9. North and west of these sites, groundwater flow is toward Crab Orchard Lake. South of these sites, the flow appears to be to the south, possibly toward a section of Crab Orchard Lake that is south and west of the COC area. Groundwater contours in the COC area are shown on Figure 1-7.

Water level elevations indicate that flow in the COP area is generally northward toward Crab Orchard Lake, although an apparent groundwater high in the immediate area of Sites COP-3 and COP-4 results in a local pattern that indicates influence from Little Wolf Creek to the east and an unnamed drainage to the west. Groundwater contours in the COP area are shown on Figure 1-8.

Specific site conditions indicate that the EMMA OU shallow groundwater meets the technical definition of a Class I groundwater classification pursuant to 35 Illinois Administrative Code Part 620 (35 IAC Part 620), Section 620.210(a). Slug tests conducted at the EMMA OU sites during the RI showed that the hydraulic conductivity is greater than $1x10^{-4}$ centimeters per second (cm/sec). Therefore, the EMMA OU shallow groundwater meets the definition of Class I groundwater.

c:\crab\s3\gw-e.dgn

405

MW-COC10-2
405.67

410

EL 410

415

EL 420

420

MW-COP1-3
420.32

EL 430

425

MW-COP2-4
430.48

430

MW-COP2-1
432.08

432

434

MW-COP3-1
444.60

MW-COP3-2
442.53

MW-COP3-3
436.83

MW-COP4-4
435.04

436

438

440

442

444

MW-COP4-1
442.06

MW-COP4-3
442.43

MW-COP4-2
442.69

EL 450

N

0 500' 1000'
SCALE: 1" = 1000'

Figure 1-8
GROUNDWATER CONTOUR PATTERNS, JULY 1993
COP AREA
CRAB ORCHARD NWR
MARION, ILLINOIS

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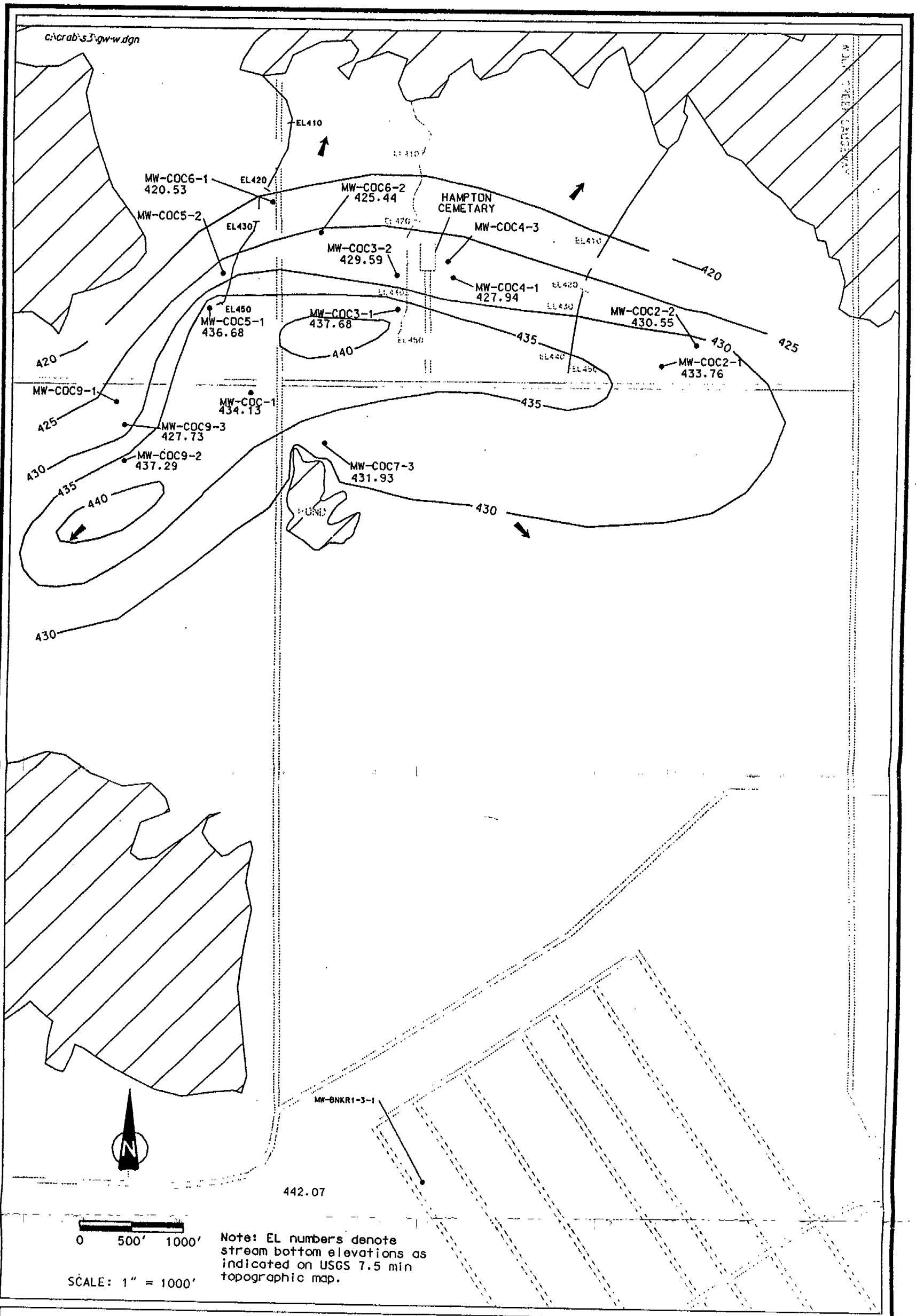

Figure 1-7
GROUNDWATER CONTOUR PATTERNS, JULY 1993
COC AREA
CRAB ORCHARD NWR
MARION, ILLINOIS

ESE Environmental Science & Engineering, Inc.
A CILCORP Company

2.0 Site History and Enforcement Activities

The eastern portion of the refuge was transferred to the War Department for construction of the former Illinois Ordnance Plant (IOP), also known as the Crab Orchard Ordnance Plant. The IOP was constructed in 1941 for the U.S. Army as part of its National Defense Program. The major activity conducted at the IOP consisted of trinitrotoluene (TNT) melt-pour operations. Various munitions and munitions items, including 500-pound bombs, anti-tank mines, and 155 millimeter (mm) shells, were filled at the former plant. The IOP also contained an ammonium nitrate production unit as well as storage and shipping areas, a shop, and maintenance area. Water for plant operations was obtained from Crab Orchard Lake and was treated in an on-site water treatment plant. The former ordnance plant maintained a complete domestic sewer system and treatment plant.

The IOP was closed in 1945, shortly after the end of World War II. The plant was transferred to the War Assets Administration (WAA) for disposition. The plant was reportedly decontaminated in accordance with military specifications in force at the time, and a portion was leased to private industrial tenants. Electrical equipment containing polychlorinated biphenyls (PCBs), boats, corrugated boxes, explosives, and plated metal parts are among the products that have been manufactured on the refuge. Accountability for the property was transferred to the USDOI in 1947. The USFWS, an agency of USDOI, continues to administer the refuge.

The Crab Orchard NWR was proposed for inclusion on the NPL in 1984 and included as final on the NPL as published in the July 22, 1987 Federal Register (52 FR 27620). The refuge is currently divided into five OUs which include the EMMA OU.

As part of the Formerly Used Defense Sites (FUDS) Program, an Inventory Project Report for the refuge was initiated by the U.S. Army Corps of Engineers (USACE) Chicago District in 1986. Site surveys were conducted and limited to areas believed to be associated with the former ordnance plant (the EMMA OU). Based upon the findings of this Inventory Project Report, a Confirmation Study was conducted at the direction of the USACE-Omaha District. The Confirmation Study Report was completed by Woodward Clyde Consultants (WCC) in April 1988 (WCC, 1988).

The Confirmation Study focused on 14 sites apparently associated with the IOP. Activities conducted as part of the Confirmation Study included magnetometer surveys, surface and subsurface soil sampling and analysis, groundwater monitoring well installation, groundwater sampling and analysis, and surface water and sediment sampling. The results of the magnetometer surveys indicated the presence of buried ferrous materials at eight sites. Results of some of the samples indicated the presence of munitions related compounds.

The 15 EMMA OU sites consist of the 14 Confirmation Study sites (COC and COP areas) plus the Bunker 1-3 Site [referred to as Site 19 from the 1988 Remedial Investigation (RI) conducted at the PCB and MA OUs]. An RI was conducted at the EMMA OU which included a Baseline Risk Assessment (BRA). Phase I of the RI field investigation involved the excavation of 40 test pits; the installation and sampling of 14 monitoring wells; the collection of samples from 12 previously existing monitoring wells; and the drilling and sampling of 10 soil borings. Samples were analyzed for volatile organic compounds (VOCs), base/neutral acid extractable compounds (BNAs), nitroaromatic compounds, metals, and total petroleum hydrocarbons. The Phase I field work was conducted from mid-August to mid-October 1991.

The Phase II RI field investigation was conducted in June, July, and September of 1993 and focused on 8 of the 15 EMMA OU sites based on data gathered in the Phase I investigation. A separate field effort was conducted in October and December 1993 based on the results of a Preliminary Ecological Risk Assessment. The Phase II investigation involved the collection of surface soil, surface water, and sediment samples; drilling and sampling of soil borings; and the installation and sampling of two monitoring wells. Groundwater samples were also collected from all 26 previously existing monitoring wells. Small mammal trapping was conducted at Site COC-9 to evaluate potential ecological effects. Surface water samples were collected for aquatic toxicity testing from Site COC-6 to assess potential effects on aquatic species. Analyses performed on collected samples included metals, nitroaromatic compounds, VOCs, and BNAs.

The RI was completed in September 1994. A Feasibility Study (FS) was performed for the 15 EMMA OU sites based on the findings of the RI and the BRA. The FS evaluated seven remedial alternatives and was completed in September 1995. A Proposed Plan was developed and submitted for public comment in September 1995.

Currently, Crab Orchard Lake provides sport fishermen with largemouth bass, catfish, sunfish, and crappie. It was used as a drinking water source for the refuge and Marion Federal Penitentiary until 1993 when the water treatment plant was closed. Water for the refuge and the penitentiary is currently supplied by the Herrin municipal system.

3.0 Highlights of Community Participation

The RI and BRA Reports for the EMMA OU were released to the public in November 1994. These two document are available to the public as part of the Administrative Record and in the information repositories maintained at the following locations.

Marion Carnegie Public Library (618) 993-5935
206 South Market Street
Marion, IL 62959
Operating Hours — Monday-Friday 9:00 a.m. to 8:30 p.m. Central Standard Time (CST)

Carbondale Public Library (618) 457-0354
405 West Main Street
Carbondale, IL 62901
Operating Hours — Monday-Thursday 9:00 a.m. to 8:00 p.m. CST,
Friday-Sunday 9:00 a.m. to 5:00 p.m. CST

Crab Orchard National Wildlife Refuge Contact: Leanne Moore
RR 3 Box 328 (618) 997-5491
Marion, IL 62959
Operating Hours — Monday-Friday 7:00 a.m. to 4:30 p.m. CST

Morris Library Contact:
Southern Illinois University (618) 453-1455
Carbondale, IL 62901
Operating Hours — Monday-Thursday 8:00 a.m. to 11:00 p.m. CST,
Friday 8:00 a.m. to 9:00 p.m. CST, Saturday 10:00 a.m. to 6:00 p.m. CST,
Sunday 1:00 p.m. to 11:00 p.m. CST

Department of Justice Contact: Legal Office
Marion Federal Penitentiary (618) 964-1441
Bureau of Prisons
RR 5, Little Grassy Road
Marion, IL 62959
Documents Available — Monday-Friday 7:30 a.m. to 4:00 p.m. CST

The notice of public availability for these two documents was published in the following four newspapers: Southern Illinoisan, Daily Egyptian, Marion Daily, and St. Louis Post Dispatch. In addition, an availability session and public meeting was held on November 1, 1994 at the refuge visitors center. At this meeting, representatives from the USFWS, USACE, Illinois Environmental Protection Agency (IEPA), and U.S. Environmental Protection Agency (USEPA) addressed questions about the RI and BRA.

The FS and the Proposed Remedial Action Plan (PP) were released to the public in September 1995. These two documents are also available in the Administrative Record located in the information repositories listed above. The notice of availability of these documents was published in the same four newspapers listed above in September 1995. An initial public comment period

was held between September 29, 1995 and October 30, 1995. The public comment period was advertised in the four newspapers listed above on September 15, 1995. At the request of the public, the comment period was extended by 30 days to November 29, 1995. An announcement of the extended public comment period was also placed in the same four newspapers on November 2, November 6, November 1, and November 3, 1995, respectively. In addition, a public availability session and meeting was held on October 19, 1995 at the refuge visitors center. At this meeting, representatives from the USFWS, USACE, USEPA, and IEPA addressed questions and received comments about the remedial alternatives under consideration. A response to the comments received during the public comment period is included in the Responsiveness Summary, which is Appendix A of this Record of Decision (ROD).

4.0 Scope and Role of the Response Action

The Crab Orchard NWR is currently divided into five separate operable units. The OUs are the PCB OU, MA OU, EMMA OU, MISCA OU, and Water Tower OU. Remedies have already been selected and implementation begun at the MA OU and PCB OU. The Water Tower OU was remediated as part of a removal action.

This ROD addresses the final remedy for each EMMA OU site except Site COC-4 which requires further evaluation. Remedial action was determined to be necessary at Sites COC-3 and COP-4, while no further action is required at the remaining 12 sites. Alternative 3A, described in Section 8.0, is the selected remedial alternative to be implemented at Sites COC-3 and COP-4. The remedial alternative selected includes:

- Excavation and offsite treatment and disposal of soils containing levels of nitroaromatic compounds greater than 100,000 mg/kg (or 10 percent) and lead above 450 mg/kg for treatment at an offsite incinerator;
- Additional removal of RDX/HMX contaminated soil at Site COP-4 to a depth of two feet below grade within the existing fenced area. Disposal of excavated soils at an offsite permitted special waste landfill;
- Sampling to ensure that remaining affected soils [i.e., soils with contaminants above remediation goals. Remediation goals have been set at the practical quantitation limit (PQL) for nitroaromatic compounds and 450 mg/kg for lead. Refer to the discussion on remediation goals in Section 10.2] at Sites COC-3 and COP-4 do not exhibit the characteristics of a RCRA hazardous waste for lead and 2,4-DNT;
- Backfill excavated areas to shape the base of the covers;
- Placing 24-inch soil covers over the remaining affected soils at Sites COC-3 and COP-4;
- Long-term maintenance of the soil covers for a period of up to 30 years;
- Implementation of land use controls at Sites COC-3 and COP-4; and
- Groundwater monitoring.

The land use controls to be implemented at Sites COC-3 and COP-4 include restrictions of the following activities: groundwater well installation; subgrade activities; and pond creation within the perimeter of the soil covers on Sites COC-3 and COP-4.

The studies undertaken at the EMMA OU have identified potential human and ecological risks associated with nitroaromatic compounds and metals, specifically lead, in soil at Sites COC -3 and COP-4. The remedial objective for the EMMA OU is to minimize potential human health and ecological risks associated with the direct contact of affected surface soil at Sites COC-3 and COP-4. The overall response strategy consistent with CERCLA is to restrict the ability of

humans and animals to contact nitroaromatic compounds and lead in soils at Sites COC-3 and COP-4, while monitoring the groundwater at Sites COC-3 and COP-4 for contaminants over time.

5.0 Documentation of Significant Changes

The preferred remedial alternative presented in the Final FS Report was Alternative 3A. However, comments were received from the USFWS on the draft FS Report expressing concern that each of the alternatives studied required nearly consistent levels of institutional controls and perpetual maintenance. Therefore, during preparation of the Proposed Plan, USACE evaluated a modified version of Alternative 4 that was intended to produce a site less dependant of engineered barriers and institutional controls. In the modified version of Alternative 4, the removal of non-reactive contaminated soil was increased from approximately 2 feet below existing grade to approximately 5 feet below grade. The contaminated soil would be disposed of in a special waste landfill as described in the FS Report. The contaminated soil would be replaced with clean soil. The Proposed Plan identified Alternative 4 as the preferred remedial alternative.

Upon further consideration, the USACE reevaluated Alternative 4 as the preferred alternative. Alternative 4 was considered in response to a USFWS concern for the well-being of burrowing animals that may be present at the sites. Upon further consideration of the cost differences, USACE could not justify the increased cost of excavating to a depth of 5 feet based upon a speculative risk to an animal that was not identified as a species of concern in the RI and was screened out in the BRA. Also, groundwater monitoring would still be required under Alternative 4 because soils with contaminants above remediation goals would remain on site.

There are some differences between the description of alternatives presented in the FS Report, the Proposed Plan, and this ROD. These differences resulted from refinements in assumptions made for the alternatives, and from correction of calculation errors discovered in the cost tables. These differences are summarized as follows:

- Alternatives as presented in the FS Report assumed that a removal action removing the soils containing nitroaromatic compounds at levels exceeding 100,000 mg/kg and lead above 450 mg/kg would be conducted prior to implementing the selected remedy. In both the Proposed Plan and this ROD, the removal action is included as a key remedial action item in the alternatives presented, with the exception of the No Action alternative.
- Alternative 3A as described in this ROD includes the excavation, removal, and offsite disposal of affected soils to a depth of two feet below grade within the existing fenced area at Site COP-4. This minimal additional excavation at Site COP-4 was not included in the description of Alternative 3A in the FS Report or Proposed Plan. It is anticipated that removal of soils within this area will reduce the concentration of nitroaromatic contaminants remaining at the site to a level approximating that at Site COC-3 and is intended to allow for similar management of residual risks between Sites COC-3 and COP-4.

- Alternative 3A, as presented in the FS Report and Proposed Plan, included fencing. Alternative 3A presented in this ROD does not include fencing. Fencing is not required since installation of the soil cover under Alternative 3A meets the remedial objective of preventing direct contact with affected soils at Sites COC-3 and COP-4. Fencing is not required to maintain the integrity of the soil cover.
- Alternative 4, as described in both the Proposed Plan and this ROD, includes the excavation, removal and offsite disposal of the remaining affected soils at both Sites COC-3 and COP-4 to a depth of 5 feet below grade. Under Alternative 4 described in the FS Report the depth of excavation was limited to 2 feet below grade. In addition, Alternative 4 described in the FS Report included fencing. Alternative 4 described in both the Proposed Plan and this ROD does not include fencing.
- Alternative 5A, as described in both the Proposed Plan and this ROD, includes the excavation and onsite treatment by composting of the affected soils at both Sites COC-3 and COP-4 to a depth of 5 feet below grade. In Alternative 5A described in the FS Report, the depth of excavation was limited to 2 feet below grade.
- The costs in the FS Report are significantly different in the ROD. This is due to the cost of offsite incineration of the soils with levels greater than 100,000 mg/kg of nitroaromatics, revised groundwater monitoring assumptions, and revised operations and maintenance costs.

6.0 Summary of Site Characteristics

During the RI, various media were sampled at the COC, COP, and Bunker 1-3 sites including soil samples collected from test pits, soil borings, and monitoring well borings; groundwater samples; sediment samples; and surface water samples. Shallow groundwater is currently not used at the EMMA OU sites and no future use of the shallow groundwater is expected. Therefore, a direct exposure pathway does not exist. Because the shallow groundwater at the EMMA OU does not represent a complete exposure pathway, groundwater flow and the extent of affected groundwater at the EMMA OU has not been thoroughly characterized. A detailed discussion of the RI data is presented in Section 4.0 of the RI Report.

6.1 Site COC-1

Site COC-1 is approximately 100 by 200 feet in area. It contains a small circular depression near the center. An east-west oriented berm approximately 3 feet high extends along the north end of the site. This site is suspected of formerly being a burial and detonation disposal area. The berm appears to be a burial mound for mine springs which are flat metal discs resembling a wagon wheel. By themselves the springs have no explosive capability.

Lead was detected in surface soil samples across the site at concentrations ranging from 22.5 to 197 milligrams per kilogram (mg/kg). Lead concentrations above background appear to occur primarily in surface soils. All but three at-depth soil samples (>4 feet) exhibited lead concentrations below background or detection levels. The three soil samples with lead concentrations detected above background ranged from 21.3 to 33.6 mg/kg. Background concentrations of lead are considered to be below 21.1 mg/kg (ESE, 1994). Lead was also detected in the offsite sediment sample (21.9 mg/kg). Noticeable concentrations of iron were detected in soils along with chromium, lead, zinc, cobalt, copper, mercury, nickel, and silver.

Chloride [31.6 milligrams per liter (mg/L)] and sulfate (1,600 mg/L) were detected above background concentrations in the groundwater during Phase I of the RI, but were not detected above background during Phase II. A probable cause of the variance is the greater influx of groundwater during Phase II sampling as evidenced by the elevated water levels noted. Metals detected in groundwater samples above background or detection limits include cadmium, aluminum, iron, manganese, vanadium, arsenic, chromium, lead, selenium, zinc, barium, copper, nickel, potassium, silver, and thallium. No nitroaromatic compounds were detected in any of the groundwater, soil, or sediment samples collected.

6.2 Site COC-2

Site COC-2 is approximately 250 by 350 feet in area and encompasses an old burn furnace and two depressions. A subsurface clay drain tile extends to the northeast from the site and discharges into a dry stream.

Lead was detected above background levels in Site COC-2 soil samples (ESE, 1994). Ash was observed at a depth of 4 inches in the old burn furnace area. Other metals above background concentrations detected in the soil samples at this site include antimony, beryllium, calcium, chromium, copper, iron, and mercury primarily from the 0- to 2-foot interval samples. Monitoring well soil boring samples contained TNT at depths of 5 to 7 feet (1.05 mg/kg) and 12 to 14 feet (1.50 mg/kg). A sediment sample collected from a dry streambed northeast of the discharge point for the clay drain tile exhibited selenium concentrations above background.

Metals detected above background levels in groundwater samples included barium, iron, manganese, potassium, and selenium. Chloride, fluoride, and sulfate were also present above background levels. One groundwater sample exhibited TNT concentrations above detection limits.

6.3 Site COC-3

Site COC-3 is a large area subdivided into two smaller areas. This site exhibits indications of explosives/munitions activity. A number of suspect berms or mounds and several detected magnetic anomalies are located within the site. The southern half of the site is fenced and fairly heavily wooded. Various sized pieces of TNT, metal debris, and transite tile (contains asbestos) are scattered across the northern half of the site. This area of concentrated debris remains largely unvegetated. The debris is largely concentrated on the west bank of a north-south oriented erosional gully that bisects the northern portion of the site. A zone of stained soil is apparent approximately 2 feet below the top of the gully bank. This zone of stained soil is the surficial expression of the apparent burn layer encountered in test pits excavated on the debris pile. A sample taken from the stained soil contained 223,000 mg/kg of TNT. Nitroaromatic compounds detected in the soils above detection limits in this area include TNT (the most prevalent compound); 1,3,5-trinitrobenzene (1,3,5-TNB); 2-amino-4,6-dinitrotoluene (2-amino-4,6-DNT); 2,4-DNT; 1,3-dinitrobenzene (1,3-DNB); 2-nitrotoluene; 4-nitrotoluene; tetryl; 2,6-DNT; and 4-amino-2,6-DNT. The most prevalent metal compounds present in soils in this area include beryllium, copper, antimony, mercury, and lead. Other metals present in soil include arsenic, barium, calcium, cadmium, chromium, cobalt, iron, magnesium, manganese, nickel, selenium, silver, and zinc. Nitroaromatic compounds detected in Site COC-3 soil samples were observed primarily in the 0- to 2-foot interval samples, with two borings exhibiting nitroaromatic compounds in the 3- to 5-foot interval and one boring exhibiting nitroaromatic compounds in the 7- to 9-foot interval samples. The prevalent metals (described above) detected in Site COC-3 soil

samples were observed primarily in the 0- to 2-foot and 7- to 9-foot interval samples, with four borings exhibiting the metals compounds in the 3- to 5-foot interval and two borings in the 4- to 6-foot interval samples.

Nitroaromatic and metal compounds above background or detection limits were also detected in Site COC-3 sediment samples.

Surface water samples collected at Site COC-3 exhibited nitroaromatic and metal compounds above background concentrations including High Melting Explosive, cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); 2,4-DNT; copper; selenium; and sulfate.

Nitroaromatic compounds above detection limits present in groundwater samples included Royal Demolition Explosive, cyclonite hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); nitrobenzene; TNT; 1,3,5-TNB; 2,6-DNT; 2-nitrotoluene; 3-nitrotoluene; 4-amino-2,6-DNT; and 2-amino-4,6-DNT. Both wells exhibited thallium and iron concentrations above background or detection limits in groundwater samples. Additional compounds detected include chloride, fluoride, and sulfate.

6.4 Site COC-4

Site COC-4 is located across the road and slightly north of Site COC-3. It is rectangular in area and measures approximately 250 by 600 feet. The area is heavily wooded with a number of shallow man-made depressions scattered throughout. A deeper man-made depression located at the north end of the site retains water and has become a pond. These depressions are thought to be the result of detonation disposal.

Soil samples exhibited TNT above detection limits. Numerous metals were detected in soil samples including beryllium, cadmium, calcium, cobalt, copper, iron, magnesium, nickel, silver, and zinc. Sediment samples collected from the depression exhibited detectable levels of antimony, beryllium, cadmium, copper, iron, and TNT.

Surface water samples collected from the man-made depression exhibited detectable metal concentrations including aluminum, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc. The groundwater samples collected from this site exhibited detectable concentrations of chloride, sulfate, TNT, barium, iron, lead, and potassium.

6.5 Site COC-5

Site COC-5 is a fenced, heavily vegetated area approximately 210 by 280 feet in size. A shallow man-made depression is located in the southwestern corner of the site. A steeply sloped depressed area on the eastern side of the site forms a north-south oriented canyon-type feature.

TNT concentrations above detection limits were exhibited in a 5- to 7-foot interval soil sample as well as in a sediment sample (1.4 mg/kg) from the man-made depression. TNT was not observed in Phase II sediment samples.

Chloride, fluoride, and sulfate were detected in the groundwater samples collected from this site. Various metals including barium, cadmium, iron, manganese, potassium, selenium, and vanadium were also detected in shallow groundwater samples. Arsenic was detected in a Phase I surface water sample. No organic constituent concentrations were observed above detection limits in surface water samples.

6.6 Site COC-6

Site COC-6 is relatively large, triangular in shape, and covers approximately 6 acres. This area is fenced. There are several variably sized man-made depressions in the central and northern areas of the site. The shape and location of these depressions indicate that they are a result of detonation disposal activities. Small metal fragments were observed scattered around these depressions. TNT was detected above background concentration limits in soil at this site. Notable iron levels (up to 102,000 mg/kg) were also observed. Beryllium, lead, and mercury were detected in soil boring samples at depth. Additional metals detected in soil samples collected at this site include antimony, barium, cadmium, calcium, cobalt, copper, iron, magnesium, nickel, potassium, silver, and zinc. Many of these metals are found in the 19- to 21-foot and 12- to 14-foot intervals. Two sediment samples exhibited detectable TNT concentrations. Metals were noted in other sediment samples including antimony, barium, cadmium, calcium, and magnesium.

Metal compounds detected above background in the surface water include aluminum, barium, calcium, iron, magnesium, manganese, potassium, and sodium. Groundwater samples also exhibited levels of metals above background including potassium, selenium, zinc, cadmium, chromium, lead, mercury, iron, barium, and nickel. Elevated levels of chloride (366 mg/L), fluoride (0.40 mg/L), and sulfate (478 mg/L) were also detected in the groundwater. No nitroaromatic compounds were noted above detection limits in the surface water or groundwater samples.

6.7 Site COC-7

Site COC-7 consists of approximately 2 acres of open area within a large field. An intact land mine and land mine casing fragments found at this site provide evidence of detonation disposal activities in this area. The intact landmine was not fused, and therefore, did not pose an immediate detonation hazard. However, it was determined to be filled with the original explosive filler, indicating a potential for detonation. The mine was isolated, collected, and destroyed by the exploded ordnance demolition (EOD) team. The characteristic depressions observed at other disposal sites are not evident at Site COC-7. No nitroaromatic compounds above detection limits were detected in soil samples collected from this site. Metals detected above background in the soil include calcium (2,530 mg/kg) and cobalt (22.9 mg/kg).

Groundwater samples collected from this site exhibited levels above background or detection limits of cadmium, iron, potassium, and selenium, as well as detectable levels of chloride, fluoride, and sulfate. A low level of TNT (0.00021 mg/L) was detected in the Phase I groundwater sample. However, no nitroaromatic compounds were detected in the Phase II sample. A probable cause of this variance is the greater influx of groundwater during Phase II sampling as evidenced by the elevated water levels noted during Phase II.

6.8 Site COC-8

Site COC-8 is located in an open area within a field that is currently farmed. Two magnetic anomalies detected during the Confirmation Study were investigated during the RI. Magnetic anomalies investigated at this site were identified as a sickle blade and metal fence posts. No nitroaromatic compounds were detected in samples collected from this site. Metals were detected in soil samples collected from test pits at Site COC-8. Mercury was detected at 0.088 mg/kg, calcium at 2,340 mg/kg, and copper at 20.1 mg/kg. Mercury was detected at a concentration only slightly above the average background concentration (0.046 mg/kg). The source of the mercury may be a result of use of agricultural chemicals for fungal or pest control. A probable source of the copper and calcium detected at this site is past farming activities [i.e., the metal farm implements noted above or use of agricultural insecticides and/or fungicides (copper), and lime or other additives to the soil (calcium)].

6.9 Site COC-9

Site COC-9 is an irregularly shaped area approximately 4 acres in size. This area is heavily vegetated with fencing around the northern portion of the site. There are several man-made depressions located in this area, with two located near the southern end and the others located near the center and northern portions of the site. The origin of the depressions is thought to be the result of ordnance disposal activities. Samples collected from test pits revealed a subsurface ash layer roughly 15 feet in diameter, providing evidence of burning at this site.

Most of the samples collected from each medium at this site exhibited metals concentrations above background with the most prevalent being arsenic, antimony, cadmium, chromium, copper, iron, lead, nickel, and selenium. Additional metals detected in the soil in this area included aluminum, barium, beryllium, calcium, cobalt, magnesium, mercury, potassium, silver, sodium, thallium, vanadium, and zinc. The highest metals concentrations were observed in soil samples from the 0- to 2-foot and 4- to 6-foot intervals. Detectable levels of TNT and 1,3,5-TNB were present in sediment samples collected from the southern and northern depressions at this site. The most commonly noted metals in the sediments were antimony, cadmium, copper, lead, and mercury. Additional metals detected in the sediment include arsenic, beryllium, chromium, iron, nickel, selenium, silver, thallium, and zinc.

Several metals concentrations above background were detected in surface water samples including aluminum, barium, calcium, cobalt, copper, iron, magnesium, manganese, nickel, selenium, and zinc. HMX was detected in a single surface water sample. Elevated sulfate levels were also detected in surface water samples. Although TNT was detected in the Phase I groundwater sample, no nitroaromatic compounds were detected in the Phase II groundwater samples. A probable cause of this variance is the greater influx of groundwater during Phase II sampling as evidenced by the elevated water levels noted during Phase II. Metals concentrations noted above background in groundwater samples include arsenic, cadmium, cobalt, iron, manganese, nickel, potassium, selenium, silver, thallium, vanadium, and zinc. Chloride, fluoride, and sulfate were also detected in the Phase I groundwater sample.

A sediment sample collected downgradient to the north of the site exhibited no nitroaromatic compounds or metals concentrations above background.

6.10 Site COC-10

Site COC-10 is small, approximately 120 feet square and consists of a fenced area on the northern edge of a corn field. This COC site is closer to the COP area than to the other COC sites. A large portion of the site is taken up by an irregularly-shaped man-made depression. No ordnance components were observed at this site.

One soil sample collected in Phase I exhibited levels of nitroaromatic compounds above detection limits (nitrobenzene at 0.0058 mg/kg). Two Phase I sediment samples contained TNT at 0.66 and 0.72 mg/kg. Phase II soil and sediment samples exhibited no detectable nitroaromatic compounds. The RI determined that explosive effects on soil and sediment at this site were defined and localized. Beryllium, barium, cadmium, and copper were also detected in sediment samples above background. Sediment samples collected downgradient of the site showed no levels of site constituents above background or detection limits, indicating that surface migration from this site has not occurred.

Aluminum, barium, calcium, copper, iron, magnesium, manganese, potassium, sodium, vanadium, and zinc were present in above background levels in surface water samples. Groundwater samples from this site exhibited no detectable nitroaromatic compounds. Arsenic, barium, beryllium, chromium, potassium, thallium, chloride and sulfate were detected in groundwater above background concentrations.

6.11 Site COP-1

Site COP-1 is an area containing a man-made impoundment that received drainage from the Group II process buildings. Drainage from the impoundment is through a 12-inch pipe on the west side of the impoundment to a small stream. This stream drains north to Crab Orchard Lake. Numerous metals were detected in sediment samples collected from the impoundment and from the streambed. However, few of the metals are consistently present in the samples. The metals most commonly detected above background in sediment samples were calcium, lead, and mercury. Additional metals detected in the sediment include antimony, beryllium, chromium, cobalt, copper, manganese, silver, and zinc. One impoundment sediment sample and two streambed sediment samples exhibited detectable levels of TNT. The compound 2,6-DNT was detected in one streambed sediment sample.

Surface water samples from the impoundment exhibited detectable levels of RDX, HMX, and 1,3-DNB. Metals present in above background levels in the impoundment surface water samples include aluminum, barium, cadmium, calcium, copper, iron, magnesium, manganese, sodium, vanadium, and zinc. The groundwater sample collected in Phase I exhibited detectable levels of 1,3,5-TNB, antimony, beryllium, cadmium, and potassium. Also, chloride, fluoride, nitrate, and sulfate were detected. With the exception of thallium at 0.0031 mg/L, no metals were detected in the Phase II groundwater sample at concentrations above background levels. No nitroaromatic compounds were detected in the Phase II groundwater samples. A probable cause of the variance in analytical results between the Phase I and Phase II sample events is the greater flux of groundwater during Phase II sampling as evidenced by the elevated water levels noted.

6.12 Site COP-2

Site COP-2 is a former underwater storage area for bulk explosives. Sodium is the most commonly detected constituent above background concentrations at this site, being present in most of the surface soil samples (0- to 2-foot interval) at concentrations ranging from 1,860 to 3,970 mg/kg and one soil boring sample (5- to 7-foot interval) at 1,960 mg/kg collected during the installation of a monitoring well. Magnesium, calcium, and mercury were present above background in one soil sample collected during installation of monitoring well MWS-1. Lead (24.9 mg/kg) and cobalt (22.1 mg/kg) were each detected in one surface soil sample. No nitroaromatic compounds or organic constituents were detected in soil samples collected.

Groundwater samples exhibited detectable levels of metals including arsenic, selenium, and thallium. Additional metals detected in groundwater samples include barium, iron, and potassium. Chloride, fluoride, nitrate, and sulfate were also detected in groundwater samples. TNT was detected in one groundwater sample during the Phase I sampling at a concentration of 0.0002 mg/L. No nitroaromatic compounds were detected in the Phase II sampling.

6.13 Site COP-3

Like Site COP-2, Site COP-3 is a former underwater storage area for bulk explosives. Metals detected above background in soils include arsenic, barium, beryllium, calcium, cobalt, iron, magnesium, manganese, mercury, and silver. Iron, calcium, magnesium, and manganese were the most prevalent metals detected. The remaining metals were detected in only one or two soil borings at various intervals between 0 and 21 feet. One soil boring exhibited TNT at the 4- to 6-foot interval at 0.25 mg/kg. Sediment samples collected from areas draining this site contained no nitroaromatic compounds or above background metals.

Elevated levels of aluminum (21 mg/L) and iron (10.1 mg/L) were detected in Phase I groundwater samples. Additional metals above background in the Phase I groundwater samples include antimony, barium, beryllium, cadmium, chromium, cobalt, manganese, and vanadium. Phase II groundwater samples exhibited an elevated chromium level (0.417 mg/L) in one well and 1,3-DNB (0.332 mg/L) in another. Groundwater samples also exhibited detectable levels of chloride, fluoride, and sulfate.

6.14 Site COP-4

Three types of disposal activities were identified at Site COP-4. These activities included burning operations in the northwest portion of the site, burial activities in the southwest portion, and surface dumping in the south central portion. The area is bounded by old roads and is transected in an east-west direction by an old railroad grade. Extensive magnetic anomalies (identified in the area south of the railroad tracks) and debris (found during excavation of test pits in this area) indicate that this area may have been used as a burial or disposal area. The area north of the railroad tracks is reported to have been used to burn ordnance. Land mine casings and pieces of TNT have been observed on the surface in the southeast corner of Site COP-4 in an area referred to as the former land mine disposal area.

TNT, HMX, RDX, and 1,3,5-TNB were detected in samples collected from the surface and throughout the soil column to a depth of 6 feet in the burial area south of the railroad tracks.

Concentrations of 2-amino-4,6-DNT, 2,6-DNT, 2-nitrotoluene, and 4-nitrotoluene were also detected in soil samples. HMX and RDX were also detected in one soil boring in the 12- to 14-foot interval. Metals such as antimony, arsenic, barium, beryllium, cadmium, calcium,

chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, silver, sodium, thallium, and zinc were also detected in soils in varying sample intervals.

Surface soil samples collected from the reported burn area north of the railroad grade contained no detectable concentrations of nitroaromatic compounds. One surface soil sample exhibited levels of barium, calcium, copper, lead, silver, and zinc above background concentrations. Soil samples collected from the former land mine disposal area revealed significant concentrations of nitroaromatic compounds. Constituent concentrations are highest in the surface soils for RDX and TNT in various sampling intervals between 0 and 10 feet. Metals detected in soil samples were sporadic in this area. Only three metals were detected above background more than once: calcium, lead and mercury.

Metals detected above background in groundwater samples include aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, selenium, silver, vanadium, and zinc. Arsenic, beryllium, chromium, copper, lead, and zinc were detected at levels above background in samples from Well COP4-3 during the Phase II sampling. RDX was detected in Phase II groundwater samples at 0.00118 and 0.00199 mg/L. No Phase I groundwater samples exhibited detectable concentrations of nitroaromatic compounds.

6.15 Site Bunker 1-3

The Bunker 1-3 Site is one of approximately 85 bunkers in Area 13 originally built for storage of 500-pound bombs. Many of the bunkers are still being used by Olin Corporation and U.S. Powder to store explosive materials. There was a report of a chemical spill occurrence at Bunker 1-3. This spill apparently occurred in the adjacent field to the northwest side of the bunker and was evidenced by an area of discolored vegetation. The nature of the spilled chemical is unknown. This area was investigated in the 1988 RI and referred to as Site 19 (O'Brien & Gere, 1988).

During the Phase I investigation, one monitoring well was installed and sampled, and three composite surface soil samples were collected to investigate the potential residues of the reported spill. The vegetation in this area appeared normal. No sign of the reported discolored vegetation or other evidence of impact was observed during the Phase I field activities. One confirmatory groundwater sample was collected from Well MW-BKR1-3-1 during the Phase II investigation and analyzed for nitroaromatic compounds and priority pollutant metals. None of the surface soil, monitoring well boring soil, or groundwater samples exhibited any nitroaromatic compounds above detection limits or metals above background levels.

6.16 Summary

Based on the findings of the RI Report, environmental media (soil, sediment, surface water, and groundwater) at 13 of the 15 sites in the EMMA OU have been affected by IOP-related activities. The sites contain metals (such as lead) and nitroaromatic compounds in various media above background concentrations. Results of the chemical analyses indicate that Sites COC-3, COC-9, and COP-4 exhibit the greatest effects from IOP-related activities. These sites were subject to disposal activities and exhibit nitroaromatic compounds and metals (such as lead) concentrations in soil, sediment, surface water, and groundwater. Data indicate that IOP-related constituents are present at the EMMA OU in discrete, localized areas within defined boundaries.

7.0 Summary of Site Risks

In order to characterize the potential current and future threats to human health and the environment that may be posed by the constituents at the EMMA OU, a BRA Report was prepared in accordance with USEPA's Risk Assessment Guidance for Superfund (RAGS): Volumes I - Human Health Evaluation Manual (Part A) and Volume II - Environmental Evaluation Manual. Because the EMMA OU sites are located on a national wildlife refuge, additional ecological studies were conducted to ensure a thorough characterization of the potential ecological risks posed by the EMMA OU sites. A Preliminary Ecological Risk Assessment (Preliminary Assessment) was completed in September 1993. The purpose of the Preliminary Assessment was to determine if any of the EMMA OU sites would require further characterization during Phase II of the RI field investigations. The result of the Preliminary Assessment indicated that further characterization was required at Sites COC-1, COC-3, COC-5, COC-6, COC-9, COC-10, COP-1, and COP-4. The additional data required at these sites were predominately surface water and sediment data in order to determine risks to aquatic life. Soil samples were required at some of the sites, and small mammal trapping was conducted in order to characterize the risks posed by constituents of concern found in the soils at Site COC-9. In addition, aquatic toxicity testing was conducted on water samples obtained from Site COC-6. The purpose of the aquatic toxicity testing was to determine if surface water from Site COC-6 would adversely effect the survival, growth or reproduction of an aquatic test species. The additional data collection activities were conducted during the Phase II RI field investigations and the results were incorporated into the BRA Report (Volume III of the RI Report).

7.1 Human Health Risks

7.1.1 Identification of Constituents of Concern

Over 40 constituents (including volatile organics, nitroaromatic compounds, and inorganics) were detected in the soil, groundwater, surface water, sediment and/or animal tissue samples (Site COC-9) collected at the EMMA OU sites. After a screening of constituents was conducted, during which blanks, background concentrations, and data useability were considered, a total of 45 constituents were selected as potential constituents of concern for the EMMA OU sites. These 45 constituents were used to evaluate the risks posed at the EMMA OU sites. However, not every constituent selected was detected at every EMMA OU site nor in every environmental medium sampled. As a result, for each exposure pathway evaluated in the BRA, the potential human health risks were characterized based on the detected potential constituents of concern present in the relevant medium at each EMMA OU site. The results of the BRA showed that potential unacceptable human health risks were limited to RDX; 1,3,5-TNB; and TNT in the soil.

7.1.2 Human Health Exposure Assessment

The exposure assessment in the BRA identified potential receptors and complete exposure pathways, and estimated chemical intakes for potentially exposed populations. The following human receptor groups were evaluated for quantitative evaluation in the BRA:

- on-site workers; and
- recreational users.

Exposures to potential human receptors were evaluated in the BRA for soil, air, surface water, and sediment. Exposure pathways evaluated were incidental ingestion, dermal contact, and inhalation. The shallow groundwater direct exposure pathway was not evaluated in the BRA because there is currently no use of the shallow groundwater, and no future use of the shallow groundwater is expected at the EMMA OU sites (i.e., it is an incomplete exposure pathway). The food chain (bioaccumulation) pathway was evaluated for human recreational receptors.

Future human and ecological exposure scenarios are expected to remain unchanged from the current scenarios at the EMMA OU. Because the site is a National Wildlife Refuge, future residential development is not possible. However, in the event that the refuge property would be transferred to the private sector, such a transfer would be subject to CERCLA/SARA Section 120(h)(3) and (4). This section states that the parcels must be uncontaminated or a covenant must be issued by USEPA that all necessary remedial action had been taken. In such a case, the future use scenario used in the BRA would be reevaluated.

The exposure concentrations for current human exposure to soil were calculated by using only soil data for the 0- to 2-foot interval at each site. The available surface water and sediment data were used to calculate the exposure concentrations for these media. The exposure concentrations for dust and volatiles in the air were based on the appropriate soil data and estimated concentrations in air.

For each human exposure pathway evaluated, carcinogenic and non-carcinogenic health risks were characterized for the reasonable maximum exposure (RME), and the reasonable average exposure (RAE) scenarios. The standard and default exposure assumptions recommended by USEPA's RAGS were used, as well as conservative assumptions and professional judgement. The methods and assumptions used in the exposure assessment are presented in Section 3.6 of the BRA Report.

7.1.3 Human Health Toxicity Assessment

Available toxicity factors of carcinogenic and noncarcinogenic chemicals of potential concern are discussed and presented in Section 4.0 of the BRA Report (Volume III of the RI Report). The chemicals of potential concern selected for the risk assessment for the site have a wide range of carcinogenic and noncarcinogenic effects associated with them. The reference dose (RfD) values

and carcinogenic slope factors (CSF) were key dose-response variables used in the BRA. The RfD, expressed in units of milligrams per kilogram per day (mg/kg/day), for a specific chemical is an estimated daily intake rate that appears to pose no risk over a lifetime of exposure. The RfD value is used to assess noncarcinogenic effects. The CSF, expressed in units of $(mg/kg/day)^{-1}$ provides a conservative estimate of the probability of cancer development from a lifetime of exposure to a particular level of a potential carcinogen. Brief toxicity summaries of the chemicals of potential concern that may present the greatest carcinogenic risks and are present at the highest concentrations at the site are presented in Appendix F of the RI Report.

7.1.4 Human Health Risk Characterization

Potential excess carcinogenic risks were calculated for individual constituents by multiplying exposure levels of each constituent by the appropriate CSF. The total combined potential health risks were also evaluated for each pathway by summing estimates derived for each constituent of concern for that pathway. Risks from inhalation, skin absorption, and oral exposures can be added to estimate total overall potential risk to human receptors.

The site-specific potential carcinogenic risk estimates were based on the RME and RAE scenarios. The potential cancer risks associated with the known or suspected carcinogens detected at the EMMA OU sites were compared to the USEPA acceptable cancer risk range of 1.0E-4 to 1.0E-06.

The potential for noncarcinogenic effects was evaluated by comparing an exposure level over a specified time period (e.g., the daily dose in mg/kg/day for a long period up to a lifetime) with a RfD derived for a similar period (USEPA, 1989a). This ratio of exposure to toxicity is called a noncarcinogenic hazard quotient (HQ). The HQ assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects (USEPA, 1989). If the exposure level exceeds the threshold level (i.e., if the HQ exceeds one or unity), there may be concern for potential noncarcinogenic effects. Total pathway hazard indexes (HIs) were calculated by summing the HQ for each constituent of concern. This additive approach assumes that multiple subthreshold exposures could result in an adverse effect and that the magnitude of the effect is proportional to the sum of the ratios of the exposure to acceptable exposures. The possible effects of multimedia exposures were evaluated by summing the HI values for the relevant exposure routes.

The BRA determined that there are no potential unacceptable human health risks associated with potential exposures to constituents at Sites COC-1, COC-2, COC-4, COC-5, COC-6, COC-7, COC-8, COC-9, COC-10, COP-1, COP-2, COP-3, and Bunker 1-3 (ESE, 1994). Although Site COC-9 has an HI of 3.0E+00 for the RME scenario, when this HI is evaluated on the basis of critical effects, the total HIs for each effect are less than unity. Therefore, there are no potential unacceptable risks to human health at Site COC-9.

Potential unacceptable human health risks are associated with potential exposures to constituents of concern in surface soils at Site COC-3. Potential unacceptable human health risks are associated with concentrations of 1,3,5-TNB and TNT in soil. The potential unacceptable human health risks posed by Site COC-3 are as follows: the total adult worker HIs (all pathways) range from 1E+01 to 5E+02. The total adult worker potential carcinogenic risk levels (all pathways) range from 8E-05 to 3E-03. The total adult and child recreational user HIs range from 2E+01 to 2E+02 and from 6E+01 to 5E+02, respectively. The total recreational user potential carcinogenic risk levels (all pathways) range from 5E-05 to 1E-03 (ESE, 1994).

As indicated by the BRA, potential unacceptable human health risks are associated with potential exposures to constituents of concern in surface soils at Site COP-4 (ESE, 1994). Potential human health risks at Site COP-4 are associated with concentrations of RDX, 1,3,5-TNB, and TNT in soil. The total adult worker HIs (all pathways) range from 9E+00 to 3E+02, and the total adult worker potential carcinogenic risk levels (all pathways) range from 1E-04 to 8E-03. The total adult and child recreational user HIs range from 1E+01 to 1E+02 and from 3E+01 to 4E+02, respectively. The total recreational user potential carcinogenic risk levels for all pathways combined range from 1E-04 to 3E-03.

7.2 Ecological Risk Summary

7.2.1 Identification of Constituents of Concern

Over 40 constituents (including volatile organics, explosives, and inorganics) were detected in soil, groundwater, surface water, sediment, and/or animal tissue samples (Site COC-9) collected at the EMMA OU sites. After a screening of constituents was conducted, during which blanks, background concentrations, and data useability were considered, a total of 45 constituents were selected as potential constituents of concern for the EMMA OU sites. These 45 constituents were used to evaluate the risks posed at the EMMA OU sites. However, not every constituent selected was detected at every EMMA OU site nor in every environmental medium sampled. As a result, for each exposure pathway evaluated in the BRA, the potential ecological risks were characterized based on the detected potential constituents of concern present in the relevant medium at each EMMA OU site.

Potential ecological risks were characterized based on the detected constituents of concern present in the relevant medium at each EMMA OU site. Information about the specific constituents of concern detected at each site and in each medium is presented in Section 6.0 of this ROD.

Based on the results of the BRA, the constituents of concern that pose an unacceptable ecological risk were identified. These constituents occurred at Sites COC-3, COP-4, COC-4, and COC-6. For Site COC-3, these constituents of concern are 1,3,5-TNB; TNT; iron; lead; and zinc in the

soil. For Site COP-4, the constituents of concern are HMX; RDX; 1,3,5-TNB; 2,4,6-TNT; and zinc in the soil. At Site COC-4, the constituents of concern are 2,4,6-TNT, aluminum, and iron. At Site COC-6, the constituent of concern is manganese.

7.2.2 Ecological Exposure Assessment

The exposure assessment in the BRA identified potential receptors and complete exposure pathways, and estimated chemical intakes for potentially exposed populations. Terrestrial, aquatic, and vegetative ecological receptor groups were evaluated for quantitative evaluation in the BRA (Volume III of the RI Report).

Exposures to potential ecological receptors, including a number of terrestrial, aquatic, and vegetative receptors, were evaluated for soil, surface water, and sediment. Because direct exposure of ecological receptors to groundwater is not expected at the EMMA OU sites, this exposure pathway was not evaluated in the BRA. The groundwater pathway was evaluated in the ecological risk assessment in terms of potential groundwater discharge to surface water causing potential risks to aquatic species through exposure to affected surface water and sediment. The food chain (bioaccumulation) pathway was also evaluated for ecological receptors. Future ecological exposure scenarios are expected to remain unchanged from the current scenarios at the EMMA OU.

Current ecological exposure scenarios at the EMMA OU sites included a number of terrestrial and aquatic receptors. Because of the large number of different species of wildlife that are known or suspected of inhabiting the EMMA OU sites, it was not possible to evaluate all ecological receptors. The ecological receptors were screened based on the analysis of the ecological setting and site characteristics, and a determination of those communities/species critical to the ecological risk assessment. A detailed analysis of the ecological receptors is presented in Section 3.4.2 of the BRA (Volume III of the RI Report). After the analysis of the ecological receptors was conducted, indicator species were selected. These indicator species were chosen from the list of potential ecological receptors and are those species that appeared to be at greatest risk from exposure to potential constituents of concern.

The selected representative ecological receptors are the following:

- Large mammal (white-tailed deer — recreational importance);
- Small mammal (mouse and squirrel — high abundance in food chain);
- Bobwhite quail (potential for bioaccumulation — primary consumer);
- Red-tailed hawk/American kestrel (bioaccumulation — secondary consumer);
- Bald eagle (endangered species at the time of BRA);
- Terrestrial vegetation (habitat indicator); and
- Aquatic life in general (water quality indicator).

Because the species of concern would be expected to be exposed to surface conditions only, the upper 0 to 2 feet of soil best represent typical exposure conditions for ecological receptors. Constituents within the upper 0 to 2 feet of soil are available for uptake by plants, transfer to food, and ultimate consumption by wildlife. In addition, the available surface water and sediment data were used to calculate the exposure concentrations for these media.

Potential exposures to mammalian receptors were evaluated for soil, surface water, sediment, and food. Potential exposures to bobwhite quail were evaluated for the consumption of food only. Since most of their daily water requirements are met through consumption of food, water ingestion was not evaluated for the bobwhite quail. The red-tailed hawk and American kestrel were assumed to be primarily exposed to constituents of concern through the consumption of prey such as small mammals. The bald eagle was assumed to be exposed to constituents of concern through the consumption of fish, in which constituents of concern may bioaccumulate. Aquatic life was assumed to be primarily exposed to constituents of concern through direct contact with surface water. The estimation of potential exposure for these aquatic species assume that they are continuously in direct contact with surface water.

Estimates of potential exposure to constituents through food for terrestrial animals were determined by approximating the uptake of constituents from soil into plants and multiplying this by the amount of vegetation consumed by the animal. The specific ecological exposure assumptions are discussed in detail in Section 3.6.2 of the BRA (Volume III of the RI Report).

7.2.3 Ecological Toxicity Assessment

The toxicities of the constituents of concern were assessed for effects on vegetation, aquatic life, and terrestrial wildlife, including birds. Toxicity data for effects on flora were primarily qualitative, whereas information on fauna were more quantitative. Toxicological literature was reviewed, and toxicity values were identified for indicator or related species. These toxicity values were converted into units of acceptable daily intake (mg/kg BW/day) and are referred to as critical toxicity values (CTV). Available CTV for constituents of concern are discussed and presented in Section 4.3 of the BRA (Volume III of the RI Report).

Toxicity data for terrestrial wildlife are not nearly as complete as that found for aquatic species. Consequently, extrapolation of toxicity data from one animal species to another was often necessary. Because of the uncertainty associated with these extrapolations, safety factors were applied to eco-toxicological endpoints to derive CTVs. Chronic or sub-chronic toxicity values were used when ever possible. A no-observed-effect level (NOEL) was used over a lowest-observed-effect level (LOEL). If only a LOEL was available, a safety factor was applied to derive a NOEL. The NOEL safety factor calculations are presented in Section 4.3 of the BRA (Volume III of the RI Report).

Toxicity data were limited for those indicator wildlife species for which potential quantitative exposure was possible for the constituents of concern. Thus, toxicity values from the literature were derived using the most closely related species, where possible. The CTVs for white-tailed deer, squirrel/mouse, bob-white quail, red-tailed hawk/American kestrel, and bald eagle were found in the literature and used in the BRA.

The toxicity of constituents of concern to aquatic life were assessed by comparing surface water concentrations at the site to available acute and/or chronic Ambient Water Quality Criteria (AWQC) for the protection of aquatic life. These criteria are derived to protect 95 percent of aquatic organisms, including fish, invertebrates, and aquatic plants. Therefore, not only fish, but also aquatic invertebrates and plants are protected (USEPA, 1986). Consequently, comparison of maximum surface water concentrations with these criteria were used to determine the likelihood of adverse effects to aquatic life.

Two site-specific studies were conducted at the EMMA OU to study toxicity (Appendices I and J of the RI Report). Toxicity of metals constituents to small mammals was studied through tissue sampling and analysis of several mice live trapped at Site COC-9 and a control area. Observations and data were statistically evaluated between Site COC-9 and the control area, and showed no significant differences. This toxicity study documented a No Observable Adverse Effect Level (NOAEL) for the concentrations of metals detected at Site COC-9. The toxicity of surface water at Site COC-6 to aquatic species was studied using *Ceriodaphnia dubia* as a representative species following procedures approved by USEPA, IEPA, and USFWS. The results of the toxicity testing showed that no adverse survival or reproductive effects were caused by exposure to surface water at Site COC-6.

7.2.4 Ecological Risk Characterization

Potential risks to terrestrial and aquatic receptors were quantified by comparing the estimated daily intakes or media exposure concentrations with CTVs. This comparison is defined as an Ecological Risk Index (ERI). Cumulative ERIs were developed to determine whether species of concern would receive excessive exposure to a mixture of constituents from each route of exposure. If the cumulative ERI is greater than 1, it suggests that the total exposure to all constituents of concern through all exposure pathways is sufficient to produce a potential risk of adverse effects to the species of concern.

Potential ecological risks were estimated on the basis of several conservative assumptions that tend to overestimate the actual risks. Uncertainties in the ecological risk assessment were associated with elevated detection limits, fate and transport modeling (sediment equilibrium model and food uptake models), exposure assumptions (media intake rates), and toxicity information. The major uncertainty associated with the ecological risk characterization is the lack of available environmental toxicity data. In order to quantify the uncertainty associated with exposure and

toxicity assumptions incorporated into the ecological risk assessment, a chronic aquatic toxicity test was conducted on a surface water sample collected from Site COC-6, and a small mammal field study was conducted at Site COC-9. Details of these ecological studies are presented in the BRA (Volume III of the RI Report). Aquatic toxicity testing suggested that the estimated ecological risks to aquatic receptors may be overly conservative by as much as two orders of magnitude. In addition, the small mammal field study suggested that estimated ecological risks to the small mammal may be overly conservative by up to three orders of magnitude.

The BRA determined that there are no potential unacceptable ecological risks associated with potential exposures to constituents at Sites COC-1, COC-2, COC-5, COC-7, COC-8, COC-9, COC-10, COP-1, COP-2, COP-3, and Bunker 1-3 (ESE, 1994).

Potential unacceptable ecological risks are associated with potential exposures to constituents of concern at Site COC-3. Potential unacceptable ecological risks (bobwhite quail and white-tailed deer) are associated with concentrations of 1,3,5-TNB and TNT in soil. The total white-tailed deer ERIs range from 1E+04 to 5E+04. In addition, potential ecological risks are also associated with concentrations of iron and lead in soil (the small mammal) and with zinc in soil (the bobwhite quail). The total small mammal ERIs (all pathways) range from 3E+02 to 1E+04. The total ERIs for the bobwhite quail range from 5E+06 to 2E+07.

The BRA indicated that Site COC-4 poses a potential ecological risk to bobwhite quail, while not posing any unacceptable risk to human health. Potential ecological risks associated with Site COC-4 are several orders of magnitude lower than the potential risks posed by Sites COC-3 and COP-4. Specifically, potential unacceptable risks exist to individual small mammals (ERI exceeds unity, 4E+00 to 6E+01) and to the bobwhite quail (ERI exceeds unity, 3E+01 to 1E+02). In order to avoid the application of order-of-magnitude uncertainty factors that result in risks being overestimated, Site COC-4 will be further evaluated.

The BRA also indicated that there is potential unacceptable risk associated with potential exposure to manganese in surface water for the bald eagle at Site COC-6 (ESE, 1994). However, this potential unacceptable risk is based on an exposure scenario that is extremely unlikely.

As indicated by the BRA, potential unacceptable ecological risks are associated with potential exposures to constituents of concern at Site COP-4 (ESE, 1994). Potential ecological risks are associated with concentrations of HMX, RDX, 1,3,5-TNB, and TNT in soil for the white-tailed deer (ERIs range from 7E+03 to 4E+04), small mammal (ERIs range from 4E+06 to 2E+07), and bobwhite quail (ERIs range from 3E+06 to 1E+07). In addition, potential ecological risks are also associated with concentrations of zinc in soil for the bobwhite quail.

While the ecological risk analysis suggested potential risks to individual animals, it is unlikely that the local (i.e., refuge) ecosystems would be adversely affected due to the relatively small size of Sites COC-3 and COP-4. These sites comprise a very small portion of the refuge. The refuge covers 43,500 acres, while Site COC-3 only covers approximately 71,500 square feet and Site COP-4 covers approximately 4,900 square feet for a total of 1.75 acres. As a consequence, this analysis in Section 5.5 of the BRA (Volume III of the RI Report) strongly suggested that effects at the population and higher levels of biological organization are unlikely.

7.3 BRA Conclusions

In conclusion, the BRA found that Sites COC-3 and COP-4 pose potential unacceptable human health and ecological risks. The potential ecological risks are to the white-tailed deer, small mammal, and bobwhite quail. Potential ecological risks posed at Sites COC-3 and COP-4 are of comparable magnitude, with the exception of the potential ecological risk to small mammals. The potential ecological risks to small mammals at Site COP-4 (primarily associated with concentrations of HMX and RDX) are several orders of magnitude greater than the potential small mammal risk found at Site COC-3. Actual or threatened releases of hazardous substances from Sites COC-3 and COP-4, if not addressed by implementing the response action selected in this ROD, may present a current or potential risk to public health, welfare, and the environment. As previously mentioned, Site COC-4 will be further evaluated. Therefore, it has not been determined if remedial action will be necessary at Site COC-4.

8.0 Description of Alternatives

Seven alternatives were analyzed in the FS for their ability to protect human health and the environment, comply with legal requirements, and be cost effective. The evaluations of capital costs, operation and maintenance (O&M) costs, net present worth costs, and implementation times presented below are estimates. Each alternative, except the No Action alternative, will include a provision for land use controls at Sites COC-3 and COP-4. Implementation of land use controls at Sites COC-3 and COP-4 will reduce the potential for future exposure to the remaining affected soil (soil containing contaminants above remediation goals) and restrict the construction of drinking water wells at Sites COC-3 and COP-4. These land use controls include restriction of the following activities: groundwater well installation; subgrade activities; and pond creation within the perimeters of the soil covers at Sites COC-3 and COP-4.

Under Alternatives 2 through 5 and 7, soil at Sites COC-3 and COP-4 with concentrations of nitroaromatic compounds greater than 100,000 mg/kg and lead above 450 mg/kg [approximately 270 cubic yards (cy)] will be excavated and transported offsite to a commercial incinerator. The soils may be reactive and pose a potential safety hazard ("Explosives Safety," U.S. Army Technical Center for Explosives Safety, June 1995). The soil will be rendered safe prior to shipment for offsite treatment and disposal. The excavated soil with greater than 100,000 mg/kg nitroaromatic compounds and 450 mg/kg lead will be classified by appropriate waste code(s) prior to shipment for offsite treatment and disposal. Potential waste codes that may be associated with the excavated soil include D003 (reactive), D008 [toxicity characteristic leaching procedure (TCLP) lead at 5 mg/L] and D030 (TCLP 2,4-DNT at 0.13 mg/L).

Soils remaining after the above removal action will be tested using TCLP. Any soil that is shown by TCLP testing to fall within the RCRA definition of a "characteristically hazardous waste" will be excavated and properly treated and disposed of at a RCRA treatment, storage, and disposal (TSD) facility.

Under Alternatives 2 through 7, groundwater monitoring will occur at Sites COC-3 and COP-4. The scope of the groundwater monitoring program presented in Table 5-2 of this ROD is for costing purposes only. The final groundwater monitoring program will be developed during design as part of the O&M plan. The construction of fencing for Alternative 2 will consist of an 8-foot high chain link fence, 2 feet of which will be buried.

Under Alternatives 3A, 3B, 3C, 5B, and 5C, where the installation of covers/caps are specified, O&M activities will include periodic maintenance and repair of the covers/caps. Repairs to the soil covers/caps will be made as required. O&M activities will also include long-term maintenance of the fencing under Alternative 2.

8.1 Alternative 1 — No Action

The No Action alternative leaves the EMMA OU sites in their current condition. Monitoring will not take place under this alternative. No remedial actions that result in the treatment, containment, or removal of affected soil are implemented under Alternative 1. The NCP requires the consideration of a No Action alternative. The No Action alternative is also used as a baseline for comparison with other remedial alternatives.

Capital Costs	$0
Present Worth O&M	$0
Total Present Worth Costs	$0
Time to Construct	0

8.2 Alternative 2 — Removal/Fencing/Land Use Controls/ Groundwater Monitoring

Alternative 2 consists of the following elements:

- removal and offsite treatment (offsite incineration) and disposal of soil containing nitroaromatic compounds greater than 100,000 mg/kg and lead above 450 mg/kg (approximately 270 cy);
- sampling to ensure that remaining affected soil (i.e., soil with contaminants above remediation goals) at Sites COC-3 and COP-4 does not exhibit the characteristics of a RCRA hazardous waste for lead and 2,4-DNT;
- backfill excavated area to grade;
- construction of fencing around the remaining affected soil at Sites COC-3 and COP-4;
- long-term maintenance of the fencing;
- groundwater monitoring at Sites COC-3 and COP-4; and
- implementation of land use controls.

Capital Costs	$3,011,000
Present Worth O&M Costs	$292,400
Total Present Worth	$3,303,400
Time to Construct	4 months

8.3 Alternative 3 — Removal/Land Use Controls/Groundwater Monitoring/Covering or Capping

Alternative 3 consists of the following elements:

- removal and offsite treatment (offsite incineration) and disposal of soil containing nitroaromatic compounds greater than 100,000 mg/kg and lead above 450 mg/kg (approximately 270 cy);

- additional removal of contaminated soils at Site COP-4 to depth of two feet below grade within the existing fenced area, with disposal of excavated soils at an offsite permitted special waste landfill (applicable to Alternative 3A only);
- sampling to ensure that remaining affected soil at Sites COC-3 and COP-4 does not exhibit the characteristic of RCRA hazardous waste for lead and 2,4-DNT;
- backfill excavated areas to shape the base of the covers;
- construction and maintenance of soil covers (Alternative 3A), multimedia (RCRA type) caps (Alternative 3B), or composite-barrier (RCRA) caps (Alternative 3C) over the remaining affected soil areas at Sites COC-3 and COP-4;
- groundwater monitoring at Sites COC-3 and COP-4;
- implementation of land use controls at Sites COC-3 and COP-4; and
- long-term maintenance of the soil covers or caps for a period of up to 30 years.

Erosion control measures including installation of a temporary stormwater retention basin will be implemented during cover/cap construction at Site COC-3 due to the gully that extends through the northern end of the site. Permanent runon/runoff control measures will remain in place for the life of the covers or caps.

The caps under Alternatives 3B and 3C will reduce the infiltration of surface water into the affected soil by diverting it through the drainage layer. The combined thickness of the soil layers and the use of a stone drainage layer will help reduce the potential risk of damage to the geomembrane and greatly restrict dermal contact with the underlying affected soil.

8.3.1 Soil Covers (Alternative 3A)

The soil covers consist of (from the top down) 6 inches of topsoil to retain moisture and promote the growth of vegetative cover, and 18 inches of clay-rich soil to support the root zone. Random fill will be placed over the excavated area to shape the base of the cover and to achieve the desired grade. Soils with contaminants above remediation goals may be consolidated and used as random fill. The total thickness of the covers (24 inches) will adequately prevent humans and animals from contacting affected soil.

Capital Costs	$3,468,000
Present Worth O&M Costs	$251,700
Total Present Worth	$3,719,700
Time to Construct	8 months

8.3.2 Multimedia Caps (Alternative 3B)

The multimedia caps will consist of 72 inches of material containing (from the top down) topsoil to retain moisture and promote the growth of vegetative cover; clay-rich soil to support the root

zone; a drainage layer consisting of stones sandwiched between layers of geotextile material; and an impermeable geomembrane. A layer of random fill will also be placed over the excavated areas to shape the base of the cap and to achieve the desired grade.

Capital Costs	$4,046,600
Present Worth O&M Costs	$290,300
Total Present Worth	$4,366,900
Time to Construct	8 months

8.3.3 Composite-barrier Caps (Alternative 3C)

The composite-barrier caps are comprised of 60 inches of material containing (from the top down) topsoil to retain moisture and promote the growth of vegetative cover; clay-rich soil to support the root zone; a drainage layer consisting of cobbles (3 to 6 inches in diameter) sandwiched between two layers of geotextile material; and an impermeable geomembrane followed by a clay barrier. A layer of random fill will also be placed over the excavated areas to shape the base of the cap and to achieve the desired grade.

Capital Costs	$4,139,500
Present Worth O&M Costs	$290,300
Total Present Worth	$4,429,800
Time to Construct	8 months

8.4 Alternative 4 — Removal/Land Use Controls/Groundwater Monitoring/Excavation/Offsite Disposal/Backfill/Restoration

Alternative 4 consists of the following elements:

- removal and offsite treatment (offsite incineration) and disposal of soil containing nitroaromatic compounds greater than 100,000 mg/kg and lead above 450 mg/kg (approximately 270 cy);
- excavation of remaining affected soils at Sites COC-3 and COP-4 to a depth of 5 feet (approximately 8,870 cy);
- sampling to ensure that remaining affected soil at Sites COC-3 and COP-4 does not exhibit the characteristic of a RCRA hazardous waste;
- transportation and disposal of these soils to an offsite permitted special waste landfill;
- backfill excavated area to grade;
- restoration of site;
- groundwater monitoring at Sites COC-3 and COP-4; and
- implementation of land use controls at Sites COC-3 and COP-4.

Restoration of sites will include covering the backfilled areas with topsoil and revegetation.

Capital Costs	$4,193,000
Present Worth O&M Costs	$193,300
Total Present Worth	$4,386,300
Time to Construct	8 months

8.5 Alternative 5 — Removal/Land Use Controls/Groundwater Monitoring/Excavation/Composting/Backfill Composted Soil/Capping

Alternative 5 consists of the following elements:

- removal and offsite treatment (offsite incineration) and disposal of soil containing nitroaromatic compounds greater than 100,000 mg/kg and lead above 450 mg/kg (approximately 270 cy);

- excavation of affected soil to a depth of 5 feet (approximately 8,870 cy) from Sites COC-3 and COP-4 for Alternative 5A;
- excavation of affected soil to a depth of 2 feet (approximately 3,550 cy) from Sites COC-3 and COP-4 for Alternatives 5B and 5C;
- sampling to ensure that remaining affected soil at Sites COC-3 and COP-4 does not exhibit the characteristic of a RCRA hazardous waste;
- subsequent treatment of this soil by composting to degrade the nitroaromatic compounds down to remediation goals;
- backfilling excavated areas with treated soils;
- site restoration;
- construction and maintenance of multimedia (RCRA-type) caps (Alternative 5B), or composite-barrier (RCRA) caps (Alternative 5C) over the remaining affected soil areas at Sites COC-3 and COP-4;
- groundwater monitoring;
- long-term maintenance of the caps (Alternatives 5B and 5C) for a period of up to 30 years; and
- implementation of land use controls at Sites COC-3 and COP-4.

Site restoration will consist of removal of the treatment equipment and structures, covering the area with topsoil, and revegetating for Alternative 5A, multimedia capping for Alternative 5B, and composite-barrier capping for Alternative 5C.

Alternative 5A:

Capital Costs	$4,967,200
Present Worth O&M Costs	$2,440,300
Total Present Worth	$7,407,500
Time to Construct	3 years

Alternative 5B:	
Capital Costs	$7,222,500
Present Worth O&M Costs	$1,584,900
Total Present Worth	$8,807,400
Time to Construct	2 years
Alternative 5C:	
Capital Costs	$7,454,900
Present Worth O&M Costs	$1,585,800
Total Present Worth	$9,040,700
Time to Construct	2 years

8.6 Alternative 6 — Land Use Controls/Groundwater Monitoring/ Excavation/On-site Incineration/Backfill Incinerated Soil/ Restoration

Alternative 6 consists of the following elements:

- excavation of approximately 3,820 cy of affected soil to a depth of 2 feet;
- sampling to ensure that remaining affected soil at Sites COC-3 and COP-4 does not exhibit the characteristic of a RCRA hazardous waste;
- incineration of this soil in a mobile on-site incineration unit;
- backfill of excavated areas with treated soil;
- site restoration;
- groundwater monitoring; and
- implementation of land use controls at Sites COC-3 and COP-4.

The mobile incineration unit will be transported in modular sections and then fully assembled at the EMMA OU. Following incineration and destruction of the nitroaromatic compounds in the excavated soil, the residual ash will be tested to verify that it is below remediation goals prior to using it as backfill material. Should the ash be characterized as a hazardous waste or exceed remediation goals for lead, it will be disposed of properly. Site restoration will consist of removal of the treatment equipment and structures, covering the backfilled areas with topsoil, and revegetating. For the purpose of this cost estimate, it is assumed that the residual ash will not be characterized as a hazardous waste.

Capital Costs	$8,129,600
Present Worth O&M Costs	$193,300
Total Present Worth	$8,322,900
Time to Construct	10 months

8.7 Alternative 7 — Land Use Controls/Groundwater Monitoring/ Excavation/Offsite Incineration/Backfill Soil/Restoration

Alternative 7 consists of the following elements:

- excavation of approximately 3,820 cy of affected soil to a depth of 2 feet;
- subsequent mixing of this soil for ease of handling;
- sampling to ensure that remaining affected soil at Sites COC-3 and COP-4 does not exhibit the characteristic of a RCRA hazardous waste;
- backfill excavated areas to grade;
- transportation of the soil to an offsite incinerator for incineration;
- site restoration;
- groundwater monitoring at Sites COC-3 and COP-4; and
- implementation of land use controls at Sites COC-3 and COP-4.

The soil will be transported offsite by a licensed transporter to a permitted waste incinerator. Site restoration will consist of covering the backfilled areas with topsoil, and revegetating.

Capital Costs	$10,545,500
Present Worth O&M Costs	$193,300
Total Present Worth	$10,738,800
Time to Construct	8 months

9.0 Summary of the Comparative Analysis of Alternatives

In accordance with the provisions set forth in CERCLA, SARA, and the NCP, each of the alternatives was evaluated against nine established criteria. Overall protection of human health and the environment and attainment of applicable or relevant and appropriate requirements (ARARs) are threshold criteria and the primary objectives of a remedial action. In addition, the selected remedial alternative must reflect the best balance among criteria such as reduction of nitroaromatic compounds; short- and long-term effectiveness; implementability; and cost. Support agency and community acceptance are also considered during the evaluation. These nine criteria are as follows:

Threshold Criteria

- **Overall Protection of Human Health and the Environment** determines whether an alternative eliminates, reduces, or controls threats to human health and the environment.
- **Compliance with ARARs** evaluates whether the alternative meets federal and state environmental laws pertaining to the site.

Balancing Criteria

- **Long-term Effectiveness and Permanence** considers the ability of an alternative to protect human health and the environment over time.
- **Reduction of Toxicity, Mobility or Volume Through Treatment** evaluates an alternative's use of treatment to reduce the harmful nature of contaminants, their ability to move in the environment, and the amount of contamination present.
- **Short-term Effectiveness** considers the length of time needed to implement an alternative and the risks it poses for workers, residents, and the environment during implementation.
- **Implementability** considers the technical and administrative feasibility of implementing an alternative.
- **Cost** evaluates estimated capital and O&M costs, as well as present-worth costs.

Modifying Criteria

- **State Acceptance** considers whether the IEPA and USFWS agree with the recommended alternative as presented in the ROD.
- **Community Acceptance** considers the public's response to the alternatives described in the FS and the Proposed Plan. Specific responses to public comments are contained in the Responsiveness Summary attached to this ROD.

The seven alternatives are compared under the various evaluation criteria, profiling the performance of the alternatives against the nine criteria. A summary of this comparison is provided in Table 9-1.

Table 9-1. Remedial Alternative Evaluation Summary

	No Further Action 1	Removal/Fencing/Land Use Controls/Groundwater Monitoring 2	Removal/Land Use Controls/ Groundwater Monitoring/Clay and Soil Covers 3A	Removal/Land Use Controls/ Groundwater Monitoring/Multimedia Caps 3B	Removal/Land Use Controls/Groundwater Monitoring/Composite-barrier Caps 3C	Removal/Land Use Controls/Groundwater Monitoring/Excavation/Offsite Disposal/Backfill/Restoration 4	Removal/Fencing/Land Use Controls/ Groundwater Monitoring/ Excavation/Composting/Backfill Compost/Restoration 5A	Removal/Fencing/Land Use Controls/ Groundwater Monitoring/Excavation/ Composting/Backfill Composted Soil/ Multimedia Caps 5B	Removal/Fencing/Land Use Controls/ Groundwater Monitoring/Excavation/ Composting/Backfill Composted Soil/ Composite-barrier Caps 5C	Fencing/Land Use Controls/Groundwater Monitoring/Excavation/Onsite Incineration/Backfill Incinerated Soil/ Restoration 6	Fencing/Land Use Controls/Groundwater Monitoring/Excavation/Offsite Incineration/Backfill Clean Soil/ Restoration 7
Protective of Human Health and Environment			✓	✓	✓	✓	✓	✓	✓	✓	✓
Complies with ARARs			✓	✓	✓	✓	✓	✓	✓	✓	✓
Long-Term Effectiveness			✓	✓	✓	✓	✓	✓	✓	✓	✓
Reduction of Mobility			✓	✓	✓	✓	✓	✓	✓	✓	✓
Reduction of Toxicity			✓	✓	✓	✓	✓	✓	✓	✓	✓
Reduction of Volume			✓	✓	✓	✓	✓	✓	✓	✓	✓
Short-Term Effectiveness		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Implementability	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost ($M)	0.0	3.3	3.7	4.3	4.4	4.4	7.4	8.8	9.0	8.3	10.7
Public Acceptance		✓	✓	✓	✓	✓	✓	✓	✓		✓
State Acceptance			✓	✓	✓	✓	✓	✓	✓	✓	✓

9.1 Overall Protection of Human Health and the Environment

No active mitigation processes are implemented under Alternative 1 (No Action). Alternative 1 provides limited protection to human health and the environment through natural processes (i.e., leaching, dilution, and chemical and biological degradation).

Alternative 2 (Removal/Fencing/Land Use Controls/Groundwater Monitoring) provides greater protection of human health than Alternative 1 through removal of soil with nitroaromatic compound concentrations greater than 100,000 mg/kg and implementation of land use controls and fencing to limit physical access by humans and animals to the remaining affected soil. However, Alternative 2 will only provide limited protection to human health and the environment. Soil with unacceptable carcinogenic, non-carcinogenic, or ecological risks would be accessible for direct contact and ingestion by humans and animals if the fencing is breached.

Alternatives 3 through 5 provide for the excavation and removal of soil with nitroaromatic compound concentrations greater than 100,000 mg/kg and lead greater than 450 mg/kg. Alternatives 6 and 7 provide for the incineration of affected soils to a depth of 2 feet from grade. Alternatives 3, 5B, and 5C provide a minimum of two feet of cover or capping over backfilled soil containing contaminants above remediation goals. Alternatives 4, 5A, 6, and 7 provide 6 inches of topsoil and seeding over two feet (5 feet for Alternatives 4 & 5A) of backfilled material containing either treated soil from composting (Alternative 5A), treated soil from incineration (Alternative 6), or clean soil (Alternatives 4 and 7). The remedial action objective of prohibiting human contact and minimizing wildlife contact with the affected soil would be met by the installation of soil covers or caps. Although the site contaminants still remain in the soil, the backfilled materials and soil covers or capping installed under the above alternatives will eliminate the pathway that presents potential unacceptable risks to human health and the environment (i.e., direct contact). Thus, the protective benchmarks of 1.0E-06 and HI/ERI <1 are met. The likelihood of the affected soils ever being exposed to the surface in quantities that pose unacceptable risks is low when covers/caps are placed over the affected areas and maintained. Thus Alternatives 3 through 7 provide equal degree of overall protection of human health and the environment. Alternative 5A will provide slightly lesser degree of protection to potential ecological receptors than Alternatives 3, 4, 5B, 5C, 6 & 7, if the backfilled soil (treated material from composting) under 6 inches of top soil does not meet remediation goals.

The RI/BRA evaluated the fate and transport of constituents of concern including the potential transport of constituents in groundwater to surface water. The BRA evaluated the potential ecological risk to aquatic receptors and determined that Sites COC-3 and COP-4 did not pose a potential unacceptable risk to aquatic receptors.

It may be necessary to remove existing trees during implementation of Alternatives 2 through 7. Every effort will be made not to cut trees during breeding and nesting season for residential and migratory wildlife. Any cutting of trees will be done in consultation with USFWS.

9.2 Compliance with ARARs

Compliance with chemical-specific ARARs, specifically 35 Illinois Administrative Code (IAC) Part 620 (Illinois Groundwater Quality Standards), will be achieved by each of the alternatives because concentrations of nitroaromatic compounds and metals in shallow groundwater will not exceed these standards. Although to be considered (TBC) values for nitroaromatic compounds in groundwater were calculated by IEPA, these values are not promulgated standards such as MCLs. Therefore, these concentrations are not chemical-specific ARARs (see Appendix B of the FS Report). Because shallow groundwater is not currently used as a drinking water source, nor is it expected to be used in the foreseeable future, a complete exposure pathway does not exist. Therefore, no unacceptable risk to human health exists. In addition, removal of soils containing greater than 100,000 mg/kg nitroaromatic compounds and lead above 450 mg/kg will occur under each alternative except the No Action alternative. Thus, Part 620 has been addressed.

Location-specific ARARs will be attained by each of the alternatives considered. Actions taken as part of the active treatment alternatives (Alternatives 2 through 7) will comply with the corresponding potential action-specific ARARs. Additional treatment of residual waste streams may potentially be required in order to comply with land disposal restrictions.

Action-specific ARARs will be met under Alternatives 2 through 7 by confirmation sampling of the excavations to ensure that soils remaining on-site do not exhibit the characteristics of a RCRA hazardous waste.

The chemical-, location-, and action-specific ARARs evaluated are presented in Section 2.0 of the FS Report. Those ARARs that apply specifically to Alternative 3A are identified in Section 11.

9.3 Long-Term Effectiveness

Because no treatment technologies have been proposed under Alternatives 1 and 2, nitroaromatic compounds and metals will be present above remediation goals in the affected soils for some time. Under each of the alternatives, the nitroaromatic compounds will degrade over time due to natural attenuation. The extent to which natural attenuation will reduce potential risks is unknown. Land use controls and fencing in Alternative 2 will restrict the use of the EMMA OU sites and potential access to the remaining nitroaromatic compounds and metals in the soil, thus reducing the potential for the pathway presenting an unacceptable risk (direct contact) to be completed.

Alternatives 3 through 7 will provide an equal degree of long-term effectiveness by further reducing the potential for direct contact with nitroaromatic compounds and metals in soil through the construction of covers or caps or increased excavation depth over the affected areas. Alternative 5A will provide a slightly lesser degree of protection to potential ecological receptors than Alternatives 3, 4, 5B, 5C, 6, and 7, if the backfilled soil (treated material from composting) under 6 inches of top soil does not meet remediation goals.

9.4 Reduction of Mobility, Toxicity, or Volume Through Treatment

Alternative 1 does not include any removal, containment, or treatment actions. Therefore, no reduction in mobility, toxicity, or volume will be attained.

Alternatives 2 through 5 include the removal and treatment (offsite incineration) of soil containing nitroaromatic compounds greater than 100,000 mg/kg. This will result in a significant reduction in the mobility, toxicity, and volume of nitroaromatic compounds and lead. In addition, Alternative 5A includes removal and treatment through composting of remaining affected soils to a depth of 5 feet. Alternatives 5B and 5C also include removal and treatment (by composting) of remaining affected soils to a depth of 2 feet. Alternatives 6 and 7 include removal and treatment (by incineration) of affected soil to a depth of 2 feet. Thus, Alternative 5A will provide the greatest reduction in mobility, toxicity, and volume through treatment followed by Alternatives 5B, 5C, 6, and 7. Alternatives 3 and 4 will provide a slightly lesser degree of reduction in mobility, toxicity and volume through treatment than Alternatives 5, 6, and 7. However, Alternatives 3A and 4 provide for additional reduction (without treatment) in mobility, toxicity, and volume through removal and offsite disposal of remaining affected soil above remediation goals. Alternative 3A includes removal and offsite disposal of remaining affected soil to a depth of 2 feet within the existing fenced area at Site COP-4. Alternative 4 includes removal and offsite disposal of remaining affected soil to a depth of 5 feet.

9.5 Short-Term Effectiveness

Since no active treatment technologies are employed in Alternative 1, there are no safety concerns associated with the implementation of this alternative. Implementation of Alternative 1 is not considered to increase the potential risk to the community and presents the least amount of potential exposure to workers, the community, and the environment during remedial activities.

Implementation of Alternatives 2 through 7 is likely to result in potential exposure of remedial workers to affected soil and dust particles generated during removal, treatment, transport, and/or containment processes. However, proper safety procedures are expected to ensure that the workers and the community are not subjected to any unnecessary risk from exposure to airborne

contaminants. The significant distance that exists between the EMMA OU sites and the Crab Orchard NWR property line will help to ensure that airborne contaminants do not the reach the community. Cattle farmers will still have access to pastureland adjacent to the sites. Handling of the site soils will potentially present safety hazards to on-site workers due to the presence of nitroaromatic compounds. This will be addressed through use of magnetic surveys in combination with a hazards analysis of equipment and procedures prior to excavation, capping or treatment activities. Recommendations on equipment and procedural modifications resulting from the hazards analysis will be carefully followed to ensure worker safety. These alternatives also involve the operation of heavy equipment, creating an on-site safety concern for remedial workers. Prudent safety procedures, the use of appropriate personal protective gear, use of a hazards analysis, and the development and implementation of a site safety and health plan will be sufficient to protect workers during remedial operations.

Alternatives 2, 3, 4, 5, and 7 present an increased exposure to the community due to the necessity for hauling affected soil through surrounding areas for offsite disposal. However, proper safety procedures taken during transportation will ensure that the surrounding community is not affected.

Of the action alternatives (Alternatives 2 through 7), Alternative 2 is anticipated to have the greatest short-term effectiveness because it does not involve repeated handling of the affected soil. Alternative 3 will have a greater degree of short-term effectiveness than the remaining alternatives due to the minor amount of handling of nitroaromatic containing soil during implementation. Alternatives 4 through 7 are considered to have a lesser degree of short-term effectiveness because of the greater degree of soil manipulation through excavation, transportation, storage, and treatment. Alternatives 4 and 7 present an increased exposure to the community due to the necessity for hauling large volumes of affected soil through surrounding areas for offsite disposal. The remaining alternatives (5 and 6) have lesser short-term effectiveness due to the extensive on-site soil handling required and the remedial action time frames. Alternative 6 requires less time to meet remediation goals (4 to 7 months) than does Alternative 5 (2 years).

9.6 Implementation

Alternative 1 employs no active remedial measures and, therefore, has no technical difficulties associated with it. Land use controls, groundwater monitoring, and fencing in Alternatives 2 through 7 would be easily implemented. Land use controls may limit management options for Sites COC-3 and COP-4.

Implementation of Alternatives 2 through 7 will require the imposition of land use controls. For Alternative 2, placement of wells, subgrade activities, and pond creation within the perimeter of the soil covers on Sites COC-3 and COP-4 will be restricted. New chain-link fences will be constructed at Sites COC-3 and COP-4 under Alternative 2. For Alternatives 3 through 7, a restriction on the placement of wells, subsurface activities, and pond creation will only extend

over the covered, capped, or backfilled areas of Sites COC-3 and COP-4. For Alternatives 3 through 7, there are no anticipated adverse effects on the recreational purposes of the COC area of the EMMA OU because current and planned management practices do not require the use of groundwater and are not invasive to soil. Current management practices do not allow visitor access to the COP area of the EMMA OU. The removal of fencing and the establishment of native grasses after completion of Alternatives 3 through 7 will provide habitat for indigenous species as well as permit big game hunting and guided and self-guided wildlife trails. Thus, the implementability of Alternatives 3 through 7 is enhanced over Alternatives 1 and 2 because they will allow the USFWS greater management flexibility.

The implementability of Alternatives 2, 3, 4, 5 and 7 are minimally affected by the necessary transport of affected soil through the surrounding community. However, potential safety hazards posted by the transportation of affected soil will be mitigated through the use of proper safety procedures such as DOT requirements, preferred traffic routes, and advance notice to emergency services. Construction and excavation activities in Alternatives 3 through 5 are expected to occur without technical difficulties as materials and equipment necessary for cover or cap construction and excavation and backfill are readily available. Tree/brush clearing to allow access of heavy equipment to the affected soil areas and construction during the dry summer months are prerequisites to implementation of Alternatives 3 through 7.

Alternative 5 will require special equipment and operators to implement the composting treatment process. However, personnel, equipment, and materials are available from vendors. In addition, Alternative 5 may present the most difficulty with regard to soil handling due to the greater manipulation of soil. A pre-design stage and/or a treatability study of the effectiveness of the composting treatment will be required under Alternative 5. The remedial technology of incineration (offsite and onsite) is technically feasible. Both commercial and mobile incinerators are readily available. Alternatives 6 and 7 can be implemented without much difficulty. However, a trial burn test is required for onsite incineration under Alternative 6. Each of the alternatives involving excavation of soil may potentially present technical difficulties due to the clayey nature of the EMMA OU site soils. Clays and silts will tend to clog equipment and impair equipment activity, which may result in longer treatment times due to extended handling activities.

9.7 Cost

The costs of the alternatives were evaluated. Alternatives 1 and 2 are the least costly of the alternatives. However, Alternative 1 provides no active remediation processes. Active remedial processes associated with Alternative 2 consist only of the excavation of soil with greater than 100,000 mg/kg nitroaromatic compounds. Passive processes implemented under Alternative 2 include fencing, groundwater monitoring, and land use controls. Of the remaining alternatives that do provide for active remediation processes (Alternatives 3 through 7), Alternatives 3A, 3B,

3C, and 4 are similar in cost ranging from $3.7 million for 3A and increasing with each alternative to $4.4 million for Alternative 4. Alternatives 5A, 5B, 5C, and 6 are also similar in cost ranging from $8.3 million for Alternative 6 to $9.0 million for Alternative 5C. Alternative 7 (Offsite Incineration) is the most costly of the alternatives at $10.7 million. The costs associated with each of the alternatives are presented in Table 9-1.

Each of the Alternatives 3 through 7 meet the criteria for protection of human health and the environment, and are accepted by the state as viable treatment alternatives. In addition, each of these alternatives also meet the requirements for compliance with ARARs; long- and short-term effectiveness; implementability; and the reduction of MTV for the nitroaromatic compounds. Although each of the Alternatives 3 through 7 meet the seven threshold criteria, Alternative 3A is the least costly of these alternatives. Therefore, Alternative 3A is the most cost effective.

9.8 State and Support Agency Acceptance

IEPA has stated that Alternative 3A would be an acceptable remedial alternative for the EMMA OU. The USFWS also concurs with Alternative 3A as the selected remedy.

9.9 Community Acceptance

The concerns raised by the public during the public comment period are summarized in the Responsiveness Summary (Appendix A). Based on public comments received both verbally at the public meeting and through letters during the public comment period, the public appears to concur with Alternative 3A as the selected remedy.

10.0 Selected Remedy

Based on careful consideration of the technical, environmental, institutional, public health and cost criteria, and in keeping with the overall response strategy, the selected remedial alternative is Alternative 3A. Alternative 3A consists of removal and treatment of soil with concentrations of nitroaromatic compounds greater than 100,000 mg/kg and lead greater than 450 mg/kg (approximately 270 cy) at Sites COC-3 and COP-4; the removal of nitroaromatic compounds in soil at Site COP-4 to a depth of 2 feet below grade within the existing fenced area; further removal and offsite disposal of soil shown by TCLP analysis to match the RCRA definition of a characteristically hazardous waste (2,4-DNT greater than 0.13 mg/L and lead greater than 5 mg/L) at both Sites COC-3 and COP-4; construction and long-term maintenance of soil covers; land use controls; and groundwater monitoring.

10.1 Detailed Description of the Selected Remedy

The following elements are necessary for implementation of Alternative 3A:

- excavation and offsite treatment and disposal (offsite incineration) of soil at Sites COC-3 and COP-4 with concentrations of nitroaromatic compounds greater than 100,000 mg/kg and lead greater than 450 mg/kg (approximately 270 cy);
- soil above 100,000 mg/kg will be rendered safe prior to transport offsite to a commercial incinerator; and
- Additional removal of RDX/HMX contaminated soil at Site COP-4 to a depth of 2 feet below grade within the existing fenced area, with disposal at an offsite permitted special waste landfill;
- sampling to ensure that remaining affected soils at Sites COC-3 and COP-4 do not exhibit the characteristics of a RCRA hazardous waste for lead and 2,4-DNT.

After the removal of soil with greater than 100,000 mg/kg nitroaromatic compounds and lead greater than 450 mg/kg, and the additional removal of soils to a depth of 2 feet below grade within the fenced area at Site COP-4, the following elements will be implemented:

- backfill of excavations to shape the base of the covers;
- the construction and maintenance of soil covers over the remaining affected soil areas at Sites COC-3 and COP-4;
- groundwater monitoring;
- land use controls at Sites COC-3 and COP-4; and
- long-term maintenance of the soil covers.

Land use controls will only be implemented at Sites COC-3 and COP-4. These land use controls include restrictions of the following activities: groundwater well installation; subgrade activities; and pond creation within the perimeter of the soil covers on Sites COC-3 and COP-4.

Removal of trees, brush, fencing, and other debris within the areas to be excavated during soil removal, as well as location and removal of unexploded ordnance (UXO), may be necessary prior to startup of soil removal activities.

The soil covers consist of (from the top down) 6 inches of topsoil to retain moisture and promote vegetation and 18 inches of clay-rich soil to support the root zone. Random fill will be placed over the excavated areas. Soils with contaminants above remediation goals identified in Table 10-1 may be consolidated and used as random fill along with native soils. The purpose of the random fill is to bring the excavated areas to the desired grade prior to installation of the soil cover. The random fill material will consist of native soils, and may include consolidated materials. A typical cross-section of a soil cover is represented in Figure 10-1.

The soil covers will cover the areas containing soils with contaminants above the remediation goals. At Site COC-3, the area to be covered is approximately 71,500 square feet (sq ft). At Site COP-4, the area to be covered is approximately 4,900 sq ft. The total square footage of the areas to be covered is approximately 76,400 sq ft. A stormwater retention basin will be placed along the perimeter of the cover at Site COC-3 to control runoff during construction of the soil covers. Long-term control of stormwater runoff will be implemented by erosion control methods such as sloping and drainage swales. Upon completion of the covers, a vegetative cover will be established to prevent cracking and erosion caused by wind and water.

Land use controls will be implemented at Sites COC-3 and COP-4 to reduce potential future exposure to the remaining affected soil and restrict the construction of drinking water wells in the EMMA OU. These land use controls will include restrictions of the following activities: groundwater well installation, subgrade activities, and pond creation within the perimeters of the soil covers at Sites COC-3 and COP-4. Groundwater monitoring will be conducted at Sites COC-3 and COP-4. The final groundwater monitoring program will be developed during design as part of the O&M plan.

The estimated capital cost of the selected remedy is $3,468,000. The estimated present worth operations and maintenance cost is $251,700, and the estimated net present worth cost is $3,719,700. These costs are detailed in Table 10-2.

10.2 Rationale for Selection

After careful consideration of the technical, environmental, institutional, public health, and cost criteria, the selected remedial action alternative for the Crab Orchard NWR EMMA OU sites is Alternative 3A (Removal/Land Use Controls/Groundwater Monitoring/Soil Covers). Implementation of Alternative 3A will achieve the remedial action objective for the Crab Orchard NWR EMMA OU sites by minimizing the potential human health and ecological risks associated

Table 10-1. Remediation Goals for EMMA OU Soil (mg/kg), Crab Orchard NWR, Marion, Illinois

Contaminants	Remediation Goal	Basis*
Nitroaromatics		
TNT	2.11	PQL
1,3,5-TNB	2.25	PQL
HMX	4.19	PQL
RDX	4.13	PQL
Metals		
Lead	450	MAOU and PCB OU Remediation Goal

* The nitroaromatics remediation goals are based on the current Practical Quantitation Levels (PQLs). PQLs are generated by the laboratory based on site-specific samples/information. In the case of the EMMA OU sites, enough data are available to provide PQLs based on analytical results from the site. These PQL values are higher than the estimated method quantitation limits (QLs) due to matrix interferences and other laboratory instrumentation interferences from the soils (clays) at the EMMA OU sites. The estimated method QLs are developed under "ideal" situations (sands), where extraction and analysis are optimal.

PQL = Practical quantitation level.

Source: ESE, 1995.

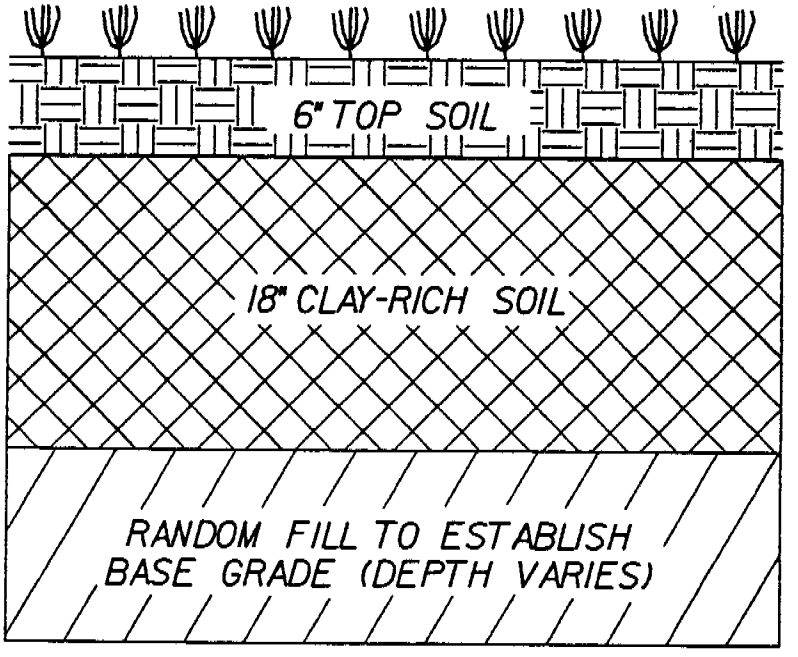

Figure 10-1
CLAY AND SOIL COVER
CRAB ORCHARD NWR-MARION ILLINOIS

ESE
A CILCORP Company
Environmental
Science &
Engineering, Inc.

Table 10-2. Estimated Costs of Selected Remedy—Alternative 3A

Capital Costs	Estimated Cost
Treatment Component	
Mobilization/Demobilization	$42,690
Fence Removal and Land Use Controls	$9,450
Soil Covers	$374,120
Excavation/Soil Staging	$125,210
Removal of Soils with Greater than 100,000 mg/kg Nitroaromatic Compounds and 450 mg/kg Lead	2,190,000
Subtotal Capital Costs	$2,741,470
Engineering — 10 percent of Subtotal	$274,150
Contingency — 15 percent of Subtotal	$452,340
Total Capital Cost	$3,467,960
Operations and Maintenance Costs	
Groundwater Monitoring	$260,910
Cover Maintenance	$3,800
Total Costs	
Net Present Worth Using a 5 Percent Discount Value for 30 Years	$3,719,700

with site contaminants present in the soil above remediation goals. Because the BRA showed potential unacceptable risk to ecological receptors, preliminary remediation goals were calculated for their protection. These preliminary remediation goals were below PQLs, and were therefore unquantifiable and unachievable by any of the alternatives. In addition, since the TBC values are below PQLs, they cannot be reliably measured. Therefore, the PQL is used as a remediation goal. Remediation goals have been set at the PQL for nitroaromatic compounds and 450 mg/kg for lead at the sites (see Table 10-1). The areas where soil exceeds remediation goals at Sites COC-3 and COP-4 are presented in Figures 10-2 and 10-3, respectively. For safety reasons, it is necessary to remove soils with levels of nitroaromatic compounds above 100,000 mg/kg. Additional removal of soils will take place within the fenced area at Site COP-4 to manage the potential risks at Sites COC-3 and COP-4 similarly. The potential detonation hazards associated with the 100,000 mg/kg (or 10 percent) levels are based on an Army report titled Testing to Determine the Relationship Between Explosive Contaminated Sludge Components and Reactivity, Army Environmental Center Report Number AMXTH-TE-CR-86096, January 1987, which is contained in the Administrative Record.

Exposure to site contaminants of concern (nitroaromatics and lead) will be effectively eliminated through implementation of this alternative thus attaining the protective benchmarks of 1.0E-06 and HI/ERI < 1. While covers are not considered irreversible, the technical feasibility and potential cost of reversing the cover process will likely provide sufficient disincentive for removal of the covers from the sites. With proper maintenance, the covers will provide adequate protection of human health and the environment by preventing human contact and minimizing animal contact with contaminants of concern.

Although not the least costly alternative, Alternative 3A provides sufficient protection of public health and the environment and complies with identified ARARs. This alternative provides for active treatment of affected soil through combination with the removal of those affected soils containing concentrations of nitroaromatics greater than 100,000 mg/kg and lead above 450 mg/kg, and removal of soils to a depth of 2 feet below grade within the fenced area of Site COP-4. This alternative also provides comparable environmental and public health protection as the other alternatives considered through elimination of potential risks associated with direct contact by humans and animals. This alternative meets USEPA's statutory preference for treatment.

CERCLA Section 120(h)(3)(B) requires that, if the property is sold or transferred, each deed contain language stating that action to protect human health and the environment has been taken before the date of property transfer. Implementation of groundwater monitoring at locations chosen to provide early indication of changing conditions will provide a warning system in case of shallow groundwater migration.

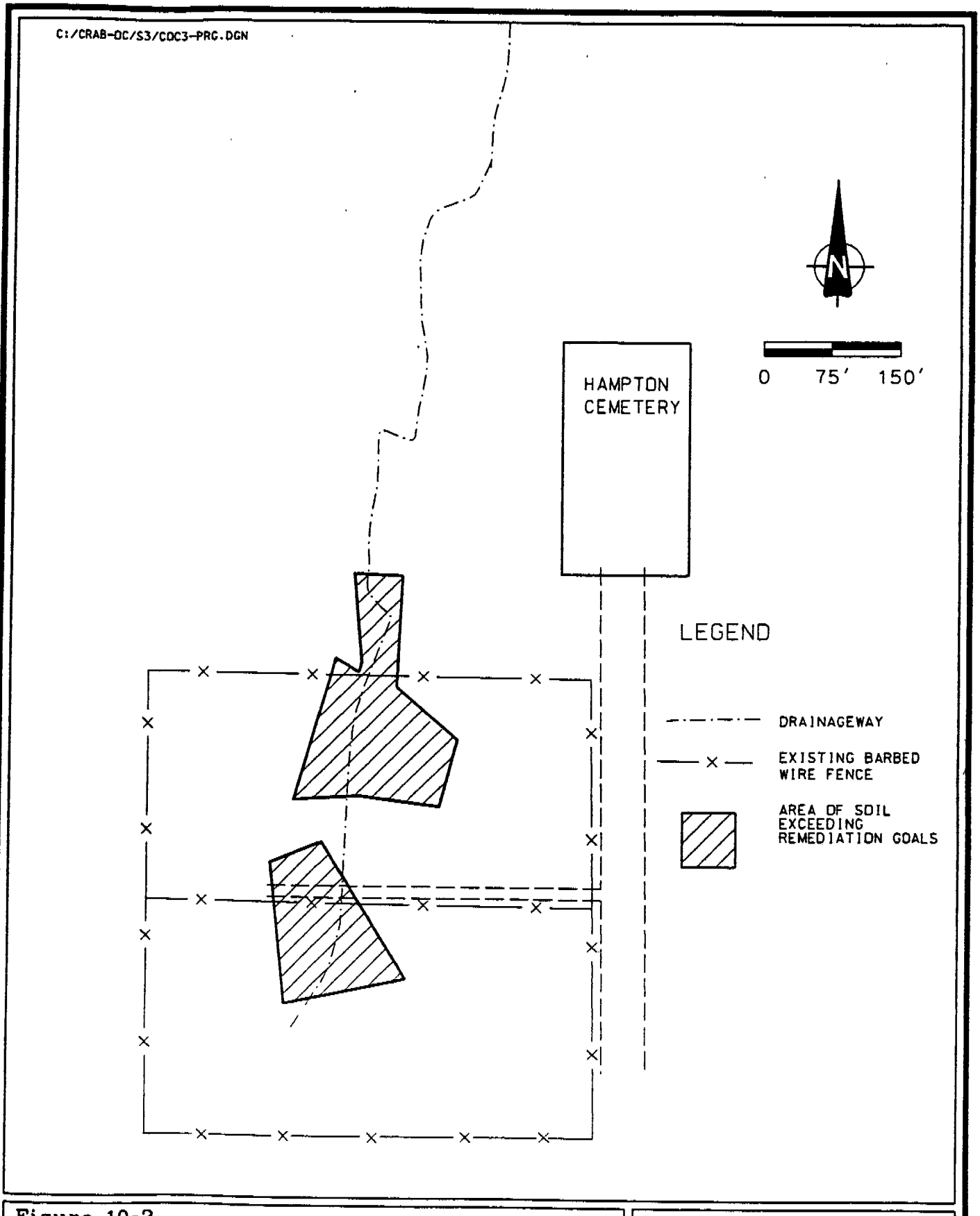

Figure 10-2
EXTENT OF SOILS WITH CONSTITUENTS OF CONCERN EXCEEDING REMEDIATION GOALS
SITE COC-3
CRAB ORCHARD NWR - MARION, ILLINOIS

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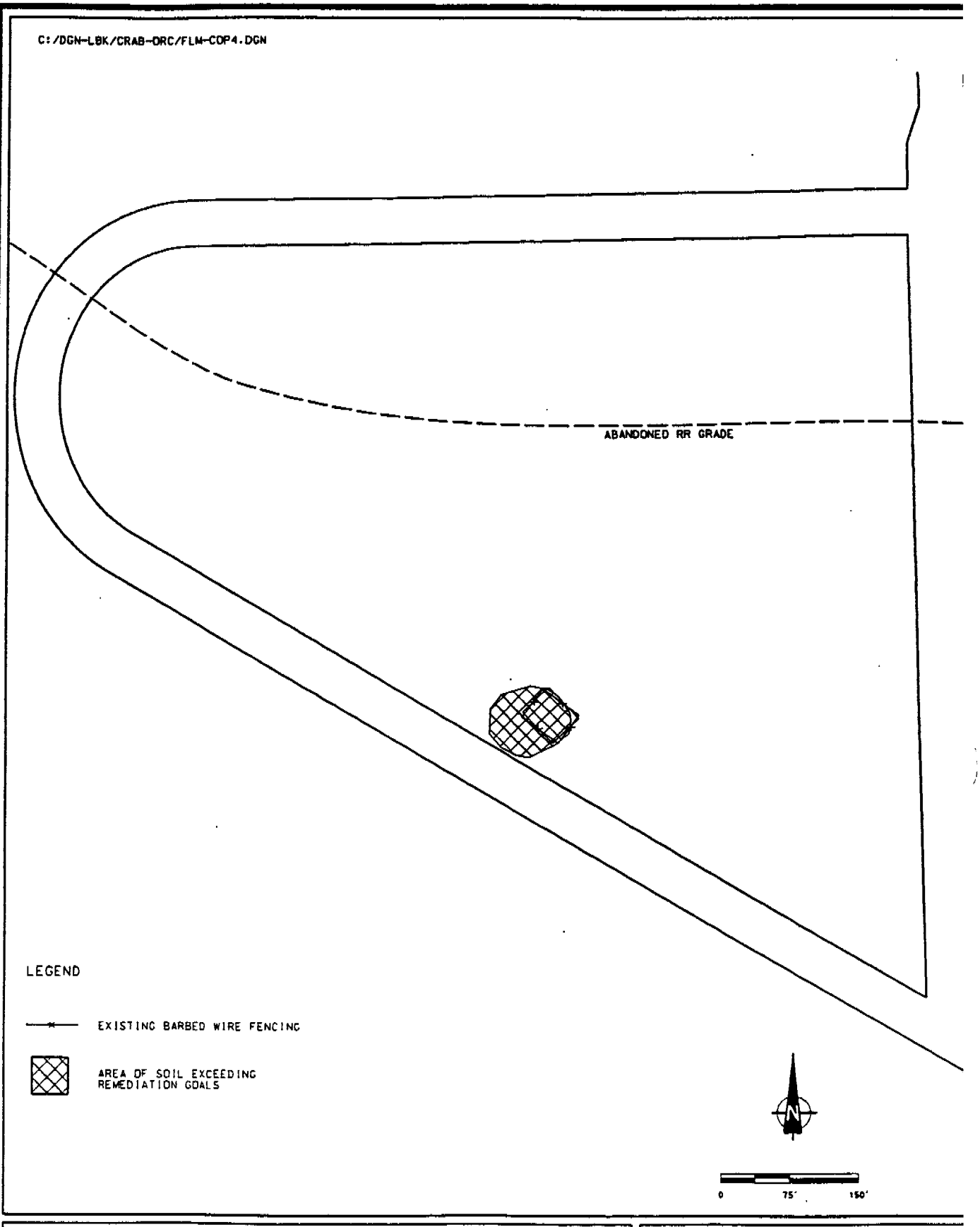

Figure 10-3
EXTENT OF SOILS WITH CONSTITUENTS OF CONCERN EXCEEDING REMEDIATION GOALS
SITE COP-4
CRAB ORCHARD NWR - MARION, ILLINOIS

ESE
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11.0 Statutory Determinations

To comply with the requirements of Section 121 of CERCLA, as amended by SARA the selected remedy must satisfy the following statutory requirements:

- Protect human health and the environment;
- Comply with ARARs;
- Be cost effective;
- Utilize permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable; and
- Satisfy the preference for treatment as a principal element, or provide an explanation as to why this preference is not satisfied.

The implementation of Alternative 3A satisfies the requirements of CERCLA, as amended by SARA, as detailed below.

11.1 Overall Protection of Human Health and the Environment

Implementation of Alternative 3A will provide for the overall protection of human health and the environment at Sites COC-3 and COP-4. Of those complete exposure pathways evaluated in the BRA (ESE, 1994), soil removal and subsequent covering of the remaining affected soil will eliminate the human exposure pathways of soil ingestion, dermal adsorption, and dust inhalation at both sites. Therefore, by preventing direct contact by humans and animals with contaminants above remediation goals, any potential unacceptable risks from the affected soils to human health and the environment would be mitigated, thus attaining the protective benchmarks of 1.0E-06 and HI/ERI < 1. The implementation of land use controls and O&M of the soil cover will prevent any compromise of the integrity of the soil cover.

The BRA indicated that Site COC-4 poses a potential ecological risk to the bobwhite quail, while not posing any unacceptable risk to human health. Potential ecological risks associated with Site COC-4 are several orders of magnitude lower than the potential risks at Sites COC-3 and COP-4 and will be further evaluated.

It may be necessary to remove existing trees during implementation of the remedy. Every effort will be made not to cut trees during breeding and nesting seasons for residential and migratory wildlife. Any cutting of trees will be done in consultation with USFWS.

11.2 Compliance with ARARs

The selected alternative will comply with federal and state ARARs. A listing of ARARs associated with the selected alternative is found on Tables 11-1 and 11-2. The following ARARs will be attained.

Table 11-1. Location-Specific ARARs for the EMMA OU Sites, Crab Orchard NWR, Marion, Illinois

Resource Conservation Recovery Act (RCRA) Location Standards (40 CFR 264.18)
Executive Order 11990 - Protection of Wetlands
Subpart 404, Clean Water Act (40 CFR 230)
Endangered Species Act (16 USC 1531, 50 CFR 200, 50 CFR 402)
Migratory Bird Treaty (16 CFR Chapter 7)
The Archaeological and Historic Preservation Act (16 USC 469)
National Wildlife Refuge System Administration Act (16 USC 668, 50 CFR 27)
Human Skeletal Remains Protection Act (Illinois revised statutes 1989, ch. 127, pars. 2661 etseq.)
Crab Orchard National Wildlife Refuge Creation (61 Stat. 770 dated Aug 5, 1947)

Source: ESE, 1995.

Table 11-2. Final and Potential Action-Specific ARARs for EMMA OU Sites, Crab Orchard NWR, Marion, Illinois

Action	Citation	Comments
Final Action Specific ARARs		
Excavation	40 CFR 264.114	Disposal or decontamination of equipment, structures, and soils
	40 CFR 61 Subpart M	NESHAPS, asbestos air emissions
Generation of Hazardous Waste	40 CFR Part 262	Establishes standards for generators of hazardous waste in general
	40 CFR Part 261 Subpart C	Requirements for determination of characteristic hazardous wastes
Illinois Special Waste Requirements	35 IAC 808 and 35 IAC 809	Non-RCRA wastes that pose a low or moderate degree of public health during their transportation, storage, treatment, or disposal.
Offsite Transport	40 CFR Part 262 Subpart C	Pre-transport requirements
	49 CFR Parts 171 through 179	DOT hazardous materials transport regulations
	40 CFR Part 263	Establishes standards that apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262
	49 CFR Parts 107, 171-177	Regulates transportation of hazardous materials
Worker Safety (OSHA)	40 CFR 1910.120	Regulates worker health and safety
Potential Action-Specific ARARs		
Illinois Discharge Limitations	35 IAC 309	Implements National Pollution Discharge Elimination System (NPDES)
	35 IAC 307	Establishes effluent requirements
	35 IAC 302	Regulates direct discharge to offsite surface water

Note: DOT = Department of Transportation
OSHA = Occupational Safety and Health Administration

Source: ESE, 1995.

Chemical-specific--This alternative will comply with Illinois Groundwater Quality Standards (35 IAC Part 620) because contaminant concentrations in shallow groundwater are not above these standards. Shallow groundwater at the EMMA OU sites is not currently used for drinking water nor is it expected to be used in the foreseeable future.

Location-specific--The Endangered Species Act and Migratory Bird Treaty will be met under this alternative by implementing proper procedures to protect wildlife during excavation of soil. Efforts will be made during excavation and construction of the soil staging area to minimize any adverse effects on potential wetlands in order to comply with Executive Order 11990-Protection of Wetlands and Section 404 of the Clean Water Act. Actions will be taken to comply with the Human Skeletal Remains Protection Act if human skeletal remains are exhumed during excavation activities. Because Native American artifacts have been discovered on the refuge, actions will be taken to comply with the Archaeological and Historic Preservation Act [40 CFR 6.301 (c)]. Excavation will stop if Native American artifacts or human skeletal remains are discovered during this remedial alternative. This alternative will be compatible with the major purposes for which the refuge was established under the National Wildlife Refuge System Act (NWRSA) including development and disposition consistent with the needs of agriculture, industry, recreation, and wildlife conservation.

Action-specific--Active remediation of Sites COC-3 and COP-4 will be implemented through removal of soils with greater than 100,000 mg/kg nitroaromatic compounds and lead above 450 mg/kg for offsite disposal, and confirmation sampling of the excavated areas to ensure that characteristically hazardous wastes do not remain on-site. This alternative will be designed to fulfill action-specific ARARs for the site. Soil is likely to be determined a hazardous waste under this alternative, the RCRA equipment decontamination and soil disposal requirements contained in 40 CFR 264.114 will be complied with for excavation activities under this alternative. The requirements of 40 CFR 263 that apply to transportation of hazardous wastes will also be met. In addition, Illinois special waste requirements (35 IAC 808 and 809) is applicable to the disposal of soils contaminated with nitroaromatic compounds less than or equal to 100,000 mg/kg in an offsite permitted special waste landfill.

11.3 Cost-Effectiveness

Although not the least costly alternative, Alternative 3A provides a greater degree of long-term effectiveness, and provides larger reduction in the toxicity, mobility, and volume of contaminants than Alternative 2. Among Alternatives 3 through 7, which provide equal degrees of protection of public health and the environment, Alternative 3A is the least costly. Therefore, Alternative 3A is selected as the remedy that would provide the greater balance of long-term effectiveness; implementability; reduction of toxicity, mobility, or volume; and cost.

11.4 Use of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

Alternative 3A represents the best combination of a permanent solution and cost effectiveness through the excavation, removal, and offsite treatment (offsite incineration) of soil containing nitroaromatic compounds greater than 100,000 mg/kg. At Site COP-4, additional soil with nitroaromatic compounds less than or equal to 100,000 mg/kg will be removed to a depth of 2 feet from grade and disposed of in an offsite permitted special waste landfill. The remaining soil above remediation goals will be covered with 24 inches of clean soil to protect human health and wildlife.

11.5 Preference for Treatment as a Principal Element

Containment of materials by the use of a soil cover is considered a reliable remediation method when augmented with land use controls. Removal and offsite treatment of those soils with concentrations of nitroaromatic compounds above 100,000 mg/kg and lead above 450 mg/kg, and covering of the remaining affected soil under Alternative 3A adequately addresses the statutory preference for treatment as a principal element.

In summary, the selected remedy for Sites COC-3 and COP-4 is protective of human health and the environment, complies with federal and state environmental requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy uses permanent solutions, to the maximum extent practicable. Because the remedy will result in hazardous substances remaining on-site, a review will be conducted within 5 years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

GLOSSARY OF TERMS

Administrative Record: A file that contains the information used to make a decision on the selection of a response action under CERCLA. The file is established at or near a site and is available for public review.

Ambient Water Quality Criteria (AWQC): USEPA designated limits for toxic chemicals in surface waters. The levels are set to protect plant, fish, and animal habitats in the areas surrounding the surface waters.

Applicable or Relevant and Appropriate Requirements (ARARs): Any state or federal law or regulation that pertains to the protection of human health and the environment in addressing certain site conditions or using a particular cleanup technology at a site. The Army must consider whether a remedial alternative meets ARARs as part of the process for selecting a cleanup alternative for a site.

Background Concentrations: Naturally occurring chemicals present in air, water, or soil in concentrations which would normally be expected.

Base/Neutral Acid Extractable Compounds (BNAs): Chemicals detected using a laboratory procedure designed to determine the concentration of semi-volatile organic compounds.

Baseline Risk Assessment (BRA): The process whereby risks to human health and the environment are quantitatively evaluated. This information is used to determine whether remedial actions are necessary. The BRA is conducted during the Remedial Investigation/Feasibility Study.

Berm: An earthen, concrete, or other man-made barrier used to keep liquids from flowing into or out of an enclosure.

Bioaccumulation: The build-up of toxic chemicals in living things.

Cancer Slope Factor (CSF): A number used to estimate the probability of potential carcinogenic effects.

Carcinogenic: Term used to describe chemicals or substances that are known or suspected to cause cancer in humans based on observed health effects in humans or existing data from animal laboratory tests.

Characteristically Hazardous Waste: A waste material that exhibits certain potentially hazardous characteristics such as flammability, toxicity, corrosivity, and reactivity or contains levels of certain chemicals, as designated by federal regulations.

Clay Rich Soil: Description of native soils in this area.

Constituents of Concern or Contaminants of Concern: Site-related chemicals that pose critical health concerns to human or environmental receptors because of their toxicity and potential for exposure. Although many chemicals at a site may pose a potential risk to human health and the environment, constituents of concern represent those chemicals that contribute the majority of potential risk. At the EMMA OU, the constituents of concern were identified as lead and nitroaromatic compounds.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): A federal law enacted in 1980 and subsequently modified by the Superfund Amendments and Reauthorization Act of 1986 (SARA). This act resulted in the creation of a trust fund, commonly known as "Superfund," which provides money to investigate and clean up abandoned or uncontrolled hazardous waste sites.

Critical Toxicity Values (CTVs): A term used to describe the level of toxicity to ecological receptors in terms of acceptable daily intake.

Detection Limits: The lowest concentration of a chemical that laboratory instruments or methods can detect.

Dose-Response: The concept in that the physiological affect (the response) is directly related to the level of chemical intake (the dose) by a living thing.

Ecological Risk Index (ERI): A calculated value used to quantify potential risks to plants and animals due to the presence of constituents of concern. The index value is calculated by dividing the estimated chemical exposure concentrations with the critical toxicity values (CTV). An ERI greater than 1.0 is considered to represent an potential unacceptable risk.

Exposure Pathways: The routes by which chemicals reach receptors. These routes may include (for example) drinking groundwater or inhaling windblown dust.

Feasibility Study (FS): A study that selects a remedial action at a site. through a series of evaluation steps. The FS identifies, develops, and evaluates several alternatives for addressing contamination.

Ferrous: Containing iron.

Groundwater: Water that is present in the open spaces between soil particles (silt, sand, gravel) and/or rock fractures below the ground surface.

Hazard Index (HI): An indicator of the potential for a hazardous substance to cause noncancerous health effects in humans. The HI is calculated by dividing estimated human exposure concentrations by exposure levels that USEPA has determined to be acceptable. Any result of this calculation that is greater than 1.0 is considered to represent a potential unacceptable risk.

Hydrogeology: The study of groundwater and aquifers.

Indicator Species: Those species from the list of potential ecological receptors that appear to be at greatest risk from exposure to potential constituents of concern.

Information Repository: A location where documents and data related to a site investigation and response actions are maintained to allow the public access to this material.

Land Use Controls: Management of a property in a manner that minimizes the potential exposure of hazardous substances to the public. For example, placing restrictions on the use of groundwater at a site.

Lowest-Observed-Effect Level (LOEL): The lowest concentration of a constituent of concern at which an adverse effect is observable.

Magnetometer: An instrument used to detect metal objects.

Manifest: A document that records the content, chemical characteristics, amount, generator, transporter and recipient for every shipment of hazardous waste. A manifest is required to accompany every shipment of hazardous waste according to hazardous waste regulations.

Milligrams per Kilogram (mg/kg): A unit of measure used to show concentrations of chemicals in dry materials such as soil, sediment, or sludge. This unit (mg/kg) is equal to parts per million. As a conceptual example, 1 mg/kg is equivalent to one dollar in a stack of one million dollars.

Milligrams per Liter (mg/L): A unit of measure used to show concentrations of chemicals in liquid materials such as groundwater and surface water.

Mobility, Toxicity, or Volume (MTV): Three indicators of chemical presence and movement in the environment. These indicators are used to assess the current and future concentrations of chemicals in the environment and determine how harmful these chemicals may be to human health and the environment.

Monitoring Well: A well installed for the purpose of collecting samples of groundwater to be analyzed for chemicals. A monitoring well is a permanent structure that can be sampled repeatedly over an extended period to track chemical concentrations.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): A federal regulation that outlines the procedures that must be followed under the Superfund Program. The NCP was most recently revised in 1990.

National Priorities List (NPL): USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response actions.

National Emission Standards for Hazardous Air Pollutants (NESHAPs): NESHAPs are USEPA air regulations that set minimum operating standards for certain activities which generate air pollution.

Nitroaromatic Compounds: Common components of explosives.

Non-carcinogenic: The term used to describe chemicals or substances that are not known or suspected to cause cancer in humans. This term generally refers to chemicals that may not cause cancer, but potentially produce other unwanted health effects.

No-Observed-Effect Level (NOEL): The concentration of a constituent of concern that results in no observable effect on an ecological system.

Operable Unit: An individual action that is part of the overall remedy for a particular site. This portion of the remedial response manages migration, or eliminates or addresses a release, threat of a release, or an exposure pathway. Operable units may address geographic portions of a site, specific-site problems, or initial phases of an action.

Ordnance: Military weapons and equipment, including artillery and ammunition.

Organic Constituents: Chemical compounds composed primarily of carbon, including materials such as solvents, oils, and pesticides.

Polychlorinated Biphenyls (PCBs): A group of organic compounds related by their basic chemical structure. They are highly resistant to degradation, but have a tendency to be retained in body tissue. Due to their efficient electrical conductivity properties, they were widely used in capacitors, transformers, and other products in the U.S. before 1980.

Practical Quantitation Limit (PQL): A value equal to 10 times the detection limit that reflects the value above which a chemical can be quantified with acceptable confidence.

Preferred Alternative: The remedial alternative initially proposed for implementation as a result of the screening process conducted during the FS.

Present Worth Cost: An economic term used to describe today's cost for a Superfund cleanup and reflect the discounted value of future costs. A present value cost estimate includes construction and future operation and maintenance costs.

Receptor: A human, animal, or plant that could potentially receive exposure to chemicals migrating from or present at hazardous waste sites.

Record of Decision (ROD): A legal document that describes in detail the remedy selected for an entire NPL site or a particular operable unit. The ROD summarizes the results of the RI/FS and includes a formal response to comments supplied by the public.

Reference Dose (RfD): The daily acceptable level of constituents of concern intake. This number is used to estimate potential for non-carcinogenic effects.

Remediation Goals: Remedial action objectives and remediation goals are the target cleanup levels for chemicals at a contaminated site.

Remedial Investigation (RI): A study that supports the selection of a remedial action at a Superfund site. The RI identifies the nature, magnitude and extent of contamination associated with a Superfund site.

Resource Conservation and Recovery Act of 1976 (RCRA): The federal law that establishes a regulatory system that governs procedures to be used in generating, storing, transporting, treating, and disposing of hazardous waste.

Responsiveness Summary: Comments presented during the public meeting and received during the public comment period that are considered and addressed by the lead agency. The Crab Orchard Responsiveness Summary is Appendix B of this ROD

Risk Assessment Guidance for Superfund (RAGS): A document produced by the USEPA as a guide for conducting risk assessments under Superfund.

Sediment: Soil and other material that settles to the bottom of a stream, creek, or lake.

Semi-Volatile Organic Compounds (semi-VOCs): Semi-VOCs are organic chemicals that vaporize less readily than VOCs. These compounds include many polynuclear aromatic hydrocarbons and pesticides.

Superfund Amendments and Reauthorization Act of 1986 (SARA): This act modified specific provisions in CERCLA.

Surface Water: Water on the earth's surface such as streams, ponds, and lakes.

To Be Considered (TBC) Values - State advisories, guidance, non-binding guidelines, or other standards that are not legally binding that may be considered when fashioning a protective remedy for a site.

Toxicity Characteristic Leaching Procedure (TCLP): USEPA-approved laboratory procedure used to determine if a waste material is characteristically hazardous.

Toxicity Value: Used to indicate the level of toxicity of the constituents of concern at the site.

Uncertainty Factor: A measure of the uncertainty inherent in assumptions made in risk assessments.

Unexploded Ordnance: An explosive device that has not been detonated.

Volatile Organic Compounds (VOCs): Organic liquids that readily evaporate under atmospheric conditions and exhibit varying degrees of solubility in water. Examples of VOCs include benzene and xylenes.

Appendix A

Responsiveness Summary

Summary of Comments Received During the Crab Orchard EMMA OU Public Meeting Held on October 19, 1995

A number of oral comments were received from members of the community during the public meeting for the Crab Orchard NWR EMMA OU, held on October 19, 1995. Public comments were solicited on the Proposed Remedial Action Plan. These comments were transcribed by Ms. Valerie Bleyer, a court recorder and Notary Public. In many cases comments were repeated by the commentor, or by other commentors throughout the course of the public meeting. In these cases, the comments have been consolidated. In most cases, the comments have been paraphrased for clarity.

A summary of the written responses received at the public meeting and letters received by the public follows the oral comments.

Comment 1 When, on what date, was the was the decision made to change from Alternative 4 to Alternative 3A?

Response: The USACE reevaluated Alternative 3A on October 13, 1995 and decided to present Alternative 3A as the preferred alternative.

Comment 2 Can the public comment period be extended in light of the fact that the proposed remedy has changed? **(several commentors, oral and written)**

Response: The public comment period was extended by 30 days. The public comment period ended on November 29, 1995.

Comment 3 Under Alternatives 3A, 3B, and 3C will affected soils be incinerated? If so, where? Do all of the Alternatives include incineration except for Alternative 1?

Response: Soils containing nitroaromatic compounds in excess of 100,000 mg/kg will be incinerated. It is intended that these soil will be transported to an existing commercially available licensed incinerator that is not located on the refuge. The specific incinerator will be identified during the design phase of the remedial action. The removal contractor will select the incinerator subject to approval by the USACE. Each of the remedial alternatives evaluated (except Alternatives 1 and 6) include offsite incineration of the soils at Sites COC-3 and COP-4 that contain levels of nitroaromatic compounds in excess of 100,000 mg/kg. Although Alternative 6 includes on-site incineration, Alternative 6 is not the selected remedial alternative.

Comment 4 I have a problem with the proposed remedial action plan that was sent out with Alternative 4 as the selected remedy. Alternative 4 is based on the assumption that a special waste landfill will accept the affected soil for disposal. If a landfill will not accept the waste, will it then be incinerated on site? Does offsite incineration depend on whether a landfill will accept the resulting ash? What will happen if no one will accept the soil?

Response: There are a number of special waste landfills in the immediate area (including one in Jackson County) that could accept the affected soils. The Army does not anticipate any problem with acceptance of the waste by a special waste landfill. Under Alternatives 1 through 5 and Alternative 7, the soils will not be incinerated on-site for any reason. The offsite incineration of soils with levels of nitroaromatic compounds in excess of 100,000 mg/kg is not dependent on the disposition of the resulting ash. In the unlikely event that no offsite facility will accept the soils, the Department of the Army will examine the options available and inform the public of its preferred option. A change in the remedy will require a ROD Amendment and further public comment.

Comment 5 Will Alternative 6 (on-site incineration) be considered?

Response: Each of the remedial alternatives were considered in the remedial alternative selection process, based on the nine criteria specified in CERCLA and NCP, and identified in Section 9.0 of the ROD. After careful evaluation of each alternative, Alternative 3A has been selected as the preferred alternative. However, selection of the final remedy will take into account input received from the public.

Comment 6 There are other safer ways than incineration to clean up affected soils. According to a specific article referenced, the most dangerous chemicals on the planet can be neutralized with common sewage sludge and water. The U.S. Army Aberdeen Proving Grounds in Maryland released their initial findings on neutralization of lethal mustard agents showing that exposing the agent to hot water and then sewage changed the agent to a nonhazardous waste. The most dangerous chemicals manufactured by humans can be neutralized very safely without incineration.

Response: The article referenced addresses neutralization of mustard gas agents. Mustard gas agents are made of very different types of chemicals than nitroaromatic compounds. Therefore, the neutralization method discussed in the article would not be effective on nitroaromatic compounds. Studies on neutralization

techniques for nitroaromatic compounds have been conducted. However, most of these techniques use solvents and would generate another potentially hazardous waste stream.

Comment 7 One commentor was concerned that the affected soil will be incinerated on-site and that other material from around the world will be brought here and burned.

Response: On-site incineration is not included in the selected remedial Alternative 3A. At no time was incineration of material from other sites considered.

Comment 8 Why, out of seven alternatives, are six of them incineration? Why haven't other technologies been considered here?

Response: Other remedial technologies were considered. For example, composting (Alternative 5) is a viable technology that was considered. However, due to the fact that the remediation goals are below detection levels, capping or covering of treated (composted soils) had to be added to increase the effectiveness of the composting alternative. Incineration is a safe and viable treatment method for nitroaromatic compounds. Only those soils that pose a potential explosive hazard are proposed for offsite incineration.

Comment 9 What is more important, people's health or money? Why is it that money always takes precedence over health?

Response: Selection of a remedial alternative is based on an evaluation of nine criteria specified in CERCLA and the NCP. Protection of human health and the environment and cost are two of the nine evaluation criteria. Cost is a consideration in instances where remedial alternatives provide equal protection for human health and the environment. This is the case for many of the alternatives evaluated for the EMMA OU.

Comment 10 Where will the excavated soil be taken for incineration? Is it a private incinerator or a government facility?

Response: Soils containing nitroaromatic compounds in excess of 100,000 mg/kg will be incinerated. It is intended in the proposed alternative that these soil will be transported to a commercially available licensed incinerator that is not located on the refuge. The specific incinerator will be identified during the design phase of the remedial action. The removal contractor will select the incinerator subject to approval by the USACE.

Comment 11 One of my big concerns is the emission of dioxins when incineration takes place.

Response: Dioxin is not a by-product of nitroaromatic compound incineration. In order for dioxin to be produced chlorine must be present. Chlorine is not a component of nitroaromatic compounds.

Comment 12 Are Sites COC-3 and COP-4 in the public area or are they closed off already?

Response: Sites COC-3 and COP-4 are closed off to the public.

Comment 13 One commentor requested that information be mailed to the public concerning the change in the preferred alternative from Alternative 4 to Alternative 3A.

Response: Information regarding the change in the preferred alternative from Alternative 4 to Alternative 3A is included in the ROD which is located in the administrative record as well as each of the information repositories. Because the ROD is readily available to the public through the information repositories, this information has not been mailed directly to the public.

Comment 14 One commentor preferred that Alternative 3C be selected as opposed to Alternative 3A, because Alternative 3C appears to be more protective due to the greater number of protective layers over the remaining soil.

Response: Both of these alternatives equally prevent direct contact with soils containing nitroaromatics and lead above remediation goals and therefore are equally protective of human health and the environment.

Comment 15 When was the last explosive or toxic material deposited on these sites? Has any refuge person become sick in the last fifty years? Why is necessary to get rid of the affected soils now?

Response: The latest that this type of material would have been deposited on the sites is when the Illinois Ordnance Plant was closed in 1945. There is no record that Crab Orchard NWR employees have ever become ill as a direct result of exposure to constituents at the EMMA OU sites. Based on the results of the BRA, soils at Sites COC-3 and COP-4 pose a potential unacceptable risk to human health and the environment. CERCLA requires the potentially unacceptable risks to be mitigated.

Comment 16 Are the constituents of concern leaching into the groundwater at increasing rates? Is it possible that constituents of concern will leach into the lake?

Response: Several of the EMMA OU wells have been affected by constituents of concern. However, it would take a very long time for the constituents of concern to migrate to the Crab Orchard Lake, due to the types of soils present. It is also likely that the constituents would be naturally degraded before it could reach Crab Orchard Lake. Based on the data collected during the RI conducted at the EMMA OU, there is no evidence that concentrations are increasing in monitoring wells, or that constituents of concern are migrating toward Crab Orchard Lake. Groundwater monitoring will provide warning of constituent migration.

Comment 17 Has the USEPA or the Army Corps of Engineers looked at the risk involved in transporting affected soil off site?

Response: The risk of transporting affected soils offsite were addressed in the Feasibility Study and the Proposed Plan under the analysis of short-term effectiveness. Precautions will be taken during offsite transportation of affected soils. Trucks leaving the site will be covered to prevent dust generation and spillage during transport. The trucks will also be decontaminated prior to leaving the site to prevent offsite transport of soils on the outside of the trucks. In addition, the trucks will be routed away from residential areas during transport. These precautions will be taken to prevent the possibility of contact with affected Sites COC-3 and COP-4 soils being transported.

Comment 18 If there will be no on-site incineration, why are all of those air monitors being put around the area? Who reads the air monitors?

Response: The air monitoring equipment is associated with the remedy for the PCBs Operable Unit, not the EMMA OU remedy. The commentor should obtain further information concerning the air monitoring activities at the PCB OU from the PCB OU information repository.

Comment 19 Are the sites here on the refuge unique nationally except for the fact that they are on a National Wildlife Refuge? Is the remedy being proposed unique or different than what is being used on other sites?

Response: Sites with nitroaromatic compounds in soil are not unique. There are many locations throughout the nation where munitions were historically manufactured

resulting in nitroaromatic compounds and metals impacting the environment. A few of these sites are also located on state or national wildlife refuges. The remedy being proposed for the EMMA OU is generally more conservative than remedies that have been proposed at other sites.

Comment 20 Would the proposed actions for the EMMA OU be setting the standard for cleanup levels state-wide for this type of contamination?

Response: Cleanup standards are determined on a site-by-site basis under CERCLA. Therefore, the clean-up levels set for the Crab Orchard National Wildlife Refuge EMMA OU are not necessarily applicable to other sites within the refuge or at other sites in Illinois.

Comment 21 Why did the US Army Corps change its mind from Alternative 4 to 3A? Was it based on a dollar figure?

Response: Alternative 3A and Alternative 4 are equally protective of human health and the environment. Therefore, the additional costs associated with Alternative 4 were not justifiable, within the constraints of federal appropriation law. Since both alternatives achieved protectiveness objectives, the least costly alternative was selected.

Comment 22 Was the big factor for the change from Alternative 4 to 3A the level of protection?

Response: No, as stated in response to Comment 22, the level of protection of human health and the environment are essentially equal.

Comment 23 To the best of USEPA's knowledge are there or have there been any sites in the United States similar to this Operable Unit that do not include incineration?

Response: Yes, there are other sites in the United States similar to the EMMA OU that do not include incineration.

Comment 24 Were the other alternatives, such as composting, screened out based on cost?

Response: As mentioned in response to Comment 9, cost is one of several factors evaluated in the remedial action selection process.

Comment 25 Will there be any detonation of explosives on-site? What is the difference in emissions of detonation compared to just striking a match and burning the affected soils? Are the emissions substantially different between detonation and incineration?

Response: It is possible that unexploded ordnance may be exploded on-site if it is deemed that transporting the material offsite would pose an unacceptable hazard. The air emissions resulting from open detonation would not be captured and treated, whereas the air emissions from incineration of nitroaromatic compounds would be captured, monitored, and treated prior to release into the environment.

Comment 26 It was stated earlier that there are monitoring wells directly under the site. When were the wells put in place and how long have you been collecting data? Have you been collecting data since 1991? How long did it take for the TNT to show up in the wells?

Response: A total of 28 monitor wells were installed at the EMMA OU sites between 1988 and 1993. Data were collected during Phases I and II of the RI in 1991 and 1993. Levels of TNT were detected in some of the wells during the 1991 sampling event.

Comment 27 The USFWS read a statement expressing concern about USACE's selection of Alternative 3A as the selected remedy.

Response: Discussions between USFWS, USACE, USEPA, and IEPA have resulted in an agreed-upon approach to implement Alternative 3A. The remedy accepted by the agencies modifies the implementation of Alternative 3A at Site COP-4. This agreed-upon change has been incorporated into this ROD.

Written Comments Received During the Crab Orchard EMMA OU Public Meeting Held on October 19, 1995, and During the Public Comment Period

Comment 1 Place the U.S. Fish and Wildlife Documents in the repository.

Response: It is unclear which documents the commentor is referring to. Those documents utilized for the decision presented in the ROD have been placed in the appropriate repositories.

Comment 2 I would like to see a remedial action alternative that does not include incineration. The health of the people should always come first. Storing the contaminated soil in large drums or barrels until we know how to safely detoxify should be an option.

Response: The soils containing levels of nitroaromatic compound above 100,000 mg/kg pose a threat of explosion. Therefore, handling these soils or storing these soils in drums or containers without any treatment would create a more dangerous situation. Incineration is a safe and viable treatment method for nitroaromatic compounds. Only those soils that pose a potential explosive hazard are proposed for offsite incineration.

Letter to Mr. Joe Laird from Ms. Rose Rowell

"If it be that USEPA and the responsible parties have made the wrong decision Southern Illinois will lose one of its greatest assets hunting and fishing at Crab Orchard a hunting ground that attracts people from all over the country."

Response: The Army believes that the implementation of Alternative 3A will protect the valuable assets of the Crab Orchard National Wildlife Refuge by removing soil with the highest concentrations of nitroaromatic compounds and destroying them in a commercial incinerator. With this removal, the wildlife at the Refuge will not come into contact with dangerous levels of nitroaromatic compounds and hunting and fishing can safely continue.

Letter to Mr. Nanjunda Gowda from Ms. Rose Rowell dated November 19, 1995
"....if a dioxin producing incinerator is sited at the Refuge, there is an imminent endangerment that deer contaminated with dioxin will be put on the family table. Scientists tell us that the body of the average American already has a dangerous level of dioxin, due to atmospheric fallout and dioxin contaminated food and the least bit of exposure could cause devastating, irreversible health problems. Surely, this includes the wildlife — as scientific researchers tell us that dioxin has a devastating effect on wildlife not only contaminating the game. It has the capability to cause birth defects, mutations, the inability to reproduce, etc. ..... we would lose the $50 million dollars that the hunters bring into this area each year. .....the right thing, the responsible thing to do is to stop the incinerator, it can be stopped. .....the imminent overall consequences are going to be too great, as the Crab-Orchard Refuge is a unique site, where food is being raised for the hunters table."

Response: This comment appears to be directed to the remedy proposed for implementation at the PCB OU. On-site incineration is not being considered for implementation at the EMMA OU.

Letter to Mr. Kevin Quinn from Ms. Rose Rowell dated November 20, 1995
"I am writing in regard to the munitions site superfund cleanup slated for the Crab Orchard National Wildlife Refuge, Marion, Illinois.

As we understand the remediation plan calls for the contaminated soil to be taken offsite to a commercial incinerator for disposal.

We are concerned because when the public was originally notified of the Munitions meeting, the preferred method was Alternative #4 by the time we got to the meeting, the Corps had revised the method to be used to Alternative #3A.

If there is a thought of changing again to another alternative - Alternative #6, we want it on record that there is great opposition to an incinerator being brought into the Crab Orchard Wildlife Refuge and with just cause."

Response: Alternative 3A is the selected remedy.

Appendix B

Administrative Record Index

ADMINISTRATIVE RECORD INDEX
EXPLOSIVES/MUNITIONS MANUFACTURING AREA OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

Doc No.	Date	Author	Recipient(s)	Title/Description	Page
1	04/11/88	Woodward-Clyde Consultants	USACE-Omaha	Confirmation Study at the Crab Orchard National Wildlife Refuge Hampton Cemetery and Ammunition Plant DERA Site (5 volumes)	1287
2	08/00/88	O'Brien & Gere Engineers, Inc.	USFWS, US Dept of Int., Sangamo Weston, Inc.	Remedial Investigation Report Crab Orchard National Wildlife Refuge (3 Volumes)	1722
3	11/15/90	UXB Int. Inc.; ESE	USACE-Omaha	Crab Orchard National Wildlife Refuge, Marion, IL, Health and Safety Work Plan	72
4	01/04/91	USEPA	Japp, USACE-Omaha; Tsai, QAS	Letter, re: Information to be included in the QAPP	37
5	03/08/91	ESE	USACE-Omaha	Site-Specific Safety & Health Plan, Phase I Activities, Former Illinois Ordnance Plant, Crab Orchard National Wildlife Refuge, Marion, IL	107
6	07/26/91	ESE	USACE-Omaha	Site-Specific Safety & Health Plan, Phase I Activities, EMMA OU, Marion, IL	106
7	07/30/91	ESE	Japp, USACE-Omaha; Farrell, USACE-LMRD; Dace, USACE-St. Louis; Ohnstead, USACE-MRD; Perro, USACE-Huntsville; Moore, DOI/FWS; Logan, USEPA; Davis, IEPA; Lombardo, UXB	EMMA OU Chemical Data Acquisition Plan, Crab Orchard Wildlife Refuge, Marion, IL (2 Volumes)	430
8	08/01/91	DOI; DA	DOI; DA; USEPA; IEPA	Memorandum of Agreement for Crab Orchard NWR	20
9	08/91	DOI; DA	DOI; DA; USEPA; IEPA	Amendment No. 1 to the Memorandum of Agreement for Crab Orchard NWR	6
10	08/16/91		USEPA Region V; IEPA; DOI, DA	Federal Facility Agreement Under CERCLA Section 120	95
11	08/19/91 through 10/02/91	UXB	Japp, USACE-Omaha	Daily Quality Control Reports	64
12	12/24/91	ESE	USACE-Omaha	EMMA OU Analytical Data Report, Crab Orchard Wildlife Refuge, Marion, IL (2 volumes)	996
13	01/00/92	ESE	USACE-Omaha	Soil Boring Logs, Monitor Well Logs, and Monitor Well Construction Diagrams, The Crab Orchard EMMA OU Phase I Investigation, Marion, IL	99

ADMINISTRATIVE RECORD INDEX
EXPLOSIVES/MUNITIONS MANUFACTURING AREA OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

Doc No.	Date	Author	Recipient(s)	Title/Description	Page
14	01/10/92	Bornhoft, USACE-Omaha	USEPA Region 5; IEPA; FWS; Liu, Japp, Bauer, USACE-Omaha	Letter, re: Expiration of Comment Period for the FFA	2
15	01/17/92	ESE	Japp, USACE-Omaha; Ohnstead, USACE-MRD; Farrell, USACE-LMRD; Dace, USACE-St. Louis; Carter, IEPA; Logan, USEPA; Moore, FWS	EMMA OU Quality Control Summary Report, Crab Orchard Wildlife Refuge, Marion, IL	165
16	02/21/92	ESE	Fischer, USACE-Omaha; Ohnstead, MRD; Nebelsick, USACE	Letter, re: Replacement pages for the Analytical Report	39
17	03/26/92	Taggart, USACE-MRD Laboratory	Japp, USACE-Omaha	Quality Assurance Laboratory Results	287
18	03/30/92	McKinley, ESE	Fischer, USACE-Omaha; Farrell, USACE-LMRD; Dace, USACE-St. Louis; Ohnstead, USACE-MRD; Logan, USEPA; Moore, DOI/FWS; Carter, IEPA; Lombardo, UXB	Technical Memorandum Crab Orchard EMMA OU Phase I Remedial Investigation, Marion, IL	340
19	05/18/92	McKinley, ESE	Fischer, USACE-Omaha; Novak, USEPA; Moore, DOI; Carter, IEPA	Letter, re: Crab Orchard EMMA OU (replacement pages for the Analytical Data Report)	46
20	05/27/93	McKinley, ESE	Fischer, USACE-Omaha; Ohnstead, USACE-MRD; Dare, USACE-St. Louis; Farrell, USACE-LMRD; Moore, DOI/FWS; Gowda, USEPA; Nussbaum, IEPA; Lombardo, UXB	EMMA OU Phase II Investigation Amended Chemical Data Acquisition Plan, Crab Orchard NWR, Marion, IL (2 Volumes)	317
21	09/10/93	McKinley, ESE	Fischer, USACE-Omaha; Nussbaum, IEPA; Gowda, USEPA; Moore, DOI	Final EMMA OU Phase II Investigation Preliminary Risk Assessment-Ecological, Crab Orchard NWR, Marion, IL	289
22	11/01/93	McKinley, ESE	Gowda, USEPA Region 5; Fischer, USACE-Omaha; Schupp, USEPA; Nussbaum, IEPA; Sattelberg, FWS	Letter, re: Crab Orchard NWR EMMA OU, SOPs for Work Performed on 10/11/93, Pursuant to the Preliminary Risk Assessment (with attachments)	54

Doc No.	Date	Author	Recipient(s)	Title/Description	Page
23	12/02/93	McKinley, ESE	Gowda, USEPA Region 5; Fischer, USACE-Omaha; Schupp, USEPA; Nussbaum, IEPA; Shaw, IEPA; Sattelberg, FWS	Letter, re: Further Information Regarding SOPs Submitted on 11/01/93 (this information to be considered addendum to Phase II CDAP)	10
24	01/21/94	ESE	USACE-Omaha	EMMA OU Crab Orchard NWR, Marion, IL, Phase II Analytical Data Report (2 Volumes)	565
25	02/11/94	ESE	USACE-Omaha	EMMA OU Quality Control Summary Report, Crab Orchard NWR, Marion, IL, Phase II RI/FS	91
26	02/18/94	Musgrave, FWS	Gowda, Deamer, USEPA Region 5; Fischer, White, USACE-Omaha; Project Manager, Nickey-Tebrugge, IEPA; Lombardo, Schlumberger Environmental Services	Draft General Fact Sheet Outlining Status of Superfund Activities at the Crab Orchard NWR	15
27	04/15/94	Butler, City of Marion, Illinois	Musgrave, FWS; Congressman Poshard; Deamer, USEPA; Nickey-Tebrugge, IEPA; White, USACE-Omaha	Letter, re: Cleanup at the Crab Orchard National Wildlife Refuge	2
28	04-05/00/94	*Technically*, Issue No. 27	Public	Article, re: Environmental and Ecological Study at the National Wildlife Refuge	1
29	09/15/94	McKinley, ESE	Fischer, USACE-Omaha; Cotner, USACE-St. Louis; Novotny, USACE-MRD; Farrell, USACE-LMRD; Gowda, USEPA; Nussbaum, IEPA; Sattelberg, FWS; Roberts, WWES	Draft Final Remedial Investigation/ Baseline Risk Assessment Report, EMMA OU, Crab Orchard NWR, Marion, IL (5 Volumes)	2318
30	09/28/94	McKinley, ESE	Fischer, USACE-Omaha; Cotner, USACE-St. Louis; Novotny, USACE-MRD; Farrell, USACE-LMRD; Gowda, USEPA; Nussbaum, IEPA; Sattelberg, FWS	Addendum to the Draft Final Remedial Investigation/Baseline Risk Assessment Report, EMMA OU, Crab Orchard NWR, Marion, IL	77
31	11/00/94	ESE	Public	Fact Sheet: Crab Orchard National Wildlife Refuge, EMMA OU	6
32	11/01/94	Butler, Daily Egyptian	Public	Newspaper Article, re: Public Meeting for the Crab Orchard NWR	2

ADMINISTRATIVE RECORD INDEX
EXPLOSIVES/MUNITIONS MANUFACTURING AREA OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

Doc No.	Date	Author	Recipient(s)	Title/Description	Page
33	11/01/94		Public	Photos, re: Availability Session and Public Meeting	4
34	11/02/94	Mariano, Southern Illinoisan	Public	Newspaper Article, re: Cleanup at the Crab Orchard NWR	3
35	11/02/94	Grimes, Marion Daily Republican	Public	Newspaper Articles, re: Cleanup Plan for the Crab Orchard NWR	2
36	11/18/94	Monett, FWS	Fischer, USACE-Omaha; White, USACE; Gowda, Deamer, USEPA; Nussbaum, Nickey-Tebrugge, IEPA; McKinley, Fieber, ESE; Boyd, WCC; Miller, FWS; Berry, CONWR	Letter, re: Questions and Comments Made During the EMMA Public Meeting, November 1, 1994	3
37	09/29/95	USACE	USACE-Laird, Administrative Record	Technical Memorandum of the Itemization of Changes and Assumptions between the FS Costs and the Proposed Plan Costs	63
38	09/29/95	ESE/USACE	Public	Proposed Plan/Fact Sheet: Crab Orchard National Wildlife Refuge, EMMA OU	16
39	02/14/95	USACE (ESE)	USACE, USFWS, IEPA, USEPA	Draft Final Addendum to the Draft Final Remedial Investigation/Baseline Risk Assessment Report Explosives/Munitions Manufacturing Areas Operable Unit, Crab Orchard National Wildlife Refuge, Marion, Illinois	82
40	09/15/95	USACE (ESE)	Public	Public Notice for Public Meeting of October 19, 1995 on Proposed Plan EMMA OU	1
41	09/26/95	USACE (ESE)	USACE, USFWS, IEPA, USEPA	Final Revised Feasibility Study Report, Explosives/Munitions Manufacturing Areas Operable Unit, Crab Orchard National Wildlife Refuge, Marion, Illinois	450
42	10/24/95	USACE (Southern Reporting)	USACE, USFWS, USEPA, IEPA, ESE	Transcripts of Proposed Remedial Action Plan Public Meeting of October 19, 1995	71
43	11/01/95 11/02/95 11/03/95 11/06/95	USACE (ESE)	Public	Public Notice for Extended Public Comment Period on the Proposed Remedial Action Plan	1

Doc No.	Date	Author	Recipient(s)	Title/Description	Page
44	02/87	United States Army Toxic and Hazardous Materials Agency (Arthur D. Little, Inc.)	USACE, Administrative Record	Testing to Determine Relationship Between Explosive Contaminated Sludge Components and Reactivity, Final Report	71
45	12/78	USFWS (Booker Associates, Inc.)	Administrative Record	Crab Orchard National Wildlife Refuge Master Plan Technical Report	169
46	2/12/96	USACE	Administrative Record	Technical Memorandum, Updated Cost Data for Remedial Alternatives Presented in ROD	129
47	4/22/96	USACE (ESE)	USACE, USFWS, USEPA, IEPA	Record of Decision (ROD) for Crab Orchard National Wildlife Refuge, Explosives/Munitions Manufacturing Areas (EMMA) Operable Unit (OU)	66

ADMINISTRATIVE RECORD INDEX
EXPLOSIVES/MUNITIONS MANUFACTURING AREA OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS
ACRONYM GUIDE

Acronym	Definition
CONWR	Crab Orchard National Wildlife Refuge
DA	U.S. Department of Army
DOI	U.S. Department of the Interior
EMMA	Explosives/Munitions Manufacturing Areas
ESE	Environmental Science & Engineering, Inc.
FFA	Federal Facility Agreement
FWS	U.S. Fish and Wildlife Service
IEPA	Illinois Environmental Protection Agency
LMRD	Lower Missouri River Division
MOA	Memorandum of Agreement
MRD	Missouri River Division
NWR	National Wildlife Refuge
OU	Operable Unit
RI/BRA	Remedial Investigation/Baseline Risk Assessment
SOP	standard operating procedure
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UXB	UXB International, Inc.

ADMINISTRATIVE RECORD GUIDANCE INDEX
EXPLOSIVES/MUNITIONS MANUFACTURING AREA OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS
(EPA Guidance Documents are available for review at USEPA Region 5, Chicago, IL)

Title	Author	Date
Environmental Impact Assessment	Larry W. Canter	00/00/77
Remedial Action of Waste Disposal Sites (Revised), EPA/625/6-85/006	USEPA	00/00/85
Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, EPA/540/6-89/004	USEPA	00/00/88
Remedial Action Costing Procedure Manual, EPA/600/8-87-049	USEPA	00/00/88
CERCLA Compliance with Other Laws Manual: Draft Guidance, EPA/540/G-89/006	USEPA	08/00/88
Guidance on Preparing Superfund Decision Documents: the Proposed Plan, the Record of Decision, Explanation of Significant Differences, the Record of Decision Amendment (Interim Final)	USEPA	10/00/88
CERCLA Compliance with State Requirements, Publication 9234.2-05/FS	USEPA	00/00/89
Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual, Part A, Interim Final, OSWER Directive 9285.7-01	USEPA	00/00/89
Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final)	USEPA	07/00/89
National Contingency Plan	USEPA	08/08/90
Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER Directive 9355.0-30	USEPA	00/00/91

Title 35: Environmental Protection Subtitle G: Waste Disposal Chapter I: Pollution Control Board	State of Illinois	04/00/92
Compost Compaction Evaluation Report No. CETHA-TS-CR-93043	Roy F. Weston, Inc.	00/00/93
Windrow Composting Demonstration for Explosives--Contaminated Soils at the Umatilla Depot Activity, Hermiston, Oregon, Report No. CETHA-TS-CR-93043	Roy F. Weston, Inc.	00/00/93
Windrow Composting Engineering/ Economic Evaluation, Report No. CETHA-TS-CR-93050	Roy F. Weston, Inc.	00/00/93
Illinois Environmental Protection Act, 415 ILCS, Title I-XV	State of Illinois	01/13/93
40 Code of Federal Regulations Parts 260-270		

Appendix C

Letters of Concurrence from Support Agencies

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

JUL 26 1996

Mr. Raymond J. Fatz
Acting Deputy-Assistant Secretary of the Army
Environment, Safety and Occupational Health
Office, Assistant Secretary of the Army
ATTN: SAILE-ESOH
110 Army Pentagon, Room 2E577
Washington, D.C. 23101-0110

Mr. Valdas V. Adamkus
Regional Administrator
U.S. Environmental Protection Agency, Region 5
77 West Jackson Blvd.
Chicago, IL 60604

Dear Messrs. Fatz and Adamkus:

The Department of the Interior has reviewed the proposed final Record of Decision (ROD), dated April 22, 1996, for the Explosives/Munitions Manufacturing Area Operable Unit (EMMA OU) at Crab Orchard National Wildlife Refuge.

Because we have concluded that the selected remedy is not inconsistent with the requirements for remedial action under the National Contingency Plan (NCP), we are concurring, with reservations due to trust resource concerns, in the selected remedy as satisfying those portions of the Army's CERCLA obligations addressed in sections 300.1 through 300.525, and 300.700 through 300.825 of the NCP.

However, we wish to reiterate our strong conviction that it will likely be more efficient--and more cost-effective in the long run--to incorporate actions that address natural resource injuries into implementation of the Army's remedial action obligations. We strongly encourage the Army, with the cooperation of USEPA and Illinois EPA, to work closely with us during the remedial design phase in order to incorporate appropriate activities that address natural resource damages liability and restoration obligations. We are presently evaluating what additional actions may be necessary and appropriate, in combination with the selected remedy, to help mitigate potential natural resource injuries. We will continue to work with you now and during the remedial design phase to advise you of our relevant findings and proposed solutions. Coordination between remedial actions and trust resource concerns usually leads to overall cost savings, even if it requires that costs above the minimum remediation requirements be incurred in the short term.

This concurrence does not constitute a determination concerning injuries to natural resources at the EMMA OU resulting from releases of hazardous substances, nor does it constitute a determination of the degree to which the design and construction of the selected remedy will or will not mitigate injuries to natural resources. In addition to liability for response costs, CERCLA liability includes liability for injury to, destruction of, or loss of natural resources, including reasonable assessment costs. See 42 U.S.C. § 9607(a)(4)(C); 43 C.F.R. Part 11 (1995). As provided in both the Federal Facility Agreement and the Memorandum of Understanding with the Department of the Army, the Department has reserved its rights to assert natural resource damages claims for this site. Our concurrence in the selected remedy does not represent a waiver of these rights or a covenant not to sue for natural resource damages, nor does implementation of the ROD relieve the Army of its liability for natural resource damages.

The Department provisionally concurs with the conclusions of the Baseline Risk Assessment in Section 7.3 of the ROD but advises that the baseline risk assessment differs substantially from a natural resource damage assessment. As the Federal trustee, the Department, through the Fish and Wildlife Service, is continuing to evaluate potential injuries to natural resources at the site, but has not completed a natural resource damage assessment. Unlike the risk assessment, a natural resource damage assessment determines the extent of injuries to natural resources resulting from a hazardous substance release, and the cost of restoration.

Regards,

Bonnie R. Cohen
Assistant Secretary
Policy, Management and Budget

cc: Ms. Mary Gade, Director
Illinois Environmental Protection Agency

State of Illinois
ENVIRONMENTAL PROTECTION AGENCY

Mary A. Gade, Director

2200 Churchill Road, Springfield, IL 62794-9276

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Crab Orchard National Wildlife Refuge, Explosives/Munitions Manufacturing Areas Operable Unit
Marion, Illinois

STATEMENT OF BASIS AND PURPOSE

This decision document represents the Illinois Environmental Protection Agency's ("Illinois EPA's") concurrence on the selected remedial action for the Crab Orchard National Wildlife Refuge Superfund Site, Explosives/Munitions Manufacturing Areas Operable Unit near Marion, Illinois. This decision document was developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("CERCLA", as amended by the Superfund Amendments and Reauthorization Act of 1980 ("SARA"), and the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"). This decision is based on the Administrative Record for this site.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the sites in this operable unit, if not addressed by implementation of the response action selected in this Record of Decision ("ROD"), may present an imminent and substantial endangerment to the public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

This remedy is intended to be the final action for the sites in this operable unit. For sites identified as COC-1, COC-2, COC-5, COC-7, COC-8, COC-9, COC-10, COP-1, COP-2, COP-3 and Bunker Area 1-3, the ROD concludes no further action is required. Due to uncertainties in the risk assessment, the site known as COC-4 has been deferred to a following operable unit to be named later by the Department of the Army.

For the remaining sites known as COC-3 and COP-4, the remedy addresses all contaminated media and includes: removal and treatment of reactive soils, cover of contaminated soils and sediments, long-term maintenance and long-term groundwater monitoring. The major components of the selected remedy include:

1. Excavation and off-site treatment (incineration) and disposal of soils containing levels of explosive compounds greater than 100,000 parts per million ("ppm") and lead greater than 450 ppm.
2. Additional removal of Royal Demolition Explosives (Hexahydro-1,3.5-trinitro-1,3.5-triazine) (RDX) and High Melting Explosives (cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine) ("HMX") contaminated soil at Site COP-4 to a depth of two feet below grade within the existing fenced area and disposal in an off-site special waste landfill.
3. Sampling to ensure remaining affected soils at COC-3 and COP-4 do not exhibit the characteristics of a hazardous waste for lead and 2,4-Dinitrotoluene ("DNT").
4. Backfill excavated areas to shape the base of the covers.
5. Placing a 24-inch clean soil cover over the remaining affected soils.
6. Long-term maintenance of the soil covers and monitoring to ensure protectiveness of the remedy.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with the Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces the toxicity, mobility, or volume as a principal element.

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

Mary A. Gade, Director
Illinois Environmental Protection Agency

12/12/96
Date