United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R04-93/160
September 1993

EPA

# Superfund Record of Decision:

# Milan Army Ammunition Plant, TN

50272-101

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SUPERFUND RECORD OF DECISION
Milan Army Ammunition Plant, TN
Second Remedial Action - Final

**5. Report Date**
09/29/93

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**7. Author(s)**

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U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

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**15. Supplementary Notes**
PB94-964049

**16. Abstract (Limit: 200 words)**


The 22,436-acre Milan Army Ammunition Plant site is an ammunition production and storage facility located in Gibson and Carroll Counties, Tennessee. Land use in the area is predominantly agricultural, with scattered residences located to the north and east of the site. The Milan Army Ammunition Plant (MAAP) lies within the coastal plain province of the Mississippi Embayment, and contains numerous small streams, creeks, and drainage ditches. The entire facility, except for the extreme southern portion, drains via small creeks and ditches into the Rutherford fork of the Obion River, which empties into the Mississippi River about 60 miles to the west. The 1,600 people presently working at MAAP, as well as the population residing within the vicinity of the site, use the Memphis Sand of the Clairborne Group aquifer as their main drinking water supply. The O-Line Ponds area, addressed in this ROD, historically received wastewater from the operations conducted at O-Line and is located in the north central portion of the site. Since 1941, the U.S. Army has used the site for the production and storage of fuses, boosters, and small- and large-caliber ammunition. The types of explosives handled in the facility include 2,4,6-trinitrotoluene (TNT) and RDX. From 1941 to 1978, the function of the O-Line area was to remove explosives from bombs and projectiles by injecting a high-pressure stream of hot water and steam into the steel shell of the


(See Attached Page)

**17. Document Analysis a. Descriptors**
Record of Decision - Milan Army Ammunition Plant, TN
Second Remedial Action - Final
Contaminated Media: soil, sediment, sw
Key Contaminants: organics; metals

**b. Identifiers/Open-Ended Terms**

**c. COSATI Field/Group**

| 18. Availability Statement | 19. Security Class (This Report) None | 21. No. of Pages 84 |
|---|---|---|
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(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

munitions. A 1978 investigation conducted under the U.S. Army water well sampling program revealed that three of the MAAP's 11 water supply wells were contaminated with explosive constituents. O-Line operations were ceased in 1978 and, beginning in 1981, effluent from the ponds was pumped into a newly-installed pink water treatment facility (PWTF) consisting of carbon adsorption and fabric filtration units. Effluent from the PWTF was discharged to an open ditch, which was then covered with a PVC liner. In 1984, a closure plan was implemented consisting of filling the ponds with clean inorganic fill followed by the installation of a multilayered cover. The site is divided into three OUs for remediation, all located within the O-Line area: OU1 is the ground water beneath and immediately downgradient from the former O-Line Ponds contaminated by past disposal practices; OU2 addresses the contaminated soil beneath and around the former ponds, and surface water and shallow sediment in the drainage ditch that flows along the east and north sides of the ponds; and OU14 addresses additional areas of ground water contamination both upgradient and downgradient of OU1 and OU2. A 1992 interim ROD addressed the remediation of contaminated ground water downgradient of the O-Line area. This ROD addresses the contaminated soil beneath and around the former ponds and surface water and shallow sediment in the drainage ditch, as OU2. A possible future ROD will address the remediation of the ground water at OU14. The primary contaminants of concern affecting the soil, sediment, and surface water are organics and metals.

The selected remedial action for this site includes extending the multilayered cap over the contaminated soil around the perimeter of the existing cap to cover an area of 237,000 $ft^2$; monitoring air during cap construction; monitoring ground water; and implementing institutional controls, including deed and land use restrictions. The estimated present worth cost for this remedial action is $1,833,000, which includes an estimated annual O&M cost of $19,000 for 30 years.

PERFORMANCE STANDARDS OR GOALS:

Not provided.

MILAN ARMY AMMUNITION PLANT (MAAP)
O-LINE PONDS AREA
SOIL, SEDIMENT, AND SURFACE WATER
OPERABLE UNIT

Milan, Tennessee

# RECORD OF DECISION

FINAL DOCUMENT

September 29, 1993

*In accordance with Army Regulation 200-2, this document is intended to comply with the National Environmental Policy Act (NEPA) of 1969.*

## DECLARATION FOR THE RECORD OF DECISION

### SITE NAME AND LOCATION

O-Line Ponds Area, Milan Army Ammunition Plant (MAAP), Milan, Tennessee

### STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for Operable Unit Two (OU2) at the O-Line Ponds Area, Milan Army Ammunition Plant, Milan, Tennessee. The selected remedial action was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR 300). This decision document explains the factual basis for selecting the remedy for OU2 and the rationale for the final decision. The information supporting this remedial action decision is contained in the Administrative Record for this site.

The U.S. Environmental Protection Agency and the State of Tennessee concur with the selected remedy.

### ASSESSMENT OF THE SITE

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

### DESCRIPTION OF THE REMEDY

The goal of the overall cleanup activities at the site is to prevent migration of contaminants from soil at the site and to prevent exposures to these contaminants, so that no adverse health effects will result from current or future off-post or on-post use. Soil contaminated with explosives compounds is known to exist in the O-Line Ponds area, and under current conditions, this contamination poses a potential threat to groundwater at the site. Currently contaminated groundwater is being addressed by separate remedial actions under different Operable Units (OUs).

The Operable Units at the O-Line Ponds area are defined as follows: Operable Unit One (OU1) addresses contaminated groundwater beneath and immediately downgradient from the former ponds which has been contaminated by past disposal practices at the ponds; OU2 addresses contaminated soils beneath and around the former ponds, and surface water and shallow sediment in the drainage ditch that flows along the east and north sides of the ponds, which have become contaminated as a result of past disposal practices; and Operable Unit 14 (OU14) addresses additional areas of contamination both upgradient and downgradient of OU1 and OU2. This Record of Decision presents the remedies that were considered for OU2 only. A Record of Decision has already been issued for OU1, and the Army is currently investigating the nature and extent of contamination in OU14.

The major component of the remedy selected for OU2 is an extension of the existing multi-media cap to cover contaminated soil. The cap extension will be designed and constructed in accordance with Resource Conservation and Recovery Act requirements for landfills. The entire capped area will be maintained to prevent degradation or erosion of the impermeable barriers. Groundwater monitoring will be conducted in conjunction with OU1 and institutional controls will be implemented and/or maintained to prevent access and exposures to the O-Line Ponds site.

*The principal threat at this site is continued migration of contaminants* to groundwater and potential future exposures to contaminated groundwater. This threat will be addressed by capping all areas of soil that are contaminated with explosives. The cap extension, along with the existing cap, will provide an impermeable barrier to infiltrating water, thereby preventing downward movement of explosives in the soil and protecting groundwater from further degradation.

The remedy specified herein will be one component of the overall remediation of the O-Line Ponds area. This action will be compatible with any current or planned future remedial actions for the site.

## STATUTORY DETERMINATIONS

This action is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to this remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site. However, because treatment of the principal threats of the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. The large areal extent and depth of the contaminated soil at the site preclude a remedy in which contaminants could be excavated and treated effectively.

Because this action will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within five years after implementation of this remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Additional remedial actions will be implemented to address contaminants in groundwater and to eliminate potential future exposures.

Everette B. Crumpler III
Lieutenant Colonel, U.S. Army
Commanding Officer, Milan Army Ammunition Plant

8 Sep 93
Date

Lewis D. Walker
Deputy Assistant Secretary of the Army
(Environment, Safety, and Occupational Health)

9/29/93
Date

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET. N.E.
ATLANTA. GEORGIA 30365

4WD-FFB

**CERTIFIED MAIL**
**RETURN RECEIPT REQUESTED**

Mr. Lewis D. Walker
Deputy Assistant Secretary of the Army
(Environment, Safety and Occupational Health)
Attention: SAILE-ESOH
The Pentagon, Room 2E577
Washington, D.C. 20310-0110

RE: Record of Decision for Operable Unit Two (2)
Milan Army Ammunition Plant, NPL Site
Milan, Tennessee

Dear Mr. Walker:

The U.S. Environmental Protection Agency (EPA) has reviewed the above referenced decision document pursuant to the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended and concurs with the proposed remedial action at Operable Unit Two (2) as supported by the previously completed Remedial Investigation and Baseline Risk Assessment Reports.

It is understood that the remedial action decision for Operable Unit 2 (O-Line Ponds Area - Soil, Sediment and Surface Water Operable Unit), is the final remedial action to address the above referenced media potentially affected by past disposal practices at the O-Line Ponds Area.

Sincerely,

Patrick M. Tobin
Patrick M. Tobin
Acting Regional Administrator

cc: Commissioner J. A. Luna, Tennessee Department of Environment and Conversation
LTC Everette B. Crumpler, III
Commanding Officer, MAAP

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
NASHVILLE, TENNESSEE 37243-0435

NED McWHERTER
GOVERNOR

J. W. LUNA
COMMISSIONER

September 30, 1993

Mr. Lewis D. Walker
Deputy Assistant Secretary of the Army
OSHA-I, LE
Office of the Assistant Secretary
Department of the Army
Washington, D.C. 20310-0103

Ref. 27-505 MAAP O-Line Ponds OU#2 ROD

Dear Mr. Walker:

The Tennessee Department of Environment and Conservation has reviewed the final Record of Decision submitted on August 26, 1993. This document has reference to the soil, shallow sediment and surface water operable unit of the O-Line Ponds Area at the Milan Army Ammunition Plant located in Milan, Tennessee. The Department concurs with the findings and the selected remedial action stated in this Record of Decision.

If you have any questions regarding this matter please contact me at (615) 532-0900 or Mr. Ron Sells, TDEC Project Manager at (9010 423-6600.

Sincerely,

Clinton W. Willer, Director
Division of Superfund
Department of Environment and Conservation

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## 1.0 SITE NAME, LOCATION, AND DESCRIPTION

Milan Army Ammunition Plant (MAAP) is located in western Tennessee, 5 miles east of Milan, Tennessee, and 28 miles north of Jackson, Tennessee (Figure 1-1). MAAP is a government-owned, contractor-operated installation with Martin Marietta Ordnance Systems, Inc., as the operating contractor. The facility was constructed in 1941 to produce and store fuzes, boosters, and small- and large-caliber ammunition. At present, the facility comprises 22,436 acres.

MAAP lies within the coastal plain province of the Mississippi Embayment, west of the Western Valley of the Tennessee River and east of the Mississippi River Valley. The topography of MAAP and surrounding area is gently rolling to flat. It slopes regionally westward and contains numerous small streams, creeks, and drainage ditches. The elevation of the plant varies from a high of approximately 590 feet above mean sea level (ft-msl) on the south side to a low of approximately 320 ft-msl on the north boundary of the plant.

Numerous perennial and ephemeral surface water features occur within the installation and flow to the north-northwest. The entire facility, except for its extreme southern portion, drains via small creeks and ditches to the Rutherford Fork of the Obion River. The northern portions of MAAP contain several well-developed, ephemeral, natural drainage bodies that join the Rutherford Fork along the northern boundary of the installation. The two parent streams, the Forked Deer River and the Obion River, empty into the Mississippi River about 60 miles west of MAAP.

Groundwater is a primary source of potable and non-potable water in this area of Tennessee. At MAAP, the Memphis Sand of the Claiborne Group is the major aquifer, and is thick, laterally continuous, and highly transmissive. Groundwater flow in the MAAP area is generally to the west, in the direction of the regional dip of these sands, and also trends northerly because of the topographic influence. On a general scale, there are no abrupt hydrologic boundaries in the aquifer. The formation is recognized as sand with clay lenses and clay-rich zones.

The facility is located in a rural area, with agriculture being a primary land use. There are scattered residences to the north and east of the facility boundary. North of the facility, the nearest residences are located north of the Rutherford Fork. These residences are downgradient from the O-Line Ponds area and are approximately 1.5 miles from the O-Line Ponds. On the east side of the facility, residences are located along the facility property line.

At present, approximately 1,600 people work within the MAAP facility. With the exception of 2 Army officers and 31 civilian employees, the work force is composed of Martin Marietta Ordnance Systems, Inc., employees.

Of the thirteen process areas that were active at the end of World War II, only seven lines are in use today. As shown in Figure 1-2, the active process areas are distributed throughout the northern half of the facility. O-Line is located in the north central portion of MAAP. Immediately north of O-Line are the O-Line Ponds (now closed), which historically received wastewater from the operations conducted at O-Line. This ROD addresses contamination that is present in the surface and subsurface soil around the former ponds, and in the surface water and shallow sediments in the ditches that drain the O-Line Ponds area. This area is described in more detail in the following section.

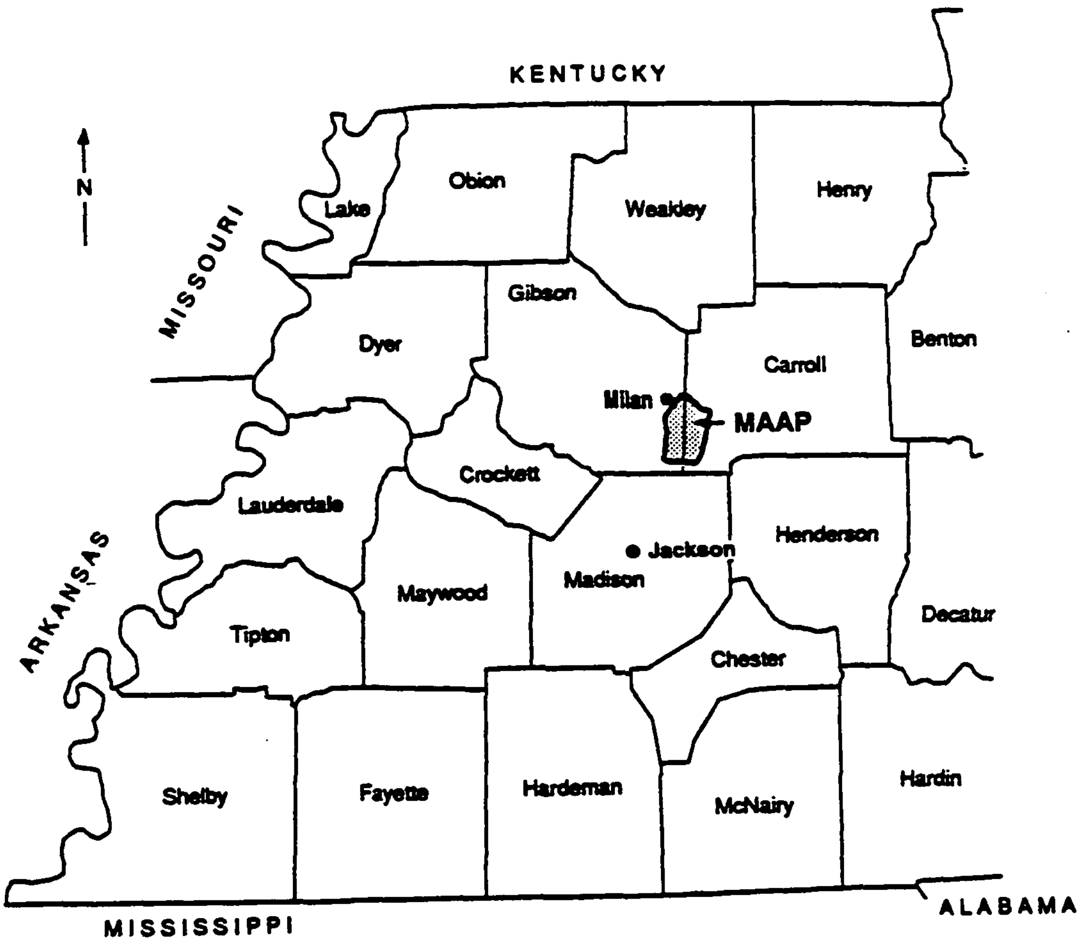


**FIGURE 1-1**
**LOCATION OF MAAP IN WESTERN TENNESSEE**

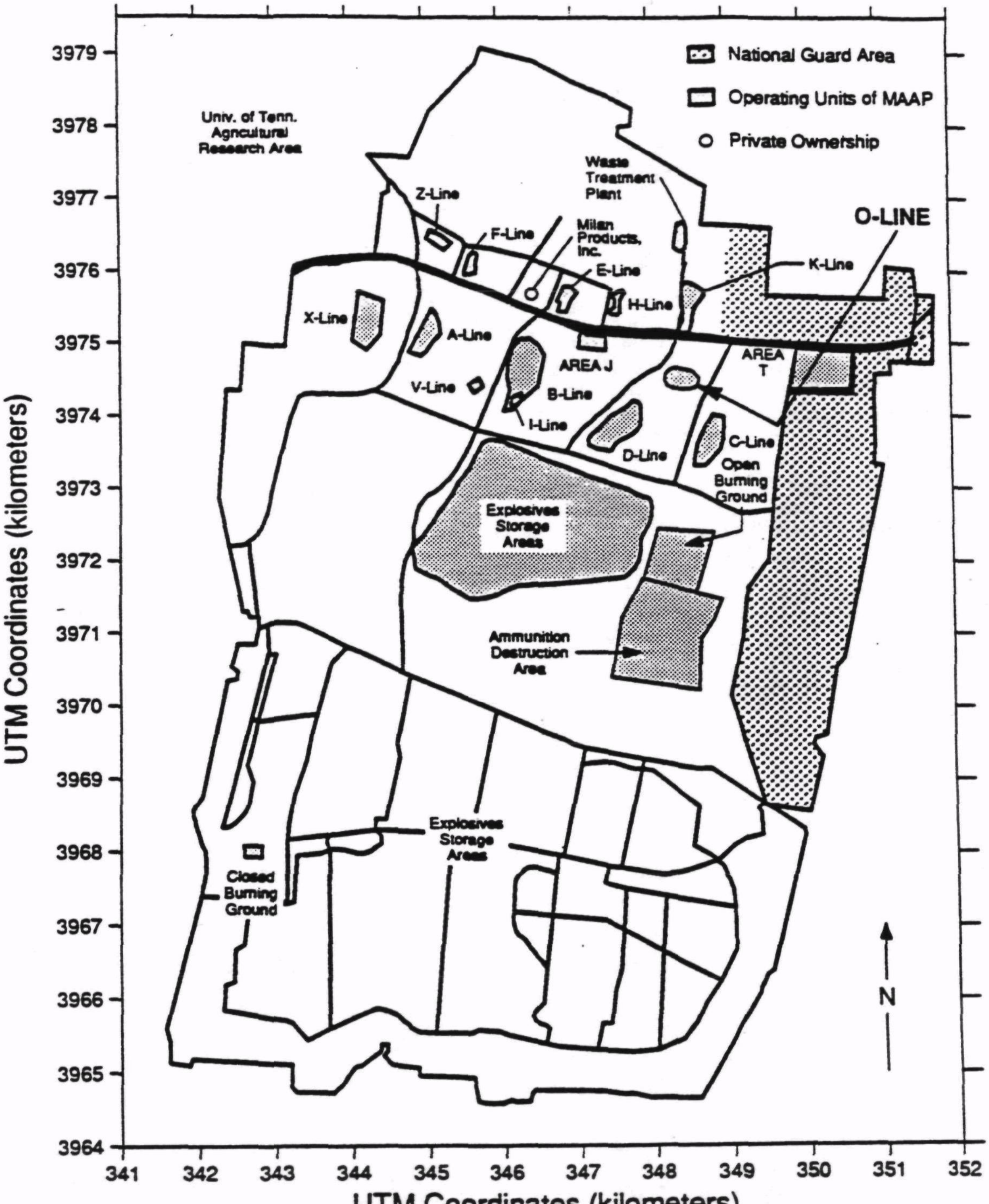


**FIGURE 1-2**
**ACTIVE AND INACTIVE PROCESS AREAS WITHIN MAAP**

## 2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The O-Line area (Figure 2-1) at MAAP was built as part of the initial plant construction activity in 1941, and has operated since 1942 as an ordnance demilitarization facility. From the start, the major function of the line has been to remove explosives from bombs and projectiles by injecting a high-pressure stream of hot water and steam into the steel shell of the munitions. The types of explosives handled in the facility include 2,4,6-trinitrotoluene (TNT) and RDX.

Wastewater contaminated with explosives was discharged from the O-Line washout operations through a series of baffled concrete sumps where cooling caused significant amounts of explosives to precipitate out of the waste stream. Effluent from the sumps was initially discharged to an open ditch which ran through the O-Line area. In 1942, 11 individual surface impoundments were excavated to receive the O-Line effluent before discharge to the open ditch. The ponds reportedly were excavated into native soil and the excavated material was used to form the pond dikes.

The ponds were 3-5 feet deep, had a total capacity of 5.5 million gallons, and covered an area of about 280,000 square feet (USATHAMA, 1982a). The ponds were interconnected with a series of spillways, open ditches, and distribution boxes allowing several pond configurations to be used in series. Effluent from the last pond flowed through a bank of sawdust-filled tanks before discharge to Ditch B. The drainage ditch that received effluent from the final pond discharged to the Rutherford Fork of the Obion River which runs along the northern boundary of MAAP.

In 1978, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) conducted an *Installation Assessment* of MAAP (USATHAMA, 1978), which consisted of a records search and interviews with employees. It was reported in this document that between 300 to 500 pounds of explosives could be washed out in an 8-hour shift, and that many types of explosive materials were handled in this area. At the time of the survey, all of the wastewater ponds were full and signs of overflow were obvious. The overflow entered the open ditch near O-Line.

Also in 1978, the U.S. Army Environmental Hygiene Agency's (USAEHA) water well sampling program (USAEHA, 1978) revealed that three of MAAP's 11 water supply wells were contaminated with explosive constituents. The affected wells were near a number of production areas, including O-Line.

MAAP facility personnel ceased using the O-Line Ponds because the ponds were determined to be one of the most likely sources of groundwater contamination. As a result, the O-Line operation was placed in a standby status in December 1978, and effluent has not been discharged to the ponds since that time. The impounded effluent remained in the ponds until 1981, when the supernatant was pumped out and treated in a newly constructed pink water treatment facility (PWTF), consisting primarily of carbon adsorption units and fabric filtration units. The effluent from the PWTF was discharged to the open ditch under the facility's National Pollutant Discharge Elimination System (NPDES) permit. A PVC liner was placed on top of the pond sediments in 1981 and the liner was filled with fresh water to stabilize it. Pond sediments that had previously been removed from the ponds and placed near the northwest corner of the ponds were placed on top of the PVC liner prior to pond closure.

MAAP subsequently prepared and submitted a closure plan for the pond site (USATHAMA, 1982b). The closure plan was approved by the Tennessee Department of Health and the Environment (TDHE) and implemented in 1984. The closure plan called for the construction of a multilayered cover system for the ponds. A cross-section of this cap is shown in Figure 2-2. The ponds were filled with clean inorganic fill, and two clay layers were placed on top and compacted. A gravel drainage layer was placed between the clay layers. Topsoil was placed on top of the upper clay layer, and a vegetative cover was then established.

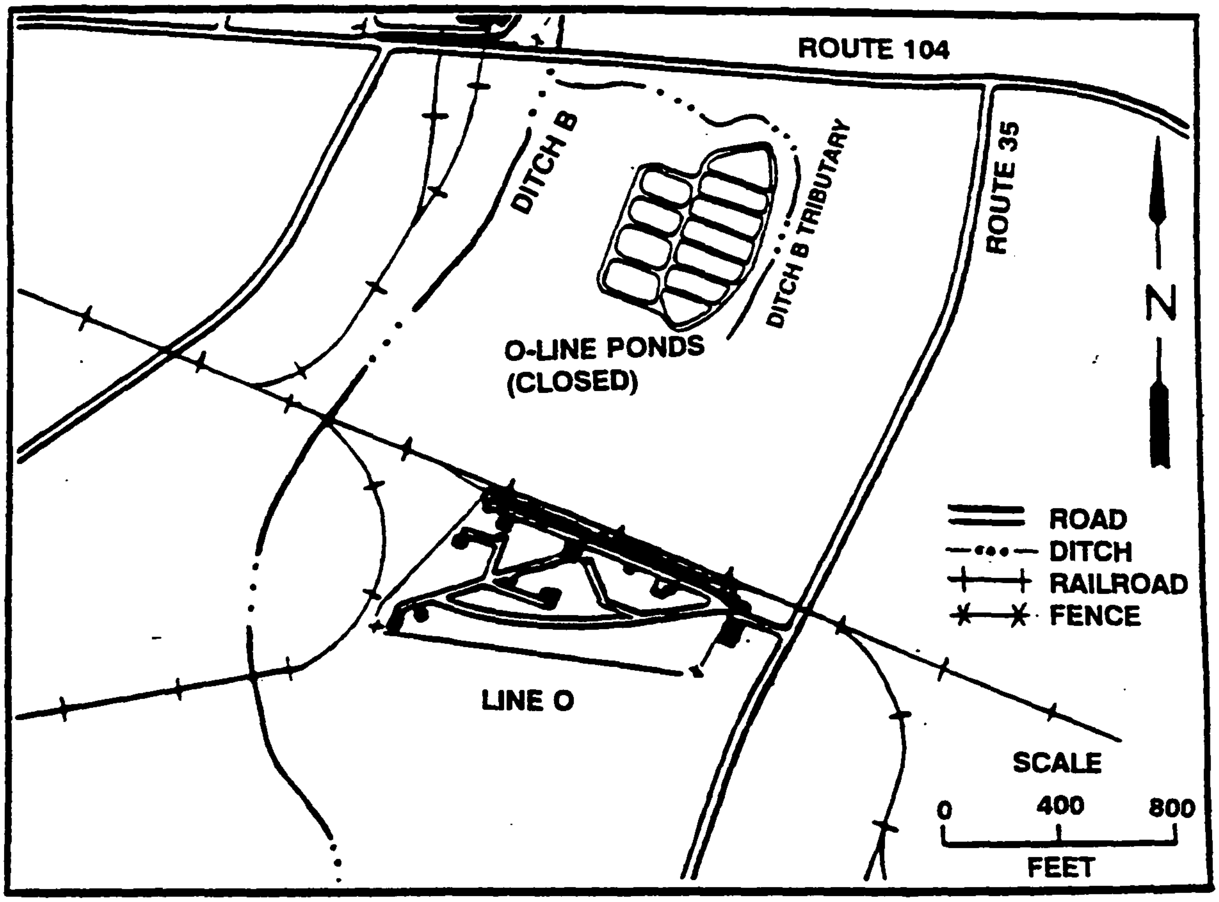


FIGURE 2-1
O-LINE AND O-LINE PONDS

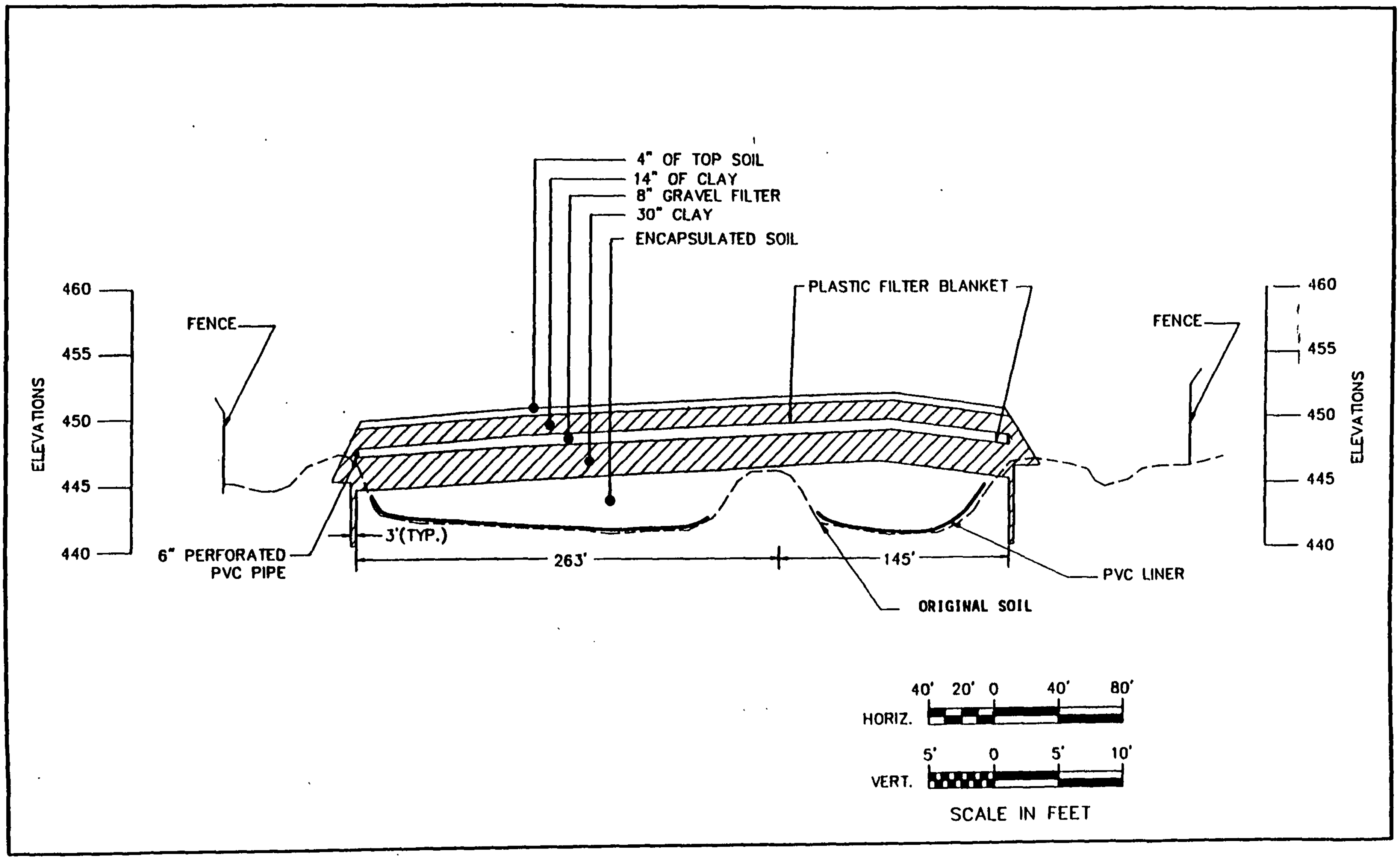


**FIGURE 2-2**
**CROSS-SECTION OF EXISTING MULTI-MEDIA COVER SYSTEM**
**O-LINE PONDS AREA**

The rationale for taking the ponds out of service and placing a liner on top of the contaminated pond sediment was to decrease hydraulic loading on the source area, thereby reducing the amount of explosives migrating to groundwater. The cap was designed to minimize hydraulic loading on the source of explosives contamination by providing a multilayered cover system.

However, in May 1984, because of the level of contamination in the groundwater, the facility was proposed for listing on the National Priorities List (NPL). The NPL is EPA's list of hazardous waste sites that present the greatest potential threat to human health and the environment if remediation does not occur. Final listing on the NPL took place in August, 1987.

In 1990-1991, USATHAMA conducted a Remedial Investigation (RI) at MAAP (USATHAMA, 1991). The RI was conducted to identify the type, concentration, and extent of contamination. Some of the results of the RI are as follows:

- The contaminants of concern in soil, surface water, shallow sediment, and groundwater include explosives such as 2,4,6-TNT, 2,4-dinitrotoluene and 2,6-dinitrotoluene (DNT), RDX, HMX, nitrobenzene, 1,3,5-trinitrobenzene (TNB), and 1,3-dinitrobenzene (DNB).

- The surface soil around the perimeter of the O-Line Ponds cap is contaminated with low levels of explosives compounds, probably as a result of overflows during use of the O-Line Ponds or from earthmoving activities that took place during pond closure. The subsurface soil around the perimeter of the cap is also contaminated with low to moderate levels of explosives compounds.

- The levels of explosives compounds immediately below the PVC liner (in the undisturbed pond sediments) are much lower than those measured before pond closure, but contained the highest levels of explosives detected in soil at MAAP during the RI.

- Concentrations of metals in the surface and subsurface soils are within the background range, or exceed background levels infrequently and only by a small amount, suggesting that detected metals are not related to past disposal activities in this area.

- The measured hydraulic conductivity of the cap material and the moisture content data indicate that water is not percolating through the contaminated soil. Therefore, the capped area of the former ponds is currently not a significant source of groundwater contamination. Leaching of contaminants to the aquifer most likely occurred between initiation of pond usage to shortly after pond closure, as indicated by the greatly reduced levels of explosives compounds immediately below the PVC liner.

- Surface water and shallow sediment samples collected from the ditches downstream of O-Line suggest that there is low-level explosives contamination. Explosives contamination found in the shallow sediment of the drainage ditches is at or below the levels attributable to permitted discharges. Metals contamination occurs in some ditches, but at generally low levels. No site-related contamination of concern was found in the perennial streams (i.e., the Rutherford Fork of the Obion River) below the outfalls of Ditch B. The levels of explosives detected in surface water were well within the facility's NPDES permit limits and, therefore, can be attributed to discharges from the O-Line PWTF.

To address the potential risks posed by the O-Line Ponds area as quickly as possible, the Army has elected to divide the O-Line Ponds area into three separate operable units (OUs) and to investigate/remediate the site in a phased approach. The OUs are defined as follows:

- OU1 consists of groundwater beneath and immediately downgradient from the former O-Line Ponds which has been contaminated by past disposal practices at the ponds;

- OU2 consists of contaminated soils beneath and around the former ponds and surface water and shallow sediment in the drainage ditch that flows along the east and north sides of the ponds. Through sampling and consideration of former site activities, the area of OU2 has been defined as consisting of the area that has been impacted by use and/or closure of the former ponds at O-Line. To be conservative, the boundary of this area has been identified as the fence that encircles the capped area, excluding the area south of the access road to the O-Line Pink Water Treatment Facility (PWTF). The area of OU2 is approximately 582,000 $ft^2$. The tributary of the drainage ditch (Ditch 5) that flows along the east and north sides of the O-Line cap, which received pond effluent while the ponds were in use and currently receives treated water from the O-Line PWTF, is included from the O-Line PWTF outfall to Route 104. Because the exposure pathways for both humans and aquatic life associated with sediment are limited to direct contact, only the shallow zone (to a maximum depth of 2 feet) is included in OU2. Deeper sediments are currently being investigated as part of the overall drainage ditch study and will be addressed in future remedial actions as needed.

- OU14 consists of the area of contaminated groundwater between Route 54 (which separates the northern industrial areas from the southern storage areas) and the northern extent of groundwater contamination, which may reach the Rutherford Fork of the Obion River. The extent of OU14 in the east-west direction is from Line B to Line C on the south side, and from Line E to Ditch 7 on the north side. All intermediate source areas are included in OU14.

To address the potential risks associated with OU1, a groundwater extraction and treatment remedial action has been selected. An Interim Action Record of Decision (ROD) was signed in September 1992. This groundwater treatment system, when operational, will extract the highly-contaminated groundwater immediately downgradient of the O-Line Ponds area, treat the water to meet discharge limits, and reinject the treated water upgradient of the ponds. This system is designed to protect off-site users of groundwater by reducing the levels of explosives compounds in the existing area of contaminated groundwater and establishing hydraulic control over this area.

Potential risks associated with OU2 and possible methods for reducing risks at the site were investigated in the Focused Feasibility Study (FFS) for Operable Unit Two (USAEC, 1993a). Based on the information gathered and presented in the FFS report, the Army has selected a preferred remedy for the O-Line Ponds area soils operable unit. The rationale behind the remedy was presented to the public in a Proposed Plan (USAEC, 1993b).

## 3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI report for MAAP was released to the public in December 1991 and presented at a public meeting held during the same month. Based on the results of the RI, work then began on the Focused Feasibility Study for OU1 (contaminated groundwater in the immediate vicinity of the O-Line Ponds). After completion of treatability studies, an additional hydrogeological investigation of the area, and finalization of a Proposed Plan and Record of Decision for OU1, work then began on OU2. The Focused Feasibility Study (FFS) Report and Proposed Plan for OU2 were released to the public in July 1993. All of these documents are available in both the Administrative Record and the information repositories maintained at the Army Chief Engineer's Office at MAAP and the Mildred G. Fields Library, Milan, TN. The notice of availability of these documents was published in The Mirror Exchange on June 30 and July 7, 1993 and The Jackson Sun on July 6, 1993.

A 45-day public comment period was held from July 1, 1993 through August 16, 1993. In addition, a public meeting was held on July 13, 1993. At this meeting, representatives from MAAP, EPA, and TDEC presented a summary of the site conditions and the remedial alternatives under consideration. A response to the comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision.

This decision document presents the selected remedial action for OU2 of the O-Line Ponds Area, Milan Army Ammunition Plant, Milan, TN. The remedy has been chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the National Contingency Plan. In addition, this decision incorporates the findings of the FFS, which evaluated potential remedial alternatives for OU2. The decision for this site is based on the Administrative Record.

## 4.0 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

Past disposal practices at the O-Line Ponds contaminated soil and groundwater near the former O-Line Ponds and released contaminants to ditches in the vicinity of the ponds. The Army has decided to manage environmental contamination in the different media at the O-Line Ponds area in a phased approach. This separation of environmental media into Operable Units allows the Army to begin remediation prior to full assessment of the O-Line Ponds site.

An Operable Unit (OU) is defined by the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300.5) as a discrete action which is an incremental step toward comprehensively mitigating site problems. The Operable Units for the O-Line Ponds site at MAAP have been defined as follows:

OU1: Contaminated groundwater beneath and immediately downgradient from the former ponds which has been contaminated by past disposal practices at the ponds.

OU2: Contaminated soil beneath and around the former ponds, and surface water and shallow sediment in the drainage ditch that flows along the east and north sides of the ponds, which have become contaminated as a result of past disposal practices.

OU14: Contaminated groundwater between Route 54 (which separates the northern industrial areas from the southern storage areas) and the northern extent of groundwater contamination, which may reach the Rutherford Fork of the Obion River. The extent of OU14 in the east-west direction is from Line B to Line C on the south side, and from Line E to Ditch 7 on the north side.

The Army has already selected a remedy for OU1. The contaminated groundwater is a principal potential threat at this site because of the high levels of explosives compounds detected in groundwater samples collected from the O-Line Ponds area. This action is in the Remedial Design stage and construction of extraction and reinjection wells is scheduled to begin in November, 1993. The award of a construction contract for the treatment plant is expected to occur in December, 1993.

This ROD addresses contamination within OU2. OU14 requires additional investigations and will be handled as a separate action.

OU2 consists of the soil, surface water, and shallow sediment that has been contaminated by explosives-contaminated wastewaters that overflowed, drained, or seeped from the ponds during past waste disposal operations. The primary contaminants are RDX, 2,4,6-TNT, and 1,3,5-TNB.

Access to the O-Line Ponds is currently restricted by a locked security fence and institutional controls preclude the possibility of residential or industrial use of the area. In addition, levels of contamination in surface soil, surface water, and shallow sediment pose risks at levels less than EPA's acceptable risk range. The principal threat posed by the site is the potential for leaching of contaminants from soil to the water table, which results in an adverse impact on groundwater quality in the area.

The RI data indicate that the existing cap over the former ponds is effectively preventing infiltration of water through the contaminated pond sediments. However, the data also indicate that the existing cap does not cover all areas of contaminated soil, and the continued leaching of contaminants from the soil around the perimeter of the cap to the water table would have an adverse impact on groundwater quality.

The purpose of this response is to prevent current or future exposure to the contaminated soils around the perimeter of the existing cap and to reduce contaminant migration into the groundwater.

Because this remedial action will eliminate further migration of contaminants from soil to groundwater within the O-Line Ponds area, and will also eliminate all potential surface soil exposure pathways, it is consistent with any planned future actions.

## 5.0 SITE CHARACTERISTICS

This section provides a summary of the physical characteristics of the O-Line Ponds area, including the setting, the nature and extent of soil, surface water, and shallow sediment contamination, and the potential routes of contaminant migration and exposure. The information presented in this section has been summarized from the RI (USATHAMA, 1991) and FFS (USAEC, 1993a).

## 5.1 HYDROGEOLOGIC AND HYDROLOGIC SETTING

### 5.1.1 Soil Profile

The surface soils at MAAP consist chiefly of a brown silty clay that extends to a depth of 10 to 20 feet below the surface. This surface silt/clay unit is present across the facility except where it has been eroded or otherwise removed (e.g., the ditches and engineered ponds). The hydrologic unit below the surface soils is the Memphis Sand unit of the Claiborne Group of Tertiary age. The Memphis Sand consists of a thick body of non-marine fine- to coarse-grained sand that includes interbedded lenses of clay and silt. The clay and silt lenses were observed to vary in thickness from 0.5 to 6 inches and cannot be correlated between adjacent boreholes; therefore, they are considered to be discontinuous. The lower confining unit of the Memphis Sand is the Flour Island Formation, which is estimated to occur at an approximate depth of 260 feet below ground surface in the O-Line Ponds area.

### 5.1.2 Site Groundwater

The Memphis Sand aquifer is thick, laterally continuous, and highly transmissive. Based on results of aquifer tests and grain size analyses of soil samples, the horizontal conductivity is estimated to be 27 ft/day. Due to the stratified nature of the aquifer, which contains numerous discontinuous lenses of silt and clay, the vertical conductivity is estimated to be an order of magnitude smaller than the horizontal conductivity. Thus, the conductivity is relatively high in both the horizontal and vertical directions.

Despite the high conductivity, the groundwater flow velocity is low because of a small gradient. Based on groundwater elevation contours developed during the RI, groundwater in the O-Line Ponds area flows toward the north-northwest (USATHAMA, 1991), and the horizontal gradient is estimated to be approximately 0.0015 ft/ft. Using an estimated effective porosity of 20% for the soils, the average groundwater velocity at the site is estimated to be 0.20 ft/day. The vertical gradient is also small (on the order of -0.004 ft/ft), but because its magnitude is equal to or larger than the horizontal gradient, groundwater flows downward at nearly the same rate that it travels laterally.

### 5.1.3 Site Surface Water Hydrology

The O-Line Ponds area of the installation drains to the Rutherford Fork of the Obion River. This portion of MAAP contains several well-developed, ephemeral, natural drainage bodies that join the Rutherford Fork along the northern boundary of the installation. A small tributary receives effluent from the O-Line Pink Water Treatment Facility (PWTF) and drains the capped area of the O-Line Ponds, then empties into Ditch 5 near Route 104. Ditch 5 is renamed Ditch B upon passing Route 104, and this ditch drains into the Rutherford Fork of the Obion River. The parent stream, the Obion River, empties into the Mississippi River about 60 miles west of MAAP.

It was observed during the surface water and sediment sampling conducted during the RI that the interior drainage ditches, such as Ditch B and Ditch 5, are "losing" ditches; that is, the base flow is zero. Surface water flow occurs only as a result of storm water runoff and PWTF discharge, and surface water recharges groundwater at these times.

## 5.2 CONTAMINATION ASSESSMENT

The results of the RI (USATHAMA, 1991) and subsequent investigations (USAEC, 1993a) indicate that the soil and groundwater in the vicinity of the former O-Line Ponds and surface water and shallow sediment in the ditches downgradient of the former ponds are contaminated with the explosives compounds 2,4,6-TNT, RDX, HMX, nitrobenzene, 2,4-DNT, 2,6-DNT, 1,3,5-TNB, and 1,3-DNB. 2,4,6-TNT and RDX are primary explosives and their presence at the site is due to the washout activities that have taken place at O-Line since 1941. The other explosives compounds are degradation compounds or contaminants of 2,4,6-TNT and RDX.

### 5.2.1 Soil Contamination

The O-Line Ponds were initially excavated in native soil, and were unlined through their operating life. The result of constant hydraulic loading on the pond bottoms was the transport of explosives compounds through the vadose zone and into the water table via infiltration of contaminated water through the porous soils and aquifer material. During pond usage, the moisture content of the soil under the ponds increased due to this infiltrating water. The analysis of soil samples collected from the pond sediments prior to pond closure indicates that usage of the ponds resulted in high concentrations of explosives compounds and high moisture content in the underlying soil.

In January-February of 1992, additional field work was conducted to evaluate the nature and extent of soil contamination at the O-Line Ponds area. This work included the drilling of boreholes, collection of soil samples, and both physical and chemical analysis of the soil samples. These data were used to evaluate the cap performance, vertical and horizontal extent of soil contamination, and the potential for further leaching of explosives compounds from soil.

Seven boreholes were drilled around the perimeter of the cap to evaluate the lateral extent of soil contamination. In addition, three boreholes were drilled through the cap and terminated at the water table. The results of the soil investigation are the following:

- The surface soil around the perimeter of the O-Line Ponds cap is contaminated with low levels of explosives compounds, probably as a result of overflows during use of the O-Line Ponds or from sediment removal and earthmoving activities that took place during pond closure.

- The subsurface soil around the perimeter of the cap is also contaminated with low to moderate levels of explosives compounds.

- The levels of explosives compounds immediately below the PVC liner (in the undisturbed pond sediments) are much lower than those measured before pond closure. The moisture content of the soil is also reduced, which implies that drainage of excess moisture has occurred since pond closure, and the bulk of the contaminants may have been transported downward with the draining water.

- Concentrations of metals in the surface and subsurface soils are in the background range and exceeded background only infrequently, and by a small amount. Those samples which had levels of metals above background levels were randomly located. The overall results for heavy metals suggest that detected metals are not related to past disposal activities in this area.

- The measured hydraulic conductivity of the cap material and the moisture content data indicate that water is not percolating through the contaminated soil. Therefore, the capped area of the former ponds are currently not a significant source of groundwater contamination. Leaching of contaminants to the aquifer most likely occurred between initiation of pond usage to shortly after pond closure, as indicated by the greatly reduced levels of explosives compounds immediately below the PVC liner.

- A biological/ecological assessment of the O-Line Ponds area concluded that a variety of terrestrial species may be exposed to chemicals in soil at this area. Because of their intimate contact with the soil, soil-dwelling invertebrates are the terrestrial species most likely to be impacted by chemicals in the soil. A series of bioassays were conducted to evaluate the potential impacts of surface soil to the earthworm *Eisenia foetida*, indicating no adverse impacts to the earthworms as a result of chemicals in the soil. It is therefore concluded that terrestrial invertebrates are unlikely to be impacted by chemicals in the soil.

**5.2.1.1 Volume of contaminated soil under the cap.** The area under the cap is approximately 280,000 $ft^2$ and the depth to groundwater is approximately 45 feet. Therefore, the volume of contaminated soil under the cap is approximately 12,600,000 $ft^3$. Based on the limited sampling and analysis performed under the cap, it has been estimated that the following quantities of principal contaminants are present in the soil: 2,4,6-TNT, 17,600 lbs; RDX, 35,000 lbs; and 1,3,5-TNB, 3,500 lbs.

**5.2.1.2 Routes of contaminant transport and exposure from soil under the cap.** The RI data indicate that the existing cap over the former O-Line Ponds is effectively preventing infiltration of rainwater through the contaminated pond sediments. However, if the existing institutional controls are relaxed and the cap is allowed to fail, then humans could potentially be exposed to contaminants that would partition to infiltrating-rainwater and would be transported to the water table.

**5.2.1.3 Volume of contaminated soil around the perimeter of the cap.** Although the levels of contamination detected in soil around the perimeter of the cap are lower than those detected under the cap, this contaminated soil also has the potential to impact groundwater quality. The surface area of the contaminated area around the perimeter of the cap is estimated to be 302,000 $ft^2$. The average depth to water is 45 feet, so the volume of contaminated soil around the perimeter of the cap is estimated to be 13,600,000 $ft^3$. Based on the sampling and analysis performed around the perimeter of the cap, it has been estimated that the following quantities of principal contaminants are present in the soil: 2,4,6-TNT, 1,900 lbs; RDX, 2,800 lbs; and 1,3,5-TNB, 340 lbs.

**5.2.1.4 Routes of contaminant transport and exposure from soil around the perimeter of the cap.** Humans could potentially be exposed to contaminants that could partition from soil to percolating rainwater and be transported to the water table. Because the soil around the perimeter of the cap is relatively permeable and is not protected by a low-permeability cover, this migration of contaminants is occurring even under the current institutional controls. In addition, because contaminants are detectable in surface soil around the perimeter of the cap, humans could be exposed to the explosives compounds through dermal contact, inhalation, and ingestion.

### 5.2.2 Surface Water and Shallow Sediment Contamination

Surface water and shallow sediment samples collected from the ditches downstream of O-Line suggest that there is low-level explosives contamination of these media. The levels of explosives detected in the shallow sediment of the drainage ditches (to a depth of 2 feet) is at or below the levels attributable to NPDES permitted discharges. Heavy metals (in particular, cadmium, chromium, and lead) were detectable in shallow sediment samples collected from Ditch 5 and Ditch B, but at generally low concentrations. Explosives compounds were not detected in samples found in the perennial stream (i.e., the Rutherford Fork) below the outfalls of Ditch B. The levels of explosives detected in surface water were well within the facility's NPDES permit limits and, therefore, can be attributed to discharges from the O-Line PWTF.

Ditch 5 is dry throughout much of the year and is not a viable aquatic habitat. However, Ditch B drains into the Rutherford Fork of the Obion River where aquatic species occur. Surface water and shallow sediment acute bioassays were conducted with *Ceriodaphnia dubia* to evaluate potential impacts to aquatic species in the Rutherford Fork of the Obion River. No mortality occurred in the surface water bioassay and it was concluded that impacts to aquatic species are unlikely to occur as a result of surface water from the O-Line Ponds Area. Results of the shallow sediment elutriate bioassay indicated that the shallow sediment in the tributary to Ditch 5 is toxic to the sensitive indicator species, although shallow sediment samples collected downgradient from this point were not toxic. Based on the absence of toxicity immediately downgradient from the O-Line Ponds Area, it was concluded that aquatic species are not likely to be impacted in the Rutherford Fork of the Obion River (located approximately 12,000 feet downstream) as a result of chemicals associated with the shallow sediments in OU2. Therefore, the ditches downgradient of the O-Line Ponds do not pose an environmental threat.

**5.2.2.1 Volume of contaminated shallow sediment.** The length of the Ditch 5 tributary that receives effluent from the O-Line PWTF and surface runoff from the O-Line Ponds cap (and which in the past received wastewater directly from the ponds) from its source to its confluence with Ditch 5 is approximately 2,800 feet. The length of Ditch 5 from the confluence with the tributary to Route 104 (where the bioassay samples showed no toxicity) is approximately 125 feet. The ditches are relatively narrow and deeply-cut, with an approximate average width of 5 feet.

**5.2.2.2 Routes of contaminant transport and exposure.** Contaminants in surface water and shallow sediment could be transported to the Rutherford Fork when the ditches are flowing (i.e., when the O-Line PWTF is discharging treated effluent or during a storm event). However, samples collected in the Rutherford Fork indicate that the explosives compounds are not detectable in either surface water or shallow sediment. In Ditch 5 and Ditch B, humans could be exposed to contaminants in the surface water and shallow sediment via dermal contact while hunting or working in the ditches. Because workers are in the ditches only infrequently, and because hunters are not permitted within the O-Line Ponds fenced area (where the higher levels of contamination have been detected), these exposures are not expected to be significant.

## 6.0 SUMMARY OF SITE RISKS

This section contains an evaluation of potential human health and environmental impacts associated with residual contamination in OU2. Risk assessment consists of the evaluation of the types and levels of contaminants present within the Operable Unit, the pathways by which receptors could potentially be exposed to these contaminants, and the toxicity and/or carcinogenicity of the contaminants. A quantitative estimate of the potential for adverse health effects to occur in the future can be constructed from these data. In estimating these risks, the assumption was made that no remedial action would be taken to address contamination within the Operable Unit; the resulting analysis is referred to as a baseline risk assessment. The main focus of the baseline risk assessment (USAEC, 1993a) was to evaluate potential risks associated with contaminated soil, surface water, and sediment from OU2 at the O-Line Ponds.

This risk assessment was conducted using generally conservative assumptions, including the concept of "reasonable maximum exposure," as outlined by the U.S. Environmental Protection Agency (USEPA, 1989a, 1990). The general purpose of using conservative assumptions is to ensure that the decisions made will be protective of human health, even in the absence of comprehensive and definitive health studies. Thus, the risks calculated in this section do not necessarily represent the true risks which are or may be experienced by the exposed population; rather, they are upper-bound risks, which are designed to provide a high level of protectiveness against adverse health effects. This is compatible with EPA's policy of protecting all members of the population, including sensitive subgroups, from adverse effects associated with exposures to hazardous chemicals.

The first five sections of the assessment review potential exposures associated with exposure to chemicals in surface soil, surface water, and sediment at the O-Line Ponds, and provide a conservative evaluation of potential risks associated with the exposure pathways evaluated. Section 6.6 presents a risk assessment of potential exposures and risks from groundwater ingestion exposures associated with groundwater from OU2 at the O-Line Ponds.

## 6.1 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Chemicals of potential concern are those chemicals believed to be associated with past activities at the O-Line Ponds area of MAAP. The soil, surface water, and shallow sediment investigations conducted from July to November 1990, in January and February 1992, and in July 1992, were the sources of sampling data used in this risk assessment. All samples were analyzed for cadmium, chromium, lead, mercury and nine explosives compounds (1,3-DNB, 2,4-DNT, 2,6-DNT, HMX, nitrobenzene, RDX, tetryl, 1,3,5-TNB, and 2,4,6-TNT). Table 6-1 summarizes chemicals of potential concern that were detected in surface soil, surface water, and shallow sediments.

### 6.1.1 Surface Soil

Soil samples were collected from seven locations around the perimeter of the O-Line Ponds. Soil samples were not collected on the cap of the O-Line Ponds, which is comprised of clean fill. All soil samples, with the exception of SS-1, consisted of vertically composite samples collected from 0-2 feet.

Based on previous sampling results, as well as the historical data and knowledge of activities at the site (no volatile or semi-volatile organic chemicals were used in the past at the O-Line Ponds), soil at the O-Line Ponds was sampled primarily for the nine explosives compounds listed above and four target inorganic compounds (i.e., cadmium, chromium, lead, and mercury). In addition to the nine explosives compounds and the four inorganic chemicals, the soil samples were analyzed for nitroglycerine and

**TABLE 6-1**
**CHEMICALS OF POTENTIAL CONCERN ADJACENT TO THE O-LINE PONDS**

| SURFACE SOIL (a) | | | |
|---|---|---|---|
| **Chemical** | **Range of Detected Concentrations** | **Frequency of Detection (b)** | **Background Concentration (c)** |
| **Organic Chemicals (μg/kg):** | | | |
| 2,4-DNT | 470 | 1/8 | – |
| HMX | 900 - 1,470 | 4/8 | – |
| RDX | 930 - 11,000 | 4/8 | – |
| 1,3,5-TNB | 1,110 | 1/8 | – |
| 2,4,6-TNT | 920 - 21,100 | 4/8 | – |
| **Inorganic Chemicals (mg/kg):** | | | |
| Manganese | 992 | 1/1 | 200 |

| SURFACE WATER (d) | | | |
|---|---|---|---|
| **Chemical** | **Range of Detected Concentrations** | **Frequency of Detection** | **Background Concentration (e)** |
| **Organic Chemicals (μg/L):** | | | |
| HMX | 1.5 | 1/3 | – |
| 1,1,2-Trichloroethane | 3.3 | 1/1 | – |
| **Inorganic Chemicals (μg/L):** | | | |
| Aluminum | 256 - 110,000 | 3/3 | 282 |
| Arsenic | 15.2 | 1/3 | 5.08 |
| Barium | 400 - 4,940 | 3/3 | 39.6 |
| Calcium | 7,630 - 35,700 | 3/3 | 4,200 |
| Chromium | 61.5 | 1/3 | 12.0 |
| Cobalt | 76.6 | 1/3 | 50.0 |
| Copper | 76 | 1/3 | 16.2 |
| Iron | 207 - 120,000 | 3/3 | 1,114 |
| Lead | 6.5 - 140 | 3/3 | 2.52 |
| Magnesium | 2,050 - 10,900 | 3/3 | 2,080 |
| Manganese | 32.8 - 6,100 | 3/3 | 462 |
| Nickel | 87.7 | 1/3 | 68.6 |
| Potassium | 4,850 - 13,700 | 3/3 | 3,380 |
| Sodium | 27,800 - 177,000 | 3/3 | 6,680 |
| Vanadium | 207 | 1/3 | 7.64 |
| Zinc | 329 | 1/3 | 42.2 |

| SHALLOW SEDIMENT (f) | | | |
|---|---|---|---|
| **Chemical** | **Range of Detected Concentrations** | **Frequency of Detection** | **Background Concentration Range (g)** |
| **Organic Chemicals (μg/kg):** | | | |
| Trichlorofluoromethane | 19 - 23 | 2/2 | 9.66 |
| **Inorganic Chemicals (mg/kg):** | | | |
| Sodium | 370 - 392 | 2/2 | 313 - 346 |

(a) - Sampling locations: SB-4, SB-5, SB-6, SB-7, SB-8, SB-9, SB-10, and SS-1.
(b) - The number of samples in which the chemical was detected divided by the total number of samples analyzed.
(c) - Background concentrations are county-specific as presented in the RI (USATHAMA, 1991).
(d) - Sampling locations: SW-2, SW-3, and DTCH5-2.
(e) - Background concentrations determined for MAAP with sample RVER-2 as in the RI (USATHAMA, 1991).
(f) - Sampling locations: DTCH5-1 and DTCH5-2.
(g) - Background concentrations from RI (USATHAMA, 1991) as determined with 3 samples (RVER-2, CREK-1, and CREK-2).
– = No background concentrations determined for these organic chemicals.

pentaerythritol tetranitrate. Soil sample SS-1, which was a discrete sample collected at a depth of 0-6 inches, was analyzed for the TAL compounds in addition to the nine explosives compounds.

As shown in Table 6-1, five explosives (1,3,5-TNB, 2,4,6-TNT, 2,4-DNT, HMX and RDX) were detected in the surface soil, at concentrations ranging from 470 $\mu$g/kg to 21,100 $\mu$g/kg. RDX, HMX, and 2,4,6-TNT were the most frequently detected explosives compounds, each detected in four of eight samples. All five explosives compounds were retained as chemicals of potential concern. The maximum concentrations for 1,3,5-TNB, 2,4,6-TNT, 2,4-DNT and RDX were detected at location SB-5. Manganese, which was detected at a concentration greater than two times the single background concentration, was the only inorganic chemical retained as a chemical of potential concern.

### 6.1.2 Surface Water

Surface water data used in the human health risk assessment were collected during RI sampling (USATHAMA, 1991) from a point adjacent to the O-line Ponds Area (designated as DTCH 5-2), and during the FS from two points immediately downstream from the O-Line Ponds Area and designated SW-2 and SW-3.

The only explosives compound detected in surface water was HMX, at SW-3, at a concentration of 1.5 $\mu$g/L. One other organic chemical (1,1,2-trichloroethane) was detected at DTCH5-2, at a concentration of 3.3 $\mu$g/L. Sixteen inorganic chemicals detected in surface water were present at concentrations above the available background concentration, and were thus retained as chemicals of potential concern. The maximum inorganic chemical concentrations were all detected at DTCH5-2, except for calcium and sodium where maximum concentrations were detected at SW-2.

### 6.1.3 Shallow Sediment

One organic chemical was detected in the shallow sediment samples (trichlorofluoromethane), at concentrations of 19 $\mu$g/kg and 23 $\mu$g/kg. Based on historical data and knowledge of activities at the site where trichlorofluoromethane was not used, it is believed that this chemical is a sampling artifact rather than associated with past activities.

Eleven inorganic chemicals were detected in shallow sediment. Only sodium was present at concentrations above background, and was therefore retained as a chemical of potential concern.

## 6.2 HUMAN HEALTH EXPOSURE ASSESSMENT

This section identifies the potential pathways by which human populations may be exposed to the chemicals of potential concern, and quantifies exposures for selected pathways. This exposure assessment discusses current and hypothetical future land use of the O-Line Ponds and surrounding area, identifies the pathways by which human populations may be exposed to chemicals of potential concern at the O-Line Ponds under current and hypothetical future land use, selects pathways for further evaluation, and presents quantitative exposure estimates for those pathways selected for quantitative evaluation.

### 6.2.1 Current and Hypothetical Future Land Use and Site Characterization

Currently, no operations occur at the O-Line Ponds that present the opportunity for significant human exposures. The area is fenced and fully vegetated with grass. The only activity at the O-Line Ponds is mowing, which occurs two to four times per year. To the east of the O-Line Ponds is a field leased for farming by a local farmer; to the north and west is mainly brush, where hunters have access, but where there is no other human activity. To the south of the O-Line Ponds are the O-Line buildings, where employees work indoors.

There are three hypothetical future land uses that could occur at the O-Line Ponds: continued active MAAP industrial operations, agricultural land use, and residential land uses. If the O-Line Ponds area remained as part of the active MAAP installation, the most plausible future worker exposure scenario would be one that was assumed for current land-use conditions (i.e., mowing). Another plausible future land use would be agricultural, given that many other tracts of land at MAAP are leased to farmers and are used for growing crops for livestock feed and for grazing cattle. No crops currently grown at MAAP are used for human consumption. The third hypothetical land use is residential, whereby a house might be built directly on the O-Line Ponds.

Because of the quality and availability of shallow groundwater, homeowners in this area of Tennessee obtain their drinking water from the shallow aquifer. Surface water is not used as a source of drinking water.

**6.2.2 Potential Exposure Pathways**

Table 6-2 summarizes the exposure pathways by which current populations could be exposed to chemicals at the O-Line Ponds, and Table 6-3 summarizes the pathways by which hypothetical future populations could be exposed. As noted earlier, no pathways were evaluated for exposure to groundwater because this was conducted in the FS Report for OU1 (USATHAMA, 1992). All potential exposure pathways that do not have negligible potential exposures are evaluated further in the following section.

**6.2.3 Quantification of Exposure**

The following human exposure pathways were selected for quantitative evaluation:

- Surface Soil. Incidental ingestion and dermal absorption of chemicals in surface soil were evaluated for hypothetical future residents living at the O-Line Ponds.

- Shallow Sediment. Dermal absorption and incidental ingestion of chemicals in shallow sediment were evaluated for hypothetical children and teenagers playing in the streams and ditches near the O-Line Ponds.

- Beef Cattle. Ingestion of beef from cattle that have consumed crops grown at the O-Line Ponds was evaluated for hypothetical nearby residents.

To assess quantitatively the potential exposures associated with these pathways, estimates of chemical concentrations at the exposure point are combined with exposure parameters describing the extent, frequency, and duration of exposure to estimate chronic daily intakes (CDIs). Based on EPA (1989a) guidance, CDIs should be quantified by estimating the reasonable maximum exposure (RME) associated with the pathway of concern. The RME is intended to represent a possible upper-bound exposure to a typical individual and is combined with upper-bound toxicity criteria to estimate risks.

Exposure point concentrations are presented first, then combined with exposure parameters to estimate intakes for each of the selected exposure pathways.

**TABLE 6-2**
**POTENTIAL CURRENT HUMAN EXPOSURE PATHWAYS AT THE O-LINE PONDS**

| Exposure Medium | Potential Exposure Pathway | Receptor Population | Potential for Significant Exposure | Method of Evaluation |
|---|---|---|---|---|
| Surface Soil | Dermal absorption and/or incidental ingestion of chemicals in surface soil. | MAAP personnel who mow grass at the O-Line Ponds. | Negligible. The O-Line Ponds are vegetated, and mowing typically would not involve any contact with surface soil. | None, given the low potential for exposure. |
| Subsurface Soil | Dermal absorption and/or incidental ingestion of chemicals in subsurface soil. | MAAP personnel who mow grass at the O-Line Ponds. | Negligible. No activities (e.g., excavation) take place that involve contact with subsurface soil. | None, given the low potential for exposure. |
| Surface Water | Dermal absorption and/or incidental ingestion of chemicals in surface water. | MAAP personnel. | Negligible. Elevated surface water concentrations were detected, but there is no human activity at the O-Line Ponds that involves contact with surface water in ditches. | None, given the low potential for exposure. |
| Shallow Sediment | Dermal absorption and/or incidental ingestion of chemicals in shallow sediment. | MAAP personnel. | Negligible. Chemical concentrations in the creeks/ditches were low, and there is no human activity involves contact with shallow sediment in these creeks/ditches. | None, given the low potential for exposure. |

## TABLE 6-3
## POTENTIAL FUTURE HUMAN EXPOSURE PATHWAYS AT THE O-LINE PONDS

| Exposure Medium | Potential Exposure Pathway | Receptor Population | Potential for Significant Exposure | Method of Evaluation |
|---|---|---|---|---|
| Surface Soil | Dermal absorption and/or incidental ingestion of chemicals in surface soil. | Residents living at the O-Line Ponds. | Moderate. Chemicals of concern were detected in surface soil at the O-Line Ponds. Individuals residing at the O-Line Ponds could have frequent dermal and incidental ingestion exposures. | Quantitative evaluation for ingestion and dermal exposures. |
| Surface Soil | Dermal absorption and/or incidental ingestion of chemicals in surface soil. | Agricultural workers farming at the O-Line Ponds. | Negligible. Although chemicals of concern were detected in surface soil, farmers would most likely be exposed to chemicals in soil only for short periods of time (e.g., during planting and harvesting). | None, given the low potential for exposure. |
| Subsurface Soil | Dermal absorption and/or incidental ingestion of chemicals in subsurface soil. | Residents living at the O-Line Ponds. | Negligible. Individuals would not be expected to come into contact with subsurface soil (greater than 2 feet deep) at the O-Line Ponds. | None. No complete exposure pathway exists. |
| Subsurface Soil | Dermal absorption and/or incidental ingestion of chemicals in subsurface soil. | Agricultural workers farming at the O-Line Ponds. | Negligible. Although farmers could come into contact with soil greater than 2 feet deep (due to tilling of the soil), exposures would be expected to occur infrequently. | None, given the low potential for exposure. |
| Surface Water | Dermal absorption and/or incidental ingestion of chemicals in surface water in ditches and creeks near the O-Line Ponds. | Individuals living at the O-Line Ponds. | Negligible. Standing water is present in the ditches and creeks for only about 10 hours following a rainfall, thus there is little potential for exposure. | None, given the low potential for exposure. |
| Shallow Sediment | Dermal absorption and/or incidental ingestion of chemicals in shallow sediment in ditches and creeks. | Individuals living at the O-Line Ponds. | Moderate. Children could play in the ditches and creeks and incidentally ingest or dermally absorb chemicals present in the shallow sediment. | Quantitative evaluation for ingestion and dermal exposures. |
| Air (dusts) | Inhalation of wind-blown dusts. | Individuals living at the O-Line Ponds. | Negligible. The O-Line Ponds would be vegetated if residents were to live there, thus chemicals would not be released from the soil. | None, given the low potential for exposure. |
| Air (dusts) | Inhalation of wind-blown dusts and dusts generated during plowing/ harvesting. | Agricultural workers plowing fields at the O-Line Ponds. | Negligible. Exposures would be of very short duration. Further, based on other studies, it is unlikely that farmers would experience high inhalation exposures while plowing. | None, given the low potential for exposure. |
| Agricultural Produce | Ingestion of crops that are grown at the O-Line Ponds. | Residents living in or near MAAP. | Negligible. Virtually all crops currently grown at MAAP are used for livestock feed, and this is considered the most likely use in the future. | None, given the low potential for exposure. |
| Beef/Dairy Produce | Ingestion of dairy milk or beef from livestock that has consumed crops grown on the O-Line Ponds. | Residents living in or near MAAP. | Moderate. It is possible that the O-Line Ponds area could be leased for agricultural purposes, and that beef cattle, more prevalent than dairy cows in the area, could consume this feed. | Quantitative evaluation for ingestion of beef. |

**6.2.3.1 Estimation of Exposure Point Concentrations.** Calculation of exposures to the chemicals of potential concern requires the combination of exposure concentrations with assumptions regarding the frequency, duration, and magnitude of receptor contact. Exposure point concentrations for soil and shallow sediment pathways were determined using the RI/FS data, while exposure point concentrations for beef were calculated using monitoring data from surface soil in combination with environmental fate and transport models. Exposure point concentrations in surface soil, shallow sediment, and beef are presented in the following sections along with estimation of chemical intakes for each exposure pathway.

**6.2.3.2 Estimation of Chemical Intakes.** Chronic daily intakes (CDIs) are expressed as the amount of a substance taken into the body per unit body weight per day, or mg/kg-day. To assess quantitatively the potential exposures associated with these pathways, estimates of chemical concentrations at the exposure point are combined with values describing the extent, frequency, and duration of exposure. The CDIs, which incorporate the RME concentrations and conservative assumptions and are intended to represent a possible upper-bound exposure to a typical individual, are combined with toxicity criteria (presented later in Table 6-7) to estimate risks.

The generic equation for calculating chemical intakes is

$$Intake = C \times \frac{CR \times EF \times ED}{BW} \times \frac{1}{AT}$$

where Intake = the amount of chemical entering the body (mg/kg body weight-day);
C = chemical concentration;
CR = contact rate; the amount of contaminated medium contacted per unit time;
EF = exposure frequency (days/year);
ED = exposure duration (years);
BW = body weight (kg); and
AT = averaging time; period over which exposure is averaged (days).

For each of the exposure pathways to be quantified, the pathway-specific exposure parameters are discussed below.

**Incidental Ingestion of Surface Soil.** Chronic daily intakes (CDIs) for ingestion of surface soil by residents at the O-Line Ponds were calculated by combining the RME exposure point concentrations with the exposure parameters discussed below. For each chemical, the concentration used in the generic equation for intake is the exposure point concentration of the specific chemical in surface soil as presented in Table 6-4.

Residential soil ingestion exposures were evaluated for a hypothetical future resident living at the O-Line Ponds. Exposures were evaluated for individuals 0-30 years of age. An exposure frequency (EF) of 350 days/year (i.e., 50 weeks per year) and an exposure duration (ED) of 30 years were used. The exposure frequency is the standard default parameter recommended by EPA (1991), and the exposure duration is the national upper-bound time at one residence (USEPA, 1991, 1989a). The standard assumption for a lifetime (AT) of 70 years (USEPA, 1989b) also was used.

The contact rate (CR) in the intake equation is equivalent to the soil ingestion rate. A soil ingestion rate (IR) of 120 mg/day was used for residents who may incidentally ingest surface soil. The soil ingestion rate value is an age-weighted average, assuming 6-year olds ingest soil at a rate of 200 mg/day, and older individuals ingest 100 mg/day (USEPA, 1989a, 1991). A time-weighted average body weight (BW) of 48 kg for a resident (0-30 years) was based on data provided in EPA (1989b). To estimate the CDIs, it was assumed that the fraction of total daily soil intake from the contaminated source was

# TABLE 6-4
# EXPOSURE POINT CONCENTRATIONS AND CALCULATED CDIs
# SURFACE SOIL EXPOSURE PATHWAYS

| Chemical | RME Exposure Point Concentration (mg/kg) | CDI: Incidental Ingestion of Surface Soil (mg/kg-day) | CDI: Dermal Absorption of Chemicals in Soil (mg/kg-day) |
|---|---|---|---|
| **Chemicals Exhibiting Carcinogenic Effects** | | | |
| Organic Chemicals | | | |
| 2,4-DNT | 4.40E-01 | 4.52E-07 | 1.08E-07 |
| RDX | 1.10E+01 | 1.13E-05 | 2.71E-06 |
| 2,4,6-TNT | 2.11E+01 | 2.17E-05 | 5.20E-06 |
| **Chemicals Exhibiting Noncarcinogenic Effects** | | | |
| Organic Chemicals | | | |
| 2,4-DNT | 4.40E-01 | 1.05E-06 | 2.53E-07 |
| HMX | 1.11E+00 | 2.66E-06 | 6.39E-07 |
| RDX | 1.10E+01 | 2.64E-05 | 6.33E-06 |
| 1,3,5-TNB | 7.50E-01 | 1.80E-06 | 4.32E-07 |
| 2,4,6-TNT | 2.11E+01 | 5.06E-05 | 1.21E-05 |
| Inorganic Chemicals | | | |
| Manganese | 9.92E+02 | 2.38E-03 | 5.71E-05 |

100%. This factor assumes that all of the daily soil intake is from soil in the contaminated yard (at the O-Line Ponds). It was also assumed that the oral absorption factor for each of the chemicals in soil was 1.0 (i.e., 100% is absorbed into the body from the soil). Therefore, the bioavailability for the chemicals of concern was conservatively assumed to be 1.0. This assumption of 100% absorption in the gastrointestinal tract may over-estimate ingestion exposures.

The exposure point concentrations and resulting CDIs for chemicals exhibiting carcinogenic effects and chemicals exhibiting noncarcinogenic effects due to the incidental ingestion of soil are summarized in Table 6-4.

**Dermal Absorption of Chemicals from Surface Soil.** Potential exposures through dermal contact with chemicals of potential concern in soil may occur by a hypothetical future resident at the O-Line Ponds. The parameters describing exposure frequency (EF), duration of exposure (ED), body weight (BW), and averaging time (AT) are identical to those used for estimating incidental ingestion of soil. The RME exposure point concentrations (i.e., surface soil concentrations) used in the dermal absorption pathway are presented in Table 6-4, along with the CDIs.

The product of several parameters determines the contact rate for this exposure pathway: skin surface area (SA); adherence factor (AF); and dermal absorption fraction (Ab). It is assumed that the skin surface area (SA) available for contact for a resident 0-30 years of age is 4,800 $cm^2$/day. This value is an age-weighted average 50th percentile surface area value from EPA (1985, 1989a), assuming that the surface area of the hands, one-half of the arms and one-half of the legs are uncovered and exposed. The recommended default soil-to-skin adherence factor (AF) of 0.6 mg/$cm^2$, which is the median of 0.2-1.0 mg/$cm^2$ (USEPA, 1992, USEPA IV, 1992), was used for this exposure scenario (USEPA, 1989a).

The amount of chemical absorbed through the skin into the body from contacting soil is required for estimating dermal exposures. For a chemical to be absorbed through the skin from soil, it must be released from the soil matrix, pass through the stratum corneum, the epidermis, the dermis, and into the systemic circulation. For the purposes of this assessment, the amount of exposure due to dermal absorption considers the fraction of absorption from contacted soil that may occur for the selected chemicals of potential concern. In accordance with EPA Region IV guidance, a default value of 1% for all organic and 0.1% for inorganic chemicals of concern was used (USEPA IV, 1992). Using this absorption fraction assumed that 1% of the organic chemical in the soil matrix was absorbed through the skin and entered the systemic circulation.

CDIs (expressed as absorbed doses) for the chemicals of potential concern were estimated using the exposure parameters discussed above, and are summarized in Table 6-4. The CDIs are calculated differently for chemicals exhibiting carcinogenic and noncarcinogenic effects (with respect to averaging time).

**Incidental Ingestion of Shallow Sediment.** Under future land use conditions, a child/teenager (6-16 years) at the O-Line Ponds is assumed to be exposed to chemicals of potential concern through incidental ingestion of shallow sediment in the ditches and creeks adjacent to the O-Line Ponds. It was considered unlikely that adults would be present in the ditches and creeks, thus this pathway was evaluated only for children/teenagers. Intakes due to incidental ingestion of shallow sediment for chemicals of concern were estimated using the same equation as for Incidental Ingestion of Surface Soil.

It was assumed that shallow sediment may be contacted while playing in the ditches and creeks for 3 days/week during the warmer months of the year (June, July and August) and 2 days/week during the spring and fall (May and September); thus, the exposure frequency (EF) is 52 days/year, and the exposure duration (ED) is 10 years (i.e., 6 to 16 years of age for a child/teenager). A soil ingestion rate (IR) of 110 mg/day was used for the children/teenagers. As discussed earlier, the soil ingestion rate value is an age-averaged value and assumes 6 year olds ingest soil at a rate of 200 mg/day and older children/teenagers ingest soil at 100 mg/day (USEPA, 1989a, 1991). A time-weighted average body weight (BW) value of 40 kg for a child/teenager (6-16 years) is based on data provided in EPA (1989b). As before, it was conservatively assumed that all chemicals of concern were 100% absorbed through the gastrointestinal tract.

RME exposure point concentrations and calculated CDIs for shallow sediment exposure pathways are presented in Table 6-5.

**Dermal Absorption of Chemicals from Shallow Sediment.** This scenario evaluates potential exposures through dermal contact with chemicals of potential concern in shallow sediment by a child/teenager 6-16 years of age in the ditches and creeks. CDIs estimated for dermal contact with chemicals of potential concern in shallow sediment are calculated using the same equation and parameters as for Dermal Absorption of Chemicals in Surface Soil.

The exposure parameters describing frequency and duration of contact, body weight, and lifetime are identical to those used for estimating incidental ingestion of shallow sediment by a child/teenager (6-16 years). For this pathway, however, it was assumed that the skin surface area (SA) available for contact for a child/teenager was 4,200 $cm^2$/day. The recommended default soil-to-skin adherence factor (AF) of 0.6 $mg/cm^2$ was also used for this exposure scenario (USEPA, 1992, USEPA IV 1992).

As discussed previously, exposures due to dermal absorption are evaluated by estimating the fraction of absorption from contacted shallow sediment that may occur for the selected chemicals of potential concern. Due to insufficient data on dermal absorption of organic chemicals of concern, EPA Region IV's default value of 1.0% was used, in accordance with EPA Region IV guidance (USEPA IV, 1992).

The RME exposure point concentrations and CDIs (expressed as absorbed doses) for the chemical of potential concern absorbed from shallow sediment are summarized in Table 6-5 for a child/teenager.

**Ingestion of Beef.** CDIs were calculated for the ingestion of beef using the exposure point concentrations presented in Table 6-6, and the beef ingestion exposure parameters as presented below. Exposures due to beef ingestion were calculated using the following equation:

$$CDI = \frac{(C_b)(IR)(CF)(EF)(ED)(FL)}{(BW)(AT)(Days)}$$

where

| | | |
|---|---|---|
| CDI | = | chronic daily intake (mg/kg-day) |
| $C_b$ | = | exposure point concentration in beef (mg/kg) |
| IR | = | ingestion rate of beef (g/day) |
| CF | = | conversion factor (kg/$10^3$) |
| EF | = | exposure frequency (days/year) |
| ED | = | exposure duration (years) |
| FL | = | fraction of beef ingested that is locally produced (unitless) |
| BW | = | average body weight over period of exposure (kg) |
| AT | = | averaging time over which risk is being estimated (a lifetime [70 years] for potential carcinogens and the period of exposure for noncarcinogens) |
| Days | = | days in a year (365 days/year) |

## TABLE 6-5
## EXPOSURE POINT CONCENTRATIONS AND CALCULATED CDIs
## SEDIMENT EXPOSURE PATHWAYS FOR A CHILD/TEENAGER

| Chemical | RME Exposure Point Concentration (mg/kg) | CDI: Incidental Ingestion of Sediment (mg/kg-day) | CDI: Dermal Absorption of Chemicals in Sediment (mg/kg-day) |
|---|---|---|---|
| **Chemicals Exhibiting Noncarcinogenic Effects** | | | |
| *Organic Chemicals* | | | |
| Trichlorofluoromethane | 2.3E-02 | 9.01E-09 | 2.06E-09 |

**TABLE 6-6**
**EXPOSURE POINT CONCENTRATIONS AND CALCULATED CDIs**
**BEEF INGESTION EXPOSURE PATHWAY**

| Chemical | RME Exposure Point Concentration (mg/kg) (a) | CDI: Ingestion of Beef (mg/kg-day) |
|---|---|---|
| **Chemicals Exhibiting Carcinogenic Effects** | | |
| **Organic Chemicals** | | |
| 2,4-DNT | 2.28E-05 | 5.78E-09 |
| RDX | 1.00E-04 | 2.54E-08 |
| 2,4,6-TNT | 6.79E-04 | 1.72E-07 |
| **Chemicals Exhibiting Noncarcinogenic Effects** | | |
| **Organic Chemicals** | | |
| 2,4-DNT | 2.28E-05 | 1.35E-08 |
| HMX | 4.92E-06 | 2.91E-09 |
| RDX | 1.00E-04 | 5.93E-08 |
| 1,3,5-TNB | 1.02E-05 | 6.03E-09 |
| 2,4,6-TNT | 6.79E-04 | 4.02E-07 |
| **Inorganic Chemicals** | | |
| Manganese | 1.19E+00 | 7.05E-04 |

(a) - The concentrations in beef reflect ingestion of hay and corn silage grown at the O-Line Ponds area.

Beef ingestion exposures were evaluated for individuals between the ages of 1-30. Average body weights for the age periods were based on data provided by EPA (1989b), and ingestion rates were derived from USDA (1982). Individuals aged 1-8 were assumed to have an average body weight of 20 kg and an ingestion rate of 92 g/day, individuals aged 9 to 18 were assumed to have an average body weight of 52 kg and an ingestion rate of 152 g/day, and individuals aged 19 to 30 were assumed to have an average body weight of 70 kg and an ingestion rate of 166 g/day. All exposed individuals were assumed to eat beef 3 times a week throughout the year (156 days/year), and obtain 44% of their beef from cattle that consume crops grown at the O-Line Ponds (USEPA, 1989b). Individuals were assumed to be exposed for 30 years (the upper bound estimate of the time a person is likely to spend in any one residence [USEPA, 1989a]) and assumed to live for 70 years (USEPA, 1989a).

It was assumed conservatively that no reductions in concentrations occur during preparation of the beef (i.e., cooking). Table 6-6 presents the estimated chemical concentrations in beef and the resulting CDIs that were derived using the assumed exposure parameters for ingestion of beef. A complete derivation of the chemical concentrations in beef can be found in the FFS (USAEC, 1993a).

## 6.3 TOXICITY ASSESSMENT

Table 6-7 presents chronic oral health effects criteria (slope factors and RfDs) for the chemicals of potential concern quantitatively evaluated in this assessment. Detailed toxicity profiles for chemicals detected in soil, surface water, and shallow sediment at the O-Line Ponds area are provided in Appendix B of the FFS (USAEC, 1993a).

No oral health effects criteria are available for sodium, thus potential risks associated with exposure to sodium will not be quantitatively evaluated. Exclusion of this chemical from the quantitative evaluation is not anticipated to result in significant underestimation of risk, because it is an essential nutrient, and it is not likely to pose adverse health effects at the concentrations present in the media evaluated for the O-Line Ponds.

## 6.4 RISK CHARACTERIZATION

Risk estimates were calculated by combining CDIs with reference doses (RfDs) or slope factors (SFs) to derive noncarcinogenic hazard indices or excess lifetime cancer risks, respectively. For carcinogens, potential risks are presented as the product of the CDI and slope factor. Risks were compared to EPA's target risk range of $10^{-4}$ to $10^{-6}$. For noncarcinogens, potential hazards are presented as the ratio of the CDI to the reference dose (CDI:RfD), and the sum of the ratios is referred to as the hazard index. In general, hazard indices that are less than one are not likely to be associated with adverse health effects, and are therefore less likely to be of regulatory concern than hazard indices greater than one. The remainder of this section presents potential risks and hazards for five different exposure pathways. Table 6-8 summarizes the estimated risks for all exposure pathways.

### 6.4.1 <u>Incidental Ingestion of Soil</u>

Excess lifetime cancer risk estimates associated with incidental soil ingestion exposures for future residents at the O-Line Ponds are $2x10^{-6}$, due primarily to RDX and 2,4,6-TNT. This value is within the EPA target risk range of $10^{-4}$ to $10^{-6}$. The hazard index for incidental ingestion of soil from the O-Line Ponds is below one. This indicates that adverse noncarcinogenic effects are unlikely to occur for those who incidentally ingest soil at the O-Line Ponds.

## TABLE 6-7
## ORAL TOXICITY VALUES FOR CHEMICALS OF POTENTIAL CONCERN AT THE O-LINE PONDS

| Chemical | Chronic Reference Dose (mg/kg-day) | Uncertainty Factor (a) | Toxicological Endpoint (b) | Reference Dose Source | Cancer Slope Factor (mg/kg-day)-1 | EPA Weight of Evidence Classification (c) | Slope Factor Source |
|---|---|---|---|---|---|---|---|
| Organic Chemicals: | | | | | | | |
| DNT (2,4-, 2,6-) | 2E-03 | 100 | Neurotoxicity | IRIS | 6.8E-01 | B2 | HEAST |
| HMX | 5E-02 | 1000 | Liver | IRIS | -- | D | IRIS |
| RDX | 3E-03 | 100 | Prostate | IRIS | 1.1E-01 | C | IRIS |
| 1,1,2-Trichloroethane | 4E-03 | 1,000 | Liver | IRIS | 5.7E-02 | C | IRIS |
| Trichlorofluoromethane | 3E-01 | 1,000 | Mortality | IRIS | -- | -- | -- |
| 1,3,5-TNB | 5E-05 | 10,000 | Spleen | IRIS | -- | -- | -- |
| 2,4,6-TNT | 5E-04 | 1,000 | Liver | IRIS | 3E-02 | C | IRIS |
| Inorganic Chemicals: | | | | | | | |
| Aluminum | -- | -- | -- | HEAST | -- | -- | -- |
| Arsenic | 3E-04 | 3 | Skin | IRIS | 1.75E+00 (d) | A | IRIS |
| Barium | 7E-02 | 3 | > Blood Pressure | IRIS | -- | -- | -- |
| Beryllium | 5E-03 | 100 | None Observed | IRIS | 4.3E+00 | B2 | IRIS |
| Calcium | -- | -- | -- | -- | -- | -- | -- |
| Chromium (VI) and compounds (e) | 5E-03 | 500 | CNS | IRIS | -- | -- | IRIS |
| Cobalt | -- | -- | -- | IRIS | -- | -- | -- |
| Copper | 3.7E-02 (f) | 1 | Gastrointestinal Tract | HEAST | -- | -- | -- |
| Iron | -- | -- | -- | HEAST | -- | -- | -- |
| Lead | -- | -- | CNS | IRIS | -- | B2 | IRIS |
| Magnesium | -- | -- | -- | -- | -- | -- | -- |
| Manganese | 1E-01 | 1 | CNS | IRIS | -- | D | IRIS |
| Mercury, inorganic | 3E-04 | 1,000 | Kidney | HEAST | -- | D | IR[illegible] |
| Nickel | 2E-02 | 300 | Body Weight | IRIS | -- | -- | I[illegible] |
| Potassium | -- | -- | -- | -- | -- | -- | [illegible] |
| Sodium | -- | -- | -- | -- | -- | -- | -- |
| Vanadium | 7E-03 | 100 | None Observed | HEAST | -- | -- | -- |
| Zinc | 2E-01 | 10 | Blood (Anemia) | HEAST | -- | -- | -- |

(a) Safety factors are the products of uncertainty factors and modifying factors. Uncertainty factors used to develop reference dos[illegible] generally consist of multiples of 10, with each factor representing a specific area of uncertainty in the data available. The standard uncertainty factors include the following:
- a 10-fold factor to account for the variation in sensitivity among the members of the human population;
- a 10-fold factor to account for the uncertainty in extrapolating animal data to the case of humans;
- a 10-fold factor to account for the uncertainty in extrapolating from less than chronic NOAELs to chronic NOAELs; and
- a 10-fold factor to account for the uncertainty in extrapolating from LOAELs to NOAELs.

Modifying factors are applied at the discretion of the reviewer to cover other uncertainties in the data.

(b) The toxicological endpoint is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, an organ or system known to be affecte[illegible] by the chemical is listed.

(c) EPA Weight of Evidence for Carcinogenic Effects:
- [A] = Human carcinogen based on adequate evidence from human studies;
- [B2] = Probable human carcinogen based on inadequate evidence from human studies and adequate evidence from animal studies;
- [C] = Possible human carcinogen based on limited evidence from animal studies in the absence of human studies; and
- [D] = Not classified as to human carcinogenicity.

(d) A unit risk of 5E-5 (ug/L)-1 has been proposed by the Risk Assessment Forum and this recommendation has been scheduled for SAB review. This value is equivalent to 1.75 (mg/kg-day)-1 assuming a 70-kg individual ingests 2 liters of water per day.

(e) Chromium (VI) was used as a surrogate to evaluate total chromium.

(f) Drinking water standard reported in mg/L was converted to mg/kg-day by assuming a 70 kg adult drinks 2 liters of water per day.

NOTE: IRIS = Integrated Risk Information System - September 1, 1992.
HEAST = Health Effects Assessment Summary Tables - First Quarter 1992.
-- = No information available.
CNS = Central Nervous System
> = Increase

**TABLE 6-8**
**SUMMARY OF RISKS**

| Pathway | Hazard Index (a) | Upper Bound Excess Lifetime Cancer Risk |
|---|---|---|
| Soil, Shallow Sediment, and Beef Pathways | | |
| Incidental Ingestion | | |
| Surface Soil | <1 (2E-01) | 2E-06 |
| Shallow Sediment | <1 (3E-08) | NA |
| Dermal Absorption | | |
| Surface Soil | <1 (5E-02) | 6E-07 |
| Shallow Sediment | <1 (7E-09) | NA |
| Ingestion of Beef | <1 (8E-03) | 1E-08 |
| TOTAL RISK | <1 (3E-01) | 3E-06 |

(a) - The hazard index is the sum of the intake:RfD ratios for the listed chemicals.
NA = Not applicable.

### 6.4.2 Dermal Exposures to Chemicals in Surface Soil

Excess lifetime cancer risk estimates associated with dermal absorption of chemicals in soil for future residents at the O-Line Ponds are $6x10^{-7}$. This value is below the EPA target risk range of $10^{-4}$ to $10^{-6}$. The hazard index for dermal absorption of chemicals in soil from the O-Line Ponds is below one. This indicates that neither carcinogenic nor adverse noncarcinogenic effects are likely to occur for those who are dermally exposed to chemicals in surface soil at the O-Line Ponds.

### 6.4.3 Incidental Ingestion of Shallow Sediment

No carcinogens were detected in shallow sediment, so no cancer risks were calculated for this exposure pathway. The hazard index for incidental ingestion of shallow sediment is much lower than one. This indicates that adverse noncarcinogenic effects are unlikely to occur for those who incidentally ingest shallow sediment at the O-Line Ponds. Risks associated with exposure to sodium were not included, because oral toxicity criteria have not been developed for this chemical. This may slightly under-estimate the risks and hazards associated with this pathway, although this is unlikely to change the conclusions regarding this pathway.

### 6.4.4 Dermal Absorption of Chemicals in Shallow Sediment

No carcinogens were detected in shallow sediment; thus, only a hazard index was calculated for dermal absorption of chemicals in shallow sediment. The hazard index for this pathway was much lower than one, indicating that adverse noncarcinogenic effects are unlikely to occur for persons dermally exposed to chemicals in shallow sediment. Once again, the risk evaluation does not include risks associated with exposure to sodium, because oral toxicity criteria have not been developed for this chemical.

### 6.4.5 Ingestion of Beef

The excess lifetime cancer risk estimate associated with consumption of beef is $1x10^{-8}$, two orders of magnitude below the lower end of the EPA target risk range of $10^{-4}$ to $10^{-6}$. All of the individual hazard indices as well as the total hazard index were below a value of one. This indicates that adverse noncarcinogenic effects are unlikely to occur for those who ingest beef from cattle that have consumed crops grown at the O-Line Ponds.

### 6.4.6 Total Risks

Risks associated with all exposure pathways evaluated in this assessment were added for hypothetical future receptors at the O-Line Ponds. As shown in Table 6-8, total risks associated with exposures to chemicals in soil, shallow sediment, and beef were $3x10^{-6}$, within the EPA target risk range of $10^{-4}$ to $10^{-6}$. In addition, the hazard index for these pathways combined was less than one, indicating that adverse noncarcinogenic effects were unlikely to occur.

## 6.5 EVALUATION OF EFFECTS OF INGESTION OF GROUNDWATER CONTAMINATED BY OU2

Two scenarios were used to estimate the level of groundwater contamination that could occur due to residual soil contamination in OU2:

- Scenario 1 consists of continued maintenance of the existing cap (which prevents migration of the contaminants under the cap) but allows rainwater to infiltrate the contaminated soil around the perimeter of the cap. Under these conditions, the explosives compounds will partition from subsurface soil to the percolating water, and will be transported to the aquifer.

- Scenario 2 consists of a discontinuation of maintenance of the existing cap. In developing this scenario, it was assumed that the cap would eventually erode and fail to prevent water infiltration through the contaminated soil currently under the cap. Calculations were performed to estimate the rate of migration of contaminants to the water table.

As required by the NCP, this evaluation of potential risks was performed under the assumption of the absence of institutional controls (e.g. controlled access to and usage of the O-Line Ponds area) and in the absence of other remedial actions (e.g. the groundwater treatment system for OU1). Therefore, the potential risks estimated in this section are those that could result solely from continued contaminant migration from OU2 and uncontrolled residential use of the area.

### 6.5.1 Chemicals Of Potential Concern

Chemicals of potential concern for the groundwater exposure pathway are those chemicals which were detected in more than one sample in the subsurface soil of OU2: 1,3,5-TNB, 2,4,6-TNT, and RDX. The resulting concentrations of explosives compounds in the shallow groundwater are shown in Tables 6-9 and 6-10, for Scenarios 1 and 2, respectively.

### 6.5.2 Exposure Assessment

In this section, the potential pathways by which individuals could be exposed to the chemicals of potential concern in groundwater are identified and exposure is quantified. This risk assessment focuses solely on potential human health risks associated with ingestion of untreated groundwater from OU2. As described above, two hypothetical scenarios were evaluated.

Chronic daily intakes (CDIs) were calculated for residential drinking water exposures using the estimated exposure point concentrations presented in Tables 6-9 and 6-10 for Scenarios 1 and 2, respectively. CDIs were estimated using the equation and assumptions presented below for groundwater ingestion:

$$CDI = \frac{Cw * X * IR * EF * ED}{BW * AT * Days}$$

where:

| | | |
|---|---|---|
| CDI | = | chronic daily intake (mg/kg-day), |
| $C_w$ | = | chemical concentration in groundwater (mg/L), |
| X | = | conversion factor (mg/$10^3$ $\mu$g) |
| IR | = | water ingestion rate (L/day), |
| EF | = | frequency of exposure (days/year), |
| ED | = | duration of exposure (years), |
| BW | = | average body weight (kg), |
| AT | = | averaging time (70 years for carcinogens, 30 years for noncarcinogens), and |
| Days | = | conversion factor (365 days/year). |

Drinking water exposures are evaluated for a hypothetical future resident between the ages of 0 to 30. For individuals 0-30 years of age, a time-weighted average body weight of 48 kg (based on data in EPA 1989a), and a drinking water rate of 1.9 liters/day are used as parameters for the reasonable maximum exposure (RME) case. The drinking water consumption rate has been calculated assuming a consumption rate of 1 liter/day for individuals up to 10 kg (approximately 3 years of age), and a rate of 2 liters/day for those over 3 years of age. An exposure duration of 30 years, the upper-bound time at one residence, is assumed for residents (USEPA, 1991, USEPA, 1989a).

CDIs calculated using these exposure assumptions for chemicals exhibiting carcinogenic effects and chemicals exhibiting noncarcinogenic effects due to ingestion of groundwater from OU2 are presented in Tables 6-9 and 6-10.

### 6.5.3 Risk Characterization

Risks and hazards were calculated using methods similar to those described in Section 6.4. Tables 6-9 and 6-10 present the exposure point concentrations, CDIs, toxicity data, and estimated risks for Scenarios 1 and 2, respectively.

Carcinogenic and noncarcinogenic risks associated with the ingestion of untreated groundwater during Scenarios 1 and 2 by future residents were calculated. The estimated upper-bound excess lifetime cancer risk for ingestion of groundwater during Scenario 1 is $2x10^{-3}$, while estimated upper bound excess lifetime cancer risk for groundwater ingestion during Scenario 2 is $1x10^{-1}$. The risks from both scenarios exceed EPA's target risk range of $10^{-6}$ to $10^{-4}$ range for human health protectiveness. For noncarcinogenic chemicals, the hazard index exceeded one for all chemicals in both Scenarios 1 and 2.

## 6.6 SUMMARY OF ECOLOGICAL RISK ASSESSMENT

This section summarizes potential impacts to nonhuman receptors resulting from exposure to the chemicals of potential concern at the O-Line Ponds area. The approaches used in this environmental assessment roughly parallel those used in the human health risk assessment. In this section, potentially exposed populations (receptors) are identified, and then information on exposure and toxicity is combined to derive qualitative or quantitative estimates of impact.

The area within several miles of the O-Line Ponds is rural and is used for agriculture, with some residential areas. Much of the land is used for crop and pastureland. The terrain of MAAP consists mainly of gently rolling hills and numerous small drainage courses. The potential receptors, potential pathways by which plants and wildlife may be exposed, and the potential ecological impacts are summarized. The pathway analysis is limited to potential exposures to chemicals of potential concern in surface and shallow subsurface soils, shallow sediments, and surface waters. Plants and wildlife will not be exposed to chemicals of potential concern in deep subsurface soils or groundwater because these media are not accessible to the potential receptors. Discussions of potential impacts include results of bioassays conducted for surface soil, surface water, and shallow sediment elutriate during the RI/FS. The potential risks to the terrestrial invertebrates and aquatic life associated with the O-Line Ponds area were evaluated based on the outcomes of these bioassays.

Absolute conclusions regarding the potential environmental impacts of the O-Line Ponds cannot be made because there are many uncertainties surrounding the estimates of toxicity and exposure. However, given the available data and limitations, several general conclusions regarding the potential for environmental impacts are presented below.

## TABLE 6-9
## ESTIMATED EXPOSURE POINT CONCENTRATIONS, CDIs, AND POTENTIAL RISKS
## GROUNDWATER EXPOSURE PATHWAYS, SCENARIO 1

| Chemicals Exhibiting Carcinogenic Effects | RME Exposure Point Concentration (μg/L) | CDI: Ingestion of Groundwater (mg/kg-day) | Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ | Upper Bound Excess Lifetime Cancer Risk |
|---|---|---|---|---|
| RDX | 9.6E+02 | 1.6E-02 | 1.1E-01 | 2E-03 |
| 2,4,6-Trinitrotoluene (246TNT) | 6.96E+02 | 1.1E-02 | 3E-02 | 3E-04 |
| TOTAL | | | | 2E-03 |
| **Chemicals Exhibiting Noncarcinogenic Effects** | **RME Exposure Point Concentration (μg/L)** | **CDI: Ingestion of Groundwater (mg/kg-day)** | **RfD (mg/kg-day)** | |
| RDX | 9.6E+02 | 3.6E-02 | 3E-03 | 1E+01 |
| 1,3,5-Trinitrobenzene (135TNB) | 1.25E+02 | 4.7E-03 | 5E-05 | 9E+01 |
| 2,4,6-Trinitrotoluene (246TNT) | 6.96E+02 | 2.6E-02 | 5E-04 | 5E+01 |
| Hazard Index | | | | 2E+02 |

## TABLE 6-10
## ESTIMATED EXPOSURE POINT CONCENTRATIONS, CDIs, AND POTENTIAL RISKS
## GROUNDWATER EXPOSURE PATHWAYS, SCENARIO 2

| Chemicals Exhibiting Carcinogenic Effects | RME Exposure Point Concentration (µg/L) | CDI: Ingestion of Groundwater (mg/kg-day) | Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ | Upper Bound Excess Lifetime Cancer Risk |
|---|---|---|---|---|
| RDX | 6.00E+04 | 9.8E-01 | 1.1E-01 | 1E-01 |
| 2,4,6-Trinitrotoluene (246TNT) | 1.02E+04 | 1.7E-01 | 3E-02 | 5E-03 |
| TOTAL | | | | 1E-01 |
| **Chemicals Exhibiting Noncarcinogenic Effects** | **RME Exposure Point Concentration (µg/L)** | **CDI: Ingestion of Groundwater (mg/kg-day)** | **RfD (mg/kg-day)** | **CDI:RfD Ratio** |
| RDX | 6.00E+04 | 2.3E+00 | 3E-03 | 8E+02 |
| 1,3,5-Trinitrobenzene (135TNB) | 2.04E+03 | 7.7E-02 | 5E-05 | 2E+03 |
| 2,4,6-Trinitrotoluene (246TNT) | 1.02E+04 | 3.9E-01 | 5E-04 | 8E+02 |
| HAZARD INDEX | | | | 3E+03 |

Given the lack of phytotoxicity data, a quantitative assessment of potential plant impacts was not done. However, it can be concluded that chemical concentrations at the site are below levels that are likely to impact at least some terrestrial plant species. This conclusion is based upon the observation that vegetation was present throughout the O-Line Ponds area, including the region adjacent to the landfill cap where chemicals were found at the highest concentration within the surface soil.

A variety of terrestrial species may be exposed to chemicals at the O-Line Ponds Area. Because of their intimate contact with the soil, soil-dwelling invertebrates are the terrestrial species most likely to be impacted by chemicals in the soil. Accordingly, a series of bioassays were conducted to evaluate the potential impacts of surface soil to the earthworm *Eisenia foetida*. The results of the bioassay indicated no impacts to the earthworms as a result of chemicals in the soil. It is therefore concluded that terrestrial invertebrates are unlikely to be impacted by chemicals in the soil.

Terrestrial vertebrates may also be exposed to chemicals through the ingestion of chemicals that have accumulated in food items (e.g., soil-dwelling invertebrates). Because of their prevalence and high concentrations, explosives compounds have the greatest potential to bioaccumulate at the O-Line Ponds Area. However, tissue residue analysis of soil-dwelling invertebrates from the O-Line Ponds Area indicated that the accumulation of explosives compounds is not occurring and this pathway is considered to be incomplete.

Ditch 5/B is dry throughout much of the year and is not a viable aquatic habitat. However, Ditch 5/B drains into the Rutherford Fork of the Obion River where aquatic species occur. Surface water and shallow sediment acute bioassays were conducted with *Ceriodaphnia dubia* to evaluate potential impacts to aquatic species in the Rutherford Fork of the Obion River. No mortality occurred in the surface water bioassay and it was concluded that impacts to aquatic species are unlikely to occur as a result of surface water from the O-Line Ponds area. Results of the shallow sediment elutriate bioassay indicated toxicity in the O-Line Ponds Area tributary, though no toxicity occurred downgradient from this point. Based upon the absence of toxicity immediately downgradient from the O-Line Ponds Area, it was concluded that impacts to aquatic species in the Rutherford Fork of the Obion River (located approximately 12,000 feet downstream) are unlikely to occur as a result of chemicals associated with the shallow sediments.

## 6.7 RISK ASSESSMENT SUMMARY

The following conclusions may be drawn from the risk analysis presented above:

- Incidental ingestion and dermal absorption of chemicals in surface soils at the O-Line Ponds, assuming future residential exposures, do not result in risks in exceedance of the EPA target risk range.
- Exposure to shallow sediments near the O-Line Ponds, assuming future residential exposures, does not pose unacceptable risks to human health.
- Ingestion of beef from cattle that have consumed crops grown on the O-Line Ponds, assuming a future agricultural exposure scenario, would result in risks that are not above unacceptable levels.
- Although inorganic chemical concentrations in surface water were elevated above background concentrations, there is no significant potential for such exposures by human receptors.
- Chemical concentrations in soil at the O-Line Ponds are below levels that are likely to impact plants and soil dwelling invertebrates.

- Terrestrial invertebrates are not likely to be impacted by chemicals that have accumulated in food items (e.g,. soil dwelling invertebrates).

- Chemicals in surface water and shallow sediment are not likely to impact aquatic species in the Rutherford Fork of the Obion River.

- Human health risks that could potentially result from ingestion of groundwater contaminated by the continued leaching of explosives compounds from the soil around the perimeter of the existing cap are at high levels (above EPA's acceptable risk range.)

- Human health risks that could potentially result from a discontinuation of cap maintenance and eventual cap failure are predicted to be at high levels (under the assumption of residential land use of the O-Line Ponds area.)

The baseline risk assessment indicates that residual explosives contamination in soil at OU2 may adversely affect groundwater quality, resulting in unacceptable future risks. The containment of these contaminants and the prevention of hydraulic loading on this source area will prevent these unacceptable risks.

This remedial action will stop further migration of contaminants of soil to groundwater and will prevent any potential exposures to contaminated soils. The cap extension will significantly reduce or eliminate the mobility of contaminants of concern in soil. Therefore, implementation of this remedial action will result in significant reduction of risks potentially posed by Operable Unit Two. Implementing this action concurrently with the interim remedial action for OU1 will provide the most effective and feasible approach to protecting human health and the environment from the contamination targeted under these remedial actions.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

## 7.0 DESCRIPTION OF ALTERNATIVES

During the technology screening conducted as part of the Focused Feasibility Study (USAEC, 1993a), applicable remedial technologies were identified, evaluated, and assembled into remedial alternatives. These remedial alternatives address the following general response actions:

- No Action;
- Limited Action;
- Containment; and
- Excavation, On-Site Treatment, and Disposal.

This section briefly describes the alternatives that were considered for remediating OU2.

### 7.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As required by the NCP, the selected alternative must be in compliance with all applicable or relevant and appropriate requirements (ARARs). ARARs are the cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a Superfund site.

The contaminated soil in the O-Line Ponds area is not a RCRA-listed waste, nor is the contaminated soil expected to exhibit the characteristic of reactivity. Therefore, Federal RCRA and Tennessee hazardous waste requirements are not applicable. However, due to the similarity of the contaminated soil to RCRA-listed waste, the RCRA requirements for closure of surface impoundments (40 CFR 264.228) and closure of landfills (40 CFR 264.310) are relevant and appropriate. In addition, the requirements of 40 CFR 264.91 (Subpart F - Releases from Solid Waste Management Units, Groundwater Monitoring Requirements) are relevant and appropriate.

The Tennessee Hazardous Waste Management Act (Title 68, Chapter 46), which govern the transport, storage, treatment, and disposal of hazardous waste are also relevant and appropriate. The Tennessee Solid Waste Processing and Disposal Regulations (Rule 1200-1-7), which lay out the closure and post-closure requirements of landfills and other disposal facilities, are applicable requirements.

For all actions that involve earthmoving (e.g., construction and excavation activities) or incineration, the State air quality requirements are applicable. These consist of Tennessee Air Quality Control Regulations for Fugitive Dust (Rule 1200-3-8.01), Visible Emissions (Rule 1200-3-5.01), Particulate Emissions (Rule 1200-3-7.03(2)), and Non-Process Emissions Standards (Rule 1200-3-6.02(3)).

For construction activities that disrupt more than 5 acres of land, the Tennessee Water Pollution Control Regulations - General Stormwater Permit for Construction Activities (Rule 1200-4-10.05) are applicable. For stormwater discharges associated with industrial activities, including incineration, the Tennessee Water Pollution Control Regulations - General Stormwater Permit for Industrial Activities (Rule 1200-4-10.04) are also applicable.

### 7.2 TO-BE-CONSIDERED GUIDANCES

The major to-be-considered guidances (TBCs) consist of the use of the EPA cancer slope factors and reference doses listed in Section 6.0. The EPA Health Advisories for 2,4,6-TNT (2 $\mu$g/L) and RDX (2 µg/L) in drinking water are also TBCs.

These TBCs have been used to derive risk-based cleanup levels for soil. For surface soil, cleanup levels have been calculated using the identical exposure assumptions discussed in Section 6.0 for incidental ingestion and dermal contact. Because these assumptions include residential land use of the O-Line Ponds area, these surface soil cleanup levels are very conservative. For subsurface soil, cleanup levels have been derived by estimating the total mass of explosives in soil, calculating the average rate of contaminant transport to the water table, and using mass balance calculations to estimate the potential concentration of each contaminant in shallow groundwater at the downgradient edge of the O-Line Ponds area. These estimates of cleanup levels for subsurface soil are based on very conservative assumptions (e.g., residential land use of the O-Line Ponds area and use of shallow groundwater as drinking water) so that the resulting cleanup levels would be fully protective.

## 7.3 ALTERNATIVE A: NO ACTION

The No Action alternative, Alternative A, has been developed to provide a basis for comparing active treatment alternatives. The NCP and CERCLA, as amended by SARA, require the evaluation of this alternative as a baseline for comparison of risk reduction achieved by each treatment alternative. Under this alternative, no further action would be taken to address contamination at the site. The risks that were calculated in the baseline risk assessment are based on the scenario presented by this alternative (i.e., no active reduction of present or future potential risks). For the No Action alternative, it is assumed that the area may be used for any purpose, including residential land use. Therefore, existing institutional controls (access restricted by the fence and maintenance of the existing cap) are not assumed under this alternative. The potential human health risk associated with cap failure, leaching of contaminants currently under the cap to groundwater, and use of the shallow groundwater as drinking water by residents, is estimated to be $1x10^{-1}$. This level of risk is in exceedance of EPA's acceptable risk range of $10^{-4}$ to $10^{-6}$.

There is no implementation time or cost associated with the No Action alternative because no additional remedial activities will be implemented at the site. This alternative is not in compliance with the ARARs because the post-closure care requirements for the existing cap would not be met.

## 7.4 ALTERNATIVE B: LIMITED ACTION

The Limited Action alternative would include implementation of the following actions:

- institutional controls to restrict site access;
- maintenance of existing cap;
- public education programs; and
- five-year reviews.

Institutional controls would include continued access restrictions (including maintenance of the existing security fence around the O-Line Ponds area), deed restrictions, and land use restrictions. Deed and land use restrictions would limit the future uses of the site and require permits, qualified supervision, and health and safety precautions for any activities conducted in the vicinity of the site. Long-term maintenance of the multi-media cap currently in place at the O-Line Ponds area would be performed to prevent infiltration of rainwater through the contaminated soil under the cap. Five-year reviews are required by the NCP at all sites where hazardous chemicals remain untreated. The review will analyze available data to make a determination as to whether additional remedial actions are required at the site.

The Limited Action alternative would address potential exposures to contaminants in surface soil and would prevent the leaching of contaminants from soil under the existing cap to the water table. However, no action would be taken to prevent the migration of contaminants from soil around the perimeter of the existing cap to groundwater. The baseline risk assessment indicates that the potential risk associated with human ingestion of groundwater contaminated by the explosives compounds that could leach from the soil around the perimeter of the cap is $2x10^{-3}$, which is in exceedance of EPA's acceptable risk range.

Because the Limited Action alternative includes care of the existing cap, it is in compliance with the ARARs identified in Section 7.1. However, because no action would be taken to remove the explosives compounds from soil around the perimeter of the cap or to prevent the migration of contaminants from the soil around the perimeter of the cap to groundwater, the action would not meet the cleanup levels (TBCs) for soil.

All components of Alternative B could be implemented within one year of the initiation of the remedial action. The cost estimate for this alternative does not include groundwater monitoring of the O-Line Ponds area, which would be performed as part of the Groundwater Operable Unit (OU1) remedial action. The capital cost of Alternative B is estimated to be $26,000, and the annual operating and maintenance (O&M) cost is approximately $19,000. The net present worth for this alternative, based on a 30 year implementation period (at a 5% discount rate), is $318,000. Maintenance of the existing cap and fence is included in the annual operating cost for this alternative.

## 7.5 ALTERNATIVE C: CLEAN SOIL COVER

Alternative C consists of maintaining the current institutional controls and existing cap to minimize human exposure to the site and, in addition, covering the area of contaminated soil around the perimeter of the existing O-Line Ponds cap with a layer of clean soil. A covering of clean soil would provide a simple and effective barrier which would prevent human and environmental exposures to contaminated surface soils.

Clean cover soil would be obtained from an uncontaminated area of MAAP. Testing would be performed to ensure that the soil does not have detectable concentrations of explosive compounds or other organic contaminants and that the concentrations of metals are within the background range. This soil would have a lower permeability than soils to be covered, which could be achieved by compaction of the clean soil during placement. Surface settlement of placed soils would be minimal because of the small thickness of the clean soil layer. After placement of soil, the new surface would be seeded with grasses and other durable vegetation. Other measures to control erosion, such as placement of geotextile erosion control materials on the perimeter of the soil cover, would be taken to ensure the integrity of the covering. Maintenance of the area would continue as described under Alternative B.

This action would prevent human exposure to contaminated surface soil and would prevent the migration of contaminants in soil under the existing cap to the water table. However, the newly-constructed surface covering would not be an engineered cap, so this action may reduce, but not prevent, the percolation of rainwater through the contaminated soil around the perimeter of the cap. To be conservative, the human health risk associated with implementation of this action is estimated to be identical to that of Alternative B (Limited Action), or $2x10^{-3}$. This level of risk exceeds EPA's acceptable risk range of $10^{-4}$ to $10^{-6}$.

The clean soil cover does not meet the requirements of 40 CFR 265.310 because of the lack of a low-permeability layer and proper drainage. This action would not remove explosives compounds from soil around the perimeter of the cap, nor would it prevent the percolation of rainwater through the contaminated soil around the perimeter of the existing cap. Therefore, the TBC cleanup levels for soil would not be met.

The soil cover would require approximately 2 to 4 months to construct. The capital cost of Alternative C is estimated to be $551,000, and the annual O&M cost is approximately $19,000. The net present worth of this alternative, based on a 30 year implementation period (at a 5% discount rate), is $843,000. These costs include all activities listed under Alternative B (Limited Action). The cost estimate does not include material costs for clean cover soil, as this is expected to be borrowed from a clean area of MAAP.

## 7.6 ALTERNATIVE D: EXTENSION OF ENGINEERED CAP

Alternative D consists of continued maintenance of the existing cap and the construction of a lateral extension of the cap over the contaminated soil around the perimeter of the existing cap. This alternative would extend the existing cap to the boundaries shown in Figure 7-1. As shown in this figure, the total area of the cap extension would be 237,000 $ft^2$. The boundary of this area is based on the data that are currently available and therefore is subject to change during the remedial design process. The cap extension boundary has been selected based on the following rationale:

- The purpose of the cap extension is to reduce the area of uncovered contaminated soil such that the potential human health risk associated with the migration of contaminants from the uncovered soil to the water table and use of the shallow groundwater as drinking water is within EPA's acceptable risk range.

- The Army performed a study of the levels of contaminants in soil in July 1993. These data were obtained by drilling boreholes in the area outside of the existing cap, collecting subsurface soil samples, and analyzing these soil samples for concentrations of explosives compounds. The chemical data were then analyzed to evaluate the required size of the cap extension such that the potential risk associated with leaching of contaminants from uncapped areas would be within EPA's acceptable risk range.

  - The chemical analysis of subsurface soil samples collected from the east side of the ponds indicates that only negligible levels of contamination are detectable east of the Ditch 5 tributary. Therefore, the cap extension will cover the soil between the existing cap and the Ditch tributary.

  - On the south side of the existing cap, contaminants were not detected in soil samples collected farther than 50 feet south of the existing cap. The cap extension will cover the soil within 50 feet of the existing cap.

  - On the west side of the cap, contaminants were detected in several locations west of the security fence; therefore, the residual risk associated with the continued leaching of contaminants from the soil west of the security fence was estimated. The results indicate that the risk associated with this potential pathway is $5 \times 10^{-10}$, which is below EPA's acceptable risk range. Therefore, the cap extension will cover the area between the existing cap and the security fence.

  - On the north side of the existing cap, explosives compounds were detected in many locations south of the Ditch 5 tributary. Based on the results of soil samples collected east of the ponds (where only negligible levels of explosives were detected beyond the Ditch 5 tributary), the cap extension will cover the area between the existing cap and the Ditch 5 tributary.

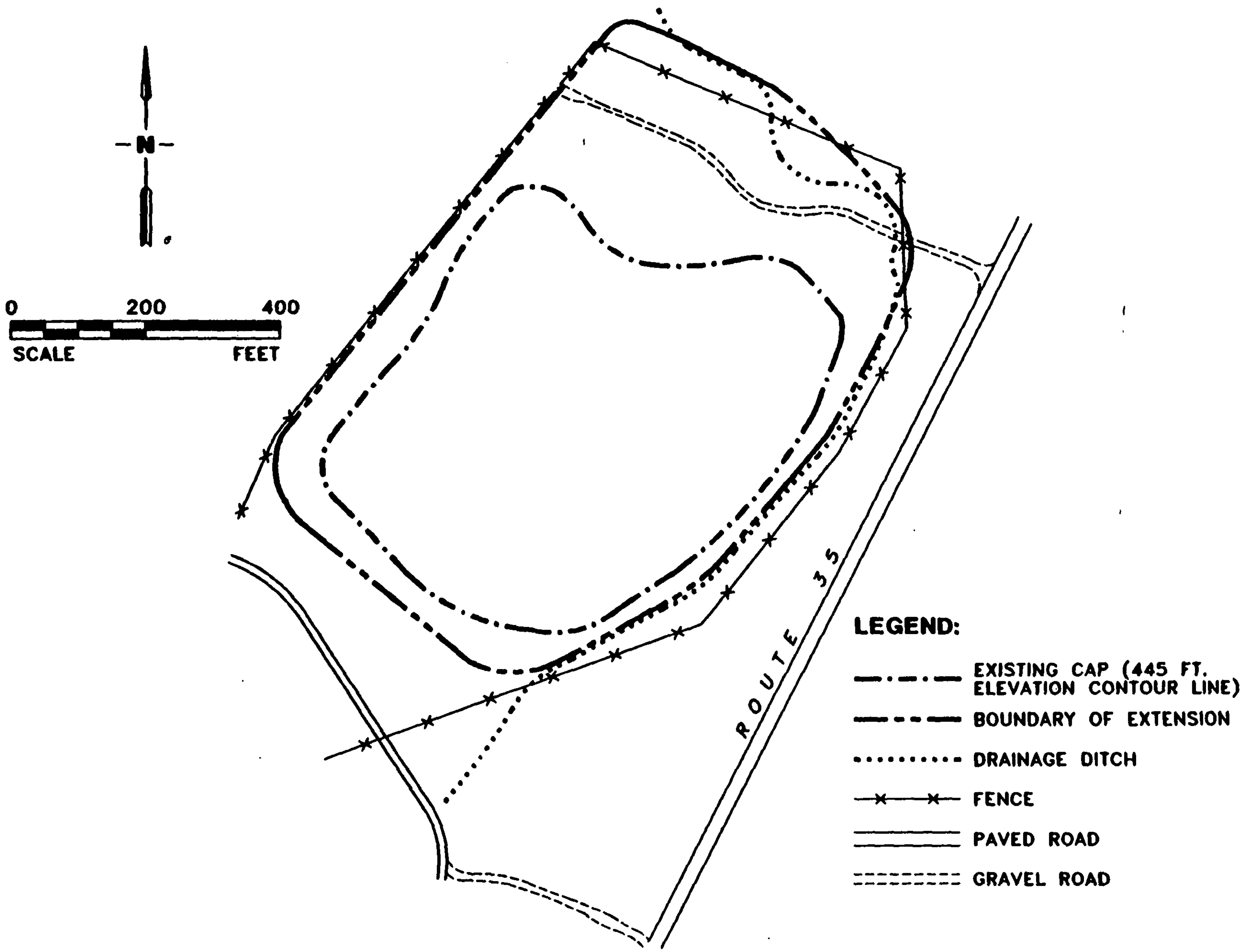


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FIGURE 7-1
CAP EXTENSION BOUNDARY

The primary objective of extending the impermeable cap at the O-Line Ponds is to prevent stormwater infiltration through the contaminated soil around the perimeter of the existing cap, thereby eliminating continued contaminant loading to groundwater. Additionally, human and animal contact with the contaminated surface soil surrounding the existing cap would be eliminated.

The cap extension would conform to RCRA requirements and would effectively tie in to the existing multi-media cap. After completion, regular maintenance will be required to maintain the integrity of the entire cap. The vegetative layer must be maintained and mowed to provide continual erosion control. The cap must be inspected for differential settling, which may cause breaching of the impermeable layers. Contingency plans for responding to subsidence problems would be devised as part of a long-term maintenance plan for the cap. Groundwater monitoring of the area would be performed as part of the OU1 remedial action.

The cap extension would serve to eliminate the migration of contaminants from the soil around the perimeter of the cap to the water table. Human exposures to contaminated surface soil would be prevented. At the same time, maintenance of the existing cap will prevent the migration of contaminants under the cap. The estimated potential human health risk associated with the residual soil contamination around the perimeter of the cap extension is $5x10^{-10}$, which is less than EPA's acceptable risk range of $10^{-4}$ to $10^{-6}$.

This alternative would meet all of the major ARARs for landfill closure and post-closure, groundwater monitoring, and all State ARARs identified in Section 7.1. Implementation of this action would not result in the removal of explosives compounds from soil; however, by preventing the percolation of rainwater through the contaminated soil under the existing cap and cap extension, risks to human health and the environment will be reduced to levels within EPA's acceptable risk range. Accordingly, EPA cancer slope factors, reference doses, and health advisories are not necessary to protect human health and the environment, and are therefore not TBCs for this alternative.

Implementation of this option would take approximately 12 to 18 months for the design phase, and 6 to 9 months for the construction phase. These time estimates include regulatory review of the design.

The total capital cost for installation of the cap is estimated to be $1,733,000. The total annual cost is estimated to be $19,000. The net present worth of the project, over a 30-year period and at a 5% discount rate, is estimated to be $1,833,000. A major assumption for this estimate is that earthen materials, such as sand and gravel, will be borrowed from clean areas of MAAP.

## 7.7 ALTERNATIVE E: PARTIAL EXCAVATION/INCINERATION

This alternative includes partial excavation of the contaminated soil in the O-Line Ponds Area around the perimeter of the existing capped area. The excavated soil would be thermally treated in a transportable incinerator located on-site. The thermally treated soil would be used as backfill along with clean soil to resurface this area.

The following partial excavation scenarios were evaluated in this alternative:

Scenario 1: Excavation of 10% of the perimeter area to a depth of 2 feet. (It has been estimated from the soil analytical data that this fraction of the area contains explosives compounds at levels corresponding to $10^{-6}$ risk and above for surface soil exposure pathways.) Approximately 3,420 tons of soil would be excavated and treated under this scenario.

Scenario 2: Excavation to a depth of 2 feet around the perimeter of the existing capped area. Approximately 34,200 tons of soil would be excavated and treated under this scenario.

Treatability studies have been performed on explosives-contaminated soil at Savanna Army Depot Activity, Savanna, Illinois. Full-scale remediation of explosives-contaminated soil has been performed at Louisiana Army Ammunition Plant. These studies indicate that high-temperature thermal treatment is effective in removing explosives compounds from soil with a destruction and removal efficiency (DRE) of 99.99%. This efficiency would reduce the concentrations of explosives compounds in surface soil to below the $10^{-6}$ risk level.

The treatment goal for this alternative is to reduce the concentrations of explosives compounds to meet risk-based levels, which were derived using EPA's cancer slope factors for the principal carcinogens detected in surface soil. The calculation of these treatment goals was performed under the assumption that humans could be exposed to contaminants both through incidental ingestion and dermal absorption. The concentrations estimated to result in a risk level of $10^{-6}$ are: for 2,4-DNT, 0.69 $\mu$g/g; for RDX, 0.70 $\mu$g/g; and for 2,4,6-TNT, 12.41 $\mu$g/g.

Conventional earthmoving equipment would be used for excavation of the contaminated soils. The rate of excavation would be determined by the volume of soil required to ensure a 1.5 week buffer volume that would be stored in the stockpile area and which would be incinerated in case of inclement weather that prevents excavation. Excavation would be performed in sections to minimize the possibility of windblown emissions. Confirmatory sampling and analysis of the soil would be performed to verify that all surface soil that exceeds the contaminant cleanup levels has been removed from the excavated section. Also, confirmatory sampling ensures that the remaining soils do not exceed the treatment goals.

The excavated section would be backfilled prior to proceeding to the next section of excavation. Treated soils may be used as backfill after confirming that the treatment goals have been met. The reduction in volume of the treated soils after incineration is not expected to be greater than 10%. Clean soil obtained from other areas of MAAP or off-site will also be used as backfill. Reseeding of the soil section would be required to prevent erosion.

Because of the large volume of soil to be treated, a transportable incineration system with a design soil feed rate of 15 tons per hour or greater would be used. Mobilization, set-up, and demobilization of the transportable system would be required. This alternative also includes institutional controls, maintenance of the existing cap and fence, public education programs, and five-year reviews as described in Alternative B.

Implementation of this alternative would result in maintenance of the existing cap and the remediation of surface soils only. Although the risk associated with exposure to contaminants in surface soil would be reduced, and the contaminants in soil under the existing cap would be prevented from migrating to the water table, the contaminants in subsurface soil around the perimeter of the cap would not be prevented from migrating to groundwater. Therefore, the potential human health risk after implementation of this remedy would be essentially equal to the risk under Alternative B (Limited Action), or $2 \times 10^{-3}$. This risk level is in exceedance of EPA's acceptable risk range.

For excavation and incineration options, the major ARARs consist of the RCRA requirements for incinerators (Subpart O), including 40 CFR 265.345 (General Operating Requirements), 265.347 (Monitoring and Inspection), and 265.351 (Closure). Because the contaminated soil to be excavated and treated is not a hazardous waste but is similar to a listed hazardous waste, these requirements are relevant and appropriate. All State ARARs for an excavation and incineration action are listed in Section 7.1. This action will meet all Federal and State ARARs. However, because no action would be taken to remove explosives compounds from subsurface soil, this action would not meet the TBC cleanup levels for soil.

Implementation of this alternative, from design to construction, will require approximately 20 - 24 months for completion. The thermal treatment technology is commonly used and commercially available. The design, review, and procurement of the thermal treatment system will require roughly 15 months, and mobilization and set-up of the transportable unit will require 1 to 2 months. Startup burns typically require 2 to 3 months for completion. Remediation of the O-Line Ponds area is expected to be completed in a total of 2 years for either scenario.

Capital costs included in the alternative are site preparation, mobilization/set-up, demobilization, and startup costs. For Scenario 1, the capital cost is estimated to be $2,672,000 and the annual O&M cost is estimated to be $315,000. The net present worth of this action, over a project lifetime of 30 years and a discount rate of 5%, is estimated to be $4,096,000. For Scenario 2, the capital cost is estimated to be $2,672,000 and the annual O&M cost is estimated to be $11,594,000. The net present worth of Scenario 2 is estimated to be $47,371,000.

## 7.8 ALTERNATIVE F: FULL EXCAVATION/INCINERATION

This alternative consists of the excavation and treatment of all of the contaminated soil in the O-Line Ponds Area, such that the residual risk would not exceed a level of $10^{-6}$. The excavated soil would be thermally treated in a fixed-site incinerator located on site. The thermally treated soil would be used as backfill to resurface the area. The following full excavation scenarios were evaluated in this alternative:

Scenario 1: Excavation to 20 feet including the existing capped area. This scenario will treat nearly half of the contaminated soil in the O-Line Ponds area, including the most-contaminated soil that is currently under the cap. The total volume excavated would be 676,000 cubic yards.

Scenario 2: Excavation to 45 feet including the existing capped area. This scenario provides the highest level of removal and treatment of contaminated soil. All explosives-contaminated soil from ground surface down to the water table would be removed and treated. The total volume excavated would be 1,322,000 cubic yards.

High-temperature thermal treatment is proposed for this alternative, and the system would operate in a manner similar to the process described in Alternative E, with the major difference being the size of the proposed incineration units. For Alternative F, two 30 ton per hour incinerators will be utilized to decrease processing time for the large quantity of soil to be treated. Rather than using a single, transportable unit, this alternative will use two units built and fixed at the site. The total capacity (60 tons per hour) will significantly reduce treatment time for this large quantity of soil.

Alternative F also includes institutional restrictions, maintenance of the fence, public education programs, and five-year reviews as described in Alternative B. Following completion of excavation, incineration, and backfilling, the site (at least the top 20 feet) would be acceptable for unrestricted use and the majority of the institutional and access controls could be eliminated.

The goal of this alternative is to remediate the site fully to allow for unlimited future land use. Therefore, the treatment goals for the explosives compounds in soil are those concentrations which will not result in unacceptable levels of risk following migration of the contaminants to groundwater. Because of the large volume of soil to be remediated in this manner, the maximum allowable concentrations in soil are less than the detection limits of explosives in soil. In order to allow backfill of the soil after treatment, the concentrations of explosives compounds must be reduced to non-detectable levels.

This action would meet the Federal and State ARARs for incineration listed in Section 7.1 and 7.7 for both Scenario 1 and Scenario 2. Implementation of Scenario 1 would reduce, but not eliminate, the potential for migration of contaminants from subsurface soil to the water table. Because of the large volume of soil remaining untreated at the site (the depth interval between 20 feet and the water table, which occurs at an average depth of 45 feet below ground surface), and because of the elimination of the cap, the contaminants left at the site would continue to migrate to the water table. The resulting concentrations in groundwater are expected to exceed the EPA Health Advisories. Therefore, Scenario 1 would not meet the TBC cleanup levels for soil. Implementation of Scenario 2 would eliminate both surface and subsurface through treatment. This action would meet ARARs and TBCs.

Implementation of this alternative, from design to construction, will require approximately 27 to 30 months for completion. The thermal treatment technology is commonly used and commercially available. The design, review, and procurement of the thermal treatment system will require roughly 15 months. The mobilization and set-up of the fixed site unit will require 10 to 12 months. Startup test burns typically require 2 to 3 months for completion. Complete remediation of the O-Line Ponds area is expected to be completed in about 24 to 26 months for the 20 foot depth, and 48 to 60 months for the 45 foot depth.

Capital costs included in the alternative are site preparation, mobilization, set-up, and startup burn costs. The capital cost for Scenario 1 is estimated to be $33,700,000 and the annual O&M cost is estimated to be $43,600,000. The net present worth of this alternative is estimated to be $239,000,000, based on a 30-year project life and a 5% discount rate. The capital cost of Scenario 2 is estimated to be $33,700,000 and the annual O&M cost is estimated to be $65,900,000. The net present worth of Scenario 2 is estimated to be $436,000,000, based on a project life of 30 years and a 5% discount rate.

## 7.9 SUMMARY OF REMEDIAL ALTERNATIVES

Six alternatives have been developed, including a No Action alternative (Alternative A), a Limited Action alternative (Alternative B), and four treatment alternatives varying from containment to on-site treatment (Alternatives C through F). A summary of these alternatives is presented in Table 7-1. Section 8 provides a comparison of these alternatives with respect to nine evaluation criteria.

## TABLE 7-1
## SUMMARY OF REMEDIAL ALTERNATIVES

| Alternative | Description | Implementation Time | | Costs in 1992 Dollars | | |
|---|---|---|---|---|---|---|
| | | Design (months) | Construct (months) | Capital Cost | Annual O&M Cost | Present Worth* |
| A | • No Action | 0 | 0 | $0 | $0 | $0 |
| B | • Limited Action | less than 6 | less than 12 | $26,000 | $19,000 | $318,000 |
| C | • Clean Soil Cover | 4 to 6 | 4 | $551,000 | $19,000 | $843,000 |
| D | • Extension of Existing Cap | 18 | 9 | $1,733,000 | $19,000 | $1,833,000 |
| E | Scenario 1:<br>• Partial Excavation of 10% of Soil to 2 feet<br>• Incineration | 18 | 4 | $2,672,000 | $315,000 | $4,096,000 |
| | Scenario 2:<br>• Partial Excavation to 2 feet<br>• Incineration | 18 | 4 | $2,672,000 | $11,594,000 | $47,371,000 |
| F | Scenario 1:<br>• Full Excavation to 20 feet<br>• Incineration | 18 | 24 to 26 | $33,700,000 | $43,600,000 | $239,000,000 |
| | Scenario 2:<br>• Full Excavation to 45 feet<br>• Incineration | 18 | 48 to 60 | $33,700,000 | $65,900,000 | $436,000,000 |

NOTE: All times and costs are estimates and are subject to change.
* - Present worth calculated over 30 years at an annual discount rate of 5%.

## 8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

This section evaluates and compares each of the alternatives described in Section 7.0 with respect to the nine criteria used to assess remedial alternatives as outlined in Section 300.430(e) of the NCP. Each of the nine criteria are briefly discussed below. All of the alternatives were evaluated for their ability to meet the threshold criteria of protection of human health and the environment and compliance with ARARs. The alternatives meet the other criteria to different degrees. To aid in identifying and assessing relative strengths and weaknesses of the remedial alternatives, this section provides a comparative analysis of alternatives. As previously discussed, the alternatives are as follows:

- Alternative A, No Action
- Alternative B, Limited Action
- Alternative C, Clean Soil Cover
- Alternative D, Extension of Engineered Cap
- Alternative E, Partial Excavation/Incineration
- Alternative F, Full Excavation/Incineration

These six alternatives are compared to highlight the differences between the alternatives, and determine their relative value in meeting the criteria for the detailed evaluation of alternatives.

### 8.1 NINE EVALUATION CRITERIA

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

The detailed criteria are briefly defined as follows:

- **Overall Protection of Human Health and Environment** is used to denote whether a remedy provides adequate protection against harmful effects and describes how human health or environmental risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- **Compliance with ARARs** addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of Federal and State environmental statutes and/or provides a basis for invoking a waiver.

- **Long-term Effectiveness and Permanence** refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment, over time, once clean-up goals have been met.

- **Reduction of Toxicity, Mobility, or Volume through Treatment** is the anticipated performance of the remedial actions employed for each alternative.

- **Short-term Effectiveness** refers to the speed with which the remedy achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment that may result during the construction and implementation period.

- **Implementability** is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

- **Cost** includes both capital and operation and maintenance costs.

- **State Acceptance** indicates whether, based on its review of the RI/FS Report and Proposed Plan, the State concurs with, opposes, or has no comment on the preferred alternative.

- **Community Acceptance** assesses the public comments received on the RI/FS Report and the Proposed Plan for the Operable Unit.

The NCP (Section 300.430 (f)) states that the first two criteria, protection of human health and the environment and compliance with ARARs, are "threshold criteria" which must be met by the selected remedial action. The next five criteria are "primary balancing criteria", and the trade-offs within this group must be weighed. The preferred alternative will be that alternative which is protective of human health and the environment, is ARAR-compliant, and provides the best combination of primary balancing attributes. The final two criteria, state and community acceptance, are "modifying criteria" which are evaluated following comment on the RI/FS reports and the Proposed Plan.

## 8.2 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Because current levels of contamination pose unacceptable levels of potential human health risk, Alternative A, No Action, will not meet this criterion because no actions are taken to eliminate, reduce or control exposure pathways. The threshold criterion of protection of human health and the environment is not achieved by Alternative A.

Alternative B, Limited Action, provides some additional protection from contaminated surface soil by implementing and maintaining restrictions such as the site fencing and the existing multi-media cap, which limit site access and human exposure to the contaminated soil. Although actions would be taken to minimize exposures to contaminants in surface soil, the migration of contaminants in the soil around the perimeter of the existing cap to the water table would not be prevented. The continued migration of contaminants to groundwater has been evaluated to have an adverse impact on groundwater quality and human consumption of this water would result in a risk level of $2 \times 10^{-3}$, which is above EPA's acceptable risk range. Therefore, Alternative B would not be protective of human health and the environment.

Alternatives C and E provide additional protection of human health and the environment by eliminating the surface soil exposure pathway. Alternative C provides protection by covering the contaminated surface soil with a clean layer of topsoil and vegetation. Alternative E would treat surface soil to a depth of 2 feet by incineration. Although each of these alternatives provides protection of human health via the surface soil exposure pathway, Alternative C and Alternative E do not include impermeable barriers or treatment of the contaminated soil and therefore do not prevent leaching of contaminants to groundwater. The level of human health risk posed by the continued migration of contaminants to the water table has been estimated to be $2 \times 10^{-3}$, which is above EPA's acceptable risk range. Alternatives C and E are therefore not protective of human health and the environment.

Both Alternative D and Alternative F would be protective of human health by preventing the leaching of contaminants from soil, thereby eliminating contaminant loading to groundwater. Potential surface soil exposure pathways would also be eliminated. Alternative D would prevent infiltration of precipitation by extending the existing cap over the contaminated soil around the perimeter of the cap and by providing for continued maintenance and institutional controls. Alternative F would be protective of human health and the environment by removing the explosives compounds from the soil through excavation and treatment of the soil.

## 8.3 COMPLIANCE WITH ARARS

Compliance with ARARs is a threshold criterion which must be met by the proposed remedial action. The No Action alternative (Alternative A) does not meet this criterion because the existing cap would not be maintained. The Limited Action alternative (Alternative B) meets this criterion because the post-closure care requirements of the existing cap would be met. Alternative C (Clean Soil Cover) would not meet the ARARs because the landfill closure requirements (40 CFR 265.310) would not be met.

Alternatives D, E, and F involve further actions to eliminate exposures to contaminated soil. Implementation of these alternatives would meet the ARARs identified in Section 7.1 and Section 7.7. Alternative D (Extension of the Existing Cap) would meet the Subpart N landfill closure requirements (40 CFR 265.310) and the Subpart F groundwater monitoring requirements (40 CFR 265.91). Alternatives E and F would meet the Subpart O incineration requirements (40 CFR 265.345, 265.347, and 265.351). In addition, State ARARs for solid waste management, hazardous waste management, air quality control, and stormwater management (listed in Section 7.1) would be met.

## 8.4 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternatives A, B, C, and E do not provide long-term effectiveness and permanence because the magnitude of the residual risk after the remedial objectives have been met would be at unacceptable levels. None of these alternatives provides sufficient, effective protection of groundwater quality.

Alternative D, extension of the existing cap, provides long-term effectiveness and permanence by isolating the contaminated soil using institutional controls (maintenance of site fencing), maintenance of the existing multi-media cap, and construction and maintenance of a cap extension. The maintenance activities required to assure effective cap performance consist of regular mowing of the vegetative cover, inspection of the cap for subsidence, repair (as needed), and groundwater monitoring.

The design and construction of a cap extension capable of preventing the infiltration of rainwater through the contaminated soil would be a relatively straightforward task, as this technology is well-understood and commonly-applied. Provided that the cap and cap extension are properly maintained, the magnitude of the residual risk following implementation of this remedial action would be within EPA's acceptable risk range. Because contaminants would remain on site, 5-year reviews would be performed to evaluate the site conditions.

Because MAAP is a currently-operating facility, the institutional controls that are currently in place to limit access to the site and prevent exposures to the contaminated media are adequately and reliably enforced. Should MAAP be closed in the future, the requirements of the Base Realignment and Closure Act, as well as this Record of Decision, would preclude the dismantling of these institutional controls. Therefore, the long-term reliability of management controls for Alternative D is excellent.

Alternative F incorporates incineration as the treatment method to provide the greatest degree of long-term effectiveness and permanence. Incineration achieves long-term effectiveness by the irreversible destruction of greater than 99.99% of the explosive contaminants in soil. Because incineration has been successfully used to treat explosives-contaminated soil, the reliability of the technology and the certainty that the treatment goals will be met are high. The magnitude of residual risk following implementation of this action would be within EPA's acceptable risk levels. Maintenance of the area would not be required after the project is complete.

Under Alternative F, residual contaminants would be removed down to levels that do not pose an unacceptable level of risk, so management controls to prevent exposures would not be needed. Long-term monitoring of groundwater also would not be needed.

## 8.5 REDUCTION OF TOXICITY, MOBILITY OR VOLUME THROUGH TREATMENT

Alternatives A and B provide no reduction of toxicity, mobility, or volume of the contaminants through treatment.

Alternative C does not meet the statutory preference for treatment, but will reduce the mobility of contaminants via the surface runoff and erosion pathways. However, implementation of Alternative C will not preclude the infiltration of rainwater through the contaminated soil and the subsequent leaching of contaminants to groundwater.

Alternative D also does not meet the statutory preference for treatment. However, implementation of this alternative will prevent contaminant migration to groundwater through extension of the existing impermeable cap.

Alternative E would meet the statutory preference for treatment by permanently destroying contaminants in surface soil through the excavation and incineration of surface soil around the perimeter of the cap. An estimated volume of 34,200 $ft^3$ would be treated in this manner. The toxicity, mobility, and volume of contaminants in surface soil would be irreversibly reduced through treatment. However, the alternative would not affect the toxicity, mobility, or volume of contaminants in subsurface soil.

Alternative F provides the greatest reduction of toxicity, mobility, and volume because the explosives compounds in the soil would be permanently destroyed through treatment. An estimated volume of 1,322,000 $ft^3$ of soil would be treated. Full excavation (the 45 foot excavation scenario) would result in complete reduction of contaminant toxicity, mobility and volume through treatment.

## 8.6 SHORT-TERM EFFECTIVENESS

Implementation of Alternatives A and B would pose the lowest risks to the community, site workers, and the environment, as well as require the shortest implementation time. These actions would not require excavation, construction, or transport of hazardous materials.

Alternative C (Clean Soil Cover), also would not pose a risk to the community because the amount of dust generated during placement of the soil is expected to be minimal. Because workers would be engaged in covering the area around the perimeter of the existing cap with clean soil, their level of exposure to contaminants in the soil would be small. Environmental impacts are expected to be minimal.

Alternative D (Extension of the Existing Cap) would not pose a risk to the community because dust generation during construction of the cap is expected to be minimal, and only non-hazardous construction materials would be transported to the site. Because workers would be engaged in construction activities rather than excavation activities, their level of exposure to the contaminated soil is expected to be minimal. Environmental impacts are not expected to occur under this alternative.

Both Alternatives E and F involve the excavation and incineration of the contaminated soil. During the implementation of these alternatives, the community could potentially be exposed to dust generated during excavation activities and to flue gas stack emissions, both of which could be reduced through the use of engineering controls. Workers at the site would also be exposed to contaminants in soil. For Alternative F, where the cap would be removed and the highly-contaminated sediments under the cap would be exposed, methods to prevent accidental detonation of deflagration and exposures would need to be deployed (e.g., use of non-sparking equipment and adequate personal protective equipment.) Also, the excavation, backfilling, and stockpiling activities would require extensive use of sediment and erosion control measures.

The length of time required to implement and complete the remedial alternatives follow in increasing order: Alternative C, Alternative D, Alternative E, and Alternative F. Alternative C would require 4 to 6 months to design and 4 months to construct the clean soil cover. Alternative D would require approximately 18 months to design and 9 months to construct. Alternative E would require 18 months to design and approximately 4 months to complete the remediation process. Alternative F would require 18 months to design and approximately 4 years to complete the remediation of the O-Line Ponds area.

## 8.7 IMPLEMENTABILITY

Alternatives A and B would be the most easily implemented of the alternatives under consideration. Alternative A requires cessation of existing institutional controls, and many components of Alternative B are already in place.

Alternative C would be relatively easy to design and construct because of the simplicity of the concept, the availability of clean soil at MAAP, and the fact that the earthmoving equipment needed for the project is readily available. The construction of a soil cover would be effective and reliable in preventing human exposure to surface soil. Because all construction activities would take place on site, permits would not be needed for this alternative.

Alternative D would require detailed engineering to ensure that the existing cap and the cap extension function together effectively. The layering within the cap extension must tie in to the layers of the existing cap. The technology is widely available, and the materials (either natural or synthetic) are also available from a large number of sources. Properly designed and constructed, this technology is expected to be very reliable. Because all construction activities would take place on site, permits would not be required.

Alternatives E and F utilize incineration, which has been successfully utilized for the treatment of explosives-contaminated soil. The technology is expected to be very reliable in reducing the levels of explosives compounds to the soil cleanup levels. However, these alternatives are most susceptible to schedule delays due to inclement weather and mechanical failure. Due to the fact that coordination of excavation, incineration, and backfilling activities must be performed within a relatively limited area, these alternatives pose the greatest technical feasibility problems. Although permits would not be required, the substantive requirements of air permits must be met. These alternatives would require the expertise of specialists in excavation and operation of the incineration equipment. Both fixed-site and mobile incineration units are available from a number of vendors.

Excavation to the depths proposed in Alternative F would make this the most difficult alternative to implement. Although feasible, excavation to groundwater (approximately 45 feet below ground surface) would pose a challenge because vertical constraints are required to ensure stability and safety and to maintain access to the excavation area for the earthmoving equipment. Shoring or bracing would be required for excavation below four feet.

## 8.8 COST

Table 8-1 provides a comparison of the costs of the remedial alternatives. Total capital and annual costs and present worth (discount rate of 5%) for each alternative are presented. The progression

**TABLE 8-1**

**COMPARISON OF COSTS FOR REMEDIAL ALTERNATIVES**

| Alternative | Description | Costs in 1992 Dollars | | |
|---|---|---|---|---|
| | | Capital Cost | Annual O&M Cost | Present Worth* |
| A | • No Action | $0 | $0 | $0 |
| B | • Limited Action | $26,000 | $19,000 | $318,000 |
| C | • Clean Soil Cover | $551,000 | $19,000 | $843,000 |
| D | • Extension of Existing Cap | $1,733,000 | $19,000 | $1,833,000 |
| E | Scenario 1:<br>• Partial Excavation Hot Spots only to 2 feet<br>• Incineration | $2,672,000 | $315,000 | $4,096,000 |
| E | Scenario 2:<br>• Partial Excavation, to 2 feet<br>• Incineration | $2,672,000 | $11,594,000 | $47,371,000 |
| F | Scenario 1:<br>• Full Excavation to 20 feet<br>• Incineration | $33,700,000 | $43,600,000 | $239,000,000 |
| F | Scenario 2:<br>• Full Excavation to 45 feet<br>• Incineration | $33,700,000 | $65,900,000 | $436,000,000 |

NOTE: All times and costs are estimates and are subject to change.

* -- Present Worth calculated over 30 years at an annual discount rate of 5%.

of total present worth from least expensive to most expensive alternative is: Alternative B, Alternative C, Alternative D, Alternative E, and Alternative F. Alternative D is more costly than Alternative C because it uses specialized materials to create the impermeable cap extension. Alternative F is more costly than Alternative E because of the greater depth and volume of excavation for Alternative F. The greater degree of treatment causes higher total capital, annual, and present worth costs as seen in a comparison of the scenarios in Alternative E and Alternative F.

## 8.9 SUMMARY OF DETAILED EVALUATION

The following is a brief summary of the evaluated alternatives:

- Alternatives A, B, C, and E are not protective of human health and the environment and therefore are eliminated from consideration.
- Alternative D provides for protection of human health and the environment by eliminating the infiltration of rainwater through the contaminated soil and preventing additional adverse impacts on groundwater quality. Surface exposure pathways are also eliminated.
- Alternative F permanently removes all contaminants from surface soil and subsurface soil within OU2 through excavation and incineration. This alternative would protect groundwater quality and eliminate all potential future exposures to contaminants associated with OU2.
- For the same level of risk reduction, comparison of Alternative D and Alternative F reveals that Alternative D poses fewer short-term risks, is more implementable, and is more than 200 times less costly.

Based on the comparative analysis of alternatives, the selected remedy is Alternative D, Extension of the Existing Cap.

## 9.0 SELECTED REMEDY

Based upon consideration of CERCLA requirements, the detailed analysis of the alternatives, and public comments, the Army, with the concurrence of EPA and TDEC, has determined that extension of the existing cap is the most appropriate remedy for OU2 at the O-Line Ponds Area of Milan Army Ammunition Plant, Tennessee. This section presents details of the selected remedy with the understanding that some changes may be made during the subsequent remedial design and construction processes.

## 9.1 ALTERNATIVE D: EXTENSION OF ENGINEERED CAP

### 9.1.1 Description

The primary objective of extending the impermeable cap at the O-Line Ponds is to prevent stormwater infiltration through the contaminated soil around the perimeter of the existing cap, thereby eliminating continued contaminant loading to groundwater. Human and animal contact with the surface soil surrounding the existing cap would also be eliminated. A simple soil cap may prevent direct contact exposures and surface runoff of contaminants, but will not adequately prevent infiltration and leaching of contaminants. Therefore, a multi-media cap system such as that prescribed in RCRA guidance and which functions similarly to the existing cap will be constructed. Although the current cap effectively isolates the contaminated sediments and the soils with the highest levels of explosives contamination, it does not cover areas of contaminated soil beyond the boundary of the former ponds, which were contaminated from pond overflows, from mis-handling of explosives-contaminated dredge spoils, and from earthwork during cap construction.

Prior to construction, the site will be prepared for installation of the cap extension by establishing site security, clearing of vegetation from the site, and the establishment of equipment and material staging areas.

Based on the results of analysis of soil samples collected in July, 1993, the cap extension will cover a total area of 237,000 $ft^2$. The boundary of this area is based on the data that are currently available and therefore is subject to change during the remedial design process. As stated in Section 7.6, the cap extension would cover the following areas: from the northern limit of the cap to the Ditch B tributary; from the existing cap eastward to the Ditch B tributary; from the existing cap southern limit to a distance of 50 feet south of the existing cap; and from the existing cap westward to the security fence. This cap extension will cover the contaminated soil around the perimeter of the cap such that the resulting risk in groundwater is within EPA's acceptable risk range.

RCRA guidance for landfill covers specifies that the minimum layering for a cap consists of a vegetated top cover, a middle drainage layer, and a low permeability bottom layer. The cap extension proposed under this alternative will include these required layers. During construction of the cap, air monitoring for particulate releases will be conducted to ensure compliance with dust-emission ARARs. Sediment and erosion control measures will also be implemented and maintained until the vegetative cover is fully established. Following completion of the cap extension construction, the security fence will be extended around the entire capped area.

After completion, regular maintenance will be conducted to maintain the integrity of both the existing cap and the cap extension. The vegetative layer will be maintained and mowed to provide continual erosion control. The cap must be inspected occasionally for differential settling, which may cause breaching of the impermeable layers. Contingency plans for responding to subsidence problems will be devised as part of a long-term maintenance plan for the cap. Groundwater monitoring will be conducted in association with OU1 groundwater remediation, and will meet the requirements of RCRA Subpart F.

## 9.2 INSTITUTIONAL CONTROLS

Institutional controls will include continued access restrictions, deed restrictions, and land use restrictions. Long-term maintenance of the fence and multi-media cap currently in place at the O-Line Ponds area will occur. Deed and land use restrictions will limit the future uses at the site and require permits, qualified supervision, and health and safety precautions for any activities conducted in the vicinity of the site. To make these restrictions more permanent, a Memorandum of Agreement could be negotiated between the facility, EPA Region IV, and the State of Tennessee.

The Army will ensure protection of on-site future users of groundwater. The cap extension will be supplemented with institutional controls to prevent direct contact with contaminated soil and ingestion of groundwater that is potentially contaminated by OU2. These institutional controls will consist of the following specific measures for cases where the Army maintains ownership and where the property may be excessed, respectively:

- The groundwater affected by OU2 will not be used for potable purposes while the levels of contaminants are higher than health-based levels; this will be ensured by Milan Army Ammunition Plant Environmental Office review of all projects and leases involving well installation and usage at the facility. Any well installed within the facility will be tested prior to use.

- In accordance with Army Regulation 200-1, entitled *Environmental Protection and Enhancement*, the Army is required to perform preliminary assessment screening for any parcel being excessed. This screening will evaluate potential use of the property, identify any remedial activities required, and/or place restrictions on the property to protect the future landowners through a document entitled *Statement of Condition*. The Army will implement the recommendations in the *Statement of Condition* prior to property transfer.

In either case, a continuing program of public awareness will be used to inform the public of the hazards associated with contaminants that remain within or that may migrate from OU2.

Five-year reviews are required by the NCP at all sites where hazardous chemicals remain untreated. The review will analyze available data to make a determination as to whether additional remedial actions are required at the site. Groundwater monitoring data collected in conjunction with OU1 at the site will be used to determine if OU2 continues to release contaminants from the unsaturated zone into the groundwater.

## 9.3 REMEDIATION GOALS

The purpose of this response action is to reduce the area of uncovered contaminated soil such that the potential human health risk associated with the migration of contaminants from the uncovered soil to the water table and use of the shallow groundwater as drinking water is within EPA's acceptable risk range. Existing conditions at the site have been estimated to pose an excess lifetime cancer risk of $2\times10^{-3}$ from the potential ingestion of contaminated groundwater. Because no Federal or State ARARs exist for soil, the size of the cap extension was determined through a site-specific analysis. Fate and transport calculations were performed to evaluate the risk reduction capability of the response action.

The basis for these remediation goals is a calculation of potential risk using EPA's cancer slope factors for 2,4,6-TNT and RDX (the principal contaminants at the site).

The results of the risk assessment discussed in Section 3.0 indicate that the level of risk posed to human health and the environment by the residual contamination in surface soil, surface water, and shallow sediment within OU2 are at acceptable levels. Therefore, remedial action objectives for cleanup of surface water and shallow sediment are not considered.

## 9.4 COST OF SELECTED REMEDY

The total capital costs for installation of the cap is estimated at $1,733,000. The total annual costs are estimated at $19,000. Total present worth of capital and annual costs are estimated at $1,833,000. The cost estimates are preliminary and are subject to change. The estimates were developed based on generic unit costs and vendor information. These costs are outlined in Table 9-1. A major assumption for this estimate is that earthen materials, such as sand and gravel, will be borrowed from clean areas of MAAP.

Implementation of this option would take approximately 12 to 18 months for the design phase, and 6 to 9 months for the construction phase. These time estimates include regulatory review of the design.

Assumptions were made for several factors that affect the time and cost estimates for this alternative, including:

- Materials and construction methods selected. The cost estimate and schedule were based on a multi-media cap extension employing both natural and synthetic layers for minimum thickness.

- Overlap with other construction projects. It was assumed that the construction of the groundwater treatment plant will not interfere with construction of the cap extension.

- Health and safety considerations. For the cost estimation, health and safety measures were assumed to be 10% of the capital subtotal. Based on actual conditions at the site and actual investigation and construction methods, health and safety measures may result in lower or higher costs.

**TABLE 9-1**
**SUMMARY OF COSTS FOR THE SELECTED REMEDY**
**ALTERNATIVE D: EXTENSION OF ENGINEERED CAP**

| ITEM | COST |
|---|---|
| **Capital Costs** | |
| Administrative Actions | $ 20,000 |
| Site Preparation and General Actions | $ 180,000 |
| Installation of Cap Extension | $ 766,000 |
| Air Monitoring During Construction | $ 10,000 |
| Subtotal | $ 976,000 |
| Contingencies (40% of Capital Subtotal) | $ 390,000 |
| Engineering & Design (25% of Capital Subtotal plus Contingencies) | $ 342,000 |
| Permitting and Coordination | $ 25,000 |
| Total Capital Costs | $1,733,000 |
| **Annual Operation and Maintenance Cost** | |
| Quarterly Mowing and Lawn Maintenance, Five Year Reviews, and Program Oversight | $ 15,000 |
| O&M Contingency (25% of Annual O&M) | $ 4,000 |
| Present Worth of Annual O&M (30 years, 5% discount rate) | $ 100,000 |
| Total Present Worth (Capital and Annual Costs @ 30 years, 5% discount rate) | $1,833,000 |

## 10.0 STATUTORY DETERMINATIONS

The selected remedial action for this site must comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery techniques to the maximum extent practicable. Finally, the statutory preference for remedies that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes through treatment as their principal element should be satisfied. The following sections discuss how the selected remedy meets these statutory requirements.

## 10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The risk assessment identified potential risks to human health and the environment from the continued leaching of contaminants from the soil around the perimeter of the cap, migration of these contaminants to groundwater, and ingestion of the contaminated groundwater as drinking water. The risk assessment also identified potential risks from discontinued maintenance of the existing cap, which would result in cap failure. The selected remedy addresses these risks and protects human health and the environment through maintenance of the existing cap and capping the explosives-contaminated soil around the perimeter of the existing cap. The cap extension will be consistent with the existing cap and will meet RCRA landfill closure requirements to prevent the leaching of contaminants from soil, thereby reducing risks posed to groundwater. There are no short-term risks associated with the selected remedy that cannot be readily controlled. In addition, no cross-media impacts are expected from the remedy.

## 10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The selected remedy of extension of the existing cap will comply with all applicable or relevant and appropriate chemical-, action- and location-specific requirements (ARARs). The ARARs are presented below.

### 10.2.1 Action-Specific ARARs

RCRA requirements for closure of surface impoundments (40 CFR 264.228) and closure of landfills (40 CFR 264.310) (relevant and appropriate).

RCRA requirements for groundwater monitoring (40 CFR 264.91) (relevant and appropriate).

Tennessee Hazardous Waste Management Act (Title 68, Chapter 46), which govern the transport, storage, treatment, and disposal of hazardous waste (relevant and appropriate).

Tennessee Solid Waste Processing and Disposal Regulations (Rule 1200-1-7), which lay out the closure and post-closure requirements of landfills and other disposal facilities (applicable).

Tennessee Air Quality Control Regulations for Fugitive Dust (Rule 1200-3-8.01), Visible Emissions (Rule 1200-3-5.01), Particulate Emissions (Rule 1200-3-7.03(2)), and Non-Process Emissions Standards (Rule 1200-3-6.02(3)) (applicable).

Tennessee Water Pollution Control Regulations - General Stormwater Permit for Construction Activities (Rule 1200-4-10.05) (applicable).

### 10.2.2 Chemical-Specific ARARs

None.

### 10.2.3 Location-Specific ARARs

None.

### 10.2.4 Other Criteria, Advisories or Guidance To Be Considered for the Remedial Action (TBCs)

None.

## 10.3 COST-EFFECTIVENESS

The selected remedy is cost-effective because it has been determined to provide overall effectiveness proportional to its costs, the net present worth value being $1,833,000. The estimated costs of the selected remedy are far less than the cost of the alternative that uses treatment of the soil as a principal element. Implementation of the selected remedy will result in risk reduction identical to the more expensive remedy, yet its costs are less than 0.5% of the alternatives involving incineration.

## 10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

The Army, EPA, and the State of Tennessee have determined that treatment is impracticable and that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for Operable Unit Two. Of those alternatives that are protective of human health and the environment and comply with ARARs, the Army, EPA, and the State of Tennessee have determined that this selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost, while considering the statutory preference for treatment as a principal element and State and community acceptance.

While the selected remedy does not offer as high a degree of long-term effectiveness and permanence as the incineration alternative, it will significantly reduce the risks posed by the contaminated soils around the perimeter of the existing cap by preventing direct contact with these soils and minimizing contaminant transport to groundwater. The selected remedy offers fewer short-term risks to the community and site workers, and a shorter timeframe for project implementation. The implementability of the selected remedy is significantly better than the incineration options. The selected remedy is also less expensive than incineration.

The major tradeoffs that provide the basis for this selection are short-term effectiveness, implementability, and cost. The selected remedy can be implemented more quickly, with less difficulty, and at less cost than the incineration alternative and is determined to be the most appropriate solution for the contaminated soils at Operable Unit Two.

## 10.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The statutory preference for remedies that employ treatment as a principal element is not satisfied.

## 11.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for Operable Unit Two, Milan Army Ammunition Plant, was released for public comment in July 1993. The Proposed Plan identified Alternative D, Extension of the Existing Cap, as the preferred alternative. The Army, EPA, and the State of Tennessee reviewed and considered all comments received during the Public Meeting (written comments were not received during the public comment period). Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, were necessary.

## 12.0 REFERENCES


TDHE, Tennessee Department of Health and Environment. 1991. Rules of the Tennessee Department of Health and Environment, Bureau of Environment, Division of Water Pollution Control. Chapter 1200-4-3. January 1991.

USAEC, U.S. Army Environmental Center, 1993a. Milan Army Ammunition Plant O-Line Ponds Area Feasibility Study. Focused Feasibility Study for Operable Unit Two. Final Document. Contract Number DAAA15-91-D-0014.

USAEC, U.S. Army Environmental Center, 1993b. Milan Army Ammunition Plant O-Line Ponds Area. Proposed Plan for Operable Unit Two. Final Document. Contract Number DAAA15-91-D-0014

USAEHA, U.S. Army Environmental Hygiene Agency, U.S. Department of the Army. 1978. Potable/Recreational Water Quality Survey No. 31-24-0163-79, Milan Army Ammunition Plant. March 28, 1978.

USATHAMA, U.S. Army Toxic and Hazardous Materials Agency. 1978. Installation Assessment of Milan Army Ammunition Plant. Report No. 122. June 1978.

USATHAMA, U.S. Army Toxic and Hazardous Materials Agency. 1982a. Milan Army Ammunition Plant Contamination Survey. Report DRXTH-FS-FP-82131. Pugh, D.L.: Envirodyne Engineers. January 1982.

USATHAMA, U.S. Army Toxic and Hazardous Materials Agency. 1982b. Milan Army Ammunition Plant O-Line Settling Ponds Closure Plan. Wirth, P.K. September 1982.

USATHAMA, U.S. Army Toxic and Hazardous Materials Agency. 1984. Incineration Test of Explosives Contaminated Soils at Savanna Army Depot Activity, Savanna, Illinois. U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, MD. Report Number DRXTH-TE-CR-84277. April 1984.

USATHAMA, U.S. Army Toxic and Hazardous Materials Agency. 1991. Milan Army Ammunition Plant Remedial Investigation Report. Final. Okusu, N., et al.: ICF Kaiser Engineers, Inc., Fairfax, VA. December, 1991.

USATHAMA, U.S. Army Toxic and Hazardous Materials Agency. 1992. Milan Army Ammunition Plant O-Line Ponds Area Feasibility Study. Focused Feasibility Study for Operable Unit One Groundwater Alternatives. Final Document. Contract Number DAAA15-91-D-0014.

USDA, U.S. Department of Agriculture. 1982. Foods Commonly Eaten by Individuals: Amount Per Day and Per Eating Occasion. Poa, E.M., Fleming, K.H., Guenther, P.M. and Mickle, S.J. Home Economics Research Report Number 44.

USEPA, U.S. Environmental Protection Agency. 1985. Developmental Statistical Distribution or Ranges of Standard Factors Used in Exposure Assessments. Office of Health and Environmental Assessment, Washington, D.C. March 1985. Final Report. OHEA-E-161.

USEPA, U.S. Environmental Protection Agency. 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Interim Final. OSWER Directive 9285.7-01a.

September 29, 1989.

USEPA, U.S. Environmental Protection Agency. 1989b. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington D.C. July.

USEPA, U.S. Environmental Protection Agency. 1990. National Oil and Hazardous Substances Contingency Plan. Final Rule. Federal Register. 55:8666-8865.

USEPA, U.S. Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual Supplemental Guidance. Standard Default Exposure Factors. Interim Final. Washington, D.C. OSWER Directive 9285.6-03. March 25, 1991.

USEPA, U.S. Environmental Protection Agency. 1992. Dermal Exposure Assessment: Principles and Applications, USEPA Interim Report, Exposure Assessment Group, Office of Health and Environmental Assessment. EPA/600/8-91/011B. January.

USEPA IV, U.S. Environmental Protection Agency (Region IV). (USEPA IV). 1992. Letter from Mr. Elmer Akin, Office of Health Assessment, Region IV EPA, to Mr. Yazdi, ARCS Contract Manager, Bechtel Environmental, Inc. March 13.

# APPENDIX A
## Responsiveness Summary

## RESPONSIVENESS SUMMARY

The Focused Feasibility Study and the Proposed Plan were made available to the public in the administrative record file located at the Mildred G. Fields Library in Milan, Tennessee, and at the Army Chief Engineer's Office at the Milan Army Ammunition Plant. In addition, a public meeting was held at the Milan Senior Citizens' Center on July 13, 1993. At this meeting, representatives of the U.S. Army and its contractor, the U.S. Environmental Protection Agency, and the State of Tennessee discussed with the public the preferred remedy as well as all remedial alternatives under consideration. The public was invited to comment between July 1 and August 15, 1993, on all alternatives.

This Responsiveness Summary addresses comments received during the public meeting. The comment is summarized and a response is provided. Written comments were not received during the public comment period.

Public Comment 1.

Of the alternatives under consideration, only one (Alternative F) represents true cleanup of the site, such that the area may be used for any purpose. The selection of any other alternative would require maintenance of the site and limited use of the land.

Response to Public Comment 1.

The selected alternative has been evaluated as being protective of human health and the environment, and in compliance with all environmental regulations. Although it would be preferred to be able to remediate the site so that the land may be used for any purpose and would not have to be managed as a contaminated site, the major reasons for selecting Alternative D are the following:

- Alternative D results in the same level of risk reduction as Alternative F, at less than 1/200th the cost;
- The short-term risks posed to the community and to site workers are significantly less for Alternative D than for Alternative F; and
- Alternative D could be implemented in a much shorter timeframe than Alternative F.

Public Comment 2.

Treatment of the soil would be the preferred alternative if the cost were not so great. Were treatment options considered that are less expensive that incineration?

Response to Public Comment 2.

A large number of treatment technologies were identified and considered during the Feasibility Study stage of this project, including a variety of innovative and emerging technologies. However, none of the other technologies is currently capable of achieving the low cleanup levels required at the site to reduce the potential human health risks to within EPA's acceptable risk range.

Public Comment 3.

Because there is a remedial alternative that can solve the problem of contaminated soil in the area, that alternative should be selected. The cost of the treatment alternative should not play such a large part in the selection of the preferred remedy.

Response to Public Comment 3.

The National Contingency Plan requires that cost be considered when selecting a remedial alternative. Cost is not considered to be a primary criterion, but is a balancing criterion that is considered when weighing the relative advantages and disadvantages of each alternative. Although the cost difference was one reason that Alternative D was selected over Alternative F, other factors were considered as well, namely that implementation of Alternative D would result in lower short-term risks and a shorter implementation time. Also, the large magnitude of the cost difference between Alternative D and Alternative F, for the same reduction in risk, was considered.

Public Comment 4.

Even if the incineration alternative were selected, would that completely solve the problem? Does use of this technology guarantee that the soil will be remediated to safe levels?

Response to Public Comment 4.

Incineration of explosives-contaminated soil has been demonstrated to achieve destruction and removal efficiencies of 99.99%. Use of this technology would result in complete remediation of the excavated soil, such that no human health risks would be posed by contaminants remaining in this soil.