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# EPA Superfund
# Record of Decision:

**LOUISIANA ARMY AMMUNITION PLANT**
**EPA ID: LA0213820533**
**OU 02**
**DOYLINE, LA**
**03/04/1997**

<IMG SRC 971180>

**Final Record of Decision (ROD) for**
**Louisiana Army Ammunition Plant**
**(LAAP) Soil/Source) Area**
**Operable Unit (0U)**

**Prepared for:**
**U.S. Army Environmental Center**
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Louisiana Army Ammunition Plant Soil/Source Operable Unit ROD

**DECLARATION**

Selected Remedial Alternative for the Soil/Source Operable Unit
Louisiana Army Ammunition Plant
Shreveport, Louisiana

**Site Name and Location**

This Record of Decision (ROD) has been prepared for the Louisiana Army Ammunition Plant (LAAP) Soil/Source Operable Unit (OU). Seven study areas are included as part of the Soil/Source OU: Area P, Burning Ground #5 (BG-5), Landfill #3 (LF-3), Oily Waste Landfarm (OWL), Burning Ground #8 Landfill (BG-8 Landfill), BG-8 Lagoon, and Manufacturing Area M-4 (M-4) Lagoon. The content of this ROD is based on recommendations in the U.S. Environmental Protection Agency (USEPA)'s Interim Final Guidance on Preparing Superfund Decision Documents (USEPA, 1989).

The Army, in consultation with the USEPA and the Louisiana Department of Environmental Quality (LDEQ), has split the shallow groundwater at the seven study areas into a separate operable unit. At seven study areas, there are now two operable units: the Soil/Source OU and the Groundwater OU. This ROD addresses only the Soil/Source OU at the seven study areas. Remedy selection for the shallow groundwater at LAAP will be addressed at a later date under a separate ROD. Groundwater will be discussed in this document only with respect to the potential effect of the constituents in the Soil/Source OU to the quality of the shallow groundwater.

**Statement and Basis of Purpose**

This ROD presents the selected remedial action for the LAAP Soil/Source OU, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1996 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This ROD explains the factual and legal basis for selecting the response actions for the Soil/Source OU. The information supporting this remedial action decision is contained in the Administrative Record for the Soil/Source OU.

**Description of the Selected Remedy**

The selected remedy for the Soil/Source OU is No Further Action for each of the seven study areas. An Interim Remedial Action (IRA) was conducted at one of the study areas, Area P, from 1987 through 1990, with approval from the USEPA and LDEQ. This action took place during the performance of the Supplemental Remedial Investigation conducted in 1990 and 1991. The

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List of Acronyms and Abbreviations

| | |
|---|---|
| BDL | below detection limit |
| BRA | Baseline Risk Assessment |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COCs | constituents of concern |
| CSF | carcinogenic slope factor |
| DA | Department of the Army |
| EQ | ecotoxicity quotient |
| FS | Feasibility Study |
| HI | hazard index |
| HMX | High Melting Explosive, cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine |
| HQ | hazard quotient |
| IEUBK | Integrated Exposure Uptake Biokinetic |
| IOC | Industrial Operations Command |
| IRA | Interim Remedial Action |
| LAAP | Louisiana Army Ammunition Plant |
| LDEQ | Louisiana Department of Environmental Quality |
| LOAEL | lowest observed adverse effect level |
| MF | modifying factor |
| NCP | National Contingency Plan |
| NOAEL | no observed adverse effect level |
| OU | Operable Unit |
| OWL | Oily Waste Landfarm |
| PCE | tetrachloroethene |
| RAGS | Risk Assessment Guidance for Superfund |
| RDX | Research and Development Explosive, cyclonite hexahydro-1,3,5-trinitro-1,3,5-triazine |
| RfDs | reference doses |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| SARA | Superfund Amendments and Reauthorization Act |
| Tetryl | N-Methyl-N,2,4,6-tetranitroaniline |
| TRCLE | trichloroethylene |
| UF | uncertainty factor |
| USAEC | U.S. Army Environmental Center |
| USEPA | U.S. Environmental Protection Agency |
| VOCs | volatile organic compounds |

## 1.0 Site Name, Location, and Description

Louisiana Army Ammunition Plant (LAAP) is located approximately 22 miles east of Shreveport, Louisiana, adjacent to the community of Doyline, on State Highway 164. LAAP lies within Bossier and Webster Parishes and consists of 14,974 acres of land measuring 9 miles east to west and 3 miles north to south. The site is bounded on the north by Interstate 20 and U.S. Highway 80. Seventy-four acres are administrative and residential land; 2,970 acres are devoted to production lines and mission support facilities, and 11,930 acres are woodlands. Nearly all undeveloped areas at LAAP are covered by pines and hardwoods. The area surrounding LAAP is primarily rural with scattered small towns.

Seven study areas are included as part of the Soil/Source Operable Unit 1 (OU): Area P, Burning Ground #5 (BG-5), Landfill #3 (LF-3), Oily Waste Landfarm (OWL), Burning Ground #8 Landfill (BG-8 Landfill), BG-8 Lagoon, and Manufacturing Area M-4 (M-4) Lagoon. The BG-8 Landfill and BG-8 Lagoon were combined into one study area (BG-8 Landfill/Lagoon) since they are contiguous, lie on the same hydrogeologic unit, and are similar in types of chemicals present. The seven study areas of concern are shown on Figure 1-1.

LAAP was added to the National Priorities List (NPL) list in March 1989 due to the potential risk to human health and the environment posed by Area P. However, the site listing on the NPL encompasses the entire installation.

### 1.1 LAAP Surface Water

LAAP is located in the Red River Basin. Surface water within LAAP leaves via two bayous and two creeks (see Figure 1-1). These waterways are Clark Bayou, which forms the western boundary of LAAP; Bayou Dorcheat, which forms the eastern boundary of LAAP; Caney Creek, located 1 to 2 miles east of Clark Bayou; and Boone Creek, which drains the central portion of LAAP. An unnamed ditch originates on LAAP and flows south, then west to join Caney Creek near the southern LAAP boundary. All of these waterways discharge into Lake Bistineau, located southeast of LAAP.

Four of the Remedial Investigation (RI) study areas drain into Boone Creek. These are BG-5, OWL, LF-3, and BG-8 Landfill Lagoon. The two remaining study areas, Area P and M-4 Lagoon, drain into Caney Creek, which then discharges into Clarke Bayou. The M-4 Lagoon drains directly to Caney Creek and Area P drains into Caney Creek via the unnamed ditch.

1 Bold indicates words that are defined in the Glossary of Terms located after Section 8.0 of the ROD

### 1.2 Hydrogeological Summary

Two aquifers are present below the LAAP installation: the Terrace/Sparta Sand aquifer and the Wilcox-Carrizo Sand aquifer. The closest aquifer to the ground surface at the LAAP installation is the Terrace/Sparta Sand aquifer, which covers the entire LAAP installation area. This aquifer is made up of two hydrogeologic units, the Terrace and the Sparta Sand formations. Because groundwater can flow between the Terrace and Sparta Sand formations in many places, they are referred to together as the Terrace/Sparta Sand aquifer. The combined Terrace/Sparta Sand aquifer makes up the shallow groundwater at LAAP. The shallow groundwater discharges to surface water on LAAP, specifically into Boone and Caney Creeks.

The Terrace portion of the aquifer ranges in thickness from zero (ground surface) to an average of 50 feet below ground surface at LAAP. The groundwater in the Terrace portion is typically found within 25 feet of the ground surface. The direction of groundwater flow in the Terrace portion is controlled primarily by topography and surface water drainage. LAAP has no water wells drawing from this aquifer. Although some private home wells in nearby Doyline use the Terrace portion of the aquifer, the soil/sources at the seven study areas have not affected these wells. In addition, one of the Village supply wells (located north of LAAP) draws water from this portion of the aquifer. The soil/sources at the seven study areas have also not affected this well. There are no known private wells in the Village.

The Sparta Sand portion of the aquifer is found below the Terrace portion only under the eastern one-half to two-thirds of the LAAP installation. The Sparta Sand portion is found at a depth of 40 to 50 feet below ground surface and ranges in thickness from 100 feet (eastern end of LAAP) to 0 feet (western end). The direction of groundwater flow in the Sparta Sand portion generally appears to follow the northeasterly dip of the formation. The Sparta Sand portion is the principal source of drinking water for the town of Minden, northeast of the plant's eastern boundary. However, Bayou Dorcheat, which is located between Minden and the plant boundary, serves as a recharge zone to the Terrace/Sparta Sand aquifer and, therefore, should be a hydraulic barrier between the installation and Minden (Water Supply Evaluation, Gravel Quarry Intake, Louisiana Army Ammunition Plant, U.S. Army Corps of Engineers, Fort Worth District, July 1996).

The Cane River formation lies below the Terrace/Sparta Sand aquifer and is considered to be a confining unit. A confining unit is a geologic unit made up of soils and clays that are so tight that water travels through it very slowly. Because there is so little water in the Cane River Formation, it is not an aquifer and cannot be used as a water source. The Cane River Formation consists of silty clay which turns to shale as depth increases. This type of silty clay and shale restricts water movement to 10 -7 to 10 -10 centimeters per second. Therefore, the Cane River formation is an effective barrier to groundwater flow between the Terrace/Sparta Sand aquifer and the Wilcox-Carrizo Sand aquifer, which lies directly below it. The Cane River Formation is present below each of the seven LAAP study areas and at the LAAP water supply wells, but diminishes west of Caney Creek. This formation is encountered at a depth of 30 to 70 feet below ground surface in the vicinity of the LAAP study areas and ranges from less than 50 to 200 feet in thickness. The LAAP water supply wells and the remaining Village supply wells draw from the Wilcox-Carrizo Sand aquifer. These wells have not been affected by the soil/source areas on LAAP.

Detailed information concerning the hydrogeology of LAAP is contained in the RI Report.

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**2.0 Site History and Enforcement Actions**

In 1941, the United States government acquired 15,868 acres of land for the LAAP installation. Major construction work was initiated by Silas Mason Company in July 1941. By May 1942, construction was completed for eight ammunition lines and one ammonium nitrate graining plant. Production ceased in August 1945 at the conclusion of World War II. In November 1945, the federal government relieved Silas Mason Company of responsibility for plant operations and placed the installation on standby status.

Remington Rand, Inc., under contract with the government, reactivated the installation in February 1951 in support of the Korean Conflict. Ammunition production was suspended in February 1958, and the installation was again placed on standby. The Vietnam Conflict brought about the reactivation of the installation by Sperry Rand, Inc. in 1961. Thiokol Corporation has operated the installation from December 1974 to the present.

Since 1941, seven land tracts of various sizes have been sold, decreasing the size of the installation by 894 acres to its current size of 14,974 acres. In 1963, approximately 158 acres were sold to Louisiana Polytechnic Institute and approximately 591 acres were sold to the Bossier Parish School Board. Both parcels of land were sold with deed restrictions for educational use only. Other land parcels sold from the installation include property on its northwest corner currently being used as a rifle range; a portion along the eastern boundary sold to a sand and gravel company; a 138-acre parcel that is used for hunting; and two small tracts of land that are used for retail businesses.

Currently, LAAP is a government-owned, contractor-operated industrial installation under contractual agreement with Thiokol Corporation to manufacture ammunition metal parts and load-assemble-pack ammunition items. The primary functions of LAAP as an Industrial Operations Command (IOC) installation are as follows:

- Loading, assembling, and packing of ammunition items;
- Manufacture of ammunition metal parts;
- Operation and maintenance of active facilities in support of current production operations; and
- Maintenance and/or layaway of standby facilities (including any machinery and package lines and production equipment packages received from industry or other government installations.

The current working population of LAAP is less than 100, which includes military personnel, contractor personnel, and civil service workers. Historically, the number of workers at the installation has exceeded 7,000 during high production periods.

A series of investigations and studies have taken place at LAAP to evaluate the potential for and extent of contamination from waste management activities at the installation. The investigations addressed in this ROD began with an initial records search in 1978 and ended with the comprehensive RI performed in 1991. In 1987, with approval from USEPA and LDEQ, the Army initiated an IRA at Area P.

In addition to the investigations conducted for the seven soil/source areas, there are currently several other areas at LAAP that are also being investigated. These areas include ten manufacturing areas, three test areas, and the Groundwater Operable Unit. These areas are not discussed in this ROD.

As part of the studies conducted at LAAP, two risk assessments, a Baseline Risk Assessment (BRA) and an expanded risk assessment, were conducted to evaluate the potential effects of the study areas on human health and the environment. The expanded risk assessment was performed as part of the Feasibility Study (FS) and was conducted using the same process as the BRA. However, it presented additional exposure scenarios. The results of these risk assessments are presented in detail in Section 6.0.

The final FS for LAAP was completed in September 1993, prior to the site being divided into separate Soil/Source and Groundwater OUs. The BRA determined that the soil/sources at the seven study areas did not pose an unacceptable risk to human health and the environment. Therefore, the FS only considered the No Further Action alternative for the soil/source portion of the site. The FS also presented remediation goals and remediation alternatives for groundwater.

In February 1995, the Department of the Army (DA), USEPA, and LDEQ agreed to divide LAAP into two separate OUs, the Soil/Source OU and the Groundwater OU. The Final Proposed Remedial Action Plan (Proposed Plan), completed December 15, 1995, and this ROD present the decision summary for the Soil/Source OU.

## 3.0 Highlights of Community Participation

The RI and BRA for the Soil/Source OU became final in February 1992. The FS became final in September 1993. These documents are available to the public as part of the Administrative Record and in the information repositories maintained at the LAAP installation. The Administrative Record File is also available for review at USEPA and LDEQ offices,

The Proposed Plan was released to the public in January 1996. This document is also available in the Administrative Record located in the information repositories listed above. The notice of availability of these documents was published on January 9, 1996. A public comment period was held from January 8, 1996 to February 6, 1996.

In addition, a public availability session and meeting was held on January 25, 1996. At this meeting, representatives from the U.S. Army Environmental Center (USAEC), U.S. Environmental Protection Agency (USEPA), and LDEQ addressed questions and received comments about the remedial alternatives under consideration. A response to the comments received during the public comment period is included in the Responsiveness Summary, which is Appendix A of this ROD.

This ROD presents the selected remedial action for the Soil/Source OU. The selected remedy presented in this ROD was chosen in accordance with CERCLA, as amended by SARA, and the NCP. The decision for the Soil/Source OU is based on the Administrative Record.

## 4.0 Scope and Role of Response Action

This ROD addresses the final remedy for the Soil/Source OU consisting of soil/source areas at seven study areas: Area P, BG-5, LF-3, OWL, BG-8 Landfill/Lagoon, and M-4 Lagoon.

The objectives of remedial actions for the Soil/Source OU include the protection of the groundwater and prevention of direct contact with Area P soils. The IRA at Area P addressed these objectives by removing chemical constituents from the soils, lagoon water, and wastewater. The studies undertaken at LAAP have shown that no potential human health or environmental risks are associated with the soils/sources at the other six study areas; therefore, there are no remedial action objectives associated with the other study areas.

In keeping with the overall response strategy, the recommended remedial action for the Soil/Source OU at LAAP is No Further Action. This consists of taking no further action regarding the study area soil/source areas beyond the completed IRA.

## 5.0 Summary of Site Characteristics

### 5.1 Area P

The chemical source areas within Area P (see Figure 1-1) consist of the former pink water lagoons. These 16 lagoons were active from the early 1940s until March 1981. Area P was also used as a waste burning ground for a number of years. Numerous investigations have been performed in Area P. These investigations were designed to determine if specific chemicals remained in the soil and/or groundwater after the past burning and pink water operations that were conducted in Area P.

The soils investigations at Area P included the following:

- In 1978, eighty-six soil, sediment/sludge and surface soil samples were collected. These samples were analyzed for Research and Development Explosive, cyclonite hexahydro-1,3,5- trinitro-1,3,5-triazine (RDX) and High Melting Explosive, cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX).
- In 1986, three additional samples were collected from one soil boring-one from the ground surface; one between 10 and 20 feet; and one from the top few feet of the Cane River Formation.

As approved by USEPA and LDEQ, an IRA was conducted from 1987 through 1990. This action took place during the performance of the Supplemental RI field investigation conducted in 1990 and 1991. The purpose of the IRA was to protect the shallow groundwater at Area P by removing soil containing more than 100 milligrams per kilogram (mg/kg) of HMX and RDX. The IRA activities began with the collection of 24 soil and sediment samples from 19 locations. The next step of the IRA consisted of excavation and treatment of lagoon sediment and soil by incineration, and treatment of lagoon water and wastewater generated during the IRA activities prior to discharge.

Three hundred forty-five (345) soil samples were collected from the excavated areas at Area P to confirm that the soil with HMX and RDX concentrations above 100 mg/kg had been removed. The soil that remained was analyzed and found to contain concentrations of HMX and RDX ranging from non-detectable levels to 91 mg/kg. Of the 345 samples collected, 267 had non-detectable levels of explosive chemicals.

After the excavated soil was incinerated, the treated soil was returned to the excavated lagoons to fill in the excavation. The filled lagoons were then covered with a cap. The cap was constructed with clay 2 feet thick followed by 4 inches of topsoil planted with bermuda grass. A four-strand barbed wire fence. 4 feet in height, was installed around the cap and the area was posted with signs reading "Area P Decontamination Area."

## 5.2 BG-8 Landfill/Lagoon

The BG-8 Landfill (see Figure 1-1) is a 60-acre area that was used as a burning ground for primarily non-explosive material from the 1950s until some time in the 1970s, and for disposal of sanitary wastes (i.e., domestic sewage) and industrial wastes (waste residue from industrial processes such as used oils, wastewater treatment sludges, etc.). Landfilling was conducted from 1970 through December 1987 when operation ceased. The landfill was closed in 1988 per closure requirements issued to LAAP by the LDEQ Solid Waste Division. According to the closure requirements, the BG-8 Landfill was covered with "a compacted clay cap to a depth of 24 inches." The closure requirements also specified that the cap should be capable of supporting vegetation. The site supports a well-established grass cover and no evidence of prior activities remain.

The BG-8 Lagoons did not have liners and were located east of the landfill. These lagoons were used for the disposal of pink water waste in the late 1960s and 1970s. The lagoons were filled with soil in 1977. The former BG-8 Lagoon area was most recently used to landfarm sludge from the onsite wastewater treatment plant until 1984. Details of the BG-8 Lagoons are unknown, and no records of the closure activities were kept. Chemicals such as RDX and HMX and volatile organic compounds (VOCs) (xylene, toluene, methylbenzene) were detected in both surface and subsurface soils at the BG-8 Landfill/Lagoon study areas.

Soil samples were collected from BG-8 Landfill/Lagoon during four investigations conducted between 1982 and 1990. A total of 104 soil samples were collected from 33 locations at depths of 0, 5, 10, and 15 feet. These samples were primarily collected from the former burning ground and lagoon areas. Soil samples were located in areas most likely to contain the highest concentrations of RDX, HMX, and VOCs. These areas were primarily the former burning ground and lagoon areas. Thus, those areas most likely to pose potential unacceptable risks and contribute site-related constituents to the groundwater were characterized.

Concentrations of RDX and HMX in BG-8 Landfill/Lagoon surface soil samples ranged from non-detect to 48.32 mg/kg with RDX (48.32 mg/kg) present at the highest concentrations. Lead was also present in soil samples at concentrations ranging from 12.21 mg/kg to 48.32 mg/kg. Concentrations of constituents dropped significantly with depth. The only explosive chemical detected at the 5-foot interval was HMX at 1.3 mg/kg. No explosive chemicals or metals were detected at either the 10-foot or 15-foot intervals.

## 5.3 BG-5

Open burning of explosives has been conducted at BG-5 (see Figure 1-1) since approximately 1947. By 1955, the burning ground consisted of at least six burning cages and several detonation areas encompassing approximately 4.5 acres. In 1966, this study area consisted of three raised earthen berms sloping toward a concrete basin on the western side of the site. Rain falling on the burn pads flowed to the basin. The rainwater that had collected in the concrete basin was treated in a wastewater treatment system on the installation, then discharged. This basin was taken out of service, dismantled, and removed in 1983. Because BG-5 is still active, there is only sparse vegetation at the study area. A portion of the study area slopes to a sand pit and some detonation depressions are visible.

Underground detonation of explosive wastes has been conducted since 1986. RDX; HMX; N-methyl-N,2,4,6-tetranitroaniline (tetryl); 2,4,6-trinitrotoluene; 1,3,5-trinitrobenzene; 2,4-dinitrotoluene; and 2,6-dinitrotoluene were detected in both the surface and subsurface soils at BG-5. Soil samples were collected from BG-5 during three investigations conducted between 1982 and 1989. A total of 57 soil samples were collected from 20 locations at a maximum depth of 14 feet. These samples were collected from the area of the former burning ground. Soil samples were located in areas most likely to contain the highest concentrations of RDX, HMX, and other explosive chemicals. These area were primarily the former and existing burning grounds. Thus, those areas most likely to pose potential unacceptable risks and contribute site-related constituents to the groundwater were characterized. Concentrations of explosive chemicals detected in BG-5 sod samples ranged from 0.6 to 100 mg/kg with RDX present at the highest concentrations.

## 5.4 LF-3

LF-3 consists of nine former pink water lagoons covering an area of approximately 7.5 acres that were used in the 1950s and 1960s (see Figure 1-1). The disposal of pink water at LF-3 was stopped in the late 1960s. The lagoons were then used as landfills for non-explosive material including building debris. The landfill operations were discontinued approximately in the 1970s. The LF-3 study area was then abandoned with no formal closure. Currently, large trees are present in the area of the former lagoons. Soil samples were collected from Landfill 3 during three investigations conducted between 1982 and 1989. A total of 44 soil samples were collected from 14 locations at a maximum depth of 40 feet at Study Area LF-3. Twelve of the sample locations were within the perimeter of the LF-3 Study Area, and two of the locations were outside of the study area to the north. Thus, those areas most likely to pose potential unacceptable risks and contribute site-related constituents to the groundwater were characterized. No explosive chemicals were detected in soil samples from LF-3.

## 5.5 OWL

The production of 155-mm ammunition metal parts at the Y-line production facility located adjacent to the OWL began in 1952 (see Figure 1-1). From early 1960 to late 1975, a series of three pits were used for the treatment of oily residues generated from the production process. These pits encompassed an area of approximately 4 acres. These residues were allowed to settle in the oil pits after settling agents had been added. The waters resulting from the settling process were allowed to flow over-land and enter Boone Creek. The settled residues (sludge) were collected and worked into the soil in the surrounding area. In 1975, the pits were filled in with clean dirt. The OWL is barely discernable from the surrounding area as there is no surface expression of the former pits and the area is becoming overgrown with shrubs and brush.

As a result of the use of the three pits and sludge disposal (landfarming) activities, the surface and subsurface soils were suspected to contain metals. Soil samples were collected at the OWL during two investigations conducted in 1989 and 1990. A total of 76 soil samples were collected from 21 locations at a maximum depth of 15 feet. Fourteen of these sample locations were situated within the former landfarm area of OWL, and 10 of these locations were situated directly east of the landfarm area. These were the areas most likely to contain the highest concentrations of VOCs and metals. These areas were primarily the former and existing burning grounds. Thus, those areas most likely to pose potential unacceptable risks and contribute site-related constituents to the groundwater were characterized. Concentrations of arsenic and lead in OWL soil samples ranged from 1.2 mg/kg to 18 mg/kg with lead being present at the highest concentrations. No VOCs were detected in OWL soil samples.

5.6 M4 Lagoon

The 0.2-acre M-4 Lagoon area (see Figure 1-1) was used from the 1960s until the early 1990s for the manufacture of ammunition metal parts, including the machining and metal plating of grenade components. The unlined lagoon was used from 1962 to 1964 to receive treated wastewater from the electroplating operation. This wastewater contained cyanide, cadmium, chromium, and zinc. As a result of past industrial activities, subsurface soils around the lagoon contain cyanide in concentrations ranging from non-detect to 1.91 mg/kg. However, cyanide was only detected in two of the eight borings sampled. The lagoon is still present and continually contains water.

Two surface water and five sediment samples were collected from the interior of the Lagoon In 1986. These samples were analyzed for the presence of metals. Metals were not detected in the surface water or the sediment in the M-4 Lagoon. Additional soil samples were subsequently collected at the M-4 Lagoon study area during an investigation conducted in 1989. During the 1989 investigation, a total of 24 soil samples were collected from eight soil borings at a maximum depth of 15 feet. These sample locations were situated primarily north and east of the M-4 Lagoon. Samples were collected from areas most likely to contain the highest concentrations of cyanide and metals in order to characterize those areas most likely to pose potential unacceptable risks and contribute site-related constituents to the groundwater. Samples collected from the sludge present in the M-4 Lagoon were analyzed for the following inorganic constituents: cyanide, arsenic, barium, cadmium, chromium, lead, and mercury. The only constituent detected in significant concentrations was cyanide (1.82 to 4.85 mg/kg detected). No metals or cyanide were detected in M-4 Lagoon soil samples.

**6.0 Summary of Site Risks**

In order to characterize the potential current and future threats to human health and the environment that may be posed by the COCs at the Soil/Source OU, two risk assessments were conducted in accordance with USEPA's Risk Assessment Guidance for Superfund (RAGS): Volumes I - Human Health Evaluation Manual (Part A) and Volume II - Environmental Evaluation Manual. These two risk assessments were the BRA and the expanded risk assessment. The expanded risk assessment was performed as part of the FS to address exposure scenarios not originally addressed in the

BRA conducted as part of the RI. The expanded risk assessment was conducted using the same process as the BRA.

Both the BRA and the expanded risk assessment evaluated each of the seven study areas to determine if they pose the potential for current or future health risks to humans or adverse effects on the environment. The BRA considered current worker exposure and future unrestricted land use (i.e., residential use) of the seven study areas in accordance with USEPA's RAGS. The expanded risk assessment, performed as part of the FS, was also conducted in accordance with RAGS. The expanded risk assessment considered future worker and future recreational exposure scenarios.

## 6.1 Identification of Constituents of Concern

Constituents of concern (COCs) were identified in order to streamline the risk assessment process by identifying chemicals that contribute most significantly to overall potential risk. COCs were evaluated separately for air, soil, groundwater, surface water, and sediment. Explosives, VOCs, and metals were identified as COCs based on methods presented in the RAGS and discussed in detail in the BRA for LAAP (ESE, 1992). These chemicals represent the most mobile, toxic, and frequently detected chemicals at LAAP. The COCs identified in the soil/source areas in the LAAP study areas are presented in Table 6-1.

## 6.2 Exposure Assessment

The BRA interpreted the RI data in order to (1) identify those exposure pathways that may pose a current or future potential risk to human health and the environment, and (2) determine the degree of this potential risk. An exposure pathway is the route that a chemical or physical agent takes from a source to an exposed population or individual (receptor). The BRA evaluated each human exposure pathway for completeness and determined that there were two significant exposure scenarios. The significant human exposure scenarios for the soil/source areas addressed in the BRA included:

- Current worker exposure to soil; and
- Future residential exposure to soil.

## Table 6-1. Chemicals of Concern in Soil by Study Area

| Site | Chemicals of Concern | |
|---|---|---|
| Area P | 1,3-Dinitrobenzene | RDX |
| | 2,4-Dinitrotoluene | Tetryl |
| | 2,6-Dinitrotoluene | 1,3,5-Trinitrobenzene |
| | HMX | 2,4,6-Trinitrotoluene |
| | Nitrobenzene | |
| BG-5 | 1,3-Dinitrobenzene* | RDX* |
| | 2,4-Dinitrotoluene | Tetryl |
| | 2,6-Dinitrotoluene | 1,3,5-Trinitrobenzene* |
| | HMX | 2,4,6-Trinitrotoluene* |
| BG-8 | 1,1-Dichloroethene | Nitrobenzene |
| | 1,3-Dinitrobenzene* | RDX |
| | 2,4-Dinitrotoluene | Tetryl |
| | 2,6-Dinitrotoluene | 1,3,5-Trinitrobenzene* |
| | HMX | 2,4,6-Trinitrotoluene* |
| | Lead | |
| LF-3 | 1,3-Dinitrobenzene | RDX |
| | 2,4-Dinitrotoluene | Tetryl |
| | 2,6-Dinitrotoluene | 1,3,5-Trinitrobenzene* |
| | HMX | |
| M-4 Lagoon | No COCs in soil | |
| OWL | No COCs in soil | |

* Indicates those constituents which contributed most significantly to the overall site risk associated with surface soils.

HMX = High Melting Explosive, cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
RDX = Research and Demolition Explosive, cyclonite hexahydro-1,3,5-trinitro-1,3,5-triazine.
tetryl = N-methyl-N,2,4,6-tetranitroaniline.

Source: ESE, 1996.

The primary human exposure pathways evaluated for two human exposure scenarios (current worker and future residential) considered in the BRA are as follows:

- Direct skin contact and unintentional eating of COCs in surface soil, and
- Inhaling of COCs in dust generated from surface soil.

Other exposure pathways, such as eating fish, game and plants, were evaluated and determined to be potentially complete at LAAP. However, as these pathways do not contribute significantly to the overall amount of chemicals that would be taken in at the individual study areas, eating of fish, game and plants were screened out during the exposure assessment and were not evaluated further in the BRA. The exposure formulas and exposure factors used to calculate chemical intakes in the BRA are presented in Table 6-2.

Currently, no activities occur at the BG-8 Landfill/Lagoon or OWL; therefore, current worker exposure to soil was quantitatively evaluated for Area P, BG-5, and LF-3 only. Future residential exposure to soil was quantitatively evaluated for Area P, BG-5, BG-8 Landfill/Lagoon, LF-3, and OWL. Exposure to soil at the M-4 Lagoon was not evaluated since surface soil is not a concern at this study area.

Since residential and agricultural use of LAAP is not likely, a separate, expanded risk assessment was performed as part of the FS Report. This expanded risk assessment was conducted using more likely exposure scenarios than the BRA. Since the installation will continue to be used for munitions production, access to LAAP will remain restricted for safety and national security reasons. Only workers and other authorized personnel can enter the installation through security checkpoints, because the installation is completely fenced. Therefore, current onsite worker exposure, future worker exposure, and future recreational exposure just outside the installation boundaries are the most likely human exposure scenarios that would occur at the installation. The exposure formulas and exposure factors used to calculate chemical intakes in the expanded risk assessment are presented in Table 6-3.

## 6.3 Toxicity Assessment

The purpose of the toxicity assessment is to identify acceptable levels of COCs in the environment. Available toxicity factors of carcinogenic and non-carcinogenic COCs are discussed and presented in the BRA Report. The COCs selected for the risk assessment for the site have a wide range of carcinogenic and non-carcinogenic effects associated with them. The reference dose (RfD) values and carcinogenic slope factors (CSF) were key dose-response variables used in the BRA. The RfD, expressed in units of milligrams per kilogram per day (mg/kg/day) for a specific chemical is an estimated daily intake rate that appears to pose no risk over a lifetime of exposure. The RfD value is used to assess non-carcinogenic effects. The RfDs for the COCs at the Soil/Source OU are shown in Table 6-4. The CSF, expressed in units of (mg/kg/day) -1 provides a conservative estimate of the probability of cancer development from a lifetime of exposure to a particular level of a potential carcinogen. The CSFs for potential carcinogens present at the Soil/Source OU are presented in Table 6-5.

**Table 6-2. Formulas and Factors Used in the Exposure Pathways Evaluated in the BRA (Page 1 of 5)**

INGESTION OF SOIL

For adult and child exposure:

$$I = \frac{CS * IR * CF * FI * BF * EF * ED}{BW * AT}$$

Where: I = intake; the amount of chemical at the exchange boundary (mg/kg-body weight/day)
CS = chemical concentration in soil [lesser of the maximum detected concentration and the 95 percent upper confident limit (UCL 95) of the mean concentration; mg/kg]
IR = soil ingestion rate (mg/day)
CF = conversion factor for soil (l0 -6 kg/mg)
FI = fraction of soil ingested from contaminated source (unitless)
= 1.0 (assumes 100% of ingested soil is from contaminated area)
BF = bioavailability factor; the amount of a chemical that is available for absorption through the gastrointestinal lining (unitless)
= 0.1 for lead (EPA, Health Effects Assessment for Lead, 1984)
= 1.0 default value for all chemicals except lead
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (period over which the exposure is averaged; days)

Current Worker:
IR = 30 mg/day [standard default for industrial exposure (EPA, 1991)]
EF = 200 days/year for BG-5 and M-4 [percentage of dry days per year (305/365) multiplied by the number of days per year working in the area (240) (Burroughs, 1991)}
= 5 days/year for LF-3 [the grass around the flow equilibration tank is cut approximately one time per month from April through August (Burroughs, 1991)]
ED = 25 years [default value for industrial exposure (EPA, 1991)]
BW = 70 kg [default value for adult body weight (EPA, 1991)]
AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1998)
= 70 years * 365 days year for carcinogenic effects (EPA, 1989)

Future Residential (Adult):

IR = 100 mg/day [default value for adult residential exposure (EPA, 1991)]
EF = 350 days/year [default value for residential exposure (EPA, 1991)]
ED = 30 years [default for residential exposure (EPA, 1991)]
BW = 70 kg [default value for adult body weight (EPA, 1991)]
AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)

Future Residential (Child):

IR = 200 mg/day (default value for child residential exposure (EPA, 1991)]
EF = 350 days/year (default value for residential exposure (EPA, 1991)]
ED = 6 years [assumes exposure for children age = 1 to 6 years, inclusive, in rural/residential areas (EPA, 1991)]
BW = 15 kg [average (male and female) of 50th percentile values for age = 1 to 6 years (EPA. 1985)]
AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)

**Table 6-2. Formulas and Factors Used In the Exposure Pathways Evaluated in BRA (Page 2 of 5)**

INGESTION OF SOIL (cont.)

For lifetime exposure:

<IMG SRC 97118D>

| i | IR | ED | BW |
|---|---|---|---|
| 1 | 200 | 6 | 15 |
| 2 | 100 | 24 | 70 |

Y c = CS * CF * FI * BF * EF / AT

Where:
- I = intake; the amount of chemical at the exchange boundary (mg/kg-body weight/day)
- CS = chemical concentration in soil [lesser of the maximum detected concentration and the 95 percent upper confident limit (UCL 95) of the mean concentration; mg/kg]
- IR = soil ingestion rate (mg/day)
- CF = conversion factor for soil ($10^{-4}$ kg/mg)
- FI = fraction of soil ingested from contaminated source (unitless)
  = 1.0 (assumes 100% of ingested soil is from contaminated area)
- BF = bioavailability factor, the amount of a chemical that is available for absorption through the gastrointestinal lining (unitless)
  = 0.1 for lead (EPA, Health Effects Assessment for Lead, 1984)
  = 1.0 default value for all chemicals except lead
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (period over which the exposure is averaged; days)

Future Residential (Lifetime):
- EF = 350 days/year [default value for residential exposure (EPA, 1991)]
- AT = 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

DIRECT CONTACT WITH SOIL

$$I = \frac{CS * CF * SA * AF * ABS * EF * ED}{BW * AT}$$

**Table 6-2. Formulas and Factors Used in the Exposure Pathways Evaluated in the BRA (Page 3 of 5)**

Where: I = intake, the amount of chemical at the exchange boundary (mg/kg-body weight/day)
CS = chemical concentration in soil [lesser of the maximum detected concentration and the 95 percent upper confident limit (UCL 95) of the mean concentration; mg/kg]
CF = conversion factor for soil (10 -6 kg/mg)
SA = skin surface area available for contact (cm 2/event) [All surface area values am 50 percentile values from EPA, 1985. 50 percentile values are used because surface area is related to body weight, and average body weights over the ED were used in the exposure calculations.]
AF = soil-to-skin adherence factor (mg/cm 2)
= 2.77 mg/cm 2 [value for kaolin clay on hands (EPA, Superfund Exposure Assessment Manual, 1988); used because site soils consist predominantly of clay with some sand (ESE, 1990), and clay has a higher AF than sand or potting soil]

DIRECT CONTACT WITH SOIL (cont.)

ABS = chemical-specific skin absorption factor (unitless)
= 0.25 for volatile organic chemicals (Ryan et al., 1987)
= 0.10 for semivolatile organic chemicals, other than PCBs (Ryan et al., 1987)
= 0.05 for PCBs (Ryan et al., 1987)
= 0.01 for inorganics, other than chromium VI (Ryan et al., 1987)
= 0.15 for chromium VI (Hawley, 1985)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight(kg)
AT = averaging time (period over which the exposure is averaged; days)

Current Worker:

SA = 1,506 cm 2 [Based on average adult (male and female) surface areas (m2) for hands and Ehead multiplied by a conversion factor of 10,000 cm 2/m 2. According to Standard Operating Procedures, base personnel are required to wear long pants, a long-sleeved shirt, and gloves while working (Thiokol, 1990). For conservativeness, it is assumed that workers will remove their gloves occasionally during breaks.)

EF = 200 days/year for BG-5 and M-4 [percentage of dry days per year (305/365) multiplied by the number of days per year working in the area (240) (Burroughs, 1991)]

= 5 days/year for LF-3 [the grass around the flow equilibration tank is cut approximately one time per month from April through August (Burroughs, 1991)]

ED = 25 years [default value for industrial exposure (EPA, 1991)]

BW = 70 kg [default value for adult body weight (EPA, 1991)]

**Table 6-2. Formulas and Factors Used in the Exposure Pathways Evaluated in the BRA (Page 4 of 5)**

AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)
= 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

Future Residential (Adult and Lifetime):

SA = 5,314 cm2 [Based on average adult (male and female) body part surface areas (m2) multiplied by a conversion factor of 10,000 cm 2/m 2. Assumes 112 days/year partially clothed (exposure of bands, arms, feet, legs, and Ehead assumed to apply 5 days/week when average maximum monthly air temperature exceeds 805F {5/7 x 157 = 112 days/year}) and remainder of time spent fully clothed (exposure limited to hands, forearms, and Ehead).]

Future Residential (Adult and Lifetime), Cont.:

EF = 350 days/year [default value for residential exposure (EPA, 1991)]
ED = 30 years [default for residential exposure (EPA, 1991)]
BW = 70 kg [default value for adult body weight (EPA, 1991)]
AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)
= 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

DIRECT CONTACT WITH SOIL (cont.)

Future Residential (Child):

SA = 2,494 cm 2 [Based on average (male and female) mean percentage of total body surface area by part (m 2) over the age range multiplied by the average (male and female) such percentile total body surface are over that age range. The final values were multiplied by a conversion factor Of 10,000 CM 2/M 2. Assumes 112 days/year partially clothed (exposure of hands, arms, feet, legs, and Ehead assumed to apply 5 days/week when average maximum monthly air temperature exceeds 805F {5/7 x 157 = 112 days/year}) and remainder of time spent fully clothed (exposure limited to hands, forearms, and Ehead).]
EF = 350 days/year [default value for residential exposure (EPA, 1991)]
ED = 6 years [assumes exposure for children age = 1 to 6 years, inclusive, in rural/residential areas (EPA, 1991)]
BW = 15 kg [average (male and female) of 50th percentile values for age = 1 to 6 years (EPA, 1985)]
AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)

**Table 6-2. Formulas and Factors Used in the Exposure Pathways Evaluated in the BRA (Page 5 of 5)**

INHALATION OF SOIL PARTICULATES

$$I = \frac{CS * RPC * IR * CF * EF * ED}{BW * AT}$$

Where:
- I = intake; the amount of chemical at the exchange boundary (mg/kg-body weight L/day)
- CS = chemical concentration in soil [Lesser of the maximum detected concentration and the 95 percent upper confident limit (UCL 95) of the mean concentration; mg/kg]
- RPC = respirable particulate (PM 10) concentration in air (mg/$m^3$)
  = 59.5 Ig/$m^3$ [Maximum 24-hour average total suspended particulate concentration detected at 2 air sampling stations at LAAP for the period 10/1/86 to 4/30/87 (Thiokol, 1987). Generally, only particles with a diameter less than 10 Im may be available for absorption through the alveolar membranes. Although the value provided by Thiokol (1987) is for total suspended particulates, which includes particulates of all sizes, this number will be used to provide a very conservative value for absorbable inhaled particulates.]
- IR = ambient air inhalation rate ($m^3$/day)
- CF = conversion factor for soil ($10^{-4}$ kg/mg)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (period over which the exposure is averaged; days)

INHALATION OF SOIL PARTICULATES (cont.)

Current Worker:

IR = 20 m 3/day [standard default for industrial exposure (EPA, 1991)]

EF = 120 days/year for Area P [percentage of dry days per year (305/365) multiplied by the percent days per year working in the area (240 x 3/5) (Burroughs, 1991). Access to Area P is restricted, and no exposure to soils inside this fenced area is expected; however, persons working at the nearby maintenance shed may be exposed to airborne particulates migrating from the contaminated area.]

= 200 days/year for BG-5 and M-4 [percentage of dry days per year (305/365) multiplied by the number of days per year working in the area (240) (Burroughs, 1991)]

= 5 days/year for LF-3 [the grass; around the flow equilibration tank is cut approximately one time per month from April through August (Burroughs, 1991)]

ED = 25 years [default value for industrial exposure (EPA, 1991)]

BW = 70 kg [default value for adult body weight (EPA, 1991)]

AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)

= 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

Future Residential (Adult and Lifetime):

IR = 15 m 3/day (default value for adult residential exposure (EPA, 1991)]

EF = 350 days/year [default value for residential exposure (EPA, 1991)]

ED = 30 years [default for residential exposure (EPA, 1991)]

BW = 70 kg [default value for adult body weight (EPA, 1991)]

AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)

= 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

Future Residential (Child):

IR = 19 m 3/day (reasonably conservative inhalation rate for a child based on the adult IR value and the child:adult ratio for ambient air intake (25.4 m 3/day {based on the child MLE value and the adult RME:MLE ratio in EPA, 1985} ≈ 20 m 3/day {conservative inhalation rate for total indoor and outdoor residential exposure in EPA, 1991}).]

EF = 350 days/year [default value for residential exposure (EPA, 1991)]

ED = 6 years [assumes exposure for children age = 1 to 6 years, inclusive, in rural/residential areas (EPA, 1991)]

BW = 15 kg [average (male and female) of 5th percentile values for age = 1 to 6 years (EPA, 1985)]

AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)

Source: ESE, 1996.

**Table 6-3. Formulas and Factors Used in the Exposure Pathways Evaluated in the Expanded RA (Page 1 of 3)**

INGESTION OF SOIL

$$I = \frac{CS * IR * CF * FI * EF * ED}{BW * AT}$$

Where:

- I = intake; the amount of chemical at the exchange boundary (mg/kg-body weight/day)
- CS = chemical concentration in soil [lesser of the maximum detected concentration and the 95 percent upper confident limit (UCL 95) of the mean concentration; mg/kg]
- IR = soil ingestion rate (mg/day)
- CF = conversion factor for soil ($10^{-6}$ kg/mg)
- FI = fraction of soil ingested from contaminated source (unitless)
  = 1.0 (assumes 100% of ingested soil is from contaminated area)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (period over which the exposure is averaged; days)

Current and Future Worker (RME):

- IR = 50 mg/day [standard default for industrial exposure (EPA, 1991)]
- EF = 250 days/year [standard default for industrial exposure (EPA, 1991)]
- ED = 25 years [national 95 th percentile time at one workplace (EPA. 1991)]
- BW = 70 kg [default value for adult body weight (EPA, 1991)]
- AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)
  = 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

Current and Future Worker (CT):

- IR = 50 mg/day [standard default for industrial exposure (EPA, 1991)]
- EF = 250 days/year [standard default for industrial exposure (EPA, 1991)]
- ED = 9 year [national 50 th percentile time at one workplace (EPA, 1991)]
- BW = 70 kg [default value for adult body weight (EPA, 1991)]
- AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)
  = 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

DIRECT CONTACT WITH SOIL

$$I = \frac{CS * CF * SA * AF * ABS * EF * ED}{BW * AT}$$

Where:

I = intake; the amount of chemical at the exchange boundary (mg/kg-body weight/day)
CS = chemical concentration in soil [lesser of the maximum detected concentration and the 95 percent upper confident limit (UCL 95) of the mean concentration; mg/kg]
CF = conversion factor for soil (l0 -6 kg/mg)
SA = skin surface area available for contact (cm 2/event) [All surface area values are 50 th percentile values from EPA, 1985. 50 th percentile values are used because surface am is related to body weight, and average body weights over the ED were used in the exposure calculations.]
AF = soil-to-skin adherence factor (mg/cm#)

**Table 6-3. Formulas and Factors Used in the Exposures Pathways Evaluated in the Expanded RA (Page 2 of 3)**

DIRECT CONTACT WITH SOIL (cont.)

ABS = chemical-specific skin absorption factor (unitless)
= 0.23 for volatile organic chemicals (Ryan et al., 1987)
= 0.10 for semivolatile organic chemicals, other than PCBs (Ryan et al., 1987)
= 0.05 tor PCBs (Ryan et al., 1987)
= 0.01 for inorganics, other than chromium VI (Ryan et al., 1987)
= 0.15 for chromium VI (Hawley, 1985)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (period over which the exposure is averaged; days)

Current and Future Worker (RME):

SA = 1,506 cm# [Based on average adult (male and female) surface areas (m 2) for hands and Ehead multiplied by a conversion factor of 10,000 cm#/m#. According to Standard Operating Procedures, base personnel am required to wear long pants, a long-sleeved shirt, and gloves while working (Thiokol, 1990). For conservativeness, it is assumed that workers will remove their gloves occasionally during breaks.]

EF = 250 days/year [standard default for industrial exposure (EPA, 1991)]

ED = 25 years [national 95 th percentile time at one workplace (EPA, 1991)]

BW = 70 kg [default value for adult body weight (EPA, 1991)]

AT = E3) * 365 days/year for non-carcinogenic effects (EPA, 1989)

= 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

Current and Future Worker (CT):

SA = 1,506 cm# (Based on average adult (male and female) surface areas (m#) for hands and E head multiplied by a conversion factor of 10,000 cm#/m#. According to Standard Operating Procedures, base personnel am required to wear long pants, a long-sleeved shirt, and gloves while working (Thiokol, 1990). For conservativeness, it is assumed that workers will remove their gloves occasionally during breaks.)

EF = 250 days/year [standard default for industrial exposure (EPA, 1991)]

ED = 9 years [national 50th percentile time at one workplace (EPA, 1991)]

BW = 70 kg [default value for adult body weight (EPA. 1991))

AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)

= 70 year * 365 days/year for carcinogenic effects (EPA, 1989)

INHALATION OF SOIL PARTICULATES

$$I = \frac{CS * RPC * IR * CF * EF * ED}{BW * AT}$$

Where:

I = intake, the amount of chemical at the exchange boundary (mg/kg-body weight/day)

CS = chemical concentration in soil [lesser of the maximum detected concentration and the 95 percent upper confident limit (UCL 95) of the mean concentration; mg/kg]

**Table 6-3.  Formulas and Factors Used in the Exposure Pathways Evaluated in the Expanded RA (Page 3 of 3)**

INHALATION OF SOIL PARTICULATES (cont.)

RPC = respirable particulate (PM 10) concentration in air ($mg/m^3$)
= 59.5 Ig/$m^3$ [Maximum 24-hour average total suspended particulate concentration detected at 2 air sampling stations at LAAP for the period 10/1/86 to 4/30/87 (Thiokol, 1987). Generally, only particles with a diameter less than 10 Im may be available for absorption through the alveolar membranes.  Although the value provided by Thiokol (1987) is for total suspended particulates, which includes particulates of all sizes, this number will be used to provide a very conservative value for absorbable inhaled particulates.]

IR = ambient air inhalation rate ($m^3$/day)
CF = conversion factor for soil ($10^{-4}$kg/mg)
EF = exposure frequency (days/year)
ED = exposure duration (days/year)
BW = body weight (kg)
AT = averaging time (period over which the exposure is averaged; days)

Current and Future Worker (RME):
IR = 20 $m^3$/day [standard default for industrial exposure (EPA, 1991)]
EF = 250 days/year [standard default for industrial exposure (EPA, 1991)]
ED = 25 years [national 95$^{th}$ percentile time at one workplace (EPA, 1991)]
BW = 70 kg [default value for adult body weight (EPA. 1991)]
AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)
= 70 years * 365 days/year for carcinogenic effects (EPA, 1989)

Current and Future Worker (CT):
IR = 20 $m^3$/day (standard default for industrial exposure (EPA, 1991)]
EF = 250 days/year [standard default for industrial exposure (EPA, 1991)]
ED = 9 years [national 50$^{th}$ percentile time at one workplace (EPA, 1991)]
BW = 70 kg [default value for adult body weight (EPA, 1991)]
AT = ED * 365 days/year for non-carcinogenic effects (EPA, 1989)
= 70 years * 365 days/year or carcinogenic effects (EPA. 1989)

NOTE:
RME =reasonable maximum exposure.
CT =central tendency.

Source:  ESE, 1996.

## 6.4 Risk Characterization

Existing data were used for the BRA to determine whether COCs detected at LAAP may pose a potential risk to human health and the environment. If data were not available, then suitable environmental models were used to predict exposures. Potential risks to human health were then evaluated with respect to carcinogenic and non-carcinogenic effects.

The potential risks associated with exposure to individual carcinogens are calculated by multiplying the chemical intake by the CSF as follows:

$$Risk = I * CSF$$

where:
- Risk = probability for an individual developing cancer under the assumed exposure conditions (unitless);
- I = daily chemical intake averaged over a lifetime of 70 years (mg/kg/day); and
- CSF = carcinogenic slope factor, expressed in $(mg/kg/day)^{-1}$.

The combined risk from exposure to multiple chemicals is evaluated by addition of resultant risks from different chemicals as follows:

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where:
- $Risk_T$ = the sum of individual chemical risks, unitless probability; and
- $Risk_i$ = the risk estimate for the $i^{th}$ chemical.

Risks are also added across exposure pathways if the exposures are to the same individual (e.g, a worker could be exposed to soil by oral, dermal, and, if relevant, inhalation).

$$Risk_{soil} = Risk_{oral} + Risk_{dermal} + Risk_{inhalation}$$

USEPA's acceptable increased cancer risk range is $1.0x10^{-6}$ to $1.0x10^{-4}$ (one individual in 1,000,000 to one individual in 10,000) as established in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The number $1.0x1^{-4}$ corresponds to a probability of one additional individual in 10,000 developing cancer from a lifetime (70 years) of exposure to chemicals on the installation. This additional cancer risk is a risk in excess of the natural incidence of cancer in the United States of two to three individuals in ten.#

Non-carcinogenic health risks are estimated by comparing actual or expected exposure levels to acceptable concentrations to produce a hazard quotient (HQ) as follows:

$$HQ = \frac{I}{\text{RâD}} \qquad (5\text{-}3)$$

where:
- I = intake of chemical (mg/kg/day); and
- RfD = reference dose of chemical (mg/kg/day).

The combined hazard from exposure to multiple chemicals is evaluated by addition of resultant HQs to produce a hazard index (HI) as follows:

$$HI = \frac{I_1}{\text{RâD}_1} + \frac{I_2}{\text{RâD}_2} + \ldots + \frac{I_i}{\text{RâD}_i} \qquad (5\text{-}4)$$

where: $I_i$ = Intake for the $i$ th chemical (mg/kg/day); and
RâD $i$ = reference dose for the $i$ th chemical (mg/kg/day).

Similar to cancer risks, HQs may also be added across exposure pathways if the exposures are to the same individual.

$$HI_{soil} = HQ_{oral} + HQ_{dermal} + HI_{inhalation}$$

An HQ or HI exceeding 1.0 indicates a potential unacceptable risk and a possible concern for potential toxic effects.

Potential, risks to ecological receptors are evaluated by comparing actual or expected chemical intakes (for terrestrial animals) or exposure point concentrations (for direct exposure of plants or aquatic life) to acceptable intakes/concentrations to produce an ecotoxicity quotient (EQ) as follows:

$$EQ = \frac{I}{TBC_I} \text{ or } \frac{EC}{TBC_C}$$

where: EC = exposure point concentration (mg/kg or mg/L),
I = intake of chemical (mg/kg/day);
$TBC_C$ = chemical concentration to be considered as "safe" (mg/kg or mg/L); and
$TBC_I$ = intake to be considered as a "safe dose" (mg/kg/day).

2 Letter dated May 22, 1995 from Ms. Cathy Gilmore, USEPA Region VI, to Mr. Doyle Williams, LAAP.

As in the case of HIs, EQs in excess of 1.0 represent potential unacceptable risks to the environment (e.g., land plants, water plants, and animals).

Potential increased carcinogenic risks associated with current worker sod exposure did not exceed USEPA's acceptable risk range of $1.0 \times 10^{-6}$ to $10^{-4}$ at any of the study areas evaluated. Also, HIs associated with soil exposure did not exceed the target HI of 1. Therefore, current worker exposure to soils at Area P, BG-5, and LF-3 are not expected to result in any unacceptable cancer risk or hazard.

Potential increased carcinogenic risks associated with future residential sod exposure did not exceed USEPA's acceptable risk range at any of the study areas. However, residential exposure to soil at BG-5, BG-8 Landfill/Lagoon, and LF-3 may result in HIs exceeding the target HI of 1 (HIs ranged from 1 to 3). While future residential exposure to soils at these study areas may not result in severe hazards, it may reduce the margin of safety incorporated in the exposure evaluations.

The potential risks associated with the COCs at each study area, as calculated in the BRA, are summarized in Table 6-6.

**Table 6-4. Chronic Toxicity Values for Potential Non-carcinogenic Effects of the Soil COCs**

| Exposure Pathway/ Chemical of Concern | Chronic RfD (mg/kg/day) | Confidence Level | Critical Effect | RfD Basis/ RfD Source | Uncertainty and Modifying Factors |
|---|---|---|---|---|---|
| Oral Exposure | | | | | |
| 1,1-Dichloroethene | 9 X 10 -3 | Medium | Liver effects | Drinking Water Study/ IRIS, 1994 | UF = 1,000 (A,H,L) MF = 1 |
| 1,3-Dinitrobenzene | 1 x 10 -4 | Low | Increased spleen weight | Drinking Water Study/ IRIS,1994 | UF = 3,000 (A,H,R,S) MF = 1 |
| 2,4-Dinitrotoluene | 2 x 10 -3 | High | Nervous system and blood effects | Diet (Food) Study/ IRIS, 1994 | UF = 100 (A,H) MF = 1 |
| 2,6 Dinitrotoluene | 1 x 10 -3 | -- | Nervous system. blood, and kidney effects | Diet (Food Study/ HEAST, 1994 | UF = 3,000 (A,H,R,S) MF = 1 |
| HMX | 5 x 10 -2 | Low | Liver effects | Diet (Food) Study/ IRIS, 1994 | UF = 1,000 (A,H.S) MF = 1 |
| Lead | ND * | -- | -- | -- | -- |
| Nitrobenzene | 5 x 10 -4 | Low | Adrenal gland, blood, kidney, and liver effects | Inhalation Study/ IRIS, 1994 | UF = 10,000 (A,H,L,S) MF = 1 |
| RDX | 3 x 3 -3 | High | Prostate gland inflammation | Diet (Food) Study/ IRIS, 1994 | UF = 100 (A.H) MF = 1 |
| Tetryl | 1 x 10 -2 | Low | Liver, kidney, and spleen effects | Oral (Gavage) Study/ HEAST, 1994 | UF = 10,000 (A,H,L,S) MF = 1 |
| 1,3,5-Trinitrobenzene | 5 x 10 -3 | Low | Increased spleen weight | Drinking Water Study/ IRIS, 1994 | UF = 10,000 (A,H,S,X) MF = 1 |
| 2,4,6-Trinitrotoluene | 5 x 10 -4 | Medium | Liver effects | Diet (Food) Study/ IRIS. 1994 | UF = 1,000 (A,H,L) MF = 1 |

| | | | | | |
|---|---|---|---|---|---|
| Inhalation Exposure | | | | | |
| All Chemicals | ND | -- | -- | -- | -- |

Notes:
- -- = not applicable.
- ND = not determined.
- RfD = reference dose; dose of a chemical that is not expected to result in an adverse effect with a lifetime exposure.
- UF = uncertainty factor.
- MF = modifying factor.
- IRIS = EPA's Integrated Risk Information System.
- LOAEL = the lowest dose level at which an adverse effect was observed.
- NOAEL = the highest dose level at which no adverse effects was observed.
- mg/kg/day = milligrams per kilogram per day.

Uncertainty adjustments:
- A = extrapolation from an animal study to human effects.
- H = variation in human sensitivity.
- L = extrapolation from a LOAEL to a NOAEL.
- R = lack of sub-chronic and reproductive toxicity data.
- S = extrapolation from a sub-chronic to a chronic NOAEL.
- X = derivation of an RfD based on a study on a structurally similar chemical (1,3-dinitrobenzene).

* By comparison to most other environmental toxicants, the degree of uncertainty about the health effects of lead is quite low. It appears that some of these effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold. EPA's RfD Work Group considers it inappropriate to develop RfD for inorganic lead.  EPA prefers to use the Integrated Exposure Uptake Biokinetic (IEUBK) Model (EPA, 1991) to evaluated total lead exposure on a site-specific basis.

Source:  ESE, 1996.

**Table 6-5.  Toxicity Values for Potential Carcinogenic Effects of the Soil COCs**

| Exposure Pathway/ Chemical of Concern | CSF (mg/kg/day) -1 | Weight-of-Evidence Classification | Type of Cancer* | CSF Basis/CSF Source |
|---|---|---|---|---|
| Oral Exposure | | | | |
| 1,1-Dichloroethene | 6.0 x 10 -3 | C | -- | Drinking Water Study / IRIS, 1994 |
| 2,4-Dinitrotoluene/ 2,6-Dinitrotoluene | 6.8 x 10 -1 (a) | B2 | -- | Drinking Water Study / IRIS, 1994 |
| Lead | NSF (b) | B2 | -- | Drinking Water Study / IRIS, 1994 |
| RDX | 1.1 x 10 -1 | C | -- | Drinking Water Study / IRIS, 1994 |
| 2,4,6-Trinitrotoluene | 3.0 x 10 -# | C | -- | Drinking Water Study / IRIS, 1994 |
| Inhalation Exposure | | | | |
| 1,1-Dichloroethene | 1.8 X 10 -1 | C | -- | Inhalation Study IRIS, 1994 |
| 2,4-Dinitrotoluene/ 2,6-DNT | NSF | B2 | -- | NSF/NSF |
| Lead | NSF (b) | B2 | -- | NSF/NSF |
| RDX | NSF | C | -- | NSF/NSF |
| 2,4,6-Trinitrotoluene | NSF | C | -- | NSF/NSF |

IRIS = EPA's Integrated Risk Information System.
NSF = No CSF is available.
--- = Not categorized by EPA as a Group A human carcinogen.
mg/kg/day = Milligrams per kilogram per day.

CSF:  The probability of a response per unit intake of a chemical over a lifetime.  CSF is used to estimate an upperbound probability of an individual developing cancer as a result of an exposure to a particular level of a chemical.
Weight-of-evidence classification:  An EPA classification system for characterizing the extent to which the available data indicate that a chemical is a human carcinogen.

A = Known human carcinogen; sufficient evidence from epidemiologic studies to support a causal association between chemical exposure and cancer in humans.

B2 = Probable human carcinogen; sufficient evidence of carcinogenicity in animal studies but inadequate or no evidence in humans.

C = Possible human carcinogen; limited evidence of carcinogenicity in animal studies and no evidence in humans.

(a) CSF is based on a mixture of 2,4- and 2,6-dinitrotoluene.

(b) By comparison to most other environmental toxicants the degree of uncertainty about the health effects of lead is quite low. It appears that some of these effects, particularly changes in the levels of certain blood enzymes; and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold. EPA prefers to use the Integrated Exposure Uptake Biokinetic (IEUBK) Model (EPA, 1991) to evaluate total lead exposure on a site-specific basis.

* In accordance with Risk Assessment Guidance for Superfund, types of cancer are only presented for EPA Group A (known human) carcinogens. None of the soil COCs at LAAP am Group A carcinogens.

Source: ESE, 1996.

The risk results of the current worker scenario indicate that the total potential risk associated with potential worker exposure to carcinogenic COCs in soil is within USEPA's acceptable risk range of 1.0x10 -6 to 1.0x10 -4 for each of the seven study area evaluated. In addition, the total HIs for non-carcinogenic COCs at each study area was less than one.

The current and future worker and future recreational scenarios were evaluated in the expanded risk assessment. The soil exposure assumptions used for the BRA were also used for these scenarios. Based on the results of the expanded risk assessment, there were no predicted unacceptable risks from soils. The results of the expanded risk assessment are summarized in Table 6-7.

<IMG SRC 97118F>
<IMG SRC 97118G>
<IMG SRC 97118H>
<IMG SRC 97118I>

6.5 Ecological Risk Summary

The potential for adverse effects to land animals, as well as sensitive ecological habitats, was also investigated during the BRA and the expanded risk assessment. The potential for accumulation within the food chain (bioaccumulation) was evaluated by comparing results from the RI to reference values obtained from published literature.

The BRA quantified risks from the soils in the Soil/Source OU to large and small animals under current and future exposure scenarios. The principal ecological exposure pathways evaluated under current use scenarios in the BRA included:

- Exposure of land animals to COCs as a result of direct contact (incidental ingestion and skin contact) with surface soil and food; and
- Exposure of land animals to COCs as a result of inhalation of dusts.

The principal ecological exposure pathways evaluated for future use scenarios in the BRA included agricultural use (production of cattle, poultry, and crops). In addition, the use of shallow groundwater for production of livestock and crops was also evaluated in the BRA under the future use scenario. This exposure pathway will be discussed further in the ROD for the groundwater OU.

The expanded risk assessment evaluated risks posed to ecological receptors by discharge of the shallow groundwater to surface water at the seven study areas. The expanded risk assessment did not evaluate additional exposure scenarios involving exposure of ecological receptors to soil. The ecological risk results will be discussed in the ROD for the Groundwater OU.

No unacceptable ecological risks from soils were predicted in the BRA or the expanded risk assessment.

**7.0 Description of the No Further Action Alternative**

Based on the careful consideration of the technical, environmental, institutional, public health, and cost criteria as presented in Section 6.0, and in keeping with the overall response strategy, the recommended remedial action alternative for the LAAP Soil/Source Operable Unit is No Further Action.

As approved by USEPA and LDEQ, an IRA was conducted from 1987 through 1990. The IRA activities included excavation and treatment of lagoon sediments and soils by incineration, and capping of the lagoons. No explosive chemicals above 100 mg/kg were detected in any soil samples collected at Area P after completion of the IRA. The cost of the IRA was approximately $30,000,000.

CERCLA, as amended by SARA, suggests that a remedial action should be selected "that is protective of human health and the environment, that is cost effective, and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable." However, the NCP recognizes that there are situations where no further action is appropriate. The NCP states no-action alternative may be appropriate where a removal or remedial action has already occurred at a site" (55FR8715). The study areas are not close to population centers and the projected future industrial land use of the installation reduces the likelihood of exposure to soil/source areas.

The results of the BRA indicated that, for the future residential use scenario, soil at BG-5, BG-8 Landfill/Lagoon, and LF-3 may pose slightly elevated non-carcinogenic risks (HIs of 1 to 3). An expanded risk assessment was conducted as part of the FS to reflect the fact that LAAP will remain industrial and will not be used for residential or agricultural use (refer to Section 4.0 of this document for a description of the expanded risk assessment). This expanded risk assessment showed that under a worker exposure scenario, potential risks to human health are within the acceptable range.

Existing Army regulations and protocol make the sale of the LAAP property unlikely (refer to Section 2.0 of the FS, Future Use of LAAP). Furthermore, CERCLA Section 120(h)(3)(B) requires that if the property is sold or transferred, each deed must contain language stating that action to protect human health and the environment has been taken before the date of property transfer. In addition, Louisiana State Statute (LSA) R.S. 30:2039 requires that a notice of hazardous waste shall be recorded into the mortgage and conveyance records of each parish where the property is located. The Army will retain control of LAAP, and access to the installation will remain restricted in the future.

Given the installation-specific conditions discussed above, combined with the numerous regulations governing the transfer of LAAP property, No Further Action would be protective of human health and the environment. Therefore, No Further Action is the recommended remedial alternative for the LAAP Soil/Source OU.

The objectives of remedial actions for the Soil/Source OU include the protection of the groundwater and prevention of direct contact with Area P soils. The IRA at Area P addressed these objectives by removing chemical constituents from the soils, lagoon water, and wastewater. The studies undertaken at LAAP have shown that no potential human health or environmental risks are associated with the soils/sources at the other six study areas; therefore, there are no remedial action objectives associated with other study areas.

If in the unlikely event the property was to be transferred in the future, and a worker exposure scenario would no longer be appropriate, then the Army would readdress potential risks based on the use scenario.

**8.0 Documentation of Significant Charges**

The Proposed Plan for the LAAP Soil/Source OU was released for public comment on January 8, 1996. The Proposed Plan identified No Further Action as the Preferred Alternative. The DA has reviewed all written and verbal comments submitted 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.

## 9.0 References

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U.S. Environmental Protection Agency (USEPA). 1991. Risk Assessment Guidance for Superfund (RAGS). Volume 1: Human Health Evaluation Manual, Supplemental Guidance (Standard Default Exposure Factors). Interim Final. Office of Emergency and Remedial Response, Washington, DC. OSWER Directive 9285.6-03.

**GLOSSARY OF TERMS**

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

Aquifer: A layer of soil or rock that can supply usable quantities of groundwater. Aquifers can be used as a source of water for drinking, irrigation, and industrial purposes.

Risk Assessment: The process whereby risks to human health and the environment are quantitatively evaluated. This information is used to determine whether remedial actions are necessary. The risk assessment is conducted during the RI/FS.

Berm: A narrow barrier used to keep liquids from flowing into or out of an enclosure.

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

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

Constituents of Concern (COCs): Site-related chemicals that pose critical health concerns to environmental receptors because of their toxicity and potential for exposure. Although many chemicals at a site may pose a risk to human health and the environment, COCs represent those constituents that contribute the majority of risk.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): A federal law enacted in 1980 and subsequently modified by the Superfund Amendments and Reauthorization Act of 1996 (SARA). This act resulted in the creation of a trust fund, commonly known as "Superfund," which provides money to investigate and clean up abandoned or uncontrolled hazardous waste sites. In the case of federal facilities such as LAAP, the Army is responsible for financing the investigation and cleanup activities.

Ecotoxicity Quotient (EQ): A value used to evaluate the potential for adverse effects on environmental receptors. The EQ relates concentrations of chemicals of concern in the environment to establish benchmark concentrations.

Explosive Chemicals: Chemicals which are used to manufacture explosive devices such as bombs and mines.

Exposure Pathways: The routes by which chemicals reach receptors. These routes may include (for example) the route of transport from the soil to the surface water to recreational use by people, and thus exposure to the chemical.

Feasibility Study (FS): A study that supports the selection of a remedial action at an NPL site. The FS identifies, develops, and evaluates several alternatives for addressing contamination.

Geologic Unit: A rock/soil mass classified as a group based on shared characteristics of the rocks and soils.

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

Hazard Index (HI): An indicator of the potential for a hazardous substance to cause noncancerous health effects in humans. The HI is calculated by dividing worst-case human exposure estimates to a particular substance by exposure levels that USEPA has determined to be acceptable. If the result of this calculation is greater than 1.0, there may be concern for potential non-cancer effects. As a rule, the greater the value above 1.0, the greater the level of concern.
Hydrogeology: The study of groundwater and aquifers.

Hydrogeologic Unit: A geologic unit that contains groundwater.

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

Interim Remedial Action (IRA): Removal or remedial actions that are taken to respond to an immediate site threat or to take advantage of an opportunity to significantly reduce risk quickly.

Landfarm: A common method of treating soils and sludges where the soil/sludge is spread out in an open area in order to allow air and sunlight to reach the soil/sludge. This method allows naturally occurring degradation processes (such as biodegradation) to occur more easily.

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

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

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

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

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

Pink Water: Pink water is the waste water created as a result of explosive manufacturing operations. The water is pink or red, and the color is caused by the presence of explosive chemical.

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

Receptor: A human, animal, or plant that could potentially receive exposure to chemicals resulting from the chemicals migration from hazardous waste sites.

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

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

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

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

Responsiveness Summary: Comments presented during the public meeting and received during the public comment period that are considered and addressed by the Army.

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

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

Source Areas: The areas where waste was once handled (treated, stored, disposed of, etc.) which later acts as a source for contaminants.

Superfund Amendments and Reauthorization Act of 1986 (SARA): This act modified CERCLA and resulted in the creation of a trust fund commonly known as "Superfund" which provides money to investigate and cleanup abandoned or uncontrolled hazardous waste sites.

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

Volatile Organic Compounds (VOCs): Organic liquids that readily evaporate under atmospheric conditions and exhibit varying degrees of solubility in water. Examples of VOCs detected at LAAP include trichloroethylene (TRCLE) and tetrachloroethene (PCE).

**Appendix A**

**Responsiveness Summary**

LAAP SOILS/SOURCE OPERABLE UNIT RESPONSIVENESS SUMMARY

Summary of Comments Received During the Louisiana Army Ammunition Plant Soil/Source Area Operable Unit Public Meeting Held on January 25, 1996

A number of comments were received from the community during the public meeting for the LAAP Soil/Source OU, held on January 25, 1996. With one exception the comments were received during the availability session prior to the start of the meeting. Comments received during the availability session were written on notecards. The one oral question received during the public meeting was transcribed by the court recorder.

The following is a summary of the questions and responses.

Comment 1 What are the standards for chemicals in groundwater?

Response: The federal government publishes standards for the maximum allowable levels of certain chemicals in drinking water. These standards are called Maximum Contaminant Levels (MCLs) and generally apply to underground sources of drinking water. There are no MCLs for explosive compounds in groundwater. Therefore, cleanup standards for explosive compounds in the groundwater at LAAP will be determined on the basis of a risk assessment, as appropriate.

Comment 2 What type(s) of chemicals are in the explosives?

Response: The primary explosive compounds used at LAAP were TNT, RDX, and HMX which stand for trinitrotoluene, Research and Development Explosive, and High/Melting Explosive, respectively. The actual chemical names for RDX and HMX are cyclotrimethylenetrinitramine and cyclotetramethylenetetranitramine. There are also several by-products of TNT present in the soils at LAAP. These compounds belong to a family of chemicals referred to as nitroaromatics. A more complete discussion of these chemicals is available in the RI Report published by ESE.

Comment 3 (What are the) concentrations of explosives in Area P groundwater?

Response: The concentrations of explosive compounds in the groundwater at Area P have varied over the 12 years that data have been collected. In 1990, concentrations of RDX ranged from below detection limits (BDL) to 19 milligrams per liter (mg/L). HMX ranged from BDL to 1.02 mg/L. TNT ranged from BDL to 16.4 mg/L. A more complete history of the concentrations of explosive compounds in the groundwater is available in Section 6.0 of the RI Report.

Comment 4 Is groundwater (contaminated) leaving the plant boundary?

Response: There are currently no data showing that contaminated groundwater is leaving the plant boundary. However, further evaluation is needed before the Army can state conclusively that chemically affected groundwater is or is not leaving the plant boundary. For this reason, the investigation at LAAP has been split into two Operable Units (OUs) consisting of the Soil/Source OU and the Groundwater OU. This split will allow the Army to pursue final action regarding the soil without waiting for the groundwater issues to be resolved. The Army is currently in the process of identifying information needs and issues with respect to the Groundwater OU so these issues can be addressed.

**Appendix B**

**Administrative Record Index**

EPA ADMINISTRATIVE RECORD
LOUISIANA ARMY AMMUNITION PLANT
Shreveport, Louisiana

April 1996

| Doc No. | Date | Author | Recipient(s) | Title/Description | Pages |
|---|---|---|---|---|---|
| 1 | May 1978 | Dept. of the Army, Office of the Project Manager for Chemical Demilitarization and Installation Restoration, Aberdeen Proving Ground, MD | LAAP | Installation Assessment of Louisiana Army Ammunition Plant (LAAP), Record Evaluation Report No. 120 | 108 |
| 2 | September 1979 - March 1980 | United States Army Environmental Hygiene Agency, Abordeen Proving Ground, MD | Commander, U.S. Army Materiel Development and Readiness Command<br><br>HODA (DAEN-MPO-U)<br>HGDA (DAEN-ZCE)<br>Superintendent, Academy of Health Sciences (HSA-IPM). | Geohydrologic Consultation No. 31-24-0152-80, LAAP, Shreveport. Louisiana | 26 |
| 3 | March 8, 1982 | Envirodyne Engineers, Inc.<br>12161 Lackland Road<br>St. Louis, MO 63141 | LAAP<br>P.O. Box 30058<br>Shreveport, LA 71130<br><br>Commander, U.S. Army Toxic and Hazardous Materials Agency (USATHAMA)<br>Aberdeen Proving Ground, MD | LAAP, Geotechnical Report Interim Report Number 2 | 197 |

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| 4 | May 15, 1982 | Envirodyne Engineers, Inc. | LAAP<br><br>Commander, USATHAMA | LAAP,<br>Contamination Analysis Report | 343 |
| 5 | September 30, 1982 | Envirodyne Engineers, Inc. | LAAP<br><br>Commander, USATHAMA | LAAP,<br>Final Report | 145 |
| 6 | October 15, 1982 | Envirodyne Engineers, | LAAP<br><br>Commander, USATHAMA | Analysis of Alternative Measures | 20 |
| 7 | June 1986 | A.T. Kearney, Inc. Alexandria, VA and<br><br>Harding Lawson Associates, Houston. Texas | EPA Region VI | Preliminary Assessment<br>LAAP<br>Shreveport, Louisiana<br>LAO 21382053 | 131 |
| 8 | December 19, 1986 | Environmental Science & Engineering, Inc. (ESE) | USATHAMA, Assessments Division, Aberdeen Proving Ground, MD | Remedial Investigation at LAAP,<br>Final Report A011<br>Volume II--Appendices<br>Part A | 182 |
| 9 | December 19, 1986 | ESE | USATHANA | Remedial Investigation at LAAP,<br>Final Report A011<br>Volume II--Appendices<br>Part B | 240 |
| 10 | January 30, 1987 | ESE | USATHANA | Remedial Investigation at LAAP,<br>Final Report A011 | 175 |
| 11 | August 1987 | U.S. Army | Public | Public Notice of Interim Response | 3 |
| 12 | May 1978 | IT | USATHAMA | Interim Response Action (IRA)<br>Remedial Investigation (RI), Area P Lagoons | -- |

| | | | | | |
|---|---|---|---|---|---|
| 13 | August 1987 | IT | USATHAMA | Feasibility Study, Final Sampling and Analysis Plan | -- |
| 14 | August 1987 | International Technology Corporation (IT) | USATHAMA | Interim Response Action (IRA), Feasibility Study, Area P Lagoons | 170 |
| 15 | October 1987 | IT | LAAP | Public Involvement and Response Plan, Interim Response Action - Area P Lagoons | 36 |
| 16 | December 1987 | IT | USATHAMA | Interim Response Action (IRA) Decisions Memorandum, Area P Lagoons | 145 |
| 17 | December 1987 | LDEQ and U.S. Army | Internal | Decision Memorandum for Interim Response action at Area P | 6 |
| 18 | December 4, 1987 | IT | Louisiana Department of Environmental Quality (LDEQ) and<br><br>U.S. Environmental Protection Agency (EPA) Region VI | Installation Restoration Incineration Program Description Interim Response Action, Part 1, Remedial Action Plan | 155 |
| 19 | December 7, 1987 | IT | LDEQ and EPA Region VI | Installation Restoration Incineration Program Description Interim Response Action, Part 2, Incineration Plan | 154 |
| 20 | December 1987 | IT | LDEQ and EPA Region VI | Installation Restoration Incineration Program Description Interim Response Action, Part 3, Trial Burn Data | -- |
| 21 | February 1988 | IT | LAAP | Public Involvement and Response Plan, Interim Response Action, Area P Lagoons | 35 |

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|---|---|---|---|---|---|
| 22 | April 11, 1988 | LDEQ | LAAP | Demand for Action | 10 |
| 23 | June 8, 1988 | IT, LAAP | LDEQ | Remedial Design/Remedial Action (RD/RA), Volume I: Work Plan, Interim Remedial Action at LAAP Area P Lagoons | 25 |
| 24 | June 8, 1988 | IT, LAAP | LDEQ | RD/RA Work Plan, Volume II: Appendix A, Safety, Health and Emergency Response Plan, Interim Remedial Action at LAAP Area P Lagoons | 350 |
| 25 | June 8, 1988 | IT, LAAP | LDEQ | RD/RA Work Plan, Volume III: Appendix B, Spill Prevention, Control, and Countermeasure Plan, Interim Remedial Action at LAAP Area P Lagoons | 35 |
| 26 | June 8, 1988 | IT, LAAP | LDEQ | RD/RA Work Plan, Volume IV: Appendix C, Quality Assurance Project Plan, Interim Remedial Action at LAAP Area P Lagoons | 300 |
| 27 | July 26, 1988 | Office of Health Assessment, Agency for Toxic Substances and Disease Registry (ATSDR) | LAAP | Preliminary Health Assessment | 5 |
| 28 | September 1988 | IT | LAAP | Revised Public Involvement and Response Plan, Interim Response Action, Area P Lagoons | 35 |
| 29 | September 1988 | Weston, Inc. | USATHAMA | Task Order - 8, Field Demonstration - Composting of Explosives - Contaminated Sediments at LAAP | 40 |

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| 30 | October 1988 | IT | LAAP | Evolutionary Enhancements to the HTTS-1 | 35 |
| 31 | January 1989 | LDEQ | Commander, LAAP | Letter granting permission to incinerate soil | 2 |
| 32 | January 31, 1989 | Robin Lyn Stein USATHAMA | LAAP | Post Remedial Investigation, Resampling Effort | 9 |
| 33 | February 10, 1989 | EPA, U.S. Army, LDEQ | Internal | Federal Facility Agreement (FFA) between the U.S. EPA, U.S. Army, and LDEQ | 83 |
| 34 | February 21, 1989 | EPA, LAAP, LDEQ | Public | News Release regarding EPA, U.S. Army, and LDEQ signing a Federal Facility Agreement for federal Superfund cleanup activities at LAAP | 4 |
| 35 | April 1989 | Weston | USATHAMA | Delivery Order 8, LAAP, Updated Remedial Investigation (Two volumes) | 600 |
| 36 | July 1989 | Hunter/ESE | USATHAMA | Public Involvement and Response Plan for LAAP | 130 |
| 37 | October 1989 | LAAP | USATHAMA | Proposal to Revise the Excavation Criteria for the LAAP Area P Interim Response Action | 45 |
| 38 | May 1990 | ESE | USATHAMA | Feasibility Study, Final Sampling and Analysis Plan, Data Item A004 | 120 |
| 39 | May 1990 | ESE | USATHAMA | Feasibility Study, Final Sampling and Analysis Plan, Volume 2, Quality Assurance Project Plan, Data Item A006 | 125 |
| 40 | May 1990 | ESE | USATHAMA | Feasibility Study, Final Health and Safety Plan, Data Item A009 | 100 |

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| 41 | May 1990 | ESE | USATHAMA | Feasibility Study, Final Feasibility Study Work Plan, Data Item A005 | 165 |
| 42 | August 2, 1990 | USACE, Fort Worth District and Toxic and Hazardous Materials Agency | Commander, LAAP | Closure Plan for the Interim Response Action at the Area P Lagoons | 45 |
| 43 | January 10, | Engineering Technologies Associates, Inc. | USATHAMA | Technical Support Services for Installation Restoration Program, Contract DAAA15-89-D-0009, Task 2 - Prepare Ground Water Model for Selected Sites at the Louisiana Army Ammunition Plant - Final Report | 145 |
| 44 | July 3, 1991 | Chemical Hazard Evaluation Program, Health and Safety Research Division, Oak Ridge National Laboratory | USATHAMA | Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for LAAP | 100 |
| 45 | September 1991 | ESE | USATHAMA | LAAP Proposed Basis for the Feasibility Study | 12 |
| 46 | February 1992 | ESE | USATHAMA | Feasibility Study, LAAP, Final Comprehensive Remedial Investigation, Vol. 1 through 7 | 1700 |
| 47 | February 1992 | ESE | USATHAMA | Feasibility Study, LAAP, Final Comprehensive Risk Assessment, Volumes 1 and 2 | 300 |
| 48 | September 1992 | USATHAMA | LAPP | Maintenance Plan, LAAP, Former Area P Lagoons | 14 |
| 49 | September 1992 | IT | USATHAMA | Final Report on Decontamination Operations (Area P) | 94 |

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| 50 | October 1992 | Department of the Army | United States Army Materiel Command, Alexandria, Virginia | Environmental Assessment, Proposed Inactivation of the LAAP Shreveport, Louisiana and of the Scranton Army Ammunition Plant, Scranton, Pennsylvania | 130 |
| 51 | January 1993 | Woodward/Clyde Federal Facilities | U.S. Army Environmental Command (USAEC) | Final Technical Work Plan, LAAP Drinking Water Monitoring, Volume I | 29 |
| 52 | January 1993 | Woodward/Clyde Federal Facilities | USAEC | Final Technical Remedial Investigation Work Plan, Management and Resource Utilization Plan, LAAP (Volumes II, III, IV) | 600 |
| 53 | October 1993 | USAEC | ESE | Revised Final Feasibility Study Report for LAAP, Shreveport, Louisiana | 325 |
| 54 | February 1994 | Science Applications International Corporation (SAIC) | U.S. Army Environmental Command (USAEC) (formerly USATHAMA) | Final Data Management Plan, Five-Year Review of Interim Remedial Action at Former Area P Lagoons, LAAP, Shreveport, Louisiana | 30 |
| 55 | February 1994 | SAIC | USAEC | Final Accident Prevention Health and Safety Plan (Five-Year Review of Interim...) | 80 |
| 56 | February 1994 | SAIC | USAEC | Final Quality Assurance Project Plan (Five-Year Review of Interim...) | 100 |
| 57 | February 1994 | SAIC | USAEC | Final Project Management Plan (Five-Year Review of Interim...) | 35 |
| 58 | February 1994 | SAIC | USAEC | Final Field Sampling Design Plan (Five-Year Review of Interim...) | 145 |

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|---|---|---|---|---|---|
| 59 | May 1994 | Woodward-Clyde Federal Services, Inc. | USAEC | Final, LAAP Drinking Water Monitoring Report | 25 |
| 60 | May 1994 | ESE | USAEC | Final Proposed Remedial Action Plan | 90 |
| 61 | May 1994 | Geophex | USAEC | Final Technical Work Plan Addenda for Drinking Water Monitor and Monitor Well Abandonment at LAAP | 17 |
| 62 | March 1995 | EPA | LAAP | Letter requesting a single groundwater unit for all of LAAP | 1 |
| 63 | May 8, 1995 | ESE | USAEC | Draft Soil/Source Operable Unit, Proposed Remedial Action Plan | 50 |
| 64 | September 1995 | Geophex, Ltd. | USAEC | Final Report for Drinking Water Monitoring and Monitor Well Abandonment | 30 |
| 65 | December 5, 1995 | ESE | USAEC | Final Soil/Source Operable Unit, Proposed Remedial Action Plan | 30 |
| 66 | December 1995 | SAIC | USAEC | Final Five-Year Review Report, Five-year Review of Interim Remedial Action at Former Area P Lagoons | 165 |
| 67 | Undated brochures | USATHAMA | Public | Notice of Public Hearing | 4 |

EPA ADMINISTRATIVE RECORD
LOUISIANA ARMY AMMUNITION PLANT
Shreveport, Louisiana

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Administrative Record Guidance Index
(EPA Guidance Documents are available for review at EPA Region 6, Ft. Worth, Texas)

| Title | Author | Date |
|---|---|---|
| Remedial Action of Waste Disposal Sites (Revised), EPA/625/6-85/006 | EPA | 00/00/85 |
| Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, EPA/540/6-89/004 | EPA | 00/00/88 |
| Remedial Action Costing Procedure Manual, EPA/600/8-87-049 | EPA | 00/00/88 |
| CERCLA Compliance with Other Laws Manual: Draft Guidance, EPA/540/G-89/006 | EPA | 08/00/88 |
| Guidance on Preparing Superfund Decision Documents: the Proposed Plan, the Record of Decision, Explanation of Significant Differences, the Record of Decision Amendment (Interim Final) | EPA | 10/00/88 |
| Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual, Part A, Interim Final, OSWER Directive 9285.7-01 | EPA | 00/00/89 |
| Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final) | EPA | 07/00/89 |
| Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER Directive 9355.0-30 | EPA | 00/00/91 |
| Superfund Exposure Factors Handbook | EPA | 00/00/89 |
| Water Well Regulations | Louisiana DOT | 00/00/85 |

**Appendix C**

**Letters of Support Agency Concurrence**

(to be added)