REVIEW OF PAST ENVIRONMENTAL STUDIES, REDSTONE ARSENAL, ALABAMA

November 1993

Contract Number DAAA15-90-D-0001

Prepared By:

Advanced Sciences, Inc.
1250 Brass Mill Road
Belcamp, Maryland 21017

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DISCLAIMER

The present document has been prepared by Advanced Sciences, Inc. under contract no. DAAA-15-D0001, Task 15, as a review and synopsis of historical data collected at Redstone Arsenal. The studies summarized herein are listed in the References section. The summaries of conclusions and comments presented in this review represent a synopsis of findings from each of the referenced studies. They do not necessarily reflect the technical judgement and/or comment of Advanced Sciences, Inc.

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LIST OF ACRONYMS
(in order of appearance)

RSA	Redstone Arsenal
RCRA	Resource Conservation and Recovery Act
SWMU's	Solid Waste Management Units
AOC's	Areas of Concern
EPA	US Environmental Protection Agency
RFI	RCRA Facility Investigation
HEA's	Health and Environmental Assessments
RDX/HMX	Royal Demolition Explosive (cyclotrimethylene trinitramine)/ High Melting Explosive (cyclomethylene tetranitroamine)
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration

EXECUTIVE SUMMARY

Redstone Arsenal (RSA) in Madison County, Alabama, is evaluating past hazardous waste management practices in accordance with the regulations set forth by the Hazardous and Solid Waste Management (HSWM) of the Resource Conservation and Recovery Act (RCRA). To this end, several studies have been performed and documents prepared to characterize the nature and extent of contamination at RSA. The sites that were investigated at RSA are regulated under RCRA as Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs).

To date, a total of 273 potential SWMUs and 13 AOCs have been identified on RSA (Geraghty & Miller, 1992). Based on the potential for release as well as an evaluation of the nature of the wastes managed, each unit was reviewed and judged "high", "moderate", or "low" with regard to its priority for evaluation (See Appendix A). Twenty-five SWMUs recieved a "high" priority rating, of these, 19 SWMUs have been investigated to determine the nature and extent of contamination present. Forty-two units recieved a "moderate" rating, of which 6 are addressed in an RCRA Facility Investigation (RFI) and 131 SWMUs rated a "low" priority, 3 are addressed in an RFI.

Advanced Sciences, Inc. (ASI), under contract No. DAAA-15-90-D0001, Task 15, has reviewed ten environmental documents pertaining to RSA investigations, focusing on the contamination detected at the 29 "high" priority SWMUs investigated. This report presents a synopsis of the contamination assessment at RSA as described in the following documents.

1.) *DRAFT, Corrective Measures Studies for Redstone Arsenal Alabama*, Volumes 1 & 2, Environmental Science and Engineering, Inc., April 1993.

This document presents the results of a "streamlined" Corrective Measures Study (CMS) for areas at RSA. This document prioritized SWMUs based on the types and associated risks of contaminants present. SWMUs and AOCs are catagorized into study areas or Corrective Management Units (CAMUs) according to their analogous contaminants. Based on a stringent evaluation process developed in accordance with the RCRA-RFI Guidance (EPA 1989), a recommended alternative was selected for the contaminated media in each of the study areas. This document summarizes the use and history of each study area, and reviews the results presented in the RFI Phase I and II Reports.

The identified study areas are:

Unit 1
- RSA-10 - Former Sanitary Landfill (closed disposal trenches and closed waste oil pits)

Unit 2
- RSA-12, 13, 14, 131, 132, 133 - Active Open Burn/Open Detonation Areas

Unit 3
- RSA-49 - Former Arsenic Ponds
- RSA-48 - Former Sanitary and Industrial Landfill
- RSA-53 - Former Sanitary and Industrial Landfill

- RSA-60 - Former Sanitary and Industrial Landfill
- RSA-59 - Former Industrial Landfill
- RSA-55/54 - Former Sanitary and Industrial Landfill
- RSA-66 - Former Ash Disposal and Demolition Area
- RSA-68 - Former Industrial Waste and Ordnance Disposal and Demolition Area

2.) *DRAFT, Site Characterization Work Plan for Redstone Arsenal Alabama*, Environmental Science & Engineering, Inc. June 28, 1993.

This document provides support of site characterization on activities at the following six SWMUs:

- RSA-46 - Former Chemical Shell Test Area
- RSA-47 - Chemical Training Facility
- RSA-51 - Inactive Demilitarization (Demil) Area
- RSA-56 - Former Arsenic Ponds South
- RSA-122 - WW-II Lewisite Manufacturing Facility Site
- RSA-139 - Arsenic Waste Lagoon

This Site Characterization Work Plan was prepared to provide a consolidated report on site history, current site activities, and potential site impacts; provide field crews with adequate knowledge of site conditions; and provide project plans and tasks for conducting site activities.

3.) *DRAFT FINAL, Corrective Action Management Plan for Redstone Arsenal*, Alabama, Environmental Science & Engineering, Inc., May 1993.

This document designates the 198 SWMUs and AOCs at RSA into high (25 sites), medium (42 sites) and low (131 sites) priority sites. This document classifies the sites into study groups and recommends actions to be taken at those sites. Appendix A of this document contains descriptions of potential receptors.

4.) *Implementation of the RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas on Redstone Arsenal Alabama*, Geraghty & Miller, Inc., June 1990.

This document describes the RFI process and the activities associated with the RFI conducted by Geraghty & Miller.

5.) *DRAFT FINAL, Phase II Addendum RCRA Facility Investigations at Unit 1, Unit 2, and selected Unit 3 Areas at Redstone Arsenal Alabama*, Volumes 1 & 2, Geraghty & Miller Inc., December 1992.

The Phase II Addendum provides a general description of the Phase II RFI activities, and also describes the site-specific RFI for each site. Sites included in this study are:

Unit 1

- RSA-10 - Former Sanitary Landfill (closed disposal trenches and closed waste oil pits)

Unit 2

- RSA-12, 13, 14, 131, 132, 133 - Active Open Burn/Open Detonation Areas

Unit 3

- RSA-49 - Former Arsenic Ponds
- RSA-48 - Former Sanitary and Industrial Landfill
- RSA-53 - Former Sanitary and Industrial Landfill
- RSA-60 - Former Sanitary and Industrial Landfill
- RSA-59 - Former Industrial Landfill
- RSA-55/54 - Former Sanitary and Industrial Landfill
- RSA-66 - Former Ash Disposal and Demolition Area
- RSA-68 - Former Industrial Waste and Ordnance Disposal and Demolition Area

6.) *FINAL, Phase I Report RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas at Redstone Arsenal, Alabama*, Volumes 1 & 2, Geraghty & Miller, Inc., May 1992.

This report presents the results of the Phase I RFI Field Investigations and Health and Environmental Assessments (HEAs) conducted at the SWMUs listed in reference #5. This report also presents recommendations for the Phase II RFI.

7.) *FINAL, Identification and Evaluation of Potential Solid Waste Management Units and Areas of Concern at Redstone Arsenal, Alabama*, Geraghty & Miller, Inc., February 1993.

This report presents the results of the survey conducted to identify, describe and evaluate potential SWMUs and AOCs at RSA. In this report, each SWMU and AOC is listed with a description; justification for being listed as a SWMU or AOC; rating of potential for release of contaminants; and prioritized sites as to high, medium or low priority.

8.) *RCRA Facility Investigation - Phase I Report for RSA-58, RSA-115, RSA-116, RSA-129, RSA-G and Target Seeker Area Redstone Arsenal, Alabama*, Engineering-Science, March 1992.

This document presents the results of the RFI conducted at RSA-58, RSA-115, RSA-116, RSA-129, RSA-G and Target Seeker Area. The purpose of this RFI was to verify releases from the investigated sites, characterize the nature and extent of contamination at each site; characterize the source at each site; perform HEAs for the sites; determine the need for interim corrective action; and supply information to determine the need for initiating a corrective measures study.

9.) *FINAL, RCRA Facility Investigation - Work Plan for RSA-58, RSA-115, RSA-116, RSA-129, RSA-G and Target Seeker Area Redstone Arsenal, Alabama*, Engineering-Science, March 1992.

This RFI Work Plan provides the necessary information needed to perform the RFI referenced in #8, to determine the nature and extent of contamination at the SWMUs studied.

10.) *FINAL, Work Plan RCRA Facility Investigation at Unit 1, Unit 2, and Selected Unit 3 Areas at Redstone Arsenal, Alabama*, Geraghty & Miller, Inc., June 1990.

This work plan was prepared to describe the investigation conducted to characterize the nature, extent, and rate of contaminant migration from the SWMUs listed in reference #6.

1.0 INTRODUCTION

The Redstone Arsenal is located in southern Madison County, Alabama. RSA is bounded by the city of Huntsville to the north and east, and by the Tennessee River on the south, which is also the southern boundary of Madison County. (See Figures 1-1 and 1-2.) Huntsville to the north of RSA, has a population of nearly 158,000. The towns of Madison and Trianna are northwest and southwest of the Facility, respectively. The total population of Madison County is greater than 233,000. Approximately 1,000 military families reside in government quarters on RSA, and approximately 31,500 government workers and contractors work at the Facility.

The Facility encompasses approximately 38,300 acres. Of that area, 36,459 acres are controlled by the U.S. Department of the Army. Approximately 2900 acres owned by the Tennessee Valley Authority (TVA) and 4100 acres of Wheeler National Wildlife Refuge are within the boundaries of RSA. Approximately 15,500 acres of RSA are woodlands and 9200 acres are leased for agricultural use.

The U.S. Army began using this site in 1941 when RSA, Huntsville Arsenal and Gulf Chemical Warfare Depot were formed. These arsenals were initially used for the storage of chemical munitions and protective equipment. Later, processing and manufacturing operations were conducted at the site. Six mustard gas manufacturing plants, located in central RSA, were in operation from 1942 to 1943. Materials that were used or produced in substantial quantities in the mustard gas operations included sulfur monochloride, ethylene, brine, caustic soda, liquid caustic, chlorine, and thionyl chloride. Two chlorine plants were constructed in support of the mustard gas activities, and remained in operation until 1970. Storage and disposal of mustard gas products and wastes were onsite at various locations throughout the Arsenal. Lewisite, a chemical warfare agent containing arsenic, was manufactured in four plants in central RSA, during 1942 to 1943. Wastes containing arsenic generated from the Lewisite manufacturing were disposed in shallow ponds at RSA. (ES 1993).

Subsequent to World War II, portions of RSA were leased to numerous private firms for the production of commercial chemicals and pesticides. The manufacturing of pesticides, primarily DDT, began in 1947 and terminated in 1971. The manufacturing of pesticides resulted in the production of significant amounts of pesticide-contaminated wastes. Thousands of pounds of DDT wastes were buried at landfills throughout RSA, and large quantities of DDT-tainted wastewater were discharged to surface waters onsite. (ES 1993).

Ordnance, including shells, grenades, and smoke pots have also been manufactured and demilitarized at RSA. Large areas on the Facility continue to be used for testing propellants, explosives, and ordnance as well as troop training.

From 1949 to present, research and development in rocketry and guided missile systems has been a major mission of RSA. Thiokol Corporation currently operates a rocket motor manufacturing plant that utilizes organic nitrogen propellants based on RDX/HMX compounds. Wastes from this manufacturing operation include propellants, propellant-contaminated shipping materials, propellant-contaminated solvents, Freon 113, solvents and waste oils. The Marshall Space Flight Center (MSFC) of NASA resides at RSA and

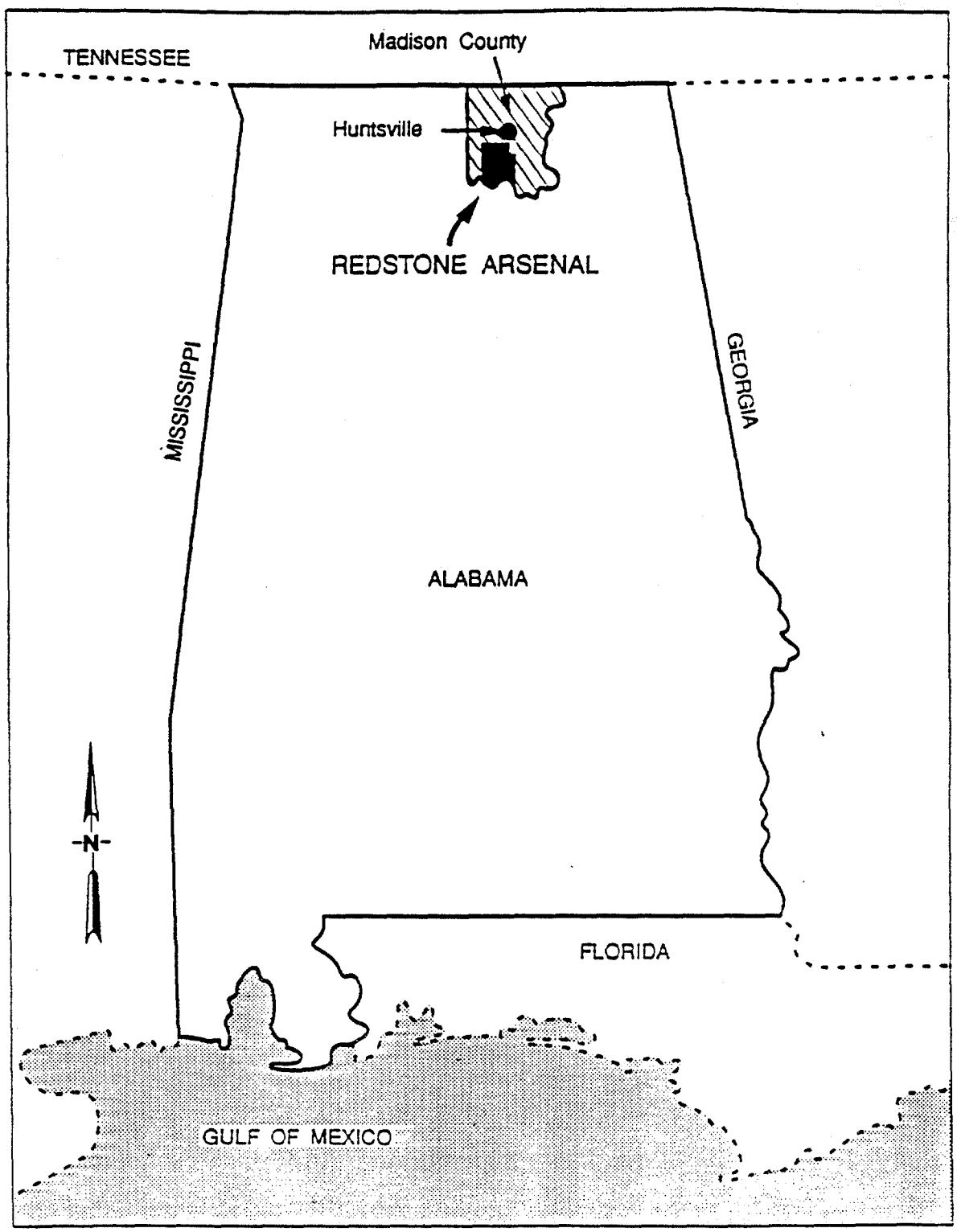

FIGURE 1-1. LOCATION MAP OF REDSTONE ARSENAL, ALABAMA.

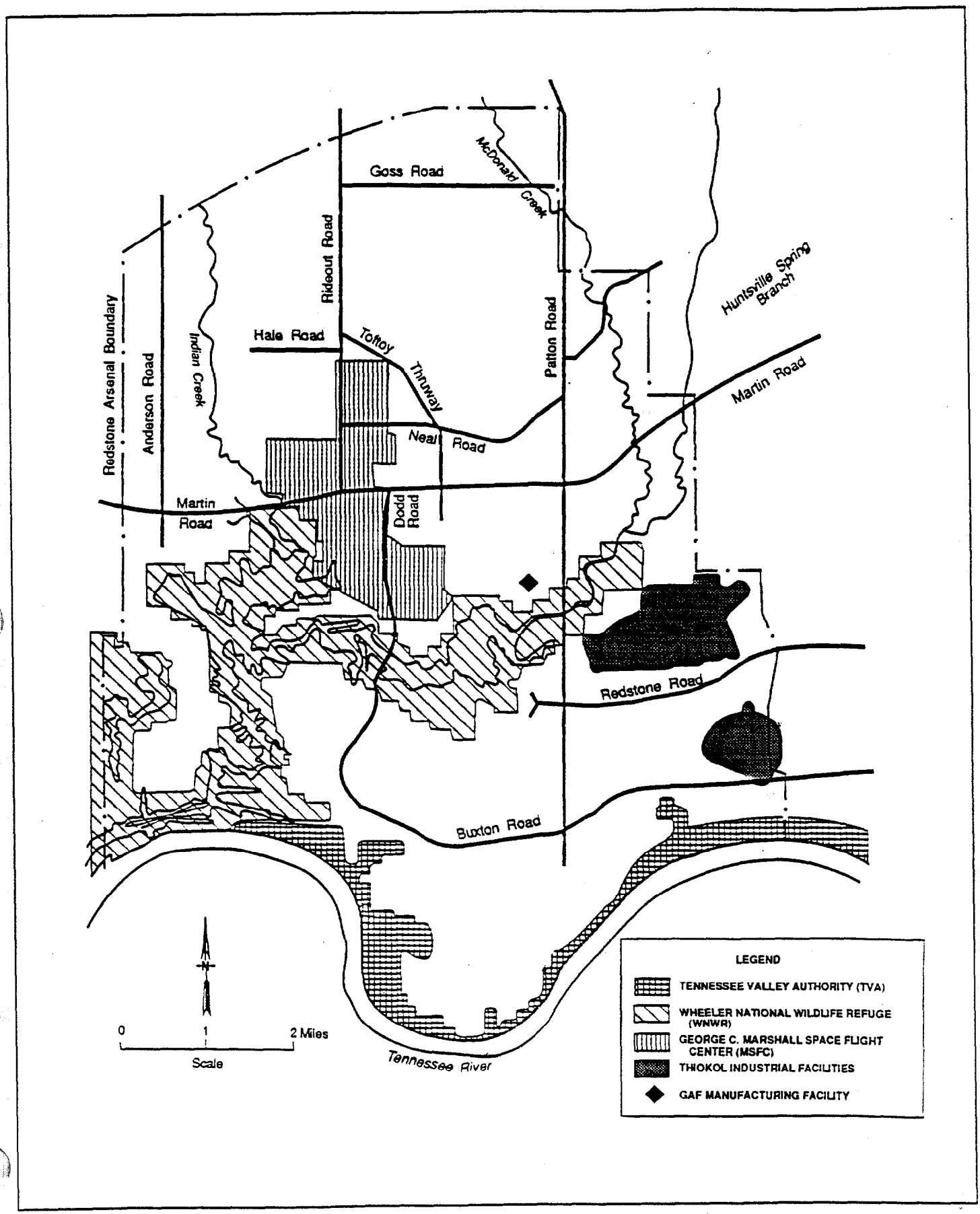

FIGURE 1-2. FACILITY MAP OF REDSTONE ARSENAL, ALABAMA.

currently develops, tests and manufactures space vehicles and components. Many of the hazardous wastes generated by production and testing activities at RSA during the last half-century were consigned to waste disposal areas, such as landfills and ponds. Toxic constituents in some of these areas, known as Solid Waste Management Units (SWMUs), have migrated from the disposal areas and have contaminated soils, surface waters, and groundwater. There are 198 SWMUs and Areas of Concern (AOCs) on RSA. These areas are described in Appendix A. Targets potentially affected by uncontrolled releases from hazardous waste sites include RSA employees and nearby residents, groundwater, surface waters and sensitive environments (wetlands). Potential users of groundwater include the households that use numerous private wells in the vicinity, as well as residents served by municipal wells in the City of Huntsville.

Several environmental studies have been conducted at RSA over a number of years to characterize the extent of contamination, with some of the fairly recent work dating back to 1990. The installation has identified 286 individual sites, and these are each numerically identified. The range of issues and large number of individual study areas associated with the complex has led to the present review and synthesis of the most recent findings. This document therefore represents a summary of the various findings in the referenced studies as a single composite review. The next section briefly describes the salient features of the Facility, while section 3.0 describes the findings by study area. These are indicated at the beginning of each subsection for readers' ready reference.

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2.0 SITE DESCRIPTION

2.1 Land Use

The majority of the land at RSA (85%) is either forest or open land, including land outleased for agriculture. Approximately 10% of the land has already been developed, and the remaining 5% is either covered by water or brush. All of the outleased agricultural land have been classified by U.S. Department of Agriculture's Soil Conservation Service as being either prime farmland or lands of state importance.

Outside the boundaries of RSA, much of the adjacent area is metropolitan with the normal single and multi-family residential areas, shopping areas, and industrial areas. The city of Huntsville borders RSA on three sides, the more rural areas are those that border RSA to the southwest and southeast and across the Tennessee River to the south. In these areas, as well as a few of the other outlying areas of Madison County, agriculture remains an economic mainstay.

The area includes 33 city parks, 2 county parks, and 1 state park. Fishing and hunting are very popular in the area; the Tennessee River and Wheeler Lake are used for both recreational and some commercial fishing.

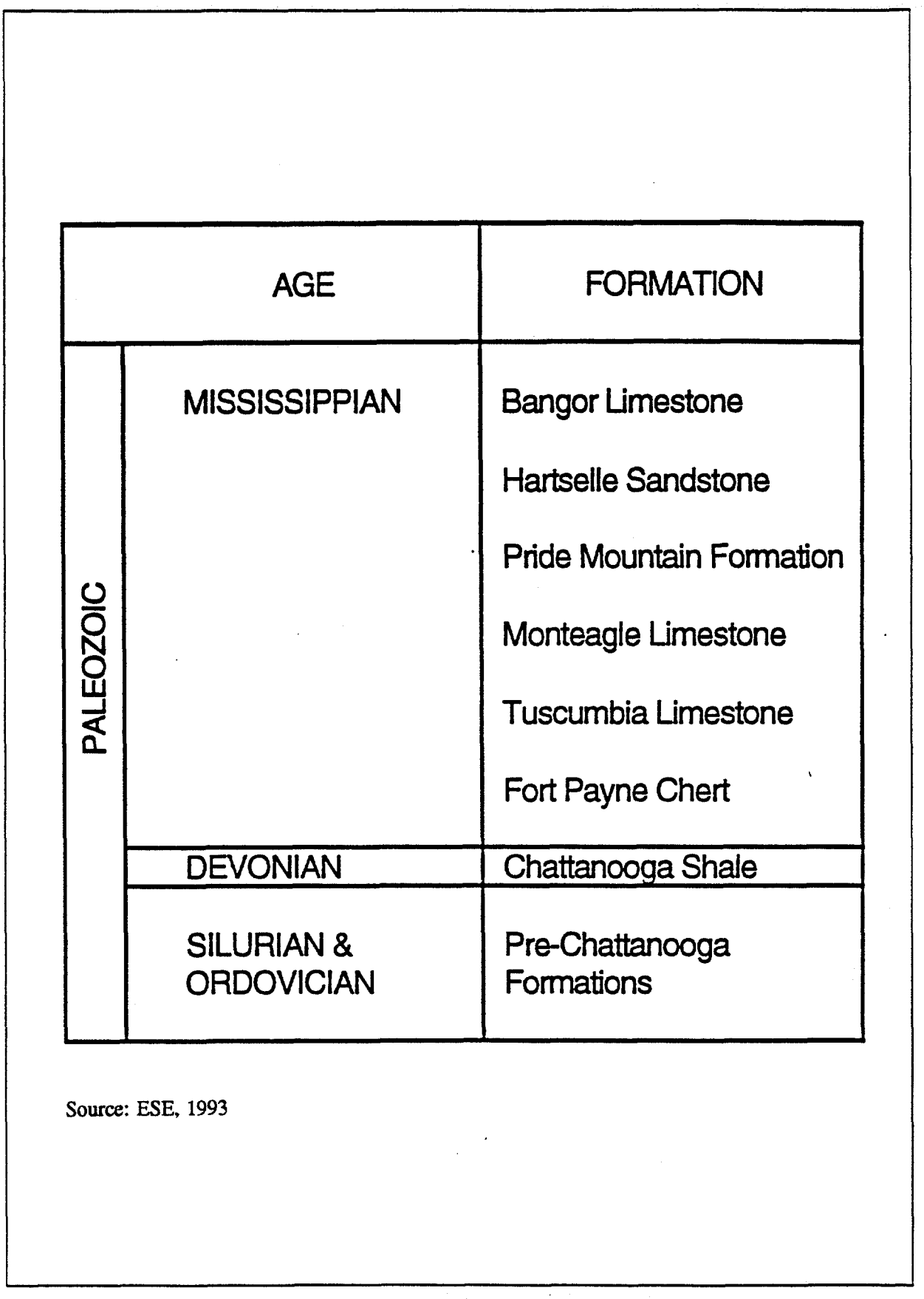
2.2 Topography

RSA lies within the Highland Rim Section of the Interior Low Plateau Physiographic Province. This area is characterized as having a gently rolling landscape with a general slope from north to south toward the Tennessee River. Topographically high areas are Weeden and Madkin Mountains. Topographically low areas include valleys and flood plains of the Tennessee River (Geraghty & Miller, 1992).

2.3 Site Geology

The geologic structure in northern Alabama is influenced by the Nashville Dome, a regional structure approximately centered around Nashville Tennessee (ESE, 1993). RSA is located on the *South Flank* of the Nashville Dome. The geologic units in the area of RSA have a gentle regional dip of 20 feet per mile to the southeast (LaMoreaux, 1975).

RSA is underlain by metamorphic and plutonic basement rocks of mid-Precambrian age. These rocks are overlain by Paleozoic age sedimentary formations. The principal sedimentary rock types occurring under RSA are shale, sandstone, limestone, and chert. In stratigraphic sequence from oldest to youngest these formations are named: Pre-Chattanooga Formations, Chattanooga Shale, Fort Payne Chert, Tuscumbia Limestone, Monteagle Limestone, Pride Mountain Formation, Hartselle Sandstone, and Bangor Limestone (See Figure 2-1).



Source: ESE, 1993

FIGURE 2-1. BEDROCK GEOLOGY AT REDSTONE ARSENAL, ALABAMA.

Overburden residual soils directly underlie most of the RSA area except for alluvial deposits in the vicinity of the Tennessee River. The limestone derived residual soils typically consist of moderate-red to moderate-reddish orange sandy clay and clay with weathering chert and limestone fragments. Generally, chert and limestone fragments are more abundant near the base of the overburden. The overburden thickness varies between depths of less than 20 feet as in the highland areas of Madkin Mountain to thicknesses of 40 feet and greater where the limestone has been deeply weathered (LaMoreaux, 1975).

Except for a few areas such as Weeden and Madkin Mountains the younger formations (i.e., Bangor Limestone, Hartselle Sandstone, Pride Mountain Formation and Monteagle Limestones) have been weathered away. Generally, stratigraphically beneath the overburden is the Mississippian age Tuscumbia Limestone. (See Figure 2-2.) The Tuscumbia Limestone has an average thickness of 150 ft. and consists of light-gray, fossiliferous limestone with chert lenses and nodules (LaMoreaux, 1975). The limestone is Karst, containing enlarged openings that have developed along joints, fractures, bedding planes, and faults (Geraghty & Miller, 1992).

The Tuscumbia Limestone is successively underlain by the Fort Payne Chert. The thickness of the Fort Payne Chert ranges from 155 to 185 feet. The Fort Payne Chert is a light-gray fossiliferous limestone with thin beds of bluish-gray nodular chert (LaMoreaux, 1975).

Below the chert is the Devonian age Chattanooga Shale which is about 10 feet thick and consists of dark-gray to black fossiliferous shale with a discontinuous thin bed of fine-grained sandstone at the base (LaMoreaux, 1975).

Beneath the shale is mostly limestone units termed *Pre-Chattanooga Formations* (LaMoreaux, 1975).

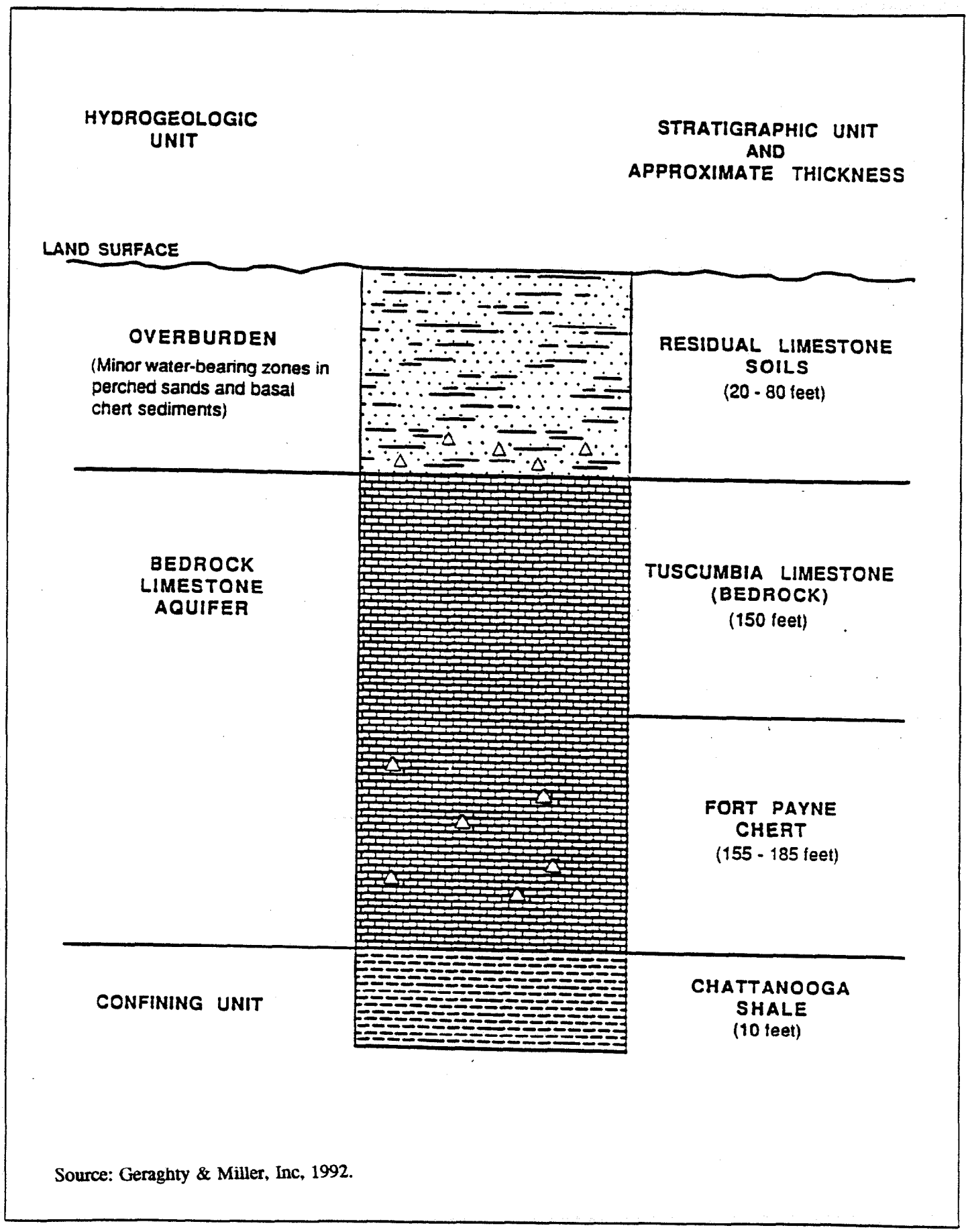
2.4 Soils

Soils in the Madison County Region are cherty silt loams, silt loams and silty clay loams. The variations depends on the overlying bedrock from which they were derived (ESE, 1993).

Much of the soils over northern portions of RSA are well suited for crops and grazing. These soils are generally well drained red fertile soils that are thick over limestone bedrock. They exist on nearly level to gently rolling terrain. The Decator Silt Loam is representative of this soil type (Geraghty & Miller, 1992).

The mountainous areas found on RSA contain thin clayey texture soils of low permeability at there bases and in some cases layers of fine sandy loams occupy the steeper mountain slopes (Geraghty & Miller).

The lowlands and the Tennessee River floodplain area are covered by significant deposits of alluvial and colluvial materials (clays, silts, sands and gravels) (ESE, 1993).



Source: Geraghty & Miller, Inc, 1992.

FIGURE 2-2. GENERAL STRATIGRAPHY AT REDSTONE ARSENAL, ALABAMA.

2.5 Climatology

The climate at RSA is mild and temperate with an average annual temperature of 62°F. Average summer temperature is 77°F, and the average winter temperature is 47°F. Average annual snowfall is 3 inches, and the average annual rainfall is 48 inches. Total monthly precipitation is usually highest in March (5.6 inches) and lowest in October (2.7 inches). Moderately dry conditions generally prevail in the autumn.

2.6 Hydrology

The Tuscumbia Limestone and Fort Payne Chert Formations comprise the primary aquifer underlying RSA. In most of the area, water in this aquifer occurs under artesian conditions with overburden and the Chattanooga Shale acting as upper and lower confining units, respectively. Groundwater is stored and transmitted along bedding planes, fractures, and solution cavities which are common in the upper 100 feet of the limestone. The thickness of the aquifer varies across the facility depending on the depth of erosion. However, in the southern portion of the facility it may exceed 300 feet. Potentiometric data indicates that groundwater in this aquifer flows from west to east in the northwestern part of the site, then southward toward Huntsville Spring Branch. (ESE, 1993).

The overburden and alluvial deposits throughout RSA appear to be hydraulically connected with the top of the limestone. The permeabilities in these units generally increase with depth. The upper portions of the overburden contain discontinuous perched water zones (ESE, 1993).

2.7 Surface Water

The Tennessee River marks the southern boundary of RSA and flows west. All surface drainage leaving the Arsenal empties into the Tennessee River. Huntsville Spring Branch, McDonald Creek, and Indian Creek are major tributaries emptying into the Tennessee River and flows relatively southward. Approximately 90% of the drainage first passes through Wheeler Lake, located in the central and southwest portion of RSA, before entering the Tennessee River. Wetlands are associated with the creeks and tributaries as well as the Tennessee River. (ESE, 1993).

Floods are common although extensive flooding is infrequent. The 100-year flood level of the Tennessee River is at an elevation of 572.5 feet above mean sea level (msl). A significant portion of the southern part of the facility is within the 100 year floodplain (ESE, 1993).

2.8 Sensitive Environments

Extensive wetlands are present along the numerous drainage pathways and in low lying areas within RSA boundaries. Wheeler National Wildlife Refuge occupies approximately 4,100 acres of RSA. There are twenty federally and/or state listed endangered or threatened fauna species that potentially occur at RSA. The Alabama Cave Shrimp was listed in 1989 as an endangered species, it occurs in a cave located on the northwestern portion of RSA.

3.0 CONTAMINATION ASSESSMENT

Past waste handling and disposal practices at RSA have resulted in 198 SWMUs and AOCs at RSA. These areas are further described in Appendix A. Contaminants of Concern (CoC) at these areas are listed in Table 3-1.

Investigations conducted at RSA to determine the nature and extent of contamination present has been performed at 28 SWMUs (see Figure 3-1). A review of the documentation has been made by ASI, and a synopsis of the contamination present at those SWMUs is presented in this section. Each subsection is devoted to the individual study areas for readers' reference.

The information presented in each subsection is structured according to the following descriptors:

- Location
- Brief History
- Contaminants of Concern
- Affected Media
- Current Status and Comments

A crosswalk of the RSA sites covered in each of the referenced studies is as follows.

REFERENCE	STUDY AREA
• *DRAFT, Corrective Measures Studies for Redstone Arsenal Alabama*, Volumes 1 & 2, ES & E, April 1993.	RSA # 10, 12, 13, 14, 131, 132, 133, 49, 48, 53, 60, 59, 54, 55, 66, 68
• *DRAFT, Site Characterization Work Plan for Redstone Arsenal Alabama*, ES & E, June 1993.	RSA # 46, 47, 51, 56, 122, 139
• *DRAFT FINAL, Phase II Addendum RCRA Facility Investigations at Unit 1, Unit 2, and selected Unit 3 Areas at Redstone Arsenal Alabama*, Volumes 1 & 2, Geraghty & Miller, December 1992.	RSA # 10, 12, 13, 14, 131, 132, 133, 49, 48, 53, 60, 59, 54, 55, 66, 68
• *FINAL, Phase I Report RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas at Redstone Arsenal, Alabama*, Volumes 1 & 2, Geraghty & Miller, May 1992.	RSA # 10, 12, 13, 14, 131, 132, 133, 49, 48, 53, 60, 59, 55, 66, 68
• *RCRA Facility Investigation - Phase I Report*	

for RSA-58, RSA-115, RSA-116, RSA-129, RSA-G and Target Seeker Area Redstone Arsenal, Alabama, Engineering-Science, March 1992. RSA # 58, 115, 116, 129, G, 140

- *FINAL, RCRA Facility Investigation - Work Plan for RSA-58, RSA-115, RSA-116, RSA-129, RSA-G and Target Seeker Area Redstone Arsenal, Alabama,* Engineering-Science, March 1992. RSA # 58, 115, 116, 129, G, 140

- *FINAL, Work Plan RCRA Facility Investigation at Unit 1, Unit 2, and Selected Unit 3 Areas at Redstone Arsenal, Alabama,* Geraghty & Miller, June 1990. RSA # 10, 12, 13, 14, 131, 132, 133, 49, 48, 53, 60, 59, 54, 55, 66, 68

TABLE 3-1
COMPOUNDS OF CONCERN AT REDSTONE ARSENAL, ALABAMA

Inorganic (Metallic) Compounds		
Antimony (Sb)	Arsenic (As)	Beryllium (Be)
Cadmium (Cd)	Chromium (Cr)	Copper (Cu)
Lead (Pb)	Mercury (Hg)	Nickel (Ni)
Palladium (Pd)	Silver (Ag)	Thallium (TL)
Zinc (Zn)		
Volatile Organic Compounds (VOCs)		
1,1-Dichloroethene	1,1-Dichloroethane	1,1,1-Trichloroethane
1,1,2-Trichloroethane	1,1,2,2-Tetrachloroethane	1,2-Dichloropropane
1,2-Dichloroethane	2-Butanone	2-Chloroethyl vinyl ether
2-Hexanone	4-Methyl-2-pentanone	Acetone
Benzene	Bromodichloromethane	Bromoform
Bromomethane	Carbon tetrachloride	Carbon disulfide
Chlorobenzene	Chloroethane	Chloroform
Chloromethane	cis-1,2-Dichloroethene	cis-1,3-Dichloropropene
Dibromochloromethane	Ethylbenzene	m-/p-Xylene
Methylene chloride	Xylene	Styrene
trans-1,3-Dichloropropene	Trichloroethene	Vinyl chloride
Vinyl acetate		

TABLE 3-1
COMPOUNDS OF CONCERN AT REDSTONE ARSENAL, ALABAMA (CONTINUED)

Semivolatile Organic Compounds (SVOCs)		
1,2-Dichlorobenzene	1,2,4-Trichlorobenzene	1,3-Dichlorobenzene
1,4-Dichlorobenzene	2-Nitrophenol	2-Chlorophenol
2-Chloronaphthalene	2-Methylphenol	2-Nitroaniline
2-Methylnaphthalene	2,4-Dimethylphenol	2,4-Dichlorophenol
2,4-Dinitrotoluene	2,6-Dinitrophenol	2,4,5-Trichlorophenol
2,4,6-Trichlorophenol	2,6-Dinitrotoluene	3-Nitroaniline
3,3-Dichlorobenzidine	4-Chloroaniline	4-Chloro-3-methyl phenol
4-Bromophenyl phenyl ether	4-Methyphenol	4-Chlorophenyl phenyl ether
4-Nitrophenol	4-Nitroaniline	4,4'-DDT
4,6-Dinitro-2-methyl phenol	Acenaphthene	Acenaphthylene
Anthracene	Benzo(a)anthracene	Benzo(a)pyrene
Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzoic acid
Benzyl alcohol	bis(-2-Chloroethyl)ether	bis(-2-Chloroethoxy)methane
bis(2-Ethylhexyl)phthalate	bis(2-Chloroisoprophyl)ether	Butylbenzyl phthalate
Chrysene	Di-n-butyl phthalate	Di-n-octyl phthalate
Dibenzo(a,h)anthracene	Dibenzo(g,h,i)perylene	Dibenzo(g,h,i)perylene
Dibenzofuran	Diethyl phthalate	Diethyl phthalate
Dimethyl phthalate	Fluoranthene	Fluorene
Hexachlorobenzene	Hexachlorobutadiene	Hexachlorocyclopentadiene
Hexachloroethane	Indeno(1,2,3-cd)pyrene	Isophorone
N-Nitroso-di-n-propylamine	N-Nitrosodiphenylamine	Naphthalene
Nitrobenzene	Pentachlorophenol	Phenanthrene
Phenol	Pyrene	

RSA No.	SWMU
10	Active Sanitary Landfill
12	Open Burn Pads
13	Unlined Open Burn Pads
14	Contaminated Waste Burn Trenches
46	Former Chemical Shell Test Area
48	Inactive Sanitary Landfill
49	Former Arsenic Ponds, North
51	Inactive Demil Area
53	Inactive Sanitary Landfill
54	Inactive Sanitary Landfill
55	Inactive Sanitary Landfill
56	Former Arsenic Ponds, South

RSA No.	SWMU
58	Inactive Rubble Fill
59	Inactive Rubble Fill
60	Inactive Sanitary Landfill
66	Former Demolition Area
68	Toxic Area Z
115	Blowdown Lagoon, East Side
116	Blowdown Lagoon, South Side
122	WWII Lewisite Manufac. Facility
129	Thiokol Burning Pit Area
131	Open Detonation Area
132	Former Popping Furnace
133	Former Rocket Washout Pad
134	Former Disposal Trench
139	Arsenic Waste Lagoon
G	TCE Spill at Thiokol Degreaser

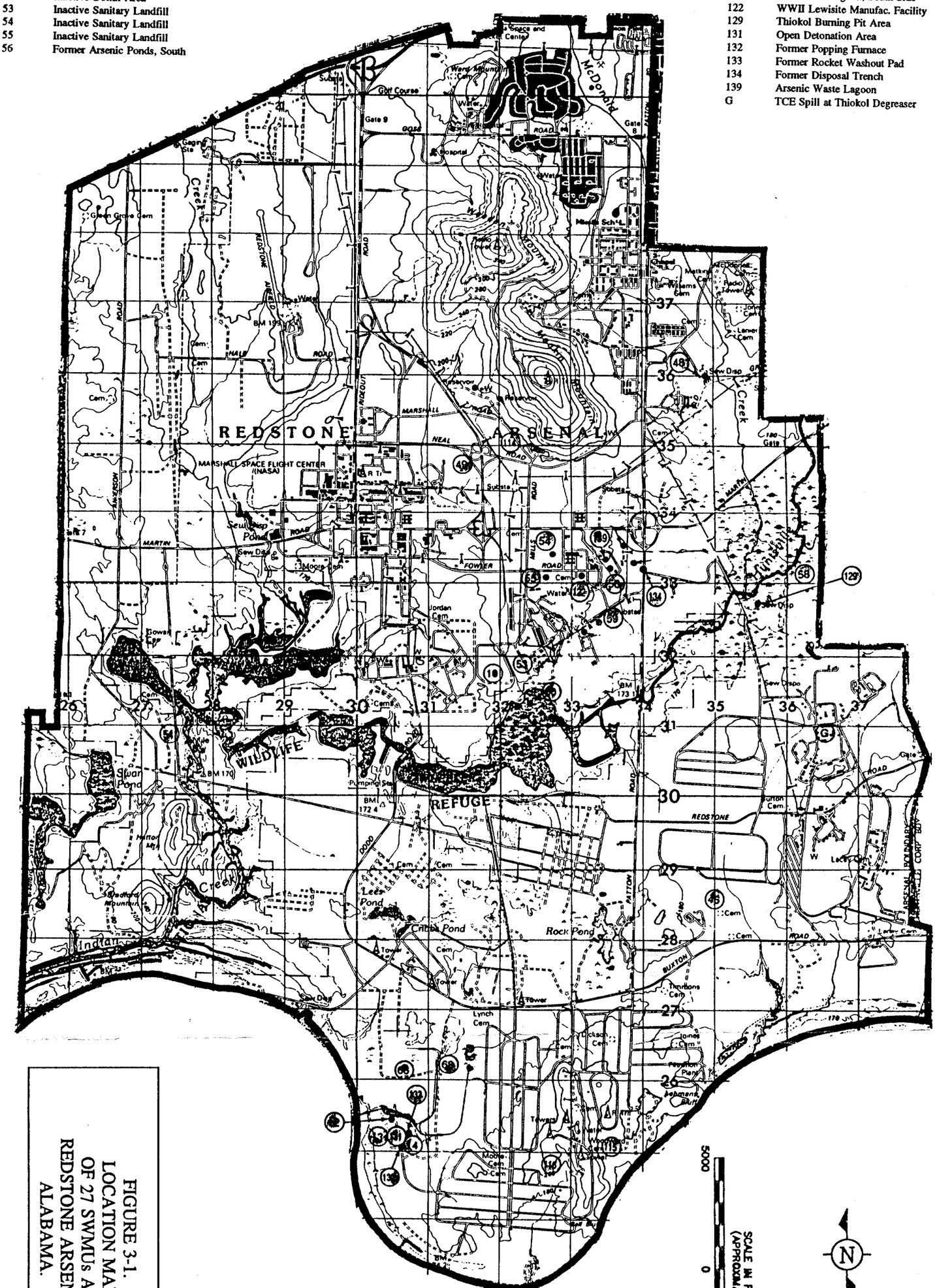


FIGURE 3-1.
LOCATION MAP
OF 27 SWMUs AT
REDSTONE ARSENAL
ALABAMA.

3.1 RSA #10 ACTIVE SANITARY LANDFILL (Unit 1, Area Q2)

3.1.1 Location

RSA #10 is located in the central portion of RSA. It is bordered by woods to the north, a closed landfill (Area Q3) to the east, wetlands to the south, and a NASA test area to the west.

3.1.2 Brief History

RSA #10 consists of an active sanitary landfill, closed disposal trenches, former waste oil pits and the former 2.5 acre DDT waste soils landfill. The sanitary landfill which occupies approximately 66 acres has been used since 1973 for disposal of a variety of wastes including typical household waste, waste oil, hospital infectious waste, construction debris, asbestos, and ash from incinerated paper. Closed portions of the landfill include disposal trenches and a rubble fill. The land surface of the closed disposal trenches is hummocky and covered with grass. The ground is unstable and subsurface gas can be observed escaping from the soil.

The DDT Waste Soils Landfill was used between 1979 and 1982 to dispose of sediments contaminated with DDT. After closing, the landfill was capped and covered with 2ft. or more of compacted clay. The former landfill is monitored under a Closure Post-Closure Plan (1983) as regulated by ADEM.

3.1.3 Contaminant(s) of Concern

Some PAHs present in the soil/waste samples from the test pits and soil borings, plus VOCs in the groundwater are at concentrations which exceed carcinogenic criteria.

Soil/waste from test pits

The highest concentrations of PAHs in the soils were found in the test pits and soil borings installed in the waste oil area and in the southernmost disposal trench system. VOCs in the form of VOAs (ethylbenzene, toluene, and xylenes) and chlorinated hydrocarbons were detected within the disposal areas. VOAs were particularly high in one test pit installed within the waste oil area(toluene (6600 ug/L) and xylenes (25000 ug/L). In a couple cases cadmium and silver were detected at elevated levels. The average concentration of cadmium in the nine soil/waste samples was 2.7 mg/kg. Silver was detected at 10.5 mg/kg.

Surface Water and Sediment Samples

Trace levels of pesticides and DDT and its metabolites were discovered in samples collected along the drainage ditch east of Unit 1. These constituents are believed to have migrated from other sources.

Groundwater

Various VOCs were detected in the groundwater samples. Volatile aromatic compounds were detected in only a few samples. Trichloroethene and its metabolites, dichloroethenes, were detected throughout the central and southern areas. The highest concentration of these contaminants was 390 ug/L in the southern area. The concentration of contaminants detected was highest in the perched water zone. Groundwater contamination found on the northern part of the site is very low and may result from local influences of the waste oil area. Apparent groundwater flow in all zones is to the southeast towards the Wheeler National Wildlife Refuge and associated wetlands.

3.1.4 Affected Media

The contamination in the soils at RSA # 10 appears to be limited to samples collected directly from the disposal trenches and waste oil pits.

3.1.5 Current Status and Comments

In the area of the waste oil pits additional soil borings are recommended to help determine the horizontal and vertical extent of the wastes and associated soil contamination. Neither the horizontal nor vertical extent of the groundwater contamination has been fully defined. However, the physical boundaries of the wetlands to the south and the access restrictions of the NASA boundary to the southwest prohibit any further drilling for extent of groundwater contamination at RSA #10.

In 1988 PELA concluded that the DDT Waste Soils Landfill was successfully containing the DDT waste and was not responsible for any local soil or groundwater contamination.

3.2 RSA # 12 OPEN BURN PADS
RSA # 13 UNLINED OPEN BURN PADS
RSA # 14 CONTAMINATED WASTE BURN TRENCHES
RSA # 131 OPEN DETONATION AREAS
RSA # 132 FORMER POPPING FURNACE
RSA # 134 FORMER ROCKET WASHOUT PAD

3.2.1 Location

These sites are located on the south end of RSA, and collectively studied as Unit 2. A large portion of this site lies within the floodplain of the Tennessee River.

3.2.2 Brief History

The active burn/open detonation area (OB/OD) used to dispose of and decontaminate explosives and explosive-contaminated materials and to dispose of reactive wastes by thermal treatment. This area consists of an open burn area with open burn pads where solvents and solvent-contaminated materials were formerly treated directly on the land surface; and open burn pans, where the same materials are thermally treated in above ground metal pans. Also part of this unit are the contaminated waste burn trenches, where waste solvents have formerly been disposed, and currently, non-hazardous propellant-contaminated materials are disposed/stored temporarily.

3.2.3 Contaminants of Concern

A variety of constituents were detected in the surface soil, subsurface soil, sediment, surface water, and groundwater samples collected within and in the vicinity of the OB/OD area. Contaminants of concern include explosives, BNAs and VOCs (primarily trichloroethene).

Soil samples

Twenty constituents (2 BNAs, 5 VOCs, 7 metals, and 6 explosives) were detected in shallow surface soil samples. 2,4,6-trinitrotoluene (145 *ug*/kg) exceeded both the systemic (40 *ug*/kg) and carcinogenic criteria (23 *ug*/kg).

Eighteen constituents (1 BNA, 10 VOCs, 6 metals, and 1 explosive) were detected in deep soil samples. Among these chemicals, trichloroethene (1870 *ug*/kg) exceeded the systemic criteria (592 *ug*/kg). Dichloroethene (4.9 *ug*/kg) and trichloroethene exceeded carcinogenic criteria (1.17 *ug*/kg; 63.6 *ug*/kg; respectively).

Surface water and Sediment samples

Two VOCs and two metals were detected in surface water samples. None of the constituents exceeded benchmark criteria.

Nine constituents (1 VOC, 5 metals, 3 explosives) were detected in the sediment samples collected. None of the constituents detected exceeded systemic or carcinogenic criteria.

Groundwater samples

Thirty-three constituents (3 BNAs, 19 VOCs, 7 metals, and 4 explosives) were detected in groundwater samples. Systemic criteria was exceeded by 1,2-dichloroethene (2440 *ug*/L; [70 *ug*/L]), and trichloroethane (5550 *ug*/L; [259 *ug*/L]). Eleven potential human carcinogens exceeded the criteria, including: bis[2-ethylhexyl]phthalate (21.3 *ug*/L), benzene (22.4 *ug*/L), 1,2-dichloroethene (96.4 *ug*/L), 1,1-dichloroethene (120 *ug*/L), methylene chloride (22.1 *ug*/L), tetrachloroethane (46.4 *ug*/L), 1,1,2,2-tetrachloroethene (6.09 *ug*/L), 1,1,2-trichloroethane (4.51 *ug*/L), trichloroethene (5550 *ug*/L), vinyl chloride (45.4 *ug*/L), and 2,4-dinitrotoluene (5.11 *ug*/L).

3.2.4 Affected Media

Environmental concerns for this site include surface soils, groundwater, surface water/sediments, and air. The most likely human exposure pathways are soil, surface water/sediment, and air. Groundwater contamination is unlikely as there are no drinking water supplies taken from groundwater in the vicinity.

The probability for contamination via air is high because the former open burn areas do not have a vegetative cover and the soils are exposed. The waste in the contaminated waste burn trenches is exposed and the waste are periodically incinerated and removed. The land surface within and in the vicinity of the trenches is not covered by vegetation. The probability of soil contact and/or ingestion is low because access to the site is restricted to workers at the site. The site is fenced and access is tightly controlled.

3.2.5 Current Status and Comments

The extent of contamination in the soils and groundwater has not been fully defined. The extent of higher concentrations of groundwater contamination has been fairly well defined. However, additional sampling should help delineate the occurrence of the constituents of concern. Additional drilling, overburden monitoring well installation, and groundwater sampling are recommended. Soil borings are also recommended within and around the contaminated waste burn trenches to help define the areal extent of surface and subsurface soil contamination in the area.

3.3 RSA-46 FORMER CHEMICAL SHELL TEST AREA CC

3.3.1 Location

RSA #46 occupies an area of approximately 24 acres in the southwest portion of RSA on Buxton Road, west of Patton Road.

3.3.2 Brief History

The area was used for the demilitarization of chemical weapons. Mustard gas and lewisite (arsenic compound) may have been disposed of at this site. It was an impact area for white phosphorus artillery rounds. Currently, the land is being used for cattle grazing.

3.3.3 Contaminants of Concern

Elevated levels of phosphorus were detected in soil and groundwater samples by PELA in 1987.

High explosives and white phosphorus rounds were observed during May 1993 soil gas geophysical surveys. According to 29 soil gas samples, all target VOCs (Trichloroethene, 1,2-dichlororethene, benzene, and toluene) were below the sample detection limit.

3.3.4 Affected Media

Affected media at RSA # 46 are the soils and groundwater.

3.3.5 Current Status and Comments

RSA # 46 is currently under investigation in the Site Characterization Work Plan.

3.4 RSA # 47 CHEMICAL TRAINING FACILITY EE

3.4.1 Location

RSA # 47 occupies an area of approximately 30 acres in the north central part of RSA.

3.4.2 Brief History

Live agents, including mustard and nerve agents were used until 1985. Soil was removed from potential contaminated areas to a depth of 8 inches and then backfilled with gravel.

3.4.3 Contaminants of Concern

25 soil gas samples show Terpenes at elevated concentrations in soil gas. Target VOCs (Trichloroethene, 1,2-dichloroethene, benzene, and toluene) were below detection limit. No intrusive studies (i.e. soil borings, monitor wells) and hydrologic studies have been conducted at RSA-47.

3.4.4 Affected Media

Potential pathways for release include groundwater infiltration and surface water runoff to the creek.

3.4.5 Current Status and Comments

Intrusive studies will be helpful in determining if contaminants were transported to other media such as groundwater and soil.

3.5 RSA # 48 INACTIVE SANITARY LANDFILL (UNIT 3 - AREA G)

3.5.1 Location

RSA # 48 occupies approximately 5.5 acres on McDonald Creek in east-central RSA.

3.5.2 Brief History

This site is a former sanitary landfill.

3.5.3 Contaminants of Concern

The principle constituents found at RSA # 48 are PAHs in the soil and trichloroethene in the surface water.

Soil/Waste samples from test pits

Thirty constituents (10 BNAs, 14 VOCs, and 6 metals) were detected in the soil/waste samples. One potential carcinogen, benzo[a]anthracene (22.1 *ug*/kg) exceeded the carcinogen criteria (0.22 *ug*/kg).

Surface soil samples

Seven constituents were detected in the surface soil samples, none of which exceeded benchmark criteria.

Deep soil boring samples

Nine constituents (3 VOCs, 6 metals) were detected, none exceeded benchmark criteria.

Surface water and Sediment samples

Three VOCs and three metals were detected in surface water samples. Among these constituents, methylene chloride (13.5 *ug*/L), and trichloroethene (38.4 *ug*/L), exceeded carcinogenic criteria (4.67 *ug*/L; 5.0 *ug*/L; respectively).

Two VOCs and five metals were detected in sediment samples. None of the constituents exceeded benchmark criteria.

Groundwater samples

One VOC and four dissolved metals were detected in groundwater samples collected from monitoring wells. No constituents exceeded groundwater quality criterion.

3.5.4 Affected Media

Relatively low levels of BNAs, VOCs, and metals were detected in the soil/waste. PAH detected in two of the test pits were the only constituents of concern to be detected at levels exceeding soil criteria values. None of the VOCs or metals detected in the soils or groundwater exceeded water quality criteria. Trichloroethene was detected in surface water samples collected from McDonald Creek at levels that exceeded water criterion.

3.5.5 Current Status and Comments

Additional surface water sampling is recommended to confirm and delineate the surface water contamination.

3.6 RSA # 49 FORMER ARSENIC PONDS (UNIT 3 - AREA F)

3.6.1 Location

RSA # 49 covers approximately 5 acres in size, and is located in central RSA.

3.6.2 Brief History

RSA # 49 consists of three closed disposal ponds formerly used for the disposal of arsenic-contaminated wastes generated from lewisite manufacturing operations. Subsequent to the disposal of arsenic wastes, rubble and industrial wastes were disposed of in the impoundments.

3.6.3 Contaminants of Concern

The principle constituents found are arsenic, and PAHs in the soils; and arsenic and chlorinated hydrocarbons in the groundwater.

Soil/Waste samples from test pits

Thirty-six constituents (22 BNAs, 8 VOCs, and 6 metals) were detected in the soil/waste samples from the test pits. Arsenic (21400 *ug*/kg) and cadmium (64.1 *ug*/kg) exceeded systemic criteria (80 *ug*/kg; 40 *ug*/kg; respectively). Three potential carcinogens, benzo[a]anthracene (13.5 *ug*/kg), benzo[a]pyrene (8.22 *ug*/kg), and dibenzo[a,h]anthracene (2.68 *ug*/kg), exceeded the carcinogenic criteria (0.22 *ug*/kg; 0.06 *ug*/kg; 0.01 *ug*/kg; respectively).

Surface soil samples

Eight constituents (2 VOCs, and 6 metals) were detected in the surface soil samples. Arsenic (11500 *ug*/kg), cadmium (178 *ug*/kg), and mercury (179 *ug*/kg) exceeded carcinogenic criteria.

Deep soil boring samples

Eight constituents (1 BNA, 2 VOCs, and 5 metals) were detected in deep soil borings, none of which exceeded benchmark values.

Surface water and Sediment samples

Barium was detected in surface water samples, but did not exceed benchmark values.

Sixteen constituents (7 BNAs, 3 VOCs, and 6 metals) were detected in sediment samples. Arsenic (225 *ug*/kg), and mercury (25 *ug*/kg) exceeded systemic criteria (80 *ug*/kg; 24 *ug*/kg; respectively).

Benzo[a]anthracene (0.36 *ug*/kg) and benzo[a]pyrene (0.36 *ug*/kg) exceeded carcinogenic criteria (0.22 *ug*/kg; 0.006 *ug*/kg; respectively).

Groundwater

Sixteen constituents (4 VOCs, 5 total metals and 7 dissolved metals) were detected in the groundwater. No constituent exceeded benchmark criteria.

3.6.4 Affected Media

The nature and extent of contamination in the soils at RSA # 49 have been fairly well defined. PAHs and metals (primarily arsenic) have been detected in the soil/waste samples from the test pits, shallow soils, soil borings, and sediments at concentrations which exceeded carcinogenic and systemic criteria.

3.6.5 Current Status and Comments

Additional soil sampling is recommended to help delineate the extent of arsenic contamination in the surface and subsurface soils within and adjacent to the disposal ponds. Soil borings are recommended within the disposal ponds to help determine the total depth of the waste and the volume of waste present. There does not appear to be groundwater contamination associated with the activities.

3.7 RSA # 51 INACTIVE DEMILITARIZATION AREA, AREA I

3.7.1 Location

RSA # 51 occupies an area of approximately 4.0 acres in the west-central portion of RSA.

3.7.2 Brief History

The area was used for ordnance disposal during the 1950s. Demil operations included open burning, burning in trenches, and detonation in pits. PELA (1988) conducted soil sampling, monitor well installation, in-situ permeability tests, and groundwater sampling efforts. Four monitoring wells were constructed (RS-119, RS-120, RS-121, and RS-122).

3.7.3 Contaminants of Concern

A total of 25 soil gas samples were collected, target VOCs were below detection limit. Report by PELA (1988) also does not show any soil or groundwater contamination.

3.7.4 Affected Media

Soil and groundwater are the media of concern at this site.

3.7.5 Current Status and Comments

RSA # 51 is currently under investigation in the Site Characterization Work Plan.

3.8 RSA # 53 INACTIVE SANITARY LANDFILL (UNIT 3 - AREA Q3)

3.8.1 Location

Approximately 50 acres in size, this area is located in central RSA.

3.8.2 Brief History

This site is a former sanitary and industrial landfill. The landfill is comprised of trenches and pits which were used to dispose of industrial and sanitary wastes.

3.8.3 Contaminants of Concern

PAHs and pesticides (primarily DDT and its metabolites) are the contaminants of concern.

Soil/Waste samples from test pits

Thirty-seven constituents (13 BNAs, 12 VOCs, 7 metals and 5 pesticides) were detected in soil/waste samples. Lead (161 *ug*/kg) exceeded systemic criteria (150 *ug*/kg), and benzo[a]anthracene (3.21 *ug*/kg) and DDT (2.59 *ug*/kg) exceeded carcinogenic criteria (0.22 *ug*/kg; 2.06 *ug*/kg; respectively).

Surface soil samples

Fifteen constituents (2 BNAs, 2 Vocs, 5 metals and 6 pesticides) were detected in shallow surface soil samples. None of these constituents exceeded benchmark criteria.

Deep soil boring samples

Ten constituents (1 BNA, 2 VOCs, 5 metals and 2 pesticides) were detected in samples, however, none of the constituents exceeded benchmark criteria.

Surface water and sediment samples

Methylene chloride and barium were detected in the surface water samples. Methylene chloride (5.0 *ug*/L), exceeded the carcinogenic criteria (4.67 *ug*/L).

Groundwater samples

Forty-two constituents (10 BNAs, 15 VOCs, 7 metals and 10 pesticides) were detected in groundwater samples. Thirteen constituents (hexachloroethane, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,3-dichloropropene, 1,2-dichloroethene, 1,1,1-trichloroethene,

vinyl chloride, aldrin, DDT, endrin, and chlordane) were detected at concentrations that exceeded the systemic criteria. Twenty-one potential human carcinogens (bis[2-chloroethyl]ether, bis[2-ethylhexyl]phthalate, 1,4-dichlorobenzene, hexachloroethane, benzene, carbon tetrachloride, chloroform, 1,2-dichloroethane, methylene chloride, tetrachloroethene, 1,1,2,2-tetrachloroethane, trichloroethene, vinyl chloride, aldrin, beta-Bhc, gamma-Bhe/lindane, DDD, DDE, DDT, dieldrin and chlordane) exceeded carcinogenic criteria.

3.8.4 Affected Media

PAHs and pesticides (primarily DDT and its metabolites) were detected in the soil/waste samples from the test pits at concentrations which exceeded carcinogenic criteria. VOCs, primarily chlorinated hydrocarbons, and pesticides, were detected in groundwater at concentrations that exceeded water quality criterion.

3.8.5 Current Status and Comments

The nature and extent of contamination in the soils and the groundwater have been fairly well defined in most areas. However, additional borings and soil sampling will be necessary to delineate the areal extent of soil contamination to the north and east. Additional drilling, overburden and bedrock monitor well installation, and groundwater sampling are also recommended to help delineate the extent of contamination in the perched, deep overburden, and shallow and deep bedrock zones to the north and east.

3.9 RSA # 54/55 INACTIVE SANITARY LANDFILL (UNIT 3 - AREA S/T)

3.9.1 Location

Approximately 18 acres in size, RSA # 54/55 is located in central RSA.

3.9.2 Brief History

RSA # 54/55 is a former sanitary/industrial landfill, approximately 18 acres in size. Located in central RSA, the site is bounded on the west by Mills Road, on the north by Martin Road, and on the east by McMorrow Labs. This site was used during the 1960s for the disposal of household, administrative, and industrial wastes. Trenches were used to dispose of wastes, then covered with a thin layer of soil. DDT wastes were buried at various locations in the landfill between 1968 and 1973. Although the landfill areas have been revegatated, remnants of disposal trenches are still evident.

3.9.3 Contaminants of Concern

A variety of constituents were detected in the test pit, shallow surface soil, subsurface soil, and groundwater samples collected within and in the vicinity of the former sanitary and industrial landfill disposal areas. The principal constituents found are PAHs, chlorobenzene, and DDT in the soils, and chlorobenzene and other chlorinated hydrocarbons in the groundwater.

Soil/Waste from test pits

Forty constituents (20 BNAs, 8 VOCs, 7 metals, 5 pesticides) were detected in soil/waste samples collected from test pits. Among these, DDT (166 *ug*/kg) and lead (227 *ug*/kg) exceeded systemic criteria (40 *ug*/kg and 150 *ug*/kg, respectively). Six potential carcinogens; benzo[a]anthracene (4.74 *ug*/kg), benzo[a]pyrene (4.82 *ug*/kg), dibenzo(a,h)anthracene (4.66 *ug*/kg), DDE (83.0 *ug*/kg), DDD (7.1 *ug*/kg), and DDT (166 *ug*/kg) exceeded cancer criteria.

Ten constituents (1 BNA, 2 VOCs, 4 metals and 3 pesticides) were detected in deep soil borings, however, none of the constituents exceeded either systemic or carcinogenic criteria.

Groundwater

Nineteen constituents (12 VOCs, and 7 total and 6 dissolved metals) were detected in groundwater samples. Chlorobenzene (395 *ug*/L) exceeded systemic criteria (100 *ug*/L); benzene (6.24 *ug*/L), trichloroethene (6.07 *ug*/L), and vinyl chloride (8.78 *ug*/L) exceeded carcinogenic criteria for groundwater (5.0 *ug*/L; 5.0 *ug*/L; 2.0 *ug*/L, respectively).

3.9.4 Affected Media

Environmental concerns for this site include surface soil, groundwater and air. Evaluation of potential human exposure routes showed surface soils to be the only pathway of concern. The probability of contaminant exposure via groundwater is low as there are no drinking water wells in the vicinity of RSA 55/54 and none are planned. The probability of contaminant exposure from surface soils and air are also low due to the vegetative cover over the former disposal areas of the sanitary and industrial landfill.

3.9.5 Current Status and Comments

Additional groundwater sampling is needed on the western side of the landfill as the groundwater contamination is not well defined here. Additional drilling and sampling in this area should help delineate the extent of the occurrence of the constituents of concern. Additional drilling, overburden monitoring well installation, and groundwater sampling is recommended.

3.10 RSA # 56, # 122, and # 139 FORMER ARSENIC PONDS SOUTH 'AREA U', WW-II LEWISITE MANUFACTURING FACILITY 'AREA U', AND ARSENIC WASTE LAGOON 'AREA U'

3.10.1 Location

The Former Arsenic Ponds are located in the east-central portion of the Facility, north of Viper Road, west of Meteorology Road and east of Calibration Road. The Lewisite Manufacturing Facility building was located southwest of the arsenic ponds, and south of Fowler Road. The Waste Lagoon is located north of Building 5434, and east of Buildings 5432 and 5436.

3.10.2 Brief History

Lewsite was manufactured in this area during the mid 1940s. Waste water containing arsenic was disposed off in man-made ponds and lagoons. Manufacturing facility has been demolished and demolition debris was disposed of in the ponds which were filled and capped in 1972.

3.10.3 Contaminants of Concern

PELA (1988) reported detection of arsenic from soil and groundwater of RSA-56 and soil of RSA-139. ES (1993) analyzed 25 soil gas samples and found all target VOCs to be below detection limits. PELA (1988) determined groundwater flow to be in southeast direction.

3.10.4 Affected Media

Soil, groundwater runoff, and surface water are potential release pathways in Area U.

3.10.5 Current Status and Comments

RSA # 56, 122, and 139 are currently under investigation in the Site Characterization Work Plan.

3.11 RSA # 58 INACTIVE RUBBLE FILL (AREA W)

3.11.1 Location

RSA #58 occupies approximately 18 acres to the east of Patton Road. It is bordered by McDonald Creek on the east, Huntsville Spring Branch on the south, and wetlands on the west. The area is flat with ground elevations ranging from approximately 564 feet in the north to 562 feet in the south. Access to the site is via the gravel road, TF10, on the west side of the site.

3.11.2 Brief History

This site was used for demolitions in the 1940s and 1950s. During the 1960s and 1970s, the site was used for rubble fill. Rubble material consisted of concrete blocks, tires, 55-gallon drums containing unknown constituents, 5-gallon containers, and metal debris. Storm-damaged PCB transformers and building materials from a nearby abandoned DDT manufacturing site may also have been disposed of at this site. The site is currently inactive.

3.11.3 Contaminants of Concern

Numerous organic contaminants have been detected at RSA #58. Surface and subsurface soil samples collected at the site detected widespread high concentrations of PAHs and DDT and its metabolites. Odors suspected of being derived from chlorinated solvents have been observed in three separate areas of the site. Health and Safety air monitoring has also measured volatile organics in the air during subsurface investigations across the site.

Soil samples

DDT and its metabolites were detected in 9/10 surface soil samples collected from within the rubble fill area. DDT (12,000 *ug*/kg), DDE (1800 *ug*/kg), and DDD (3800 *ug*/kg), exceeded benchmark criteria. Twenty-one additional organic compounds (7 volatile, including; chloroform, trichloroethene, chlorobenzene, tetrachloroethene, benzene, toluene, and 4-methyl-2-pentanone. 14 semi-volatile, predominately PAH compounds) were detected.

DDT and its metabolites were also detected in 15/16 subsurface soil samples. DDT (3400 *ug*/kg), DDE (1400 *ug*/kg), DDD 27,000 *ug*/kg), chlorobenzene (4900 *ug*/kg), and arsenic (112 *ug*/kg), exceeded criterion values for soils. Other compounds detected included twenty additional organic compounds (9 volatiles, 10 semi-volatiles, and 1 PCB), low levels of chlorinated and petroleum hydrocarbons (similar to those identified in surface samples), and moderate levels of PAH compounds.

Groundwater samples

Samples taken from the 9 shallow and 2 deep water monitoring wells indicate the presence of chlorobenzene at concentrations as high as 190 *ug/L* (MCL = 100 *ug/L*), cadmium (4 times greater than MCL), lead, chromium, and TCE below MCLs. Trihalomethanes that exceeded EPA human-health based criteria may have been introduced during the permeability test using tap water that contains chlorine.

Surface water and sediment samples

Downstream surface water samples were collected in McDonald Creek near its confluence with Huntsville Spring Branch, downstream of the site. TCE was detected in both samples at concentrations less than the upstream sample (TCE and Dieldrin were detected in a background surface water sample collected upstream of the site in McDonald Creek). Neither DDT or its metabolites, nor PAH compounds were detected in any of the samples. Metals were detected at low levels, below respective MCLs, in downstream samples. Arsenic was detected at a concentration of 150 *ug/L*, (which is above the MCL of 50 *ug/L*) in a surface water seep which drains into Huntsville Spring Branch. Trace levels of toluene were detected in the upstream sample from Huntsville Spring Branch.

Acetone, pyrene, and bis(2-ethylhexyl)phthalate were detected in a sediment sample collected upstream of the rubble fill area. Acetone was also detected (at a lower concentration than the upstream sample) in the sediment sample collected below the rubble fill area in Huntsville Spring Branch. Bis(2-ethylhexyl)phthalate was detected in the sediment sample collected in McDonalds Creek near the site, however, it was also detected in a number of background samples and is suspected to be a laboratory contaminant.

3.11.4 Affected Media

Several potential exposure routes exists that are considered to have a moderate to high chance for completion. These pathways all stem from the very high contaminant concentrations detected in surface and subsurface soil samples. Flooding, rainfall runoff, erosion, and groundwater seeps all have potential to transport contaminants in the soil to nearby wetlands, creeks, and the Wheeler National Wildlife Refuge. Direct contact with or ingestion of site soils is another potential pathway. Area wildlife, base workers, fisherman, and hunters are the likely receptors.

3.11.5 Current Status and Comments

Additional investigations recommended for the site should focus on evaluating the surface water and sediments of adjoining wetlands; confirming the absence of contamination in the nearby streams; determining the vertical extent of groundwater contamination. As an interim action, it is recommended that access to the site be restricted by placing locked gates across both access roads to the site.

3.12 RSA # 59 INACTIVE RUBBLE FILL (UNIT 3 - AREA R)

3.12.1 Location

RSA # 59 covers approximately 8 acres in central RSA. It is bounded on the north, east and south by wetlands.

3.12.2 Brief History

RSA #59 is a former landfill utilized from 1972 to 1976 for rubble, construction debris and industrial waste. Located in central RSA, the landfill is approximately 8-acres in size and is bounded on the north, east, and south sides by wetlands. Surface drainage is generally to the east and southeast.

No remediation has been conducted at this site, the area has not been capped. However, a thin soil covers most of the area and vegetation has become established on the landfill. Some exposed drums, rubble, and debris are visible at the site, particularly along the south and east boundaries.

3.12.3 Contaminants of Concern

A variety of constituents were detected in the soil/waste, surface soil, subsurface soil, sediment, surface water and groundwater samples collected within and in the vicinity of the rubble fill areas. Among the six environmental media sampled, no constituents were reported above MCL or systemic criteria in any of the media. Three potential human carcinogens were reported to have exceeded carcinogenic criteria. Benzo[a]anthracene (1.37 *ug*/kg [soil], 0.774 *ug*/kg [sediments]), and benzo[a]pyrene (0.996 *ug*/kg [soil], 0.88 *ug*/kg [sediment]) exceeded criteria for soil and sediment samples (0.224 *ug*/kg and 0.061 *ug*/kg, respectively). Bis-[2-ethylhexyl]phthalate exceeded carcinogenic criteria (2.50 *ug*/L) in surface water (16.9 *ug*/L) and groundwater (6.13 *ug*/L) samples.

3.12.4 Affected Media

Environmental concerns for this site include soils, sediment, groundwater and surface water. Evaluation of potential human exposure routes showed surface water/sediment and surface soil to be the most likely pathways to be complete. The probability of contaminant exposure via groundwater is low as there are no drinking water wells in the vicinity of RSA-59 and none are planned. The probability of soil contact and contaminant exposure is low because of the vegetative cover on the site.

3.12.5 Current Status and Comments

The extent of contamination in the soils is fairly well defined; PAH contamination appears to be confined to the top five inches of the landfill, within the boundaries of the landfill and sediments in adjacent drainage ways. No additional sampling is recommended.

3.13 RSA # 60 INACTIVE SANITARY LANDFILL (UNIT 3 - AREA Q4)

3.13.1 Location

RSA # 60 is located in central RSA directly south of the former DDT manufacturing operations.

3.13.2 Brief History

This 25-acre site was operated as a sanitary/industrial landfill from 1963 to 1968. This unlined landfill is located in central RSA adjacent to and southeast of RSA # 53.
This landfill was used for the disposal of household, administrative and industrial wastes. Waste oil was reportedly disposed into the pits in the southern portion; DDT wastes from the DDT manufacturing operations were reportedly buried at various locations in this area.

The landfill site is bounded on the east by surface water diversion ditch and former DDT ditches; bounded on the south and west by remediated former channel and floodplain of the Huntsville Spring Branch (now wetlands), also a large segment is within the boundaries of the Wheeler National Wildlife Refuge. Surface drainage of the site is generally south and west into the wetlands.

3.13.3 Contaminants of Concern

A variety of constituents were detected in the soil/waste, surface soil, subsurface soil, sediment, surface water, and groundwater samples collected within and in the vicinity of the former disposal area.

Soil/Waste from test pits

Test pit samples revealed DDT (190 *ug*/kg); DDD (21.6 *ug*/kg); DDE (6.31 *ug*/kg); and chlorobenzene (18000 *ug*/kg) above cancer criteria (2.06 *ug*/kg; 2.92 *ug*/kg; 2.06 *ug*/kg; and 1600 *ug*/kg respectively). Lead was also detected (249 *ug*/kg) above systemic criteria (150 *ug*/kg). Sediment samples detected methylene chloride (10.4 *ug*/kg); 1,1,2,2-tetrachloroethane (7.58 *ug*/kg); trichloroethene (6.45 *ug*/kg); Aldrin (0.33 *ug*/kg); DDD (3.01 *ug*/kg); DDE (0.23 *ug*/kg); and DDT (1.10 *ug*/kg) above cancer criteria (4.67 *ug*/kg; 0.18 *ug*/kg; 5.0 *ug*/kg; 0.002 *ug*/kg; 0.15 *ug*/kg; 0.10 *ug*/kg; 0.10 *ug*/kg; respectively).

The nature and extent of the soil contamination is fairly well defined. Contamination in the soils, particularly DDT, is not confined to the boundaries of the disposal trenches. Relatively high levels of DDT were detected in the northwest corner of the site, and trace to moderate levels were detected in sediment samples from areas surrounding the site. Samples collected of the presumably native soils, underlying the test pits also showed them to be contaminated with pesticides.

Groundwater

Groundwater contamination was detected in the upper bedrock in all monitoring wells in the zone, twenty eight constituents (3 BNAs, 13 VOCs, 6 metals and 6 pesticides) were detected. The concentration of chlorobenzene (4-1500 *ug*/L) exceeded Federal Drinking Water MCLs in seven samples collected near the disposal trenches and waste oil pits on the southern end of the site, near the disposal pits in the center of the landfill, and near the wetlands on the southwest side of the landfill. Benzene (6.91 *ug*/L); trichloroethene (7.29 *ug*/L); barium (102 *ug*/L); cadmium (28 *ug*/L); chromium (2.58 *ug*/L); and lead (14.7 *ug*/L) were also detected above MCL. The boundaries of contamination are defined by the absence of constituents in upgradient wells to the north and to the east. To the south, the absence of chlorobenzene defines the southern edge of chlorobenzene contamination. To the west, the wetlands and Wheeler National Wildlife Refuge limits access for sampling and areal limit of contamination is undefined. Vertically, contamination seems to be more prevalent in the deep overburden than in the shallow overburden, as evidenced by the detection of low chlorobenzene concentrations in shallow monitoring well relative to nearby deep monitoring wells.

Surface water

Surface water samples contained low levels of VOCs, pesticides (DDT and metabolites) and metals. Chlordane (0.92 *ug*/L); DDT (1.10 *ug*/L); and chromium (12.8 *ug*/L) exceeded Federal Water Quality Criteria for surface waters (0.004 *ug*/L; 0.001 *ug*/L; and 11 *ug*/L, respectively). These results indicate ubiquitous "background" pesticide contamination throughout the local Wheeler National Wildlife Refuge and former channel and floodplain of Huntsville Spring Branch.

3.13.4 Affected Media

Environmental concerns for this site include soils, sediment, groundwater and surface water. Evaluation of potential human exposure routes showed surface water/sediment and surface soil to be the most likely pathways to be complete. The probability of contaminant exposure via groundwater is low as there are no drinking water wells in the vicinity of RSA-60 and none are planned. The probability of exposure to soils is low due to the vegetative cover on the site, and limited access. Exposure probability for surface water/sediment is also low due to restrictions imposed by the current DDT Mitigation Program on the use and access to the Wheeler National Wildlife Refuge in the area.

3.13.5 Current Status and Comments

Additional shallow soil sampling should be conducted to help evaluate the background levels of pesticides in the soils. Furthermore, additional drilling and sampling will be necessary to help determine the nature and extent of groundwater contamination in the multiple aquifer zones. Also, the horizontal and vertical extent of groundwater contamination within the bedrock has not been determined.

3.14 RSA # 66 FORMER DEMOLITION AREA/ASH DISPOSAL SITE (UNIT 3 - AREA X1)

3.14.1 Location

RSA # 66 is located on the south side of RSA within one-half mile of the Tennessee River.

3.14.2 Brief History

RSA #66 is a former ash disposal and demolition area occupying approximately 2 acres on the south side of RSA within one-half mile of the Tennessee River. This area was used from the 1950s through the 1970s to dispose of ash, residue and debris from open burning of wastes. Drums, bottles of unidentified chemicals, ordnance, and mustard gas test kits have been observed on the land surface. In addition, there is evidence that open detonation may have occurred at this site.

3.14.3 Contaminants of Concern

The principal constituents found at RSA #66 are chlorinated hydrocarbons and PETN (a chemical associated with explosives) in the soils, and chlorinated hydrocarbons in the groundwater.

Soil/Waste samples from test pits

Sixteen constituents (7 VOCs, 7 metals, and 2 explosives) were detected in test pit samples. Among these chemicals, only lead (556 *ug*/kg) exceeded the carcinogenic criteria (150 *ug*/kg).

Soil samples

Nine individual constituents (2 BNAs, 2 VOCs, and 5 metals) were detected in shallow soil samples. No constituent exceeded either systemic or carcinogenic criteria.

Nine constituents (1 BNA, 3 VOCs, and 5 metals) were detected in deep soil boring samples. No constituent exceeded the systemic or carcinogenic criteria.

Surface water and Sediment samples

Three constituents (1 VOC and 2 metals) were detected in surface water samples, none of which exceeded systemic or carcinogenic criteria.

Six constituents (2 VOCs, and 4 metals) were detected in sediment samples, none individually exceeded systemic or carcinogenic criteria.

Groundwater samples

A number of constituents (10 VOCs, 6 total metals, and 5 dissolved metals) were detected in groundwater samples. One constituent, 1,2-dichloroethene (223 *ug*/L) exceeded systemic criteria (70 *ug*/L). Four potential carcinogens, tetrachloroethene (101 *ug*/L), 1,1,2,2-tetratchloroethene (75.7 *ug*/L), 1,1,2-trichloroethene (3.43 *ug*/L), and trichloroethene (1.18 *ug*/L) exceeded the carcinogenic criteria [tetrachloroethene (5.0 *ug*/L), 1,1,2,2-tetratchloroethene (1.75 *ug*/L), 1,1,2-trichloroethene (0.61 *ug*/L), and trichloroethene (5 *ug*/L)].

3.14.4 Affected Media

Evaluation of potential human exposure routes showed no complete human exposure pathways. The probability of exposure due to groundwater is low as there are no drinking water wells in the vicinity, and none are planed. The pathways for surface soils and air are not complete because of the remoteness and restrictive access to the area, together with the thick vegetative cover over the former disposal areas.

3.14.5 Current Status and Comments

The horizontal extent of the groundwater contamination has been well defined in the overburden, but not in the bedrock. Additional drilling, bedrock monitoring well installation, and groundwater sampling are recommended to help delineate the extent of contamination in the upper weathered and deep bedrock zones.

3.15 RSA # 68 TOXIC AREA Z (UNIT 3)

3.15.1 Location

RSA # is a former 5-acre landfill and disposal area located in the southern part of RSA. This site is located directly north of the former mustard gas storage area, approximately 2000 feet east of RSA #66; 3,500 feet northeast of the open burn/open detonation area, and approximately 4,000 feet east of the Tennessee River. The area is bounded on the west by low-lying forested area, "Igloo" ponds, and associated drainage ditches. The topography of the area is nearly flat with surface drainage being controlled by drainage ditches west and east of the site and wetland areas to the north. Vegetation at the site consists primarily of grasses, briars and small pines.

3.15.2 Brief History

This landfill was used from the 1950s to 1980 for the demilitarization of high explosives and disposal of inhibited red fuming nitric acid (IRFNA), cyanide, chromium, metallic salts, laboratory chemicals, chlorine trifluride and beryllium. Explosives were reportedly detonated or burned on the land surface, wastes were disposed of in trenches. Operations at the site ceased in 1980, and was reportedly cleaned of metal fragments.

3.15.3 Contaminants of Concern

A variety of constituents were detected in the test pit, surface soil, subsurface soil, sediment, surface water and groundwater samples collected within and in the vicinity of the former waste disposal area. A variety of constituents were detected at elevated levels in the soils and soil/waste samples, including chlorinated hydrocarbons, volatile organic aromatics, polynuclear aromatic hydrocarbons, chromium, pesticides, and explosives. Chlorinated hydrocarbons and explosives are the principal constituents of concern in the groundwater.

Soil/Waste samples from the test pits

Thirty-five constituents (7 BNAs, 14 VOCs, 7 metals, 3 pesticides, and 4 explosives) were detected in test pit samples. Among these chemicals, lead (264 *ug*/kg) exceeded the systemic criteria (160 *ug*/kg); and benzo[a]anthracene (0.61 *ug*/kg) exceeded carcinogenic criteria (0.22 *ug*/kg).

Soil samples

Eight individual constituents (2 VOCs, and 6 metals) were detected in soil samples. No constituent exceeded either systemic or carcinogenic criteria.

Eight constituents (4 VOCs and 4 metals) were detected in deep soil boring samples. None of the constituents exceeded systemic or carcinogenic criteria.

Surface water and Sediment Samples

Seven constituents (2 VOCs, 2 metals, and 3 pesticides) were detected in surface water samples. Among these constituents, methylene chloride (7.13 *ug*/L) and DDT (0.79 *ug*/L) exceeded carcinogenic criteria (4.67 *ug*/L; 0.1 *ug*/L; respectively). DDT (0.79 *ug*/L), Lindane (0.2 *ug*/L), and heptachlor (0.19 *ug*/L) exceeded Federal, EPA, and State surface water criteria.

Twelve constituents (4 BNAs, 3 VOCs, 4 metals and 1 pesticide) were detected in sediment samples. None of the constituents detected exceeded systemic or carcinogenic criteria.

Groundwater samples

Fourteen VOCs, 7 total metals, 4 dissolved metals and 3 explosives were detected in groundwater samples. 1,2-dichloroethene (119 *ug*/L), and trichloroethene (2280 *ug*/L) exceeded systemic criteria (7.0 *ug*/L; and 260 *ug*/L, respectively). Five potential human carcinogens: tetrachloroethene (96.5 *ug*/L), 1,1,2,2-tetrachloroethane (1230 *ug*/L), 1,1,2-trichloroethane (11.7 *ug*/L), trichloroethene (2280 *ug*/L), and vinyl chloride (5.1 *ug*/L), exceeded carcinogenic criteria (5.0 *ug*/L; 0.18 *ug*/L; 0.61 *ug*/L; 5.0 *ug*/L; 2.0 *ug*/L; respectively).

3.15.4 Affected Media

Environmental concerns for this site include surface soils, surface water/sediment, and air. The probability of contaminant exposure via groundwater is low since there are no drinking water wells in the vicinity. Dermal contact and ingestion of surface water could occur because of the proximity of the drainage ditch to the site. Access to the drainage ditch is possible through the Igloo pond, located at the head of the drainage ditch. Fishing is permitted in the Igloo pond and boating is common. Exposure to the surface soil and air is high due to the large areas of bare soil at the site. However, due to the discovery of chemical munitions and ordnance in October 1990, the area has been fenced and access to the area and vicinity has been restricted.

3.15.5 Current Status and Comments

The extent of contamination in the soils appears to be restricted to isolated areas within the boundaries of the site. The extent of groundwater contamination has been fairly well-defined to the east and west. Additional drilling, overburden and bedrock monitor well installation, and groundwater sampling are recommended to help delineate the extent of contamination to the northwest and south.

3.16 RSA # 115 TEST AREA 5 BLOWDOWN LAGOON (EAST)

3.16.1 Location

RSA # 115 covers approximately 7500 square feet, and is situated on a ridge a little over one-half mile north of the Tennessee River in the southern portion of the arsenal, south of Buxton and Pershing Roads. The site is well above the 100-year floodplain.

3.16.2 Brief History

The blowdown lagoon was a holding basin for cooling water of Lance rocket engines from Test stand 8887. The Lagoon has been inactive since the mid-1980s.

3.16.3 Contaminants of Concern

Primary contaminants of concern are unsymmetrical dimethyl hydrazine (UDH), nitric acid, and lead. Groundwater samples analyzed from well RSA-419 detected TCE at 5 *ug*/L, which is equal to the MCL, no other volatile organics were detected. Metal concentrations did not exceed the MCLs except for iron which showed concentration of 3,500ug/L.

3.16.4 Affected Media

The preliminary health assessment indicated a very low potential exposure pathway for all site media.

3.16.5 Current Status and Comments

Based on the low concentrations of volatile organics and absence of ammonia, nitrates, UDMH and metals in groundwater along with the absence of volatile organics in soils, no interim remedial action was recommended for this site. However, additional monitoring wells may be needed in the shallow water bearing zone to determine the direction of groundwater flow and to define the horizontal extent of TCE contamination. Groundwater sampling of the shallow site well is recommended to confirm the presence of low TCE contamination in the perched bedrock zone.

3.17 RSA # 116 TEST AREA 5 BLOWDOWN LAGOON (SOUTH)

3.17.1 Location

The south lagoon is approximately 0.5 acre in size, located approximately 500 feet west of Test Stand 8879, in the southern portion of the arsenal. It is located in a small, dammed ravine which enters the Tennessee River approximately 2 miles downstream. The site is usually dry and covered by sparse vegetation.

3.17.2 Brief History

The lagoon serves as a holding basin for cooling water discharged during test firing of rocket engines from Test Stand 8879. The lagoon has been in operation since mid-1960s. The lagoon is unlined, but plans are to retrofit the lagoon in the future. Water stored in the lagoon leaves the site through evaporation, seepage into the ground, flow over the spillway on the west side of the dam, or through an 18-inch drain pipe in the base of the dam. Cooling water may contain dissolved solid rocket propellant and rocket exhaust.

3.17.3 Contaminants of Concern

Contaminants of concern are UDMH, nitric acid, and lead.

Groundwater samples

Groundwater samples were taken from three existing wells and two new monitoring wells. TCE concentration was 39 and 150 ug/L in wells RSA-404 and RSA-405 respectively, which exceeds the MCL of 5 *ug*/L. Detected concentrations of 1,2-DCE (83 *ug*/L) and vinyl chloride (14 *ug*/L) also exceeded MCLs (70 *ug*/L; 2 *ug*/L, respectively) in the sample collected at RSA-405 (which lies downgradient of the lagoon along the ravine lineament). Metal and ammonia were not detected above MCLs in any sample.

Anomalous concentrations of analytes were not detected in any other media.

3.17.4 Affected Media

The TCE, 1,2-DCE and vinyl chloride detected in the groundwater may present the most significant source of contamination. However, the lagoon may not be the only source of detected volatile organics. Surface and sub-surface soil sampling has not identified significant contaminant concentrations in the lagoon soils or in the adjacent stream sediments.

3.17.4 Affected Media

The TCE, 1,2-DCE and vinyl chloride detected in the groundwater may present the most significant source of contamination. However, the lagoon may not be the only source of detected volatile organics. Surface and sub-surface soil sampling has not identified significant contaminant concentrations in the lagoon soils or in the adjacent stream sediments.

The preliminary health assessment indicates very low potential exposure pathways for all site medias, except for the groundwater pathway. The low groundwater concentrations of TCE may be related to an unidentified upgradient source.

3.17.5 Current Status and Comments

The installation of additional bedrock wells is recommended to determine the areal extent of groundwater contamination.

3.18 RSA # 129 THIOKOL BURNING PIT AREA

3.18.1 Location

RSA #129 is situated in the east central portion of the arsenal at the north end of Magazine Road. Huntsville Spring Branch lies to the north and west. Total area is about 9 to 10 acres and is surrounded by wetlands. Access to the area is by a locked gate across a raised road bed that traverses the wetlands. The burn and washout pit that has been filled with soil and capped with concrete is at the end of the road. The remains of a settling pond are located 100 feet northwest of the pit. Heavy vegetation surrounds the pond. A breach in the settling pond allows drainage of the pond.

3.18.2 Brief History

The concrete pit was used in the 1950s as an underwater rocket testing area. In the late 1960s and early 1970s, the pit was used as a rocket cleanout area. Cleaning water was reused by passing through nearby settling pond. Primary propellants used consisted of ammonium perchlorate and powdered aluminum. Iron oxide was used as a catalyst. The pit was capped in 1973-1974. Thiokol reacquired the area in 1988 and is using it for destructive testings.

3.18.3 Contaminants of Concern

Groundwater samples

Groundwater samples were taken from 4 wells that detected organic contaminants including vinyl chloride (3 *ug*/L, exceeds MCL of 2 *ug*/L), TCE, 1,2-dichlorethylene, and trihalomethanes. Concentrations of TCE and 1,2-dichlorethylene did not exceed the MCL and trihalomethane may have been introduced during permeability testing using tap water. Cadmium, chromium and lead were detected at concentrations of 18, 130, and 99 ug/L; all exceed MCLs.

3.18.4 Affected Media

The most likely potential for contaminant exposure pathway completion are through surface water flooding and from groundwater discharge to nearby surface waters. The site is known to flood frequently and flush the settling pond allowing the potential for contamination of surface water to enter nearby swamps.

3.18.5 Current Status and Comments

The horizontal extent of groundwater contamination has been determined to be localized near monitoring well RSA-408, which may be discharged into the swamp located 50 feet to the north of this well. Access for further well installation is limited in this area. The vertical extent of volatile organic contamination in the underlying Tuscumbia Limestone is unknown. Surface water, sediment and soil samples collected

in the vicinity have not confirmed the presence of contamination in either the concrete pit, or settling pond.

The preliminary health assessment indicates a moderate potential exposure pathway for groundwater and surface water pathways. The site is located within a topographic low with site residuum groundwater discharging to the nearby wetlands. Additional activities should concentrate on characterizing the extent of contamination in the wetlands north of the monitoring well where vinyl chloride has been detected.

3.19 RSA G TCE SPILL AT THIOKOL DEGREASER

3.19.1 Location

RSA G is located in the southeast section of the arsenal in Building 7664, within the Thiokol Complex. The site is to the east of Magazine Road, north of Redstone, and west of Line Road. The area of the spill is located adjacent to a crushed rock road and an adjacent grassy field. The site is surrounded by structures and elevated steam piping.

3.19.2 Brief History

Due to valve malfunction at a degreaser in 1989 a reported maximum of 30 gallons of TCE was discharged to the sanitary sewer system. An airstripper was installed to treat the water in the contaminated sanitary sewer line prior to discharge to the main sewer line. The facility later disconnected the contaminated sewer to isolate the TCE source. All water sources within Building 7664 were rerouted to an approved sanitary sewer.

3.19.3 Contaminants of Concern

Soil samples

A total of 39 soil gas samples were taken that indicated presence of TCE at concentrations as high as 6,700 ppb, and Cis-1,2-dichlorethylene (a common degradation product of TCE).

Acetone, toluene, TCE and xylene were also detected in soil samples, as were anomalous concentrations of chromium, copper and iron. None of the analytes exceeded benchmark criterion.

Groundwater samples

Groundwater samples taken from 4 wells during the preliminary investigation showed high concentration of TCE (up to 39,000 ug/L), tetrachloroethylene (18 ug/L), methylene chloride (7.3 ug/L) and trihalomethanes and were in excess of MCLs. Cadmium (18 ug/L), chromium (240 ug/L), nickel (110 ug/L) and lead (54 ug/L) were all detected above MCLs in the upgradient well.

3.19.4 Affected Media

Affected media at RSA G are the soils and groundwater. The preliminary health assessment indicates a high potential exposure pathway for groundwater users.

3.19.5 Current Status and Comments

The horizontal and vertical extent of groundwater contamination has not been determined. Additional monitoring well installation and groundwater sampling are recommended to determine the vertical and horizontal extent of contamination in both the residuum and bedrock aquifers. Based on the high concentrations of TCE contamination detected in the bedrock aquifer and a presence of water supply well within 6 miles of the site, interim corrective measures are recommended at the site.

3.20 RSA # 140 TARGET/SEEKER DISPOSAL AREA

3.20.1 Location

RSA # 140 is situated in the southeastern section of the arsenal, north of Buxton Road and south of the DRMO area. The site lies on the side of a forest covered hill above the 100-year floodplain.

3.20.2 History

No waste water disposal history is known about this site, it is suspected that the area was an old DRMO disposal area. It is possible that organic solvents were placed in the trenches, ordnance materials may also have been buried at the site.

3.20.3 Contaminants of Concern

Groundwater samples

Groundwater samples collected from 4 wells during the preliminary assessment indicated the presence of TCE at a maximum concentration of 23 ug/L (exceeds MCL). TCE was not detected above MCL during the Phase I sampling rounds. Chromium was also detected at a concentration of 150 ug/L (exceeds MCL) during the preliminary investigation, but not in the Phase I rounds. No anomalous concentrations of contaminates were detected during Phase I sampling.

Soil sampling

25 soil gas samples were collected during the preliminary assessment that showed trace amount of TCE, xylene, and some unknown compounds. Leachate samples indicated the presence of Trichloroethylene at concentration up to 23 ppb.

Surface soil samples were collected from four test pits during the Phase I sampling rounds. A total of two volatile organic compounds, five semi-volatile organic compounds, five pesticides/PCBs and sixteen metals were detected. PCB-1254 was detected at 260 *u*g/kg, which exceeds the RCRA human health-based criteria of 90 *u*g//kg.

Twenty-nine subsurface samples were collected during the Phase I sampling. Detected volatile and semi-volatile organics were not detected at unacceptable levels. None of the samples had concentrations of metal analytes that were anonymously high compared to site background levels, and all substantially below benchmark criterion. Pesticides and/or PCBs were detected in six samples, PCB concentrations exceeded the proposed criteria of 90 *u*g/kg.

3.20.4 Affected Media

Low levels of surface and subsurface soil contamination has been detected at RSA # 140, however, soil contamination was confined to the soils within and immediately adjacent to the waste piles.

Groundwater contamination is also present at this site.

3.20.5 Current Status and Comments

Test pit excavations and soil samples completed in Phase I detected low levels of surface and sub-surface soil contamination. The extent of debris was limited to a relatively small area and was found to consist primarily of construction debris. The wastes were generally found to be surface debris extending to a maximum depth of 3 feet. Additional surface soil sampling is recommended to confirm the absence of soil contamination.

The nature and extent of TCE groundwater contamination has been adequately determined. The vertical extent of contamination has been defined by one bedrock well located adjacent to the most highly contaminated shallow well. The horizontal extent of contamination has been determined to the west and southwest by installing two new shallow monitoring wells in Phase I. Additional monitoring wells are not required.

4.0 REFERENCES

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2) *DRAFT, Site Characterization Work Plan for Redstone Arsenal Alabama,* Environmental Science & Engineering, Inc., June 28, 1993.

3) *DRAFT FINAL, Corrective Action Management Plan for Redstone Madison County, Alabama,* Environmental Science & Engineering, In., May 1993.

4) *IMPLEMENTATION OF THE RCRA FACILITY INVESTIGATION AT REDSTONE ARSENAL, ALABAMA,* JUNE 1990. Geraghty & Miller, Inc. **(TIC#1035)**

5) *DRAFT FINAL, PHASE II ADDENDUM RCRA FACILITY INVESTIGATIONS AT UNIT 1, UNIT 2, AND SELECTED UNIT 3 AREAS REDSTONE ARSENAL, ALABAMA,* Geraghty & Miller, Inc., December 1992.

6) *FINAL, PHASE I REPORT RCRA FACILITY INVESTIGATIONS AT UNIT 1, UNIT 2, AND SELECTED UNIT 3 AREAS REDSTONE ARSENAL, ALABAMA,* Volumes 1 & 2, Geraghty & Miller, Inc., May 1992. **(TIC#405)**

7) *FINAL, IDENTIFICATION AND EVALUATION OF POTENTIAL SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN REDSTONE ARSENAL, ALABAMA,* Geraghty & Miller, In., February 1991.

8) *RCRA FACILITY INVESTIGATION-PHASE 1 REPORT FOR RSA-58, RSA-115, RSA-116, RSA-129, RSA-G, AND TARGET SEEKER AREA, REDSTONE ARSENAL, ALABAMA,* Engineering-Science, February 1993.

9) *FINAL, RCRA FACILITY INVESTIGATION-WORK PLAN FOR RSA-58, RSA-115, RSA-116, RSA-129, RSA-G, AND TARGET SEEKER AREA REDSTONE ARSENAL, ALABAMA,* Engineering-Science, March 1992. **(TIC#3915)**

10) *FINAL, WORK PLAN RCRA FACILITY INVESTIGATIONS UNIT 1, UNIT 2, AND SELECTED UNIT 3 AREAS REDSTONE ARSENAL, ALABAMA,* Geraghty & Miller, Inc., June 1990. **(TIC#1034)**

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APPENDIX A
SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN
REDSTONE ARSENAL, ALABAMA

4.0 SWMU AND AOC IDENTIFICATION AND EVALUATION

4.0.a. As a result of the existing data review, aerial photo review, personnel interviews, and VSI, a total of 273 potential SWMUs and 13 AOCs were identified on RSA and MSFC. These units are listed on Tables 4.1 and 4.2 together with an assessment of their potential for release and an evaluation of the priority for further investigation. Table 4.1 provides an evaluation for the SWMUs and AOCs on RSA; Table 4-2 provides an evaluation for the SWMUs and AOCs on MSFC.

4.0.b. The potential for release is judged "high", "moderate", "low", or "dependent on the integrity of the unit". Unlined, land-based units, units with no evidence of containment, and units with a history of past release are typically considered as having a high potential for release. Units located indoors or for which there are secondary containment structures or for which management practices appear adequate, typically are judged as having a low potential for release. Units for which the potential for release is dependent on the integrity of the unit and thus cannot be readily determined have been marked with an "*".

4.0.c. Based on the potential for release as well as an evaluation of the nature of the wastes managed, each unit was judged as "high", "moderate", or "low" with regard to its priority for further study. Units having a low potential for release rank low in priority for further investigation. Units which have a high potential for release were further evaluated on the basis of the toxicity of wastes managed and whether or not there has ever been a record of release and the results of such investigations. Those which handle or have handled large volumes and/or highly toxic materials typically received a "high" rating. Those which have a history of managing small volumes and/or nonhazardous materials typically received a "low" rating. An RFI is currently being conducted at several of the SWMUs on RSA which have a high

potential for release and have managed significant volumes of hazardous and/or toxic wastes. These units are so noted on Table 4.1.

4.0.d. The results of the preliminary evaluation are as follows:

109 SWMUs received a "low" priority rating. These units likely do not warrant further study at this time.

72 SWMUs received a "moderate" priority rating. These units appear to pose no immediate or significant health or environmental risk; however, they are of enough concern to warrant further investigation (i.e., sampling) at some time in the future.

53 SWMUs received a "high" priority rating. If these units are not currently being investigated as part of the RFI, they should either be considered for further sampling or monitoring and/or be considered for inclusion into an RFI.

Table 4.1. Evaluation of Solid Waste Management Units and Areas of Concern on Redstone Arsenal (RSA)

SOLID WASTE MANAGEMENT UNITS

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-1	Hospital Incinerator	Low	Low	Covered; concrete floor
RSA-2	Oil/Water Separator, Building 3338	*	Low	Release potential is dependent on integrity of unit; otherwise release of water is regulated by NPDES permit. Low volumes of waste handled; low to moderate toxicity of waste; low migration potential.
RSA-3	Oil/Water Separator Sump, Building 3617	*	Low	Release potential is dependent on integrity of unit; otherwise release of water is regulated by NPDES permit. Low volumes of waste handled; low to moderate toxicity of waste; low migration potential.
RSA-4	Oil/Water Separators and Wash Rack, RSA Motor Pool	*	Low	Release potential is dependent on integrity of unit; otherwise release of water is regulated by NPDES permit. Low volumes of waste handled; low to moderate toxicity of waste; low migration potential.
RSA-5	Satellite Waste Accumulation Area, RSA Motor Pool	High	Moderate	Soil staining detected in original waste accumulation area; outdoors; uncovered. Relatively low volumes of waste handled.
RSA-6	Paint Shop and Paint Booth Sumps, Building 3634, RSA Motor Pool	*	Low	Indoors; release potential is dependent on integrity of sumps. Low volumes of waste handled; low to moderate toxicity of waste. low migration potential.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-7	Hazardous Waste Storage Area, Building 3775	Moderate	Low	Outdoors; storage practices not consist but no evidence of past release.
RSA-8	Sewage Treatment Plant 4	*	Moderate	Dependent on integrity of unit; discharg surface water regulated by NPDES perm Volumes of wastes handled are substantial concentrations of regulated constituents dilute.
RSA-9	Sewage Treatment Plant 3	*	Moderate	Dependent on integrity of unit; discharg surface water regulated by NPDES perm Volumes of wastes handled are substantial concentrations of regulated constituents dilute.
RSA-10	Active Sanitary Landfill, Area Q2, Unit 1	High	High	Land-based unit; evidence of past rele soil/waste/ground water/surface water sampling to be conducted as part of an
RSA-11	Sewage Treatment Plant 1	*	Moderate	Dependent on integrity of unit; discharg surface water regulated by NPDES perm Volumes of wastes handled are substantial concentrations of regulated constituents dilute.
RSA-12	Open Burn Pans, Unit 2	Moderate	High	Elevated pans on concrete, but outdoors within 100-year floodplain; large volume hazardous wastes are handled. Soil/gr water/surface water sampling to be condu as part of an RFI.
RSA-13	Unlined Open Burn Pads, Unit 2	High	High	Evidence of past release; within 100- floodplain; large volumes of hazardous wa are handled. Soil/ground water/surface w sampling to be conducted as part of an I

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-14	Contaminated Waste Burn Trenches, Unit 2	High	High	Evidence of past release; within 100-yea floodplain; soil/ground water/surface wate sampling to be conducted as part of an RFI
RSA-15	Hazardous Waste Storage Igloo 1 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-16	Hazardous Waste Storage Igloo 2 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-17	Hazardous Waste Storage Igloo 3 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-18	Hazardous Waste Storage Igloo 4 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-19	Hazardous Waste Storage Igloo 5 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-20	Hazardous Waste Storage Igloo 6 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-21	Hazardous Waste Storage Igloo 7 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-22	Hazardous Waste Storage Igloo 8 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-23	Hazardous Waste Storage Igloo 9 (RCRA-Permitted)	Low	Low	Indoors; concrete floor; berms; spill containment.
RSA-24	Hazardous Waste Storage Igloo 10 (New)	Low	Low	Indoors; concrete floor; berms.
RSA-25	Hazardous Waste Storage Igloo 11 (New)	Low	Low	Indoors; concrete floor; berms.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-26	Hazardous Waste Storage Igloo 12 (New)	Low	Low	Indoors; concrete floor; berms.
RSA-27	Hazardous Waste Storage Igloo 13 (New)	Low	Low	Indoors; concrete floor; berms.
RSA-28	Oil/Water Separator in the 5693 Area	*	Low	Release potential is dependent on integr of unit; otherwise release of water is regulated by NPDES permit. Low volumes waste handled; low to moderate toxicity waste; low migration potential.
RSA-29	Sewer System	*	High	Dependent on integrity of unit; otherw release of water is regulated by NPDES permit. Volumes of wastes handled are substantial. Evidence that integrity of u is impaired; however, sewer lines are currently being sliplined.
RSA-30	Central Oil/Water Separator	*	Low	Dependent on integrity of unit; otherw release of water is regulated by NPDES permit.
RSA-31	Central Oil/Water Separator Storage Tank	Low	Low	Above-ground steel tank; good conditic
RSA-32	Scrap Metal Storage Area (Same as MSFC-26)	High	Moderate	No release controls, gravel base; histor releases; reported PCB contamination i soils; within 100-year floodplain.
RSA-33	Plating Room Floor Drains, Plating Shop Building 5432	Low	Low	Indoors; concrete; discharge to sewer.
RSA-34	Waste Aviation Fuel Storage Area	Low	Low	Asphalt pad; drums in good condition.
RSA-35	Oil/Water Separator at Building 4812, Redstone Army Airfield	High	Moderate	Uncontrolled discharges occur during peri of heavy rainfall; NOV received. Low moderate toxicity of waste.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-36	Oil/Water Separator at Building 4832, Redstone Army Airfield	High	Moderate	May not function properly, oil not separated; uncontrolled discharges.
RSA-37	Underground Waste Oil Storage Tank at Building 7846	*	Moderate	Dependent on integrity of unit; has not been pressure-tested; low to moderate toxicity of waste.
RSA-38	Underground Waste Oil Storage Tank at Building 3240d	*	Moderate	Dependent on integrity of unit; has not been pressure-tested; low to moderate toxicity of waste.
RSA-39	Underground Waste Oil Storage Tank at Building 3338	*	Moderate	Dependent on integrity of unit; has not been pressure-tested; low to moderate toxicity of waste.
RSA-40	Underground Waste Oil Storage Tank at Building 3617	*	Moderate	Dependent on integrity of unit; has not been pressure-tested; low to moderate toxicity of waste.
RSA-41	Underground Waste Oil Storage Tank at RSA Motor Pool	*	Moderate	Dependent on integrity of unit; has been stick-tested; releases suspected; low to moderate toxicity of waste.
RSA-42	Underground Waste Oil Storage Tank at Building 4812e	*	Moderate	Dependent on integrity of unit; has not been pressure-tested; low to moderate toxicity of waste.
RSA-43	Underground Waste Oil Storage Tank at Building 5435a	*	Moderate	Dependent on integrity of unit; has not been pressure-tested; low to moderate toxicity of waste.
RSA-44	Underground Waste Oil Storage Tank at Building 5435b	*	Moderate	Dependent on integrity of unit; has not been pressure-tested; low to moderate toxicity of waste.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-45	Underground Waste Oil Storage Tank at Building 3775	Low	Low	Tank and surrounding soils removed in 19
RSA-46	Former Chemical Shell Test Area CC	High	Low	Land-based unit; elevated levels of phosphorus in soil and ground water.
RSA-47	Chemical Training Facility EE	Low	Low	Purpose of unit was to test and cleanu warfare agent.
RSA-48	Inactive Sanitary Landfill, Area G	High	High	Land-based unit; evidence of past relea soil/waste/ground water/surface water sampling to be conducted as part of an RI
RSA-49	Former Arsenic Ponds North, Area F	High	High	Land-based unit; evidence of past relea soil/waste/ground water/surface water sampling to be conducted as part of an R
RSA-50	Inactive Chemical Disposal Site H	High	Low	Land-based unit; elevated levels of phosphorus detected in ground-water; n organic or explosive contamination. Acc restricted; located in an active test ran
RSA-51	Inactive Demil Area I	High	Low	Land-based unit; has only been analyzed explosives (not found); located in an act test range.
RSA-52	Inactive Disposal Site N	High	High	Land-based unit; evidence of past releas VOCs and metals detected in ground wat
RSA-53	Inactive Sanitary Landfill, Area Q3	High	High	Land-based unit; evidence of past relea soil/waste/ground water/surface water sampling to be conducted as part of an R
RSA-54	Inactive Sanitary and Industrial Landfill, Area T	High	High	Land based unit; evidence of past relea soil/waste/ground water/surface water sampling to be conducted as part of an R

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-55	Inactive Sanitary and Industrial Landfill, Area S	High	High	Land based unit; evidence of past release; soil/waste/ground water/surface water sampling to be conducted as part of an RFI.
RSA-56	Former Arsenic Ponds South, Area U	High	High	Land-based unit; arsenic detected in soils, TCE in ground water.
RSA-57	Former Lewisite Storage Area V	High	Moderate	Land-based unit; arsenic detected in soils. Previous investigations indicate potential for only low levels of contamination.
RSA-58	Inactive Rubble Fill, Area W	High	High	Land-based unit; high concentrations of VOCs and metals detected in soil.
RSA-59	Inactive Rubble Fill, Area R	High	High	Land based unit, evidence of past release; soil/waste/ground water/surface water sampling to be conducted as part of an RFI.
RSA-60	Inactive Sanitary Landfill, Area Q4	High	High	Land based unit, evidence of past release; soil/waste/ground water/surface water sampling to be conducted as part of an RFI.
RSA-61	Former Disposal Site P	High	Moderate	Land-based unit; elevated levels of phosphorus in ground water.
RSA-62	Former Disposal Site O	High	Moderate	Land-based unit; elevated levels of phosphorus in ground water.
RSA-63	Former Chemical Disposal Site M	Moderate	Low	Land-based unit; waste encased in concrete. Access restricted; area is in active test area.
RSA-64	Former Mustard Gas Demil Site BB	High	Moderate	Land-based unit; evidence of past release to soil. Access restricted.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-65	Former Chemical Storage Area X	High	Low	Land-based unit; waste reportedly rem limited sampling conducted to date. largely under water.
RSA-66	Former Demolition Area/Ash Disposal Site X1	High	High	Land-based unit; evidence of past rel soil/waste/ground water/surface wate sampling to be conducted as part of an
RSA-67	Former Chemical Storage Area AA	High	Low	Land-based unit; waste reportedly rem unit largely under water.
RSA-68	Toxic Area Z	High	High	Land-based unit; evidence of past rel soil/waste/ground water/surface wate sampling to be conducted as part of an
RSA-69	Former Mustard Gas Storage Area Y	High	Low	Land-based unit; waste reportedly rem limited sampling conducted to date. largely under water.
RSA-70	Toxic Chemical Area Y1	High	Low	Not enough information to determine natu wastes, if any; no sampling conducted date. Area Y1 does not appear to be independent from Area Y.
RSA-71	High Explosive Drop Area A	High	Low	Land-based unit; inactive since WWII; reportedly surface cleared.
RSA-72	Mortar Shell Test Area B	High	Low	Land-based unit; inactive since WWII; reportedly surface cleared.
RSA-73	High Explosive Impact Area C	High	Low	Land-based unit; inactive since the 19 reportedly surface cleared.
RSA-74	High Explosive Impact Area D	High	Low	Land-based unit; inactive since WWII; reportedly surface cleared.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-75	Inactive Solid Waste Incinerator	Low	Low	Inactive; indoors.
RSA-76	RDX/HMX Filtration Unit #1	Low	Low	Indoors; elevated above concrete.
RSA-77	RDX/HMX Filtration Unit #2	Low	Low	Never been used; indoors; elevated above concrete.
RSA-78	RDX/HMX Filtration Unit Sump #1	Low	Low	Recent construction that receives treated wastewater.
RSA-79	RDX/HMX Filtration Unit Sump #2	Low	Low	Never been used; recent construction.
RSA-80	RDX/HMX Filtration Unloading Pad	Low	Low	Recent construction that receives treated wastewater.
RSA-81	Charcoal Column Dolly	Low	Low	Indoors; elevated above concrete.
RSA-82	Former Sparge Unit, Building 7595	Low	Low	Inactive; indoors; permitted air releases.
RSA-83	Paint Spray Booth Sump, Building 7344	*	Low	Dependent on integrity of the unit.
RSA-84	Temporary Storage Area at Building 7344	Low	Low	Inactive; replaced/renovated.
RSA-85	Temporary Storage Area #1 at Building 7359	Low	Low	Inactive; replaced/renovated.
RSA-86	Temporary Storage Area #2 at Building 7359	Low	Low	Inactive; replaced/renovated.
RSA-87	Temporary Storage Area #2 at Building 7368	Low	Low	Inactive; replaced/renovated.
RSA-88	Temporary Storage Area at Building 7625	Low	Low	Inactive; replaced/renovated.
RSA-89	Temporary Storage Area at Building 7726	Low	Low	Inactive; replaced/renovated.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-90	Temporary Storage Area at Building 7340	Low	Low	Inactive; replaced/renovated.
RSA-91	Temporary Storage Area at Building 7595	Low	Low	Inactive; replaced/renovated.
RSA-92	Temporary Storage Area at Building 7552	Low	Low	Indoors; concrete pad in good condit
RSA-93	Empty Drum Storage Area, Building 7368	Low	Low	Concrete is cracked but waste handli this unit is minimal.
RSA-94	TCE/TCA Solvent Still No. 1	Low	Low	Self-contained; indoors; elevated at concrete.
RSA-95	TCE/TCA Solvent Still No. 2	Low	Low	Self-contained; indoors; elevated at concrete.
RSA-96	TCE/TCA Solvent Still No. 3	Low	Low	Self-contained; indoors; elevated at concrete.
RSA-97	TCE/TCA Solvent Still No. 4	Low	Low	Self-contained; indoors; elevated at concrete.
RSA-98	TCE/TCA Solvent Still No. 5	Low	Low	Self-contained; indoors; elevated at concrete.
RSA-99	Abandoned Plating Shop, Building 7614	*	Moderate	Dependent on integrity of floors and s inactive but plating solutions still or and building is deteriorating.
RSA-100	Waste Oil Tank, Building 7630	Low	Low	Aboveground; spill control prevention
RSA-101	DDT Contaminated Area DD	High	High	Documented soil, groundwater, surface w and biological contamination; area i currently monitored per the Consent De

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-102	DDT Plant Site Q6	High	High	Documented soil, groundwater, surface water, and biological contamination; area is currently monitored by the MICOM Environmental Office as part of environmental program and NPDES permit.
RSA-103	DDT Settling Lagoons	High	High	Documented soil, groundwater, surface water, and biological contamination; area is currently monitored by the MICOM Environmental Office as part of environmental program and NPDES permit.
RSA-104	Former GAF Discharge Area	High	Moderate	Direct discharge to an unlined ditch; no sampling conducted to date.
RSA-105	DDT Drainage Ditches	High	High	Documented soil, groundwater, surface water, and biological contamination; area is currently monitored by the MICOM Environmental Office as part of environmental program and NPDES permit.
RSA-106	DDT Earthen Dams	High	High	Documented soil, groundwater, surface water, and biological contamination; area is currently monitored by the MICOM Environmental Office as part of environmental program and NPDES permit.
RSA-107	DDT Waste Soils Landfill, Q1, Unit 1	Low	Low	Lined and covered; monitored under ADEM Solid Waste Disposal Permit.
RSA-108	2.75 Rocket Test Firing Site	High	High	Wastes in place; high potential for release to soil and surface water (Indian Creek).

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-109	Suspected World War II Staging Area	High	Low	Land-based disposal area, but not eno information or sampling conducted to determine nature or risk potential of wastes.
RSA-110	Former Drum Storage Area, Southwest of Area Y	High	Low	Not enough information to determine natu wastes, if any; no sampling conducted date.
RSA-111	Building Debris Southwest of Area W	High	Moderate	Land-based disposal area, but not eno information or sampling conducted to determine nature or risk potential of wastes.
RSA-112	Suspected Former Demolition Area, North of Area W	High	Low	Land-based; not enough information to determine nature of wastes, if any; n sampling conducted to date.
RSA-113	Inactive Disposal Trenches North of Creek Road	High	Moderate	Land-based disposal area, but not enc information or sampling conducted to determine nature or risk potential of wastes.
RSA-114	Large Quarry	High	Moderate	Waste materials in place; not enough information or sampling conducted to determine nature or risk potential of wastes.
RSA-115	Blowdown Lagoon, East Side of Test Area 5	High	High	No sampling conducted to date; potentia discharge of reactive fuels and by-produ high.
RSA-116	Blowdown Lagoon, South Side of Test Area 5	High	High	No sampling conducted to date; potentia discharge of reactive fuels and by-produ high.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-117	Former Liquid Caustic Plant, West of Area R	High	Moderate	Aerial photos and soil sampling associated with RSA-49 indicate past releases; RFI studies for RSA-49 may provide additional information on potential releases from RSA-117.
RSA-118	Former GAF Ammonia Lagoon	High	Moderate	Direct discharge to an unlined pond; no sampling conducted to date; moderate toxicity but dilute wastes.
RSA-119	GAF Manufacturing Facility	High	Moderate	Soil contamination documented.
RSA-120	Matthews Cave and Ravine	High	Moderate	Land-based disposal area; military debris and metal wastes still in place in the interior of the cave.
RSA-121	Paint Shop at Research Lab 4762	Low	Low	Sumps and tanks new and in good condition.
RSA-122	WWII Lewisite Manufacturing Facility Site	High	Moderate	Land-based disposal area, but not enough information or sampling conducted to determine nature or risk potential of the wastes, if any.
RSA-123	Sump Under Mixer at Former Cement Plant	Low	Low	Inactive; concrete; likely no wastes remain.
RSA-124	Former Calgon Water Treatment Plant	Low	Low	Inactive; sumps cleaned out; buildings demolished.
RSA-125	Satellite Waste Accumulation Area, Building 5477	Low	Low	Outdoors, no containment but covered. However, drums on-site during VSI in good condition.
RSA-126	Former Burn Trench	High	Moderate	Unlined pit; not enough information to determine nature of wastes, if any; suspected SWMU, but no sampling conducted to date.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-127	Photo Lab Sump, Building 5451	Low	Low	Concrete sump; discharge to sewer.
RSA-128	Area of Former Mustard Gas Demil Operations	High	Moderate	Land-based disposal area, but not eno information or sampling conducted to determine nature or risk potential of wastes.
RSA-129	Thiokol Burning Pit Area	High	High	Wastes in-place in settling pond; in year floodplain; no sampling conducte date.
RSA-130	Septic Tank at Radiographic Lab, Building 7345	High	High	Wastes in place in septic tank.
RSA-131	Open Detonation Area, Unit 2	High	Moderate	Soil/ground water/surface water sampli be conducted as part of an RFI.
RSA-132	Former Popping Furnace, Unit 2	Moderate	Moderate	Soil/ground water surface water sampli be conducted as part of an RFI.
RSA-133	Former Rocket Washout Pad, Unit 2	Moderate	Moderate	Past use has not been determined. Sc sampling is to be conducted as part c RFI.
RSA-134	Former Disposal Trench/Burning Pit	High	Moderate	Unlined pit, but not enough informatic determine nature of wastes, if any; susp SWMU, but no sampling conducted to de
RSA-135a-135n	Captive Sumps for 1.1 Propellant Wastes at Thiokol	Low	Low	Concrete; captive (no outlet). Appear be well-maintained.
RSA-136a-136j	Temporary Storage Areas for 1.1 Propellant Wastes at Thiokol	Low	Low	New; covered; enclosed on three sides concrete floor with a berm and spill containment sump; monitored frequentl
RSA-137a-137p	Sumps for 1.3 Wastes at Thiokol	Low	Low	Concrete; releases to sewer.

Table 4.1. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
RSA-138a-138q	Temporary Storage Areas for 1.1 Wastes at Thiokol	Moderate	Low	New; covered; concrete floor with a berm and spill containment; monitored frequently.
RSA-139	Arsenic Waste Lagoon	Moderate	Moderate	Land-based unit; low levels of arsenic detected in the soils

Table 4.1. (Continued)

AREAS OF CONCERN

AOC No.	Description of AOC	Potential for Release	Priority	Justification
RSA-A	Propellant Storage Wells	*	Moderate	Not enough information to determine rel potential; depends on integrity of we and/or whether or not any propellent is stored in them.
RSA-B	Abandoned Army Propellant Manufacturing Building 7598	*	Low	Not enough information to determine natu wastes, if any.
RSA-C	Abandoned Army Mixer Building 7596	*	Low	Not enough information to determine natu wastes, if any.
RSA-D	Paint Shed and Storage Near Building 3540	*	Moderate	Not enough information to determine natu wastes, if any.
RSA-E	Product Spill at Fuel Tank Farm	High	Moderate	Approximately 10,000 gallons of fuel oil was not contained by containment berm released to soil/groundwater. A larg portion was believed to be recovered; however, additional soil/ground water sampling may be necessary to determir media are contaminated.
RSA-F	Open Storage 54-1	*	Moderate	Not enough information to determine natu wastes, if any; soil staining outside fenced area.
RSA-G	TCE Spill at Thiokol Degreaser	High	High	Documented discharge of TCE and poten soil and ground-water contamination.

* Potential for release is dependent on the structural integrity of the unit.

Table 4.2. Evaluation of Solid Waste Management Units and Areas of Concern on Marshall Space Flight Center (MSFC)

SOLID WASTE MANAGEMENT UNITS

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-1	Driller's Mud Disposal Site	High	High	Land-based disposal area; in-place; close proximity to drainage channel; documented soil and ground-water contamination.
MSFC-2	Abandoned Drum Disposal Site	High	Moderate	Land-based disposal area; in-place; unlined, close proximity to Indian Creek; potentially hazardous nature of waste handled.
MSFC-3	Old Bone Yard Site	High	High	Land-based disposal area; unlined; documented metals contamination in soils.
MSFC-4	Deluge Pond, MSFC West Test Area	High	High	Unlined; discharges from pond to natural drainageways; documented TCE and heavy organics in sediments
MSFC-5	Holding Pond, MSFC Test Complex 300 Area	High	High	Unlined; discharges from pond to natural drainage; documented heavy organics in sediments.
MSFC-6	Retention Pond 4586	High	High	Unlined; shallow depths to ground water; potentially hazardous nature of wastes managed; routine discharge from pond to natural drainage.
MSFC-7	Retention Pond and Drainage Pathway for Cold Calibration Test Stand Site	High	High	Unlined; shallow depths to ground water; reported chloroform contamination in soil; routine discharges from pond to surface drainage.

Table 4.2. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-8	Retention Pond, MSFC Test Complex 500 Area	High	High	Unlined; shallow depths to ground wate potentially hazardous nature of wastes managed; reported chloroform contaminatio soil; routine discharges from pond to sur drainage.
MSFC-9	Retention Pond 4579, MSFC East Test Area	High	High	Unlined; reported heavy organic and met contamination in soil and TCE in grour water; routine discharges from pond tc natural surface drainage.
MSFC-10	Retention Pond (north-central), MSFC East Test Area	High	High	Unlined; reported heavy organic and met contamination in soils; routine dischar from pond to natural surface drainage.
MSFC-11	Hydrogen Burn Pond	Low	Low	Non-hazardous waste; acceptable waste management practices.
MSFC-12	Retention Pond for Building 4572	High	High	Unlined; shallow depth to ground water potentially hazardous nature of wastes managed; close proximity of pond to unconfined drainage pathway.
MSFC-13	Old Soil/Rubble Dump Site	High	Moderate	Land-based; not enough information to determine nature of wastes, if any; suspec SWMU, but no sampling to date.
MSFC-14	Satellite Waste Accumulation Area for Buildings 4760 and 4707	Moderate	Low	Staining on cracked pavement at unit; relatively small amounts of waste handl
MSFC-15	Satellite Waste Accumulation Area for Building 4707-A	*	Low	Dependent on integrity of original pavem which has been repaired.
MSFC-16	Satellite Waste Accumulation Area for Building 4707-B	Moderate	Low	Staining on cracked pavement at unit; relatively small amounts of waste handl

Table 4.2. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-17	Satellite Waste Accumulation Area for Building 4707-C	Low	Low	Indoors; waste drummed; stored above concrete.
MSFC-18	Satellite Waste Accumulation Area for Building 4705	Low	Low	Indoors; waste drummed; stored above concrete.
MSFC-19	Satellite Waste Accumulation Areas for Building 4755	Moderate	Moderate	Drums stored on pallets above a gravel surface.
MSFC-20	Satellite Waste Accumulation Areas for Building 4755	Moderate	Moderate	Drums stored on pallets above a gravel surface.
MSFC-21	Satellite Waste Accumulation Areas for Building 4744	High	Moderate	Soil stains leading to a nearby drainage area.
MSFC-22	Satellite Waste Accumulation Area for Buildings 4741 and 4244	Moderate	Moderate	Staining on cracked pavement at unit; poo past waste management practices.
MSFC-23	Satellite Waste Freon Accumulation Area	Moderate	Low	Drums stored on pallets above a gravel surface; waste piped directly into drums
MSFC-24	Satellite Waste Oil Accumulation Area	Low	Low	Drums on concrete pavement.
MSFC-25	Satellite Waste Paint Accumulation Area	Low	Low	Indoors; drums situated above concrete.
MSFC-26	Shields Road Container Storage Area	High	Moderate	Gravel base; no secondary containment; history of releases; reported PCB contamination in soils; within 100-year floodplain.
MSFC-27	M-1 Waste Accumulation Area	High	Moderate	No secondary containment or release controls; poor past waste management practices; DDT sludge still onsite.
MSFC-28	Satellite Waste Accumulation Area for Building 4483	Low	Low	No secondary containment, but drummed waste on asphalt of good integrity.

Table 4.2. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-29	Photograph Lab Satellite Waste Accumulation Area	Low	Low	Drums stored on asphalt surface.
MSFC-30	Satellite Waste Accumulation Area at Building 4471	Low	Low	Indoors; enclosed waste above concret
MSFC-31	MSFC Hazardous Waste Container Storage Area	Moderate	Moderate	Uncontained drainage; visible stainin exposed soil; cracks in pavement; howe bays for hazardous waste storage have secondary containment.
MSFC-32	Contact Printer Waste Accumulation Area at Building 4491	Low	Low	Indoor; waste enclosed and located ab concrete.
MSFC-33	Satellite Waste Accumulation Area for Building 4815	High	Moderate	Soil staining; close proximity to sur drainage.
MSFC-34	Sump in the North Central Part of Building 4481	*	Low	Dependent on integrity of below-grade s low to moderate toxicity of waste.
MSFC-35	Sump and Drain Field at North End of MSFC East Test Area	Low	Low	Non-hazardous waste managed.
MSFC-36	Sump in South Addition of Building 4708	*	Low	Dependent on integrity of below-grade s
MSFC-37	Building 4767 Holding Tanks	*	Moderate	Not enough information to determine natur wastes.
MSFC-38	Building 4656 Oil Trap and Drainage Area	*	Low	Dependent on integrity of in-ground u
MSFC-39	Underground Waste Oil Tank at Building 4483	Low	Low	Recent tank testing indicated tank wa good condition.
MSFC-40	Waste Acid and Sodium Dichromate Holding Tank at Building 4705	Low	Low	Indoors; enclosed unit.

Table 4.2. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-41	Waste Anderol Storage Tank at Building 4744	Moderate	Moderate	Soil staining on berm at discharge point; proximity of drainage pathway.
MSFC-42	Waste Oil Trap for Fuel Oil Tanks	*	Moderate	Soil staining; proximity of drainage pathway.
MSFC-43	Waste Oil Trap for Building 4816	*	Low	Dependent on integrity of in-ground trap.
MSFC-44	Industrial Wastewater Treatment Basin	High	High	Documented ground-water contamination.
MSFC-45	Concentrate Receiving Tank	*	High	Dependent on integrity of in-ground unit; large volumes of concentrated waste handled.
MSFC-46	Transfer Tank	*	High	Dependent on integrity of in-ground unit.
MSFC-47	Hydrostatic Dump Lagoon	High	High	Unlined; earthen; documented metals contamination in ground water.
MSFC-48	Mix Tank	*	High	Dependent on integrity of in-ground unit; large volumes of concentrated waste handled.
MSFC-49	East Ultimate Lagoon	High	High	Documented ground-water contamination; large volumes of concentrated waste handled.
MSFC-50	West Ultimate Lagoon	High	High	Documented ground-water contamination; large volumes of concentrated waste handled.
MSFC-51	Industrial Wastewater Treatment Facility, Building 4760	Low	Low	Indoors; concrete construction.
MSFC-52	Industrial Wastewater Sewer Pipeline	*	High	Dependent on integrity of in-ground unit; large volumes of concentrated waste handled.
MSFC-53	Former Propellant Storage Area and Test Stand Site.	High	High	Routine wastewater discharges; poor past waste management practices.

Table 4.2. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-54	Site of Former Beryllium Metal Machining Facility	Moderate	Low	Levels of beryllium detected in soils n natural.
MSFC-55	Site of Former Stauffer Chemical Company Plant	High	Moderate	Routine wastewater discharges; poor waste management practices.
MSFC-56	Fuel Oil Loading Area and Tanks at Pump Station 4673	High	Moderate	Stains on soil and in nearby drainag pathway; adjacent to surface water drai
MSFC-57	Unleaded Gasoline Loading Area for Tanks 4632 and 4633	High	Moderate	Soil staining at the unit; adjacent surface water drainage.
MSFC-58	Waste Anderol UST, Unloading Area, and Satellite Waste Accumulation Area, Building 4747	Moderate	Moderate	Observed staining on cracked asphalt pav around loading area; potential for re from UST dependent on integrity of in-g unit.
MSFC-59	Waste Anderol UST and Unloading Area, Building 4647	Moderate	Moderate	Observed staining on concrete and as pavement around loading area; potentia release from UST dependent on integri in-ground unit.
MSFC-60	Drainage System for Historic Redstone Test Site	High	High	Past wastewater discharges from test s documented chloroform contamination i samples.
MSFC-61	Surface Drainage System for Disposal Pond 4586	High	Moderate	Unlined drainage areas; routine waste discharges; poor past waste manageme practices.
MSFC-62	Uncontained Drainage Pathways-North Section of MSFC East Test Area	High	Moderate	Unlined drainage areas; routine waste discharges; poor past waste manageme practices; documented VOC contaminati soil.

Table 4.2. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-63	Uncontained Drainage Pathways - Southeast MSFC East Test Area	High	Moderate	Unlined drainage areas; routine wastewater discharges; poor past waste management practices; documented VOC contamination in soil.
MSFC-64	Buried Pipeline at Building 4572	*	Moderate	Dependent on integrity of in-ground unit.
MSFC-65	Building 4241 Surface Drainage	High	Low	Unlined drainage areas; routine stormwater discharges.
MSFC-66	Building 4347 Surface Drainage	High	Low	Unlined drainage areas; routine stormwater discharges.
MSFC-67	Building 4618 Surface Drainage	High	Low	Unlined drainage areas; routine stormwater discharges; past releases at nearby hydraulic tanks.
MSFC-68	Building 4815 Surface Drainage	High	Moderate	Unlined drainage areas; routine stormwater discharges; close proximity of a waste accumulation area with no secondary containment.
MSFC-69	Drainage Accumulation Areas near Building 4530	High	Low	Unlined drainage areas; routine stormwater discharges.
MSFC-70	Vehicle Wash Rack and Oil/Water Separator	*	Low	Construction and design to channel discharges to oil/water separator; potential for releases from separator dependent on integrity of unit.
MSFC-71	Vehicle Wash Area at Building 4483	Low	Low	Indoors.
MSFC-72	Particulate Collection System	Low	Low	Enclosed design of unit.
MSFC-73	Construction/Rubble Fill in MSFC East Test Area	High	Moderate	Land-based unit; unlined; exposed and covered waste; observed iron leaching.

Table 4.2. (Continued)

SWMU No.	Description of SWMU	Potential for Release	Priority	Justification
MSFC-74	Former Disposal Area in MSFC East Test Area	High	Moderate	Not enough information to determine natur wastes, if any; suspected SWMU, but n sampling conducted to date.
MSFC-75	Product Storage/Waste Accumulation Area Near Building 4677	Moderate	Moderate	Drums on pallets on gravel; no second containment; soil staining.
MSFC-76	Product Storage/Waste Accumulation Area at Building 4707	Low	Low	Small amounts of drummed waste; covered concrete above ground.
MSFC-77	Former Burning Pits	High	Moderate	Not enough information to determine natur wastes, if any; suspected SWMU, but n sampling conducted to date.
MSFC-78	NASA Storage Area South of MSFC West Test Area	High	Moderate	Not enough information to determine natur wastes, if any.
MSFC-79	Drainage and Retention Pond for Building 4564	High	Moderate	Unlined; apparent routine discharges pond to natural drainage; not enough information to determine nature of wa managed; no sampling conducted to dat determine releases.
MSFC-80	Satellite Waste Fuel Accumulation Area East of Redstone Airfield	Low	Low	Drums on pallets on asphalt in good condition; no secondary containment.
MSFC-81	Paint Spray Booth at the M-1 Storage Area	High	Moderate	Direct drainage from paint spray booth natural drainage; low waste volume.
MSFC-82	Former Mustard Gas Demil Site and Mustard Shell Disposal Trenches	High	High	Land-based unit; unlined; documented disp of mustard gas waste.

Table 4-2 (continued)

AREAS OF CONCERN

AOC No.	Description of AOC	Potential for Release	Priority	Justification
MSFC-A	Caustic Storage Tank at Former MSFC Industrial Lagoon Area	*	High	Dependent on integrity of in-ground tank; large volumes of hazardous materials handled.
MSFC-B	Containment Area for Old Storable Propellant, Building 4688	High	Moderate	Documented trace levels of cyanide contamination in soil.
MSFC-C	Product Storage Tanks 4636, 4632, and 4633	Moderate	Moderate	Stains observed on side of one tank extending to ground surface.
MSFC-D	Containment Area for Tanks 4234A, B, and C	High	High	Observed stains around tanks and nearby drainage; past releases from one of the tanks; large volumes of hazardous materials handled.
MSFC-E	Buildings 4241 and 4244, Product Storage Area (BAMSI Storage Yard)	High	Moderate	Observed spillage in gravel beneath drums; low volumes of waste handled.
MSFC-F	MSFC Storage Area at Building 4644	High	Moderate	Not enough information to determine nature of wastes, if any; soil staining.

NOTES:

* Potential for release is dependent on the structural integrity of the unit.

DEPARTMENT OF THE ARMY

US ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY

ABERDEEN PROVING GROUND, MARYLAND 21010-5401

REPLY TO ATTENTION OF

CETHA-IR-P (50-6c)

7 May 92

MEMORANDUM FOR Commander, U.S. Army Missile Command, ATTN: AMSMI-RA-EQ (Mr. Bruce Whisenant), Redstone Arsenal, AL 35898-5000

SUBJECT: Preliminary Site Inspection Report for Redstone Arsenal, AL

1. Enclosed are ten (10) copies of the subject final report, revised in accordance with your comments. These additional copies are provided for your information and to honor any additional outside agency requests.

2. Point of contact for this action is Mr. Conrad Swann, this Agency, at DSN 584-1543, or commercial (410) 671-3182.

FOR THE COMMANDER:

Joseph F. Kunz
LTC CM

ROBERT J. YORK
Chief
Installation Restoration Division

Encl

CF (w/encl):
Commander, U.S. Army Corps of Engineers, ATTN: CEMP-RI, 20 Massachusetts Avenue, NW., Washington, DC 20314-1000 (4 copies)
Commander, U.S. Army Materiel Command, ATTN: AMCEN-A (Mr. Cunanan), 5001 Eisenhower Avenue, Alexandria, VA 22333-0001 (2 copies)

Administrator, Defense Technical Information Center, Cameron Station, Alexandria, VA 22314 (4 copies)

Director, Defense Logistics Studies Information Exchange, U.S. Army Logistics Management Center, Fort Lee, VA 23801 (2 copies)