



**US Army Corps  
of Engineers**

Toxic and Hazardous  
Materials Agency

**HAZARD RANKING SYSTEM SCORE (HRS2)  
SUMMARY REPORT FOR  
REDSTONE ARSENAL**

**FINAL**

**July 1992**

**Prepared For:  
U.S. Army Corps of Engineers  
Toxic and Hazardous Materials Agency  
Aberdeen Proving Ground, MD**

**Contract No. DAAA15-90-D-0001, Task 9**

**Prepared By:  
Advanced Sciences, Inc.  
1250 Brass Mill Road  
Belcamp, MD 21017**

**HAZARD RANKING SYSTEM SCORE (HRS2)  
SUMMARY REPORT FOR  
REDSTONE ARSENAL**

FINAL

July 1992

Prepared For:  
U.S. Army Corps of Engineers  
Toxic and Hazardous Materials Agency  
Aberdeen Proving Ground, MD

Contract No. DAAA15-90-D-0001, Task 9

Prepared By:  
Advanced Sciences, Inc.  
1250 Brass Mill Road  
Belcamp, MD 21017

# TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES .....	iii
1.0 INTRODUCTION .....	1
2.0 SOURCE (WASTE AREAS) DESCRIPTIONS .....	2
2.1 ✓RSA-10, Inactive Sanitary Landfill, Area Q2, Unit 1 .....	2
2.2 ✓RSA-53, Inactive Sanitary Landfill, Area Q3 .....	2
2.3 ✓RSA-48, Inactive Sanitary Landfill, Area G .....	2
2.4 ✓RSA-54 & 55, Inactive Sanitary Landfills, Areas T & S .....	2
✓2.5 RSA-60, Inactive Sanitary Landfill, Area Q4 .....	2
✓2.6 RSA 67, Former Chemical Storage, Area AA .....	2
✓2.7 RSA-12, Open Burn Pad .....	3
✓2.8 RSA-489, Former Arsenic Ponds North, Area F .....	3
✓2.9 RSA-50, Inactive Chemical Disposal Site .....	3
✓2.10 RSA-52, Inactive Disposal Site N .....	3
✓2.11 RSA-56, Former Arsenic Ponds South, Area U .....	3
✓2.12 RSA-66, Former Demolition Area and Ash Disposal Site X1 .....	3
2.13 RSA-139, Arsenic Waste Lagoon .....	3
✓2.14 RSA-58 & 59, Inactive Rubble Fill Area W and Area R .....	4
2.15 RSA-G, TCE Spill at Thiokol Degreaser .....	4
2.16 Hazardous Constituents .....	4
3.0 HAZARDOUS CONSTITUENT QUANTITY .....	4
4.0 SENSITIVE ENVIRONMENTS .....	6
5.0 AIR MIGRATION PATHWAY .....	6
5.1 Likelihood of Release .....	7
5.2 Waste Characteristics .....	7
5.3 Targets .....	7
6.0 GROUNDWATER MIGRATION PATHWAY .....	7
6.1 Likelihood of Release .....	7
6.2 Waste Characteristics .....	8
6.3 Targets .....	8

TABLE OF CONTENTS  
(Continued)

	<u>Page</u>
7.0 SURFACE WATER MIGRATION PATHWAY .....	8
7.1 Overland Flood Migration Component .....	8
7.1.1 Potential to Release .....	8
7.1.2 Drinking Water Threat .....	9
7.1.3 Human Food Chain Threat .....	9
7.1.4 Environmental Threat .....	9
8.0 SOIL EXPOSURE PATHWAY .....	9
8.1 Resident Population Threat .....	9
8.2 Nearby Population Threat .....	10
9.0 SUMMARY .....	10

REFERENCES

APPENDIX A

LIST OF TABLES

	<u>Page</u>
TABLE 1 Hazardous Constituents of Concern At Redstone Arsenal .....	10

## 1.0 INTRODUCTION

The primary purpose of the hazardous ranking score (HRS) is to accurately assess the relative degree of risk to human health and the environment posed by sites and facilities under review. These sources are then evaluated to determine potential listing on the National Priorities List (NPL). The HRS scoring system is based on a review and analysis of data available through the preliminary site assessment. The HRS does not bind the U.S. Environmental Protection Agency (EPA) in its review of the data contained in this report in the context of the NPL candidacy for this facility. The final HRS for the NPL is an EPA determination.

The HRS is a numeric scoring system which evaluates four separate exposure pathways: air, groundwater, surface water and soil exposure. Each pathway is scored based on factors grouped into three factor categories: likelihood of exposure, waste characteristics and targets. The factor categories are multiplied, and then normalized to 100 points to obtain a pathway score. The final HRS score is obtained by combining the pathway scores using a root-mean-square method, resulting in a score that also ranges from 0 to 100. Where site scores exceed 28.50, sites are considered eligible for listing on the NPL.

When performing a HRS evaluation of a site during a Preliminary Assessment (PA), insufficient data are available to definitively score all HRS factors. Thus, it becomes necessary to incorporate assumptions regarding conditions at the site. These assumptions are based on reasonable worst case conditions. The intent of using worst-case scenarios is to ascertain the potential a site has of being listed on the NPL. Consequently, HRS evaluations generated during a PA are deemed a prescore of the site and should only be utilized as an indication of whether additional investigations are necessary to characterize the site more definitively, and as a tool in predicting the final HRS score evaluated by EPA.

The purpose of this HRS summary is to identify potential sources of CERCLA hazardous substances at the Redstone Arsenal in Alabama. This summary was formulated based on the information findings contained in the Preliminary Site Inspection Report prepared by Advanced Sciences, Inc. dated January 1992. The scope of this summary does not include any field investigations or site inspection, except where conducted by previous investigations.

Sites that are considered sources for this HRS evaluation include the (1) RSA-10, active sanitary landfill, Area Q-2, unit 1; (2) RSA-53, inactive sanitary landfill, Area Q-3; (3) RSA-48, inactive sanitary landfill, Area G; (4) RSA-54 & 55, inactive sanitary and industrial landfills, Areas T & S; (5) RSA-60, inactive sanitary landfill, Area Q-4; (6) RSA-67-69, chemical storage and disposal areas; (7) RSA-12, burn pad; (8) RSA-49, arsenic ponds; (9) RSA-50, chemical disposal site; (10) RSA-52 surface impoundment; (11) RSA-56; surface impoundment, (12) RSA-66, burn pit, (13) RSA-138 temporary storage areas; (14) RSA-139, arsenic waste lagoon; and (15) RSA 58 & 59, inactive rubble fill. These sources were chosen to produce the worst-case scenarios. For purposes of performing an HRS evaluation, all sources are being combined into a single source. This approach is consistent with EPA policy for addressing non-contiguous sources and federal facilities.

The HRS methodology and scoring was done in accordance with EPA 40 CFR Part 300 Final Rule, Friday, December 14, 1990. HRS score sheets, which this summary is based upon, are provided in Appendix A.

## **2.0 SOURCE (WASTE AREAS) DESCRIPTIONS**

The following sites at Redstone Arsenal were utilized in the evaluation of the HRS score. These sites were chosen because they epitomize the worst-case scenario needed to assess the relative degree of risk to human health and environment.

### **2.1 RSA-10, Sanitary Landfill, Area Q2, Unit 1**

Only half of this landfill is active. The landfill is used for the disposal of household, administrative and industrial wastes; asbestos removed from buildings; and sludge from the three RSA sewage treatment plants. Metals and organic compounds have been detected in the soil and groundwater samples.

### **2.2 RSA-53, Inactive Sanitary Landfill, Area Q3**

This landfill was used from 1963 to 1973 for the disposal of household, administrative, sanitary and industrial wastes. Investigations show that the soil and groundwater are contaminated with metals and organic compounds.

### **2.3 RSA-48, Inactive Sanitary Landfill, Area G**

This unlined, uncapped, earthen landfill was active from 1947 to 1950. It received rubble from construction materials and sanitary wastes, but received no hazardous materials. Metals have been detected in the groundwater monitoring.

### **2.4 RSA-54 & 55, Inactive Sanitary Landfills, Areas T & S**

These landfills were active in the 1960s and early 1970s as disposal areas for household, administrative and industrial wastes; DDT was deposited from 1968 to 1973. DDT was detected in the soils from both landfills. Metals and organic compounds were detected in the groundwater from both sites.

### **2.5 RSA-60, Inactive Sanitary Landfill, Area Q4**

This unlined landfill was active from 1962 to 1968. Wastes received include household, administrative and industrial wastes. Metals and organic compounds have been detected in groundwater and soil/refuse samples.

### **2.6 RSA 67, Former Chemical Storage, Area AA**

This site was an earthen storage area for mustard gas drums in the 1940s and 1950s. The groundwater is contaminated with heavy metals.

## **2.7 RSA-12, Open Burn Pad**

This site is used for thermal treatment of solid and liquid propellants and propellant-contaminated solvents and wastes. The unit is designed to release vapors into the air. Volatile organic compounds have been detected in two wells in the vicinity.

## **2.8 RSA-489, Former Arsenic Ponds North, Area F**

This site consists of three closed surface impoundments used in the 1940s for the disposal of arsenic-contaminated wastes. The disposal of waste ashes, rubble, and industrial wastes also took place at this site from 1940 to 1977. Groundwater samples indicate concentrations of arsenic exceeding maximum concentration limits in two of the wells closest to the site.

## **2.9 RSA-50, Inactive Chemical Disposal Site**

This site was active from 1940 to 1950 for the demilitarization of high explosives, white phosphorus and mustard gas. Elevated levels of phosphorus have been detected in groundwater samples.

## **2.10 RSA-52, Inactive Disposal Site N**

Chemical munitions, including mustard gas and Lewisite agents, were disposed of at this site from 1940 to 1950. Maximum contaminant levels (MCLs) for arsenic, lead and chromium are exceeded in groundwater samples, and organic compounds have also been detected in the groundwater samples.

## **2.11 RSA-56, Former Arsenic Ponds South, Area U**

This site consists of closed-surface impoundments which received arsenic-contaminated wastes and waste water from Lewisite manufacturing facilities in the 1940s. The disposal ponds were filled and capped in 1972, with parts of the pond being filled with arsenic rubble. Groundwater samples detected low levels of arsenic in two of the four wells tested. Trichloroethane (TCE) and methylene chloride were also detected in the samples. High concentrations of arsenic have been detected in sediment samples collected from the bottoms of the closed impoundments.

## **2.12 RSA-66, Former Demolition Area and Ash Disposal Site X1**

This open area was used for an ash disposal area and possibly for demolition activities from the 1950s to the 1970s. Ash residues from open burning of propellants, solvent wastes, and metal debris were disposed of in this area. Metals and chlorinated solvents were found in soil and groundwater samples.

## **2.13 RSA-139, Arsenic Waste Lagoon**

In the 1950s, possible arsenic-contaminated wastes and waste water from the Lewisite manufacturing facilities were disposed at this site. Arsenic has been detected in soil samples.

## 2.14 RSA-58 & 59, Inactive Rubble Fill Area W and Area R

These sites received ashes from demolition operations and rubble from construction activities. Metals, PCBs, VOCs and BNA compounds have been detected in soil samples from these sites. Metals and trihalomethanes were detected in groundwater samples.

## 2.15 RSA-G, TCE Spill at Thiokol Degreaser

In 1989, a malfunctioning valve resulted in overflow to a manhole and an estimated 10 to 15 gallons of TCE was discharged into the sanitary sewer and onto Sewage Treatment Plant 1. Measures taken to treat the water prior to discharge generally brought TCE levels to below detection levels, but it is suspected that TCE residues remain in the lines. TCE is believed to have pooled in low sections of the sewer, which is constructed of vitreous clay. TCE is also believed to be leaching into the soil.

## 2.16 Hazardous Constituents

Hazardous substances detected in sampling at Redstone Arsenal that were used in evaluating this HRS score are listed in Table 1.

## 3.0 HAZARDOUS CONSTITUENT QUANTITY

Waste quantity is based on sources known to contain hazardous constituents. The quantity is calculated by a tier equation based on (1) hazardous constituent quantity; (2) hazardous waste quantity; (3) volume; and/or (4) area. In the case of Redstone Arsenal, the following areas were used in the waste quantity evaluation:

RSA #	SWMU	Quantity(ft <sup>2</sup> )	Tier level Value (Table 2-5)
10	Landfill	2,874,960	845
53	Landfill	2,178,000	641
48	Landfill	239,580	70
54-55	Landfill	784,080	231
60	Landfill	1,089,000	320
67-69	Landfill	7,361,640	2,165
12	Burn Pad	936	72
49	Arsenic Pond d	21,780	1,675
50	Chem Disp Site	479,160	36,853
52	Surf Impoundment	1,568,160	120,628
56	Surf Impoundment	87,120	6,702
66	Burn Pit	348,480	26,806
139	Lagoon	27,780	1,675
58-59	Waste Pile	1,219,680	93,821

Hazardous waste quantity is assigned the value of 10,000 from HRS Table 2-7, based on the sum of the above waste areas at 292,578. This value is used throughout the evaluations of groundwater, surface water, and air migration pathways. The soil exposure pathway is calculated the same, but is only based on the source areas with observed soil contamination.

**TABLE 1**  
**HAZARDOUS CONSTITUENTS OF CONCERN AT REDSTONE ARSENAL**

Source	Contaminant
RSA-10	Metals, volatile organic compounds (VOCs), base neutrals and acid extractables (BNA). DDT in soils. Metals and volatiles in the groundwater.
RSA-53	Chlorobenzene, chloroform, other organic compounds in groundwater.  Lead, arsenic, chromium, cadmium, barium above Primary Drinking Water Standards (PDWS), VOC, BNA, DDT, and metals in refuse samples.
RSA-48	Arsenic, barium, cadmium, chromium, lead in groundwater samples.
RSA-54 - 55	VOCs, chlorinated benzene compounds in groundwater samples. Metals, VOC, DDT in soils.
RSA-60	VOCs, metals in groundwater samples. VOCs, BNAs, DDT and metals in soil samples.
RSA-67	Arsenic, barium, cadmium, chromium, lead above PDWS.
RSA-12	BNAs, VOCs, and metals in soil samples.
RSA-49	Arsenic above PDWS in groundwater.
RSA-50	Elevated phosphorus in groundwater samples.
RSA-52	Arsenic, lead, chromium above PDWS in groundwater samples.
RSA-56	Arsenic in soil and groundwater VOCs in groundwater.
RSA-66	Metals and chlorinated benzene compounds in soils and groundwater. VOCs in groundwater.
RSA-139	Arsenic in soils.

#### 4.0 SENSITIVE ENVIRONMENTS

Several sensitive environments exist in the study area surrounding Redstone Arsenal. In the HRS scoring, sensitive environments are assigned values based on their ecological values. The following areas have been rated for this study:

- Wheeler National Wildlife Refuge
- Wheeler Lake
- Tennessee River
- Indian Creek
- McDonald Creek
- Wetlands

Each of the watersheds has:

- habitats known to be used by Federal designated species
- habitats known to be used by State designated species
- State designated natural areas
- State designated area for the protection of aquatic life

Several plant and animal species are known to reside or are transient to this area, including:

- |                             |                       |
|-----------------------------|-----------------------|
| • Florida Panther           | • Eastern Cougar      |
| • Indiana Bat               | • Hoary Bat           |
| • Southeastern Shrew        | • Black Bear          |
| • Red-Cockaded Woodpecker   | • Osprey              |
| • American Peregrine Falcon | • Bald Eagle          |
| • Arctic Peregrine Falcon   | • Golden Eagle        |
| • Sharp Skinned Hawk        | • Bewick's Wren       |
| • American Alligator        | • Flame Chub          |
| • Tennessee Cave Salamander | • Tuscumbia Darter    |
| • Southern Cavefish         | • Alabama Cave Shrimp |

#### 5.0 AIR MIGRATION PATHWAY

An evaluation of the air migration pathway at Redstone Arsenal yielded a score of 0.86 out-of 100. The pathway consists of evaluating the likelihood of release of hazardous substances to the atmosphere, the waste characteristics of potentially airborne contaminants, and the potential human and environmental targets within a four-mile radius of the source.

This Facility has been classified as a potential source of air releases and has been issued air permits. Based on recent inspections, the Facility was determined to be in compliance with EPA and State air regulations. A radon testing program is also in effect.

## 5.1 Likelihood of Release

Likelihood of release is a measure of the likelihood that a waste has been or will be released into the environment. In this case, the potential to release was determined by evaluating the gas vapor and particulate migration potential to release. Gas potential to release scored 360, based on values assigned to the Burn Pit for active fire, with no evidence of a biogas release; and the migration potential based on Henry's Law.

## 5.2 Waste Characteristics

This category is evaluated based on the hazardous waste quantity and the toxicity and mobility of vapors and particulate substances. Hazardous waste quantities are based on sources known to contain hazardous substances. This value is then combined with toxicity and mobility factors to derive a score for the factor. For the air migration pathway surrounding the Redstone Arsenal study area, waste quantity received a score of 10,000. Waste constituent, arsenic, rated the highest values for toxicity, mobility, and migration factors to give waste characteristics an assigned value of 6.

## 5.3 Targets

Human and environmental targets for the air migration pathways were evaluated within four miles of sources at Redstone Arsenal. Nearest individual received a value of 20, because the nearest resident or worker to be potentially harmed is within a 0 to 1/4 mile radius. Population was evaluated using distance-weighted population values. Population received a value of 5.6. Resources in the study area include agriculture and recreation, therefore, this factor received a 5. Sensitive environments potentially contaminated include 25 acres of wetlands for each distance category. These areas include habitat for several federal and state protected threatened and endangered species of wildlife. This factor received a score of 1.8. Overall, the targets category scored a value of 33, no maximum value is applicable.

## 6.0 GROUNDWATER MIGRATION PATHWAY

The groundwater migration pathway rated a pathway score of 54/100. The evaluation of the groundwater pathway is based on the likelihood of substances being released into an aquifer, the waste characteristics of the substances at the site, and the human targets within a four-mile radius of the source. In the four-mile study area of Redstone Arsenal, numerous private wells are used for potable water. There are also four municipal wells in the City of Huntsville. Redstone Arsenal is situated over the top the Tusculmbia Limestone aquifer system which exhibits features typical of Karst terrain.

### 6.1 Likelihood of Release

Analytical data indicating the presence of arsenic in groundwater above benchmark, gives an observed release value of 550 to this factor.

## 6.2 Waste Characteristics

Waste characteristics of groundwater migration are evaluated based on the hazardous waste quantity and the human toxicity/mobility factor. Based on the presence of arsenic in groundwater samples, characteristic factor scored a value of 100.

## 6.3 Targets

Groundwater targets are based on the nearest drinking water well, total population using that water, groundwater use in the area, and the existence of wellhead protection areas within four miles of the source. The nearest well location is 1 mile from RSA-52, hence the nearest well factor received a score of 5. Distance-weighted population values were used to assess the potential contamination from drinking water wells within a four-mile region. The population factor was assigned a value of 70.8. Resources scored a 5 for the agricultural and recreational activities in the study area. No wellhead protection is designated in this study area. Targets scored a value of 81, no maximum value is applicable.

## 7.0 SURFACE WATER MIGRATION PATHWAY

The surface water migration pathway is evaluated based on two migration components: overland/flood migration to surface water and groundwater to surface water migration. One or both components may be scored, considering their relative importance. If only one component is scored, that score is assigned to the pathway. If both components are scored, the higher of the two scores is selected and assigned to the pathway. Each component is evaluated based on the same three threats, namely, drinking water threat, human food chain threat, and environmental threat. Further, each threat involves the evaluation of the three factors: likelihood to release, waste characteristics, and targets. In the Redstone Arsenal evaluation, overland flood component was evaluated and scored 35.5. Therefore, the surface water migration pathway evaluation was assigned a score of 35.5.

### 7.1 Overland Flood Migration Component

This component evaluates surface water threats that result from overland migration of hazardous substances from a source at the site to surface water. The three threats evaluated consist of drinking water threat, human food chain threat, and environmental threat.

**7.1.1 Potential to Release.** Insufficient data is available to establish an observed release of hazardous substances into the watershed. Consequently, the potential to release was evaluated. The potential to release is evaluated using two components: potential to release by flood and potential to release by overland flow. The scores for these two components are added to obtain the factor value for the watershed.

Potential to release by overland flow is ranked according to containment, runoff, and distance to surface water. In this study, containment scored a 10 for no cover or run-on/run-off control system at RSA-13. The run-off factor attained a score of 3 based on the 50 to 250 acre drainage area which is predominately

sands, and the 2-year/24-hour rainfall value of 3.5 inches. The minimum distance to surface water is approximately 400 feet, yielding a score of 20 to the distance factor. Potential to release by overland flow scored 230.

Potential to release by flood is the product of two components: containment and flood frequency. Containment ranked a 10 due to the lack of documentation of washout prevention. Redstone Arsenal is located on the 100 year flood plain which is valued at 25. A score of 250 was assigned to the potential to release by flood, generating a score of 480 for the likelihood to release.

This score is used for all three threats of the overland flood component of surface water migration.

**7.1.2 Drinking Water Threat.** Waste characteristics were calculated based on the toxicity and persistence of arsenic and the previously computed hazardous waste quantity, producing a score of 100. Potential contamination to the population is based on a dilution weighted value. In this study area, the only surface water intake within 15 downstream miles is a City of Huntsville intake at the Tennessee River River Mile 319.4. Nearest intake factor scored 0.002, based on a dilution factor for a large river. Resource factor scored a 5 for recreational use of the watershed, irrigation of crops and watering of livestock. The overall scoring for the drinking water threat is 4.07/100.

**7.1.3 Human Food Chain Threat.** Waste characteristics scored 180/1000, and was calculated as before with the enhancement of a bioaccumulation factor for arsenic. The Tennessee River is used for recreational fishing. Based on available harvest records, the dilution factor of a large river, and the bioaccumulation of arsenic, the food chain individual factor was assigned a value of .002/50, and the potential to contaminate the human food chain was ranked at 0.00003. Overall scoring for the human food chain threat yields 0.001.

**7.1.4 Environmental Threat.** The environmental threats scored 31.4. Waste characteristics were calculated using values for PCBs; for ecosystem toxicity, persistence, and bioaccumulation. The score assigned to waste characteristics is 1000. The sensitive environments in this study area include several habitats for endangered species and approximately 20 miles of wetlands. Sensitive environments scored a 5.4.

## **8.0 SOIL EXPOSURE PATHWAY**

Evaluation of the soil exposure pathway is based on two threats: resident population threat and nearby population threat. Both threats are based on the three factor categories of likelihood of exposure, waste characteristics and targets. The soil exposure pathway ranked a score of 17.1/100.

### **8.1 Resident Population Threat**

The resident population threat is evaluated if there is an area of observed contamination within 200 feet of a residence, school, and/or workplace boundary. This sub-pathway is appraised using the likelihood to release along with waste characteristics and targets. Observed release of TCE at RSA-G ranked a 550

for likelihood of exposure. Analysis indicates levels of hazardous substances above reference dose listed for the soil pathway exposing potential populations to level I contamination. Within the 200 feet area of contamination, there are no resident individuals, or resident population. There are also no resources or terrestrial sensitive environments within the 200 feet study area. There are, however, approximately 20 personnel which are subject to exposure. The resident population threat scored a 88,000.

## 8.2 Nearby Population Threat

This threat evaluates the nearby population who live, work or attend school within a one mile travel distance of the surficial contamination area. Attractiveness, accessibility and frequency of use, along with the area of contamination are assessed to determine the likelihood of exposure. This factor is multiplied by the waste characteristics and targets to ascertain the score for this sub-pathway threat.

Within the cantonment area, the source of contamination is surrounded by a maintained fence or a natural barrier, giving attractiveness and accessibility factor a value of 5/500. The area of contamination is greater than 500,000 square feet, which is assigned a factor value of 100. The likelihood of exposure was assigned a 5/500.

A value of 1 was assigned to the nearest individual. The population within one mile is 1200, which scored 6.0, and nearby individual received a value of 1. The nearby population threat was assigned a value of 256.

## 9.0 SUMMARY

Utilizing the root-square-mean equation with the scores of the four pathways; air migration, groundwater migration, surface water migration and soil exposure, an overall HRS score of 33.4 out of 100 was computed. The EPA employs a cut off score of 28.5 as a management tool for identifying sites that are candidates for the NPL. Accordingly, this HRS score of Redstone Arsenal indicates a potential to score high enough for listing on the NPL.

## REFERENCES

Advanced Sciences, Inc. 1992, "Preliminary Site Inspection for Redstone Arsenal," Prepared for U.S. Army Corps of Engineers, Toxic and Hazardous Materials Agency, Aberdeen, MD, January.

Maseena 1992. Telephone conversation between M. Maseena of Auburn University Fisheries Coop and L. Fritz of Advanced Sciences, March 18.

**APPENDIX A**

Redstone Arsenal

PRELIMINARY SCORING PACKAGE			
SUMMARY SCORESHEET FOR COMPUTING $S_m$			
Groundwater Migration Pathway Score ( $S_{gw}$ )		54.0	2916.00
Surface Water Migration Pathway Score ( $S_{sw}$ )		33.5	1260.25
Soil Exposure Pathway Score ( $S_s$ )		17.1	292.41
Air Migration Pathway Score ( $S_a$ )		0.86	0.74
		$S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$	4469.40
		$(S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2)/4$	1117.35
		$[(S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2)/4]^{0.5} = S$	33.4

Site Name: Redstone Arsenal		
Date Prepared: March 1992		
<b>GROUNDWATER MIGRATION PATHWAY SCORESHEET</b>		
<b>LIKELIHOOD OF RELEASE TO AN AQUIFER</b>	<b>Maximum Value</b>	<b>Minimum Assigned</b>
1. Observed Release	550	550
2. Potential to Release		
2a. Containment	10	
2b. Net Precipitation	10	
2c. Depth to Aquifer	5	
2d. Travel Time	35	
2e. Potential to Release [lines 2a(2b + 2c + 2d)]	500	0
3. Likelihood of Release (higher of lines 1 and 2e)	550	550
<b>WASTE CHARACTERISTICS</b>		
4. Toxicity/Mobility		10000
5. Hazardous Waste Quantity		10000
6. Waste Characteristics	100	100
<b>TARGETS</b>		
7. Nearest Well	50	5
8. Population		
8a. Level I Concentrations		0
8b. Level II Concentrations		0
8c. Potential Contamination		71
8d. Population (lines 8a + 8b + 8c)		71
9. Resources	5	5
10. Wellhead Protection Area	20	0
11. Targets (lines 7 + 8d + 9 + 10)		
<b>GROUNDWATER MIGRATION SCORE FOR AN AQUIFER</b>		
12. Aquifer Score [(lines 3x 6 x 11)/82500]	100	54,0
<b>GROUNDWATER MIGRATION PATHWAY SCORE</b>		
13. Pathway Score (Sgw)		
(Highest Value from line 12 for all aquifers evaluated)		54.0

## GROUNDWATER MIGRATION PATHWAY

**OBSERVED RELEASE: 550** (Based on analytical data indicating the presence of arsenic in groundwater exceeding benchmark values.)

### WASTE CHARACTERISTICS:

Toxicity/Mobility: 10,000 (Based on Superfund Chemical Data Matrix (SCDM) for arsenic.)  
 Hazardous Waste Quantity: 10,000

Source	Quantity (ft <sup>2</sup> )	Equation(Table 2-5)	Factor Value
RSA-10 Landfill	2,874,960	A/3400	845
RSA-53 Landfill	2,178,000	"	641
RSA-48 Landfill	239,580	"	70
RSA-54&55 Landfill	784,080	"	231
RSA-60 Landfill	1,089,000	"	320
RSA-67-69 Landfill	7,361,640	"	2,165
RSA-12 Burn Pad	936	A/13	72
RSA-49 Arsenic Ponds	21,780	"	1,675
RSA-50 Chem Disp Site	479,160	"	36,853
RSA-52 Surf. Impound.	1,568,160	"	120,628
RSA-56 Surf. Impound.	87,120	"	6,702
RSA-66 Burn Pit	348,480	"	26,806
RSA-138	100	"	8
RSA-139 Lagoon	21,780	"	1,675
RSA 58&59 Waste Pile	1,219,680	"	93,821
Total:			292,578

Hazardous Waste Quantity Factor: 10,000 (Table 2-6)  
 Waste Characteristics: 100 (Table 2-7)

### TARGETS:

Nearest well: 5 (1 mile from RSA-52.)

Population:

Level I concentration: 0

Level II concentration: 0

Potential contamination:

Distance Category	# people served by groundwater wells	Distance Weighted Population Values
0 - 1/4	0	0
>1/4-1/2	240	102
>1/2-1	5	2
>1-2	135	82
>2-3	725	261
>3-4	320	261

TOTAL: 708

$$PC = \frac{1}{10}(708) = 7.1$$

Note: Estimates for population served include a factor for wells subject to potential contamination 0.04 (1 out of 24) at >1 miles; 0.08 (2 out of 24) at >2 to 3 miles; and 0.04 (1 out of 24) at >3 to 4 miles) as well as a mixture factor of 0.3.

Resources: 5

Wellhead Protection: 0

Groundwater Pathway Score: 54.0

Site Name: Redstone Arsenal		
Date Prepared: March 1992		
<b>SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET</b>		
<b>DRINKING WATER THREAT</b>	<b>Maximum Value</b>	<b>Value Assigned</b>
<b>LIKELIHOOD OF RELEASE TO AN AQUIFER</b>		
1. Observed Release	550	0
2. Potential to Release by Overland Flow		
2a. Containment	10	10
2b. Runoff	25	3
2c. Distance to Surface Water	25	20
2d. Potential to Release by Overland Flow [lines 2a(2b + 2c)]	500	230
3. Potential to Release by Flood		
3a. Containment (Flood)	10	10
3b. Flood Frequency	50	25
3c. Potential to Release by Flood (lines 3a x 3b)	500	250
4. Potential to Release (lines 2d + 3c)	500	250
5. Likelihood of Release (higher of lines 1 and 4)	550	480
<b>WASTE CHARACTERISTICS</b>		
6. Toxicity/Persistence		10000
7. Hazardous Waste Quantity		10000
8. Waste Characteristics	100	100
<b>TARGETS</b>		
9. Nearest Intake	50	0.002
10. Population		
10a. Level I Concentrations		0
10b. Level II Concentrations		0
10c. Potential Contamination		2
10d. Population (lines 10a + 10b + 10c)		2
11. Resources	5	5
12. Targets (lines 9 + 10d + 11)		7.002
13. Drinking Water Threat Score ([lines 5x8x12]/82500)	100	4.07

HUMAN FOOD CHAIN THREAT		
LIKELIHOOD OF RELEASE	Maximum Value	Minimum Assigned
14. Likelihood of Release (same value as line 5)	550	480
WASTE CHARACTERISTICS		
15. Toxicity/Persistence/Bioaccumulation		50000
16. Hazardous Waste Quantity		10000
17. Waste Characteristics	1000	180
TARGETS		
18. Food Chain Individual	50	0.002
19. Population		
19a. Level I Concentrations		0
19b. Level II Concentrations		0
19c. Potential Human Food Chain Contamination		0.00003
19d. Population (lines 19a + 19b + 19c)		0.00003
20. Targets (lines 18 + 19c)		0.00203
HUMAN FOOD CHAIN THREAT SCORE		
21. Human Food Chain Threat Score ((lines 12x15x18)/825000)		0.002
ENVIRONMENTAL THREAT		
LIKELIHOOD OF RELEASE		
22. Likelihood of Release (same value as line 5)	550	480
WASTE CHARACTERISTICS		
23. Ecosystem Toxicity/Persistence/Bioaccumulation		5.00e+08
24. Hazardous Waste Quantity		10000
25. Waste Characteristics	1000	1000
TARGETS		
26. Sensitive Environments		
26a. Level I Concentrations		0
26b. Level II Concentrations		0
26c. Potential Contamination		5.4
26d. Sensitive Environments (lines 26a + 26b + 26c)		5.4
27. Targets (value from line 26d)		5.4
ENVIRONMENTAL THREAT SCORE		
28. Environmental Threat Score ((lines 22x25x27)/82500)	60	31.4
SURFACE WATER OVERLAND/FLOW MIGRATION COMPONENT SCORE FOR A WATERSHED		
29. Watershed Score (lines 13 + 21 + 28)	100	35.5
30. Component Score (sgs) (highest score from line 29 for all watersheds evaluated)	100	35.5

## SURFACE WATER OVERLAND/FLOOD MIGRATION PATHWAY

**OBSERVED RELEASE:** 0 No data available to establish a release to surface water.

### POTENTIAL TO RELEASE:

Containment: 10 (No cover or runoff control system at RSA-13.)

Runoff: 3

Drainage Area Value: 2 (50 - 250 acres)

Soil Group Designation: C (Moderately fine textured soils)

Rainfall/Runoff Value: 5 (2yr/24hr rainfall = 3.5 inches)

Runoff Factor Value: 3 (HRS Table 4-6)

Distance to Surface Water: 20 (400 ft from RSA-13.)

### POTENTIAL TO RELEASE BY FLOOD: 250

Containment (Flood): 10 (No containment documentation)

Flood Frequency: 25 (100-yr flood plain)

### LIKELIHOOD OF RELEASE: 480

### WASTE CHARACTERISTICS:

Toxicity/Persistence: 10,000 (Based on arsenic in soils near RSA-10.)

Hazardous Waste Quantity: 10,000 As previously determined.

Waste Characteristics: 100 (Table 2-7)

### TARGETS:

Nearest Intake: 0.002

Dilution Factor 0.0001 (Large River)  $(20)(0.0001)=0.002$

Population:

Level I concentrations: 0

Level II concentrations: 0

Potential contamination:

20% from intake below RSA

Population served  $(60,000)(0.2)=12,000$

Potential contamination factor: 2 (Table 4-14)

Resources: 5

### DRINKING WATER THREAT SCORE: 4.07

### HUMAN FOOD CHAIN THREAT:

### LIKELIHOOD OF RELEASE: 480

### WASTE CHARACTERISTICS:

Toxicity/Persistence/Bioaccumulation: 500,000 (Based on arsenic.)

Hazardous Waste Characteristics: 10,000 (As previously determined.)

Waste Characteristics: 180 (Table 2-7)

**SURFACE WATER OVERLAND FLOOD MIGRATION PATHWAY  
(Continued)**

**TARGETS:**

Food Chain Individual:  $(0.0001)(20)=0.002$

Population:

Level I concentrations: 0

Level II concentrations: 0

Potential Human Food Chain Contamination:

Estimated human food chain production 1000 to 10,000 lbs/yr.

Factor value: 3 Dilution weight 0.0001 (Large River) Lakes

$(3)(0.0001)=0.00003$

**HUMAN FOOD CHAIN THREAT SCORE: 0.001**

**ENVIRONMENTAL THREAT**

**LIKELIHOOD OF RELEASE: 480**

**WASTE CHARACTERISTICS:**

Ecosystem Toxicity/Persistence/Bioaccumulation 5.0E08 (Based on PCBs in soil near RSA-58.)

**TARGETS:**

Sensitive Environments:

Level I Concentration: 0 No data Available.

Level II Concentration: 0 No data Available.

Potential Contamination:

Sensitive Environment:	Rating	Dilution Factor	Total
Habitat for Tuscumbia Darter	75	0.01	0.75
Habitat for Southern Cavefish	75	0.01	0.75
Habitat for Flame Chub	75	0.01	0.75
Habitat for American Alligator	75	0.01	0.75
Habitat for TN. Cave Salamander	50	0.01	0.50
Estimated 20 miles of wetlands	500	0.1	50
4 miles	100	0.0001	0.01

$$SP = \frac{1}{10}(3.5+50)(0.1) = 5.4$$

**ENVIRONMENTAL THREAT SCORE: 31.4**

**SURFACE WATER OVERLAND/FLOOD COMPONENT SCORE: 35.5**

Site Name: Redstone Arsenal		
Date Prepared: March 1992		
SOIL EXPOSURE PATHWAY SCORESHEET		
RESIDENT POPULATION THREAT		
LIKELIHOOD OF RELEASE TO AN AQUIFER	Maximum Value	Minimum Assigned
1. Likelihood of Exposure	550	550
WASTE CHARACTERISTICS		
2. Toxicity		100
3. Hazardous Waste Quantity		10000
4. Waste Characteristics	100	32
TARGETS		
5. Resident Individual	50	0
6. Resident Population		
6a. Level I Concentrations		0
6b. Level II Concentrations		0
6c. Resident Population (lines 6a + 6b)		0
7. Workers	15	5
8. Resources	5	0
9. Terrestrial Sensitive Environments		75
10. Targets (lines 5 + 6c + 7 + 8 + 9)		80
RESIDENT POPULATION THREAT SCORE		
11. Resident Population Threat (lines 1 x 4 x 10)		1408000
NEARBY RESIDENT THREAT		
LIKELIHOOD OF EXPOSURE		
12. Attractiveness/Accessibility	100	10
13. Area of Contamination	100	100
14. Likelihood of Exposure	500	5
WASTE CHARACTERISTICS		
15. Toxicity		100
16. Hazardous Waste Quantity		10000
17. Waste Characteristics	100	32
TARGETS		
18. Nearby Individual	1	1
19. Population Within 1 Mile		1.6
20. Targets (lines 18 + 19)		2.6
NEARBY POPULATION THREAT		
21. Nearby Population Threat (lines 14 x 17 x 20)		416
SOIL EXPOSURE PATHWAY SCORE		
22. Soil Exposure Pathway Score (Ss) (lines [11 + 21]/82500)	100	17.1

## SOIL EXPOSURE PATHWAY

### Resident Population Threat

**LIKELIHOOD OF RELEASE: 500** (Based on analytical data indicating presence of TCE in soils above benchmark values near RSA-G.)

### WASTE CHARACTERISTICS:

Toxicity: 100 (SCDM for TCE)  
Hazardous Quantity: 10,000 (As previously determined.)  
Waste characteristics: 32 (Table 2-7)

### TARGETS

Resident Individual: 0  
Resident Population:  
    Level I concentrations: 0  
    Level II concentrations: 0  
Workers: 5 (20 workers near RSA-G.)  
Terrestrial Sensitive Environments: 0  
Resident Population Threat: 88,000

### Nearby Resident Threat

**LIKELIHOOD OF EXPOSURE: 550**

Attractiveness/Accessibility: 5 (Area surrounded by maintained fence.)  
Area of contamination: 100 (greater than 500,00 feet) \*  
Likelihood of exposure: 5 (Table 5-8)

### WASTE CHARACTERISTICS:

Toxicity: 100 (SCDM based on TCE)  
Hazardous Waste Quantity: 10,000 (As previously determined.)  
Waste Characteristics: 32 (Table 2-7)

### TARGETS

Nearby Individual: 1 (less than 1/4 mile)  
Population within 1 mile:

Distance Category	Population	Distance-Weighted Population Values
0 - 1/4	75	1
>1/4 - 1/2	125	2
>1/2 - 1	1000	3
SUM		6.0

$$\text{Potential Contamination} = \frac{1}{10}(6.0) = 0.6$$

Nearby Population Threat: 256

Soil Exposure Pathway Score: 1.07

Site Name: Redstone Arsenal		
Date Prepared: March 1992		
AIR MIGRATION PATHWAY SCORESHEET		
LIKELIHOOD OF RELEASE	Maximum Value	Value Assigned
1. Observed Release	550	0
2. Potential to Release		
2a. Gas Potential to Release	500	360
2b. Particulate Potential to Release	500	280
2c. Potential to Release (higher of lines 2a and 2b)	500	360
3. Likelihood of Release (higher of lines 1 and 2c)	550	360
WASTE CHARACTERISTICS		
4. Toxicity/Mobility		0.8
5. Hazardous Waste Quantity		10000
6. Waste Characteristics	100	6
TARGETS		
7. Nearest Individual	50	20
8. Population		
8a. Level I Concentrations		0
8b. Level II Concentrations		0
8c. Potential Contamination		6
8d. Population (lines 8a + 8b + 8c)		6
9. Resources	5	5
10. Sensitive Environments		
10.a Actual Contamination		0
10b. Potential Contamination		2
10c. Sensitive Environments (lines 10a + 10b)		33
11. Targets (lines 7 + 8d + 9 + 10c)		
AIR MIGRATION PATHWAY SCORE		
12. Pathway Score (Sa [(lines 3 x 6 x 11)/82500])	100	0.86

## AIR MIGRATION

**OBSERVED RELEASE:** 0 No data available to establish a release to air.

**POTENTIAL TO RELEASE:**

Source	Gas	Gas Source	Gas Migration	SUM	Gas Potential
RSA-53 Landfill	10	11	17	28	280
RSA-66 Burn Pit	10	19	17	36	360

Source	Particulate	Particulate	Particulate	SUM	Particulate
RSA-53 Landfill	10	22	6	28	280
RSA-66 Burn Pit	10	22	6	28	280

**LIKELIHOOD OF RELEASE:** 360

**WASTE CHARACTERISTICS:**

Toxicity/Mobility: 0.8

Toxicity: 10,000 (Based on arsenic.)

Mobility: 0.00008 (Figure 6-3)

Hazardous Waste Quantity: 10,000 As previously Determined.

Waste Characteristics: 6 (Table 2-7)

**TARGETS:**

Nearest Individual: 20 (Table 6-16)

Population:

Level I concentration: 0

Level II concentration: 0

Potential Contamination:

Distance Category	Population	Distance Weighted Population Values
On a source	20	17
0 - 1/4	75	13
>1/4-1/2	125	9
>1/2-1	200	3
>1-2	1150	8
>2-3	2000	4
>3-4	2750	2

TOTAL: 56

$$PC = \frac{1}{10}(56) = 5.6$$

**AIR MIGRATION**  
(Continued)

Resources: 5

**Sensitive Environments:**

Actual Contamination: 0 No data available.

Potential Contamination: Assume 25 acres wetlands for each distance category.

The area is a habitat for the following species. Each has a rating from Table 4-23 as 75, and a Distance (midpoint) rating from Table 6-15 as 0.016. The species include: Florida panther, Eastern cougar, Indiana Bat, Southeastern bat, Hoary Bat, Red-cockaded woodpecker, American Peregrin falcon, Artic Peregrine falcon, Sharp skinned hawk, Copper's Hawk, Golden Eagle, Bald Eagle, Osprey, and Bewick's Wren.

Rating:  $(75)(0.16)(14)=16.8$ .

Wetlands for the area are rated at 25, with a distance factor of 0.054, scoring a  $(25)(0.054)=1.4$ .

Total:  $16.8+1.4=18.2$

$$EP = \frac{1}{10}(18.2) = 1.8$$

Air Migration Pathway Score: 0.86



PRODUCT REVIEW AND APPROVAL

PROJECT NAME: Redstone Arsenal

PROJECT/PROPOSAL MGR.: K Walters PROJECT/PROPOSAL NO.: \_\_\_\_\_

TITLE OF DOCUMENT: HRS Summary DUE DATE: \_\_\_\_\_

TOTAL DOLLAR VALUE: \_\_\_\_\_ CLIENT: \_\_\_\_\_

LEAD AUTHOR: L. Frite SECTIONS\*: \_\_\_\_\_

OTHER AUTHORS (SECTIONS\*): \_\_\_\_\_

DISCIPLINES INVOLVED: \_\_\_\_\_

OUTLINE APPROVED: \_\_\_\_\_ DATE: \_\_\_\_\_

SIGNATURE OF PROJECT/PROPOSAL MANAGER

APPROVAL BY REVIEW MGR./REVIEWER

APPROVAL BY DIV. MGMT.

DATE

LEVELS OF REVIEW	DRAFT DESIGNATION	NAME OF REVIEWER	REVIEWER SIGNATURE AND DATE**
A. COWORKER REVIEW	WORKING DRAFT	<u>Kelly Blach</u>	<u>[Signature] 4/14/91</u>
B. PROJECT REVIEW	PRELIMINARY DRAFT	_____	_____
● EDITOR'S SIGN OFF (WHEN DESIGNATED BY PM)			
C. DIV. MGMT. REVIEW	FINAL DRAFT OR CLIENT REVIEW	<u>H Winderker</u>	<u>[Signature] 4/15</u>

NOTE: FINAL DRAFT AND FINAL REPORT WILL NOT BE TYPED WITHOUT DIVISION MANAGEMENT REVIEW SIGNOFF. SUBMIT THIS FORM WITH WORD PROCESSING REQUEST FORM.

APPROVAL OF FINAL DRAFT: \_\_\_\_\_ DATE: \_\_\_\_\_

SIGNATURE OF DIV. MGMT. OR DESIGNEE

APPROVAL OF FINAL REPORT: \_\_\_\_\_ DATE: \_\_\_\_\_

SIGNATURE OF DIVISIONAL V.P.

REVIEWER COMMENTS: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\* FOR MULTIDISCIPLINARY REPORTS, USE SEPARATE SHEET FOR EACH DISCIPLINE.  
\*\* AFTER COMMENTS RESOLVED AND DOCUMENT REVISED