DRAFT FINAL
UNIT 2 SITE SPECIFIC WORK PLAN
(RSA-13, RSA-14, RSA-132, AND RSA-133)

REDSTONE ARSENAL, ALABAMA

DACA87-95-D-0018

TASK ORDER 0005

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE CENTER

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SEPTEMBER 1996

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AEHA	Army Environmental Hygiene Agency
ARARs	Applicable or Relevant and Appropriate Requirements
BAFs	Bioaccumulation Factors
BCFs	Bioconcentration Factors
BLS	Below Land Surface
BRAs	Baseline Risk Assessments
CEHNC	U.S. Army Corps of Engineers, Huntsville Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory
COPCs	Chemicals of Potential Concern
CPSS	Chemicals Present in Site Samples
CSM	Conceptual Site Model
DQOs	Data Quality Objectives
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ESE	Environmental Science and Engineering, Inc.
FCMs	Food Chain Multipliers
FS	Feasibility Study
FSP	Field Sampling Plan
HHRA	Human Health Risk Assessment
IDW	Investigation-Derived Waste
IFF	Interchange File Format
MCLs	Maximum Concentration Limits

MSL	Mean Sea Level
OB/OD	Open Burn/Open Detonation
PELA	P.E. LaMoreaux and Associates
QC	Quality Control
RAGS	Risk Assessment Guidance For Superfund
RBC	Risk-Based Concentrations
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RSA	Redstone Arsenal
SAP	Sampling Analysis Plan
SOW	Statement of Work
SVOCs	Semi-Volatile Organic Compounds
SWMUs	Solid Waste Management Units
TAL	Target Analyte List
TBC	To Be Considered
TCL	Target Compound List
TOC	Total Organic Compound
TVA	Tennessee Valley Authority
USCOE	US Corps of Engineers
USEPA	US Environmental Protection Agency
VOCs	Volatile Organic Compounds

SECTION 1
INTRODUCTION

1.0.a This document was prepared by Parsons Engineering Science (Parsons ES) of Atlanta, Georgia, for the U.S. Army Corps of Engineers, Huntsville Center (CEHNC), Huntsville, Alabama. The preparation of this document was conducted under Task Order 0005 of Contract No. DACA87-95-D-0018.

1.1 PURPOSE OF REPORT

1.1.a This document presents site-specific information concerning Sites RSA-13, RSA-14, RSA-132, and RSA-133, also referred to as Unit 2, at Redstone Arsenal (RSA).

1.1.b This document also identifies specific requirements for RI/FS activities requested by CEHNC and Environmental Science and Engineering, Inc. (ESE) to be conducted at these sites. General information applicable to all RSA sites is presented in the General RI/FS Work Plan (Parson ES, 1996).

1.2 REPORT ORGANIZATION

1.2.a Site conditions specific to Unit 2 are presented in Section 2. Section 3 presents the site-specific conceptual site models (CSMs). Remedial technologies that are potentially applicable at these sites, the preliminary identification of applicable or relevant and appropriate requirements (ARARs), and data quality objectives are also discussed in Section 3. The RI task plan, including requirements for pre-field activities, field investigations, data reduction, baseline risk assessments, and data reporting, is presented in Section 4. The feasibility study (FS) methodology is presented in Section 5. Requirements for plans and project management are discussed in Section 6. References cited in this document are listed in Section 7. Appendices to this document include the Site-Specific Safety and Health Plan, the Field Sampling Plan, and the Chemical Data Acquisition Plan.

1.3 PROJECT PERSONNEL

1.3.a The following Parsons ES personnel provided significant contributions to the preparation of this document:

• Thomas M. Roth, P.E.	Project Manager
• Kenneth J. Stockwell, P.E.	Technical Director
• Alyse Getty	Ecological Assessment
• Janet Hall	Data Quality
• Ronda Simmons, Ph.D, P.G.	Geology and Field Investigations
• Cindy Lewis	Health and Safety
• Karen Scruton	Risk Assessment

2.3.2.c The overburden thickness ranges from 25 feet to 54 feet. The overburden consists of a surficial sandy clay from 10 feet to greater than 20 feet in thickness and an underlying silty, clayey, fine-grained micaceous sand. Grain size increases with depth and the base of the overburden consists of a silty to clayey coarse grained sand and gravel. The basal sand and gravel deposits are generally thicker and coarser at topographic lows of the Tuscumbia Limestone and thinner and finer grained at topographic highs (G&M, 1992). The elevation of the top of the Tuscumbia Limestone typically ranges from 500 ft MSL to 550 ft MSL.

2.4 HYDROGEOLOGY

2.4.a The hydrogeologic settings of Unit 2 are described below.

2.4.1 Regional Hydrogeology

2.4.1.a Regional hydrogeology is discussed in the General Installation RI/FS Work Plan (Parsons ES, 1996).

2.4.2 Site Hydrogeology

2.4.2.a Previous hydrogeological investigations at Unit 2 (G&M, 1992, 1993) identified water-bearing zones in the alluvial overburden and the weathered Tuscumbia Limestone bedrock. G&M completed wells in both the upper Tuscumbia and deeper Tuscumbia limestone bedrock. A hydrogeologic profile of Unit 2 is found in Figure 2.5.

2.4.2.b Results from water level measurements, collected during the Phase I and Phase II RFI, indicate the direction of groundwater flow in the overburden and the upper portion of the Tuscumbia Limestone to be away from the topographic high areas in the south-central portion of Unit 2 (Figures 2.6, 2.7, and 2.8). The maximum hydraulic gradient in the alluvial overburden and the upper bedrock is approximately 0.008. Groundwater flow in the deep Tuscumbia Limestone bedrock is to the southwest, towards the Tennessee River (Figure 2.9). Hydraulic gradients within the deeper bedrock are approximately 0.0003. Water levels in the deep bedrock monitoring wells are typically lower than overburden and upper bedrock monitoring wells, indicating a downward vertical hydraulic gradient (G&M, 1993).

2.4.2.c Hydraulic conductivity in the alluvial overburden ranges from 6.1×10^{-5} cm/sec. to 1.3×10^{-2} cm/sec (G&M, 1992, 1993). Hydraulic conductivity in the Tuscumbia Limestone varies depending on the location of interconnected solution-enlarged cavities and fractures. Values of hydraulic conductivity in the upper bedrock range from 3.7×10^{-5} cm/sec. to 1.8×10^{-1} cm/sec. Hydraulic conductivity in the deeper bedrock of the Tuscumbia Limestone range from 7.2×10^{-3} cm/sec. to 3.5×10^{-1} cm/sec.

2.2.3 RSA-132 (Former Popping Furnace)

2.2.3.a RSA-132, also known as the Former Popping Furnace, is located in the central eastern portion of Unit 2, south of Buxton Road, west of McAlpine Road, and east of the Tennessee River. The land surface is relatively flat with creeks and wetlands north and east of the site. The area where the popping furnace (a metal kettle) was is now covered by grass (ESE, 1996). The elevation of RSA-132 is approximately 570 feet MSL.

2.2.4 RSA-133 (Former Rocket Washout Pad)

2.2.4.a RSA-133, also known as the Former Rocket Washout Pad, is located in the central portion of Unit 2, south of Buxton Road, west of McAlpine Road, and east of the Tennessee River. The site is within the floodplain of the Tennessee River. The land surface is relatively flat with creeks and wetlands north and east of the site. The area is fenced off, overgrown with grass, and labeled with warning signs (ESE, 1996). The elevation of RSA-133 is approximately 567 feet MSL.

2.3 GEOLOGY

2.3.a The geologic setting of Unit 2 is described below.

2.3.1 Regional Geology

2.3.1.a A discussion of the regional geologic setting is provided in the General RI/FS Work Plan (Parsons ES, 1996).

2.3.2 Site Geology

2.3.2.a Interpretation of site geology was based on investigations from the Phase I and II RFI at Unit 2 (G&M, 1992, 1993). These investigations involved the collection of soils (seven shallow surface samples and fifteen subsurface boring samples) and the installation of 28 groundwater monitoring wells. Locations of soil sampling and the monitoring wells are shown in Figures 2.2 through 2.4. Soil boring logs and groundwater monitoring logs are found in the Phase I and II RFI Report(G&M, 1992, 1993).

2.3.2.b The soil borings and monitoring well installation completed during the Phase I and II RFI and previously collected data (PELA, 1988b) indicate the presence of three distinct geologic units: 1) a surficial sandy clay (overburden), 2) a silty, clayey, fine-grained micaceous sand (overburden), and 3) the Tuscumbia Limestone with fracture zones and solution cavities (bedrock).

2.1.3 RSA-132 (Former Popping Furnace)

The dismantled popping furnace was active during the 1940s when the Redstone Ordnance Plant was testing charges and manufacturing small arms ordnance. After WWII, RSA-132 was used to demilitarize captured and off-spec ordnance. Small arms ammunitions charges were tested and demilitarized in a closed-top metal vessel, or kettle, that was heated by a portable diesel fuel burner. The heat exploded the charge and the metal was salvaged. It was highly unlikely that live rounds were disposed of in the popping furnace. RSA-132 was dismantled and removed in 1970.

2.1.4 RSA-133 (Former Rocket Washout Pad)

This site is the inactive rocket motor washrack and concrete captive sump. The washrack and sump is 10 feet by 10 feet. The exact depth of the sump is unknown, but is speculated to be 30 feet. The site served as an area to clean residual propellant from rocket motors using chlorinated solvents, typically trichloroethylene. All infrastructure has been dismantled and removed, but a hardstand remains. The sump is open to rainwater. It is speculated that the washout pad was used only once, because shortly after construction in the early to mid-1950s, the Army changed to a better rocket motor that did not require cleanouts.

2.2 PHYSICAL SETTING

2.2.a The topography and surface features of RSA-13, RSA-14, RSA-132, and RSA-133 are described below and shown on Figure 2.1.

2.2.1 RSA-13 (Unlined Open Burn Areas)

2.2.1.a RSA-13, also known as the Unlined Open Burn Areas, is located in the northwestern portion of Unit 2, south of Buxton Road, west of McAlpine Road, and east of the Tennessee River. The site is within the floodplain of the Tennessee River. The land surface is relatively flat with creeks and wetlands bordering the site on the north. RSA-13 consists of two unlined open burning pads. The pads cover an area of approximately 200 ft^2 and are located at an elevation of approximately 565 feet Mean Sea Level (MSL).

2.2.2 RSA-14 (Waste Burn Trenches)

2.2.2.a RSA-14, also known as the Waste Burn Trenches, is located in the southeastern portion of Unit 2, south of Buxton Road, west of McAlpine Road, and east of the Tennessee River. The land surface is relatively flat with drainage ditches north and east of the site. RSA-14 consists of two formerly used unlined trenches (see Figure 2.3). The trenches cover an area of approximately 22,500 ft^2 and are at a depth of 20 feet Below Land Surface (BLS). The elevation of RSA-14 is approximately 575 feet MSL.

SECTION 2
SITE CONDITIONS

2.0.a This section presents background information on RSA Unit 2 and describes the physical setting of this site. Regional and arsenal-wide information is presented in the General RI/FS work plan (Parsons ES, 1996).

2.1 SITE BACKGROUND

2.1.a Unit 2 is an active open burn/open detonation (OB/OD) area located in the southwest corner of RSA south of McAlpine Road, and north and east of the Tennessee River. Unit 2 is bordered by woods and marshes with the Tennessee River on the west and creeks and marshes on the north and east. A large portion of the site is located on the 100-year flood plain of the Tennessee River and adjoins Tennessee Valley Authority property. Six SWMUs, including the sites subject to investigation under this document, are contained within Unit 2: Open Burn Pans (RSA-12), Unlined Open Burn Areas (RSA-13), Waste Burn Trenches (RSA-14), Open Detonation Area (RSA-131), Former Popping Furnace (RSA-132), and Former Rocket Washout Pad (RSA-133) (see Figure 2.1).

2.1.1 RSA-13 (Unlined Open Burn Areas)

2.1.1.a RSA-13 consists of an open burn area with two unlined open burning pads. From the 1950s to 1986, these pads were used for the open burning of waste propellants, as well as solvent-contaminated and propellant-contaminated materials (ESE, 1996). The resulting ash was disposed of at RSA-14 and RSA-66. Flashed metal was salvaged.

2.1.2 RSA-14 (Waste Burn Trenches)

2.1.2.a RSA-14 consists of two unlined trenches used to incinerate solid materials contaminated with rocket propellant. Even though this was the primary purpose of the trenches, it is suspected that the trenches were also used to incinerate waste solvents and solvent-contaminated materials. The trenches were constructed in the 1940s when the Gulf Chemical Warfare Depot used them for incinerating wood pallets and inert packing materials as a result of munitions shipments. They were used from the early 1940s until 1986.

2.5 RESULTS OF PREVIOUS INVESTIGATIONS

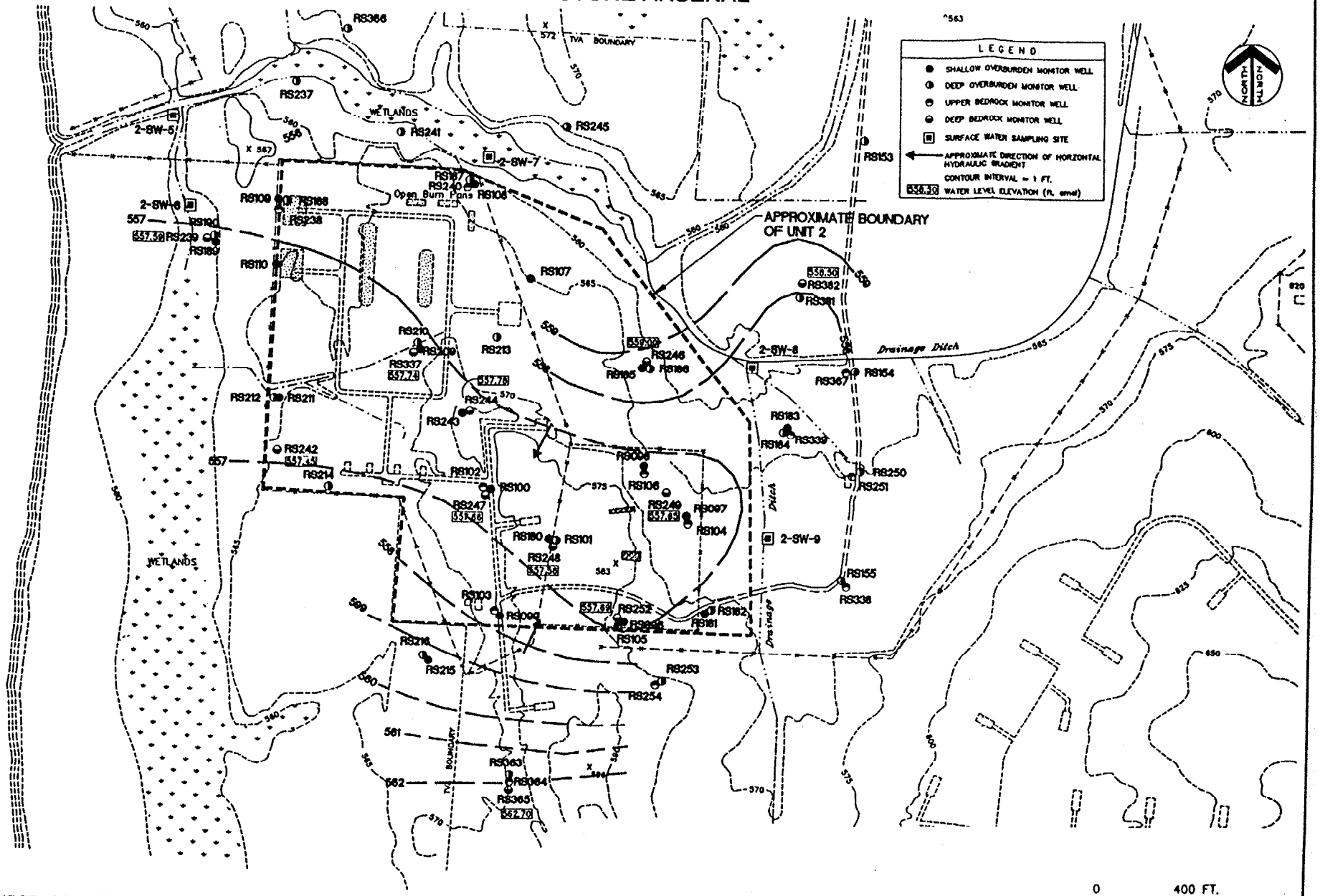
2.5.a A hazardous waste study was conducted by the Army Environmental Hygiene Agency (AEHA) in 1986 to investigate soil contamination at RSA-13 and RSA-14. Results of this investigation indicated that VOCs, BNAs, and metals were detected in the soils at RSA-14. VOCs, BNAs, and explosives were detected in the soils at RSA-13. Soil sampling results indicated RSA-132 and RSA-133 were potential contamination source areas. Recommendations were made by AEHA to install groundwater monitoring wells to evaluate groundwater contamination.

2.5.b In 1988 USACE contracted P.E. LaMoreaux & Associates, Inc. (PELA) to perform a RI/FS-type investigation at Unit 2 on behalf of MICOM. This investigation involved the installation of nine overburden wells and five bedrock wells and the collection of groundwater, soil, and surface water samples for analysis. Results from PELA (1988a) indicated that VOCs, BNAs, explosives, and metals were detected in the groundwater and soils at RSA-14. VOCs, BNAs, and explosives were detected in the soils at RSA-13.

2.5.c In 1991, G&M was contracted to conduct a Phase I RFI at Unit 2. The investigation involved soil gas sampling, shallow and deep soil sampling, sediment and surface water sampling, and the installation of twenty groundwater monitoring wells. Results of the investigation indicated that the soils within RSA-14 and RSA-13 were contaminated with VOCs and explosives. Explosives, metals, and VOCs were detected in sediment samples. VOCs and metals were detected in surface water samples. Sampling from the shallow and deep groundwater monitoring wells indicated the presence of VOCs, primarily trichloroethene.

2.5.d In 1992, G&M was contracted to conduct a Phase II RFI at Unit 2. The investigation involved shallow and deep soil sampling and the installation of eight groundwater monitoring wells. Results of the investigation indicated the presence of VOCs in the surface and subsurface soils in the vicinity of RSA-14. Sampling of the eight groundwater monitoring wells indicated the presence VOCs within the vicinity of RSA-13, RSA-14, and RSA-131.

UNIT 2 - HYDRAULIC HEAD ELEVATION WITHIN THE DEEP BEDROCK, JUNE 4, 1992
REDSTONE ARSENAL

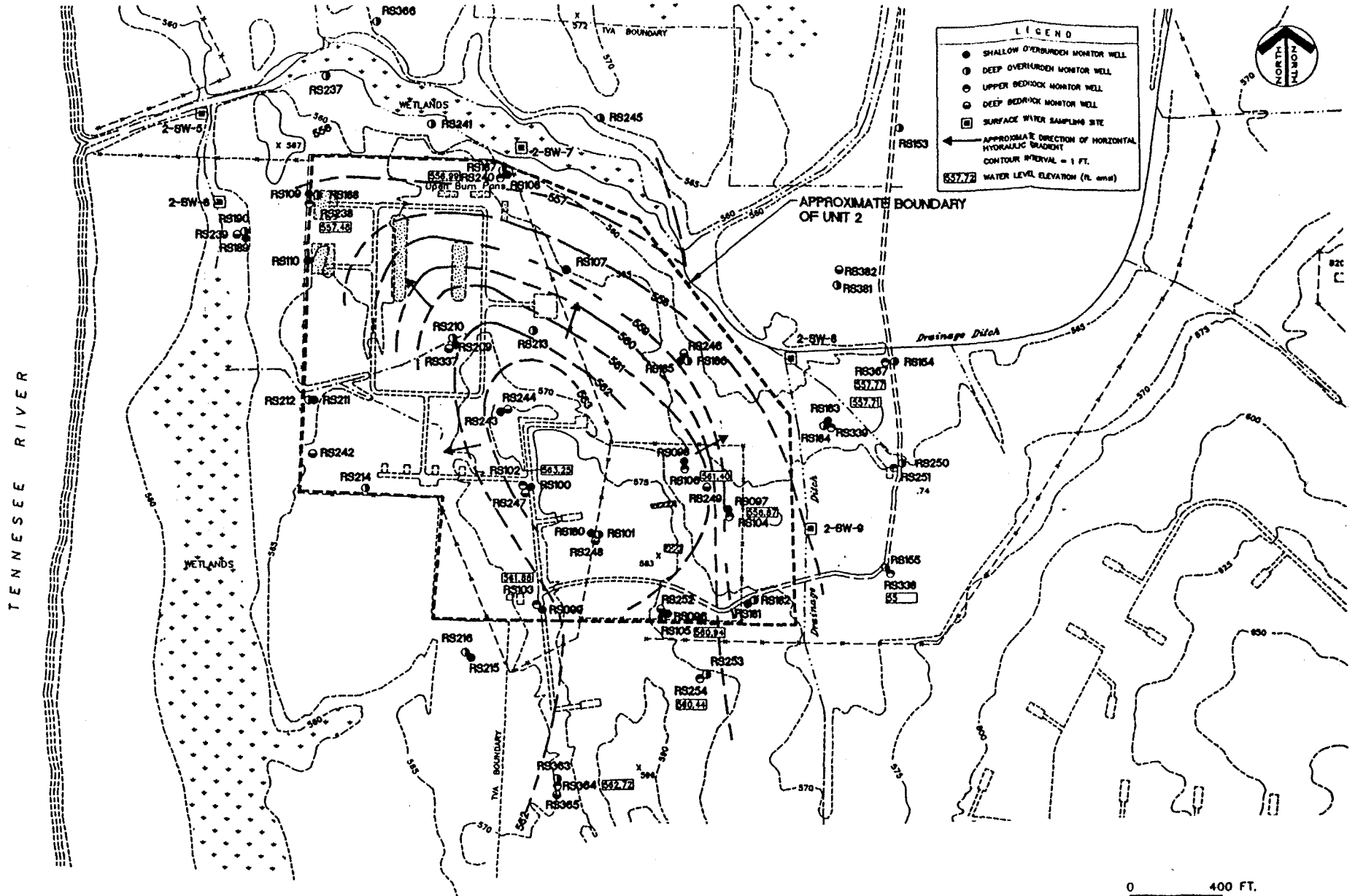


SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.9

PARSONS ENGINEERING SCIENCE, INC.

UNIT 2 - HYDRAULIC HEAD ELEVATION WITHIN THE UPPER BEDROCK, JUNE 4, 1992
REDSTONE ARSENAL

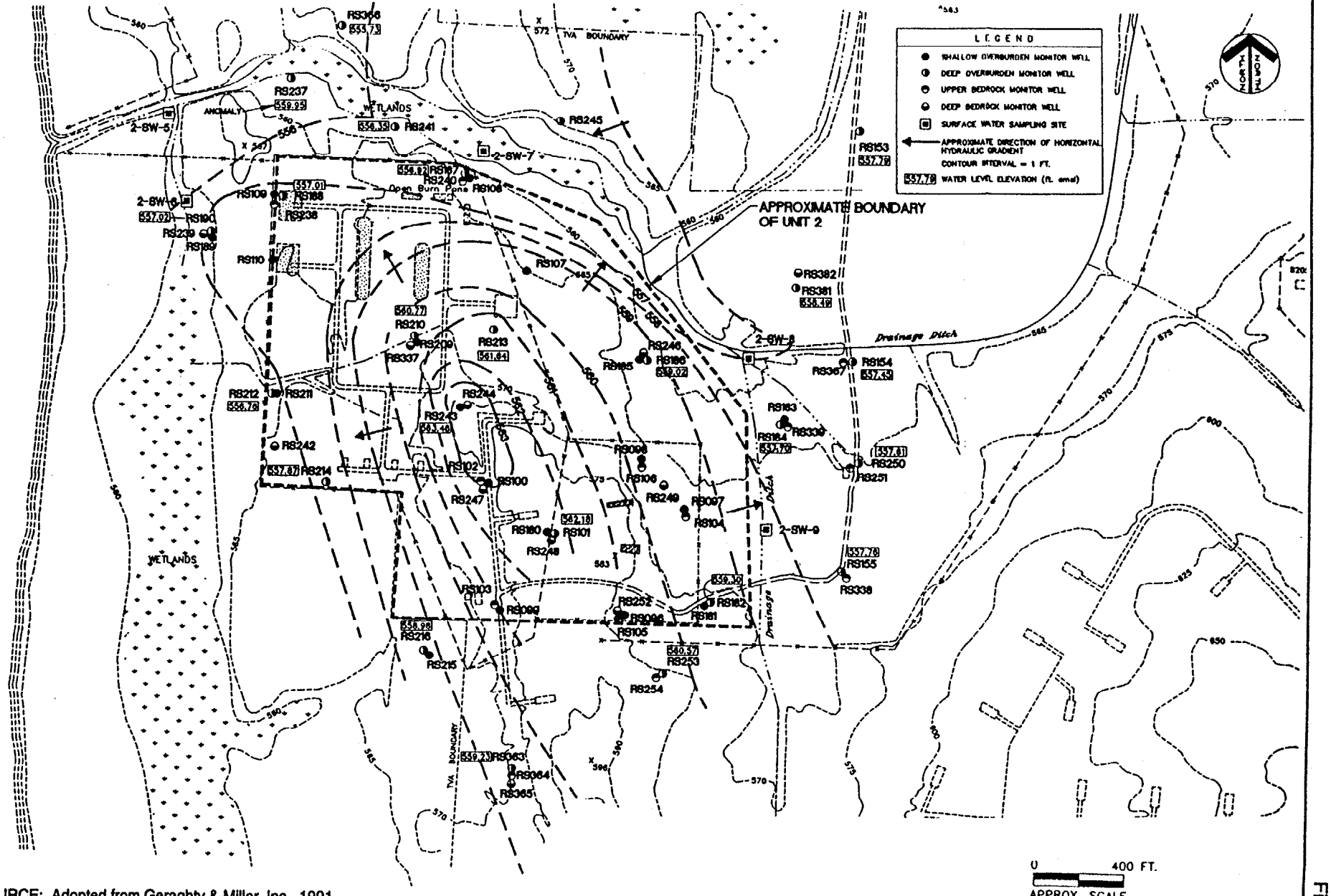


SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.8

PARSONS ENGINEERING SCIENCE, INC.

UNIT 2 - HYDRAULIC HEAD ELEVATION WITHIN THE DEEP OVERBURDEN, JUNE 4, 1992
REDSTONE ARSENAL

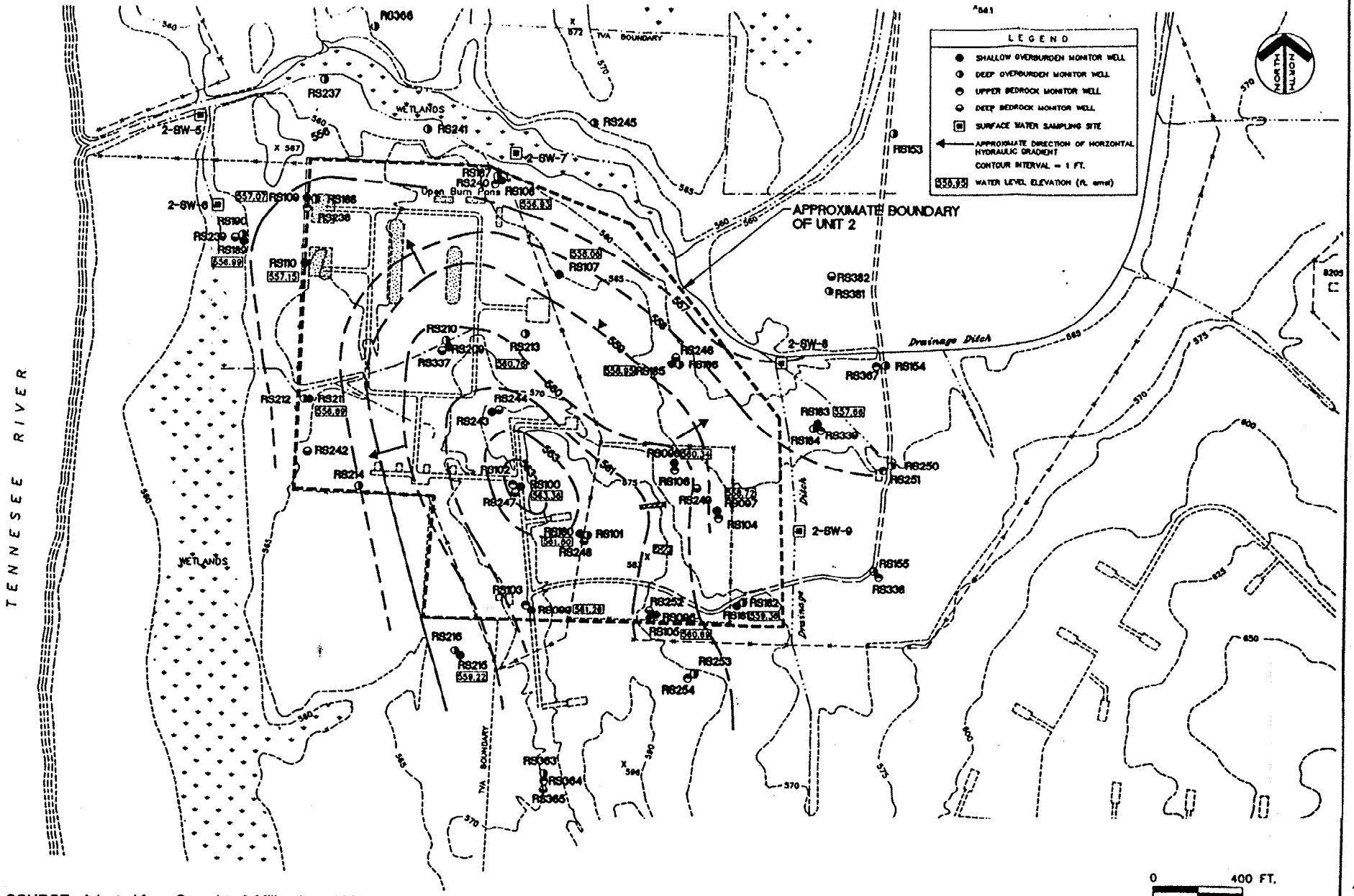


SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.7

PARSONS ENGINEERING SCIENCE, INC.

UNIT 2 - WATER TABLE ELEVATION, JUNE 4, 1992
REDSTONE ARSENAL

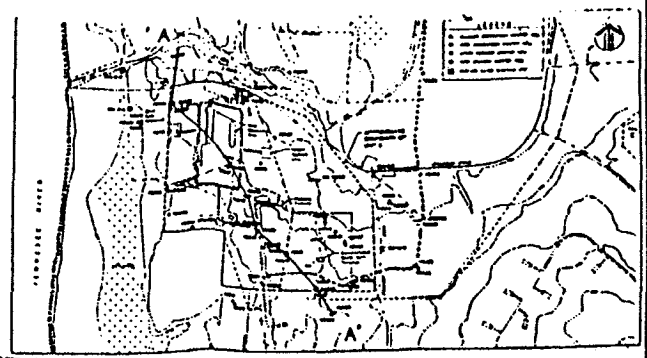


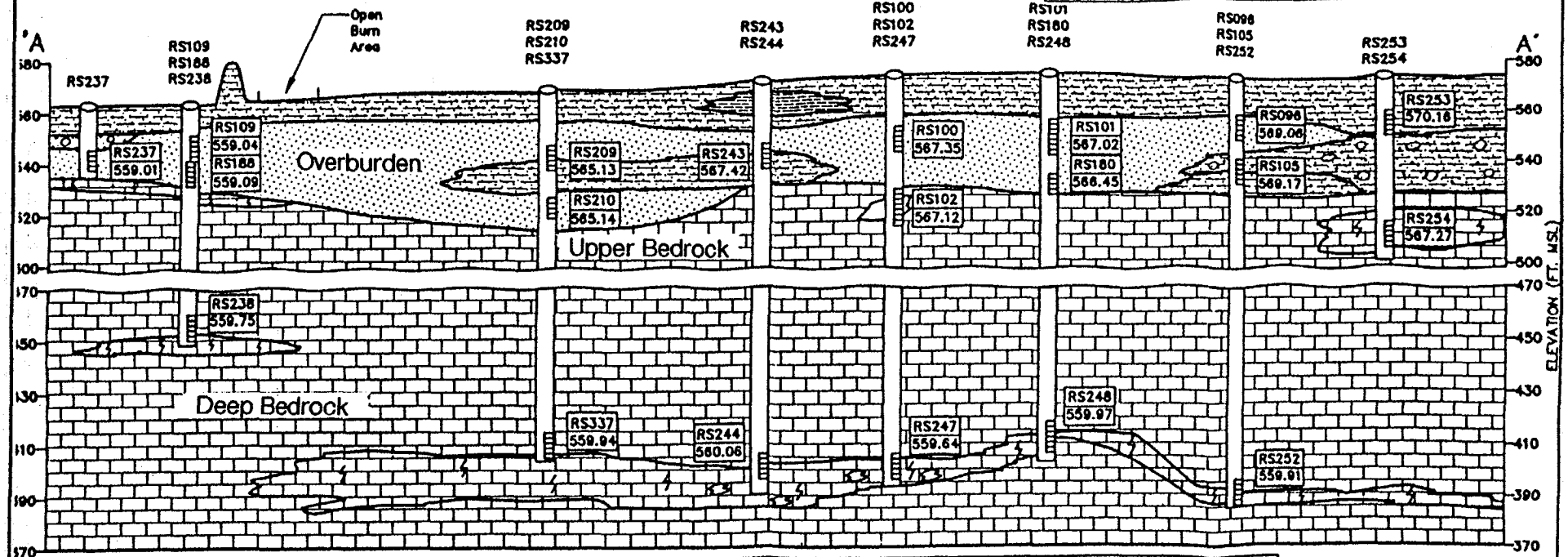
SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.6

PARSONS ENGINEERING SCIENCE, INC.

UNIT 2 - HYDROGEOLOGIC PROFILE A-A'
REDSTONE ARSENAL





LEGEND

RS237 559.01 — Composite Well Bore, Number and Water Level for Screened Interval

Water Level Measurements Obtained April 30, 1991

- Sandy Clay
- Poorly Sorted Sand
- Sandy Clay with Gravel and Sand Interbeds
- Dense Clay
- Limestone
- Limestone with Fracture Zones or Solution Cavities

Vertical Exaggeration = 5X

Horizontal Scale: 0 — 200

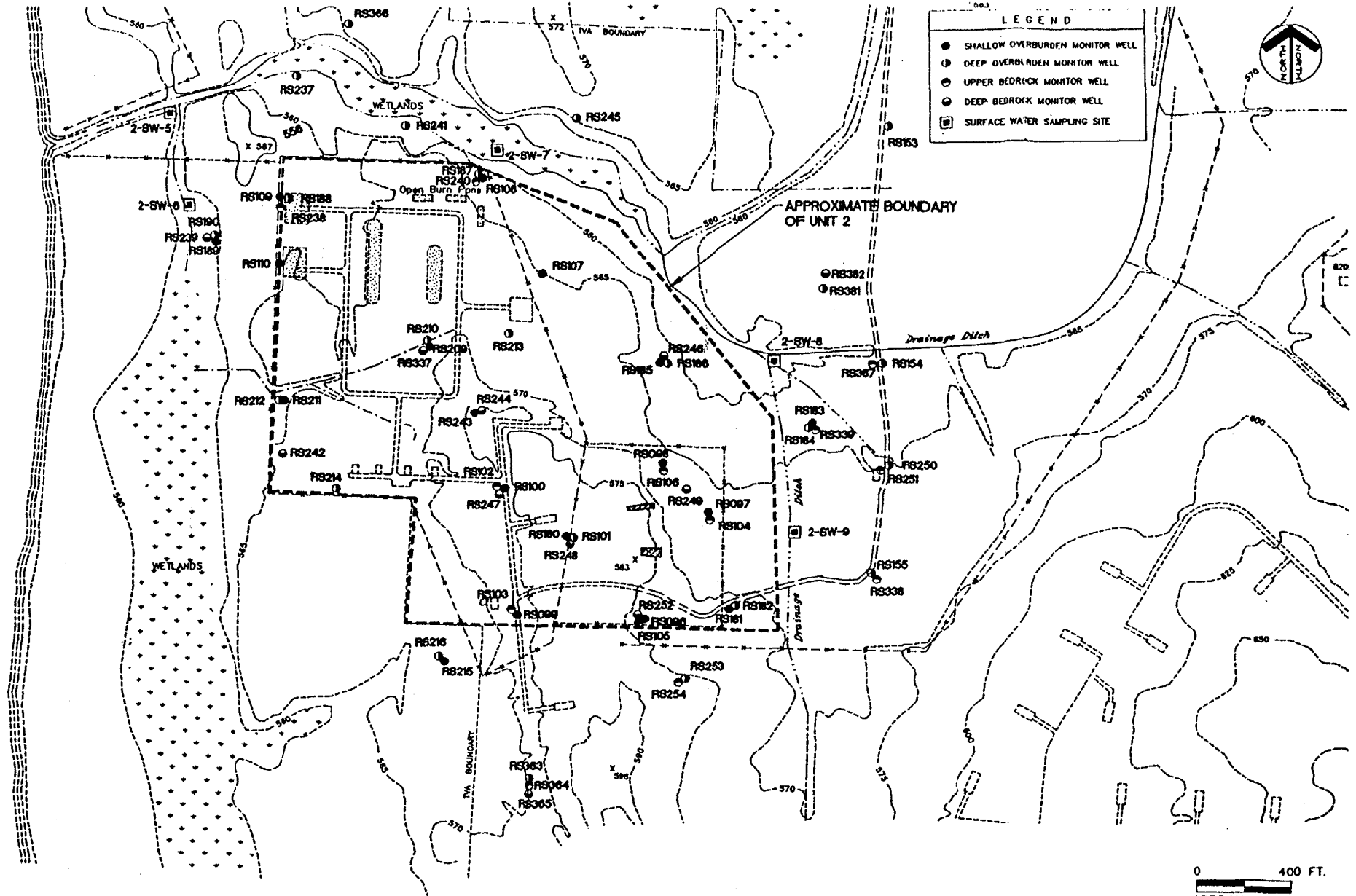
Vertical Scale: 580 — 540

SOURCE: Adopted from Geraghty & Miller, Inc., 1991, Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas Redstone Arsenal, Alabama

Figure 2.5

PARSONS ENGINEERING SCIENCE, INC.

UNIT 2 - PHASE I AND PHASE II GROUND-WATER AND SURFACE WATER SAMPLING LOCATIONS
REDSTONE ARSENAL

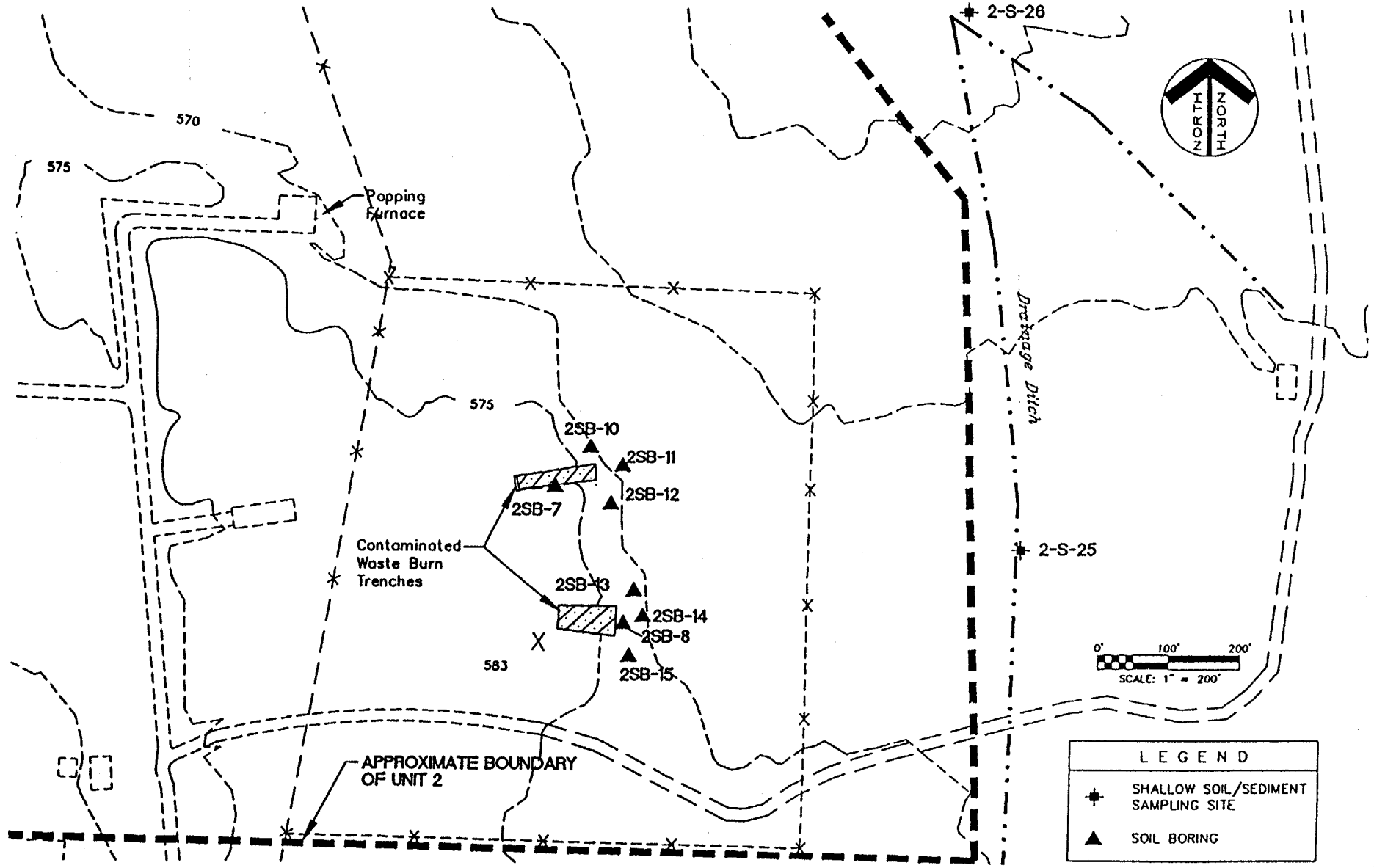


SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.4

PARSONS ENGINEERING SCIENCE, INC.

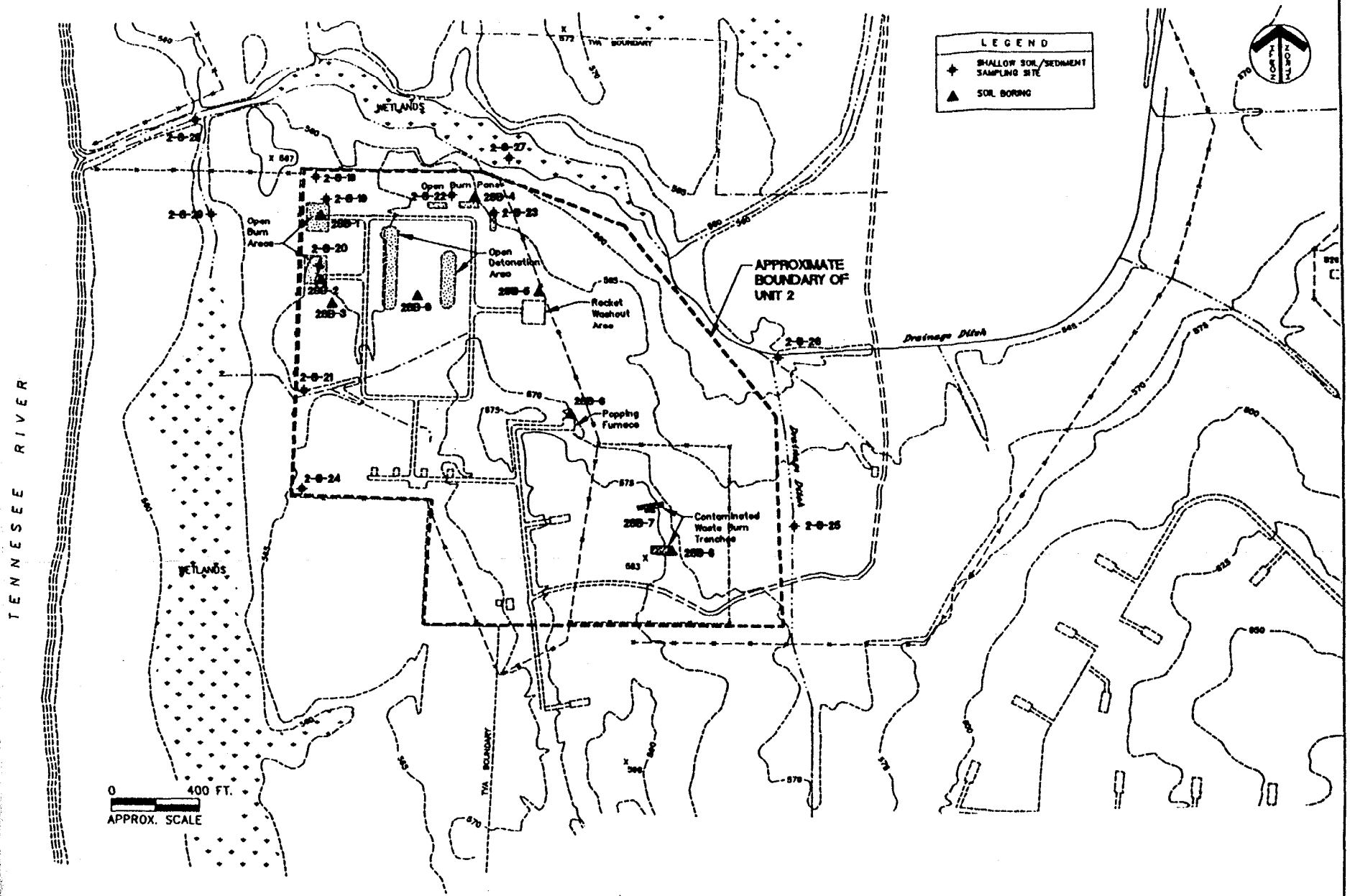
UNIT 2 CONTAMINATED WASTE BURN TRENCHES - PHASE I AND II SOIL SAMPLING LOCATIONS REDSTONE ARSENAL



SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.3

UNIT 2 - SOIL SAMPLING LOCATIONS
REDSTONE ARSENAL

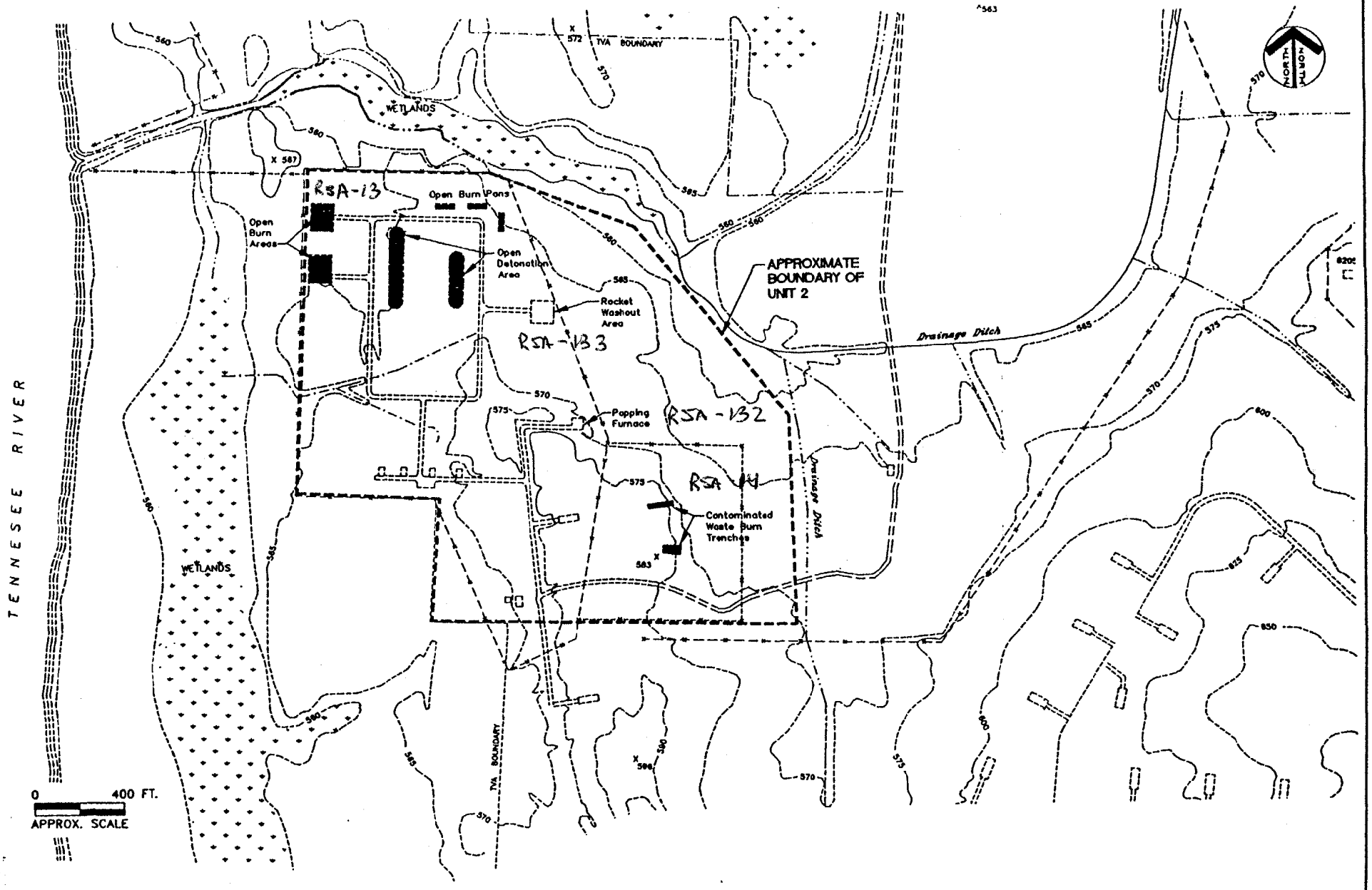


SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.2

PARSONS ENGINEERING SCIENCE, INC.

UNIT 2 - OPEN BURN / OPEN DETONATION AREA
REDSTONE ARSENAL



SOURCE: Adopted from Geraghty & Miller, Inc., 1991,
Phase I Report RCRA Facility Investigation at Unit 1, Unit 2, and Unit 3 Areas
Redstone Arsenal, Alabama

Figure 2.1

PARSONS ENGINEERING SCIENCE, INC.

SECTION 3
SCOPING OF THE RI/FS

3.0.a This section presents information used for developing the scope of activities to be conducted during the RI/FS, including the conceptual site model, potential remedial action technologies, preliminary identification of ARARs, data quality objectives, and data gaps and data needs.

3.1 CONCEPTUAL SITE MODEL

3.1.a The CSM depicts the relationship between potential sources of contamination, exposure pathways, and receptors. The number of contaminant pathways is determined by the characteristics of the contaminants, complexity of the site and ecosystem, and potential for exposure to both human and ecological receptors. Site-specific CSMs for Unit 2 are discussed in Section 4.

The media of concern identified at Unit 2 are as follows:

- Surface soil;
- Subsurface soil;
- Groundwater;
- Surface water/sediment in the wetland area;
- Surface water/sediment in the drainage ditches; and
- Surface water/sediment in the Tennessee River.

3.2 SCOPING OF POTENTIAL REMEDIAL ACTION TECHNOLOGIES

3.2.a The following remedial alternatives were identified in the draft CMS Report (ESE, 1993) as being potentially applicable:

- Alternative 1 - Capping
- Alternative 2 - Excavation/Onsite Incineration
- Alternative 3 - Excavation/Offsite Incineration

- Alternative 4 - Excavation/Offsite Landfill
- Alternative 5 - No action

3.3 PRELIMINARY IDENTIFICATION OF ARARS

3.3.a Potential chemical specific ARARs or To Be Considered (TBC) criteria must be identified initially in order to establish data quality objectives (Section 3.4). Quantitation limits for the analytical methods used during the RI should not exceed the ARAR values for given contaminants.

3.3.b Applicable requirements are defined as those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. Relevant and appropriate requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations reasonably similar to those encountered at the site. Potential sources for ARARs for RSA are described below. TBC criteria include state or federal screening criteria that may be used to evaluate contaminants when ARARs are not available.

3.3.1 Groundwater ARARs

3.3.1.a Potential ARARs for groundwater are listed on Table 3.1 of the General Work Plan (Parsons ES, 1996) and include Safe Drinking Water MCLs and Alabama Maximum Contaminant Levels and Secondary Drinking Water Standards. Potential TBC criteria include EPA Region III Risk-Based Concentrations (RBC) for tap water issued for the protection of human health.

3.3.2 Surface Water ARARs

3.3.2.a Potential ARARs for surface water are listed on Table 3.2 of the General Work Plan (Parsons ES, 1996) and include Federal and Alabama water quality criteria for freshwater organisms and Federal water quality criteria for human health with respect to ingestion of organisms. Potential TBC criteria include EPA Region IV freshwater surface water screening values for freshwater organisms.

3.3.3 Soil and Sediment ARARs

3.3.3.a ARARs are not available for soil or sediment. TBC criteria for sediment include EPA Region IV sediment screening values for EPA Ecotox thresholds and ecological receptors (Table 3.3 of the General Work Plan). EPA Region III RBCs may

be used as TBC criteria for soil and sediment for the evaluation of potential impacts to human health from these media (Table 3.4 of the General Work Plan).

3.4 DATA QUALITY OBJECTIVES

3.4.a Data quality objectives (DQOs) are qualitative statements that define the acceptability of data generated by an investigation. The DQO process and data categories are described in Section 3 of the Generic Work Plan (Parsons ES, 1996).

3.4.1 Intended Uses of Data

3.4.1.a The data generated by the investigations at the Unit 2 Sites must be of sufficient quality to support the RI and FS efforts.

3.4.2 Data Quality

3.4.2.a Both screening and definitive data will be required to meet the data quality necessary to support the BRA and FS efforts. The screening data will be generated by the following field analyses.

- **Groundwater** screening for pH, conductivity, temperature, and turbidity to ensure that the samples are from the formation water and determine general water quality for evaluation of treatment technologies in FS.
- **Surface water** screening will be conducted for pH and hardness to establish existing water quality characteristics. Since availability of metals for uptake by plants and animals is related to pH and hardness, these measurement are also required for the ecological risk assessment. Hardness will be measured using a Hach® test kit and pH will be measured with a direct reading probe.
- **Sediment** analyses for pH will be conducted to determine basic chemical characteristics of the sediment. Measurement of pH is also required for the ecological risk assessment, since availability of metals in sediments is pH-dependent. Measurements of pH will be made with a direct reading probe or with pH paper.
- **Soil** screening for pH will be conducted to determine physical characteristics of the soil. Screening for volatile organics using a portable photoionization detector or organic vapor analyzer will be conducted to aid in the selection of samples to be sent to the laboratory for definitive analyses.

3.4.2.b Definitive data will be generated by the following laboratory analyses.

- **Groundwater** definitive chemical analyses for target compound lists (TCL) VOCs by USEPA CLP SOW for Organic Analyses OLM03.1, target analyte list

(TAL) metals by USEPA CLP SOW for Inorganic Analyses ILM3.0, and explosives by USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW846) SW8330 Method.

- **Surface water** definitive chemical analyses for TCL VOCs, TCL SVOCs, and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1; TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0, and explosives by SW846 SW8330 Method.
- **Sediment** definitive chemical analyses for TCL VOCs, TCL SVOCs and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1, TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0, explosives by SW846 SW8330 Method, and total organic carbon (TOC) by SW846 SW9060 Method.
- **Sediment bioaccumulation studies**. TVA will conduct toxicity testing in accordance with *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* EPA/600/R-94/024, June 1994. The sediment bioaccumulation study will be conducted by TVA (3 stations) using *Hyalella azteca. Hyalella azteca* is a small freshwater amphipod and *Chironomus tentans* is a freshwater midge that have been shown to be a sensitive indicator of the presence of contaminants in freshwater sediments.
- **Soil** definitive chemical analyses for TCL VOCs, TCL SVOCs, and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1; TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0; explosives by SW846 SW8330 Method; and TOC by SW846 SW9060 Method.
- **Soil** definitive geotechnical analyses for hydraulic conductivity by ASTM D-5084, identification of soils by ASTM D-2488, particle size by ASTM D-422, and distribution ratios (the short-term batch method) by ASTM D-4319.

A summary of the accuracy and precision DQOs for the definitive laboratory chemical data is presented in Table 3.5 of the General Work Plan.

SECTION 4
TASK PLAN FOR THE RI

4.0.a This section identifies the activities that will be conducted during the RI at Unit 2. Field activities will be conducted under Task Order 0006 of Contract No. DACA87-95-D-0018.

4.0.b A total of 24 soil samples, 69 groundwater samples, 7 surface water, and 7 sediment samples will be collected from Unit 2 for chemical analysis. Four subsurface soil borings will be analyzed for limited geotechnical testing. Analyses for all of the media to be sampled are summarized in Section 3, Data Quality Objectives.

4.1 PRE-FIELD ACTIVITIES

4.1.a Prior to commencement of field activities, underground utilities will be cleared by RSA and the Parsons ES field personnel will assure that all locations scheduled for drilling, borings, and sampling will be accessible. If local conditions, such as flooding, preclude planned field work from being performed at a specific location, the well, borings, or sample point will be relocated in consultation with the CEHNC project manager.

4.2 FIELD INVESTIGATIONS

4.2.a The following field investigations will be performed to complete the RI/FS under CERCLA at Unit 2:

- Soil investigation;
- Surface water and sediment investigation;
- Groundwater investigation;
- Ecological investigation; and
- Surveying.

4.2.b All field procedures are provided in the Field Sampling Plan (FSP, Appendix B) and in the Monitoring Well Installation Plan and Field Investigation Procedures (General RI/FS Work Plan (Parsons ES, 1996) Appendix D). Investigation-derived waste (IDW) generated during this field effort will be handled according to the

procedures described in the IDW Plan (General RI/FS Work Plan (Parsons ES, 1996) Appendix E). All field activities will be performed in compliance with the site-specific Safety and Health Plan (Appendix A) and the Ordnance Management Plan (General RI/FS Work Plan (Parsons ES, 1996) Appendix C).

4.2.c Background data is currently being compiled for groundwater and soil at RSA by CESAS. If available, it will be incorporated in this study.

4.2.1 Soils Investigation

4.2.1.a The soil investigation program for the RI/FS Work Plan will consist of collecting both shallow surface and subsurface soil samples from soil borings in the unlined Open Burn Areas (RSA-13), Waste Burn Trenches (RSA-14), Former Popping Furnace (RSA-132), and Former Rocket Washout Pad (RSA-133). A total of 16 soil borings will be drilled at Unit 2. The locations of these new soil borings and previous soil borings are shown in Figure 4.1. The purpose of the soil borings will be to obtain samples of soil for chemical and geotechnical analysis. These data will be used to supplement existing contaminant data from the Phase I and Phase II RFI.

4.2.1.b Six soil borings will be drilled at RSA-13, located in the northwest corner of Unit 2. Three soil borings will be taken from each open burn area. Two soil borings will be drilled at RSA-133, located in the north-central portion of Unit 2. One boring will be located within the footprint of the pad and one boring will be located adjacent to the pad. Two soil borings will be drilled at RSA-132, located in the south-central portion of Unit 2. One boring will be located within the original footprint of the furnace and one boring will be located adjacent to the original footprint of the furnace. Six soil borings will be drilled at RSA-14, located in the southeast corner of Unit 2. Three soil borings will be located in each trench area. Refer to Figure 4.1 for the specific locations of each boring.

4.2.1.c A total of 12 soil borings will be drilled to a maximum depth of approximately 6 feet below land surface (bls) using conventional hollow stem augering (HSA). Soil samples will be collected at 2-foot intervals by the split-spoon method. RSA-13 and RSA-14 will each have five shallow (0-12") and five deep (maximum 6 feet bls) soil samples collected and submitted for chemical analysis. The second sample will be selected according to the following procedures: samples will be collected from 1 to 6 ft bls at two foot intervals. The samples will be screened for VOCs using a portable PID or OVA. A duplicate of the sample showing the greatest VOC concentration will be shipped for chemical analysis. If no VOCs are detected, the deepest sample from the boring will be shipped for analysis. RSA-132 and RSA-133 will each have one shallow (0-12") and one deep (maximum 6 feet bls) soil samples collected and submitted for chemical analysis.

4.2.1.d A total of 4 soil borings will be drilled to a maximum depth of approximately 50 feet bls using conventional hollow stem augering (HSA). One boring each from RSA-13, 14, 132, and 133 will be collected for limited geotechnical analysis. Soil samples will be collected at an appropriate depth (as determined by the field geologist) within the overburden material using a thin-walled steel sample tube.

4.2.1.e Soil sampling procedures and the criteria for the selection of the subsurface soil samples submitted to the laboratory for chemical and geotechnical testing are provided in the General Installation RI/FS Work Plan (Parsons ES, 1996), Appendix B, Field Sampling Plan. The soil samples will be tested according to the analyses specified in Section 3, Data Quality Objectives.

4.2.2 Surface Water and Sediment Investigation

4.2.2.a Surface water and sediment sampling will be conducted in areas of Unit 2 that have the potential for acting as an exposure pathway for off-site transport of site contaminants. Refer to Figure 4.1 for the specific locations of each surface water and sediment sampling point.

4.2.2.b Potential on-site surface water and sediment sampling locations will be co-located and include the Tennessee River, the wetland area west of Unit 2, and the drainage ditch northeast of Unit 2. In the Tennessee River, three surface water and three sediment samples will be collected at the following locations: one upstream of Unit 2, one adjacent to Unit 2, and one downstream of Unit 2. These samples will be collected along the right (west) bank (looking downstream) in zones of active deposition. Sediment samples will be collected using a dredge or diver depending on site conditions. Two surface water and two sediment samples will be collected in the wetland area between Unit 2 and the Tennessee River. Two additional surface water and sediment samples will be collected from the drainage ditch on the northeast side of Unit 2.

4.2.2.c The surface water and sediment samples will be collected by Tennessee Valley Authority (TVA) personnel. The sediment samples and surface water samples will be tested according to the analyses described in Section 3, Data Quality Objectives. The sediment and surface water sampling procedures are described in Appendix B, Field Sampling Plan.

4.2.2.d Sediment samples will be dried and tested according to the analyses described in Section 3.4, Data Quality Objectives. In addition, three samples, one each from the Tennessee River adjacent to Unit 2, the wetland, and the drainage ditch, will be subjected to whole sediment toxicity testing in accordance with EPA's testing procedures for measuring the toxicity of sediment associated contaminants with freshwater invertebrates. Acute toxicity (10-day) testing will be performed. The freshwater species

selected for sediment toxicity testing include: *Hyalella azteca*, a small freshwater amphipod, and *Chironomus tentans*, a fairly large midge. These species will be tested in accordance with EPA methods as described in Section 3.4.

4.2.3 Groundwater Investigation

4.2.3.a Twenty-eight monitoring wells were installed as part of the Phase I and Phase II RFI at Unit 2. Based upon the water level measurements from the Phase I and Phase II RFI, the groundwater in the overburden and the upper Tuscumbia Limestone flows from the topographic high areas in the south-central portion of Unit 2 (Figures 2.6, 2.7, and 2.8) toward the wetlands and streams. Groundwater flow in the deep Tuscumbia Limestone bedrock is to the southwest, towards the Tennessee River (Figure 2.9).

4.2.3.b Groundwater samples from the Phase I and Phase II RFI contained three SVOCs, four munitions/nitroaromatics, seven inorganics, and twenty VOCs. The highest concentrations of contaminants were elevated chlorinated hydrocarbons, particularly trichloroethene and 1,2-dichloroethene (total). Additional groundwater investigation is required to define the nature and extent of the contaminant migration from RSA-13, 14, 132, and 133.

4.2.3.c The goals of this groundwater investigation are to verify previous sampling data from the Phase I and Phase II RFI, determine the extent of groundwater contamination, and gather additional potentiometric data. To accomplish this, two shallow overburden and two upper bedrock monitoring wells will be installed at the approximate locations shown in Figure 4.2. The overburden wells will be drilled using an HSA and the upper bedrock wells will be drilled using either air rotary methods or Vibracore methods.

4.2.3.d Groundwater will be sampled and groundwater levels will be measured in all 69 monitoring wells (including the 4 new wells). In addition, the four new monitoring wells will have at least two soil samples from each well collected for physical testing. Monitoring well installation, development, sampling, and decontamination procedures are described in the General Installation RI/FS Work Plan (Parsons ES, 1996), Appendix D, Monitoring Well Installation Plan and Field Investigation Procedures. The groundwater samples will be tested as described in Section 3, Data Quality Objectives.

4.2.4 Ecological Investigation

4.2.4.a The ecological characterization of Unit 2 will be based on the methods described in the General RI/FS Work Plan (Parsons ES, 1996). Specific methods to be employed for the ecological characterization of Unit 2 are detailed below.

4.2.4.b Unit 2 is located near the southern end of the RSA, approximately one mile east of the Tennessee River. Unit 2 is bordered on the north by a wetland/creek system which drains west into the Tennessee River and a much larger wetland system along the western edge (see Figure 4.1).

4.2.4.c Available information on the ecology of Unit 2 will be obtained and reviewed as described in the General RI/FS Work Plan (Parsons ES, 1996). The most recent information on the actual or potential presence of state- and federally-listed threatened and endangered species, species of special concern, and wildlife and fisheries resources within the vicinity of Unit 2 will be obtained. Information on unique and special-concern habitats, other preserves, and natural areas in the vicinity of Unit 2 will also be obtained and reviewed.

4.2.4.d A field survey of the area within a 0.5 mile radius of Unit 2 will be conducted to collect qualitative information on the types, extent, values, and locations of biological resources. The field survey will include the follows elements:

- **Plant communities.** Plant communities will be identified as described in the General RI/FS Work Plan (Parsons ES, 1996).
- **Dominant plant species.** Dominant plant species will be identified qualitatively within each major terrestrial and wetland plant community. This will include the large wetland complex on the east side of Unit 2, and the wetland system associated with the creek and ditch on the northern border of the site. Wetland areas will be qualitatively examined on foot where accessible.
- **Terrestrial fauna.** Observations of terrestrial fauna will be made within the boundaries of Unit 2, within the adjacent wetland and floodplain areas of the Tennessee River, and adjacent upland areas to the east. Mammals will be identified by tracks, scat, burrows, and actual sightings. Bird, reptile, and amphibian identifications will be made by actual sightings. All observations will be qualitative in nature.
- **Aquatic life.** Fish and mussels will be collected for identification and whole tissue sampling at selected locations in the Tennessee River and adjacent wetland and floodplain areas by TVA personnel. Actual sampling locations will be determined in the field during the field survey. One resident (nonmigratory) fish species, such as catfish (*Ictalurus sp.*), sunfish (*Lepomis sp.),* or sucker (*Catostomus sp., Moxostoma sp*) will be collected from the wetland and drainage ditch for whole body chemical analysis. The species to be selected will be determined based on site conditions and availability. Ten specimens of the selected species will be collected from both the wetland and the drainage ditch. Specimens will be collected by electroshocking. Methods used by TVA

personnel will be in accordance with *Macroinvertebrate and Fish Sampling - "Field Operation Biological Resources Procedure Manual,"* (TVA, 1995).

Specimens of sessile species, preferably mussels, will be collected from the Tennessee River along the right bank (looking downstream), upstream of the RSA and downstream of the drainage ditch confluence. Mussels will also be collected for soft tissue chemical analysis, from the wetland, and two locations in the drainage ditch. Actual sampling locations will be determined in the field during the field survey. Specimens will be collected by TVA divers in the Tennessee River and by wading where depth allows. Preservation and handling will be conducted in accordance with standard procedures as outlined by EPA (see Field Sampling Plan).

- **Vegetation stress.** Upland and wetland vegetation within the boundaries of Unit 2 and within the 0.5-mile radius area will be examined for vegetative stress, including plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage.

4.4.2.4.e A map will be prepared that illustrates the major upland and wetland plant communities in the vicinity of Unit 2. Aquatic habitats and sampling locations will also be indicated, as well as habitat or actual occurrence of any state- or federally- listed species, or federal species of special concern.

4.4.2.4.f A description of the ecological features of Unit 2 will be prepared based on the updated literature review and field survey. This will provide the basis for selection of representative receptors, refinement of exposure scenarios for the risk assessment, and identification of protected species or valuable habitats in the vicinity of Unit 2.

4.2.5 Surveying

4.2.5.a Coordinates and elevations will be established for each monitoring well, soil boring, surface water, and sediment sampling site. The location, identification, coordinates, and elevations of the wells, borings, and surface water/sediment sampling sites will be plotted on planimetric maps to show their location with reference to surface features within the project area. Site surveys will be performed in accordance with established land surveying practices and conform to all pertinent state, federal, and USCOE laws and regulations governing land surveying. The surveyor shall be licensed and registered in the state of Alabama. Refer to Appendix B, Field Sampling Plan, Section 4.4 for specific surveying requirements.

4.3 DATA REDUCTION, VALIDATION, AND DOCUMENTATION

Data generated during the Unit 2 Site investigations will be managed to document findings and to support the completion of the RI and FS. Qualitative data will be assembled and where possible, copied, for the project files. Quantitative data will be assembled both in hard-copy and electronic format for subsequent comparisons, evaluation and reporting. Quantitative data will become part of the site file also. The data reporting requirements of ERDMIS and USEPA's interchange file format (IFF) format shall be part of the data management process.

The descriptions of the data reduction, validation and documentation processes for the RSA projects may be found in Section 4 of the General Work Plan (Parsons ES, 1996) and in the agency-approved Revised Final Work Plan to prepare Baseline Risk Assessments (USACE, 1994).

4.4 BASELINE RISK ASSESSMENT

4.4.a A baseline risk assessment, composed of a human health risk assessment (HHRA) and an ecological risk assessment (ERA), will be performed to provide an estimate of current and future human health risk and ecological risk associated with hazardous substance releases at potentially contaminated sites. The results of the HHRA and the ERA will contribute to the overall characterization of Unit 2 and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives.

4.4.b A risk-based screening of the data will be performed to identify chemicals of potential concern (COPCs) for both human health and ecological endpoints. The screening process and the methodology for performing the HHRA and ERA are briefly described below. The screening process and methodology are detailed in Section 4 of the General RI/FS Work Plan (Parsons ES, 1996) and in Section 2 of the pre-approved Revised Final Work Plan to prepare Baseline Risk Assessments (USACE, 1994).

4.4.c Pre-existing data will be evaluated for use in the HHRA and ERA. Sample data collected as outlined in this work plan will be quantitatively evaluated where appropriate.

4.4.1 Identification of Chemicals of Potential Concern

4.4.1.a Prior to initiation of a baseline HHRA, a list of chemicals present in site samples (CPSS) and COPCs will be compiled. All chemicals detected in site media in Unit 2 are considered CPSSs. From the list of CPSSs, COPCs are selected using the pre-approved Work Plan screening methodology. The details of the screening methodology are presented in Section 2.2 of the pre-approved Work Plan (USACE, 1994).

4.4.1.b Chemicals not eliminated using the screening process will be considered COPCs and will be quantitatively evaluated in the HHRA and/or ecological evaluation.

4.4.2 Human Health Risk Assessment

4.4.2.a Following identification of COPCs for the HHRA, the following major steps will be completed as detailed in Section 4 of the General RI/FS Work Plan (Parsons ES, 1996) and in Section 2 of the pre-approved Work Plan (USACE, 1994).

- Data evaluation
- Exposure Assessment
- Toxicity assessment
- Risk characterization

4.4.2.b Components of these steps are discussed in this section where specific information is warranted. Otherwise, the General Work Plan and the pre-approved Work Plan provide detailed methods and background material.

4.4.2.c Unit 2 will be evaluated using site-specific exposure scenarios. Evaluation of past site activities and comparison of on-site and downgradient sample analytical data to background analytical data will be considered to determine which chemicals detected are likely to be site-related. A conceptual site model (CSM) for human health for Unit 2 is presented in Figure 4.3. The CSM depicts the relationship between potential sources of contamination, exposure pathways, and receptors.

4.4.2.1 Data Evaluation

4.4.2.1.a COPCs will be identified as discussed in Section 4.4.1.1. Environmental media to be considered in the HHRA include shallow soil (0-1 ft), subsurface soil (0-6 ft), surface water, sediment, and groundwater. Validated data from the most recent sampling efforts will be used, along with appropriate historical data, to quantify potential human health risks. Water media will be expressed in units of mg/L (ppm) and solid media (soil, sediment) in units of mg/kg (ppm).

4.4.2.2 Exposure Assessment

4.4.2.2.a The objective of the exposure assessment is to estimate the type and magnitude of exposures to the chemicals of potential concern that are present at or migrating from a site. A completed pathway is comprised of the following four elements:

- A source and mechanism for chemical release;

- An environmental transport medium;
- An exposure point; and
- A human or ecological receptor and a feasible route of exposure at the exposure point.

4.4.2.2.b A pathway is not considered complete unless each of these elements is present.

4.4.2.2.c Consistent with RAGS (Risk Assessment Guidance for Superfund (RAGS)(EPA, 1989a) and EPA Region IV policy (EPA, 1995a), current and reasonably foreseeable future land-use scenarios will be considered for Unit 2. The site is located in a restricted area used by industrial workers; therefore, exposure of these workers will be assessed. Given the restrictions, trespassing onto the site is not likely to occur. In the future, land use will remain industrial; therefore, potential future receptors include only industrial workers. The Master Plan for RSA indicates that, in the future, Unit 2 will be located in an area designated for Operational Maintenance Facilities (US Army, 1996). Per EPA's "Land Use in the CERCLA Remedy Selection Process" (OSWER Directive No. 9355.7.04, 1995c), residential exposure is only considered appropriate when the current land use at the site is residential, or when there is a strong probability that residential development will occur at the site in the future. Given that neither of these criteria apply at Unit 2, residential development is not a reasonable future land use.

Receptor Definitions

4.4.2.2.d The potential receptors are defined as follows for Unit 2:

4.4.2.2.e **Current and Future Workers:** Workers are defined as individuals that are employed at or near the site, and who have unlimited access to site media. Current and future workers are assumed to be exposed to surface soil (0 to 1 foot in depth). However, future workers are considered exposed to mixed soil, given natural erosion effects and potential excavation. Incidental ingestion of soil, dermal contact with soil, inhalation of fugitive dust from soil, and inhalation of volatiles from soil are potential pathways for exposure to soil. Future workers are also assumed to be exposed to groundwater (drinking water) via ingestion and dermal contact. Inhalation of volatiles while showering/bathing will not be considered for these receptors assuming showering activities will occur at home rather than at the site. Exposure of workers to surface water and sediment located in the wetland and drainage-ditch are not expected to be significant given that these site workers are not expected to contact these media routinely during the course of the workday. TVA workers, however, may contact surface water and sediments located in the Tennessee River during the course of their environmental evaluation work.

4.4.2.2.f Details concerning the methodology to be used for determining exposure estimates (RME and CT), exposure point concentrations, and the toxicity assessment are provided in Section 2 of the pre-approved Work Plan (USACE, 1994).

4.4.2.2.g Current and future risks for each receptor at each site will be calculated and depicted in the Risk Characterization Section of the BRA, in accordance with the pre-approved Work Plan. An uncertainty assessment will also be completed as outlined in the (USACE, 1994). Remediation goals will be calculated in accordance with EPA Region IV guidance as described in Sections 2.5.1.1 and 2.5.2.1 of the pre-approved Work Plan (USACE, 1994).

4.4.3 Ecological Risk Assessment

4.4.3.a Methods used to conduct the ERA are outlined in Section 2 of the pre-approved Work Plan (USACE, 1994). The purpose for collecting additional data is to supplement pre-existing data from previous investigations and fill data gaps identified. Previous data will be evaluated for use in the risk assessment. The data to be collected as described in this risk assessment will be quantitatively evaluated.

4.4.3.1 Problem Formulation

4.4.3.1.a The protection of ecological resources, such as habitats and species of non-domesticated plants and animals, is a principal motivation for conducting the ERA. Ecological endpoints will be identified in the text of the ERA to assess whether significant adverse ecological effects have occurred or may occur at Unit 2 as a result of ecological receptors' exposure to COPCs. COPCs will be selected for use in the ERA in accordance with the methodology as described in the pre-approved Work Plan (USACE, 1994).

4.4.3.1.b The ecological characterization will be performed as described in Section 4.2.5 Ecological Investigation. The result of the ecological characterization will be to provide the risk assessors with information to select representative receptors, refine exposure scenarios for the ERA, and provide information on protected species. Ecological endpoints will be defined in the ERA in accordance with the guidance set forth in the General RI/FS Work Plan (Parsons ES, 1996). Given the diversity at Unit 2, ecological endpoints will consider sensitive habitats and species associated with the adjacent wetland areas and surface waters (i.e. the drainage ditch and the Tennessee River).

4.4.3.1.c Receptors will be selected based on the results of the site characterization and other selection factors as identified in the pre-approved Work Plan (USACE, 1994). Terrestrial and aquatic receptors selected will be identified and described in the ERA.

4.4.3.1.d A conceptual site model is presented in Figure 4-4. This CSM is based on previous investigation results, a brief site visit, and evaluation of the site investigation results. Professional judgment will be used to select the most appropriate risk hypotheses and document the rationale for selection of endpoints.

4.4.3.2 Exposure Characterization

4.4.3.2.a Potential exposure pathways are depicted in the CSM, Figure 4-4. Soil, sediment, and surface water pathways will be evaluated. The exposure profile will be detailed in the ERA to include a discussion of endpoint selection. Empirical and site specific data will be used to determine endpoints. Toxicity reference values will be developed in accordance with methods provided in the pre-approved Work Plan (USACE, 1994).

4.4.3.2.b Site-specific bioconcentration factors will be derived for fish (nonmigratory) and mussels at Unit 2. Tissue data will be analyzed for quality assurance purposes and site-specific BCFs and BAFs will be calculated for the test species. These values can then be used to calculate the relevant food chain multipliers (FCMs), assuming data are available from at least two directly linked trophic levels. These site-specific values can then be used to adjust the derived exposure estimates. Exposure estimates for higher trophic levels will incorporate the measured tissue residue concentrations in food organisms. Estimates of bioavailability using media-specific physical and chemical factors will be used to refine uptake/intake models and adjust exposure estimates to be used. Sediment toxicity testing results will also be incorporated into the analysis.

4.4.3.3 Risk Characterization

4.4.3.3.a The risk characterization section of the ERA will describe the likelihood, severity, and characteristics of adverse effects to environmental stressors present at Unit 2. Hazard quotients will be developed as described in the pre-approved Work Plan (USACE, 1994).

4.4.3.4 Analysis of Risk Uncertainty

4.4.3.4.a A qualitative analysis will be made of the uncertainties associated with the ERA. The components of the uncertainty analysis are described in the pre-approved Work Plan (USACE, 1994).

4.5 DATA REPORTING

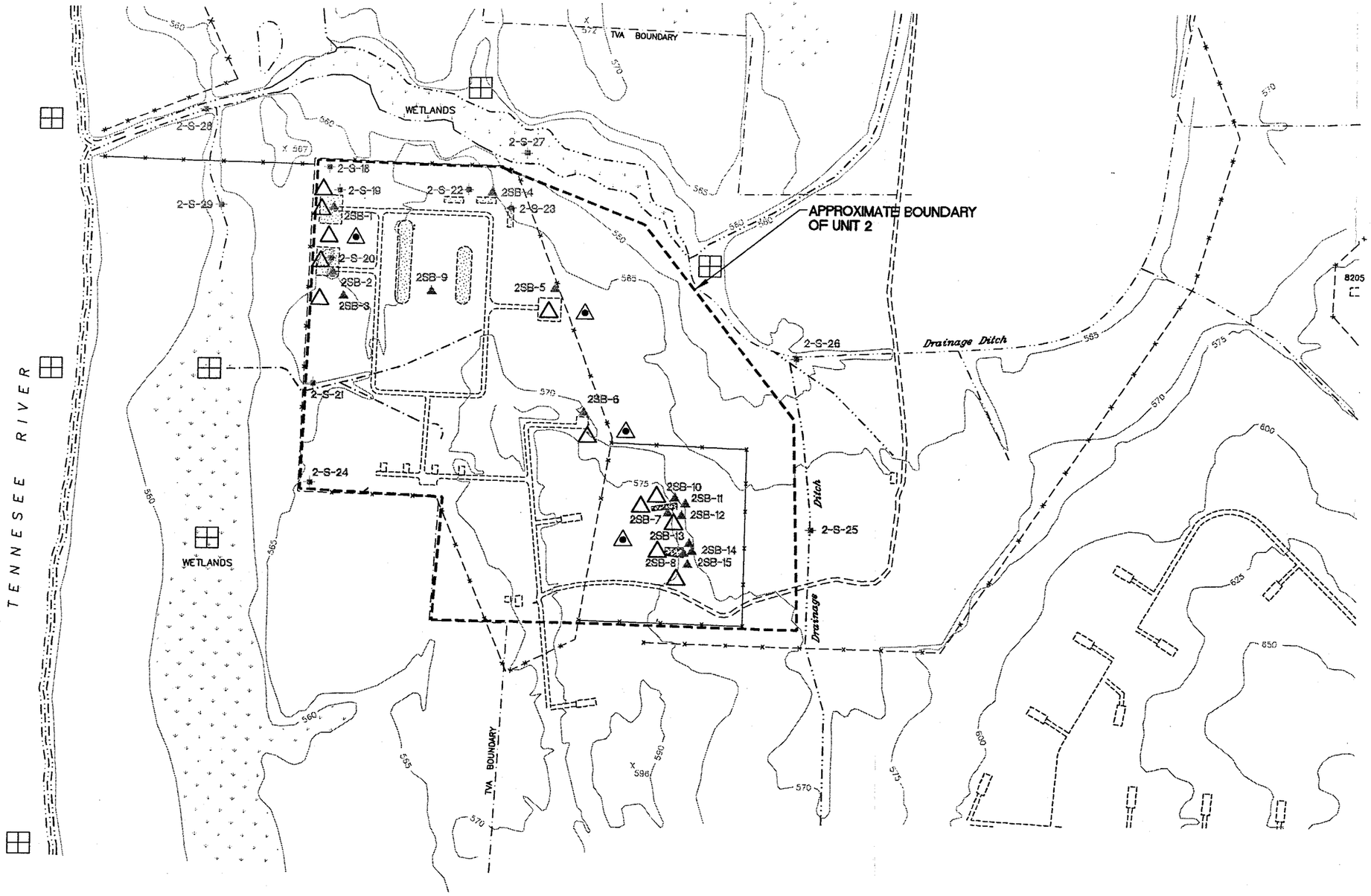
Upon completion of all field and analytical work specified in the SAP, Parsons ES will submit a QC summary Report. The report will summarize the QC activities, non-

conformance reports and the Parsons ES's review of field and laboratory data. A description of the contents of the report may be found in Section 4.5 of the General Work Plan (Parsons ES, 1996).

Figure 4.1

PROPOSED SOIL, SEDIMENT, AND SURFACE WATER LOCATION MAP

UNIT-2
REDSTONE ARSENAL



LEGEND

- △ PROPOSED CHEMICAL SOIL BORING (SHALLOW/DEEP)
- ◬ PROPOSED GEOTECHNICAL SOIL BORING (DEEP)
- ⊞ PROPOSED SEDIMENT, SURFACE WATER AND SEDIMENT TOXICITY TESTING STATION
- ▲ SOIL BORING
- ✱ SHALLOW SOIL/SEDIMENT SAMPLING SITE

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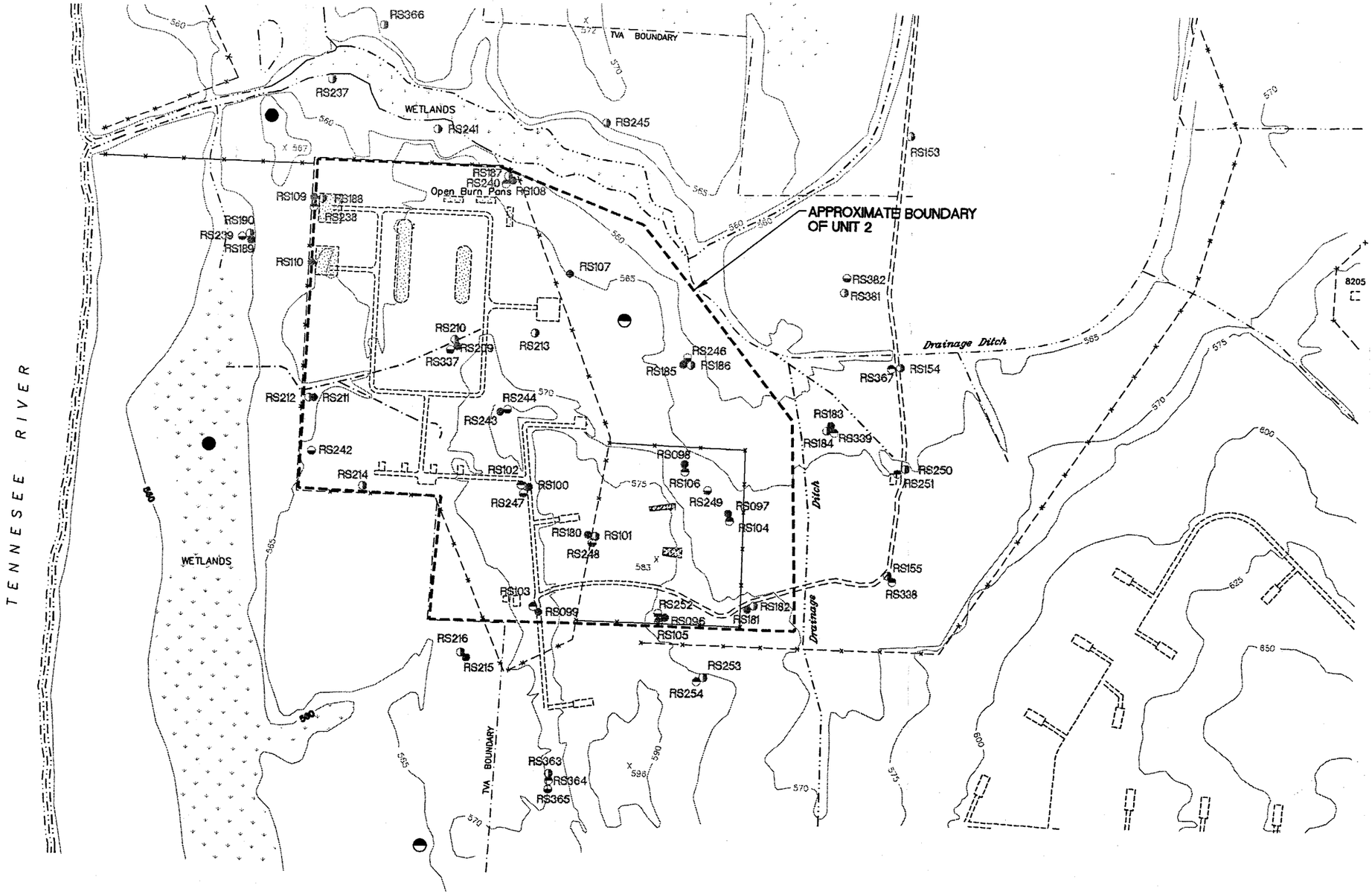
PARSONS ENGINEERING SCIENCE, INC.

Figure 4.2

PROPOSED GROUNDWATER SAMPLE LOCATION MAP

UNIT-2

REDSTONE ARSENAL



LEGEND

- PROPOSED SHALLOW OVERBURDEN MONITORING WELL
- PROPOSED UPPER BEDROCK MONITORING WELL
- SHALLOW OVERBURDEN MONITOR WELL
- DEEP OVERBURDEN MONITOR WELL
- UPPER BEDROCK MONITOR WELL
- DEEP BEDROCK MONITOR WELL

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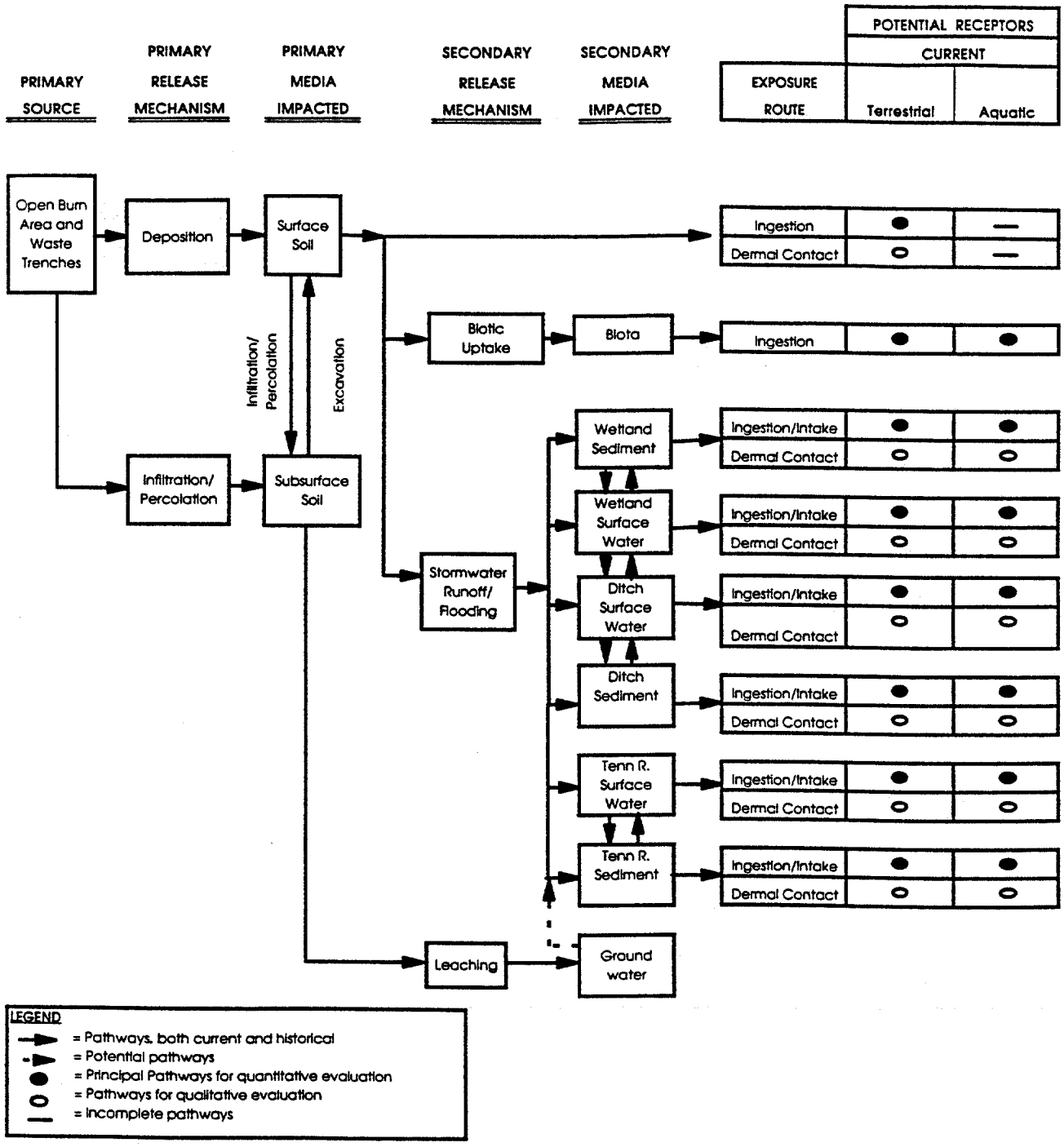
ECOLOGICAL CONCEPTUAL SITE MODEL FOR RSA-UNIT 2: OPEN BURN AREA AND WASTE TRENCHES REDSTONE ARSENAL



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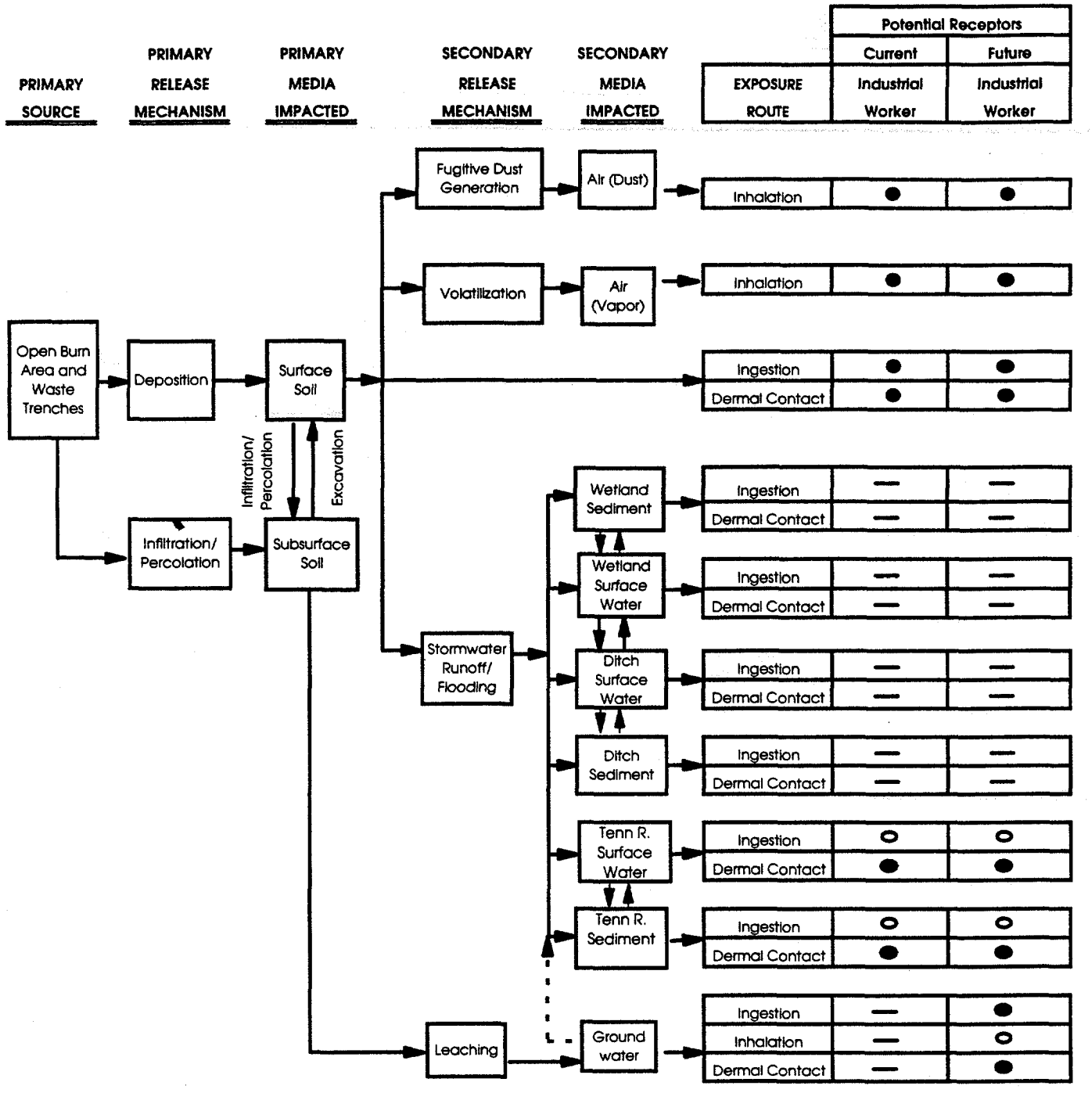
HUMAN HEALTH CONCEPTUAL SITE MODEL FOR RSA-UNIT 2: OPEN BURN AREA AND WASTE TRENCHES REDSTONE ARSENAL



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SECTION 5
TASK PLAN FOR THE FEASIBILITY STUDY (FS)

5.0.a The Feasibility Study (FS) will be performed according to the procedures outlined in the *Final Work Plan to Prepare Feasibility Studies at RSA Unit 1, Unit 2, and Various Sites at Unit 3 Redstone Arsenal* (ESE, 1994). A RCRA CMS has previously been conducted for the site (ESE, 1993). Information gathered during the CMS, as applicable, will be used during preparation of the FS.

SECTION 6
PLANS AND MANAGEMENT

6.0.a This section presents the schedule for RI activities and identifies key project personnel.

6.1 SCHEDULING

6.1.a The anticipated schedule of activities is presented as Figure 6.1. The schedule of deliverables is as follows:

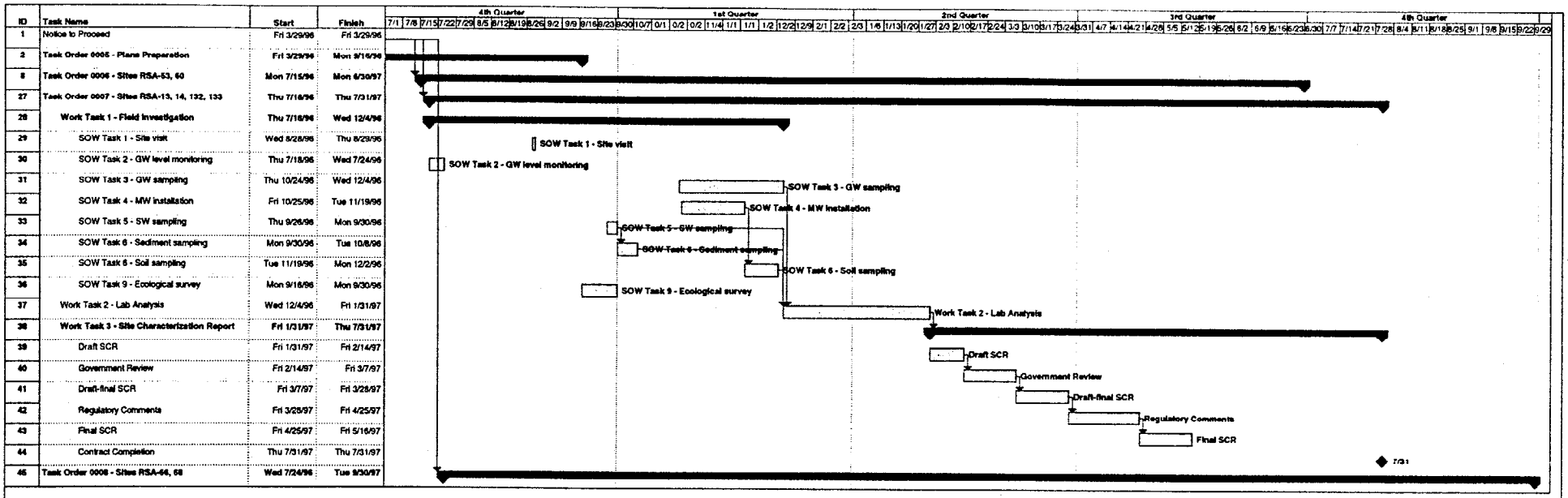
Deliverable	Date
Draft - Site Characterization Report for Unit 2	14-Feb-97
Draft Final - Site Characterization Report for Unit 2	28-Mar-97
Final - Site Characterization Report for Unit 2	16-May-97
Task Order completion date	31-Jul-97

6.2 STAFFING

6.2.a Key Parsons ES personnel on this project are:

- Thomas M. Roth, P.E. Project Manager;
- Ken Stockwell, P.E. Technical Director;
- Ronda Simmons, Ph.D, P.E. Field Team Leader;
- Alyse Getty Risk Assessment Coordinator;
- Janet Hall Quality Assurance Officer, Data Coordinator;
- Ed Grunwald Health and Safety Officer.

6.2.b The project organization is shown on Figure 6.2.



ID	Task Name	Start	Finish
1	Notice to Proceed	Fri 3/29/96	Fri 3/29/96
2	Task Order 0005 - Plans Preparation	Fri 3/29/96	Mon 9/16/96
8	Task Order 0006 - Sites RSA-53, 60	Mon 7/15/96	Mon 6/30/97
27	Task Order 0007 - Sites RSA-13, 14, 132, 133	Thu 7/18/96	Thu 7/31/97
28	Work Task 1 - Field Investigation	Thu 7/18/96	Wed 12/4/96
29	SOW Task 1 - Site visit	Wed 8/28/96	Thu 8/29/96
30	SOW Task 2 - GW level monitoring	Thu 7/18/96	Wed 7/24/96
31	SOW Task 3 - GW sampling	Thu 10/24/96	Wed 12/4/96
32	SOW Task 4 - MW installation	Fri 10/25/96	Tue 11/19/96
33	SOW Task 5 - SW sampling	Thu 9/26/96	Mon 9/30/96
34	SOW Task 6 - Sediment sampling	Mon 9/30/96	Tue 10/8/96
35	SOW Task 6 - Soil sampling	Tue 11/19/96	Mon 12/2/96
36	SOW Task 9 - Ecological survey	Mon 9/16/96	Mon 9/30/96
37	Work Task 2 - Lab Analysis	Wed 12/4/96	Fri 1/31/97
38	Work Task 3 - Site Characterization Report	Fri 1/31/97	Thu 7/31/97
39	Draft SCR	Fri 1/31/97	Fri 2/14/97
40	Government Review	Fri 2/14/97	Fri 3/7/97
41	Draft-final SCR	Fri 3/7/97	Fri 3/28/97
42	Regulatory Comments	Fri 3/28/97	Fri 4/25/97
43	Final SCR	Fri 4/25/97	Fri 5/16/97
44	Contract Completion	Thu 7/31/97	Thu 7/31/97
45	Task Order 0008 - Sites RSA-44, 58	Wed 7/24/96	Tue 9/30/97

SCHEDULE OF ACTIVITIES
REDSTONE ARSENAL

Project: Redstone Arsenal
Date: Tue 8/11/96

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

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Page 1

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Figure 6.1

PROJECT ORGANIZATION

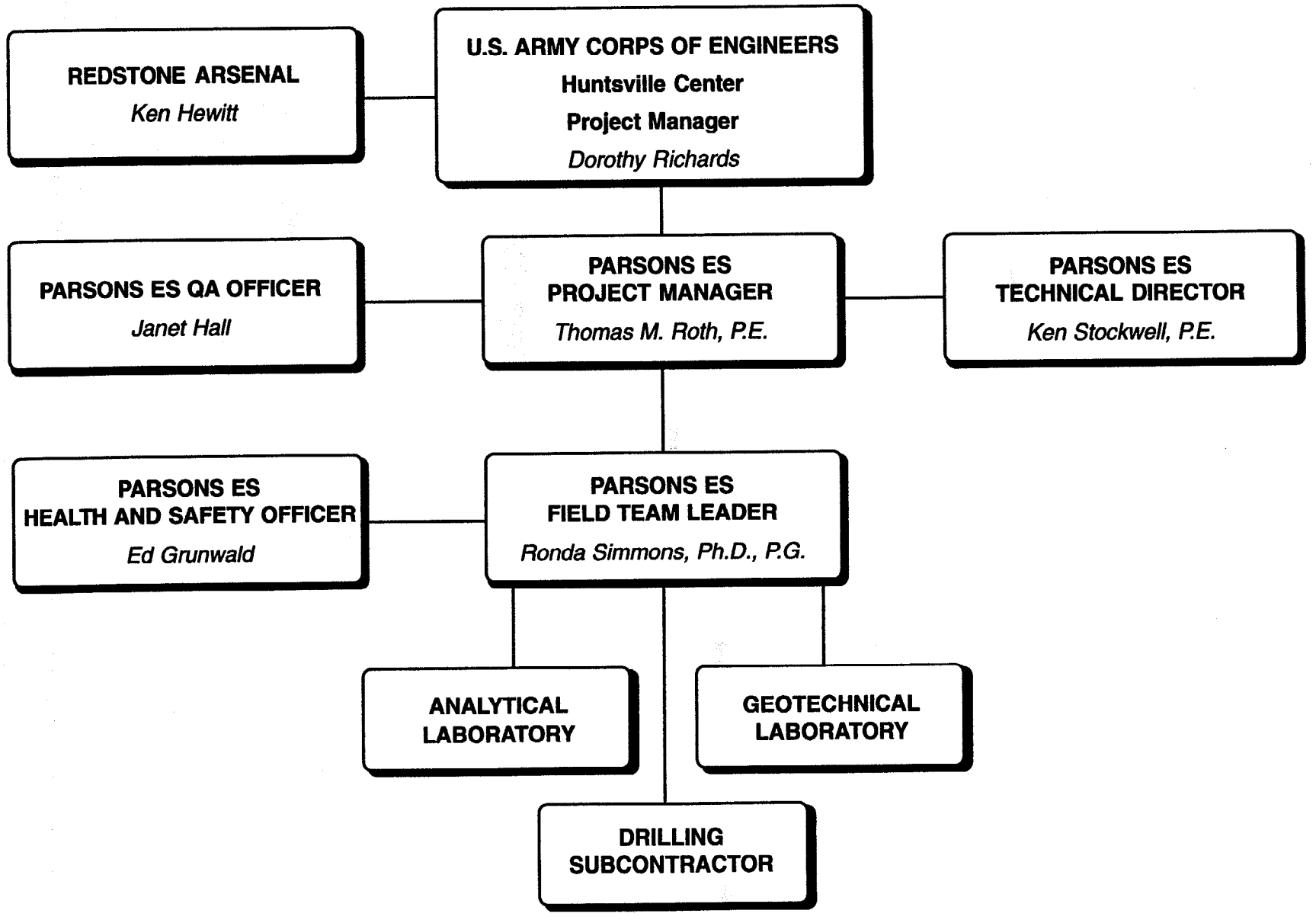

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Figure 6.2

SECTION 7
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APPENDIX A
SITE SPECIFIC SAFETY AND HEALTH PLAN

SITE SPECIFIC SAFETY AND HEALTH PLAN FOR SITES RSA-13, -14, -132, AND -133 (UNIT 2) REDSTONE ARSENAL, ALABAMA

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE CENTER
Huntsville, Alabama

Contract No. DACA 87-95-D0018
Task Order No. 0005

PREPARED BY

PARSONS ENGINEERING SCIENCE, INC
57 Executive Park South, N.E.
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June 1996

Reviewed and Approved:

Thomas M. Roth, P.E.
Project Manager

Edward L. Grunwald, C.I.H.
Health and Safety Officer

TABLE OF CONTENTS

LIST OF TABLES

SECTION 1
PURPOSE AND POLICY

1.0.a The purpose of this Site Safety and Health Plan (SSHP) is to identify safety and health (S&H) policies, practices, and procedures to be followed during field activities The site activities will be conducted in support of a remedial investigation/feasibility study (RI/FS) at the Redstone Arsenal sites RSA-13, RSA-14, RSA-132, and RSA-133, located in Huntsville, Alabama under Delivery Order 0005 of Contract Number DACA87-95-D-0018. All work performed under this contract will be in compliance with the Ordnance Management Plan (Appendix C, Generic RI/FS Work Plan, Parsons ES, 1996). The four sites are as follows:

- RSA-13, Unlined Open Burn Area,
- RSA-14, Burn Trenches,
- RSA-132, Former Popping Furnace; and
- RSA-133, Former Rocket Washout Pad.

1.0.b The provisions of this Plan represent mandatory minimum requirements for activities conducted during the field work at these sites. This Plan meets the requirements of the Occupational Safety and Health Administration's (OSHA) final rule on Hazardous Waste Operations and Emergency Response (29 CFR 1910.120). Any supplemental plans used by subcontractors shall conform to this Plan as a minimum. The provisions of this Plan are applicable to Parsons Engineering Science (Parsons ES) personnel and subcontractors. Personnel who engage in activities covered by this Plan shall be familiar with its contents and comply with its requirements.

1.0.c This SSHP is supplemented with a generic Safety and Health Plan (SHP). As previously described, the SSHP provides site- and activity-specific S&H protocols and procedures to be used during field operations at the above referenced sites. The SHP establishes *general* personnel protective standards, safety practices, and safety procedures for use during remedial investigation/feasibility study (RI/FS) activities at Redstone Arsenal. The generic document is intended to provide guidance to contractors in preparing the SSHP, stipulate consistent S&H related activities for the site, and aid in the cost-effective production of SSHPs.

SECTION 2
PROJECT TEAM ORGANIZATION

2.0.a The following personnel are designated to perform the stated job function for this project:

Project Manager	Tom Roth, P.E.
Project Safety & Health Officer	Ed Grunwald, C.I.H.
Site Safety & Health Officer	Cindy Lewis
Field Team Leader	Ronda Simmons, Ph.D., P.G.
Field Team Member	TBD

Table 2.1 Field Activities Supporting RI/FS
RSA-13, RSA-14, RSA-132, and RSA-133
Redstone Arsenal

Project Team Responsibilities

Title	General Description	Responsibilities
Project Manager	Reports to upper-level management. Has authority to direct response operations. Controls site activities.	• Ensures that the Work Plan is completed on schedule. • Serves as the liaison with public officials. • Uses the Project Safety and Health Officer to ensure that safety and health requirements are met. • Assigns personnel to develop Work Plan and Site Safety and Health Plan (SSHP). • Coordinates activities with appropriate officials. • Briefs the field team on specific assignments. • Prepares the final report and support files on the response activities.
Project Safety and Health Officer	Advises the Project Manager on all aspects of safety and health.	• Confirms each team member's suitability based upon training and medical surveillance report. • Develops Site Safety and Health Plan • Selects Site Safety and Health Officer • Conducts periodic inspections to determine if the SSHP is being followed.
Site Safety and Health Officer	Informs Project Safety and Health Officer of site safety and health issues. Stops work if any operation threatens workers or public.	• Periodically inspects protective clothing and equipment. • Conducts daily safety and health inspections. • Maintains a safety and health logbook. • Ensures that protective clothing and equipment are properly stored and maintained. • Monitors the work parties for signs of stress, such as cold stress and fatigue. • Implements the SSHP. • Enforces the "buddy" system.

Table 2.1 (Continued) Field Activities Supporting RI/FS
RSA-13, RSA-14, RSA-132, and RSA-133
Redstone Arsenal

Project Team Responsibilities

Title	General Description	Responsibilities
Site Safety and Health Officer (Continued)		• Knows emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department. • Ensures decontamination lines and decontamination solutions are appropriate for the type of chemical contamination on the site. • Controls the decontamination of all equipment, personnel and samples from the contaminated areas. • Assures proper disposal of contaminated clothing and materials.
Field Team Leader	Responsible for field team operations.	• Manages field operations. • Executes the Work Plan. • Enforces safety procedures. • Coordinates with the Site Safety and Health Officer in determining protection level. • Enforces site control. • Documents field activities and sample collection. • Serves as a site liaison with public officials. • Controls entry and exit at the Access Control Points.
Field Team Members	Other ES personnel and subcontractor entering site to conduct activities covered by plan.	• Safely complete the onsite tasks required to fulfill the Work Plan. • Read and comply with SSHP. • Notify Site Safety and Health Officer or Field Team leader of suspected unsafe conditions. • Practice the "buddy" system.

SECTION 3
SITE DESCRIPTIONS AND SCOPE OF WORK

3.0.a Parsons ES has been contracted by the U.S. Army Corps of Engineers, Huntsville District (CESHND) to conduct field activities supporting remedial investigation/feasibility studies at four sites at Redstone Arsenal (RSA). The sites included under this phase of activities are:

- RSA-13, Unlined Open Burn Area,
- RSA-14, Burn Trenches,
- RSA-132, Former Popping Furnace, and
- RSA-133, Former Rocket Washout Pad.

3.0.b The locations and descriptions of the study sites are provided in the Field Sampling Plan for these sites. The following sections summarize the scope of work to be performed and provide background information on each of the areas to be visited.

3.1 SCOPE OF WORK

3.1.a The scope of work covered by this SSHP includes:

- installation of shallow overburden and upper bedrock groundwater monitoring wells; borings will be conducted by drill rig and mud rotary methods;
- groundwater level measurements;
- groundwater sampling;
- surface water sampling;
- sediment sampling;
- soil sampling using hand augers and split spoons; and
- biota sampling.

3.1.b These activities will be conducted in order to provide sufficient data for completion of a baseline risk assessment and remedial action feasibility study for RSAs-

13, -14, -132, and -133. Field activities should be conducted in late summer and should be completed within one month.

3.2 RSA-13, UNLINED OPEN BURN AREAS

3.2.a RSA-13 is located in the northwestern corner of Unit 2, south of Buxton Road, west of McAlpine Road, and north and east of the Tennessee River. The unit is on the floodplain of the Tennessee River.

3.2.b RSA-13 contains two former unlined open burn areas. Each pad is approximately 200 square feet. From the 1950s to 1986, these pads were actively used for the open burning of waste propellant solvent-contaminated and propellant-contaminated materials. Contaminated metal was also flashed on the ground surface at RSA-13 and sold as scrap metal.

3.3 RSA-14, BURN TRENCHES

3.3.a RSA-14 is located south of Buxton Road, west of McAlpine Road, and north and east of the Tennessee River. It is located in the southeastern portion of Unit 2.

3.3.b The study area consists of two formerly used unlined trenches approximately 300 ft long by 75 ft wide by 20 ft deep. The two Burn Trenches were used to incinerate waste propellants, waste solvents, and propellant-contaminated materials. Contaminated metal was also flashed on the ground surface and sold as scrap metal. In addition to burning waste materials, the trenches were used for incineration of packaging and pallets used to ship munitions. In 1984, it was discovered that the trenches had also been used to burn waste solvents from an RSA explosive production area. After this discovery, such activities were ceased. In the past, spent solvents from Thiokol manufacturing operations and ash generated from open burning of propellant-related wastes were disposed in the open field immediately adjacent to the east of RSA-14.

3.4 RSA-132, FORMER POPPING FURNACE

3.4.a This site is located south of Buxton Road, west of McAlpine Road, and north and east of the Tennessee River. RSA-132 was a demilitarization unit disassembled in the late 1970s. The area where the popping furnace (a metal kettle) was located is now covered by grass. Small arms ordnance was thermally treated in the furnace. The furnace used a diesel fuel burner as the heat source. It is likely that the diesel storage was a temporary above ground storage tank. The furnace was used during and after the resolution of the European Theater of WWII for explosive and ordnance

disposal of ammunition. The popping furnace was not used after 1949, but not dismantled and removed until late 1970s.

3.5 RSA-133, FORMER ROCKET WASHOUT PAD

3.5.a RSA-133 is located south of Buxton Road, west of McAlpine Road, and north and east of the Tennessee River. It is on the floodplain of the Tennessee River. The area is fenced off, overgrown with grass, and labeled with warning signs.

3.5.b The pad, consisting of an open washrack/concrete sump that is approximately 10 ft by 10 ft, was used for rocket washouts. If used, the rocket washout pad would have served as an area to clean residual/propellant out of rocket motors.

SECTION 4
PHYSICAL AND CHEMICAL HAZARD ANALYSIS

4.0.a Field activities planned for RSA-13, -14, -132, and -133 (to include installing groundwater wells, groundwater level measurements, groundwater sampling, surface water sampling, sediment sampling, soil sampling, and biota sampling) could result in employee exposure via several pathways, including inhalation exposure to volatiles from all media (including subsurface soil and sediment), and semi- and non-volatiles adhering to particulates. Monitoring well installation could also result in dermal exposure to contaminants of subsurface soil. Therefore, no class of chemical or media can be excluded from evaluation.

4.0.b General pathways for exposure during field investigation activities at these sites along with potential chemical and physical hazards are included in Table 4.1 of the generic SHP. Additional physical hazards posed by the specific activities to be conducted at this site include:

- slip, trip, and fall hazards during mud rotary drilling, and
- dermal contact with drilling mud and entrained contaminated soil.

4.0.c Drilling safety practices will be in accordance with Corps of Engineers EM385-1-1 16.M. The following is a partial list of the safety practices that will be required:

- Drilling equipment will operated, inspected, and maintained as specified in the manufacturer's operating manual;
- Prior to brining drilling equipment to the job site, a survey will be performed to identify potential hazards;
- Training for all drilling crews;
- Drilling equipment will have two easily-accessible emergency shutdown devices; and
- Clearance from electrical sources.

4.0.d Extensive monitoring data are available for these sites. Previous studies (reported in ESE 1996) have evaluated existing data and determined exposure point

concentrations for each detected compound at the site. If a sufficient number of data points existed, these exposure point concentrations represent the 95% upper confidence limit. If an insufficient number of data points exited, the exposure point concentration is the maximum concentration detected. Because these exposure point evaluations represent the outcome of extensive evaluation of all data collected to date, and they represent worst case concentrations, they are appropriate for use in evaluating potential health and safety hazards and determining protective personal protective equipment. That evaluation combined data from all four sites into one dataset. Any error introduced by use of this combined data set would result in overestimating potential hazards, and would, therefore, be protective of employee health.

4.0.e Exposure point concentrations of chemicals of potential concern during the proposed activities at RSA-13, -14,-132, and -133 are provided in Table 4.1. The chemicals identified on this table as potential concerns represent a subset of those detected at the site. The full range of detected chemicals (as reported by ESE 1996) is included in Appendix A.

4.0.f The chemicals of potential concern were selected based on evaluation of the physicochemical characteristics, permissible exposure limits, and toxicological properties combined with the concentrations in various media. These properties are presented in the generic SHP. No additional chemicals of potential concern have been identified for this site. As noted in Table 4.1, only volatile compounds in groundwater and soil present potential health and safety concerns at these areas.

Table 4.1 Exposure Point Concentrations of Chemicals of Potential Concern at RSA-13, -14, -132, and -133

MEDIA	CHEMICAL	CONCENTRATION
Groundwater	Benzene	0.0199 mg/l
	Chloroform	0.052 mg/l
	1,1-dichloroethene	0.105 mg/l
	1,2 dichloroethene	2.134 mg/l
	trichloroethene	4.85 mg/l
	Vinyl Chloride	0.040 mg/l
Soil	Chloroform	0.133 mg/kg
	Tetrachloroethene	3.41 mg/kg
	Trichloroethene	5.78 mg/kg

Notes:

*Exposure point concentrations were extracted from ESE, 1996. They represent the 95% UCL value of concentrations detected during the Phase I and II investigations, as determined and reported by ESE. If the number of samples precluded determination of the 95% UCL, the maximum values were reported.

SECTION 5
PERSONAL PROTECTIVE EQUIPMENT

5.0.a Personal protective equipment to be employed at the initial stage of each planned activity at RSA-13, -14, -132, and -133 is shown in Table 5.1. The appropriate equipment to be used for each respective PPE level is provided in the generic SHP. The level of PPE employed at each activity is subject to change, based on the results of air monitoring, as stipulated in Section 6.

TABLE 5.1
PERSONAL PROTECTIVE EQUIPMENT LEVEL FOR RSA-13, -14, -132, AND -133

Activity	PPE Level
Installing groundwater monitoring wells	D
Measuring groundwater level	D
Sampling groundwater	D
Sampling soil	D
Biota sampling	D

SECTION 6
AIR MONITORING AND ACTION LEVELS

6.0.a Air monitoring to be conducted during field activities at RSA-13, -14, -132, and -133 has been determined in accordance with the guidelines presented in the generic SHP. In addition, for each potential exposure pathway, worst case air concentrations were calculated and compared with the permissible exposure limits to evaluate the potential for overexposure to one or a combination of similar acting chemicals during each phase of activity. Air monitoring requirements were then determined based on that evaluation.

6.0.b Evaluation of potential worst case air concentrations based on concentrations of volatile contaminants detected in groundwater and soil at these areas indicate that the potential exists for exposure exceeding the permissible exposure limits. Both benzene and vinyl chloride (VC) have been detected in the groundwater at these areas. Therefore, in accordance with the requirements in the generic SHP, air monitoring will be conducted utilizing both OVA (FID) and colorimetric tubes during all activities involving contact with groundwater, including well installation, water level measurements, sampling groundwater, and conducting aquifer pump tests. Action levels triggering additional levels of respiratory protection are noted on Table 6.1. In addition to the noted air monitoring, care will be taken to avoid particulate (both water and soil) generation during mud rotary drilling.

Table 6.1
Action Levels for Air Monitoring Conducted When Accessing Groundwater

Concentration of Organic Vapors in the Breathing Zone over Background	Colorimetric Tube Indication	Level of Respiratory Protection
0 - 1 ppm	None required	D
1 ppm - 25 ppm	benzene: <1 ppm and VC: <1	D
1 ppm - 10 ppm	benzene: <1 ppm and VC: >1, <10	C
1 ppm - 50 ppm	benzene: >1, <10 and VC: <1	C
50 ppm - 500 ppm	benzene: >10	B

10 ppm - 50 ppm	benzene: <1 and VC: >1, <10	C
50 ppm - 500 ppm	VC: >10	B

6.0.c In addition, evaluation of potential worst case air concentrations based on concentrations of volatile contaminants detected in soil at these areas indicates that the potential exists for exposure to volatiles exceeding the permissible exposure limit. Fuel-associated solvents, including benzene, have been detected in the soil. Although chlorinated solvents have also been detected, vinyl chloride has not. Therefore, benzene will be selected as the indicator chemical during real-time monitoring of field activities contacting soil at these areas. Air monitoring requirements and the associated action levels are provided in Table 6.2.

Table 6.2
Action Levels for Air Monitoring Conducted When Accessing Soil

Concentration of Organic Vapors in the Breathing Zone over Background	Colorimetric Tube Indication	Level of Respiratory Protection
0 - 1 ppm	None required	D
1 ppm - 25 ppm	benzene: <1 ppm	D
25 ppm - 50 ppm	benzene: 1 - 10 ppm	C
50 ppm - 500 ppm	benzene: >1	B

6.0.d Evaluation of concentrations detected in sediment and surface water indicate that no potential exists for exceeding permissible exposure limits during the proposed activities contacting these media. Therefore, no additional air monitoring is warranted at this site.

APPENDIX A.1
EXPOSURE POINT CONCENTRATIONS

Human Exposure Concentrations Used in Analyses

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
RSA-68	Sediment	Acetone	ACET	2.17E-01	mg/kg	UCL95	I
		Barium	BA	1.17E+02	mg/kg	UCL95	I
		Benzoic acid	BENZOA	3.00E+00	mg/kg	max	I
		Bis(2-ethylhexyl) phthalate	B2EHP	1.70E-01	mg/kg	max	I
		Carbon tetrachloride	CCL4	2.02E-02	mg/kg	UCL95	I
		Chromium	CR	2.58E+01	mg/kg	UCL95	I
		DDE, 4,4'	PPDDE	1.00E-02	mg/kg	max	I
		Diethyl phthalate	DEP	2.40E-01	mg/kg	max	I
		Lead	PB	1.80E+01	mg/kg	max	I
		Methylene chloride	CH2CL2	1.29E-01	mg/kg	UCL95	I
		Pentachlorophenol	PCP	6.40E-01	mg/kg	max	I
		Selenium	SE	1.40E+00	mg/kg	UCL95	I
	Shallow Soil	Acetone	ACET	3.60E-02	mg/kg	max	I
		Methylene chloride	CH2CL2	2.00E-02	mg/kg	max	I
	Surface Water	Acetone	ACET	3.60E-02	mg/L	max	I
		Barium	BA	3.76E-02	mg/L	max	I
		DDT, 4,4'	PPDDT	1.90E-04	mg/L	max	I
		Heptachlor	HPCL	7.00E-05	mg/L	max	I
		Lindane	LIN	5.00E-05	mg/L	max	I
		Methylene chloride	CH2CL2	7.00E-03	mg/L	max	I
		Selenium	SE	3.60E-03	mg/L	max	I
Unit 2	Groundwater	Acetone	ACET	1.71E-01	mg/L	UCL95	I/II
		Arsenic	AS	3.57E-03	mg/L	UCL95	I
		Barium	BA	1.38E-01	mg/L	UCL95	I
		Benzene	C6H6	1.99E-02	mg/L	UCL95	I/II
		Bis(2-chloroethoxy)methane	B2CEXM	5.51E-03	mg/L	UCL95	I
		Bis(2-ethylhexyl) phthalate	B2EHP	2.13E-02	mg/L	UCL95	I
		Cadmium (aqueous matrix)	CD-A*	4.91E-03	mg/L	UCL95	I
		Carbon tetrachloride	CCL4	3.92E-03	mg/L	UCL95	I/II
		Chlorobenzene	CLC6H5	5.58E-03	mg/L	UCL95	I/II
		Chloroform	CHCL3	5.22E-02	mg/L	UCL95	I/II
		Chloromethane	CH3CL	6.82E-03	mg/L	UCL95	I/II
		Chromium	CR	1.52E-02	mg/L	UCL95	I
		Dichloroethane, 1,1-	11DCLE	1.25E-02	mg/L	UCL95	I/II
		Dichloroethane, 1,2-	12DCLE	8.75E-03	mg/L	UCL95	I/II
		Dichloroethene, 1,1-	11DCE	1.05E-01	mg/L	UCL95	I/II
		Dichloroethene, 1,2- (total)	12DCE	2.13E+00	mg/L	UCL95	I/II
		Dinitrobenzene, 1,3	13DNB	7.20E-04	mg/L	UCL95	I
		Dinitrotoluene, 2,4	24DNT	4.90E-03	mg/L	max	I
		Ethylbenzene	ETC6H5	3.48E-03	mg/L	UCL95	I/II
		Lead	PB	6.18E-03	mg/L	UCL95	I
		Mercury	HG	3.60E-04	mg/L	UCL95	I
		Methylene chloride	CH2CL2	2.00E-02	mg/L	UCL95	I/II
		Phenol	PHENOL	5.46E-03	mg/L	UCL95	I
		RDX	RDX	5.88E-03	mg/L	UCL95	I
		Selenium	SE	2.79E-03	mg/L	UCL95	I
		Tetrachloroethane, 1,1,2,2-	TCLEA	5.63E-03	mg/L	UCL95	I/II
		Tetrachloroethene	TCLEE	4.09E-02	mg/L	UCL95	I/II
		Toluene	MEC6H5	3.96E-03	mg/L	UCL95	I/II
		Trichloroethane, 1,1,1-	111TCE	8.28E-02	mg/L	UCL95	I/II
		Trichloroethane, 1,1,2-	112TCE	4.25E-03	mg/L	UCL95	I/II
		Trichloroethene	TRCLE	4.85E+00	mg/L	UCL95	I/II
		Trinitrobenzene, 1,3,5-	135TNB	3.52E-02	mg/L	UCL95	I
		Vinyl chloride	C2H3CL	4.03E-02	mg/L	UCL95	I/II
		Xylenes (total)	XYLEN	2.96E-02	mg/L	UCL95	I/II

. Human Exposure Concentrations Used in Analyses

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
Unit 2 (Continued)	Sediment	Arsenic	AS	8.00E+00	mg/kg	UCL95	I
		Barium	BA	2.50E+02	mg/kg	UCL95	I
		Cadmium (solid matrix)	CD-S*	4.60E+00	mg/kg	UCL95	I
		Chromium	CR	2.44E+01	mg/kg	UCL95	I
		DNT, 2,6-	26DNT	5.00E-01	mg/kg	UCL95	I
		Ethylbenzene	ETC6H5	1.01E-02	mg/kg	UCL95	I
		HMX	HMX	3.10E+00	mg/kg	UCL95	I
		Lead	PB	2.99E+01	mg/kg	UCL95	I
		PETN	PETN	4.30E+00	mg/kg	UCL95	I
	Shallow Soil***	Acetone	ACET	3.70E+01	mg/kg	max	II**
		Bis(2-ethylhexyl) phthalate	B2EHP	3.30E-01	mg/kg	max	I
		Chloroform	CHCL3	1.70E-02	mg/kg	max	II**
		Di-n-butyl phthalate	DNBP	3.80E-01	mg/kg	max	I
		Dichloroethane, 1,1-	11DCLE	1.30E-02	mg/kg	max	II**
		Dichloroethene, 1,2- (total)	12DCE	1.20E+00	mg/kg	max	II**
		Dinitrotoluene, 2,4-	24DNT	8.39E-01	mg/kg	max	I
		HMX	HMX	9.06E-01	mg/kg	max	I
		Methylene chloride	CH2CL2	2.60E+00	mg/kg	max	I**
		PETN	PETN	2.23E+01	mg/kg	max	I
		RDX	RDX	1.43E+00	mg/kg	max	I
		Tetrachloroethene	TCLEE	9.70E+00	mg/kg	max	I**
		Toluene	MEC6H5	7.00E-03	mg/kg	max	II**
		Trichloroethene	TRCLE	1.30E+01	mg/kg	max	I**
		Trinitrobenzene, 1,3,5-	135TNB	1.16E+00	mg/kg	max	I
		Trinitrotoluene, 2,4,6-	246TNT	8.57E+02	mg/kg	max	I
	Surface Water	Acetone	ACET	1.54E-02	mg/L	UCL95	I
		Barium	BA	4.65E-02	mg/L	UCL95	I
		Lead	PB	1.10E-03	mg/L	UCL95	I
		Trichloroethene	TRCLE	4.20E-03	mg/L	UCL95	I

Note:
- I = Samples were analyzed for this chemical during Phase I only. UCL95 or maximum was obtained from Phase I sample results.
- II = Samples were analyzed for this chemical during Phase II only. UCL95 or maximum was obtained from Phase II sample results.
- I** = Samples were analyzed for this chemical during both Phases I and II. Maximum was obtained from Phase I sample results.
- II** = Samples were analyzed for this chemical during both Phases I and II. Maximum was obtained from Phase II sample results.
- I/II = Samples were analyzed for this chemical during both Phases I and II. UCL95 or maximum was obtained from both Phase I and Phase II sample results.
- *** = Maximum values from Phase I and/or II samples were used exclusively for Unit 2 shallow soil ECs. The Phase II RFI (G&M, 1992a) did not provide UCL95s for all Phase I and II data combined. See Data Uncertainties section of report for further discussion.

EC = exposure concentration
UCL95 = 95% upper confidence limit
max = maximum concentration

Human Exposure Concentrations for Fish Used in Analyses

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
RSA-68	Fish	Acetone	ACET	2.14E-02	mg/kg	only	I
		Barium	BA	3.46E-01	mg/kg	only	I
		DDT, p,p'-	PPDDT	1.03E+01	mg/kg	only	I
		Heptachlor	HPCL	1.10E+00	mg/kg	only	I
		Lindane	LIN	6.50E-03	mg/kg	only	I
		Methylene chloride	CH2CL2	3.50E-02	mg/kg	only	I
		Selenium	SE	8.80E-01	mg/kg	only	I
Unit 2	Fish	Acetone	ACET	3.45E-03	mg/kg	only	I
		Barium	BA	3.33E-01	mg/kg	only	I
		Lead	PB	8.50E-02	mg/kg	only	I
		Trichloroethene	TRCLE	1.95E-01	mg/kg	only	I

Note: These exposure concentrations are derived from one of two samples taken from close to the river or in the Igloo Pond.
One sample is the Phase I surface water sample, SW-Z-5 (pond), and the other sample is 2-SW-5 (near river).

only = Exposure concentration was derived from one sample concentration.

APPENDIX A.2
PLAN ACCEPTANCE FORM

PLAN ACCEPTANCE FORM
PROJECT SAFETY AND HEALTH PLAN

I have read and agree to abide by the contents of the Safety and Health Plan for the following project:

Field Work Supporting RI/FS Activities at RSA-53 and RSA-60

Redstone Arsenal

Name (print)

Signature

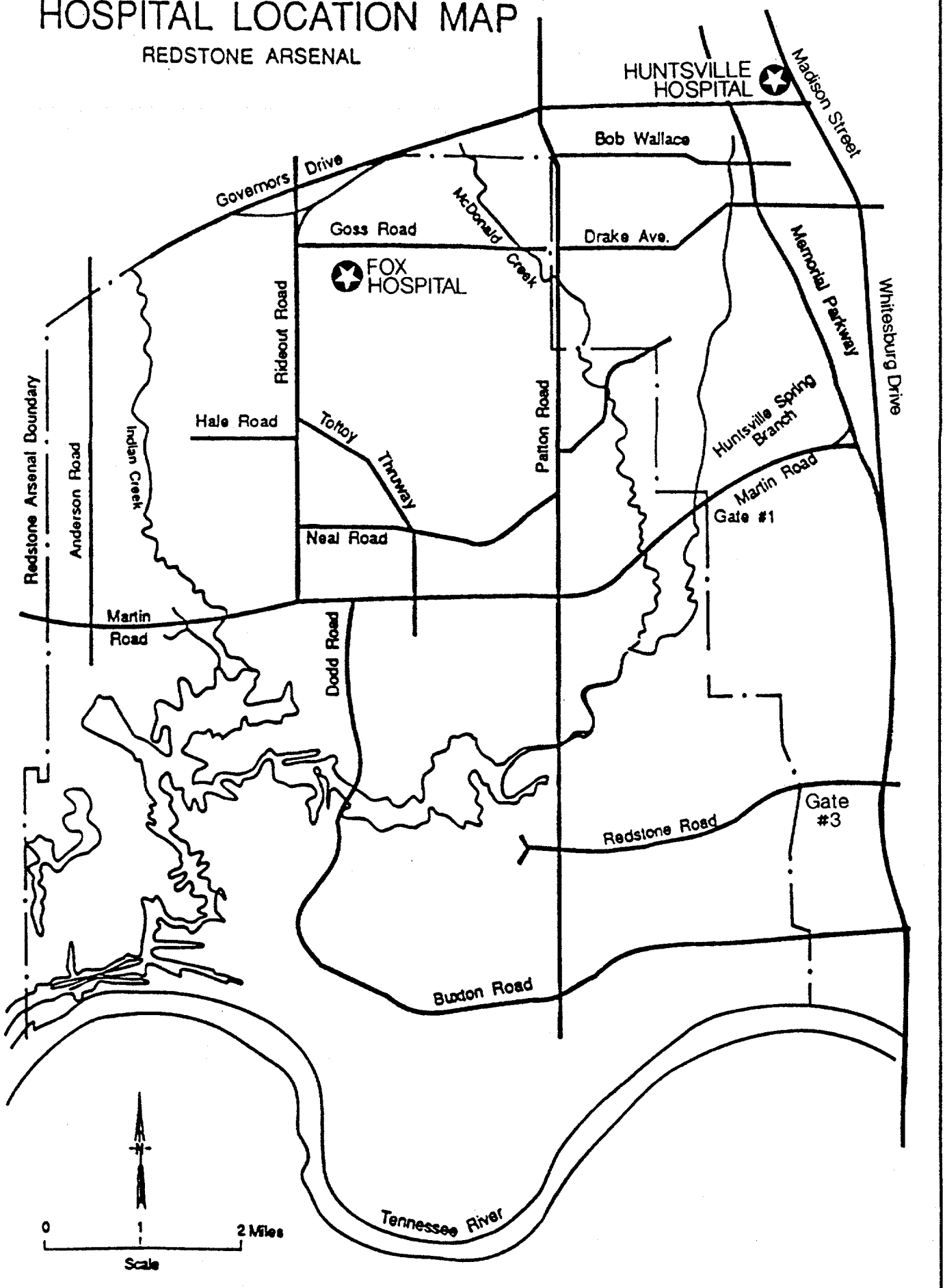
Date

Return to Onsite Safety and Health Officer before starting work at the site.

APPENDIX A.3
MAP TO NEAREST HOSPITAL

HOSPITAL LOCATION MAP

REDSTONE ARSENAL



APPENDIX A.4
ACCIDENT REPORT FORM

ACCIDENT REPORT FORM

Project: Redstone Arsenal RI/FS

EMPLOYER

1. Name: _____

2. Mail Address: _____
(No. and Street) *(City or Town)* *(State)*

3. Location, if different from mail address: _____

_____

INJURED OR ILL EMPLOYEE

4. Name _____ Social Security Number: _____
(First) (Middle) (Last)

5. Home Address: _____
(No. and Street) *(City or Town)* *(State)*

6. Age _____ 7. Sex: Male ____ Female ____ (Check one)

8. Occupation: _____
(Specific job title, not the specific activity employee was performing at time of injury)

9. Department: _____
(Enter name of department in which injured person is employed, even though they may have been temporarily working in another department at the time of injury)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident or exposure: _____
(No. and Street) (City or Town) (State)

11. Was place of accident or exposure on employer's premises? (Yes/No)

12. What was the employee doing when injured? _____
(Be specific - Was employee using tools or

_____
equipment or handling material?)

_____

ACCIDENT REPORT FORM *(continued)*

OTHER

20. Name and address of physician: _____

21. If hospitalized, name and address of hospital: _____

_____

Date of report _____ Prepared by _____

Official position _____

APPENDIX B
FIELD SAMPLING PLAN

APPENDIX B
FIELD SAMPLING PLAN

B.0.a This Field Sampling Plan (FSP) presents the detailed sampling and testing methods for field activities to be conducted during the RI at Unit 2 sites. The FSP will be used as a guide for the collection of precise, accurate, and representative field data.

B.1 INTRODUCTION AND SCOPE

B.1.a Standard operating procedures will be followed to minimize errors which could result in the collection of invalid data or nonrepresentative samples. Non-standard situations encountered in the field will be resolved by the Parsons ES Project Manager in consultation with the CEHNC Project Manager. The Alabama Department of Environmental Management and USEPA will be notified of any changes or situations that may require approvals.

B.1.b The tasks described in this FSP will be conducted while following health and safety procedures defined in the Installation Restoration Program Safety and Health Plan, and the Site Specific Safety Health and Plan (Site Specific RI/FS Scoping Document Appendix A) and the Monitoring Well Installation Plan and Field Investigation Plan which is located as Appendix D in the General RI/FS Work Plan. The following field activities will be conducted during the RI field effort at RSA Unit 2:

- Groundwater level measurements from 69 existing monitoring wells;
- 12 soil borings, collection of two samples per boring for chemical analysis;
- 4 soil borings, collection of one undisturbed sample per boring for geotechnical testing;
- Installation of 2 shallow overburden monitoring wells and 2 upper bedrock monitoring wells;
- Collection of 69 groundwater samples for chemical analysis;
- Collection of 7 surface water samples for chemical analysis;
- Collection of 7 sediment samples for chemical analysis; and
- Survey of horizontal locations and surface elevations of monitoring wells and horizontal locations of all sampling points.

B.2 FIELD EQUIPMENT AND SUPPLIES

B.2.a This section identifies parameters to be measured in the field. Calibration and maintenance of instruments used for field measurements are described below. Decontamination procedures for sampling equipment are summarized in Section B.5.

B.2.1 Field Parameters

B.2.1.a The following parameters may be measured in the field with the specified instruments:

- Temperature: Thermometer or temperature probe
- pH: Portable pH meter
- Conductivity: Portable conductivity meter
- Organic Vapors: Organic vapor analyzer (OVA) or photoionization detector (PID)
- Water Level: Electronic water level indicator
- Distance: Surveyor's tape measure or surveyed location

B.2.2 Field Equipment Calibration

B.2.2.a Each instrument will be calibrated following the manufacturer's recommendations or standard operating procedures presented in this document. The acceptance criteria and corrective actions for each piece of equipment are as specified in the manufacturer's recommendations. An equipment calibration log sheet is provided in Attachment B-1.

B.2.3 Field Equipment Maintenance

B.2.3.a Equipment maintenance and repair will be performed as required for each instrument. Preventive maintenance for all equipment includes inspection before use, cleaning as necessary during use, and thorough cleaning and inspection after use. During the performance of field activities, all downhole augers, rods, and samplers will be visually inspected. Rechargeable batteries will be checked before use and recharged after use. For equipment using disposable batteries, replacement batteries will be stocked. Maintenance and repairs on field equipment will occur when corrective action needs are identified. If the instrument cannot be repaired (or re-calibrated), the instrument will be replaced.

APPENDIX C
CHEMICAL DATA ACQUISITION PLAN

APPENDIX C
CHEMICAL DATA ACQUISITION PLAN FOR UNIT 2 SITES

C.1 CHEMICAL DATA ACQUISITION PLAN

C.1.a This appendix presents the Chemical Data Acquisition Plan (CDAP) for the Unit 2 Sites at the RSA.

C.1.1 Purpose and Scope of the CDAP

C.1.1.a The purpose of the CDAP is to document the quality assurance requirements applicable to the investigations at the Unit 2 Sites at the RSA. The scope of the CDAP includes the quality assurance and quality control criteria associated with the field sampling, field testing and laboratory analytical testing efforts of the investigations at the Unit 2 Sites at the RSA. The CDAP as presented herein applies to work performed at the Unit 2 RSA Sites or in any office or laboratory performing services for the investigations at Unit 2 Sites.

C.1.2 Contents of the CDAP

C.1.2.a The contents of this CDAP is limited to those elements that are not presented in the Unit 2 Sites Field Sampling Plan (FSP) and/or the General Work Plan. The following list the required elements of the CDAP and the document that contains the element.

Element	Location
Project Description	FSP, Section 3
Project Organization and Responsibilities	FSP, Section 6
Data Quality Objectives	FSP, Section 3
Data Quality Objectives for Measurement Data	CDAP, Section C.2
Field Activities	FSP, Section 4
Sample Custody Procedures	General Work Plan QAPP, App. B.3
Calibration Procedures and Frequency	CDAP, Section C.3
Analytical Procedures	CDAP, Section C.4
Data Reduction Validation and Reporting	General Work Plan, Section 4
Internal Quality Control Checks	CDAP, Section C.5

Performance and System Audits	General Work Plan QAPP, App. A.7
Preventative Maintenance	General Work Plan QAPP, App. A.8
Formulas for Calculating Data Quality Indicators	General Work Plan QAPP, App. A.9
Corrective Action	General Work Plan QAPP, App. A.10
Quality Assurance Reports to Management	General Work Plan QAPP, App. A.11

C.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

C.2.a The overall objective of investigations at the RSA is to provide an accurate, precise, and representative summary of data necessary to fill in data gaps. The collected samples and the data generated from these samples and other site-generated data are intended to provide the information necessary to meet the site-specific data needs as defined in the Sections 3.5 and 3.6 of the Unit 2 Site Work Plan. . Definitions and descriptions of these PARCC parameters are contained in the General Plan QAPP. This section describes data quality objectives (DQO) in terms of the precision, accuracy, representativeness, comparability and completeness (PARCC) requirements for the field and laboratory analyses for investigations at Unit 2 Sites at the RSA.

C.2.1 Field DQOs and PARCC Parameters

C.2.1.a All the field analyses are for screening data only. The requirements for the precision and accuracy are field duplicate samples, blanks and calibration of the equipment. Duplicates samples and blanks will be analyzed at a frequency of one for every ten samples or one per day, which ever is the most frequent. The calibration of the field equipment will be as specified by the instrument manufacture. The QC criteria for the field analyses is presented in Table C.1.

C.2.2 Laboratory DQOs and PARCC Parameters

C.2.2.a All the geochemical and chemical laboratory analyses are for definitive data. The geotechnical data will be generating using ASTM methods. The QC requirements are defined in these methods. Targeted acceptable precision and accuracy QC limits are dependent on the sample matrix and are defined in the CLP SOWs, SW846 Methods and summarized in Table 3.5 of the General Work Plan. Table C.2 presents the number and types of definitive investigative and quality control samples to be sampled and analyzed at the Unit 2 Sites.

C.3 CALIBRATION PROCEDURES AND FREQUENCY

C.3.a The calibration procedures and frequencies for field equipment will be as specified by the instrument manufacture. The calibration procedures and frequencies for laboratory instruments shall be specified in CLP SOWs and other standard methodologies.

C.4 ANALYTICAL PROCEDURES

C.4.a The following discusses the field screening and laboratory definitive analysis of samples collected for chemical analysis during field sampling activities at the RSA .

C.4.1 Field Analyses

C.4.1.a Field screening analyses are listed in Section 3.5.

C.4.2 Field Measurement Procedures

C.4.2.a All field screening analyses shall be performed in accordance with written methods that contain clear procedures, appropriate QC, directions for corrective actions and reporting limits based on actual method performance.

C.4.3 Laboratory Analyses

C.4.3.a The laboratory chemical and geochemical analyses are listed in Section 3.5.

C.4.4 Laboratory Analytical Procedures

C.4.4.a Laboratory definitive chemical and geochemical analyses shall be performed according to the procedures contained in the CLP SOWs, SW846 and ASTM Methods.

C.5 INTERNAL QUALITY CONTROL CHECKS

C.5.a Internal QC checks are used to assess the quality of the field and laboratory analytical processes and provide a means to evaluate the need for corrective action. The internal QC checks for field analyses are:

- Field duplicate analyses;
- Field blanks; and
- Equipment calibrations.

C.5.b The USEPA CLP SOWs, SW846, and ASTM methodologies define the QA/QC procedures and analytical procedures to be used in the laboratory. These laboratory internal QC checks are method specific and include but are not limited to, the following:

- Initial and continuing calibration verifications;
- Method blanks;

- Internal standards, surrogates, matrix and blank spikes; and
- Replicate analyses.

TABLE C.1
QC CRITERIA FOR FIELD ANALYSES AT THE UNIT 2 SITES

Matrix	Parameter	Field Duplicates	Field Blanks
Groundwater	pH	± 0.1 s.u.	NR
	conductivity	5% RPD	NR
	temperature	± 1.0 °C	NR
	turbidity	no criteria (record results) - due to natural turbidity fluctuations, measurements may not agree	< Reporting Limit
Surface Water	pH	± 0.1 s.u.	NR
	hardness	5% RPD	< Reporting Limit
Sediment	pH	NA	NR
Soil	pH	NA	NR
	non-selective VOCs	NA	< Reporting Limit

NR = not required

NA = not applicable, measurements are intended for qualitative screening.

TABLE C.2
INVESTIGATIVE AND QC SAMPLES FOR THE UNIT 2 SITES

Matrix	Analysis	Investigative Samples	Trip Blanks[1]	Rinseate Blanks	Field Duplicates	MS/MSD[2]
Groundwater	VOCs	69	25	2	7	4
	Metals	69		2	7	4
Surface Water	VOCs	7	2		1	1
	SVOCs	7			1	1
	Metals	7			1	1
	Pesticides	7			1	1
	Explosives	7			1	1
Sediment	VOCs	7			1	1
	SVOCs	7			1	1
	Metals	7			1	1
	Pesticides	7			1	1
	Explosives	7			1	1
	TOC	7			1	
	Bioassay	7			1	
Soil	VOCs	24			3	1
	SVOCs	24			3	1
	Metals	24			3	1
	Pesticides	24			3	1
	TOC	24			3	

(1) One per cooler containing samples for VOC analyses.

(2) The value given is the number of MS/MSD pairs. The number of samples will be twice the value given.