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AMSMI-EQ

U.S. Army Missile Command
Redstone Arsenal, Alabama 35898-5349

Date: 4/13/94

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Comments: UNIT 2 Revised Final W.P dtd 29 March 94 Comments & Observations from Tim & Me

ENVIRONMENTAL MANAGEMENT OFFICE

AMSMI-EQ
REDSTONE ARSENAL

DOCUMENT REVIEW COMMENTS

1 of 1

DOCUMENT TITLE	FROM	REVIEWER NAME	DATE	PHONE
REVISED FINAL UNIT 2 WORK PLAN.		Tim Brown	4/12/94	842-0314

ITEM NO.	PAGE NO.	PARAGRAPH	COMMENTS
1.	COVER		Take off mention of RSA-12 & 131 as these are not DERA eligable.
2.	1-3	1.1.2	Describe specifically - ① Burn Trenches, ② Pop & Burn, ③ Rocket wash out - unlined as being the sites targeted for clean up. ALSO ④ OPEN Burn PAD's
3.	2-1b	2.1.b	RSA-61 ? Is this correct number? Should be RS-061.?
4.	2-14	2.5a	Must consider protection of pipe (especially flexible pipe) from mowers and other heavy equipment used in area. Also, should we consider blast protection? I do not recommend anything except steel pipe for the final ICM. It should also be painted a noticable color to keep mowers off. A good idea would be to lay the pipe on existing ground and cover with enough dirt that mowers would not have to avoid.

ENVIRONMENTAL MANAGEMENT OFFICE

AMSMI-EQ
REDSTONE ARSENAL

DOCUMENT REVIEW COMMENTS

1 of 1

DOCUMENT TITLE	FROM	REVIEWER NAME	DATE	PHONE
W.P UNIT 2 Revised March 29, 1994	EBASCO	SCHRODER	4/13/94	X 8607

ITEM NO.	PAGE NO.	PARAGRAPH	COMMENTS
1.	Cover	—	Does not meet EPA's Standards: Leave off Contract #, COE Insignia & EBASCO staff
2.	—	—	SEE TIM BROWNS COMMENTS 1 Thru 4
3.	2-6	2.1.2.C	Should be "OPEN Burn PADS", NOT OB/OD Area This is A NO-NO from NOW ON! MAKE Changes Throughout This & Future Literature, please.
4.	2-10	2.2.1.9	Is Savannah District going to consider the 2 Phase Vapor extraction Treatment System in these options? If So we need to Present it here.
5	3-1	3.1.1a	UGH- This is the 3rd or 4th TIME Ive read this Universal Statement. IS IT Necessary?

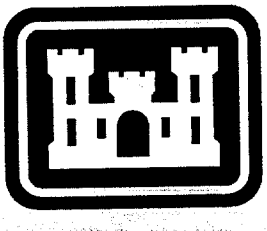
920127-01

FINAL

Work Plan

Interim Corrective Measure Design at Unit 2
Redstone Arsenal, Alabama

Prepared for:



U.S. ARMY CORPS OF ENGINEERS
Savannah District

Contract: DACA 21-91-D-0024

February 26, 1993

EBASCO ENVIRONMENTAL
A Division of Ebasco Services Incorporated

DELIVERY ORDER NO. 0007
UNDER
CONTRACT NO. DACA 21-91-D-0024

EBASCO SERVICES INCORPORATED

WORK PLAN
INTERIM CORRECTIVE MEASURE DESIGN AT UNIT 2
REDSTONE ARSENAL, ALABAMA

FEBRUARY 26, 1993

DELIVERY ORDER NO. 0007
UNDER
CONTRACT NO. DACA 21-91-D-0024

EBASCO SERVICES INCORPORATED

WORKPLAN
INTERIM CORRECTIVE MEASURE DESIGN AT UNIT 2
REDSTONE ARSENAL, ALABAMA

FEBRUARY 26, 1993

Prepared Under the Supervision of

Albert D O'Rear

Albert D. O'Rear, P.E.

Date: 2 / 28 / 1993

Alabama P.E. License No. 16395

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DELIVERY ORDER NO. 0007
UNDER
CONTRACT NO. DACA 21-91-D-0024

EBASCO SERVICES INCORPORATED

WORK PLAN
INTERIM CORRECTIVE MEASURE DESIGN AT UNIT 2
REDSTONE ARSENAL, ALABAMA

FEBRUARY 26, 1993

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EXECUTIVE SUMMARY

This Work Plan describes the services which the Ebasco Team will provide for the design of the Interim Corrective Measure (ICM) at Unit 2, the Open Burning/Open Detonation Area at Redstone Arsenal, Alabama.

The Work Plan describes the preparation of Design Reports for the installation and operation of an on-site groundwater recovery, treatment and disposal system. No field work will be conducted under this project. The Design Reports to be prepared include a Topographic Survey, Drawings, Specifications, System Design Analysis, and Health and Safety Design Analysis.

Ebasco also will prepare Installation and Operation (I&O) Plans which describe how the designed facility will be installed and operated. These will include a Personnel Training Plan, Operations and Maintenance Plan, Installation Quality Control Plan, Field Sampling Plan, and Site-Specific Health and Safety Plan. Ebasco will submit detailed cost estimates for ICM installation and operation. Following a period of one year after system startup, Ebasco will analyze the operating conditions of the ICM and submit three additional reports: a Performance Evaluation Report, an Operations and Maintenance Manual, and a Service Contract Document.

In addition to the Design Reports, I&O Plans, cost estimates, and follow-up reports, Ebasco will provide Community Relations support to the US Army Corps of Engineers and to Redstone Arsenal throughout the duration of design activities.

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SECTION 1.0 INTRODUCTION

1.0.a The Environmental Office of Redstone Arsenal, Alabama, has tasked the U.S. Army Corps of Engineers (USACE), Savannah District (CESAS) to conduct an interim remedial action (IRA) at Unit 2, the Open Burn/Open Detonation Area at Redstone Arsenal. The project involves the design and construction of an Interim Corrective Measure (ICM) to mitigate groundwater contamination.

The CESAS has tasked Ebasco Services Incorporated (Ebasco) under the Indefinite Delivery Order Contract DACA 21-91-D-0024 to prepare interim remedial design documents pertaining to the ICM at Unit 2. The objective of this Corrective Measures Design Work Plan is to describe the tasks which will be conducted during the performance of the project.

1.1 LOCATION

1.1.1 Redstone Arsenal

1.1.1.a Redstone Arsenal (RSA) is located in north central Alabama in the southwestern portion of Madison County as shown in **Figure 1-1: Location of Redstone Arsenal**. RSA is bounded by the City of Huntsville to the north and east, and the Tennessee River to the south. The towns of Madison and Triana are northwest and southwest of the Arsenal, respectively. Principal roadway access to the Huntsville area and RSA is provided by U.S. Highways 72, 231 and 431 and Interstate Highways 65 and 565.

1.1.1.b RSA encompasses approximately 38,300 acres. Of that area, 1,841 acres in the central part of RSA are leased to Marshall Space Flight Center (MSFC) of the National Aeronautics and Space Administration (NASA). The remaining 36,459 acres are controlled by the Department of the Army and support many land use functions. An additional 2,900 acres owned by the Tennessee Valley Authority (TVA) and 4,100 acres of Wheeler National Wildlife Refuge are located within the boundaries of RSA. Approximately 15,500 acres of RSA are woodlands and 9,200 acres are leased for agricultural use. Over 10,200 acres include maintained grassy areas, buildings, roads, and RSA facilities. The area surrounding the Arsenal is mixed containing light industry, residential, commercial and agricultural uses.

1.1.1.c The population of Madison County exceeds 250,000. Huntsville, located to the north of RSA, has a population of approximately 158,000. Approximately 1,000 military families reside in government quarters on RSA and approximately 31,500 government workers and contractors work at the facility.

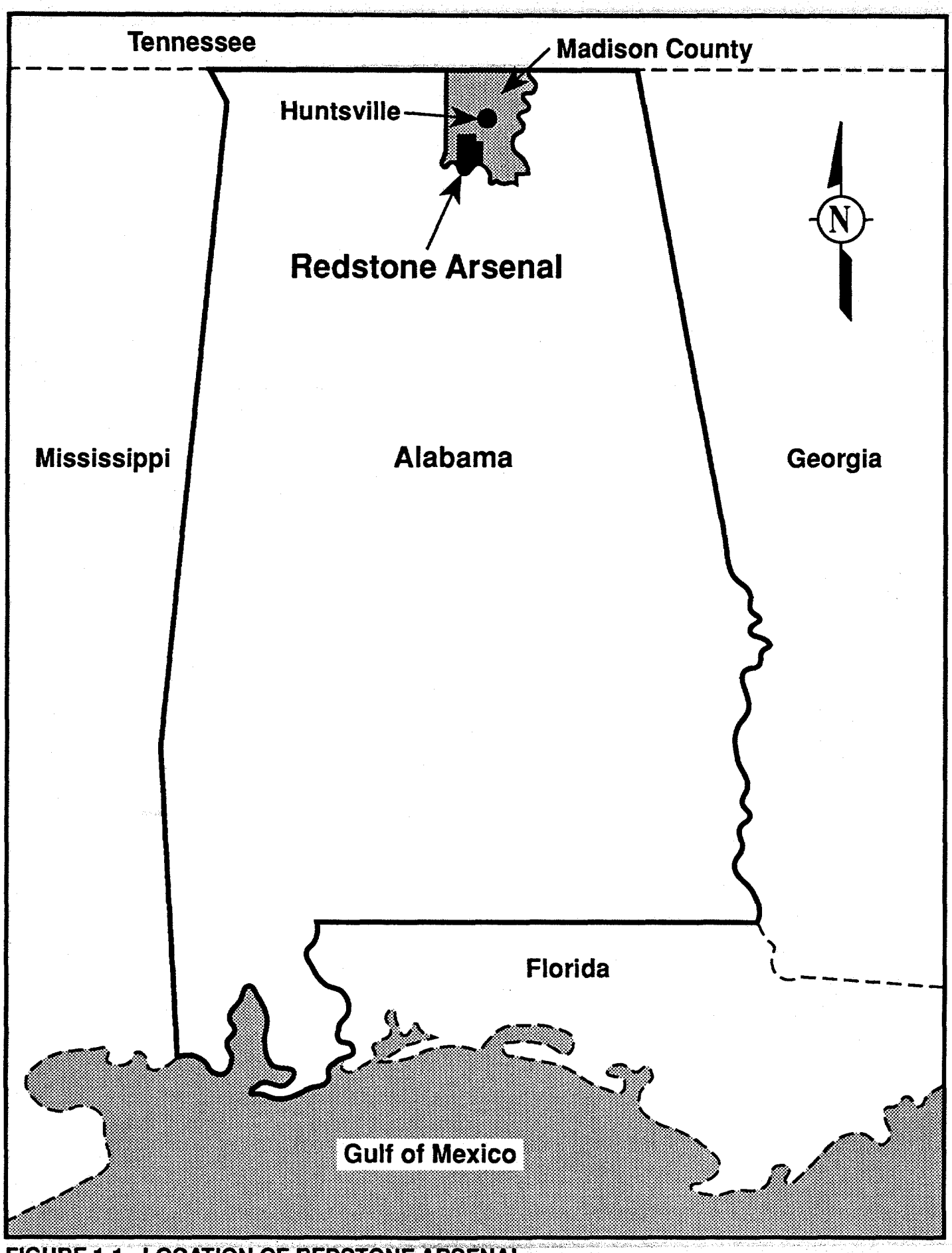


FIGURE 1-1 LOCATION OF REDSTONE ARSENAL

Source: P.E. Lamoreax & Associates, Inc., 1988

1.1.2 Unit 2

1.1.2.a Unit 2, the Open Burn/Open Detonation (OB/OD) Area, is approximately 89 acres in size and is located in the southern part of RSA near the Tennessee River **(Figure 1-2: Location of Unit 2)**. More than half of the OB/OD Area is within Tennessee Valley Authority (TVA) property on RSA. Areas to the west, north, and northeast of Unit 2 also belong to TVA. The southeastern portion of Unit 2 is within Army property bordered by TVA. Unit 2 has been separated into two areas: the "Contaminated Waste Burn Trenches" in the southeast portion of the site and the Open Burn Area and Open Detonation Area in the northwest portion **(Figure 1-3: Unit 2 - Open Burn/Open Detonation Area)**. These areas are used to dispose of reactive wastes by thermal treatment. The reactive wastes include bulk propellants, propellant-contaminated solvents and nonhazardous propellant-contaminated waste such as rags and wood containing 4% or less propellent [Ref. 8.17]. Explosives and explosive-contaminated materials are decontaminated on site by detonation in an area on the northern end of Unit 2.

1.2 PHYSIOGRAPHY

1.2.1 Climate

1.2.1.a The climate at RSA is mild and temperate with an average annual temperature of 62°F. The average summer temperature is 77°F and the average winter temperature is 47°F. The average annual snowfall is 3 inches and the average annual rainfall is 48 inches. Total monthly precipitation is usually highest in March (5.6 inches) and lowest in October (2.7 inches). The last frost in the spring is typically no later than April 5, and the first frost in the fall occurs around October 31. Floods are common from mid-December to mid-April, although extensive flooding is infrequent. The 100-year flood level of the Tennessee River is at an elevation of 572.5 feet above mean sea level (msl). Moderately dry conditions generally prevail throughout autumn.

1.2.1.b Madison County experiences a prevailing southeast wind, but winds from the north and south also are common. The strongest winds are recorded in the winter, while mild winds persist throughout the summer.

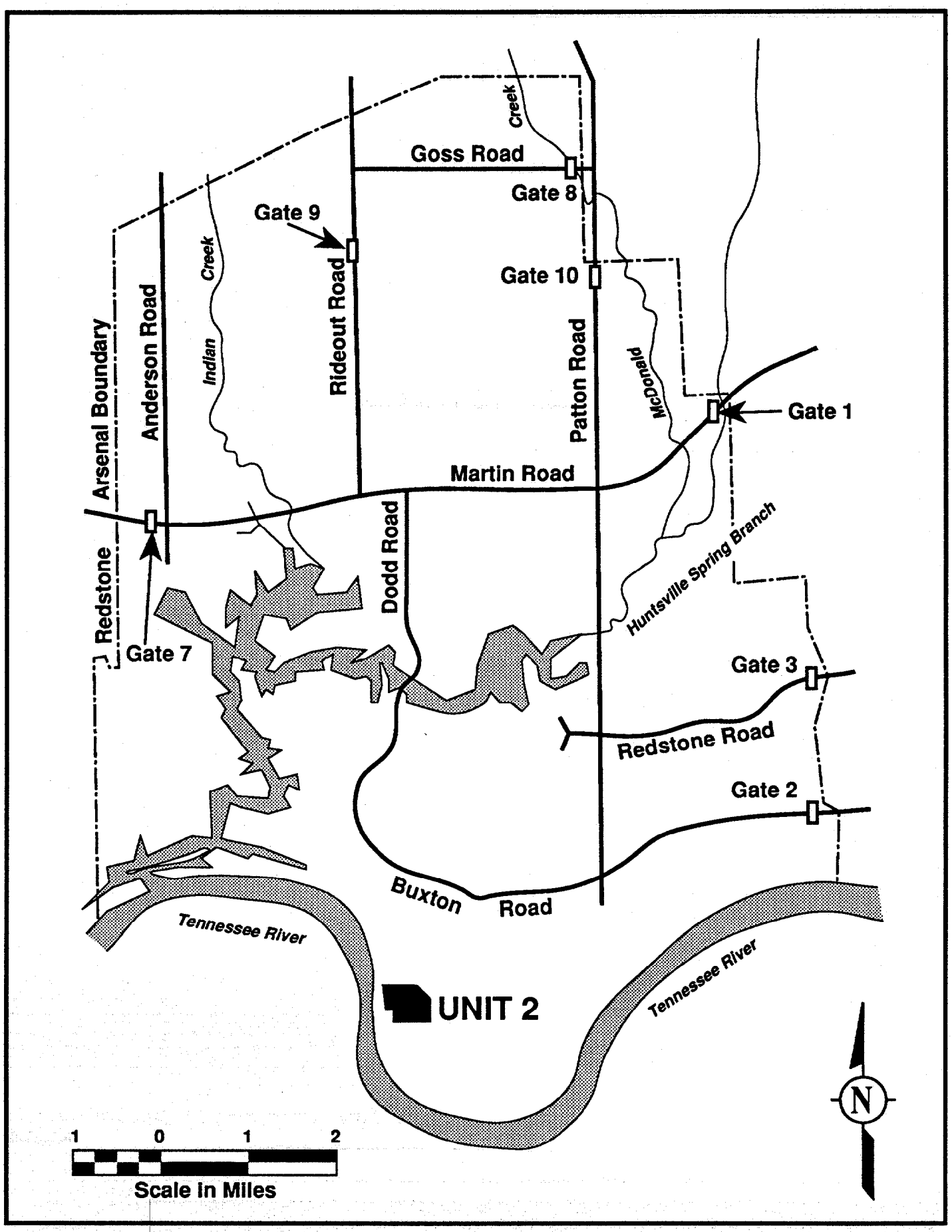


FIGURE 1-2 LOCATION OF UNIT 2

Source: P.E. Lamoreax & Associates, Inc., 1988

SECTION 2.0 INTERIM CORRECTIVE MEASURE

2.0.a The Interim Corrective Measure (ICM) for Unit 2 is focused on accomplishing both short-term and long-term goals as discussed in the ICM Design kickoff meeting held at RSA on November 16 and 17, 1992. In the short-term, aggressive interim groundwater remediation efforts are anticipated to start within a few months of ICM design completion and construction contractor procurement. On a longer-term basis, the ICM will provide important design input data to be used in the final corrective measure design.

2.0.b The ICM for Unit 2 will consist of groundwater extraction using extraction wells and pumps, treatment of extracted groundwater to remove or destroy organic contaminants, and on-site discharge of treated groundwater. ICM operation and maintenance will be provided by the construction contractor (or subcontractor) with minimal oversight requirements from RSA staff resources, and is expected to continue at least through procurement for final corrective measures. The final corrective measure may or may not utilize the ICM installation, depending upon the most cost effective approach to the final cleanup remedy.

2.1 GROUNDWATER COLLECTION SYSTEM

2.1.a The design kickoff meeting held November 16 and 17 at RSA focused on setting the overall goals of the ICM. Based on that meeting and subsequent telephone conversations between Mr. Fred Moser (CESAS) and the Ebasco project engineer (Victor Owens), Ebasco recommends an approximate extraction well layout as shown in **Figure 2-1: Conceptual Extraction Well Configuration**. This layout addresses the design criteria described in the following Sections. Although it was first proposed to install an extraction well northeast of the Unit 2 site (near well RSA 61), further evaluation based upon a site visit and examination of topographic maps has led to the determination that placing a well in that location would prove costly for an interim corrective measure. Extensive piping would be required to include this well in the network. An alternative location, midway between the two well fields and southeast of the Rocket Washout Pad, has been selected (Figure 2-1). It is expected that this well will produce equally meaningful results.

2.1.1 Design Flow Rate

2.1.1.a The aquifer reasonably should be expected to yield the design flow of 25 gpm per well or 250 gpm total without excessive stress on the extraction wells or the aquifer. Excessive well stress is assumed to be approximately 25% drawdown of the static water column measured from bottom of well to top of groundwater, assuming a 100% efficient well. This criteria is intended to avoid excessive entrance velocity requirements at the well screen, allows for well inefficiencies of up to 50%, tends to avoid bio-fouling of the well and should allow for some "fine tuning" of the overall capture zone. Excessive aquifer dewatering could occur if recharge to the aquifer cannot keep pace with extraction rates. Proximity to the Tennessee River and surrounding wetlands suggests that dramatic dewatering will not occur. However, it is desirable to avoid impacts to nearby wetlands and to maintain as much contaminated aquifer material in contact with groundwater as possible.

2.1.2 Extraction Well Locations

2.1.2.a Well placement should emphasize the most highly contaminated areas of the overburden and upper bedrock (Tuscumbia Limestone) aquifers without attempting 100% plume capture (unrealistic and costly objective). The areal extent of the contamination plume is based on Geraghty & Miller, 1992 [Ref. 8.25] total chlorinated hydrocarbon concentrations in the overburden (contours on Figure 2-1), the TCE concentrations in the bedrock aquifer that includes eleven upper bedrock and eleven deep bedrock wells (**Figure 2-2: TCE Contamination - Upper Bedrock**), and the top of bedrock structure map (**Figure 2-3: Structure Map - Top of Tuscumbia Limestone**).

2.1.2.b With data being sparse in the upper bedrock aquifer, Figure 2-2 was constructed with the assumption that the contamination in the upper bedrock would be at least as high as that in the lower bedrock aquifer. This assumption allowed using analyses from the eleven deeper wells, and resulted in a contamination plume outline consistent with the overburden plume. The deep aquifer contamination seems to be elongated along the northwest-southeast structure, and probably reflects a karst or fracture zone associated with this structure.

2.1.2.c The top of Tuscumbia Limestone structure map shows a northwest to southeast anticlinal ridge crossing Unit 2 (Figure 2-3). The Open Burn and Detonation Areas in the northwest section of Unit 2 are located on or near the crest of this high. This structural high will influence groundwater flow and contaminants to assume a radial pattern in the overburden and upper bedrock aquifers. This radial flow pattern was confirmed by Geraghty & Miller, 1992 deep overburden and upper bedrock hydraulic head elevation maps showing direction of horizontal hydraulic gradient (Figures III-5 and III-6, Appendix C). The circular nature of the contaminant plume in this area also confirms this hypothesis.

2.1.2.d The Contaminated Waste Burn Trenches area in the southeast section of Unit 2 is located off the end of this structural high and to the north of an associated high. These bounding structures to the west and south coupled with a structural low to the northeast probably is the controlling factor in the northeast elongated contaminant plume.

2.1.2.e The goal of the extraction system is to maximize dissolved contaminant removal, and possibly to remove nearby free-phase contaminants. One extraction well in each of the two separate plume areas will be placed directly into or adjacent to the targeted OB/OD Area and an additional well will be located in the structural low to the northeast of the Contaminated Waste Burn Trenches. It is desirable to place one or more backup extraction wells in these areas. These backup wells are theoretically redundant, but the current lack of pump data, known aquifer variability, and uncertain contaminant extraction characteristics increase the chances that one or two extraction wells in the source area will be marginally effective. Dense free-phase liquids are prone to "nugget effects" where pockets or pools of contaminant are formed beneath the source area by coalescence. Essentially, these extra extraction wells greatly increase the likelihood of aggressive source removal and control, and add flexibility in the final system operation.

2.1.3 Extraction Zones

2.1.3.a Well screens will be placed to maximize the groundwater extraction in the Upper Bedrock/Deep Overburden zone. Due to the hydraulic connection between the shallow groundwater (Shallow Overburden in the Draft RFI [Ref. 8.17]), and deeper groundwater (both Upper Bedrock and Shallow Overburden based on groundwater elevations), aggressive pumping of the deeper groundwater should also control and ultimately collect shallower contaminants. Furthermore, it is difficult to predict the net water-table drawdown that may result from Upper Bedrock/Shallow Overburden groundwater extraction. This is due largely to highly uncertain hydraulic boundary conditions. Due to this uncertainty and relatively unpredictable performance, Ebasco does not recommend that well screens be placed in the Upper Overburden.

2.1.4 Extraction System Operation

2.1.4.a The criteria for operation will be 24 hour, automatic continuous operation with controls for site-specific variations and performance optimization. The extraction system will incorporate control logic that functions with treatment system operations and controls.

2.2 GROUNDWATER TREATMENT SYSTEM

2.2.a The primary constituents of concern which require treatment include trichloroethylene (TCE) and 1,2 - Dichloroethylene (DCE). However, treatment system sizing will be based on total chlorinated hydrocarbons (TCH). The influent concentration of 30,000 ppb TCH is based on the approximate average of the extracted groundwater concentrations from the shallow bedrock/deep overburden. Data from Figure III-9 (Appendix C) of the Geraghty and Miller RFI [Ref. 8.25] shows that well Number 106, located adjacent to a proposed extraction well, has a TCH concentration over 150,000 ppb. Assuming that the other extraction wells produce some concentration above zero, the average will be above 30,000 ppb for the proposed eastern field of five wells. However, there also is expected to be some slow reduction in influent concentration over time; therefore, the value of 30,000 ppb TCH was selected.

2.2.b The groundwater treatment system consists of equipment to remove organic contaminants to a level that can be discharged in the manner recommended, controls for maintaining continuous unattended operation, and all associated equipment and appurtenances. A pretreatment system also will be designed and included as an optional item for the government to exercise based on actual field conditions after system start-up. It is anticipated that the treatment equipment and supplies will be housed in a prefabricated shelter with considerations for site flood conditions and current RSA activities within Unit 2. **Figure 2-4: Tentative Treatment System and Discharge Point Locations** shows the optimum location of the system based on the currently available site data. This location is at an elevation above the 100 year flood plain (572.5 ft msl) and also minimizes the piping and power distribution requirements by being at a point between the two extraction systems.

2.2.1.f Ebasco believes that the biological treatment process is not feasible for the Unit 2 site for the following reasons: (1) contaminant concentrations are too low to sustain biological growth, (2) a carbon source and other nutrients are needed to properly maintain the process, (3) groundwater flows are not steady and (4) other technologies appear less sensitive and more appropriate to be used at the site. Other technologies considered applicable for this application are: the liquid phase carbon adsorption process, the advanced oxidation process, air stripping, the air stripping process with off-gas treatment by GAC and polishing treatment by GAC, and the air stripping process with off-gas treatment by Catalytic Oxidation.

Economic Evaluation

2.2.1.g The economic evaluation is provided to establish the most cost effective treatment system based on a full service contract provided by the contractor over the anticipated life of the treatment program. Under the full service contract, the contractor will provide the treatment systems which include equipment, maintenance, replacement parts, emergency service and regular service. The contractor will guarantee that the performance of the system will meet the discharge effluent limitations. All of these services are included in the monthly service fee. The treatment options under evaluation are:

Option 1 - Advanced Oxidation Process
Option 2 - Liquid Phase Carbon Adsorption Process
Option 3 - Air Stripping with Vapor-Phase and Liquid-Phase Carbon Adsorption
Option 4 - Air Stripping
Option 5 - Air Stripping with Catalytic Oxidation of TCE in the Vapor Phase

The design criteria for the five (5) treatment options are:

1. Maximum flow rate is 250 gpm.
2. Treatment criteria are drinking water standards, Maximum Contaminant Levels (MCLs) or Maximum Contaminant Level Goals (MCLGs)
3. Influent contaminant concentration is 30,000 ppb Total Chlorinated Hydrocarbons.

A Relative Cost Analysis for the five (5) options is shown as follows:

TREATMENT OPTIONS					
	1	2	3	4	5
1. Initial Setup Fee	5,500	75,000	105,000	30,000	105,000
2. Monthly Service Fee	7,800	5,500	9,000	3,500	10,000
3. Monthly Power Costs	3,582	150	600	400	1,100
4. Additional Carbon Cost Per Year	0	348,000	88,000	0	0
5. One Air Stripper	0	0	55,000	55,000	55,000
6. One Catalytic Incinerator	0	0	0	0	150,000
TOTAL ESTIMATED COST FOR TWO-YEAR TREATMENT	278,700	906,600	566,400	178,600	576,400

2.2.2 Selection of Treatment Technology

2.2.2.a All treatment options evaluated for the ICM are technically feasible in terms of meeting surface water discharge requirements. However, Option 4, Air Stripping without off-gas treatment is not feasible because without extensive studies, the State limits TCE discharge to air to 0.1 lbs/hr. Based on the design criteria listed in paragraph 2.2.1.g, it is anticipated that between 3 and 4 lbs/hr total chlorinated hydrocarbons would be emitted using air stripping, which is 30 to 40 times too high. The remaining options (1,2,3 and 5) are all technically feasible based on both regulatory requirements and discharge requirements.

2.2.2.b Ebasco recommends that UV Oxidation be required for the treatment technology, both for its lower cost and several added benefits including:

- UV Oxidation destroys all the organic contaminants to very low levels making permitting the discharge simpler.
- UV Oxidation will not require extensive treatability testing because the technology is not extremely sensitive to contaminant loading.
- UV Oxidation will not result in spent carbon disposal requirements or periodic cleaning of stripping tower packing.

- UV Oxidation does not transfer the contaminant from water to air, an action which would trigger air dispersion modeling requirements and increased monitoring expenses.

2.2.2.c In the presence of UV radiation, the rate of oxidant decomposition is accelerated, with a corresponding increase in the rate of hydroxyl radical formation. Organic molecules that have adsorbed UV energy are in an excited state and are more susceptible to attack. Therefore, the rate at which organic compounds are oxidized is significantly higher than that attained by using UV radiation or chemical oxidants alone. Previous studies of the UV/chemical oxidation process indicate that the overall reaction mechanism displays first-order rate kinetics with respect to the contaminant concentration oxidant dosage, and UV intensity.

2.2.2.d Organic carbon, soluble iron and manganese, and other constituents which produce general turbidity can reduce the efficiency of the UV/chemical oxidation process by reducing the amount of UV energy available for adsorption by the organic contaminants and the chemical oxidant. Organic carbon will compete with the constituent of concern by adsorbing UV energy and consuming oxidant. Soluble iron and manganese will oxidize to their insoluble form, thereby directly competing with the contaminant for UV energy and oxidant. Highly turbid water will reduce UV intensity in a similar manner. The effect of these factors generally can be dealt with either through pretreatment or by considering their effects during the design process.

2.3 TREATED WATER DISPOSAL

2.3.a Options for treated water disposal include reinjection via wells back into the aquifer, spray field application, recharge gallery, and point discharge to a surface water body. Discussions with the Alabama Department of Environmental Management (ADEM) regarding each option indicate that each is feasible in terms of permitting, but spray field (or land application) and reinjection may involve the most difficulties, primarily resulting in the need for additional site specific data and impact studies. For purposes of this ICM, point discharge appears to be the best option based on the following reasons:

- Aquifer Reinjection: Reinjection is not recommended because at this stage of site characterization there is the risk that an improperly placed injection well(s) could spread contamination rather than push it toward a recovery well. Furthermore, proper design of an injection system is dependent upon a thorough site characterization, including injection testing, and should be carefully modeled with a properly documented and supportable digital flow model. Finally, reinjection is often used where recharge boundaries are poorly defined or difficult to predict. At Unit 2, proximity to the river and other considerations suggest that there will be sufficient natural recharge to the extraction areas.

- Spray Field/Land Application: This option typically will require from 100 to 500 acres for a flow of 250 gpm. Land area requirements of potentially a square mile are probably not realistic under the constraints of the Unit 2 area. Furthermore, discussions with ADEM suggest that this option may be the most difficult to permit in terms of time and ADEM requirements. Therefore, this option is not recommended.

- Recharge Gallery: A recharge gallery is not recommended for the same reasons aquifer reinjection is not recommended. Proper recharge gallery design would require additional site data and could risk adverse impact on plume containment.

- Point Discharge: Point discharge will require National Pollutant Discharge Elimination System (NPDES) permitting and appears to be the most technically feasible disposal option. Based on communications with ADEM, permitting an outfall of the type expected from the ICM treatment system should be relatively straight forward.

2.3.b **Figure 2-4: Tentative Treatment System and Discharge Point Locations,** indicates the most desirable location for the outfall from the treatment system. This location was chosen as a result of a site visit conducted on February 1, 1993 by an Ebasco design engineer and hydrologist. The proposed discharge area currently receives drainage from ditches in the vicinity, and in turn discharges to the Tennessee River. It is anticipated that treated water from the ICM system will be discharged via a pipeline that follows the existing north-south fenceline traversing Unit 2. The selected discharge point is strategically located near the fence.

2.4 ELECTRICAL DESIGN

2.4.a The following general items will be considered in the electrical design:

- The site is above the 100 year flood plain of the Tennessee River; therefore, power drops, panels, and other equipment not otherwise protected by the design of the treatment building will not be endangered by potential floods. It is expected that in most cases, water-proof components will be specified.

- Power requirements are anticipated to be on the order of 170 KW, or approximately 230 horse power. These power requirements will entail special consideration of current site use and selection of the location for power takeoff.

- Operational control/kill switches will be included to protect against power losses or system malfunctions.

2.5 MECHANICAL DESIGN

2.5.a The mechanical design will include all piping, pumps, valves, metering and well head appurtenances not otherwise provided in the electrical design. The following criteria and design options will be considered in the design of the mechanical system:

- Except for road crossings, piping will be above grade with heat-tracing to facilitate freeze protection. The use of above grade piping is preferred to avoid the requirement for clearing the site of potential unexploded ordnance prior to trenching. Above grade piping also will facilitate pipe inspection and maintenance.

- The long distances (potentially up to 2000 feet) from extraction wells to treatment system may result in the need for a transfer or lift station centrally located in each of the extraction well fields. If technically and economically feasible, only submersible pumps with sufficient head for both lift and flow head loss will be used to extract and convey water to the treatment system.

- Piping material will be selected based on material compatibility and expected operation characteristics. If possible, non-rigid piping will be used to minimize construction cost and minimize joints where leakage is likely to occur.

2.6 CIVIL DESIGN

2.6.a Civil design will include the drawings and specifications for temporary roads, drainage, pre-engineered building foundation, pipe and cable installation below road crossings, and channel improvements at the treated water discharge point. Criteria for design of these ICM components will include the following:

- Roads will be temporary and are intended to facilitate routine maintenance of ICM components and systems.

SECTION 3.0 TECHNICAL APPROACH TO ICM DESIGN

3.0.a Ebasco's technical approach to the ICM Design is based upon the design criteria and assumptions presented throughout this section. A summary of these design criteria is presented in **Appendix B.**

3.1 ADDITIONAL DATA REQUIREMENTS

3.1.1 Treatability Studies

3.1.1.a No treatability testing will be required in order to complete the ICM design. At the request of CESAS, Ebasco will include treatability testing as a requirement for accepting proposals to construct the ICM. Ebasco does not, however, recommend that the treatability costs be expressly reimbursable.

3.1.2 Discharge Stream Survey

3.1.2.a Potential impacts to the stream and wetlands due to continuous discharge from the treatment system should be evaluated early in the design process and prior to Draft Design submittal. On February 1, 1993, an Ebasco design engineer and Ebasco hydrologist conducted a field investigation at the Unit 2 site. Based on the results of this investigation, Ebasco will prepare a report for inclusion in the design. This information is expected to be necessary to evaluate NPDES permitting of the discharge.

3.1.2.b The stream survey consisted of measurements of channel depth and width from the treatment discharge point to the point the stream discharges to the river. Analysis of the data will include simple hydraulic computer modeling to obtain flow velocities and maximum flow conditions. The stream survey will be included as a calculation in the Design Analysis. No additional stream data is required for this design.

3.2 DESIGN OF GROUNDWATER COLLECTION SYSTEM

3.2.1 Well Field Layout

3.2.1.a **Figure 2-1: Conceptual Extraction Well Configuration** (see Section 2.0, page 2-3), shows a preliminary layout of extraction wells. The purpose of Figure 2-1 is to present tentative extraction rates, number of wells and the extent of plume capture. These tentative recovery well locations as well as the final well layout will be based on permeability data and groundwater contamination contours from the Draft Final RCRA Facility Investigation by Geraghty and Miller, 1991, and the Draft Phase II Addendum, also by Geraghty and Miller, October 1992. These reports by Geraghty and Miller are fully referenced in Section 8.0, and were furnished to Ebasco by CESAS for the purpose of supporting the ICM design effort. Key figures and tables to be used in determining the well layout are excerpted from these reports and are included in **Appendix C** to this Work Plan. Using these data, the final well layout will be determined using the following approach:

- Slug test permeability data for the deep overburden and upper bedrock will be used to obtain a representative areal average permeability. Data extremes, such as permeabilities several orders of magnitude above the average will be deemphasized or not used in the calculation.

- The Theis Equation will be used to obtain drawdown versus distance assuming: 1) storage coefficient of 0.15; 2) equilibrium conditions will be achieved within 20 days of initial pumping, and; 3) an saturated thickness of 40 feet.

- Approximately 10 feet of theoretical drawdown in the pumped well will be used as the design criteria, assuming an saturated zone of 40 feet. Based on Ebasco's experience, it is desirable to allow for up to 50% well inefficiency which will double well drawdown at a given pump rate.

- Approximately one foot of drawdown at the edge of the capture zone will be necessary to overcome natural gradients.

- Contamination contour maps from the Geraghty & Miller reports, derived from existing contaminant data; the top of bedrock structure map; and horizontal hydraulic gradient maps (See Figures 2-1 to 2-3; Figures III-5 and III-6, Appendix C) will be the basis for laying out approximately five wells in each of the separate plume areas for a total of ten extraction wells.

3.2.1.b The simplified technical approach to designing an extraction well field such as described above will be used for design of the ICM and is justified when there is a significant lack of aquifer data, particularly pump test data. For this site, pump testing would be particularly useful to obtain measurements of the boundary recharge conditions. These data are model input parameters essential in order to realistically simulate aquifer responses to stresses. It is reasonable to expect this type of modelling in the final remedial design, when the hydrogeologic data obtained as a result of implementing the ICM is available.

3.2.2 Extraction Well Design Criteria

3.2.2.a Basic extraction well design criteria are the following:

- Wells will be six (6) inch diameter stainless steel casing and continuous slot screen. Schedule 80 PVC could be substituted for stainless steel, but the presence of chlorinated solvents can damage PVC under some circumstances.

- Well bores will be approximately twelve (12) inch diameter to allow a minimum of three inches of gravel pack.

- Well design will include careful specification of gravel pack and screen slot size to ensure maximum well efficiency. Slot size selection will be based on 90% retention of the filter pack, and the filter pack will be based on grain-size distribution of the aquifer. Since no field data will be collected during design, it will be made part of the bid package that the constructor will perform pilot hole borings and measure grain-size distribution prior to selecting screens and filter packs.

- Wells will be drilled at least ten (10) feet into the Tuscumbia Limestone and screened over at least a twenty foot interval that extends from the aquifer in the upper bedrock upwards into the basal overburden aquifer. The depth to the top of bedrock will be approximately calculated using the top of Tuscumbia Limestone structure map (Figure 2-2). Data from driller logs included in the Geraghty & Miller reports [Ref. 8.17 and 8.25] shows that the upper bedrock aquifer in the Contaminated Waste Burn Trenches area will be encountered six to eight feet into the formation and can vary from two to twenty feet in thickness. Data to determine depth to this aquifer does not exist in the Open Burn Area and Open Detonation Area, but will be assumed to be ten feet into the formation. Every well will be logged to determine the depth and extent of this aquifer zone, and this data will be used to determine screen length and interval. Waste material (drill cutting, water, and disposal equipment) generated from these well installations will be contained in 55-gallon drums and properly disposed of off-site.

3.3 DESIGN OF GROUNDWATER TREATMENT SYSTEM

3.3.1 Process Design Consideration

3.3.1.a The design of the UV/oxidation process shall consider several important parameters including flow rate, nature and concentrations of contaminants and other oxidizable constituents, UV dosage, H_2O_2 dosage and reaction time requirements. The maximum design flow rate is projected to be 250 gpm. The primary contaminant of concern is Total Chlorinated Hydrocarbons, primarily TCE, at an average influent concentration of 30,000 ppb (see Section 2.2.a). The UV dosage and H_2O_2 dosage can be determined based on the following equations.

$$K_{TCE} = -1/It \ln (C_e/C_i)$$

$$D = It = -1/k \ln (C_e/C_i)$$

where

K_{TCE}	=	TCE oxidation rate constant,gal/KW-min
I	=	total UV intensity in the reactor,KW/gal
t	=	oxidation time, min
C_e	=	effluent TCE concentration,ug/l
C_i	=	influent TCE concentration,ug/l
D	=	UV dosage, KW-min/gal

3.3.2 Process Costing Basis

3.3.2.a Pretreatment is often required if: (1) iron is greater than 2 mg/l, (2) alkalinity is greater than 200 mg/l, (3) total suspended solids is greater than 5 mg/l, or (4) turbidity is greater than 10 NTU. General groundwater quality information as provided by the U.S. Army Corps of Engineers indicated the following: (1) iron was 3.1 mg/L, (2) TSS was 210 mg/L, (3) chemical oxygen demand was 20 mg/L and (4) chloride was 11 mg/L. Ebasco recommends including an option for pretreatment, to be exercised based on actual field performance. Pretreatment would remove iron and TSS to enhance the advanced oxidation process performance and would consist of coagulation, flocculation, precipitation and filtration.

SECTION 4.0 HEALTH AND SAFETY PROGRAM

4.0.a The Health and Safety Program for this project is based on activity occurring at the Unit 2 site during design tasks. Project requirements during design will include several site visits by various members of the Ebasco Design Team. The purpose of the site visits is to obtain site specific information for the design and will not include intrusive activities. A limited Health and Safety Plan developed for this project will be implemented during these visits. The limited Health and Safety Plan is included as **Appendix A** of this Work Plan.

4.0.b Design activities will include the development of a Design Analysis Report. The design analysis will include evaluation of the Health and Safety provisions to be required at the Unit 2 site during implementation of the project. Information from the Design Analysis Report will be used to prepare a Site Specific Health and Safety Plan (Task 9) and the Safety, Health and Emergency Response section of the Specifications (Task 3) to be included in the Contract Bid Package. A detailed list of the elements to be addressed in the Site Specific Health and Safety Plan is included in Section 5.9 of this Work Plan.

SECTION 6.0 PROJECT MANAGEMENT AND QUALITY CONTROL

6.1 PROJECT ORGANIZATION

6.1.a The organizational structure of the project identifies the interrelationships of the Ebasco Design Team and is shown in **Figure 6-1: Project Organization.** The following paragraphs describe the responsibilities of each leadership position in the project organization. Resumes of all Team members are included in **Appendix E.**

6.1.b The Ebasco *Project Manager (PM)*, Mr. David W. Schaer, is responsible for Ebasco's overall performance of the ICM project. He is in charge of meeting the requirements of the contract and establishing an effective organization to complete all activities identified in the scope of work.

6.1.c The Ebasco *Task Manager (TM)*, Ms. Kimberly R. Soovajian, is responsible for day-to-day oversite of all activities under the project. She is in charge of assuring that project tasks are completed on schedule and within budgeted costs. She is responsible for reviewing all project submittals for conformance with the approved Statement of Work. The TM maintains close communication with the Client, with supervisors of the various disciplines with the Ebasco Design Team, as well as with all individual team members. The TM directs and supervises Ebasco subcontractors working on the project.

6.1.d The Ebasco *Community Relations Lead*, Ms. Loretta A. Garcia, is responsible for coordinating with the USACE and Redstone Arsenal Public Affairs Offices to develop a Community Relations Plan for their implementation during ICM activities. She is responsible for recognizing community needs and identifying media resources which will provide the client guidance in addressing community concerns and providing opportunities for public participation.

6.1.e The Ebasco *Cost/Schedule Controller*, Mr. Steven E. Werner, is responsible for identifying and maintaining cost control for all activities under the project; for monitoring the project performance schedule, and for reporting any irregularities to the Project and Task Managers.

6.1.f The Ebasco *Engineering Manager*, Mr. Albert D. O'Rear, P.E., is responsible for ensuring the overall quality and accuracy of all engineering documents produced by the Design Team. Mr. O'Rear will schedule internal reviews and perform quality reviews, and is responsible for maintaining adherence to established Ebasco and USACE design procedures. He will be the Registered Professional Engineer of record who will seal the plans and specifications.

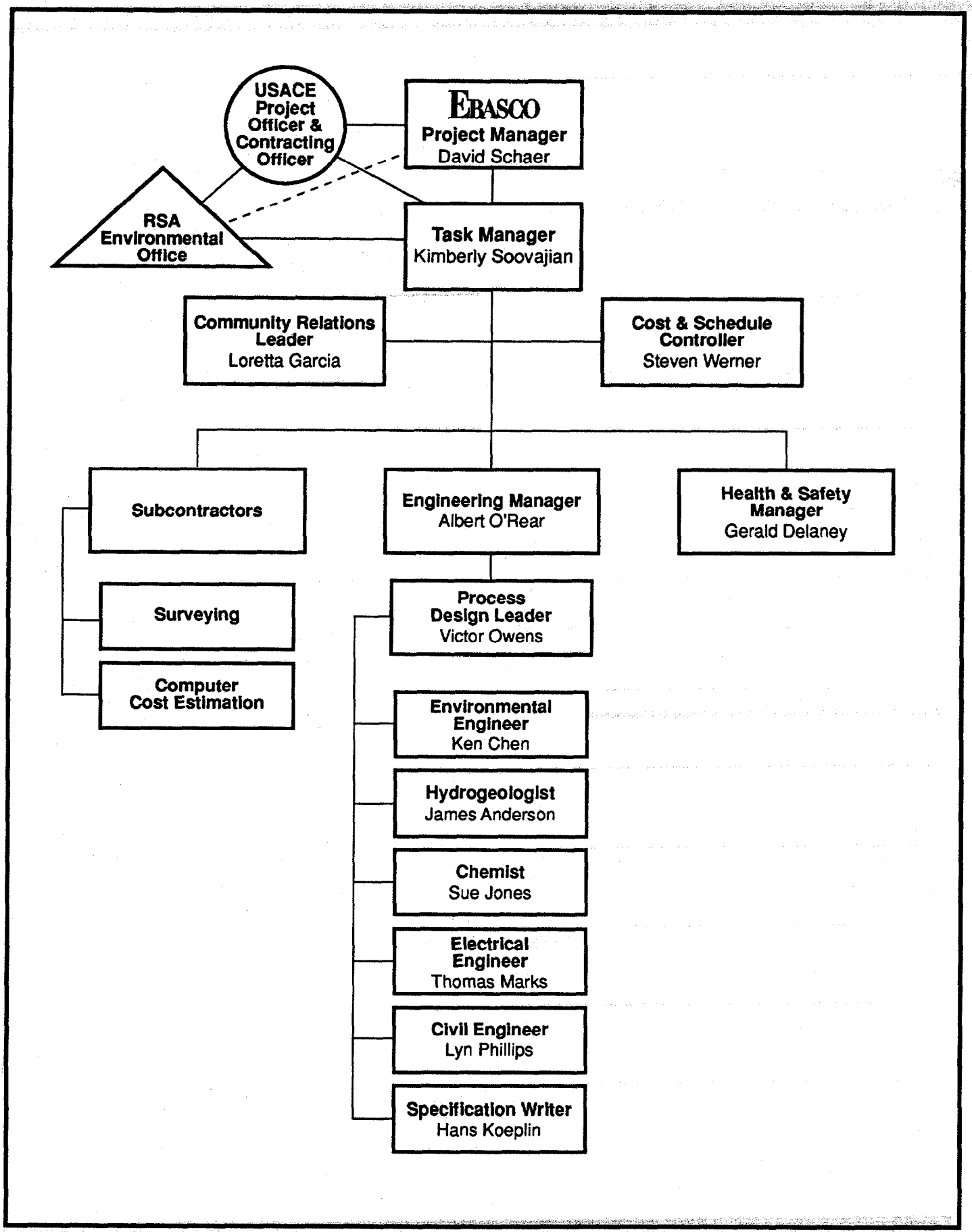


FIGURE 6-1 PROJECT ORGANIZATION

6.1.g The Ebasco *Project Engineer*, Mr. Victor Owens, is responsible for coordinating the Design Team disciplines, assembling specifications, plans and other contact documents, and ensuring that the design meets design criteria and goals.

6.2 TECHNICAL QUALITY ASSURANCE

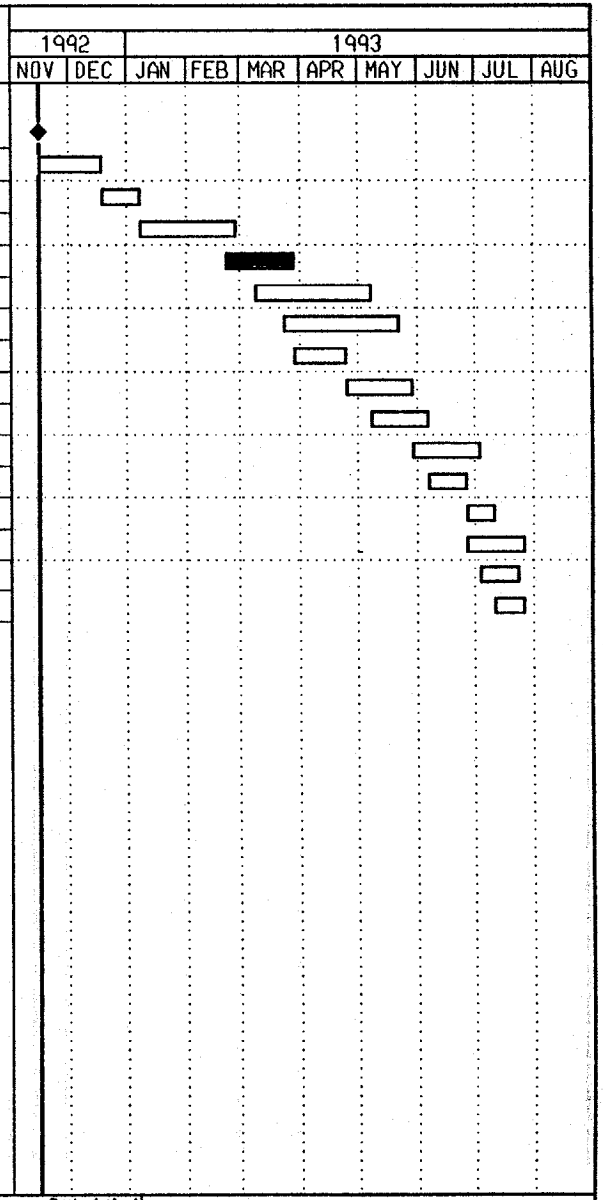
6.2.a The Ebasco design team will incorporate various levels of technical quality assurance and control throughout the design process. All calculations that will be incorporated into the Task 4 Design Analysis will be checked by a third-party engineer who is trained and experienced in the subject matter. All design drawings undergo several levels of peer review and require signoff by all staff with input into the drawing. Ultimately, the engineer in responsible charge will ensure review by all engineering disciplines involved in the design. It is Ebasco policy that internal value engineering procedures are followed as part of the quality assurance and control process.

6.3 SCHEDULE FOR DESIGN

6.3.a The project schedule is identified in **Table 6-1: Project Schedule**. The submittal dates, indicated in the column "Early Finish," follow an aggressive schedule to achieve timely project completion. Prompt review by and receipt of comments from all designated reviewers, including state and federal regulators, is critical to maintain this schedule.

TABLE 6-1 PROJECT SCHEDULE AS OF 2/26/93

ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	ORIG DUR
Start Work (Unit 2)	16NOV92		0
Draft WP (Unit 2)	16NOV92	18DEC92	33
COE Review of Draft WP (Unit 2)	19DEC92	7JAN93	20
Final WP (Unit 2)	8JAN93	26FEB93	50
Draft Survey (Unit 2)	22FEB93	28MAR93	35
DFT Design Docs (Unit 2)	9MAR93	7MAY93	60
Draft I&O Plans (Unit 2)	24MAR93	22MAY93	60
COE Review DFT Survey (Unit 2)	29MAR93	24APR93	27
DFT-Final Survey (Unit 2)	25APR93	29MAY93	35
COE Review of DFT Design Docs/I&O (Unit 2)	8MAY93	6JUN93	30
COE Review of DFT-Final Survey (Unit 2)	30MAY93	3JUL93	35
DFT-Final Design Docs/I&O (Unit 2)	7JUN93	26JUN93	20
COE Review of DFT-FNL Design Docs/I&O (Unit 2)	27JUN93	11JUL93	15
Cost Estimate (Unit 2)	27JUN93	26JUL93	30
Final Survey (Unit 2)	4JUL93	23JUL93	20
Final Design Docs/I&O (Unit 2)	12JUL93	26JUL93	15
Draft Service Contract Document	***SS+180**	**SS+210**	**30**
Draft Performance Eval Rep./O&M Manual	**SS+180**	**SS+260**	**80**
COE Review of Dft Service Document	**SS+210**	**SS+235**	**25**
Final Service Contract Document	**SS+235**	**SS+260**	**25**
COE Review of P.E.R./O&M Manual	**SS+260**	**SS+295**	**35**
Final P.E.R./O&M Manual	**SS+295**	**SS+330**	**35**



***SS = System Startup Date**

Plot Date 24FEB93
Data Date 16NOV92
Project Start 16NOV92
Project Finish 26OCT93

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

ACOE/SAVANNAH DISTRICT
ICM FOR RSA SITES
ICM UNIT 2 GANTT CHART

Sheet 1 of 1

Date	Revision	Checked	Approved

SECTION 7.0 LIST OF CONTRIBUTORS

7.0.a The following is a list of Ebasco Environmental personnel involved in the technical preparation and/or review of this Interim Corrective Measure Design Document. The input function of each member with respect to the document, and the professional title of each member, respectively, also are listed. Resume's of the individuals listed are contained in **Appendix E.**

Albert D. O'Rear, P.E.	-	Professional Engineer Registered in the State of Alabama responsible for document review and approval; Ebasco Regional Chief Environmental Engineering Manager
David W. Schaer	-	Project Manager; Principal Geologist
Kimberly R. Soovajian	-	Project Task Manager; Environmental Engineer
Victor H. Owens	-	Project Lead Design Engineer; Principal Engineer
Steven E. Werner	-	Project Cost & Schedule Controller; Senior Cost Engineer
Loretta A. García	-	Community Relations Scope Preparation; Community Relations Specialist
Ken Chen	-	Project Design Engineer; Principal Engineer
James P. Anderson	-	Project Hydrogeological Design; Principal Hydrogeologist
Tammy S. Jackman	-	Health and Safety Plan (HASP) Preparation; Associate Industrial Hygiene Technician
Gerald L. Delaney, C.I.H.	-	Review/Approval of HASP; Ebasco Regional Health and Safety Manager

SECTION 8.0 REFERENCES

8.1 Vol 1 "Design Manual for Military Construction", Second Edition, Volume I of III - General Administrative, and Value Engineering Requirements. US Army Corps of Engineers, Savannah District, June 1989.

8.1 Vol 2 ...,"Volume II of III - Technical Requirements.

8.1 Vol 3 ...,"Volume III of III - Exhibits

8.2 "Environmental Effects of Army Actions," Army Regulation 200-2, Department of the Army, December 1988.

8.3 "Safety Health Requirements Manual," Engineering Manual 385-1-1, April 1981, Revised October 1987.

8.4 Occupational Safety and Health Administration Standards 1910 and 1926.

8.5 NIOSH/OSHA/USCG/EPA "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985.

8.6 ANSI Z-358.1, "Emergency Eyewash and Shower Equipment," 1990.

8.7 ANSI Z-88.2, "Practices for Respiratory Protection," 1980.

8.8 "Safety and Occupational Health Document Requirements for Hazardous Waste Site Corrective Measures," Engineer Regulations 385-1-92, December 13, 1991.

8.9 "Engineering and Design Chemical Data Quality Management for Hazardous Waste Remedial Activities," Department of the Army, Engineer Regulation 1110-263, 1 October 1990.

8.10 "Interim Final Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties," OSWER Directive 9355.5-01, US Environmental Protection Agency, February 1990.

8.11 Memorandum, "Minimum Chemistry Data Reporting Requirements for DERP and Superfund HTW Projects," US Army Corps of Engineers, CEMRD-ED-GL, August 1989.

8.12 "Confirmation Report - Unit 3 Investigations, Redstone Arsenal, Alabama," Volume I-Text, P.E. Lamoreaux and Associates, Inc, July 1988.

8.13 "Remedial Investigation Engineering Report, Redstone Arsenal, Alabama; Unit 1-DDT and Sanitary Landfills and Unit 2-Open Burn/Open Demolition Area," Volume I-Text, P.E. Lamoreaux and Associates, Inc, September 1988.

8.14 "Upgrade Confirmation Report and Assessment of Remedial Alternatives for Selected Unit 3 Sites, Redstone Arsenal, Alabama," P.E. Lamoreaux and Associates, Inc, April 1989.

8.15 Draft "Environmental Impact Statement, Redstone Arsenal Base Realignment," Ebasco Environmental, October 1992.

8.16 "Identification and Evaluation of Potential Solid Waste Management Units and Areas of Concern, Redstone Arsenal, Alabama, "Geraghty and Miller, February 1991.

8.17 "Phase I Report, RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas, Redstone Arsenal, Alabama," Books 1 and 2, Geraghty and Miller, Inc, December 1991.

8.18 "Interim RCRA Facility Assessment Report of the Redstone Arsenal Huntsville, Alabama, EPA I.D. NO. AL 7210020742," A. T. Kearney, Inc, September 1989.

8.19 "RCRA Facility Investigation Work Plan for RSA-58, RSA-115, RSA-116, RSA-G, and Target Seeker Area, Redstone Arsenal, Alabama," Engineering-Science, Inc, March 1992.

8.20 ADEM Letter to Redstone Arsenal dated 27 March 1992.

8.21 "Safety and Occupational Health Document Requirements for Hazardous/Toxic Waste (HTW) Activities," US Department of the Army, March 1987.

8.22 "Architectural and Engineering Instructions," Department of the Army, March 1987.

8.23 "Community Relations in Superfund, A Handbook," OSWER Directive 9230.0-3C, US Environmental Protection Agency, September 1990.

8.24 Internal Draft "RCRA Facility Investigation Phase I Report for RSA-58, RSA-115, RSA-116, RSA-129, RSA-G, and Target Seeker Area, Redstone Arsenal, Alabama," Volume I, Engineering Science, Inc., September 1992.

8.25 Draft "Phase II Addendum, RCRA Facility Investigations at Unit 1, Unit 2 and Selected Unit 3 Areas, Redstone Arsenal, Alabama," Geraghty and Miller, Inc, October 1992.

8.26 "Site Safety Plan, Sites Investigation for S.O.W. IRP-DERP, Redstone Arsenal, Huntsville, Alabama," US Army Corps of Engineers, June 10, 1992.

8.27 "Final Design Report for Operable Unit No. 2 - Construction Specifications, Defense Depot, Ogden, Utah," Canonie Environmental, March 1992.

MAP LIST

M8.1	USGS Topographic Quadrangle - Huntsville, Alabama, 1975
M8.2	USGS Topographic Quadrangle - Madison, Alabama, 1982
M8.3	USGS Topographic Quadrangle - Triana, Alabama, 1982
M8.4	USGS Topographic Quadrangle - Farley, Alabama, 1982
M8.5	Redstone Arsenal, Alabama - Reservation Map, 1989
M8.6	Redstone Arsenal, Alabama - Master Plan Basic Information Maps, Sheets 1-17, 1987.
M8.7	Federal Emergency Management Agency, Flood Insurance Rate Map, Madison County Alabama, Panel Number 300, Effective July 2, 1981.
M8.8	Federal Emergency Management Agency, Flood Insurance Rate Map, Madison County Alabama, Panel Number 425, Effective July 2, 1981.
M8.9	Federal Emergency Management Agency, Flood Insurance Rate Map, Madison County Alabama, Panel Number 450, Effective July 2, 1981.

APPENDIX A

SITE-SPECIFIC HEALTH AND SAFETY PLAN FOR RSA ICM DESIGN ACTIVITIES

SITE-SPECIFIC HEALTH AND SAFETY PLAN FOR RSA INTERIM CORRECTIVE MEASURES DESIGN ACTIVITIES

(Short Form for RCRA walk through, surveying and staking and other special circumstances. Approval of HSM (805) 830-4100 must be secured to use this form.)

SITE: 4 SITES AT REDSTONE ARSENAL, ALABAMA

LOCATION: REDSTONE ARSENAL, ALABAMA

DATE PREPARED: DECEMBER 11, 1992

PREPARED BY: TAMMY JACKMAN/EBASCO
(NAME/COMPANY)

PLANNED SITE VISIT DATE(s):

REVISION: 1

EBASCO SERVICES INCORPORATED, EBASCO SUBCONTRACTORS AND THE UNITED STATES ARMY CORPS OF ENGINEERS DO NOT GUARANTEE THE HEALTH OR SAFETY OF ANY PERSON ENTERING THIS SITE. DUE TO THE HAZARDOUS NATURE OF THIS SITE AND THE ACTIVITY OCCURRING THEREON, IT IS NOT POSSIBLE TO DISCOVER, EVALUATE, AND PROVIDE PROTECTION FOR ALL POSSIBLE HAZARDS WHICH MAY BE ENCOUNTERED. STRICT ADHERENCE TO THE HEALTH AND SAFETY GUIDELINES SET FORTH HEREIN WILL REDUCE, BUT NOT ELIMINATE, THE POTENTIAL FOR INJURY AT THIS SITE. THE HEALTH AND SAFETY GUIDELINES IN THIS PLAN WERE PREPARED SPECIFICALLY FOR THIS SITE AND SHOULD NOT BE USED ON ANY OTHER SITE WITHOUT PRIOR RESEARCH BY TRAINED HEALTH AND SAFETY SPECIALISTS.

PROJECT NAME: RSA INTERIM CORRECTIVE MEASURE DESIGN

PROJECT NO. DACA21-91-D-0024

SCOPE OF WORK AND PURPOSE OF VISIT:

Site visits before and during design to get an overview of the existing site conditions for Sites Unit 1, Unit 2, RSA-G, and Area F. Descriptions of each site is can be found on pages 4-7.

POTENTIAL SITE VISIT PERSONNEL:	RESPONSIBILITY:
1. Tammy Jackman	Health and Safety Officer
2. Arthur Holcomb	Certified Industrial Hygienist
3. Gerald Delaney	Health and Safety Manager
4. Kimberly Soovajian	Task/Site Manager
5. David Schaer	Project Manager
6. Ken Chen	Site Investigator
7. Victor Owens	Site Investigator
8. Lyn Phillips	Site Investigator
9. Kirk Mays	Site Investigator
10. Albert O'Rear	Professional Engineering Review/Approval
11. Hal Frediani	Site Investigator
12. Thomas Marks	Site Investigator
13. Loretta García	Community Relations
14. Surveying Subcontractor Personnel	Surveying and Staking

OTHER CONTACTS	PHONE NOS.
N/A	N/A

EMERGENCY INFORMATION:

CONTACT	PHONE NOS.
Police:	
On Base:	(205) 876-2222
Off Base:	911
Emergency Fire:	
On Base:	(205) 876-2117
Off Base:	911
Ambulance:	
On Base:	(205) 876-8239
Off Base:	911 or (205) 536-6658
Hospital:	
On Base:	
Fox Hospital (life threatening emergencies only)	(205) 876-6110
Off Base: Huntsville Hospital	(205) 533-8202
Poison Control Center:	1-800-292-6678
Regional HSM: Gerald Delaney	(205) 830-4100
Site Manager: Kimberly Soovajian	(404) 662-2438

HOSPITAL ROUTE:

Huntsville Hospital (Off Base)

Unit 1: Take Patton Road North to Martin Road. Turn left onto Martin Road and exit through Gate 1 to Memorial Parkway. Then follow directions described below.*

Unit 2: Take Buxton Road east to Patton Road North. Then take Redstone Road east through Gate 3 to Memorial Parkway. Follow directions given below.*

Area F: Take Toftoy Throughway South to Martin Road East. Exit Gate 1 and proceed to Memorial Parkway. Then follow directions below.*

RSA-G: Take Redstone Road to Gate 3. Proceed to Memorial Parkway. Then follow directions below.*

* Turn left (north) onto Memorial Parkway. Follow Memorial Parkway for approximately 7.5 miles. Exit right onto Governors Drive East and proceed approximately 0.7 miles. Huntsville Hospital is located on the left at the intersection of Madison and Governor's drive (See Figure 2 in Attachment 1).

FOX Hospital (On-Base, Life threatening emergencies only).

Unit 1: Take Dodd Road North to Martin Road West. Then turn right (North) onto Rideout Road. Then turn right onto Goss Road after 1 mile; FOX Hospital is on the immediate right (See Figure 2 in Attachment 1).

Unit 2: Take Buxton Road West. Turns into Dodd Road going North. Continue to Martin Road West. Then take Rideout Road North to Goss Road. Turn right onto Goss Road after 1 mile; FOX Hospital is on the right.

AREA F: Take Toftoy (Northwest) to Rideout Road (North). Then turn Right onto Goss Road and go East for 1 mile. FOX Hospital is on the right.

RSA G: Take Redstone Road West to Patton Road North. Then Turn left (West) onto Martin Road and continue to Rideout Road. Turn right onto Rideout Road. Then turn Right (East) onto Goss Road. FOX Hospital is 1 mile on the right.

INCLEMENT WEATHER PROCEDURES:

Site activities will be limited to the daylight hours and normal weather conditions. Inclement working conditions include heavy rain, high winds and lightning. Observe daily weather reports, evacuate site in case of inclement working conditions.

SITE BACKGROUND/OVERALL INFORMATION:

Redstone Arsenal (RSA) is a US Army facility located in Madison County, Alabama. RSA occupies approximately 38,300 acres. It is bounded on the north and east by the city of Huntsville, on the south by Wheeler National Wildlife Refuge and the Tennessee River, and on the west by agricultural, residential and light industrial areas.

DESCRIPTION AND HISTORY OF UNIT 1

Unit 1 consists of approximately 68.5 acres bordered by woods to the north, a closed landfill (Area Q3) to the east; wetlands, Wheeler National Wildlife Refuge and the remediated "old" channel and floodplains of Huntsville Spring Branch to the south; and a NASA test area to the west . The most prominent topographic feature of Unit 1 is the approximately 40-feet-deep excavated drainage ditch that borderes its east site. The ditch channels runoff water from Unit 1, Area Q3 to the east, and other areas to the north, towards the wetlands to the south. Unit 1 is composed of two Solid Waste Management Units (SWMUs); the active and closed sanitary landfill and the DDT Waste Soils Landfill.

The sanitary landfill, which occupies approximately 66 acres, has been used since 1973 for disposal of a variety of wastes including typical household waste, waste oil, hospital infectious wastes, construction debris, asbestos, and ash from incinerated paper. Closed portions of the sanitary landfill include disposal trenches oriented east-west and a rubble fill, located in the southern part of Unit 1. The closed landfill consists of three to four disposal trenches that are approximately 25 ft. wide, 400 ft. long, and greater than 20 ft. deep. Wastes disposed in the closed trenches included household waste, paper products, waste oil, and construction debris. The land surface of the closed disposal trenches is hummocky and covered with grass. The ground is unstable and subsurface gas can be observed escaping from the soil.

DESCRIPTION AND HISTORY OF UNIT 2

Unit 2, consisting of active open burn/open detonation (OB/OD) areas, is located in the southern part of RSA near the Tennessee River. Unit 2 is recognized as a "miscellaneous unit" as regulated under 40 CFR 265, RCRA Subpart X. An application for a RCRA Part B permit for Unit 2 has been submitted and is pending approval by EPA. The OB/OD area is used to dispose and decontaminate explosives and explosive contaminated materials and to dispose of reactive wastes by thermal treatment. The reactive wastes include bulk propellants, propellant-contaminated solvents; and nonhazardous propellant-contaminated waste such as rags and wood containing 4% or less propellant. Prior to January 1986, solvents and solvent-contaminated materials were routinely incinerated directly on the ground at two open burn pads of the Open Burn Area located on the northwest part of Unit 2. Liquids have not been burned regularly on unprotected ground since 1986.

Propellant-contaminated wastes are currently thermally treated in two elevated open burn pans and one temporary open burn pan located on the northeast corner of Unit 2. Three additional pans are currently being constructed.

Two "contaminated waste burn trenches" located in the southeast part of Unit 2 also were used to incinerate materials contaminated with propellants. The Contaminated Waste Burn Trenches were originally designed for incineration of packaging and pallets used to ship munitions. In 1984, the Army Environmental Hygiene Agency (AEHA) discovered that the trenches had also been used to dump and burn waste solvents from an RSA explosive production area, and such activities were ceased. In 1991, the use of these trenches to incinerate packaging and pallets was ceased. According to RSA personnel, the Contaminated Waste Burn Trenches were no longer used.

DESCRIPTION AND HISTORY OF RSA-G THIOKOL DEGREASER AT BUILDING 7664

The Thiokol Degreaser, Building 7664, is within the Thiokol complex located in the southeast section of the Arsenal. The site is east of magazine Road, north of Redstone Road, and west of Line Road. The area of the spill is located adjacent to a crushed rock road and an adjacent grass field. The site is surrounded by structures and elevated stream piping.

In 1989, facility representatives reported a valve malfunction at a degreaser at Thiokol Building 7664. The malfunction resulted in an overflow to a manhole and a reported maximum of 30 gallons of TCE (Trichloroethylene) being discharged to the sanitary sewer system. Subsequent to the spill, TCE was detected in the sanitary sewer and the sewage treatment plant. An air stripper was installed to treat the water in the contaminated sanitary sewer line prior to discharge to the main sewer line. The stripper operated for a period of several months. Thiokol representatives believe that contaminated groundwater was flowing into the clay pipe sanitary sewer line on the site and that the TCE detected in the air stripper influent was not only related to this recorded spill but the result of other nearby sources. The facility disconnected the contaminated sewer to isolate the TCE source. All water sources within Building 7664 were rerouted to an approved sanitary sewer.

DESCRIPTION AND HISTORY OF AREA F

Area F, approximately 5 acres in size and located in central RSA, consists of three closed disposal ponds formerly used for the disposal of arsenic-contaminated water generated from lewisite manufacturing operations. Subsequent to the disposal of arsenic wastes, rubble and industrial wastes were disposed of in the impoundment. RSA field investigations at the site included test pit excavations with associated air monitoring, shallow soil sampling; soil borings with shallow and deep soil sampling; sediment and surface water sampling; and monitor well installation and ground-water sampling. Test pit excavations encountered solid waste and construction debris, overlaying layers of arsenic waste and poly aromatic hydrocarbons (PAH)-

contaminated waste that continued to the total depths of the test pits (11 to 12 ft). The hydrogeology at Area F is complex, with shallow perched and deep basal overburden zones overlying shallow weathered and intermediate bedrock water-bearing zones. The apparent direction of ground water flowing the basal overburden and shallow bedrock is north-northeast.

The nature and extent of contamination in the soils at Area F have been fairly well-defined. A Health and Environmental Analysis (HEA) showed PAHs and metals (primarily arsenic) to be present in the soil/waste samples from the test pits, shallows soils, soil borings, and sediments at concentrations which exceed carcinogenic and systematic criteria, respectively. There does not appear to be ground water contamination associated with the activities at Area F. One chlorinated hydrocarbon (carbon tetrachloride) was detected in ground water, but the source of the contamination is not believed to be Area F.

MAXIMUM DETECTED GROUNDWATER CONTAMINATION

RSA G:	TCE - (Trichloroethylene)	120,000 ppb
Unit 2:	TCE	98,000 ppb
	Total Chlorinated Hydrocarbons	151,850 ppb
Unit 1:	TCE	390 ppb
	Total Chlorinated Hydrocarbons	475 ppb
	Total BTEX	853 ppb
	BNA	1,300 ppb
Area F:	Arsenic	100 ppb

MAXIMUM DETECTED SOIL CONTAMINATION:

Area F:	Arsenic	7.9 mg/kg
	Total Aromatic Hydrocarbons	6000 ug/kg

HAZARD ASSESSMENT:

According to the information available in the Remedial Investigation Reports, a low potential exists for exposure due to the chemicals found at the sites.

STANDARD OPERATING PROCEDURES: (i.e., basic hygiene, buddy system, no oral contact with any articles when working on site, etc.)

Basic hygiene procedures include common sense practices such as no eating, drinking or smoking on site. Keep hands and equipment away from face, eyes and mouth. Avoid areas where obvious contamination can occur if possible. Do not enter site alone. Maintain visual and audio contact with others at all times. In the event of an incident at the site, an Incident Report and Follow Up form (Attachment 2) will be completed and forwarded to the Ebasco Regional Health and Safety Manager, and copies furnished to the US Army Corps of Engineers Project Manager.

PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIREMENTS:

Minimum - Steel toe/shank shoes or boots, standard field clothes. Hard hats and safety glasses will be worn when applicable (i.e., in areas where there are overhead hazards, when there is a potential of eye injury).

PPE SELECTION CRITERIA:

Very low level of possibilities for contact with potentially hazardous substances - site survey inspection will be of short duration.

PPE DECON/DISPOSAL (IF APPLICABLE):

N/A

MONITORING EQUIPMENT AND CALIBRATION INFORMATION:

N/A

MONITORING EQUIPMENT SELECTION CRITERIA:

N/A

ACTION LEVELS FOR UPGRADING OF PPE AND/OR SITE WITHDRAWAL:

Site withdrawal for inclement working conditions listed on page 3

MEDICAL DATA SHEET:

The brief Medical Data Sheet on the following page can be completed by on-site personnel and will be kept in the Project Support Zone (i.e., uncontaminated area near the project site) during the conduct of site operations. It is in no way a substitute for the Medical Surveillance Program requirements consistent with the Ebasco Corporate Health and Safety Program for Hazardous Waste Sites. This data sheet will accompany any personnel when medical assistance is required or if transport to hospital facilities is required.

EBASCO SERVICES INCORPORATED

PROJECT 4 Sites At Redstone Arsenal - Alabama

NAME _____ HOME TELEPHONE _____

ADDRESS _____

AGE _____ HEIGHT _____ WEIGHT _____ BLOOD TYPE _____

ALLERGIES _____

PARTICULAR SENSITIVITIES _____

DO YOU WEAR CONTACTS? _____

PROVIDE A CHECKLIST OF PREVIOUS ILLNESSES OR EXPOSURES TO HAZARDOUS CHEMICALS: _____

WHAT MEDICATIONS ARE YOU PRESENTLY USING? _____

DO YOU HAVE ANY MEDICAL RESTRICTIONS? _____

PHYSICIAN _____ TELEPHONE _____

EBASCO

MEDICAL DATA SHEET

REDSTONE ARSENAL, ALABAMA

FIELD TEAM REVIEW:

Each field team member shall sign this section after site-specific training is completed and before being permitted to work on site.

I have read and understand this Site-Specific Health and Safety Plan. I will comply with the provisions contained therein.

Site/Project: 4 Sites At Redstone Arsenal, Alabama

Name Printed	Signature	Date

APPROVALS:

By their signature, following, the undersigned certify that this Health and Safety Plan will be utilized for the protection of the health and safety of workers during the field investigation of the four Redstone Arsenal sites.

EBASCO ENVIRONMENTAL

_____	_____
Health and Safety Officer	Date
_____	_____
Site Manager	Date
_____	_____
Project Manager	Date
_____	_____
Manager, Health and Safety, CIH	Date

ATTACHMENT 1

SITE MAPS

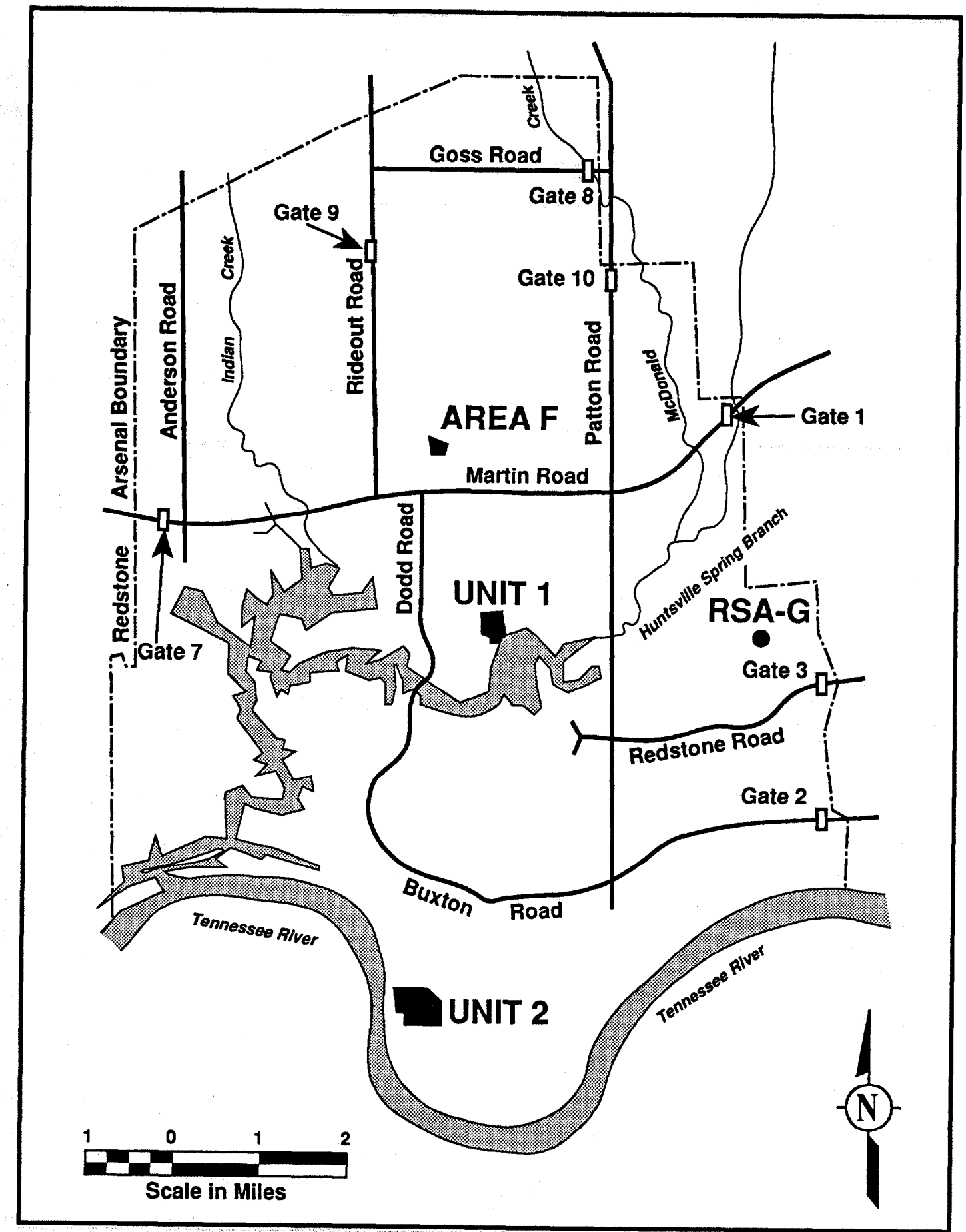


FIGURE 1 LOCATION OF UNIT 1, UNIT 2, AREA F AND RSA-G

Source: P.E. Lamoreax & Associates, Inc., 1988

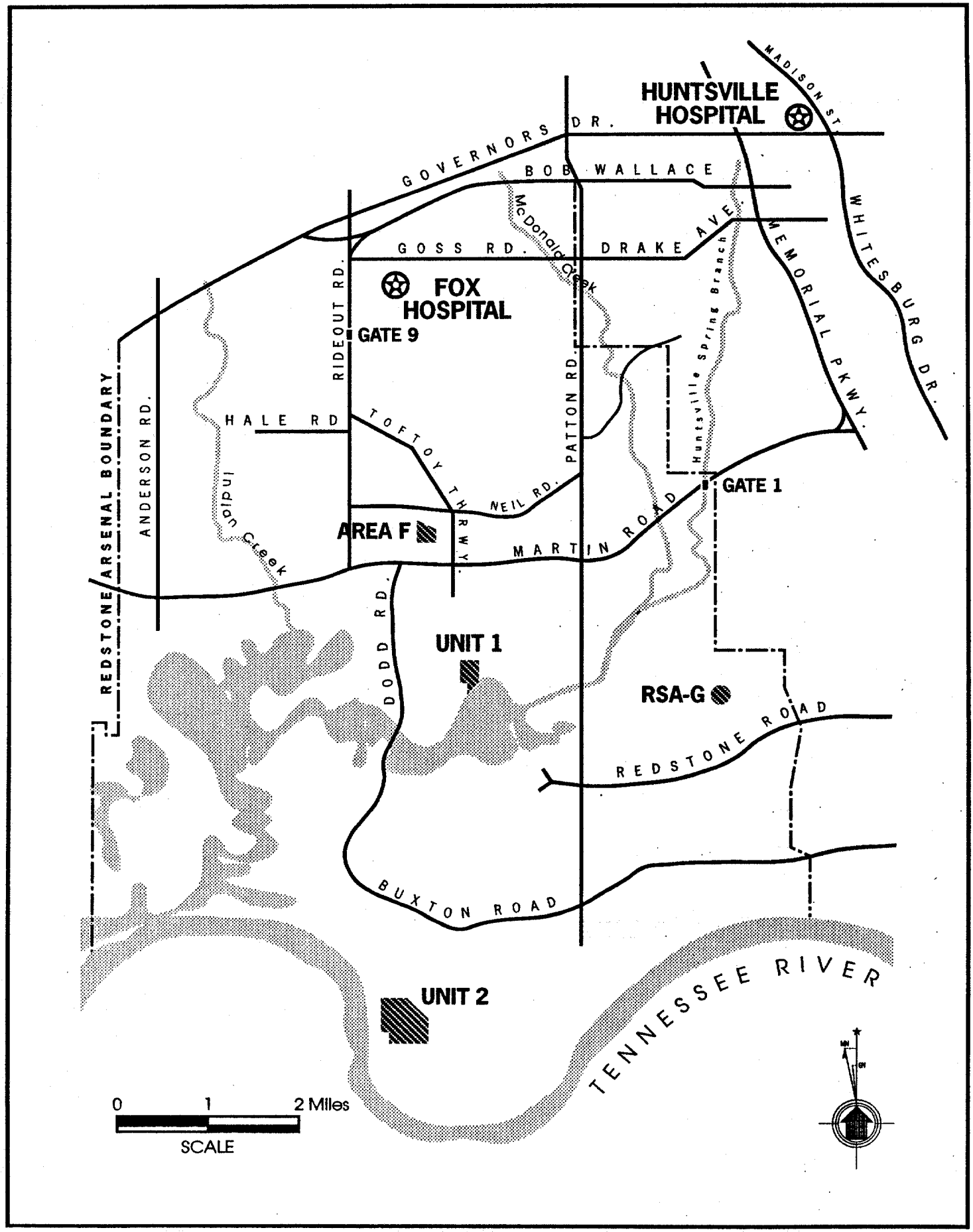


FIGURE 2 HOSPITAL LOCATION MAP - Redstone Arsenal

EBASCO

ATTACHMENT 2

STANDARD INCIDENT AND FOLLOW-UP FORM

INCIDENT REPORT

SITE:_____

SITE LOCATION:_____

REPORT PREPARED BY:_____

Name Printed Title

INCIDENT CATEGORY:
(check all that apply)

___Injury	____Illness	____Property Damage
___Near Miss	____On Site Equipment	____Chemical Exposure
___Motor Vehicle		
___Mechanical	____Electrical	
___Fire	____Other	

DATE AND TIME OF INCIDENT: _____

Narrative Report of Incident:

(Provide sufficient detail so that the reader may fully understand the actions leading to or contributing to the incident, the incident occurrence, and actions following the incident. Append additional sheets of paper if necessary).

_____
_____
_____
_____
_____
_____
_____
_____
_____

INCIDENT REPORT
(SHEET 2 OF 6)

WITNESSES TO INCIDENT

1. NAME _____COMPANY_____
   ADDRESS_____
   TELEPHONE NO. _____

2. NAME _____COMPANY_____
   ADDRESS_____
   TELEPHONE NO. _____

INJURIES

FIRST INJURED PERSON

Name of Address of Injured: _____
_____
_____
SSN: _____Age: _____Sex: _____
Years of Service: _____Time on Present Job: _____
Title/Classification: _____
Severity of Injury or Illness:

____Disabling ____Non-disabling
____Fatality ____Medical Treatment

Estimated Number of Days Away from Job: _____
Nature of Injury or Illness: _____
_____

Classification of Injury:

____Fractures ____Heat Burns ____Cold Exposure
____Dislocations ____Chemical Burns ____Frostbite

INCIDENT REPORT
(SHEET 3 OF 6)

____ Sprains	____ Radiation Burns	____ Heat Stroke
____ Abrasions	____ Bruises	____ Heat Exhaustion
____ Lacerations	____ Blisters	____ Concussion
____ Punctures	____ Toxic Respiratory Exposure	____ Toxic Ingestion
____ Faint/Dizziness	____ Bites	____ Respiratory Allergy
____ Dermal Allergy		

Part of Body Affected: _____
Degree of Disability: _____
Date Medical Care was Received: _____
Where Medical Care was Received: _____
Address (if off-site): _____
If Hospitalized, Name, Address and Telephone No. of Hospital:

_____

Name, Address and Telephone No. of Physician:

_____

SECOND INJURED PERSON

Name and Address of Injured: _____

_____

SSN: _____ Age: _____ Sex: _____
Years of Service: _____ Time on Present Job: _____
Title/Classification: _____

Severity of Injury or Illness:

____Disabling	____Non-disabling
____Fatality	____Medical Treatment

Estimated Number of Days Away from Job: _____
Nature of Injury or Illness: _____

_____

INCIDENT REPORT
(SHEET 4 OF 6)

Classification of Injury:

____ Fractures	____ Heat Burns	____ Cold Exposure
____ Dislocations	____ Chemical Burns	____ Frostbite
____ Sprains	____ Radiation Burns	____ Heat Stroke
____ Abrasions	____ Bruises	____ Heat Exhaustion
		Concussion
____ Lacerations	____ Blisters	____ Toxic Ingestion
____ Punctures	____ Toxic Respiratory	____Respiratory
	Exposure	Allergy
____ Faint/Dizziness	____ Bites	
____ Dermal Allergy		

Part of Body Affected: _____
Degree of Disability:
Date Medical Care was Received: _____
Where Medical Care was Received:_____
Address (if off-site): _____
If Hospitalized, Name, Address and Telephone No. of Hospital:

_____

Name, Address and Telephone No. of Physician:

_____

(If more than two injuries, provide information on separate sheet).

PROPERTY DAMAGE

Brief Description of Property Damage:

_____
_____
_____
_____

Estimate of Damage: $_____

INCIDENT REPORT
(SHEET 5 OF 6)

INCIDENT LOCATION

_____

_____

_____

INCIDENT. ANALYSIS

Causative agent most directly related to accident (object, substance, material, machinery, equipment, conditions):

_____

_____

Was weather a factor?_____

Unsafe mechanical/physical/environmental condition at time of incident (be specific):_____

_____

_____

Unsafe act by injured and/or others contributing to the incident (be specific, must be answered): _____

_____

Personal factors (improper attitude, lack of knowledge or skill, slow reaction, fatigue): ____

_____

_____

On Site Incidents:

Level of personal protection equipment required in Site Safety Plan:

_____

_____

_____

Modifications: _____

_____

_____

Was injured using required equipment?:_____

_____

INCIDENT FOLLOW-UP

Date of Incident: _____

Site: _____

Brief Description of Incident: _____

_____

Outcome of Incident: _____

_____

Physician's Recommendations: _____

_____

_____

Date Injured Returned to Work: _____

ATTACH ANY ADDITIONAL INFORMATION TO THIS FORM

APPENDIX B

SUMMARY OF INTERIM CORRECTIVE MEASURE DESIGN CRITERIA

APPENDIX D

SAMPLE WATER TREATMENT SYSTEM BUILDING SKETCHES

PROVIDED AS EXAMPLE ONLY

EBASCO SERVICES INCORPORATED

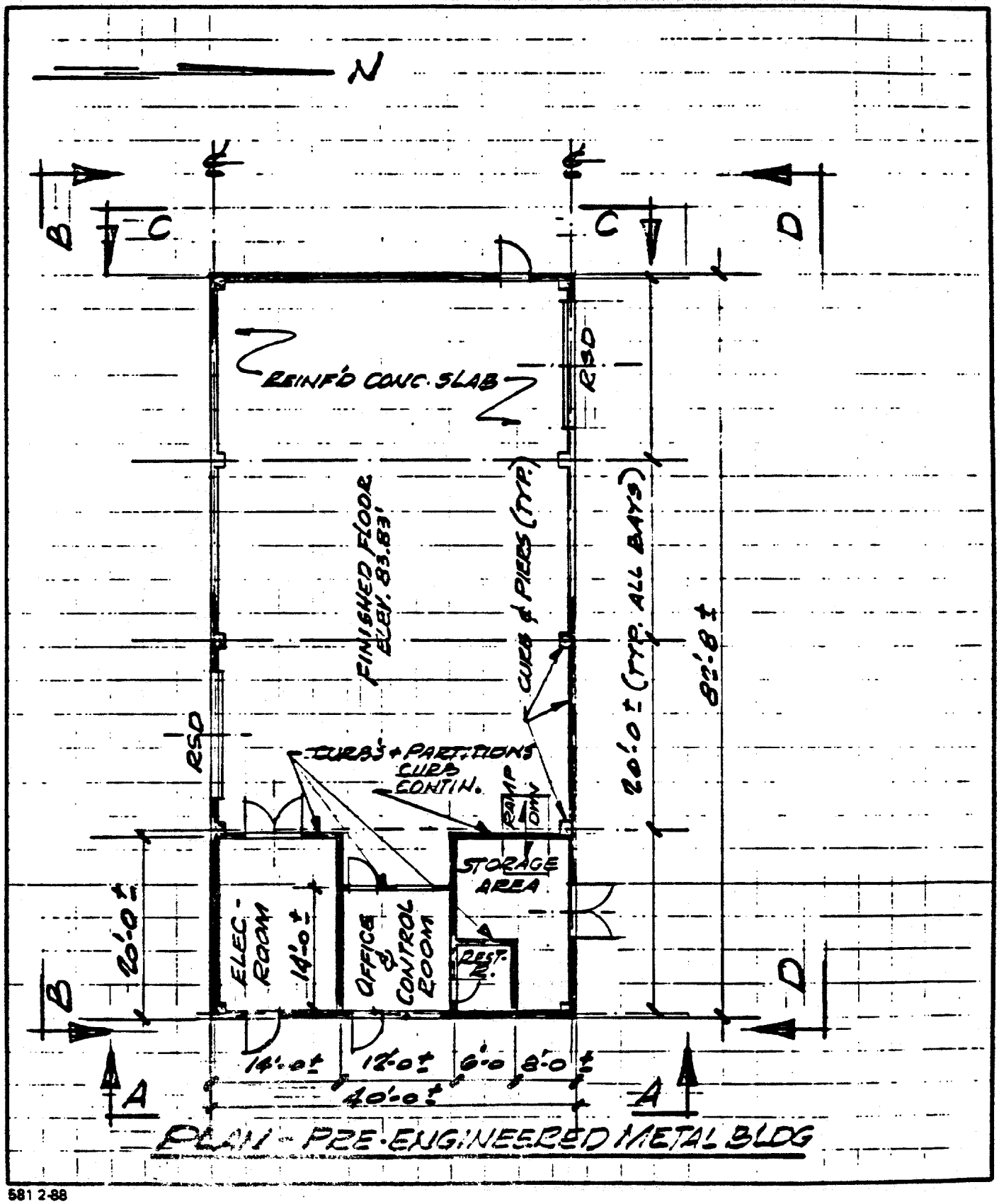
BY H.K. DATE 8/8/89 SHEET 1 OF 3

CHKD. BY K.C. DATE 8/3/190 OFS NO. DEPT. NO.

CLIENT

PROJECT TOWER CHEMICAL SITE

SUBJECT WWT - BUILDING ARRANGEMENT



PLAN - PRE-ENGINEERED METAL BLDG

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EBASCO SERVICES INCORPORATED

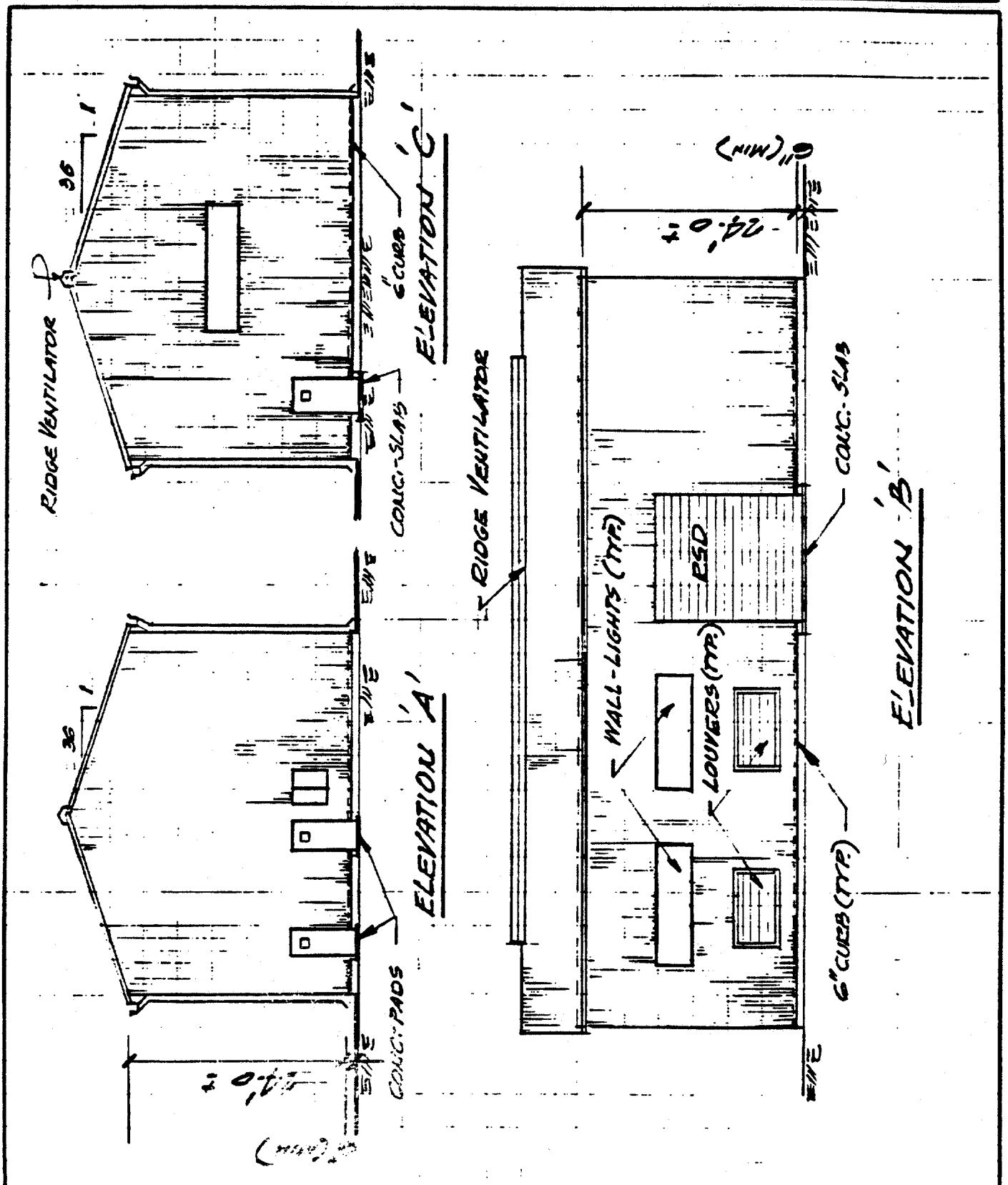
BY H.K DATE 8/8/89 SHEET 2 OF 3

CHKD. BY K.C. DATE 8/3/90 OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT TOWER CHEMICAL SITE

SUBJECT WWT - BUILDING AERIAL ENLIGHTENMENT



581 2-88

EBASCO SERVICES INCORPORATED

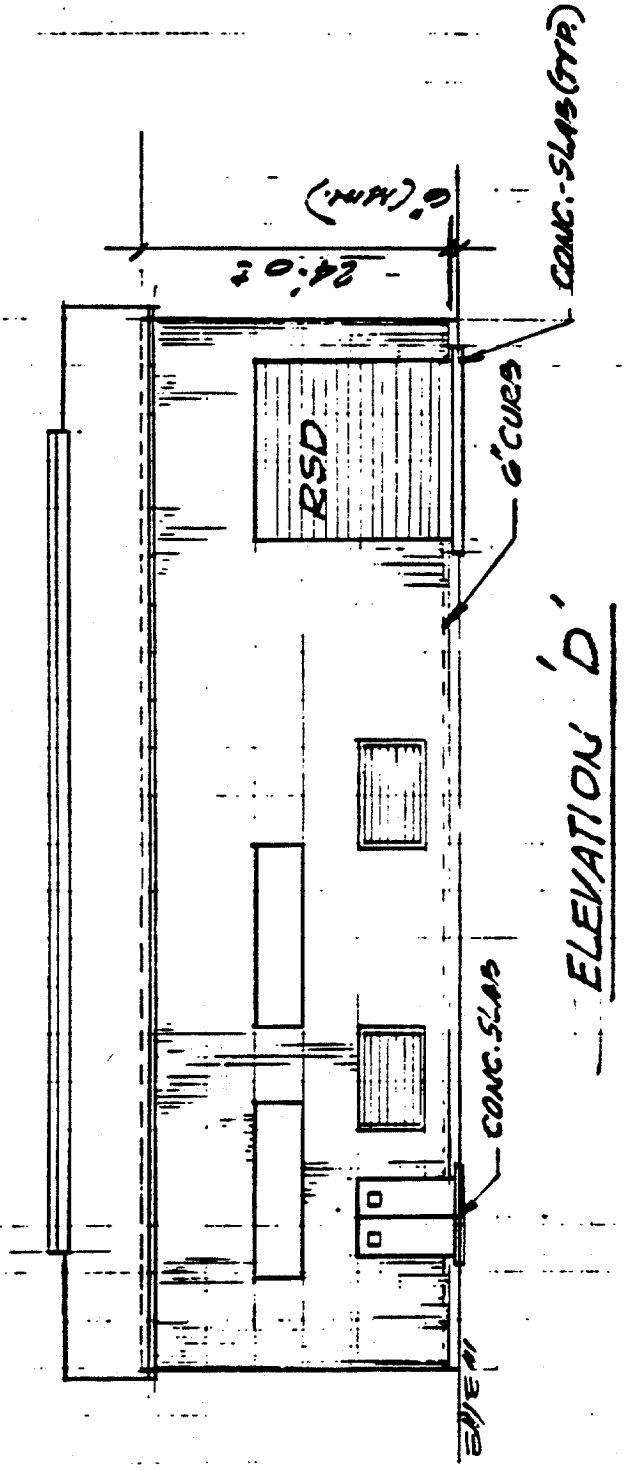
BY H.L DATE 8/9/89 SHEET 3 OF 3

CHKD. BY KC DATE 8/13/90 OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT TOWER CHEMICAL SITE

SUBJECT WWT - BUILDING ARRANGEMENT



581 2-88

APPENDIX E

RESUMES OF EBASCO DESIGN TEAM MEMBERS

DAVID W. SCHAER, P.G.
Principal Geologist

SUMMARY OF EXPERIENCE (Since 1977)

Total Experience - Fourteen years experience in performing and managing remedial investigations, feasibility studies, site inspections and economic minerals exploration.

Education - B.S., Geology, MESA State College, 1977
AAS, Civil Engineering Technology, MESA State College, 1975

Courses - Volcanic Rocks and Their Vent Areas - Mackey School of Mines
Tailings Ponds and Their Impoundments, Colorado State University
40 Hour Health and Safety Training for Hazardous Waste Site, 1985
Principals of Groundwater Hydrology, NWWA, 1992

Registrations - North Carolina No. 236
South Carolina No. 446
Florida No. 495
Tennessee No. 544
Wyoming (in progress)

REPRESENTATIVE EBASCO EXPERIENCE (Since 1987)

Principal Geologist/Hydrogeology Supervisor

Supervises a group of professional geologists/hydrogeologists and chemists. Responsible for job cost control and overhead accounts, in addition to making intragroup decisions.

Technically responsible for design, implementation and managing of remedial investigations for government agencies and industrial facilities. Tasks typically include preparing and implementing work plans for remedial investigations, site inspections and baseline environmental surveys for determining the presence or absence of contaminated soils and water.

Projects Include:

U.S. EPA Region IV - Sangamo Weston Site, Pickens County, South Carolina. Site Manager for an EPA Superfund Project that was designed to assess the effects of PCB contamination at several county landfills. Responsible for planning and managing the overall project and coordinating project activities with the EPA and state officials. This project was completed on schedule with a cost savings of $40K from the budget of $160K.

D. W. SCHAER (Continued)

Georgia Pacific Corporation, Spartanburg, South Carolina. Project Manager responsible for providing client with integrity/inspection of five solid waste management units at GP's container plant to determine the environmental impact caused by each individual SWMU. Tasks included providing the client with a report suitable for submission to the EPA documenting the investigations findings. Additional tasks include the removal and thermal treatment of contaminated soils.

U.S. EPA - Tri-City Industrial Disposal Site, Bullitt County, Kentucky. Site Manager for an EPA Superfund RI/FS Project. Responsible for planning and managing both the remedial investigation and the feasibility study for the entire project and coordinating project activities with the EPA and state officials. These responsibilities included assisting the EPA at public meetings with technical responses to concerns voiced by the community.

U.S. EPA - Whitehouse Waste Oil Pits Site, Duval County, Florida. Responsible as Site Manager for planning and investigating bioremediation and solidification/stabilization technologies that could be used in support of a remedial action. A portion of this project included obtaining data sufficient to prepare a risk assessment and providing the EPA with a final risk assessment.

U.S. EPA - Zellwood Groundwater Contamination Site, Orange County, Florida. Responsible as Site Manager for assisting the EPA with a soil solidification/stabilization project. Additional responsibilities included planning, managing and implementing a groundwater monitoring system for monitoring the solidified product and investigating the extent of existing groundwater contamination to support a remedial design for groundwater remediation.

U.S. EPA - Picillo Farm Site, Coventry, Rhode Island. Remedial Investigation Task Leader on a RI/FS project which focused on assessing the areal extent of contamination attributable to six years of illegal bulk dumping of toxic and hazardous wastes. Tasks included developing and coordinating the plans for a field investigation for soils, surface waters, and the groundwater system.

U.S. EPA - Bluff Road Site, Columbia, South Carolina. Project Task Leader on a remedial investigation/feasibility study to assess the environmental impact caused by unregulated disposal of hazardous materials.

Teledyne-Brown Engineering/U.S. Army Missile Command - Redstone Arsenal, Huntsville, Alabama. Technical Lead responsible for the design of a monitoring plan for soils and groundwater to determine any environmental impacts associated with the destruction of Pershing missile motors at two sites in the western United States. Tasks included preparing detailed field plans for State and Federal agencies review.

Georgia Pacific Corporation, Atlanta, Georgia. Project Leader on a baseline environment survey of an existing plant which was being considered for purchase by the client. Tasks included supervision of field sampling, well installation, and preparation of final reports.

D. W. SCHAER (Continued)

PRIOR EXPERIENCE

Versar Inc., Manager of Technical Services. Responsible as technical manager for all remedial investigations and feasibility tasks associated with an EPA technical support contract (TES 7). Duties included providing EPA with independent cost analysis for remedial alternatives identified in feasibility studies generated by primary responsible parties. Additional duties included presenting feasibility studies alternatives, and EPA preferred methods at public meetings.

Project Geologist, Camp Dresser and McKee

Responsible for all aspects of groundwater monitor systems and supervision of field crews conducting remedial investigations. Other responsibilities included project planning and report preparation.

Superfund Projects Include:

Munisport Landfill, North Miami, Florida. Hollingsworth Solderless Terminal, Fort Lauderdale, Florida; Mowbray Engineering Company, Greenville, Alabama (Celanese-Shelby Fiber Operations), Shelby, North Carolina; Coleman-Evans Wood Preserving Company, Whitehouse, Florida; Newsom Brothers/Old Reichold, Columbia, Mississippi; Bypass 601 Groundwater Contamination, Concord, North Carolina; Hipps Road Landfill, Duval County, Florida; Maxey Flats Nuclear Disposal, Hillsboro, Kentucky and Perdido Groundwater Contamination, Perdido, Alabama.

Oak Ridge National Laboratory, Geologist. Team leader responsible for planning and conducting filed radiological surveys to investigate potential hazardous radioactive contamination. Prepared final reports from field-generated data for the Department of Energy's uranium mill tailings removal act.

Bendix Field Engineering Corporation, Staff Geologist. Project Geologist for remedial action programs dealing with the study of radioactive tailing piles. Duties included interpretation, sampling of tailings and installation of monitor wells. Also, as part the Bendix Exploration staff, conducted exploration drilling programs in the western United States. Planned and supervised the completion of, and lithologically logged, 54,000 feet of rotary and core test holes. Conducted comprehensive geochemical, geophysical, and reconnaissance mapping surveys as part of grass roots exploration programs in the Basin and Range Province of Nevada, California, and southeastern Utah.

Idaho Mining Company, Exploration Geologist. Conducted drilling programs in Colorado and Utah for mining exploration and development. Planned, supervised, and provided lithological and geophysical logging of more than 300 rotary test holes.

D. W. SCHAER (Continued)

SELECTED PUBLICATIONS

Publications

Schaer, D. W., 1981. A Geological Summary of the Owens Valley Drilling Project, U. S. Department of Energy, Open File Report GJBX-128(81).

Schaer, D. W., 1984. Monticello Remedial Action Project Site Analysis Report, Geological Investigation Section, U. S. Department of Energy, Open File Report GJ10.

Morrison, Schaer, Daniels, 1984. Minerals Evaluation of a Denied Area, Classified Document.

KIMBERLY R. SOOVAJIAN
Environmental Engineer

SUMMARY OF EXPERIENCE

Over four years of experience in applications related to environmental compliance of solid and hazardous waste projects, including regulatory and licensing activites for the government sector. Ms. Soovajian is responsible for preparing Engineering Reports for Remedial Investigations under DERP, Environmental Aassessments and Environmental Impact Statements under NEPA, Preliminary Assessments under CERCLA, Contamination Assessments, RCRA Part A and Part B permitting.

Education: BS, Civil Engineering, Syracuse University, 1988.

Registrations: E-I-T/1988/New York

Courses: 40-hour Hazardous Waste Operations Training Course
Ebasco Hazardous Waste Operations Cross Training Course
Ebasco Project Managers Training, 1992

Professional Affiliations: Society of American Value Engineers
Society of American Military Engineers
Chi Epsilon National Civil Engineering Honor Society
American Society of Civil Engineers

REPRESENTATIVE EBASCO EXPERIENCE

City of Atlanta Department of Water: Project Manager of Hemphill; developed the scope of work to assess level of soil and groundwater contamination. Contaminants of concern include TCE, PCE, TCA and polyaromatic hydrocarbons. Field sampling supervision and engineering report preparation.

U.S. Army Corps of Engineers, Huntsville Division: Site Manger and Site Health and Safety Officer for topographic survey of areas suspected of chemical ordnance contamination. She conducted an archives search to determine the potential for UXO contamination, conducted a risk assessment, prepared an engineering report of findings, and prepared work plans for remediation of the contaminated areas.

U.S. Army Corps of Engineers, Huntsville Division: Preparation of environmental assessment pertaining to interim remedial treatment of fuel contaminated soil and ground water at Defense Fuel Supply Point, Ozol, CA.

U.S. Army Corps of Engineers, Huntsville Division: Preparation of RCRA Part A and Part B permit applications for munition deactivation furnaces at seven Army installations.

NASA, Marshall Space Flight Center: Determination of environmental baseline conditions at the entire facility and subsequent preparation of an environmental resource document.

The University of Alabama in Huntsville and U.S. Army MICOM: Preparation of supplemental environmental assessment for the addition of an Aero-Optics laboratory and photographic laboratory to the Aerophysics Test Facility on Redstone Arsenal, AL.

PRIOR EXPERIENCE

As an Environmental Engineer with Stone & Webster Engineering, Boston, MA, Ms. Soovajian managed preparation of environmental reports for the Federal Energy Commission and NY Public Service Commission and was responsible for permitting on federal, state and local levels of over 200 miles of pipeline in northeast U.S. She has been primarily responsible for the environmental impact assessments of large scale engineering and utility projects on water quality, ecological resources, topography, and other environmental resources.

Ms. Soovajian was assigned as an Environmental Inspector of construction and has participated in and testified at numerous public hearings.

Experience in Waste Management includes: Assisting in the development of Environmental Impact Statement for the ongoing New York City Sludge Management Project; siting studies for long-term sludge disposal; site assessments to identify potential hazardous waste sources at candidate construction site, and review of state-of-the-art and proven sludge processing and disposal technologies applying various site/ technology constraints.

As an Engineering Aide for New York State Electric and Gas, Binghamton, NY, Ms. Soovajian designed weir to mitigate thermal plume effects of power plant cooling water discharge to meet NPDES permit requirements; coordinated contractors and vendors, prepared bid package and conducted prebid meeting site visits; and prepared numerous cost estimates and wrote technical specifications.

ALBERT D. O'REAR, SR., P.E.
Regional Engineering Manger

SUMMARY OF EXPERIENCE

Mr. O'Rear is a Registered Professional Engineer with over 25 years experience in siting and other geotechnical engineering aspects of electric power generating stations and light to heavy industrial/commercial projects. He has nineteen years experience in waste management facility design.

Education - Graduate Courses in Civil Engineering, 1970
Bachelor of Civil Engineering, Georgia Institute of Technology, 1969
40-Hour Health and Safety Training for Hazardous Waste Site

Registrations - Professional Engineer in Alabama, Georgia, Kentucky, North Carolina, Florida, South Carolina, Oklahoma, Mississippi, Louisiana, Missouri, Tennessee, Texas, and Washington

REPRESENTATIVE EBASCO EXPERIENCE

Mr. O'Rear is the Regional Manager of Engineering for Ebasco's Southeast region with overall responsibility for remedial design tasks on EPA Superfund and other hazardous waste sites. His project management tasks include work plan preparation with budget/schedule forecasts and direction of technical and administrative activities during preparation of site remediation contract design packages. He provides claims prevention review of contract packages and project bid evaluations.

Mr. O'Rear's other responsibilities include laboratory testing and physical properties of soil and construction materials; impervious liner systems including compacted soil, bituminous and concrete paving and synthetic liner materials; physical layout and evaluation of subsurface investigation programs and interpretation of laboratory data; structural design and evaluation of hydraulic structures including liquid waste disposal and holding ponds, sedimentation ponds and municipal water supply dams and spillway systems; and design of shallow and deep foundation systems for structural support including spread footings, driven and cost-in-place piling and drilled piers.

As Project Engineer for Remedial Design and Remedial Action at the Crystal City Airport, Texas, Superfund site, Mr. O'Rear was responsible for design elements included RCRA cell for deposition of pesticide contaminated soils and demolition debris. He provided engineering support to Construction Management personnel during Remedial Action, which was completed in June 1990 on schedule and under budget.

A. D. O'REAR, SR. (Continued)

For the USEPA - Region IV, Mr. O'Rear was responsible for all Remedial Design activities on Superfund sites for the REM and ARCS programs in EPA Region IV. His remedy elements have included: groundwater pump/treat, bioremediation of contaminated soils, thermal treatment, stabilization and solidification, gas collection systems, and containment in landfills. He provided design/engineering support to the EPA on 15 Superfund sites in 5 EPA Region IV states.

As Engineer, Mr. O'Rear was responsible for Feasibility Study and Remedial Design for a fuel spill at the Lone Star Army ammunition Plant in Texarkana, Texas for the USACE-Huntsville District.

Mr. O'Rear was responsible for the remedial design for cleanup of petroleum contaminated sites throughout Central and South Florida for Florida Department of Environmental Regulation. His experience in remedial measures for soil include soil ventilating, thermal treatment, excavation, aeration and land forming farming of BTEX contaminated soil. His experience includes groundwater remedial measures to pump/treat and floating product recovery systems. Sixty-five sites were assigned to EBASCO through May 1990.

VICTOR H. OWENS, P.E.
Chemical Engineer

SUMMARY OF EXPERIENCE

Mr. Owens has over ten years of progressive experience planning, managing, and conducting investigations, designs, and remedial actions on hazardous waste sites and petroleum spill sites. He has served in various technical and management positions on projects involving groundwater extraction, water treatment, soil treatment, incineration, soil washing, treatability testing, and support facilities. His technical expertise includes groundwater flow modeling, contaminant fate, and transport modeling, hydrogeologic data collection and analysis, and groundwater remediation system design.

Education - M.S./Chemical Engineering, University of Oklahoma, 1982
B.S./Chemistry, University of Oklahoma, 1980

Registrations - Professional Engineer - Georgia, Texas

Specialized Training -
16-Hour Risk Assessment/Decision Analysis, 1987
40-Hour Health and Safety Training, 1985
8-Hour Refresher, 8-Hour Supervisor Training, 1991
80-Hour Project Management Training, 1982
40-Hour Contract Officer's Technical Representation, 1983
40-Hour Cost Schedule Control Systems Training, 1983
40-Hour Applied Simulation of Process Engineering, 1983
50-Hour NOAA Oil Spill Trajectory Modeling (OSSM), 1985

REPRESENTATIVE EBASCO EXPERIENCE

Mr. Owens provides both technical and administrative management of large hazardous waste and petroleum spill sites. As Manager of Remedial Design, he was responsible for multiple projects ranging from $500,000 to $18 million in scope and multiple engineering discipline designs of over 10,000 hours' effort. Mr. Owens has completed both detailed- and performance-based remedial designs incorporating air stripping, diffused air, carbon adsorption, electrochemical coprecipitation, chemical precipitation, in-situ soil flushing, incineration, and various groundwater extraction and disposal technologies.

Environmental Operations Manager - Responsible for administrative and technical management of Ebasco Environmental operations in North Carolina.

V. H. OWENS, P.E. (Continued)

Remedial Design Manager - Responsible for coordinating and conducting multiple hazardous waste remedial designs and petroleum spill clean-up designs.

Project Manager - Tower Chemical CERCLA Site - Responsible for management of Remedial Design for cleanup of pesticide and metals contamination in soil and groundwater. Design elements included in-situ soil washing, groundwater extraction, on-site water treatment and thermal treatment of contaminated soils. Project included field sampling for soil characterization, treatability studies for soil flushing and water treatment and various subcontracts for drilling surveying. Project duration was 18 months, over 11,000 man-hours effort and $800,000.

Project Engineer - National Aeronautics and Space Administration, Johnson Space Center - Designed and conducted a soil gas sampling program within the Thermochemical Test area to determine source-point and possible excursion of Freon-113 leaking from damaged propellant sewer line. Both soil gas extraction as well as passive adsorption methods of soil gas sampling were used. Performed receptor point risk analysis to determine off-site migration rates. Prepared closure plans for two underground hazardous waste storage tanks. Designed and conducted pilot-scale (2 gpm) water treatment system to remove metals and cyanide contamination from electroplating and photographic wastewaters.

Project Engineer - Storage Tank Conversion - Texas Utilities - Designed, constructed and operated two small (20 GPM) water treatment facilities to remove organics, suspended solids and metals from water used to wash two 250,000 barrel fuel-oil storage tanks. Performed environmental monitoring inside the storage tank including lower explosive limit, VOA level monitoring, oxygen and air exchange rate.

Project Hydrologist - Whitehouse Waste Oil Pits - Responsible for designing and conducting a groundwater contaminant transport modeling effort to determine off-site receptor impact for five metal and four organic contaminants. A novel modeling technique was required to account for statistical variability of input data and subsequent effects on output. A fully parametric analysis resulted showing most likely, least likely and distribution of results that confirmed the need for more thorough site characterization.

Project Hydrologist - U.S. EPA, Distler Farm and Distler Brickyard CERCLA Sites - Responsible for preparation of engineering design of soil and groundwater cleanup for both sites. Prepared remedial work plan including hydraulic analysis and contaminant recovery system design.

Project Engineer - Georgia UST Program - Provided detailed design and construction oversight of complete remedial systems for leaking UST sites throughout Georgia, including groundwater extraction, treatment, and disposal.

V. H. OWENS, P.E. (Continued)

PRIOR RELEVANT EXPERIENCE

Research Planning Institute, Inc.
Senior Engineer

Managed and conducted computer modeling study of industrial discharge of toxic wastes into Gulf Coast estuaries in Florida, Alabama, Louisiana and Texas. Managed the preparation of data bases for NPDES permitted discharge of wastes containing toxic constituents from 170 facilities. Designed and conducted soil gas sampling programs for investigation of leaking underground storage tanks. Designed, conducted and evaluated multiple well pump tests in remedial design of groundwater contaminated with metals. Designed passive recovery and storage system for underground oil spill from ruptured fuel lines. Developed and applied computer models of sediment transport of PCB's in streambeds for remedial design purposes. Developed and applied computer models for transport of organic contaminants in estuarine environments. Designed and conducted a field test of the formation of respirable asbestos from construction activities at an abandoned asbestos waste landfill.

Morgantown Energy Technology Center
Chemical Engineer

Managed research in multiphase flow in petroleum reservoirs. Designed and conducted laboratory experiments on recovery of petroleum from scaled flow cells. Designed and directed the study of surfactant assisted and miscible (carbon dioxide) recovery of water-flooded petroleum reservoirs. Designed, prepared and tested multicomponent, multiphase equation of state solution algorithms for application in reservoir models. Designed and prepared a multiphase, multicomponent reservoir flow computer model (compositional model).

PUBLICATIONS: JOURNALS AND SYMPOSIA

S. Watanasiri, K. E. Starling, and V. Owens. 1985. Correlations for Estimating Critical Constants, Acentric Factor, and Dipole Moment for Undefined Coal-Fluid Fractions. I & EC Process Design and Development, Vol. 24: pp. 294.

W. J. Sexton, J. Michael, J. Maceolik, and V. Owens. 1987. A Comparison of Soil-gas Sampling Methods Used a Two Harbor Sites. Proceedings, 1987 Oil Spill Conference. Baltimore, Maryland.

T. Y. R. Lo and V. Owens. 1987. Development of Methodologies for Evaluation of Well-Point Systems. Superfund '87, Proceedings of the 8th National Conference. Washington, D.C.

N. A. Ellington, B. Houston, and V. Owens. 1991. Tower Chemical: Remedial Design for a Small but Complex NPL Site. Proceedings, 1991 Design and Construction Issues at Hazardous Waste Sites Conference. Dallas, Texas.

LYN R. PHILLIPS, P.E.
Civil/Structural Engineer

SUMMARY OF EXPERIENCE

Total Experience - Registered Professional Engineer with 15 years experience in structural and general civil design, construction and management on hazardous waste remediation, electric power generation, and pulp and paper industry projects.

Education - Georgia Institute of Technology, 1977

Registrations - Professional Engineer - Georgia, Florida

REPRESENTATIVE EBASCO PROJECT EXPERIENCE (Since 1977)

Experience includes structural steel, reinforced concrete, and general civil design; preparation of job specifications, design criteria and procedures; coordination of inspection and testing programs; quality assurance reviews; field engineering; project management.

Projects Include:

Geiger Site, Charleston County, South Carolina - US EPA ARCS IV Program. Functioned as site manager for this remedial design project, which includes soil and groundwater investigations and remediation. Groundwater is to be extracted, treated, and released to surface water; soil is to be treated by solidification/stabilization and/or thermal treatment methods.

Hollingsworth Solderless Terminal Company Site, Fort Lauderdale, Florida - US EPA REM III Program. Functioned as site manager for the project which involves review of remedial design documents, procurement activities, and remedial action oversight. Remedial action includes VOC contaminated soil and groundwater remediation. Soil is to be treated in-situ; groundwater is to be extracted from the aquifer, pumped through stripping towers until "clean", and then reinjected.

Sikes Disposal Pits, Crosby, Texas - Texas Water Commission. Functioned as staff engineer on the proposal for the remedial action at this site which involves excavation of contaminated material, incineration, disposal of ash on-site, treatment of surface water, and discharge into an adjacent river. Responsible for earth work quantity calculations.

L. R. PHILLIPS (Continued)

PRIOR EXPERIENCE (3 years)

600-MW Coal Fired Unit 1, Killen Electric Generating Station, Manchester, Ohio - Dayton Power and Light Company. Functioned as staff engineer on the design of this power plant. Responsible for miscellaneous structural steel framing and reinforced concrete design; design of structures for the coal barge unloading facility; design of earthwork, including sheet piling and drainage structures, at the ash pond and the river front area; field engineering prior to and during start-up operations.

Dravo Engineering Companies, Inc./Sandwell Swan Wooster, Inc.
Atlanta, GA

Structural Engineer

Responsible for all aspects of design of buildings and miscellaneous facilities for pulp and paper industry clients, including layout of main building systems (framing, bracing, foundations) and design of individual elements; layout and design of pipe bridges, coal and biomass handling system structures; on-site engineering support to construction. Also responsible for maintaining updated project documents; interfacing with clients, construction forces, and other engineering disciplines; coordination of work within the project group.

KEN CHEN, P.E.
Lead Water Treatment Process Engineer

SUMMARY OF EXPERIENCE (Since 1970)

Total Experience - Registered Professional Engineer with over 20 years experience in water quality and treatment technology, wastewater control, regulatory compliance, and solid waste management.

Education - BS/Civil and Environmental Engineering,
MS/Environmental Engineering, 1970

Courses - 40-Hour Health and Safety Training for Hazardous Waste Site, 1989

Registrations - Professional Engineer - New York (#048448), Pennsylvania (#19280), Florida (#20457), Virginia (#9414), Georgia (#17908), Texas (#66004)

Affiliations - Water Pollution Control Federation
American Society of Civil Engineers

REPRESENTATIVE EBASCO EXPERIENCE (Since 1988)

Mr. Chen has performed groundwater treatment process selection and design at numerous petroleum-contamination sites in Florida, Georgia, and Texas. Representative Projects include:

Lone Star Army Ammunition Plant Texarkana, Texas - Functioned as principal engineer to evaluate the extent of petroleum contamination, to develop a remedial plan and to prepare technical drawings and specifications for the soil and groundwater remediation.

Petroleum Contamination Sites in Florida - Functioned as principal engineer to evaluate the extent of the hydrocarbon contamination in the groundwater and to develop treatment processes for groundwater remediation.

Coleman Evans Wood Preserving Company Site, Whitehouse, Florida - Functioned as principal engineer in reviewing the bioremediation and stabilization treatability studies for soil remediation.

Tower Chemical Company, Clermont, Florida - Functioned as Principal Engineer in review of the technical feasibility and cost effectiveness of the groundwater cleanup system. Established design criteria, developed Water Treatment processes, prepared construction drawings and technical specifications for the Water Treatment System.

Bog Creek Farm Site, Monmouth County, New Jersey - Functioned as Principal Engineer in review of the technical feasibility, design criteria, and specifications for an aqueous water treatment system.

Hollingsworth Solderless Terminal Company, Fort Lauderdale, Florida - Functioned as Principal Engineer in review of the design criteria, construction drawings and technical specifications and shop drawings for an air stripping system to treat the VOC-contaminated groundwater.

K. CHEN (Continued)

SCRDI Dixiana Remedial Action Site, Lexington County, South Carolina - Functioned as Principal Engineer in review of the design criteria, construction drawings, and technical specifications and shop drawings for the groundwater treatment system.

Colonial Pipeline Company, Atlanta, Georgia - Functioned as Project Manager for preparation of a proposal for wastewater treatment program for 14 tank farm locations and design of two aerated ponds for wastewater treatment at two locations.

NASA Wallops Flight Facility - Functioned as Principal Engineer in developing groundwater treatment processes and the design criteria.

Florida Power & Light Company - Functioned as Principal Engineer in a technical feasibility and cost effectiveness study of a wastewater treatment system for the repowering of Fort Lauderdale Units 4 and 5. Established design criteria, developed schematic process diagram and prepared technical specifications for the wastewater treatment system.

North Cavalcade Superfund Site Harris County, TX - Functioned as principal engineer in preparation of a proposal and a technical plan for groundwater treatability study and remediation and construction drawings and technical specifications for the groundwater treatment system.

PRIOR EXPERIENCE (18 Years)

Tennessee Valley Authority
Chattanooga, Tennessee
Chemical Engineer

Functioned as a lead engineer in the area of water, wastewater, coal ash, and indoor air projects. Responsibilities included preparing proposals, developing and implementing project plans, process development and testing, test data evaluation, technical supervision, coordination, inspection, and preparation of comprehensive technical reports. Representative specific project responsibilities included:

Water Projects

1. Technical feasibility study and cost estimate of reverse osmosis (RO) systems to supplement plant makeup water systems.
2. A technical proposal for an online boiler water chemistry diagnostic monitoring system.

Wastewater Projects

1. Study of coal pile drainage treatment
2. Pilot plant study to treat priority pollutants.
3. Removal of polychlorinated biphenyls (PCB) from contaminated transformer oils.

K. CHEN (Continued)

L. Robert Kimball & Associates
Ebenburg, Pennsylvania
Assistant Department Head

Functioned as a project manager. The responsibility included preliminary planning, report, design, and preparation of plans and specifications for water and wastewater treatment facilities and solid waste management projects. The project responsibilities are extended to cover project management, supervision, construction coordination, and periodic inspection.

Clinton Bogert Associates
Fort Lee, New Jersey
Sanitary Engineer

Functioned as a sanitary engineer performing hydraulic and process design of water and wastewater treatment plant, sludge handling and disposal study, and computer analysis of operating data for the Bergen County Sewer Authority Sewage Treatment Plant (150 MGD), Little Ferry, New Jersey.

Hazen and Sawyer, Consulting Engineers
New York, New York
Sanitary Engineer

Functioned as a sanitary engineer, involved in report preparation, planning, and design for various water and wastewater facilities and laboratory and pilot plant studies of activated sludge treatment of industrial wastes combined with municipal sewage, using air or pure oxygen aeration.

PUBLICATIONS

"Evaluation of the Sunohio PCBX Process for Reclamation of Transformer Oils Containing PCBs," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-102, pp. 3893-3898, December 1983.

"Characterization and Treatment of Trace Metals in Coal Pile Drainage," 44th International Water Conference, pp. 83-94, October 1983.

"Pilot Plant Study to Treat Priority Pollutants in Coal Pile Drainage," 45th International Water Conference, pp. 284-292, October 1984.

LORETTA A. GARCIA
Community Relations

SUMMARY OF EXPERIENCE (Since 1979)

Total Experience - Thirteen years experience including community relations plans and programs, quality assurance activities, land use/rezoning presentations, radiological emergency response planning, evacuation time estimate studies, environmental assessments and report preparation, and toxicological research.

Education - BS/Natural Resources and Environmental Science, Purdue University, 1979
Graduate course on Geology of Tropical Marine Environments, University of Miami (FL) Rosensteil School of Marine and Atmospheric Sciences, 1977

Courses - "Dealing with Upset Citizens and the Public," Workshop sponsored by University of Nebraska-Lincoln, Center for Leadership Development, 1991

REPRESENTATIVE EBASCO EXPERIENCE (Since 1986)

Community Relations/Environmental Planner

Responsible for community relations planning and programs for hazardous waste projects; socioeconomics and land use identification including rezoning; radiation emergency response planning at and around nuclear power plants; support to environmental assessments and permitting; and quality assurance compliance on siting studies for private utility and federal agencies.

Projects Include:

EPA Region IV - ARCS IV and REM III Superfund Projects. Prepared community relations plans and programs, fact sheets, public notices, and arranged for public meetings and press briefings for remedial investigation and implementation phases of numerous Superfund hazardous waste site cleanups in Florida, Kentucky, Tennessee, North Carolina, South Carolina and Connecticut. Performed project closeout responsibilities which included file reviews and audits for final preparation and submittal of hard copy and microfiche files.

Federal Energy Regulatory Commission - Mobile Bay, Southern Natural and Gateway Offshore Gas Pipeline Projects. As part of a comprehensive EIS, identified the affected federal, state and local jurisdictional governments, agencies, public interest groups, libraries, newspapers, parties in the proceeding and interested individuals to receive a "Notice of Intent" to prepare the draft EIS. Prepared a coded and sortable mailing list for mailing label creation.

Public Service of New Hampshire - Seabrook Station. Provided licensing reviews and presented legal issues on draft emergency response plans and procedures of two states in an effort to support award of an operating license for Seabrook Station nuclear plant in New Hampshire.

L. A. Garcia (Continued)

Florida Power & Light Company - Martin Coal Gasification/Combined Cycle Expansion Project, Indiantown, Florida. Quality Assurance Coordinator for the monitoring and program established to meet state and federal environmental licensing requirements. Prepared QA Plan and Procedures, performed audits, inspections and training of personnel. Also responsible to Project Management for coordination of socioeconomic, land use and environmental preservation studies required to meet county requirements for rezoning in compliance with Site Certification Application requirements.

Clean Power Cogeneration, Inc. - Air Blown Integrated Gas Combined Cycle Demonstration Project, Tallahassee, Florida. Quality Assurance and Document Development coordinator. Responsible for preparing QA plan and procedures to include technical discipline coordination, as well as develop document style guides and identify administration needs in order to produce the Plan of Study, Volume of Environmental Information and Site Certification Application for a demonstration IGCC unit at an existing generating station site in Florida.

Black & Veatch, Engineers/Architects - Oglethorpe Power Corporation Combustion Turbine Project Limnology Study. As Quality Assurance Specialist, developed the QA plan and procedures and coordinated the reviews and responsibilities of the environmental QA leads. Provided QA training to project personnel and assured implementation of the program through periodic monitoring of documentation and scheduled audits.

Confidential Client - Various mine site feasibility analyses in southeast Georgia. Responsible for technical review and coordination of state regulatory and licensing updates and client impacts.

Georgia Power Company - Vogtle Nuclear Plant. Performed quality assurance verification and review of the Vogtle Nuclear Plant operations assessment program (OAP) in preparation of a low-power license application including database and file reviews with multi-discipline interface.

Florida Power & Light Company - Turkey Point Unit 4. Conducted work as part of an extensive project quality assurance program. Established 28-volume support document collection for presentation to the U.S. NRC of activities determining root cause and affect analysis, and mitigation of a reactor containment boric acid leak at Turkey Point Unit 4 nuclear power plant.

L. A. Garcia (Continued)

PRIOR EXPERIENCE (7 Years)

Ambric Environmental Sciences, Inc., Philadelphia, PA (Summer 1986)

Research Assistant - Prepared research and literary review for presentation to legal staff on toxicity, carcinogenicity, safety and occupational hazards of polynuclear aromatic hydrocarbons (PAHs) and specific volatile organic compounds (VOCs) discovered at a site in litigation. Included database searches on DIALOG and BRS data files.

Stone & Webster Engineering Corporation, Boston, MA (1979-1986)

Prepared radiological emergency response plans for the states of New Jersey and Maryland and counties and municipalities in the 10-mile emergency planning zone. Responsibilities included meeting with and assessing state and local agencies' capabilities and resources, identification and designation of notification and protective actions warranted for public safety in fulfillment of federal and state regulations, and directed planning team members in the preparation of the planning documents. Prepared and developed sections of these plans and developed and updated implementing procedures for state and local agencies involved.

Prepared the evacuation time estimate study for two nuclear power plants affecting the states of Ohio, Kentucky, Pennsylvania, and Maryland. Included field work and data acquisition to determine affected permanent and transient populations, and evacuation roadway network definition for coding and input into the NETVAC2 computer evacuation simulation model.

Coordinated engineering tasks with construction and quality assurance representatives to meet Project 2 (P2) computer scheduling commitments for N-5 certification stamp on ASME III piping in 260 systems. Modified P2 computer sub-program for tracking piping status to outstanding materials and work responsibility. Hired and trained data entry and records management staff.

Identified critical pathways of outstanding nonconformance and disposition reports (N&Ds) and Engineering and Design Change Reports (E&DCRs) for client presentation. Supported Engineering Assurance in meeting auditing directives on record maintenance of site, corporate, and nuclear safety training of engineering personnel.

Responsible for preparation of environmental report sections on: surface water use of the lower Mississippi River and on Long Island Sound; land uses along a 120-mile transmission line corridor in Louisiana; archaeological and historical site identification and description along the same corridor; visual impacts by a plant site. Drafted aquatic ecology section.

H. R. KOEPLIN
Civil/Structural Engineer

SUMMARY OF EXPERIENCE (Since 1956)

Total Experience - Civil Engineer with 35 years experience in engineering, analysis, design, layout and construction of chemical plants, harbor facilities, electric generating stations, industrial plants, commercial facilities and environmental projects.

Education - BS, State School of Engineering, Eckernfoerde, Germany, 1956 - Civil Engineering

Courses - Earthquake Engineering Conference, University of South Carolina, January 1975

REPRESENTATIVE EBASCO PROJECT EXPERIENCE (Since 1970)

Principal Engineer, Supervising Design Engineer, Senior Design Engineer, Design Engineer

Responsible for the development of engineering, analysis and design concepts from conceptual layout through the final engineering, design, detail and construction phase. Responsibilities have included supervision, coordination and review of engineering analysis, design and details.

Technical responsibilities include coordination with other engineering disciplines; support and guidance of design teams; preparation of studies, reports and estimates; development of specifications, of design criteria and concepts, of schedule and budget and preparation of progress reports.

Construction experience include preparation of construction bid packages, construction specifications, and bid evaluations, including site and home office pre-bid briefings with construction contractors and construction liaison.

Major civil responsibilities for various projects included civil site structures (excavation, fill and site grading; dikes, retaining structures, sheet piling, clean and contaminated site drainage systems with lined and unlined basins, intake and discharge structures, pump structures and revetments); roads and railroads; environmental control structures; waste treatment facilities and major plant structures and buildings; waterfront facilities for barge unloading and storage, coal unloading facilities with mooring and berthing facilities.

H. R. KOEPLIN (Continued)

Projects Include:

Current environmental project responsibilities include Remedial Design for the EPA - REM III Program for the Tower Chemical Company site project in Lake County, Florida, and preparation of site specific contract documents and drawings to perform Remedial Action with thermal treatment objectives for contaminated site soils and for site preparation and water treatment (groundwater, stormwater runoff).

Further environmental tasks have included preparation of final Remedial Design and contract packages with drawings for the Coleman Evans Wood Preserving Project in Jacksonville, Florida, and for the Texas Water Commission Remedial Action at the Crystal City Airport site, Zavala County, Texas; preparation of site specific specifications and construction drawings for the Remedial Ohio River Bank Protection Controls at the Lees Lane Landfill site, Louisville, Kentucky; preparation of draft Guidance Documents for Bidability Review and Constructability Review for the EPA Regional and State Superfund Staff for REM III-EPA Contract work assignments, and assist the regional EPA in performing operation and maintenance tasks for the Newport Dump site, Winder, Campbell County, Kentucky.

Louisiana Power and Light Company - Nine Mile Point Unit 4. Size 750 MW. Fuel - coal.
U. S. Army Corps of Engineers, Mobile District - Redstone Arsenal Central Boiler Plant. Size 25 MW. Fuel - coal.

U.S. Environmental Protection Agency Region IV, Atlanta, Georgia - Tower Chemical Company Site, Lake County, Florida.

U.S. Environmental Protection Agency Region IV, Atlanta, Georgia - American Creosote Site, Escambia County, Florida.

Texas Water Commission, Austin, Texas - North Cavalcade Superfund Site, Harris County, Texas.

U. S. Environmental Protection Agency Region IV, Atlanta, Georgia - Coleman Evans Wood Preserving Company Site, Whitehouse, Florida; Lee's Lane Landfill Site, Jefferson County, Kentucky; New port Dump Site, Winder Campbell County, Kentucky.

H. R. KOEPLIN (Continued)

PRIOR EXPERIENCE

Major civil responsibilities for projects prior to 1970 included engineering, analysis and design of circulating water systems with cooling towers, pump basins, intake and discharge structures; civil site structures; roads and railroads; environmental control structures; waste treatment facilities; major plant structures (boiler building, turbine building with T/G pedestal, auxiliary buildings, warehouses, service/administration buildings, transformer, switchyard and miscellaneous equipment foundations) coal handling and storage facility structures and foundations (car dumper, transfer houses, crusher building, stacker-reclaimer, conveying system, active and inactive coal storage and coal silos); miscellaneous tanks and tank foundations, pump stations, riverfront facilities and chimneys.

SUE K. JONES, REPA
Environmental Chemist

SUMMARY OF EXPERIENCE (Since 1979)

Total experience - Work experience consists of thirteen years of environmental chemistry experience. This background covers hands-on laboratory analyses of a wide variety of environmental and industrial samples and supervisory level management of laboratory activities.

Education - B.S., Villa Maria College, 1979 - Biology/Chemistry

Member - American Chemical Society, National Registry of Environmental Professionals

Courses - 40 Hour Health and Safety Training for Hazardous Waste Site, 1988
REM III Supervisory Training, 1989
8 Hour Health and Safety Refresher, 1990
Numerous Hazardous Waste Seminars and Conferences

REPRESENTATIVE EBASCO PROJECT EXPERIENCE (Since 1988)

Environmental Chemist

Ms. Jones performs as Technical Lead on many hazardous waste and environmental projects. This involves writing and reviewing FSAPs, QAPPs, subcontractor laboratory bid specifications, and other technical documents. Also consults with Project Managers regarding sampling and analysis protocols. Coordinates all non-CLP laboratory analysis.

REM III Program. Coordinated all laboratory support services provided by the REM team members. The analytical level of support for this project was in excess of 3 million dollars in lab fees over a 4 year period. Performed audits on mobile laboratory operations at Superfund sites.

EPA Regions I, III, and V. Data validation experience for Regions I and III consists of more than 400 hours of Contract Laboratory Program (CLP) protocol validation. Designed mobile lab specifications for the ARCS V program which was chosen out of three as the prototype lab trailer for the Region.

S. K. JONES (Continued)

State of Georgia and Gwinnett County. Serves as laboratory liaison for the Underground Storage Tank (UST) programs for these two clients. This involves writing technical specifications for all laboratory activities and analyzing reported results. Writes Health and Safety Plans for field activities and serves as Health and Safety Officer for these sites. Performs well searches as part of Corrective Action Plans.

Army Corps of Engineers. Is Technical Lead for ongoing UST and hazardous waste sites that involves compiling all analytical data, evaluating it for usability, and writing Chemical Data Acquisition Plans, Work Plans, and Engineering Reports. Five sites are currently in progress in this program. Was Technical Lead on Part B Permit Applications at 20 sites across the country and developed waste characterization and analysis plans for these sites. These sites involved open burning and/or open detonation of waste munitions. Also prepared Part B Permit Applications for the United States Military Academy at West Point, Crane Army Ammunition Activity, and the NASA facility at Wallops Island.

FPL. Developed a Hazardous Waste/Materials Minimization Plan which included creating a database of all hazardous materials presently used or in design specifications and utilizing a hazard ranking system to prioritize minimization efforts.

Penelec. Developed contractor bid specifications for all environmental aspects of demolition of a coal-fired power plant. The environmental concerns included asbestos, fly-ash, and PCBs.

United States Postal Service and Various Clients. Has performed real-estate transfer audits to comply with various environmental regulatory and internal requirements.

Prior Experience (8 years)

Metallurgical Engineers, Div. of ATEC Associates (1987)

Ms. Jones was engaged to re-initiate activities of the chemistry laboratory at this division. She was responsible for planning and design of the laboratory and for all instrument and equipment maintenance and performance. She was also responsible for the hiring, training, and supervision of laboratory technicians.

S. K. JONES (Continued)

One of Ms. Jones' principal tasks was to obtain certification of the laboratory by the American Association of Laboratory Accreditation and the State of Florida. To accomplish this, she composed and implemented a Quality Assurance/Quality Control Manual that was used by all three divisions of the Company, and successfully completed on-site evaluations by both agencies as well as analyses of performance evaluation samples. Ms. Jones was responsible for tracking all quality control activities and summarizing the information in graphs and charts.

Dunn Laboratories (1980-1987)

Ms. Jones obtained extensive background in the analysis of environmental and industrial samples. Because of the variety of the work load, Ms. Jones was called upon to develop new methods or modify existing methods.

Ms. Jones regularly performed laboratory analyses of potable water using EPA-approved methodology. She also analyzed wastewater for its conformance to N.P.D.E.S. permitting limitations and assisted clients in completing permit applications and reporting. Ms. Jones has extensive experience in the analysis of solid waste for the determination of its hazardous characteristics, such as ignitability, corrosivity, reactivity, and E P Toxicity metals using the methods in SW-846. This testing was done for some clients as part of delisting petitions or for informational purposes prior to disposal. Ms. Jones also analyzed debris obtained from fire and/or explosion scenes to determine presence of accelerants.

STEPHEN E. WERNER
Senior Cost Engineer

SUMMARY OF EXPERIENCE (Since 1979)

Mr. Werner provides pricing and financial analysis support to various levels of management, ensuring cost proposal compliance with applicable Cost Accounting Standards, and Federal Acquisitions Regulations. He has over ten years experience in the government contracts arena, providing programmatic support to various cost-reimbursable and fixed-price contracts. His experience also includes the planning, scheduling and cost control of engineering and construction projects.

Education: MBA/1984/Contracts Management
BS/1981/Business/Finance

Certifications: Twice certified in Cost/Schedule Control Systems Criteria (C/SCSC)

REPRESENTATIVE EBASCO EXPERIENCE

Mr. Werner has provided cost and schedule administration support to delivery order and project managers on firm-fixed price A-E services contracts with U.S. Army Corps of Engineers' Mobile, Savannah, and Tulsa Districts and the Huntsville Division.

Mr. Werner also supports Ebasco's tasks including assignments for remedial investigations. Primavera schedules and cost estimates are established early in the project and are used to monitor each task for schedule and cost status and to evaluate the overall contract performance.

As a Cost Control Analyst with Rexham Aerospace & Defense in Huntsville, Mr. Werner was responsible for the development and maintenance of a project control database for the U.S. Navy five-inch Guided Projectile contract; conceptualized and implemented a baseline control system and appropriate policies and procedures, and served as a Deputy for the program manager.

Mr. Werner was a Project Control Administrator for TRW Defense Systems Group. His responsibilities included the cost/schedule control, performance measurement, and business management of a number of cost-reimbursable and fixed price contracts with the U.S. Army Strategic Defense Command, Missile Intelligence Agency, and NASA. Mr. Werner ensured compliance with DoD Directives 7000.1 and 7000.2 (PMS, C/SCS), and successfully passed AFPRO and DCAA audits on his projects.

STEPHEN E. WERNER (Continued)

As a Buyer (Solid Rocket Booster/Space Shuttle Program) for United Technologies/ United Space Boosters, Inc., Mr. Werner was responsible for subcontract administration of SRB Battery hardware, consultant contracts, and assisted in administering several cost-reimbursable subcontracts in excess of $10 million. He also played a lead role in RFP evaluation, cost/price analysis of contract changes, negotiations, and other procurement-related transactions.

Mr. Werner provided program control expertise and software applications support to the Joint Technical Fusion Program Office, a $1 billion joint U.S. Army/Air Force effort developing automated tactical command and control intelligence systems. Develops, analyzes, and maintains master/detailed schedules utilizing the Critical Path Method (CPM) while integrating cost/performance data, such as spend plans, CPR reports, and Baseline Cost Estimates, provides decision support analyses to all levels of military/ contractor insight to the program office.

GERALD L. DELANEY, C.I.H.
Regional Health and Safety Manger

SUMMARY OF EXPERIENCE

Mr. Delaney has over 25 years of progressively responsible experience in safety, industrial hygiene, environmental engineering and project management for hazardous and toxic waste and environmental programs. He provided program oversight for the Department of the Army in both the occupational health and environmental health arenas.

Education: MS/1966/Environmental Engineering
BCE/1964/Civil Engineering

Registrations: 1980/Certified Industrial Hygienist

REPRESENTATIVE EBASCO EXPERIENCE

As Industrial Hygiene Consultant to the Army Surgeon General, LTC Delaney provided oversight of the Army's industrial hygiene program worldwide. As Director for Industrial Hygiene at the U.S. Army Environmental Hygiene Agency (USAEHA) Col Delaney managed a worldwide industrial hygiene support program which supported DERP, IRP, and the Kuwait Oil Fire Health Risk assessment.

As Director for Environmental Quality/Environmental Health Engineering at the U.S. Army Environmental Hygiene Agency, Col Delaney managed oversight of USAEHA support of the Army's DERP, IRP and all hazardous waste projects worldwide. He oversaw the USAEHA and the Agency for Toxic Substances and Disease Registry (ATSDR) interface on all hazardous waste projects/sites which the ATSDR evaluated. He developed and presented the 8-Hour annual OSHA update to employees requiring annual recertification within the Hazardous Waste Division at the USAEHA.

As Commander, U.S. Army Pacific Environmental Health Engineering Agency, Sagami, Japan, he directed studies and laboratory services in environmental health, environmental pollution, environmental sanitation, industrial hygiene, medical entomology, radiological health, and toxic and hazardous waste disposal, for all U.S. Army and selected DoD installations in the western pacific area of operations.

As Project Officer at U.S. Army Medical Laboratory, Ft. Baker, CA, he conducted radiation protection surveys and industrial hygiene surveys at U.S. Army facilities throughout the western United States and Alaska.

As Industrial Hygienist at USAEHA, he conducted comprehensive industrial hygiene studies at U.S. Army facilities worldwide.

JAMES P. ANDERSON, P.G.
Principal Hydrogeologist

SUMMARY OF EXPERIENCE

Mr. Anderson has over eighteen years of experience in hydrogeologic studies, field mapping, soil and water contamination investigations, site assessments, satellite and aerial photo interpretation, groundwater modeling, geological modeling, and computer applications. His experience includes well-developed skills and demonstrated ability to organize and supervise projects including geologic report writing, regulatory requirements, client presentations, strategic and organizational planning, and project management.

Education - M.S., Colorado School of Mines, Golden, Colorado, 1977, Geology/Hydrogeology

B.S., Eastern Illinois University, Charleston, Illinois, 1973, Geology/Geochemistry

Professional Affiliations - American Association of Petroleum Geologist - CG #2637
American Institute of Professional Geologist - CG #8513
Registered Geologist - State of Wyoming - #1814
Registered Geologist - State of Georgia - Pending

Certification - 40-Hour Refresher Health & Safety Training for Hazardous Waste Sites -1992

Refresher Training Annually

REPRESENTATIVE EBASCO EXPERIENCE

As Principal Geologist, Mr. Anderson's responsibilities include planning, conducting and managing surface and subsurface investigations to determine geological and hydrological conditions such as aquifer properties, groundwater modeling, site stratigraphy and structure, and contamination levels and potential for migration. Representative projects include:

Army Corps of Engineers - Hydrogeologist for ongoing UST and hazardous waste sites that included writing Chemical Data Acquisition Plan, Work Plan, and Monitoring Well Installation and Soil Sampling Plan.

Tennessee Valley Authority - Geologist and author of geological, hydrogeological and soil sections of the Environmental Impact Statement for Land-Between-the-Lakes, Tennessee and Kentucky.

J. P. ANDERSON, P.G. (Continued)
Principal Hydrogeologist

REPRESENTATIVE EBASCO EXPERIENCE

Times Beach, St. Louis, Missouri - This project involves on-site incineration of dioxin contaminated soils. As hydrogeologist, Mr. Anderson's responsibilities included well design and specifications for 50 gpm well, review of geological and hydrological conditions of contaminated site, and review of groundwater models.

PRIOR EXPERIENCE SINCE (Since 1984)

As a Senior Geologist/Project Manager/Hydrogeologist, Mr. Anderson led site investigations, hydrogeologic studies, and geologic mapping throughout the South Pacific and Rocky Mountain Region. Project Manager for a 12-company consortium working in the South Pacific.

As a Project Manager/Hydrogeologist, Mr. Anderson's responsibilities included field geologic mapping, site investigation work, satellite imagery analysis, regulatory requirements, and strategic and organizational planning. Set up soil and water testing laboratory. Supervised collection and analysis of thousands of water and soil samples.

As a Senior Hydrogeologist, Mr. Anderson supervised three in the monitoring, collection, and analysis of groundwater and soil samples. Mapped contamination plumes and wrote computer program to calculate mixing of groundwaters.

As an Exploration Geologist, Mr. Anderson conducted exploration and drilling programs in Colorado, Kansas, Wyoming, Nebraska, and Texas for petroleum exploration. Responsibilities included project development, planning, supervision, well site geological logging, and geophysical logging. Efforts lead to a 35 percent success rate in oil/gas discoveries.

THOMAS L. MARKS
Electrical Engineering Technologist

SUMMARY OF EXPERIENCE (Since 1973)

Total Experience - Twenty years of combined electrical design and engineering experience with supervisory capabilities to fulfill positions of responsibility. Experience includes the design of lighting, power, control and communication systems for fossil and nuclear power plants as well as commercial, industrial and institutional projects. Responsibilities have included the supervision of an administrative services department of 20 personnel, supervision of construction for quality assurance, review of vendor shop drawings and preparation of reports. Has been responsible for projects from start to finish including: manpower estimates, design, specifications, cost estimates, meetings with client, bid evaluations and field inspection.

Education - University of Alabama - 1969 - 1972 (Part Time)
Prerequisite course studies for degree in EE

University of Alabama - 1967 - 1969 (Part Time)
Prerequisite course studies for degree in EE

Professional Affiliations - State of Georgia Electrical Contractors License

Certification - Completed Leadership and Development Programs offered by Ebasco.
Completed Courses in Data Base Management and Traffic Engineering at Northern Telecom's Training Facility in Dallas, Texas.
Completed Courses in Computer Programming including Basic, Dbase II, and CPM offered by Ebasco.
Completed Courses in Computer Aided Design for Intergraph CAD System offered by Ebasco.

REPRESENTATIVE EXPERIENCE

CLIENT	PROJECT	POSITION
City of Huntsville, AL	Huntsville Space and Rocket Center Museum	Sr. Designer
Jacksonville Electric Authority/Florida Power and Light Co.	St. Johns River Power Park 1&2 - 600 MW Fossil Plant	Sr. Designer

T. L. MARKS (Continued)
Electrical Engineering Technologist

REPRESENTATIVE EXPERIENCE

CLIENT	PROJECT	POSITION
Florida Power & Light Co.	St. Lucie - 890 MW Nuclear Plant Unit 1	Sr. Designer
City of Atlanta	Fire Station #5 - Design of lighting and electrical power distribution system. Construction Cost - $1 Million	Lead Engineer
City of Atlanta	Maddox Park Greenhouse Coordination with GA Power for site lighting	Support Engineer
City of Atlanta	Bitsy Grant Tennis Center Design of power system for HVAC renovations. Construction Cost - $150,000	Lead Engineer
City of Atlanta	Gun Club Road Landfill - Design of lighting, controls and power distribution system	Lead Engineer
City of Atlanta	Chattahoochee Hydrated Lime Silo Addition - Design of electrical distribution system	Lead Engineer
City of Atlanta	Piedmont Park Sports Lighting	Lead Engineer
City of Atlanta	High Rise Home for The Elderly at 10th and Juniper. Construction Support	Sr. Designer
City of East Point	High Rise Home for The Elderly Construction Support	Sr. Designer

T. L. MARKS (Continued)
Electrical Engineering Technologist

REPRESENTATIVE EXPERIENCE

CLIENT	PROJECT	POSITION
City of Atlanta	Red Oak Housing Project Construction Support	Sr. Designer
City of Kennesaw	City Government Complex Incl. Jail and Administration Building	Lead Engineer
Courtaulds North America	Complete Plant Relighting With Associated Power Distribution	Sr. Designer
Washington County Hospital	Renovation of Hospital to Comply with Code	Sr. Designer

EMPLOYMENT HISTORY

Ebasco Services Incorporated, Atlanta, Georgia, 1977 - Present

- Electrical Engineering Technologist, 1988 - Present
- Administrative Services Supervisor, 1980 - 1988
- Senior Electrical Designer, 1977 - 1980

Lockwood Greene Engineers, Atlanta, Georgia, 1972 - 1977

- Senior Electrical Designer/Group Leader, 1972 - 1977

James W. Ellis Electrical Consultant, Huntsville, Alabama, 1970 - 1972

- Electrical Designer, 1970 - 1972

Willis Engineering Company, Florence, Alabama, 1966 - 1970

- Electrical/Mechanical Draftsman, 1966 - 1970