FINAL REPORT

INVESTIGATION OF FORMER NIKE MISSILE SITES
FOR POTENTIAL
TOXIC AND HAZARDOUS WASTE CONTAMINATION

VOLUME I

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ARAACOM	U.S. Army Anti-Aircraft Command
ARADCOM	U.S. Army Air Defense Command
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Continuous Flight Auger
COE	U.S. Army Corps of Engineers
CONAD	Continental Air Defense Command
CONUS	Continental United States
DERP	Defense Environmental Restoration Program
DOD	Department of Defense
EPA (US)	United States Environmental Protection Agency
gal	Gallons
HSA	Hollow Stem Auger
ICBM	Intercontinental Ballistic Missile
IFC	Integrated Fire Control
IRP	Installation Restoration Program
lb	Pounds
ml	Milliliter
MR	Mud Rotary
NATO	North Atlantic Treaty Organization
NORAD	North American Air Defense Command
OSHA	Occupational Safety & Health Administration
OVA	Organic Vapor Analyzer
PDP	Preliminary Determination Phase
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SCBA	Self Contained Breathing Apparatus
VOA	Volatile Organic Analysis
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency

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SECTION 1.0 - EXECUTIVE SUMMARY

As part of the Department of Defense's (DOD) Defense Environmental Restoration Program (DERP), this investigation was authorized to determine the potential for toxic or hazardous contamination applicable to all former NIKE Missile Sites located throughout the Continental United States. Phase I of this study provided for specific literature reviews and related data gathering functions to provide general information about potential NIKE site contamination. This report addresses these issues. A summary of the pertinent information is presented as follows:

1. NIKE Ajax and NIKE Hercules missiles were deployed by the United States Army throughout the Continental United States to protect major metropolitan areas and strategic military installations from aerial attack. The NIKE system was generally in place in the time frame encompassing the early 1950s to the mid 1970s.

2. A NIKE site typically consisted of two separate and distinct operating units. These included the Launcher Area and the Integrated Fire Control (IFC) Area. The Launcher Area was generally located on approximately 40-60 acres of land although each site could vary significantly in size and shape. The IFC Area, generally ranged in size from 10-50 acres. The barracks facilities were either incorporated as part of the Launcher Area or the IFC Area, or a third separate and distinct Facility Area was constructed.

3. Maintenance of the missile batteries in a combat ready status required the storage, handling and disposal of missile components as well as solvents, fuels, hydraulic fluids, paints, and other materials required for support functions. Normal operating practices at NIKE batteries in the conduct of these functions possibly resulted in

contamination of the subsurface soil and/or groundwater regime.

4. Virtually all of the information concerning the potential for contamination at NIKE Sites came from interpretation of Operating Manuals and resulting questions directed to past NIKE site operators and the general discussion with these operators which followed in the interview phase of this investigation.

5. Potential contamination source areas at NIKE Sites included:

LAUNCHER AREA

- Missile Assembly Drainage and Seepage Systems
- Diesel and Fuel Oil Storage Tanks
- Magazine Sump Seepage System
- Secluded Areas Adapted to Unofficial Dumping
- Warheading/Fueling Area Drainage Systems
- Motor Pool (when present)
- Septic Systems (when present)

INTEGRATED FIRE CONTROL (IFC) AREA

- Motor Pool (when present)
- Septics Systems (when present)
- Diesel, Fuel Oil, and Gasoline Storage Tanks
- Secluded Areas Adapted to Unofficial Dumping

Of these two Areas, the Launcher Area had the greater potential for contamination.

6. Operating practices producing a potential for contamination at NIKE Sites included:

LAUNCHER AREA

- Missile Assembly and Disassembly
- Missile Fueling and Warheading
- Missile Maintenance and Testing
- General Launcher and Magazine Maintenance

INTEGRATED FIRE CONTROL (IFC) AREA

- Fire Control Operations Maintenance
- Vehicle Maintenance

GENERAL OPERATIONS

- General Facilities Maintenance
- Utility Service
- Deactivation

7. The Master Contaminants List which consists of the potential contaminants of former NIKE Sites that should be investigated for the NIKE Preliminary Determination phase (Phase II of this investigation program) includes:

- Benzene
- Carbon Tetrachloride
- Chromium
- Petroleum Hydrocarbons
- Lead
- Perchlorethylene
- Toluene
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- Trichloroethene

SECTION 2.0 - INTRODUCTION

The Department of the Defense (DOD), conducts a number of industrial processes and manufacturing operations that are similar to private industry. In the late 1970's, DOD became aware of the negative impacts of what were previously considered acceptable disposal practices of waste materials associated with these processes and operations. In response to that knowledge, programs were developed between 1975 and 1978 by each service component to identify and assess potential contamination on active military installations. Authority to address problems of other than active installations was lacking since funds could not be spent on sites not owned by DOD.

The passage of the 1984 Defense Appropriations Act corrected this problem. Specific language in the Act directed DOD to extend its efforts to include sites formerly used by DOD and broaden the definition of "hazard" to include structures and debris which were to be abandoned or had been abandoned upon termination of its military use.

The Act directed that the Secretary of Defense assume overall management of the program to assure consistent approach and adequate resource allocation. A Defense Environmental Restoration Account was established and provided the resources for the Defense Environmental Restoration Program (DERP). The work performed relative to this study falls within the jurisdiction of the DERP program.

The objective of this investigation addresses the potential for toxic or hazardous contamination applicable to all former NIKE Missile Sites located throughout the Continental United States (CONUS). Contamination includes hazardous or toxic substances formed in ground water, surface water and soil with contaminants specified by regulatory criteria. To fulfill this objective, the work elements described in the following paragraphs were performed in accordance with the provisions of our contract. Discussion of the manner in which each work element was conducted as well as how it is reported in this document is also presented.

1) **Obtain an updated list of the CONUS NIKE sites.** This list is presented in Appendix A in the form of individual site reports, entitled "NIKE Site Listing Forms", which describe pertinent known information about each site. This data was gathered during the summer of 1985 and is not considered current beyond that date. Most of the information came from site reports on file at the Corps of Engineers, Huntsville Division offices and from data presented by the Corps of Engineers District offices. The initial working list of CONUS NIKE sites came from the report "Historical Overview of the NIKE Missile System" reference 1, Appendix B-1.

2) **Identify the primary agencies involved with the command at the time of operations of the site and identify the responsibilities of the primary agencies involved, relative to the operations of various NIKE Missile systems.** This information was gathered through interviews with site operators and basically substantiated the information presented in reference 1. Section 4.0 of this report addresses this subject.

3) **Conduct an archive search to obtain copies of the active NIKE site operating procedures, technical manuals, training manuals and field manuals, and develop a summary of information relative to activities which may have caused contamination.** Contact was made with the NIKE Project Management Office at Redstone Arsenal for specific input regarding the manuals and procedures which would give information relative to activities which may have caused contamination. Specific manuals were recommended and have

been reviewed in the context of this investigation. This information is presented in Report Sections 6.0 and 7.0.

4) **Meet with three different previous NIKE Site operators and obtain information on site operating practices. Any information relative to site contamination shall be recorded.** This task was carried out with the assistance of the NIKE Project Management office at Redstone Arsenal and included a trip to Ft. Bliss, Texas where the interviews were conducted. The information gathered in this interview process has been incorporated into the basic findings and conclusions of this report.

5) **Review the four USATHAMA reports listed and make reference to the contamination or waste associated with the particular sites.** This review was conducted and information has been used compiling the results of this report. A significant amount of background information has been incorporated from reference 1 to permit proper understanding of the history and operation of the NIKE program.

6) **Determine the location of the "As-Built" drawings for all sites and specify their locations in the report.** Each of the Corps of Engineers District offices was contacted regarding the location of the "As-Built" drawings for NIKE sites under their jurisdiction. A few of the districts reported that "As-Built" drawings were on file at the District office that had jurisdiction over a particular site. In most cases however, the "As-Built" drawings cannot be located. Information regarding the location of the "As-Built" drawings is recorded on the NIKE Site Listing Form for each site given in Appendix A.

7) **Obtain and review the deactivation plans for the NIKE Systems and provide information concerning possible contamination.** Each of the Corps of Engineers District

offices as well as the Redstone Arsenal NIKE Project Management Office was contacted regarding the location of deactivation plans. In no case was it possible to locate any site specific deactivation plans. Two generic deactivation procedures documents were located at the Redstone Arsenal NIKE Project Management Office. These were reviewed for practices concerning possible contamination and the finding were incorporated in the general findings of this report. These documents are listed as part of the reference material.

8) **List substances that may act as possible sources of contamination, such as: solvents, starting fluid mixtures (UDMH), fuels, hydraulic fluids, paints, etc. The list should also include the contaminants from each source. Any substances associated with operations, maintenance or deactivation of the NIKE site should be addressed. The substances must have been used in quantities that justifies evaluation as a contamination source.** The findings of the data gathering process as outlined in paragraphs 1-7 led to the conclusion of the listed substances that may act as possible sources of contamination. The findings as determined by this investigative process are discussed in Section 8.0.

9) **Identify any disposal, maintenance or operating practices that may have caused contamination.** The data gathering process described above also provided information that responded to that requested by this contract task. The results are presented in Section 7.0.

10) **Survey the research information and identify potential contamination source areas within the general NIKE sites.** The data gathering process described above yielded the pertinent information. The results are presented in Section 6.0.

11) **Based on the data developed from tasks 1-10, develop a Generic Sampling and Analysis Plan conforming to the requirements of Contract Annex A. Further, a Quality Control and Quality Assurance (QA/QC) Plan shall be developed along with the Sampling and Analysis Plan.** The Generic Sampling and Analysis Plan and the Quality Control and Quality Assurance Plan as specified are presented in the Appendix C of this Report. As a corollary to the Sampling and Analysis Plan, a Generic Well Installation Plan has also been developed and is presented in Appendix D of this report.

12) **Prepare a Safety Plan that meets the requirements of Annex C** of the contract. The Generic Safety Plan as required is presented in Appendix E of this Report.

Work items (1) through (12) constitute Phase I of the NIKE missile site study of potential toxic or hazardous contamination, which is the subject of this report. Phase II constitutes a Sampling and Analysis field investigation of 10 Representative NIKE Sites which will be addressed in subsequent Reports.

Subsequent sections of this report give pertinent background data regarding the NIKE missile program identify potential contamination source areas within the general NIKE site, describe disposal, maintenance or operating practices that may have caused contamination, and present a list of substances that may have acted as possible sources of contamination including the contaminants that result from these sources.

SECTION 3.0 - NIKE PROGRAM BACKGROUND

The main source of background material regarding the history of the NIKE program was included in reference 1. Portions of this reference are summarized herein to provide proper background information regarding the NIKE program.

NIKE Ajax and NIKE Hercules missiles were deployed by the United States Army throughout the Continental United States to protect major metropolitan areas and strategic military installations from aerial attack. The NIKE system was generally in place in the time frame encompassing the early 1950s to the mid 1970s. Maintenance of the missile batteries in a combat ready status required the storage, handling and disposal of missile components as well as solvents, fuels, hydraulic fluids, paints, and other materials required for support functions.

Initial development studies began on the system right after the end of World War II, with the objective of forming an air defense system capable of engaging high speed maneuverable targets at greater ranges than the conventional artillery available at that time. The research and development program for the NIKE system became accelerated in the early 1950s with initial guided missiles becoming operational for the first time in 1954 when combat ready missiles (known as NIKE Ajax) were deployed. Conventional anti-aircraft gun units were outnumbered by NIKE Ajax units by December 1956, and the conversion to guided missiles was completed by mid 1958.

During the period of its operational life, the NIKE Ajax system remained essentially unchanged. However, a second generation NIKE system, to be named NIKE Hercules, was under development by the mid 1950s. NIKE Ajax batteries were similar in design and construction with all units having similar operational components. Minimal field changes were made during the operational life of the NIKE Ajax system. These were limited to minor equipment modifications to improve operational efficiency. Beginning in late 1958, selected NIKE Ajax batteries began conversion to the more advanced NIKE Hercules system. However, it was not until early 1964, that the last NIKE Ajax battery was deactivated and the entire operational system deployed the NIKE Hercules missile. The primary role of the NIKE Hercules system was its ability to attack high speed, high-flying aircraft formations with a single nuclear warhead. Another significant advancement concerned the nature of the rocket fuels. The NIKE Ajax system used liquid fuels which were highly toxic and had to be handled with extreme care. The NIKE Hercules missiles made more use of solid fuel which significantly simplified the fueling and maintenance operations of the missile system. The initial design guidelines for the NIKE Hercules missile provided for maximum use of proven components from the NIKE Ajax program and stipulated that both missiles must be compatible with all sets of ground and launching equipment. Therefore, a minimal amount of modification of the battery units was required to convert from the NIKE Ajax to the NIKE Hercules system.

During its term of service in the field, the NIKE Hercules system underwent numerous design modifications. As originally conceived, the system was known as basic Hercules. However, several improvement programs were subsequently implemented to keep the system up to date. The design modifications primarily provided improved target tracking, guidance, and interception capabilities by modifying or replacing radar and electronic equipment. However, these modifications to the missile system did not produce any significant change in the battery configuration.

Not all Hercules batteries were retro-fitted for the new equipment , because of budget limitations. Guidelines provided for retro-fitting of certain batteries within any particular defense area, based on the number of batteries located in that defense area. Hence, the field deployment within a single defense area in the early 1960s may have included Ajax, basic Hercules, and improved Hercules batteries.

NIKE Zeus, the third generation missile of the NIKE program, was the first missile developed in the United States that was designed to defend against Intercontinental Ballistic Missiles (ICBM). However, NIKE Zeus was never approved for production or deployment as a tactical system.

In 1962, the Army began transferring operation of certain NIKE batteries to National Guard Units. Shortly thereafter, deactivation of NIKE batteries began. By 1970, the Army had deactivated most CONUS NIKE sites. National Guard Units continued to maintain a few sites until the late 1970s. Some NIKE equipment is still retained in Ft. Bliss for the purpose of training troops from other North Atlantic Treaty Organization (NATO) countries that still incorporate NIKE missiles in their defense programs.

SECTION 4.0 - NIKE PROGRAM MILITARY ORGANIZATION

4.1 NATIONAL AIR DEFENSE ORGANIZATION

Background information for this Section was taken directly from reference 1 and was substantiated during the site operator interviews, with minor modifications. The reference states that the development of a missile-based air defense system (NIKE) was paralleled by changes in command structure in the defense organization, beginning in July 1950. At that time the Army placed all artillery units with continental air defense missions under the newly organized U.S. Army Anti-Aircraft Command (ARAACOM) located at Ent Air Force Base in Colorado Springs, Colorado. The installation of NIKE Ajax batteries beginning in 1953, led to further re-organization of the Continental Air Defense structure and the Army's Anti-Aircraft missions and organization. On September 1, 1954, ARAACOM and corresponding elements in the U.S. Air Force and the U.S. Navy were combined to form the Continental Air Defense Command (CONAD) at Colorado Springs under the direction of the Joint Chiefs of Staff. In 1957, the Army's air defense responsibility within CONAD was defined as point air defense by missiles fired from the ground to aerial targets not more than 100 miles away. Point defense was to include "Geographical areas, cities, and vital installations that could be defended by missile units which received their guidance information from radars near launching site" and also was to include the responsibility of a ground commander for air protection of his forces. To represent this expanded, all missile role more clearly, ARAACOM was re-designated the U.S. Army Air Defense Command (ARADCOM) on March 21, 1957.

Further development on a national scale occurred in September 1957, when the North American Air Defense Command (NORAD) was formed to combine air defense capabilities of Canada and United

States under a one Commander in Chief, who also headed CONAD. Like CONAD, NORAD elements in the United Stated report directly to the Joint Chiefs of Staff. All Army ARADCOM units were placed under the operational control of NORAD. ARADCOM continued in this basic configuration until 1975, at which time the NIKE missile program had essentially been disbanded in CONUS.

4.2 NIKE SYSTEM ORGANIZATION

The basic operational un_t of a NIKE site was the Battery. The Battery was commanded by an Army Captain. On a specific site the Battery was sub-divided into six elements. These are listed below, followed by a brief mission statement:

1) Headquarters Section: The headquarters section was responsible for the operational and administrative control of personnel and equipment.

2) Communications Section: The communications section was responsible for installing and maintaining non-commercial communication nets and operating the commercial communication nets within the Battery.

3) Fire Control Platoon: The fire control platoon was responsible for the operation and maintenance of fire control equipment in the Integrated Fire Control (IFC) area.

4) Launching Platoon: The launching platoon had administrative control over one launching platoon headquarters and three launching sections, which are described in the next paragraphs.

5) Launching Platoon Headquarters: The launching platoon headquarters was responsible for the operation and training of three launching sections. It contained personnel who assembled, tested and performed organizational maintenance

on the NIKE missile and maintained the rounds at the launching section.

6) Launching Section: The three launching sections were responsible for the preparation of the missile and booster for firing after they were delivered to the launching section from the assembly and test area. In addition, they performed the routine non-technical tests, checks, adjustments, and organizational maintenance.

The next organizational unit above the Battery was the Battalion. Generally, there were four Batteries in each Battalion. The Battalion was typically commanded by a Lieutenant Colonel. The Battalion generally consisted of a headquarters and headquarters Battery, four Firing Batteries (described above), and a Medical Section. In addition, any motorpool maintenance activities other than the most routine, were performed at the Battalion level.

The Battalion headquarters and headquarters Battery comprised the following 7 elements:

1) Battery Headquarters
2) Battalion Administration Supply Section
3) Operation and Intelligence Section
4) Battalion Motor and Maintenance Section
5) Communications Section
6) Radar Section
7) Assembly and Service Section

The Assembly and Service Section was a team of technical experts who supervised and assisted in the assembly, testing and performance of organizational maintenance on missiles and boosters.

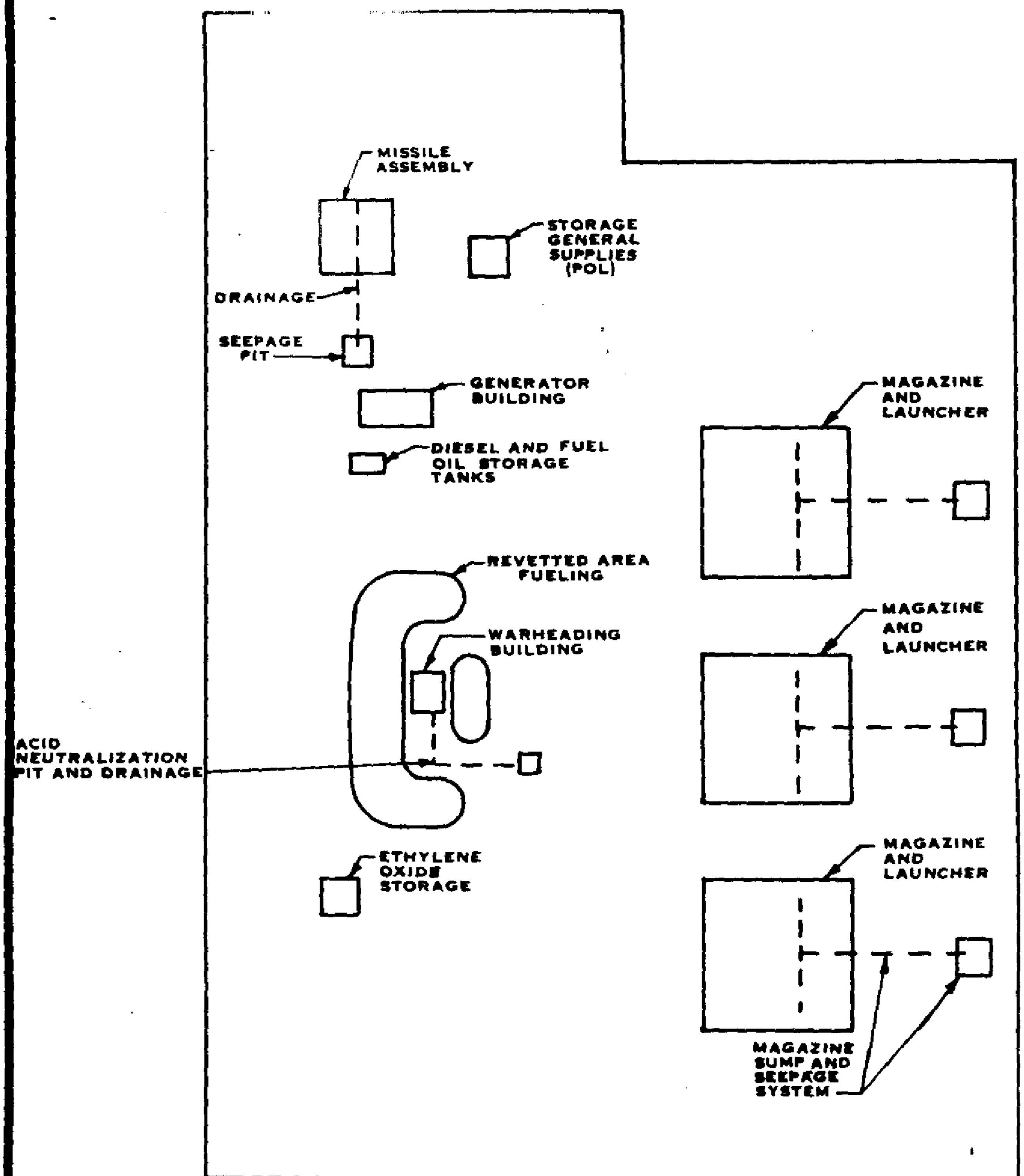
The organizational unit above the Battalion level consisted of either a Group or a Brigade. This level was usually commanded by either a Colonel or a Brigadier General. A Group had only NIKE Battalions reporting to it, whereas a Brigade could have other military entities reporting to it besides NIKE Battalions. The Group or Brigade level was organized into United States Regions. The Region was usually commanded by a Brigadier General or a Major General. The Region could have a number of different types of military units reporting to it other than NIKE Groups. As the number of United States military units increased or decreased, the number of regions also changed. The maximum number of regions that constituted the division of the United States military organization was six. The Regions reported to ARADCOM at Ent Air Force Base in Colorado. This organizational structure basically functioned during the period of the maximum activity of the NIKE program during the mid 1960s. As was previously stated, ARADCOM was disbanded in 1975.

SECTION 5.0 - NIKE BATTERY DESCRIPTION

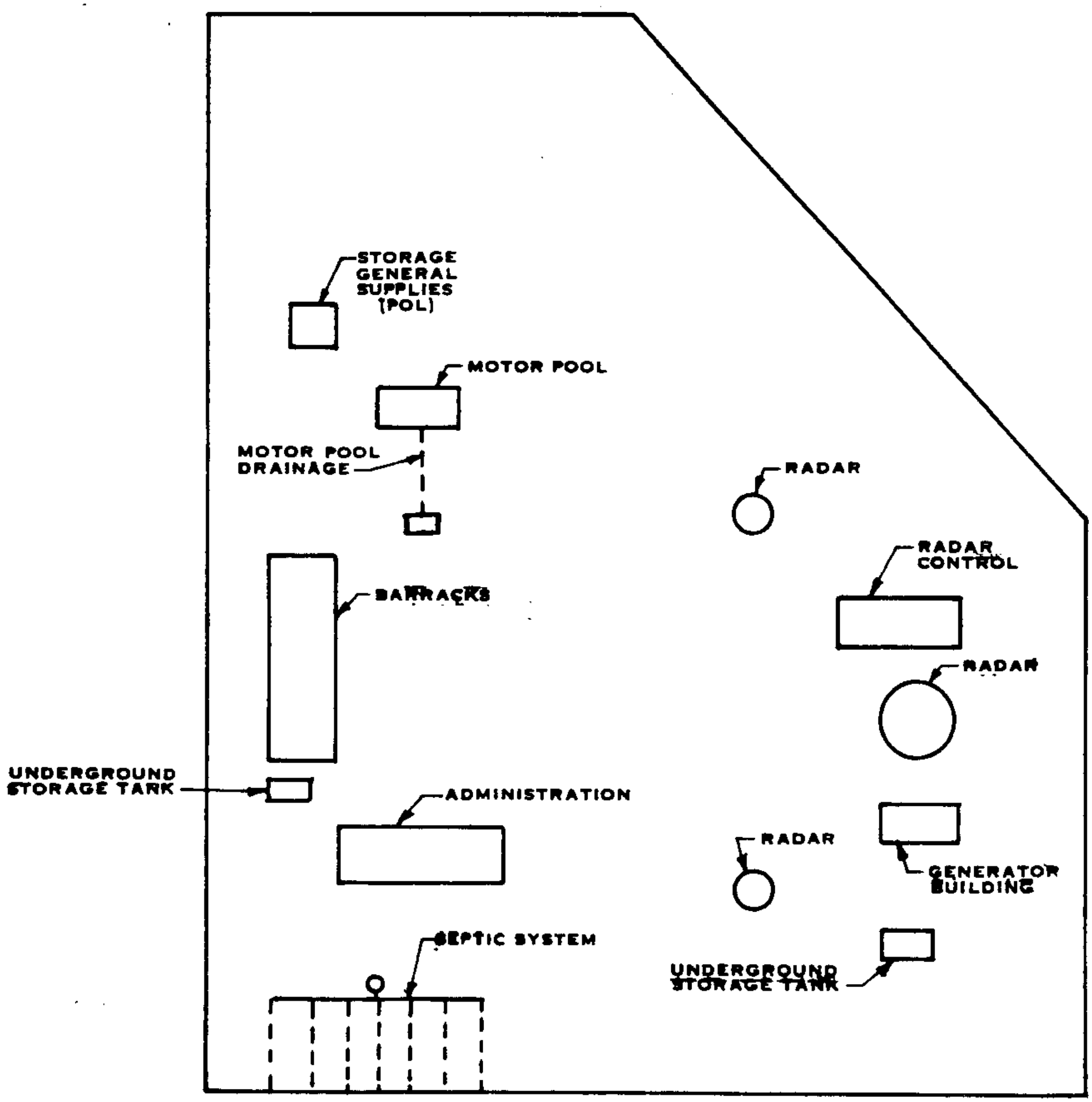
5.1 BATTERY LAYOUT

A NIKE site typically consisted of two separate and distinct operating units. These included the Launcher Area and the Integrated Fire Control (IFC) Area. The Launcher Area was generally located on approximately 40-60 acres of land although each site could vary significantly in size and shape. The IFC Area, generally ranged in size from 10-50 acres. The Barracks facilities were either incorporated as part of the Launcher Area or the IFC Area, or a third separate and distinct Facility Area was constructed. The Launcher Area and the IFC Area would generally be located 1-2 miles apart to facilitate necessary distance and equipment restrictions that involved the successful interaction of the two Areas.

The layout of structures within each Area appears to have been site specific, although each site appeared to have certain structures in common. Figures 1 and 2 illustrate a generalized NIKE Launcher Area and a generalized NIKE IFC Area. These Figures illustrate the structural units that appeared to be common to most Batteries although their general location to each other could vary significantly. For the Launcher Area, the key structural units include the missile assembly building, general storage and supply buildings, the generator building, the warhead building, and the three magazine (Missile Storage)/launch units. The IFC Area generally included the radar units, the generator building, general storage and supply buildings, and in most cases, the motorpool. At some sites, the motorpool could have been located at the Launcher Area. In many cases, the IFC Area also had facilities for administration and barracks. Generally, the administration and barracks areas were located at the IFC Area, however, on occasion they were located at the Launcher Area or on a separate parcel of land. These sites also generally



GENERALIZED NIKE SITE CONTRACT DACA 87-85-0104	LAW ENVIRONMENTAL SERVICES MARIETTA, GEORGIA	LAUNCHER AREA FIGURE 1



GENERALIZED
NIKE SITE

CONTRACT DACA [illegible]

LAW
ENVIRONMENTAL
SERVICES
MARIETTA, GEORGIA

INTERGRATED
FIRE CONTROL
AREA

FIGURE 2

included a number of forms of waste disposal including sump and draining systems, seepage pits, septic tanks with infiltration wells for liquid waste disposal, and occasionally on-site landfills.

5.2 GENERAL UNIT OPERATIONS

5.2.1 Launcher Area

The Launcher Area of a NIKE site was the location where the missiles and warheads were assembled, maintained, and prepared for firing. The missiles arrived at the site disassembled into 13 specific components. All operations necessary to make the missiles flight ready were then conducted in specific locations in the Launcher Area. These operations as they applied to contamination are discussed in Sections 6.0 and 7.0. In general, routine maintenance and checking procedures were performed on the missile at the Launcher Area. However, on a periodic basis missiles were returned to the Battalion support shop for more detailed maintenance and service checking. It is estimated that approximately 30 missiles per year were sent from the Battery Launch Area to the Battalion support shop. It was also common practice to randomly select certain missiles to be returned to one of the three national Depot areas for more complete maintenance and service checking operations. The national Depots were located at Letterkenny, Pennsylvania; Tooele, Utah; and Pueblo, Colorado.

Approximately 10 missiles per year were sent from a particular Battalion to Depot. Any shipping of the missile required it to be totally disassembled into its 13 component parts, packed in its original crates, and shipped. This was done at the Battery missile assembly building. It was also routine practice for the personnel of a particular Battery to be sent to McGregor Range in southern New Mexico for test firing practice, about once a year.

When this occurred, the radar units were disassembled at the Battery location for major maintenance and service checking.

5.2.2 Integrated Fire Control (IFC) Area

The IFC Area at a site contained all the radar, guidance, electronic, and communications equipment needed to identify incoming targets, launch missiles, and direct missiles in flight. These operations as they applied to contamination are discussed in Sections 6.0 and 7.0.

SECTION 6.0 - POTENTIAL CONTAMINATION SOURCE AREAS

Because of the nature of site operations, several individual source areas exist for potential contamination on former NIKE sites. Some source areas will be fairly consistent in the type and degree of contamination they present, whereas other sources will reflect site-specific variation.

Generalized site diagrams are presented in Figures 1 and 2. The intent of these Figures is primarily to indicate the major structural units for reference to areas that could have resulted in waste. As previously stated, the location of these units on any given site varied with the terrain and the general arrangement of facilities.

6.1 GENERAL - WASTE FLUID DISPOSAL

Probably the most significant general practice that occurred on site that could lead to contamination was the method of dealing with waste fluids. Standard operating practices dictated that waste fluids were to be accumulated in POL (Petroleum, Oils, Lubricants) Barrels which were periodically transported to official dumps. However waste fluids were reported to have been disposed of directly to the soil surface on occasion, rather than be transported to POL Barrels, resulting in localized contamination. The POL Barrel contents were also reported to have been occasionally dumped in a random "Unofficial" manner, creating concentrations of waste material in the soil both on-site or off-site. Locations of such dumps are predictable only by general site characteristics. This practice was discussed at length in the interviews and will be discussed further in this report relative to specific site units.

Specific site units that could have resulted in waste within the general vicinity of that unit are described in the next sections.

6.2 LAUNCHER AREA

Within the Launcher Area, three or four unit locations can be expected to have the highest probability of contamination. They were the following:

- Missile Assembly Drainage and Seepage Systems
- Diesel and Fuel Oil Storage Tanks
- Magazine Sump Seepage System
- Secluded Areas Adapted to Unofficial Dumping

Three additional areas present some possibility of contamination, however, to a less significant extent.

- Warheading/Fueling Area Drainage Systems
- Motorpool (when present)
- Septic Systems (when present)

6.2.1 Missile Assembly Drainage and Seepage Systems

The missile assembly building operations involved the use of various solvents, anticorrosion products, and paints as the missile was assembled and disassembled. The building was equipped with a full-length drainage system. Spilled or waste materials could be washed or dumped into this drainage system.

The drainage in most cases was a gravity-fed system. Waste materials were washed out of the building and into a small seepage system consisting of perforated tile or a seepage pit. The construction of the seepage system was highly variable and reflects features of the local terrain and soils. Porous soils would require a less elaborate system, since they would readily facilitate drainage. Pits were excavated and filled with gravel or other coarse fill. Seepage pits would tend to concentrate contaminants, when they were in use. It is also a possibility that seepage systems were abandoned and replaced on sites with long operating histories. Therefore, multiple pits could be present in the vicinity of each other.

6.2.2 Diesel and Fuel Oil Storage Tanks

A number of generators were reportedly used on NIKE sites and storage of diesel fuel was considerable. Tanks were also used to store fuel oil for heating purposes. These tanks were probably steel, but this could not be documented. It is probable that several tanks were present at each site, holding up to 5000 gallons each.

Tanks were usually buried underground. They probably leaked hydrocarbons to some degree into the surrounding soil, due to leakage at connections and possible spillage during transfer operations. Upon deactivation of the NIKE site, some quantities of fuel were abandoned on-site. In many cases, the tanks were never drained. It is now known that there is a high probability of tank deterioration and consequent leakage over time. According to industry standards, underground storage tanks have a working life of 10 to 15 years, and today, most of these tanks have probably begun leaking because of corrosion. Under the new U.S. Environmental Protection Agency program, leaking underground storage tanks (LUST) are considered a priority hazardous waste problem. Thus, buried tanks could present an existing problem.

6.2.3 Magazine Sump Seepage Systems

Within the typical NIKE magazine, a floor drainage system permitted waste materials to be washed to a central sump located under the missile elevator shaft. This sump was equipped with a pump to deliver water and waste out of the magazine and into a seepage system. Solvents, paints, and hydraulic fluid were routinely washed to the sump.

As with the assembly building seepage system, this probably entailed drainage tiles and/or seepage pits. The volume of waste material handled by the magazine sump was probably greater than that of the assembly building, and seepage pits were more likely to be in use. The arrangement of the seepage system varied with the terrain and the arrangement of the magazines and launcher sections. It is also possible that on sites with steep terrain, sumps were simply pumped to a ravine or other watercourse.

6.2.4 Secluded Areas Adapted to "Unofficial" Dumping

Dumping of various wastes was reported as common at NIKE sites. The primary factor affecting the incidence of dumping was convenience. Certain authorized disposal routes were available to NIKE sites. However, utilization of these disposal routes varied from site to site. Solid waste could be delivered to municipal landfills, and the Army POL service was responsible for removing waste solvents, oils, and paints. When the landfill was not convenient or the POL was irregular about their pick-up, other methods were used to dispose of the waste. Rural sites were particularly prone to "unofficial" dumping. Dumping reportedly occurred both on-site and off-site. On-site dumps were secluded locations which would evade the attention of inspecting military officers. Lakes, ponds, swamps, and ravines were suited to this purpose. Off-site dumps could have made use of virtually any nearby ravine or water course. It was reported during the site operator interviews that "unofficial" dumping, including off-site locations was virtually a daily practice at some rural Battery locations. There was also use of "unofficial" dumps as well as public landfills at deactivation, as was learned in the site operator interviews.

6.2.5 Warheading/Fueling Area Drainage System

The potential for contamination in this area is considered to be less than that found in other areas. Liquid fuels were rarely spilled in quantities. The IRFNA (nitric acid), UDMH (dimethyl hydrazine), and ethylene oxide were hazardous, volatile materials and were handled very carefully. It was very rare that quantities of these materials escaped accidentally. No persistent contamination would result from the spillage or leakage, due to the extreme reactivity of each.

Battery electrolyte was reportedly discarded in this area as well. Modest amounts of lead may have been introduced as a result of this operation. However, it is likely that other sources of lead, such as paint, were of much greater magnitude. Sulfates and nitrates in the warheading/fueling area would be insignificant in the concentrations at which they would occur.

6.2.6 Motor Pool

NIKE Site motor pools were not extensive. Most motor pool operations were performed at the Battalion level. However, some minor contamination by solvents, fuels, and lubricants could have occurred. Motor pools as a source of contamination are discussed in greater detail under Section 6.3.1.

6.2.7 Septic Systems

When barracks were sited on the launcher area, a septic system of significant size was required. Urban and suburban NIKE sites tied into municipal wastewater systems. However rural sites required a septic tank and leaching system. Barracks were more often sited at the IFC area, along with the battery administration and other facilities. Septic systems as a source of contamination are discussed in greater detail under Section 6.3.2.

6.3 INTEGRATED FIRE CONTROL (IFC) AREA

The IFC Area was less prone to chemical contamination than the Launcher Area. The diversity of chemicals was smaller, and the primary mission of the IFC radar operation, did not require significant chemical use. The main units of concern with regard to contamination at the IFC area were the following:

- Motor Pool
- Septic System
- Diesel, Fuel Oil, and Gasoline Storage Tanks
- Secluded Areas Adapted to Unofficial Dumping (Refer to discussion under Launch Control Area, Section 6.2.4)

6.3.1 Motor Pool

NIKE site motor pools did not involve extensive operations. Significant motor pool operations were performed at the Battalion location. However, some minor contamination by solvents, fuels, and lubricants could have occurred. In some cases, motor pools were equipped with floor drains and a drainage system similar to that of the assembly building in the Launcher Area. Thus, contamination by hydrocarbons and chlorinated hydrocarbon materials possibly occurred in the immediate vicinity of the motor pool.

6.3.2 Septic Systems

On rural sites, on-site waste water systems composed of septic tanks, distribution boxes, and leaching areas were used. The major function of these systems was handling sewage. However, on occasion, they may have been used to dispose of chemical products, and to that extent they present a potential source of contamination. In urban situations where sewage services were provided by the municipality, this source of contamination would not be present.

The materials most likely to have been disposed of via septic systems are paints and general domestic cleaning products. Of these, paints present the only threat of significant contamination in the form of oils and metallic pigments. Contamination in this instance would be spread over the area of the leaching field and within the septic tank.

Leaching fields vary in size according to the number of people using the facility and the type of soil at the site. Certain soil characteristics require much larger fields than others, depending on their ability to purify sewage product. On NIKE sites that were manned for many years, it is also likely that septic systems were occasionally replaced.

6.3.3 Diesel, Fuel Oil, and Gasoline Storage Tanks

Fuel storage tanks pose the greatest potential for contamination at the IFC areas. Tanks were present for diesel powered generators and trucks, heating oil, and gasoline for vehicles. As with the Launcher Area, large capacity diesel tanks served emergency power generators. Radar operations required considerable electricity and these generators were fairly large. Generators were routinely tested and leakage and spillage of fuel was common.

On most sites, depending on climatic condition, large volumes of fuel oil were consumed for heating purposes. Barracks and administration facilities were medium sized buildings capable of using thousands of gallons of fuel annually. Other facilities were also heated. Separate mess halls and recreational facilities were often present.

Some gasoline was stored at NIKE site motor pools, although not in quantities as extensive as those used for heating and generator operation.

As discussed earlier, underground storage tanks were reported to have leaked during NIKE site operations, however a greater source of possible contamination was material remaining in the tanks after deactivation. In many cases, fuels were not removed at the time of deactivation, and over a period of time, the likelihood of leaks from these tanks grows significantly. In all probability, most underground tanks at NIKE sites have begun to leak due to deterioration of the tanks.

SECTION 7.0 - POTENTIAL OPERATIONS PRODUCING CONTAMINATION

Virtually all chemical use at NIKE sites posed some potential for contamination. However, those chemicals used as missile fuels were controlled more strictly than maintenance and other operating materials because they were known to be toxic. In many cases, the missile fuels and igniters are strong oxidizers or reducers, and even incidental releases of them would not result in persistent contamination because of their reactivity. Other NIKE operations, including missile and launcher hydraulics, and maintenance operations, had considerably greater potential for causing contamination.

The following list of operating practices covers all major chemical uses that could potentially result in site contamination. The list is followed by a discussion of each operation. These discussions include mention of the chemicals and materials involved, as well as consideration of all factors affecting the potential for contamination.

Launcher Area

1) Missile Assembly and Disassembly
2) Missile Fueling and Warheading
3) Missile Maintenance and Testing
4) General Launcher and Magazine Maintenance

IFC Area

5) Fire Control Operations Maintenance
6) Vehicle Maintenance

General Operations

7) General Facilities Maintenance
8) Utility Service
9) Deactivation

7.1 LAUNCHER AREA

7.1.1 Missile Assembly and Disassembly

Missile assembly at NIKE sites was conducted in an assembly building located in the Launcher Area. All missile components were shipped to the sites in metal canisters and wooden fin crates. Minor chemical use occurred during assembly to remove anti-corrosion compounds, and lubricate and seal various parts. In the early phases of the NIKE program, some sanding and grinding of missile parts were conducted to repair defects. However, these operations were abandoned later in the program and defective parts were returned to the battalion or depot for repair, or return to the manufacturer.

Some painting was also conducted in the assembly building. This was done on an as-needed basis, and battalion commanders could choose to have missiles painted with optional camouflage.

Solvents used for missile preparation and cleaning included petroleum distillates (Stoddard Solvent, etc.), chlorinated solvents, and small use of alcohols. Waste solvent could be saved for POL Turn-In or, perhaps more often, was washed into drains that had a surface leaching system connected. Large quantities of certain solvents would evaporate during use. This particularly applies to the chlorinated solvents, such as carbon tetrachloride. The effects of surface leaching systems on contamination, depends greatly on the depth of the system, soil types, and local climate. Arid, sandy environments encourage further evaporation and rapid leaching of unevaporated materials. Finer grained soils (clays or silts) with routine rainfall discourage evaporation and decelerate leaching of some solvents.

Lubricants, sealants and paints are less adapted to disposal by drainage systems, although this was probably practiced for small quantities of left-over or waste material. Cans of waste and left-over material were dumped as solid waste which was delivered to local landfills. Rural sites may have frequently used unofficial dumps for disposal of these materials.

7.1.2 Missile Fueling and Warheading

Missile fueling and warheading was conducted in a revetted area separate from the assembly building. During the early period of the NIKE program, when conventional warheads were in service, this area was open. With the deployment of nuclear warheads, a Warheading Building was constructed and used for these operations.

In this area, missiles were fueled with the various materials and warheading of the missile was accomplished. The electrical batteries were installed here, as well as certain other delicate structural maintenance. Service and filling of the missile Accessory Power Supply was often conducted in this area as well.

Fueling with unsymmetrical dimethylhydrazine (UDMH), inhibited red fuming nitric acid (IRFNA), aniline, furfuryl alcohol, and ethylene oxide required care and presented fire and personnel safety hazards. Their use was governed by fairly strict protocol. Turn-In to depot for official disposal, as a mens of recycling to maintain fresh fuel on site, was probably strictly practiced. Environmental contamination was probably limited to incidental releases. With the exception of aniline and furfuryl alcohol, these materials were all reactive, and would dissipate rapidly in soil. Resulting compounds in most cases would be of low toxicity (nitrate, carbon dioxide, water, and ammonia). Reaction of UDMH and IRFNA could generate nitrosamine compounds. However, the likelihood of this occurring because of safety precautions, was very remote.

Ethylene oxide was used as a fuel for the Accessory Power Supply (APS) on the missile. It was maintained and used to test the system periodically. Ethylene oxide was routinely disposed of on-site via burning or dilution with water and subsequent surface dumping. As mentioned, ethylene oxide was used in moderate quantities and is reactive. Thus, there is virtually no possibility of persistent contamination.

As far as other fuels were concerned, the primary propellants were either hydrocarbons such as JP-4, or solid materials. JP-4 was used in the sustainer stage of the Ajax missiles and leakage could present some potential for contamination. All deployed Hercules missiles utilized sealed solid propellants with essentially no potential for release.

The fueling/warheading area had acid neutralization pits and general surface drainage. Spilled material occurring during "top-off" of fuel tanks was washed into the drainage system. Spilled battery electrolyte would also cause some light contamination from lead ions in the solution.

7.1.3 Missile Maintenance and Testing

Missile maintenance was conducted in four locations: the magazine, above ground at the launcher, the fueling area, and the assembly building. Refer to Figure 1 for the general location of these units. Where the maintenance took place depended on the specific operation. Simple procedures not involving the fuels or warhead or related electronics could be handled in the magazine. Other procedures required that the missile be taken above ground or to the fueling area. Major structural repairs required that the missile be defueled and returned to the assembly building.

Maintenance or repair of corrosion or hydraulic problems were most common. Certain missile parts were composed of magnesium or magnesium alloys and were very subject to corrosion. Hydraulic systems needed frequent checks and leakage was not uncommon.

Removal of corrosion from metal parts was conducted with at least three types of cleaners. Phosphoric acid in alcohol solution was used for aluminum parts, and alodine powder was used in water for certain minor cleaning. Most significant was the use of chromates in the form of chromium trioxide and sodium dichromate. Chromium trioxide is a solid material available in 5 pound containers. This was dissolved in water and used to wash magnesium and steel. Sodium dichromate is also a solid, but was dissolved in acids to form a pickling solution. Metal parts were dipped in this solution. These chromates may have been used in quantities large enough to cause contamination. Chromates are heavy metals, highly toxic, and in some cases are carcinogenic. Solutions used for decorrosion were undoubtedly washed into sumps and allowed to leach into the soil. It is also possible that significant dumping of chromium trioxide may have occurred during deactivation. This was discussed in the interviews.

Cleaning solvents were also used in missile maintenance. General cleaning and degreasing used Stoddard-type solvents (petroleum distillate), carbon tetrachloride, trichloroethane(s), perchlorethene, and trichloroethene, with minor use of alcohol and acetone. Chlorinated solvents are preferred degreasers and were heavily used. Solvents supplied by the depot were sometimes substituted and available excess quantities of certain solvents may have encouraged their use. Inventories of old solvents continued to be delivered to NIKE sites after the solvent was eliminated from military procurement. Perchlorethene was used on NIKE sites, but was previously unreported. This was disclosed in the interviews.

Painting of missile components also involved the use of chromium and another priority pollutant, lead. Zinc chromate paint was used to prime magnesium parts subsequent to cleaning. Lead-based paint was used for steel. Much of the paint was consumed. However, wastes resulted from the removal of old paint and unused paint remaining in cans. Paint is not well suited to drainage disposal, however, it is likely that some was eliminated in this manner. More often, leftover paint was disposed of via POL collection or "solid" waste dumping. Dumping may have been practiced on-site or off-site in unofficial dumps, or else community landfills may have been used.

Heavy metal contamination from paints may be a problem on NIKE sites. However, mobility in ground water is limited by the paint vehicle and the solubility of the metal ion. While hexavalent chrome from chromium trioxide is soluble, lead and chrome in paints is much less soluble. This somewhat decreases the probability of finding these metals in ground water samples even when they are present in soils.

Missile hydraulic fluid was replaced on a regular basis, and leakage, particularly of Ajax systems, was common. Used fluid that was drained from the missile may have been wasted to the sump, returned to POL, or dumped. Leakage was usually washed to the drainage sump. Unused hydraulic fluid also was disposed of, because once a can of fluid was opened, it was used immediately or disposed.

Aircraft turbine fluid was used for lubricating gears in the Missile Accessory Power Supply system. This fluid was probably synthetic tricresyl phosphate, which is a moderately toxic material. This was used in comparatively small quantities, however, some fluid probably did contaminate NIKE sites.

Hydraulic fluids and paints are composed primarily of petroleum oils. In instances where these were disposed of on-site, persistent contamination would occur.

The Accessory Power Supply and Hydraulic Pumping Unit provided critical power for control functions during the flight of a missile. Both systems were tested frequently, along with the electrical systems. Testing of the Accessory Power Supply sometimes utilized a "hot run" in which the ethylene oxide fuel was actually burned. Hot runs required that the missile be out of the magazine. Ethylene oxide was refueled after the run. As mentioned earlier, ethylene oxide waste was disposed of via burning or put into surface water. It is reactive, and would not have persisted on NIKE sites.

Periodic wipe testing of nuclear-armed missiles and the warheads were conducted for radiation leakage. Protocol required that rags utilized for these tests be disposed in lead-lined barrels and delivered for disposal as radioactive waste. This protocol was frequently not followed, however, and rags were often disposed as regular solid waste. No accounts of radiation leakage were identified, and since leakage of this type was taken very seriously and warheads strictly constructed, it is unlikely that rags were ever contaminated by any measurable amounts of radiation. Interviews confirmed this information.

7.1.4 General Launcher and Magazine Maintenance

Maintenance of the structural, mechanical, and hydraulic systems of the launcher and magazine were significant chemical-using operations. Similar to the maintenance functions required for the missile, the launcher and magazine required cleaning, painting, and hydraulic work. Launchers routinely leaked hydraulic fluid. The elevator used to move missiles up from underground magazines had an extensive hydraulic system.

NIKE sites varied somewhat in their magazine and launcher configuration. Underground magazines were standard, but were impractical in areas with high water tables (Florida) or permafrost (Alaska). Arrangement of the various facilities was dependent on the orientation of local terrain.

The magazine stored missiles and contained storage racks and a rail system used to deliver the missiles to the elevator. Once above ground, the missile was moved on rails to the launchers. Rail handling of missiles required that all portions of the rails; racks, and dolly wheels be clean and free of corrosion. The rail system was cleaned with metal brushes and solvent. Naphtha type solvents were routinely used to wipe down the rails, leaving a light, oily residue coating the surface. Painting of the rail structures probably utilized a lead oxide primer followed by a coat of "GI green", in accordance with Operating Manual procedures.

As with the launchers the missiles also routinely leaked hydraulic fluid and required routine maintenance. Leaking fluid was washed into surrounding soil. Used fluid that was drained from the launchers probably was collected for dumping or disposal by Army POL personnel. In some instances, disposal to a sump and subsequent subsurface leaching may have been practiced.

In the magazine, waste materials -- solvents, paints, and hydraulic fluid -- were often washed to the magazine sump located at the bottom of the elevator shaft. Leakage of fluid from elevator hydraulics could produce a considerable volume for disposal to the sump. Hydraulic system "blow-outs" occurring during operation of any hydraulic equipment would cause instant release of fluid.

Hydraulic fluid is a hydrocarbon oil of moderate viscosity. The constituents of hydraulic fluid, as with other petroleum products, are varied and numerous.

7.2 INTEGRATED FIRE CONTROL (IFC) AREA

7.2.1 Operations Maintenance

The primary mission of the IFC area was radar tracking and missile guidance. Radar, consisting of three systems, did not require extensive chemical use. Maintenance of radar was mostly electrical, utilizing small amounts of solvent for cleaning. The HIPAR System (High-Power Acquisition Radar) used a coolant pumping system consisting of an ethylene glycol circulating system and pump. The ethylene glycol was replaced annually. The pump was oil lubricated.

Paint composed the most significant chemical use on the radar systems. Disposal of paint at the IFC area was limited by the availability of disposal facilities. Waste paints were more likely to be collected and removed for off-site disposal or occasional "unofficial" dumping.

Fire control electronics also used certain electronic tubes that contain low-level radiation sources in minute amounts. These tubes were often disposed of indiscriminately in earlier portions of NIKE site operations. Tubes may have been disposed with solid waste or even "tossed" on the ground. In the latter portions of the NIKE program, these tubes were more strictly controlled. Despite possible on-site disposal, the volume and hazard of this material is minimal. A probable maximum of six of these tubes per year were discarded in this manner, according to the site interviews.

7.2.2 Vehicle Maintenance

Limited motor pool operations occurred on NIKE sites. An individual NIKE Battery did not have responsibility for vehicle maintenance. Vehicles were delivered to the battalion for all maintenance and service. Occasional minor service or emergency service may have consumed small volumes of solvents, paints, and lubricants, so that minor contamination in the area of the motor pool is possible. Some limited contamination from gasoline is also possible. It is noted that at some locations, the Battery motor pool was located in the Launcher Area.

7.3 GENERAL OPERATIONS

7.3.1 General Facilities Maintenance

Painting and cleaning were the only consistent chemical using operations for maintenance of other NIKE facilities. Buildings and structures were maintained and certain punitive functions for military personnel consumed paints and cleaning materials. The common building paints of the NIKE period used lead as a pigment (20-30 percent). On-site disposal of paint was variable. In some cases, ground leaching systems, such as the drainage at the assembly building, are likely to have been used. "Unofficial" dumping of paint was also likely. Septic systems may also have been used for disposal to a limited extent.

Water-soluble cleaning products are likely to have been discarded via surface disposal on-site, "flushing" to septic systems, or ground leaching systems. These products are unlikely to pose contamination problems, however, because of the limited quantities used.

Pesticides had some use at NIKE sites, however, their use was quite variable and probably did not pose a serious contamination hazard. Herbicides were used at some NIKE sites to maintain vegetation-free areas around site perimeters and launch areas. The function of this use was primarily fire control.

7.3.2 Utility Service

NIKE sites were supported by certain on-site utilities which pose significant potential for contamination. A number of generators were used to support emergency operation of the site, including radar on the IFC Area and missile readiness on the Launcher Area. Generators were carefully maintained and routinely tested. Diesel fuel was stored in large quantities for generator operation. Fuel was likely to have spilled during transfer and pumping operations. Tanks were typically located below ground, and remained on-site after deactivation. Tanks probably leaked fuel while the site was operated, and fuel left in the tank after deactivation is likely to have leaked as the tanks deteriorated.

Tanks were also used to store fuel oil for heating purposes. Similar problems existed with these tanks, and quantities of fuel oil also are likely to have contaminated NIKE sites. These tanks could have been located either on the ground surface or below ground. Quantities of fuel oil and diesel fuel in use on NIKE sites consisted of an annual use of several thousand gallons. The extent of possible contamination from these tanks could vary considerably from site to site. The diesel and fuel oil storage tanks were sited at several locations on both the IFC Area and the Launcher Area.

Waste oils and hydraulic fluid were routinely used to control vegetation along underground cable-runs. Cable was usually run through shallow, concrete-walled troughs. Large cables connected the Launcher Area and the IFC Area . Oil was poured in or on the troughs to eliminate vegetation. This produced widespread, but low-level contamination in both the Launcher Area and the IFC Area.

Polychlorinated Biphenyls (PCBs) were also in use at NIKE sites in transformers. Release of PCBs would have been very infrequent since these are sealed units. Occasional rupture of transformers is possible and would have resulted in contamination with comparatively small volumes of material. When deactivation occurred, transformers remained on-site and eventual deterioration may also have resulted in some contamination. PCBs are relatively immobile in soil and contamination would have been limited to the area in the immediate vicinity of a leaking transformer. The quantities and infrequent release of PCBs make it unlikely that serious and consistent contamination will be found on NIKE sites.

Asbestos was in widespread use at NIKE sites for insulation purposes. It is unlikely that any quantity of asbestos was disposed on-site, since the material remained in place during operation and would require disposal as a solid waste. Although there is probably little asbestos present as a ground contaminant, it is likely to remain on-site in its original form in buildings, on piping and ductwork, until removed during demolition.

7.3.3 Deactivation

As previously stated in Section 2.0, paragraph (7), no site specific deactivation plans were obtained. The primary information concerning deactivation practices came from the site operator interviews. Two generic plans (references 8 and 9) were reviewed; however they did not address issues pertaining to chemicals or practices that may have involved contamination.

As stated, deactivation protocol according to stated procedures does not suggest any source of contamination, however, actual practice of deactivation probably resulted in disposal and/or abandonment of considerable volumes of potentially hazardous materials according to the site interviews. Specific practices varied significantly from site to site. Used chemical materials were normally returned to the depot at the time of deactivation for credit on the battalion budget. However, during deactivation, it often proved expeditious to simply abandon some materials, and partially-used or waste material was probably removed by the most efficient means. Dumping in municipal or "unofficial" dumps was reported to be widely practiced, as revealed in the interviews.

As an example of deactivation procedures at a particular site, an instance of dumping chromium trioxide (chrome VI) in excess of 100 pounds during deactivation was reported in the interviews. Waste oils, paints and solvents were discarded via sumps and other drainage. Barrel volumes of waste were delivered to landfills and dumps. On-site landfilling of waste probably occurred to some extent. Any dumping of UDMH canisters would have occurred at this time. Pesticide dumping in barrel quantities was also reported in the interviews. This could present a potentially serious, although very infrequent, contamination at the dump site. The serious possibility of contamination resulting from deactivation is difficult to address, however, because of the high variability of the disposal locations and the quantities of materials discarded. Any low-lying areas on-site which would be secluded from the primary operating area were likely candidates for some "unofficial" dumping both during site operation and at deactivation.

NIKE site operations and the resulting potential associated material contamination as discussed herein are summarized in two Tables as follows:

Table I (NIKE Site Operations and Associated Materials) presents the materials used under each NIKE site operations category together with the usual disposal method and results of such disposal.

Table II (General Materials Inventory of NIKE Sites) presents an alphabetical listing of the materials used, together with a quantity estimate of annual use, the purpose for which it was used, and the results of disposal. Table II was used to determine the Master Contaminant List for the purposes of NIKE Field Investigation Studies which is discussed in Section 8.0.

TABLE I

NIKE SITE OPERATIONS AND ASSOCIATED MATERIALS

OPERATIONS	MATERIALS	DISPOSAL METHOD	RESULTS OF DISPOSAL
1. Missile Assembly and Disassembly			
- Cleaning and Preparation	Solvents	Evaporation Drainage and Leaching	None Persistent in Soils
	Anticorrosion Compound	Solid Waste Disposal Drainage and Leaching	Minimal-Small Quantities Minimal-Small Quantities
- Lubrication, Sealing and Painting	Lubricants, Sealants, and Paints	Solid Waste Disposal POL Turn-In Drainage and Leaching	Dependant on Dumping Practices None Persistent in Soils
2. Missile Fueling and Warheading	UDMH	Depot Turn-In Burial (rare)	None None-Rapid Reactive Decay
	IRFNA	Depot Turn-In Spills (rare)	None None-Rapid Reactive Decay
	Aniline-Furfuryl Alcohol	Depot Turn-In Spills (rare)	None Minimal-Small Quantities
	JP-4	Depot Turn-In Spills	None Small-Persistent in Small Quantities
- Electrical Batteries	Sulfuric Acid (Electrolyte)	Draining and Leaching	None-Small Quantities, Reactive Deacay
	Lead	Draining and Leaching	Small-Limited Quantities

TABLE I

NIKE SITE OPERATIONS AND ASSOCIATED MATERIALS

OPERATIONS	MATERIALS	DISPOSAL METHOD	RESULTS OF DISPOSAL
3. Missile Maintenance and Testing			
- Cleaning and Corrosion Removal	Phosphoric Acid	Drainage and Leaching	None-Small Quantities, Reactive Decay
	Alodine Powder	Drainage and Leaching	Minimal-Small Quantities
	Chromium Trioxide Trioxide and Sodium Dichromate	Drainage and Leaching	Persistent in Soils
	Acids	Drainage and Leaching	Minimal-Reactive Decay
	Solvents (petroleum distillates and chlorinated hydrocarbons)	Drainage and Leaching POL Turn-In	Persistent in Soils None
- Painting	Zinc chromate and Lead	Drainage and Leaching POL Turn-In Solid Waste Disposal	Persistent in Soils None Dependent on Dumping Practices
- Hydraulic Work	Hydraulic Fluid	Drainage and Leaching POL Turn-In Solid Waste Disposal	Persistent in Soils None Dependent on Dumping Practices
- APS Testing	Ethylene Oxide	Burning Surface Dumping	None None-Rapid Reactive Decay

TABLE I

NIKE SITE OPERATIONS AND ASSOCIATED MATERIALS

OPERATIONS	MATERIALS	DISPOSAL METHOD	RESULTS OF DISPOSAL
4. General Launcher and Magazine Maintenance			
- Cleaning and Painting	Solvents, Paints, Lead	Drainage and Leaching POL Turn-In Solid Waste Disposal	Persistent in Soils None Dependent on Dumping Practics
- Hydraulic Work	Hydraulic Fluid	Drainage and Leaching POL Turn-In	Persistent in Soils None
5. Fire Control Operations Maintenance			
- Radar Operation	Ethylene Glycol	Unknown	Minimal-Small Quantities
- Electronics	Low-Level Radio-activity (Electronic Tubes)	Solid Waste Disposal Surface Dumping	Minimal-Small Quantities Minimal-Small Quantities
6. Vehical Maintenance	Solvents, Fuels, Lubricants, Paints	Drainage and Leaching Consumed POL Turn-In	Small-Limited Quantities None None
7. General Facility Maintenance			
- Painting and Cleaning	Paints, Lead	POL Turn-In Solid Waste Disposal Septic	None Dependent on Dumping Practices Persistent in Soils
- Vegetation Control	Herbicides	Consumed	Non Persistent

TABLE I

NIKE SITE OPERATIONS AND ASSOCIATED MATERIALS

OPERATIONS	MATERIALS	DISPOSAL METHOD	RESULTS OF DISPOSAL
8. Utility Service			
- Generator Operation	Diesel Fuel	Consumed Leakage	None Persistent in Soils
- Heating	Heating Oil	Consumed Leakage	None Persistent in Soils
- Vegetation Control in Cable Runs	Hydraulic Fluid and Oils	Surface Dumping	Small-Limited Quantities
- Electricity Service	Polychlorinated Biphenyls	Leakage	Small, Highly Variable
- Insulation (Fire Proofing)	Asbestos	None-Remains in structures	None (Minimal)
9. Deactivation	All Materials o Solvents o Lubricants o Fuels o Etc.	Dumping	Highly Variable-Persistent When Present

TABLE II

GENERAL MATERIALS INVENTORY OF NIKE SITES

MATERIAL	ANNUAL USE	USE CHARACTERISTICS	DISPOSAL METHOD
Acetone	20 gal.	Special Cleaning	Evaporation, Drainage and Leaching
Adhesives	50 lb.	Sealing Missile Components	Consumed, Solid Waste Disposal
Alodine Powder	10 lb.	Decorroding Metal Parts	Drainage and Leaching
Aniline	10 gal.	Ajax Fuel/Starter	Depot Turn-In, Spillage to Soil
Asbestos	500 lb.total	Insulation/Fire Proofing	Minor Release, Intact on Site
Benzene	100 gal.	Solvent	Evaporation, Drainage and Leaching
		General Solvent and Fuel Constituent	Fuel Tank Leakage
n-Butanol	20 gal.	Missile Cleaning	Drainage and Leaching
Carbon Tetrachloride	300 gal.	Solvent	Evaporation, Drainage and Leaching
Corrosion Preventatives (Pastes)	20 lb.	Metal Sealing of Missile	Consumed, Solid Waste Disposal
Chromium Trioxide	100 lb.	Decorroding Missile Parts	Drainage and Leaching, Surface Disposal

TABLE II

GENERAL MATERIALS INVENTORY OF NIKE SITES

MATERIAL	ANNUAL USE	USE CHARACTERISTICS	DISPOSAL METHOD
Diesel Fuel (Hydrocarbons)	10,000 gal.	Fuel for Generators	Consumed, Spillage to Soil, Fuel Tank Leakage
unsym.-Dimethyl Hydrazine	10 gal.	Missile Fuel/Starter	Depot Turn-In, Landfill
Dry Cleaning Solvent (Hydrocarbons)	500 gal.	Solvent	Evaporation, Drainage and Leaching
Electrical Insulating Oil	20 gal.	Electronics Lubricant	POL Turn-In, Leakage
Ethanol	20 gal.	Solvent	Drainage and Leaching
Ethylene Glycol	25 gal.	HIPAR Coolant	Unknown
Ethylene Oxide (Liquid Form)	200 gal.	APS Fuel	Burning, Surface Disposal
Freons (Chlorofuorocarbons)	Unknown	Solvent	Evaporation, Drainage and Leaching
Furfuryl Alcohol	10 gal.	Ajax Fuel/Starter	Depot Turn-In, Spillage to Soil
Gasoline (Hydrocarbons)	1,000 gal.	Vehicle Fuel	Consumed, Fuel Tank Leakage

TABLE II

GENERAL MATERIALS INVENTORY OF NIKE SITES

MATERIAL	ANNUAL USE	USE CHARACTERISTICS	DISPOSAL METHOD
Greases (Hydrocarbons)	100 lb.	Machinery Lubricant	Consumed, Drainage and Leaching, POL Turn-In
Heating Oil (Hydrocarbons)	20,000 gal.	Fuel	Consumed, Fuel Tank Leakage
Herbicides	20 lb.	Vegetation Control	Consumed
Hydraulic Fluid (Hydrocarbons)	2,000 gal.	Hydraulic Fluid	Drainage and Leaching, POL Turn-In, Surface Disposal
Isopropanol	20 gal.	Deicing of Equipment	Evaporation, Surface Disposal
JP-4 (Hydrocarbons)	500 gal.	Missile Fuel	Depot Turn-In, Drainage and Leaching
Lead (Carbonates and Oxide)	200 lb.	Paints and Battery Electrolyte	Drainage and leaching, POL Turn-In
Low-Level Radiation Sources	<1 lb.	Electrical Tubes	Solid Waste Disposal, Depot Turn-In
Lubricating Oils (Hydrocarbons)	200 gal.	Lubrication of Machinery	POL Turn-In, Drainage and Leaching Surface Disposal
Mineral Spirits (Hydrocarbons)	500 gal.	Solvent/Thinner	Drainage and Leaching

TABLE II

GENERAL MATERIALS INVENTORY OF NIKE SITES

MATERIAL	ANNUAL USE	USE CHARACTERISTICS	DISPOSAL METHOD
Molybdenum Disulfide	5 lb.	Lubricant	Consumed, Drainage and Leaching
Naphtha (Hydrocarbons)	50 gal.	Solvent/Thinner	Drainage and Leaching, Evaporation
Nitric Acid (IRFNA)	300 gal.	Missile Fuel/Starter	Depot Turn-In, Spillage to Soil
Paints (Hydrocarbons & Pigments)	300 gal.	Paint	Consumed, POL Turn-In, Drainage and Leaching, Surface Disposal, Solid Waste Disposal
Perchlorethylene (Tetrachloroethene)	100 gal.	Solvent	Evaporation, Drainage and Leaching
Phosphoric Acid	20 gal.	Cleaning Metal	Drainage and Leaching, Surface Disposal
Polychlorinated Biphenyls (PCBs)	100 gal.total	Electric Insulator	Removed, Intack on Site, Leakage to Soils
Propanol	10 gal.	Missile Cleaning	Drainage and Leaching
Selenium (Metallic)	100 lb. total	Rectifier Parts	Removal, Intact On Site, Solid Waste Disposal

TABLE II

GENERAL MATERIALS INVENTORY OF NIKE SITES

MATERIAL	ANNUAL USE	USE CHARACTERISTICS	DISPOSAL METHOD
Sodium Dichromate	50 lb.	Metal Cleaning	Drainage and Leaching
Sodium Phosphate (Tribasic)	50 lb.	Equipment Cleaning	Drainage and Leaching, Septic disposal
Stoddard Solvent (Hydrocarbons)	500 gal.	Solvent	Drainage and Leaching, Evaporation
Sulfuric Acid	30 gal.	Battery Acid	Drainage and Leaching
Toluene	50 gal.	Solvent	Drainage and Leaching
		Constituent of Fuels	Fuel Tank Leakage
1,1,1-Trichloroethane	500 gal.	Solvent	Evaporation, Drainage and Leaching
1,1,2-Trichloroethane	500 gal.	Solvent	Evaporation, Drainage and Leaching
Trichloroethene (Trichloroethylene)	500 gal.	Solvent	Evaporation, Drainage and Leaching
Tricresyl Phosphate	20 gal.	Special Lubricant	Drainage and Leaching
Zinc Chromate	100 lb.	Paint	Drainage and Leaching, POL Turn-In, Solid Waste Disposal

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SECTION 8.0 - MASTER CONTAMINANTS LIST

8.1 GENERAL

Based on the previous analysis of site operations, this section presents the Master Contaminants List which consists of the potential contaminants of former NIKE sites. These contaminants should be investigated in the NIKE Preliminary Determination Phase (Phase II of this investigative program). As shown in Tables I and II, a number of many different substances were found to have potentially contaminated NIKE sites. Many of them, however, were not used in quantities that justify evaluation as a contaminant. Certain other substances that are potential contaminants were used erratically, and have an extremely small likelihood of being discovered on NIKE sites. Other possible contaminants have very brief life expectancies in the environment, and will no longer be present.

Also, further discussion is presented of criteria used for developing the Master List from the general inventory and discusses particular materials regarding their likelihood of being considered a potential site contaminant. The Master Contaminants List is presented as Table III at the conclusion of this Section.

8.2 MASTER LIST CONTAMINANTS

Each of the substances identified on the master list was used in significant quantities on NIKE sites and has a high probability of causing contamination. Most of the other materials identified in this investigation were eliminated from consideration since the volume of use on NIKE sites was small. Certain of the chemicals identified in previous investigations conducted by the United States Army Toxic and Hazardous Materials Agency were not included on the master list. The primary criteria for not including materials on the master list included:

- the materials were used only in small quantities,
- the materials were used with extreme care such that only minor quantities could have caused contamination and,
- the materials were reactive to the environment such that possible contamination from these materials would have dissipated rapidly with time.

Specific discussions of the substances comprising the master list, and of certain significant materials that were eliminated from the list, are presented in the following paragraphs. Materials on the Master List that represent additions relative to previous studies are so designated.

Benzene (New Listing)

Benzene was mentioned in Manual TM 9-1400-250-15/3. Benzene was probably in use as a solvent in the early stages of the NIKE program and was eliminated from updated standard equipment inventories. It remained in the text of the unrevised portions of the manual. Benzene was removed from military use due to its toxicity, much the same as was carbon tetrachloride. Benzene is also a common constituent of other solvents and fuels. Gasoline, for example, often contains significant amounts of benzene, so that NIKE site contamination from leaking fuel tanks or other solvent use increases the threat of benzene contamination.

Carbon Tetrachloride

As indicated in previous studies of NIKE sites (USATHMA DRXTH-AS-IA-83016), carbon tetrachloride was used in the early portions of the NIKE program. It is a superior solvent, and was used extensively for cleaning and degreasing.

Chromium (New Listing)

Chromium originates on NIKE sites in the cleaning materials chromium trioxide and sodium dichromate, as well as in zinc chromate and other paints.

Petroleum Hydrocarbons

Fuels, non-chlorinated solvents, naphthas, lubricants, paints, and hydraulic fluid all fall into the class of petroleum hydrocarbons. Because there are thousands of different but similar hydrocarbons, they are considered as a group when dealing with contamination from the materials mentioned above. In sheer quantity, hydrocarbons constitute the most significant potential contaminant of former NIKE sites.

Lead

Lead originates on NIKE sites in battery electrolyte and lead-based paints. Paint disposal at NIKE sites may have caused extensive contamination by lead.

Perchlorethylene (New Listing)

Interviews confirmed the use of perchloroethylene on NIKE sites. It was used as a solvent, probably after carbon tetrachloride use ceased, and before the introduction of trichloroethene and trichloroethanes. High volume use could be expected during that period.

Toluene

Toluene was specified as a cleaning solvent for missile components. It is also a major component of fuels and other solvents.

1,1,1-Trichloroethane, 1,1,2-Trichloroethane, and Trichloroethene

The use of these solvents was previously documented by USATHMA and was confirmed by this investigation.

8.3 OTHER MATERIALS CONSIDERED

The materials discussed in the following paragraphs are potential contaminants that were not placed on the master list of contaminants for the reasons previously discussed, but which warrant further discussion because they are mentioned in other source material as possible contaminants.

Unsymmetrical Dimethyl Hydrazine (UDMH)

UDMH was used in small amounts and stored for use in small sealed canisters. UDMH was carefully handled and controlled on NIKE sites. Spills very rarely occurred, and only intentional landfilling would present a contamination situation. In the environment, UDMH does not persist, because of its reactivity. UDMH will not occur on NIKE sites, except in sealed canisters, and will not be found in water or soil samples.

Ethylene Oxide

Ethylene oxide was used throughout the NIKE program as a fuel for the Accessory Power Supply (APS) system. This system burned ethylene oxide primarily to power missile guidance hydraulics. The system was tested periodically with a "hot run". Waste ethylene oxide was disposed of immediately by burning or dilution in water and on-site dumping. Ethylene oxide is a reactive, volatile liquid stored at low temperatures. (It has a boiling point of 11° Centigrade). In the environment, it decays in a very short time. No ethylene oxide will remain as a NIKE site contaminant.

Aniline and Furfuryl Alcohol

These starter fuels were not used in large quantities and pose very little contamination hazard.

JP-4

JP-4 is a hydrocarbon fuel. Contamination by JP-4 is considered along with other fuels under the hydrocarbon category.

Low-Level Radiation

Radiation resulting from electrical tube disposal caused extremely minute contamination with no associated hazard. Leakage from nuclear weapons did not occur to the best of our knowledge.

IRFNA (Nitric Acid)

IRFNA was an extremely hazardous material that was treated with great respect by NIKE site operators. Very little contamination via spillage occurred. The small amounts that were spilled rapidly reacted to become nitrates. Nitrates occur naturally in soils and are very commonly used as fertilizer. There is practically no chance that serious contamination of NIKE sites occurred as a result of the use of IRFNA.

Polychlorinated Biphenyls (PCBs)

PCBs were present on NIKE sites in permanent, sealed electric transformers. Small, erratic leakage of transformers probably occurred during site operation and after deactivation. Contamination resulting from PCB's would be small, localized, unpredictable, and unlikely to be discovered except from visual observation of a leaking transformer. Therefore, PCBs were not included in the Master List for screening during the Preliminary Determination Phase. If PCB contamination is suspected, it will be investigated on a site specific basis.

Asbestos

Asbestos remains on-site in its original form in buildings, on piping and ductwork. It should be removed during demolition. Asbestos was not included on the Master List for screening during the Preliminary Determination Phase.

TABLE III
MASTER LIST OF SIGNIFICANT POTENTIAL NIKE SITE CONTAMINANTS

MATERIAL	USE CHARACTERISTICS	DISPOSAL METHOD
Benzene	Solvent	Evaporation, Drainage and Leaching
	General Solvent and Fuel Constituent	Fuel Tank Leakage
Carbon Tetrachloride (Tetrachloromethane)	Solvent	Evaporation, Drainage and Leaching
Chromium (Chromates, Chrome III, IV, and VI)	Decorroding Missile Parts	Drainage and Leaching, Surface Disposal
Petroleum Hydrocarbons	Fuels, Lubricants, Hydrocarbons	Consumed, Fuel Tank Leakage, Spillage to Soil, POL Turn-In, Drainagae and Leaching, Surface Disposal
Lead (Carbonates and Oxide)	Paints and Battery Electrolyte	Drainage and Leaching, POL Turn-In
Perchlorethylene (Tetrachloroethene)	Solvent	Evaporation, Drainage and Leaching
Toluene	Solvent Constituent of Fuels	Drainage and Leaching Fuel Tank Leakage
1,1,1-Trichloroethane	Solvent	Evaporation, Drainage and Leaching
1,1,2-Trichloroethane	Solvent	Evaporation, Drainage and Leaching
Trichloroethylene	Solvent	Evaporation, Drainage and Leaching

REFERENCES

1) USATHMA Historical Overview of the NIKE Missile System. December, 1984. DRXTH-AS-IA-83016

2) USATHMA Assessment of Contamination: Phoenix Military Reservation Launch Control Area. August, 1984. DRXTH-AS-CR-84296

3) USATHMA Fulton Property Survey. December, 1980. DAAK-79-C-0148

4) USATHMA Survey of the Former NIKE Site, Bristol, Rhode Island. December, 1980. DRXTH-IS-TR-81088

5) Personal Communication with five former NIKE site operators.

6) Personal Communication with military radiation safety personnel.

7) Personal Communication with municipal and industry representatives.

8) U.S.Army, NIKE Hercules Phaseout Plan. February, 1981.

9) U.S.Army, NIKE Hercules Inactivation Plan. February 1974.

10) U.S.Army, TM 9-1400-250-15/3. General and Preventative Maintenance Services (NIKE-Hercules and Improved NIKE-Hercules Air Defense Guided Missile System and NIKE-Hercules Anti-Tractical Ballistic Missile System). March, 1968.

11) U.S.Army, TM 9-1410-250-12/1. Operator and Organizational Maintenance Manual: Intercept-Aerial Guided Missile MIM-14A and MIM-14B.

12) U.S.Army, TM 9-1440-252-34. DS and GS Maintenance of the Hercules Monorail Launcher, Launching-Handling Rail, Side Truss, Loading Rack Support, Launcher-Transport Modification Kit, Launcher-Subsurface Four-Rack Modification Kit, and Launcher Basis Accessory Kit. August, 1960.

FINAL REPORT

INVESTIGATION OF FORMER NIKE MISSILE SITES
FOR POTENTIAL
TOXIC AND HAZARDOUS WASTE CONTAMINATION

VOLUME II

Prepared for:
DEPARTMENT OF THE ARMY
HUNTSVILLE DIVISION, CORPS OF ENGINEERS
HUNTSVILLE, ALABAMA
CONTRACT #DACA87-85-C-0104

Prepared by:
LAW ENGINEERING TESTING COMPANY
LES-GOVERNMENT SERVICES DIVISION
ATLANTA, GEORGIA
LEGS JOB NO. 601

March, 1986

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WORK PLAN PREAMBLE

The initial effort described in the following Generic Plans is called the Preliminary Determination Phase (PDP). It is unique in terms of both breadth and complexity as compared with Remedial Investigations (RI) under CERCLA and Confirmation Studies under the IRP. Although many technical requirements apply especially in the Sampling and Analysis area, some latitude is available because of the preliminary nature of this effort.

These PDP studies are designed only to confirm or deny the existence of contamination which could have been caused by DOD, and are not equivalent to RCRA ground water quality assessments, or CERCLA investigations. Only when contamination is discovered is it necessary to follow the much stricter EPA guidance for site investigations.

The Plans are structured so that headings describing the intent of each section are given in **CAPITALIZED BOLD FACE TYPE.** This language would not appear in a site specific plan. In some cases, site specific examples are given. They appear in **Bold Face Regular Type.** The site specific data should be inserted in place of these examples for a specific case. Other suggested language for site specific plans is given in regular type. Where specific equipment is mentioned, "equivalent equipment" that performs the required task in an acceptable manner **may** be specified and used.

TABLE OF CONTENTS

GENERAL

SAMPLING AND ANALYSIS PLAN

CONTRACT DACA87-85-C-0104

1.0 *INTRODUCTION*

THIS SECTION DISCUSSES THE OBJECTIVE OF SAMPLING AND DESCRIBES THE CONTENTS OF THE SAMPLING AND ANALYSIS PLAN.

The basic objective of any sampling campaign is to collect samples that are representative of the media under investigation. Therefore, sampling methodology, handling and analysis must all be controlled within a narrow band of tolerance in order to provide samples that are representative of actual in-situ conditions. At the same time sampling activities and programs must incorporate practicality, simplicity, economics, reproducibility and safety considerations.

The following Sampling and Analysis Plan has been designed to encompass the preceding objectives. Procedures incorporated into this Plan are taken from a number of sources. However, much of the material has been derived from EPA hazardous waste sampling publications. A primary source document is "Characterization of Hazardous Waste Sites - A Methods Manual, Volumes I, II and III".

The NIKE Site Sampling and Analysis Plan contains the following sections:

- Project objective
- Project Background
- Organization of Field Team
- Sampling Program
- Quality Assurance/Quality Control
- Safety Considerations

Reference is made to the NIKE Site Well Installation Plan. The Well Installation Plan discusses well construction materials, specifications and procedures. It also presents a detailed description and rationale for well locations and depths.

*****

2.0 PROJECT OBJECTIVE

THIS SECTION DISCUSSES THE PROJECT OBJECTIVE AND THE OBJECTIVE OF THE SAMPLING AND ANALYSIS PLAN FOR EACH SITE. ENVIRONMENTAL AND HAZARDOUS SAMPLES ARE DESCRIBED, AND GRAB AND COMPOSITE SAMPLING TECHNIQUES ARE PRESENTED.

The primary objective of NIKE Site investigations (under U.S. Army Contract DACA87-85-C-0104) is to make a preliminary determination of whether Department of Defense (DOD) activities caused contamination at former NIKE missile sites. The word contamination includes hazardous or toxic substances found in ground water, surface water and soil with contaminants specified by regulatory criteria. A secondary objective of the program is to provide reliable data for subsequent investigations, if necessary, that would define the extent of contamination, its rate of movement, and potentially feasible remedial measures.

The primary objective of the NIKE Site Sampling and Analysis Plan is to provide consistent methodology and procedures for obtaining representative samples of the media (water and soil) under investigation. A representative sample is defined as "a sample that possesses the same qualities or properties as the material under investigation". In relation to media, two basic types of samples can be considered: environmental (diluted) and hazardous (concentrated) samples. Environmental samples (ambient air, soils, rivers, streams, or biota) are generally dilute and usually do not require the special handling procedures used for concentrated samples. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples. Hazardous samples, are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, etc., and required special handling because of their potential toxicity or hazard.

In general, when collecting environmental or hazardous samples, two basic types of sampling techniques are recognized: grab samples and composite samples. A grab sample is a single sample representative of a specific location at a given point in time. The sample is collected all at once and at one particular point in the sample medium. Composite samples are combinations of more than one sample collected at various sampling locations. Analysis of composite sample yields an average value.

At the NIKE Site, it is anticipated that environmental samples will be collected from soil, ground water, and surface water. Grab samples will be obtained from each sampling location as discussed in Section 5 (Sampling Program) of this Plan.

*****

3.0 PROJECT BACKGROUND

THIS SECTION PROVIDES SITE SPECIFIC BACKGROUND INFORMATION RELEVANT TO THE SAMPLING AND ANALYSIS PLAN. AN EXAMPLE OF TYPICAL SITE SPECIFIC LANGUAGE IS GIVEN. INFORMATION COMPRISING SEVERAL PARAGRAPHS OF SITE LOCATION AND LAYOUT INFORMATION CONSTITUTE THE FIRST PORTION OF THIS SECTION. SUBSEQUENT PARAGRAPHS DESCRIBE DATA OBTAINED IN THE SITE INSPECTION TRIP AND INCLUDES INFORMATION ABOUT SITE GEOLOGY, GROUNDWATER, TOPOGRAPHY AND PRESENT SITE LOGISTICS. EXAMPLE LANGUAGE THAT IS SITE SPECIFIC IS GIVEN IN BOLD FACE TYPE. EACH PLAN MUST DEVELOP ITS OWN SITE SPECIFIC INFORMATION FOR THIS SECTION.

The NIKE site is located in the town of Needham (Norfolk County) Massachusetts. Needham is a suburban community located in the southwestern part of the Metropolitan Boston Area, approximately 12 miles from downtown Boston. It is bordered by the cities of **Newton and Boston on the northeast side and the Town of Wellesley on the northwestern side. The southern borders abut the Towns of Dover, Dedham and Westwood.** The Charles River serves as the Town border for about three quarters of its perimeter. The Launcher Area of the site is located near the intersection of Charles River Street and Pine Street in **Needham.**

The site was formerly owned by the Department of Defense (DOD) **from about 1956 until about 1967.** The site contained a total of **86.20 acres, with 28.88 acres "Fee" and 57.20 acres "Easement".** The primary tract of interest is the Launcher Area which consisted of 19.11 acres. Facilities at the Launcher Area **included officers quarters, missile assembly and test building,** a revetted fueling area, three silo areas, and other smaller structures. **The IFC Area is located about one mile northeast of** the site, but is not being considered in this investigation because of its lack of facilities that would apparently cause contamination. The Launcher Area is presently owned by the City of Needham and has served no use since purchase. It is eventually intended for use for new school facilities.

At other NIKE facilities across the United States, records indicate the possibility that hazardous/toxic substances may have been released and/or disposed on similar sites. The primary area of concern is generally at the Launcher Area and is related to missile fueling/defueling, procedures operation and maintenance activities, and site deactivation. Therefore, ground water, surface water, and soil samples will be taken only at the Launcher Area and analyzed for hazardous constituents.

To better understand existing site conditions, a preliminary site investigation was performed. Agencies presently involved with the site were visited and regional data were obtained. Preliminary data were collected on general site characteristics to assist in locating the proposed ground water monitoring wells. Discussions were also conducted with local authorities, owners, and others that may have site information who were familiar with the Launcher Area. The following data were learned from the preliminary site investigation:

- The geology of Needham has examples of both bedrock and glacial action. The bedrock is primarily volcanic from the Devonian or Carboniferous Age along with some later massive conglomerate sediments and a small region of earlier granodiorite. The glacier features include drumlins, a large lake filled plain, eskers, kettle-holes, erratic boulders and bedrock striation. In addition, the course of the Charles River was extensively relocated as a result of the glacial deposits in Needham and surrounding communities.

- Needham lies entirely within the Charles River Watershed and is bordered on three sides by the Charles River. This river frontage totals 12.3 miles, or approximately 15 percent of the total river length. The Charles River is Massachusetts' largest intrastate waterway.

- Topography at the Launcher Area slopes predominantly toward the eastern edge of the facility. Ground water is locally controlled by topography. Significant fill has been placed on the site to achieve construction grade for several of the buildings. Wetlands e·ist both to the east and northwest of the site.

- From initial information obtained during the site visit, the IFC Area appears to be free from surface contamination. It does not appear that any activities were conducted at the IFC Area that would have resulted in contaminating the site. Therefore, all subsequent investigations for this study will be focused at the Launcher Area.

- The Launcher Area was purchased by the City of Needham in 1968 for future educational purposes. It has not been developed since that time. Parkland exist adjacent the site and citizens using the parks occasionally gain access to the site.

- There is evidence that some dumping of refuse and possibly other materials has occurred in the past. It is not known to what extent past NIKE operations may have contributed to such refuse. The sampling program will consider this possibility.

- The site is heavily wooded and minor adjustments to boring locations may be necessary considering field access difficulties.

Based upon investigations at other NIKE facilities (Contract DACA87-85-D-0004), the NIKE literature study, (Contract DACA87-85-C-0104) and the site visit to the NIKE Site, contamination is most likely to be related to the following Launcher Area facilities: Missile assembly facilities, diesel and fuel oil storage facilities, magazine seepage facilities, secluded areas around the periphery of the site boundary convenient for dumping, missile warheading and fueling areas, the motor pool (when present) and septic systems (when present). Likely contaminants include: Volatile organic solvents, gasoline, diesel fuel, rocket fuel, fuel additives, paints and related substances, and battery electrolyte. The Sampling Program (Section 5.0) describes the proposed sampling procedures and analytical methodologies to address the potential contaminants at the launch site areas.

*****

4.0 ORGANIZATION OF PROJECT TEAM

THIS SECTION PRESENTS THE PROJECT TEAM ORGANIZATION FOR EACH SITE INVESTIGATION. KEY WORK ASSIGNMENTS AND PERSONNEL ARE DESCRIBED. EACH COMPANY SHOULD PROVIDE THE QUALIFICATIONS FOR EACH OF THE PERSONNEL LISTED FOR THE ORGANIZATIONAL POSITIONS DESCRIBED.

Key project participants for the NIKE Site investigation include the project manager, senior technical staff, site manager, safety officer, laboratory manager, and work party. Described in the following paragraphs are the proposed project assignments and responsibilities. A list of individuals expected to serve in each capacity and a brief synopsis of the participants experience for similar investigations should be included in each individual plan.

- PROJECT MANAGER - Is responsible for overall management of the NIKE Site Investigation. Coordinates between office and field personnel, manages administrative requirements and schedules, oversees technical project approach, implementation, and report preparation.

- SENIOR ENGINEER - Provides technical oversight and direction for all aspects of the site investigation and data evaluation, and serves as Senior Author of the engineering report.

- SITE MANAGER - Is responsible for implementation of Sampling and Analysis Plan, Well Installation Plan, Quality Assurance/ Quality Control, and Safety during the field investigation phase. Reports directly to the Project Manager.

- SAFETY OFFICER - Oversees the site specific Health and Safety Plan for the NIKE Site, conducts personnel training, administers company hazardous assessment and surveillance medical program, and coordinates with Site Manager for site safety. He is available for consultation during the actual investigation.

- LABORATORY MANGER - Is responsible for handling and analysis of ground-water and soil samples received by the laboratory. He also oversees sample travel through the lab, analytical procedures, quality control, reporting and sample disposal.

- WORK PARTY - Performs on-site tasks contained in the Sampling and Analysis Plan and Well Installation Plan under the direction of the Site Manager.

*****

5.0 SAMPLING PROGRAM

THIS SECTION DESCRIBES THE PROPOSED SAMPLING PROGRAM FOR EACH SITE. THE PROGRAM INCLUDES THE FOLLOWING INFORMATION: TYPES OF SAMPLES, NUMBER OF SAMPLES, LOCATION OF SAMPLES, SAMPLE CONTAINERS, SAMPLING PROTOCOL, FIELD CHARACTERIZATION TECHNIQUES, SAMPLE PRESERVATION, AND LABORATORY HANDLING. A FIGURE SHOWING THE SAMPLING LOCATIONS SHOULD BE PROVIDED. THE FIGURE SHOWN HEREIN IS AN EXAMPLE OF A SPECIFIC SITE.

The objective of the NIKE Site Investigation program is to make a preliminary determination of whether DOD activities caused contamination of the media (soil, ground water, and surface water) at the facility. In order to accomplish this objective, representative samples of the media must be obtained. The following Sampling Program provides a methodical and controlled procedure for collecting and handling media samples at the NIKE Site. Included are subsections that discuss types, numbers, locations, containers, protocols, field characterization, preservation, labeling, and shipping of the samples. Analytical procedures are discussed in the following section.

5.1 Types of Samples

Media to be sampled at the NIKE Site will include soil, ground water, and surface water. As such, the samples will be environmental rather than hazardous (or concentrated) samples. Both grab and composite sampling techniques can be used too collect environmental samples. However, the overall objective of the NIKE site investigation program is to provide a one time determination of whether DOD contamination exists. Therefore, grab samples will be collected from the soil, surface water, and ground water at the NIKE Site.

5.2 Number of Samples

IT IS SUGGESTED THAT APPROXIMATELY TWELVE GROUND-WATER (INCLUDING SURFACE WATER) AND TWELVE SOIL SAMPLES BE TAKEN FOR EACH SITE. HOWEVER, VARIATIONS AT EACH SITE ARE EXPECTED DUE TO SITE SPECIFIC CONSIDERATIONS. AN EXAMPLE IS GIVEN AS FOLLOWS. At this NIKE Site, seven ground-water, five surface water and twelve soil samples will be collected. These will include the following:

At this NIKE Site, seven ground-water, four surface water (involving open silos) and fourteen soil samples will be collected. These will include the following:

- Ground Water	No. of Samples
. 1 sample will be collected from each of the 4 wells	4
. 1 duplicate (QA) sample from 1 of the wells	1
. 1 duplicate (QA) sample for spiking from 1 of the wells	1
. 1 travel blank (QA)	1
TOTAL	7

- Surface Water

	No. of Samples
. 1 sample (at different locations) will be collected from each surface impoundment (two open silos)	2
. 1 duplicate (QA sample from each location	2
TOTAL	4

- Soil

	No. of Samples
. 1 sample from each of the 4 well borings (0-1.5 feet deep)	4
. 1 sample from each of 2 auger borings (5-10 feet deep) adjacent tanks	2
. 6 samples throughout the site collected with a hand auger (0-1.5 feet deep)	6
. 1 duplicate (QA) soil sample	1
. 1 duplicate (QA) soil sample for spiking	1
TOTAL	14

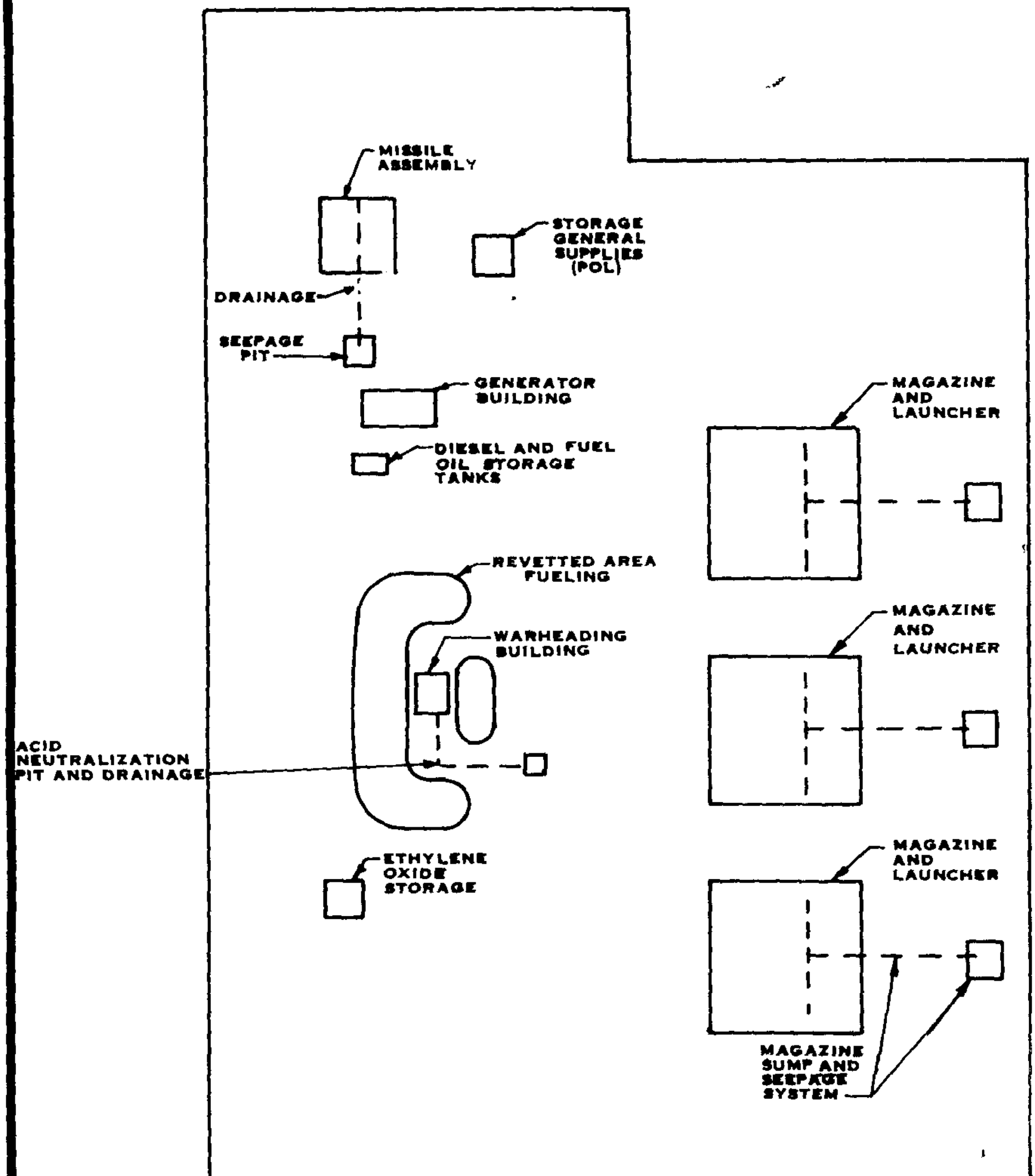
In addition to the sampling program described above for the analytical phase of the investigation, additional samples shall be taken for the Corps of Engineers' laboratory at Missouri River Division (MRD) in Omaha for QA analyses. For this purpose, a number of split samples equal to approximately ten percent of the total (not less than one per set) shall be taken. In the example given, there should be one additional water and one additional soil sample taken for this purpose. One set of Field Blanks is also required for MRD QA purposes.

5.3 Location of Samples

SEVERAL PARAGRAPHS SHOULD BE GIVEN WHICH RELATE TO THE SITE MAP AND EXPLAIN THE RATIONALE FOR THE SAMPLING LOCATIONS. AN EXAMPLE IS GIVEN WHICH RELATES TO THE SAMPLING LOCATION PLAN (FIGURE 1). THE RATIONALE GIVEN FOR LOCATING THE OBSERVATION WELLS AND SAMPLING POINTS IS REASONABLY TYPICAL.

This NIKE Site Launcher Area contains a number of places where contamination of the site media could have occurred. These include the officers quarters, the missile assembly and test building, a revetted fueling area, three underground silo areas and random locations around the site and along the site periphery where surface drainage may have taken place. A site map showing various facilities at the NIKE Site Launcher Area is provided as Figure 1. In addition to showing the Launcher Area facilities, Figure 1 also shows the proposed location for each of the sampling points. Rationale for the sample locations are discussed as follows and are also presented in the Well Installation Plan (Appendix A, to this document).

Based upon the information gathered during the initial site visit, the NIKE Site could be monitored using the scenario of sample locations outlined in Figure 1. The wells are positioned around the periphery of the site and in an apparent down-gradient position from the key NIKE base units which may have caused site contamination. Since the ground water table is suspected to be essentially flat with some impact of topography, locations were picked primarily to be adjacent facilities that might cause contamination in the direction that is topographically down-gradient from these facilities. Soil samples are planned to be



GENERALIZED NIKE SITE

CONTRACT DACA 87-85-0104

LAW ENVIRONMENTAL SERVICES

MARIETTA, GEORGIA

LAUNCHER AREA

FIGURE 1

taken from topographic low areas, from shallow auger borings adjacent to fuel tanks, and from each of the monitoring wells to provide any possible soil correlation with the monitoring well data. In addition, surface water samples will be taken from each of the two silos that are open. There are no other surface water features on the site. The sample locations as now envisioned are given on Figure 1. The precise location of the samples will be left to the discretion of the Site Manager, based on final utility clearance, etc.

5.4 Sample Containers

Samples collected and prepared in the field shall include: groundwater samples, surface water samples including samples of water standing in the underground missile storage structures (if present), soil samples, and field control samples, as described above. All sample collections and subsequent sample handling procedures shall be in accordance with the sampling analysis - QC/QA plan and with applicable EPA requirements. Sampling containers will consist of plastic (polyethylene) and glass bottles as shown in Tables I and II (Section 6.0) depending upon the analytical method that will be utilized.

All container caps have Teflon liners. Each container is labeled giving the sample identification, date, sampler, and project number.

Prior to use at the NIKE Site, the containers and caps will all go through cleaning procedures including: hand-washing in Alconox or equivalent water solution at 150°F; rinse with hot tap water, rinse with cold tap water; rinse with distilled water. In addition, containers used for collection of samples to be analyzed for EPA organic priority pollutants will be cleaned in the appropriate manner for the specific container. This process is discussed in more detail in Section 7.3.

5.5 Sampling Protocols

Different sample matrices require different sampling techniques, as described herein. Care must be taken to determine the best practical sampling procedure that will result in obtaining representative samples. The samples must maintain the integrity of the original medium through collection, transportation and delivery to the analyst. The NIKE Site samples will be collected and containerized as described in the following paragraphs for each medium at the site.

5.5.1 Ground Water

The subsurface is a unique heterogeneous environment. Gas exchange, biological and other chemical reactions and conditions are different from the surface environment. Ground water is somewhat insulated from surface temperature and pressure variations. Rapid and significant changes can occur in ground-water sample upon exposure to the surface (sunlight, temperature and pressure). Therefore, ground-water sampling is conducted in a manner to minimize interaction of the sample and the surface environment. The equipment and protocol for collecting ground-water samples at the NIKE Site is discussed in the following paragraphs.

5.5.1.1 Equipment

Many variations of ground-water sampling equipment are available depending upon the objective of program. For the NIKE Site, ground-water samples will be obtained with pre-cleaned PVC bailers. Pre-cleaning will consist of hand washing inside and outside with Alconox, or equivalent detergent and water solution, and rinsing with reagent water. Bailers will be air-dried and wrapped in plastic to prevent contamination prior to use. A dedicated bailer will be used for each well at the site to minimize the potential for cross-contamination. If a peristaltic pump is used for pumping or sampling, dedicated Tygon tubing will be utilized for each well.

5.5.1.2 Protocol

The sampling protocol at the NIKE Site will be as follows:

a. Measure Water Level - Using clean, non-contaminating equipment, (i.e., an electronic level indicator, or a fiberglass tape and high intensity light source) determine the water level in the well and calculate the fluid volume in the casing and screen.

b. Purge Well - Remove at least 5 well volumes with a bailer, or peristaltic pump. Groundwater samples shall be collected only after the water levels in the monitoring wells have been measured and recorded, and the wells have been pumped or bailed (with clean equipment), so as to remove a quantity of water at least equal to five (5) times the submerged volume of the casing. In those cases where the well is not able to recharge at a rate sufficient to evacuate five (5) well casing volumes, the well shall be pumped or bailed dry. When the well has recharged to a sufficient degree, the sample may then be obtained. If the well is incapable of producing a sufficient volume of samples at each incidence of sampling, the largest quantity possible shall be collected.

c. Collect Sample - Lower the bailer slowly until it contacts the water surface and allow the bailer to sink to the desired depth and fill with a minimum of surface disturbance. Slowly withdraw the bailer, being careful to prevent contact of the bailer line with the ground. Tip the bailer and slowly discharge the contents into the appropriate containers. Rinse the ground water sample containers with a portion of the ground water prior to filling. Repeat the process as necessary to fill each container to the required volume. Samples for volatile organics should be completely filled leaving no air space above the liquid portion (to minimize volatilization). Samples for hydrocarbons should have a headspace. Check that a Teflon-liner is present in the cap and secure the cap tightly. All samples are taken as quickly as possible once the sampling process begins, generally well within the 3 day guideline. Sample preservation is discussed in Section 5.7.

d. Label Sample - Once the sample is collected, label each container providing the following data: sample identification number, project number, date, time, method of preservation, analysis required, and person sampling. Record the information in the field log book and complete all chain-of-custody (Exhibit 1) and request for analysis (Exhibit 2) documents. The field log book will consist of a bound note book. All entries and labeling will be waterproof or indelible ink.

e. Handling and Shipping - Place the properly labeled sample bottle in the appropriate carrying container and maintain the sample at 4°C throughout sampling and transportation. The shipping container will be a sturdy cooler. Each sample will be wrapped with bubble wrap. Additional bubble wrap will be placed between the bottles for protection against breakage. "This Side Up" and "Fragile" labels will be placed on the cooler. The lid of the cooler will be taped shut with fiber tape or duct tape. Samples are shipped from the site directly to the laboratory by overnight courier. Chain-of-custody and request for analysis documents are shipped in air-tight plastic bags in each container (taped to the inside of the lid) with applicable samples. The laboratory is notified by phone of the sample shipment.

CH... OF CUSTODY RECORD
I. CORPORATION

EXHIBIT 1

SAMPLER(S): ______________________ HIGH HAZARD?: __________ DATE COLLECTED: __________

REASON FOR SAMPLING: ______________________________ DESTINATION: __________

SAMPLE NUMBER	DESCRIPTION	TIME COLLECTED	AMOUNT COLLECTED	SAMPLE TYPE	CONTAINER TYPE	CONDITION ON RECEIPT
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

SPECIAL INSTRUCTIONS: ______________________________

1. Relinquished by: ______________________
Received by: ______________________

3. Relinquished by: ______________________
Received by: ______________________

2. Relinquished by: ______________________
Received by: ______________________

4. Relinquished by: ______________________
Received by: ______________________

***Transfer of Custody Instructions: Sign full name, company name, and date/time of transfer in appropriate [illegible] above to relinquish or receive a set of samples.

IT CORPORATION

EXHIBIT 2

IT ANALYTICAL SERVICES
5815 Middlebrook Pike
Knoxville, TN 37921
(615)588-6401

REQUEST FOR ANALYSIS

This Form Must be Shipped With Samples
Please Do Not Mail Under Separate Cover

Date Samples Shipped________________

REPORT TO:______________________________ BILL TO:______________________________

ATTN:______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

TELEPHONE NUMBER:______________________ PURCHASE ORDER NO.: ______________

NO. & TYPE OF SAMPLES (i.e. water, sediment, waste, specific chemical, etc): _______

____

____

____

ANALYSIS REQUIRED: ____

____

____

____

TURNAROUND TIME NEEDED (see Service Policies on back):

_____Normal, usually 5-15 working days _____RUSH, 3 working days (50% surcharge

_____Other, ____

POSSIBLE HAZARD IDENTIFICATION (Please note if sample (s) are hazardous materials and/or suspected to contain high levels of chemical compounds):

_____Poison _____Skin Irritant _____Toxic _____Other, ____________

Identify hazardous material or chemical matrix: ______________________________

____

Samples Requiring Disposal As Hazardous Materials Are Subject to Additional Charges*

REMARKS:____

*See Service Policies on Reverse Side

5.5.2 Surface Water (Impoundment or Water Courses)

Surface water samples will be obtained at different locations around the NIKE Site. These locations should include any accessible silos which contain water. The following section presents a discussion of equipment and protocol for surface water sampling at the NIKE S te

5.5.2.1 Equipment

A pond sampler is used to collect grab liquid samples from ponds, pits, lagoons and similar reservoirs and slow moving water courses. A typical device is shown in Figure 2. Pre-cleaning shall consist of hand washing with Alconox, or equivalent detergent, and water solution, and rinsing with reagent water. The sampling device will be cleaned between each use as necessary.

5.5.2.2 Protocol

Collecting surface water samples with the pond sampler will be as described in the following sections. It is noted that this procedure is for samples taken at the water surface. The pond sampler shown is not designed to take samples at depth. Depth of surface water samples should be considered on a site specific basis.

a. Collect Sample - Assemble the pond sampler making sure that the sampling beaker and the bolts and nuts that secure the clamp to the pole are tightened properly. With proper protective garment and gear, take grab samples by slowly submerging the beaker with minimal surface disturbance. Retrieve the pond sampler from the surface water with minimal disturbance. Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the

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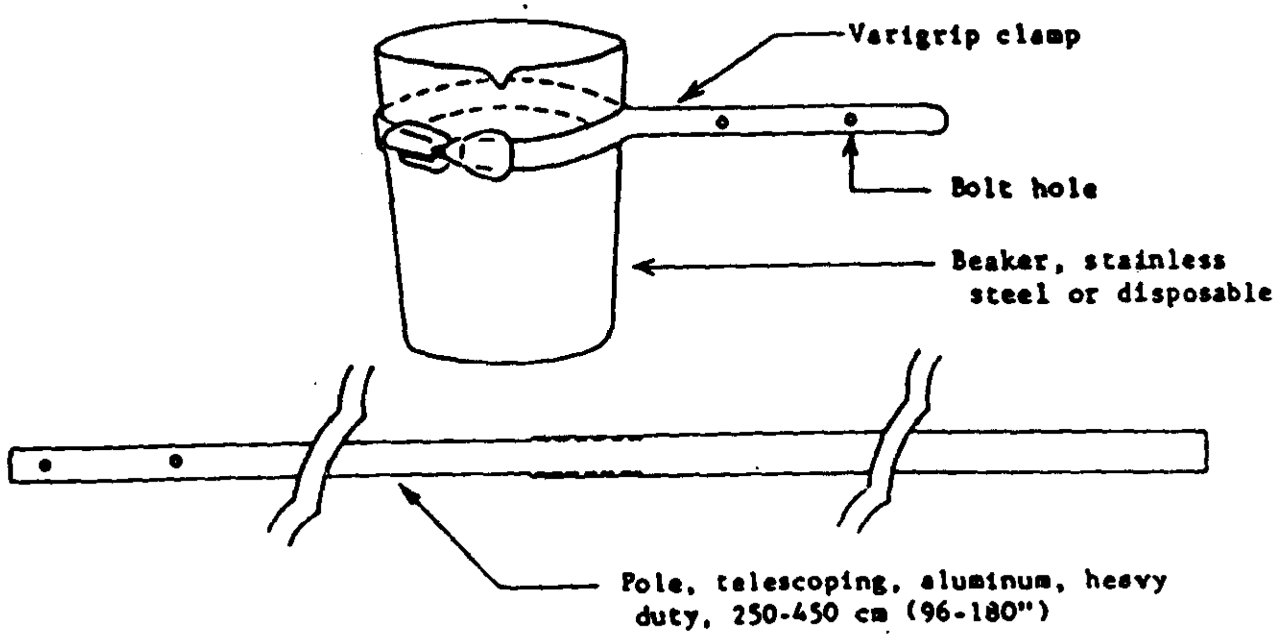

Figure 2 Pond sampler.

dipper/device edge. Empty the sampler slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence. Continue delivery of the sample until the required volume is obtained (same as ground water samples). Check that a Teflon liner is present in the cap and secure the cap tightly. Sample preservation is discussed in Section 5.7.

b. Label Sample - Label the sample bottle with an appropriate sample tag (same as ground water samples). Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field log book and complete the chain-of-custody documents.

c. Handling and Shipping - Place the properly labeled sampled bottle in an appropriate carrying container (as previously described) maintained at 4°C throughout the sampling and transportation period. Samples are shipped from the site directly to the laboratory by overnight courier. Chain-of-custody and request for analysis forms documents are shipped in air-tight plastic bags in each container with applicable samples. The laboratory is notified by phone of the sample shipment.

5.5.3 Soils

Soil samples will be obtained at different locations around the NIKE Site using different sampling techniques. The following section presents a discussion of equipment and protocol for soil sampling at the NIKE Site.

5.5.3.1 Equipment

Two basic types of equipment will be used to collect soil samples: a stainless steel hand auger and a stainless steel scoop. Specific use of these tools will depend upon the sampling location and technique. The stainless steel hand auger will be used to obtain soil samples around the site buildings. The stainless steel scoop will be used to collect the sample from the auger cuttings at each borehole. Each device will be pre-cleaned before use to minimize potential cross-contamination. Pre-cleaning shall consist of hand washing with Alconox, or equivalent detergent, and water solution, and rinsing with reagent water.

5.5.3.2 Protocol

Collecting soil samples with the stainless steel hand auger and scoop will be as follows:

a. Collect Sample - Hand auger from the land surface to a depth of six inches, emptying the auger as necessary into a clean, stainless steel tray. Soil samples will also be obtained from the soil cuttings at each borehole. These will be collected from drill cuttings of the top 1.5 feet of the boreholes with a stainless steel scoop. Composite the sample and transfer into an appropriate sample jar with a stainless steel lab spoon or equivalent. Check that a Teflon liner is present in the cap and secure the cap tightly.

b. Label Sample - Label the sample bottle with the appropriate sample tag. Be sure to label carefully and clearly, addressing all the categories, or parameters. Complete all chain of custody documents and record the sampling event in the field log book.

c. Handling and Shipping - Place the sample jar in a appropriate carrying container (as previously described) maintained at $4^{\circ}C$ throughout the sampling and transportation period. Samples are shipped from the site directly to the laboratory by overnight courier. Chain-of-custody and request for analysis forms documents are shipped in air-tight plastic bags in each container with applicable samples. The laboratory is notified by phone of the sample shipment.

5.6 Field Characterization of Samples

Certain parameters regarding ground-water samples can vary considerably with time. Those of primary interest regarding the NIKE Site are pH, temperature and conductivity. Therefore, these parameters will be measured in the field when the samples are obtained.

- Field pH will be measured with a Gallenkamp Field pH stick. The instrument will be field calibrated with pH 4, pH 7 and Ph 10 buffer solutions before beginning each days use and after use on two consecutive wells. The pH stick will be rinsed with reagent water between each use.

- Temperature and specific conductance will be measured with a portable YSI (Yellow Springs Instrument) S-C-T (Salinity, Conductivity, Temperature) meter. Calibration of the instrument is performed at the factory periodically. The instrument probe will be rinsed with reagent water between each use.

5.7 Sample Preservation

All of the samples will be stored and shipped on ice to maintain the temperature at approximately 4°C. Additionally, monitoring well samples to be analyzed for dissolved metals will be filtered in the field and acidified to pH 2 with two milliliters (ml) of nitric acid (HNO_3) per liter of sample. Surface water samples to be analyzed for total metals will be acidified in the field with two milliliters (ml) of nitric acid (HNO_3) per liter of sample. Other laboratory preservation requirements are carried out as necessary for each Analytical Procedure.

5.8 Laboratory Handling and Tracking

Upon receipt of the samples in the laboratory, the Sample Coding Specialist will inventory the coolers and samples, reporting condition, temperature and numbers, and sign the Chain-of-Custody forms. The sample information and analytical requirements will be logged into the Perkin Elmer 2000 Laboratory Information Management System. The samples are then stored and logged into a refrigerator until logged out for analysis. The VOA vials are stored in a separate refrigerator exclusively used for volatiles.

*****

6.0 ANALYTICAL PROGRAM

THIS SECTION PRESENTS THE PROPOSED ANALYTICAL PROGRAM FOR EACH SITE. THIS PROGRAM IS BASED ON THE CONTAMINANTS LIST AS PRESENTED IN TABLE III IN THE REPORT. IF A DEVELOPED METHOD IS USED, IT SHOULD BE DESCRIBED IN THE MANNER SHOWN FOR THE EXAMPLE GIVEN FOR HYDROCARBONS.

The analytical methodology proposed for use at the NIKE Site is referenced by matrix in Tables I and II. The methods are summarized as follows:

Purgeable Halocarbons and Aromatics

The purgeable halocarbons and volatile aromatics will be analyzed by the USEPA purge and trap gas chromatography/mass spectrometer procedure (EPA Method 624 for water and Method 8240 for soil). This will include the halogenated and non-halogenated solvents on the USEPA priority pollutant list.

Hydrocarbons

One of the analytical needs for the NIKE Sites is to have an analytical method which could detect and quantitate the presence in surface water, groundwater, or soil of gasoline or diesel fuel which may have been spilled, leaked or disposed on the site. The method being utilized for this purpose is based on an internally used method obtained from a specific USEPA approved laboratory to rapidly evaluate gasoline and diesel fuel in water and soil from leaking underground storage tanks and subsequent monitoring during site mitigation. The method is a modification of the method entitled: ASTM D 3328-78 (Reapproved 1982) Standard Methods for Comparison of Waterborne Petroleum Oils by Gas Chromatography. The water microextraction approach was derived from the USEPA Effluent Guidelines' approach to rapidly monitor water samples.

TABLE I

ANALYTICAL PROCEDURES

Water Samples

Parameter	Method	Container	Preservation	Maximum Holding Time	Minimum Volume	Detection Limit
Metals (ICAP)	EPA 200.7[a]	High density Polyethylene	Cool to 4°C HNO_3 to pH2 after field filtration	6 months (except Hg 28 days)	1 Liter	Variable (<.003 - <1 ppm)
Purgeable Halocarbons	EPA 624[b]	Glass, Teflon lined cap	Cool to 4°C	14 days	2-40 ml Vials	<10 ppb
Purgeable Aromatics	EPA 624[b]	Same sample	Cool to 4°C	14 days	Same sample	<10 ppb
Petroleum Hydrocarbons	Developed[c] Method	Glass, Teflon lined cap	Cool to 4°C	28 days	1 Liter	Gas <1 ppm Diesel <0.5 ppm

Notes: a. Instrument used is ICAP Emission Spectrometer
b. Instrument used is Gas Chromatograph/Mass Spectrometer
c. Developed Method - See text. Instrument used is Gas Chromatograph

TABLE II

ANALYTICAL PROCEDURES

Soil Samples

Parameter	Method	Preservation	Maximum Holding Time	Minimum[b] Volume	Detection Limit
Metals (ICAP)	EPA 3050[a] EPA 6010	Cool to 4°C	6 months (except Hg 28 days)	1 Liter	< 1 ppm to < 100 ppm
Purgeable Halocarbons	EPA 8240	Cool to 4°C	14 days	2 - 40 ml Vials	< 10 ppb
Purgeable Aromatics	EPA 8240	Cool to 4°C	14 days	Same Sample	< 10 ppb
Petrolem Hydrocarbons	Developed Method	Cool to 4°C	28 days	Same sample as Metals	Gas < 50 ppm Diesel < 20 ppm

Notes: a. Preparation Method

b. All containers are glass, Teflon lined cap

This analytical approach was taken to allow chromatographic comparison of standards made from gasoline and diesel fuel with water and soil extracted samples to qualitate their presence. The EPA methods and Standard Methods [1] for oil and grease do not differentiate diesel fuel, extractable organic compounds, animal or vegetable oils and would give very poor recovery for gasoline.

To the best of our knowledge, the Corps of Engineers or USEPA does not have a published method for gasoline/diesel fuel in water or soil. The US Army Corps of Engineers' Report[2] has several references to determining petroleum hydrocarbons by gas chromatography with flame ionization detection.

The procedure is briefly described as follows: Perform microextraction of a water sample (100 ml H_2O) with 2 ml of hexane for 10 minutes in a volumetric flask with full inversion during extraction. The hexane will then be analyzed by gas chromatography with a non-polar silicon column and flame ionization detection using a temperature program run. The sample will be compared to gasoline and motor oil standards and quantitated against the best comparative standard. Soils will be analyzed as above following a 1:1 extraction with hexane using mechanical shaking and sonification.

References:

(1) Standard Methods for the Examination of Water and Wastewater, 1985, 16th Edition APHA-AWWA-WPCF.

(2) US Army Corps of Engineers Technical Report, D77-26, Assessment and Significance of Sediment - Associated Oil and Grease in Aquatic Environments, November 1977.

Metals

The water and soil samples will be analyzed for metals following acid digestion by inductively coupled plasma (ICAP) technique following EPA procedure 200.7 (water) and 6010 (soil). Method 3050 is a preparatory step for the soil matrix samples.

Other Methods

Other methods of analysis can be utilized in the analytical program at NIKE sites. However some inherent difficulties are evident with other methodologies. For example, for purgeable halocarbons and volatile aromatic compounds in a water matrix, EPA Methods 601 and 602 (gas chromatography) are acceptable, but these methodologies require a confirmatory step to positively identify constituents. The confirmation step must be either EPA Method 624 (GC/MS) or use of a second GC column. Purgeable halocarbons and volatile aromatics in a soil matrix can be analyzed by Method 5030, Method 8010, and Method 8020 but these procedures may give a false positive reading due to naturally occurring interferences (i.e., decaying vegetation, etc.). For hydrocarbons, EPA Method 418.1 for oils and greases may be acceptable, but low levels of gasoline and diesel fuels can be driven off during the drying process.

A list of substances identified for each of the Analytical Methods is given in Table III.

*****

TABLE III

SUBSTANCES IDENTIFIED BY EACH ANALYTICAL METHOD

VOLATILE ORGANICS

- acrolein
- acrylonitrile
- benzene
- bromoform
- carbon tetrachloride
- chlorobenzene
- chlorodibromomethane
- chloroethane
- 2-chloroethyl vinyl ether
- chloroform
- dichlorobromomethane
- dichlorodifluoromethane
- 1,1-dichloroethane
- 1,2-dichloroethane
- 1,1-dichloroethylene
- 1,2-dichloropropane
- cis-1,3-dichloropropylene
- trans-1,3-dichloropropylene
- ethyl benzene
- methyl bromide
- methyl chloride
- methylene chloride
- 1,1,2,2-tetrachloroethane
- tetrachloroethylene
- toluene
- trans-1,2-dichloroethylene
- 1,1,1-trichloroethane
- 1,1,2-trichloroethane
- trichloroethylene
- trichlorofluoromethane
- vinyl chloride

METALS

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Lithium
- Magnesium
- Manganese
- Molybdenum
- Nickel
- Selenium
- Silicon
- Silver
- Sodium
- Strontium
- Thallium
- Tin
- Titanium
- Vanadium
- Zinc

HYDROCARBONS

- Diesel Fuel
- Gasoline

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7.0 QUALITY ASSURANCE PROGRAM

THIS SECTION DESCRIBES THE QUALITY ASSURANCE/QUALITY CONTROL PROGRAM FOR EACH SITE. THE PROGRAM INCLUDES A GENERAL DESCRIPTION OF QUALITY ASSURANCE SAMPLES AND DOCUMENT CONTROL, AND THE SITE SPECIFIC QA/QC PROGRAM. CHAIN-OF-CUSTODY AND REQUEST-FOR-ANALYSIS F RM ; ARE SHOWN.

The major concerns of a QA/QC plan are quality assurance samples and document control (chain-of-custody). Each of these areas is discussed in the following paragraphs.

7.1 Quality Assurance Samples

Generally it is recommended that quality assurance (QA) samples should be obtained in all sampling surveys. The purpose of QA samples is to verify the quality of the data obtained from the sampling and analytical programs. Basically, four types of samples can be used in a QA program: Sample blanks, duplicates, split samples and spiked samples. Each type is discussed below.

- Sample (Travel) Blanks -- These are samples of deionized or distilled water that are handled in the same manner as the field sample and subsequently analyzed to identify possible sources of contamination during collection, preservation, handling, or analysis.

- Duplicates -- Duplicate samples are essentially identical samples collected at the same time, in the same way, and contained, preserved, and transported in the same manner as the field samples. These samples are often used to verify the reproducibility of the data.

- Split Samples -- Split samples are duplicate samples given to the owner, operator, or person in charge for separate independent analysis.

- Spiked Samples -- Spiked samples are duplicate samples that have a known amount of a substance of interest added to them. These samples are used to corroborate the accuracy of the analytical technique and could be used as an indicator of sample quality change during shipment to the laboratory.

Quality assurance samples collected at the NIKE Site are discussed in a following section of this Plan.

7.2 Document Control

Strict adherence to document and data control are essential elements of quality assurance and quality control for hazardous site investigations. The purpose of document control is two-fold: (1) to ensure document availability during and after project completion; and, (2) to document sample handling. Important documents generated and utilized during hazardous investigations include maps, drawings, photographs, work plans, QA plans, log books, data sheets, etc. These documents will be available for inspection at any time during the investigation of the NIKE Site. In addition, all relevant documents will be incorporated into the engineering report for the project.

Chain-of-custody procedures document the sample identity, handling and shipping procedures and, in general, sampling personnel are responsible for the care and security of samples from the time the samples are taken until they are turned over to the shipper or laboratory. A sample chain-of-custody form is presented as Exhibit 1.

7.3 QA/QC Plan

The laboratory will incorporate QA/QC procedures applicable to specific laboratory analyses which meet or exceed those recommended in Test Methods for Evaluating Solid Wastes (SW-846), or EPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories (EPA 600/4-79-019). In addition to these routine quality contro procedures, the following checks will be performed during the laboratory analysis.

Duplicate Sample - A duplicate water sample taken in the field and labeled with different identification numbers will be submitted for analysis with each batch of samples.

Sample(Travel) Blank - To monitor the potential contamination during sampling, handling and shipping of the samples, a set of water field blanks will be submitted with the other samples.

Method Blank - A method blank consisting of reagent water will be analyzed in the laboratory by each of the analytical procedures being performed on samples.

Spiked Sample - A duplicate ground-water and soil sample will be taken and spiked with known quantities of several of the compounds/metals of interest and analyzed to determine recovery.

Container cleaning procedures are an essential part of quality control. The methodology utilized by the analytical laboratory for cleaning containers is described below:

> The initial cleaning step will be the same for all types of containers. Containers will be hand-washed in a Alconox or equivalent water solution at approximately 150°F. Subsequently, each container will be given three rinses: hot tap water, cold tap water, and distilled water. In addition, containers which are used for the collection of

samples to be analyzed for EPA organic priority pollutants will be cleaned as follows:

- Vials and one liter glass containers - Bake for four hours at 110°C.

- One liter containers for organics - Rinse with nanograde methanol.

Container caps and liners will be cleaned as outlined above for containers.

All analytical results and QA/QC results will be reviewed by the project manager and quality assurance coordinator. Corrective action will be taken as necessary.

A TYPICAL LABORATORY APPROACH TO QA/QC REGARDING POSSIBLE METHOD PROBLEMS IS PRESENTED AS AN EXAMPLE. THIS IS NOT INTENDED TO LIMIT CONSIDERATION OF OTHER POSSIBLE METHOD PROBLEMS.

Determination of Metals by
Inductively Coupled Plasma Emission Spectrometry (ICPES)

Environmental samples are analyzed by ICPES to determine metals content following EPA Methods 200.7[1] for water and 3050/6010[2] for soils, sediments, sludges, etc. It is to be noted that the methods differ only in the means of sample preparation, the latter requiring a more vigorous digestion to effect sample dissolution. Experience has shown that most problems encountered in the use of these methods are due to sample matrix interferences. Some specific problems which may occur, and their solutions, are as follows:

Problem	Solutions
Sample contamination in the labortory	Use of method/reagent blanks with each batch of samples processed will show any systematic contamination problem, in the event of which the source is identified and corrected prior to reanalysis of the samples.
Instrument improperly calibrated	Use of an independent calibration check of standard at the beginning of each run confirms calibration.
Instrument malfunction during analysis run	Regular use of check standards continuously monitors instrument condition.
Sample matrix interferences	Use of background correction, inter-element interference correction software, and dilution and reanalysis when any analyte concentration exceeds the known linear range of the instrument will correct for or point out most interferences. Regular use of duplicate and spiked samples are applied to determine precision and accuracy of the methods.

References:

(1) "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, USEPA (1979), and subsequent amendments (1982).

(2) "Test Methods for Evaluating Solid Waste" (2nd ed.), SW-846, USEPA (1982), and subsequent amendments (1984).

Volatile Priority Pollutants - Purge and Trap
GC/MS EPA Method 624 (Water) and SW-846 Method 8240 (Soil)

Problems	Solutions
Detectable quantities in blank water	Blank subtraction values above detection limits are investigated for possible contamination.
Compounds of interest exceed calibration range, i.e., greater than 200 ppb	If no peaks saturate the detector, the report is analyzed. If peaks saturate detector, dilute sample and re-analyze.
Non-target compounds cause interferences	Dilute to allow qualitative and quantitative determination of target compounds.
Sample foaming	Dilute until foaming is under control in system.

GC-Hydrocarbon Scan Method

Problems	Solutions
Emulsion forms on extraction	Break emulsion with sodium sulfate addition or centrifuging hexane extract.
Soils with water present and visible	Add anhydrous sodium sulfate prior to extraction.
Major interfering peak(s) on GC scan	Dilute or alter temperature to minimize overlap with gasoline or diesel fuel peaks.

8.0 SAFETY CONSIDERATIONS

THIS SECTION DISCUSSES GENERAL SAFETY CONSIDERATIONS FOR EACH SITE. SPECIFIC ASSIGNMENTS FOR SAFETY AND SITE OPERATING PROCEDURES ARE PRESENTED.

A major concern during hazardous waste site investigations is safety, both for the general public and the site investigators. This section provides a general overview of safety concerns and practices used at the NIKE Site. A more detailed discussion of safety is presented in the NIKE Site Health and Safety Plan (under separate cover).

8.1 Responsibilities

The Site Manager, under the auspices of the LETCO Safety Officer, is responsible for establishing, and adjusting as necessary safety precautions at hazardous waste sites under investigation. It is his responsibility to ensure that work is conducted in compliance with the directions contained in the Health and Safety Plan. The following areas are important aspects of the Safety Plan and under the supervision of the Site Manager:

- Protective Equipment - The Site Manager should ensure that each member of the site investigation team is properly attired according to the level of protection (A,B,C,D or E) established in the Safety Plan.

- Emergency Equipment - The following emergency equipment should be available at hazardous site investigations: first-aid kit, fire extinguisher, and full face respirators. Other equipment on-site, or within easy access, should include shower, communication equipment, extra work uniforms, etc.

- Work Plans - A copy of the site work plans (Sampling and Analysis Plan, Well Installation Plan, and Health and Safety Plan) should be available on-site.

- Emergency Procedures - The Site Manager should be aware of emergency procedures discussed in the Health and Safety Plan. At a minimum, a preliminary safety meeting should be held initially to discuss emergency procedures, such as evacuation, emergency telephone numbers, general first aid, accidents, etc.

- Site Operating Procedures - Prior to initiating investigations on the site, the Site Manager should discuss general site operating procedures including work zone locations on the site, drilling and sampling protocols, decontamination procedures, etc.

8.2 Site Operating Procedures

Environmental (dilute) samples will be collected from media at the NIKE Site. These samples do not require the same safety precautions as hazardous samples would require. However, even environmental samples can contain elevated levels of toxic or hazardous substances. Therefore, general site operating procedures for drilling and sampling at the NIKE Site will include the following:

a. **Level E Protection - Work uniforms will consist of cotton coveralls, steel toe boots, hard hats and neoprene gloves. The following personnel precautions should be observed.**

   1) **No eating or drinking in the vicinity (within 50 feet) of drilling or sampling.**

   2) **Wash hands and face upon leaving the work area and before eating or drinking.**

3) Direct contact with suspected contaminated material (soil, ground water, and surface water) should be avoided.

4) Prescribed drugs should not be taken on the site without medical approval.

5) Alcoholic beverages should not be taken during site investigations.

If warranted by site conditions encountered during drilling or sampling, the protection level will be upgraded to Level D with the concurrence of the LETCO Safety Officer. If more than Level D hazardous conditions are encountered, the Safety Officer will be requested to visit the site personally to supervise safety.

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APPENDIX D

WELL INSTALLATION PLAN

GENERAL WELL INSTALLATION PLAN

CONTRACT DACA87-85-C-0104

Prepared for

Department of the Army
Huntsville Division, Corps of Engineers
P. O. Box 1600
Huntsville, Alabama 35807-4301

Prepared by

Law Environmental Services
Government Services Division
P. O. Box 888013
Atlanta, Georgia 30356

March, 1986

WORK PLAN PREAMBLE

The initial effort described in the following Generic Plans is called the Preliminary Determination Phase (PDP). It is unique in terms of both breadth and complexity as compared with Remedial Investigations (RI) under CERCLA and Confirmation Studies under the IRP. Although many technical requirements apply especially in the Sampling and Analysis area, some latitude is available because of the preliminary nature of this effort.

These PDP studies are designed only to confirm or deny the existence of contamination which could have been caused by DOD, and are not equivalent to RCRA ground water quality assessments, or CERCLA investigations. Only when contamination is discovered is it necessary to follow the much stricter EPA guidance for site investigations.

The Plans are structured so that headings describing the intent of each section are given in **CAPITALIZED BOLD FACE TYPE.** This language would not appear in a site specific plan. In some cases, site specific examples are given. They appear in **Bold Face Regular Type.** The site specific data should be inserted in place of these examples for a specific case. Other suggested language for site specific plans is given in regular type. Where specific equipment is mentioned, "equivalent equipment" that performs the required task in an acceptable manner may be specified and used.

TABLE OF CONTENTS

GENERAL
WELL INSTALLATION PLAN
CONTRACT DACA87-85-C-0104

THIS SECTION OF THE WELL INSTALLATION PLAN DISCUSSES THE OBJECTIVES OF MONITORING WELLS AND PROVIDES PRELIMINARY BACKGROUND INFORMATION ON THE SITE. AN EXAMPLE OF TYPICAL SITE SPECIFIC LANGUAGE IS GIVEN. INFORMATION COMPRISING SEVERAL SENTENCES OF SITE LAYOUT INFORMATION ARE INCLUDED IN THE SECTION AS WELL AS SEVERAL PARAGRAPHS OF DATA OBTAINED IN THE SITE INSPECTION TRIP AND INCLUDES INFORMATION ABOUT SITE GEOLOGY, GROUND WATER, TOPOGRAPHY AND PRESENT SITE LOGISTICS. EXAMPLE LANGUAGE THAT IS SITE SPECIFIC IS GIVEN IN BOLD FACE TYPE. EACH PLAN MUST DEVELOP ITS OWN SITE SPECIFIC INFORMATION FOR THIS SECTION.

1.0 INTRODUCTION AND BACKGROUND

Monitoring wells must be installed in a manner to accomplish the following objectives: to collect representative groundwater samples; to prevent contamination of the aquifer by the drilling equipment; to prevent inter-aquifer contamination; and, to prevent vertical seepage of surface water into the monitoring well water-intake zone. This well installation plan discusses the equipment, procedures and personnel that will be utilized at the NIKE Site to accomplish these objectives.

The site was formerly owned by the Department of Defense (DOD) from about 1956 until about 1967. The site contained a total of 86.20 acres, with 28.88 acres "Fee" and 57.20 acres "Easement". The primary tract of interest is the Launcher Area which consisted of 19.11 acres. Facilities at the Launcher Area included officers quarters, missile assembly and test building, a revetted fueling area, three silo areas, and other smaller structures. The IFC Area is located about one mile northeast of the site, but is not being considered in this investigation because of its lack of facilities that would apparently cause contamination. The Launcher Area is presently owned by the City of Needham and has served no use since purchase. It is eventually intended for use for new school facilities.

At other NIKE facilities across the U.S., records indicate the possibility that hazardous/toxic substances may have been released and/or disposed on similar sites. The primary area of concern is generally at the Launcher Area and is related to missile fueling/defueling, operation and maintenance activities, and deactivation of the sites. Therefore, groundwater and soil samples will be taken only at the Launcher Area and analyzed for hazardous constituents (see NIKE Site Sampling and Analysis Plan, under separate cover).

The following sections of this Plan discuss well and soil sampling locations, well depths, drilling equipment and materials, drilling procedures, well development, in-situ permeability testing, well sampling, and project assignments.

2.0 WELL LOCATIONS AND DEPTHS

2.1 Well Locations

As specified in the "Investigation of Former NIKE Missile Sites Throughout CONUS" Statement of Work (SOW) dated July 3, 1985, four ground-water monitoring wells are to be installed at the NIKE Site. The well locations are to be related to previous DOD activities on the site that may have released hazardous/toxic substances.

To better understand existing site conditions, a preliminary site investigation was performed. Agencies presently involved with the site were visited and regional data was obtained. Preliminary data were collected on the general site characteristics to assist in locating the proposed groundwater monitoring wells. Discussions were also conducted with local authorities, owners and others that may have site information who were familiar with the Launcher Area and previous activities at the site. The following data was learned from the preliminary site investigation:

- **The geology of Needham has examples of both bedrock and glacial action. The bedrock is primarily volcanic from the Devonian or Carboniferous Age along with some later massive conglomerate sediments and a small region of earlier granodiorite. The glacier features include drumlins, a large lake filled plain, eskers, kettle-holes, erratic boulders and bedrock striation. In addition the course of the Charles River was extensively relocated as a result of the glacial deposits in Needham and surrounding communities.**

- **Needham lies entirely within the Charles River Watershed and is bordered on three sides by the Charles River. This river frontage totals 12.3 miles, or approximately 15 percent of the total river length. The Charles River is Massachusetts' largest intrastate waterway.**

- **Topography at the Launcher Area slopes predominantly toward the eastern edge of the facility. Ground water is locally controlled by topography. Significant fill has been placed on the site to achieve construction grade for several of the buildings. Wetlands exist both to the east and northwest of the site.**

- **From initial information obtained during the site visit, the IFC Area appears to be free from surface contamination. It does not appear that any activities were conducted at the**

IFC Area that would have resulted in contaminating the site. Therefore, all subsequent investigations for this study will be focused at the Launcher Area.

- The Launcher Area was purchased by the City of Needham in 1968 for future educational purposes. It has not been developed since that time. Parklands exist adjacent to the site and citizens using the parks occasionally gain access to the site.

- There is evidence that some dumping of refuse and possibly other materials has occurred in the past. It is not known to what extent past NIKE operations may have contributed to such refuse. The sampling program will consider this possibility.

- The site is heavily wooded and minor adjustments to boring locations may be necessary considering field access difficulties.

Based upon the information gathered during the initial site visit, the NIKE Site could be monitored in the following manner.

SEVERAL PARAGRAPHS SHOULD BE GIVEN WHICH RELATE TO THE SITE MAP AND EXPLAIN THE RATIONALE FOR THE SAMPLING LOCATIONS. (NO EXAMPLE IS GIVEN TO PROVIDE MAXIMUM LATTITUDE IN DEVELOPING SITE SPECIFIC RECOMMENDATIONS).

2.2 Well Depths

SEVERAL SENTENCES SHOULD BE GIVEN WHICH ESTIMATE MONITORING WELL DEPTHS AND ANY EXTENUATING CIRCUMSTANCES (NO EXAMPLE IS GIVEN).

Procedures for determining well depth in the field will be predicated upon the depth of the water table. During drilling (see following Section 5.2), the borings will be logged continuously. At the first indication of the water table (fully saturated conditions), the depth of the boring will be noted. The water table will be further penetrated a minimum of 10 feet unless rock is encountered. However, no well will exceed a total depth greater than 100 feet without specific concurrence by the Contracting Officer, or his representative.

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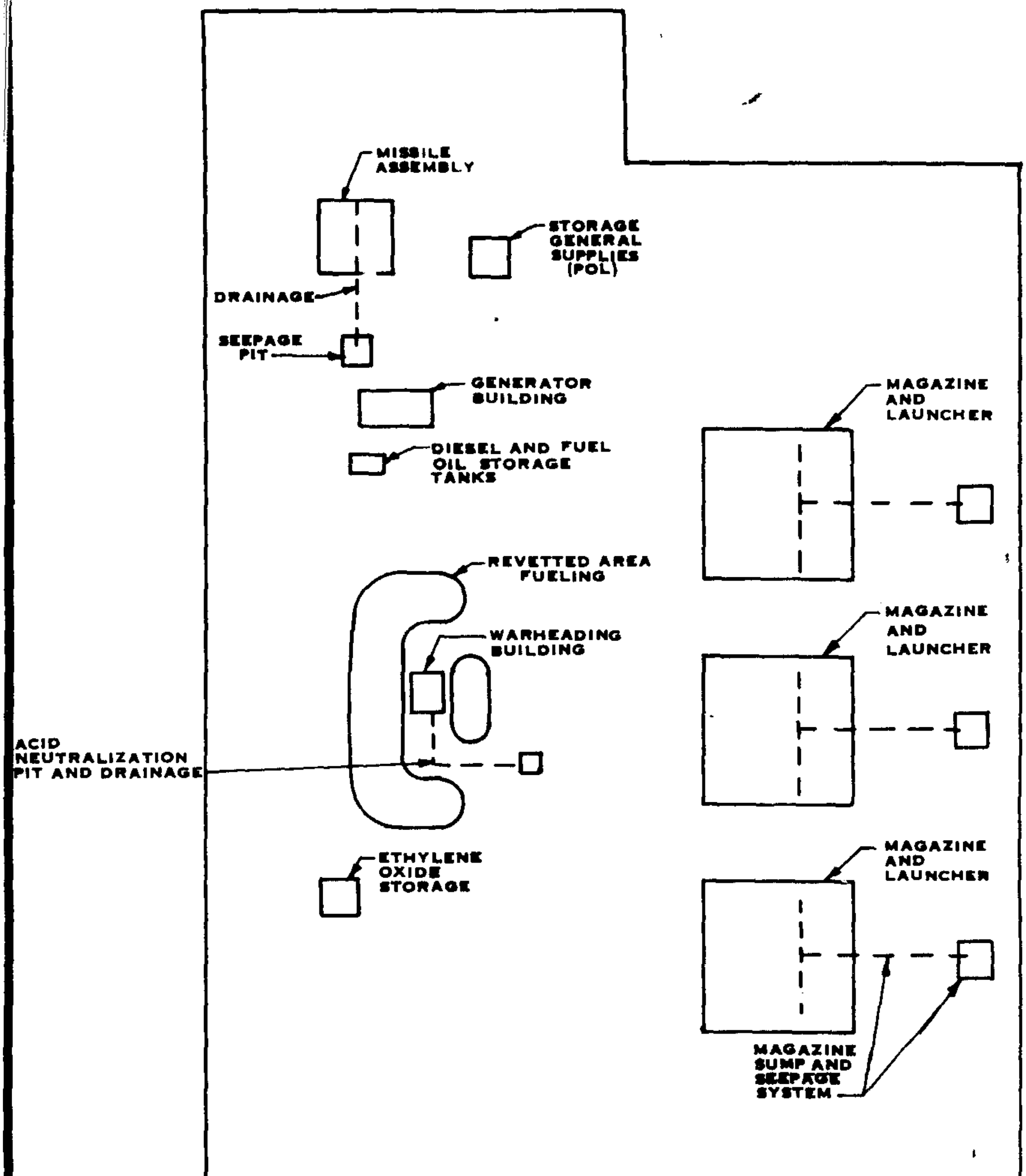

GENERALIZED NIKE SITE CONTRACT DACA 87-85-0104	LAW ENVIRONMENTAL SERVICES MARIETTA, GEORGIA	LAUNCHER AREA FIGURE 1

3.0 OTHER SAMPLING LOCATIONS

THIS SECTION OF THE WELL INSTALLATION PLAN DISCUSSES OTHER SAMPLING LOCATIONS (I.E. SOIL, SEDIMENT, ETC.) AT THE SITE.

In addition to the four wells, 12 soil samples will also be obtained from the Launcher Area. Five of the samples will be from the well borings (includes a duplicate sample from one of the wells) and the remaining seven samples will be distributed around the site at the discretion of the site investigation team. Attempts will be made to select the most probable locations for contamination around former DOD areas of activity. The samples will be collected, handled, shipped and analyzed as discussed in the NIKE Site Sampling and Analysis Plan (under separate cover).

4.0 DRILLING EQUIPMENT AND MATERIALS

THIS SECTION DISCUSSES WELL DRILLING EQUIPMENT AND MATERIALS FOR INSTALLING THE MONITORING WELLS AT EACH SITE. SPECIFIC INFORMATION IS PROVIDED FOR THE TYPE OF DRILLING RIG, WELL CASING AND SCREEN, SAND PACK, BENTONITE SEAL, GROUT AND DRILLING FLUIDS.

4.1 Drilling Rig

The NIKE Site monitoring wells will be installed utilizing one of the following drilling techniques:

- Hollow Stem Auger (HSA)
- Continuous Flight Auger (CFA)
- Mud Rotary (MR)

It is acknowledged that the Hollow Stem Auger technique is preferable and will be used if possible.

The drill rigs will install a minimum 7-inch diameter borehole in order to facilitate installation of 2-inch (ID) wells. The drill rig will also have the capability to collect split spoon samples according to ASTM procedures. At a minimum, the rig will be equipped with a cathead operated, 140-pound hammer with a 30-inch draw. The 30-inch draw distance will be marked on the hammer rod. Drill rigs and drill rods will be free from oil and grease, and will be cleaned with live steam prior to initiating drilling on each well.

If rock coring is required it will be conducted according to the ASTM D 2113 procedures for Diamond Core Drilling.

4.2 Well Casing and Screen Materials

4.2.1 Well Casing (Riser)

All monitoring well casing (riser pipe) will consist of new, threaded, flush joint, PVC with a minimum inside diameter of 2 inches. The casing will conform to ASTM-D 1785 Schedule pipe and inches. The casing will conform to ASTM-D 1785 Schedule pipe and will bear markings that will identify the material as that which is specified. At a minimum the riser pipe will be Schedule 40 or greater. No organic solvents or glue will be used in joining the pipe. Instead, Teflon tape will be wrapped on the threads to facilitate joining and to provide a more adequate seal.

4.2.2 Well Screen

All well screens will consist of new, commercially fabricated, threaded, flush joint 2-inch (I.D.) PVC. Screen slot openings will be pre-manufactured at 0.010 inch (10-slot) and a PVC threaded plug will be provided for the bottom of the well. No organic solvents or glue will be used in joining the screen and casing. Instead Teflon tape will be wrapped on the threads.

4.2.3 Centralizers

Depending upon the type of drilling technique, PVC centralizers may be necessary to maintain the well casing and screen in the center of the boring. Centralizers will not be installed on the screen.

4.3 Artificial Sand Pack

An artificial gravel/sand pack will be installed in the annulus between the boring and the well screen. The sand pack will consist of clean, inert, non-carbonate materials. The sand pack will be placed by manually pouring the sand into the annulus space or with a tremie pipe, if necessary. The sand pack will be placed from the bottom of the boring to approximately 3 feet above the top of the well screen. The following Section 6.0 describes well installation procedures.

4.4 Bentonite Seal

A minimum 2 foot bentonite seal will be installed above the artificial sand pack. The bentonite seal will be tamped, if feasible, wetted, and allowed to swell at least 30 minutes prior to placement of grout.

4.5 Grout Mixture

A sand-cement-bentonite grout mixture will be placed in the annular space between the well casing and boring from the tip of the bentonite seal to the ground surface. The sand/cement mixture will consist of Portland cement (ASTM-C150), and sand (ASTM-C33) with water added in the proportion of 5 to 7 gallons per 94 pound bag of cement. Additionally, 3 percent by weight of bentonite powder may be added to the mixture to help reduce shrinkage.

4.6 Drilling Fluids

4.6.1 Water

Water used to assist drilling operations shall consist of fresh, potable water, and in no manner will a potentially contaminated source of water be used in the drilling operation.

4.6.2 Drilling Mud

In the event that drilling mud is necessary, bentonite is the only drilling fluid additive that will be used. No organic additives will be used. Data on the bentonite will be provided including: brand name, manufacturer, manufacturer's address, product description, and mixing ratios. It is currently anticipated that the wells will be installed without the need for drilling mud or supplemental water.

4.7 Well Completion Details

4.7.1 Concrete Pad

A minimum 3 foot x 3 foot x 4 inch concrete pad will be installed around each of the monitoring wells at the site. The pads can consist of ready-mix concrete mixed in appropriate proportions (i.e. ready-mix and water). The pad should be sloped slightly from the well to the edges of the pad to ameliorate surface run off. A 3 ft. x 3 ft. form should be constructed (out of 2x4 lumber) to pour the form. The form may remain in-place.

4.7.2 Steel Security Cap

A round, or square, steel security cap will be installed over the PVC well stick-up. The security cap should have a hinged locking cap feature. The diameter of the security cap should allow easy access to the PVC well stick-up. It will be installed in concrete pad. Key-alike locks will be provided for each of the wells.

4.7.3 Protective Posts

Protective Posts consisting of nominal 2 inch diameter steel posts shall be placed at each corner of the concrete pad and to a sufficient height to protect the PVC well pipe from being damaged.

4.7.4 Well Painting

The steel security cap will be painted with a bright, (yellow or orange) rust-inhibiting paint (i.e., Krylon, or equal) to prevent corrosion.

5.0 DRILLING PROCEDURES

THIS SECTION DISCUSSES THE WELL DRILLING PROTOCOL AT EACH SITE. A FIGURE ILLUSTRATING A TYPICAL WELL LOG IS PROVIDED FOR EACH SITE.

5.1 Initial Activities

Prior to setting up the drilling rig on a monitoring well location, the site will be checked with appropriate authorities for underground utilities. Drilling will only proceed where no service lines are near the well locations.

5.2 Drilling Protocol

After the initial site survey, the drill rig will be set up on the selected location. Once the drill rig is in position, the following protocol will be followed for each well:

- Collect split spoon sample (ASTM-D 1586 67) from the ground surface to 1.5 feet using standard penetration procedures, i.e., 140 pound weight falling 30 inches to drive 1.375 inch I.D., 2 inch O.D., split barrel sampler.

- Begin augering, or drilling, and collect split spoon samples continuously down to 10 feet then every 5 feet, i.e., 14-15.5 feet, 19-20.5 feet, etc., or at changes in strata.

- A soil test boring log will be completed during drilling by a qualified geologist, or geotechnical engineer. It will be similar to the log shown in Figure 2 and will record the following data:

  . Sample number and depth
  . Standard penetration test blow counts per 6 inch advance
  . Percentage recovered
  . Soil classification, color, consistency or density, and moisture content
  . Depth of boring
  . Boring refusal
  . Water table depth
  . Water losses, if applicable
  . Method of advancing boring

- Soil samples will be collected from each split barrel sample, stored in glass jars, and labeled. The samples will be delivered to a laboratory for analysis of grain size, moisture content, and Atterberg limits.

- The depth of first encountered free water will be indicated on the drilling log. Drilling will continue into the saturated zone approximately 10 feet at which point the boring will be terminated and the well will be installed.

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AW ENGINEERING TESTING CO. - SOIL TEST BORING

B NO. ______ DRILLER ______ GROUND SURFACE ELEV. ______

B NAME ______ CREW ______ ______ING ______

______ WEATHER ______ PAGE ______ OF ______

SAMPLING					SCALE	UD	REC	SOIL CLASSIFICATION	REMARKS
		"N"							
No.	Depth	1ST 6"	2ND 6"	3RD 6"					
					0				
					5				
					0				
					5				
					0				
					5				
					0				
					5				
					0				

+STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES.

BORING TERMINATED: ______

BORING REFUSAL: ______

WATER TOB DEPTH ______

WATER 24 HR.: DEPTH ______

WATER LOSSES ______

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER SOLID	TO
HAND CHOP: W/MUD: W/WATER	TO
ROTARY DRILL: W/MUD: W/WATER	TO
DIAMOND CORE	TO

Once the boring is completed, a well will be installed as soon as practical, but no later than within 24 hours. Measures will be taken to protect the integrity of the well during any interim periods.

In the event that a boring should prove to be unusable for any reason, it will be grouted from the base to the land surface.

6.0 WELL INSTALLATION

THIS SECTION DISCUSSES THE WELL INSTALLATION PROTOCOL AT EACH SITE. A FIGURE SHOWING A TYPICAL MONITORING WELL IS PROVIDED WITH EACH SITE PLAN.

Installation of the well casing and screen can differ slightly depending upon the drilling technique utilized in advancing the boring. The following sections discuss well installation using either a Hollow Stem Auger (HSA) technique, or Continuous Flight Auger (CFA) or Mud Rotary (MR) techniques.

6.1 Hollow Stem Auger Technique

When a boring is advanced using Hollow Stem Augers, the following protocol will be followed to install the well casing and screen:

- install approximately 15 feet of 2-inch (I.D.), threaded flush jointed, pre-manufactured well screen in the outer drill pipe (individual joint threads will be wrapped with Teflon tape).

- install solid riser PVC to ground surface plus 24-30 inch stick-up.

- remove one auger flight (5 feet) and install artificial sand pack through annular opening between auger and well casing. Water will be used to prevent bridging of the sand in the annulus.

- continue removing augers and installing sand pack until at least 3 feet above the top of the well screen.

- remove remaining augers and install minimum 2-foot bentonite seal.

- grout boring annulus to land surface with grout/bentonite mixture, previously described. Install steel security cap, concrete pad and posts. The grout shall be allowed to set a minimum of 24 hours before developing the wells.

6.2 Continuous Flight Augers or Mud Rotary Technique

Well installation procedures for Continuous Flight Augers or Mud Rotary drilling will be similar to the Hollow Stem Auger procedure with the following exception:

- after termination of boring, all drilling rods will be removed and the 2-inch PVC well will be installed with centralizers. The centralizers will maintain the well in the center of the boring for installation of the sand pack, bentonite seal and grout. If the boring collapses, it will be re-drilled to the proper depth prior to well installation. The sand pack will be installed with a tremie pipe from the bottom of the boring.

- continue installing sand pack until at least 3 feet above the top of the well screen.

- install minimum 2-foot bentonite seal.

- grout boring annulus to land surface with grout/bentonite mixture, previously described. Install steel security cap, concrete pad and posts. The grout shall be allowed to set a minimum of 24 hours before developing the wells.

A typical water quality monitoring well is shown in Figure 3. This type diagram will be completed for each of the 4 wells at the NIKE Site. Each well diagram will provide the following data:

- total well depth
- depth of well screen
- depth to top of sand pack
- thickness of bentonite seal
- depth to base of grout seal
- water table elevation
- well stick-up

7.0 WELL DEVELOPMENT

THIS SECTION DISCUSSES THE WELL DEVELOPMENT PROCEDURES FOR EACH OF THE WELLS ON EACH SITE. WELL DEVELOPMENT FORMS ARE PROVIDED TO RECORD PERTINENT DATA.

The development of the 4 wells at the NIKE Site will be performed as soon as practical after well installation, but no sooner than 24 to 48 hours after placement of the internal grout collar. Development protocol will be as follows:

- measure static water level of well

- measure total well depth

- remove a minimum of 5 well volumes using compressed air technique, or manually

- collect water sample initially, twice during development and at the end of development, and perform field measurement of specific conductance, pH and temperature

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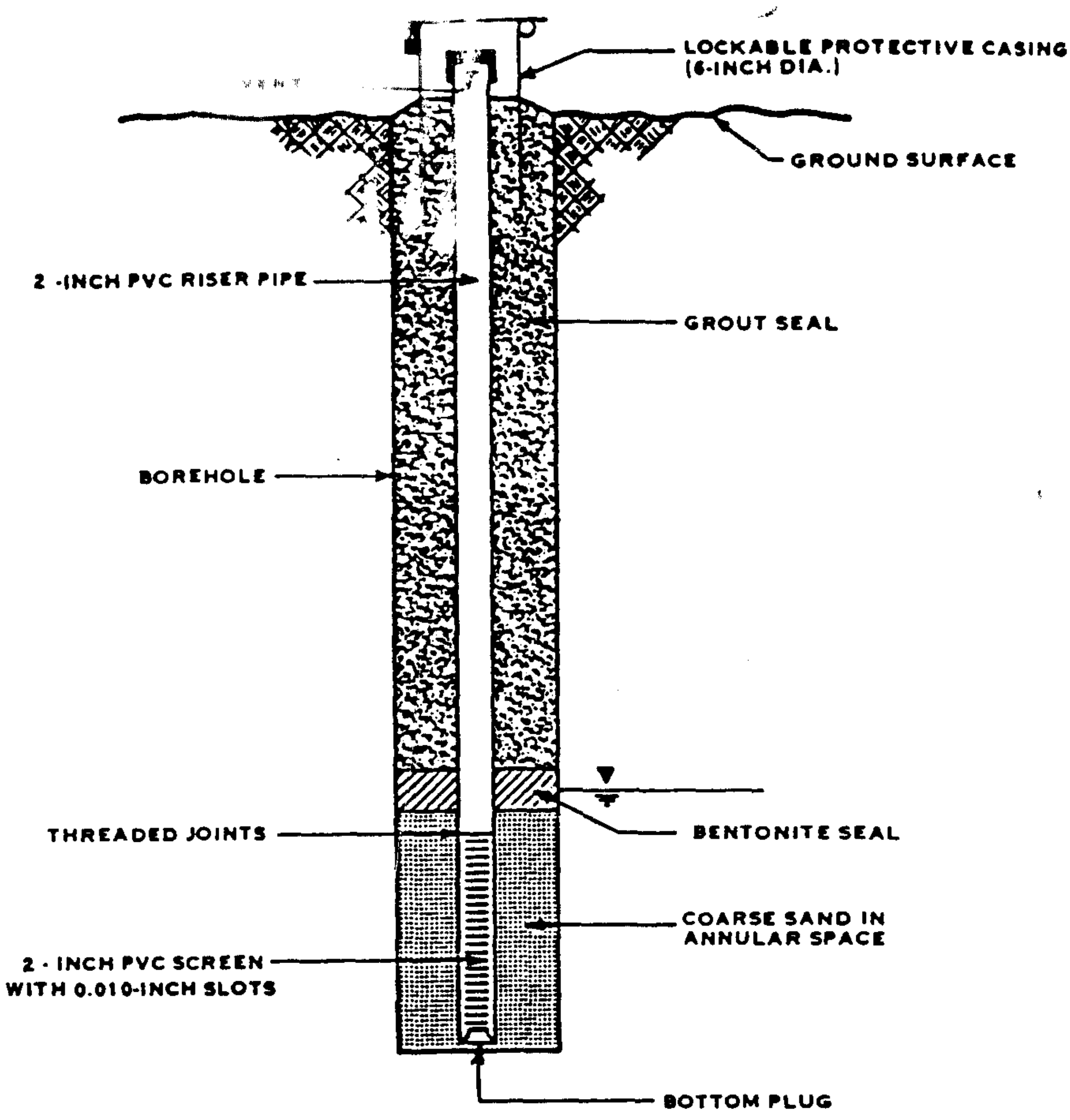

(NOT TO SCALE)

NIKE SITE CONTRACT DACA 87-85-C-0104	LAW ENGINEERING TESTING COMPANY MARIETTA, GEORGIA	SCHEMATIC OF A TYPE II WATER QUALITY MONITORING WELL FIGURE 3

- denote physical characteristics of water throughout well development (color, odor, turbidity, etc.)
- record the total quantity of water removed
- measure static water level
- measure total well depth

Well development will continue at least 4 hours and until the following conditions are met: well water is reasonably clear; sediment thickness remaining in the well is less than 5 percent of the saturated screen length; and, at least 5 well volumes (including saturated annulus sand pack, 30% porosity) have been removed.

Well development data will be recorded on a form similar to Figure 4.

8.0 IN-SITU PERMEABILITY

To determine in-situ permeability (hydraulic conductivity), a slug test will be performed on each well. The following protocol will be followed:

- measure static water level
- introduce or remove a slug of known volume
- record the fall or rise of the water level with time

The data are then plotted on semi-logarithmic paper and should form a straight line. The following formula is utilized to calculate hydraulic conductivity (K):

$$K = \frac{r_c^2 \ln (R_e/r_w)}{2 L_e} \quad \frac{1}{t} \quad \ln \frac{y_o}{y_t}$$

Where r_c - well radius

R_e - effective radial distance over which the head difference is dissipated

r_w - radial distance between well center and undisturbed aquifer

L_e - height of saturated screen

y_o - y at time zero

y_t - y at time t

t - time since y_o

(after Bower, 1978)

AW ENGINEERING TESTING COMPANY JOB NAME ______________________ ______

BY ____________ DATE ____________ CK ____________ DATE ____________ SHEET _____ OF _____

WELL DEVELOPMENT DATA

1. Well No. ____________
2. Date of Installation: ________________
3. Date of Development: ________________
4. Static Water Level: Before Dev. ____________ ft.; 24 Hours After ____________ ft.
5. Quantity of Water Loss During Drilling, If Used ________________ Gal.
6. Quantity of Standing Water in Well and Annulus Before Dev. ________________ Gal.

	Start	During		End
7. Specific Conductance (umhos/cm)	______	______,	______	______
Temperature (c°)	______	______,	______	______
PH (s.u.)	______	______,	______	______

8. Depth From Top of Well Casing to Bottom of Well ____________ ft.
9. Screen Length ____________ ft.
10. Depth to Top of Sediment: Before Dev. ____________ ft.; After Dev. ____________ ft.
11. Physical Character of Water: ________________________________

    ____
12. Type and Size of Well Development Equipment: ________________________

    ____
13. Description of Surge Technique, If Used: ________________________

    ____
14. Height of Well Casing Above Ground Surface: ________________ ft.
15. Quantity of Water Removed: ____________ Gal.

    Time for Removal: ________________ Hr./Min.
16. 1-Pint Water Sample Collected: ________________ (Time)

*Development Conditions:
1) Well Water is Reasonably Clear
2) Sediment Thickness < 5% of Screen Length
3) Removal of 5 Well Volumes, Including Saturated Filter Annulus

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9.0 WELL SAMPLING

GROUND-WATER SAMPLING PROCEDURES ARE DISCUSSED SEPARATELY IN THE SAMPLING AND ANALYSIS PLAN.

Groundwater sampling procedures are discussed in the NIKE Site Sampling and Analysis Plan (under separate cover).

10.0 PROJECT ASSIGNMENTS

THIS SECTION DISCUSSES PROJECT ASSIGNMENTS DURING WELL DRILLING AND INSTALLATION.

A geologist, or geotechnical engineer, shall be present at each operating drill rig and be responsible for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of each rig. Each geologist, or geotechnical engineer will only be responsible for one operating rig. The geologist, or engineer, will have on-site QA/QC and safety responsibility and each will have a copy of the Site Safety Plan and Well Installation Plan. The geologist/geotechnical engineer will report directly to the Project Manager.

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APPENDIX E

HEALTH AND SAFETY PLAN

GENERAL

HEALTH AND SAFETY PLAN

CONTRACT DACA87-85-C-0104

Prepared for:

Department of the Army
Huntsville Division, Corps of Engineers
P. O. Box 1600
Huntsville, Alabama 35807-4301

Prepared by:

Law Environmental Services
Government Services Division
P. O. Box 888013
Atlanta, Georgia 30356

March, 1986

WORK PLAN PREAMBLE

The initial effort described in the following Generic Plans is called the Preliminary Determination Phase (PDP). It is unique in terms of both breadth and complexity as compared with Remedial Investigations (RI) under CERCLA and Confirmation Studies under the IRP. Although many technical requirements apply especially in the Sampling and Analysis area, some latitude is available because of the preliminary nature of this effort.

These PDP studies are designed only to confirm or deny the existence of contamination which could have been caused by DOD, and are not equivalent to RCRA ground water quality assessments, or CERCLA investigations. Only when contamination is discovered is it necessary to follow the much stricter EPA guidance for site investigations.

The Plans are structured so that headings describing the intent of each section are given in **CAPITALIZED BOLD FACE TYPE.** This language would not appear in a site specific plan. In some cases, site specific examples are given. They appear in **Bold Face Regular Type.** The site specific data should be inserted in place of these examples for a specific case. Other suggested language for site specific plans is given in regular type. Where specific equipment is mentioned, "equivalent equipment" that performs the required task in an acceptable manner may be specified and used.

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CONTENTS

CONTENTS (Cont'd)

1. INTRODUCTION

THIS SECTION DISCUSSES THE BASIC FRAMEWORK OF THE HEALTH AND SAFETY PLAN AND PROVIDES A BRIEF DESCRIPTION OF THE CONTENTS OF THE PLAN AND BACKGROUND INFORMATION REGARDING THE SITE. PARAGRAPHS IN BOLD FACE GIVE A SPECIFIC EXAMPLE OF HOW THE SITE INSPECTION GENERATES I RE IMINARY FINDINGS REGARDING THE INITIAL LEVEL OF SITE SAFETY REQUI_EMENTS. A COMPLETED COPY OF APPENDIX A IS ATTACHED AS AN EXAMPLE

The health and safety of site workers and the public is a primary concern and goal during hazardous materials investigations. Thus, a comprehensive, carefully managed, and thoroughly documented health and safety plan is crucial for successful project completion.

The following general plan describes specific responsibilities, training requirements, protective equipment, and general site operating procedures that will be adapted to meet site-specific requirements. Its flexibility allows unanticipated site-specific problems to be addressed while assuring adequate and suitable worker protection. The site specific plan based on an initial site inspection is attached as Appendix A.

General sections dealing with protective equipment, site operating procedures, and emergency responses are also included, along with other information such as respirator maintenance, etc., and will be given to each site worker as a field reference manual.

Based on a preliminary site inspection trip, there is presently minimal evidence of hazardous conditions that would require significant precautions in the inspection, sampling, and well drilling phases of the NIKE Site project. Accordingly, we plan to begin initial site activities using Level E equipment. Based

on this trip, the site specific Health and Safety Plan (Appendix A) has been completed and is attached. It is intended, that the complete Health and Safety Plan will be distributed and discussed with all site personnel. This is necessary so that there will be sufficient awareness of the potential of hazardous conditions. Further, this provides for the proper advance preparation and knowledge of the proper procedures that should be followed, if hazardous conditions are encountered.

If explosive contamination or unexploded ordnance is discovered at any time during the confirmation study operations at the site, the location will be marked, operations in the affected area will immediately be stopped, and the Contracting Officer will be notified.

*****

2. FIELD IMPLEMENTATION OF HEALTH AND SAFETY PLAN

THIS SECTION DISCUSSES FIELD IMPLEMENTATION OF THE HEALTH AND SAFETY PLAN. DISCUSSIONS ARE GENERAL RATHER THAN SPECIFIC, ALTHOUGH SOME EXAMPLE MATERIAL IS GIVEN. REFERENCE IS MADE TO APPENDIX A OF THE PLAN. THIS APPENDIX PROVIDES SITE SPECIFIC INFORMATION FOR EACH SITE.

Prior to beginning site operations, the Project Manager performed a site reconnaissance to verify that current conditions are as described in previous reports and investigations. The primary purpose of this reconnaissance was to determine airborne organic vapor levels, and to finalize all planning and logistics for site work.

Based on the information received about site conditions, it is anticipated that the site reconnaissance will be performed with EPA level E personnel protection. Higher levels of protection equipment will be available if necessary.

A written, site-specific health and safety plan (see Appendix A) was developed after the reconnaissance, and will be distributed to site workers, and explained through training and on-site briefings. The plan covers all phases of operations at the NIKE site, including:

- Work practices
- Hazard identification and assessment
- Established work zones
- Level of personnel protective equipment required in each zone
- Sampling procedures
- Entry and exit routes
- Decontamination procedures
- Accident/emergency response

2.1 PERSONAL PROTECTIVE EQUIPMENT

Based on experience at similar sites, it appears that the primary exposure will be through physical contact or through inhalation while handling potentially contaminated samples. It seems appropriate, therefore, to specify protective measures based on the work activity, rather than requiring a site-wide level of protection.

It is well established that worker safety and efficiency decrease in direct proportion to the amount of protective gear required. Thus, it is always desirable to use as little equipment as possible which provides adequate protection. Anything less than maximum protection (levels A or B) cannot be specified, however, without carefully defining site conditions, allowing extra safety margins, having higher level equipment readily available, and anticipating worst-case conditions. **Based on these criteria, and the results of our site inspection, we have chosen to use level E protection for various site activities consistent with EPA protocols, the provisions of OSHA (29 CFR 1910 & 1926) and EM 385-1-1, U.S. Army Corps of Engineers Safety and Health Requirements Manual.** In the event of conflicting requirements, the most restrictive shall apply. It cannot be emphasized too strongly that these requirements are subject to change at any time by the Health and Safety Officer based on contaminant monitoring, visual observations, or changes in work or site conditions.

2.1.1 Well Installation, Soil Borings, Water Samples

The primary concern is physical contact with contaminated soil or water, although frequent OVA measurements (and explosimeter readings, if indicated) will be made. Respiratory protection equipment will be readily available.

Required gear at the work site includes:

- **Distinct field work clothes**
- **Polylaminated Tyvek coveralls (readily available)**
- **Steel toed boots and gloves (chemical resistant)**
- **Safety glasses or goggles (readily available)**
- **Hardhat**
- **Air-purifying respirator (readily available)**
- **Fire extinguisher (readily available)**
- **First aid kit (readily available)**
- **Emergency oxygen (readily available)**

2.1.2 Sediment Sampling (not applicable)

2.2 MONITORING

Extensive monitoring will be conducted with an organic vapor detector. If breathing zone readings of greater than 5 ppm over background are obtained, the situation will be evaluated to determine the need and/or adequacy of air-purifying respirators. We will maintain sufficient equipment on-site to immediately address increased contaminant levels and upgrade personal protection if necessary. An explosimeter will be used to check for explosive atmospheres in the bore holes. We also will use other monitoring procedures if warranted by site conditions, such as oxygen deficiency meters, hydrogen sulfide detectors, and detector tube sampling.

Workers will continually be observed (through the buddy system and by on-site managers) for signs of heat stress and other adverse health effects.

*****

3. RESPONSIBILITIES

THIS SECTION DISCUSSES GENERAL PROJECT RESPONSIBILITIES FOR ENFORCING THE HEALTH AND SAFETY PLAN.

The Project Manager, Site Manager, and Health and Safety Officer are responsible for formulating and enforcing health and safety requirements. These responsibilities include:

- Assuring that all site team members have received the required health and safety training
- Assuring that all team members have completed the required medical examination and have met the qualification criteria for site work
- Assuring that all equipment used on site is suitable and adequate
- Addressing any unusual problems or conditions that may be encountered
- Assuring that site standard operating procedures are followed at all times

The Site Manager has direct responsibility for administering the Health and Safety Plan relative to all site activities and will be in the field full time while site activities are in progress. The Project Manager has general overview responsibility for the success of the Project and may make occasional site visits during field operations. The Health and Safety Officer has responsibility for approving the Health and Safety Plan and responding to any non routine matters that relate to Health and Safety during the Project life.

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4. PERSONNEL TRAINING

THIS SECTION DISCUSSES BASIC PERSONNEL TRAINING AND PROVIDES THE OUTLINE FOR A TYPICAL TRAINING COURSE.

A thorough understanding of the types of hazards most likely to be encountered at hazardous waste sites and personal protection measures needed to protect personnel from them are the first requirements of a complete health and safety plan. Each project team member participates in continuous comprehensive training courses. Additional briefings will be held as necessary to explain and discuss site-specific health and safety matters.

All subcontractors (e.g., drillers, excavators) will be required to complete health and safety training and have documentation of same prior to authorizing their access to the site. A list of safety equipment intended for use by each subcontractor, and written certification that appropriate training has been provided to the personnel scheduled for site work, will be reviewed by the Health and Safety Officer and kept on file. Deficiencies in subcontractor plans will be resolved before authorization to proceed is granted.

An outline of a typical comprehensive training course follows. All topics may not be covered if not applicable to a project.

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HEALTH AND SAFETY PROCEDURES
AT
HAZARDOUS WASTE SITES

I HEALTH AND SAFETY

A. Introduction/Background
B. Attitude and Behavior
C. General Safety Practices

   1. Overview of personnel protection equipment
   2. EPA levels of protection
   3. Procedures for site investigation

      a. Planning before departure
      b. At the site
      c. Decontamination and site exit

   4. Environmental monitoring equipment

      a. Detector tubes (Draeger)
      b. Organic vapor analyzers (OVA, HNu)

D. General Occupational Health

   1. Common classes of chemicals
   2. Exposure routes
   3. Physical, chemical properties, toxicity
   4. Medical monitoring
   5. Pulmonary function tests

E. DOT Labeling Regulations
F. Safety Regulations

II PERSONAL PROTECTION

A. EPA Levels of Protection

1. Selection criteria
2. Equipment

B. Respiratory Prote.tion

1. Types of respirators
2. Fit testing
3. Cartridge selection
4. Cleaning, maintenance, storage

C. Protective Clothing

1. Types, materials
2. Selection
3. Protection from various chemicals

D. Self-contained Breathing Apparatus

III RESPIRATOR FIT TESTING

A. Qualitative Fit Testing of Employees

1. Personal safety data sheets
2. Cleaning, repairing, maintenance

IV EQUIPMENT DEMONSTRATION AND PRACTICE SESSIONS

A. Draeger Detector Tube Sampling
B. Organic Vapor Analyzers
C. Biomarine, Scott SCBAs
D. Protective Clothing

V HAZARDOUS WASTE FUNDAMENTALS

A. Determination of a Hazardous Waste
B. Labeling, Manifests, Placarding
C. Proper Shipping Names, Transportation
D. Material Safety Data Sheets

VI QA/QC CONSIDERATIONS

A. Requirements
B. Standard Forms
C. Chain of Custody

VII SITE OPERATIONS

A. Work Zones
B. Sampling Techniques
C. Equipment Decontamination
D. Sample Handling

VIII REVIEW OF SITE-SPECIFIC STANDARD OPERATION PROCEDURES

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5. PERSONAL PROTECTIVE EQUIPMENT

THIS SECTION PROVIDES A GENERIC DISCUSSION ON PERSONNEL PROTECTIVE EQUIPMENT. LEVELS OF PROTECTION AND EMERGENCY EQUIPMENT ARE PRESENTED AND REFERENCE IS MADE TO PROTECTIVE EQUIPMENT AND SELECTION CRITERIA IN APPENDIX B. SITE SPECIFIC DATA ARE PRESENTED IN APPENDIX A.

5.1 LEVELS OF PROTECTION

Personal protective equipment selection is based on EPA Levels of Protection as defined in Standard Operating Safety Guides (November, 1984), but we have further defined the protection levels to provide an additional level of protection between EPA levels C and D. The required protective equipment and selection criteria are summarized in Appendix B.

In addition, specialty and reserve equipment will be issued to each team, as necessary, including:

- First aid kit (approved by consulting physician in accordance with 29 CFR 1910.151)
- Emergency oxygen (or escape unit)
- Additional boots, gloves, hardhats, suits, respirators
- Two-way radio communication
- Field manual (site operating procedures)
- Fire extinguisher
- Portable eyewash (as appropriate) and sufficient potable water for copious flushing

5.2 EMERGENCY EQUIPMENT

(As needed based on site conditions)

5.2.1 Fire Extinguishers

Because of the potential threat of fire at many hazardous waste sites during initial remedial measures, fire extinguishers will be readily available and at hand throughout the investigation. All fire extinguishers will be Class ABC. One fire extinguisher will be kept with the field crew during any subsurface activity such as drilling or backhoe excavations, one will remain in the decontamination area, and one will be placed in all vehicles.

5.2.2 First Aid Kits

An industrial first aid kit with sufficient supplies for 10 people will be kept in the decontamination area. Smaller first aid kits will be kept in clean areas and with field crews. At least one individual at the site will be trained and certified in First Aid and CPR.

5.2.3 Eye Wash

An eye wash station (meeting the minimum requirements of ANSI 2358.1) will be maintained at the decontamination zone and portable eyewash stations (as appropriate) will also be kept with field crews.

5.2.4 Communications

A telephone will be installed whenever long-term investigations require the use of a field office trailer. Emergency telephone numbers will be posted at the telephone, outside of the trailer, and be included in each team member's field manual. As a minimum, the Site Manager and one individual in each work zone will be provided with a radio for field communications.

5.2.5 Emergency Shower

If required by site contaminants and conditions, an emergency shower (meeting the minimum requirements of ANSI 2358.1) will be located either outside the decontamination trailer, in the decontamination area, or other suitable location. Otherwise, end-of-day showers will be required. End-of-day showers will occur at each individual's temporary field residence.

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6. SITE OPERATING PROCEDURES

THIS SECTION PROVIDES A GENERIC DISCUSSION OF SITE OPERATING PROCEDURES INCLUDING INITIAL SITE SURVEILLANCE, WORK ZONES, SITE STANDARD OPERATING PROCEDURES, AND DECONTAMINATION PROCEDURES.

6.1 INITIAL SITE SURVEILLANCE

Prior to beginning site operations, the Site Manager and/or the Health and Safety Officer will perform a site reconnaissance to verify that current conditions on site are similar to the description provided in previous investigations. Included in this effort will be atmospheric monitoring of total vapor/gas concentrations, and becoming familiar with the locations of residences, sampling and well sites, work zones, etc. The atmospheric sampling performed at this time should verify conditions reported and, depending on these results, the necessary monitoring that will be conducted during field operations, in accordance with the particular site needs. Typical analyses include airborne particulates, organic vapors, combustible gases, and oxygen. **(This section should also include a brief description of the results of the site inspection which leads to the completion of Appendix A. No example is given.)**

6.2 WORK ZONES

A hazardous waste site is usually divided into three specific zones: Zone 1 - exclusion zone; Zone 2 - contamination reduction zone; and Zone 3 - support zone. These three zones are established on the basis of contamination potential.

The exclusion zone is the area of greatest environmental contamination and presents the greatest potential for worker exposure. Personnel entering the area must wear the previously mandated level of protection. In certain instances, different levels of protection will be required depending on the tasks to be completed.

The contamination reduction zone acts as a transition between "hot spots" and clean areas. The support zone serves as a clean, control area, and decontamination facilities end here. All areas will be defined and marked as appropriate for the particular site.

6.3 SITE STANDARD OPERATING PROCEDURES

The following items are requirements to protect the health and safety of field workers and will be included in the field manual. Depending on site-specific conditions, items may be added or deleted.

- The buddy system will be used. Hand signals will be established.

- During site operations, each worker should consider himself as a safety backup to his partner. Offsite personnel provide emergency assistance. All personnel should be aware of dangerous situations that may develop.

- Visual contact must be maintained between buddies onsite.

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated as contaminated.

- Prescription drugs should not be taken by personnel where the potential for contact with toxic substances exist, unless specifically approved by a qualified physician. Alcoholic beverage intake is prohibited during the work day.

- No excessive facial hair which interferes with the satisfactory fit of respiratory protection is allowed on personnel required to wear such equipment. Each staff member must pass the fit-testing for respirators.

- Contact lenses will not be permitted at the site.

- Disposable clothing will be used whenever possible to minimize the risk of cross-contamination.

- The number of personnel and amount of equipment in any contaminated area should be minimized, but allow for effective site operations.

- Work areas for various operational activities (equipment testing, decontamination) will be established.

- Procedures for leaving any contaminated area will be planned and reviewed prior to going onsite.

- Work areas and decontamination procedures will be established based on prevailing site conditions and are subject to change.

- Wind indicators will be strategically located onsite.

- Contact with contaminated or potentially contaminated surfaces should be avoided. Whenever possible, do not walk through puddles, mud, or any discolored ground surface; do not kneel on the ground, lean, sit, or place equipment on drums, containers, vehicles, or on the ground.

- No personnel will be admitted to the site without the proper safety equipment.

- Proper decontamination procedures must be followed before leaving the site.

- All personnel must comply with established safety procedures. Any staff member who does not comply with safety policy, as established by the Health and Safety Officer or the Project Manager, will be immediately dismissed from the site.

- Any medical emergency supercedes routine safety requirements.

- No street clothes will be worn at the site. At a minimum, a separate distinct set of work clothes will be worn.

6.3.1 Prior to Leaving Field Office

- Review site information (see Site Manager).

  - Expected hazards
  - Special conditions
  - Sampling procedures
  - Location of showers and telephones
  - Emergency medical information
  - Level of personnel protection required

- Check safety gear and equipment. The following equipment is available for issue, depending on site-specific conditions.

  - Steel-toe safety boots
  - Rubber boots
  - Coveralls, Tyvek, Saran, etc.
  - Hardhat with strap
  - Faceshield
  - Goggles

- VITON inner gloves
- Half-face (or full-face) respirator with appropriate cartridges and prefilters
- SCBAs
- Nylon backpack for gear sampling equipment
- Ziplock(R) baggies, quart and gallon size, to keep spare equipment clean
- Belt
- Belt pack for respirator
- Belt pack with personal first aid kit containing: (First aid kit will be approved by consulting physician in accordance with 29 CFR 1910.151)

  * can of spray-on bandage
  * bottle of vegetable oil (for PCB/oil irritation on eye contact)
  * knuckle bandages
  * ammonia inhalant
  * sting relief packet
  * isopropyl alcohol pads
  * snake bite kit (optional)
  * roll of 1/2 in. adhesive tape
  * finger tip bandages
  * instant ice pack
  * emergency compress
  * poison ivy wash
  * insect repellent (seasonal)

- Field standard operating procedures

. Backup equipment and spares will be maintained at the field office:

- Extra suits and gloves
- First aid kits
- Respirators with cartridges and prefilters
- Portable emergency oxygen unit
- Other self-contained breathing apparatus
- Communication devices
- Duct tape

- Trash barrel for return transportation of contaminated gear and equipment
- Salt replacement drinks (GATORADE)
- Safety harness and lines (if necessary)

6.3.2 Before Entering Site

. No eating/drinking/smoking while suited up.
Exception: Gatorade. When getting Gatorade, clean your gloves, etc.

. Drink some Gatorade.

. Place sample containers in field sample carrier (backpacks or carrier).

. Check location of showers/lavatory/water supply and telephones.

. Lay out and check alternate safety gear.

  - Oxygen masks
  - First aid kit
  - Extra clothing

. Don required safety gear in order.

  - Suit
  - Boots
  - VITON inner gloves
  - Neoprene and/or other synthetic outer gloves
  - Tape neoprene gloves to suit sleeves
  - Get long sleeve gloves if collecting soil samples, etc.

If suit has long enough legs, gather excess material at top of boot and tape the cuff over the top of the boot. If wet conditions prevail and no cuff can be formed, either connect the suit and boots with tape or cut off excess suit and tape suit on outside of boots.

Remember: Suits are splashproof, not completely waterproof.

- Respirator (test even if you are not going to wear it immediately). (See attached fitting instructions)
- Hardhat with integral goggles and face shield.

Put hardhat on and use the chin strap. Especially when well pumping, use <u>both</u> the face shield <u>and</u> the goggles. The face shield is meant to break impact of liquids and solid objects. <u>Only</u> the goggles, however, are splash proof.

- Check gear for rips/tears/malfunctions.

- Set up buddy prior to proceeding.

- Check your buddy's equipment and have him check yours.

- Preliminary site survey.

  - Characterize physical conditions of site
  - Use as much <u>excess</u> caution as possible
  - Use sampling gear (such as long handled dippers for sampling holes/pipes/gaps/tanks/trunks/manhole)

- Use caution - go slowly.

- If any problems with gear or equipment arise, exit by <u>same</u> route as you entered .... <u>NO SHORTCUTS</u>

- On return, have buddy check for external contamination. Check gear for damage.

6.3.3 Sampling

- No eating/drinking/smoking while sampling.

- Use standard sampling techniques (see field manual or site manager).

- Use excessive ca e ir handling samples. If the sampling site is not accessibie using your gear (i.e., water too high, slippery, steeply sloped, holes, etc.), don't take a sample. Confer with buddy and team leader about alternate sampling site.

- Wipe off spills, dirt, and residue immediately.

- If any gear or equipment damage develops, immediately repair or replace.

- If you experience any physical discomfort, abnormalities, or lightheadedness - stop work, tell your buddy, and go back.

- Always go back by the SAME ROUTE as you came.

6.4 DECONTAMINATION PROCEDURES

All personnel must complete appropriate decontamination procedures prior to leaving the site in a manner that is responsive to actual site conditions. A decontamination area will be set up at an appropriate site location. Receptacles will be provided for all disposable clothing. The receptacles will be conventional trash cans lined with heavy duty polyethylene trash bags. Wash tubs containing a detergent-water solution or an appropriate decon solution (see below) and soft-bristle brushes will be used to decontaminate reusable personnel protective clothing and boots. Following the detergent-water washing, an intermediate rinse will be applied when applicable. Clean, potable water will be used for the final rinsing. Each individual shall conduct proper personal hygiene which may include washing any exposed skin prior to eating, smoking, or leaving the site, consistent with site conditions.

Air monitoring equipment will be brushed to remove any obvious contamination, and will be taken into the trailer for recharging and calibration. The wash waters used and the disposable items will be collected.

6.4.1 Initial Decontamination

- Wash boots, gloves, respirators (see below).

- Put re-useable field gear inside trash barrel for transport to central wash facility. Put respirators in separate baggie, if contaminated, and label.

- Dispose of disposable suits and any other disposable and/or uncleanable equipment in the proper receptacle on site. Check with team leader if uncertain.

6.4.2 Decontamination Procedures

- Respirators

  - Remove filters and cartridges and carefully wipe clean as much as possible. If prefilters (outside filters in snap-on rings) are dirty, replace them with fresh ones. Put filters/cartridges in baggies. If respirator has surface dirt, clean external and internal surfaces with the decon solution provided and water. Wipe internal surfaces with alcohol. Use packaged wipe for daily nominal disinfection.

- At least once a month disinfect/sterilize respirators by leaving them 10-30 minutes in CIDEX or a comparable solution. Thoroughly rinse respirator with distilled water, rub dry, wipe with alcohol wipes, and store in baggie. See additional instructions in field manual. Note that we use high-efficiency filters, which, coupled with prefilters, should increase the lifetime about 6 times as compared to comparable standard cartridges.

  [Note: Personnel with respiratory tract infections, however minor they may seem, should disinfect at least weekly and, if possible, daily.]

. Other Equipment

- Brush and scrub gloves and boots, then continue with decon solution and water.

- Rinse thoroughly. Use some disinfectant or alcohol wipes for inside of gloves. Occasionally use chlorox or CIDEX on inside of boots to alleviate odor problems. Be sure to rinse thoroughly after using CIDEX or chlorox. Hang boots and gloves to dry on drying rack. Dry other equipment with paper towels.

. Heavy Equipment

- All heavy equipment must be decontaminated prior to leaving the site. This will include manual removal of gross contamination with shovels, etc., followed by a steam or high pressure wash, paying particular attention to tracks, wheels, and undercarriages.

6.4.3 Decon Solutions

Decon solutions are prepared to react with, neutralize, or physically remove specific contaminants on a site. All decon solutions and rinse waters are collected for proper disposal.

Decon Solution 1 - for light contamination; liquinox-based

Decon Solution 2 - for organic contaminants; detergent-based

Decon Solution 3 - for most acids and alkalies; trisodium phosphate based

Decon Solution 4 - for organophosphates, cyanides; calcium hypochlorite based

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7. EMERGENCY PROCEDURES

THIS SECTION DISCUSSES EMERGENCY PROCEDURES FOR EACH SITE. EMERGENCY TELEPHONE NUMBERS ARE PROVIDED FOR LOCAL AMBULANCE, POLICE, FIRE AND HOSPITAL SERVICES AND KEY TEAM PARTICIPANTS (I.E., SITE MANAGER, SAFETY OFFICER, ETC.). THE SECTION ALSO DISCUSSES ACCIDENTS AND INJURIES, FIRE, EXPLOSION, SITE EVALUATION, AND SAFETY OF THIRD PARTIES.

7.1 EMERGENCY TELEPHONE NUMBERS

Ambulance:

Police:

Fire Department:

Hospital:

Field Office:

Project Manager:

Health & Safety Officer:

7.2 HOSPITAL

Hospital emergency room personnel will be contacted and briefed regarding the scope of the study. The emergency route to the hospital will be mapped and posted inside and outside the field office and in the field manual. Travel time to the emergency room will be posted on the map.

The list of emergency telephone numbers will also be posted. A local accredited physician will be identified for emergency referrals and the hospital will be notified accordingly.

7.3 ACCIDENTS/INJURIES

Depending on the severity of the injury, treatment may be given at the site by trained personnel, additional assistance may be required at the site (emergency medical technicians), or the victim may have to be transported to hospital.

In life threatening situations, care must begin WITHOUT considering decontamination.

Outside protective clothing can be removed if it does not cause delays or aggravate the problem. Respirators must always be removed. Normal decontamination procedures should be followed when at all possible.

Heat-related illnesses can occur at any time when protective clothing is worn. Heat stroke requires prompt treatment to prevent irreversible damage or death. Unless the victim is obviously contaminated, decontamination should be minimized and treatment begun immediately.

It will be the responsibility of the Health and Safety Officer to investigate thoroughly the details of any accident or injury. Based on his findings, he should recommend any corrective action relative to field procedure to prevent recurrence. ENG Form 3394 will be completed in accordance with AR 385-40 and the USACE Supplement 1 to that regulation.

7.4 FIRE

The potential for fire is significant at many hazardous waste sites. During subsurface operations, explosimeters and organic vapor analyzers are used to monitor levels of potentially combustible gases. Fire extinguishers (Class ABC) will be kept at each drilling rig or backhoe, at the decontamination area, and in the office. Local fire departments will be alerted to the nature and location of any field investigation.

7.5 EXPLOSION

There is frequently the possibility of explosion during hazardous material investigations. Work will be stopped and the situation evaluated when readings in excess of 20% of the lower explosive limit are obtained.

7.6 SITE EVACUATION

7.6.1 Stages of Evacuation

Three stages of evacuation have been determined:

- Withdraw from immediate work area
- Withdraw from site
- Withdraw from area

Withdrawal from Work Area

Withdrawal to a safe upwind location will be required if any of the following occur:

- Concentrations of volatile organics, combustible, or toxic gases are detected above safe levels for the level of protection being worn.

- Occurrence of a minor accident - Field operations will resume after first aid and/or decontamination procedures have been administered.

- Equipment, protective clothing, or respirator malfunctions.

Evacuation of Site

The site will be evacuated in the following cases:

- Explosive levels of combustible gases, toxic gases, or volatile organics are detected (<50 percent LEL)

- A major accident or injury occurs

- Fire and/or explosion occurs

Evacuation of Nearby Area Facilities

The Site Manager is responsible for determining if circumstances exist for area contamination, and should always assume worst-case conditions until proven otherwise. Fire and police departments must be contacted. A list of their addresses and telephone numbers will be located in the field office, and will be carried by the Site Manager.

7.7 SAFETY OF THIRD PARTIES

Site access will be controlled such that only verified team members, waste removal subcontractors, and previously approved guests will be allowed in work areas or areas containing potentially hazardous materials or conditions. Special badges/passes may be issued as needed. Unauthorized, after hours access will be deterred by locked gates, fences, etc., as is practical and appropriate for the site. The enclosed and non-enclosed areas of the site will be posted with warning and/or No Trespassing signs, subject to community relations considerations.

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8. MEDICAL MONITORING PROGRAM

THIS SECTION PROVIDES A GENERIC DISCUSSION OF THE MEDICAL MONITORING PROGRAM.

Each individual will undergo and pass a comprehensive physical examination prior to going to any hazardous site. Subcontractor personnel are required to furnish documentation of equally comprehensive examinations. Annual or quarterly monitoring may be required if indicated.

The tests included in the examination are described in Table 8-1. Other tests can be added if warranted by special needs or exposure history. An example of the medical history forms are shown in Appendix C.

8.1 INITIAL EXAMINATION

The initial examination is intended to determine each employee's complete medical history as well as the compatibility of the (bio)medical status with the job description. For example, minimum physical requirements must be met:

- Vision - Binocular vision is required, and must be correctable to 20/40 (Snellen) in one eye and 20/20 in the other. Normal depth perception and basic color distinction are required.

- Hearing - Hearing loss in either ear should be no more than 30 dB at 500, 1000 and 2000 hertz

- Smell - Normal

- Speech - No conditions causing indistinct speech

- Other - No disease or condition which would interfere with the full performance of duties.

An electrocardiogram and spirometry are performed. The electrocardiogram is recorded as optional for annual re-examination. It is, however, suggested that employees over 35 years of age and employees with cardiac risk factors (overweight, smoking) be required to have annual EKGs.

Chest x-rays have, for the most part, been eliminated from the physical examination except for the initial baseline exam. The physician gives the patient a complete examination of the chest. This, coupled with the pulmonary function studies, gives the doctor sufficient information relative to any potential pulmonary problems. If chest x-rays are indicated from the results of later examinations, they are then performed. This decision is left to the discretion of the examining physician.

In addition, an extensive battery of hematological and serum chemistry determinations are performed. Hematological tests include a full blood count with differential and platelet count.

The standard serum-enzyme chemistry is also performed for the following parameters:

Alsanine aminostransferase (ALT, SGPT)
Aspartate aminotransferase (AST, SGOT)
Albumin
Alkaline phosphatease
Bilirubin (total)
Blood Urea Nitrogen (BUN)
BUN/Creatinine ratio
Calcium
CO_2 (Content)
Cholesterol

Chloride
Creatinine
Globulin
Glucose
Lactate dehydrogenase (LDH)
Phosphorus (Inorganic)
Potassium
Protein
Sodium
Triglycerides
Uric acid

A routine urine analysis is performed, including observation of color, specific gravity, and microscopic examination of formed elements and pathologically significant elements not normally present such as glucose, protein, blood, ketones, and bile acids. The majority of these parameters are indicative of kidney dysfunction.

Audiometry (hearing examination) is often included in the examination cycle if significant noise exposure is anticipated (i.e., working in close proximity to heavy equipment for extended periods of time).

8.2 QUARTERLY EXAMINATIONS

Quarterly examinations consist of blood chemistry and enzyme tests, focused on the detection of preclinical signs and imminent adverse health effects. These tests require serum and urine analysis only and can be performed by licensed paramedical personnel. Quarterly exams can be performed on all site members, as deemed necessary by the Health and Safety Officer, depending on frequency and duration of field work.

8.3 ANNUAL EXAMINATION

Annual examinations are generally a repeat of the initial examination. A number of the recommended biomedical tests for the establishment of baseline and sensitivity parameters can sometimes be dispensed with at this time. All personnel included in the initial exam program are given annual exams.

8.4 SPECIAL PARAMETERS

If indicated by the medical history and/or initial laboratory results, the examining physician will order additional tests. In addition, a host of parameters can be added to the parameters mentioned to account for prior and expected exposure conditions. An example would be exposure of heavy metals. If lead is a primary agent, a blood lead evaluation would be performed, including a quantitative blood lead determination. Other heavy metals could be analyzed in either blood or urine samples.

Summary reports of the examinations are provided and reviewed with each employee. Medical/exposure monitoring records will be maintained for a specified period of time in accordance with the provisions of OSHA (29 CFR 1910).

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TABLE 8-1 STANDARD BIOMEDICAL MONITORING

Test	Initial Examination	Quarterly Checkup	Annual Examination
Full physical	X		X
EKG	X		(X)
Chest X-ray	X		(X)
Hematology evaluation (including complete blood count, differential and platelet count)	X	X	X
Hemoglobin and hematocrit	X	(X)	X
Urinalysis	X	X	X
Vision screen	X		X
Executive profile (SMA-22, CBC, thyroid profile)	X		X
Pulmonary function	X		X
Audiometry	X		(X)
Proctoscopic exam	(X)		(X)

(X) - Included at the discretion of the accredited physician.

APPENDIX A

SITE SPECIFIC HEALTH AND SAFETY PLAN

LAW ENVIRONMENTAL SERVICES
Government Services Division
1140 Hammond Drive, Suite 5150-E
P. O. Box 888013
Atlanta, Georgia 30356
TEL: (404) 396-8000

HEALTH AND SAFETY PLAN

REVIEW AND APPROVAL

Health and Safety Officer	Bill Harris
Senior Engineer/Scientist	Harold Whitney
Field Safety Coordinator	Steven Shugart
Chief Engineer	Harold Whitney

DATE OF PLAN PREPARATION

DATES OF PLANNED FIELD ACTIVITIES

MEDICAL SURVEILLANCE

All LES field personnel participate in the LES medical monitoring program.

DESCRIPTION OF CLIENT SAFETY PROGRAM

All work accomplished in accordance with the provisions of OSHA (29 CFR 1910 & 1926) and EM 385-1-1 COE. The most restrictive requirements apply.

EMERGENCY PHONE NUMBERS

(To be obtained by Field Safety Coordinator prior to beginning work.)

HOSPITAL: To be filled in
FIRE: on site specific basis
POLICE:

EMERGENCY PROCEDURES

In event of overt personnel exposure (skin contact, inhalation, ingestion):

Skin - remove contaminated clothing, wash with soap and water

Inhalation - remove to fresh air

Eye Contact - flush with eye wash and copious amounts of water - get medical help

Ingestion - get medical help if indicated

In event of personnel injury:

Administer first aid if needed. Medical emergencies take precedence over decontamination procedures. Know route to nearest medical facility.

In event of potential or actual fire or explosion:

Do not fight fire. Contact Fire Department and/or client company officials as appropriate. Evacuate if necessary to upwind "clean" location.

In event of environmental accident (spread of contamination outside HWS):

Contact Harold Whitney or Bill Harris

SITE INFORMATION

HAZARDOUS/TOXIC MATERIAL (known or suspected)
Chlorinated solvents, hydrocarbons, IRFNA - nitrogen dioxide dissolved in nitric acid

HAZARD ASSESSMENT
Based on initial inspection, likelihood of exposure to contaminants appear minimal, other than direct contact with possibly contaminated soil or water samples.

LOCATION OF SITE "CLEAN AREA" AND DECONTAMINATION STATION

Clean area is outside a radius of 25 feet surrounding any operating unit, i.e. a drill rig, Sampling crew etc.

WORK PROCEDURES

PLANNED FIELD ACTIVITIES

Install 4 Monitoring wells - Take Soil and Water Samples

SITE MONITORING PROCEDURES

Monitor boreholes with organic vapor detector and explosimeter to detect toxic materials as well as volatile or combustible gases.

PERSONNEL MONITORING PROCEDURES

Visual observations during drilling by Site Manager. Quarterly and annual medical exams administered by Atlanta Occupational Medicine.

CLOTHING AND PROTECTIVE GEAR REQUIRED

Required to be worn while drilling:

Steel toed, chemically resistant (Neoprene) Safety Shoe
Distinct set of field clothes
Hardhat, gloves

To be readily available on Site:

Polylaminated Tyvek coveralls, Fire extinguisher
Safety glasses or goggles, First aid kit,
Air-purifying respirator

DECONTAMINATION PROCEDURES

Personnel - soap and water (as appropriate)
Equipment - Detergent or calcium hypochlorite based cleaning solution or live steam

DISPOSAL PROCEDURES

Disposable items handled as refuse at discretion of Site Manager

WORK PRECAUTIONS

1. Prior to any employee or subcontractor personnel beginning work on the HWS, the Field Safety Coordinator shall brief the employee on the contents of this plan.

2. No eating, drinking, smoking or putting hands in mouth while on the site.

3. ~~Wear tyvek suits, rubber gloves and rubber boots at all times while on the site.~~ Begin site work at Level E and upgrade to Level D if necessary.

4. Wash all exposed skin areas with soap and water before departing from the site, as appropriate. Take shower after arriving at temporary field place of residence.

5. Remove and change any non-impervious clothing that becomes contaminated during site activities.

6. Do not go anywhere on the site other than where directed by the Field Safety Coordinator.

7. Use safe and legal procedures for sample storage and shipment.

PERSONNEL POTENTIALLY EXPOSED TO HAZARDOUS MATERIALS

Personnel Authorized to Enter HWS

1. LES - Gov't Services Personnel
2. Drilling Contractor
3. Survey Crew
4. Representatives of site owner
5. Representatives of COE

Other Personnel Assigned to Handle Hazardous Materials (decontaminate, analyze samples)

1. IT Analytical Services
2. ______
3. ______
4. ______
5. ______

FIELD SAFETY COORDINATOR'S SUMMARY

(To be completed by Field Safety Coordinator after completion of field work, and returned to Health and Safety Officer.)

During the work and covered by the Safety Plan, there were:

a. No violations of the Safety Plan provisions and no obvious contamination of LES employees or subcontractors.

b. The following violations of the Safety Plan provisions or obvious contamination of LES personnel or subcontractors. (Give details of who, when, type of contamination, circumstances, first aid or medical assistance.)

____

____

____

____

____

Signature____________________________Date________________

Field Safety Coordinator or
Site Manager

ALL ACCIDENTS AND INCIDENTS CAUSING POTENTIAL EXPOSURE TO HAZARDOUS MATERIALS MUST BE REPORTED AS SOON AS POSSIBLE TO:

1) **HEALTH AND SAFETY OFFICER, or**
2) **CHIEF ENGINEER, or**
3) **BRANCH MANAGER**

APPENDIX B

PERSONAL PROTECTIVE EQUIPMENT

A.1 PERSONAL PROTECTION AND SAFETY EQUIPMENT

The health and safety plan recognizes five levels of protection. This represents a slight variance from EPA operating guidelines and allows an additional level of protection between EPA levels C and D. The following proposed levels of protection are based on organic vapor analyzer readings, as recommended by EPA.

A.1.1 Protective Equipment and Selection Criteria

Level A

Level A is worn when the highest level of respiratory, skin, and eye protection is required.

Protective Equipment Required

- Pressure-demand (positive pressure) SCBA, NIOSH/MSHA approved
- Fully encapsulated suit
- Gloves (inner) viton
- Gloves (outer) chemical-resistant, Neoprene
- Boots, chemical-resistant, steel toe and shank
- Hard hats
- Two-way radio communication
- Disposable coverall chemical suit

Selection Criteria

Any of the following conditions warrants Level A protection:

- Chemical substance has been identified which requires highest form of protection based on measured (or potential) high concentrations of atmospheric vapors, gases, or particulates; or work functions involve high potential for exposure to vapors, gases, or particulates.
- Extremely hazardous substances (e.g., dioxin, Department of Transportation [DOT] Class "A" poisons, concentrated pesticides) are known or suspected, and skin contact is possible.
- The potential exists for contact with substances that destroy skin.
- Reading on the organic vapor analyzer meter exceeds 500 ppm.
- Operations are conducted in confined, poorly ventilated areas or unknown air quality hazards.

Level B

Level B safety gear is worn when the highest level of respiratory protection is required, but a lesser degree of skin protection is required.

Protective Equipment

- Pressure-demand (positive pressure) SCBA, NIOSH/MSHA approved

- Chemical-resistant splash suit or polycoated disposable chemical-resistant coveralls
- Gloves (inner), vitron
- Gloves (outer), chemical resistant (taped to sleeves)
- Boots, inner, chemical-resistant, steel toe and shank
- Boots, outer, disposable (taped to cuffs)
- Emergency escape air supply
- Hard hats
- Two-way radio communication

Selection Criteria

- Atmospheres with chemical concentrations considered Immediately Dangerous to Life and Health (IDLH).
- Atmospheres exceeding limits of protection afforded by a full-face, air-purifying respirator.
- Atmospheres containing substances with poor warning properties, substances for which air-purifying cartridges do not exist, or have low removal efficiency.
- Atmosphere containing <19.5 percent oxygen.
- Conditions are such that small exposed areas about the head and neck will not be contacted by hazardous substances.
- Atmosphere contains from 50 to 500 ppm volatile organics as measured by the organic vapor analyzer.

<u>Level C</u>

Level C safety equipment will be worn when the types and concentrations of airborne contaminants are known, and the criteria for using air-purifying respirators are met.

Protective Equipment

- Full-face, air-purifying respirator with suitable cartridges, fit tested
- Chemical-resistant suit or polycoated disposable chemical-resistant coveralls
- Gloves (inner), viton
- Gloves (outer, chemical-resistant (taped to sleeves)
- Boots (inner), steel toe and shank
- Boots (outer), disposable (taped to cuffs)
- Emergency escape air supply
- Hardhat

Selection Criteria

- Atmospheric contaminant concentrations do not exceed IDLH levels.
- Air concentrations of identified substances will be reduced by the respirator to below the substance(s) exposure limit.
- Service limit of respirator cartridges will not be exceeded.
- Conditions are such that small exposed areas about the head and neck will not be contacted by hazardous substances.

- Job functions do not require SCBAs.
- Atmospheres contain between 19.5 and 25 percent oxygen.
- Atmosphere contains between 10 and 50 ppm volatile organics as measured by the organic vapor analyzer.
- Individual has been sucessfully fit tested.

Level D

Level D safety equipment has been modified from EPA protocols so that an additional safety level can be added between the requirements of Level C and the basic work uniform (EPA Level D). The basic work uniform is presented as part of Level E.

Protective Equipment

- Half-face, air-purifying respirator
- Chemical-resistant suit or disposable chemical-resistant coveralls
- Gloves, neoprene
- Cotton gloves as liners if needed
- Boots (inner), steel toe and shank
- Boots (outer), disposable
- Emergency escape air supply
- Harahats
- Safety goggles
- Face shield (integral to hardhat)

Selection Criteria

- Atmospheric contaminant concentrations do not exceed IDLH levels.
- Air concentrations of identified substances will be reduced by the respirator to below the substance(s) exposure limit.
- Service limit of respiratory cartridges will not be exceeded.
- Conditions are such that small exposed areas about the had and neck will not be contacted by hazardous substances.
- Job functions do not require SCBAs.
- Atmospheres contain between 19.5 and 25 percent oxygen.
- Atmosphere contains detectable levels of volatile organics, but <10 ppm as measured by the organic vapor analyzer.

Level E

Level E equipment will be worn only in areas where contact with contaminated materials is extremely unlikely. It is primarily intended for surface reconnaissance work.

Protective Equipment

- Half-face, air-purifying respirator (carried)
- Coveralls, cotton
- Boots, steel toe and shank

- Boots (outer), disposable (optional)
- Hard hats
- Neoprene gloves with cotton liners (optional)

Selection Criteria

Level E protection is the basic work uniform. It can be worn in areas where only boots can be contaminated, and no inhalable toxic substances are present.

APPENDIX C

MEDICAL FORMS

ac Past Illnesses: (Age)

			(Age)			(Age)			
☐	Chickenpox	______	☐	Pneumonia	______	☐	Mononucleosis	______
☐	Measles	______	☐	Bronchitis	______	☐	Venereal Disease	______
☐	German Measles	______	☐	Pleurisy	______	☐	Meningitis	______
☐	Mumps	______	☐	Tuberculosis	______	☐	Heart Attack	______
☐	Scarlet Fever	______	☐	Malaria	______	☐	Kidney Trouble	______
☐	Rheumatic Fever	______	☐	Ulcer	______	☐	Stroke	______
☐	Hay Fever	______	☐	Hepatitis	______	☐	Phlebitis	______
☐	Asthma	______	☐	Cancer	______	☐	High Blood Pressure	______

Other:

Operations: (Age) ______________________________

Serious Injuries (broken bones, knocked unconscious, etc.): (Age) ______________________________

Pregnancies (and any serious complications): (Age) ______________________________

Contraception (type): ______________ Have you had a skin test for tuberculosis? ________ Result: ________

Immunizations or Vaccinations within the past ten years (and approximate date): ______________________________

Current drugs or patent medicines (include laxatives, antacids, aspirin, etc): ______________________________

Allergies (medications, pollens, foods, etc.): ______________________________

Sleep (how much; sound or fitful?): ______________________________

Diet (is it well balanced? ______ Special?): ______________________________

Tobacco (packs per day): ______ Alcohol (drinks per day or week): ______ Coffee (cups per day): ______ Regular or no caffeine: ______

Have you ever smoked? ____________ How Long? ____________ Have you ever tried to stop smoking? ____________

What Symptoms did you have? ______________________________

Birthplace, States where you have resided, and Foreign Travel: ______________________________

Education (highest level completed; special studies): ______________________________

Type of exercise and hobbies: ______________________________

Special problems related to home or work conditions: ______________________________

Check if anyone in your family has ever had the following

	Relationship		Relationship		Relationship
☐ Diabetes	______	☐ High Blood Pressure	______	☐ Anemia	______
☐ Heart Disease	______	☐ Cancer	______	☐ Bleeding Disorder	______
☐ Stroke	______	☐ Migraine Headaches	______	☐ Obesity	______
☐ Thyroid Disorder	______	☐ Ulcers	______	☐ Kidney Disease	______
☐ Gout	______	☐ Hay Fever or Asthma	______	☐ Epilepsy	______
☐ Mental Illness	______	☐ Allergies	______	☐ Other	______

	If Living		If Deceased			If Living		If Deceased	
	Age	State of Health	Age	Cause		Age	State of Health	Age	Cause
Mother	____	______	____	______	Father	____	______	____	______
Brothers	____	______	____	______	Sisters	____	______	____	______
Husband Wife	____	______	____	______	Children	____	______	____	______

(If you need more space use back side)

NAME
DATE

Check the preceding box if you now have (or have recently had) any of the following:

- ☐ Fever
- ☐ Poor appetite
- ☐ Skin itching
- ☐ Easy bruising
- ☐ Severe blow to the head
- ☐ Double vision
- ☐ Need for glasses
- ☐ Ear drainage
- ☐ Nosebleeds
- ☐ Frequent sneezing
- ☐ Frequent sore throats
- ☐ Chronic cough
- ☐ Trouble breathing
- ☐ Irregular or excessively rapid heartbeat
- ☐ Blue lips, fingers, toes
- ☐ Heartburn
- ☐ Regurgitation of food or vomiting
- ☐ Painful bowel movements
- ☐ Mucus with bowel movements
- ☐ Intestinal worms
- ☐ Urgent urination
- ☐ Awakening from sleep to urinate - How many times each night? ________
- ☐ Age at first period (   )
- ☐ Discomfort during periods
- ☐ Hot flashes
- ☐ Joint stiffness
- ☐ Bursitis
- ☐ Excessive appetite, thirst, or urination
- ☐ Impotence
- ☐ Paralysis
- ☐ Nervousness
- ☐ Crying spells
- ☐ Excessive anger or temper
- ☐ Feeling that people are "out to get you"

- ☐ Sweats
- ☐ Weight gain
- ☐ Facial flushing
- ☐ Excessive bleeding
- ☐ Fainting spells
- ☐ Blind spots
- ☐ Earache
- ☐ Ear blockage
- ☐ Nasal obstruction
- ☐ Sores in the mouth
- ☐ Frequent runny nose
- ☐ Coughing up phlegm
- ☐ Shortness of breath with exertion
- ☐ Varicose veins
- ☐ Cold hands or feet
- ☐ Indigestion
- ☐ Vomiting blood
- ☐ Greasy bowel movements
- ☐ Constipation
- ☐ Burning with urination
- ☐ Bloody urine
- ☐ Difficulty starting urination
- ☐ Duration of periods (   )
- ☐ Unusually light flow
- ☐ Bleeding after menopause
- ☐ Tender bones or joints
- ☐ Body deformity
- ☐ Change in size of head, hands, or feet
- ☐ Loss of sexual drive
- ☐ Tremors, seizures, twitching, convulsions
- ☐ Anxiety
- ☐ Feelings of helplessness
- ☐ Trouble accepting criticism
- ☐ Seeing or hearing things that don't exist (hallucinations, voices)

- ☐ Chills
- ☐ Weight loss
- ☐ Boils
- ☐ Anemia
- ☐ Lightheadedness
- ☐ Eye pain
- ☐ Trouble hearing
- ☐ Ear itching
- ☐ Sinus trouble
- ☐ Hoarseness
- ☐ Breast lumps, swelling, or pain
- ☐ Coughing up blood
- ☐ Trouble breathing when lying flat
- ☐ Ankle swelling
- ☐ Heart murmur
- ☐ Frequent belching or passing gas
- ☐ Abdominal or stomach pain or discomfort
- ☐ Frequent loose bowel movements
- ☐ Hernia
- ☐ Frequent urination
- ☐ Kidney stones
- ☐ Prostate trouble
- ☐ Time between periods (   )
- ☐ Unusually heavy flow
- ☐ Vaginal discharge or irritation
- ☐ Tender muscles
- ☐ Goiter or enlarged thyroid gland
- ☐ Darkening of the skin
- ☐ Numbness or tingling of mouth, arms, or legs
- ☐ Incoordination
- ☐ Irritability
- ☐ Thoughts of suicide
- ☐ Strong fears

- ☐ Fatigue
- ☐ Skin rash
- ☐ Swollen glands (or lymph nodes)
- ☐ Headache
- ☐ Blurred vision
- ☐ Eye inflammation
- ☐ Ringing in the ears
- ☐ Dizziness
- ☐ Post nasal drip
- ☐ Serious dental problems
- ☐ Discharge from the nipple
- ☐ Wheezing
- ☐ Chest pain
- ☐ Leg cramps
- ☐ Trouble swallowing
- ☐ Nausea
- ☐ Black bowel movements
- ☐ Blood with bowel movements
- ☐ Yellow jaundice or liver trouble
- ☐ Excessive urine volume
- ☐ Inability to control the urine
- ☐ Pain, ulceration, swelling of, or discharg the genitals
- ☐ Discomfort before periods
- ☐ Menopause (change of life) Age
- ☐ Joint pain
- ☐ Back trouble
- ☐ Sugar in the urine (diabetes)
- ☐ Sterility
- ☐ Weakness
- ☐ Slurred speech
- ☐ Depression
- ☐ Desire to harm someone
- ☐ Constant worrying

NAME:

DATE: