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0034373

DOE/RL-93-47
Revision 0

UC-630

North Slope (Wahluke Slope) Expedited Response Action Cleanup Plan

Date Published
February 1994

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release

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EXECUTIVE SUMMARY

The purpose of this action is to mitigate any threat to public health and the environment from hazards on the North Slope and meet the expedited response action (ERA) objective of cleanup to a degree requiring no further action. The ERA may be the final remediation of the 100-IU-3 Operable Unit. A No Action record of decision (ROD) may be issued after remediation completion.

The U.S. Department of Energy (DOE) currently owns or administers approximately 140 mi^2 (about 90,000 acres) of land north and east of the Columbia River (referred to as the North Slope) that is part of the Hanford Site. Approximately half of the North Slope is DOE acquired land. The balance is made up of U.S. Bureau of Reclamation (BoR) acquired and withdrawn lands and U.S. Bureau of Land Management withdrawn lands. The BoR acquired lands are administered by DOE under a memorandum of agreement. This agreement allows BoR to continue all activities on the North Slope that relate to the operation, maintenance, and repair of their irrigation canals and wasteways, since these facilities predate Hanford activities.

DOE, in turn, permits approximately 25% of the North Slope area to the U.S. Fish and Wildlife Service. This area is managed as the Saddle Mountain National Wildlife Refuge with limited public access. The remaining 75% of the North Slope is permitted to the State of Washington Department of Wildlife and is operated as a State Wildlife Recreation Area that is opened to the public during daylight hours.

The North Slope, also commonly known as the Wahluke Slope, was not used for plutonium production or support facilities; it was used for military air defense of the Hanford Site and vicinity. The North Slope contained seven antiaircraft gun emplacements and three Nike-Ajax missile positions. These military positions were vacated in 1960-1961 as the defense requirements at Hanford changed. They were demolished in 1974. Prior to government control in 1943, the North Slope was homesteaded.

Since the initiation of this ERA in the summer of 1992, DOE signed the modified *Hanford Federal Agreement and Consent Order* (Tri-Party Agreement) with the Washington Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA), in which a milestone was set to complete remediation activities and a draft closeout report by October 1994. Remediation activities will make the North Slope area available for future non-DOE uses.

Thirty-nine sites have undergone limited characterization to determine if significant environmental hazards exist. This plan documents the results of that characterization and evaluates the potential remediation alternatives.

Four remediation alternatives were developed for evaluation in an engineering evaluation/cost analysis under the *Comprehensive Environmental Response, Compensation, and Liability Act*. They are No Action, Hazard Mitigation, Hazard Removal, and Characterization and Hazard Mitigation. The evaluation included a land-use scenario options, technical feasibility, risk to the environment and public, and costs.

The ERA proposal has undergone concurrent reviews by the EPA, Ecology, and the public during a 60-day public comment period. Based on public comment received and regulatory comments, the ERA proposal has been significantly revised. At completion of the public review evaluation by Ecology, Ecology, with EPA concurrence, will issue an action memorandum. The memorandum will authorize implementation of the Ecology/EPA-selected remediation alternative.

The DOE preferred alternative is Characterization and Hazard Mitigation. DOE believes that this alternative will meet the Hanford Future Site Uses Working Group recommendation for "unrestricted land use" for any of the three land-use options identified. However, the regulatory agencies will review all of the options provided and select an appropriate remediation alternative in the action memorandum.

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) currently owns or administers approximately 140 mi^2 (about 90,000 acres) of land north and east of the Columbia River (referred to as the North Slope) that is part of the Hanford Site (see Figure 1). Approximately half of the North Slope is DOE acquired land. The balance is made up of U.S. Bureau of Reclamation (BoR) acquired and withdrawn lands and U.S. Bureau of Land Management withdrawn lands. The BoR acquired lands are administered by DOE under a memorandum of agreement. This agreement allows BoR to continue all activities on the North Slope that relate to the operation, maintenance, and repair of their irrigation canals and wasteways, since these facilities predate Hanford activities.

DOE, in turn permits, approximately 25% of the North Slope area to the U.S. Fish and Wildlife Service (AEC 1971). This area is managed as the Saddle Mountain National Wildlife Refuge with limited public access. The remaining 75% of the North Slope is permitted to the State of Washington Department of Wildlife and is operated as a State Wildlife Recreation Area that is opened to the public during daylight hours.

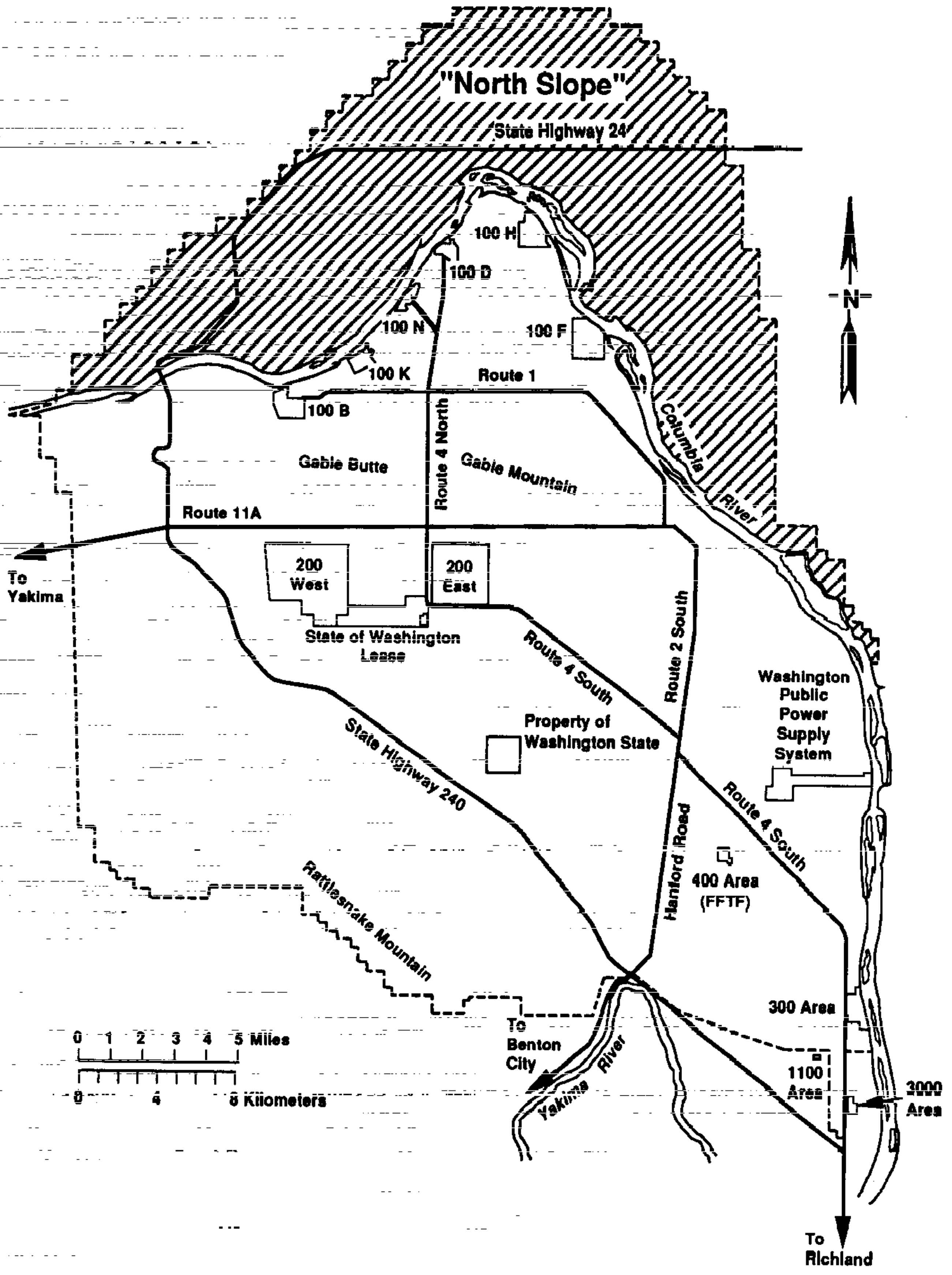
The North Slope, also commonly known as the Wahluke Slope, was not used for plutonium production or support facilities, but was used for military air defense of the Hanford Site and vicinity. Seven antiaircraft gun emplacements and three Nike-Ajax missile positions were located on the North Slope. These military positions were vacated in 1960-1961 as the defense requirements at Hanford changed and eventually demolished in 1974. Prior to government control in 1943, the North Slope was homesteaded.

With the recent change in mission at Hanford from plutonium production to environmental cleanup, much attention has been given to releasing tracts of land for other uses. The North Slope area is considered to be one of these relatively clean tracts of land by the DOE.

The State of Washington Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) recommended that DOE prepare an expedited response action (ERA) proposal for the North Slope landfills (Appendix A). The ERA lead regulatory agency is Ecology and EPA is the support agency.

The ERA proposal has undergone concurrent reviews by EPA, Ecology, and the public during a 60-day public comment period. Based on public and regulatory comments, the ERA proposal has been significantly revised. At completion of the public review evaluation by Ecology, Ecology, with EPA concurrence, will issue an action memorandum. The memorandum will authorize implementation of the Ecology- /EPA-selected remediation alternative.

Figure 1. Location of the Hanford Site North Slope.



The North Slope ERA is non-time-critical. A non-time-critical ERA is utilized for releases requiring removal actions that can start later than 6 months after the determination that a response is necessary. This requires an engineering evaluation/cost analysis (EE/CA) per Federal Register, Vol. 55, No. 46, March 8, 1990, p. 8843, and 40 CFR 300.415. The EE/CA is similar to a feasibility study that considers applicable or relevant and appropriate requirements (ARAR), protection of the environment and human health, timeliness, effectiveness, and cost to implement a preferred alternative. This document contains the EE/CA for the North Slope ERA.

1.1 GOAL

The goal of the ERA is to conduct early remedial actions in an area accessible to the public prior to the occurrence of an injury or exposure to potentially hazardous wastes (WHC 1992a). The potential hazards include refuse disposal areas, drywells, acid neutralization pits, the 2,4-D disposal site, and ordnance and explosive waste (Figure 2 and Plate 1). Physical hazards will also be mitigated as necessary to minimize possible injury to wildlife and persons using the area. The ERA may be the final remediation of the 100-IU-3 Operable Unit. A no-action record of decision may be issued after remediation completion.

Since the initiation of this ERA in the summer of 1992, DOE has signed the modified Tri-Party Agreement (Appendix B) with Ecology and the EPA, in which a milestone was set to complete remediation activities and a draft closeout report by October 1994. Remediation activities will make the North Slope area available for future non-DOE uses.

1.2 BACKGROUND

When Euro-Americans first arrived in the Hanford area, they found the Columbia River between present-day Richland and Vantage occupied by the Chamnapum, Wanapum, and Yakima Indian Groups (Spier 1936; Relander 1956). The Wanapum are generally considered the major occupants of this region. Both the Wanapum and the Chamnapum are described as belonging to the Sahaptin linguistic family (Ray 1939). In addition, the Umatilla, Walla Walla, and the Palus Indians from the Lower Snake River frequented the area to fish (Relander 1956; Trafzer and Scheuerman 1986). The local Wanapum population occupied winter villages in the Richland and Priest Rapids areas, and utilized temporary camps along the Columbia and Yakima rivers during the remainder of the year. Winter villages and temporary villages of the Wanapum (and Chamnapum) are described (Relander 1956) as occurring along the entire Hanford Reach of the Columbia River, the confluence of the Snake and Columbia Rivers, and portions of the Yakima River. Lewis and Clark estimated the Wanapum population to be around 3,000 individuals.

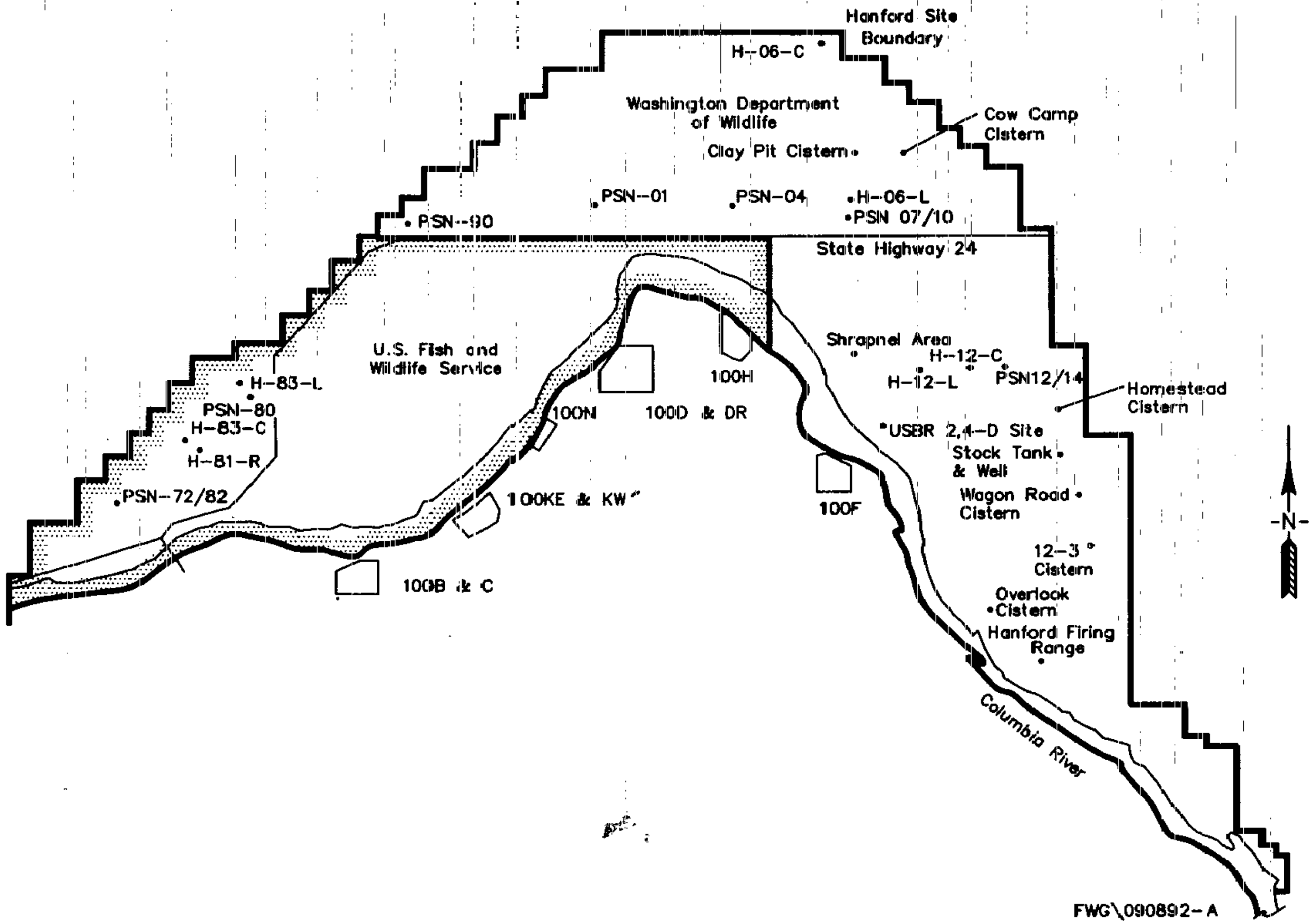


Figure 2. Location of North Slope Waste Sites.

This area and the Hanford Site were ceded to the United States in the Treaties of 1855 by the Confederated Tribes and Bands of the Yakima Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation. Perhaps the first Euro-Americans to pass through the region were Lewis and Clark who, in 1805, traveled up the Columbia to the mouth of the Yakima River after descending the Snake River (Coues 1893; Relander 1956; Thwaites 1959). The expedition referred to the Indian people of the area as the Sokulks.

Lewis and Clark were followed by fur traders and trappers who passed through the Hanford area to more productive locations to trap and trade furs, including Wilson Hunt of the Astoria Company in 1811, and David Thompson of the Northwest Company also in 1811. Robert Stuart of the Astoria Company arrived in the Hanford area shortly after Thompson reached Astoria. Ross Cox and Alexander Ross from the Hudson's Bay Company passed through the Hanford Reach in 1814 traveling separately up the Columbia. The Northwest Fur Company post, Fort Nez Perces, was established at the mouth of the Walla Walla River in 1818 (Chance 1973; Rich 1947).

Commander Charles Wilkes and Captain John C. Fremont of the U.S. Army Corps of Topographical Engineers traveled through the region during the 1830s, however, the Hanford stretch of the Columbia was not traversed. By the late 1830s, missionaries such as Marcus Whitman, Henry Spaulding, and Elkanah Walker, began arriving in the region to convert the Indians to Christianity. Father Pascal Ricard arrived in the area in 1847. Ricard's goal was to establish a mission on the Yakima River; the original location of this mission is reported to have been on the Yakima River flood plain south of present-day Richland (Kowrach 1978). A mission site was selected along Mnassatas Creek in 1848 (Parker 1979). The hostilities leading to the so-called Whitman massacre at the Waiilatpu Mission near Walla Walla temporarily halted missionary activity and settlement in the local region for several years.

Although a wagon train followed by personnel from the U.S. Army Corps of Engineers passed through the area in 1853 and 1854, and military Depot Camp was established at White Bluffs during the Yakima Indian War between 1855 and 1858, it was not until the 1860s that settlement by Euro-Americans occurred (Rice 1968).

In 1861, Jordan Williams arrived in the White Bluffs area with a herd of cattle (Parker 1979), followed by others attracted by the grazing potential of the area. This, coupled with the discovery of gold in Idaho in 1859 and areas to the north along the Colville River and southern British Columbia in the 1860s, stimulated interest in the Columbia River Valley by settlers and merchants with the desire to provide goods and services to the prospectors passing through the Hanford area. At this time, "merchants set up stores, a freight depot, and the White Bluffs Ferry on the Hanford Reach" were established, followed shortly thereafter by Chinese gold miners (Chatters 1992). A steamship to transport miners and equipment to Priest Rapids enroute to the gold fields in the northern Okanogan Valley was available in 1859. The Caribou Trail, which passed thorough the Hanford area at White Bluffs, was also an important link to the northern gold fields between 1858 and 1868. In the 1860s, several wagon roads between the gold fields and White Bluffs were established to transport supplies brought by steamships on the Columbia River. Construction of the Mullen Road from Walla Walla to Fort Benton in Montana ended White Bluffs brief reign as the primary supply route to the gold fields. Amazingly, despite the incursion of miners, settlers, and merchants, hostilities between Indians and whites in the Hanford area were minor. The notable exception to this was the murder of two horse ranchers at Rattlesnake Spring in 1878 (Ruby and Brown 1965).

Although Yakima County was founded in 1865, by the 1870s ferry service in the Hanford area had decreased markedly, and many people left the region. Beginning in the late 1800s, however, ranchers and settlers began using the area for winter sheep grazing, horse and cattle ranching, occasional homesteading, and road construction. Of these land use practices, sheep grazing was probably the most profitable venture. Sheep ranchers constructed numerous water cisterns, wells, and irrigation troughs, as well as altered the vegetation by removing sagebrush. In the 1890s, small numbers of homesteaders began arriving and building ranches near reliable water sources and raising sheep, cattle, and swine. Some attempted dry land farming as well. This type of settlement continued until 1943 when the Hanford Site was established. In 1892, the Yakima Irrigation and Improvement Company was founded to build canals and irrigation networks to provide reliable water sources for crop production (Parker 1979).

By the late 1800s and early 1900s, the towns of White Bluffs, Hanford, Ringold, Wahluke, Haven, Mitchell, and other small communities, began to emerge along the river (Chatters 1992), and new ferries began operation at Richmond and Wahluke. The Hanford Irrigation and Power Company formed in 1906 to provide water to the local farmers and ranchers. Fruit farming became the most profitable venture for many farmers along the Hanford Reach. Most of these historic sites were removed in the 1940s when the U.S. Government established the Hanford Works (Chatters and Hoover 1986; Rice 1980) on February 9, 1943.

Homesteading of the Hanford region began sometime in the 1890s. Wood was scarce, and homesteaders built homes with whatever wood was available. Settlers raised livestock and planted small gardens. Because of the arid climate, most efforts at dryland farming resulted in failure. Also, those homesteads that relied primarily on rainfall did not have an adequate water source, and were abandoned before the end of the 1920s. Those that succeeded depended on grazing or sheep raising activities.

The North Slope was acquired by the U.S. Department of Defense (DoD) primarily by permits from the U.S. Atomic Energy Commission (AEC), for the Continental Air Defense Command and later the U.S. Army Air Defense Command in 1950-1956. The North Slope originally consisted of 10 antiaircraft batteries. Between 1957-1958, three of the antiaircraft batteries were modified to support Nike missile operations, while the remaining batteries were phased out of service. Since 1964, there has been no permanent military installation on the North Slope. However, the area has been used for military training maneuvers since 1964 (WHC 1990). See Appendix C for a summary of the history of the U.S. Army's Camp Hanford and the North Slope forward positions.

Since 1975, the 134-mi^2 area permitted by DOE to the Washington Department of Wildlife and the U.S. Fish and Wildlife Service has been opened for public access or designated as a wildlife refuge. Certain areas included in the wildlife management area have been opened for cattle grazing to ranchers who obtain grazing agreements.

In 1989 and 1990, an investigation of the North Slope area was performed to assess potential health, safety, and environmental concerns raised to DOE by Ecology and the public. As a result of this survey, 39 sites associated with either military or homesteading activities were identified. The following section summarizes information from the *North Slope Investigation Report* (WHC 1990).

In August 1992, a categorical exclusion (CX) to the National Environmental Policy Act (NEPA) was deemed applicable by DOE for the removal actions of this ERA. This review under NEPA was performed in accordance with DOE procedures implementing NEPA (10 CFR 1021) and the then current DOE Order 5440.1D, describing the NEPA compliance program. The CX is part of the administrative record for the North Slope.

1.2.1 Military Sites

Military records from the U.S. Army Corps of Engineers identify three Nike missile battery sites (H-06 [Battery "A"], H-12 [Battery "B"], and H-83 [Battery "C"]) and seven antiaircraft battery sites (PSN-01, PSN-04, PSN-07/10, PSN-12/14, PSN-72/82, PSN-80, and PSN-90) positioned on the North Slope. Evidence remaining of these sites includes reinforced-concrete foundation pads, scattered bottles and metal cans, gravel walkways, building rubble, dry wells, and solid waste landfill disposal areas. Aboveground structures have been demolished. Seven water well structures made of reinforced concrete remain. Other underground structures have been destroyed or filled in. Exceptions are two rooms associated with an antiaircraft site (PSN-04) and a few small structures at other sites.

During the military occupation of the North Slope, nine water wells were installed but only eight have been found. Seven of the eight water wells are covered by concrete wellhead structures. The wells were installed in the early 1950's and water production was permanently discontinued in the early 1960's. Two wells were investigated by video in early December 1993. The well at site PSN-07/10 had a plug at 208 ft below the surface and was dry. The well at site PSN-72/82 had a plug 370 ft below the surface with 16 ft of water above the plug.

The concrete water well structures are typically 2 to 3 ft tall and extend into subsurface chambers approximately 6 by 8 by 10 ft deep. The well shaft is located on the floor of the chamber. The well at site PSN-90 is being utilized by the local irrigation district and is not addressed in this ERA.

Most of the well structures had metal covers that could be opened. The well covers were locked to prevent unauthorized access. The public has cut locks and latches off to open the doors. Efforts at opening the covers have been so persistent that even spot welding the doors shut has been ineffective. DOE is concerned with these acts of vandalism because it places the public at risk to injury from physical hazards.

Appendix D presents copies of the military water supply well logs, which include the physical description of these water wells.

Along with the military water supply wells, several other water supply and resource protection wells inside of the North Slope area have been identified for decommissioning. Many of these wells have not been located and have no construction or geologic information.

Many of the buildings and permanent structures associated with these sites remained in place until they were demolished in 1974. These structures were demolished under AEC direction as they were determined to be a liability. Demolition debris was typically landfilled onsite.

Historical research on the North Slope military structures located construction drawings for each of the three Nike missile sites. The Nike installations are similar in construction and layout. Each site consisted of a control center (designated as C), a launch site (designated as L), and associated barracks and administration buildings. An early-warning radar site is also associated with each of the facilities.

Reports from personnel assigned to military units at and near the North Slope indicate that there was no centralized disposal system in operation. Several landfills associated with the military operations are evident. It is assumed that a disposal site is located at each of the military sites. Investigation of debris at the surface of these disposal areas reveals the typical range of military camp items (e.g., food cans and bottles, motor pool refuse, office and personal supplies) and debris from site demolition activities.

The debris found in the vicinity of the military sites include oil and lubricant cans ranging in size from 1 qt to 5 gal. Only a few cans were found to have small volumes of oil in them. These cans have collected dust, plant debris, and insect bodies so that no free liquid remains. Paint cans are also common and some are partially full of dried paint. Several empty 1-gal solvent cans have been found. Nothing has been found that is considered to be an imminent hazard to personnel, the public, or the environment.

Each military site contains scraps of asbestos-transite siding from building structures. The pieces are generally small, apparently overlooked as materials were being removed from the sites during the demolition activities. Personnel associated with site demolition activities indicate that building structures were knocked down and buried in pits near the original locations.

Each military site was reported to have had its own small motor pool. Major, nonroutine vehicle maintenance was completed at the main Hanford motor pool located across the Columbia River. Only routine maintenance was performed at the military sites. Reports indicate that standard procedure at that time was to use used oil for dust control on roadways. Some of the military sites have maintenance areas with sunken grease pits and concrete ramps for convenient access by mechanics to the underside of vehicles.

Four drywells associated with the military sites have been located. The drywells consist of 55-gal drums, buried vertically to the rim with holes punched into the bottom to allow for percolation of the disposed (unknown) liquid. Additional drywells appear on facility drawings available for the Nike missile positions. Field investigations were unable to locate these additional structures. Field survey activities are included in the field logbook. The inconsistencies between the drawings and actual field observations indicate that these drawings are not as-built plans.

Construction drawings also indicate the use of underground fuel tanks. Geophysical surveys (including magnetometer and electromagnetic induction) failed to detect the presence of these tanks. An interview with a former soldier stationed at Nike position H-83-C indicated that the tanks were not underground but rather of the skid-mounted variety. It may also be possible that the tanks were removed during the deactivation activities.

In addition to the military camps, three sites were found or reported that may contain unexploded ordnance. Interviews with former personnel assigned to the North Slope military sites indicate that unexploded ordnance may have been disposed of in random locations throughout the area. The three potential ordnance sites were investigated by personnel from the U.S. Army Explosive Ordnance Detachment (EOD), Department of the Army, 53rd Ordnance Detachment, with assistance from the Hanford Site Patrol and Westinghouse Hanford Company (WHC) in the fall of 1989. The EOD performed a records search, conducted personal interviews, and completed walk-through surveys of the area, sweeping the area with magnetometers where appropriate. No unexploded ordnance was located during this cursory investigation.

1.2.2 Non-Military Sites

Prior to the federal government's acquisition of the North Slope, the area was used for orchards and row crops near the Columbia River, wheat on the high ground away from the river, and as a grazing area where soil conditions would not allow the raising of crops.

Homestead structures (e.g., homes and outbuildings) were leveled and removed in 1974 along with the military structures by the AEC. Typically, homestead locations can be identified by scattered cans, bottle shards, and pieces of weathered lumber. Occasionally, a section of fenceline, a water cistern, or disposal pit may remain.

Cisterns were structures used for the storing of water for domestic and livestock use. Seven cisterns have been located on the North Slope. They are typically concrete- or mortar-lined and range in size from 3 to 10 ft in diameter and 4 to 14 ft deep. Cisterns that are relatively intact may present a physical hazard to persons and livestock. A person or animal falling into one of the larger cisterns may be injured, and the sheer walls may make escape difficult without assistance.

No specific environmental hazards have been found associated with the homestead disposal pits. One former resident indicated that, because money was scarce, canned goods were expensive and rarely purchased. Most goods came in paper containers. Anything that could be reused was, and the few items that could not be re-used were burned.

Historic usage of pesticides included lime sulphur and lead arsenate. In latter years, DDT and other pesticides may have been used. No areas have been found that are suspected of being pesticide disposal areas. Soil contaminated with the herbicide 2,4-D from four leaking tanks owned by the U.S. Bureau of Reclamation was disposed of on the North Slope in 1966.

1.2.3 Geology and Groundwater

The area referred to as the North Slope of the Hanford Site is situated on the northern limb of the Wahluke Syncline, a geologic structure formed between the Saddle Mountains and Gable Butte/Gable Mountain anticlines. The regional dip of strata is to the south (western north slope) and southwest (eastern north slope). The stratigraphic units that overlie the Columbia River basalts include sand and gravel deposits of the Hanford and Ringold formations. These deposits are thickest in the central part of the Hanford Site; they become progressively thinner towards the north and pinch out against the Saddle Mountains. A geologic description of the northern Hanford Site on the south side of the Columbia River is provided by Lindsey (1992). This report (Lindsey 1992) provides a good introduction to potential conditions on the north slope.

Groundwater flow in the unconfined aquifer of the North Slope is generally toward the Columbia River, where it discharges into the river. Flow is heavily influenced by irrigation practices, including an east-west irrigation canal that flows across the northern part of the North Slope. Leakage and/or overflow from this canal results in surface ponds and wetland areas. Elevated nitrate is expected in North Slope groundwater and surface ponds as the result of agricultural practices.

There is a scarcity of data to describe the water quality and water table characteristics for the North Slope. No Hanford Site programs have monitored the area, and very few wells are available for monitoring. Investigations have been conducted by the Water Resources Division, U.S. Geologic Survey, that provide a regional picture of water quality and flow characteristics. They maintain records of wells, hydrologic head measurements, and water quality information that could be used to describe the general conditions on the north slope; however, no published summary currently is available.

The locations of known wells, their construction characteristics, and the dates for which water quality and water level data are available are presented by Peterson (1992). This report compiles information contained in *Hanford Wells* (McGhan 1989) and the former Hanford Groundwater Data Base, which was maintained by the Pacific Northwest Laboratory (PNL). The latter database has been superseded by the Hanford Environmental Information System (HEIS).

A groundwater monitoring program would be initiated in the event that information developed during remediation of the waste sites indicates the potential for contaminant impacts to groundwater.

2.0 CHARACTERIZATION ACTIVITIES

The North Slope includes two small waste sites that are identified in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) as the 100-IU-3 Operable Unit. The waste sites are the 2,4-D herbicide-contaminated soil and storage tank landfill and the Battery A (H-06) Nike missile site (Figure 2). These sites and several other areas of military origin must be investigated for possible environmental and ordnance and explosive waste hazards prior to excessing the property from DOE control. Physical hazards associated with the military emplacements as well as homesteading activities must be mitigated as well.

Thirty-nine sites have undergone limited characterization to determine if significant environmental hazards exist. This proposal documents the results of that characterization and assesses the potential remedial alternatives. Remedial alternatives have been selected for waste sites mandated for investigation/cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in an EE/CA.

2.1 LIMITED GEOPHYSICAL SURVEYS

Limited geophysical surveys were conducted at three sites on the North Slope from July 27 through August 4, 1992. The objectives were to characterize possible waste disposal sites and to locate areas for further environmental investigation. The geophysical surveys were not intended to delineate the entire disposal area at each site. To meet these objectives, magnetic and electromagnetic induction surveys were conducted in four small areas totaling 5.3 acres at site PSN-04, two areas totaling 20.9 acres at site H-06-H, and one 2.1-acre area at site H-83-L.

Results of the limited geophysical surveys are described in Appendix E. Areas where the surveys indicated trenches and disposal sites were staked and marked. The surfaces of these areas were evaluated for signs of subsidence/stressed vegetation/presence of partially buried debris. Environmental sampling locations were selected as close as possible to the center of the more significant anomalies and near areas of subsidence or stressed vegetation.

2.2 LIMITED ENVIRONMENTAL SAMPLING ACTIVITIES

Operations at Nike missile batteries required assembly, maintenance, and storage of components of military hardware plus handling, disposal, and storage of fuels, cleaners, solvents, hydraulic fluids, and other materials. As with any use of military or industrial hardware, generation of hazardous waste materials was a typical byproduct. Studies of continental U.S. Nike missile batteries completed for the U.S. Army (LETC 1986) to assess hazardous waste contamination potential indicated that the chemicals and materials listed in Table 1 were typically in use at the Nike batteries. Appendix F presents generic background information on the Nike missile program, describes a typical site layout, and presents general information about site operations that might have led to hazardous waste contamination.

Table 1. Potential Contaminants for Nike Sites.

Area Activity	Potential Contaminant
Missile maintenance and assembly area transformer pad	Polychlorinated biphenyls (PCB)
Missile assembly area	Petroleum distillates; chlorinated solvents; alcohols
Missile fueling and warhead area	Unsymmetrical dimethyl hydrazine (UDMH); inhibited red fuming nitric acid (IRFNA); aniline; furfuryl alcohol; ethylene oxide; hydrocarbons such as jet fuel (JP-4)
Missile maintenance and testing	Phosphoric acid; alodine powder; chromium trioxide; sodium dichromate; petroleum distillates; carbon tetrachloride; trichloroethene; trichloroethane; alcohol; acetone; paints containing chromium and lead; missile hydraulic fluid; tricresyl phosphate
General launcher and magazine maintenance	Hydraulic fluid; paints; solvents
Control center operations maintenance	Solvents used for cleaning electrical parts; ethylene glycol
Vehicle maintenance	Petroleum, oils, and lubricants
Facility maintenance	Lead paints; pesticides and herbicides
Utilities	Transformers (PCBs); above and below ground storage tanks used for gasoline or fuel oil; hydraulic fluid
Deactivation	Solvents; fuels; paints; asbestos-containing debris

Regulator approved environmental sampling locations were selected based on this indefinite generic historical information and the results of the limited geophysical surveys. Sampling locations were selected as close as possible to the center of the more significant anomalies identified in the geophysical surveys and near areas of subsidence or stressed vegetation. The bulk of the sampling activities was performed in areas covered by the limited geophysical surveys.

Disposal areas, such as landfills associated with each of the military sites, were assumed to contain similar wastes. The basis for this analogous, and regulatory approved, approach results from similar activities being performed at each of the sites by the same organization at the same time, using the same operational procedures. These types of waste sites include landfills, drywells, and acid neutralization pits. Homestead cisterns were included in the sampling because detailed history on these structures is not available.

If the waste site was considered to be one-of-a-kind or was suspected of being a potential hazardous liquid disposal site, the site was individually sampled. These types of waste sites include drywells and the 2,4-D burial site.

It is important to note that the North Slope has no history of activities which might have resulted in radioactive contamination nor is there reason to suspect the presence of radioactive material as a result of Hanford operations. As described in Appendix F, the presence of low-level radiation due to leakage from Nike Hercules nuclear missiles (which were present at Battery H-06 for a short time) is considered highly unlikely and did not occur to the best of our knowledge. Therefore, the North Slope was exempted from radiological controls in October 1992 in accordance with the radiological release survey. However, field screening for radionuclides will be performed during characterization and remediation.

Table 2 lists areas identified in the original North Slope survey performed in 1989-90 and summarizes the investigative activities performed at each site. Figure 2 shows the location of the more significant sites. Offsite laboratory analytical result and field screening results are provided in Appendix G and H.

2.2.1 Landfills

It is estimated that there are at least 10 landfills associated with the former military installations on the North Slope. The burial grounds in these 10 landfills total approximately 38 acres. The specific contents of the military landfills are unknown. It is probable, based on debris scattered on the surface, that domestic trash and demolition debris were disposed of at these sites. It is possible that the landfills contain quantities of hazardous wastes based on the operational information contained in Appendix F.

Appendix F presents generic background information on the Nike missile program, describes a typical site layout, and presents general information about site operations that might have led to hazardous waste contamination. Therefore, it is possible that the landfills contain quantities of hazardous wastes such as aniline, petroleum distillates, chlorinated solvents such as carbon tetrachloride, trichloroethene, trichloroethane, and perchloroethene, alcohols, inhibited red fuming nitric acid (IRFNA), unsymmetrical dimethyl hydrazene (UMDH), phosphoric acid, alodine powder, chromium oxides, acetone, paints containing chromium and lead, tricresyl phosphate, ethylene glycol, pesticides, herbicides, polychlorinated biphenyls (PCB), and hydraulic fluid.

Table 2. North Slope Military Installations and Suspect Waste Sites. (sheet 1 of 5)

Site number	Description	Investigative activities
Nike Missile Sites		
H-06-C	Radar control site for H-06-L. Concrete foundation pads, leveled area on north side of access road may be disposal area, below site in "saddle" are a few 5- and 55-gal drums and other small quantities of trash.	Visual inspection, transite tile remains on foundation pads. No other environmental hazards identified.[a]
H-06-L	Nike missile launch site. All surface structures leveled (foundations, roadways, parking areas, and drainage structures only remain). One drywell made from metal drum also located at site. Some scattered surface debris. Access to underground rooms partially excavated with exposed rebar.	Drywell was sampled, no environmental hazards identified.[a]
H-12-C	Radar site for Nike missile launch H-12-L. Communication wire leading from site, trench north of site (no evidence of buried material), some paint and lubricant cans, some exposed rebar at building foundations.	No environmental hazards identified in visual inspection.[a]
H-12-L	Nike missile launch site. Concrete foundations, entrance to underground rooms and electrical access port partially excavated, soil depression at northwest corner of site (potential disposal site).	Acid neutralization pit sampled. No environmental hazards identified.[a]
H-81-R	Potential Nike radar site. Concrete footings, large disturbed area at west side of site (potential disposal area), soil berm contains refuse (batteries, bottles, etc.), 55-gal drum buried flush to ground (unknown function).	Visual inspection, significant amount of oil-contaminated soil identified.[a]
H-83-C and Well	Radar site for Nike missile launch H-83-L. Well structure (mostly filled in), small pit containing several hundred rounds of fired 30-06 blank ammunition along with links for belt-fed automatic weapons, tires, small trench west of site (potential disposal area).	Attempted to sample drywells identified in facility drawings. Excavations could not locate structures. No environmental hazards identified.[a]
H-83-L and Well	Nike missile launch site. Buildings removed, well structure, underground launch structures filled in.	Visual inspection, no environmental hazards identified.[a]
Antiaircraft Battery Sites		
PSN-01 and Well (H-01)	Antiaircraft gun site. Well structure, areas south/west/north of site potential disposal areas.	Visual inspection, no environmental hazards identified.[a]
PSN-04 and Well (H-04)	Antiaircraft gun site. Gun sandbag enclosures, well structure, disposal sites southeast of site, cat scars north and south of site, six empty blue plastic 55-gal drums (photographic chemical) east of site.	Visual inspection, no environmental hazards identified.[a]

Table 2. North Slope Military Installations and Suspect Waste Sites. (sheet 2 of 5)

Site number	Description	Investigative activities
Antiaircraft Battery Sites (cont.)		
PSN-07/10 (H-07)	Antiaircraft gun site/headquarters for Nike launch site H-06-L. 55-gal drum, drywell, motor pool grease pit, underground wood structure (3 by 8 ft by 18 in. deep) of unknown use, concrete-lined pit of unknown use, pavement and building foundations, mostly filled in homestead cistern is northwest of site.	Sampled drywell associated with grease pit, no environmental hazards identified.[a]
PSN-72/82 (H-82) and Well	Antiaircraft gun site. Small disposal pits containing oil cans and antiaircraft gun shell packing boxes, two plywood boxes buried flush to ground (one containing empty lubricant cans), 22-caliber firing range at northeast corner of site, gun emplacements and aboveground structures are leveled, and well structure.	No environmental hazards identified in visual inspection.[a]
PSN-80	Barracks area in associated with Nike launch site/antiaircraft gun site. Concrete foundation pads. No obvious disposal pit identified.	No environmental hazards identified in visual inspection.[a]
PSN-12/14 and Well (H-14)	Antiaircraft gun site/barracks area in association with nearby Nike missile site. Small burial site with metal paint cans and metal scraps. A well and well structure are located at the site.	No environmental hazards identified in visual inspection.[a]
PSN-90 and Well (H-90)	Antiaircraft gun site. In-service well, concrete vehicle maintenance ramp, vehicle maintenance building foundations along with other foundations, soil piles with debris in them and scattered surface debris west of the site.	Vehicle maintenance ramp demolished in August 1992, partial removal of oil-saturated soils. Sampled oil dump site. No other environmental hazards identified.[a]
Disposal Areas		
H-06 Disposal Area	About 8 acres in size. Disturbance of soil is apparent. Debris on surface includes paint cans, construction materials, asbestos siding, asbestos brake pad. This disposal area was thought to also be part of PSN-07/10 when active.	Limited geophysical survey and limited landfill sampling performed. No environmental hazards other than asbestos materials identified.[a]
H-12 Disposal Area	Approximately 5 acres in size. Limited debris on surface. Disturbance of soil is apparent.	Visual inspection, no environmental hazards identified.[a]
H-83 Disposal Area	Potential disposal area east of H-83-L and C. Appears to be 5 acres in size. Approximately 50 acres has a large amount of trash scattered over it.	Limited geophysical survey and limited landfill sampling performed. No environmental hazards identified.[a]
PSN-01 Disposal Area	Potential disposal areas located to the south, west, and north of PSN-01. Assume total landfill areas are approximately 3 acres in size.	Visual inspection, no environmental hazards identified.[a]

Table 2. North Slope Military Installations and Suspect Waste Sites. (sheet 3 of 5)

Site number	Description	Investigative activities
Disposal Areas (cont.)		
PSN-04 Disposal Area	Located southeast of PSN-04, approximately 3 acres in size. Debris, including wood and metal, are scattered over the surface.	Limited geophysical survey and limited landfill sampling performed. No environmental hazards identified.[a]
PSN-12/14 Disposal Area	Disposal area is located southeast of PSN-12/14. The site is approximately 3 acres in size. A portion of the landfill contents has been exposed because of blow-out conditions. Exposed debris included standard domestic garbage, a wringer washing machine, a water tank and heater, and packing tubes for 120-mm antiaircraft projectiles.	Visual inspection, no environmental hazards identified.[a]
PSN-72/82 Disposal Area	Disposal areas located north and south of PSN-72/82. Total surface area of landfills is approximately 3 acres. Debris on surface of area includes empty oil and paint cans, communication type wire, and demolition debris.	Visual inspection, no environmental hazards identified.[a]
PSN-90 Disposal Area	Contains tent parts, electronic equipment, auto parts, several small pits (some with debris in them, and one had sand bags around perimeter). Disposal area is approximately 3 acres in size.	Visual inspection, no environmental hazards identified.[a]
Bridge Disposal Area	Located in saddle of hill overlooking Vernita Bridge. Area of a demolished building location or dump of probable military origin. Consists of three or four wood frame structures, metal roofing, window screen, railroad ties, oil cans, personal items (tooth brushes, razors), bottles, cans. Disposal area is approximately 3 acres.	Visual inspection, no environmental hazards identified.[a]
Military Construction Dump	Located 2/3 mi north and east of military site PSN 12/14. Demolished wooden buildings, construction debris, lubricant cans, auto parts (greatest concentration scattered over 2-acre area).	Visual inspection, no surface or environmental hazards identified.[a]
Miscellaneous Military Sites		
Asbestos Pipe Site Disposal Area	Sand blowout containing concrete/asbestos pipe and other debris located southeast of Nike launch site H-12-L.	Only asbestos identified in visual inspection.
Igloo Site	Ordnance storage site. Building removed, area generally clean except for several broken boxes that once contained 120-mm antiaircraft projectiles.	No environmental hazards identified in visual inspection.
Land Mine Site (PSN-07/10)	Two deteriorated metal practice antitank land mines were found just southwest of PSN-07/10.	Land mines were removed in 1989 by the U.S. Army Yakima Firing Center.

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Table 2. North Slope Military Installations and Suspect Waste Sites. (sheet 4 of 5)

Site number	Description	Investigative activities
Miscellaneous Military Sites (cont.)		
Underground Wood Room Site	Located southeast of PSN-04. Site consists of three underground wooden rooms (probable military origin, one room demolished), northwest of each room is a set of concrete pads, probably used for radar or guns	Entry prohibited for safety reasons. Animal carcass identified in visual inspection. No environmental hazards identified.
Hanford Firing Range	Site is an area used by early Hanford Site security forces. 55-gal drums present with holes made from 30- and 50-caliber small arms and 37-mm ordnance. A nearby trench contained metal boxes for 50-caliber rounds, 50-caliber brass, links from 50-caliber machine gun belts, and packing tubes for 37-mm rounds. Spent ammunition slugs found.	Area investigated by ordnance teams. No unexploded ordnance or environmental hazards identified.
Antiaircraft Gun Shrapnel Sites	Three known separate areas containing shrapnel from antiaircraft gun firing. Shrapnel consists of iron fragments and aluminum or magnesium fuze ring pieces.	Visual and ordnance inspection. No hazards identified.
Asphalt Batch Plant Site	Graveled area approximately 2 acres in size. Several small piles of asphalt and gravel are present, along with a pile of concrete and two pits with no apparent trash.	Visual inspection, no environmental hazards identified.
Coyote Bait Can	5-gal military type container with "Bait Can" written on it. Contents at bottom of can appear to be oily. Also, an anchor stake for a leg-hole trap is nearby, along with a 5-gal fuel-type can.	Visual inspection, no environmental hazards identified.
Coyote Bait Station	Area of approximately 10 acres strewn with animal bones (coyote skulls and large animal bones). Bones appear to be old.	Visual inspection, no environmental hazards identified.
Gravel Pit #47	Two apparently active gravel pits. Smaller pit has trash in it consisting of cans, bottles, fencing wire, wire spools, two military paint cans, and an oil can.	Visual inspection, significant amount of oil-contaminated soil identified.
Gravel Pit #56	Consists of several pits but no signs of trash disposal except for some military communication wire.	Visual inspection, no environmental hazards identified.
Miscellaneous Nonmilitary Sites		
2,4-D Burial Site	Buried 2,4-D-contaminated soil and associated crushed empty tanks. Buried at the foot of a dune 1966-1967.	Site sampled, no environmental hazards identified.
Homestead Cisterns	Nine known cisterns consisting of circular concrete-lined pits. Largest is 8 ft across and 14 ft deep. Three cisterns are filled in with soil. Others have wood debris, wire, homestead trash (cans), or more recent trash consisting of oil cans, glass bottles, pesticide cans, paint cans, beverage containers, etc.	Field screening and offsite laboratory samples taken from two of the structures. No environmental hazards identified.

Table 2. North Slope Military Installations and Suspect Waste Sites. (sheet 5 of 5)

Site number	Description	Investigative activities
Miscellaneous Nonmilitary Sites (cont.)		
Stock Tank and Well Site	Consists of a barbed wire corral and a 12- by 12- by 4-ft concrete stock tank. Tank top is 2 ft aboveground. A cased well is north of tank. Well construction data are not available, but is assumed to be similar to army wells in construction. Scattered debris found.	Visual inspection identified no environmental hazards.
Dune Homestead	Domestic trash disposal area southwest of trees; building locations nearby.	No environmental hazards visually identified.
Lonetree Homestead	Consists of one live cherry tree and several dead trees. No aboveground structures. Scattered debris and a wagon road identified.	No environmental hazards visually identified.
Wahluke Schoolhouse	Consists of concrete steps from former schoolhouse.	Visual inspection, no environmental hazards identified.

[a]Even though visual inspection and limited environmental sampling identified no environmental hazards, Table 1 indicates a "potential" for environmental contamination exists.

Limited vehicle maintenance activities may have contributed used motor oil to the landfills. Demolition wastes likely include asbestos-based materials such as transite. Limited environmental sampling activities conducted at the landfill locations were performed using an analogous approach. One Nike missile position (H-83), one antiaircraft position (PSN-04), and one combination Nike/antiaircraft (H-06) landfill were selected for investigation. Landfill trench locations at each of these sites were determined by the geophysical surveys (Appendix E, Figures E-1 through E-7). The survey areas were determined based on surface characteristics such as stressed vegetation, subsidence, and surface and partially buried debris. The complete results of these surveys are documented (WHC 1992b) and summarized in Appendix E.

Areas where the geophysical surveys (including magnetic and electromagnetic induction surveys) indicated trenches and disposal sites were staked and marked. The surface of these areas were evaluated for signs of subsidence/stressed vegetation/presence of partially buried debris. Sampling locations were selected as close as possible to the center of the more significant anomalies and near areas of subsidence or stressed vegetation.

A hollow-stem auger rig was used to obtain the samples. Cuttings from the auger were screened for organic vapors at 2-ft intervals using an organic vapor monitor (OVM). Debris associated with the cuttings included wood, metal drums and cans, and transite.

Field screening was used extensively to determine the exact scope of sampling at each location. Screening samples were taken at approximately the 6- and 10-ft levels (bottom of the landfill was estimated to be 9 to 11 ft). At least one sample per anomaly (area where the geophysics indicate a the possible presence of a buried object) was taken for analysis at an offsite laboratory.

Field screening analysis routinely included pH, heavy metals, and volatile organic compounds depending on characteristics of the sample (i.e., color and OVM readings). Offsite laboratory analysis included volatile and semivolatile analysis; pesticide/herbicide, and PCB analysis; inductively coupled plasma (ICP) and atomic absorption (AA) metals (including mercury) analysis; and anions, chrome VI, total petroleum hydrocarbons, and total activity analysis.

A total of 32 samples from 45 auguring locations were taken from the three landfills for analysis at offsite laboratories (Table 3 and Appendix E, Figures E-1 through E-7). This includes 6 samples from Nike position H-83, 14 from Nike position H-06, from antiaircraft position PSN-04, and 6 quality assurance/quality control samples (taken from the three sites). A total of 90 field screening samples were also taken during this effort (two per auger boring).

No areas of contamination above Model Toxics Control Act (MTCA), Method A, (WAC 173-340) regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

2.2.2 Drywells

Field investigations and historical drawings indicated the presence of six drywells used in support of the military positions on the North Slope. The specific uses of these dry wells could not be determined.

Two drywells, described on a construction drawing for H-83-C, could not be located in the field. Geophysical surveys performed in the vicinity were not successful in explicitly locating the structures. They did identify two areas that exhibited stronger feedback signals than the surrounding area, which were later investigated with a backhoe. The excavation did not reveal drywells, but rather areas with extensive demolition debris as was typical of the surrounding area.

2.2.2.1 H-81-R Drywell. This drywell is located at H-81-R, a site that was thought to contain a radar system used in conjunction with the Nike missile batteries. The drywell was constructed using a metal drum buried flush to the ground. The lid of the drum had several holes punched through it. Soil was contained inside of the drum at a depth of 2.5 ft from the top of the drum to the soil surface.

A hollow-stem auger was used to drill down the center of the drywell through the bottom of the drum. At the -4-ft level, a material resembling asphalt was encountered. A sample of this material was collected for field analysis (aqueous headspace volatile organic analysis using gas chromatograph).

Table 3. Military Landfill Offsite Laboratory Sampling Summary.

Auger Sample Site	Type of Analyses[a]
H-83-L/A-1-3	SW-846
H-83-L/A-2-2	SW-846
H-83-L/A-2-3	CLP
H-83-L/A-3-2	CLP
H-83-L/A-3-3	SW-846
H-83-L/A-4-1	CLP
H-04(W)/A-1-2	SW-846
H-04(W)/A-1-3	CLP
H-04(W)/A-2-2	SW-846
H-04(W)/A-3-1	SW-846
H-04(E)/A-1-1	SW-846
H-04(E)/A-1-2	CLP
H-06-H(W)/A-2-2	SW-846
H-06-H(W)/A-5-2	SW-846
H-06-H(W)/A-5-5	CLP
H-06-H(W)/A-7-1	SW-846
H-06-H(W)/A-16-1	SW-846
H-06-H(W)/A-19-2	SW-846
H-06-H(W)/A-19-3	CLP
H-06-H(E)/A-2-1	SW-846
H-06-H(E)/A-6-4	SW-846
H-06-H(E)/A-7-1	SW-846
H-06-H(E)/A-11-1	CLP
H-06-H(E)/A-11-2	SW-SW-846
H-06-H(E)/A-12-1	CLP
H-06-H(E)/A-12-2	SW-846

[a](EPA 1986, 1990a,b).

A split-spoon sampler was then used to collect a soil sample from the -4 to -6 ft level. Native soils were encountered approximately 5 ft below the surface. The soil sample was sent to a qualified offsite laboratory for analysis using Contract Laboratory Program (CLP) protocol (EPA 1990a,b) for volatile organics, semivolatile organics, PCB/pesticides, phosphorus pesticides, herbicides, ICP metals, AA metals (arsenic, lead, selenium, thallium), mercury, anions, chrome VI, and total petroleum hydrocarbons. A sample was also collected for determining volatile organics using EPA field analysis methods (EPA 1986).

Sample analysis indicated an increased level of total petroleum hydrocarbons. The increase of hydrocarbons may be a result of the asphalt found at the -4-ft level. Sample results are contained in Appendices G and H.

2.2.2.2 H-06-L-1 Drywell. This drywell consists of a metal drum buried on the west perimeter of Nike missile launch site H-06-L. Soil/debris was located at 1.25 to 1.8 ft from the surface. An 8-in.-diameter hole is cut into side of drum at the 4.5-in. depth.

A hollow-stem auger was used to drill inside the drum starting at the soil/debris surface. The bottom of the drum was encountered at the 3-ft level. A 6-in.-diameter transite pipe entered the side of the drum at this level. A split-spoon soil sampler was then used to collect soil from the 3- to 5-ft level. The sample consisted of 60 to 70% crushed gravel and 30 to 40% fines (typical of the surrounding area). The material appeared to be dry. The material was analyzed using field analysis.

A sample was then collected for analysis at a qualified offsite laboratory and using field methods from 4 in. above the bottom of drum, near the opening of the transite pipe. The soil sample collected from this site was analyzed per CLP protocol for volatile organics, semivolatile organics, PCB/pesticides, phosphorus pesticides, herbicides, ICP metals, AA metals, mercury, anions, chrome VI, and total petroleum hydrocarbons. No areas of contamination above regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

2.2.2.3 H-06-L-2 Drywell. This drywell is a 12- by 10- by 15-ft, rock-filled pit (as described in construction information drawings) used to dispose of rainwater from the missile storage area at Nike missile launch site H-06-L. A 6-in. drainpipe routed the liquid to the drywell. At the supposed location (per construction drawings) of the drywell is a depression in the soil. It is possible this structure was used to dispose of unknown liquid. The soil depression was sampled.

Hollow-stem auguring was performed at center of drywell site. Based on soil matrix resistance of the auger, a probable gravel layer was encountered at the 13-ft level. A field analysis soil sample and a sample for offsite analysis were taken from the 8-ft and 13.5- to 15.5-ft level.

The soil sample collected from this site was analyzed at an offsite laboratory per CLP protocol for volatile organics, semivolatile organics, PCB/pesticides, phosphorus pesticides, herbicides, ICP metals, AA metals, mercury, anions, chrome VI, and total petroleum hydrocarbons.

No areas of contamination above regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

2.2.2.4 H-07-H Drywell. This drywell consists of two metal drums welded one on top of the other, buried vertically with the top almost flush with the surrounding ground surface. A 5-in.-diameter pipe entered the drum at the 2.5-ft level. The pipe came from the direction of what construction drawings indicate was a wash rack associated with a vehicle repair shop at Nike launch site H-07-H. The depth from the top of the drywell to soil was approximately 3.8 ft. Originally, this site was to be investigated using a hollow-stem auger and split-spoon sampler. During augering, river cobble was encountered at the 1-ft level that eventually prevented further operation of the auger. It was decided to utilize a backhoe to excavate the drywell and sample at the cobble/soil interface.

During excavation of this drywell, another 5-in.-diameter pipe, buried approximately 2.5 ft deep was uncovered. This pipe was not connected to the to the drywell, but ran in-line with the pipe that was connected to the drywell. The end of this pipe was located 7 ft from the actual drywell in the cobble material. A third pipe was uncovered that ran north northeast/south southeast. Again, this pipe was not connected to the drywell but ended with the cobble material about 5 ft from the side of the drums.

The drywell was excavated to a depth of 16 ft, where the soil/cobble interface was located. A soil sample was collected from the backhoe bucket for field analysis. A sample was also collected for analysis at an offsite laboratory per CLP protocol for volatile organics, semivolatile organics, PCB/pesticides, phosphorus pesticides, herbicides, ICP metals, AA metals, mercury, anions, chrome VI, and total petroleum hydrocarbons. The drywell and attached metal pipe were removed from the excavation to allow for sampling. No areas of contamination above regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

2.2.3 Acid Neutralization Pits

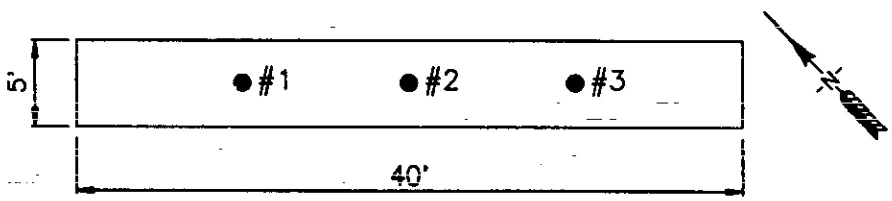
These structures, located at the Nike missile launch sites, were used to dispose of soda solutions used to neutralize residual IRFNA contained in hoses used in missile fueling/defueling operations. The pits would also receive any IRFNA spilled during these activities. Historical interviews indicate that no spills were known to have occurred, and the neutralization pit was not used for disposal purposes.

Using the analogous site approach, only one pit was investigated. Facility drawings for the Nike sites were used to locate the pits. One pit was identified at each of the three Nike missile positions. Field investigations were unable to positively locate the pit at Nike missile position H-06-L however. A pit was located and, consequently, investigated at position H-12-L. The pit at position H-83-L was not sampled.

The pit at H-12-L is 5 ft wide by 40 ft long and constructed into a 1-ft-thick concrete pad located in the missile fueling area. Field investigations indicated the pit was excavated to a depth of approximately 4 ft and backfilled with pea gravel. A backhoe was used to investigate three locations along the length of the pit.

Samples were taken within the pit at the native soil (sand/silt) and pea gravel interface. A map of the sample locations is provided in Figure 3. The samples were field screened for pH. The pH of samples 1 and 2 was approximately 6.5, while sample 3 was 5.9 to 6.2. Soil samples taken from locations 2 and 3 were sent for analysis at a offsite laboratory. The offsite soil samples were analyzed one per CLP (EPA 1990a,b) and one per RCRA (EPA 1986) protocol for ICP/AA metals and anions. No areas of contamination above regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

Figure 3. H-12-L Acid Neutralization Pit.
(overhead view of sample locations)



2.2.4 Concrete Grease Ramp

A concrete grease ramp, originally constructed for maintenance of military vehicles was dismantled in August 1992 during site investigation activities. The ramp, located at antiaircraft site PSN-90, was being utilized by the public for performing oil changes on their vehicles. As a result, used motor oil was disposed on the ground beneath the ramp.

An area approximately 15 by 24 ft of obviously contaminated soil was excavated to a depth ranging from 0 to 8 in. The contaminated soil was placed into five, plastic-lined 55-gal drums. Additional contaminated material was placed onto a sheet of plastic. This material will be properly disposed of during implementation of the ERA.

Samples were taken from the bottom of the excavation, from the drummed material, and from just outside of the excavation boundary. Field analyses for volatile organics using gas chromatograph and for total petroleum hydrocarbons (TPH) (using immunoassay kit) were performed on these samples. Sample analysis indicated an increased level of TPH in the materials that were removed and in the materials remaining in the excavation (Table 4). No other contaminants were detected. The immunoassay kit results are as follows:

- drummed material - 100 to 1,000 ppm TPH
- bottom of excavation - <100 ppm TPH
- outside of excavation - <100 ppm TPH
- composite sample from excavation - >100 ppm TPH.

Table 4. Grease Ramp Sample Analysis Results.

Sample Location	Sample Number	Analytical Protocol	TPH, $\mu g/g$	Lead-AA, $\mu g/g$	Phorphorus-ICP, $\mu g/g$
Drummed material	B07KR9	SW-846	60,000	1,200	890
	B07KS0	SW-846	65,000	760	860
Bottom of excavation	B07KS1	SW-846	940	120	760
	B07KS2	CLP	1,700	N/A	1,430

Two representative samples were collected from the drums for waste designation using SW-846 protocol for TPH and ICP/AA metals. Two additional soil samples were collected from the scraped area for offsite analysis for TPH, and ICP/AA metals per EPA protocols (1986, 1990a,b). Sample results are summarized in Table 4 and contained in Appendices G and H.

2.2.5 Ordnance and Explosive Waste

Ordnance and explosive waste (OEW) is a form of contamination that presents imminent hazards to exposed individuals. It is typically unique to military operations in that the material comprising the contamination was munitions or munitions related and generally designed to do damage to enemy personnel or material.

Thorough recordkeeping of ordnance usage was not an enforced requirement until recent decades. Very few of the older sites, such as Hanford, have accurate logs of what types of ordnance were used, where they were used, or how and where disposal of OEW took place. Even in cases where a previous attempt was made to clean up OEW at a facility, the remedial action generally produced only cursory records and few maps showing what was found where and generally performed only a surface cleanup.

Prior to about 1970, land burial of unneeded/unused OEW was an accepted practice at remote locations throughout the United States. If a facility handled OEW at some time in the past, there is a good possibility that there are some OEW burial pits at the site. In support of this premise, interviews with former personnel assigned to the North Slope military sites indicate that OEW may have been disposed of in burial pits throughout the area. Conversely, other personnel have indicated that this disposal practice was very unlikely. Since the North Slope was once home to seven antiaircraft batteries and a firing range, the possibility still remains that the North Slope may be contaminated with subsurface OEW in these burial pits. It is unknown if the "possible" burial pits are separate entities or part of the landfills associated with each antiaircraft battery.

In addition to the possibility that OEW may exist in burial pits, unexploded ordnance (UXO) may exist as well. The use of small arms (30- and 50-caliber), high trajectory fuzed (37- and 120-mm) projectiles, and other ordnance in training exercises is evident at four sites on the North Slope. Shrapnel from 120-mm antiaircraft projectiles has been found in the "Shrapnel Area." It is unknown if the shrapnel originated from live or practice rounds. Empty 120-mm packing tubes have been found on the surface of the disposal area at site PSN 12/14. Empty 37-mm packing tubes have been found on the Hanford Firing Range along with evidence that 37-mm guns have been fired (punctured 55-gal drums). Two deteriorated metal practice landmines were found at site PSN 07/10 and removed by military authorities.

The Shrapnel Area, the Hanford Firing Range, and site PSN 07/10 were investigated by personnel from the U.S. Army Explosive Ordnance Detachment (EOD), Department of the Army, 53rd Ordnance Detachment, Yakima Firing Center, with assistance from the Hanford Site Patrol in the fall of 1989. The EOD performed a limited records search, conducted personal interviews, and completed walk-through surveys of the areas, sweeping the areas with magnetometers. No surface or subsurface OEW or UXO was located during this cursory investigation. It should be mentioned that none of the landfills were investigated for OEW during this search.

In view of the contradictory burial pit information and the fact that ordnance debris has been found at the four sites described above, it is prudent to assume worst case that OEW and UXO hazards may still exist on the North Slope. Therefore, in November 1993, the U.S. Army Corps of Engineers commenced a complete three-phased ordnance survey of the North Slope to determine if any OEW or UXO hazards still remain.

Phase 1 of the survey was a comprehensive record and archives search that was performed at various military records depositories throughout the country. From this archives search, the U.S. Army Corps of Engineers will be able to make informed decisions about the OEW threat a site poses, the need for further investigation, and identify other OEW threat areas.

The following describes preliminary findings of the North Slope archives search. It is emphasized that the archives search is far from complete, so these findings are preliminary and should not be construed as final.

These findings incorporate information gathered during the period of November 15, 1993 through January 7, 1994. During this period, onsite visits to the North Slope area were completed. In addition to the onsite visits, records stored at the following locations were reviewed and or duplicated for additional research:

- University of Washington, Richland Extension, Library
- WHC Environmental Resources Library
- Richland Public Library
- Pacific Northwest Laboratory

- U.S. Army Corps of Engineers, Seattle District
- U.S. Army Corps of Engineers, Huntsville Division
- National Archives - Pacific Northwest Region
- National Archives - Washington, D.C.
- National Archives - Suitland References Branch.

In addition to the records centers noted, interviews with individuals having general or specific knowledge of the history of the Hanford site have been conducted. To date, over 50 individuals, including veterans who served onsite and current WHC, PNL, DOE, and national archives historians, have been interviewed. Interviews have also been conducted with other interested parties including long-time residents of the Hanford area, Manhattan Project historians and specialists, and scientists who have conducted extensive research on the Hanford Site.

Based on the preliminary information obtained from interviews and reviews of the records noted above, the potential for OEW contamination appears to exist on the North Slope.

The following preliminary information is presented regarding ordnance-related activities on the North Slope:

- In 1948, the Sixth Army Commanding General determined that air defense of the Hanford Site was required because of the increased role of the site in nuclear weapons production following World War II. In 1948, the U.S. Army reactivated the 5th Antiaircraft Artillery (AAA) Group at Fort Bliss, Texas.

- In December 1949, the 5th AAA Group was moved to Fort Lewis, Washington. The 5th AAA Group consisted of the 501st, 518th, and 519th AAA Gun Battalions, the 15th AAA Automatic Weapons Battalion, and the 501st Operations Detachment. The 501st, 518th, and 519th AAA Battalions were identified as 120-mm semimobile antiaircraft gun battalions. The 15th AAA Automatic Weapons Battalion was identified as a self-propelled automatic weapons antiaircraft battalion.

- In March 1950, the 5th AAA Group was reassigned to Camp Hanford, Washington, to provide air defense of the Hanford Engineer Works. Prior to the move to Camp Hanford in March 1950, the 15th AAA Automatic Weapons Battalion was reassigned to Fort Lewis and not assigned to Camp Hanford. On March 18, 1950, "C" Battery of the 518th AAA Gun Battalion was ready for action.

- During the period 1950 through 1952, the 5th AAA Group mobilized several times to the Yakima Firing Center to conduct firing training using the 120-mm guns. Because of the ongoing mission at Hanford, not all of the guns would be moved to Yakima Firing Center.

No firing training was conducted at the Hanford Site; however, the guns were fired for other reasons at the site. The guns were fired onsite after having mobilized for a training session at Yakima Firing Center. After return to Hanford, the guns would be remounted at their respective battery locations and would then fire a single "settling" round per gun. The purpose of the settling round was to ensure that the gun had been properly installed and leveled at its battery location.

After the settling round, the guns usually fired four to five "calibration" rounds and a single "verification" round. Each round of fire was conducted on one gun at a time and one round of ammunition at a time. No additional firings of the guns were conducted until the previous burst was observed. On those occasions where a burst was not observed, the approximate impact are of the dud was noted. Following completion of calibration firing, U.S. Army EOD personnel searched the probable impact area for evidence of the dud. In those few cases recorded of duds, no evidence of the unexploded rounds were found. In addition to the occasional firing of the guns, each gun battery had onsite storage of ammunition. Most ammunition storage was aboveground, however, some of the batteries had belowground storage. Ammunition storage included 120-mm projectiles and propellant, .30- and .50-caliber machine gun ammunition, rifle and pistol ammunition, 3.5-in. rockets and hand grenades.

According to the 59th AAA Gun Battalion Command Report, dated 1952, only "D" Battery had rockets and rocket launchers as part of its arsenal. Apparently none of the other battalions or batteries noted the use or storage of the rocket and rocket launcher types of munitions.

Interviews conducted by others of some veterans and other key site personnel uncovered rumors of buried truckloads of munitions. Investigations conducted by U.S. Army EOD and WHC personnel apparently have not been able to confirm these rumors. One possible explanation for the source of these rumors was identified during the archives search. Photographs of the gun batteries and supporting equipment were found showing vehicles entrenched in "foxholes." The foxholes were covered with tarpaulins and surrounded with sandbags, probably to protect the vehicles in case of an air attack.

In summary, based on the archives search and interviews conducted to date, the greatest potential for unexploded ordnance exists in areas of the North Slope. At least two duds were noted in records reviewed during this study. Searches conducted by U.S. Army EOD personnel following the dud firings failed to find the unexploded rounds. Research is continuing to identify additional records of dud rounds and to identify the most likely impact areas of the dud rounds.

Appendix I presents general information as to the reasons for the potential for OEW contamination on the North Slope, defines OEW and UXO, compares OEW contamination with hazardous waste contamination, and discusses OEW/UXO disposal techniques.

2.2.6 2,4-D Disposal Site

The 2,4-D burial site is located approximately 0.5 mi east of the Columbia River across from and south of the old White Bluffs townsite at the toe of an encroaching sand dune, which is over 60 ft in height. The disposal area is approximately 400 by 60 ft in size and is posted on the northern and southern ends of the burial site. The signs read "2,4-D Burial Site, June 1966." The site is approximately 700 ft above sea level (350 ft above the Columbia River). Groundwater is over 300 ft below grade with the nearest drinking water source located over 3 mi to the east.

The site was used in 1966 to dispose of 2,4-D-contaminated soil generated from leaking storage tanks located at a U.S. Bureau of Reclamation Station in Eltopia, Washington. The leaking tanks were taken out of service, emptied, crushed and then disposed of at the site in 1967. As a result of this disposal technique, only residual amounts of 2,4-D would have been disposed of within the tanks themselves.

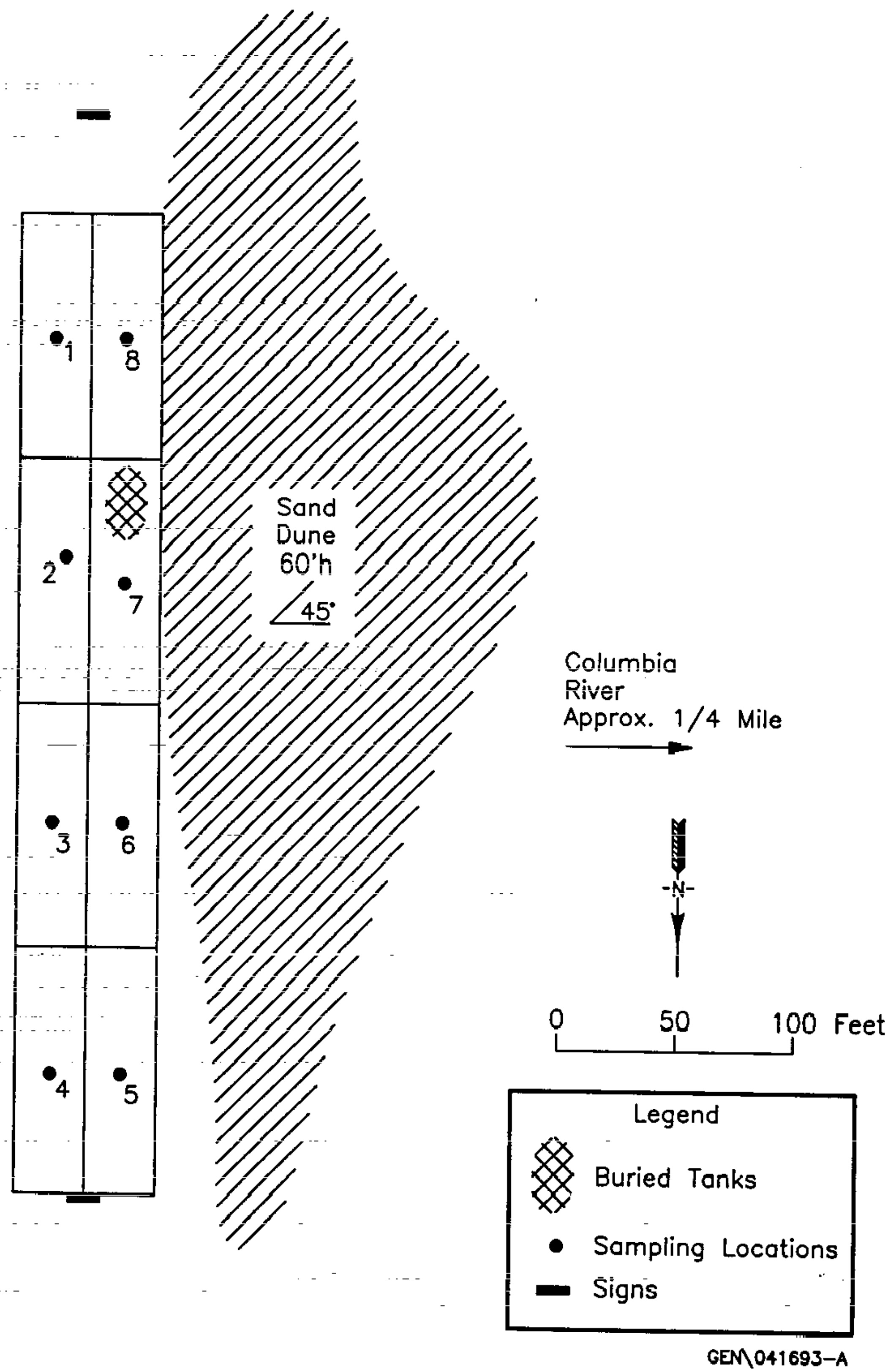
2,4-D was used as a commercial herbicide. 2,4-D is one of the only herbicides that is able to be metabolized by bacteria (Appendix J). The breakdown takes approximately 30 days. Additional information indicates a typical 2,4-D half-life of 9.4 to 254 days under dry conditions (Howard 1991). The area was not used for 2,4-D disposal after 1967. The sand dune and disposal site have since stabilized with cheatgrass and sage.

The Waste Information Data System (WIDS) database (WHC 1991) indicates that approximately 50 yd^3 of soil containing 900 gal of 2,4-D were disposed of at the site (a relatively small volume of soil when compared with the areal extent of the site), 4 ft below grade. Discussions with personnel from the U.S. Bureau of Reclamation indicate that the 2,4-D tanks were flattened and disposed of over the 2,4-D-contaminated soil. This would indicate that the soil was buried significantly deeper than the 4 ft indicated in WIDS. There should be no traces of the herbicide remaining as the 2,4-D was disposed of over 26 yr ago (well over 10 half lives).

Prior to performing sampling activities, a magnetometer was used to verify the presence and location of the tanks disposed of at the site.

An auger rig was used to obtain soil samples from eight locations within the boundaries of the disposal site (Figure 4). Auger cuttings were predominantly a fine sand typical of the surrounding geology. Drilling indicated that the disturbed material-native material interface is at approximately 13 to 15 ft below the surface. A readily evident soil moisture horizon was located 3 to 5 ft below grade.

Figure 4. 2-4,D Burial Ground Sampling Location.



Samples were obtained from the 13- to 15-ft depths at each of these locations using a split-tube sampler. Each sample set consisted of a 60-mL amber glass bottle for total activity analysis, a 250-mL amber glass bottle for offsite laboratory analysis (if required), and a field screening sample. The 250-mL sample was sent offsite for analysis only if field screening indicated the presence of 2,4-D.

A 2,4-D field screening test kit was used to analyze for 2,4-D at each of the sampling locations. The results of this test indicated the presence of 2,4-D at sampling location #8. The test indicated the presence of 2,4-D at approximately 2 ppm, which is near the detection limit of the field test kit. However, 2,4-D was not detected in subsequent field runs of the analysis. A sample from this location was sent to an offsite laboratory for confirmatory analysis under CLP protocol. The offsite laboratory did not report any 2,4-D.

An additional field screening sample was taken at location #7 from the 6-ft level as clay "globules" were seen in the cuttings. Field analysis did not indicate the presence of 2,4-D. Two composite samples (one consisting of soils from locations 1, 2, 3, and 4 and one from locations 5, 6, and 7) were also sent for analysis at an offsite laboratory.

No areas of contamination above regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

2.2.7 Homestead Cisterns

Significant amounts of soil and debris are located in the bottom of the seven cisterns located on the North Slope. The possibility exits that the pits may have been used in the disposal of pesticides or oil as empty product containers can be found in several of the cisterns. Due to the remote locations of the cisterns, the disposal of significant quantities is unlikely. Three of the cisterns exhibiting the greatest potential for having contamination were characterized. A visual inspection of the remaining four cisterns was also completed.

No areas of contamination above regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

2.2.7.1 Clay Pit Cistern. The clay pit cistern is a circular, concrete-lined pit located north east of Nike position H-06-L (see Figure 2). The cistern was filled with water due to melted snow. This site was investigated because of the presence of pesticide and oil containers. The cistern is approximately 5 ft 6 in. deep by 5 ft in width. The water was within 1 ft 6 in. from the top with sediments located 1 ft below the water surface.

Utilizing a hand bucket auger, an attempt to collect a sediment sample was made. The sample material could not be retained in the auger due to excessive amounts of water in the sediments being sampled. An attempt was made several times to collect sufficient material for an offsite soil sample, but was unsuccessful. Enough soil was collected for field analysis. The trash removed from the cistern included transmission oil cans, motor oil cans, cattle pesticide containers, beverage containers, aerosol cans, coffee cans, food cans, and an oil filter. Field screening did not indicate the presences of any environmental contaminants.

2.2.7.2 Cow Camp Cistern. This cistern is approximately 4 ft 8 in. in diameter. The depth of the cistern could not be determined due to extensive amounts of debris located 2 ft below the top. The cistern was characterized because of the presence of large quantities of debris including rusted metal, light bulbs, beverage bottles, livestock pesticide containers, electrical components, wood, and food containers.

A shovel was used to attempt to remove the debris so a soil sample could be obtained. The trash continued to a level below the reach of the shovel however. No soil could be collected for analysis at an offsite laboratory. A small volume of soil containing small pieces of rusted metal was collected for field screening analysis. Field screening did not indicate the presences of any environmental contaminants.

2.2.7.3 Homestead Cistern. The homestead cistern is approximately 5 ft 6 in. across. Soil and debris are located approximately 4 ft below the surface. The debris in the bottom of the cistern appears to be homestead-associated food containers. A hand auger was used to collect a sample of the cistern sediments at two co-located spots. The sample was sent to an offsite laboratory for analysis per CLP protocol.

Analytes included semivolatile organics, PCB/pesticides, phosphorus pesticides, herbicides, ICP metals (using CLP routine analytical services for inorganics), AA metals (specifically for arsenic, lead, selenium, and thallium), mercury, anions, chrome VI, and TPH. Volatile organic compounds were not anticipated and field screening (using a flame-ionization detector) did not indicate the presence of any volatile organics so no offsite analysis was performed. TPH analysis (EPA 1986, Method 418.1) was performed since the field screening method does not detect the heavier petroleum hydrocarbons.

No areas of contamination above regulatory limits were detected as a result of the sampling effort. Sample results are contained in Appendices G and H.

2.2.7.4 Stock Tank and Well/Wagon Road Cistern/12-3 Cistern/Overlook Cistern. These four homestead sites were each inspected for potential environmental hazards. These four cisterns range is size from 6 to 8 ft in diameter by 6 to 14 ft in depth. The cistern bottoms were relatively free of debris with the exception of wood. No unusual discolorations were noted. No identifiable environmental hazards were observed. Therefore, soil sampling was not warranted.

2.3 FLORA AND FAUNA SURVEY

A flora and fauna survey was performed in each area where ground disturbance will likely occur (Appendix K). The purpose of the survey was to identify any threatened or endangered species of wildlife or plants or species of special concern that might occur in the work areas and to identify ways to minimize impacts to these species. No federally listed species were observed, although two candidate species, the loggerhead shrike and Swainson's hawk, were observed. Both of these species are known to nest at some of the cleanup sites. Because the survey was performed at a time of year when many plant species are not readily identifiable and many wildlife species have moved out of the area, followup surveys will be performed at sites to be cleaned up after February 1994. Cleanup activities at sites where there are or may be active raptor nests will be scheduled for either before or after the birds' nesting activities occur. Remedial actions can be conducted from August to February with little or no impact on these species.

In addition to the flora and fauna survey, a biological assessment was prepared to identify the impacts of the cleanup activities on any federally listed species that might be found in the project area. The U.S. Fish and Wildlife Service identified two listed species, the bald eagle and the peregrine falcon, and five candidate species, the ferruginous hawk, western sage grouse, loggerhead shrike, Columbia yellowcress, and Columbia milkvetch, as potentially occurring in the project area. The biological assessment concluded there would be no effect on any of these species. Bald eagles and peregrine falcons winter along the Columbia River, but no cleanup activities will be occurring along or near the river. Bald eagles have attempted to nest at Hanford, but the nest sites are greater than one-half mile away from any cleanup site. Only one inactive ferruginous hawk nest site has been identified on the North Slope and it is not located near any of the cleanup sites. There are no confirmed sightings of sage grouse on the North Slope and cleanup activities are not near any known leks. Disturbance of sagebrush will be kept to a minimum to avoid impacting potential sage grouse habitat. Loggerhead shrikes nest throughout Hanford and a known nest site is at PSN-72/82. Cleanup activities will not destroy the trees and shrubs used by the shrikes and will be scheduled to avoid nesting areas between May and mid-July. The Columbia yellowcress is a wetland plant found along the shoreline of the Columbia River. Since no cleanup sites are near the river, this plant will not be affected. The Columbia milkvetch has not been identified on the North Slope and was not identified in the flora and fauna survey.

Disturbances to existing vegetation will be kept to a minimum to protect the fragile shrub-steppe habitat. Vehicles will be required to remain on existing roads or on designated tracks to minimize trampling of vegetation. As much necessary off-road driving as possible will be scheduled during the August-to-February dormant period to minimize damage to vegetation. Cleanup activities will be performed in a way to avoid disturbing existing trees and shrubs as much as possible. Disturbed areas will be reseeded, preferably with native vegetation adapted to the Hanford environment. Plantings will be made in consultation with U.S. Fish and Wildlife Service and Washington Department of Wildlife.

Thorough, seasonally correct, flora and fauna surveys will be performed at each remediation site prior to any characterization or remediation activities.

2.4 CULTURAL RESOURCE REVIEW

The cultural resource review of the waste sites was performed in August 1993 (Appendix L). All but five of the waste sites were considered as insignificant. The five significant sites, the Homestead Cistern, the Stock Tank Cistern, the Overlook Cistern, the 12-3 Cistern, and the Wagon Road Cistern, are considered to be significant for their ability to provide information about early Euro-American activities on the Hanford Site. The State of Washington Office of Archaeology and Historic Preservation has concurred with these findings.

3.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 7.5 of the Tri-Party Agreement Action Plan (Ecology et al. 1989) contains the basic description of applicable or relevant and appropriate requirements (ARAR). For this ERA, the ARAR's include: 40 CFR 61, Subpart M, "National Emission Standards for Hazardous Air Pollutants"; 40 CFR 262, 263, 300 (Subpart 3); 40 CFR 100-177; Washington Administrative Code (WAC), Chapter 173-303, "Dangerous Waste Regulations"; the MTCA (WAC, Chapter 173-340); CERCLA; 16 CFR 470, "National Historic Preservation Act"; and 40 CFR 402, "Endangered Species Act."

There are no applicable federal cleanup standards or chemical-specific ARAR for compounds in soil (hazardous or radioactive) except the EPA standards for lead and radium. The potential cleanup standards for the North Slope ERA have been developed using the MTCA.

4.0 SAMPLING DATA

Contaminants of concern for the North Slope sampling efforts were based on operational processes utilized at Nike missile and antiaircraft gun emplacements. These analyses included volatile and semivolatile organics, metals, anion, and TPH. Herbicide and pesticide analysis was also included as these substances were routinely used by both homesteaders and the military. The results of this sampling effort are provided in Appendix G. Numerous field screening analyses were also performed. The individual results are documented in the field logbook. The results of the VOA field screening analysis are provided in Appendix H.

4.1 DATA VALIDATION

The data packages were verified for required laboratory deliverables associated with the analysis performed. All CLP protocol sample analysis are being validated using WHC procedures (WHC 1992c).

4.2 DATA ASSESSMENT

The data obtained from sample analyses were compared to the action levels for residential soils in accordance with Method A of the MTCA (WAC 173-340, Section 740). These action levels were selected to accommodate proposed unrestricted land use for the North Slope. After comparison, the only analytes exceeding action levels were total petroleum hydrocarbons and lead. The sample sites and sample concentrations associated with these analytes are located in Table 5.

Table 5. Contaminants of Concern.

Sample No.	Location	Analyte	Concentration (ppm)	MTCA Method A Action Levels (ppm)	Comments
B07KR9	H-90	Lead	1,200	250	Oil site waste drum
B07KS0	H-90	Lead	760	250	Oil site waste drum
B07KQ1	H-81-R	TPH	910	100	Dry well
B07KR9	H-90	TPH	60,000	100	Oil site waste drum
B07KS0	H-90	TPH	65,000	100	Oil site waste drum
B07KS1	H-90	TPH	940	100	Oil site scraped area
B07KS2	H-90	TPH	1,700	100	Oil site scraped area

Not all of the identified analytes were listed under the residential soil action levels. Sampling analytes not listed under the residential soil action levels were compared to the maxima and 95/95 reference threshold levels for sitewide soil background as listed (DOE-RL 1993). No sample analytes were identified that differed significantly from background results. Strontium and phosphorous did not have background values identified. A background value (world mean value in soil - 280 ppm) for strontium was identified (Alloway 1990, Table 4.7, pg. 65). Sample data concentrations fell below this average level. A background value (200 to 5,000 ppm) for phosphorous was identified by EPA (1987). Sample data concentrations for phosphorous fell within this range.

The semivolatile and volatile organic sample analytes identified were all <1 ppm, and are common plasticizer and laboratory contaminants. Identified herbicides/pesticides (including phosphorous-based) concentrations were all <1 ppm or were laboratory blank contamination. No risk assessment was determined necessary for these analytes.

5.0 RESPONSE ACTIONS ALTERNATIVES

Potential response action alternatives were developed based on hazards identified during site investigation activities.

5.1 NO ACTION

Under this alternative, no additional field activities would be performed. Remedial actions for CERCLA sites, if required, would be examined under the remedial investigation/feasibility study process for which no start date has been established for the North Slope.

5.2 HAZARD MITIGATION

This alternative, if implemented, would remove/minimize the physical hazards present on the North Slope. This alternative would include backfilling landfill depressions. This would reduce the potential for future subsidence and exposure of buried debris.

A haul truck and front-end loader operation would be used in performing the stabilization activities. Fill material from a local, active gravel pit would be brought on the site and put in place with a front-end loader. (If gravel pit 47 is used as a source of fill material, it will first be confirmed that there are no Piper's daisy [*Erigeron piperianus*] plants present.) The bucket from the front-end loader would then be used to compact the material. The disturbed area will be revegetated at the appropriate time of year, preferably with native vegetation. Revegetation plans will be coordinated with U.S. Fish and Wildlife Service and State of Washington Department of Wildlife.

These activities would include the backfilling to grade of the underground structure located at PSN-90 and the numerous cisterns and subsidence areas associated with all the military sites (including landfill areas), removal of surface debris left by the military, and an OEW survey/cleanup effort. Concrete rubble material would be removed.

A semiannual survey of the area would be required to identify any further subsidence or physical hazards associated with the sites. The survey and mitigation of these hazards should be handled by the site landlord.

The petroleum-contaminated soil associated with the concrete grease ramp and the drywell located at military position H-81-R would be removed and disposed of according to current site procedures. An estimated 110 ft^3 (15 55-gal drums) of contaminated soil would be removed.

Additional soil sampling and analysis will be performed at the 2,4-D site. Based on the results and Ecology direction, either the site will be remediated or certified as not requiring any further action.

The OEW survey/cleanup effort will be performed by the U.S. Army Corps of Engineers following a three-phased approach. Phase 1 was a comprehensive record and archive search performed at various military records depositories throughout the country. From this archives search, the U.S. Army Corps of Engineers will be able to make informed decisions about the OEW threat a site poses, the need for further investigation, and identify other OEW threat areas. Under Phase 2, for sites requiring further investigation, a comprehensive site investigation will be conducted. This site investigation will be for both surface and subsurface OEW. The phased results will allow the U.S. Army Corps of Engineers to recommend land transfer, if no OEW is located, or propose OEW remediation before land transfer. Phase 3 is final OEW remediation (only those sites recommended by the site investigation. OEW will be remediated to the greatest extent practicable with best available technology, based on the proposed land use after transfer. All OEW clearance operations will be performed with the philosophy of protecting public safety in the future, after land use transfer. Phase 1 commenced in November 1993, and is scheduled for completion in early 1994. Phase 2 will commence in early spring 1994. The completion date for Phase 2 and the start date for Phase 3 are contingent on the results of Phase 1.

In cases where landfill remediation activities must commence prior to completion of the OEW survey (to meet the October 1994 cleanup date), OEW safety protocols developed by the U.S. Army Corps of Engineers will be followed. Under these protocols, the U.S. Army Corps of Engineers is responsible for providing a site safety officer, explosive safety oversight of OEW efforts, reviewing and amending scopes of work and work plans for OEW safety, and other OEW-related activities. From the preliminary results of the archives search, the likelihood of encountering OEW in these landfills is considered to be minimal.

An evaluation of the existing water wells has been made. Under all the remediation alternatives, the decision to abandon these wells was included. The method for abandonment follows. (In all cases, the concrete wellhead structures will be demolished to ground level to aid decommissioning and filled in after decommissioning.)

Military Water Wells:

Location	Number	Decommissioning Method
PSN-72/82	699-79-104	Downhole video camera verified a cement plug at 370 ft below surface. Perforate from 370 to 304 ft and grout to surface.
H-83-C	699-86-95	Verify well construction by down-hole video or other means. Lead packers are not to be perforated, but will be encased in cement (do not try to cut and remove). Perforate 12-in. casing to just below packer and pressure grout same interval. Perforate 16-in. casing to just below packer and pressure grout same interval. Pressure grout from top of last grout lift (top of 16-in.) to surface.

PSN-12/14	699-92-14	Decommission using same method as for well 699-86-95.
H-83-L	699-93-93	Decommission using same method as for well 699-86-95.
PSN-90	699-107-79	Currently being utilized as water supply well. Either leave as is, or if decision made to decommission, use same method as for well 699-86-95.
PSN-07/10	699-108-20	Unable to locate, will call it abandoned.
PSN-07/10	699-111-24	Downhole video camera verified cement plug at 208 ft. Perforate 208 to 108 ft. Pressure grout to surface.
PSN-04	699-112-37	Decommission using same method as for well 699-86-95.
PSN-01	699-115-61	Decommission using same method as for well 699-86-95.

Nonmilitary Water Wells:

699-51-7	No information. Not located.
699-61-16A	Total depth of 607 ft. No construction information. Homestead area - environmentally sensitive.
699-61-16B	Total depth of 81 ft. No construction information. Homestead area - environmentally sensitive.
699-70-17	(DH-19) Total depth of 766 ft. Basalt Waste Isolation Project investigation well. No intended use. Grout from total depth to surface.
699-76-90	Total depth of 41 ft. No construction information. Not located.
699-80-73B	Total depth of 37 ft. No construction information. Not located.
699-86-64	(BH-18) (Washington Public Power Supply System well) Total depth of 950 ft. No construction information.
699-98-54A	No information.

As well decommissioning activities are being conducted, communication with Ecology will be maintained to resolve any field problems arising that impact completion of activities in accordance with WAC requirements.

5.3 HAZARD REMOVAL

The hazardous and toxic waste components of all identified disposal areas would be removed under this alternative. The activities identified in the hazard mitigation alternative would also be performed. The following description does not account for the demolition debris located at the military positions. The removal of this material would be a simple expansion of the work described below. Due to the limited knowledge about the configuration of these sites, some assumptions must be made to complete a basis for planning the waste removal.

It is assumed that each of these landfill areas is covered with a 5-ft layer overburden on a 5-ft-thick layer of debris and soil mixed. Sizes of the actual burial grounds in the various landfills are presented in Table 2 under "Disposal Areas" and total about 38 acres. Actual disposal volume at each of these sites is considered to be 25% of the total available landfill volume. Hazardous and toxic waste constituents are assumed to comprise 5% of this disposal volume. Of the estimated 10 sites, seven are antiaircraft and three are Nike.

The excavation and removal of the hazardous or toxic waste at these landfills will be performed at each of the 10 sites. A mobile office and change and lunch facilities will be staged at the removal site. Necessary equipment and trucks will also be staged. Excavated nonregulated materials will be disposed of at the Central Landfill Facility (CLF) south of the 200 East Area. Any excavated regulated materials will be disposed per the appropriate procedures.

Large volumes of water for dust control may be a necessity for all locations. Assuming permission is granted, water will be obtained from two irrigation wasteways. The Saddle Mountain Wasteway can provide the western five sites and the Wahluke Wasteway, Branch 10, can provide the eastern five sites. If the waste removal cannot be completed during the irrigation season, it may be possible to withdraw water from the Columbia River. River access is possible; however, the haul distances are longer.

Once the equipment is set up, hand labor will begin clearing surface debris from the landfill. As soon as enough of the surface debris has been cleared, the overburden will be pushed to the side with a bulldozer. Landfill contents will then be characterized. Excavated materials will be field screened visually to identify obvious potential contaminants or sources of contamination (i.e., stained or discolored soils, or discarded drums, etc.). Additionally, instrumented field screening methods will be employed to analyze for organic vapors. Potentially contaminated material identified by field screening methods will be segregated, sampled and analyzed using offsite laboratories. If determined to contain hazardous or toxic constituents, the materials will be disposed of in accordance with regulations. Materials not containing hazardous constituents will be disposed of in the CLF.

Hazardous or toxic waste will be handled and transported in accordance with U.S. Department of Transportation regulations. Any asbestos- or transite-bearing waste will be handled in accordance with 29 CFR 1910.1001. This waste will be disposed of in special trenches at the CLF.

Overburden adjacent to the cleaned areas will be pushed back into the excavation and the area recontoured with the surrounding terrain when hazardous or toxic waste removal is complete. Trailers and equipment used for these operations will then be demobilized and restaged at the next site.

Excavated landfills will be recontoured with the surrounding terrain. For large areas this will be accomplished by a bulldozer and grader. No backfilling of the excavated areas is currently anticipated. However, if recontouring would impact native plant communities along the margins of the excavation, backfill material could be used to minimize the need for excessive recontouring. Backfill material would be obtained from already established borrow pits if possible. New borrow sources containing native plant communities would be avoided. The upper soil layers of the filled-in areas will be suitable for revegetation. The areas will be revegetated with native plants as much as possible. Revegetation plans will be coordinated with U.S. Fish and Wildlife Service and Washington Department of Wildlife.

In the event that remediation of the waste sites indicates the potential for contaminant impacts to groundwater, groundwater monitoring locations would be established.

5.4 CHARACTERIZATION AND HAZARD MITIGATION

This alternative includes (1) all of the work described under the hazard mitigation alternative, (2) the full characterization of burial grounds within landfill H-06-L following the procedures outlined in the hazard removal alternative (with the exceptions described below), and (3) the limited characterization of the remaining nine landfills by geophysical survey and soil sampling.

Landfill H-06-L was selected for full characterization because it was used for both antiaircraft battery and Nike missile battery operations. If hazardous wastes and ordnance contamination exists in any of the landfills, it would most likely be encountered in this landfill. The results of the H-06-L landfill characterization will be used to determine if further actions (beyond the full and limited characterization activities) are required at it and the remaining nine landfills. As in the initial characterization activities performed for this report, an analogous approach will be used to extrapolate the findings of these activities. For instance, if little or no environmental contamination or OEW is found at the H-06-L landfill, it will be assumed that the same would be true for the other nine landfills. Conversely, the same argument can be made if large amounts of environmental contamination or OEW are found. Use of an analogous approach is based on the assumption that the disposal areas used at each site contain similar wastes. This is a result of the performance of similar activities by the same organization at the same time using the same standard operating procedures.

As opposed to the hazard removal alternative, excavated materials not containing hazardous constituents will be returned to the excavation instead of being disposed of at the

CLF. Asbestos- or transite-bearing waste will also be returned to the excavation. Once non-regulated wastes, demolition debris, and asbestos- or transite-bearing wastes are returned to the landfill excavation, the landfill will be covered with a minimum of 2 ft of clean fill material. This will allow the various landfills to be closed as asbestos landfills in accordance with 40 CFR Part 61.151. Locations of these landfills will be established by the global positioning system, identified on maps, and record a notation on the deed as specified in 40 CFR Part 61.151.

Characterization activities will follow the procedures described in Appendix M.

In the event that characterization of the waste sites indicates the potential for contaminant impacts to groundwater, groundwater monitoring locations would be established.

6.0 EVALUATION OF REMEDIAL ALTERNATIVES

Selection of the preferred alternative is a two-phased process. The initial alternative screening phase (first phase) eliminates those alternatives that will not meet the goal or intent of the ERA. The second phase, detailed alternative evaluation, evaluates each alternative with respect to timeliness, protection of human health (including the pubic and those performing the work) and the environment, effectiveness, and cost. This second phase rates a preferred ERA performance method.

Each of the alternatives was evaluated to determine if it met the goal of the ERA. The alternative must take the steps necessary to protect human health and the environment from potential exposure to hazardous substances. Alternatives considered for further evaluation must also minimize the physical hazards identified in the previous sections.

The Hanford Future Site Uses Working Group (HFSUWG 1992) has proposed three future use options as both plausible and possible for the North Slope of the Hanford Site. The array of potential uses included:

> <u>Option 1: Agriculture, Wildlife, and Native American Uses</u>
> Agriculture and livestock grazing would occur in certain portions of this geographic area outside the Red Zone. The Red Zone north of Highway 24 would be studied to see if irrigated agriculture could be safely practiced. If not, the Red Zone would be managed, with other portions of the area where soils or conditions are inappropriate for agriculture, for wildlife habitat, and recreational uses. Native American uses would be assumed to occur in certain areas along the River. There would be a 0.25-mi buffer zone along the Columbia River where agriculture would not be allowed.

This option would preserve values associated with the Columbia River: spawning beds for salmon and steelhead, eagle habitat, recreational uses, and species dependent on riverine habitat.

Wildlife and recreational uses would be compatible with Native American uses, except for livestock grazing.

Option 2: Wildlife and Wildlife/Wild Lands Recreation
Shrub steppe habitat, one of the fastest disappearing habitats in the state of Washington, would be protected in the area north of the Columbia River and would provide a buffer zone for the Hanford Reach. Existing recreational uses and opportunities for research and education would continue. This option would be compatible with Red Zone constraints and would preserve values associated with the river: spawning beds for salmon and steelhead, eagle habitat, recreational uses, and species dependent on the habitat.

This option would be compatible with Native American uses, except for livestock grazing. It would allow access to the Columbia River and would ensure that archaeological sites would continue to remain undisturbed.

Option 3: Native American Uses
Traditional Native American uses of the area: hunting, fishing, pasturing animals, and gathering foods and medicines would occur. In addition to access to the Columbia River, there would be access to and protection of cultural and religious sites. Archaeological districts on the land, the islands and the river would be protected.

The Hanford Future Site-Uses Working Group identified a single, "unrestricted" cleanup scenario for the North Slope. Under this unrestricted scenario, potential future uses of the North Slope would in no way be constrained by the presence of contamination on the surface or in the groundwater.

6.1 NO ACTION

Under the no-action alternative, no attempts to remediate identified hazards would be made. Based on the results of the limited environmental sampling effort, the potential for environmentally damaging consequences, including human exposure to potentially hazardous substances, is considered to be negligible. It is possible for unknown hazards to surface in the future due to wind and rain erosion, frost heave, and animal activities. Even though there has been no reported injuries associated with the North Slope sites to date, the likelihood for physical injury still exists. Therefore, this alternative does not meet the goal of the ERA, which includes minimizing the presence of physical hazards to both the public and Hanford employees. This alternative will not be considered further.

6.2 HAZARD MITIGATION

This alternative would include both minimization of physical hazards and cleanup of the oil-contaminated soils associated with the grease ramp and drywell. It would therefore minimize the potential for human exposure to potentially hazardous substances and reduce the risk of injury due to the physical hazards present. It would minimize the potential for exposure to asbestos-regulated materials or other unidentified hazardous materials present on the surface. It is possible for unknown hazards to surface in the future due to wind and water erosion, frost heave, and animal intrusion. This alternative meets the goal of the ERA and would be sufficient for the wildlife/refuge land use scenario. Implementation of this alternative would not be supportive of the unrestricted land-use scenario. This alternative will be retained for further evaluation.

6.3 HAZARD REMOVAL

This alternative would include both minimization of physical hazards and removal of all material within the landfills and oil-contaminated soils associated with the grease ramp and drywell. While removal of the materials in the landfills would reduce the risk of exposure to the public of asbestos materials, a substantial volume of this material would remain with the buried demolition debris located at the military sites. This material would also require removal to minimize the potential for human exposure to asbestos-regulated materials or other hazardous materials that may be present.

Implementation of this alternative would meet the goal of the ERA and would be supportive of the wildlife/refuge land-use scenario. If the demolition debris is also removed, this alternative would support all identified land-use scenarios. This alternative will be retained for further evaluation.

6.4 CHARACTERIZATION AND HAZARD MITIGATION

This alternative would include minimization of physical hazards, the full characterization of the burial grounds within the worst case landfill (H-06-L), characterization of the remaining nine landfills, and, if required, complete excavation of any or all remaining landfills. This alternative also includes the cleanup of the oil-contaminated soils associated with the grease ramp and drywell. Under this alternative, the H-06-L landfill will be completely excavated to determine if there are any hazardous materials or ordnance present that may pose a danger to the environment or the public. If any hazardous material is found in this landfill and considered significant by the regulators, the remaining nine landfills will be excavated fully, using the analogous approach, and all hazardous materials will be removed from the site. If no such material is found in the H-06-L landfill, adequate characterization (sampling procedures) will be carried out in the remaining landfills to determine if they contain any hazardous materials other than demolition debris. If a significant amount of hazardous material is found in a particular landfill, that landfill will be fully excavated and the hazardous materials removed from the site. Nonhazardous and asbestos- or transite-bearing materials, if found, that are excavated would be returned to the landfills from which they originated and capped with 2 ft of clean fill. Any regulated hazardous materials or ordnance found would be disposed of in accordance with the appropriate procedures and regulations. This alternative will minimize the asbestos or other potential hazards to the public and the environment while also providing greater assurance that hazardous materials or OEW are not present in these landfills.

Implementation of this alternative would meet the goal of the ERA and will support unrestricted use for more than 99.5% of the North Slope. The remaining portion may require some restrictions. The details of the restrictions, if required, will depend on the materials found at the site. Any restrictions would be recorded on the deed. This alternative will be retained for further evaluation.

7.0 ALTERNATIVE EVALUATIONS

Three of the four alternatives were retained for further evaluation. These are Hazard Mitigation, Hazard Removal, and Characterization and Hazard Mitigation. These alternatives were evaluated based on how well the alternative protected human health and the environment. This includes exposures resulting from implementation of the alternative and when implementation is complete. Specific evaluation criteria include environmental impacts, managerial feasibility, and cost.

The environmental impact criterion considers the anticipated/potential effects each of the alternatives may have on human health and the environment. This includes impacts seen during implementation and over the long term, after implementation is complete.

Managerial feasibility focuses on the ability to perform the activity and includes availability of equipment and the necessary labor forces and required permits.

The cost for implementing each alternative must also be considered in selection of the preferred alternative. While protection of human health and the environment is the primary concern, the cost associated with implementing the alternative may determine the appropriate alternative when environmental considerations between the various alternative are equal.

7.1 PROTECTION OF HUMAN HEALTH/ENVIRONMENT EVALUATION

As stated previously, the level to which the alternatives will protect human health is dependent on what the property will be used for. Each of the alternatives equally addresses mitigation of the physical hazards. The primary difference between the alternatives is stabilizing the landfills, excavating one landfill and characterizing the remaining nine landfills, and removing all 10 landfills. The primary hazard identified at these landfills is the presence of asbestos and asbestos-based materials and the potential for other hazardous materials and OEW.

If the contents of one landfill are excavated and the other nine are characterized, the asbestos exposure risk and the potential exposure to other unknown hazardous materials and OEW to the environment and public is minimal as long as the excavation and characterization results are negative. An assessment would be performed if any regulated material or OEW is found during the landfill excavation and characterization activities.

If the contents of the landfills are removed, the potential for public exposure in the long term is reduced for all land-use scenarios. This risk would be further reduced if the demolition debris is removed from the military sites. If the land is to be made available for unrestricted land use, this material would also require removal. Excavation of these materials requires extensive controls to ensure the asbestos materials do not become airborne. A potential for worker and public exposures to the asbestos materials during the removal activities exists and must be considered in the selection of a remedial alternative. A potential for worker and public exposures to any regulated materials or OEW during the removal activities exists and must be considered as well.

7.2 TECHNICAL FEASIBILITY

The tasks required for implementing each of the alternative are considered to be routine by industry today. The primary difference between the two alternatives is the removal of the landfills and demolition debris versus stabilization of these areas. While both alternatives are technically feasible, the removal actions require considerably more resources, including equipment and labor for completion.

The hazard removal alternative will require the leasing of heavy equipment and the labor force to run it. The resources necessary for performing these activities would not be available onsite. An offsite contractor would therefore be required. Additional landfill space at the CLF would also have to be created. Any regulated wastes would be sent offsite to an appropriately permitted facility.

The resources necessary for performing the stabilization activities would be available onsite and would not require additional leasing or purchasing of equipment.

7.3 ACTIVITY-SPECIFIC COST ESTIMATES

The cost estimate for performing each of the activities associated with each of the ERA alternatives is provided in Appendix N. These costs estimates are for comparative purposes only. Table 6 summarizes the costs associated with performing each alternative.

Table 6. Alternative Cost Estimate Summaries.

Alternative	Cost, $
Hazard Mitigation	1,159,790
Characterization and Hazard Mitigation	3,396,020[a]
Hazard Removal	9,766,830
Hazard Removal (including demolition debris)	21,870,220

[a]This estimate assumes that only one landfill will be fully characterized. If this characterization indicates that the remaining nine landfills require removal, then the cost estimates will necessarily increase.

8.0 PREFERRED REMEDIAL ALTERNATIVE

The selection of the preferred alternative is dependent on cost, risk to the environment and public, whether it supports the unrestricted land-use recommendation of the Hanford Future Site Uses Working Group (HFSUWG 1992), and technical feasibility. All of the alternatives are feasible. The alternative differences are in the degree of risk to the public and environment and costs.

The hazard mitigation alternative risk to the environment and public, while adequate for a wildlife refuge scenario, does not provide enough assurance that landfill problems do not exist and will not appear in the future. This alternative does not support the unrestricted land-use recommendation of the Hanford Future Site Uses Working Group and is eliminated from further consideration.

The characterization and hazard mitigation alternative provides sufficient assurances that landfill problems do not exist, thus supporting the unrestricted land-use recommendation of the Hanford Future Site Uses Working Group.

The hazard removal alternative provides assurances that landfill problems do not exist, thus supporting the unrestricted land-use recommendation of the Hanford Future Site Uses Working Group.

Since the characterization and hazard mitigation alternative and the hazard removal alternative both support the unrestricted land-use recommendation, alternative cost and risk comparisons must be made to select the preferred alternative. This comparison indicates that the preferred alternative is characterization and hazard mitigation. Implementation of this alternative would support the goal of the ERA and would support the "unrestricted" land-use recommendation of the Hanford Future Site Uses Working Group. This approach would eliminate unnecessary excavation and disposal costs that would be involved with total excavation of all landfills (hazard removal) without characterization. Therefore, the characterization and hazard mitigation alternative is considered to be the appropriate action.

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APPENDIX A

JOINT LETTER FROM REGULATORS

9413145.1723

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

April 30, 1992

Mr. Steven H. Wisness
Hanford Project Manager
U.S. Department of Energy
P.O. Box 550 A5-19
Richland, WA 99352-0550

Re: Expedited Responses Action Planning Proposals

Dear Mr. Wisness:

The Washington Department of Ecology and the U.S. Environmental Protection Agency have been reviewing the four planning proposals received from you on April 8.

- North Slope landfills
- 618-11 burial ground
- river pipelines
- sodium dichromate drum burial site

All four of the proposals represent significant progress in cleanup action on the Hanford site. For now, Ecology and EPA recommend that an EE/CA be prepared immediately for two of the proposals; the sodium dichromate drums and the North Slope sites.

Ecology and EPA expect to receive two additional planning proposals towards the end of this month.

- river railroad wash station
- picking acid cribs

From the four sites remaining of the six proposed, Ecology and EPA will select two more for which EE/CAs will be prepared. Ecology and EPA will then be in the position of identifying which of the four sites with EE/CAs should be commenced first, in the context of the limited funds and resources available. All will be accomplished when such limitations are overcome.

Ecology and EPA have some general comments on the first four planning proposals, and some specific comments on the two selected. These comments should be addressed in future planning proposals, as Ecology and EPA do not wish to delay those currently under consideration. Gaps in these first proposals should be addressed in the EE/CAs.

Schedule:

- The schedules are drawn out for unnecessarily long durations.

- Preparation of the proposal may begin at the start of the schedule, in parallel with safety documentation etc.

- NEPA documentation is not necessary for removal actions, according to EPA and USDOE policy. Any delays for NEPA documentation are unwarranted.

- There are three serial review periods, USDOE, Ecology/EPA, and public. Some of these may be run in parallel. The NCP does not require a second public review at the end of the process.

Cost:

- Project management costs are exaggerated by the excessive duration of the projects. In one proposal, project management comprises one half of the total cost. There is no explanation of what will keep a project engineer fully occupied and dedicated to each of the projects for their full duration.

Description:

- The likely remedial alternatives are not described, although the cost estimate is based on an assumption of a particular alternative. There is not enough description of the likely removal alternatives to allow EPA or Ecology to make a fully informed approval of the planning proposals. Ecology and EPA would like more description of the alternatives being focused on prior to granting an approval that would initiate the expenditure of resources for preparing the EE/CA.

North Slope ERA Planning Proposal

Schedule:

- The schedule extends for 2 years although this looks like one of the simplest removals on the Hanford site.

Description:

- There is no description of what actual remedial work would be undertaken, notably with respect to soils.

- There should be no need to replace fences and signs if the ERA successfully removes the physical and environmental hazards.

- Test pits may be more informative than cone penetrometer tests in the landfills. Some of the physical hazards could be contemporaneously eliminated while the back-hoe is mobilized.

- The 2-4-D tanks can not be sampled with a cone penetrometer. The likely alternative should be excavation of the tanks with direct sampling to confirm the absence of residual contamination. The

Steven H. Wisness
April 30, 1992
Page 3

tanks themselves may not be dangerous waste, pursuant to WAC 173-303-160.

Sodium Dichromate Barrel Disposal Site ERA Planning Proposal

Schedule:

- The schedule extends for 2.5 years although this looks like one of the simplest removals on the Hanford site.

Cost:

- The necessity of, and alternatives to the expensive disposal of the barrels as hazardous waste need to be explored. The proposal allocates $500,000 to disposing of the excavated barrels. The empty barrels may not need to be treated as dangerous waste, according to WAC 173-303-160. They may be disposed of as solid waste, or even recycled as scrap.

Description:

- There is no description of what actual remedial work would be undertaken, notably with respect to soils.

- The likely remedial alternatives are not described, although the cost estimate is based on an assumption of a particular alternative. It is only suggested that removal of drums and contaminated sediment is the plan. There is no explanation of how potential contamination in soil will addressed.

Should you have any questions about the ERA process, please contact either Steve Cross of Ecology (206) 459-6675 or Doug Sherwood of EPA (509) 376-9529.

Sincerely,

Paul T. Day
Hanford Project Manager
EPA Region 10

David B. Jansen, P.E.
Hanford Project Manager
Department of Ecology

PD:DJ:jw

cc. Dave Nylander, Ecology
B. Stewart, USDOE
T. Veneziano, WHC

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APPENDIX B

TRI-PARTY AGREEMENT MILESTONE

Hanford Federal Facility Agreement and Consent Order

Fourth Amendment

January 1994

by

Washington State
Department of Ecology

United States
Environmental Protection Agency

United States
Department of Energy

Change Number	Federal Facility Agreement and Consent Order Change Control Form Do not use blue ink. Type or print using black ink.	Date
M-16-93-03		Jan. 25, 1994

Originator: Walter D. Perro, DOE-RL, ERB — **Phone**: (509) 372-3704

Class of Change

[ ] I - Signatories [X] II - Project Manager [ ] III - Unit Manager

Change Title

North Slope Assessment and Remediation

Description/Justification of Change

The change package provides milestone (M-16-82) for the remediation of the North Slope of the Hanford site.

See attached pages for justification and specific milestone description.

Impact of Change

The implementation of this change will add interim milestone M-16-82
Due Date: October 1994.

Affected Documents

Hanford Federal Facility Agreement and Consent Order Action Plan, Appendix D.

Approvals X Approved __ Disapproved

This change form approved by Amendment Four to the Hanford Federal Facility Agreement and Consent Order executed by the signatories on January 25, 1994.

Signature	Date
John Wagoner DOE	January 25, 1994 Date
Gerald Emison EPA	January 25, 1994 Date
Mary Riveland	January 25, 1994

Description/Justification of Change (Continued)

On March 31, 1993, an "Agreement in Principle" (AIP) was signed by DOE-RL, Ecology, and USEPA. The AIP committed the three parties to identify additional measures which will be taken to accelerate cleanup of the Hanford site. The Three parties agreed to look for such cleanup opportunities both within the outside the current scope of the Hanford Federal Facility Agreement and Consent Order. To this end, DOE has committed to expedite the remediation of the North slope to complete all remediation activities by October 1994.

The DOE proposes that a Tri-Party Agreement milestone be established to provide accelerated remediation for the North Slope. The following are the activities to be performed:

A. The North Slope area was selected as an Expedited Response Action (ERA) candidate site in April 1992, by Ecology and EPA. To date, historical research of the area, site inspections, and characterization activities have been completed on suspect waste sites. The North slope ERA Proposal, which includes an Engineering Evaluation/Cost Analysis (EE/CA), will be released for a 30-day public review and comment period and public meeting.

B. Upon completion of the public review and comment period. Ecology and EPA will prepare the Action Memorandum for EPA and Ecology signing.

C. Prepare design for the North Slope remediation based upon the requirements of the Action Memorandum. The design will be provided to Ecology and EPA for review and approval concurrent with DOE.

D. Upon completion of the design phase for the North Slope, a remediation contract will be awarded. However, remediation will not actually commence until completion of the cultural resources review process.

E. Upon completion of field remediation activities, a CERCLA Action Assessment Report will be developed to document remediation activities for both the CERCLA and non-CERCLA (e.g. cisterns, underground bunkers) areas.

The major milestone shall read:

M-16-82: Complete remediation and submit draft CERCLA Action Assessment Report for the North Slope.
Due Date: October 1994

IT IS SO AGREED:

Each undersigned representative of a Party certifies that he or she is fully authorized to enter into this Agreement and Action Plan and to legally bind such Party to this Agreement and Action Plan. These change requests and amendments shall be effective upon the date on which this amendment agreement is signed by the Parties. Except as amended herein, the existing provisions of the Agreement shall remain in full force and effect.

FOR THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY:

1-25-94

Gerald Emison
Acting Regional Administrator
Region 10
U.S. Environmental Protection Agency

Date

9413146.1732

FOR THE UNITED STATES DEPARTMENT OF ENERGY:

1/25/94

John Wagoner
Manager
U.S. Department of Energy
Richland Operations Office

Date

FOR THE WASHINGTON STATE DEPARTMENT OF ECOLOGY:

Mary Riveland

1/25/94

Mary Riveland
Director
State of Washington
Department of Ecology

Date

APPENDIX C

MILITARY HISTORY OF CAMP HANFORD

AIR DEFENSES OF HANFORD

CAMP HANFORD - THE FORWARD POSITIONS 1950-1964

1.0 INTRODUCTION

The following outlines the development of the U.S. Army's Camp Hanford from 1950 to its closure in 1961. The information contained in the report has been compiled from documentary sources, interviews, and site visits. The objectives were to identify specific locations of military activity and describe land use, site development, and operations which have or may have left physical remains on the land, particularly potentially hazardous remains. The present discussion is focused mainly on the "Forward Positions" and outlying facilities situated on the North Slope and the Arid Lands Ecology Reserve.

2.0 THE ARMY MOVES IN

Camp Hanford consisted of an extensive cantonment area north of Richland and various forward positions situated throughout the Hanford Reservation. The purpose of Camp Hanford was the air defense of the "Hanford Works." This was accomplished initially by ringing the facility with antiaircraft artillery (AAA) batteries with 90- and 120-mm guns. Later these were replaced with Nike Ajax missile sites.

Camp Hanford was officially established as a Class I installation under the jurisdiction of the Commanding General, 6th Army, effective 28 March 1951, by General Order 20, published 18 April 1951. Actual site selection and construction planning was actively under way by July 1950. Camp Hanford ultimately involved nearly 3,700 acres of the Hanford Reservation.

A comprehensive agreement between the Army and the U.S. Atomic Energy Commission (AEC), simply titled the "Army Agreement" (Contract No. DA-45-164-ENG-1187) dated 1 March 1951, provided the basic terms under which the Army would occupy, use, and develop (sometimes jointly) AEC lands, structures, services and utilities, both in the cantonment and in the forward positions. This agreement was amended by several supplements, the last of which was effective on August 12, 1964. The later supplements provided for the restoration and return to AEC of various lands and facilities then remaining under Army jurisdiction.

The early agreements, understandings, letters, and permits generally reveal the Army's site selection and development activities. After 1955, they reflect the transition from AAA to Nike defenses, followed by a rather rapid transition to elimination of all Army air defenses. AEC interests took priority except in the case of hostile attacks.

The 6th Army, 5th Artillery Group (Air Defense) personnel began moving into the Camp Hanford cantonment area in late 1950 and early 1951. Most of the cantonment had already been constructed by the AEC beginning in 1947. Sites for nine AAA positions were selected and plans for their development were complete when a Right-of-Entry to the sites was granted to the Army by AEC by letter dated December 5, 1950. Dates on Walla Walla District, U.S. Army Corps of Engineers survey monuments located at several sites read 1951. Eighteen AAA positions, including four battalion headquarters (HQ), were developed; however two, BC 130 and PSN 71, were abandoned by 1954, possibly because they could be subject to flooding by the Columbia River. In 1953, the Camp Hanford Firing Range was created. By 1955, extensive military additions or enhancements to the road, water (including wells and distribution systems), power, and communications systems in the area were essentially complete, and four Nike Ajax surface-to-air missile batteries were operational. Other significant developments included upgrading the White Bluffs and Hanford Ferry sites and construction of ammunition storage facilities (igloo style) on the North Slope and central reservation area.

Battery H-06 merits special mention because it was the only Hanford battery to convert from the conventionally armed Nike-Ajax to the nuclear-capable Nike-Hercules (i.e., W-31 nuclear warheads). The control site had apparently been modified from its initial appearance and probably included the addition of a heliport. Conversion construction ran between June and December 1958, with an operational readiness date with Hercules missiles of July 9, 1959. Thus, from this date, H-06-L <u>may</u> have had nuclear warheads. Operations with the Hercules did not last long. The hardware from this battery was transferred to the Hampton Roads, Virginia, defense battery sometime during FY 1961. Based on a June 1960 construction start date for the receiving Hampton Roads battery, it is evident that H-06-L could have had nuclear warheads onsite for a maximum of about 1 year.

3.0 THE ARMY MOVES OUT

Beginning in late 1957 or early 1958, 13 AAA sites were phased out of service and their associated structures and much equipment were declared excess to the needs of the Army. The process of disposal began at once. During the next 2 years, everything of value that could be removed was sold, donated, or transferred to public and private groups for transport offsite. Three AAA sites were retained and modified to support the three North Slope Nike sites. One of these, H-07-H (formerly PSN 10), became the Nike battalion HQ for the 52nd Artillery/1st Battalion (83rd Battalion).

On December 21, 1960, the land-use permit for the 13 AAA sites was terminated by the AEC. The termination letter also acknowledged that site restoration was satisfactory. Early in 1961, operations at the four Nike sites and remaining former AAA sites ceased and the disposal of improvements at those sites commenced.

Camp Hanford was placed in inactive status, effective 31 March 1961, by General Order 5, published 7 March 1961. According to General Order 39, published 6 July 1962, Camp Hanford was discontinued as an Army installation, effective 1 November 1961. On July 6, 1962, the AEC terminated the remaining land-use permits with the Army, excepting one building (T-52C-6, part of the former Rattlesnake Mountain Nike control site) and portions of the North Richland cantonment area. On September 4, 1964, the AEC terminated the permit for the remaining lands in the cantonment. The permit for T-52C-6 was transferred to the Yakima Firing Center. This permit terminated in February 1965.

Various documents reflect understandings between the Army and the AEC about how the land and property that constituted Camp Hanford would be restored after Army occupancy ceased. The vigorous program of excessing structures and equipment for offsite removal from 1958 on was part of the Army's effort to comply with restoration requirements. Since most buildings at the AAA sites were of metal prefab ("Butler Building") or wood construction, removal for salvage or adaptive reuse elsewhere was a relatively easy matter. Responses to the declarations of excess property appear to have been spirited. Virtually anything of value, including buildings, water piping, electrical lines and transformers, fencing, fuel tanks, (both above and below ground), and other equipment was bid on or requested, awarded, and taken away.

Improvements, including septic sewer systems, permanent concrete structures and foundations, found mainly at the Nike sites, remained. Surface paving, foundations or footings, septic tanks, and drain fields were not considered to be problems requiring restoration by either the AEC or the Army. Aboveground concrete structures were stripped of equipment and partly or entirely demolished, but the resulting debris was left onsite. The underground missile magazines at Nike launch sites H-06 and H-12 were supposed to have been sealed (access doors welded shut), but it does not appear that this was done, or it was done ineffectually. All wells, mainly located on the North Slope, were to be capped. The sandbag and wood AAA gun emplacements were left intact.

In several instances, the AEC allowed improvements to remain in place, in lieu of restoration, for use by the AEC or others. In July 1958, the AEC requested that battalion HQ position H-03-H be conveyed to AEC, essentially intact, for unspecified purposes. The Army agreed to do so, but the AEC eventually determined that the site and structures were unsuitable to their needs and the transfer process was terminated in April 1959. The structures were subsequently conveyed to others and removed. By letter dated December 30, 1960, the AEC detailed a long list of improvements which they wished to obtain, in-place, as they became available. These included a number of Army constructed buildings in the cantonment area, the Nike H-52 launch and control sites, selected water mains, communications cables, power lines, the ammunition storage facilities, ferry landings, a radio communications building on Gable Mountain, and the firing range.

In May 1961, the U.S. Bureau of Reclamation (BOR) requested that the structures at the former Nike launch site H-83L to be transferred to them for use as an operations and maintenance (O&M) center. This request was granted and BOR continued to use the property until the early 1970's. In addition, they requested and obtained permission to use three North Slope wells originally constructed by the Army at positions H-01, H-82, and H-90.

4.0 POST-MILITARY RESTORATION

The Army "restoration" of the Camp Hanford forward positions resulted in the removal of most of the buildings and salvageable materials, but a considerable amount of debris and some structures remained. Between 1974 and 1977, the AEC or, after 1974, U.S. Energy Research and Development Administration undertook to clean up the North Slope and other selected areas of Hanford.

The Atlantic Richfield Hanford Company was directed to undertake the cleanup. While the scope of this housecleaning was comprehensive, a good deal of it focused on former military facilities, particularly the Nike sites.

The three North Slope Nike sites had more permanent structures with less salvage potential than the older AAA positions. Consequently, they posed the greatest cleanup challenge. At each of the launch sites, H-06L, H-12L, and H-83-L (originally transferred to BOR), the two underground missile magazines were blown up. Debris from the demolition of nearby buildings was pushed into the pits and covered over. All the magazines were handled in this fashion during June 1974, after any remaining salvageable metal had been removed. Construction debris at the control sites was apparently buried as necessary.

The gun emplacements at the AAA sites were bulldozed and the debris buried. Paving at both the AAA and Nike sites was generally left in place (e.g., parking areas, sidewalks, foundations). In November 1975, the four igloo structures which constituted the ammunition storage facility on the North Slope were moved to Wheezier, Idaho, for use by the U.S. Department of Commerce. Sporadically since the 1970's, other cleanup efforts have occurred on a site-by-site basis as physical hazards have been encountered or reported.

5.0 SO WHAT'S LEFT

On the North Slope, concrete and asphalt debris is probably the most visually obvious residue of the Camp Hanford era. Sidewalks, roads, parking areas, paving, foundations, and the Nike launch fields remain much in evidence. These are as much artifacts of Camp Hanford as they are of early agreements between the Army and the AEC about what constituted restoration.

Less evident are the underground sewer piping, septic tanks, drain fields, and refuse dumps which still exist at virtually every site. Disposal of garbage and other material was necessary because it was generated at virtually every facility. The "Army Agreements of 1951" provided for the disposal of refuse by the Army as follows: "Army will dispose of its trash and garbage in a manner acceptable to AEC. Army may make disposal pits off Army land, as necessary, at locations designated by AEC and such pits shall be subject to AEC inspection. Disposal by burial was probably commonplace, particularly in view of the relative remoteness of these sites, but finding these pits 30 years after the fact has proven difficult unless the elements have exposed them, or they were poorly covered in the first place.

Domestic refuse disposal sites are of concern, but disposal practices for excess or expended petroleum products, solvents, acids, pesticides, herbicides, and other chemicals are of even greater interest. Generally there were standard procedures for dealing with such wastes; however, these may not have been followed on all occasions. Also, some standard procedures would not constitute acceptable practices today.

6.0 RESEARCH METHODOLOGY

The fundamental sources for this report are documentary, including maps, with a heavy reliance on real estate files (agreements, letters requesting, granting, or terminating permission to use property or services, etc.) and property disposal data (declarations of excess, property lists, sales or transfer records). A basic chronology is established by such sources. In addition, the disposal records reveal what was constructed on each site. Of course, some things may not be listed in such records so the view is essentially the minimum development. For example, the presence, number or absence of artillery pieces at a site never appears in the kinds of documents consulted. Informants and sites visits may help clear up such questions. At this point, a great many questions about Camp Hanford remain to be answered.

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APPENDIX D

MILITARY WATER WELL DRILLING LOGS

The log for well 699-108-20 is not available. The well has not been located to date.

WELL CONSTRUCTION AND COMPLETION SUMMARY AS-BUILT

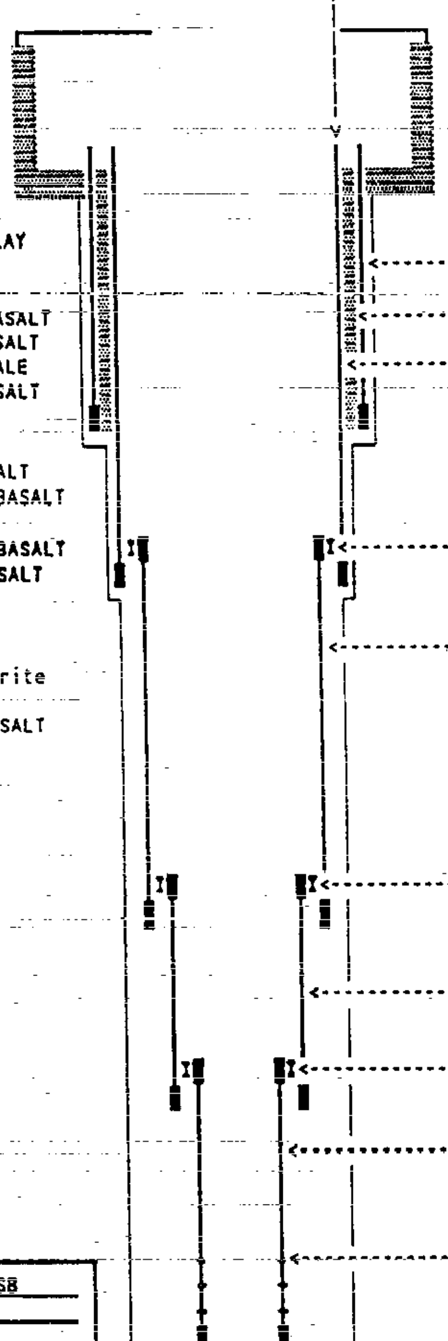
Drilling Method: Cable tool	Sample Method: Hard tool	WELL NUMBER: 699-92-14 — TEMPORARY WELL NO: Well #9, PSN 505
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 92,000 — E/W W 14,000
Driller's Name: R. J. Strasser (?)	WA State Lic Nr: Not documented	State Coordinates: N 497,266 — E 2,281,000
Drilling Company: Strasser Drilling Co	Company Location: Portland, OR	Start Card #: Not documented — T14N R27E S24C1
Date Started: Not documented	Date Complete: 10Nov53	Elevation Ground surface (ft): Not documented

Depth to water: 383 ft Nov53

Elevation of reference point: 862.01 ft (Top of casing)

GENERALIZED Driller's STRATIGRAPHY Log

0-3: CLAY, SILT, TOP SOIL
3-9: CALICHE
9-206: Light brown CLAY
206-573: Blue, brown green CLAY
573-580: Pea GRAVEL with CLAY
580-589: SANDSTONE
589-601: Hard gray BASALT
601-631: Soft red porous BASALT
631-697: Black and gray BASALT
697-730: Green and blue SHALE
730-874: Black and gray BASALT
874-883: Porous red ROCK and CLAY
883-1027: Porous black BASALT
1027-1165: Black and gray BASALT
1165-1191: Blue CLAY
1191-1246: Gray and black BASALT
1246-1261: Porous black BASALT
1261-1276: CONGLOMERATE
1276-1283: Blue CLAY
1283-1291: CONGLOMERATE, rotten wood, pyrite
1291-1371: Black BASALT
1371-1393: Porous black BASALT
1393-1396: BASALT



Drawing By: RKL/6#92#14.ASB
Date: 14Jan91
Reference:

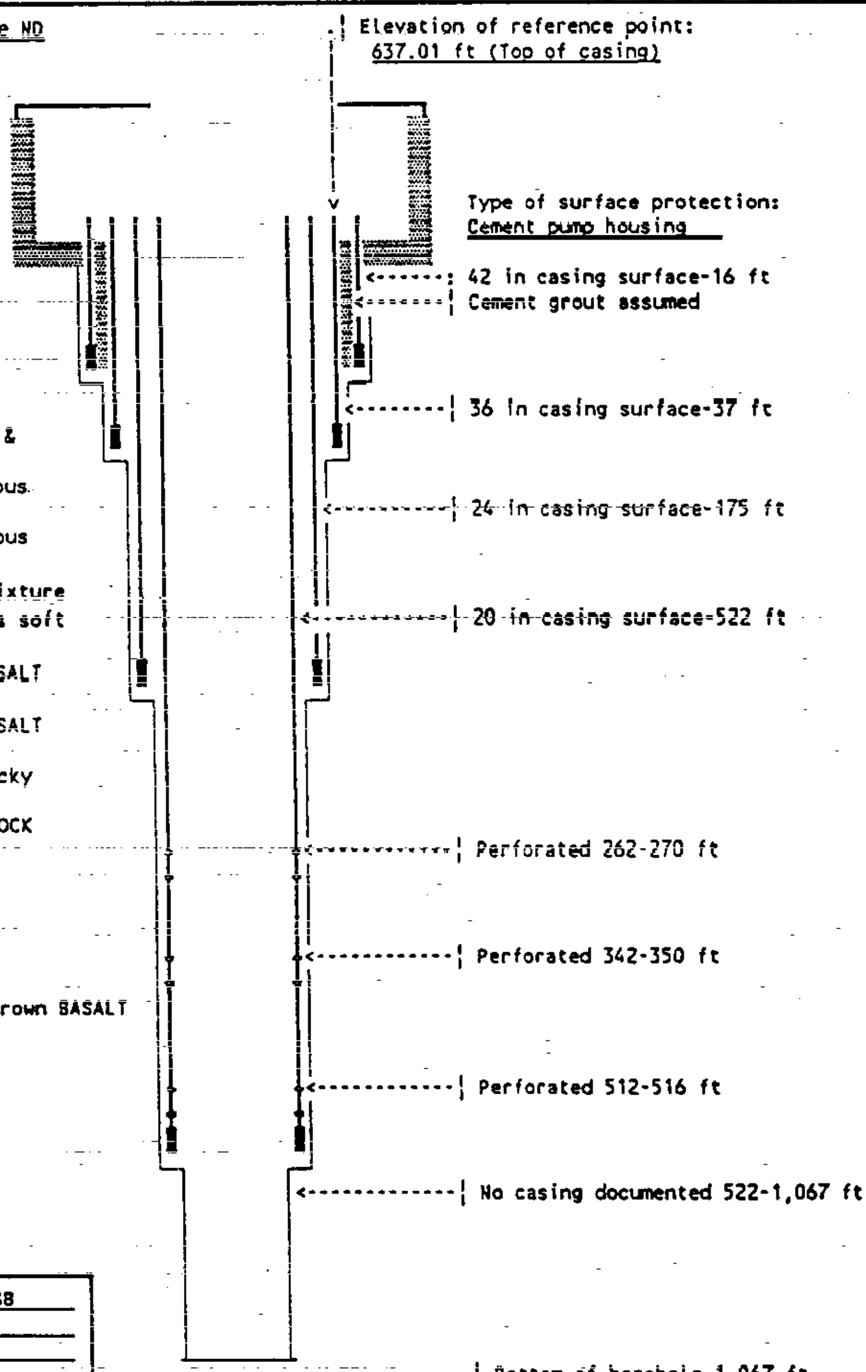
WELL CONSTRUCTION AND COMPLETION SUMMARY AS-BUILT

Drilling Method: Cable tool	Sample Method: Hard tool	WELL NUMBER: 699-93-93 TEMPORARY WELL NO: PSN 525
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 93,000 E/W W 93,000
Driller's Name: Not documented	WA State Lic Nr: Not documented	State Coordinates: N 498,000 E 2,202,000
Drilling Company: Strasser Drilling Co	Company Location: Portland, OR	Start Card #: Not documented T14N R24E S2181
Date Started: Not documented	Date Complete: May53	Elevation Ground surface (ft): Not documented

Depth to water: 235 ft Date ND

GENERALIZED Driller's STRATIGRAPHY Log

0-6: TOPSOIL
6-23: CALICHE
23-25: White CLAY and GRAVEL
25-56: White CLAY
56-78: Gray CLAY
78-107: Brown CLAY with few GRAVELS
107-145: CALICHE?
145-158: Sandy CLAY, brown
158-277: Sandy CLAY, brown & GRAVELS & SAND
277-300: Black BASALT, porous
300-324: Gray BASALT
324-358: Black BASALT, porous
358-377: Gray BASALT
377-404: BASALT and CLAY mixture
404-510: Gray BASALT, veins soft to hard
510-565: Grey and black BASALT
565-580: Gray CLAY
580-765: Gray and black BASALT
765-797: Blue CLAY
797-846: Gray CLAY and sticky yellow CLAY
846-872: Black CLAY with ROCK
872-879: Black BASALT
879-921: Black SANDSTONE
921-955: Gray BASALT
955-982: Black BASALT
982-998: Brown BASALT
998-1032: Black BASALT
1032-1038: Gray, red and brown BASALT
1038-1064: Black BASALT
1064-1067: Brown BASALT



Drawing By: RKL/6#93#93.ASB
Date: 08Jan91
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY AS-BUILT

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: R. J. Strasser (?)
Drilling Company: Strasser Drilling Co
Date Started: Not documented

Sample Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Portland, OR
Date Complete: 10May52

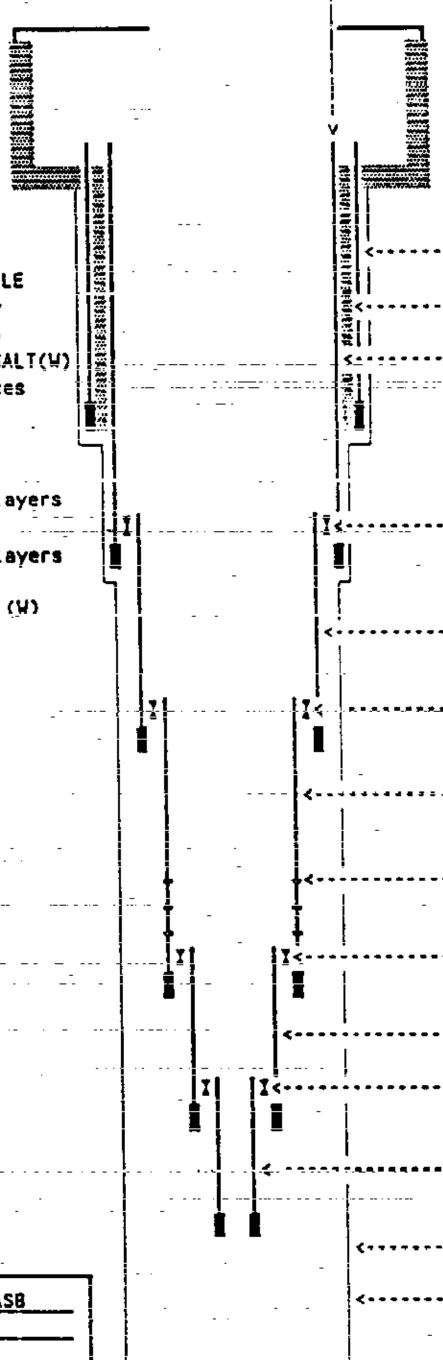
WELL NUMBER: 699-107-79
TEMPORARY WELL NO: Well #2, PSN 410
Hanford Coordinates: N/S N 107,000 E/W W 78,890
State Coordinates: N 512,000 E 2,216,200
Start Card #: Not documented T14N R25E S10
Elevation Ground surface (ft): Not documented

Depth to water: 182 ft May52

Elevation of reference point: 659.02 ft (Top of casing)

GENERALIZED STRATIGRAPHY Driller's Log

0-12: TOPSOIL, sandy SILT
12-21: CALICHE
21-63: GRAVEL
63-183: CLAY and sandy SHALE
183-249: Sandy CLAY (W)
249-252: CALICHE
252-355: SAND, CLAY and SHALE
355-625: BASALT, hard, gray
625-630: BASALT, broken (W)
630-663: Brown CLAY and BASALT(W)
663-680: BASALT with crevices
680-685: BASALT with CLAY layers
685-753: Porous BASALT
753-895: BASALT with CLAY layers
895-900: SAND (W)
900-906: SAND with BASALT layers
906-924: BASALT
924-938: White porous ROCK (W)



Drawing By: RKL/6#107#79.ASB
Date: 14Jan91
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY AS-BUILT

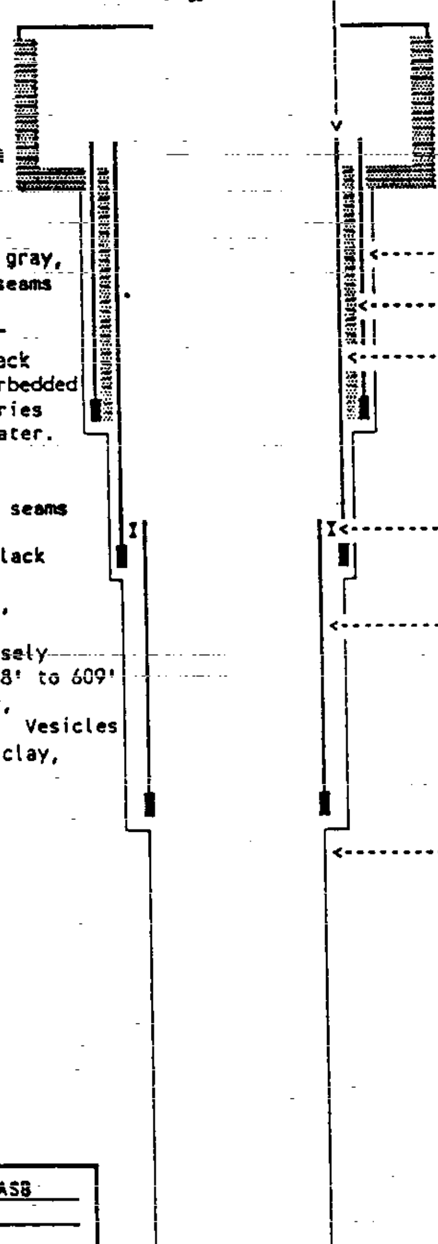
Drilling Method: Cable tool	Sample Method: Hard tool	WELL NUMBER: 699-111-24 — TEMPORARY WELL NO: PSN 500, 500-1
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 114,000 — E/W W 24,000
Driller's Name: R. J. Strasser (?)	WA State Lic Nr: Not documented	State Coordinates: N 516,240 — E 2,271,200
Drilling Company: Strasser Drilling Co	Company Location: Portland, OR	Start Card #: Not documented — T14N R27E S2C1
Date Started: 05Nov51	Date Complete: 15Jan52	Elevation Ground surface (ft): Not documented

Depth to water: 287 ft Jan52

Elevation of reference point: 699.14 ft (Top of casing)

GENERALIZED STRATIGRAPHY Driller's Log

- 0-109: CLAY, hard, compact white
- 109-148.5: SHALE, red-brown
- 148.5-151: SAND lens
- 151-204: SHALE, red-brown
- 204-208: CLAY, blue
- 208-254: BASALT, brown and gray, hard, green CLAY seams
- 254-269: BASALT, black somewhat vesicular
- 269-294: BASALT, dense, black
- 294-350: BASALT, with interbedded Sand lenses. Carries small amount of water.
- 350-509: BASALT, dense, gray to black
- 509-527: BASALT, gray with seams of blue CLAY
- 527-604: BASALT, gray to black
- 604-608: BASALT, gray with soapstone streaks, water bearing
- 608-614: BASALT, gray, closely fractured from 608' to 609'
- 614-620: BASALT, vesicular, slightly altered. Vesicles coated with blue clay, water bearing
- 620-634.5: BASALT



Drawing By: RKL/6#111-24.ASB
Date: 14Jan91
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY AS-BUILT

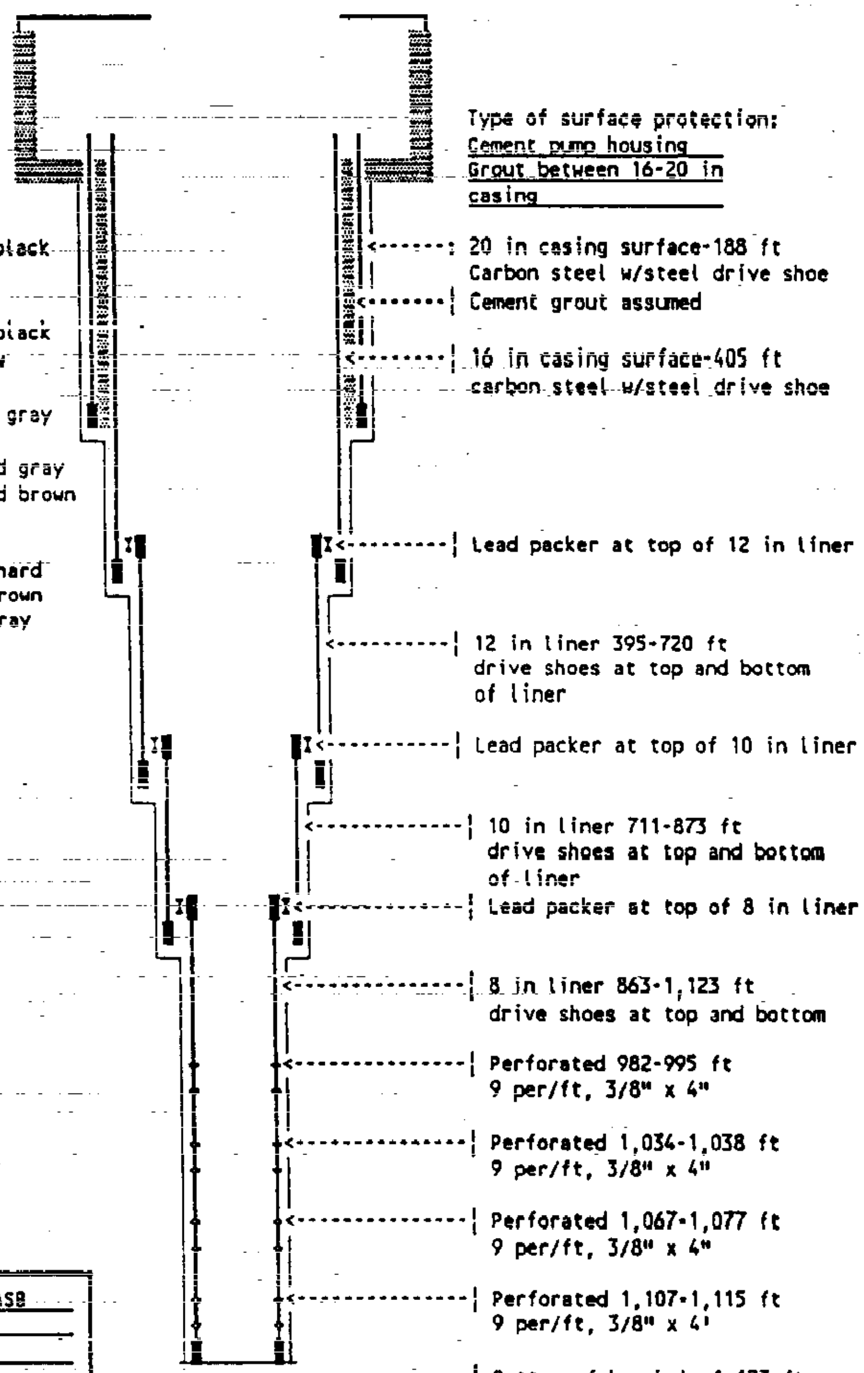
Drilling Method: Cable tool	Sample Method: Hard tool	WELL NUMBER: 699-112-37	TEMPORARY WELL NO: Well #8, PSN 535
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 111,737	E/W W 36,569
Driller's Name: R. J. Strasser (?)	WA State Lic Nr: Not documented	State Coordinates: N 516,945	E 2,258,469
Drilling Company: Strasser Drilling Co	Company Location: Portland, OR	Start Card #: Not documented	T15N R27E S32E
Date Started: Not documented	Date Complete: 29Jan54	Elevation Ground surface (ft): Not documented	

Depth to water: 262 ft Jan54

Elevation of reference point: 741.82 ft (Southwest corner

GENERALIZED Driller's STRATIGRAPHY Log

0-3: TOP SOIL
3-277: CALICHE and CLAY, some SAND
277-372: BASALT, porous black and gray
372-404: CLAY, SAND, TALUS
404-565: BASALT, gray and black
565-575: CLAY, gray
575-580: Coarse SAND, CLAY
580-765: BASALT, gray and black
765-862: CLAY, blue, yellow w/broken BASALT
862-982: BASALT, black and gray
982-998: BASALT, brown (W)
998-1034: BASALT, black and gray
1034-1038: CINDERS, red and brown
1038-1067: BASALT, black
1067-1077: BASALT, brown
1077-1107: BASALT, black, hard
1107-1115: BASALT, light brown
1115-1123: BASALT, hard, gray



Drawing By: RKL/6#112#37.ASB
Date: 14Jan91
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY AS-BUILT

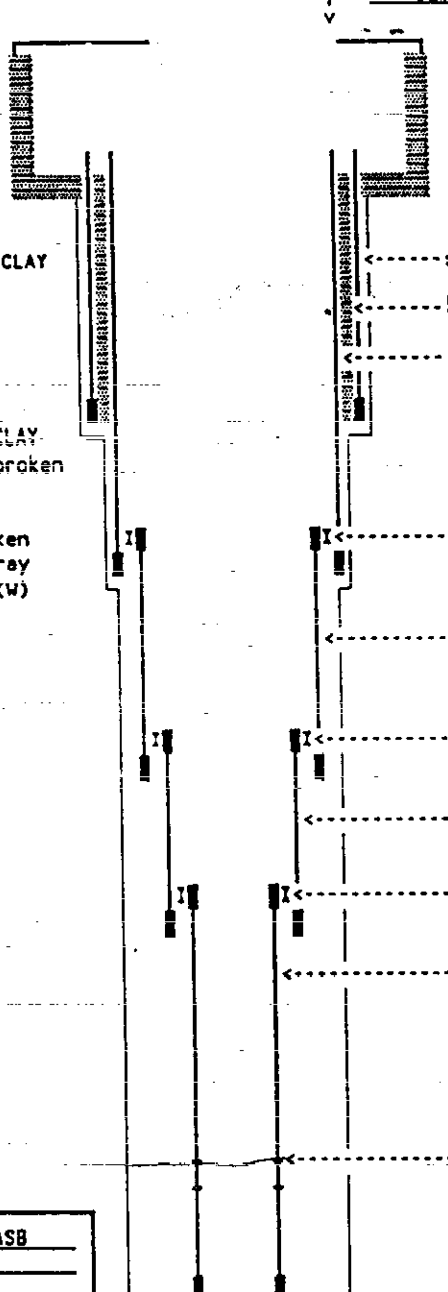
Drilling Method: Cable tool	Sample Method: Hard tool	WELL NUMBER: 699-115-61 TEMPORARY WELL NO: Well #7, PSN 420
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 114,633 E/W W 60,557
Driller's Name: R. J. Strasser (?)	WA State Lic Nr: Not documented	State Coordinates: N 519,779 E 2,234,474
Drilling Company: Strasser Drilling Co	Company Location: Portland, OR	Start Card #: Not documented T15N R26E S28Q
Date Started: Not documented	Date Complete: 01Sep53	Elevation Ground surface (ft): Not documented

Depth to water: 317 ft Sep53

Elevation of reference point: 790.60 ft (Top Steel Plate)

GENERALIZED Driller's STRATIGRAPHY Log

0-13: TOPSOIL
13-16: CLAY and GRAVEL
16-23: Brown SAND
23-216: Brown and gray CLAY
216-276: CLAY and SAND, brown and gray
276-298: Broken BASALT and CLAY
298-341: Hard gray BASALT
341-360: Porous black ROCK w CLAY
360-366: Yellow CLAY
366-398: Porous black ROCK
398-522: Gray BASALT
522-558: Gray, red, brown CLAY
558-660: BASALT, gray and broken
660-788: Yellow, brown and gray CLAY
788-861: BASALT, gray, broken
861-868: Red, yellow and gray broken (BASALT?) (W)
868-892: Gray BASALT



Type of surface protection: Cement pump housing Grout between 16-20 in casing

20 in casing surface-258 ft Carbon steel w/steel drive shoe

Cement grout assumed

16 in casing surface-415 ft carbon steel w/steel drive shoe

Lead packer at top of 12 in liner

12 in liner 405-582 ft drive shoes at top and bottom of liner

Lead packer at top of 10 in liner

10 in liner 562-767 ft drive shoes at top and bottom of liner

Lead packer at top of 8 in liner

8 in liner 757-892 ft drive shoes at top and bottom

Perforated 860-870 ft 9 per/ft, 3/8" x 4"

Bottom of borehole 892 ft

Drawing By: RKL/6#115#61.ASB
Date: 14Jan91
Reference:

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APPENDIX E

LIMITED GEOPHYSICAL SURVEY

LIMITED GEOPHYSICAL SURVEY

1.1 MAGNETIC METHODS

Magnetic instruments used during this investigation consisted of magnetic gradiometers. These instruments, which are proton precession magnetometers, measure the intensity of the earth's magnetic field in nanoteslas (nT) and the vertical gradient of the magnetic field in nanoteslas per meter (nT/m). The vertical gradient is measured by simultaneously recording the magnetic field with two sensors at different heights. To determine the vertical magnetic gradient, the upper sensor reading is subtracted from the lower sensor reading, and the result is then divided by the distance between the sensors.

During operation of the proton precession magnetometer, direct current is applied to a coil that is wrapped around a sensor bottle filled with a hydrogen-rich fluid. The current temporarily polarizes the protons in the fluid. When the current is turned off, the protons precess around the earth's magnetic field at a frequency proportional to the total magnetic field intensity (Milsom 1989). Measurement of the precession frequency, as a voltage induced in another coil, permits the calculation of the intensity of the earth's magnetic field.

The earth's magnetic field originates in currents in the earth's liquid outer core. The magnetic field varies in intensity from about 25,000 nT near the equator, where it is parallel to the earth's surface, to about 70,000 nT near the poles, where it is perpendicular to the earth's surface. In North America, the intensity of the earth's magnetic field varies from about 48,000 to 60,000 nT.

Anomalies in the earth's field are caused by induced or remanent magnetism. Remanent magnetism is magnetism caused by naturally magnetic materials. Induced magnetic anomalies result from the induction of a secondary magnetic field in a ferromagnetic material (such as pipelines, drums, tanks, or well casings) due to the earth's magnetic field. The shape and amplitude of an induced magnetic anomaly over a ferromagnetic object depends on the geometry, size, depth, and magnetic susceptibility of the object and on the magnitude and inclination of the earth's magnetic field in the study area (Dobrin 1976; Telford et al. 1976). The inclination of the earth's magnetic field varies from about 60 to 75 degrees in North America, and induced magnetic anomalies over buried objects such as drums, pipes, tanks, and buried metallic debris generally exhibit an asymmetrical, south up/north down signature (maximum amplitude on the south side and minimum on the north). Magnetic anomalies due to buried metallic objects have dimensions much greater than the dimensions of the objects themselves. As an extreme example, a magnetometer may begin to sense a buried oil well casing at a distance of more than 50 ft.

The magnetic method is not effective in areas having ferromagnetic material at the surface because the signal from the surface material obscures the signal from any buried objects. Because of the high precision required in the measurement of the frequency at which the protons precess, the presence of an alternating current electrical power source can render the signal immeasurable (Breiner 1973). Furthermore, the precession signal is sharply degraded in the presence of large magnetic gradients exceeding about 600 nT/m (Breiner 1973).

Large volumes of data can be acquired quickly with modern magnetometers, and the clear signatures from strong magnetic sources such as metallic objects make magnetometers effective in their search. The magnetic method has been effectively used to delineate old waste sites and to search for oil wells, drums, tanks, pipes, and buried metallic debris. The method is also useful for searching for magnetic ore bodies, delineating basement rock, and mapping subsurface geology characterized by volcanic or mafic rocks.

1.2 ELECTROMAGNETIC METHODS

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Electromagnetic induction equipment used during this investigation consisted of a Metrotech Model 810 utility locator (a trademark of Metrotech Corporation), a Radio Detection Model RD-400 utility locator (RD-400) (a trademark of Radio Detection Corporation), a Fisher TW-6 metal detector (a trademark of Fisher Corporation), and a terrain conductivity meter (EM-31) with a digital data logger.

1.2.1. Utility Locator Methods

The Metrotech and RD-400 line tracers are specifically designed to accurately locate and delineate underground pipes and utilities. A transmitter emits a radio frequency signal that induces a secondary EM field in nearby utilities. A receiver unit measures the signal strength of this secondary field and emits an audible response to allow the precise location and tracing of the pipe, cable, or other conductor in which the signal is induced. If the utility is accessible, the source signal can be directly applied to it, making the secondary field much larger and more readily measured. These line tracers are effective in locating long metallic objects. A Fisher TW-6 metal detector was used to find smaller metallic objects and to aid in the accurate delineation of pits during field verification. The TW-6 has a transmitter and a receiver at the ends of a short boom. The transmitter induces an EM field, generating currents in flow when good conductors are encountered in the subsurface. These currents generate secondary fields that are measured by the receiver when the conductor is crossed.

1.2.2 Electromagnetic Induction Methods

The EM-31 has a transmitter coil mounted at one end and a receiver coil at the other end of a 12-ft-long plastic boom. An audio frequency alternating current is applied to the transmitter coil, causing the coil to radiate a primary electromagnetic (EM) field. As described by Faraday's law of induction, this time-varying magnetic field induces eddy currents in conductive materials in the subsurface. These eddy currents have an associated secondary magnetic field with a strength and phase shift (relative to the primary field) that depend on the conductivity of the medium. The receiver coil measures the resultant effect of both primary and secondary fields. By comparing the signal at the receiver to that at the transmitter, the instrument records the component of the secondary field in-phase (in-phase) and 90 degrees out-of-phase (quadrature) with the primary field.

Most geologic materials are poor conductors. The flow of current through the material takes place in the pore fluids (Keller and Frischknecht 1966); as such, conductivity is predominantly a function of soil type, porosity, permeability, pore fluid ion content, and degree of saturation. The EM-31 is calibrated so that the out-of-phase component is converted to electrical conductivity in units of millisiemens per meter (mS/m) (McNeill 1980). The in-phase component is read in parts per thousand (ppt) of the primary EM field and is generally adjusted in the field to read zero response over background materials.

The depth of penetration for EM induction instruments depends on the transmitter/receiver separation and coil orientation (McNeill 1980). The EM-31 has an effective exploration depth of about 18 ft when operating in the vertical dipole mode (horizontal coils). In this mode, the maximum instrument response results from materials at a depth about two-fifths the coil spacing (about 2 ft below ground surface with the instrument at the normal operating height of about 3 ft), providing that no large metallic features such as tanks, drums, pipes, and reinforced concrete are present. A single buried drum typically can be located to depths of about 5 ft, whereas clusters of drums can be located to significantly greater depths if background noise is limited or negligible. The EM-31 has an effective exploration depth of about 9 ft when operating in the horizontal dipole mode (vertical coils) and is most sensitive to materials immediately beneath the ground surface.

The EM-31 generally must pass over or very near to a buried metallic object to detect it. Both the out-of-phase and in-phase components exhibit a characteristic anomaly over near-surface metallic conductors. This anomaly consists of a narrow zone having strong negative amplitude centered over the target and a broader lobe of weaker, positive amplitude on either side of the target. For long, linear conductors such as pipelines, the characteristic anomaly is as described when the axis of the coil (instrument boom) is at an angle to the conductor. However, when the instrument boom is oriented parallel to the conductor, a positive amplitude anomaly is obtained.

EM applications include mapping conductive groundwater contaminant plumes in very shallow aquifers and delineating oil brine pits; landfill boundaries; buried pipes, cables, drums, tanks; and pits and trenches containing buried metallic and nonmetallic debris.

2.0 RESULTS OF GEOPHYSICAL SURVEYS

2.1 SITE PSN-04 (NORTH)

Interpretation of the geophysical data for site PSN-04 (north) is summarized in Figure E-1.

No anomalies indicative of significant amounts of buried metallic debris are evident on the contour maps of total magnetic field and vertical magnetic gradient. Two anomalies that appear to be associated with subsurface geology are evident on the contour maps of conductivity. A decrease in conductivity occurs over a soil mound (topographic high) and an increase in conductivity occurs in a topographic depression, indicating that a geologic unit with higher conductivity than the overlying layer occurs in the shallow subsurface. Another anomaly, labeled A-1, is indicative of a small metallic object buried at shallow depth.

2.2 SITE PSN-04 (SOUTH)

Interpretation of the geophysical data for site PSN-04 (south) is summarized in Figure E-2.

Several anomalies are evident on the contour maps of magnetic and EM-31 data. First, an anomaly caused by a reinforced-concrete pad located immediately south of the survey area is apparent on the contour maps of both magnetic and EM-31 data. Second, a northeast-trending buried pipe appears as an anomaly on contour maps of both magnetic and EM-31 conductivity data. This pipe is not apparent on contour maps of EM-31 in-phase component data. The pipe was accurately traced and marked at the site using an EM utility locator. Finally, an anomaly indicative of a buried metallic object, possibly a vault, is evident at the central portion of the pipe in the contour maps of both magnetic and EM-31 conductivity and in-phase component data and is labeled anomaly A-1.

2.3 SITE PSN-04 (EAST)

Interpretation of the geophysical data for site PSN-04 (east) is summarized in Figure E-3.

One anomaly indicative of buried metallic debris is apparent on the contour maps of magnetic and EM-31 data. This anomaly, labeled A-1, appears to be caused by a trench containing metallic debris. Partially buried barbed wire and wood debris on the surface indicate that the top of the debris is immediately below ground surface. With the exception of a small anomaly on the southern boundary of the site caused by a large roll of barbed wire lying on the surface, no other anomalies are apparent on the contour maps of magnetic data. In addition, no other EM-31 in-phase component anomalies are apparent on the contour maps. EM-31 conductivity data are highly variable across the site, most likely due to a combination of changing subsurface geology and elevation changes. In the eastern portion of the site, conductivity decreases over topographic highs and increases over depressions as a result of changes in relative distance to a fine-grained subsurface geologic layer. An increase in conductivity in the western portion of the site is associated with an increase in slope and probably reflects changing geologic materials.

2.4 SITE PSN-04 (WEST)

Interpretation of the geophysical data for site PSN-04 (south) is summarized in Figure E-4.

Three anomalies that are probably caused by trenches containing metallic debris are evident on the contour maps of magnetic data and are labeled as anomalies A-1 through A-3. Anomalies A-1 and A-2 are associated with topographic depressions exhibiting stressed vegetation. Soil stockpiles are located at the northeastern end of these features, indicating that the depressions may be the result of past excavation. Only very slight positive anomalies are evident over these trenches on the EM-31 in-phase component contour maps. EM-31 conductivity data are highly variable within the survey area, most likely due to changing subsurface geology. A linear zone of higher conductivity correlates with anomaly A-1 on the magnetic and in-phase component contour maps, and a linear zone of lower apparent conductivity correlates with anomaly A-3. The trench associated with anomaly A-2 on the contour maps of magnetic and EM-31 in-phase component data is not evident on the contour maps of conductivity. The minimal EM-31 response to the three trenches suggests that the top of metallic debris may be at depths of more than 3 ft in the trenches. Nonmetallic debris and minor amounts of metallic debris may be present at shallower depths. Although no significant magnetic or EM-31 anomalies are associated with an area of stressed vegetation observed between anomalies A-2 and A-3, the stressed vegetation may be due to disposal of nonmetallic materials near the surface or in a trench.

2.5 SITE H-06-H (EAST)

Interpretation of the geophysical data for site H-06-H (east) is summarized in Figure E-5.

A total of 15 anomalies indicative of buried metallic debris are evident on the contour maps of magnetic and/or EM-31 data. Anomalies A-1, A-2, A-3, A-4, A-5, A-7, A-8, A-10, and A-14 are caused by pits containing near-surface metallic debris. These pits were field checked with the EM-31 and staked after preliminary data processing; they range in size from about 5 by 5 ft to about 15 by 30 ft. Pits A-1 and A-2 are evident as relatively high-amplitude magnetic anomalies but only low-amplitude EM-31 anomalies. The low-amplitude EM-31 response over these pits may indicate metallic debris buried at depths of 3 ft or more or may be simply a function of the location of the survey lines relative to the buried metallic debris. Pits A-3, A-7, and A-8 are evident as high-amplitude magnetic and EM-31 anomalies and, therefore, most likely contain relatively near-surface metallic debris. Pits A-4, A-5, A-10, and A-14 are evident as weak magnetic and EM-31 anomalies. These anomalies are relatively small and may be indicative of only minor amounts of metallic debris or the amplitudes of these anomalies may be a function of the measurement station locations relative to the pits rather than of the pit contents.

Anomaly A-9, which is only clearly visible on the contour maps of EM-31 data collected along east-west lines, is caused by a number of partially buried, liquid-bearing paint cans on the side of a small depressed area. Anomalies A-13 and A-15 are very small and appear to be caused by a single buried metallic object or possibly a very small pit (<5 by 5 ft) containing metallic debris. Anomaly A-13 is apparent on contour maps of both magnetic and EM-31 data, and A-15 is visible on the contour maps of magnetic data. Anomalies A-6, A-11, and A-12 have high amplitudes on contour maps of both magnetic and EM-31 data and are caused by large trenches containing buried metallic and nonmetallic debris. These trenches were accurately delineated with the EM-31 after preliminary field data processing had been completed. Trenches A-6 and A-12, both of which probably contain significant amounts of near-surface metallic debris, are about 15 by 60 ft and 15 by 40 ft, respectively. Trench A-11 is the most predominant anomalous zone on the site. Delineating this feature with the EM-31 indicated that the trench extends approximately 175 ft north of the site and may have a total length of about 325 ft. Significant portions of the trench may contain predominantly nonmetallic debris. Reevaluation of the geophysical data indicated that the trench may extend south to include anomalies A-10 and A-7.

2.6 SITE H-06-H (WEST)

Interpretation of the geophysical data for site H-06-H (west) is summarized in Figure E-6.

A total of 22 anomalies possibly caused by buried metallic debris were identified during the geophysical investigation at this site. Although almost all of the anomalies are apparent on the contour maps of magnetic data, many are not evident on the contour maps of EM-31 data; however, most of the anomaly sources were located and delineated with the EM-31 during the field verification phase. The sources of many of the anomalies not evident on the EM-31 contour maps were found between survey lines. Many small pits or buried metallic objects onsite may not have been located during this survey because magnetic and EM-31 data were acquired along lines spaced 30 ft apart; however, all large pits and trenches are believed to have been successfully located. Because of the relatively coarse line spacing used during this survey, many of the conclusions made as to the characteristics of the anomalies are derived from notes taken during the field verification of anomalies instead of from the characteristics of the anomalies observed on the contour maps.

To facilitate discussion, the anomalies are grouped into several categories as follows: those caused by trenches (longest dimension exceeding approximately 50 ft), those caused by large pits (dimensions exceeding about 20 by 20 ft), those caused by small pits (dimensions ranging from about 5 by 5 ft to 20 by 20 ft), and those caused by small buried metallic objects.

Anomalies A-2, A-5, A-7, A-16, and A-19 are caused by trenches containing metallic and nonmetallic debris. Trench A-2 generated only two small magnetic and EM-31 anomalies. However, stressed vegetation, a slight topographic depression/subsidence, and scattered glass fragments and bottles on the surface indicate that the trench encompasses an area larger than suggested by the anomalies. The trench is thought to contain predominantly nonmetallic debris, and the boundary probably coincides with the stressed vegetation and topographic depression. Trench A-5 is evident as high-amplitude magnetic and EM-31 anomalies and probably contains significant amounts of near-surface metallic debris. Metallic debris is exposed at the surface in some portions of this trench. Field verification of anomaly A-7 indicated that some areas of the trench likely contain high concentrations of metallic debris and other areas contain predominantly nonmetallic debris. Trench A-16 is apparent on contour maps of both magnetic and EM-31 data, indicating that it probably contains significant amounts of near-surface metallic debris. Trench A-19 generated a high-amplitude magnetic anomaly but only weak EM-31 anomalies. The trench was difficult to delineate with the EM-31; as a result, stressed vegetation and slight subsidence were used as guides in staking the trench. The metallic debris causing the magnetic anomalies may be at depths exceeding 4 ft, and the trench may contain significant amounts of nonmetallic debris.

Anomalies A-1, A-4, A-12, A-13, and A-17 are caused by large pits containing buried metallic debris. Field verification of these anomalies indicated the following: (1) minor amounts of metallic debris are exposed at the surface in pits A-1 and A-4; (2) pits A-12 and A-13 appear to contain only minor amounts of metallic debris, but may contain significant amounts of nonmetallic debris; and (3) pit A-17 contains near-surface metallic debris.

Anomalies A-6, A-8, A-10, A-11, A-15, and A-20 are caused by small pits containing metallic debris. Metallic debris is exposed at the surface in pits A-6 and A-8.

Field checking of magnetic and/or EM-31 anomalies A-3, A-9, A-14, A-18, A-21, and A-22 with the EM-31 indicated that they are most likely caused by small buried metallic objects. Many more small features like these may be present at the site, but may not have been located because of the course line spacing used during this investigation.

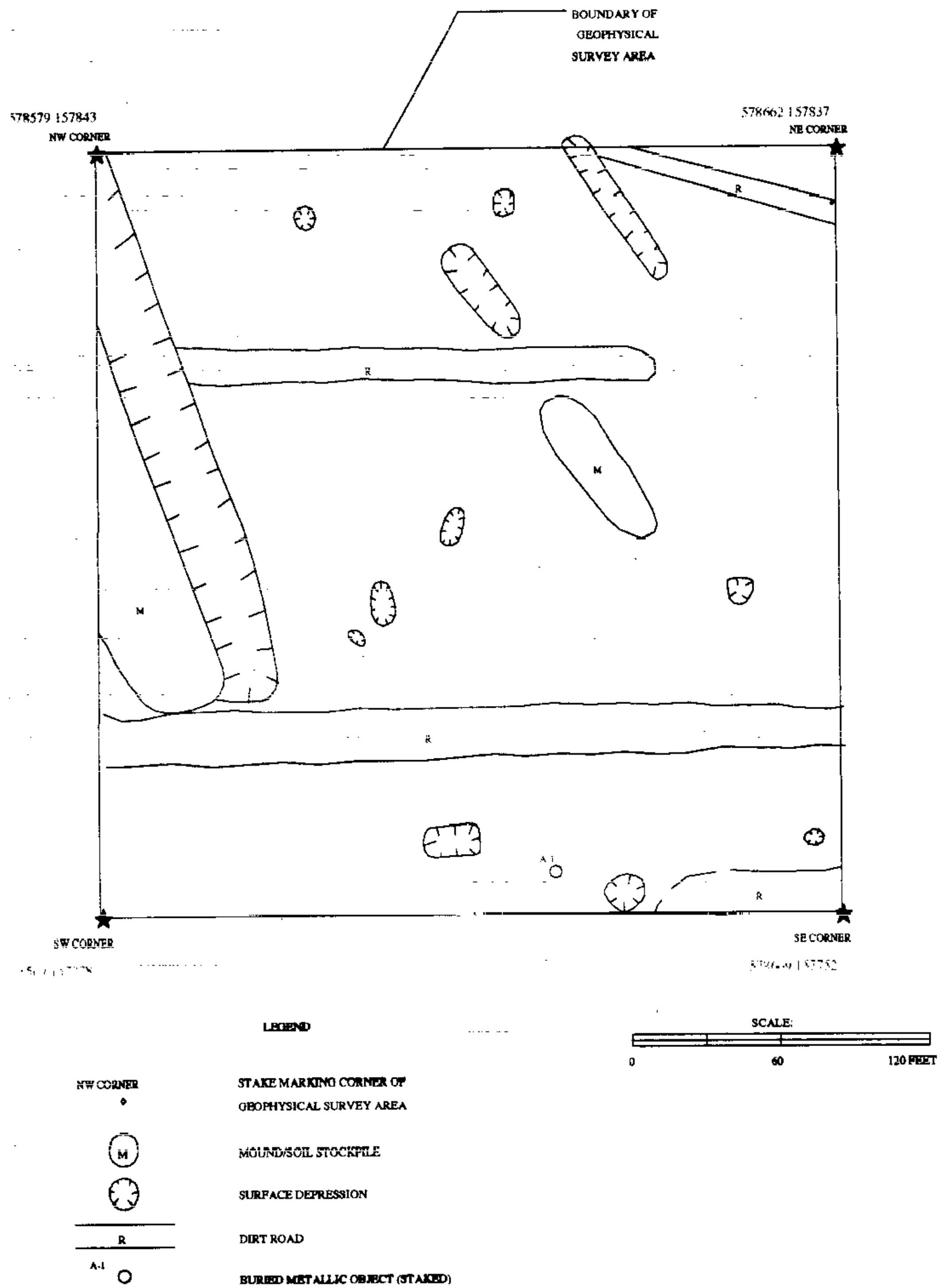
2.7 SITE H-83-L

Interpretation of the geophysical data for site H-83-L is summarized in Figure E-7.

Seven anomalies labeled A-1 through A-7 are evident on contour maps of magnetic and/or EM-31 data. In general, all magnetic and EM-31 anomalies were field checked, delineated with the EM-31, and marked with stakes and flagging.

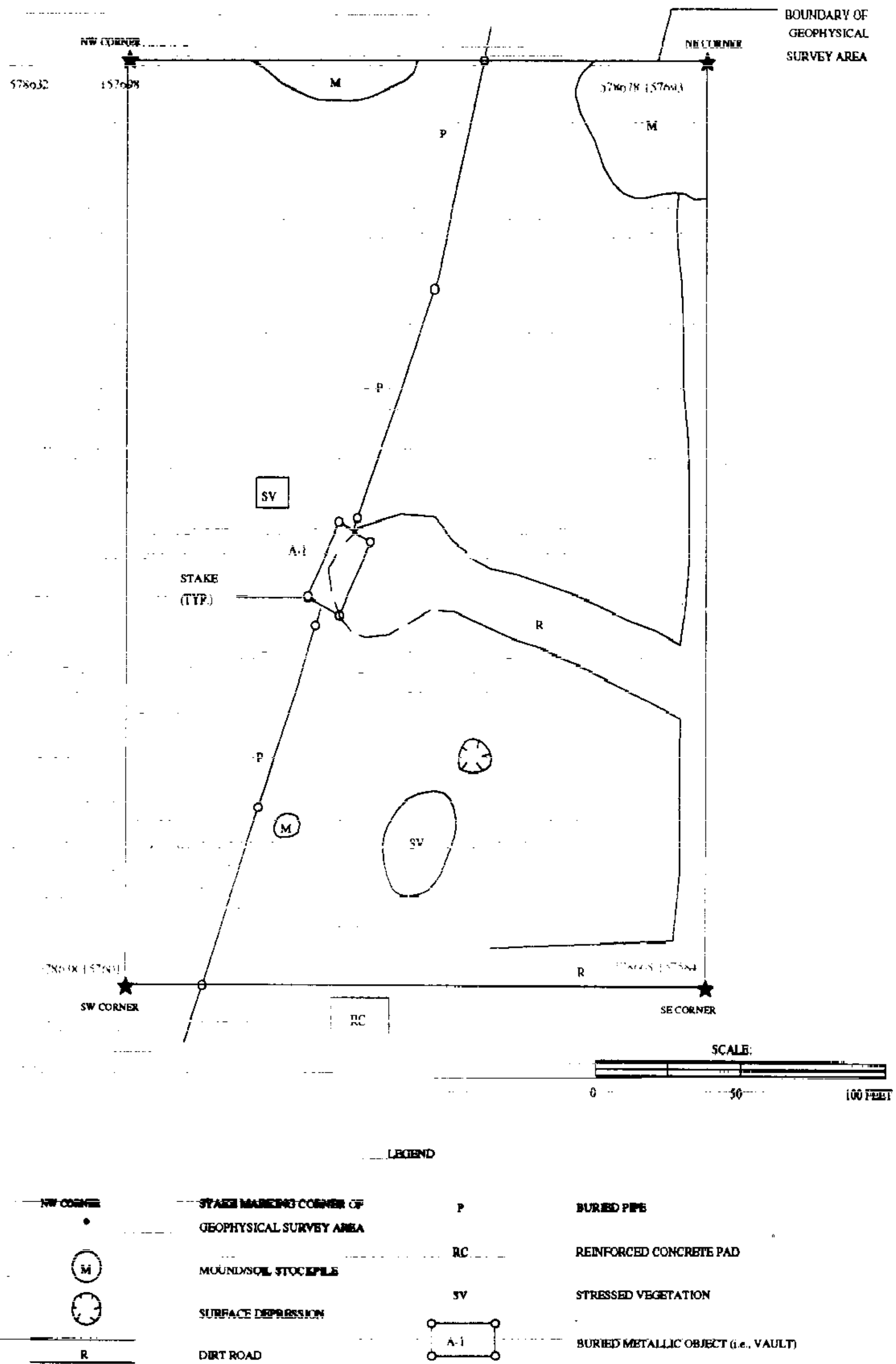
A-1 is evidenced by strong magnetic but relatively weak EM-31 anomalies. This anomaly coincides with two small depressions and is probably caused by a trench containing metallic debris. A-2 and A-3 are indicated by strong magnetic and EM-31 anomalies. Anomaly A-2 is associated with a topographic depression and is caused by a trench containing metallic debris. No apparent surface disturbances are associated with anomaly A-3, which also appears to be caused by a trench containing metallic debris. Anomaly A-4, which is apparent only on the contour maps of EM-31 conductivity, is associated with a slight topographic depression. When passing through the depression, the EM-31 is closer to a subsurface geologic layer having higher conductivity than the overlying layer, resulting in a slight increase in conductivity. This anomaly was staked in the field because a large amount of surface metallic objects such as drums and metal pails were removed from the depressed area prior to conducting the geophysical survey, indicating possible contamination of near-surface soils. Anomaly A-5 is evident on contour maps of both magnetic and EM-31 data. A piece of buried steel cable is exposed at the surface, and the anomaly likely results from a small pit containing steel cable and possibly other debris. Anomaly A-6, which is evident on contour maps of both magnetic and EM-31 data, was caused by approximately 20 1-quart containers of oil discovered under a pile of wood. Most of these containers contain liquid, and no evidence of subsurface disposal was found at this location. Anomaly A-7 is a low-amplitude anomaly that occurs only on the contour map of in-phase component for southeast-northwest survey lines. This anomaly is likely caused by a small object buried in the shallow surface. This anomaly was not field checked or staked.

Figure E-1. Site Map with Geophysical Interpretation
Site PSN-04 (North) Wahluke Slope.



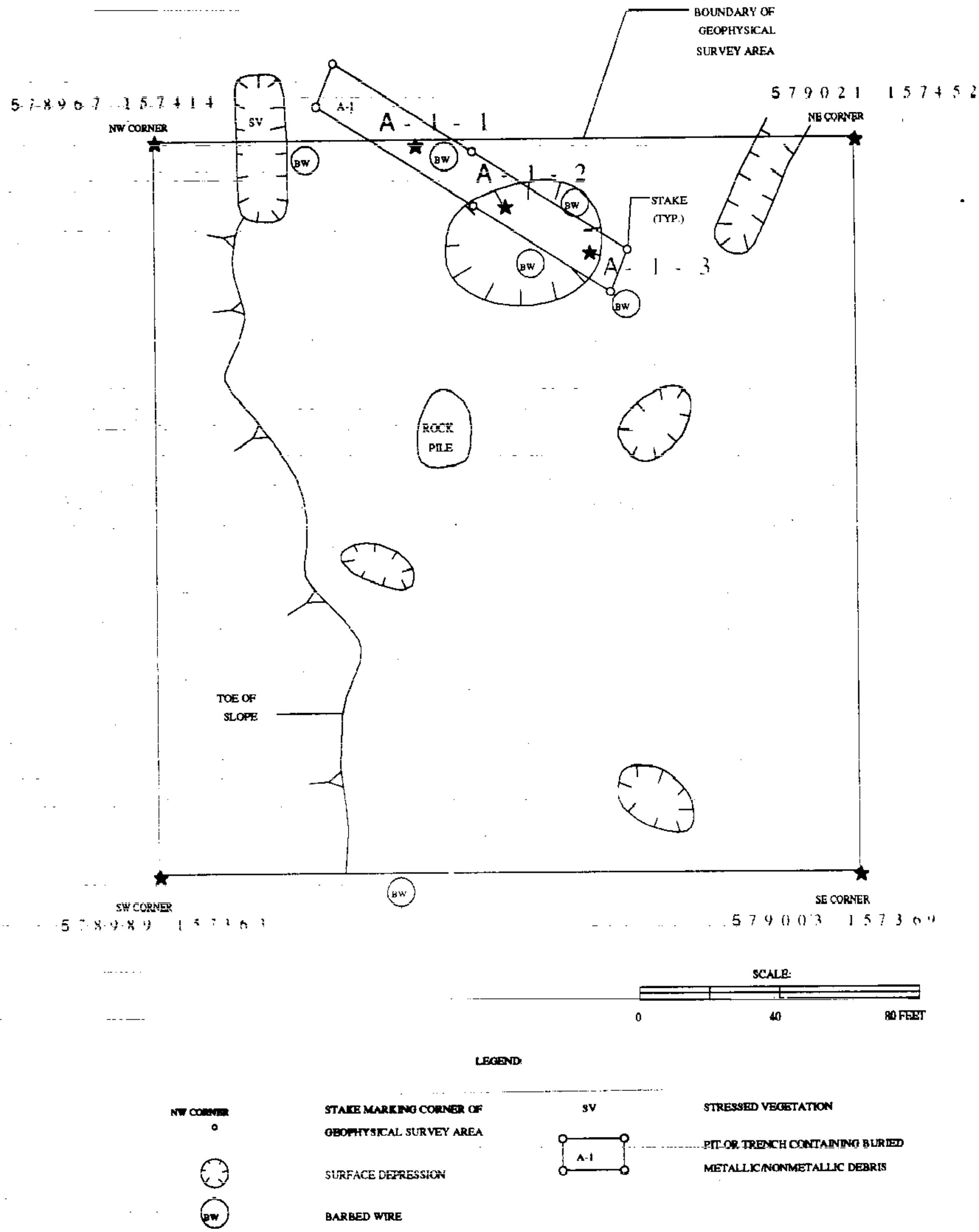
The * represents the approximate sample locations. In addition, the site numerical designator from Table 2 is included in the sample location description in the laboratory analytical results appendix (Appendix G).

Figure E-2. Site Map with Geophysical Interpretation Site PSN-04 (South) Wahluke Slope.



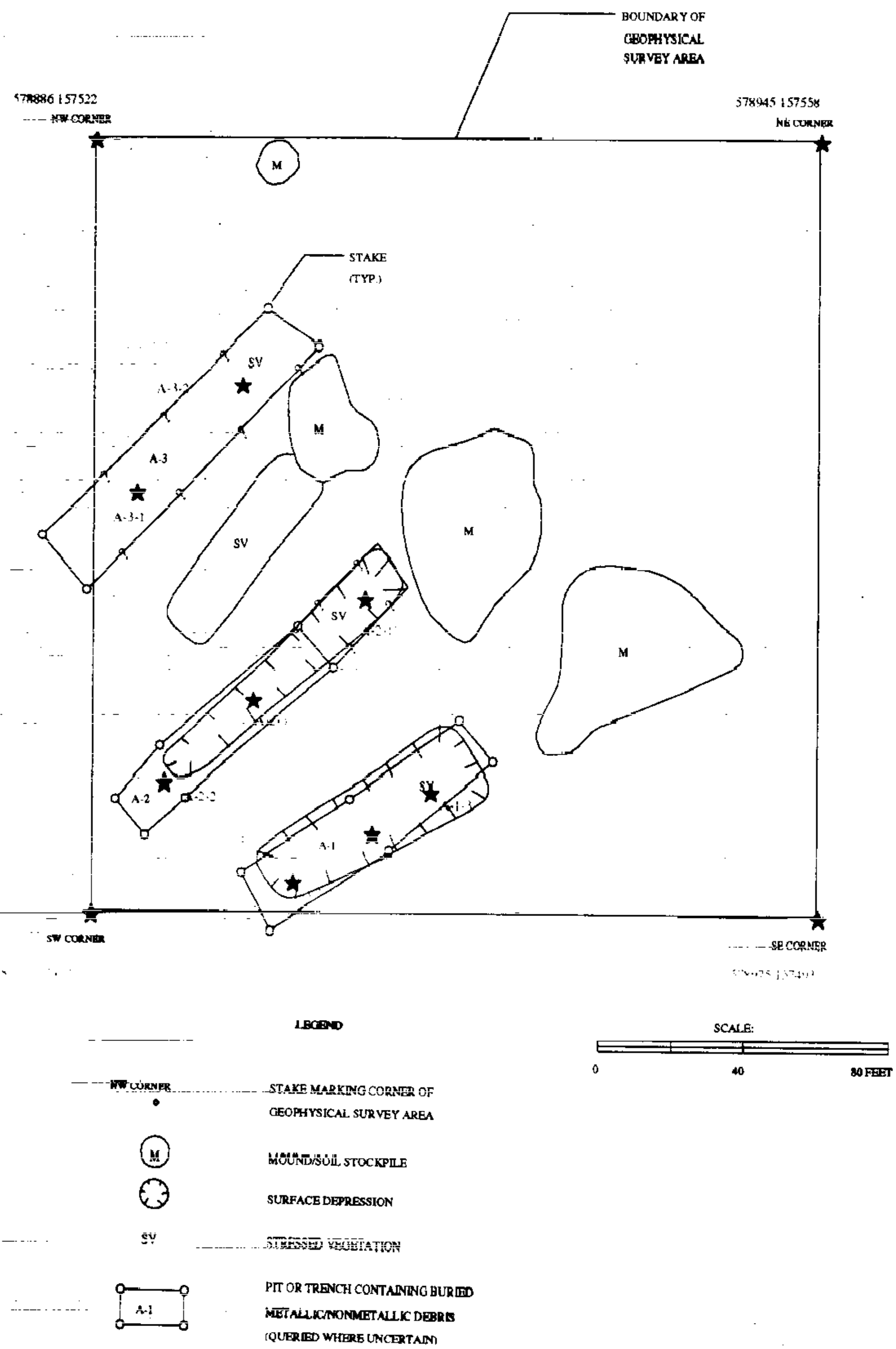
The * represents the approximate sample locations. In addition, the site numerical designator from Table 2 is included in the sample location description in the laboratory analytical results appendix (Appendix G).

Figure E-3. Site Map with Geophysical Interpretation
Site PSN-04 (East) Wahluke Slope.



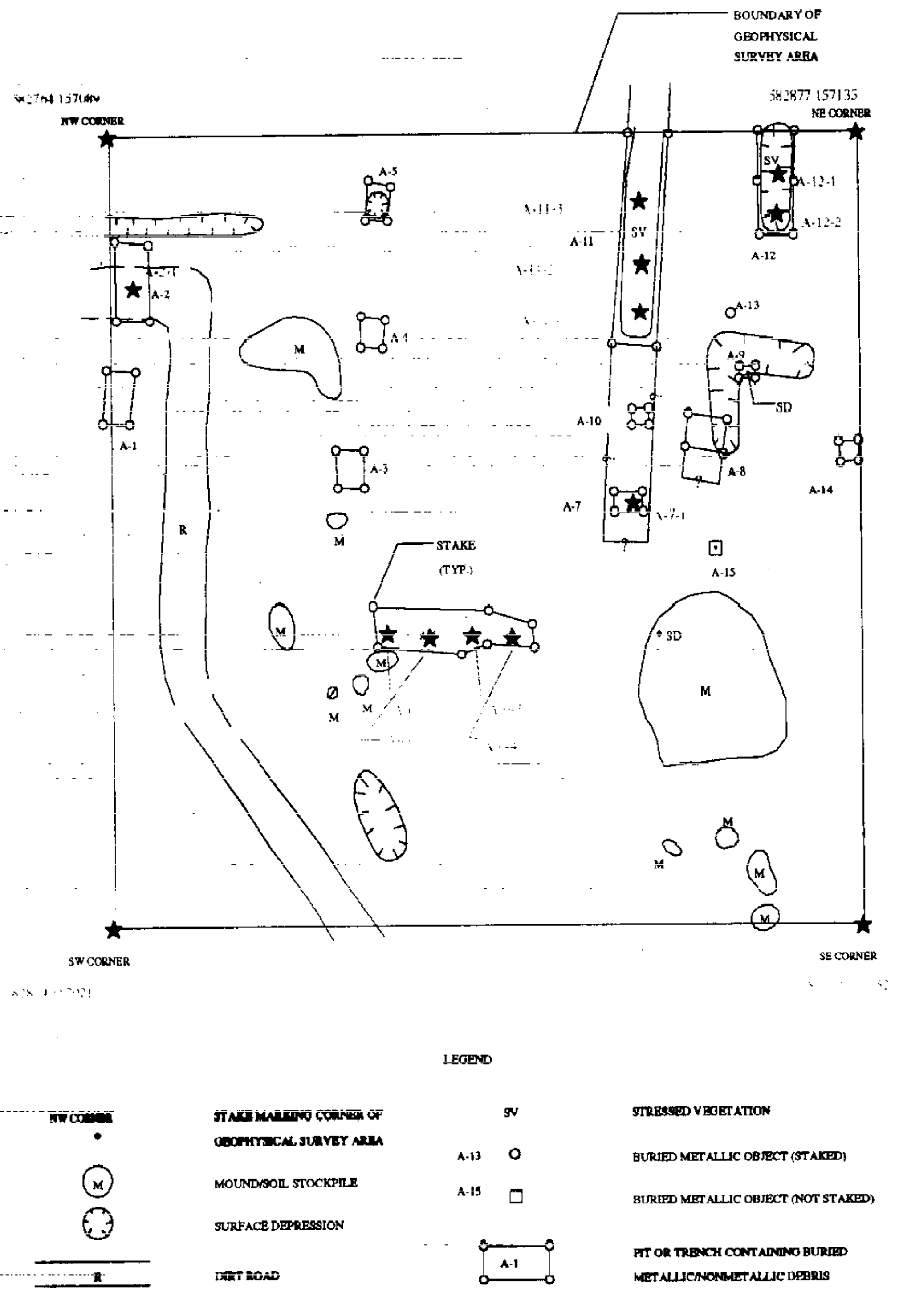
The * represents the approximate sample locations. In addition, the site numerical designator from Table 2 is included in the sample location description in the laboratory analytical results appendix (Appendix G).

Figure E-4. Site Map with Geophysical Interpretation
Site PSN-04 (West) Wahluke Slope.



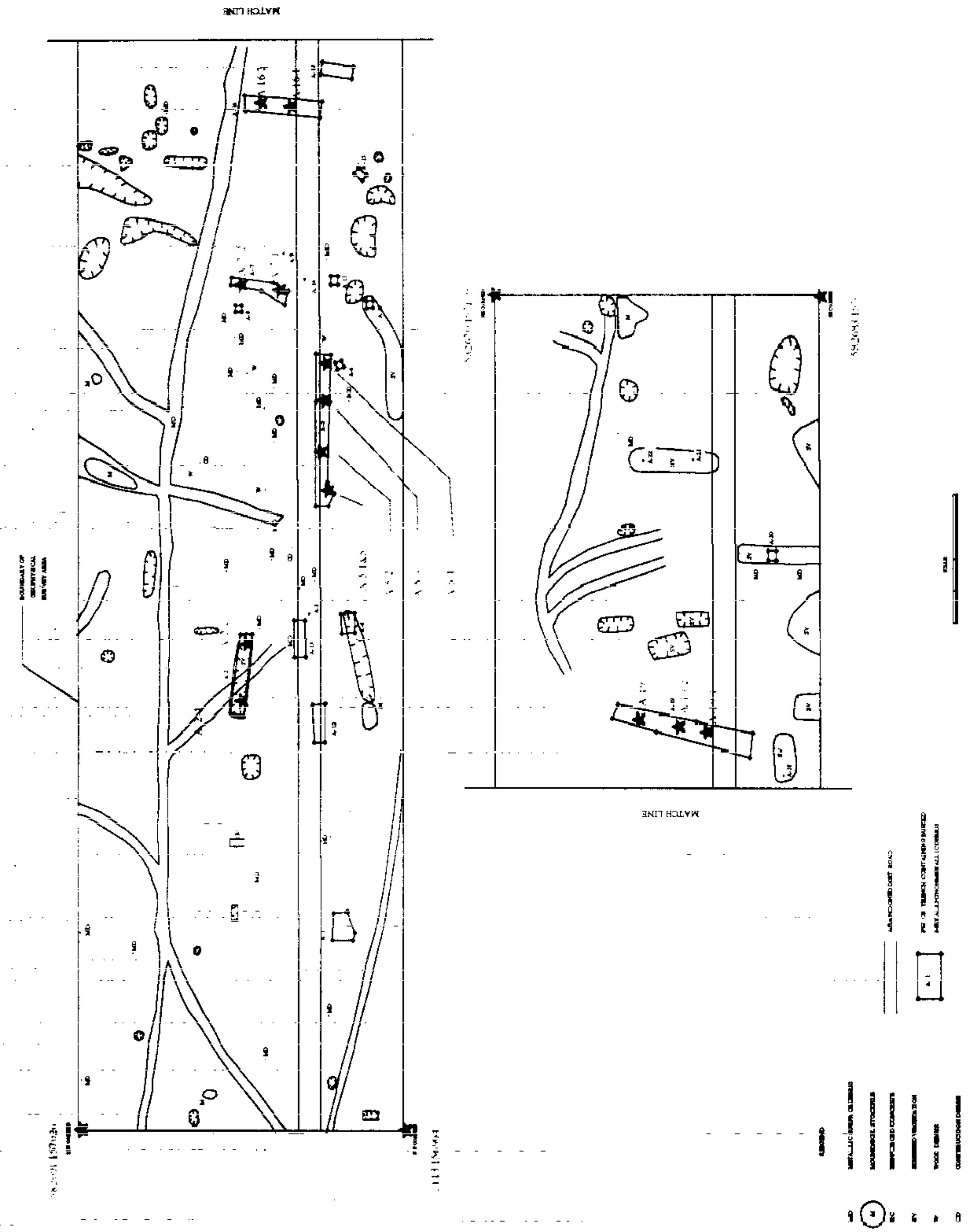
The * represents the approximate sample locations. In addition, the site numerical designator from Table 2 is included in the sample location description in the laboratory analytical results appendix (Appendix G).

Figure E-5. Site Map with Geophysical Interpretation
Site H-06-H (East) Wahluke Slope.



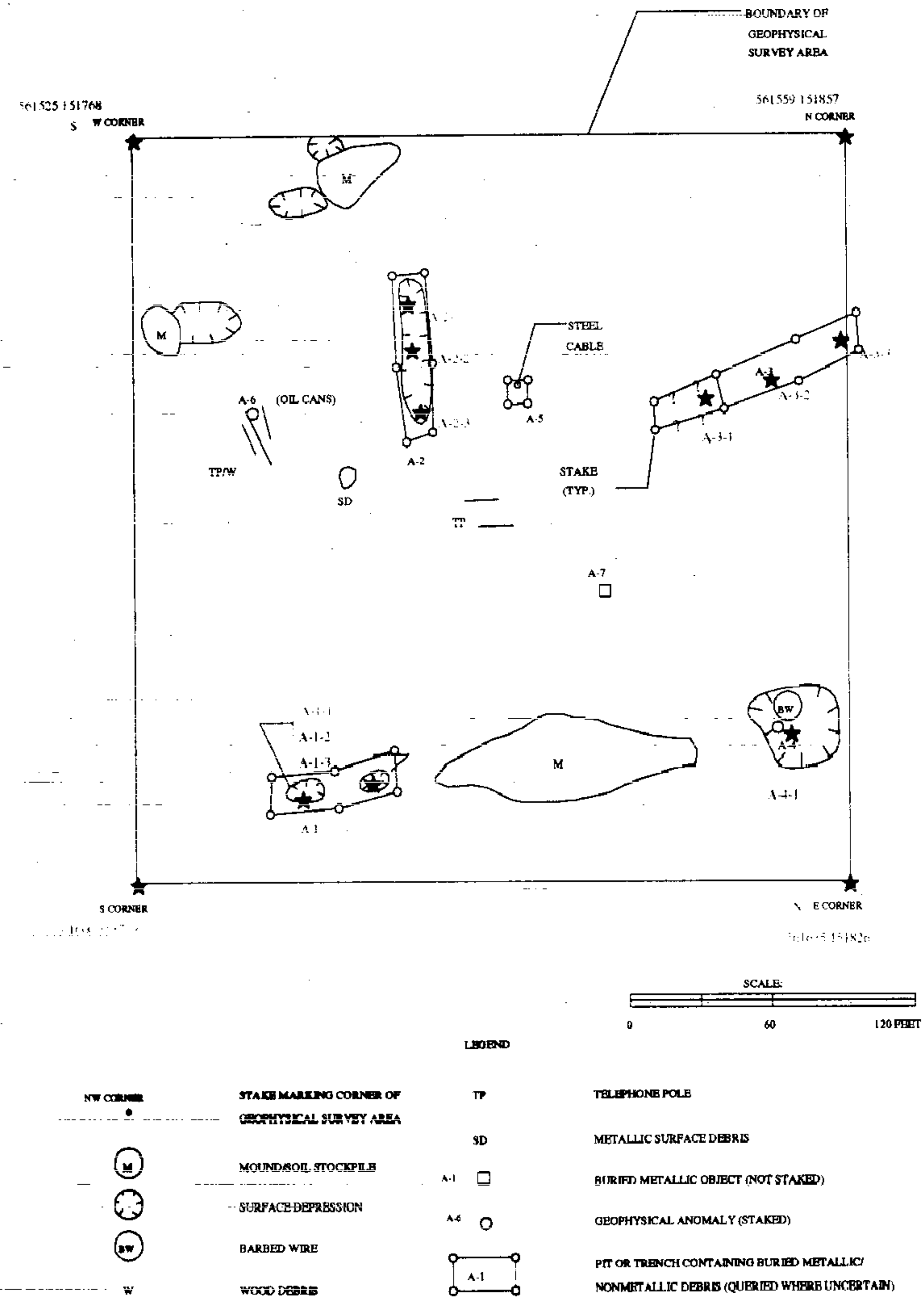
The * represents the approximate sample locations. In addition, the site numerical designator from Table 2 is included in the sample location description in the laboratory analytical results appendix (Appendix G).

Figure E-6. Site Map with Geophysical Interpretation
Site H-06-H (West) Wahluke Slope.



The * represents the approximate sample locations. In addition, the site numerical designator from Table 2 is included in the sample location description in the laboratory analytical results appendix (Appendix G).

Figure E-7. Site Map with Geophysical Interpretation
Site H-83-L Wahluke Slope.



The * represents the approximate sample locations. In addition, the site numerical designator from Table 2 is included in the sample location description in the laboratory analytical results appendix (Appendix G).

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APPENDIX F

NIKE MISSILE BATTERY HISTORICAL OVERVIEW

1.0 NIKE PROGRAM BACKGROUND

The *Historical Overview of the Nike Missile System* (McMaster et al. 1984) was the main source of background material regarding the history of the Nike program. Portions of this overview are summarized herein to provide proper background information regarding the Nike program.

Nike Ajax and Nike Hercules missiles were deployed by the U.S. Army throughout the continental United States (CONUS) 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 antiaircraft 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 retrofitted for the new equipment, because of budget limitations. Guidelines provided for retrofitting 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. 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, Texas, for the purpose of training troops from other North Atlantic Treaty Organization countries that still incorporate Nike missiles in their defense programs.

2.0 NIKE PROGRAM MILITARY ORGANIZATION

2.1 NATIONAL AIR DEFENSE ORGANIZATION

Background information for this section was taken directly from the historical overview and was substantiated during site operator interviews, with minor modifications. 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 Antiaircraft Command (ARAACOM) located at Ent Air Force Base in Colorado Springs, Colorado. The installation of Nike Ajax batteries beginning in 1953, led to further reorganization 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 1951, the Army's air defense responsibility within CONUS was defined as point air defense by missiles fired from the ground to aerial targets not more than 100 mi 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 redesignated 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 one Commander in Chief, who also headed CONAD. Like CONAD, NORAD elements in the United States 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.

2.2 NIKE SYSTEM ORGANIZATION

The basic operational unit of a Nike site was the battery. The battery was commanded by an Army Captain. On a specific site, the battery was subdivided 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 noncommercial 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.
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 nontechnical 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, and a medical section. In addition, any motorpool maintenance activities other than the most routines were performed at the battalion level.

The battalion headquarters and headquarters battery comprised the following seven 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 Asembly 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.

3.0 NIKE BATTERY DESCRIPTION

3.1 BATTERY LAYOUT

A Nike site typically consisted of two separate and distinct operating units. These included the launcher area and the IFC area. The launcher area was generally located on approximately 40 to 60 acres of land, although each site could vary significantly in size and shape. The IFC area, generally ranged in size from 10 to 50 acres. The barracks facilities were either incorporated as part of the launcher area of 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 to 2 mi 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 F-1 and F-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, 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 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 onsite landfills.

3.2 GENERAL UNIT OPERATIONS

3.2.1 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 Chapters 4 and 5. 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.

Figure F-1. Site Plan Launcher Area (typical).

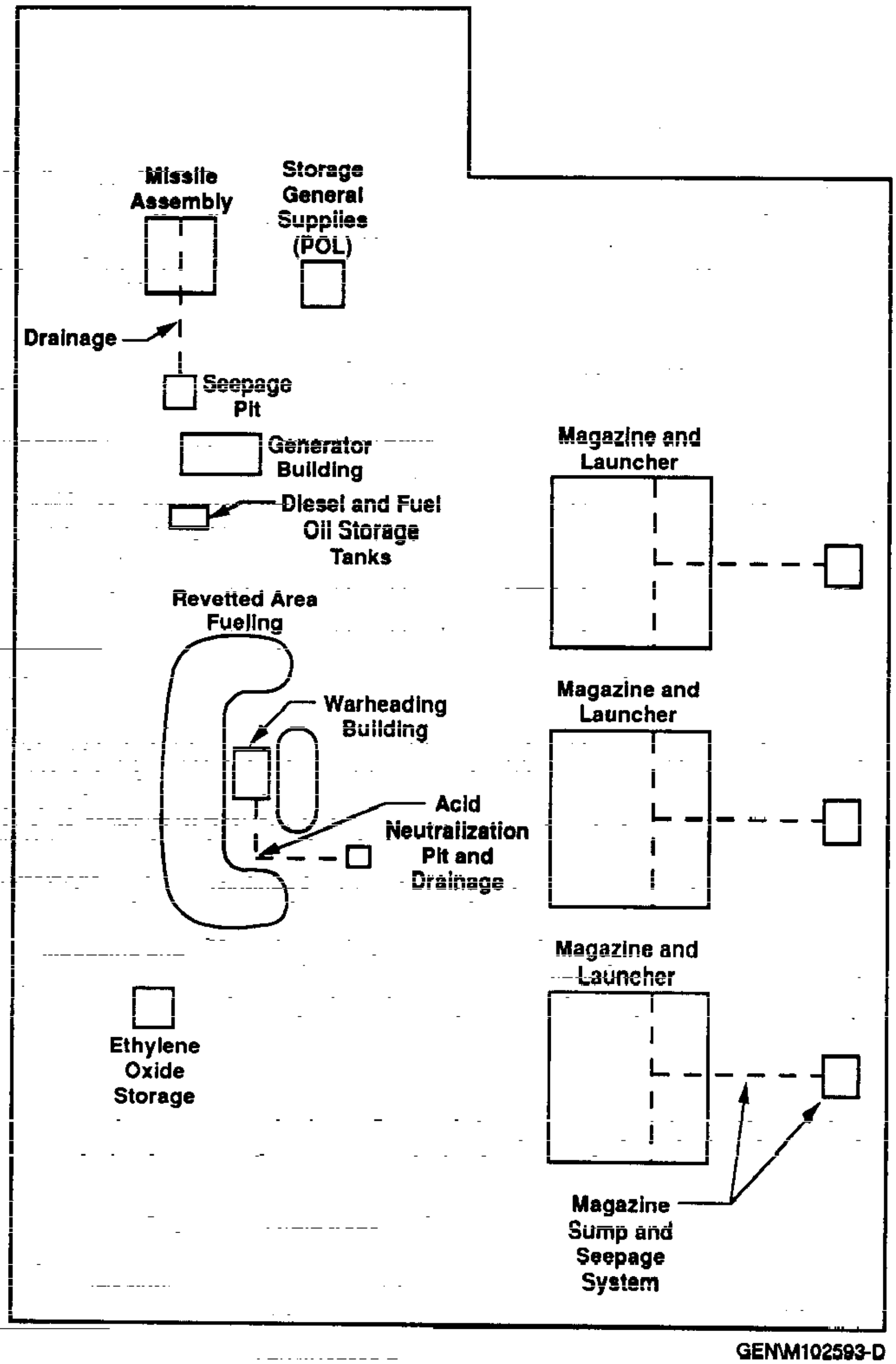
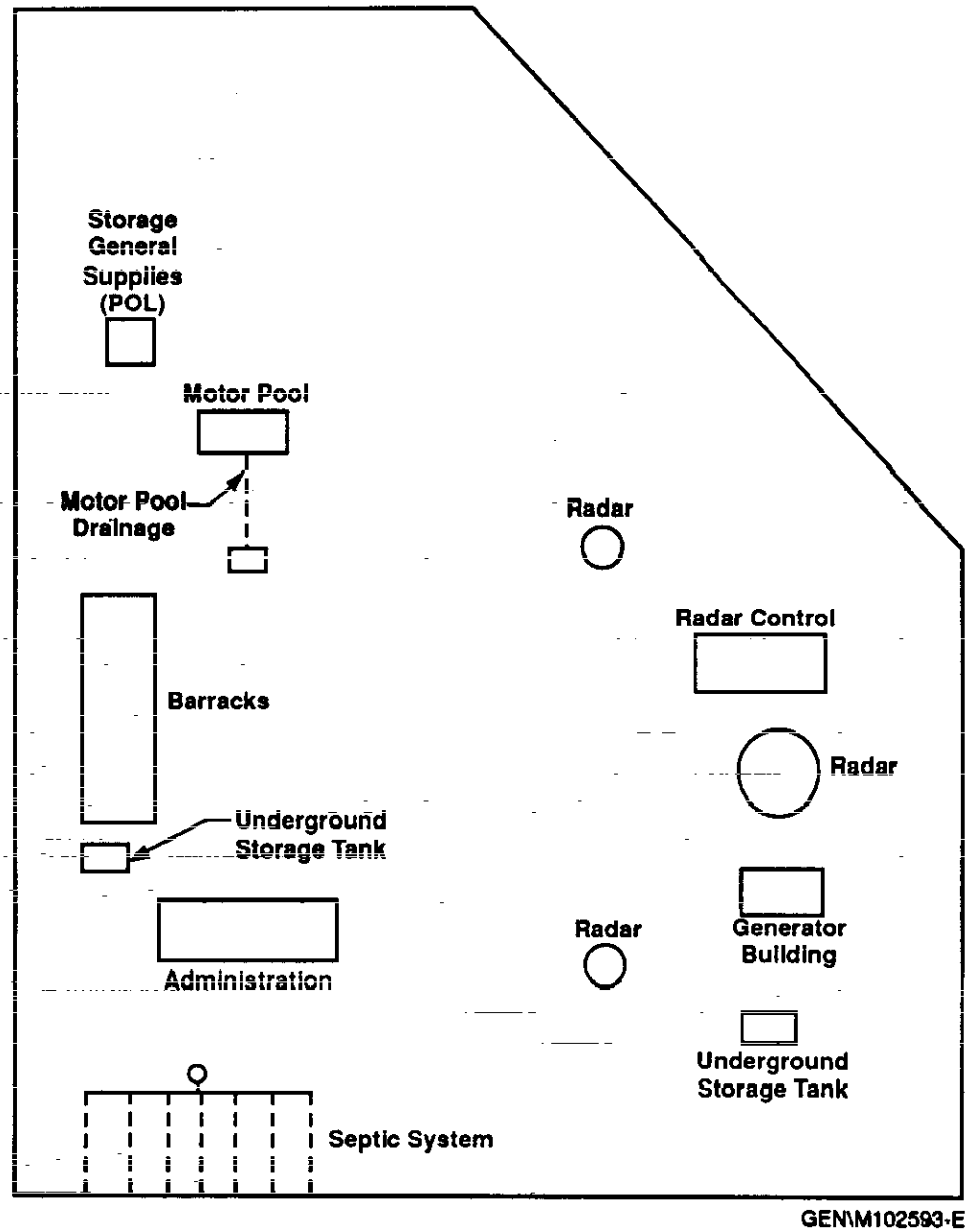


Figure F-2. Site Plan Integrated Launch Control Area.



3.2.2 Integrated Fire Control 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 Chapters 4 and 5.

4.0 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 F-1 and F-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.

4.1 GENERAL - WASTE FLUID DISPOSAL

Probably the most significant general practice that occurred onsite 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 petroleum, oils, lubricants (POL) 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 onsite and offsite. Locations of such dumps are predictable only by general site characteristics. This practice was discussed at length in interviews and are discussed further 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.

4.2 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
- motor pool (when present)
- septic systems (when present).

4.2.1 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 required 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.

4.2.2 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 5,000 gal 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 onsite. 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. Thus, buried tanks could present a problem.

4.2.3 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.

4.2.4 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 pickup, other methods were used to dispose of the waste. Rural sites were particularly prone to "unofficial" dumping. Dumping reportedly occurred both onsite and offsite. Onsite dumps were secluded locations which would evade the attention of inspecting military officers. Lakes, ponds, swamps, and ravines were suited to this purpose. Offsite dumps could have made use of virtually any nearby ravine or water course. It was reported during site operator interviews that "unofficial" dumping, including offsite 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 site operator interviews.

4.2.5 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 inhibited red fuming nitric acid (IRFNA), unsymmetrical dimethyl hydrazine (UDMH), 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.

4.2.6 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.

4.2.7 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.

4.3 INTEGRATED FIRE CONTROL 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.

4.3.1 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.

4.3.2 Septic Systems

On rural sites, onsite wastewater 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.

4.3.3 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 previously, 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.

5.0 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 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

5.1 LAUNCHER AREA

5.1.1 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 anticorrosion 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 returned 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, 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 leftover or waste material. Cans of waste and leftover 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.

5.1.2 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 an certain other delicate structural maintenance. Service and filling of the missile Accessory Power Supply was often conducted in this area as well.

Fueling with UDMH, IRFNA, anilines, furfuryl alcohols, 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 means of recycling to maintain fresh fuel onsite 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 on the missile. It was maintained and used to test the system periodically. Ethylene oxide was routinely disposed of onsite 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.

5.1.3 Missile Maintenance and Testing

Missile maintenance was conducted in four locations: the magazine, aboveground at the launcher, the fueling area, and the assembly building. Refer to Figure F-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 aboveground 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-lb 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 solvents (petroleum distillate), carbon tetrachloride, trichloroethane(s), perchlorethene, and trichloroethane(s), perchlorethene, and tichloroethene, 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 personal 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 onsite or offsite 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 groundwater 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 groundwater 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 onsite, 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.

5.1.4 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 aboveground, 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", per 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 "blowouts" 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.

5.2 INTEGRATED FIRE CONTROL AREA

5.2.1 Operating 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 high-power acquisition radar system 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 offsite 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 onsite 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 site interviews.

5.2.2 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.

5.3 GENERAL OPERATIONS

5.3.1 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 to 30%). Onsite 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 onsite, "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.

5.3.2 Utility Service

Nike sites were supported by certain onsite 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 belowground, and remained onsite 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 belowground. 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 (PCB) 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 onsite 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 onsite, 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 onsite in its original form in buildings, on piping and ductwork, until removed during demolition.

5.3.3 Deactivation

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. 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 interviews.

As an example of deactivation procedures at a particular site, an instance of dumping chromium trioxide (chrome VI) in excess of 100 lb 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. Onsite 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 onsite which would be secluded from the primary operating area were likely candidates for some "unofficial" dumping both during site operation and at deactivation.

6.0 MASTER CONTAMINANTS LIST

6.1 GENERAL

Based on the previous analysis of site operations, the master list of contaminants is provided, which consists of the potential contaminants of former Nike sites. As shown in Tables F-1 and F-2, 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 on criteria used for developing this master list from the general inventory and discusses particular materials regarding their likelihood of being considered a potential site contaminant. The master list of contaminants is presented as Table F-1. Table F-2 presents a listing of all "potential" contaminants based on location of activities.

Table F-1. Master Contaminants List.

Material	Use Characteristics	Disposal Method
Benzene	Solvent and fuel constituent	Evaporation, drainage, and leaching. Fuel tank leakage.
Carbon tetrachloride	Solvent	Evaporation, drainage, and leaching.
Chromium (chromates, chromium [III,IV, and V])	Decorroding missile parts	Drainage and leaching. Surface disposal.
Petroleum hydrocarbons	Fuels, lubricants	Consumed, fuel tank leakage, spill to soil, POL turn-in, drainage and leaching, surface disposal.
Lead	Paints and battery electrolyte	Drainage and leaching, POL turn-in.
Perchlorethylene	Solvent	Evaporation, drainage, and leaching.
Toluene	Solvent and fuel constituent	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.

Table F-2. Potential Contaminants for Nike Sites.

Area Activity	Potential Contaminant
Missile maintenance and assembly area transformer pad	Polychlorinated byphenyls (PCB)
Missile assembly area	Petroleum distillates; chlorinated solvents; alcohols
Missile fueling and warheading area	Unsymmetrical dimethyl hydrazine (UDMH); inhibited red fuming nitric acid (IRFNA); aniline; furfuryl alcohol; ehtylene oxide; hydrocarbons such as jet fuel (JP-4)
Missile maintenance and testing	Phosphoric acid; alodine powder; chromium trioxide; sodium dichromate; petroleum distillates; carbon tetrachloride; trichloroethene; trichloroethane; alcohol; acetone; paints containing chromium and lead; missile hydraulic fluid; tricresyl phosphate
General launcher and magazine maintenance	Hydraulic fluid; paints; solvents
Control center operations maintenance	Solvents used for cleaning electrical parts; ethylene glycol
Vehicle maintenance	Petroleum, oils, and lubricants
Facility maintenance	Lead paints; pesticides and herbicides
Utilities	Transformers (PCBs); above and below ground storage tanks used for gasoline or fuel oil; hydraulic fluid
Deactivation	Solvents; fuels; paints; asbestos-containing debris

6.2 MASTER LIST OF 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 U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) were not included on the master list. The primary criteria for not including materials on the master list included:

- materials were used only in small quantities
- materials were used with extreme care such that only minor quantities could have caused contamination
- 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.

6.2.1 Benzene

Benzene was mentioned in U.S. Army 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.

6.2.2 Carbon Tetrachloride

As indicated in previous studies of Nike sites (McMaster et al. 1984), 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.

6.2.3 Chromium

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

6.2.4 Petroleum Hydrocarbons

Fuels, nonchlorinated 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 previously. In sheer quantity, hydrocarbons constitute the most significant potential contaminant of former Nike sites.

6.2.5 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.

6.2.6 Perchlorethylene

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.

6.2.7 Toluene

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

6.2.8 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, and Trichloroethene

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

6.3 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.

6.3.1 Unsymmetrical Dimethyl Hydrazine

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.

6.3.2 Ethylene Oxide

Ethylene oxide was used throughout the Nike program as a fuel for the accessory power supply 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 onsite dumping. Ethylene oxide is a reactive, volatile liquid stored at low temperatures. (It has a boiling point of 11°C.) In the environment, it decays in a very short time. No ethylene oxide will remain as a Nike site contaminant.

6.3.3 Aniline and Furfuryl Alcohol

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

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6.3.4 JP-4

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

6.3.5 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.

6.3.6 Inhibited Red Fuming 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.

6.3.7 Polychlorinated Biphenyls

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 PCBs 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.

6.3.8 Asbestos

Asbestos remains onsite in its original form in buildings and on piping and ductwork. Asbestos was not included on the master list for screening during the preliminary determination phase.

7.0 REFERENCES

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APPENDIX G

LABORATORY ANALYTICAL RESULTS

SAMPLE NUMBER LOCATION COMMENTS	B07GM0 H-83-L/A-2-2 9-11 ft, SW-846	B07GM1 H-83-L/A-2-3 9-11 ft, CLP	B07GM2 H-83-L/A-1-3 9-11 ft, SW-846	B07GM3 H-83-L/A-3-2 9-11 ft, CLP	B07GM4 H-83-L/A-3-3 9-11 ft, SW-846	B07GM5 H-83-L/A-4-1 9-11 ft, SW-846
SEMI-VOA (ug/kg)						
di-n-butylphthalate	140 JB	U	U	U	U	U
diethyl phthalate	U	U	U	U	U	U
phenanthrene	U	U	U	U	U	U
fluoranthene	U	U	U	U	U	U
pyrene	U	U	U	U	U	U
benzo(a)anthracene	U	U	U	U	U	U
chrysene	U	U	U	U	U	U
benzo(b)fluoranthene	U	U	U	U	U	U
benzo(k)fluoranthene	U	U	U	U	U	U
benzo(a)pyrene	U	U	U	U	U	U
bis(2-ethylhexyl)phthalate		U	U	U	U	U
indeno(1,2,3-cd)pyrene	U	U	U	U	U	U
dibenzo(a,h)anthracene	U	U	U	U	U	U
benzo(g,h,i)perylene	U	U	U	U	U	U
VOA (ug/kg)						
acetone	U	5 BJ	3.8	5 BJ	4.3	5.8
2-hexanone	9.8	U	3.8	U	U	U
methylene chloride	U	U	U	U	U	U
toluene	U	U	U	U	U	U
methyl-pentanone	U	U	U	U	U	U
ICP METALS (ug/g)						
Al	7300	7000	7700	6610	9600	8000
Sb	U	U N	U	U N	U	U
Ba	67	70.2	77	119 E	100	88
Be	U	U	U	U	U	U
Cd	U	U	U	U	U	U
Ca	9600	9000	9400	8670	11000	11000
Cr	12	12	13	11	14	13
Co	5	5.2 B	7	5.1 B	8	7
Cu	9	21.2 *	13	11 *	12	12
Fe	14000	14500	20000	14500	20000	18000
Li	10	NA	10	NA	12	11
Mg	5200	5060	5500	4690	6100	5700
Mn	270	273	350	283	370	340
Mo	U	NA	U	NA	U	U
Ni	11	11.2	12	11.8	14	11
P	400	NA	570	NA	550	530
K	1400	1330	1700	1420	1800	1700
Ag	U	U	U	U NW	U	U
Na	170	245 B	180	269 B	240	190
Sr	37	NA	32	NA	47	36
V	28	26.5	32	28.2	43	35
Zn	35	37.4	46	48.2	45	42
Hg		0.068		0.05 B		
As		3.3		3.3		
Pb		5.5 N*		9.2 N*		
Se		U NW		U		
Tl		U		U		
AA METALS (ug/g)						
As	2.9		4.7		3.3	3.6
Pb	5.6		22		4.6	5.2
Se	U		U		U	U
Tl	U		U		U	U
MERCURY (ug/g)	U	0.06 B	U	0.05 B	U	U

SAMPLE NUMBER LOCATION COMMENTS	B07GM0 H-83-L/A-2-2 9-11 ft, SW-846	B07GM1 H-83-L/A-2-3 9-11 ft, CLP	B07GM2 H-83-L/A-1-3 9-11 ft, SW-846	B07GM3 H-83-L/A-3-2 9-11 ft, CLP	B07GM4 H-83-L/A-3-3 9-11 ft, SW-846	B07GM5 H-83-L/A-4-1 9-11 ft, SW-846
HERBICIDES (ug/kg)						
2,4-D	U	U	U	U	U	U
2,4-DB	U	U	U	U	U	U
2,4,5-T	U	U	U	U	TBA	TBA
2,4,5-TP	U	U	U	U	U	U
Dalapon	U	U	U	U	U	U
Dicamba	U	U	U	U	U	U
Dichlorprop	U	U	U	U	U	U
Dinoseb	U	U	U	U	U	U
MCPA	U	U	U	U	U	U
MCPP	U	U	U	U	U	U
TTL PET. HYDROCARBONS (ug/g)	U	U	20	U	U	U
PCB/Pesticides (ug/kg)						
DDE	U	2.5 JP	150	17	U	49
DDD	U	2.4 J	U	U	U	U
DDT	220	7.1	35	5.3 P	U	59
Dieldrin	U	0.55 JP	36	U	U	10
Endrin	U	U	U	U	U	U
Methoxychlor	U	19 B	U	49 B	U	U
Endosulfan II	U	U	U	U	U	NA
Alpha Chlordane	NA	U	NA	U	NA	U
Aroclor 1254	U	U	U	U	U	U
Gamma-BHC (Lindane)	U	U	U	U	U	U
Beta-BHC	U	U	U	U	U	U
Endosulfan I	U	U	U	U	U	U
Endosulfan sulfate	U	U	U	U	U	U
Endrin ketone	NA	U	NA	U	NA	NA
ANIONS (ug/g)						
F	U	U	U	U	2	U
CL	U	3	9	14	7	6
PO4-P	U	U	U	U	U	U
So4	6	8	14	46	11	16
No3-N+No2-N	1	2	3	4	2	5
Cr-6	U	U	U	U	U	U
PHOSPH-PEST (ug/kg)						
TPP	NA	NA	NA	NA	NA	NA

SAMPLE NUMBER	B07GM6	B07GM7	B07GM8	B07GM9	B07GN0	B07GN1
LOCATION	H-04(W)/A-1-2	H-04(W)/A-1-3	H-04(W)/A-1-3	H-04(W)/A-1-3	H-04(W)/A-2-2	H-04(W)/A-3-1
COMMENTS	9-11 ft, SW-846	8-9 ft, CLP	8-9 ft, CLP, duplicate	8-9 ft, CLP, split	7.5-9.5 ft, SW-846	7-9 ft, SW-846
SEMI-VOA (ug/kg)						
di-n-butylphthalate	U	U	130 J	U	U	54
diethyl phthalate	U	U	52 J	U	U	U
phenanthrene	U	U	U	U	U	U
fluoranthene	U	U	U	U	U	U
pyrene	U	U	U	U	U	U
benzo(a)anthracene	U	U	U	U	U	U
chrysene	U	U	U	U	U	U
benzo(b)fluoranthene	U	U	U	U	U	U
benzo(k)fluoranthene	U	U	U	U	U	U
benzo(a)pyrene	U	U	U	U	U	U
bis(2-ethylhexyl)phthalate	U	100 BJ	52 BJ	U	U	U
indeno(1,2,3-cd)pyrene	U	U	U	U	U	U
dibenzo(a,h)anthracene	U	U	U	U	U	U
benzo(g,h,i)perylene	U	U	U	U	U	U
VOA (ug/kg)						
acetone	67	34 B	34 B	42 B	31	46
2-hexanone	U	U	U	U	U	U
methylene chloride	U	U	U	28 B	U	1.3
toluene	U	U	U	U	U	2.6
methyl-pentanone	U	U	U	U	U	U
ICP METALS (ug/g)						
Al	13000	14400	14400	15400	17000	20000
Sb	U	U N	U N	U N	U	U
Ba	110	401	431	346	260	130
Be	1	0.92 B	0.86 B	1.2	U	U
Cd	U	U	U	0.7 B	U	U
Ca	22000	17300	17600	18300	21000	19000
Cr	11	14.6	13.8	15.5	17	15
Co	9	8.2 B	9 B	10.2 B	9	11
Cu	13	29.5	21.5	20.9	14	16
Fe	11000	19000	19100	22000	20000	19000
Li	9	NA	NA	NA	15	13
Mg	5100	7460	7400	7260	8300	9200
Mn	230	299	334	362	360	370
Mo	U	NA	NA	NA	U	U
Ni	11	8.2 B	13.6	14.6	16	15
P	130	NA	NA	NA	450	500
K	1000	1560	1590	1820	1300	2000
Ag	U	U	U	16.5 N	U	U
Na	490	590 BE	590 E	706 B	720	690
Sr	88	NA	NA	NA	92	100
V	28	43.3	43.3	46.6	73	45
Zn	25	41.9	45.6	55.7	41	71
Hg		U	U	U		
As		5.6	5.5	U WN		
Pb		15.7	15	18.9 *		
Se		U NW	U NW	U WN		
Tl		0.32 B	U	U WN		
AA METALS (ug/g)						
As	4.2				8.1	8.5
Pb	7.1				5.6	14
Se	U				U	U
Tl	U				U	U
MERCURY (ug/g)	U				U	U

SAMPLE NUMBER LOCATION COMMENTS	B07GM6 H-04(W)/A-1-2 9-11 ft, SW-846	B07GM7 H-04(W)/A-1-3 8-9 ft, CLP	B07GM8 H-04(W)/A-1-3 8-9 ft, CLP, duplicate	B07GM9 H-04(W)/A-1-3 8-9 ft, CLP, split	B07GN0 H-04(W)/A-2-2 7.5-9.5 ft, SW-846	B07GN1 H-04(W)/A-3-1 7-9 ft, SW-846
HERBICIDES (ug/kg)						
2,4-D	U	U	U	U	U	U
2,4-DB	U	U	U	182	U	U
2,4,5-T	U	U	U	66.4	U	U
2,4,5-TP	U	U	U	U	U	U
Dalapon	U	U	U	U	U	U
Dicamba	U	U	U	U	U	U
Dichloroprop	U	U	U	152	U	U
Dinoseb	U	U	U	U	U	U
MCPA	U	U	U	U	U	U
MCPP	U	U	U	U	U	U
TTL PET. HYDROCARBONS (ug/g)	U	U	50		U	30
PCB/Pesticides (ug/kg)						
DDE	U	78	140	70.9	U	44
DDD	U	1.3 JP	1.5 JP	U	U	U
DDT	U	24	48	18.4	U	65
Dieldrin	U	U	U	NA	U	U
Endrin	U	0.057 JB	0.85 JP	U	U	U
Methoxychlor	U	390 B	3 PB	U	U	U
Endosulfan II	U	U	U	U	U	U
Alpha Chlordane	NA	U	U	U	NA	NA
Aroclor 1254	U	U	U	U	U	U
Gamma-BHC (Lindane)	U	U	U	U	U	U
Beta-BHC	U	U	U	U	U	U
Endosulfan I	U	U	U	U	U	U
Endosulfan sulfate	U	U	U	U	U	U
Endrin ketone	NA	U	U	U	NA	NA
ANIONS (ug/g)						
F	U	3	3	4.82	3	7
CL	33	27	28	32.8	82	190
PO4-P	U	U	U	0.82	U	U
So4	280	680	770	651	1300	3100
No3-N+No2-N	6	4	4	0.4	6	10
Cr-6	U	U	U	0.0078	U	U
PHOSPH-PEST (ug/kg)						
TPP	303	139	166	NA	305	329

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SAMPLE NUMBER LOCATION COMMENTS	B07GN2 H-04(E)/A-1-1 7-9 ft, SW-846	B07GN3 H-04(E)/A-1-2 8-10 ft, CLP	B07GN4 H-06-H(W)/A-2-2 9-11 ft, SW-846	B07GN5 H-06-H(W)/A-5-2 9-11 ft, SW-846	B07GN6 H-06-H(W)/A-5-5 9-11 ft, CLP	B07GN7 H-06-H(W)/A-7-1 9-11 ft, SW-846
SEMI-VOA (ug/kg)						
di-n-butylphthalate J	U	U	U	U	66 J	U
diethyl phthalate	970	U	U	U	22 J	U
phenanthrene	95 J	U	U	U	U	U
fluoranthene	220 J	U	U	U	U	U
pyrene	240 J	U	U	U	U	U
benzo(a)anthracene	220 J	U	U	U	U	U
chrysene	310 J	U	U	U	U	U
benzo(b)fluoranthene	400	U	U	U	U	U
benzo(k)fluoranthene	340 J	U	U	U	U	U
benzo(a)pyrene	360	U	U	U	U	U
bis(2-ethylhexyl)phthalate	970	96 BJ	U	U	56 BJ	U
indeno(1,2,3-cd)pyrene	390	U	U	U	U	U
dibenzo(a,h)anthracene	140 J	U	U	U	U	U
benzo(g,h,i)perylene	450	U	U	U	U	U
VOA (ug/kg)						
acetone	31	32 B	32	49	24 B	40
2-hexanone	U	U	U	U	U	U
methylene chloride J	U	U	U	U	U	U
toluene	U	U	U	U	U	U
methyl-pentanone	U	U	U	U	3 J	U
ICP METALS (ug/g)						
Al	9700	10500	13000	10000	13300	12000
Sb	U	U N	U	U	U N	U
Ba	96	308	130	110	114	110
Be	U	0.78 B	U	U	0.54 B	U
Cd	U	U	U	U	U	U
Ca	14000	23900	14000	9600	14600	13000
Cr	11	12.6	18	14	19	18
Co	9	8.8 B	10	9	10.8	10
Cu	15	16.3	18	15	21.1	21
Fe	22000	19200	21000	20000	23400	21000
Li	10	NA	15	12	NA	15
Mg	5900	6160	7500	5900	7580	7100
Mn	350	341	420	380	466 *	550
Mo	U	NA	U	U	NA	U
Ni	13	9.9	19	16	19.2	18
P	730	NA	620	620	NA	620
K	1300	1250	2100	1600	2130	2000
Ag	U	U	U	U	U	U
Na	410	516 BE	530	550	586 BE	520
Sr	59	NA	54	42	NA	53
V	51	48.2	38	40	44.2	36
Zn	48	38.5	52	58	58.6	250
Hg		U			U	
As		6.8			6.1	
Pb		11.4 NS			15 NS	
Se		U			U NW	
Tl		U			U	
AA METALS (ug/g)						
As	4.3		5.3	4.6		5.5
Pb	6.7		8.2	7.8		47
Se	U		U	U		U
Tl	U		U	U		U
MERCURY (ug/g)	U		U	U		U

SAMPLE NUMBER LOCATION COMMENTS	B07GN2 H-04(E)/A-1-1 7-9 ft, SW-846	B07GN3 H-04(E)/A-1-2 8-10 ft, CLP	B07GN4 H-06-H(W)/A-2-2 9-11 ft, SW-846	B07GN5 H-06-H(W)/A-5-2 9-11 ft, SW-846	B07GN6 H-06-H(W)/A-5-6 9-11 ft, CLP	B07GN7 H-06-H(W)/A-7-1 9-11 ft, SW-846
HERBICIDES (ug/kg)						
2,4-D	U	U	U	U	U	U
2,4-DB	U	U	U	U	U	U
2,4,5-T	U	U	U	U	U	U
2,4,5-TP	U	U	U	U	U	U
Dalapon	U	U	U	U	U	U
Dicamba	U	U	U	U	U	U
Dichloroprop	U	U	U	U	U	U
Dinoseb	U	U	U	U	U	U
MCPA	U	U	U	U	U	U
MCPP	U	U	U	U	U	U
TTL PET. HYDROCARBONS (ug/g)	U	U	U	U	U	U
PCB/Pesticides (ug/kg)						
DDE	U	8.2	U	U	3.3 J	U
DDD	U	U	U	U	U	U
DDT	U	3 J	U	U	2.9 J	U
Dieldrin	U	U	U	U	U	U
Endrin	U	U	U	U	U	U
Methoxychlor	U	3 PB	U	U	5.7 B	U
Endosulfan II	U	U	U	U	U	U
Alpha Chlordane	NA	U	NA	NA	U	NA
Arocklor 1254	U	U	U	U	U	U
Gamma-BHC (Lindane)	U	U	U	U	U	U
Beta-BHC	U	U	U	U	U	U
Endosulfan I	U	U	U	U	U	U
Endosulfan sulfate	U	U	U	U	U	U
Endrin ketone	NA	U	NA	NA	U	NA
ANIONS (ug/g)						
F	3	3	4	2	3	6
CL	U	2	73	28	73	6
PO4-P	U	U	U	1.3	U	U
So4	28	13	270	200	170	42
No3-N+No2-N	1	2	6	3	3	2
Cr-6	U	U	U	U	U	U
PHOSPH-PEST (ug/kg)						
TPP	323	112	317	324	236	325

SAMPLE NUMBER LOCATION COMMENTS	B07GN8 H-06-H(W)/A-16-1 9-11 ft, SW-846	B07GN9 Equip. Blank(sand) CLP	B07GP0 H-06-H(W)/A-19-2 9-11 ft, SW-846	B07GP1 H-06-H(W)/A-19-3 9-11 ft, CLP	B07GP2 H-06-H(E)/A-2-1 9-11 ft, SW-846	B07GP3 H-06H(E)/A-6-4 9-11 ft, SW-846
SEMI-VOA (ug/kg)						
di-n-butylphthalate	U	U	400	110 J	110 J	91
diethyl phthalate	U	U	U	37 J	U	U
phenanthrene	U	U	U	U	U	U
fluoranthene	U	U	U	U	U	U
pyrene	U	U	U	U	U	U
benzo(a)anthracene	U	U	U	U	U	U
chrysene	U	U	U	U	U	U
benzo(b)fluoranthene	U	U	U	U	U	U
benzo(k)fluoranthene	U	U	U	U	U	U
benzo(a)pyrene	U	U	U	U	U	U
bis(2-ethylhexyl)phthalate	U	U	U	120 J	110 J	U
indeno(1,2,3-cd)pyrene	U	U	U	U	U	U
dibenzo(a,h)anthracene	U	U	U	U	U	U
benzo(g,h,i)perylene	U	U	U	U	U	U
VOA (ug/kg)						
acetone	33	21 B	22	21 B	26	22
2-hexanone	U	U	U	U	U	U
methylene chloride	U	U	U	U	U	U
toluene	U	U	U	U	U	U
methyl-pentanone	U	3 J	U	U	U	U
ICP METALS (ug/g)						
Al	13000	131	15000	11100	19000	20000
Sb	U	U N	U	U N	U	U
Ba	120	1.4 B	130	120	130	130
Be	U	U	U	0.55 B	U	U
Cd	U	U	U	U	U	U
Ca	15000	29.9 B	13000	14600	17000	18000
Cr	18	U	23	17.9	25	25
Co	10	U	8	8.8 B	10	10
Cu	21	U	35	53.5	43	31
Fe	22000	170	29000	20800	28000	25000
Li	15	NA	16	NA	21	20
Mg	7600	20.8 B	7300	7250	9100	8800
Mn	430	3.9	470	424	500	460
Mo	U	NA	U	U	2	U
Ni	17	U	18	18.1	22	21
P	600	NA	610	NA	590	600
K	2100	U	2700	2230	3000	3100
Ag	U	U	U	U	U	U
Na	640	11.8 B	540	271 BE	790	560
Sr	56	NA	54	NA	65	64
V	38	U	42	36	44	43
Zn	56	U	87	72.2	62	61
Hg		U		U		
As		U		11.1		
Pb		0.65		20.1 S*		
Se		0.23 B		U NW		
Tl		U		0.6 B		
AA METALS (ug/g)						
As	5.5		7.2		8.5	9.2
Pb	9.9		38		13	11
Se	U		U		U	U
Tl	U		U		U	U
MERCURY (ug/g)	U		U		U	U

SAMPLE NUMBER LOCATION COMMENTS	B07GN8 H-06-H(W)/A-18-1 9-11 ft, SW-846	B07GN9 Equip. Blank(sand) CLP	B07GP0 H-06-H(W)/A-19-2 9-11 ft, SW-846	B07GP1 H-06-H(W)/A-19-3 9-11 ft, CLP	B07GP2 H-06-H(E)/A-2-1 9-11 ft, SW-846	B07GP3 H-06H(E)/A-6-4 9-11 ft, SW-846
HERBICIDES (ug/kg)						
2,4-D	U	U	U	U	U	U
2,4-DB	U	U	U	U	U	U
2,4,5-T	U	U	U	U	U	U
2,4,5-TP	U	U	U	U	U	U
Dalapon	U	U	U	U	U	U
Dicamba	U	U	U	U	U	U
Dichloroprop	U	U	U	U	U	U
Dinoseb	U	U	U	U	U	U
MCPA	U	U	U	U	U	U
MCPP	U	U	U	U	U	U
TTL PET. HYDROCARBONS (ug/g)	U	U	U	90	U	U
PCB/Pesticides (ug/kg)						
DDE	U	U	U	11 X	U	U
DDD	U	U	U	1.4 JPX	U	U
DDT	U	U	U	U	U	U
Dieldrin	U	U	U	2.3 JPX	U	U
Endrin	U	1.5 PB	U	10 PX	U	U
Methoxychlor	U	U	U	0.71 JPB	U	U
Endosulfan II	U	U	U	0.84 JPX	U	U
Alpha Chlordane	NA	U	NA	4.9 PX	NA	NA
Aroclor 1254	U	U	U	210 P	U	U
Gamma-BHC (Lindane)	NA	U	NA	U	NA	NA
Beta-BHC	U	U	U	U	U	U
Endosulfan I	U	U	U	U	U	U
Endosulfan sulfate	U	U	U	U	U	U
Endrin ketone	NA	U	NA	U	NA	NA
ANIONS (ug/g)						
F	4	U	3	3	5	3
CL	3	U	140	15	75	78
PO4-P	U	U	U	U	U	U
So4	200	U	140	1300	180	120
No3-N+No2-N	1	U	16	25	12	2
Cr-6	U	U	U	U	U	U
PHOSPH-PEST (ug/kg)						
TPP	336	347	U	U	U	U

SAMPLE NUMBER LOCATION COMMENTS	B07GP4 Equip. Blank (sand) CLP	B07KP4 H-06-H(E)/A-11-1 9-11 ft, CLP	B07KP5 H-06-H(E)/A-11-1 9-11 ft, CLP, duplicate	B07KP6 H-06-H(E)/A-11-1 9-11 ft, CLP, split	B07KP7 H-06-H(E)/A-11-2 9-11 ft, SW-846
SEMI-VOA (ug/kg)					
di-n-butylphthalate J	70 J	260 BJ	200 J	260 J	U
diethyl phthalate	39 J	U	U	U	U
phenanthrene	U	U	U	U	U
fluoranthene	U	U	U	U	U
pyrene	U	U	U	U	U
benzo(a)anthracene	U	U	U	U	U
chrysene	U	U	U	U	U
benzo(b)fluoranthene	U	U	U	U	U
benzo(k)fluoranthene	U	U	U	U	U
benzo(a)pyrene	U	U	U	U	U
bis(2-ethylhexyl)phthalate	U	U	U	U	U
indeno(1,2,3-cd)pyrene	U	U	U	U	U
dibenzo(a,h)anthracene	U	U	U	U	U
benzo(g,h,i)perylene	U	U	U	U	U
VOA (ug/kg)					
acetone	23 B	25 B	73 B	7 JB	12
2-hexanone	U	U	U	U	U
methylene chloride	U	U	U	6 JB	U
toluene	U	U	U	U	U
methyl-pentanone	U	U	U	U	U
ICP METALS (ug/g)					
Al	138	13300	13900	13400	19000
Sb	U	U N	13.9 N	U	U
Ba	1.5 B	163	187	157	150
Be	U	0.61 B	0.6 B	0.64 B	U
Cd	U	U	1.9	0.64 B	U
Ca	26.9 B	15000	15100	16100	16000
Cr	U	20.2	22.4	21	26
Co	U	10.5 B	11.4	14.6	10
Cu	U	22.3	24.2	27.1	24
Fe	185	24400	30300	27600	26000
Li	NA	NA	NA	NA	21
Mg	U	7580	7810	7700	9000
Mn	4.3	524	533	571	500
Mo	NA	NA	NA	NA	U
Ni	U	20.6	19.8	20.6	23
P	NA	NA	NA	NA	580
K	U	2170	2220	2330	2600
Ag	U	U	U	7	U
Na	7.5 B	367 BE	373 BE	U	600
Sr	NA	NA	NA	NA	60
V	U	45.5	47.3	52.2	44
Zn	U	117	161	96.1	73
Hg	U	U	U	U	
As	U	7.3	6.3	10.6 B	
Pb	0.32 B	190 *	26.5 S*	29.9	
Se	U	U NW	U NW	U	
Tl	U	0.24 B	U	U	
AA METALS (ug/g)					
As					5.1
Pb					21
Se					U
Tl					U
MERCURY (ug/g)					U

SAMPLE NUMBER LOCATION COMMENTS	B07GP4 Equip. Blank (sand) CLP	B07KP4 H-06-H(E)/A-11-1 9-11 ft, CLP	B07KP5 H-06-H(E)/A-11-1 9-11 ft, CLP, duplicate	B07KP6 H-06-H(E)/A-11-1 9-11 ft, CLP, split	B07KP7 H-06-H(E)/A-11-2 9-11 ft, SW-846
HERBICIDES (ug/kg)					
2,4-D	U	U	U	U	U
2,4-DB	U	U	U	U	U
2,4,5-T	U	U	U	U	U
2,4,5-TP	U	U	U	U	U
Dalapon	U	U	U	U	U
Dicamba	U	U	U	U	U
Dichloroprop	U	U	U	U	U
Dinoseb	U	U	U	U	U
MCPA	U	U	U	U	U
MCPP	U	U	U	U	U
TTL PET. HYDROCARBONS (ug/g)	U	20	U	U	U
PCB/Pesticides (ug/kg)					
DDE	U	150 PY	170 PY	262 BC	34
DDD	U	1.4 JP	2.2 JP		U
DDT	U	210 PY	200 PY	341 BC	36
Dieldrin	0.061 JP	4 P	7.5	U	U
Endrin	U	U	U	U	U
Methoxychlor	0.55 JPB	2.4 JPB	1.7 JPB	U	U
Endosulfan II	U	U	U	U	U
Alpha Chlordane	U	U	U	U	U
Aroclor 1254	U	U	U	U	NA
Gamma-BHC (Lindane)	U	U	U	U	U
Beta-BHC	U	U	U	U	NA
Endosulfan I	U	U	U	U	U
Endosulfan sulfate	U	U	U	U	U
Endrin ketone	U	U	U	U	NA
ANIONS (ug/g)					
F	U	2	1	1.96	5
CL	2	7	7	10.9	9
PO4-P	U	U	U	1.43	U
So4	1	630	550	311	42
No3-N+No2-N	U	2	2	13.01<.2	2
Cr-6	U	U	U	<0.133	U
PHOSPH-PEST (ug/kg)					
TPP	U	U	U	NA	NA

SAMPLE NUMBER LOCATION COMMENTS	B07KP8 H-08-H(E)/A-12-1 9-11 ft, CLP	B07KP9 H-08-H(E)/A-12-2 9-11 ft, SW-846	B07KQ0 H-08-H(E)/A-7-1 9-11 ft, SW-846	B07KQ1 H-81-R 4-6 ft, CLP	B07KQ2 H-06-L 3 ft, CLP	B07KQ3 H-06-L 13-15 ft, CLP
SEMI-VOA (ug/kg)						
di-n-butylphthalate	63 J	U	U	U	U	U
diethyl phthalate	U	U	U	U	U	U
phenanthrene	U	U	U	U	U	U
fluoranthene	U	U	U	U	U	U
pyrene	U	U	U	U	U	U
benzo(a)anthracene	U	U	U	U	U	U
chrysene	U	U	U	U	U	U
benzo(b)fluoranthene	U	U	U	U	U	U
benzo(k)fluoranthene	U	U	U	U	U	U
benzo(a)pyrene	U	U	U	U	U	U
bis(2-ethylhexyl)phthalate	80 J	U	82 J	U	U	U
indeno(1,2,3-cd)pyrene	U	U	U	U	U	U
dibenzo(a,h)anthracene	U	U	U	U	U	U
benzo(g,h,i)perylene	U	U	U	U	U	U
VOA (ug/kg)						
acetone	40 B	10	11	U	U	U
2-hexanone	U	U	U	U	U	U
methylene chloride	U	U	U	U	U	U
toluene	U	U	U	U	U	U
methyl-pentanone	U	U	U	U	U	U
ICP METALS (ug/g)						
Al	18100	20000	17000	7960	11500	29600
Sb	U N	U	U	U N	U N	U N
Ba	148	150	200	66.4	114	41.9 B
Be	0.76 B	U	U	0.47 B	0.79 B	1.3
Cd	U	U	U	U	U	U
Ca	17300	17000	16000	10800	12400	113000
Cr	24.1	25	25	10.4	15.5	23.1
Co	11.5	11	10	10.1 B	9.9 B	8.4 B
Cu	29.2	26	21	21.7	37.8	22.8
Fe	27300	28000	24000	29700	22100	23200
Li	NA	21	19	NA	NA	NA
Mg	8960	9200	8500	5930	6130	12100
Mn	497	510	460	475	417	176
Mo	NA	U	U	NA	NA	NA
Ni	20.3	22	20	13.1	13.6	16.3
P	NA	610	600	NA	NA	NA
K	2630	3000	2700	1120	2540	1510
Ag	U	U	U	U	U	U
Na	576 BE	570	610	189 B	235 B	719 BB
Sr	NA	62	62	NA	NA	NA
V	46.1	43	43	70.7	46.8	97.3
Zn	106	65	56	65.6	92.3	55.1
Hg	U			U	U	U
As	9.3			1.9	4.3	6.8
Pb	22.7 *			46.4	26.1	12 S
Se	U NW			U NW	U NW	U NW
Tl	U			U	U	U
AA METALS (ug/g)						
As		6.8	8.5			
Pb		14	11			
Se		U	U			
Tl		U	U			
MERCURY (ug/g)		U	U			

SAMPLE NUMBER	B07KP8	B07KP9	B07KQ0	B07KQ1	B07KQ2	B07KQ3
LOCATION	H-06-H(E)/A-12-1	H-06-H(E)/A-12-2	H-06-H(E)/A-7-1	H-81-R	H-06-L	H-06-L
COMMENTS	9-11 ft, CLP	9-11 ft, SW-846	9-11 ft, SW-846	4-6 ft, CLP	3 ft, CLP	13-15 ft, CLP
HERBICIDES (ug/kg)						
2,4-D	U	U	U	U	U	U
2,4-DB	U	U	U	U	U	U
2,4,5-T	U	U	U	U	U	U
2,4,5-TP	U	U	U	U	U	U
Dalapon	U	U	U	U	U	U
Dicamba	U	U	U	U	U	U
Dichloroprop	U	U	U	U	U	U
Dinoseb	U	U	U	U	U	U
MCPA	U	U	U	U	U	U
MCPP	U	U	U	U	U	U
TTL PET. HYDROCARBONS (ug/g)	U	U	U	910	U	U
PCB/Pesticides (ug/kg)						
DDE	100 PY	U	U	U	2.2 J	U
DDD	2.1 JP	U	U	U	U	U
DDT	96 PY	U	U	U	4.9	U
Dieldrin	10 P	U	U	0.46 JP	U	U
Endrin	0.69 JP	U	U	U	0.86 J	U
Methoxychlor	1.8 JPB	U	U	1.3 JPB	2.2 JPB	2 JB
Endosulfan II	U	U	U	U	U	U
Alpha Chlordane	U	NA	NA	0.35 JP	U	U
Aroclor 1254	U	U	U	U	U	U
Gamma-BHC (Lindane)	1.2 JP	NA	NA	U	U	U
Beta-BHC	U	U	U	1.9 P	U	U
Endosulfan I	U	U	U	0.13 JP	U	U
Endosulfan sulfate	U	U	U	1.5 JP	0.19 JP	0.21 JP
Endrin ketone	U	NA	NA	U	U	U
ANIONS (ug/g)						
F	4	5	5	U	U	4
CL	52	4	28	3	6	2
PO4-P	U	U	U	U	8	U
So4	150	45	240	14	28	330
No3-N+ No2-N	6	U	1	5	77	3
Cr-6	U	U	U	3	21	U
PHOSPH-PEST (ug/kg)						
TPP	NA	NA	NA	300	310	350

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SAMPLE NUMBER LOCATION COMMENTS	B07KQ4 Hm-stied 8 in, CLP	B07KQ5 2,4-D 13-15 ft, CLP	B07KQ6 2,4-D 13-15 ft, SW-846	B07KQ7 2,4-D CLP	B07KR3 H-12-L 4 ft, CLP	B07KR4 H-12-L 4 ft, SW-846
SEMI-VOA (ug/kg)						
di-n-butylphthalate	100 BJ		U	U	NA	NA
diethyl phthalate	U	U	U	U	NA	NA
phenanthrene	U	U	U	U	NA	NA
fluoranthene	U	U	U	U	NA	NA
pyrene	U	U	U	U	NA	NA
benzo(a)anthracene	U	U	U	U	NA	NA
chrysene	U	U	U	U	NA	NA
benzo(b)fluoranthene	U	U	U	U	NA	NA
benzo(k)fluoranthene	U	U	U	U	NA	NA
benzo(a)pyrene	U	U	U	U	NA	NA
bis(2-ethylhexyl)phthalate	U	U	U	U	NA	NA
indeno(1,2,3-cd)pyrene	U	U	U	U	NA	NA
dibenzo(a,h)anthracene	U	U	U	U	NA	NA
benzo(g,h,i)perylene	U	U	U	U	NA	NA
VOA (ug/kg)						
acetone	NA	NA	NA	NA	NA	NA
2-hexanone	NA	NA	NA	NA	NA	NA
methylene chloride	NA	NA	NA	NA	NA	NA
toluene	NA	NA	NA	NA	NA	NA
methyl-pentanone	NA	NA	NA	NA	NA	NA
ICP METALS (ug/g)						
Al	7410	NA	NA	NA	7960	7100
Sb	10.5 N	NA	NA	NA	U	U
Ba	128 N	NA	NA	NA	71.3	59
Be	U	NA	NA	NA	0.39 B	U
Cd	U	NA	NA	NA	U	U
Ca	4100	NA	NA	NA	4300	3200
Cr	16.8 N	NA	NA	NA	11.4	11
Co	9.5 B	NA	NA	NA	7.8 B	8
Cu	40.7 N*	NA	NA	NA	17.3	10
Fe	39000 *	NA	NA	NA	16300	16000
Li	NA	NA	NA	NA	NA	8
Mg	3690	NA	NA	NA	4120	4000
Mn	422 N	NA	NA	NA	267 N	250
Mo	NA	NA	NA	NA	NA	U
Ni	23.4 *	NA	NA	NA	6.7 B	10
P	1550	NA	NA	NA	1600	530
K	NA	NA	NA	NA	NA	1300
Ag	U	NA	NA	NA	U	U
Na	175 B	NA	NA	NA	411 B	220
Sr	NA	NA	NA	NA	NA	19
V	45.3	NA	NA	NA	35.2	36
Zn	144 N*	NA	NA	NA	33.6	34
Hg	U	NA		NA	U N	
As	3.4 NS	NA		NA	2.3	
Pb	216	NA		NA	4.7 NS	
Se	0.35 B	NA		NA	0.24 B	
Tl	0.18 BW	NA		NA	0.1 B	
AA METALS (ug/g)						
As		NA	NA	NA		1.8
Pb		NA	NA	NA		4.3
Se		NA	NA	NA		U
Tl		NA	NA	NA		U
MERCURY (ug/g)		NA	NA	NA		U

SAMPLE NUMBER LOCATION COMMENTS	B07KQ4 Hm-stead 8 in, CLP	B07KQ5 2,4-D 13-15 ft, CLP	B07KQ6 2,4-D 13-15 ft, SW-846	B07KQ7 2,4-D CLP	B07KR3 H-12-L 4 ft, CLP	B07KR4 H-12-L 4 ft, SW-846
HERBICIDES (ug/kg)						
2,4-D	U	U	U	U	NA	NA
2,4-DB	U	U	U	U	NA	NA
2,4,5-T	U	U	U	U	NA	NA
2,4,5-TP	U	U	U	U	NA	NA
Dalapon	U	U	U	U	NA	NA
Dicamba	U	U	U	U	NA	NA
Dichloroprop	U	U	U	U	NA	NA
Dinoseb	U	U	U	U	NA	NA
MCPA	U	U	U	U	NA	NA
MCPP	U	U	U	U	NA	NA
TTL PET. HYDROCARBONS (ug/g)	U	NA	NA	NA	NA	NA
PCB/Pesticides (ug/kg)						
DDE	U	U	SEE RECORD OF DISPOSITION	U	NA	NA
DDD	U	U		U	NA	NA
DDT	4.5	U		U	NA	NA
Dieldrin	1.2 JP	U		U	NA	NA
Endrin	U	U		U	NA	NA
Methoxychlor	2.5 JPB	U		U	NA	NA
Endosulfan II	U	U		U	NA	NA
Alpha Chlordane	U	U		U	NA	NA
Aroclor 1254	U	U		U	NA	NA
Gamma-BHC (Lindane)	U	U		U	NA	NA
Beta-BHC	U	U		U	NA	NA
Endosulfan I	U	U		U	NA	NA
Endosulfan sulfate	U	0.079 JP		U	NA	NA
Endrin ketone	0.47 JP	U		U	NA	NA
ANIONS (ug/g)						
F	U	NA	NA	NA	15	U
CL	12	NA	NA	NA	55	20
PO4-P	5	NA	NA	NA	U	U
So4	11	NA	NA	NA	31	20
No3-N+No2-N	2	NA	NA	NA	1	1
Cr-6	U	NA	NA	NA	2	2
PHOSPH-PEST (ug/kg)						
TPP	230.6	330	370	370	NA	NA

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SAMPLE NUMBER LOCATION COMMENTS	B07KR5 H-07-H 16 ft, CLP	B07KR6 H-07-H 16 ft, CLP duplicate	B07KR7 H-07-H 16 ft, CLP split	B07KR8 H-06-H 9-11 ft, CLP	B07KR9 H-90 SW-846
SEMI-VOA (ug/kg)					
di-n-butylphthalate	U	U	U	U	NA
diethyl phthalate	U	U	U	U	NA
phenanthrene	U	U	U	U	NA
fluoranthene	U	U	U	U	NA
pyrene	U	U	U	U	NA
benzo(a)anthracene	U	U	U	U	NA
chrysene	U	U	U	U	NA
benzo(b)fluoranthene	U	U	U	U	NA
benzo(k)fluoranthene	U	U	U	U	NA
benzo(a)pyrene	U	U	U	U	NA
bis(2-ethylhexyl)phthalate	U	U	U	32 BJ	NA
indeno(1,2,3-cd)pyrene	U	U	U	U	NA
dibenzo(a,h)anthracene	U	U	U	U	NA
benzo(g,h,i)perylene	U	U	U	U	NA
VOA (ug/kg)					
acetone	7 J	U	8 J	U	NA
2-hexanone	U	U	U	U	NA
methylene chloride	2 BJ	3 BJ	U	3 BJ	NA
toluene	U	0.8 BJ	U	U	NA
methyl-pentanone	U	U	U	U	NA
ICP METALS (ug/g)					
Al	11800	11900	11600	43.6	6500
Sb	U	U	5.4 BM	U	U
Ba	88	86.4	98.1	86.4	90
Be	0.56 B	0.56 B	0.59 B	U	U
Cd	1.2	1 B	1.8	U	U
Ca	11200	11000	12200	16.3 B	10000
Cr	17.8	18.4	17.1	U	12
Co	10.2 B	11.7	11.8	U	6
Cu	25.4	24.4	28.8	1.5 B	31
Fe	20800	20600	22900	320	18000
Li	NA	NA	NA	NA	6
Mg	6460	6320	6970	61 B	3900
Mn	310	303	369	U	240
Mo	NA	NA	NA	NA	U
Ni	17	13.4	16.9	U	9
P	2090	2130	NA	171 B	890
K	NA	NA	21.6	NA	1200
Ag	0.95 B	1.1 B	U	0.77 B	U
Na	413 B	412 B	181 B	18.2 B	320
Sr	NA	NA	NA	NA	41
V	41.1	39.9	46.4	U	46
Zn	92.3	88.2	103	U	290
Hg	UN	UN	U	U	
As	5.7	6	6.1 N	0.18 B	
Pb	19.7 N*	20.5 N*	21.3	0.18 B	
Se	0.41 BS	0.37 BW	0.52 B	0.27 B	
Tl	U	0.13 B	UN	U	
AA METALS (ug/g)					
As					690
Pb					1200
Se					U
Tl					U
MERCURY (ug/g)					0.09

SAMPLE NUMBER LOCATION COMMENTS	B07KR5 H-07-H 16 ft, CLP	B07KR6 H-07-H 16 ft, CLP duplicate	B07KR7 H-07-H 16 ft, CLP split	B07KR8 H-08-H 9-11 ft, CLP	B07KR9 H-90 SW-846
HERBICIDES (ug/kg)					
2,4-D	U	U	245	U	NA
2,4-DB	U	U	1210 B	U	NA
2,4,5-T	U	U	U	U	NA
2,4,5-TP	U	U	U	U	NA
Dalapon	U	U	NA	U	NA
Dicamba	U	U	U	U	NA
Dichlorprop	U	U	U	U	NA
Dinoseb	U	U	U	U	NA
MCPA	U	U	NA	U	NA
MCPP	U	U	NA	U	NA
TTL PET. HYDROCARBONS (ug/g)	60	60	72 mg/kg	U	60000
PCB/Pesticides (ug/kg)					
DDE	0.15 JP	0.56 JP	U	U	NA
DDD	1.1 P	1.2 P	U	U	NA
DDT	3.2 JP	3.1 J	NA	U	NA
Dieldrin	1.6 J	1.6 JP	U	U	NA
Endrin	U	U	U	U	NA
Methoxychlor	7.6 J	6.4 J	U	5.5 J	NA
Endosulfan II	U	0.57 PB	U	U	NA
Alpha Chlordane	U	U	U	U	NA
Aroclor 1254	U	U	U	U	NA
Gamma-BHC (Lindane)	U	U	U	U	NA
Beta-BHC	U	U	U	U	NA
Endosulfan I	U	U	U	U	NA
Endosulfan sulfate	U	U	U	U	NA
Endrin ketone	U	U	U	U	NA
ANIONS (ug/g)					
F	U	U	1.42	U	NA
CL	7	10	6.35	7	NA
PO4-P	U	U	4.56	U	NA
So4	26	26	23.7	5	NA
No3-N+No2-N	14	14	27.9	U	NA
Cr-6	2	2	<2.74 mg/kg	2	NA
PHOSPH-PEST (ug/kg)					
TPP	450	460	NA	450	NA

SAMPLE NUMBER LOCATION COMMENTS	B07KS0 H-90 SW-846	B07KS1 H-90 6 in, SW-846	B07KS2 H-90 6 in, CLP
SEMI-VOA (ug/kg)			
di-n-butylphthalate	NA	NA	NA
diethyl phthalate	NA	NA	NA
phenanthrene	NA	NA	NA
fluoranthene	NA	NA	NA
pyrene	NA	NA	NA
benzo(a)anthracene	NA	NA	NA
chrysene	NA	NA	NA
benzo(b)fluoranthene	NA	NA	NA
benzo(k)fluoranthene	NA	NA	NA
benzo(a)pyrene	NA	NA	NA
bis(2-ethylhexyl)phthalate	NA	NA	NA
indeno(1,2,3-cd)pyrene	NA	NA	NA
dibenzo(a,h)anthracene	NA	NA	NA
benzo(g,h,i)perylene	NA	NA	NA
VOA (ug/kg)			
acetone	NA	NA	NA
2-hexanone	NA	NA	NA
methylene chloride	NA	NA	NA
toluene	NA	NA	NA
methyl-pentanone	NA	NA	NA
ICP METALS (ug/g)			
Al	7700	7400	8450
Sb	U	U	19.9 N*
Ba	100	92	95.8
Be	U	U	0.52 B
Cd	1	U	U
Ca	9100	9200	11000
Cr	14	13	10.2
Co	7	8	11
Cu	29	23	18.2
Fe	19000	28000	20000
Li	6	7	NA
Mg	4300	4200	4420
Mn	250	350	391 N
Mo	U	U	NA
Ni	11	11	8.8
P	860	760	1430
K	1400	1400	NA
Ag	U	U	0.94 B
Na	440	270	610 BE
Sr	37	31	NA
V	46	52	51.5
Zn	490	230	56.5
Hg			U N
As			3.4
Pb			68.5 N*
Se			0.32 B
Tl			0.14 B
AA METALS (ug/g)			
As	3.1	2.1	
Pb	760	120	
Se	U	U	
Tl	U	U	
MERCURY (ug/g)	U	U	

SAMPLE NUMBER LOCATION COMMENTS	B07KS0 H-90 SW-846	B07KS1 H-90 6 in, SW-846	B07KS2 H-90 6 in, CLP
HERBICIDES (ug/kg)			
2,4-D	NA	NA	NA
2,4-DB	NA	NA	NA
2,4,5-T	NA	NA	NA
2,4,5-TP	NA	NA	NA
Dalapon	NA	NA	NA
Dicamba	NA	NA	NA
Dichloroprop	NA	NA	NA
Dinoseb	NA	NA	NA
MCPA	NA	NA	NA
MCPP	NA	NA	NA
TTL PET. HYDROCARBONS (ug/g)	65000	940	1700
PCB/Pesticides (ug/kg)			
DDE	NA	NA	NA
DDD	NA	NA	NA
DDT	NA	NA	NA
Dieldrin	NA	NA	NA
Endrin	NA	NA	NA
Methoxychlor	NA	NA	NA
Endosulfan II	NA	NA	NA
Alpha Chlordane	NA	NA	NA
Aroclor 1254	NA	NA	NA
Gamma-BHC (Lindane)	NA	NA	NA
Beta-BHC	NA	NA	NA
Endosulfan I	NA	NA	NA
Endosulfan sulfate	NA	NA	NA
Endrin ketone	NA	NA	U
ANIONS (ug/g)			
F	NA	NA	NA
CL	NA	NA	NA
PO4-P	NA	NA	NA
So4	NA	NA	NA
No3-N+No2-N	NA	NA	NA
Cr-6	NA	NA	NA
PHOSPH-PEST (ug/kg)			
TPP	NA	NA	NA

ORGANIC DATA QUALIFIERS

U - Indicates compound was analyzed for but not detected.
J - Indicates an estimated value.
P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns.
C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
B - This flag is used when the analyte is found in the associated blank as well as in the sample.
E - This flag identifies compounds whose concentrations exceeded the calibration range of the GCMS instrument for that specific analysis.
D - This flag identifies all compounds identified in a analysis at a secondary dilution factor.
A - This flag indicates that a TIC is a suspected aldol-condensation product.
N - Indicates presumptive evidence of a compound.

INORGANIC DATA QUALIFIERS

C (Concentration) Qualifier: "B" will be entered if the reported value was obtained from a reading that was less than the Contract Required Detection. Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL). If the analyte was analyzed for but not detected, a "U" will be entered. The field will be left blank if the result is above the CRDL.

Q Qualifier: Specified entries and their meanings are as follows:
E - The reported value is estimated because of the presence of interference. An explanatory note must be included under Comments on the Cover Page or on the specific FORM I - IN.
M - Duplicate injection precision of 20% not met.
N - Spiked sample recovery not within control limits of 75-125%.
S - The reported value was determined by the Method of Standard Additions (MSA).
W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
* - Duplicate analysis not within control limits of 20% or +/- CRDL.
+ - Correlation coefficient for the MSA is less than 0.995.

PESTICIDE/PCB ANALYSIS

X - Used to flag the results of single component target pesticides in samples found to contain Aroclor 1254.
Y - Used to flag the results of compounds which were detected at levels above the concentration of the high standard.

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APPENDIX H

FIELD SCREENING ANALYTICAL RESULTS

North Slope Expedited Response Action
Volatile Organics Field Screening Results

Sample #	Site	Sample Date	Sample Time	Soil Type: Depth (ft)	Results
A2-1-001	H-83-L	10-12-92	1045	Sand w/wood: -10	Less-than detectable VOC
A2-2-002	H-83-L	10-12-92	1145	Sand w/wood: -6	Less-than detectable VOC
A2-2-003	H-83-L	10-12-92	1218	Sand: -10	Less-than detectable VOC
A2-3-004	H-83-L	10-12-92	1320	Sand: -6	Less-than detectable VOC
A2-3-005	H-83-L	10-12-92	1350	Sand: -10	Less-than detectable VOC
A1-1-006	H-83-L	10-13-92	0828	Sand: -5	Less-than detectable VOC
A1-1-007	H-83-L	10-13-92	0850	Sand: -10	Less-than detectable VOC
A1-2-008	H-83-L	10-13-92	0839	Wet Sand: -4	Unquantified heavy hydrocarbons
A1-3-009	H-83-L	10-13-92	1055	Sand: -6	Less-than detectable VOC
A1-3-010	H-83-L	10-13-92	1123	Sand: -10	Less-than detectable VOC
A3-1-011	H-83-L	10-13-92	1310	Sand: -5	Less-than detectable VOC
A3-1-012	H-83-L	10-13-92	1335	Sand: -10	Less-than detectable VOC
A3-2-013	H-83-L	10-14-92	0920	Sand w/wood: -6	Less-than detectable VOC
A3-2-014	H-83-L	10-14-92	0950	Sand: -10	Less-than detectable VOC
A3-3-015	H-83-L	10-14-92	1050	Sand: -6	Less-than detectable VOC
A3-3-016	H-83-L	10-14-92	1107	Sand: -10	Less-than detectable VOC
A4-1-017	H-83-L	10-14-92	1150	Moist sand: -6	Less-than detectable VOC
A4-1-018	H-83-L	10-14-92	1208	Moist sand: -10	Less-than detectable VOC
A1-1-019	PSN-04W	10-20-92	1030	Sand: -6	Less-than detectable VOC
A1-1-020	PSN-04W	10-20-92	1053	Sand: -10	Less-than detectable VOC
A1-2-021	PSN-04W	10-20-92	1153	Sand: -6	Less-than detectable VOC
A1-2-022	PSN-04W	10-20-92	1238	Sand: -10	Less-than detectable VOC
A1-3-023	PSN-04W	10-20-92	1400	Sand: -6	Less-than detectable VOC
A1-3-024	PSN-04W	10-20-92	1429	Sand/silt: -8	Less-than detectable VOC
A2-1-025	PSN-04W	10-20-92	1534	Sand w/wood: -6	Less-than detectable VOC
A2-1-026	PSN-04W	10-20-92	1559	Fine sand: -8	Less-than detectable VOC
A2-2-027	PSN-04W	10-21-92	0921	Sand/clay: -6	Less-than detectable VOC
A2-2-028	PSN-04W	10-21-92	0942	Sand/clay: -9	Less-than detectable VOC
A2-3-029	PSN-04W	10-21-92	1004	Fine sand: -6	Less-than detectable VOC
A2-3-030	PSN-04W	10-21-92	1030	Sand/clay: -8	Less-than detectable VOC
A3-1-031	PSN-04W	10-21-92	1101	Sand: -6	Less-than detectable VOC
A3-1-032	PSN-04W	10-21-92	1125	Sand/clay: -8	Less-than detectable VOC
A3-2-033	PSN-04W	10-21-92	1224	Clay: -6	Less-than detectable VOC
A3-2-034	PSN-04W	10-21-92	1250	Clay: -8	Less-than detectable VOC
A1-1-035	PSN-04E	10-21-92	1400	Sand/clay: -6	Less-than detectable VOC
A1-1-036	PSN-04E	10-21-92	1440	Sand/clay: -9	Less-than detectable VOC
A1-2-037	PSN-04E	10-21-92	1503	Sand/clay: -6	Less-than detectable VOC
A1-2-038	PSN-04E	10-21-92	1527	Sand/clay: -9	Less-than detectable VOC
A1-3-039	PSN-04E	10-21-92	1604	Sand w/wood: -6	Less-than detectable VOC
A1-3-040	PSN-04E	10-21-92	1624	Sand w/wood: -9	Less-than detectable VOC
A2-1-041	H-06-HW	10-23-92	0912	Sand/silt: -6	Less-than detectable VOC
A2-1-042	H-06-HW	10-23-92	0931	Sand/silt: -10	Less-than detectable VOC
A2-2-043	H-06-HW	10-23-92	1048	Sand/silt: -6	Unquantified heavy hydrocarbons
A2-2-044	H-06-HW	10-23-92	1128	Silt/clay: -10	Unquantified heavy hydrocarbons
A5-1-045	H-06-HW	10-23-92	1213	Sand/silt: -6	Less-than detectable VOC
A5-1-046	H-06-HW	10-23-92	1230	Silt/clay: -10	0.54 ppm (wt) PCE
A5-2-047	H-06-HW	10-23-92	1325	Sand/silt: -6	Unquantified heavy hydrocarbons
A5-2-048	H-06-HW	10-23-92	1345	Silt/clay: -10	Unquantified heavy hydrocarbons
A5-3-049	H-06-HW	10-23-92	1415	Sand/silt: -6	Unquantified heavy hydrocarbons
A5-3-050	H-06-HW	10-23-92	1500	Sand/silt: -10	Unquantified heavy hydrocarbons
A4-4-052	H-06-HW	10-23-92	1530	Sand/silt: -6	Less-than detectable VOC
A4-4-053	H-06-HW	10-23-92	1600	Silt/clay: -10	Less-than detectable VOC
A5-5-054	H-06-HW	10-26-92	0920	Sand/silt: -6	Less-than detectable VOC
A5-5-055	H-06-HW	10-26-92	0950	Silt/clay: -10	Less-than detectable VOC
A7-1-056	H-06-HW	10-26-92	1045	Silt/clay: -6	Less-than detectable VOC
A7-1-057	H-06-HW	10-26-92	1115	Silt/clay: -10	Less-than detectable VOC
A7-2-058	H-06-HW	10-26-92	1155	Silt/clay: -6	Less-than detectable VOC
A7-2-059	H-06-HW	10-26-92	1205	Silt/clay: -10	Less-than detectable VOC
A16-1-060	H-06-HW	10-26-92	1345	Silt/clay: -6	Unquantified heavy hydrocarbons

North Slope Expedited Response Action
Volatile Organics Field Screening Results

Sample #	Site	Sample Date	Sample Time	Soil Type: Depth (ft)	Results
A16-1-061	H-06-HW	10-26-92	1420	Silt: -10	Less-than detectable VOC
A16-2-062	H-06-HW	10-27-92	0907	Sand/silt: -6	Less-than detectable VOC
A16-2-063	H-06-HW	10-27-92	0927	Silt/clay: -10	Less-than detectable VOC
A19-1-064	H-06-HW	10-30-92	0830	Sand/silt w/wood: -6	Less-than detectable VOC
A19-1-065	H-06-HW	10-30-92	0842	Sand/silt w/wood: -10	Less-than detectable VOC
A19-2-066	H-06-HW	10-30-92	0915	Sand/silt: -6	Less-than detectable VOC
A19-2-067	H-06-HW	10-30-92	1000	Sand/silt: -10	Less-than detectable VOC
A19-3-068	H-06-HW	10-30-92	1015	Sand: -6	Less-than detectable VOC
A19-3-069	H-06-HW	10-30-92	1125	Sand/silt: -10	Less-than detectable VOC
A2-1-070	H-06-HE	10-30-92	1330	Sand/silt: -6	Less-than detectable VOC
A2-1-071	H-06-HE	10-30-92	1345	Sand/silt: -10	Less-than detectable VOC
A6-1-072	H-06-HE	10-30-92	1430	Sand/silt w/wood: -6	Less-than detectable VOC
A6-1-073	H-06-HE	10-30-92	1440	Sand/silt: -10	Less-than detectable VOC
A6-2-074	H-06-HE	10-30-92	1510	Sand/silt: -6	Less-than detectable VOC
A6-2-075	H-06-HE	10-30-92	1517	Sand/silt: -10	Less-than detectable VOC
A6-3-076	H-06-HE	10-30-92	1550	Sand/silt: -6	Less-than detectable VOC
A6-3-077	H-06-HE	10-30-92	1555	Sand/silt: -10	Less-than detectable VOC
A6-4-078	H-06-HE	11-2-92	0840	Sand/silt: -6	Less-than detectable VOC
A6-4-079	H-06-HE	11-2-92	0906	Sand/silt: -10	Less-than detectable VOC
A11-1-080	H-06-HE	11-2-92	1020	Sand/silt: -6	Less-than detectable VOC
A11-1-081	H-06-HE	11-2-92	1045	Sand/silt: -10	Less-than detectable VOC
A11-2-082	H-06-HE	11-2-92	1200	Sand/silt: -6	Less-than detectable VOC
A11-2-083	H-06-HE	11-2-92	1228	Sand/silt: -10	Less-than detectable VOC
A11-3-084	H-06-HE	11-2-92	1330	Sand/silt: -6	Less-than detectable VOC
A11-3-085	H-06-HE	11-2-92	1340	Sand/silt: -10	Less-than detectable VOC
A12-1-086	H-06-HE	11-2-92	1420	Sand/silt: -6	Less-than detectable VOC
A12-1-087	H-06-HE	11-2-92	1445	Sand/silt: -10	Less-than detectable VOC
A12-2-088	H-06-HE	11-3-92	0825	Sand/silt: -6	Less-than detectable VOC
A12-2-089	H-06-HE	11-3-92	0840	Sand/silt: -10	Less-than detectable VOC
A7-1-090	H-06-HE	11-3-92	0925	Silt/clay: -6	Less-than detectable VOC
A7-1-091	H-06-HE	11-3-92	1055	Silt/clay: -10	Less-than detectable VOC
H-81R-092	H-81-R	12-14-92	1100	Sand: Augar Flights	Less-than detectable VOC
H-81R-093	H-81-R	12-14-92	1135	Sand: Bottom of Well	Less-than detectable VOC
H06-L-1-094	H-06-L	12-15-92	1319	Sand: -4	Less-than detectable VOC
H06-L-1-095	H-06-L	12-15-92	1327	Sand: -2.6	Less-than detectable VOC
H06-L-1-096	H-06-L	12-16-92	0900	Sand/silt: -8	Less-than detectable VOC
H06-L-1-097	H-06-L	12-16-92	1000	Clay: -14	Less-than detectable VOC
Cis-1-098	Clay Pit Cistern	2-10-93	1010	Sand/water: -1	Less-than detectable VOC
Cis-2-099	Cow Camp Cistern	2-10-93	1145	Sand/debris: -2	Less-than detectable VOC
Cis-3-100	Homestead Cistern	2-10-93	1341	Sand/debris: -1	Less-than detectable VOC
H07-H-1-101	H-07-H Drywell	2-16-93	1505	Sand/cobble: -16	Less-than detectable VOC
H-90-102	H-90 Soil	2-17-93	0830	Oil-stained sand: -0.5	Less-than detectable VOC

APPENDIX I

POTENTIAL FOR ORDNANCE AND EXPLOSIVE WASTE CONTAMINATION ON FORMER ANTIAIRCRAFT BATTERY SITES

1.0 ORDNANCE AND EXPLOSIVE WASTE PROBLEM

The use of explosive ordnance by the military predates the Revolutionary War. It is possible for ordnance items to remain dangerous for many, many years. Hazardous pieces or ordnance are still found occasionally on Civil War battlegrounds. Advances in materials make it likely that some of today's weapons will be lethal for hundreds of years. In the United States, former battlegrounds are not the most common types of sites containing ordnance and explosive waste (OEW). Firing ranges and testing areas, munition manufacturing areas, weapon and ammunition storage areas, munition disposal areas, air defense sites, and weapon transport staging areas are all likely to contain OEW contamination.

Prior to about 1970, land burial of unneeded ordnance was an accepted practice if sea burial or demilitarization was not practical. If a facility handled ordnance at some time in the past, there is a good possibility that there are some ordnance burial pits at the site.

Not all OEW contamination in the United States consists of United States ordnance. During and after military campaigns, it has long been common practice for captured foreign weapons and ammunition to be brought into the United States for test and evaluation, or for disposal. After World War II, for example, train cars of foreign ordnance items were brought to munitions plants and eventually buried. This practice adds to the complexity of OEW remediation since very little of this foreign material even enters the inventory records.

Thorough recordkeeping was not an enforced requirement until recent decades. Very few of the older sites have accurate logs of what types of ordnance were used, where they were used, or how and where disposal took place. Even in cases where a previous attempt was made to clean up OEW at a facility, the remedial action generally produced only cursory records and few maps showing what was found and where.

One of the strongest drivers making OEW contamination a serious concern now is the increasing value and scarcity of undeveloped land. At many active defense sites, space is at a premium. It is no longer economically acceptable to keep large sections of land from being used because of OEW contamination.

2.0 ORDNANCE AND EXPLOSIVE WASTE DEFINED

OEW is a form of contamination that presents imminent hazards to exposed individuals. It is typically unique to military operations in that the material comprising the contamination was munitions or munitions related and generally designed to do damage to enemy personnel or material. OEW consists of the following types of materials: bombs and warheads, guided and ballistic missiles, artillery, mortar, and rocket ammunition, small arms ammunition, antipersonnel and antitank mines, demolition charges, pyrotechnics, grenades, torpedoes and depth charges, containerized or uncontainerized high explosives and propellants, materials depleted uranium projectiles, chemical warfare materials (mustard, nerve, etc., agents), components of the above items that are explosive in nature or otherwise designed to cause damage to personnel or material (e.g., fuzes, boosters, bursters, rocket mortors), and soils with explosive constituents in concentrations sufficient to present an imminent safety hazard. Soils and groundwater contaminated with trace explosives are considered hazardous waste.

Unexploded ordnance (UXO) is explosive ordnance that has been primed, fuzed, armed, or otherwise prepared for action, and which has been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to friendly operations, installations, personnel, or materiel and remains unexploded either through malfunction or design or for any other cause.

UXO personnel are graduates of the U.S. Naval Explosive Ordnance Disposal (EOD) School, located at Indian Head, Maryland,

3.0 DISTINCTION BETWEEN OEW AND HAZARDOUS AND TOXIC WASTE

OEW that presents an imminent and substantial endangerment to the public or the environment must be eliminated. In addition, remedial action must be taken if hazardous and toxic waste (HTW) is present. The HTW program is more mature than explosive ordnance engineering and many professionals have grown to associate Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response with HTW.

The OEW and HTW contamination categories are separate and distinct. Neither one is a subset of the other.

There are some fundamental differences between the characteristics and behavior of OEW and HTW contamination. These differences make it necessary to use different remediation equipment, procedures, and safeguards for OEW and HTW environmental restoration efforts. Consequently, personnel skill requirements and training needs are also somewhat different between the two categories. The following paragraphs summarize factors that set OEW and HTW contamination apart. The distinctions represent the majority of cases, but are not absolute. Exceptions exist to all of them.

a. <u>Mobility.</u> The HTW contaminants are generally more mobile than OEW contaminants. Hazardous and toxic waste products can move through the environment by direct contact with humans and animals, by becoming entrained in the air, by seeping through the soil, by mixing with groundwater or surface water, or by being absorbed into the food chain of humans and animals. Most of these mobility options do not apply to OEW, particularly not to cased explosive materials. Once deposited at a site, OEW typically remains at that site. There have been instances where OEW objects were moved by localized flooding and erosion. In some climates, the freeze and thaw cycle of the ground causes upward vertical movement of buried objects. About the only ways that OEW will move any significant distance are through ocean tidal action, or through a deliberate human action, e.g., a dredging operation, or a person collecting souvenirs.

b. Chemical Determination. Laboratory analysis of soil, air and water samples collected at a HTW site can give an accurate indication of the type and concentration of chemical present. Similar determination cannot be made at the typical OEW site. It is too hazardous to attempt to open old ordnance items to sample the energetic materials inside. Examination of the exterior of an ordnance item often does not give a reliable indication of the interior contents. For example, a given artillery shell design may get filled with inert stimulant, any of a number of different explosives, a shaped charge, multiple explosive bomblets or mines, or chemical weapons material. There are few external clues except paint color to indicate the type of fill. At manufacturing and training sites, there can be a wide variety of ordnance items present. Discovery and identification of one ordnance item does not give much information about what type might be located a few feet away.

c. Concentration. The severity of a HTW hazard and the type of response action selected are strong functions of the concentration level of the HTW remediation actions can stop. On the other hand, concentration has little meaning with respect to OEW contamination, except in the case where uncased explosive is mixed with soil. OEW concentration is sometimes interpreted as the number of items present per unit volume, but this definition has serious shortcomings. It is difficult to quantify since OEW does not spread uniformly over an area. Also, the definition does not take into account the size of the items. There is no minimum acceptable concentration level associated with OEW. It only takes one item to produce a casualty.

d. Population at Risk. The target population for HTW contamination can be very broad. Because of the mobility of the HTW, people can be placed at risk long distances from the source of contamination. People who have no direct contact at all with the contamination can still be affected through the food chain. This is not true for OEW. The population at risk is effectively limited to those people on the site who can have nearly direct personal contact with the OEW items.

e. Onset of Effect. Exposures to HTW contaminants can produce near term and/or long term negative effects. In the case of long term consequences of exposure, a direct cause and effect relationship is often hard to establish for a given individual because the health of an exposed individual is also being affected by so many other stimuli and events unrelated to the HTW contamination. However, statistical assessments covering many years and many idividuals have made it clear that prolonged exposure to HTW is a serious health hazard. The effects of OEW exposures are much more immediate and easier to measure. Most of the time, being in close proximity to OEW does not produce any lasting negative effect. When an OEW accident does occur, the result is immediate and there is little doubt about the cause and effect relationship.

f. Control. An individual's control over HTW exposure can be very low. The contaminations generally are not obvious to the individual. The exposure path is often related to life requirements such as breathing, drinking, and eating, so options for avoiding contamination are limited. In contrast, an individual's control over OEW is usually higher. Being in close proximity to ordnance does not automatically lead to adverse effects. In most cases, the ordnance has to be disturbed in some way before a significant health hazard exists. Curiosity is the most common reason for disturbing an ordnance item. An adult who has been informed of the danger has total control over exposure.

4.0 ORDNANCE AND EXPLOSIVE WASTE/UNEXPLODED ORDNANCE DISPOSAL

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When OEW is found at a site, the location used for disposal is selected from three options: (1) the OEW is destroyed or rendered safe in-place, (2) the OEW is transported to a remote area on or in the general vicinity of the OEW site and destroyed, or (3) the OEW is transported off the OEW site to an active military installation and destroyed at the installation.

The main consideration when deciding which option to take is the imminence of the hazard. Two primary factors must be weighed: the suspected sensitivity of the OEW to movement and the level of public exposure. Transport of OEW increases the risk to the Government and contract personnel, and also increases public exposure. Consequently, the preferred option is to destroy the OEW in place, assuming it can be accomplished safely, and the least desirable option is to transport the material off the OEW site to an active military installation.

Only UXO personnel are permitted to perform OEW/UXO disposal and related tasks.

a. Onsite Demolition/Disposal. OEW items are usually disposed of onsite whenever the situation allows. This is in keeping with the primary criterion of minimizing public exposure to the OEW. RCRA permits and state/local blasting permits are not required for this action.

Once OEW has been detected and exposed, the standard technique for destruction is to use a countercharge. This demolition charge is placed in contact with the OEW and detonated. The goal is to cause the sympathetic detonation of the ordnance and/or apply sufficient pressure and heat to completely neutralize the hazard. The countercharge is positioned to maximize the likelihood of complete destruction of the OEW while controlling and containing debris. After the detonation, the area is always carefully re-examined to make sure that destruction was complete.

Safety constraints may not always permit OEW disposal in-place. An alternative is to collect the items at a specific location on the site where destruction can safely take place.

The countercharge destruction method can again be used to destroy the collected items. Burning is another destruction technique. Detonation or burning of explosive wastes are currently the most effective means of onsite OEW disposal.

Burning has been a widely used ordnance disposal technique for many decades. It has disadvantages; however, that are now curtailing its use in many OEW remediation operations. An incendiary device is used to initiate burning of the OEW. Safety procedures must always prepare for the possibility that the burn will transition to a detonation. In particular, primary explosives such as lead azide, mercury fulminate, lead styphnate, and tetracene can be expected to detonate when involved in a fire. Some explosives give off toxic fumes when burned. Explosives that have been exposed to fire, but not completely destroyed must be treated with extreme care. Chemical and physical changes may have occurred that make the material much more sensitive than in its original state.

The fuze is considered the most hazardous component of unexploded ordnance. The condition of the fuze is one of the factors considered when deciding whether or not to transport munitions. Often the fuze condition cannot be ascertained from an external examination of an unexploded ordnance item. In such cases, the fuze is assumed to be in the armed condition, and in-place destruction should be used. Piezoelectric fuzes are of particular concern. They are extremely sensitive and can fire at the slightest physical change.

b. <u>Transport to an Installation.</u> If OEW must be transported offsite for disposal, the provisions of 49 CFR 100-199, U.S. Army manual TM 9-1300-206, "Explosives and Ammunition Standards," and state and local laws shall be followed.

c. <u>Coexistance of HTW/OEW.</u> It sometimes happens that both OEW and HTW coexist at the same site. In such a case, the ordnance hazard is dealt with first. The OEW remediation personnel must wear protective clothing to safeguard against HTW exposure. Subsequently, when the HTW remediation effort begins, it must be conducted using OEW safety protocols.

d. <u>Depth of Cleanup.</u> Depth of cleanup is site specific and is limited by the state-of-the-art in detection technology. There is no statement or certification issued after a remedial action which states that the site is now "clean." No one can truthfully make such a statement. U.S. Department of Defense (DoD) regulation DoD 6055.9-STD, "Ammunition and Explosive Safety Standards," states that sites which go from active to former status must be cleaned up to be innocuous. This is sometimes unapproachable with today's technology. The practical standard is use of the best available technology. Land use restrictions are an option when an adequate confidence level cannot be assured. An after action report must be filed following every remedial action.

5.0 REGULATORY CLIMATE

The DoD is the recognized national expert in matters relating to the safe handling and disposition of military munitions and ordnance. DoD and Army regulations governing transportation, storage, maintenance, inspections, safety, and security in handling of military munitions and ordnance are very stringent and provide maximum protection for personnel and the environment. Further, Section 300.120 (C) of the Final National Contingency Plan states that DoD is the removal response authority for incidents involving military weapons and munitions. The U.S. Environmental Protection Agency has concurred in the preparation of Army Regulation (AR) 200-1, which requires that clearance of conventional ordnance from private lands be conducted under Ammunition and Explosives Safety Standards (AR 385-64). As stated in Chapters 1 through 4, the DoD is the lead agency for OEW remediation. Authority has been delegated to the Huntsville Division of the U.S. Army Corps of Engineers as a mandatory center of expertise and design center. The Huntsville Division will perform all OEW investigations and remedial actions.

OEW removal activities do not require HTW-type or Resource Conservation and Recovery Act Part B permits from local, state, or federal agencies. The Huntsville Division uses environmental regulators and state agencies as consultants regarding environmental and other concerns; however, no permits are solicited from environmental regulators or other agencies in the remediation of OEW on or offsite.

APPENDIX J

BACTERIAL METABILIZATION OF 2-4,D

Date October 1, 1985

To HCCP File

From Kathy Cramer KC

Subject USBR 2, 4-D Burial Site

TJ McLaughlin
RE Wheeler (RHO)
File/LB

On September 20, 1985, a site visit was made to the "U.S. Bureau of Reclamation (USBR) 2, 4-D Burial Ground" near Wahluke Slope (R 14, T 27, 535). Tom McLaughlin and Kathy Cramer form PNL, Alan Conklin and William Osborne from Rockwell, were escorted by USBR Soil Scientist Alan Hattrup.

The disposal area is marked with two signs, at the northerly and southerly boundry (~400' apart), which state "2, 4-D Burial Site, June 1966". The area of the site approximates 400' x 60' and is located at elevation 700' (~350' above and 1/2 mile from the Columbia River), is very remote (1 mile from the nearest access road) and is at the base of an encroaching sand dune (45^{o}, ~60' high).

The closest flowing man made water source is the WB-10 Wasteway, 1 mile to the north at elevation 684'. The closest drinking water source, according to Mr. Hattrup, was about 2 miles to the east.

The initial burial of 2, 4-D contaminated soil was generated from leaking storage tanks in Eltopia, WA in June, 1966. A second burial, in 1967, consisted of the empty 2, 4-D storage tanks.

According to Mr. Hattrup, 150 to 250 gallons of 6 pounds/gallon 2.4-D (equating to 200-1200 pounds of amine) was disposed at the site. The soil was transported to the site in dump trucks, and placed into a large shallow pit (probably dug out with a bulldozer. Little surface settling was noted. Then, in 1967 (according to Mr. Hattrup), the six storage tanks were flattened and buried in the same location.

The documentation provided on this site indicates some differences in what Mr. Hattrup recalled. Some past letters and correspondance from USBR and DOE indicate that in June 1966, 900 gallons of 2, 4-D had leaked into 50 yards of soil, and the second burial in 1967 consisted of 10 tanks that were flattened and buried.

The site has not been used post 1967, and the site vegetation has reestablished itself with cheatgrass and sage. There was evidence that coyotes, deer and other wildlife frequented the area. Burrowing animals/insects noted in the area include snakes, beetles, and ants. Evidence of the presence of a motorcycle was noted on top of the sand dune. Several shotgun shells presumably from bird hunters was also evident. One medium size, very green Russian thistle plant was observed near the center of the disposal site.

HCCP File
October 1, 1985
Page 2

2, 4-D (2, 4-Dichlorophenoxyacetic acid), is used as a commercial herbicide. Of primary concern in this situation is its persistance in the soil. More specifically, the ability of the pesticide to be transported with eroding soil particles to hearby waterways and the accumulation in insects and earthworms which would show up in high levels and other wildlife feeding in the area.

Fortunately, 2, 4-D is one of the only herbicides which is able to be metabolized by bacteria. As shown in the diagram below, the breakdown rate approximately thirty days. Therefore, with some site specific soil and water samples an analysis for 2, 4-D should show no traces of the herbicide.

The only known or potential noteworthy concerns associated with the site are public relations (i.e., public has access to the site and can observe signs and possibly animal intrusion.) For more additional information, see correspondence between DOE and USBR in the HCCP files and photographs.

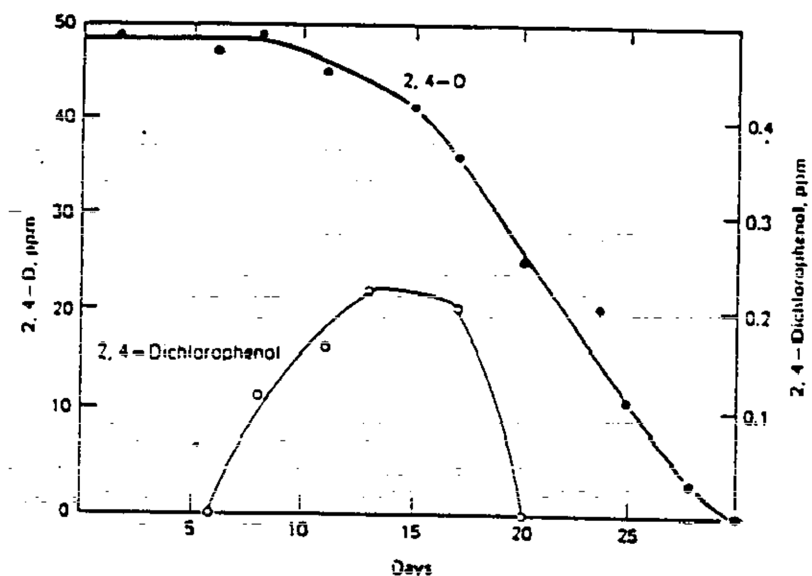

Figure 26.4. Metabolism of 2,4-D (2,4-dichlorophenoxyacetic acid) and formation of 2,4-dichlorophenol in soil (28). Note that the concentration of the product is low.

KHC:sc

APPENDIX K

FLORA AND FAUNA SURVEY

ECOLOGICAL SURVEY FORM

REPORT #: 93-600-10 **LOCATION:** North Slope

PROJECT: North Slope Expedited Actions (Debris and Trash Removal)

PLANT SURVEY DATE: 07/26-27/93 **INVESTIGATOR:** M. R. Sackschewsky

ANIMAL SURVEY DATE: 07/26-27/93 **INVESTIGATOR:** D. S. Landeen

SPECIES OF SPECIAL CONCERN OBSERVED:

PLANTS: Stalked-pod milkvetch
WILDLIFE: Loggerhead shrike, Swainson's hawk

IS THE AREA UNDER VEGETATION MANAGEMENT: No

DESCRIPTION OF AREA: The area designated as the North Slope is the Department of Energy controlled land north of the Columbia River. The sites on the North Slope which will be cleaned up occur on the Saddle Mountain Wildlife Refuge area near Vernita Bridge all the way to the Wahluke Wildlife Area including the north and south sides of Highway 24. The sites on the north side of the road occur in disturbed areas which are dominated by cheatgrass and tumblemustard. Other sites occur in undisturbed sagebrush habitat. A list of the sites visited is attached (Attachment 3). This list was taken from the first draft of the North Slope Expedited Actions Scope of Work. Several cisterns associated with old homestead sites were also visited which do not occur on the attached list.

PLANTS OBSERVED: It needs to be stressed that the timing of the survey was not ideal for plant identification and that a number of species were not identified or observed that may be present. However, there were no indications of any of the know rare plant species.

The only species of concern identified was the stalked pod milkvetch (*Astragalus sclerocarpus*) which was observed at two sites. This species is a state monitor and is common at the Hanford Site. The only other possible species of concern might be Piper's daisy (*Erigeron piperianus*) at gravel pit 47. This gravel pit should be revisited in the spring to determine if the plants observed were indeed Piper's daisy.

An attachment (Attachment 2) is provided which lists all of the plant species observed during these surveys.

WILDLIFE OBSERVED:

Birds: Bird species observed were the western meadow lark, horned lark, savannah sparrow, magpie, red-tailed hawk, northern harrier, common nighthawk, barn swallow, bank swallow, common raven, northern mockingbird, western kingbird, eastern kingbird, red-winged blackbird, and American kestrel. A northern mockingbird was observed at the Coyote Bait Can site on a power line pole. This may be the first documented sighting of this species on the north slope.

Bird species observed that have been designated as species of concern by the state and federal governments were the loggerhead shrike and Swainson's hawk. Loggerhead shrikes are classified as a federal candidate two (FC_2) species and as a state candidate (SC) species. The Swainson's hawk is classified as a federal candidate three (FC_3) species and as a state candidate (SC) species.

Mammals: Mammals known to inhabit this area based on actual observation during the surveys or direct evidence such as tracks and burrows were the Great Basin pocket mouse, badger, coyote, mule deer, and black-tailed jackrabbit. Coyotes and badgers are the principal predators, consuming such prey as rodents, insects, rabbits, birds, snakes, and lizards. The Great Basin pocket mouse is the most abundant small mammal, which thrives in sandy soils and lives entirely on seeds from local plant species.

Other mammals known to inhabit the North Slope in general include the striped skunk, long-tailed weasel, bobcat, porcupine, and various rodent species.

Reptiles and Amphibians: Reptiles observed during the surveys were the gopher snake, racer, and sideblotched lizards. Other reptiles and amphibians which probably reside on the North Slope include sagebrush lizards, short-horned lizards, western spadefoot toads, and the Pacific rattlesnake.

SUMMARY AND CONCLUSIONS:

Wildlife: Due to the time of the year when these surveys were conducted many species that reside on the North Slope have left and as a result were not observed. Wildlife species that are listed as species of concern by the state and/or federal governments that are known to inhabit the North Slope include the long-billed curlew, Great blue heron, Black-crowned night heron, burrowing owl, Ferruginous hawk, prairie falcon, and sage sparrow.

Cleanup activities at those sites where there are active raptor nests should be conducted when these birds have finished nesting. In most cases cleanup activities at known nesting sites could be conducted from the middle of August to the end of February. The same statement can be made for the other species of concern also. Remedial actions and cleanup activities can be conducted from August to February with little or no impact on these species.

Plants: There should be little or no impact to threatened or endangered plant species as a result of the remedial actions and cleanup activities planned on the North Slope.

REFERENCES: Allen, J.N., 1980, The Ecology and Behavior of the Long-billed Curlew in Southeastern Washington, Wildlife Monographs, No. 73, 67 pp.

Landeen, D.S., A.R. Johnson, and R.M. Mitchell. 1992. Status of Birds at the Hanford Site in Southeastern Washington, WHC-EP-0402 Rev 1, Westinghouse Hanford Company, Richland, Washington.

Sackschewsky M.R., D.S. Landeen, J.L. Downs, W.H. Rickard, and G.I. Baird, 1992. Vascular Plants of the Hanford Site, WHC-EP-0554, Westinghouse Hanford Company, Richland, Washington.

Sackschewsky, M.R., 1992. Biological Assessment for Rare and Endangered Plant Species Related to CERCLA Characterization Activities, WHC-EP-0526, Westinghouse Hanford Company, Richland, Washington.

Poole, L.D., 1992. Reproductive Success and Nesting Habitat of Loggerhead Shrikes in Shrubsteppe Communities, Masters Thesis, Washington State University, Pullman, Washington.

Plant Species Observed on North Slope Surveys

SPECIES	Pos. 72-82	Bridge Dump Site	H81-R Dry Well	Gravel Pit 47	Pos. 1	Asphalt site	Igloo Site	Clay Pit Cistern	Shrapnel Site
Cymopteris terebinthinus	X	X	X						
Lomatium macrocarpum	X								
Achillea millefolium	X								
Ambrosia acanthicarpa	X	X	X	X	X	X	X		X
Antennaria umbrinella									
Artemisia tridentata	X	X	X	X	X	X	X		X
Balsamorhiza careyana	X	X	X						
Centaurea diffusa									
Centaurea solstitialis									
Chrysothamnus nauseosus	X	X	X						
Chrysothamnus viscidiflorus	X	X	X						
Conyza canadensis									
Erigeron filifolius									
Erigeron piperianus				?					
Erigeron poliospermus				X					
Erigeron pumilus				X				X	
Lactuca serriola				X	X	X	X	X	
Machaeranthera canescens	X	X	X	X	X	X	X	X	X

SPECIES	Pos. 72-82	Bridge Dump Site	H81-R Dry Well	Gravel Pit 47	Pos. 1	Asphalt site	Igloo Site	Clay Pit Cistern	Shrapnel Site
Sonchus uliginosus									
Tragopogon dubius								X	X
Amsinckia lycopsoides	X	X							X
Cryptantha circumscissa									
Erysimum asperum									X
Sisymbrium altissimum	X				X	X	X	X	X
Holosteum umbellatum									
Grayia spinosa	X	X							
Salsola kali	X	X	X	X	X	X	X	X	X
Thuja sp.					X				
Scirpus sp.									
Elaeagnus angustifolia					X				
Equisetum sp.									
Eremocarpus setigerus	X								
Euphorbia serpyllifolia	X								
Astragalus caricinus	X								X
Astragalus sclerocarpus									X
Melilotus alba									
Psoralea lanceolata		X							
Robinia psuedo-acacia	X				X				

SPECIES	Pos. 72-82	Bridge Dump Site	H81-R Dry Well	Gravel Pit 47	Pos. 1	Asphal t site	Igloo Site	Clay Pit Cistern	Shrapne l Site
Swainsona salsula									
Erodium cicutarium	X								
Phacelia hastata									X
Asparagus officinalis									
Calochortus macrocarpus	X								
Mentzelia laevicaulis				X					
Sphaeralcea munroana									
Fraxinus pennsylvanica	X								
Epilobium paniculatum									
Oenothera pallida	X	X		X					X
Orobanche corymbosa	X								
Plantago patagonica									
Agropyron dasytachyum									X
Agropyron sibericum			X						
Bromus tectorum	X	X	X	X	X	X	X	X	X
Koeleria cristata									
Muhlenbergia asperifolia									
Oryzopsis hymenoides	X	X							X
Poa sandbergii	X	X	X	X	X	X	X	X	X
Polypogon monspeliensis									

SPECIES	Pos. 72-82	Bridge Dump Site	H81-R Dry Well	Gravel Pit 47	Pos. 1	Asphalt site	Igloo Site	Clay Pit Cistern	Shrapnel Site
Sitanion hystrix									
Sporobolus cryptandrus				X					X
Stipa comata									X
Gilia minutiflora	X								
Leptodactylon pungens									X
Phlox longifolia									
Eriogonum microthecum	X								
Eriogonum niveum	X	X							
Eriogonum vimineum	X								
Polygonum sp.									
Purshia tridentata	X	X							
Comandra umbellata	X	X							
Castilleja exilis									
Penstemon acuminatus									
Verbascum thapsus									
Tamarix parviflora									
Typha latifolia									

SPECIES	Asbestos Pipes	Motorpool & 12-14 dump	Homestead Cistern	Stocktank Cistern	Firing Range	Overlook & Coyote Bait	12-3 Cistern	Wagon Wheel	Stove Cistern
Cymopteris terebinthinus		X				X			
Lomatium macrocarpum						X			
Achillea millefolium	X	X	X	X	X	X	X	X	X
Ambrosia acanthicarpa	X	X	X	X		X	X	X	X
Antennaria umbrinella									X
Artemisia tridentata	X	X	X			X	X	X	X
Balsamorhiza careyana		X	X			X	X		X
Centaurea diffusa					X				
Centaurea solstitialis						X			
Chrysothamnus nauseosus	X	X	X	X	X	X		X	X
Chrysothamnus viscidiflorus	X	X	X	X	X	X			X
Conyza canadensis				X					
Erigeron filifolius						X			X
Erigeron piperianus									
Erigeron poliospermus									
Erigeron pumilus						X			
Lactuca serriola	X			X	X	X	X	X	X
Machaeranthera canescens	X	X			X	X	X		X
Sonchus uliginosus				X					X

SPECIES	Asbestos Pipes	Motorpool & 12-14 dump	Homestead Cistern	Stocktank Cistern	Firing Range	Overlook & Coyote Bait	12-3 Cistern	Wagon Wheel	Stove Cistern
Tragopogon dubius						X	X	X	
Amsinckia lycopsoides									
Cryptantha circumscissa						X			
Erysimum asperum	X								
Sisymbrium altissimum		X			X	X	X	X	
Holosteum umbellatum							X		
Grayia spinosa									
Salsola kali	X	X		X	X	X	X	X	X
Thuja sp.									
Scirpus sp.				X					
Elaeagnus angustifolia		X		X					X
Equisetum sp.				X					
Eremocarpus setigerus					X				
Euphorbia serpyllifolia									
Astragalus caricinus		X				X			
Astragalus sclerocarpus	X					X			
Melilotus alba				X					X
Psoralea lanceolata				X					X
Robinia psuedo-acacia	X	X							
Swainsona salsula				X					

SPECIES	Asbestos Pipes	Motorpool & 12-14 dump	Homestead Cistern	Stocktank Cistern	Firing Range	Overlook & Coyote Bait	12-3 Cistern	Wagon Wheel	Stove Cistern
Erodium cicutarium	X								
Phacelia hastata									
Asparagus officinalis					X				
Calochortus macrocarpus					X	X	X		
Mentzelia laevicaulis									
Sphaeralcea munroana	X				X				
Fraxinus pennsylvanica									
Epilobium paniculatum							X		
Oenothera pallida	X	X	X	X		X	X	X	X
Orobanche corymbosa						X		X	
Plantago patagonica		X			X				
Agropyron dasytachyum		X							
Agropyron sibericum		X							
Bromus tectorum	X	X	X	X	X	X	X	X	X
Koeleria cristata		X							
Muhlenbergia asperifolia				X					
Oryzopsis hymenoides	X	X	X	X		X		X	
Poa sandbergii	X	X	X	X	X	X	X	X	X
Polypogon monspeliensis				X					
Sitanion hystrix		X				X			

SPECIES	Asbestos Pipes	Motorpool & 12-14 dump	Homestead Cistern	Stocktank Cistern	Firing Range	Overlook & Coyote Bait	12-3 Cistern	Wagon Wheel	Stove Cistern
Sporobolus cryptandrus					X				
Stipa comata	X	X		X		X		X	
Gilia minutiflora						X			
Leptodactylon pungens									
Phlox longifolia						X			
Eriogonum microthecum									
Eriogonum niveum	X	X	X						X
Eriogonum vimineum	X								
Polygonum sp.				X					
Purshia tridentata	X	X	X						
Comandra umbellata		X							
Castilleja exilis				X					
Penstemon acuminatus						X			
Verbascum thapsus									X
Tamarix parviflora				X					
Typha latifolia				X					

DRAFT
July 21, 1993

TABLE 1- TRASH AND DEBRIS REMOVAL SITES	
Site	**Description of Action**
Military Construction Dump	Pickup and remove remains of wood structures, construction debris, lubricant cans, and auto parts.
H-12-C	Pickup and remove communication wire, paint and lubricant cans.
H-12-R	Pickup and remove remains of wood structures, domestic trash, 5-gal oil cans, 5-gal drums, and auto parts.
H-81-R	Pickup and remove batteries and bottles.
H-83-C	Pickup and remove rounds of 30-06 blank casings, links for belt fed automatic weapons, and tires.
H-83-L	Pickup and remove trash associated with landfill (remains of wood structures, bottles, and oil cans).
Igloo Site	Pickup and remove broken wooden ammunition crates.
PSN-04 (H-04)	Pickup and remove empty blue plastic 55-gal drums.
PSN 12/14 (H-14)	Pickup and remove paint cans and metal scraps at small burial site. At large dump site pickup and remove commissary type trash, wringer washing machine, water tank and heater, packing crates and overpack for antiaircraft gun shells.
PSN 72/82 (H-82)	Pickup and remove oil cans, antiaircraft gun shell crates and overpack, and lubricant cans.
PSN 90 (H-90)	Pickup and remove debris in soil piles, concrete debris and rebar.
PSN 90 Disposal Site	Pickup and remove tent parts, electronic equipment, auto parts, and debris in pits.
Antiaircraft Gun Shrapnel Sites	Pickup and remove shrapnel at three locations.
Bridge Disposal Site	Pickup and remove remains of wood structures, metal roofing, window screen, railroad ties, oil cans, personal items (toothbrushes, razors) bottles, and cans.
Stock Tank and Well Site	Pickup and remove barbed wire fencing, metal cans and remains of wooden structures.
Dune Homestead	Pickup and remove flour mill and carriage parts.
Lonetree Homestead	Pickup and remove metal cans, broken glass, and debris in trash pit.
Asbestos Pipe Site	Pickup and remove concrete asbestos pipe and small amounts of debris.
Asphalt Batch Plant Site	Pickup and remove small piles of asphalt and concrete.
Coyote Bait Can	Pickup and remove 5-gal military container, anchor stake, and 5-gal fuel type can.
Gravel Pit #47	Pickup and remove cans, bottles, fencing wire, wire spools, two military paint cans, and oil can.
Hanford Firing Range	Pickup and remove 55-gal drums, metal ammunition boxes, brass links and packing tubes.

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APPENDIX L

CULTURAL RESOURCE REVIEW

9306608

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509)
372-2225

RECEIVED
AUG 19 1993
CORRESPONDENCE CONTROL

August 12, 1993

Cultural Resources Present

Mr. Frank Gustafson
Westinghouse Hanford Company
Restoration and Remediation
P.O. Box 1970/H6-04
Richland, WA 99352

CULTURAL RESOURCES REVIEW OF THE NORTH SLOPE WASTE SITES PROJECT, HCRC #92-600-028.

Dear Frank:

In response to your request received June 15, 1992, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project, located in the 600 Area of the Hanford Site. According to the information that you supplied, the project entails cleaning up thirty-nine hazardous waste sites, including such actions as backfilling cisterns and removing contaminated soils and concrete rubble from military installations and chemical dump sites.

Following the 106 process of the National Historic Preservation Act, HCRL first performed a literature and records review to determine if previous archaeological surveys had been conducted in the vicinity of any potential waste sites. Next, staff took preliminary field trips to the sites to determine which locations were archaeological or historic sites and/or whether proposed clean-up activities could impact undisturbed soils adjacent to the hazardous locations. As a result of the these two processes, twenty-nine of the thirty-nine locations were recorded as archaeological or historic sites; twenty-four are insignificant, five are significant.

The insignificant sites, which include all of the military sites and the Wasteway Cistern, Clay Pit Cistern, and Cow Camp Cistern, have been fully documented by HCRL staff. No special protection is recommended for these sites. The five significant sites, the Homestead Cistern, Stock Tank Cistern, Overlook Cistern, 12-3 Cistern, and Wagon Road Cistern, are considered to be significant for their ability to provide information about early Euro-American activities on the Hanford Site. On their own, these historic sites do not retain nationally significant information. If, however, these sites are viewed in terms of a greater thematic category, that of the Euro-American ranching movement in southeastern Washington, then these five sites represent a single component of the greater archaeological record which contains a "set" of property types including habitations, water improvements, and cow camps. Backfilling cisterns located within each site will have no effect on any characteristics that would eventually make them eligible for the National Register of Historic Places. More importantly, backfilling will preserve the cistern walls. However, damage to cultural features and artifacts could easily occur during the backfilling by heavy machinery. The use of machinery at these five sites will be directed by HCRL staff to ensure avoidance of cultural materials. If historic trash at these sites needs to be removed as part of the clean-up process, HCRL will conduct a controlled collection.

Battelle

Mr. Frank Gustafson
August 12, 1993
Page 2

The insignificant military sites and three cistern sites do not require any special protection or monitoring. The workers, however, must be directed to watch for cultural materials (e.g., bones, artifacts) during excavations. If any are encountered, work in the vicinity of the discovery must stop until an HCRL archaeologist has been notified, assessed the significance of the find, and, if necessary, arranged for mitigation of the impacts to the find. This cultural resources review pertains only to the thirty-nine waste sites outlined in the project description. Any new projects that will affect additional areas of the North Slope will require separate reviews.

No work can proceed on the five significant cistern sites until HCRL has received advisement from the State Historic Preservation Officer (SHPO) and an agreement has been reached for avoidance of cultural materials.

A copy of this letter has been sent to Charles Pasternak, DOE, Richland Operations Office, as official documentation. If you have any questions, please call me at 372-2225. Please use the HCRC# above for any future correspondence concerning this project.

Very truly yours,

M. K. Wright

M. K. Wright
Scientist
Cultural Resources Project

cc: C. R. Pasternak, RL (2)
R. E. Jaquish
File/LB

STATE OF W
DEPARTMENT OF COM...
OFFICE OF ARCHAEOLOGY AND HISTORIC PRESERVATION
111 21st Avenue S.W. • P.O. Box 48343 • Olympia, Washington 98504-8343 • (206) 753-4011 • SCAN 234-4011

October 22, 1993

Mr. Charles Pasternak
Cultural Resources Program Manager
Department of Energy
Richland Field Office
Post Office Box 550
Richland, WA 99352

Log: 081993-21-DOE
Re: Waluke Slope Cultural Resources

Dear Mr. Pasternak: Charlie

Thank you sending the Washington State Office of Archaeology and Historic Preservation (OAHP) additional documentation concerning the above referenced projects. The aerial photographs, information on Camp Hanford and the air defenses of Hanford from 1951 to 1975 and the NIKE Program Background are helpful in understanding the context of NIKE sites at the Hanford Site.

In response, I concur with your opinion that the NIKE sites on the Waluke Slope do not appear to be eligible for listing in the National Register of Historic Places. This opinion is based upon the understanding that the sites have been totally demolished (except for debris, foundations, and pavement) with little, if any, potential to yield information on the Cold War Era. We look forward to additional contextual information for evaluation of other NIKE sites at Hanford, particularly the site located on the Arid Land Ecology Reserve. Therefore, in view of our opinion that the Waluke Slope NIKE sites are not National Register eligible, further contact with OAHP regarding this action is not necessary.

Charles, thank you for the additional information and opportunity to comment on this action. Should you have any questions, please feel free to contact me at (206) 753-9116.

Sincerely,

Greg Griffith

Gregory A. Griffith
Comprehensive Planning Specialist

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APPENDIX M

LANDFILL CHARACTERIZATION AND REMEDIATION ACTIVITIES

1.0 GOAL

This appendix discusses the objectives and associated activities for the landfill characterization and remediation program.

1.1 LANDFILLS

The North Slope consists of a number of uncharacterized landfills. The types and locations of contaminants can be speculated on at some landfills; in other cases, there is no information regarding potential contamination whatsoever. The objectives for the landfills in advance of remediation are as follows:

- Determine the types of contaminants present at each landfill
- Determine which sites require no remediation
- For sites that require remediation, identify which contaminants are present at concentrations that require remediation
- Where relatively little additional effort is necessary, determine the approximate extent of remediation that will be required.

1.2 TYPES OF CONTAMINANTS PRESENT

The types of contaminants present at each landfill will be determined through the use of geophysical surveys and/or soil sampling. Geophysical surveys do not determine the types of contaminants present, but they will identify the locations of possible releases so that followup soil sampling can be performed to identify the contaminants. The objectives of the geophysical surveys are to: (1) be sensitive enough to identify anomalies including drums and underground storage tanks (i.e., avoid false negatives); (2) within the constraints of the first objective, minimize the number of anomalies identified that do not correspond to probable sources of contamination (i.e., false positives); (3) perform measurements with a close enough spacing so that likely sources of contamination will not be missed; and (4) identify the location of each anomaly to within a 10-ft radius so that followup sampling will collect either potentially contaminated soil or be close enough to the release so that a negative result will be adequate to indicate that any release is too small to warrant remediation.

Geophysical surveys will be followed by exploratory trenching and soil sampling in areas where anomalies and surface indications are detected. As trenching proceeds, visual and instrumented field screening procedures will be used to identify possible contamination and contaminant sources. Soil sampling will then be performed to confirm or deny the presence of hazardous constituents. The results of the soil sampling will be used to determine whether a landfill requires remediation, which contaminants require remediation, and the approximate extent of remediation. Soil sample analyses will generally require methods that provide positive identification of contaminants. Analytical methods that only rule out the presence of contamination can be used if methods that positively identify the contaminants are used as a followup measure.

1.3 CLEANUP LEVELS

The detection limits of the analyses must be below cleanup levels. These cleanup levels for the various contaminants will be developed in consultation with the regulatory agencies during preparation of the field sampling plan prior to characterization activities.

2.0 LANDFILL CHARACTERIZATION

2.1 GEOPHYSICAL SURVEY

Due to their heterogeneous nature, landfills will be investigated with several geophysical methods. An electromagnetic (EM) survey also will be conducted to determine anomalous areas within the landfill that could be indicative of buried metallic materials (i.e., buried drums). A ground penetrating radar (GPR) survey will be conducted in areas determined by the EM survey to contain anomalous readings. The GPR survey will be used to provide better definition of subsurface conditions in these areas and to define locations of any buried materials. Using a permanent landmark adjacent to the site as an origin, a grid will be staked out over the landfill area. Grids for the EM survey will cover a wide area to provide general information on subsurface conditions. Grids for the GPR survey will be closely spaced over areas indicated by the EM survey to contain anomalies.

2.2 SOIL SAMPLING

Using geophysical results as a basis for sampling locations, trenching with associated soil sampling will be conducted to determine the extent of soil contamination. Test pits will be completed through areas indicated by geophysical survey results to contain anomalies. The position of each test pit with respect to the permanent landmark referenced for the geophysical surveys will be described in detail in the field logbook. Soil samples will be logged to assess soil characteristics and the presence of visible contamination. Samples will be field screened for the presence of organic vapors. Samples with visible contamination and/or registering detectable contamination through field screening will be submitted to the laboratory for analysis using U.S. Environmental Protection Agency (EPA) Method SW-846 for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), chlorinated pesticides and polychlorinated biphenyls (PCB), and RCRA metals. Ten percent of all samples taken will be analyzed using EPA Contract Laboratory Program protocols with full validation. Test pits will be completed to the depth where contamination is no longer detected or through the anomalous area. Laterally, soil borings will be completed to the position where contamination is no longer detected.

3.0 LANDFILL REMEDIATION

The following discusses remediation activities at landfill sites where contaminants are detected above cleanup levels during the characterization sampling. Landfill sites will not be remediated if contaminants are not detected above cleanup levels during the characterization sampling.

If the results of field screening and sampling (as described in Chapter 2) indicate contaminants are present above cleanup levels, the contaminated soil will be excavated. During excavation, samples will be collected and field screened. Excavated materials will be stockpiled prior to treatment or disposal in lined containers or stockpiled on liners that are shaped to prevent runoff. Excavation will continue until field screening results indicate contaminants are not present above action levels. At this point, confirmation samples will be collected from each side and the bottom of the excavation. At a minimum, one sample will be collected from each wall and the base of the excavation. These samples will be collected from the area of the walls and base that was adjacent to contaminated areas in the excavation. Samples will not include debris, so that samples will be representative of the landfill proper. Confirmation samples will be sent to an offsite laboratory to certify that the excavations are free of contaminants above cleanup levels with a 24-hr turnaround time. These analyses will consist of analytes detected above cleanup levels during characterization sampling.

If contamination is determined to reach a depth below ground surface that cannot safely be excavated, excavation will cease. In this event, the site will require further characterization and reevaluation of remedial alternatives.

In the event confirmation sampling reveals a wall or the base of the excavation to be contaminated over cleanup levels, the wall or base will be further excavated. After overexcavation, confirmation sampling will be performed. This process will continue until the excavation is determined to be free of contaminants over cleanup levels.

4.0 GEOPHYSICAL SURVEY TECHNIQUES

Geophysical surveys will be performed based on a grid system. Although no actual samples will be collected during a geophysical survey, data collected will be logged electronically in a data collector/recorder or in the field logbook. A description of the location of the survey point will be noted along with the results of each geophysical survey.

4.1 ELECTROMAGNETIC

EM surveys will be conducted in areas suspected of containing buried metallic wastes (i.e., buried drums or underground storage tanks). An EM survey typically utilizes an EM field generated at the ground surface. This EM field induces secondary EM fields in the earth, which are measured at the surface. Fluctuations in the secondary EM fields are indicative of differing materials under the surface. In this way, areas registering anomalous readings that may be indicative of buried metallic objects can be located. EM surveys can typically scan to a depth of 10 to 20 ft.

General procedures for performing an EM survey will be in accordance with the standard operating procedures (SOP) developed by the U.S. Army Corps of Engineers for the Hanford Site. Specific instrument calibration and operation procedures will be in accordance with the manufacturer's instructions. Readings will be taken at evenly spaced intervals along grid lines placed over the area under investigation. Data collected from readings will be graphed to allow interpretation of areas displaying anomalous readings that may be indicative of buried metallic objects.

4.2 GROUND PENETRATING RADAR

GPR is a method that provides a continuous, high resolution cross-section depicting variations in the electrical properties of the shallow subsurface. This method is particularly sensitive to variations in electrical conductivity and electrical permitivity (the ability of a material to hold a charge when an electrical field is applied). The system operates by continuously radiating an electromagnetic pulse into the ground from a transducer (antenna) as it is moved along a traverse. Since most of the earth materials are transparent to electromagnetic energy, only a portion of the radar signal is reflected back to the surface from interfaces representing variations in electrical properties. When the signal encounters a metal object, however, all of the incident energy is reflected. The reflected signals are received by the same transducer and are printed in cross-section form on a graphical recorder. The resulting records can provide information regarding stratification, the thickness and extent of fill material, the location of buried objects, changes in material conditions such as saturation, and changes in subsurface chemistry where this is reflected by different electrical properties.

General procedures for performing a GPR survey will be in accordance with the SOPs adopted by the U.S. Army Corps of Engineers for the Hanford Site. Specific instrument calibration and operation procedures will be in accordance with the manufacturer's instructions. Equipment calibration will be conducted at regular intervals according to the manufacturer's instructions. The GPR locations will be in areas where EM anomalies were detected. The survey locations will hone in on the location and orientation of the EM anomaly. The location of features causing the EM anomaly will then be staked.

5.0 SOIL SAMPLING TECHNIQUES

5.1 CHARACTERIZATION SOIL TRENCHING EQUIPMENT

Trenching will be performed using an excavator (i.e., backhoe or equivalent).

5.1.1 Characterization Soil Sampling Procedures

Samples will be collected in accordance with procedures detailed in the SOPs adopted by the U.S. Army Corps of Engineers for the Hanford Site.

5.1.2 Equipment Decontamination

Equipment decontamination shall follow procedures detailed in the SOPs adopted by the U.S. Army Corps of Engineers for the Hanford Site. Excavators will be decontaminated as follows before proceeding to any new trench when suspect contaminated soil is encountered. Any large soil deposits will be scraped off with a shovel. The excavator will then be decontaminated by manually wiping the bucket down using cloth and a wetting detergent. Only the portions of the excavator contacting the soil will require decontamination. All decontamination procedures will be conducted over a temporary decontamination pad which will be shaped to contain all fluids generated during the process.

5.2 PRE-EXCAVATION TEST PIT SAMPLING EQUIPMENT

To avoid placing personnel in an excavation, samples shall be collected from ground surface using the excavator bucket when possible. Samples shall be collected directly with the excavator bucket. In the event samples cannot be collected with the excavator, samples shall be collected with a stainless steel hand auger or hand trowel. All measures will be taken to ensure the safety of personnel who enter an excavation. Under no circumstances will personnel enter an unshored, vertical-walled excavation >4 ft deep.

5.2.1 Pre-Excavation Test Pit Sampling Procedures

Samples will be collected in accordance with procedures detailed in the SOPs adopted by the U.S. Army Corps of Engineers for the Hanford Site.

5.2.2 Equipment Decontamination

Equipment decontamination shall follow procedures detailed in the SOPs adopted by the U.S. Army Corps of Engineers for the Hanford Site. Excavation equipment will be decontaminated as described in Section 5.1.2.

5.3 CONFIRMATION SAMPLING EQUIPMENT

In excavations of 4 ft or less in depth, or in deeper excavations with tapered sides, confirmatory samples will be collected with a stainless steel hand trowel or a stainless steel hand auger. Samples for VOC analysis will be collected with a hand-driven core sampler (i.e., a split-spoon sampler or equivalent). Vertical wall excavations >4 ft in depth will require differing sample collection methods. To avoid placing personnel in these excavations, samples shall be collected from ground surface using the excavator bucket whenever feasible. If possible, the contractor shall attach a core sampler to the excavator bucket for use in collecting samples for VOC analysis. Samples for other analyses shall be collected directly with the excavator bucket unless this approach is not feasible. In the event samples cannot be collected with the excavator, samples shall be collected with a stainless steel hand auger or hand trowel. All measures will be taken to ensure the safety of personnel who enter the excavation. Under no circumstances will personnel enter an unshored, vertical-walled excavation >4 ft deep.

5.3.1 Confirmation Sampling Procedures

Samples will be collected in accordance with procedures detailed in the SOPs adopted by the U.S. Army Corps of Engineers for the Hanford Site.

5.3.2 Equipment Decontamination

Equipment decontamination shall follow procedures detailed in the SOPs adopted by the U.S. Army Corps of Engineers for the Hanford Site. Excavation equipment will be decontaminated as described in Section 5.1.2.

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5.4 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

QA/QC procedures will be developed in consultation with the regulatory agencies during preparation of the field sampling plan prior to characterization activities.

6.0 FIELD SCREENING TECHNIQUES

To expedite remediation of the North Slope, various field screening methods will be employed for preliminary determination of the presence and extent of contamination. Followed by confirmatory sampling, field screening will also be used as an indicator of when an area has been excavated to below remediation criteria. Various field screening techniques have been identified which may be applicable to contaminants of concern at the North Slope.

Although VOC concentrations in soil samples cannot be determined, organic vapor detectors can be used for headspace screening to determine the presence of VOCs in a sample. Organic vapor detectors may be photo- or flame-ionization detectors. Headspace screening is accomplished by filling a container (i.e., a jar or ziplock bag) about half full of soil. The container is closed and allowed to sit or is heated at a constant temperature for 5 min. Following this period, the detector probe is inserted into the container and a reading is taken.

An organic vapor detector will be utilized to identify samples with the highest concentrations of VOCs, which will the be sent to a laboratory for analysis and to delineate areas containing VOC contamination. Based on current information regarding the sites associated with the North Slope, use of an organic vapor detector is recommended at the landfill sites. Calibration procedures shall be in accordance with manufacturer's recommendations.

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APPENDIX N

COST ESTIMATES

North Slope Well Decommissioning Cost Estimate.

Well no.	Mobilize & set up	Camera survey	Clean out	Perforate	Install grout	Expendable material	Remove wellhead	Oversight	Overhead expenses	Estimated cost/well
699-61-16A	$12,000	$1,200	$ 19,200	$ 9,600	$ 4,800	$ 10,000	$ 2,400	$ 9,000	$ 38,900	$107,100
699-61-16B	2,400	N/A	7,200	4,800	4,800	10,000	2,400	4,300	15,200	51,100
699-70-17	4,800	N/A	N/A	N/A	7,200	6,000	2,400	2,900	13,600	36,900
699-76-90	4,800	500	9,600	9,600	4,800	4,000	2,400	3,600	18,000	52,500
699-79-104	4,800	N/A	N/A	N/A	4,800	4,000	2,400	3,600	14,800	41,600
699-80-73B	4,800	500	9,600	4,800	4,800	4,000	2,400	3,600	18,000	52,500
699-86-64	4,800	500	9,600	9,600	7,200	10,000	2,400	7,200	23,800	75,100
699-86-95	4,800	N/A	9,600	9,600	4,800	8,000	N/A	5,400	20,100	62,300
699-92-14	4,800	N/A	9,600	12,000	7,200	12,000	N/A	7,200	23,800	76,600
699-93-93	4,800	500	9,600	7,200	4,800	12,000	N/A	5,400	21,400	65,700
699-98-54A	4,800	500	2,400	4,800	2,400	3,000	2,400	3,600	14,400	38,300
699-107-79	4,800	500	2,400	9,600	4,800	6,000	N/A	3,600	17,000	48,700
699-111-24	4,800	N/A	N/A	2,400	2,400	3,000	N/A	2,500	10,800	25,900
699-112-37	4,800	500	9,600	9,600	4,800	8,000	N/A	5,400	20,900	63,600
699-115-61	4,800	500	9,600	9,600	4,800	7,000	N/A	5,400	20,600	62,300
Categorical Subtotals	$76,800	$5,200	$108,000	$105,600	$74,400	$107,000	$19,200	$72,700	$291,300	
Total										$860,200

N/A = not applicable to the specific well.

Alternative Cost Estimates

Alternatave	Cost, $
Hazards Mitigation:	
Well Decommissioning	860,200
Physical Hazards & Ordnance	299,590
Total	1,159,790
Characterization and Hazards Mitigation:	
Hazards Mitigation	1,159,790
Characterization	2,236,230
Total	3,396,020
Hazards Removal:	
Hazards Mitigation	1,159,790
Landfill Removals	8,607,140
Total	9,766,830
Hazards Removal and Demolition Debris:	
Hazards Mitigation	1,159,790
Landfill Removals	8,607,140
Demolition Debris Removal	12,103,290
Total	21,870,220

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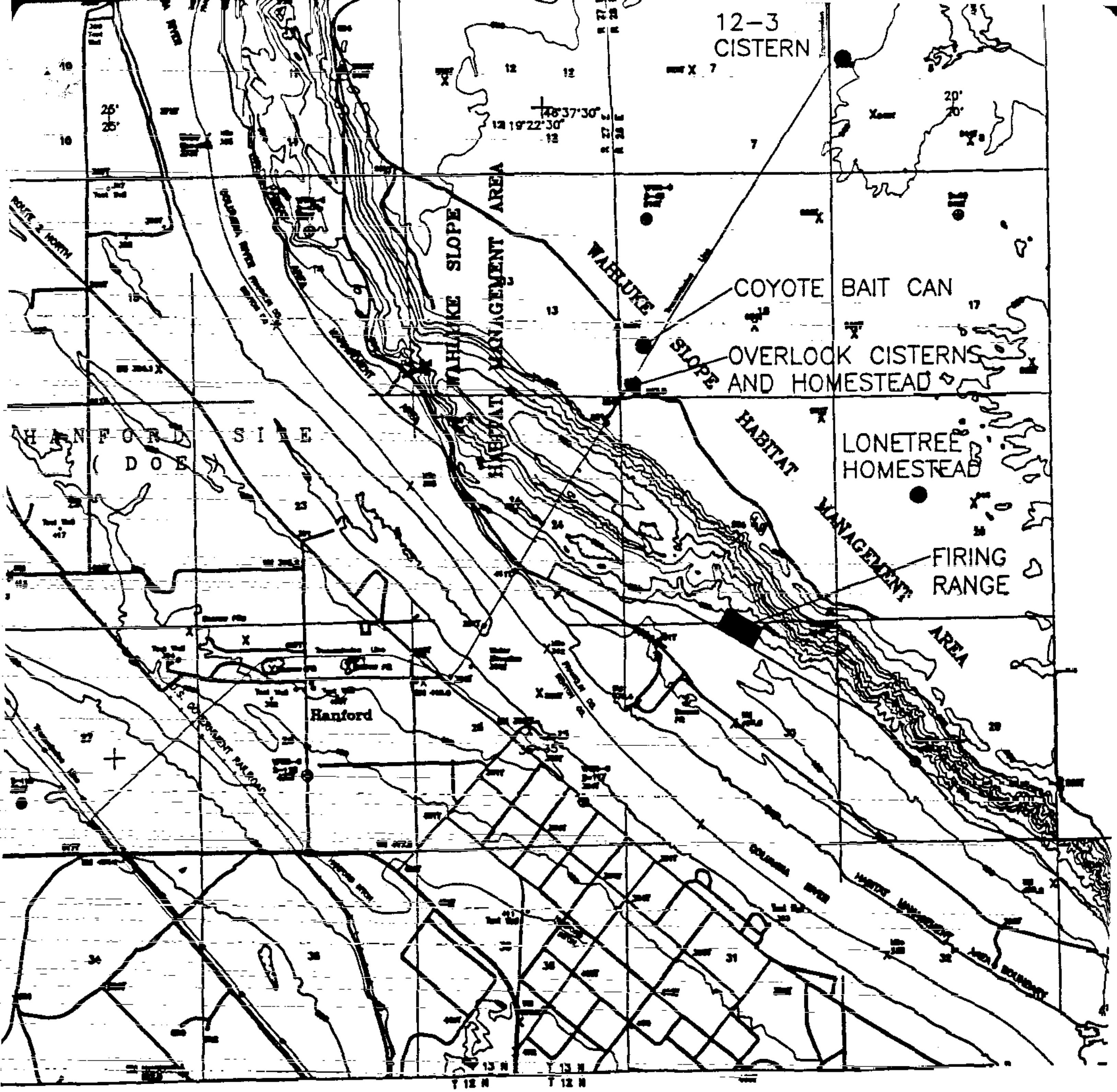

PLATE 1. Topographic Map of the North Slope of the Hanford Site. (1992)

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