

FINAL

REMEDIAL INVESTIGATION INTERIM REPORT
NAVAL SUPPLY CENTER (NORFOLK)
CHEATHAM ANNEX

Prepared for:

Naval Facilities Engineering Command
Atlantic Division

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1.0 INTRODUCTION

This document is the Final Remedial Investigation (RI) Interim Report for the Navy Installation Restoration Program (IRP) at the Naval Supply Center (NSC), Cheatham Annex (CA), Williamsburg, Virginia. This report was prepared by Dames & Moore under subcontract to the Naval Facilities Engineering Command, Atlantic Division (LANTDIV). It is provided as an Interim Report and summarizes efforts completed to date with respect to RI efforts at sites of concern identified at CA during the completion of the Installation Assessment Study (IAS) by the Navy (NEESA, 1984). Following IAS completion, sites identified as potentially posing a threat to public health or the environment were investigated during a two-phase field investigation (identified as Step IA, verification phase). The Step IA efforts were conducted in two separate phases, identified as Round One and Round Two; this report presents results from both. Step IA was conducted in accordance with approved work plans and resulted in data collection and brief evaluation regarding possible sources of hazardous constituents and surface/subsurface characteristics.

This report marks the conversion between the two Navy programs and summarizes work completed during the Step IA phase of the old Navy Assessment and Control of Installation Pollutants (NACIP) program for site evaluation based on a review of data available for each site; it also presents recommendations for additional efforts to complete the RI for the sites of concern.

Recommendations are provided for each site to: (1) Exclude the site from further investigation because it appears to pose no threat to human health or the environment; (2) Conduct a baseline risk assessment to evaluate whether the site poses a potential threat to human health or the environment; or (3) Collect additional RI data necessary to further evaluate the extent and potential for contaminant migration and perform a baseline risk assessment to evaluate whether the site poses a threat to human health or the environment.

A total of four sites at CA (Figures 1-1 and 1-2), are discussed in this report: a landfill, a storage area, a surface disposal area, and a burial disposal area. Based on efforts completed to date, it is recommended that one of these sites be excluded from further consideration because it appears to pose no threat to human health or the environment. Additional RI efforts are proposed for the remaining three sites, as discussed herein. Some contamination has been confirmed at two of the three sites; the type, magnitude, and extent of contamination in terms of the potential threat to human health and the environment are partially addressed by Rounds One and Two, as discussed herein.

Following submittal of this RI Interim Report, a sampling plan will be developed for the additional investigations recommended herein. A final RI report will be prepared subsequent to implementation of the sampling program.

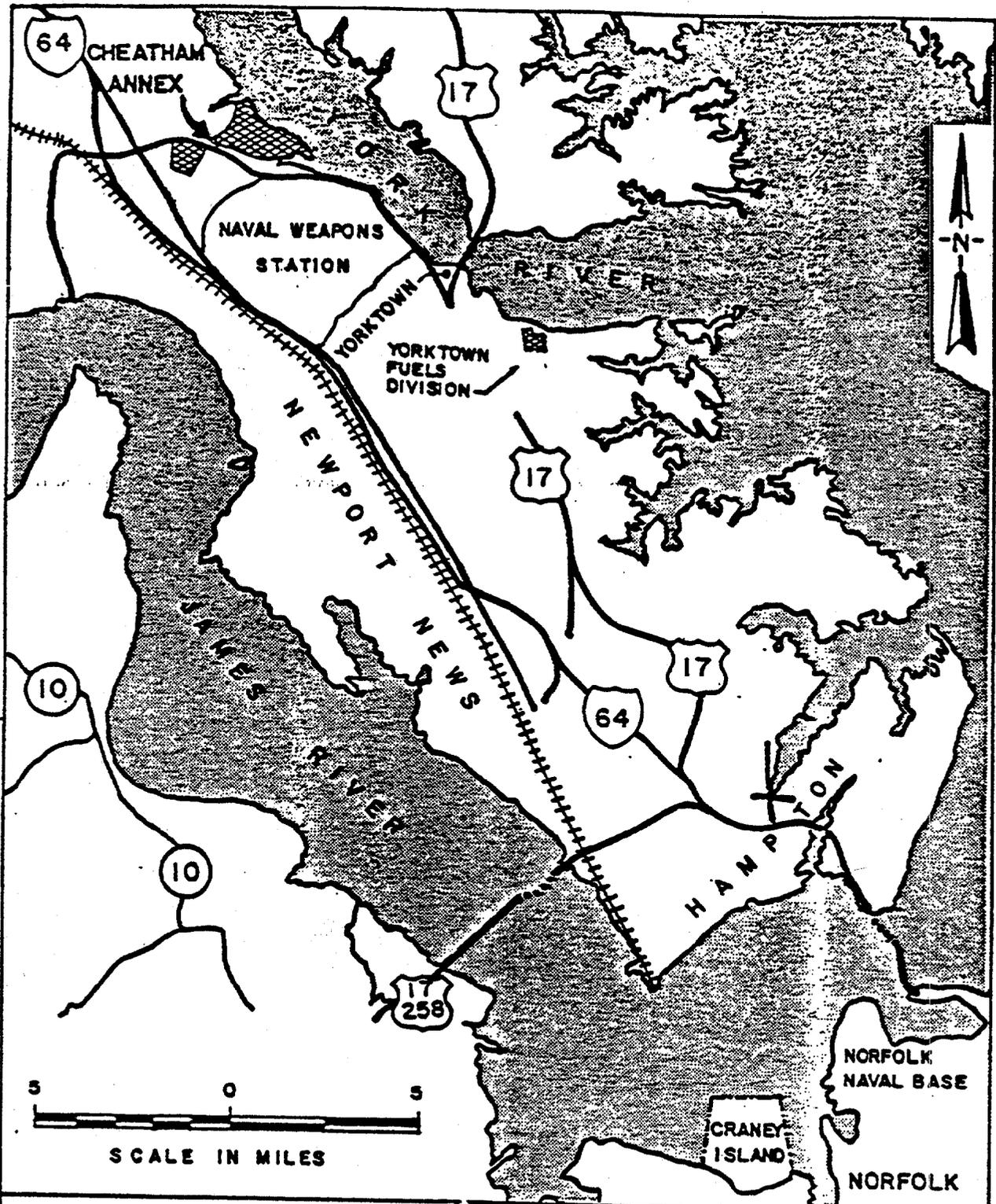


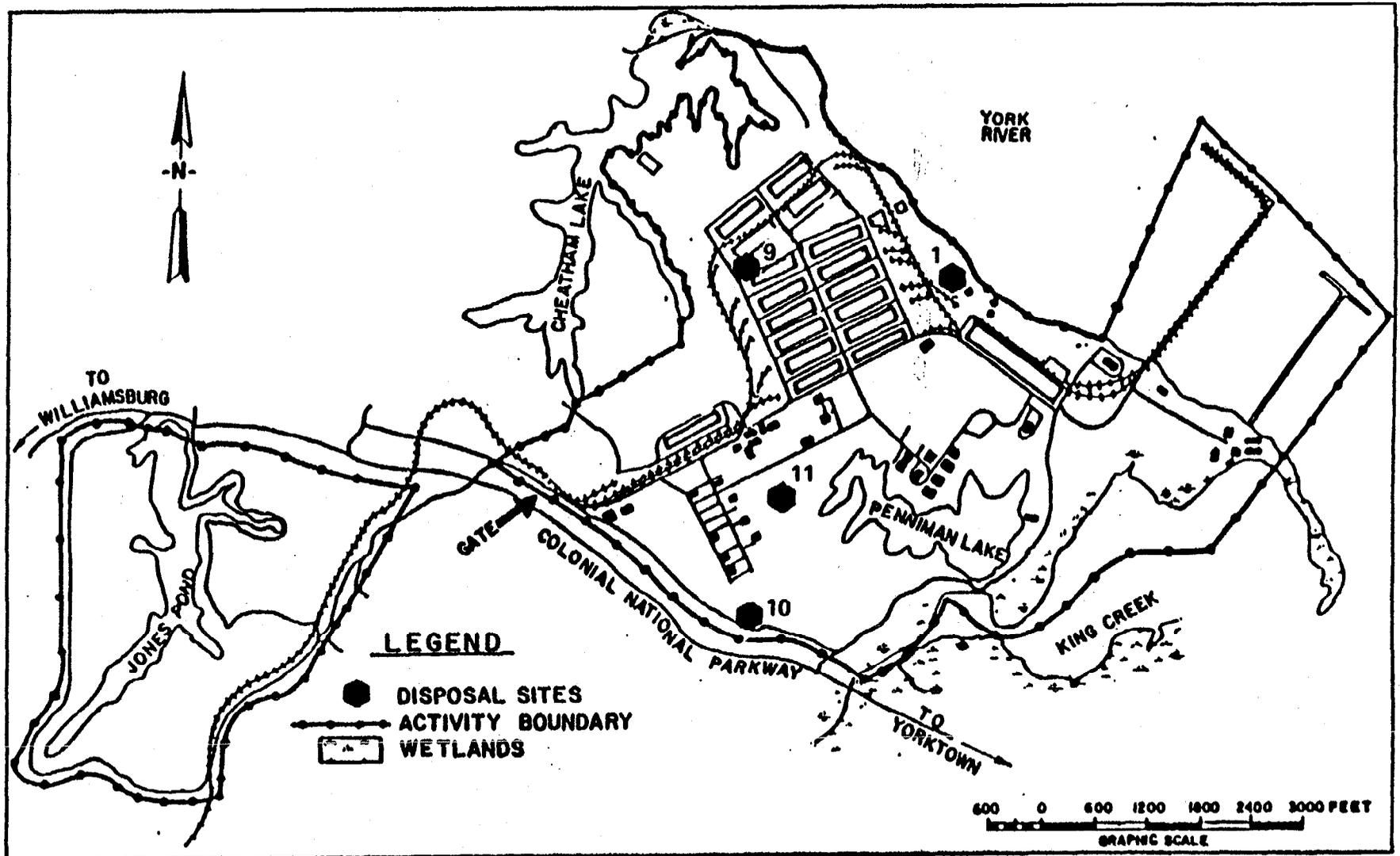
FIGURE I-1
VICINITY MAP
CHEATHAM ANNEX



INITIAL ASSESSMENT STUDY
NAVAL SUPPLY CENTER
(NORFOLK)
CHEATHAM ANNEX

SOURCE: NEESA, 1984.

Figure 1-2
Naval Supply Center (Norfolk)
Cheatham Annex
Location of Study Sites



2.0 INSTALLATION RESTORATION PROGRAM

2.1 BACKGROUND

The Department of Defense (DOD) began its Installation Restoration Program (IRP) in 1975 to assess past activities related to the storage and disposal of toxic and hazardous materials. DOD policy is to identify and fully evaluate suspected problems associated with former hazardous materials disposal sites, and to control hazards to health and welfare that may have resulted from these past activities.

After the initiation of DOD's IRP, Congress passed the Resource Conservation and Recovery Act (RCRA) of 1976 as the primary means for governing the disposal of hazardous wastes. Under Sections 3012 and 6003 of this act, Federal agencies are directed to assist the US Environmental Protection Agency (EPA) and state agencies in inventorying past disposal sites and making the information available to requesting agencies. Similarly, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 to assess and alleviate potential adverse public health and environmental impacts resulting from past hazardous waste management practices that were the accepted procedures of the time. When these activities are conducted by EPA and state agencies, they are commonly referred to as the "Superfund" program.

On 14 August 1981, in Executive Order 12316, the President delegated certain authority to the Secretary of Defense, as specified in CERCLA. The current DOD IRP policy is contained in DEQPPM 81-5, dated 11 December 1981. DEQPPM 81-5 reissued and amplified all previous directives and memoranda regarding the IRP. To fulfill the requirements imposed by the DOD IRP, the Department of the Navy initiated its program entitled Navy Assessment and Control of Installation Pollutants (NACIP). The Navy formerly managed this program in three phases: Initial Assessment Study (IAS), Confirmation Study, and Remedial Action.

In response to the Superfund Amendments and Reauthorization Act (SARA) of 1986, the Navy changed the terminology and structure of the IRP to conform to that used by EPA. The sequential efforts of the program are as follows:

- The IAS identifies potential threats to human health or the environment caused by past hazardous substance storage, handling, or disposal practices at Naval activities. The IAS is equivalent to a Preliminary Assessment (PA) conducted by EPA under the Superfund program.

- The four-step Confirmation Study analyzes contaminants present at sites of concern and evaluates contaminant migration. In Step IA (verification), short-term analytical testing and monitoring determine whether specific toxic and hazardous materials (identified in the IAS), are present in concentrations considered hazardous. If required, Step IB (characterization) uses longer term testing and monitoring to provide more detailed information concerning the extent and rate of contaminant migration, as well as site hydrogeology and possibly geophysics and other factors. The sum of Steps IA and IB is referred to as the Remedial Investigation (RI).
 - If the RI indicates that remedial actions are necessary, a Feasibility Study (FS) is required to evaluate remediation alternatives that will achieve compliance with environmental standards. The FS, referred to as Step II, also includes projecting the effectiveness of the alternatives and preparing cost estimates.

 - If deemed necessary after the RI/FS, Step III (remedial design) includes preparation of plans, specifications, and government project documentation with cost estimates satisfactory for project funding requests. Step III includes the required corrective measures to mitigate or eliminate confirmed problems.

- Within the EPA RI/FS framework, this RI interim report summarizes verification and characterization efforts completed to date under the IR program. Additional efforts are necessary for completion of the RI within the current EPA framework.

2.2 SCOPE

The objectives of the Dames & Moore Round One and Two investigations at CA were to obtain data to determine the nature and extent of hazardous constituents in surface water, groundwater, soil, and/or sediment media at each of the four sites of concern, and to evaluate the need for corrective action measures. Hydrogeologic and chemical data were collected to use in identifying the presence, approximate extent, and migration potential of contaminants at each site. The data collection effort included drilling five exploratory boreholes; installing five monitor wells in the boreholes and defining local hydrogeology; and obtaining a total of 52 environmental samples and 20 drum samples for a variety of constituents, including priority pollutants, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), PCBs, oil and grease, phenols (total), ethylene dibromide (EDB), hexavalent chromium, and in the case of drum samples, RCRA characterization analyses.

Environmental samples were collected from three sites during the first round of sampling (winter, 1986). A geophysical survey was also conducted at one of the sites. Only the analytical effort was documented in the report "Confirmation Study Step IA (Verification), Round One," submitted to LANTNAVFACENCOM on 11 June 1986. Round One work included installing five monitor wells and collecting and analyzing groundwater samples from each new well and the four existing wells. This effort also involved collecting and analyzing three surface water samples and three bottom sediment samples from the same locations. Twenty-two soil samples were also collected and analyzed. Twenty drum/tank samples were collected from one of the sites for waste characterization and disposal.

The second round of sampling for the Confirmation Study was conducted during November and December 1987. The Round Two effort required collecting and analyzing nine groundwater, three surface water, and three sediment samples. The chemical analyses results and comparisons with applicable regulatory standards were presented in the report "Confirmation Study Step IA (Round Two)," submitted to LANTNAVFACENGCOM on 20 June 1988.

This report provides results of the previous Round One and Two investigations, an evaluation of the sites with respect to those data, methodologies for previous data collection efforts, and pertinent environmental setting data useful for site evaluation. The purpose of this report is to summarize existing available data for each site and, based on the data, provide recommendations for additional efforts to be conducted to complete the RI. Sufficient information has been gathered to conclude that one site does not appear to pose a threat to human health or the environment. At other sites, the extent of contamination and site characteristics have not been adequately identified to complete the RI. Recommendations for additional RI efforts are outlined as a result of identified data gaps.

3.0 NATURAL SETTING

3.1 LOCATION AND HISTORY

Cheatham Annex (CA) is located in Williamsburg, Virginia in Central York County on the Virginia Peninsula, between the York and James Rivers, bordering on the York River (Figure 2-1). The proximity to two major tidal tributaries of the Chesapeake Bay is an important influence on the natural environment of the activity. The 1,579-acre facility is bounded on the north by the York River, on the south by the Colonial Parkway, on the west by Department of Interior land, and on the east by Naval Weapons Station, Yorktown.

CA was initially commissioned as a satellite unit of the Naval Supply Depot in June 1943 to provide bulk storage facilities. During World War I and prior to establishing CA, the annex had been the location of a large powder and shell-loading facility operated by Dupont. Following closeout in 1918, the land was used for farming or left idle until CA was established in 1943. The mission of CA has remained essentially the same since it was commissioned: receiving, storing, packaging, and shipping of materials to Federal facilities on the east coast and major distribution centers in Europe.

3.2 CLIMATE

The climate of the Virginia Peninsula is moderate continental, with mild winters and long, warm summers. Average monthly temperatures in the area range from approximately 41°F in January to 79°F in July. Precipitation is well distributed throughout the year, and the heaviest rains occur in July and August. Prevailing winds are usually from the southwest, but northeasterly winds are common in some months. The average wind speed is 10.6 miles per hour (mph) and average annual net precipitation is approximately 45 inches.

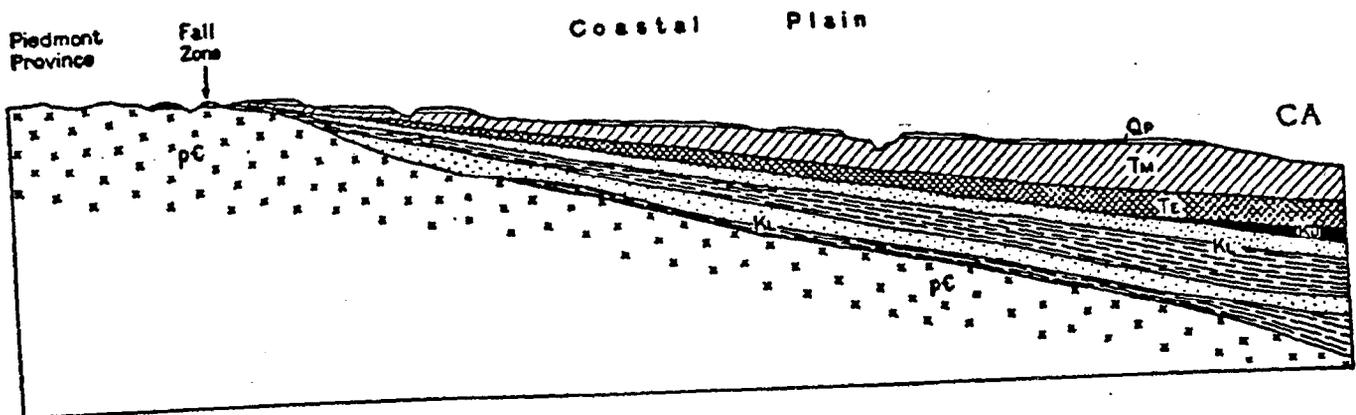
3.3 TOPOGRAPHY AND PHYSIOGRAPHY

CA is located on the York-James Peninsula, which is an embayed portion of the Atlantic Coastal Plain Physiographic Province. (VWCB, 1973) This elongated peninsula trends northwest-southeast and occupies an area of approximately 1,752 square miles. The peninsula is roughly bordered to the southwest by the James River, to the northeast by the York River, and to the southeast by the confluence of the James River and the Chesapeake Bay.

The topography is characterized by gently rolling terrain dissected by ravines and stream valleys trending predominantly northeastward toward the York River. Ground elevations vary from sea level along the eastern boundary bordering the York River, to a maximum elevation of approximately 90 feet mean sea level (msl) on a few scattered hills in the western portion of the activity.

3.4 GEOLOGY

The geology of the Atlantic Coastal Plain Physiographic Province is characterized by unconsolidated sediments of Cretaceous, Tertiary, and Quaternary ages that dip gently eastward and rest on pre-Cretaceous aged bedrock at a depth of approximately 1,900 feet. (VWCB, 1973) The bedrock consists primarily of crystalline igneous and metamorphic rock and scattered triassic ("red bed") sedimentary rocks. A generalized east-west trending cross-section of the Atlantic Coastal Plain in Virginia is provided in Figure 3-1. The fall zone illustrated here is roughly coincident with Richmond, Virginia, and marks the location where the eastwardly thickening mantle of unconsolidated sediments (coastal plain deposits) begins. The relative location of CA is also depicted in Figure 3-1 and the general geologic characteristics of the coastal plain deposits that underlie CA are summarized in Table 3-1.



- Qp = Pleistocene terrace Formation
- TM = Miocene marl
- TE = Eocene glauconitic sand and marl
- KU = Upper Cretaceous sands and clays
- KL = Lower Cretaceous sands and clays
- pC = Crystalline basement rock, chiefly pre-Cambrian

FIGURE 3-1
 GENERALIZED GEOLOGIC CROSS-SECTION
 OF THE ATLANTIC COASTAL PLAIN IN VIRGINIA

SOURCE: Cederstrom, 1946.

Dames & Moore

TABLE 3-1
Stratigraphic Section of the Coastal Plain Deposits
Underlying Cheatham Annex, Williamsburg, Virginia

SYSTEM	SERIES ¹	AGE ¹	FORMATION ²	APPROXIMATE THICKNESS	LITHOLOGIC CHARACTER	HYDROLOGIC COMMENTS
Quaternary	Post-Pliocene			20 - 100	Mostly sand, and gravels of fluvial and terrace deposits	Supplies ground water to low-yield water table wells throughout the area
Tertiary	Miocene	Late Miocene Middle Miocene	Yorktown	0 - 150	Fossiliferous sands, marls, and coquinas	Supplies ground water to water table wells in parts of the area
			St. Mary's	0 - 150	Dark-colored sands, silts and clays; often referred to as "blue sand" and "blue clay"	Acts as a confining bed for the upper artesian aquifer system
			Colvert	0 - 60	Fossiliferous silts and sands, occasionally glauconitic	Upper artesian aquifer; yields sufficient water for domestic, subdivision and light agricultural and industrial purposes
	Eocene	Jackson	Chickahominy	0 - 30	Fine to medium grained sands, poorly to moderately sorted, occasionally glauconitic	
			Claborne	Nonjomy (Claborne age)		
	Paleocene	Mlawey	Nonjomy (Wilson Age) Aquia Mattaponi (Glauconitic Member)		0 - 100	Highly glauconitic sands, silts and clays; often referred to as "greensand" or "black sand"
Cretaceous	Lower Cretaceous	F G H	Mattaponi (Lower) Potomac Growl	0 - 1500	Interbedded sands, silts and clays of fluvial and deltaic origin; some thin marginal marine beds; unit F dominantly silts & clays of interdeltic region in extreme eastern part of the area	Capable of high yield with proper development in most areas of York-James Peninsula; mostly undeveloped at present time
Triassic					Prejudominantly soft red and brown shales; some thin beds of hard red shale and sandstone	Supplies ground water to a few low-yield water table wells in Ashland area
Pre-Triassic Crystalline Rock					Highly variable rock types	Supplies moderate quantities of ground water to deep wells near Fall Zone
¹ Brown (1972) ² Cedarstrom (1957)						

Source: Virginia State Water Control Board, 1973.

As discussed in the IAS for CA (NEESA, 1984), the surficial unconsolidated sediments at the site have been mapped as the Windsor Formation of the Pleistocene series. This formation is composed of a series of sands and silts deposited in marine and estuarine environments. Its thickness is estimated to vary from 0 to 40 feet.

The Miocene deposits of the Yorktown, St. Mary's, and Calvert formations underlie the Windsor Formation. The Miocene deposits range in thickness from about 200 feet in western James City County to slightly more than 300 feet in the Hampton area. The top portion of the Yorktown Formation (consisting of shells and shell fragments cemented with calcite) was encountered during drilling of several monitor wells installed during Round One. The Yorktown Formation grades downward into the St. Mary's Formation, which is comprised of fine-grained, subround-to-round quartz sand with a decrease in shell fragment content. The St. Mary's Formation has a darker color and is often called blue sand or blue clay in driller's logs. The Calvert Formation underlies the St. Mary's Formation. The base of the Calvert Formation is marked by a marl or coquina. (VWCB, 1973, cited in NEESA, 1984)

The Eocene deposits underlie the Miocene deposits and consist of the Chickahominy and Nanjemoy formations. These formations consist of fine-to-medium grained sand with varying concentrations of glauconite. The thickness of the Eocene deposits varies considerably, but averages approximately 70 feet in the vicinity of the western part of the Virginia Peninsula. (VWCB, 1973)

Paleocene deposits underlie the Eocene deposits and consist of the Nanjemoy, Aquia, and Mattaponi formations. In the central part of the York-James Peninsula, these formations consist of fine-grained quartz sand with 10 to 25 percent glauconite and numerous, relatively thin silty clay stringers. These formations are approximately 100 feet thick in the central part of the York-James Peninsula. (VWCB, 1973)

Cretaceous deposits of the Mattaponi (Lower) and Potomac Group formations underlie the Paleocene deposits and constitute the lowermost unconsolidated sediments of the area. The Cretaceous deposits are characterized by discontinuous sand bodies interbedded with silts and clays. In the York-James Peninsula, these deposits are characteristic of a fluvial-deltaic depositional environment. The fluvial deposits are characteristically channel sand bodies that are coarse-grained at the base and become finer grained upward. The deltaic deposits are medium-grained, moderately sorted sands. The Cretaceous deposits in the vicinity of CA are approximately 1,450 feet thick. (VWCB, 1973, cited in NEESA, 1984)

3.5 HYDROLOGY

3.5.1 SURFACE WATER

As discussed in the IAS for CA (NEESA, 1984), the site lies within the York River Basin near the mouth of the river. This basin, in the central and eastern sections of Virginia, is located between the Rappahannock River Basin to the north and the James River Basin to the south. The headwaters rise in Orange County and flow approximately 120 miles in a southeasterly direction to the Chesapeake Bay. The basin is approximately 5 miles wide at CA.

The main tributaries of the York River at the portion of CA currently under investigation are King Creek along the southern boundary of the Annex, Cheatham Lake along the western boundary, and Jones Pond in the southwest. Cheatham Lake is the main drainage feature of the activity. Penniman Lake is located in the northwestern portion of the annex and drains to King Creek. Surface runoff from the sites addressed in this report enter stormwater systems, open surface ditches, and drains that discharge to Penniman Lake, King Creek, and the York River.

Extensive wetlands are found along all the major creeks that drain the Annex, in addition to some shoreline areas of the York River. The tidal reaches of the York River extend throughout CA, upstream through the entire 30-mile length of the river, and another 30 miles up both tributaries (the Mattaponi

and Pamunky rivers). The tributary creeks that drain CA are also tidal up to a mile inland from the riverbank. The tidal reaches of the York River, including the vicinity of CA, are classified as shellfish waters by the VWCB.

3.5.2 GROUNDWATER

Groundwater occurs in three major aquifer systems in the York-James Peninsula: the water table aquifer, the upper artesian aquifer, and the principal artesian aquifer. The water table aquifer is the uppermost of the three and consists of deposits from the Windsor and the Yorktown formations. It ranges in thickness from 20 feet at the western end of the peninsula to approximately 150 feet at the seaward end in the vicinity of CA. This aquifer is the dominant source of domestic (individual home) water supplies in many parts of Charles City, New Kent, James City, and York counties.

Data from the Dames and Moore Remedial Investigation Report for monitor wells installed at CA (as part of Rounds One and Two) were used to assess the occurrence of groundwater within the water table aquifer. The water table aquifer generally occurs at depths less than 30 feet. The groundwater flow direction within the water table aquifer is generally toward groundwater discharge zones coincident with surface streams. Therefore, the water table elevation maps roughly parallel surface topography. Seasonal variations in groundwater flow direction within the water table aquifer are not evident.

The upper artesian aquifer underlies the water table aquifer and consists of the Calvert, Chickahominy, and Nanjemoy formations. The bluish-clayey St. Mary's Formation (approximately 100 feet thick) functions as an aquiclude between the upper artesian aquifer and the water table aquifer. The upper artesian aquifer is generally 50 to 80 feet thick and consists of medium-grained sand, moderately-to-poorly sorted with glauconite, usually called green sand or black sand. The depth to the upper artesian aquifer is approximately 250 feet below mean sea level (msl) in the vicinity of CA. The aquifer is a reliable source of domestic water supply. Much of the recharge to the aquifer is probably derived from silts and clays of the St. Mary's

Formation. Specific capacities of wells completed in this system range from 1 to 10 gallons per minute per foot (gpm/ft). (VWCB, 1973, cited in NEESA, 1984)

The principal artesian aquifer is the deepest of the three aquifers and consists of deposits of the Mattaponi and Potomac Group formations of the Lower Cretaceous Series. This aquifer consists of several discontinuous sand bodies interbedded with silt and clay. The top of the aquifer is approximately 450 feet below msl in the vicinity of CA. Recharge to the aquifer occurs through the outcrop in Henrico, Hanover, and western King William counties. However, substantial recharge also occurs east of these areas from vertical leakage between the adjacent aquifers through the confining layers; vertical leakage has been estimated at 30,500 gallons per day per square mile (gpd/mi²) of area.

Transmissibilities in the central and eastern part of the aquifer (including CA) vary from 15,000 to 50,000 gpd/ft. Flow direction is generally eastward toward the Chesapeake Bay. The most extensive aquifer development has occurred in the Richmond metropolitan area. Dissolved solids in the water increase with depth in an easterly direction and result in limited aquifer use east of Williamsburg, where total dissolved solids range from 1,500 to 9,000 parts per million (ppm) and chlorides may exceed 1,000 ppm. (VWCB, 1973, cited in NEESA, 1984) The aquifer is unusable as a potable water source at CA because of its naturally poor quality.

3.6 BIOLOGY

3.6.1 TERRESTRIAL BIOLOGY

Terrestrial flora on CA is predominately woodland species. Three types of tree stands are present: pine stands composed primarily of loblolly and Virginia pines, mixed pine and hardwood stands, and hardwood stands. Elevated level areas are the predominant location of pine stands, and hardwood stands

are found on slopes and ravines. These wooded areas are important in reducing soil erosion and providing wildlife habitat. Native tree species found at CA include such species as beech, black cherry, red maple, sweet gum, white ash, and white oak.

The woodland understory is composed of various seedling trees and vine species, including Virginia creeper, briars, and honeysuckle; ferns are found in many moist, shaded areas. Ornamental trees and shrubs were planted in the improved areas and along major roadways. None of the plant species that thrive at CA are found on the Federal or state endangered species lists.

Small undeveloped tracts of land at CA support a variety of indigenous wildlife species: white-tail deer, beavers, skunks, bobcats, red and gray fox, squirrels, racoons, opossums, and rabbits are present. Gamebirds such as wild turkey, quail, duck, and pheasants also exist. Songbirds common to the eastern Virginia area are abundant at CA, along with a raptor population consisting of small hawks, owls, and osprey. Carrion-feeding birds such as crows and turkey vultures are also common. The southern bald eagle (found on the Federal endangered species list) is known to nest nearby at Camp Peary; suitable habitat exists for roosting and perching in the area, but only occasional sightings have been made. Infrequent sightings of several endangered/ threatened avian species, including the peregrine falcon and Bachman's and Kirtland's warblers, have been made in the general area. (Naval Facilities Engineering Command, 1983)

3.6.2 WETLAND BIOLOGY

Wetlands at CA are found primarily along principal York River tributaries and along the York River shoreline. Four major marsh types exist in the vicinity:

- Type I: saltmarsh cordgrass community
- Type V: big cordgrass community
- Type VI: cattail community
- Type XII: brackish water mixed community

The wetlands are grouped into classifications based on their estimated environmental value per acre. Group One marshes, of which Type I and Type XII are a part, have the highest productivity and use for wildfowl and wildlife, as well as a close association with fish spawning and nursery areas. They are also important to the shellfish industry and as shoreline erosion inhibitors. These wetlands merit the highest order of protection, and the majority of wetlands on CA are this type. Type V and Type VI marshes are in Group Two and are only slightly less important than the Group One marshes. Because these marshes are found on higher elevations, less opportunity exists for detritus to be washed into nearby waterways by the tides. This group of marshes is also valuable as flood buffers and should be preserved. The CA wetlands and adjacent creeks provide nursery areas for striped bass, white perch, and other species, and are prime habitats for migrating waterfowl.

The habitat of aquatic floral species is generally determined by water salinity and bottom types. In this area of the York River, the following species are associated with certain salinity ranges:

- Hornwort: freshwater only
- Water-celery: freshwater only
- Pondweed: fresh to 5 parts per thousand (ppt)
- Horned pondweed: fresh to 5 ppt
- Waterweed: fresh to 10 ppt
- Watermilfoil: fresh to 10 ppt
- Pondweed: 5 to 25 ppt
- Eelgrass: 10 to 35 ppt
- Widgeon grass: 5 to 40 ppt

These species are commonly found growing at depths of 3 to 9 feet in soft bottom muds. Waterweed and watermilfoil have been plant pests at times due to increased nutrient loading. Eelgrass is most often found growing in soft mud. Widgeon grass is sensitive to both increased water temperature and turbidity.

Oysters, blue crabs, and hard and soft-shell clams are found in the York River offshore of CA; this area of the York River is designated as a crab pot fishery. Additionally, the river south of Queens Creek (immediately north of CA) is a spawning and nursery ground for blue crabs. Fish species commonly found in the York River include hogchoker, white perch, white catfish, channel catfish, bay anchovy, oyster toadfish, striped bass, Atlantic croaker, weakfish, spotted hake, spot, and silver perch. It was found that these 12 species account for over 92 percent of a total catch of 98 species. The first seven of these are considered resident species, and the remaining five inhabit the waters only seasonally. No threatened or endangered fish or invertebrates have been found on CA or nearby. However, several species of endangered sea turtles (the green, hawksbill, leatherback, loggerhead, and Atlantic ridley) are known to feed in the Chesapeake Bay and occasionally swim up the York River during the summer.

4.0 INSTALLATION RESTORATION PROGRAM

Four of the sites identified in the IAS (NEESA, 1984) as areas of potential concern based on past handling, storage, or disposal operations involving hazardous wastes were recommended for further investigation and evaluation. These sites addressed in the Round One and Two confirmation efforts and included in this report are:

- Site 1: Landfill Near Incinerator
- Site 9: Transformer Storage Area
- Site 10: Decontamination Agent Disposal Area Near First Street
- Site 11: Bone Yard

Brief descriptions of these four sites, a discussion of the Round One and Two investigative program at each site, and evaluation of results based on available Round One and Two data are provided in Section 4.2. The majority of the site description information is a summary of data provided in the IAS (NEESA, 1984).

Tables 4-1 and 4-2 summarize the Round One and Two investigative programs for CA. These tables provide data on the number of samples collected at each site for each media, wells installed, and the analytical program. Table 4-3 provides well construction details for the wells identified in Tables 4-1 and 4-2. Specific well designations and locations are discussed in Section 4.2. Quality assurance (QA) and quality control (QC) data related to Rounds One and Two are presented in Appendix D.

Section 4.1 provides a discussion of the applicable water quality standards/criteria used to evaluate sites and assess the potential threat to human health or the environment.

TABLE 4-1
 Summary of Round One Investigative Efforts
 Cheatham Annex, Williamsburg, Virginia

Site No.	Wells to be Installed	Ground-water Samples	Surface Water Samples	Bottom Sediment Samples	Soil Samples	Other Samples	Analytical Parameters (a)
Cheatham Annex							
1	2	6	-	-	-	-	A.C.J.L.M(Cr+6).N
9	-	-	-	-	13	-	I
10	-	-	-	-	-	-	Magnetometer Survey
11	3 (b)	3 (b)	3	3	9 (c)	-	B.C.J.K.L.M(Pb).N
11	-	-	-	-	-	20 drum/tank	R

(a) List of analytical parameters, as follows:

- A - Priority pollutants (except asbestos)
- B - VOAs and Base-Neutrals
- C - Xylene, MEK, MIBK
- I - PCBs and TCDDs
- J - EDB
- K - Phenols, total
- L - Oil and grease
- M - Metals (indicated by chemical symbol)
- N - pH (Water samples only, in the field)
- R - RCRA characterization analyses

(b) Modification to scope of work from contract negotiations.

(c) Soil samples collected during drilling of each well at these sites were blended to make one composite soil sample per well.

TABLE 4-2
 Summary of Round Two Investigative Efforts
 Cheatham Annex, Williamsburg, Virginia

Site No.	Ground- water Samples	Surface Water Samples	Bottom Sediment Samples	Analytical Parameters (a)
Cheatham Annex				
1	6	-	-	A, C, J, L, M(Cr+6), N
11	3	3	3	B, C, J, K, L, M(Pb), N

(a) List of analytical parameters, as follows:

- A - Priority pollutants (except asbestos)
- B - VOAs and Base-neutrals
- C - Xylene, MEK, MIBK
- J - EDB
- K - Phenols, total
- L - Oil and grease
- M - Metals (indicated by chemical symbol)
- N - pH (Water samples only, in the field)

TABLE 4-3

Well Construction Details

Cheatham Annex, Williamsburg, Virginia

Site No.	Well No.	Completion Date	Total Boring Depth (ft)	Well			Ground Surface Elevation (ft)	Elevation of Screen	Depth to Top of Sand Pack	Water Level Winter 1986	Top of Yorktown
				From TOC (ft)	Casing Stickup (ft)	Screen Material					
Site 1	CA1GW05	12/13/85	21.5	24.0	2.5	2-in. PVC	23.5	2 - 17	18.5	14.20	NA
Site 1	CA1GW06	12/15/85	31.5	34.3	2.8	2-in. PVC	26.0	-5.5 - 9.5 ^a	11.0	6.12	9.5 - 4.5
Site 1	CA1EW01	--	--	--	2.0	Steel	22.2	--	--	6.23	--
Site 1	CA1EW02	--	--	--	1.7	Steel	24.9	--	--	9.92	--
Site 1	CA1EW03	--	--	--	2.1	Steel	22.0	--	--	8.51	--
Site 1	CA1EW04	--	--	--	1.5	Steel	25.7	--	--	8.71	--
Site 11	CA11GW01	1/22/86	21.5	23.8	2.3	2-in. PVC	28.0	6.5 - 21.5	22	21.3	23.5 - 16.5
Site 11	CA11GW02	2/14/86	21.5	24.0	2.5	2-in. PVC	27.2	5.7 - 20.7	--	19.09	22.7 - 15.7
Site 11	CA11GW03	1/22/86	21.5	23.8	2.3	2-in. PVC	28.4	6.9 - 21.9	20.4	17.95	23.9 - 16.9

^aThe negative number indicates that the screen interval is below mean sea level.

4.1 APPLICABLE STANDARDS AND CRITERIA FOR SITE EVALUATION

Various USEPA and state groundwater and surface water regulations were reviewed to identify requirements applicable to the evaluation of sites at CA. Table 4-4 presents the standards/criteria considered to be most applicable to the sites currently under investigation. The applicable standards/criteria for groundwater, surface water, and soil/sediment are briefly discussed below.

4.1.1 GROUNDWATER

Legally enforceable standards for groundwater include USEPA Federal Maximum Contaminant Levels (MCLs) and Virginia State Groundwater Standards (VGS). Nonenforceable standards for groundwater include USEPA Federal Maximum Contaminant Level Goals (MCLGs) and Secondary Maximum Contaminant Levels (SMCLs).

MCLs are established by EPA's Office of Drinking Water and are described in the National Primary Drinking Water Regulations (NPDWR; 40 CFR 141) established under the authority of the Safe Drinking Water Act. Technically, MCLs are applicable only to public drinking water supplies, defined as water supplies delivered by a public water utility, or a private drinking water source with 25 or more service connections. Because groundwater at CA is not currently used for drinking water purposes, the current applicability of MCLs is somewhat questionable. However, the potential use of groundwater from CA as a drinking water source cannot be completely ruled out. Therefore, MCLs are currently considered in the site evaluations.

MCLGs are nonenforceable standards established prior to evaluation of the technological and cost constraints associated with achieving the MCLs. Therefore, MCLGs frequently are more stringent (in many cases zero) than the enforceable MCLs. In the absence of MCLs, MCLGs are useful for assessing groundwater contamination.

TABLE 4-4
Summary of Applicable Standards/Criteria

Analytical Parameters	USEPA Groundwater Standards (ug/l)			Virginia Groundwater Standards (VGS) (ug/l) (d)	Surface Water Criteria (ug/l)			Typical Soil Concentration (mg/kg)	
	MCL	MCLG	SMCL		FAWQC	VAWQC	ASWL	mean	Upper Range
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(h)
PURGEABLE ORGANICS									
Benzene	5	0			700				
Toluene		2000	40(i)		5000				
Ethylbenzene		700	30(i)						
Carbon tetrachloride	5	0							
Chlorobenzene		100	100(i)						
1,2-Dichloroethane	5	0							
1,1,1-Trichloroethane	200	200							
1,1-Dichloroethane									
1,1-Dichloroethylene	7	7							
1,1,2-Trichloroethane									
1,1,2,2-Tetrachloroethane									
Chloroethane									
2-Chloroethyl vinyl ether									
Chloroform					6400				
1,2-Dichloropropane		0			3040				
1,3-Dichloropropane									
Ethylene dibromide		0							
Trans-1,3-Dichloropropane									
Cis-1,3-Dichloropropane									
Methyl ethyl ketone									
Methyl isobutyl ketone									
Methylene chloride									
Methyl chloride									
Methyl bromide									
Bromoform					6400				
Dichlorobromomethane									
Trichlorofluoromethane									
Chlorodibromomethane									
Tetrachloroethylene			0		460				
Trichloroethylene	5	0							
Vinyl chloride	2	0							
1,2-trans-Dichloroethylene			10						
Acetone									
Carbon Disulfide									
2-Butanone									
Vinyl acetate									
4-Methyl-2-pentanone									
2-Hexanone									
Styrene		0							
Xylenes (total)		10000	20(i)						
M-Xylene									
O-Xylene									
P-Xylene									
BNA EXTRACTABLES									
1,2-Dichlorobenzene		600	10(i)						
1,3-Dichlorobenzene									
1,4-Dichlorobenzene	75	75	5(i)						
Hexachloroethane									
Hexachlorobutadiene									
Hexachlorobenzene									
1,2,4-trichlorobenzene									
bis(2-Chloroethoxy) methane									
Naphthalene									
2-Chloronaphthalene									
Isophorone									
Nitrobenzene									
2,4-Dinitrotoluene									
2,6-Dinitrotoluene									

TABLE 4-4 (cont'd)
Summary of Applicable Standards/Criteria

Analytical Parameters	USEPA Groundwater Standards (ug/l)			Virginia Groundwater Standards (VGS) (ug/l) (d)		Surface Water Criteria (ug/l)		Typical Soil Concentration (mg/kg)	
	MCL (a)	MCLG (b)	SMCL (c)			FAWQC (e)	VAWQC (f)	ASWL (g)	Upper Mean Range (h)
4-Bromophenyl phenyl ether									
Butyl benzyl phthalate						3.4	3.0		
bis(2-Ethylhexyl) phthalate						3.4	3.0		
Di-n-octyl phthalate						3.4	3.0		
Dimethyl phthalate						3.4	3.0		
Diethyl phthalate						3.4	3.0		
Di-n-butyl phthalate						3.4	3.0		
Fluorene									
Fluoranthene							16		
Chrysene									
Pyrene									
Phenanthrene									
Anthracene									
Benzo(a)anthracene									
Benzo(b)fluoranthene									
Benzo(k)fluoranthene									
Benzo(a)pyrene									
Indeno(1,2,3-c,d)pyrene									
Dibenzo(a,h)anthracene									
Benzo(g,h,i)perylene									
4-Chlorophenyl phenyl ether									
3,3'-Dichlorobenzidine									
bis(2-Chloroethyl) ether									
Hexachlorocyclopentadiene									
N-Nitrosodiphenylamine									
Acenaphthylene									
Acenaphthene							710		
N-Nitrosodi-n-propylamine									
bis(2-Chloroisopropyl) ether									
ACID EXTRACTABLE ORGANIC COMPOUNDS									

Phenols (Total)						1.0		1.0	
Phenol									
2-Nitrophenol									
4-Nitrophenol									
2,4-Dinitrophenol									
4,6-Dinitro-o-cresol (2-methylphenol)									
Pentachlorophenol							7.9		
p-chloro-m-cresol (4-chloro-3-methylphenol)									
2-Chlorophenol									
2,4-Dichlorophenol									
2,4,6-Trichlorophenol									
2,4-Dimethylphenol									
PESTICIDES/PCBS									

Alpha-Endosulfan (-I)						0.0087	0.0087		
Beta-Endosulfan (-II)						0.0087	0.0087		
Endosulfan sulfate									
Alpha-BHC									
Beta-BHC									
Delta-BHC									
Gamma-BHC									
Aldrin						0.003		0.003	
Dieldrin							0.0019	0.0019	
4,4'-DDE									
4,4'-DDD									
4,4'-DDT						0.001	0.001	0.001	
Endrin						0.004	0.0023	0.0023	
Endrin aldehyde									
Heptachlor						0.001	0.0036	0.0036	

TABLE 4-4 (cont'd)
Summary of Applicable Standards/Criteria

Analytical Parameters	USEPA Groundwater Standards (ug/l)			Virginia Groundwater Standards (VCS) (ug/l) (d)	Surface water Criteria (ug/l)			Typical Soil Concentration (mg/kg)	
	MCL (a)	MCLG (b)	SMCL (c)		FAWQC (e)	VAWQC (f)	ASWL (g)	Mean (h)	Upper Range (h)
Heptachlor epoxide		0		0.001					
Chlordane		0		0.01	0.004	0.004			
Toxaphene	5	0			0.0002	0.0007			
Arochlor 1016					0.03	0.03			
Arochlor 1221					0.03	0.03			
Arochlor 1232					0.03	0.03			
Arochlor 1242					0.03	0.03			
Arochlor 1248					0.03	0.03			
Arochlor 1254					0.03	0.03			
Arochlor 1260					0.03	0.03			
METALS									
Antimony								0.76	8.8
Arsenic	50			50	13/36	63		7.4	10
Barium	1000	5000		1000				420	1500
Beryllium								0.85	7
Cadmium	10	5		4	9.3				
Chromium (Total)	50	100		50				52	1000
Chromium (hexavalent)					50	54			
Copper	1300	1300	1000	1000	2.9	2.0		22	700
Lead	50	0		50	5.6	8.6		17	300
Mercury	2	2		0.05	0.025	0.1		0.12	3.4
Nickel					8.3			18	700
Selenium	10	50		10	54	54		0.45	3.9
Silver			90			0.023			
Thallium								8.6	23
Zinc			5000	50	86	48		52	2900
MISCELLANEOUS									
Total cyanides				5	1.0	0.57			
Oil and Grease									
pH			6.5-8.5		6.5-8.5	6-9			
EXPLOSIVES									
TNT								540	
RDX								200	
2,4-DNT					370			200	
HMX								750	
4-Amino-2,6-Dinitrotoluene									
2-Amino-4,6-Dinitrotoluene									
2,4-Diamino-6 Nitrotoluene									
2,6-Diamino-4-Nitrotoluene									

- (a) MCL - Maximum contaminant level.
 (b) MCLG - Maximum contaminant level goal.
 (c) SMCL - Secondary maximum contaminant level.
 (d) VCS - Virginia Groundwater Standard.
 (e) FAWQC - U.S. EPA ambient water quality criterion.
 (f) VAWQC - Virginia criterion for the protection of aquatic life.
 (g) ASWL - ambient safety-related water limit (Small, 1988).
 (h) Mean/upper range of typical regional soil concentrations.

However, care must be exercised in evaluating the significance of MCLG exceedance because the subsequent MCL is likely to be higher than the MCLG (i.e., the contaminant concentration that was in excess of the MCLG may not exceed the future MCL).

SMCLs were created to protect the aesthetic qualities of groundwater, such as taste and odor. Exceedance of the SMCLs does not necessarily represent a potential health problem, but suggests a reduction of the groundwater usefulness as a potable water source. SMCLs are considered in the present study because they are available for a number of contaminants for which neither MCLs nor MCLGs are available.

Virginia State Groundwater Standards (VR 680-21-00) apply statewide and to all groundwater occurring at and below the uppermost seasonal limits of the water table. Chemical constituents for which the state standards are not applicable statewide include pH and nitrogen, for example, which vary regionally according to physiographic province. For the most part, Virginia has adopted the MCLs for inorganics, with notable exceptions such as cadmium and mercury, which have more stringent (lower) state standards. Similarly, state groundwater standards are available for a variety of pesticides for which Federal standards are not available.

4.1.2 SURFACE WATER

Surface water criteria include Federal Ambient Water Quality Criteria (FAWQC) and Virginia State Ambient Water Quality Criteria (VAWQC). FAWQCs are developed by EPA to fulfill the requirement to protect and improve surface water quality, as described in Section 304(a) of the Clean Water Act. The intent is to promote sufficient surface water quality to maintain public health and welfare and to maintain aquatic life. This dual intent of the FAWQCs has frequently resulted in establishing more than one FAWQC for some

chemicals. The applicability of the FAWQCs depends on the intended use of the surface water. At CA, the intended use of streams and other surface water bodies does not include human consumption of water; therefore, the applicable FAWQCs are the criteria for the protection of marine aquatic life.

The FAWQCs for the protection of marine organisms are considered more applicable than the FAWQCs for the protection of fresh water organisms because tidal (marine) influences extend well up the streams that drain CA, as discussed in Section 3.5.1. Also, marine organisms such as oysters are important commercial commodities in the vicinity of CA.

The FAWQCs for the protection of aquatic life consist of both marine water acute criteria and marine water chronic criteria. The acute criterion is larger than the chronic criterion for a given chemical. The acute criterion (derived from acute toxicity data) is for short-term exposures at high concentrations. It corresponds to the maximum allowable contaminant level to which marine water aquatic life may be exposed regardless of the exposure period. The chronic criterion for a given chemical is derived from chronic toxicity data; i.e., relatively long-term exposures at low concentrations. It corresponds to the acceptable exposure concentration that may persist for a period of up to 24 hours. The chronic marine criteria are considered more applicable at CA than the acute marine criteria because most of the potential surface water contamination at the CA has been detected at very low concentrations (see Section 4.2). Such low levels are likely chronic, considering the old age of most of the sites.

4.1.3 SOIL/SEDIMENT

No Federal or state standards or criteria are established for soil or sediment. However, Shacklette and Boerngen performed a survey for the US Geological Survey (USGS, 1984) in which they measured background levels of 50 inorganic chemical elements in hundreds of background soils samples throughout the eastern United States and Virginia. This database is useful for assessing whether the metals concentrations observed in soil and sediment

samples from the subject sites are within the range of concentrations observed for regional soils. The database is not officially sanctioned by either EPA or the Commonwealth of Virginia, although it has been used by both on an unofficial basis for the purpose described above.

4.2 IDENTIFIED SITES

4.2.1 SITE 1, LANDFILL NEAR INCINERATOR

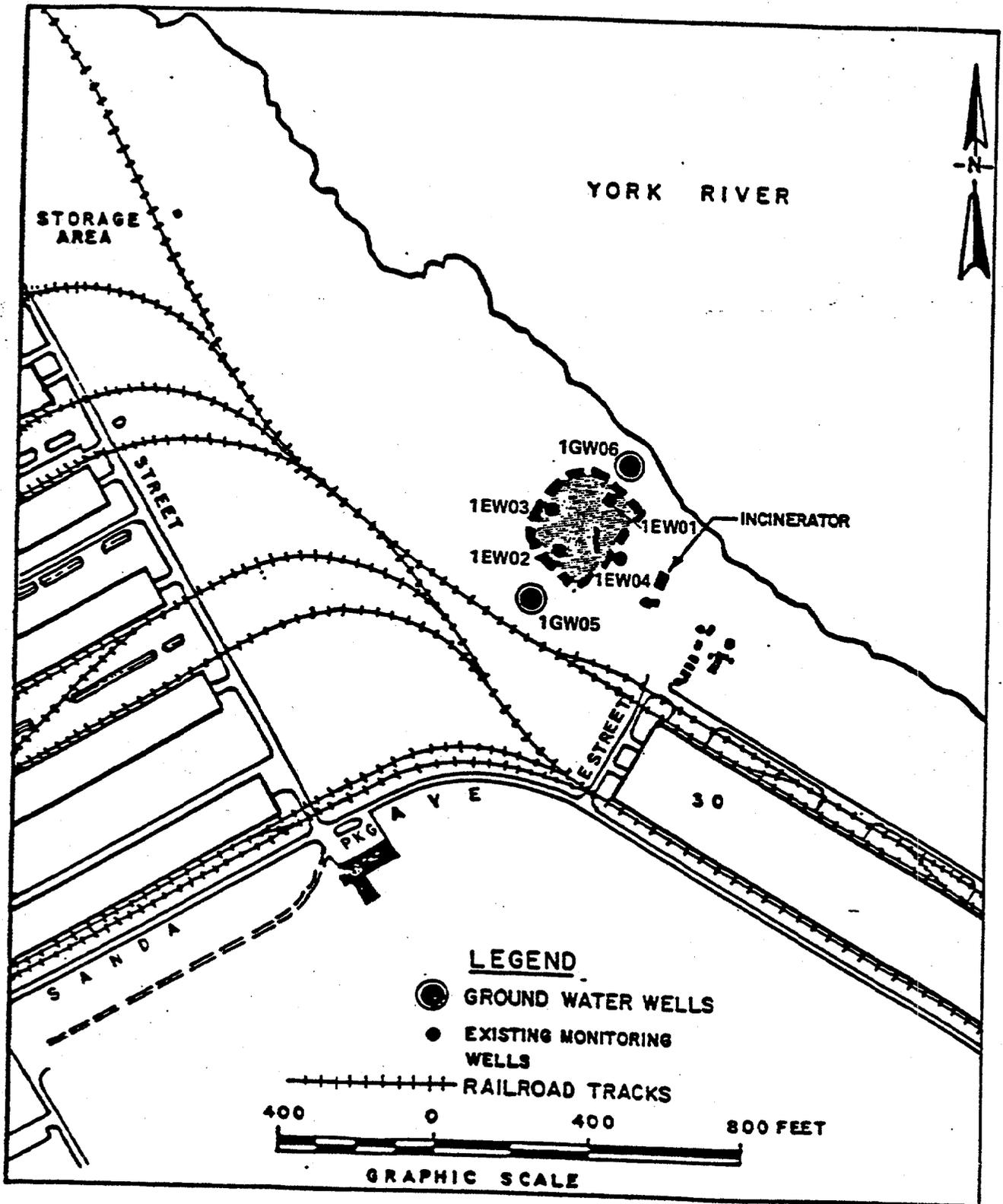
4.2.1.1 Site Description

Site 1 is approximately 2 acres in size and located along the York River behind the old incinerator near Building CAD 129 (Figure 4-1). The landfill was in use from 1942 to 1951 as a disposal area for incinerator burning residues, and from 1951 to 1972 as a general landfill. A variety of wastes, including empty paint and paint thinner cans, cartons of ether and other unspecified drugs, railroad ties, tar paper, sawdust, rags, concrete, and lumber were burned and disposed in the landfill until its closure in 1981. The site was also a disposal area for masonry and wood. Approximately 34,500 tons of domestic, industrial, and commercial solid waste was buried in the landfill. The percentage breakdown of waste types is unknown.

The site is currently overgrown with scrub grasses, and there is little surface evidence of a landfill. Although the landfill is immediately adjacent to the York River, the presence of a natural berm between the landfill and the York River suggests that the landfill was not created by dozing waste material out into the river; therefore, potential contaminant migration into the river may occur less readily than it would if wastes were submerged along the bank of the river.

The landfill occupies a low-lying area (elevation 20 feet msl); therefore, the dominant surface drainage mechanism is most likely infiltration, possibly contributing to leachate formation. If surface runoff occurs under heavy precipitation conditions, the York River is the receiving surface water body.

Figure 4-1
Site 1-Landfill Near Incinerator



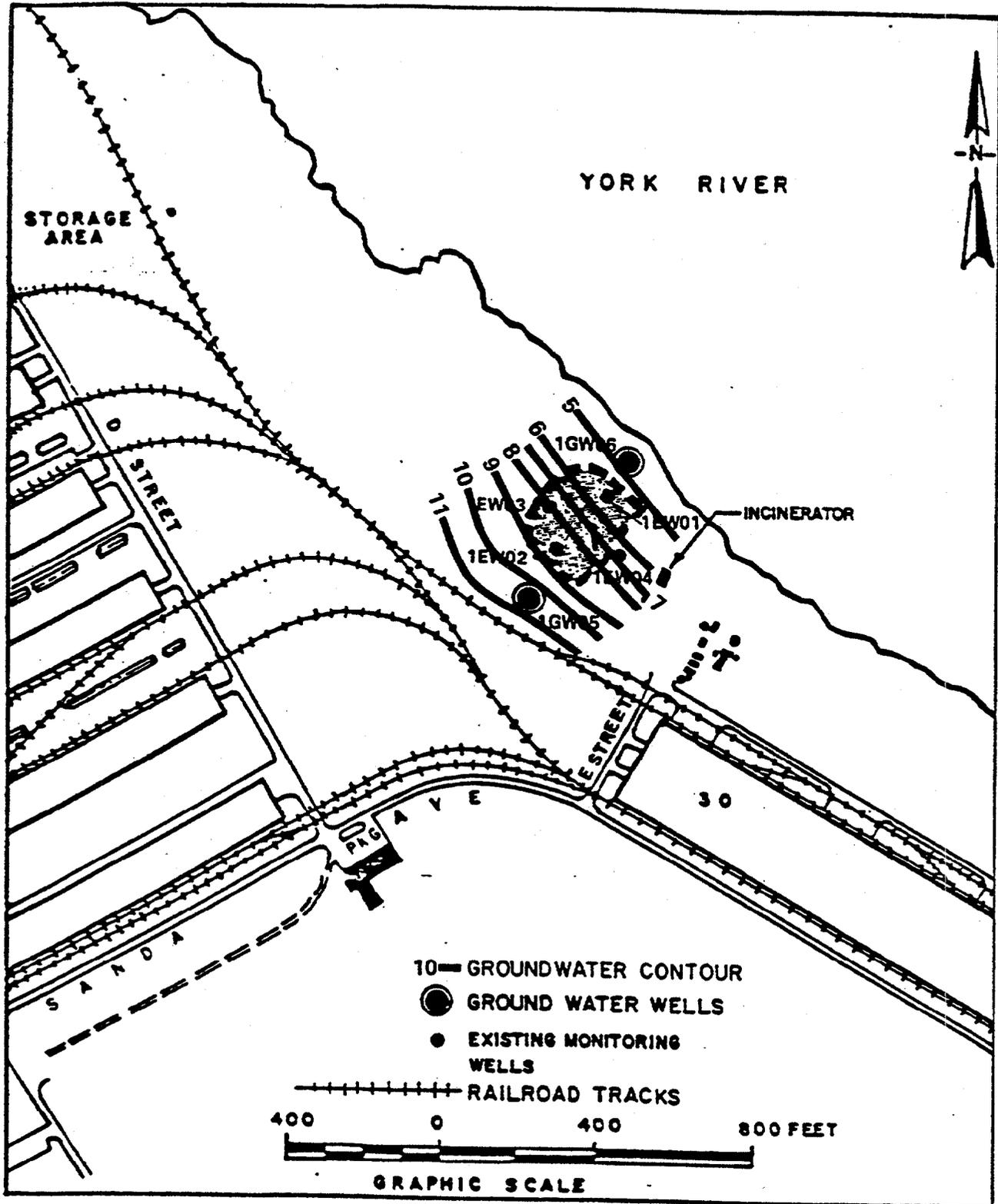
Four wells with steel casings were previously installed at the site prior to initiation of the current Round One program; however, neither well construction diagrams or boring logs are available for these wells. Boring logs and well construction diagrams (Appendix A) for two additional wells (1GW05 and 1GW06) installed during Round One indicate that the site is immediately underlain by recent sediments deposited by the York River. These two wells are 21.5 and 31.5 feet deep, respectively. The elevation at which the top of the Yorktown Formation was encountered in well 1GW06 was between 9.5 and 4.5 feet msl. For both wells, it is not clear from the boring logs whether the Windsor Formation is present between the York River deposits and the top of the Yorktown Formation. It is possible that the Windsor Formation is not present at this location as a result of erosion by the York River.

The groundwater elevations observed in wells 1EW01, 1EW02, 1EW03, 1EW04, 1GW05, and 1GW06 were 6.23, 9.92, 8.51, 8.71, 14.20, and 6.12 feet msl, respectively, during the winter of 1986; they measured 5.68, 7.57, 8.02, 6.58, 10.85, and 4.88 feet msl, respectively, in the fall of 1987. These elevations indicate northeastward groundwater flow, as illustrated in Figures 4-2 and 4-3. The groundwater gradient was slightly steeper in winter 1986 as compared to fall 1987.

4.2.1.2 Investigative Program

The Round One (1986) investigative effort included installing two groundwater monitor wells and collecting six groundwater samples (one from each of the four existing steel wells and the two new PVC wells) from the well locations illustrated in Figure 4-1. The two new wells were installed to better assess upgradient and downgradient groundwater conditions. Construction details for the two new wells are provided in Table 4-3; boring logs for these wells are presented in Appendix A. The six groundwater samples were analyzed for priority pollutants, MEK, MIBK, EDB, oil and grease, and metals (including hexavalent chromium), as summarized in Table 4-1. Round Two (1987) sampling repeated the sampling described above for Round One.

Figure 4-3
 Water Table Contour Map, Site 1,
 Landfill Near Incinerator, Cheatham Annex,
 Williamsburg, Virginia, Fall 1987



4.2.1.3 Analytical Results and Data Evaluation

A summary of the samples collected during Rounds One and Two at Site 1 is presented in Table 4-5, along with chemical analysis results. Only analytes that were detected in groundwater are presented in this table. Chemical results were evaluated to identify exceedances of applicable Federal and Virginia State water quality standards/criteria. Other human health toxicity criteria will be considered later in the risk assessment phase of this program. Standards applicable to data provided in Table 4-5 are shown for comparison purposes, and a complete listing of the analytical results are presented in Appendix C.

Groundwater. Round One groundwater samples tested positive for purgeable organics, BNA, oil and grease, and metals. The observed concentrations of methylene chloride, less than 27 ug/l, are low enough to suggest that methylene chloride is a laboratory artifact. The Virginia groundwater standard (VGS) for zinc (50 ug/l) was exceeded by all of the groundwater samples except the sample for the upgradient well (monitor well 1GW05) in which zinc was not detected in Round One. The occurrence of zinc in well 1GW06 may be a laboratory artifact as discussed in Appendix D. The highest zinc concentrations were detected in the four pre-existing wells constructed with steel casings, suggesting that the steel casings may be the source.

Round Two groundwater samples also tested positive for methylene chloride, three BNAs, oil and grease, and five metals. As with Round One, the observed concentrations of methylene chloride were low enough to suggest that methylene chloride is a laboratory artifact. The VGSs for zinc (1.0 ug/l) were exceeded in all wells, except 1GW05. The maximum oil and grease concentration observed in Round Two (14 ug/l) was significantly lower than that during Round One (118,900 ug/l). For both rounds of monitoring, the detection limits were low enough to determine if applicable criteria were exceeded, with the exception of total phenols and mercury detection limits which were above VGS standards. Concentrations of total phenols that were above the detection limit and the VGS standards were found in monitor wells 1EW04 and 1GW06.

TABLE 4-3
 Summary of Detected Analytes
 Naval Supply Center, Cheatham Annex, Williamsburg, Virginia
 Site 1, Landfill Near Incinerator

ANALYTICAL PARAMETERS	GROUNDWATER												Criteria (ug/l) (a)
	1EW01		1EW02		1EW03		1EW04		1CW05		1CW06		
	86 (ug/l)	87 (ug/l)											
PURGEABLE ORGANICS													
Methylene chloride	2.0	<5	8.0	<5	27	<5	4.0	<5	3.0	11	6.0	<5	NA (a)
BNA EXTRACTABLES													
bis (2-ethylhexyl) phthalate	49.8	<10	72	<10	49.8	1145	49.8	<10	49.8	11	49.8	<10	NA
Di-n-octyl phthalate	46.5	<10	46.5	<10	46.5	427	46.5	<10	46.5	<10	46.5	17	NA
Total phenols	<2.0	<3.0	<2.0	<3.0	<2.0	<3.0	<2.0	6.1	<2.0	<3.0	<2.0	4.3	1.0 (b)
METALS													
Antimony	7.3	<3.0	5.2	3.3	5.9	<3.0	5.5	<3.0	4.2	<3.0	10.6	<3.0	NA
Arsenic	14	<3.0	14	<3.0	14	3.2	14	<3.0	14	<3.0	14	<3.0	50 (b)
Lead	2.3	<2.5	11	<2.5	2.9	<2.5	2.8	<2.5	2.8	<2.5	11	<2.5	50 (b)
Mercury	<0.2	<0.2	<0.21	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.05 (b)
Zinc	1550	2390	909	60	2550	1850	7940	18600	42	37	105	63	50 (b)
MISCELLANEOUS													
Oil and grease	<5000	<5	118900	<5	<5000	<5	<5000	<5	<5000	14	12900	<5	NA
pH	7.2	6.88	7.4	7.24	7.4	7.07	7.1	6.91	7.2	7.25	6.8	6.90	6.5-8.5 (c)
Sp Cond (umhos/cm @ 25 deg C)	640	620	370	389	525	533	500	738	380	479	817	966	NA

(a) Applicable standard/criteria are identified as reported in Table 4-3 according to the following:

- (a) NA - not available.
- (b) VCS - Virginia groundwater standard.
- (c) SMCL - secondary maximum contaminant level.

4.2.1.4 Summary

Limited evidence exists of groundwater impacts at Site 1; metals results are somewhat inconclusive due to the previous use of steel casings. Exceedance of the VGS for total phenols and occasional elevated concentrations of oil and grease suggest some degradation of groundwater quality. Collection of additional RI data appears warranted to further evaluate the occurrence of site-related contaminants and the extent of contamination. Site-specific recommendations for additional RI efforts are provided in Section 5.0.

4.2.2 SITE 9, TRANSFORMER STORAGE AREA

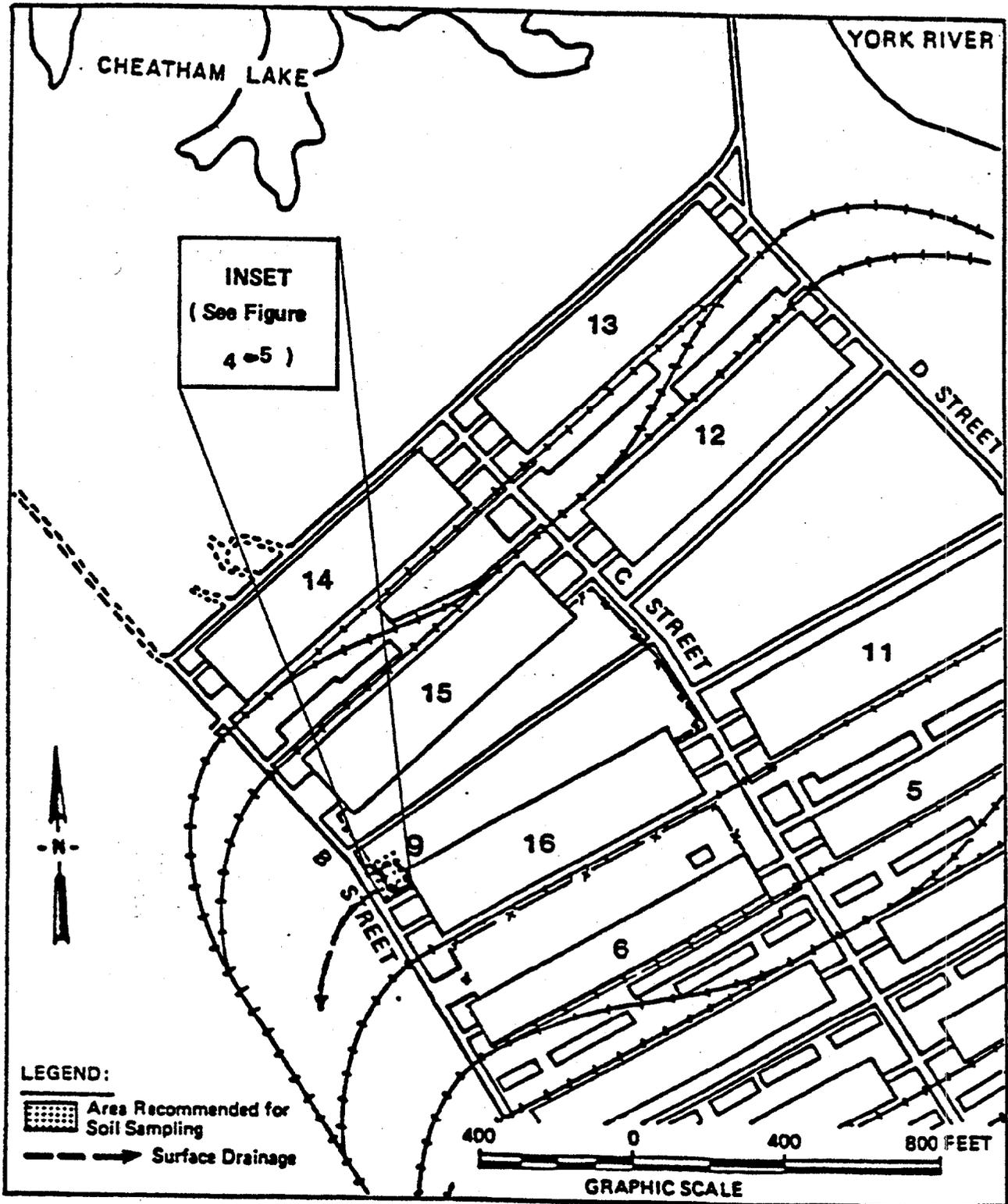
4.2.2.1 Site Description

Site 9 is approximately 7,000 square feet in size and located at the northwest corner of Building CAD 16 (Figure 4-4). Available information indicates that Site 9 was used to store electrical transformers, including those containing PCBs. The area was used for storage from 1973 through 1980. Information on the volume of PCB oil stored at Site 9 over the seven-year period and the number of leaking transformers and associated spill volumes is not known. After 1980, transformers were no longer stored at this location, and the site was graded and covered with gravel. The site is presently cleared, and there is little or no visual evidence of where the site was located.

Surface drainage at the site is westward toward a north-south oriented tributary to Cheatham Creek. The distance from Site 9 to the York River by way of this tributary and Cheatham Creek is approximately 1 mile.

No groundwater monitor wells have been installed at this site; however, the upland location of this site suggests that it is underlain by the Windsor Formation. The groundwater flow direction at the site is likely topographically controlled, suggesting northwestward flow toward Cheatham Creek and its tributary.

Figure 4-4
Site 9-Transformer Storage Area



4.2.2.2 Investigative Program

The Round One (1986) investigative effort included collecting 13 soil samples from the locations illustrated in Figure 4-5, and analyzing these samples for PCBs and tetrachlorodibenzodioxins (TCDDs), as summarized in Table 4-1. No Round Two sampling or analysis were conducted at Site 9.

4.2.2.3 Analytical Results and Data Evaluation

A summary of the samples collected during Rounds One and Two at Site 9 is presented in Table 4-6, along with chemical analysis results. Table 4-6 illustrates that the only detected analyte in any of the Site 9 soil samples was arochlor 1260, a PCB. The concentrations ranged from below detection (<10 ug/kg) to 321 ug/kg. The samples exhibiting the highest concentrations were 9S09 (195 ug/kg) and 9S12 (321 ug/kg). A complete listing of analytical results is presented in Appendix C.

4.2.2.4 Summary

Residual PCB contamination is present at Site 9. The results for offsite samples (9S12 and 9S13) suggest that offsite migration has occurred. Although standards/criteria for PCBs in soil are not specified under RCRA or CERCLA, it is important to note that 1 ppm is the lowest PCB concentration in soil requiring remedial action under the Toxic Substance Control Act (TSCA). None of the observed PCB concentrations in soil at Site 9 exceed 1 ppm.

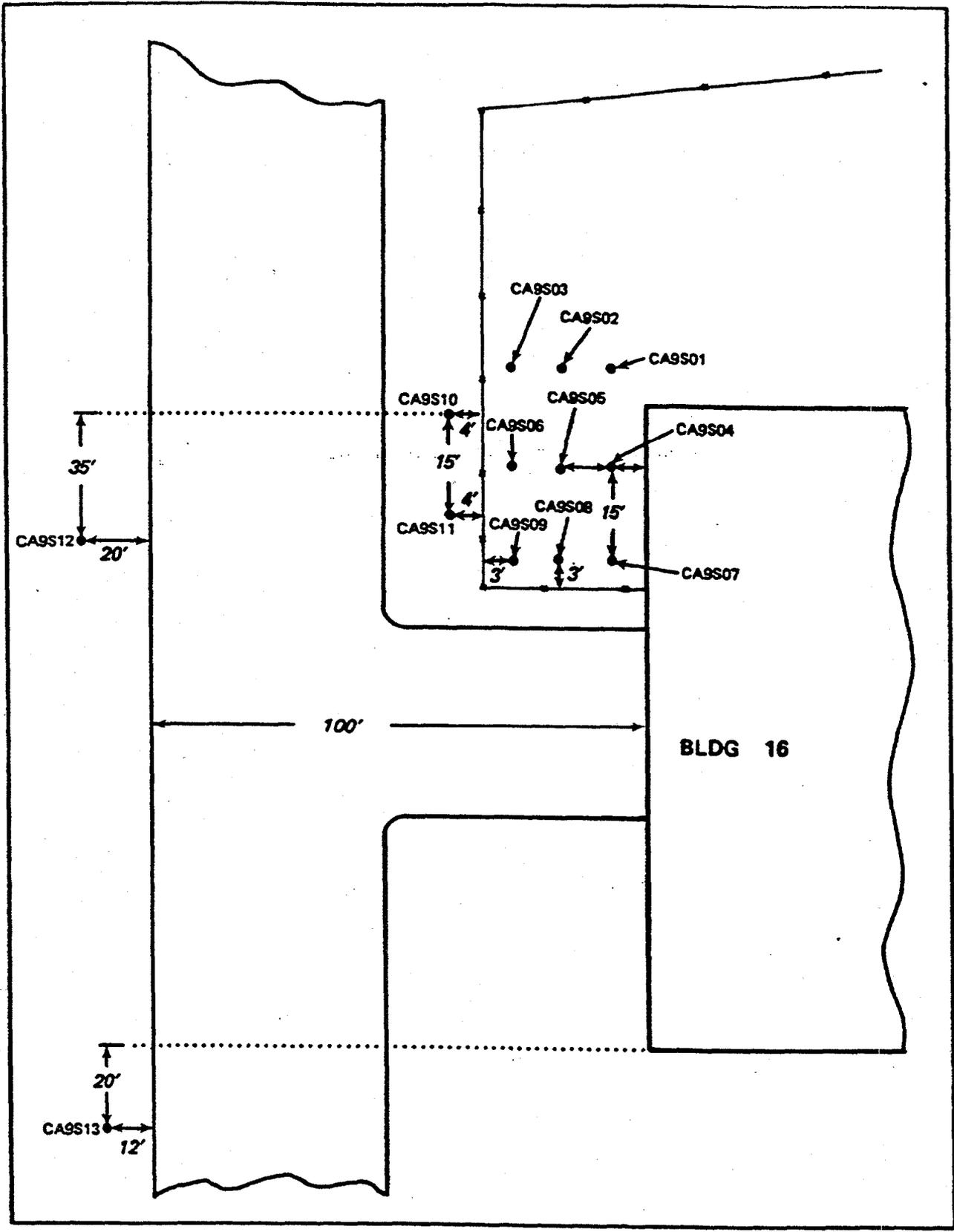


Figure 4-5
SITE 9
TRANSFORMER STORAGE AREA SOIL SAMPLING LOCATIONS

TABLE 4-6
 Summary of Detected Analytes
 Naval Supply Center, Chesham Annex, Williamsburg, Virginia
 Site 9, Transformer Storage Area

ANALYTICAL PARAMETERS	SOILS												
	9S01	9S02	9S03	9S04	9S05	9S06	9S07	9S08	9S09	9S10	9S11	9S12	9S13
	86 (ug/kg)												
PESTICIDES/PCB'S													
Arochlor 1260	<10	<10	<10	41	35	22	<10	<10	195	21	29	321	82

4.2.3 SITE 10, DECONTAMINATION AGENT DISPOSAL AREA NEAR FIRST STREET

4.2.3.1 Site Description

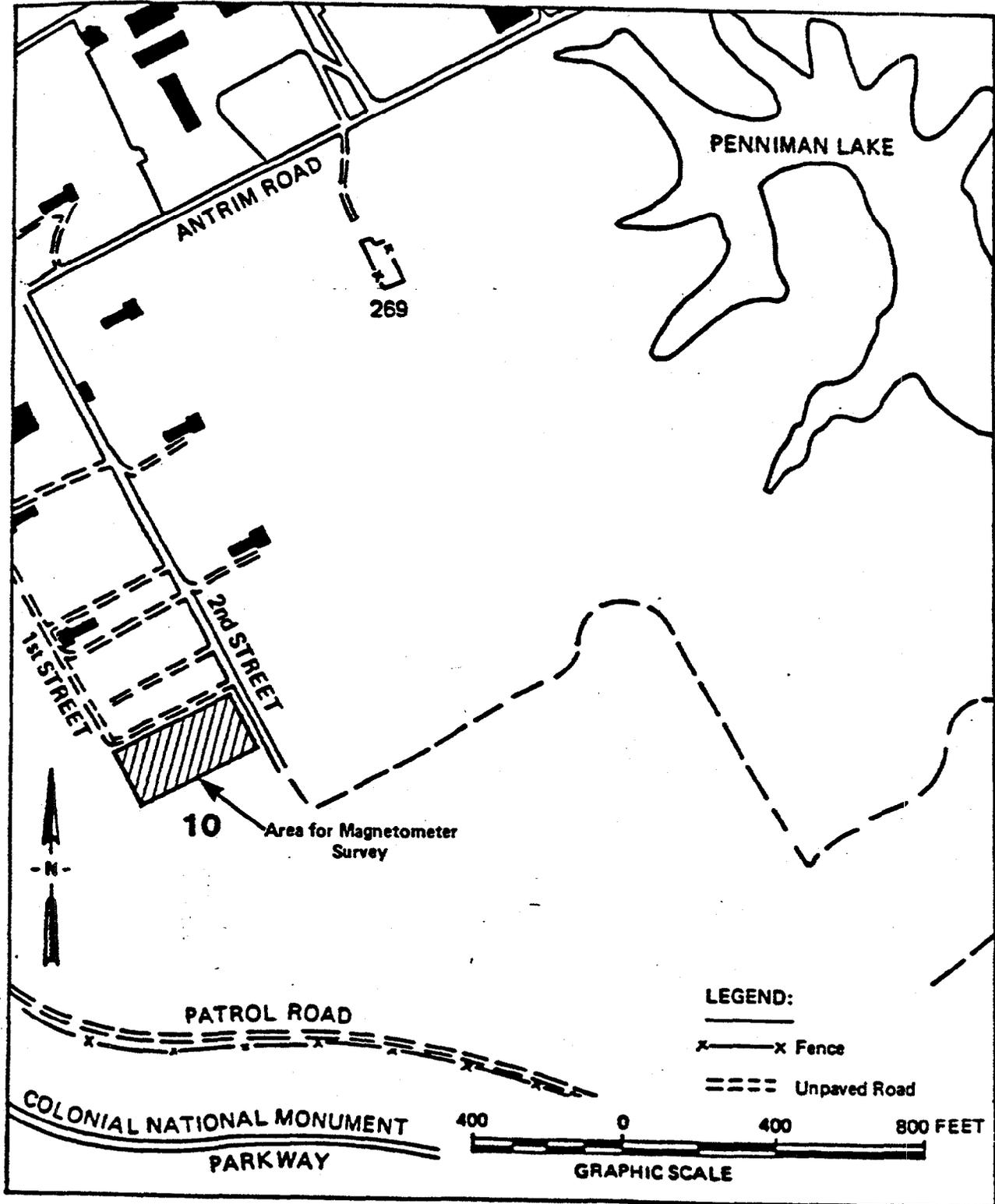
Site 10 is an estimated 1-acre site located south of First Street in the southernmost part of the old DuPont munitions plant area (Figure 4-6); the site history is unknown. No information is available concerning when the wastes were buried; however, according to the IAS (NEESA, 1984), the general appearance of the site indicates that burial probably occurred prior to 1982. Available information indicates that an estimated 75 to 100 gallons of DS-2 decontamination agent were buried at the site. The chemical composition of DS-2 is 70 percent diethylene triamine, 28 percent ethylene glycol monomethyl ether, and 2 percent sodium hydroxide. The site is presently a grassed area that is maintained (mowed) by Cheatham Annex maintenance personnel and an adjacent wooded area.

The topography at the site is flat (approximately 40 feet msl), coincident with a surface water drainage divide that separates the King Creek drainage basin and the Cheatham Creek drainage basin. For these reasons, surface water runoff is likely to be minimal, and subsurface infiltration and evaporation may be the dominant mechanisms facilitating removal of surface water.

4.2.3.2 Investigative Program

The location where the DS-2 contamination agent was buried at Site 10 was not well enough known during Round One (1986) to warrant groundwater or soil sampling (surface water and sediment are not present near the site). Therefore, a geophysical survey was conducted in an attempt to identify subsurface magnetic anomalies possibly suggestive of DS-2 burial. Appendix F presents the findings of the magnetic survey. No additional work was conducted during Round Two (1987).

Figure 4-6
Site 10-Decontamination Agent
Disposal Area Near First Street



4.2.3.3 Equipment and Procedures

The magnetometer survey to identify ferrous metals (iron and steel) was conducted using a pair of Scintrex MP-2 proton magnetometers. These instruments measure the total density of the magnetic field.

One magnetometer monitored the temporal change of the earth's magnetic field. Measurements were automatically recorded at two minute intervals. Data from the base magnetometer showed that the magnetic field was not large, as shown in Figure F-1 in Appendix F.

The second magnetometer provided spatial measurements of the magnetic field. The sensor was at an elevation of 9.25 feet to minimize the effect of small, shallow iron objects that could cause noise in the data. A total of 648 magnetic measurements generated the map of Figure F-2 in Appendix F. Data was collected at 10-foot intervals that covered a 170-foot by 400-foot area.

The diurnal effect was monitored. Because of the small temporal shift relative to anomaly amplitude, no data correction was necessary.

4.2.3.4 Data Evaluation

Figure F-3 in Appendix F presents the findings of the magnetic survey conducted at Site 10; four main buried iron masses are marked by stippled ovals. This information is derived from the magnetic map of Figure F-2 in Appendix F, which shows the paired high and low anomalies typically caused by nearby iron.

For example, the area of low magnetic field around S100E240 is caused by iron masses close to the magnetic highs to the south. With a 10-foot measurement spacing, the magnetic anomalies are sufficiently resolved for a rough estimate of source depth and mass. It illustrates that four magnetic anomalies were detected, approximately corresponding to 40, 2000, 4000, and 30 pounds of

iron. The smallest anomaly was detected in the open grassy area at the site, and the other three anomalies were detected near the edge of the wooded area at the southeastern edge of the site.

Using the "half-width rule," it is seen that the iron sources are shallow, probably 1 to 4 feet underground. The "half-width rule" in magnetic interpretation is the half peak width that is approximately the depth to the center of a spherical body. For these depths, the anomaly amplitude (in nanotesla nT) is roughly equal to iron weight (in pounds). This information, with approximate location, is given in Figure F-3 in Appendix F; large errors in these estimates are possible.

Although the source of the magnetic anomalies is likely to be buried metallic iron (containers or general debris), brick, slag, or ash could also contribute in each area. The obvious topographic mounds in the wooded area appear to contain little iron.

4.2.3.5 Summary

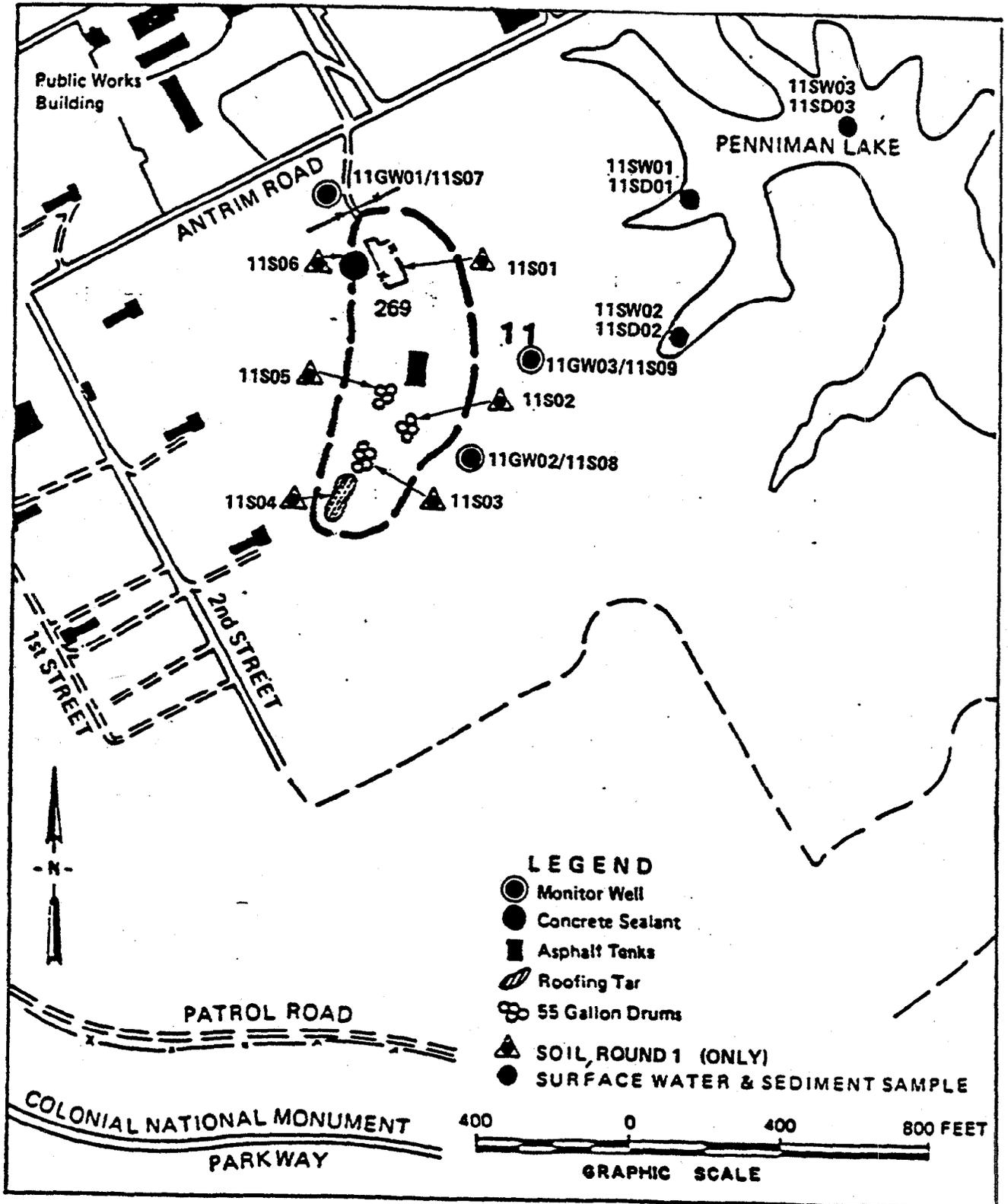
The magnetic survey conducted at Site 10 confirmed the presence of buried materials causing anomalous magnetic responses; the total area represented by the anomalies is approximately 1500 square feet, and the burial depth is up to 3 feet. The total volume of material that would need to be excavated to fully investigate the four magnetic anomalies is roughly 170 cubic yards.

4.2.4 SITE 11, BONE YARD

4.2.4.1 Site Description

At the time of the IAS (NEESA, 1984) conducted at Site 11, this site encompassed an estimated 8-acre area, approximately 250 feet south of Antrim Road, behind the public works facility (Figure 4-7); site access was from the northern end through a secured gate. Immediately inside the gate was an estimated 1-acre cleared area that contained numerous pieces of scrap metal, old containers (fuel oil containers, mixing tanks, etc.), fence posts, and

Figure 4-7
Site 11-Bone Yard



abandoned cars; various discarded clamshell buckets and other surplus metal objects used in heavy construction were also scattered around the area. Approximately ten 5-gallon cans labeled "paraplastic" (concrete sealant) were observed in this area.

South of the one-acre area described above, numerous drums containing petroleum products were discovered, as well as several 500-gallon square tanks which reportedly contained asphalt or oil used in making asphalt, reported to have leaked in the past. During the IAS site visit, approximately 15 drums and two 500-gallons tanks containing petroleum products were noted.

Numerous tar cylinders used for roofing were deposited at the end of the road leading into the site. The cylinders had apparently been there for quite a while: their initial cardboard containers had decomposed and the tar had melted. Numerous pieces of scrap metal and surplus construction equipment were scattered along the path. It was also reported that wastes may have been buried in this area, but this was not confirmed by other reports.

It is not known how long the site was used for waste disposal because no records are available regarding its operations. Available information indicates that the site was active from the World War II era until as recently as 1978. Based on visual observations and other reports, the wastes deposited at this site have included oil, possibly from automobile maintenance and/or fuel oil sludge; gasoline; and asphalt oil from road maintenance supplies. For the most part, the available information suggests that the site was used as a scrap yard rather than a burial site. Since the IAS site visit, most of the 55-gallon drums and scrap metal have been removed from the site.

The site is approximately 80 percent wooded; it slopes slightly toward the east, so surface water runoff is eastward toward Penniman Lake. Two small drainage ditches border the site and lead toward Penniman Lake. The first is roughly parallel to Antrim Road and coincident with the entrance gate to the site. The second ditch is oriented northeast-southwest, immediately south of the site.

Three shallow wells (11GW01, 11GW02, and 11GW03) installed at the site during Round One efforts each extend to depths of 21.5 feet. Boring logs and well construction diagrams for these wells are presented in Appendix A. The subsurface soils are indicative of the Windsor Formation. The top of the Yorktown Formation was encountered between 23.5 and 16.5 feet msl in well 11GW01, between 22.7 and 15.7 feet msl in well 11GW02, and between 23.9 and 16.9 feet msl in well 11GW03.

The groundwater elevations observed in wells 11GW01, 11GW02, and 11GW03 during the winter of 1986 were 21.3, 19.08, and 17.95 feet msl, respectively; they measured 19.11, 14.84, and 13.80 feet msl, respectively, in the fall of 1987. These water levels indicate eastward groundwater flow toward Penniman Lake, as illustrated by the water table contour maps presented in Figure 4-8 (1986) and Figure 4-9 (1987). The hydraulic gradient was steeper in the fall of 1987, as compared to the winter of 1986, which is opposite to what was observed at Site 1 (see Section 4.2.1.1).

4.2.4.2 Investigative Program

The investigative program for Site 11 is summarized in Table 4-1. Round One of the program consisted of installing three groundwater monitor wells, and collecting three groundwater samples, three surface water samples, three sediment samples, and nine soil samples from the locations illustrated in Figure 4-7. In addition to sampling these environmental media, the contents of 15 drums were sampled. The environmental media were analyzed for purgeable

Figure 4-8
 Water Table Contour Map, Site 11,
 the Bone Yard, Cheatham Annex,
 Williamsburg, Virginia, Winter 1986

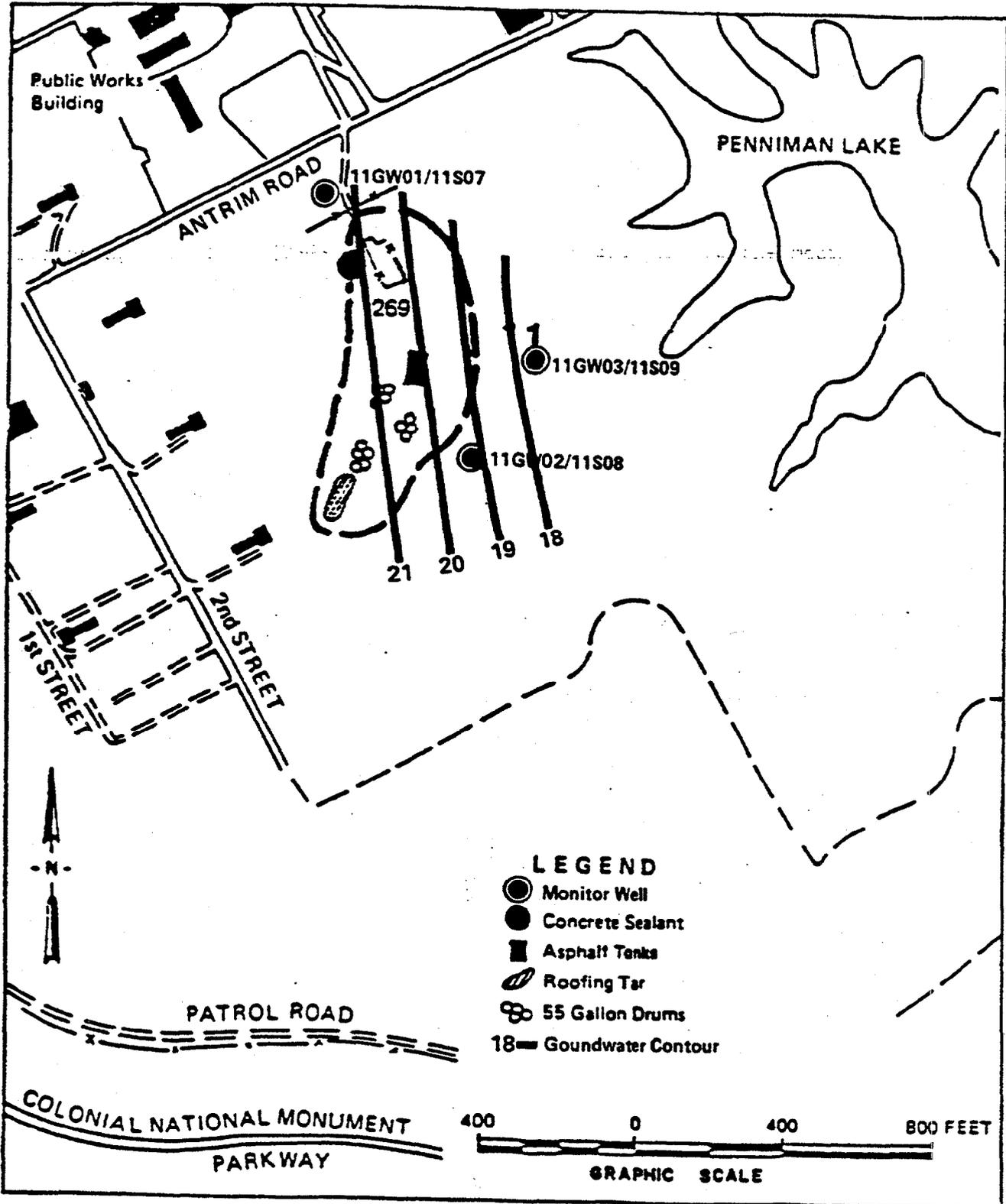
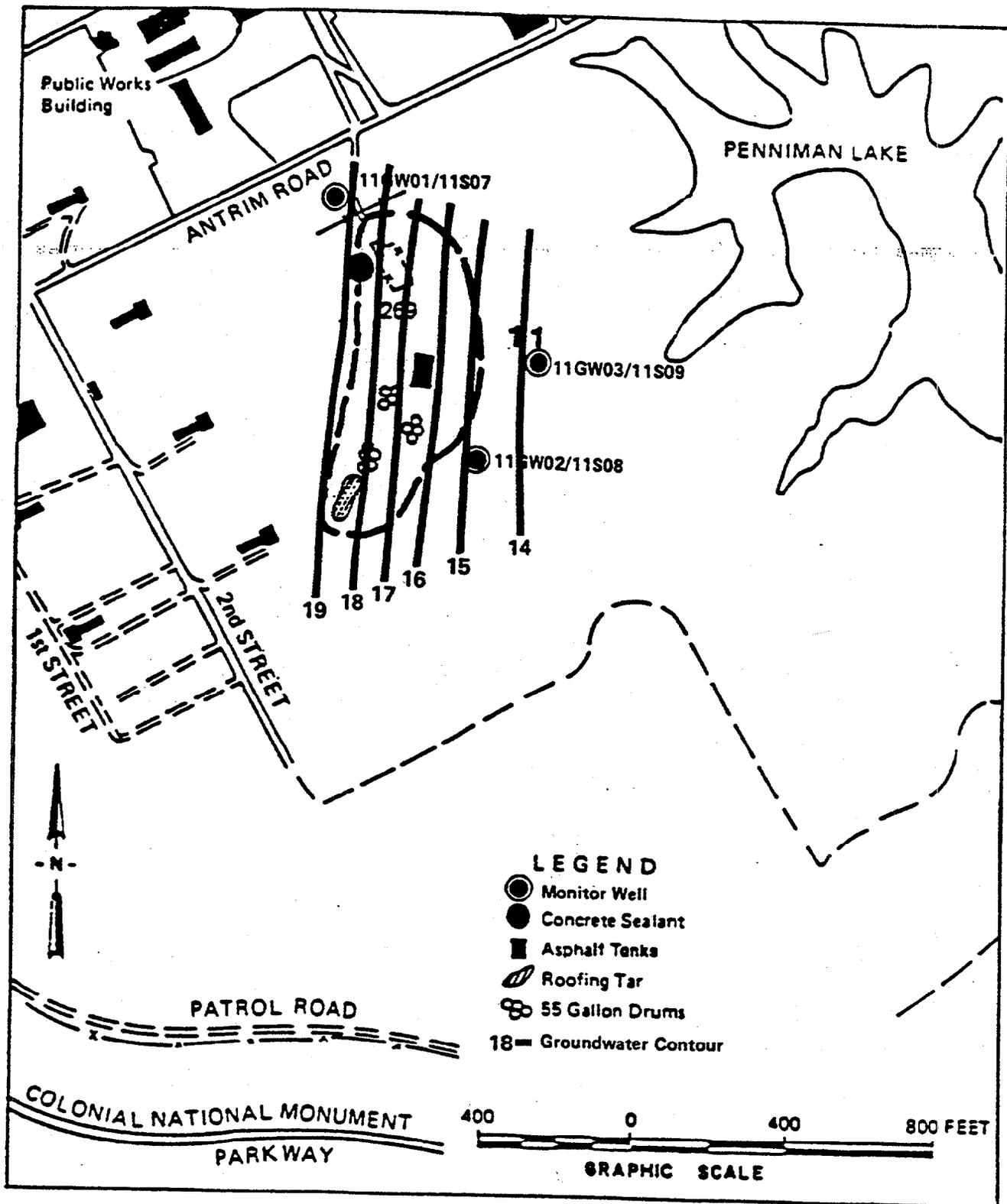


Figure 4-9
 Water Table Contour Map, Site 11,
 the Bone Yard, Cheatham Annex,
 Williamsburg, Virginia, Fall 1987



organics, BNAs, MEK, MIBK, EDB, total phenols, oil and grease, and metals. The drum contents were tested for the RCRA hazardous waste characteristics (EP toxicity, reactivity, corrosivity, and ignitability). Round Two of the program was the same as Round One, excluding the drum and soil sampling analysis.

4.2.4.3 Analytical Results and Data Evaluation

A summary for the samples collected during Rounds One and Two at Site 11 is presented in Table 4-7, along with chemical analysis results. Only analytes that were detected in any of the sampled media are presented in this table. Results for groundwater, surface water, sediment, soil and tank/drum contents are discussed below. Chemical results were evaluated to identify exceedances of applicable Federal and Virginia State water quality standards/criteria. Other human health toxicity criteria will be considered later in the risk assessment. Standards applicable to data provided in Table 4-7 are shown for comparison purposes. A complete listing of the analytical results is presented in Appendix C.

Groundwater

Analytes detected in groundwater during Round One included toluene, methylene chloride, bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, lead, total phenols, and oil and grease. However, toluene, methylene chloride, and bis(2-ethylhexyl)phthalate may be laboratory artifacts as discussed in Appendix D. The SMCL was exceeded for pH; pH of 6.4 was observed in well 11GW01, below the lower pH limit of 6.5 specified by the SMCL.

The Round Two (1987) groundwater results exhibited exceedance of the VGS for total phenols. Total phenols were detected in all three monitor wells at concentrations ranging from 4 to 90 ug/l. The two wells that exceeded the VGS (1.0 ug/l) for total phenols were 11GW01 and 11GW03. Exceedances of the SMCL for pH was not observed in Round Two. The methylene chloride concentrations observed in Round One and Round Two were low enough to suggest laboratory artifacts.

TABLE 4-7
 Summary of Detected Analytes
 Naval Supply Center, Cheatham Annex, Williamsburg, Virginia
 Site 11, The Bone Yard

ANALYTICAL PARAMETERS	GROUNDWATER							SURFACE WATER							Criteria (ug/l)
	11GW1		11GW2		11GW3		Criteria (ug/l)	11SW1		11SW2		11SW3		DUP (ug/l)	
	86 (ug/l)	87 (ug/l)	86 (ug/l)	87 (ug/l)	86 (ug/l)	87 (ug/l)		86 (ug/l)	87 (ug/l)	86 (ug/l)	87 (ug/l)	86 (ug/l)	87 (ug/l)		
PURGEABLE ORGANICS															
Toluene	0.8	<5	0.6	<5	0.9	<5	.40 (d)	<0.42	<5	<0.42	<5	<0.42	<5	<5	3000 (f)
1,1,1-Trichloroethane	<1.2	<5	<1.2	<5	<1.2	<5	200 (a)	3	<5	9	<5	<11.2	<5	<5	NA
Methyl ethylketone	<10.0	<10	10.0	<10	<10.0	<10	NA	12	<10	15	<10	13	<10	<10	NA
Methylene chloride	3.0	22	7.0	6	6.0	7	NA	21	<10	861	<10	20	<10	<10	NA
Acetone	NA	<10	NA	<10	NA	<10	NA	NA	52	NA	<10	NA	11	<10	NA
SWA EXTRACTABLES															
Bis(2-ethylhexyl) phthalate	<9.8	49	11	22	<9.8	<10	NA	<9.8	103	<9.8	<10	<9.8	<10	34	30 (g)
Di-n-octyl phthalate	<6.5	15	<6.5	<10	<6.5	<10	NA	<6.5	<10	<6.5	16	<6.5	<10	<10	3.0 (g)
Dimethyl phthalate	<3.5	<10	<3.5	<10	<3.5	<10	NA	11	<10	<3.5	<10	11.0	<10	<10	3.0 (g)
Di-n-butyl phthalate	<3.4	<10	<3.4	<10	<3.4	<10	NA	<3.4	<10	<3.4	<10	<3.4	<10	<10	3.0 (g)
Fluorene	<4.0	<10	<4.0	<10	<4.0	<10	NA	<4.0	<10	<4.0	<10	<4.0	<10	<10	NA
Fluoranthene	<4.9	<10	<4.9	<10	<4.9	<10	NA	<4.9	<10	<4.9	<10	<4.9	<10	<10	16 (f)
Chrysene	<9.0	<10	<9.0	<10	<9.0	<10	NA	<9.0	<10	<9.0	<10	<9.0	<10	<10	NA
Pyrene	<5.1	<10	<5.1	<10	<5.1	<10	NA	<5.1	<10	<5.1	<10	<5.1	<10	<10	NA
Phenanthrene	<3.8	<10	<3.8	<10	<3.8	<10	NA	<3.8	<10	<3.8	<10	<3.8	<10	<10	NA
Anthracene	<3.8	<10	<3.8	<10	<3.8	<10	NA	<3.8	<10	<3.8	<10	<3.8	<10	<10	NA
Benzo(a)anthracene	<9.0	<10	<9.0	<10	<9.0	<10	NA	<9.0	<10	<9.0	<10	<9.0	<10	<10	NA
Benzo(b)fluoranthene	<11.2	<10	<11.2	<10	<11.2	<10	NA	<11.2	<10	<11.2	<10	<11.2	<10	<10	NA
Benzo(k)fluoranthene	<11.2	<10	<11.2	<10	<11.2	<10	NA	<11.2	<10	<11.2	<10	<11.2	<10	<10	NA
Benzo(a)pyrene	<12.5	<10	<12.5	<10	<12.5	<10	NA	<12.5	<10	<12.5	<10	<12.5	<10	<10	NA
Indeno (1,2,3-c,d)pyrene	<7.4	<10	<7.4	<10	<7.4	<10	NA	<7.4	<10	<7.4	<10	<7.4	<10	<10	NA
Benzo(g,h,i)perylene	<14.2	<10	<14.2	<10	<14.2	<10	NA	<14.2	<10	<14.2	<10	<14.2	<10	<10	NA
Acenaphthylene	<2.5	<10	<2.5	<10	<2.5	<10	NA	<2.5	<10	<2.5	<10	<2.5	<10	<10	NA
Acenaphthene	<4.4	<10	<4.4	<10	<4.4	<10	NA	<4.4	<10	<4.4	<10	<4.4	<10	<10	710 (f)
Total phenols	<2.0	90	<2.0	4	<2.0	51	1.0 (e)	<2.0	<3.0	<2.0	<3.0	4000	4	3.7	1.0 (g)
METALS															
Barium	NA	NA	NA	NA	NA	NA	1000 (e)	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	.4 (e)	NA	NA	NA	NA	NA	NA	NA	NA
Lead	1.5	<2.5	1.4	<2.5	1.2	<2.5	50 (e)	11	<2.5	11	8.2	11	<2.5	<2.5	93 (f)
MISCELLANEOUS															
Oil and grease	<5000	<5000	<5000	<5000	<5000	<5000	NA	<5000	<5000	<5000	<5000	<5000	<5000	<5000	NA
pH	6.4	6.86	6.9	6.85	6.8	6.61	6.5-8.5 (d)	8.4	7.27	8.2	7.19	8.1	7.31	7.31	6-9 (g)
Sp Cond (uMhos/cm @ 25 deg C)	771	999	846	859	889	1143	NA	785	527	820	614	432	315	315	NA
Reactivity	NA	NA	NA	NA	NA	NA	NA	NA	NA						
Ignitability	NA	NA	NA	NA	NA	NA	NA	NA	NA						
Corrosivity	NA	NA	NA	NA	NA	NA	NA	NA	NA						
EP Toxicity	NA	NA	NA	NA	NA	NA	NA	NA	NA						

NA - Not Available

(a) FAWQC - EPA Ambient Water Quality Criteria

(d) SMCL - Secondary Maximum Contaminant Level

(e) VGS - Virginia Groundwater Standard

(f) FAWQC - EPA Ambient Water Quality Criteria

(g) VAQC - Virginia Criteria for the Protection of Aquatic Life

TABLE 4-7 (cont'd)

ANALYTICAL PARAMETERS	SEDIMENT							Typical Soil Concentration (ug/kg) (a)	SOIL										Typical Soil Concentration (ug/kg) (a)
	115D01		115D02		115D03		DUP (ug/kg)		11501	11502	11503	11504	11505	11506	11507	11508	11509		
	86 (ug/kg)	87 (ug/kg)	86 (ug/kg)	87 (ug/kg)	86 (ug/kg)	87 (ug/kg)			86 (ug/kg)										
PURGEABLE ORGANICS																			
Toluene	10.42	19	10.42	17	10.42	17	17	NA	10.42	3	10.42	10.42	10.42	10.42	1	10.42	0.5	NA	
1,1,1-Trichloroethane	12	19	8	17	11.2	17	17	NA	11.2	11.2	11.2	11.2	11.2	3	2	9	2	NA	
methyl ethylketone	110	117	38	113	68	115	115	NA	15	110.0	110.0	110.0	12	12	15	110.0	13	NA	
methylene chloride	37	55	61	16	266	16	25	NA	18	39	17	22	25	16	23	86	32	NA	
Acetone	NA	11	NA	36	NA	37	122	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
BNA EXTRACTABLES																			
Bis(2-ethylhexyl) phthalate	163	1563	233	1442	1163	1485	1471	NA	1163	1163	1163	1163	1163	510	1163	1163	1163	NA	
Di-n-octyl phthalate	1108	1563	1108	1442	1108	1485	1471	NA	1108	1108	1108	1108	1108	1108	1108	1108	289	NA	
Dimethyl phthalate	158	1563	158	1442	158	1485	1471	NA	158	158	158	158	158	158	158	158	158	NA	
Di-n-butyl phthalate	157	1563	157	1442	157	1485	1471	NA	41	157	99	114	72	119	157	157	157	NA	
Fluorene	167	1563	167	1442	167	1485	1471	NA	167	167	167	167	327	167	167	167	167	NA	
Fluoranthene	182	1563	182	1442	182	1485	1471	NA	182	182	134	182	1937	182	182	1104	182	NA	
Chrysene	1150	1563	1150	1442	1150	1485	1471	NA	1150	1150	1150	1150	928	1150	1150	1395	1150	NA	
Pyrene	185	1563	185	1442	185	1485	1471	NA	185	185	185	185	1681	185	185	185	185	NA	
Phenanthrene	163	1563	163	1442	163	1485	1471	NA	163	163	105	163	2108	163	163	163	163	NA	
Anthracene	163	1563	163	1442	163	1485	1471	NA	163	163	163	163	642	163	163	279	163	NA	
Benzo(a)anthracene	1150	1563	1150	1442	1150	1485	1471	NA	1150	1150	1150	1150	851	1150	1150	449	1150	NA	
Benzo(b)fluoranthene	1187	1563	1187	1442	1187	1485	1471	NA	1187	1187	1187	1187	550	1187	1187	358	1187	NA	
Benzo(k)fluoranthene	1187	1563	1187	1442	1187	1485	1471	NA	1187	1187	1187	1187	528	1187	1187	315	1187	NA	
Benzo(a)pyrene	1208	1563	1208	1442	1208	1485	1471	NA	1208	1208	1208	1208	729	1208	1208	208	1208	NA	
Indeno (1,2,3-c,d)pyrene	1237	1563	1237	1442	1237	1485	1471	NA	1237	1237	1237	1237	429	1237	1237	1237	1237	NA	
Benzo(g,h,i)perylene	1237	1563	1237	1442	1237	1485	1471	NA	1237	1237	1237	1237	295	1237	1237	1237	1237	NA	
Acenaphthylene	142	1563	142	1442	142	1485	1471	NA	142	4967	142	142	72	142	142	142	142	NA	
Acenaphthene	173	1563	173	1442	173	1485	1471	NA	173	173	173	173	173	173	173	173	173	NA	
Total phenols	10.04	3	140	13	140	15000	4800	NA	140	140	140	140	140	140	140	140	140	NA	
METALS																			
Barium	NA	7400/10000	NA	7400/10000															
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA							
Lead	110000	6300	39000	51500	16500	2500	2500	17000/300000	95000	195000	81000	79000	11000	16800	23000	17000	15000	17000/300000	
MISCELLANEOUS																			
Oil and grease	326800	588000	1316000	215000	865000	641000	15000	NA	150000	420900	655800	133900	797200	109000	94000	150000	150000	NA	
pH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA							
Sp Cond (umhos/cm @ 25 deg C)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA							
Reactivity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA							
Ignitability	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA							
Corrosivity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA							
EP Toxicity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA							

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TABLE 4-7 (cont'd)

ANALYTICAL PARAMETERS	TANK/DRUM PAD																	
	11TD01	11TD02	11TD03	11TD03	11TD04	11TD05	11TD06	11TD07	11TD07	11TD08	11TD08	11TD09	11TD10	11TD11	11TD12	11TD13	11TD14	11TD15
	86 (mg/l)	86 (mg/l)	U-OIL 86 (mg/l)	L-H2O 86 (mg/l)	86 (mg/l)	86 (mg/l)	86 (mg/l)	U-OIL 86 (mg/l)	L-H2O 86 (mg/l)	U-OIL 86 (mg/l)	L-H2O 86 (mg/l)	86 (mg/l)						
PURGEABLE ORGANICS																		
Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
methyl ethylketone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
methylene chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BNA EXTRACTABLES																		
Bis(2-ethylhexyl) phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno (1,2,3-c,d)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total phenols	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
METALS																		
Barium	<40	<40	76	<40	<40	<40	<40	76	<40	<40	50	337	105	230	414	<40	<40	<40
Cadmium	<20	<20	<20	<20	<20	<20	494	<20	<20	619	94	<20	<20	<20	<20	<20	<20	<20
Lead	<100	<100	<100	<100	<100	<100	360000	1520	<100	505000	19000	30600	<100	<100	2180	2280	<100	170
MISCELLANEOUS																		
Oil and grease	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
pH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sp Cond (uamhos/cm @ 25 deg C)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Reactivity	Yes																	
Ignitability	All greater than 60 deg. C																	
Corrosivity	All negative																	
EP Toxicity											Lead	Lead		Lead	Lead			

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Surface Water

The Round One (1986) and Round Two (1987) surface water samples tested positive for purgeable organics and BNAs. Detected purgeable organics were 1,1,1-trichloroethane, methylene chloride, and acetone. Two of the three detections of methylene chloride were at concentrations low enough to suggest that methylene chloride was present in the sample as a laboratory artifact. However, sample 11SW02 showed the highest methylene chloride concentration of samples collected during Rounds One and Two (861 ug/l), indicating that it is more likely site-related. The acetone is also a likely laboratory artifact, as discussed in Appendix D.

Phthalates were the only BNAs detected. Two of the detected phthalates (di-n-octyl phthalate and dimethyl phthalate) were detected at concentrations in excess of the VAWQC. The concentrations ranged from 11 to 103 ug/l and did not vary significantly from Round One to Round Two. The highest concentration was observed for bis(2-ethylhexyl)phthalate. Phthalates result from synthetics (e.g., plastic) and could be related to sampling. Total phenols were detected at a maximum concentration of 4000 ug/l, well in excess of the VAWQC of 3.7 ug/l. MEK was detected in Round One at concentrations ranging between 12 and 15 ug/l; it was not detected in Round Two.

Lead was detected in surface water sample 11SW02 in Round Two at a concentration (8.2 ug/l) in excess of the FAWQC of 5.6 ug/l. Lead was not detected in any other surface water sample collected during either Round One or Round Two.

Sediment

Purgeable organics detected in sediment samples from Round One and Round Two included 1,1,1,-trichloroethane, methylene chloride, and acetone. Both the acetone and methylene chloride concentrations were low enough to suggest that they may have been present as laboratory artifacts. Evidence of the variability of the concentrations of laboratory artifacts is exhibited by the

results for acetone for sample 11SD03. The duplicate sample result for acetone is 122 ug/l, much greater than the original sample concentration.

Bis(2-ethylhexyl)phthalate was the only detected BNA. It was detected in two of three sediment samples (11SD01 and 11SD02) at concentrations of 163 and 233 ug/kg, respectively. Lead was detected in the sediment samples at concentrations ranging from 8,300 to 39,000 ug/kg. The upper end of this concentration range for lead does not exceed the upper end of the concentration range for lead observed in soil samples from the eastern United States and Virginia (USGS, 1984), although it does exceed the mean concentration for lead observed in soil samples from the eastern United States and Virginia. Lead was not observed in sediment sample 11SD03, located the furthest distance from Site 11.

Elevated concentrations of oil and grease were observed in all three sediment samples at concentrations ranging from 295,000 ug/l to 1,316,000 ug/kg.

Soil

Soil samples from Site 11 tested positive for purgeable organics, BNAs, and metals. Detected purgeable organics were toluene, 1,1,1-trichloroethane, and methylene chloride. The concentrations of methylene chloride are typical of laboratory artifacts; toluene and 1,1,1-trichloroethane concentrations were below 10 ug/kg. Toluene was also detected in groundwater, as previously discussed, which is a confirming factor concerning the likelihood of Site 11 as a source of toluene contamination. On the other hand, 1,1,1-trichloroethane was not previously detected in groundwater, although it was detected in site soils.

Detected BNAs included phthalates and PAHs. Soil samples 11S05 and 11S08 exhibited the highest concentrations and greatest variety of PAHs. The PAH concentrations ranged up to 2,108 ug/kg; however, this is within the range of endogenous PAH concentrations in the terrestrial environment (Edwards, 1983). Sample 11S05 exhibited the most PAHs; it was collected from an area where

55-gallon drums had been previously stored. Oil and grease was detected at concentrations ranging from 94,000 to 797,200 ug/kg. The soil sample (11S05) that exhibited the highest oil and grease concentration is also the sample that exhibited the largest number of BNAs. This suggests that the BNA results are influenced by the occurrence of oil and grease.

Lead concentrations appear higher than expected background in several soil samples (particularly 11S02 though 11S04); however, the concentrations did not exceed the upper end of the concentration range for lead observed in soil samples from the eastern United States and Virginia. The three soil samples that exhibited the highest lead concentrations were all obtained from the southern portion of Site 11, an indication that the observed lead concentrations are related to waste disposal/storage activities at the site.

Tanks/Drums

The tanks and drums sampled at Site 11 were removed and disposed of since the time of sampling. The EP toxicity test results indicated that the tank/drum contents included leachable lead, cadmium, and barium at concentrations ranging up to 505,000, 494, and 76 ug/l, respectively. The lead results correlate well with the lead results for soil, groundwater and, possibly, surface water and sediment.

4.2.4.4 Summary

VAWQC and FAWQC were exceeded for surface water for di-n-octyl phthalate, bis(2-ethylhexyl) phthalate, dimethyl phthalate, total phenols, and lead; VGS were exceeded for total phenols and pH. Collection of additional RI data appears necessary to further evaluate the occurrence of site-related contaminants and the extent of contamination. Site-specific recommendations for additional RI efforts are provided in Section 5.0.

5.0 RECOMMENDATIONS

5.1 INTRODUCTION

This RI Interim Report includes recommended courses of action for the four sites addressed herein and listed in Table 5-1. Additional RI efforts are recommended for three of the four sites. For each of these three sites, it appears that a risk assessment is warranted, as well as collection and evaluation of additional data. Based on previous data collection efforts, additional investigations are not considered necessary at one of the four sites.

The three sites for which additional data collection is recommended were the sites considered to pose a potential threat to human health or the environment; additional data are considered necessary for further characterization of the magnitude and extent of contamination. For all proposed sampling, VOC, BNA, and metals analyses (only as specified) will be in accordance with the Target Compound List (TCL). Previous sampling efforts (Round One and Two) used the priority pollutant list. The TCL analytes are identified in Appendix E. In those instances where analytes recommended include Extraction Procedure (EP) metals, the metals included are arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), selenium (Se), and silver (Ag).

5.2 SITE RECOMMENDATIONS

Sections 5.2.5 through 5.2.7 include well installation, sampling, and analytical testing recommendations specific to each site. In addition to site-specific sampling and analyses, several additional efforts pertinent to data collection and evaluation are recommended for implementation, including: aerial photographic interpretation; completing an off-base well inventory;

TABLE 5-1
Summary of Proposed Recommendations
Naval Supply Center, Cheatham Annex, Williamsburg, Virginia

<u>SITE NO.</u>	<u>SITE NAME</u>	<u>NO ACTION</u>	<u>PERFORM RISK ASSESSMENT</u>	<u>PERFORM RA AND COLLECT ADDITIONAL RI DATA</u>
<u>NSC - CHEATHAM ANNEX</u>				
1	LANDFILL NEAR INCINERATOR			X
9	TRANSFORMER STORAGE AREA	X		
10	DECONTAMINATION AGENT DISPOSAL AREA NEAR FIRST STREET		X	
11	BONE YARD			X

conducting a biota sampling program; and sampling background soil, surface water, and sediment for better site evaluation. These efforts are addressed in Sections 5.2.1 through 5.2.4. A summary of recommended actions for the three sites is presented in Table 5-2.

5.2.1 AERIAL PHOTOGRAPHIC INTERPRETATION

Aerial photographs of the Annex will be collected and reviewed to identify sizes, shapes, and boundaries of the three sites. The history of each landfill or burial site will be confirmed through the photographic analyses of sites prior to, throughout, and after their periods of use. Boundary changes and site clearing and revegetation history will be delineated. Stressed vegetation and any unusual or unexpected occurrences will be recorded. The US Department of Agriculture, Aerial Photography Field Office, Salt Lake City, Utah; the US Navy/National Archives Cartographic Branch; and/or state agencies are possible sources for historical aerial photography coverage. Historical stereoscopic pairs of appropriate scale will be collected for site evaluation. Current aerial photography will also be used to develop more detailed site maps than are currently available.

5.2.2 OFF-BASE WELL INVENTORY

A well inventory of the potential receptors of groundwater contamination in the vicinity of CA will be performed. Based on hydrogeologic conditions in the vicinity, it is unlikely that any supply wells in areas surrounding the installation would be impacted by site contamination problems; known wells are located upgradient of the sites of concern. Shallow groundwater flow is ultimately toward the York River, and the site located adjacent to the York River. It is proposed that all supply wells in the vicinity of the site be identified. Data to be collected, if available, will include owner, location, usage, depth, daily pumpage rate, well diameter, and installation date. Well data will be obtained through water supply company records, local well drillers, and the local Health Department.

TABLE 5-2
 Summary of Proposed Additional RI Efforts
 Naval Supply Center, Cheatham Annex, Williamsburg, Virginia

- o Historical Aerial Photographic Interpretation
- o Off-Base Well Inventory
- o Biota Sampling Program

Site No.	Wells Installed	Sampling (a)					Analytes
		CW	SW	SD	SOil	Biota	
NSC - CHEATHAM ANNEX							
1	--	6	--	--	--	X	BNAs, Phenols, Oil and Grease
9	--	--	--	--	--	--	--
10	--	--	--	--	--	--	--
11	--	3	3	3	6	X	CW--Phenols SW,SD--VOCs, BNAs, MEK, lead, Oil and Grease, Phenols SO--VOCs, BNAs, lead, Oil and Grease
Background	--	--	8	8	8	X	SW--TCL metals, phenols SD,SO--EP metals, phenols

(a) GW = groundwater; SW = surface water; SD = sediment; and SO = soil.

5.2.3 BIOTA SAMPLING PROGRAM

Limited biota sampling is recommended to assess potential impacts of site contamination on the surrounding environment. The goal of this sampling is to evaluate the status of the indigenous aquatic and benthic populations by testing for the potential presence of site-related contaminants within the existing biota and by assessing species diversity and distribution. The assessment of potential human exposure to site-related contaminants through consuming contaminated biota will be made by focusing attention on aquatic species such as crayfish, catfish, and shellfish, if present. Although the local environment also contains substantial terrestrial and wetland areas, it is recommended that the biota assessment focus on the aquatic component of the environment because of its significance in the vicinity of CA (see Section 3.0). The only site at CA where biota sampling is recommended is Site 11, due to confirmed site contaminants and the proximity of this site to Penniman Lake. Biota monitoring is not recommended for Site 9 because of the acceptable low levels of detected contaminants, nor for Site 10 because of the distance of this site from potential aquatic biota receptors.

The only potential aquatic environment associated with Site 1 is the York River. Biota monitoring of the York River near this site is not recommended. It is considered probable that the biota monitoring results for Site 1 would be inconclusive regarding whether potential biota impacts which might be observed are related to the site or numerous other potential contaminant sources not related to CA that contribute to the overall chemistry of the York River.

To develop an integrated picture of whether impacts on the environment are occurring from site-related contaminants, chemical, physical, and biological testing will be performed concurrently. Depending on the findings of this testing, some type of toxicological testing may be conducted during a follow-on study. The chemical testing will be performed on samples selected from both sediments and surface water for constituents that are thought to be

related to sites in the vicinity of the proposed biota monitoring stations, based on the Round One and Two chemical results.

The physical testing will include parameters such as dissolved oxygen, pH, conductivity, and temperature, which will be measured in the surface water at the proposed biota monitoring stations at the time of biological sampling to determine the overall characteristics and health of the aquatic system. The biological testing will consist of collecting and identifying benthic invertebrates and fish species. As an indication of the health of the aquatic population, statistical analysis of invertebrate species' diversity, evenness, and richness will be performed if large enough invertebrate populations are present at the time of sampling. Fish will be analyzed to determine their age, class, and length. Bio-tissue from fish and/or invertebrates (i.e., shellfish) that are commonly caught by commercial and recreational fishermen will be analyzed for constituents that are thought to be related to sites located in the vicinity of the biota monitoring stations and that are suspected to bioconcentrate.

The results from the proposed chemical, physical, and biological testing will assist in assessing potential human health impacts from the consumption of potentially contaminated biota.

The combined results from the proposed chemical, physical, and biological tests will aid in the analysis of whether environmental impact from site-related contaminants is occurring on or near the sites of concern, and whether any potential environmental impact could also pose potential human health concerns.

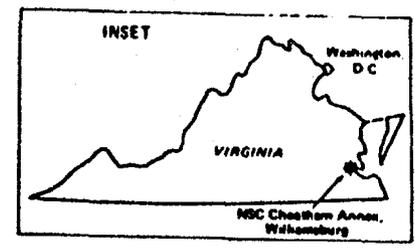
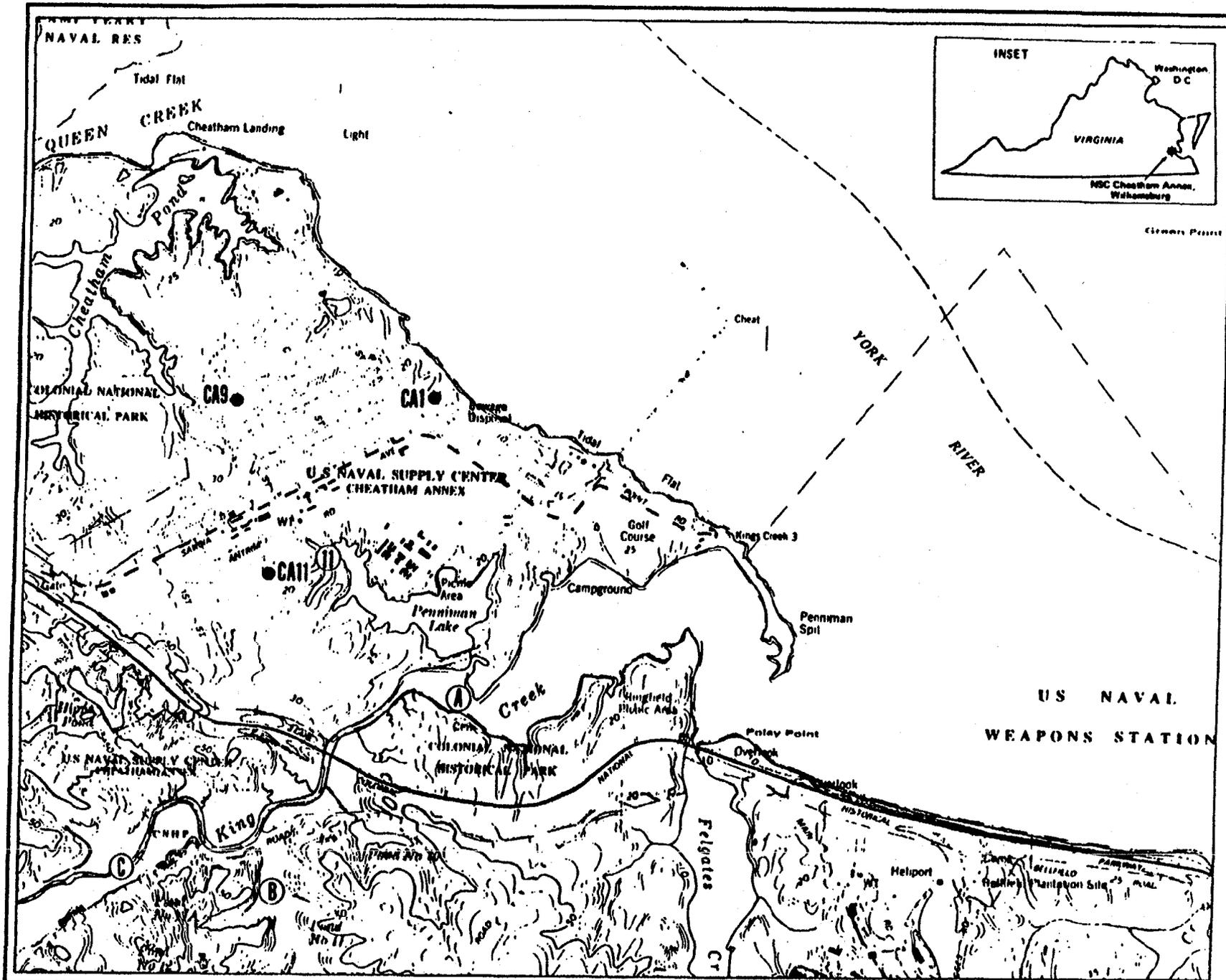
Biota sampling will be conducted along creeks and lakes associated with Site 11 where results from Round One and Round Two monitoring efforts indicated the presence of site-related contaminants in surface water and sediments. These creeks and ponds include Penniman Lake and King Creek. In addition to these biota monitoring stations, background reference stations

will be sought to provide background data for comparison, when feasible. Reference stations will be chosen at locations that are not believed to be impacted by site-related contaminants.

Biota sampling at downstream reference stations is also recommended to assess whether any possible contamination from CA is entering the York River, and whether aquatic habitats near the York River have been impacted from site-related contaminants. If it is determined that the vicinity of the York River has been impacted, a subsequent program of sampling biota along the river will be recommended to assess the magnitude and extent of the problem.

As shown in Figure 5-1, four locations (stations) are recommended for biota sampling. One of these stations (Station No. 11) is proposed to be located at Site 11 where biota monitoring was deemed appropriate based on Round One and Two analytical results. The other three stations (A through C) will serve as control stations. Control Station A is located on King Creek near the outfall of Penniman Lake; it will serve to evaluate whether potentially observed impacts at Station 11 also extend to King Creek. Station B is located on Pond No. 11 located approximately 1 mile southwest of Penniman Lake, and will serve as a reference station for Station No. 11 located at Penniman Lake. Station C is located on King Creek, upstream of the confluence of King Creek and the Penniman Lake outfall; it will serve as a reference station for Station A.

The exact locations of these proposed stations may be altered after field reconnaissance to provide sampling points that may best assess the possibility of contamination of the biota. As mentioned previously, all stations will include collecting water and sediment samples for chemical analysis of constituents that have previously been detected in samples at the respective station. Biological and chemical testing of benthic invertebrate and fish species will be conducted at all stations where species exist. Ambient aquatic toxicity testing water will also be collected at all stations. Table 5-3 summarizes the scope of the recommended biota sampling program.



- CA11 ● STUDY SITE
- II ○ PROPOSED BIOTA MONITORING STATION
- A ○ PROPOSED BIOTA REFERENCE STATION

FIGURE 8-1
 LOCATION OF STUDY SITE AND PROPOSED BIOTA MONITORING STATION CHEATHAM ANNEX, WILLIAMSBURG, VIRGINIA

TABLE 5-3
Summary of Recommended Biota Sampling Program
Cheatham Annex, Yorktown, Virginia

Sampling (a) Station	Chemical Analytes (b)	Biological Analysis		Chemical Analysis
		Benthic Invertebrate Study	Fish Population (c) Study	Fish Bioconcentration (c) Study
Penniman Lake: 11	VOCs, BNAS, Oil and Grease, Lead Total Phenols	X	X	X
Pond NO. 11: B (Penniman Lake Reference)	VOCs, BNAS, MEK, Oil and Grease, Lead, Total Phenols	X	X	X
King Creek: A	VOCs, BNAS, MEK, Oil and Grease, Lead, Total Phenols	X	X	X
C (upstream reference)	VOCs, BNAS, MEK, Oil and Grease, Lead, Total Phenols	X	X	X

-
 (a) See Figure 5-1 for location.
 (b) Applicable to surface water, sediment, and fish.
 (c) Performance dependent on availability of fish at time of sampling.

5.2.4 BACKGROUND SAMPLING

Background soil, surface water, and sediment samples will be collected to better define the variability of concentrations of naturally occurring parameters of interest. Metals and phenols have been detected in area media in upgradient and downgradient locations. Background data will be used to further evaluate whether constituents detected are site related, especially where exceedances of criteria have been identified for upgradient sampling locations at a given site.

Eight surface water and sediment sampling locations have been selected to collect background samples. It is anticipated that these samples will be collected from along undeveloped tributaries to King Creek, west of Site 11. In addition, a maximum of eight background soil samples will also be collected. The actual locations of these samples will be selected during a site reconnaissance. The soil and sediment samples collected will be tested for the eight EP metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag) and total phenols. The surface water samples will be analyzed for the TCL metals and total phenols.

5.2.5 SITE 1, LANDFILL NEAR INCINERATOR

Type and Number of Samples: Six groundwater

Analytes: BNAs, phenols, and oil and grease. Data will confirm previous results and identify the extent of contaminant migration.

5.2.6 SITE 10, DECONTAMINATION AGENT DISPOSAL AREA NEAR FIRST STREET

Investigation: Historical aerial photographic interpretation is recommended for the purpose of trying to define the date, type, and history of the disposal activities.

5.2.7 SITE 11, BONE YARD

Investigation: Biota sampling is recommended in Penniman Lake and Kings Creek.

Type and Number of Samples: Three groundwater, three surface water, three sediment, and six soil.

- Analytes:
- Groundwater: total phenols
 - Surface water and sediment: VOCs, BNAs, MEK, oil and grease, lead, and total phenols
 - Soil: VOCs, BNAs, lead, and oil and grease

Data will be useful to confirm previous results, better define background conditions, and evaluate the extent of contaminant migration into Penniman Lake. Groundwater, surface water, and sediment sampling locations will be the same as for Round Two efforts shown in Figure 4-7. Soil samples will be collected away from known source areas, in drainageways or low-lying areas. Results from soil sample analyses will be useful to evaluate whether contamination migration via overland runoff has occurred.

6.0 SUMMARY AND CONCLUSIONS

A summary of current environmental conditions for each of the four sites addressed in this RI Interim Report is presented in Section 4.0. Section 5.0 summarizes the recommendations for future actions for each of the sites.

For sites where contaminants have been confirmed in site media, the ground-water and surface water gradient and concentrations indicate the direction of contaminant movement. Where site contamination has been confirmed, the potential for off-base migration is based on hydrogeologic conditions as well as geographic location with respect to the installation boundary. Thus, the distance from the site to the installation boundary is useful to help evaluate whether contaminant concentrations will be significantly reduced by attenuation, adsorption, dissipation, or dilution prior to potentially exiting the installation. A recommendation for future action is provided for each site as follows:

- No further action: This recommendation is made for sites where the RI is considered complete, and no further action appears to be warranted.
- Perform a Risk Assessment (RA): Although low-level concentrations of contaminants have been detected in site media, results of the RA are necessary to evaluate whether the type and concentrations of contaminants pose a risk to human health or the environment and will determine whether additional data collection is necessary.
- Perform RA and collect additional RI data: Although contaminants have been detected in site media where additional RI data collection is recommended, the available data are not sufficient to define the magnitude and extent of contaminant migration. Therefore, the collection of additional data and the performance of an RA is recommended prior to completion of the RI.

Based on the results of the site evaluations, it is recommended that no further action be taken at one site, and that additional RI data be collected and an RA performed for the other three sites.

The site recommended for exclusion from further efforts is:

- Site 9, Transformer Storage Area

The sites recommended for additional RI efforts, including performance of a RA, are:

- Site 1, Landfill Near Incinerator
- Site 10, Decontamination Agent Disposal Area Near First Street
- Site 11, Bone Yard

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APPENDIX A: BORING LOGS

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 4901165

Client NAVFACENGCOM

Project Cheatham Annex

Location of Boring:	
Water Level	
Time	
Date	

CAIGW05

Boring No. _____ Date 12-15-85 Sheet 1 of 1

Type of Boring _____ Rig _____

Casing used Auger Size 7 1/2" Drilling mud used _____

Boring begun 11:00 Boring completed 12:30

Ground Elevation _____ referred to _____ Datum

Field Party: Dames & Moore

Depth of Casing, ft.	Sample No.	Sample depth from-to (in feet)	Blows/foot on Sampler	ID of Sampler (inches)	Tot. length of receiv. sample	Length of Lab. sample	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION <small>Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.</small>
	1	0-1.5	6 7 8				1		Orange-brown Silty Sand, Fine, Medium Dense
	2	1.5-3.0	8 8				2 3		Black Silty Sand, Fine to Medium, Medium Dense
	3	3.0-4.5	6 4				4		Light Brown Sand, Fine to Medium, Silty, Loose
							5	sm	
	4	10.0-11.5	5 5 7				10		Orange-brown Sand, Fine to Medium Little Black Silt, Medium Dense, Moist
	5	15.0-16.5	2 3 3				15		Loose, Wet
	6	20.0-21.5	4 4 6				20		Light Brown to Brown Medium Dense
									Bottom of Hole 22.0 feet

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 4901165

Client NAVFACENGCOM

Project Cheatham Annex

Location of Boring:	
Water Level	
Time	
Date	

CAIGW06

Boring No. _____ Date 12-15-85 Sheet 1 of 2

Type of Boring _____ Rig _____

Casing used _____ Size _____ Drilling mud used _____

Boring begun 13:00 Boring completed 14:00

Ground Elevation _____ referred to _____ Datum

Field Party: Dames & Moore

Depth of Casing, ft.	Sample No.	Sample depth from-to (in feet)	Blows/foot on Sampler	ID of Sampler (inches)	Tot. length of recov. sample	Length of Lab. sample	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
	1	0-1.5	2 2				1		Orange-Brown Clayey Silt and Sandy Fine, Medium Stiff
	2	1.5-3.0	3 3				2	ml	
			4 3				4		Light Brown Sand, Fine to Medium Loose, Sorted
	3	3.0-4.5	3				5	sp	
							6		
							7		
							8		
							9		
							10		
	4	10.0-11.5	3 3				10		
			5				11		
							12		
							13		
							14		
	5	15.0-16.5	4 3				15		
			3				16		
							17		
							18		
							19		
							20	sm	Brown Silty Sandy, Fine loose Shell fragments
	6	20.0-21.5	2 2				20		
			1				21		
							22		

ESI ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 4901165

Client NAVFACENCOM

Project _____

Location of Boring: _____

Water Level _____

Time _____

Date _____

CAIIGW01
Boring No. _____ Date 1-22-86 Sheet 1 of 1

Type of Boring _____ Rig _____

Casing used _____ Size _____ Drilling mud used _____

Boring begun 9:00 Boring completed 12:00

Ground Elevation _____ referred to _____ Datum _____

Field Party: Dames & Moore

Depth of Casing, ft.	Sample No.	Sample depth from-to (in feet)	Blows/foot on Sampler	ID of Sampler (inches)	Tot. length of recov. sample	Length of Lab. sample	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
	1	0-1.5	6				1		Light Brown Silty Sand, Fine Medium Dense, Moist
			7						
			6				2	sm	Dense
	2	1.5-3.0	12				3		
			18				4		Gray silty clay, Trace Sand, Fine, Plastic Hard, Mottled Brown, Moist
			6				5	ml cl	
	3	3.0-4.5	20						
							10		Light Brown Silty Sand, Fine, Shell Fragments Very Loose, Wet
	4	10.0-11.5	1					sm	
							15		Greenish Gray Silty Sand and Shell Fragments Medium Dense
	5	15.0-16.5	9						
			11						
			16				20		Green Dense
	6	20.0-21.5	12						
			15						
			18						Bottom of Hole - 21.5

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 4901165

Client NAVFACENGCOM

Project Cheatham Annex

Location of Boring: _____

Water Level _____

Time _____

Date _____

CAIGW03 Boring No. _____ Date 1-22-86 Sheet 1 of 1

Type of Boring _____ Rig _____

Casing used _____ Size _____ Drilling mud used _____

Boring begun 14:00 Boring completed 15:00

Ground Elevation _____ referred to _____ Datum

Field Party: Dames & Moore

Depth of Casing, ft.	Sample No.	Sample depth from top (in feet)	Blows/load on Sampler	ID of Sampler (inches)	Tot. length of recov. sample	Length of Lab. sample	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
1		1.5-3.0	4 5				1	sm	Brown Silty Sand, Medium Dense, Moist
			7 7				2		Brown Silty Clay, Plastic, Very Stiff, Moist
2		1.5-3.0	11 12				3	cl	
			11 12				4	cl	Brown to Light Brown Sandy Clay, Very Stiff, Moist
3		3.0-4.5	15				10	sm	Light Brown Silty Sand, Shell Fragments, Medium Dense, Wet
4		10.0-11.5	5 7 7				15		Silty Sand and Shell Fragments
5		15.0-16.5	12 13 16				20		
6		20.0-21.5	14 18 20						Bottom of Hole-21.5 Feet

APPENDIX B: WELL LEVEL MEASUREMENTS

WATER LEVEL DATA - WINTER 1986 AND FALL 1987

Water level data collected in the winter of 1986 and fall of 1987 are presented in Table 1. Figures 1 through 4 are water table contour plots of the 1986 and 1987 data for Cheatham Annex.

Figures 1 and 2 demonstrate ground water flow from the southwest to the northeast at Site 1, Cheatham Annex. Although there is a 1.9 foot average reduction in the water table surface from 1986 to 1987 (possible seasonal flux), the overall trend of flow out of the southwest towards the York River remains constant. The average horizontal gradients are .0245 ft/ft and .0164 ft/ft for the 1986 and 1987 data, respectively.

The water table contour plots for Site 11, the Bone Yard, in Figures 3 and 4, show flow directions from west-southwest to east and slightly northeast for 1986 and 1987 data. Ground water flow, in this vicinity, is directed towards Penniman Lake with the variability in flow aspect appearing to be minimal for this site. There is an average 3.5 foot reduction in the ground water surface from the reported 1986 and 1987 data with respective average horizontal gradients of .011 ft/ft and .015 ft/ft for 1986 and 1987.

Table 1 Water Level Data for Cheatham Annex and Yorktown Fuels Division, Winter 1986 and Fall 1987

WELL NUMBER	ELEVATION T.O.C. (FT.,MSL)	DEPTH TO WATER(FT)		WATER TABLE ELEVATION (FT.,MSL)	
		WINTER 1986	WINTER 1986	FALL 1987	FALL 1987
Cheatham Annex					
CA1EW01	24.23	18.00	6.23	18.55	5.68
CA1EW02	26.62	16.70	9.92	19.05	7.57
CA1EW03	24.13	15.62	8.51	16.11	8.02
CA1EW04	27.22	18.51	8.71	20.64	6.58
CA1GW05	26.40	12.20	14.20	15.55	10.85
CA1GW06	28.85	22.73	6.12	23.97	4.88
CA11GW01	30.30	9.00	21.30	11.19	19.11
CA11GW02	29.73	10.65	19.08	14.89	14.84
CA11GW03	30.70	12.75	17.95	16.90	13.80

WATER LEVEL DATA - WINTER 1986 AND FALL 1987

Water level data collected in the winter of 1986 and fall of 1987 are presented in Table 1. Figures 1 through 4 are water table contour plots of the 1986 and 1987 data for Cheatham Annex.

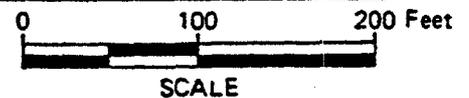
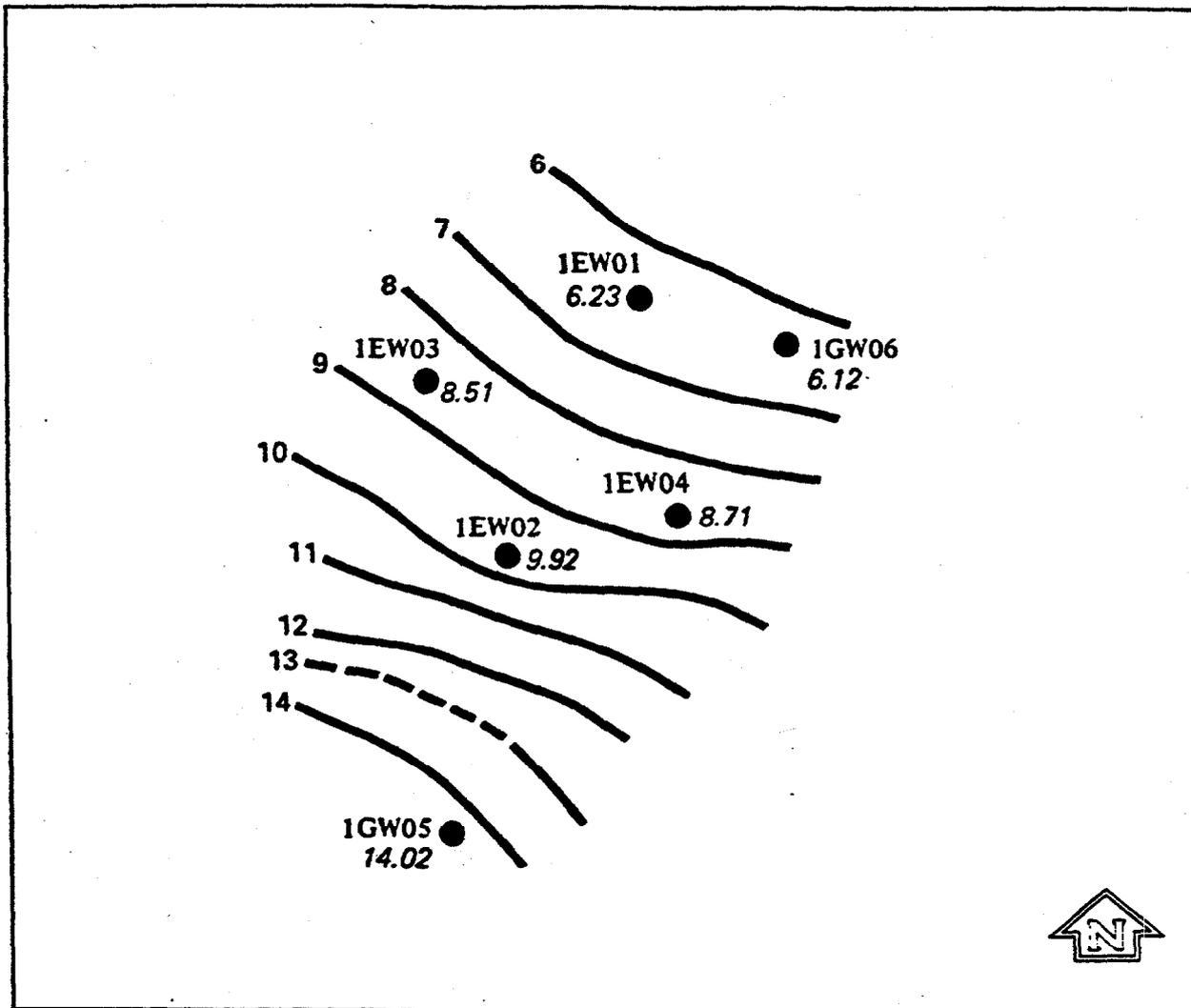
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The water table contour plots for Site 11, the Bone Yard, in Figures 3 and 4, show flow directions from west-southwest to east and slightly northeast for 1986 and 1987 data. Ground water flow, in this vicinity, is directed towards Penniman Lake with the variability in flow aspect appearing to be minimal for this site. There is an average 3.5 foot reduction in the ground water surface from the reported 1986 and 1987 data with respective average horizontal gradients of .011 ft/ft and .015 ft/ft for 1986 and 1987.

Table 1 Water Level Data for Cheatham Annex and Yorktown Fuels Division, Winter 1986 and Fall 1987

WELL NUMBER	ELEVATION T.O.C. (FT.,MSL)	DEPTH TO WATER(FT)		WATER TABLE ELEVATION (FT.,MSL)	
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Cheatham Annex					
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CA1EW02	26.62	16.70	9.92	19.05	7.57
CA1EW03	24.13	15.62	8.51	16.11	8.02
CA1EW04	27.22	18.51	8.71	20.64	6.58
CA1GW05	26.40	12.20	14.20	15.55	10.85
CA1GW06	28.85	22.73	6.12	23.97	4.88
CA11GW01	30.30	9.00	21.30	11.19	19.11
CA11GW02	29.73	10.65	19.08	14.89	14.84
CA11GW03	30.70	12.75	17.95	16.90	13.80

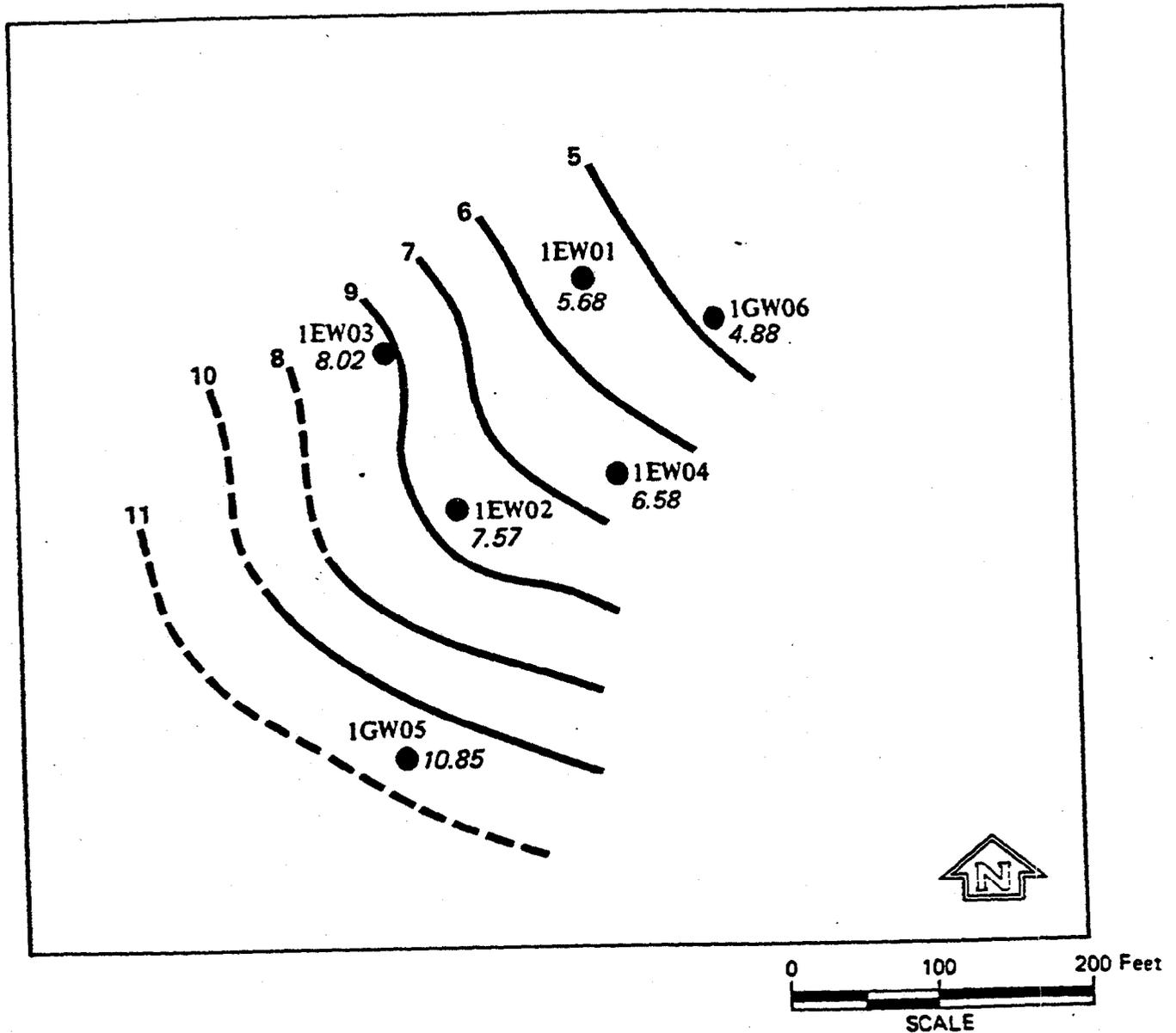
Figure 1
Water Table Contour Map, Site 1,
Landfill Near Incinerator, Cheatham Annex,
Williamsburg, Virginia, Winter 1986



● Monitoring Well Location

Water Table Elevation, in Feet, Mean Sea Level (Contours dashed where inferred)
 Water Table Contour Interval is 1 Foot

Figure 2
Water Table Contour Map, Site 1,
Landfill Near Incinerator, Cheatham Annex,
Williamsburg, Virginia, Fall 1987



● Monitoring Well Location

Water Table Elevation, in Feet, Mean Sea Level (Contours dashed where inferred)

Water Table Contour Interval is 1 Foot

Figure 3
Water Table Contour Map, Site 11,
the Bone Yard, Cheatham Annex,
Williamsburg, Virginia, Winter 1986

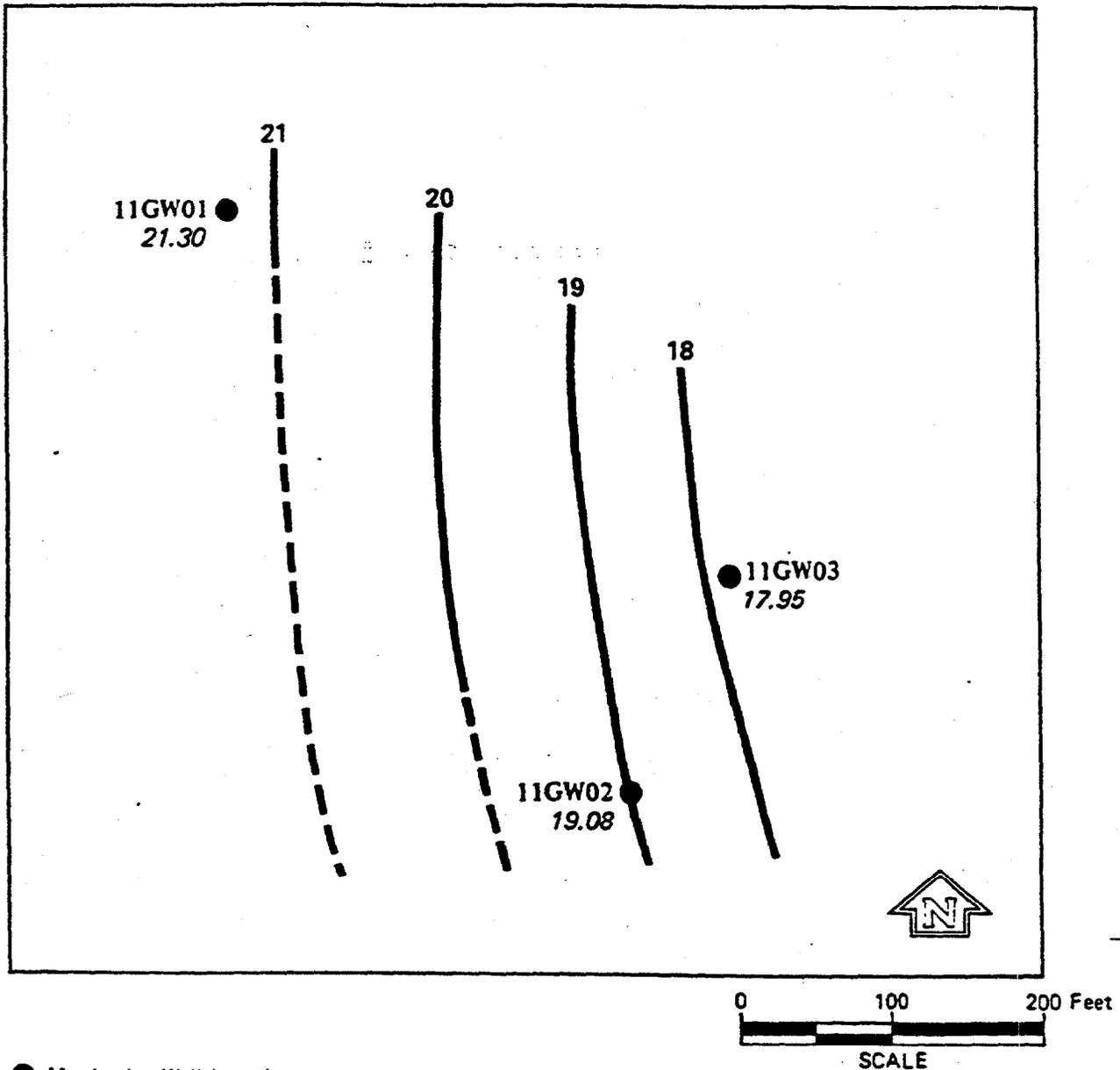
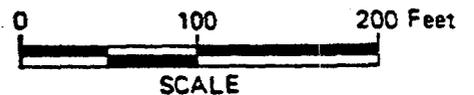
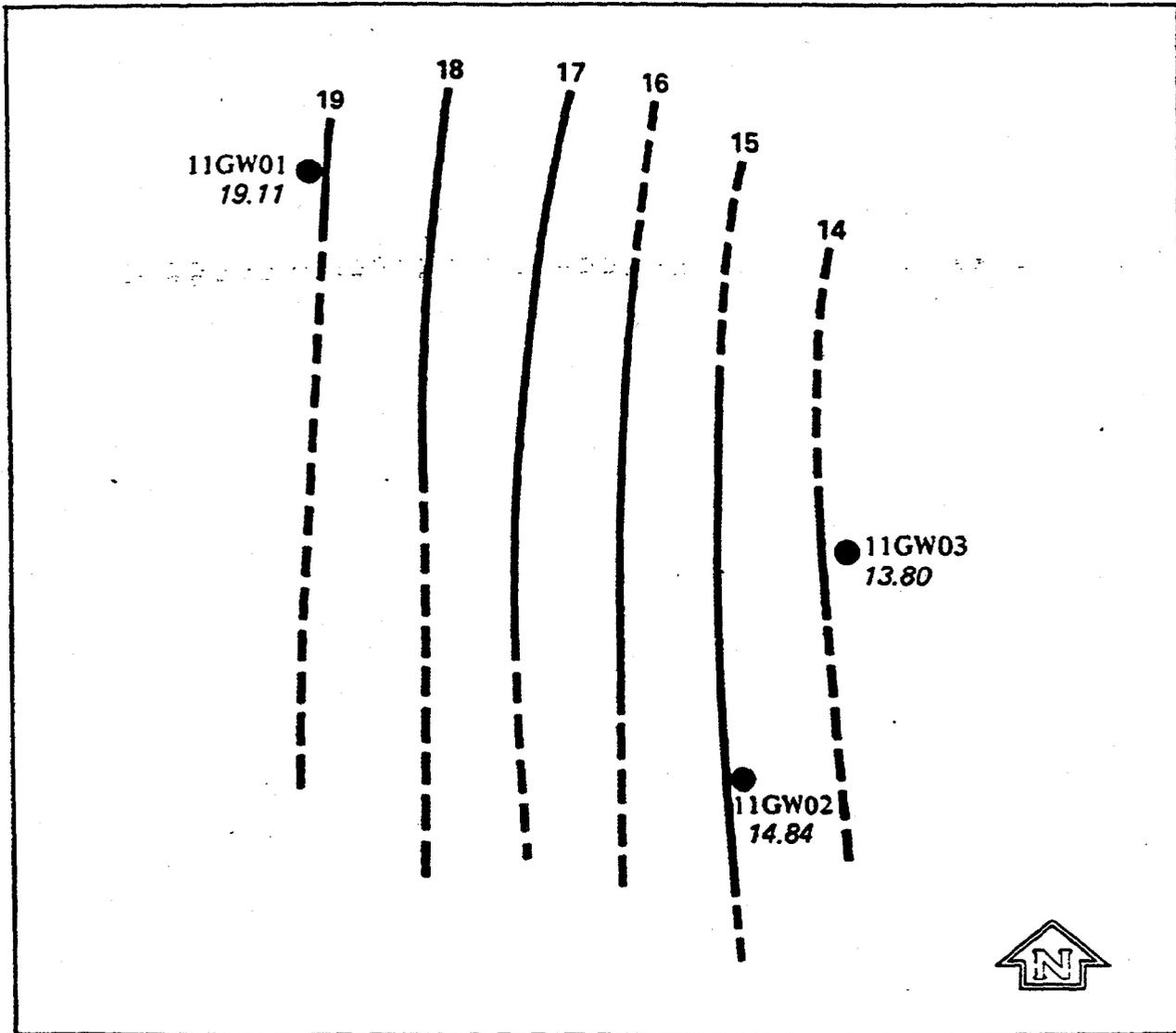


Figure 4
Water Table Contour Map, Site 11,
the Bone Yard, Cheatham Annex,
Williamsburg, Virginia, Fall 1987



● Monitoring Well Location

Water Table Elevation, in Feet, Mean Sea Level (Contours dashed where inferred)

Water Table Contour Interval is 1 Foot

APPENDIX C: CHEMICAL/ANALYTICAL DATA

ROUND 1

SAMPLE STATIONS

Analytical Parameters	1EW01	1EW02	1EW03	1EW04	1EW05	1EW06
Alpha-BHC	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Beta-BHC	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Delta-BHC	<0.005	<0.005	0.008	<0.005	<0.005	<0.005
Gamma-BHC	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Aldrin	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dieldrin	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
4,4'-DDE	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
4,4'-DDD	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021
4,4'-DDT	<0.037	<0.037	<0.037	<0.037	<0.037	<0.037
Endrin	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022
Endrin aldehyde	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
Heptachlor	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Heptachlor epoxide	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Chlordane	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Toxaphene	<0.521	<0.521	<0.521	<0.521	<0.521	<0.521
Arochlor 1016	<0.047	<0.047	<0.047	<0.047	<0.047	<0.047
Arochlor 1221	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arochlor 1232	<0.096	<0.096	<0.096	<0.096	<0.096	<0.096
Arochlor 1242	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Arochlor 1240	<0.063	<0.063	<0.063	<0.063	<0.063	<0.063
Arochlor 1254	<0.139	<0.139	<0.139	<0.139	<0.139	<0.139
Arochlor 1260	<0.170	<0.170	<0.170	<0.170	<0.170	<0.170
METALS	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
Antimony	7.3	5.2	5.0	5.5	4.2	10.6
Arsenic	<4	<4	<4	<4	<4	<4
Beryllium	<1	<1	<1	<1	<1	<1
Cadmium	<1	<1	<1	<1	<1	<1
Chromium	<4	<4	<4	<4	<4	<4
Copper	<4	<4	<4	<4	<4	<4
Lead	2.3	<1	2.9	2.0	2.0	<1
Mercury	<0.2	0.21	<0.2	<0.2	<0.2	<0.2
Nickel	<4	<4	<4	<4	<4	<4
Selenium	<4	<4	<4	<4	<4	<4
Silver	<1	<1	<1	<1	<1	<1
Thallium	<2	<2	<2	<2	<2	<2
Zinc	1550	909	2550	7940	<2	105
MISCELLANEOUS						
Total cyanides MG/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total phenols MG/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Xylene UG/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Methyl Ethylketone UG/L	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Methyl isobutylketone UG/L	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
Ethylene dibromide UG/L	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
OIL and GREASE MG/L	<5	110.9	<5	<5	<5	12.9

Analytical Parameters	SAMPLE LOCATIONS																	
	116W01	116W02	116W03	11501	11502	11503	11504	11505	11506	11507	11508	11509	115D01	115D02	115D03	115W01	115W02	115W03
PURGEABLE ORGANICS	UG/L	UG/L	UG/L	UG/KG	UG/KG	UG/KG	UG/L	UG/L	UG/L									
Benzene	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45
Toluene	0.0	0.6	0.9	<0.42	3	<0.42	<0.42	<0.42	<0.42	1	<0.42	0.5	<0.42	<0.42	<0.42	<0.42	<0.42	<0.42
Ethylbenzene	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36
Carbon tetrachloride	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chlorobenzene	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63	<0.63
1,2-Dichloroethane	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1,1-Trichloroethane	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	3	2	9	2	12	8	<1.2	3	8	<1.2
1,1-Dichloroethane	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84	<0.84
1,1-Dichloroethylene	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
1,1,2-Trichloroethane	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
1,1,2,2-Tetrachloroethane	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Chloroethane	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
2-Chloroethyl vinyl ether	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Chloroform	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82	<0.82
1,2-Dichloropropene	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Trans-1,3-Dichloropropene	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
Cis-1,3-Dichloropropene	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Methylene chloride	3.0	7.0	0.0	10	39	17	22	25	16	23	86	32	37	61	266	20	861	20
Methyl chloride	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Methyl bromide	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Bromoform	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Dichlorodibromomethane	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
Trichlorofluoroethane	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7
Chlorodibromoethane	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Tetrachloroethylene	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Trichloroethylene	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Vinyl Chloride	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
1,2-trans-Dichloroethylene	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
BASE/NEUTRAL EXTRACTABLE ORGANIC COMPOUNDS	UG/L	UG/L	UG/L	UG/KG	UG/KG	UG/KG	UG/L	UG/L	UG/L									
1,2-Dichlorobenzene	<5.4	<5.4	<5.4	<90	<90	<90	<90	<90	<90	<90	<90	<90	<90	<90	<90	<5.4	<5.4	<5.4
1,3-Dichlorobenzene	<5.6	<5.6	<5.6	<93	<93	<93	<93	<93	<93	<93	<93	<93	<93	<93	<93	<5.6	<5.6	<5.6
1,4-Dichlorobenzene	<5.4	<5.4	<5.4	<90	<90	<90	<90	<90	<90	<90	<90	<90	<90	<90	<90	<5.4	<5.4	<5.4
Hexachloroethane	<12.0	<12.0	<12.0	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<12.0	<12.0	<12.0
Hexachlorobutadiene	<13.4	<13.4	<13.4	<223	<223	<223	<223	<223	<223	<223	<223	<223	<223	<223	<223	<13.4	<13.4	<13.4
Hexachlorobenzene	<15.0	<15.0	<15.0	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250	<15.0	<15.0	<15.0
1,2,4-Trichlorobenzene	<7.4	<7.4	<7.4	<123	<123	<123	<123	<123	<123	<123	<123	<123	<123	<123	<123	<7.4	<7.4	<7.4
bis (2-Chloroethoxy) methane	<3.9	<3.9	<3.9	<65	<65	<65	<65	<65	<65	<65	<65	<65	<65	<65	<65	<3.9	<3.9	<3.9
Naphthalene	<2.1	<2.1	<2.1	<35	1515	<35	<35	174	<35	<35	<35	<35	<35	<35	251	<35	<2.1	<2.1
2-Chloronaphthalene	<3.0	<3.0	<3.0	<63	<63	<63	<63	<63	<63	<63	<63	<63	<63	<63	<63	<3.0	<3.0	<3.0
Isophorone	<2.3	<2.3	<2.3	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<2.3	<2.3	<2.3
Nitrobenzene	<4.5	<4.5	<4.5	<75	<75	<75	<75	<75	<75	<75	<75	<75	<75	<75	<75	<4.5	<4.5	<4.5
2,4-Dinitrotoluene	<14.2	<14.2	<14.2	<237	<237	<237	<237	<237	<237	<237	<237	<237	<237	<237	<237	<14.2	<14.2	<14.2
2,6-Dinitrotoluene	<15.9	<15.9	<15.9	<265	<265	<265	<265	<265	<265	<265	<265	<265	<265	<265	<265	<15.9	<15.9	<15.9
4-Bromophenyl phenyl ether	<16.3	<16.3	<16.3	<272	<272	<272	<272	<272	<272	<272	<272	<272	<272	<272	<272	<16.3	<16.3	<16.3
bis (2-Ethylhexyl) phthalate	<9.0	11	<9.0	<163	<163	<163	<163	<163	510	<163	<163	<163	163	233	<163	<9.0	<9.0	<9.0

Analytical Parameters	SAMPLE LOCATIONS																		
	110W01	110W02	110W03	11S01	11S02	11S03	11S04	11S05	11S06	11S07	11S08	11S09	11SD01	11SD02	11SD03	11SW01	11SW02	11SW03	
Di-n-octyl phthalate	<6.5	<6.5	<6.5	<100	<100	<100	<100	<100	<100	<100	<100	289	<100	<100	<100	<6.5	<6.5	<6.5	
Diethyl phthalate	<3.5	<3.5	<3.5	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	11	<3.5	11.0	
Diethyl phthalate	<3.0	<3.0	<3.0	<63	<63	<63	<63	<63	<63	<63	<63	<63	<63	<63	<63	<3.0	<3.0	<3.0	
Di-n-butyl phthalate	<3.4	<3.4	<3.4	41	<57	91	114	72	119	<57	<57	<57	<57	<57	<57	<3.4	<3.4	<3.4	
Fluorene	<4.0	<4.0	<4.0	<67	<67	<67	<67	327	<67	<67	<67	<67	<67	<67	<67	<4.0	<4.0	<4.0	
Fluoranthene	<4.9	<4.9	<4.9	<82	<82	134	<82	1937	<82	<82	1104	<82	<82	<82	<82	<4.9	<4.9	<4.9	
Chrysene	<9.0	<9.0	<9.0	<150	<150	<150	<150	928	<150	<150	1395	<150	<150	<150	<150	<9.0	<9.0	<9.0	
Pyrene	<5.1	<5.1	<5.1	<85	<85	<85	<85	1681	<85	<85	<85	<85	<85	<85	<85	<5.1	<5.1	<5.1	
Phenanthrene	<3.8	<3.8	<3.8	<63	<63	105	<63	2108	<63	<63	<63	<63	<63	<63	<63	<3.8	<3.8	<3.8	
Anthracene	<3.8	<3.8	<3.8	<63	<63	<63	<63	842	<63	<63	279	<63	<63	<63	<63	<3.8	<3.8	<3.8	
Benzo(a)anthracene	<9.0	<9.0	<9.0	<150	<150	<150	<150	851	<150	<150	449	<150	<150	<150	<150	<9.0	<9.0	<9.0	
Benzo(b)fluoranthene	<11.2	<11.2	<11.2	<107	<107	<107	<107	550	<107	<107	358	<107	<107	<107	<107	<11.2	<11.2	<11.2	
Benzo(k)fluoranthene	<11.2	<11.2	<11.2	<107	<107	<107	<107	520	<107	<107	315	<107	<107	<107	<107	<11.2	<11.2	<11.2	
Benzo(a)pyrene	<12.5	<12.5	<12.5	<200	<200	<200	<200	729	<200	<200	<200	<200	<200	<200	<200	<12.5	<12.5	<12.5	
Indeno(1,2,3-c,d)pyrene	<7.4	<7.4	<7.4	<237	<237	<237	<237	429	<237	<237	<237	<237	<237	<237	<237	<7.4	<7.4	<7.4	
Dibenzo(a,h)anthracene	<16.4	<16.4	<16.4	<273	<273	<273	<273	<273	<273	<273	<273	<273	<273	<273	<273	<16.4	<16.4	<16.4	
Benzo(g,h,i)perylene	<18.2	<18.2	<18.2	<237	<237	<237	<237	295	<237	<237	<237	<237	<237	<237	<237	<18.2	<18.2	<18.2	
4-Chlorophenyl phenyl ether	<8.8	<8.8	<8.8	<147	<147	<147	<147	<147	<147	<147	<147	<147	<147	<147	<147	<8.8	<8.8	<8.8	
3,3'-Dichlorobenzidine	<160.9	<160.9	<160.9	<2680	<2680	<2680	<2680	<2680	<2680	<2680	<2680	<2680	<2680	<2680	<2680	<160.9	<160.9	<160.9	
bis(2-Chloroethyl) ether	<4.3	<4.3	<4.3	<72	<72	<72	<72	<72	<72	<72	<72	<72	<72	<72	<72	<4.3	<4.3	<4.3	
Hexachlorocyclopentadiene	<12.5	<12.5	<12.5	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<12.5	<12.5	<12.5	
N-Nitrosodiphenylamine	<81.7	<81.7	<81.7	<1360	<1360	<1360	<1360	<1360	<1360	<1360	<1360	<1360	<1360	<1360	<1360	<81.7	<81.7	<81.7	
Aconaphthylene	<2.5	<2.5	<2.5	<42	8967	<42	<42	72	<42	<42	<42	<42	<42	<42	<42	<2.5	<2.5	<2.5	
Aconaphthene	<4.4	<4.4	<4.4	<73	<73	<73	<73	173	<73	<73	<73	<73	<73	<73	<73	<4.4	<4.4	<4.4	
Butyl benzyl phthalate	<13.0	<13.0	<13.0	<217	<217	<217	<217	<217	<217	<217	<217	<217	<217	<217	<217	<13.0	<13.0	<13.0	
N-Nitroso-Di-n-Propylamine	<6.1	<6.1	<6.1	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	<6.1	<6.1	<6.1	
bis(2-Chloroisopropyl) ether	<3.2	<3.2	<3.2	<53	<53	<53	<53	<53	<53	<53	<53	<53	<53	<53	<53	<3.2	<3.2	<3.2	
	UG/L	UG/L	UG/L	UG/KG	UG/L	UG/L	UG/L												
Total Xylene	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	<8.48	
Methyl Ethylketone	<10.0	10.0	<10.0	15	<10.0	<10.0	<10.0	12	12	15	<10.0	13	<10	30	60	12	15	13	
Methyl isobutylketone	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	
Ethylene dibromide	<0.006	<0.006	<0.006	<0.163	<41	<0.163	<0.163	<0.163	<0.163	<0.163	<0.163	<0.163	<0.163	<0.163	<0.052	<0.001	<0.001	<0.006	
MISCELLANEOUS																			
Total Phenols MG/L AND UG/B	<0.002	<0.002	<0.002	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.002	<0.002	<0.002	
OIL and GREASE MG/L AND UG/B	<5	<5	<5	<50	420900	855.8	133.9	787.2	109	94	<50	<50	326.8	1316	865	<5	<5	<5	
METALS																			
Lead UG/L AND UG/B	1.5	1.8	1.2	55.0	195.0	81.0	79.0	11.0	16.0	23.0	17.0	15.0	<10	39.0	16.5	<1	<1	<1	
pH	6.4	6.9	6.6													8.4	8.2	8.1	
Sp Cond (umhos/cm @25 deg C)	771	846	889													785	820	432	

RESULTS OF ANALYSES OF SAMPLES COLLECTED IN THE VICINITY OF CHEATHAM ANNEX SITE 11 - TANK/DRUM PAD, WINTER 1986.

CHEATHAM ANNEX DRUM/TANK	SAMPLE LOCATIONS																		EP TOXICITY STANDARDS	
	110T01	110T02	110T03	110T03	110T04	110T05	110T06	110T07	110T07	110T08	110T08	110T09	110T10	110T11	110T12	110T13	110T14	110T15		
			U-OIL	L-H2O				U-OIL	L-H2O	U-OIL	L-H2O									
Reactivity	#	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Ignitibility Degree C	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	54	>60	>60	
Corrosivity	NEGATIVE																			
EP Toxicity	NEGATIVE																			
METALS	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
Barium	<0.04	<0.04	0.076	<0.04	<0.04	<0.04	<0.04	0.076	<0.04	<0.04	0.05	0.337	0.105	0.230	0.414	<0.04	<0.04	<0.04	<0.04	100
Cadmium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.494	<0.02	<0.02	0.619	0.094	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.0
Chromium	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	5.0
Lead	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	360	1.52	<0.1	505	19	30.6	<0.1	<0.1	2.10	2.20	<0.1	0.17	5.0	

= POSITIVE REACTIVITY DUE TO SULFIDE

EP TOXICITY STANDARDS FROM 40 CFR 261.24

ROUND 2

RESULTS OF ANALYSES OF SAMPLES COLLECTED IN THE VICINITY OF CHEATNAM ANNEX SITE 1, WINTER 1987.

SAMPLE STATIONS

Analytical Parameters	1EW01	1EW02	1EW03	1EW04	1GW05	1GW06
PURGEABLE ORGANICS						
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Benzene	< 5	< 5	< 5	< 5	< 5	< 5
Toluene	< 5	< 5	< 5	< 5	< 5	< 5
Ethylbenzene	< 5	< 5	< 5	< 5	< 5	< 5
Carbon tetrachloride	< 5	< 5	< 5	< 5	< 5	< 5
Chlorobenzene	< 5	< 5	< 5	< 5	< 5	< 5
1,2-Dichloroethane	< 5	< 5	< 5	< 5	< 5	< 5
1,1,1-Trichloroethane	< 5	< 5	< 5	< 5	< 5	< 5
1,1-Dichloroethane	< 5	< 5	< 5	< 5	< 5	< 5
1,1-Dichloroethylene	< 5	< 5	< 5	< 5	< 5	< 5
1,1,1,2-Trichloroethane	< 5	< 5	< 5	< 5	< 5	< 5
1,1,2,2-Tetrachloroethane	< 5	< 5	< 5	< 5	< 5	< 5
Chloroethane	< 10	< 10	< 10	< 10	< 10	< 10
2-Chloroethyl vinyl ether	< 10	< 10	< 10	< 10	< 10	< 10
Chloroform	< 5	< 5	< 5	< 5	< 5	< 5
1,2-Dichloropropane	< 5	< 5	< 5	< 5	< 5	< 5
1,3-Dichloropropene	< 5	< 5	< 5	< 5	< 5	< 5
Methylene chloride	< 5	< 5	< 5	< 5	11	< 5
Methyl chloride	< 10	< 10	< 10	< 10	< 10	< 10
Methyl bromide	< 10	< 10	< 10	< 10	< 10	< 10
Bromoform	< 5	< 5	< 5	< 5	< 5	< 5
Dichlorobromomethane	< 5	< 5	< 5	< 5	< 5	< 5
Chlorodibromomethane	< 5	< 5	< 5	< 5	< 5	< 5
Tetrachloroethylene	< 5	< 5	< 5	< 5	< 5	< 5
Trichloroethylene	< 5	< 5	< 5	< 5	< 5	< 5
Vinyl Chloride	< 10	< 10	< 10	< 10	< 10	< 10
1,2-trans-Dichloroethylene	< 5	< 5	< 5	< 5	< 5	< 5
Acetone	<10	<10	<10	<10	<10	<10
Carbon Disulfide	< 5	< 5	< 5	< 5	< 5	< 5
2-Butanone	< 5	< 5	< 5	< 5	< 5	< 5
Vinyl Acetate	<10	<10	<10	<10	<10	<10
4-Methyl-2-Pentanone	<10	<10	<10	<10	<10	<10
Styrene	< 5	< 5	< 5	< 5	< 5	< 5
Xylenes(total)	< 5	< 5	< 5	< 5	< 5	< 5
2-Hexanone	<10	<10	<10	<10	<10	<10

Analytical Parameters	SAMPLE STATIONS					
	1EW01	1EW02	1EW03	1EW04	1GW05	1GW06
BASE/NEUTRAL EXTRACTABLE ORGANIC COMPOUNDS						
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
1,2-Dichlorobenzene	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	<10	<10	<10	<10	<10	<10
Hexachloroethane	<10	<10	<10	<10	<10	<10
Hexachlorobutadiene	<10	<10	<10	<10	<10	<10
Hexachlorobenzene	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	<10	<10	<10	<10	<10	<10
bis (2-Chloroethoxy) methane	<10	<10	<10	<10	<10	<10
Naphthalene	<10	<10	<10	<10	<10	<10
2-Chloronaphthalene	<10	<10	<10	<10	<10	<10
Isophorone	<10	<10	<10	<10	<10	<10
Nitrobenzene	<10	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	<10	<10	<10	<10	<10	<10
2,6-Dinitrotoluene	<10	<10	<10	<10	<10	<10
4-Bromophenyl phenyl ether	<10	<10	<10	<10	<10	<10
bis (2-Ethylhexyl) phthalate	<10	<10	1145	<10	11	<10
Di-n-octyl phthalate	<10	<10	27	<10	<10	17
Dimethyl phthalate	<10	<10	<10	<10	<10	<10
Diethyl phthalate	<10	<10	<10	<10	<10	<10
Di-n-butyl phthalate	<10	<10	<10	<10	<10	<10
Fluorene	<10	<10	<10	<10	<10	<10
Fluoranthene	<10	<10	<10	<10	<10	<10
Chrysene	<10	<10	<10	<10	<10	<10
Pyrene	<10	<10	<10	<10	<10	<10
Phenanthrene	<10	<10	<10	<10	<10	<10
Anthracene	<10	<10	<10	<10	<10	<10
Benzo(a)anthracene	<10	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10	<10	<10	<10
Indeno(1,2,3-c,d)pyrene	<10	<10	<10	<10	<10	<10
Dibenzo(a,h)anthracene	<10	<10	<10	<10	<10	<10
Benzo(g,h,i)perylene	<10	<10	<10	<10	<10	<10
4-Chlorophenyl phenyl ether	<10	<10	<10	<10	<10	<10
3,3'-Dichlorobenzidine	<20	<20	<20	<20	<20	<20
bis(2-Chloroethyl) ether	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	<10	<10	<10	<10	<10	<10
N-Nitrosodiphenylamine	<10	<10	<10	<10	<10	<10
Acenaphthylene	<10	<10	<10	<10	<10	<10
Acenaphthene	<10	<10	<10	<10	<10	<10
Butyl benzyl phthalate	<10	<10	<10	<10	<10	<10
N-Nitrosodi-n-proplamine	<10	<10	<10	<10	<10	<10
bis(2-Chloroisopropyl) ether	<10	<10	<10	<10	<10	<10

Analytical Parameters	SAMPLE STATIONS					
	1EW01	1EW02	1EW03	1EW04	1GW05	1GW06
ACID EXTRACTABLE ORGANIC COMPOUNDS						
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Phenol	<10	<10	<10	<10	<10	<10
2-Nitrophenol	<10	<10	<10	<10	<10	<10
4-Nitrophenol	<50	<50	<50	<50	<50	<50
2,4-Dinitrophenol	<50	<50	<50	<50	<50	<50
4,6-Dinitro-o-cresol	<50	<50	<50	<50	<50	<50
Pentachlorophenol	<50	<50	<50	<50	<50	<50
p-chloro-m-cresol	<10	<10	<10	<10	<10	<10
2,4-Dichlorophenol	<10	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10
PESTICIDES/PCBs						
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Alpha-Endosulfan *	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Beta-Endosulfan	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan sulfate	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Alpha-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Beta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Gamma-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aldrin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
4,4'-DDE	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
4,4'-DDD	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
4,4'-DDT	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor epoxide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chlordane	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Toxaphene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arochlor 1016	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arochlor 1221	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arochlor 1232	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arochlor 1242	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arochlor 1248	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arochlor 1254	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arochlor 1260	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Delta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

RESULTS OF ANALYSES OF SAMPLES COLLECTED IN THE VICINITY OF CHEATHAM ANNEX SITE 1, WINTER 1987.

Analytical Parameters	SAMPLE STATIONS					
	1EW01	1EW02	1EW03	1EW04	1GW05	1GW06
METALS						
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Antimony	<3.0	3.3	<3.0	<3.0	<3.0	<3.0
Arsenic	<3.0	<3.0	3.2	<3.0	<3.0	<3.0
Beryllium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chromium	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Copper	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Lead	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Mercury	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Selenium	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Silver	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Thallium	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Zinc	2390	60	1850	18600	37	63
MISCELLANEOUS						
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Total cyanides	< 5	< 5	< 5	< 5	< 5	< 5
Total phenols	<3.0	<3.0	<3.0	6.1	<3.0	4.3
M-Xylene	<5	<5	<5	<5	< 5	< 5
O-Xylene	<5	<5	<5	<5	< 5	< 5
P-Xylene	<5	<5	<5	<5	< 5	< 5
Methyl Ethylketone	<10	<10	<10	<10	<10	<10
Methyl isobutylketone	<10	<10	<10	<10	<10	<10
Ethylene dibromide	< 0.086	< 0.086	< 0.086	< 0.086	< 0.063	< 0.086
OIL and GREASE	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
	<5	<5	<5	<5	14	<5
METALS						
UNITS	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Hexavalent chromium	< 10	< 10	< 10	< 10	< 10	< 10
pH	6.88	7.24	7.07	6.91	7.25	6.90
Sp Cond (umhos/cm @25 deg C)	620	389	533	738	479	966
Temperature deg C	15.5	14.8	14.8	15.2	17.5	13.3

RESULTS OF ANALYSES OF SAMPLES COLLECTED IN THE VICINITY OF CHEATHAM ANNEX SITE 11, WINTER 1987.

Analytical Parameters	SAMPLE LOCATIONS							
	11GW01	11GW02	11GW03	11SD01	11SD02	11SD03	11SD03DUP02	11SW01
PURGEABLE ORGANICS								
UNITS	ug/l	ug/l	ug/l	ug/kg	ug/kg	ug/kg	ug/kg	ug/l
Benzene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Toluene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Ethylbenzene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Carbon tetrachloride	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Chlorobenzene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,2-Dichloroethane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,1,1-Trichloroethane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,1-Dichloroethane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,1-Dichloroethylene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,1,2-Trichloroethane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,1,2,2-Tetrachloroethane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Chloroethane	< 10	< 10	< 10	< 17	< 13	< 15	< 15	< 10
2-Chloroethyl vinyl ether	< 10	< 10	< 10	< 17	< 13	< 15	< 15	< 10
Chloroform	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,2-Dichloropropane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
1,3-Dichloropropene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Methylene chloride	22	6	7	55	16	16	25	< 10
Methyl chloride	< 10	< 10	< 10	< 17	< 13	< 15	< 15	< 10
Methyl bromide	< 10	< 10	< 10	< 17	< 13	< 15	< 15	< 10
Bromoform	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Dichlorobromomethane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Chlorodibromomethane	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Tetrachloroethylene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Trichloroethylene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Vinyl Chloride	< 10	< 10	< 10	< 17	< 13	< 15	< 15	< 10
1,2-trans-Dichloroethylene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Acetone	<10	<10	<10	91	36	37	122	52
Carbon Disulfide	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
2-Butanone	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Vinyl Acetate	<10	<10	<10	<17	<13	<15	<15	<10
4-Methyl-2-Pentanone	<10	<10	<10	<17	<13	<15	<15	<10
2-Hexanone	<10	<10	<10	<17	<13	<15	<15	<10
Styrene	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5
Xylenes (total)	< 5	< 5	< 5	< 9	< 7	< 7	< 7	< 5

Analytical Parameters	SAMPLE LOCATIONS							
	11GW01	11GW02	11GW03	11SD01	11SD02	11SD03	11SD03DUP02	11SW01
BASE/NEUTRAL EXTRACTABLE ORGANIC COMPOUNDS								
UNITS	ug/l	ug/l	ug/l	ug/kg	ug/kg	ug/kg	ug/kg	ug/l
1,2-Dichlorobenzene	<10	<10	<10	<563	<442	<485	<471	<10
1,3-Dichlorobenzene	<10	<10	<10	<563	<442	<485	<471	<10
1,4-Dichlorobenzene	<10	<10	<10	<563	<442	<485	<471	<10
Hexachloroethane	<10	<10	<10	<563	<442	<485	<471	<10
Hexachlorobutadiene	<10	<10	<10	<563	<442	<485	<471	<10
Hexachlorobenzene	<10	<10	<10	<563	<442	<485	<471	<10
1,2,4-Trichlorobenzene	<10	<10	<10	<563	<442	<485	<471	<10
bis(2-Chloroethoxy) methane	<10	<10	<10	<563	<442	<485	<471	<10
Naphthalene	<10	<10	<10	<563	<442	<485	<471	<10
2-Chloronaphthalene	<10	<10	<10	<563	<442	<485	<471	<10
Isophorone	<10	<10	<10	<563	<442	<485	<471	<10
Nitrobenzene	<10	<10	<10	<563	<442	<485	<471	<10
2,4-Dinitrotoluene	<10	<10	<10	<563	<442	<485	<471	<10
2,6-Dinitrotoluene	<10	<10	<10	<563	<442	<485	<471	<10
4-Bromophenyl phenyl ether	<10	<10	<10	<563	<442	<485	<471	<10
bis(2-Ethylhexyl) phthalate	49	22	<10	<563	<442	<485	<471	103
Di-n-octyl phthalate	15	<10	<10	<563	<442	<485	<471	<10
Dimethyl phthalate	<10	<10	<10	<563	<442	<485	<471	<10
Diethyl phthalate	<10	<10	<10	<563	<442	<485	<471	<10
Di-n-butyl phthalate	<10	<10	<10	<563	<442	<485	<471	<10
Fluorene	<10	<10	<10	<563	<442	<485	<471	<10
Fluoranthene	<10	<10	<10	<563	<442	<485	<471	<10
Chrysene	<10	<10	<10	<563	<442	<485	<471	<10
Pyrene	<10	<10	<10	<563	<442	<485	<471	<10
Phenanthrene	<10	<10	<10	<563	<442	<485	<471	<10
Anthracene	<10	<10	<10	<563	<442	<485	<471	<10
Benzo(a)anthracene	<10	<10	<10	<563	<442	<485	<471	<10
Benzo(b)fluoranthene	<10	<10	<10	<563	<442	<485	<471	<10
Benzo(k)fluoranthene	<10	<10	<10	<563	<442	<485	<471	<10
Benzo(a)pyrene	<10	<10	<10	<563	<442	<485	<471	<10
Indeno(1,2,3-c,d)pyrene	<10	<10	<10	<563	<442	<485	<471	<10
Dibenzo(a,h)anthracene	<10	<10	<10	<563	<442	<485	<471	<10
Benzo(g,h,i)perylene	<10	<10	<10	<563	<442	<485	<471	<10
4-Chlorophenyl phenyl ether	<10	<10	<10	<563	<442	<485	<471	<10
3,3'-Dichlorobenzidine	<20	<20	<20	<1127	<885	<969	<941	<20
bis(2-Chloroethyl) ether	<10	<10	<10	<563	<442	<485	<471	<10
Hexachlorocyclopentadiene	<10	<10	<10	<563	<442	<485	<471	<10
N-Nitrosodiphenylamine	<10	<10	<10	<563	<442	<485	<471	<10
Acenaphthylene	<10	<10	<10	<563	<442	<485	<471	<10
Acenaphthene	<10	<10	<10	<563	<442	<485	<471	<10
Butyl benzyl phthalate	<10	<10	<10	<563	<442	<485	<471	<10
N-Nitrosodi-n-proplamine	<10	<10	<10	<563	<442	<485	<471	<10
bis(2-Chloroisopropyl) ether	<10	<10	<10	<563	<442	<485	<471	<10

RESULTS OF ANALYSES OF SAMPLES COLLECTED IN THE VICINITY OF CHEATHAM ANNEX SITE 11, WINTER 1987.

Analytical Parameters	SAMPLE LOCATIONS							
	11GW01	11GW02	11GW03	11SD01	11SD02	11SD03	11SD030UP02	11SW01
ACID EXTRACTABLE ORGANIC COMPOUNDS								
UNITS	ug/l	ug/l	ug/l	ug/kg	ug/kg	ug/kg	ug/kg	ug/l
Phenol	<10	<10	<10	<563	<442	<485	<471	<10
2-Nitrophenol	<10	<10	<10	<563	<442	<485	<471	<10
4-Nitrophenol	<50	<50	<50	<2732	<2145	<2349	<2282	<50
2,4-Dinitrophenol	<50	<50	<50	<2732	<2145	<2349	<2282	<50
4,6-Dinitro-o-cresol	<50	<50	<50	<2732	<2145	<2349	<2282	<50
Pentachlorophenol	<50	<50	<50	<2732	<2145	<2349	<2282	<50
p-chloro-m-cresol	<10	<10	<10	<563	<442	<485	<471	<10
2,4-Dichlorophenol	<10	<10	<10	<563	<442	<485	<471	<10
2,4,6-Trichlorophenol	<10	<10	<10	<563	<442	<485	<471	<10
2,4-Dimethylphenol	<10	<10	<10	<563	<442	<485	<471	<10
MISCELLANEOUS								
UNITS	ug/l	ug/l	ug/l	ug/kg	ug/kg	ug/kg	ug/kg	ug/l
Toluene	<5							
Benzene	<5							
M-Xylene	<5	<5	<5	< 9	< 7	< 7	< 7	<5
O-Xylene	<5	<5	<5	< 9	< 7	< 7	< 7	<5
P-Xylene	<5	<5	<5	< 9	< 7	< 7	< 7	<5
Methyl Ethylketone	<10	<10	<10	<17	< 13	< 15	< 15	<10
Methyl isobutylketone	<10	<10	<10	<17	< 13	< 15	< 15	<10
UNITS	ug/l	ug/l	ug/l	ug/kg	ug/kg	ug/kg	ug/kg	ug/l
Ethylene dibromide	<0.108	<0.108	<0.108	<0.108	<0.941	<0.941	<0.941	<0.108
UNITS	ug/l	ug/l	ug/l	ug/g	ug/g	ug/g	ug/g	ug/l
Total Phenols	90	4	51	3	<3	<5	4	<3.0
UNITS	mg/l	mg/l	mg/l	ug/g	ug/g	ug/g	ug/g	mg/l
OIL and GREASE	< 5	<5	<5	588	295	641	<5	<5
METALS								
UNITS	ug/l	ug/l	ug/l	ug/g	ug/g	ug/g	ug/g	ug/l
Lead	<2.5	<2.5	<2.5	8.3	51.5	<2.5	<2.5	<2.5
pH	6.86	6.85	6.61				::	7.27
Sp Cond (umhos/cm @ 25 deg C)	999	859	1143					527
Temperature deg C	15.9	14.1	14.8					7.4

RESULTS OF ANALYSES OF SAMPLES COLLECTED IN THE VICINITY OF CHEATHAM ANNEX SITE 11, WINTER 1987.

Analytical Parameters	11SW02	11SW03	11SW030UP01
PURGEABLE ORGANICS			
UNITS	ug/l	ug/l	ug/l
Benzene	< 5	< 5	< 5
Toluene	< 5	< 5	< 5
Ethylbenzene	< 5	< 5	< 5
Carbon tetrachloride	< 5	< 5	< 5
Chlorobenzene	< 5	< 5	< 5
1,2-Dichloroethane	< 5	< 5	< 5
1,1,1-Trichloroethane	< 5	< 5	< 5
1,1-Dichloroethane	< 5	< 5	< 5
1,1-Dichloroethylene	< 5	< 5	< 5
1,1,2-Trichloroethane	< 5	< 5	< 5
1,1,2,2-Tetrachloroethane	< 5	< 5	< 5
Chloroethane	< 10	< 10	< 10
2-Chloroethyl vinyl ether	< 10	< 10	< 10
Chloroform	< 5	< 5	< 5
1,2-Dichloropropane	< 5	< 5	< 5
1,3-Dichloropropane	< 5	< 5	< 5
Methylene chloride	< 10	< 10	< 10
Methyl chloride	< 10	< 10	< 10
Methyl bromide	< 10	< 10	< 10
Bromoform	< 5	< 5	< 5
Dichlorobromomethane	< 5	< 5	< 5
Chlorodibromomethane	< 5	< 5	< 5
Tetrachloroethylene	< 5	< 5	< 5
Trichloroethylene	< 5	< 5	< 5
Vinyl Chloride	< 10	< 10	< 10
1,2-trans-Dichloroethylene	< 5	< 5	< 5
Acetone	<10	11	<10
Carbon Disulfide	< 5	< 5	< 5
2-Butanone	< 5	< 5	< 5
Vinyl Acetate	<10	<10	<10
4-Methyl-2-Pentanone	<10	<10	<10
2-Hexanone	<10	<10	<10
Styrene	< 5	< 5	< 5
Xylenes (total)	< 5	< 5	< 5

Analytical Parameters 11SW02 11SW03 11SW030UP01

BASE/NEUTRAL EXTRACTABLE ORGANIC COMPOUNDS

UNITS	ug/l	ug/l	ug/l
1,2-Dichlorobenzene	<10	<10	<10
1,3-Dichlorobenzene	<10	<10	<10
1,4-Dichlorobenzene	<10	<10	<10
Hexachloroethane	<10	<10	<10
Hexachlorobutadiene	<10	<10	<10
Hexachlorobenzene	<10	<10	<10
1,2,4-Trichlorobenzene	<10	<10	<10
bis (2-Chloroethoxy) methane	<10	<10	<10
Naphthalene	<10	<10	<10
2-Chloronaphthalene	<10	<10	<10
Isophorone	<10	<10	<10
Nitrobenzene	<10	<10	<10
2,4-Dinitrotoluene	<10	<10	<10
2,6-Dinitrotoluene	<10	<10	<10
4-Bromophenyl phenyl ether	<10	<10	<10
bis (2-Ethylhexyl) phthalate	<10	<10	34
Di-n-octyl phthalate	16	<10	<10
Dimethyl phthalate	<10	<10	<10
Diethyl phthalate	<10	<10	<10
Di-n-butyl phthalate	<10	<10	<10
Fluorene	<10	<10	<10
Fluoranthene	<10	<10	<10
Chrysene	<10	<10	<10
Pyrene	<10	<10	<10
Phenanthrene	<10	<10	<10
Anthracene	<10	<10	<10
Benzo(a)anthracene	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10
Indeno(1,2,3-c,d)pyrene	<10	<10	<10
Dibenzo(a,h)anthracene	<10	<10	<10
Benzo(g,h,i)perylene	<10	<10	<10
4-Chlorophenyl phenyl ether	<10	<10	<10
3,3'-Dichlorobenzidine	<20	<20	<20
bis(2-Chloroethyl) ether	<10	<10	<10
Hexachlorocyclopentadiene	<10	<10	<10
N-Nitrosodiphenylamine	<10	<10	<10
Acenaphthylene	<10	<10	<10
Acenaphthene	<10	<10	<10
Butyl benzyl phthalate	<10	<10	<10
N-Nitrosodi-n-proplamine	<10	<10	<10
bis(2-Chloroisopropyl) ether	<10	<10	<10

RESULTS OF ANALYSES OF SAMPLES COLLECTED IN THE VICINITY OF CHEATHAM ANNEX SITE 11, WINTER 1987.

Analytical Parameters 11SW02 11SW03 11SW03DUP01

ACID EXTRACTABLE ORGANIC COMPOUNDS

UNITS	ug/l	ug/l	ug/l
Phenol	<10	<10	<10
2-Nitrophenol	<10	<10	<10
4-Nitrophenol	<50	<50	<50
2,4-Dinitrophenol	<50	<50	<50
4,6-Dinitro-o-cresol	<50	<50	<50
Pentachlorophenol	<50	<50	<50
p-chloro-m-cresol	<10	<10	<10
2,4-Dichlorophenol	<10	<10	<10
2,4,6-Trichlorophenol	<10	<10	<10
2,4-Dimethylphenol	<10	<10	<10

MISCELLANEOUS

UNITS	ug/l	ug/l	ug/l
Toluene			
Benzene			
M-Xylene	<5	<5	<5
O-Xylene	<5	<5	<5
P-Xylene	<5	<5	<5
Methyl Ethylketone	<10	<10	<10
Methyl isobutylketone	<10	<10	<10

UNITS	ug/l	ug/l	ug/l
Ethylene dibromide	<0.108	<0.108	<0.108

UNITS	ug/l	ug/l	ug/l
Total Phenols	<3.0	4	3.7

UNITS	mg/l	mg/l	mg/l
OIL and GREASE	<5	<5	<5

METALS

UNITS	ug/l	ug/l	ug/l
Lead	8.2	<2.5	<2.5

pH	7.19	7.31	7.31
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Sp Cond (umhos/cm @ 25 deg C)	614	315	315
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Temperature deg C	7.6	7.5	7.5
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Appendix D: QA/QC Data

APPENDIX D: QA/QC DATA

QA/QC

A QA/QC data report dated 8 February 1989 has been prepared for Rounds One and Two of the chemical analyses of the environmental samples collected from CA, Williamsburg, Virginia. This report was prepared by Envirodyne Engineers (1989). It provides information concerning analytical methodologies used to perform the analysis of the environmental samples, the results of monitoring, and analysis of sample holding times, method blanks, and analytical control spikes. The following pages summarize the results of review of holding time exceedances, method blank results, and analytical control spike results. Appendices A and B referenced in the QA/QC report are supporting analytical lab sheets that have not been included herein.

INTRODUCTION

Sampling from the sites for Navy assessment and control of installation of pollutants began in January 1986 for Round I and November 1987 for Round II. This Navy program is now referred to as the Navy Installation Restoration (IR) Program. A total of three separate facilities were included in both rounds. These facilities were the Naval Weapons Station at Yorktown, Virginia; the Naval Supply Center, Cheatham annex; and the Naval Supply Center, Yorktown Fuels Division. This QC report addresses only those samples from the Naval Supply Center, Cheatham annex.

The samples from the Cheatham annex were analyzed for priority pollutants, including volatile organics, extractable organics (BNA), cyanide, priority pollutant metals, pesticides, and PCBs. Additional analyses included xylenes, MEK, MIBK, EDB, total phenols, hexavalent chromium, RCRA parameters (corrosivity, ignitability, reactivity, EP toxicity metals - Ba, Cd, Cr, Pb) and grease/oil. EEP's analyses were based on methods selected from the USEPA Federal Register (10/84) for water samples and SW846 (3rd Edition) for soil and sediment samples. In some instances other sources such as USGS, ASTM, USATHAMA, and Standards Methods (15th Edition) were also used.

Organic priority pollutants were extracted using modifications adapted in the USEPA Contract Laboratory Program (CLP). The hazardous substances list of the organic CLP was used as the target list of analytes. Semi-volatile BNA analyses were performed using capillary column per the analytical scope of work of the organic CLP and SW846, Method 8270.

Ethylene dibromide was analyzed by liquid-liquid extraction followed by gas chromatography using an electron capture detector (ECD).

Metals were analyzed by atomic absorption spectroscopy, AA/graphite furnace, and inductively coupled plasma (ICP) using EPA methods.

All samples were logged-in per chain-of-custody procedures described in EEP's QA Manual and stored per analytical protocol. Samples for BNA, and pesticides/PCBs were collected in amber glass bottles with Teflon lined caps. Samples for VOAs were collected in duplicate 40 ml glass serum vials with Teflon lined septa. All samples were kept at 4° C during shipment and storage in the laboratory. Samples for metals analyses (except hexavalent chromium) were collected in polyethylene bottles and preserved with HNO₃ to pH of ≤ 2 after filtration in the field. Hexavalent chromium samples were not preserved with acid.

Analytical holding times were adhered-to as per the criteria established in the scope of work, except as described in the text below.

Initial calibration standards were run for all analyses. These standards bracketed the working range of the instruments and were verified at least daily with a single-point calibration verification standard.

Each lot of samples (< 20 samples per lot), included a method blank, a laboratory control spike (LCS), and a laboratory duplicate. The LCS was prepared by spiking blank water or soil with the target analytes. For multi-analyte analyses (ie. pesticides/PCBs), a selected number of target analytes were chosen for monitoring control. Surrogates were spiked into VOA and BNA samples to aid data evaluation. After completing the analysis, the data were checked by the laboratory section manager or laboratory manager. Evaluation of data acceptability was based on the following criteria:

- Method blanks containing concentrations of the target analytes at less than the method detection limit, with the exception of common laboratory solvents and phthalate esters (USEPA CLP acceptance criteria of values less than or equal to five times the CLP contract required detection limits were used for common laboratory solvents and phthalate esters).
- Control spike recoveries within +/- 3SD of the mean. Control charts were used to monitor control limits for recoveries of spikes.
- For multi-analyte methods, USATHAMA guidelines were used to check the minimum number of in-control points (these guidelines state that roughly two-thirds of the control analytes must be in-control for the lot to be considered in-control).

Deviations to these criteria and to the methodologies are discussed in more detail below.

CHANGES IN ANALYTICAL METHODS AND EQUIPMENT

During the Round I analyses, several modifications to methods and equipment occurred. These modifications were:

- a slight modification to the method 3540 (SW846) for the BNA soil extraction procedure. The method states that 10 grams be extracted and concentrated to 10 ml. EEI has modified the method to use 30 grams extracted and concentrated to 1 ml. This modification was made to allow use of the existing control charts for BNA at that time.

During Round II analyses, the following modifications were made:

- EPA method 335.3 (colorimetric, automated) for cyanide was used instead of EPA Method 335.2 (manual reflux distillation). The method technologies are identical, except EPA method 335.3 is automated, which is more accurate and quicker. This change had been approved by Martin Marietta and the method is USATHAMA-approved.

All above mentioned modifications were either brought to the attention of Ms. Gloria Mencer of Martin Marietta and Mr. Bill Adams of Dames and Moore, or were discussed in the QC progress reports that were prepared and delivered during the performance of the project.

QA/OC PERFORMANCE AND TRENDS

Enclosed in appendices A & B are summary forms for each analytical lot from Rounds I and II. These forms identify each sample associated with each analytical lot, the sample collection date, and whether the analysis was done within the required holding time. The forms also summarize the results of the method blank associated with the lot and the results of the control spike. The following discussions are made with reference to these summary forms.

Holding Times

During Round I and Round II, the majority of analyses were conducted within the prescribed holding times for each analytical method. However, several exceptions are noted which include samples in the following lots:

- BNA lot NBW08. Nine samples exceeded their analytical holding time by 22 days. All sample extraction holding times were met. Except for the poor recovery of the 2,4,6-Tribromophenol surrogate (reference the corrective action form included in appendix B), the recoveries of the other surrogates have not shown any unusual deterioration due to analytical delays.
- Mercury lots NMW03 and NMW04. Five samples exceeded their holding times by 9 days; one sample exceeded its holding time by 13 days. EEI conducted a validation study for mercury between 2/87 and 4/87. The results of this study (which are included with the mercury lot NMW03 summary sheet in appendix B) showed no significant affect to the results due to analytical delays. It is felt that the data should be acceptable.
- GC/MS VOA lots NVW36 and NVS33. One sample from lot NVW36 exceeded its holding time by four days. Two samples from lot NVS33 exceeded their holding times by three days. Based on the analytical work

plan, EEI was to receive a maximum lot size of 6-8 VOA samples per day. Instead, 18 samples were received on 12/23/87; which includes the samples from lots NVW36 and NVS33. The sample load at the time, coupled with the Christmas holiday, resulted in backlogs in the GC/MS laboratory. EEI has done numerous holding time validation studies for volatile organics in soil and water samples and found that a few days delay in analysis does not affect the data results. It was felt that the data for these samples would be acceptable.

Method Blanks

Common laboratory solvents frequently are detected in small amounts for many trace organic analyses. For volatile organics, levels of approximately 5 to 30 ppb are common for methylene chloride and acetone. For the base/neutral-acid extractable organics, levels of approximately 1 to 10 ppb of the phthalate compounds are common. For both the volatile and extractable organics analyses, the method blank background levels consisted primarily of the common laboratory solvents and at the above-mentioned levels. As such, for the most part the interpretation of the volatile and BNA data can assume that the presence of these solvents at the above-mentioned levels is a result of laboratory background. It should be noted that for soil/sediment samples with high percentages of moisture would show higher levels of the background contaminants since the soil/sediment samples are reported on a dry weight basis and the calculation to adjust for percent moisture raises the instruments reported value.

For several lots, the background levels of contaminants exceeds the anticipated levels, or other contaminants are found in the method blank. These situations are:

- Bis (2-ethylhexyl)phthalate has been shown to be higher than routinely seen in the method blanks associated with lots NBS01, NBW08, and NBW12. This background level has probably strongly influenced the reported value for bis (2-ethylhexyl)phthalate in samples CA11S09, CA11S06, CA11S07, CA11S01, CA11GW01, CA1GW05, CA11GW03, CA11GW02, CA1EW03, CA1EW04, CA1GW06, CA1EW02, CA1EW01, CA11SW02, DUP01, CA11SW01, and CA11SW03.
- Di-n-butylphthalate has been shown to be present in levels higher than routinely seen in method blanks associated with lots NBS01, and NBS02. The levels of di-n-butylphthalate in the method blanks probably influenced the reported values in samples CA11S09, CA11S06, CA11S07, CA11S01, CA11S03, CA11S04, CA11S05, and CA11S02.
- Diethylphthalate has been shown to higher than routinely seen in the method blanks associated with lots NBS01, and NBS02. The levels of diethylphthalate

in the method blanks probably influenced the reported values in samples CA11S09, CA11S06, CA11S07, CA11S01, CA11S03, CA11S04, CA11S05, and CA11S02.

Several method blanks have trace levels of methyl ethyl ketone (MEK) and/or toluene. These lots are NVW09, NVW11, NVW16, NVW20, NVS03, NVS05, NVS15, and NVS17. The organic water charcoal filter was changed, but these compounds were later found in the blanks again. It was suspected that the methanol used in the preparation of the internal standard mix could be the source of contamination. The toluene values reported for samples CA11GW01, CA11GW02, and CA11GW03 have all probably been influenced to some degree by the toluene background. The MEK values reported for samples CA11SW01, CA11SW02, CA11SW03, CA11GW01, CA11GW02, CA11GW03, CA1GW01, CA1GW03, CA1GW02, CA1GW06, CA1GW04, CA1GW05, CA11S01, CA11S06, CA11S07, CA11S09, CA11S02, CA11S03, CA11S04, CA11S05, CA11SD02, and CA11SD03 have all probably been strongly influenced to some degree by the MEK background levels.

Acetone has been shown to be present in levels larger than routinely seen for one method blank (note; acetone was not a target analyte during the Round I analyses, as such acetone for those samples is not addressed). This lot is NVW33, which includes samples CA11SW02, CA11SW01, and CA11SW03. It had been mentioned in the third QA report for Round II that some of the acetone background problems may be related to the fact that some of the volatile and semi-volatile samples were bottled together. Normally, volatile samples are taken in separate bottles that have been prepared without any solvents. Semi-volatile bottles are prepared by cleaning with soapy water, rinsing with DI water, and then rinsing with acetone and methylene chloride.

Method blanks are not applicable for RCRA parameters ignitability or corrosivity. For other inorganic analyses, the following target analytes have been found in the method blanks:

- Lead lots NMW04, NMS 05, 06, 07, and 08. For all lots, the lead levels present in the method blanks are less than the reported detection limits for the associated samples. These samples are: CA1GW01, CA1GW03, CA1GW02, CA1GW06, CA1GW04, CA1GW05, CA11SD02, CA11SD01, and CA11SD03.
- Zinc lots NMW06 and 07. The samples associated with these lots are: CA1EW03, CA1EW04, CA1GW06, CA1EW02, and CA1EW01. The zinc data for these samples should be corrected for the analytical background.

Analytical Control Spikes

Several analyses are not charted (certified) analyses. These include grease and oil, PCB screens, and all RCRA parameters (i.e. ignitability, corrosivity, EP Toxicity, reactivity).

For several analyses, the control chart was under development at the time of the analysis; consequently control limits were not available at that time. These include the following:

- EDB in lots NEW02, NEW03, NES01, NES04, and OPA574.
- Antimony in lot NMW02.
- Nickel in lot NMW03.
- Thallium in lot NMW03.
- Phenolics in lots NPS01, and NPS02.

For several analyses, the control spike recovery data were not entered on the control chart. The QC summaries in appendices A & B provide the recovery of the control spike and an interpretation of the control status. The following lots are included in this group:

- Cyanide from analysis done on 12/23/87.
- Zinc from analysis done 03/03/88.
- Phenolics from analysis done 12/17/87.

The following notable trends, shifts, and biases were observed from the control charts for the Round I and Round II analyses:

- The chromium recoveries between lots NMW04 and NMW13 represent the 7th to the 15th consecutive point above the mean. The spike solutions were verified and the analytical runs rechecked. The recoveries all range from 100% to 114%; the data appear valid and should be acceptable.
- The 2,4,6-Tribromophenol recoveries in lots NBW08 and NBW12 are very high and are outside the upper control limit. The standard mix, (GCA-596) was improperly prepared. The problem has been brought to the attention of the organic prep laboratory supervisor and a new set of standards have been made. Since only one out six control analytes is outside the control limits, the lots are considered in control and the data should be acceptable.

The QC summary forms in appendices A & B provide a detailed description of the control status for each analytical lot. This description addresses both the data point position on the chart with respect to the warning and control limits, and whether any trends have developed. A trend was considered to be either, 1) seven consecutive points on either

side of the mean, 2) five consecutive points moving in one direction, 3) 2 consecutive points between the warning and control limits, or 4) any cyclical pattern.

ARCHIVE INVENTORY

All analytical data, raw data, data summaries, QC charts, sample lists, chain-of-custody forms, analytical logbooks, notebooks, worksheets, and computer diskettes associated with Rounds I and II for all three Navy facilities are presently stored in locked file cabinets at EEI. Round I data will soon be transferred to storage books and shipped to EEI's data storage warehouse which is kept locked and is temperature and moisture controlled. The Round II data will be transferred similarly after one year of data reporting.

APPENDIX E: TARGET COMPOUND LIST
(used in EPA's Contract Lab Program)

LIST OF PARAMETERS

For

**Contract Laboratory Program (CLP)
Analyses**

**Applicable Under Comprehensive Environmental
Response, Compensation and Liability Act
(CERCLA) or Superfund**

**Based on SOW for
Organic Analysis 10/86**

TARGET COMPOUND LIST (TCL)
VOLATILE ORGANIC COMPOUNDS
(USEPA - SOW for Organic Analysis 10/86)

<u>Compound</u>	<u>CAS Number</u>
1. Acetone	67-64-1
2. Benzene	71-43-2
3. Bromodichloromethane	75-27-4
4. Bromoform	75-25-2
5. Bromomethane	74-83-9
6. 2-Butanone	78-93-3
7. Carbon Disulfide	75-15-0
8. Carbon Tetrachloride	56-23-5
9. Chlorobenzene	108-90-7
10. Chloroethane	75-00-3
11. Chloroform	67-66-3
12. Chloromethane	74-87-3
13. cis-1,3-Dichloropropene	10061-01-5
14. Dibromochloromethane	124-48-1
15. 1,1-Dichloroethane	75-34-3
16. 1,2-Dichloroethane	107-06-2
17. 1,1-Dichloroethene	75-35-4
18. 1,2-Dichloroethene (total)	544-59-0
19. 1,2-Dichloropropane	78-87-5
20. Ethyl Benzene	100-41-4
21. 2-Hexanone	591-78-6
22. Methylene Chloride	75-09-2

TARGET COMPOUND LIST (TCL)
VOLATILE ORGANIC COMPOUNDS
(USEPA - SOW for Organic Analysis 10/86)

<u>Compound</u>	<u>CAS Number</u>
23. 4-Methyl-2-pentanone	108-10-1
24. Styrene	100-42-5
25. 1,1,2,2-Tetrachloroethane	79-34-5
26. Tetrachloroethene	127-18-4
27. Toluene	108-88-3
28. Total Xylenes	1330-20-7
29. trans-1,3-Dichloropropene	10061-02-6
30. 1,1,1-Trichloroethane	71-55-6
31. 1,1,2-Trichloroethane	79-00-5
32. Trichloroethene	79-01-6
33. Vinyl Acetate	108-05-4
34. Vinyl Chloride	75-01-4

TARGET COMPOUND LIST (TCL)
SEMI-VOLATILE OR ACID BASE, AND NEUTRAL (AB&N)
EXTRACTABLE ORGANIC COMPOUNDS
(USEPA - CLP - SOW for Organic Analysis 10/86)

<u>Compound</u>	<u>CAS Number</u>
1. Acenaphthene	83-32-9
2. Acenaphthylene	208-96-8
3. Anthracene	120-12-7
4. Benzoic Acid	65-85-0
5. Benzo(a)anthracene	56-55-3
6. Benzo(a)pyrene	50-32-8
7. Benzo(b)fluoranthene	205-99-2
8. Benzo(g,h,i)perylene	191-24-2
9. Benzo(k)fluoranthene	207-08-9
10. Benzyl Alcohol	100-51-6
11. bis(2-ethylhexyl)phthalate	117-81-7
12. bis(2-chloroethoxy) methane	111-91-1
13. bis(2-chloroethyl) ether	111-44-4
14. bis(2-chloroisopropyl) ether	108-60-1
15. 4-Bromophenyl-phenylether	101-55-3
16. Butylbenzylphthalate	85-68-7
17. 4-Chloroaniline	106-47-8
18. 2-Chloronaphthalene	91-58-7
19. 2-Chlorophenol	95-57-8
20. 4-Chlorophenyl-Phenyl ether	7005-72-3
21. 4-chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7
22. Chrysene	218-01-9

TARGET COMPOUND LIST (TCL)
SEMI-VOLATILE OR ACID BASE, AND NEUTRAL (AB&N)
EXTRACTABLE ORGANIC COMPOUNDS
(USEPA - CLP - SOW for Organic Analysis 10/86)

<u>Compound</u>	<u>CAS Number</u>
23. Dibenzofuran	132-64-9
24. Dibenz(a,h)anthracene	53-70-3
25. 1,2-Dichlorobenzene	95-50-1
26. 1,3-Dichlorobenzene	541-73-1
27. 1,4-Dichlorobenzene	106-46-7
28. 3,3-Dichlorobenzidine	91-94-1
29. 2,4-Dichlorophenol	120-83-2
30. Diethylphthalate	84-66-2
31. Dimethylphthalate	131-11-3
32. 2,4-Dimethylphenol	105-67-9
33. 2,4-Dinitrophenol	51-28-5
34. 2,4-Dinitrotoluene	121-14-2
35. 2,6-Dinitrotoluene	606-20-2
36. 4,6-Dinitro-2-methylphenol	534-52-1
37. Di-n-butylphthalate	84-74-2
38. Di-n-octylphthalate	117-84-0
39. Fluoranthene	206-44-0
40. Fluorene	86-73-7
41. Hexachlorobenzene	118-74-1
42. Hexachlorobutadiene	87-68-3
43. Hexachlorocyclopentadiene	77-47-4
44. Hexachloroethane	67-72-1

TARGET COMPOUND LIST (TCL)
SEMI-VOLATILE OR ACID BASE, AND NEUTRAL (AB&N)
EXTRACTABLE ORGANIC COMPOUNDS
(USEPA - CLP - SOW for Organic Analysis 10/86)

<u>Compound</u>	<u>CAS Number</u>
45. Indeno(1,2,3-cd)pyrene	193-39-5
46. Isophorone	78-59-1
47. 2-Methylnaphthalene	91-57-6
48. 2-Methylphenol	95-48-7
49. 4-Methylphenol	106-44-5
50. Naphthalene	91-20-3
51. 2-Nitroaniline	88-74-4
52. 3-Nitroaniline	99-09-2
53. 4-Nitroaniline	100-01-6
54. Nitrobenzene	98-95-3
55. 2-Nitrophenol	88-75-5
56. 4-Nitrophenol	100-02-7
57. N-nitrosodiphenylamine	86-30-6
58. N-Nitroso-di-n-dipropylamine	621-64-7
59. Pentachlorophenol	87-86-5
60. Phenanthrene	85-01-8
61. Phenol	108-95-2
62. Pyrene	129-00-0
63. 1,2,4-Trichlorobenzene	120-82-1
64. 2,4,5-Trichlorophenol	95-95-4
65. 2,4,6-Trichlorophenol	88-06-2

TARGET COMPOUND LIST (TCL)
PESTICIDES
(USEPA - CLP - SOW for Organic Analysis 10/86)

<u>Compound</u>	<u>CAS Number</u>
1. Aldrin	309-00-2
2. alpha-BHC	319-84-6
3. alpha-Chlordane	5103-71-9
4. AROCLOR-1016	12674-11-2
5. AROCLOR-1221	11104-28-2
6. AROCLOR-1232	11141-16-5
7. AROCLOR-1242	53469-21-9
8. AROCLOR-1248	12672-29-6
9. AROCLOR-1254	11097-69-1
10. AROCLOR-1260	11096-82-5
11. beta-BHC	319-85-7
12. 4,4'-DDD	72-54-8
13. 4,4'-DDE	72-55-9
14. 4,4'-DDT	50-29-3
15. delta-BHC	319-86-8
16. Dieldrin	60-57-1
17. Endosulfan I	959-98-8
18. Endosulfan II	33213-65-9
19. Endosulfan Sulfate	1031-07-8
20. Endrin	72-20-8
21. Endrin Ketone	53494-70-5
22. gamma-BHC (Lindane)	58-89-9

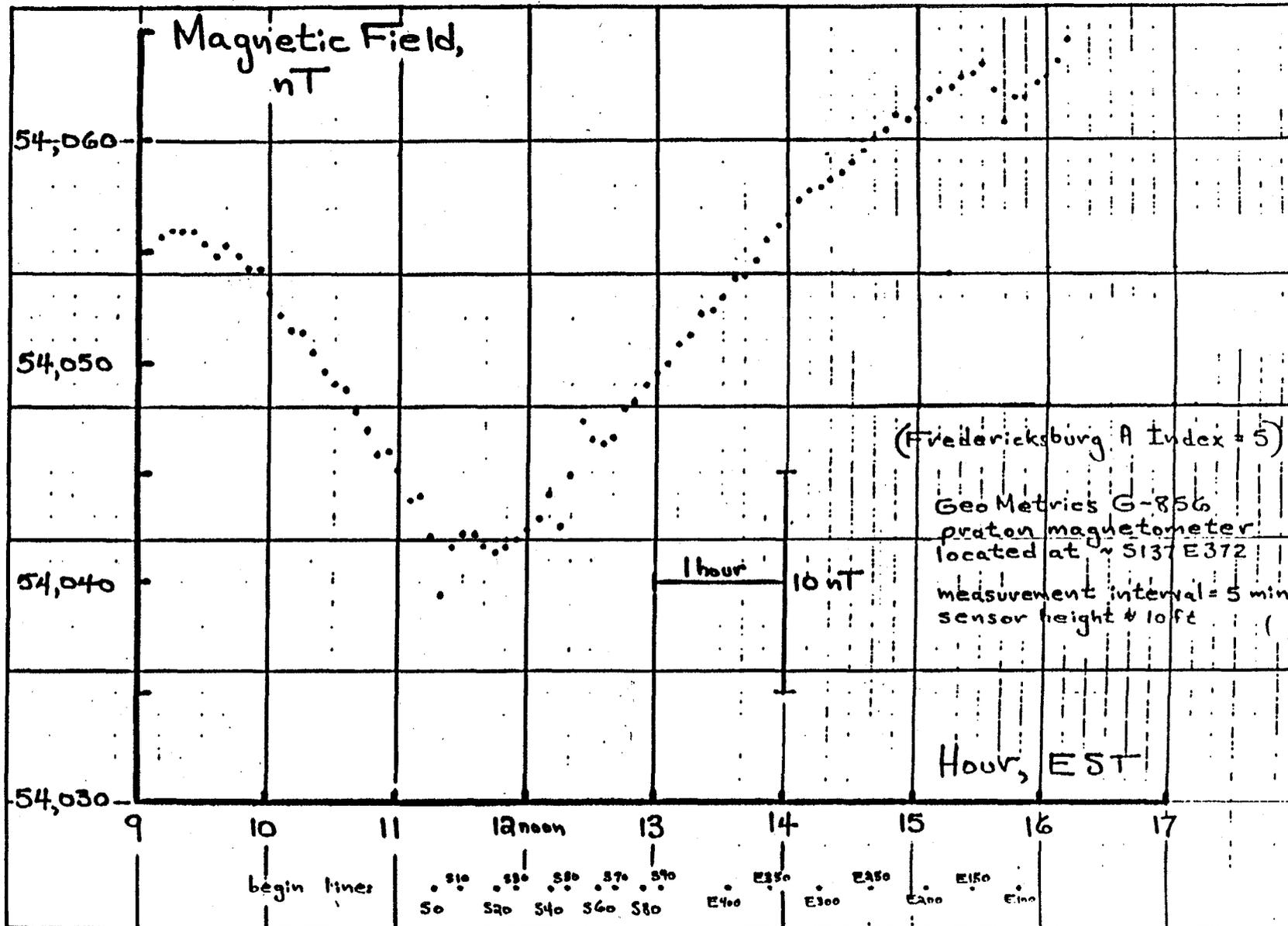
TARGET COMPOUND LIST (TCL)
PESTICIDES
(USEPA - CLP - SOW for Organic Analysis 10/86)

<u>Compound</u>	<u>CAS Number</u>
23. gamma-Chlordane	5103-74-2
24. Heptachlor	76-44-8
25. Heptachlor Epoxide	1024-57-3
26. Methoxychlor	72-43-5
27. Toxaphene	8001-35-2

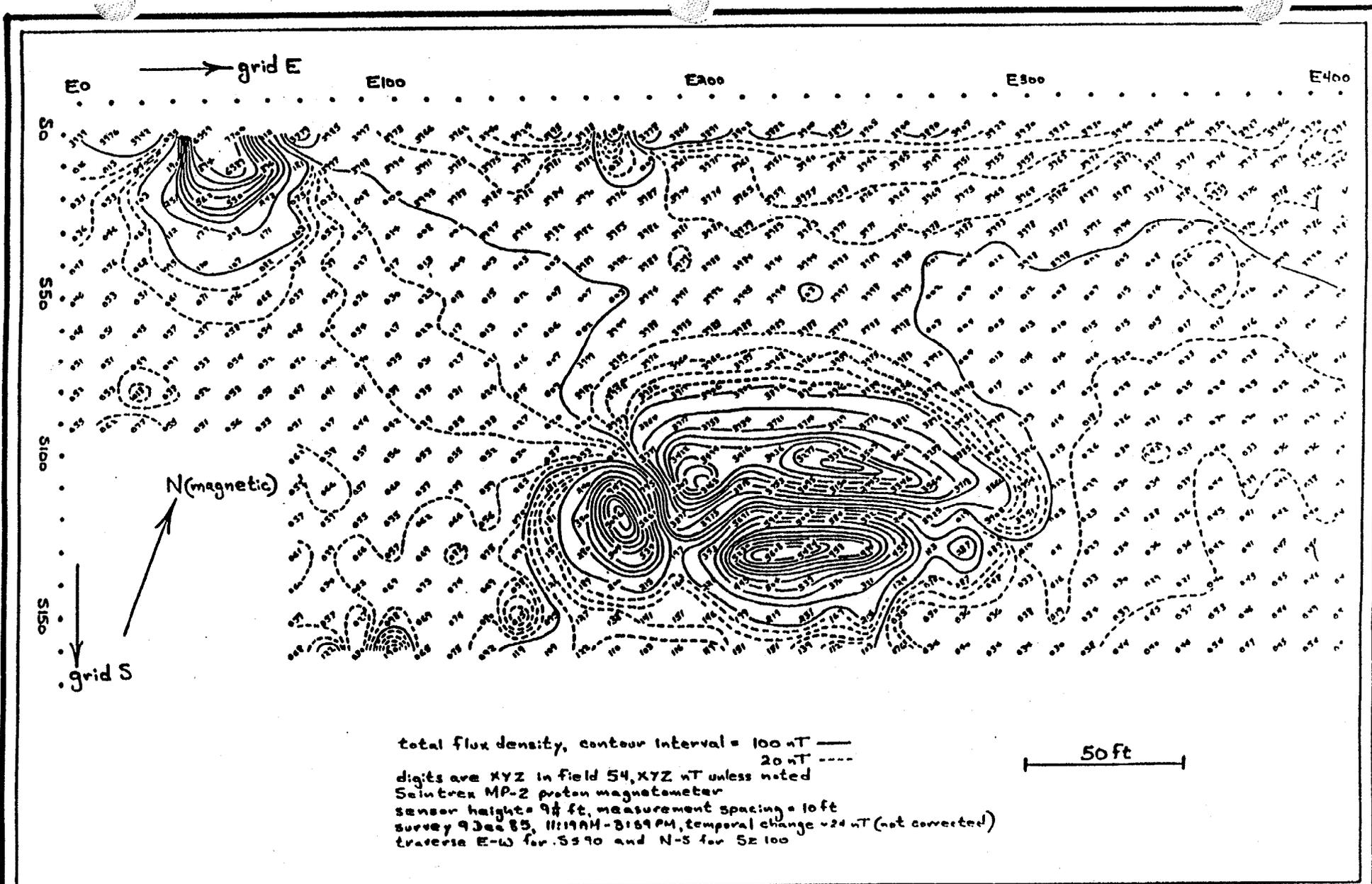
METALS

1. Aluminum
2. Antimony
3. Arsenic
4. Barium
5. Beryllium
6. Cadmium
7. Calcium
8. Chromium
9. Cobalt
10. Copper
11. Iron
12. Lead
13. Magnesium
14. Manganese
15. Mercury
16. Nickel
17. Potassium
18. Selenium
19. Silver
20. Sodium
21. Thallium
22. Vanadium
23. Zinc

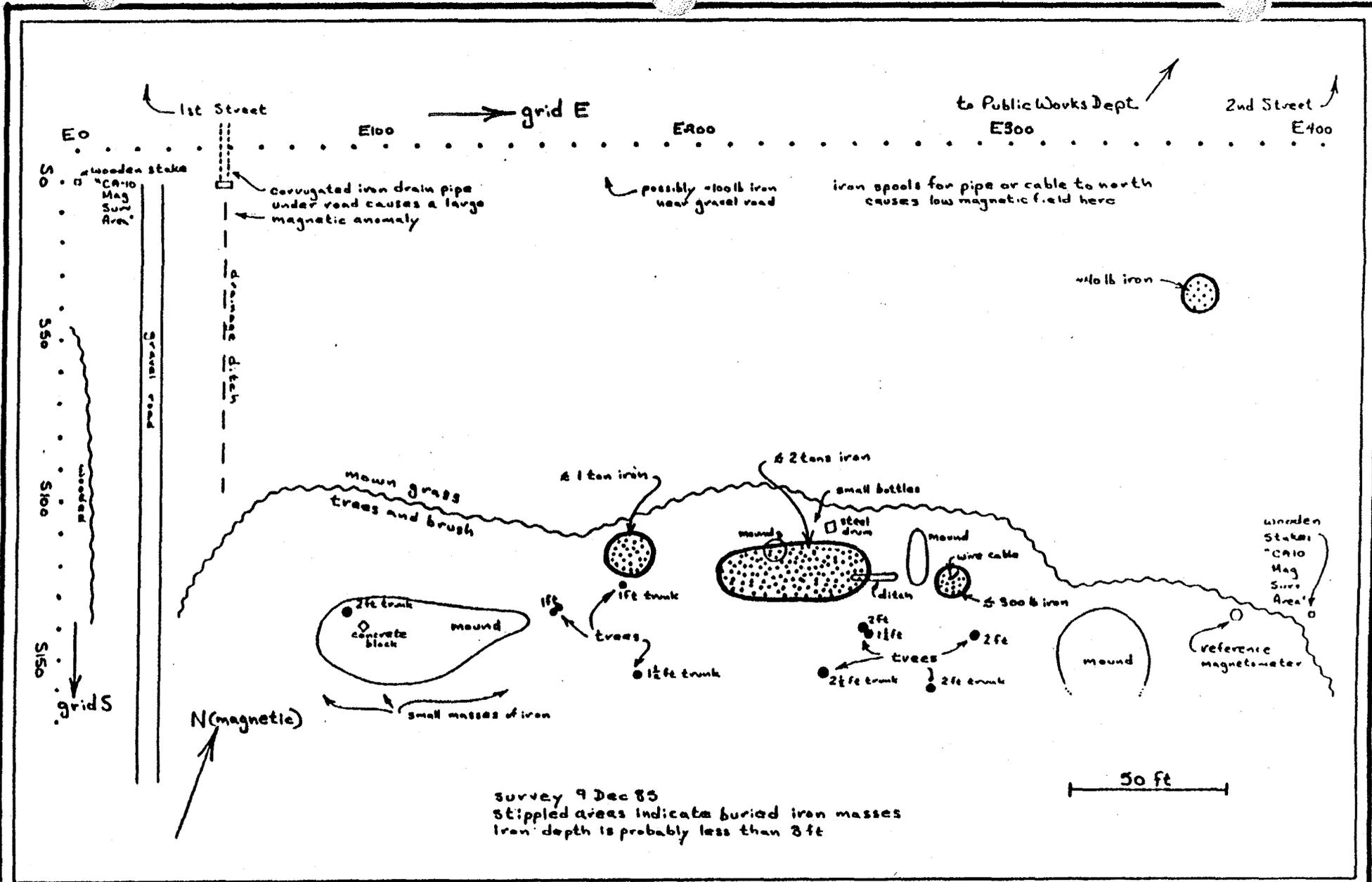
APPENDIX F: SITE 10
Geophysical Survey Results



DATE	1-17-91	SCALE	SHOWN	TITLE TEMPORAL CHANGE IN MAGNETIC FIELD ON DECEMBER 9, 1985 NSC CHEATHAM ANNEX, SITE 10	FIGURE 1
DRAWN BY	LAF	APPROVED BY	<i>[Signature]</i>		
JOB NO.	4901165	DWG. NO./REV. NO.	1 -		



DATE	1-17-91	SCALE	SHOWN	TITLE	
DRAWN BY	LAF	APPROVED BY	<i>[Signature]</i>	MAGNETIC MAP	
JOB NO.	4901165	DWG. NO./REV. NO.	2 -	NSC CHEATHAM ANNEX, SITE 10	
		CLIENT	NSC CHEATHAM	FIGURE	2



DATE	1-17-91	SCALE	SHOWN	TITLE GEOPHYSICAL SUMMARY AND SURFACE CONDITIONS - NSC CHEATHAM ANNEX, SITE 10	FIGURE 3
DRAWN BY	LAF	APPROVED BY	<i>[Signature]</i>		
JOB NO.	4901165	DWG. NO./REV. NO.	3 -		