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FINAL RESOURCE CONSERVATION AND RECOVERY FACILITY INVESTIGATION WORK PLAN ZONE K CNC CHARLESTON SC

9/12/1996

ENSAFE/ ALLEN AND HOSHALL

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA
CTO-029

FINAL
ZONE K RFI WORK PLAN

Prepared for:

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Charleston, South Carlona

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ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AFCEE	Air Force Center for Environmental Excellence
AL	Action Level
AOC	Area of Concern
APX9	Appendix IX
AST	Above-ground Storage Tank
bgs	below ground surface
BRA	Baseline Risk Assessment
CEC	Cation Exchange Capacity
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CHASP	Comprehensive Health and Safety Plan
CMS	Corrective Measures Study
COC	Constituent of Concern
COPC	Constituent of Potential Concern
CRZ	Contamination Reduction Zone
CSI	Confirmatory Sampling Investigation
DOD	Department of Defense
DPT	Direct Push Technology
DQO	Data Quality Objectives
E/A&H	EnSafe/Allen & Hoshall
EBS	Environmental Baseline Survey
EZ	Exclusion Zone
FID	Flame Ionization Detector
HSWA	Hazardous and Solid Waste Amendments
HAZWOPER	Hazardous Waste Operations and Emergency Response
HPLC	High Performance Liquid Chromatography
IDLH	Immediately Dangerous to Life and Health
LBP	Lead-Based Paint
LEL	Lower Explosive Limit
mg/m^3	milligram per cubic meter
MOMAG 11	Mobile Mine Assembly Group 11
MSDS	Material Safety Data Sheet
msl	mean sea level
NAVBASE	Charleston Naval Base
NFI	No Further Investigation
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PEL	Permissible Exposure Limit
PFD	Personal Flotation Device
PHSO	Project Health and Safety Officer

ACRONYMS AND ABBREVIATIONS

PID	Photoionization detector
PPE	Personal Protective Equipment
ppm	part per million
PRG	Preliminary Remedial Goal
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SAR	Supplied-Air Respirator
SCBA	Self-Contained Breathing Apparatus
SCDHEC	South Carolina Department of Health and Environmental Control
SESE	Shipboard Electronics Systems Evaluation
SHSO	Site Health and Safety Officer
STEL	Short-Term Exposure Limit
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SZ	Support Zone
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leachate Procedure
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
USCG	United States Coast Guard
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
UTL	Upper Tolerance Limit
UV	Ultraviolet
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
ZK-HASP	Zone K Health and Safety Plan

1.0 INTRODUCTION

As part of the U.S. Navy Comprehensive Long-Term Environmental Action Navy Program, the following Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan has been prepared by EnSafe/Allen and Hoshall (E/A&H) for Zone K of Naval Base Charleston (NAVBASE) (Figure 1-1). This work plan addresses sampling and analysis requirements specific to sites within Zone K and is intended to be used in conjunction with the *Final Comprehensive RFI Work Plan* (E/A&H, August 30, 1994) prepared for NAVBASE. Each Solid Waste Management Unit (SWMU) and Area of Concern (AOC) located in Zone K are described in Appendix A and are shown on Figures 1-2 and 1-3.

Zone K is comprised of the following non-contiguous NAVBASE properties: 1) the Naval Annex, 2) the Clouter Island property, 3) the Short Stay facility, 4) the Sullivans' Island Shipboard Electronics Systems Evaluation (SESE) facility, and 5) the Downtown Degaussing Station. Of the five non-contiguous NAVBASE properties, only the Naval Annex and the Clouter Island property have sites which require a RFI or confirmatory sampling investigation (CSI) as determined by the *Final RCRA Facility Assessment* (RFA) for Naval Base Charleston (E/A&H, June, 1995). Sites at the Short Stay facility, the SESE facility, and the Downtown Degaussing Station were recommended for No Further Investigation (NFI) (E/A&H, June, 1995) and will not be included in this RFI work plan.

1.1 Environmental Setting

Physiography and Past/Current Use

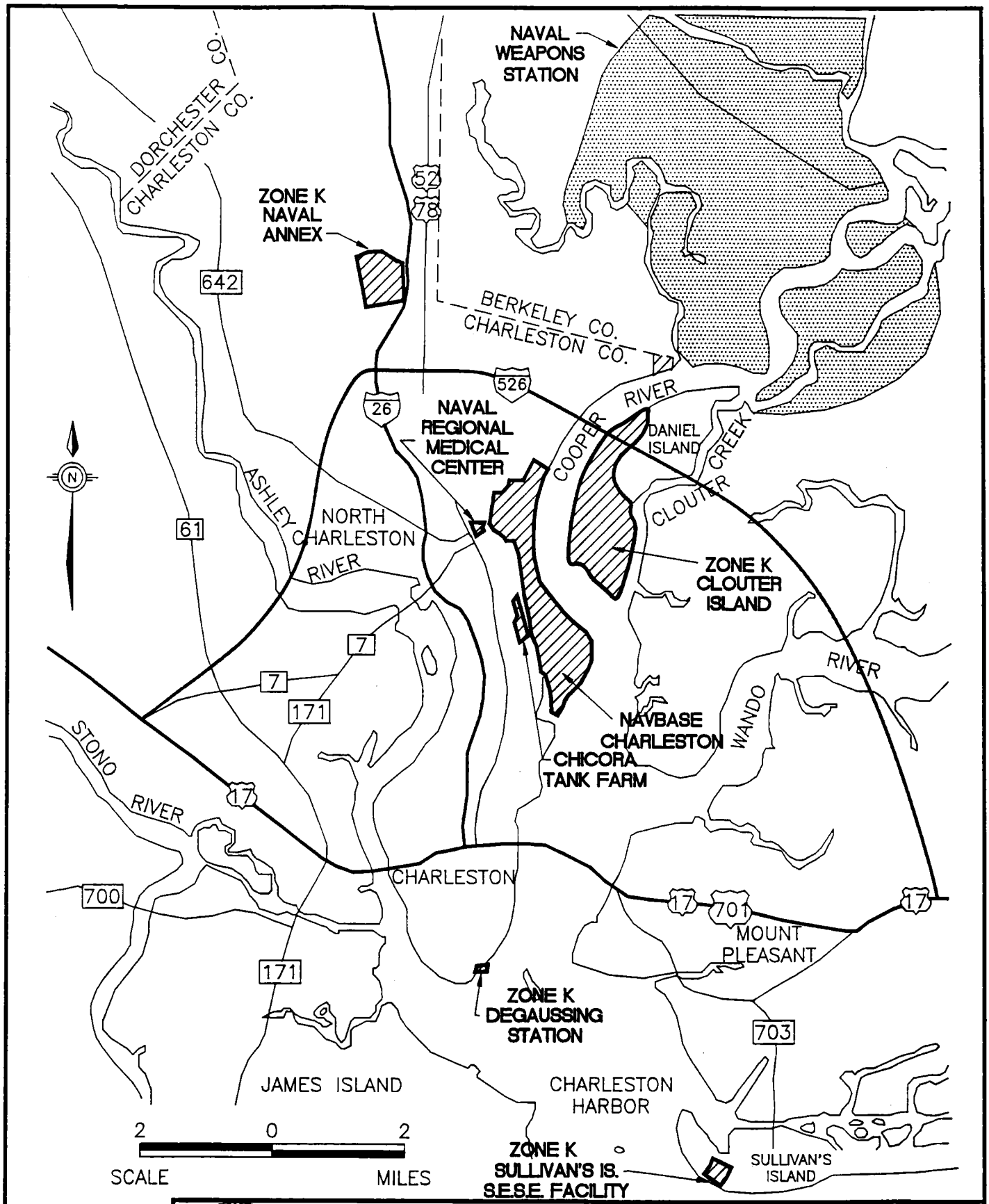
The Naval Annex is north/northwest of NAVBASE and is bounded to the north by Airport Road, to the east by I-26, to the south by Air Park Road, and to the west by the Charleston Air Force Base. Naval Annex is a flat-lying area, approximately 40 feet above mean sea level (msl). The property now occupied by Naval Annex has a diverse history of occupation. Aerial photographs indicate the Naval Annex area consisted of open spaces and forested areas prior to 1941. During World War II, Naval Annex was owned by the Air Force and was the location

of a weather forecasting facility. According to historical documents provided by the Air Force, Naval Annex was turned over to the 792nd Squadron of the Tactical Air Command in 1954. From 1954 until 1981, Naval Annex was an operating radar station. In 1981, the radar station was dismantled, and the entire Naval Annex was acquired by Naval Station Charleston. Mobile Mine Assembly Group 11 (MOMAG 11) assumed operations at that time. Aerial photographs and maps indicate Naval Annex was fully developed by 1960.

Clouter Island is across the Cooper River from NAVBASE and is bounded by Cooper River and Clouter Creek. Clouter Island is undeveloped and is primarily used for dredge spoil disposal. An approximately 1,400-acre portion of Clouter Island on the eastern side of the Cooper River directly across from NAVBASE has been reserved by the U.S. Navy for dredge spoil deposition. The physiography of Clouter Island is flat-lying, with low elevations, similar to NAVBASE. A portion of Clouter Island has been altered by dredge spoil disposal practices. A dike, designed to retain liquified spoils during deposition and allow dewatering of the spoils, encloses most of the southern end of Clouter Island. This dike parallels the Cooper River shoreline a short distance toward the interior of the island. The dike has modified the former natural dendritic drainage pattern observed in aerial photographs taken of the area in 1941. The interior of the island is drained through constructed dewatering spillways. Ground surface within the dredge spoil area has been raised through the deposition of the spoils. A portion of the area comprising AOCs 693 and 694 may be in an area where dredge spoil has been deposited.

Geologic and Hydrogeologic Information

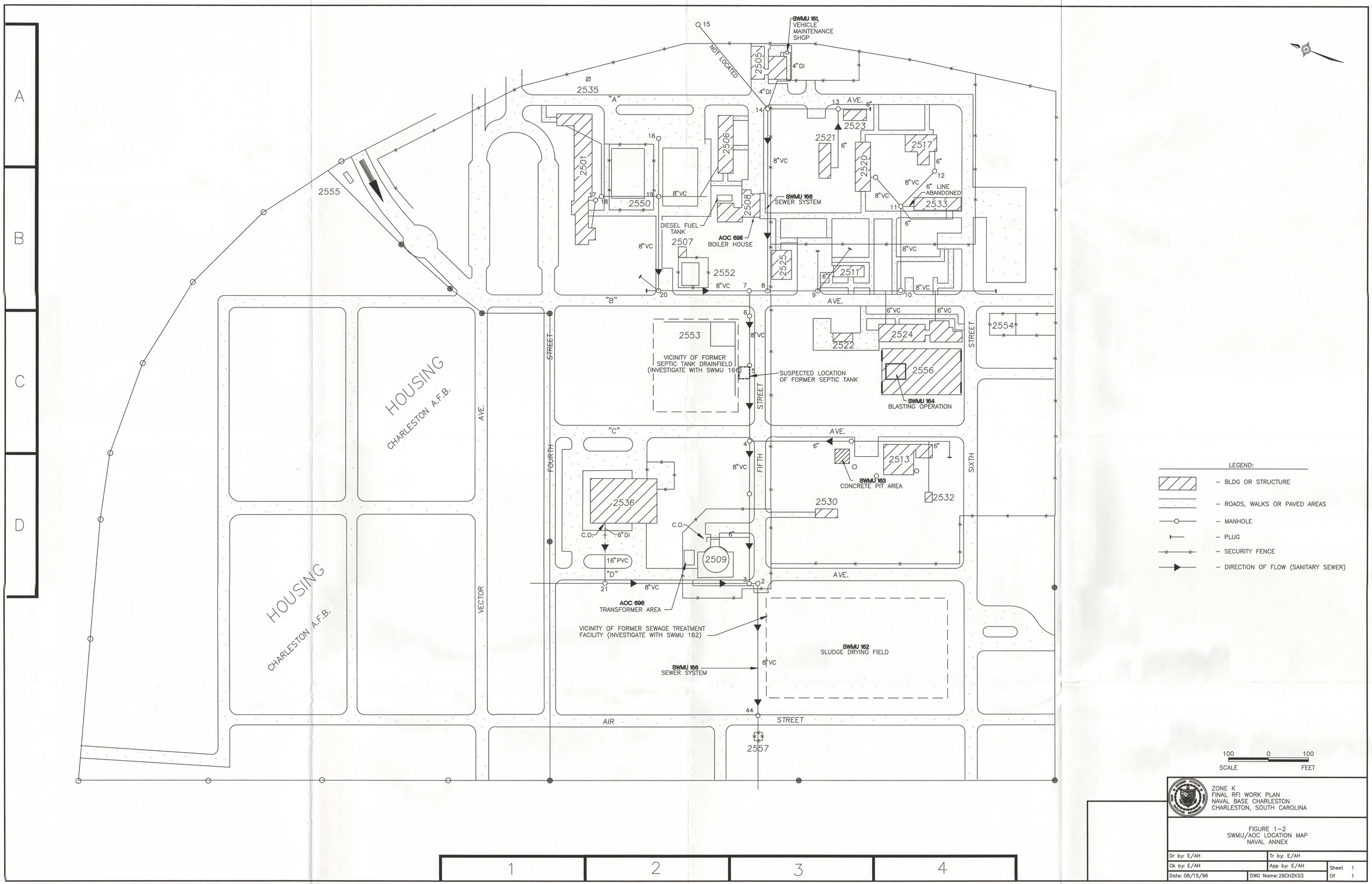
The local and regional geologic/hydrogeologic characteristics of the NAVBASE area are described in Volume II, Sections 1.2 through 1.5 of the *Final Comprehensive RFI Work Plan* (E\A&H, 1994). Based on Navy Maps 2505-4 and 2556-27, the sediments underlying Naval Annex consist of a light gray fine sand to a depth of approximately 25 feet to 30 feet. A soft to very stiff inorganic clay is present at a depth of 25 feet to 30 feet below ground surface (bgs).



ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 1-1
LOCATION OF NAVBASE CHARLESTON
NAVAL ANNEX
AND CLOUTER ISLAND

DWG DATE: 08/15/96 | DWG NAME: 29CHZK02


SWMU 161
VEHICLE MAINTENANCE SHOP
NOT LOCATED
2505
4" DI
2535
"A"
AVE.
2523
2521
2517
2520
2501
2506
2550
8"VC
6" LINE ABANDONED
2533
2555
SWMU 166
SEWER SYSTEM
2508
DIESEL FUEL TANK
AOC 698
BOILER HOUSE
2507
2552
2525
2511
"B"
2553
VICINITY OF FORMER SEPTIC TANK DRAINFIELD (INVESTIGATE WITH SWMU 166)
SUSPECTED LOCATION OF FORMER SEPTIC TANK
2522
2524
2554
2556
SWMU 164
BLASTING OPERATION
HOUSING
CHARLESTON A.F.B.
STREET
AVE.
"C"
FOURTH
FIFTH
SIXTH
2513
SWMU 163
CONCRETE PIT AREA
2532
2530
2536
C.O.
6" DI
16"PVC
"D"
2509
AOC 696
TRANSFORMER AREA
VICINITY OF FORMER SEWAGE TREATMENT FACILITY (INVESTIGATE WITH SWMU 162)
SWMU 162
SLUDGE DRYING FIELD
SWMU 166
SEWER SYSTEM
VECTOR
AIR
2557
LEGEND:
– BLDG OR STRUCTURE
– ROADS, WALKS OR PAVED AREAS
– MANHOLE
– PLUG
– SECURITY FENCE
– DIRECTION OF FLOW (SANITARY SEWER)
100 0 100
SCALE FEET
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA
FIGURE 1-2
SWMU/AOC LOCATION MAP
NAVAL ANNEX
Dr by: E/AH
Tr by: E/AH
Ck by: E/AH
App by: E/AH
Sheet 1
Of 1
Date: 08/15/96
DWG Name: 29CHZK03

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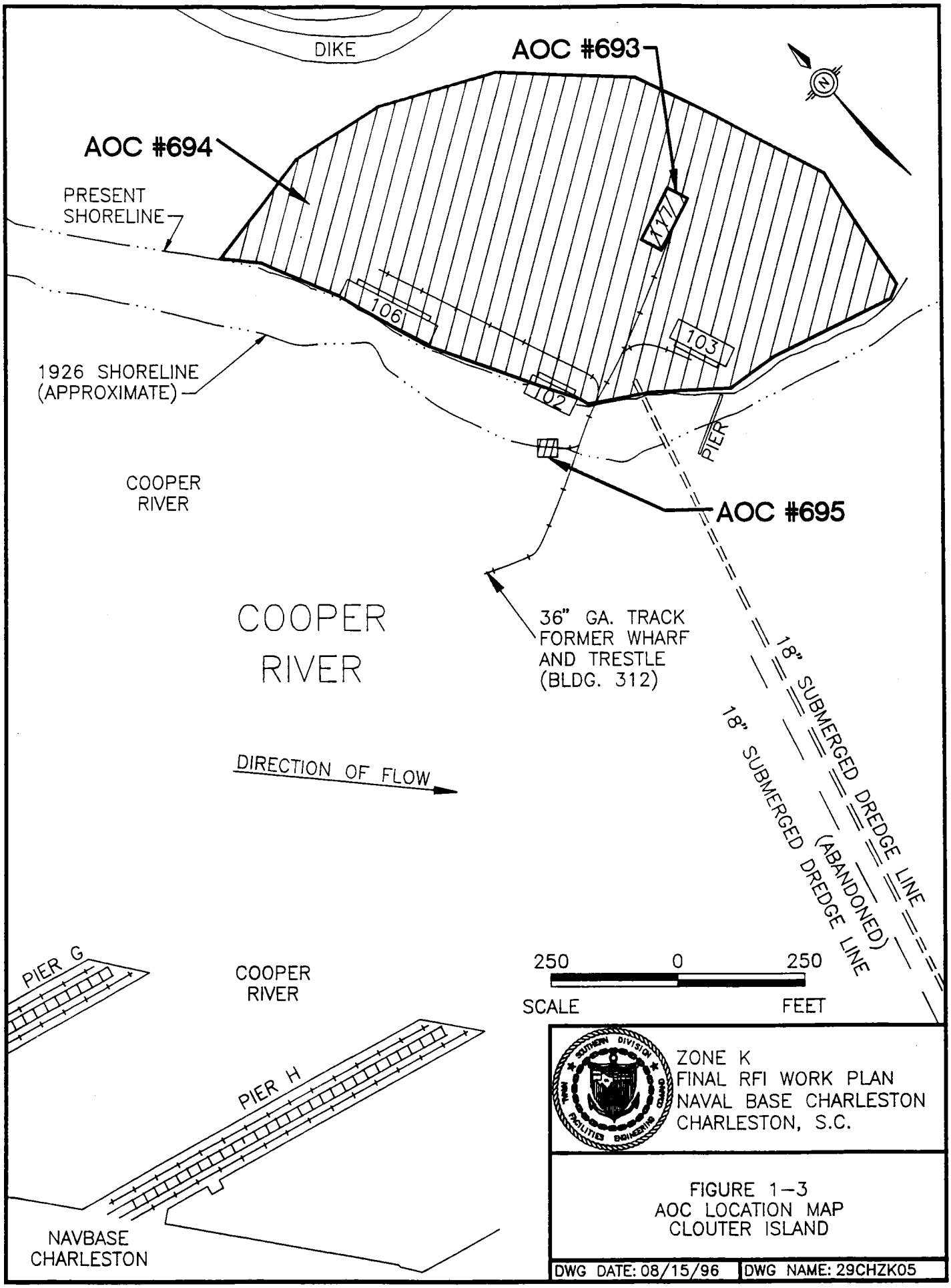

DIKE
AOC #693
AOC #694
PRESENT SHORELINE
1926 SHORELINE (APPROXIMATE)
106
102
103
111
PIER
COOPER RIVER
AOC #695
COOPER RIVER
36" GA. TRACK FORMER WHARF AND TRESTLE (BLDG. 312)
18" SUBMERGED DREDGE LINE
18" SUBMERGED DREDGE LINE (ABANDONED)
DIRECTION OF FLOW
250 0 250
SCALE FEET
PIER G
COOPER RIVER
PIER H
NAVBASE CHARLESTON
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 1-3
AOC LOCATION MAP
CLOUTER ISLAND
DWG DATE: 08/15/96
DWG NAME: 29CHZK05

No lithologic data are available for sediments lower than 30 feet bgs at Naval Station. However, two industrial water-supply well logs for wells in the North Charleston area (obtained from the South Carolina Water Resources Commission) identify the presence of strata likely to act as aquitards (impede downward groundwater flow) at depths of 33 feet and 45 feet bgs. According to the *Final RCRA Facility Investigation Work Plan for Charleston Air Force Base, Charleston, South Carolina* (AFCEE, 1993) the Ladson Formation is the principal coastal terrace deposit in the vicinity of Charleston Air Force Base and is the most widespread Pleistocene marine deposit in the Charleston area. The Ladson Formation consists of layered sequences of fine- to coarse-grained sand and clay that were deposited in a shallow marine environment and a basal phosphatic, conglomerate layer. According to the report, the Cooper Formation (referred to as the Ashley Formation in previous NAVBASE RFI reports) unconformably underlies the Ladson Formation.

The lithology of the sediments underlying Clouter Island is expected to be similar to other, previously investigated, areas of NAVBASE. The lithology of the naturally deposited sediments at NAVBASE is typically a fine to medium sand with varying amounts of silt and clay down to a depth of 20 feet to 80 feet bgs. However, in places on NAVBASE, at varying depths overlying the Ashley Formation, silt and clay predominate, and the sand fraction is minimal. Below these sediments, the lithology changes to a dense, clayey carbonate deposit, referred to as the Ashley Formation or more commonly the "Cooper Marl." Dredge spoils may be encountered overlying naturally deposited sediments over a portion of the area to be investigated on Clouter Island.

Based on Navy Maps 2505-4 and 2556-27, depth to groundwater at Naval Annex is between 3 feet and 9 feet bgs. Naval Annex is on a topographic high, and groundwater flow may occur in all directions away from that high. A preliminary United States Geological Survey (USGS) groundwater flow model, which encompasses the Naval Annex area, provided information relative to groundwater flow direction at Naval Annex. The model predicted groundwater flow

from Naval Annex to the north, south, east, and west. A hydrogeologic cross-section presented in the Charleston Air Force Base RFI Work Plan identifies a clay-rich zone of sediment at approximately 20 feet to 30 feet bgs in the vicinity of the South Carolina Department of Health and Environmental Control (SCDHEC) District Office monitoring well located approximately 750 feet southwest of Naval Annex. Groundwater flow direction on this cross section is toward the west. A potentiometric map included in this same work plan identifies the direction of groundwater flow for the surficial aquifer to be in the west/southwest direction from Naval Annex.

The probable direction of groundwater flow in the water table aquifer on Clouter Island is toward Cooper River or Clouter Creek. The expected depth to groundwater on Clouter Island is one foot to three feet below ground surface. The Ashley Formation, as determined in previous investigations at NAVBASE, is expected to be the uppermost, laterally extensive aquitard/confining unit underlying Clouter Island. The Ashley Formation is reported to be 200 feet to 300 feet thick in the Charleston area. The top of the Ashley Formation is a former erosional surface; therefore, the relief of that surface and the overall thickness of the formation are irregular. Horizontal hydraulic conductivity of the shallow aquifer as determined by previous investigations at NAVBASE is approximately 6 feet to 7 feet per year.

Climatology

The climatological setting of the NAVBASE area is described in Volume II, Section 1.6 of the *Final Comprehensive RFI Work Plan* (E/A&H, 1994).

1.2 Investigative Strategy

The proposed investigative approach, emphasizing a fast-track cleanup program, for each site was developed in accordance with the overall investigative strategy presented in Section 2, Volume I, *Final Comprehensive RFI Work Plan* (E\A&H, 1994).

Central to this idea is a phased approach to data collection that will ultimately identify constituents of potential concern (COPCs) if present, define nature and extent of any contamination, and provide data for a corrective measures study (CMS). To meet these objectives, sampling methods and locations discussed in this work plan are designed to be as complete as possible.

If the proposed sampling efforts do not achieve this goal, sampling will continue until sufficient data are obtained. To determine the need for additional sampling not specified in this work plan, data collected under this plan will be evaluated regarding potential human health impacts expressed as preliminary remedial goals (PRGs), ecological risk, and technical requirements for a CMS. For some chemicals, additional information regarding background concentrations will be required, necessitating onsite and offsite data collection. Background concentrations, migration pathways, human and ecological receptors, and PRGs are discussed in Section 1, Volume III of the *Final Comprehensive RFI Work Plan* (E\A&H, 1994). Sampling will continue until the extent of contamination is determined, which is defined herein as the horizontal and vertical area in which concentrations of COPCs in the investigated media are above either PRGs or background reference concentrations. Methods for establishing background reference concentrations of naturally occurring or ubiquitous chemicals/compounds are addressed in Section 3 of this work plan.

The zone-specific work plans outline the data collection process for each SWMU and AOC. The *Final Comprehensive RFI Work Plan* (E\A&H, 1994) discusses how these data will be used to fulfill the investigation goals. A RFI Report and Baseline Risk Assessment (BRA) will be generated when the Zone K investigation concludes. A final RFI Report and final BRA will address NAVBASE as a single entity once all zone investigations are complete.

The proposed schedule for conducting the investigation for Zone K is included in the *Corrective Action Management Plan* (E/A&H, April, 1995) prepared for the NAVBASE RFI. Activity scheduling during the investigation for Zone K will be closely coordinated with the Navy, U.S. Environmental Protection Agency (USEPA) Region IV, and SCDHEC.

1.3 Preliminary Sub-Zone Identification and Habitat and Biota Survey

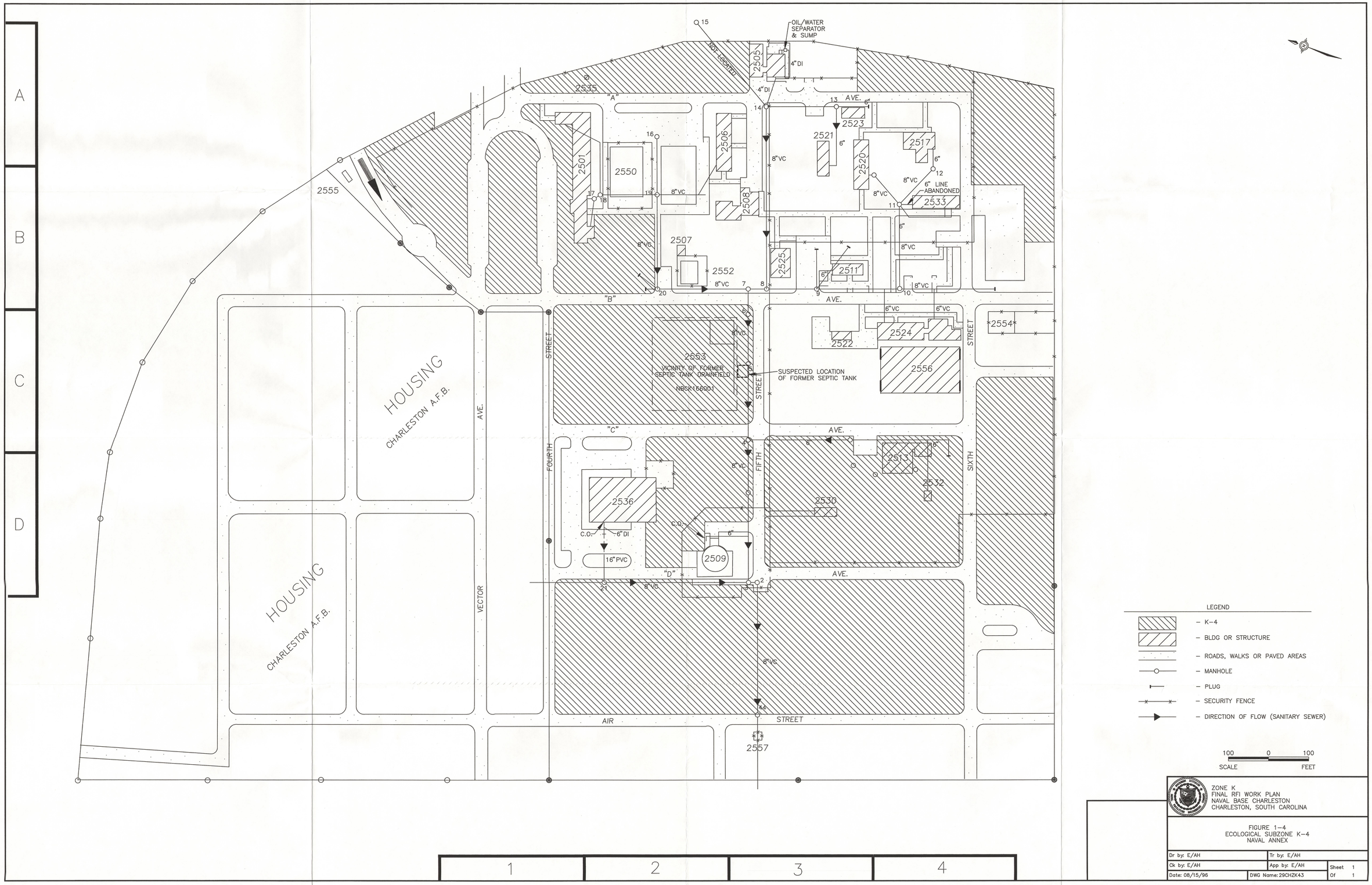
Based on information collected from site visits and review of documents pertaining to basewide habitat surveys, a preliminary habitat evaluation has been performed for the Zone K RFI Work Plan. An ecological risk assessment will be performed in accordance with the procedures outlined in the *Final Comprehensive Baseline Risk Assessment RCRA Facility Investigation* (E\A&H, 1994).

Naval Annex

Naval Annex consists of an industrially developed area surrounded by grass fields. These fields may provide suitable habitat for meadow voles (*Microtus pennsylvanicus*) and raptors such as red-tailed hawks (*Buteo jamaicensis*). Also, a large grass field is located in the area of SWMU 162 where an employee of Naval Annex reported that whitetail deer (*Odocoileus virginianus*) have been observed feeding. These areas have collectively been designated as K-4 (Figure 1-4).

Clouter Island

Clouter Island consists of extensive marsh and early succession habitats as well as a *Spartina* (marsh grass) community on the shores of the Cooper River and Clouter Creek. Two AOCs, AOC 693, Fuse and Primer House, and AOC 694, Former Naval Ammunition Depot, are on Clouter Island. AOC 695 is in the Cooper River. The potential for exposure to ecological receptors will be addressed for these areas. Based on habitat assessments conducted during Zone J Work Plan preparation, three habitats exist in this area (Figure 1-5): 1) the salt-marsh


OIL/WATER SEPARATOR & SUMP
NOT LOCATED
2505
4" DI
2535
"A"
AVE.
2523
2521
2517
2520
2506
2501
2550
2555
8"VC
6" LINE ABANDONED
2533
2508
2507
2552
2525
2511
"B"
2524
2522
2554
2556
2553
VICINITY OF FORMER SEPTIC TANK DRAINFIELD
NBCK156001
SUSPECTED LOCATION OF FORMER SEPTIC TANK
STREET
HOUSING
CHARLESTON A.F.B.
"C"
FOURTH
FIFTH
SIXTH
2513
2532
2530
2536
C.O.
6" DI
16" PVC
2509
"D"
VECTOR
AIR
2557
LEGEND
– K–4
– BLDG OR STRUCTURE
– ROADS, WALKS OR PAVED AREAS
– MANHOLE
– PLUG
– SECURITY FENCE
– DIRECTION OF FLOW (SANITARY SEWER)
100 0 100
SCALE FEET
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA
FIGURE 1–4
ECOLOGICAL SUBZONE K–4
NAVAL ANNEX
Dr by: E/AH
Tr by: E/AH
Ck by: E/AH
App by: E/AH
Sheet 1
Of 1
Date: 08/15/96
DWG Name: 29CHZK43

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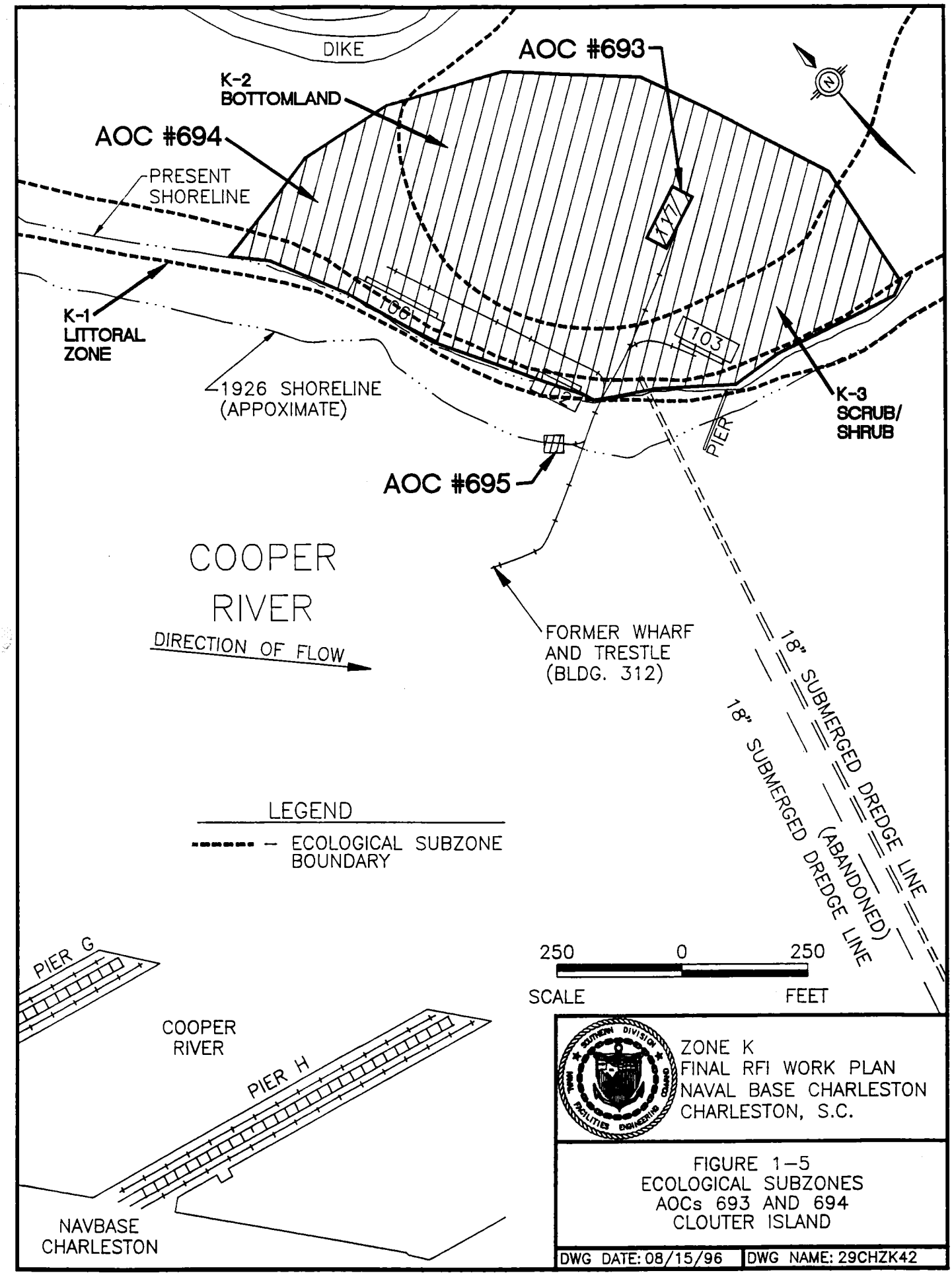

DIKE
AOC #693
K-2
BOTTOMLAND
AOC #694
PRESENT
SHORELINE
K-1
LITTORAL
ZONE
1926 SHORELINE
(APPOXIMATE)
K-3
SCRUB/
SHRUB
PIER
AOC #695
COOPER
RIVER
DIRECTION OF FLOW
FORMER WHARF
AND TRESTLE
(BLDG. 312)
18" SUBMERGED DREDGE LINE
18" SUBMERGED DREDGE LINE
(ABANDONED)
LEGEND
ECOLOGICAL SUBZONE
BOUNDARY
250
0
250
SCALE
FEET
PIER G
COOPER
RIVER
PIER H
NAVBASE
CHARLESTON
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 1-5
ECOLOGICAL SUBZONES
AOCs 693 AND 694
CLOUTER ISLAND
DWG DATE: 08/15/96
DWG NAME: 29CHZK42

bordering the Cooper River (K-1), 2) a bottomland hardwood community (K-2), and 3) a scrub/shrub community along the perimeter of the dike north of AOCs 693 and 694 (K-3). K-1 consists of the littoral (intertidal) zone along the Cooper River and is dominated by *Spartina alterniflora*. A wide variety of fauna is typical for this type of habitat and may include marsh wrens (*Cistoborus palustris*), shore and wading birds, and numerous invertebrates.

K-2 consists of a nearly monotypic bottomland hardwood community dominated by southern hackberry (*Celtis laeuigata*), which provides suitable habitat for passerine birds and small mammals such as short tail shrews (*Blarina brevicauda*).

K-3 consists of a dense, mid-succession scrub/shrub community. Vegetative species occurring here include southern bayberry (*Myrica cerifera*), tallow tree (*Sapium sebiferum*), and red mulberry (*Morus rubus*). Fauna typical for Coastal Plain mid-succession habitats include passerines birds such as sparrows and warblers, while mammals may include meadow voles (*Microtus pennsylvanicus*).

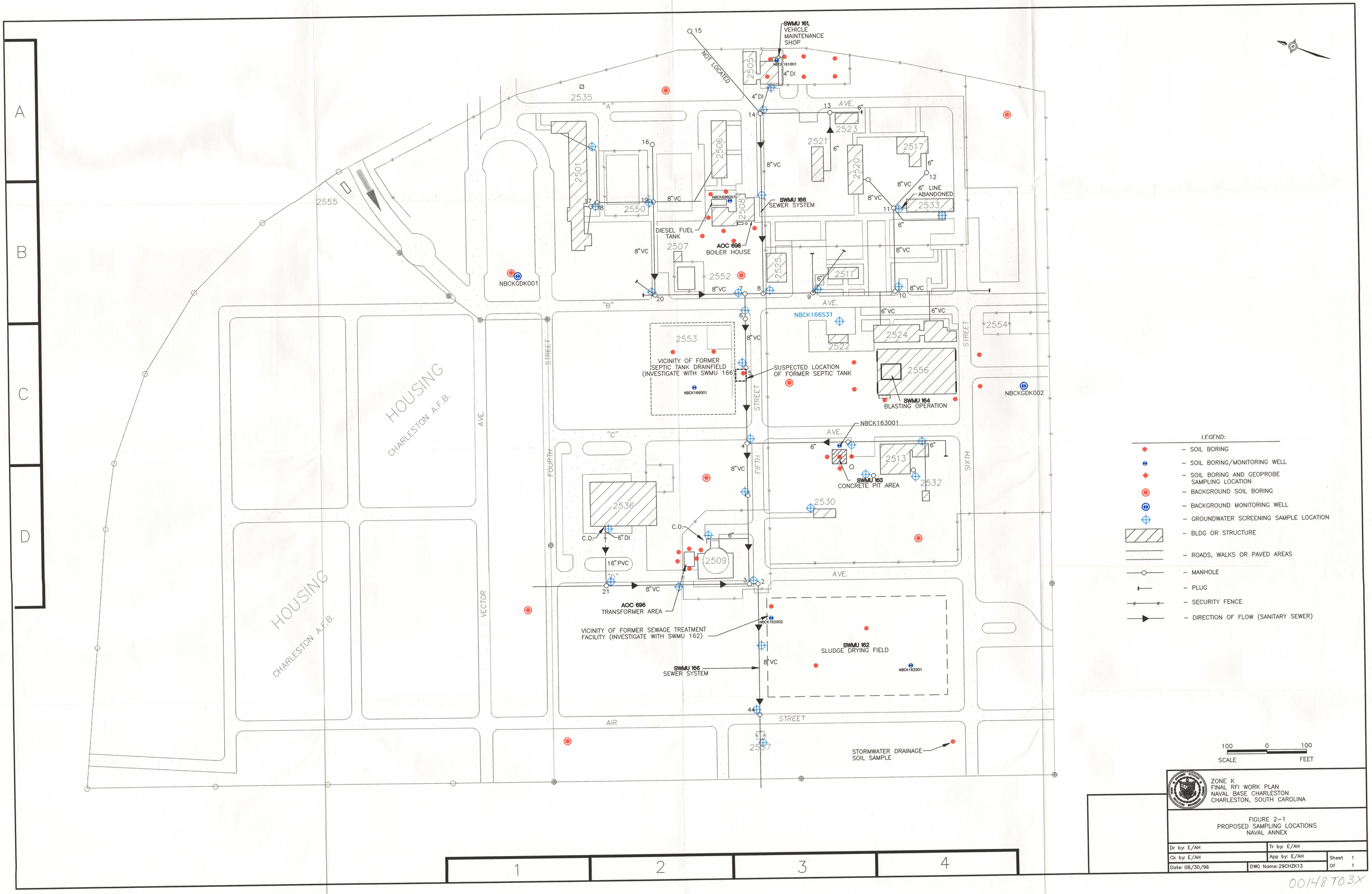
1.4 Other Relevant Investigations

Because the Zone K investigation is part of a larger investigative strategy, some pathways included for investigation in Volume III of the *Final Comprehensive RFI Work Plan (E\A&H, 1994)* that may be relevant to Zone K will be considered in other zone investigations. For instance, sediment and surface water sampling of Cooper River to measure potential impact from NAVBASE activities at Clouter Island will be addressed in the Zone J investigation. However, any apparent contaminant migration pathways (dewatering spillways, ditches...) from Clouter Island to the Cooper River will be sampled during the Zone K investigation.

2.0 SWMU AND AOC-SPECIFIC INVESTIGATORY APPROACH

The SWMUs and AOCs in Zone K requiring either CSI or RFI activities, as determined in the *RFA*, are presented in the following sections and shown on Figures 2-1 and 2-2. Tables A and B (Appendix A) provide a reference of the location of each site within Zone K, their proximity to existing structures, and the respective site investigative approach as proposed by the RFA.

Groundwater flow direction for Naval Annex will be determined with data collected from all wells installed as part of the Naval Annex RFI.


SWMU 161
VEHICLE MAINTENANCE SHOP
NBCK161001
NOT LOCATED
4" DI
2505
2535
"A"
AVE.
2523
2521
2517
2520
2506
2501
2550
2555
8"VC
6" LINE ABANDONED
2533
SWMU 166
SEWER SYSTEM
NBCK696001
2503
DIESEL FUEL TANK
AOC 698
BOILER HOUSE
2507
2552
2525
2511
NBCKGDK001
"B"
NBCK166S31
2524
2522
2554
STREET
2553
VICINITY OF FORMER SEPTIC TANK DRAINFIELD (INVESTIGATE WITH SWMU 166)
NBCK166001
SUSPECTED LOCATION OF FORMER SEPTIC TANK
2556
SWMU 164
BLASTING OPERATION
NBCKGDK002
HOUSING
CHARLESTON A.F.B.
"C"
NBCK163001
2513
SWMU 163
CONCRETE PIT AREA
2532
2530
FOURTH
FIFTH
SIXTH
2536
C.O.
6" DI
16" PVC
2509
"D"
AOC 696
TRANSFORMER AREA
VICINITY OF FORMER SEWAGE TREATMENT FACILITY (INVESTIGATE WITH SWMU 162)
NBCK162002
SWMU 162
SLUDGE DRYING FIELD
NBCK162001
SWMU 166
SEWER SYSTEM
VECTOR
AIR
2537
STORMWATER DRAINAGE SOIL SAMPLE
LEGEND:
– SOIL BORING
– SOIL BORING/MONITORING WELL
– SOIL BORING AND GEOPROBE SAMPLING LOCATION
– BACKGROUND SOIL BORING
– BACKGROUND MONITORING WELL
– GROUNDWATER SCREENING SAMPLE LOCATION
– BLDG OR STRUCTURE
– ROADS, WALKS OR PAVED AREAS
– MANHOLE
– PLUG
– SECURITY FENCE
– DIRECTION OF FLOW (SANITARY SEWER)
100 0 100
SCALE FEET
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA
FIGURE 2-1
PROPOSED SAMPLING LOCATIONS
NAVAL ANNEX
Dr by: E/AH
Tr by: E/AH
Ck by: E/AH
App by: E/AH
Sheet 1
Of 1
Date: 08/30/96
DWG Name: 29CHZK13

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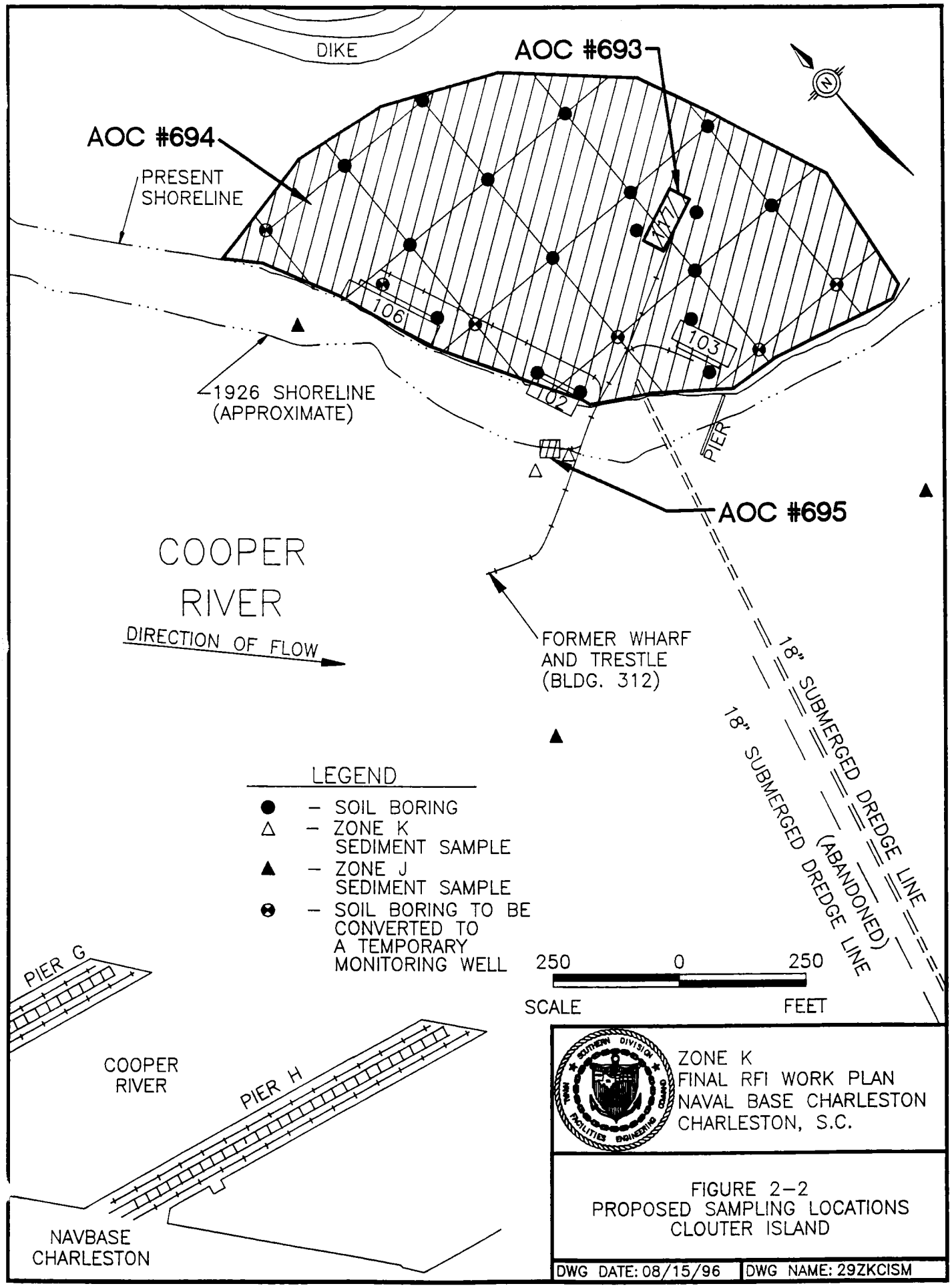

DIKE
AOC #693
AOC #694
PRESENT SHORELINE
1926 SHORELINE (APPROXIMATE)
106
102
103
101
PIER
AOC #695
COOPER RIVER
DIRECTION OF FLOW
FORMER WHARF AND TRESTLE (BLDG. 312)
18" SUBMERGED DREDGE LINE
18" SUBMERGED DREDGE LINE (ABANDONED)
LEGEND
● – SOIL BORING
△ – ZONE K SEDIMENT SAMPLE
▲ – ZONE J SEDIMENT SAMPLE
⊗ – SOIL BORING TO BE CONVERTED TO A TEMPORARY MONITORING WELL
250 0 250
SCALE FEET
PIER G
COOPER RIVER
PIER H
NAVBASE CHARLESTON
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 2-2
PROPOSED SAMPLING LOCATIONS
CLOUTER ISLAND
DWG DATE: 08/15/96
DWG NAME: 29ZKCISM

2.1 SWMU 161, Vehicle Maintenance Shop, Naval Annex

SWMU 161 consists of a gravel parking lot, and a vehicle maintenance and wash bay and Building 2505 (Figure 2-3). The gravel parking area is adjacent to the south side of Building 2505; and heavy equipment such as trucks and backhoes are parked in this area. Isolated stains, as would be expected in a heavy equipment parking area, are present across the parking area. The vehicle maintenance and wash bay of Building 2505 was constructed over a portion of the parking area in 1993. This area has a drainage system and collection sump; the contents of which are pumped into an approximately 250-gallon oil/water separator. A parts washer is located in the wash bay area. The SWMU 161 RFA reported that water from the oil/water separator is discharged into the Naval Annex storm sewer. However, upon further examination and records review, it has been determined that water from the separator is discharged into the sanitary sewer system. The oil/water separator would have overflowed into the storm water drainage system only during heavy precipitation before the wash bay roof was constructed. However, evidence of past releases to the storm water drainage system, the presence of the oil/water separator and the associated sump and tank, the use of solvents to clean automotive parts, along with the presence of stained gravel/soil in the parking area adequately justify maintaining the site's CSI status. Table 2-1 provides a description of SWMU 161.

2.1.1 Previous Investigations

There have been no previous investigations of SWMU 161.

2.1.2 Treatment Alternatives

Because there are no site-specific environmental media data, treatment alternatives for this site cannot be evaluated. As outlined in the overall sampling strategy presented in the *Final Comprehensive RFI Work Plan*, treatment alternatives are being identified for sites likely to require remedial action. Data collection efforts will support evaluating these alternatives.

Table 2-1
SWMU 161
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 161, Vehicle Maintenance Shop, Naval Annex	SWMU 161 consists of a gravel parking area and a vehicle maintenance and washing bay associated with Building 2505. The gravel parking area is adjacent to the south side of Building 2505, and heavy equipment such as trucks and backhoes are parked in this area. Isolated stains are present across the parking area. A parts washer is located in the maintenance bay area. The vehicle maintenance and wash bay of Building 2505 was constructed over a portion of the parking area in 1993. The wash bay has a drainage system and collection sump; the contents of which are pumped into an approximately 250-gallon oil/water separator connected to the sanitary sewer system.	Petroleum Products, Metals Solvents	**Soil** Soil Gas **Groundwater**

Notes:
[a] Described in the *RCRA Facility Assessment, June 6, 1995*.
[b] Pathways scheduled for sampling are in bold.

Tables B-1 and B-2 (Appendix B) are a list of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify feasible treatment alternatives.

2.1.3 Data Gaps

Currently, no environmental media data have been collected at SWMU 161 to characterize the site, conduct a BRA, or to support detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are no data to establish whether COPCs are present for any of the potential migration pathways.

- There are no data to allow a BRA to be conducted.

- No data exist to support a detailed evaluation of treatment alternatives, if necessary.

2.1.4 Potential Receptors

Potential receptors of exposure to contaminants include current land users and any future users this area may support. Data will be generated during the CSI to determine the level of risk to the entire spectrum of current and potential users, including any highly sensitive individuals, who might be exposed through invasive or noninvasive activities at SWMU 161. Sampling will characterize the pathways highlighted in bold in Table 2-1.

2.1.5 Objectives

The goal of the CSI is to classify the site as NFI or RFI by using Data Quality Objective (DQO) Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at SWMU 161 are: 1) to assess the impacts to the vehicle parking area and the area of the wash bay and oil/water separator from former and current activities; 2) to provide data to be used in the BRA; and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.1.6 Screening Alternatives

No sampling has been conducted to determine COPCs; therefore, selecting a quantitative screening alternative would be premature. If the proposed collection of high-quality samples is inadequate to define the areal extent of contamination (if present), the feasibility of employing screening methods will be reevaluated. All soil boring samples will be qualitatively screened for volatile organic compounds (VOCs) with a flame ionization detector (FID). All VOC screening results will be recorded in field notebooks and boring logs.

2.1.7 Sampling and Analysis Plan

To fulfill the CSI objectives, site-specific sampling and analysis requirements have been proposed. Eight soil borings are proposed for SWMU 161 (Figure 2-3). Three borings will be in the general parking area. One soil boring will be at the entrance to the most prominent storm water sewer grate in the parking area. One soil boring will be in the vehicle bay area. Three sample locations will be in the vicinity of the wash area and the oil/water separator. Each soil sample will be analyzed for the full suite of analytical parameters (volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), cyanide, total petroleum hydrocarbons (TPHs), and metals). The boring location closest to the wash bay sump will also be the location of a permanent groundwater monitoring well. The well will be constructed to allow sampling of groundwater from the upper portion of the water table aquifer. A groundwater sample will be collected from this well and analyzed for the full suite of analytical parameters. The monitoring well will also provide data to be used in the construction of a Naval Annex potentiometric map.

Samples will be collected at two depth intervals for each of the eight soil borings, surface (0 feet to 1 foot) and subsurface (3 feet to 5 feet). Each proposed boring location is illustrated on Figure 2-3. Table 2-2 is a summary of the types of samples to be collected at SWMU 161 and the analytical parameters. All sampling will be conducted in accordance with the NAVBASE *Final Comprehensive RFI Work Plan* (E\A&H, 1994).

2.1.8 Quality Assurance/Quality Control Samples

Additional soil will be collected at one subsurface sample location adjacent to the oil/water separator at SWMU 161. This sample will be submitted for Appendix IX (APX9) analyses at DQO Level IV in addition to the site-specific suite of analyses reported at DQO Level III. APX9 analyses include the standard full suite of analytical parameters (VOCs, SVOCs, pesticides/PCBs, metals, TPH, and cyanide) plus dioxin, hexavalent chromium, organophosphorus pesticides, and herbicides.

Table 2-2
SWMU 161
Sampling Plan

Matrix	Quantity	Analyses
Soil (0-1' bgs)	8	Soil - Full Suite
Soil (3-5' bgs)	8	
Groundwater (Shallow Well)	1	Groundwater - Full Suite

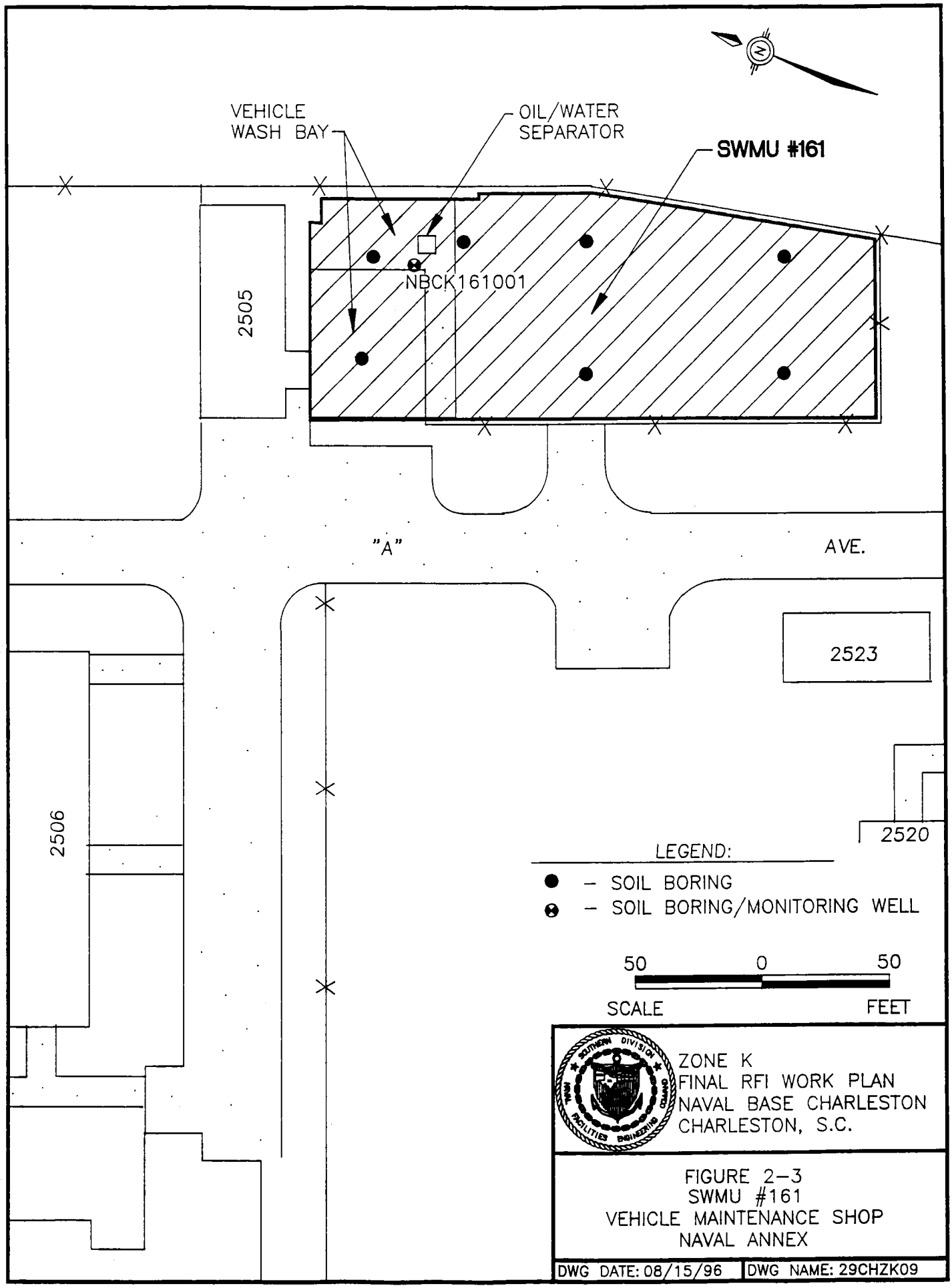
Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Notes:
Groundwater monitoring wells will be sampled quarterly for one year.

The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Depth to water may prevent the collection of the lower interval soil samples. Actual locations may need to be adjusted to accommodate utilities. Justification for any significant (> 10 feet) sample location adjustment will be provided in the Zone K RFI.

All analyses will be performed per SW-846 except where other methods are specified. Data Quality Objective (DQO) Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10% duplicates analyzed for all Appendix IX (APX9) constituents at DQO Level IV. The sample quantities presented do not include quality assurance/quality control (QA/QC) samples.

Quality control (QC) samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).


VEHICLE
WASH BAY
OIL/WATER
SEPARATOR
SWMU #161
NBCK161001
2505
"A"
AVE.
2523
2506
2520
LEGEND:
– SOIL BORING
– SOIL BORING/MONITORING WELL
50
0
50
SCALE
FEET
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 2–3
SWMU #161
VEHICLE MAINTENANCE SHOP
NAVAL ANNEX
DWG DATE: 08/15/96
DWG NAME: 29CHZK09

2.2 SWMU 162, Sludge Drying Field, Naval Annex

SWMU 162 consists of a former sludge drying field at Naval Annex. This site was used for dewatering wastewater treatment sludge from an Air Force-operated sewage treatment plant. No information was available regarding the contents of the waste stream originating from Air Force activities. A soccer field has been constructed in the sludge drying field area. SWMU 162 is between Fifth and Sixth Streets and "D" Avenue and Air Street. Table 2-3 provides a description of SWMU 162. Based on interviews with Naval and Air Force personnel, it is possible that a liner was installed in the unit prior to use. However, no documentation or other evidence confirming this has been located. Drawings reviewed at the NAVBASE Public Works Department identified a sewage treatment facility located adjacent to the sludge drying field at Fifth Street and Avenue D. Figure 2-4 identifies the location of the sludge drying field and the former sewage treatment facility. The location of the former sewage treatment facility and sludge beds was determined from NAVBASE Maps #25713-21, March 6, 1968, and #25713-21 (Appendix C).

Table 2-3
SWMU 162
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 162, Sludge Drying Field and Former Sewage Treatment Facility, Naval Annex	SWMU 162 consists of a former sludge drying field located at Naval Annex. This site was used for the dewatering of wastewater treatment sludge from an Air Force-operated sewage treatment plant. SWMU 162 is between Fifth and Sixth Streets and "D" Avenue and Air Street. SWMU 162 also includes the former sewage treatment facility.	Paint residue, heavy metals, decomposition gases	**Soil** Soil Gas **Groundwater**

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

2.2.1 Previous Investigations

This site has not been previously investigated.

2.2.2 Treatment Alternatives

Because there are no environmental media data, treatment alternatives for this site cannot be evaluated. Tables B-1 and B-2 (Appendix B) are a list of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify feasible treatment alternatives.

2.2.3 Data Gaps

Currently no environmental media data have been collected at SWMU 162 to characterize the site, to conduct a BRA, or to support a detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are no data to establish whether COPCs are present for any of the potential migration pathways.
- There are insufficient data to conduct a BRA.
- No data exist to support a detailed evaluation of treatment alternatives, if necessary.

2.2.4 Potential Receptors

Potential receptors that may be exposed to site contaminants include current land users and any future users this area may support following closure. Data will be generated during the investigation to determine the level of risk to the spectrum of current and potential future receptors, including any highly sensitive individuals within the population, who may be exposed through invasive or noninvasive activities. Sampling will characterize the potential pathways highlighted in Table 2-3.

The area of SWMU 162 has been used as a soccer field. Therefore, if those activities continue, potential receptors would include participants and spectators of soccer games.

2.2.5 Objective

The goal of the CSI is to classify the site as NFI or RFI by using DQO Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at SWMU 162 will be: 1) to assess impact to soil and groundwater from former sludge disposal and sewage treatment activities, 2) to provide data to be used in the BRA, and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.2.6 Screening Alternatives

No sampling has been conducted to determine COPCs; therefore, selecting a quantitative screening alternative would be premature. If the proposed collection of high-quality samples is inadequate to define the areal extent of contamination (if present), the feasibility of employing screening methods will be reevaluated. All soil boring samples will be qualitatively screened for volatile organic compounds (VOCs) with a flame ionization detector (FID). All VOC screening results will be recorded in field notebooks and boring logs.

2.2.7 Sampling and Analysis Plan

To fulfill the CSI objectives, the following site-specific sampling and analysis requirements have been proposed for SWMU 162. Table 2-4 is a summary of the types of samples to be collected and the analytical parameters. Three soil borings are proposed to detect the presence of COPCs within the perimeter of the sludge disposal area. At the location of one of these soil borings, a shallow monitoring well will be constructed to assess impact to groundwater from the sludge disposal activities. Two soil borings are proposed to detect the presence of COPCs in the vicinity of the former treatment facility. An additional monitoring well will be installed at the location of one of these two soil boring locations. The two wells installed as part of the SWMU 162 investigation will also be used to provide water level data to be used in construction of a Naval Annex potentiometric map.

Samples will be collected at two depth intervals for each of the soil borings, surface (0 foot to 1 foot) and subsurface (3 feet to 5 feet). The proposed sampling locations are illustrated on Figure 2-4. All sampling will be conducted in accordance with the NAVBASE *Final Comprehensive RFI Work Plan* (E/A&H, 1994). The monitoring wells will be constructed to allow sampling of groundwater from the upper portion of the water table aquifer.

Table 2-4
SWMU 162
Sampling Plan

Matrix	Quantity	Analyses
Soil (0-1' bgs)	5	Soil - Full Suite including Nitrates and Sulfides
Soil (3-5' bgs)	5	
Groundwater (Shallow Wells)	2	Groundwater - Full Suite

Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Notes:
Groundwater monitoring wells will be sampled quarterly for one year.

The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Depth to water may prevent the collection of the lower interval samples. Actual locations may need to be adjusted to accommodate utilities. Justification for any significant (>10 feet) sample location adjustment will be provided in the Zone K RFI.

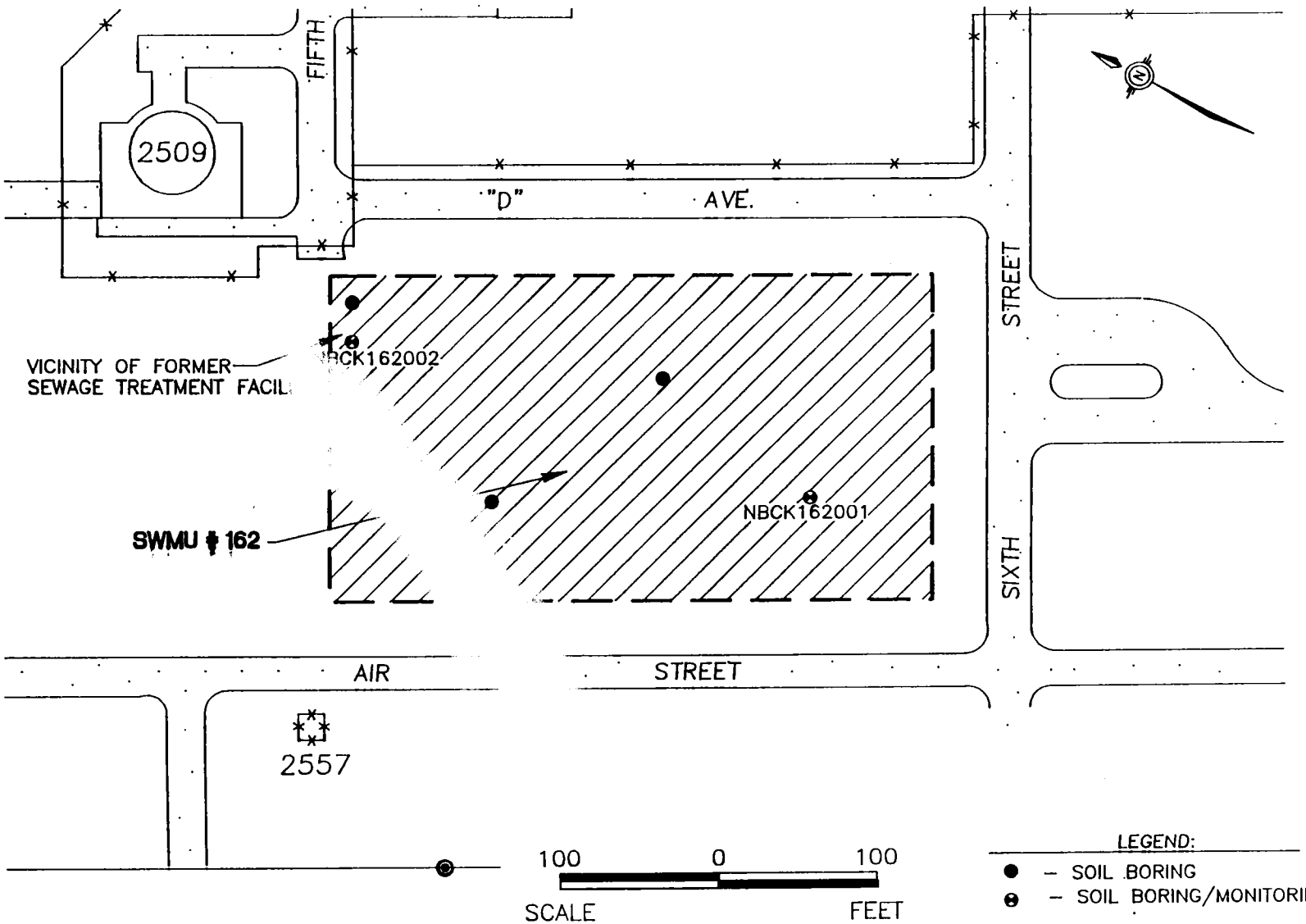
All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10% duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

2.2.8 Quality Assurance/Quality Control Samples

Additional soil will be collected at one lower interval sample location within the area of the sludge drying field and at one surface sample location at the location of the former treatment facility. These samples will be submitted for APX9 analyses at DQO Level IV in addition to the site-specific suite of analyses reported at DQO Level III. APX9 analyses include the standard full suite of analytical parameters (VOCs, SVOCs, pesticides/PCBs, metals, TPH, and cyanide) plus dioxin, hexavalent chromium, organophosphorus pesticides, and herbicides. The

groundwater sample collected from the sludge drying field area will be duplicated and submitted for the entire set of APX9 analytical parameters at DQO Level IV in addition to the standard full suite of analyses reported at DQO Level III.

QC samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).



ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 2–4
SWMU #162
SLUDGE DRYING FIELD
NAVAL ANNEX

DWG DATE: 08/15/96 | DWG NAME: 29CHZK01

2.3 SWMU 163, Concrete Pit Area, Naval Annex

SWMU 163 consists of a 10 feet x 10 feet x 2 feet uncovered concrete pit, approximately 100 feet north of Building 2513 at Naval Annex (Figure 2-5). The pit was used as a less-than-90-day accumulation area for hazardous waste generated at the facility. As reported by the June 1995 RFA, the concrete base and walls of this unit are heavily cracked. The pit was not apparently constructed with a cover. No information regarding rainwater handling at this facility was available. No drains or sumps were observed in the pit. Wastes accumulated in this structure consisted of spent solvents and paint wastes containing heavy metals, including arsenic, barium, cadmium, lead, mercury, silver, and chromium. Hazardous waste accumulation in the unit commenced in the mid-1980s and was discontinued in the spring of 1994 when MOMAG 11 was reclassified as a small quantity hazardous waste generator and a new less-than-180-day accumulation area (SWMU 167) was placed in service. Table 2-5 provides a description of SWMU 163.

Table 2-5
SWMU 163
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 163, Concrete Pit Area, Naval Annex	SWMU 163 consists of a 10'x10'x2' uncovered concrete pit, approximately 100 feet north of Building 2513 at Naval Annex. The pit was used as a less-than-90 day accumulation area for hazardous waste generated at the facility.	Solvents, paint wastes, heavy metals	**Soil** Soil Gas **Groundwater**

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume I, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

2.3.1 Previous Investigations

This site has not been previously investigated.

2.3.2 Treatment Alternatives

Because there are no environmental media data, treatment alternatives for this site cannot be evaluated. As outlined in the overall sampling strategy presented in the *Final Comprehensive*

RFI Work Plan, treatment alternatives are being identified for sites likely to require remedial action. Data collection efforts will support evaluating these alternatives. Tables B-1 and B-2 (Appendix B) are a list of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify feasible treatment alternatives.

2.3.3 Data Gaps

Currently, no environmental media data have been collected at SWMU 163 to characterize the site, to conduct a BRA, or to support detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are no data to establish whether COPCs are present for any of the potential migration pathways.
- There are no data to allow a BRA to be conducted.
- No data exist to support a detailed evaluation of treatment alternatives, if necessary.

2.3.4 Potential Receptors

Potential receptors that may be exposed to site contaminants include current land users and any future users this area may support following closure. Data will be generated during the investigation to determine the level of risk to the spectrum of current and potential future receptors, including any highly sensitive individuals within the population who may be exposed through invasive or noninvasive activities. Sampling will characterize the potential pathways noted in bold in Table 2-5.

2.3.5 Objective

The goal of the CSI is to classify the site as NFI or RFI by using DQO Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at SWMU 163 are: 1) to assess impact to soil and groundwater underlying and in the immediate vicinity of the concrete pit, 2) to provide data to be used in the BRA, and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.3.6 Screening Alternatives

No sampling has been conducted to determine COPCs; therefore, selecting a quantitative screening alternative would be premature. If the proposed collection of high-quality samples is inadequate to define the areal extent of contamination (if present), the feasibility of employing screening methods will be reevaluated. All soil boring samples will be qualitatively screened for volatile organic compounds (VOCs) with a flame ionization detector (FID). All VOC screening results will be recorded in field notebooks and boring logs.

A groundwater sample will be collected by direct push technology (DPT), such as a GeoProbe sampling system, on the west side of the concrete pit for VOC analysis. Based on results of the screening sample, a permanent monitoring well(s) may be installed.

2.3.7 Sampling and Analysis Plan

To fulfill the CSI objectives, the following site-specific sampling and analysis requirements have been proposed for SWMU 163. Table 2-6 is a summary of the types of samples to be collected and analytical parameters. Five soil borings are proposed to detect the presence of COPCs at the concrete pit area. One of these soil borings will be advanced through the portion of the pit that, based on cracks visible from the surface, appears as though it had the greatest potential for leakage. Soil borings will be placed on each side of the pit. The soil boring placed in an area of stressed vegetation between the pit and the storm water sewer grate at the front end of the concrete pit where the wall enclosing the pit is at its lowest will be converted to a permanent

monitoring well. The soil boring location to the southwest of the pit will also be the location of a groundwater screening sample. If results of the groundwater sample analysis indicate the presence of COPCs, additional monitoring wells will be installed where appropriate. Figure 2-5 identifies proposed sample locations.

Samples will be collected at two depths for each of the soil borings, surface (0 feet to 1 foot) and subsurface (3 feet to 5 feet). Proposed sampling locations are illustrated on Figure 2-5. All sampling will adhere to the NAVBASE *Final Comprehensive RFI Work Plan* (August 30, 1994). The monitoring well(s) will be constructed to allow sampling of groundwater from the upper portion of the water table aquifer and will provide data that will be used to construct a Naval Annex potentiometric map.

2.3.8 Quality Assurance/Quality Control Samples

Additional soil will be collected at the upper interval sample location in the concrete pit and will be submitted for APX9 analyses at DQO Level IV in addition to the standard full suite of analyses reported at DQO Level III. APX9 analyses include the stand[illegible] suite of analytical parameters (VOCs, SVOCs, pesticides/PCBs, metals, and cya[illegible] dioxin, hexavalent chromium, organophosphorus pesticides, and herbicides.

QC samples will be collected as specified in Section 1[illegible] *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (F[illegible]94).

Table 2-6
SWMU 163
Sampling Plan

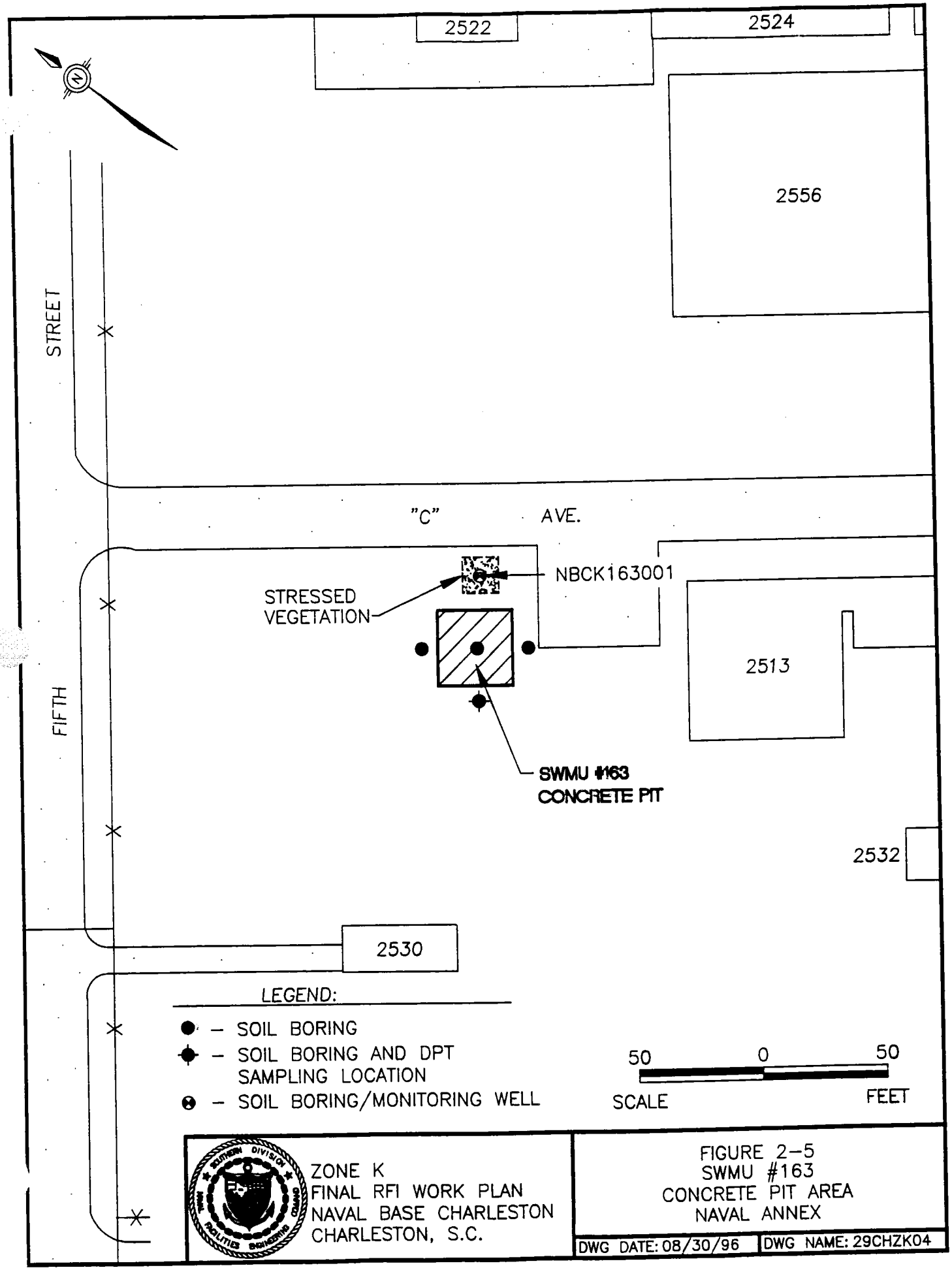
Matrix	Quantity	Analyses
Soil (0-1' bgs)	5	Soil - Full Suite
Soil (3-5' bgs)	5	
Groundwater	1	Groundwater - Full Suite
Groundwater Screening	1	Groundwater Screening - VOCs

Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Notes:
Groundwater monitoring wells will be sampled quarterly for one year.

The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Depth to water may prevent the collection of the lower interval soil samples. Actual sample locations may need to be adjusted to accommodate utilities. Justification for any significant (> 10 feet) sample location adjustment will be provided in the Zone K RFI.

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10% duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.


2522
2524
2556
STREET
"C" AVE.
NBCK163001
STRESSED VEGETATION
2513
FIFTH
SWMU #163
CONCRETE PIT
2532
2530
LEGEND:
– SOIL BORING
– SOIL BORING AND DPT SAMPLING LOCATION
– SOIL BORING/MONITORING WELL
50 0 50
SCALE FEET
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 2-5
SWMU #163
CONCRETE PIT AREA
NAVAL ANNEX
DWG DATE: 08/30/96
DWG NAME: 29CHZK04

2.4 SWMU 164, Blasting Operation, Naval Annex

SWMU 164 consists of an abrasive blasting booth formerly located in Building 2556 at Naval Annex. Blasting was conducted to remove paint from various types of equipment. The former blasting booth was located in the western half of Building 2556 (Figure 2-6) based on NAVBASE Map #2556-23; June 14, 1982. Reportedly, the former blasting booth was not constructed in a manner that made it possible to prevent dust emissions. Due to the proximity of exterior doors, impact to the soil in the vicinity of the doors or in runoff collection areas may have occurred. Table 2-7 is a description of SWMU 164.

A new blasting booth, installed in approximately 1986 in the same location as the former blasting booth, consists of a metal structure underlain with concrete. The floor of the booth includes a metal grate to recover blast media during abrasive blasting operations. The booth operates under a negative pressure system to recover blast media for reuse. During operation, exhaust air from the booth, containing airborne blast media, enters a cyclone separator where particulates are removed. However, fugitive emissions of airborne particulates, including lead and cadmium particulates, may occur from this system. Dust has been noted outside the booth, and, given the presence of an exterior bay door approximately 35 feet from the booth, it is possible that dust from the booth has migrated from the building, potentially impacting the surrounding soil. A fuel oil aboveground storage tank (AST) is at the northwest corner of Building 2556.

2.4.1 Previous Investigations

This site has not been previously investigated.

2.4.2 Treatment Alternatives

As outlined in the overall sampling strategy presented in the *Final Comprehensive RFI Work Plan*, treatment alternatives are being identified for each of the sites likely to require some type of remedial action. Data will be collected to support evaluation of these alternatives. Table

Table 2-7
SWMU 164
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 164, Blasting Operation, Naval Annex	SWMU 164 consists of a former abrasive blasting booth located in Building 2556 at Naval Annex. Fugitive dust emissions are likely to have migrated through exterior bay doors, potentially impacting the surrounding soil. A fuel oil AST is at the corner of Building 2556.	Metals, PAHs, Petroleum Products	**Soil** Air Surface Water Groundwater

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathway scheduled for sampling is in bold.

B-1 (Appendix B) is a list of treatment alternatives for groundwater; Table B-2 is a list of treatment alternatives for soil. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify the most feasible treatment alternatives.

2.4.3 Data Gaps

Currently, no environmental media data have been collected to characterize this site, to conduct a BRA, or to support a detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigative objectives, the following data gaps have been identified and will be resolved:

- The nature and extent of impact to environmental media (soil and groundwater) has not been defined.
- There are no data to allow a BRA to be conducted.
- No data exist to support a detailed evaluation of treatment alternatives.

2.4.4 Potential Receptors

Potential receptors that may be exposed to site contaminants include current land users and any future users this area may support following closure. Data will be generated during the investigation to determine the level of risk to the spectrum of current and potential future receptors, including any highly sensitive individuals within the population who may be exposed through invasive or noninvasive activities. Sampling will characterize the potential pathway noted in bold in Table 2-7.

2.4.5 Objective

The goal of the CSI is to classify the site as NFI or RFI by using DQO Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at SWMU 164 will be: 1) to assess impact to soil in the immediate vicinity of the bay doors, 2) to provide data to be used in the BRA, and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.4.6 Screening Alternatives

No sampling has been conducted to determine COPCs; the [illegible] electing a quantitative screening alternative would be premature. If the prop[illegible] f high-quality samples is inadequate to define the areal extent of c[illegible], the feasibility of employing screening methods will be reeval[illegible] samples will be qualitatively screened for volatile organic compou[illegible] ith a flame ionization detector (FID). All VOC screening results will be [illegible] ield notebooks and boring logs.

2.4.7 Sampli[illegible] lysis Plan

To fulfill [illegible] ectives, site-specific sampling and analysis requirements have been propos[illegible] U 164. Table 2-8 provides a summary of the types of samples to be collected and the [illegible]ytical parameters. Figure 2-6 identifies proposed sample locations.

Six soil borings are proposed for the purpose of determining if the blasting booth operation has impacted areas outside Building 2556. Each of these locations is in a grassy area adjacent to the large door openings of Building 2556 and/or in nearby areas where surface water runoff would accumulate. If the blasting booth operation activities have impacted areas outside of Building 2556, analysis of the soil from these grassy areas is expected to provide a worst-case measure of that impact. If analytical results for samples collected from the six soil borings reveal the presence of COPCs, and impact to groundwater is suspected, monitoring wells will be installed where appropriate. If monitoring wells are installed, they will be constructed to allow samples to be collected from the upper portion of the water table aquifer and to provide data to be used to construct a Naval Annex potentiometric map.

Samples from two depth intervals are proposed for each of the six soil borings, surface (0 feet to 1 foot) and subsurface (3 feet to 5 feet). All sampling will adhere to the NAVBASE *Final Comprehensive RFI Work Plan* (E/A&H, 1994).

Table 2-8
SWMU 164
Sampling Plan

Matrix	Quantity	Analyses
Soil (0-1' bgs)	6	[illegible]s, TPH, SVOCs
Soil (3-5' bgs)	6	

Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, po[illegible]anic carbon (TOC), and cation exchange capacity (CEC).

Notes:
If groundwater monitoring wells are installed, they will be s[illegible]arterly for one year.

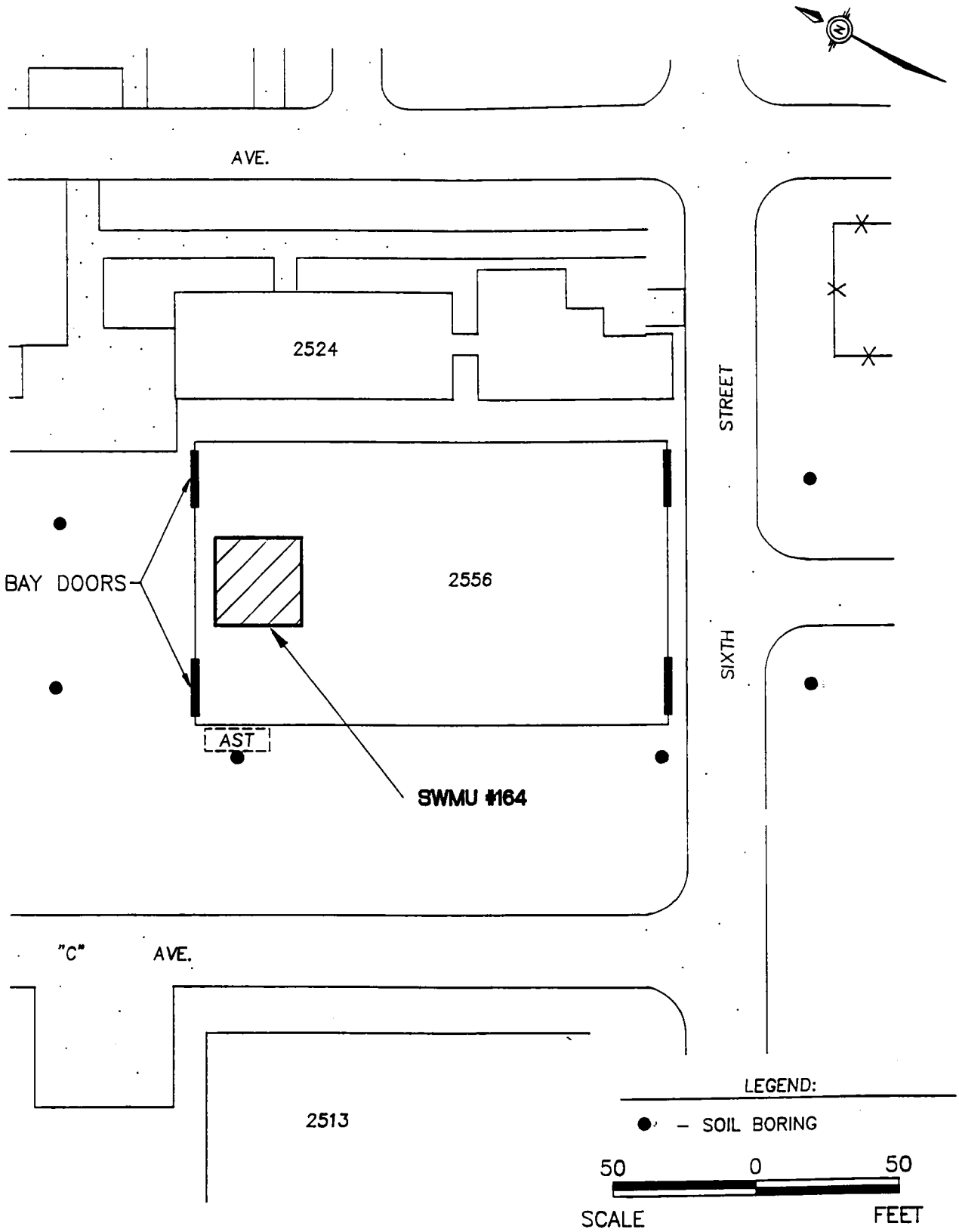
The quantities presented are estimated numbers of samp[illegible]ed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated ob[illegible]ves. [illegible]epth to groundwater may prevent collection of lower interval soil samples. Actual locations may need to be adjuste[illegible] [illegible]commodate utilities. Justification for any significant (>10 feet) sample location adjustment will be provided in the Zone K RFI.

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10% duplicates analyzed for all Appendix IX constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

2.4.8 Quality Assurance/Quality Control Samples

Additional soil will be collected at one upper interval sample location and submitted for APX9 analyses at DQO Level IV in addition to the site-specific suite of analyses reported at DQO Level III. APX9 analyses include the standard full suite of analytical parameters (VOCs, SVOCs, pesticides/PCBs, metals, TPHs, and cyanide) plus dioxin, hexavalent chromium, organophosphorus pesticides, and herbicides.

QC samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).



ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 2–6
SWMU #164
BLASTING OPERATION
NAVAL ANNEX

DWG DATE: 08/15/96 | DWG NAME: 29CHZK07

2.5 SWMU 166, Sewer System and Former Septic Tank System, Naval Annex

SWMU 166 consists of the sanitary sewer system serving Naval Annex and the former septic system, excluding the housing area. The sanitary sewer system is comprised of approximately 5,300 linear feet of gravity sewer lines. Most lines are constructed of vitrified clay, although some are constructed of ductile iron, cast iron, polyvinyl chloride (PVC), or polypropylene. All wastewater generated at the Naval Annex is collected by a single trunk line which exits the property at the southwest boundary. A March 5, 1957, Naval Annex schematic identifies the former septic tank system located between Fourth and Fifth Streets and Avenues B and C (Appendix C). The associated leach or tile field contained 26 lines and was located in this same area. It is unknown how long the septic system operated or what was discharged through the system. Figure 2-7 illustrates the layout of the Naval Annex sewer system and the location of the former septic tank and associated drainfield. Table 2-9 provides a description of SWMU 166.

The composition of effluent from the sewer system is unknown. No known industrial discharges currently enter the sanitary sewer system. However, a review of activities conducted at Naval Annex indicates possible contaminants such as heavy metals, petroleum products, and waste paint/solvents were in use at Naval Annex and may have been disposed of through the sanitary sewer. Also, limited biological degradation may occur within the sewer system, generating waste products such as methane and hydrogen sulfide gas. A records review of past building practices is summarized in Table 2-10. Based on this records review, a portion of the sanitary sewer line (enclosed by a red open box on Figure 2-7) has been designated for further investigation. The portions of the sewer line enclosed by a green open box on Figure 2-7 will not be considered for further investigation due to the past history of the buildings connected to those portions of the sewer line.

Table 2-9
SWMU 166
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 166, Sewer System, Naval Annex	SWMU 166 consists of the sanitary sewer system serving the Naval Annex, excluding the housing area. It is comprised of approximately 5,300 linear feet of gravity sewer lines. Most lines are constructed of vitrified clay, although some are constructed of ductile iron, cast iron, PVC, or polypropylene. A former septic tank and drainfield were also identified during research of the sewer system.	Metals, petroleum products, solvents, paints, and biodegradation gases.	**Soil** **Groundwater** Soil Gas Air

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

2.5.1 Previous Investigations

This site has not been previously investigated.

2.5.2 Treatment Alternatives

Because there are no environmental media data, treatment alternatives for this site cannot be evaluated. As outlined in the overall sampling strategy presented in the *Final Comprehensive RFI Work Plan*, treatment alternatives are being identified for sites likely to require remedial action. Data collection efforts will support evaluating these alternatives. Tables B-1 and B-2 (Appendix B) provide lists of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify feasible treatment alternatives.

Table 2-10
Naval Annex Building Survey
with Regard to Materials Stored or Handled and Sewer Connections
SWMU 166, Zone K

Building Number	Building Processes	Hazardous Materials	Sewer Connection (Based on Naval Annex Maps and Environmental Baseline Survey [EBS]	Further Investigation
2501	Lounge, Hospital, Officer's Quarters, Dining Facility	Detergents, Bleach, Gasoline, and Oil	Yes	Yes
2505	Vehicle Maintenance Shop	Waste Water Discharged from Oil/Water Separator, Solvents, Oil	Yes	Yes
2506	Barracks	Lead-Based Paint (LBP) in bulk containers	Yes	No
[illegible]	Bath[illegible]ouse	No Hazardous Material Storage	Yes	No
2508	[illegible]	Sodium Sulfite, Disodium Phosphate, Diesel Fuel	Yes	Yes
2509	Rada[illegible] [illegible]e of Non-hazardous Material	Unknown, Nonhazardous Mine Components	Navy's map shows connection; EBS says there is no connection.	Yes
2511	Administrative Off[illegible]	None	Yes	No
2513	Former Diesel Plant with [illegible] [illegible]rea	Diesel Fuel	Yes	Yes
2517	Administrative Building and R[illegible]	None	Yes	No
2520	Classrooms, Administrative Office[illegible] Facility	Nonprescription Medications and Disinfectants	Yes	No
2521	Armory and Firearms Storage, Former D[illegible]	[illegible]ne	Yes	No
2522	Powerhouse Generator Storage Area and Mine Battery Storage Area	[illegible] Acid Batteries	Navy's map shows connection, EBS says there is no connection.	Yes
2523	Administrative and Training Facility	None	Yes	No
2524	Communications Building, Supply Depot, and Mine Component Testing	Lead Acid Batteries and Electronic Explosive Devices	Yes	Yes

Table 2-10
Naval Annex Building Survey
with Regard to Materials Stored or Handled and Sewer Connections
SWMU 166, Zone K

Building Number	Building Processes	Hazardous Materials	Sewer Connection (Based on Naval Annex Maps and Environmental Baseline Survey [EBS]	Further Investigation
2525	Crew's Lounge	None	Yes	No
2530	Maintenance Storage Building	Lawn Maintenance Equipment, Welding Equipment, and Gasoline	Navy's map shows connection; EBS says there is no connection.	Yes
2532	Paint Storage Building	1-gallon and 5-gallon Metal Paints, Canned Grease, Lubricants	Navy's map shows connection; EBS says there is no connection.	Yes
2533	Galley-Supply Storage Building	Various Cleaning Supplies	Yes	Yes
2535	Water Treatment Facility	Possibly chlorine used in water treatment. No connection could be found to sanitary sewer.	No	No
2536	Administrative Offices	Paint, Oil, Gas, Solvents, Wax Remover	Yes	Yes
2550	Basketball Court	None	No	No
2552	Swimming Pool	None	No	No
2553	Soccer Field	None	No	No
2554	Electric Power Substation	None	No	No
2555	Entrance Sign to Annex	None	No	No
2556	Mine Refurbishment	None	No	No
2557	Sewage Pumping Station	Organic Compounds and Metals	Navy's map shows connection; EBS says there is no connection.	Yes

2.5.3 Data Gaps

Currently no environmental media data have been collected at SWMU 166 to characterize the site, to conduct a BRA, or to support a detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are no data to establish whether COPCs are present for any of the potential migration pathways.
- No data have been collected for the purpose of performing a BRA.
- No data exist to support a detailed evaluation of treatment alternatives, if necessary.

2.5.4 Potential Receptors

Potential receptors that may be exposed to site contaminants include current land users, such as NAVBASE personnel, and any future users this area may support. Data will be generated during the investigation to determine the level of risk to the entire spectrum of current and potential future receptors, including any highly sensitive individuals, who might be exposed through invasive or noninvasive activities.

2.5.5 Objective

The goal of the CSI is to classify the site as NFI or RFI by using DQO Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at SWMU 166 are: 1) to assess impacts to the former septic tank drain field area and along the portion of the sanitary sewage lines which, based upon records review, may have transported and leaked hazardous materials, 2) to provide data to be used in the BRA, and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.5.6 Screening Alternatives

Groundwater samples (utilizing DPT methods) will be collected as described in the following section for screening purposes. Each of these screening samples will be analyzed for VOCs and metals. If necessary, permanent monitoring wells will be sited and installed based upon analytical results for the screening samples.

2.5.7 Sampling and Analysis Plan

Sanitary Sewer System

The primary pathway of contaminant migration from the sanitary sewer system is exfiltration of COPCs into groundwater from damaged pipelines or manholes. COPC exfiltration occurs during surcharged periods and along structurally defective pipelines above the water table.

The plan of investigation for the sanitary sewer system is divided into two phases. The first phase of the groundwater investigation will be accomplished by sampling adjacent to sanitary sewer lines at specific locations downgradient of potential sources of contaminants. DPT will be utilized to collect groundwater screening samples. These samples will be analyzed for VOCs and metals at an offsite laboratory, thus providing DQO Level III analytical data. Results from metals' analysis may be increased due to higher turbidity levels c[illegible] to groundwater samples collected using DPT methods. The second phase of the investig[illegible] involve the installation of permanent groundwater monitoring wells (at least 10% of the number of groundwater screening locations) at locations which will be selected based on results of the groundwater screening samples, at primary junctures of the sewer system, or in the vicinity of potential release sources. If required, additional DPT samples will be obtained as necessary, during the second phase of investigation, to aid in the definition of the nature and extent of identified COPCs.

If DPT equipment is unable to access a groundwater sample location, the sample location will be relocated to an accessible area as close as possible to the original location. Each sample will be collected as close to the sewer pipe as possible and below the elevation of the pipe's invert.

These sample locations were chosen due to the standard construction practice of installing underground utility lines. When constructing a sanitary or storm sewer line, a trench is dug into the native ground, and the pipe is placed on a granular bedding material such as gravel. The trench is then filled with this same granular material to a certain height above the pipe, then native backfill material is used to bring the top of the trench to the ground surface. The cross sectional area which contains the granular material may then act as a "secondary conduit" or pathway for fluids released from the pipeline. It can be expected that this fluid will travel along this "secondary conduit" to the next downgradient manhole where the fluid may continue past the manhole or be trapped in the granular bedding material below the base of the manhole. Therefore, when sampling at a manhole, a groundwater sample will be collected near the bottom of the manhole on the inlet side.

Segments of the sewer system to be included in the investigation will be sampled at 200-foot intervals. The first groundwater sample will be collected at the intersection of the pipeline with the building's face or the first manhole if it is within 200 feet of the building. Additional samples will be collected on alternating sides of the pipeline at 200-foot intervals with one groundwater sample at each manhole. However, if the distance between manholes is less than 300 feet, samples will be collected only at each manhole. If the distance between manholes is 300 feet to 500 feet, one sample will be collected at the midway point with one sample at each manhole. For lines greater than 500 feet, the interval spacing will be 200 feet with one sample at each manhole. The interval-based sampling will terminate at the exiting point of the main trunk line from the NAVBASE property.

Groundwater screening sample location NBCK166S20 was placed west of Building 2513 due to the presence of manholes. It is not known whether these manholes are a part of the sewer system.

Figure 2-7 represents proposed sample locations selected based on the strategy, research, and justification outlined in this work plan. Sample locations were determined based on the best

information available. However, due to the limited accuracy of available information, some locations may change slightly based on field conditions. All sampling will adhere to the NAVBASE *Final Comprehensive RFI Work Plan* (E/A&H, 1994). Table 2-11 is a summary of the type of samples and analytical parameters.

Permanent monitoring wells will be constructed to allow groundwater in the upper portion of the water table aquifer to be sampled. The monitoring wells will also provide data to be used to construct a Naval Annex potentiometric map.

Former Septic System and Associated Drainfield

Four soil borings will be located at the former septic tank and associated drainfield (Figure 2-7) to determine if any COPCs are present as a result of substances disposed of through the septic system. A monitoring well will be constructed at the soil boring location closest to the center of the former drainfield area. This monitoring well will be constructed to allow sampling of groundwater in the upper portion of the water table aquifer. The monitoring well will also provide data to be used to construct a potentiometric map for Naval Annex. Table 2-12 provides a summary of the type of samples and analytical parameters.

Samples from two depths are proposed for each of the four soil borings, surface (0 feet to 1 foot) and subsurface (3 feet to 5 feet). All sampling will be in accordance with the NAVBASE *Final Comprehensive RFI Work Plan* (E/A&H, 1994).

2.5.8 Quality Assurance/Quality Control Samples

Additional volume of sample will be collected at one lower interval soil sample location within the area of the septic tank drainfield and at the permanent monitoring well installed within the drainfield. These samples will be submitted for APX9 analyses at DQO Level IV in addition to the standard full suite of analyses reported at DQO Level III. APX9 analyses include the standard full suite of analytical parameters (VOCs, SVOCs, pesticides/PCBs, metals, and cyanide) plus dioxin, hexavalent chromium, organophosphorus pesticides, and herbicides.

Table 2-11
SWMU 166
Sampling Plan

Matrix	Quantity	Analysis
Groundwater Screening	31	Groundwater Screening - VOCs and Metals
Groundwater	4	Groundwater - Full Suite

Notes:
The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion of the investigation may be necessary to meet the stated objectives.

Groundwater monitoring wells will be sampled quarterly for one year.

All analyses will be performed per SW-846 except where other methods are specified. Data Quality Objectives (DQO) Level III analysis as specified in the sampling plan will be used, with a minimum of 10% duplicates analyzed for all APX9 constituents at DQO Level IV. Duplicates will be collected at locations where contaminants are most likely to be found. The sample quantities presented do not include Quality Assurance/Quality Control (QA/QC) samples.

The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Actual locations may need to be adjusted to accommodate utilities. Justification for any significant (> 10 feet) sample location adjustment will be provided in the Zone K RFI.

Table 2-12
Septic Tank and Associated Drainfield
Sampling Plan

Matrix	Quantity	Analyses
Soil (0-1' bgs)	4	Soil-Full Suite
Soil (3-5' bgs)	4	
Groundwater (Shallow Well)	1	Groundwater-Full Suite

Notes:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Groundwater monitoring wells will be sampled quarterly for one year.

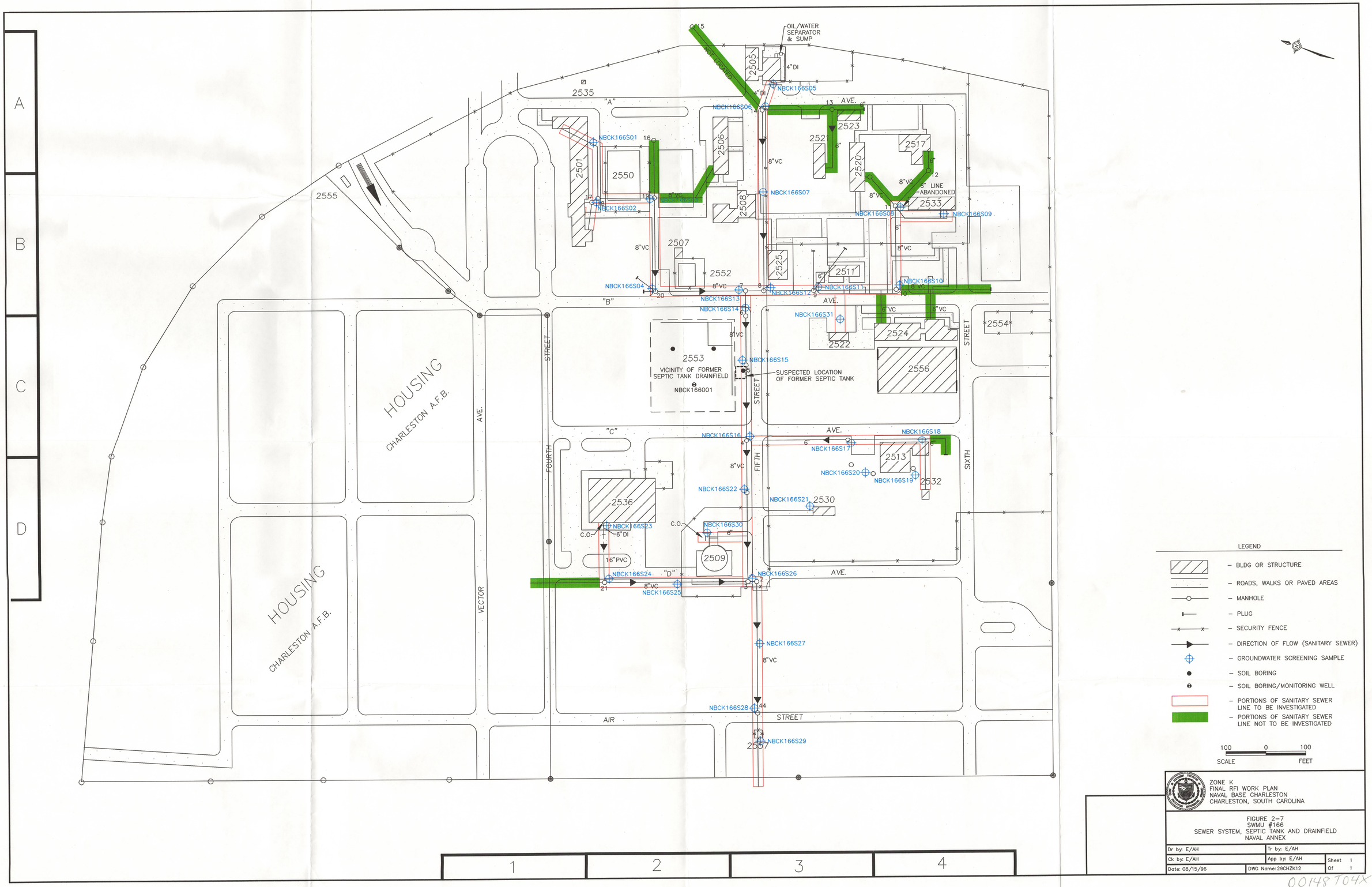
The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Depth to groundwater may prevent collection of lower interval samples. Actual sample locations may need to be adjusted to accommodate utilities. Justification for any significant (> 10 feet) sample location adjustment will be provided in the Zone K RFI.

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10% duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

Additional volume will be collected for at least 20% of the groundwater screening samples and submitted for duplicate VOC analysis. At least 50% of these duplicate samples will be reported at DQO Level IV.

If permanent monitoring wells are installed following the initial phase of groundwater screening sample collection, samples from at least one or as many as 10% of them will be duplicated and submitted for APX9 analyses at DQO Level IV in addition to the standard full suite of analyses reported at DQO Level III.

QC samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).



LEGEND

- BLDG OR STRUCTURE
- ROADS, WALKS OR PAVED AREAS
- MANHOLE
- PLUG
- SECURITY FENCE
- DIRECTION OF FLOW (SANITARY SEWER)
- GROUNDWATER SCREENING SAMPLE
- SOIL BORING
- SOIL BORING/MONITORING WELL
- PORTIONS OF SANITARY SEWER LINE TO BE INVESTIGATED
- PORTIONS OF SANITARY SEWER LINE NOT TO BE INVESTIGATED

100 0 100
SCALE FEET

ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA

FIGURE 2-7
SWMU #166
SEWER SYSTEM, SEPTIC TANK AND DRAINFIELD
NAVAL ANNEX

Dr by: E/AH	Tr by: E/AH	
Ck by: E/AH	App by: E/AH	Sheet 1
Date: 08/15/96	DWG Name: 29CHZK12	Of 1

00148T04X

2.6 AOC 696, Transformer Area Near Building 2509, Naval Annex

AOC 696 consists of five transformers (2 former, 3 present) located immediately north of Building 2509 at Naval Annex (Figure 2-8). In 1991, sampling was performed on the five transformers to determine if the dielectric fluid contained PCBs. The fluid was determined to contain less than 50 parts per million (ppm) PCBs. That same year, two of the five transformers were removed. It is not known what the contents of the transformers were prior to 1991. The remaining transformers are situated on a concrete pad. These transformers supply power to Building 2509. Areas of distressed vegetation are in the vicinity of the transformer pad (between 100 and 200 square feet). Table 2-13 provides a description of AOC 696.

Table 2-13
AOC 696
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
AOC 696, Transformer Area near Building 2509, Naval Annex	AOC 696 consists of five transformers (2 former, 3 present) immediately north of Building 2509 at Naval Annex. In 1991, sampling was performed on the five transformers to determine if the dielectric fluid contained PCBs. The fluid was determined to contain <50 ppm PCBs. Only two of the five transformers are still in service. A UST is immediately west of AOC 696.	PCBs, TPH	**Soil** Soil Gas Groundwater Air

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathway scheduled for sampling is in bold.

2.6.1 Previous Investigations

Samples of the transformer fluid were collected in 1991 and determined to contain less than 50 ppm PCBs.

2.6.2 Treatment Alternatives

Because there are no environmental media data, treatment alternatives for this site cannot be evaluated. As outlined in the overall sampling strategy presented in the *Final Comprehensive*

action. Data collection efforts will support evaluating these alternatives. Tables B-1 and B-2 (Appendix B) are a list of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify feasible treatment alternatives.

2.6.3 Data Gaps

Currently no environmental media data have been collected at AOC 696 to characterize the site, to conduct a BRA, or to support a detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are no data to establish whether COPCs are present for any of the potential migration pathways.
- There are no data for conducting a BRA.
- No data exist to support a detailed evaluation of trea[illegible]atives, if necessary.

2.6.4 Potential Receptors

Potential receptors that may be exposed to site contar[illegible]clude current land users and any future users this area may support. Data will be [illegible]uring the investigation to determine the level of risk to the entire spectrum of curr[illegible]otential future receptors, including any highly sensitive individuals who might be ex[illegible]rough invasive or noninvasive activities. Sampling will characterize the potential pa[illegible]ghlighted in Table 2-13.

2.6.5 Objective

The goal of the CSI is to classify the site as NFI or RFI by using DQO Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at AOC 696 will be: 1) to assess impact to soil adjacent to the concrete pad and UST, 2) to provide data to be used in the BRA, and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.6.6 Screening Alternatives

No sampling has been conducted to determine COPCs; therefore, selecting a quantitative screening alternative would be premature. If the proposed collection of high-quality samples is inadequate to define the areal extent of contamination (if present), the feasibility of employing screening methods will be reevaluated. A FID will be used to qualitatively screen for VOCs in all soil boring samples. However, VOC screening results will be recorded in the field notes and on boring logs.

2.6.7 Sampling and Analysis Plan

Six soil borings are proposed for AOC 696. Three of these soil borings are located in areas of stressed vegetation. If results of the samples collected from the six soil borings reveal the presence of COPCs, and impact to groundwater is suspected, monitoring wells will be installed where appropriate. If monitoring wells are installed, they will be constructed to allow samples to be collected from the upper portion of the water table aquifer. The wells will also provide data to be used to construct a potentiometric map for Naval Annex. Table 2-14 provides a summary of the type of samples and analytical parameters.

Soil samples will be collected at two depth intervals for each soil boring, surface (0 feet to 1 foot) and subsurface (3 feet to 5 feet). Each proposed sampling location is illustrated on Figure 2-8. All sampling will adhere to the NAVBASE *Final Comprehensive RFI Work Plan* (E\A&H, 1994).

Table 2-14
AOC 696
Sampling Plan

Matrix	Quantity	Analysis
Soil (0-1' bgs)	6	PCBs and TPH
Soil (3-5' bgs)	6	

Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Notes:
If groundwater monitoring wells are installed, they will be sampled quarterly for one year.

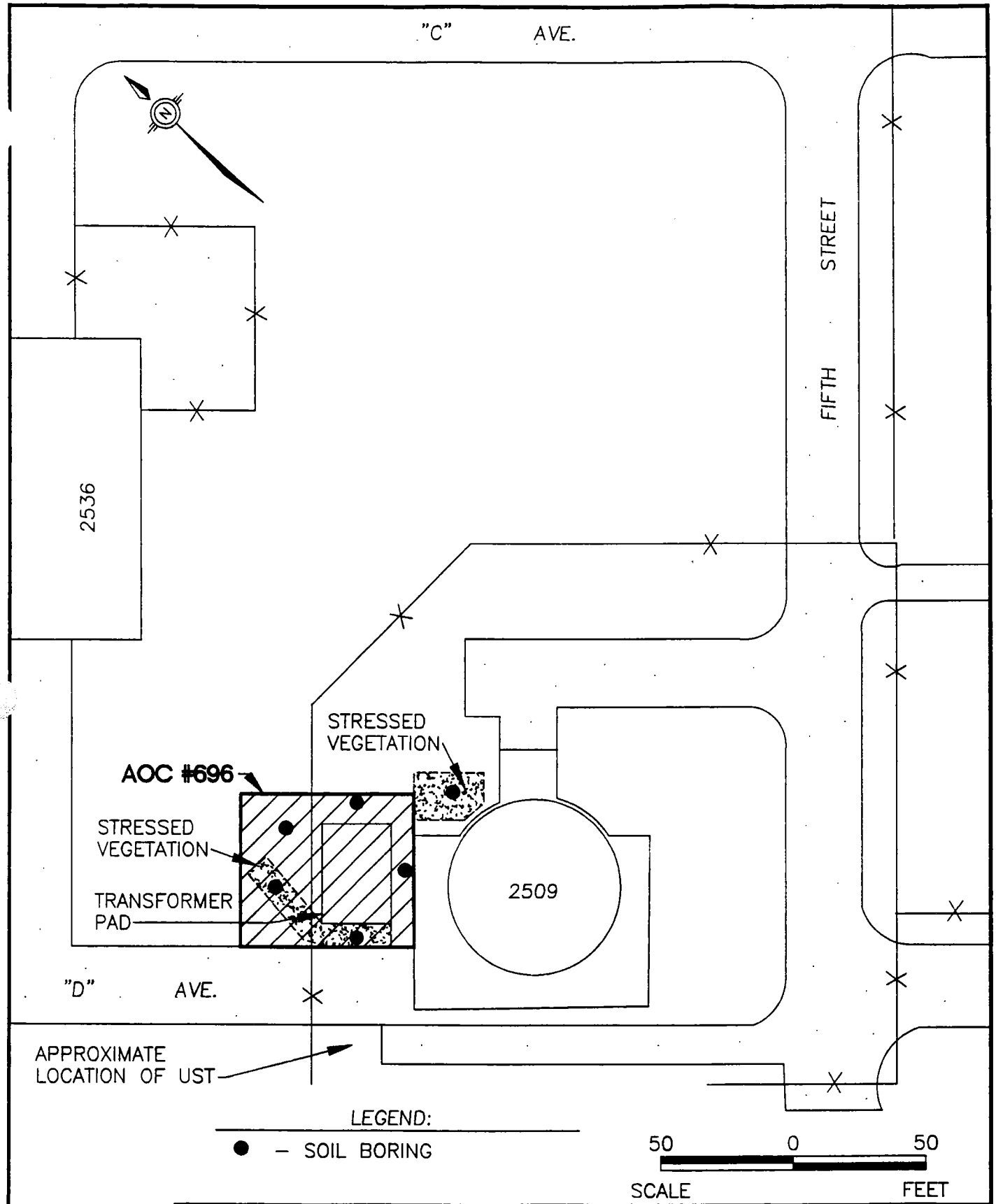
The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Depth to groundwater may prevent collection of lower interval soil samples. Actual locations may need to be adjusted to accommodate utilities. Justification for any significant (>10 feet) sample location adjustment will be provided in the Zone K RFI.

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10% duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

2.6.8 Quality Assurance/Quality Control Samples

Additional soil will be collected for the upper interval soil sample collected in the area of distressed vegetation. This sample will be submitted for APX9 analyses at DQO Level IV in addition to the site-specific suite of analyses. APX9 analyses include the standard full suite of analytical parameters (VOCs, SVOCs, pesticides/PCBs, metals, TPHs, and cyanide) plus dioxin, hexavalent chromium, organophosphorus pesticides, and herbicides.

QC samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).



ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 2-8
AOC 696
TRANSFORMER AREA NEAR BLDG 2509
NAVAL ANNEX

DWG DATE: 08/30/96 | DWG NAME: 29CHZK08

2.7 AOC 698, Building 2508, Boiler House, Naval Annex

AOC 698 consists of Building 2508 at Naval Annex (Figure 2-9). The unit is designated as an AOC due to the presence of peeling lead-based paint which is on both the interior and exterior of the building. Paint chips that have fallen to the ground are subject to decomposition by weather and human activities such as grass cutting. As the size of the chip decreases, surface area increases, which in turn increases the oxidation potential. As lead-based paint oxidizes, a lead-containing powder forms that is readily leachable and will migrate to soil and may percolate through the soil into the groundwater. The building was formerly operated as a boiler house and has been out of service for several years. An approximately 7,500-gallon AST is inside a concrete containment structure, approximately 35 feet from the building. The tank is coated with peeling paint which may also contain lead. A smoke stack for Building 2508 is on the west side of the building. Stained soil is in the immediate area of the smoke stack. Table 2-15 provides a description of AOC 698.

Table 2-15
AOC 698
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
AOC 698, Building 2508, Boiler House, Naval Annex	AOC 698 consists of Building 2508 at Naval Annex. The unit is designated as an AOC due to the presence of peeling lead-based paint which is on both the interior and exterior of the building. The building was formerly operated as a boiler house and has been out of service for several years. An approximately 7,500-gallon AST is inside a concrete containment structure, approximately 35 feet from the building. The tank is coated with peeling paint which may contain lead. A smokestack is present on the exterior of the building.	Lead, TPH associated with the AST	**Soil** Surface Water Soil Gas **Groundwater** Air

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

2.7.1 Previous Investigations

Laboratory testing of soils collected from areas visually determined to contain paint chips confirm elevated levels of lead in the soil. This testing was conducted using method SW-836 for analysis of toxicity characteristic leachate procedure (TCLP) metals.

2.7.2 Treatment Alternatives

Insufficient data are available to evaluate treatment alternatives for this site. As outlined in the overall sampling strategy presented in the *Final Comprehensive RFI Work Plan*, treatment alternatives are being identified for sites likely to require remedial action. Data collection efforts will support evaluating these alternatives. Tables B-1 and B-2 (Appendix B) are lists of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be collected to identify feasible treatment alternatives.

2.7.3 Data Gaps

Currently there are insufficient environmental data from AOC 698 to characterize the site, to conduct a BRA, or to support a detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are insufficient data to establish whether COPCs are present for any of the potential migration pathways.

- There are insufficient data to conduct a BRA.

- Insufficient data exist to support a detailed evaluation of treatment alternatives, if necessary.

2.7.4 Potential Receptors

Potential receptors that may be exposed to site contaminants include current land users and any future users this area may support. Data will be generated during the investigation to determine the level of risk to the entire spectrum of current and potential future receptors, including any highly sensitive individuals who might be exposed through invasive or noninvasive activities. Soil and groundwater sample data will be utilized to characterize the potential pathways highlighted in Table 2-15.

2.7.5 Objective

The objectives of the proposed RFI at AOC 698 will be: 1) to assess impact to soil and groundwater due to the presence of lead-based paint, the AST, and former boiler room activities at Building 2508, 2) to provide data to be used in the BRA, and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.7.6 Screening Alternatives

No sampling has been conducted to determine COPCs; therefore, selecting a quantitative screening alternative would be premature. If the proposed collection of high-quality samples is inadequate to define the areal extent of contamination (if present), the feasibility of employing screening methods will be reevaluated. All soil boring samples will be qualitatively screened for VOCs with a FID. All VOC screening results will be recorded in field notebooks and boring logs.

2.7.7 Sampling and Analysis Plan

To fulfill the CSI objectives, the following site-specific sampling and analysis requirements have been proposed. Table 2-16 provides a summary of the types of samples to be collected and the analytical parameters.

Eight soil boring locations are proposed to detect the presence of COPCs due to a release from AOC 698. Samples will be collected at two depth intervals for each soil boring, surface (0 feet to 1 foot) and subsurface (3 feet to 5 feet). Each proposed sampling location is illustrated on Figure 2-9. All sampling will adhere to the NAVBASE *Final Comprehensive RFI Work Plan* (E\A&H, 1994).

A permanent monitoring well will be installed at the location of one of the soil borings (between Building 2508 and the AST). This monitoring well will be constructed to allow sampling of groundwater from the upper portion of the water table aquifer and provide data to be used to construct a potentiometric map for Naval Annex. This monitoring well is located in a grassy area.

Table 2-16
AOC 698
Sampling Plan

Matrix	Quantity	Analyses
Soil (0-1' bgs)	8	Soil - VOCs, SVOCs, and Metals
Soil (3-5' bgs)	8	
Groundwater	1	Groundwater - Full Suite

Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Notes:
Groundwater monitoring wells will be sampled quarterly for one year.

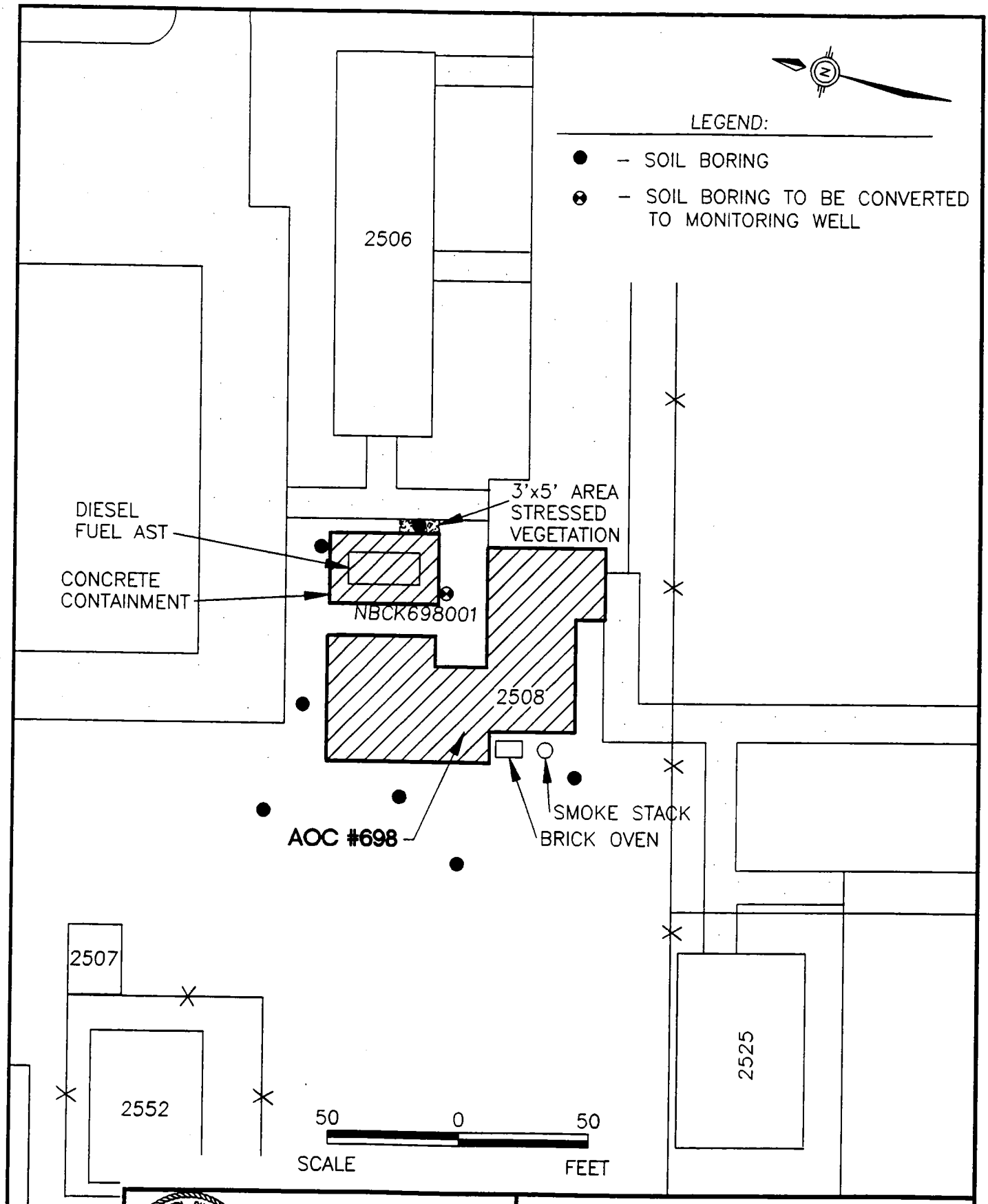
The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Depth to water may prevent the collection of the lower interval soil samples. If the three to five foot soil sample can not be collected due to depth to water, a soil sample will be collected at the soil/groundwater interface. Actual locations may need to be adjusted to accommodate utilities. Justification for any significant (>10 feet) sample location adjustment will be provided in the Zone K RFI.

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10% duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

2.7.8 Quality Assurance/Quality Control Samples

Additional soil will be collected for an upper interval soil sample collected in the area of the smoke stack and will be submitted for APX9 analyses at DQO Level IV in addition to the site-specific suite of analyses reported at DQO Level III. The soil immediately surrounding the smoke stack was stained and the vegetation was apparently stressed. APX9 analyses include the standard full suite of analytical parameters (VOCs, SVOCs, pesticides/PCBs, metals, TPHs, and cyanide) plus dioxin, hexavalent chromium, organophosphorus pesticides, and herbicides.

QC samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).



ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 2-9
AOC #698
BOILER HOUSE
NAVAL ANNEX

DWG DATE: 08/15/96 | DWG NAME: 29CHZK06

2.8 AOC 693, Fuse and Primer House, Former Building 117 and AOC 694, Former Naval Ammunition Depot

Due to their proximity and similar histories, AOCs 693 and 694 will be investigated together. AOC 694 encompasses the area of AOC 693 (Figure 2-10). Portions of the multiple-site sampling plan will be AOC-specific.

AOC 693 consists of former Building 117, a fuse and primer house, which operated from 1930 until 1939. It is located in a wooded area adjacent to the Clouter Creek Dredge Area on Clouter Island. The structure consists of two rooms. No visual evidence of past operations is present in the building. No other information was found pertaining to the design features or operating practices of this fuse and primer house.

AOC 694, a Naval Ammunition Depot in operation from the 1920s until the 1940s, consists of the area surrounding former Building 117. The exact location and dimensions of this explosives storage area are not known. Dredged materials may have been deposited in this area since its use as an ammunition depot was discontinued. No other information was found pertaining to the design features or operating practices of this facility.

The remnants of three other structures also remain within the former depot. The northernmost structure along the river shoreline is the foundation of Building 106, the Fixed Ammo Storehouse. Approximately 200 feet south of Building 106, also at the shoreline, is the foundation of Building 102, the Shellhouse. The only other foundation observed in the depot is between the Building 102 and the intact Fuse and Primer House (Building 115; AOC 693). This is the former site of Building 103, the Magazine, also located near the shore but is completely within the wooded bottomland.

Three distinct ecological subzones were identified in association with the Naval Depot. These include a narrow salt marsh in the at the water's edge (K-1), a wooded bottomland (K-2) which

is dominated by hackberry trees, and a scrub/shrub community (K-3) along the perimeter of the dike and at the outer edge of K-2. Figure 1-5 presents the locations and areal extent of these various habitats with respect to the Clouter Island AOCs.

According to construction details of the Dredge Disposal Area at Clouter Island, there are a total of 9 dewatering spillways, all of which discharge from the shore opposite the AOCs and into Clouter Creek. No impact to the Zone K AOCs is anticipated from these spillways.

Waste materials associated with the former ammunition depot include military explosives. Based on their toxicity characteristic, some explosives contain leachable concentrations of metals. A survey conducted by an unexploded ordnance subcontractor will be completed prior to initiating any surveillance or sampling effort at AOCs 693 and 694. The survey will be designed to identify the presence of unexploded ordnance from ground surface to a depth of 5 feet bgs throughout the gridded area illustrated on Figure 2-10. Material of an unknown origin has been reported in the AOC 694 area (observed by persons conducting a site walk through during the RFA process, October 18, 1994). Table 2-17 provides a description of AOCs 693 and 694.

2.8.1 Previous Investigations

These sites have not been previously investigated.

2.8.2 Treatment Alternatives

Because there are no environmental media data, treatment alternatives for these sites cannot be evaluated. As outlined in the overall sampling strategy presented in the *Final Comprehensive RFI Work Plan*, treatment alternatives are being identified for sites likely to require remedial action. Data collection efforts will support evaluating these alternatives. Tables B-1 and B-2

Table 2-17
AOCs 693 and 694
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
AOC 693, Fuse and Primer House, Former Building 117, Clouter Island	AOC 693 consists of former Building 117, a fuse and primer house which operated from 1930 until 1939. It is located in a wooded area adjacent to the Clouter Creek Dredge Area on Clouter Island.	Metals, explosives	**Soil** Soil Gas **Sediment** Surface Water **Groundwater** Air
AOC 694, Former Naval Ammunition Depot, Clouter Island	AOC 694, a Naval Ammunition Depot in operation from the 1920s until the 1940s, consists of the area surrounding former Building 117. The exact location and the dimensions of this explosives storage area are not known. Dredged materials have reportedly been deposited in this area since its use as an ammunition depot was discontinued. Unknown granular material has been reported in the area.		

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

(Appendix B) are lists of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify feasible treatment alternatives.

2.8.3 Data Gaps

No environmental media data have been collected at AOCs 693 and 694 to characterize the sites, to conduct a BRA, or to support a detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are no data to establish whether COPCs are present for any of the potential migration pathways.

- No data are available for conducting a BRA.

- No data exist to support a detailed evaluation of treatment alternatives, if necessary.

2.8.4 Potential Receptors

Potential receptors that may be exposed to site contaminants include current land users, such as NAVBASE personnel, and any future users this area may support and terrestrial and wetland ecological receptors. Data will be generated during the investigation to determine the level of risk to the entire spectrum of current and potential future receptors, including any highly sensitive individuals, who might be exposed through invasive or noninvasive activities. Confirmatory sampling will characterize the potential pathways highlighted in Table 2-17.

2.8.5 Objective

The goal of the CSI is to classify the sites as NFI or RFI by using DQO Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at AOCs 693 and 694 are: 1) to assess impact to soil from explosives storage, 2) to provide data to be used in the BRA, and 3) to provide data to be used for [illegible]essment of treatment alternatives, if necessary.

2.8.6 Screening Alternatives

No sampling has been conducted to determine COPCs; therefore, selecting a quantitative screening alternative for soil samples would be premature. If the proposed collection of the high-quality soil samples is inadequate to define the areal extent of contamination (if present), the feasibility of employing screening methods will be reevaluated. All soil boring samples will be qualitatively screened for VOCs with a FID. All VOC screening results will be recorded in field notebooks and boring logs.

2.8.7 Sampling and Analysis Plan

To fulfill the CSI objectives, the following site-specific sampling and analysis requirements have been proposed. Table 2-18 provides a summary of the types of samples to be collected and the analytical parameters. If the foundation of AOC 693 is identifiable, soil samples will be collected immediately adjacent to or within the structure. If the foundation of the building is not distinguishable, a 200-foot x 200-foot grid, established for the purpose of sampling the area of AOC 694, which includes AOC 693, will be utilized in the area of AOC 693 to identify sampling locations. Any unknown material (the presence of different types of unknown granular material located in AOC 693 and in the AOC 694 area was observed by persons conducting a site walk through during the RFA process, October 18, 1994) within the AOC 694 area or associated with any of the buildings will be sampled and analyzed for APX9 analytical parameters.

Table 2-18
AOCs 693 and 694
Sampling Plan

Matrix	Quantity	Analyses
Soil (0-1' bgs)	23	APX9 Analytical Parameters with Target Analyte List (TAL) Metals (at least 10% of the soil samples will be duplicated and reported at DQO Level IV).
Soil (3-5' bgs)	23	
Sediment	1 (given appropriate conditions)	Sediment and surface water samples will be analyzed for APX9 analytical parameters with TAL Metals.
Surface Water	1 (given appropriate conditions)	
Groundwater	6	Groundwater will be analyzed for APX9 analytical parameters with TAL metals. One of the groundwater samples will be duplicated.
Unknown Material	2 (if unknown material is located)	Unknown material will be analyzed for the APX9 list of analytical parameters. All samples will also be analyzed for explosives residue by SW-846 Method 8330.

Table 2-18
AOCs 693 and 694
Sampling Plan

Matrix	Quantity	Analyses

Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Notes:
SW-846 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), is a method intended for the trace analysis of explosives residues by HPLC using an ultraviolet (UV) detector.

The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives. Depth to groundwater may prevent second interval samples from being collected. Actual locations may need to be adjusted to due to unexploded ordnance. Justification for any significant (> 10 feet) sample location adjustment will be provided in the Zone K RFI.

The Target Analyte List (TAL) for metals will be used instead of the APX9 list of metals. The TAL list includes elements that are not part of the APX9 list (aluminum, calcium, iron, magnesium, manganese, potassium, and sodium).

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10 percent duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

Twenty-three soil boring locations are proposed to detect the presence of contamination due to a release from AOCs 693 and 694. Samples will be collected at two depth intervals for each soil boring, surface (0 feet to 1 foot) and subsurface (3 feet to 5 [illegible] e soil borings are located in areas where dredge spoil has not been deposited. I[illegible] boring locations are covered with dredge spoil, soil samples will be collected at [illegible]et to 1 foot, from 3 feet to 5 feet, and from 8 feet to 10 feet, if necessary to reach the natural soil horizon. Beginning at the natural soil horizon, a soil sample will be collected from 0 feet to 1 foot below the horizon and from 3 feet to 5 feet below the natural soil horizon, if possible, due to the shallow depth to groundwater. Given the area's proximity to sea level, it is doubtful that a non-saturated sample can be collected below the 3-foot to 5-foot bgs sampling interval.

Groundwater samples will be collected from six of locations within AOC 694. These locations are illustrated in Figure 2-10. The location of these groundwater samples should intercept contaminants originating in the area of AOC 694 and moving toward the Cooper River. The

groundwater samples will be collected from temporary wells installed using hand auger methodology. Groundwater is not expected to be more than a couple of feet deep at these locations and easily accessed with a hand auger. Five-foot sections of PVC screens will be installed in each of augered boreholes. Filter pack material will be added to the annular space around the PVC. No grout will be used since the samples will be collected immediately after installation. Disposable polyethylene bailers will be used to withdraw the samples. A minimum of three well volumes will be withdrawn from the wells prior to the collection of the sample.

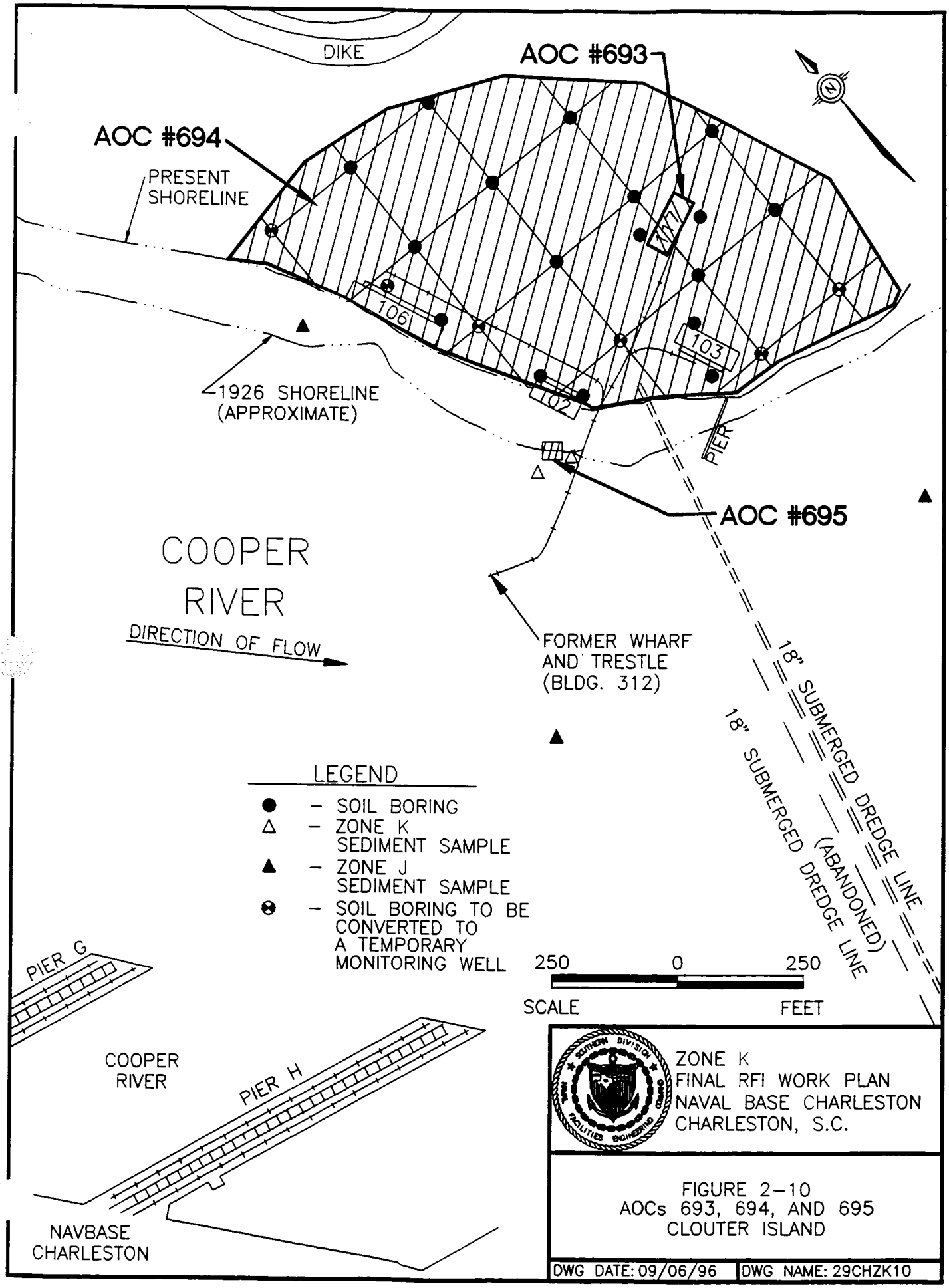
Each proposed sampling location is illustrated on Figure 2-10. No sampling will occur until the entire AOC 694 area has been surveyed and cleared for explosive hazards by an ordnance remediation subcontractor. All sampling will be in accordance with the NAVBASE *Final Comprehensive RFI Work Plan* (E/A&H, 1994).

Based on historical aerial photographs, a drainage feature exited the island in the vicinity of AOCs 693 and 694. The drainage feature is not apparent in more recent aerial photographs. If a drainage feature exits the island in the vicinity of the AOCs, a sedi[illegible]t and surface water sample will be collected from the feature upgradient from [illegible] influence from the Cooper River would be expected and downgradient from whe[illegible]s would have impacted the sediment if a release had occurred.

2.8.8 Quality Assurance/Quality Control Sa[illegible]

Additional soil will be collected at two surfa[illegible]locations and at one subsurface sample location at AOCs 693 and 694. Additional gr[illegible]er will be collected at one of the proposed groundwater sample locations. These [illegible] will be submitted for duplicate analyses at DQO Level IV in addition to the site-sp[illegible]ite of analyses to be reported at DQO Level III.

QC samples will be collected as s[illegible] in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facil[illegible]vestigation* (E\A&H, 1994).


DIKE
AOC #693
AOC #694
PRESENT SHORELINE
106
103
102
1926 SHORELINE (APPROXIMATE)
PIER
AOC #695
COOPER RIVER
DIRECTION OF FLOW
FORMER WHARF AND TRESTLE (BLDG. 312)
18" SUBMERGED DREDGE LINE
18" SUBMERGED DREDGE LINE (ABANDONED)
LEGEND
● – SOIL BORING
△ – ZONE K SEDIMENT SAMPLE
▲ – ZONE J SEDIMENT SAMPLE
⊗ – SOIL BORING TO BE CONVERTED TO A TEMPORARY MONITORING WELL
250 0 250
SCALE FEET
PIER G
COOPER RIVER
PIER H
NAVBASE CHARLESTON
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 2-10
AOCs 693, 694, AND 695
CLOUTER ISLAND
DWG DATE: 09/06/96
DWG NAME: 29CHZK10

2.9 AOC 695, Electric Locomotive Shed, Former Building 119, Clouter Island

AOC 695 consists of former Building 119, an electric locomotive shed which operated from approximately 1922 until 1925, as shown on NAVBASE Charleston maps (Figure 2-2). No other information is available regarding the design features, dimensions, or operating practices of the shed. Upon review of a 1926 map of the Naval Ammunition Depot (obtained after the 1995 RFA was prepared), the original location of Building 119 was determined to be on a portion of a railroad trestle which extended over the Cooper River. The map indicated that this shed was on a spur constructed at the river's shoreline. Since 1929, however, the shoreline has apparently receded and the former location of the AOC is now approximately 50 to 100 feet offshore. No records were obtained which document the demolition and removal of this structure. Waste materials associated with this AOC include solvents and degreasers. Table 2-19 is a description of AOC 695.

Table 2-19
AOC 695
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
AOC 695, Electric Locomotive Shed, Former Building 119, Clouter Island	AOC 695 consists of former Building 119, an electric locomotive shed which operated from approximately 1922 until 1925, as shown on Naval Base Charleston maps. No other information is available regarding the design features, dimensions, or operating practices of the shed. Waste materials formerly associated with this AOC include solvents and degreasers.	Solvents and Degreasers	**Sediment**

Notes:
Pathways highlighted in bold will be sampled.
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*

2.9.1 Previous Investigations

This site has not been previously investigated.

2.9.2 Treatment Alternatives

Because there are no environmental media data, treatment alternatives for this site cannot be evaluated. As outlined in the overall sampling strategy presented in the *Final Comprehensive RFI Work Plan*, treatment alternatives are being identified for sites likely to require remedial action. Data collection efforts will support evaluating these alternatives. Tables B-1 and B-2 (Appendix B) are lists of the treatment alternatives for groundwater and soil/sediment, respectively. Alternatives presented in Appendix B are for preliminary evaluation only. If contaminants are present at concentrations requiring remediation, a CMS will be conducted to identify feasible treatment alternatives.

2.9.3 Data Gaps

No environmental media data have been collected at AOC 695 to characterize the site, to conduct a BRA, or to support a detailed evaluation of treatment alternatives, if necessary. To ensure data collection efforts are sufficient to meet the stated investigation objectives, the following data gaps have been identified and will be resolved:

- There are no data to establish whether COPCs are present for any of the potential migration pathways.
- No data are available for conducting a BRA.
- No data exist to support a detailed evaluation of treatment alternatives, if necessary.

2.9.4 Potential Receptors

Potential receptors that may be exposed to site contaminants include ecological receptors. Data will be generated during the investigation to determine the level of risk to the entire spectrum of current and potential future receptors. Confirmatory sampling will characterize the potential pathways highlighted in Table 2-20.

2.9.5 Objective

The goal of the CSI is to classify the sites as NFI or RFI by using DQO Level III and IV data to determine whether COPCs are present. The objectives of the proposed field investigation at AOC 695 are: 1) to assess impact to sediment from material storage, 2) to provide data to be used in the BRA, and 3) to provide data to be used for the assessment of treatment alternatives, if necessary.

2.9.6 Screening Alternatives

No sampling has been conducted to determine COPCs; therefore, selecting a quantitative screening alternative for sediment samples would be premature. If the proposed collection of the high-quality sediment samples is inadequate to define the areal extent of contamination (if present), the feasibility of employing screening methods will be reevaluated. All sediment samples will be qualitatively screened for VOCs with a FID. All VOC screening results will be recorded in field notebooks and boring logs.

2.9.7 Sampling and Analysis Plan

To fulfill the CSI objectives, the following site-specific sampli[illegible] [illegible] equirements have been proposed. Table 2-20 provides a summary of the t[illegible] [illegible] be collected and the analytical parameters.

Two samples are proposed to be collected fr[illegible] [illegible]ent in the bed of Cooper River in the vicinity of the former electric locomotive s[illegible]

Each proposed sampling location is [illegible]d on Figure 2-10. All sampling will be in accordance with the NAVBASE *Fin[illegible] [illegible]rehensive RFI Work Plan* (E/A&H, 1994).

Table 2-20
AOC 695
Sampling Plan

Matrix	Quantity	Analyses
Sediment	2	Sediment samples will be analyzed for APX9 analytical parameters with TAL Metals.

Engineering Parameters:

Notes:
The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Expansion may be necessary to meet the stated objectives.

The Target Analyte List (TAL) for metals will be used instead of the APX9 list of metals. The TAL list includes elements that are not part of the APX9 list (aluminum, calcium, iron, magnesium, manganese, potassium, and sodium).

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in the *Final Comprehensive RFI Work Plan* (E\A&H, 1994), with a minimum of 10 percent duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

2.9.8 Quality Assurance/Quality Control Samples

Additional sediment will be collected at one sediment sample location at AOC 695. This sample will be submitted for duplicate analyses at DQO Level IV in addition to the site-specific suite of analyses to be reported at DQO Level III.

QC samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).

2.10 Summary of Zone K Sampling

Tables 2-21 and 2-22 are summaries of each site to be investigated and the type and number of samples to be collected for Naval Annex and Clouter Island, respectively. Additional samples for background determination and downgradient stormwater drainage have also been proposed. Sampling for background determination is discussed in Section 3.0.

The downgradient surface/stormwater drainage sample is a nonsite-specific sample proposed to serve as an indicator of the types of materials passing through the stormwater drainage system. Physical inspection and associated mapping of the stormwater drainage system at Naval Annex identified one outlet as the primary exit for stormwater from the area. The location of this outlet is at the southwestern corner of Naval Annex. The sample to be collected at this location is identified on Figure 2-1.

Table 2-23 provides a summary of the monitoring wells to be installed as part of the Zone K RFI and the proposed identification numbers for the monitoring wells.

Table 2-21
Summary of Samples and Analyses
Zone K, Naval Annex

SWMU/AOC	Site Description	Samples		Analyses	Duplicate Samples[d]
		Type	Quantity		
SWMU 161	Vehicle Maintenance Shop	Soil	16	Full Suite[a]	1 APX9[b] at DQO[c] Level IV[c]
		Groundwater	1	Full Suite	None
SWMU 162	Sludge Drying Field	Soil	10	Full Suite	2 APX9 at DQO Level IV
		Groundwater	2	Full Suite	1 APX9 at DQO Level IV

Table 2-21
Summary of Samples and Analyses
Zone K, Naval Annex

SWMU/AOC	Site Description	Samples		Analyses	Duplicate Samples[d]
		Type	Quantity		
SWMU 163	Concrete Pit Area	Soil	10	Full Suite	1 APX9 at DQO Level IV
		Groundwater	1	Full Suite	None
		Groundwater Screening	1	VOC	None
SWMU 164	Blasting Operation	Soil	12	Metals, TPH, SVOC	1 APX9 at DQO Level IV
SWMU 166	Sewer System	Soil	8	Full Suite	1 APX9 at DQO Level IV
		Groundwater	5	Full Suite	1 APX9 at DQO Level IV
		Groundwater Screening	31	VOCs	20% Duplicate, 50% of Duplicates at DQO Level IV
AOC 696	Transformer Area Near Building 2509	Soil	12	PCBs, TPH	1 APX9 at DQP Level IV
AOC 698	Building 2508, Boiler House	Soil	16	VOCs, SVOCs, Metals	1 APX9 at DQO Level IV
		Groundwater	1	Full Suite	None
Storm Water Downgradient	NA	Soil	1	APX9	None
Naval Annex Background	NA	Soil	18	Full Suite	3 APX9 at DQO Level IV
		Groundwater	2	Full Suite	1 APX9 at DQO Level IV
Sample Totals (These totals represent only samples collected for chemical analysis. Additional samples will be collected at each site and tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).		Soil	101		11 APX9 at DQO Level IV
		Groundwater	8		3 APX9 at DQO Level IV
		Groundwater Screening	32		20% Duplicate, 50% of Duplicates at DQO Level IV

Notes:

[a] Full suite of analyses includes volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), cyanide, total petroleum hydrocarbons (TPHs), and metals.

[b] APX9 analyses include the full suite of analyses plus herbicides, organophosphorus pesticides, dioxin, and hexavalent chromium.

[c] Data Quality Objectives (DQO)

[d] Quality control (QC) samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).

Table 2-22
Summary of Samples and Analyses
Zone K, Clouter Island

AOC	Site Description	Samples		Analysis	Duplicate Samples[c]
		Type	Quantity		
AOC 693 and 694	Fuse and Primer House, Former Building 117 and Former Naval Ammunition Depot	Soil	43	APX9[a]	5 APX9 at DQO Level IV[b]
		Groundwater	7	APX9	1 APX9 at DQO Level IV
AOC 695	Electric Locomotive Shed, Former Building 119	Sediment	2	APX9	1 APX at DQO Level IV
Background Samples		Soil	8	APX9	1 APX at DQO Level IV
Sample Totals		Soil	51	APX9	6 APX9 at DQO Level IV
		Groundwater	7	APX9	1 APX9 at DQO Level IV
		Sediment	2	APX9	1 APX9 at DQO Level IV

Notes:

[a] APX9 analyses include the full suite of analyses plus herbicides, organophosphorus pesticides, dioxin, and hexavalent chromium.

[b] Data Quality Objectives (DQO)

[c] Quality control (QC) samples will be collected as specified in Section 13.2 of the *Final Comprehensive Sampling and Analysis Plan, RCRA Facility Investigation* (E\A&H, 1994).

Table 2-23
Zone K
Summary of Monitoring Wells to be Installed at Naval Annex

AOC/SWMU	Number of Proposed Monitoring Wells	Proposed Monitoring Well Identifications
SWMU 161, Vehicle Maintenance Shop	1	NBCK161001
SWMU 162, Sludge Drying Field	2	NBCK162001 and NBCK162002
SWMU 163, Concrete Pit Area	1	NBCK163001
SWMU 166, Sewer System	11	NBCK166001 through NBCK166011
AOC 698, Building 2508, Boiler House	1	NBCK698001
AOC 693 and AOC 694, Clouter Island	6	NBCK694001 through NBCK694006
Background Monitoring Wells	3 (one on Clouter Island)	NBCKGDKNS1, NBCKGDKNS2 (Naval Annex), and NBCKGDKCI1 (Clouter Island)

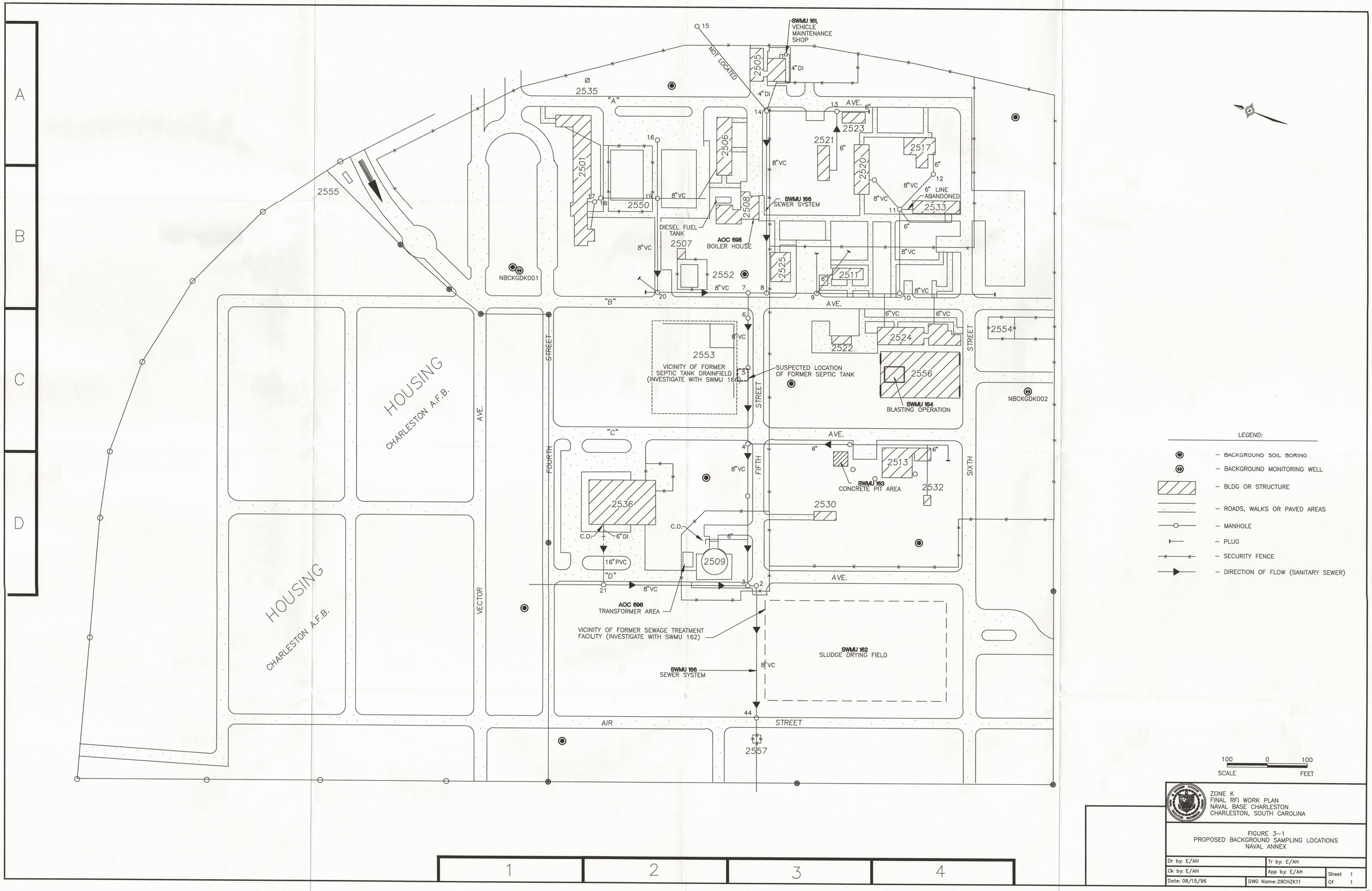
3.0 BACKGROUND DETERMINATION SAMPLING PLAN

Some constituents of soil and groundwater are naturally occurring and ubiquitous, such as metals, or anthropogenic and relatively ubiquitous in some settings, such as polyaromatic hydrocarbons (PAHs) in industrial areas. The following sampling plan will provide data to be used to characterize background concentrations of these naturally occurring or ubiquitous constituents of soil and groundwater. In addition, data from background samples will be used to establish upper bounds (reference concentrations) to which concentrations of inorganic constituents can be compared to determine whether they are significantly higher than background.

Soil samples from nine locations at Naval Annex will be collected for determination of background (Figure 3-1). These samples will be distributed across Naval Annex in apparently unimpacted areas. The full suite (Table 3-1) of analyses will be conducted on samples from four of the sample locations. Metals analysis (SW-846) will be the only analysis conducted on samples from the remaining five sample locations. Two of the samples analyzed for the full suite of analyses will be duplicated and submitted for APX9 analyses to be reported at DQO Level IV.

Four locations on Clouter Island will be selected for collection of background soil samples. If the area of the AOCs on Clouter Island is covered or partly covered with dredge spoil, two of the background sample locations will be selected away from the vicinity of past munitions activities and where no dredge spoil is apparent, while the other two will be away from munitions activities but where dredge spoil is apparent. If the area of the AOCs on Clouter Island is not covered with dredge spoil, all background samples will be collected from areas where no dredge spoil is apparent.

Upper bounds for background concentrations of inorganic constituents in soil can be established by using specified upper tolerance limits (UTLs) of the distribution of background values and/or using the 2-times background criteria. Valid UTLs for background can be calculated if at least


SWMU 161, VEHICLE MAINTENANCE SHOP
NOT LOCATED
2505
4" DI
2535
"A"
AVE.
2523
2521
2517
2520
2501
2506
2550
8"VC
6" LINE ABANDONED
2533
SWMU 166 SEWER SYSTEM
2508
DIESEL FUEL TANK
2507
AOC 698 BOILER HOUSE
2555
NBCKGDK001
2552
2525
2511
"B"
2553
VICINITY OF FORMER SEPTIC TANK DRAINFIELD (INVESTIGATE WITH SWMU 166)
SUSPECTED LOCATION OF FORMER SEPTIC TANK
2522
2524
2556
SWMU 164 BLASTING OPERATION
2554
NBCKGDK002
STREET
HOUSING
CHARLESTON A.F.B.
"C"
FOURTH
FIFTH
SIXTH
2513
SWMU 163 CONCRETE PIT AREA
2532
2530
2536
C.O.
6" DI
16" PVC
2509
"D"
VECTOR
AOC 696 TRANSFORMER AREA
VICINITY OF FORMER SEWAGE TREATMENT FACILITY (INVESTIGATE WITH SWMU 162)
SWMU 162 SLUDGE DRYING FIELD
SWMU 166 SEWER SYSTEM
AIR
2557
LEGEND:
– BACKGROUND SOIL BORING
– BACKGROUND MONITORING WELL
– BLDG OR STRUCTURE
– ROADS, WALKS OR PAVED AREAS
– MANHOLE
– PLUG
– SECURITY FENCE
– DIRECTION OF FLOW (SANITARY SEWER)
100 0 100
SCALE FEET
ZONE K
FINAL RFI WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA
FIGURE 3-1
PROPOSED BACKGROUND SAMPLING LOCATIONS
NAVAL ANNEX
Dr by: E/AH
Tr by: E/AH
Ck by: E/AH
App by: E/AH
Date: 08/15/96
DWG Name: 29CHZK11
Sheet 1
Of 1

00148T05X

Table 3-1
Zone K
Background Sampling Plan

Matrix	Quantity	Analysis
Soil (surface)	9 (Naval Annex) 4 (Clouter Island)	Naval Annex (Soil and Groundwater) - Full Suite[a]
Soil (depth)	9 (Naval Annex) 4 (Clouter Island)	Clouter Island - APX9[b] with TAL metals plus SW-846 Method 8330 Analysis
Groundwater (Shallow)	2 (Naval Annex)	

[a] The full suite of analyses includes VOCs, SVOCs, pesticides/PCBs, cyanide, TPHs, and metals.
[b] APX9 analyses include the full suite of analyses plus herbicides, organophosphorus pesticides, dioxin, and hexavalent chromium.

Engineering Parameters:
Selected soil samples will be tested for permeability, grain size, porosity, total organic carbon (TOC), and cation exchange capacity (CEC).

Notes:
SW-846 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), is a method intended for the trace analysis of explosives residues by HPLC using a UV detector.

Groundwater monitoring wells will be sampled quarterly for one year.

The quantities presented are estimated numbers of samples believed to be needed to fulfill the objectives of the investigation. Additional samples may be necessary to meet the stated objectives. A portion of the lower interval soil samples may not be collected due to shallow depth to groundwater.

Sample locations at Naval Annex as shown on Figure 3-1 may be adjusted due to observations made during the field investigation. Sample locations at Clouter Island will be selected during the field investigation.

All analyses will be performed per SW-846 except where other methods are specified. DQO Level III analyses will be performed as specified in sampling plan, with a minimum of 10% duplicates analyzed for all APX9 constituents at DQO Level IV. The sample quantities presented do not include QA/QC samples.

eight to ten data values are available to estimate standard deviations of background concentrations. Where there are fewer values, upper bounds for background can be established by multiplying the means of the background concentrations by two. Using UTLs is considered to be the more statistically powerful of the two approaches, because UTLs take into account the variance of the background concentrations. The UTL method has been used for previous zone investigations at NAVBASE (Zones H, C, I, and B).

Two monitoring wells will be installed to obtain a measure of the background quality of groundwater in the vicinity of Naval Annex. The location of these background wells will be determined after site-specific wells are installed and the direction of groundwater flow is determined.

4.0 HEALTH AND SAFETY PLAN

4.1 Introduction

The following Zone K Health and Safety Plan (ZK-HASP) is designed to assure the safety and health of site workers throughout the completion of activities related to the U.S. Navy CLEAN Program, RFI for Zone K at NAVBASE Charleston. The Navy project contract number with E/A&H is *N62467-89-D-0318.*

The USEPA has identified numerous SWMUs and AOCs at NAVBASE. Individual SWMUs and AOCs are referred to as sites. Where SWMUs and AOCs overlap or are close together, they are investigated as one site. For investigative purposes, "sites" have been grouped into "Zones." This HASP has been developed for investigating sites in Zone K. Figures 1-2 and 1-3 are maps of Zone K (Naval Annex and Clouter Island, respectively). These maps show the locations of Zone K sites to be investigated.

This ZK-HASP is intended to complement the *E/A&H NAVBASE Charleston Comprehensive Health and Safety Plan* (CHASP) by providing site- and activity-specific details which are not addressed in the CHASP. This document is organized as follows to provide site workers concise discussions of site conditions and expected hazards.

- Section 4.2, Employee Protection, identifies the chemical and physical hazards expected to be encountered throughout and specifies procedures and controls to abate these hazards.

- Section 4.3, Decontamination, provides information on decontamination procedures.

- Section 4.4, Authorized Personnel, specifies who is authorized to do site work.

- Section 4.5, Site-Specific Information, provides site-specific details, including potential site contaminants, proposed site activities, initial level of personal protective equipment (PPE) required for site entry, and action levels for upgrading PPE.

- Section 4.6, Emergency Procedures, provides information on emergency procedures, including, where to go, who to contact, and what E/A&H personnel are and are not authorized to do in an emergency.

Prior to beginning work at a site, personnel shall review the ZK-HASP to make sure that they are aware of known and potential site hazards. A copy of the applicable site-specific section will be photocopied and carried into the field. At least one copy of both this plan and the CHASP shall be available in the field trailer.

4.1.1 Applicability

The provisions of this plan are mandatory for E/A&H Zone K field personnel. These personnel must read this plan and sign the acceptance form (Appendix D) before starting site activities. In addition, personnel will adhere to the most current requirements of Title 29 Code of Federal Regulations 1910.120, Standards for Hazardous Waste Operations and Emergency Response (29 CFR 1910.120 [HAZWOPER]), as specified for workers involved with corrective actions under RCRA.

All non-E/A&H personnel present in E/A&H work areas shall either adopt and abide by this ZK-HASP and the corresponding CHASP or shall have their own safety plan which, at a minimum, meets the requirements of E/A&H's plans. Subcontractors who adopt the provisions of this plan will be responsible for enforcing the plan requirements with their employees and shall provide each employee with PPE and implement controls as specified in the ZK-HASP and the CHASP.

The ZK-HASP applies to specific planned activities and procedures such as hand auguring; installing and developing groundwater monitoring wells; surveying; and collecting soil, groundwater, surface water, and sediment samples. Non-routine procedures and tasks involving non-routine hazards are not adequately addressed in this plan. Examples of such procedures are:

- Confined space entry
- Trenching
- Sampling, handling, or removing unidentified drums
- Working with, or near unexploded ordnance (UXO)

Should it be necessary to conduct these or other high-risk tasks, specific health and safety procedures must be developed, approved, and implemented before proceeding.

4.1.2 Work Zones

Section 2.1 of the CHASP describes the function and interrelation of the three work zones which, in combination, comprise the work area. The three work zones are:

- Exclusion Zone (EZ)
- Contamination Reduction Zone (CRZ)
- Support Zone (SZ)

These work zones will be established and used during field work covered under the ZK-HASP. The location of these zones depends on the work task, layout of the site, weather, and logistical factors. These zones need to be formally marked when working in Level C or Level B.

For purposes of site control, the entire work zone should be delineated to keep unauthorized personnel a safe distance from field activities.

4.1.3 Work Area Access

Authorized personnel (Section 4.4) will be allowed access to work areas as long as they follow the requirements of the ZK-HASP and the CHASP. See also Work Area Access, Section 2.2 of the CHASP.

4.2 Employee Protection

Employee protection appropriate to the work being completed under the Zone K RFI Work Plan was determined through research of site conditions and knowledge of planned activities. This section will identify the chemical and physical hazards known or thought to be present in Zone K. These hazards and hazard abatement procedures are discussed in general in the following sections:

- Section 4.2.1: Work Limitations
- Section 4.2.2: Physical Hazards
- Section 4.2.3: Chemical Hazards
- Section 4.2.4: Selection of PPE
- Section 4.2.5: Air Monitoring

Site-specific issues and concerns are addressed in Section 4.5, Site-Specific Information.

4.2.1 Work Limitations

All site activities will be conducted during daylight. E/A&H assumes that during this investigation, normal activities will continue in Zone K; therefore, investigatory work should be coordinated to minimize impacts to unrelated site activities.

4.2.2 Physical Hazards

Field personnel should be aware of and act in a manner to minimize the dangers associated with physical hazards typically encountered during environmental investigations. These hazards

include heat- and cold-related illnesses, severe weather, aboveground and underground utilities, working with and around drill rigs and heavy equipment, uneven terrain, slippery surfaces, and lifting.

Within Zone K, Clouter Island sites could provide habitat for poisonous flora and fauna, such as poison ivy, stinging insects, and snakes. Depending on the time of year, and the site location, the use of snake chaps could be prudent. Before working at these sites, personnel must check with the Site Health and Safety Officer (SHSO) for more definitive information. Zone K sites at Naval Annex are open, grassy areas; therefore, neither poisonous flora or fauna are expected.

4.2.2.1 Underground Utilities

One safety concern at Zone K is underground utilities. Clouter Island (reportedly) has aboveground utilities; however, underground utilities are likely at Naval Annex sites. To assure site workers' safety during intrusive activities, the following precautions will be utilized:

- A subcontractor specializing in utility location techniques will be employed to assist the field teams in clearing locations for subsurface sampling points.

- Sites covered with asphalt or concrete will be cored before drilling or hand-augering activities begin.

- Subsurface borings will be advanced with a posthole digger or hand auger to 5 feet bgs to ensure that the drill rig will not encounter a subsurface utility.

- If a subsurface obstruction is encountered, the boring will be terminated. When a boring is terminated, the borehole will be pressure grouted to the soil/asphalt or concrete interface, and the asphalt or concrete plug will be cemented back in place flush with the existing surface grade.

Due to the conditions outlined above, all intrusive work will be completed with respect to the requirements specified in 29 CFR 1926.416, including posting the area with appropriate warning signs and using insulated gloves and boots when appropriate.

4.2.2.2 Procedures and Equipment for Extreme Hot or Cold Weather

The SHSO shall be aware of the potential for heat stress and other environmental illnesses. When environmental or work conditions dictate, work regimens shall be implemented to reduce the potential for employee illness. Field staff will be responsible for monitoring co-workers for signs or symptoms of heat- or cold-induced illness. For a discussion of the more common heat- and cold-related illnesses and their associated symptoms, see CHASP Section 6.5.1.

Due to the ambient environmental conditions typical for Charleston, South Carolina, the heat index and/or core body temperature (area and/or personal) will be monitored during hot weather and/or when elevated levels of PPE are used. Measures available to prevent the onset of heat-related illness include adjusting work-rest regimens, using cool vests to help control core body temperature, and providing drinks designed to replenish spent electrolytes (Gatorade, Squench, or similar products). More radical measures such as working at night with proper lighting will be considered if additional precautions are needed.

4.2.2.3 Severe Weather

During extreme weather conditions, the Site Supervisor or SHSO shall use his/her best judgment and has the authority to stop field work or dismiss workers for the day. Examples of conditions that may warrant work stoppage include tornado or hurricane warnings, thunder and/or lightning, high winds, hail, flooding, and snow and ice storms.

Field work shall not be conducted when lightning can be seen from the work area. When lightning is observed or thunder is heard, personnel will cease work, shut down equipment, perform emergency personal and equipment decontamination (Section 4.3.1) as needed, then seek shelter.

4.2.2.4 Working Around Drill Rigs and Heavy Equipment

Heavy equipment and drill rig operations will adhere to the procedures outlined in the CHASP, Appendix B, Drilling Safety Guide.

4.2.2.5 Drilling or Coring Within Buildings

In addition to the hazards present during routine drilling and coring operations, drilling or coring in a building presents an additional hazard — the buildup of exhaust gases and, in particular, carbon monoxide. Carbon monoxide, a colorless and odorless gas, can affect a person with little advance warning or physiological indicators. Early symptoms of overexposure include drowsiness, lack of attention, and headaches. While severe cases of overexposure to carbon monoxide can cause death, a more likely scenario is that a lesser exposure would cause a worker to be inattentive, drowsy, or make a poor decision that results in an serious accident.

While drilling within buildings is not planned for this zone, the following procedures shall be utilized if the drilling program is adjusted to include interior drilling.

The Threshold Limit Value (TLV) (recommended standard) of carbon monoxide is 25 ppm and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) is 35 ppm with a Ceiling Limit (not to exceed) of 200 ppm. When operating an internal-combustion-powered drill or coring rig indoors, even in large open spaces, the TLV and PEL can be reached in a few minutes. To minimize the potential of overexposure, whenever drilling or coring in an enclosed structure, regardless of its size, the following minimum procedures shall be followed:

- Exhaust ducts and "smoke ejectors" (or equivalent) shall be attached to the exhaust stack of the drill or coring rig and extended outside the building. (A smoke ejector is a fan that attaches to flexible ducting and is used to draw exhaust gases down through the duct and exhaust them outside.) The duct exhaust will be located such that the potential for re-entrainment of exhaust gases is negated.

- A real-time, direct-reading carbon monoxide meter shall continuously monitor the EZ. Carbon monoxide readings shall be taken and documented at regular intervals (no more than 30 minutes between readings). The remainder of the time the instrument shall be left running in the work area. The audible alarm shall be set to trigger at a carbon monoxide concentration no higher than 25 ppm.

- To the extent practical, additional measures should be taken to assure adequate ventilation. Suggested measures include opening doors and windows to the outside, using exhaust fans to draw exhaust fumes out of and circulate fresh air into the work area, and setting heating, ventilation, and air conditioning systems to 100% outside air. Use these ventilation measures **before** initiating drilling operations.

- Should carbon monoxide readings reach 25 ppm, work shall be halted, drilling equipment deactivated, and personnel evacuated from the area. Work may not resume in the area until carbon monoxide concentration is less than 10 ppm.

4.2.2.6 Confined Space Entry

E/A&H personnel are required to characterize the potential hazards associated with entering any confined space. Space characterization information is defined as follows:

Confined Space — A space that is (1) large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit; and (3) is not designed for human occupancy. Confined spaces may include, but are not limited to, storage tanks, manholes, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, trenches, vats, and open-top spaces more than 4 feet deep such as pits, tubs, vaults, or any place with limited ventilation.

Permit-Required Confined Space (Permit Space) — A confined space with one or more of the following characteristics: (1) contains or has the potential to contain a hazardous atmosphere; (2) contains a material that can engulf an entrant; (3) has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; or (4) contains any other recognized serious safety or health hazard.

Non-Permit Confined Space — A confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain, any hazard capable of causing death or serious physical harm.

NOTE: **E/A&H PERSONNEL SHALL NOT PERFORM PERMIT- OR NON-PERMIT-REQUIRED CONFINED SPACE ENTRY WITHOUT FIRST OBTAINING WRITTEN APPROVAL FROM A COMPANY PRINCIPAL AND THE PROJECT HEALTH AND SAFETY OFFICER (PHSO). ALL CONFINED SPACE ENTRY WILL BE SUPERVISED BY THE PROJECT HEALTH AND SAFETY OFFICER AND WILL BE CONDUCTED WITH RESPECT TO THE E/A&H CORPORATE CONFINED SPACE ENTRY PROGRAM AND 29 CFR 1910.146.**

It is not anticipated that E/A&H or subcontractor personnel will be required to perform permit- or non-permit-required confined space entry to collect samples. However, if field conditions warrant performance of confined space entry for sample collection or investigation purposes, it will be conducted under the requirements of the E/A&H Corporate Confined Space Entry Program and 29 CFR 1910.146.

4.2.2.7 Radiation Protection

Radioactive materials/hazards are potentially present within Zone K as a result of past operational activities at NAVBASE Charleston. As part of the base closure process, the Navy is required to conduct radiological surveys to verify that all naval-related radioactive materials have been removed.

Once the survey has been completed and the Navy releases the site, work may be performed at that site. This applies to all E/A&H employees and their contractors while conducting field work in Zone K, including but not limited to walkover investigations, drilling, well development, soil sampling, water sampling, and trenching.

4.2.2.8 Waterborne Operations

Waterborne activities are presently proposed for the Clouter Island RFI. Activities involving the use of motorized boats less than 26 feet in length shall be conducted in accordance with the following procedures:

- Each person shall wear a United States Coast Guard (USCG)-approved Type I, II, or III personal flotation device (PFD) while on board.
- Only personnel with boating experience may operate the boat.
- The boat shall be operated at safe speeds at all times.
- All required equipment (listed below) shall be on board before departure.
- Operations involving boating activities should be performed during warm periods (if possible) to minimize cold stress potential. Bulky clothing increases potential for falling overboard.

- Operations involving boating activities will not be performed in rough water or during severe weather conditions (e.g., thunder or lightning).

- Smoking is prohibited while on board.

Equipment Required for Each Boat Used by Field Personnel

- Type I, II, or III PFD per passenger
- Type IV PFD (throw cushion) with rope
- USCG B-I fire extinguisher
- Anchor and line
- Visual distress signal (flag)
- Airhorn
- First-aid kit
- Sunscreen with a sun protection factor of 15 or greater
- Mobile phone with watertight carrying case

4.2.2.9 Standard Safe Work Practices

- Personnel should walk when conducting field work. Running greatly increases the probability of slipping, tripping, and falling.

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

- Hands and face must be thoroughly washed upon leaving the work area.

- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as practical after leaving the CRZ.

- Contact with contaminated or suspected contaminated surfaces should be avoided. Whenever possible, do not walk through puddles, leachate, or discolored surfaces, or lean, sit, or place equipment on drums, containers, or on soil suspected of being contaminated.

- Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on cleanup or response operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Consumption of alcoholic beverages is prohibited.

- Adequate side and overhead clearance must be maintained to ensure that the drill rig boom does not touch or pass close to any overhead power lines or other overhead obstacles or obstructions (Appendix B, Drilling Safety Guide, CHASP).

- Utility lines should be marked using characteristic spray paint or labeled stakes. A buffer zone, 3 yards to either side of a utility line, should be maintained during all subsurface investigations.

- Due to the flammable properties of the potential chemical hazards, all spark or ignition sources should be bonded and/or grounded or mitigated before soil boring advancement or other site activities begin.

4.2.2.10 General Rules of Conduct

- Liquor, firearms, narcotics, tape recorders, and other contraband items are not permitted on the premises.

- Any violation of local, state, or federal laws, or conduct which is outside the generally accepted moral standards of the community is prohibited.

- Violation of the Espionage Act, willfully hindering or limiting production, or sabotage is not permitted.

- Willfully damaging or destroying property, or removing government records is forbidden.

- Misappropriation or unauthorized altering of any government records is forbidden.

- Securing government tools in a personal or contractor's tool box is forbidden.

- Gambling in any form, selling tickets or articles, taking orders, soliciting subscriptions, taking collections, etc., is forbidden.

- Doing personal work in a government shop or office, using government property or material for unauthorized purposes, or using government telephones for unnecessary or unauthorized local or long-distance telephone calls is forbidden.

- Compliance with posted signs and notices is required.

- Boisterousness and noisy or offensive work habits, abusive language, or any verbal, written, symbolic, or other communicative expression which tends to disrupt the work or morale of others is forbidden.

- Fighting or threatening bodily harm to another is forbidden.

- Defacing any government property is forbidden.

- Wearing shorts of any type and/or offensive logos, pictures, or phrases on clothing is forbidden. Shirts, shoes, and pants, slacks, or coverall-type garments will be worn at all times on government property.

- All persons operating motor vehicles will obey all NAVBASE traffic regulations.

4.2.2.11 Medical Monitoring Program

See CHASP Section 7.0.

4.2.3 Chemical Hazards

Chemical hazards are selected to represent the range of acute and chronic health (toxicological) hazards that are, or may foreseeably be present on site. That is, not every chemical known or suspected of being present is listed as a chemical hazard. Rather, one or two of the most toxic or most prevalent contaminants within a class of chemicals are listed. To illustrate this principle, listed below are classes of chemicals or chemical categories in one column, and examples of chemical hazards in the second column.

Class of Chemical/Product	Chemical Hazard
• Chlorinated solvents	perchloroethylene, chloroform, trichloroethylene
• Degreasers	methylene chloride, and 1,1,1-trichloroethane
• Non-chlorinated solvents	benzene, toluene, xylene, ethylbenxene, and hexane
• Metals/heavy metals	lead, cadmium, chromium, hexavalent chromium, mercury, silver, and nickel
• Fuels — gasoline, fuel oil,	benzene, toluene, tetraethyl lead, kerosene, xylene,

Class of Chemical/Product	Chemical Hazard
diesel, lubricants, oils	hexane
• Paints	see Solvents and Metals above, plus tributyl tin
• Pesticides, chlorinated	chlordane, dieldrin, and endrin

The chemical hazards for each investigative site are based on a review of the RFA. Where the RFA identifies specific chemicals, those chemicals are listed in the ZK-HASP as chemical hazards. However, where historical information does not identify the use or disposal of specific COPC(s), the work plan specifies only chemical classes. For the purposes of measuring, evaluating, and preventing worker exposures, the procedures outlined in this document utilize available information and base control measures and PPE on worst-case scenario assumptions. Section 4.5, Site-Specific Information, identifies the specific chemical hazards, when known, and bases exposure monitoring, controls, and PPE on that information. When only the class of chemical is known, exposure monitoring, control procedures, and PPE are designed to accommodate the wide range of chemicals within that class.

Due to the lack of reliable historical data for some sites within Zone K, E/A&H will approach each site investigation with appropriate caution and with site workers trained and equipped to measure and identify chemical hazards potentially generated during each intrusive procedure.

Table 4-1 is a list of chemicals specifically identified in the RFA and others suspected of being present.

Table 4-1
Zone K
Chemical Hazards
Exposure Information

Compound	Ionization Potential (ev)[3]	Odor Threshold (ppm)	OSHA PEL[1]	ACGIH TLV[2]	NIOSH REL[3]	Action Level	Flammable Range[3] (% by volume)
Solvents/Degreasers							
Perchloroethylene	9.3	5	25 ppm	25 ppm 100 ppm- STEL	Potential Occupational Carcinogen	12 ppm	NA
Chloroform	11.4	205	2 ppm	10 ppm Suspected Human Carcinogen	2 ppm Potential Occupational Carcinogen	1 ppm	NA
Trichloroethylene	9.5	50	50 ppm 200 ppm - STEL	50 ppm 100 ppm - STEL	25 ppm Potential Occupational Carcinogen	12 ppm	8 - 10.5
Vinyl Chloride	7.6	260	1 ppm 5 ppm - Ceiling Confirmed Carcinogen	5 ppm Confirmed Human Carcinogen	Potential Occupational Carcinogen	0.5 ppm	3.6 - 33.0
Methylene Chloride	11.4	214	500 ppm 1000 ppm - Ceiling	50 ppm Suspected Human Carcinogen	Potential Occupational Carcinogen	25 ppm	13.0 - 23.0
1,1,1-Trichloroethane	Not Listed	100	350 ppm 450 ppm - STEL	350 ppm 450 ppm - STEL	350 ppm - Ceiling	175 ppm	6.0 - 15.5
Benzene	9.25	4.7	1 ppm 5 ppm - STEL	10 ppm Suspected Human Carcinogen	0.1 ppm 1 ppm Ceiling Potential Occupational Carcinogen	0.5 ppm	1.2 - 7.8
Toluene	8.8	40	100 ppm 150 ppm	50 ppm Skin	100 ppm 200 ppm - Ceiling	25 ppm	1.1 - 7.1

Table 4-1
Zone K
Chemical Hazards
Exposure Information

Compound	Ionization Potential (ev)[3]	Odor Threshold (ppm)	OSHA PEL[1]	ACGIH TLV[2]	NIOSH REL[3]	Action Level	Flammable Range[3] (% by volume)
Solvents/Degreasers							
Ethylbenzene	8.8	140	100 ppm 125 ppm - STEL	100 ppm 125 ppm - STEL	Not Listed	50 ppm	0.8 - 6.7
Xylene	8.6	0.05	100 ppm 150 ppm - STEL	100 ppm 150 ppm - STEL	100 ppm 200 ppm - Ceiling	50 ppm	0.9 - 7.0
2-Butanone (MEK)	6.7	10	200 ppm 300 ppm - STEL	200 ppm 300 ppm - STEL	200 ppm	100 ppm	1.4 - 11.4 (200° F)
Hexane	10.2	130 ppm	500 ppm 1000 ppm - STEL	50 ppm	100 ppm	25 ppm	1.1 - 7.5
Polychlorinated Biphenyls (PCBs)	Not Listed	Not Listed	0.5 mg/m³ Skin	0.5 mg/m³ 1 mg/m³ Skin	Not Listed	0.25 mg/m³	NA
Ethylene Glycol	9.3	Not Listed	50 ppm - Ceiling	50 ppm - Ceiling	Not Listed	25 ppm	NA
Metals							
Lead	N/A	N/A	0.05 mg/m³	0.15 mg/m³	<0.1 mg/m³	0.025 mg/m³	NA
Cadmium	N/A	N/A	0.05 mg/m³	0.002 mg/m³ - Respirable Fraction 0.01 mg/m³ - Total Dust	Lowest Feasible Concentration	0.01 mg/m³	NA
Chromium	N/A	N/A	1 mg/m³	1 mg/m³	0.5 mg/m³	0.25 mg/m³	NA
Mercury	N/A	N/A	0.05 mg/m³ - Skin	0.025 mg/m³ - Skin	0.05 mg/m³	0.012 mg/m³	NA
Silver	N/A	N/A	0.01 mg/m³	0.1 mg/m³	Not Listed	0.005 mg/m³	NA

Table 4-1
Zone K
Chemical Hazards
Exposure Information

Compound	Ionization Potential (ev)[3]	Odor Threshold (ppm)	OSHA PEL[1]	ACGIH TLV[2]	NIOSH REL[3]	Action Level	Flammable Range[3] (% by volume)
Metals							
Copper	N/A	N/A	0.1 mg/m³ - Fume 1 mg/m³ - Dust	0.2 mg/m³ - Fume 1 mg/m³ - Dust	Not Listed	0.05 mg/m³ - Fume 0.5 mg/m³ - Dust	NA
Potassium Cyanide	N/A	N/A	5 mg/m³	5 mg/m³ - Ceiling Skin	5 mg/m³ - Ceiling	2.5 mg/m³	NA
Sodium Cyanide	N/A	N/A	5 mg/m³	5 mg/m³ - Ceiling Skin	5 mg/m³ - Ceiling	2.5 mg/m³	NA
Nickel	Not Listed	Not Listed	1 mg/m³	1 mg/m³	0.015 mg/m³ Potential Occupational Carcinogen	0.007 mg/m³	NA
Fuels							
Tetraethyl Lead	11.1	Not Listed	0.075 mg/m³ - Skin	0.1 mg/m³ - Skin	<0.1 mg/m³	0.037 mg/m³	? - 1.8
Kerosene	6.8	1	Not Listed	Not Listed	100 mg/m³	50 mg/m³	0.7 - 5.0
Acids							
Nitric Acid	N/A	N/A	2 ppm 4 ppm - STEL	2 ppm 4 ppm - STEL	2 ppm	1 ppm	NA
Sulfuric Acid	N/A	N/A	1 mg/m³	1 mg/m³ 3 mg/m³ - STEL	1 mg/m³	0.5 mg/m³	NA
Hydrochloric Acid	N/A	N/A	7 mg/m³ - Ceiling	7 mg/m³ - Ceiling	Not Listed	3.5 mg/m³	NA
Chromic Acid	N/A	N/A	0.1 mg/m³ - Ceiling	0.05 mg/m³ - Confirmed Human Carcinogen	0.001 mg/m³	0.0005 mg/m³	NA

Table 4-1
Zone K
Chemical Hazards
Exposure Information

Compound	Ionization Potential (ev)[3]	Odor Threshold (ppm)	OSHA PEL[1]	ACGIH TLV[2]	NIOSH REL[3]	Action Level	Flammable Range[3] (% by volume)
Pesticides							
DDT	Not Listed	Not Listed	1 mg/m³ - Skin	1 mg/m³	0.5 mg/m³	0.25 mg/m³	NA
DDE	Not Listed	Not Listed	Not Listed	Not Listed	Not Listed	—	NA
Chlordane	13.4	Not Listed	0.5 mg/m³ - Skin	0.5 mg/m³ - Skin	Potential Occupational Carcinogen	0.25 mg/m³	NA
Dieldrin	Not Listed	0.041	0.25 mg/m³ - Skin	0.25 mg/m³ - Skin	Potential Occupational Carcinogen	0.12 mg/m³	NA
Endrin	Not Listed	Not Listed	0.1 mg/m³ - Skin	0.1 mg/m³ - Skin	Not Listed	0.05 mg/m³	NA
Malathion	Not Listed	Not Listed	10 mg/m³	10 mg/m³ - Skin	15 mg/m³	5 mg/m³	NA
Parathion	Not Listed	Not Listed	0.1 mg/m³ - Skin	0.1 mg/m³ - Skin	0.05 mg/m³	0.025 mg/m³	NA
Additional Site Contaminants							
Freon (Chlorodifluoro - Methane)	Not Listed	Not Listed	1000 ppm	1000 ppm	Not Listed	500 ppm	NA
Hydrogen Sulfide	10.46	0.009	10 ppm, 8 hr. 15 ppm STEL	10 ppm, 8 hr. 15 ppm STEL			4.0 - 44.0
Benzo (a) pyrene	NA	NA	0.2 mg/m³	0.2 mg/m³ Confirmed Human Carcinogen	0.1 mg/m³ Potential Occupational Carcinogen	0.1 mg/m³	NA

Table 4-1
Zone K
Chemical Hazards
Exposure Information

Compound	Ionization Potential (ev)[3]	Odor Threshold (ppm)	OSHA PEL[1]	ACGIH TLV[2]	NIOSH REL[3]	Action Level	Flammable Range[3] (% by volume)
Benzo (b) fluoranthene	NA	NA	0.2 mg/m³	0.2 mg/m³ Confirmed Human Carcinogen	0.1 mg/m³ Potential Occupational Carcinogen	0.1 mg/m³	NA

Notes:
1 29 CFR 1910.1000, Table Z-1-A. Limits For Air Contaminants.
2 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGIH.
3 NIOSH Pocket Guide to Chemical Hazards, June 1990.
4 Odor Thresholds for Chemicals with Established Occupational Health Standards, American Industrial Hygiene Association, 1989, Range of All Reference Values.

4.2.4 Selection of PPE

Protective equipment is selected based on the types, concentrations, and routes of personal exposure that may be encountered. In situations where the types of materials and possibilities of contact are unknown or the hazards are not clearly identifiable, a more subjective determination must be made of the PPE required, and greater emphasis is placed on experience and sound safety practices. As discussed above, PPE for site workers will be based on previous site history and on the activities to be performed there. Section 4.5, Site-Specific Information, is a description of the site, the work planned there, and the hazards and specify PPE for those activities, based on the site chemical and physical hazards. PPE requirements are subject to change as site information is updated or changes. **A decision to deviate from specified levels of PPE as contained in this ZK-HASP must be made or reviewed by the PHSO.** Table 4.2 presents the levels of PPE which may be employed at Zone K, and the criteria for upgrading PPE.

Table 4-2
Level of Protection and Criteria

Level of Protection	Criteria for Use	Equipment
Level A	• When atmospheres are "immediately dangerous to life and health" (IDLH in the *NIOSH/OSHA Pocket Guide to Chemical Hazards* or other guides.) • When known atmospheres or potential situations exist that could affect the skin or eyes or be absorbed into the body through these surfaces. Consult standard references to obtain concentrations hazardous to skin, eyes, or mucous membranes. • Potential situations include those where immersion may occur, vapors may be generated, or splashing may occur through site activities. • Where atmospheres are oxygen-deficient. • When the type(s) and or potential concentration of toxic substances are not known.	• Positive-pressure, full-facepiece, self-contained breathing apparatus (SCBA) or positive-pressure supplied air respirator (SAR) with escape SCBA • Fully encapsulating chemical protective suit • Chemical-resistant inner and outer gloves • Steel toe and steel shank chemical-resistant boots • Hard hat under suit • Two-way radios worn inside suit • Optional: coveralls, long cotton underwear, disposable protective suit, gloves and boots, over fully encapsulating suit

Table 4-2
Level of Protection and Criteria

Level of Protection	Criteria for Use	Equipment
Level B	• When respiratory protection is warranted and cartridge respirators are not appropriate. Examples of these conditions are: — when work area may contain less than 19.5% oxygen, — when expected contaminants do not have appropriate warning properties (e.g., vinyl chloride) or — when cartridges are not available to protect against all contaminants. — potential exposure may exceed protection factor of cartridge respirator. • Hazards associated with limited dermal exposure are not significant.	• Chemical-resistant clothes, coveralls • Positive-pressure, full-face SCBA or SAR with escape bottle • Hard hat • Chemical-resistant outer and inner gloves • Steel toe and steel shank boots • Chemical-resistant outer boots
Level C	• When respiratory protection is warranted and cartridge respirators are appropriate. • When PID or FID readings exceed the AL. • When air monitoring indicates airborne concentration of a chemical is 50% or more of the PEL or TLV. • And the work area contains at least 19.5% oxygen.	• Chemical-resistant coveralls • Full-face, air-purifying respirator equipped with cartridges suitable for the hazard • Hard hat • Chemical-resistant outer and inner gloves • Steel toe and steel shank boots • Disposable outer boots
Modified Level D	• When chemical contamination is known or expected to be present, yet inhalation risk is low and respiratory protection is not required. • Site contaminants may be absorbed through the skin. • The "default level" of PPE required when the ZK-HASP does not specify another level of PPE. • And the work area has at least 19.5% oxygen. • When minimal or no chemical contamination is expected. • When ZK-HASP specifies Level D protection is adequate. • And the work area has at least 19.5% oxygen.	• Chemical-resistant coveralls • Chemical-resistant outer gloves; inner gloves, or glove liners, optional • Steel toe and steel shank boots • Hard hat • Safety glasses with side shields or safety goggles • Work clothes • Inner gloves or chemical-resistant gloves needed to handle soil or water samples • Optional: chemical-resistant outer boots• • Optional: coveralls
Level D	• No significant chemical contamination is expected. • No other level of PPE is specified.	• steel toe shank boots • hard hats • work clothes • chemical resistant gloves when handling or in contact with soils, sediment, or groundwater.

4.2.5 Air Monitoring

Air monitoring for VOCs will be conducted during all invasive site activities. Air monitoring may also be conducted to evaluate airborne contaminants other than VOCs such as mercury

vapors, hydrogen sulfide, carbon monoxide, and combustible gases. When possible, real-time monitoring instruments will be used to measure airborne contaminant levels. If an acceptable real-time instrument is not available or appropriate, colorimetric indicating tubes or air sampling pumps and sorbent tubes will be used.

Air monitoring for VOCs will be accomplished using a photoionization detector (PID) or FID. The PID or FID will be field calibrated to measure VOCs relative to a 100 ppm isobutylene standard. If VOCs are detected, colorimetric detector tubes or other sampling media may be used to determine the identification and approximate concentration of these compounds.

The PHSO reserves the right to require personal exposure monitoring or other types of air sample collection and analysis. These samples may be required for a variety of reasons including: PID or FID readings exceed or approach the Action Level (AL), to determine if personal exposures are below OSHA PELs, or to identify a chemical odor. Personal samples may be collected during each site activity in which Level C PPE is prescribed. Sampling strategies will be biased to represent worst case exposures. Personal monitoring samples will be collected and analyzed with respect to National Institute for Occupational Safety and Health (NIOSH) *Manual of Analytical Methods*.

Air monitoring for respirable dusts may be performed using a real-time aerosol monitor (miniRAM) to measure airborne dust concentrations. In addition to the real-time monitor, some air samples should be collected to document the actual concentrations measured per a NIOSH-approved method.

A combustible gas indicator (CGI) may be used during soil borings and well installations. The CGI will be field-calibrated to measure flammable gases relative to a methane standard. Downhole CGI readings will be collected periodically during soil-disturbing operations. If CGI readings reach 17% of the lower explosive limit monitoring should be semi-continuous. Field

activities will immediately cease if downhole readings exceed 20% of the LEL. The area will be evacuated and the situation re-evaluated to determine how to proceed. LEL site operations may not proceed until downhole readings are below 10%.

4.2.5.1 Action Level and Ceiling Concentration

Each site at NAVBASE has a designated AL and ceiling concentration. For this project, the AL is defined as the PID or FID reading in the breathing zone above which respiratory protection must be upgraded; chemical protective clothing may also be upgraded. The AL is determined on a site-by-site basis. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

The general AL for this zone, as determined on a properly calibrated PID or FID, is 5 PID or FID units above background. PPE shall be upgraded to Level C (assuming that cartridge respirators are appropriate, otherwise Level B) if airborne VOC concentrations in the breathing zone exceed the AL, or if the concentration of any contaminant exceeds 50% of the OSHA PEL. This baseline AL and PPE requirement may be superseded by more stringent site-specific levels, as identified in each Site-Specific Hazard Analysis and Employee Protection section.

If breathing zone concentrations exceed the AL, or if site conditions indicate that additional health and safety precautions are needed, field activities in the area shall stop. Field staff shall notify the Site Supervisor of the situation and he/she shall contact the Project Manager and/or the PHSO. The PHSO will be responsible for reassessing the hazards and prescribing revised health and safety requirements as necessary, including upgraded PPE requirements, revised work schedules, and revised decontamination procedures. Table 4-2 includes specific criteria for each protection level.

If PID or FID readings exceed 10 units, the SHSO shall contact the PHSO to discuss the need to identify and quantify airborne contaminants. Work shall not proceed until breathing zone concentrations return to background levels and it is reasonably anticipated that breathing zone readings will stay approximately at background levels, or the chemical constituent(s) are identified and appropriate PPE is donned.

The ceiling concentration is defined as the maximum allowable PID or FID reading in the breathing zone regardless of PPE. A ceiling concentration of 50 PID or FID units has been established. Should VOC concentrations exceed 50 ppm in the breathing zone, field workers should secure their equipment and leave the site. Work shall not resume until the Site Supervisor understands why VOC concentrations became elevated, knows the major constituents of the VOCs being generated, and the VOCs in the breathing zone are less than 5 ppm or workers have upgraded to Level C or Level B. The proper PPE upgrade shall be determined by the PHSO based on site-specific chemical information (i.e., if there is enough information to determine that air-purifying respirators will provide sufficient protection).

Field monitoring readings will be recorded in a field logbook, and copies must be posted daily for field personnel review.

4.2.5.2 Equipment Maintenance

Before being used daily, PIDs, FIDs, CGIs, and other monitoring equipment shall be calibrated or their proper function verified. Throughout the day, this equipment shall be periodically checked to ensure that it is working properly. A final calibration shall be conducted at the end of the work day, at which time each instrument will be checked to ensure that it is free from surface contamination. Air monitoring equipment shall detect the calibration standard within a range of plus or minus 10%, otherwise, the instrument shall be considered malfunctioning. Field staff shall note in their field logbooks that they conducted these calibrations and checks and note whether the equipment was functioning properly.

When equipment is not functioning properly, it should be brought to the attention of the Site Supervisor or SHSO, who will arrange to repair or replace that equipment as needed.

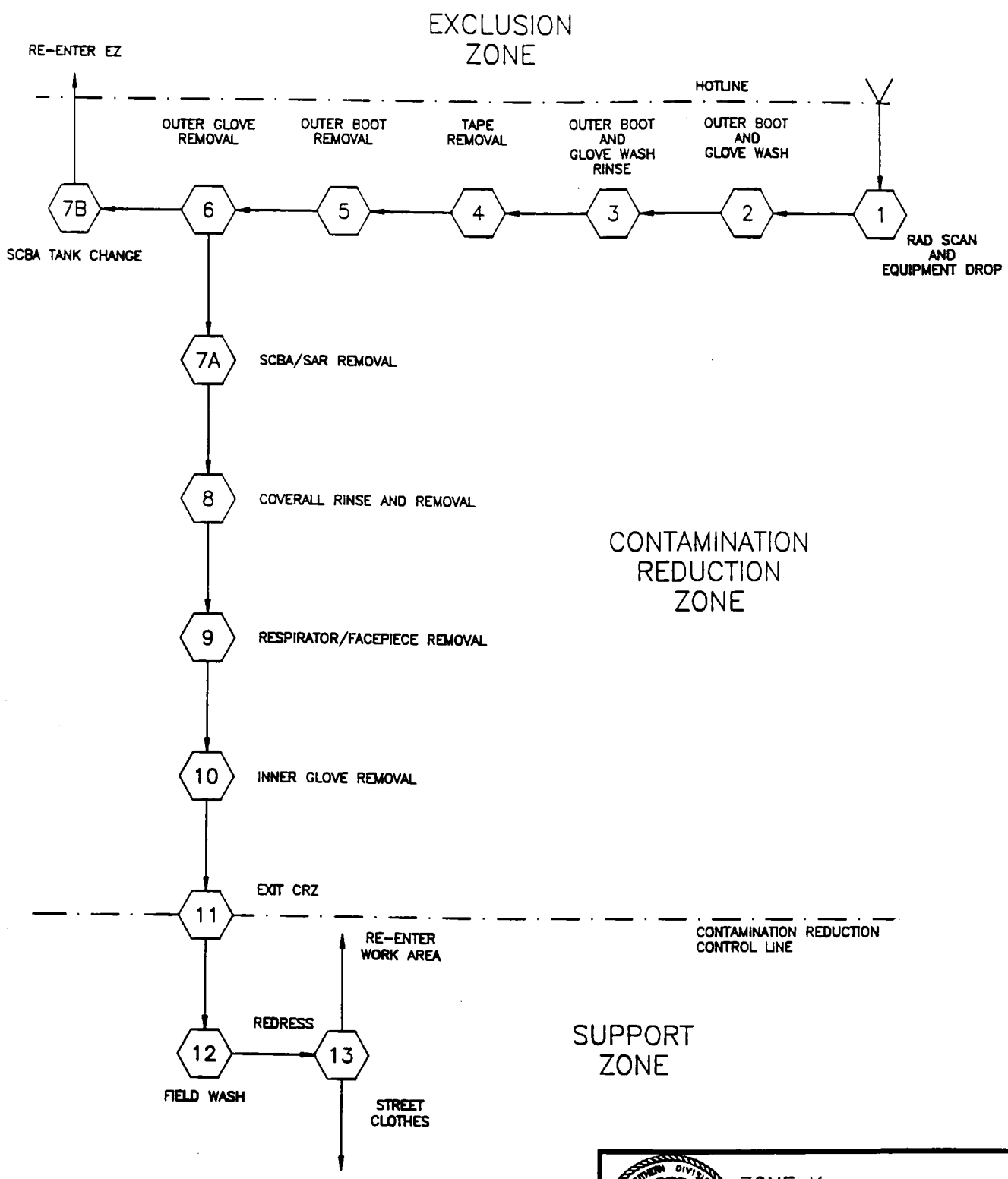
4.3 Decontamination

4.3.1 Personnel and Equipment Decontamination

As needed, a CRZ will be established adjacent to EZs established for invasive activities and will include stations for decontaminating personnel, PPE, and hand tools. Typically, a portion of the CRZ will be covered with sheets of 6-mil polyethylene (generally, an area 20 feet by 20 feet is sufficient) with specific stations to accommodate the removal and disposal of the protective clothing, boot covers, gloves, and respiratory protection.

Heavy equipment and field equipment that cannot be adequately decontaminated in the CRZ may be decontaminated at a more centrally-located decontamination pad. Table 4.3 is a list of equipment that may be convenient to have on site to decontaminate heavy equipment and vehicles; this table also has an explanation of how this equipment may be used.

The full contamination layout provided on Figure 4-1 shows one method of setting up an acceptable decontamination area for Level B PPE. There are numerous ways to lay out decontamination areas. Decontamination areas for Level C and Modified Level D PPE should be based on this concept of decontamination but can be scaled back in accordance with the decontamination needs of the specific site and level of PPE. As a general rule, people working in the CRZ, assisting in the decontamination of workers leaving the EZ, shall be outfitted in PPE that is one protection level below what the exiting workers are using. For example, if workers leave the EZ in Level C, personnel in the CRZ should be in Modified Level D.



ZONE K
HEALTH AND SAFETY PLAN
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4-1
FULL DECONTAMINATION LAYOUT
LEVEL B PROTECTION

DWG DATE: 03/27/96 | DWG NAME: 29FDLLPK

Often equipment may be adequately decontaminated using a soapy wash solution and following specified rinsing procedures. Normally, equipment decontamination will be completed in Level D with gloves or Modified Level D PPE.

Table 4-3
Equipment Recommended for Decontaminating Heavy Equipment and Vehicles

- Tanks or drums to store collected wash and rinse solutions. Alternatively, equipment to treat collected wash and rinse solutions may be substituted.
- Pumps and filters as needed to collect wash and rinsate solutions.
- Pressurized steam sprayers for steam cleaning equipment.
- Long-handled brushes for general cleaning of exterior surfaces. Also, shovels and other equipment may be used to dislodge caked-on contaminated mud on the undercarriage or in the tires.
- Wash solutions, selected for their ability to remove (dissolve, etc.) contaminants
- Rinse solutions, selected for their ability to remove contaminants and wash solutions.
- Pressurized sprayers for washing and rinsing, particularly hard-to-reach areas.
- Clean buckets that can hold cleaning and rinsing solutions.
- Brooms and brushes that can be used to clean the interior, operator areas of vehicles and equipment.

In the event of inclement weather (e.g., lightning) or an emergency requiring immediate evacuation, contaminated equipment will be bagged or wrapped and taped in 6-mil polyethylene sheeting and tagged as "contaminated" for later decontamination. Respirators not only need to be decontaminated and cleaned between uses but also need to be sanitized. Alcohol swabs are generally sufficient.

4.3.2 Full Decontamination Procedures

Workers shall use the following cleaning and decontamination procedures when exiting the EZ. These procedures should be followed when workers are leaving the area for lunch, at the end of their shift, or when work is completed for an EZ. Procedures for rest breaks and changing

SCBA tanks and cartridges are described in Section 4.3.3. Not all steps apply to every situation; workers should follow applicable procedures. Decontamination procedures shall start at the EZ/CRZ interface and continue away from the EZ toward the SZ.

Full Decontamination

1. ***Equipment drop***. Deposit used equipment onto plastic drop cloths or into a plastic-lined tub. All gross contamination should be removed here, fine cleaning and decontamination of equipment may be completed here or elsewhere. Before moving equipment that is still contaminated, it must be wrapped and taped.

2. ***Outer boot and glove wash***. Wash/remove gross contamination from outer boots, outer gloves, SCBA, and/or airline equipment.

3. ***Tape removal***. Remove tape from ankles and wrists and dispose of in plastic-lined drum.

4. ***Outer boot removal***. Remove outer boots; disposable outer boots may be disposed of in the same waste container used in Step 4. Non-disposable boots need a thorough cleaning before they can be removed from the site. (If non-disposable boots are used, it is preferable to have them dedicated to the project.)

5. ***Outer glove removal***. Remove and dispose of outer gloves. Gloves may be disposed in the same waste container as used in Step 4.

6. ***SCBA and SAR removal***. For Level B*.

   SCBA — With buddy or other site worker, remove backpack, remove facepiece, and shut off air flow.

SAR — With buddy or other site worker, remove harness and escape bottle, remove face piece, and shut off air flow.

* If coveralls are significantly contaminated, leave the respirator facepiece on, disconnect the air hose just downstream of the regulator, turn off the flow of air, remove the backpack or equipment harness, and leave the facepiece in place. Remove the facepiece in Step 9.

7. ***Coverall removal.*** Rinse coveralls, if needed; remove coveralls and dispose of them. The same drum may be used as in Step 4. Non-disposable coveralls shall be double-bagged with the outer bag clearly labeled "contaminated."

8. ***Respirator removal.*** Remove respirator (or facepiece of Level B equipment, if it is still being worn). Dispose of spent cartridges, clean, disinfect, dry, and properly store respirator or facepiece.

9. ***Inner glove removal.*** Remove and dispose of inner gloves.

10. ***Exit area.*** Exit the CRZ via the SZ.

11. ***Field wash.*** Wash and rinse hands and face.

12. ***Re-dress.*** Re-dress into appropriate PPE for re-entry or change into street clothes.

Notes:

- All wastes (soil and water) generated during personal decontamination will be collected in 55-gallon drums. The drums will be labeled by E/A&H personnel; final disposal will be by the Navy.

- Hard hats and eye protection should be washed at the end of each work day with soap and water solution.

4.3.3 Partial Decontamination Procedures

To change a respirator cartridge or SCBA tank:

1. ***Outer boot and glove wash.*** Wash outer boots and gloves. Wash/remove gross contamination from SCBA and/or airline equipment.

2. ***Tape removal.*** Remove tape from ankles and wrists and dispose of it in a plastic-lined drum.

3. ***Facepiece removal.*** Disconnect facepiece and air hose just downstream of regulator. The facepiece may remain in place, or be removed and cleaned. Remove the spent tank from the backpack and replace it with a full tank. Connect air hose and turn on air.

4. ***Respirator removal.*** Remove respirator, remove used cartridges, clean and disinfect respirator, install new cartridges, and don respirator.

5. ***Respirator check.*** Check to make sure that the respirator still seals properly to your face.

6. ***Don clean PPE.*** Put on clean outer gloves, tape wrists (as applicable), and re-enter EZ.

When taking a rest break:

1. ***Outer boot and glove wash.*** Wash outer boots and gloves. Wash/remove gross contamination from SCBA and/or SAR equipment.

2. ***Tape removal.*** Remove tape from ankles and wrists and dispose in a plastic-lined drum.

3. ***Respirator removal.*** Remove SCBA unit, SAR harness, or respirator, and place in a clean area; plastic sheeting may be needed.

4. ***Coverall removal.*** Remove outer wear if it is ripped or significantly contaminated. In hot weather, at least unzip and pull down upper half of coveralls.

5. ***Inner glove removal.*** Remove and dispose of inner gloves.

6. ***Wash.*** Wash and rinse hands and face at the field wash station.

7. ***Rest break.*** Take rest break. Remember to drink plenty of water, Gatorade, or other similar beverage.

8. ***Don inner gloves.*** Put on inner gloves.

9. ***Don PPE.*** Don coveralls, outer boots, and outer gloves. Tape wrists and ankles (as needed), and re-enter the EZ.

Decontamination procedures, based on Level D protection:

- Brush heavily soiled boots and rinse outer gloves and boots with soap and water.
- Remove gloves and deposit them in a trash container.
- Dispose of gloves and other disposable PPE in a trash container.
- Wash hands and face, and preferably shower as soon as practical.

4.3.4 Closure of the Decontamination Station

All disposable clothing and plastic sheeting used during site activities at sites with Level D through Level C will be double-bagged and disposed of in a refuse container. Decontamination and rinse solutions and disposable PPE from Level B sites will be placed in a labeled 55-gallon drum (separate solids and liquids) for later analysis and disposal. All washtubs, pails, buckets, etc., will be washed and rinsed at the end of each workday.

4.4 Authorized Personnel

Authorized Personnel — Only those individuals identified as necessary to the investigative operations at each work site will be considered authorized. The Navy and E/A&H will determine which personnel are necessary and authorized. E/A&H personnel who are to perform work in an E/A&H controlled area shall have current HAZWOPER training certificates on file on site, shall be under appropriate medical surveillance, and shall be equipped and willing to don all PPE specified by the health and safety plan. Individuals whose current documentation is not on file, or those with more recent documentation (have attended a refresher course), will provide the Site Supervisor copies of their documentation before entering any work area.

Subcontractors, Department of Defense (DOD) oversight personnel, and other site visitors shall also demonstrate compliance with the requirements specified above, prior to being designated "authorized personnel."

Personnel anticipated to be on site at various times during site activities include:

- Engineer-in-Charge — Matthew A. Hunt (SOUTHDIV)
- Site Contact — Bo Camp (Caretaker Site Office, Naval Base Charleston)
- Principal-In-Charge — James Speakman PhD, PE (E/A&H)
- Task Order Manager/Project Manager — Lawson Anderson (E/A&H)
- Project Health and Safety Officer — David Isenberg, CIH (E/A&H)

- Site Supervisor — Britton Dotson, PG (E/A&H)
- Site Health and Safety Officer — Tim McCord (E/A&H)
- Field staff and subcontractors to be determined.

Responsibilities of Key Field Staff

Key field staff for this project, in terms of health and safety are:

- Site Supervisor
- Site Health and Safety Officer
- (All) Field Staff

The primary health and safety responsibilities associated with each of these positions are delineated in the CHASP, Sections 8.1, 8.2, and 8.3, respectively.

4.5 Site-Specific Information

4.5.1 SWMU 161, Vehicle Maintenance Shop, Naval Annex

SWMU 161 consists of a gravel parking area, a vehicle maintenance and washing area associated with Building 2505 (Figure 2-2). The gravel parking area is adjacent to the south side of Building 2505, and heavy equipment such as trucks and backhoes are parked in this area. Isolated stains, as would be expected in a heavy equipment parking area, are present across the parking area. A vehicle maintenance and wash bay was constructed over a portion of the parking area in 1993. This area is equipped with a drainage system and collecting tank, the contents of which are pumped into an approximately 250-gallon oil/water separator. Table 4-4 is a summary of available site information.

Table 4-4
SWMU 161
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 161, Vehicle Maintenance Shop, Naval Annex	SWMU 161 consists of a gravel parking area and a vehicle maintenance and washing bay associated with Building 2505. The gravel parking area is adjacent to the south side of Building 2505, and heavy equipment such as trucks and backhoes are parked in this area. Isolated stains are present across the parking area. A parts washer is located in the maintenance bay area. The vehicle maintenance and wash bay was constructed over a portion of the parking area in 1993. The wash bay has a drainage system and collection sump; the contents of which are pumped into an approximately 250-gallon oil/water separator connected to the sanitary sewer system.	Petroleum Products, Metals Solvents	**Soil** Soil Gas **Groundwater**

Notes:
[a] Described in the *RCRA Facility Assessment, June 6, 1995*.
[b] Pathways scheduled for sampling are in bold.

4.5.1.1 Site Activities

Proposed invasive site activities include collecting soil samples; drilling; hand augering; and the installation, development, and sampling of monitoring wells.

4.5.1.2 Hazard Analysis and Employee Protection

The primary chemical hazard at this site is potential exposure to fuels, oils, solvents, and lubricants, and possibly heavy metals contained in spent motor oils. The initial level of PPE is Level D with nitrile gloves. For air monitoring, implement an AL of 5 units using either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the action level, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

For a discussion of physical hazards present in Zone K, see Section 4.2.2.

4.5.2 SWMU 162, Sludge Drying Field, Naval Annex

SWMU 162 consists of a former sludge drying field located at Naval Annex. This site was used for dewatering wastewater treatment sludge from an Air Force-operated sewage treatment plant. A soccer field has subsequently been constructed in the sludge drying field area. SWMU 162 is located between Fifth and Sixth Streets and "D" Avenue and Air Street. Table 4-5 is a summary of available site information. Based on interviews with Naval and Air Force personnel, it is possible that a liner was installed in the unit prior to use. However, no documentation or other evidence confirming this could be located. Based on an October 19, 1960, schematic drawing reviewed at the NAVBASE Public Works Department, a sewage treatment facility was formerly located adjacent to the sludge drying field at Fifth Street and Avenue D. Figure 2-3 identifies the location of the sludge drying field and the former sewage treatment facility. The location of the former sewage treatment facility and sludge beds was determined from NAVBASE Maps #25713-24, March 6, 1968, and #25713-21. Table 4-5 is a summary of available site information.

Table 4-5
SWMU 162
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 162, Sludge Drying Field and Former Sewage Treatment Facility, Naval Annex	SWMU 162 consists of a former sludge drying field located at Naval Annex. This site was used for the dewatering of wastewater treatment sludge from an Air Force-operated sewage treatment plant. SWMU 162 is between Fifth and Sixth Streets and "D" Avenue and Air Street. SWMU 162 also includes the former sewage treatment facility.	Paint residue, heavy metals, decomposition gases	**Soil** Soil Gas **Groundwater**

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

4.5.2.1 Previous Investigations

This site has not been investigated previously.

4.5.2.2 Site Activities

Proposed invasive site activities include: collecting soil samples; drilling; hand augering; and the installation, development, and sampling of monitoring wells.

4.5.2.3 Hazard Analysis and Employee Protection

No known chemical contamination is present at this site. Potential contaminants include solvents, paints, and fuels. Heavy metals could be associated with paints and spent oils. Also, as a result of sludge decomposition, anaerobic conditions could be present and if so, could generate methane and/or hydrogen sulfide.

The initial level of PPE for this site is Level D with nitrile gloves. While subsurface soil disturbing activities are being conducted, air monitoring shall be conducted for methane and hydrogen sulfide. For methane, follow E/A&H standard procedures for working in potentially explosive atmospheres. Use extreme caution when vapors reach 10% of the LEL. Discontinue operations, shut down equipment, and immediately leave the area if vapors reach 20% of the LEL.

While no volatile compounds are expected, if odors are detected, implement an AL of 5 units on either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

For a discussion of physical hazards present in Zone K, see Section 4.2.2.

4.5.3 SWMU 163, Concrete Pit Area, Naval Annex

SWMU 163 consists of a 10-foot x 10-foot x 2-foot uncovered concrete pit, approximately 100 feet north of Building 2513 at Naval Annex (Figure 2-4). The pit was formerly used as a less-than-90-day accumulation area for hazardous waste generated at the facility. Hazardous waste accumulation in the unit commenced in the middle 1980s and was discontinued in the spring of 1994 when MOMAG 11 was reclassified as a small-quantity hazardous waste generator and a new less-than-180-day accumulation area (SWMU 167) was placed in service. Table 4-6 is a summary of available site information.

Table 4-6
SWMU 163
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 163, Concrete Pit Area, Naval Annex	SWMU 163 consists of a 10'x10'x2' uncovered concrete pit, approximately 100 feet north of Building 2513 at Naval Annex. The pit was used as a less-than-90 day accumulation area for hazardous waste generated at the facility.	Solvents, paint wastes, heavy metals	**Soil** Soil Gas **Groundwater**

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume I, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

4.5.3.1 Previous Investigations

This site has not been investigated previously.

4.5.3.2 Site Activities

Proposed invasive site activities include concrete coring, collecting soil samples; drilling; hand augering; and groundwater sampling using DPT.

4.5.3.3 Hazard Analysis and Employee Protection

No known chemical contamination is present at this site. Potential contaminants include lubricants, solvents, paints, and fuels. Heavy metals could be associated with these wastes.

The initial level of PPE for this site is Level D with nitrile gloves. VOCs may be released during site activities. For air monitoring, use an AL of 5 units as determined using either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

For a discussion of physical hazards present in Zone K, see Section 4.2.2.

4.5.4 SWMU 164, Blasting Operation, Naval Annex

SWMU 164 consists of an abrasive blasting booth formerly located in Building 2556 at Naval Annex (Figure 2-6). Blasting was conducted to remove paint from various types of equipment. The former blasting booth was located in the western end of Building 2556.

A newer blasting booth, installed in approximately 1986, consists of a 15-foot x 15-foot x 10-foot metal structure underlain with concrete. The floor of the booth includes a metal grate to recover blast media during abrasive blasting operations. The booth operates under a negative pressure system to recover blast media for reuse. During operation, exhaust air from the booth, containing airborne blast media, enters a cyclone separator where particulates are removed. However, fugitive emissions of airborne particulates, including lead and cadmium particulates, may occur from this system. Dust has been noted outside the booth, and, given the presence of an exterior bay door approximately 35 feet from the booth, it is possible that dust from the booth has migrated from the building, potentially impacting the surrounding soil. A fuel oil

AST is at the northwest corner of Building 2556. Available site information is summarized in Table 4-7.

Table 4-7
SWMU 164
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
SWMU 164, Blasting Operation, Naval Annex	SWMU 164 consists of a former abrasive blasting booth in Building 2556 at Naval Annex. Fugitive emissions of the dust are likely to have migrated through exterior bay doors, potentially impacting the surrounding soil. A fuel oil AST is at the corner of Building 2556.	Metals, PAHs, Petroleum Products	**Soil** Air Surface Water Groundwater

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathway scheduled for sampling is in bold.

4.5.4.1 Previous Investigations

This site has not been investigated previously.

4.5.4.2 Site Activities

Site activities will include hand augering and collecting soil samples.

4.5.4.3 Hazard Analysis and Employee Protection

No known chemical contamination is present at this site. Potential contaminants include particulate wastes generated by blasting operations, such as lead, cadmium, zinc, tributyltin, and crystalline silica.

The initial level of PPE for this site is Level D with nitrile gloves. VOCs may be released during site activities. This site has an AL of 5 units as determined using either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C.

To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

For a discussion of physical hazards present in Zone K, see Section 4.2.2.

4.5.5 SWMU 166, Sewer System, Naval Annex

SWMU 166 consists of the sewer system serving Naval Annex and the former septic system, excluding the housing area. It is comprised of approximately 5,300 linear feet of gravity sewer lines. Most lines are constructed of vitrified clay, although some are constructed of ductile iron, cast iron, PVC, or polypropylene. All wastewater generated at the Naval Annex is collected by a single trunk line which exits the property at the southwest boundary. A March 5, 1957, Naval Annex schematic identifies the former septic tank system located between Fourth and Fifth Streets and Avenues B and C. The associated leach or tile field contained 26 lines and was located in this same area. It is unknown how long the septic system operated or what was discharged through the system. Figure 2-7 illustrates the layout of the Naval Annex sewer system and the location of the former septic tank and associated drainfield.

The composition of effluent from the sewer system is unknown. No known industrial discharges currently enter the sanitary sewer system. However, a review of processes conducted at the Naval Annex indicates possible contaminants such as heavy metals, petroleum products, and waste paint/solvents. Also, limited biological degradation may occur within the sewer system, generating waste products such as methane and hydrogen sulfide gas. A records review of past building practices is summarized in Table 2-10. Based on this records review, a portion of the sanitary sewer line (enclosed by an open box on Figure 2-7) has been designated for further investigation. The portions of the sewer line highlighted in green on Figure 2-7 will not be considered for further investigation due to the past history of the buildings connected to those portions of the sewer line. Available site information is summarized in Table 4-8.

Table 4-8
SWMU 166
Site Description[a]

Number	Description	Chemical Hazards	Potential Pathways[b]
SWMU 166, Sewer System, Naval Annex	SWMU 166 consists of the sanitary sewer system serving the Naval Annex, excluding the housing area. It is comprised of approximately 5,300 linear feet of gravity sewer lines. Most lines are constructed of vitrified clay, although some are constructed of ductile iron, cast iron, PVC, or polypropylene. A former sewage treatment facility and septic system were also identified during research of the sewer system.	Metals, petroleum products, solvents, paints, and biodegradation gases.	**Soil** **Groundwater** Soil Gas Air

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

4.5.5.1 Previous Investigations

This site has not been investigated previously.

4.5.5.2 Site Activities

The purpose of the field investigation is to identify potentially contaminated areas. The sanitary sewer lines that have the potential to transport toxic chemicals have been identified, and a proposed sampling scheme consisting of strategically placed groundwater sampling and soil boring locations has been developed for each. Site information and proposed sampling locations for sewer lines are shown in Figure 2-7. Sanitary sewer lines with low potential to transport COPCs will not be investigated further.

4.5.5.3 Hazard Analysis and Employee Protection

The sanitary sewer system has not previously undergone an environmental investigation. A review of available site information provides insufficient information for E/A&H to narrow the list of potential chemical hazards which include solvents, chlorinated solvents, paints, fuels, lubricants, and heavy metals.

Due to the potential dermal hazards associated with handling soil and groundwater potentially contaminated with biohazardous material (infectious waste), the initial PPE level specified for invasive field activities is modified Level D with a surgical mask. Nitrile inner and outer gloves (see Table 4-2 for Level of Protection and Criteria) will be used, and outer gloves should be replaced immediately if they become damaged. The AL for this site is a continuous FID or PID reading of 5 units or greater in the breathing zone. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

When conducting invasive activities at this site, air monitoring shall be conducted to ensure that workers do not encounter an explosive atmosphere or high levels of hydrogen sulfide.

Presently, the environmental investigation procedures for this sanitary sewer system call for sampling using DPT. Using this technique, there is no reason for E/A&H personnel or their subcontractors to enter confined spaces. Specific hazards potentially encountered in confined space entry into a sewer system include reduced concentrations of oxygen, combustible concentrations of methane and other gases, hydrogen sulfide, and direct contact, inhalation, and/or ingestion of biohazards (infectious sanitary waste) or chemical contamination.

Should investigatory procedures change to necessitate entrance to a manhole, sewer line, or other confined space, site personnel must immediately notify the PHSO so that acceptable confined space entry procedures can be established. Prior to personnel entering a confined space, acceptable procedures must be written, rehearsed, and followed. Requirements are outlined in OSHA 29 CFR 1910.146 and in the E/A&H Confined Space Entry Program *(E/A&H, A Joint Venture, Corporate Field Health and Safety Manual, 1996.)* An acceptable Confined Space Entry Permit requires the signature of an E/A&H Principal.

Zone K physical hazards and hazard abatement procedures are discussed in Section 4.2.2.

4.5.6 AOC 696, Transformer Area Near Building 2509, Naval Annex

AOC 696 consists of five transformers (2 former, 3 present) located immediately north of Building 2509 at Naval Annex (Figure 2-7). In 1991, sampling was performed on the five transformers to determine if the dielectric fluid contained PCBs. The fluid was determined to contain less than 50 ppm PCBs. That same year, two of the five transformers were removed from service. The remaining transformers are situated on a concrete pad and supply power to Building 2509. A UST is immediately west of AOC 696. An area of distressed vegetation is between the UST and the transformer pad. Available site information is summarized in Table 4-9.

Table 4-9
AOC 696
Site Description[a]

Number	Description	Chemical Hazards	Potential Pathways[b]
AOC 696, Transformer Area near Building 2509, Naval Annex	AOC 696 consists of five transformers (2 former, 3 present) located immediately north of Building 2509 at Naval Annex. In 1991, sampling was performed on the five transformers to determine if the dielectric fluid contained PCBs. The fluid was determined to contain <50 ppm PCBs. Only two of the five transformers are still in service. A UST is immediately west of AOC 696.	PCBs, TPH	**Soil** Soil Gas Groundwater Air

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathway scheduled for sampling is in bold.

4.5.6.1 Previous Investigations

Samples of the transformer fluid were collected in 1991 and determined to contain less than 50 ppm PCBs.

4.5.6.2 Site Activities

Proposed invasive site activities include hand augering and collecting soil samples.

4.5.6.3 Hazard Analysis and Employee Protection

The primary chemical hazard at this site is potential exposure to PCBs and associated oils and lubricants. The initial level of PPE is Level D with nitrile gloves. Heavily stained areas may have been caused by PCB-containing oils; therefore, personnel should avoid walking through such stains. PCBs can be absorbed through the skin and through leather work boots.

VOCs are not expected to be present at this site; however, if odors are detected, implement an AL of 5 units using either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

For a discussion of physical hazards present in Zone K, see Section 4.2.2.

4.5.7 AOC 698, Building 2508, Boiler House, Naval Annex

AOC 698 consists of Building 2508, a former boiler house, located at Naval Annex (Figure 2-8). The unit is designated as an AOC due to the presence of peeling lead-based paint which is present on both the interior and exterior of the building. The building was formerly operated as a boiler house and has been out of service for several years. An approximately 7,500-gallon AST is inside a concrete containment structure, approximately 35 feet from the building. The tank is also coated with peeling paint which may contain lead. A smoke stack for Building 2508 is on the west side of the building. Table 4-10 is a summary of available site information.

Table 4-10
AOC 698
Site Description[a]

Number	Description	Chemical Hazards	Potential Pathways[b]
AOC 698, Building 2508, Boiler House, Naval Annex	AOC 698 consists of Building 2505, a former boiler house, located at Naval Annex. The unit is designated as an AOC due to the presence of peeling lead-based paint which is present on both the interior and exterior of the building. The building was formerly operated as a boiler house and has been out of service for several years. An approximately 7,500-gallon AST is inside a concrete containment structure, approximately 35 feet from the building. The tank is also coated with peeling paint which may contain lead.	Lead, Cadmium, Zinc, from paints and TPH associated with the AST	Soil Surface Water Soil Gas Groundwater Air

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

4.5.7.1 Previous Investigations

Analytical testing of soils collected from areas visually determined to contain paint chips confirmed elevated concentrations of lead in the soil. This testing was conducted using method SW-846 for analysis of TCLP metals.

4.5.7.2 Site Activities

Site activities will include collecting soil samples; drilling; hand augering; and the installation, development, and sampling of monitoring wells.

4.5.7.3 Hazard Analysis and Employee Protection

Expected site hazards are minimal as long as personnel stay away from building structures that are in a poor state of repair. Lead paint and asbestos exposure may be present inside the structure.

The primary chemical hazard at this site is potential exposure to lead-containing paints. These paints may also have other metals present to provide a particular pigment. Cadmium and zinc were often used in paint pigments. The initial level of PPE is Level D with nitrile gloves. While no volatile compounds are expected if odors are detected, implement an AL of 5 units on either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

No site-specific physical hazards are anticipated other than Zone K hazards discussed in Section 4.2.2.

4.5.8 AOC 693, Fuse and Primer House, Former Building 117 and AOC 694, Former Naval Ammunition Depot

Due to proximity and similar histories, AOCs 693 and 694 will be investigated together. AOC 694 encompasses the area of AOC 693. Portions of the multiple-site sampling plan will be AOC-specific.

AOC 693 consists of former Building 117, a fuse and primer house which operated from 1930 until 1939. It is located in a wooded area adjacent to the Clouter Creek Dredge Area on Clouter Island. The structure consists of two rooms with 4-foot x 4-foot entrances. Due to the period of operation of this unit, no other information was found pertaining to the design features or operating practices of this fuse and primer house.

AOC 694 consists of the area surrounding former Building 117, a Naval Ammunition Depot in operation from the 1920s until the 1940s. The location and the dimensions of this explosives storage area are not known. Dredged materials may have been deposited in this area since its

use as an ammunition depot was discontinued. This AOC includes all of the Clouter Creek Dredge Area. Due to its period of operation, no other information was found pertaining to the design features or operating practices of this facility.

Waste materials associated with these units include military explosives. Based on their toxicity characteristic, some explosives contain leachable concentrations of metals. A survey conducted 0by an unexploded ordnance subcontractor will be completed prior to initiating any surveillance or sampling effort at AOC 693 and 694. The survey will be designed to identify the presence of unexploded ordnance at ground surface down to 5 feet bgs throughout the gridded area illustrated on Figure 2-10. Available site information is summarized in Table 4-11.

Table 4-11
AOCs 693 and 694
Site Description[a]

Number	Description	Chemical Hazards	Potential Pathways[b]
AOC 693, Fuse and Primer House, Former Building 117, Clouter Island	AOC 693 consists of former Building 117, a fuse and primer house which operated from 1930 until 1939. It is in a wooded area adjacent to the Clouter Creek Dredge Area on Clouter Island.	Metals, explosives	**Soil** Soil Gas **Sediment** **Surfacewater** Groundwater Air
AOC 694, Former Naval Ammunition Depot, Clouter Island	AOC 694 consists of the area surrounding former Building 117, a Naval Ammunition Depot in operation from the 1920s until the 1940s. The location and the dimensions of this explosives storage area are not known. Dredged materials have reportedly been deposited in this area since its use as a ammunition depot was discontinued. Due to its period of operation, no information was found pertaining to the design features or operating practices of this facility.		

Notes:
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*
[b] Pathways scheduled for sampling are in bold.

4.5.8.1 Previous Investigations

These sites have not been investigated previously.

4.5.8.2 Site Activities

Proposed invasive site activities include hand augering and collecting soil samples and possibly collecting sediment and surface water samples.

4.5.8.3 Hazard Analysis and Employee Protection

No known chemical contamination is present at this site. Potential contaminants include propellants, exploded and unexploded ordnance, and metals.

The initial level of PPE for this site is Level D with nitrile gloves. VOCs may be released during site activities. For air monitoring, use an AL of 5 units as determined using either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

For a discussion of physical hazards present in Zone K, see Section 4.2.2.

4.5.9 AOC 695, Electric Locomotive Shed, Former Building 119, Clouter Island

AOC 695 consists of former Building 119, an electric locomotive shed which operated from approximately 1922 until 1925, as shown on NAVBASE Charleston maps (Figure 2-2). No other information is available regarding the design features, dimensions, or operating practices of the shed. Upon review of a 1926 map of the Naval Ammunition Depot (obtained after the 1995 RFA was prepared), the original location of Building 119 was determined to be on a portion of a railroad trestle which extended over the Cooper River. The map indicated that this shed was on a spur constructed at the river's shoreline. Since 1929, however, the shoreline has apparently receded and the former location of the AOC is now approximately 50 to 100 feet offshore. No records were obtained which document the demolition and removal of this

structure. Waste materials associated with this AOC include solvents and degreasers. Table 2-19 is a description of AOC 695.

Table 4-12
AOC 695
Site Description[a]

Number	Description	Materials of Concern	Potential Pathways[b]
AOC 695, Electric Locomotive Shed, Former Building 119, Clouter Island	AOC 695 consists of former Building 119, an electric locomotive shed which operated from approximately 1922 until 1925, as shown on Naval Base Charleston maps. No other information is available regarding the design features, dimensions, or operating practices of the shed. Waste materials formerly associated with this AOC include solvents and degreasers.	Solvents and Degreasers	**Sediment**

Notes:
Pathways highlighted in bold will be sampled.
[a] Described in the *Final RCRA Facility Assessment, Volume II, June 6, 1995.*

4.5.9.1 Previous Investigations

This site has not been previously investigated.

4.5.9.2 Site Activities

This site is in the Cooper River, sediment sampling is proposed for this site. As the river is expected to be up to ten feet deep at the proposed sample locations, sampling will require the use of a boat. Waterborne activities shall be conducted in accordance with Section 4.2.2.8, Waterborne Activities.

4.5.9.3 Hazard Analysis and Employee Protection

No known chemical contamination is present at this site. Potential contaminants include propellants, exploded and unexploded ordnance, and metals.

The initial level of PPE for this site is Level D with nitrile gloves. VOCs may be released

during site activities. For air monitoring, use an AL of 5 units as determined using either a PID or FID. Should sustainable readings in the breathing zone reach or exceed the AL, upgrade to Level C. To exceed the AL, PID or FID readings should be sustainable. Readings should remain above the AL for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the AL and do not require workers to upgrade their level of PPE.

For a discussion of physical hazards present in Zone K, see Section 4.2.2.

4.6 Emergency Information

All hazardous waste site activities present a potential risk to onsite personnel. During routine operations, risk is minimized by establishing good work practices, staying alert, and using proper PPE. Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated.

If any situation or unplanned occurrence requires emergency assistance, immediately call the appropriate contact from the following list:

Contact	Agency or Organization	Telephone
Bo Camp	Naval Base Charleston, Caretaker Site Office	(803) 743-9985
Matthew A. Hunt	SOUTHDIV Engineer-in-Charge	(803) 743-0525
Law Enforcement	N. Charleston Police	911
Fire Department	N. Charleston Fire Department	911
Ambulance Service	N. Charleston Fire Department	911
Hospital	Roper Hospital	(803) 744-2110
Southern Poison Control Center	———	(800) 922-1117

Contact	Agency or Organization	Telephone
Todd Haverkost	E/A&H Office Manager	(803) 884-0029
Lawson Anderson	E/A&H Task Order Manager	(901) 372-7962
David Isenberg	E/A&H PHSO	(615) 399-8800
Britton Dotson	E/A&H Site Manager	(615) 399-8800 (803) 747-7336

As soon as practical, Bo Camp, NAVBASE; Matthew Hunt, SOUTHDIV Engineer-in-Charge; Todd Haverkost, E/A&H Charleston Office Manager; and David Isenberg, E/A&H PHSO, shall be fully apprised of the situation. Other persons, as appropriate, may also need to be contacted.

4.6.1 Site Resources

A cellular telephone will be available in the SZ for routine and emergency communication/ coordination with NAVBASE, SOUTHDIV, and the E/A&H field office. First-aid and eye wash equipment will be available at the work area and in each field vehicle.

4.6.2 Emergency Procedures

Examples of an emergency include:

- A fire, explosion, or similar event occurs at or near the site whether related to this project or not.

- A member of the field crew sustains a significant injury, or experiences symptoms of a chemical exposure.

- A condition is discovered which suggests that site conditions are imminently more

- A condition is discovered which suggests that site conditions are imminently more dangerous or hazardous than anticipated.

In an emergency, the following emergency procedures should be followed:

- If it is necessary to evacuate the area, immediately proceed to a rally point and remain there until instructed otherwise.

- Use planned escape routes.

- If a member of the field team experiences effects or symptoms of exposure while on the scene, the field crew will immediately halt work and act according to the instructions provided by the Site Supervisor or in his absence the SHSO.

- For applicable site activities, including all Level B activities, use wind indicators to continuously indicate preferred upwind escape routes.

- Investigate condition(s) that suggest that site conditions are more hazardous than anticipated. The condition observed and the decisions made shall be recorded in the safety logbook or in the field logbook if a safety logbook is not being maintained. If there are doubts about how to proceed, suspend work and leave the work area until the PHSO has evaluated the situation and provided the appropriate instructions to the field team.

- If an accident occurs, the Site Supervisor is to complete an Accident Report Form (see Appendix C) for submittal to the managing Principal-in-Charge of the project.

- If a member of the field crew suffers a personal injury, **call 911 if an ambulance is needed**. Next, alert appropriate emergency response agencies as the situation dictates. Complete an Accident Report Form for any such incident.

- If a member of the field crew suffers chemical exposure, flush the affected areas immediately with copious amounts of clean water, and if the situation dictates, the SHSO should alert appropriate emergency response agencies, or personally ensure that the exposed individual is transported to the nearest medical treatment facility for prompt treatment. An Accident Report Form will be completed for any such incident.

Directions to the nearest emergency medical facility capable of providing general emergency medical assistance and treating chemical burns are in Appendix E of this ZK-HASP.

4.7 Forms

The following forms will be used in implementing this HASP:

- Plan Acceptance Form
- Plan Feedback Form
- Exposure History Form
- Accident Report Form

A ZK-HASP Plan Acceptance Form will be completed by all onsite employees before site activities begin. The Plan Feedback Form will be filled out by the SHSO and any other onsite employee who wishes to do so. The Exposure History Form will be completed by both the Site Manager and the individual(s) for whom the form is intended. Examples of each form are in Appendix H of this HASP.

All completed forms must be returned to the Task Order Manager at EnSafe/Allen & Hoshall, Memphis, Tennessee.

5.0 SIGNATORY REQUIREMENT

Condition I.E. of the Hazardous and Solid Waste Amendments (HSWA) portion of RCRA Part B Permit (EPA SCO 170 022 560) states: *All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with 40 CFR §270.11.* The certification reads as follows:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Caretaker Site Officer
Naval Base Charleston

9/13/96
Date

6.0 REFERENCE LIST

AFCEE/ESR. July 1993. *Final RCRA Facility WorkPlan for Charleston Air Force Base, Charleston, South Carolina.* Air Force Center for Environmental Excellence, Environmental Services Office, Environmental Restoration Division, Brooks Air Force Base, Texas 78235-5000.

EnSafe/Allen & Hoshall. 1996. *E/A&H, A Joint Venture, Corporate Field Health and Safety Manual.*

EnSafe/Allen & Hoshall. April 21, 1995. *Comprehensive Corrective Action Management Plan.*

EnSafe/Allen & Hoshall. June 6, 1995. *Final RCRA Facility Assessment for Naval Base Charleston, Volumes I and II.* United States Environmental Protection Agency. Permit, USEPA I.D. No. SCD 170 022 260

EnSafe/Allen & Hoshall. August 30, 1994. *Final Comprehensive RFI Work Plan (E\A&H, 1994)s, Volumes I through V.*

United States Environmental Protection Agency. Region IV. Environmental Services Division. February 1, 1991. *Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual.*

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APPENDIX A

ZONE K SUMMARY OF SWMUs and AOCs

Table A-1
Zone K
Naval Base Charleston
SWMU RFI Summary

SWMU Number	SWMU/AOC Name	Materials Released, Stored, or Disposed	Investigative Approach	Location
161	Vehicle Maintenance Shop	Petroleum Products, Metals, Solvents	CSI	East side of Naval Annex, adjacent to I-26.
162	Sludge Drying Field and Associated Sewage Treatment Facility	Paint Residue, Metals, Methane, Biodegradation Gases	CSI	Naval Annex at the end of Fifth Street between Air Street and "D" Avenue.
163	Concrete Pit Area	Solvents, Paint Wastes, and Metals	CSI	Naval Annex north of Building 2513, adjacent to "C" Avenue.
164	Blasting Operation	Metals, PAHs, and Petroleum Products (due to AST at corner of Building 2556)	CSI	Naval Annex located in Building 2556.
165	Painting Operation	Paint, Lead	NFI	Naval Annex located in Building 2556.
166	Sewer System and Former Septic Tank and Associated Drainfield	Metals, Petroleum Products, Paints, Solvents, and Biodegradation Gases	CSI	Sewer system located throughout Naval Annex. Septic tank and drainfield are located between Fourth and Fifth Streets and "B" and "C" Avenues.
167	Less-than-180-day Accumulation Area, MOMAG 11, CNSY Permit #94	Waste Paints, Petroleum Products, Spent Solvents, Batteries, Heavy Metals, Aerosol Cans	NFI	Naval Annex, south of Building 2522.
194	Building 197, Paint Storage, Naval Short Stay	Paint Waste	NFI	Building 197, Short Stay
195	Building 207, Flammable Storage, Naval Short Stay	Petroleum Products, Solvents	NFI	Building 207, Short Stay

Table A-2
Zone K
Naval Base Charleston
AOC RFI Summary

AOC Number	AOC Name	Materials Released, Stored, or Disposed	Investigative Approach	Location
693	Fuse and Primer House, Former Building 117	Explosives, Metals	CSI	Southern tip of Clouter Island, directly across Cooper River from NAVBASE.
694	Former Naval Ammunition Depot	Explosives, Metals	CSI	
695	Electric Locomotive Shed, Former Building 119	Solvents, Degreasers	CSI - Recommended for NFI	Clouter Island formerly at end of railroad track pier. Now submerged in Cooper River.
696	Transformer Area near Building 2509	PCBs and Petroleum Products (due to UST west of concrete pad)	CSI	Naval Annex, northwest side of Building 2509.
697	Transformer Area near Building 2554	PCBs	NFI	Naval Annex, Building 2554.
698	Boiler House, Building 2508	Lead, Petroleum Products (due to AST adjacent to Building 2508)	RFI	Naval Annex, between "A" and "B" Avenues.

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APPENDIX B

TREATMENT ALTERNATIVES

B-1

Treatment Alternati r Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for impacted groundwater and leachate	Vertical barrier	Slurry wall	Trench around site or hot spot is excavated and filled with bentonite slurry.	Organic/inorganic water chemistry[d] Soil type Soil moisture Particle size distribution Porosity Hydraulic conductivity (saturated and unsaturated) Relative permeability Clay content Soil sorptive capacity Cation exchange capacity Organic carbon content Soil pH Depth to groundwater Groundwater velocity and direction Depth to aquitard (Pilot - Compatibility testing with slurry wall material)
	Groundwater collection	Vertical extraction wells	Vertical wells are used to extract impacted groundwater.	Use of aquifer Depth to water table Direction of flow Rate of flow Hydraulic conductivity (vertical and horizontal) Effective porosity Aquifer type Hydraulic gradient Identification of recharge and discharge areas Identification of aquifer boundaries Aquitard characteristics (Pilot - slug test)

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
	Leachate collection	Subsurface drains	System of perforated pipe laid in trenches onsite to collect impacted groundwater.	Use of aquifer Depth to water table Direction of flow Rate of flow Hydraulic conductivity (vertical and horizontal) Effective porosity Aquifer type Hydraulic gradient Identification of recharge and discharge areas Identification of aquifer boundaries Aquitard characteristics (Pilot - slug test)
To evaluate the feasibility and implementability of treatments for impacted groundwater and leachate	Chemical treatment	Ion exchange	Ion exchange is the process of exchanging selected dissolved ionic contaminants with a set of substitute ions. Ion exchangers are primarily used for recovery of dilute solutions of metals or to soften water by removing calcium and manganese.	Organic/inorganic water chemistry[d] Indicator parameters Bicarbonate Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Copper Iron Magnesium Manganese Nickel Oil and grease pH Potassium Sodium Sulfate Total organic carbon (TOC) Total suspended solids Zinc

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
		Oxidation	Oxidation is a chemical reaction in which one or more electrons are transferred from the chemical being oxidized to an oxidizing agent. Chemical oxidation includes destruction of cyanide transformation of organics to biodegradable forms or detoxification of organics and inorganics.	Organic/inorganic water chemistry[d] Indicator parameters Bicarbonate Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Copper Iron Magnesium Manganese Nickel Oil and grease pH Potassium Sodium Sulfate Total organic carbon Total suspended solids Zinc (Pilot - reagent consumption, optimal pH, and reaction time)

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for impacted groundwater and leachate	Chemical treatment	Metal precipitation	Precipitation is a chemical unit process in which soluble metallic ions are removed from solution by conversion to an insoluble form. Precipitation is commonly used to treat heavy metals, phosphorus, and hardness.	Organic/inorganic water chemistry[d] Indicator parameters Bicarbonate Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Copper Iron Magnesium Manganese Nickel Oil and grease pH Potassium Sodium Sulfate Total organic carbon Total Suspended Solids Zinc (Pilot - chemical dosage, contact time, mixing rate, optimal pH, and sludge handling)
		pH adjustment	Neutralizing agents are added to adjust pH.	Indicator parameters Bicarbonate Calcium Chloride Iron Magnesium Manganese pH Potassium Sodium Sulfate Total Suspended Solids (Pilot - titration curve)

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for impacted groundwater and leachate	Biological treatment	Aerobic	Aerobic treatment is the use of oxygen-utilizing micro-organisms to biodegrade contaminants.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Dissolved oxygen Hardness Metals, dissolved Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Oil and grease Organic carbon pH Phosphorus Total solids Specific conductance Sulfate Sulfide Suspended solids Temperature Volatile suspended solids

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
	Biological treatment	Anaerobic	Anaerobic treatment is the use of non-oxygen-utilizing micro-organisms to biodegrade contaminants.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Dissolved oxygen Hardness Metals, dissolved Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Oil and grease Organic carbon pH Phosphorus Total solids Specific conductance Sulfate Sulfide Suspended solids Volatile suspended solids

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for impacted groundwater and leachate	Physical treatment	Adsorption (granular activated carbon)	Adsorption is a physical separation process in which organic and inorganic materials are removed by sorption or the attraction and accumulation of one substance on the surface of another.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Dissolved oxygen Hardness Iron Metals, dissolved Manganese Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Oil and grease Organic carbon pH Phosphorus Sulfate Sulfide Suspended solids
		Air Stripping	Air stripping refers to the removal of relatively volatile components from wastewater by passage of air, steam, or other gas through the impacted liquid. Air stripping is effective in removing ammonia, chlorinated solvents, monoaromatics, and other VOCs.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Chemical oxygen demand Hardness Iron Manganese Metals, dissolved Oil and grease pH

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for impacted groundwater and leachate	Physical treatment	Sedimentation	Sedimentation is a physical process that removes suspended solids from a liquid matrix by gravitational settling.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Dissolved oxygen Hardness Iron Metals, dissolved Manganese Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Oil and grease Organic carbon pH Phosphorus Sulfate Sulfide Suspended solids

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
		Filtration	Filtration is a physical process used to remove suspended solids from wastewater and is generally preceded by chemical precipitation and neutralization.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Dissolved oxygen Hardness Iron Metals, dissolved Manganese Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Oil and grease Organic carbon pH Phosphorus Sulfate Sulfide Suspended solids

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for impacted groundwater and leachate	Disposal	POTW	A chemical, physical, or biological wastewater treatment plant designed and constructed to treat municipal domestic wastewater.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Dissolved oxygen Hardness Iron Metals, dissolved Manganese Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Oil and grease Organic carbon pH Phosphorus Sulfate Sulfide Suspended solids

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
		RCRA TSDF	The process of chemical, physically, or biologically treating the wastewater in an offsite permitted commercial hazardous waste facility.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Biochemical oxygen demand Calcium Chemical oxygen demand Chloride Dissolved oxygen Hardness Iron Metals, dissolved Manganese Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Oil and grease Organic carbon pH Phosphorus Sulfate Sulfide Suspended solids

Table B-1
Treatment Alternatives For Groundwater/Leachate

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for impacted groundwater and leachate	Disposal	Land application	The process of applying wastewater directly on the land for or to infiltration into the soil.	Depth to water table Total phosphorous Chloride Ammonia Nitrate Alkalinity pH Sodium Total dissolved solids Soil type hydraulic conductivity application rate
		Injection	The process of hydraulically placing wastewater into the aquifer using either vertical or horizontal wells.	Depth to water table Total phosphorous Chloride Ammonia Nitrate Alkalinity pH Sodium Total dissolved solids Total organic carbon Soil type hydraulic conductivity application rate (2.5 gallons/ft^2/day or 5/square root of slowest percolation rate.

[a] USEPA *Conducting Remedial Investigations/Feasibility Studies for Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Municipal Landfill Sites*, EPA/540/P-91/001, Office of Solid Waste and Emergency Response Directive 9355.3-11, February 1991

[b] 40 Code of Federal Regulations (CFR) 268 Land Disposal Restriction

[c] USEPA *CERCLA Site Discharges to POTWs Treatability Manual*, EPA/540/2-90/007, Office of Solid Waste and Emergency Response, August 1990.

[d] VOC and SVOC with TICs, Metals, Cyanide, Pesticides, and PCBs

Table B-2
Treatment Alternatives For Hot Spots, Soil, Sediments, and Waste Materials

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls to prevent contact or runoff	Cap	Native Soil Single Barrier Double Barrier	Capping is the process of placing a physical horizontal barrier across the site.	Moisture content Permeability In-Situ density Atterberg limits Grain size analysis Porosity Depth
	Excavation	Dig up	Excavation is the process of physically removing the hot spot, soil, or waste from the site.	Organic/inorganic water chemistry[d] Moisture content Permeability In-Situ density Atterberg limits Grain size analysis Porosity Depth
	Surface Water Controls	Erosion and runon/runoff controls	Surface water control is a system of vegetation and site grading for preventing soil erosion and stormwater runon/runoff.	Organic/inorganic water chemistry[d] Indicator parameters Acidity-alkalinity Nitrogen, ammonia Nitrogen, kjeldahl Nitrogen, nitrate-nitrite Phosphorus Suspended solids
To evaluate the feasibility and implementability of treatments for impacted soil or waste	Thermal Treatment	Thermal Destruction	Thermal destruction is the process of oxidizing organic and inorganics using high temperature.	Organic/inorganic water chemistry[d] Moisture content Particle size BTU content TCLP
		Thermal Desorption	Thermal desorption is the process of using low temperature to volatilize organics and inorganics from a solid matrix.	Organic/inorganic water chemistry[d] Moisture content Particle size TCLP

Table B-2
Treatment Alternatives For Hot Spots, Soil, Sediments, and Waste Materials

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of treatments for impacted soil or waste	Biological Treatment	Aerobic	Aerobic treatment is the use of oxygen-utilizing micro-organisms to biodegrade contaminants.	Organic/inorganic water chemistry[d] Moisture content Soil Texture Temperature pH Soil microorganisms Total nitrogen Total phosphorus Depth to groundwater Dissolved oxygen Methane Chemical oxygen Demand
To evaluate the feasibility and implementability of treatments for impacted soil or waste	Biological Treatment	Anaerobic	Anaerobic treatment is the use of non-oxygen-utilizing micro-organisms to biodegrade contaminants.	Organic/inorganic water chemistry[d] Moisture content Soil Texture Temperature pH Soil microorganisms Total nitrogen Total phosphorus Depth to groundwater Methane Chemical oxygen Demand
	Physical Treatment	Solidification/ fixation	Solidification is a physical process in which organic and inorganic materials are bound to the surface of another.	Organic/inorganic water chemistry[d] Moisture content Soil Texture Suspended Solids Bulk Density Grain size analysis Atterberg limits Cone index Unconfined Compressive strength Temperature pH
To evaluate the feasibility and implementability of treatments for impacted soil or waste	Physical Treatment	Vacuum Extraction	Vacuum extraction is the removal of relatively volatile components from soil or waste by passage of air, steam, or other gas through the impacted matrix. Air stripping is effective in removing chlorinated solvents, monoaromatics, and other VOCs.	Organic/inorganic water chemistry[d] Moisture content Air Permeability Temperature pH Depth to groundwater

Table B-2
Treatment Alternatives For Hot Spots, Soil, Sediments, and Waste Materials

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of treatments for impacted soil or waste	Physical Treatment	Solvent Extraction	Solvent extraction is a physical separation process in which organic and inorganic materials are removed from the surface of a solid matrix and are added to a liquid matrix.	Organic/inorganic water chemistry[d] Total Organic Carbon Total Recoverable Hydrocarbons Moisture content Soil Texture Permeability Bulk Density Grain size analysis Clay Content Temperature pH Chemical oxygen Demand Cation Exchange Capacity Depth to groundwater TCLP
	Disposal	Consolidation	Consolidation is the process of consolidating the waste, soil, and other debris in a properly designed and constructed landfill.	Organic/inorganic water chemistry[d] Moisture content Permeability In-Situ density Atterberg limits Grain size analysis Depth to Groundwater TCLP
To evaluate the feasibility and implementability of treatments for impacted soil or waste	Disposal	RCRA TSDF	The process of chemical, physically, or biologically treating the contaminant, soil, and other debris in an offsite permitted commercial hazardous waste facility.	Organic/inorganic water chemistry[d] Moisture content Soil Texture Temperature pH Soil microorganisms Total nitrogen Total phosphorus Depth to groundwater Dissolved oxygen TCLP

a USEPA *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, EPA/540/P-91/001, Office of Solid Waste and Emergency Response Directive 9355.3-11, February 1991
b 40 Code of Federal Regulations (CFR) 268 Land Disposal Restriction
c USEPA *CERCLA Site Discharges to POTWs Treatability Manual*, EPA/540/2-90/007, Office of Solid Waste and Emergency Response, August 1990.
d VOC and SVOC with TICs, Metals, Cyanide, Pesticides, and PCBs

TABLE B-3
Treatment Alternatives For Soil Gas

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of controls for subsurface gas	Cap	Native Soil Single Barrier Double Barrier	Capping is the process of placing a physical horizontal barrier across the site.	Moisture content Permeability In-Situ density Atterberg limits Grain size analysis Porosity Depth
	Vent	Vertical Horizontal	Vertical or horizontal wells are used to vent gases.	Moisture content Air Permeability Atterberg limits Grain size analysis Porosity Depth
To evaluate the feasibility and implementability of treatments for impacted soil and contaminants	Thermal Treatment	Thermal Destruction	Thermal destruction is the process of oxidizing organics and inorganics using high temperature.	Organic/inorganic water chemistry[d] Moisture content Particle size BTU content TCLP
		Thermal Desorption	Thermal desorption is the process of using low temperature to volatilize organics and inorganics from a solid matrix.	Organic/inorganic water chemistry[d] Moisture content Particle size BTU content TCLP
	Physical Treatment	Carbon Absorption	Adsorption is a physical separation process in which organic and inorganic materials are removed by sorption or the attraction and accumulation of one substance on the surface of another.	Organic/inorganic water chemistry (VOA and SVOC with TICs, Pesticides, and PCBs) Moisture content Temperature Total Organic Carbon
To evaluate the feasibility and implementability of treatments for impacted soil and contaminants	Physical Treatment	Vacuum Extraction	Vacuum extraction refers to the removal of relatively volatile components from soil or waste by the passage of air, steam, or other gas through the impacted matrix. Air stripping is effective in removing chlorinated solvents, monoaromatics, and other VOCs.	Organic/inorganic water chemistry[d] Moisture content Air Permeability Temperature pH Depth to groundwater

TABLE B-3
Treatment Alternatives For Soil Gas

Data Quality Objective Elements	Remedial Technology[a]	Process Option[b,c]	Description	Data Quality Needs
To evaluate the feasibility and implementability of treatments for impacted soil and contaminants	Disposal	RCRA TSDF	The process of chemically, physically, or biologically treating the contaminant in an offsite permitted commercial hazardous waste facility.	Organic/inorganic water chemistry[d] Moisture content Soil Texture Temperature pH Soil microorganisms Total nitrogen Total phosphorus Depth to groundwater Dissolved oxygen TCLP

[a] USEPA *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, EPA/540/P-91/001, Office of Solid Waste and Emergency Response Directive 9355.3-11, February 1991

[b] 40 Code of Federal Regulations (CFR) 268 Land Disposal Restriction

[c] USEPA *CERCLA Site Discharges to POTWs Treatability Manual*, EPA/540/2-90/007, Office of Solid Waste and Emergency Response, August 1990.

[d] VOA and SVOA w/TICs, Metals, Cyanide, Pesticides, and PCBs

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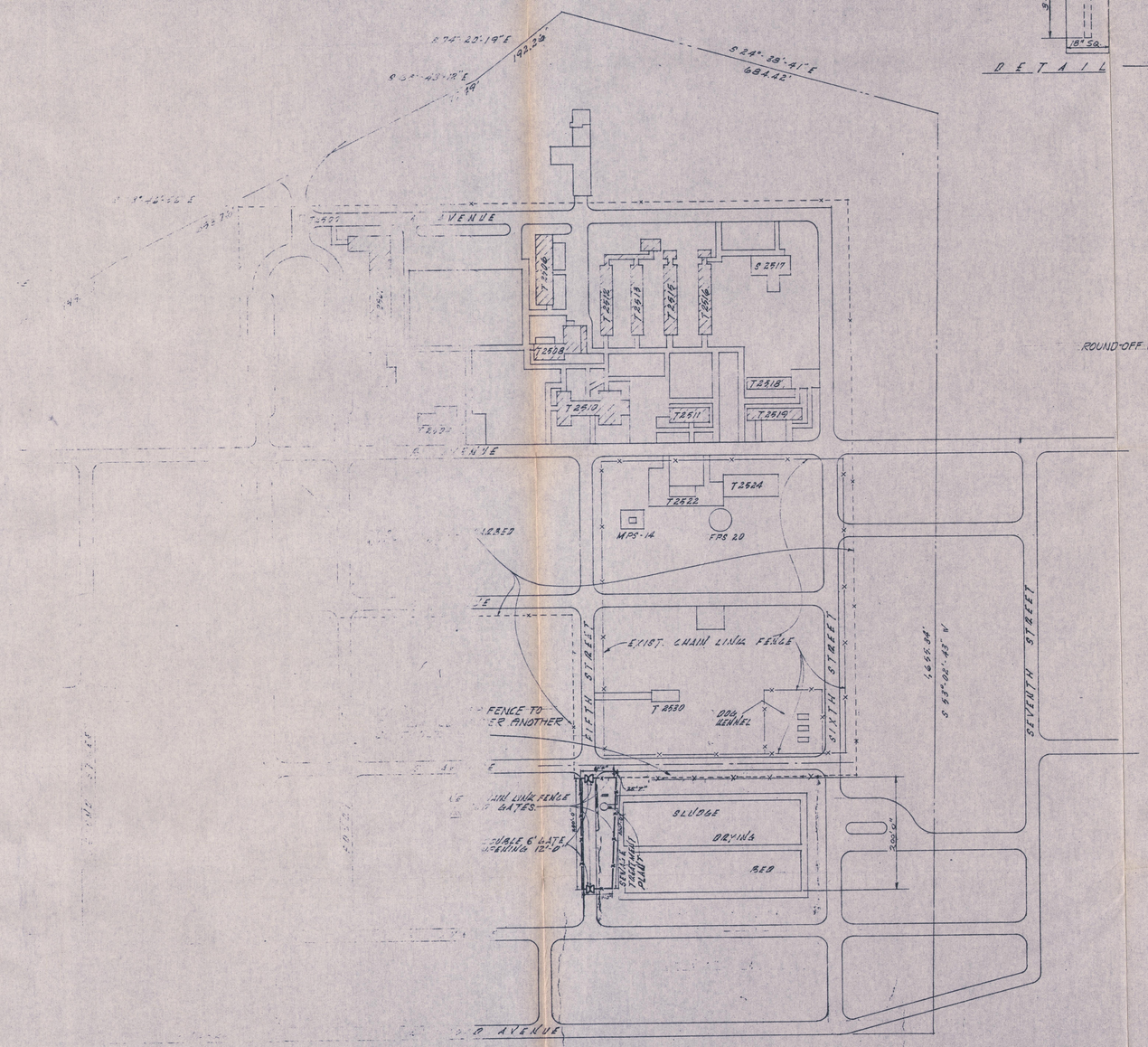
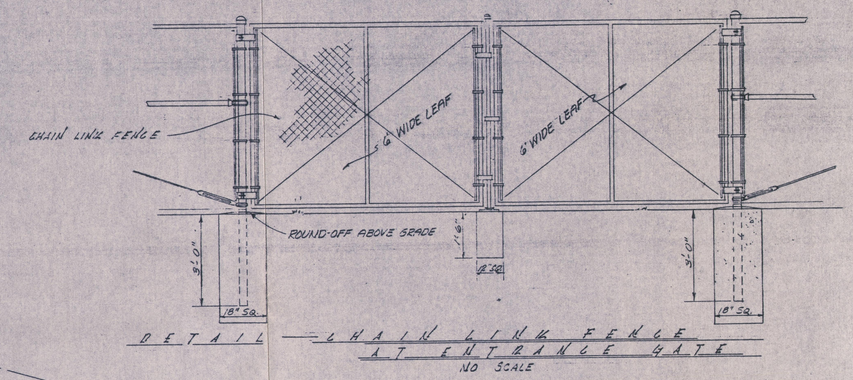
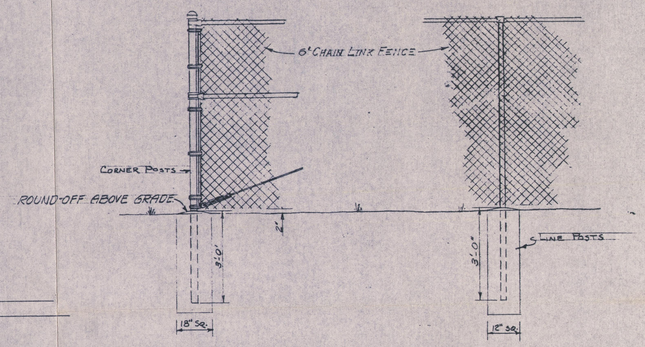
APPENDIX C

FORMER SEWAGE TREATMENT FACILITY MAPS





DETAIL — CHAIN LINK FENCE AT ENTRANCE GATE
NO SCALE



CORNER AND END POST — LINE POST
TYPICAL FENCE DETAILS
No Scale

DATE	REVISION	DESCRIPTION	BY
30 Jul 60	A	AS BUILT VOL. 1-61	W.D.M.

FENCING SEWAGE TREATMENT PLANT
NORTH CHARLESTON AIR FORCE STATION
NCH 22-59

CUMMINGS & McCRADY
ARCHITECTS - ENGINEERS
CHARLESTON, SOUTH CAROLINA

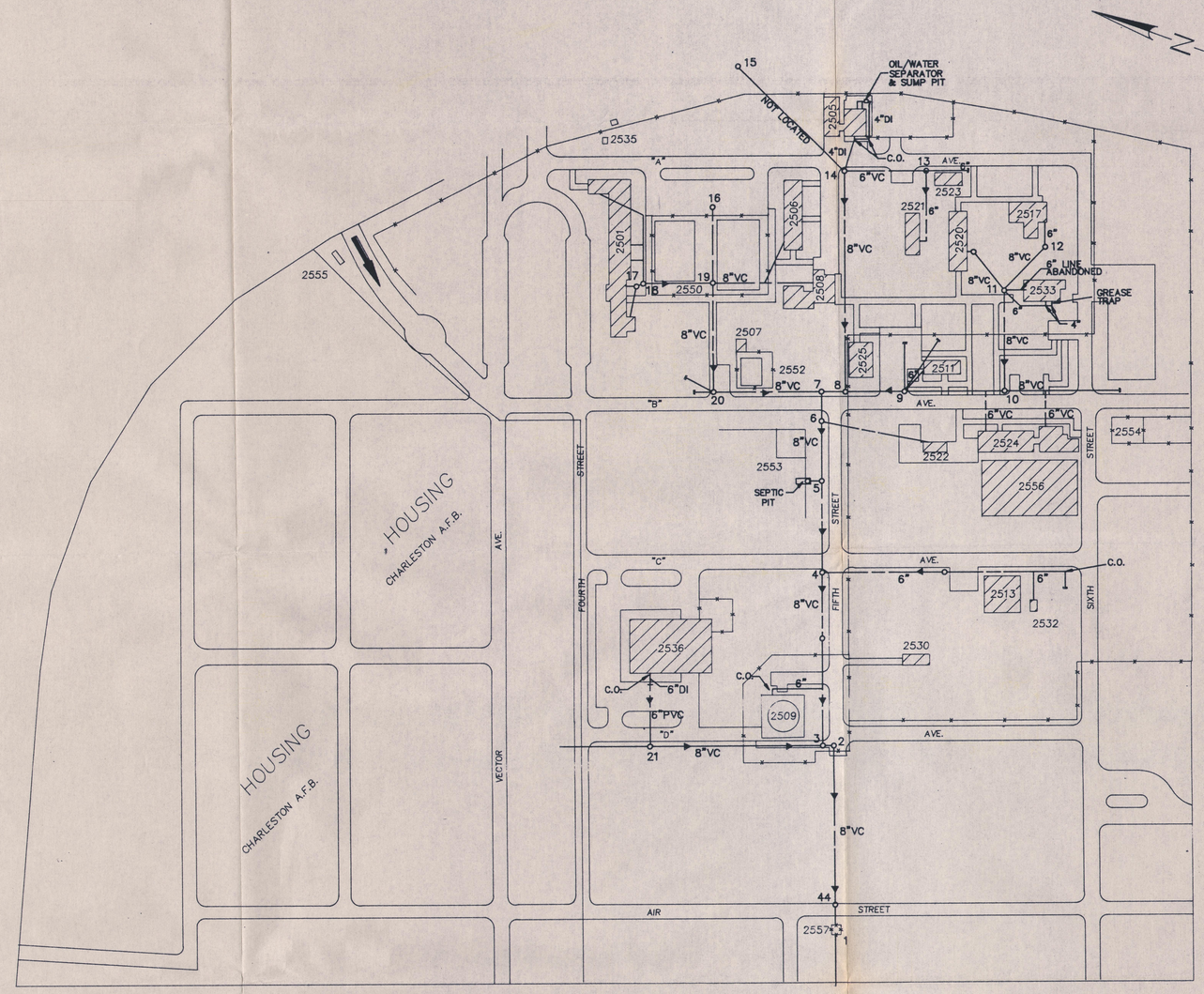
CHARLESTON AIR FORCE BASE
OFFICE OF THE
1608TH INSTALLATIONS ENGINEER
CHARLESTON, SOUTH CAROLINA

APPROVED — DEPUTY FOR ENGINEERING
APPROVED — INSTALLATIONS ENGINEER
APPROVED — for BASE COMMANDER

APPROVED
DATE
SCALE: AS NOTED
SHEET 1 OF 1
DRAWING NO. 86.2-B-60-56

RECORD DRAWING

00148 T B:6 X
2571 3-21



LEGEND

- LINE ON PILES
- MANHOLE
- MANHOLE–ESTIMATED LOCATION
- MANHOLE ON PILES
- LIFT STATION
- SANITARY SEWER
- PLUG
- DIRECTION OF FLOW
- SEPTIC TANK
- P.S. — PRESSURE SEWER
- C.O. — CLEAN OUT
- C.I. — CAST IRON
- D.I. — DUCTILE IRON
- V.C. — VITRIFIED CLAY
- P.V.C. — POLYVINYL CHLORIDE
- PP — POLYPROPYLENE

GRAPHIC SCALE:

100' 0' 100' 200' 300'

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

P.W. DWG. NO. 25713-50

DESIGNED:
DRAWN: SIMMS
SECT. HD.: —
BR. MGR.: T.W. Brinson
APPROVED: T.W. Brinson 4/4/94
DIRECTOR ENGR. DIVISION DATE
APPROVED:
OFFICER IN CHARGE DATE
SATISFACTORY TO:
DATE

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

CHARLESTON NAVAL SHIPYARD, CHARLESTON, S.C.

NAVAL STATION ANNEX
CHARLESTON, S.C.

SEWAGE COLLECTION SYSTEM

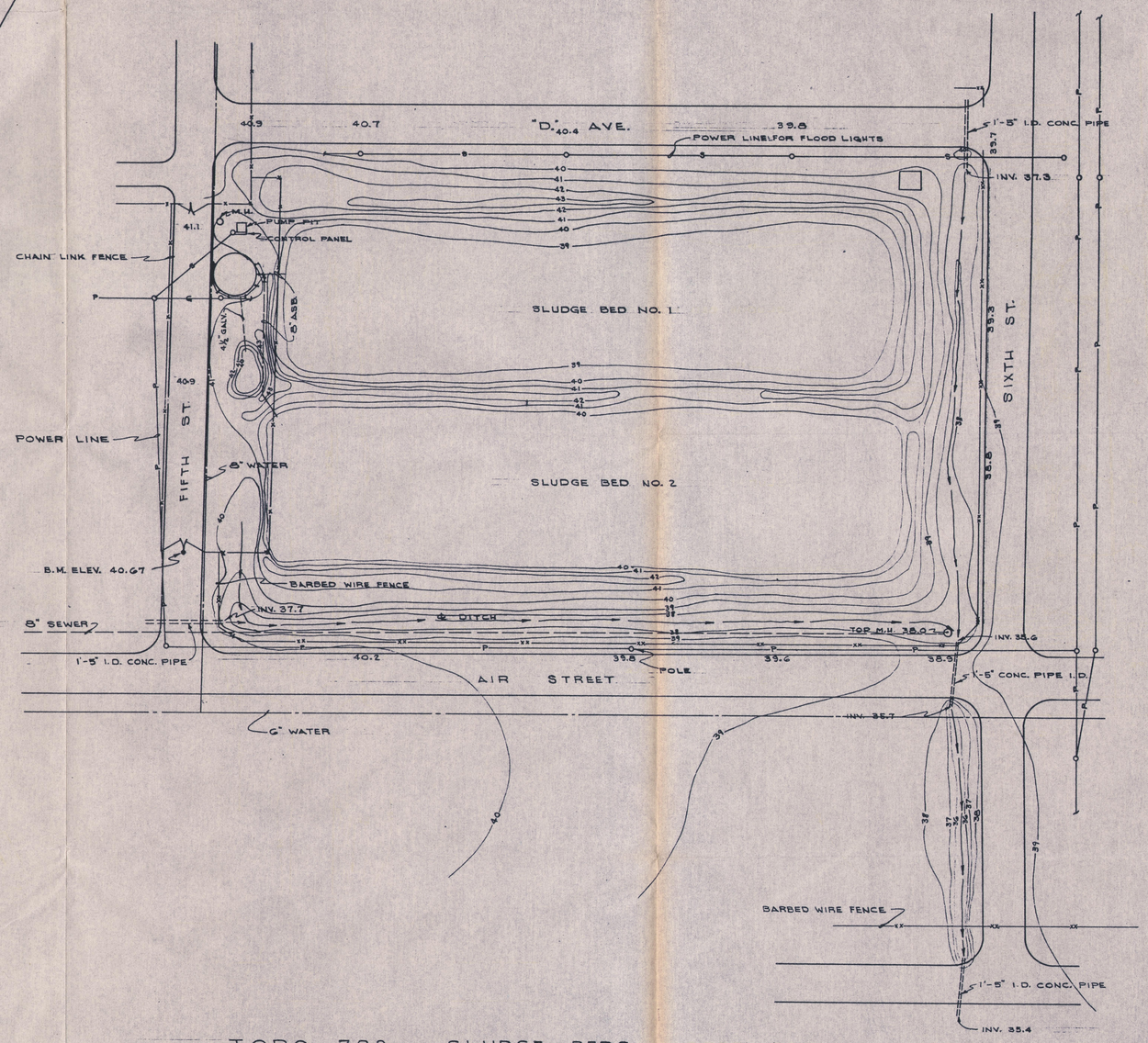
APRIL 1994

REQUEST NO.
NAV. FAC. DRAWING NO.
CONSTR. CONTR. NO.
SCALE 1"=100'
SPEC
SHEET 1 OF 1

ENSNO 11013 (Rev 12-82)

NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED



TOPO 792ND SLUDGE BEDS

SCALE: 1" = 30'

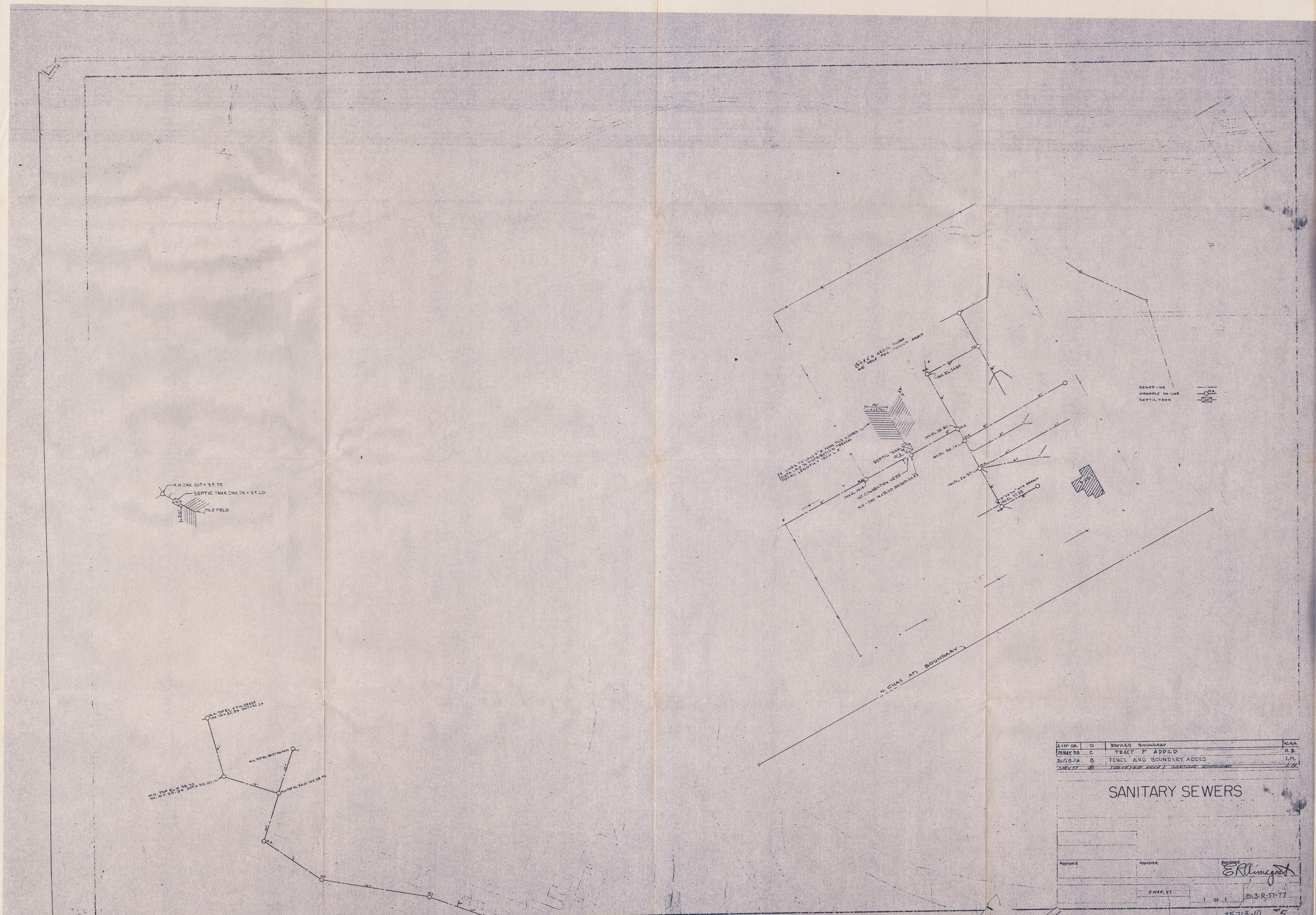
ADDITIONAL CODE IDENT NO.	DRAFTSMAN WATTS	DATE 6MAR68	U.S. AIR FORCE
	CHECKER		TOPO of 792nd. SLUDGE BEDS
	DESIGN ENGR		
	DESIGN ACTIVITY AUTHENTICATION (NAME, SYMBOL AND DATE)	CODE IDENT NO. F	SIZE
		SCALE 1" = 30'	DWG. NO. 81.3-B-68-37 SHEET 1 OF 1

AF FORM DEC 61 1657

ENGINEERING DRAWING LAYOUT

U.S. GOVERNMENT PRINTING OFFICE 1962 OF-631669

25713-24



2 SEP 58	D	REVISED BOUNDARY	C.M.
21 MAY 58	C	TRACT F ADDED	H.B.
25/12/58	B	FENCE AND BOUNDARY ADDED	I.M.
5 NOV 57	A	SURVEYED INTO I SERVICE BOUNDARY	J.S.

SANITARY SEWERS

Approved:

Approved:

Approved: E R Armegast

5 MAR. 57

1 OF 1

B13-R-57-77

25713-10

DRAFT

APPENDIX D

HEALTH AND SAFEY PLAN FORMS

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

INSTRUCTIONS: This form is to be completed by each person working on the project site and returned to : EnSafe/Allen & Hoshall. Memphis Tennessee.

Job Number: 2903-08420

Contract Number: N62467-89-D-0318

Project: Zone C - Naval Base Charleston

I have read and understand the contents of the above plan and agree to perform my work in accordance with it.

_____

Signed

_____

Print Name

_____

Company

_____

Date

EMPLOYEE EXPOSURE HISTORY FORM

Employee: _____

Job Name: _____

Date(s) From/To: _____

Hours Onsite: _____

Contaminants (Suspected/Reported):

_____

_____

_____

_____

_____

_____

_____

(See Attached Laboratory Analysis)

PLAN FEEDBACK FORM

Problems with plan requirements:

_____

_____

_____

Unexpected situations encountered:

_____

_____

_____

_____

Recommendations for revisions:

_____

_____

_____

ACCIDENT REPORT FORM

SUPERVISOR'S REPORT OF ACCIDENT	DO NOT USE FOR MOTOR VEHICLE OR AIRCRAFT ACCIDENTS
TO	FROM TELEPHONE (Include area code)

NAME OF INJURED OR ILL WORKER AND COMPANY

WORKER'S SOCIAL SECURITY NUMBER

DATE OF ACCIDENT	TIME OF ACCIDENT	EXACT LOCATION OF ACCIDENT

NARRATIVE DESCRIPTION OF ACCIDENT

NATURE OF ILLNESS OR INJURY AND PART OF BODY INVOLVED	LOST TIME YES ☐ NO ☐

PROBABLE DISABILITY (Check one)

FATAL ☐	LOST WORK DAY WITH ____ DAYS AWAY FROM WORK	LOST WORK DAY WITH ____ DAYS OF RESTRICTED ACTIVITY	NO LOST WORK DAY ☐ FIRST-AID ONLY ☐

CORRECTIVE ACTION RECOMMENDED (By whom and by when)

NAME OF SUPERVISOR	TITLE
SIGNATURE	DATE

DRAFT

APPENDIX E

LOCATION MAP FOR HOSPITAL

LEGEND

- Town, Small City
- Interstate, Turnpike
- US Highway
- Airfield
- County Boundary
- Population Center
- Major Street/Road
- Interstate Highway
- State Route
- US Highway
- Airfield
- Land Mass
- Open Water

Scale 1:125,000 (at center)

2 Miles

2 KM

Mag 12.00
Tue Mar 05 16:26:12 1996