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CORRECTIVE MEASURES STUDY WORK PLAN ADDENDUM ZONE H SOLID WASTE  
MANAGEMENT UNIT 17 WITH TRANSMITTAL CNC CHARLESTON SC  
10/22/1999  
ENSAFE INC.



DEPARTMENT OF THE NAVY  
SOUTHERN DIVISION  
NAVAL FACILITIES ENGINEERING COMMAND  
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Code 18B1  
23 October, 99

Mr. John Litton, P.E.  
Director, Division of Hazardous and Infectious Waste Management  
Bureau of Land and Waste Management  
South Carolina Department of Health and Environmental Control  
2600 Bull Street  
Columbia, SC 29201

9  
Subj: SUBMITTAL OF FINAL ZONE H CORRECTIVE MEASURES STUDY  
WORK PLAN ADDENDUM, SWMU 17

Dear Mr. Thompson,

The purpose of this letter is to submit the Final Zone H Corrective Measures Study Workplan Addendum for Naval Base Charleston. The Workplan is submitted to fulfill the requirements of condition II.G.1(a) of the RCRA Part B permit issued to the Navy by the South Carolina Department of Health and Environmental Control and U.S. Environmental Protection Agency.

We request that the Department and the EPA review the addendum and provide comment or approval as appropriate. If you should have any questions, please contact Amy Daniel or myself at (803) 743-9985 and (803) 820-5525 respectively.

Sincerely,

M.A.HUNT, P.E.  
BRAC Environmental Coordinator  
BRAC Division

Encl: Final Zone H CMS Workplan Addendum, SWMU 17, 22 October, 1999

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**COMPREHENSIVE LONG-TERM  
ENVIRONMENTAL ACTION NAVY  
CHARLESTON NAVAL COMPLEX  
NORTH CHARLESTON, SOUTH CAROLINA  
CTO-029**



**ZONE H CORRECTIVE MEASURES STUDY  
WORK PLAN ADDENDUM, SWMU 17**

**SOUTH DIV CONTRACT  
NUMBER: N62467-89-D-0318**

**Prepared for:**

**DEPARTMENT OF THE NAVY  
SOUTHERN DIVISION  
NAVAL FACILITIES ENGINEERING COMMAND  
NORTH CHARLESTON, SOUTH CAROLINA**



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**October 22, 1999  
Revision No.: 0**

**Release of this document requires prior notification of the Commanding Officer of the Southern Division, Naval Facilities Engineering Command, North Charleston, South Carolina.**

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## **1.0 Introduction**

This addendum to the 26 November 1997 CMS Work Plan presents additional investigative work addressing distribution and extent of free product, as well as soil and groundwater contamination at SWMU 17 in Zone H at Charleston Naval Complex (CNC). This work is proposed to complete objectives of the Zone H RFI for SWMU 17. However, it is being performed as part of CMS activities since the Zone H RFI was submitted to SCDHEC and conditionally approved with the understanding that completing the nature and extent delineation would be completed as part of the CMS field work. In addition to satisfying RFI objectives, data from this work will provide the basis for the determining what, if any, data gaps remain with respect to being able to complete the CMS. The scope of work proposed in this addendum is intended to:

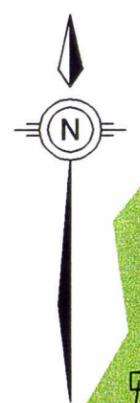
- Delineate Nature and Extent of soil contamination to Residential RBCs, Site Specific SSLs, and/or background.
- Delineate the distribution and extent of free product.
- Estimate the volume of free product.
- Delineate the extent of groundwater contamination.
- Determine current groundwater flow direction.
- Provide detailed cross sections of the near surface geology.

## **2.0 Site History**

SWMU 17 (Figure 1) is the site of an oil leak in 1987 that released approximately 14,000 gallons of fuel from a ruptured underground boiler fuel supply line leading to Building FBM 61 from an above ground tank located just north of the building. In an effort to recover as much of the product as possible, the Navy installed three sumps around the wing of the building where the release occurred. The sumps were constructed by welding together 55 gallon drums end to end and placed vertically below ground. Other site features at SWMU 17 which are considered possible sources of the contamination identified during the RFI are an oil/water separator (OWS) and electrical transformer, both of which are located on the north side of FBM 61. Figure 2 is a site map presenting locations from which soil and groundwater samples were collected during the RFI.

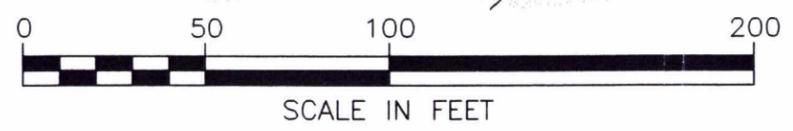
The RFI identified polynuclear aromatic hydrocarbons (PAHs) expressed as benzo(a)pyrene equivalents (BEQs) and the polychlorinated biphenyl (PCB), Arochlor 1260, as the contaminants of concern (COCs) driving unacceptable levels of risk in soil at SWMU 17. Benzidine and various chlorobenzenes were identified as the risk drivers for groundwater. Non-aqueous phase liquids (NAPLs) were discovered in two of the monitoring wells during groundwater sampling events subsequent to those used to generate the data used in the risk assessment.

Arochlor 1260 was detected by the Navy in 1987 during an investigation of the spill and also was widely detected during the RFI. Figures 3 and 4 present contours of Arochlor 1260 concentrations in soil samples collected as part of the Zone H RFI. Whether the Arochlor present at SWMU 17 is the result of transformer fluid spillage or as part of the fuel oil is unclear since the highest areas of contamination can be closely associated with the AST, the fuel lines, and the transformer vault as indicated on the figures. Dense non-aqueous phase liquid (DNAPL) found in monitoring well 017002 was found to contain approximately 38% Arochlor 1260.



**LEGEND:**

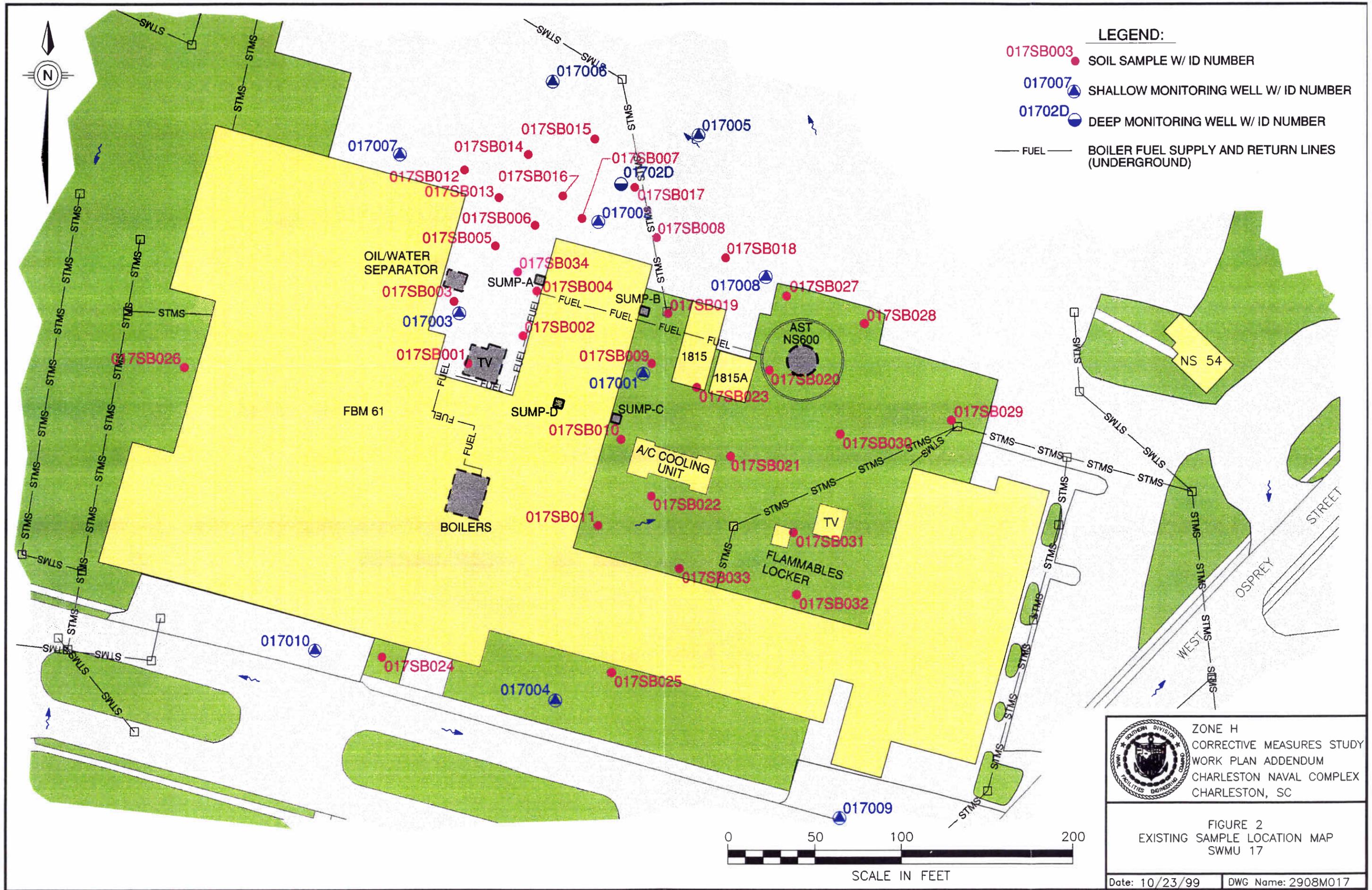
- FUEL — BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)
- STMS — STORM SEWER LINE
- ↘ SURFACE RUNOFF
- JUNCTION BOX
- BUILDING
- GRASS/SOIL OR OTHER POROUS GROUNDCOVER
- ASPHALT OR OTHER NON-POROUS PAVING MATERIAL
- SWMU 17 FEATURES



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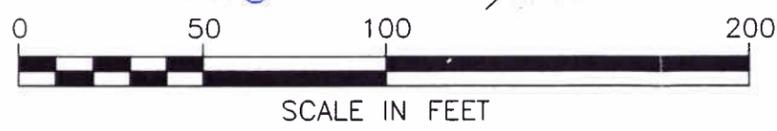
FIGURE 1  
SITE MAP  
SWMU 17

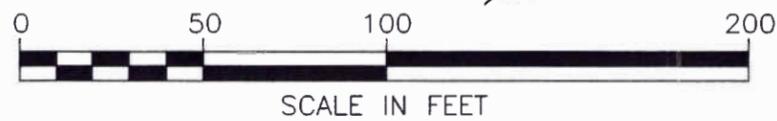
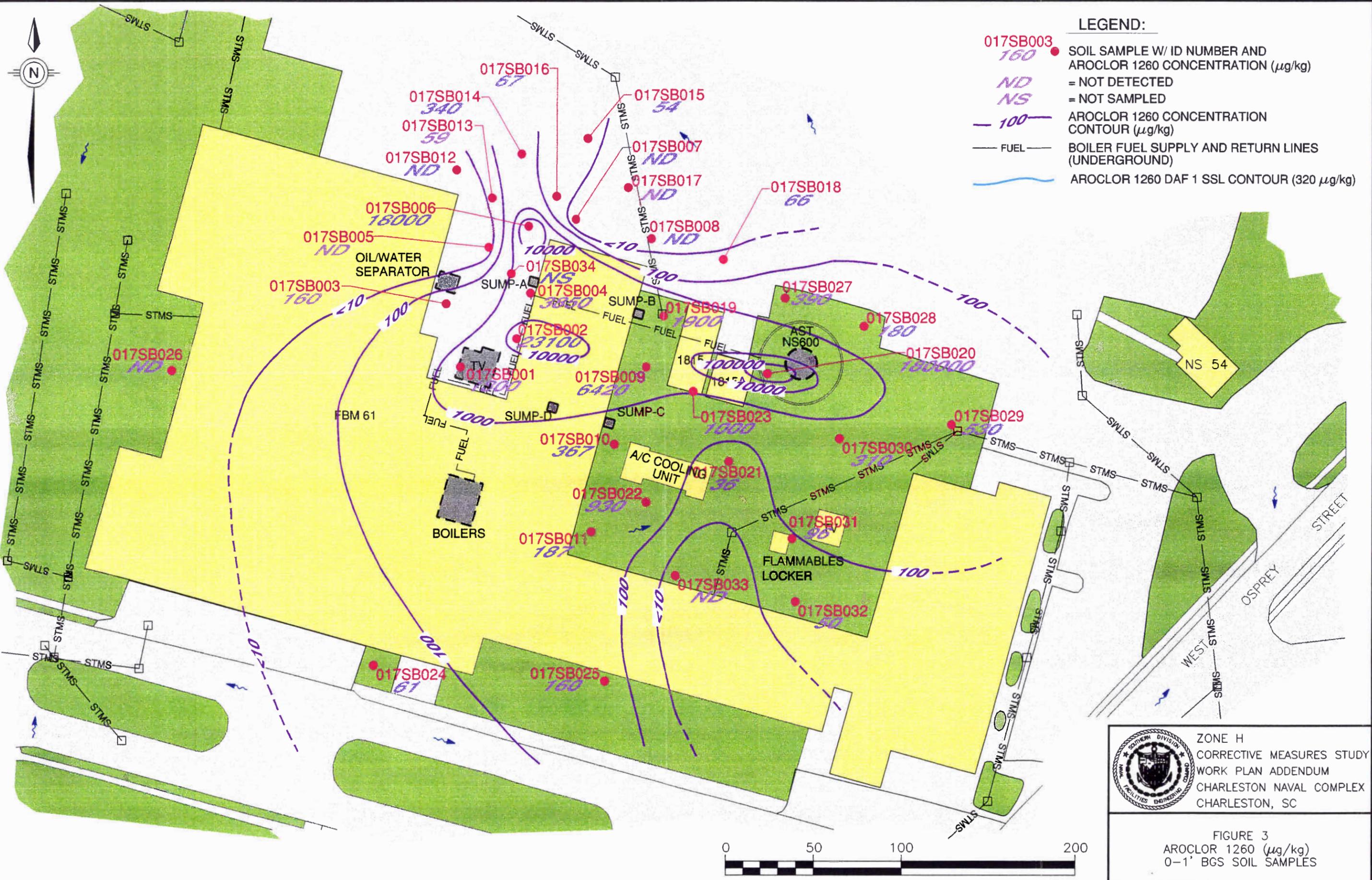
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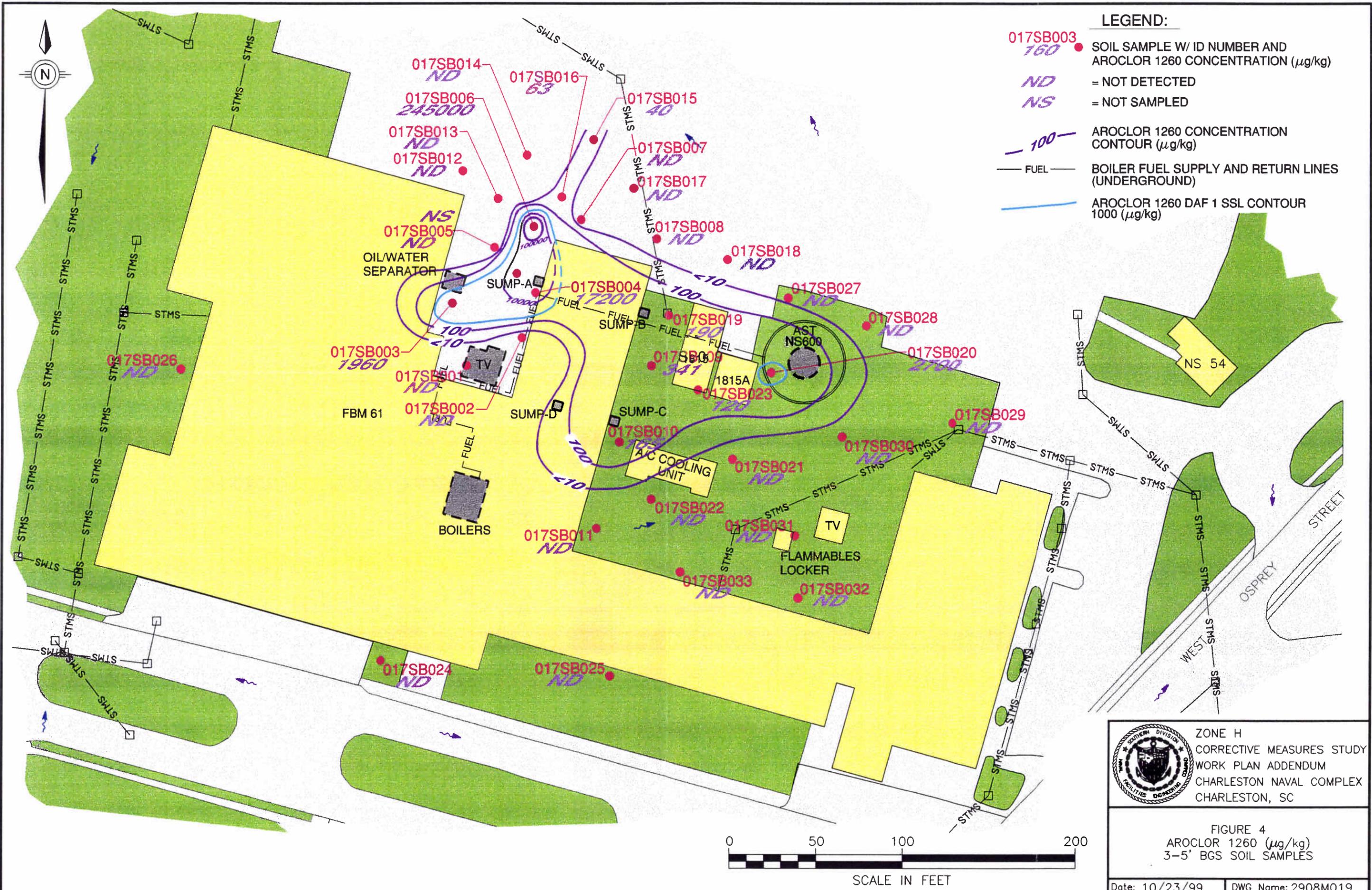
FIGURE 2  
 EXISTING SAMPLE LOCATION MAP  
 SWMU 17  
 Date: 10/23/99 | DWG Name: 2908M017






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FIGURE 3  
 AROCLOR 1260 ( $\mu\text{g}/\text{kg}$ )  
 0-1' BGS SOIL SAMPLES



- LEGEND:**
- 017SB003  
160 SOIL SAMPLE W/ ID NUMBER AND AROCLOR 1260 CONCENTRATION ( $\mu\text{g}/\text{kg}$ )
  - ND = NOT DETECTED
  - NS = NOT SAMPLED
  - 100 AROCLOR 1260 CONCENTRATION CONTOUR ( $\mu\text{g}/\text{kg}$ )
  - FUEL BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)
  - AROCLOR 1260 DAF 1 SSL CONTOUR 1000 ( $\mu\text{g}/\text{kg}$ )



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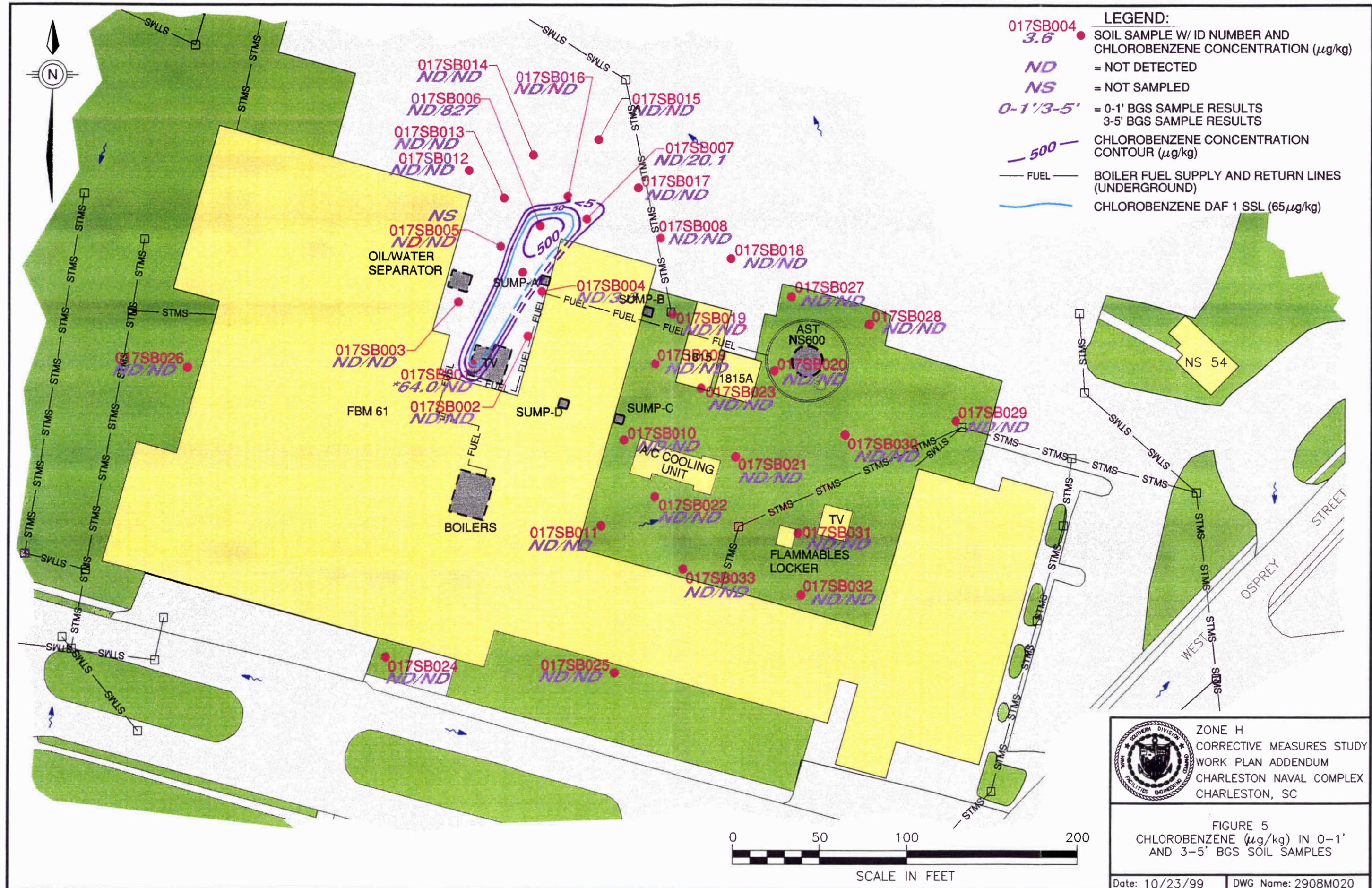
FIGURE 4  
AROCLOR 1260 ( $\mu\text{g}/\text{kg}$ )  
3-5' BGS SOIL SAMPLES

Date: 10/23/99      DWG Name: 2908M019

Zone H RFI soil sampling data indicate that various chlorobenzenes have also been detected in soils at SWMU 17. These compounds are chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene. However, unlike the Arochlor 1260 which is widespread, these detections are limited to the alcove area between the transformer vault and well 017002. Literature references list heat transfer medium as one of the possible uses of the chlorobenzenes which seems to be the most plausible explanation why these compounds are co-located with the PCB detections. Also worth noting is the fact that the significant levels of these compounds were detected in subsurface soil. Because of the solvent-like chemical/physical properties of these compounds, they are expected to be some of the more mobile constituents which could be found in a heat transfer medium. Figures 5, 6, 7, and 8 present the distribution of these compounds. Chlorobenzene compounds were also detected in DNAPL recovered from well 017002, and in groundwater samples from wells 017002, 017003, 017005, and 017010 (Figure 9).

Fuel oil has been detected in monitoring well 017001 as a Light Non-Aqueous Phase Liquid (LNAPL). Light and dense phase non-aqueous liquids were recovered from the sumps around FBM 61 as part of a 1998 expedited ISM performed by the Environmental Detachment (DET).

The only detections of BEQs above residential RBCs occurred at soil boring locations 017SB009 and 017SB022. Since these detections occurred within the larger area of PCB detections a separate map was not prepared to show the distribution of BEQs.



017SB004 3.6 ● SOIL SAMPLE W/ ID NUMBER AND CHLORO BENZENE CONCENTRATION ( $\mu\text{g}/\text{kg}$ )

ND = NOT DETECTED

NS = NOT SAMPLED

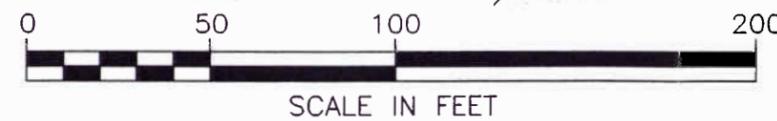
0-1' BGS SAMPLE RESULTS

3-5' BGS SAMPLE RESULTS

500 CHLORO BENZENE CONCENTRATION CONTOUR ( $\mu\text{g}/\text{kg}$ )

FUEL BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)

CHLORO BENZENE DAF 1 SSL ( $65\mu\text{g}/\text{kg}$ )

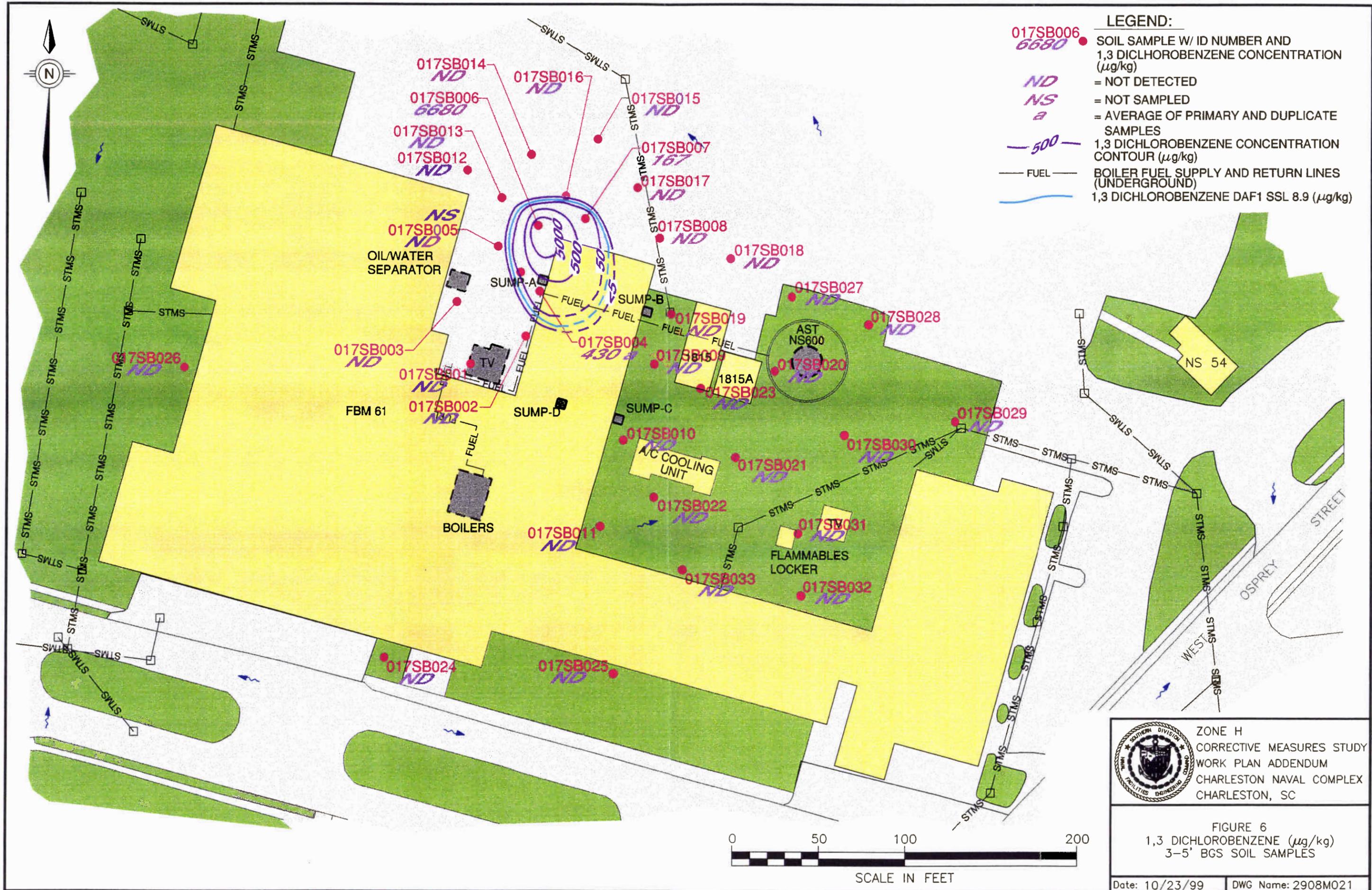


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**FIGURE 5**  
 CHLORO BENZENE ( $\mu\text{g}/\text{kg}$ ) IN 0-1'  
 AND 3-5' BGS SOIL SAMPLES

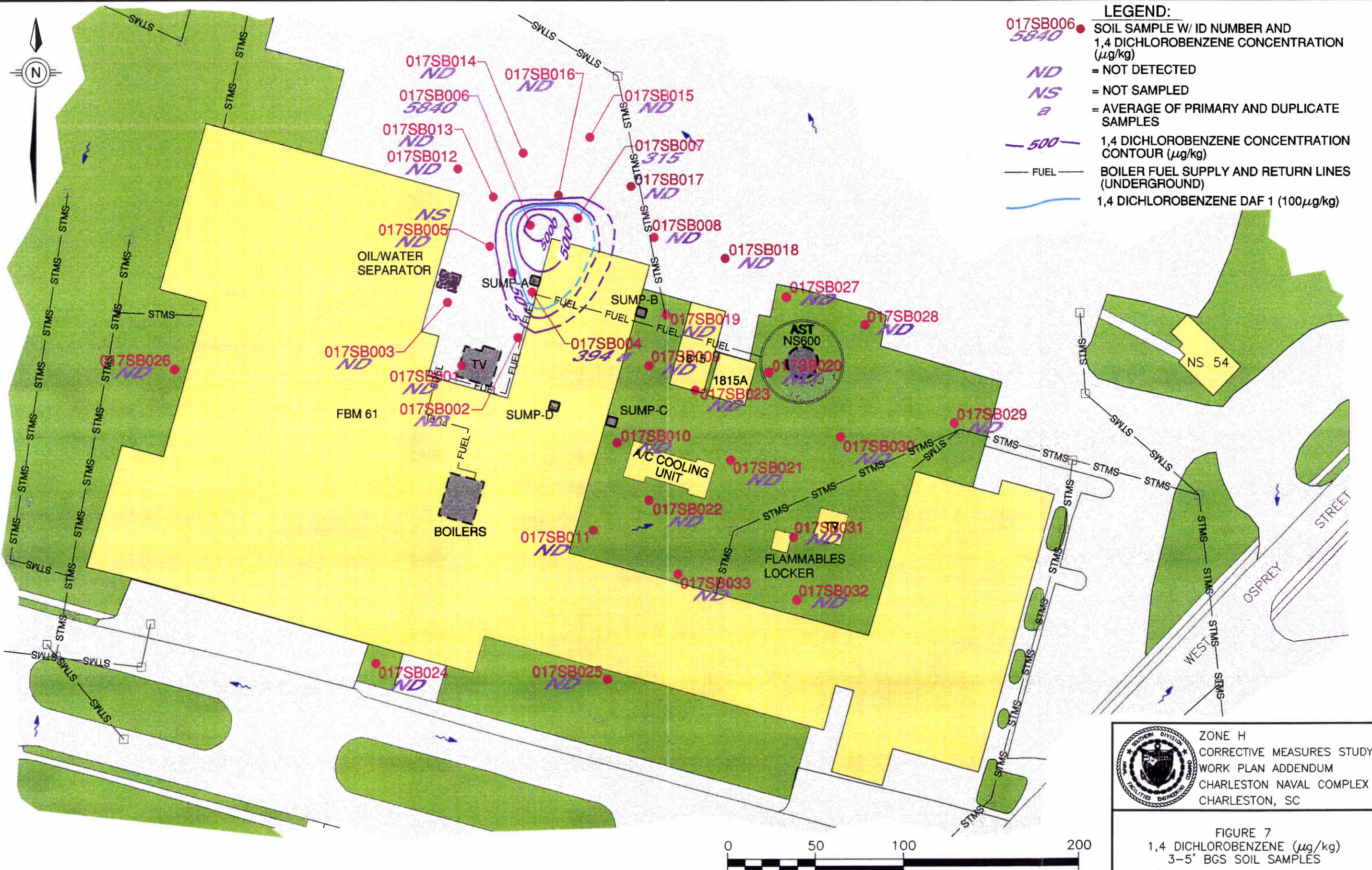
Date: 10/23/99 DWG Name: 2908M020

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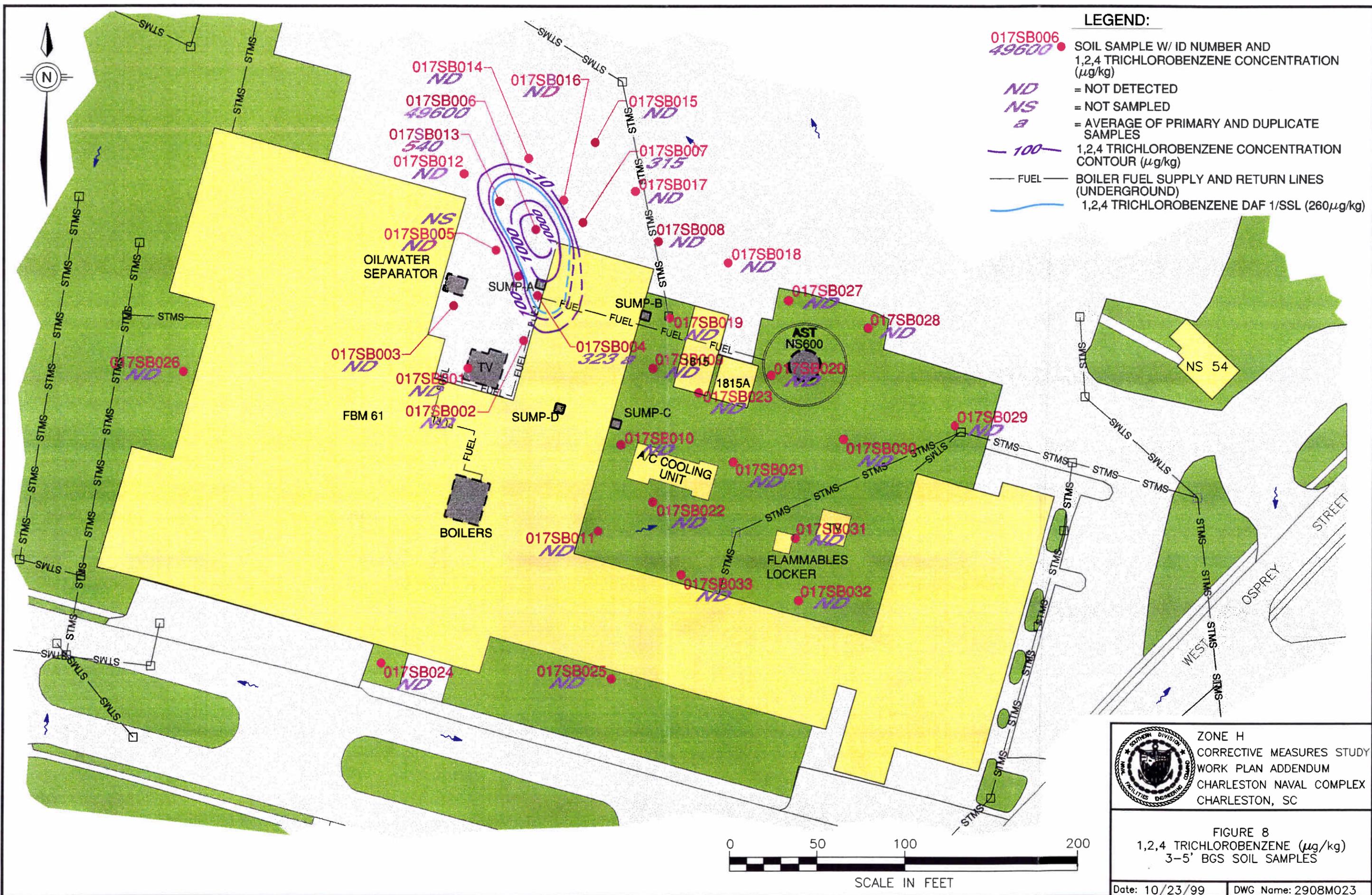


- LEGEND:**
- 017SB006 ● SOIL SAMPLE W/ ID NUMBER AND 1,4 DICHLOROBENZENE CONCENTRATION ( $\mu\text{g}/\text{kg}$ )
  - 5840 = NOT DETECTED
  - ND = NOT DETECTED
  - NS = NOT SAMPLED
  - a = AVERAGE OF PRIMARY AND DUPLICATE SAMPLES
  - 500 — 1,4 DICHLOROBENZENE CONCENTRATION CONTOUR ( $\mu\text{g}/\text{kg}$ )
  - FUEL — BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)
  - 1,4 DICHLOROBENZENE DAF 1 ( $100\mu\text{g}/\text{kg}$ )




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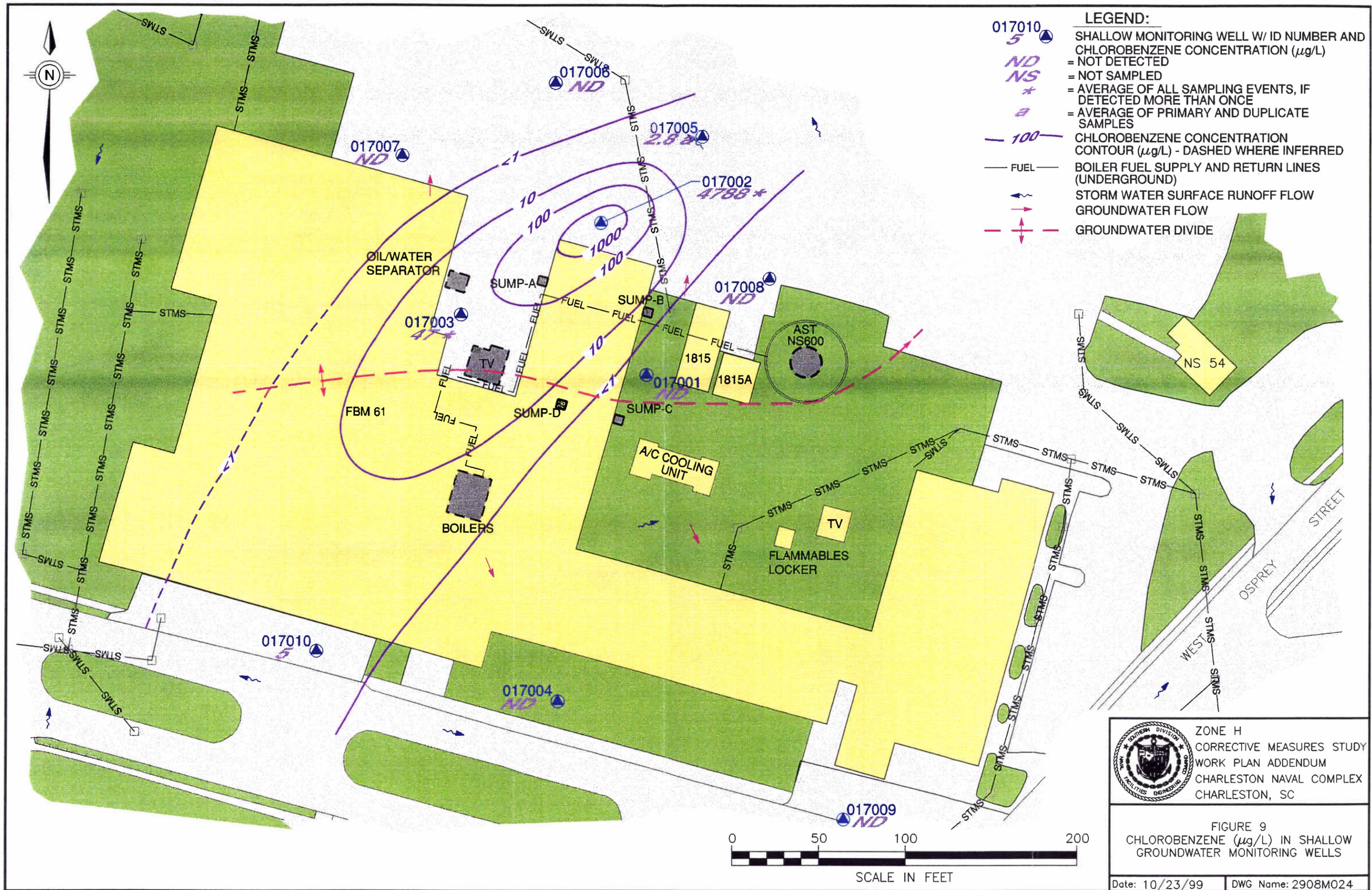
FIGURE 7  
 1,4 DICHLOROBENZENE ( $\mu\text{g}/\text{kg}$ )  
 3-5' BGS SOIL SAMPLES



- LEGEND:**
- 017SB006  
49600 SOIL SAMPLE W/ ID NUMBER AND 1,2,4 TRICHLOROBENZENE CONCENTRATION ( $\mu\text{g}/\text{kg}$ )
  - ND = NOT DETECTED
  - NS = NOT SAMPLED
  - a = AVERAGE OF PRIMARY AND DUPLICATE SAMPLES
  - 100 — 1,2,4 TRICHLOROBENZENE CONCENTRATION CONTOUR ( $\mu\text{g}/\text{kg}$ )
  - FUEL — BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)
  - 1,2,4 TRICHLOROBENZENE DAF 1/SSL ( $260\mu\text{g}/\text{kg}$ )


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FIGURE 8  
 1,2,4 TRICHLOROBENZENE ( $\mu\text{g}/\text{kg}$ )  
 3-5' BGS SOIL SAMPLES




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FIGURE 9  
 CHLOROBENZENE ( $\mu\text{g/L}$ ) IN SHALLOW  
 GROUNDWATER MONITORING WELLS

Date: 10/23/99      DWG Name: 2908M024

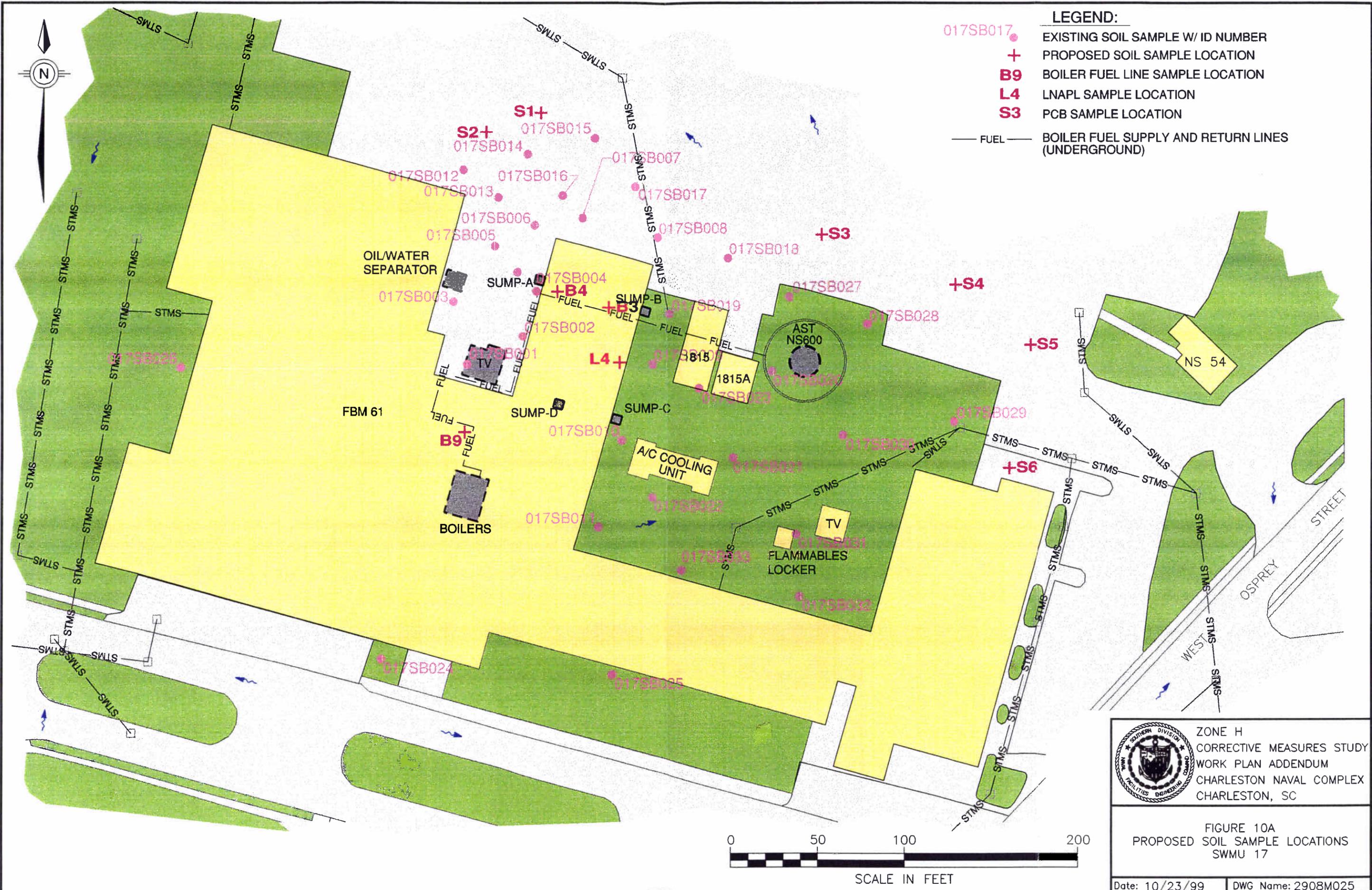
### **3.0 SCOPE OF WORK**

Data from the RFI and the CMS have indicate the highest levels of contamination are in close proximity to the above ground storage tank, the boiler fuel oil line, the transformer vault, and the OWS. A review of the analytical data for SWMU 17 revealed the following data gaps:

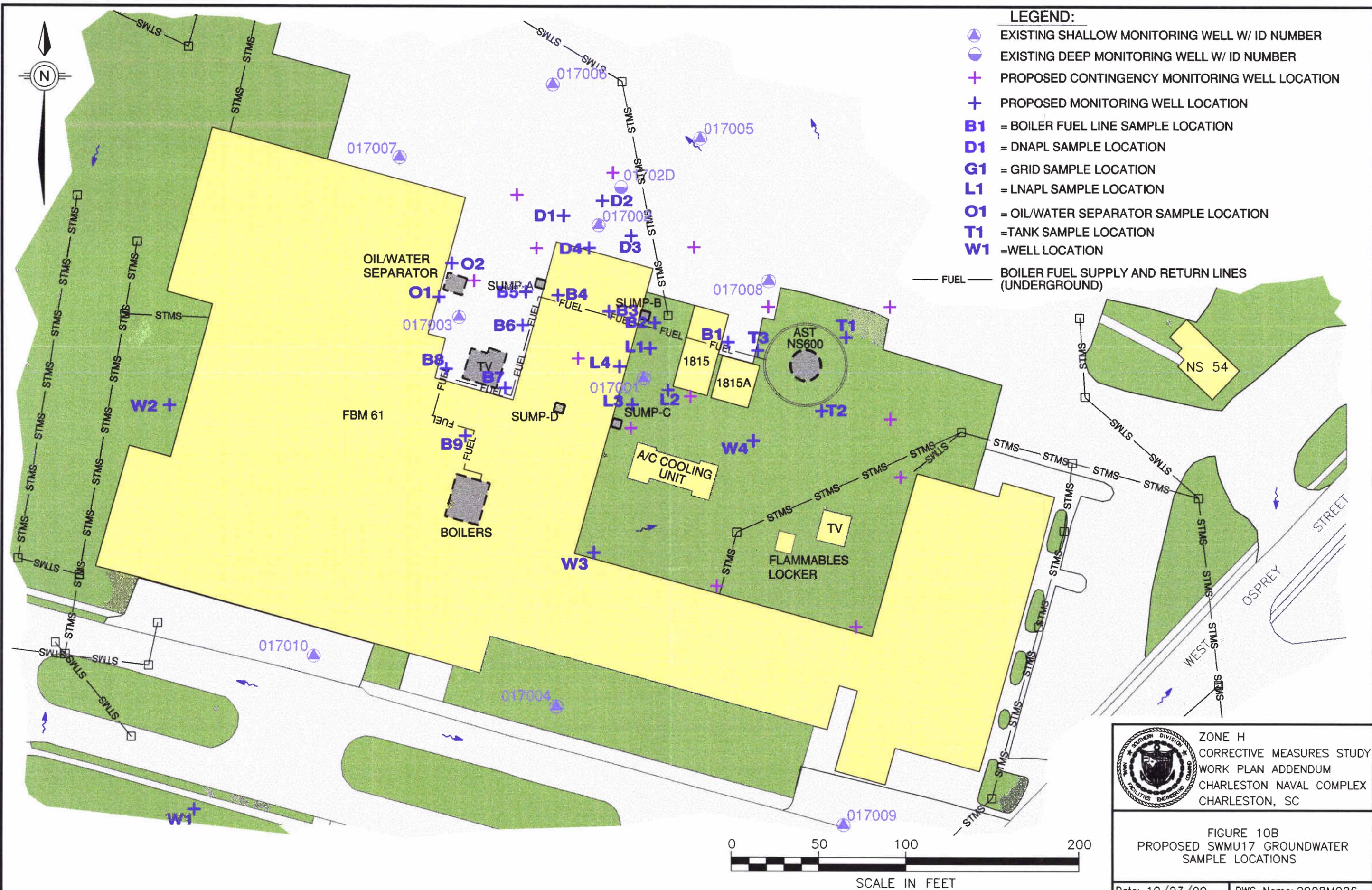
- Extrapolation of the soil and groundwater data indicates a high probability that significant levels of contamination exist beneath the building.
- Arochlor 1260 has not been completely delineated to levels below the residential RBC.
- The extent of chlorobenzene in groundwater has not been completely defined.
- The areal extent of NAPL in monitoring wells 017001 and 017002 has not been completely defined.

Additional soil and groundwater sampling is proposed to fill these data gaps. The proposed locations are presented in Figures 10A and 10B. The sites targeted for investigation are:

- Boiler fuel distribution pipeline (delineating leak area).
- Well 017001 (delineating extent of associated LNAPL).
- Well 017002 (delineating extent of associated DNAPL).
- Above ground fuel storage tank (potential source).
- Oil/Water Separator (potential source).
- Area north of boring 14, area northeast of borings 27, 28, and 29.
- Areas to the northwest and southwest of well 017010 (delineating extent of chlorobenzene in groundwater).



00297VVB32



- LEGEND:**
- EXISTING SHALLOW MONITORING WELL W/ ID NUMBER
  - EXISTING DEEP MONITORING WELL W/ ID NUMBER
  - + PROPOSED CONTINGENCY MONITORING WELL LOCATION
  - + PROPOSED MONITORING WELL LOCATION
  - B1** = BOILER FUEL LINE SAMPLE LOCATION
  - D1** = DNAPL SAMPLE LOCATION
  - G1** = GRID SAMPLE LOCATION
  - L1** = LNAPL SAMPLE LOCATION
  - O1** = OIL/WATER SEPARATOR SAMPLE LOCATION
  - T1** = TANK SAMPLE LOCATION
  - W1** = WELL LOCATION
  - FUEL — BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)



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FIGURE 10B  
PROPOSED SSMU17 GROUNDWATER  
SAMPLE LOCATIONS

Date: 10/23/99    DWG Name: 2908M026

### **Boiler Fuel Pipeline**

Nine DPT locations are proposed along the piping route to determine if elevated concentrations of COCs remain along the pipeline which is a known source of a release. The proposed soil and groundwater sample locations for this area are listed in Tables 1 and 2. The locations are shown on Figures 10A and 10B. The locations associated with this site feature are denoted by a "B" preceding a numeric designation. Contingency locations may be sampled if physical or chemical data indicate the need to expand the area of investigation.

Soil samples are only proposed to be collected from the 3 locations that fall within the footprint of the building because sufficient data was generated during the RFI to delineate the extent of contamination outside the building footprint. As mentioned earlier, an extrapolation of that data indicated the possibility of high concentrations beneath the building which the proposed samples should be able to either confirm or refute. At the remaining 6 locations soil cores will be collected per the procedure described in Section 3.1 with the primary intent of providing a borehole in which to install a temporary well and mapping the top of the marsh clay that is beneath the site which appears to be acting as a confining layer for DNAPL that has been observed. If soil is encountered in any of these 6 borings that shows visible signs of contaminated (heavy staining) or produces elevated flame ionization detector (FID) readings, a sample of the soil will be collected for chemical analysis including soil that is below the water table. Temporary well points will be installed using DPT at all 9 locations. The methodology for installing the temporary wells is described in Section 3.2.

### **Well 017001**

Although LNAPL has been detected in the sumps, monitoring well 017001 is the only well at the site in which a measurable amount of LNAPL has been found. Four temporary well locations are proposed in proximity to 017001 to determine the extent of LNAPL. Soil samples are proposed to be collected from the one location inside the building to assist in determining whether or not

soil contamination exists beneath the building. The proposed soil and groundwater sample locations for this area are listed in Tables 1 and 2. The locations are shown on Figures 10A and 10B. The locations associated with this site feature are denoted by a "L" preceeding a numeric designation. In addition, the locations identified as "W3" and "W4" will be used to assist in delineating any dissolved phase groundwater contamination which may be associated with this area. Contingency DPT locations are proposed at a distance of 20 feet away from the primary locations in the event LNAPL is detected.

With the exception of location "L4" shown Figures 10A and 10B, soil samples collected for chemical analysis are not proposed since adequate data was collected during the RFI to characterize this area. However, similar to the scenario described above, continuous soil cores are being collected to facilitate the installation of temporary wells at each of the sampling points. If soil is encountered that exhibits visual signs of contamination or produces elevated FID readings a sample will be collected from the suspect interval and submitted for chemical analysis. Groundwater samples for chemical analysis will are not proposed to be collected from any of the temporary well points with the "L" designation because they are in an area know to be contaminated and the primary intent at these locations is simply to determine the extent of LNAPL in the area. The locations with the "W" designation will have groundwater samples collected for chemical analysis to assist in delineated the edge of the dissolved phase contamination in the area.

#### **Well 017002**

The only detection of PCBs and DNAPL in groundwater occurred at 017002. Four temporary well locations are proposed in proximity to 017002 to determine the extent of DNAPL. Contingency DPT locations are proposed at a distance of 20 feet away from form the primary locations in the event DNAPL is detected. The proposed groundwater sample locations for this area are listed in Table 2. The locations are shown on Figure 10B. The locations associated

Soil samples are not proposed since adequate data was collected during the RFI to characterize this area. However, similar to the scenario described above, continuous soil cores are being collected to facilitate the installation of temporary wells at each of the sampling points. If soil is encountered that exhibits visual signs of contamination or produces elevated FID readings a sample will be collected from the suspect interval and submitted for chemical analysis. Likewise, groundwater samples for chemical analysis will are not proposed to be collected from any of the temporary well points with the "D" designation because they are in an area know to be contaminated and the primary intent at these locations is simply to determine the extent of DNAPL in the area.

Table 1  
SWMU 17  
Proposed Soil Sample Locations & Analyses

Location	Analytical Parameters	Rationale
B3	VOCs, SVOCS, PCBs	Determine if contamination exists beneath Building 61
B4	VOCs, SVOCS, PCBs	Determine if contamination exists beneath Building 61
B9	VOCs, SVOCS, PCBs	Determine if contamination exists beneath Building 61
L4	VOCs, SVOCS, PCBs	Determine if contamination exists beneath Building 61
S1	PCBs	Determine PCB extent north of borings 14 & 15
S2	PCBs	Determine PCB extent north of borings 14 & 15
S3	PCBs	Determine PCB extent northeast of borings 27, 28, 29
S4	PCBs	Determine PCB extent northeast of borings 27, 28, 29
S5	PCBs	Determine PCB extent northeast of borings 27, 28, 29
S6	PCBs	Determine PCB extent northeast of borings 27, 28, 29
T1	VOCs, SVOCS, PCBs	Provide additional characterization of possible source area.
T2	VOCs, SVOCS, PCBs	Provide additional characterization of possible source area.
T3	VOCs, SVOCS, PCBs	Provide additional characterization of possible source area.

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Table 2  
SWMU 17  
Proposed Groundwater Sample Locations & Analyses

Location	Analytical Parameters	Purpose
B1	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B2	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B3	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B4	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B5	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B6	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B7	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B8	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
B9	VOCs, SVOCs, PCBs	Assess boiler fuel lines, visual inspection for the presence of NAPL.
D1	None - visual inspection only	Assess the extent of DNAPL observed in monitoring well 017002.
D2	None - visual inspection only	Assess the extent of DNAPL observed in monitoring well 017002.
D3	None - visual inspection only	Assess the extent of DNAPL observed in monitoring well 017002.
D4	None - visual inspection only	Assess the extent of DNAPL observed in monitoring well 017002.
L1	None - visual inspection only	Assess the extent of LNAPL observed in monitoring well 017001.
L2	None - visual inspection only	Assess the extent of LNAPL observed in monitoring well 017001.
L3	None - visual inspection only	Assess the extent of LNAPL observed in monitoring well 017001.
L4	None - visual inspection only	Assess the extent of LNAPL observed in monitoring well 017001.
O1	VOCs, SVOCs, PCBs	Assess the OWS as a potential source of petroleum and/or PCB contamination.

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Table 2  
SWMU 17  
Proposed Groundwater Sample Locations & Analyses

O2	VOCs, SVOCs, PCBs	Assess the OWS as a potential source of petroleum and/or PCB contamination.
T1	VOCs, SVOCs	Assess the AST as a potential source of the petroleum contamination.
T2	VOCs, SVOCs	Assess the AST as a potential source of the petroleum contamination.
T3	VOCs, SVOCs	Assess the AST as a potential source of the petroleum contamination.
W1	VOCs	Assess the extent of chlorobenzene at the southwest corner of building FBM 61.
W2	VOCs	Assess the extent of chlorobenzene south of monitoring well 017010.
W3	VOCs, SVOCs	Aid in the delineation of petroleum contamination detected in monitoring well 017001.
W4	VOCs, SVOCs	Aid in the delineation of petroleum contamination detected in monitoring well 017001.
Well 017001	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017002	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017003	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017004	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017005	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017006	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017007	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017008	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017009	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.
Well 017010	VOCs	Aid in providing a complete round of data to evaluate chlorobenzene distribution.

### **Above Ground Fuel Storage Tank (NS 600)**

Three locations will be advanced to determine if the AST is a source for either the fuel oil or PCB contamination. The proposed soil and groundwater sample locations for this area are listed in Tables 1 and 2. The locations are shown on Figures 10A and 10B. The locations associated with this site feature are denoted by a "T" preceding a numeric designation. Both soil and groundwater samples will be collected for chemical analysis from this area. Contingency locations have been proposed at a distance of 20 feet from the primary locations in the event COCs are detected above screening levels that require additional delineation.

### **Oil/Water Separator**

Two locations will be advanced to determine if the Oil/Water Separator (O/WS) has contributed contamination present at SWMU 17. The proposed soil and groundwater sample locations for this area are listed in Table 2. The locations are shown on Figure 10B. The locations associated with this site feature are denoted by a "O" preceding a numeric designation. Only groundwater samples have been proposed for this area since the OWS is a subsurface feature and the concern is whether or not it is a source of groundwater contamination in the area. Once again however, continuous soil cores are being collected to facilitate the installation of temporary wells at each of the sampling points. If soil is encountered that exhibits visual signs of contamination or produces elevated FID readings a sample will be collected from the suspect interval and submitted for chemical analysis. Contingency locations will be advanced if physical or chemical data indicate that leakage from the OWS has occurred.

### **PCB Delineation**

Seven surface soil sample locations are proposed to complete the delineation of PCB contamination in soil that is depicted on Figure 3. The proposed soil sample locations for this area are listed in Table 1 and shown on Figure 10A. The locations associated with this portion of the investigation are denoted by a "S" preceding a numeric designation.

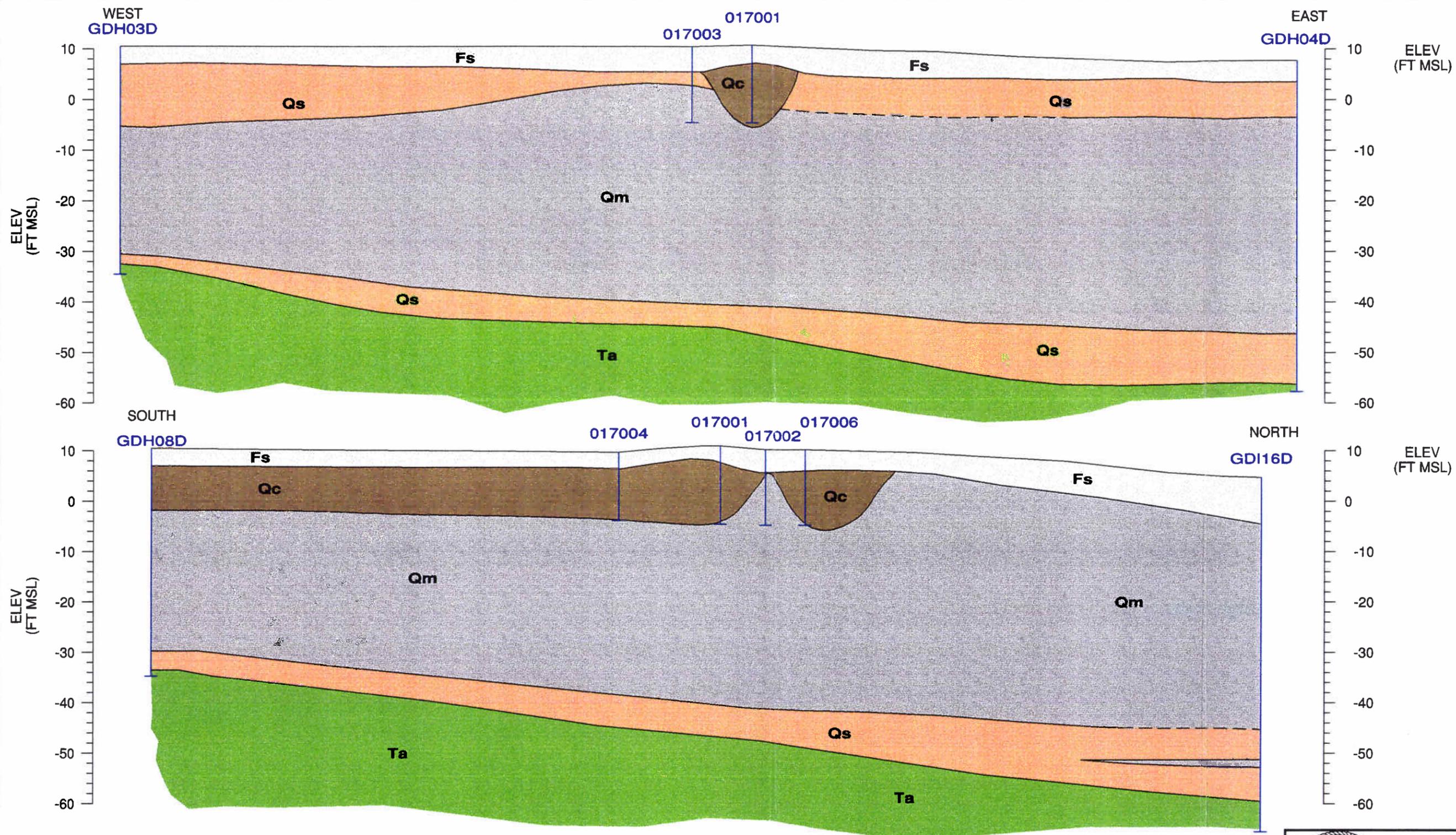
### **Chlorobenzene Delineation**

Chlorobenzene has been detected at multiple wells at SWMU 17 but the focus of this phase of work is completing the delineation of the plume. Chlorobenzene isoconcentration contours indicate that extent has been verified except for well 017010 (5  $\mu\text{g/l}$  - 7/98). Chlorobenzene was also detected on the edge of the well network at well 017005 but the detection occurred only once and that was during the first in groundwater sampling event (2.8  $\mu\text{g/l}$  - 4/95). Since the detection of chlorobenzene was not repeated at 017005 during the subsequent events, a new downgradient well is not proposed for this area. However, a temporary well (W1) is proposed downgradient of 017010 since there has been only the one sampling event. A second temporary well (W2) is proposed along the west side of building FBM 61. Groundwater samples from the temporary wells and all of the existing shallow monitoring wells will be analyzed for VOCs to provide a complete "snapshot" of the chlorobenzene distribution at the site. The proposed locations are shown on Figure 10B.

### **3.1 Soil Sampling**

With the exception of the surface soil sample locations identified by the "S" prefix, each location will be advanced to a depth of two to three feet into the underlying marsh clay using Direct Push Technology (DPT). Geologic cross sections for SWMU 17 are presented as Figure 11. The maximum anticipated soil boring depth is 15 feet bgs. Soil samples from each location will be continuously collected for visual examination and screening with an FID.

If, during the installation of the temporary wells described below, soil is encountered that is obviously contaminated (based on visual observation, PID readings, etc.) samples will be collected and submitted for chemical analysis. This includes soil below the water. Soil samples from the above locations will be collected from the 0-1 ft (bgs) and 3-5ft (bgs) intervals. Soil samples from two locations will be submitted for SPLP and TOC analyses in addition to the primary analytes.



- Fs - FILL SAND AND CLAYEY SAND
- Qc - QUATERNARY CLAY POSSIBLY SOME FILL CLAY
- Qm - QUATERNARY MARSH CLAY
- Qs - QUATERNARY SAND
- Ta - ASHLEY FORMATION
- — — - GEOLOGIC CONTACT: DASHED WHERE INFERRED

VERT: 1" = 20'  
 HORIZ: 1" = 200'  
 VERT EXG: 10

ZONE H  
 CORRECTIVE MEASURES STUDY  
 WORK PLAN ADDENDUM  
 CHARLESTON NAVAL COMPLEX  
 CHARLESTON, SC

FIGURE 11  
 GEOLOGIC CROSS-SECTIONS  
 SWMU 17

00297VV042

### **3.2 Groundwater Sampling**

A temporary well will be installed at each DPT boring except for locations S1 and S2. Wells will be installed inside a large diameter DPT casing, and constructed using one (1) inch ID (minimum) PVC well materials. A sand filter pack will be placed in the well annulus. The DPT installation method should minimize disturbance of the formation. Well screen intakes will be of sufficient length to intersect both the water table and top of the underlying marsh clay (Figure 11). The full length screen is to allow for accumulation of NAPLs. Well development will be performed by pumping using peristaltic pumps. Wells will be allowed to rest for a period of two weeks prior to any measurements or sampling to provide for groundwater and any NAPL stabilization in the wells.

Above ground well heads will be secured using galvanized pipe set into a concrete collar at ground surface. Wells installed in the parking areas will be completed using a watertight cover set in concrete. These wells will remain until it is determined if pumping tests are warranted (if so these will be described in a separate addendum) so that they may be used in assessing the effects of drawdown in the pumping well. Wells will be abandoned in accordance with South Carolina Regulations either upon completion of the pumping test, or within a period of 120 days after report submittal on findings for this investigation. All well locations and elevations will be surveyed.

### **3.3 Groundwater and Phase Measurements**

Three synoptic water level and phase measurement events will be performed. Measurements will be taken prior to the start of collecting groundwater samples, again 30 days after sample collection, and prior to abandonment of the wells. PVC screens shall be visually inspected for fuel/oil staining during abandonment of the temporary wells where possible. Depth and thickness of discoloration are to be recorded. Fuel/oil staining on well screens would indicate the presence of free product in the well bore.

#### **4.0 Data Presentation**

Lithologic and well construction logs for all new and existing wells will be included in the subsequent report. A minimum of two geologic cross sections through the spill area will be generated. Locations where free product or NAPLs are observed will be presented on site maps. Measurable NAPL thicknesses will be contoured. Groundwater elevation contours and flow will be presented on site maps. Groundwater elevation and NAPL contours will be drawn based on synoptic measurements made in all wells prior to collecting groundwater samples. Chemical data from soil and groundwater samples will be plotted on site maps and contoured. Topographic contours of the contact between near surface sediments and the underlying confining Marsh Clay will be generated on a site map.