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CNC CHARLESTON
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DRAFT AREA OF CONCERN 607 (AOC 607) TREATABILITY STUDY WORK PLAN CNC CHARLESTON SC

12/18/1998

ENSAFE

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY CHARLESTON NAVAL COMPLEX CHARLESTON, SOUTH CAROLINA

ZONE F
DRAFT AOC 607 TREATABILITY STUDY WORK PLAN

Revision: 0

CTO: 029

Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering command
North Charleston, South Carolina

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

December 18, 1998

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
P.O. BOX 190010
2155 EAGLE DRIVE
NORTH CHARLESTON, S.C 29419-9010

5090/11
Code 1877
24 December, 1998

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

Subj: SUBMITTAL OF AOC 607 TREATABILITY STUDY WORKPLAN

Dear Mr. Litton,

The purpose of this letter is to submit the enclosed Area of Concern (AOC) 607 Treatability Study Work Plan Naval Base Charleston. The work plan is submitted as an addendum to the SWMU 166/AOC 607 CMS Work Plan. The CMS Work Plan is submitted to fulfill the requirements of condition IV.E.2 of the RCRA Part B permit issued to the Navy by the South Carolina Department of Health and Environmental Control and the U.S. Environmental Protection Agency.

The Navy requests that the Department and the USEPA review the document and provide approval or comments whichever is appropriate. If you should have any questions please contact Billy Drawdy or myself at (843) 743-9985 and (843) 820-5525 respectively.

Sincerely,

M. A. Hunt

M.A. HUNT, P.E.
Remedial Project Manager
Installation Restoration III

Enclosure: (1) Zone F Draft AOC 607 Treatability Study Work Plan

Copy to:
SCDHEC (Paul Bergstrand, Johnny Tapia)
USEPA (Dann Spariosu)
CSO Naval Base Charleston (Billy Drawdy, David Dodds)
SPORTENVDETCHASN (Bobby Dearhart)

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

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1.0 PROJECT DESCRIPTION

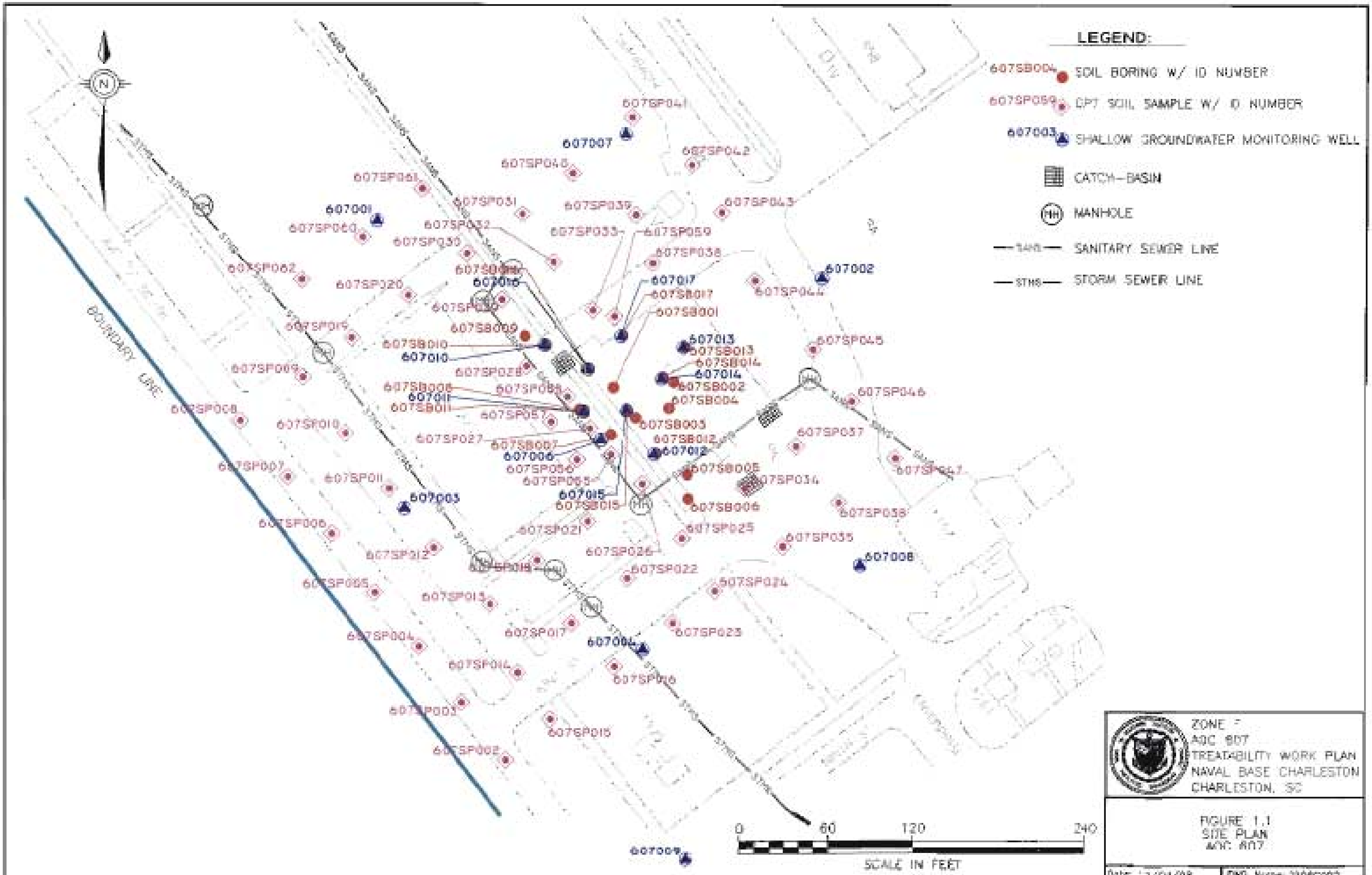
This treatability study work plan is based on information presented in Zone F Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report (EnSafe Inc., December 1997), the Area of Concern (AOC) 607 and Solid Waste Management Unit (SWMU) 166 Corrective Measures Study (CMS) Work Plan (EnSafe, April, 1998), and additional sampling performed as part of monitored natural attenuation and CMS data gap sampling activities performed since production of the CMS Work Plan.

1.1 Site Description

AOC 607 is a former dry-cleaning facility located in Building 1189 that operated from 1942 to 1986. To the south, east, and west of Building 1189 is an asphalt parking lot. A grassed area surrounds the balance of the dilapidated building. Figure 1.1 shows the AOC 607 site and all borings, Direct Push Technology (DPT) points, and monitoring wells installed in conjunction with the Zone F RFI and CMS.

AOC 607 is located within a moderately developed commercial/industrial area of NAVBASE and most surrounding parcels are occupied by buildings and/or service roads. Building 1189 is not currently in use; however, Building 225 located immediately west of Building 1189 is in use as residential apartment housing.

Chlorinated volatile organic compounds (VOCs) - tetrachloroethene (PCE), trichloroethene (TCE), 1,2-dichloroethene (DCE), and vinyl chloride - were detected in shallow and deep portions of the surficial aquifer. High chlorinated VOC concentrations indicate that dense non-aqueous phase liquids (DNAPLs) may be present in some areas, although no DNAPLs were found during sampling.


LEGEND:
607SB004 SOIL BORING W/ ID NUMBER
607SP059 DPT SOIL SAMPLE W/ ID NUMBER
607003 SHALLOW GROUNDWATER MONITORING WELL
CATCH-BASIN
MH MANHOLE
SANS SANITARY SEWER LINE
STMS STORM SEWER LINE
BOUNDARY LINE
0 60 120 240
SCALE IN FEET
ZONE F
AOC 607
TREATABILITY WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SC
FIGURE 1.1
SITE PLAN
AOC 607
Date: 3/04/98
DWG Name: 2866C002

1.2 Site Geology and Hydrogeology

The site is underlain by a layer of fill soil 2 to 3 feet thick. The fill is a heterogeneous mixture of sand, silt and clay, often described as black in color.

Beneath the fill are Quaternary age deposits of silty sand and sandy clay that extend to a depth of approximately 25 feet. According to the boring logs available, individual layers of the silty sand and sandy clay range from less than 1 foot to greater than 5 feet in thickness. However, how well these individual beds correlate across the site rom one boring to another cannot be determined from available information.

The water table lies within the Quaternary age stratum, at a depth of 2 to 4 feet below ground surface (bgs). The groundwater level is influenced slightly by tidal effects that produce diurnal variations of up to 0.2 feet.

The total thickness of the Quaternary age stratum is approximately 22 feet. The total saturated thickness below the groundwater table is also about 22 feet. According to the log of boring 607-06D, the saturated portion of the Quaternary aquifer unit contains 13.5 feet of silty or clayey sand, interbedded with 6.5 feet of sandy clay distributed in layers 1.0 to 2.5 feet in thickness.

Slug permeability tests were conducted in three monitor well pairs having well screen set at depths of 10 feet and 20 feet each. The values of horizontal hydraulic conductivity range from 0.19 to 2.04 feet/day for the 10-foot zone, and 0.37 to 1.33 feet/day for the 20-foot zone. The average horizontal conductivity value for all six zones tested is 0.835 feet/day.

Using a high-end hydraulic conductivity value of 1.25 feet/day as representative of the more permeable regions of the formation, and taking an average sand thickness of 13 feet within the

Quaternary age stratum, a transmissivity value of 16 $feet^2$ /day is computed and may be used for preliminary design calculations.

The lowest stratum encountered during the subsurface investigation program is the Tertiary age group. This deposit is described as sandy silt containing phosphate nodules and shells. This formation is saturated and has a piezometric level generally within 0.1 feet of the Quaternary aquifer unit.

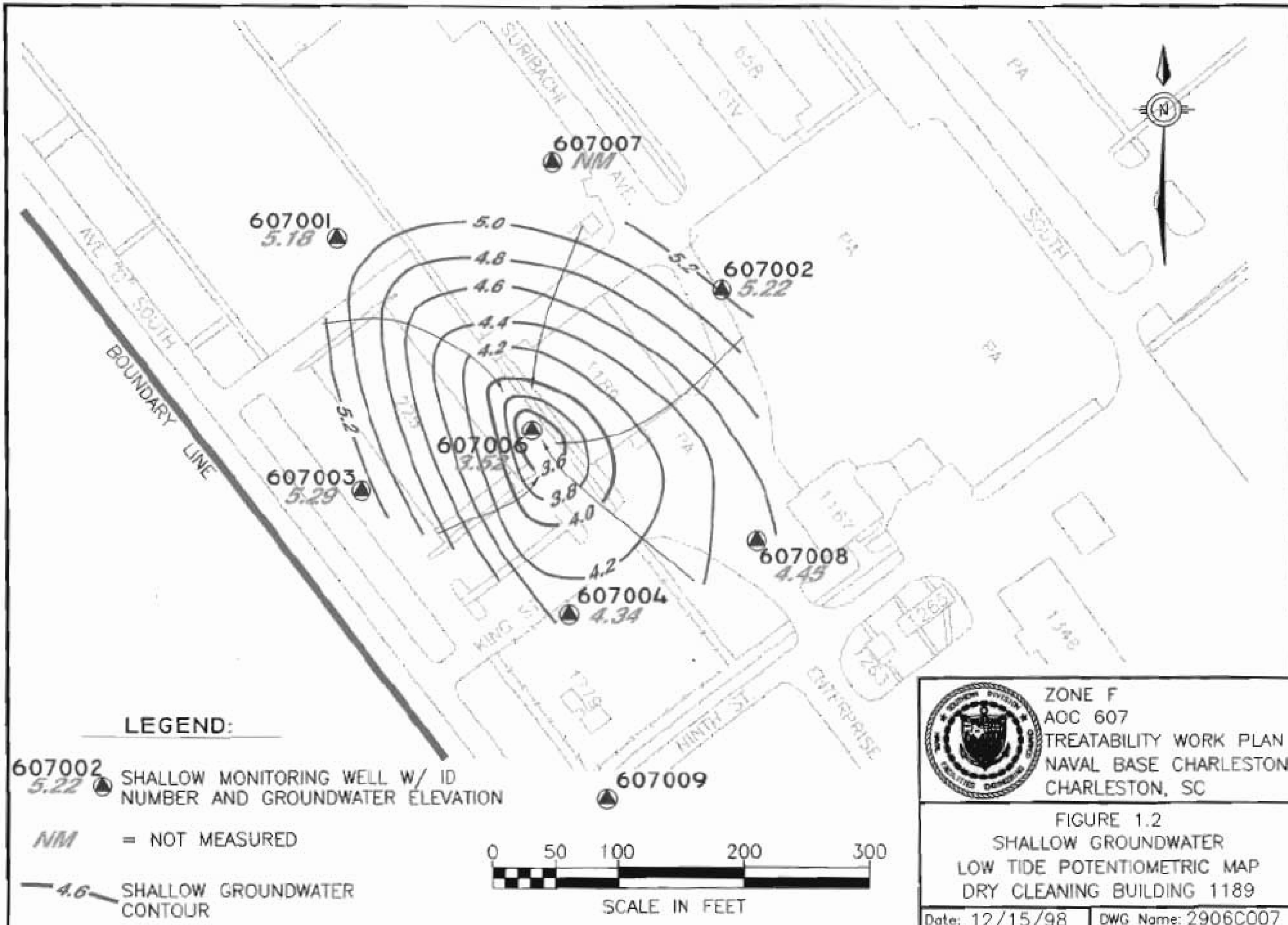
Slug permeability tests conducted in the Tertiary age sediments at a depth of 30 feet yielded values ranging from 0.008 to 0.027 feet/day for the three wells tested. On the average, this formation appears to be about two orders of magnitude less permeable than the overlying Quaternary stratum.

The piezometric surface of the two Quaternary units and one Tertiary unit are shown on Figures 1.2, 1.3, and 1.4. The cone of depression shown in for the Quaternary unit is believed to be caused by infiltration to a sanitary sewer installed approximately 12 feet below the ground surface, running north and parallel to the western side of Building 1189. The apparent hydraulic mound shown on the piezometric map for the Tertiary unit may be caused by recharge through the sewer trench or a leak in the borehole seal intended to isolate the tertiary aquifer screen interval in well 60706D from the overlying quaternary aquifer.

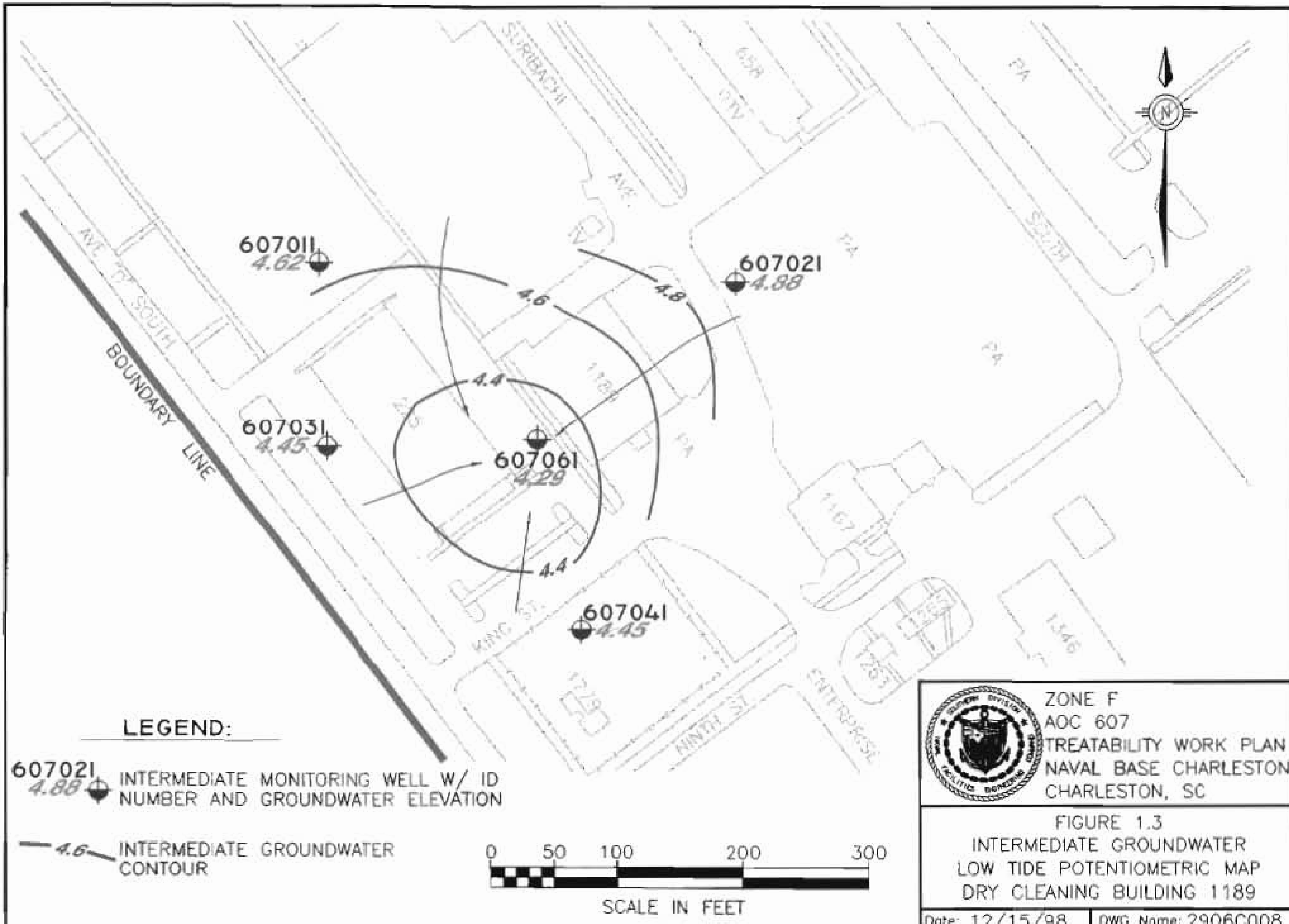
1.3 Nature and Extent of Contamination

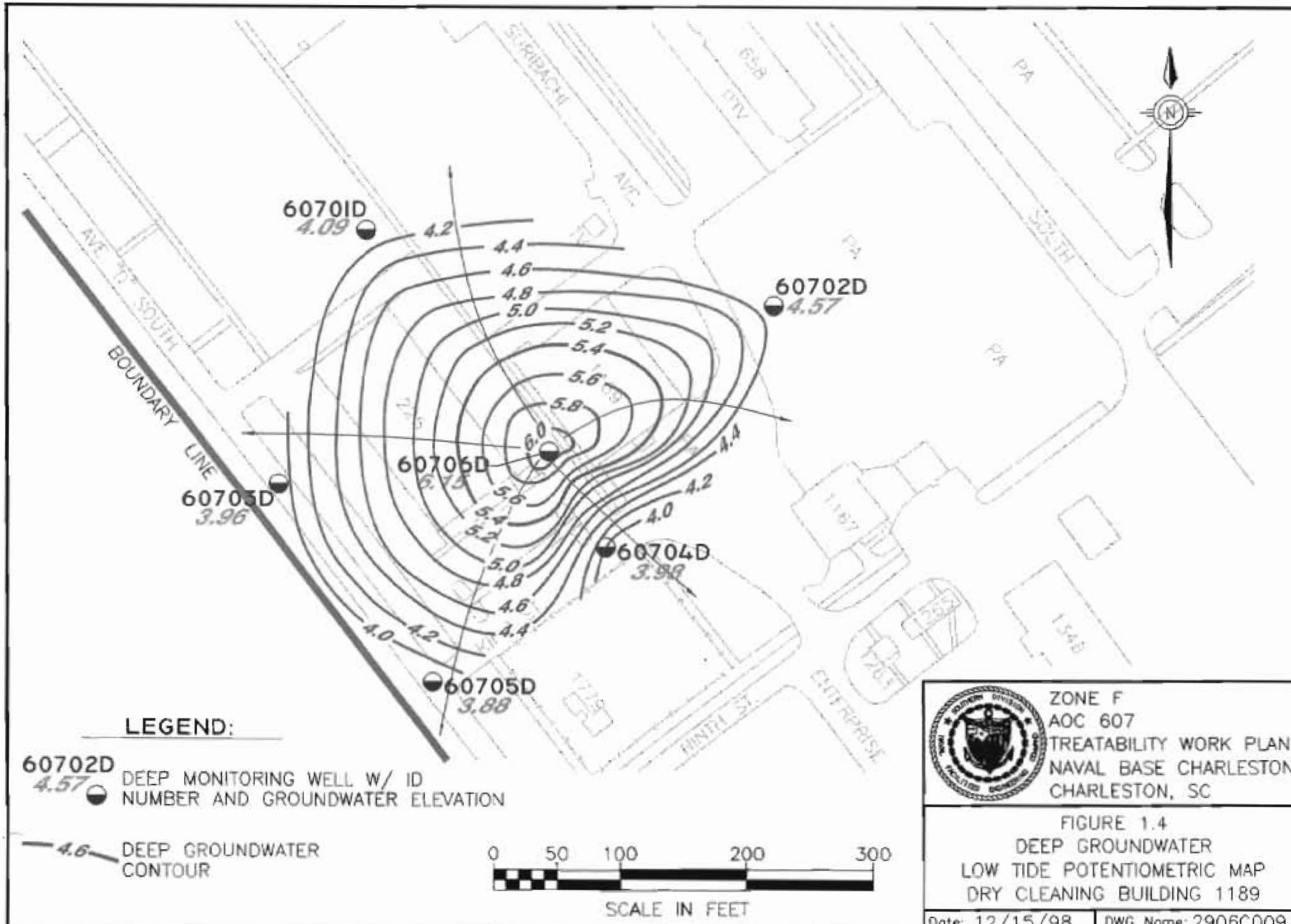
Soil

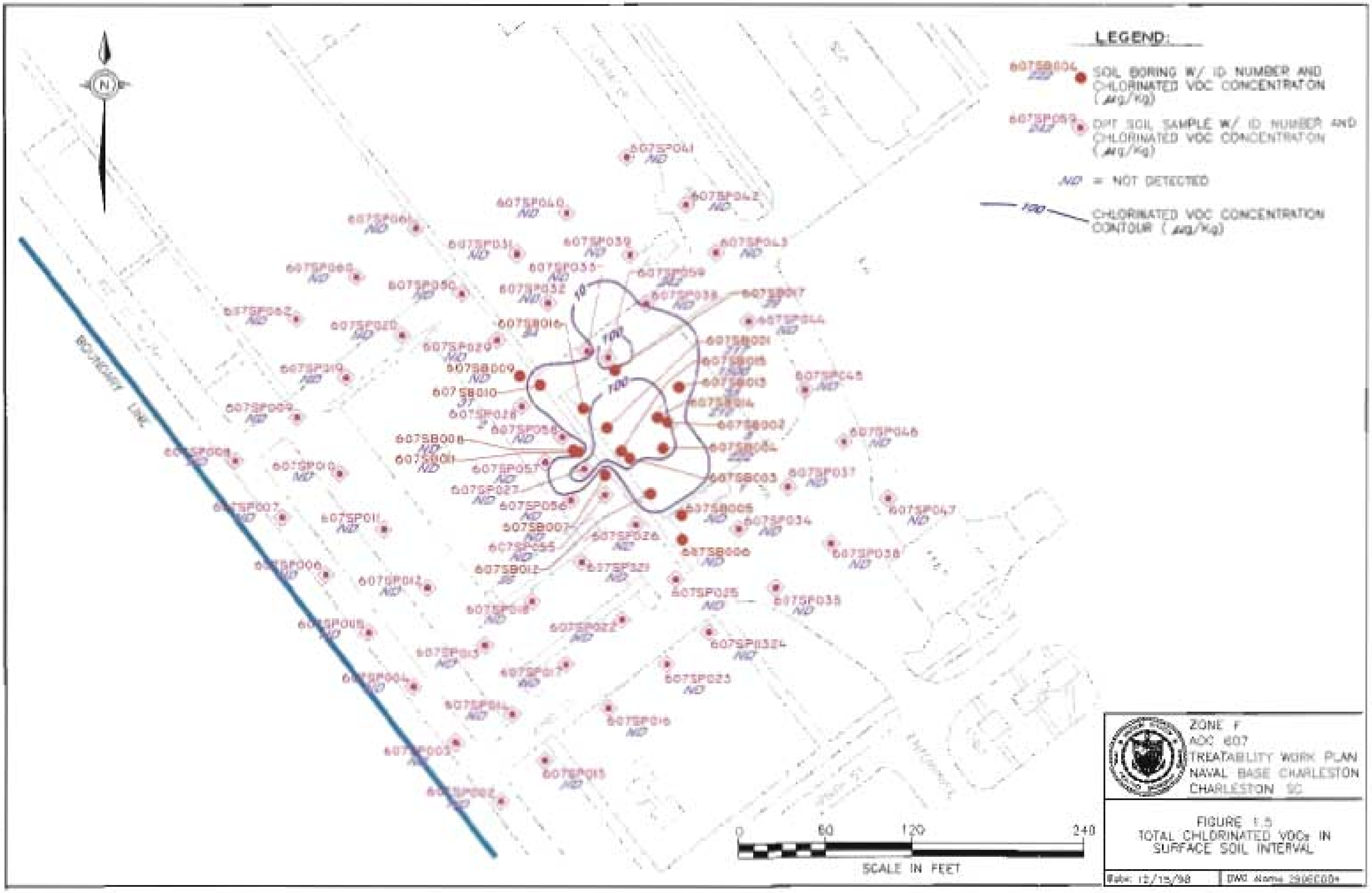
Soil samples collected beneath Building 1189 contained tetrachloroethene (PCE) at concentrations ranging from 29 to 1,500 μg/kg (Figure 1.5 and 1.6). The highest concentrations were seen in well boring 607-015. Soil contamination appears isolated to the area beneath Building 1189 and the area immediately west of the building.

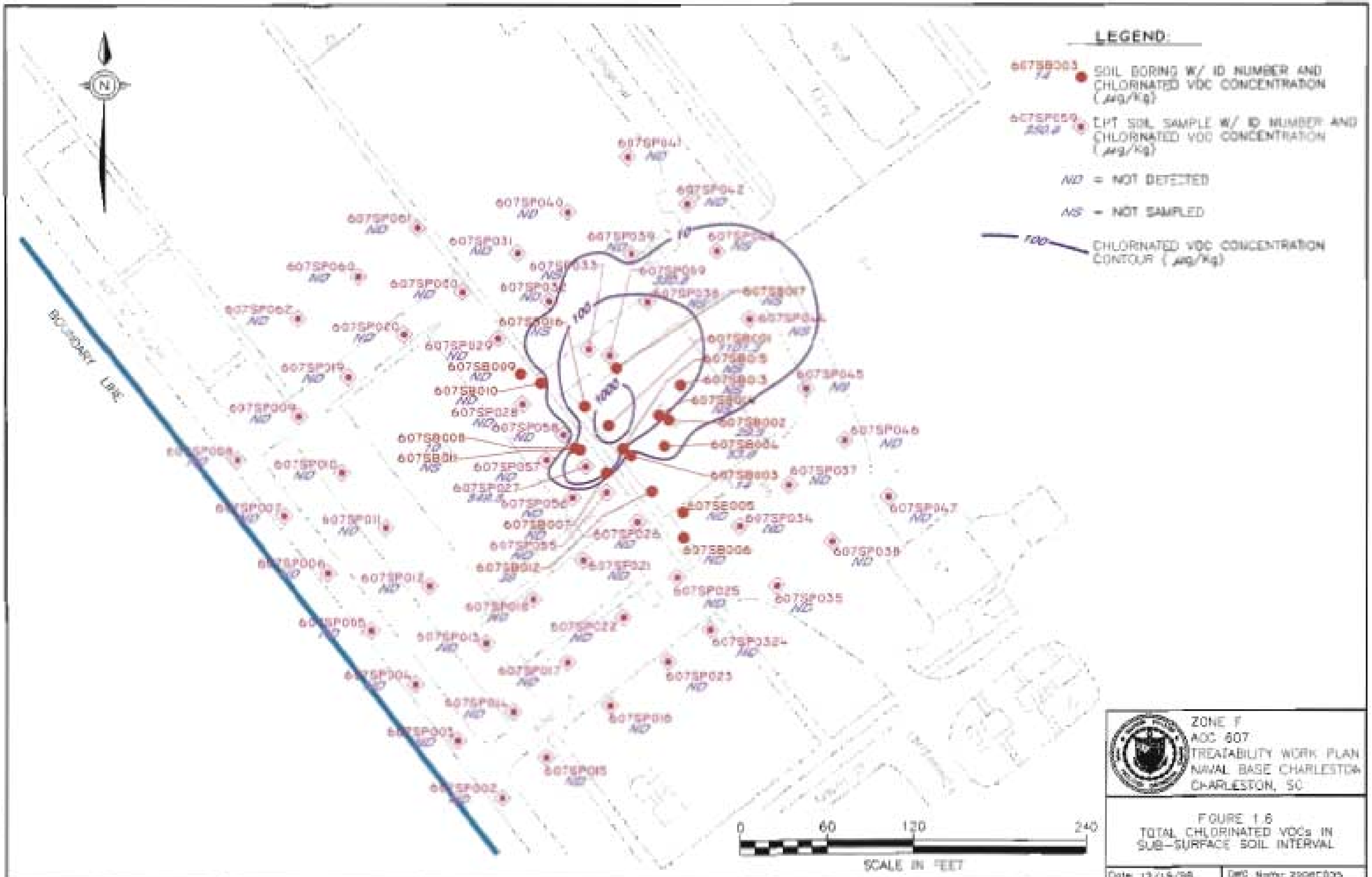


ZONE F
AOC 607
TREATABILITY WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SC
FIGURE 1.2
SHALLOW GROUNDWATER
LOW TIDE POTENTIOMETRIC MAP
DRY CLEANING BUILDING 1189
Date: 12/15/98
DWG Name: 2906C007
LEGEND:
607002 5.22 SHALLOW MONITORING WELL W/ ID NUMBER AND GROUNDWATER ELEVATION
NM = NOT MEASURED
4.6 SHALLOW GROUNDWATER CONTOUR
0 50 100 200 300
SCALE IN FEET
607007 NM
607001 5.18
607002 5.22
607003 5.29
607006 3.52
607008 4.45
607004 4.34
607009
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
5.2
BOUNDARY LINE
SURIBACHI AVE.
AVE. SOUTH
KING ST.
NINTH ST.
ENTERPRISE
PA
1189
1167
1265
1348


607011
4.62
607021
4.88
607031
4.45
607061
4.29
607041
4.45
4.6
4.8
4.4
4.4
BOUNDARY LINE
SURIBACHI AVE.
SOUTH AVE.
KING ST.
NINTH ST.
ENTERPRISE
PA
1189
1167
1346
1279
N
LEGEND:
607021 4.88 INTERMEDIATE MONITORING WELL W/ ID NUMBER AND GROUNDWATER ELEVATION
4.6 INTERMEDIATE GROUNDWATER CONTOUR
0 50 100 200 300
SCALE IN FEET
ZONE F
AOC 607
TREATABILITY WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SC
FIGURE 1.3
INTERMEDIATE GROUNDWATER
LOW TIDE POTENTIOMETRIC MAP
DRY CLEANING BUILDING 1189
Date: 12/15/98
DWG Name: 2906C008


60701D
4.09
60702D
4.57
60706D
6.15
60703D
3.96
60704D
3.96
60705D
3.88
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
BOUNDARY LINE
AVE "D" SOUTH
SURIBACHI AVE.
ENTERPRISE
HINTH ST.
PA
SOUTH
658
1189
1187
1255
1263
1548
1779
N
LEGEND:
60702D 4.57 DEEP MONITORING WELL W/ ID NUMBER AND GROUNDWATER ELEVATION
4.6 DEEP GROUNDWATER CONTOUR
0 50 100 200 300
SCALE IN FEET
ZONE F
AOC 607
TREATABILITY WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SC
FIGURE 1.4
DEEP GROUNDWATER
LOW TIDE POTENTIOMETRIC MAP
DRY CLEANING BUILDING 1189
Date: 12/15/98
DWG Name: 2906C009


LEGEND:
SOIL BORING W/ ID NUMBER AND CHLORINATED VOC CONCENTRATION (µg/Kg)
DPT SOIL SAMPLE W/ ID NUMBER AND CHLORINATED VOC CONCENTRATION (µg/Kg)
ND = NOT DETECTED
CHLORINATED VOC CONCENTRATION CONTOUR (µg/Kg)
BOUNDARY LINE
0
60
120
240
SCALE IN FEET
ZONE F
AOC 607
TREATABILITY WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON SC
FIGURE 1.5
TOTAL CHLORINATED VOCs IN SURFACE SOIL INTERVAL
Date: 12/15/98


LEGEND:
607SB003 74 SOIL BORING W/ ID NUMBER AND CHLORINATED VOC CONCENTRATION (µg/Kg)
607SP059 EPT SOIL SAMPLE W/ ID NUMBER AND CHLORINATED VOC CONCENTRATION (µg/Kg)
ND = NOT DETECTED
NS = NOT SAMPLED
100 CHLORINATED VOC CONCENTRATION CONTOUR (µg/Kg)
BOUNDARY LINE
0 60 120 240
SCALE IN FEET
ZONE F
AOC 607
TREATABILITY WORK PLAN
NAVAL BASE CHARLESTON
CHARLESTON, SC
FIGURE 1.6
TOTAL CHLORINATED VOCs IN SUB-SURFACE SOIL INTERVAL

Groundwater

Chlorinated VOCs - PCE, trichloroethene (TCE), 1,2-dichloroethene (DCE), and vinyl chloride - are the primary contaminants of concern in groundwater at this site, and the removal of these VOCs in the focus of this treatability study. Total chlorinated VOCs in shallow groundwater (8 to 11 feet bgs) from the most recent round of sampling (October, 1998) were contoured (Figure 1.7) to estimate the location of the VOC source zone. The area of highest concentration appears to extend from Well 607-017 to Well 607-006. Total chlorinated VOC concentrations in this area ranged from 3 to 17 mg/L. These concentrations indicate dense non-aqueous phase liquids (DNAPL) may be present in this area.

The information available to date indicates the VOC contamination is mostly confined to the upper portion of the Quaternary age sediments. However, some VOC contamination has migrated downwards, at least in the vicinity of well 607-06I (5.7 mg/L total VOC, September 1998), where it was detected at a depth of 20 feet.

Most of the VOC contamination lies within the footprint of Building 1189. VOCs appear to be migrating towards the sanitary sewer line where groundwater is being captured by infiltration through cracks and joints in the sewer pipe. The rate of infiltration has not been quantified, however groundwater infiltration is common for both sanitary and storm sewers that lie below the water table. Since this sewer line is acting as a downgradient receptor, the rate of migration of VOCs (originating from Building 1189) southwest of the sewer line is currently inhibited.

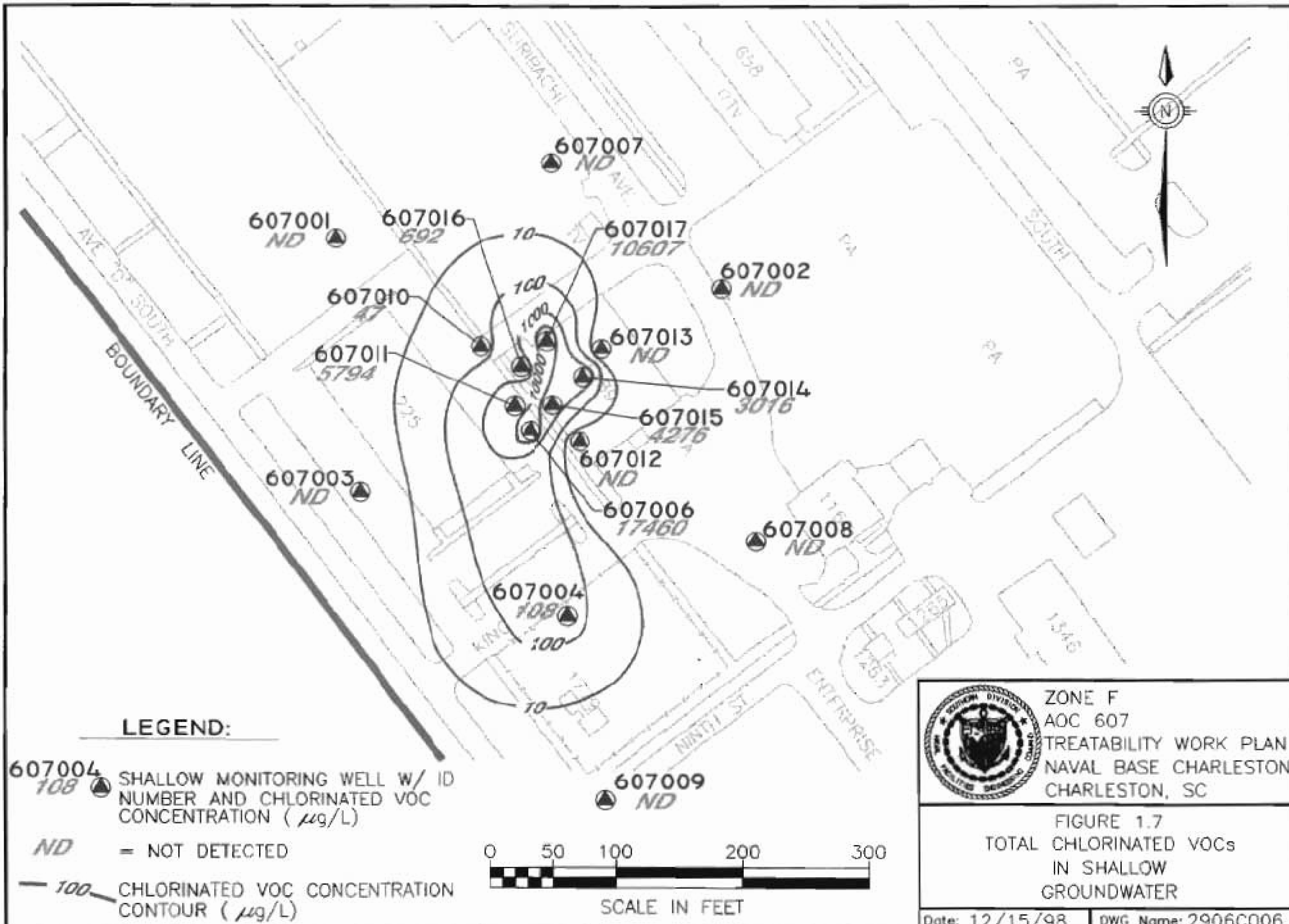


FIGURE 1.7
TOTAL CHLORINATED VOCs
IN SHALLOW
GROUNDWATER

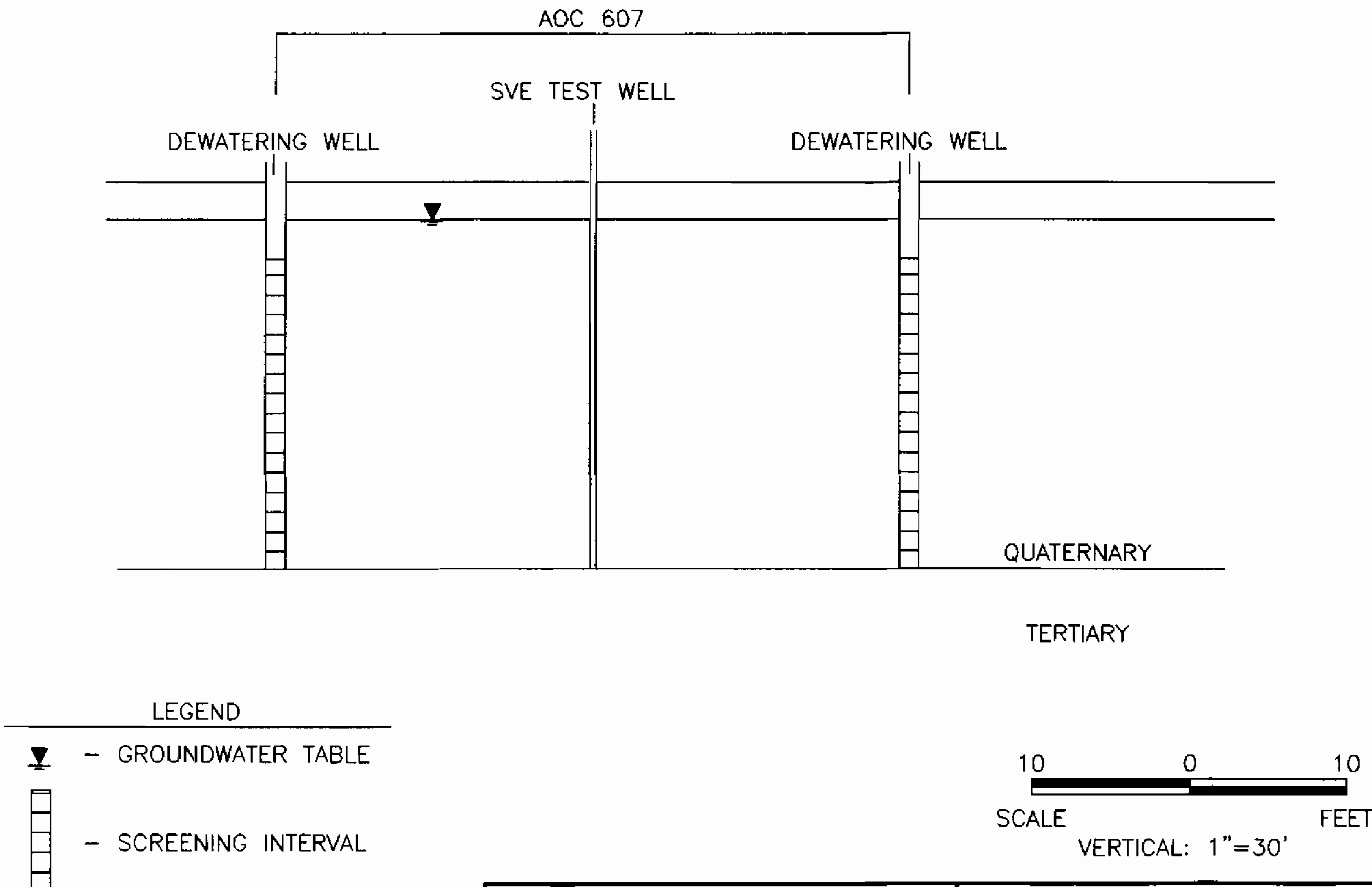
2.0 REMEDIAL TECHNOLOGY DESCRIPTION

2.1 Soil Vapor and Vacuum Enhanced Groundwater Extraction

Soil vapor extraction (SVE) is a remedial technology used to treat soil affected by dissolved and free-phase VOCs. The extracted fluids and vapors are treated in an aboveground remedial system before being discharged. SVE systems are designed to operate in the vadose, or unsaturated zone, but can be extended to incorporate a portion of the saturated zone if a suitable dewatering system is used in conjunction with SVE.

In a subsurface environment like AOC 607, the most critical aspect of operating a successful SVE system is to install an effective dewatering system around the area to be treated. Without the dewatering system in operation, there can be no effective movement of air because groundwater forms an imperious boundary, both laterally and vertically, as shown in Figure 2.1. In addition, negative air pressure created by the SVE system can cause an "upwelling" of groundwater that could rise in proportion to the negative pressure applied (expressed in inches of water). In other words, the application of 200 inches of vacuum in an SVE well could cause a rise in the groundwater table of as much as 200 inches. Since the groundwater table at AOC 607 is at a depth of only 2 to 4 feet, any application of vacuum would probably drown out the thin vadose zone that presently exists under the building.

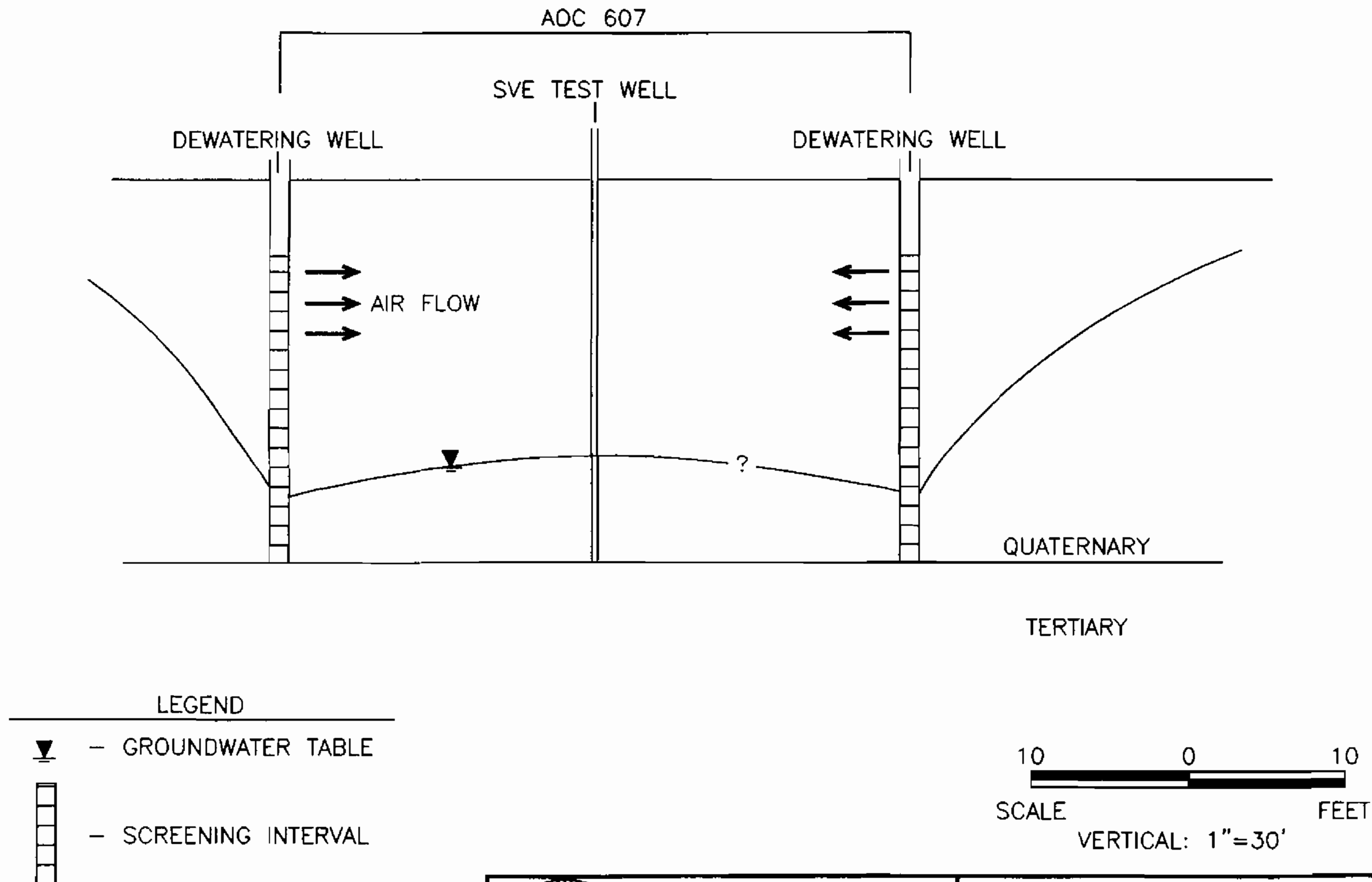
When the VOC-contaminated zone is dewatered, as shown in Figure 2.2, residual moisture can be stripped out of the drained soil horizon by application of vacuum in the SVE wells. However, there must also be a source of air so that flow through the treatment zone can be maintained. In this case, the floor slab of Building 1189 and paved areas outside of the structure will act to prevent the entry of air through the ground surface. This prevents "short circuiting" of air flow from the ground surface close to the SVE extraction well. However, either active or passive zones of air entry must be created within the dewatered zone to establish a source of fresh air.



AOC 607
TREATABILITY STUDY
WORK PLAN
CHARLESTON
NAVAL COMPLEX

FIGURE 2.1
SCHEMATIC PROFILE
BEFORE DEWATERING

DWG DATE: 12/16/98 | DWG NAME: 2906B001



AOC 607
TREATABILITY STUDY
WORK PLAN
CHARLESTON
NAVAL COMPLEX

FIGURE 2.2
SCHEMATIC PROFILE
AFTER DEWATERING

DWG DATE: 12/16/98 | DWG NAME: 2906B002

In this case, the dewatering wells can be used to establish points of passive air entry by screening them from top to bottom across the saturated zone, and by venting them to the surface. The sewer system can also be used as a zone of passive air entry by dewatering to below its invert elevation. Places where groundwater used to infiltrate along cracks and joints will now become points of air entry.

Dewatering the treatment zone will generate substantial quantities of groundwater, which will also require treatment and disposal. For this treatability project, primary treatment will be by passing water through granulated activated carbon (GAC), with disposal into the sanitary sewer under permit from the Publically Owned Treatment Works (POTW).

2.2 Theory

When chlorinated solvents such as PCE and TCE enter the ground, they are often held by capillary tension in the vadose or unsaturated zone. Fine grain soil types such as silt or clay are likely to adsorb a greater volume of these solvent than sand or gravel because of their greater surface area and more frequent intergranular contact. These chlorinated solvents also migrate into the soil gas phase due to their relatively high vapor pressure, and into soil moisture that is also held by capillary tension. Thus, chlorinated solvents in the vadose zone are held in three possible ways.

- As DNAPL adsorbed by soil particulates
- As vapor in soil gas
- As a solute in soil moisture

In the phreatic or saturated zone, chlorinated solvents usually exist as a solute in groundwater. Occasionally, when the volume of dense chlorinated solvent released is high enough to overwhelm the adsorptive capacity of soil in the vadose zone, free-phase solvent drains into the saturated zone and migrates downward until a low permeability barrier is encountered. In this case, the DNAPL may simply puddles within (or throughout) the phreatic zone and act as a mobile source of contamination that constantly replenishes migrating groundwater with chlorinated solvent.

SVE works by applying a negative pressure or vacuum to a zone of VOC-contaminated soil in the unsaturated zone, and/or the dewatered portion of the saturated zone. Provided that a source of clean air is available, the circulation of airflow from the zone of atmospheric pressure (for passive air supply wells) to the vacuum applied in the SVE well creates a flow of air that is capable of removing both the soil gas and soil moisture, including solvent that is contained in either media. As the flow of air continues, DNAPL held by capillary tension is released (because of its relatively high vapor pressure) and is transferred into vapor phase. Thus, continued air flow through porous media of the vadose zone is effective in removing chlorinated solvents. The actual rate of removal can be calculated as a function of the rate of air exchanged in the pore volume of the media.

Subsurface conditions occasionally exist that reduce the effectiveness of SVE, or have the impact of increasing the time required for remediation goals to be met. One such condition is the presence of DNAPL puddled on top of a low permeability layer. The analytical treatment of this condition results in a boundary layer problem where the change in state (from a liquid to a gas) occurs only at the surface of the DNAPL layer. Another special condition is when DNAPL has been adsorbed onto one or more low permeable layers. The migration of DNAPL though this layer depends on ionic diffusion, which is a relatively slow process. These conditions and others like them can impact both the time required and ultimate effectiveness of SVE in the treatment of contaminated soil.

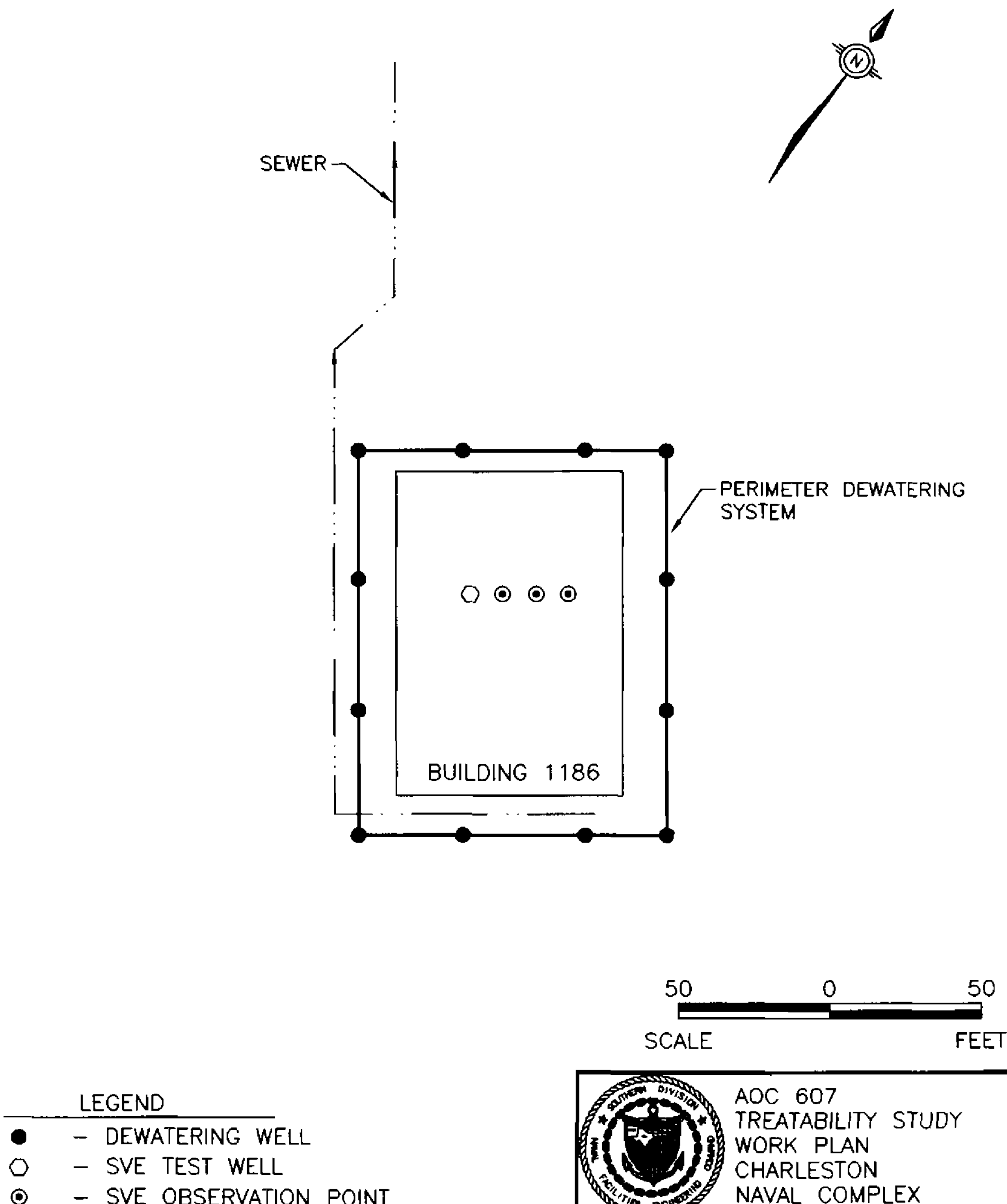
2.3 Application at AOC 607

High concentrations of dissolved chlorinated solvents found at AOC 607 indicate the possible presence of free-phase solvent. The release of these solvents has primarily affected water quality in the shallow aquifer. Groundwater flow appears to be migrating towards a central location to the west of Building 1189 where it is being intercepted by infiltration to a sanitary sewer.

In order for an SVE system to operate effectively in the vicinity of AOC 607, the area beneath it must be dewatered. The dewatering system will incorporate a series of wells screened to the bottom of the Quaternary unit (approximately 25 feet deep) in a square pattern, approximately 120 feet on each side, as shown on Figure 2.3. An aquifer pumping test will be performed on one corner of the square boundary to assess the aquifer coefficients and to identify any hydraulic boundaries that may be present. Once the aquifer pumping test is completed, the spacing and pumping rate of the dewatering system can be estimated. Although the water table aquifer cannot be completely dewatered, the study will show what level of dewatering can be achieved and at what cost. Conceptually, the perimeter of the dewatered area will result in wells spaced from 20 to 40 feet on center. The wells will be pumped using an eductor system operated by a single electric pump. The dewatering system will be installed and operated by an experienced construction dewatering contractor.

After the dewatering system has been placed in operation, a single SVE treatability well will be placed inside Building 1189. The well will be screened across the entire Quaternary unit and sealed in the floor and fill zone underlying it. Three vacuum piezometers will also be placed into the Quaternary unit, at 10 feet, 20 feet, and 30 feet from the SVE treatability well. These will be used to measure vacuum pressures while the SVE treatability well is in operation.

For clean sand, in the absence of complex subsurface conditions, a treatability test is often a short-term affair, lasting 3 to 5 days. However, subsurface conditions at this site are both complex and influenced by fine-grained soil strata. Where low permeability soil zones are tested, the initial application of vacuum will usually result in high wellhead pressures and relatively low flow of air, because the high soil moisture has a low relative permeability to air. As the flow of air increases



AOC 607
TREATABILITY STUDY
WORK PLAN
CHARLESTON
NAVAL COMPLEX

FIGURE 2.3
DEWATERING SYSTEM LAYOUT

DWG DATE: 12/16/98 | DWG NAME: 2906B003

over time, the moisture content of the soil becomes less and the relative permeability to air increases. After 3 to 4 weeks (typically) pressure at the wellhead falls off and the rate of airflow increases. Therefore, the treatability test for AOC 607 is expected to last approximately 1 month. However, the treatability test can be extended to generate additional data and to keep the remediation process active until additional SVE wells can be designed and installed (if necessary). Once the dewatering system is placed into service, it is recommended that it be kept operational to prevent the continued uncontrolled release of VOC solvents into the sanitary sewer.

3.0 TREATABILITY STUDY OBJECTIVES

The treatability studies under consideration include both an aquifer pumping test to aid in design of the dewatering system, and an SVE treatability test to aid in the design of the SVE remediation system. Results of these studies will be used as part of the CMS to scale up design requirements, costs, and estimate time for full-scale remediation.

Currently, monitored natural attenuation is also being evaluated at AOC 607. However, source removal is required prior to natural attenuation. Integrated technologies such as SVE followed by natural attenuation will be evaluated during the CMS.

3.1 Aquifer Pumping Test

The aquifer pumping test will be used to measure the following parameters.

- The coefficiency of transmissivity
- The coefficiency of storage
- The presence of hydraulic boundaries
- Specific capacity of pumping wells
- Safe yield
- Water treatability requirements

This information will be synthesized and integrated into mathematical models to assist in the prediction of:

- Optimum well spacing
- Expected dewatered elevation within the Quaternary unit
- Time requirements for system operation
- Treatment capacity of the pretreatment unit
- Permit requirements for continued use of the sanitary sewer

As a corollary to the aquifer pumping test, soil samples will be taken in zones of soft, loose, or compressible strata. Shelby tube samples may be subjected to consolidation tests so that total settlement of the ground in response to dewatering may be examined.

3.2 SVE Treatability Test

The SVE treatability test is designed to measure the following parameters.

- Determine air flow rates at different vacuum pressures for individual SVE wells
- Estimate the radius of influence for individual SVE wells
- Determine the time needed to dry out the formation in order to establish permeability to air
- Compute effective intrinsic permeability of the formation in-situ
- Assess the mass flow rate of VOC removal

This information will be used to prepare engineering plans and drawings for design of the complete SVE remediation system. Mathematical models will also be used to determine optimum well spacing, operational cycling (necessary to eliminate zones of stagnation), to forecast cleanup time, and to establish cleanup goals.

4.0 RECOMMENDATIONS FOR CONDUCTING THE AQUIFER PUMPING TEST

4.1 Introduction

The first step in the design process is to conduct an aquifer pumping test at one corner of the area to be dewatered. The test well will eventually become part of the dewatering system itself so it should be installed at a location that is suitable for both phases of its intended use. This section describes recommendations for installing and testing the dewatering test well.

4.2 Well Installation

The dewatering test well will be installed in a boring drilled to a depth of 25 feet, or into the top of the Tertiary sediments, whichever is greater. Driven soil samples will be taken at 2-1/2 feet intervals, except where pushed Shelby tube samples are taken. Two Shelby tube samples will be taken in clay strata at the direction of the engineer. The clay samples will be carefully sealed with caps, tape, and wax, and delivered to a geotechnical laboratory for consolidation testing. Driven samples of granular material collected from the split-spoon samples will be preserved in plastic jars and delivered to a geotechnical laboratory for grain size distribution analyses, at the direction of the engineer.

The completed drill hole will have an outer diameter of 8 to 12 inches, and should be large enough to accommodate a 4-inch inside diameter (ID) well screen and standpipe. The well screen will consist of a 20-foot section of machine-slotted polyvinyl chloride (PVC) flush-joint casing, equipped with a solid cap at the bottom and a 7-foot (nominal) joint of solid PVC flush-joint casing above it, resulting in a stick-up of approximately 2-feet above the ground surface. The No. 20 slot screened section shall have a centralizer at the top and bottom. The annulus between the screen and the natural formation shall consist of Global™ No. 7 silica sand filter pack, or equivalent approved by the engineer. The sand pack shall extend 2 feet above the top of the screen, followed by a 1-foot layer of granular bentonite, followed by a 2-foot-thick seal of concrete at the ground surface.

After installation, the dewatering test well shall be thoroughly developed by the drill crew for at least 2 hours, using a combination of pumping, surging, and flushing with potable water. All residuals derived from drilling and developing the dewatering test well will be managed as hazardous waste. Development will be completed when the engineer has judged the well to be clean and hydraulically responsive. Short-term specific capacity and pumping rate information will be recorded to aid in design of the step test, using pumps provided by the drilling contractor.

Two nested piezometer pairs will be installed in boreholes 10 feet and 20 feet away from the dewatering test well and in line with the perimeter of the proposed dewatering system. Piezometer pairs will be screened from 7 to 10 feet and from 17 to 20 feet. The test borings will not be sampled, unless additional Shelby tube samples or driven (split spoon) samples are required for laboratory testing. The piezometers shall consist of 2-inch ID screen and flush-joint casing. The machine slot PVC screen shall have a No. 20 slot size and centralizers placed on the top and bottom of the screened section. Flush-joint PVC casing shall be installed above the screen and a solid cap placed at the bottom of the screen. The piezometers will be placed in holes no less than 6 inches in diameter. The annulus between the well screen and the formation shall be filled with Global™ No. 7 silica sand or approved equivalent to a level of 2 feet above the top of the screen, followed by a 1-foot layer of granular bentonite, followed by a grout seal to the ground surface.

After installation, piezometers shall be thoroughly developed by the drill crew for at least 1 hour each, using a combination of pumping, surging, and flushing with potable water. All residuals derived from drilling and developing the piezometers shall be managed as investigative derived waste.

4.3 Step Test

A step pumping test shall be performed in the dewatering test well to determine the following information.

- Safe yield for the constant rate test
- Specific capacity of the dewatering test well
- Well efficiency or "well loss" of the test well
- Responsiveness of the two piezometers to pumping at the dewatering test well

Using estimates of sustainable pumping rate acquired during the well development program, an appropriately size, electrically-powered pump will be used for the step pumping test. The expected short-term yield is 1 to 10 gallons per minute (gpm), but this could change depending on the water-bearing strata encountered. The pump shall be equipped with a discharge control valve capable of controlling the flow to accommodate the number of steps required. Typically, this will consist of three to five steps starting with the lowest flow rate and ending with the highest flow rate. Each flow rate is held constant for a period for 30 minutes and the water level is measured in the pumping well every 5 minutes. Water levels in the piezometers may be checked every 10 or 15 minutes.

At the end of each 30 minute step, the flow will be increased and the next step begun. The test will be completed when the maximum flow rate of the pump is reached or the water level in the dewatering test well falls below the level of the pump intake, whichever occurs first.

Since the same pump will probably be used for both the step test and the constant rate test, it will be appropriate to run the groundwater produced directory through a drum(s) of granular activated carbon (GAC), then discharge it into the sanitary sewer for disposal. A letter of authorization should be obtained from the local POTW before this test is begun and the drum(s) of GAC should be appropriately sized to accommodate the maximum flow rate anticipated. During the test, the actual flow rate should be determined using a calibrated 5-gallon bucket and stopwatch at the discharge of the GAC treatment unit, or a calibrated in-line water meter, or both.

4.4 Constant Rate Test

As soon as the step drawdown test is completed, the constant rate test can be set up by running the test pump and setting the discharge valve to the pumping rate that will be used for the constant rate test. Then the entire system will be shut down and allowed to reach hydraulic equilibrium at least overnight. Pressure transducers shall then be placed in:

- The dewatering test well
- Both piezometers
- Selected monitor wells in close proximity to the test

The pressure transducers shall then be attached to data loggers and allowed to record tidal effects and antecedent water level trends for a period of at least 48 hours prior to the start of pumping.

Prior to the start of the constant rate test, the data loggers will all be reset to record the early data in a logarithmic sequence. When the test is begun, the pump will be turned on at its preset rate and the pumping rate checked periodically to make sure it is constant. Manual measurements will be recorded using electric water level indicators as a backup to the electronically recorded data.

While the constant rate test is in progress, water samples will be taken at 12-hour intervals from a sampling tap placed in the discharge line, before it reaches the drum of GAC. The samples will be tested for VOCs by United States Environmental Protection Agency (USEPA) Method 8260. Samples will also be collected at the discharge side of the GAC drum at 24-hour intervals and tested for VOCs in accordance with USEPA Method 8260.

The constant rate test will run uninterrupted for a period of 48 to 72 hours. When the decision is made by the engineer or hydrogeologist to shut down the test, the data loggers will again be reset to start recording logarithmically when the pump is stopped to acquire the recovery data.

The data loggers will continue to record water level data for at least 8-hours after the pump is turned off.

When the test is completed, the dewatering test well and both piezometers will be capped securely to prevent vandalism from occurring. All of the pumping and water level measuring equipment should then be removed.

4.5 Engineering Design of the Dewatering System

Results of the aquifer pumping tests will be analyzed to compute the distance-drawdown relationships necessary to establish parameters for design of the dewatering system. As presently envisioned, the dewatering system will consist of from 12 to 24 pumping wells set 20 to 40 feet apart along the perimeter of a square, 120 feet per side. Each well will be screened from 5 to 25 feet bgs and vented to the atmosphere to provide a passive source of air to the SVE wells. Water entering the wells will be removed by an eductor system that recirculates water under high pressure through a Venturi nozzle that causes suction. The system shall be installed and operated by a qualified dewatering contractor who has experience in the Charleston area. Each well shall be equipped with valves so the contractor can "tune" them according to that yield.

The dewatering system will operate from a single electrically powered pump. Each well will be served by two header pipes; one high pressure supply line and one low pressure return. These lines will be carried below grade only where they constitute a barrier to traffic or prevent access to a building. Otherwise, they will be placed on the ground surface. If winter operation is required, the headers will be protected from mild freezing temperatures by hay bales, Styrofoam, or other forms of surface installation. Because the winter climate is not usefully severe at this location, no extraordinary means of freeze protection will be provided.

Treatment of the discharge water will be part of the design and will not be addressed until the design flow rate is known from the aquifer pumping tests. However, it is expected that direct treatment through GAC and discharge into the sanitary sewer under permit from the POTW would be the easiest and least expensive method of handling the water. Design of the water treatment system will provide for sampling the groundwater discharge, before and after treatment on a weekly basis for the first 4 weeks, and monthly there after. All water analyses will be conducted in accordance with USEPA Method 8260.

If the geotechnical laboratory testing and analysis indicates that measurable settlement is likely to occur as a result of dewatering, settlement markers will be established at locations within the zone to be treated and the risk of potential structural distress will be identified.

5.0 SVE TREATABILITY TEST

After the perimeter dewatering system is installed, a single SVE treatability well will be installed inside Building 1189. This well will be installed in a boring drilled using a skid rig or other small, maneuverable apparatus designed to work in confined areas. The SVE treatability well will be screened from approximately 5 to 25 feet deep and be constructed in a manner similar to the piezometers used as observation wells during the aquifer test. While details of the engineering design will be formulated after the aquifer pumping test is completed, it is likely that three SVE observation points will be installed at a radial distance of 10, 20, and 30 feet from the SVE treatability well. The SVE observation points will be constructed of 1-inch ID PVC pipe screened from 5 to 25 feet in depth. Each SVE observation point will be equipped with a petcock to facilitate sample collection and vacuum measurements.

5.1 Plans and Specification Design Document Outline

A plans and specifications design document will be developed prior to the treatability test and it will include the following elements:

- Electrical
- Concrete
- Steel
- Piping
- Pumps
- Blowers
- Air stripping system
- Instrumentation information

- Drawings

  a. Process and Instrumentation Diagram (P&ID)
  b. P&ID Symbol Sheet
  c. Layout Drawing (equipment)

A conceptual process flow diagram of the remedial system is shown in Figure 5.1. Detailed drawings will be provided in the design document.

5.1.1 SVE Equipment

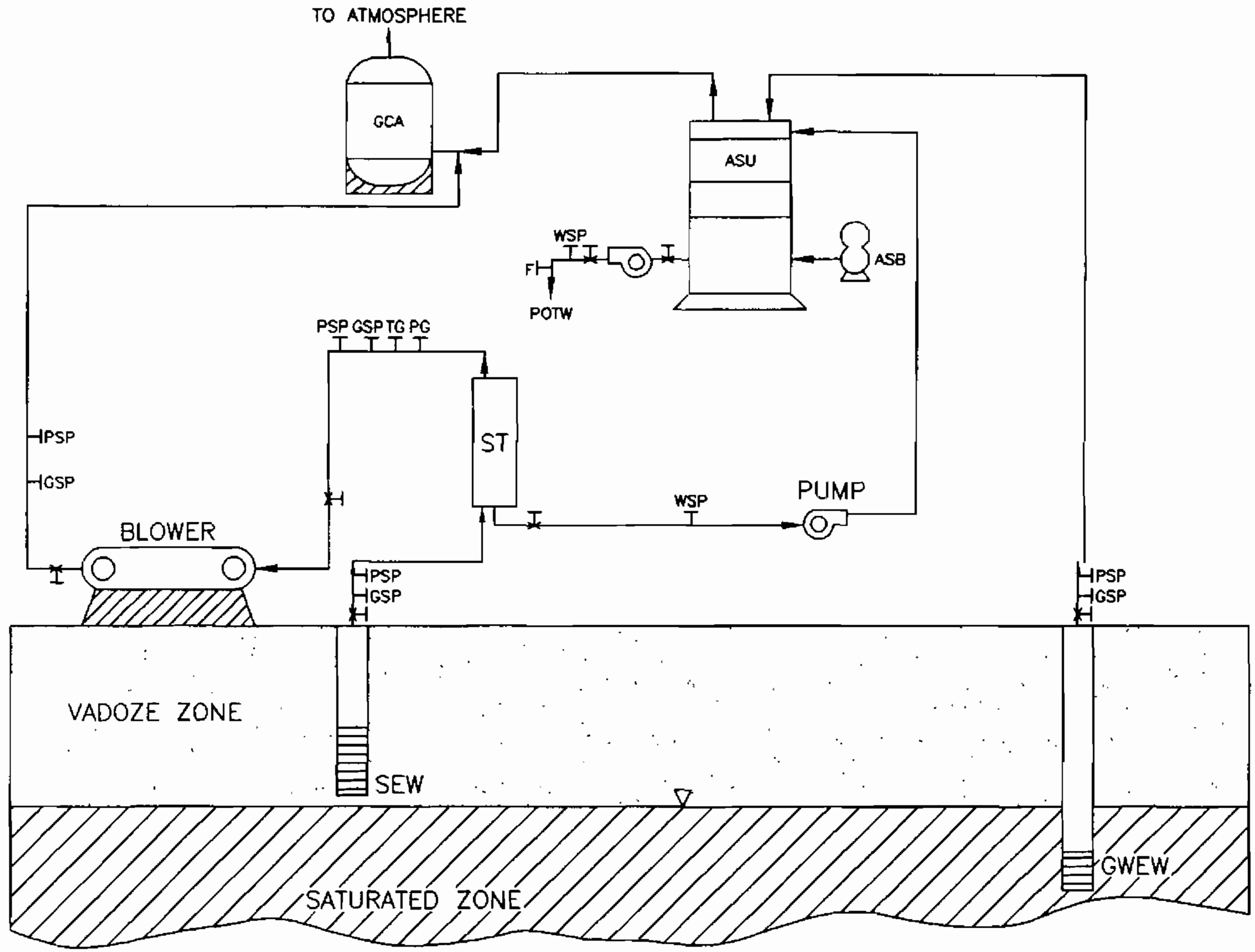
- Two hundred-gallon capacity 32 inch diameter x 60 inch high steel vessel
- De-misting material
- Six inch air inlet/outlets
- Sight gauge with high level alarm and pump operation switches
- Maximum airflow 1,200 cfm
- Ambient air bypass valve for vacuum break
- Ninety-nine percent removal of droplets 10 microns or larger

5.1.2 Progressive Cavity Pump

- Five gpm at 15 psi
- One hp, 230V, three-phase, XP motor

5.1.3 Vacuum Pump System

- Seventy-five acfm at 25 inches of Hg vacuum
- Five hp, 230V, three-phase XP motor
- Seal oil reservoir with level gauge
- High efficiency discharge air/liquid separator



LEGEND

ASU – AIR STRIPPING UNIT
ASB – AIR STRIPPING BLOWER
ST – SEPARATION TANK
GCA – GAS PHASE CARBON ADSORPTION
PSP – PRESSURE SAMPLE PORT
GSP – GAS SAMPLE PORT
WSP – WATER SAMPLE PORT
POTW – PUBLICLY OWN TREATMENT WORK
TG – TEMPERATURE GAUGE
PG – PRESSURE GAUGE
SEW – SOIL VAPOR EXTRACTION WELL
GWEW – GROUNDWATER EXTRACTION WELL
F – FLOW TOTALIZER
⋈ – VALVE

NOT TO SCALE

AOC 607
TREATABILITY STUDY
WORK PLAN
CHARLESTON
NAVAL COMPLEX

FIGURE 5.1
CONCEPTUAL PROCESS
FLOW DIAGRAM
PILOT STUDY
AOC #607

DWG DATE: 12/15/98 | DWG NAME: 2906S017

- High efficiency air cooled heat exchanger
- Automatic temperature control valve for seal oil
- High temperature switch
- Inlet check valve
- Vacuum gauge
- Interconnecting piping
- Steel base mounting

5.1.4 Recovery and Treatment Equipment

- Oil/water separator with a capacity of 10 gpm and a working volume of 81 gallons
- Fifty-seven gallon capacity sump
- Sixty inches long by 28 inches wide x 34 inches high FRP vessel
- Two inch inlets and outlets
- Coalescing media
- Vapor tight cover
- Solids collection sump
- Adjustable oil skimmer
- Sight gauge with high level alarm and pump operation switches
- Steel stand mounting

5.1.5 Surge Tank

- FRP-constructed 100-gallon capacity tank
- High level alarm switch
- Pump operation switches

5.1.6 Centrifugal Transfer Pump

- Twelve gpm 98 inch TDH capacity pump
- One hp, 230V, three-phase, XP motor

5.1.7 Control System

The system will be controlled by a Nema 4x control panel. The panel will include the control to operate the entire system and will be mounted on the skid. The control panel will consist of:

- Nema 4x controller
- Inner door with interlocked disconnect
- H.O.A. switches with lights
- Motor starter with overload
- Elapsed run time meters
- Alarm interlocks with lights
- Reset button
- Intrinsic safety barriers
- UL listing
- Receptacle with weather-proof cover
- System interlocks and automatic control logic
- Skid-mounted system

5.2 Water Treatment System

The water treatment system well consist of either a sieve-tray type air stripping unit or GAC. If GAC is used to treat groundwater from the dewatering system, the transfer pump may be designed to pump water collected by the SVE system directly into the same GAC unit used to treat water originating from the dewatering wells.

All details of the water treatment system, sewer use agreement requirements, and waste water treatment permitting will be addressed during the design phase of the project.

5.3 Air Treatment System

It is anticipated that air discharge from the SVE system can be vented to the atmosphere without further treatment. If this is not possible, then the exhaust will be treated using GAC prior to discharge. Air discharge permit requirements will be addressed during the design phase of the project.

6.0 SYSTEM OPERATION AND MAINTENANCE

EnSafe will provide personnel to monitor the operation and maintenance of the dewatering system and SVE systems during the treatability study. An operations monitoring and maintenance manual will be included in the system design document along with schedules and field forms for recording data.

Maintenance shall consist of general upkeep of the blowers, pumps, controllers, wells, piping, and other system equipment. Maintenance procedures and schedules for the blowers and pumps shall be provided with the system.

7.0 EFFECTIVENESS MONITORING AND SAMPLING

Effectiveness system monitoring and sampling will be performed to measure or estimate the effectiveness of the treatment technology and develop scale-up factors for the design and cost of subsequent full-scale remediation. Monitoring will include physical monitoring and analytical sampling.

7.1 Physical Monitoring

The physical system parameters listed in Table 7.1 will be measured at least daily during the first week of system operation and at least once per week during subsequent weeks of the study. Physical monitoring will always be performed during analytical sampling events.

Table 7.1
Physical Monitoring Protocol

System	Monitored Parameter
Dewatering System	• Fluid flow rate, temperature
SVE Well	• Pressure at well head
	• Soil vapor flow rate, temperature
Soil Vapor Monitoring Points	• Pressure
Separation Tank Pumps	• Flow rate
Water Pump from the Air Separation Unit	• Flow rate
Groundwater Monitoring Wells	• Water elevation
Blower (in-line, intake side)	• Temperature

7.2 Analytical Sampling

Analytical sampling will be periodically performed to assess the effectiveness of the system, estimate the mass of contaminant removed, and ensure discharge compliance. Water samples will be collected from the extracted groundwater. Soil gas samples will also be sampled periodically.

Table 7.2 lists the sampling analysis, frequency, and other sampling protocol. All sampling will be performed in accordance with the Comprehensive Sampling and Analysis Plan for Naval Base Charleston (EnSafe, 1994). Samples will be sent to a contracted laboratory for analysis. Analytical work on 10 percent of the samples submitted will be performed at CLP IV standards with the remainder at CLP Level III standards, all at standard turnaround times.

Table 7.2
Sampling Protocol

Analyte	Analytical Method	Wells to be Sampled	Sampling Frequency
VOCs in groundwater	SW 8260	Dewatering system before and after GAC treatment	Weekly first 4 weeks, monthly thereafter
VOCs in off-gas from SVE Wells	SW8260	SVE test wells	At start of study; three times during system operation; and at the end of the study

8.0 EVALUATION OF RESULTS

Results of groundwater sampling, vapor sampling, and other measurements performed during the treatability study will be used to evaluate its effectiveness and its potential application to full-scale remediation. Results of the treatability study will be used to make the following estimates.

- The liquid, dissolved, and gaseous volumes and compositions of VOCS extracted during the study will be estimated.

- The percentage of total VOCS recovered during the study will be estimated by comparing the amount removed to the initial amount of contaminant present in the subsurface.

- VOC concentrations in monitoring wells and treatment system influent will be plotted versus time to assess recovery system efficiency and VOC removal rates.

- Changes in groundwater levels in area monitoring wells will be used to estimate the influence of the dewatering system in the area during the treatability study.

- Pressure measurements at the soil monitoring points will be used to estimate the radius of influence of the SVE system and to calculate the intrinsic soil air permeability. These will be determined following the protocol outlined in the Test Plan and Technical Protocol for Field Treatability Test for Bioventing (Air Force Center for Environmental Excellence, May 1992).

- The efficiency of the aboveground treatment systems (the air striper and/or carbon adsorption system) will be estimated from influent and effluent VOC sample results.

- If the treatability system is effective, study results will be used to project clean-up times, scale-up requirements, and costs for full-scale system implementation.

9.0 SCHEDULING AND REPORTING

9.1 Schedule

Following submission and approval of the treatability study work plan, the system will be designed and installed. The schedule for installing and constructing, implementing, and completing the study is shown in Table 9.1 The schedule is subject to minor variations depending on equipment availability, unexpected weather conditions, progress during operating, and unforeseen site conditions. It is expected that the treatability study results and report will be completed in July 1999.

9.2 Reporting

The treatability study results and evaluation will be summarized in a report after field studies are completed. This report will include an engineering analysis of the feasibility of vacuum extraction of contaminated groundwater and SVE in the AOC 607 area. The report will include a completed chronology of activities performed onsite and tabulation of the performance monitoring data. The report will include estimates of quantities (mass) of DNAPLs extracted from the aquifer, and an estimate of the length of time and cost required to meet the goals of full-scale treatment. The operating and design criteria required for full-scale treatment of the shallow aquifer at AOC 607 will be presented.

Table 9.1
AOC 607 Treatability Study Schedule

Task	Start Date		Finish Date
Permitting	12-18-98		12-31-99
Aquifer Test Well Installation	1-4-99		1-15-99
Field Pumping Test	1-18-99		1-29-99
Draft Aquifer Test Report Generation	2-1-99		2-12-99
▲Aquifer Test Report		2-12-99	
System Design	2-15-99		3-6-99
▲Treatability System Design Document		3-6-99	
Subcontractor Procurement	3-8-99		3-29-99
System Installation and Construction	3-29-99		4-19-99
Dewatering System Start-up and Operation	4-19-99		5-2-99
SVE Field Test	5-3-99		5-10-99
Evaluation and Reporting	5-10-99		5-31-99
▲Treatability Study Results Document		5-31-99	

10.0 REFERENCES

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