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CORRECTIVE ACTION PLAN FOR SITE 4 BUILDING 640 ZONE H WITH TRANSMITTAL

CNC CHARLESTON SC

12/1/2000

CH2M HILL

CORRECTIVE ACTION PLAN
FOR
SITE 4, BUILDING 640, ZONE H

Site Identification # 00955

Charleston Naval Complex
Charleston, South Carolina

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

Contract Number N62467-99-C-0960

December 2000

D H E C
PROMOTE PROTECT PROSPER
2600 Bull Street
Columbia, SC 29201-1708

27 September 1999

Department of the Navy
Southern Division NFEC
P.O. Box 190010
North Charleston, SC 29419-9010
Attention: Mr. Gabriel Magwood

Re: Closure Assessment Report dated 2 August 1999
Building 640 (Site Identification # 00955)
Zone H/Site 4
Charleston Naval Complex/Charleston Naval Base
Charleston, SC
Charleston County

Dear Mr. Magwood:

The author has completed technical review of the referenced document. As submitted, the report provides a narrative describing closure activities and analytical results of environmental sampling to establish if releases have occurred resultant from operation of the referenced vessels and/or associated piping system. The analytical results provided indicate free phase petroleum product was measured in monitoring well CNC04-M01. With this consideration, it appears that additional endeavors for contaminant characterization and/or remedial actions are warranted at the referenced site. An appropriate assessment/corrective action plan should be developed which is technically sufficient and reasonable to determine the extent and severity (including horizontal and vertical delineation) and provide for free product recovery as expeditiously as possible. Please be aware that the author does not concur with the current determination of site specific target levels (SSTL) utilizing the Cooper River as the exposure point. As all property on base is intended to be transferred (when appropriate), each property should be evaluated as an independent entity. In this regard, appropriate boundaries for the Building 640 site should be developed and SSTLs established accordingly.

Further, the Department considers the goal of groundwater corrective actions as the restoration of impacted waters to the quality consistent with the use associated with the described water class. As groundwaters of the state are currently classified as Class GB (underground source of drinking water), the appropriate remedial goals for this site will be the quality standards established in R.61-68 (Water Classifications and Standards), if reasonably and technically attainable, utilizing available technology. With this consideration, the Department retains the authority to request additional assessments and/or remedial endeavors, as appropriate, if future conditions or information warrant and are deemed necessary.

Please submit a schedule for development of the above requested assessment/corrective action plan to my attention before 31 October 1999. Should you have any questions please contact me at (803) 898-3559.

Should you have any questions please contact me at (803) 898-3559.

Sincerely,

Paul L. Bristol, Hydrogeologist
Groundwater Quality Section
Bureau of Water

cc: Trident District EQC

CORRECTIVE ACTION PLAN
FOR
SITE 4, BUILDING 640, ZONE H

Site Identification # 00955

Charleston Naval Complex
Charleston, South Carolina

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, South Carolina 29406

Submitted by:
CH2M-JONES, LLC.
115 Perimeter Center Place NE
Suite 700
Atlanta, Georgia 30346-1278

J.A. JONES
ENVIRONMENTAL SERVICES

CH2MHILL

Contract Number: N62467-99-C-0960

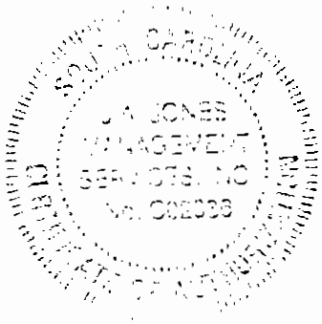
December 2000

CERTIFICATION

I certify that the information contained in this report is true, and complete to the best of my knowledge, information, and belief.

Approved By: R. Garcia Date: 12/8/00

South Carolina Registration No. 14220



ACRONYMS

AFVR	Aggressive Fluid - Vapor Recovery
AST	aboveground storage tank
bls	below land surface
BTEX	benzene, toluene, ethylbenzene and xylenes
BRAC	Defense Base Realignment and Closure Act
CAP	Corrective Action Plan
CNC	Charleston Naval Complex
CoC	Chemical of Concern
CSAP	Comprehensive Sampling and Analysis Plan
DOT	Department of Transportation
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
EPA	Environmental Protection Agency
ft bls	feet below land surface
mg/kg	microgram per kilogram
mg/L	microgram per liter
OVA	Organic Vapor Analyzer
PAHs	Polyaromatic Hydrocarbons
QA	Quality Assurance
QC	Quality Control
RA	Rapid Assessment
RAR	Rapid Assessment Report
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation Recovery Act
SCDHEC	South Carolina Department of Health and Environmental Control
SOUTHDIV	Southern Division Naval Facilities Engineering Command
SSTL	Site-Specific Target Level
SWMU	Solid Waste Management Unit
TTNUS	Tetra Tech NUS
UST	underground storage tank

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Notes

1.0 INTRODUCTION

This Corrective Action Plan (CAP) has been prepared by CH2M-JONES, LLC. The plan is designed for Site 4, Building 640, Zone H; located at the Charleston Naval Complex (CNC), Charleston, South Carolina. Site 4 contains the location of a former petroleum Underground Storage Tank (UST) system and a former petroleum Aboveground Storage Tank (AST) system; both systems were used to supply fuel oil to Building 640. The South Carolina Department of Health and Environmental Control (SCDHEC) has designated this site as Identification Number: 00955.

This CAP provides a method for active remediation of the site by removing free petroleum product identified in the vicinity of the former UST basin; conducting groundwater sampling to evaluate the active remediation of the site; and implementing intrinsic remediation and monitoring well abandonment as a corrective action in accordance with SCDHEC Corrective Action Guidance, June 1997. The CAP was developed using the information provided in the Rapid Assessment Report (RAR) for Site 4 prepared by Tetra Tech NUS, Inc. (TTNUS), dated August 1999. The applicable tables and figures from the RAR have been incorporated into this CAP.

1.1 General Site Description

The CNC is located in the city of North Charleston, on the west bank of the Cooper River in Charleston County, South Carolina (**Figure 1**). This installation consists of two major areas: an undeveloped dredge materials area on the east bank of the Cooper River on Daniel Island in Berkley County, and a developed area on the west bank of the Cooper River. The developed portion of the base is on the peninsula bounded on the west by the Ashley River and on the east by the Cooper River. The site is located within the developed portion of the base (**Figure 2**).

The area surrounding CNC is "mature urban", having long been developed with commercial, industrial, and residential land use. Commercial areas are primarily west of CNC; industrial areas are primarily to the north of the base along Shipyard Creek. A site vicinity map, which exhibits adjacent properties and structures, vicinity roads, current utilities, and vicinity surface drainage, is included as **Figure 2**.

1.2 Site Background

The CNC began operations in 1901, when the Navy acquired the property. In 1993, the CNC was added to the list of bases schedule for closure under the Defense Base Realignment and Closure Act (BRAC). BRAC regulates the closure of the base and transition of the property back to the community. With the scheduled closure of the base, environmental cleanup has proceeded to make the property available for redevelopment after closure.

Building 640 is the former Chief Petty Officer Club and Mess on CNC. UST 640B was a 3,000-gallon steel tank reportedly installed in 1963, and AST 640 was a 1,000-gallon steel tank reportedly installed more than 25 years ago to replace UST 640B. Both petroleum systems were used to supply heating oil to Building 640. UST 640B was located approximately 10 feet

north of the northwestern corner of Building 640, and AST 640 was located approximately 15 feet west of the northwestern corner of Building 640 (**Figure 3**).

In January and February 1997, the AST and UST for Building 640, and their distribution lines were removed from the site. Any excavated soils were returned to their original locations. A SCDHEC UST Assessment Report was completed by SPORTENVDETCHASN in 1997. Mild petroleum odors were observed in the UST excavation. Polynuclear aromatic hydrocarbons (PAHs) were identified in soil samples collected during the tank closures activities. No groundwater was encountered in any excavations.

From December 1998 through March 1999, TTNUS completed a Rapid Assessment (RA) for Site 4. The information from the Rapid Assessment Report (RAR), prepared by TTNUS, dated August 1999, is summarized in **Section 2.0** of this report. The RAR was approved by SCDHEC on September 27, 1999.

Notes

2.0 RAPID ASSESSMENT SUMMARY

TTNUS completed a Rapid Assessment Report (RAR), dated August 1999, for Site 4, Building 640, Zone H. The assessment information was used to develop this CAP. The information from the RAR is summarized in this section.

2.1 Receptor Survey

A receptor survey of the site vicinity was conducted by TTNUS personnel to identify potential receptors for petroleum hydrocarbon contamination. **Figure 2** depicts the public utilities located within 250 feet of the former UST study area. The receptor utilities located on or near the site include sanitary sewer, potable water, natural gas, storm sewer, and electrical. Specific information concerning the depth of utilities below land surface is currently unavailable, however, utilities at this site generally are between 2 to 6 feet below land surface (ft bls).

A survey of groundwater users within a 7-mile radius of CNC was conducted by the South Carolina Water Resources Commission to ascertain the extent of any shallow groundwater usage. Results of the water use investigation revealed that no shallow potable water wells within a 4-mile radius of the site or irrigation wells within 1,000-feet radius of the site. Numerous monitoring wells are located within 1,000 feet of the site. The nearest surface water body is Cooper River located approximately 730 feet to the northwest and downgradient of the site.

There are no city, county or state-zoning ordinances, the property (CNC) is currently owned by the federal government. Information concerning zoning ordinances was obtained from the SOUTHDIV Remedial Project Manager located at 2155 Eagle Drive, North Charleston, South Carolina 29406.

2.2 Assessment Information

From December 1998 through March 1999, TTNUS conducted field activities for the RA, which included the installation and sampling of thirty-three (33) soil borings, ten (10) shallow monitoring wells, one (1) deep monitoring well, one (1) permanent piezometer, and three (3) temporary piezometers. Sample locations are shown on **Figure 3**. The soil and groundwater field and laboratory sampling data from the RA is summarized in **Tables 1** through **10**.

As reported in the RAR, the site lithology consists of mixtures of silty sand, clayey sand, sandy clay, and clay layers from ground surface to 12 ft bls and underlain by light brown to dark gray mucky clay and silt layers from approximately 15 to 32 ft bls. Two geologic cross sections of the site are depicted in **Figures 4** and **5**. Groundwater levels ranged from 3 to 9 ft bls with an average depth to groundwater of approximately 4 to 5 ft bls (**Table 1**). Based upon groundwater measurement data collected on March 4, 1999, surficial groundwater flow is generally towards the northwest; a groundwater potentiometric map for this date is presented in **Figure 6**.

During the RA, no soil contaminant concentrations exceeded Risk-Based Screening Levels (RBSLs) established by SCDHEC (Risk-Based Corrective Action For Petroleum Release, January 5, 1998) (**Table 7** and **Figures 8** and **9**).

Free product was detected in one shallow monitoring well, CNC04-MO1 (**Table 1**). The areal extent of free product is depicted on **Figure 7**. For concentrations of wells containing free product, the maximum solubility in equilibrium with fuel oil was calculated using Raoult's Law. Calculated concentrations for benzene, toluene and naphthalene in equilibrium with free product exceeded their respective RBSLs (Appendix G, TTNUS, August 1999).

In addition to the presence of free product and based upon groundwater sampling conducted during the RA, no other groundwater contaminant concentrations exceeded RBSLs (**Table 8**). The distribution of selected Chemicals of Concern (CoC) in groundwater is presented in **Figures 7** and **10**.

Table 10 compares the soil and groundwater contaminant concentrations to the soil and groundwater RBSLs.

2.3 Fate and Transport Modeling

The aquifer characterization calculated by TTNUS and the fate and transport parameters determined by TTNUS during the RA are summarized in **Table 9**. As illustrated in **Figures 11** and **12**, the Domenico model was used to predict the distance at which the tip of the contaminant plume is attenuated to SCDHEC RBSLs in 10 and 20 years, respectively.

2.4 Exposure Pathway Analysis

In the RA, TTNUS evaluated the receptor characterizations of the potentially exposed populations in the vicinity of the site and identified the potentially complete exposure pathways for those receptors. Exposure pathway analysis for current land use and future land is summarized in **Tables 11** and **12**, respectively.

2.5 Site-Specific Target Levels (SSTLs)

No SSTLs were calculated for soils, because no soil contaminant concentration exceeded RBSLs. Based upon the exposure pathway analysis in the RA, TTNUS considered only one scenario for the calculations of SSTLs: groundwater flow into the Cooper River. No other exposure routes pathways were considered likely threats (**Tables 11** and **12**). **Table 13** compares the groundwater contaminant concentrations to the calculated groundwater SSTLs protective of groundwater flow. The contaminant of naphthalene in groundwater exceeded its calculated SSTL. Therefore, the petroleum groundwater contamination detected at Site 4 may pose a threat to the surface water of Cooper River.

In the RA approval letter, dated September 27, 1999, SCDHEC requested that the SSTLs established by TTNUS in the RA be evaluated in accordance with the site boundaries for Building 640. No groundwater contaminants were detected in any perimeter or off-site

monitoring wells (**Table 8**). Furthermore, as illustrated by TTNUS in the RAR using the Domenico model to predict the 10 and 20 years migration pathways, the groundwater contaminant plume is predicted to move downgradient no more than approximately five feet in 20 years and appears to pose no threat to any property boundaries (**Figures 11** and **12**). Therefore, the original SSTLs calculated in the RAR will be utilized for this CAP.

Notes

3.0 PROPOSED CORRECTIVE ACTION

This CAP provides a method for active remediation of the site by removing free petroleum product identified in the vicinity of the former UST 640 basin; conducting groundwater sampling to evaluate the active remediation of the site; and implementing intrinsic remediation and monitoring well abandonment as a corrective action in accordance with SCDHEC Corrective Action Guidance, June 1997. Based on the results of the RA, source removal of free petroleum product will be performed at this site to remove CoCs from groundwater and to reduce contaminant concentrations below SSTLs. At which time, intrinsic remediation will be implemented until contaminant concentrations decrease below RBSLs or action levels approved by SCHDEC. The proposed active remediation plan is described in **Section 4.0**, and the proposed intrinsic remediation plan is described in **Section 5.0**.

3.1 Soil Remediation

Because no soil contaminant concentration exceeded RBSLs in the RA, active soil remediation as a part of this CAP is not warranted at this time.

3.2 Groundwater Remediation

Free product and groundwater contamination was identified in the vicinity of the former UST 640B basin. Contaminant concentrations in groundwater exceeded the minimum calculated SSTLs protective of nearby Cooper River. The maximum source concentrations for groundwater were calculated based upon the presence of free product using Raoult's Law. Therefore, the active groundwater remediation of the site will include the removal free product identified in the vicinity of the former UST 640B basin and groundwater sampling to evaluate the active remediation of the site.

The following document was used as a source for remedial design: United States Environmental Protection Agency (EPA), 1996, EPA How to Effectively Recover Free Product at Leaking Underground Storage Tank Sites. Three approaches were considered for free product recovery: passive removal/skimmer system, bioremediation (injection), and dual-phase vapor and groundwater recovery.

The volume of free product at this site is estimated at 0.3 cubic feet or 2.3 gallons using the following data obtained from the RAR: area of free product is approximately 60 square feet (**Figure 7**), average thickness of free product over the affected area is 0.01 feet (**Table 1**), and porosity (n) = 0.52 (**Table 9**). Due to the limited affected area of free product, thin thickness of free product, and low volume of free product estimated at the site, the following remedial strategy was designed for the Site 4.

Step 1: A passive removal/skimmer system will be implemented at the site to remove free product. A passive, floating skimmer with a product recovery filter canister is designed to remove free product down to a sheen or thickness of 0.01 feet thickness. Typically, the skimmer is lowered into the well until the midpoint of the skimmer is located at the fluid level in the well. Floating hydrocarbons (free product) enters the

skimmer through the floating intake outer debris screen and then through an inner oileophilic hydrophobic screen, and down into a clear canister for storage. To empty the skimmer, the device is brought to the surface, and the canister is drained using the discharge valve at the skimmer base. A dedicated, free product bailer may be utilized to remove free product from the top of the wells in the target area.

Step 2: In addition, if contaminant concentrations continue to remain above the minimum calculated SSTLs, enhanced bioremediation may be used to target specific locations to enhance the natural degradation of contaminants at the site. Bioremediation consist of the injection of naturally occurring microbes with an affinity towards digesting specific contaminants and the injection of nutrients to support the microbes. Typically, the bioremediation mixture of microbes and nutrients is injected through well points that are installed into the contaminated zone using direct push technology.

Step 3: Other active removal methods may be employed if free product persist at the site, an 8-hour Aggressive Fluid – Vapor Recovery (AFVR) event or multiple events may be conducted to remove free product from the source area. The AFVR will consist of a vacuum truck utilized to extract fluid and vapor from target well points. The AFVR assembly will connect the vacuum hose to the top of the wellhead with the design such that liquid and vapor will be extracted from the top of the water column in the target well point.

Notes

4.0 PROPOSED ACTIVE REMEDIATION

Active remediation of the site will include removing free product identified in the vicinity of the former UST 640 basin, and conducting groundwater sampling to evaluate the active remediation of the site. A passive removal/skimmer system will be implemented at the site to remove free product. If free product persist at the site, an 8-hour Aggressive Fluid – Vapor Recovery (AFVR) event or multiple events may be conducted to remove free product from the source area. In addition, if groundwater contaminant concentrations do not decrease below SSTLs, bioremediation may be used to target specific locations to enhance the natural degradation of the contamination at the site.

4.1 Free Product Recovery System

Free product will be removed using a passive removal/skimmer system. A passive, floating skimmer with a product recovery filter canister will be used for the removal of free product in recovery wells with free product thickness greater than 0.01 feet. A Product Recovery Canister (Model PRC-94) or an equivalent device for a 2-inch diameter well with a capacity of 0.25 liter or greater should be adequate for the conditions at the site assuming that product levels are greater than 0.01 feet in recovery wells (**Appendix A**). A minimum thickness of 0.01 feet is required for the Model PRC-94 and most passive skimmer devices. A dedicated, free product bailer may be utilized to remove free product from the top of the wells.

The proposed free product recovery well diagram is included as **Figure 13**. Existing monitoring well CNC04-M01 will be utilized as the free product recovery well, assuming free product is present in this well. The location of the proposed recovery well is shown on **Figure 7**. If free product is detected in any other monitoring wells during remediation activities, these wells may also be utilized as free product recovery wells. Any free product and contaminated groundwater removed from the wells will be containerized in DOT-approved (Specification 7H) 55-gallon drums and disposed of at a later date pending fluid contents analysis. The drums will be secured in a location coordinated with site management and base support (see **Section 6.0**).

Monitoring well CNC04-M01 may also be used as the target well point if AFVR is warranted for this site. Any free product and contaminated groundwater from the AFVR event will be containerized in a tanker vehicle and disposed at an appropriate facility based upon fluid contents.

The former UST basin and its associated contaminant plume will be the target area if bioremediation is warranted at the site. An SCDHEC-approved bioremediation product will be utilized at the site. The bioremediation product will be delivered into the contaminated zone through injection points typically installed using direct push technology in a grid pattern over the target area.

SCDHEC will be contacted prior to the implementation of AFVR and bioremediation, if these remedial approaches are warranted at the site.

4.2 Monitoring Well Installation

Assuming the wells installed during the RA are in good condition, no monitoring wells will be installed for the CAP. If any wells are unsuitable or new wells are warranted for any other reason, the wells will be installed to the same specification as existing monitoring wells unless site conditions change and warrant otherwise. The wells will be installed in accordance with South Carolina Well Standards and Regulations R.61-71. A utility locate will be completed prior to any well installation activities. Any necessary permits will be acquired prior to well installation activities.

4.3 Surveying

Surveying of any new well locations will be conducted as a part of this CAP, if warranted.

4.4 Soil Boring Schedule

Because no soil contaminant concentration exceeded RBSLs in the RA, no soil borings are scheduled to be installed in this CAP unless site conditions change and warrant otherwise.

4.5 System Operation and Maintenance

System operation and maintenance will conducted every week for the first month, and a minimum of once per month thereafter. The actual frequency of sites visit will depend on the free product removal rates. During scheduled site visits, free product will be removed by hand bailing. System operation and maintenance will include the measurement of free product levels in the recovery well (CNC04-M01), the estimate of free product amount removed from the recovery well, and the examination of the downgradient and nearby monitoring wells (CNC04-M04, CNC04-M05 and CNC04-M11D) for free product.

4.6 Sampling and Analysis Plan

During system operation and maintenance, groundwater samples will be collected at system start-up and semi-annually from monitoring wells CNC04-M01, CNC04-M04, and CNC04-M05. Once free product has been removed from the site, groundwater samples will collected from all monitoring wells. The groundwater samples will be submitted to a certified laboratory for analysis of benzene, toluene, ethylbenzene and xylenes (BTEX) and naphthalene by EPA Method 8260, and Polyaromatics Hydrocarbons (PAHs) by EPA Method 8270.

Groundwater level measurements will be collected from all monitoring wells prior to all groundwater sampling events. Measurements will be taken with an electrical water level indicator or interface probe if floating product is present. No groundwater sample will be collected if free product is measurable in the monitoring well.

From three to six well volumes will be purged from each well prior to groundwater sampling. Field measurements of pH, groundwater temperature, specific conductance, dissolved oxygen, and turbidity will be taken during groundwater sampling events.

All sampling procedures will be conducted in accordance with EPA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), 1996, and Ensafe/ Allen & Hoshall, Comprehensive Sampling and Analysis Plan, 1996. Any contaminated groundwater collected during the well sampling events will be containerized in DOT-approved (Specification 7H) 55-gallon drums and disposed of at a later date pending fluid contents analysis.

4.7 Reporting

Semi-annual monitoring reports will be submitted to SCDHEC. The reports will summarize and include copies of field and laboratory analytical data. Upon completion of active remediation, a Performance Evaluation Report will also be submitted to SCDHEC to summarizes the remediation activities, evaluate the soil and water quality data, and provide recommendations for the site.

4.8 Equipment Decontamination

All drilling equipment, augers, well casing and screens, and soil and groundwater sampling equipment involved in field sampling activities will be decontaminated according to the EPA EISOPQAM.

4.9 Sample Handling

Sample handling will be conducted in accordance to the following references: EPA EISOPQAM, Code of Federal Regulations 136, 1990, and EPA Users Guide to Contract Laboratory Program, 1988. The following forms will be completed for packing/shipping process: sample labels, chain-of-custody labels, appropriate labels applied to shipping coolers, and chain-of-custody forms.

4.10 Quality Control

In addition to periodic calibration of field equipment and the completions of the appropriate documentation, quality control (QC) samples will be collected during sampling events. QC samples may include field blanks, field duplicates, and trip blanks. Definitions of each can be found below as described by the EPA EISOPQAM:

- **Field Blank:** A sample collected using organic-free water, which has been run over/through sample collection equipment. These samples are used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been field cleaned.

- **Field Duplicates:** Two or more samples collected from a common source. The purpose of a duplicate sample is to estimate the variability of a given characteristic or contamination associated with a population.

- **Trip Blank:** A sample, which is prepared prior to the sampling event in the actual container and is stored with the investigative samples throughout the sampling event. They are often packaged for shipment with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to determine if samples were contaminated during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If samples are to be shipped, trip blanks are to be provided with each shipment but not for each cooler.

4.11 Field Quality Assurance / Quality Control (QA/QC)

All sampling procedures will be conducted in accordance with EPA EISOPQAM. More information on field QC can be found in **Sections 4.8** through **4.10**.

QA/QC specifications for selected field measurements are summarized below.

Analysis	Control Parameter	Control Limit	Corrective Action
Air Monitoring	Check Calibration of OVA daily	Calibrate to manufactures specifications	Recalibrate. If unable to calibrate, replace.
pH of water	Continuing calibration check of pH 7.0 buffer	pH = 7.0	Recalibrate. If unable to calibrate, replace electrode.
Specific Conductance of water	Continuing calibration check of standard solution	> 1% of standard	Recalibrate.

4.12 Record keeping

In addition to required sampling documentation (see **Section 4.9**), standardized forms, log sheets and logbooks will be completed during all field activities.

Notes

5.0 PROPOSED INTRINSIC REMEDIATION

Upon completion of active remediation, if warranted, intrinsic remediation will be implemented until contaminant concentrations decrease below RBSLs or other action levels approved by SCHDEC. This CAP provides a method for implementing intrinsic remediation and monitoring well abandonment as a corrective action in accordance with SCDHEC Corrective Action Guidance, June 1997. The intrinsic remediation method may be modified based upon the results of active remediation.

5.1 Monitoring Well Installation

Assuming the wells from the active remediation method are in good condition, no monitoring wells will be installed for the CAP. If any wells are unsuitable or new wells are warranted for any other reason, the wells will be installed to the same specification as existing monitoring wells unless site conditions change and warrant otherwise.

5.2 Surveying

No new monitoring wells are scheduled to be installed as a part of the intrinsic CAP. Surveying of any new well locations will be conducted if warranted.

5.3 Soil Boring Schedule

No other soils borings are scheduled for the CAP unless site conditions change and warrant otherwise.

5.4 Monitoring Well Abandonment

All monitoring wells will be abandoned upon receiving approval by SCDHEC. The wells will be abandoned following the South Carolina Well Standards and Regulations R.61-71. The well abandonment will include grouting wells, removing stick-ups and removing all guard posts. Any well casing and screen removed will be decontaminated and disposed of as general refuse.

5.5 Sampling and Analysis Plan

Groundwater samples will be collected semi-annually for a period of 18 months from monitoring wells CNC04-M01, CNC04-M04, and CNC04-M05. The groundwater samples will be submitted to a certified laboratory for analysis of BTEX and naphthalene by EPA Method 8260, and PAHs by EPA Method 8270. The following parameters will also be considered for analysis in order to evaluate the effectiveness of intrinsic remediation: nitrate (NO^{-3}), sulfate (SO^{-4}), total dissolved iron, methane (CH_4), and alkalinity.

Groundwater level measurements will be collected from all monitoring wells prior to all groundwater sampling events. Measurements will be taken with an electrical water level

indicator or interface probe if floating product is present. No groundwater sample will be collected if free product is measurable in the monitoring well.

From three to six well volumes will be purged from each well prior to groundwater sampling. Field measurements of pH, groundwater temperature, specific conductance, dissolved oxygen, and turbidity will be taken during groundwater sampling events.

All sampling procedures will be conducted in accordance with EPA EISOPQAM, and Ensafe/ Allen & Hoshall, Comprehensive Sampling and Analysis Plan, 1996. Any contaminated groundwater collected during the well sampling events will be containerized in DOT-approved (Specification 7H) 55-gallon drums and disposed of at a later date pending fluid contents analysis.

5.6 Reporting

Semi-annual monitoring reports will be submitted to SCDHEC. The reports will summarize and include copies of field and laboratory analytical data. Upon completion of 18 months of sampling, a Performance Evaluation Report will also be submitted to SCDHEC to summarizes the sampling activities, evaluate the soil and water quality data, and provide recommendations for the site.

Notes

6.0 SITE MANAGEMENT AND BASE SUPPORT

Throughout the investigation activities, work on the CNC will be coordinated through SOUTHDIV and SCDHEC.

The primary contacts for each are as follows:

1. SOUTHDIV point of contact
   Gabe Magwood
   Southern Division Engineering Command
   2155 Eagle Drive
   North Charleston, SC 29406
   (843) 820-7307

2. SOUTHDIV point of contact
   Tony Hunt
   Southern Division Engineering Command
   2155 Eagle Drive
   North Charleston, SC 29406
   (843) 820-5525

3. SCDHEC point of contact
   Chuck Williams
   South Carolina Department of Health and Environmental Control
   2600 Bull Street
   Columbia, SC 29201
   (843) 898-4339

Notes

7.0 REFERENCES

Ensafe/ Allen & Hoshall. July 1996. Comprehensive Sampling and Analysis Plan

South Carolina Department of Health and Environmental Control. 1997. Corrective Action Guidance.

SPORTENVDETCHASN. 1997. UST Assessment Report.

Tetra Tech NUS, Inc. August 1999. Rapid Assessment Report for Site 4, Building 640, Zone H, Charleston, South Carolina.

United States Environmental Protection Agency. 1990. Code of Federal Regulations 136.

United States Environmental Protection Agency. 1996. EPA Environmental Investigations Standard Operating Procedures for Quality Assurance Manual.

United States Environmental Protection Agency. 1988. EPA Users Guide to Contract Laboratory Program.

United States Environmental Protection Agency. 1988. EPA How to Effectively Recover Free Product at Leaking Underground Storage Tank Sites.

Notes

APPENDIX A

REMEDIAL EQUIPMENT – PASSIVE SKIMMER

TABLE 1

GROUNDWATER ELEVATIONS
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL BASE COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
PAGE 1 OF 2

Well #	Total Depth of Well (ft)	Top of Casing Elevation, ft (MSL)	Date Measured	Depth to Water, ft (BTOC)	Depth to Product, ft (BTOC)	Product Thickness (ft)	Groundwater Elevation (MSL)
CNC04-M01	12	8.63	2/20/99	NM	Free Product	NM	ND
			3/4/99	6.33	6.32	0.01	2.30
CNC04-M02	12	8.45	2/20/99	2.68	ND	ND	5.77
			2/20/99	5.72	ND	ND	2.73
			3/4/99	6.05	ND	ND	2.40
CNC04-M03	12	7.22	2/20/99	3.90	ND	ND	3.32
			2/20/99	4.94	ND	ND	2.28
			3/4/99	5.19	ND	ND	2.03
CNC04-M04	12	7.58	1/22/99	5.27	ND	ND	2.31
			2/20/99	5.01	ND	ND	2.57
			3/4/99	5.32	ND	ND	2.26
CNC04-M05	12	6.93	1/22/99	5.52	ND	ND	1.41
			2/5/99	4.02	ND	ND	2.91
			2/6/99	3.94	ND	ND	2.99
			2/20/99	4.44	ND	ND	2.49
			3/4/99	4.74	ND	ND	2.19
CNC04-M06	12	5.91	1/22/99	4.85	ND	ND	1.06
			2/5/99	2.81	ND	ND	3.10
			2/6/99	2.86	ND	ND	3.05
			2/20/99	3.34	ND	ND	2.57
			3/4/99	3.61	ND	ND	2.30
CNC04-M07	12	6.59	1/22/99	5.94	ND	ND	0.65
			2/5/99	3.50	ND	ND	3.09
			2/6/99	3.54	ND	ND	3.05
			2/20/99	4.05	ND	ND	2.54
			3/4/99	4.36	ND	ND	2.23
CNC04-M08	12	6.24	1/22/99	6.97	ND	ND	-0.73
			2/20/99	5.47	ND	ND	0.77
			3/4/99	5.69	ND	ND	0.55
CNC04-M09	12	8.17	1/22/99	8.35	ND	ND	-0.18
			2/5/99	4.34	ND	ND	3.83
			2/6/99	4.36	ND	ND	3.81
			2/20/99	5.07	ND	ND	3.10
			3/4/99	5.28	ND	ND	2.89

TABLE 1 (CONTINUED)

GROUNDWATER ELEVATIONS
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL BASE COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well #	Total Depth of Well (ft)	Top of Casing Elevation (MSL)	Date Measured	Depth to Water (BTOC)	Depth to Product (BTOC)	Product Thickness (ft)	Groundwater Elevation (MSL)
CNC04-M10	12	9.93	1/22/99	2.32	ND	ND	7.61
			2/6/99	6.50	ND	ND	3.43
			2/20/99	7.09	ND	ND	2.84
			3/4/99	7.43	ND	ND	2.50
CNC04-M11	32	8.29	2/20/99	4.81	ND	ND	3.48
			3/4/99	4.95	ND	ND	3.34
CNC04-P04	12	7.87	3/4/99	5.59	ND	ND	2.28

Well #	Total Depth of Well (ft)	Top of Casing Elevation (MSL)	Date Measured	Depth to Water (BTOC)	Depth to Product (BTOC)	Product Thickness (ft)	Groundwater Elevation (LRS)
CNC04-P01	12	100.00	12/7/98	8.73	ND	ND	91.27
			12/8/98	8.76	ND	ND	91.25
CNC04-P02	12	100.51	12/7/98	9.45	ND	ND	91.06
			12/8/98	9.48	ND	ND	91.03
CNC04-P03	12	98.89	12/7/98	7.82	ND	ND	91.07
			12/8/98	7.90	ND	ND	90.99

MSL - Mean Sea Level
LRS - Local Relative Survey
BTOC - Below Top of Casing
NM - Not Measured

ND- Not Detected
ft - Feet

TABLE 2

GROUNDWATER FIELD MEASUREMENTS
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL BASE COMPLEX.
NORTH CHARLESTON, SOUTH CAROLINA

Well I.D.	Date sampled	Purge Method	Volume Gallons	°C	pH	Conductivity uMHOS/cm	Turbidity (NTU)
CNC04-M02	3/4/99	PP	5.0	17.0	7.38	1.0	1.8
CNC04-M03	3/4/99	PP	6.0	16.2	7.85	0.7	1.0
CNC04-M04	3/4/99	PP	9.0	16.8	7.3	1.7	3.7
CNC04-M05	3/6/99	PP	6.0	19.6	7.07	7.5	9.5
CNC04-M06	3/6/99	PP	7.0	20.0	7.2	4.2	1.8
CNC04-M07	3/4/99	PP	6.5	15.8	7.2	3.8	3.8
CNC04-M08	3/6/99	PP	6.0	21.7	7.2	4.2	1.4
CNC04-M09	3/6/99	PP	5.5	20.5	7.4	2.4	3.9
CNC04-M10	3/4/99	PP	4.0	16.7	7.3	0.8	1.8
CNC04-M11	3/6/99	PP	6.0	20.7	6.9	27.3	19.3
CNC04-P04	3/6/99	PP	3.5	18.8	7.1	2.4	10.6

°C - Degree Celcius
PP - Peristaltic pump, low flow purge
umHOS/cm - Micr MHOS per Centimeter
NTU - Nephelometric Turbidity Units

TABLE 3
GROUNDWATER NATURAL ATTENUATION FIELD MEASUREMENTS
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well I.D.	Date Sampled	Dissolved Oxygen (%)	Akalinity (mg/l)	Carbon Dioxide (mg/l)	Sulfide (mg/l)	Ferrous Iron (mg/l)	Nitrite (mg/l)	Manganese (mg/l)	Nitrogen/ Nitrate (mg/l)*	Sulfate (mg/l)*
CNC04-M04	3/4/99	0.0	410	108	0.02	2.68	0.012	0.8	ND	75.3
CNC04-M07	3/4/99	0.0	760	158	0.01	3.30	0.048	0.0	ND	64.0
CNC04-M10	3/4/99	1.04	180	80	0.01	0.04	0.320	0.0	ND	32.9

% - Percent
* - Fixed base laboratory analysis
ND - Not Detected
mg/l - miligrams per liter
ug/l - micrograms per liter

TABLE 4

**SUMMARY OF OVA SOIL SCREENING RESULTS,
DECEMBER 1998 AND JANUARY 1999
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
PAGE 1 OF 3**

Sample Location	Sample Identification	Sample Depth (feet)	Total Organic Vapor Headspace Concentration (PPM)
CNC04-B01	04SSB0101	1	2
	04SSB0102	2	4
CNC04-B02	04SSB0201	1	3
	04SSB0202	2	1
	04SSB0203	3	3
	04SSB0204	4	130
	04SSB0206	6	60
CNC04-B03	04SSB0301	1	2
	04SSB0302	2	2
	04SSB0303	3	700
	04SSB0304	4	1500
	04SSB0305	5	2000
	04SSB0307	7	130
CNC04-B04	04SSB0401	1	2
	04SSB0402	2	3
	04SSB0403	3	4
	04SSB0404	4	900
CNC04-B05	04SSB0501	1	2
	04SSB0502	2	3
	04SSB0503	3	3
	04SSB0504	4	35
CNC04-B06	04SSB0601	1	2
	04SSB0602	2	4
	04SSB0603	3	5
	04SSB0604	4	6
CNC04-B07	04SSB0701	1	2
	04SSB0702	2	4
	04SSB0703	3	4
	04SSB0704	4	8
CNC04-B08	04SSB0801	1	4
	04SSB0802	2	4
	04SSB0803	3	5
	04SSB0804	4	6
CNC04-B09	04SSB0901	1	1
	04SSB0902	2	3
	04SSB0903	3	7
	04SSB0904	4	4
	04SSB0905	5	2
	04SSB0906	6	5
CNC04-B10	04SSB1001	1	3
	04SSB1002	2	4
	04SSB1003	3	3
	04SSB1004	4	85
	04SSB1005	5	70

TABLE 4 (CONTINUED)

SUMMARY OF OVA SOIL SCREENING RESULTS,
DECEMBER 1998 AND JANUARY 1999
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Total Organic Vapor Headspace Concentration (PPM)
CNC04-B11	04SSB1101	1	4
	04SSB1102	2	5
	04SSB1103	3	3
	04SSB1104	4	100
CNC04-B12	04SSB1201	1	1
	04SSB1202	2	3
	04SSB1203	3	4
	04SSB1204	4	600
CNC04-B13	04SSB1301	1	2
	04SSB1302	2	3
	04SSB1303	3	2
	04SSB1304	4	7
CNC04-B14	04SSB1401	1	ND
	04SSB1402	2	1
	04SSB1403	3	4
	04SSB1404	4	15
CNC04-B15	04SSB1501	1	2
	04SSB1502	2	2
	04SSB1503	3	60
	04SSB1504	4	150
CNC04-B16	04SSB1601	1	5
	04SSB1602	2	8
	04SSB1603	3	15
	04SSB1604	4	90
CNC04-B17	04SSB1701	1	3
	04SSB1702	2	3
	04SSB1703	3	3
	04SSB1704	4	15
CNC04-B18	04SSB1801	1	2
	04SSB1802	2	1
	04SSB1803	3	2
	04SSB1804	4	13
CNC04-B19	04SSB1901	1	2
	04SSB1902	2	120
	04SSB1903	3	70
	04SSB1904	4	35
CNC04-B20	04SSB2001	1	4
	04SSB2002	2	2
	04SSB2003	3	4
	04SSB2004	4	12
CNC04-B21	04SSB2102	2	8
	04SSB2104	4	110
CNC04-B22	04SSB2201	1	2
	04SSB2202	2	2
	04SSB2203	3	4

TABLE 4 (CONTINUED)

SUMMARY OF OVA SOIL SCREENING RESULTS,
DECEMBER 1998 AND JANUARY 1999
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Total Organic Vapor Headspace Concentration (PPM)
CNC04-B23	04SSB2301	1	2
	04SSB2302	2	2
	04SSB2303	3	2
	04SSB2304	4	7
CNC04-B24	04SSB2401	1	4
	04SSB2402	2	2
	04SSB2403	3	4
	04SSB2404	4	14
CNC04-B25	NS		
CNC04-B26	04SSB2601	1	320
	04SSB2602	2	800
	04SSB2603	3	400
CNC04-B27	04SSB2702	2	20
	04SSB2704	4	30
CNC04-B28	04SSB2802	2	3
	04SSB2803	3	1
	04SSB2804	4	20
CNC04-B29	NR		
CNC04-B30	NR		
CNC04-B31	04SSB3102	2	110
	04SSB3103	3	800
	04SSB3104	4	60
CNC04-B32	04SSB3202	2	16
	04SSB3203	3	120
	04SSB3204	4	35
	04SSB3206	6	12
CNC04-B33	04SSB3301	1	6
	04SSB3302	2	18
	04SSB3303	3	50
	04SSB3304	4	35
	04SSB3305	5	30

NOTES:
OVA - organic vapor analyzer equipped with a flame ionization detector
PPM - parts per million
NS- no sample was collected from this boring location
NR - no soil sample was recovered from this boring location
ND – not detected

TABLE 5

SUMMARY OF LABORATORY SOIL SCREENING RESULTS
DECEMBER 1998 AND JANUARY 1999
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Laboratory Screening Data (PPB) [1]				
			Benzene	Toluene	Ethylbenzene	Total Xylenes	Diesel Range Organics
CNC04-B01	04SFB0102	2	<0.5	<0.05	<0.5	<1.0	789.17
CNC04-B02	04SFB0204	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B03	04SFB0305	5	<0.5	<0.5	<0.5	<1.0	4,380.57
CNC04-B04	04SFB0404	4	<0.5	1.03	<0.5	<1.0	134,548.04
CNC04-B05	04SFB0504	4	<0.5	<0.5	<0.5	<1.0	6,036.00
CNC04-B06	04SFB0604	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B07	04SFB0704	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B08	04SFB0804	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B09	04SFB0903	3	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B10	04SFB1004	4	<0.5	<0.5	<0.5	<1.0	163.06
CNC04-B11	04SFB1104	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B12	04SFB1204	4	<0.5	<0.5	<0.5	<1.0	102,883.65
CNC04-B13	04SFB1304	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B14	04SFB1404	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B15	04SFB1504	4	<0.5	<0.5	<0.5	<1.0	207.29
CNC04-B16	04SFB1604	4	<0.5	<0.5	<0.5	<1.0	247.56
CNC04-B17	04SFB1704	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B18	04SFB1804	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B19	04SFB1902	2	<0.5	<0.5	<0.5	<1.0	24,654.88
CNC04-B20	04SFB2004	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B21	04SFB2104	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B22	04SFB2203	3	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B23	04SFB2304	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B24	04SFB2404	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B25	04SFB2504	4	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B26	04SFB2602	2	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B27	04SFB2704	4	<0.5	<0.5	<0.5	<1.0	548.49
CNC04-B28	04SFB2804	4	<0.5	<0.5	<0.5	<1.0	1,337.23
CNC04-B29	04SFB2903	3	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B30	NS						
CNC04-B31	NS						
CNC04-B32	04SFB3203	3	<1.0	<1.0	<1.0	<1.0	151,000
CNC04-B33	04SFB3303	3	<1.0	<1.0	<1.0	<1.0	124,000

NOTES:
[1] Laboratory screening data was analyzed using USEPA Method 8260. Compounds not detected are reported as less than the instrument detection limit.
PPB - parts per billion
NS - no sample collected from this boring location

TABLE 6

SUMMARY OF GROUNDWATER SCREENING RESULTS
DECEMBER 1998 AND JANUARY1999
SITE 4, BUILDING 640
ZONE H, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Laboratory Screening Data (PPB) [1]				
		Benzene	Toluene	Ethylbenzene	Total Xylenes	Diesel Range Organics
CNC04-P01	04GFP0101	<0.5	<0.5	<0.5	<1.0	198.16
CNC04-P02	04GFP0201	<0.5	<0.5	<0.5	<1.0	<100
CNC04-P03	04GFP0301	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B01	04GFB01	<0.5	<0.5	<0.5	<1.0	57,389.61
CNC04-B03	04GFB03	<0.5	<0.5	<0.5	<1.0	23,461.99
CNC04-B04	04GFB04	<0.5	<0.5	<0.5	<1.0	1,684.35
CNC04-B05	04GFB05	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B06	04GFB06	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B07	04GFB07	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B08	04GFB08	<0.5	<0.5	<0.5	<1.0	422.90
CNC04-B09	NS					
CNC04-B10	04GFB10	<0.5	<0.5	<0.5	<1.0	385.36
CNC04-B12	04GFB12	<0.5	<0.5	<0.5	<1.0	378.02
CNC04-B13	04GFB13	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B15	04GFB15	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B16	04GFB16	<0.5	<0.5	<0.5	<1.0	228.27
CNC04-B17	04GFB17	<0.5	<0.5	<0.5	0.83	1,468.04
CNC04-B18	04GFB18	<0.5	<0.5	<0.5	<1.0	186.87
CNC04-B19	0EGFB19	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B20	04GFB20	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B21	04GFB21	1.22	<0.5	<0.5	0.54	874.00
CNC04-B22	04GFB22	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B23	04GFB23	<0.5	<0.5	<0.5	<1.0	1,006.03
CNC04-B24	04GFB24	<0.5	<0.5	<0.5	<1.0	128.12
CNC04-B25	04GFB25	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B26	04GFB26	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B27	04GFB27	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B28	04GFB28	<0.5	<0.5	<0.5	<1.0	1,002.43
CNC04-B29	04GFB29	<0.5	<0.5	<0.5	1.84	1,860.80
CNC04-B30	04GFB30	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B31	04GFB31	<0.5	<0.5	<0.5	<1.0	<100
CNC04-B32	04GFB32	<1.0	<1.0	<1.0	<1.0	<10
CNC04-B33	04GFB33	<1.0	<1.0	<1.0	<1.0	<10
CNC04-B34	04GFB34	<1.0	<1.0	<1.0	<1.0	<10

NOTES:
[1]Laboratory screening data was analyzed at a fixed laboratory using USEPA Method 8260. Compounds, which were not detected during the analysis, are reported as less than the instrument detection limit.
PPB - parts per billion
NS- no sample was collected from this boring

TABLE 7

SUMMARY ANALYTICAL RESULTS FOR SOIL SAMPLES
CHEMICALS OF CONCERN
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

SOIL BORING/ SAMPLE NO	SAMPLE DATE	Benzene ug/kg	Toluene ug/kg	Ethylbenzene ug/kg	Xylenes (TOTAL) ug/kg	Benzo(a) anthracene ug/kg	Benzo(b) flouranthene ug/kg	Benzo(k) flouranthene ug/kg	Chrysene ug/kg	Dibenzo(a,h) anthracene ug/kg	Naphthalene ug/kg
RBSL[1]		5	478	364	1119	17687	7042	5593	3146	21265	52
CNC04-B02/ 04SLB-0204	15-Jan-99	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
CNC04-B04/ 04SLB-0404	14-Jan-99	ND	ND	2.94 [J]	1.20 [J]	ND	ND	ND	ND	ND	ND
	19-Jan-99	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA
CNC04-B04/ 04SLB-0404[2]	14-Jan-99	ND	ND	1.64[J]	ND	ND	ND	ND	ND	ND	ND
CNC04-B10/ 04SLB-1004	15-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-B11/ 04SLB-1104	15-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-B12/ 04SLB-1204	14-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04B-15/ 04SLB-1504	15-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-B17/ 04SLB-1704	14-Jan-99	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND
	19-Jan-99	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA
CNC04-B19/ 04SLB-1902	14-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-B20/ 04SLB-2004	14-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-B21/ 04SLB-2104	14-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-B22/ 04SLB-2203	14-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ZHRL00101 [3]	14-Jan-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.37 [J]

Notes:

ND - not detected

NA - not analyzed

ug/kg - microgram per kilogram

[J] Indicates presence of analyte at a concentration less than the reporting limit and greater than the detection limit.

[1] RBSL - South Carolina Department of Health and Environmental Control-Risk Based Screening Levels for clay-rich soils, depth to groundwater less than 5 feet.

[2] Duplicate

[3] Rinsate blank

TABLE 8

SUMMARY ANALYTICAL RESULTS FOR GROUND WATER SAMPLES
CHEMICALS OF CONCERN
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL BASE COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

MONITORING WELL / SAMPLE NO.	SAMPLE DATE	Benzene ug/l	Toluene ug/l	Ethyl-benzene ug/l	Xylenes (TOTAL) ug/l	MTBE ug/l	Benzo(a) anthracene ug/l	Benzo(a) pyrene ug/l	Benzo(b) flouranthene ug/l	Benzo(ghi) perylene ug/l	Benzo(k) Flouranthene ug/l	Chrysene ug/l	Dibenzo(a,h) anthracene ug/l	Naphthalene ug/l
RBSL[1]		5	1000	70	10000	40	10[2]	10[2]	10[2]	10[2]	10[2]	10[2]	10[2]	10[2]
CNC04-M02/ 04GLM-0201	04-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.94[J]
CNC04-M03/ 04GLM-0301	04-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-M04/ 04GLM-0401	04-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-M04/ 04GLM-0401D [3]	04-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04M-05/ 04GLM-0501	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04M-06/ 04GLM-0601	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04M-07/ 04GLM-0701	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04M-08/ 04GLM-0801	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04M-09/ 04GLM-0901	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04M-10/ 04GLM-1001	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04M-11/ 04GLM-1101	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNC04-P04/ CNC04-P0401	06-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ZHRL00401[4]	04-Mar-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

ND - not detected

ug/l - microgram per liter

[1] RBSL - South Carolina Department of Health and Environmental Control-Risk Based Screening Levels for clay-rich soils, depth to groundwater less than 5 feet.

[2] The Risk Based Screening Level for Individual PAH COC is 10 ug/l for PAH's.

[3] Duplicate

[4] Rinsate Blank

[J] Indicates presence of analyte at a concentration less than the reporting limit and greater than the detection limit.

TABLE 9

FATE AND TRANSPORT INPUT PARAMETERS
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Parameter	Domenico Dilution/Attenuation Model[1]
Hydraulic Conductivity [m/sec]	3.70E-06
Hydraulic Gradient	0.0125
Porosity[a]	0.52
Estimated Plume Length [ft]	NA
Soil Bulk Density[a] [kg/L]	1.35
Partition Coefficient [L/kg]	chemical specific
Fractional Organic Carbon	9.77E-02
First Order Decay Rate [sec^{-1}]	0
Modeled Plume Length [ft]	NA
Modeled Plume Width [ft]	NA
Source Width[b] [m]	15
Source Thickness[b] [m]	2
Soluble Mass [kg]	Infinite[c]

(1) - *South Carolina Risk-Based Corrective Action for Petroleum Releases,* South Cerolina Department of Health and Environmental Control, 1998.
(a) - Determined from SCDHEC 1998 Tables C1 and C3
(b) - Default value
(c) - Assumption of the Domenico model

TABLE 10

COMPARISON OF MAXIMUM CONCENTRATIONS TO RBSLs
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Chemical of Concern	Maximum Concentration (Soil) (mg/kg)	RBSLs (Soil) (mg/kg)[a]	Maximum Concentration (GW) (mg/L)	RBSLs (GW) (mg/L)[b]
Benzene	ND	0.005	**0.31**[c]	0.005
Toluene	ND	0.478	**4.65**[c]	1
Ethybenzene	0.00294	0.36	0.1[c]	0.7
Xylenes	0.0012	1.119	0.79[c]	10
Benzo(a)anthracene	ND	17.687	-	-
Benzo(b)flouranthene	ND	7.042	-	-
Benzo(k)flouranthene	ND	5.593	-	-
Chyrsene	ND	3.146	-	-
Dibenzo(a,h)anthracene	ND	21.265	-	-
Naphthalene	0.00137	0.052	**23.35**[c]	0.010

(a) - From Risk-Based Corrective Action for Petroleum Releases, Table B4, Depth to GW - <5 ft, SCDHEC RBCA Guidelines, 1998.
(b) - From Risk-Based Corrective Action for Petroleum Releases, Table B1, SCDHEC RBCA Guidelines, 1998.
(c) - Groundwater concentration in equilbrium with free product as calculated using Raoult's Law.
GW - Groundwater
RBSLs - Risk Based Screening Levels
ND - Not detected
NA - Not analyzed
Bold value indicates the concentration exceeded the RBSL.

TABLE 11

EXPOSURE PATHWAY ASSESSMENT - CURRENT USE
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Media	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (If pathway selected)
Air	Inhalation	No	No volatilization to enclosed space.	
	Explosion Hazard	No	No explosion hazard.	
Groundwater	Ingestion	No	No water supply well downgradient or residential basements.	
	Dermal contact	No		
	Inhalation	No		
Surface Water	Ingestion	Yes		
	Dermal contact	Yes	Cooper River 730 ft downgradient	No additional data required
	Inhalation	No		
Surficial Soil	Ingestion	No	No impacted surface soil	
	Dermal contact	No		
	Inhalation	No		
Subsurface Soil	Ingestion	No	No subsurface soil with BTEX or PAHs including naphthalene above RBSLs	
	Dermal contact	No		
	Inhalation	No		

TABLE 12

EXPOSURE PATHWAY ASSESSMENT - FUTURE USE
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

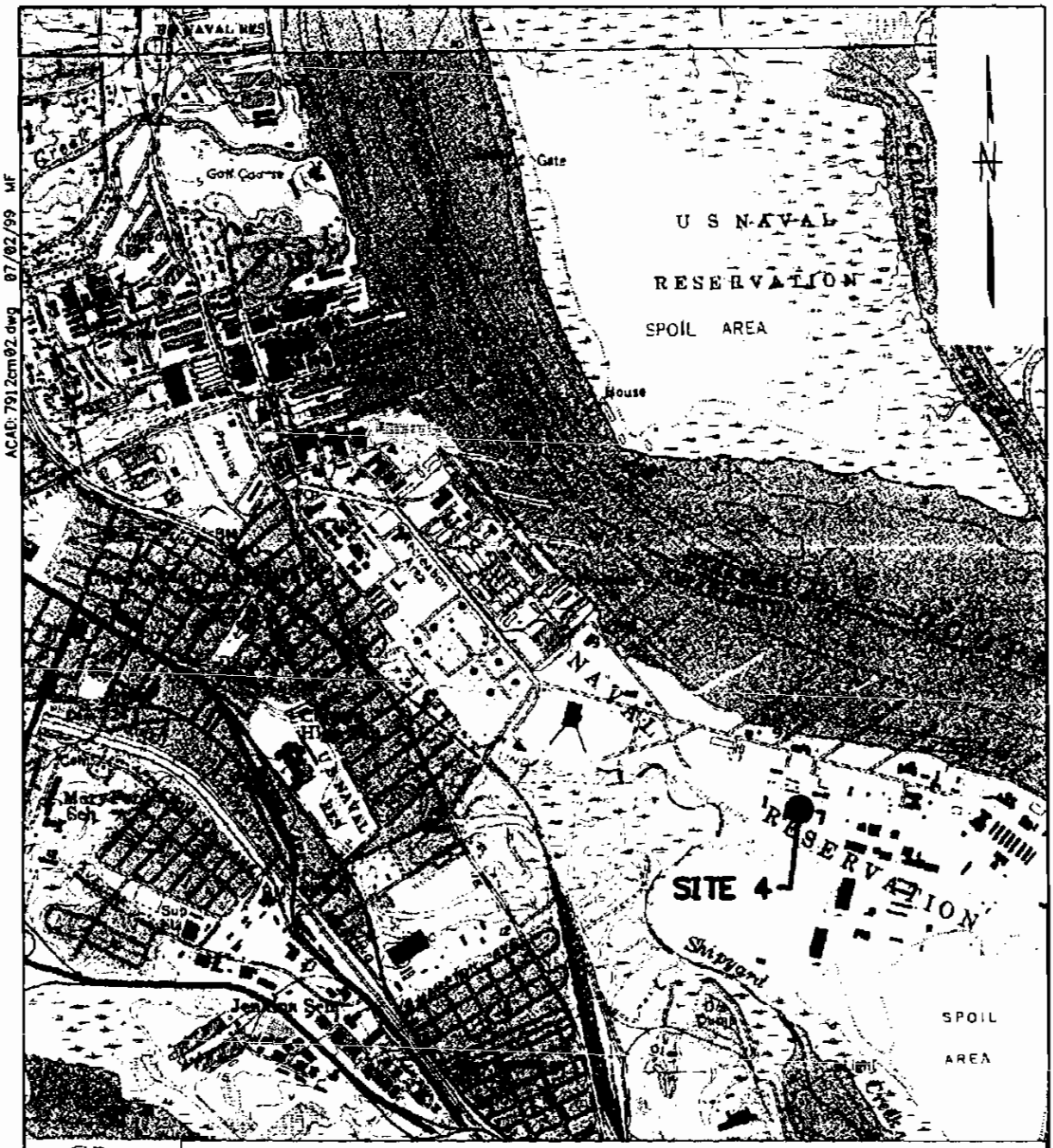
Media	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (If pathway selected)
Air	Inhalation	No	No volatilization to enclosed space.	
	Explosion Hazard	No	No explosion hazard.	
Groundwater	Ingestion	No	Future use of property expected to be industrial or commercial. No underground utilities in area of groundwater impact; therefore construction worker exposure unlikely.	
	Dermal contact	No		
	Inhalation	No		
Surface Water	Ingestion	Yes	Cooper River 730 ft downgradient	No additional data required
	Dermal contact	Yes		
	Inhalation	No		
Surficial Soil	Ingestion	No	No impacted surface soil	
	Dermal contact	No		
	Inhalation	No		
Subsurface Soil	Ingestion	No	No subsurface soil with BTEX or PAHs including naphthalene above RBSLs	
	Dermal contact	No		
	Inhalation	No		

TABLE 13

COMPARISON OF MAXIMUM CONCENTRATIONS TO SSTLs
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Chemical of Concern	Source Area Concentration [mg/L]	Source SSTL [mg/L]	Compliance Point Concentration [mg/L]	Compliance Point SSTL [mg/L]
Benzene	0.31	0.672	ND	0.618
Toluene	4.65	134.427	ND	123.650
Ethybenzene	0.10	140.050	ND	122.730
Xylenes	0.79	1344.269	ND	1236.503
Naphthalene	**23.35**	2.001	ND	1.753

mg/l - milligrams per liter
GW - Groundwater
MTBE - Methyl tertiary butyl ether
ND - Analyte not detected above method detection limit
Bold value indicates the concentration exceed the SSTL.



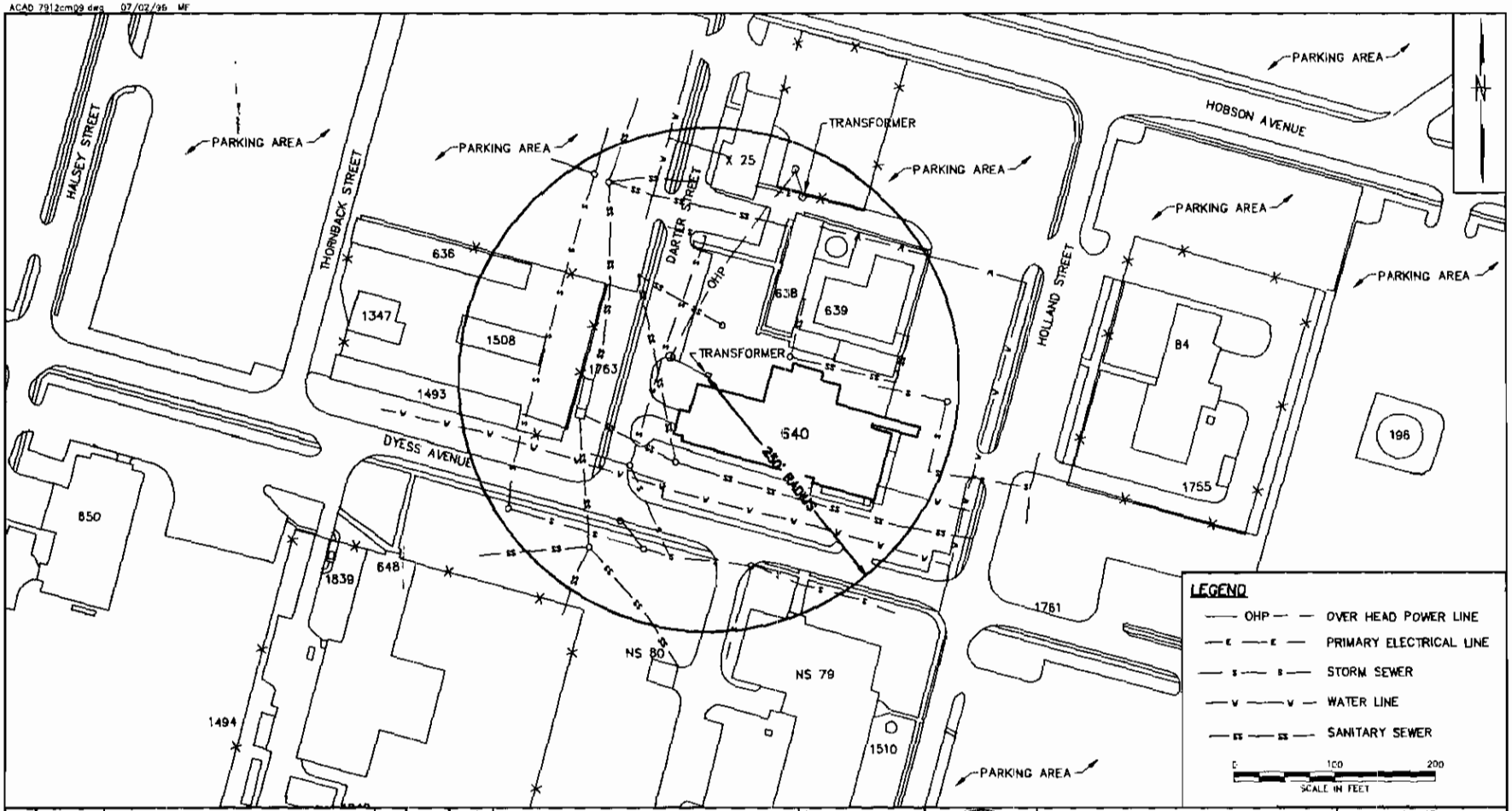
ACAD: 7912cm02.dwg 07/02/99 MF

SOURCE: QUADRANGLE MAP SOUTH CAROLINA, REVISED 1979
QUADRANGLE MAP NORTH CHARLESTON REVISED, 1979

DRAWN BY HJP DATE 5/18/99		SITE LOCATION MAP SITE 4, BUILDING 648, ZONE H CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SC	CONTRACT NO. 7912
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

ACAD 7912cm09.dwg 07/02/96 MF



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

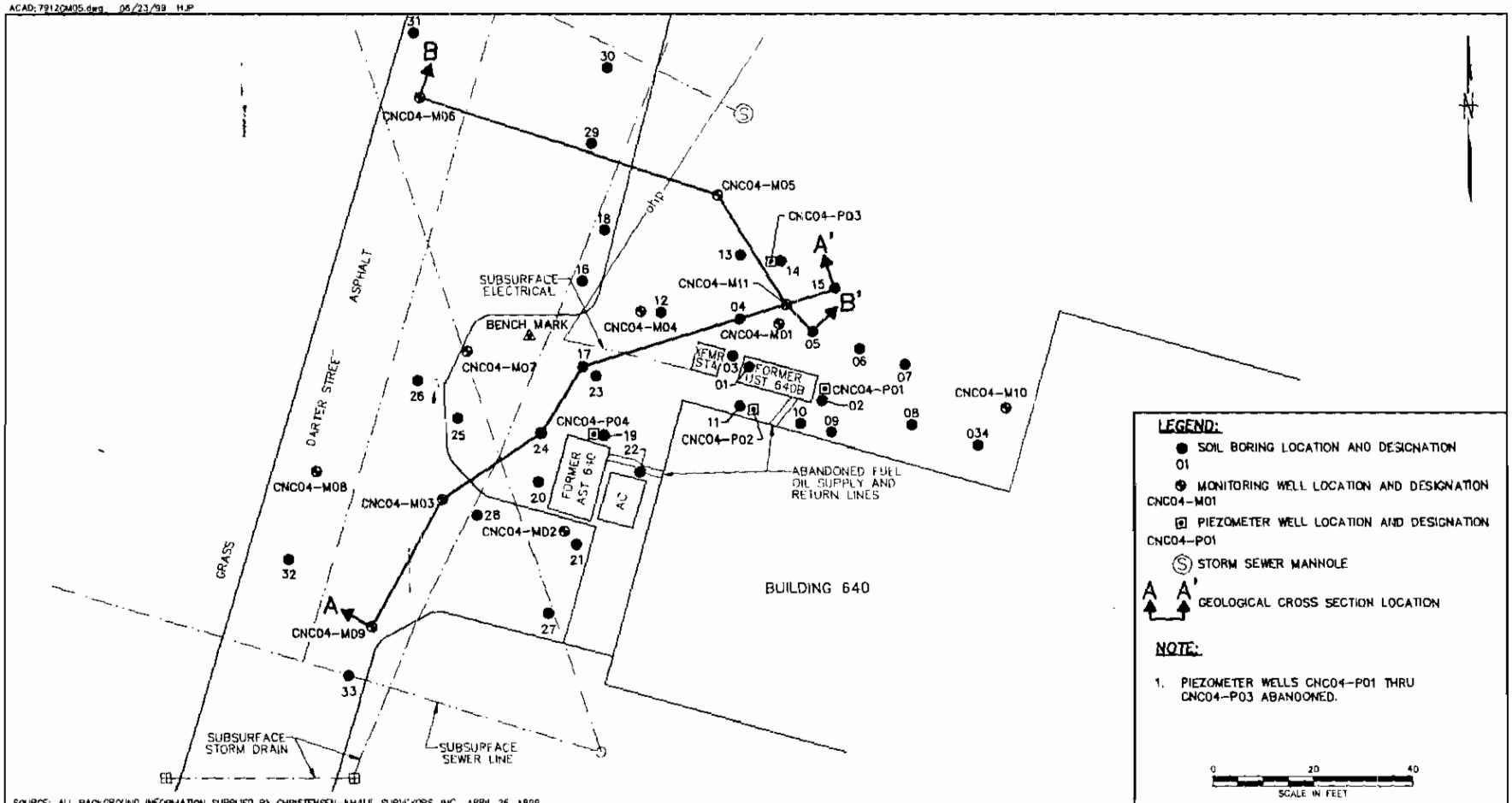
DRAWN BY KW DATE 5/24/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SITE VICINITY MAP
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2
REV. 0

FORM CADD NO 5DIV_3H.DWG - REV 0 - 1/28/96

ACAD: 7912QM05.dwg 06/23/99 HJP



SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSEN-KHALIL SURVEYORS, INC. APRIL 26, 1999

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

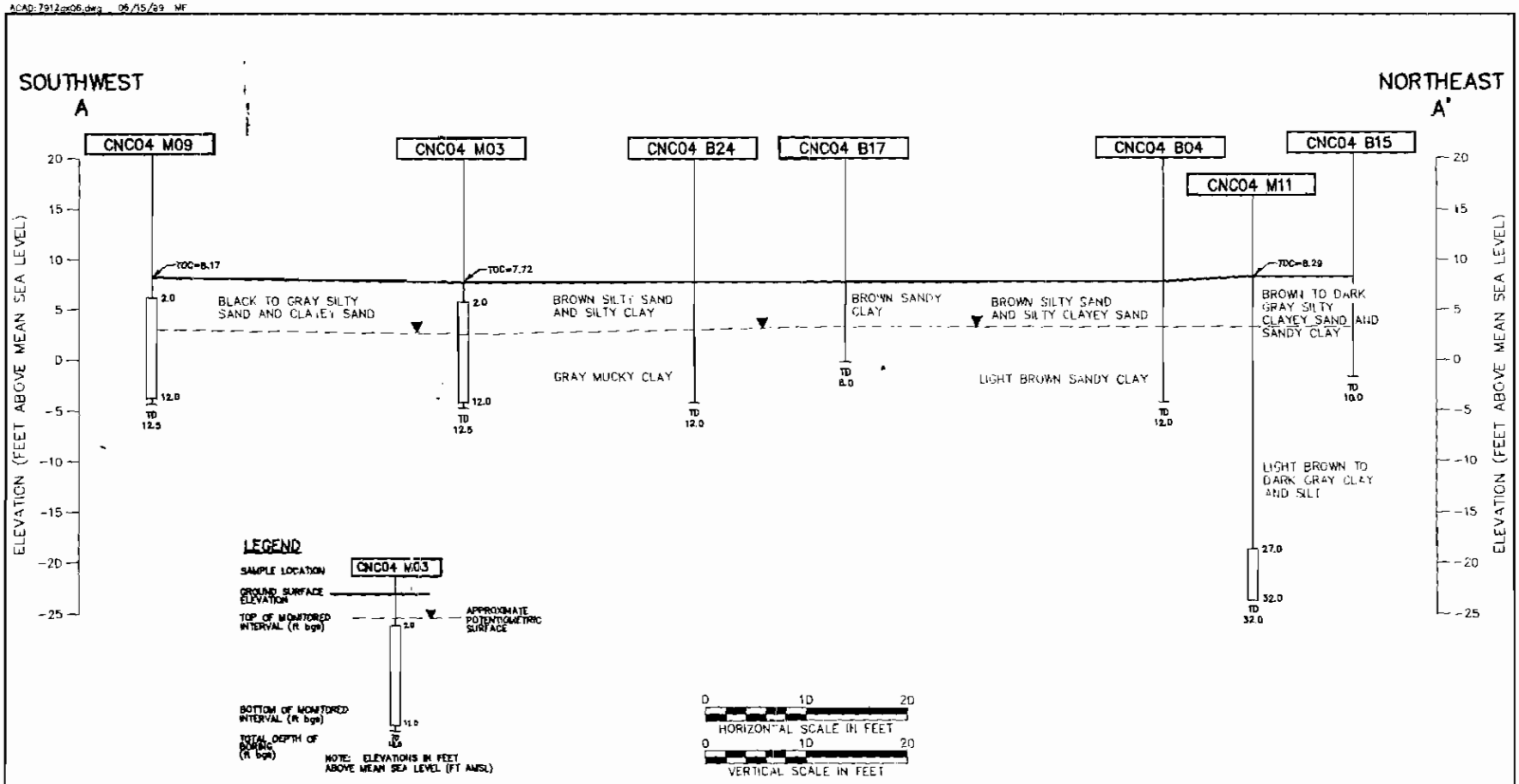
DRAWN BY MF DATE 5/24/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SITE MAP AND SAMPLING LOCATIONS
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 3
REV. 0

FORM CADD NO SDIV_BH.DWG – REV 0 – 1/29/98

ACAD: 7912gx06.dwg 06/15/99 MF



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 6/15/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GEOLOGIC CROSS SECTION
A-A'
SITE 4, BUILDING 840
ZONE H CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 4
REV. 0

FORM EADD NO. SDIV_BH.DWG - REV 0 - 1/28/98

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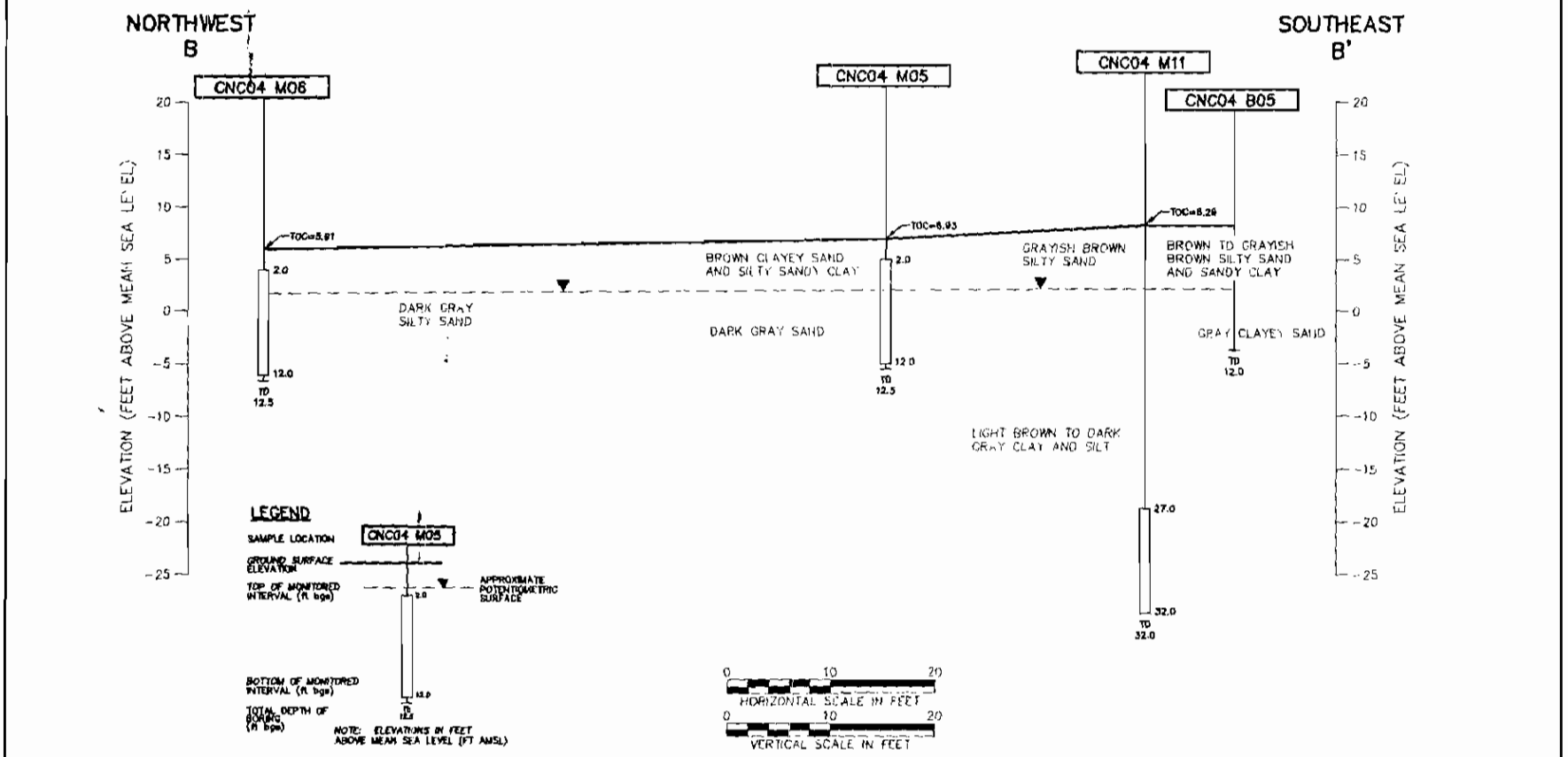

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 6/15/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GEOLOGIC CROSS SECTION
B-B'
SITE 4, BUILDING 640
ZONE H CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 5
REV. 0

FORM CADD NO. 331V_BH.DWG - REV 0 - 1/26/96

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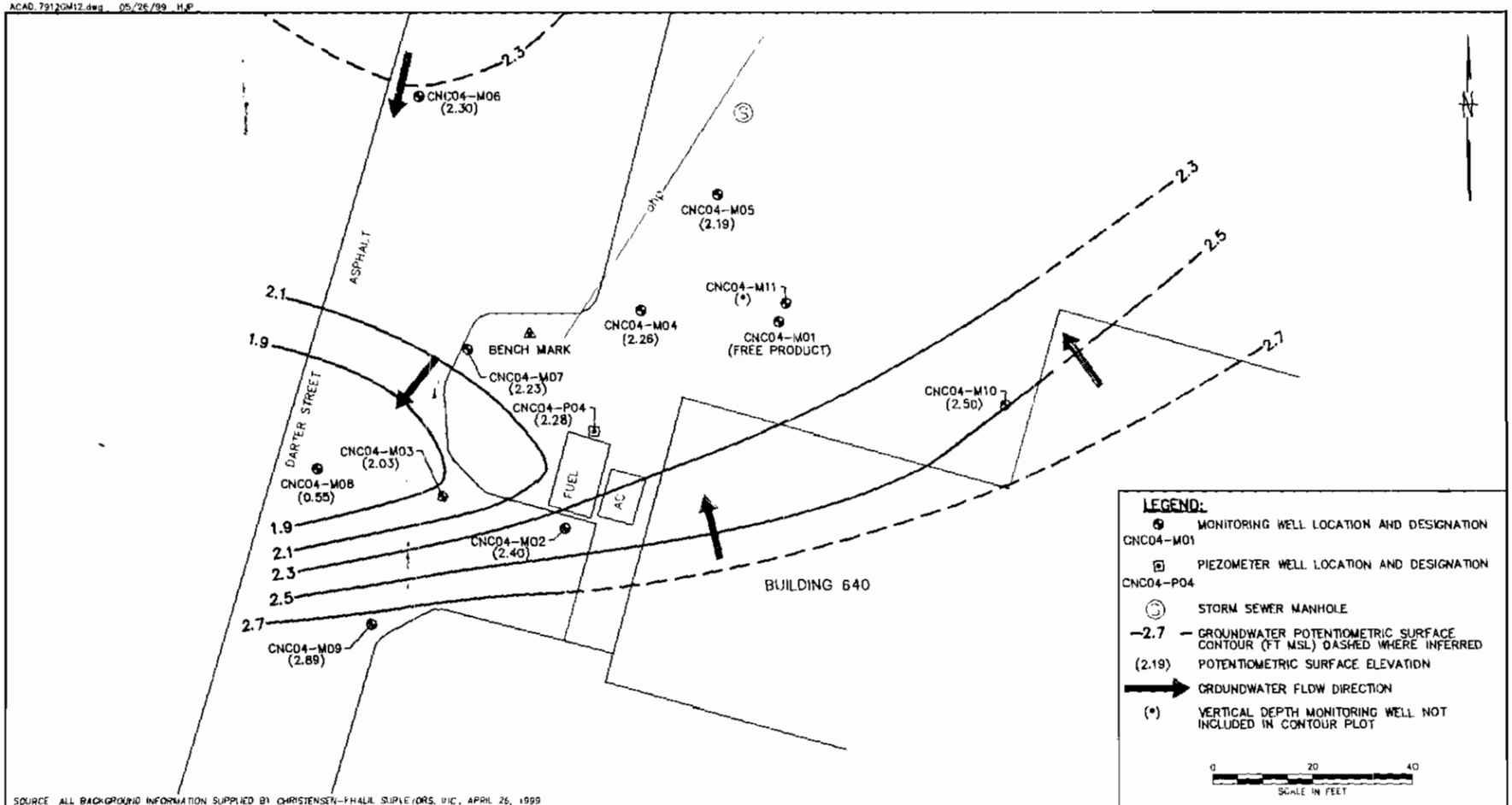

SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSEN-PHALIL SUPPLIERS, INC., APRIL 26, 1999

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY: MF DATE: 5/25/99
CHECKED BY: DATE:
COST/SCHED-AREA:
SCALE: AS NOTED

GROUNDWATER POTENTIOMETRIC MAP
(MARCH 4, 1999)
SITE 4, BUILDING 840
ZONE H, CHARLESTON NAVAL BASE
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY: DATE:
APPROVED BY: DATE:
DRAWING NO. FIGURE 6
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

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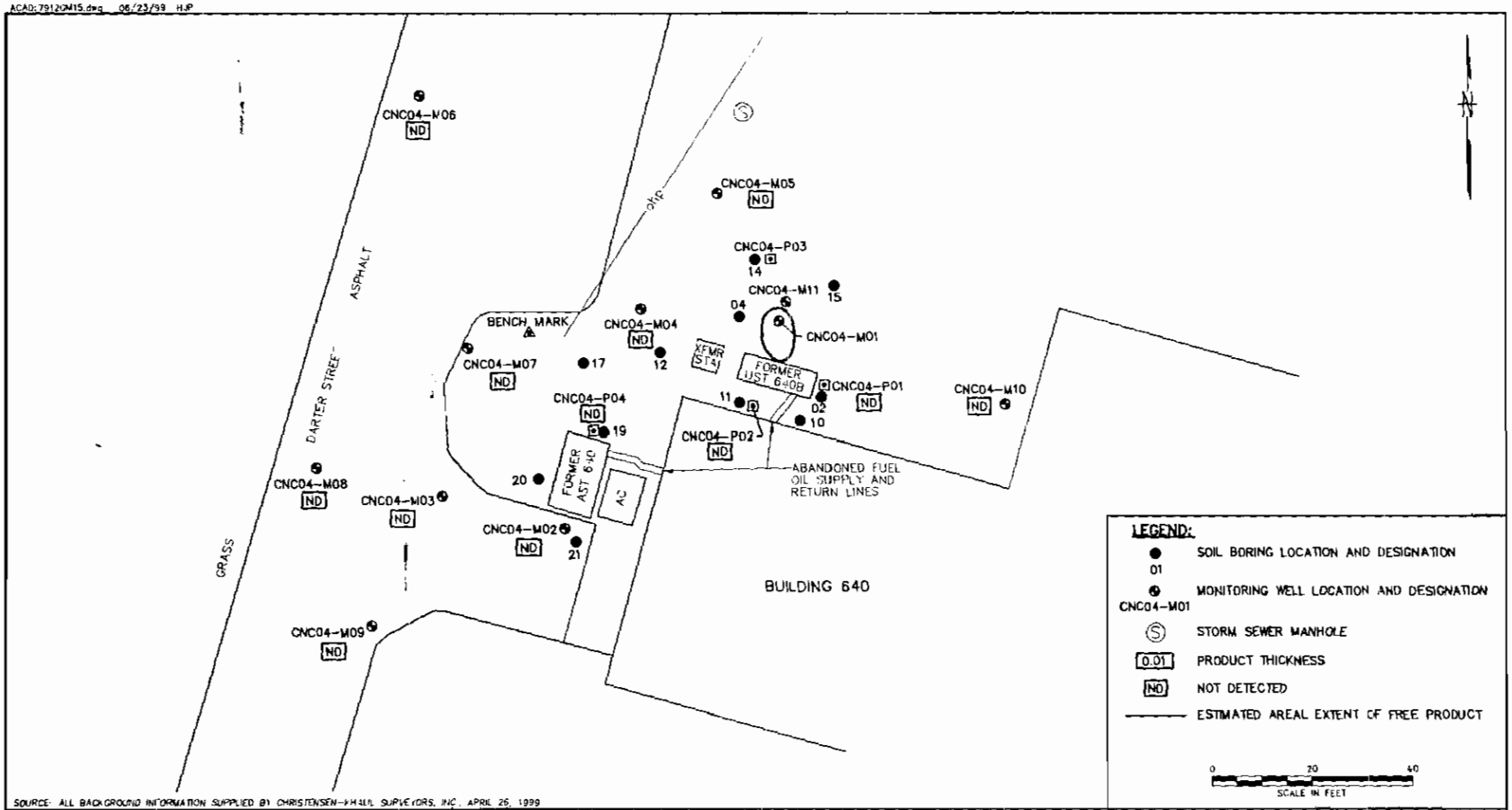

SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSEN-KHALIL SURVEYORS, INC. APRIL 26, 1999

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 5/26/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

AREAL EXTENT OF FREE PRODUCT
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 7
REV. 0

FORM CADD NO SDM_BH.DWG - REV 0 - 1/29/98

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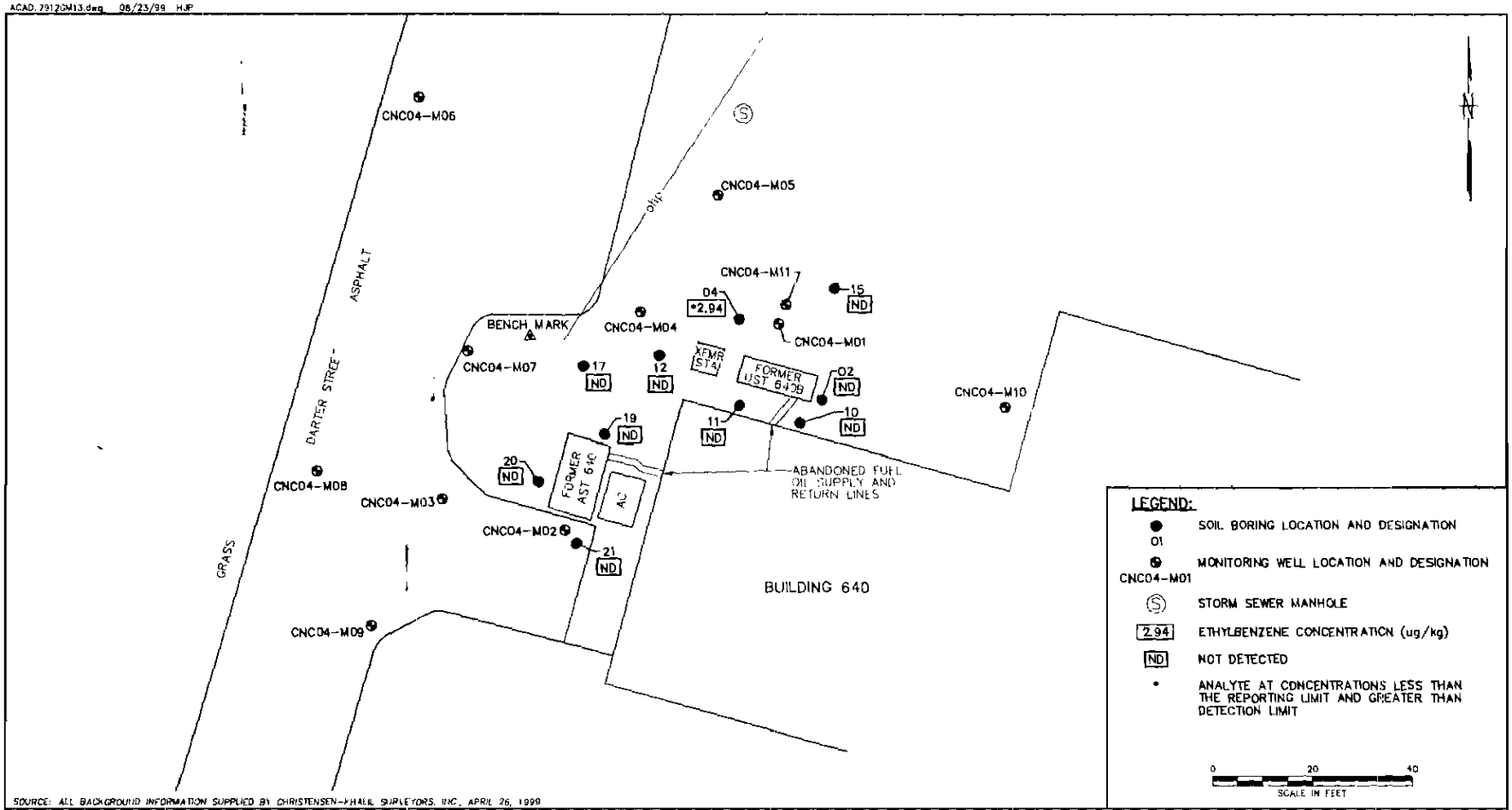

SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSEN-KHALIL SURVEYORS, INC., APRIL 26, 1999

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 5/24/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SOIL ETHYLBENZENE CONCENTRATION MAP
(JANUARY 14, 1999)
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 8
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

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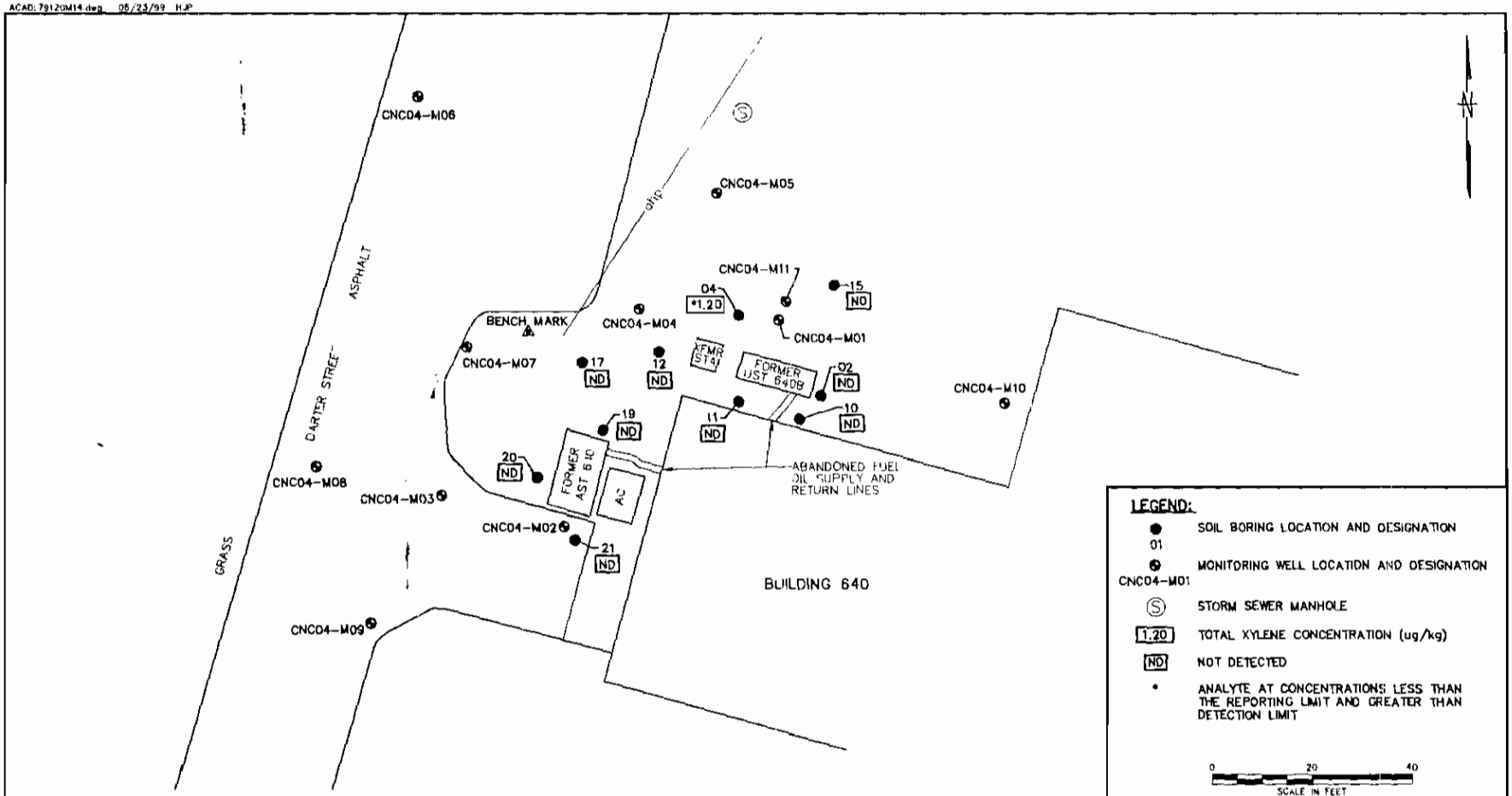

LEGEND:

- ● 01 — SOIL BORING LOCATION AND DESIGNATION
- ⊕ CNC04-M01 — MONITORING WELL LOCATION AND DESIGNATION
- Ⓢ — STORM SEWER MANHOLE
- [1.20] — TOTAL XYLENE CONCENTRATION (ug/kg)
- [ND] — NOT DETECTED
- * — ANALYTE AT CONCENTRATIONS LESS THAN THE REPORTING LIMIT AND GREATER THAN DETECTION LIMIT

0 20 40
SCALE IN FEET

SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSEN-KHALIL SURVEYORS, INC., APRIL 26, 1999

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DATE: MF 5/25/99
CHECKED BY DATE:
COST/SCHED--AREA:
SCALE: AS NOTED

SOIL TOTAL XYLENES CONCENTRATION MAP
(JANUARY 14, 1999)
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 9
REV. 0

FORM CADD NO. SOIL_BH.DWG - REV 0 - 1/29/98

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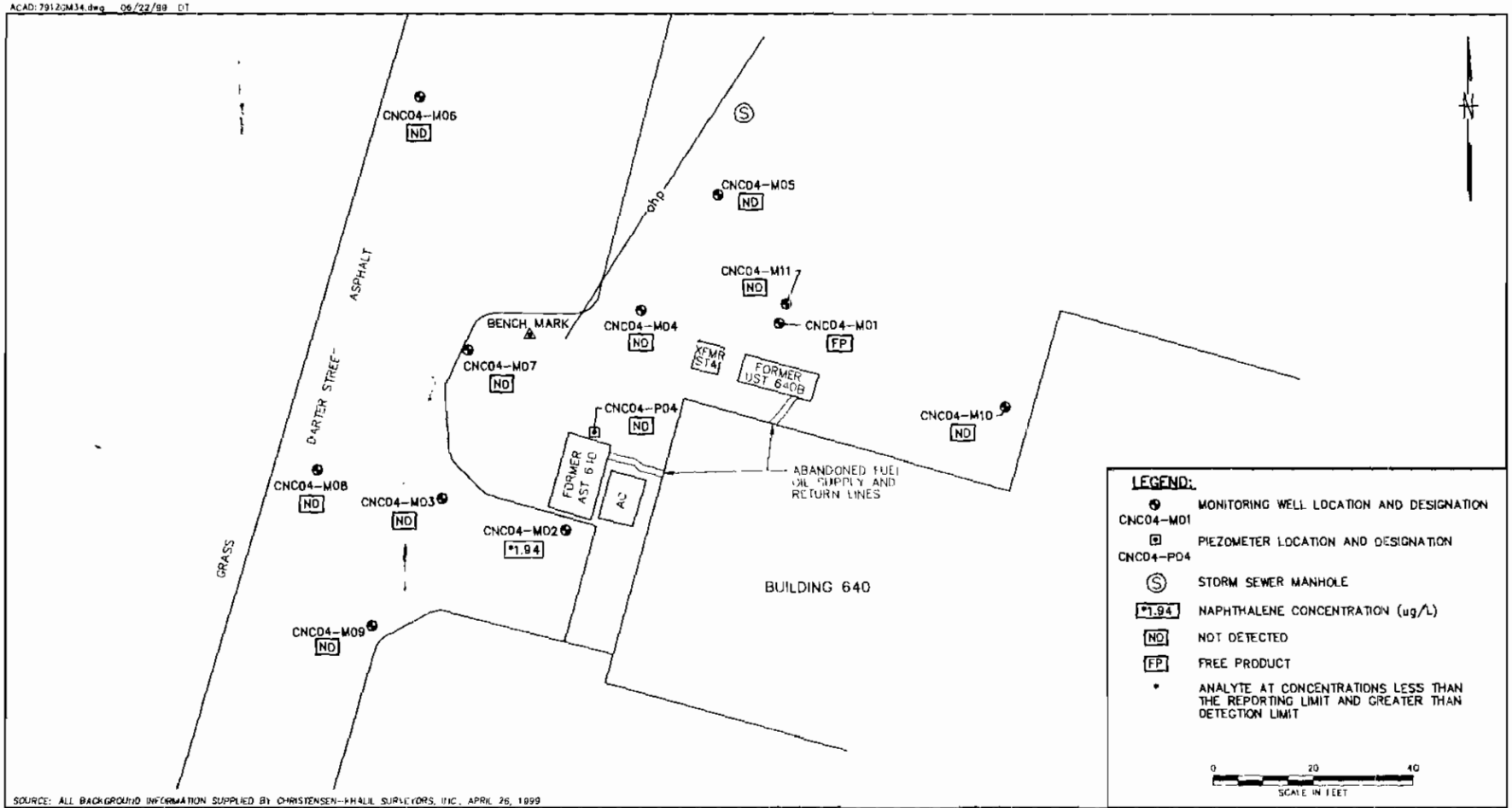

SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSEN-KHALIL SURVEYORS, INC., APRIL 26, 1999

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DLT DATE 6/21/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GROUNDWATER NAPHTHALENE CONCENTRATION MAP
(JANUARY 14, 1999)
SITE 4, BUILDING 640
ZONE H, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 10
REV. 0

FORM CADD NO. SDIV_BH.DRG - REV 0 - 1/29/98

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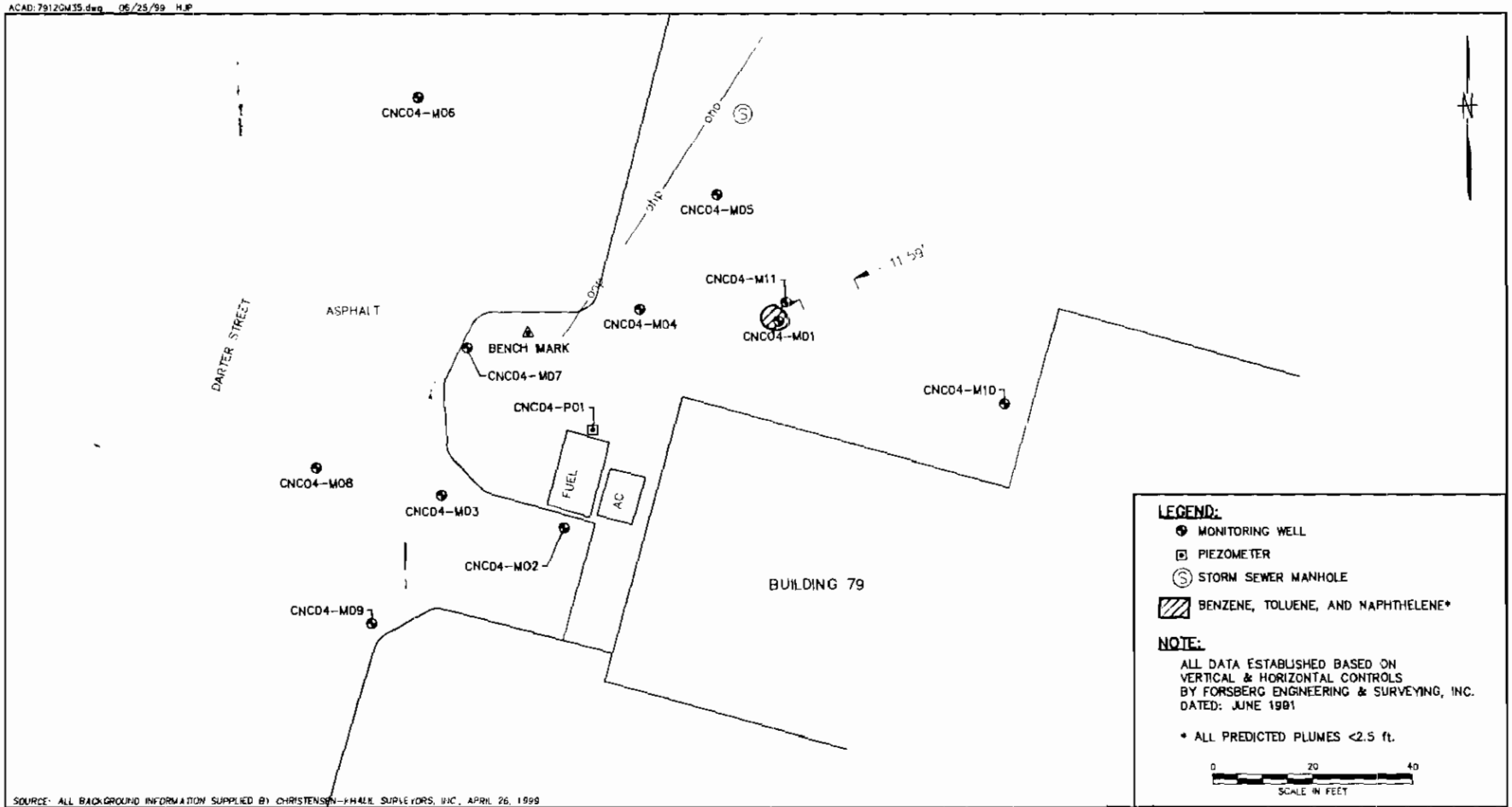

SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSON-KHALIL SURVEYORS, INC., APRIL 26, 1999

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DLT DATE 5/7/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

AREA 4
PREDICTED 10-YEAR MIGRATION
CNC CHARLESTON SOUTH CAROLINA
NORTH CHARLESTON
CHARLESTON COUNTY, SOUTH CAROLINA

CONTRACT NO. 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 11
REV. 0

FORM CADD NO SDN_BNDRG - REV D - 1/29/98

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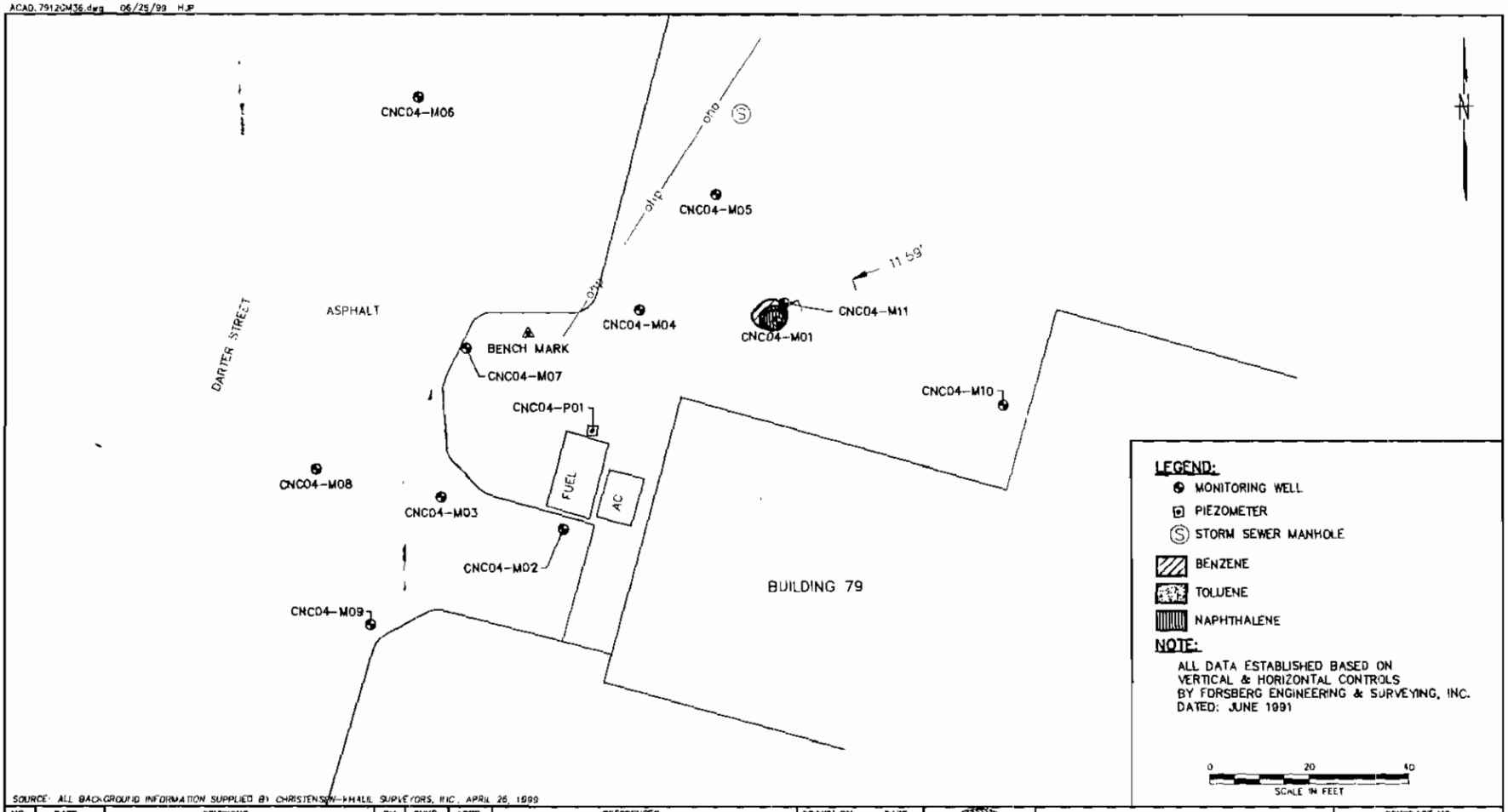


SOURCE: ALL BACKGROUND INFORMATION SUPPLIED BY CHRISTENSON-KHALIL SURVEYORS, INC., APRIL 26, 1999

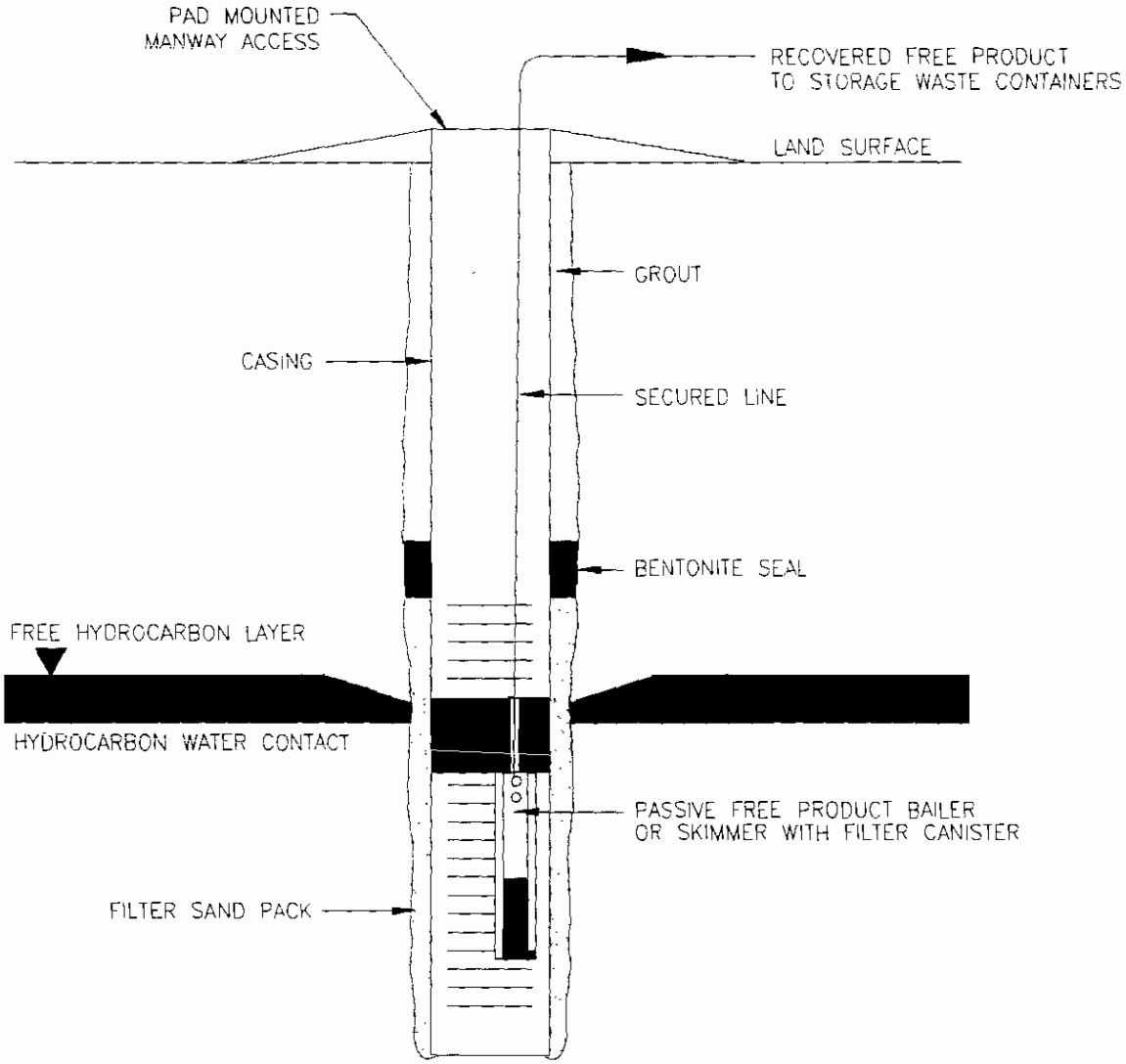
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DLT DATE 5/7/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

AREA 4
PREDICTED 20-YEAR MIGRATION
CNC CHARLESTON SOUTH CAROLINA
NORTH CHARLESTON
CHARLESTON COUNTY, SOUTH CAROLINA

CONTRACT NO 7912
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 12
REV. 0

FORM CADD NO SDN_BH.DWG - REV 0 - 1/20/98



J.A. JONES

PROPOSED FREE PRODUCT RECOVERY WELL DIAGRAM
SITE 4, BUILDING 640
ZONE 1, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

SCALE:	NONE
JOB NO.	093
DRAWING NO.	FIGURE 13

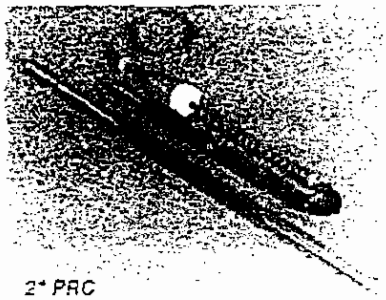
APPENDIX A

REMEDIAL EQUIPMENT – PASSIVE SKIMMER

For more info:
enviro @ geneq.com

Hydrocarbon Recovery Canister

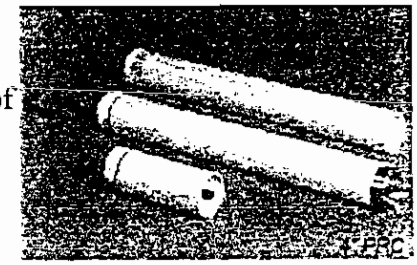
New, Revolutionary, Answer to your Hydrocarbon Recorvery Needs.



The PRC is a passive, floating skimmer device designed to separate and recover light hydrocarbons from the ground water. Incorporating Keck's original skimmer technology with a storage canister, the device will automatically collect floating product is evacuated from the device through a discharge valve at the bottom of the canister.

Featuring a hydrophobic filter buoy for product recovery without water, the PRC skimmer has a travel of 12" to compensate for water table fluctuation and well placement.

The PRC Recovery Canister is available for 2" or larger monitor wells. It requires no external means of power, is easily installed and can be installed at remote sites.



Specifications

- **Dimensions**
  - **Length :** 39"/99cm (4"/100mm canister), 50"/127cm (2"/50mm canister)
  - **O.D. :** 3.5"/90mm or 1.75"/44mm
  - **Weight :** 7 lbs./3.2kg (4"/100mm canister), 4 lbs./1.8kg (2"/50mm canister)
- **Recovery Canister Capacity**
  2"/50mm .5 liter transparent cylinder
  4"/100mm 1 liter standard, other capacities available; easily changed in the field.

CAT. NO.	DESCRIPTION
KEPRC4-000	**PRC-94 Canister for 4" well**
KEPRC2-000	**PRC-94 Canister for 2" well**