Section : 06.04
Site 20903-5640 (White Oak)
Doc. #: 0006

N60921.AR.000362
NSWC WHITE OAK
5090.3a

Final Design Submission
Operable Unit 2
Closure Design

Former
Naval Surface Warfare Center
White Oak
Silver Spring, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0273

June 2001

TETRA TECH NUS, INC.

Section : 06.04
Site 20903-5640 (White Oak)
Doc. #: W/00060
00162

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PITT-06-1-074

June 25, 2001

Project Number 7427

Mr. Walter Legg
Department of the Navy
Engineering Field Activity Chesapeake
Code 181
Washington Navy Yard
1314 Harwood Street, S.E
Washington, D.C. 20374-5018

Reference: Clean Contract No. N62472-90-D-1298
Contract Task Order No. 0273

Subject: Final Design – Operable Unit 2
Former Naval Surface Warfare Center (NSWC) White Oak
Silver Spring, Maryland

Dear Walter,

Enclosed is the final design submission for closure of Operable Unit 2 at the former NSWC White Oak, located in Silver Spring, Maryland. The design package incorporates changes to the 100% design to address the comments received from the White Oak BRAC Cleanup Team. Copies have also been forwarded to members of the White Oak BRAC Cleanup Team and the other interested parties identified below.

Please feel free to contact me at (412) 921-7134 with any comments or questions regarding the information submitted.

Very truly yours,

Scott A. Nesbit, P.E.
Project Manager

SAN/kf
Enclosures

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Mr. Darius Ostraskus, USEPA Region III (2 copies)
Mr. Jeff Thornburg, MDE
Mr. Steven Richard, GSA
Mr. Bob Ridgway, GSA/ANADAC
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Project File – 7427

Section: 06.04
Site 20903-5640 (White Oak)
Doc. #: 0006

REVISION 0
JUNE 2001

FINAL DESIGN SUBMISSION

OPERABLE UNIT 2
CLOSURE DESIGN

FORMER NAVAL SURFACE WARFARE CENTER
WHITE OAK
SILVER SPRING, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
1314 Harwood Street, SE
Washington, D.C. 20374-2121

Submitted by:
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CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0273

JUNE 2001

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Operable Unit 2
Closure Design
Final Design Submission

Former
Naval Surface Warfare Center
White Oak
Silver Spring, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0273

June 2001

REVISION 0
JUNE 2001

BASIS OF DESIGN REPORT
FOR
OPERABLE UNIT 2 CLOSURE DESIGN

FINAL DESIGN SUBMISSION

FORMER NAVAL SURFACE WARFARE CENTER
WHITE OAK
SILVER SPRING, MARYLAND

COMPREHENSIVE LONG-TERM
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LIST OF ACRONYMS

ALC	Adelphi Laboratory Center
ARARs	applicable or relevant and appropriate requirements
BCT	BRAC Cleanup Team
bgs	below ground surface
BRAC	Base Realignment and Closure
CBC	Chillum-Beltsville-Croom
CLEAN	Comprehensive Long-Term Environmental Action Navy
COCs	Contaminants of Concern
CTO	Contract Task Order
DVSAP	Design Verification Sampling and Analysis Plan
ECM	Erosion Control Matting
EE/CA	Engineering Evaluation/Cost Analysis
EM	Electromagnetic
EM31	Geonics EM-31 Terrain Conductivity Meter
ft msl	feet above mean sea level
GMC	Glenelg-Manor-Chester
GSA	General Services Administration
LLDPE	Linear Low Density Polyethylene
NSWC-White Oak	Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak
OU2	Operable Unit 2
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PP	Proposed Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial Investigation
Site 1	Parking Lot Landfill
Site 2	Apple Orchard Landfill
SUs	Standard Units
TBC	to be considered
TCL	target compound list
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon
TP	Test Pit
TS	total solids

TtNUS	TetraTech NUS, Inc.
TVS	Total volatile solids
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this report is to provide the basis for a remedial design for Operable Unit (OU2) at the former Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWC-White Oak), located in Silver Spring, Maryland. OU2 consists of waste and contaminated soil and sediment present within the Parking Lot Landfill (Site 1), and the Apple Orchard Landfill (Site 2). The remedial design consists of installing an engineered multimedia cap over the contaminated soil, sediment, and waste material consolidated within OU2. The design addresses soil and sediment contamination and indirectly addresses surface water and groundwater contamination associated OU2. The consolidation of Site 1, Site 2, and the contaminated sediments from the unnamed stream will be placed under the multimedia cap. Any waste encountered during excavation activities that are suspected to be hazardous will be disposed offsite. Institutional controls, as well as groundwater and surface water monitoring will also be part of the remedy. This Basis of Design Report was prepared by Tetra Tech NUS, Inc. (TtNUS) for the U.S. Navy under Contract Task Order (CTO) No. 0273 as part of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62472-90-D1298.

NSWC-White Oak is a former Navy-owned and-operated laboratory for Naval Surface Warfare research, located approximately 5 miles north of Washington, D.C., off New Hampshire Avenue in Silver Spring, Maryland (see Figure 1-1). NSWC-White Oak covered approximately 712 acres and was located in both Prince George's and Montgomery Counties. Approximately 662 acres were transferred to the General Services Administration (GSA) in the fall of 1997. The remaining area in the southeastern portion of the facility was transferred to the U.S. Army in February 1998. NSWC-White Oak is bordered by the U.S. Army's Adelphi Laboratory Center (ALC) along with a mixture of residential, park, industrial, and commercial properties. The facility lies in gently rolling terrain. Local drainage patterns are dominated by Paint Branch and its tributaries. This remedial design is limited to Sites 1 and 2 which are shown on Figure 1-2.

Construction of the OU2 landfill multi-media cap with off-site disposal of suspect hazardous waste was selected to minimize the potential release of contamination from the waste/fill materials contained in the landfill into the environment, and to prevent human and ecological exposure to these waste/fill materials. The Navy's goal is to begin remedial actions at the former NSWC-White Oak as quickly as possible to protect human health and the environment and to comply with applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) criteria.

The extent of the landfills, nature of contamination, and associated risks at Sites 1 and 2 were derived from the investigations conducted by Malcolm-Pirnie, Kearney/Centaur Division, and TtNUS (formerly Halliburton NUS and Brown & Root Environmental). TtNUS has also completed a pre-design investigation at OU2 in December 2000. The results of the pre-design investigation are included in Section 3.0 of this report. The reports generated from the previous studies are:

- NEESA (Naval Energy and Environmental Support Activity), 1984. Initial Assessment Study, Naval Surface Warfare Center, White Oak, Silver Spring, Maryland, Port Hueneme, California.

- Malcolm-Pirnie, 1987. Confirmation Study/Verification Phase, Naval Surface Warfare Center, White Oak, Silver Spring Maryland. Prepared for Chesapeake Division, Naval Facilities Engineering Command, Washington, D.C.

- Kearney/Centaur Division, 1990. Phase II RCRA Facility Assessment of the Naval Surface Warfare Center, White Oak Laboratory, Silver Spring, Maryland. November.

- Malcolm-Pirnie, 1992. Draft Remedial Investigation Report, Dahlgren Division, White Oak Detachment, Silver Spring, Maryland. March.

- Malcolm-Pirnie, 1993. Draft Feasibility Study Report, Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. March.

- Halliburton NUS, 1995. Draft Design Verification Report for Sites 2, 3, 4, & 9, Naval Surface Warfare Center White Oak, Silver Spring, Maryland. Prepared for the Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. Wayne, Pennsylvania. August.

- TtNUS, 1999a. Addendum Round 2 Groundwater Data, RCRA Facility Investigation, Sites 2, 3, 4, 7, 8, 9, Former Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania. September.

- TtNUS, 1999b. Engineering Evaluation/Cost Analysis for Site 1 at the Former Naval Surface Warfare Center – White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania. November.

- TtNUS, 1999c. Addendum Round 3 Groundwater Data, RCRA Facility Investigation, Sites 2, 3, 4, 7, 8, 9, Former Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. Prepared for

Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania. December.

- TtNUS, 2000a. Addendum Round 1, 2, 3, 4 Groundwater Data, RCRA Facility Investigation, Sites 2, 3, 4, 7, 8, 9, Former Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania.

- TtNUS, 2000b. RCRA Facility Investigation for Sites 2, 3, 4, 7, 8, 9 and Paint Branch, Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. Prepared for the Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania. October.

- TtNUS, 2000c. Basewide Ecological Risk Assessment. Prepared for the Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, December.

- TtNUS, 2001. Corrective Measures Study for OU2. Prepared for the Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, March.

1.2 BASIS OF DESIGN REPORT ORGANIZATION

The following highlights the information contained in each section of this report.

- Section 1.0 provides an introduction and summary of the Basis of Design Report.

- Section 2.0 summarizes site characteristics including site history, surface/subsurface soil and hydrological characteristics.

- Section 3.0 summarizes the results of the Design Verification Study and Pre-Design Investigation.

- Section 4.0 presents the selected remedy and details design requirements for the remedial action.

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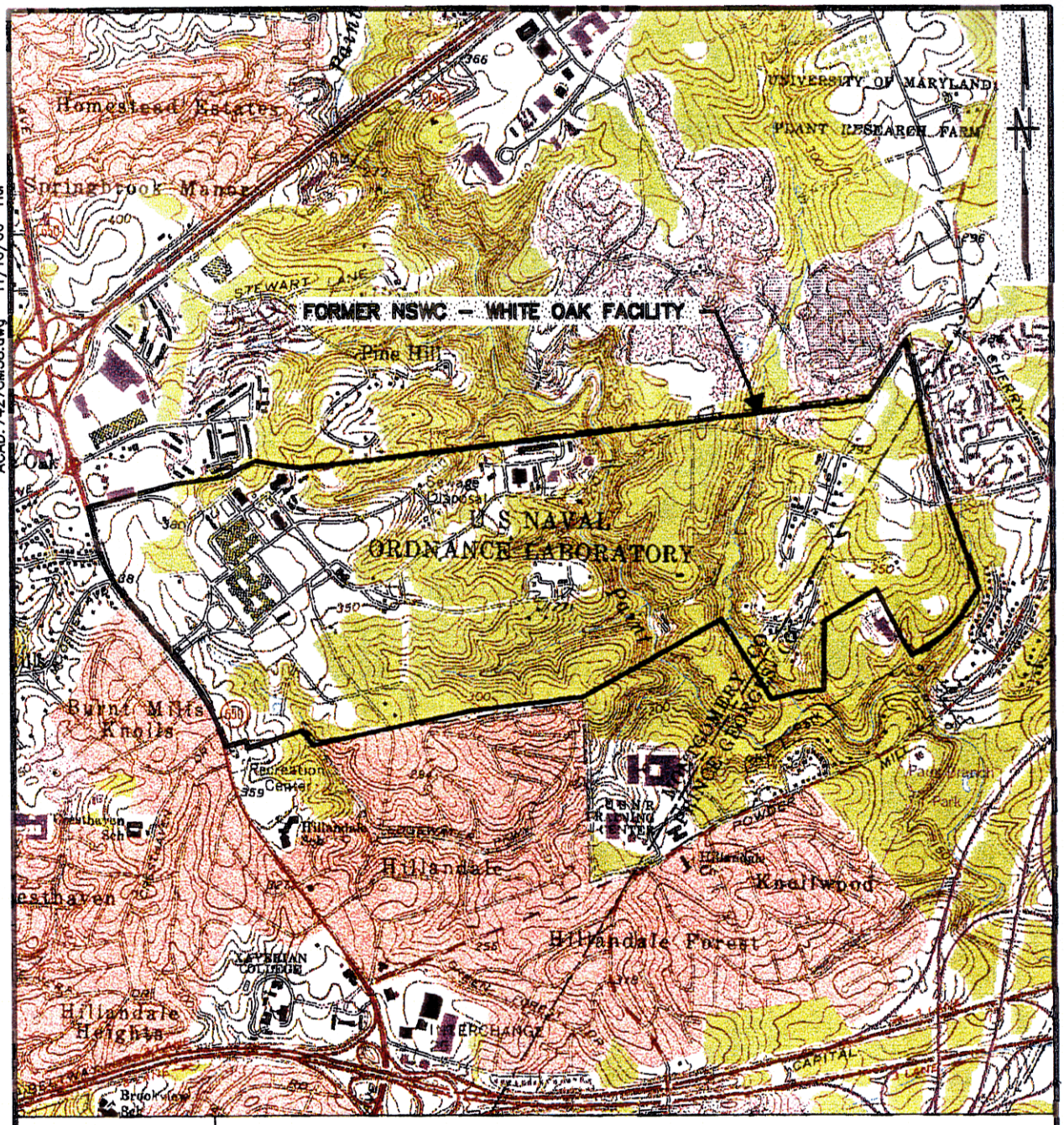

SOURCE: U.S.G.S QUADRANGLE MAP, BELTSVILLE, MD. PHOTOREVISED 1979.

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COST/SCHED–AREA		APPROVED BY	DATE
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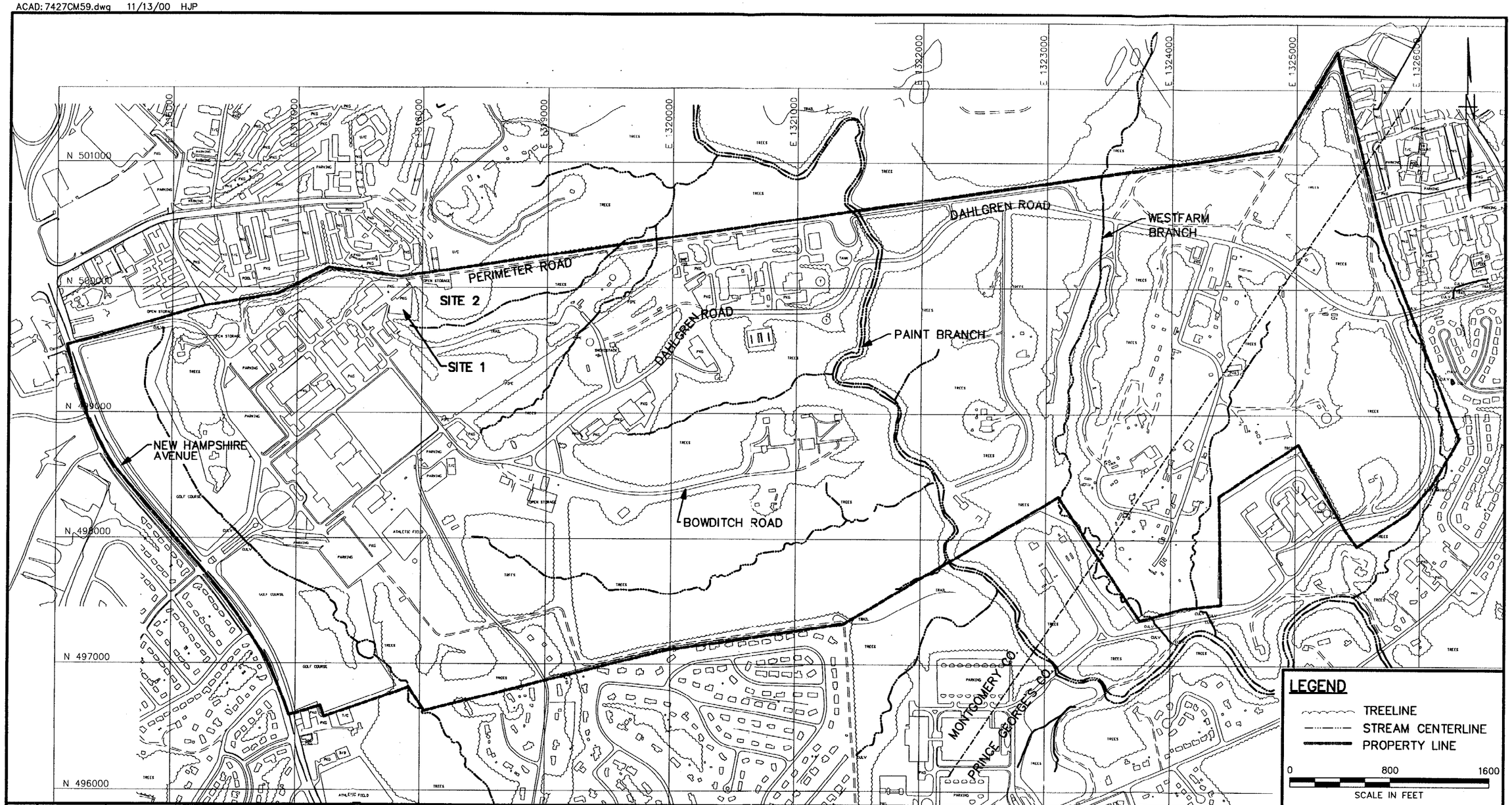

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DRAWN BY HJP DATE 11/13/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LOCATION MAP
OPERABLE UNIT 2
FORMER NSWC-WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 273
APPROVED BY SN
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2.0 EXISTING SITE CHARACTERISTICS

2.1 SITE DESCRIPTION

2.1.1 Site 1 - Parking Lot Landfill

The Parking Lot Landfill was used as an open disposal site and landfill between 1948 and 1953. The site is located east of Building 110 and south of Building 111 and is adjacent to the Apple Orchard Landfill (Site 2) (Figure 2-1). The wastes reportedly disposed within this landfill include lubricating oil, battery acid, metal plating wastes, and metal scrap. It has been reported that approximately 60 automobile batteries were disposed at the site over its operating life. The site is now used as a parking lot and is paved with asphalt; however, visible wastes from the landfill including tires, glass, and old metal equipment have been observed on the southern and eastern slopes beyond the edge of the parking lot. The landfill covers approximately 1 acre and contains approximately 7,000 cubic yards of waste (TtNUS, 1999b).

The surface of Parking Lot Landfill is a slightly sloping paved area. Runoff from the paved area is directed toward the southeastern corner. The eastern and southern faces of the landfill, outside the boundaries of the paved area, are both steeply sloped into drainage swales.

A decontamination pad is located in the southwestern corner adjacent to the site. It has been used during environmental restoration work at various sites at NSWC-White Oak. The decontamination pad was constructed with a tap water spigot and a drain that directs the wash water to a secondary containment vault.

2.1.2 Site 2 - Apple Orchard Landfill

The Apple Orchard Landfill is an inactive landfill located to the south of Perimeter Road in the northwestern end of the former NSWC-White Oak property (Figure 2-1). The landfill forms a plateau, with a peak elevation of approximately 340 feet mean sea level (ft msl). The landfill slopes steeply to an unnamed stream along its southern edge and a drainage swale along its western perimeter. The stream flows north/northeast towards Paint Branch. The drainage swale that separates Site 1 from Site 2 conveys stormwater flow from adjacent properties and joins the unnamed stream in the southwestern corner of the site.

The Apple Orchard Landfill reportedly operated as an open disposal area and landfill from 1948 until 1982. The landfill is a single unit that is composed of several disposal areas. In addition to domestic refuse, wastes reportedly disposed at the site included oils containing polychlorinated biphenyls (PCBs),

solvents, paint residue, acids and miscellaneous compounds. An estimated 500 gallons of PCB-contaminated oils were deposited at the site prior to 1970. It has been estimated that the landfill contains 75,000 cubic yards of waste/fill.

The landfill covers approximately 4.3 acres, the majority of which consists of the plateau adjacent to Perimeter Road. The landfill cover supports old field vegetation with successional hardwood forest on the short but very steep side slopes. The steep slopes range in height from a few feet (along the eastern and western perimeter) to approximately 35 feet along the southern perimeter. The slopes are moderately eroded and exposed waste and fill material are evident throughout. The landfill is abutted to the south and west by mixed deciduous forest, to the east by Virginia Pine Forest, and to the north by private lands supporting residential development and Virginia Pine Forest. Minor erosion is evident on the landfill surface, but the steep slopes along the southern perimeter expose waste and fill material resulting from erosion of the cover materials or lack of placement of initial cover materials.

2.2 SOILS AND GEOLOGY

The former NSWC-White Oak lies near the boundary between the Piedmont and Coastal Plain Physiographic Provinces. The boundary, known as the Fall Line, runs generally southwest to northeast and is roughly parallel to the Montgomery-Prince George's County line in the White Oak area. Physically, the Fall Line represents the contact where older Piedmont rocks, exposed to the northwest, dip beneath Coastal Plain sediments that increase in thickness to the southeast.

At the facility, Coastal Plain sediments are only a few tens of feet thick and in many places have been entirely eroded away. They are primarily unconsolidated sand and gravel deposits. The underlying or exposed Piedmont bedrock is the Wissahickon Formation, a metamorphic gneiss of late Precambrian age. The upper 50 to 70 feet of the Wissahickon gneiss has been highly weathered to a clayey saprolite material that retains the character of the parent material but is unconsolidated. This saprolite is considered a separate lithologic unit. The Wissahickon gneiss and saprolite together account for at least 50 percent of the exposed formations at the former NSWC-White Oak. The gneiss tends only to crop out in or near the Paint Branch channel where overlying sediments have been removed by erosion.

The facility soils, with the exception of streambed soils, tend to be moderately to excessively well drained and moderately to severely eroded. The soils generally fall within one of two major associations present in the vicinity: the Glenelg-Manor-Chester (GMC) association and the Chillum-Beltsville-Croom (CBC) association. The GMC association is developed in materials weathered from Piedmont metamorphic rocks, and the CBC association is derived from Coastal Plain materials. Soils at the facility tend to be moderately acidic, with a pH range ranging from 4 to 6 Standard Units (SUs). This may be due to the presence of hydroxyl, humic, and fulvic acids derived from the decay of organic matter. As shown on

Figure 2-2, the majority of OU2 is Glenelg-Manor-Chester silt loam (2C), with Blacktown Channery silt loam (116E) along the unnamed stream. Both soils are typically well drained, with moderate permeability.

2.2.1 Site 1 - Parking Lot Landfill

As evidenced by observations made during temporary well point placement and test pit excavation, the Parking Lot Landfill consists mostly of fill comprised of sandy clay with a silty component and some gravel. Native materials at the base of the test pits was typically tan silty clay, with saprolite at a depth of 7 feet in one test pit. Solid wastes, including wood, metal scraps, used equipment, tires, glass, shingles, and automotive batteries, are buried within the landfill.

2.2.2 Site 2 - Apple Orchard Landfill

The geology underlying Site 2 is derived from information collected from borings around the perimeter of the landfill and test pits along its northern edge. A north-south cross section of Site 2 is illustrated in Figure 2-3. The thickness of the landfill was estimated from the topography prior to landfill activities and the present topography. The landfill thickens from Perimeter Road at approximately 4 feet to 36 feet at the edge of the landfill plateau. Test pits along the northern perimeter and northeastern corner of the landfill revealed sand with silt, gravel, concrete, and asphalt as the fill material (Halliburton NUS, 1995c).

The native material surrounding the landfill consists of a thin mantle of soil resisting on the saprolite of the Wissahickon gneiss. The shallow surface material is variable, ranging from clayey silt to sandy silt to gravel with a thickness of 2 to 6 feet. The saprolite ranges in thickness from 8 feet along the unnamed stream to greater than 49 feet along the northern edge of the site.

Bedrock was encountered along the southern perimeter of the landfill approximately 10 feet below ground surface (bgs), and 30 feet bgs in the northwestern corner of the site.

2.3 HYDROGEOLOGY

2.3.1 Site 1 - Parking Lot Landfill

Five temporary well points were installed along the eastern and southern edges of the Parking Lot Landfill (Figure 2-4). The static water levels measured within these five temporary well points lies between 14 feet and 17 feet bgs. Differences among the static water levels in the five temporary wells, along with the locations of streams along the southern and eastern edges of the site, suggest that groundwater flows through the landfill material in a southeastward direction (Figure 2-4).

2.3.2 Site 2 - Apple Orchard Landfill

Groundwater at the site is unconfined and present in the saprolite and bedrock and, to a lesser extent, the surface soils along the drainage swale. Depth to the water table at Site 2 ranges from approximately 3 to 4 feet bgs along the toe of the landfill to 32.5 feet bgs along Perimeter Road.

Groundwater flows radially from the northwest corner of the site to the southeast, discharging to the unnamed stream. Figure 2-5 illustrates the potentiometric surface of the groundwater across Site 2. The hydraulic gradient steepens from approximately 0.04 across the surface of the landfill to 0.2 along its southern slope.

Malcolm-Pirnie calculated the mean hydraulic conductivity of the saprolite at Site 2 to be 2.35×10^{-3} cm/sec (6.66 feet/day) (Malcolm-Pirnie, 1992). Five wells installed for the RFI were also tested to determine hydraulic conductivity. The mean hydraulic conductivity of the saprolite (wells 2GW100 and 2GW101) was 3.38×10^{-3} cm/sec (9.58 feet/day) and for the bedrock (2GW102 and 2GW103) 2.70×10^{-5} cm/sec (7.66×10^{-2} feet/day) (TtNUS, 2000b).

2.4 SURFACE WATER HYDROLOGY

2.4.1 Site 1 - Parking Lot Landfill

An intermittent stream flows southward in the drainage swale located parallel to the eastern edge of the landfill. An unnamed stream, fed by culvert pipes east of Building 112 and 113 and the swale east of Site 1, flows eastward along the southern edge of the landfill. The stream and swale join near the southeastern corner of the landfill. The combined flow is directed eastward to Paint Branch, along the toe of the Apple Orchard Landfill.

2.4.2 Site 2 - Apple Orchard Landfill

Surface runoff from the landfill generally flows to the south into the adjacent unnamed stream. This stream is a gaining stream with groundwater discharging into the stream channel. In addition, surface water within the northwest portion of former NSWC White Oak is conveyed through the storm drains and discharged into this unnamed stream.

2.5 GEOPHYSICAL INVESTIGATION

2.5.1 Site 1 - Parking Lot Landfill

The Engineering Evaluation/Cost Analysis (EE/CA) at Site 1 (TtNUS, 2000a) included an electromagnetic (EM) terrain conductivity survey to map and delineate the lateral limits of buried wastes associated with the landfill. The survey was performed across the site and extended to the edge of the pavement along the eastern and southern boundaries. Thick brush and steep slopes prevented the survey boundaries from being extended in these areas. The grid spacing was 10 feet. A Geonics EM-31 Terrain Conductivity Meter (EM31) was used to measure the conductivity and magnetic susceptibility in the immediate vicinity of the instrument to a depth of approximately 10 feet.

The EM survey identified four anomalies that could be representative of buried metallic debris, deeply buried metal objects, fill materials that may contain metallic debris, or contaminated soils. One was believed to represent the approximate lateral extent of the landfill. A second anomaly was believed to represent the presence of buried metallic objects or containers within the landfill. The remaining anomalies were believed to represent the presence of clean sandy fill, or other resistive materials such as concrete debris. Other anomalies identified were determined to be the result of surface metallic debris, buried metallic pipes or utilities, or interference from nearby structures (TtNUS, 1999b).

2.5.2 Site 2 - Apple Orchard Landfill

An EM survey of Site 2 was completed in 1995 as part of the Design Verification Report (Halliburton NUS, June 1995) to define the northern boundary of Apple Orchard Landfill. The survey was conducted across the entire northern boundary and extended into the wooded area in the northeast portion of the site. The survey grid was approximately 50 feet wide and 650 feet long, with grid spacing of 10 feet. An EM-31 was used to measure the ground conductivity in the immediate vicinity of the instrument to a depth of approximately 10 feet. Readings from this instrument were recorded at two positions at each grid point (with the EM-31 pointing north-south and again pointing east-west). Any anomalous readings between grid points were noted and investigated further with the EM instrument (Halliburton NUS, June 1995)

Results of the EM survey did not clearly delineate the boundary of the landfill in the northern portion of the site along Perimeter Road. However, the lack of a measurable response with the EM measuring device appears to indicate landfill contents do not extend past Perimeter Road (Halliburton NUS, June 1995).

2.6 WASTE CHARACTERIZATION

2.6.1 Site 1 - Parking Lot Landfill

The wastes reportedly disposed within the Site 1 landfill include lubricating oil, battery acid, metal plating wastes, and metals scrap. It has been reported that approximately 60 automobile batteries were disposed at the site over its operating life.

Eleven test pits were excavated In April 1999 to a maximum depth of 9 feet bgs to identify the boundaries of the landfill and the depth of the waste. Figure 2-6 provides a site map showing the test pit locations and the boundary of the buried waste based on visual observations during test pit excavation activities. A dashed line is shown where this boundary is inferred. Test pit logs are provided in Appendix A. The majority of the area investigated contains municipal and low hazardous military waste. The depth to the top of the waste varies between 1 and 3 feet bgs and the depth of the bottom of the waste ranges between 3 and 6 feet bgs. Native soil was encountered at the bottom of each test pit, with the exception of test pit (TP) number 8 (TP-08).

TP-01 was excavated to a depth of 6 feet bgs in the southwestern corner of the site; some broken bricks were found between the surface and 1 foot bgs and a black ash layer was encountered throughout the test pit from 1 to 3 feet bgs. Native soil was found below this material.

TP-02 was comprised of two sections. The first section extended perpendicular to Building 111 in the north-central portion of the site; fuel and solvent odors were noted and reddish-brown soil was encountered at a depth of 3 to 4 feet bgs with natural soil at 5 feet bgs. The second section of TP-02 was excavated from the center of the paved area towards TP-08; a 5-inch thick concrete vault top, measuring 5 feet by 7 feet, was encountered 2 feet bgs as well as broken glass and wood debris. Native soil was encountered between 3 and 4 feet bgs.

TP-03 was located in the northwestern corner of the site and natural soil was found to its total depth of 3 feet bgs.

TP-04 was excavated to a depth of between 6 and 7 feet bgs beginning at Building 111; thin layers of black ash soil with intermixed blocks of asphalt were present as well as pieces of concrete, brick, and rebar. Fuel and solvent odors were noted and native soil was encountered at 5 feet bgs.

TP-05 was located in the northern portion of the site; small pieces of brick and blocks of asphalt were encountered throughout, to a depth of 4 feet bgs with native soil below.

TP-06 was excavated to a depth of 6.5 feet bgs in the northern corner of the site; asphalt blocks, concrete, and small pieces of brick and glass were encountered between 1 and 4 feet bgs with native soil at 4 feet bgs.

TP-07 was located perpendicular to the eastern boundary of the site and had a varied depth between 6 and 8 feet bgs; red bricks, concrete blocks, and tile were encountered from 1 to 3 feet bgs and part of a telephone pole, pieces of wood and metal, cans, rags, and battery packs were encountered between 3 and 6 feet bgs with native soil being encountered at approximately 6 feet bgs.

Large ordnance items were found in TP-08 between 0.5 and 3 feet bgs, which were removed from the site and stored for disposal. Two anomalies identified during the EM study, were in the approximate location of TP-08. In addition, two metal containers filled with batteries were found 1-foot bgs and pieces of glass, concrete, and fire brick were also encountered.

TP-09 was excavated along the southern site boundary to a depth ranging from 6 to 8 feet bgs; black ash, burned wood, tile, brick, red clay pipe, glass, and battery packs were encountered.

TP-10 was excavated perpendicular to the southern site boundary; layers of black ash and glass were encountered between 2 and 3 feet bgs with native soil at 4 feet bgs.

The northernmost portion of TP-11 was excavated to a depth of 3.5 feet bgs and the remaining portion to a depth of 6 feet; metal containers, pieces of metal, glass, wood, and plastic were found between 3 and 6 feet bgs with native material below this depth.

Toxicity Characteristic Leaching Procedure (TCLP) results for soil samples collected at Site 1 indicate that fill material at Site 1 is unlikely to be classified as hazardous (TtNUS, 1999b).

Based on the results of the streamlined risk evaluation conducted in the EE/CA for Site 1, risks are unacceptable for residential exposure to surface soil. The primary contributors are iron and carcinogenic PAHs (TtNUS, 1999b).

2.6.2 Site 2 - Apple Orchard Landfill

Wastes reportedly disposed at Site 2 included domestic refuse, oils containing PCBs, solvents, paint residue, acids and miscellaneous compounds. An estimated 500 gallons of PCB-contaminated oils were deposited at the site prior to 1970.

Seven test pits were placed along the north and east perimeter of Site 2 in 1995 in an attempt to define the limits of waste placement at the landfill. During the prior site reconnaissance, potential unexploded ordnance (UXO) hazards were observed in the face along the toe of the landfill. Accordingly a Halliburton NUS UXO specialist screened all locations prior to and during intrusive work to avoid contact with potential UXO hazards. The UXO specialist surveyed the test pit locations with a magnetometer at 2 foot depth intervals. The test trenches were excavated with a backhoe at the locations identified on Figure 2-5. Test pit logs are provided in Appendix A (Halliburton NUS, June 1995).

Test pits were excavated to a depth of approximately five feet. Fill and disturbed earth were encountered along the Perimeter Road and along the tree line to the east of the site. A small undisturbed, wooded area was located south of Perimeter Road (Halliburton NUS, June 1995).

TP-01 was excavated on the eastern boundary of the site to a total depth of 3 feet bgs; only natural material consisting of organics and roots were encountered. TP-02 was located to the north of TP-01 and excavated to a total depth of 3 feet bgs; concrete/asphalt pieces were found throughout. TP-03 was excavated adjacent to Perimeter Road and north of TP-02; only natural soil was found to a total depth of 3 feet. Concrete pieces and asphalt were encountered 2.5 feet bgs at TP-04 with clean fill above 2.5 feet. TP-05 and TP-06 were excavated within the boundary of Site 2 to a depth of 4 feet and 5 feet bgs, respectively; fill and natural soil were encountered within the test pit excavations. TP-07 was excavated on the western boundary of the landfill to a depth of 5 feet bgs; fill material consisting of gravel and sand with asphalt pieces was found throughout.

Based on the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for Site 2 (TtNUS 200b), elevated risks were estimated for construction workers, day care center children, and child and adult residents. The primary contributors to the elevated risks for exposure to soil and sediment were due to polycyclic aromatic hydrocarbons (PAHs), PCBs, manganese and arsenic.

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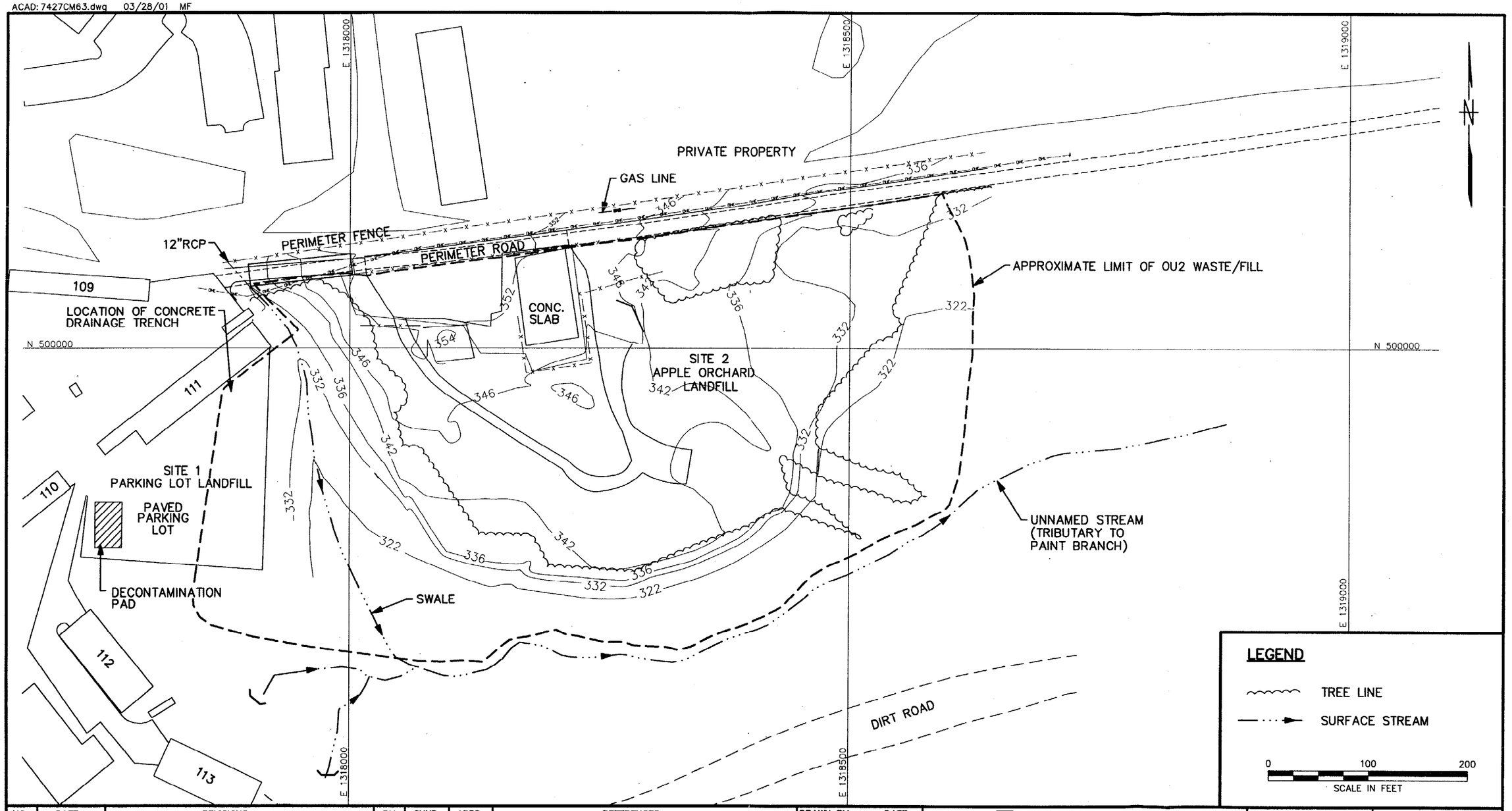


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/14/00
CHECKED BY DATE 3/29/01
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

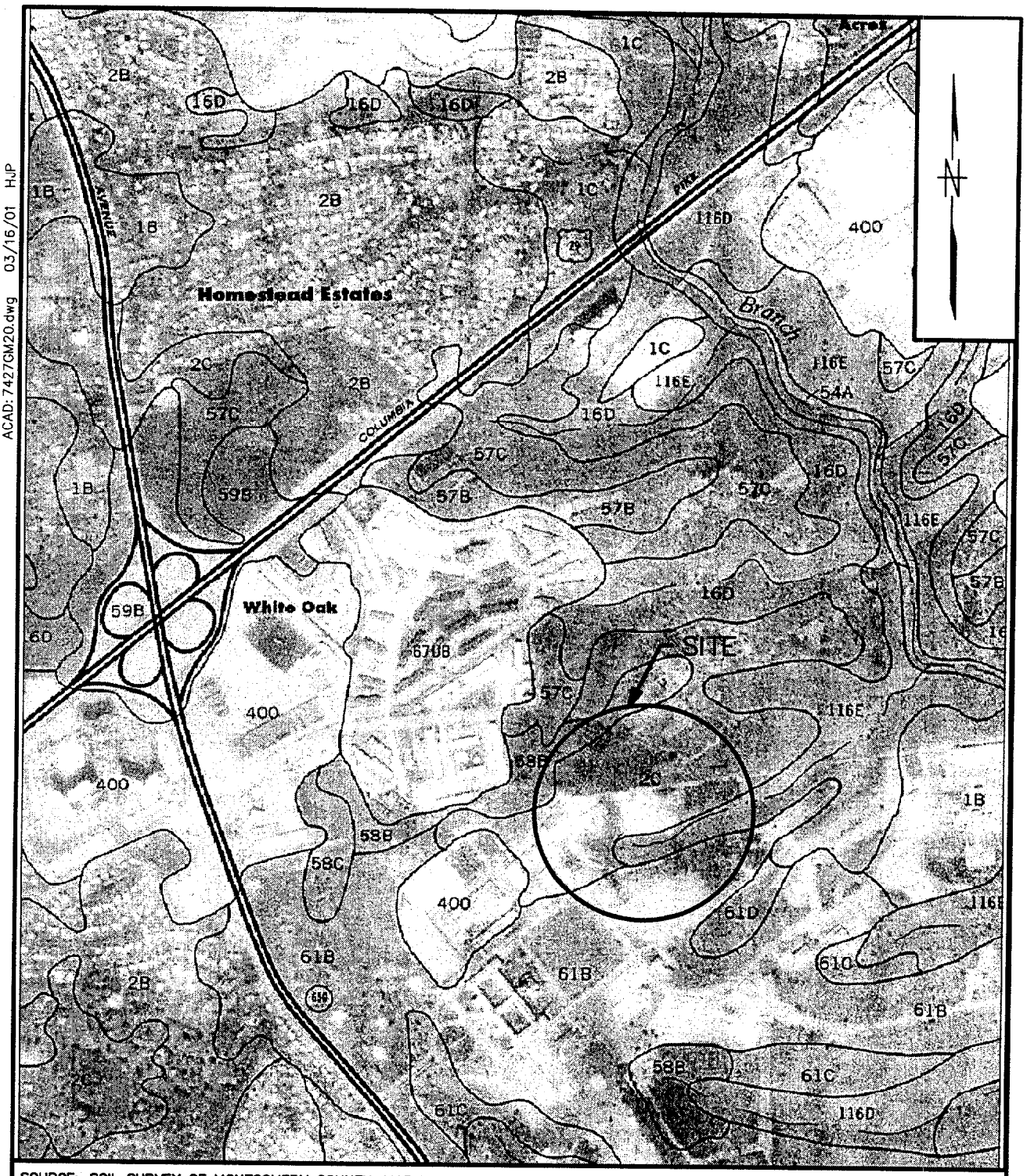
SITE LAYOUT MAP
OPERABLE UNIT 2
FORMER NSWC – WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 0273
APPROVED BY SN DATE 3/29/01
APPROVED BY DATE
DRAWING NO. FIGURE 2–1
REV. 0

FORM CADD NO. T+NUS_BH.DGN - REV 0 - 1/20/98

00162D032

ACAD: 7427GM20.dwg 03/16/01 HJP



SOURCE: SOIL SURVEY OF MONTGOMERY COUNTY, MARYLAND 1995

DRAWN BY HJP DATE 11/17/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7427	OWNER NO. 0273
CHECKED BY DATE 3/30/01	SOILS MAP OPERABLE UNIT 2 FORMER NSWC – WHITE OAK SILVER SPRING, MARYLAND	APPROVED BY SN	DATE 3/30
COST/SCHED-AREA		APPROVED BY	DATE
SCALE NOT TO SCALE		DRAWING NO. FIGURE 2-2	REV. 0

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

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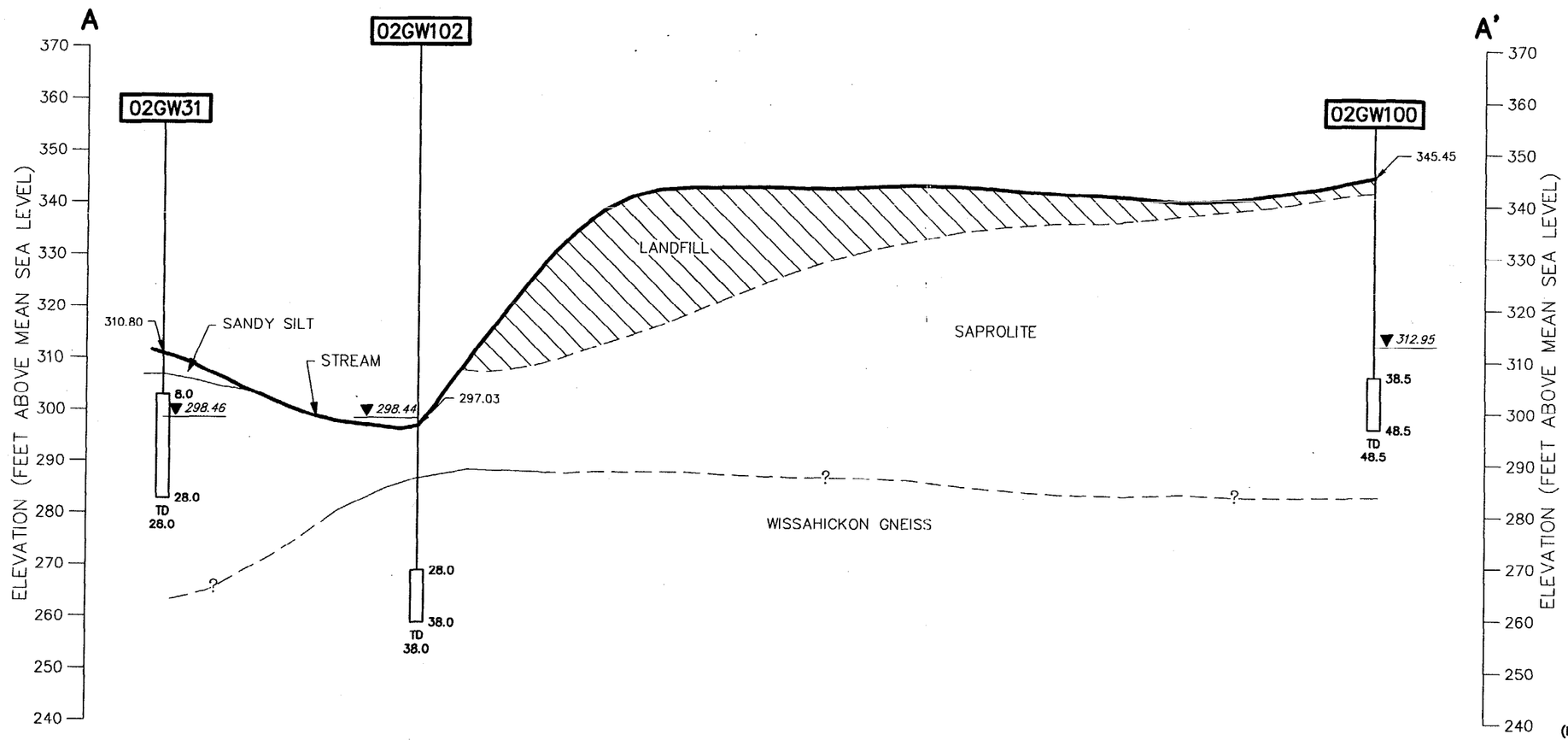

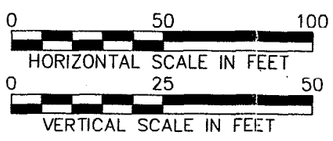

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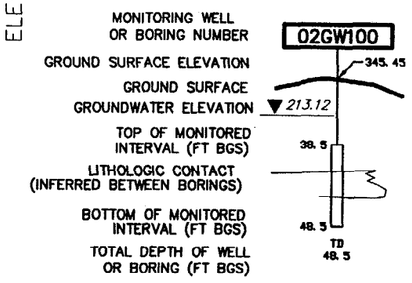


NOTE:

DEPTH OF LANDFILL BOTTOM ESTIMATED FROM TOPOGRAPHY PRIOR TO FILL ACTIVITIES (NAVAL ORDNANCE LABORATORY MAP QYC 907-52)

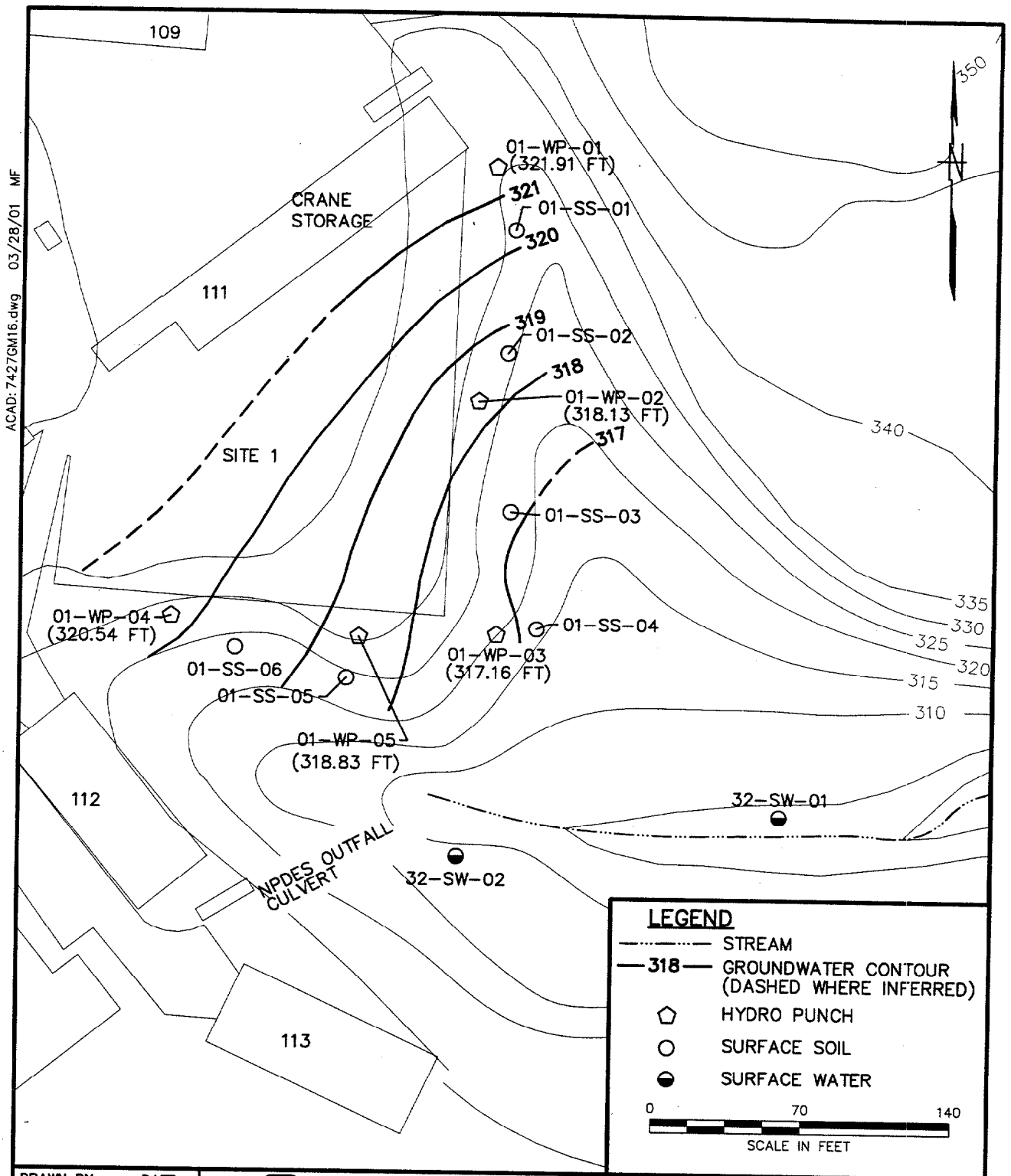
LOCATON OF CROSS SECTION ILLUSTRATED ON FIGURE 2-5.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP	DATE 11/13/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7427 / OWNER NO. 0273
CHECKED BY	DATE 3/30/01	CROSS SECTION A-A' OPERABLE UNIT 2 FORMER NSWC WHITE OAK SILVER SPRING, MARYLAND	APPROVED BY / DATE 3/30
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-3 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 0 - 9/9/98

00162D042



ACAD: 7427GM16.dwg 03/28/01 MF

DRAWN BY HJP DATE 11/13/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7427	OWNER NO. 0273
CHECKED BY TWS DATE 3/29/01	SITE 1 GROUNDWATER CONTOURS OPERABLE UNIT 2 FORMER – NSWC WHITEOAK SILVER SPRING, MARYLAND	APPROVED BY SJ	DATE 3/29/01
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 2-4	REV. 0

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

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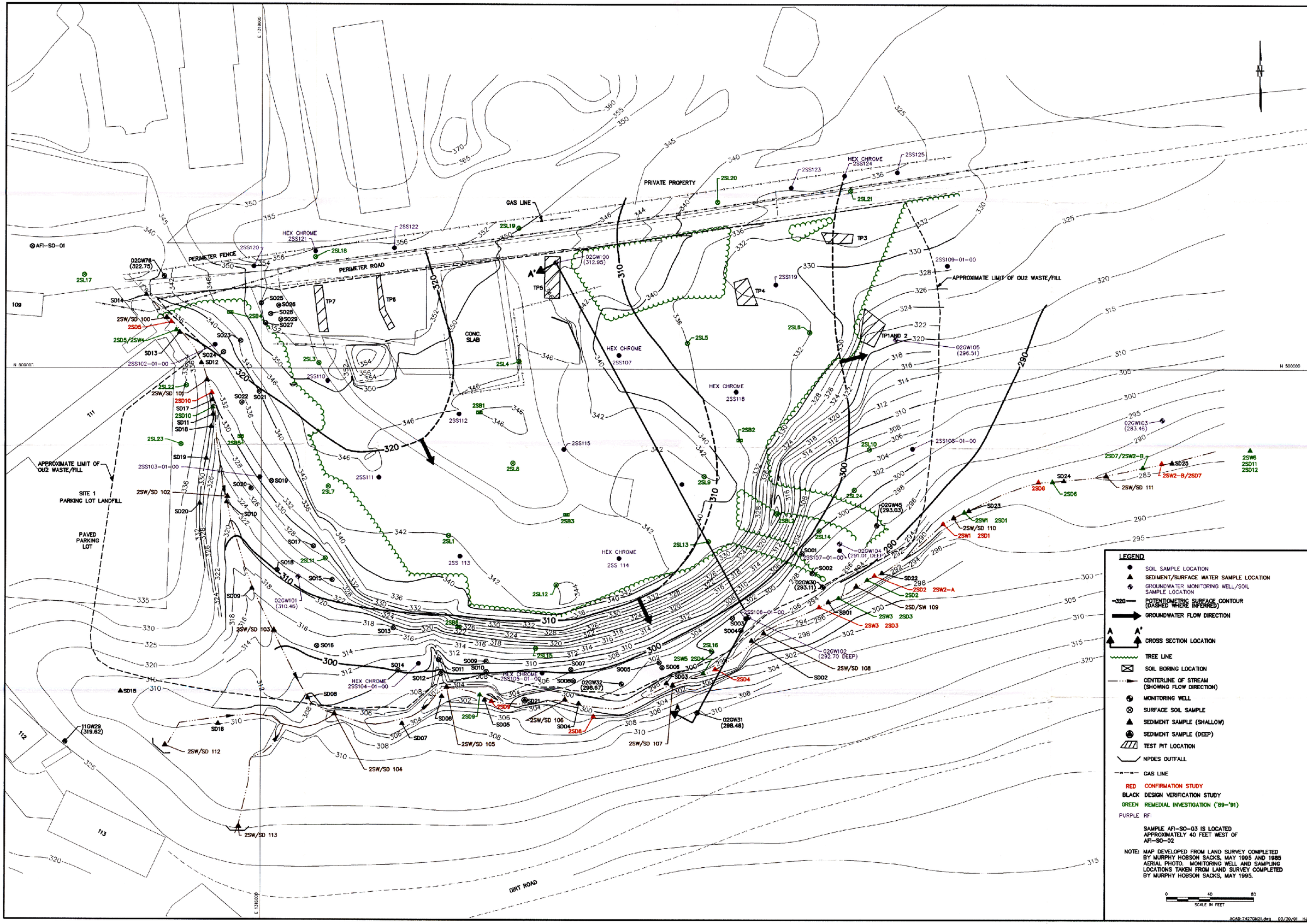

SYMBOL	DESCRIPTION	DATE	APPROVED
D9A	403		
D4	404		
E.I.C.	405		
401	406		
402	1418	DATE	REVIEWED BY RCCC

REVISIONS

DES. DR. A.P. SUBMITTED BY: SAN TITLE CHIEF, PROGRAM MANAGER DATE 3/30/01 DATE APPROVED DATE

EFD FOR COMMANDER NAVFAC

SEAL AREA

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND — CHESAPEAKE DIVISION — WASHINGTON, D.C.

SITE 2 – LAYOUT AND SAMPLE LOCATION MAP
OPERABLE UNIT 2
FORMER NSWC–WHITE OAK
SILVER SPRING, MARYLAND

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
SPEC.
NAVFAC DRAWING NO.
SHEET OF

FIG. 2–5

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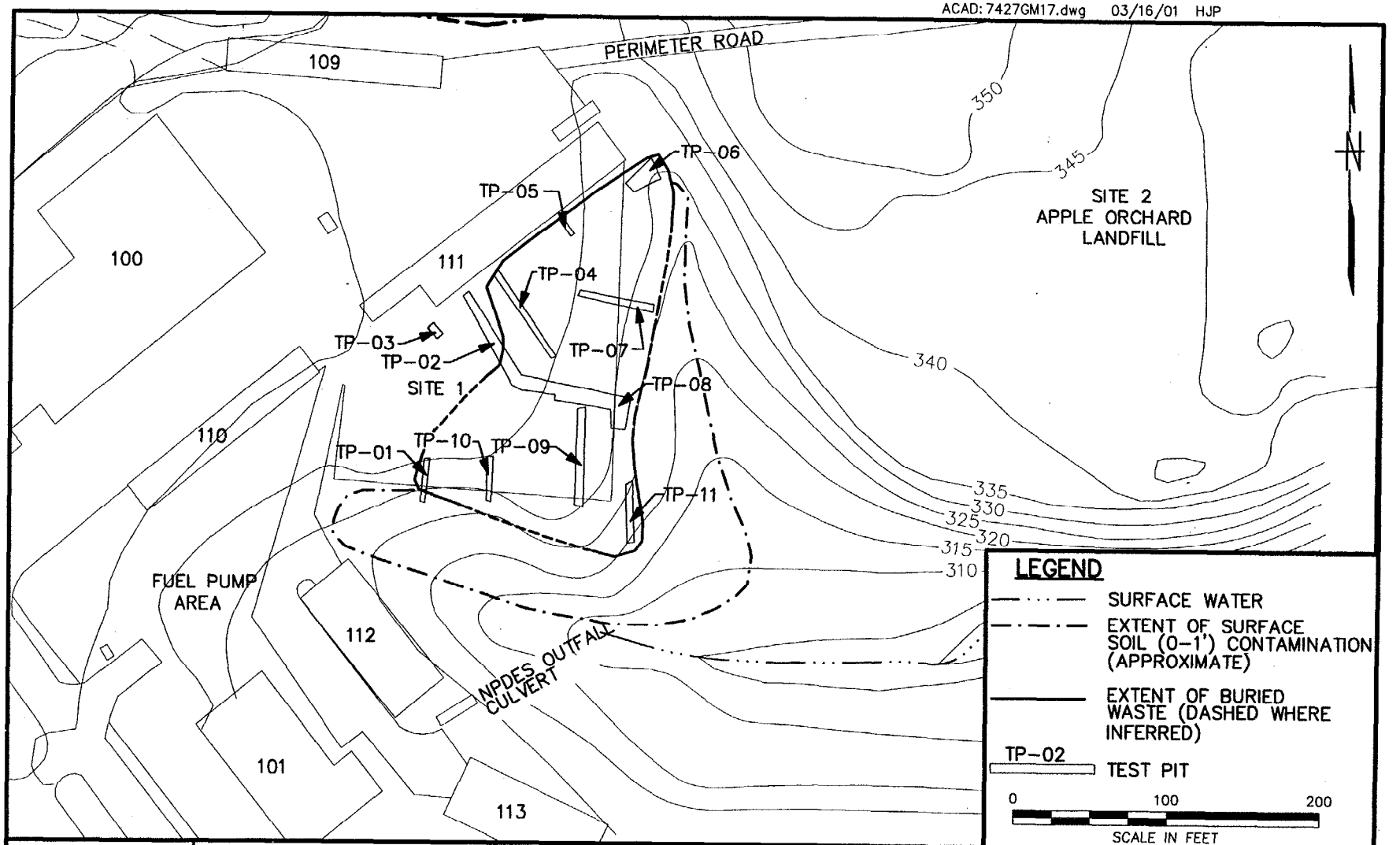

DRAWN BY HJP DATE 11/13/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7427	OWNER NO. 0273
CHECKED BY DATE	TEST PIT LOCATIONS AND EXTENT OF BURIED WASTE OPERABLE UNIT 2 FORMER NSWC – WHITE OAK SILVER SPRING, MARYLAND	APPROVED BY	DATE
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 2-6	REV. 0

FORM CADD NO. TtNUS_AH.DWG - REV 0 - 1/22/98

3.0 DESIGN VERIFICATION STUDY AND PRE-DESIGN INVESTIGATION SUMMARIES

The objective of the design verification study conducted in 1995 was to further define the scope of the remedial action proposed at Site 2 in the draft Feasibility Study (Malcolm-Pirnie, 1993). The objective of the pre-design investigation conducted December 2000 was to determine the extent of landfilled material at OU2 to the east, and to evaluate the possibility of using onsite soil for borrow material. The pre-design investigation results have been used to augment the OU2 closure design effort described in Section 4.0. The design verification study field activities are described in Section 3.1. The pre-design investigation results are described in Section 3.2.

3.1 DESIGN VERIFICATION STUDY FIELD ACTIVITIES

Halliburton NUS conducted a design verification study at Site 2 in 1995 to support engineering design activities. In order to determine the location and extent of waste along the northern and eastern boundary of the landfill, an EM survey and subsurface trenching were performed at the site. In addition, to determine the extent of PCB contamination above proposed site action levels, surface soil and sediment samples were collected and analyzed.

3.1.1 Design Verification Study Results

The results of the EM survey and subsurface trenching are summarized previously in Sections 2.5.2 and 2.6.2, respectively.

Surface Soil Samples

To determine the extent of PCB contamination in surface soil between the unnamed tributary to Paint Branch and the landfill, twenty-four surface soil samples (02-SO-01 through 02-SO-24) were collected on transects spaced approximately 80 feet apart along the base of the landfill. At each sample transect, two surface samples were taken between the edge of the landfill and the stream bed. One sample was collected immediately below the break in slope, at the interface of fill and natural material. The second sample was collected half-way between the first sample and the stream bed. In addition, five surface soil samples (02-SO-25 through 02-SO-29) were collected in the vicinity of the former waste oil storage tank in the northwest corner of the landfill. The locations of surface soil samples are shown in Figure 2-5.

Surface soil samples were collected from the top three inches of soil and consisted of a composite of five points within a two foot radius. Samples were tested for PCBs (Aroclor 1260) using Ensys RIS$^{\underline{C}®}$ Soil

field screening kits. In addition to field screening tests, two duplicate surface soil samples (02-SO-21 and 02-SO-28) were sent to a fixed based laboratory for analysis of target compound list (TCL) PCBs to confirm field screening results. Table 3-1 (page 2 of 2) provides a summary of the surface soil test kit results, and Table 3-3 presents a comparison of the test kit and analytical laboratory results.

Elevated PCB contamination in the surface soils is predominantly found in the northwest face of the landfill (samples 02-SO-21 through 02-SO-24). A single detection of elevated PCB contamination was found in 02-SO-13 located on the southwestern slope of the landfill. These sample locations are downgradient of an alleged former PCB storage tank area. In addition, surface samples collected in the vicinity of the former PCB storage tank area (02-SO-25 through 29) exhibited elevated concentrations of Aroclor 1260. No PCB contamination was identified in surface soil samples collected off-site.

Stream Sediment Samples

To determine the extent of PCB contamination within the streambed, 25 sediment samples (02-SD-01 through 02-SD-25) were collected on sampling transects approximately 80 feet apart along the unnamed stream at the base of Site 2. Sampling locations included drainage ditches, which originate near the maintenance buildings west of the landfill.

Sediment samples were collected from the top of the sediment layer (0.0 to 0.5 feet bgs). Only one sample, 02-SD-21, was collected at depth in the sediment layer (1.5 to 2.0 feet bgs). Sediment samples were tested for PCBs (Aroclor 1260) using Ensys RISC® Soil field screening kits. In addition to field screening tests, seven duplicate sediment samples (02-SD-02, 02-SD-05, 02-SD-06, 02-SD-07, 02-SD-11, 02-SD-19, and 02-SD-23) were sent to a fixed based laboratory for analysis of TCL PCBs to confirm field screening results. Table 3-1 (page 1 of 2) provides a summary of the test kit results. Table 3-2 provides a summary of the analytical laboratory results, and Table 3-3 presents a comparison of the field and laboratory results.

To calculate the average carbon content for use in determining PCB action levels, four sediment samples (02-SD-05, 02-SD-10, 02-SD-15, and 02-SD-20) were analyzed for total organic carbon (TOC). In addition, these samples were analyzed for total volatile solids (TVS) and total solids (TS) to aid in the evaluation of treatment technologies for sediment remediation if necessary.

In an attempt to identify the presence of off-site sources for PCB contamination, three surface soil samples were collected on the property to the north of the Apple Orchard Landfill. The samples were collected in the vicinity of a stormwater retention pond located on the property. An apartment complex has been constructed on this property, and site drainage patterns appear to have been altered compared

with previous conditions identified on aerial photographs. The sampling locations are shown on Figure 2-5. The samples were collected and analyzed for Pesticide/PCBs at a fixed based lab.

The results of the field test kits (Table 3-1) indicate that PCB contamination (> 0.4 ppm Aroclor 1260) in the stream sediments is prevalent in all sample locations, excluding 02-SD-06, 02-SD21 (deep sample), and 02-SD-25. Furthermore, PCB contamination in the sediment extends approximately 350 feet downstream of monitoring well 2GW30.

Data Validation

The results of laboratory analysis for the nine confirmatory samples and four TOC samples are summarized in Table 3-2. The results of the testing indicate that Aroclor 1260 was confirmed present in all samples analyzed. The concentrations of PCBs found during the laboratory analysis correlated well with the results found using the PCB field kit analysis. The comparison of the results is shown in Table 3-3. Two samples (02-SD-02 and 02-SO-21) were incorrectly identified as positive for PCBs (>4.0 ppm) utilizing the field screening analysis. However, the PCB field screening analysis did correctly identify those samples as being greater than 0.4 ppm.

Wetland and Forest Stand Investigation

A delineation of wetlands and other waters of the United States was completed for OU2 in 1995 (Halliburton NUS, 1995) using the routine, onsite procedures in the Corps of Engineers Wetlands Delineation Manual. Wetland boundaries were flagged and surveyed on the ground. The delineation revealed that waters of the United States were limited to areas within the steeply defined banks of the streams. No wetlands occur outside of the banks. The location of the delineated wetlands is provided in Figure 3-1.

In addition to the wetland delineation performed in 1995 a forest stand delineation was also completed in 1995 for the area adjoining the unnamed stream, and a benthic and fishery survey of the unnamed stream was conducted in 1992. The following is a summary of the findings of these investigation.

The results of the forest stand delineation indicates that adjoining the banks of the unnamed stream is deciduous forest dominated by tulip poplar (*Liriodendron tulipifera*) between 10 and 30 inches in diameter at breast height and red maple (*Acer rubrum*) increases in dominance close to the stream banks. Other canopy trees reported include red oak (*Quercus rubra*), white oak (*Quercus alba*), and Virginia pine (*Pinus virginiana*). The understory is described as containing scattered flowering dogwood (*Cornus florida*) saplings and spicebush (*Lindera benzoin*) shrubs. Japanes honeysuckle (*Lonicera japonica*), an invasive and exotic vine that compete with other vegetation was described as prevalent throughout much

of the forest. A 47-inch DBH tulip poplar, a 37-inch DBH white oak, and a 33-inch DBH red maple outside of the south bank of the unnamed stream were determined to meet the State of Maryland's definition of a specimen tree (individually outstanding tree) (Halliburton NUS, 1995).

The results of the benthic and fishery survey of the unnamed stream indicated that benthic organisms were found in two samples collected from an upstream location. These organisms included six Annelids including one Tubificid worm, one *Copepoda*, and one Chironomid midge. Benthic organisms found in two samples collected from a midstream location included three Annelids, two Tubificid worms, two oligochaete worms, one *Diplopoda*, and one crane fly (*Tipula*). Benthic organisms found in two samples collected from a downstream location included two Annelids, 44 oligochaete worms, one *Brychius*, 18 *Tipulidae*, three caddisfly larvae (*Cheumatopsyche* sp.), one chironomid midge larva, and one dance fly larva (*Phylodronia* sp.). The prevalence of oligochaete worms suggests impaired water quality (Malcolm Pirnie, 1992). The only fish found in the unnamed stream during the survey were black-nose dace. The report speculates that the paucity of fish in the stream may be the result of the shallow water depth, impaired water quality, inadequate riparian cover, and/pr lack of riffle and pool complexes (Malcolm Pirnie, 1992).

Water Level Measurements

One round of synoptic groundwater elevations were measured at five monitoring wells during implementation of the DVSAP to be used to determine groundwater flow directions in the vicinity of Site 2. Water levels were measured from all facility wells during an eight hour period of consistent weather conditions (March 29, 1995) to minimize atmospheric/precipitation effects on groundwater levels. Measurements were taken with an electronic water level indicator using the top of the open well casing as the reference point for determining depths to water. Groundwater level measurements were recorded to the nearest 0.01 foot. Further groundwater level measurements have been made in association with Remedial Investigation (RI) completed at Site 2. Similar groundwater depths and flow directions were observed during the verifications study and RI. Table 3-4 presents the groundwater level measurements collected for OU2.

Site Mapping and Surveying

Test pits, monitoring well, surface soil sample, and sediment sample locations have been surveyed by a surveyor licensed in the state of Maryland. The surveyed location of all samples, test pits, and existing monitoring wells are shown on Figure 2-5.

In addition, detailed topographic mapping of the Apple Orchard Landfill and its surroundings was completed. The topographic survey identifies significant details including wooded areas, roadways, and

fence lines. The results of the topographic survey are shown on the Existing Conditions Plan (Design Drawing C-1)

3.1.2 Conclusions

Based on the data acquired during the Design Verification Study, Halliburton NUS recommended modifying the approach proposed in the FS. The following summarizes the additional information that was gathered during the study:

- PCB contamination was detected in stream sediments to a distance approximately 350 feet downstream of the landfill. Removal of contaminated stream sediments and capping of the site was believed to minimize further PCB contamination of the stream and soils adjacent to the landfill.

- To minimize future landfill contaminant migration off-site, capping of the landfill was proposed. Cap components would be evaluated in the alternative analysis.

- No significant groundwater contamination was identified. It is expected that construction of the landfill cap and removal of contaminated stream sediments will minimize the potential for groundwater contamination.

3.2 PRE-DESIGN INVESTIGATION FIELD ACTIVITIES

In December 2000, a limited test pit program was conducted at OU2 to assist in the identification of the limit of landfill waste and potential borrow materials for use in the cap construction. The program consisted of the excavation of three test pits along the eastern perimeter of the operable unit at the approximate locations identified on Figure 3-1. The test pits were excavated to depths ranging between three to five feet. While surface debris (i.e., bottles, cans) was evident on the ground surface near the test pits, the subsurface at each test pit was found to be free of fill/waste. From these observations and the prior test pit placement at Sites 1 and 2, the limit of waste/fill at OU2 does not extend beyond the limits identified on the design drawings.

The subsurface soil consisted primarily of silty sand and silty loam. Weathered bedrock was encountered at depths of five feet in test pit 3, but was not encountered in test pits 1 and 2. A soil sample was collected from each test pit and grain-size analyses were performed on each. The grain-size analyses are included in Appendix B. From a review of the grain-size analyses, the soils may be considered for use in the intermediate cover during cap construction. Additional geotechnical testing would be required to verify this assumption.

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TABLE 3-1

SITE 2
APPLE ORCHARD LANDFILL
DVSAP PCB FIELD SCREENING RESULTS
NSWC - WHITE OAK
PAGE 1 OF 2

STREAM SEDIMENT SAMPLES			
Sample	Aroclor 1260 < 0.4 ppm	Aroclor 1260 > 0.4 ppm; < 4.0 ppm	Aroclor 1260 > 4.0 ppm
02-SD-01			X
02-SD-02			X
02-SD-03			X
02-SD-04			X
02-SD-05		X	
02-SD-06	X		
02-SD-07		X	
02-SD-08			X
02-SD-09			X
02-SD-10			X
02-SD-11			X
02-SD-12			X
02-SD-13		X	
02-SD-14		X	
02-SD-15			X
02-SD-16			X
02-SD-17		X	
02-SD-18			X
02-SD-19			X
02-SD-20		X	
02-SD-21	X		
02-SD-22			X
02-SD-23		X	
02-SD-24			X
02-SD-25	X		

TABLE 3-1

SITE 2
APPLE ORCHARD LANDFILL
DVSAP PCB FIELD SCREENING RESULTS
NSWC - WHITE OAK
PAGE 2 OF 2

SURFACE SOIL SAMPLES			
Sample	Aroclor 1260 < 0.4 ppm	Aroclor 1260 > 0.4 ppm; < 4.0 ppm	Aroclor 1260 > 4.0 ppm
02-SO-01		X	
02-SO-02		X	
02-SO-03	X		
02-SO-04	X		
02-SO-05		X	
02-SO-06		X	
02-SO-07		X	
02-SO-08		X	
02-SO-09	X		
02-SO-10	X		
02-SO-11	X		
02-SO-12	X		
02-SO-13			X
02-SO-14		X	
02-SO-15		X	
02-SO-16		X	
02-SO-17	X		
02-SO-18		X	
02-SO-19	X		
02-SO-20	X		
02-SO-21			X
02-SO-22			X
02-SO-23			X
02-SO-24			X
02-SO-25		X	
02-SO-26			X
02-SO-27			X
02-SO-28		X	
02-SO-29			X

TABLE 3-2

SITE 2
APPLE ORCHARD LANDFILL
DVSAP ANALYTICAL RESULTS
NSWC - WHITE OAK
PAGE 1 OF 3

Parameter	02-SD-02		02-SD-05		02-SD-06		02-SD-07		02-SD-10		02-SD-11	
Pesticides/PCBs (ug/Kg)												
AROCLOR 1016	ND		ND		ND		ND		NA		ND	
AROCLOR 1221	ND		ND		ND		ND		NA		ND	
AROCLOR 1232	ND		ND		ND		ND		NA		ND	
AROCLOR 1242	ND		ND		ND		ND		NA		ND	
AROCLOR 1248	ND		ND		ND		ND		NA		ND	
AROCLOR 1254	ND		ND		ND		ND		NA		ND	
AROCLOR 1260	*1,247		*1,063		380		622		NA		143,000	
HEPTACHLOR EPOXIDE	NA		NA		NA		NA		NA		NA	
DIELDRIN	NA		NA		NA		NA		NA		NA	
4,4'-DDE	NA		NA		NA		NA		NA		NA	
4,4'-DDT	NA		NA		NA		NA		NA		NA	
MISCELLANEOUS												
TOTAL ORGANIC CARBON (mg/Kg)	NA		2,750		NA		NA		1,660		NA	
TOTAL SOLIDS (%)	86.6		87.6		77.8		82.8		93.7		81.7	
TOTAL VOLATILE SOLIDS (%)	NA		17.4		NA		NA		2.31		NA	

ND - Not Detected
NA - Not Analyzed
* - Result taken from dilution analysis
J - Positive result is considered estimated

TABLE 3-2

SITE 2
APPLE ORCHARD LANDFILL
DVSAP ANALYTICAL RESULTS
NSWC - WHITE OAK
PAGE 2 OF 3

Parameter	02-SD-15		02-SD-19		02-SD-20		02-SD-23		02-SO-21	
Pesticides/PCBs (ug/Kg)										
AROCLOR 1016	NA		ND		NA		ND		ND	
AROCLOR 1221	NA		ND		NA		ND		ND	
AROCLOR 1232	NA		ND		NA		ND		ND	
AROCLOR 1242	NA		ND		NA		ND		ND	
AROCLOR 1248	NA		ND		NA		ND		ND	
AROCLOR 1254	NA		ND		NA		ND		ND	
AROCLOR 1260	NA		47,100		NA		*1,146		477	
HEPTACHLOR EPOXIDE	NA		ND		NA		NA		NA	
DIELDRIN	NA		ND		NA		NA		NA	
4,4'-DDE	NA		ND		NA		NA		NA	
4,4'-DDT	NA		ND		NA		NA		NA	
MISCELLANEOUS										
TOTAL ORGANIC CARBON (mg/Kg)	10,300		NA		20,100		NA		NA	
TOTAL SOLIDS (%)	60.5		70.5		80.8		74		67.1	
TOTAL VOLATILE SOLIDS (%)	10.4		NA		7.69		NA		NA	

ND - Not Detected
NA - Not Analyzed
* - Result taken from dilution analysis
J - Positive result is considered estimated

TABLE 3-2

SITE 2
APPLE ORCHARD LANDFILL
DVSAP ANALYTICAL RESULTS
NSWC - WHITE OAK
PAGE 3 OF 3

Parameter	02-SO-28		AFI-SO-01		AFI-SO-01-D		AFI-SO-02		AFI-SO-03	
Pesticides/PCBs (ug/Kg)										
AROCLOR 1016	ND		ND		ND		ND		ND	
AROCLOR 1221	ND		ND		ND		ND		ND	
AROCLOR 1232	ND		ND		ND		ND		ND	
AROCLOR 1242	ND		ND		ND		ND		ND	
AROCLOR 1248	ND		ND		ND		ND		ND	
AROCLOR 1254	ND		ND		ND		ND		ND	
AROCLOR 1260	1,840	J	ND		ND		ND		ND	
HEPTACHLOR EPOXIDE	NA		ND		ND		0.710	J	ND	
DIELDRIN	NA		ND		ND		0.930	J	ND	
4,4'-DDE	NA		0.83	J	0.75	J	1.60	J	ND	
4,4'-DDT	NA		ND		ND		1.70	J	ND	
MISCELLANEOUS										
TOTAL ORGANIC CARBON (mg/Kg)	NA		NA		NA		NA		NA	
TOTAL SOLIDS (%)	83.5		83.5		83.5		83.5		83.5	
TOTAL VOLATILE SOLIDS (%)	NA		NA		NA		NA		NA	

ND - Not Detected
NA - Not Analyzed
* - Result taken from dilution analysis
J - Positive result is considered estimated

TABLE 3-3

SITE 2
APPLE ORCHARD LANDFILL
PCB FIELD KIT AND LABORATORY ANALYSIS
DVSAP RESULTS
NSWC - WHITE OAK

Sample ID Number	Sample Date	Ensys PCB Field Kit (1) Aroclor 1260 (ppm)	"Laboratory" GP Environmental Organic Aroclor 1260 (ppm)	Comments
02-SD-02	3/21/95	> 4.0	1.247	False Positive for greater than 4.0 ppm (3)
02-SD-05	3/22/95	> 0.4 but < 4.0	2.750	
02-SD-06	3/22/95	< 0.4	0.379	
02-SD-07	3/22/95	> 0.4 but < 4.0	0.622	
02-SD-11	3/23/95	> 0.4	143	
02-SD-19	3/27/95	> 4.0	47.1	
02-SD-23	3/27/95	> 0.4 but < 4.0	1.146	
02-SO-21	3/23/95	> 0.4	0.477	False Positive for greater than 4.0 ppm (3)
02-SO-28	3/24/95	> 0.4 but < 4.0	1.84	
04-SB09-0209	3/27/95	< 0.4	0.239	

1 For the purpose of this investigation, the Ensys PCB Field Kits were pre-packaged for analysis of Aroclor 1260 at concentrations less than 0.4 ppm, between 0.4 and 4.0 ppm, and greater than 4.0 ppm. The Ensys PCB Field Kits provide semi-quantitative measurement of PCB concentration.

2 Analysis using EPA SOW 3/90.

3 Ensys Field Kit successfully identified Aroclor 1260 at a concentration greater than 0.4 ppm in the sample. However, the field analysis indicated Aroclor 1260 concentrations were greater than 4.0 ppm (False Positive).

TABLE 3-4

SUMMARY OF GROUNDWATER LEVEL MEASUREMENTS
OPERABLE UNIT 2
NSWC-WHITE OAK
SILVER SPRING, MARYLAND

Well Number	Elevation of Top of Riser (ft msl)	Elevation of Ground Surface (ft msl)	Elevation of Screened Interval (bgs)	1986		November-97		March-99	
				Depth to Groundwater (ft bTOR)	Groundwater Elevation (ft msl)	Depth to Groundwater (ft bTOR)	Groundwater Elevation (ft msl)	Depth to Groundwater (ft bTOR)	Groundwater Elevation (ft msl)
Site 1 (1)									
01-WP-01	337.51	335.51	13.0 - 23.0	NA	NA	15.60	321.91	NA	NA
01-WP-02	336.78	334.78	13.0 - 23.0	NA	NA	18.65	318.13	NA	NA
01-WP-03	335.14	333.14	13.0 - 23.0	NA	NA	17.98	317.16	NA	NA
01-WP-04	338.64	336.64	13.0 - 23.0	NA	NA	18.10	320.54	NA	NA
01-WP-05	337.53	335.53	13.0 - 23.0	NA	NA	18.70	318.83	NA	NA
Site 2 (2)									
02GW30	299.10	296.19	2 - 17	5.22	293.88	NA	NA	5.99	293.11
02GW31	314.06	310.80	8 - 28	12.87	301.19	NA	NA	15.60	298.46
02GW32	305.13	302.60	5 - 20	6.06	299.07	NA	NA	6.46	298.67
02GW45	298.43	295.96	6.5 - 9.5	NA	NA	NA	NA	5.40	293.03
02GW76	341.82	341.20	28 - 38	NA	NA	NA	NA	19.07	322.75
02GW100	346.59	345.45	38.5 - 48.5	NA	NA	NA	NA	33.64	312.95
02GW101	323.19	320.67	15 - 25	NA	NA	NA	NA	10.41	312.78
02GW102	298.44	297.03	28 - 38	NA	NA	NA	NA	5.74	292.70
02GW103	299.37	296.64	15 - 25	NA	NA	NA	NA	15.91	283.46
02GW104	297.41	295.79	25 - 35	NA	NA	NA	NA	6.40	291.01
02GW105	320.89	319.29	28 - 38	NA	NA	NA	NA	24.38	296.51

Notes:
1 See Figure 2-4 for well locaitons.
2 See Figure 2-5 for well locaitons.
msl - mean sea level (National Geodetic Vertical Datum, 1929)
bTOR - below Top of Riser
NA - not available

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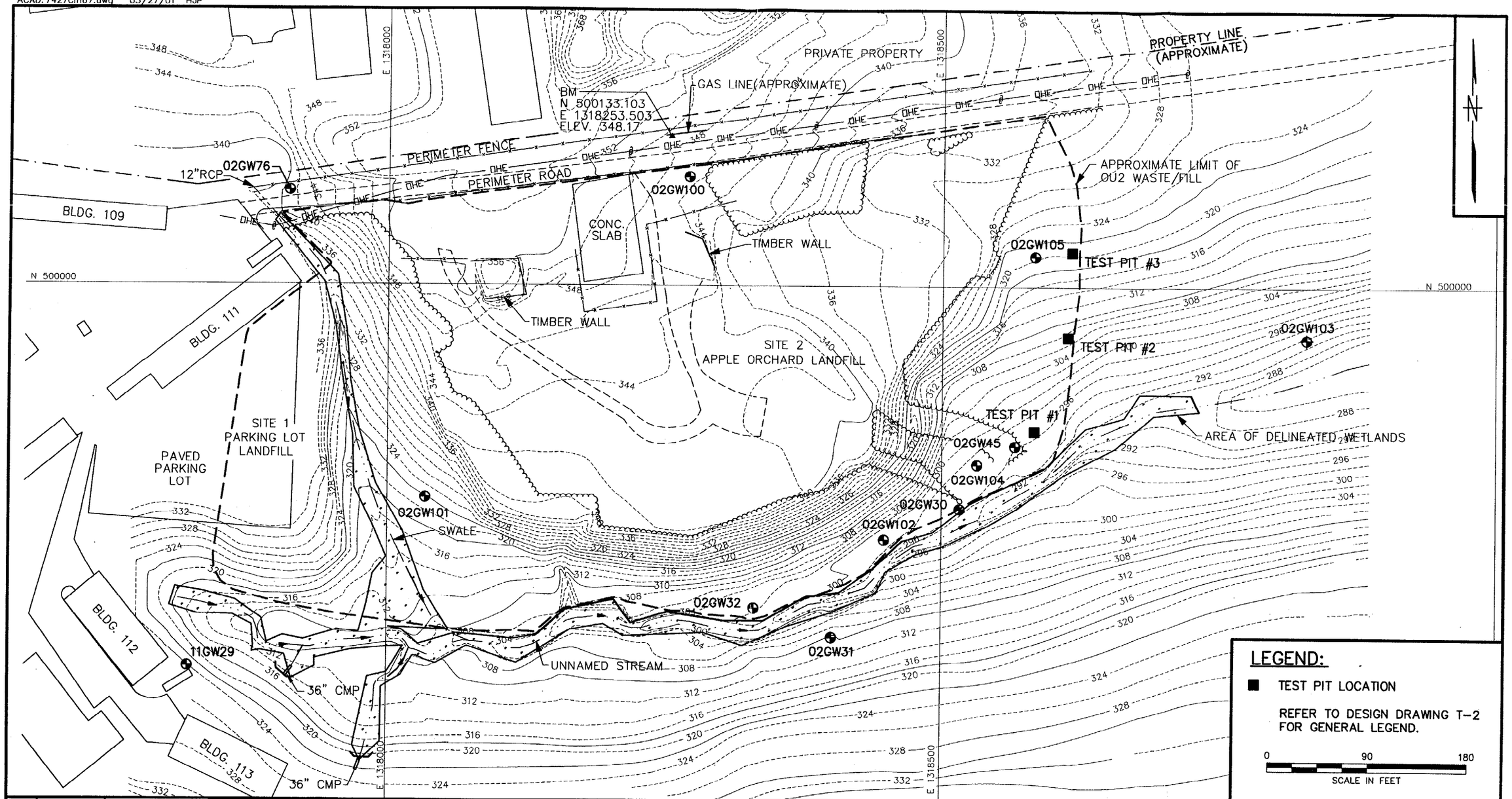
ACAD: 7427Cm67.dwg 03/27/01 HJP



LEGEND:

■ TEST PIT LOCATION

REFER TO DESIGN DRAWING T-2 FOR GENERAL LEGEND.

0 90 180
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP	DATE 3/27/01
CHECKED BY	DATE 3/29/01
COST/SCHED-AREA	
SCALE AS NOTED	

Tetra Tech NUS, Inc.

SITE CONDITIONS MAP
OPERABLE UNIT 2
FORMER NSWC – WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427	OWNER NO. 0273
APPROVED BY SN	DATE 3/29/01
APPROVED BY	DATE
DRAWING NO. FIGURE 3-1	REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

00162D062

4.0 DESIGN REQUIREMENTS

4.1 DESCRIPTION OF THE SELECTED REMEDY

A Proposed Plan (PP) presenting the selected remedy has been developed for OU2. A Record of Decision will be prepared to stipulate the remedy for OU2. The remedial action selected in the Corrective Measure Study (TtNUS, 2000a) and presented in the PP addresses contamination associated with Site 1 and 2 landfill contents, soil, and sediment and indirectly addresses the surface water and groundwater of OU2. Groundwater and surface water contaminants of concern (COCs) were identified and considered during the completion of the Site 2 human health risk assessment. However, by addressing the source of the contamination, the COCs identified in these media will attenuate with time. Therefore, groundwater and surface water will be evaluated as part of a post-remedial long-term monitoring program. Additional actions for the OU2 groundwater and surface water, if necessary, will be addressed as part of the long-term monitoring program.

The selected remedy for OU2 is the consolidation of OU2 contaminated soil, sediment, and waste/fill under a multimedia cap. This cap will prevent direct exposure to these contaminated media and minimize contaminant migration to the groundwater and surface water. The multimedia cap will meet Federal and state requirements for landfill closure (i.e., 40 CFR 258, 40 CFR 264, COMAR 26.04.07, and COMAR 26.13.05). The remedy also includes; excavation and offsite treatment/disposal of characteristically hazardous waste (if found), installation of surface water controls, institutional controls, and long-term monitoring.

The major components of the selected remedy are:

- Excavation/regrading is necessary to consolidate the waste material of OU2 into one location for capping. The following portions of OU2 would require excavation and regrading: Site 1 contaminated waste/fill, contaminated sediment from the unnamed stream, and Site 2 contaminated waste/fill.

- Disposal of generated wastewater and any suspect hazardous waste encountered during the excavation and consolidation activities. These materials will be disposed offsite at an approved disposal facility.

- Restoration of excavated OU2 areas and unnamed stream.

- Capping of the landfill with an engineered, multi-layer cap to address soil contamination and contaminant mobility issues.

- Installation of passive landfill gas vents and gas monitoring wells. The vents will be included as part of the remedy since small amounts of organic wastes (such as municipal refuse, wood, and plant material) are known to have been disposed at Sites 1 and 2 and since it is possible that low volumes of gas could be generated by decomposition of organic plant material.

- Institutional controls, including land use restrictions would be used to prevent future residential land use and disturbance of the final capped area.

- Groundwater and surface water monitoring. The monitoring, including 5-year reviews, will be conducted to verify that the corrective action is working acceptably and to evaluate the need for any additional corrective actions are necessary.

- Cover of Site 1 with 12-inch of soil. Following the removal and verification of removal of waste/fill from Site 1 12-inches of soil will be placed on the exposed surface to protect ecological receptors.

4.2 SITE GRADING CRITERIA

The final grading plan for OU2 was developed to satisfy the following criteria:

- Side slopes shall be graded at a maximum of 4 horizontal to 1 vertical (4H:1V), as specified by the Base Realignment and Closure (BRAC) Cleanup Team (BCT).

- The height of fill shall not exceed 10 ft above the high point of the Perimeter Road (Elevation 354 ft msl).

- Slopes shall not be flatter than 4%, based on Maryland Regulations COMAR 26.04.07.21, Landfill Closures.

- In accordance with the Maryland Erosion and Sedimentation Control Manual, a terrace or bench sloped at 2 to 3% shall be placed every 40 ft vertically and have a maximum flow length of 800 feet.

- Building 111 shall be left in place.

- The southern toe of the landfill shall be set back 10 feet from the existing toe of slope to limit stream encroachment.

Based on these criteria, the side slopes will be graded at 4H:1V, with one bench. The top of the landfill will reach elevation 364 ft msl, with a resulting plateau slope of 3%.

4.3 MATERIAL / SOILS MANAGEMENT

Material and soils management for this remedial action includes excavation/consolidation of waste/fill and sediment materials, placement and compaction of subgrade soil, installation of geosynthetic cap materials, drainage piping, soil cover and various sizes of rock for erosion and sediment control.

4.3.1 Excavation/Consolidation of Waste/Fill and Sediment

Waste from Site 1 and the steep slopes of Site 2 along with the sediments from the unnamed stream south of OU2 will be excavated and consolidated within the proposed limits of waste identified on Design Drawing C-7. Excavated waste will be monitored for UXO and suspect hazardous materials. A UXO technician will be present during all excavation activities to inspect any shapes or suspect ordnance encountered during the consolidation of waste/fill and sediments. Concrete filled shapes (dummy ordnance) will be broken up and randomly distributed throughout the limits of waste/fill. Potentially live UXO identified by the UXO technician will be transported off-site by Navy personnel for proper disposal. Suspect hazardous materials will be stockpiled separately for characterization sampling. In the event sampling indicates that materials are indeed hazardous the material will be disposed off-site at an approved disposal facility. If the sampling indicates that the material is not hazardous, the materials will be consolidated within the proposed limits of waste/fill.

During consolidation select waste/fill material will be stockpiled for use as the top layer of waste. This layer will be a minimum of 6-inches in depth and screened for UXO and sharp objects that could damage the geosythetics. This layer will be compacted to support the remaining cap layers.

The waste grades were established to accommodate 37,300 cy of waste/fill excavated from Site 1 and the side slopes of Site 2, 1,000 cy of contaminated sediment from the unnamed stream, and 4,500 cy of waste/fill or contaminated soil. The extra 4,500 cy of waste/fill or contaminated soil is included in the quantities to be consolidated under the cap as a contingency in the event waste extends beyond the reported limits of Site 1 and/or excess excavation of residual contaminated soils following the removal of waste materials is necessary.

Table 4-1 summarizes the volumes of materials expected to be excavated and consolidated within the proposed limit of waste/fill. Appendix C presents the volume reports generated by Terramodel.

4.3.2 Cover System

The limits of the multimedia cap will extend north under Perimeter Road and south to the unnamed stream. The western boundary of the multimedia cap will be located west of the existing swale (approximately 50-feet west at the southern end of the swale) and the eastern boundary will generally follow the eastern extent of Site 2 waste/fill.

The multimedia cap will be placed over the consolidated/prepared waste/fill. The multimedia cap will consist of (from bottom to top) 6-inches of subgrade soil, a geosynthetic clay liner, a 60 mil linear low density polyethylene (LLDPE) geomembrane, a geocomposite drainage layer, 18-inches of cover soil, and 6-inches of topsoil.

The 6-inches of subgrade soil layer will be placed to the limits shown in Design Drawing C-7 and the geosynthetics, cover soils, and topsoil will be placed to establish the final grades indicated in Design Drawing C-8. The completed cap will occupy a surface area of approximately 6.2 acres. The side slopes of the cap will tie into the existing ground surface with a maximum slope of 25% (4H:1V). The crown of the landfill will have a slope of 3% and a peak elevation of 364 ft msl.

Following excavation of waste/fill from Site 1, 1-foot of clean soil will be placed on the exposed earth and the area will be re-seeded. The 1-foot of soil material will consist of 6-inches of subgrade soil and 6-inches of topsoil. The seed mix used to seed the area will be the permanent mix provided on Design Drawing C-3.

Table 4-1 summarizes the volumes of materials required to establish the multimedia cap.

4.4 MULTIMEDIA CAP DESIGN

A multimedia cap to be placed over waste/fill material will be constructed to limit rainfall infiltration through the waste/fill and prevent human exposure to the waste/fill. As indicated in Section 4.3.2, the multimedia cap will consist of the following layers (from top to bottom):

- Vegetated topsoil – 6 inches thick (off site borrow),
- Cover soil – 18 inches thick (off site borrow),
- Geocomposite drainage layer (triplanar geonet with nonwoven geotextiles heat bonded to both sides),
- Textured 60-mil LLDPE geomembrane,
- GCL, and
- Subgrade soil - 6 inches thick (off site borrow).

Note: Along the toe of the multimedia cap the 6-inch top soil layer and 18-inch cover soil layer will be replaced with 18-inches of riprap (d_{50} = 6-inches) and 6-inches of MD SHA graded aggregate. This change in cap veneer will extend 20 feet up the cap slope and will provide protection against erosion during flooding.

The selection of these layers was based on the design components of an USEPA-recommended cover system for a subtitle C landfill. The USEPA recommended multimedia cap will contain a vegetation/soil layer, drainage layer, and low hydraulic conductivity geomembrane/soil layer. The following paragraphs describe the materials that make up the proposed multimedia cap.

The combination of cover soil and topsoil will be material suitable to support a permanent vegetative cover. The drainage layer will prevent saturation of the cover soil, maintain veneer stability, and prevent a buildup of hydrostatic pressure over the geomembrane. Geonet will provide drainage comparable to a one-foot thick layer of natural aggregate. This cap will have a composite liner, i. e., a geomembrane underlain by a clay layer. The geomembrane will be provided to minimize infiltration of rainfall into the landfill. It will be textured to provided sufficient interface friction to resist sliding forces imposed by the weight of the cover soil. Although geomembranes are documented to have very low permeabilities (typically comparable 1×10^{-11} cm/sec), punctures have occurred. Composite liners were developed such that a clay layer is placed immediately beneath the geomembrane to block leakage from possible punctures in the geomembrane.

To consolidate the waste/fill from Sites 1 and 2 and the contaminated sediments of the unnamed stream within a minimum area while satisfying this site's height restriction, geosynthetics have been specified for both the drainage (geonet) and clay (GCL) layers. Together the geonet and GCL will save approximately 20,000 cy of air space compared to traditional materials, thus reducing the lateral extent of the landfill.

The unit gradient design method for drainage layers in final covers was used to establish the size and number of drains needed within the cover system. The unit gradient method is supported by field data obtained in the mid-Atlantic region (GFR May 2000). The purpose of this method is to design a drain which should function adequately over the life of the structure, rather than designing the drainage layer for a specific storm event. The maximum drainage layer inflow is calculated assuming that the soil above the drainage layer is saturated, i. e., flows under a gradient of 1.0 (unit gradient). The rate of water infiltration into the geocomposite is calculated under the unit gradient, such that the infiltration rate is equal to the soil's permeability. The geocomposite flow will discharge into pipes spaced at various intervals along the landfill. Thus, the quantity of water infiltrating into a unit width of drainage composite is also determined by the pipe spacing. Therefore, soil cover permeability, geocomposite flow capacity (transmissivity), and pipe spacing are interrelated.

Based on typical cover soil permeabilities and reasonable drainage pipe spacing, a drainage composite with high flow capacity tri-planar geonet is needed to provide the required transmissivity. Cover soil permeability is specified indirectly on this project by specifying soil classification. Using the specified cover soils, a pipe spacing of 60-feet, and the tri-planar geonet, the drains will be 4-inch diameter (inside) plastic pipe. Refer to Appendix D for calculations.

In addition to the cover soils, geosynthetics, and pipes, gas vents will be installed at high points along the landfill and gas monitoring wells will be installed along the northern side of Perimeter Road. The locations of these items are identified on Design Drawing C-8.

4.5 GEOTECHNICAL ANALYSIS

Geotechnical analysis of the landfill slope stability and multimedia cap stability were performed for the OU2 remedial design. Site conditions were analyzed to estimate the shear strength associated with the existing landfill wastes. As waste shear strength characteristics are difficult to measure in the laboratory due to waste heterogeneity, analysis of the existing landfill slopes is believed to provide a practical estimate of the waste shear strength.

The steepest existing slope within OU2 has a rise of 40 ft, standing at a slope of 1.65 H:1V (31 degrees), based on topographic mapping. Assuming that this slope is at least marginally stable, the landfill material at the slope face would represent an angle of internal friction of at least 31 degrees. Using the infinite slope equation the factor of safety for the stability of the regraded landfill slope at that location is:

$$\text{Factor of Safety} = \tan \phi / \tan \alpha$$

where: ϕ = angle of internal friction of the waste/fill

α = slope angle

The factor of safety for the waste regraded to 4H:1V (14 degrees) would then be:

$$\text{Factor of Safety} = \tan 31° / \tan 14°$$

$$\text{Factor of Safety} = 2.4$$

Therefore the slope stability factor of safety is at least 2.4, assuming that the remaining waste and foundation materials have friction angles equal to that of the existing slope materials at the steepest slopes.

The multi-layer cap (2-foot thick soil cover and geosynthetics) has been designed to achieve a minimum factor of safety of 1.5. The infinite slope method of analysis was used with a 4H:1V slope to determine the minimum friction angle needed to achieve the final cover factor of safety of 1.5. Although the geocomposite drainage layer is designed to virtually eliminate head over the geomembrane to be conservative, a depth of saturation of 8 inches was assumed to evaluate large rainfall events. An interface friction angle of 25° within and between each geosynthetic interface is needed to achieve a factor of safety of 1.5 when this depth of saturation is realized in the infinite slope calculation.

Refer to Appendix D for design calculations.

4.6 RESTORATION

The proposed remedial action at Site 2 will disturb approximately 23,500 sf of wetlands (length of drainage swale located between Sites 1 and 2 and length of the tributary to Point Branch south of Site 2) (see Design Drawing C-1). The disturbance of the wetlands is unavoidable since the proposed consolidation area includes the existing drainage swale and the remedy includes the removal of impacted sediments in the stream south of Site 2. Therefore, the remedial design includes a restoration plan for the disturbed wetlands within the limits of disturbance. The purpose of the restoration is to replace the ecological benefits lost by the removal of the existing wetlands within the proposed limits of disturbance.

4.6.1 Swale Restoration

The most important function provided by the existing vegetation in the swale is to slow the velocity of surface runoff before it enters the unnamed tributary to Paint Branch. The tributary supports a diverse aquatic community and is designated as a Class III stream by the state of Maryland. By slowing the velocity of flow, the swale reduces the suspended sediment load entering the tributary. Other secondary benefits include providing a habitat for wildlife and aesthetics.

Following excavation and consolidation of waste/fill a channel will be constructed along the western edge of the proposed extent of landfill. The restoration is designed to restore the natural, dense stand of vegetation within the channel to inhibit soil scour when flow is present in the channel. A riprap apron will be constructed immediately down slope from the reinforced concrete pipe (RCP) located under Perimeter Road in the northwest corner of Site 2. The riprap will slow the velocity of the flow from the RCP, and the northern perimeter channel that will feed the swale before it enters the vegetated area of the swale. The purpose of the vegetation will be to reduce the flow velocity of the flow in the western and eastern channels thus reducing the suspended sediment load entering the unnamed stream south of the consolidated landfill.

As indicated on Design Drawings C-6 through C-8 the existing swale will be relocated west of its current location to allow room for the consolidation of the Site 1 and 2 landfill waste. The new location will vary from 10- to 50- feet west of its current location. Because the swale will be collecting sheet flow runoff from the landfill cap, channel flow runoff from the landfill bench, and concentrated runoff from the drainage layer piping, the swale will be replaced with a trapezoidal channel. The channel will have a depth of 1.5-feet, a base width of 2-feet and side slopes of 3-feet horizontal to 1-foot vertical.

From interim grade, 6-inches of topsoil will be placed within the channel to establish final grade of the channel. The properties of the topsoil and the fertilization of the topsoil shall be as indicated in Specification Section 02351 (Excavation and Fill). Following the placement of the topsoil, the channel will be seeded. It is recognized that one or more growing seasons may be necessary to establish wetland vegetation that is capable of effectively dissipating the energy of landfill discharges and preventing soil scour. Therefore erosion control matting (ECM) (coir or coconut fiber) will be placed on the perimeter of the channel to protect the surface soils against the erosive forces of the channel flows associated with the discharge from the landfill cap and watershed north of Perimeter Road.

The seed mix to be used in the eastern and western channel is a mixture of indigenous and natural grass species recognized for its effectiveness in stabilizing exposed soils. The grass species include a mixture of cool-season and warm-season grasses. The cool-season grasses germinate quickly and establish rapidly to provide effective short-term soil stabilization. The warm-season grasses are generally of greater wildlife value but germinate and grow more slowly than cool-season grasses. In addition, the warm-season grasses tend to grow better in poor quality soils and under drought conditions. The seed mix includes redtop, barnyard grass, switchgrass, deertongue grass and a seasonal nurse crop. Although the eastern channel does not replace an existing swale, its function is identical to the western channels. Therefore the eastern channel will receive the same seed mix as the western channel. The application rate is identified on Design Drawing C-3 and is identified as "Channel Seed Mixture".

4.6.2 Stream Restoration

On March 15, 2001 a pedestrian survey of the unnamed stream was conducted to determine the existing conditions and stream makeup (physical and biological). The results of this survey indicate that the stream serves primarily as a conduit for storm water discharge from the urbanized areas in the northwestern part of former NSWC-White Oak and the densely developed areas off-base to the north. The stream has become deeply incised due to repeated discharges of storm water. Deep incision of the stream has undercut and caused the steep banks to fail in several locations. The substrate in the stream consists of gravel and cobbles, interspersed with small boulders, bedrock outcrops, and small deposits of sand and soft sediment. The stream lacks riffle, pool complexes, and bordering wetlands. Riparian vegetation lines the top of the banks and consists primarily of mature hardwood trees that shade the

stream, but continued incision and bank failure threaten to uproot many of these trees. Aquatic biota in the stream is likely limited to benthic macroinvertebrates tolerant of frequent heavy discharges, absence of pools, and impaired water quality.

As indicated in Section 4.3 approximately 1,000 cy of impacted sediments will be removed from the unnamed stream and placed beneath the multimedia cap. This sediment will be excavated from the stream bed and side slopes. Following excavation the stream will be restored to stable conditions by restoring the bank to a height of 2 to 3 feet and sloped at 3H : 1V, with a stream bottom width of 15 feet. These stream characteristics correspond to existing conditions where stream erosion is at a minimum.

Following the re-establishment of the bank characteristics, the stream substrate will be replaced with Maryland Class 0 Riprap ($d_{50} \approx$ 4-inches) placed to establish final grades. The bank slopes will be established by placing subgrade soil to 6" below final grade and placing 6" of topsoil to establish final grades. The bank slopes will be stabilized using a ECM (coir or coconut fiber) and indigenous species of woody species spaced on 3-foot centers. The woody species would be live stakes 2- to 4-feet in length and capable of generating root systems when placed in the ground. The cuttings will ultimately grow into mature trees and shrubs. The tree species selected include black willow (*Salix nigra*), silky dogwood (*Cornus amonum*), and buttonbush (*Cephalanthus occidentalis*) (See Plant Schedule A). Each is indigenous to natural stream valleys in Montgomery County, Maryland, fast growing, and readily available from regional nurseries that specialize in providing material for wetland mitigation and ecological restoration. Plant Schedule A uses black willow for 80 percent of the live stakes because black willow has a high survival rate and because fast-growing trees are needed on the banks to restore shade to the stream. Shade is necessary to produce the cool in-stream temperatures required by the biota typical of streams in forested landscapes.

Plant Schedule A also uses seedlings (plugs or bare-root seedlings) of regionally indigenous and fast-growing wetland rushes and bulrushes on 3-foot centers on the banks. The planter will have to use a dibble bar or other device to cut small holes in the coir fiber to create planting holes. These herbaceous plants will develop extensive root systems faster than the live stakes and thereby provide additional early stabilization. Design Drawing C-13 provides the restoration vegetation plan and Plant Schedule A.

4.6.3 Site Restoration

All areas within the limits of disturbance, other than the channels, stream, and gravel paved areas, will be revegetated using the permanent seed mixture provided on Design Drawing C-3. This seed mix will consist of native warm season grasses which will result in a more beneficial natural habitat and will result in lower maintenance costs. This permanent seed mix was developed by the USEPA's Biological Technical Assistance Group and contains big bluestem, little bluestem, switchgrass, indiangrass, canada

wild rye, partridge pea, and annual rye grass. The rye grass and partridge pea will germinate and become established quickly to provide the necessary erosion control until the warm season grasses can become established.

4.7 EROSION, SEDIMENT, AND STORMWATER MANAGEMENT REQUIREMENTS

4.7.1 Erosion and Sediment Control

An erosion and sediment control plan was prepared and has been included in this Design Submission. The plan was prepared in accordance with state of Maryland regulations as set forth in the 1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control Handbook. Runoff quality during the remedial action is addressed via erosion and sediment control devices located around the perimeter of disturbed areas. Refer to the Erosion and Sediment Control Plan Report for detailed information regarding the planned controls as well as pre- and post-development run-off calculations.

4.7.2 Stormwater Management

As the site will be returned to a grassed or natural type existing condition following the remedial action, extensive stormwater management structures are not required. However, channels will be constructed along the northern, eastern, and western edges of the completed landfill cap during the remedial action for stormwater run-on and run-off management purposes. Additionally, riprap will be placed along the southern toe of the landfill along the unnamed stream.

Three channels and one bench will be constructed during the remedial action. The channels will divert offsite run-off from the landfill cap limits thus protecting the cap from erosion. In addition the channels and bench will convey a portion of the landfill cap run-off to the unnamed stream located south of the proposed landfill cap. The channels and bench were designed to convey the flow resulting from a 25-year 24-hour storm recurrence event while maintaining a 0.5 foot of free-board.

The east and west channels will be grass-lined with erosion control matting (cori or coconut fiber) to prevent erosion and sedimentation from occurring. Riprap will also be placed at channel discharge locations to reduce flow velocity and erosive forces. The channel capacity and bench capacity calculations along with riprap size calculations are provided in Appendix A of the Erosion and Sedimentation Plan. The following is a summary of the channel dimensions and lining materials.

Channel	Shape	Side Slopes H/V	Width (ft)	Depth (ft)	Lining
Northern Channel	Triangle	3/1 & 3/1	0	1.5	Riprap
Western Channel	Trapezoid	3/1 & 3/1	2	1.5	Grass and Riprap*
Eastern Channel	Trapezoid	3/1 & 3/1	2	1.5	Grass and Riprap*
Bench	Triangle	4/1 & 8/1	0	1.5	MD SHA Aggregate

* Riprap lined at channel junctions.

4.8 OTHER DESIGN REQUIREMENTS

4.8.1 Utilities

Underground utilities exist near OU2. The contractor will be obligated through specifications, to verify all utility locations and adequately protect the utility prior to any earth disturbance activities.

4.8.2 Monitoring Wells

It is anticipated that existing groundwater monitoring wells will be impacted by the consolidation and capping efforts at OU2. As indicated in the design drawings all wells are to be protected and extended during construction of the multimedia cap. Decisions to abandon and/or replace monitoring wells will be made by the BCT during construction. In addition, three gas monitoring wells will be installed north of the Perimeter Road and five gas vents will be installed along the crest and high points of the landfill.

4.8.3 Maintenance and Repair

There should be very little maintenance required for the constructed cap. An annual inspection procedure and repair procedures will be established in the OU2 Operation and Maintenance Plan. Plans for periodic mowing, reseeding and repair of sparsely vegetated areas, repair of areas of differential, settlement, channel repair, etc., will be identified in the plan. The Operation and Maintenance Plan is not part of this design package.

4.8.4 Regulatory Standards

The OU2 cap system complies with the action-specific ARARs and TBCs as discussed in the Environmental Permits Report.

4.9 POST-REMOVAL VERIFICATION SAMPLING

Post-removal verification soil (sediment) samples will be collected from the Site 1 area and stream area following removal activities to verify that soil and sediment exceeding the PRGs has been removed. A sampling and analysis plan will be prepared and approved by the BCT prior to initiation of field activities. Verification sampling will be performed following excavation activities.

4.10 STRUCTURES

Care will be taken to minimize damage to Building 111 through the completion of the project. It is believed that the building will be removed during future site development, but it will be maintained during the OU2 remedial action activities.

The contractor shall coordinate field work through the Base Environmental and safety office for specific requirements related to Building 111.

TABLE 4-1

**SUMMARY OF MATERIAL / SOIL MANAGEMENT
OPERABLE UNIT 2
NSWC-WHITE OAK
SILVER SPRING, MARYLAND**

Material Type	Area (sf)	Thickness (ft)	Excavation Volume [2] (cy)	Fill Volume (cy)
Excavation/Consolidation				
Site 1 Waste/Fill		Unknown	8,300	--
Site 2 Waste/Fill		Unknown	29,000	--
Contaminated Sediments		Unknown	1,000	--
Unknown Waste/Fill [1]		Unknown	4,500	--
Cover System				
Sub-grade Soil	264,000	0.5	--	4,900
Cover Soil	264,000	1.5	--	14,700
Topsoil	264,000	0.5	--	4,900
Geosynthetics				
Geocomposite Drainage Layer[2]	290,400	--	--	--
60-mil LLDPE Geomembrane[2]	290,400	--	--	--
GCL[2]	290,400	--	--	--

1 The waste grades have been established to allow for unexpected waste extending beyond reported Site 1 limits and potential residual contaminated soils following removal of the waste/fill from Site 1.

2 10/% added to excess to account for overlap and anchoring.

-- Not Applicable

REFERENCES

Geotechnical Fabrics Report, "Percolation through Landfill Final Covers", by G.N. Richadson and G.D. Garnett, Vol. 18, No. 3, May 2000. pp 22-25.

Halliburton NUS, June 1995. Design Verification Report for Remedial Actions at Site 2, 3, 4, and 9, Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. Prepared for the Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. Wayne, Pennsylvania.

Halliburton NUS. 1995. *Wetland and Forest Stand Delineation Report for Installation Restoration Program Sites, Naval Surface Warfare Center, Dahlgren Division, White Oak Detachment, Silver Spring, Maryland.* Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, Washington, D.C. August 1995.

Malcolm-Pirnie, 1993. Draft Feasibility Study Report, Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. March.

Malcolm Pirnie. 1992. Remedial Investigation Report, Dahlgren Division, White Oak Detachment, Silver Spring, Maryland. October 1992.

TtNUS, March 2000a. Final Engineering Evaluation/Cost Analysis (EE/CA) for Site 1 at the Former Naval Surface Warfare Center – White Oak, Silver Spring, Maryland.

TtNUS, October 2000b. RCRA Facility Investigation for Sites 2, 3, 4, 7, 8, 9, and Paint Branch. Naval Surface Warfare Center, White Oak, Silver Spring, Maryland. Prepared for the Engineering Field Activity Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania.

APPENDIX A

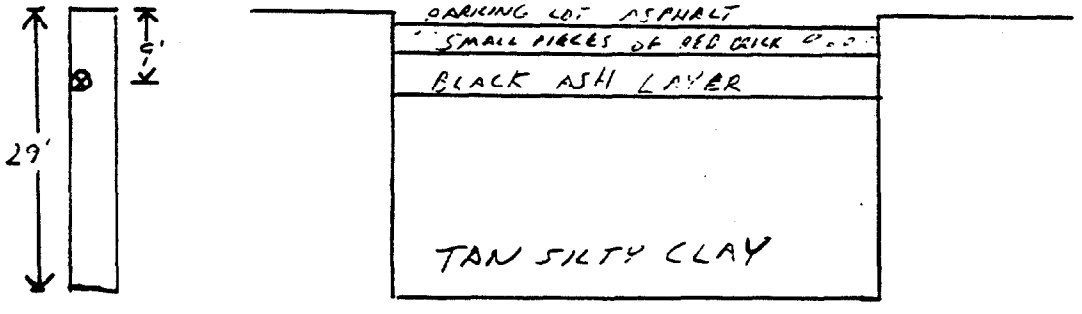
SUBSURFACE INVESTIGATION LOGS

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 7909-0502
LOCATION: SITE 1-PARKING LOT LANDFILL
TEST PIT NUMBER: 01-TP-01
DATE: 4/9/99
GEOLOGIST: MATT WOODFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID REA: Source (ppm)
0					
1		SMALL PIECES OF RED BRICK			
2		BLACK ASH LOOKING SOIL FROM 1.5-2'			
3		EXTENDING ALONG THE WESTERN AND			
4		~~STORMWATER~~ EASTERN SIDEWALLS			
5					
6		TAN SILTY CLAY			

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ⊗ SAMPLE 01-TP-01 WAS COLLECTED @ A DEPTH OF 2.5' ANALYZED FOR VOC, SVOC, PESTICIDES/PCBs/TAL METALS/EXPLOSI

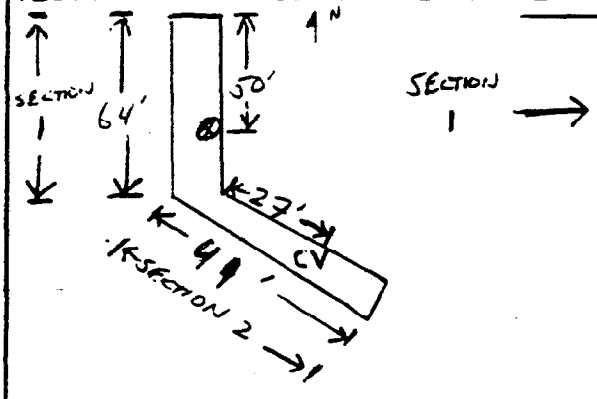
PHOTO LOG:

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909-0502
LOCATION: SITE 1 - PARKING LOT LANDFILL
TEST PIT NUMBER: 01-TP-02
DATE: 4/10/99
GEOLOGIST: MATT WOODFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READI: Source (ppm)	BZ (ppm)
0					0	
1					0	
2					0	
3		REDDISH-BROWN SUSPECT LOOKING SOIL AT 3'			0	
4		BEGAN 45' FROM NORTH EDGE			0	
5					0	
6						

TEST PIT CROSS SECTION AND / OR PLAN VIEW



SECTION 1

PARKING LOT ASPHALT
TAN SANDY SILT
OLIVE CLAYEY SILT
REDDISH-BROWN SANDY SILT
TAN SILTY CLAY

CV - CONCRETE VAULT TOP MEASURING 5' x 7' x 5" AT A DEPTH OF 2'

REMARKS: ⊗ SAMPLE 01-TP-02 WAS COLLECTED @ A DEPTH OF 3' ANALYZED FOR VOC, SVOC, PESTICIDES/PCBs, TAL METALS, EXPL
⊗ SAMPLE 01-LF-05 WAS COLLECTED @ A DEPTH OF 3' ANALYZED FOR

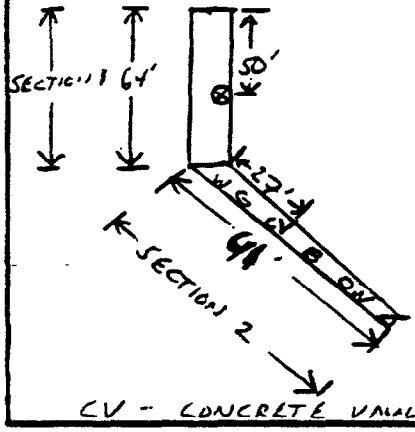
PHOTO LOG:

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 7909-0502
LOCATION: SITE 1-PARKING LOT LANDFILL
TEST PIT NUMBER: 01-TP-02
DATE: 4/10/99
GEOLOGIST: MATT WOOLFORD

Depth (Ft.)	Lithology Change (Depth/FL)	MATERIAL DESCRIPTION Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READ Source (ppm)	
0						
1						
2						
3		WOOD DEBRIS, LITTLE BITS OF GLASS				
4						
5						
6						
7						
8						
9						

TEST PIT CROSS SECTION AND / OR PLAN VIEW SECTION 2



PARKING LOT ASPHALT
SILTY SAND RED BRICK
GLASS PIECES WOOD DEBRIS
ORGANIC WOOD-OLIVE GRAY

CV - CONCRETE VAULT TOP MEASURING 5' x 7' x 5" @ A DEPTH OF 2'

REMARKS:

PHOTO LOG:

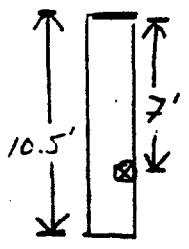
TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909-0503
LOCATION: SITE 1 - PARKING LOT LANDFILL

TEST PIT NUMBER: 01-TP-03
DATE: 4/7/99
GEOLOGIST: MATT WOOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READI: Source (ppm)	B7 (ppm)
0					0	
1		LIGHT BROWN SILTY SAND W/ TRACE			0	
2		GRAVEL			0	
3					0	

TEST PIT CROSS SECTION AND / OR PLAN VIEW



PARKING LOT ASPHALT

LIGHT - MEDIUM BROWN SILTY SAND W/ TRACE GRAVEL

REMARKS: ⊗ SAMPLE 01-TP-03 WAS COLLECTED @ A DEPTH OF 2.5' ANALYZED FOR VOC, SVOC, PESTICIDES/PCB, TAL METALS, ETC

PHOTO LOG:

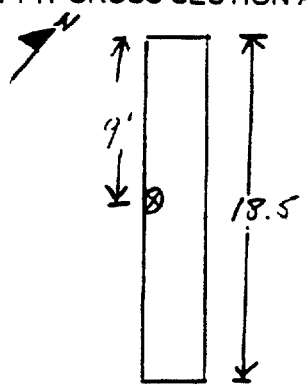
TEST PIT LOG

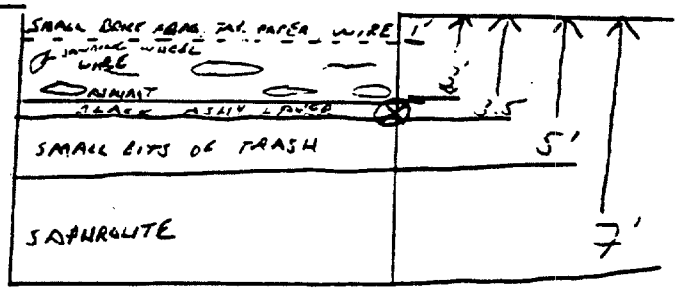
PROJECT NAME: NSWC WHITE OAK.
PROJECT NUMBER: 7909-0502 CTO 315
LOCATION: ~~WHITE OAK~~ SITE 1

TEST PIT NUMBER: 01-TP-04
DATE: 4/6/99
GEOLOGIST: MATTHEW WOOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READ: Source (ppm)	PID/FID READ: B7 (ppm)
1		SMALL BRICK FRAGMENTS, BITS OF TAR PAPER,			0	
		PIECES OF WIRE				
3		WIRE, GLASS JAR AND PIECES OF GLASS,		BLACK ASHY	0	
		PIECES OF METAL AND ASPHALT.		SOIL		
		SANDING WHEEL, GASKET, ANTHER'S BEER				
		CAN				
5		NATIVE SOIL BROWN-TAN CLAY			0	
7		SAPHROLITE GREEN AND RED			0	

TEST PIT CROSS SECTION AND / OR PLAN VIEW





REMARKS: ⊗ SAMPLE 01-TP-04 WAS COLLECTED @ 1815

PHOTO LOG: PHOTO 3 - PICTURE OF THE TEST PIT LENGTH
PHOTO 4 - PICTURE OF THE EASTERN SIDEWALL

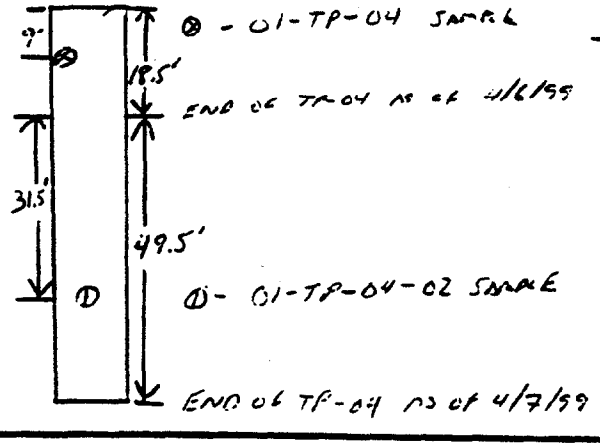
NEED TO REVISE FOR EXTENSION ON 4/7
DRILLING

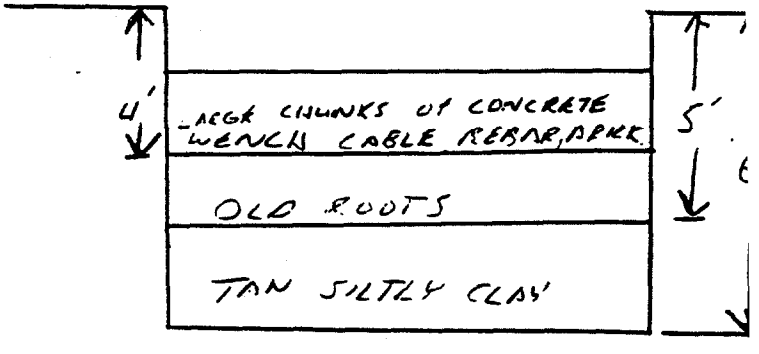
TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 7909-0502
LOCATION: SITE 1 - PARKING LOT LANDFILL
TEST PIT NUMBER: 01-TP-04
DATE: 4/6/99 - 4/7/
GEOLOGIST: MATT WOOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READ Source (ppm)
1		SMALL BRICK FRAGMENTS, BITS OF			
		TAR PAPER PIECES OF WIRE			
3		WIRE, GLASS, TAR, PIECES OF GLASS			
		PIECES OF METAL AND OLD RIPRAP			
		SANDING WHEEL, GASKET, ANTHER'S			
		BEER CAN, LARGE PIECE OF			
		CONCRETE REBAR.			
5		BROWN TAN CLAY			
7		LOPHROLITE SAREAN - RED			

TEST PIT CROSS SECTION AND / OR PLAN VIEW





REMARKS: ⊗ - SAMPLE 01-TP-04 WAS COLLECTED @ 1815 ON 4/6
① - SAMPLE 01-TP-04-02 WAS COLLECTED @ 0900 ON 4/7

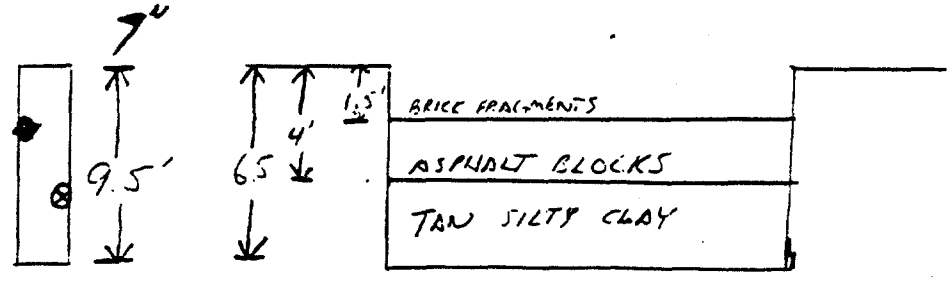
PHOTO LOG:

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909 - 0502
LOCATION: SITE 1
TEST PIT NUMBER: 01 - TP - 05
DATE: 4/6/99
GEOLOGIST: MATT WOOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID REA Source (ppm)
0					0
1		SMALL BRICK FRAGMENTS			0
2					0
3		ASPHALT BLOCKS			0
4					0
5		TAN CLAYEY SILT			0
6.5					0

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ⊗ COLLECTED SAMPLE 01-TP-05 @ 1610 DEPTH OF 4'
ANALYZED FOR VOC, SVOC, PESTICIDES/PCB, TAL METALS

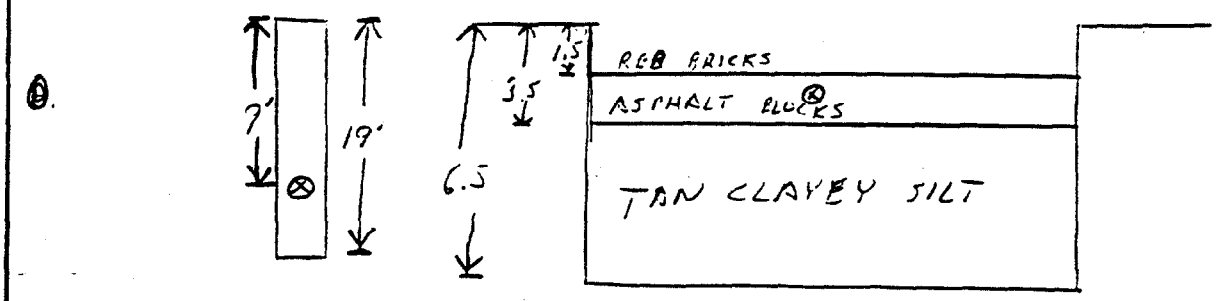
PHOTO LOG:

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK - CTO 315
PROJECT NUMBER: 7909 - 0502
LOCATION: SITE 1
TEST PIT NUMBER: 01 - TP - 06
DATE: 4/6/99
GEOLOGIST: MATT WOODFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READI: Source (ppm)	BZ (ppm)
0					0	
1		RED BRICKS, SOME GLASS			0	
2					0	
3		ASPHALT BLOCKS, SOME CONCRETE			0	
4					0	
5		TAN CLAYEY SILT			0	
6.5						

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ⊗ SAMPLE 01-TP-06 COLLECTED @ 1655 DEPTH - 2'
ANALYZED FOR VOC SVOC PESTICIDES/PCBs TAL METALS

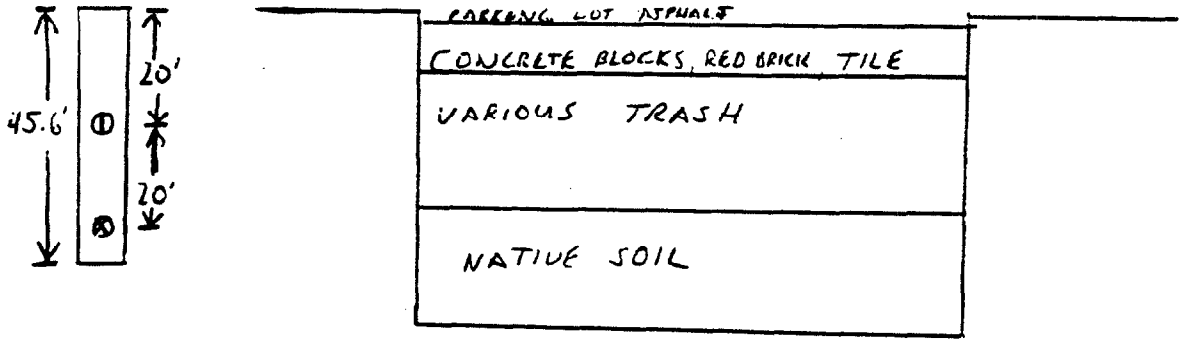
PHOTO LOG: PHOTO #1 - PICTURE OF THE TEST PIT LENGTH
PHOTO #2 - PICTURE OF THE NORTH SIDEWALL

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909 - 0502
LOCATION: SITE 1 - PARKING LOT LANDFILL
TEST PIT NUMBER: 01-TP-07
DATE: 4/7/99
GEOLOGIST: MATT WOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READ: Source (ppm)	
0					0	
1		CONCRETE BLOCKS, TILE RED BRICK			0	
2					0	
3		TELEPHONE POLE (PARTIAL) PIECES OF WOOD AND			0	
4		METAL, BURIED CANS, GLASS, RAGS,			0	
5		WIRES, LICENSE PLATES, 35mm FILM,			0	
6		RAGS, METAL SLAG			0	
7		NATIVE SOIL			0	
8						

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ② SAMPLE 01-TP-07 WAS COLLECTED @ A DEPTH OF 4'
ANALYZED FOR VOC, SVOC, PESTICIDES/PCBs, TAL METALS, EXPLOS
① SAMPLE 01-LF-01 WAS COLLECTED FROM SOIL AROUND THE BATTERIES

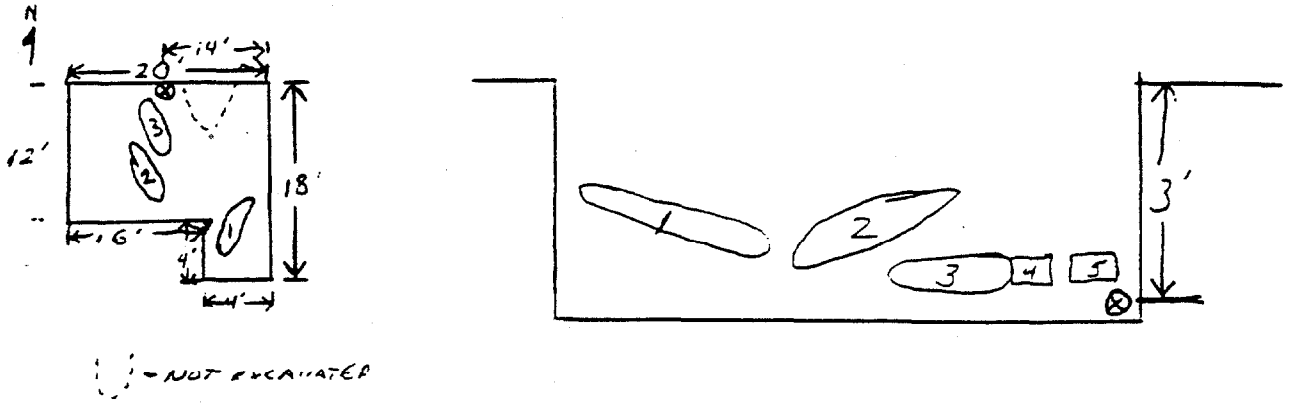
PHOTO LOG: PHOTO 5-7: BATTERY OIL FUNNEL RAG
PHOTO 3: PORTION OF TELEPHONE POLE

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909-0502
LOCATION: SITE 1 - PARKING LOT LANDFILL
TEST PIT NUMBER: 01-TP-08
DATE: 4/8/99
GEOLOGIST: MATT WOOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READIN: Source (ppm)	BZ (ppm)
0					0	
6"		BOMB-SHAPES PIECES OF GLASS, CONCRETE			0	
1		BATTERY PACKS			0	
2		FIRE BRICK			0	
3					0	

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ⊗ SAMPLE 01-TP-08 WAS COLLECTED @ 1600 DEPTH - 3' ANALYZED VOC, TCL, TAL, PE
TCLP SAMPLES - 01-LF-02 WAS COLLECTED @ 1430 OF WHITE
01-LF-03 AND DUPL 01-LF-06 WERE COLLECTED @ 1610
THE WASTE FOUND IN THE METAL CONTAINER CONTAI
BATTERIES

PHOTO LOG:

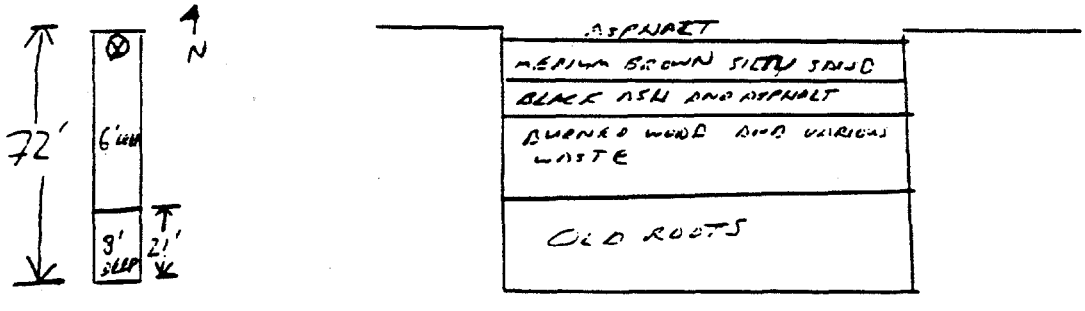
TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909-0502
LOCATION: SITE 1 - PARKING LOT LANDFILL

TEST PIT NUMBER: 01-TP-09
DATE: 4/9/99
GEOLOGIST: MATT WOODFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READ: Source (ppm)
0					0
1					0
2		BLACK ASH AND ASPHALT PIECES			0
3		BURNED WOOD, TILE BRICK, RED CLAY PIPE			0
4		BATTERY PACKS			0
5					0
6		OLD ROOTS			0
7					
8					

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ⊗ SAMPLES 01-TP-09 WAS COLLECTED @ A DEPTH OF 2.5' MS/MSD ANALYZED FOR VOC, SVOC, PESTICIDES/PCBs, TAL METALS, EXPLO

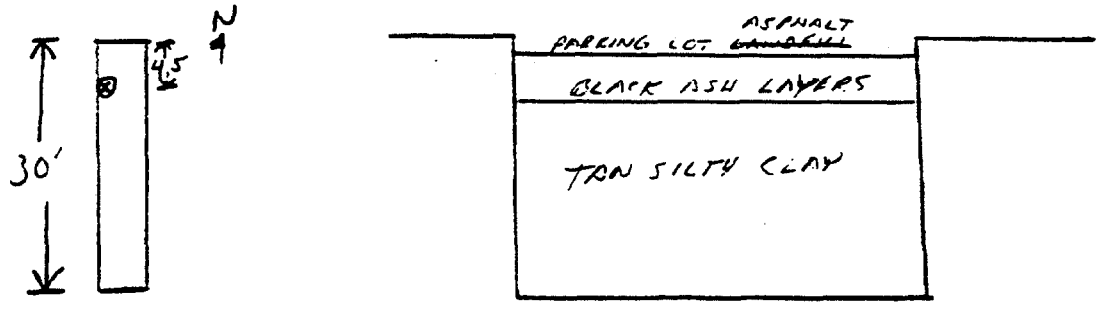
PHOTO LOG:

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909-0502
LOCATION: SITE 1 - PARKING LOT LANDFILL
TEST PIT NUMBER: 01 - TP - 10
DATE: 4/9/99
GEOLOGIST: MATT WOOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID REA Source (ppm)
0					0
1					0
2		BLACK ASPHALT AND ASH LOOKING			0
3		MATERIAL PIECES OF GLASS			0
4					0
5		TAN SILTY CLAY			0
6					0

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ⊗ SAMPLE 01-TP-10 WAS COLLECTED @ A DEPTH OF 1.5'
ANALYZED FOR VOC, SVOC, PESTICIDES/PCBs, TAL METALS, El
PHOTO OF BLACK ASH LAYER

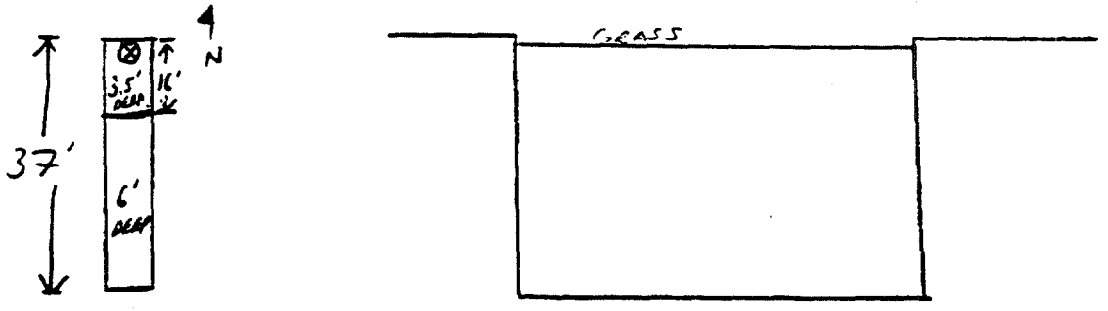
PHOTO LOG:

TEST PIT LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO 315 - 7909-0502
LOCATION: SITE 1 - PARKING LOT LANDFILL
TEST PIT NUMBER: 01 - TP - 11
DATE: 4/10/99
GEOLOGIST: MATT WOOLFORD

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID REA: Source (ppm)
0					0
1					0
2					0
3		METAL CONTAINERS PIECES OF METAL GLASS,			0
4		WOOD, SLATE, SOME			0
5		PLASTIC WRAPPING			0
6					0

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: ⊗ SAMPLE 01-TP-11 WAS COLLECTED @ A DEPTH OF 3' 14 ppm
ANALYZED FOR VOC, SVOC, PESTICIDES/PCBs, TAL METALS, EXPLO
① SAMPLE 01-LF-17 WAS COLLECTED FROM THE VARIOUS PIECES OF

PHOTO LOG: WASTE FOUND

TEST PIT LOG

HALLIBURTON NUS

PROJECT: WHITE OAK TEST PIT NO.: 2-TP 1

PROJECT NO.: 2295 DATE: 3/7/95

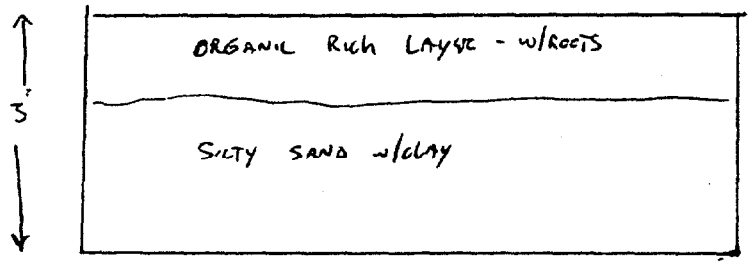
LOCATION: IN WOODS, SE SIDE of LANDFILL

FIELD GEOLOGIST: P. NIMMER / R. Willowby

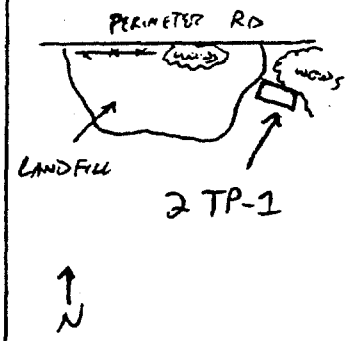
DEPTH (ft.)	LITHOLOGY CHANGE (Depth,ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS
		BLK - ORG ORGANIC RICH SILTY SAND		NATURAL MATERIAL
1.0	OH	W/ROOTS.		
	SC	ORG SILTY SAND W/CLAY		
2.0				
	SC	AS ABOVE		
3.0				
	TD=3'			

Test Pit Cross Section and / or Plan View

TEST PIT CROSS-SECTION



TEST PIT LOCATION



REMARKS ALL NATURAL MATERIAL
Pit 10' LONG x 3' deep x 3' wide

PHOTO LOG

TEST PIT 2-TP 1

PAGE 1 OF 1

TEST PIT LOG

HALLIBURTON NUS

PROJECT: WHITE OAK TEST PIT NO.: 2-TP2

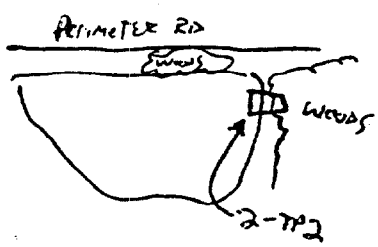
PROJECT NO.: 2295 DATE: 3/7/95

LOCATION: EAST side of site 2.

FIELD GEOLOGIST: P. NIMMER / R. Willowby

DEPTH (ft.)	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS
	SM	BRN SILTY SAND w/CLAY		FILL - CONSTRUCTION DEBRIS
1.0		MANY LARGE CONCRETE / ASPHALT PIECES.		
2.0		AS ABOVE		
3.0		AS ABOVE		
	TD = 3'			

Test Pit Cross Section and / or Plan View



REMARKS CONSTRUCTION DEBRIS @ 3'
30' LONG x 3' DEEP x 3' WIDE

PHOTO LOG

TEST PIT 2-TP2

PAGE 1 OF 1

TEST PIT LOG **HALLIBURTON NUS**

PROJECT: WHITE OAK TEST PIT NO.: 2-TP3

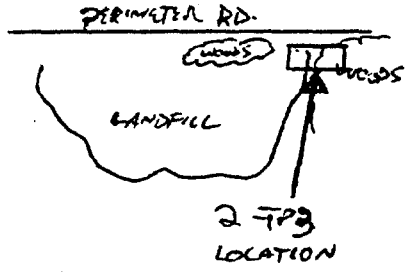
PROJECT NO.: 2295 DATE: 3/7/95

LOCATION: EAST SIDE of Site 2, NEAR PERIMETER ROAD

FIELD GEOLOGIST: P. NIMMER / R. W. HOWDE

DEPTH (ft.)	LITHOLOGY CHANGE (Depth,ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS
		ORG/BRN SILTY ~~FINE~~ SAND		MANY ROOTS IN TOP 1'
1.0				NATURAL MATERIAL
	SM			
2.0		AS ABOVE		
3.0		AS ABOVE		
	TD=3'			

Test Pit Cross Section and / or Plan View



REMARKS Pit 16' Long x 3' wide x 3' deep

NO FILL OR TRASH - ALL NATURAL MATERIAL

PHOTO LOG

TEST PIT 2-TP3

PAGE 1 OF 1

TEST PIT LOG **HALLIBURTON NUS**

PROJECT: WHITE OAK TEST PIT NO.: 2-TP4

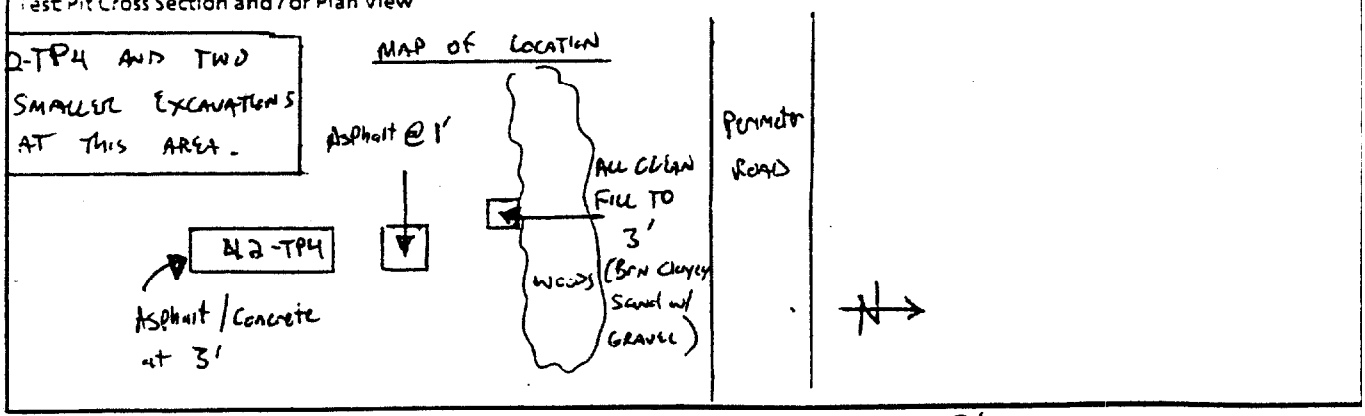
PROJECT NO.: 2295 DATE: 3/7/95

LOCATION: EAST CENTRAL PORTION OF SITE ~100' South of Perimeter ROAD

FIELD GEOLOGIST: P. NIMMER / A. Willoughby

DEPTH (ft.)	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS
	SM	ORG/BRN GRADED SAND W/ SILT AND GRAVEL		FILL
1.0				
2.0		AS ABOVE		
3.0		CONCRETE PIECES / ASPHALT @ 2.5'		CONCRETE PIECES
	TD=3'	(REFUSAL)		

Test Pit Cross Section and / or Plan View



REMARKS CONCRETE PIECES @ 3'. CLEAN FILL ABOVE 3'.

PIT 40' LONG x 3' deep x 3' wide

PHOTO LOG

TEST PIT 2-TP4

PAGE 1 OF 1

TEST PIT LOG

HALLIBURTON NUS

PROJECT: WHITE OAK TEST PIT NO.: 2-TP5

PROJECT NO.: 2295 DATE: 3/7/95

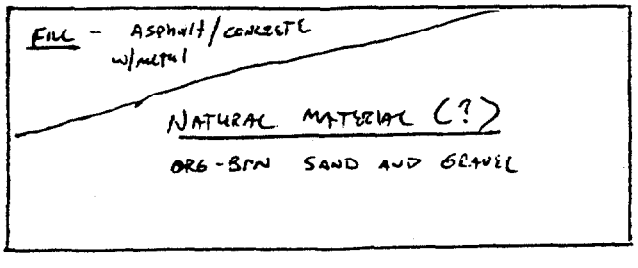
LOCATION: CENTER OF SITE, 100' SOUTH OF PERIMETER ROAD

FIELD GEOLOGIST: P. NIMMER / R. Willowbe

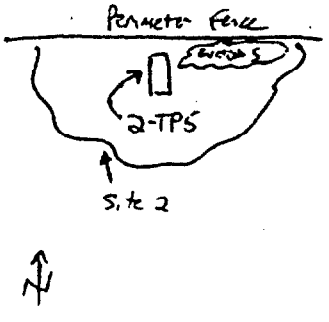
DEPTH (ft.)	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS
	FILL GM	POORLY SORTED SAND AND GRAVEL - Grey to		FILL
1.0		BLACK, w/ ASPHALT, CONCRETE, METAL		
2.0	NATURAL SM	BRN - ORG COARSE SAND w/ SILT AND		POSSIBLE NATURAL MATERIAL
		GRAVEL		
3.0				
4.0		AS ABOVE		
	TD=4'			

Test Pit Cross Section and / or Plan View

Pit & CROSS-SECTION



LOCATION MAP



REMARKS POSSIBLE FEATHER EDGE OF FILL MATERIAL.

PIT 40' LONG x 3' wide x 4' deep

PHOTO LOG

TEST PIT 2-TP5

PAGE 1 OF 1

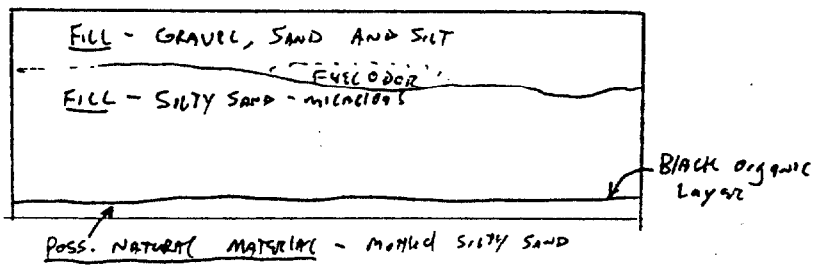
TEST PIT LOG **HALLIBURTON NUS**

PROJECT: White Oak TEST PIT NO.: 2-TP6
PROJECT NO.: 2295 DATE: 3/9/95
LOCATION: Near Entrance to Site 2 In Parking lot
FIELD GEOLOGIST: P. Nimmer / R. Willowbe

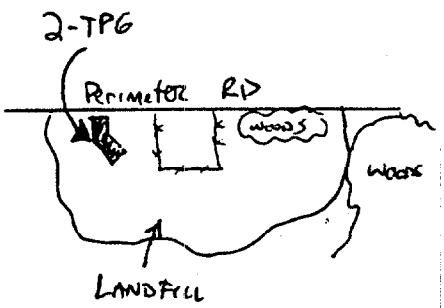
DEPTH (ft.)	LITHOLOGY CHANGE (Depth.ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS
		Poorly Graded SAND, SILT w/GRAVEL		FILL
1.0	GL	ORG-BRN.		
2.0				
		ORG BRN SILTY SAND w/mica		POSSIBLE FILL - FUEL ODOR
3.0				at 2.5'. HNu = 3 ppm
	SM			
4.0		AS ABOVE		
5.0	SM	ORGANIC LAYER @ 5' above BRN-ORG		Possible Natural Material. organ
	TD=5'	SILTY SAND, mottled		Layer may be Former Grass/Leaves.

Test Pit Cross Section and / or Plan View

TEST PIT CROSS SECTION



TEST PIT LOCATION



REMARKS
Pit 65' long x 4' wide x 5' ft deep

PHOTO LOG

TEST PIT 2-TP6

PAGE 1 OF 1

TEST PIT LOG **HALLIBURTON NUS**

PROJECT: White Oak TEST PIT NO.: 2-TP~~6~~ 7
PROJECT NO.: 2295 DATE: 3/9/95
LOCATION: Near Entrance to Site 2, in parking lot
FIELD GEOLOGIST: P. Nimmer / R. Willowbe

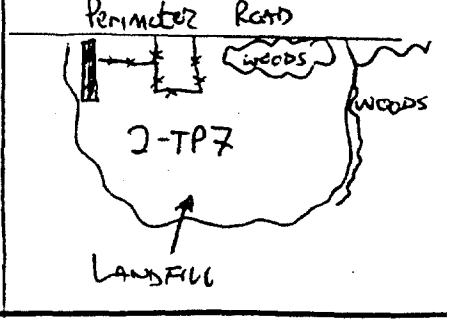
DEPTH (ft.)	LITHOLOGY CHANGE (Depth.ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS
X		GRAVEL, SAND AND SILT. ORG-BRN.		FILL
1.0		w/ Asphalt Pieces.		
2.0		As ABOVE		
3.0	GC	As ABOVE		
4.0				
5.0		As ABOVE		
	TD=5'			

Test Pit Cross Section and / or Plan View

TEST Pit CROSS-SECTION

FILL - GRAVEL + SAND w/ Asphalt Pieces.

TEST Pit LOCATION



REMARKS
Pit ' long x 4 ' wide x ' deep

PHOTO LOG

TEST PIT 2-TP7

PAGE 1 OF 1

Tetra Tech NUS, Inc.

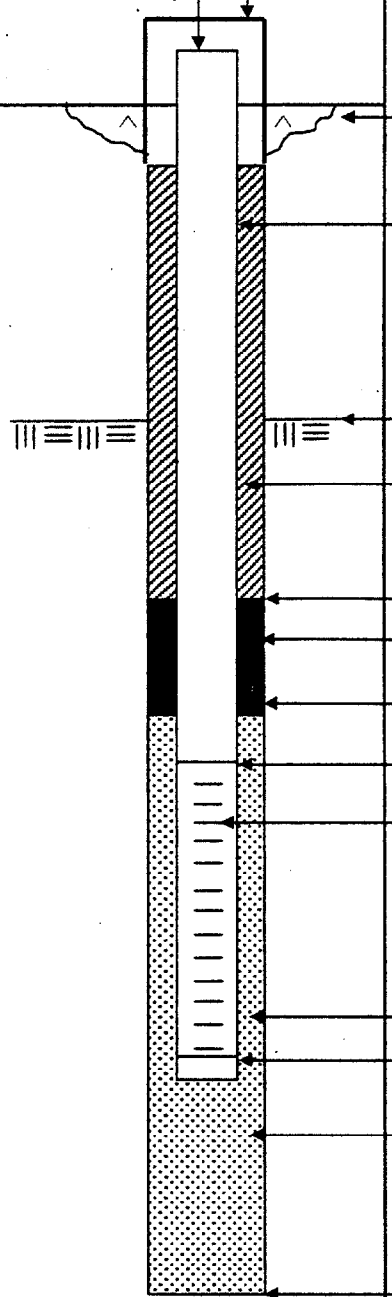
WELL No.: 2GW100

MONITORING WELL SHEET

PROJECT:	NSWC - WO RFI	DRILLING Co.:	Parratt Wolff	BORING No.:	2GW100
PROJECT No.:	CTO 298	DRILLER:	A. Chapel	DATE COMPLETED:	12/01/98
SITE:	2	DRILLING METHOD:	HSA	NORTHING:	
GEOLOGIST:	C. Laney	DEV. METHOD:		EASTING:	

Ground Elevation =

Datum:



Not to Scale

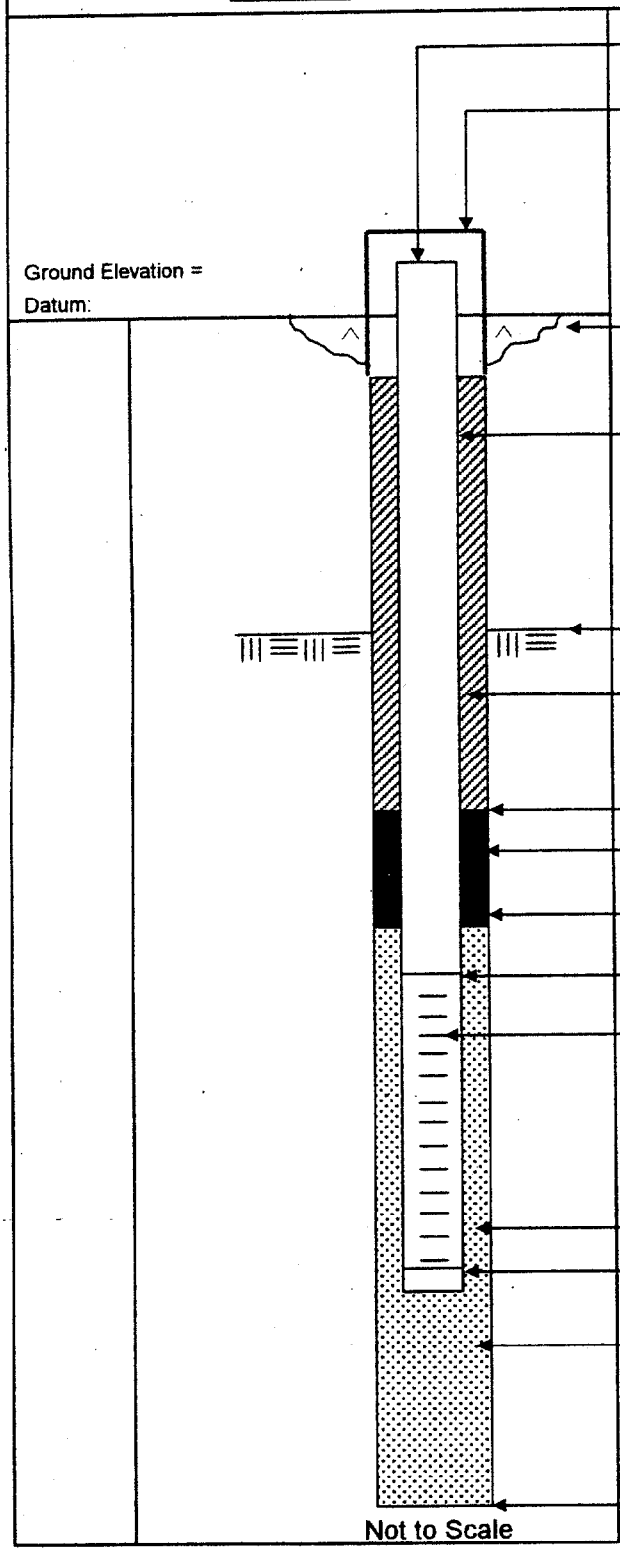
Elevation / Depth of Top of Riser:		/
Elevation / Height of Top of Surface Casing:		/
I.D. of Surface Casing:		
Type of Surface Casing:		
Type of Surface Seal:	Concrete	
I.D. of Riser:	2 inches	
Type of Riser:	PVC	
Borehole Diameter:	8 inches	
Elevation / Depth Top of Rock:		NA/ NA
Type of Backfill: grout	Cement/bentonite	
Elevation / Depth of Seal:		/ 32.0'
Type of Seal:	Bentonite chips	
Elevation / Depth of Top of Filter Pack:		/ 36.0'
Elevation / Depth of Top of Screen:		/ 38.5'
Type of Screen:	PVC	
Slot Size x Length:	0.10 X 10 feet	
I.D. of Screen:	2 inches	
Type of Filter Pack:	#1 silica	
Elevation / Depth of Bottom of Screen:		/ 48.5'
Elevation / Depth of Bottom of Filter Pack:		/ 48.5'
Type of Backfill Below Well:		
Elevation / Total Depth of Borehole:		/ 48.5'

Tetra Tech NUS, Inc.

WELL No.: 2GW101

MONITORING WELL SHEET

PROJECT:	NSWC - WO RFI	DRILLING Co.:	Parratt Wolff	BORING No.:	2GW101
PROJECT No.:	CTO 298	DRILLER:	R. Bush	DATE COMPLETED:	12/05/98
SITE:	2	DRILLING METHOD:	HSA	NORTHING:	
GEOLOGIST:	M. Shoemaker	DEV. METHOD:		EASTING:	



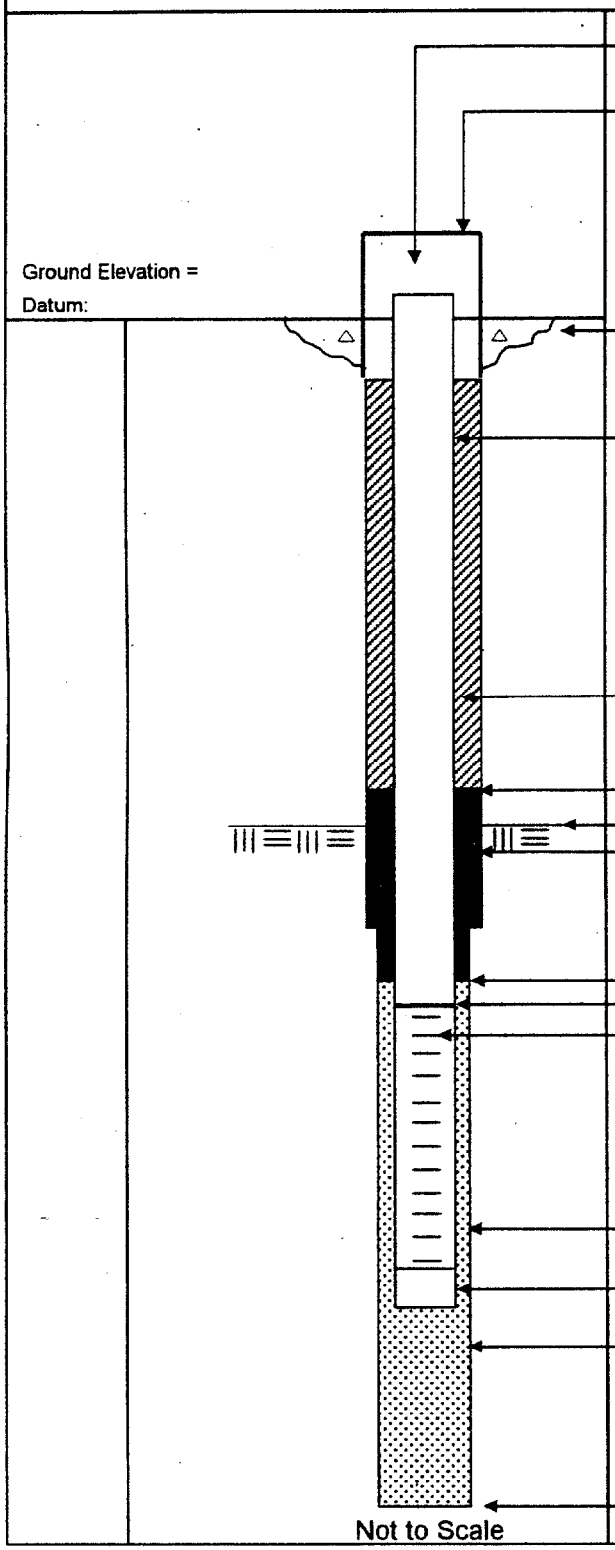
Elevation / Depth of Top of Riser:		/
Elevation / Height of Top of Surface Casing:		/
I.D. of Surface Casing:		
Type of Surface Casing:		
Type of Surface Seal:	Concrete	
I.D. of Riser:	2 inches	
Type of Riser:	PVC	
Borehole Diameter:	8 inches	
Elevation / Depth Top of Rock:		NA/ NA
Type of Backfill:	Cement/bentonite grout	
Elevation / Depth of Seal:		/ 9.5'
Type of Seal:	Bentonite chips	
Elevation / Depth of Top of Filter Pack:		/ 12.8'
Elevation / Depth of Top of Screen:		/ 15'
Type of Screen:	PVC	
Slot Size x Length:	0.10 X 10 feet	
I.D. of Screen:	2 inches	
Type of Filter Pack:	#1 silica	
Elevation / Depth of Bottom of Screen:		/ 25'
Elevation / Depth of Bottom of Filter Pack:		/ 25'
Type of Backfill Below Well:		
Elevation / Total Depth of Borehole:		/ 25'

Tetra Tech NUS, Inc.

WELL No.: 2GW102

MONITORING WELL SHEET

PROJECT:	NSWC - WO RFI	DRILLING Co.:	Parratt Wolff	BORING No.:	2GW102
PROJECT No.:	CTO 298	DRILLER:	R. Bush	DATE COMPLETED:	12/14/98
SITE:	2	DRILLING METHOD:	HSA/Air Rotary	NORTHING:	
GEOLOGIST:	M. Shoemaker	DEV. METHOD:		EASTING:	



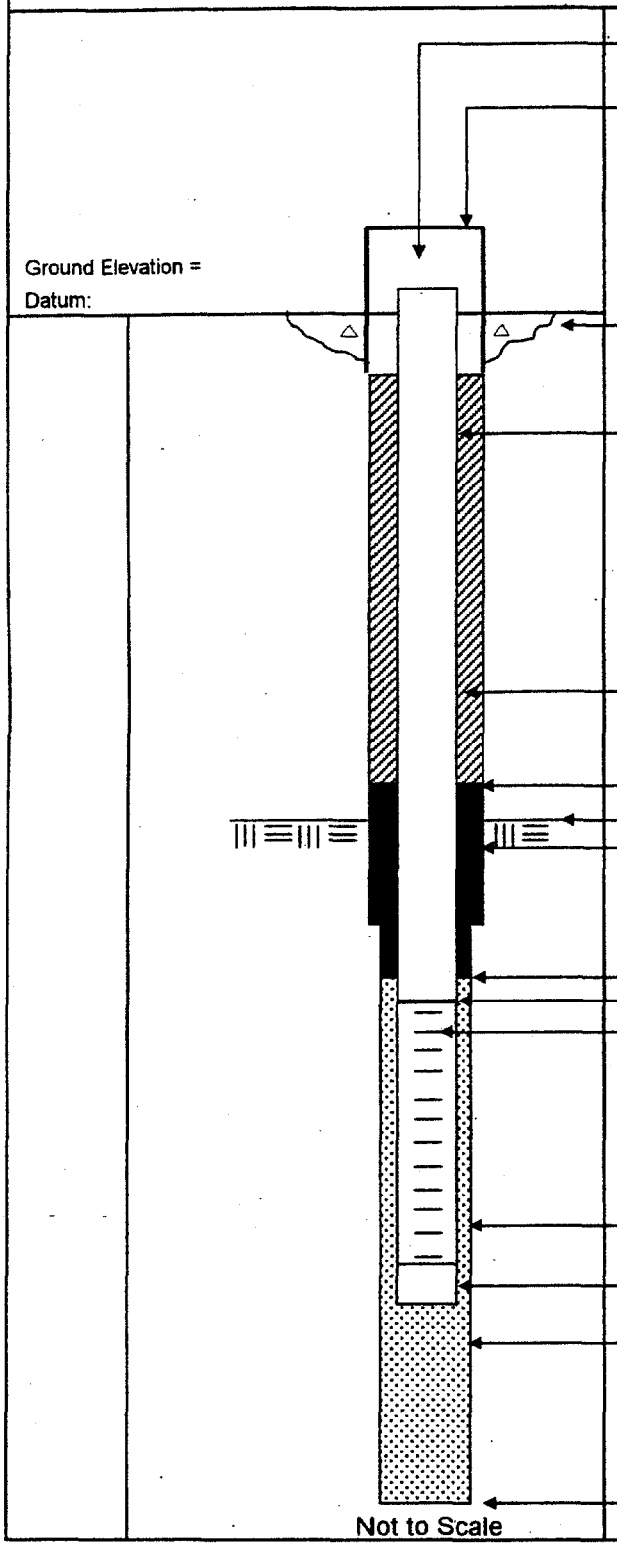
Elevation / Depth of Top of Riser:		/
Elevation / Height of Top of Surface Casing:		/
I.D. of Surface Casing:	4 inches	
Type of Surface Casing:	steel	
Type of Surface Seal:	Concrete	
I.D. of Riser:	2 inches	
Type of Riser:	PVC	
Borehole Diameter:	8 inches (0-10 ft) 5.75 " (10-38 ft)	
Type of Backfill: grout	Cement/bentonite	
Elevation / Depth of Seal:		/ 23.0'
Elevation / Depth Top of Rock:		/ 10.0'
Type of Seal:	Bentonite chips	
Elevation / Depth of Top of Filter Pack:		/ 26.0'
Elevation / Depth of Top of Screen:		/ 28.0'
Type of Screen:	PVC	
Slot Size x Length:	0.10 X 10 feet	
I.D. of Screen:	2 inches	
Type of Filter Pack:	#1 silica	
Elevation / Depth of Bottom of Screen:		/ 38.0'
Elevation / Depth of Bottom of Filter Pack:		/ 38.0'
Type of Backfill Below Well:		
Elevation / Total Depth of Borehole:		/ 38.0'

Tetra Tech NUS, Inc.

WELL No.: 2GW103

MONITORING WELL SHEET

PROJECT:	NSWC - WO RFI	DRILLING Co.:	Parratt Wolff	BORING No.:	2GW103
PROJECT No.:	CTO 298	DRILLER:	R. Bush	DATE COMPLETED:	12/16/98
SITE:	2	DRILLING METHOD:	HSA/Air Rotary	NORTHING:	
GEOLOGIST:	M. Shoemaker	DEV. METHOD:		EASTING:	



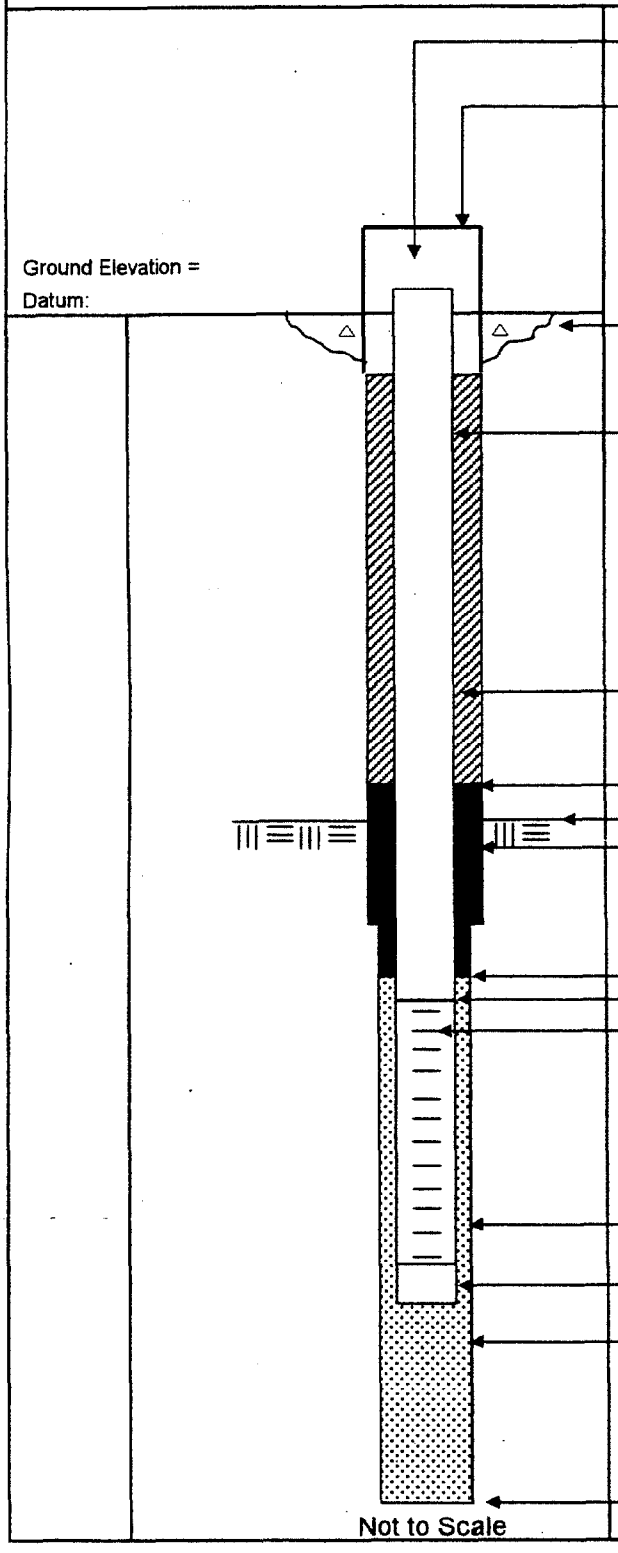
Elevation / Depth of Top of Riser:		/
Elevation / Height of Top of Surface Casing:		/
I.D. of Surface Casing:	4 inches	
Type of Surface Casing:	steel	
Type of Surface Seal:	Concrete	
I.D. of Riser:	2 inches	
Type of Riser:	PVC	
Borehole Diameter:	8 inches (0-10 ft) 5.75 " (10-25 ft)	
Type of Backfill: grout	Cement/bentonite	
Elevation / Depth of Seal:		/ 10.0'
Elevation / Depth Top of Rock:		/ 10.5'
Type of Seal:	Bentonite chips	
Elevation / Depth of Top of Filter Pack:		/ 13.0'
Elevation / Depth of Top of Screen:		/ 15.0'
Type of Screen:	PVC	
Slot Size x Length:	0.10 X 10 feet	
I.D. of Screen:	2 inches	
Type of Filter Pack:	#1 silica	
Elevation / Depth of Bottom of Screen:		/ 25.0'
Elevation / Depth of Bottom of Filter Pack:		/ 25.0'
Type of Backfill Below Well:		
Elevation / Total Depth of Borehole:		/ 25.0'

Tetra Tech NUS, Inc.

WELL No.: 2GW104

MONITORING WELL SHEET

PROJECT:	NSWC - WO RFI	DRILLING Co.:	Parratt Wolff	BORING No.:	2GW104
PROJECT No.:	CTO 298	DRILLER:	R. Bush	DATE COMPLETED:	12/17/98
SITE:	2	DRILLING METHOD:	HSA/Air Rotary	NORTHING:	
GEOLOGIST:	M. Shoemaker	DEV. METHOD:		EASTING:	



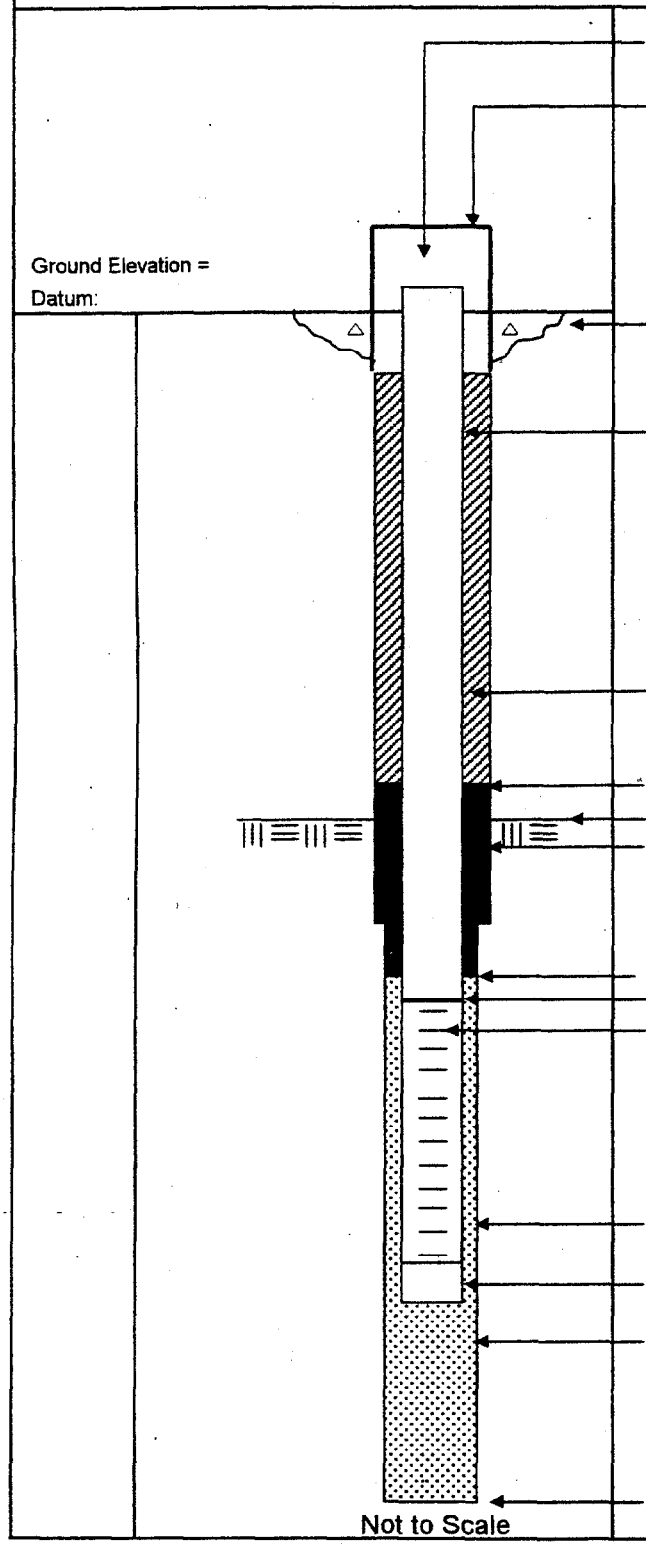
Elevation / Depth of Top of Riser:		/
Elevation / Height of Top of Surface Casing:		/
I.D. of Surface Casing:	4 inches	
Type of Surface Casing:	steel	
Type of Surface Seal:	Concrete	
I.D. of Riser:	2 inches	
Type of Riser:	PVC	
Borehole Diameter:	8 inches (0-6 ft) 5.75 " (6-22 ft)	
Type of Backfill: grout	Cement/bentonite	
Elevation / Depth of Seal:		/ 20.0'
Elevation / Depth Top of Rock:		/ 6.0'
Type of Seal:	Bentonite chips	
Elevation / Depth of Top of Filter Pack:		/ 23.0'
Elevation / Depth of Top of Screen:		/ 25.0'
Type of Screen:	PVC	
Slot Size x Length:	0.10 X 10 feet	
I.D. of Screen:	2 inches	
Type of Filter Pack:	#1 silica	
Elevation / Depth of Bottom of Screen:		/ 35.0'
Elevation / Depth of Bottom of Filter Pack:		/ 35.0'
Type of Backfill Below Well:		
Elevation / Total Depth of Borehole:		/ 35.0'

Tetra Tech NUS, Inc.

WELL No.: 2GW105

MONITORING WELL SHEET

PROJECT:	NSWC - WO RFI	DRILLING Co.:	Parratt Wolff	BORING No.:	2GW105
PROJECT No.:	CTO 298	DRILLER:	R. Bush	DATE COMPLETED:	12/16/98
SITE:	2	DRILLING METHOD:	HSA/Air Rotary	NORTHING:	
GEOLOGIST:	M. Shoemaker	DEV. METHOD:		EASTING:	



Elevation / Depth of Top of Riser:		/
Elevation / Height of Top of Surface Casing:		/
I.D. of Surface Casing:	4 inches	
Type of Surface Casing:	steel	
Type of Surface Seal:	Concrete	
I.D. of Riser:	2 inches	
Type of Riser:	PVC	
Borehole Diameter:	8 inches (0-20 ft) 5.75 " (20-38 ft)	
Type of Backfill:	Cement/bentonite grout	
Elevation / Depth of Seal:		/ 23.0'
Elevation / Depth Top of Rock:		/ 20.0'
Type of Seal:	Bentonite chips	
Elevation / Depth of Top of Filter Pack:		/ 25.8'
Elevation / Depth of Top of Screen:		/ 28.0'
Type of Screen:	PVC	
Slot Size x Length:	0.10 X 10 feet	
I.D. of Screen:	2 inches	
Type of Filter Pack:	#1 silica	
Elevation / Depth of Bottom of Screen:		/ 38.0'
Elevation / Depth of Bottom of Filter Pack:		/ 38.0'
Type of Backfill Below Well:		
Elevation / Total Depth of Borehole:		/ 38.0'

BORING LOG

PROJECT NAME: NSWC White Oak
PROJECT NUMBER: CTO - 298
DRILLING COMPANY: Parrot Wolff, Inc.
DRILLING RIG: Truck Mount
BORING NUMBER: 02 GW 100
DATE: 11/30/98
GEOLOGIST: Charles C. Lawey III
DRILLER: Arnold Chapel

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Sample Readings Remarks PID Reading (ppm)	PID/FID Reading (ppm): Sample ppm	Sampler BZ	Borehole**	Driller BZ**
1	1	10/10	1.8'	DRY	HARD	DK BRN GRAY	SANDY CLAY w/ Large Cobbles	CLS	0.0	0.0			
	2	10/10		"	"	ORG. BRN	SANDY CLAY with a lot of micas	CLS	0.0	0.0			
2	3	5/3	2.0'	"	Slightly Loose	ORG BRN	Silty SAND with a lot of micas & Noticeable Layering	SM	0.0	0.0			
	4	3/4		"	"	"	" "	SM	0.0	0.0			
3	5	6/9	Ø	—	—	—	NO RECOVERY	—	—	—			
	6	8/9		—	—	—	" "	—	—	—			
4	7	6/8	Ø	—	—	—	NO RECOVERY	—	—	—			
	8	8/8		—	—	—	" "	—	—	—			
5	9	13/16	2.0'	DRY	HARD	ORG BRN	Silty SAND with a lot of micas & Noticeable Layering	SM	0.0	0.0			
	10	15/15		"	"	"	" "	SM	0.0	0.0			
6	11	3/5	2.0'	"	"	"	Silty SAND with a lot of MICAS	SM	0.0	0.0			
	12	8/12		"	"	"	" "	SM	0.0	0.0			
7	13	11/16	2.0'	"	"	"	" "	SM	0.0	0.0			
	14	16/21		"	"	"	" "	SM	0.0	0.0			
8	15	9/11	2.0'	"	"	"	" "	SM	0.0	0.0			
	16	13/16		"	"	"	" "	SM	0.0	0.0			
9	17	23/20	2.0'	"	"	"	" "	SM	0.0	0.0			
	18	16/24		"	"	"	" "	SM	0.0	0.0			
Begin on → 12/1 10	19	24/30	1.6'	"	"	"	" "	SM	0.0	0.0			
	20	36/34		"	"	"	" "	SM	0.0	0.0			
11	21	10/19	2.0'	"	"	"	Silty Sand with a lot of micas & Noticeable Layering	SM	0.0	0.0			
	22	32/39		"	"	"	" "	SM	0.0	0.0			
12	23	30/41	2.0'	"	"	"	" "	SM	0.0	0.0			
	24	29/47		"	"	"	" "	SM	0.0	0.0			

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ✓ No _____ Well I.D. #: 02 GW 100

BORING LOG

PROJECT NAME: NSWC White Oak
PROJECT NUMBER: CTO-298
DRILLING COMPANY: Parrot Wolff, Inc.
DRILLING RIG: Truck Mount

BORING NUMBER: 02 GW 100
DATE: 12/1/98
GEOLOGIST: Charles C. Lawey III
DRILLER: Arnold Chapel

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Sample Readings Remarks PID Reading (ppm)	PID/FID Reading (ppm): Sample ppm	Sampler BZ	Borehole**	Drilling Area**
13	25	8/13	2.0'	Dry	Hard	Org. Brn	Silty Sand with a lot of micas & noticeable layering	SM	0.0	0.0			
	26	25/30		"	"	"	" "	SM	0.0	0.0			
14	27	14/24	2.0'	Slightly moist	"	"	" "	SM	0.0	0.0			
	28	28/30		"	"	"	" "	SM	0.0	0.0			
15	29	13/19	2.0'	Dry	"	"	Silty Sand with a lot of Large sized micas & noticeable layering	SM	0.0	0.0			
	30	27/47		Dry	"	"	" "	SM	0.0	0.0			
16	31	19/30	2.0'	"	"	"	Silty Sand with a lot of micas & noticeable layering	SM	0.0	0.0			
	32	25/28		"	"	"	" "	SM	0.0	0.0			
17	33	30/40	1.6'	"	"	"	" "	SM	0.0	0.0			
	34	50/3"		"	"	"	" "	SM	0.0	0.0			
18	35	32/50	1.6'	"	"	"	" "	SM	0.0	0.0			
	36	50/3"		"	"	"	" "	SM	0.0	0.0			
	37						No spoon taken	—	—	—			
	38						No spoon taken	—	—	—			
19	39	40/50	2.0'	Slightly moist	Hard	"	Silty Sand with a lot of micas & noticeable layering	SM	0.0	0.0			
	40			Moist	Slightly Loose	"	" "	SM	0.0	0.0			
20	41	40/50		Wet	Loose	"	" "	SM	0.0	0.0			
	42			Wet	Slightly Loose	"	" "	SM	0.0	0.0			
							Total depth = 48'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: A field decision is made after spoon #18 to auger to 40' & take a sample. A field decision is made to set the bottom of the well at 48' bgs.

Drilling Area Background (ppm): [illegible]

Converted to Well: Yes ✓ No ____ Well I.D. #: 02 GW 100

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO -298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME-850 ATV NSA

BORING NUMBER: 2 SB101
DATE: 12/5/98
GEOLOGIST: SNOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample PID	Sampler BZ	Borehole**	Driller BZ**
	1	4/7			DRY	TAN	SANDY SILT + QTZ	GM		0.0			
	2	12/15	14		LOOSE		PEBBLES			0.0			
	3	12/12			—	—	NO RECOVERY	—		—			
	4	11/12	0		—	—				—			
	5	14/14			COHESIVE	MED BRN	MICACEOUS CLAYEY SAND	SC		0.0			
	6	17/20	24		DRY		SAPROLITE			0.0			
	7	24/27			DAMP	"	SAME	SC		0.0			
	8	25/26	22		COHESIVE SOIL	"				0.0			
	9	29/28			COHESIVE	TAN TO	SAPROLITE, MICACEOUS	SM		0.0			
	10	42/46	24		FIRM	GRAY	SILTY SAND			0.0			
	11	18/30			"	MED TO	MICACEOUS SILTY SAND, SAPROLITE	SM		0.0			
	12	33/60	24		"	DARK BRN				0.0			
	13	36/29			"	"	SAME	SM		0.0			
	14	43/41	24		"	"				0.0			
	15	9/14			"	TAN TO	MICACEOUS SILTY SAND	SC		0.0			
	16	18/20	24		"	GRAY	FOLIATED, SOMEWHAT CLAYEY			0.0			
	17	18/17			SOFT	GRAY WHT	FOLIATED CLAYEY SAND	SC		0.0			
	18	19/22	24		COHESIVE MOIST	DK BRN	MICACEOUS SAPROLITE			0.0			
	19	11/17			"	"	SAME, SPOON IS	SC		0.0			
	20	24/42	22		WET	"	WET			0.0			
	21	16/21			"	"	SAME, ABUNDANT DARK	SC		0.0			
	22	16/18	24		"	"	MINERALS			0.0			
	23	12/15			"	"	SAME	SC		0.0			
	24	17/21	24		"	"				0.0			
	25						TD = 25'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 026W101

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME-850 ATV NSA

BORING NUMBER: 2SB106
DATE: 12/7/98
GEOLOGIST: SHOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample ppm	Sampler BZ	Borehole**	Driller BZ**
	1	1/1			MOIST SOFT	DK BRN	ORGANIC-RICH SANDY SILT	SM		0.0			
	2	20/9	12							0.0			
	3	1/2			"	BRN TO	MICACEOUS SILTY SAND	SM		0.0			
	4	6/12	16		"	GRAY				0.0			
	5	20/60			DRY	TAN BRN	SILTY SAND MICACEOUS	SM		0.0			
	6	75/105	24		FIRM	DK GRAY	SAPROLITE			0.0			
	7	58/-					REFUSAL @ 6.5'						
	8												
	9												
	10												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm):

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME-850 ATV HSA

BORING NUMBER: 02SB104
DATE: 12/5/98
GEOLOGIST: SHOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (pp Sample ppm	Sampler BZ	Borehole**
	1				SOFT	MED BRN	SANDY SILT, FGW	GM		0.0		
	2		7				PEBBLES			0.0		
	3				"	TAN	SAND + COBBLES	GW		0.0		
	4		11		"					0.0		
	5				—	—	NO RECOVERY	—		—		
	6		0		—	—				—		
	7				DRY	GRAY BLK	MICACEOUS SAPROLITE, SILTY SAND	SM		0.0		
	8		24		LOOSE	BRN	ABUNDANT DARK MINERALS FOLIATED			0.0		
	9				SATURATED		SAPROLITE	SM		0.0		
	10		24							0.0		

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME-850 ATV HSA

BORING NUMBER: 02SB109
DATE: 12/6/98
GEOLOGIST: SNOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample PPM	Sampler BZ	Borehole**	Driller BZ**
	1	3/4			DRY	BRN	SANDY SILT, SOME PEBBLES	GM		0.0			
	2	10/13	21		FIRM					0.0			
	3	12/17			DRY	RED BRN	SILTY SAND, MICACEOUS	SM		0.0			
	4	20/22	20		FIRM					0.0			
	5	15/26			"	"	SAME	SM		0.0			
	6	26/28	13		"	"				0.0			
	7	23/32			DRY	RED BRN	SAME	SM		0.0			
	8	32/41	19		SOFT	+ TAN				0.0			
	9	13/12			"	"	SAME	SM		0.0			
	10	15/32	18		"	"				0.0			

* When rock coring, enter rock brokeness.

** Include monitor reading in 5 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME-850 ATV HSA

BORING NUMBER: 0258108
DATE: 12/6/98
GEOLOGIST: SHOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample ppm	Sampler BZ	Borehole**	Driller BZ**
	1	2/3			DRY	TAN	MICACEOUS SILTY SAND	SM		0.0			
	2	6/8	18		FRIABLE					0.0			
	3	9/14			DRY	TAN BRN	SILTY SAND GRADES TO SAPROLITE	SM		0.0			
	4	31/36	17		SHALEY TEX.	BLK GRAY	FOLIATED, SHALEY TEXTURE			0.0			
	5	25/100	12		DRY LOOSE	GRAY	SILTY SAND MICACEOUS ~~SANDY~~ SAPROLITE	SM		0.0			
	6	—/—	—		—	—	—	—	—	—			
	7	55/75	12				SAME	SM		0.0			
	8	—/—					AUGER REFUSAL @ 7' BEDROCK						
	9												
	10												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: NGWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: BARRATT-WOLFF
DRILLING RIG: CME-850 ATV NSA

BORING NUMBER: 0258103
DATE: 12/5/98
GEOLOGIST: SNODEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample PPM	Sampler BZ	Borehole**	Driller BZ**
	1	5/8			LOOSE	TAN	SILTY SAND + PEA GRAVEL	SM		0.0			
	2	13/17	8		DRY					0.0			
	3	16/15			SOFT	TAN	GRADES TO SILTY SAND,	SM		0.0			
	4	13/12	21		DRY		MICACEOUS			0.0			
	5	15/19			FRIABLE	RED BRN	MICACEOUS CLAYEY SAND SAPROLITE,	SC		0.0			
	6	26/32	24		DRY		SHALEY TEXTURE			0.0			
	7	37/36			LOOSE	TAN	SAPROLITE, SILTY SAND	SM		0.0			
	8	34/38	22		DRY		MICACEOUS			0.0			
	9	42/50			"	"	SAME	SM		0.0			
	10	41/44	24		"	"	"			0.0			

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: GTO-298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME-850 ATV NSA

BORING NUMBER: 258102
DATE: 12/5/98
GEOLOGIST: SHOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length (INCHES)	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample Port	Sampler BZ	Borehole**	Drilling area
	1	1/3			MOIST	TAN	SANDY SILT, FLECKS OF	ML		0.0			
	2	2/3	7		SOFT		MICA			0.0			
	3	2/6			"	TAN	GRADES TO MICACEOUS	SM		0.0			
	4	2/2	17		"		SILTY SAND, SOME QTZ FRAGS			0.0			
	5	4/5			"	TAN + GRAY	SAPROLITE, MICACEOUS	SM		0.0			
	6	6/12	22		"		SILTY SAND, SOME CLAY			0.0			
	7	10/11			"	"	SAME	SM		0.0			
	8	12/12	24		"	"				0.0			
	9	15/44			SOFT	TAN	SAME	SM		0.0			
	10	28/20	24		DRY	RED BRN	GRADES TO RED-BROWN SAPROLITE			0.0			

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME 850 ATV

BORING NUMBER: 26W102
DATE: 12/8/98 - 12/14/98
GEOLOGIST: SNOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	INCHES Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample AIR	Sampler BZ	Borehole**	Driller BZ**
	1	1/2	12		SOFT	MED BRN	SILTY SAND	SM		0.0			
	2	2/1			MOIST								
	3	2/6	3"		"	TAN + BROWN	MICACEOUS SILTY SAND	SM		0.0			
	4	6/9			"								
	5	10/14	14"		SATUR.	GRAY BLK	SILTY SAND, FOLIATED	SM		0.0			
	6	15/21				BRN	SAPROLITE						
	7	19/24	18		"	"	SAME	SM		0.0			
	8	24/24			"	"							
	9	14/60			LOOSE	TAN BLK	GRADES TO SANDY	SM		0.0			
	10	50/1				GRAY	SAPROLITE, DARK MINERALS						
				ROCK			BEDROCK						
							CUTTINGS ARE						
							GRAY MICACEOUS						
							MATERIAL						
	38						TD: 38'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: HSA TO 10' BGS (8"); 5 3/4" AIR ROTARY TO 25'; 3 3/4" AIR ROTARY TO 38'

Drilling Area Background (ppm): [illegible]

Converted to Well: Yes X No _____ Well I.D. #: 26W102

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: BARRATT-WOLFF
DRILLING RIG: CME-850 ATV HSA

BORING NUMBER: 02GW103
DATE: 12/6/98
GEOLOGIST: SHOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample ppm	Sampler BZ	Borehole**	Driller BZ**
	1	2/3	16		SOFT	TAN	SILTY SAND, MICACEOUS	SM		0.0			
	2	4/7								0.0			
	3	13/18	19		DRY	TAN TO	SAPROLITE - SILTY SAND	SM		0.0			
	4	27/25			FIRM	GRAY	MICACEOUS			0.0			
	5	44/45	24		"	"	SAND	SM		0.0			
	6	70/75			"	"				0.0			
	7	—/—	—		—	—	NO SAMPLE	—	—	—			
	8	—/—	—		—	—	—	—	—	—			
	9	37/50/1	6		DRY SOFT	TAN DARK	SAPROLITE - DARK MINERALS	SM		0.0			
	10	—/—			—	—	—			—			
	11	34/50/1	4		"	"	SAND	SM		0.0			
	12						AUGER REFUSAL @ 10.5' - BEDROCK						
							CUTTINGS ARE GRAY TO TAN						
							MICACEOUS SAND						
	25						TD = 25'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 8" HSA TO 12' BGS; SET 4" STEEL CASING; ~~5 3/4"~~ MLS 3 3/4" AIR ROTARY TO 25'

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: 2GW103

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO-298
DRILLING COMPANY: PARRATT-WOLFF
DRILLING RIG: CME-850 ATV USA
BORING NUMBER: 02GW105
DATE: 12/6/98
GEOLOGIST: SHOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length INCHES	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample PPM	Sampler BZ	Borehole**	Driller BZ**
	1	3/5			DRY	TAN	SANDY SILT	ML		0.0			
	2	7/13	8		SOFT					0.0			
	3	13/17			DRY	MED BRN	MICACEOUS SANDY SILT	ML		0.0			
	4	20/20	15		FIRM					0.0			
	5	20/21			"	"	SAME, MICA FLAKES	ML		0.0			
	6	26/27	11		"	"	BECOME LARGER			0.0			
	7	29/46			DRY	MED BRN	MICACEOUS SILTY SAND	SM		0.0			
	8	51/72	24		LOOSE	TAN BLK				0.0			
	9	68/70			DRY	"	SAPROLITE, CLAYEY SAND	SC		0.0			
	10	72/89	22		FIRM	"	FOLIATED, MICACEOUS			0.0			
	11	12/24			"	"	SAME	SC		0.0			
	12	31/26	22		"	"				0.0			
	13	20/28			SOFT DAMP	"	SAME, INCREASE IN DARK MINERALS	SC		0.0			
	14	35/42	24		FRIABLE ~~FIR~~	"				0.0			
	15	7/19			SOFT	"	SAME, SILTY SAND	SM		0.0			
	16	21/24	20			"				0.0			
	17	~~31/39~~ ~~65/24~~			SOFT	"	SAME	SM		0.0			
	18	~~31/65~~	12		MOIST	"				0.0			
	19	20/38			"	"	SAME	SM		0.0			
	20	44/50/2	18		"	"				0.0			
		60/1			—	—	NO RECOVERY - BEDROCK @ 20'			—			
		—	0		—	—				—			
	38						TD = 38'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 8" NSA TO 21.5' BGS; SET 4" STEEL CASING; 3¾" AIR ROTARY TO 38'

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 2GW105

BORING LOG

PROJECT NAME: NSWC WHITE OAK
PROJECT NUMBER: CTO - 298
DRILLING COMPANY: PARRATT - WOLFF
DRILLING RIG: CME - 850 ATV
BORING NUMBER: 2GW104
DATE: 12/15/98 - 12/17/98
GEOLOGIST: SNOEMAKER
DRILLER: RON BUSH

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Inches Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample Area	Sampler BZ	Borehole**	Driller BZ**
	1	H / H	14		SOFT	DK BRN	MICACEOUS SILTY SAND	SM		0.0			
	2	1 / 2			MOIST								
	3	1 / 1	14		SOFT	MED BRN	MICACEOUS SANDY CLAY	SC		0.0			
	4	3 / 3			MOIST		SOME ORGANICS + PEBBLES						
	5	37 / 44	16		BRITTLE	GRAY BLK	FOLIATED SAPROLITE			0.0			
	6	41 / 55				BRN TAN	WITH LARGE MICA FLAKES						
	7	50/0	0				NO RECOVERY						
	8						BEDROCK @ 6'						
	35						TD = 35'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 8" HSA TO 6'; SET 6" TEMP CASING; 5 3/4" AIR ROTARY TO 22'; 4" STEEL CASING SET; 3 3/4" AIR ROTARY TO 35'. H = WEIGHT OF HAMMER

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No _____ Well I.D. #: 2GW104

APPENDIX B

GEOTECHNICAL LABORATORY TEST RESULTS

GTS *Geotechnical Testing Services Inc.*
Independent CQA Laboratories

103 Coraopolis Rd. -- Coraopolis, PA 15108 -- 1-800-853-7309 -- Fax 412-771-5336

Transmittal

Friday, December 22, 2000

Mr. Scott Nesbit
Tetra Tech NUS, Inc.
Foster Plaza VII
661 Anderson Drive
Pittsburgh, PA 15220

Laboratory Testing Results

Project Name:	Former NSWC White Oak, MD
GTS Project No.:	20465
Date Received:	

Thank you for choosing GTS for your geotechnical laboratory testing needs. Please find the results for the above referenced project. The testing was conducted in general accordance with ASTM standards and industry practice.

GTS is pleased to be of service and trusts that our efforts have contributed to the success of your project. Should you have any questions or concerns or if we may be of further assistance, please call!

This report shall not be reproduced, except in full, without the written approval of Geotechnical Testing Services, Inc.

Sincerely,

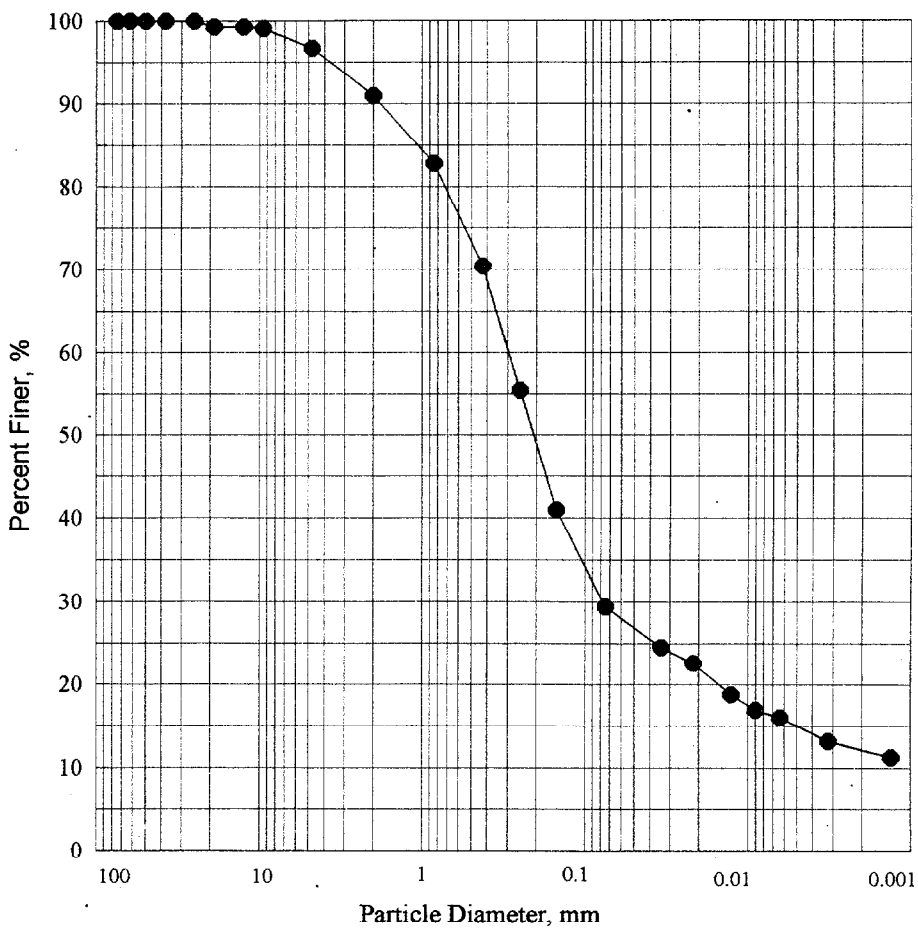
Steven V. Grimaldi
President

Disclosure:
These test results reflect the properties and characteristics only of the sample tested and GTS accepts no responsibility as to its correlation to field conditions. GTS makes no claims or warranties, expressed or implied, as to the suitability of the materials for their intended use and accepts no responsibility for the interpretation of the test results reported.

PARTICLE-SIZE ANALYSIS OF SOILS

Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-1
		Lab Sample No.	20465001

USCS Description BROWNISH YELLOW SILTY SAND
USCS Group Symbol SM
USDA Classification BROWNISH YELLOW SANDY LOAM



US Std. Sieve Size	Particle Diameter (mm)	Percent Finer (%)
3"	75	100.0
2 1/2"	62.5	100.0
2"	50	100.0
1 1/2"	37.5	100.0
1"	25	100.0
3/4"	19	99.4
1/2"	12.5	99.4
3/8"	9.5	99.1
#4	4.75	96.8
#10	2.00	91.0
#20	0.85	82.8
#40	0.425	70.3
#60	0.250	55.4
#100	0.150	40.9
#200	0.075	29.4
NA	0.0339	24.5
NA	0.0216	22.6
NA	0.0126	18.8
NA	0.0090	17.0
NA	0.0064	16.0
NA	0.0032	13.2
NA	0.0013	11.3

SOIL CLASSIFICATION

USCS CLASSIFICATION

Corrected for 100% Passing a 3" Sieve

% Gravel (-3" & +#4)	3.2	D60, mm	0.294
% Sand (-#4 & +#200)	67.4	D30, mm	0.078
% Fines (-#200)	29.4	D10, mm	NA
% Plus #200 (-3")	70.6	Cc	NA
		Cu	NA

USCS Description
BROWNISH YELLOW SILTY SAND

USCS Group Symbol	**Atterberg Limits Group Symbol**
SM	ML

Auxiliary Information	Wt Ret, gm	% Retained	% Finer
12" Sieve - 300 mm	0	0	100.0
6" Sieve - 150 mm	0	0	100.0
3" Sieve - 75 mm	0	0	100.0

USDA CLASSIFICATION

Particle Size (mm)	Percent Finer (%)	Percent of Each Component (Material)	(%)	Corrected Percent of -2.0 mm Material for USDA
100	100.0			
		Gravel	9.0	0.0
2	91.0			
		Sand	64.1	70.5
0.05	26.9			
		Silt	14.7	16.2
0.002	12.2			
		Clay	12.2	13.4

USDA Classification
BROWNISH YELLOW SANDY LOAM

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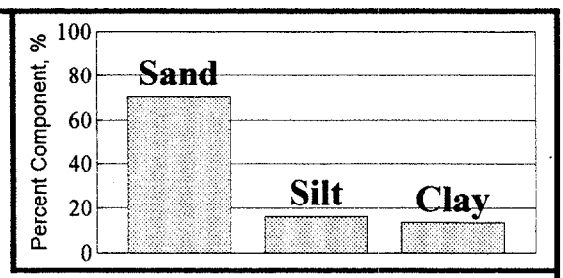
USDA CLASSIFICATION CHART

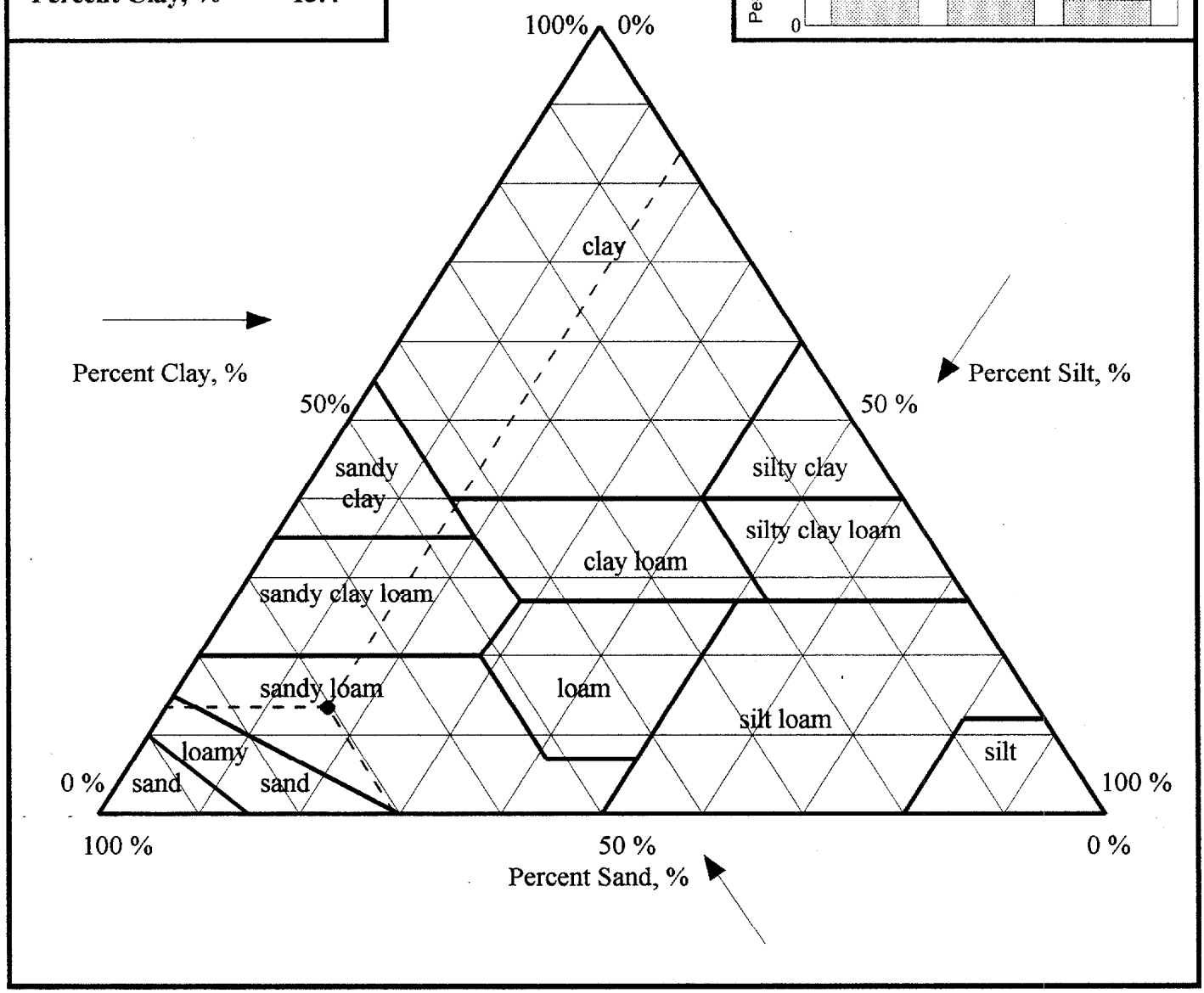
Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-1
		Lab Sample No.	20465001

USCS Description	BROWNISH YELLOW SILTY SAND
USCS Group Symbol	SM
USDA Classification	BROWNISH YELLOW SANDY LOAM

Corrected for 0% gravel

Percent Gravel, %	**0.0**
Percent Sand, %	**70.5**
Percent Silt, %	**16.2**
Percent Clay, %	**13.4**





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PARTICLE-SIZE ANALYSIS OF SOILS

Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-1
		Lab Sample No.	20465001

USCS Description: BROWNISH YELLOW SILTY SAND
USCS Group Symbol: SM
USDA Classification: BROWNISH YELLOW SANDY LOAM

MECHANICAL SIEVE ANALYSIS

As-Received Sample	
Correction For Split Samples (J-Factor)	
+3/4" Air Dry Wt, gm	20
-3/4 Wet Wt., gm	3908
-3/4 Dry Wt., gm,	3141.2
Total Sample Dry Wt, gm	3161.7
Passing -3/4" (J-Factor)	0.994
Split Sample, -3/4"	
Tare No.	953
Wt. Tare + WS., gm	745.3
Wt. Tare + DS., gm	618.73
Wt. Tare, gm	100.26
Wt. of DS., gm	518.47
Water Content, %	24.4
Wt. of +#200 Sample, gm	365.2
Wt. of -#200 Sample, gm	153.3

US Std. Sieve Size	Sieve Opening (mm)	Wt. of Soil Retained (gm)	Percent Retained (%)	Cumulative Percent Retained	Percent Finer (%)	Final Percent Finer
3"	75.0	0	0.0	0.0	100.0	100.0
2 1/2"	62.5	0	0.0	0.0	100.0	100.0
2"	50.0	0	0.0	0.0	100.0	100.0
1 1/2"	37.5	0	0.0	0.0	100.0	100.0
1"	25.0	0	0.0	0.0	100.0	100.0
3/4"	19.0	20.48	0.6	0.6	99.4	99.4
1/2"	12.5	0	0.0	0.0	100.0	99.4
3/8"	9.5	1.32	0.3	0.3	99.7	99.1
#4	4.75	12.21	2.4	2.6	97.4	96.8
#10	2.00	30.28	5.8	8.4	91.6	91.0
#20	0.85	42.59	8.2	16.7	83.3	82.8
#40	0.425	65.09	12.6	29.2	70.8	70.3
#60	0.250	77.67	15.0	44.2	55.8	55.4
#100	0.150	75.62	14.6	58.8	41.2	40.9
#200	0.075	60.39	11.6	70.4	29.6	29.4
Pan	-	153.3	29.6	100.0	-	-

The final percent finer combines the gradation of the plus 3/4" and minus 3/4" material.

HYDROMETER ANALYSIS

Hydrometer Sample Weight	
Tare No.	950
Wt. Tare + DS., gm	120.04
Wt. Tare, gm	99.62
Wt. Dispers., gm	5
Wt. Dry Soil, gm	15.42
Hydrometer Bulb Serial #	174448
K Factor	0.01335
Composite Correction	7
a Factor	0.99
Average Test Temp, °C	20.8
Specific Gravity, Assumed	2.7

Elapsed Time (min.)	R Measured	Composite Correction	R Corrected	Percent Finer (%)	Particle Diameter (mm)	Adjusted % Finer (%)
0	NA	NA	NA	NA	NA	NA
2	20	7.0	13.0	83.4	0.0339	24.5
5	19	7.0	12.0	77.0	0.0216	22.6
15	17	7.0	10.0	64.1	0.0126	18.8
30	16	7.0	9.0	57.7	0.0090	17.0
60	15.5	7.0	8.5	54.5	0.0064	16.0
240	14	7.0	7.0	44.9	0.0032	13.2
1440	13	7.0	6.0	38.5	0.0013	11.3

The adjusted percent finer is corrected for the percent passing the -#200 sieve.

SOIL CLASSIFICATION

USCS CLASSIFICATION

Corrected for 100% Passing a 3" Sieve

% Gravel (-3" & +#4)	3.2	D60, mm	0.294
% Sand (-#4 & +#200)	67.4	D30, mm	0.078
% Fines (-#200)	29.4	D10, mm	NA
% Plus #200 (-3")	70.6	Cc	NA
		Cu	NA

USCS Description
BROWNISH YELLOW SILTY SAND

USCS Group Symbol	Atterberg Limits Group Symbol
SM	ML

Auxiliary Information	Wt Ret, gm	% Retained	% Finer
12" Sieve - 300 mm	0	0.0	100.0
6" Sieve - 150 mm	0	0.0	100.0
3" Sieve - 75 mm	0	0.0	100.0

USDA CLASSIFICATION

Particle Size (mm)	Percent Finer (%)	Percent of Each Component (Material)	(%)	Corrected Percent of -2.0 mm Material for USDA
100	100.0			
		Gravel	9.0	0.0
2	91.0			
		Sand	64.1	70.5
0.05	26.9			
		Silt	14.7	16.2
0.002	12.2			
		Clay	12.2	13.4

USDA Classification
BROWNISH YELLOW SANDY LOAM

Input Validation: Reviewed By: Date Tested: 12/13/00

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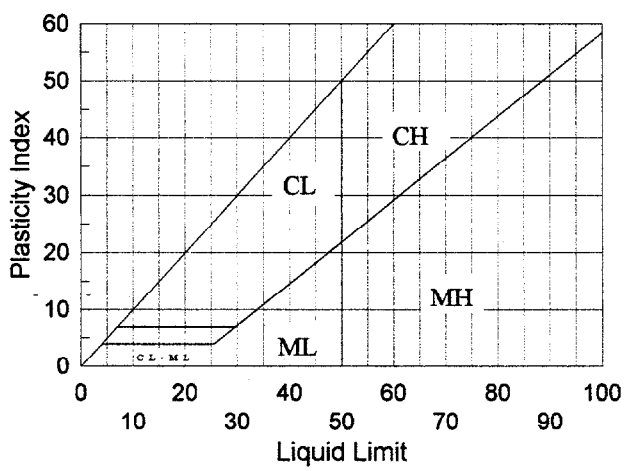
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS
ASTM D 4318-95a (SOP-20)

Client	Tetra Tech NUS, Inc.	Boring No.	12/05/00
Client Project	Former NSWC White Oak, MD	Depth(ft)	NA
Project No.	20465	Sample No.	TP-1
		Lab Sample No.	20465001
Soil Description *(-#40 Fraction)*	NON-PLASTIC MATERIAL		

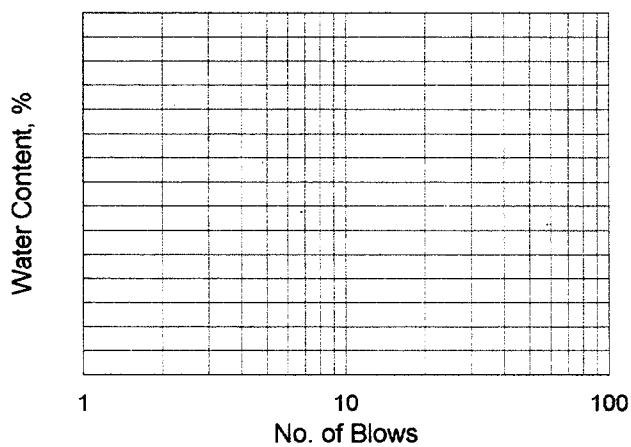
AS-RECEIVED W.C.		*SAMPLE SUMMARY*	
Tare Number	953	Liquid Limit, %	NA
Wt. Tare & WS, gm	745.3	Plastic Limit %	NA
Wt. Tare & DS, gm	618.73	Plasticity Index, %	NA
Wt. Water, gm	126.57	USCS Symbol	NP (NON-PLASTIC)
Wt. Tare, gm	100.26	*(-#40 Fraction)*	
Wt. DS, gm	518.47		
Water Content, %	24.4	Sample Preparation: Air Dry Method	

PLASTIC LIMIT				*LIQUID LIMIT*				
Test Number	1	2	3	1	2	3	4	5
Tare Number								
Wt. Tare & WS, gm								
Wt. Tare & DS, gm								
Wt. Water, gm								
Wt. Tare, gm								
Wt. DS, gm								
Water Content, %								
No. of Blows								

PLASTICITY CHART



FLOW CURVE



Input Validation: Reviewed By: Date Tested: 12/13/00

(DCN: CR-3; Created: 12/26/98; Revision: Original; Approved: SVG; Original File Name: limit-np.wk4)

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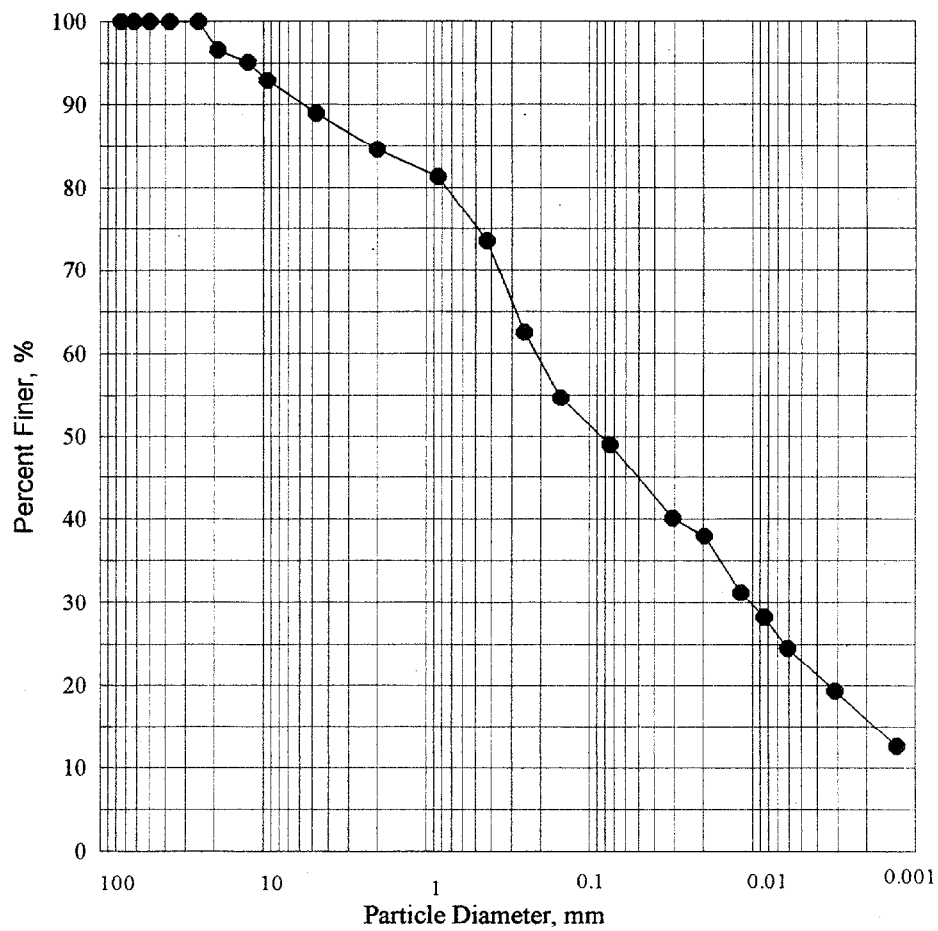
PARTICLE-SIZE ANALYSIS OF SOILS

Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-2
		Lab Sample No.	20465002

USCS Description: YELLOWISH BROWN CLAYEY SAND
USCS Group Symbol: SC
USDA Classification: YELLOWISH BROWN LOAM



US Std. Sieve Size	Particle Diameter (mm)	Percent Finer (%)
3"	75	100.0
2 1/2"	62.5	100.0
2"	50	100.0
1 1/2"	37.5	100.0
1"	25	100.0
3/4"	19	96.6
1/2"	12.5	95.1
3/8"	9.5	92.9
#4	4.75	89.0
#10	2.00	84.6
#20	0.85	81.3
#40	0.425	73.5
#60	0.250	62.6
#100	0.150	54.7
#200	0.075	49.0
NA	0.0308	40.2
NA	0.0197	37.9
NA	0.0117	31.2
NA	0.0084	28.3
NA	0.0061	24.5
NA	0.0031	19.3
NA	0.0013	12.6

SOIL CLASSIFICATION

USCS CLASSIFICATION

Corrected for 100% Passing a 3" Sieve

% Gravel (-3" & +#4)	11.0	D60, mm	0.212
% Sand (-#4 & +#200)	40.0	D30, mm	0.010
% Fines (-#200)	49.0	D10, mm	NA
% Plus #200 (-3")	51.0	Cc	NA
		Cu	NA

USCS Description
YELLOWISH BROWN CLAYEY SAND

USCS Group Symbol	**Atterberg Limits**
SC	CL, LL=33, PL=20, PI=13

Auxiliary Information	Wt Ret, gm	% Retained	% Finer
12" Sieve - 300 mm	0	0	100.0
6" Sieve - 150 mm	0	0	100.0
3" Sieve - 75 mm	0	0	100.0

USDA CLASSIFICATION

Particle Size (mm)	Percent Finer (%)	Percent of Each Component (Material)	(%)	Corrected Percent of -2.0 mm Material for USDA
100	100.0			
		Gravel	15.4	0.0
2	84.6			
		Sand	39.6	46.9
0.05	45.0			
		Silt	29.0	34.3
0.002	16.0			
		Clay	16.0	18.9

USDA Classification
YELLOWISH BROWN LOAM

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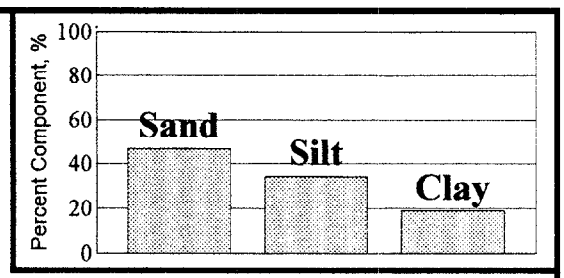
USDA CLASSIFICATION CHART

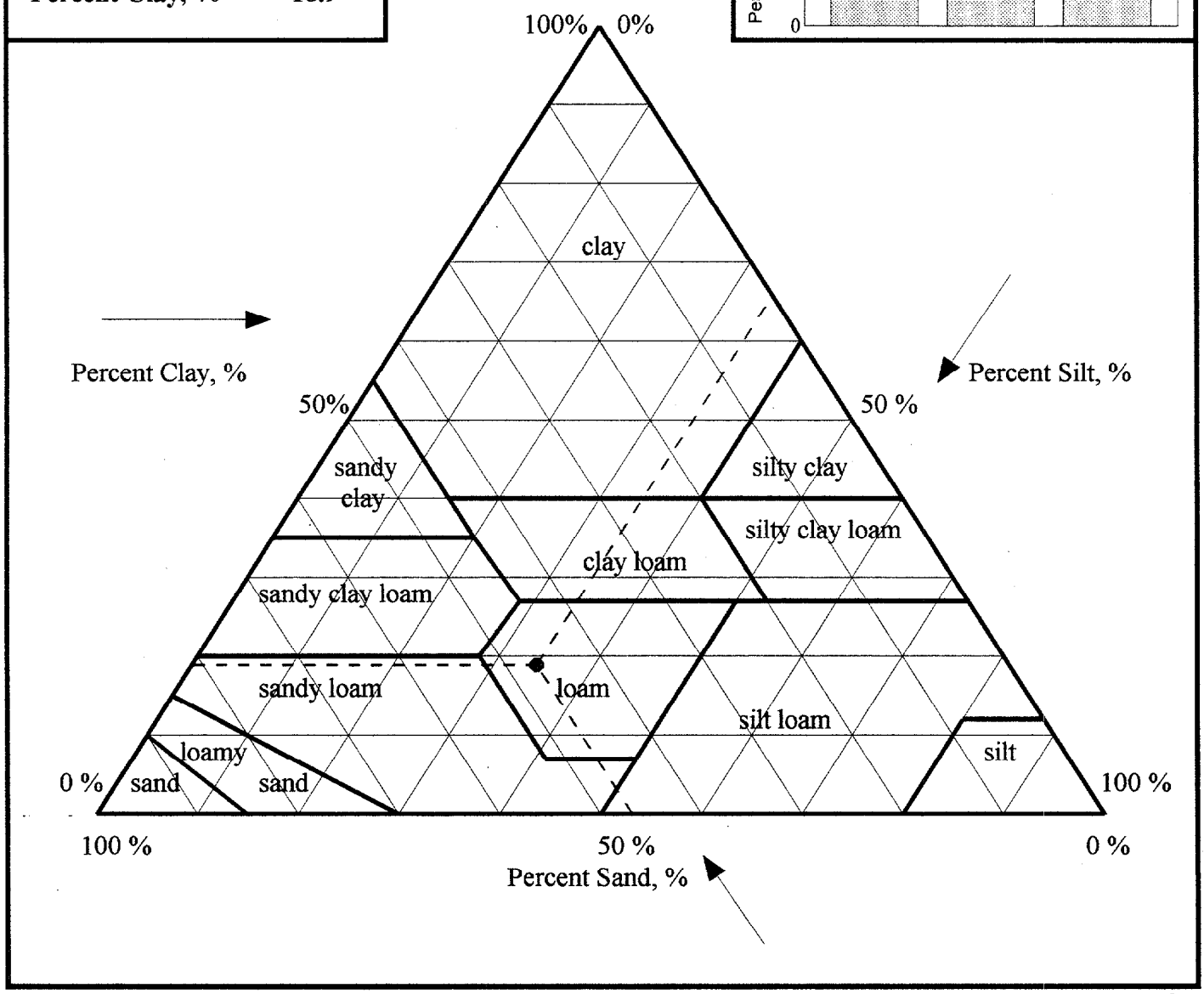
Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-2
		Lab Sample No.	20465002

USCS Description	YELLOWISH BROWN CLAYEY SAND
USCS Group Symbol	SC
USDA Classification	YELLOWISH BROWN LOAM

Corrected for 0% gravel

Percent Gravel, %	**0.0**
Percent Sand, %	**46.9**
Percent Silt, %	**34.3**
Percent Clay, %	**18.9**





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PARTICLE-SIZE ANALYSIS OF SOILS

Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-2
		Lab Sample No.	20465002

USCS Description: YELLOWISH BROWN CLAYEY SAND
USCS Group Symbol: SC
USDA Classification: YELLOWISH BROWN LOAM

MECHANICAL SIEVE ANALYSIS

As-Received Sample	
Correction For Split Samples (J-Factor)	
+3/4" Air Dry Wt, gm	128
-3/4 Wet Wt., gm	4118
-3/4 Dry Wt., gm,	3642.6
Total Sample Dry Wt, gm	3770.9
Passing -3/4" (J-Factor)	0.966
Split Sample, -3/4"	
Tare No.	302
Wt. Tare + WS., gm	836.5
Wt. Tare + DS., gm	751.72
Wt. Tare, gm	102.09
Wt. of DS., gm	649.63
Water Content, %	13.1
Wt. of +#200 Sample, gm	320.1
Wt. of -#200 Sample, gm	329.6

US Std. Sieve Size	Sieve Opening (mm)	Wt. of Soil Retained (gm)	Percent Retained (%)	Cumulative Percent Retained	Percent Finer (%)	Final Percent Finer
3"	75.0	0	0.0	0.0	100.0	100.0
2 1/2"	62.5	0	0.0	0.0	100.0	100.0
2"	50.0	0	0.0	0.0	100.0	100.0
1 1/2"	37.5	0	0.0	0.0	100.0	100.0
1"	25.0	0	0.0	0.0	100.0	100.0
3/4"	19.0	128.27	3.4	3.4	96.6	96.6
1/2"	12.5	9.95	1.5	1.5	98.5	95.1
3/8"	9.5	15.13	2.3	3.9	96.1	92.9
#4	4.75	26.27	4.0	7.9	92.1	89.0
#10	2.00	29.18	4.5	12.4	87.6	84.6
#20	0.85	22.26	3.4	15.8	84.2	81.3
#40	0.425	52.45	8.1	23.9	76.1	73.5
#60	0.250	73.58	11.3	35.2	64.8	62.6
#100	0.150	53.09	8.2	43.4	56.6	54.7
#200	0.075	38.17	5.9	49.3	50.7	49.0
Pan	-	329.55	50.7	100.0	-	-

The final percent finer combines the gradation of the plus 3/4" and minus 3/4" material.

HYDROMETER ANALYSIS

Hydrometer Sample Weight	
Tare No.	906
Wt. Tare + DS., gm	138.06
Wt. Tare, gm	100.48
Wt. Dispers., gm	5
Wt. Dry Soil, gm	32.58
Hydrometer Bulb Serial #	174448
K Factor	0.01335
Composite Correction	7
a Factor	0.99
Average Test Temp, °C	20.8
Specific Gravity, Assumed	2.7

Elapsed Time (min.)	R Measured	Composite Correction	R Corrected	Percent Finer (%)	Particle Diameter (mm)	Adjusted % Finer (%)
0	NA	NA	NA	NA	NA	NA
2	34	7.0	27.0	82.0	0.0308	40.2
5	32.5	7.0	25.5	77.4	0.0197	37.9
15	28	7.0	21.0	63.7	0.0117	31.2
30	26	7.0	19.0	57.7	0.0084	28.3
60	23.5	7.0	16.5	50.1	0.0061	24.5
240	20	7.0	13.0	39.5	0.0031	19.3
1440	15.5	7.0	8.5	25.8	0.0013	12.6

The adjusted percent finer is corrected for the percent passing the -#200 sieve.

SOIL CLASSIFICATION

USCS CLASSIFICATION

Corrected for 100% Passing a 3" Sieve

% Gravel (-3" & +#4)	11.0	D60, mm	0.212
% Sand (-#4 & +#200)	40.0	D30, mm	0.010
% Fines (-#200)	49.0	D10, mm	NA
% Plus #200 (-3")	51.0	Cc	NA
		Cu	NA

USCS Description
YELLOWISH BROWN CLAYEY SAND

USCS Group Symbol	Atterberg Limits
SC	CL, LL=33, PL=20, PI=13

Auxiliary Information	Wt Ret, gm	% Retained	% Finer
12" Sieve - 300 mm	0	0.0	100.0
6" Sieve - 150 mm	0	0.0	100.0
3" Sieve - 75 mm	0	0.0	100.0

USDA CLASSIFICATION

Particle Size (mm)	Percent Finer (%)	Percent of Each Component (Material)	(%)	Corrected Percent of -2.0 mm Material for USDA
100	100.0			
		Gravel	15.4	0.0
2	84.6			
		Sand	39.6	46.9
0.05	45.0			
		Silt	29.0	34.3
0.002	16.0			
		Clay	16.0	18.9

USDA Classification
YELLOWISH BROWN LOAM

Input Validation: Reviewed By: Date Tested: 12/13/00

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LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS

Client	Tetra Tech NUS, Inc.	Boring No.	12/05/00
Client Project	Former NSWC White Oak, MD	Depth(ft)	NA
Project No.	20465	Sample No.	TP-2
		Lab Sample No.	20465002

Soil Description: YELLOWISH BROWN LEAN CLAY
(-#40 Fraction)

AS-RECEIVED W.C.	
Tare Number	302
Wt. Tare & WS, gm	836.5
Wt. Tare & DS, gm	751.72
Wt. Water, gm	84.78
Wt. Tare, gm	102.09
Wt. DS, gm	649.63
Water Content, %	13.1

SAMPLE SUMMARY	
Liquid Limit (LL), %	33
Plastic Limit (PL), %	20
Plasticity Index (PI), %	13
USCS Symbol (-#40 Fraction)	CL
Sample Preparation:	Air Dry Method
Liquidity Index, %	-53.5%
Clay Fraction (% 2 microns)	16.0%
Skempton's Activity (A)	0.81

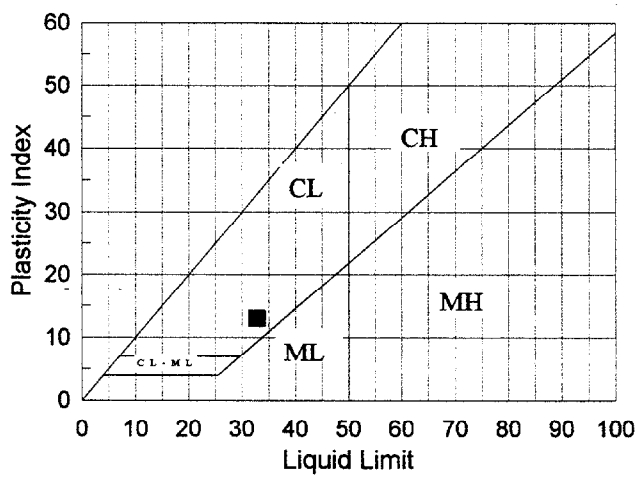
PLASTIC LIMIT

Test Number	1	2	3
Tare Number	130	140	120
Wt. Tare & WS, gm	18.54	18.45	18.6
Wt. Tare & DS, gm	17.42	17.3	17.46
Wt. Water, gm	1.12	1.15	1.14
Wt. Tare, gm	11.75	11.53	11.76
Wt. DS, gm	5.67	5.77	5.70
Water Content, %	19.8	19.9	20.0

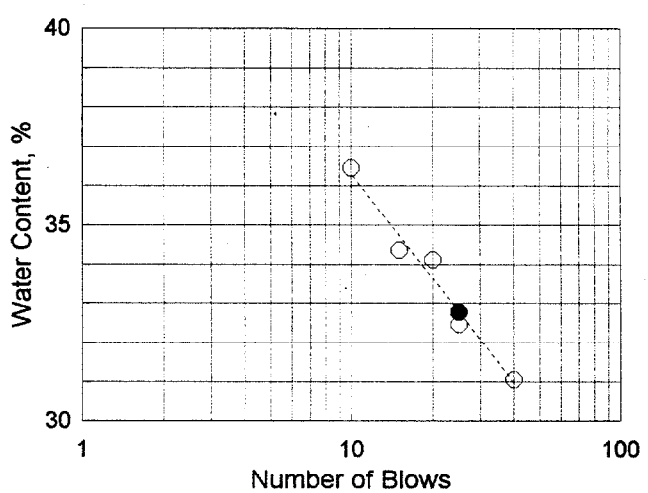
LIQUID LIMIT

Test Number	1	2	3	4	5
Tare Number	443	513	467	440	423
Wt. Tare & WS, gm	16.52	17.24	17.05	16.8	16.95
Wt. Tare & DS, gm	15	15.58	15.46	15.3	15.49
Wt. Water, gm	1.52	1.66	1.59	1.5	1.46
Wt. Tare, gm	10.83	10.75	10.8	10.68	10.79
Wt. DS, gm	4.17	4.83	4.66	4.62	4.7
Water Content, %	36.5	34.4	34.1	32.5	31.1
No. of Blows	10	15	20	25	40

PLASTICITY CHART



FLOW CURVE



Input Validation: 8 Reviewed By: 8 Date Tested: 12/13/00

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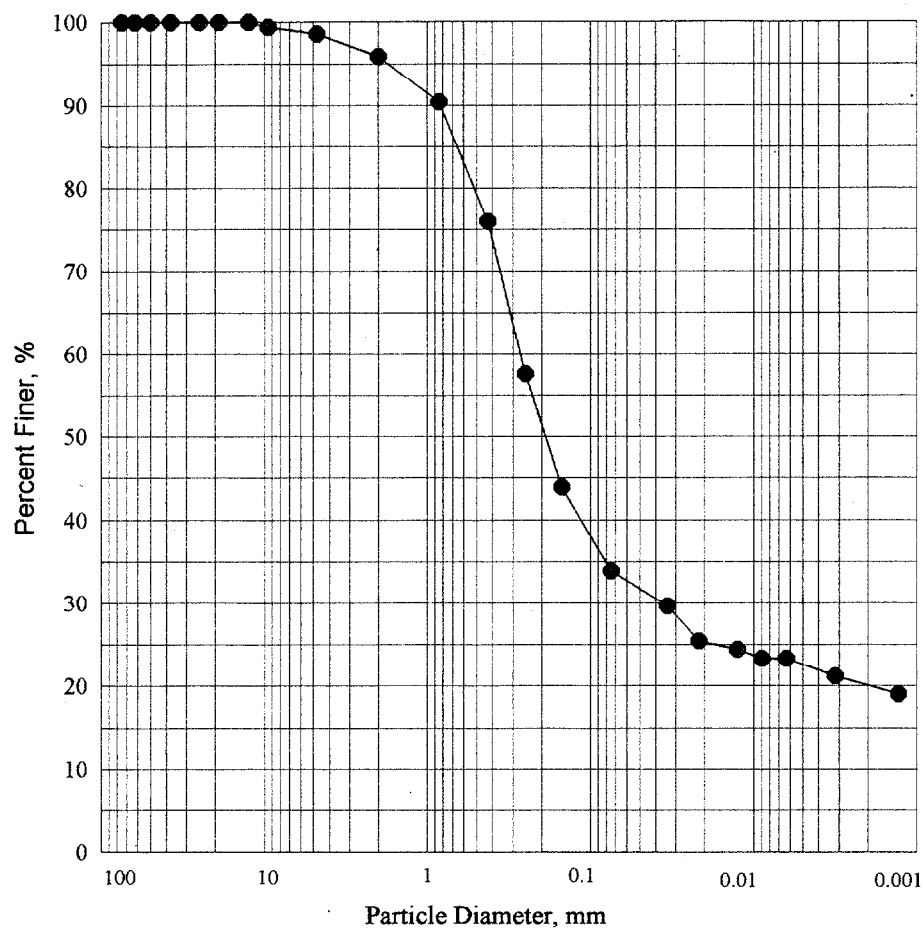
PARTICLE-SIZE ANALYSIS OF SOILS

Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-3
		Lab Sample No.	20465003

USCS Description STRONG BROWN SILTY SAND
USCS Group Symbol SM
USDA Classification STRONG BROWN SANDY CLAY LOAM



US Std. Sieve Size	Particle Diameter (mm)	Percent Finer (%)
3"	75	100.0
2 1/2"	62.5	100.0
2"	50	100.0
1 1/2"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
1/2"	12.5	100.0
3/8"	9.5	99.5
#4	4.75	98.6
#10	2.00	95.9
#20	0.85	90.4
#40	0.425	76.0
#60	0.250	57.6
#100	0.150	43.9
#200	0.075	33.9
NA	0.0337	29.7
NA	0.0216	25.4
NA	0.0125	24.4
NA	0.0089	23.3
NA	0.0063	23.3
NA	0.0032	21.2
NA	0.0013	19.1

SOIL CLASSIFICATION

USCS CLASSIFICATION

Corrected for 100% Passing a 3" Sieve

% Gravel (-3" & +#4)	1.4	D60, mm	0.268
% Sand (-#4 & +#200)	64.7	D30, mm	0.036
% Fines (-#200)	33.9	D10, mm	NA
% Plus #200 (-3")	66.1	Cc	NA
		Cu	NA

USCS Description
STRONG BROWN SILTY SAND

USCS Group Symbol	**Atterberg Limits Group Symbol**
SM	ML

Auxiliary Information	Wt Ret, gm	% Retained	% Finer
12" Sieve - 300 mm	0	0	100.0
6" Sieve - 150 mm	0	0	100.0
3" Sieve - 75 mm	0	0	100.0

USDA CLASSIFICATION

Particle Size (mm)	Percent Finer (%)	Percent of Each Component (Material)	(%)	Corrected Percent of -2.0 mm Material for USDA
100	100.0			
		Gravel	4.1	0.0
2	95.9			
		Sand	64.1	66.9
0.05	31.8			
		Silt	11.6	12.1
0.002	20.1			
		Clay	20.1	21.0

USDA Classification
STRONG BROWN SANDY CLAY LOAM

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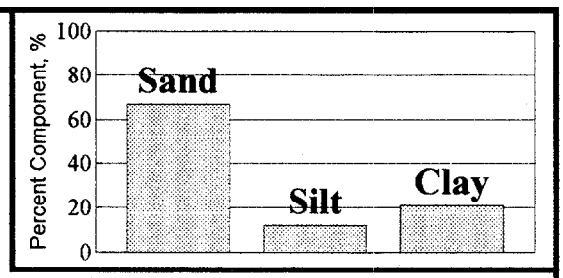
USDA CLASSIFICATION CHART

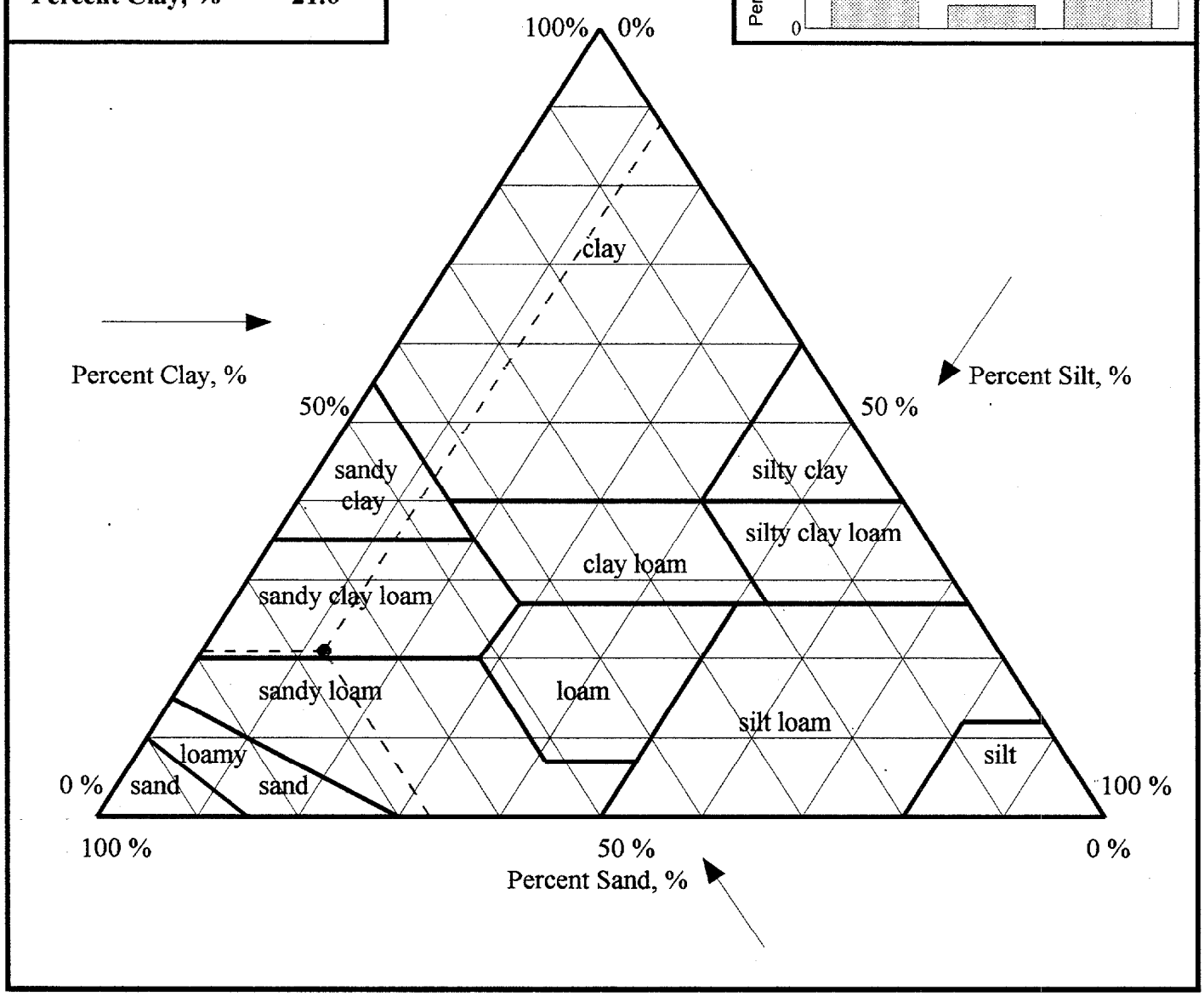
Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-3
		Lab Sample No.	20465003

USCS Description	STRONG BROWN SILTY SAND
USCS Group Symbol	SM
USDA Classification	STRONG BROWN SANDY CLAY LOAM

Corrected for 0% gravel

Percent Gravel, %	**0.0**
Percent Sand, %	**66.9**
Percent Silt, %	**12.1**
Percent Clay, %	**21.0**





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PARTICLE-SIZE ANALYSIS OF SOILS

Client	Tetra Tech NUS, Inc.	Boring	12/05/00
Client Project	Former NSWC White Oak, MD	Depth	NA
Project No.	20465	Sample	TP-3
		Lab Sample No.	20465003

USCS Description STRONG BROWN SILTY SAND
USCS Group Symbol SM
USDA Classification STRONG BROWN SANDY CLAY LOAM

MECHANICAL SIEVE ANALYSIS

As-Received Sample	
Correction For Split Samples (J-Factor)	
+3/4" Air Dry Wt, gm	0
100% Passing 3/4 Sieve. No Correction Needed.	
Passing -3/4" (J-Factor)	1.000
Split Sample, -3/4"	
Tare No.	955
Wt. Tare + WS., gm	834.1
Wt. Tare + DS., gm	756.31
Wt. Tare, gm	100.69
Wt. of DS., gm	655.62
Water Content, %	11.9
Wt. of +#200 Sample, gm	433.4
Wt. of -#200 Sample, gm	222.3

US Std. Sieve Size	Sieve Opening (mm)	Wt. of Soil Retained (gm)	Percent Retained (%)	Cumulative Percent Retained	Percent Finer (%)	Final Percent Finer
3"	75.0	0	0.0	0.0	100.0	100.0
2 1/2"	62.5	0	0.0	0.0	100.0	100.0
2"	50.0	0	0.0	0.0	100.0	100.0
1 1/2"	37.5	0	0.0	0.0	100.0	100.0
1"	25.0	0	0.0	0.0	100.0	100.0
3/4"	19.0	0	0.0	0.0	100.0	100.0
1/2"	12.5	0	0.0	0.0	100.0	100.0
3/8"	9.5	3.56	0.5	0.5	99.5	99.5
#4	4.75	5.6	0.9	1.4	98.6	98.6
#10	2.00	17.81	2.7	4.1	95.9	95.9
#20	0.85	35.72	5.4	9.6	90.4	90.4
#40	0.425	94.9	14.5	24.0	76.0	76.0
#60	0.250	120.12	18.3	42.4	57.6	57.6
#100	0.150	90.23	13.8	56.1	43.9	43.9
#200	0.075	65.42	10.0	66.1	33.9	33.9
Pan	-	222.26	33.9	100.0	-	-

The final percent finer combines the gradation of the plus 3/4" and minus 3/4" material.

HYDROMETER ANALYSIS

Hydrometer Sample Weight	
Tare No.	313
Wt. Tare + DS., gm	121.31
Wt. Tare, gm	100.49
Wt. Dispers., gm	5
Wt. Dry Soil, gm	15.82
Hydrometer Bulb Serial #	174448
K Factor	0.01335
Composite Correction	7
a Factor	0.99
Average Test Temp, °C	20.8
Specific Gravity, Assumed	2.7

Elapsed Time (min.)	R Measured	Composite Correction	R Corrected	Percent Finer (%)	Particle Diameter (mm)	Adjusted % Finer (%)
0	NA	NA	NA	NA	NA	NA
2	21	7.0	14.0	87.5	0.0337	29.7
5	19	7.0	12.0	75.0	0.0216	25.4
15	18.5	7.0	11.5	71.9	0.0125	24.4
30	18	7.0	11.0	68.8	0.0089	23.3
60	18	7.0	11.0	68.8	0.0063	23.3
240	17	7.0	10.0	62.5	0.0032	21.2
1440	16	7.0	9.0	56.3	0.0013	19.1

The adjusted percent finer is corrected for the percent passing the -#200 sieve.

SOIL CLASSIFICATION

USCS CLASSIFICATION

Corrected for 100% Passing a 3" Sieve

% Gravel (-3" & +#4)	1.4	D60, mm	0.268
% Sand (-#4 & +#200)	64.7	D30, mm	0.036
% Fines (-#200)	33.9	D10, mm	NA
% Plus #200 (-3")	66.1	Cc	NA
		Cu	NA

USCS Description
STRONG BROWN SILTY SAND

USCS Group Symbol	Atterberg Limits Group Symbol
SM	ML

Auxiliary Information	Wt Ret, gm	% Retained	% Finer
12" Sieve - 300 mm	0	0.0	100.0
6" Sieve - 150 mm	0	0.0	100.0
3" Sieve - 75 mm	0	0.0	100.0

USDA CLASSIFICATION

Particle Size (mm)	Percent Finer (%)	Percent of Each Component (Material)	(%)	Corrected Percent of -2.0 mm Material for USDA
100	100.0			
		Gravel	4.1	0.0
2	95.9			
		Sand	64.1	66.9
0.05	31.8			
		Silt	11.6	12.1
0.002	20.1			
		Clay	20.1	21.0

USDA Classification
STRONG BROWN SANDY CLAY LOAM

Input Validation: Reviewed By: Date Tested: 12/13/00

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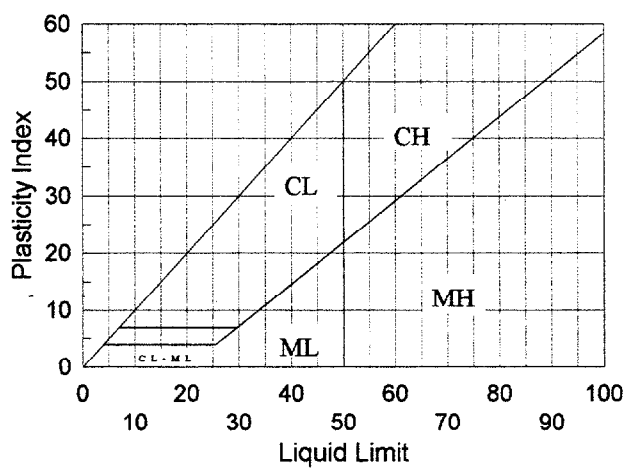
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS
ASTM D 4318-95a (SOP-20)

Client	Tetra Tech NUS, Inc.	Boring No.	12/05/00
Client Project	Former NSWC White Oak, MD	Depth(ft)	NA
Project No.	20465	Sample No.	TP-3
		Lab Sample No.	20465003
Soil Description *(-#40 Fraction)*	NON-PLASTIC MATERIAL		

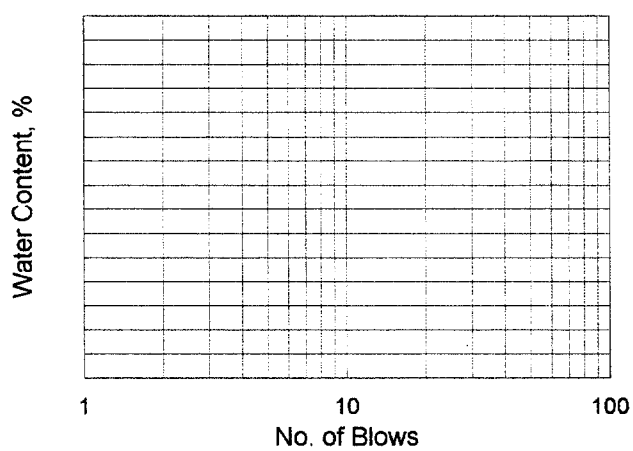
AS-RECEIVED W.C.		*SAMPLE SUMMARY*	
Tare Number	955	Liquid Limit, %	NA
Wt. Tare & WS, gm	834.1	Plastic Limit %	NA
Wt. Tare & DS, gm	756.31	Plasticity Index, %	NA
Wt. Water, gm	77.79	USCS Symbol	NP (NON-PLASTIC)
Wt. Tare, gm	100.69	*(-#40 Fraction)*	
Wt. DS, gm	655.62		
Water Content, %	11.9	Sample Preparation: Air Dry Method	

PLASTIC LIMIT				*LIQUID LIMIT*				
Test Number	1	2	3	1	2	3	4	5
Tare Number								
Wt. Tare & WS, gm								
Wt. Tare & DS, gm								
Wt. Water, gm								
Wt. Tare, gm								
Wt. DS, gm								
Water Content, %								
No. of Blows								

PLASTICITY CHART



FLOW CURVE



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(DCN: CR-3; Created: 12/26/98; Revision: Original; Approved: SVG; Original File Name: limit-np.wk4)

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APPENDIX C

VOLUME CALCULATIONS

C.1 CUT AND FILL VOLUMES

C.2 LIMIT OF WASTE CONSOLIDATION

C.3 LIMIT OF COVER

C.1 CUT AND FILL VOLUMES

Spectra Precision Software, Inc.
5901 Peachtree-Dunwoody Rd., Suite A-300
Atlanta, GA 30328-5548
800-235-4972
Fri Mar 23 17:50:06 2001

PROJECT: C:\My Documents\white_oak\topo2.pro

DTM TO DTM VOLUME

1.05 AC ← SHEET 2
5.74 AC ← SHEET 3
6.79 AC ✓ OK

Cut and Fill Volumes

Volume limited to boundary record 114788
Area within boundary: 295800.4173 Sq. Ft. ← AREA = 6.79 AC
Total triangulated area: 295800.4183 Sq. Ft.

Shrinkage/swell factors: Cut 1.0000 Fill 1.0000

Original DTM Layer Name	# of Points	Final DTM Layer Name	# of Points
EX-TOPO	18,612	REG MERGE 2	755

Cut Volume (Cu. Yd.)	Cumulative Cut Volume	Fill Volume (Cu. Yd.)	Cumulative Fill Volume
37,270.3	37,270.3	41,774.1	41,774.1

Net Difference: 4503.8 Cu. Yd. BORROW

REGRADED WASTE LAYER CAPACITY

8,303.2 ← SHEET 2 → 1,598.7
28,977.7 ← SHEET 3 → 40,175.5
37,280.9 CY 41,774.2

Δ = 4,493.3 CY

SAY 4,500 CY

Spectra Precision Software, Inc.
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Fri Mar 23 17:46:21 2001

PROJECT: C:\My Documents\white_oak\topo2.pro

DTM TO DTM VOLUME

Cut and Fill Volumes

Volume limited to boundary record 114771
Area within boundary: 45785.2345 Sq. Ft. ← AREA = 1.05 AC
Total triangulated area: 45785.2345 Sq. Ft.

Shrinkage/swell factors: Cut 1.0000 Fill 1.0000

Original DTM Layer Name	# of Points	Final DTM Layer Name	# of Points
EX-TOPO	18,612	REG MERGE 2	755

Cut Volume (Cu. Yd.)	Cumulative Cut Volume	Fill Volume (Cu. Yd.)	Cumulative Fill Volume
8,303.2	8,303.2	1,598.7	1,598.7

Net Difference: 6704.5 Cu. Yd. WASTE

EXCAVATION WEST OF EXISTING STREAM ℄

EXCESS CUT = 6,704.5 CY

Spectra Precision Software, Inc.
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PROJECT: C:\My Documents\white_oak\topo2.pro

DTM TO DTM VOLUME

Cut and Fill Volumes

Volume limited to boundary record 114790
Area within boundary: 250181.7711 Sq. Ft. ← AREA = 5.74 AC
Total triangulated area: 250181.7721 Sq. Ft.

Shrinkage/swell factors: Cut 1.0000 Fill 1.0000

Original DTM Layer Name	# of Points	Final DTM Layer Name	# of Points
EX-TOPO	18,612	REG MERGE 2	755

Cut Volume (Cu. Yd.)	Cumulative Cut Volume	Fill Volume (Cu. Yd.)	Cumulative Fill Volume
28,977.7	28,977.7	40,175.5	40,175.5

Net Difference: 11197.7 Cu. Yd. BORROW

EXCAVATION EAST OF EXISTING STREAM ℄

CAPACITY = 11,197.7 CY

C.2 LIMIT OF WASTE CONSOLIDATION

Spectra Precision Software, Inc.
5901 Peachtree-Dunwoody Rd., Suite A-300
Atlanta, GA 30328-5548
800-235-4972
Fri Mar 23 17:12:44 2001

PROJECT: C:\My Documents\white_oak\topo2.pro

GEOMETRY REPORT

Traverse name: LIMIT OF WASTE CONSOLIDATION SEE LAST PAGE

Bearing	Distance	Northing	Easting
		499996.2187	1318630.7171
S09°17'01"E	16.12 ft		
		499980.3118	1318633.3173
S12°08'39"E	13.63 ft		
		499966.9879	1318636.1845
S16°04'54"E	13.28 ft		
		499954.2240	1318639.8642
S22°55'56"E	22.81 ft		
		499933.2200	1318648.7505
S20°33'22"E	14.95 ft		
		499919.2182	1318654.0011
S14°16'52"E	8.07 ft		
		499911.3953	1318655.9924
S14°15'09"E	3.87 ft		
		499907.6449	1318656.9451
S62°24'32"W	14.32 ft		
		499901.0112	1318644.2512
S62°24'32"W	18.45 ft		
		499892.4652	1318627.8980
S62°24'32"W	20.20 ft		
		499883.1073	1318609.9912
S48°06'27"W	16.32 ft		
		499872.2083	1318597.8408
S48°06'27"W	18.45 ft		
		499859.8875	1318584.1055
S48°06'27"W	18.45 ft		
		499847.5667	1318570.3701
S48°06'27"W	13.77 ft		
		499838.3716	1318560.1193
S61°44'56"W	5.04 ft		
		499835.9861	1318555.6798
S61°44'56"W	18.45 ft		
		499827.2523	1318539.4261
S61°44'56"W	18.45 ft		
		499818.5185	1318523.1723
S61°44'56"W	18.45 ft		
		499809.7847	1318506.9186
S61°44'56"W	18.45 ft		
		499801.0509	1318490.6649
S61°44'56"W	18.45 ft		
		499792.3171	1318474.4112
S61°44'56"W	18.45 ft		
		499783.5833	1318458.1575
S61°44'56"W	18.45 ft		
		499774.8495	1318441.9038
S61°44'56"W	15.42 ft		
		499767.5486	1318428.3166
S61°31'20"W	3.02 ft		
		499766.1080	1318425.6610
S61°31'20"W	18.45 ft		
		499757.3099	1318409.4420
S61°31'20"W	18.45 ft		
		499748.5119	1318393.2230

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S61°31'20"W	9.59 ft	499743.9369	1318384.7891
S64°09'28"W	8.93 ft	499740.0461	1318376.7559
S64°09'28"W	18.45 ft	499732.0032	1318360.1495
S64°09'28"W	19.64 ft	499723.4432	1318342.4757
S89°07'17"W	17.93 ft	499723.1683	1318324.5481
S89°07'17"W	18.45 ft	499722.8854	1318306.0986
S89°07'17"W	18.45 ft	499722.6025	1318287.6492
S89°07'17"W	18.45 ft	499722.3196	1318269.1997
S89°07'17"W	18.45 ft	499722.0367	1318250.7503
S89°07'17"W	18.45 ft	499721.7539	1318232.3008
S89°07'17"W	3.97 ft	499721.6930	1318228.3292
N78°39'31"W	14.80 ft	499724.6036	1318213.8175
N78°39'31"W	18.45 ft	499728.2322	1318195.7262
N78°39'31"W	6.01 ft	499729.4143	1318189.8328
S81°31'25"W	11.92 ft	499727.6577	1318178.0462
S81°31'25"W	34.07 ft	499722.6358	1318144.3484
S58°13'29"W	20.67 ft	499711.7531	1318126.7795
S58°13'29"W	5.30 ft	499708.9614	1318122.2726
S84°20'22"W	13.85 ft	499707.5957	1318108.4942
S84°20'22"W	16.48 ft	499705.9699	1318092.0928
N79°47'58"W	20.84 ft	499709.6605	1318071.5828
N79°47'58"W	18.45 ft	499712.9282	1318053.4228
N79°47'58"W	18.45 ft	499716.1959	1318035.2629
N79°47'58"W	5.16 ft	499717.1098	1318030.1836
S83°37'25"W	12.85 ft	499715.6823	1318017.4094
S83°37'25"W	18.45 ft	499713.6331	1317999.0719
S83°37'25"W	18.45 ft	499711.5839	1317980.7344
S83°37'25"W	12.85 ft	499710.1564	1317967.9610
S87°43'07"W	24.16 ft	499709.1948	1317943.8226
S87°43'07"W	18.45 ft		

Spectra Precision Software, Inc.
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PROJECT: C:\My Documents\white_oak\topo2.pro

S87°43'07"W	3.05 ft	499708.4604	1317925.3856
N00°46'07"E	22.69 ft	499708.3391	1317922.3419
N00°46'07"E	22.33 ft	499731.0240	1317922.6462
N06°02'02"E	11.90 ft	499753.3527	1317922.9457
N02°12'09"W	21.07 ft	499765.1897	1317924.1969
N02°12'09"W	9.51 ft	499786.2479	1317923.3870
N02°12'09"W	31.97 ft	499795.7466	1317923.0216
N02°12'09"W	7.85 ft	499827.6884	1317921.7931
N05°59'05"E	21.90 ft	499835.5289	1317921.4916
N05°59'05"E	31.97 ft	499857.3099	1317923.7750
N05°59'05"E	19.30 ft	499889.1010	1317927.1079
N19°01'42"E	9.12 ft	499908.2927	1317929.1198
N19°01'42"E	23.13 ft	499916.9187	1317932.0948
N30°03'11"E	5.85 ft	499938.7812	1317939.6347
N30°03'11"E	12.45 ft	499943.8426	1317942.5631
N19°02'41"E	27.41 ft	499954.6188	1317948.7981
N04°42'56"W	34.18 ft	499980.5247	1317957.7408
N28°14'59"W	25.90 ft	500014.5914	1317954.9306
N43°44'44"W	28.17 ft	500037.4072	1317942.6714
N82°12'02"E	16.86 ft	500057.7593	1317923.1915
N82°57'13"E	14.93 ft	500060.0468	1317939.8917
N83°27'46"E	16.20 ft	500061.8779	1317954.7055
N83°27'46"E	14.87 ft	500063.7226	1317970.8031
N83°27'46"E	15.77 ft	500065.4161	1317985.5813
N83°27'46"E	16.41 ft	500067.2116	1318001.2496
N84°45'40"E	23.51 ft	500069.0799	1318017.5536
N84°43'29"E	28.95 ft	500071.2266	1318040.9664
N84°49'47"E	22.38 ft	500073.8884	1318069.7954
N82°38'06"E	11.73 ft	500075.9053	1318092.0855
		500077.4091	1318103.7192

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N82°38'06"E	46.68 ft	500083.3928	1318150.0129
N82°38'06"E	39.82 ft	500088.4967	1318189.5001
N82°38'06"E	29.13 ft	500092.2311	1318218.3917
N82°38'06"E	31.56 ft	500096.2767	1318249.6905
N82°27'29"E	39.59 ft	500101.4732	1318288.9391
N81°20'46"E	32.69 ft	500106.3924	1318321.2603
N81°20'46"E	33.62 ft	500111.4517	1318354.5017
N81°20'46"E	30.06 ft	500115.9746	1318384.2190
N81°20'46"E	53.92 ft	500124.0881	1318437.5276
N81°25'05"E	52.10 ft	500131.8622	1318489.0407
N81°47'59"E	49.42 ft	500138.9109	1318537.9528
N81°47'59"E	29.27 ft	500143.0859	1318566.9242
S72°00'07"E	20.32 ft	500136.8061	1318586.2538
S72°00'07"E	5.00 ft	500135.2613	1318591.0088
S46°01'23"E	8.25 ft	500129.5319	1318596.9465
S32°03'01"E	17.88 ft	500114.3775	1318606.4345
S20°33'22"E	10.14 ft	500104.8826	1318609.9951
S17°39'00"E	17.23 ft	500088.4601	1318615.2204
S13°44'57"E	29.03 ft	500060.2580	1318622.1209
S07°16'01"E	22.87 ft	500037.5713	1318625.0139
S08°11'16"E	22.10 ft	500015.6967	1318628.1613
S08°11'16"E	7.49 ft	500008.2834	1318629.2280
S07°02'12"E	12.16 ft	499996.2187	1318630.7171

Total Perimeter = 2074.38 ft
Area = 243208.43 Sq. Ft.
Area = 5.5833 Acres

C.3 LIMIT OF COVER

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GEOMETRY REPORT

Traverse name: LIMIT OF COVER SEE LAST PAGE

Point Number / Bearing	Description / Distance	Vertical Angle	Northing	Easting	Elevation
90842			499699.2560	1317907.7187	
N24°16'37"E	11.28 ft				
90840			499709.5398	1317912.3571	
N00°46'07"E	21.62 ft				
90906			499731.1581	1317912.6471	
N00°46'07"E	54.97 ft				
90905			499786.1227	1317913.3844	
N02°12'09"W	9.25 ft				
90904			499795.3623	1317913.0290	
N02°12'09"W	31.97 ft				
90938			499827.3040	1317911.8005	
N02°12'09"W	8.56 ft				
90903			499835.8597	1317911.4714	
N05°59'05"E	22.62 ft				
90902			499858.3525	1317913.8295	
N05°59'05"E	31.97 ft				
90901			499890.1437	1317917.1624	
N05°59'05"E	20.44 ft				
90900			499910.4723	1317919.2935	
N19°01'42"E	10.27 ft				
90899			499920.1790	1317922.6412	
N19°01'42"E	24.09 ft				
90898			499942.9539	1317930.4958	
N30°03'11"E	6.81 ft				
90897			499948.8506	1317933.9075	
N30°03'11"E	11.49 ft				
90896			499958.7928	1317939.6599	
N19°02'41"E	24.34 ft				
90846			499981.7992	1317947.6017	
N04°42'56"W	30.00 ft				
90937			500011.6932	1317945.1357	
N28°14'59"W	22.46 ft				
90845			500031.4755	1317934.5064	
N43°44'44"W	26.84 ft				
90844			500050.8655	1317915.9474	
N41°34'08"W	9.59 ft				
90943			500058.0381	1317909.5862	
N48°25'52"E	12.37 ft				
90945			500066.2478	1317918.8431	336.00
N82°12'02"E	20.01 ft				
90946			500068.9635	1317938.6704	
N82°57'07"E	15.12 ft				
90947			500070.8194	1317953.6808	
N83°27'46"E	16.20 ft				
90948			500072.6640	1317969.7784	
N83°27'46"E	14.87 ft				
90949			500074.3575	1317984.5567	
N83°27'46"E	15.77 ft				
90950			500076.1530	1318000.2250	
N83°27'46"E	16.51 ft				
90951			500078.0330	1318016.6303	
N84°45'40"E	23.61 ft				

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90952		500080.1888	1318040.1417	
N84°43'29"E	28.95 ft			
90953		500082.8503	1318068.9679	
N84°50'48"E	22.05 ft			
90967		500084.8311	1318090.9318	
N82°38'06"E	11.73 ft			
90965		500086.3348	1318102.5655	
N82°38'06"E	46.68 ft			
90954		500092.3185	1318148.8592	
N82°38'06"E	39.82 ft			
90955		500097.4225	1318188.3464	
N82°38'06"E	29.13 ft			
90956		500101.1569	1318217.2380	
N82°38'06"E	31.56 ft			
90957		500105.2024	1318248.5368	
N82°27'37"E	39.39 ft			
90958		500110.3707	1318287.5849	
N81°20'46"E	32.69 ft			
90959		500115.2899	1318319.9061	
N81°20'46"E	33.62 ft			
90960		500120.3492	1318353.1475	
N81°20'46"E	30.06 ft			
90961		500124.8721	1318382.8648	
N81°20'46"E	53.92 ft			
90962		500132.9856	1318436.1734	
N81°25'05"E	52.17 ft			
90963		500140.7702	1318487.7570	
N81°47'59"E	49.42 ft			
90964		500147.8189	1318536.6690	
N81°47'59"E	33.63 ft			
90843		500152.6157	1318569.9553	
S72°00'07"E	20.39 ft			
89587		500146.3168	1318589.3436	332.00
S72°00'07"E	7.31 ft			
90983		500144.0592	1318596.2925	
S46°01'23"E	11.78 ft			
90982		500135.8772	1318604.7721	
S32°03'01"E	20.11 ft			
90981		500118.8311	1318615.4444	
S20°33'22"E	11.40 ft			
90980		500108.1563	1318619.4474	
S17°39'00"E	17.83 ft			
90979		500091.1676	1318624.8529	
S13°44'57"E	29.94 ft			
90978		500062.0846	1318631.9690	
S07°16'01"E	23.36 ft			
90977		500038.9160	1318634.9234	
S08°11'16"E	22.09 ft			
90976		500017.0501	1318638.0696	
S07°22'05"E	18.45 ft			
90975		499998.7542	1318640.4354	
S09°17'01"E	16.80 ft			
90974		499982.1714	1318643.1460	
S12°08'39"E	13.04 ft			
90973		499969.4277	1318645.8884	
S16°04'54"E	12.34 ft			
90972		499957.5691	1318649.3071	
S22°55'56"E	22.42 ft			
90971		499936.9254	1318658.0409	

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S20°33'22"E	15.71 ft		
90970		499922.2162	1318663.5569
S14°16'52"E	8.62 ft		
90969		499913.8597	1318665.6840
S14°15'09"E	21.62 ft		
90968		499892.9005	1318671.0079
S86°52'31"W	21.93 ft		
90839		499891.7053	1318649.1144
S62°24'32"W	18.45 ft		
90838		499883.1593	1318632.7611
S62°24'32"W	18.89 ft		
90837		499874.4115	1318616.0218
S48°06'27"W	15.01 ft		
90836		499864.3921	1318604.8521
S48°06'27"W	18.45 ft		
90835		499852.0713	1318591.1167
S48°06'27"W	18.45 ft		
90834		499839.7506	1318577.3813
S48°06'27"W	15.03 ft		
90833		499829.7168	1318566.1956
S61°44'56"W	6.30 ft		
90815		499826.7368	1318560.6498
S61°44'56"W	18.45 ft		
88409		499818.0030	1318544.3961
S61°44'56"W	18.45 ft		
88408		499809.2692	1318528.1424
S61°44'56"W	18.45 ft		
88407		499800.5354	1318511.8886
S61°44'56"W	18.45 ft		
88406		499791.8016	1318495.6349
S61°44'56"W	18.45 ft		
88405		499783.0679	1318479.3812
S61°44'56"W	18.45 ft		
88404		499774.3341	1318463.1275
S61°44'56"W	18.45 ft		
88403		499765.6003	1318446.8738
S61°44'56"W	15.40 ft		
88401		499758.3091	1318433.3049
S61°31'20"W	3.00 ft		
88400		499756.8785	1318430.6676
S61°31'20"W	18.45 ft		
88399		499748.0804	1318414.4486
S61°31'20"W	18.45 ft		
88398		499739.2823	1318398.2296
S61°31'20"W	9.84 ft		
88397		499734.5922	1318389.5834
S64°09'28"W	9.17 ft		
88396		499730.5962	1318381.3328
S64°09'28"W	18.45 ft		
88395		499722.5532	1318364.7264
S64°09'28"W	21.96 ft		
88394		499712.9801	1318344.9607
S89°07'17"W	20.25 ft		
88393		499712.6696	1318324.7090
S89°07'17"W	18.45 ft		
88392		499712.3867	1318306.2596
S89°07'17"W	18.45 ft		
88391		499712.1038	1318287.8101
S89°07'17"W	18.45 ft		

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88390		499711.8209	1318269.3607
S89°07'17"W	18.45 ft		
88389		499711.5380	1318250.9112
S89°07'17"W	18.45 ft		
88388		499711.2551	1318232.4618
S89°07'17"W	5.10 ft		
88387		499711.1770	1318227.3663
N78°39'31"W	15.92 ft		
88386		499714.3086	1318211.7526
N78°39'31"W	18.45 ft		
88385		499717.9373	1318193.6613
N78°39'31"W	4.18 ft		
88384		499718.7586	1318189.5664
S81°31'25"W	10.08 ft		
88383		499717.2724	1318179.5939
S81°31'25"W	31.91 ft		
88382		499712.5696	1318148.0372
S58°13'29"W	18.50 ft		
88381		499702.8268	1318132.3087
S58°13'29"W	7.74 ft		
88380		499698.7528	1318125.7316
S84°20'22"W	16.28 ft		
88379		499697.1469	1318109.5299
S84°20'22"W	17.94 ft		
88378		499695.3769	1318091.6729
N79°47'58"W	22.30 ft		
88377		499699.3265	1318069.7233
N79°47'58"W	18.45 ft		
88376		499702.5941	1318051.5633
N79°47'58"W	18.45 ft		
88375		499705.8618	1318033.4034
N79°47'58"W	3.63 ft		
88374		499706.5049	1318029.8296
S83°37'25"W	11.32 ft		
88373		499705.2472	1318018.5755
S83°37'25"W	18.45 ft		
88372		499703.1980	1318000.2380
S83°37'25"W	18.45 ft		
88371		499701.1488	1317981.9005
S83°37'25"W	13.23 ft		
88370		499699.6797	1317968.7540
S87°43'07"W	24.53 ft		
88369		499698.7032	1317944.2405
S87°43'07"W	18.45 ft		
87461		499697.9687	1317925.8035
N85°55'43"W	18.13 ft		
90842		499699.2560	1317907.7187

Total Perimeter = 2161.45 ft
Area = 264197.97 Sq. Ft.
Area = 6.0652 Acres

APPENDIX D

CAP SYSTEM CALCULATIONS

D.1 PIPE BACKFILL AGGREGATE

D.2 DRAINAGE DESIGN

D.3 SLOPE STABILITY

D.4 COVER SOIL/GEOTEXTILE COMPATABILITY

D.1 PIPE BACKFILL AGGREGATE

CLIENT:	**EFAC NSWC - WHITE OAK**		JOB NUMBER: **7427-1503**
SUBJECT:	**PIPE BACKFILL AGGREGATE (100% DESIGN)**		
BASED			DRAWING NUMBER:
BY: Date:	NJB 03/20/01	CHECKED BY: [illegible] Date: 3/20/01	APPROVED BY: Date:

PURPOSE:

Determine filter compatible pipe backfill aggregate and pipe perforation size.

REFERENCES:

1. *Standard Specifications for Construction and Materials*, Maryland Department of Transportations, State Highway Administration, October 1993, pp. 436-437 (attached)

2. *Design Manual DM-7.1, Soil Mechanics,* Department of the Navy, Naval Facilities Engineering Command (NAVFAC), Alexandria, VA, 1982. Figure 4, "Design Criteria of Protective Filters, p. 7.1-273.

GIVEN:

Use MD SHA #67 aggregate (Ref 1)(sheet 2)

	SIEVE SIZE				
	1"	3/4"	3/8"	No. 4	No. 8
% passing	100.0	90-100	20-55	0-10	0-5

METHOD:

To avoid movement of filter particles in pipe perforations, D_{85} / hole diameter must be greater than 1.0 - 1.2. (Ref 2)

D_{85} is determined by plotting the gradation of the aggregate on semi-log paper, see sheet 4

From plot, D_{85} min = 15.5 mm = 0.61 in.

D_{85} min / 1.2 = 0.508" therefore use up to 1/2 inch perforations

SOLUTION:

Use MD SHA #67 aggregate for pipe bedding and backfill

Use 1/2 inch perforations or smaller

TABLE

AGGREGATE GRADING REQUIREMENTS

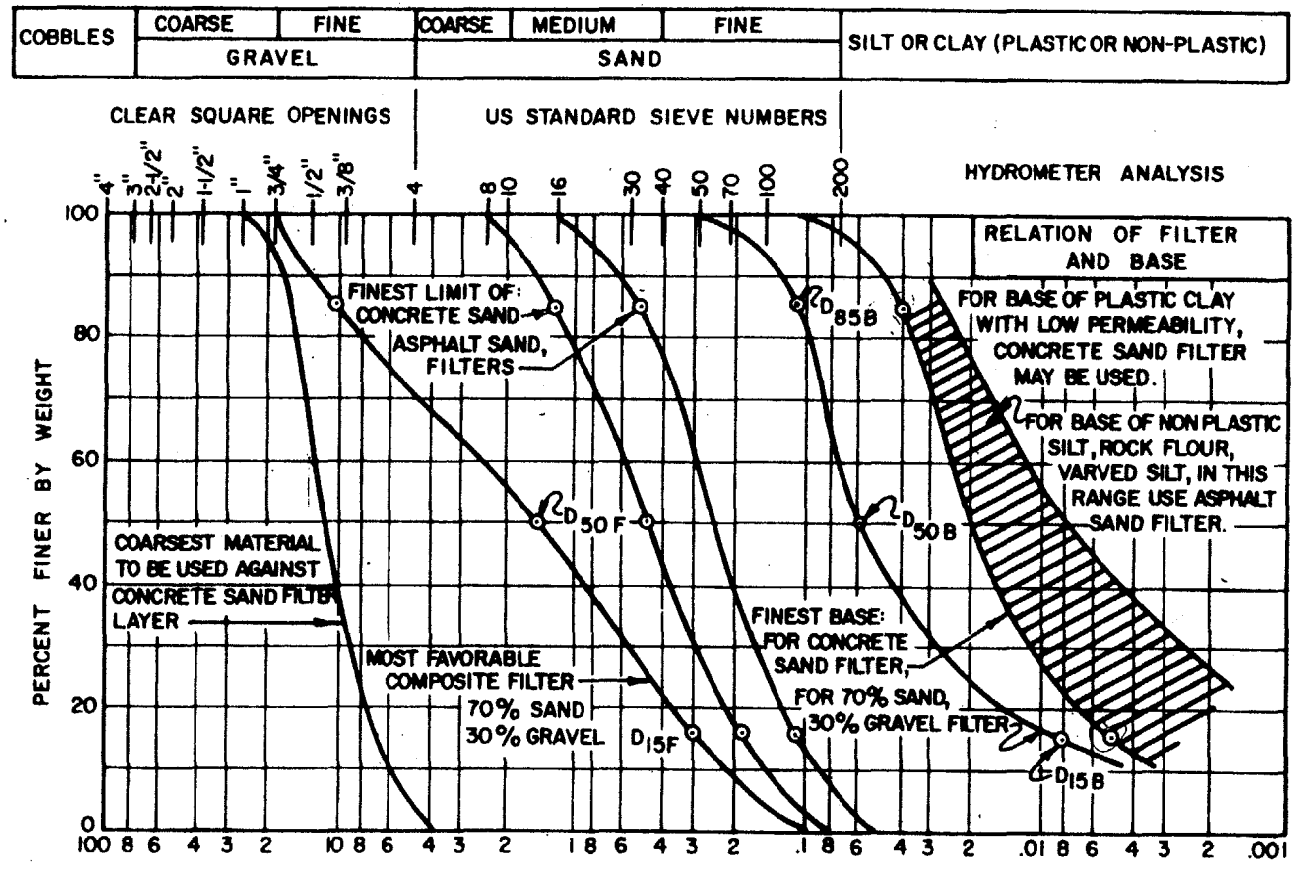
MATERIAL		SIEVE SIZE					
		2-1/2″	2″	1-1/2″	1″	3/4″	1/2″
GRADED AGGREGATE—SUBBASE DESIGN RANGE (a)		—	100	90–100	—	60–85	—
TOLERANCE (b)		—	−3	±5	—	±10	—
BANK RUN GRAVEL—SUBBASE		100	—	—	90–100	—	60–100
GRADED AGGREGATE—BASE DESIGN RANGE (a)		—	100	95–100	—	70–92	—
TOLERANCE (b)		—	−2	±5	—	±8	—
BANK RUN GRAVEL—BASE		100	—	—	85–100	—	60–100
COARSE AGGREGATE—PORTLAND CEMENT CONCRETE	57 and UNDERDRAIN	—	—	100	95–100	—	25–60
	67	—	—	—	100	90–100	—
	7	—	—	—	—	100	90–100
FINE AGGREGATE—PORTLAND CEMENT CONCRETE and UNDERDRAIN (d)		—	—	—	—	—	—
COARSE AGGREGATE—LIGHTWEIGHT PORTLAND CEMENT CONCRETE		—	—	—	100	90–100	—
FINE AGGREGATE—LIGHTWEIGHT PORTLAND CEMENT CONCRETE (d)		—	—	—	—	—	—
FINE AGGREGATE/SAND MORTAR and EPOXIES (d)		—	—	—	—	—	—
MINERAL FILLER		—	—	—	—	—	—
CRUSHED GLASS (e)		—	—	—	—	100	—

(a) To establish target values for design.
(b) Production tolerance.
(c) ±2 for field grading. (omitting T 11)
(d) Fine aggregate includes natural or manufactured sand.
(e) Crushed glass shall not contain more than one percent contaminants by weight.

901 A

TEST METHOD T 27

SIEVE SIZE									
3/8″	No. 4	No. 8	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
40–70	30–60	—	—	—	—	10–25	—	—	0–12
6 10	6 10	—	—	—	—	6 5	—	—	6 5
—	—	—	35–90	—	—	20–55	—	—	5–25
50–70	35–55	—	—	—	12–25	—	—	—	0–8
6 8	6 8	—	—	—	6 5	—	—	—	6 3 (c)
—	—	—	35–75	—	—	20–50	—	—	3–20
—	0–10	0–5	—	—	—	—	—	—	—
20–55	0–10	0–5	—	—	—	—	—	—	—
40–70	0–15	0–5	—	—	—	—	—	—	—
100	95–100	—	—	45–80	—	—	10–30	2–10	—
10–50	0–15	—	—	—	—	—	—	—	—
100	85–100	—	—	40–80	—	—	10–35	5–25	—
—	100	95–100	—	—	—	—	—	0–25	0–10
—	—	—	—	—	100	—	95–100	—	70–100
—	0–55	—	—	—	—	—	—	—	—



GENERAL REQUIREMENTS:

1. TO AVOID HEAD LOSS IN FILTER: $\frac{D_{15F}}{D_{15B}} > 4$, AND PERMEABILITY OF FILTER MUST BE LARGE ENOUGH TO SUFFICE FOR PARTICULAR DRAINAGE SYSTEM.
2. TO AVOID MOVEMENT OF PARTICLES FROM BASE: $\frac{D_{15F}}{D_{85B}} < 5$, $\frac{D_{50F}}{D_{50B}} < 25$, $\frac{D_{15F}}{D_{15B}} < 20$

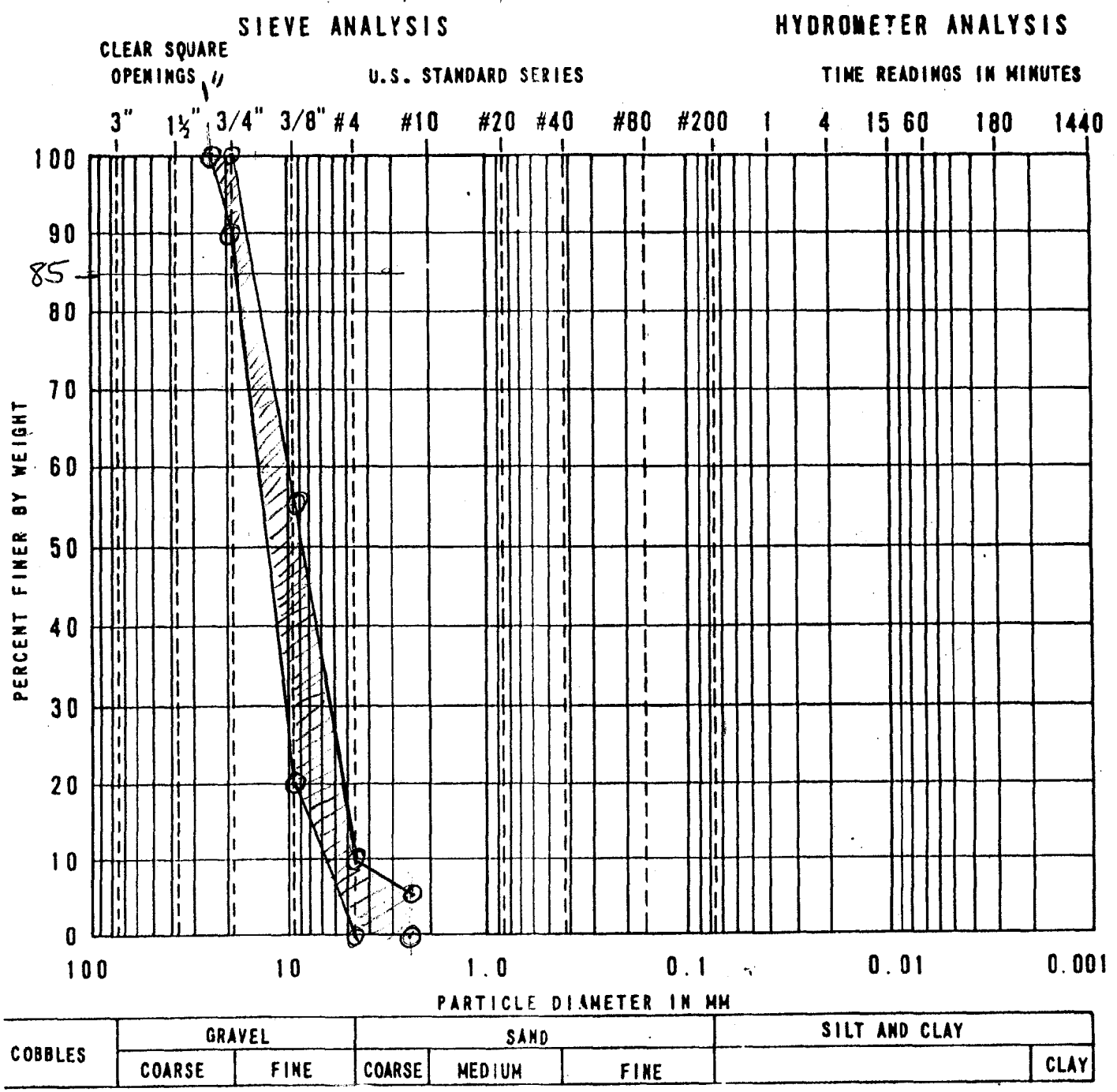
   FOR VERY UNIFORM BASE MATERIAL ($C_u < 1.5$): D_{15F}/D_{85B} MAY BE INCREASED TO 6

   FOR BROADLY GRADED BASE MATERIAL ($C_u > 4$): D_{15F}/D_{15B} MAY BE INCREASED TO 40
3. TO AVOID MOVEMENT OF FILTER IN DRAIN PIPE PERFORATIONS OR JOINTS: D_{85F}/SLOT WIDTH > (1.2 TO 1.4), D_{85F}/HOLE DIAMETER > (1.0 TO 1.2)
4. TO AVOID SEGREGATION, FILTER SHOULD CONTAIN NO SIZES LARGE THAN 3".
5. TO AVOID INTERNAL MOVEMENT OF FINES, FILTER SHOULD HAVE NO MORE THAN 5% PASSING No. 200 SIEVE.

FIGURE 4 (continued)
Design Criteria for Protective Filters

452-636 O - 84 - 10

MSHA #67


SIEVE ANALYSIS
HYDROMETER ANALYSIS
CLEAR SQUARE OPENINGS
U.S. STANDARD SERIES
TIME READINGS IN MINUTES
3" 1½" 3/4" 3/8" #4 #10 #20 #40 #80 #200 1 4 15 60 180 1440
100 90 85 80 70 60 50 40 30 20 10 0
PERCENT FINER BY WEIGHT
100 10 1.0 0.1 0.01 0.001
PARTICLE DIAMETER IN MM
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT AND CLAY
CLAY

D.2 DRAINAGE DESIGN

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1503
SUBJECT:	DRAINAGE DESIGN CALCULATIONS		
BASED			DRAWING NUMBER:
BY: Date:	NJB 03/29/01	CHECKED BY: Date: 3/29/01	APPROVED BY: Date:

Objective: Design a system to adequately drain the cover soil during large rainfall events by:

1) Determining the geonet transmissivity required to carry flow from the overlying cover soil under a unit gradient (i = 1) (i. e., as fast as water can flow through the soil, the geonet and pipes can carry it away (Ref 1)),

2) Determining pipe spacing to delineate flow areas and discharge from the geonet, and

3) Determining the pipe diameter and number and size of perforations required to convey the required flow.

References:

1) "Design of Lateral Drainage Systems for Landfills", G. N. Richardson and Aigen Zhao, 1999, *Geosynthetics for Advanced Solutions Seminar,* Sponsored by GSE Lining Technology, Synthetic Industries, and Tenax, Pittsburgh, Pennsylvania, July 13, 2000

2) Soil Mechanics, Lambe and Whitman, John Wiley & Sons, 1969, p. 251.

3) HELP Model User's Guide, Table 4 (attached, sheet 7)

4) Brater, E. F. and King, H. W. *Handbook of Hydraulics*, 6th Ed. McGraw-Hill, New York, 1976.

5) Advanced Drainage Systems (ADS) Product Literature

6) Phone conversation with ADS, March 1, 2001.

Method:

1) For a given cover soil type and drainage length, determine the needed transmissivity for a geocomposite to discharge water at the same rate that it enters the geocomposite.
2) Determine pipe spacing and slope to outlet flow from the geocomposite.
3) Determine pipe diameter and perforation size and spacing to carry the flow.

Solution:

Triplanar geocomposite with a transmissivity of 2.2 x 10-3 m^3/sec/m

4-inch dia plastic pipe with Manning's n < or = 0.012

Soil cover hydraulic conductivity of not more than 0.00037 cm/sec under minimal compaction (USDA loam Class L, SiL, SCL, CL, and SiCL)

60 ft spacing between pipes (general guidance).
Variable pipe slope and spacing as shown, 2.5% minimum pipe slope.
Slotted pipe or 3/16 - 3/8-inch dia circular perforations, 0.5 sq in per ft open area

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CALCULATIONS: Ref 1, pp. 27-35

L_h = Horizontal separation between drainage outlets (pipes)
k_{veg} = Permeability of the vegetative cover soil
S = percent slope
Π_{rf} = product of all relevant reduction safety factors (for landfill covers, Ref 1, pp. 21-22)

Method of solution:

Step 1. Input the necessary data. Trial 1: Pipes at the bench only, any USDA loam for cover soil.

L_h = 195 ft (distance from crest of landfill to bench)
Π_{rf} = 8
k_{veg} = 0.0017 cm/sec (Ref 3)
max value for any of the USDA loams (Sheet 7, Classes LS, LFS, SL, FSL, L, SiL, SCL, CL, and SiCL)
θ = transmissivity of geocomposite under site specific stress and gradient

Step 2. Calculate inflow Q_{in} over a unit width.

Q=k*i*a Darcy's Equation, Ref 2

Calculate inflow Q_{in} assuming the soil is saturated, so the vertical seepage gradient = i = 1 m/m.

i = 1 m/m
a=L*1 for a 1 m unit width
$Q_{in} = k_{veg} * 1 * L_h * 1$ =(.0017 cm/sec * 1 m/100cm) * (195 ft * 0.3046 m/ft) *(1 m/m)
Q_{in} = 1.0E-03 m^3/sec/m

Step 3. Calculate outflow of the drainage composite (Q_{out}).

$Q_{out} = Q_{in} = \theta_{required}$ i (for a unit width of slope) =
i = gradient = h / L = 0.25
$\theta_{required}$ = Q_{out} / i (for a unit width of slope) = 1.0E-03 m^3/sec/m / 0.25
$\theta_{req'd}$ = transmissivity of the geocomposite = 4.0E-03 m^3/sec/m

Step 4. Calculate $\theta_{ultimate}$ for the geocomposite

$\theta_{ultimate}$ = $\theta_{req'd} * \Pi_{rf}$
= 4.0E-03 m^3/sec/m *8 = 3.2E-02 m^3/sec/m

Geocomposite with 3.2 x E-02 m^3/sec/m is needed but is not commercially available

Available triplanar geocomposite has a transmissivity of 2.2 x 10-3 m^3/sec/m (at gradient = 0.1 and 15,000 psf, see sheet 8), too low.

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Step 5: Trail 2: Determine cover soil texture class and pipe spacing suitable for available geocomposite

Available geocomposites do not have the required transmissivity from Step 4. Therefore the pipe spacing is too far and/or the cover soil permeability is too high. Try other combinations for a transmissivity which does not exceed that which is available in manufactured geocomposites.

Ultimate Transmissivity* (laboratory test values, m^3/sec/m)

Soil Texture Class**	LS	SL	FSL	L	SiL
kveg (cm/sec)	0.0017	0.00072	0.00052	0.00037	0.00019
pipe spacing (ft)					
180	3.0E-02	1.3E-02	9.1E-03	6.5E-03	3.3E-03
90	1.5E-02	6.3E-03	4.6E-03	3.2E-03	**1.7E-03**
60	9.9E-03	4.2E-03	3.0E-03	**2.2E-03**	**1.1E-03**
45	7.5E-03	3.2E-03	**2.3E-03**	**1.6E-03**	**8.3E-04**
30	5.0E-03	**2.1E-03**	**1.5E-03**	**1.1E-03**	**5.6E-04**
25	4.1E-03	**1.8E-03**	**1.3E-03**	**9.0E-04**	**4.6E-04**
20	3.3E-03	**1.4E-03**	**1.0E-03**	**7.2E-04**	**3.7E-04**

* θult = kveg (cm/sec) * pipe spacing (ft)* 0.3046 m/ft * .01 m/cm * 8 (factor of safety) / gradient (0.25 m/m)
** HELP Table 4 (attached, sheet 7)
Bold numbers indicate transmissivities achievable for marketed geocomposites

Result:
Generally use 60 ft pipe spacing
kveg < or = 3.7 x 10-4 cm/sec or specify USDA loams Class L, SiL, SCL, CL and SiCL (sheet 7) to satisfy the hydraulic conductivity requirement

Step 6: To size the pipes, determine inflow into entire pipe length based on watershed area, pipe slope and k_{veg}. (See plan view, sheet 9, attached)

Area Label	Planimetered Area (ft^2)	Pipe Slope
1A	24,560	variable, >3%
1B1	11,520	2.5%
1B1+ 1B2	31,375	variable, min. 4.4%
1C	15,120	3%
1D	22,240	variable, >3%
2A	13,600	2.5% - 3.3%
2B	11,200	variable, >3%
2C	17,025	variable, >3%
2D	24,640	3%
2E	15,040	2.5%

Determine inflow into pipe 2D based on inflow through area 2D soil cover:
Qreq'd = kveg * 1 * inflow area
= (.00037 cm/sec * 1 m/100 cm * 3.281 ft/m) * 1 * 24,640 ft^2
= 0.299 cfs

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Step 7: Determine the pipe size and slope required using Manning's equation.

Q = 1.49/n(A)(r_H)2/3(s)1/2

n = 0.012 (Ref 4, sheet 10) corrugated plastic pipe

try a 6-inch pipe and 4-inch pipe

check 4-in pipe for Area 2D at 3%.

slope = 0.03 ft/ft

Nominal Dia (in)	6	4
ID (in)	6.0	4.0
ID (ft)	0.500	0.333
A (sf)	0.196	0.087
rH	0.125	0.083
Q (cfs)	1.1	0.358

Q of 4-inch pipe = 0.358 cfs > 0 .299 cfs, so 4-inch pipe is acceptable for Area 2D, as well as any areas that are smaller and/or steeper, so 4-in pipe is acceptable for Areas 1A, 1C, 1D, 2B, 2C, and 2D.

check 4-in pipe for Area 2E at 2.5%.

Qreq'd = kveg * 1 * inflow area

= (.00037 cm/sec * 1 m/100 cm * 3.281 ft/m) * 1 * 15,040 ft^2

= 0.183 cfs

For 2.5% pipe:

slope = 0.025	6	4
Q (cfs)	1.0	0.327

Q of 4-inch pipe = 0.327 cfs > 0.183 cfs, so 4-inch pipe is acceptable for area 2E and any 2.5% pipe slope with smaller inflow areas, i. e. Area 1B1 and Area 2A

check 4-in pipe for combined Areas 1B1 and 1B2 at 4.4%.

Qreq'd = kveg * 1 * inflow area

= (.00037 cm/sec * 1 m/100 cm * 3.281 ft/m) * 1 * 31,375 ft^2

= 0.381 cfs

For 4.4% pipe:

slope = 0.044	6	4
Q (cfs)	1.3	0.433

Q of 4-inch pipe = 0.433 cfs > 0.381 cfs, so 4-inch pipe is acceptable for areas 1B1 and 1B2 combined

Result:

4-in dia plastic pipe (n = 0.012) at a the layout shown on sheet 9 will carry the maximum expected inflow for all inflow areas.

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Step 8: Determine specifications for pipe perforation size and spacing. Are the specifications on sheet 11 adequate?

Step 8A: Slotted Perforations

Compare area of standard slots to specification

Product literature indicates that perforations are 0.875 inches long by 0.125 inches wide. There are 3 perforations per corrugation. (See Sheet 12, Ref 5)
There are 18 corrugations per foot, or 3 x 18 = 54 perforations per foot. (Ref 6)

Therefore open area = 0.875 in x 0.125 in x 54 = 5.9 sq in / ft

Specifications call for 0.5 sq in /ft, therefore standard manufactured slotted pipe satisfies this specification.

Compare area of standard slots to calculated required area for inflow

For simplicity, use equation for orifice flow for round holes 0.125 inches in diameter (conservative):

Q = C*a*(2gh)^1/2 (Ref 4)

Q = flow cpacity per perforation
a = area of perforation
g = 32.2 ft/sec^2
h = head over the perforation

pipe is perforated all the way around, therefore average head will be 1/2 pipe diameter plus minimum height of backfill

h = 1/2 pipe diameter + backfill to top of pipe trench = 2 inch + 12 inch = 14 in, use 1.17 ft

C = coefficient of discharge for a circle at a head of one ft = .622 (Ref 4, p. 4-29)

d_{perf} = 0.125 in

r_{perf} = 0.0625 in

$a = \pi * r_{perf}$^2 = 0.0001 sf = 0.012 sq in

Q = C*a*(2gh)^1/2

Q = 0.0005 cfs per perforation

x 54 = 0.0250 cfs per foot

(actual inflow will be greater because perforations are wide slots, not round holes)

Determine inflow per foot

Q for combined areas 1B1 and 1B2 is 0.381 cfs 0.000636
pipe for Areas 1B1 and 1B2 is 500 ft long
Qrequired for 1 ft = 0.381 / 500 = 6.4 x 10-4 cfs per foot

Q pipe (0.025 cfs/ft) > Qrequired (0.00064 cfs/ft), therefore standard ADS N-12 slotted pipe perforations are adequate

Compare specified slot dimensions to manufacturers standard slot dimensions

Specified dimension, sheet 11, is 1/8 to 1/32 by < 1/10 times inside circumference for slotted perforations

circumference = 2 x π x r = 2 x 3.14 x 2 in = 12.56

otherefore specified slot dimensions are 1/8 to 1/32 in by <1.256 in

Standard manufacturer's slot is 0.125 by 0.875, satisfies specification, OK

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Step 8B: Circular perforations

for orifice flow for round holes: (Ref 4)

Q = C*a*(2gh)^1/2

Q = flow cpacity per perforation
a = area of perforation
g = 32.2 ft/sec^2
h = head over the perforation
Assume perforations are near the bottom of the pipe
h =3/4 of pipe diameter + backfill to top of pipe trench = 3 inch + 12 inch = 15 in, use 1.25 ft

C = coefficient of discharge for a circle at a head of one ft = .622 (Ref 4, p. 4-29)

Compare perforation diameter to attached specifications (sheet 11)

Based on pipe backfill aggregate calculations, round perforations should be 1/2 inches in diameter or smaller to prevent intrusion of aggregate into the perforations.

Specifications call for 3/16 to 3/8 inch diameter round holes

Attached specifications satisfy filter compatibility to aggregate, OK. Check inflow capacity of specification

d_{perf} = 0.188 in (use minimum specified perforation diameter)
r_{perf} = 0.094 in

a = π*r_{perf}^2 = 0.0276 si
a = π*r_{perf}^2 = 0.0002 sf
Q = C*a*(2gh)^1/2
Q = 0.0011 cfs per perforation

Q of perforation (0.0011 cfs) > Q required (0.00064) therefore only 1 hole per foot would be adequate to let in flow.

Compared area of perforations required for inflow to specification

Specifications call for 0.5 sq in /ft, this is greater than the area of one 3/16 hole, therefore this specification is adequate.

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REF: HELP MODEL USER'S GUIDE

TABLE 4. DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0×10^{-2}
2	S	SW	0.437	0.062	0.024	5.8×10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1×10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7×10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0×10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2×10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2×10^{-4}
8	L	ML	0.463	0.232	0.116	3.7×10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9×10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2×10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4×10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2×10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3×10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5×10^{-5}
15	C	CH	0.475	0.378	0.265	1.7×10^{-5}
16	Barrier Soil		0.427	0.418	0.367	1.0×10^{-7}
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0×10^{-9}
18	Municipal Waste (900 lb/yd^3 or 312 kg/m^3)		0.671	0.292	0.077	1.0×10^{-3}
19	Municipal Waste (channeling and dead zones)		0.168	0.073	0.019	1.0×10^{-3}
20	Drainage Net (0.5 cm)		0.850	0.010	0.005	$1.0 \times 10^{+1}$
21	Gravel		0.397	0.032	0.013	3.0×10^{-1}
22	L*	ML	0.419	0.307	0.180	1.9×10^{-5}
23	SiL*	ML	0.461	0.360	0.203	9.0×10^{-6}
24	SCL*	SC	0.365	0.305	0.202	2.7×10^{-6}
25	CL*	CL	0.437	0.373	0.266	3.6×10^{-6}
26	SiCL*	CL	0.445	0.393	0.277	1.9×10^{-6}
27	SC*	SC	0.400	0.366	0.288	7.8×10^{-7}
28	SiC*	CH	0.452	0.411	0.311	1.2×10^{-6}
29	C*	CH	0.451	0.419	0.332	6.8×10^{-7}
30	Coal-Burning Electric Plant Fly Ash*		0.541	0.187	0.047	5.0×10^{-5}
31	Coal-Burning Electric Plant Bottom Ash*		0.578	0.076	0.025	4.1×10^{-3}
32	Municipal Incinerator Fly Ash*		0.450	0.116	0.049	1.0×10^{-2}
33	Fine Copper Slag*		0.375	0.055	0.020	4.1×10^{-2}
34	Drainage Net (0.6 cm)		0.850	0.010	0.005	$3.3 \times 10^{+1}$

* Moderately Compacted

(Continued)

Standard Property and Frequency Sheet
GSE Tri-Planar Drainage Material

Tested Property	Test Method	Values		Qualifier	Frequencies
Resin					
Resin Density, g/cm³	ASTM D 1505	0.94		C	Upon Request
Resin Melt Index, g/10 min.	ASTM D 1238	1.0		E	Upon Request
Geonet(1)		**TP225**	**TP275**		
Geonet Roll Length, ft		200	200	B	
Geonet Density, g/cm³	ASTM D 1505	0.94	0.94	C	Every 40,000 ft²
Carbon Black Content, %	ASTM D 4218	2.0	2.0	C	Every 40,000 ft²
Tensile Strength – MD, lb/ft (lb/in)	ASTM D 4595	700 (58)	900 (75)	C	Every 40,000 ft²
Compressive Behavior (**short** term) % retained thickness	ASTM D 1621	50 @ 40,000 psf	50 @ 50,000 psf	A	Every 40,000 ft²
Compressive Behavior (**long** term) % retained thickness		95 @ 2000 psf After 10,000 hrs	65 @ 25,000 psf after 10,000 hrs	A	Certified
Transmissivity - MD, m³/sec-m Plate / liner / net / liner / Plate	ASTM D 4716-99 15 min. seat time	Load = 10,000 psf i = 1.0 1.6×10^{-3}	Load = 20,000 psf i = 1.0 1.4×10^{-3}	B	Every 100,000 ft²
Thickness, mils	ASTM D 5199	225	275	C	Every 40,000 ft²
Geocomposite (6 or 8 oz/yd²)		**TP225**	**TP275**		
Geocomposite Roll Length, ft		200	200	B	
Ply Adhesion(2), lb/in	ASTM F 904	1.0	1.0	D	Every 40,000 ft²
Transmissivity - MD, m³/sec-m Plate / soil / composite / liner / Plate	ASTM D 4716-99 15 min. seat time	Load = 500 psf i = 0.33 2.2×10^{-3}	Load = 15,000 psf i = 0.10 2.2×10^{-3}	B	Every 100,000 ft²
Geotextile – Synthetic Industries Standard Tests and Frequencies Apply		**GeoTex 651**	**GeoTex 861**		
Mass per Unit Area, oz/yd²	ASTM D 5261	6.0	8.0	B	Every 90,000 ft²
Grab Tensile Strength, lbs	ASTM D 4632	170	220	B	Every 90,000 ft²
Grab Tensile Elongation, %	ASTM D 4632	50	50	B	Every 90,000 ft²
Puncture Strength, lbs	ASTM D 4833	110	135	B	Every 90,000 ft²
Trapezoidal Tear Strength, lbs	ASTM D 4533	70	95	B	Every 90,000 ft²
AOS, US Sieve (mm)	ASTM D 4751	70 (0.212)	80 (0.180)	B	Every 540,000 ft²
Permittivity, sec⁻¹	ASTM D 4491	1.30	1.50	B	Every 540,000 ft²
Permeability, cm/sec	ASTM D 4491	0.24	0.38	B	Every 540,000 ft²
Water Flow Rate, gpm/ft²	ASTM D 4491	110	110	B	Every 540,00(

Qualifiers: A = Typical, B = Minimum Average Roll Value (MARV), C = Minimum, D = Average, E = Maximum

(1) Geonet has a minimum roll width of 6.7 ft.
(2) Ply adhesion is measured per F 904 using a 2 in. wide strip, 2.0 in/minute. The value reported for each side tested is the average of the peak value from 5 tested specimens

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BASELINE A & B
STA. 0+00
N 500073.63
E 1317754.63

BASELINE B
STA. 9+00
N 500204.63
E 1318645.22

BASELINE A
STA. 4+60
N 499827.81
E 1317816.73

PROPERTY BOUNDARY (APPROXIMATE)

PRIVATE PROPERTY

GRAVEL

BLDG. 109

BLDG. 111

BLDG. 112

BLDG. 113

PERIMETER ROAD

12" RCP

GAS MONITORING POINT C-8/C-12

NORTH CHANNEL TERMINATION C-8/C-11

GAS LINE TO LOCATED BY REMEDIAL ACTION CONTRACTOR (RAC)

NORTHERN CHANNEL C-7/C-5

EAST CHANNEL TERMINATION C-8/C-11

4" ø PERFORATED PE PIPE

LIMIT OF REGRADED WASTE/FILL

BENCH TYP. C-8/C-11

TRAPEZOIDAL RIPRAP LINED CHANNEL (TYP.) C-8/C-5

TRAPEZOIDAL GRASS LINED CHANNEL (TYP.) C-8/C-5

FINAL COVER SYSTEM C-8/C-11

GAS VENT C-8/C-12

CAP DRAIN 4" ø PERFORATED PE PIPE (SEE NOTE 3) C-8/C-11

SEE NOTE 2

WEST CHANNEL TERMINATION C-8/C-11

4" ø PERFORATED PE PIPE

BENCH DRAIN C-8/C-11

LIMIT OF DISTURBANCE

STREAM TERMINATION C-8/C-11

36" CMP

2A 2B 2C 2E 1A 1B1 1B2 1C 1D

02GW76 02GW100 02GW105 02GW101 02GW104 02GW43 02GW102 02GW103 02GW32 02GW31 110W29

N 500000

N 499500

E 1318000

E 1318500

LIMIT OF INFLOW AREA

PIPE

LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

- ● LANDFILL GAS MONITORING POINT
- ○ GAS VENTS
- LIMIT OF CAP
- LIMIT OF REGRADED WASTE
- EDGE OF CHANNEL
- WETLAND RESTORATION

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. WETLAND RESTORATION AREA TO BE SEEDED AS INDICATED ON C-3. ALL OTHER DISTURBED AREAS TO BE SEEDED WITH PERMANENT SEED MIX.

3/29/01

0 40 80
SCALE IN FEET
CHECK GRAPHIC SCALE BEFORE USING

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

DSN	403		
DI	404		
C.L.C.	405		
401	406		
402	D43		
REVIEWED BY NAVFAC			

Tetra Tech NUS, Inc.
1000 Corporate Boulevard
Aiken, South Carolina 29803

SCALE	TRE	DR.	HJP	DSN.	
SUBMITTED BY:			TITLE	DATE	
PROGRAM MANAGER				DATE	
APPROVED				DATE	

EPA POC COMMANDER BARFIELD

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY—CHESAPEAKE
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON NAVY YARD, 1322 PATTERSON AVENUE, SE, SUITE 1000
WASHINGTON, DC 20374-5065

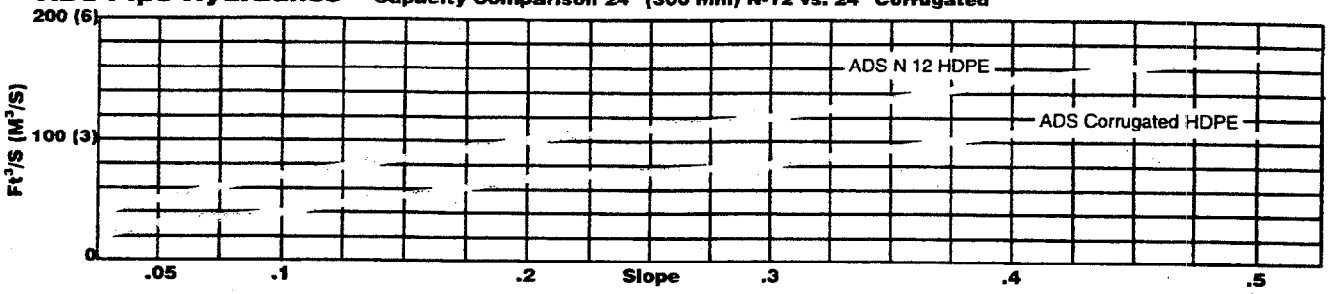
OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC – WHITE OAK
FINAL GRADING PLAN

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
N62470-97-D-
SPEC. 21-97-8000-
NAVFAC DRAWING NO.

SHEET 10 OF 16
C-8

00162D072

ADS Pipe Hydraulics — Capacity Comparison 24" (300 mm) N-12 vs. 24" Corrugated



ADS Recommended Manning's "n" For Design

Pipe Diameter	ADS Corrugated Polyethylene	*ADS-N-12 Polyethylene*	Concrete Pipe*	Corrugated Metal Pipe*
4,6,8,10,12"	.018	*.010 – .012*	.011 – .015	.022 – .026
15"	.018	*.010 – .012*	.011 – .015	.022 – .026
18"	.020	*.010 – .012*	.011 – .015	.022 – .026
24"	.020	*.010 – .012*	.011 – .015	.022 – .026
30"	.020	*.010 – .012*	.011 – .015	.022 – .026
36"	.020	*.010 – .012*	.011 – .015	.022 – .026

*ASCE Manual and Report on Engineering Practice #37

ADS N-12 Pipe Stiffness

Pipe Diameter in. (mm)	Minimum Pipe Stiffness* PSI (kPa)
4,6,8"(100,150,200)	50 (345)
10"(250)	50 (345)
12"(300)	50 (345)
15"(375)	42 (289)
18"(450)	40 (276)
24"(600)	34 (235)
30"(750)	28 (193)
36"(900)	22 (152)

*Per ASTM D2412

Weight Comparison Pounds/Linear Foot

Inside Diameter (inches)	ADS N-12* HDPE Pipe	Clay or Concrete	Corrugated Metal
10"	2.0	50	9.0
12"	3.2	79	10.5
15"	4.6	103	12.9
18"	6.4	131	15.8
24"	11.5	217	19.4
30"	15.4	384	30.0
36"	18.1	524	36.0

*Standard Length of N-12 Pipe is 20'

Height of Cover Table for ADS N-12 or Corrugated Pipe

—Depth of Cover for Corrugated Polyethylene Pipe
—H20 or E80 Live Load
—Pipe Manufactured to AASHTO M-294 or M-252

Diameter in. (mm)	Minimum Cover H20 in. (mm)	Minimum Cover E80 in. (mm)	Maximum Cover feet (meters)
4,6,8,10,12"(100-300)	12 (300)	24 (600)	58 (18)
15"(375)	12 (300)	24 (600)	59 (18)
18"(450)	12 (300)	24 (600)	62 (19)
24"(600)	12 (300)	24 (600)	61 (19)
30"(750)	12 (300)	24 (600)	61 (19)
36"(900)	12 (300)	24 (600)	61 (19)

Notes:

1. Cover limitations calculated using load factor design per AASHTO Procedures.
2. Soil density of 100#/cu. ft. (1600 kg/m³) is assumed.
3. Backfill around the pipe must be compacted to a density of 90% per AASHTO T-99.
4. Use reasonable care in handling and installation.
5. Cover limitations are measured from the top of the pipe.
6. Special situations such as cover less than 12" (300mm) or fills greater than 60 ft. (18 meters) should be discussed with an ADS Regional Engineer.

Pipe Perforations

Water inlet area shall be a minimum of 0.5 square inch per linear foot. Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Contracting Officer.

a. Circular Perforations in Plastic Pipe: Circular holes shall be cleanly cut not more than 3/8 inch) or less than 3/16 inch in diameter and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches center-to-center along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

b. Slotted Perforations in Plastic Pipe: Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 1/8 inch nor be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3 inch diameter tubing, 10 percent of the tubing inside nominal circumference on 4 to 8 inch diameter tubing, and 2-1/2 inches on 10 inch diameter tubing.

Product Notes

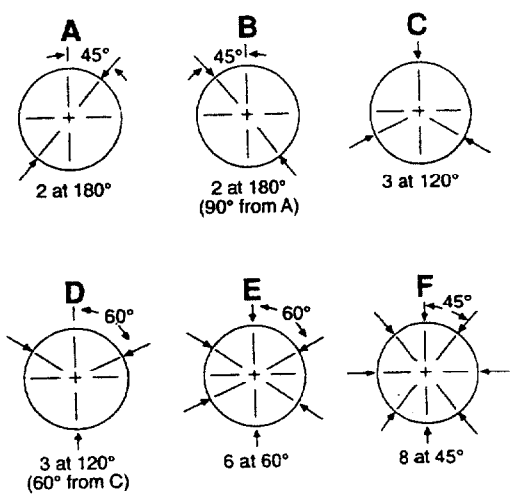
Product Note 3.106

Re: Standard Pipe Perforations
4-36" I.D. N-12® Pipe
Date: May 1, 1995

Nominal I.D. In. (mm)	Perforation Type	Slot Length or Diameter, Max. In. (mm)	Slot Width, Max. In. (mm)	Perforation Configuration
4 (100)	Slot	0.875 (22.2)	0.125 (3.18)	CD
6 (150)	Slot	0.875 (22.2)	0.125 (3.18)	CD
8 (200)	Slot	1.250 (31.8)	0.125 (3.18)	CD
10 (250)	Slot	1.250 (31.8)	0.125 (3.18)	CD
12 (300)	Circular	0.375 (9.52)	—	E
15 (375)	Circular	0.375 (9.52)	—	E
18 (450)	Circular	0.375 (9.52)	—	E
*24 (600)	Circular	0.375 (9.52)	—	F
**24 (600)	Circular	0.375 (9.52)	—	F
30 (750)	Circular	0.375 (9.52)	—	F
36 (900)	Circular	0.375 (9.52)	—	F

* Annular Corrugation
** Spiral Corrugation

Perforation Configurations



NOTE 1
ADS pipe is perforated for water entry with slots or circular perforations. The perforations are uniformly spaced along the length and circumference of the pipe.

NOTE 2
Unless otherwise specified, ADS pipe is manufactured to comply with the perforation requirements specified in the following industry standards: ASTM F405, ASTM F667, AASHTO M252, AASHTO M294, and SCS Code 606.

ADVANCED DRAINAGE SYSTEMS, INC. 4640 RIVERSIDE DR., P.O. BOX 018206, COLUMBUS, OHIO 43221 (614) 457-3051

D.3 SLOPE STABILITY CALCULATION

CLIENT:	EFAC NSWC - WHITE OAK		JOB 7427-1503
SUBJECT:	SLOPE STABILITY CALCULATIONS		
BASED ON:			DRAWING NUMBER:
BY: Date:	NJB 03/07/01	CHECKED BY: [illegible] Date: 3-15-01	APPROVED BY: Date:

Objective: Determine the minimum interface friction angle required between each geosynthetic-geosynthetic and geosynthetic-soil interface to maintain a stable cap/cover soil.

References:

1 Lambe and Whitman, *Soil Mechanics*, John Wiley & Sons, 1969, p.193

2 "Design of Lateral Drainage Systems for Landfills", G. N. Richardson and Aigen Zhao, 1999, *Geosynthetics for Advanced Solutions Seminar* sponsored by GSE Lining Technology, Synthetic Industries, and Tenax, Pittsburgh, Pennsylvania, July 13, 2000, p. 28

Given: Slope is 4H:1V.

β = 14.0 degrees = slope

δ = interface friction or internal friction

a = 2 ft = thickness of cover soil

d_w = thickness of saturated layer

γ_w = unit weight of water = 62.4 pcf

γ_a = unit wt of soil = 120 pcf

FS_{slope} = Minimum factor of safety against sliding for soil/geocomposite or geocomposite/geomebrane interface = 1.5

Method: FS_{slope} = Resisting Forces / Driving Forces

$FS_{slope} = \tan\delta\,[1-\gamma_w{*}d_w/\gamma_a{*}a)] / \tan\beta$

Solution: Theoretically, the geocomposite can carry the water out as fast as it can enter, and d_w, thickness of the geocomposite, is essentially zero. Therefore:

$$FS_{slope} = \frac{\tan\delta}{\tan\beta} \quad \text{(Ref 1)}$$

determine δ so the $FS_{slope} = 1.5$

$\tan\beta * FS_{slope} = \tan\delta$

$\delta = \tan^{-1}(\tan\beta * FS_{slope})$

$\delta = 20.5$ degrees

CLIENT:	EFAC NSWC - WHITE OAK		JOB 7427-1503
SUBJECT:	SLOPE STABILITY CALCULATIONS		
BASED ON:			DRAWING NUMBER:
BY: Date:	NJB 03/07/01	CHECKED BY: Date: 3-15-01	APPROVED BY: Date:

However, to be conservative, determine the required δ if the cover soil becomes saturated. (i. e., determine δ to achieve FS = 1.5 with increase in head in cover soil layer)

$\tan \delta = [1.5 (\tan \beta)/(1 - (\gamma_w * d_w/\gamma_a * a))$

d_w (ft)	tan δ	δ (degrees)
0.00	0.375	20.6
0.50	0.431	23.3
0.75	**0.466**	**25.0**
1.00	0.507	26.9
1.25	0.556	29.1
1.50	0.615	31.6
1.75	0.688	34.5
2.00	0.781	38.0

Check above equation with simplified equation for fully saturated layer:

FS = resisting forces/driving forces = $(\gamma_b * \tan\delta)/(\gamma_{sat} * \tan\beta)$ (Ref 2)

where $\gamma_b = \gamma_t - \gamma_w$ = 120 pcf - 62.4 pcf = 57.6 pcf

FS = 57.6 pcf * tan 38 / 120 pcf *tan 14 = 1.5 same as above, OK

For design purposes, assume the saturated depth of the cover soil is 0.75 ft.

Based on the above calculation, to achieve a factor of safety of 1.5, **the required interface friction angle must be at least 25.0 degrees.**

Although the drain is designed to completely prevent head buildup, to be conservative, some head should be considered. A saturated depth of 0.75 ft is reasonable, as the drain should prevent infiltration from further saturating the cover soil.

A required value of 25 degrees for the interface friction is reasonable because most combinations of manufactured textured geomembranes/geotextiles should achieve this value when tested under site conditions. Also, the cover soil itself will be uncompacted, therefore it should achieve but may not greatly exceed this value for the angle of internal friction. (For example, a value of 38 degrees for the fully saturated layer would not be necessary for the geosynthetic interface, as the soil itself would not have 38 degrees and so would have slid off the liner.)

D.4 COVER SOIL/GEOTEXTILE COMPATABILITY

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1502
SUBJECT:	COVER SOIL/GEOTEXTILE COMPATIBILITY (65% DESIGN)		
BASED ON:			DRAWING NUMBER:
BY: Date:	NJB 11/19/00	CHECKED BY: TNS Date: 11/29/00	APPROVED BY: Date:

PURPOSE;

Determine a compatible filter geotextile and cover soil.

REFERENCES:

1 *Designing with Geosynthetics*, Third Ed., Robert M. Koerner, Prentice Hall, 1994, pp. 100-102

2 "Designer's Forum: Geotextiles in Drainage Systems", Gregory N. Richardson and Barry Christopher, *Geotechnical Fabrics Report*, April 1997, pp. 19-23 (attached, sheets 6 - 10)

DISCUSSION:

White Oak OU 2 will be covered with a geosynthetic cap system. The top layer of the system will be a geocomposite consisting of a geonet bonded between two layers of geotextiles. Cover soil will be placed over the geosynthetic cap system. Design the geotextile and compatible cover soil so that the geocomposite can function properly. Because geocomposites are manufactured only with nonwoven geotextiles bonded to geonets, only nonwoven geotextiles will be evaluated.

METHOD:

A geotextile which acts as a filter around a drain should satisfy the following criteria:

1 The geotextile must retain the soil (retention criterion)

2 Allow the water to pass (permittivity criterion)

3 Maintain flow for the life of the structure (clogging resistance criterion)

4 Have sufficient strengths for installation conditions (survivability criteria)

STEP 1: RETENTION CRITERION

Use method recommended by Task Force #25 (Ref 1), Carroll (Ref 1), and AASHTO M 288 (Ref 2)

1A: Task Force #25 recommends:

For soil $\leq$ 50% passing the No. 200 sieve, $O_{95} < 0.59$ mm (AOS of the fabric $\geq$ No. 30 sieve)

For soil > 50% passing the No. 200 sieve, $O_{95} < 0.30$ mm (AOS of the fabric $\geq$ No. 50 sieve)

where O_{95} = apparent opening size (AOS) = 95% opening size of the geotextile

Because the cover soil has not yet been selected, use $O_{95} < 0.30$ mm because it is suitable for any % passing the No. 200 sieve.

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1502
SUBJECT:	COVER SOIL/GEOTEXTILE COMPATIBILITY (65% DESIGN)		
BASED ON:			DRAWING NUMBER:
BY: Date:	NJB 11/19/00	CHECKED BY: Date: 11/29/00	APPROVED BY: Date:

1B: Carroll recommends (for wovens and nonwovens)

$O_{95} < (2 \text{ or } 3)\ d_{85}$

where d_{85} is the soil particle size in mm for which 85% of the total soil is finer

if geotextile AOS is No. 50, $d_{85} > 0.30/(2 \text{ or } 3) = 0.15$ or .10

if geotextile AOS is No. 70, $d_{85} > 0.21/(2 \text{ or } 3) = 0.10$ or .07

1C: AASHTO M 288-96 geotextile criteria for subsurface drainage:

maximum $O_{95} = 0.22$ mm satisfies all soils %s passing the No. 200 sieve (see Ref 2, Table 3)

Therefore use geotextile AOS No. 70 ($O_{95} = 0.21$ mm) and $d_{85} > .10$ mm

STEP 2: PERMITTIVITY CRITERIA

The purpose of the permittivity criteria is to select a fabric that will allow water to pass through to the geonet as quickly as it passes through the soil.
Use AASHTO M 288 geotextile criteria for subsurface drainage (Ref 2)

Minimum permittivity varies with soil % passing the No. 200 sieve, from
0.5 sec^{-1} for < 15% passing the No. 200 sieve to
0.1 sec^{-1} for >50% passing the No. 200 sieve

6 oz/sy nonwoven fabrics with No. 70 AOS have a typical permittivity of 1 sec^{-1}, therefore specify AOS No. 70, permittivity ≥ 0.5 sec^{-1}

STEP 3: CLOGGING CRITERIA

Geotextile:
Geotextile should not be a heat-calendered nonwoven (Ref 2)

Soil:

Property	ASTM method
Grain size distribution	D 422
Atterberg Limits	D 4318
Gradient Ratio (If required)	D 5101

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1502
SUBJECT:	COVER SOIL/GEOTEXTILE COMPATIBILITY (65% DESIGN)		
BASED ON:			DRAWING NUMBER:
BY: Date:	NJB 11/19/00	CHECKED BY: TMA Date: 11/29/00	APPROVED BY: Date:

To minimize the possibility of clogging, select a cover soil that satisfies one of the following (Ref 3):

1 Plastic soil, with a Plasticity index (PI) >15

2 Uniformly graded, sandy soil with $C_u < 3$

where C_u = uniformity coefficient = D_{60}/D_{10}
D_{60} = diameter at which 60 percent of the soil is finer
D_{10} = diameter at which 10 percent of the soil is finer

OR

3 Well graded soil with $C_u > 4$ and $1 < (D_{30})^2/D_{10}*D_{60} < 3$

where D_{30} = diameter at which 30 percent of the soil is finer

in addition, if >15% passing the No. 200 sieve and the fines are non-plastic or low plastic, ASTM D 5101 Gradient Ratio Test should be performed. Passing criteria: gradient ratio ≤ 3 (Pεϕ 1, π. 102)

To avoid clogging, potentially unstable soils in which the nonplastic fines can migrate within the coarse fraction should not be used for cover soil, including:

gap-graded soils, in which there is coarse and fine soil fractions but very little medium fraction

non-plastic broad-graded soils in which Cu > 20 and the gradation curve is concave upwards

OR

dispersive soils that deflocculate in the presence of water, including but not limited to sugar sands

STEP 4: SURVIVABILITY CRITERIA

For subsurface drainage, use AASHTO M288-96 Geotextile Class 2. Nonwoven Class 2 geotextiles have the following properties:

Property	ASTM method	Units	Value
Grab Strength*	D 4632	lb.	160
Seam Strength*	D 4632	lb.	140
Tear Strength*	D 4533	lb.	55
Puncture Strength*	D 4833	lb.	55
Burst Strength*	D 3786	psi	200

* elongation > 50%

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1502
SUBJECT:	COVER SOIL/GEOTEXTILE COMPATIBILITY (65% DESIGN)		
BASED ON:			DRAWING NUMBER:
BY: Date:	NJB 11/19/00	CHECKED BY: TWS Date: 11/29/00	APPROVED BY: Date:

SOLUTION:

Nonwoven geotextiles with the following properties are acceptable:

Property	ASTM method	Units	Value
Grab Strength*	D 4632	lb.	160
Seam Strength*	D 4632	lb.	140
Tear Strength*	D 4533	lb.	55
Puncture Strength*	D 4833	lb.	55
Burst Strength*	D 3786	psi	200
AOS	D 4751	U. S. sieve	70
Permittivity	D 4491	sec^{-1}	0.5
Not heat-calendered	NA	-	-

* elongation > 50%

Cover soils with the following properties are acceptable:

1 d_{85} > .10 mm

AND

2a Plastic soil, with a Plasticity index (PI) >15

2b Uniformly graded, sandy soil with $C_u < 3$

OR

2c Well graded soil with $C_u > 4$ and $1 < (D_{30})^2/D_{10}*D_{60} < 3$

in addition, if >15% passing the No. 200 sieve and the fines are non-plastic or low plastic, ASTM D 5101 Gradient Ratio Test should be performed. The gradient ratio must be less than or equal to 3 to pass (Ref 1, p. 102)

Potentially unstable soils in which the nonplastic fines can migrate within the coarse fraction **should not be used for cover soil, including:**

gap-graded soils, in which there is coarse and fine soil fractions but very little medium fraction

non-plastic broad-graded soils in which $C_u > 20$ and the gradation curve is concave upwards

OR

dispersive soils that deflocculate in the presence of water, including but not limited to sugar sands

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1502
SUBJECT:	COVER SOIL/GEOTEXTILE COMPATIBILITY (65% DESIGN)		
BASED ON:			DRAWING NUMBER:
BY: Date:	NJB 11/19/00	CHECKED BY: TMS Date: 11/29/00	APPROVED BY: Date:

Additional restrictions to Cover Soils:

Use a soil capable of supporting vegetation, therefore, specify a USDA textural class loam.

From "Drainage System (65% Design)" calculations, USDA loam types sandy loam and loamy sand are too permeable.
Clay loam does not drain well, makes a poor growing medium.

Therefore, use USDA textural types: sandy clay loam, loam, silt loam, or silty clay loam.
Use USDA grain size criteria when determining USDA soil type.

DESIGNER'S FORUM

Geotextiles in drainage systems

By Gregory N. Richardson and Barry Christopher

WE HAVE SPENT MUCH OF THE last 15 months presenting one-day seminars on using geotextiles in transportation-related systems. Amoco Fabrics and Fibers Co., Atlanta, has sponsored these seminars and was brave enough to step back and let Barry and I develop a pragmatic course for design professionals. It's a brave manufacturer that lets go of the microphone and actually tolerates a course not totally flattering to their *entire* product line. It also was encouraging to discover that Barry and I approach many common filtration applications in essentially the same simplistic fashion.

Our approach here also serves as a good lead-in to a more in-depth series of articles on filtration that will begin in the August issue and for subsequent columns on roadway stabilization and separation applications. *GFR's* filtration series will help you evaluate some of the difficult applications skirted here by addressing design procedures for final critical and extremely challenging applications.

First, some simple background. The removal of water is important to the success of many types of civil structures. In filtration applications, the geotextile must allow water to freely pass through, while at the same time retain the finer soil up-gradient from the geotextile. Filtration applications include trench drains (**Figure 1**), vertical drains behind retaining walls, and coastal erosion-control applications. In these instances, the retained soil may be plastic or granular. The classic filtration application—first used by the late Bob Barrett of Carthage Mills, Cincinnati, almost 40 years ago—was a geotextile to prevent loss of fine sands beneath shoreline-armoring systems. In this application, the flow may be continual or even reversing in nature.

Filtration requires the removal of water in a controlled fashion. Otherwise, severe erosion, piping, or settlement of soils may result in undermining adjacent structures or rendering facilities useless. Hence, a drainage system should provide for the removal of water without excessive loss of the retained soil. This can be accomplished by using either a graded soil or geotextile filter. Now, we'll address the design of a geotextile filter for common filtration system applications, and identify soil types that may require a more rigorous evaluation.

The filtration process

A filter consists of any porous material that has openings small enough to prevent movement of soil into the drain, and that is sufficiently pervious to offer little resistance to seepage. For most soils (we'll refer to them as stable soils), it is not necessary for a filter to screen out all the particles in the soil. Instead, a filter need only restrain the coarse fraction of the various particle sizes present. As flow across the filter occurs, the coarse particles collect against the filter, bridging the filter openings. The voids of the coarse particles create smaller openings to trap even smaller particles of soil. In this manner a filter bridge is developed. It is this filter bridge that actually performs the filtration function. Additionally, the geotextile must be properly seated into the retained soil such that water cannot flow or pool between the retained soil and the geotextile.

Filter criteria

Geotextiles present an attractive alternative to graded-granular filters for many projects because they are comparatively inexpensive and easy to install. As the use of geotextile filters has increased, so has the understanding of their capabilities and limitations. We won't go into a detailed analysis for determining the required geotextile-hydraulic properties in this column. Rather, we'll recommend specific types of woven and nonwoven fabrics on the basis of soil criteria.

This simplified approach should not be used for heat-calendered nonwovens, i.e., set by running fibers between hot rollers, or woven geotextiles made exclusively from slit tape. If you desire a detailed analysis of required geotextile hydraulic properties, I suggest you refer to Holtz et al. (1995), Luettich et al. (1991), Koerner (1994), and *GFR's* pending filtration series.

Steady-state vs. dynamic flow

The type of flow in the drainage system must be identified before proceeding with a filter design. Flow can be classified as either steady-state or dynamic. Steady-state flow is usually present in trench drains adjacent to roads and parking lots, behind retaining walls, under foundations, and below recreational fields. Steady-state flow means that water moves in one principle direction; this is the simplest application for a geotextile filter.

Dynamic flow is usually encountered in permanent erosion-control applications for shorelines and canals. In contrast to static flow, dynamic flow occurs in more than one direction. It is important to recognize cases of dynamic flow because, under these conditions, the development of a filter bridge adjacent to the geotextile may not be possible unless the geotextile is properly seated to the retained soil. In such cases, the dynamic, cyclic or pulsating loads can create very high localized-flow gradients that may cause actual free flow of water and movement of the coarse fraction behind the geotextile. This is typically the case in shoreline erosion-control applications where a single layer of large stones is placed directly on the geotextile (**Photo 1**).

Soil properties

Most geotextile filter designs can be performed on the basis of the *retained* soil

Figure 1. Trench drain illustration (used with permission from Synthetic Industries).

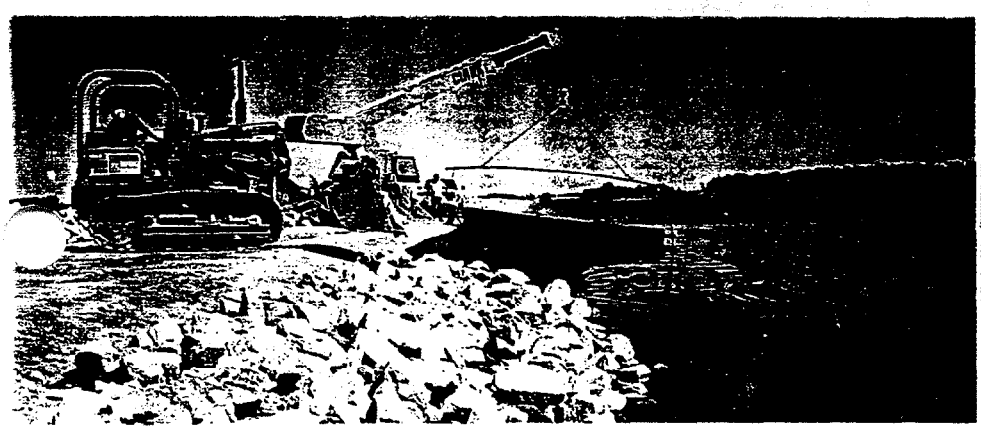


Photo 1. The dynamic flow encountered in permanent erosion-control applications, such as this project on the Ohio River, can create very high localized-flow gradients that may cause actual free flow of water and movement of the coarse fraction behind the geotextile.

characteristics. Atterberg limits and grain-size distribution often provide adequate soil information for most filter designs. Since these tests are very inexpensive, such data can be obtained for even small applications. Atterberg limits (ASTM D 4318) indicate the liquid limit (LL), plastic limit (PL), and plasticity index (PI) of the soil—information that is helpful in assessing the flow capacity and clogging potential of a geotextile. The following information enables the designer to quickly decide if the retained soil is stable (suitable for this simple filtration evaluation) or unstable (requires a more rigorous geotextile evaluation):

- **Stable soils** can perform the self-filtration process, i.e., develop a filter bridge, previously described. Typically, these soil types include both plastic, uniformily graded granular, and well-graded soils.
- **Unstable soils** cannot perform self-filtration, i.e., they have the potential to pipe internally. Such soils may include gap-graded, and nonplastic broad-graded soils. In gap-graded soils, there is a coarse and fine fraction, but very little medium fraction. The fine-soil particles pipe through the coarse fraction and a filter bridge cannot form behind the geotextile. In some broad-graded soils, the medium fraction also is limited and soil fines tend to pipe through the coarser particles without forming a filter bridge.

This column focuses on selecting a geotextile for filtration and typical separation applications with stable soils. When unstable soils are present, we urge you to refer to more rigorous methods.

Stable soils

Plastic, uniform and well-graded soils provide the easiest application of a geotextile filter. Such soils can be defined as one of the following:

- **Plastic soils** with a PI greater than 15. Generally, *particles do not move within soils with a PI higher than 15 percent.* Bedded cohesive soil layers separated by thin sand or silt seams are an exception to this general rule. The clogging potential of cohesive soils is minimal and not normally of concern.
- **Uniformly graded, sandy soils** are actually a class of poorly graded soils that contain only one grain size. They are characterized by having a coefficient of uniformity, C_u, less than approximately 3. C_u is defined as D_{60}/D_{10} where D_{60} = the diameter at which 60 percent of the soil is finer, and D_{10} = the diameter at which 10 percent of the soil is finer. Common beach sand is a good example of a uniform soil.
- **Well-graded soils** must meet the following criteria:

$$\frac{D_{60}}{D_{10}} > 4 \qquad 1 < \frac{D_{30}^2}{D_{10} \cdot D_{60}}$$

where:

D_{10} = the diameter at which 10 percent of the soil is finer

D_{30} = the diameter at which 30 percent of the soil is finer

D_{60} = the diameter at which 60 percent of the soil is finer.

Figure 2 shows sample gradation curves of stable well-graded and uniformly graded granular soils. These soils are recommended for the simple geotextile filter design procedure presented in this column.

Potentially unstable soils

Gap-graded and broad-graded soils are the most common potentially unstable soils. These soils are unstable if the percentage of nonplastic fines is so large that the coarse fraction particles are not in contact, but float within the fine fraction. When the percentage of nonplastic fines is so large, the filter bridge will not be established adjacent to the geotextile and all the fines will be lost. **Figure 3** shows typical grain-size distribution curves for such soils. One characteristic that distinguishes an unstable, broad-graded soil from a well-graded soil is the value of D_{60}/D_{10}. For broad-graded soils, this value exceeds 20. Another characteristic of unstable, broad-graded soils is that the gradation curve is concave upward. Broad-graded soils with a gradation curve that is concave downward, have a large coarse fraction, will be stable, and can be treated as well-graded soils.

The simplified design procedures presented here should *not* be applied to unstable soils. For such soils, consult an expert and plan on performing soil-specific laboratory testing.

Geotextile requirements

A filter geotextile must be designed to satisfy both survivability and hydraulic requirements for the particular installation. Barry and I perform the following geotextile filter evaluation for *stable* soil applications.

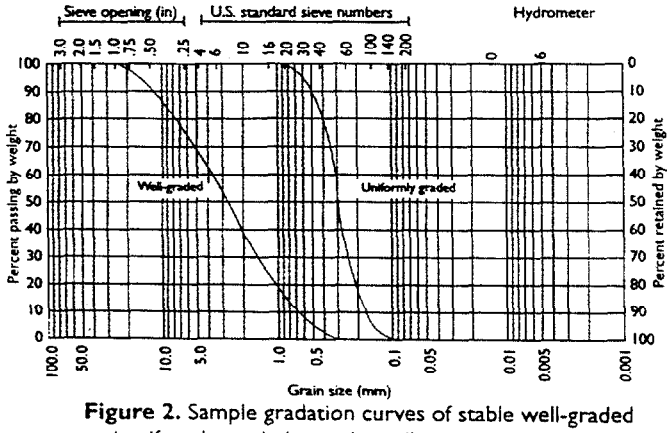


Figure 2. Sample gradation curves of stable well-graded and uniformly graded granular soils.

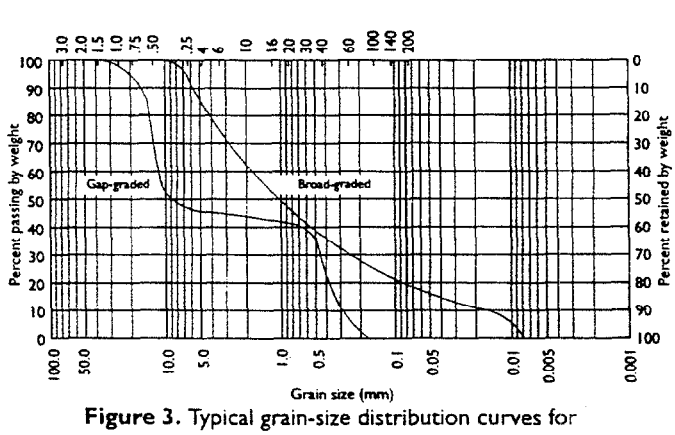


Figure 3. Typical grain-size distribution curves for potentially unstable soils.

Survivability requirements for filtration

It is generally agreed that the installation day is most difficult in the life of a filter geotextile. Installation damage may result from trafficking by construction equipment and from stone drainage layers placed over the geotextile. In general, the stronger the geotextile, the greater its resistance to installation damage, i.e., the greater its potential for survivability. The ability of a geotextile to survive installation damage is difficult to quantify using design equations, but you can do it based on past experience.

We recommend using the survivability criteria in AASHTO M 288-96. This document defines three geotextile-strength categories (**Table 1**) that are required for survivability under typical installation conditions for different geotextile functions. **Table 2** shows the particular class required for a given function or application. M 288 recommends a Class 2 geotextile for typical filtration applications. If you are going to use unusually aggressive stone immediately adjacent to the geotextile—or if you anticipate the contractor from hell—you may opt to increase the survivability class.

TABLE 1. AASHTO M 288-96 GEOTEXTILE SURVIVABILITY REQUIREMENTS

Property	ASTM test method	Units	Geotextile class: Class 1 <W 50%	Class 1 >NW 50%	Class 2 <W 50%	Class 2 >NW 50%	Class 3 <W 50%	Class 3 >NW 50%
Grab strength	D 4632	N (lb)	1400 (315)	900 (205)	1100 (250)	700 (160)	800 (180)	600 (115)
Seam strength	D 4632	N (lb)	1260 (280)	810 (185)	990 (220)	630 (140)	720 (165)	450 (100)
Tear strength	D 4533	N (lb)	500 (115)	350 (80)	400 (90)	250 (55)	300 (70)	180 (40)
Puncture strength	D 4833	N (lb)	500 (115)	350 (80)	400 (90)	250 (55)	300 (70)	180 (40)
Burst strength	D 3786	kPa (psi)	3500 (510)	1700 (255)	2700 (400)	1300 (200)	2100 (305)	950 (140)

• Elongation at break as measured in accordance with ASTM D 4632

Hydraulic requirements for filtration

For **stable soils**, the geotextile selected should have openings small enough to retain the coarse fraction, but large enough to allow the fine fraction to move through the geotextile. For stable soils, we recommend using the M 288 filtration hydraulic criteria (**Tables 3** and **4**). It is the simplest to understand for each stable-soil type.

Plastic soils that have a PI greater than 15 do not have clogging problems or high internal-flow rates. Geotextile filters for such soils must provide only a minimum permittivity, Ψ. The M 288 permittivity requirement for such soils is $\Psi \geq 0.1$ sec^{-1} for all applications. According to M 288, the geotextile's AOS should be equal to or less than 0.22 mm. Both woven and nonwoven geotextiles can be used in this application, though both Barry and I acknowledge a historic bias towards nonwovens.

Uniformly graded, sandy soils typically have a sand fraction of less than 5 percent passing the No. 200 sieve (0.75 mm). Such soils may have a fairly high internal-flow rate and require higher permittivity, Ψ. The M 288 permittivity requirement for such soils is $\Psi \geq 0.5$ sec^{-1} for steady-state applications, and $\Psi \geq 0.7$ sec^{-1} for dynamic applications. The AOS of the geotextile must be selected to retain the sand particles. For uniform sandy soils, the AOS should be equal to or less than 0.43 mm. This is approximately the D_{85} of typical sands. In dynamic applications, we also recommend a minimum percent open area (POA) of 4 percent. Again, both woven and nonwoven geotextiles can be used for this application, however, we still have a bias towards wovens.

Well-graded soils require an assessment of the geotextile's flow capacity and clogging potential based on the percent fines. Soils with less than 15 percent passing the No. 200 sieve (0.75 mm) may have a high internal-flow capacity and low-clogging potential. Thus, geotextiles with higher permittivities (e.g., greater than 0.5 sec^{-1} for steady-state flow and 0.7 sec^{-1} for dynamic flow) may be required. The AOS for such soils should be less than 0.43 mm. Non- or low-plastic soils with fine contents greater than 15 percent have reduced flow capacity, but a higher clogging potential. For such soils, geotextiles with lower permittivities, e.g., greater than 0.2 sec^{-1}, may be used, but their clogging resistance must be evaluated. The AOS for such soils should be less than 0.25 mm.

For soils containing more than 5 percent nonplastic fines, we commonly perform a simple field test to empirically assess the clogging potential of a geotextile filter. While certainly not a standardized test by ASTM rules, we have found the simple jar test to be very useful. It is essentially a fine-fraction filtration test and permits a quali-

TABLE 2. AASHTO M 288 96 DEFAULT GEOTEXTILE CLASS

Application	Default geotextile class
Subsurface drainage	2
Separation	2
Stabilization	1
Permanent erosion control	2 for woven monofilament 1 for all others

TABLE 3. GEOTEXTILE CRITERIA FOR SUBSURFACE DRAINAGE

	Percent soil passing No. 200 (0.75 mm) sieve: <15	15 to 50	>50
Survivability	Class 2		
Minimum permittivity ASTM D 4491	0.5 sec^{-1}	0.2 sec^{-1}	0.1 sec^{-1}
Maximum AOS ASTM D 4751	0.43 mm	0.25 mm	0.22 mm

• after AASHTO M 288-96

TABLE 4. GEOTEXTILE CRITERIA FOR PERMANENT EROSION CONTROL

	Percent soil passing No. 200 (0.75 mm) sieve: <15	15 to 50	>50
Survivability	Class 2—woven monofilaments Class 1—all other geotextiles		
Minimum permittivity ASTM D 4491	0.7 sec^{-1}	0.2 sec^{-1}	0.1 sec^{-1}
Maximum AOS ASTM D 4751	0.43 mm	0.25 mm	0.22 mm

• after AASHTO M 288-96

tative evaluation of the ability of fines to pass through a geotextile.

To perform the jar test, place a small amount of soil in a jar (approximately ¼ full). The jar should preferably have a removable center lid (e.g., a Mason jar). Fill the jar with water, replace and secure the lid. Then shake to form a soil-water slurry. Cover the jar opening with a sample of the candidate geotextile and secure it. Allow the jar to stand for about one minute to allow coarser particles to settle. Pour the liquid from the jar through the geotextile, tilting the jar such that trapped air does not impede water flow.

If the fines pass through the geotextile, it should not clog. If very little fine soil passes and a significant buildup of fines is observed on the surface of the geotextile, a clogging potential may exist. Either evaluate another geotextile or perform a more sophisticated filtration test (i.e., the ASTM D 5101 Gradient Ratio Test).

The success of the geotextile filter also is very dependent on the quality of installation. Proper installation requires seating the geotextile against the soil to be retained and placing the overlying stone without excessively damaging the geotextile.

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Geotextile filter design

Step 1: Evaluate the soil to be filtered (the retained soil). As a minimum, this should include:

- visual classification (ASTM D 2488)
- Atterburg limits (ASTM D 4318)
- grain-size distribution analysis (ASTM D 422)

Proceed with the simplified design if the soil is stable.

Step 2: Determine the geotextile's minimum survivability requirements by using the M 288 guidelines in Tables 1 and 2. M 288 recommends a Class 2 geotextile.

Step 3: Determine the geotextile's minimum hydraulic requirements by using the M 288 guidelines in Tables 3 and 4.

Step 4: Select the geotextile in accordance with Steps 2 and 3.

Step 5: Perform the jar test if required.

Design example: geotextile filter

Design a geotextile filter for a trench drain that will be used to de-water a construction site. Limited site investigation has indicated that the trench will be excavated in silty-sand-type soils.

Step 1: Visual identification and classification indicate that the soil to be filtered is a silty sand (SM), and that the silt fraction is relatively nonplastic. A grain-size analysis has indicated that the soil is uniformly graded and is, therefore, likely to be internally stable. The analysis also showed that 15 percent passed the No. 200 (0.75 mm) sieve.

Step 2: Determine the minimum survivability requirements for the geotextile using the M 288 guidelines in Tables 1 and 2. This should be a Class 2 geotextile with the minimum (MARV) strength values in **Table 5.**

Step 3: Determine the geotextile's minimum hydraulic requirements by using the M 288 guidelines in Tables 3 and 4. The permittivity of the geotextile must be greater than 0.2 sec^{-1}, and the AOS must be less than 0.25 mm.

Step 4: Select a suitable geotextile that meets the criteria in Steps 2 and 3. With the exception of woven geotextiles constructed exclusively from slit tape and heat-calendered nonwovens, almost any woven or

TABLE 3. MINIMUM STRENGTH VALUES FOR STEP 2 OF THE GEOTEXTILE FILTER DESIGN FLOWCHART

Properties	Test Method	Units	Woven Geotextile	Nonwoven Geotextile
[illegible]	D [illegible]	[illegible]	[illegible]	160
[illegible]	D 1682	[illegible]	[illegible]	140
[illegible]	D [illegible]	[illegible]	[illegible]	55
[illegible]	D 4833	[illegible]	[illegible]	55
[illegible]	D 4632	[illegible]	100	200
[illegible]	Nonwoven Geotextile			

nonwoven geotextile can be used if it meets the requirements in Steps 2 an 3. The geotextile specifications, therefore, can be written as follows:

- The geotextile shall be a woven with monofilament or fibrillated yarns or a needlepunched nonwoven geotextile.
- The geotextile shall have MARV strength properties that meet the requirements of an M 288 Class 2 geotextile.
- The geotextile shall have MARV hydraulic properties that meet the requirements of M 288 geotextile criteria for subsurface drainage for soils having 15 to 50 percent fines.

Step 5: If a jar test is run, it will be necessary to obtain samples of candidate geotextiles for evaluation.

The geotextile specifications can simply reference the M 288 guidelines or they can reference the guidelines and present the actual specifications referenced. Placing the actual strength and hydraulic values in the specifications makes it easier to verify that the materials submitted in the field meet the requirements. Conversely, using only the M 288 reference produces very compact specifications and eliminates the possibility of errors between M 288 criteria and the actual material properties specified. It is clear, however, that using the M288 guidelines provides the designer with a very quick method of evaluating and designing geotextiles for most filtration applications for stable soils.

I hope one day the geotextile suppliers will reduce the mind-boggling array of geotextiles now sold and provide generic geotextiles that satisfy, and are so marked, the M288 Class X requirements. This would simplify the design and field inspection of common separators, stabilizers, and erosion-control geotextiles.

Acknowledgments

Thanks to Alan Ossege, Carthage Mills, Cincinnati, Rick Valentine, Amoco Fabrics and Fibers Co., Atlanta; and Deron Austin, Synthetic Industries Inc., Chattanooga, Tenn., for their comments on this article. GFR

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References

Holtz, R. D., Christopher, B. R., and Berg, R. R., (1995) "Geosynthetic Design and Construction Guidelines." Publication No. FHWA HI-95-038, NHI Course No. 13213, U.S. Department of Transportation, Washington D.C.

Luettich, S. M., Giroud, J. P., and Bacchus, R. C., (1991) "Geotextile Filter Design Guide." *Geosynthetic Filtration, Drainage and Erosion*, Fifth Annual Geosynthetic Research Institute seminar, Drexel University, Philadelphia, Pa.

Koerner, R.M. (1994) *Designing with Geosynthetics*, Third Edition, , 3d Ed., Prentice Hall, Englewood Cliffs, N.J.

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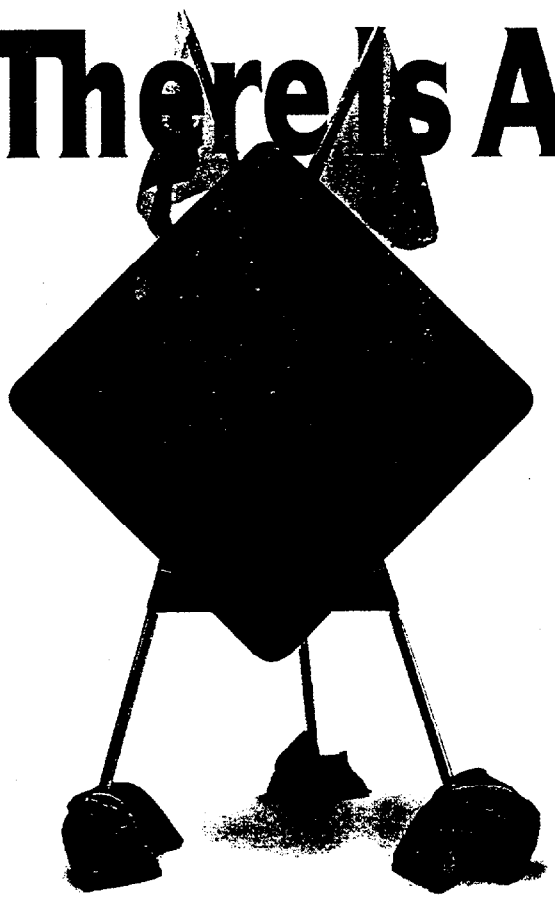

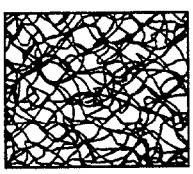

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APPENDIX E

DEVELOPMENT OF GEOTEXTILE SPECIFICATIONS

CLIENT:	EFAC NSWC - WHITE OAK	JOB NUMBER:	7427-1502
SUBJECT:	Development of Geotextile Specifications		
BASED ON:	AASHTO M-288-96	DRAWING NUMBER:	
BY: NJB Date: 12/8/00	CHECKED BY: [illegible] Date: 12/11/00	APPROVED BY:	DATE:

PURPOSE:

Establish the specifications for the geotextiles to be used in the construction of the landfill cap at White Oak OU2

REFERENCE:

1 Designing with Geosynthetics, Fourth Edition, Robert M. Koerner, 1998. (pp. 6 and 7 of 9)
2 *Standard Specifications for Construction and Materials*, Maryland Department of Transportations, State Highway Administration, October 1993. (pp. 8 and 9 of 9)

DISCUSSION:

Geotextiles are to be used in the construction of the landfill cap at White Oak OU2 (consolidation of Sites 1 & 2). The four situations in which the geotextiles are to be used include the following:

Geotextile on the bench beneath base aggregate

Design for separation

The purpose of the geotextile is to separate the base aggregate from the cover soil layer. Rainfall which infiltrates the geotextile can discharge through the geocomposite.

Geotextile beneath riprap on the southern slope

Design for separation

The purpose of the geotextile is to separate the riprap stone from the bedding layer and the bedding layer from the cover soil. During floods, water will flow parallel to the slope. Any water which flows through the geotextile can discharge through the geocomposite.

Geotextile beneath channel rock lining

Design for separation

The purpose of the geotextile is to separate the rock lining from the underlying natural soil.

Geotextile for pipe trench

Design for filtration and separation

Geotextile properties provided in "Cover Soil/Geotextile Compatibility (65% Design)" calculations for White Oak by NJB, 11/19/00

CLIENT: EFAC NSWC - WHITE OAK			JOB NUMBER: 7427-1502
SUBJECT: Development of Geotextile Specifications			
BASED ON: AASHTO M-288-96			DRAWING NUMBER:
BY: NJB Date: 12/8/00	CHECKED BY: TNA Date: 12/11/00		APPROVED BY: DATE:

Geotextile Properties:

Table 1

Standard geotextile specified properties:	
Geotextile Property	**Description**
Grab Tensile Strength	measure of breaking load and elongation of geotextiles.
Sewn Seam Strength	measure of force required to separate a sewn seam in a geotextile
Tear Strength	measure of force required to propagate a tear in a geotextile.
Puncture Strength	measure of the puncture resistance of a geotextile.
Burst Strength	measure of the extent of deformity of a geotextile.
Wide-Width Tensile Strength	measure of the geotextiles tensile strength
Permittivity	roughly equivalent to the measure of soil permeability.
Apparent Opening Size (AOS)	measure of the particle size allowed to pass through the geotextile.
Ultraviolet Stability	the percent of retained strength after 500 hr of sun exposure
Geotextile Clogging	measure of the geotextiles clogging potential
Mass per Unit Area	measure of geotextiles conformance to specifications
Asphalt Retention	measurement of geotextiles ability to retain pavement mixtures (used for paving fabrics only).

Geotextile Survivability:

The term "geotextile survivability" refers to the fabric's ability to withstand installation stresses associated with a particular application, and to perform as intended in the project design. The following is a summary of geotextile requirements for the three classes of geotextiles (AASHTO M 288-96).

Table 2

Property	Test Method	Unit(s)	Geotextile Class					
			Class 1		Class 2		Class 3	
			Elongation < 50%*	Elongation > 50%*	Elongation < 50%*	Elongation > 50%*	Elongation < 50%*	Elongation > 50%*
Grab Tensile Strength	ASTM D 4632	lbs	315	205	250	160	180	115
Sewn Seam Strength	ASTM D 4632	lbs	280	185	220	140	165	100
Tear Strength	ASTM D 4533	lbs	115	80	90	55	70	40
Puncture Strength	ASTM D 4833	lbs	115	80	90	55	70	40
Burst Strength	ASTM D 3786	lbs	510	255	400	200	305	140

* Typically woven geotextiles elongate < 50% and nonwoven geotextiles elongate > 50% during grab testing.

CLIENT:	EFAC NSWC - WHITE OAK	JOB NUMBER:	7427-1502
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BY: NJB Date: 12/8/00	CHECKED BY: TAL Date: 12/11/00	APPROVED BY:	DATE:

The class of geotextile required on a project is dependent on the specific application the following is a listing of default geotextile classes based on application (AASHTO M 288-96)

Table 3

Application	Default Geotextile Class
Subsurface Drainage	2
Separation	2
Stabilization	1
Permanent Erosion Control	2 for woven monofilament
	1 for all others

Mass per unit area and thickness are descriptive properties rather than design-oriented properties. Therefore, other than providing typical ranges of weights and thickness, they are not discussed in this calculation. However, minimum weights and minimum thickness are provided in the Specification section of the design documents.

ASSUMPTIONS:

For the three situations in which geotextiles are to be used for separation, either a woven or nonwoven geotextile may be used.

DEVELOPMENT OF SPECIFICATIONS:

For use beneath base aggegate, riprap, and rock lining - design for separation.

From Table 3 above

Function	Class
Separation	2

Specify Using Properties of Class 2 Geotextile.

CLIENT:	EFAC NSWC - WHITE OAK	JOB NUMBER:	7427-1502
SUBJECT:	Development of Geotextile Specifications		
BASED ON:	AASHTO M-288-96	DRAWING NUMBER:	
BY: NJB Date: 12/8/00	CHECKED BY: [illegible] Date: 12/11/00	APPROVED BY:	DATE:

From Table 2 above

Property	Test Method	Unit(s)	Geotextile Class	
			Class 2	
			Elongation < 50%*	Elongation > 50%**
Grab Strength	ASTM D 4632	lbs	250	160
Sewn Seam Strength	ASTM D 4632	lbs	220	140
Tear Strength	ASTM D 4533	lbs	90	55
Puncture Strength	ASTM D 4833	lbs	90	55
Burst Strength	ASTM D 3786	lbs	400	200

* Indicates woven geotextile.
** Indicates nonwoven geotextile

From Table 2.2c - AASHTO M288-96 SEPARATION GEOTEXTILE PROPERTY REQUIREMENTS (Ref 1)

Property	Test Method	Unit(s)	Separation Requirements
Permittivity	ASTM D 4491	sec^{-1}	0.02 min.
AOS	ASTM D 4751	mm	0.60*
Ultraviolet Stability	ASTM D 4355	%	50**

* maximum average roll value.
** % of strength after 500 hr of exposure.

CONCLUSION:

Usea geotextile with the following properties beneath base aggegate, riprap, and rock lining.

Properties	Unit(s)	Class 2	
Type	---	Woven	Nonwoven
Grab Strength	lbs	250	160
Sewn Seam Strength	lbs	220	140
Tear Strength	lbs	90	55
Puncture Strength	lbs	90	55
Burst Strength	lbs	400	200
Permittivity	sec^{-1}	0.02	0.02
AOS (m~~[illegible]~~v)	mm	0.25	0.25
Ultraviolet Stability	%	50	50

CLIENT:	EFAC NSWC - WHITE OAK	JOB NUMBER:	7427-1502
SUBJECT:	Development of Geotextile Specifications		
BASED ON:	AASHTO M-288-96	DRAWING NUMBER:	
BY: NJB Date: 12/8/00	CHECKED BY: TWD Date: 12/11/00	APPROVED BY:	DATE:

DETERMINE MD SHA GEOTEXTILE CLASS:

Maryland State Highway Administration Geotextile Classes A through E shall resists UV deterioration, have a minimum permeability of 0.010 cm/sec, and conform to additional requirements as follows (Ref 2, sheets 8 & 9, attached):

Geotextile Class	Maximum Apparent Opening Size (mm)	Grab Tensile Strength* (lb,min)	Minimum Burst Strength (psi)
A	0.30	250	500
B	0.60	200	320
C	0.30	200	320
D	0.60	90	145
E	0.30	90	145

* with a minimum elongation of 20%

Woven Geotextile Class A and Nonwoven Geotextile Classes A, B, and C meet the requirements.

Specify Nonwoven MD SHA Geotextile Class C.

TABLE 2.2a AASHTO M288-96 GEOTEXTILE STRENGTH PROPERTY REQUIREMENTS

			Geotextile Classification*,†					
			Class 1		Class 2		Class 3	
	Test Methods	Units	Elongation < 50%	Elongation ≥ 50%	Elongation < 50%	Elongation ≥ 50%	Elongation < 50%	Elongation ≥ 50%
Grab strength	ASTM D4632	N	1400	900	1100	700	800	500
Sewn seam strength‡	ASTM D4632	N	1200	810	990	630	720	450
Tear strength	ASTM D4533	N	500	350	400§	250	300	180
Puncture strength	ASTM D4833	N	500	350	400	250	300	180
Burst strength	ASTM D3786	kPa	3500	1700	2700	1300	2100	950
Permittivity	ASTM D4491	s^{-1}	Minimum property requirements for permittivity, AOS and UV stability are based on geotextile application. Refer to Table 2.2b for subsurface filtration, Table 2.2c for separation, Table 2.2d for stabilization, and Table 2.2e for permanent erosion control.					
Apparent opening size	ASTM D4751	mm						
Ultraviolet stability	ASTM D4355	%						

*Required geotextile classification is designated in Tables 2.2b, c, d, e for the indicated application.

†As measured in accordance with ASTM D4632. Woven geotextiles fail at elongations (strains) < 50%, while nonwovens fail at elongation (strains) > 50%.

‡When sewn seams are required. Overlap seam requirements are application specific.

§The required MARV tear strength for woven monofilament geotextiles is 250 N.

TABLE 2.2b
SPECIFICATI

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TABLE 2.2c

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TABLE 2.2b AASHTO M288-96 SUBSURFACE FILTRATION (CALLED "DRAINAGE" IN THE SPECIFICATION) GEOTEXTILE REQUIREMENTS

			Requirements		
			Percent In Situ Soil Passing 0.075 mm		
	Test Methods	Units	< 15	15 to 50	> 50
Geotextile Class				Class 2*	
Permittivity[†,‡]	ASTM D4491	s^{-1}	0.5	0.2	0.1
Apparent opening size[†,‡]	ASTM D4751	mm	0.43 max. avg. roll value	0.25 max. avg. roll value	0.22[§] max. avg. roll value
Ultraviolet stability (retained strength)	ASTM D4355	%	50% after 500 hr of exposure		

*Default geotextile selection. The Engineer may specify a Class 3 geotextile from Table 2.2a if conditions are less severe.

[†]In addition to the default permittivity value, the Engineer may require geotextile permeability and/or performance testing in problematic soil environments.

[‡]Site specific geotextile design should be performed if unstable or highly erodable soils such as noncohesive silts; gap-graded soils; alternating sand/silt laminated soils; dispersive clays; and/or rock flour are encountered.

[§]For cohesive soils with a plasticity index greater than 7, geotextile Max ARV is 0.30 mm.

Table 2.2a is used in association with tables for various applications that are commonly encountered. They are as follows:

Table 2.2b	filtration applications (Class 2)
Table 2.2c	separation of soil subgrades (soaked CBR > 3; or shear strength > 90 kPa) (Class 2)
Table 2.2d	stabilization of soft subgrades (1 < CBR < 3; or shear strengths between 30 and 90 kPa) (Class 1)
Table 2.2e	erosion control, e.g., geotextiles beneath rock riprap (Classes 1 and 2)
Table 2.2f	temporary silt fences
Table 2.2g	prevention of reflective cracking

TABLE 2.2c AASHTO M288-96 SEPARATION GEOTEXTILE PROPERTY REQUIREMENTS

	Test Methods	Units	Requirements
Geotextile Class			Class 2*
Permittivity	ASTM D4491	s^{-1}	0.02[†]
Apparent opening size	ASTM D4751	mm	0.60 max. avg. roll value
Ultraviolet stability (retained strength)	ASTM D4355	%	50% after 500 hr of exposure

*Default geotextile selection. The Engineer may specify a Class 3 geotextile from Table 2.2a if conditions are less severe.

[†]Default value. Permittivity of the geotextile should be greater than that of the soil ($\Psi_g > \Psi_s$). The Engineer may also require the permeability of the geotextile to be greater than that of the soil ($k_g > k_s$).

[‡]As measured in accordance with ASTM D4632. Woven geotextiles [illegible] elongations (strains) < 50%, while nonwovens fail at elongation (strains) > 50%.

[†]When sewn seams are required. Overlap seam requirements are application specific.

[§]The required MARV tear strength for woven monofilament geotextiles is 250 N.

921.04 EPOXY ADHESIVES. Epoxy resin bonding material shall consist of a thermosetting epoxy resin and a hardener. The individual components of mixed epoxy shall not settle or skin and contain no volatile solvents, lumps or foreign materials. The epoxy shall conform to C 881. Unless otherwise specified, epoxy adhesive used for bearing and expansion pads shall be nonsagging.

The manufacturer shall furnish certification as specified in TC-1.02. The certification or data sheet shall show actual test results for each required property of the type, grade and class of epoxy submitted, and shall accompany each sample.

The manufacturer shall supply actual bond test results for each batch submitted for use.

921.05 STRUCTURAL TIMBER AND LUMBER. The manufacturer shall furnish certification as specified in TC-1.02. Structural timber and lumber shall conform to M 168.

921.06 TIMBER PRESERVATIVES. Preservatives and pressure treatment for timber shall conform to M 133.

921.07 CONDUITS. Conduit shall conform to the following:

921.07.01 Metallic Conduit.

MATERIAL	SPECIFICATION
Electrical Metallic Tubing	UL 797
Intermediate Metal Conduit	UL 1242
Rigid Metal Conduit	UL 6
Rigid Steel Conduit, Zinc Coated	ANSI C80.1
Metallic Outlet Boxes	UL 514A
Fittings for Conduit and Outlet Boxes	UL 514B

921.07.02 Nonmetallic Conduit. The manufacturer shall furnish certification as specified in TC-1.02. Each length shall be stamped or embossed with the grade or type and applicable UL or NEMA designation.

MATERIAL	SPECIFICATION
Schedule 40 and 80 Rigid Polyvinyl Chloride (PVC) Conduit	UL 651
Electrical Plastic Tubing (EPT) and Electrical Plastic Conduit (EPC-40 and EPC-80)	NEMA TC 2
Nonmetallic Outlet Boxes, Flush Device Boxes and Covers	UL 514C
Electrical Nonmetallic Conduit (ENC)	NEMA TC 13
PVC Fittings for use with Rigid PVC Conduit and Tubing	NEMA TC 3
Flexible PVC Coated Conduit	UL 360
Liquid Tight Flexible Nonmetallic Conduit for Detector Sleeves	UL 1660

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921.07.03 PVC Coated Metallic Conduit.

MATERIAL	SPECIFICATION
PVC Externally Coated, Galvanized, Rigid Steel Conduit and Electrical Metallic Tubing	NEMA RN 1

921.08 STRAW BALES. Straw bales for erosion and sediment control shall conform to the Contract Documents and shall be approximately 14 × 18 × 36 in. (360 × 460 × 910 mm).

921.09 GEOTEXTILES. Geotextiles shall conform to the class specified in the Contract Documents. The geotextile shall be manufactured from fibers consisting of long chain synthetic polymers, composed of a minimum 85 percent by weight of polyolephins, polyesters or polyamides. The geotextile shall resist deterioration from ultraviolet exposure. Geotextiles used in the construction of silt fence shall contain sufficient amounts of ultraviolet ray inhibitors and stabilizers to provide a minimum of 12 months of expected usable construction life at a temperature range of 0 to 120 F (-18 to 49 C).

All values specified are minimum or maximum roll values.

Classes A through E Geotextiles shall have a 0.010 cm/sec minimum permeability when tested in conformance with D 4491, and an apparent minimum elongation of 20 percent when tested for conformance with the grab tensile strength requirements specified below. Classes A through E Geotextiles shall also conform to the following additional requirements:

GEOTEXTILE CLASS	MAXIMUM APPARENT OPENING SIZE mm	GRAB TENSILE STRENGTH lb (N) min	MINIMUM BURST STRENGTH psi (MPa)
A	0.30	250 (1110)	500 (3.4)
B	0.60	200 (890)	320 (2.2)
C	0.30	200 (890)	320 (2.2)
D	0.60	90 (400)	145 (1.0)
E	0.30	90 (400)	145 (1.0)

Class F Geotextiles (Silt Fence) shall have a 50 lb/in. (8.8 kN/m) minimum tensile strength and a 20 lb/in. (3.5 kN/m) minimum tensile modulus when tested in conformance with D 4595. The material shall also have a 0.3 gal/ft^2(12.2 l/m^2) per minute minimum flow rate and a 75 percent minimum filtering efficiency when tested in conformance with D 5141.

The properties shall be determined as follows:

TEST	METHOD
Apparent Opening Size	D 4751
Grab Tensile Strength	D 4632, Grab Test—4 × 8 in. (100 × 200 mm) specimen, 1 × 2 in. (25 × 50 mm) clamps; 12 in. (300 mm)/minute strain rate both principal directions of geotextile.
Burst Strength	D 3786

Sewing of the geotextile will be allowed provided it conforms to the following:

(a) Seams shall be either "J" or "butterfly" type and shall utilize a lock stitch.

(b) Seams shall conform to the tensile strength requirements for the geotextile when tested across the seam.

(c) The thread for seaming shall be of equal or greater durability than the geotextile itself.

921.10 POLYETHYLENE (PE) MANHOLES. PE manholes shall conform to D 1248, Type III, Class C, Category 3, Grade P34.

Working drawings shall be submitted to the Engineer prior to fabrication.

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Compressive strength shall be determined in conformance with D 2412, modified pipe stiffness test. Pipe stiffness shall be a minimum of 12 psi (80 kPa) at 5 percent deflection, including joints. Axial compressive strength shall be a minimum of 10 000 lb (68.9 MPa) at less than 3 percent deflection.

PE manholes for storm drains shall be manufactured with an invert bowl which will not interrupt flow. Manholes for sanitary sewers shall have a factory molded invert for channeled flow.

The manufacturer shall furnish certification as specified in TC-1.02. The certification shall accompany each shipment of PE manholes and shall show actual test results, the quantity of manhole sections and date of manufacture. Manholes shall be marked with the manufacturer's name and trademark.

921.11 RAPID HARDENING CEMENTITIOUS MATERIALS FOR CONCRETE PAVEMENT REPAIRS. Materials shall be a dry, packaged cementitious mortar having less than 5 percent by weight of aggregate retained on the 3/8 in. (9.5 mm) sieve and shall conform to the following requirements:

Classification.

Class I—For use at ambient temperatures below 50 F (10 C).
Class II—For use at ambient temperatures of 50–90 F (10–32 C).
Class III—For use at ambient temperatures above 90 F (32 C).

Chemical Requirements. The material shall conform to the chemical requirements of C 928 and contain no organic compounds such as epoxy resins or polyesters as the principal binder.

Environmental Permits Report
for
Operable Unit 2
Closure Design
Final Design Submission

Former
Naval Surface Warfare Center
White Oak
Silver Spring, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0273

June 2001

REVISION 0
JUNE 2001

ENVIRONMENTAL PERMITS REPORT FOR OPERABLE UNIT 2 CLOSURE DESIGN

FINAL DESIGN SUBMISSION

FORMER NAVAL SURFACE WARFARE CENTER
WHITE OAK
SILVER SPRING, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
1314 Harwood Street, SE
Washington, D.C. 20374-2121

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0273

JUNE 2001

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ACRONYMS AND ABBREVIATIONS

bgs	Below ground surface
BRAC	Base Realignment and Closure
CLEAN	Comprehensive Long-Term Environmental Action Navy
COCs	contaminants of concern
COE	Army Corps of Engineers
cm/sec	centimeters per second
CTO	Contract Task Order
DOD	Department of Defense
FDA	Food and Drug Administration
GCL	geosynthetic clay liner
GSA	General Services Administration
MDE	Maryland Department of the Environment
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NSWC-White Oak	Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak
OU2	Operable Unit 2
PCBs	polychlorinated biphenyls
POTW	Publicly Owned Treatment Works
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RSC	Regulatory Services Coordination Office
Site 1	Parking Lot Landfill
Site 2	Apple Orchard Landfill
TtNUS	Tetra Tech NUS, Inc.
USEPA	U.S. Environmental Protection Agency

1.0 INTRODUCTION

This Environmental Permits Report was prepared under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298, Contract Task Order (CTO) No. 273. Under CTO 273, Tetra Tech NUS, Inc. (TtNUS) is performing engineering, design, and construction-phase services for the remedial actions at the Parking Lot Landfill (Site 1) and the Apple Orchard Landfill (Site 2) at the former Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWC-White Oak) in Silver Spring, Maryland. Location and vicinity maps for NSWC-White Oak showing the approximate location of NSWC-White Oak and Sites 1 and 2 are presented on Figures 1-1 and 1-2, respectively.

The landfills were originally identified as separate sites, but they are now jointly considered as Operable Unit 2 (OU2). The limits of OU2 are identified in Figure 1-3. The sites were combined because of their proximity to each other, the similar periods of operation for both, and the similar wastes disposed in both.

NSWC-White Oak was identified as a Base Realignment and Closure (BRAC) facility and was closed in 1997. The property was transferred to the General Services Administration (GSA) and U.S. Army. GSA is currently investigating plans with the U.S. Food and Drug Administration (FDA) for the reuse and redevelopment of the NSWC-White Oak property.

1.1 BACKGROUND INFORMATION

1.1.1 Site 1 - Parking Lot Landfill

Site 1 is an inactive landfill located east of Building 101A and is adjacent to Site 2 (Figure 1-3). Site 1 was used as an open disposal site and landfill between 1948 and 1953. The wastes supposedly disposed within this landfill include lubricating oil, battery acid, metal plating wastes, and metal scrap. It has been reported that approximately 60 automobile batteries were disposed at the site over its operating life. The site is now used as a parking lot and is paved with asphalt. However, visible wastes, including tires, glass, and old metal equipment are present on the southern and eastern slopes beyond the edge of the parking lot. The landfill covers approximately 1 acre and contains an estimated 8,300 cubic yards of waste and fill.

Site 1 consists mostly of fill comprised of sandy clay with a silty component and some gravel. Solid wastes are buried within the fill. The depth to the top of the waste varies between 1 and 3 feet below ground surface (bgs), and the depth to the bottom of the waste ranges between 3 and 6 feet bgs. The depth to groundwater ranges from 14 to 17 feet bgs. Groundwater flows to the southeast.

Runoff from the paved area flows toward the southeastern corner of the site. The eastern and southern faces of the landfill, outside the boundaries of the paved area, are both steeply sloped into the drainage swale and unnamed stream. An intermittent stream flows southward in the drainage swale located along the eastern edge of the landfill. The intermittent stream feeds the unnamed stream which flows eastward along the southern edge of the landfill. The unnamed stream is also fed by a National Pollutant Discharge Elimination System (NDPES) Outfall 009. These two swales join near the southeastern corner of the landfill and then flow eastward along the toe of Site 2 to Paint Branch.

1.1.2 Site 2 - Apple Orchard Landfill

Site 2 is an abandoned landfill located on the south side of Perimeter Road in the northwestern end of the former NSWC-White Oak property adjacent to Site 1 (Figure 1-3). Site 2 reportedly operated as an open disposal area and landfill from 1948 until 1982. The landfill is a single unit that is composed of several disposal areas. In addition to domestic refuse, wastes reportedly disposed at the site include oils containing polychlorinated biphenyls (PCBs), solvents, paint residue, acids, and miscellaneous compounds. An estimated 500 gallons of PCB-contaminated oils were disposed before 1970. The landfill covers approximately 4.3 acres and contains approximately 75,000 cubic yards of waste and fill.

The majority of the landfill is a plateau adjacent to Perimeter Road. The landfill thickens from approximately 4 feet near Perimeter Road to 36 feet at the edge of the landfill plateau. The native material surrounding the landfill consists of a thin mantle of soil resting on saprolite. The shallow surface material is variable with a thickness of 2 to 6 feet. The saprolite ranges in thickness from 8 feet (southern portion) to greater than 49 feet (northern edge). Bedrock was encountered at a depth of 10 feet bgs along the southern perimeter and at 30 feet bgs in the northwestern corner.

Groundwater at the site is unconfined and present in the saprolite and bedrock and, to a lesser extent, the surface soils along drainage swales. The depth to the water table ranges from approximately 3 to 4 feet along the toe of the landfill to 32.5 feet bgs along Perimeter Road. The water levels were measured during drought conditions and may be several feet higher than during non-drought conditions. Groundwater flows radially from the northwest corner of the site to the southeast and discharges to an unnamed stream.

The landfill forms a small, level hill with an elevation of approximately 340 feet above mean sea level. The landfill slopes steeply to an unnamed stream along its southern edge and a drainage swale along its western perimeter. The stream flows north/northeast towards Paint Branch. The drainage swale conveys stormwater flow from adjacent properties and joins the unnamed stream in the southwest corner of the site. Surface runoff from the landfill generally flows to the south into the adjacent unnamed stream.

The landfill cover supports old field vegetation with successional hardwood forest on the short but very steep slopes. The steep slopes range in height from a few feet along the eastern and western perimeters to approximately 35 feet along the southern perimeter. The slopes are moderately eroded, and exposed waste and fill materials are evident throughout. Minor erosion is evident on the landfill surface.

1.2 PURPOSE

This report identifies applicable permits, filing procedures, and filing costs required to complete the remedial action outlined in Section 2.0. The substantive aspects of permit regulations are also identified in this report.

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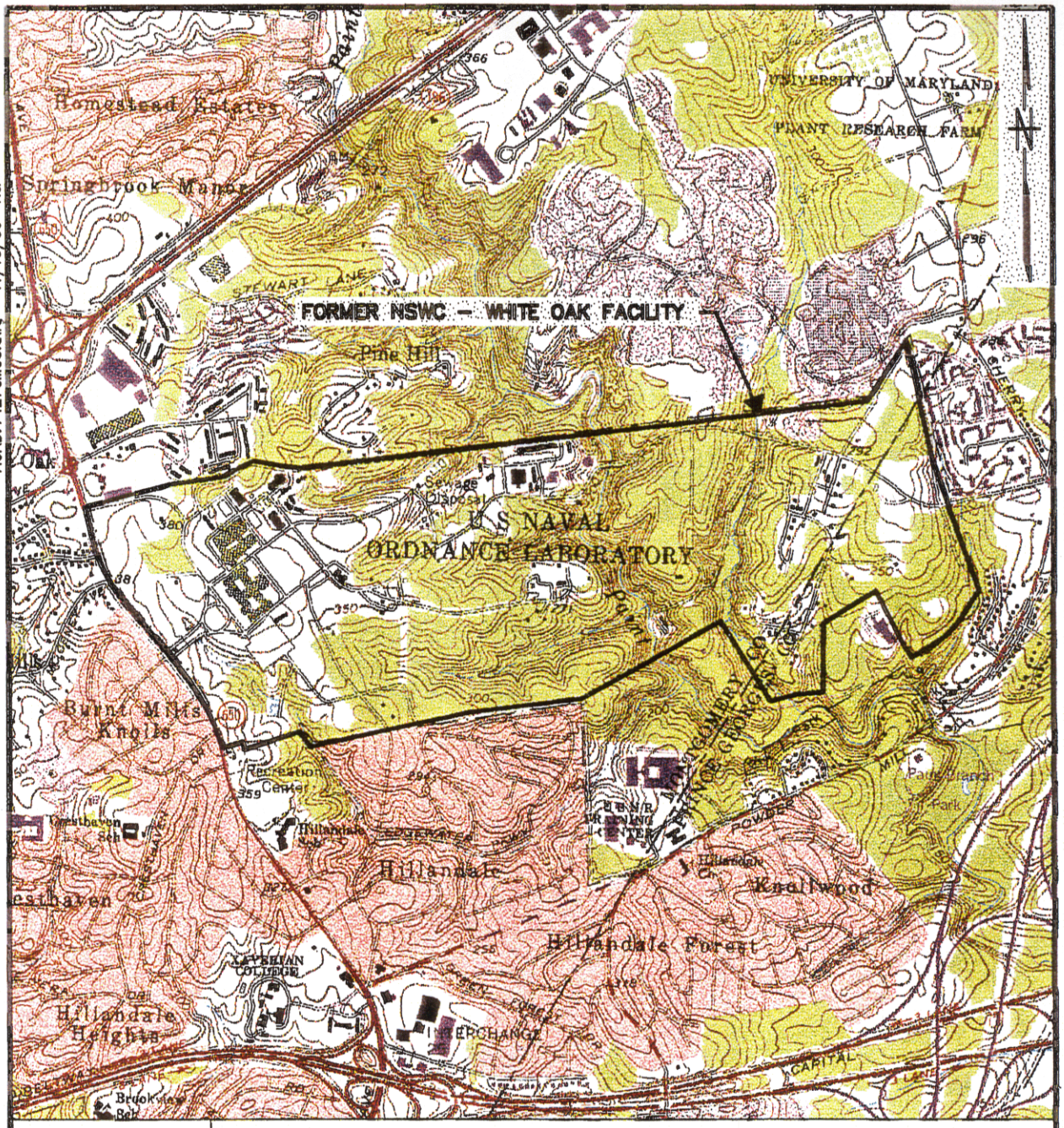

SOURCE: U.S.G.S QUADRANGLE MAP, BELTSVILLE, MD. PHOTOREVISED 1979.

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CHECKED BY DATE	SITE VICINITY MAP OPERABLE UNIT 2 FORMER NSWC – WHITE OAK SILVER SPRING, MARYLAND	APPROVED BY SN	DATE 12/13/00
COST/SCHED–AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 1–1	REV. 0

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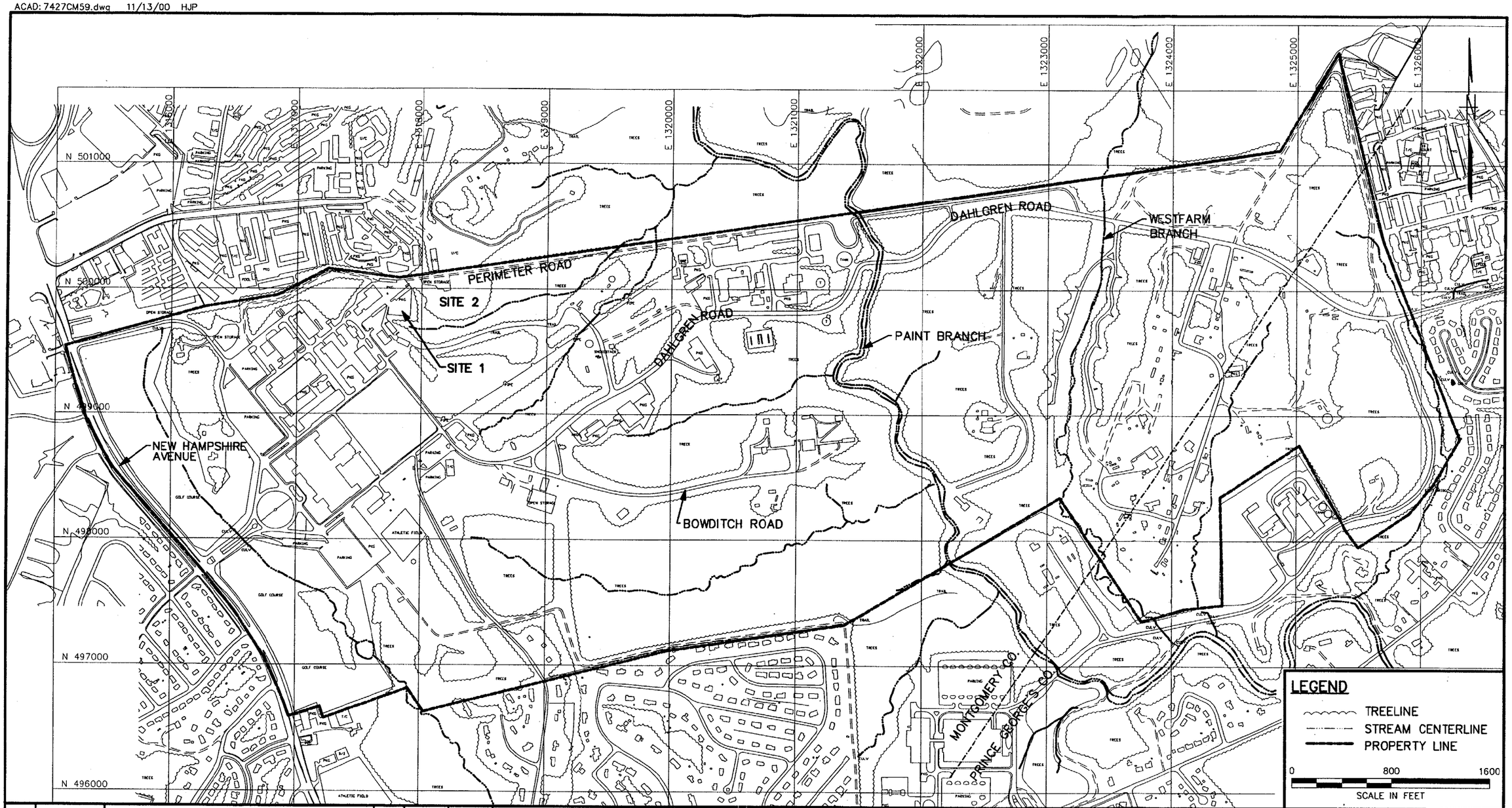

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DRAWN BY HJP DATE 11/13/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LOCATION MAP
OPERABLE UNIT 2
FORMER NSWC-WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 273
APPROVED BY SOJ DATE 12/13/00
APPROVED BY DATE
DRAWING NO. FIGURE 1-2
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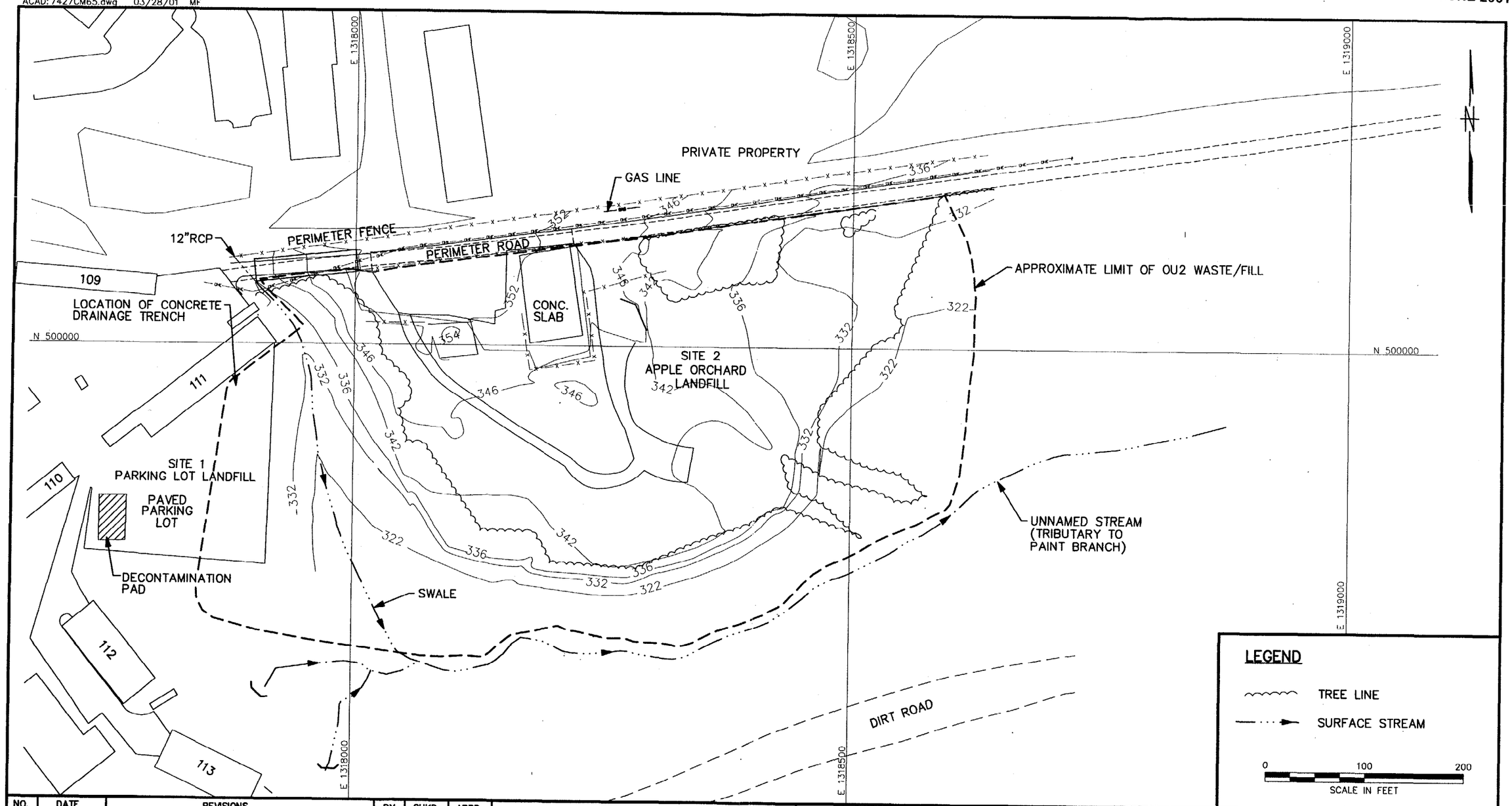

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/14/00
CHECKED BY DATE 3/28/01
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LAYOUT MAP
OPERABLE UNIT 2
FORMER NSWC – WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 0273
APPROVED BY SN
DATE 7/29/01
APPROVED BY
DATE
DRAWING NO. FIGURE 1–3
REV. 0

FORM CADD NO. TtNUS_BH.DGN – REV 0 – 1/20/98

2.0 PROPOSED REMEDIAL ACTION

2.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are based on the contaminated media, potential human health and environmental threats, and regulatory standards, requirements, and guidance. The media of concern for OU2 were determined to be soil and sediment. Groundwater and surface water contaminants of concern (COCs) were identified and considered during the human health risk assessment. However, the concentrations and nature (i.e., naturally attenuating) of the COCs in these media, as well as the fact that there is no current direct exposure pathway between receptors and groundwater, suggests that the COCs do not pose a current or significant risk. It is likely that the source of the groundwater and surface water COCs is the waste and contaminated soil and sediment. By addressing the source of the contamination, the COCs identified in the groundwater and surface water are expected to naturally attenuate with time. The scope of this report is limited to waste, soil, and sediment. Groundwater and surface water will be evaluated as part of a long-term monitoring program. Additional actions for groundwater and surface water, if necessary, will be addressed as part of this program.

Based on the investigations conducted at OU2, the following are the primary corrective action objectives:

- Prevent direct contact with landfill contents/surface soils.
- Minimize infiltration and resulting contaminant migration to groundwater.
- Control surface water runoff and erosion.
- Reduce the exposure to contaminants of concern in sediment by ecological and human receptors.

The first three objectives are consistent with the presumptive remedy for municipal / military landfills as described in the previously referenced directives. Per the presumptive remedy directives, landfill gas should be also be controlled and treated as necessary.

2.2 REMEDIAL ACTION DESCRIPTION

The remedial action for OU2 will consist of general site preparation work, excavating Site 1 waste and soil, excavating contaminated sediment from the unnamed stream, consolidating excavated materials within OU2, installing a multi-media cap at OU2, and restoring OU2. Any suspect hot spots (e.g., hazardous waste, high-hazard military waste) encountered during excavation that would be considered hazardous will be segregated and disposed off site as necessary. Wastewater collected during dewatering activities will be sampled and disposed at an appropriate off-site facility. Institutional controls will be imposed, and the site will be monitored.

General Site Preparation: The areas in which construction activities will be performed will be cleared. In addition, appropriate erosion and sediment control measures will be implemented.

Excavating, Regrading, and Consolidating Soil, Waste, and Sediment: This component includes the following activities:

- Approximately 37,300 cubic yards of soil and waste from OU2 will be excavated, reduced in size as necessary, and consolidated within OU2. Excavation will continue until confirmatory sampling indicates that no waste or soil remains with COC concentrations higher than clean-up goals.

- Wastes along the side slopes of OU2 will be regraded and stabilize. The regraded waste will be consolidated in a more appropriate location within OU2.

- Approximately 1,000 cubic yards of sediment from the unnamed stream south of OU2 will be excavated, dewatered as necessary, and consolidated within OU2. Excavation will continue until confirmatory sampling indicates that no sediment remains with COC concentrations higher than clean-up goals.

Treatment and Disposal of Hot Spots and Wastewater: If any suspect hot spots of waste (e.g., high-hazard military wastes) that would be considered hazardous are encountered during excavation activities, they will be segregated and disposed off site. Wastewater collected during decontamination activities will be sampled and disposed off site at an appropriate treatment facility. Water generated during consolidation/dewatering activities will be allowed to percolate to the groundwater.

Restoration of Excavated Areas: The excavated area at Site 1 will be restored by placing and grading 1 foot of clean fill over the area. The area will be revegetated as necessary. The drainage swale will be restored in a manner that will prevent erosion of the swale and the toe of the cap, maintain its flow capacity, and replace any wetlands that have been affected.

Cap Construction: An engineered, multimedia cap will be constructed over the soil, sediment, and waste materials consolidated at Site 2. The total area of the cap will be approximately 5.5 acres, and it will cover approximately 84,300 cubic yards of waste material. The multimedia cap will meet or exceed the requirements of federal and state solid waste and hazardous waste landfill closure regulations. The cap will limit precipitation and runoff from entering the consolidated waste material and will significantly reduce the amount of infiltration that could leach contaminants from the material. The cap components will include a 6-inch subgrade soil above the waste that will allow passive gas venting, a geosynthetic clay

liner (GCL) covered by a flexible membrane liner, a geocomposite drainage layer, and 24 inches of cover and topsoil. Erosion control measures (i.e., rip-rap) will be installed along the toe of the landfill cap to protect it against flooding from the adjacent unnamed stream.

Surface Water Controls and Revegetation: Temporary surface water controls will be constructed to accommodate excavation activities at Site 1 and the unnamed stream and construction of the cap. Permanent surface water controls will be constructed to limit run-on to the cap and to properly collect and direct runoff from the cap. All run-on and runoff will be directed to the adjacent drainage swale. The entire capped area will be revegetated as necessary.

Institutional Controls and Monitoring: Institutional controls will be implemented to further reduce the potential for exposure. These controls will include land use restrictions. Land use restrictions will be included in the GSA Master Plan for the former NSWC-White Oak. Periodic groundwater and surface water monitoring will be conducted after installation of the cap. The results of the monitoring will be used to evaluate the effectiveness of the remedial action and to determine whether additional actions are necessary.

3.0 REQUIRED PERMITS

Table 3-1 presents a project permit checklist to assess what permits may be required for specific projects to assure regulatory compliance. This table lists the type of permit, license, or certification that may be required by government agencies for specific types of projects. Based on a review of the permit checklist and federal, state, and local laws and regulations, permits may be required for work in the unnamed stream adjacent to the site and associated wetlands and discharges of stormwater associated with industrial activity and construction. Approval of an erosion and sediment control plan and a stormwater management plan may be required. A Resource Conservation and Recovery Act (RCRA) remedial action permit is not required because the work is being conducted following a RCRA Section 7003 administrative order.

3.1 FEDERAL PERMITS AND REQUIREMENTS

Although Maryland issues Controlled Hazardous Substance Facility Permits for facilities used to treat, store, or dispose hazardous waste, the U.S. Environmental Protection Agency (USEPA) is responsible for the RCRA remedial action program. On July 3, 1998, a unilateral administrative order was issued by USEPA to the Navy pursuant to Section 7003 of RCRA requiring remedial action at the former NSWC-White Oak. Therefore, a RCRA remedial action permit is not required. However, substantive aspects of landfill closure requirements must be met.

The Army Corps of Engineers (COE) can issue nationwide permits for dredge and fill activities and work within wetlands and streams. However, certain activities are eligible for authorization under the Maryland State Programmatic General Permit. Applicants apply by completing a Maryland/Corps Joint Permit Application that is processed by the state.

3.2 STATE PERMITS AND REQUIREMENTS

A Nontidal Wetlands and Waterways Permit is required for any activity that alters a nontidal wetland or its 25-foot buffer. The 25-foot buffer is expanded to 100 feet for wetlands of special state concern (identified in COMAR 26.23.06) or wetlands with adjacent areas containing steep slopes or highly erodible soils (COMAR 26.23.01.04). This permit is also required to change the course, current, or cross-section of a nontidal stream or body of water, including the 100-year floodplain. The activities covered under this permit are covered under the COE Maryland State Programmatic General Permit discussed in Section 3.1. Applicants apply by completing a Maryland/Corps Joint Permit Application that is processed by the state.

Permits are also required for stormwater discharges to surface water. The Stormwater General Discharge Permit is for discharges associated with industrial activity. This is defined as the discharge from any conveyance that is used for collecting and conveying stormwater and that is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant [40 CFR 122.26(b)(14)]. Landfills, land application sites, and open dumps that receive or have received any industrial wastes is a category of facility considered to be engaged in industrial activity. The General Permit for Construction Activity is for discharges from construction activities that cover 5 or more acres. The NPDES permit for existing discharges at the former NSWC-White Oak has been transferred to the GSA. It may be possible to modify existing permits to include the new discharges rather than to obtain new general permits.

Permits are not required for erosion/sediment control or stormwater management; however, approval of these plans by the state is required. Plan approval is required for any construction activity that disturbs 5,000 square feet or more of soil or results in the excavation of 100 cubic yards or more or soil. As a condition of receiving plan approval, the applicant must certify that a "responsible person" will be on site during construction. This requires attendance at a training class and an examination.

A Stormwater Management Plan is required to prevent stream bank erosion by controlling the rate of stormwater runoff. Approval of this plan is required for any new development project that disturbs 5,000 square feet or more of land. "Develop land" means to change the runoff characteristics of a parcel of land in conjunction with residential, commercial, industrial, or institutional construction or alteration (COMAR 26.17.02.02B).

3.3 LOCAL PERMITS AND REQUIREMENTS

No local permits or approvals are required. The Montgomery County Department of Permitting Services reviews and approves Erosion and Sediment Control Plans and Stormwater Management Plans for private and local government projects. However, the Maryland Department of the Environment (MDE) reviews and approves these plans for state and federal projects. The remedial action at OU2 is a federal project.

TABLE 3-1

PROJECT PERMITS CHECKLIST
OU2 (SITES 1 AND 2)
FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND
PAGE 1 OF 2

Type of Project	Type of Permit, License, Certification	Issuing Agency	Applicability	Reason
Stationary Air Emission Source	Permit to Construct Permit to Operate	State State	Not applicable Not applicable	Permit not required for crushers, shredders, and grinders with a throughput of less than 5 tons per hour.
Construction in Floodplain, Waterway, or Wetland	Nontidal Wetlands and Waterways Permit Section 404 Dredge/Fill Permit	State Army Corp of Engineers	Applicable Applicable	Construction in waterway or wetlands will occur. Construction will not adversely affect or harm the flood plain.
Wastewater Discharge to "Waters of the U.S."	Surface Water Discharge Permit (NPDES)	State and USEPA	Not applicable	Discharge of wastewater will not occur.
Wastewater Discharge to Sewer	Pretreatment Permit (if to municipal POTW)	State or local	Not applicable	Discharge of wastewater will not occur.
Dredging/Fill and Filling Wetlands	Section 404 Dredge/Fill Permit Nontidal Wetlands and Waterways Permit Ocean Disposal Permit	Army Corps of Engineers State State or USEPA	Applicable Applicable Not applicable	Excavation, filling, and restoration will occur in wetlands adjacent to site. Ocean disposal will not be performed.
Structure in Navigable Waters	Section 10 Permit Nontidal Wetlands and Waterways Permit	Army Corps of Engineers State	Not applicable Not applicable	No structures are being built (placed) in navigable waters.
Stormwater Discharge to "Waters of the U.S."	Stormwater General Discharge Permit General Permit for Construction Activity	State State	Applicable Applicable	Stormwater discharge from landfill is "associated with industrial activity." Construction activity covers more than 5 acres.

TABLE 3-1

PROJECT PERMITS CHECKLIST
OU2 (SITES 1 AND 2)
FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND
PAGE 2 OF 2

Type of Project	Type of Permit, License, Certification	Issuing Agency	Applicability	Reason
Earth Moving Operations	Erosion and Sediment Control Plan Stormwater Management Plan	State State	Applicable Applicable	No permit required. Plan approval is required for construction activities and development that cover more than 5,000 square feet.
Solid Waste Landfills	Permit-to-Operate	State	Applicable	The landfills are RCRA SWMUs. No permit required for corrective action.
Hazardous Waste Generation	USEPA Identification Number	State	Not applicable	Off-site shipment of hazardous waste will not occur.
Hazardous Waste Transporting	State Waste Hauler License/Permit	State	Applicable	Off-site shipment of hazardous waste may occur.
Hazardous Waste Treatment, Storage, Disposal	Permit-to-Construct Permit-to-Operate (Part B Permit)	State or USEPA	Applicable	No permit required. Corrective action is being conducted under RCRA Section 7003 administrative order.
Underground Storage Tanks	Permit-to-Construct Permit-to-Operate Registration	State or USEPA	Not applicable	No underground storage tanks are associated with this project.
Pesticide Application	Applicator Certification	DOD	Not applicable	Herbicides will not be used.

USEPA U.S. Environmental Protection Agency
DOD Department of Defense
POTW Publicly Owned Treatment Works

4.0 PERMIT APPLICATIONS AND COMPLIANCE

Based on a review of the permit checklist and federal, state, and local laws and regulations, state permits would be associated with work in the unnamed stream adjacent to the site and associated wetlands and discharges of stormwater associated with industrial activity and construction. Approval of the erosion and sediment control plan and the stormwater management plan by MDE would be required. Although a RCRA permit is not required because the remedial action is being conducted under a Section 7003 unilateral administrative order, there are regulatory requirements for landfill closure. Permits and compliance with regulatory requirements are discussed in the following sections.

4.1 CONSTRUCTION IN FLOODPLAIN, WATERWAY, OR WETLAND AND DREDGE/FILL IN WETLAND

A state Nontidal Wetland and Waterways Permit is required. This permit is required for any activity that alters a nontidal wetland or its 25-foot buffer (COMAR 26.23). The buffer is expanded to 100 feet for nontidal wetlands with adjacent areas containing steep slopes (greater than 15 percent) or highly erodible soils (erodibility factor greater than 0.35). The following activities are regulated: grading or filling, excavating or dredging, changing existing drainage patterns, disturbing the water level or water table, and destroying or removing vegetation. Applicants are required to demonstrate that proposed impacts to nontidal wetlands are necessary and unavoidable. An alternatives analysis may be required as part of this process. Mitigation is required for all authorized impacts. Wetland mitigation monitoring is required and will extend beyond construction of an approved mitigation project.

This permit is also required for work in a nontidal stream or body of water, including the 100-year floodplain (COMAR 26.17.04). Authorization is required for construction of the following projects in a waterway or 100-year floodplain: excavation, filling, or construction; channelization; changing the course, current, or cross-section of any stream; temporary construction; and any other similar project. An engineering analysis is required for filling and other construction. Activities are evaluated for impacts on the floodplain, public safety and welfare, and natural resources. In addition, environmental impacts associated with the proposed project, including impacts to nontidal wetlands, wildlife, endangered species and their critical habitat, and alternatives to reduce or eliminate adverse impacts are required to be submitted with the application. Site location and design criteria are contained in the regulations.

The application process is as follows:

- Complete a "Joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal Wetland, or Nontidal Wetland Maryland" application.

- Mail the original plus four copies of the application, plans, vicinity maps, and any supporting documentation to the following address:

  Regulatory Services Coordination Office
  MDE, Water Management Administration
  2500 Broening Highway
  Baltimore, MD 21224

- Upon receipt of the application package, the Regulatory Services Coordination Office (RSC) will determine what type of permit is necessary and will forward the application to the appropriate governmental agencies. The RSC receives applications for the Nontidal and Waterways Division of MDE as well as the U.S. Army Corps of Engineers. MDE conducts the permit application review in cooperation with local, state, and federal agencies.

- Depending on the nature of the project, it may be advertised for comment and an opportunity for a public informational hearing. The applicant may be required to notify adjacent property owners. If requested, a public informational hearing is conducted by MDE.

- MDE may perform a site evaluation.

- At the conclusion of the review process, MDE will make a decision on the application. Upon final receipt of final construction plans, a permit or letter of authorization may be issued by MDE.

The standard turnaround time is 3 months for minor projects and 6 months for major projects. Permits may be issued for a maximum of 5 years and extended for an additional 5 years. Construction must be initiated within 2 years (waterway and floodplain) or 3 years (nontidal wetland). There is no fee associated with this permit application.

4.2 STORMWATER DISCHARGES

State general permits cover certain stormwater discharges. These include the discharge of stormwater associated with industrial activity (COMAR 26.08.01 through 26.08.04) and stormwater from construction activity (COMAR 26.08.04). The existing NPDES permit for the former NSWC-White Oak has been transferred to the GSA. It may be possible to modify the existing NPDES permit to include the stormwater associated with activities at OU2 rather than to obtain new permits. MDE will determine this during the application review process.

4.2.1 Stormwater Associated with Industrial Activity

Landfills, land application sites, and open dumps that receive or have received any industrial wastes are considered to be engaging in industrial activity [40 CFR 122.26(b)]. To obtain coverage under a general permit, all requirements listed in the general permit package must be met. The application process is as follows:

- Complete a Notice of Intent (NOI) form and include a facility map, if required.
- Mail the completed form and payment to the following address:

  MDE/WATER
  P.O. Box 2057
  Baltimore, MD 21203-2057

- MDE reviews the submitted NOI to ensure that the proposed discharge can be covered by a general permit.
- MDE will notify the applicant in writing of coverage under the general permit.

The standard turnaround time is 60 days, and the standard fee is $550.

4.2.2 General Permit for Construction Activity

This permit is required in addition to standard erosion and sediment control and stormwater management plan approvals (see Section 4.3). To obtain coverage, applicants must meet all the conditions outlined in the general permit. The application process is as follows:

- Complete an NOI form (MDE 310 for federal projects) and mail with payment to the following address:

  MDE
  P.O. Box 1417
  Baltimore, MD 21203-1417

- MDE reviews the NOI to insure completion and scans site specific data into an NOI database.

- MDE then sends the applicant a package that includes a letter verifying coverage and issuing the project a unique NOI number, a copy of the general permit, and a receipt card that must be posted at the site.

The NOI can be submitted any time prior to the start of construction activity, as long as it reaches MDE at least 48 hours before construction begins. The standard turnaround time for review is two days. Coverage under the general permit is issued for the duration of the project as long as plan approvals are renewed. For federal projects, the application fee is based on the amount of the land disturbance. The fee for a disturbance of 5 acres to less than 10 acres is $100. Facilities covered under the general permit for stormwater associated with industrial activities are not required to obtain this general permit for construction activity. The stormwater general permit has provisions for construction activity.

4.3 EROSION AND SEDIMENT CONTROL AND STORMWATER MANAGEMENT PLANS

Erosion and sediment control plan approval is required, before construction, to prevent siltation from releases of sediment (soil) from active construction sites. Plan approval is required for any construction activity that disturbs 5,000 square feet or more of soil or results in the excavation of 100 cubic yards or more of soil. As a condition of receiving plan approval, the applicant must certify that a "responsible person" will be on site during construction. The purpose of the "responsible person" certification is to train field personnel on techniques and standards that assist with field implementation of erosion and sediment controls.

Stormwater management plan approval is required to prevent stream bank erosion by controlling the rate of stormwater runoff from newly developed areas by using infiltration practices, shallow marshes, retention, and detention ponds. This approval is required for any development project that disturbs 5,000 square feet or more of land. It can be obtained as the same time as the erosion and sediment control approval.

These plans must meet the 1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control, adhere to the Erosion and Sediment Control Guidelines issued by MDE in January 1990, and adhere to the Stormwater Management Guidelines for State and Federal Projects issued by MDE in July 1987. MDE has recently amended the stormwater management regulations and issued the 2000 Maryland Stormwater Design Manual. The effective date of these changes was October 2, 2000.

The erosion and sediment control plan approval and stormwater management plan approval for state and federal projects is as follows:

- The applicant submits one set of erosion and sediment control and stormwater management plans and calculations to MDE.

- MDE either approves the plans or responds with comments to be addressed by the applicant before approval can be granted.

- Upon approval, MDE informs the applicant in writing.

- MDE conducts site inspections. Plans must be approved and implemented prior to the start of construction.

The standard turnaround time for state and federal facilities is 6 months. The term of approval is 2 years for erosion and sediment control. There is no expiration for stormwater management plan approval. There are no fees associated with MDE approval of these plans.

4.4 LANDFILL CLOSURE

The landfills were used for disposal of domestic refuse, lubricating oil, battery acid, batteries, metal plating wastes, metal scrap, oils containing PCBs, solvents, paint residue, acids, and miscellaneous compounds. Some of the industrial solid wastes may also have been hazardous. Requirements for closing industrial waste landfills are addressed in COMAR 26.04.07.21, and requirements for closing hazardous waste landfills are addressed in COMAR 26.13.05.14. USEPA requirements are similar to state requirements.

Industrial waste landfills must install a closure cap that includes the minimum design features:

- A low permeability cap shall be placed over the final cover. The cap material may consist of synthetic material with a minimum thickness of 20 mil and a maximum permeability of 1×10^{-10} cm/sec or a minimum of 1 foot of clay or other natural fine-grained material having an in-place permeability less than or equal to 1×10^{-5} cm/sec. The cap shall be installed with a minimum slope of 4 percent to facilitate drainage.

- A drainage layer with a minimum thickness of 6 inches shall be placed immediately above the low permeability cap. Acceptable drainage material shall include clean sand or other natural coarse-grained material with an in-place permeability greater than 1×10^{-3} cm/sec. The drainage layer shall be free of materials that may puncture or otherwise jeopardize the integrity of the low permeability

cap. Commercially available filter fabrics, when used in conjunction with synthetic drainage blankets, may serve instead of the fine material, with MDE approval.

- Final earthen cover shall be placed over the drainage layer. Minimum cover thickness shall be 2 feet. Minimum cover slope shall be 4 percent for facilitate surface drainage of the site. The cover material shall contain sufficient organic materials and nutrients to sustain a vegetative cover over time.

- Vegetative stabilization shall be place over the final earthen cover. Within 30 days after the final earthen cover has been installed, the areas shall be stabilized using a perennial cover species as recommended by the county soil conservation district. Sufficient lime and commercial fertilizer shall be applied to sustain vegetative growth.

- Gas venting is not required for industrial waste landfills.

- Alternate cap designs may be approved by MDE.

Hazardous waste landfills must be closed in a manner that minimizes the need for further maintenance and controls, minimizes, or eliminates to the extent necessary to protect human health and the environment post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff, or waste decomposition products to the groundwater, surface water, or the atmosphere. The landfill cover shall be designed and constructed to achieve the following:

- Provide long-term minimization of migration of liquids through the closed landfill.
- Function with minimum maintenance.
- Promote drainage and minimize erosion and abrasion of the cover.
- Accommodate settling and subsidence so that the cover integrity is maintained.
- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoil present.

The proposed landfill cap meets or exceeds the industrial waste and hazardous waste landfill closure requirements.

Erosion and Sediment Control Plan Report

for

Operable Unit 2 Closure Design Final Design Submission

Former Naval Surface Warfare Center White Oak Site

Silver Spring, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0273

June 2001

REVISION 0
JUNE 2001

EROSION AND SEDIMENT CONTROL PLAN FOR OPERABLE UNIT 2 CLOSURE DESIGN

FINAL DESIGN SUBMISSION

FORMER NAVAL SURFACE WARFARE CENTER
WHITE OAK
SILVER SPRING, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 181
Naval Facilities Engineering Command
1314 Harwood Street, S.E.
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

Submitted by:
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600 Clark Avenue, Suite 3
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CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0273

JUNE 2001

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ACRONYMS

ALC	Adelphi Laboratory Center
ARARs	applicable or relevant and appropriate requirements
BCT	BRAC Cleanup Team
BRAC	Base Realignment and Closure
CLEAN	Comprehensive Long-Term Environmental Action Navy
CTO	Contract Task Order
cy	cubic yards
ECM	erosion control matting
GCL	geosynthetic clay liner
GSA	General Services Administration
HSG	hydrologic soil group
NSWC – White Oak	Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak
OU2	Operable Unit 2
PCBs	polychlorinated biphenyls
RAC	Remedial Action Contractor
RALs	remedial action levels
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Officer in Charge of Construction
SCS	Soil Conservation Service
Site 1	Parking Lot Landfill
Site 2	Apple Orchard Landfill
TBC	to be considered
TtNUS	Tetra Tech NUS, Inc.
USDA	United States Department of Agriculture
UXO	unexploded ordnance

1.0 INTRODUCTION

This Erosion and Sediment Control Plan Report was prepared under Contract Task Order (CTO) No. 0273 under Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Number N62472-90-D-1298. Under this CTO Tetra Tech NUS, Inc. (TtNUS) is performing engineering, design and post construction award services for the remedial action at the Parking Lot Landfill (Site 1) and the Apple Orchard Landfill (Site 2) at the former Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWC-White Oak), located in Silver Spring, Maryland. Because of their proximity to each other, similarity of contents, and time of operation, Sites 1 and 2 are now referred to as Operable Unit 2 (OU2).

NSWC-White Oak is located in both Montgomery and Prince George's Counties, Maryland, approximately 5 miles north of Washington, D.C., off New Hampshire Avenue (see Figure 1-1). NSWC-White Oak encompasses approximately 712 acres. In the fall of 1997, 662 acres were transferred to the General Services Administration (GSA). The remaining area in the southeastern portion of the facility was transferred to the U.S. Army in February 1998. NSWC-White Oak is bordered by the Adelphi Laboratory Center (ALC) along with a mixture of residential, park, industrial, and commercial properties. The facility lies in gently rolling terrain, and the drainage patterns are dominated by Paint Branch and its tributaries (see Figure 1-2). This remedial design is limited to Sites 1 and 2.

1.1 SITE HISTORY

1.1.1 Site 1 (Parking Lot Landfill)

The Parking Lot Landfill was used as an open disposal site and landfill between 1948 and 1953. The site is located east of Building 101A and is adjacent to the Site 2 (Figure 1-2). The wastes reportedly disposed within this landfill include lubricating oil, battery acid, metal plating wastes, and metal scrap. It has been reported that approximately 60 automobile batteries were disposed at the site over its operating life. When the site was deactivated in 1953, it was paved with asphalt. The site is currently used as a parking lot; however, visible wastes from the landfill including tires, glass, and old metal equipment have been observed on the southern and eastern slopes beyond the edge of the parking lot. The landfill covers approximately 1 acre in size and contains approximately 8,300 cubic yards (cy) of waste (TtNUS 2000).

1.1.2 Site 2 (Apple Orchard Landfill)

The Apple Orchard Landfill is an abandoned landfill located on the south side of the Perimeter Road in the northwestern end of the former NSWC-White Oak property (Figure 1-2). The landfill forms a small,

level hill with a peak elevation of approximately 340 feet mean sea level. The landfill slopes steeply to an unnamed stream along its southern edge and a drainage swale along its western perimeter. The unnamed stream flows eastward towards Paint Branch. The drainage swale conveys stormwater flow from adjacent properties and joins the unnamed stream in the southwestern corner of the site

The Apple Orchard Landfill reportedly operated as an open disposal area and landfill from 1948 until 1982. The landfill is a single unit that is composed of several disposal areas. In addition to domestic refuse, wastes reportedly disposed at the site included oils containing polychlorinated biphenyls (PCBs), solvents, paint residue, acids and miscellaneous compounds. An estimated 500 gallons of PCB-contaminated oils were deposited at the site prior to 1970. It has been estimated that the landfill contains 75,000 cubic yards of waste/fill (TtNUS 2001).

1.2 REPORT OBJECTIVE

The objective of this report is to describe the project and present the erosion and sediment control measures that will be used during implementation of the remedial action at OU2.

1.3 REPORT FORMAT

Section 2.0 presents a narrative on the requirements for Erosion and Sediment Control Plans. Section 3.0 presents a generalized sequence of construction. Section 4.0 presents conclusions. Erosion and Sediment Control calculations are presented in Appendix A. Construction drawings including Drawing C-2 "Erosion and Sediment Control Plan" and technical specifications are provided under separate cover.

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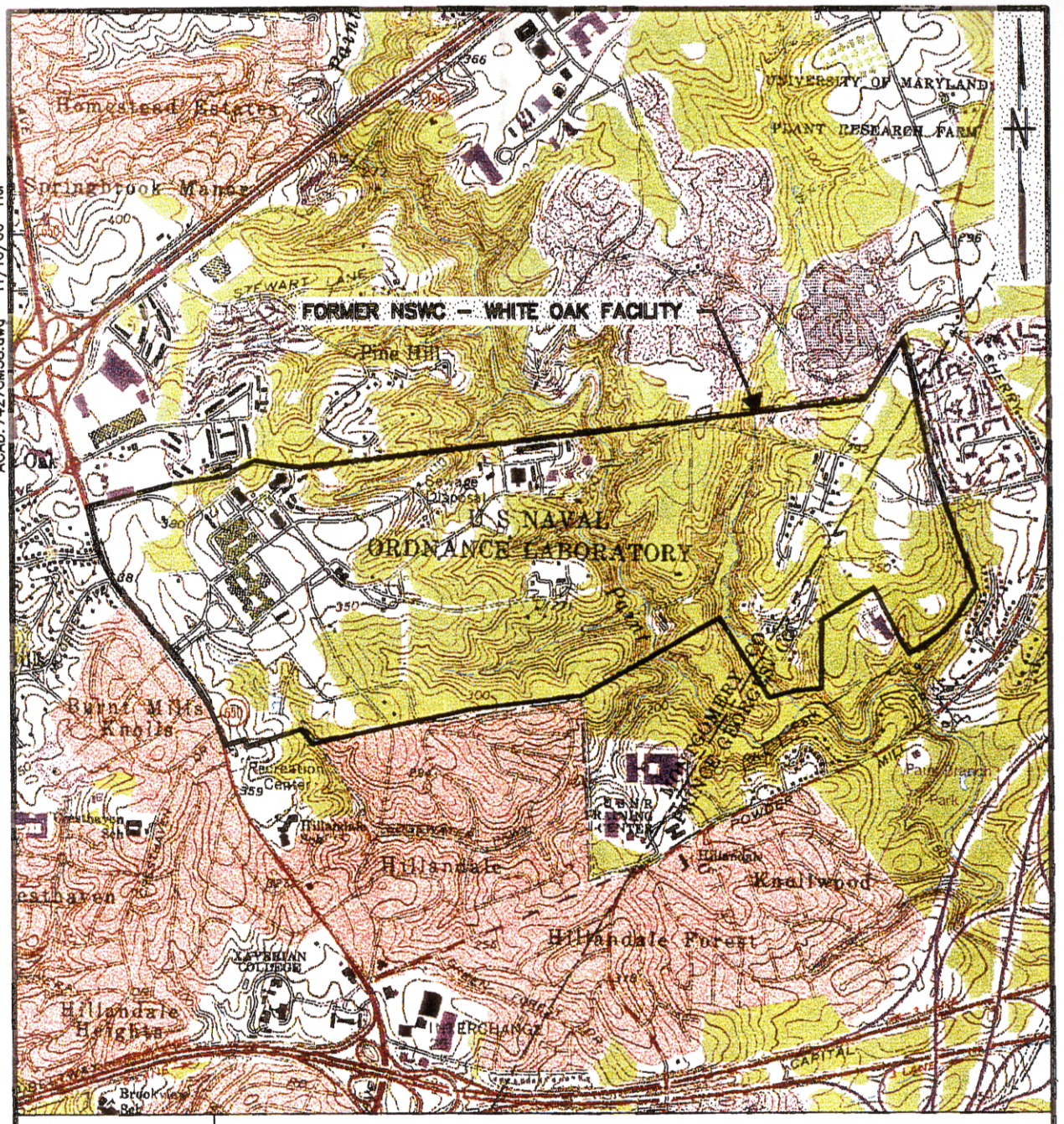

MARYLAND

QUADRANGLE LOCATION

0 2000 4000

SCALE IN FEET

SOURCE: U.S.G.S QUADRANGLE MAP, BELTSVILLE, MD. PHOTOREVISED 1979.

DRAWN BY HJP DATE 4/4/00	Tetra Tech NUS, inc.	CONTRACT NO. 7427	OWNER NO. 0273
CHECKED BY DATE	SITE VICINITY MAP OPERABLE UNIT 2 FORMER NSWC – WHITE OAK SILVER SPRING, MARYLAND	APPROVED BY SN	DATE 12/13/00
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 1-1	REV. 0

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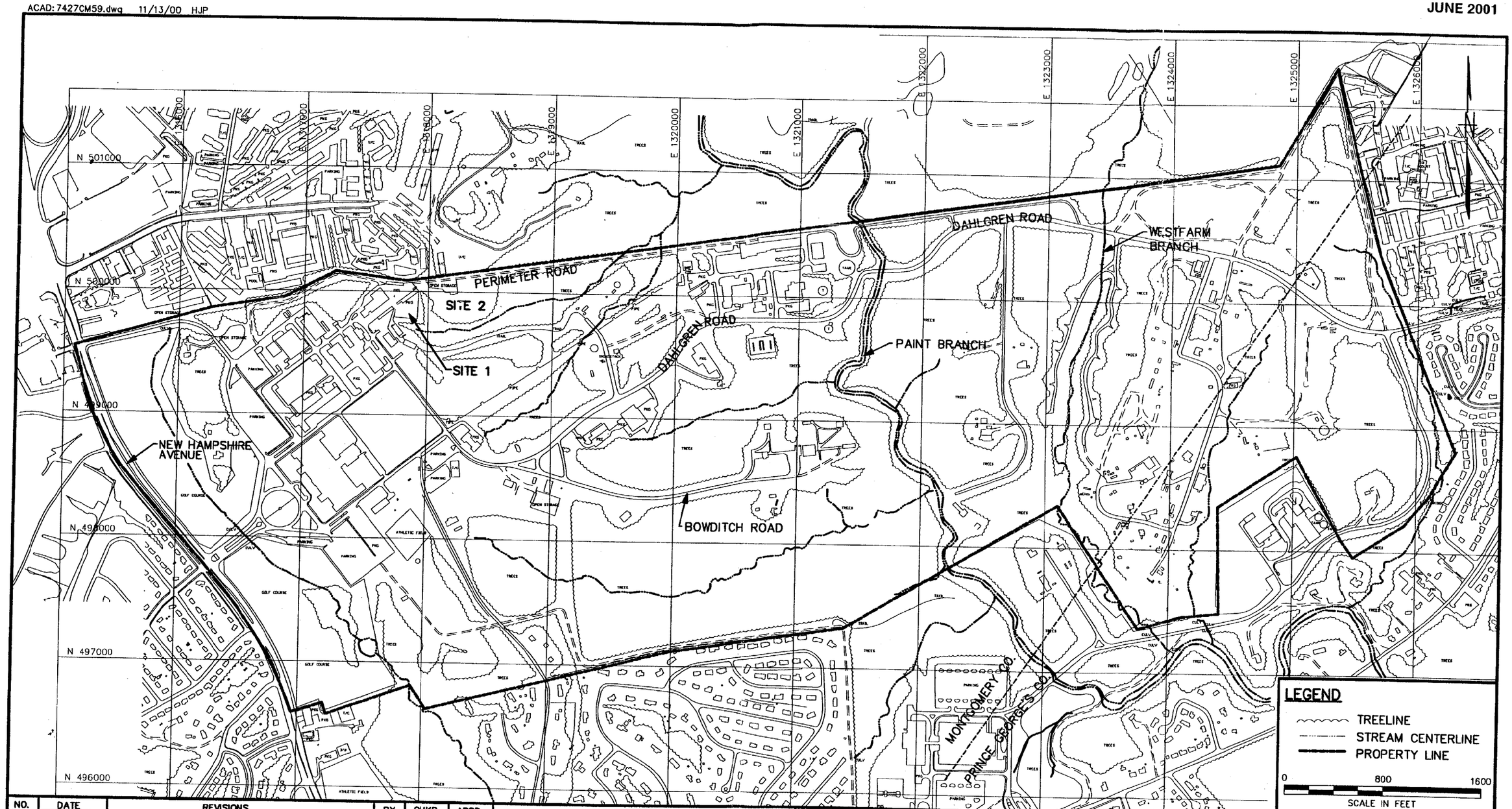

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DRAWN BY HJP DATE 11/13/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LOCATION MAP
OPERABLE UNIT 2
FORMER NSWC-WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 273
APPROVED BY SN DATE 12/13/00
APPROVED BY DATE
DRAWING NO. FIGURE 1-2
REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

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2.0 NARRATIVE REQUIREMENTS

OU2 encompass approximately 6 acres of the northwestern end of the former NSWC-White Oak property. The location is illustrated in Figure 1-2 and the site layout is illustrated in Figure 2-1.

2.1 PROJECT DESCRIPTION

The remedial action will include the excavation of approximately 8,300 cy of waste material from Site 1 for consolidation with Site 2 landfill material. Following consolidation an engineered cap will be constructed on the regraded OU2 waste. Additional activities include the removal of impacted sediments from the unnamed stream south of OU2 and the restoration of that stream. These actions were selected to minimize the release into the environment of contamination from the waste materials of both landfills.

The goal of the White Oak Base Realignment and Closure (BRAC) Cleanup Team (BCT) is to begin remedial actions at the NSWC-White Oak facility as quickly as possible to protect human health and the environment and to comply with applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) criteria.

2.2 EXISTING SITE CONDITIONS

OU2 consists of Site 1 and Site 2 which are inactive/abandoned landfills located in the northwestern portions of the former NSWC-White Oak (Figure 2-1). Access to the site from the entrance of NSWC-White Oak is via Nahan Road, Erickson Road, Fulton Road, and Perimeter Road.

2.2.1 Site 1 (Parking Lot Landfill)

The Parking Lot Landfill is a slightly sloping paved area that covers approximately 1 acre of land and contains approximately 8,300 cy of waste material. Runoff from the paved area is directed toward the southeastern corner and is collected in the unnamed stream which is a tributary to Paint Branch located east of the site. The eastern and southern faces of the landfill, outside the boundaries of the paved area, are both steeply sloped into drainage swale and unnamed stream. A concrete trench is located along the northern edge of the paved area adjacent to Building 111. The trench appears to have been used to capture runoff from inside Building 111. A decontamination pad is located southwest of the site. It has been used during environmental restoration work at various sites at former NSWC-White Oak. The decontamination pad was constructed with a tap water spigot and a drain that directs the wash water to a secondary containment vault (TtNUS 2000).

2.2.2 Site 2 (Apple Orchard Landfill)

The landfill covers approximately 4.3 acres and contains an estimated 75,000 cy of waste. The majority of the landfill was constructed on a plateau adjacent to Perimeter Road (Figure 2-1). Surface drainage at Site 2 flows south and southeast to the unnamed stream and west to the drainage swale. The landfill cover supports old field vegetation with successional hardwood forest on the short but very steep side slopes. The steep slopes range in height from a few feet (along the eastern and western perimeter) to approximately 35 feet along the southern perimeter. The slopes are moderately eroded and exposed waste and fill material are evident throughout. The cover is abutted to the south and west by mixed deciduous forest, to the east by Virginia Pine Forest, and to the north by private lands supporting residential development and Virginia Pine Forest. Minor erosion is evident on the landfill surface, but the steep slopes along the southern perimeter expose waste and fill material resulting from erosion of the cover materials or lack of placement of initial cover materials. Recent site visits and sampling activities indicate the presence of ordnance shapes in the landfill (TtNUS 2001).

2.3 OFFSITE AREAS

Areas not within the limits of OU2 include the unnamed stream south of Site 2, Perimeter Road and north of Perimeter Road, and the borrow area(s) where soils for cap construction and site restoration may be obtained. Each of these areas, with the exception of the borrow area(s), are located within the limits of disturbance for this remedial design. Therefore, the erosion and sediment control devices required to protect these areas are presented on the Erosion and Sediment Control Plan (Design Drawing C-2) and are described in this report.

The borrow area(s) are selected by the Remedial Action Contractor (RAC) and will not be located within the limits of disturbance of this remedial design. Therefore, the RAC will submit a supplemental erosion and sediment control plan to the Navy addressing any and all offsite source(s) if an approved erosion and sediment control plan for the offsite source(s) does not exist.

2.4 SOILS

A soils map of the site from the Soil Conservation Service (SCS), United States Department of Agriculture (USDA), is provided as Figure 2-2. The approximate locations of the site has been indicated on the map. The soil types present at the site are:

2C Glenelg silt loam (8 to 15 percent slopes)

116E Blocktown Channery silt loam (25 to 45 percent slopes, very rocky)

Glenelg Silt Loam: This soil is very deep and well drained. The soil is most often found on smooth side slopes or uplands. Properties include a moderate permeability, a high available water capacity, a moderate erosion hazard, and a moderate potential for frost action (SCS, 1995). According to the SCS Urban Hydrology for small watersheds (SCS, 1986), the hydrologic soil group (HSG) for Glenelg silt loam is B.

Blocktown Channery Silt Loam: This soil is shallow and well drained. The soil is most often found on side slopes in the uplands. Properties include a moderate permeability, a very low available water capacity, and a severe erosion hazard. According to the SCS Urban Hydrology for small watersheds (SCS, 1986), the HSG for Blocktown Channery silt loam is C/D.

2.5 CRITICAL AREAS

Critical areas are those that have potentially serious erosion problems due to the presence of steep slopes, poor vegetative cover, run-off channels, or areas identified as wetlands. The critical areas associated with OU2 include the drainage swale located between Sites 1 and 2 and the unnamed stream located along the southern toe of slope of OU2. The drainage swale located between Sites 1 and 2 will be relocated as a result of the remedial action at OU2. However, prior to relocation, the existing drainage swale will be protected using silt fence and supersilt fence. The impacted sediments in the unnamed stream will be excavated and consolidated within the proposed limits of waste for OU2. Following removal of impacted sediments the stream and associated wetlands will be restored. During construction, the unnamed stream will be protected using straw bales, supersilt fencing, and various other controls. The protection devices named here and other erosion and sediment control devices are described further in Section 2.6. No other critical areas have been identified on or adjacent to Sites 1 and 2. However, during construction areas may require temporary protection while portions of the site are unvegetated. The RAC will be responsible to identify these areas in their work plan and for the protection of these areas during construction.

2.6 EROSIONS AND SEDIMENT CONTROL MEASURES

Erosion and sediment control measures will be implemented, installed, and maintained according to the standards and specifications of the Maryland Erosion and Sediment Control Handbook unless otherwise noted in this plan and the construction documents. Design specifications for erosion and sediment control structures have been obtained from the Maryland Standards and Specifications for Soil Erosion and Sediment Control.

The required erosion and sediment control measures are shown on Design Drawing C-2 and are as follows.

- The stabilized stone construction entrance(s) will be provided off of Perimeter Road and will be protected with silt fence.

- The southern boundary of OU2 along the existing unnamed stream will be protected using super silt fence (silt fence supported by wire fence). Supersilt fence will also be provided along both sides of the drainage swale located between Sites 1 and 2.

- Silt fence will be placed to protect the construction entrance structures and the stockpile pad.

- Drainage channels will be constructed along the northern, western and eastern perimeters of the landfill cap to convey run-off from the landfill cap and surrounding areas to the unnamed stream located south of OU2. In addition, a bench will be constructed on the landfill cap to increase cap stability and to provide a break in the drainage areas associated with the landfill cap. The east and west channels will be protected by erosion control matting, and during construction, rock check dams will also be utilized to reduce sedimentation. The bench and northern channels will be rock lined.

- Riprap will be placed at critical locations within the drainage channels constructed along the east and western sides of the constructed landfill cap. The location of riprap placement is identified on Design Drawing C-8.

- Permanent, channel, and temporary seeding will be used throughout the construction process to stabilize disturbed areas and channels.

- A temporary access culvert will be placed across the drainage swale located between Site 1 and 2 to provide a means of transporting the excavated material from Site 1 to the proposed stockpile located within Site 2.

- Straw bales will be placed across the unnamed stream during sediment removal and stream restoration.

2.6.1 Structural Practices

The following structural practices will be used during and/or following construction activities at OU2 to control erosion and sedimentation. The number listed, if any, references the Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994.

Stone Construction Entrance - F17.0. Temporary stone construction entrance(s) will be installed to provide access to OU2 via Perimeter Road. Construction vehicles will be cleaned before exiting the site.

Super Silt Fence - H26.0. Super silt fence will be installed along the southern slopes of OU2 and along both sides of the drainage swale located between Sites 1 and 2.

Stormwater Conveyance Channel – H28.0. Permanent drainage channels will be installed along the northern, eastern, and western boundaries of the constructed landfill cap to divert runoff away from the cap edge. Additionally, a bench will be constructed within the limits of the landfill cap to increase the stability of the landfill and to break the flow length of runoff generated in the drainage areas of the landfill cap.

Surface Roughening - NA. The surface of regraded areas will be roughened to reduce run-off velocity and to aid in the establishment of vegetative cover.

Temporary Seeding - G20.0. All regraded areas that will be left dormant for extended periods of time will be seeded with fast germinating temporary vegetation immediately following grading. Seeding will be performed with a 50/50 mixture of annual rye grass and cereal (winter) rye.

Permanent Seeding - G20.0. All regraded areas will be permanently seeded with a seed mixture that will minimize erosion and provide suitable cover for wildlife.

Mulching - G20.0. All areas receiving permanent seeding will be mulched with an organic material to prevent erosion by protecting the soil surface from raindrop impact and reduce the velocity of overland flow.

Rock Check Dams – B8.0. Rock check dams will be temporary control devices constructed in the permanent channels to trap sediment and reduce flow rates in the channels. Rock check dams will be removed following final stabilization (establishment of permanent vegetation) of all disturbed areas.

Temporary Access Culvert – H29.10. A temporary access culvert will be constructed within the drainage swale located between Sites 1 and 2 to provide a construction road between the two sites for the movement of waste/fill material. The access culvert will remain in place until the permanent channel is constructed around the western side of the landfill cap.

Straw Bales - H25.0. Straw bales will be placed across the unnamed stream during the restoration of the unnamed stream. The bales, or approved other, will remain in-place until the restoration is complete and the stream is stabilized.

2.6.2 Management Strategies

1. Unstabilized, disturbed areas will be minimized and construction activities will be staged.

2. Seeding or other stabilization measures will follow immediately after grading.

3. Areas that are not to be disturbed will be clearly marked by flags, signs, etc.

4. The construction superintendent will be responsible for ensuring the installation and maintenance of all erosion and sediment control practices.

5. Erosion and sediment control structures will be installed and/or constructed before the start of any earth disturbance activities.

6. Erosion and sediment control structures will remain in place until permanent vegetation is established over disturbed surfaces, as described in the revegetation notes on Design Drawing C-4.

2.7 PERMANENT STABILIZATION

All areas disturbed by remedial action activities with the exception of the unnamed stream will be stabilized with either permanent seeding or channel seeding mixtures as soon as possible following final grading, but no later than 7 to 14 days (as noted on the Design Drawings). Permanent seeding mixture will consist of native warm season grasses which will, over the long term, result in lower maintenance costs and more beneficial natural habitat. The mix will include big bluestem (*Andropogon gerrardi*) little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*), indian grass (*Sorghastrum nutans*), canada wild rye (*Elymus canadensis*), partridge pea (*Cassia fasciculata*), and annual rye grass (*Lolium multiflorum*). The rye grass and partridge pea will germinate and become established quickly to provide the necessary erosion control until the warm season grasses can become established. This seed mixture was provided by the Biological Technical Assistance Group through USEPA correspondence dated February 14, 2001.

The channel seed mix will consist of indigenous and natural grass species recognized for their effectiveness in stabilizing exposed soils. The grass species include a mixture of cool-season and warm-season grasses. The cool-season grasses germinate quickly and establish rapidly to provide effective

short-term soil stabilization. The warm-season grasses are generally of greater wildlife value but germinate and grow more slowly than cool-season grasses. In addition, the warm-season grasses tend to grow better in poor quality soils and under drought conditions. The seed mix includes redtop (*Agrostis alba*), barnyard grass (*Echinochloa crusgalli*), switchgrass (*Panicun virgatum*), deertongue grass (*Dichanthelium chandestium*), and a seasonal nurse crop. The application rate is identified on Design Drawing C-3 and is identified as the "Channel Seed Mixture".

2.8 STORMWATER RUNOFF CONSIDERATIONS

Following completion of the remedial action, the site will be returned to grassed or natural existing conditions. Therefore, aside from the northern, eastern, and re-aligned western channels, permanent stormwater management controls are not required for this site.

Run-off calculations were performed using QuickTR-55™ (Haestad Methods, Inc). The software uses procedures outlined in SCS TR-55 manual. Channel capacity calculations, pre-development run-off calculations, and post-development run-off calculations are provided in Appendix A.

2.9 MAINTENANCE

In general, all erosion and sediment control measures will be checked weekly and after each significant rainfall event to assure that all erosion and sediment controls remain in effective operating conditions. Any required repairs will be made immediately. The following items will be checked:

- The stabilized stone construction entrances will be maintained in a condition that will minimize tracking sediment onto roads, including the addition of stone or other repairs.

- The super silt fence will be checked regularly for undermining or deterioration of the fabric. Sediment will be removed when the level of sediment deposition causes "bulging" or reaches half of the fabric height.

- The silt fence will be checked regularly for undermining or deterioration of the fabric. Sediment will be removed when the level of sediment deposition causes "bulging" or reaches half of the fabric height.

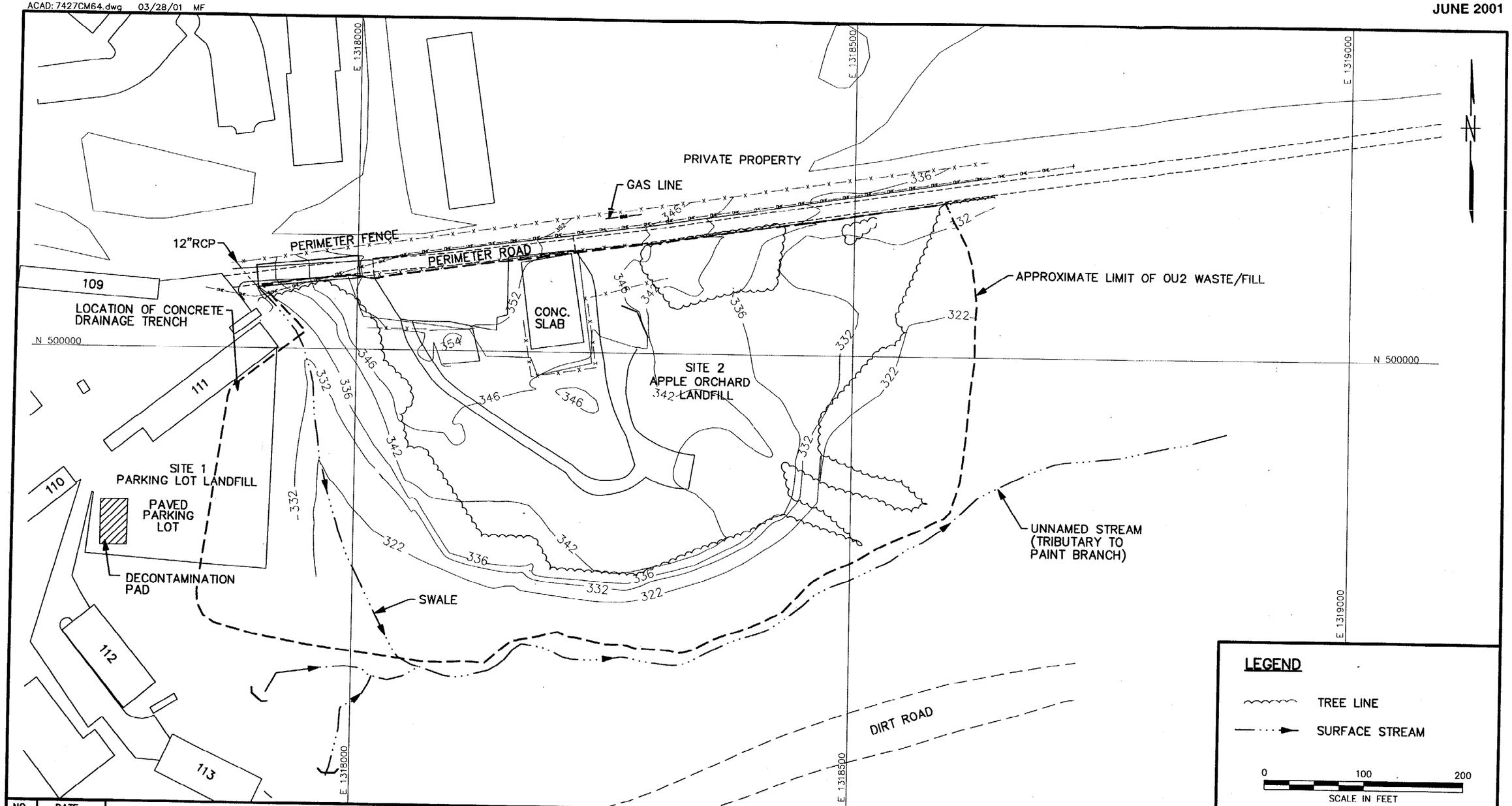
- Rock check dams will be checked for sediment accumulation. Sediment will be removed when it reaches one half of the original height of the check dam. Regular inspections will be made to ensure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam will be corrected immediately.

- Straw bales will be checked for sediment accumulation. Sediment will be removed when it reaches one half the bale height. Straw bales will be replaced if required.

- During the establishment of the channels, repairs will be made immediately and grass re-established. After grass has been established, the channels will be checked periodically to determine if the grass and associated erosion control matting is withstanding flow velocities without damage.

- The seeded areas will be checked regularly to ensure that a good stand of vegetation is maintained. Areas shall be fertilized and re-seeded as needed. The RAC is responsible for maintenance until formal acceptance by the Contracting Officer.

ACAD: 7427CM64.dwg 03/28/01 MF



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

DRAWN BY HJP DATE 12/14/00
CHECKED BY DATE 3/29/01
COST/SCHED-AREA
SCALE AS NOTED

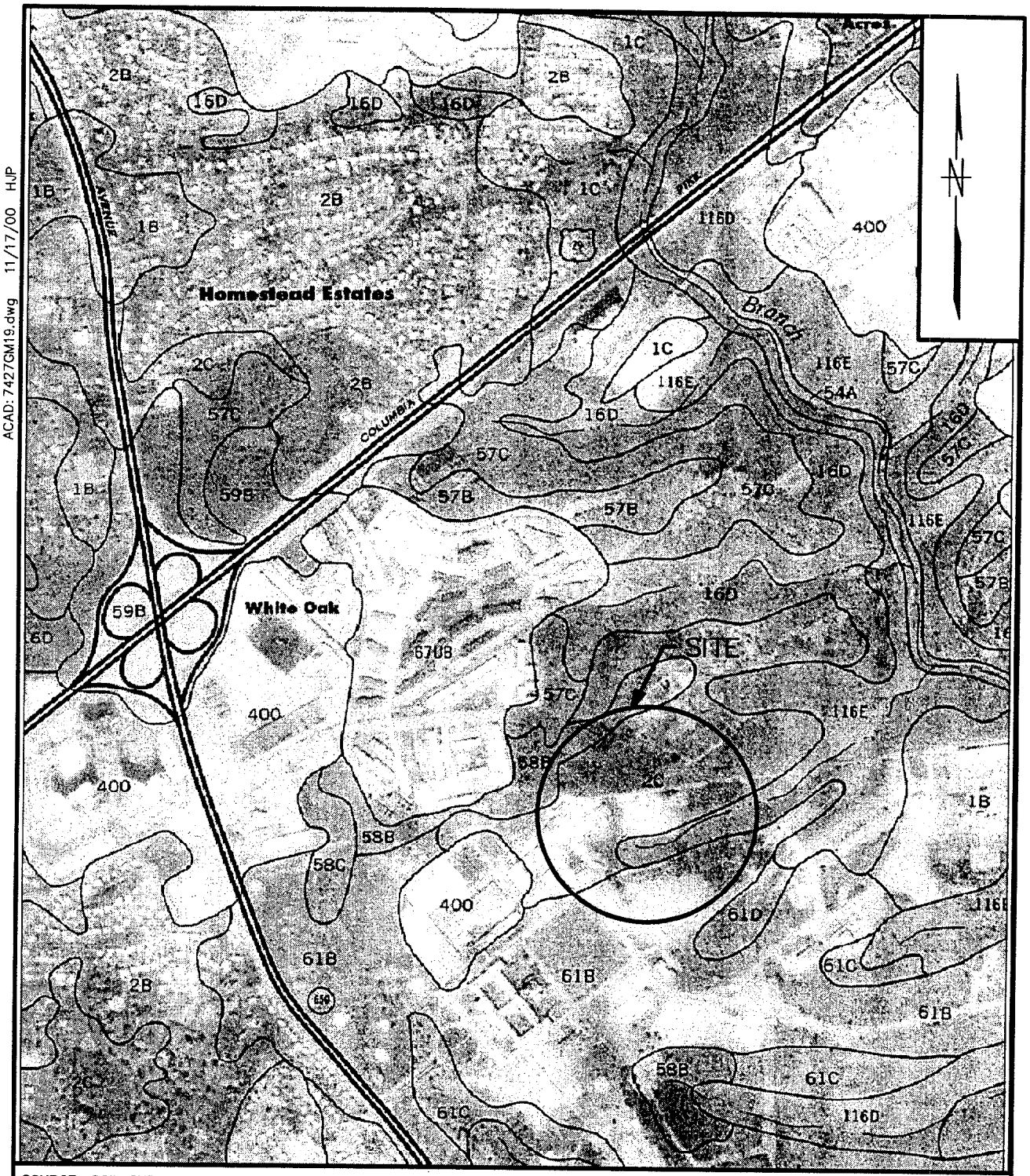
Tetra Tech NUS, Inc.

SITE LAYOUT MAP
OPERABLE UNIT 2
FORMER NSWC – WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 0273
APPROVED BY SN
DATE 3/29/01
APPROVED BY
DATE
DRAWING NO. FIGURE 2–1
REV. 0

00162D12Z

ACAD: 7427GM19.dwg 11/17/00 HJP



SOURCE: SOIL SURVEY OF MONTGOMERY COUNTY, MARYLAND 1995

DRAWN BY HJP DATE 11/17/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7427	OWNER NO. 0273
CHECKED BY DATE	SOILS MAP OPERABLE UNIT 2 FORMER NSWC – WHITE OAK SILVER SPRING, MARYLAND	APPROVED BY SN	DATE 12/13/00
COST/SCHED–AREA		APPROVED BY	DATE
SCALE NOT TO SCALE		DRAWING NO. FIGURE 2–2	REV. 0

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

3.0 SEQUENCE OF CONSTRUCTION

The time to perform the required construction activities is estimated to be approximately 240 days. The generalized sequence of construction activities is:

1. Hold pre-construction meeting with the Contracting Officer.

2. Inspect site prior to construction to verify existing site conditions and underground utility locations.

3. Establish horizontal and vertical control for construction. Stake the location of all areas to be excavated or disturbed prior to actual work.

4. Install all perimeter controls, stabilized stone construction entrance as indicated on Drawing C-2, and additional stabilized stone construction entrance(s) if approved by the Resident Officer in Charge of Construction (ROICC) prior to any earth disturbance activities. All perimeter controls shall conform to Standards and Specifications identified in the 1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control Manual unless otherwise specified. The perimeter controls to be installed include, but not limited to, the following:

   - silt fence on downhill sides of all stockpile locations and construction entrance(2);

   - super silt fence along the northern side of the unnamed stream located south of OU2, and along both sides of drainage swale located between Sites 1 and 2;

   - temporary stream crossing within drainage swale located between Sites 1 and 2 (see Drawing C-2) to provide a transportation route between Sites 1 and 2;

   - additional controls as may be required by the Contracting Officer and/or warranted by site conditions and best construction practices.

5. Clear and grub construction laydown, material storage and staging area(s), material handling pad, and decontamination pad if necessary.

6. Construct decontamination pad, materials handling pad, construction laydown, and storage and staging areas if necessary.

7. Breakup concrete slabs within the limits of OU2 and relocate as necessary.

8. Clear but do not grub within limits of OU2. Clear and grub within remainder of limits of disturbance.

9. Excavate waste/fill material within OU2 west of the drainage swale for placement within proposed limits of waste. During excavation, breakup concrete filled shapes designated by unexploded ordnance (UXO) oversight personnel as not containing ordnance for general distribution within the proposed limits of waste. In the event that suspect hazardous materials are identified during excavation and consolidation of OU2 waste/fill, the suspect hazardous materials are to be segregated and characterized for proper off-site disposal. If through characterization sampling of suspect hazardous waste, the materials are determined to be non-hazardous, material will be consolidated within the proposed limits of waste.

10. Perform verification sampling following excavation of all waste/fill material outside the proposed limit of waste. If verification sampling test results indicate contaminants are either completely removed or at levels below the remedial action levels (RALs), excavation of waste/fill material is complete. In the event that verification sampling test results indicate that exposed soils contain contaminants above RALs continue excavation and conduct additional verification sampling. Continue process until contaminants are removed or RALs are met.

11. Following excavation of material outside of proposed limits of waste, establish perimeter channels and begin re-grading waste/fill within proposed limits of waste. During re-grading breakup concrete filled shapes designated by UXO oversight personnel for general distribution within landfill limits.

12. Establish Erosion and Sedimentation controls in the unnamed stream as indicated on Drawing C-2. Excavate impacted sediments from unnamed stream and place within proposed limits of waste. Excavation of sediments in the unnamed stream shall proceed upstream to downstream. Stabilize disturbed areas in the unnamed stream by planting wetland plants and installing temporary Erosion Control Matting (ECM).

13. Perform UXO screening to a depth of 4-feet below final grade. Grade waste/fill material to 6-inches below interim grade (see Drawing C-6), followed by placement of 6-inches of subgrade soil to establish interim grade (see Drawing C-7). During regrading extend and protect identified monitoring wells.

14. Prepare the sub-grade soil by compacting and fine grading to create a smooth firm surface. Remove material that is considered objectionable for the placement of geosynthetic clay liner (GCL), including

but not limited to sharp-edged materials and protrusions extending more than ½ inch. Regrade and compact as necessary.

15. Install cap materials including GCL, Geomembrane, geocomposite drainage material, trenches, drainage piping, and gas vents. Cover GCL immediately with geomembrane. Place only as much GCL as can be covered at the end of the day with geomembrane or temporary water proof tarp.

16. Install cover and topsoil materials and vegetate immediately after topsoil is placed.

17. Plant permanent vegetation on all disturbed areas.

18. Install signs along the site perimeter.

19. Remove all temporary facilities (i.e. decontamination pad, material handling pads, etc.). Restore and revegetate as needed. When all upstream areas have been stabilized and have been accepted by the Contracting Officer, remove all remaining perimeter controls.

4.0 CONCLUSIONS

This remedial action will result in the improvement of the site over the long term. Waste/fill materials will be consolidated under a Resource Conservation Recovery Act (RCRA) equivalent engineered cap. Appropriate steps will be implemented during construction to control run-off from the site and reduce the impacts of erosion and sedimentation.

Run-off quality during the remedial action will be addressed via temporary erosion and sediment control devices around the perimeter of the disturbed areas.

REFERENCES

TtNUS (Tetra Tech NUS, Inc.) 2000. Final Engineering Evaluation/Cost Analysis (EE/CA) for Site 1 at the Former Naval Surface Warfare Center – White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, March.

TtNUS 2001. Corrective Measures Study For Operable Unit 2 at the Former Naval Surface Warfare Center – White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, March.

Soil Conservation Service, July 1995. Soil Survey of Montgomery County, Maryland, United States Department of Agriculture.

Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994, Maryland Department of the Environment, Water Management Administration.

Soil Conservation Service, June 1986. Urban Hydrology for Small Watersheds, United States Department of Agriculture, Technical Release 55.

APPENDIX A

HYDROLOGY CALCULATIONS

A.1 PRE-DEVELOPMENT HYDROLOGY

A.2 POST-DEVELOPMENT HYDROLOGY

A.3 CHANNEL DESIGN CALCULATIONS

A.4 SILT FENCE/SUPER SILT FENCE DESIGN

A.1 PRE-DEVELOPMENT HYDROLOGY

CLIENT: White Oak		JOB NUMBER: N-7427-1502	
SUBJECT: Pre-Development Hydrology			
BASED ON:		DRAWING NUMBER:	
BY: T.W.S. Date: 10/25/00	CHECKED BY: NJB Date: 11/22/00	APPROVED BY:	DATE:

OBJECTIVE:

To calculate the 25-year pre-development peak discharge at the Site 2 landfill.

APPROACH:

1. Delineate the drainage areas for pre-development conditions and measure the surface area with a planimeter. The pre-development drainage area (DA) map is provided on page 3 of 13.

2. Use the Haestad Method Quick TR-55 computer program to calculate the weighted runoff curve number, time of concentration, and peak 25-year discharge for the drainage area.

ASSUMPTIONS:

1. With regard to the time of concentration (Tc) six separate flow paths within the drainage area were evaluated to determine the greatest Tc. The following is a description of the flow path and the data entered into TR-55 for the flow path with the greatest Tc.

   With regard to the Tc for flow path 6, sheet flow shall begin at 354 ft msl and extend 300 ft to 336 ft msl, resulting in a slope equal to 0.06 ft/ft. The surface description for sheet flow is meadow (dense grass). According to Table 3-1 in the SCS TR-55 manual, the roughness coefficient (n) is 0.24. Shallow concentrated flow begins at 336 ft msl and extend 400 ft to 289 ft msl, resulting in a slope equal to 0.118 ft/ft. The surface description is unpaved. Channel flow begins at 289 ft msl and extends 150 ft to 285 ft msl, resulting in a slope equal to 0.027 ft/ft. The channel is trapezoidal in shape and has a 10-foot width with 2H to 1V side-slopes, and an average depth of 2 feet. The flowpath ends in the existing channel at elevation 285 ft msl.

CONCLUSIONS

The total peak discharge from the Site 2 pre-development drainage area resulting from a 25-year 24-hour storm event is 28.91 cfs. This includes the 5.91 cfs that is contributed by the 12-inch RCP.

REFERENCES

1) SCS TR-55 Users Guide, Release 5.0
2) Haestad Flow Master v4.1b, Haestad Methods, Inc. 1994.

CLIENT: White Oak		JOB NUMBER: N-7427-1502	
SUBJECT: Pre-Development Hydrology			
BASED ON:		DRAWING NUMBER:	
BY: T.W.S. Date: 10/25/00	CHECKED BY: Date:	APPROVED BY:	DATE:

CALCULATIONS:

1. Drainage Area:

The pre-development drainage area is delineated on page 3 of 13. The drainage area calculations and flowpath slope calculations are provided on page 4 of 13 . With regard to the land covers in each drainage area, this information is presented in the runoff curve number calculations according to hydrologic soil group (HSG) on page 4 of 13.

2. Runoff Curve Numbers:

The different types of land cover with respect to HSG were measured with a planimeter in each DA. The Quick TR-55 computer program was then used to calculate a weighted runoff curve number for each drainage area. The weighted runoff curve number for the Site 2 drainage area is 73 (TR-55 output provided on page 8 of 13.

3. Time of Concentration:

Six Tc flowpaths were drawn for the drainage area (the Tc for each flow path is presented on page 5 of 13). The longest Tc calculated by TR-55 is 0.39 hours. TR-55 output data is provided on page 9 of 13 and the flow paths are illustrated on the figure provided on page 3 of 13. Tc calculations uses the 2-year 24-hour storm occurrence, a chart of the 24-hour storm events for Montgomery County is provided on page 6 of 13.

4. Peak Discharges:

The peak discharges for the 25-year storm during pre-development conditions were calculated by the Quick TR-55 computer program. The inputs include the drainage area size, corresponding weighted runoff curve number and Tc, as well as the 25-year precipitation equal to 5.9 inches (refer to 25-year precipitation map provided on page 7 of 13). The pre-development peak discharge from the drainage area for a 25-year 24-hour storm is 23 cfs (TR-55 output is provided on pages 10-12 of 13).

In addition to the flow generated during a 25-year storm event within the drainage area delineated on page 3 of 13, the drainage area receives flow from the 12-inch RCP below the road north of the site. FlowMaster was used to determine the maximum flow that the drain pipe can handle. The following information was used as input data for FlowMaster.

Water Depth in Pipe =	0.95 ft	Maximum Flow
Slope of 12-inch CMP =	0.0238 ft/ft	
Manning's "n" =	0.013	
Flow from 12-inch RCP =	5.91 cfs	
Run-off from drainage area =	23 cfs	
Total Run-off for Drainage Area =	28.91 cfs	

The FlowMaster output data is presented on page 13 of 13.

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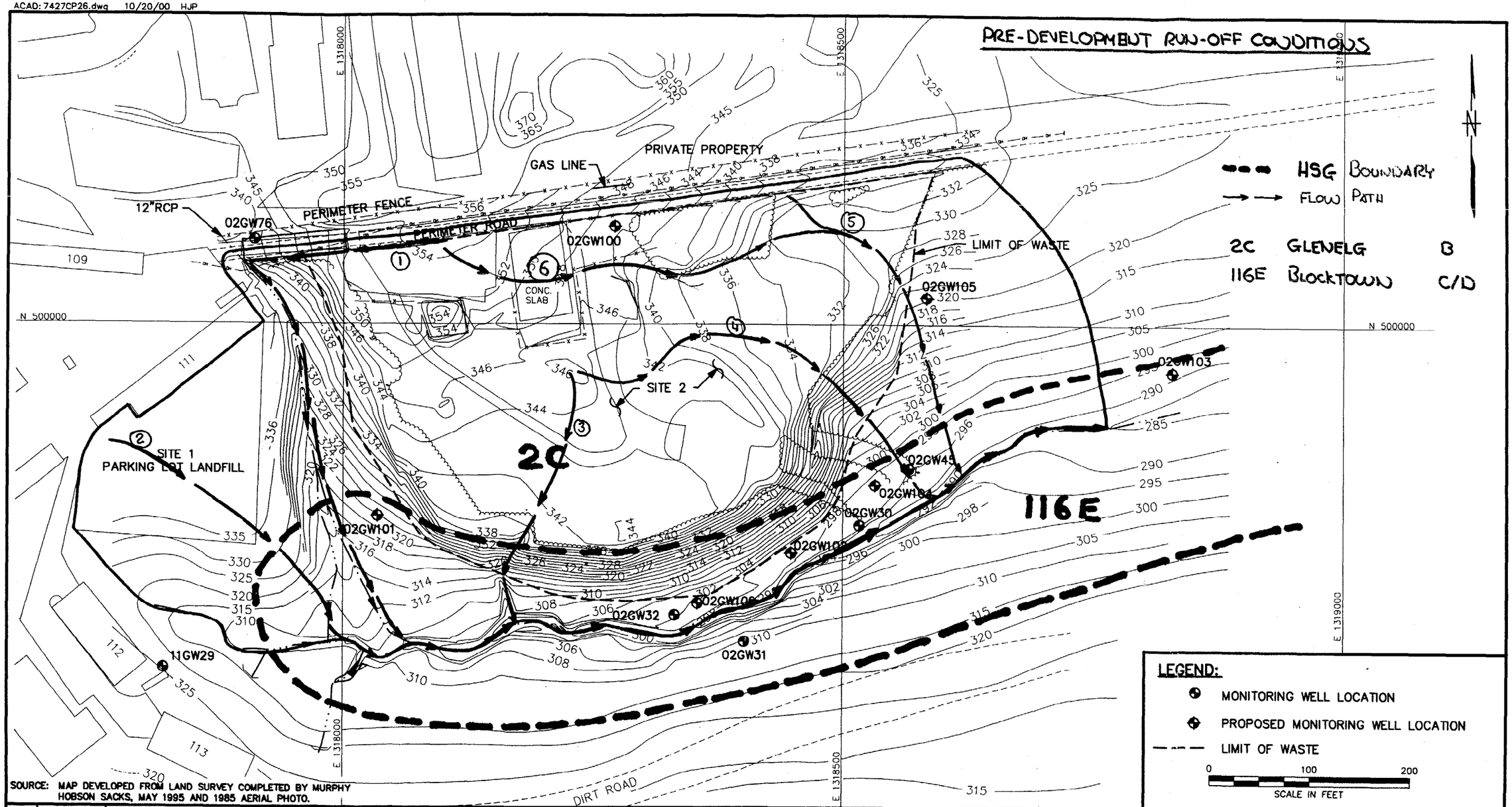


SOURCE: MAP DEVELOPED FROM LAND SURVEY COMPLETED BY MURPHY HOBSON SACKS, MAY 1995 AND 1985 AERIAL PHOTO.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP	DATE 10/19/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7427 / OWNER NO. 0273
CHECKED BY	DATE	OPERABLE UNIT 2 CLOSURE DESIGN FORMER NSWC – WHITE OAK EROSION AND SEDIMENT CONTROL PLAN	APPROVED BY / DATE
COST/SCHED–AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE / REV. 0

FORM CADD NO. T:NUS_BH.DGN - REV 0 - 1/20/98

00162D132

CLIENT: White Oak			JOB NUMBER: N-7427-1502
SUBJECT: Pre-Development Hydrology			
BASED ON:			DRAWING NUMBER:
BY: T.W.S. Date: 10/25/00	CHECKED BY: Date:		APPROVED BY: DATE:

Scale of Drawing 1-inch = 100-feet

Site Soil Types:

Soil Types	Description	Corresponding HSG
2C	Glenelg	B
116E	Blocktown	C/D

Discharge Area

Soil Type	HSG	Surface Description	Planimeter Reading (si)	Area (sf)	Area (acres)	CN *
2C	B	Woods	13.7	137,000	3.2	73
2C	B	Meadow	10.4	104,000	2.4	58
2C	B	Pavement	3.7	37,201	0.9	98
116E	C/D	Woods	7.2	72,230	1.7	83

Total Acres 8.05

* CN Table 2-2 of TR-55 Reference Guide, Release 5.0.

Slope of Flow Path

Flow Path	Reach	Start Elev. (ft-msl)	End Elev. (ft-msl)	Length of Reach (ft)	Slope (ft/ft)	Type of Flow
1	1-M	355	338	200	0.085	Shallow Concentrated
	2-W	338	308	440	0.068	Channel
	3-W	308	285	760	0.030	Channel
2	1-P	336	335	175	0.006	Sheet
	2-W	335	308	150	0.180	Shallow Concentrated
	3-W	308	285	840	0.027	Channel
3	1-M	346	338	155	0.052	Sheet
	2-W	338	302	100	0.360	Shallow Concentrated
	3-W	302	285	655	0.026	Channel
4	1-M	346	332	280	0.050	Sheet
	2-W	332	290	160	0.263	Shallow Concentrated
	3-W	290	285	200	0.025	Channel
5	1-M	336	328	140	0.057	Sheet
	2-W	328	289	210	0.186	Shallow Concentrated
	3-W	289	285	150	0.027	Channel
6	1-M	354	336	300	0.060	Sheet
	2-W	336	289	400	0.118	Shallow Concentrated
	3-W	289	285	150	0.027	Channel

M = Surface type is meadow
W = Surface type is wooded
P = Surface type is pavement

CLIENT: White Oak		JOB NUMBER: N-7427-1502	
SUBJECT: Pre-Development Hydrology			
BASED ON:		DRAWING NUMBER:	
BY: T.W.S. Date: 10/25/00	CHECKED BY: Date:	APPROVED BY:	DATE:

From quick TR-55 the following time of concentrations were calculated for the flow paths identified in the above table.

Flow Path	Time of Concentration from TR-55
1	0.27 Hours
2	0.08 Hours
3	0.25 Hours
4	**0.39 Hours**
5	0.22 Hours
6	**0.39 Hours**

As noted in the text, the TR-55 output provided on page 9 of 13 represents the time of concentration for the flow path with the largest Tc.

Table 2.2 Rainfall Depths Associated with the 1,2,10 and 100-year, 24-hour Storm Events

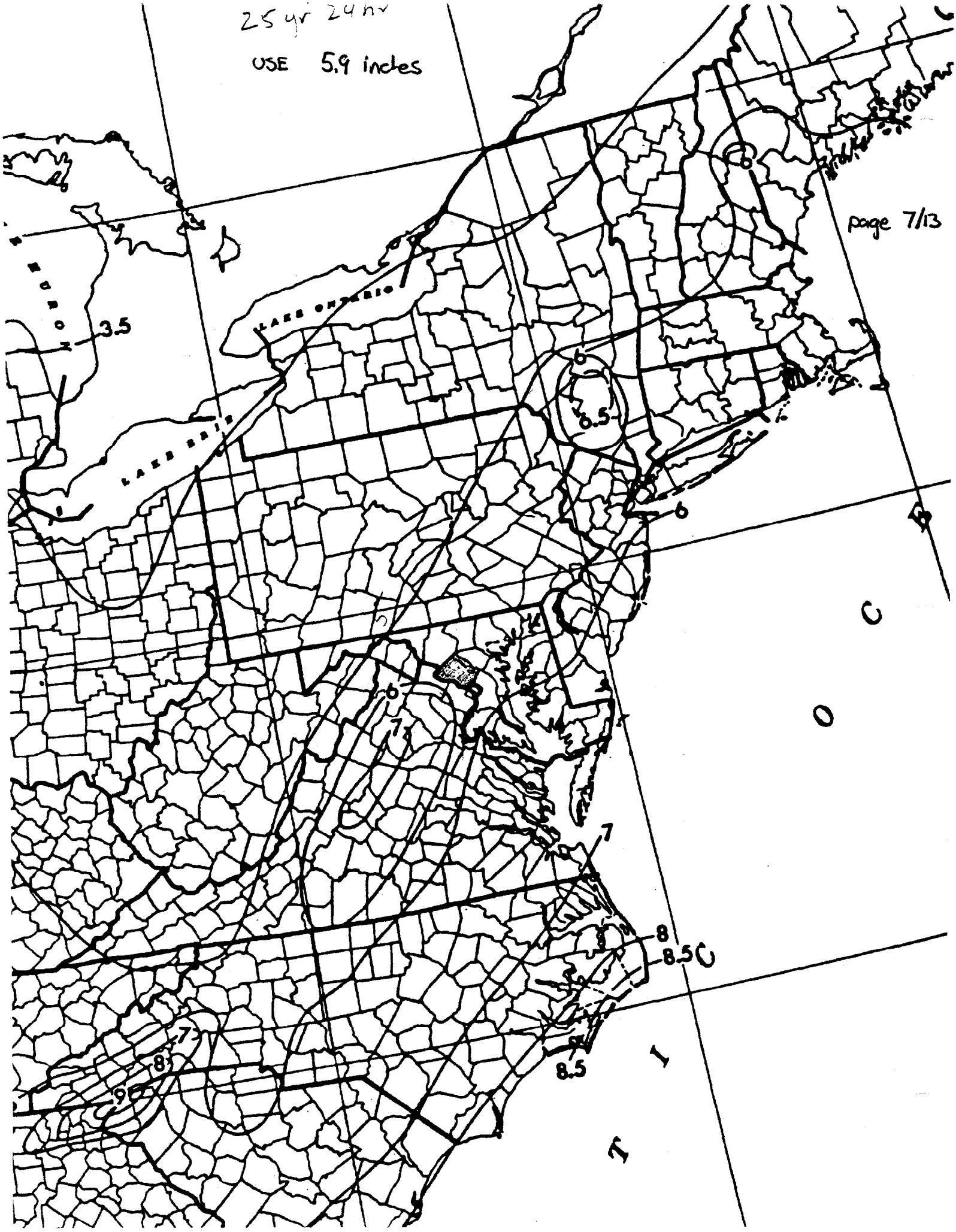
County	Rainfall Depth			
	1 yr - 24 hr	2 yr-24 hr	10 yr-24 hr	100 yr-24 hr
Allegany	2.4 inches	2.9 inches	4.5 inches	6.2 inches
Anne Arundel	2.7	3.3	5.2	7.4
Baltimore	2.6	3.2	5.1	7.1
Calvert	2.8	3.4	5.3	7.6
Caroline	2.8	3.4	5.3	7.6
Carroll	2.5	3.1	5.0	7.1
Cecil	2.7	3.3	5.1	7.3
Charles	2.7	3.3	5.3	7.5
Dorchester	2.8	3.4	5.4	7.8
Frederick	2.5	3.1	5.0	7.0
Garrett	2.4	2.8	4.3	5.9
Harford	2.6	3.2	5.1	7.2
Howard	2.6	3.2	5.1	7.2
Kent	2.7	3.3	5.2	7.4
Montgomery	2.6	3.2	5.1	7.2
Prince George's	2.7	3.3	5.3	7.4
Queen Anne's	2.7	3.3	5.3	7.5
St. Mary's	2.8	3.4	5.4	7.7
Somerset	2.9	3.5	5.6	8.1
Talbot	2.8	3.4	5.3	7.6
Washington	2.5	3.0	4.8	6.7
Wicomico	2.9	3.5	5.6	7.9
Worcester	3.0	3.6	5.6	8.1

25yr2

say 5.

25 yr 24 hr

USE 5.9 inches



Quick TR-55 Ver.5.47 S/N:
Executed: 08:16:51 11-22-2000

WHITE OAK - SITE 2
PRE-DEVELOPMENT
DRAINAGE AREA

RUNOFF CURVE NUMBER DATA

::

Composite Area: DRAINAGE AREA

SURFACE DESCRIPTION	AREA (acres)	CN	
2C WOODS (HSG = B)	3.50	73	
2C MEADOW (HSG = B)	2.39	58	
2C PAVEMENT (HSG = B)	0.85	98	
116E WOODS (HSG = C/D)	1.66	83	
COMPOSITE AREA --->	8.40	73.2	(73)

::

```
Quick TR-55 Ver.5.47   S/N:
Executed: 13:32:42   10-25-2000    WO-PRE.TCT

                          WHITE OAK - SITE 2
                           PRE-DEVELOPMENT
                            DRAINAGE AREA

                  Tc COMPUTATIONS FOR: DRAINAGE AREA

 SHEET FLOW (Applicable to Tc only)
     Segment ID                                      REACH 1
     Surface description                        MEADOW
     Manning's roughness coeff., n                    0.2410
     Flow length, L (total < or = 300)     ft      300.0
     Two-yr 24-hr rainfall, P2              in      3.200
     Land slope, s                         ft/ft    0.0600
                           0.8
          .007 * (n*L)
     T =  --------------               hrs       0.37          =   0.37
             0.5     0.4
           P2    *   s

 SHALLOW CONCENTRATED FLOW
     Segment ID                                      REACH 2
     Surface (paved or unpaved)?                     Unpaved
     Flow length, L                          ft      400.0
     Watercourse slope, s                  ft/ft    0.1180

                              0.5
     Avg.V =  Csf *   (s)                 ft/s     5.5424
     where:   Unpaved Csf = 16.1345
              Paved   Csf = 20.3282

     T = L / (3600*V)                    hrs       0.02          =   0.02


 CHANNEL FLOW
     Segment ID                                      REACH 3
     Cross Sectional Flow Area, a        sq.ft     28.00
     Wetted perimeter, Pw                   ft      18.94
     Hydraulic radius, r = a/Pw             ft      1.478
     Channel slope, s                     ft/ft    0.0270
     Manning's roughness coeff., n                 0.0350

                         2/3      1/2
          1.49   *   r     *    s
     V =  --------------------                ft/s     9.0779
                         n

     Flow length, L                          ft        150

     T = L / (3600*V)                    hrs       0.00          =   0.00

     ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                            TOTAL TIME (hrs)        0.39
```

Return Frequency: 2 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

10/13

Executed: 11-22-2000 08:22:57
Watershed file: --> WO-PRE .MOP
Hydrograph file: --> WO-PRE02.HYD

WHITE OAK - SITE 2
PRE-DEVELOPMENT
DRAINAGE AREA

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
DRAINAGE AREA	8.40	73.0	0.40	0.00	3.20	0.98	.23	.30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 8.40 acres or 0.01312 sq.mi
Peak discharge = 6 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
DRAINAGE AREA	0.39	0.00	0.40	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

11/13

Executed: 11-22-2000 08:22:57
Watershed file: --> WO-PRE .MOP
Hydrograph file: --> WO-PRE10.HYD

WHITE OAK - SITE 2
PRE-DEVELOPMENT
DRAINAGE AREA

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
DRAINAGE AREA	8.40	73.0	0.40	0.00	5.10	2.36	.15	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 8.40 acres or 0.01312 sq.mi
Peak discharge = 18 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
DRAINAGE AREA	0.39	0.00	0.40	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

12/13

Executed: 11-22-2000 08:22:57
Watershed file: --> WO-PRE .MOP
Hydrograph file: --> WO-PRE25.HYD

WHITE OAK - SITE 2
PRE-DEVELOPMENT
DRAINAGE AREA

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
DRAINAGE AREA	8.40	73.0	0.40	0.00	5.90	3.01	.13	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 8.40 acres or 0.01312 sq.mi
Peak discharge = 23 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
DRAINAGE AREA	0.39	0.00	0.40	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

12 inch RCP
Worksheet for Circular Channel

Project Description	
Project File	c:\fmw\wo-en.fm2
Worksheet	12 inch RCP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.023800	ft/ft
Depth	0.95	ft
Diameter	1.00	ft

Results		
Discharge	5.91	ft^3/s
Flow Area	0.77	ft^2
Wetted Perimeter	2.69	ft
Top Width	0.44	ft
Critical Depth	0.95	ft
Percent Full	95.00	%
Critical Slope	0.023829	ft/ft
Velocity	7.66	ft/s
Velocity Head	0.91	ft
Specific Energy	1.86	ft
Froude Number	1.02	
Maximum Discharge	5.91	ft^3/s
Full Flow Capacity	5.50	ft^3/s
Full Flow Slope	0.027479	ft/ft
Flow is supercritical.		

A-2 POST-DEVELOPMENT HYDROLOGY

CLIENT: White Oak			JOB NUMBER: N-7427-1403
SUBJECT: Post-Development Hydrology			
BASED ON:			DRAWING NUMBER:
BY: T.W.S. Date: 03/23/01	CHECKED BY: [illegible] Date: 03/23/01		APPROVED BY: DATE:

OBJECTIVE:

To calculate the 25-year post-development peak discharge runoff from the OU2 landfill cap.

APPROACH:

1. Delineate the drainage areas for post-development conditions and measure the surface area with a planimeter. The post-development drainage area (DA) map is provided on page 3 of 13.

2. Use the Haestad Method Quick TR-55 computer program to calculate the weighted runoff curve number, time of concentration, and peak 25-year discharge for the drainage area.

ASSUMPTIONS:

1) With regard to the time of concentration (Tc) six separate flow paths within the drainage area were evaluated to determine the greatest Tc. The following is a description of the flow path and the data entered into TR-55 for the flow path with the greatest Tc.

   With regard to the Tc for flow path 3, sheet flow shall begin at 365 ft msl and extends 72 ft to 362 ft msl, resulting in a slope equal to 0.042 ft/ft. Sheet flow continues from elevation 362 ft msl and extends 160 ft to 328.5 ft msl resulting in a slope equal to 0.209 ft/ft. The surface description for sheet flow is meadow (dense grass). According to Table 3-1 in the SCS TR-55 manual, the roughness coefficient (n) is 0.24. Shallow concentrated flow begins at 328.5 ft msl and extends 400 ft to 315 ft msl, resulting in a slope equal to 0.034 ft/ft. The surface description is paved. Channel flow begins at 315 ft msl and extends 160 ft to 308 ft msl, resulting in a slope equal to 0.0.044 ft/ft. The channel is trapezoidal in shape and has a 2-foot width with 3H to 1V side-slopes and a depth of 1.5-feet. Channel flow continues in the existing channel at 308 ft msl and extends 880 ft to 285 ft msl. The channel is trapezoidal in shape and has a 10-foot width with 2H to 1V side-slopes, and an average depth of 2-feet. The flowpath ends in the existing channel at elevation 285 ft msl.

CONCLUSIONS

The total peak discharge from the Site 2 post-development drainage area resulting from a 25-year 24-hour storm event is 23.91 cfs. This includes the 5.91 cfs that is contributed by the 12-inch RCP.

REFERENCES

1) SCS TR-55 Users Guide, Release 5.0
2) Haestad Flow Master v4.1b, Haestad Methods, Inc. 1994.

CLIENT:	White Oak	JOB NUMBER:	N-7427-1403
SUBJECT:	Post-Development Hydrology		
BASED ON:		DRAWING NUMBER:	
BY: T.W.S. Date: 03/23/01	CHECKED BY: JRW Date: 03/23/01	APPROVED BY:	DATE:

CALCULATIONS:

1. Drainage Area:

The post-development drainage area is delineated on page 3 of 13. The drainage area calculations and flowpath slope calculations are provided on page 4 and 5 of 13 . With regard to the land covers in each drainage area, this information is presented in the runoff curve number calculations according to hydrologic soil group (HSG) on page 4 of 13.

2. Runoff Curve Numbers:

The different types of land cover with respect to HSG were measured with a planimeter for the DA. The Quick TR-55 computer program was then used to calculate a weighted runoff curve number for each drainage area. The weighted runoff curve number for the post-development Site 2 drainage area is 63 (TR-55 output provided on page 8 of 13).

3. Time of Concentration:

Six Tc flowpaths were drawn for the drainage area (the Tc for each flow path is presented on page 5 of 13). The longest Tc calculated by TR-55 is 0.33 hours. TR-55 output data is provided on page 9 of 13 and the flow paths are illustrated on the figure provided on page 3 of 13. Tc calculations use the 2-year 24-hour storm occurrence. A chart of the 24-hour storm events for Montgomery County is provided on page 6 of 13.

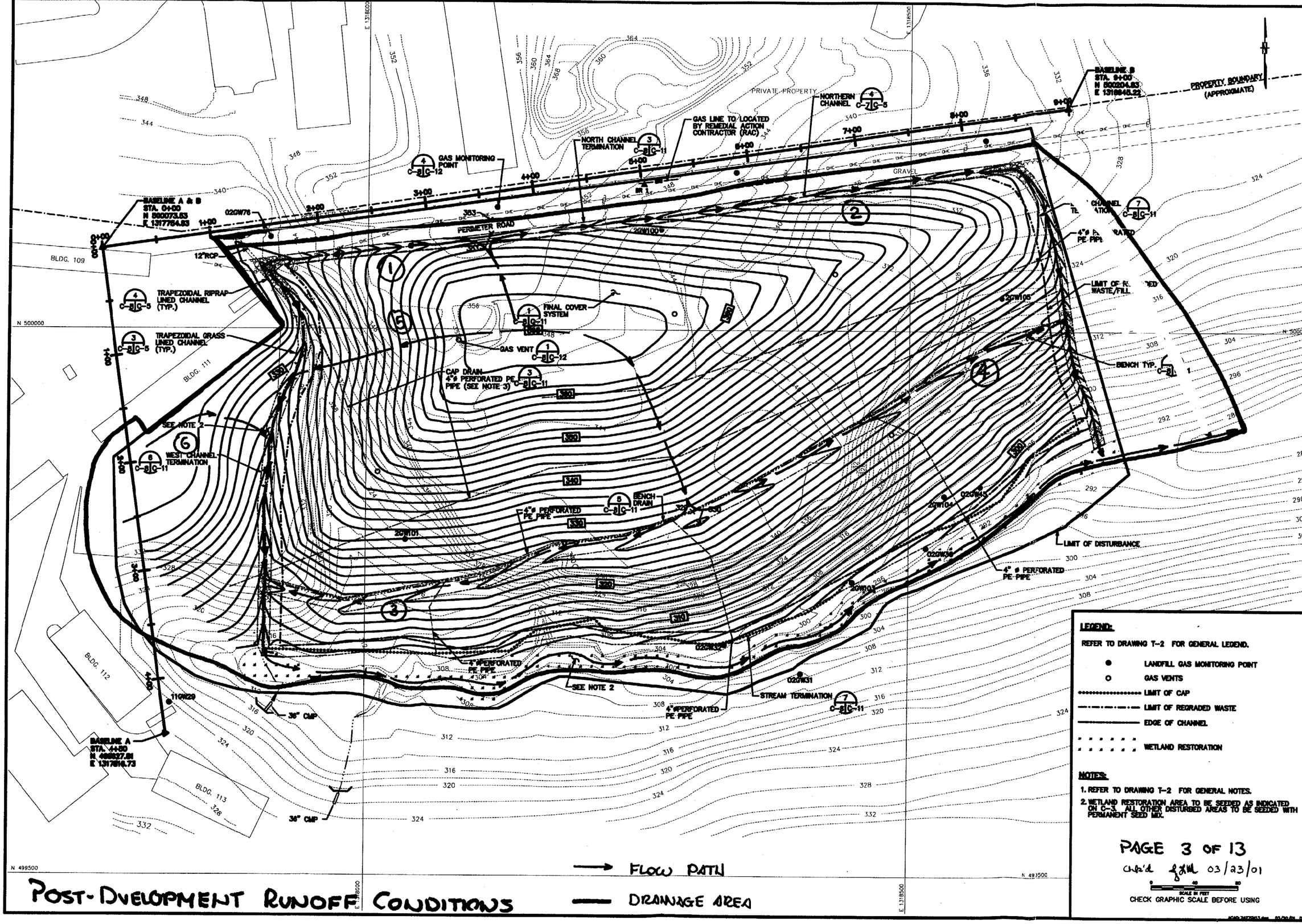
4. Peak Discharges:

The peak discharges for the 25-year storm for post-development conditions were calculated by the Quick TR-55 computer program. The inputs include the drainage area size, corresponding weighted runoff curve number and Tc, as well as the 25-year precipitation equal to 5.9 inches (refer to 25-year precipitation map provided on page 7 of 13). The post-development peak discharge from the drainage area for a 25-year 24-hour storm is 18 cfs (TR-55 output is provided on pages 10-12 of 13).

In addition to the flow generated during a 25-year storm event within the drainage area delineated on page 3 of 13, the drainage area receives flow from the 12-inch RCP below the road north of the site. FlowMaster was used to determine the maximum flow that the drain pipe can handle. The following information was used as input data for FlowMaster.

Water Depth in Pipe =	0.95 ft	Maximum Flow
Slope of 12-inch CMP =	0.0238 ft/ft	
Manning's "n" =	0.013	
Flow from 12-inch RCP =	5.91 cfs	
Run-off from drainage area =	18 cfs	
Total Run-off for Drainage Area =	23.91 cfs	

The FlowMaster output data is presented on page 13 of 13.



POST-DEVELOPMENT RUNOFF CONDITIONS

LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

- ● LANDFILL GAS MONITORING POINT
- ○ GAS VENTS
- LIMIT OF CAP
- LIMIT OF REGRADED WASTE
- EDGE OF CHANNEL
- WETLAND RESTORATION

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. WETLAND RESTORATION AREA TO BE SEEDED AS INDICATED ON C-3. ALL OTHER DISTURBED AREAS TO BE SEEDED WITH PERMANENT SEED MIX.

PAGE 3 OF 13

chk'd 03/23/01

SCALE IN FEET 0 40 80

CHECK GRAPHIC SCALE BEFORE USING

1794	4/23				
04	4/04				
E.I.C.	4/05				
441	4/06				
4/02	DATE				
DATE	REVIEWED BY NAVFAC				

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
NAVAL FACILITIES ENGINEERING COMMAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
FINAL GRADING PLAN

CODE ID. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-
SPEC. 31-97-0000
NAVFAC DRAWING NO.
SHEET 10 OF 16
C-8

00162 D142

CLIENT:	White Oak	JOB NUMBER:	N-7427-1403
SUBJECT:	Post-Development Hydrology		
BASED ON:		DRAWING NUMBER:	
BY: T.W.S. Date: 03/23/01	CHECKED BY: [illegible] Date: 03/23/01	APPROVED BY:	DATE:

Scale of Drawing 1-inch = 80-feet

Site Soil Types: Because the soils located in the watershed are being moved around during construcion and since off-site soils are being placed over the soils that are existing, post-construction soil conditions will be analyized with a hydraulic soil grouping of B.

Discharge Area

Soil Type	HSG	Surface Description	Planimeter Reading (si)	Area (sf)	Area (acres)	CN *
2C	B	Woods	3.41	21,824	0.50	73
2C	B	Meadow	46.40	296,960	6.82	58
2C	B	Pavement	5.00	32,000	0.73	98

Total Acres 8.05

* CN Table 2-2 of TR-55 Reference Guide, Release 5.0.

Slope of Flow Path

Flow Path	Reach	Start Elev. (ft-msl)	End Elev. (ft-msl)	Length of Reach (ft)	Slope (ft/ft)	Type of Flow
1	1-M	365	362	40	0.075	Sheet
	2-M	362	355	40	0.175	Sheet
	3-P/G	355	336	192	0.099	Shallow Concentrated
	4-M	336	308	480	0.058	Channel
	5-W	308	285	880	0.026	Channel
2	1-M	365	362	40	0.075	Sheet
	2-M	362	355	40	0.175	Sheet
	3-P/G	355	330	512	0.049	Shallow Concentrated
	4-M	330	290	280	0.143	Channel
	5-W	290	285	144	0.035	Channel
3	1-M	365	362	72	0.042	Sheet
	2-M	362	328.5	160	0.209	Sheet
	3-P/G	328.5	315	400	0.034	Shallow Concentrated
	4-M	315	308	160	0.044	Channel
	5-W	308	285	880	0.026	Channel
4	1-M	365	362	72	0.042	Sheet
	2-M	362	328.5	160	0.209	Sheet
	3-P/G	328.5	316	400	0.031	Shallow Concentrated
	4-M	316	290	152	0.171	Channel
	5-W	290	285	144	0.035	Channel

CLIENT:	White Oak	JOB NUMBER:	N-7427-1403
SUBJECT:	Post-Development Hydrology		
BASED ON:		DRAWING NUMBER:	
BY: T.W.S. Date: 03/23/01	CHECKED BY: RW Date: 03/23/01	APPROVED BY:	DATE:

Slope of Flow Path (Continued)

Flow Path	Reach	Start Elev. (ft-msl)	End Elev. (ft-msl)	Length of Reach (ft)	Slope (ft/ft)	Type of Flow
5	1-M	365	362	48	0.063	Sheet
	2-M	362	328	144	0.236	Shallow Concentrated
	3-M	328	308	360	0.056	Channel
	4-W	308	285	880	0.026	Channel
6	1-M	338	324	128	0.109	Sheet
	2-M	324	308	288	0.056	Channel
	3-W	308	285	880	0.026	Channel

M = Surface type is meadow
W = Surface type is wooded
P/G = Surface type is pavement/gravel

From quick TR-55 the following time of concentrations were calculated for the flow paths identified in the above table.

Flow Path	Time of Concentration from TR-55
1	0.16 Hours
2	0.16 Hours
3	**0.33 Hours**
4	0.31 Hours
5	0.12 Hours
6	0.18 Hours

As noted in the text, the TR-55 output provided on page 9 of 13 represents the time of concentration for the flow path with the largest Tc.

Table 2.2 Rainfall Depths Associated with the 1,2,10 and 100-year, 24-hour Storm Events

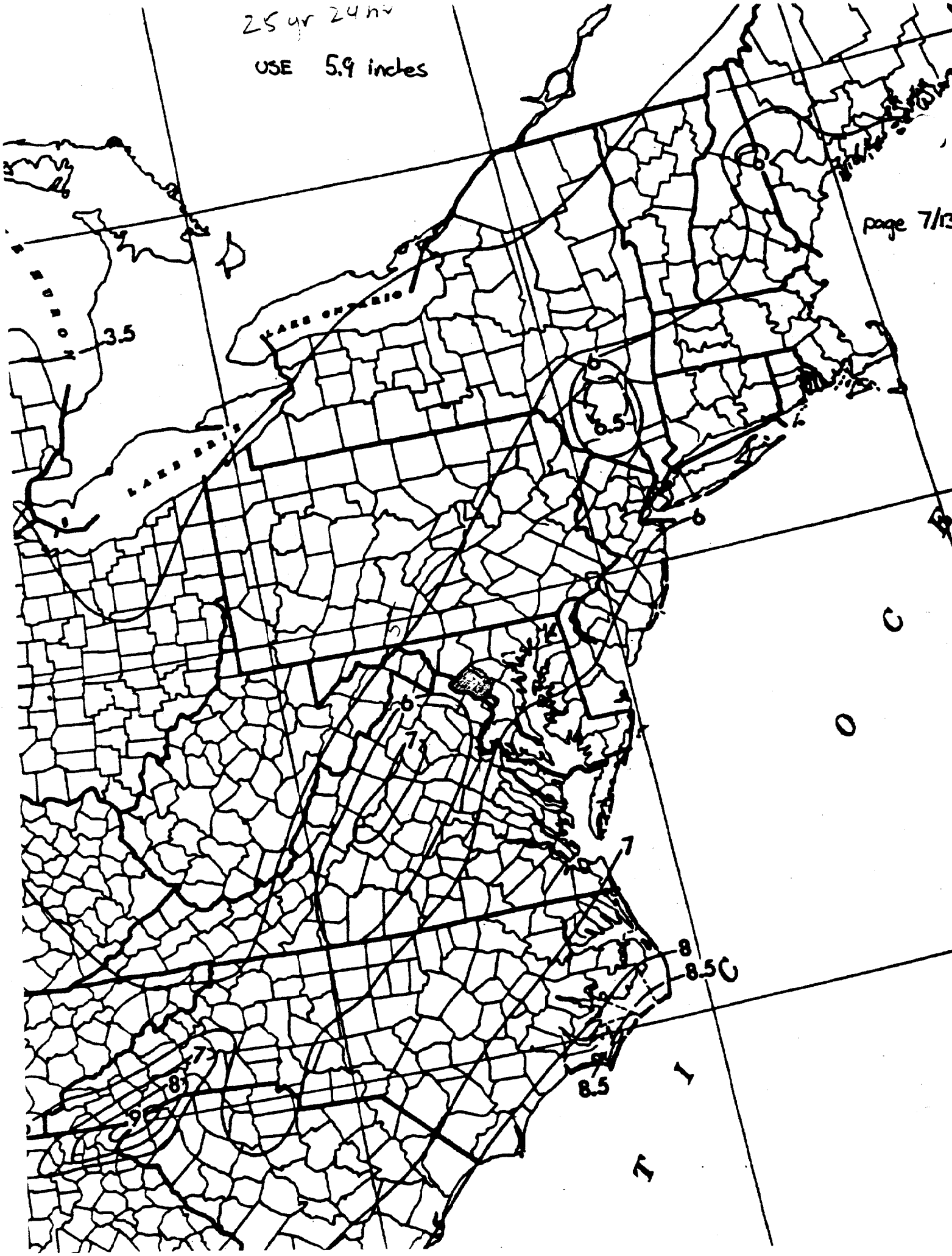
County	Rainfall Depth			
	1 yr - 24 hr	2 yr-24 hr	10 yr-24 hr	100 yr-24 hr
Allegany	2.4 inches	2.9 inches	4.5 inches	6.2 inches
Anne Arundel	2.7	3.3	5.2	7.4
Baltimore	2.6	3.2	5.1	7.1
Calvert	2.8	3.4	5.3	7.6
Caroline	2.8	3.4	5.3	7.6
Carroll	2.5	3.1	5.0	7.1
Cecil	2.7	3.3	5.1	7.3
Charles	2.7	3.3	5.3	7.5
Dorchester	2.8	3.4	5.4	7.8
Frederick	2.5	3.1	5.0	7.0
Garrett	2.4	2.8	4.3	5.9
Harford	2.6	3.2	5.1	7.2
Howard	2.6	3.2	5.1	7.2
Kent	2.7	3.3	5.2	7.4
Montgomery	2.6	3.2	5.1	7.2
Prince George's	2.7	3.3	5.3	7.4
Queen Anne's	2.7	3.3	5.3	7.5
St. Mary's	2.8	3.4	5.4	7.7
Somerset	2.9	3.5	5.6	8.1
Talbot	2.8	3.4	5.3	7.6
Washington	2.5	3.0	4.8	6.7
Wicomico	2.9	3.5	5.6	7.9
Worcester	3.0	3.6	5.6	8.1

25yr.

Say

25 yr 24 hr

USE 5.9 inches



page 7/13

Quick TR-55 Ver.5.47 S/N:
Executed: 14:34:59 11-22-2000

8/13

WHITE OAK - SITE 2
POST-DEVELOPMENT CONDITIONS
DRAINAGE AREA

RUNOFF CURVE NUMBER DATA

::

Composite Area: DRAINAGE AREA

SURFACE DESCRIPTION	AREA (acres)	CN	
WOODS HSG = B	0.50	73	
MEADOW HSG = B	6.82	58	
PAVEMENT/GRAVEL HSG = B	0.73	98	
COMPOSITE AREA --->	8.05	62.6	(63)

::

CHK'D 8&M 11-27-00

Quick TR-55 Ver.5.47 S/N:
Executed: 10:36:50 03-23-2001 WO-POST.TCT

WHITE OAK - OU2
POST-DEVELOPMENT CONDITIONS
DRAINAGE AREA

Tc COMPUTATIONS FOR: DRAINAGE AREA

SHEET FLOW (Applicable to Tc only)

Segment ID		REACH 1	REACH 2		
Surface description		MEADOW	MEADOW		
Manning's roughness coeff., n		0.2410	0.2410		
Flow length, L (total < or = 300)	ft	72.0	160.0		
Two-yr 24-hr rainfall, P2	in	3.200	3.200		
Land slope, s	ft/ft	0.0420	0.2090		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.14	+ 0.14	=	0.27

SHALLOW CONCENTRATED FLOW

Segment ID		REACH 3		
Surface (paved or unpaved)?		Paved		
Flow length, L	ft	400.0		
Watercourse slope, s	ft/ft	0.0340		
$Avg.V = Csf * (s)^{0.5}$	ft/s	3.7483		
where: Unpaved Csf = 16.1345; Paved Csf = 20.3282				
T = L / (3600*V)	hrs	0.03	=	0.03

CHANNEL FLOW

Segment ID		REACH 3	REACH 4		
Cross Sectional Flow Area, a	sq.ft	9.75	28.00		
Wetted perimeter, Pw	ft	11.49	18.94		
Hydraulic radius, r = a/Pw	ft	0.849	1.478		
Channel slope, s	ft/ft	0.0440	0.0260		
Manning's roughness coeff., n		0.0250	0.0350		
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	%11.2054	8.9082		
Flow length, L	ft	160	880		
T = L / (3600*V)	hrs	0.00	+ 0.03	=	0.03

::

TOTAL TIME (hrs) 0.33

CHK'D [initials] 03/23/01

Return Frequency: 2 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

10/13

Executed: 03-23-2001 10:52:46
Watershed file: --> WO-POST .MOP
Hydrograph file: --> WO-POST1.HYD

WHITE OAK - OU2
POST-DEVELOPMENT CONDITIONS
DRAINAGE AREA

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
DRAINAGE AREA	8.05	63.0	0.30	0.00	3.20	0.52	.37	.30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 8.05 acres or 0.01258 sq.mi
Peak discharge = 4 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
DRAINAGE AREA	0.33	0.00	0.30	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

CHK'D gRW 03/23/01

Return Frequency: 10 years

11/13

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 03-23-2001 10:52:46
Watershed file: --> WO-POST .MOP
Hydrograph file: --> WO-POST2.HYD

WHITE OAK - OU2
POST-DEVELOPMENT CONDITIONS
DRAINAGE AREA

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
DRAINAGE AREA	8.05	63.0	0.30	0.00	5.10	1.57	.23	.30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 8.05 acres or 0.01258 sq.mi
Peak discharge = 11 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
DRAINAGE AREA	0.33	0.00	0.30	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

CHK'D 03/23/01 gRM

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

12/13

Executed: 03-23-2001 10:52:46
Watershed file: --> WO-POST .MOP
Hydrograph file: --> WO-POST3.HYD

WHITE OAK - OU2
POST-DEVELOPMENT CONDITIONS
DRAINAGE AREA

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
DRAINAGE AREA	8.05	63.0	0.30	0.00	5.90	2.11	.2	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 8.05 acres or 0.01258 sq.mi
Peak discharge = 18 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
DRAINAGE AREA	0.33	0.00	0.30	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

CHK'D JRW 03/23/01

12 inch RCP
Worksheet for Circular Channel

Project Description	
Project File	c:\fmw\wo-en.fm2
Worksheet	12 inch RCP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.023800	ft/ft
Depth	0.95	ft
Diameter	1.00	ft

Results		
Discharge	5.91	ft^3/s
Flow Area	0.77	ft^2
Wetted Perimeter	2.69	ft
Top Width	0.44	ft
Critical Depth	0.95	ft
Percent Full	95.00	%
Critical Slope	0.023829	ft/ft
Velocity	7.66	ft/s
Velocity Head	0.91	ft
Specific Energy	1.86	ft
Froude Number	1.02	
Maximum Discharge	5.91	ft^3/s
Full Flow Capacity	5.50	ft^3/s
Full Flow Slope	0.027479	ft/ft
Flow is supercritical.		

CHK'D JRM 11-27-00

A.3 CHANNEL DESIGN CALCULATIONS

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1503
SUBJECT:	CHANNEL DESIGN		
BASED ON:	FINAL GRADING PLAN		DRAWING NUMBER:
BY: Date:	NJB 11/28/00	CHECKED BY: TAA Date: 3/28/01	APPROVED BY: Date:

Purpose:

Design channels and bench for White Oak OU2 Closure.

Given:

Use the 25-year, 24-hour precipitation as the design storm.

Method:

Haestad Quick TR-55 to determine peak discharge, Haestad FlowMaster using Manning's equation to determine channel depth and culvert flow.

References:

1 *Soil Survey of Montgomery County, MD*

2 *Urban Hydrology for Small Watersheds*, Soil Conservation Service, TR 55, June 1986

3 *Open Channel Hydraulics*, Chow

4 *Design Verification Report for Remedial Actions at Sites 2, 3, 4 and 9*, NSWC White Oak, June 1995

5 Worksheet 1, Plan view drawing, Closure Design

Summary of Results:

Channel	Shape	$z_1/z_2/b$	Qp (cfs)	Depth of Flow (ft)	Depth (ft) (ft)	Freeboard (ft)
North Channel	triangular	3/3/0	3	0.46	1.5	1.04
Bench	triangular	4/8/0	3	0.38	1.5	1.12
East Channel	trapezoid	3/3/2	5	0.45	1.5	1.05
West Channel	trapezoid	3/3/2	11.91	0.75	1.5	0.75

z_1 Horizontal to vertical component of channel side slope (right side)
z_2 Horizontal to vertical component of channel side slope (left side)
b Base width of channel
Qp Peak run-off flow

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1503
SUBJECT:	CHANNEL DESIGN		
BASED ON:	FINAL GRADING PLAN		DRAWING NUMBER:
BY: NJB Date: 11/28/00		CHECKED BY: TMS Date: 3/28/01	APPROVED BY: Date:

Calculations:

STEP 1: Break the landfill into watershed Sub areas - see plan view, Worksheet 1 (attached, page 6).

STEP 2: Determine Sub areas for bench and channel design (Worksheet 1, attached page 6)

North Channel: Use the flow from Sub area 2A to size channel along road
Bench: Use the flow from Sub area 1C to size bench
East Channel: Use the flow from Sub areas 2A, 2B, 2C, and 2D to size the channel to the east of the landfill.
West Channel: Use the flow from 12" RCP flowing full and Sub areas 1A, 1B, 1C, and 1D, to size the channel west of the landfill.

STEP 3: *Determine the curve number for each sub area.*

First determine Hydrologic Soil Group (HSG) A, B, C, or D.

In general, Group A is sandy, results in highest infiltration, lowest runoff; Group D is clayey, results in lowest infiltration, highest runoff.

From the Reference 1, most of Sties 1 & 2 are Soil 2C, Glenelg, which is Group B. The lower portion of Site 2 is 116E, Blockhouse, Group C/D.

Post development conditions will have offsite topsoil for uppermost 6 inches of cover. 18 inches of soil under topsoil will be purchased from off-site or possibly excavated from the area east of Site 2. Therefore, the surface soil of Site 2 under post-construction conditions, will have an HSG of B.

Second, determine the CN for each type of ground cover.

Road, bench and north channel will be gravel. CN = 85 (Table 2-2a, Ref 2, attached as page 24 of 32).
East & West Channels will be vegetated, maintained. CN = 58 (Table 2-2c, Ref 2, attached as page 25 of 32).
Landfill will be vegetated, maintained. CN = 58 (Table 2-2c, Ref 2, attached as page 25 of 32).

Third, input areas and associated CNs data into the Quick TR-55 model (TR-55) for each of the areas contributing to the four channels to generate a weighted CN value for each area. The weighted CN output from TR-55 is provided on pages 7 - 10 of 32 and are summarized below.

Areas Contributing to	Area (sf)	Weighted CN
North Channel:	40,950	63
Bench:	58,800	61
East Channel:	107,150	62
West Channel:	132,300	60

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1503
SUBJECT:	CHANNEL DESIGN		
BASED ON:	FINAL GRADING PLAN		DRAWING NUMBER:
BY: NJB Date: 11/28/00	CHECKED BY: TMJ Date: 3/28/01		APPROVED BY: Date:

STEP 4: Determine time of concentration (Tc).

The following information was entered into TR-55 to determine the Tc for each of the areas contributing to the four channels.

Manning's roughness coefficient (n) for sheet flow, for short grass prairie = 0.15 (Ref 2)(Table 3-1, Ref 2)

Manning's roughness coefficient (n) for channel flow, for excavated channels not maintained, weeds and brush uncut, interpolated between "dense weeds" and "clean bottom", use n = 0.065 (Table 5-6, Ref 3, attached)

Manning's roughness coefficient (n) for channel flow, for excavated channels gravel, use n = 0.025 (Ref 2)(Table 5-6, Ref 3, attached)

North channel: (Path 1)

Slope of sheet flow is (El 364 - El 354)/ 100 = 0.1
Slope of channel =(El 354 - El 330)/ 516 ft = 0.047
Assume a triangular channel. Determine area A and wetted perimeter P.

z =	3.0	
y =	1.0	
Area =	6.750	sf
Wetted Perimeter =	6.710	ft

Quick TR-55 Output for Tc = 0.10 hrs. (TR-55 output provided on page 11 of 32)

Bench: (Path 2)

Slope of upper sheet flow is (El 364 - El 362)/ 48 = 0.042
Slope of lower sheet flow is (El 362 - El 328.5)/ 132 = 0.25
Slope of bench =(El 328.5 - El 315)/ 408 ft = 0.033
Assume a triangular channel. Determine area A and wetted perimeter P.

z_1 =	4.0	
z_2 =	8.0	
y =	1.0	
Area =	13.500	sf
Wetted Perimeter =	18.270	ft

Quick TR-55 Output for Tc = 0.15 hrs. (TR-55 output provided on page 12 of 32)

East channel: (Path 3)

Slope of upper sheet flow is (El 364 - El 362)/ 48 = 0.042
Slope of lower sheet flow is (El 362 - El 328.5)/ 132 = 0.25
Slope of bench = (El. 328.5 - El. 315)/ 392 = 0.033
Slope of Trapezoidal Channel = (El. 315 - El 290)/ 120 = 0.208
Assume Trapezoidal Channel. Determine area A and wetted perimeter P.

z =	3.0	ft
b =	2.0	ft
y =	1.5	ft
Area =	9.75	sf
Wetted Perimeter =	11.487	ft

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1503
SUBJECT:	CHANNEL DESIGN		
BASED ON:	FINAL GRADING PLAN		DRAWING NUMBER:
BY: NJB Date: 11/28/00		CHECKED BY: TMD Date: 3/28/01	APPROVED BY: Date:

Quick TR-55 Output for Tc = 0.16 hrs. (TR-55 output provided on page 13 of 32)

West channel: (Path 4)

Use travel paths for Bench and add 70 ft of trapezoidal channel flow.
Slope of trapezoidal channel is (El 315 - El 310)/ 70 ft = 0.072
Use same channel characteristics as east channel.

Area = 9.75 sf
Wetted Perimeter = 11.487 ft

Quick TR-55 Output for Tc = 0.16 hrs. (TR-55 output provided on page 14 of 32)

STEP 5: Determine the peak run-off from each of the drainage areas.

To calculate the peak run-off values from the drainage areas, TR-55 uses the weighted CN, the calculated Tc, and the precipitation rates of the desired storm events. The storm events that peak run-off is calculated for is the 25-year 24-hour storm events (precipitation rate for this storm is provided on page 32 of 32).

The following table summarizes the run-off for each drainage area and storm event.

Drainage Area	25-year Storm Event
North Channel	3 cfs
Bench	3 cfs
East Channel	5 cfs
West Channel	6 cfs

TR-55 output provided on pages 15 - 18 of 32.

CLIENT:	EFAC NSWC - WHITE OAK		JOB NUMBER: 7427-1503
SUBJECT:	CHANNEL DESIGN		
BASED ON:	FINAL GRADING PLAN		DRAWING NUMBER:
BY: NJB Date: 11/28/00	CHECKED BY: TMH Date: 3/28/01		APPROVED BY: Date:

STEP 6: Determine the flow velocity and flow depth for the assumed channel dimensions presented in Step 4 and determine if the required freeboard is provided.

The Haestad Methods FlowMaster modeling program was used to calculate the flow depth and velocity in the channels described in Step 4 of this calculation. For each of the channels, the following information was used as the input data.

FlowMaster Input Parameters	Units	Channels			
		North	Bench	East	West
Mannings "n"	--	0.025	0.025	0.065	0.065
Channel Slope	ft/ft	0.047	0.033	0.147	0.071
Left Side Slope	ft	3.00	4.00	3.00	3.00
Right Side Slope	ft	3.00	8.00	3.00	3.00
Bottom Width	ft	0.00	0.00	2.00	2.00
Flow Rate	cfs	3	3	5	11.91*

* Flow rate includes the flow calculated from TR-55 for the areas contributing to the western channel plus the maximum flow that the 12-inch RCP located at the northwest corner of the site is capable of handling. This flow is equal to 5.91 cfs (see page 23 of 32). The slope of the 12-inch RCP was calculated using the measured length from Ref. 1 and the surveyed invert data provide on pages 30 and 31 of 32.

The following table summarizes the output from FlowMaster and the desired height of freeboard.

Channel	Flow Depth (ft)	Flow Velocity (ft/s)	Freeboard (ft)	Channel Status
North channel	0.46	4.68	1.04	ok
Bench	0.38	3.51	0.62	ok
East channel	0.45	3.32	1.05	ok
West channel	0.75	3.71	0.75	ok

* Desired freeboard is 0.5 feet.

6/32

BASELINE A & B
STA. 0+00
N 500073.83
E 1317764.83

BASELINE B
STA. 9+00
N 500204.83
E 1318845.22

PROPERTY BOUNDARY (APPROXIMATE)

PRIVATE PROPERTY

BLDG. 109

BLDG. 111

BLDG. 112

BLDG. 113

12"RCP

TRAPEZOIDAL RIPRAP LINED CHANNEL (TYP.)

TRAPEZOIDAL GRASS LINED CHANNEL (TYP.)

SEE NOTE 2

WEST CHANNEL TERMINATION

GAS MONITORING POINT

NORTH CHANNEL TERMINATION

GAS LINE TO LOCATED BY REMEDIAL ACTION CONTRACTOR (RAC)

NORTHERN CHANNEL

FINAL COVER SYSTEM

GAS VENT

CAP DRAIN 4"ø PERFORATED PE PIPE (SEE NOTE 3)

BENCH DRAIN

4"ø PERFORATED PE PIPE

EAST CHANNEL TERMINATION

LIMIT OF REGRADED WASTE/FILL

BENCH TYP.

LIMIT OF DISTURBANCE

STREAM TERMINATION

36" CMP

BASELINE A
STA. 4+50
N 499527.91
E 1317816.73

1A 1B 1C 1D 2A 2B 2C 2D

FLOW PATH

2C DRAINAGE AREAS

LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

- LANDFILL GAS MONITORING POINT
- GAS VENTS
- LIMIT OF CAP
- LIMIT OF REGRADED WASTE
- EDGE OF CHANNEL
- WETLAND RESTORATION

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. WETLAND RESTORATION AREA TO BE SEEDED AS INDICATED ON C-3. ALL OTHER DISTURBED AREAS TO BE SEEDED WITH PERMANENT SEED MIX.

Tmd 3/28/01

SCALE IN FEET

CHECK GRAPHIC SCALE BEFORE USING

SYMBOL	DESCRIPTION	DATE	APPROVED
	RE-VISIONS		

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
FINAL GRADING PLAN

CODE ID. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
N62470-97-D-
SPEC. 21-97-5000
NAVFAC DRAWING NO.

SHEET 10 OF 16

C-8

00162D152

Quick TR-55 Ver.5.47 S/N:
Executed: 12:50:37 03-28-2001

7/32

3/28/01

White Oak OU2 Cap Design
North Channel by Road
Contributing area 2A

RUNOFF CURVE NUMBER DATA

::

Composite Area: North Channel

SURFACE DESCRIPTION	AREA (acres)	CN	
Gravel	0.17	85	
Topsoil/Meadow	0.77	58	
COMPOSITE AREA --->	0.94	62.9	(63)

::

Quick TR-55 Ver.5.47 S/N:
Executed: 12:51:04 03-28-2001

8/32

3/28/01

White Oak OU2 Cap Design
Bench
Contributing Area 1C

RUNOFF CURVE NUMBER DATA

Composite Area: Bench

SURFACE DESCRIPTION	AREA (acres)	CN	
Topsoil/meadow	1.20	58	
Gravel	0.15	85	
COMPOSITE AREA --->	1.35	61.0	(61)

TWA
3/28/01

Quick TR-55 Ver.5.47 S/N:
Executed: 12:53:16 03-28-2001

White Oak OU2 Cap Design
East Channel
Contributing Areas 2A, 2B, 2C, & 2D

RUNOFF CURVE NUMBER DATA

::

Composite Area: East Channel

SURFACE DESCRIPTION	AREA (acres)	CN	
Gravel	0.32	85	
Meadow	2.14	58	
COMPOSITE AREA --->	2.46	61.5	(62)

::

Quick TR-55 Ver.5.47 S/N:
Executed: 12:53:53 03-28-2001

FMH
3/28/01

White Oak OU2 Cap Design
West Channel
Contributing Areas 1A, 1B, 1C, & 1D

RUNOFF CURVE NUMBER DATA

::

Composite Area: West Channel

SURFACE DESCRIPTION	AREA (acres)	CN	
Gravel	0.23	85	
Topsoil/meadow	2.82	58	
COMPOSITE AREA --->	3.05	60.0	(60)

::

Quick TR-55 Ver.5.47 S/N:
Executed: 13:05:38 03-28-2001 WO-NORTH.TCT

11/32

TMM
3/28/01

White Oak OU2 Cap Design
North Channel by Road
Contributing Area 2A

Tc COMPUTATIONS FOR: North Channel

```
SHEET FLOW (Applicable to Tc only)
    Segment ID                                      Reach 1
    Surface description                          meadow
    Manning's roughness coeff., n                   0.1500
    Flow length, L (total < or = 300)     ft        100.0
    Two-yr 24-hr rainfall, P2             in        3.200
    Land slope, s                         ft/ft     0.1000
                     0.8
         .007 * (n*L)
    T =  --------------                   hrs        0.09          =  0.09
              0.5    0.4
           P2    *  s

SHALLOW CONCENTRATED FLOW
    Segment ID
    Surface (paved or unpaved)?
    Flow length, L                        ft          0.0
    Watercourse slope, s                  ft/ft     0.0000

                         0.5
    Avg.V =  Csf *  (s)                   ft/s      0.0000
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                      hrs        0.00          =  0.00


CHANNEL FLOW
    Segment ID                                      Reach 2
    Cross Sectional Flow Area, a          sq.ft      6.75
    Wetted perimeter, Pw                  ft         6.72
    Hydraulic radius, r = a/Pw            ft        1.005
    Channel slope, s                      ft/ft     0.0470
    Manning's roughness coeff., n                   0.0250

                     2/3     1/2
         1.49  *  r    *  s
    V =  --------------------             ft/s      %12.9658
                  n

    Flow length, L                        ft          516

    T = L / (3600*V)                      hrs        0.01          =  0.01

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                          TOTAL TIME (hrs)         0.10
```

```
Quick TR-55 Ver.5.47   S/N:
Executed: 13:18:55   03-28-2001     WO-BENCH.TCT
```

12/32

TMJ 3/28/01

```
                         White Oak OU2 Cap Design
                                  Bench
                          Contributing Area 1C


                   Tc COMPUTATIONS FOR: Bench

SHEET FLOW (Applicable to Tc only)
    Segment ID                                     Reach 1    Reach 2
    Surface description                        meadow         meadow
    Manning's roughness coeff., n                   0.1500     0.1500
    Flow length, L (total < or = 300)     ft        48.0      132.0
    Two-yr 24-hr rainfall, P2             in        3.200      3.200
    Land slope, s                      ft/ft       0.0420     0.2500
                        0.8
         .007 * (n*L)
    T =  --------------                hrs         0.07  +    0.07    =  0.14
            0.5    0.4
          P2    *  s

SHALLOW CONCENTRATED FLOW
    Segment ID
    Surface (paved or unpaved)?
    Flow length, L                        ft         0.0
    Watercourse slope, s               ft/ft      0.0000

                          0.5
    Avg.V =  Csf *   (s)                 ft/s     0.0000
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                     hrs        0.00                  =  0.00


CHANNEL FLOW
    Segment ID                                    Reach 3
    Cross Sectional Flow Area, a      sq.ft        13.50
    Wetted perimeter, Pw                 ft        18.27
    Hydraulic radius, r = a/Pw           ft        0.739
    Channel slope, s                  ft/ft       0.0330
    Manning's roughness coeff., n                 0.0250

                      2/3    1/2
         1.49  *  r    *  s
    V =  --------------------            ft/s     8.8491
                  n

    Flow length, L                       ft          408

    T = L / (3600*V)                     hrs        0.01                  =  0.01

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                             TOTAL TIME (hrs)              0.15
```

Quick TR-55 Ver.5.47 S/N:
Executed: 14:02:16 03-28-2001 WO-EAST.TCT

13/32

White Oak OU2 Cap Design
East Channel
Contributing Areas 2A, 2B, 2C, & 2D

3/28/01

Tc COMPUTATIONS FOR: East Channel

SHEET FLOW (Applicable to Tc only)

		Reach 1		Reach 2		
Segment ID						
Surface description		meadow		meadow		
Manning's roughness coeff., n		0.1500		0.1500		
Flow length, L (total < or = 300)	ft	48.0		132.0		
Two-yr 24-hr rainfall, P2	in	3.200		3.200		
Land slope, s	ft/ft	0.0420		0.2500		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.07	+	0.07	=	0.14

SHALLOW CONCENTRATED FLOW

Segment ID						
Surface (paved or unpaved)?						
Flow length, L	ft	0.0				
Watercourse slope, s	ft/ft	0.0000				
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000				
where: Unpaved Csf = 16.1345						
Paved Csf = 20.3282						
T = L / (3600*V)	hrs	0.00			=	0.00

CHANNEL FLOW

		Reach 3	Reach 4
Segment ID			
Cross Sectional Flow Area, a	sq.ft	13.50	9.75
Wetted perimeter, Pw	ft	18.27	11.49
Hydraulic radius, r = a/Pw	ft	0.739	0.849
Channel slope, s	ft/ft	0.0330	0.2080
Manning's roughness coeff., n		0.0250	0.0650
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	8.8491	9.3721
Flow length, L	ft	392	120
T = L / (3600*V)	hrs	0.01 + 0.00	= 0.02

::

TOTAL TIME (hrs) 0.16

White Oak OU2 Cap Design
West Channel
Contributing Areas 1A, 1B, 1C, & 1D

3/28/01

Tc COMPUTATIONS FOR: West Channel

SHEET FLOW (Applicable to Tc only)

		Reach 1		Reach 2		
Segment ID						
Surface description		meadow		meadow		
Manning's roughness coeff., n		0.1500		0.1500		
Flow length, L (total < or = 300)	ft	48.0		132.0		
Two-yr 24-hr rainfall, P2	in	3.200		3.200		
Land slope, s	ft/ft	0.0420		0.2500		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.07	+	0.07	=	0.14

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.00	= 0.00

CHANNEL FLOW

		Reach 3	Reach 4
Segment ID			
Cross Sectional Flow Area, a	sq.ft	13.50	9.75
Wetted perimeter, Pw	ft	18.27	11.49
Hydraulic radius, r = a/Pw	ft	0.739	0.849
Channel slope, s	ft/ft	0.0330	0.0720
Manning's roughness coeff., n		0.0250	0.0650
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	8.8491	5.5141
Flow length, L	ft	408	70
T = L / (3600*V)	hrs	0.01 + 0.00	= 0.02

::

TOTAL TIME (hrs) 0.16

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

15/32

Executed: 03-28-2001 14:14:36
Watershed file: --> WO-NORTH.MOP
Hydrograph file: --> WO-NORTH.HYD

TAH 3/28/01

White Oak OU2 Cap Design
North Channel by Road
Contributing Area 2A

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
North Channel	0.94	63.0	0.10	0.00	5.90	2.11	.2	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 0.94 acres or 0.00147 sq.mi
Peak discharge = 3 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
North Channel	0.10	0.00	**	**	No	--

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

16/32

Executed: 03-28-2001 14:15:07
Watershed file: --> WO-BENCH.MOP
Hydrograph file: --> WO-EB.HYD

3/28/01

White Oak OU2 Cap Design
Bench
Contributing Area 1C

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
Bench	1.35	61.0	0.20	0.00	5.90	1.94	.22	.30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 1.35 acres or 0.00211 sq.mi
Peak discharge = 3 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
Bench	0.15	0.00	0.20	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

17/32

Executed: 03-28-2001 14:15:28
Watershed file: --> WO-EAST .MOP
Hydrograph file: --> WO-EAST.HYD

3/28/01

White Oak OU2 Cap design
East Channel
Contributing Areas 2A, 2B, 2C, & 2D

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
East Channel	2.46	62.0	0.20	0.00	5.90	2.02	.21	.30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 2.46 acres or 0.00384 sq.mi
Peak discharge = 5 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
East Channel	0.16	0.00	0.20	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

18/32

Executed: 03-28-2001 14:15:47
Watershed file: --> WO-WEST .MOP
Hydrograph file: --> WO-WEST.HYD

White Oak OU2 Cap Design
West Channel
Contributing Areas 1A, 1B, 1C, & 1D

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
West Channel	3.05	60.0	0.20	0.00	5.90	1.86	.23	.30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 3.05 acres or 0.00477 sq.mi
Peak discharge = 6 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
West Channel	0.16	0.00	0.20	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

White Oak - North Channel
Worksheet for Triangular Channel

19/32

TMD
3/28/01

Project Description	
Project File	c:\fmw\whiteo~1.fm2
Worksheet	North Channel
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.047000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	3.00	ft^3/s

Results		
Depth	0.46	ft
Flow Area	0.64	ft^2
Wetted Perimeter	2.92	ft
Top Width	2.77	ft
Critical Depth	0.57	ft
Critical Slope	0.014813	ft/ft
Velocity	4.68	ft/s
Velocity Head	0.34	ft
Specific Energy	0.80	ft
Froude Number	1.72	
Flow is supercritical.		

White Oak - Bench
Worksheet for Triangular Channel

20/32

TWS
3/28/01

Project Description	
Project File	c:\fmw\whiteo~1.fm2
Worksheet	Bench
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.033000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	8.00	H : V
Discharge	3.00	ft^3/s

Results		
Depth	0.38	ft
Flow Area	0.85	ft^2
Wetted Perimeter	4.60	ft
Top Width	4.53	ft
Critical Depth	0.43	ft
Critical Slope	0.015460	ft/ft
Velocity	3.51	ft/s
Velocity Head	0.19	ft
Specific Energy	0.57	ft
Froude Number	1.43	
Flow is supercritical.		

White Oak - East Channel
Worksheet for Trapezoidal Channel

21/32
FMW
3/28/01

Project Description	
Project File	c:\fmw\whiteo~1.fm2
Worksheet	East Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.100000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	2.00	ft
Discharge	5.00	ft^3/s

Results		
Depth	0.45	ft
Flow Area	1.51	ft^2
Wetted Perimeter	4.85	ft
Top Width	4.70	ft
Critical Depth	0.46	ft
Critical Slope	0.093257	ft/ft
Velocity	3.32	ft/s
Velocity Head	0.17	ft
Specific Energy	0.62	ft
Froude Number	1.03	
Flow is supercritical.		

White Oak - West Channel
Worksheet for Trapezoidal Channel

22/32

3/28/01

Project Description	
Project File	c:\fmw\whiteo~1.fm2
Worksheet	West Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.071000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	2.00	ft
Discharge	11.91	ft^3/s

Results		
Depth	0.75	ft
Flow Area	3.21	ft^2
Wetted Perimeter	6.77	ft
Top Width	6.52	ft
Critical Depth	0.73	ft
Critical Slope	0.082676	ft/ft
Velocity	3.71	ft/s
Velocity Head	0.21	ft
Specific Energy	0.97	ft
Froude Number	0.93	
Flow is subcritical.		

23/32
3/28/01

White Oak - 12 inch RCP
Worksheet for Circular Channel

Project Description	
Project File	c:\fmw\whiteo~1.fm2
Worksheet	12 inch RCP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.023800	ft/ft
Depth	0.95	ft
Diameter	1.00	ft

Results		
Discharge	5.91	ft^3/s
Flow Area	0.77	ft^2
Wetted Perimeter	2.69	ft
Top Width	0.44	ft
Critical Depth	0.95	ft
Percent Full	95.00	%
Critical Slope	0.023829	ft/ft
Velocity	7.66	ft/s
Velocity Head	0.91	ft
Specific Energy	1.86	ft
Froude Number	1.02	
Maximum Discharge	5.91	ft^3/s
Full Flow Capacity	5.50	ft^3/s
Full Flow Slope	0.027479	ft/ft
Flow is supercritical.		

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	[illegible]
Gravel (including right-of-way)		76	85	89	
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1]Average runoff condition, and $I_a = 0.2S$.
[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to o space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2] *Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3] *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be compute from the CN's for woods and pasture.

[6] *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow stea uniform flow, (2) constant intensity of rainfall exce (that part of a rain available for runoff), (3) rainfal duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figu 3-1, in which average velocity is a function of watercourse slope and type of channel. For s s less than 0.005 ft/ft, use equations given in appen F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always f directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, u equation 3-1 to estimate travel time for the shallo concentrated flow segment.

Open channels

Open channels are assumed to begin where survey cross section information has been obtained, where channels are visible on aerial photographs, or whe blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheet Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determin for bank-full elevation.

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT *n*
(**Boldface** figures are values generally recommended in design)

Type of channel and description	Minimum	Normal	Maximum
A. CLOSED CONDUITS FLOWING PARTLY FULL			
A-1. Metal			
a. Brass, smooth	0.009	**0.010**	0.013
b. Steel			
1. Lockbar and welded	0.010	0.012	0.014
2. Riveted and spiral	0.013	0.016	0.017
c. Cast iron			
1. Coated	0.010	0.013	0.014
2. Uncoated	0.011	0.014	0.016
d. Wrought iron			
1. Black	0.012	0.014	0.015
2. Galvanized	0.013	0.016	0.017
e. Corrugated metal			
1. Subdrain	0.017	0.019	0.021
2. Storm drain	0.021	**0.024**	0.030
A-2. Nonmetal			
a. Lucite	0.008	0.009	0.010
b. Glass	0.009	**0.010**	0.013
c. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
d. Concrete			
1. Culvert, straight and free of debris	0.010	0.011	0.013
2. Culvert with bends, connections, and some debris	0.011	**0.013**	0.014
3. Finished	0.011	0.012	0.014
4. Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
5. Unfinished, steel form	0.012	0.013	0.014
6. Unfinished, smooth wood form	0.012	**0.014**	0.016
7. Unfinished, rough wood form	0.015	0.017	0.020
e. Wood			
1. Stave	0.010	0.012	0.014
2. Laminated, treated	0.015	0.017	0.020
f. Clay			
1. Common drainage tile	0.011	**0.013**	0.017
2. Vitrified sewer	0.011	0.014	0.017
3. Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
4. Vitrified subdrain with open joint	0.014	0.016	0.018
g. Brickwork			
1. Glazed	0.011	0.013	0.015
2. Lined with cement mortar	0.012	0.015	0.017
h. Sanitary sewers coated with sewage slimes, with bends and connections	0.012	0.013	0.016
i. Paved invert, sewer, smooth bottom	0.016	0.019	0.020
j. Rubble masonry, cemented	0.018	0.025	0.030

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT *n* (*continued*)

Type of channel and description	Minimum	Normal	Maximum
B. LINED OR BUILT-UP CHANNELS			
B-1. Metal			
a. Smooth steel surface			
1. Unpainted	0.011	**0.012**	0.014
2. Painted	0.012	0.013	0.017
b. Corrugated	0.021	0.025	0.030
B-2. Nonmetal			
a. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
b. Wood			
1. Planed, untreated	0.010	0.012	0.014
2. Planed, creosoted	0.011	0.012	0.015
3. Unplaned	0.011	0.013	0.015
4. Plank with battens	0.012	0.015	0.018
5. Lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. Trowel finish	0.011	**0.013**	0.015
2. Float finish	0.013	0.015	0.016
3. Finished, with gravel on bottom	0.015	0.017	0.020
4. Unfinished	0.014	0.017	0.020
5. Gunite, good section	0.016	0.019	0.023
6. Gunite, wavy section	0.018	0.022	0.025
7. On good excavated rock	0.017	0.020	
8. On irregular excavated rock	0.022	0.027	
d. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
5. Dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone in mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. Glazed	0.011	**0.013**	0.015
2. In cement mortar	0.012	**0.015**	0.018
g. Masonry			
1. Cemented rubble	0.017	0.025	0.030
2. Dry rubble	0.023	0.032	0.035
h. Dressed ashlar	0.013	0.015	0.017
i. Asphalt			
1. Smooth	0.013	0.013	
2. Rough	0.016	0.016	
j. Vegetal lining	0.030	.....	0.500

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
. EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	**0.022**	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140
). NATURAL STREAMS			
D-1. Minor streams (top width at flood stage <100 ft)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	**0.030**	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Dense willows, summer, straight	0.110	0.150	0.200
2. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.100	0.120	0.160
D-3. Major streams (top width at flood stage >100 ft). The n value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	.....	0.060
b. Irregular and rough section	0.035	.....	0.100

slopes. The *drop* is similar to a chute, but the change in elevation is effected in a short distance. The *culvert* flowing partly full is a covered channel of comparatively short length installed to drain water through highway and railroad embankments. The *open-flow tunnel* is a comparatively long covered channel used to carry water through a hill or any obstruction on the ground.

2-2. Channel Geometry. A channel built with unvarying cross section and constant bottom slope is called a *prismatic channel.* Otherwise, the channel is *nonprismatic;* an example is a trough spillway having variable width and curved alignment. Unless specifically indicated, the channels described in this book are prismatic.

The term *channel section* used in this book refers to the cross section of a channel taken normal to the direction of the flow. A *vertical channel section,* however, is the vertical section passing through the lowest or bottom point of the channel section. For horizontal channels, therefore, the channel section is always a vertical channel section.

Natural channel sections are in general very irregular, usually varying from an approximate parabola to an approximate trapezoid. For streams subject to frequent floods, the channel may consist of a main channel section carrying normal discharges and one or more side channel sections for accommodating overflows.

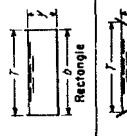
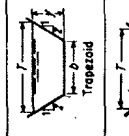
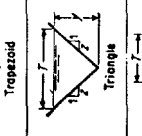
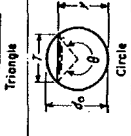
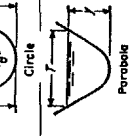
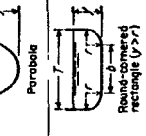
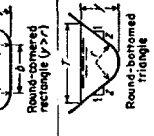
Artificial channels are usually designed with sections of regular geometric shapes. Table 2-1 lists seven geometric shapes that are in common use. The trapezoid is the commonest shape for channels with unlined earth banks, for it provides side slopes for stability. The rectangle and triangle are special cases of the trapezoid. Since the rectangle has vertical sides, it is commonly used for channels built of stable materials, such as lined masonry, rocks, metal, or timber. The triangular section is used only for small ditches, roadside gutters, and laboratory works. The circle is the popular section for sewers and culverts of small and medium sizes. The parabola[1] is used as an approximation of sections of small and medium-size natural channels. The round-cornered rectangle is a modification of the rectangle. The round-bottom triangle is an approximation of the parabola; it is a form usually created by excavation with shovels.

Closed geometric sections other than the circle are frequently used in sewerage, particularly for sewers large enough for a man to enter. These sections are given various names according to their form; they may be

[1] The side slope $z:1$ of a parabolic section at the intersection of the sides with the free surface can be computed easily by the simple formula $z = T/4y$.

Russian engineers [1] also use semielliptical and parabolic sections of higher order: $y = ax^p$ with $p = 3$ or 4. The constant a is computed from the side slope assumed at the free surface.

TABLE 2-1. GEOMETRIC ELEMENTS OF CHANNEL SECTIONS

Section	Area A	Wetted perimeter P	Hydraulic radius R	Top width T	Hydraulic depth D	Section factor Z
 Rectangle	by	$b + 2y$	$\frac{by}{b + 2y}$	b	y	$by^{1.5}$
 Trapezoid	$(b + zy)y$	$b + 2y\sqrt{1 + z^2}$	$\frac{(b + zy)y}{b + 2y\sqrt{1 + z^2}}$	$b + 2zy$	$\frac{(b + zy)y}{b + 2zy}$	$\frac{[(b + zy)y]^{1.5}}{\sqrt{b + 2zy}}$
 Triangle	zy^2	$2y\sqrt{1 + z^2}$	$\frac{zy}{2\sqrt{1 + z^2}}$	$2zy$	$\frac{1}{2}y$	$\frac{\sqrt{2}}{2}zy^{2.5}$
 Circle	$\frac{1}{8}(\theta - \sin\theta)d_o^2$	$\frac{1}{2}\theta d_o$	$\frac{1}{4}\left(1 - \frac{\sin\theta}{\theta}\right)d_o$	$(\sin\frac{1}{2}\theta)d_o$ or $2\sqrt{y(d_o - y)}$	$\frac{1}{8}\left(\frac{\theta - \sin\theta}{\sin\frac{1}{2}\theta}\right)d_o$	$\frac{\sqrt{2}}{32}\frac{(\theta - \sin\theta)^{1.5}}{(\sin\frac{1}{2}\theta)^{0.5}}d_o^{2.5}$
 Parabola	$\frac{2}{3}Ty$	$T + \frac{8}{3}\frac{y^2}{T}$ *	$\frac{2T^2y}{3T^2 + 8y^2}$ *	$\frac{3}{2}\frac{A}{y}$	$\frac{2}{3}y$	$\frac{2}{3}\sqrt{6}\,Ty^{1.5}$
 Round-cornered rectangle ($y > r$)	$\left(\frac{\pi}{2} - 2\right)r^2 + (b + 2r)y$	$(\pi - 2)r + b + 2y$	$\frac{(\pi/2 - 2)r^2 + (b + 2r)y}{(\pi - 2)r + b + 2y}$	$b + 2r$	$\frac{(\pi/2 - 2)r^2}{b + 2r} + y$	$\frac{[(\pi/2 - 2)r^2 + (b + 2r)y]^{1.5}}{\sqrt{b + 2r}}$
 Round-bottomed triangle	$\frac{T^2}{4z} - \frac{r^2}{z}(1 - z\cot^{-1}z)$	$\frac{T}{z}\sqrt{1 + z^2} - \frac{2r}{z}(1 - z\cot^{-1}z)$	$\frac{A}{P}$	$2[z(y - r) + r\sqrt{1 + z^2}]$	$\frac{A}{T}$	$A\sqrt{\frac{A}{T}}$

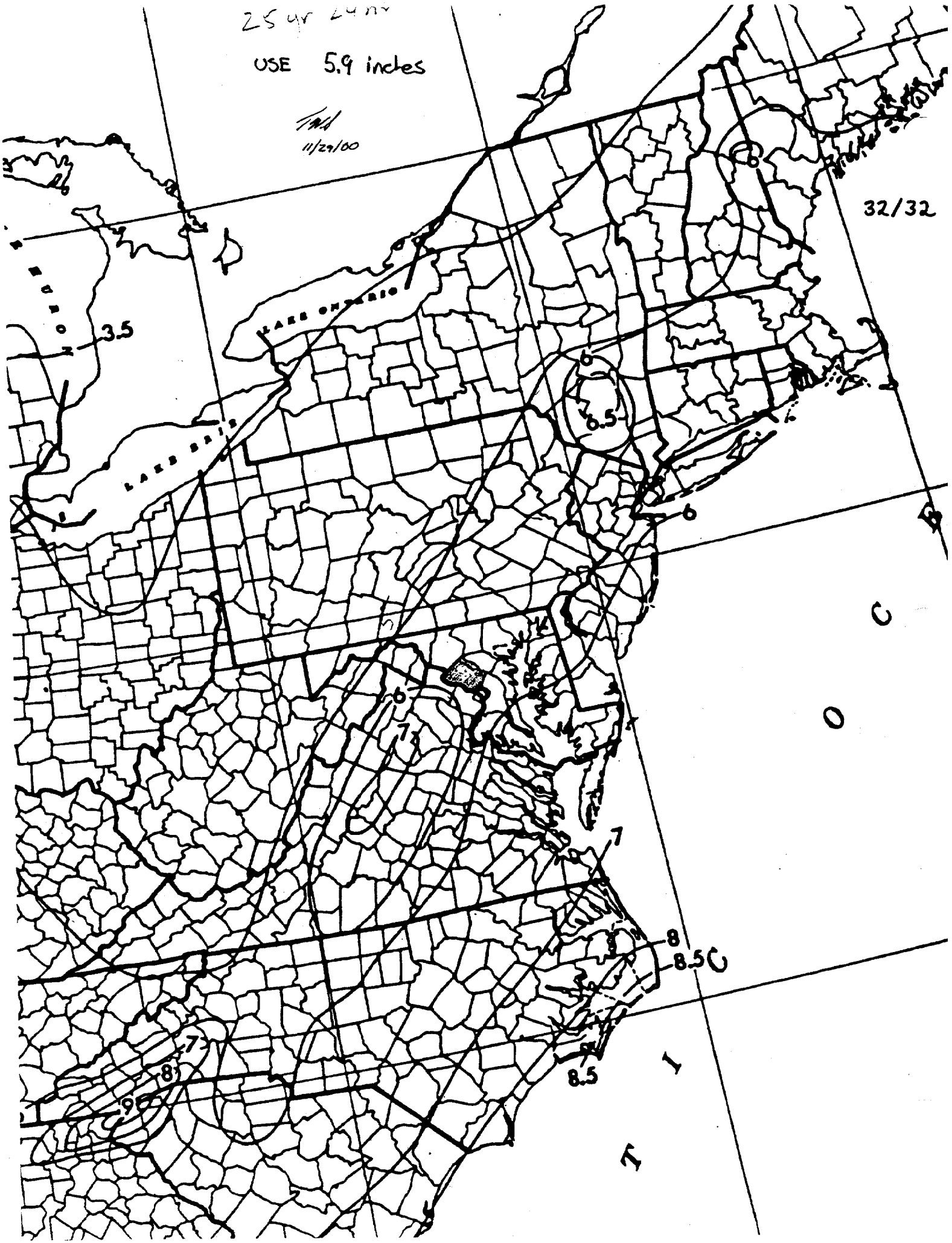
* Satisfactory approximation for the interval $0 < z \leq 1$, where $z = 4y/T$. When $z > 1$, use the exact expression $P = (T/2)[\sqrt{1 + z^2} + 1/z \ln(z + \sqrt{1 + z^2})]$.

30

294	500,089.267	1,317,902.978	ELEV 339.24	CLF
295	500,083.625	1,317,903.240	ELEV 339.75	BRKE
	500,081.049	1,317,903.361	ELEV 340.53	CONC
297	500,073.216	1,317,904.529	ELEV 340.59	CONC
298	500,067.265	1,317,904.716	ELEV 340.62	CONC
299	500,065.972	1,317,888.879	ELEV 339.24	CCPC
300	500,062.480	1,317,882.010	ELEV 338.70	CCOC
301	500,056.086	1,317,880.157	ELEV 338.41	CCOC
302	500,052.418	1,317,882.260	ELEV 339.93	ZPT
303	500,047.699	1,317,886.449	ELEV 338.26	ZCOT
304	500,047.348	1,317,886.729	ELEV 338.25	CCOT
305	500,028.995	1,317,901.741	ELEV 337.90	CCFL
306	500,027.652	1,317,902.815	ELEV 337.79	CLFL
307	500,026.514	1,317,903.569	ELEV 337.84	FLUM
308	500,033.477	1,317,908.043	ELEV 336.71	FLUM
309	500,032.351	1,317,908.408	ELEV 336.53	CLFL
310	500,031.351	1,317,909.543	ELEV 337.01	FLUM
311	500,036.376	1,317,915.930	ELEV 335.28	FLUM
312	500,037.310	1,317,915.703	ELEV 334.92	CLFL
313	500,038.301	1,317,915.157	ELEV 335.09	FLUM
314	500,034.217	1,317,923.404	ELEV 334.90	SD13
315	500,038.858	1,317,922.218	ELEV 334.68	CL
316	500,038.216	1,317,918.885	ELEV 336.09	F
317	500,040.405	1,317,927.724	ELEV 335.25	TOE
318	500,047.918	1,317,949.418	ELEV 340.40	ONSL
319	500,059.453	1,317,944.841	ELEV 344.11	WL
320	500,059.194	1,317,943.363	ELEV 343.94	TOP
321	500,053.230	1,317,935.726	ELEV 339.50	ONSL
322	500,061.301	1,317,914.449	ELEV 340.53	TOP
323	500,064.933	1,317,900.078	ELEV 339.72	TOP
324	500,058.158	1,317,895.885	ELEV 339.89	TOP
325	500,056.821	1,317,897.540	ELEV 338.90	2C11
326	500,057.136	1,317,899.000	ELEV 338.21	SD14
327	500,051.225	1,317,896.179	ELEV 339.25	ZUP
328	500,057.787	1,317,859.387	ELEV 338.90	ZLIN
329	500,037.980	1,317,898.648	ELEV 338.35	TOPE
330	500,039.056	1,317,904.626	ELEV 338.36	TOP
331	500,041.382	1,317,911.274	ELEV 337.78	TOP
332	500,046.729	1,317,901.140	ELEV 338.82	TOP
333	500,050.976	1,317,905.412	ELEV 335.40	TOE
334	500,052.673	1,317,907.435	ELEV 334.61	CL
335	500,053.391	1,317,908.926	ELEV 334.76	TOE
336	500,060.191	1,317,900.379	ELEV 334.87	INV
337	500,062.933	1,317,902.026	ELEV 337.91	~~2C12~~
338	500,026.488	1,317,903.707	ELEV 339.26	ZBLD
339	500,024.120	1,317,906.411	ELEV 338.30	TOPE
340	500,029.126	1,317,912.601	ELEV 337.89	TOP
341	500,003.116	1,317,922.824	ELEV 339.20	ZBLD

31

344	500,079.853	1,317,886.122	ELEV 339.07	CONC
345	500,084.265	1,317,885.181	ELEV 337.23	BRK
346	500,086.754	1,317,884.293	ELEV 337.68	CLF
347	500,088.294	1,317,896.291	ELEV 337.82	HDWL
348	500,078.868	1,317,874.242	ELEV 338.36	CONC
349	500,082.770	1,317,873.703	ELEV 337.48	BRK
350	500,084.861	1,317,872.524	ELEV 337.72	CLF
351	500,081.341	1,317,850.769	ELEV 334.90	ZHWL
352	500,085.854	1,317,876.988	ELEV 335.82	ZINV
353	500,045.904	1,317,904.633	ELEV 338.05	WL
354	500,013.140	1,317,923.026	ELEV 338.16	SPUR
355	500,003.709	1,317,922.698	ELEV 338.17	GRND
356	500,003.633	1,317,922.807	ELEV 338.85	TOPE
357	500,003.310	1,317,922.995	ELEV 338.85	TOPE
358	500,003.221	1,317,923.089	ELEV 338.50	BOT
359	500,001.703	1,317,924.394	ELEV 338.54	BOT
360	500,001.555	1,317,924.434	ELEV 338.89	TOP
361	500,001.301	1,317,924.648	ELEV 338.89	TOP
362	500,001.151	1,317,924.794	ELEV 338.58	PVMT
363	500,005.475	1,317,929.959	ELEV 338.10	EPE
364	500,007.096	1,317,931.660	ELEV 338.41	TOPE
365	500,007.371	1,317,931.461	ELEV 338.40	TOPE
366	500,007.439	1,317,931.378	ELEV 338.03	BOTE
367	500,008.243	1,317,931.232	ELEV 335.90	GRND
368	500,009.012	1,317,930.171	ELEV 338.06	BOTE
369	500,009.120	1,317,930.150	ELEV 338.33	TOPE
370	500,009.381	1,317,929.951	ELEV 338.32	TOPE
371	500,009.529	1,317,929.679	ELEV 337.00	GRND
372	500,009.267	1,317,928.440	ELEV 337.36	TOPE
373	500,013.861	1,317,934.120	ELEV 334.34	TOE
374	500,017.291	1,317,941.031	ELEV 334.25	CL
375	500,020.871	1,317,946.056	ELEV 334.41	TOE
376	500,029.061	1,317,968.218	ELEV 339.97	ONSL
377	500,032.730	1,317,984.712	ELEV 345.42	ONSL
378	500,024.929	1,317,980.720	ELEV 342.16	SO23
379	500,014.920	1,317,965.249	ELEV 337.12	SO24
380	500,008.715	1,317,954.679	ELEV 334.17	2C13
381	500,005.968	1,317,946.980	ELEV 334.06	SD12
382	500,002.371	1,317,942.497	ELEV 334.23	2C10
383	500,006.105	1,317,932.035	ELEV 337.15	TOPE
384	499,979.075	1,317,986.220	ELEV 337.27	SPUR
385	499,980.192	1,317,935.593	ELEV 337.41	EPOC
386	499,980.888	1,317,939.348	ELEV 336.55	TOP
387	499,970.527	1,317,942.727	ELEV 335.90	SD17
388	499,977.979	1,317,950.965	ELEV 330.88	SRO
389	499,978.288	1,317,952.479	ELEV 330.24	CL
390	499,978.586	1,317,953.508	ELEV 330.47	SRO
391	499,982.201	1,317,977.761	ELEV 335.40	ONSL


25 yr 24 hr
USE 5.9 inches
11/29/00
32/32
LAKE ONTARIO
LAKE ERIE
3.5
6
6.5
6
14
6
7
7
8
8.5
8.5
7
8
9

A.4 SILT FENCE/SUPER SILT FENCE DESIGN

CLIENT: White Oak		JOB NUMBER: 7427-1403	
SUBJECT: Silt Fence Design			
BASED ON: Maryland E&S Standards and Specs.		DRAWING NUMBER:	
BY: T.W.S. Date: 11/27/00	CHECKED BY: Date: 11-27-00	APPROVED BY:	DATE:

OBJECTIVE:

To properly locate and determine the type of silt fence to intercept and detain small amounts of sediment from disturbed areas during earth disturbance activities at Sites 1 and 2, and provide protection for the existing drainage channels south and west of Site 2 to which the sites drain.

APPROACH:

1) Locate and determine the type of silt and or super silt fence required according to Part 15.0 and 26.0, Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994.

CALCULATIONS:

According to Section E, Part 15.0 (silt fence) and Section H, Part 26.0 (super silt fence) of the Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994, no formal design is required for silt and super silt fencing. However, the following is a list of suggestions for installation:

Silt Fence (Standards and Specifications provided on page 3 of 4)

1) Silt fence is limited to intercepting sheet flow runoff from limited distances according to slope. Silt fence provides filtering and velocity dissipation to promote gravity settling of sediments.
2) Fence posts shall be a minimum of 36-inches long driven 16-inches minimum into the ground. Wood posts shall be 1 1/2-inch square cut or 1 3/4-inch diameter and shall be of sound quality hardwood. Steel posts shall be standard T or U section weighting not less than 1.00 pounds per linear foot.
3) Where ends of geotextile fabric come together, they shall be overlapped, folded and stapled to prevent sediment bypass.
4) Silt fence shall be inspected after each rainfall event and maintained when bulges occur or when sediment accumulation reaches 50% of the fabric height.

Super Silt Fence (Standards and Specifications provided on page 4 of 4)

1) Super silt fence can be placed as close to the contour as possible.
2) Fencing shall be 42-inches in height and constructed in accordance with the latest Maryland State Highway (SHA) details for chain link fencing. The SHA specification for a 6-foot fence shall be used, substituting 42-inch fabric and 6-foot length posts.
3) Filter cloth shall be fastened securely to chain link fence with ties spaced every 24-inches at the top, and mid section. Additionally, filter cloth must be embedded a minimum of 8-inches into the ground.
4) Maximum slope length behind the barrier is unlimited for slopes less than or equal to 10%. Refer to chart provided on page 3 of 3 for slope lengths at different slopes.

CLIENT: White Oak		JOB NUMBER: 7427-1403	
SUBJECT: Silt Fence Design			
BASED ON: Maryland E&S Standards and Specs.		DRAWING NUMBER:	
BY: T.W.S. Date: 11/27/00	CHECKED BY: JAM Date: 12-27-00	APPROVED BY:	DATE:

Actual Conditions (Conditions prior to re-grading)

Type of Fence	Length of Fence (ft)	Max. Approaching Slope (ft/ft)	Max. Approaching Slope Length (ft)
Silt Fence	140	0.294	60
Super Silt Fence	1440	0.343	30

CONCLUSIONS

Silt fencing and super silt fencing shall be utilized at Sites 1 and 2 to intercept and detain sediment from upgradient disturbed areas. The silt fence and the super silt fence shall be placed in the locations shown on Design Drawing C-2 of the Basis of Design Report.

REFERENCES

1) Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994.

15.0 STANDARDS AND SPECIFICATIONS

FOR

SILT FENCE

Definition

Temporary barriers of woven geotextile fabric used to intercept, reduce velocity and filter surface runoff from disturbed areas.

Purpose

Silt fences filter sediment from runoff so that deposition of transported sediment can occur. Silt fences can be used to intercept sheet flow only. They cannot be used as velocity checks in ditches or swales, or placed where they will intercept concentrated flow.

Conditions Where Practice Applies

Silt fence is limited to intercepting sheet flow runoff from limited distances according to slope. Silt fence provides filtering and velocity dissipation to promote gravity settling of sediments.

Design Criteria

1. Silt fence should be used with caution in areas of rocky soils that may prevent trenching.

2. Silt fence should be placed on or parallel to contours.

3. The length of silt fences must conform to the following:

Table 17 Silt Fence Design Constraints

Slope Steepness	(Maximum) Slope Length	(Maximum) Silt Fence Length
Flatter than 50:1 (2%)	unlimited	unlimited
50:1 to 10:1 (2 - 10%)	125 feet	1,000 feet
10:1 to 5:1 (10 - 20%)	100 feet	750 feet
5:1 to 3:1 (20 - 33%)	60 feet	500 feet
3:1 to 2:1 (33 - 50%)	40 feet	250 feet
> 2:1 (> 50%)	20 feet	125 feet

4. In areas of less than 2% slope and sandy soils (USDA general classification system, soil class A) maximum slope length and silt fence length will be unlimited. In these areas a silt fence may be the only perimeter control required.

5. Downslope from the silt fence should be undisturbed ground.

26.0 SUPER SILT FENCE

Definition

A temporary barrier of Geotextile Class F over chain link fence used to intercept sediment laden runoff from small drainage areas.

Purpose

To reduce runoff velocity and allow the deposition of transported sediment to occur. Limits imposed by ultraviolet light stability of the fabric will dictate the maximum period that the silt fence may be used.

1. Super silt fence provides a barrier that can collect and hold debris and soil, preventing the material from entering critical areas, streams, streets, etc.

2. Super silt fence can be used where the installation of a dike would destroy sensitive areas, woods, wetlands, etc.

3. Super silt fence should be placed as close to the contour as possible. No section of silt fence should exceed a grade of 5% for a distance of more than 50 feet.

Table 30 Design Criteria

Length of the flow contributing to Super Silt Fence shall conform to the following limitations:

Slope	Slope Steepness	Slope Length (maximum)	Silt Fence Length (maximum)
0 - 10%	0 - 10:1	Unlimited	Unlimited
10 - 20%	10:1 - 5:1	200 feet	1,500 feet
20 - 33%	5:1 - 3:1	100 feet	1,000 feet
33 - 50%	3:1 - 2:1	100 feet	500 feet
50% +	2:1 +	50 feet	250 feet

Where ends of the geotextile fabric come together, the ends shall be overlapped, folded, and stapled to prevent sediment bypass.

Stormwater Pollution Prevention Plan

for

Operable Unit 2 Closure Design Final Design Submission

Former Naval Surface Warfare Center White Oak Site

Silver Spring, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0273

June 2001

REVISION 0
JUNE 2001

STORMWATER POLLUTION PREVENTION PLAN FOR OPERABLE UNIT 2 CLOSURE DESIGN

FINAL DESIGN SUBMISSION

FORMER NAVAL SURFACE WARFARE CENTER
WHITE OAK
SILVER SPRING, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 181
Naval Facilities Engineering Command
1314 Harwood Street, SE
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0273

JUNE 2001

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APPENDIX
A USEPA CONSTRUCTION GENERAL PERMIT REQUIREMENTS PRECONSTRUCTION CHECK LIST

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ACRONYMS

ALC	Adelphi Laboratory Center
ARARs	applicable or relevant and appropriate requirements
BCT	BRAC Cleanup Team
BRAC	Base Realignment and Closure
CLEAN	Comprehensive Long-Term Environmental Action Navy
CTO	Contract Task Order
cy	cubic yards
ECM	erosion control matting
GCL	geosynthetic clay liner
GSA	General Services Administration
LLDPE	Linear Low Density Polyethylene
NPDES	National Pollutant Discharge Elimination System
NSWC – White Oak	Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak
OU2	Operable Unit 2
PCBs	polychlorinated biphenyls
RAC	Remedial Action Contractor
RALs	remedial action levels
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Officer in Charge of Construction
SCS	Soil Conservation Service
Site 1	Parking Lot Landfill
Site 2	Apple Orchard Landfill
TBC	to be considered
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance

1.0 INTRODUCTION

This Stormwater Pollution Prevention Plan was prepared under Contract Task Order (CTO) No. 0273 under Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Number N62472-90-D-1298. Under this CTO, Tetra Tech NUS, Inc. (TtNUS) is performing engineering, design and post-construction award services for the remedial action at the Parking Lot Landfill (Site 1) and the Apple Orchard Landfill (Site 2) at the former Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWC-White Oak), located in Silver Spring, Maryland. Because of their proximity to each other, similarity of contents, and time of operation, Sites 1 and 2 are now referred to as Operable Unit 2 (OU2). This plan was prepared in accordance with the United States Environmental Protection Agency (USEPA) Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practice, Summary Guidance, October 1992 (USEPA 1992).

NSWC-White Oak is located in both Montgomery and Prince George's Counties, Maryland, approximately 5 miles north of Washington, D.C., off New Hampshire Avenue (see Figure 1-1). NSWC-White Oak encompasses approximately 712 acres. In the fall of 1997, 662 acres were transferred to the General Services Administration (GSA). The remaining area in the southeastern portion of the facility was transferred to the U.S. Army in February 1998. NSWC-White Oak is bordered by the Adelphi Laboratory Center (ALC) along with a mixture of residential, park, industrial, and commercial properties. The facility lies in gently rolling terrain, and the drainage patterns are dominated by Paint Branch and its tributaries (see Figure 1-2). This remedial design is limited to Sites 1 and 2.

1.1 SITE HISTORY

1.1.1 Site 1 (Parking Lot Landfill)

The Parking Lot Landfill was used as an open disposal site and landfill between 1948 and 1953. The site is located east of Building 101A and is adjacent to Site 2. The wastes reportedly disposed within this landfill include lubricating oil, battery acid, metal plating wastes, and metal scrap. It has been reported that approximately 60 automobile batteries were disposed at the site over its operating life. When the site was deactivated in 1953, it was paved with asphalt. The site is currently used as a parking lot; however, visible wastes from the landfill including tires, glass, and old metal equipment have been observed on the southern and eastern slopes beyond the edge of the parking lot. The landfill covers approximately 1 acre and contains approximately 8,300 cubic yards (cy) of waste (TtNUS 2000).

1.1.2 Site 2 (Apple Orchard Landfill)

The Apple Orchard Landfill is an abandoned landfill located on the south side of Perimeter Road in the northwestern end of the former NSWC-White Oak property. The landfill forms a small, level hill with a peak elevation of approximately 340 feet mean sea level. The landfill slopes steeply to an unnamed stream along its southern edge and a drainage swale along its western perimeter. The unnamed stream flows eastward towards Paint Branch. The drainage swale conveys stormwater flow from adjacent properties and joins the unnamed stream in the southwestern corner of the site.

The Apple Orchard Landfill reportedly operated as an open disposal area and landfill from 1948 until 1982. The landfill is a single unit that is composed of several disposal areas. In addition to domestic refuse, wastes reportedly disposed at the site included oils containing polychlorinated biphenyls (PCBs), solvents, paint residue, acids and miscellaneous compounds. An estimated 500 gallons of PCB-contaminated oils were deposited at the site prior to 1970. It has been estimated that the landfill contains 75,000 cy of waste/fill (TtNUS, 2001).

1.2 PROJECT DESCRIPTION

The remedial action will include the excavation of approximately 8,300 cy of waste material from Site 1 for consolidation with Site 2 landfill material. Following consolidation an engineered cap will be constructed on the regraded OU2 waste. Additional activities include the removal of impacted sediments from the unnamed stream south of OU2 and the restoration of that stream. These actions were selected to minimize the release into the environment of contamination from the waste materials of both landfills.

The goal of the White Oak Base Realignment and Closure (BRAC) Cleanup Team (BCT) is to begin remedial actions at the NSWC-White Oak facility as quickly as possible to protect human health and the environment and to comply with applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) criteria.

1.3 REPORT OBJECTIVE AND CONTENT

The objective of this report is to describe the project and present the stormwater pollution prevention measures that will be utilized during implementation of the remedial action at OU2.

Section 2.0 presents a description of control measures to be implemented during the remedial action and the sequence of proposed construction activities. Section 3.0 presents a generalized summary of state and local requirements for stormwater management. Section 4.0 presents the inspection and maintenance program proposed for the remedial action. Section 5.0 presents a summary of non-

stormwater discharges and pollution prevention measures to be employed during the remedial action. Sections 6.0 and 7.0 present the required plan certifications. Copies of the USEPA checklists for Stormwater Pollution Prevention Plans are presented in Appendix A. Design drawings and technical specifications are provided under separate cover.

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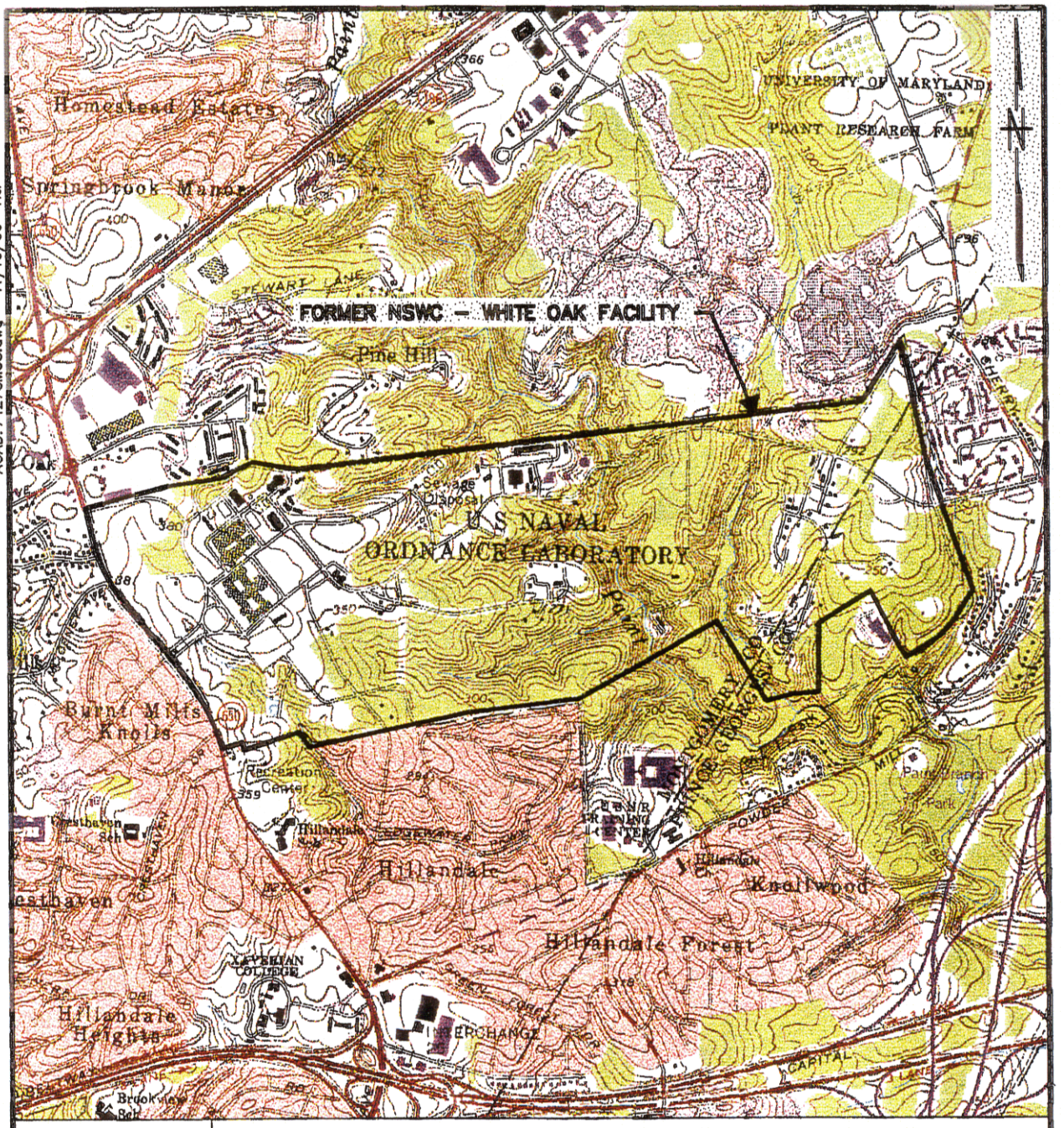

QUADRANGLE LOCATION

0 2000 4000
SCALE IN FEET

SOURCE: U.S.G.S QUADRANGLE MAP, BELTSVILLE, MD. PHOTOREVISED 1979.

DRAWN BY HJP DATE 4/4/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7427	OWNER NO. 0273
CHECKED BY DATE	SITE VICINITY MAP OPERABLE UNIT 2 FORMER NSWC – WHITE OAK SILVER SPRING, MARYLAND	APPROVED BY SN	DATE 12/13/00
COST/SCHED–AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 1–1	REV. 0

FORM CADD NO. T4NUS_AV.DWG – REV 0 – 1/22/98

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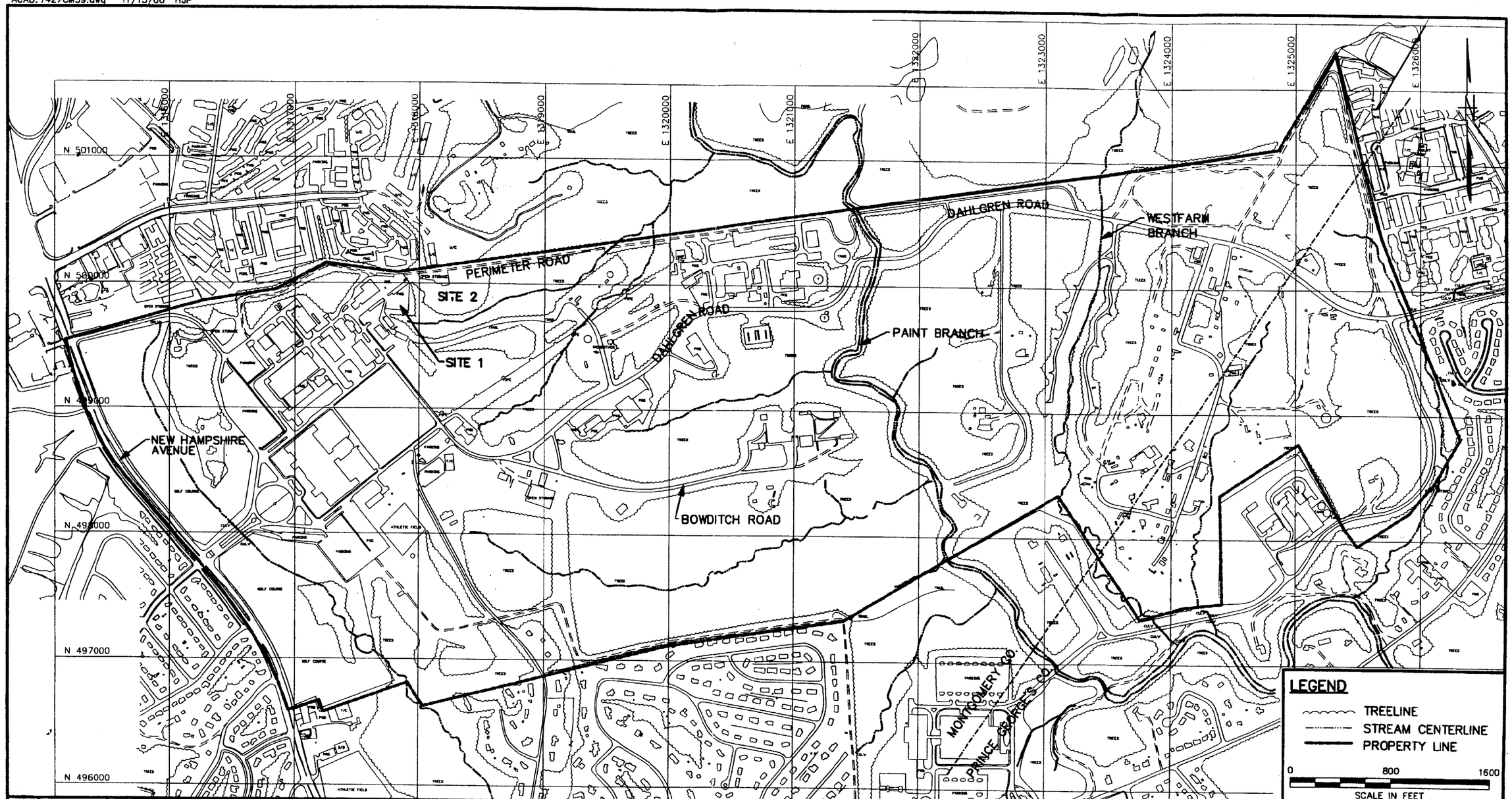

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 11/13/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LOCATION MAP
OPERABLE UNIT 2
FORMER NSWC-WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 273
APPROVED BY SN
DATE 12/13/00
APPROVED BY
DATE
DRAWING NO. FIGURE 1-2
REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

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2.0 DESCRIPTION OF CONTROLS

This section presents a description of stormwater controls, including erosion and sedimentation controls proposed for the remedial action. A copy of the completed USEPA pre-construction checklist is provided in Appendix A. The Construction/Implementation and Final Stabilization/Termination Checklists are also provided in Appendix A. These checklists were obtained from the USEPA Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practice, Summary Guidance, October 1992. Requirements specified in these checklists and documents are incorporated into this Stormwater Pollution Prevention Plan.

2.1 EXISTING SITE CONDITIONS

OU2 consists of Site 1 and Site 2 which are inactive/abandoned landfills located in the northwestern portion of the former NSWC-White Oak (Figure 2-1). The total area of OU2 is approximately 5.3 acres. Access to the site from the entrance of NSWC-White Oak is via Nahan Road, Erickson Road, Fulton Road, and Perimeter Road.

2.1.1 Site 1 (Parking Lot Landfill)

The Parking Lot Landfill is a slightly sloping paved area that covers approximately 1 acre and contains approximately 8,300 cy of waste material. Runoff from the paved area is directed toward the southeastern corner and is collected in the unnamed stream which is a tributary to Paint Branch located east of the site. The eastern and southern faces of the landfill, outside the boundaries of the paved area, are both steeply sloped into drainage swale and unnamed stream. A concrete trench is located along the northern edge of the paved area adjacent to Building 111. The trench appears to have been used to capture runoff from inside Building 111. A decontamination pad is located southwest of the site. It has been used during environmental restoration work at various sites at former NSWC-White Oak. The decontamination pad was constructed with a tap water spigot and a drain that directs the wash water to a secondary containment vault (TtNUS 2000)

2.1.2 Site 2 (Apple Orchard Landfill)

The landfill covers approximately 4.3 acres and contains an estimated 75,000 cy of waste. The majority of the landfill was constructed on a plateau adjacent to Perimeter Road. Surface drainage at Site 2 flows south and southeast to the unnamed stream and west to the drainage swale. The landfill cover supports old field vegetation with successional hardwood forest on the short but very steep side slopes. The steep slopes range in height from a few feet (along the eastern and western perimeter) to approximately 35 feet along the southern perimeter. The slopes are moderately eroded and exposed waste and fill material are

evident throughout. The cover is abutted to the south and west by mixed deciduous forest, to the east by Virginia pine forest, and to the north by private lands supporting residential development and Virginia pine forest. Minor erosion is evident on the landfill surface, but the steep slopes along the southern perimeter expose waste and fill material resulting from erosion of the cover materials or lack of placement of initial cover materials. Recent site visits and sampling activities indicate the presence of ordnance shapes in the landfill (TtNUS 2001).

2.2 EROSION AND SEDIMENT CONTROL MEASURES

Erosion and sediment control measures will be implemented, installed, and maintained according to the Maryland Standards and Specifications for Soil Erosion and Sediment Control (Maryland 1994) unless otherwise noted in this plan or the construction documents. Design specifications for erosion and sediment control structures have been obtained from the Maryland Standards and Specifications for Soil Erosion and Sediment Control.

The total area of Disturbance is estimated to be 8.4 acres. The required erosion and sediment control measures are shown on Design Drawing C-2 and are as follows.

- The stabilized stone construction entrance(s) point will be provided off of Perimeter Road and will be protected with silt fence.

- The southern boundary of OU2 along the unnamed stream will be protected using super silt fence (silt fence supported by wire fence). Supersilt fence will also be provided along both sides of the drainage swale located between Sites 1 and 2.

- Silt fence will be placed to protect the construction entrance structures and the stockpile pad.

- Drainage channels will be constructed along the northern, western and eastern perimeters of the landfill cap to convey run-off from the landfill cap and surrounding areas to the unnamed stream located south of the OU2. In addition, a bench will be constructed on the landfill cap to increase cap stability and to provide a break in the drainage areas associated with the landfill cap. The east and west channels will be protected by erosion control matting, and during construction, rock check dams or approved other will also be utilized to reduce sedimentation. The bench and northern channels will be rock lined.

- Riprap will be placed at critical locations within the drainage channels constructed along the east and western sides of the constructed landfill cap. The location of riprap placement is identified in Design Drawing C-8.

- Permanent, channel, and temporary seeding will be used throughout the construction process to stabilize disturbed areas and channels.

- A temporary access culvert will be placed across the drainage swale located between Site 1 and 2 to provide a means of transporting the excavated material from Site 1 to the proposed stockpile located with in Site 2.

- Straw bales will be placed across the unnamed stream during sediment removal and stream restoration.

2.2.1 Structural Practices

The following structural practices will be used during and/or following construction activities at OU2 to control erosion and sedimentation. The number listed, if any, references the Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994.

Stone Construction Entrance - F17.0. Temporary stone construction entrance(s) will be installed to provide access to OU2 via Perimeter Road. Construction vehicles will be cleaned before exiting the site.

Super Silt Fence - H26.0. Super silt fence will be installed along the southern slopes of OU2 and along both sides of the drainage swale located between Sites 1 and 2.

Stormwater Conveyance Channel – H28.0. Permanent drainage channels will be installed along the northern, eastern, and western boundaries of the constructed landfill cap to divert runoff away from the cap edge. Additionally, a bench will be constructed within the limits of the landfill cap to increase the stability of the landfill and to break the flow length of runoff generated in the drainage areas of the landfill cap.

Surface Roughening - NA. The surface of regraded areas will be roughened to reduce run-off velocity and to aid in the establishment of vegetative cover.

Temporary Seeding - G20.0. All regraded areas that will be left dormant for extended periods of time will be seeded with fast germinating temporary vegetation immediately following grading. Seeding will be performed with a 50/50 mixture of annual rye grass and cereal (winter) rye.

Permanent Seeding - G20.0. All regraded areas will be permanently seeded with a seed mixture that will minimize erosion and provide suitable cover for wildlife.

Mulching - G20.0. All areas receiving permanent seeding will be mulched with an organic material to prevent erosion by protecting the soil surface from raindrop impact and reducing the velocity of the overland flow.

Rock Check Dams – B8.0. Rock check dams will be temporary control devices constructed in the permanent channels to trap sediment and reduce flow rates in the channels. Rock check dams will be removed following final stabilization (establishment of permanent vegetation) of all disturbed areas.

Temporary Access Culvert – H29.10. A temporary access culvert will be constructed within the drainage swale located between Sites 1 and 2 to provide a construction road between the two sites for the movement of waste/fill material. The access culvert will remain in place until the permanent channel is constructed around the western side of the landfill cap.

Straw Bales - H25.0. Straw bales will be placed across the unnamed stream during the restoration of the unnamed stream. The straw bales, or approved other, will remain in place until the restoration is complete and the stream is stabilized.

2.2.2 Management Strategies

1. Unstabilized, disturbed areas will be minimized and construction activities will be staged.

2. Seeding or other stabilization measures will follow immediately after grading.

3. Areas that are not to be disturbed will be clearly marked by flags, signs, etc.

4. The construction superintendent will be responsible for ensuring the installation and maintenance of all erosion and sediment control practices.

5. Erosion and sediment control structures will be installed and/or constructed before the start of any earth disturbance activities.

6. Erosion and sediment control structures will remain in place until permanent vegetation is established over disturbed surfaces, as described in the revegetation notes on Design Drawing C-4.

2.3 SEQUENCE OF CONSTRUCTION

The time to perform the required construction activities is estimated to be approximately 240 days. The generalized sequence of construction activities is:

1. Hold pre-construction meeting with the Contracting Officer.

2. Inspect site prior to construction to verify existing site conditions and underground utility locations.

3. Establish horizontal and vertical control for construction. Stake the location of all areas to be excavated or disturbed prior to actual work.

4. Install all perimeter controls, stabilized stone construction entrance as indicated on Drawing C-2, and additional stabilized stone construction entrance(s) if approved by the Resident Officer in Charge of Construction (ROICC) prior to any earth disturbance activities. All perimeter controls shall conform to Standards and Specifications identified in the 1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control Manual unless otherwise specified. The perimeter controls to be installed include, but not limited to, the following:

- silt fence on downhill sides of all stockpile locations and construction entrance(2);

- super silt fence along the northern side of the unnamed stream located south of OU2, and along both sides of drainage swale located between Sites 1 and 2;

- temporary stream crossing within drainage swale located between Sites 1 and 2 (see Drawing C-2) to provide a transportation route between Sites 1 and 2;

- additional controls as may be required by the Contracting Officer and/or warranted by site conditions and best construction practices.

5. Clear and grub construction laydown, material storage and staging area(s), material handling pad, and decontamination pad if necessary.

6. Construct decontamination pad, materials handling pad, construction laydown, and storage and staging areas if necessary.

7. Breakup concrete slabs within the limits of OU2 and relocate as necessary.

8. Clear but do not grub within limits of OU2. Clear and grub within remainder of limits of disturbance.

9. Excavate waste/fill material within OU2 west of the drainage swale for placement within proposed limits of waste. During excavation, breakup concrete filled shapes designated by unexploded ordnance (UXO) oversight personnel as not containing ordnance for general distribution within the proposed limits of waste. In the event that suspect hazardous materials are identified during excavation and consolidation of OU2 waste/fill, the suspect hazardous materials are to be segregated and characterized for proper off-site disposal. If through characterization sampling of suspect hazardous waste, the materials are determined to be non-hazardous, material will be consolidated within the proposed limits of waste.

10. Perform verification sampling following excavation of all waste/fill material outside the proposed limit of waste. If verification sampling test results indicate contaminants are either completely removed or at levels below the remedial action levels (RALs), excavation of waste/fill material is complete. In the event that verification sampling test results indicate that exposed soils contain contaminants above RALs continue excavation and conduct additional verification sampling. Continue process until contaminants are removed or RALs are met.

11. Following excavation of material outside of proposed limits of waste, establish perimeter channels and begin re-grading waste/fill within proposed limits of waste. During re-grading breakup concrete filled shapes designated by UXO oversight personnel for general distribution within landfill limits.

12. Establish Erosion and Sedimentation controls in the unnamed stream as indicated on Drawing C-2. Excavate impacted sediments from unnamed stream and place within proposed limits of waste. Excavation of sediments in the unnamed stream shall proceed upstream to downstream. Stabilize disturbed areas in the unnamed stream by planting wetland plants and installing temporary Erosion Control Matting (ECM).

13. Perform UXO screening to a depth of 4-feet below final grade. Grade waste/fill material to 6-inches below interim grade (see Drawing C-6), followed by placement of 6-inches of subgrade soil to establish interim grade (see Drawing C-7). During regrading extend and protect identified monitoring wells.

14. Prepare the sub-grade soil by compacting and fine grading to create a smooth firm surface. Remove material that is considered objectionable for the placement of geosynthetic clay liner (GCL), including but not limited to sharp-edged materials and protrusions extending more than ½ inch. Regrade and compact as necessary.

15. Install cap materials including GCL, Geomembrane, geocomposite drainage material, trenches, drainage piping, and gas vents. Cover GCL immediately with geomembrane. Place only as much GCL as can be covered at the end of the day with geomembrane or temporary water proof tarp.

16. Install cover and topsoil materials and vegetate immediately after topsoil is placed.

17. Plant permanent vegetation on all disturbed areas.

18. Install signs along the site perimeter.

19. Remove all temporary facilities (i.e. decontamination pad, material handling pads, etc.). Restore and revegetate as needed. When all upstream areas have been stabilized and have been accepted by the Contracting Officer, remove all remaining perimeter controls.

2.4 PERMANENT STABILIZATION

All areas disturbed by remedial action activities with the exception of the unnamed stream will be stabilized with permanent seeding as soon as possible following final grading, but no later than 7 to 14 days (as noted on the Design Drawings). Permanent seeding mixture will consist of native warm season grasses which will, over the long term, result in lower maintenance costs and more beneficial natural habitat. The mix will include big bluestem (*Andropogon gerrardi*) little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*), indian grass (*Sorghastrum nutans*), canada wild rye (*Elymus canadensis*), partridge pea (*Cassia fasciculata*), and annual rye grass (*Lolium multiflorum*). The rye grass and partridge pea will germinate and become established quickly to provide the necessary erosion control until the warm season grasses can become established. This seed mixture was provided by the Biological Technical Assistance Group through USEPA correspondence dated February 14, 2001.

The channel seed mix will consist of indigenous and natural grass species recognized for their effectiveness in stabilizing exposed soils. The grass species include a mixture of cool-season and warm-season grasses. The cool-season grasses germinate quickly and establish rapidly to provide effective short-term soil stabilization. The warm-season grasses are generally of greater wildlife value but germinate and grow more slowly than cool-season grasses. In addition, the warm-season grasses tend to grow better in poor quality soils and under drought conditions. The seed mix includes redtop (*Agrostis alba*), barnyard grass (*Echinochloa crusgalli*), switchgrass (*Panicun virgatum*), deertongue grass (*Dichanthelium chandestium*), and a seasonal nurse crop. The application rate is identified on Design Drawing C-3 and is identified as the "Channel Seed Mixture".

2.5 STORMWATER RUNOFF CONSIDERATIONS

Following completion of the remedial action, the site will be returned to grassed or natural existing conditions. Therefore, aside from the northern, eastern, and re-aligned western channels, permanent stormwater management controls are not required for this site.

Runoff calculations were performed using QuickTR-55™ (Haestad Methods, Inc.). The software utilizes procedures outlined in the Soil Conservation Service (SCS) TR-55 manual. Pre-development runoff calculations, and post-development runoff calculations along with channel capacity calculations are provided in Appendix A of the Erosion and Sediment Control Plan Report.

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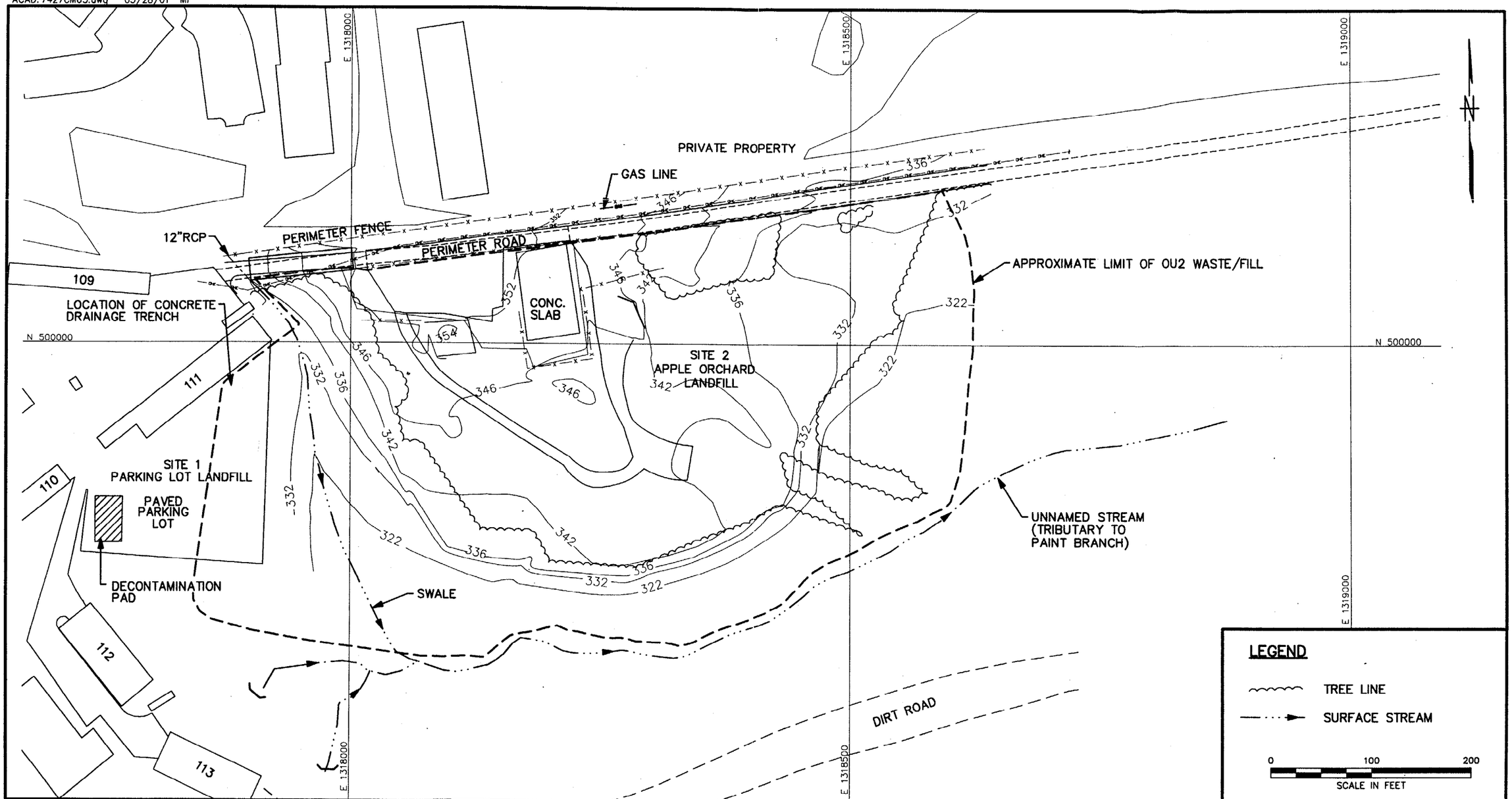

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/14/00
CHECKED BY TMM DATE 3/29/01
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LAYOUT MAP
OPERABLE UNIT 2
FORMER NSWC – WHITE OAK
SILVER SPRING, MARYLAND

CONTRACT NO. 7427
OWNER NO. 0273
APPROVED BY SN DATE 3/29/01
APPROVED BY DATE
DRAWING NO. FIGURE 2–1 REV. 0

FORM CADD NO. T+NUS_BH.DGN – REV 0 – 1/20/98

3.0 STATE AND LOCAL REQUIREMENTS

This plan was prepared in accordance with the USEPA Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practice, Summary Guidance, October 1992, and, in part, the Maryland Stormwater Design Manual Volumes I and II.

According to Maryland Environmental Regulations, erosion and sediment control oversight shall be performed by a certified responsible person.

4.0 INSPECTION AND MAINTENANCE PROCEDURES

In general, all erosion and sediment control measures will be checked weekly and after each significant rainfall event to assure that all erosion and sediment controls remain in effective operating conditions. Any required repairs will be made immediately. The following items will be checked:

- The stabilized stone construction entrances will be maintained in a condition that will minimize tracking sediment onto roads, including the addition of stone or other repairs.

- The super silt fence will be checked regularly for undermining or deterioration of the fabric. Sediment will be removed when the level of sediment deposition causes "bulging" or reaches half of the fabric height.

- The silt fence will be checked regularly for undermining or deterioration of the fabric. Sediment will be removed when the level of sediment deposition causes "bulging" or reaches half of the fabric height.

- Rock check dams will be checked for sediment accumulation. Sediment will be removed when it reaches one half of the original height of the check dam. Regular inspections will be made to ensure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam will be corrected immediately.

- Straw bales will be checked for sediment accumulation. Sediment will be removed when it reaches one half the bale height. Straw bales will be replaced if required.

- During the establishment of the channels, repairs will be made immediately and grass re-established. After grass has been established, the channels will be checked periodically to determine if the grass and associated erosion control matting is withstanding flow velocities without damage.

- The seeded areas will be checked regularly to ensure that a good stand of vegetation is maintained. Areas shall be fertilized and re-seeded as needed. The RAC is responsible for maintenance until formal acceptance by the Contracting Officer.

- The hazardous materials storage area and hazardous materials containers will be inspected regularly for leakage. Any leakage will be addressed immediately.

5.0 NON-STORMWATER DISCHARGES AND POLLUTION PREVENTION

This section presents a description of non-stormwater discharges and pollution prevention measures that will be employed during the proposed remedial action.

5.1 NON-STORMWATER DISCHARGES

It not anticipated that non-stormwater discharges will be required during construction activities. All decontamination water will be collected in a specifically designed, lined decontamination pad area, the collected decontamination water will be characterized and transported to an appropriate off-site treatment facility. All sediment will be removed from the wastewater prior to treatment.

5.2 POLLUTION PREVENTION MEASURES

The following is a list of materials or substances that are anticipated to be stored onsite during the proposed remedial action.

- Detergents for decontamination efforts.
- Diesel fuel and other vehicle maintenance substances.
- Fertilizer as soil amendment to promote vegetative growth.
- Small quantities of laboratory chemicals, paints and other flammable substances.

Detergents and small containers or drums of oil, grease, antifreeze, hydraulic fluids, etc., if any, will be stored within an enclosed, lined, and diked area, along with any diesel fuel stored in tanks. The storage area will be bermed and lined with a 60 mil polyethylene geomembrane. It will be designed to contain at least 10 percent of the total contents of all materials stored in the area plus an allowance for precipitation. A small sump or low point will be designed to serve as a monitoring point for any leaks or spills from the containers. Inspection of the area and management of substances collected in this area were addressed previously in Section 4.0.

Small quantities of laboratory chemicals, paints and other flammable substances may be stored onsite during the remedial action. These materials, when not in use, will be stored in a flammable storage cabinet located in the decontamination trailer. Practices that will be followed to reduce risks associated with these materials include:

- Products will be kept in original containers unless they are not resealable.
- Original labels and material safety data sheets will be retained.

- If surplus product must be disposed, manufacturers' or local and state recommended methods for proper disposal will be followed.

The following paragraphs describe specific spill prevention and material management practices that will be employed during the proposed remedial action.

Good Housekeeping

The following are the material management practices that will be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff.

- An effort will be made to store only enough product required to accomplish the task.
- All materials stored onsite will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, all of a product will be used before disposing of the container.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The assigned individuals will inspect areas daily to ensure proper use and disposal of materials onsite.

Spill Control Practices

In addition to the good housekeeping and material management practices discussed above, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies.

- Materials and equipment necessary for spill cleanup will be kept in the material storage area onsite. Equipment and materials will include but not be limited to brooms, dust pans, mops, rags, gloves, goggles, absorbent material and plastic and metal containers specifically for this purpose.

- All spills will be cleaned up immediately after discovery.

- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.

- Spills of toxic or hazardous material will be reported to the appropriate state or local government agency, if deemed necessary, in accordance with state and local ordinances.

- This Stormwater Pollution Prevention Plan will be modified to include measures to prevent this type of spill from reoccurring and how to clean up the spill if there is a recurrence. A description of the spill, what caused it, and the cleanup measures will also be included.

- The on-site construction superintendent responsible for the day-to-day site operations, will be the spill prevention and cleanup coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage areas and in the decontamination and office trailers located on-site.

6.0 POLLUTION PREVENTION PLAN CERTIFICATION

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

Signed:_____

Date:_____

7.0 CONTRACTOR'S CERTIFICATION

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit, if any, that authorizes the stormwater discharges associated with construction activity at the site identified as part of this certification.

Signature	For	Responsible for
_____ Contractor Date:_____	Company Name and Address	Contractor
_____ Contractor Date:_____	Company Name and Address	Contractor
_____ Subcontractor Date:_____	Company Name and Address	Subcontractor

REFERENCES

Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994, Maryland Department of the Environment, Water Management Administration.

TtNUS (Tetra Tech NUS, Inc.) 2000. Final Engineering/Cost Analysis (EE/CA) for Site 1 at the Former Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, March.

TtNUS 2001. Corrective Measures Study for Operable Unit 2 at the Former Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity Chesapeake, Naval Facilities Engineering Command, March.

USEPA, September 1992, Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005).

USEPA, October 1992, Storm Water Management for Construction Activities Summary Guidance for Developing Pollution Prevention Plans and Best Management Practice.

APPENDIX A

USEPA CONSTRUCTION GENERAL PERMIT REQUIREMENTS PRECONSTRUCTION CHECKLIST

USEPA CONSTRUCTION GENERAL PERMIT REQUIREMENTS PRECONSTRUCTION CHECKLIST

Storm Water Pollution Prevention Plans

1. A site description, including:

   ☒ The nature of the activity.

   Refer to Section 1.2 of the Storm Water Pollution Prevention Plan.

   ☒ Intended sequence of major construction activities.

   Refer to Section 2.3 of the Storm Water Pollution Prevention Plan.

   ☒ The total area of the site.

   Refer to Section 2.1 of the Storm Water Pollution Prevention Plan.

   ☒ The area of the site that is expected to undergo excavation.

   Refer to Section 2.2 of the Storm Water Pollution Prevention Plan.

   ☒ The runoff coefficient of the site after construction is complete.

   Refer to the Post-Development Runoff Calculation provided in Appendix A of the Erosion and Sediment Control Plan Report.

   ☒ Existing soil or storm water data.

   Refer to the Pre-Development Runoff Calculation provided in Appendix A of the Erosion and Sediment Control Plan Report.

A site map with:

   ☒ Drainage patterns.

   Refer to the Pre-Development Runoff Calculation and the Post-Development Runoff Calculations provided in Appendix A of the Erosion and Sediment Control Plan Report.

   ☒ Approximate slopes after major grading.

   Refer to Design Drawing C-8 of the Basis of Design Report.

   ☒ Area of soil disturbance.

   Refer to Design Drawing C-2 of Basis of Design Report.

   ☒ Outline of areas which will not be disturbed.

   Refer to Design Drawing C-2 of the Basis of Design Report.

   ☒ Location of major structural and non-structural controls.

   Refer to Design Drawing C-2 of the Basis of Design Report.

☒ Areas where stabilization practices are expected to occur.

Refer to Design Drawing C-2 of the Basis of Design Report.

☒ Surface waters.

Refer to Figures 2-1 and Section 2.2 of the Stormwater Pollution Prevention Plan.

☒ Storm water discharge locations.

Refer to Figure 2-1 and Section 2.2 of the Stormwater Pollution Prevention Plan.

☒ The name of the receiving water(s).

Refer to Figure 2.1 of the Stormwater Pollution Prevention Plan.

2. A description of controls:

2.1 Erosion and sediment controls, including:

☒ Stabilization practices for all areas disturbed by construction.

Refer to Section 2.2, Section 2.2.1, and Section 2.4 of the Stormwater Pollution Prevention Plan.

☒ Structural practices for all drainage/discharge locations.

Refer to Section 2.2 and Section 2.2.1 of the Stormwater Pollution Prevention Plan.

2.2 Storm water management controls, including:

☒ Measures used to control pollutants occurring in stormwater discharges after construction activities are complete.

Refer to Section 2.2 and 2.4 of the Stormwater Pollution Prevention Plan.

☒ Velocity dissipation devices to provide nonerosive flow conditions from the discharge point along the length of any outfall channel.

Refer to Section 2.4 and Figure 2.1 of the Stormwater Pollution Prevention Plan.

2.3 Other controls including:

☒ Waste disposal practices which prevent discharge of solid materials to waters of the U.S.

Refer to Section 2.2.1 of the Stormwater Pollution Prevention Plan.

☒ Measures to minimize offsite tracking of sediments by construction vehicles.

Refer to Section 2.2.1 of the Stormwater Pollution Prevention Plan.

☒ Measures to ensure compliance with State or local waste disposal, sanitary sewer, or septic system regulations.

N/A.

2.4 ☒ Description of the timing during the construction when measures will be implemented.

Refer to Section 2.3 of the Stormwater Pollution Prevention Plan.

3. ☒ State or local requirements incorporated into the plans.

Refer to Sections 2.0, 2.2.1 and 3.0 of the Stormwater Pollution Prevention Plan.

4. ☒ Inspection and maintenance procedures for control measures identified in the plan.

Refer to Section 4.0 of the Stormwater Pollution Prevention Plan.

5. ☒ Identification of allowable non-stormwater discharges and pollution prevention measures.

Refer to Section 5 of the Stormwater Pollution Prevention Plan.

6. ☒ Contractor certification.

Refer to Section 7 of the Stormwater Pollution Prevention Plan.

7. ☒ Plan certification.

Refer to Section 6 of the Stormwater Pollution Prevention Plan.

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY - CHESAPEAKE
NAVAL FACILITIES ENGINEERING COMMAND
BUILDING 212, WASHINGTON NAVY YARD
WASHINGTON, D.C. 20374

SPECIFICATION NO:
21-97-5000-0069

CONTRACT NO:
N62470-97-D-5000-0069

OPERABLE UNIT 2

at the

FORMER NAVAL SURFACE WARFARE CENTER, WHITE OAK

SILVER SPRING, MARYLAND

DESIGN BY:

TETRA TECH NUS, INC.
600 CLARK AVENUE, SUITE 3
KING OF PRUSSIA, PENNSYLVANIA 19406-1433

SPECIFICATION PREPARED BY:

Architectural:

N/A

Structural:

N/A

Electrical:

N/A

Mechanical:

N/A

Submitted by:

Scott A. Nett

JUNE 2001

SPECIFICATION APPROVED BY: _____ DATE: _____

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SECTION 01115

GENERAL PARAGRAPHS (REMEDIAL ACTION CONTRACTS)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926-SUBPART V	Power Transmission and Distribution

CORPS OF ENGINEERS (COE)

COE EP 1110-1-8	(1997) Construction Equipment Ownership and Operating Expense Schedule
COE EM-385-1-1	(1996) Safety and Health Requirements Manual

FEDERAL STANDARDS (FED-STD)

FED-STD-595	(Rev. B) Colors Used in Government Procurement

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 241	(1996) Safeguarding Construction, Alteration, and Demolition Operations

1.2 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0, of the Basic Contract.

SD-01 Preconstruction Submittals

Work Plan; G

SD-11 Closeout Submittals

As-Built records; G

Environmental Conditions Report; G

Status reports; G

QC meeting minutes; G

Test Results Summary Report; G

Contractor Production Report; G

QC Report; G

Rework Items List; G

Stormwater Pollution Prevention Plan; G

Notice of Intent; G

Notice of Termination; G

Contractor's Closeout Report; G

1.3 WORK PLAN

Submit a Work Plan consisting of the following elements:

a. Narrative: Provide a brief description of the project objectives, scheduling, sampling and analysis requirements, decontamination procedures, wastewater treatment plan (water resulting from decontamination, excavated waste dewatering), removal and excavation procedures, and storage, transportation, and treatment requirements; and a detailed sequence of events for the construction.

b. Technical Specifications: Provide, in an amendment format, any additional specifications and any modifications to the contract specifications required to accurately describe the materials and work procedures envisioned to satisfy the requirements of the delivery order. Contact Code 0425, Structural/Civil Branch, EFA Chesapeake, (202) 685-3137, POC Allen Wilson, for availability of guide specification sections for those sections required, but not included in the contract documents.

c. Shop drawings: Shop drawings shall detail and describe components of the project not currently indicated on the contract drawings such that the shop drawings and the contract drawings, when taken together, provide a complete representation of the project requirements. Shop drawings shall be prepared and sealed by a registered professional engineer. Shop drawings shall include:

(1) Erosion Control Plan in accordance with State and local regulations.

d. Environmental Protection Plan: At the preconstruction conference, meet with the Resident Officer in Charge of Construction's (ROICC's) Navy Technical Representative (ROICC NTR) to discuss environmental protection requirements for the project. Prepare and submit an Environmental Protection Plan in accordance with Section C, Part 4.0, of the Basic Contract, and as specified herein.

(1) Hazardous materials (HM) to be brought onto the center: A list of hazardous materials planned for use on the center shall be provide to the environmental office. The Contractor shall submit

a list (including quantities) of HM to be brought to the center and copies of the corresponding material safety data sheets (MSDS). This list shall also be submitted to the ROICC NTR. At project completion, any hazardous material brought onto the center shall be removed from the site by the Contractor. The Contractor shall account for the quantity of HM brought to the center, the quantity used or expended during the job, and the leftover quantity which (1) may have additional useful life as a HM and shall be removed by the Contractor, or (2) may be a hazardous waste, which shall then be removed as specified herein.

(2) Hazardous waste (HW) generated: The Environmental Protection Plan shall list and quantify any HW to be generated during the project.

(3) Storage of hazardous waste: In accordance with center regulations, hazardous waste shall be stored near the point of generation up to a total quantity of one quart of acutely hazardous waste or 55 gallons of hazardous waste. Any volume exceeding these quantities shall be removed from the center within 3 days. Prior to generation of HW, contact the ROICC NTR for labeling requirements for storage of hazardous wastes.

(4) Minimization of hazardous waste: The Contractor should substitute materials as necessary to reduce the generation of HW and include a statement to that effect in the Environmental Protection Plan.

(5) Environmental conditions likely to be encountered during this project: Contact the ROICC NTR for conditions in the area of the project which may be subject to special environmental procedures. Include this information in the Preconstruction Survey. Describe in the Environmental Protection Plan any permits required prior to working the area, and contingency plans in case an unexpected environmental condition is discovered.

(6) Permitting plans for any transportation and disposal, excavation, or construction of hazardous waste that will require an environmental permit from an issuing agency: The Contractor is responsible for generating the permits and delivering the completed documents to the ROICC NTR. The ROICC NTR will review the permits and the Contractor shall file the documents with the appropriate agency and complete disposal with the approval of the ROICC NTR. Correspondence with the State concerning the environmental permits and completed permits shall be delivered to the ROICC NTR.

(7) Environmental Protection Plan format

ENVIRONMENTAL PROTECTION PLAN

Contracting Organization
Address and Phone Numbers

1. Hazardous materials to be brought onto the center
2. MSDS package
3. Employee training documentation
4. HW storage plan
5. HW to be generated

ENVIRONMENTAL PROTECTION PLAN

Contracting Organization
Address and Phone Numbers

6. Preconstruction Survey results
7. Permitting requirements identified

e. Health and Safety Plan: Provide a site specific Health and Safety Plan (HASP) in accordance with Section C, Part 3.0, of the Basic Contract. The HASP shall include, but is not limited to, the following:

(1) Names of the health and safety officer and names of alternates responsible for health and safety.

(2) 29 CFR 1910.

(3) 29 CFR 1926.

(4) 29 CFR 1926-SUBPART V, tagout and lockout procedures.

(5) Contract Clause "FAR 52.236-13, Accident Prevention."

(6) Contract Clause "FAR 52.223-3, Hazardous Material Identification and Material Safety Data."

(7) NFPA 241.

f. QC Plan: Provide a QC Plan in accordance with Section C, Part 6.0, of the Basic Contract, and as specified herein.

(1) Table of Contents

I. QC ORGANIZATION
II. NAMES AND QUALIFICATIONS
III. DUTIES, RESPONSIBILITY, AND AUTHORITY OF QC PERSONNEL
IV. OUTSIDE ORGANIZATIONS
V. APPOINTMENT LETTERS
VI. SUBMITTAL PROCEDURES AND INITIAL SUBMITTAL REGISTER
VII. TESTING LABORATORY INFORMATION
VIII. TESTING PLAN AND LOG
IX. PROCEDURES TO COMPLETE REWORK ITEMS
X. DOCUMENTATION PROCEDURES

(2) Submittal Register: As part of the QC Plan, submit a completed Submittal Register to document quality control for materials, inspection, and testing in accordance with Section C, Part 7.0 of the Basic Contract. A copy of the Submittal Register is provided at the end of this section.

(3) Testing laboratory qualifications: As part of the QC Plan, submit qualifications for each laboratory which shall be used in accordance with Section C, Part 6.0, of the Basic Contract. Laboratories engaged in hazardous materials testing shall meet the requirements of Section C, Part 6.0 of the Basic Contract.

g. Sampling and Analysis Plan: Provide a Sampling and Analysis Plan describing sampling and analyses requirements for the delivery

order. The plan shall contain a Field Sampling Plan and a Quality Assurance Plan.

1.3.1 Forwarding Preconstruction Submittals

Within 30 calendar days of issuance of the delivery order, and before procurement, fabrication, or mobilization, submit to Walter Legg, Project Manager, Engineering Field Activity Chesapeake, 1314 Harwood Street, Washington Navy Yard, Washington, DC 20374-5018, and to distribution as directed by the ROICC NTR, the Work Plan, complete as specified. The Architect-Engineer shall review the Work Plan for the ROICC NTR to determine compliance of the Contractor's Work Plan with the requirements of the contract documents for this delivery order.

1.3.2 Review Comments

The Contractor's Work Plan shall be reviewed. The ROICC NTR shall compile and coordinate Government review comments, and forward consolidated review comments to the Contractor. Review comments on the Work Plan shall be resolved, and Work Plan modified as required. After the correction of the Work Plan, submit one corrected final copy to Walter Legg, Project Manager, Engineering Field Activity Chesapeake, 1314 Harwood Street, Washington Navy Yard, Washington, DC 20374-5018 for final review. The Work Plan shall be approved prior to commencement of any other work associated with this delivery order.

1.4 RECORDS

1.4.1 As-Built Records

Maintain two sets of full size contract drawings and two sets of full size approved shop drawings marked to show any deviations which have occurred, including buried or concealed construction and utility features revealed during the course of construction. Record horizontal and vertical locations of buried utilities that differ from the contract drawings. These drawings shall be available for review by the ROICC NTR at any time. At the completion of the work, deliver marked sets of the contract drawings to the ROICC NTR. The Contractor shall incorporate shop drawing deviations, and deliver one complete set of the shop drawings to the ROICC NTR.

1.4.2 Environmental Conditions Report

Prior to starting work, perform a preconstruction survey with the ROICC NTR. Take photographs showing existing environmental conditions on and adjacent to the site. Prior to starting work, submit the results of the survey in an Environmental Conditions Report to the ROICC NTR.

1.4.3 Contract Management System (CMS)

The CMS shall be a system able to provide, as a minimum, the activities in sorts or groups as specified in the Basic Contract and any subsequent delivery orders.

a. Status reports: Status reports shall comply with the Basic Contract and any subsequent delivery orders. Submit a Technical Progress Report, Cost Performance Report, modification log, time-scaled logic diagram, and Waste Materials Report. Submit the first delivery order status report approximately 15 days after the

end of the month in which the Contractor's Work Plan was approved. Thereafter, submit status reports every 30 days. Status report periods shall be consistent with the invoice reporting periods.

1.4.4 QC Meeting Minutes

The QC representative shall document QC meetings by delivering copies of the minutes to the ROICC NTR within 3 calendar days after each QC meeting. The submittals shall comply with Section C, Part 6.0 of the Basic Contract.

1.4.5 Test Results Summary Report

A summary report of field tests and laboratory analytical results shall be submitted to the ROICC NTR within 15 days after laboratory receipt of samples and in accordance with Section C, Part 6.0 of the Basic Contract.

1.4.6 Contractor Production Report (CPR)

The CPR shall be prepared and submitted daily to the ROICC NTR in accordance with Section C, Part 6.0, of the Basic Contract.

1.4.7 QC Report

The QC Report shall be submitted by the QC representative to the ROICC NTR every day work is performed, material is delivered, direction is pending, or a labor force is present in accordance with Section C, Part 6.0, of the Basic Contract.

1.4.8 Rework Items List

The QC representative shall deliver a copy of the Rework Items List to the ROICC NTR on a monthly basis in accordance with Section C, Part 6.0, of the Basic Contract.

1.4.9 Contractor's Closeout Report

Submit upon completion of the project. This report shall include: introduction, summary of action, final Health and Safety Report, summary of record documents, field changes and contract modification, final documents, complete set of field test and geotechnical laboratory results, complete set of data validation results, documentation of offsite transportation and treatment of materials, QC Summary Report, surveyed As-Builts, color photographs documenting each major task of the project, and final cost data.

1.5 FORWARDING SUBMITTALS

After approval of the work plan, and before procurement or fabrication, submit, except as specified otherwise, to Walter Legg, Project Manager, Engineering Field Activity Chesapeake, 1314 Harwood Street, Washington Navy Yard, Washington, DC 20374-5018, the shop drawings and technical data required in the technical sections of this specification. The Architect-Engineer for this project shall review and provide surveillance for the ROICC NTR to determine if Contractor-approved submittals comply with the contract requirements, and shall review and approve for the ROICC NTR those submittals not permitted to be Contractor approved to determine if submittals comply with the contract requirements. At each "Submittal" paragraph in the individual specification sections, a notation "G," following a submittal item, indicates the Architect-Engineer, acting as the agent for the ROICC NTR, is the approving authority for that submittal

item. One copy of the transmittal form for submittals shall be forwarded to the ROICC NTR.

1.6 PROJECT DESCRIPTION

This work includes the preparation of a work plan as previously described, and the provision of construction of a landfill cap, site restoration, and other related work.

1.7 LOCATION

The work shall be located at the Former Naval Surface Warfare Center - White Oak, Silver Spring, Maryland, approximately as shown. The exact location shall be as indicated by the ROICC NTR.

1.8 DESCRIPTION OF CONTAMINANTS PRESENT

Subsurface soils and groundwater at the project site have been contaminated with volatile organic compounds, inorganic compounds and explosive residues. Site characterization activities conducted at the site have indicated contaminant levels of VOCs that range from "not detected" to 0.03 ppm. The results of the chemical analyses for the soil borings and monitoring wells installed at the site are indicated in the reference documents. The above list of contaminants may not be all inclusive.

1.9 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK

The Contractor shall be required to (a) commence work on the Work Plan within 5 calendar days after receiving the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 365 calendar days after receiving the notice to proceed. The time stated for completion shall include final cleanup of the premises and the restoration of the site.

1.10 PROJECT INFORMATION

1.10.1 Contract Drawings

Contract drawings are as follows:

DWG No.	NAVFAC DWG No.	Title
T-1	3307621	Title Sheet
T-2	3307622	General Notes and Legend
C-1	3307623	Existing Conditions Plan
C-2	3307624	Erosion and Sediment Control Plan
C-3	3307625	Erosion and Sediment Control Notes
C-4	3307626	Erosion and Sediment Control Details (Sheet 1 of 2)
C-5	3307627	Erosion and Sediment Control Details (Sheet 2 of 2)
C-6	3307628	Waste Grading Plan
C-7	3307629	Interim Grading Plan
C-8	3307630	Final Grading Plan
C-9	3307631	Cross Sections (Sheet 1 of 2)
C-10	3307632	Cross Sections (Sheet 2 of 2)
C-11	3307633	Landfill Cap Details
C-12	3307634	Miscellaneous Details
C-13	3307635	Restoration Plan

DWG No.	NAVFAC DWG No.	Title

1.10.2 Reference Reports

The following reference reports are available for examination in the office of the EFACHES Project Manager and are intended only to show the existing conditions. The reports and drawings are the property of the Government and shall not be used for any purpose other than that intended by the specification.

Reports

a. TtNUS (Tetra Tech NUS, Incorporated), 2000. RCRA Facility Investigation for Sites 2, 3, 4, 7, 8, 9, and Paint Branch for Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity - Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania. October.

b. TtNUS, 1999. Engineering Evaluation/Cost Analysis (EE/CA) for Site 1 at the Former Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity - Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania. November.

c. TtNUS, 1998a. Site Screening Report for Installation Restoration Program Sites 1, 5, 6, 12, 13, 28, 29, 31, 32, 33, and EBS 100 for Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity - Chesapeake, Naval Facilities Engineering Command. King of Prussia, Pennsylvania. December.

d. Brown & Root Environmental, 1997b. Draft Groundwater Results for Various Sites. Prepared for Engineering Field Activity - Chesapeake, Naval Facilities Engineering Command. Wayne, Pennsylvania. September.

e. Halliburton NUS, 1995d. Wetland and Forest Stand Delineation Report for IRP Sites, Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity - Chesapeake, Naval Facilities Engineering Command. Wayne, Pennsylvania. August.

f. Halliburton NUS, 1995c. Draft Design Verification Report for Sites 2, 3, 4, & 9, Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. Prepared for Engineering Field Activity - Chesapeake, Naval Facilities Engineering Command. Wayne, Pennsylvania. June.

g. Malcolm-Pirnie, 1987. Confirmation Study/Verification Phase, Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. April.

h. NEESA (Naval Energy and Environmental Support Activity), 1984. Initial Assessment Study, Naval Surface Warfare Center - White Oak, Silver Spring, Maryland. November.

1.11 SCHEDULING

The Contractor shall schedule the work as to cause the least amount of interference with center operations. Work schedules shall be subject to the approval of the ROICC NTR. Permission to interrupt center roads shall be requested in writing a minimum of 15 calendar days prior to the desired date of interruption. Notify the ROICC NTR 48 hours prior to starting excavation.

1.11.1 Regular Work Hours

Regular working hours shall consist of an 8 1/2 hour period established by the ROICC NTR, Monday through Friday, excluding Government holidays.

1.11.2 Work Outside Regular Hours

Work outside regular hours requires ROICC NTR approval. Contractor shall submit an application to the ROICC NTR, 2 regular working days prior to the scheduled working date, to allow ample time to enable satisfactory arrangements to be made by the Government for inspecting the work in progress. At night, the Contractor shall light the different parts of the work in an approved manner.

1.12 SECURITY REQUIREMENTS

The Contractor shall comply with the general security requirements as stipulated in Section C, Part 2.0, of the Basic Contract.

1.13 STORAGE AND TEMPORARY BUILDINGS

1.13.1 Storage in Existing Buildings

Storage in existing buildings shall be allowed, as approved by the ROICC NTR.

1.13.2 Open Site Storage Size and Location

The open site available for storage, laydown, and decontamination shall be confined to the areas indicated by the ROICC NTR.

1.13.3 Trailers, Storage, and Temporary Buildings

Locate trailers, storage, and temporary buildings where directed and within the indicated operations area. Trailers or storage buildings shall be permitted where space is available subject to the approval of the ROICC NTR. The trailers or storage buildings shall be suitably painted and kept in a good state of repair. Failure of the Contractor to maintain the trailers or storage buildings in good condition shall be considered sufficient reason to require their removal. Trailers shall be anchored to resist high winds and shall meet applicable State or local standards for anchoring mobile trailers. A sign that conforms to the following requirements and shows the company name, telephone number, and emergency telephone number, shall be mounted on the trailer or building.

Graphic panel: Aluminum, painted blue; FED-STD-595 25053

Copy: Screen painted or vinyl die-cut, white, Univers 65 u/lc typeface.

1.13.4 Contractor Quality Control Field Office

Provide a trailer of sufficient size for an office trailer work area and

floor area for the exclusive use of the quality control (QC) representative. Also provide room in the same trailer for the QC records. Provide the QC representative with a 4 by 8 foot plan table, a standard size office desk and chair, and telephone service. QC records shall be filed in the office and available at all times to the Government. QC field office trailer shall comply with the requirements specified above for other Contractor trailers.

1.14 LOCATION OF UNDERGROUND UTILITIES

Contractor shall comply with the requirements specified in Section C, Part 2.0 of the Basic Contract, and with requirements specified herein. Verify elevations of existing underground utilities and obstructions before installing new work closer than the nearest manhole or other structure at which an adjustment can be made.

1.15 UTILITY SERVICES

1.15.1 Temporary Utilities

Contractor shall provide his own utilities.

1.15.2 Utility Cutovers and Interruptions

Make utility cutovers and interruptions outside regular working hours. Conform to procedures specified herein for work outside regular working hours. Ensure that new utilities are complete, except for the connection, before interrupting the existing service.

1.16 RESTRICTIONS ON EQUIPMENT

1.16.1 Radio Transmitter Restrictions

The Contractor shall conform to the restrictions and procedures for the use of radio transmitting equipment, as directed by the ROICC NTR. Do not use transmitters without prior approval.

1.17 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE

In conjunction with the Contract Clause "DFARS 252.236-7000, Modification Proposals-Price Breakdown," and where actual ownership and operating costs of construction equipment cannot be determined from Contractor accounting records, equipment use rates shall be based upon the applicable provisions of the COE EP 1110-1-8.

1.18 PUBLIC RELEASE OF INFORMATION

Contractor shall comply with requirements stated in Section C, Part 2.0, of the Basic Contract.

1.19 STORM PROTECTION

Contractor shall conduct storm protection measures in accordance with the requirements of Section C, Part 2.0, of the Basic Contract, and as specified herein.

1.19.1 Hurricane Condition of Readiness

Unless directed otherwise, comply with:

a. Condition ONE (sustained winds of 50 knots or greater expected within 12 hours): Secure the jobsite, and leave Government premises.

b. Condition TWO (sustained winds of 50 knots or greater expected within 24 hours): Curtail or cease routine activities until securing operation is complete. Reinforce or remove form work and scaffolding. Secure machinery, tools, equipment, materials, or remove from the jobsite. Expend every effort to clear missile hazards and loose equipment from general base areas. Contact ROICC NTR for weather and condition of readiness (COR) updates and completion of required actions.

c. Condition THREE (sustained winds of 50 knots or greater expected within 48 hours): Maintain Condition FOUR requirements and commence securing operations necessary for Condition ONE which cannot be completed within 18 hours. Cease routine activities which might interfere with securing operations. Commence securing and stow gear and portable equipment. Make preparations for securing buildings. Review requirements pertaining to Condition TWO and continue action as necessary to attain Condition THREE readiness. Contact ROICC NTR for weather and COR updates and completion of required actions.

d. Condition FOUR (sustained winds of 50 knots or greater expected within 72 hours): Normal daily jobsite cleanup and good housekeeping practices. Collect and store in piles or containers scrap lumber, waste material, and rubbish for removal and disposal at the close of each work day. Maintain the construction site including storage areas, free of accumulation of debris. Stack form lumber in neat piles less than 4 feet high. Remove debris, trash, or objects that could become missile hazards. Contact ROICC NTR for COR updates and completion of required actions.

1.20 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain, during the life of the delivery order, environmental protection as defined in Section C, Part 4.0, of the Basic Contract, and as specified herein.

1.20.1 Stormwater Pollution Prevention Plan

The Contractor shall prepare a Stormwater Pollution Prevention Plan (SWPPP), a completed Notice of Intent (NOI) form, and a completed Notice of Termination (NOT) form in accordance with the requirements of the State's general permit for storm water discharges from construction sites. Submit SWPPP, NOI, NOT, and the appropriate permit fee to the ROICC NTR a minimum of 14 days prior to start of construction.

The Contractor shall keep a copy of the SWPPP and the approved permit on site at the Contractor's trailer at all times. The SWPPP shall be continually updated as necessary to reflect current and changing conditions on site.

1.20.2 Fire Protection

Comply with COE EM-385-1-1, NFPA 241, and activity fire regulations. Post the activity fire poster in conspicuous locations and at telephones in

construction trailers.

1.21 PRECONSTRUCTION CONFERENCE

After approval of the Work Plan, but prior to commencement of any work at the site, Contractor shall meet with the ROICC NTR to discuss and develop a mutual understanding relative to the administration of the HASP, preparation and submission of submittals, scheduling, programming, and prosecution of the work. Major subcontractors who will be engaged in the work shall also attend.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 CLEANING UP

During the progress of the remediation, the work area and adjacent areas shall be kept clean and free of rubbish, surplus materials, and unneeded construction equipment. No material or debris shall be allowed to flow or wash into watercourses, ditches, gutters, drains, or pipes. Upon completion of the work, sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish, and construction facilities from the site.

-- End of Section --

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
OU-2, LANDFILL CAP, FNSWC, WHITE OAK, SILVER SPRING, MD

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01115	SD-01 Preconstruction Submittals															
			Work Plan	1.3	G													
			SD-11 Closeout Submittals															
			As-Built records	1.4.1	G													
			Environmental Conditions Report	1.4.2	G													
			Status reports	1.4.3	G													
			QC meeting minutes	1.4.4	G													
			Test Results Summary Report	1.4.5	G													
			Contractor Production Report	1.4.6	G													
			QC Report	1.4.7	G													
			Rework Items List	1.4.8	G													
			Pollution Prevention Plan	1.20.1	G													
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			Notice of Termination	1.20.1	G													
			Contractor's Closeout Report	1.4.9	G													
		02315	SD-06 Test Reports															
			Borrow Site Testing	1.6	G													
			Subgrade soil	3.7.2.2														
			Select waste	3.7.2.1														
			Cover soil	3.7.2.3														
			Topsoil	2.1.3														
			Density tests	3.7.2.4														
		02372	SD-02 Shop Drawings															
			Layout and Detail Drawings	3.1.1														
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			QC Manual	3.6														

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		02372	SD-03 Product Data															
			Raw Materials	2.1.1														
			Sheet Material	2.2.2.2														
			SD-04 Samples															
			Samples	3.5														
			SD-06 Test Reports															
			Thickness Measurement	3.3.2														
			Interface Friction Testing	2.2.1														
			SD-07 Certificates															
			Qualifications	1.3														
			SD-08 Manufacturer's Instructions															
			Tests, Inspections, and	2.2														
			Verifications															
			Field Seaming	3.4														
			SD-09 Manufacturer's Field															
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			Surface Preparation	3.1.2														
			Non-Destructive Field Seam	3.6.1														
			Continuity Testing															
			Destructive Field Seam Testing	3.6.2														
			Destructive Seam Test Repairs	3.7.1														
		02373	SD-03 Product Data															
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			Tests															

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		02373	SD-06 Test Reports															
			Seams	3.3														
			SD-07 Certificates															
			Independent Laboratory	1.3														
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			Geotextiles	2.1.1														
			SD-08 Manufacturer's Instructions															
			Manufacturing Quality Control	2.2														
			Sampling and Testing															
		02374	SD-03 Product Data															
			Construction Quality Control	2.3.2														
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			End Seams	3.2.3.2														
			Penetrations	3.2.4														
			SD-07 Certificates															
			Independent Laboratory	1.3														
			Qualifications															
			Geocomposite Drainage Layer	2.1														
		02376	SD-02 Shop Drawings															
			Layout and Detail Drawings	3.3.2														
			SD-03 Product Data															
			GCL Properties	2.1														
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		02376	Samples	3.2.1														
			SD-06 Test Reports															
			Friction Testing	2.2.2														
			Conformance Tests	3.2.2														
			Subgrade Preparation	3.3.1														
			SD-07 Certificates															
			Qualifications	1.3														
			SD-08 Manufacturer's Instructions															
			Tests, Inspections, and	2.2														
			Verifications															
			SD-09 Manufacturer's Field															
			Reports															
			Subgrade Preparation	3.3.1														
		02525	SD-03 Product Data															
			Well casing	2.1														
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			SD-07 Certificates															
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			Well Construction Permit	1.6.4														
			SD-11 Closeout Submittals															
			Well Construction Report	1.6.5														
			Well Abandonment Report	1.6.3														
			Well Extension Report	1.6.6														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
OU-2, LANDFILL CAP, FNSWC, WHITE OAK, SILVER SPRING, MD

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02630	SD-03 Product Data															
			Corrugated Polyethylene	2.1.1.1														
			SD-04 Samples															
			Pipe and fittings	2.1.1.1														
			SD-07 Certificates															
			Pipe and fittings	2.1.1.1														

SECTION 02231

CLEARING AND GRUBBING

PART 1 GENERAL

Not used.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.2 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Contracting Officer in ample time to minimize interruption of the service.

3.2 CLEARING

Shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Cut off flush with or below the original ground surface trees, stumps, roots, brush, and other vegetation in areas to be cleared, except for trees and vegetation indicated or directed to be left standing.

3.3 TREE REMOVAL

Where indicated, remove designated trees and stumps and grub roots.

3.4 GRUBBING

Remove and dispose of roots larger than 3 inches in diameter, matted roots, and designated stumps to a depth of not less than 18 inches below the original soil surface in areas as indicated and as directed by the Contracting Officer. Chip and dispose of grubbed materials in uniform layer thoroughly mixed with waste under final cover system. Fill depressions made by grubbing with waste/fill material and compact in accordance with the requirements specified in Section 02315, "Excavation and Fill."

3.5 DISPOSAL OF CLEARED AND GRUBBED MATERIALS

3.5.1 Saleable Timber

Consider felled timber from which fuelwood can be produced as saleable timber. Trim limbs and tops, and saw into saleable lengths of 1.5 feet for fuelwood, and stockpile adjacent to the site. The stockpile timber will remain the property of the Government.

3.5.2 Nonsaleable Materials

Chip, transport and store on the center as directed by the ROICC-NTR.

-- End of Section --

SECTION 02315

EXCAVATION AND FILL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 698	(1991) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2434	(1968: R 2000) Permeability of Granular Soils (Constant Head)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1995; Rev. A) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5101	(1999) Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio

CORPS OF ENGINEERS (COE)

COE EM-385-1-1	(1996) Safety and Health Requirements Manual

DEPARTMENT OF AGRICULTURE (USDA)

USDA Manual	(1993) Soil Survey Manual, Soil Survey Division Staff

MARYLAND DEPARTMENT OF THE ENVIORNMENT (MDE)

MDE SESC	(1994) Maryland Standards and Specifications for Soil Erosion and Sediment Control

MARYLAND STATE HIGHWAY ADMINISTRATION (MDSHA)

MDSHA CM	(1993) Construction and Materials

1.2 DEFINITIONS

1.2.1 Waste

Includes existing waste at Site 1, Site 2 and contaminated stream sediment. Existing Site 1 waste may include waste soil, wood, metal scraps, used equipment, tires, broken glass, automotive batteries, lubricating oil, battery acid, metal plating waste, black ash, concrete, brick, rebar, asphalt blocks, cans, tiles, plastic, rags and ordnance/shapes. Waste soil may be sandy clay with silt and gravel.

Existing Site 2 waste may include waste soil, domestic refuse, PCB contaminated oils, concrete, asphalt, solvents, paint, residue, and ordnance/shapes. Waste soil may be sand with silt and gravel.

1.2.2 Select Waste

Excavated waste from Site 1 and Site 2 to be used as fill. Select waste shall not contain ordnance/shapes, construction debris, or sharp objects. Select waste shall have a maximum particle size not to exceed four inches, with not more than 50 percent of the particles by weight larger than one-inch.

1.2.3 Ordnance/Shapes

1.2.3.1 Ordnance

Unexploded ordnance (UXO) may be buried at Sites 1 and 2. Suspect materials shall be identified as UXO by the UXO Technician during excavation.

1.2.3.2 Shapes

Concrete-filled dummy bombs (shapes) may be buried at Sites 1 and 2. Shapes shall be identified as non-UXO by the UXO Technician during excavation.

1.2.4 UXO Technician

Provide a UXO Technician capable of identifying UXO and directing UXO management during waste excavation. The UXO Technician shall be approved by the ROICC NTR prior to the start of waste excavation.

1.3 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0 of the Basic Contract.

SD-06 Test Reports

Borrow Site Testing; G

Subgrade soil test

Select waste test

Cover soil test

Topsoil

Density tests

1.4 DELIVERY, STORAGE, AND HANDLING

Perform in a manner to prevent contamination or segregation of materials.

1.5 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Groundwater elevations indicated by the monitoring wells were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

d. Groundwater elevation was 14 to 17 feet below existing surface elevation at Site 1. Depth to the water table at Site 2 ranged from approximately 3 to 4 feet below ground surface along the toe of the landfill to 32.5 feet below ground surface along the Perimeter Road.

e. Blasting will not be permitted. Remove material in an approved manner.

1.6 REQUIREMENTS FOR OFF SITE SOIL

Soils brought in from off site for use as backfill shall contain less than 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and less than 1 ppm of the sum of Benzene, Toluene, Ethylbenzene, and Xylene (BTEX). Provide Borrow Site Testing for TPH and BTEX from a composite sample of material from the borrow site, with at least one test from each borrow site. Material shall not be brought on site until tests have been approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

Free of debris, roots, wood, scrap material, sharp rocks, vegetation, refuse, soft unsound particles, and frozen, deleterious, or objectionable materials. Materials which is excessively moistened by precipitation shall be dried to a satisfactory moisture content prior to placement.

2.1.1 Subgrade Soil

Subgrade soil shall be approved unclassified soil material with the characteristics required to compact to the soil density specified. Subgrade soil shall have a maximum particle size of two inches and shall be free of debris, vegetation, sticks, sharp rocks, objects protruding more than 1/2 inch, void spaces, ice, abrupt elevation changes, standing water, and sharp objects which could damage the geosynthetic components of the cap. Subgrade soils shall have a permeability greater than or equal to 1 x 10^{-4} cm/sec (ASTM D 2434) when compacted as specified.

2.1.2 Cover Soil

Classified by USDA Manual as loam, silt loam, silty clay loam, clay loam, or sandy clay loam, and a maximum particle size of four inches and have a pH between 6.0 and 7.5. Lime or other soil amendments may be used to adjust pH with the approval of the Contracting Officer. Soil shall not have soluble salt content greater than 500 ppm. Soil shall not indicate either piping or clogging when tested with the top geotextile portion of the selected geocomposite drainage layer in accordance with the Gradient Ratio test, ASTM D 5101.

2.1.3 Topsoil

MDE SESC, Section G, 21, II and III, and limited to loam, silt loam, silty clay loam, clay loam, or sandy clay loam.

2.1.4 Pipe Bedding and Backfill

MDSHA CM, Section 901.01,Table 901A, Number 67.

2.1.5 Base Aggregate

MDSHA CM, Section 901.01, Table 901A, Graded Aggregate-Base.

2.2 BORROW

Obtain borrow materials required in excess of those furnished from excavations from sources outside of Government property.

2.3 MATERIAL FOR RIP-RAP

Rock conforming to MDSHA CM for construction indicated. Geotextiles in accordance with Section 02373, "Separation/Filtration Geotextile."

2.3.1 Rock

MDSHA CM, Section 901.02.01, Rip-rap Class 0 or a D_{50} equal to 6 inches as indicated. D_{50} is defined as the rock diameter at which 50 percent by weight is finer. Rock used for channel shall conform to the quality requirements of MDSHA CM, Section 901.03.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

3.1.1 Clearing and Grubbing

Provide in accordance with Section 02231, "Clearing and Grubbing."

3.2 PROTECTION

3.2.1 Protection Systems

Provide shoring, bracing, and sheeting in accordance with COE EM-385-1-1, except that banks may be sloped only when approved by the Contracting Officer.

3.2.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.2.2.1 Drainage

So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil and waste materials sufficiently dry. The Contractor shall establish/construct storm drainage features (ditches) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and groundwater conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.2.2 Dewatering

When groundwater flows toward, from, or on excavated areas, stop work and notify Contracting Officer for direction.

3.2.3 Underground Utilities

Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor shall contact the "Miss Utility" at 1-800-257-7777 48 hours prior to any excavation work for assistance in locating existing utilities.

3.2.4 Machinery and Equipment

A minimum of two feet of fill shall be placed over piping prior to movement of full size construction machinery and equipment over pipes during construction. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

3.3 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil and waste disturbed or weakened by Contractor's operations, soils and waste softened or made unsuitable for subsequent construction due to exposure to weather. Refill with select waste and compact in thin lifts to form a stable fill, as approved by the Contracting Officer. Unless specified otherwise, refill excavations cut below indicated depth with

select waste and compact in thin lifts to form a stable fill, as approved by the Contracting Officer.

3.3.1 Pipe Trenches

Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement.

3.4 FILLING AND BACKFILLING

Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

3.4.1 Waste

Excavate and place waste within the limit of waste to an elevation 6 inches below the indicated waste grade. Prior to fill placement, clear within the limit of fill and breakup surface concrete and asphalt to a maximum particle dimension of 12 inches. Concrete and asphalt slabs shall not be piled or stacked in the fill such that voids are created.

During excavation, all excavated waste shall be examined by the UXO Technician to identify any UXOs or shapes. UXO will be disposed off site by the Government. Concrete shapes shall be broken to a maximum dimension of 12 inches and distributed randomly throughout the fill. Concrete shapes shall not be piled or stacked in the fill such that voids are created.

When excavation to grade requires overexcavation of large debris, resulting in voids, voids shall be filled with compacted select waste. During excavation, excavated waste which appears to be hazardous waste shall be isolated and tested on site. Waste determined to be hazardous shall be disposed in a permitted hazardous waste disposal facility in accordance with the Basic Contract.

Waste shall be placed in 12-inch thick level lifts. Compacted waste which pumps when proof rolled or otherwise demonstrates instability shall be mixed with other waste to proportions necessary to create a stable mixture as directed by the Contracting Officer.

3.4.2 Select Waste

Select waste shall be placed within the limit of waste to indicated waste grade.

3.4.3 Subgrade Soil

Subgrade soil shall be placed to interim grade. Soil cracks larger than 1/4 inch and voids shall be filled, regraded, and recompacted. Protrusions larger than 1/2 inch which cannot be pressed flush with the surface as well as sharp objects, shall be removed and the surface shall be filled and recompacted. Sharp or protruding materials removed from surface of the subgrade soil may be placed elsewhere in the landfill waste but may not be used as subgrade soil.

3.4.4 Cover Soil

Cover soil shall be placed from the bottom of the slope upwards. Cover soil shall not be dropped onto the geocomposite drain layer from a height greater than 3 feet. The soil shall be pushed over the geocomposite drain

layer in an upward tumbling motion. The initial soil lift thickness shall be 12 inches. Equipment with approved pressures not to exceed 5 psi shall be used to place the first lift of cover soil. A minimum of 12 inches of soil shall maintained between low-ground-pressure (5 psi) equipment tires/tracks and the geocomposite drain layer. Place subsequent lift using equipment with ground pressures not to exceed 7 psi. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph. Any damage to the geocomposite drain layer, geomembrane, or GCL shall be repaired.

3.4.5 Topsoil

Topsoil shall be placed from the bottom of the slope upwards using equipment with ground pressures not to exceed 11 psi.

3.4.6 Pipe Trench Backfilling

Backfill pipe trenches as rapidly as construction permits. Place backfill in 6 inch lifts. Backfill as indicated in accordance with ASTM D 2321.

3.4.6.1 Bedding Requirements

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with ASTM D 2321. Bedding as indicated.

3.5 COMPACTION

Expressed as a percentage of maximum density or by counting number of passes. A pass shall cover 100 percent of the surface being compacted. Travel out and back will be defined as two passes.

3.5.1 Waste

Compact with 4 passes of a smooth drum or pad-foot roller (minimum weight 10 tons, maximum travel speed 5 mph). As an alternative, the number of passes maybe determined and approved by the QC Inspector based on a demonstration with site-specific waste, compaction equipment, and of the number of passes required to eliminate rutting, shoving, excessive settlement or other signs of instability.

3.5.2 Select Waste

Compact with 6 passes of a smooth drum or pad-foot roller (minimum weight of 10 tons), maximum travel speed of 5 mph. To fill voids, select waste shall be compacted in 6-inch lifts using 6 passes of a ROICC-approved compactor. Scarify surface following compaction prior to next lift.

3.5.3 Subgrade Soil

Compact to 95 percent of ASTM D 698 maximum density. Scarify surface following compaction prior to next lift.

3.5.4 Cover Soil

Compact first lift by one pass of the track area with a wide track dozer with a ground pressure not to exceed 5 psi. Compact subsequent lift by one pass of the track area per lift with a wide track dozer with ground pressures not to exceed 7 psi.

3.5.5 Topsoil

Compact by one pass of the track area per lift with a wide track dozer with ground pressures not to exceed 11 psi.

3.5.6 Base Aggregate-Bench

Spread and placement to grade shall be adequate compaction.

3.5.7 Base Aggregate-Road

Visual inspection for stability (non-movement) during placement.

3.6 FINISH OPERATIONS

3.6.1 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.6.2 Seed

Provide 6 inches of topsoil for newly graded finish earth surfaces and areas disturbed by the Contractor. Seed mixtures and rates as indicated. Soil amendments, seed bed preparation, seed quality, methods of seeding and mulch specifications shall be in accordance with MDE SESC, Section G.

3.6.3 Protection of Surfaces

Protect newly graded areas from traffic, erosion, and settlement that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

Take the number and size of samples required to perform the following tests.

3.7.2 Testing

Perform one of each of the following tests for each material used. Provide additional tests for each source change.

3.7.2.1 Select Waste Testing

Test particle size in accordance with ASTM D 422 once per acre per lift. Material not in accordance the paragraph entitled "Select Waste" shall be placed under the landfill cap as waste.

3.7.2.2 Subgrade Soil Testing

Test subgrade soil particle size in accordance with ASTM D 422 once per acre per lift.

3.7.2.3 Cover Soil Testing

Test cover soil for grain size distribution and maximum particle size in

accordance with ASTM D 422, for plasticity in accordance with ASTM D 4318 or test for USDA Textural Classification in accordance with MD SHA T88. Complete each test once per 5,000 cubic yards and each change in borrow source. Test for gradient ratio once per borrow source in accordance with ASTM D 5101.

3.7.2.4 Density Tests

Test density in accordance with ASTM D 1556, or ASTM D 2922 and ASTM D 3017. When ASTM D 2922 and ASTM D 3017 density tests are used, verify density test results by performing an ASTM D 1556 density test at a location tested in accordance with ASTM D 2922 and ASTM D 3017. Perform an ASTM D 1556 density test at the start of the job, and for every 10 ASTM D 2922 and ASTM D 3017 density tests thereafter.

a. For Subgrade Soil: test once per acre/lift.

-- End of Section --

SECTION 02372

WASTE CONTAINMENT GEOMEMBRANE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 638	(1998) Tensile Properties of Plastics
ASTM D 1004	(1994a) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1238	(1998) Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1505	(1998) Density of Plastics by the Density-Gradient Technique
ASTM D 1603	(1994) Carbon Black in Olefin Plastics
ASTM D 3895	(1997) Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D 4218	(1996) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4833	(1988; R 1996) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5321	(1992; R 1998) Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D 5596	(1994) Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D 5617	(1999) Multi-Axial Tension Test for Geosynthetics
ASTM D 5641	(1994e1) Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D 5721	(1995) Air-Oven Aging of Polyolefin

	Geomembranes
ASTM D 5820	(1995) Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D 5885	(1995) Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D 5994	(1998) Measuring Core Thickness of Textured Geomembrane
ASTM D 6392	(1999) Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM-7	(1995) Accelerated Curing of Geomembrane Test Strip Seams Made by Chemical Fusion Methods
GSI GRI GM-11	(1997) Accelerated Weathering of Geomembranes Using a Fluorescent UVA Device

1.2 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0 of the Basic Contract.

SD-02 Shop Drawings

Layout and Detail Drawings

As-Built Drawings

QC Manual

SD-03 Product Data

Raw Materials

Sheet Material

SD-04 Samples

Samples

SD-06 Test Reports

Thickness Measurement

Interface Friction Testing

SD-07 Certificates

Qualifications

SD-08 Manufacturer's Instructions

Tests, Inspections, and Verifications

Field Seaming

SD-09 Manufacturer's Field Reports

Surface Preparation

Non-Destructive Field Seam Continuity Testing

Destructive Field Seam Testing

Destructive Seam Test Repairs

1.3 QUALIFICATIONS

Submit manufacturer's, and fabricator's qualification statements, including resumes of key personnel involved in the project, a minimum of 7 days prior to geomembrane shipment. Submit installer's, QC Inspector's, and QC laboratory's qualification statements including resumes of key personnel involved in the project, a minimum of 7 days prior to geomembrane placement.

1.3.1 Manufacturer

Manufacturer shall have produced the proposed geomembrane sheets for at least 5 completed projects having a total minimum area of 10 million square feet.

1.3.2 Installer

The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. The installer shall have installed the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet. At least one seamer shall have experience seaming a minimum of 500,000 square feet of the proposed geomembrane using the same type of seaming equipment, polymer and geomembrane thickness specified for this project.

1.3.3 QC Inspector

The QC Inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the QC of the geomembrane from manufacturing through installation. The QC Inspector shall have provided QC inspection during installation of the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet.

1.3.4 QC Laboratory

The QC laboratory shall have provided QC and/or Quality Assurance (QA) testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.4 DELIVERY, STORAGE AND HANDLING

1.4.1 Delivery

The QC Inspector shall be present during delivery and unloading of the geomembrane. Each geomembrane roll/panel shall be labeled with the manufacturer's name, product identification number, roll/panel number, and roll dimensions.

1.4.2 Storage

Temporary storage at the project site shall be on a level surface, free of sharp objects and where water cannot accumulate. The geomembrane shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances. Storage shall not result in crushing the core of roll goods or flattening of the rolls. Rolls shall not be stored more than two high. Palleted materials shall be stored on level surfaces and shall not be stacked on top of one another. Damaged geomembrane shall be removed from the site and replaced with geomembrane that meets the specified requirements.

1.4.3 Handling

Rolls/panels shall not be dragged, lifted by one end, or dropped. A pipe or solid bar, of sufficient strength to support the full weight of a roll without bending, shall be used for all handling activities. The diameter of the pipe or solid bar shall be small enough to be easily inserted through the core of the roll. Approved lifting slings shall be used to link the ends of the pipe or bar to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the slings from rubbing against the ends of the roll. Alternatively, a stringer bar protruding from the end of a forklift or other equipment may be used. The stringer bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the roll without bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.5 WEATHER LIMITATIONS

Geomembrane shall not be deployed or field-seamed in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of excess wind. No placement or seaming shall be attempted at ambient temperatures below 40 degrees F or above 104 degrees F. Ambient temperature shall be measured at a height no greater than 6 inches above the ground or geomembrane surface. In marginal conditions, seaming shall cease unless destructive field seam tests, conducted by the QC laboratory, confirm that seam properties meet the requirements listed in Tables 2 and 3. Tests shall be conducted in accordance with paragraph "Destructive Field Seam Testing."

1.6 EQUIPMENT

Equipment used in performance of the work shall be in accordance with the geomembrane manufacturer's recommendations and shall be maintained in satisfactory working condition.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Raw Materials

Resin used in manufacturing geomembrane sheets shall be made of virgin uncontaminated ingredients with a maximum density of 0.955 g/ml measured in accordance with ASTM D 1505 and a melt index value of less than 1.0 g/10 min measured in accordance with ASTM D 1238. No more than 10 percent regrind, reworked, or trim material in the form of chips or edge strips shall be used to manufacture the geomembrane sheets. All regrind, reworked, or trim materials shall be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced. No post consumer materials or water-soluble ingredients shall be used to produce the geomembrane. For geomembranes with plasticizers, only primary plasticizers that are resistant to migration shall be used. Submit manufacturer's certified raw material test reports and a copy of the QC certificates, a minimum of 7 days prior to shipment of geomembrane to the site.

2.1.2 Sheet Materials

Geomembrane sheets shall be unreinforced and manufactured as wide as possible to minimize field seams. Geomembrane sheets shall be uniform in color, thickness, and surface texture. Sheets shall be textured on both faces. The textured surface features shall consist of raw materials identical to that of the parent sheet material and shall be uniform over the entire face of the geomembrane. The sheets shall be free of and resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants and other imperfections. Geomembrane sheet shall conform to the requirements listed in Table 1 for Manufacturing Quality Control (MQC).

TABLE 1. TEXTURED LLDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Thickness (min ave)	60 mils	per roll	ASTM D 5994
Lowest individual for 8 out of 10 values	-10 percent	per roll	ASTM D 5994
Lowest individual for any of the 10 values	-15 percent	per roll	ASTM D 5994
Density (min) (max)	0.92 g/cc 0.939 g/cc	per 200,000 lb	ASTM D 1505
Tensile Properties (1) (min ave)		per 20,000 lb	ASTM D 638 Type IV
-break stress	90 lb/in		
-break elong	250 percent		

TABLE 1. TEXTURED LLDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Tear Resistance (min ave)	27 lb	per 45,000 lb	ASTM D 1004
Puncture Resistance (min ave)	55 lb	per 45,000 lb	ASTM D 4833
Axi-Symmetric Break Resistance Strain (min)	30 percent	per formulation or per 150,000 sq ft whichever is greater	ASTM D 5617
Carbon Black Content	2.0-3.0 percent	per 20,000 lb	ASTM D 1603 (2)
Carbon Black Dispersion	Note (3)	per 45,000 lb	ASTM D 5596
Oxidative Induction Time (OIT) (min ave) (4)		per 200,000 lb	
-Std OIT	100 min		ASTM D 3895
or -High Pres OIT	400 min		ASTM D 5885
Oven Aging at 85 deg C (min ave) (4), (5)		per year and change in formulation	ASTM D 5721
-Std OIT	35 percent at 90 days		ASTM D 3895
or -High Pres OIT	60 percent at 90 days		ASTM D 5885
UV Resistance (min ave) (6)		per year and change in formulation	GSI GRI GM-11
-High Pres OIT	35 percent after 1,600 hrs		ASTM D 5885

MQC = Manufacturing Quality Control

Note (1): Minimum average machine direction and minimum average cross machine direction values shall be based on 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 inches.

Note (2): Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation to ASTM D 1603 can be established.

Note (3): Carbon black dispersion for 10 different views:
- minimum 8 of 10 in Categories 1 or 2
- all 10 in Categories 1, 2, or 3

Note (4): The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.

Note (5): Evaluate samples at 30 and 60 days and compare with the 90 day response.

Note (6): The condition of the test shall be a 20 hour UV cycle at 167 degrees F followed by a 4 hour condensation cycle at 140 degrees F.

TABLE 2. SPRAY ON TEXTURED LLDPE SEAM PROPERTIES

PROPERTY	TEST VALUE	TEST METHOD
Seam Shear Strength (min) (1)	84 lb/in	ASTM D 6392
Seam Peel Strength (min) (1) (2)	72 lb/in	ASTM D 6392

TABLE 3. COEXTRUDED (BLOWNFILM) TEXTURED LLDPE SEAM PROPERTIES

PROPERTY	TEST VALUE	TEST METHOD
Seam Shear Strength (min) (1)	66 lb/in	ASTM D 6392
Seam Peel Strength (min) (1) (2)	60 lb/in	ASTM D 6392

Note (1): Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.

Note (2): Where applicable, both tracks of a double hot wedge seam shall be tested for peel adhesion.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit manufacturer's and fabricator's QC manuals, a minimum of 7 days prior to geomembrane shipment.

2.2.1 Interface Friction Testing

Certified laboratory interface friction test results including description of equipment and test method, a minimum of 7 days prior to geomembrane shipment.

Laboratory interface friction tests shall be conducted on the following interfaces: 1) geomembrane vs. geocomposite drainage layer and 2) geomembrane vs. upper face of geosynthetic clay layer (GCL). The frequency of testing for each interface shall be at a rate of 1 per project. Tests shall be conducted in accordance with ASTM D 5321. Normal stresses of 150, 300, and 600 psf along with a displacement rate of 0.04 inches per minute shall be used. GCL components shall be saturated for 24 hours prior to shear. Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field. A minimum interface friction angle of 25 degrees measured at 2 inches of displacement is required for all interfaces.

2.2.2 Manufacturing, Sampling, and Testing

2.2.2.1 Raw Materials

Raw materials shall be tested in accordance with the approved MQC manual. Any raw material which fails to meet the geomembrane manufacturer's specified physical properties shall not be used in manufacturing the sheet. Seaming rods and pellets shall be manufactured of materials which are essentially identical to that used in the geomembrane sheet. Seaming rods and pellets shall be tested for density, melt index and carbon black content in accordance with the approved MQC manual. Seaming rods and pellets which fail to meet the corresponding property values required for the sheet material, shall not be used for seaming.

2.2.2.2 Sheet Material

Geomembrane sheets shall be tested in accordance with the approved MQC manual. As a minimum, MQC testing shall be conducted at the frequencies shown in Table 1. Manufacturer's certified sheet material test reports and a copy of the QC certificates, a minimum of 7 days prior to shipment of geomembrane to the site. Sheets not meeting the minimum requirements specified in Table 1 shall not be sent to the site.

2.2.2.3 Multi-Axial Tensile Test

One multi-axial tensile test shall be performed per 150,000 square feet of geomembrane produced. Testing shall be conducted by the laboratory and certification shall be provided by the laboratory of test results prior to installation in accordance with ASTM D 5617. A minimum multi-axial tensile strain at rupture of 30 percent is required.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Layout and Detail Drawings

Geomembrane panel layout and penetration detail drawings, a minimum of 7 days prior to geomembrane placement.

3.1.2 Surface Preparation

Install geomembrane over GCL the same day GCL is installed. GCL must be dry, clean and free of debris when installing geomembrane. Geomembrane shall be placed in a manner to protect the GCL from rainfall, runoff, or other moisture.

3.2 CONTRACTOR'S RESTRICTIONS

No equipment or tools shall be used that damage the geosynthetic materials (geomembrane/GCL/drainage geocomposite) by handling, trafficking or other means. No personnel working on the geomembrane shall smoke, wear damaging footware or engage in other activities that can damage the geosynthetic materials. The method used to unroll the panels shall not disturb pipes, backfill or underlying geosynthetics.

The storage of fuel oils and other petroleum products shall be restricted to off-capping areas and shall not be located adjacent to or immediately up-gradient to select waste or geosynthetic covered areas. Equipment maintenance (fueling, replacing oil & filters, etc.) shall not take place on select waste or geosynthetic covered areas. Any leakage of petroleum products shall be immediately removed from the select waste or geosynthetic covered areas.

The QC Inspector shall visually observe each panel, after placement and prior to seaming for damage. The QC Inspector shall determine which panels or portions of panels shall be rejected, repaired or accepted. Damaged panels or portions of panels which have been rejected shall be marked and their removal or repair recorded by the QC Inspector.

3.3 GEOMEMBRANE DEPLOYMENT

The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the geomembrane or underlying GCL subgrade. Textured geomembrane shall not be dragged across the GCL. The Contracting Officer will have the option of requiring the use of a slip sheet during installation. Geomembrane damaged during installation shall be replaced or repaired at the QC Inspector's discretion. Only geomembrane panels that can be anchored and seamed together the same day shall be deployed. Adequate ballast (i.e., sand bags) shall be placed on the geomembrane, without damaging the geomembrane, to prevent uplift by wind. No equipment shall be operated on the top surface of the geomembrane without permission from the QC Inspector. If approved, small rubber tired equipment, with a maximum tire inflation pressure of 5 lb per square inch, may be used directly on the geomembrane. The small rubber tired equipment shall not operate on slopes steeper than 5 horizontal on 1 vertical and the tires shall be inspected for rocks lodged in the treads prior to and during use on top of the geomembranes. No stops or turns shall be allowed by equipment on the geomembrane. Seams shall be oriented parallel to the line of maximum slope. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel.

3.3.1 Wrinkles

The methods used to deploy and backfill over the geomembrane shall minimize wrinkles and tensile stresses in the geomembrane. The geomembrane shall have adequate slack to prevent the creation of tensile stress. The wrinkle height to width ratio for installed geomembrane shall not exceed 0.5.

3.3.2 Thickness Measurement

A minimum of five thickness measurements shall be taken along the edge of each roll width and at least two thickness measurements shall be taken along each roll length. For textured geomembrane, thickness shall be measured in accordance with ASTM D 5994. Thickness tests shall be performed by an independent laboratory prior to installation. If thickness

readings fall below the values specified in Table 1, the entire roll shall be rejected and replaced. Thickness measurements shall be certified by the QC Inspector.

3.4 FIELD SEAMING

Submit installer's QC manual, a minimum of 7 days prior to geomembrane placement.

3.4.1 Trial Seams

Trial seams shall be made under field conditions on strips of excess geomembrane. Trial seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel, seaming equipment or when seaming equipment is turned off or unplugged and at least once every four hours, by each seamer and each piece of seaming equipment used that day. One sample shall be obtained from each trial seam. This sample shall be at least 36 inches long by 20 inches wide with the seam centered lengthwise. Ten random specimens 1 inch wide shall be cut from the sample. Five seam specimens shall be field tested for shear strength and 5 seam specimens shall be field tested for peel adhesion using an approved quantitative tensiometer. Jaw separation speed shall be in accordance with the installer's approved QC manual. Where necessary, accelerated curing of trial seams made by chemical methods shall be conducted in accordance with GSI GRI GM-7. To be acceptable, 4 out of 5 replicate test specimens shall meet seam strength requirements specified in Table 2 or 3, as appropriate. If the field tests fail to meet these requirements, the entire operation shall be repeated. If the additional trial seam fails, the seaming apparatus or seamer shall not be used until the deficiencies are corrected by the installer and 2 consecutive successful trial seams are achieved.

3.4.2 Field Seams

Panels shall be seamed in accordance with the geomembrane manufacturer's recommendations. In corners and odd-shaped geometric locations, the number of field seams shall be minimized. Seaming shall extend to the outside edge of panels. Wet surfaces shall be thoroughly dried and soft subgrades compacted and approved prior to seaming. The seam area shall be free of moisture, dust, dirt, and foreign material at the time of seaming. Fish mouths in seams shall be repaired. The following information shall be recorded for each seam:

a. Panel Number

b. Seam number

c. Date and time seam was constructed

d. Temperature of geomembrane at time of seaming

e. Seaming unit designation

f. Name of seamer

g. Seaming equipment temperature and pressures

3.4.2.1 Polyethylene Seams

Polyethylene geomembranes shall be seamed by thermal fusion methods.

Extrusion welding shall only be used for patching and seaming in locations where thermal fusion methods are not feasible. Seam overlaps that are to be attached using extrusion welds shall be ground prior to welding. Grinding marks shall be oriented perpendicular to the seam direction and no marks shall extend beyond the extrudate after placement. Extrusion welding shall begin within 10 minutes after grinding. Where extrusion welds are temporarily terminated long enough to cool, they shall be ground prior to applying new extrudate over the existing seam. The total depth of the grinding marks shall be no greater than 10 percent of the sheet thickness.

3.5 SAMPLES

One QC sample, 18 inches in length, for the entire width of a roll, shall be obtained for every 50,000 square feet of material delivered to the site. Samples shall not be obtained from the first three feet of the roll. The samples shall be identified by manufacturer's name, product identification, lot and roll number, and panel/seam numbers. The seaming and sample collection dates, a unique sample number, and the machine direction shall also be noted. In addition, a 12 inch by 12 inch QA sample shall be collected, labeled, and submitted to the Contracting Officer each time QC samples are collected.

3.6 TESTS

Provide all QC samples to the QC laboratory to determine density, thickness, tensile strength at break, elongation at break, and tear resistance in accordance with the methods specified in Table 1 and QC Manual. Samples not meeting the specified requirements shall result in the rejection of applicable rolls/panels. As a minimum, rolls/panels produced immediately prior to and immediately after the failed roll/panel shall be tested for the same failed parameter. Testing shall continue until a minimum of three successive rolls/panels on both sides of the original failing roll/panel pass the failed parameter.

3.6.1 Non-Destructive Field Seam Continuity Testing

Field seams shall be non-destructively tested for continuity over their full length in accordance with the installer's approved QC manual. At a minimum, field seams created using a dual hot wedge fusion welder shall be tested by air channel pressure testing in accordance with ASTM D 5820. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Any seams which fail shall be documented and repaired in accordance with the installer's approved QC manual. QC Inspector shall certify all test results for all field seams.

3.6.2 Destructive Field Seam Testing

A minimum of one destructive test sample per 750 feet of field seam shall be obtained at locations specified by the QC Inspector. Sample locations shall not be identified prior to seaming. Samples shall be a minimum of 12 inches wide by 42 inches long with the seam centered lengthwise. Each sample shall be cut into 3 equal pieces, with one piece retained by the installer, one piece given to the QC laboratory, and the remaining piece given to the Contracting Officer for QA testing and/or permanent record. Each sample shall be numbered and cross referenced to a field log which identifies: (1) panel number; (2) seam number; (3) date and time cut; (4) ambient temperature within 6 inches above the geomembrane; (5) seaming unit designation; (6) name of seamer; and (7) seaming apparatus temperature and pressures (where applicable). Ten 1 inch wide replicate specimens

shall be cut from the installer's sample. Five specimens shall be tested for shear strength and 5 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be in accordance with the approved QC manual. To be acceptable, 4 out of 5 replicate test specimens shall meet the specified seam strength requirements in Tables 2 and 3. If the field tests pass, 5 specimens shall be tested at the QC laboratory for shear strength and 5 for peel adhesion in accordance with ASTM D 6392. To be acceptable, 4 out of 5 replicate test specimens shall meet the specified seam strength requirements in Tables 2 and 3. If the field or laboratory tests fail, the seam shall be repaired in accordance with paragraph entitled "Destructive Seam Test Repairs." Holes for destructive seam samples shall be repaired the same day they are cut.

3.7 DEFECTS AND REPAIRS

3.7.1 Destructive Seam Test Repairs

Seams that fail destructive seam testing may be overlaid with a strip of new material and seamed (cap stripped). Alternatively, the seaming path shall be retraced to an intermediate location a minimum of 10 feet on each side of the failed seam location. At each location a 12 by 18 inch minimum size seam sample shall be taken for 2 additional shear strength and 2 additional peel adhesion tests using an approved quantitative field tensiometer. If these tests pass, then the remaining seam sample portion shall be sent to the QC laboratory for 5 shear strength and 5 peel adhesion tests in accordance with ASTM D 6392. To be acceptable, 4 out of 5 replicate test specimens must meet specified seam strength requirements. If these laboratory tests pass, then the seam shall be cap stripped between that location and the original failed location. If field or laboratory tests fail, the process shall be repeated. QC Inspector shall certify all test results for all repaired seams. After cap stripping, the entire cap stripped seam shall be non-destructively tested in accordance with paragraph entitled "Non-Destructive Field Seam Continuity Testing."

3.7.2 Patches

Tears, holes, blisters and other defects shall be repaired with patches. Patches shall have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects. Minor localized flaws shall be repaired by spot welding or seaming as determined by the QC Inspector. Repairs shall be non-destructively tested in accordance with ASTM D 5641. The Contracting Officer or the QC Inspector may also elect to perform destructive seam tests on suspect areas.

3.8 VISUAL INSPECTION AND EVALUATION

Immediately prior to covering, the geomembrane, seams, and non-seam areas shall be visually inspected by the QC Inspector and Contracting Officer for defects, holes, or damage due to weather conditions or construction activities. At the Contracting Officer's or the QC Inspector's discretion, the surface of the geomembrane shall be brushed, blown, or washed by the installer if the amount of dust, mud, or foreign material inhibits inspection or functioning of the overlying material. Each suspect location shall be non-destructively tested in accordance with paragraph entitled " Non-Destructive Field Seam Continuity Testing". Each location that fails non-destructive testing shall be repaired in accordance with paragraph entitled "Patches" and non-destructively retested.

3.9 PENETRATIONS

Geomembrane penetration details shall be as shown. Factory fabricated boots shall be used wherever possible. Field seams for penetrations shall be non-destructively tested in accordance with the installer's approved QC manual. Seams that fail non-destructive testing shall be repaired in accordance with the installer's approved QC manual and non-destructively tested prior to acceptance.

3.10 PROTECTION AND BACKFILLING

The deployed and seamed geomembrane shall be covered with the geocomposite drainage layer within 5 calendar days of acceptance. Wrinkles in the geomembrane shall be prevented from folding over during placement of cover materials. Cover soil compaction and testing requirements are described in Section 02315, "Excavation and Fill." Equipment placing cover soil shall not stop abruptly, make sharp turns, spin wheels, or travel at speeds exceeding 5 mph. Full scale construction equipment maybe used on the bench following placement of the base course aggregate.

3.11 AS-BUILT DRAWINGS

Final as-built drawings of geomembrane installation shall be prepared. These drawings shall include panel numbers, seam numbers, location of repairs, destructive seam samples, and penetrations.

-- End of Section --

SECTION 02373

SEPARATION/FILTRATION GEOTEXTILE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3786	(1987) Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Test Method
ASTM D 4354	(1996) Sampling of Geosynthetics for Testing
ASTM D 4355	(1999) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1999) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1997) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1999) Apparent Opening Size of a Geotextile
ASTM D 4759	(1988; R 1996) Determining the Specification Conformance of Geosynthetics
ASTM D 4833	(1988; R 1996) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873	(1995) Identification, Storage, and Handling of Geosynthetic Rolls

MARYLAND STATE HIGHWAY ADMINISTRATOIN (MDSHA)

MDSHA CM	(1993) Construction and Materials

1.2 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0 of the Basic Contract.

SD-03 Product Data

Thread

SD-04 Samples

Quality Assurance Samples and Tests

SD-06 Test Reports

Seams

SD-07 Certificates

Independent Laboratory Qualifications

Geotextiles

SD-08 Manufacturer's Instructions

Manufacturing Quality Control Sampling and Testing

1.3 INDEPENDENT LABORATORY QUALIFICATIONS

The independent construction quality control (QC) laboratory shall have provided QC and/or quality assurance (QA) testing of geotextiles for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.4 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of geotextile shall be in accordance with ASTM D 4873.

1.4.1 Delivery

The QC Inspector shall be present during delivery and unloading of the geotextile. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.4.2 Storage

Geotextile rolls shall be protected from becoming saturated. Rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic. The geotextile rolls shall also be protected from the following: construction equipment, ultraviolet radiation, chemicals, sparks and flames, temperatures in excess of 160 degrees F, and any other environmental condition that may damage the physical properties of the geotextile.

1.4.3 Handling

Geotextile rolls shall be handled and unloaded with load carrying straps, a fork lift with a stringer bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 RAW MATERIALS

2.1.1 Geotextiles

Geotextiles shall be a nonwoven pervious sheet of polymeric material and shall consist of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Stabilizers and/or inhibitors shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material may also be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages. Heat calendered geotextile are not acceptable. Geotextiles and factory seams shall meet the requirements specified in Tables 1 and 2. Where applicable, Tables 1 and 2 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1. NONWOVEN FILTRATION GEOTEXTILE PHYSICAL PROPERTIES

PROPERTY	TEST VALUE	TEST METHOD
Elongation at Break, percent	Greater Than 50	ASTM D 4632
Apparent Opening Size, mm	0.212	ASTM D 4751
Permittivity, sec-1	1.0	ASTM D 4491
Puncture, lbs.	55	ASTM D 4833
Grab Tensile, lbs.	160	ASTM D 4632
Trapezoidal Tear, lbs.	55	ASTM D 4533
Burst Strength, psi	200	ASTM D 3786

TABLE 1. NONWOVEN FILTRATION GEOTEXTILE PHYSICAL PROPERTIES

PROPERTY	TEST VALUE	TEST METHOD
Ultraviolet Stability (percent strength retained at 500 hours)	50	ASTM D 4355
Seam Strength, lbs.	140	ASTM D 4632

TABLE 2. NONWOVEN SEPARATION GEOTEXTILE PHYSICAL PROPERTIES

Use MDSHA CM, Section 921.09, Class C.

A minimum of 14 days prior to scheduled use, manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section shall be submitted. This submittal shall include copies of manufacturer's quality control test results. For needle punched geotextiles, the manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

2.1.2 Thread

Sewn seams shall be constructed with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile. A minimum of 14 days prior to scheduled use, proposed thread type for sewn seams along with data sheets showing the physical properties of the thread.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. A minimum of 14 days prior to scheduled use, manufacturer's quality control manual including instructions for geotextile storage, handling, installation, seaming, and repair. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D 4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

PART 3 EXECUTION

3.1 QUALITY ASSURANCE SAMPLES AND TESTS

Samples for quality assurance testing; 7 days shall be allotted in the schedule to allow for testing.

3.1.1 Quality Assurance Samples

Samples shall be collected upon delivery to the site for quality assurance testing at a frequency of one per 100,000 square feet. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date

and a unique sample number shall also be noted on the sample. The outer layer of the geotextile roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately rewrapped in their protective covering.

3.1.2 Quality Assurance Tests

Provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Table 1. Test method ASTM D 4355 shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

3.2 INSTALLATION

3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 02315, "Excavation and Fill."

3.2.2 Placement

The QC Inspector shall be present during handling and installation. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes greater than 5 horizontal on 1 vertical, the geotextile shall be laid with the machine direction of the fabric parallel to the slope direction.

3.3 SEAMS

3.3.1 Overlap Seams

Geotextile panels shall be continuously overlapped a minimum of 12 inches. Where it is required that seams be oriented across the slope, the upper panel shall be lapped over the lower panel. The Contractor has the option of field sewing instead of overlapping.

3.3.2 Sewn Seams

A flat seam type SSQ-1 401 two-thread chain stitch shall be used unless otherwise recommended by the manufacturer. The minimum distance from the geotextile edge to the stitch line nearest to that edge shall be 3 inches unless otherwise recommended by the manufacturer. The thread at the end of each seam run shall be tied off to prevent unraveling. Seams shall be on the top side of the geotextile to allow inspection. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum stitching overlap of 18 inches.

3.4 PROTECTION

The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent

uplift by wind. The geotextile shall not be left uncovered for more than 14 days during installation.

3.5 REPAIRS

Geotextile damaged during installation shall be repaired by placing a patch of the same type of geotextile which extends a minimum of 12 inches beyond the edge of the damage or defect. Patches shall be continuously fastened using a sewn seam or other approved method. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile which cannot be repaired shall be replaced.

3.6 PENETRATIONS

Engineered penetrations of the geotextile shall be constructed as indicated.

3.7 COVERING

Geotextile shall not be covered prior to inspection and approval by the QC Inspector. The QC Inspector shall be present during covering of the geotextile. Cover soil requirements are described in Section 02315, "Excavation and Fill." The direction of backfilling shall proceed in the direction of downgradient shingling of geotextile overlaps. However, on side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves.

-- End of Section --

SECTION 02374

GEOCOMPOSITE DRAINAGE LAYER

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 413	(1998) Rubber Property - Adhesion to Flexible Substrate
ASTM D 1505	(1998) Density of Plastics by the Density-Gradient Technique
ASTM D 4218	(1996) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4355	(1999) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1999) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1997) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	(2000) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic using a Constant Head
ASTM D 4751	(1999) Apparent Opening Size of a Geotextile
ASTM D 4833	(1988; R 1996) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5035	(1995) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5199	(1998) Nominal Thickness of Geotextiles and Geomembranes
ASTM D 5261	(1992; R 1996) Measuring Mass per Unit Area of Geotextiles

ASTM D 5321	(1992; R 1998) Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM F 904	(1998) Comparison of Bond Strength or Ply Adhesion of Similar Laminates made from Flexible Materials

1.2 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0 of the Basic Contract.

SD-03 Product Data

Construction Quality Control Testing Results

SD-06 Test Reports

Seams and Overlaps

End Seams

Penetrations

SD-07 Certificates

Independent Laboratory Qualifications

Geocomposite Drainage Layer

1.3 INDEPENDENT LABORATORY QUALIFICATIONS

The independent construction quality control (QC) laboratory shall have provided QC and/or quality assurance (QA) testing of geocomposite drainage layers for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.4 DELIVERY, STORAGE AND HANDLING

Geocomposite drainage layer material shall not be damaged during shipping, storage, or handling. Any drainage layer material found to be damaged shall be repaired or replaced. Material shall be delivered only after the required submittals have been approved. Each roll shall be labelled with the Manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls that have attached geotextiles shall be individually wrapped in plastic.

1.4.1 Delivery

The QC Inspector shall be present during delivery and unloading of the geocomposite drainage layer material.

1.4.2 Storage

Geocomposite material shall be protected from becoming saturated. Rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic. Geocomposite rolls shall also be protected from the following: construction equipment, ultraviolet radiation, chemicals, sparks and flames, temperatures in excess of 160 degrees F, and any other environmental conditions that may damage the physical properties of the geocomposite.

1.4.3 Handling

Geocomposite rolls shall be handled and unloaded with load carrying straps, a fork lift with stringer bar, or an axle bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 GEOCOMPOSITE DRAINAGE LAYER

The polymer used to manufacture the tri-planar geonet component of the geocomposite drainage layer shall be polyethylene which is clean and free of any foreign contaminants. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the tri-planar geonet; however, post-consumer recycled materials shall not be used. The geocomposite drainage layer shall conform to the property requirements listed in Table 1 and shall be free of defects. Submit one properly identified 24 by 24 inch minimum size geocomposite drainage layer sample with any attached geotextiles. The fasteners proposed for use shall also be submitted. The minimum manufactured geocomposite roll width shall be 6.7 feet and the minimum manufactured geocomposite roll length shall be 200 feet.

2.2 GEOCOMPOSITE DRAINAGE LAYER PROPERTIES

The geonet shall be covered on both sides with nonwoven geotextile. Geotextile shall not be heat calendered. Geocomposite drainage layer shall be created by heat bonding geotextile to the geonet.

TABLE 1 - GEOCOMPOSITE DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM TESTING FREQUENCY
GEONET			
Thickness, minimum	ASTM D 5199	225 mil	40,000 sq ft
Polymer Density, minimum	ASTM D 1505	0.940 g/cc	once per project
Carbon Black Content, min.	ASTM D 4218	2 percent	40,000 sq ft
Tensile Strength, minimum	ASTM D 5035	58 lbs/in	40,000 sq ft

TABLE 1 - GEOCOMPOSITE DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM TESTING FREQUENCY
NON-WOVEN GEOTEXTILE - Attached to Geonet on both sides.			
Mass/Unit Area, MARV	ASTM D 5261	6.0 oz/sq yd	90,000 sq ft
Grab Strength, MARV	ASTM D 4632	160 lbs	90,000 sq ft
Permittivity, MARV	ASTM D 4491	1.3 sec^{-1}	540,000 sq ft
AOS(O95), MARV	ASTM D 4751	0.21 mm	540,000 sq ft
Puncture, MARV	ASTM D 4833	85 lbs	90,000 sq ft
UV Resistance, MARV	ASTM D 4355	70 percent retained	once per project
Trapezoid Tear, MARV	ASTM D 4533	55 lbs	90,000 sq ft
GEOCOMPOSITE DRAINAGE LAYER			
Transmissivity, minimum, including attached geotextiles (Note 1)	ASTM D 4716	2.2×10^{-3} m^2/sec	100,000 sq ft
Geonet/Geotextile Adhesion, minimum (Note 2)	ASTM D 413 or ASTM F 904	1.0 lbs/in	40,000 sq ft

MARV = Minimum Average Roll Value

Note 1: Manufacturing quality control transmissivity tests shall be measured using water at 20 degrees C with a gradient of 0.10 under a normal pressure of 15,000 psf. A minimum seating period of 15 minutes shall be used.

Note 2: Minimum of five equally spaced tests across the roll width.

2.3 SAMPLING AND TESTING

2.3.1 Manufacturing Quality Control Testing

Manufacturing quality control test methods and frequencies shall be in accordance with Table 1 unless otherwise approved.

2.3.2 Construction Quality Control Testing

A minimum of one transmissivity test shall be performed by an independent laboratory in accordance with the requirements of this paragraph. Transmissivity shall be measured using water at 68 degrees F with a hydraulic gradient of 0.25 under a normal pressure of 300 psf. Geotextile shall be attached to the geonet in the same configuration as will be used in the field. The drainage layer shall be sandwiched between 60 mil textured LLDPE geomembrane on the bottom and site-specific cover soil on the top. A minimum seating period of one hour or until equilibrium is reached, whichever is greater, shall be used. The construction quality

control test results must achieve a minimum transmissivity of 2.2 X 10^{-3} m^2 /sec.

2.3.2.1 Interface Friction Tests

Laboratory interface friction tests shall be conducted by an independent laboratory on the following interface: geocomposite drainage layer versus site cover soil. The frequency of testing shall be once per borrow source of cover soil. Tests shall be conducted in accordance with ASTM D 5321. Normal stresses of 150, 300 and 600 psf along with a displacement rate of 0.04 inches per minute shall be used. Components shall be saturated for one hour prior to shear. Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field. A minimum interface friction angle of 25 degrees measured at 2 inches of displacement is required. Delamination of the geocomposite during interface shear testing shall indicate an unacceptable geocomposite.

PART 3 EXECUTION

3.1 CONTRACTOR'S RESTRICTIONS

In accordance with Section 02372, "Waste Containment Geomembrane."

3.2 INSTALLATION

3.2.1 Surface Preparation

Prior to placement of the geocomposite drainage layer, the surface of the geomembrane shall be cleaned.

3.2.2 Placement

The QC Inspector shall be present during handling and installation. The geocomposite drainage layer shall not be damaged during placement. Faulty or damaged material shall be replaced or repaired as specified in paragraph entitled "Repairs." The drainage layer shall be unrolled in the direction of maximum slope, keeping the net in slight tension to minimize wrinkles and folds. The drainage layer shall not be dragged across textured geomembrane. Adequate ballast (e.g. sandbags) shall be placed to prevent uplift by wind prior to covering. During placement of geocomposite, care shall be taken not to entrap dirt or dust in the geotextile or geonet that could cause clogging of the system. When directed by the QC Inspector, dirt or dust entrapped shall be washed clean with water prior to placement of the next material on top of it. Care should be taken with the handling of sandbags to prevent rupture or damage of the sandbags.

3.2.3 Seams and Overlaps

3.2.3.1 Geonet Side Seams

Geonet components shall overlap a minimum of 2 inches to join adjacent edges of geonet along the length of the geocomposite. Side seam fastener spacing shall be a maximum of 5 feet.

3.2.3.2 Geonet End Seams

Geonet components shall be overlapped a minimum of 1 foot when joining geocomposite rolls end to end. End seam fastener spacing shall be a maximum of 6 inches. The overlaps shall be shingled in the direction of

flow. End seams shall not be allowed on side slopes steeper than 4 horizontal on 1 vertical.

3.2.3.3 Geonet Fasteners

Geonet rolls shall be tied together with plastic fasteners for both end seams and side seams. The fasteners shall be a contrasting color from the geonet and attached geotextiles. Metallic fasteners will not be allowed.

3.2.3.4 Geotextile End and Side Seams

The bottom layers of geotextile shall be overlapped. The top layers of geotextiles shall be continuously sewn. Geotextile shall be overlapped a minimum of 4 inches prior to seaming. Seams of geotextile which require sewing shall be sewn using polymeric thread with chemical resistance properties equal to or exceeding those of the geotextile which it is securing. Thread shall be of a contrasting color be bonded and thermally set and a minimum 2,000 denier. Seams shall be prayer seam, "J" seam or butterfly seam. The seam shall be a two-thread double-lock stitch or double row of single thread chain stitch. Seams shall contain 4 to 7 stitches per row per inch.

3.2.3.5 Geocomposite Edges

Geotextile component extending beyond the geonet shall be sewn together at the termination of the geocomposite drainage layer.

3.2.4 Penetrations

Geotextile shall be attached to penetrations so that soil is prevented from getting into the drainage layer. The apron of the attached geotextile shall extend out from the penetration a minimum of 2 feet. The geotextile shall be thermally bonded to the geotextile component of the geocomposite.

3.3 REPAIRS

3.3.1 Geonet Damage

Repairs shall be made by placing a patch of the geocomposite drainage layer over the damaged area. The patch shall extend a minimum of 2 feet beyond the edge of the damage. Approved fasteners, spaced every 6 inches around the patch, shall be used to hold the patch in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.3.2 Geotextile Damage

Damaged geotextile shall be repaired by placing a patch of geotextile over the damaged area with a minimum of 12 inches of overlap in all directions. The geotextile patch shall be thermally bonded in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.4 PROTECTION AND BACKFILLING

The deployed and seamed geocomposite drainage layer shall be covered with soil within 5 calendar days after acceptance. Cover soil compaction and testing requirements are described in Section 02315, "Excavation and Fill." Equipment placing cover soil shall not stop abruptly, make sharp turns,

spin their wheels, or travel at speeds exceeding 5 mph. Full scale construction equipment maybe used on the bench following placement of the base course aggregate.

-- End of Section --

SECTION 02376

GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 698	(1991) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 4632	(1991; R 1997) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4643	(2000) Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D 5084	(1990; Rev. 1997) Measure of Hydraulic Conductivity of Saturated Porous Materials Using Flexible Wall Permeameter
ASTM D 5321	(1992; R 1998) Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D 5887	(1995) Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D 5888	(1995) Storage and Handling of Geosynthetic Clay Liners
ASTM D 5889	(1995) Quality Control of Geosynthetic Clay Liners
ASTM D 5890	(1995) Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D 5891	(1995) Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D 5993	(1996) Measuring Mass Per Unit of Geosynthetic Clay Liners

1.2 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0 of the Basic Contract.

SD-02 Shop Drawings

Layout and Detail Drawings

SD-03 Product Data

GCL Properties

Warranty

SD-04 Samples

Samples

SD-06 Test Reports

Friction Testing

Conformance Tests

Subgrade Preparation

SD-07 Certificates

Qualifications

SD-08 Manufacturer's Instructions

Tests, Inspections, and Verifications

SD-09 Manufacturer's Field Reports

Subgrade Preparation

1.3 QUALIFICATIONS

Submit manufacturer's, installer's, QC Inspector's, and QC laboratory's qualification statements including resumes of key personnel involved in this project, a minimum of 7 days prior to GCL shipment. Submit Installer's, QC Inspector's, and QC Laboratory's qualifications statements including resume of key personnel involved in the project, a minimum of 7 days prior to GCL placement.

1.3.1 Manufacturer

Geosynthetic clay liner shall be the product of a GCL Manufacturer who has produced the proposed GCL using the same bentonite, geotextiles, sewing thread, and adhesive for at least 5 completed projects having a total minimum of 10,000,000 square feet.

1.3.2 Installer

The installer is responsible for field handling, deploying, seaming, and

anchoring. The installer shall have installed the proposed GCL for at least 5 completed projects having a total minimum area of 2 million square feet.

1.3.3 QC Inspector

The QC Inspector is responsible for monitoring and documenting activities related to the QC of the GCL from manufacturing through installation. The QC Inspector shall have provided QC and/or QA inspection during installation of GCL material for at least 5 projects and shall have performed QC and/or QA inspection on a minimum of 2 million square feet of GCL.

1.3.4 QC Laboratory

The QC laboratory is responsible for QC GCL testing. The QC laboratory shall have provided QC and/or QA testing of GCL for at least 5 completed projects and shall have performed QC and or QA testing for a total minimum area of 2 million square feet of GCL. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP).

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Delivery, storage, and handling of GCL shall be in accordance with ASTM D 5888. The QC Inspector shall be present during delivery and unloading of the GCL. Rolls shall be packaged in an opaque, waterproof, protective covering and wrapped around a central core. Tears in the packaging shall be repaired to restore a waterproof protective barrier around the GCL. Unloading of rolls from the delivery vehicles shall be done preventing damage to the GCL and its packaging. Each GCL roll shall be labeled with the manufacturer's name, product identification number, roll/panel number, and roll dimensions.

1.4.2 Storage

Field storage shall be in flat dry areas where water cannot accumulate and the GCL rolls can be protected from damage. Storage of the rolls on blocks or pallets will not be allowed unless the GCL rolls are fully supported. Stacks of GCL rolls shall be no greater than three high. Rolls shall be covered with a water proof tarpaulin or plastic sheet if stored outdoors.

1.4.3 Handling

Rolls shall not be dragged, lifted by one end, or dropped to the ground from the delivery vehicle. A pipe or solid bar of sufficient strength to support the full weight of the roll without significant bending shall be used for all unloading and handling activities. The diameter of the pipe shall be small enough to be easily inserted through the core of the GCL roll. Approved lifting slings shall be used to link the ends of the core pipe to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the slings from rubbing against the ends of the GCL roll. Alternatively, a stringer bar protruding from the end of a forklift or other equipment may be used. The stringer bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the GCL without significant bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading

straps may be used.

1.5 WARRANTY

The manufacturer's warranty shall state that GCL material meets all requirements of the contract documents and that for the intended use, the GCL is warranted for 5 years against deterioration. The installer's warranty shall state that the GCL shall not fail due to improper installation within 5 years.

PART 2 PRODUCTS

2.1 GCL PROPERTIES

GCL shall be a manufactured product consisting of a sodium montmorillonite clay (bentonite) layer evenly distributed between two non-woven geotextiles. GCL shall conform to the property requirements listed in Table 1 and shall be free of tears, holes, or other defects which may affect its serviceability. Encapsulating geotextiles shall be mechanically bonded together (reinforced) using a needle punch process. Needle punched GCLs shall be continuously inspected for broken needles using an in-line metal detector and broken needles shall be removed. The minimum manufactured GCL sheet width shall be 13.5 feet and the minimum manufactured GCL sheet length shall be 150 feet.

TABLE 1 - REINFORCED GCL PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	FREQUENCY
BENTONITE			
Swell Index Test, minimum	ASTM D 5890	24 mL	1 per 50 tons
Fluid Loss, maximum	ASTM D 5891	18 mL	1 per 50 tons
COMPOSITE			
Grab Strength (lbs)	ASTM D 4632	>85	1 per project
Bentonite Mass/Unit Area, (MARV, Notes 1 & 2)	ASTM D 5993	0.75 (lbs/sq ft)	1/40,000 sf
Peak Mid-Plane Shear Strength (hydrated), minimum at a normal stress of 200 psf (Note 3)	ASTM D 5321	500 psf	1 per project
Interface Friction Angle (hydrated), minimum (Note 3)	ASTM D 5321	25 degrees	1 per interface per project (Note 4)
Index Flux, max. ($m^3/m^2/sec$)	ASTM D 5887	1×10^{-8}	1 per project

TABLE 1 - REINFORCED GCL PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	FREQUENCY
Peel Strength, MARV MD	ASTM D 4632	15 lbs.	1/40,000 sf
Permeability under 5 psi effective confining pressure (cm/sec)	ASTM D 5084	$<5 \times 10^{-9}$	1 per project

Note 1: MARV = minimum average roll value.

Note 2: Bentonite mass/unit area shall be computed at 20 percent moisture content. Moisture content shall be determined by ASTM D 2216 or ASTM D 4643. Bentonite mass/unit area is exclusive of glues added to the bentonite.

Note 3: Test conditions shall comply with the paragraph entitled "Friction Testing."

Note 4: Once per borrow source for lower interface of GCL against subgrade soil.

Submit manufacturer's certified raw and roll material data sheets. The certification shall indicate that the GCL has been continuously inspected for broken needles using an in-line metal detector and all broken needles have been removed. The certified data sheets shall be attested to by a person having legal authority to bind the GCL manufacturing company. Certified test results shall be submitted at least 7 working days prior to delivery of the GCL.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit manufacturer's quality control (QC) manual which describes testing procedures, frequency of testing and acceptance/rejection criteria for QC testing at least 7 days prior to delivery of the GCL.

2.2.1 Manufacturing Sampling and Testing

GCL and its components shall be sampled and tested in accordance with the manufacturer's approved QC manual. The manufacturer's QC procedures shall be in accordance with ASTM D 5889. Test results not meeting the requirements specified in Table 1 shall result in the rejection of applicable rolls. The manufacturer's QC manual shall describe procedures used to determine rejection of applicable rolls. As a minimum, rolls produced immediately prior to and immediately after the failed roll shall be tested for the same failed parameter. Testing shall continue until a minimum of three successive rolls on both sides of the original failing roll pass the failed parameter.

2.2.2 Friction Testing

Interface shear strength testing shall be performed on both interfaces of the GCL and reported in accordance with ASTM D 5321. The hydration fluid to be used for both mid-plane and interface shear strength testing shall be tap water. The final moisture content of the GCL at the center of each specimen shall be included with the test results. GCL and adjacent

geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of the geosynthetics in the field. Modifications to the test procedures described in this section shall be submitted and approved prior to use. Submit friction test results at least 14 days prior to deployment.

2.2.2.1 Mid-Plane Shear Strength Testing

One set of mid-plane direct shear tests shall be performed. Specimens shall be allowed to hydrate prior to shearing for a minimum of 24 hours. Free drainage shall be provided along both sides of the GCL to aid in hydration. Specimens shall be allowed to consolidate prior to shearing for a minimum of 8 hours. Normal stresses of 150, 300, and 600 psf shall be used during hydration, consolidation, and shearing. The normal stresses shall not be relieved prior to or during shearing of the specimens. The shear rate shall be 0.04 inches per minute.

2.2.2.2 Interface Shear Strength Testing

One set each of interface direct shear tests shall be performed on both interfaces of the GCL. The upper face of the GCL shall be tested against the selected textured 60 mil LLDPE geomembrane. The lower face of the GCL shall be tested against subgrade soil (as per Section 02315, "Excavation and Fill") compacted to 95 percent of ASTM D 698 at the the optimum moisture content plus 2 percent. Follow manufacturer's instructions to determine which side is the upper face of the GCL. Specimens shall be allowed to hydrate prior to shearing for a minimum of 24 hours. Free drainage shall be provided along one side of the GCL to aid in hydration. The other side of the GCL shall be placed against the interface material on which the test will be run. This interface material shall remain in place during hydration, consolidation, and shearing. Specimens shall be allowed to consolidate prior to shearing for a minimum of 8 hours per load increment. Use 150 pcf as the initial load increment, loads shall be doubled until final normal stress is achieved. Final normal stresses of 150, 300, and 600 psf shall be used during consolidation, and shearing. The normal stresses shall not be relieved prior to or during shearing of the specimens. The shear rate shall be 0.04 inches per minute. Tests shall be run until a minimum total displacement of 2 inches is reached.

PART 3 EXECUTION

3.1 CONTRACTOR'S RESTRICTIONS

In accordance with Section 02372, "Waste Containment Geomembrane."

3.2 SAMPLES AND TESTS

3.2.1 Samples

QC samples shall be collected at approved locations upon delivery to the site at a frequency of one test sample per 50,000 square feet. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot and roll number. The date, a unique sample number, the machine direction, and the top surface of the GCL shall also be noted on the sample. The outer layer of the GCL roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the GCL sheet a minimum of 3 feet wide in the machine direction. After cutting, the GCL sample shall be manually rolled around a core at least 3.0 inches in diameter. The GCL shall be wound on the core

without slack. Strapping tape a minimum of 2 inches in width shall then be wound around the sample in at least two places to secure the loose end. A minimum of two layers of plastic sheeting shall be used to wrap the GCL sample roll for shipment. A thin cellophane material which covers the entire sample a minimum of three times shall be used as the inner wrapping. The outer wrapping shall be at least 6 mils in thickness and shall be wrapped and fastened to minimize the amount of GCL shifting within the wrapping.

3.2.2 Conformance Tests

Provide QC samples to the QC laboratory for testing. Samples shall be tested to determine mass per unit area in accordance with ASTM D 5993 on each sample submitted. Peel strength, flux, and tensile strength shall be tested at the request of the Contracting Officer. Tests not meeting the requirements specified in Table 1 shall result in the rejection of applicable rolls. Determination of applicable rolls shall be as described in paragraph entitled, "Tests, Inspections and Verifications."

3.3 INSTALLATION

3.3.1 Subgrade Preparation

The subgrade shall be compacted in accordance with Section 02315, "Excavation and Fill." The subgrade surface shall be smooth and free of vegetation, standing water, and angular stones or other foreign matter that could damage the GCL. At a minimum, the subgrade surface shall be rolled with a smooth-drum compactor of sufficient weight to remove any wheel ruts, voids, cracks, footprints, or other abrupt grade changes. All protrusions extending more than 0.5 inches from the subgrade (or less if recommended by the manufacturer) shall either be removed, crushed, or pushed into the surface with the smooth-drum compactor. The GCL shall not be installed on a frozen subgrade. Each day during placement of GCL, the QC Inspector and installer shall inspect the surface on which GCL is to be placed and certify in writing that the surface is acceptable.

3.3.2 Layout and Detail Drawings

Submit GCL panel layout and penetration detail drawings a minimum of 7 days prior to deployment.

3.3.3 Placement

GCL shall be installed as soon as practical after completion and approval of the subgrade; but, GCL shall not be deployed if it is frozen. Rolls shall be delivered to the work area in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. GCL which has been hydrated prior to being covered by an overlying geomembrane shall be removed and replaced. Hydrated GCL is defined as material which has become soft as determined by squeezing the material with finger pressure or material which has exhibited swelling. Construction equipment may be used to deploy GCL without damaging the subgrade. On side slopes, GCL shall be anchored at the top by sufficient runout. GCL shall be deployed down the slope to minimize wrinkles. Dragging of GCL panels over the ground surface shall be minimized. The Contracting Officer has the option of requiring the use of a slip sheet. Deployed GCL panels shall lie flat on the subgrade surface, with no wrinkles or folds.

Equipment which can damage the GCL shall not travel directly on the GCL. GCL is to be unrolled in front of the backward moving equipment. When equipment causes damage to the subgrade, restore subgrade to the previous condition prior to GCL placement

3.3.4 Seams

On side-slopes, GCL shall be placed with seams oriented parallel to the line of maximum slope and shall be free of tension or stress upon completion of the installation. Panels shall be positioned with the overlap recommended by the manufacturer, but not less than 6 inches after shrinkage for panel sides or 24 inches after shrinkage for panel ends. Dirt or other foreign matter shall be removed from the overlap area immediately prior to seaming. Granular bentonite of the same type as the bentonite used for the GCL shall be placed along the entire overlap width at a minimum rate of 0.25 lbs/linear foot or as recommended by the manufacturer. Construction adhesive or other approved seaming methods recommended by the manufacturer shall be used for horizontal seams on slopes. Overlaps which occur on slopes shall be constructed with the up slope GCL shingled over the down slope GCL. Alternate seaming methods may be approved if recommended by the manufacturer.

3.3.5 Protection

Only those GCL panels which can be covered in the same day shall be unpackaged and installed. If exposed GCL cannot be permanently covered before the end of a working day, it shall be temporarily covered with plastic or other waterproof material to prevent hydration.

3.4 REPAIRS

Holes or tears in GCL shall be repaired by placing a patch of GCL extending a minimum of 12 inches beyond the edges of the hole or tear on all sides. Granular bentonite or bentonite mastic shall be applied in the overlap area. Patches shall be secured with a construction adhesive or other approved methods as recommended by the manufacturer.

3.5 PENETRATIONS

Penetration details shall be as recommended by the GCL manufacturer. Dry bentonite or bentonite paste shall be placed around the penetration for additional protection.

3.6 COVERING

GCL shall not be covered with geomembrane prior to inspection and approval by the QC Inspector. Covering shall be in accordance with Section 02372, "Waste Containment Geomembrane."

-- End of Section --

SECTION 02525

MONITORING WELLS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C 150	(1998; Rev. A) Portland Cement
ASTM C 778	(2000) Standard Sand
ASTM D 1586	(1984; R 1992) Penetration Test and Split-Barrel Sampling of Soils
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2488	(1993) Description and Identification of Soils (Visual-Manual Procedure)
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 5088	(1990) Decontamination of Field Equipment Used at Nonradioactive Waste Sites
ASTM F 480	(1995) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80
ASTM F 883	(1997) Padlocks

CODE OF MARYLAND REGULATIONS (COMAR)

COMAR 26.04.04.11	Well Construction/Abandonment Standards

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600-4-89-034	(1989) Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells

1.2 DESCRIPTION OF WORK

Provide groundwater monitoring well abandonment services, gas monitoring

well installation, and gas vent installation, including drilling, casing, well screen, gravel packing, cement, bentonite, grout, and incidental related work, complete and ready for operation, as appropriate. Extend well casings and protective casings for selected wells, including provision of well and casings, protective casings, locking caps, grout, and incidental related work.

1.3 GENERAL REQUIREMENTS

Each system, including equipment, materials, installation, and performance, or well abandonment, shall be in accordance with local, State, and Federal regulations, COMAR 26.04.04.11, and EPA 600-4-89-034 except as modified herein. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" has been substituted for the word "should" wherever it appears. Reference to the "Project Representative" and the "Owner" shall be interpreted to mean the Contracting Officer. Mark and secure monitoring wells to avoid unauthorized access and tampering.

1.4 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0 of the Basic Contract.

SD-03 Product Data

Well casing

Well screen

Filter pack

Neat cement grout

Bentonite seal

SD-07 Certificates

Well Survey Report

Gas Monitoring Well Construction Permit

SD-11 Closeout Submittals

Gas Monitoring Well Construction Report

Well Abandonment Report

Well Extension Report

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials in an undamaged condition. Unload and store with minimal handling. Store materials in on-site enclosures or under protective coverings. Store materials under cover, out of direct sunlight. Store materials off the ground. Keep insides of pipes and fittings free of dirt and debris. Replace defective or damaged materials with new materials.

1.6 QUALITY ASSURANCE

1.6.1 Professional Oversight

Reports shall be prepared by a State certified professional geologist or hydrogeologist, or by a State registered professional civil engineer, hereafter referred to as the Contractor's Professional Consultant (CPC). Reports shall be sealed.

1.6.2 Health and Safety Plan (HASP)

Provide in accordance with Section 01115, "General Paragraphs (Remedial Action Contracts)."

1.6.3 Well Abandonment Report

Provide report, containing the following data for each well: project name and location, well designation, date and time of well abandonment, static water level from top of well casing prior to abandonment, depth of well from top of casing to bottom of well, description of abandonment methodology, volume of cement and/or bentonite grout added. Complete an "Abandoned Well Report" form for each well abandoned.

1.6.4 Gas Monitoring Well Construction Permit

Submit a completed permit application and a proposed method of construction to the appropriate state agency prior to construction of the well. Construction of the well will not be allowed until an approved Well Construction Permit has been submitted to the Contracting Officer.

1.6.5 Gas Monitoring Well Construction Report

Submit report containing the following data for each gas monitoring well: project name and location, well designation, boring log, date and time of well installation, depth of well from top of casing to bottom of well, screened interval, and backfill materials/depths. Provide a well construction diagram for each well.

1.6.6 Well Extension Report

Well construction report for the wells that were extended. Provide details regarding the methodologies employed, materials used, length of extensions added, and protective casing installation.

PART 2 PRODUCTS

2.1 WELL CASING

2.1.1 PVC Piping

ASTM F 480, Type 1, Grade 1, PVC 12454, NSF wc or NSF pw, Schedule as indicated, with flush threaded joint fittings.

2.2 WELL SCREEN

Well screens shall be located as indicated. The length of each screen shall be as indicated. Slot size shall be 0.030 inch. Slotted openings shall be distributed uniformly around the circumference of the screen. Open area shall approach the formation's natural porosity.

2.2.1 PVC Screens

ASTM D 1785, PVC 1120, NSF wc or NSF pw, Schedule as indicated, screen, machine-slotted construction, flush threaded joint ends. Slots shall be even in width, length, and separation.

2.3 PRIMARY FILTER PACK

Provide clean, durable, well-rounded, and washed quartz or granite, with less than 5 percent non-siliceous material. The filter pack shall not contain organic matter or friable materials. The filter pack shall allow free flow of gas/air in the well, and shall prevent the infiltration of surrounding materials. Filter pack shall have passed the U.S. Standard Number 8 Sieve and be retained on the U.S. Standard Number 14 Sieve.

2.4 SECONDARY FILTER PACK

ASTM C 778, 20 - 30 Sand.

2.5 ANNULAR SEALANTS

2.5.1 Bentonite Seal

Provide pelletized, sodium montmorillonite in sealed containers from a commercial source, free of impurities.

2.5.2 Neat Cement Grout

Provide neat cement grout in accordance with COMAR 26.04.04.11. Cement shall be in accordance with ASTM C 150. Quick setting admixtures shall not be allowed. Drilling mud or cuttings shall not be used as a sealing material.

2.6 BOTTOM PLUGS

Provide flush threaded solid plug at the bottom of the gas monitoring well and gas vents. Plug shall be the same material as the well to which it is attached.

2.7 WELL CAP

Provide a slip-on, vented, removable well cap on the top of each groundwater monitoring well. Well cap shall be of the same material as the well casing. Provide sample port as indicated for each gas monitoring well.

2.8 SCREENED END CAPS

Provide flush threaded open end cap at the outlet of each gas vent. End cap shall be of the same material as the vent riser to which the cap is attached. The face of the cap shall consist of screen as indicated.

2.9 WELL HEAD COMPLETIONS

Clearly mark and secure the monitoring well to avoid unauthorized access and tampering. Cast the words "MONITORING WELL" on the well head cover. Provide stamped metal identification tag as follows:

DO NOT DISTURB
ID #: Date:
Installed By:
Total Depth:
Screened Interval:
TOC Elevation:
Other:
For Information, Call:

2.9.1 Aboveground Completions

Provide protective outer casing around the monitoring well casing extending above grade. The diameter of the protective outer casing shall be a minimum of 4 inches larger than the well casing diameter. The top of the protective outer casing shall extend a minimum of 4 inches and a maximum of 6 inches above the top of the well casing cap. The protective outer casing shall be set in cement grout and the bottom of the protective well casing shall extend below the depth of the frost line. A 1/4 inch diameter weep hole shall be drilled in the protective outer casing 3 inches above the ground surface. The annular space between the protective outer casing and the well casing shall be filled with pea gravel or coarse sand to just below the level of the cap on the well casing. A locking protective casing cap shall be provided on top of the protective outer casing. Provide a long shackled padlock in accordance with ASTM F 883. Provide two keys for the padlock, and turn them over to the Contracting Officer. Locks at the well site shall be keyed alike.

2.9.1.1 Protective Outer Casing

ASTM A 53, Type E or S, Grade B.

2.9.1.2 Monitoring Well Protective Casing Cap

Provide secure locking cap on top of the protective outer casing.

2.10 POLYETHYLENE SHEETING

ASTM D 4397.

PART 3 EXECUTION

3.1 GENERAL

Notify the Contracting Officer at least 15 days prior to commencement of work. Locations of wells shall be as indicated. Drilling, installation, and abandonment and extension of the monitoring wells and vents shall be supervised, directed, and monitored by the CPC. Drilling, sampling, and abandonment equipment introduced to the well shall be decontaminated before and after each use in accordance with ASTM D 5088.

3.2 DRILLING

Borehole shall be advanced using conventional hollow-stem auger drilling methods. Drill crew shall be experienced and trained in drilling and safety requirements for contaminated sites.

3.2.1 Sampling

Obtain samples in accordance with ASTM D 1586. Perform standard

penetration tests at the following depths: 0.0 to 1.5 feet; 1.5 to 3.0 feet; 3.0 to 4.5 feet; and 5 foot centers or at changes in soil formation thereafter. Each soil sample shall be screened in the field with an organic vapor analyzer/flame ionization device (OVA/FID) capable of detecting vapors to a minimum of one ppm. Log boring in accordance with ASTM D 2488. Groundwater elevation shall be indicated.

3.2.2 Alignment

Verify that the well is straight by lowering a 10 foot section of steel pipe into the well.

3.3 SOIL REMOVED FROM THE BOREHOLE

Place all soils removed from borehole under landfill cap.

3.4 WELL ABANDONMENT

Well abandonment procedures shall be in accordance with COMAR 26.04.04.11 and EPA 600-4-89-034. The steel protective casing, padlock, bumper poles (if present) and surface concrete shall be removed and disposed. A cement bentonite grout mixture shall be delivered to the bottom of groundwater monitoring well through the use of a tremie pipe and pump system. The casing shall then be removed to a minimum depth of 30-inches below surface and the resulting borehole annulus grouted to surface. The grout shall be allowed to settle for a period of 24-hours and additional grout applied, when necessary. Submit an Abandoned Well Report form at completion.

3.5 GAS MONITORING WELL AND GAS VENT INSTALLATION

Well installation shall be as indicated. Borehole shall be stable and shall be verified straight before beginning installation.

3.5.1 Casings and Screens

Well casings, screens, plugs, and caps shall be decontaminated prior to delivery by the manufacturer and shall be certified clean. Materials shall be delivered, stored, and handled in such manner as to ensure that grease, oil, or other contaminants do not contact any portion of the well screen and casing assembly prior to installation. If directed by the Contracting Officer, the well screen and casing assembly shall be cleaned with high pressure water prior to installation. Personnel shall wear clean cotton or surgical gloves while handling the assembly. Centralizers shall be used to ensure that the well screen and casing assembly is installed concentrically in the borehole. When the assembly has been installed at the appropriate elevation, it shall be adequately secured to preclude movement during placement of the filter packs and annular seals. The top of the well casing shall be capped during filter pack placement.

3.5.2 Primary and Secondary Filter Packs

Primary and secondary filter packs shall be placed as indicated to fill the entire annular space between the screen and casing assembly and the outside wall of the borehole. Place both the primary and secondary filters with a tremie pipe. Placement of the primary filter by gravity or free fall methods is not allowed. Control speed of filter placement to prevent bridging and to allow for settlement. Prior to commencement of work, equipment and methods required to place filters shall be approved by the Contracting Officer.

3.5.3 Bentonite Seal

Bentonite pellets shall be placed through a tremie pipe. Control speed of bentonite placement to prevent bridging. Additional water shall be added to the annular space as directed by the CPC to ensure complete hydration of the bentonite. Bentonite shall cure a minimum of 48 hours before the placement of cement grout to ensure complete hydration and expansion of the bentonite.

3.5.4 Neat Cement Grout

Cement grout shall be placed in the annular space above the bentonite seal as indicated on the gas vent/well construction drawings. Cement grout shall be placed as a slurry through a tremie pipe, and injected under pressure to reduce chance of voids. Grout shall be injected in one continuous operation until full strength grout flows out at the ground surface without evidence of drilling cuttings or fluid. Cement grout shall cure a minimum of 48 hours before beginning well development operations.

3.5.5 Well Head and Gas Vent Completions

Well head and gas vent completions shall be as indicated and as specified herein.

3.6 GROUNDWATER MONITORING WELL EXTENSION

The existing monitoring well protective casing shall be removed and the PVC riser pipe inspected for damage. A PVC slip collar will be placed on the existing stickup and the visible outside surfaces only will be joined together using manufacturer's approved PVC cement. A PVC riser pipe extension will then be cut to the appropriate length and inserted into the slip collar. The PVC cement shall then be used to join the visible outside surfaces only and the glue allowed to cure following the manufacturers instructions. Extreme care must be used to insure that the inside surfaces of the PVC riser pipe are not contaminated with the PVC cement. Provide bentonite seal and geomembrane boot as shown.

3.7 PROTECTIVE CASINGS/CONCRETE APRONS

As indicated.

3.8 WATER FROM WELL ABANDONMENT OPERATIONS

Water from the well abandonment operations shall be containerized in accordance with State and local regulations.

3.8.1 Testing

Test in accordance with the Basic Contract.

3.8.2 Disposal of Containerized Water

Dispose in accordance with the Basic Contract.

3.9 TRANSPORTATION OF CONTAMINATED SOIL AND WATER

In accordance with the Basic Contract.

3.10 DISPOSAL OF CONTAMINATED SOIL AND WATER

Dispose contaminated materials under landfill cap. When contaminated materials are generated after the cap is completed, removed from the site and dispose in a treatment/disposal facility permitted to accept such materials in accordance with the Basic Contract and written approval from the Contracting Officer.

3.11 INSTALLATION SURVEY

Upon completion of well and vent installation and development and acceptance by the Contracting Officer therefor, the vertical and horizontal position of each well shall be determined by a registered land surveyor licensed in the State of Maryland. The survey shall document the vertical elevations of the top of the casing pipe and the ground surface elevation adjacent to each well. The survey shall also determine the horizontal location of each well based on the Maryland State Plane coordinate system, North Zone, North American Datum, 1983 (NAD83). Survey shall be accurate to the nearest 0.01 foot. This data shall be submitted with a well location map as the Well Survey Report.

3.12 CLEANUP

Upon completion of well abandonment and extension activities, remove debris and surplus materials from the jobsite.

-- End of Section --

SECTION 02630

STORM DRAINAGE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2412	(1996; Rev. A) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM F 405	(1996) Corrugated Polyethylene (PE) Tubing and Fittings

1.2 SYSTEM DESCRIPTION

PE piping shall be used for underdrain and gas venting systems.

1.3 SUBMITTALS

Submit the following in accordance with Section C, Part 7.0 of the Basic Contract.

SD-03 Product Data

Corrugated Polyethylene piping including fittings

SD-04 Samples

Pipe and fittings materials

SD-07 Certificates

Pipe and fittings, including factory-applied linings and joint materials

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

1.4.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the

ground. Keep inside of pipes and fittings free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Carry, do not drag pipe to trench.

PART 2 PRODUCTS

2.1 PIPE FOR SUBDRAINS

Pipe for subdrains shall be of the types and sizes indicated.

2.1.1 Plastic Pipe

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2.1.1.1 Corrugated Polyethylene (PE) Pipe and Fittings

Use ASTM F 405. Pipe shall be manufactured with a smooth interior so that the Manning's roughness coefficient ("n") does not exceed 0.012. Minimum pipe stiffness shall be 50 psi (ASTM D 2412). Fittings shall be manufacturer's standard type and shall conform to the indicated specification.

2.1.1.2 Pipe Perforations

Water inlet area shall be a minimum of 0.5 square inch per linear foot. Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Contracting Officer.

a. Circular Perforations in Plastic Pipe: Circular holes shall be cleanly cut not more than 3/8 inch in diameter or less than 3/16 inch in diameter and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be spaced approximately 3 inches center-to-center along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

b. Slotted Perforations in Plastic Pipe: Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the piping. Width of slots shall not exceed 1/8 inch nor be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3 inch diameter piping, 10 percent of the piping inside nominal circumference on 4 to 8 inch diameter tubing, and 2-1/2 inches on 10 inch diameter piping. Rows of slots shall be symmetrically spaced. Slots shall be centered in the valleys of the corrugations of profile wall pipe.

2.2 FILTER FABRIC

In accordance with Section 02373, "Separation/Filtration Geotextile."

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to pipeline installation except where specific exception is made under paragraph entitled "Special Requirements."

3.1.1.1 Earthwork

Perform earthwork operations in accordance with Section 02315, "Excavation and Fill."

3.1.1.2 Pipelaying

Each pipe shall be carefully inspected before it is laid. Any defective or damaged pipe shall be rejected. No pipe shall be laid when the trench conditions or weather is unsuitable for such work. Water shall be removed from trenches by sump pumping or other approved methods. The pipe shall be laid to the grades and alignment as indicated. The pipe shall be bedded to the established gradeline. Perforations shall be centered on the bottom of the pipe. Pipes of either the bell-and-spigot type or the tongue-and-groove type shall be laid with the bell or groove ends upstream. All pipes in place shall be approved before backfilling.

3.1.1.3 Jointings

Perforated Corrugated Polyethylene Pipe: Perforated corrugated polyethylene drainage pipe shall be installed in accordance with the manufacturer's specifications and as specified herein. A pipe with physical imperfections shall not be installed. No more than 5 percent stretch in a section will be permitted.

3.1.2 Special Requirements

3.1.2.1 Installation of Corrugated PE Pipe

Bedding, haunching and initial backfill in accordance with ASTM D 2321. Materials and compaction as indicated and in accordance with Section 02315, "Excavation and Fill."

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

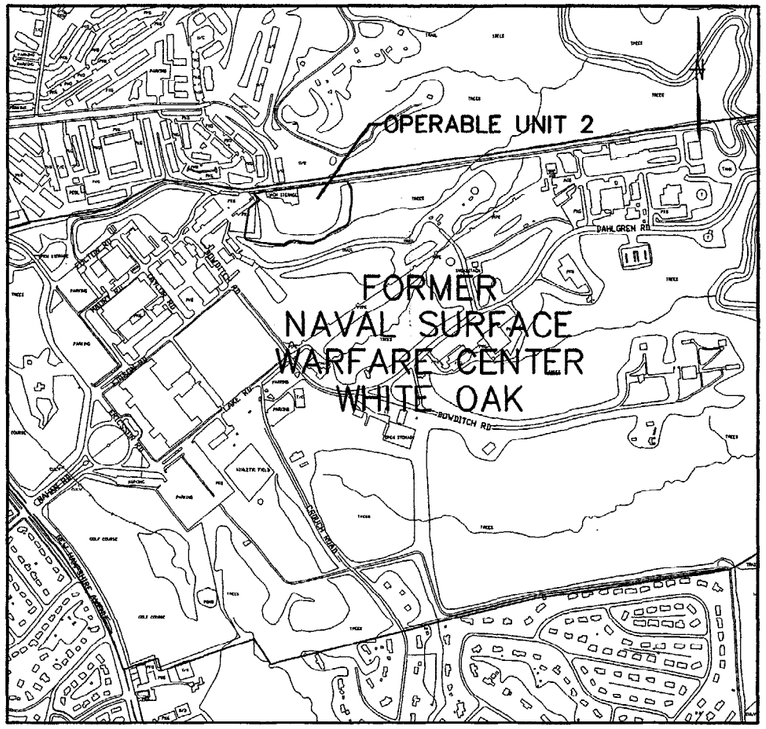
The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing. The Contractor shall be able to produce evidence, when required, that each item of work has been constructed properly in accordance with the drawings and specifications.

3.2.2 Pipeline Testing

Check each straight run of pipeline for gross deficiencies by holding a light; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line.

-- End of Section --

FINAL SUBMISSION
OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NAVAL SURFACE WARFARE CENTER - WHITE OAK
SILVER SPRING, MARYLAND
RAC CONTRACT NO. N62470-97-D-5000 D.O. 0069



PROJECT LOCATION MAP

0 800 1600
SCALE IN FEET

DRAWING INDEX

SHEET TITLE	NAVFAC DWG. No.	SHEET No.
TITLE SHEET	3307621	T-1
GENERAL NOTES AND LEGEND	3307622	T-2
EXISTING CONDITIONS PLAN	3307623	C-1
EROSION AND SEDIMENT CONTROL PLAN	3307624	C-2
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EROSION AND SEDIMENT CONTROL DETAILS (SHEET 1 OF 2)	3307626	C-4
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LANDFILL CAP DETAILS	3307633	C-11
MISCELLANEOUS DETAILS	3307634	C-12
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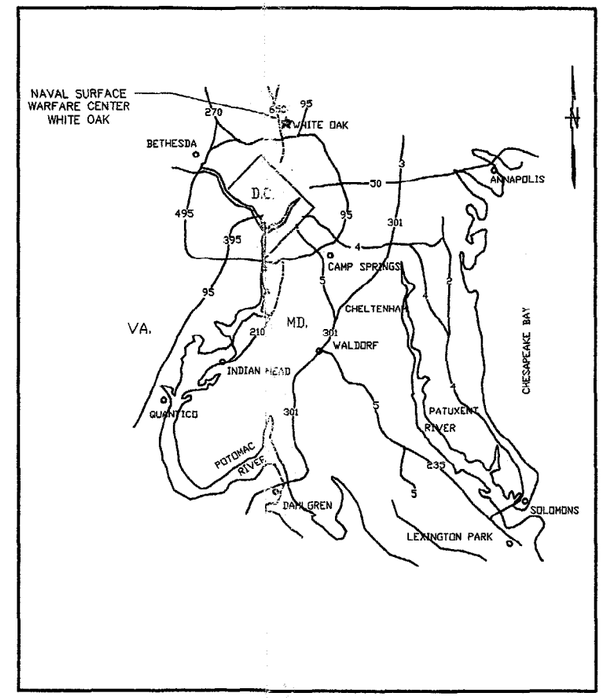

VICINITY MAP

10 0 10 20
SCALE IN MILES

CAUTION: EXCEPT WHERE DIMENSIONS ARE INDICATED, GRAPHIC SCALE MUST BE USED.

ROICC REVIEW

SIGNATURE _____ DATE _____

SYMBOL	DESCRIPTION	DATE	APPROVED
D9A	403		
D4	404		
E.I.C.	405		
401	408		
D4B	402		

REVISIONS

Fluor Daniel NSG, Inc. — CENTER ROAD 36 PITTSBURGH, PA 15220
DES. TWS DR. MF CHK. SAM
SUBMITTED BY TITLE DATE 6/24/01
PROGRAM MANAGER DATE JUNE 2001
APPROVED STD FOR COMMANDER NAVFAC DATE
REVIEWED BY ROICC DATE

SEAL AREA

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
WASHINGTON, D.C.
NAVAL FACILITIES ENGINEERING COMMAND
SILVER SPRING, MARYLAND
NAVAL SURFACE WARFARE CENTER WHITE OAK

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
TITLE SHEET

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO. 3307621
SHEET 1 OF 15
T-1

ACAD:74227D01.dwg 08/22/01 DT

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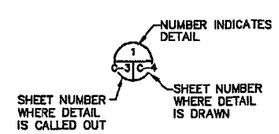
GENERAL NOTES

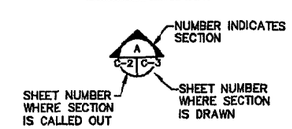
1. GRID COORDINATES REFERENCE MARYLAND STATE PLANE COORDINATE SYSTEM, NORTH ZONE, NORTH AMERICAN DATUM, 1983 (NAD83).
2. ELEVATIONS REFERENCE NATIONAL GEODETIC VERTICAL DATUM, 1929 (NGVD29).
3. EXISTING TOPOGRAPHY AND FEATURES WERE PREPARED BY MURPHY HOBSON SACKS VIA FIELD SURVEY PERFORMED FEBRUARY 1995.
4. TWO FOOT CONTOUR INTERVAL UNLESS OTHERWISE INDICATED.
5. UNDERGROUND UTILITIES WERE OBTAINED FROM WHITE OAK BASEWIDE MAP. LOCATIONS SHOWN ARE APPROXIMATE. VERIFICATION OF THE UTILITY LOCATIONS MUST BE MADE PRIOR TO ANY CONSTRUCTION.
6. ALL WORK FOR THIS PROJECT SHALL BE IN STRICT ACCORDANCE WITH THE CONTRACT DRAWINGS AND SPECIFICATIONS. ALL METHODS OF WORK FOR THIS PROJECT SHALL ALSO COMPLY WITH FEDERAL, STATE OF MARYLAND, AND LOCAL ORDINANCES.
7. FIGURED DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS. CHECK GRAPHIC SCALE BEFORE SCALING DRAWING.
8. THE CONTRACTOR SHALL THOROUGHLY INSPECT THE SITE PRIOR TO CONSTRUCTION TO VERIFY EXISTING SITE CONDITIONS.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING HORIZONTAL AND VERTICAL CONTROL FOR CONSTRUCTION. SEE DRAWING C-1 FOR EXISTING MONUMENTS.
10. THE CONTRACTOR SHALL STAKE THE LOCATION OF ALL AREAS TO BE EXCAVATED OR DISTURBED PRIOR TO ACTUAL WORK. THE FIELD LOCATIONS MUST BE REVIEWED AND APPROVED BY THE RESIDENT OFFICER IN CHARGE OF CONSTRUCTION (ROICC).
11. THE CONTRACTOR STAGING AREA(S) ARE TO BE APPROVED BY THE ROICC AND SHALL BE OUT OF THE WAY OF TRAFFIC AND/OR PEDESTRIAN FLOW. ALL TO-BE-DETERMINED STAGING AREAS OUTSIDE APPROVED LIMITS OF DISTURBANCE SHALL, AT A MINIMUM, BE RINGED WITH SILT FENCE AND HAVE ONLY ONE POINT OF INGRESS/EGRESS OVER APPROVED STABILIZED STONE CONSTRUCTION ENTRANCE(S).
12. THE SOLE POINT FOR INGRESS AND EGRESS OF THE SITE SHALL BE VIA STABILIZED STONE CONSTRUCTION ENTRANCE(S) WHICH SHALL BE CONSTRUCTED ACCORDING TO THE APPROVED EROSION AND SEDIMENT CONTROL PLAN.
13. THE CONTRACTOR SHALL PROVIDE INGRESS/EGRESS CONTROL INTO THE SITE AS PART OF MOBILIZATION ACTIVITIES.
14. THE CONTRACTOR SHALL PROVIDE MAXIMUM PROTECTION FOR EXISTING UTILITIES WHICH ARE TO REMAIN IN SERVICE. THE CONTRACTOR SHALL PROVIDE ALL TEMPORARY SERVICES. THE CONTRACTOR SHALL CONTACT "MISS UTILITY OF MARYLAND" AT (800) 257-7777 PRIOR TO INTRUSIVE ACTIVITIES. THE CONTRACTOR SHALL ALSO CONTACT THE ROICC AT (301) 295-1814 TO ARRANGE FOR LOCATION OF THE BASE UTILITIES. VERIFICATION OF THE UTILITY LOCATIONS MUST BE MADE PRIOR TO ANY CONSTRUCTION.
15. ALL EXISTING GROUNDWATER MONITORING WELLS SHALL BE PROTECTED THROUGHOUT THE CONSTRUCTION PERIOD. ANY DAMAGE TO THE EXISTING MONITORING WELLS SHALL BE REPAIRED TO PREEXISTING CONDITIONS BY THE CONTRACTOR SUBJECT TO THE APPROVAL OF THE ROICC.
16. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LIMITING ALL WORK TO THE IMMEDIATE PROJECT AREA WITHIN THE APPROVED LIMITS OF DISTURBANCE. ALL AREAS DISTURBED BY THE CONTRACTOR THAT ARE OUTSIDE THE LIMITS OF DISTURBANCE SHALL BE RESTORED BY THE CONTRACTOR TO LIKE OR BETTER CONDITION.
17. THE CONTRACTOR SHALL MAINTAIN ALL WORK AREAS FREE FROM DUST AND ODORS IN A MANNER APPROVED BY THE ROICC.
18. ALL DISTURBED AREAS SHALL BE GRADED TO MAINTAIN POSITIVE DRAINAGE.
19. ALL DISTURBED AREAS SHALL BE STABILIZED (SEEDED AND MULCHED, RIPRAPPED, PAVED OR COVERED WITH STONE) IMMEDIATELY UPON ESTABLISHING FINAL GRADE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING THE MEASURES INDICATED ON THE APPROVED EROSION AND SEDIMENT CONTROL PLAN.
20. THE GOVERNMENT OR THEIR DESIGNEE WILL PERFORM VERIFICATION SAMPLING AND ANALYSIS. THE CONTRACTOR SHALL ESTABLISH SURVEY CONTROL TO FACILITATE SAMPLING. BACKFILLING AND REGRADING ACTIVITIES IN THE AREA OF EXCAVATION SHALL NOT BE PERFORMED UNTIL AUTHORIZATION HAS BEEN GIVEN BY THE ROICC.
21. CLEARED MATERIAL SHALL BE CHIPPED AND STOCKPILED ON SITE FOR USE AS DIRECTED BY THE ROICC. THIS MATERIAL WILL NOT BE ALLOWED TO BE CONSOLIDATED UNDER THE CAP.
22. SHAPES IDENTIFIED BY UXO OVERSIGHT AS CONTAINING OR POTENTIALLY CONTAINING ORDNANCE SHALL BE HANDLED IN ACCORDANCE WITH NAVY REQUIREMENTS.
23. GAS LINE LOCATED ALONG PERIMETER ROAD TO BE LOCATED BY THE RAC.

GENERAL LEGEND

- BM — BENCHMARK
- 02GW105 — EXISTING GROUNDWATER MONITORING WELL
- LANDFILL GAS MONITORING WELL
- ROCK CHECK DAM
- 353 — SPOT ELEVATION
- EXISTING HEADWALL
- TREELINE
- GAS — GAS LINE
- SF — SILT FENCE
- SSF — SUPER SILT FENCE
- FENCE
- OHE — OVERHEAD POWER LINE (WITH UTILITY POLE)
- PROPERTY LINE
- STREAM CENTERLINE/DRAINAGE CHANNEL CENTERLINE
- LIMIT OF DISTURBANCE
- APPROXIMATE LIMIT OF OU2 WASTE/FILL
- LIMIT OF REGRADED WASTE/FILL
- CENTERLINE OF PIPE
- EDGE OF CHANNEL
- ROAD BOUNDARY
- 300 — EXISTING ELEVATION CONTOUR
- 300 — FINAL GRADE ELEVATION CONTOUR
- 5+00 — CONSTRUCTION BASELINE
- EXISTING WETLANDS
- WETLANDS RESTORATION



DETAIL IDENTIFIER



SECTION IDENTIFIER

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

D9A	403		
04	404		
E.I.C.	405		
DATE	406		
401	408		
402	D4B	DATE	
REVIEWED BY ROICC			

Tetra Tech NUS, Inc. — FORT WASHINGTON, PENNSYLVANIA 19034

DES. TWS | DR. MF | CHK. SAM | SUPV. TWS | TITLE | DATE 6/5/01 | PROJ. MANAGER | APPROVED | DATE 6/25/01

IFD FOR COMMANDER NAVFAC

SEAL AREA

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
WASHINGTON, D.C.

NAVAL FACILITIES ENGINEERING COMMAND

NAVAL SURFACE WARFARE CENTER WHITE OAK — SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
GENERAL NOTES AND LEGEND

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO. 3307622
SHEET 2 OF 15

T-2

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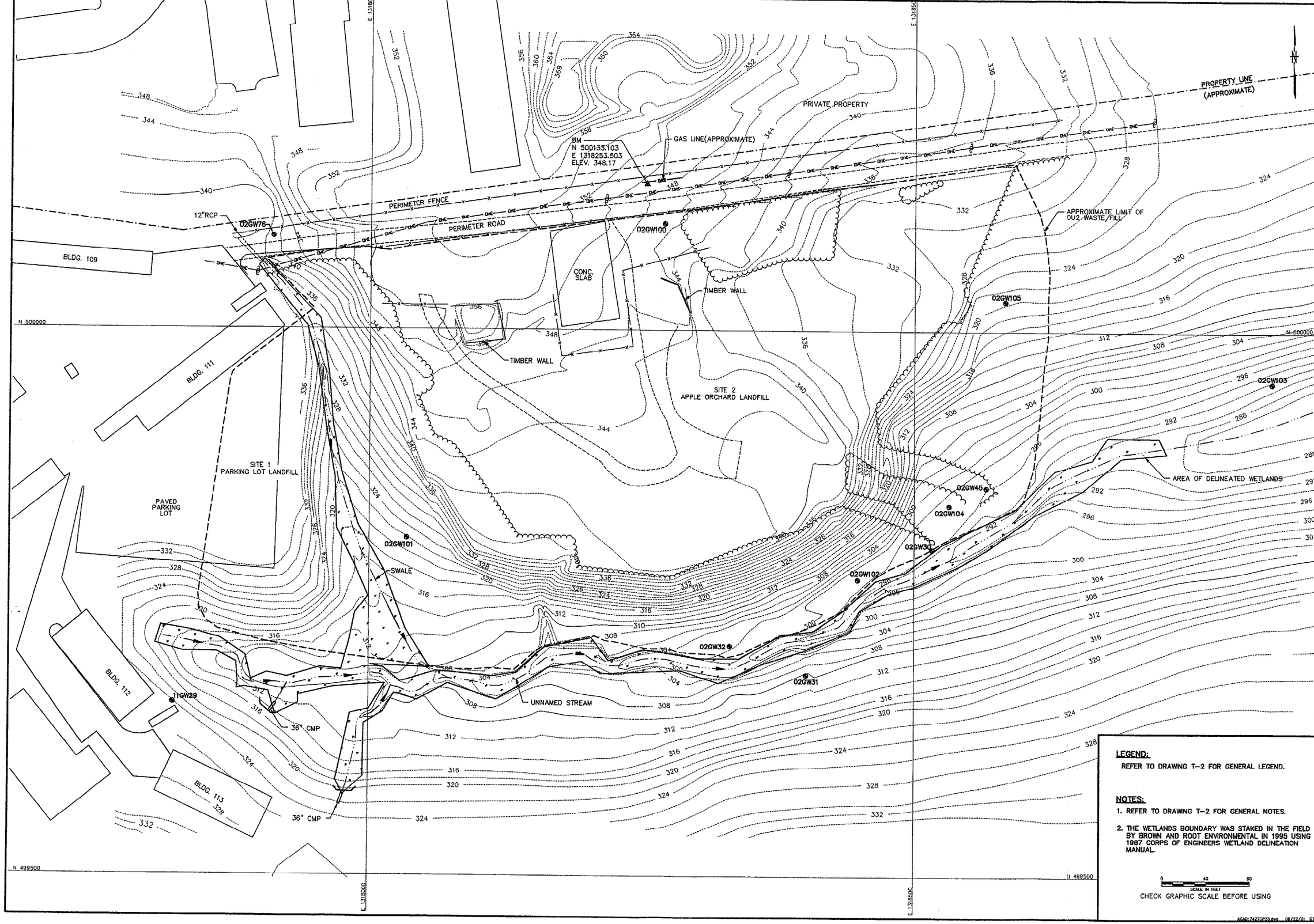

LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. THE WETLANDS BOUNDARY WAS STAKED IN THE FIELD BY BROWN AND ROOT ENVIRONMENTAL IN 1995 USING 1987 CORPS OF ENGINEERS WETLAND DELINEATION MANUAL.

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SCALE IN FEET
CHECK GRAPHIC SCALE BEFORE USING

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

403	D9A		
404	04		
405	E.I.C.		
406	401		
048	402		

DATE REVIEWED BY RDRC

Tetra Tech NUS, Inc.
FOSTER PLAZA VII
661 ANDERSON DRIVE
PITTSBURGH, PA 15220

DES. THS DR. DLT TITLE CHK. SHM DATE 6/15/01

SUBMITTED BY: PROGRAM MANAGER DATE 6/15/01

APPROVED DATE

TTO FOR COMMANDER NAVFAC

SEAL AREA

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
WASHINGTON, D.C.
NAVAL SURFACE WARFARE CENTER WHITE OAK
SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC – WHITE OAK
EXISTING CONDITIONS PLAN

CODE I.D. NO. 80091

DRAWING SIZE: D

CONST. CONT. NO.
N62470-97-D-5000

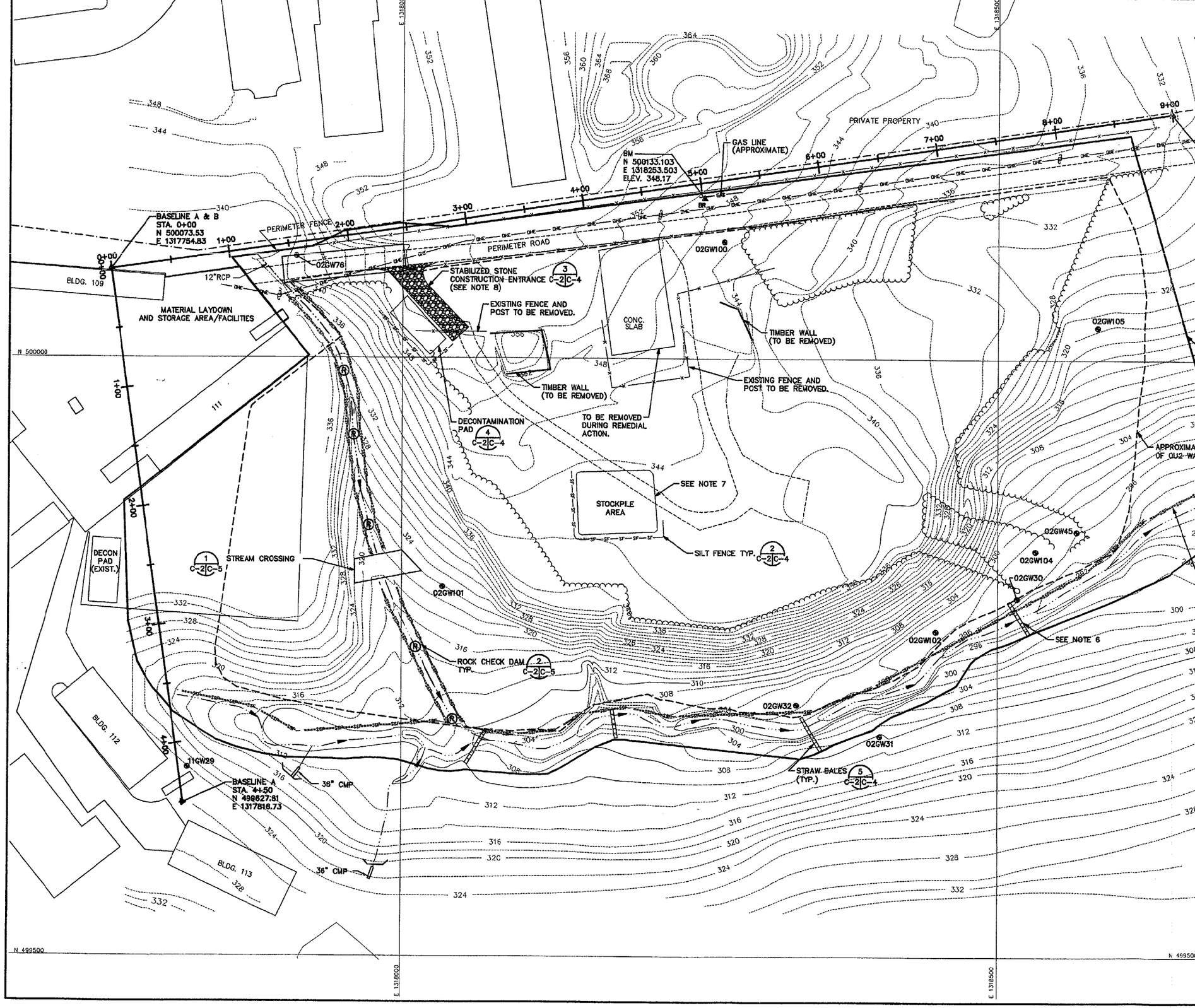
SPEC. 21-97-5000-0069

NAVFAC DRAWING NO.
3307623

SHEET 3 OF 15

C-1

ACAD:7427CP23.dwg 06/22/01 GT



LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

STRAW BALES

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. REFER TO DRAWING C-3 FOR EROSION AND SEDIMENT CONTROL PLAN NOTES.
3. CLEAR AND GRUB WITHIN THE LIMITS OF DISTURBANCE UNLESS OTHERWISE INDICATED.
4. STABILIZED STONE CONSTRUCTION ENTRANCE(S), DECONTAMINATION PAD, MATERIALS HANDLING PAD, CONSTRUCTION LAY-DOWN AREA(S), AND MATERIAL STOCKPILE LOCATION(S) TO BE DETERMINED PRIOR TO CONSTRUCTION BY THE RAC SUBJECT TO APPROVAL BY THE ROICC.
5. TEMPORARY SECURITY FENCE SHALL BE INSTALLED ALONG THE SITE PERIMETER AS NECESSARY TO RESTRICT ACCESS.
6. STRAW BALES LOCATED ALONG TRIBUTARY STREAM TO BE ADDED PRIOR TO EXCAVATION OF SEDIMENTS IN TRIBUTARY STREAM. DEVICE CAN BE REMOVED ONCE UPSTREAM SECTIONS ARE SEEDED AND EROSION CONTROL MATTING (ECM) IS IN PLACE.
7. STOCKPILE SIZE AND LOCATION TO BE DETERMINED BY THE RAC AND APPROVED BY THE ROICC.
8. STABILIZED STONE CONSTRUCTION ENTRANCE LOCATION(S) CAN BE RELOCATED DURING DIFFERENT STAGES OF CONSTRUCTION.

0 40 80
SCALE IN FEET
CHECK GRAPHIC SCALE BEFORE USING

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

DPA	403		
04	404		
E.I.C.	405		
401	406		
402	D4B		
REVIEWED BY ROICC	DATE		

Tetra Tech NUS, Inc. 661 ANDERSON DRIVE PITTSBURGH, PA 15220
DES. TNS DRK. DLT CHK. SAH
SUBMITTED BY: TITLE DATE 6/2/01
APPROVED: TITLE DATE 6/22/01
APPROVED FOR COMMANDER NAVFAC

STATE OF MARYLAND REGISTERED PROFESSIONAL ENGINEER No. 21-97-5000-0088 SEAL AREA

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
WASHINGTON, D.C.
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL SURFACE WARFARE CENTER WHITE OAK
SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
EROSION AND SEDIMENT CONTROL PLAN

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0088
NAVFAC DRAWING NO. 3307624
SHEET 4 OF 15
C-2

ACAD:74270CP24.dwg 06/22/01 DT

EROSION AND SEDIMENT CONTROL PLAN NOTES

1. UNLESS OTHERWISE INDICATED, ALL VEGETATION AND STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES WILL BE CONSTRUCTED AND MAINTAINED ACCORDING TO MINIMUM STANDARDS AND SPECIFICATIONS OF THE MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL.

2. THE CONTRACTOR SHALL NOTIFY THE ROICC IN WRITING AND BY TELEPHONE:
   A. 7 DAYS PRIOR TO THE REQUIRED PRE-CONSTRUCTION MEETING
   B. FOLLOWING INSTALLATION OF EROSION AND SEDIMENT CONTROL DEVICES
   C. 7 DAYS PRIOR TO FINAL INSPECTION

3. CONSTRUCT ALL EROSION AND SEDIMENT CONTROL MEASURES PER THE APPROVED PLAN AND SEQUENCE OF CONSTRUCTION CONTAINED IN THE EROSION AND SEDIMENT CONTROL PLAN REPORT AND DRAWINGS, AND HAVE THEM INSPECTED AND APPROVED BY THE ROICC PRIOR TO BEGINNING ANY OTHER LAND DISTURBANCES. MINOR SEDIMENT CONTROL DEVICE LOCATION ADJUSTMENTS MAY BE MADE IN THE FIELD WITH THE APPROVAL OF THE ROICC. ENSURE THAT ALL RUNOFF FROM DISTURBED AREAS IS DIRECTED TO THE SEDIMENT CONTROL DEVICES AND DO NOT REMOVE ANY EROSION OR SEDIMENT CONTROL MEASURE WITHOUT PRIOR APPROVAL FROM THE ROICC. THE CONTRACTOR MUST OBTAIN PRIOR APPROVAL FROM THE ROICC FOR CHANGES TO EROSION AND SEDIMENT CONTROL PLAN AND/OR THE SEQUENCE OF CONSTRUCTION.

4. ALL INGRESS TO, AND EGRESS FROM THE SITE SHALL BE AT LOCATIONS PROTECTED BY AN APPROVED STABILIZED STONE CONSTRUCTION ENTRANCE.

5. THE CONTRACTOR SHALL MAINTAIN CONTINUOUSLY IN AN EFFECTIVE OPERATING CONDITION ALL EROSION AND SEDIMENT CONTROL MEASURES UNTIL SUCH TIME AS THEY ARE REMOVED WITH PRIOR APPROVAL FROM THE ROICC.

6. THE MAXIMUM SIDE SLOPE FOR CHANNELS AND DISTURBED SIDE SLOPES SHALL BE 3H:1V. ALL CHANNELS ARE CONSIDERED SENSITIVE AREAS AND WILL HAVE EROSION CONTROL MATTING (CORI OR COCONUT FIBER) INSTALLED IMMEDIATELY UPON CHANNEL ESTABLISHMENT WHERE INDICATED. FINAL STABILIZATION WITH STONE, SEED AND ANCHORED STRAW MULCH, OR OTHER APPROVED STABILIZATION MEASURES SHALL BE INSTALLED IMMEDIATELY AND UNDER NO CIRCUMSTANCES LATER THAN 7 DAYS OF CHANNEL ESTABLISHMENT.

7. THE CONTRACTOR SHALL APPLY SEED AND ANCHORED STRAW MULCH, OR APPROVED STABILIZATION MEASURES TO ALL DISTURBED AREAS AND STOCKPILES WITHIN 14 CALENDAR DAYS AFTER STRIPPING AND GRADING ACTIVITIES HAVE CEASED IN THE AREA (7 DAYS FOR SENSITIVE AREAS). MAINTENANCE SHALL BE PERFORMED AS NECESSARY FOR CONTINUED STABILIZATION.

8. ALL DISTURBED AREAS ARE TO DRAIN TO APPROVED EROSION AND SEDIMENT CONTROL MEASURES AT ALL TIMES DURING LAND DISTURBANCE ACTIVITIES AND DURING SITE DEVELOPMENT UNTIL FINAL STABILIZATION IS ACHIEVED. ALL ACCUMULATED WATER IN EXCAVATIONS WILL BE COLLECTED AND TESTED TO DETERMINE THE APPROPRIATE DISPOSAL METHOD.

9. IN THE EVENT THAT A DETERMINATION IS MADE TO ALLOW SURFACE DISCHARGE OF WATER COLLECTED IN EXCAVATIONS, ALL WATER RESULTING FROM DEWATERING OPERATIONS SHALL PASS THROUGH AN APPROVED FILTRATION DEVICE AND THENCE TO A PROTECTED INLET OR SHALL BE BROADCAST UPON AN APPROVED VEGETATED AREA.

10. THE CONTRACTOR SHALL INSPECT ALL EROSION AND SEDIMENT CONTROL MEASURES WEEKLY AND AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT. THE STABILIZED STONE CONSTRUCTION ENTRANCE(S) SHALL BE INSPECTED DAILY AND AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF THE EROSION AND SEDIMENT CONTROL DEVICES AND THE STABILIZED STONE CONSTRUCTION ENTRANCE(S) SHALL BE MADE IMMEDIATELY. ANY SEDIMENT REMOVED FROM THE EROSION AND SEDIMENT CONTROL DEVICES DURING MAINTENANCE ACTIVITIES PRIOR TO PLACEMENT OF THE SUBGRADE SOIL LAYER OF THE CAP SYSTEM SHALL BE PLACED UNDER THE CAP SYSTEM.

11. PRIOR TO REMOVAL OF EROSION AND SEDIMENT CONTROL MEASURES THE CONTRACTOR SHALL STABILIZE AND HAVE ESTABLISHED PERMANENT STABILIZATION FOR ALL CONTRIBUTORY DISTURBED AREAS USING THE PERMANENT SEED MIXTURE INDICATED ON DRAWING C-3 WITH REQUIRED SOIL AMENDMENTS AND AN APPROVED ANCHORED MULCH. WOOD FIBER MULCH MAY ONLY BE USED IN SEEDING SEASON WHERE THE SLOPE DOES NOT EXCEED 10% AND GRADING HAS BEEN DONE TO PROMOTE SHEET FLOW DRAINAGE. AREAS BROUGHT TO FINISHED GRADE DURING THE SEEDING SEASON SHALL BE PERMANENTLY STABILIZED AS SOON AS POSSIBLE, BUT NO LATER THAN 14 CALENDAR DAYS AFTER ESTABLISHMENT. WHEN PROPERTY IS BROUGHT TO FINISHED GRADE DURING THE MONTHS OF NOVEMBER THROUGH FEBRUARY, AND PERMANENT STABILIZATION IS FOUND TO BE IMPRACTICAL, TEMPORARY SEED AND ANCHORED STRAW MULCH SHALL BE APPLIED TO DISTURBED AREAS. THE FINAL PERMANENT STABILIZATION OF SUCH PROPERTY SHALL BE APPLIED BY MARCH 15 OR EARLIER IF GROUND AND WEATHER CONDITIONS ALLOW.

12. THE SITE'S APPROVAL LETTER, APPROVED EROSION AND SEDIMENT CONTROL PLAN, TEST REPORTS, AND LOG OF ALL EROSION AND SEDIMENT CONTROL FEATURES INSPECTIONS SHALL BE MAINTAINED BY THE CONTRACTOR AND THE LOGS SHALL BE AVAILABLE AT THE SITE AT ALL TIMES FOR INSPECTION BY DULY AUTHORIZED OFFICIALS.

13. SURFACE DRAINAGE FLOWS OVER UNSTABILIZED CUT AND FILL SLOPES SHALL BE CONTROLLED BY EITHER PREVENTING DRAINAGE FLOWS FROM TRAVERSING THE SLOPES OR BY INSTALLING PROTECTIVE DEVICES TO MINIMIZE DOWNSLOPE EROSION. PROTECTIVE METHODS, SUCH AS EROSION CONTROL MATTING AND RIPRAP MUST BE PROVIDED AT POINTS OF CONCENTRATED FLOW WHERE EROSION IS LIKELY TO OCCUR.

14. PERMANENT CHANNELS OR OTHER POINTS OF CONCENTRATED WATER FLOW SHALL BE STABILIZED WITH SEED, WITH AN APPROVED EROSION CONTROL MATTING, RIPRAP, OR BY OTHER MEASURES APPROVED BY THE ROICC.

15. TEMPORARY EROSION AND SEDIMENT CONTROL DEVICES SHALL BE REMOVED, WITH APPROVAL OF THE ROICC, WITHIN 30 CALENDAR DAYS FOLLOWING ESTABLISHMENT OF PERMANENT STABILIZATION IN ALL CONTRIBUTORY DRAINAGE AREAS.

16. FOR FINISHED GRADING, THE CONTRACTOR SHALL PROVIDE ADEQUATE GRADIENTS TO PREVENT WATER FROM STANDING ON THE SURFACE MORE THAN 24 HOURS AFTER THE END OF A RAINFALL EVENT EXCEPT IN DESIGNATED DRAINAGE COURSES AND CHANNEL FLOW AREAS WHICH MAY DRAIN AS LONG AS 48 HOURS AFTER THE END OF A RAINFALL EVENT. AREAS DESIGNED TO HAVE STANDING WATER SHALL NOT BE REQUIRED TO MEET THIS REQUIREMENT.

17. THE ROICC HAS THE OPTION OF REQUIRING ADDITIONAL SAFETY OR SEDIMENT CONTROL MEASURES IF DEEMED NECESSARY.

18. VEGETATIVE STABILIZATION SHALL BE PERFORMED IN ACCORDANCE WITH THE STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL. REFER TO APPROPRIATE SPECIFICATIONS FOR TEMPORARY SEEDING, PERMANENT SEEDING, MULCHING, AND GROUND COVER.

19. OFF-SITE SPOIL OR BORROW AREAS ON STATE OR FEDERAL PROPERTY MUST HAVE PRIOR APPROVAL FROM THE ROICC. ALL WASTE AND BORROW AREAS OFF-SITE MUST BE PROTECTED BY SEDIMENT CONTROL MEASURES AND STABILIZED.

20. PRIOR TO COMMENCING LAND DISTURBING ACTIVITIES IN AREAS OTHER THAN INDICATED ON THE PLANS (INCLUDING, BUT NOT LIMITED TO OFF-SITE BORROW), THE CONTRACTOR SHALL SUBMIT A SUPPLEMENTAL EROSION CONTROL PLAN TO THE ROICC FOR SUBMISSION TO THE STATE OF MARYLAND FOR REVIEW AND CONCURRANCE. THE SUPPLEMENTAL PLAN IS NOT TO BE IMPLEMENTED UNTIL APPROVAL IS RECEIVED FROM THE ROICC.

21. ALL UNDISTURBED AREAS SHALL BE PROTECTED AT ALL TIMES DURING CONSTRUCTION ACTIVITIES AND UNTIL PERMANENT VEGETATION IN THE DISTURBED AREAS HAS BEEN ESTABLISHED.

22. SITE INFORMATION:
   TOTAL AREA OF SITE 8.36 ACRES
   AREA DISTURBED 8.36 ACRES
   TOTAL CUT 37,300 CUBIC YARDS
   TOTAL FILL 68,300 CUBIC YARDS
   OFF-SITE BORROW 24,500 CUBIC YARDS
   OFF-SITE DISPOSAL 1,000 CUBIC YARDS

SEQUENCE OF CONSTRUCTION

THE TIME TO PERFORM THE REQUIRED CONSTRUCTION ACTIVITIES IS ESTIMATED TO BE APPROXIMATELY 240 DAYS. THE GENERALIZED SEQUENCE OF CONSTRUCTION ACTIVITIES IS:

1. HOLD PRE-CONSTRUCTION MEETING WITH THE CONTRACTING OFFICER.

2. INSPECT SITE PRIOR TO CONSTRUCTION TO VERIFY EXISTING SITE CONDITIONS AND UNDERGROUND UTILITY LOCATIONS.

3. ESTABLISH HORIZONTAL AND VERTICAL CONTROL FOR CONSTRUCTION. STAKE THE LOCATION OF ALL AREAS TO BE EXCAVATED OR DISTURBED PRIOR TO ACTUAL WORK.

4. INSTALL ALL PERIMETER CONTROLS, STABILIZED STONE CONSTRUCTION ENTRANCE AS INDICATED ON DRAWING C-2, AND ADDITIONAL STABILIZED STONE CONSTRUCTION ENTRANCE(S) IF APPROVED BY THE RESIDENT OFFICER IN CHARGE OF CONSTRUCTION (ROICC) PRIOR TO ANY EARTH DISTURBANCE ACTIVITIES. ALL PERIMETER CONTROLS SHALL CONFORM TO STANDARDS AND SPECIFICATIONS IDENTIFIED IN THE 1994 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL MANUAL UNLESS OTHERWISE SPECIFIED. THE PERIMETER CONTROLS TO BE INSTALLED INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:
   * SILT FENCE ON DOWNHILL SIDES OF ALL STOCKPILE LOCATIONS AND CONSTRUCTION ENTRANCE(S);
   * SUPER SILT FENCE ALONG THE NORTHERN SIDE OF THE UNNAMED STREAM LOCATED SOUTH OF OU2, AND ALONG BOTH SIDES OF DRAINAGE SWALE LOCATED BETWEEN SITES 1 AND 2;
   * TEMPORARY STREAM CROSSING WITHIN DRAINAGE SWALE LOCATED BETWEEN SITES 1 AND 2 (SEE DRAWING C-2) TO PROVIDE A TRANSPORTATION CORRIDOR BETWEEN SITES 1 AND 2;
   * ADDITIONAL CONTROLS AS MAY BE REQUIRED BY THE CONTRACTING OFFICER AND/OR WARRANTED BY SITE CONDITIONS AND BEST CONSTRUCTION PRACTICES.

5. CLEAR AND GRUB CONSTRUCTION LAYDOWN, MATERIAL STORAGE AND STAGING AREA(S), MATERIAL HANDLING PAD, AND DECONTAMINATION PAD IF NECESSARY.

6. CONSTRUCT DECONTAMINATION PAD, MATERIAL HANDLING PAD, CONSTRUCTION LAYDOWN, AND STORAGE AND STAGING AREAS IF NECESSARY.

7. BREAKUP CONCRETE SLABS WITHIN THE LIMITS OF OU2 AND RELOCATE AS NECESSARY.

8. CLEAR BUT DO NOT GRUB WITHIN LIMITS OF OU2. CLEAR AND GRUB WITHIN REMAINDER OF LIMITS OF DISTURBANCE.

9. EXCAVATE WASTE/FILL MATERIAL WITHIN OU2 WEST OF THE DRAINAGE SWALE FOR PLACEMENT WITHIN PROPOSED LIMITS OF WASTE. DURING EXCAVATION, BREAKUP CONCRETE-FILLED SHAPES DESIGNATED BY UXO OVERSIGHT PERSONNEL AS NOT CONTAINING ORDNANCE FOR GENERAL DISTRIBUTION WITHIN THE PROPOSED LIMITS OF WASTE. IN THE EVENT THAT SUSPECT HAZARDOUS MATERIALS ARE IDENTIFIED DURING THE EXCAVATION AND CONSOLIDATION OF OU2 WASTE/FILL, THE SUSPECT HAZARDOUS MATERIALS ARE TO BE SEGREGATED AND CHARACTERIZED FOR PROPER OFF-SITE DISPOSAL. IF THROUGH CHARACTERIZATION SAMPLING OF SUSPECT HAZARDOUS WASTE, THE MATERIALS ARE DETERMINED TO BE NON-HAZARDOUS, MATERIAL WILL BE CONSOLIDATED WITHIN THE PROPOSED LIMITS OF WASTE.

10. PERFORM VERIFICATION SAMPLING FOLLOWING EXCAVATION OF ALL WASTE/FILL MATERIAL OUTSIDE THE PROPOSED LIMIT OF WASTE. IF VERIFICATION SAMPLING TEST RESULTS INDICATE CONTAMINANTS ARE EITHER COMPLETELY REMOVED OR AT LEVELS BELOW THE REMEDIAL ACTION LEVELS (RALs), EXCAVATION OF WASTE/FILL MATERIAL IS COMPLETE. IN THE EVENT THAT VERIFICATION SAMPLES INDICATE THAT EXPOSED SOILS CONTAIN CONTAMINANTS ABOVE RALs CONTINUE EXCAVATION AND CONDUCT ADDITIONAL VERIFICATION SAMPLING. CONTINUE PROCESS UNTIL CONTAMINANTS ARE REMOVED OR RALs ARE MET.

11. FOLLOWING EXCAVATION OF MATERIAL OUTSIDE OF PROPOSED LIMITS OF WASTE, ESTABLISH PERIMETER CHANNELS AND BEGIN RE-GRADING WASTE/FILL WITHIN PROPOSED LIMITS OF WASTE. DURING RE-GRADING BREAKUP CONCRETE-FILLED SHAPES DESIGNATED BY UXO OVERSIGHT PERSONNEL FOR GENERAL DISTRIBUTION WITHIN LANDFILL LIMITS.

12. ESTABLISH E&S CONTROLS IN THE UNNAMED STREAM AS INDICATED ON DRAWING C-2. EXCAVATE IMPACTED SEDIMENTS FROM UNNAMED STREAM AND PLACE WITHIN PROPOSED LIMITS OF WASTE. EXCAVATION OF SEDIMENTS IN THE UNNAMED STREAM SHALL PROCEED UPSTREAM TO DOWNSTREAM. STABILIZE DISTURBED AREAS IN THE UNNAMED STREAM BY PLANTING WETLAND PLANTS AND INSTALLING TEMPORARY ECM.

13. PERFORM UXO SCREENING TO A DEPTH 4-FEET BELOW FINAL GRADE. GRADE WASTE/FILL MATERIAL TO 6-INCHES BELOW INTERIM GRADE (SEE DRAWING C-6), FOLLOWED BY PLACEMENT OF 6-INCHES OF SUBGRADE SOIL TO ESTABLISH INTERIM GRADE (SEE DRAWING C-7). DURING REGRADING EXTEND AND PROTECT MONITORING WELLS.

14. PREPARE THE SUBGRADE SOIL BY COMPACTING AND FINE GRADING TO CREATE A SMOOTH FIRM SURFACE. REMOVE MATERIAL THAT IS CONSIDERED OBJECTIONABLE FOR THE PLACEMENT OF GEOSYNTHETIC CLAY LINER (GCL), INCLUDING SHARP-EDGED MATERIALS, PROTRUSIONS EXTENDING MORE THAN 1/2" AND OTHER AS IDENTIFIED IN THE SPECIFICATIONS. REGRADE AND COMPACT AS NECESSARY.

15. INSTALL CAP MATERIALS INCLUDING GCL, GEOMEMBRANE, GEOCOMPOSITE DRAINAGE LAYER, TRENCHES, DRAINAGE PIPING, AND GAS VENTS. COVER GCL IMMEDIATLEY WITH GEOMEMBRANE. PLACE ONLY AS MUCH GCL AS CAN BE COVERED AT THE END OF THE DAY WITH GEOMEMBRANE OR TEMPORARY WATER-PROOF TARP.

16. INSTALL COVER AND TOPSOIL MATERIALS AND VEGETATE AFTER TOPSOIL IS PLACED.

17. PLANT PERMANENT VEGETATION ON ALL DISTURBED AREAS.

18. INSTALL SIGNAGE AND POSTS ALONG THE SITE PERIMETER.

19. REMOVE ALL TEMPORARY FACILITIES (I.E. DECONTAMINATION PAD, MATERIAL HANDLING PADS, ETC.). RESTORE AND REVEGETATE AS NEEDED. WHEN ALL UPSTREAM AREAS HAVE BEEN STABILIZED AND HAVE BEEN ACCEPTED BY THE CONTRACTING OFFICER, REMOVE ALL REMAINING PERIMETER CONTROLS.

DESIGN CERTIFICATION:

"I HEREBY CERTIFY THAT THIS PLAN HAS BEEN DESIGNED IN ACCORDANCE WITH THE 1994 STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL OR CURRENT REVISIONS OF THEREOF, AND DEPARTMENT OF THE ENVIRONMENT STORMWATER MANAGEMENT REGULATION."

DATE

MD. REGISTRATION NO. ______

P.E., R.L.S., OR R.L.A.

REVEGETATION

TEMPORARY SEEDING

VEGETATION — ANNUAL GRASS OR GRAIN USED TO PROVIDE COVER ON DISTURBED AREAS FOR UP TO TWELVE MONTHS. FOR LONGER DURATION OF VEGETATIVE COVER, PERMANENT SEEDING IS REQUIRED.

TEMPORARY SEEDING SUMMARY

SEED MIXTURE					FERTILIZER RATE (10-20-10)	LIME RATE
BOTANICAL NAME	COMMON NAME	APPLICATION RATE (lb/ac)	SEEDING DATES	SEEDING DEPTHS		
LOLIUM MULTIFLORUM	ANNUAL RYE GRASS	25-50	9/1-2/15	1/4-1/2 INCHES	600 lb/ac (15 lb/1000 sf)	4000 lb/ac (100 lb/1000 sf)
SECALE CEREALE	CEREAL (WINTER) RYE	25-50	9/1-2/15	1/4-1/2 INCHES		

NOTE:
1) IN LIEU OF PROVIDING MARYLAND STANDARD FERTILIZER AND LIME RATES, PERFORM SOIL TEST TO DETERMINE THE EXACT RATIOS AND APPLICATION RATES FOR BOTH LIME AND FERTILIZER.

PERMANENT AND CHANNEL SEEDING

SEEDING GRASS AND LEGUMES TO ESTABLISH GROUND COVER FOR A MINIMUM PERIOD OF ONE YEAR ON DISTURBED AREAS GENERALLY RECEIVING LOW MAINTENANCE.

PERMANENT SEEDING SUMMARY

SEED MIXTURE					FERTILIZER RATE (10-20-10)	LIME RATE
BOTANICAL NAME	COMMON NAME	APPLICATION RATE (lb/ac)	SEEDING DATES	SEEDING DEPTHS		
PANICUM VIRGATUM	SWITCHGRASS	7	YEAR ROUND	1/4-1/2 INCHES	1000 lb/ac (23 lb/1000 sf)	4000 lb/ac (100 lb/1000 sf)
CASSIA FASCICULATA	PARTRIDGE PEA	20	YEAR ROUND	1/4-1/2 INCHES		
ANDROPOGON SCOPARIUS	LITTLE BLUESTEM	7	YEAR ROUND	1/4-1/2 INCHES		
LOLIUM MULTIFLORUM	ANNUAL RYE GRASS	10	YEAR ROUND	1/4-1/2 INCHES		
ELYMUS CANADENSIS	CANADIAN WILD RYE	6	YEAR ROUND	1/4-1/2 INCHES		
SORGHASTRUM NUTANS	INDIAN GRASS	7	YEAR ROUND	1/4-1/2 INCHES		
ANDROPOGON GERARDI	BIG BLUESTEM	7	YEAR ROUND	1/4-1/2 INCHES		

NOTE:
1) IN LIEU OF PROVIDING MARYLAND STANDARD FERTILIZER AND LIME RATES, PERFORM SOIL TEST TO DETERMINE THE EXACT RATIOS AND APPLICATION RATES FOR BOTH LIME AND FERTILIZER.

CHANNEL SEEDING SUMMARY

SEED MIXTURE					FERTILIZER RATE (10-20-10)	LIME RATE
BOTANICAL NAME	COMMON NAME	APPLICATION RATE (lb/ac)(1)	SEEDING DATES	SEEDING DEPTHS		
AGROSTIS ALBA	REDTOP	6	YEAR ROUND	1/4-1/2 INCHES	1000 lb/ac (23 lb/1000 sf)	4000 lb/ac (100 lb/1000 sf)
ECHINOCHLOA CRUSGALLI	BARNYARD GRASS	20	YEAR ROUND	1/4-1/2 INCHES		
PANICUM VIRGATUM	SWITCHGRASS	25	YEAR ROUND	1/4-1/2 INCHES		
DICHANTHELIUM CLANDESTIUM	DEERTONGUE GRASS	12	YEAR ROUND	1/4-1/2 INCHES		
SEE NOTE 2	SEASONAL NURSE CROP(2)	20	YEAR ROUND	1/4-1/2 INCHES		

NOTES:
1) POUND PURE LIVE SEED PER ACRE
2) NURSE CROP WILL INCLUDE ANNUAL RYE (LOLIUM MULTIFLORUM) 2/1 – 4/30, FOXTAIL MILET (SETARIA ITALICA) 5/1 – 8/31, ANNUAL RYE (LOLIUM MULTIFLORUM) 9/1 – 11/15 OR WINTER RYE (SECALE CEREALE) 11/15 – 1/31. APPLICATION RATE FOR SEASONAL NURSE CROP IS 20 LB/AC.
3) IN LIEU OF PROVIDING MARYLAND STANDARD FERTILIZER AND LIME RATES, PERFORM SOIL TEST TO DETERMINE THE EXACT RATIOS AND APPLICATION RATES FOR BOTH LIME AND FERTILIZER.

ACAD: 7427CN02.dwg 06/24/01 DT

SYMBOL	DESCRIPTION	DATE	APPROVED

REVISIONS

Tetra Tech NUS, Inc. FOSTER PLAZA VII, 661 ANDERSEN DRIVE, PITTSBURGH, PA 15220

DES. TWS DR. MF CHK. SAN

SUBMITTED BY: TITLE DATE 6/24/01

PROGRAM MANAGER DATE 6/25/01

APPROVED DATE

EFD FOR COMMANDER NAVFAC

REVIEWED BY ROICC DATE

STATE OF MARYLAND — SCOTT A. NESBIT — No. 26015 — PROFESSIONAL ENGINEER

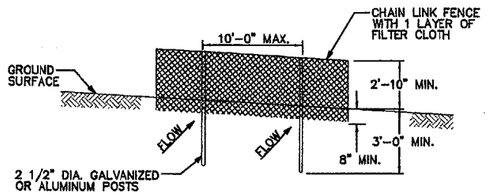
SEAL AREA

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY—CHESAPEAKE
WASHINGTON, D.C.
NAVAL SURFACE WARFARE CENTER WHITE OAK — SILVER SPRING, MARYLAND

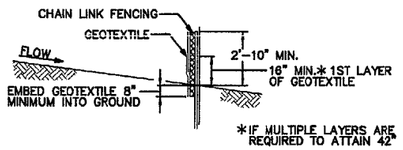
OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC — WHITE OAK
EROSION AND SEDIMENT CONTROL NOTES

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO. 3307625
SHEET 5 OF 15
C-3

NOTE: FENCE POST SPACING SHALL NOT EXCEED 10'-0" CENTER TO CENTER



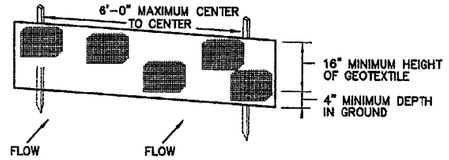
PERSPECTIVE VIEW



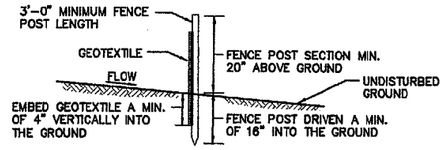
CROSS SECTION

SUPER SILT FENCE DETAIL (1 / C-2 | C-4)

NTS



PERSPECTIVE VIEW



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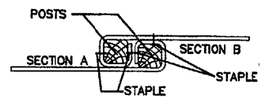
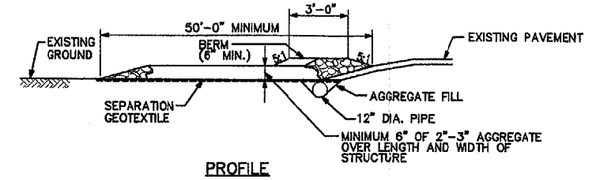


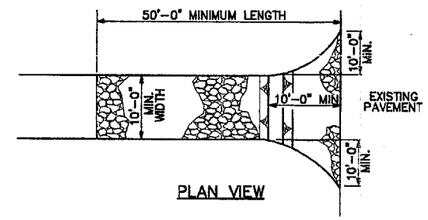
TOP VIEW – JOINING TWO ADJACENT SILT FENCE SECTIONS

SILT FENCE DETAIL (2 / C-2 | C-4)

NTS



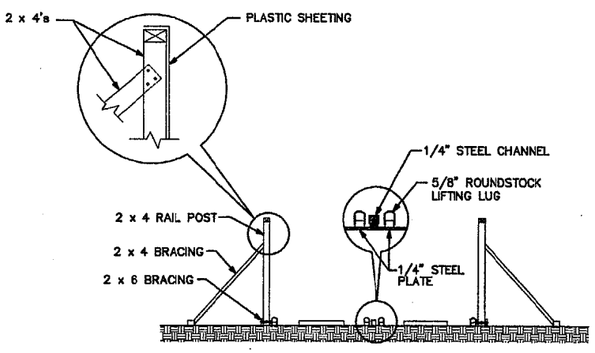
PROFILE



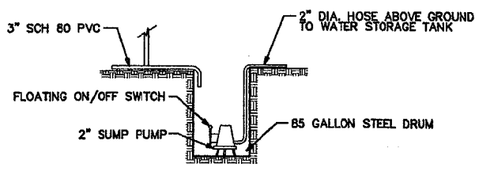
PLAN VIEW

STABILIZED STONE CONSTRUCTION ENTRANCE DETAIL (3 / C-2 | C-4)

NTS



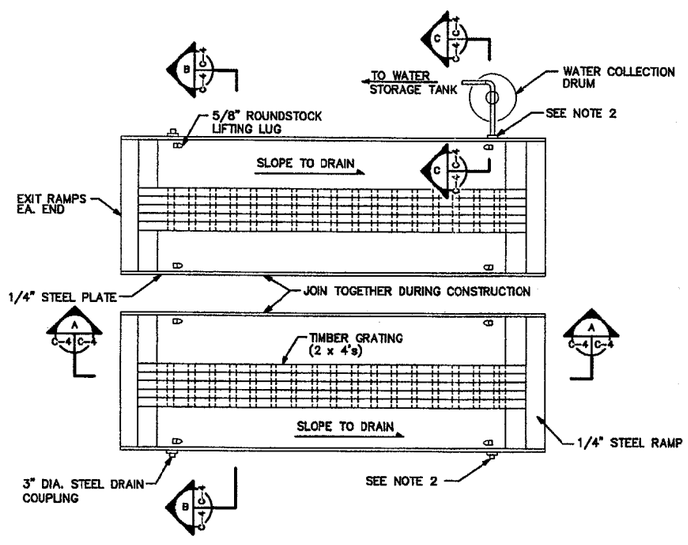
SECTION (B / C-4 | C-4)



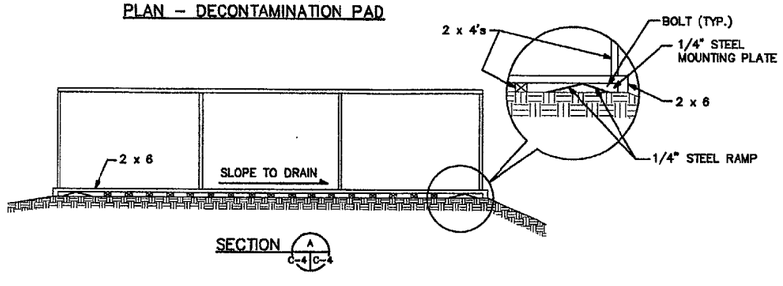
SECTION (C / C-4 | C-4)

NOTES:

1. ON/OFF OPERATION OF PUMP IS CONTROLLED BY FLOAT SO THAT PUMP STARTS WHEN SUMP WATER LEVEL REACHES 4" BELOW SUMP INLET AND SHUTS OFF WHEN WATER LEVEL DROPS TO PUMP DISCHARGE LEVEL.
2. DRAIN COUPLING IS TO BE FITTED WITH QUICK DISCONNECT AND 3" DIA. SCH 80 PVC (INNER COUPLING) OR 3" DIA. RUBBER DISCHARGE HOSE (OUTER COUPLING) TO SUMP. THE OUTER DRAIN COUPLING IS TO BE USED ONLY AFTER VEHICLE HAS LEFT THE PAD. PLUG ALL DRAINS NOT BEING USED.



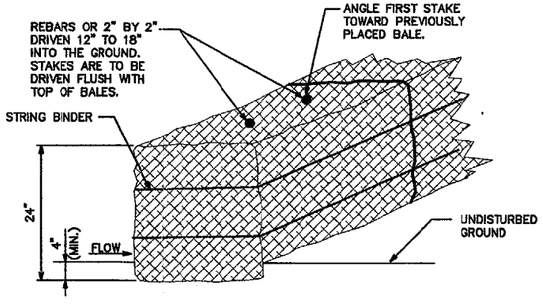
PLAN – DECONTAMINATION PAD



SECTION (A / C-4 | C-4)

DECONTAMINATION PAD DETAIL (4 / C-2 | C-4)

NTS



STRAW BALE DETAIL (5 / C-2 | C-4)

NTS

403				
404				
405				
406				
401				
402				
048				
	SYMBOL	DESCRIPTION	DATE	APPROVED

REVISIONS

REVIEWED BY RGCC DATE

Tetra Tech NUS, Inc. PITTSBURGH, PENNSYLVANIA

DES. TWG DR. MF CHK. SAN

SUBMITTED BY: TITLE E.I.C. DATE 6/12/01

APPROVED DATE 6/12/01

EFD FOR COMMANDER NAVFAC

STATE OF MARYLAND PROFESSIONAL ENGINEER

SEAL AND SIGNATURE

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

ENGINEERING FIELD ACTIVITY-CHESAPEAKE
NAVAL SURFACE WARFARE CENTER WHITE OAK SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC – WHITE OAK
EROSION & SEDIMENT CONTROL DETAILS (1 OF 2)

CODE I.D. NO. 80091

DRAWING SIZE: D

CONST. CONT. NO. N62470-97-D-5000

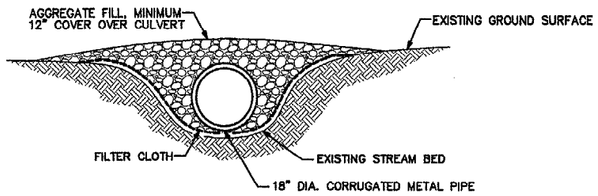
SPEC. 21-97-5009-0069

NAVFAC DRAWING NO. 3307626

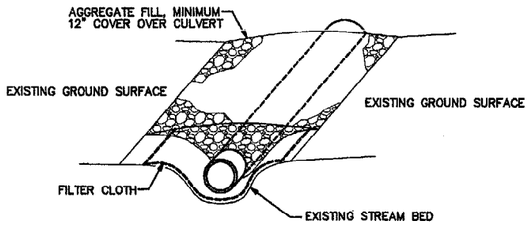
SHEET 6 OF 15

C-4

ACAD:74370D06.dwg 06/22/01 DT



PROFILE

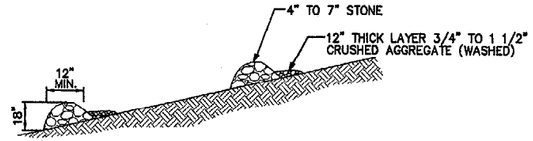


PERSPECTIVE VIEW

1. CULVERT SHALL EXTEND A MINIMUM OF 1-FOOT BEYOND THE UPSTREAM AND DOWNSTREAM TOE OF AGGREGATE PLACED AROUND CULVERT.

STREAM CROSSING DETAIL (1 / C-2 | C-5)

NTS



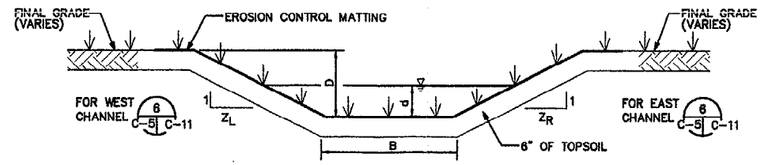
PROFILE

END VIEW

1. ROCK CHECK DAMS WILL BE REMOVED FOLLOWING FINAL STABILIZATION.
2. SEDIMENT SHALL BE REMOVED FROM BEHIND ROCK CHECK DAM WHEN IT HAS ACCUMULATED TO ONE HALF OF THE ORIGINAL HEIGHT OF THE ROCK CHECK DAM.

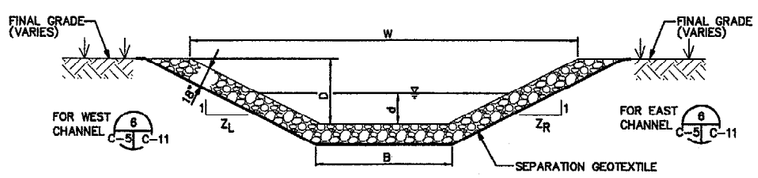
ROCK CHECK DAM DETAIL (2 / C-2 | C-5 / C-7)

NTS



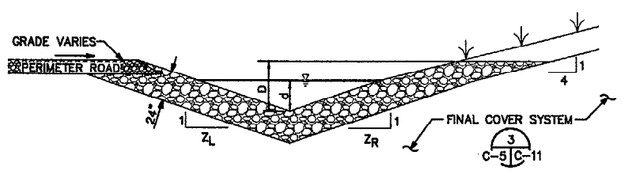
TRAPEZOIDAL GRASS LINED CHANNEL DETAIL (3 / C-8 | C-5)

NTS



TRAPEZOIDAL RIPRAP LINED CHANNEL DETAIL (4 / C-8 | C-5)

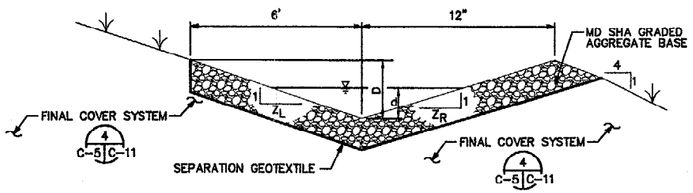
NTS



NOTE:
DETAIL PROVIDED FOR E&S INFORMATION ONLY.
SEE DETAIL 3 ON DRAWING C-11 FOR RELATIONSHIP TO COVER SYSTEM.

NORTHERN CHANNEL DETAIL (5 / C-8 | C-5)

NTS



NOTES:
1. SEE DRAWING C-11 FOR CAP AND DRAIN CONSTRUCTION DETAILS.
2. DETAIL PROVIDED FOR E&S INFORMATION ONLY. SEE DETAIL 4 ON DRAWING C-11 FOR RELATIONSHIP TO COVER SYSTEM.

BENCH DETAIL (6 / C-8 | C-5)

NTS

CHANNEL SCHEDULE

CHANNEL	DETAIL	DESIGN FLOW (CFS)	SHAPE	SLOPE (FT/FT) MIN.	SLOPE (FT/FT) MAX.	BOTTOM WIDTH, B (ft)	SIDE SLOPE RATIO Z_L	SIDE SLOPE RATIO Z_R	MAX. VELOCITY (fps)	MAX. FLOW DEPTH, d (ft)	TOTAL DESIGN DEPTH, D (ft)	CHANNEL LINING
WEST CHANNEL	3 AND 4	12	TRAPEZOIDAL	0.057	0.080	2	3	3	3.87	0.79	1.5	GRASS WITH ECM/RIPRAP (SEE NOTE 3)
EAST CHANNEL	3 AND 4	5	TRAPEZOIDAL	0.044	0.286	2	3	3	3.32	0.55	1.5	GRASS WITH ECM/RIPRAP (SEE NOTE 3)
NORTH CHANNEL	5	3	"V" SHAPED	0.033	0.125	0	3	3	6.22	0.49	1.5	RIPRAP CLASS 0
BENCH	6	3	"V" SHAPED	0.033	0.033	0	4	8	3.51	0.38	1.5	MD SHA GRADED AGGREGATE BASE

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. VIEW OF CHANNEL IS LOOKING SOUTH FOR THE TRAPEZOIDAL CHANNELS AND EAST FOR THE "V" SHAPED CHANNELS.
3. REFER TO DRAWING C-8 FOR RIPRAP PLACEMENT LIMITS. RIPRAP SHALL BE PLACED FOR THE FULL CHANNEL TOTAL DESIGN DEPTH. TOP OF RIPRAP SHALL MATCH EXISTING TRIBUTARY INVERT AND BANK ELEVATIONS.

ACAD:7427CD07.dwg 06/22/01 DT

SYMBOL	DESCRIPTION	DATE	APPROVED

REVISIONS

C6A	403		
D4	404		
E.I.C.	405		
401	408		
402	C4B	DATE	
REVIEWED BY ISOCC			

Tetra Tech NUS, Inc. — FORT WASHINGTON OFFICE PARK, FORT WASHINGTON, PA 19034

DES. TWS | DR. MF | CHK. SAN | SUBMITTED BY | TITLE | DATE 8/23/01 | PROGRAM MANAGER | DATE 6/25/01 | APPROVED | DATE

ED FOR COMMANDER NAVFAC

STATE OF MARYLAND — SCOTT A. KEARNEY — No. 21-32-5000-0059 — PROFESSIONAL ENGINEER — SEAL AREA

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND — WASHINGTON, D.C.

ENGINEERING FIELD ACTIVITY-CHESAPEAKE

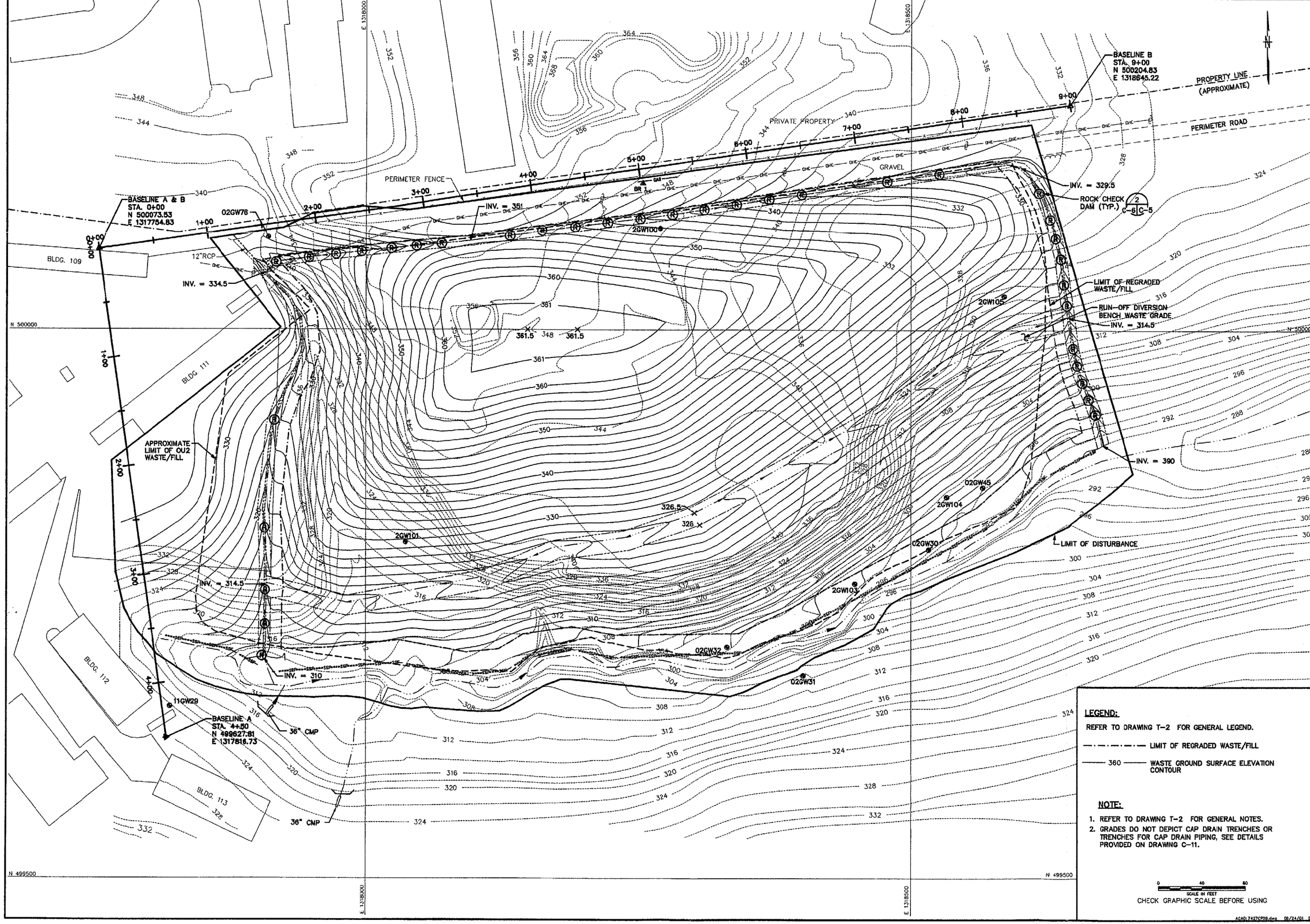
NAVAL SURFACE WARFARE CENTER WHITE OAK — SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK

EROSION & SEDIMENT CONTROL DETAILS (2 OF 2)

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0059
NAVFAC DRAWING NO. 3307627
SHEET 7 OF 15

C-5



LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

— · — · — · — LIMIT OF REGRADED WASTE/FILL

—— 360 —— WASTE GROUND SURFACE ELEVATION CONTOUR

NOTE:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. GRADES DO NOT DEPICT CAP DRAIN TRENCHES OR TRENCHES FOR CAP DRAIN PIPING, SEE DETAILS PROVIDED ON DRAWING C-11.

0 40 80
SCALE IN FEET
CHECK GRAPHIC SCALE BEFORE USING

ACAD:7427CP2B.dwg 08/24/01 DT

SYMBOL	DESCRIPTION	DATE	APPROVED
403			
404			
405			
408			
043			

REVISIONS

09A			
04			
403			
404			
405			
408			
043			

DATE:
REVIEWED BY RODC

Weston Tetra Tech, Inc.
4370 TUDOR LANE
PITTSBURGH, PA 15236

DES. TWG DR. DLT CHK. SAM
SUBMITTED BY: TITLE DATE 6/25/01
PROGRAM MANAGER: TITLE DATE
APPROVED DATE

CTD. FOR COMMANDER NAVFAC

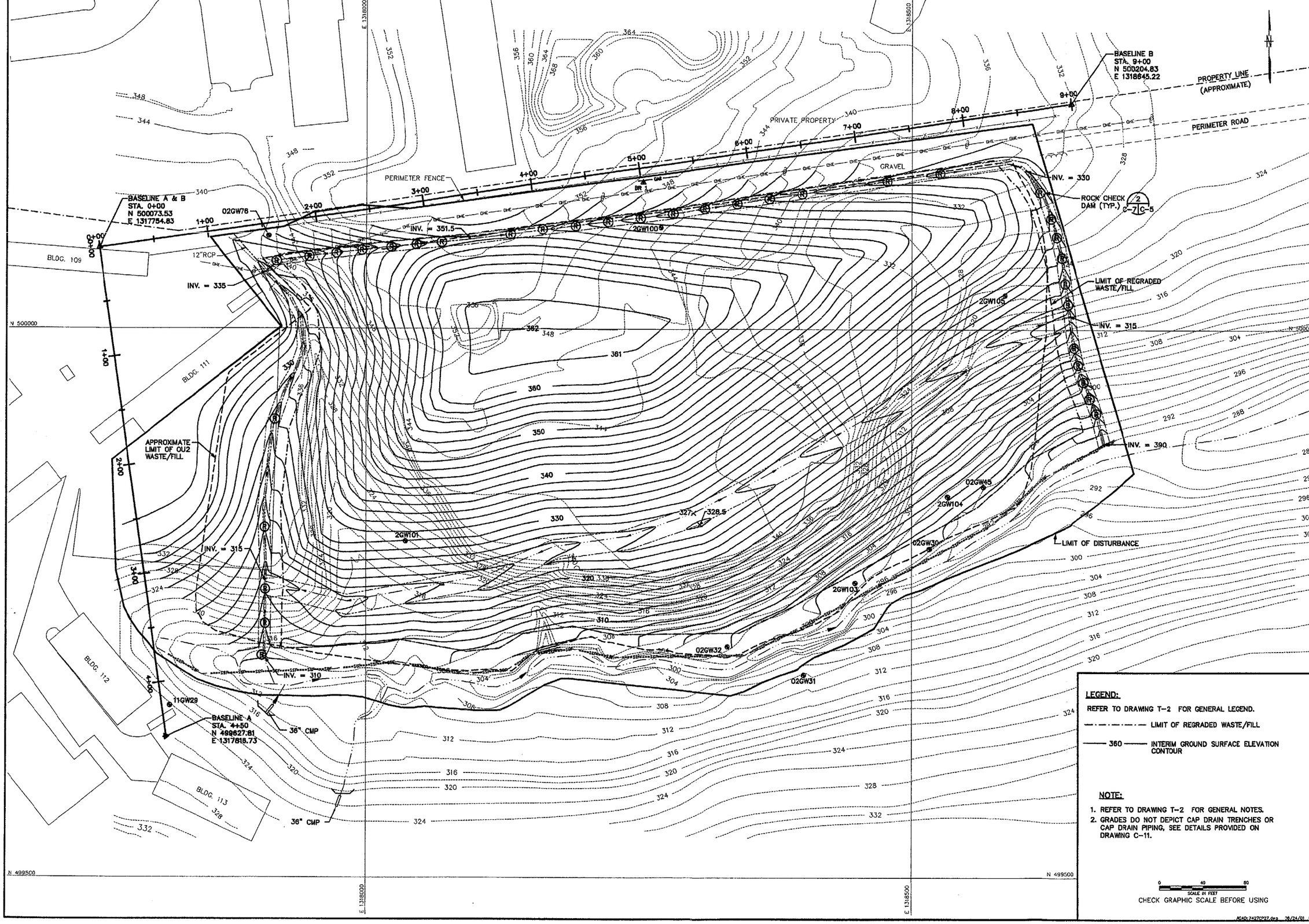
STATE OF MARYLAND
PROFESSIONAL ENGINEER
No. 20015
SEAL AREA

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

NAVAL SURFACE WARFARE CENTER WHITE OAK
SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
WASTE GRADING PLAN

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO.
3307628
SHEET 8 OF 15
C-6



LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

—·—·—·— LIMIT OF REGRADED WASTE/FILL

—— 360 —— INTERIM GROUND SURFACE ELEVATION CONTOUR

NOTE:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. GRADES DO NOT DEPICT CAP DRAIN TRENCHES OR CAP DRAIN PIPING, SEE DETAILS PROVIDED ON DRAWING C-11.

0 40 80
SCALE IN FEET
CHECK GRAPHIC SCALE BEFORE USING

REVISIONS			
SYMBOL	DESCRIPTION	DATE	APPROVED
D9A	403		
04	404		
E.I.C.	405		
	401		
	408		
D43	402		
DATE	REVIEWED BY RGGC		

Tetra Tech NUS, Inc.
CENTER PLAZA IV
160 FEDERAL STREET
PITTSBURGH, PA 15212

DES.	TWC	DR.	DLT	CHK.	SAN
SUBMITTED BY:		TITLE		DATE	6-25-01
PROJECT MANAGER				DATE	6/25/01
APPROVED		STD FOR COMMANDER NAVFAC			

STATE OF MARYLAND — PROFESSIONAL ENGINEER — No. 28815 — SEAL AND SIGNATURE

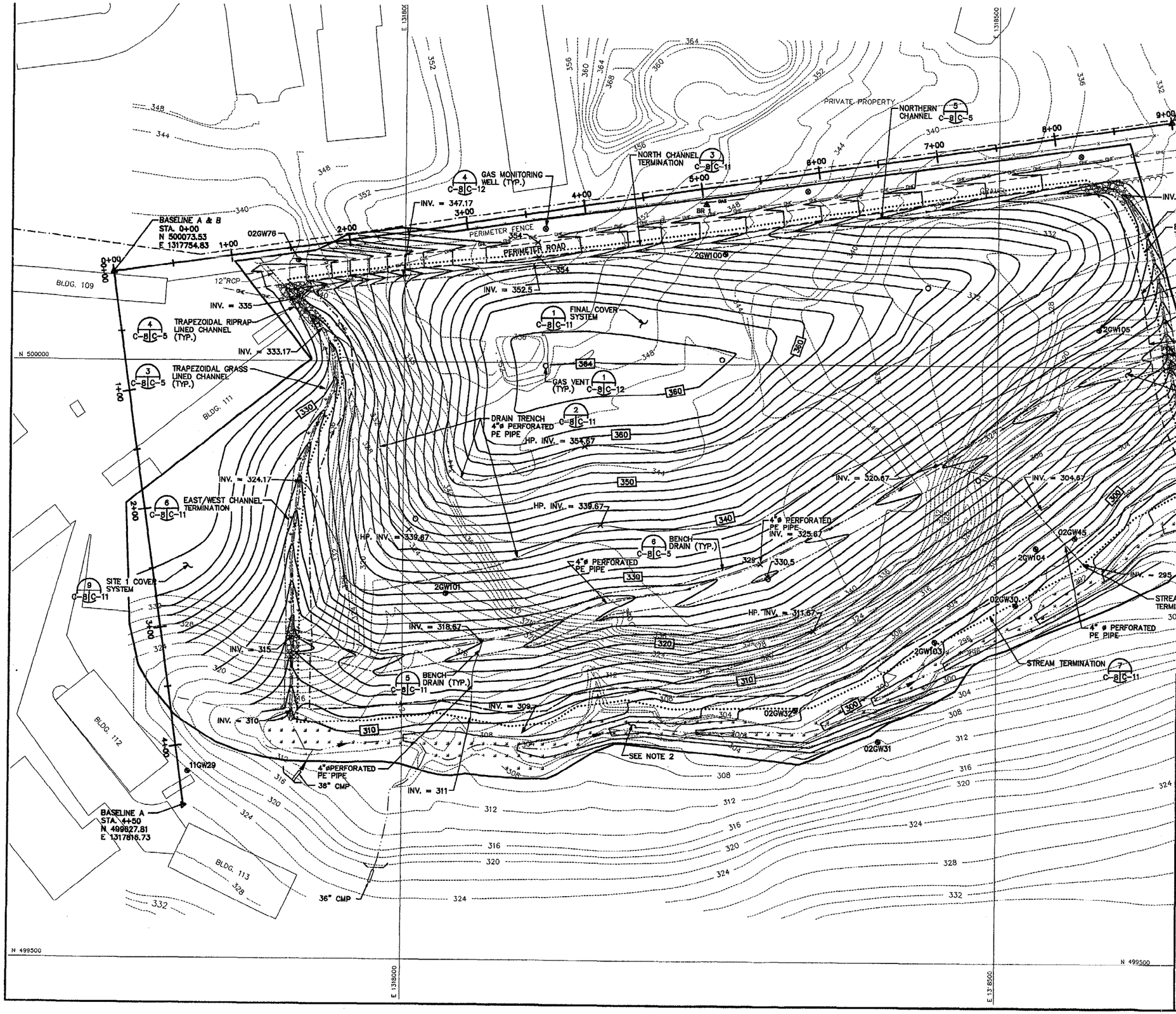
DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
NAVAL FACILITIES ENGINEERING COMMAND
SILVER SPRING, MARYLAND

NAVAL SURFACE WARFARE CENTER WHITE OAK
DAHLGREN, VA.

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
INTERIM GRADING PLAN

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
N82470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO.
3307629
SHEET 9 OF 15
C-7

ACAD:74270C27.dwg 06/24/01 07



LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

- GAS MONITORING WELL
- GAS VENTS
- LIMIT OF CAP
- LIMIT OF REGRADED WASTE
- WETLAND RESTORATION

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES.
2. WETLAND RESTORATION AREA TO BE SEEDED AS INDICATED ON DRAWING C-13. ALL OTHER DISTURBED AREAS TO BE SEEDED WITH PERMANENT OR CHANNEL SEED MIX.

0 40 80
SCALE IN FEET
CHECK GRAPHIC SCALE BEFORE USING

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

403	DYA		
404	04		
405	E.I.C.		
406			
407			
408			
D48	DATE	DATE	

Tetra Tech NUS, Inc. — POTTER PLAZA VI, 301 GRANT STREET, PITTSBURGH, PA 15219

DES. TWS | DR. KJP | CHK. SAM | SUBMITTED BY: | TITLE | DATE 6/14/01 | PROJ. MANAGER | DATE | APPROVED | REVIEWED BY RDCO | DATE

ETD FOR COMMANDER NAVFAC

STATE OF MARYLAND — PROFESSIONAL ENGINEER — SEAL AND SIGNATURE

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND, WASHINGTON, D.C.

ENGINEERING FIELD ACTIVITY-CHESAPEAKE

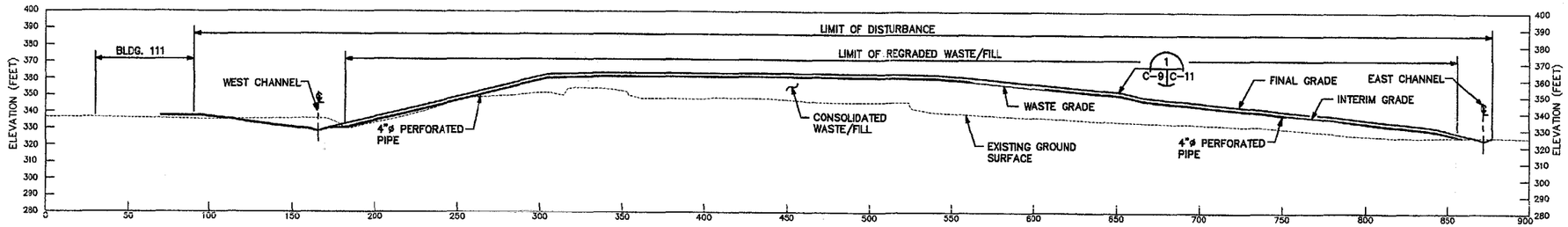
NAVAL SURFACE WARFARE CENTER WHITE OAK — SILVER SPRING, MARYLAND

OPERABLE UNIT 2 CLOSURE DESIGN FORMER NSWC – WHITE OAK FINAL GRADING PLAN

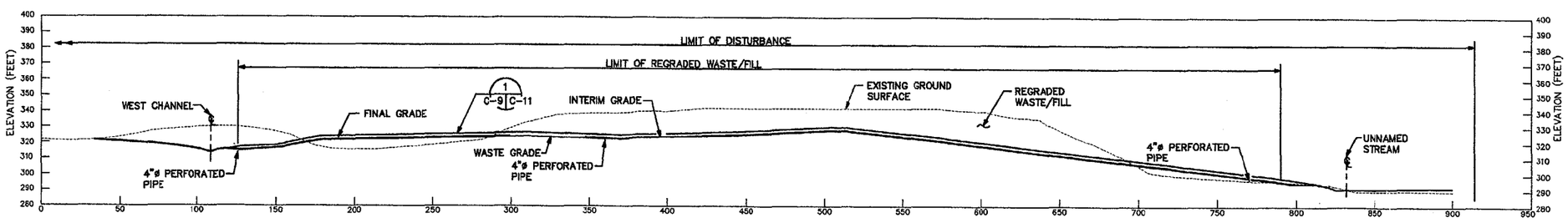
CODE I.D. NO.	80091
DRAWING SIZE:	D
CONST. CONT. NO.	N62470-97-D-5000
SPEC.	21-97-5000-0069
NAVFAC DRAWING NO.	3307630
SHEET 10 OF 15	

C-8

ACAD:7427GM13.dwg 08/24/01 DT



BASELINE A STA. 1+30



BASELINE A STA. 3+30

LEGEND:
REFER TO DRAWING T-2 FOR GENERAL LEGEND.

NOTES:
REFER TO DRAWING T-2 FOR GENERAL NOTES.

0 40 80
SCALE IN FEET

AC4D:74270X01.dwg 06/22/01 DT

SYMBOL	DESCRIPTION	DATE	APPROVED
D9A	403		
D4	404		
E.I.C.	405		
401	406		
402	D48		
DATE	REVISED BY RDCO		

REVISIONS

Tetra Tech NUS, Inc.
661 ANDERSON DRIVE
PITTSBURGH, PA 15220

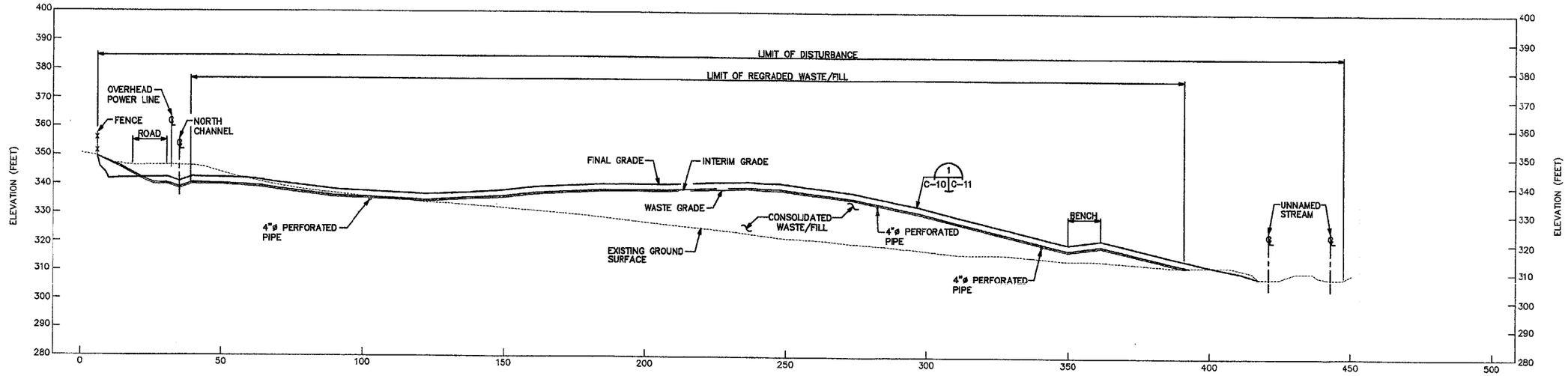
DESIGN TWG | DR. TWP | CHK. SKM | TITLE | DATE 6/15/01
SUBMITTED BY
PROGRAM MANAGER
APPROVED | DATE 6/15/01
EFD FOR COMMANDER NAVFAC

STATE OF MARYLAND
JOHN T. KEASBEY
No. 20895
PROFESSIONAL ENGINEER
SEAL AREA

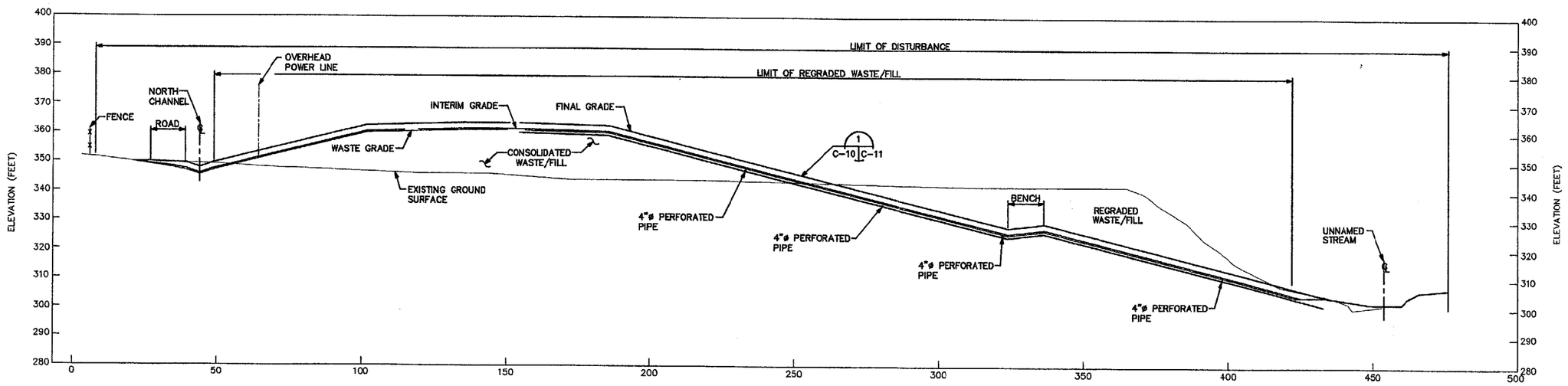
NAVAL FACILITIES ENGINEERING COMMAND
DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
WASHINGTON, D.C.
NAVAL SURFACE WARFARE CENTER WHITE OAK
SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC-WHITE OAK
CROSS SECTIONS (SHEET 1 OF 2)

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO.
3307631
SHEET 11 OF 15
C-9



BASELINE B STA. 2+00



BASELINE B STA. 4+70

LEGEND:
REFER TO DRAWING T-2 FOR GENERAL LEGEND.

NOTES:
REFER TO DRAWING T-2 FOR GENERAL NOTES.

0 20 40
SCALE IN FEET

ACAD:74270X02.dwg 06/22/01 DT

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

D9A	403	
D4	404	
E.I.C.	405	
401	408	
402	D19	
RENEWED BY NCSC		DATE

Tetra Tech NUS, Inc. 661 ANDERSON DRIVE PITTSBURGH, PA 15220

DES.	TMS	DR.	DLT	CHK.	SAH
SUBMITTED BY:		TITLE		DATE 6/14/01	
APPROVED				DATE 6/15/01	

ERD FOR COMMANDER NAVFAC

SEAL AREA

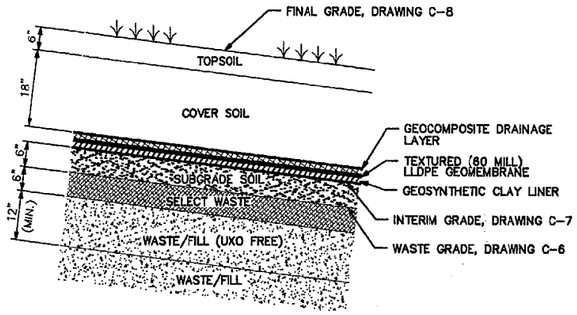
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

NAVAL SURFACE WARFARE CENTER WHITE OAK
SILVER SPRING, MARYLAND

ENGINEERING FIELD ACTIVITY-CHESAPEAKE

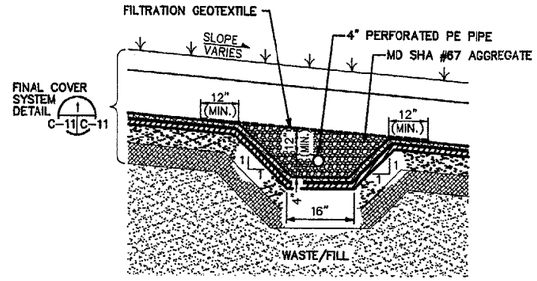
OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC-WHITE OAK
CROSS SECTIONS (SHEET 2 OF 2)

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO. 3307632
SHEET 12 OF 15
C-10



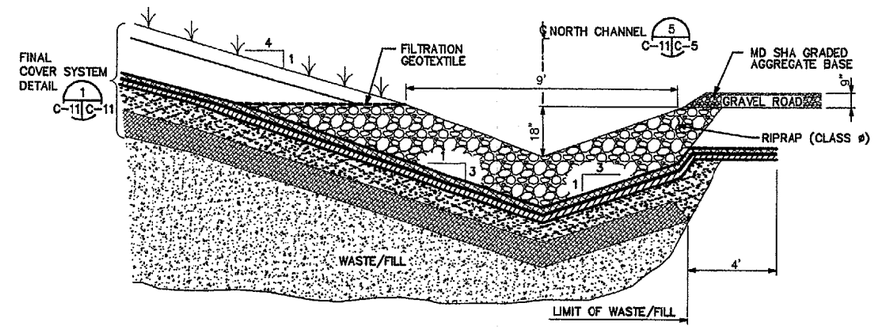
FINAL COVER SYSTEM DETAIL (1 C-8 C-11; C-9, C-10, C-11, C-12)

NTS



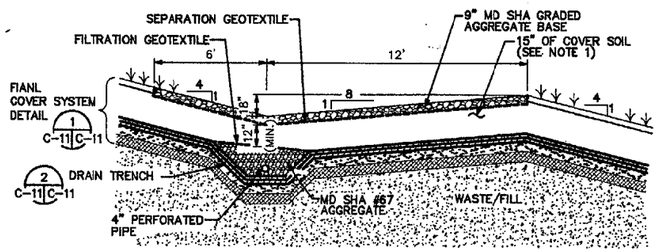
DRAIN TRENCH DETAIL (2 C-8 C-11)

NTS



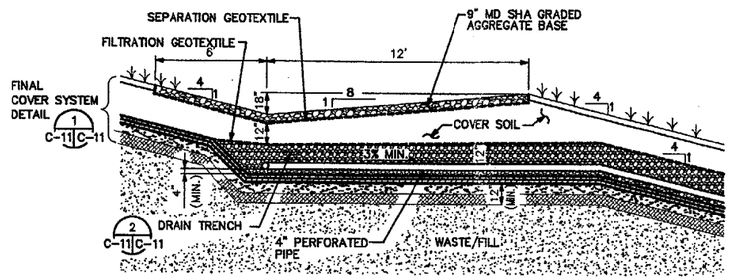
NORTH CHANNEL TERMINATION DETAIL (3 C-5 C-11)

NTS



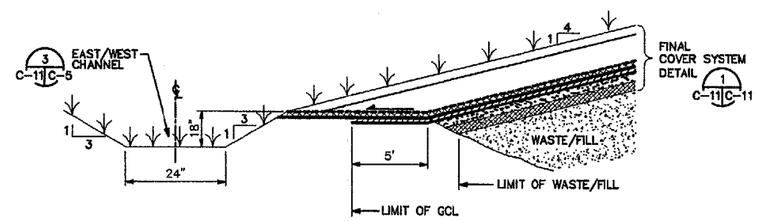
BENCH DETAIL (4 C-5 C-8 C-11)

NTS



BENCH DRAIN DETAIL (5 C-8 C-11)

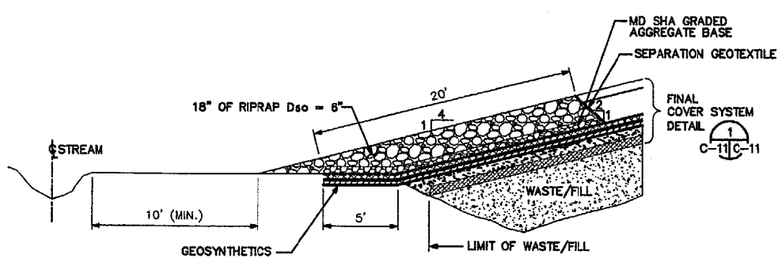
NTS



NOTE: FOR EAST CHANNEL VIEW IS LOOKING SOUTH
FOR WEST CHANNEL VIEW IS LOOKING NORTH.

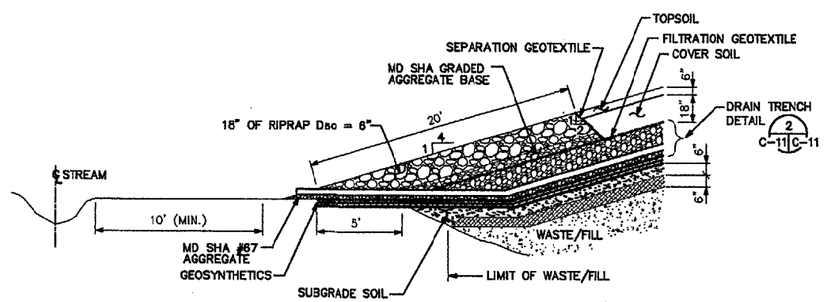
EAST/WEST CHANNEL TERMINATION DETAIL (6 C-5 C-8 C-11)

NTS



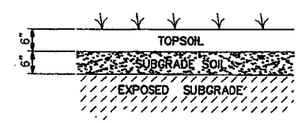
STREAM TERMINATION DETAIL (7 C-8 C-11)

NTS



STREAM DRAIN TERMINATION DETAIL (8 C-8 C-11)

NTS



SITE 1 COVER SYSTEM (9 C-8 C-11)

NTS

NOTES:

1) TO MAINTAIN 24" OF COVER MATERIAL ABOVE GEOSYNTHETICS PROVIDE 15" OF COVER SOIL WHERE 9" OF MD SHA GRADED AGGREGATE BASE IS USED.

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

D9A	403		
04	404		
E.I.C.	405		
401	406		
402	D4B		
REVIEWED BY RDCC	DATE		

Tetra Tech NUS, Inc. 661 ANDERSON DRIVE PITTSBURGH, PA. 15220

DES. TRG | DR. MF | CHK. SAM | TITLE | DATE 6/21/01

SUBMITTED BY: PROJ. MANAGER 6/25/01 DATE

APPROVED 6/25/01 DATE

IFD FOR COMMANDER NAVFAC

STATE OF MARYLAND REGISTERED PROFESSIONAL ENGINEER No. 28015 SEAL AREA

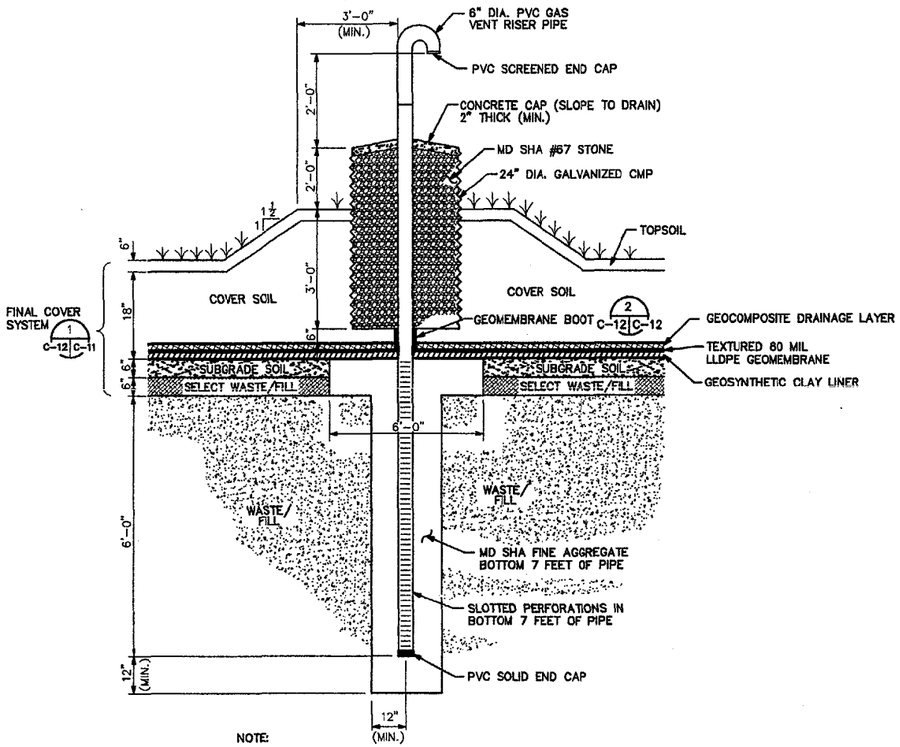
DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY-CHESAPEAKE
NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
NAVAL SURFACE WARFARE CENTER WHITE OAK SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
LANDFILL CAP DETAILS

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0089
NAVFAC DRAWING NO. 3307633
SHEET 13 OF 15

C-11

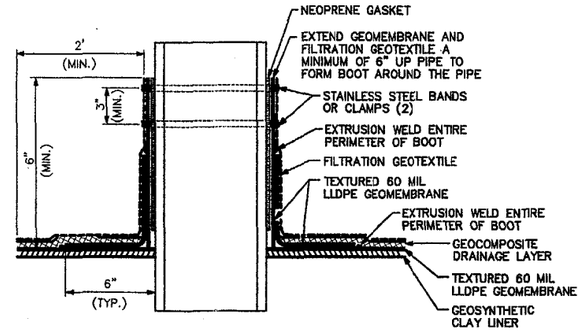
ACAD:7427CD04.dwg 06/22/01 07



NOTE:
SCREENED MATERIAL ON PVC SCREENED END CAP SHALL BE SIZED TO PREVENT INSECTS FOR ENTERING VENT.

GAS VENT DETAIL 1 C-8 C-12

NTS

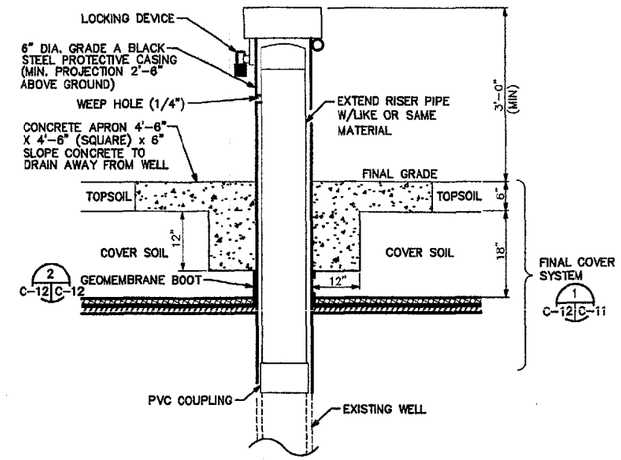


NOTES:

1. FOR GAS VENTS AND MONITORING WELLS.
2. NEOPRENE GASKET TO BE PLACED BETWEEN THE GEOMEMBRANE AND PIPE AND SHALL EXTEND BEYOND THE LOCATIONS OF THE STAINLESS STEEL CLAMPS.

GEOMEMBRANE BOOT 2 C-12 C-12

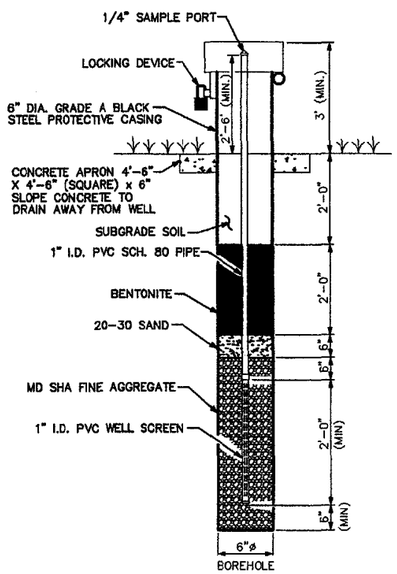
NTS



NOTE:
REMOVE EXISTING CONCRETE COLLAR TO THE EXTENT POSSIBLE WITHOUT DISTURBING EXISTING PVC WELL RISER AND EXISTING STEEL CASING.

MONITORING WELL EXTENSION DETAIL 3 C-8 C-12

NTS



GAS MONITORING WELL DETAIL 4 C-8 C-12

NTS

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

D9A	403		
D4	404		
E.I.C.	405		
401	406		
402	DLR	DATE	
REVIEWED BY RGEC			

Tetra Tech NUS, Inc. FOSTER PLAZA VII, 661 ANDERSON DRIVE, PITTSBURGH, PA 15220

DES. TWS | DR. MF | TITLE | CHK. SAM | DATE 6/22/01

SUBMITTED BY: PROJECT MANAGER DATE 6/22/01

APPROVED DATE

CITY FOR COMMANDER, NAVFAC

STATE OF MARYLAND REGISTERED PROFESSIONAL ENGINEER

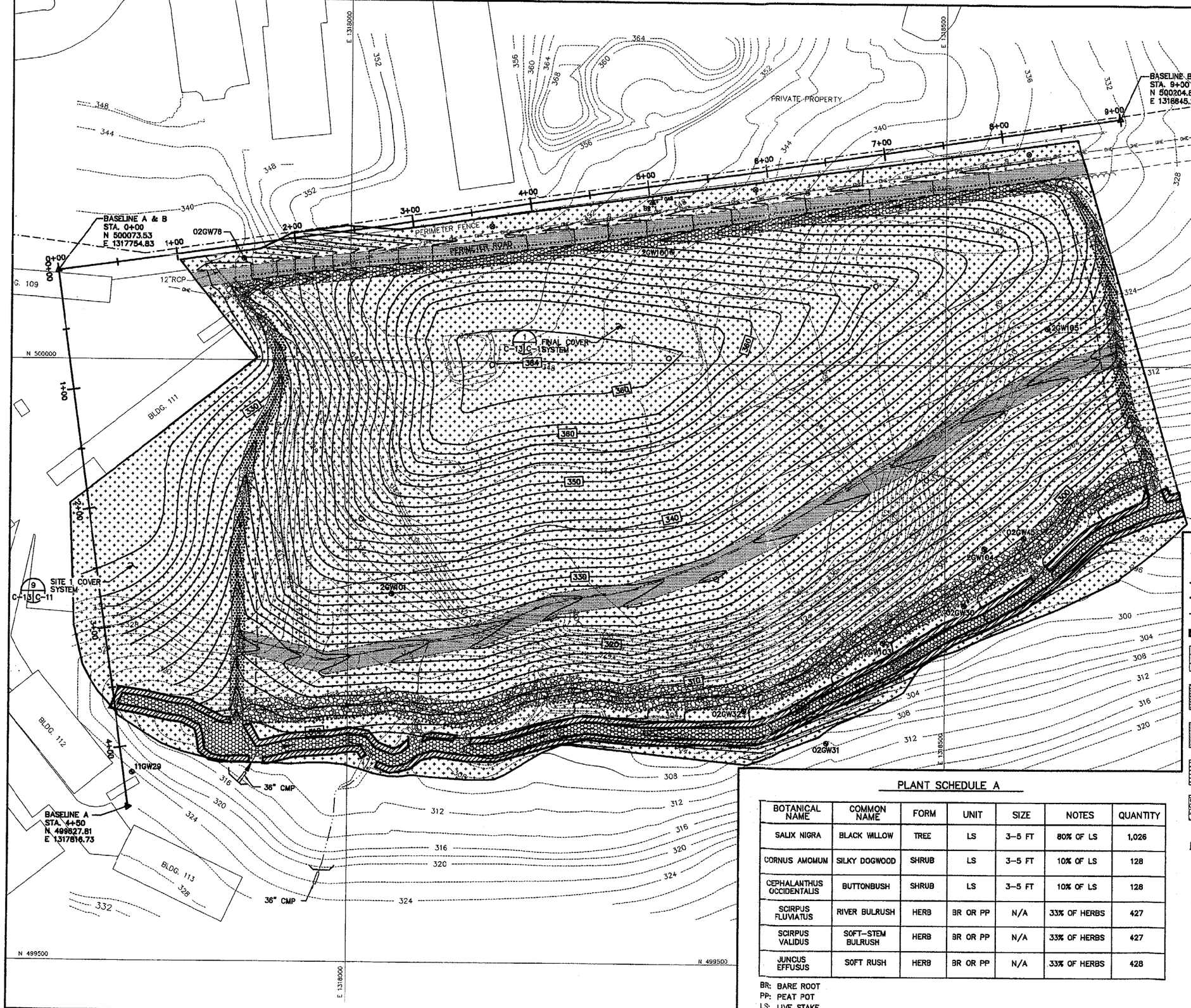
SEAL AREA

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY—CHESAPEAKE
WASHINGTON, D.C.
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL SURFACE WARFARE CENTER WHITE OAK
SILVER SPRING, MARYLAND

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC – WHITE OAK
MISCELLANEOUS DETAILS

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO. 3307634
SHEET 14 OF 15
C-12

ACAD: 74270D09.dwg 06/22/01 DT



LEGEND:

REFER TO DRAWING T-2 FOR GENERAL LEGEND.

- LIMIT OF DISTURBANCE
- LIMIT OF CAP
- LIMIT OF REGRADED WASTE
- PLANT SCHEDULE A
- PERMANENT SEED MIX SEE DRAWING C-3)
- CHANNEL SEED MIX SEE DRAWING C-3)
- MD SHA AGGREGATE BASE
- RIP RAP (CLASS 0)
- RIP RAP (D_{50}= 6")

PLANT SCHEDULE A

BOTANICAL NAME	COMMON NAME	FORM	UNIT	SIZE	NOTES	QUANTITY
SALIX NIGRA	BLACK WILLOW	TREE	LS	3-5 FT	80% OF LS	1,026
CORNUS AMOMUM	SILKY DOGWOOD	SHRUB	LS	3-5 FT	10% OF LS	128
CEPHALANTHUS OCCIDENTALIS	BUTTONBUSH	SHRUB	LS	3-5 FT	10% OF LS	128
SCIRPUS FLUVIATUS	RIVER BULRUSH	HERB	BR OR PP	N/A	33% OF HERBS	427
SCIRPUS VALIDUS	SOFT-STEM BULRUSH	HERB	BR OR PP	N/A	33% OF HERBS	427
JUNCUS EFFUSUS	SOFT RUSH	HERB	BR OR PP	N/A	33% OF HERBS	428

BR: BARE ROOT
PP: PEAT POT
LS: LIVE STAKE

NOTES:

1. REFER TO DRAWING T-2 FOR GENERAL NOTES AND DRAWING C-3 FOR ADDITIONAL PLANTING SCHEDULES.
2. THE EXISTING COBBLE SUBSTRATE SHALL BE PRESERVED TO THE EXTENT POSSIBLE.
3. THE EROSION CONTROL MATTING USED (CORI OR COCONUT FIBER) TO STABILIZE THE BANKS SHALL NOT EXTEND CHANNELWARD BEYOND THE TOE OF THE BANKS.
4. THE TREES, SHRUBS, AND HERBS INDICATED IN PLANT SCHEDULE A SHALL BE PLANTED ON 3-FOOT CENTERS.

0 40 80
SCALE IN FEET
CHECK GRAPHIC SCALE BEFORE USING

AGAD:74270P20.dwg 06/22/01 DT

REVISIONS

SYMBOL	DESCRIPTION	DATE	APPROVED
D39A	403		
D4	404		
E.I.C.	405		
	406		
	401		
	402		
D4B	REVISED BY RGCC	DATE	

Tetra Tech NUS, Inc.
FORTITE PLACE DR.
PITTSBURGH, PA 15220

DES. TNS DR. DLT CHK. SAM
SUBMITTED BY: S.J.V. TITLE DATE 6/14/01
RECOMMENDED BY: TITLE DATE 6/14/01
APPROVED: TITLE DATE 6/22/01
EFD FOR COMMANDER NAVFAC

STATE OF MARYLAND
PROFESSIONAL ENGINEER
SEAL AREA

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
NAVAL SURFACE WARFARE CENTER WHITE OAK
SILVER SPRING, MARYLAND

ENGINEERING FIELD ACTIVITY-CHESAPEAKE

OPERABLE UNIT 2
CLOSURE DESIGN
FORMER NSWC - WHITE OAK
RESTORATION PLAN

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO. N62470-97-D-5000
SPEC. 21-97-5000-0069
NAVFAC DRAWING NO. 3307635
SHEET 15 OF 15
C-13