FINAL SOILS AND FOUNDATION REPORT

(Phase VII – Final PS&E)

Mulligan Road

Grading, Drainage, and Base from Pole Road to Telegraph Road, Bridges over Kingman Road and Piney Run, and other work

Fairfax County, VA

Project:
VA-A-AD 48(1)

Prepared for:
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL
LANDS HIGHWAY DIVISION

June 2008

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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Authorization, Purpose and Scope 1
1.2 Project Location and Description 2
1.3 General Geology 3
2.0 PROCEDURES 3
2.1 NDT Program 4
2.2 Condition Survey 4
2.3 Pavement Test Borings 5
2.4 Non-Pavement Test Borings 5
2.5 Laboratory Testing Program 7
2.6 Pavement Structural Analyses 7
3.0 RESULTS AND FINDINGS 7
3.1 NDT Results 7
3.2 Pavement Condition Survey 8
3.2.1 Richmond Highway 8
3.2.2 Mount Vernon Memorial Highway 8
3.2.3 Old Mill Road 8
3.2.4 Telegraph Road 8
3.3 Pavement Test Borings 9
3.3.1 Richmond Highway 9
3.3.2 Mount Vernon Memorial Highway 9
3.3.3 Old Mill Road 10
3.3.4 Telegraph Road 10
3.4 Non-Pavement Test Borings 10
3.4.1 Mulligan Road and Telegraph Road Widening 10
3.4.2 Kingman Road Bridge 11
3.4.3 Piney Run Bridge at HEC 12
3.4.4 Piney Run Bridge at Telegraph Road 13
3.4.5 Wildlife Crossing Box Culvert 14
3.4.6 Stormwater Management Basins and Culverts 14
3.5 Laboratory Testing Program 15

4.0 ANALYSES AND DISCUSSION 16
4.1 Pavements 16
4.1.1 Traffic Data 16
4.1.2 Pavement Structural Analyses 17
4.1.3 Mulligan Road and Shared Use Path 17
4.2 Earthwork 17
4.2.1 Site Clearing/UXO 17
4.2.2 Excavations/Cut Slopes 18
4.2.3 Embankments/Fill Slopes 20
4.2.4 Stormwater Management Basins and Culverts 22
4.2.5 Underdrains 23
4.3 Structure Foundations 23
4.3.1 General 23
4.3.2 Kingman Road Bridge 24
4.3.3 Piney Run Bridge at HEC 25
4.3.4 Wildlife Crossing Box Culvert 27
5.0 RECOMMENDATIONS 28
5.1 Pavements 28
5.1.1 Mulligan Road and Shared Use Path 28
5.2 Earthwork 29
5.2.1 Site Clearing/UXO 29
5.2.2 Excavations/Cut Slopes 29
5.2.3 Embankments/Fill Slopes 29
5.2.4 Stormwater Management Basins and Culverts 31
5.2.5 Underdrains 31
5.2.6 Utility Excavations 32
5.3 Structure Foundations 32
5.3.1 General 32
5.3.2 Kingman Road Bridge 33
5.3.3 Piney Run Bridge at HEC 33
5.3.4 Wildlife Crossing Box Culvert 34
6.0 LIMITATIONS 35
7.0 BIBLIOGRAPHY 36

APPENDICES

Appendix A Figures
Appendix B Boring Location Plans
Appendix C Test Boring Logs
Appendix D Laboratory Test Results
Appendix E Pavement Condition Survey Field Sheets
Appendix F RDM Nondestructive Testing and Structural Pavement Evaluation Report
Appendix G Analyses
Appendix H Details

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1.0 INTRODUCTION

1.1 Authorization, Purpose, and Scope

This Final Soils and Foundation Report has been prepared by HDR Engineering, Inc (HDR) for the Eastern Federal Lands Highway Division (EFLHD) to summarize pavement and geotechnical investigations authorized under Task Order No. 07-010 and Contract Number DTFH71-02-00008 for Mulligan Road, Project VA-A-AD-48(1). The purpose of the investigation was to:

- Evaluate existing pavement for portions of Richmond Highway (U.S. Route 1), Old Mill Road, Mount Vernon Memorial Highway, and Telegraph Road.
- Evaluate subgrade conditions for widening areas along portions of Richmond Highway, Old Mill Road, Mount Vernon Memorial Highway, and Telegraph Road.
- Evaluate subgrade conditions and provide recommendations for new pavement design for an approximately 1.7 mile long section of new alignment of Mulligan Road within Fort Belvoir.
- Evaluate the subsurface conditions along the new alignment to determine material types and condition.
- Perform cut and fill slope stability analyses and provide slope recommendations for the new alignment.
- Evaluate the subsurface conditions for three proposed bridges, perform foundation design and analyses for the bridges, and provide foundation recommendations.

The scope of this investigation included:

- Field reconnaissance of the project.
- Nondestructive testing (NDT) program of existing pavements.
- Condition survey of the existing pavements.
- Test boring program to investigate pavement composition, distressed areas, and subgrade conditions within existing pavements and to determine the subsurface conditions along the new alignment. The field investigation included unexploded ordnance (UXO) avoidance.
- Laboratory testing program.

The work was performed in general conformance with Chapter 6 of the Federal Highway Administration Eastern Federal Lands Highway Division (FHWA-EFLHD) Design Manual in English units of measurement. The Standard Specifications for Construction of Roads and

Bridges on Federal Highway Projects (FP-03) will be the governing specification document for this project.

1.2 Project Location and Description

The project is located in southeastern Fairfax County, Virginia and will connect Richmond Highway to Telegraph Road via a new road to be known as Mulligan Road. The project was originally referred to as the Richmond Highway-Telegraph Road Connector Road. The revised project name is utilized in the text of this report, however the data in the appendices still reflect the original project name. Mulligan Road will provide a new access route through Fort Belvoir, which is an active U.S. Army installation. The project will be constructed in two phases. Phase I will consist only of work within the actual limits of Fort Belvoir and will include the following major components:

- Constructing approximately 1.7 miles of new roadway alignment (Mulligan Road) through Fort Belvoir with maximum cuts of approximately 30 feet and maximum fills of approximately 25 feet. This will include constructing seven permanent stormwater management basins and installing all permanent drainage structures. The aggregate base course for Mulligan Road will also be placed in Phase I.
- Constructing two new bridges with lengths of 130 feet (1 span) and 200 feet (2 spans). Respectively, the first bridge will carry Mulligan Road over John J. Kingman Road, which is a gravel-surfaced internal access road for the Fort near station 182 of Mulligan Road. The second bridge will carry Mulligan Road over Piney Run and through the southwest corner of the secure area of the U.S. Army Corps of Engineers Humphrey Engineer Center (HEC) near station 220 of Mulligan Road.
- Constructing a precast concrete bottomless culvert structure as a wildlife crossing. The box culvert will be located at station 168+00 of Mulligan Road and will have a length of 132 feet, with an opening width of 12 feet, and an opening height of 10 feet. The box culvert will have a skew of approximately 60 degrees to Mulligan Road.
- Constructing a 10-foot wide asphalt-surfaced Shared Use Path. The path alignment will be parallel to the proposed Mulligan Road alignment. The Shared Use Path and Mulligan Road will be separated by a horizontal distance of approximately 5 feet. Cuts and fills for the path will be within the cut and fill prisms for Mulligan Road. The aggregate base course for the Shared Use Path will also be placed in Phase I.

The proposed new alignment portion of Mulligan Road to be constructed in Phase I will be a four-lane divided facility with a 14- to 16- foot wide median and the shared use path adjacent to it. The two outer lanes will be 14 feet wide and the two inner lanes will be 12 feet wide. All grading, drainage, aggregate base, and structures work for Mulligan Road will be performed during Phase I of the project. Paving Mulligan Road and all incidental curb and gutter and median work will be performed during Phase II of the project. All construction work related to Richmond Highway, Old Mill Road, Telegraph Road and Mount Vernon Memorial Highway (i.e. work outside of Fort Belvoir) will also be in Phase II of the project. All of the information obtained in the field investigations and laboratory testing programs are included in this report for informational purposes. However, this report provides the analyses and recommendations only for Phase I of the project. Analyses and recommendations for Phase II will be submitted under separate cover at a later date. The Site Location Map and Site Topographic Map included as

Figures 1 and 2 in Appendix A illustrate the location, configuration, and topography of the project.

1.3 General Geology

Geologically, the project site is located within the Atlantic Coastal Plain Physiographic Province. The Coastal Plain extends from the eastern edge of the Piedmont Physiographic Province eastward to the Atlantic Ocean. The generalized topography of the Coastal Plain is a terraced landscape that steps down to the coast and major rivers.

According to available geologic literature and conditions encountered in the field, the proposed roadway alignment is underlain by the Potomac Formation and the Shirley Formation. The Cretaceous-age Potomac Formation consists of light gray to pinkish- and greenish-gray, fine- to coarse-grained pebbly sand, commonly thick-bedded and trough cross-bedded. The sand is interbedded with gray to green massive to thick-bedded sandy clay and silt with lesser amounts of clay clast conglomerate and thin-bedded to laminated carbonaceous clay and silt. The Pleistocene-age Shirley Formation consists of light- to dark-gray, bluish-gray, and brown sand, gravel, silt and clay which constitutes surficial deposits of riverine terraces and relict baymouth barriers and bay-floor plains. The fluvial-estuarine facies comprises a lower pebble to boulder sand, overlain by fine to coarse sand interbedded with clayey silt which grades upwards into medium- to thick-bedded, clayey and sandy silt and silty clay. (Virginia Division of Mineral Resources, 1993). A Geologic Map of the project vicinity showing the proposed roadway alignment is included as Figure 3 in Appendix A.

According to the Soil Survey of Fairfax County, the surficial soils along the roadway alignment consist of the Lunt, Beltsville, and Matapeake-Mattapex-Woodstown Series. The Lunt Series consists of deep, well-drained, brownish soils that have formed in the weathered products of Coastal Plain sand, silt and clay of fluvial and marine origin. The Beltsville Series consists of light-colored somewhat poorly drained to moderately well drained soils that have developed from Coastal Plain sand, silt, and clay. The Matapeake-Mattapex-Woodstown Series consist of deep, moderately well drained to well drained soils that have formed from a mixture of sand, silt, and clay (United States Department of Agriculture, 1963).

2.0 PROCEDURES

A Field Investigation Plan (FIP) was prepared for the project and submitted to EFLHD March 15, 2007. The FIP included field reconnaissance, a nondestructive testing (NDT) program, a test boring program, a pavement condition survey, and a laboratory testing program.

- A field reconnaissance visit was performed on April 2, 2007.
- The NDT program was conducted on April 11 and 12, 2007 by Roy D McQueen and Associates, Ltd. (RDM) of Sterling, Virginia, a subconsultant to HDR. Traffic control for the NDT program was provided by Protection Services, Inc., of Upper Marlboro, Maryland, a subconsultant to HDR.

- The pavement test borings were performed between April 16 and 23, 2007 by Froehling & Robertson (F&R) of Richmond, Virginia, a subconsultant to HDR. Traffic control for the pavement borings was provided by Protection Services, Inc., of Upper Marlboro, Maryland. The non-pavement test borings were conducted by F&R between April 30 and May 25, 2007. An HDR inspector was present throughout the field investigation to monitor the drilling operations and log the borings. A certified level II Unexploded Ordnance (UXO) Technician subcontracted to UXB International, Inc., a subconsultant to HDR, was present for the duration of all drilling on Fort Belvoir property for UXO avoidance purposes.

- The condition survey of project pavements was conducted by HDR geotechnical personnel on May 29, 2007. It should be noted that VDOT milled and overlaid the subject portion of Mount Vernon Memorial Highway after the field investigation was performed but before the condition survey could be conducted.

2.1 NDT Program

The NDT program was performed by RDM to assess the load/deformation characteristics of the existing pavement sections and subgrades on the relevant sections of Richmond Highway, Old Mill Road, Mount Vernon Memorial Highway, and Telegraph Road. This program included a series of NDT tests generally performed at intervals ranging from 250 to 500 feet along the length of the project in each lane of each roadway. The testing interval was determined based on the number of lanes per roadway. The tests were staggered evenly between adjacent lanes. At each test location a ½ inch diameter pilot hole was drilled through the asphalt, the hole was filled with oil, a thermometer was inserted into the oil, and the temperature was recorded upon stabilizing. This procedure was requested by EFLHD in order to obtain mid-depth pavement temperatures. The NDT data was reduced and evaluated to determine the elastic moduli of the pavement layers and the subgrade for use in pavement structural analyses for both rehabilitation (overlay) and reconstruction. In accordance with the AASHTO Guide for Design of Pavement Structures (1993), the deflection data was normalized to a temperature of 68°F for back-calculation of layer elastic moduli. The deflection at a distance of 24 inches from the center of the load plate was utilized for determination of the subgrade resilient modulus (M_R). Parametric analyses and pavement designs were performed using the normalized NDT data and the 1993 DARWin ™ Pavement Design System (with current updates).

2.2 Condition Survey

A condition survey of the subject portions of the Richmond Highway, Old Mill Road, and Telegraph Road pavements was performed on May 29, 2007 to identify areas of pavement distress and quantify any necessary pavement repairs to be performed in Phase II of the project. It should be noted that the portion of Mount Vernon Memorial Highway to be included in this project was milled and overlaid by the Virginia Department of Transportation (VDOT) in May 2007 before the condition survey could be performed. No distress was observed in the new overlay and therefore, no condition survey was performed for this roadway. It should also be noted that Old Mill Road was milled and overlaid by VDOT in May 2008 subsequent to the condition survey being performed. The condition survey data and pavement recommendations

for Old Mill Road are still included in this report. The methodology utilized in the condition survey is consistent with the SHRP "Distress Identification Manual for the Long-Term Pavement Performance Project" (SHRP, 1993). The survey was performed by walking the entire alignment of each road while measuring distressed areas and sketching them on the project plan sheets. If a particular type of distress was consistently present throughout certain intervals or the entirety of a roadway, the individual cracks were not measured. Instead the distress was noted as being present throughout. The relevant pavement condition survey plan sheets are included in Appendix E.

2.3 Pavement Test Borings

A total of twenty-eight (28) soil test borings were drilled during the initial field investigation in April 2007 to determine the thickness and composition of the existing pavements for NDT evaluations, to aid in determining the causes of pavement distresses, and to evaluate the subgrade material characteristics for pavement design. The data obtained from these borings is summarized and presented in Appendix A. The pavement boring locations are shown on the Boring Location Plans in Appendix B and the pavement boring logs are presented in Appendix C.

The pavement borings were advanced using a truck-mounted drill rig by coring a 4-inch diameter hole in the asphalt/concrete pavement, followed by two continuous, 24-inch long Standard Penetration Test (SPT) samples beginning at the base of the asphalt or concrete. The SPT samples were sealed in glass jars and labeled with the boring and SPT information. These borings were backfilled with sand and patched with hand-tamped, cold-patch asphalt mix. All SPTs for the project were conducted using a safety hammer.

2.4 Non-Pavement Test Borings

Prior to mobilizing to the site for the non-pavement test borings, UXB International, Inc. prepared a Work Plan for UXO Avoidance Support. The Work Plan includes a brief history of the military uses of the Fort Belvoir property. A level II UXO Technician was present with the drill rigs for the duration of all borings performed on Fort Belvoir property for UXO avoidance. A hand-held magnetometer was used to check for buried ordnance in each boring to a depth of 10 feet. Additionally, where the drill rig access paths were located in wooded areas, the UXO Technician went ahead of the drill rigs and checked the access paths.

The following soil test borings were drilled during the initial field investigation in May, 2007:

- Twenty-six (26) borings for the new Mulligan Road alignment
- Five (5) borings for the ultimate widening of Telegraph Road
- Fifteen (15) deep borings for the three proposed bridge structures

The roadway borings were advanced to depths of between 10 feet and 25 feet. The structure borings were advanced to depths of between 60 feet and 90 feet.

The following soil test borings were drilled during the second field investigation in May, 2008:

- Eleven (11) borings for the nine stormwater management (SWM) basins that were originally proposed for the project. SWM Basin No.s 3 and 5 were subsequently deleted from the project.
- Two (2) borings for the proposed bottomless culvert structure to be located at station 168+00 of Mulligan Road.
- Three (3) borings for proposed pipe culverts which are greater than 36 inches in diameter.
- One (1) supplemental deep boring for the Kingman Road bridge structure due to an alignment shift after the initial investigation. The purpose of this boring was to confirm that the same general subsurface stratigraphy exists at the new bridge location, which is approximately 100 feet west of the original location.

The SWM Basin and culvert borings were advanced to a depth of 10 feet each. The supplemental structure boring was advanced to a depth of 75 feet.

The non-pavement boring locations are shown on the Boring Location Plans in Appendix B and the non-pavement boring logs are presented in Appendix C.

No borings were conducted for the shared use path since its alignment was not established at the time of the field investigation. However, due to its close proximity to the proposed Mulligan Road alignment, the Mulligan Road borings should provide sufficient subsurface information for the shared use path alignment.

The FIP originally included twelve borings for signal pole foundations. However, after discussion with EFLHD personnel at the 30% review meeting, it was determined that these borings were not necessary and they were deleted from the drilling program.

The non-pavement borings were advanced by a rubber-tired all terrain vehicle mounted drill rig and a track-mounted drill rig using 3-1/4" and 2-1/4" inside diameter hollow stem augers. SPTs were taken continuously in the top 10 feet of each boring and at five foot intervals thereafter. The SPT samples were sealed in glass jars and labeled with the boring and SPT information. Pocket penetrometer (PP) tests were performed on all fine-grained (cohesive) SPT samples. These borings were backfilled with the auger cuttings. All SPTs for the project were conducted using a safety hammer. The non-pavement boring locations are shown on the Boring Location Plans in Appendix B. It should be noted that the new Mulligan Road alignment was shifted up to 125 feet away from the original alignment after the initial field investigation was completed. The alignment shifts were made to avoid having a superelevation transition on one of the bridges, to minimize impacts to wetlands, and to avoid specific site features (i.e. utility vaults).

Ten bulk soil samples were obtained at various locations along the new roadway alignment for laboratory testing. Undisturbed (Shelby tube) samples were attempted in several of the structure borings, but none of these tubes had any recovery, most likely due to the soft, wet condition of the soil and possibly the presence of some sand in the samples.

2.5 Laboratory Testing Program

All SPT jar samples from the new roadway borings, the existing pavement borings, the bridge borings, and the SWM/culvert borings were visually reviewed and classified by HDR's field geologist. Representative soil jar samples were then selected for laboratory testing. The soil testing program included natural moisture content, gradation, Atterberg Limits, standard Proctor (moisture-density relationship), California Bearing Ratio (CBR), pH, and electrical resistivity tests, which were performed in accordance with applicable ASTM and AASHTO Methods per Table 6-10 in Chapter 6 of the FHWA-EFLHD Design Manual. All laboratory tests were performed by F&R of Richmond, Virginia and Sterling, Virginia, both of which are AASHTO-accredited laboratories.

2.6 Pavement Structural Analyses

RDM performed analyses of the existing project pavements to identify their structural capacity, develop options for rehabilitation and reconstruction, and determine the structural requirements for each option. The analysis used pavement moduli developed from processed NDT data, pavement thicknesses developed from the pavement test borings, and traffic data that was developed by Vanasse, Hangen, and Brustlin, Inc. in January 2006 as part of the Environmental Assessment (EA) for the project. These analyses were performed in accordance with the "1993 AASHTO Guide for Design of Pavement Structures," (AASHTO, 1993) using the DARWin™ Pavement Design program. RDM also performed pavement design for the new alignment portion of Mulligan Road within Fort Belvoir using the DARWin™ Pavement Design program.

3.0 RESULTS AND FINDINGS

3.1 NDT Results

The NDT program was used to develop the impulse stiffness moduli (ISM), elastic moduli of the various pavement layers, the subgrade resilient moduli (M_r) for the existing pavements on Old Mill Road, Mount Vernon Memorial Highway, and Telegraph Road, and the modulus of subgrade reaction (k) on Richmond Highway (since it consists of an asphalt overlay of a concrete pavement). The representative subgrade resilient modulus and modulus of subgrade reaction values back-calculated from the NDT data and used for design are summarized in Table 1. The range of values for each roadway are shown in parentheses.

TABLE 1 – SUBGRADE MODULI

Roadway	M_r (psi)	K (psi/inch)
Richmond Highway	----	100 (61-276)
Mount Vernon Memorial Highway	6,000 (6,054-8,929)	----
Old Mill Road	4,500 (3,597-8,040)	----
Telegraph Road	6,000 (4,623-15,732)	----

These resilient modulus values correlate to CBR values of approximately 3 to 6, which correspond reasonably well with the laboratory CBR test values reported in Section 3.5.

The ranges of ISM values obtained from the NDT testing were generally between 502 and 2,930 kips per inch. Plots of ISM values by station for each roadway are presented in Appendix B of RDM's Nondestructive Testing and Pavement Evaluation Report. The complete RDM Nondestructive Testing and Structural Pavement Evaluation Report is included in Appendix F of this report, under a separate cover.

It should be noted that based on VDOT comments at the 95% resolution meeting, several of the pavement design input parameters were subsequently revised and the pavement structural analyses were rerun. The output from the revised analyses are summarized in Appendix F.

3.2 Pavement Condition Survey

Pavement distress types were observed and documented for the condition survey and categorized using the SHRP Manual (SHRP, 1993). Each type of distress observed was assigned a severity rating of low, moderate, or high. A summary of all the distress types identified by SHRP for flexible pavements are included in the Asphalt Concrete Condition Survey Legend in Appendix E. The Pavement Condition Survey plan sheets are also included in Appendix E.

3.2.1 Richmond Highway

Minimal distress was observed in the Richmond Highway pavement surface. The majority of the pavement borings performed on Richmond Highway encountered an asphalt concrete overlay of the original concrete pavement. The majority of the observed distress consists of low to moderate severity longitudinal reflective cracking along paving joints with a minor amount of low severity transverse reflective cracking at some of the joints in the underlying concrete slab.

3.2.2 Mount Vernon Memorial Highway

VDOT milled and overlaid the subject portion of Mount Vernon Memorial Highway in May 2007 before the pavement condition survey could be performed. There is no observable distress in the new overlay. Therefore, a condition survey was not performed for this road.

3.2.3 Old Mill Road

It should be noted that Old Mill Road was milled and overlaid by VDOT in May 2008 subsequent to conducting the pavement condition survey. The following describes the pavement condition that existed at the time of the pavement condition survey in May 2007.

Low to moderate severity block and longitudinal wheelpath cracking were present throughout the length of Old Mill Road. Low to moderate severity longitudinal (non-wheelpath) cracking was observed at the paving joints. Utility patches were present at several locations. Additionally, the outer half of the southbound lane contained extensive moderate to high severity longitudinal wheelpath cracking and fatigue cracking. Rutting of the outer wheelpath was also observed. Several sections of the southbound lane had been slurry sealed.

3.2.4 Telegraph Road

The central portion of the westbound lane of Telegraph Road (approximate stations 72+50 to 82+00) has been recently milled and overlaid by VDOT. New guardrail and curb and gutter were

also installed in conjunction with this work. The remainder of the Telegraph Road pavement is considerably older and contains low to moderate severity longitudinal wheelpath cracking throughout. A longitudinal utility patch for a Fairfax County sewer line is present in the westbound lane between approximate stations 91+60 and 97+00. Several patches are present in the outer half of the eastbound lane near the west end of the project. Extensive low to moderate severity block cracking is present throughout both lanes at the extreme west end of the project.

3.3 Pavement Test Borings

3.3.1 Richmond Highway

Eleven pavement borings (designated with the prefix RH-) were drilled in Richmond Highway to determine the thickness and composition of the pavement section and evaluate the subgrade materials. Boring RH-1A was drilled as an offset to boring RH-1, which encountered refusal on reinforcing steel at a depth of 1.2 feet. Boring RH-10 fell (at the east end of the project) ultimately was located outside of the reduced limits of work on Richmond Highway.

These borings encountered between 5 and 14 inches of asphalt concrete (AC). Eight of the borings encountered between 6 and 10 inches of Portland cement concrete pavement (PCC) directly beneath the asphalt. Five of the borings encountered aggregate base, with the thickness ranging from 2 to 7 inches.

The pavement subgrade materials are variable and consist of silty clay, sandy clay, sandy silt, and fine sand. SPT N-values in the subgrade materials ranged from 6 to 54 blows per foot (bpf), with the majority between 8 and 22 bpf. The moisture condition of the subgrade materials was generally described as very moist. None of these borings encountered groundwater. The results of the Richmond Highway pavement borings are summarized in Appendix A. The boring logs are presented in Appendix C.

3.3.2 Mount Vernon Memorial Highway

Five pavement borings (designated with the prefix MV-) were drilled in Mount Vernon Memorial Highway to determine the thickness and composition of the pavement section and evaluate the subgrade materials.

These borings encountered between 5.5 and 9 inches of AC. All five of the borings encountered aggregate base, with the thickness ranging from 2 to 10 inches.

The pavement subgrade materials generally consist of silty clay and sandy clay. SPT N-values in the subgrade materials ranged from 9 to 44 bpf, with the majority between 12 and 32 bpf. The moisture condition of the subgrade materials was generally described as moist to very moist. None of these borings encountered groundwater. The results of the Mount Vernon Memorial Highway pavement borings are summarized in Appendix A. The boring logs are presented in Appendix C.

3.3.3 Old Mill Road

Six pavement borings (designated with the prefix OM-) were drilled in Old Mill Road to determine the thickness and composition of the pavement section and evaluate the subgrade materials.

These borings encountered between 5 and 9 inches of AC. Five of the six borings encountered aggregate base, with the thickness ranging from 6 to 7 inches.

The pavement subgrade materials are variable and consist of silty clay, sandy silt, silty sand, and clayey gravel. SPT N-values in the subgrade material ranged from 8 to 47 bpf, with the majority between 8 and 30 bpf. The moisture condition of the subgrade materials was generally described as moist to very moist. None of these borings encountered groundwater. The results of the Old Mill Road pavement borings are summarized in Appendix A. The boring logs are presented in Appendix C.

3.3.4 Telegraph Road

Six pavement borings (designated with the prefix T-) were drilled in Telegraph Road to determine the thickness and composition of the pavement section and evaluate the subgrade materials.

These borings encountered between 6.5 and 10 inches of AC. Only one of the six borings (T-5) encountered aggregate base.

The pavement subgrade materials are variable and consist of sandy clay, clayey sand, silty sand, and sand with gravel. SPT N-values in the subgrade material ranged from 6 to 39 bpf, with the majority between 7 and 31 bpf. The moisture condition of the subgrade materials was generally described as very moist. None of the borings encountered groundwater. The results of the Telegraph Road pavement borings are summarized in Appendix A. The boring logs are presented in Appendix C.

3.4 Non-Pavement Test Borings

3.4.1 Mulligan Road and Telegraph Road Widening

Twenty-six roadway borings (B-11 to B-35) were drilled for the new Mulligan Road alignment within Fort Belvoir starting at the Telegraph Road end of the alignment. An additional four roadway borings (B-7 to B-10) were drilled for the widening intervals along Telegraph Road. The borings originally designated B-1 to B-6 were marked in the field as the pavement borings for Telegraph Road and were subsequently re-designated as borings T-1 to T-6.

The new roadway borings (B-11 to B-35 and B-7 to B-10) encountered variable mixtures of interlayered sand with gravel (SW,SP), silty sand (SM, SP-SM), clayey sand (SC), and fine sandy silt (ML), clayey silt (MH), sandy clay (CL), and silty clay (CL,CH) to the maximum exploration depth of 40 feet.

The relative density of the coarse-grained soils (sands and gravels) ranged from very loose to very dense, with the majority being medium dense. SPT N-values ranged from 3 to 94 bpf, with the majority between 11 and 30 bpf

The consistency of the fine-grained soils (silts and clays) ranged from soft to hard, with the majority being medium stiff to very stiff. SPT N-value ranged from 4 to 50 bpf, with the majority between 7 and 23 bpf. PP values ranged from 0.75 tsf to 4.5+ tsf, with the majority between 1.25 tsf and 3.0 tsf.

None of the thirty roadway borings encountered weathered rock or rock. Several of the roadway borings (all on the proposed Mulligan Road alignment) encountered groundwater as shown in Table 2.

TABLE 2 – GROUNDWATER DEPTHS (NEW ROADWAY BORINGS)

Boring No.	Station	Offset	Depth to GW at Time of Drilling (feet)	Depth to GW After 24 Hours (feet)
B-13	228+00	C.L.	5.0	Not taken
B-20A	202+50	5' Left	23.5	21.6
B-22	196+08	C.L.	Dry	11.7
B-26	183+00	C.L.	Dry	15.1
B-32	161+92	10' Right	Dry	3.2

No borings were conducted for the multipurpose trail since its alignment was not set at the time of the field investigation. However, due to its proximity to the proposed Mulligan Road alignment, it is reasonable to assume that similar soils and subgrade conditions will be encountered along the multipurpose trail alignment.

3.4.2 Kingman Road Bridge

Four bridge borings (BS-1 to BS-4) were advanced near the corners of the original location of the proposed single span structure that will carry Mulligan Road over the existing aggregate-surfaced Kingman Road. These borings generally encountered interbedded layers of stiff to very stiff sandy/clayey silt and silty clay (ML, CL) and medium dense to dense silty/clayey sand and gravel (SC,SM,GC,GM) to depths of between 48 feet and 51 feet at the Abutment A and to a depth of 57 feet at Abutment B. At these depths, all four borings encountered very dense sand with varying percentages of fines (SC,SP) to depths of between 57 and 60 feet. Borings BS-1 and BS-2 (Abutment A) encountered very stiff silt beneath the dense sands. Borings BS-3 and BS-4 (Abutment B) did not encounter the stiff silt layer. A representative subsurface profile along the original bridge alignment is included in Appendix A.

The location of the Kingman Road Bridge was shifted approximately 100 feet to the west of the original location after the initial field investigation was completed in April and May 2007. A supplemental boring (designated KR-1) was advanced at the revised bridge location during the supplemental field investigation (conducted in April and May 2008) to determine if the subsurface conditions at the new location are similar to the conditions encountered at the original location. Boring KR-1 was advanced to a depth of 75 feet and confirmed that the subsurface conditions at the revised bridge location are similar to those at the original bridge location.

SPT N-values in the clays and silts ranged from 4 to 46 bpf with the majority between 10 and 32 bpf. PP readings ranging from 1.0 to 5.0 tsf with the majority between 2.0 and 4.0 tsf.

SPT N-values in the upper sands and gravels ranged from 8 to 68 bpf with the majority between 10 and 35 bpf. SPT N-values in the lower sands ranged from 43 to 60 bpf.

Boring BS-1 encountered groundwater at a depth of 39 feet at the time of drilling. After 24 hours, the groundwater table was at a depth of 21 feet and the boring was caved in at a depth of 26 feet. The remaining borings were dry at completion.

No weathered rock or unweathered rock was encountered in these bridge borings. The Test Boring Logs are included in Appendix C.

3.4.3 Piney Run Bridge at HEC

Eight bridge borings (BS-5 to BS-12) were advanced along the alignment of the originally proposed three span structure to carry Mulligan Road over Piney Run, which was subsequently revised to two spans after completion of the initial field investigation.

These borings generally encountered loose to medium dense sand and gravel (SM,GM) to depths of between 27 and 32 feet. Beneath this the borings encountered two layers of very soft to stiff clayey/sandy silt and silt/sandy clay (ML,CL) with some intebedded layers of loose to medium dense silty/clayey sand and gravel (SM,GM,SP) to depths of between 62 and 82 feet. Beneath this, all eight of the borings encountered stiff to very stiff clayey/sandy silt to the boring termination depths of between 75 and 90 feet. The upper clay layer is located directly beneath the upper sands and gravels and ranges in thickness from approximately 25 feet at Abutment A to 5 feet at Abutment B. The lower clay layer was encountered at depths of between 57 feet (Abutment A) and 42 feet (Abutment B). The thickness of the lower clay layer ranges from approximately 16 feet at Abutment A to 10 feet at Abutment B. A representative subsurface profile along the bridge is included in Appendix A.

SPT N-values in the upper sands and gravels ranged from 2 to 32 bpf with the majority between 6 and 25 bpf.

SPT N-values in the two clay layers ranged from 2 to 13 bpf with the majority between 4 and 8 bpf. PP readings ranging from 0.25 to 2.0 tsf with the majority between 0.25 and 0.75 tsf. Several attempts to obtain undisturbed (Shelby tube) samples of the clays resulted in no sample recovery. It is believed that this is due to the high moisture content and possibly the presence of same sand in the samples.

SPT N-values in the lower sands and gravels ranged from 6 to 31 bpf with the majority between 10 and 22 bpf.

SPT N-values in the lower silt layer ranged from 7 to 46 bpf with the majority between 9 and 32 bpf. PP readings ranging from 0.25 to 4.5+ tsf with the majority between 1.0 and 4.0 tsf.

Groundwater was encountered in all eight bridge borings at the time of drilling at depths of between 2.6 feet and 6.5 feet. After 24 hours, stabilized groundwater levels were measured in four of the borings at depths of between 3.2 feet and 5.1 feet.

No weathered rock or unweathered rock was encountered in these bridge borings. The Test Boring Logs are included in Appendix C.

3.4.4 Piney Run Bridge at Telegraph Road

Three bridge borings (BS-15 to BS-17) were advanced along the alignment of the presently proposed two span structure to carry Telegraph Road over Piney Run. Five borings were originally planned, but borings BS-13 and BS-14 (both located at the west end of the proposed structure) were deleted due to the presence of very soft, wet, surficial soils in the low-lying wetlands adjacent to Piney Run. At the time the field investigation was performed, the proposed bridge was a single span structure with an overall length of approximately 100 feet. Subsequent to completing the investigation, the proposed bridge was lengthened to a two span arrangement with an overall length of 266 feet. However all work on Telegraph Road (including the bridge) was subsequently removed from Phase I of the project and will be redesigned during Phase II.

The borings for this structure generally encountered very loose to dense sand and gravel (SW,SP,SM,GM) with some interbedded layers of very soft to stiff fine sandy clay and silt (CL,ML) to depths of between 42 and 75 feet. Beneath this the borings encountered very stiff silt (ML) to the boring termination depths of between 65 and 80 feet. The lower stiff silt layer was encountered at a depth of 75 feet in Boring BS-15 (west of Piney Run) and at depths of 42 feet and 47 feet, respectively in Borings BS-16 and BS-17 (east of Piney Run). A representative subsurface profile along the bridge is included in Appendix A.

SPT N-values in the sands and gravels ranged from 2 to 90 bpf with the majority between 4 and 25 bpf.

SPT N-values in the upper clays and silts ranged from 3 to 15 bpf with the majority between 4 and 10 bpf. PP readings ranging from 0.25 to 1.75 tsf with the majority between 0.25 and 1.0 tsf.

SPT N-values in the lower silt layer ranged from 15 to 41 bpf with the majority between 21 and 41 bpf. PP readings ranging from 1.75 to 4.5+ tsf with the majority between 2.5 and 4.5+ tsf.

Artesian groundwater conditions were encountered in all three bridge borings at the time of drilling at depths of between 15 and 30 feet and groundwater levels could not be obtained. Groundwater flowed out of boring BS-17 for several days before stabilizing. The artesian conditions are the result of water-bearing sand and gravel layers being located beneath relatively impermeable layers of clay and silt and also at a topographic low.

No weathered rock or unweathered rock was encountered in these borings. The Test Boring Logs are included in Appendix C.

3.4.5 Wildlife Crossing Box Culvert

Two borings (designated PB-03 and PB-04) were advanced at either end of the proposed bottomless box culvert location.

These borings generally encountered loose to medium dense clayey/silty sand and gravel (SC,SM,SW,GW,GP-GM) with a minor amount of fine sandy clay and silt of low to high plasticity (CL,ML,CL-ML,MH) to the boring termination depths of 10 feet.

SPT N-values in the sands and gravels ranged from 5 to 21 bpf with the majority between 7 and 17 bpf.

The three SPT N-values obtained in the clays and silts were 4, 10, and 16 bpf. The three PP readings obtained were 0.25, 1.75, and 2.25 tsf.

Both of these borings were dry upon completion of drilling. No weathered rock or unweathered rock was encountered in either of the box culvert borings. The Test Boring Logs are included in Appendix C.

3.4.6 Stormwater Management Basins and Culverts

Fourteen borings (designated PB-01, PB-02 and PB-05 through PB-16) were drilled at the nine originally proposed SWM basin locations and three planned culvert locations with culverts larger than 36 inches in diameter. Subsequent to completing the field investigation for these, two of the SWM basin locations (SWM No.s 3 and 5) were deleted.

These borings generally encountered interbedded layers of loose to dense clayey/silty sand and gravel (SC,SM,SW,SP GW,GP-GM) and fine sandy clay and silt of low to high plasticity (CL,ML,CL-ML,CH,MH) to the boring termination depths of 10 feet.

SPT N-values in the sands and gravels ranged from 3 to 97 bpf with the majority between 12 and 47 bpf.

SPT N-values in the clays and silts ranged from 2 to 39 bpf with the majority between 5 and 29 bpf.

Eight of these borings encountered groundwater at depth of between 0.6 feet and 9.1 feet at the time of drilling. The remaining borings were dry upon completion of drilling. The borings that encountered groundwater are summarized in Table 3.

TABLE 3 – GROUNDWATER DEPTHS (SWM AND CULVERT BORINGS)

Boring No.	Station	Offset	Depth to GW at Time of Drilling (feet)
PB-05	168+56	124' Right	4.0
PB-07	183+36	155' Right	8.2
PB-08	189+11	156' Left	0.6
PB-10	216+10	131' Left	8.1
PB-11	217+91	133' Left	9.1
PB-13	228+76	89' Left	4.3
PB-15	227+30	C.L.	3.3
PB-16	234+08	C.L.	5.1

No weathered rock or unweathered rock was encountered in either of the box culvert borings. The Test Boring Logs are included in Appendix C.

3.5 Laboratory Testing Program

The laboratory tests conducted on representative jar and bulk soil samples selected for testing indicate a wide range of Coastal Plain soils (sand, gravel, silt, and clay) are present in interbedded layers throughout the length of the project. The majority of the samples tested classified as clays of low to high plasticity (CL,CH,) and clayey sand (SC) with minor amounts of low to high plasticity silt (ML,MH) and silty sand (SM). Numerous samples which were described on the field logs as clayey/silty/sandy gravel (GC,GM,GP-GM,GW,GP) were not selected for laboratory testing. The laboratory natural moisture content and classification test results (gradations and Atterberg Limits tests) are included in Appendix D.

In addition to the natural moisture content and classification tests on the jar samples, laboratory tests were conducted on several bulk soil samples. Tests conducted on the bulk samples consisted of natural moisture content, gradation, Atterberg limits, standard Proctor, CBR, pH, and resistivity. The results of these tests are included in Appendix D and are summarized in Table 4. The stations and offsets of the borings in Table 4 are indicated on the boring logs in Appendix C.

TABLE 4– BULK SOIL SAMPLE LABPRATORY TEST DATA

Boring No.	Sample Depth (feet)	Nat. Moist	Fines	Class.	Max. Dry Density (pcf)	Optimum Moisture Content	CBR 1)	pH	Min. Resistivity (ohm-cm)
B-7	0-6	24.2%	66%	CH	101.5	20.4%	3.7	3.4	2,680
B-10	4-8	17.2%	47%	CH	118.0	13.3%	9.8	4.4	6,920
B-17	0-13	---	---	SC	110.4	16.9%	7.6	4.2	11,200
B-31	0-6	---	---	SC	113.7	15.6%	8.8	4.4	27,200
B-34	0-10	---	---	CL	107.4	16.8%	2.9	4.8	6,340

1) Soaked value @ 0.1" penetration

The natural moisture content data from the laboratory tests are summarized by soil type for the new Mulligan Road alignment in Table 5 and for all of the existing roadways in Table 6. Table 5 does not include moisture content data from the bridge borings.

TABLE 5– NATURAL MOISTURE CONTENT DATA – MULLIGAN ROAD

Silty, clayey Sands (SC,SM, etc)	High Plasticity Clays (CH)	Low Plasticity Clays (CL)
17.2%	24.2%	23.7%
16.8%	21.3%	18.7%
8.6%	26.8%	26.9%
21.4%	26.0%	11.8%
13.5%	30.8%	16.1%
12.8%	20.7%	18.2%
		18.6%
Avg. = 15.1%	Avg. = 25.0%	Avg. = 19.1%

TABLE 6– NATURAL MOISTURE CONTENT DATA – ALL EXISTING ROADWAYS

Silty, clayey Sands (SC,SM, etc)	High Plasticity Clays (CH)	Low Plasticity Clays (CL)
13.2%	25.0%	19.5%
8.1%		15.4%
11.9%		22.5%
10.5%		17.3%
13.5%		
6.6%		
12.7%		
13.3%		
Avg. = 11.2%	Avg. = 25.0%	Avg. = 18.7%

4.0 ANALYSES AND DISCUSSION

The analyses and discussion section of this report addresses only the components of the project that are to be constructed in Phase I. Analyses and discussion of the Phase II components of the project will be submitted under separate cover at a later date.

4.1 Pavements

4.1.1 Traffic Data

The Average Daily Traffic (ADT) data for the proposed new Mulligan Road was obtained from the Environmental Assessment (EA) that was previously developed for the project. For Mulligan Road, the ADT is projected to be 20,300 (year 2010) with a directional distribution of 38%/62% and a lane distribution factor of 1.0 (slightly conservative for a four-lane divided roadway).

A compound growth rate of 3.5% per year was specified in the analyses. The truck percentage was estimated by HDR to be 5% of the ADT volume. In accordance with EFLHD pavement design procedures, a 20-year design period was also specified for the analyses.

The following parameters were specified for new flexible pavement design for Mulligan Road:

Reliability = 90% (per AASHTO)
Overall Standard Deviation = 0.49 (per VDOT)
Initial Serviceability = 4.2 (per AASHTO - flexible pavement)
Terminal Serviceability = 2.8 (per VDOT)

The reliability value of 90% is based on Mulligan Road being classified as an urban arterial. The traffic data is summarized in RDMs Nondestructive Testing and Structural Pavement Evaluation Report in Appendix F

4.1.2 Pavement Structural Analyses

Consistent with the original scope of the project, RDM's report summarizes the structural analyses conducted for all of the existing pavements and the new pavements on all of the project roadways. RDM's complete pavement report is included for informational purposes. However, as Phase I of the project now consists only of work within the limits of Fort Belvoir, only the new pavement design for Mulligan Road and the Shared Use Path are addressed in this report.

The pavement structural analyses for the new Mulligan Road pavement are based on an average back-calculated subgrade resilient modulus (M_r) value of 4,500 psi. This correlates to an approximate CBR value of 3.0 using the following standard equation:

$$CBR = M_R/1500$$

All pavement analyses and design were performed in accordance with the 1993 AASHTO pavement design procedures. All input parameters and pavement structural number calculations are presented in RDM's report in Appendix F.

4.1.3 Mulligan Road and Shared Use Path Pavement Sections

For the new pavement on the proposed Mulligan Road alignment, a conventional asphaltic concrete (AC) and aggregate base pavement section was evaluated by RDM. Based on the traffic data presented in Section 4.1.1 and the back-calculated subgrade modulus value in Section 4.1.2, the pavement section should consist of 3 inches of AC surface course overlying 6 inches of AC base course and 9 inches of aggregate base course. As a precautionary measure for frost protection, RDM's report suggests using an additional 6 inches of aggregate base below the proposed pavement section. However, this measure has not been utilized on other EFLHD projects in the area and frost heave has not proven to be an issue. For this reason and to minimize cost and potential utility conflicts, the additional 6 inches of aggregate base is not recommended.

The shared use path is intended primarily for pedestrian and bicycle traffic with occasional use by maintenance trucks. Therefore, the pavement section for the shared use path should be relatively light-duty and consist of 2 inches of AC surface course overlying 6 inches of aggregate base course.

4.2 Earthwork

4.2.1 Site Clearing/UXO

Prior to commencing earthwork operations, the proposed widening areas and the new Mulligan Road alignment should be cleared, grubbed, and stripped of all topsoil and vegetation. Topsoil

depths are expected to range from 6 to 12 inches. In the wooded portions of the alignment, removing the root mats of large trees may result in up to 2 to 3 feet of excavation.

Due to the varied military functions of Fort Belvoir over the decades, it is expected that some unexploded ordnance (UXO) will be encountered during the clearing and grubbing phase of the site work as well as during site grading operations. Based on discussions with Fort Belvoir personnel and the pre-investigation historical research conducted by UXB International it is suspected that the majority of the UXO that will be encountered will be small arms rounds. However, during field reconnaissance an abandoned concrete bunker was observed in the woods in the vicinity of station 210. The bunker is outside of the proposed construction limits, but is indicative that more substantial ordnance may be encountered during site earthwork operations.

Additionally, buried debris, ordnance, or other military materials may be randomly encountered during site earthwork operations, particularly in natural low areas that may have been previously filled in.

HDR understands that Fort Belvoir has procured a contract for, and completed UXO range clearance within the proposed roadway construction limits on the Fort property. This range clearance was intended to provide 100% clearance coverage of the proposed construction footprint. However, it is expected that the contractor will still need to provide UXO personnel on-site during construction.

4.2.2 Excavations/Cut Slopes

There are several relatively major cuts planned along the proposed Mulligan Road alignment. The primary cuts are summarized in Table 7.

TABLE 7 – ROADWAY CUT SECTIONS (MULLIGAN ROAD)

Roadway	Cut Stations	Max. Cut Depth (feet)	Remarks
Mulligan Road	148+00 to 166+50	20	Sidehill cut – left side
Mulligan Road	192+00 to 194+00	16	Through cut
Mulligan Road	194+00 to 198+00	15	Sidehill cut – left side
Mulligan Road	198+00 to 206+00	20	Through cut
Mulligan Road	208+00 to 215+00	28	Sidehill cut – right side and Through cut

As described in Section 3.4.1, the materials to be encountered in the cuts will consist of interbedded sand, gravel, silt, and clay. The majority of the soils to be excavated are expected to suitable for use as embankment fill material. However, depending on the moisture conditions upon excavation, some of these soils will likely require drying back prior to being placed as compacted fill material. The fine-grained soils (clays and silts) will require considerably more effort and time to dry back than will the coarse-grained soils (sands and gravels). If earthwork operations are performed during a period of wet weather, it may not be possible to dry the soils out enough to use them as fill material or at subgrade. If this is the case, then application of lime may be required to dry them out or they will need to be excavated and replaced. Based on the

laboratory natural and optimum moisture content tests conducted, it appears that the majority of the on-site soils to be excavated will be above their optimum moisture contents.

Based on the borings and laboratory tests, it is anticipated that the wet subgrade conditions will be encountered in the central and northern portions of the deep cut between approximate stations 208+50 and 215+00 of Mulligan Road. Based on Borings B-17 and B-16, moderate to high plasticity clays (CL,CH) with relatively high moisture contents are expected to be encountered at subgrade for a significant portion of the cut. It is estimated that two feet of subexcavation and replacement with granular fill as well as a stabilization geotextile will be required where the clays are encountered (estimated to be approximately the central 150 feet and northern 150 feet of the cut, along centerline). Furthermore, it is anticipated that additional isolated areas in the remaining cuts will require subexcavation and replacement and the use of a stabilization geotextile. Estimated quantities for these items are presented in Section 5.2.2. Subexcavation and replacement quantities can be heavily dependent on the weather conditions at the time of excavation as well as the contractor's equipment and methods of operation.

It should be noted that the earthwork quantity for the project is approximately balanced.

Standard heavy-duty excavation equipment should be satisfactory to efficiently excavate these materials from open cuts and in utility excavations and other confined excavations. No weathered rock or rock was encountered in any of the borings.

While a well-defined groundwater table was not encountered at or above the proposed subgrade elevations in the cut borings, it is anticipated that perched groundwater will be encountered in some of the sand and gravel layers located above and/or between layers of relatively impermeable silts and clays. This situation will likely result in random springs and/or seeps occurring within cut slopes and at subgrade once they are excavated. The plans should include a pay item and quantity for spring drains to address this issue when it arises.

Slope stability analyses were performed for the critical cut slope on the project, which is located at station 211+00 (right) of Mulligan Road. This is a through cut section with a maximum cut depth of 25 feet, a maximum cut slope height of 30 feet, and a proposed 2(H):1(V) cut slope geometry. The nearest boring (B-17 located at station 212+50) was utilized to establish the subsurface conditions in the cut. Soil strength parameters were selected based on SPT N-values for cohesionless soils and PP values for cohesive soils. All strength parameters are presented in Appendix G. The computer program STABL6H was utilized for the stability analyses. Based on the analyses, the resulting short-term and long-term safety factors are 1.8 and 1.4, respectively. The output files from the slope stability analyses are included in Appendix G.

Soil cut slopes steeper than 2(H):1(V) would require some form of in-situ reinforcement to provide adequate long-term stability, which would incur considerable additional costs to the project. Therefore cut slopes steeper than 2(H):1(V) should not be utilized.

4.2.3 Embankments/Fill Slopes

The only two major embankment fills on the project are the approach embankments for the proposed bridges over Kingman Road (bridge stations 181+89 to 183+19) and over Piney Run at HEC (bridge stations 219+78 to 222+06). The Kingman Road bridge has a maximum approach fill height of 26 feet and the Piney Run bridge at HEC has a maximum approach fill height of 22 feet.

Slope stability analyses were performed for the critical embankment fill slope on the project, which is located at the south abutment of the Piney Run bridge at HEC. Even though the approach embankments for the Kingman Road bridge are several feet higher than the embankments for the Piney Run bridge, the foundation soils at Piney Run are much softer/looser and thus represent a more critical case for slope stability. The south approach embankment at Piney Run has a maximum fill slope height of 20 feet, and a proposed 2(H):1(V) fill slope geometry. Boring B-7 (station 220+00) was utilized to establish the foundation conditions for the embankment. For the foundation soils, soil strength parameters were selected based on SPT N-values for cohesionless soils and pocket penetrometer values for cohesive soils. For the embankment fill material, soil strength parameters were selected based on our experience with similar soil types. All strength parameters are presented in Appendix G. The computer program STABL6H was utilized for the stability analyses. Based on the analyses, the resulting short-term and long-term safety factors were both at least 1.5 and both had the same critical circle. The output files from the slope stability analyses are included in Appendix G.

Embankment fill slopes steeper than 2(H):1(V) would require the use of rock embankment fill or geosynthetic reinforcement to provide adequate long-term stability. Either of these options would incur considerable additional costs to the project. Therefore, fill slopes steeper than 2(H):1(V) should not be considered.

Based on the stiff/dense consistency of the foundation soils, settlement of the approach embankments for the Kingman Road bridge is expected to be less than one inch and should be complete shortly after construction is complete.

Settlement will be more of an issue for the approach embankments for the Piney Run bridge at HEC. Due to the presence of the two soft clay layers, some consolidation settlement of the foundation soils is expected to occur after the embankments are constructed to their full height of approximately 20 feet. The thickness of the upper clay layer ranges from approximately 25 feet at Abutment A to approximately 5 feet at Abutment B. The thickness of the lower clay layer ranges from approximately 15 feet at Abutment A to approximately 10 feet at Abutment B. Refer to the subsurface profile along the proposed bridge alignment in Appendix A. Consolidation settlement calculations were based on Boring BS-08 (Abutment A) which is expected to be the worst case situation for settlement as a result of having the thickest clay layers. Several undisturbed (Shelby tube) samples were attempted in the two clay layers, but no material was recovered. Therefore, the magnitude and time rate of consolidation calculations were based on established correlations to soil index properties (Atterberg limits and in-situ moisture content) for the two subject clay layers. The laboratory index testing data is summarized in Table 8.

TABLE 8 – LABORATORY INDEX TEST DATA

Boring	Classification	Liquid Limit	Plasticity Index	Natural Moisture Content
BS-05	CH	54	33	31.4%
BS-08	CH	65	43	29.2%
BS-09	CH	59	37	40.3%
BS-10	CH	72	46	35.6%
BS-11	CH	62	43	30.9%
Average	---	62	40	33.5%

Due to the lack of consolidation test data, two methods were utilized to calculate estimates of both the magnitude of consolidation settlement of the two clay layers. The first method is from the Soils and Foundations Workshop Manual, (FHWA, 1993). Using this method, it was concluded that all of the settlement would be in the recompression range based on the liquidity index being considerably less than 0.7. The settlement calculations using this method indicate that a maximum total consolidation settlement of approximately 3.5 inches will occur within the two soft clay layers.

The second method to estimate the magnitude of consolidation settlement is from the textbook Geotechnical Properties of Soil (Das, 2004). Using this method, and conservatively assuming the sensitivity of the clay to be 2, it was concluded that the majority of the settlement would be in the recompression range, but that some would also occur in the virgin compression range. The settlement calculations using this method indicate that a maximum total consolidation settlement of approximately 5 inches will occur within the two soft clay layers.

The time rate of consolidation settlement was evaluated using the correlation of coefficient of vertical consolidation (C_v) to liquid limit presented in the Corps of Engineers Manual EM 1110-1-1904. In order to bracket the likely range of the time for settlement, the coefficient of vertical consolidation was selected using both the recompression curve and the virgin compression curve. Based on an average liquid limit of 62 for the five clay samples tested, the recompression value of C_v is 0.029 cm/sec^2 and the virgin compression value of C_v is 0.009 cm/sec^2. Utilizing these values in the standard time rate of consolidation equation and assuming double drainage, the time for 90% consolidation ranges from 50 days for the recompression case to 150 days for the virgin compression case. It should be noted that this is a worst case scenario based on the thickest clay layer encountered at Abutment A, which is 25 feet. At Abutment B, the thickest clay layer encountered was 10 feet thick. Since the time for consolidation varies with the square of the length of the drainage path, this has a significant impact on the time for settlement. Using the same C_v values as for Abutment A, the time for 90% consolidation at Abutment B ranges from 10 days for the recompression case to 25 days for the virgin compression case. This should allow for construction to begin at Abutment B well before the settlement at Abutment A has essentially ceased. All settlement calculations are presented in Appendix G.

It is anticipated that subexcavation and replacement and possibly the use of a stabilization geotextile will be required beneath portions of the footprints of the approach embankments at the Piney Run bridge at HEC. Several of the structure borings encountered up to 2 to 3 feet of soft, loose, and/or wet soil at the ground surface. The exact amount of subexcavation will have to be

determined during construction by the use of proofrolling and/or test pits. The amount of undercut required will also likely depend on the weather conditions at the time of construction. The plans should include pay items and quantities for subexcavation, replacement with granular material, and stabilization geotextile. Estimated quantities for these items are presented in Section 5.2.3.

A significant portion of the proposed fills for the project will be sidehill fills. All sidehill fills should be benched into the existing hillsides in accordance with Section 204.09 of the FP-03 Specifications. A detail for fill benching is included in Appendix H.

4.2.4 Stormwater Management Basins and Culverts

The seven currently proposed stormwater management basins are underlain by a wide variety of soil types. The boring logs and laboratory test results should be reviewed in conjunction with the grading plans for each of the basins to determine which soil type(s) will be present at each specific basin location. If clays are present beneath a proposed infiltration basin, alternative design measures will be required. Conversely, if sands or gravels are present beneath a proposed retention basin, a clay or geosynthetic liner will be required.

The maximum height of earthen embankment for any of the proposed SWM basins is approximately 6 feet and the lengths of the embankments are relatively short (most less than 50 feet). Earthen embankments for SWM basins should be constructed using the on-site clays or silts. Standard compaction requirements should be appropriate. Special attention will be required around drainage structures within the embankments to ensure that proper compaction is attained. Due to the limited embankment heights and generally stiff to medium dense foundation soils, stability of the earthen embankment slopes is not expected to be a concern.

The three test borings conducted for the three culvert pipe runs with diameters greater than 36 inches generally encountered medium stiff to hard clays and silts, and medium dense sand and gravels. Borings B-15 and B-16 encountered groundwater at depths of 3.3 feet and 5.1 feet, respectively. If pipe inverts are to be located within or below water-bearing sand or gravel layers, some basic dewatering measures (pumping from sumps and possibly shallow wellpoints) as well as some overxecvavation and replacement of saturated bearing soils may be necessary.

The results of the laboratory tests performed to evaluate the corrosivity potential of the on-site soils are presented in Section 3.5. The pH values of the five samples tested ranged from 3.4 to 4.8, indicating acidic soils. The minimum resistivity values ranged from 2,680 to 27,200 ohm-cm, with four of the five values between 2,680 and 11,2000 ohm-cm. Based on the laboratory test results and using the Overall Corrosiveness Index methodology (FHWA, 1991), the on-site soils are considered to be of average corrosiveness. Selection of culvert materials and gauge thicknesses (metal) should include consideration of the corrosion potential of the on-site soils. The methodology and calculations of the Overall Corrosiveness Index is presented in Appendix G.

4.2.5 Underdrains

In order to promote rapid positive drainage of water from within the pavement sections, VDOT Standard UD-4 underdrains should be installed along the edges of on all new/reconstructed roadway pavements throughout the project.

In order to control groundwater that may seep out at the cut-to-fill transitions (grade points), VDOT standard CD-1 combination underdrains should be installed at each cut-to-fill transition on the project.

Due to the potential for encountering springs in water-bearing sand and gravel layers that may be encountered, an additional pay item and quantity for standard groundwater underdrains should be included in the contract documents.
One area of groundwater seepage area was detected and flagged as part of the wetland delineation for the project. This area is referred to as the Lizard Tail seep wetland. This seepage area is located between approximate stations 217+00 and 217+50 of Mulligan Road, right of centerline. This is an intermittent seep with a significant amount of flow during periods of wet weather. An approximately 15 foot high fill is planned at the location of the seepage, and it will have to be addressed prior to beginning embankment construction in that location. As the seepage is located within a natural existing swale, the most effective remediation will likely be install a spring box with an outlet pipe that drains out beyond the toe of the fill. FHWA Standard Detail E604-7 for the spring box (porous) is included in Appendix H. An additional quantity of spring boxes (porous) should be included in the contract documents to address random springs and seepage areas that may be encountered.

4.3 Structure Foundations

4.3.1 General

Due to the presence of numerous and variable layers of loose/soft Coastal Plain deposits throughout the project, shallow foundations (spread footings) were not considered to be a viable option for foundation support of the two proposed bridges on Mulligan Road which are to be constructed in Phase I of the project (over Kingman Road and Piney Run).

Deep foundations will be required to support the two proposed bridges. The use of drilled shafts was considered, but it was concluded that the presence of water-bearing sand and gravel layers, some of which are under considerable artesian pressure (refer to borings BS-15, BS-16, and BS-17), could pose constructability issues and potentially increase the cost of drilled shafts significantly.

Driven piles are considered to be the most feasible and economical deep foundation system given the subsurface conditions at the bridge locations. Precast, prestressed, concrete piles are considered to be the most suitable and economical type of driven piles for the project given the subsurface conditions. However, due to the prevalent use and local manufacture of steel piles in the Northern Virginia area, concrete-filled, closed-end steel pipe piles are also considered to be a feasible and economical deep foundation alternative.

The FHWA computer program DRIVEN (version 1.2) was utilized to calculate the ultimate axial compressive capacities for driven piles at each of the two Mulligan Road bridge sites. The computer-generated soil profiles, output files, and the graphs of ultimate capacities versus depth are included in Appendix G.

Wave equation analyses were performed for the 12-inch and 18-inch square concrete piles and for the 12-inch and 18-inch diameter closed-end steel pipe piles at the Kingman Road Bridge to determine if the piles could be installed with reasonably-sized hammers while maintaining the penetration rate (blows per inch) and the compressive and tensile driving stresses within allowable limits. The analyses were performed using the computer program GRLWEAP (version 2005). The Kingman Road Bridge was selected for the wave equation analyses since the piles for this bridge will be driven into the densest soils and will have the highest capacities of the three bridges on the project. The results indicate that both the penetration rates and the compressive and tensile driving stresses should be within the allowable limits for the prestressed concrete piles and the steel piles. The wave equation analyses are presented in Appendix G.

Due to the anticipated relatively light foundation loads and stiff/dense natural soils encountered at the proposed footing bearing elevations, the proposed precast Wildlife Crossing box culvert to be located at station 168+00 of Mulligan Road may be supported by conventional spread footings bearing on undisturbed natural soil.

4.3.2 Kingman Road Bridge

The Kingman Road bridge will be a single span structure with a total length of 130 feet and will be supported by two semi-integral abutments on approach embankments. The station limits of the bridge are from stations 181+89 to 183+19 of Mulligan Road. The southern and northern approach embankments will have maximum heights of 21 feet and 26 feet, respectively.

Based on the soil conditions at the bridge site and discussion with HDR's structural engineers, 12-inch or 18-inch square prestressed concrete piles and 12-inch to 18-inch round closed-end steel pipe piles were determined to be adequate for foundation support of the abutments.

The axial pile capacity will be developed by a combination of skin friction and end-bearing in the dense clayey and silty sands underlying the bridge site. The ultimate and allowable capacities for both concrete and steel piles are summarized in Table 9.

TABLE 9 – PILE CAPACITIES – KINGMAN ROAD BRIDGE

Substructure Unit	Pile Type [1]	Pile Size	Pile Length (feet)	Q_{ULT} (kips)	Q_{ALL} (kips)[2]	Q_{ALL} (tons)
Abutments	PCP	12"	60 +/-	496	220	110
Abutments	CEP	12"	60+/-	327	145	73
Abutments	PCP	18"	60+/-	933	415	207
Abutments	CEP	18"	60+/-	653	290	145

1) PCP = Prestressed Concrete Pile; CEP = Closed-End Pipe
2) Safety factor = 2.25

The above allowable axial capacities include a safety factor of 2.25, which is consistent with FHWA guidelines if dynamic load testing and CAPWAP analyses are conducted. However, structural criteria may control the pile design and dictate that a lower allowable load per pile be utilized. Graphs of ultimate pile capacity versus depth are included with the DRIVEN output in Appendix G. If it is desired to utilize lower allowable capacities per pile than those indicated above, they can be obtained by applying a safety factor of 2.25 to the ultimate capacities in the graphs.

Estimated pile lengths are generally expected to be on the order of 60 feet at Abutment A and 65 feet at Abutment B. Pile length variations on the order of +/- 5 feet should be expected

Settlement of driven concrete pile foundations bearing in the dense sand underlying the bridge site is expected to be less than ½".

Lateral loads can be resisted by either battering the front row of piles at each abutment at a batter of 1(H):4(V) or 1(H):6(V), or by the lateral resistance provided by the embankment fill material against vertical piles.

Lateral pile capacity analyses were performed using the computer program LPile Plus (version 5.0.7). A fixed head condition was assumed for the piles. Based on the analyses, an applied lateral load of 24 kips on a 12-inch square pile will result in a lateral deflection of approximately ½ inch, and an applied lateral load of 48 kips on an 18-inch square pile will result in a lateral deflection of approximately ½ inch. With a safety factor of 2.0, the allowable lateral load is 12 kips per pile for 12-inch square piles and 24 kips per pile for 18-inch square piles. These allowable lateral capacities may also be utilized for the 12-inch and 18-inch diameter closed-end pipe piles, respectively. The output data files and graphs of lateral deflection and bending moment versus pile depth from the LPile analyses are presented in Appendix G. All soil strength and unit weight parameters and pile properties specified in the analyses are presented in the output data files.

As the foundation soils at the Kingman Road bridge site are generally stiff to dense, embankment settlement is expected to be nominal and should occur during or shortly after construction. Negative skin friction (downdrag) is not expected to be a concern for the piles at this bridge. However, the embankment settlement should be monitored to verify this prior to commencing pile driving operations.

4.3.3 Piney Run Bridge at HEC

The Piney Run bridge at HEC will be a two span structure with a total length of 200 feet and will be supported by two stub abutments on approach embankments and one center pier. The station limits of the bridge are from stations 219+78 to 221+78 of Mulligan Road. The southern and northern approach embankments will have maximum heights of 22 feet.

Based on the soil conditions at the bridge site and discussion with HDR's structural engineers, 12-inch or 18-inch square prestressed concrete piles, or 12-inch or 18-inch round closed-end steel pipe piles were determined to be adequate for foundation support of the abutments. For

support of the center pier, 18-inch or 24-inch square prestressed concrete piles, or 18-inch or 24-inch round closed-end steel pipe piles were determined to be adequate. The pier will be constructed as a bent, with the piles extending above the ground surface to an elevated pile cap directly beneath the bridge superstructure.

The axial pile capacity will be developed by a combination of skin friction and end-bearing in the very stiff to hard silts underlying the upper soft/loose alluvial soils at the bridge site. The ultimate and allowable capacities for both concrete and steel piles are summarized in Table 10.

TABLE 10 – PILE CAPACITIES – PINEY RUN BRIDGE AT HEC

Substructure Unit	Pile Type [1)]	Pile Size	Pile Length (feet)	Q_{ULT} (kips)	Q_{ALL} (kips)[2)]	Q_{ALL} (tons)
Abutments	PCP	12"	90+/-	289	128	64
Abutments	CEP	12"	90+/-	183	81	41
Abutments	PCP	18"	90+/-	542	241	120
Abutments	CEP	18"	90+/-	371	165	82
Pier	PCP	18"	90+/-	380	169	84
Pier	CEP	18"	90+/-	266	118	59
Pier	PCP	24"	90+/-	556	247	124
Pier	CEP	24"	90+/-	394	175	88

1) PCP = Prestressed Concrete Pile; CEP = Closed-End Pipe
2) Safety factor = 2.25

The above allowable axial capacities include a safety factor of 2.25, which is consistent with FHWA guidelines if dynamic load testing and CAPWAP analyses are conducted. However, structural criteria may control the pile design and dictate that a lower allowable load per pile be utilized. Graphs of ultimate pile capacity versus depth are included with the DRIVEN output in Appendix G. However, due to the presence of the upper soft/loose alluvial soils, it will be necessary to have a minimum embedment length in the stiff to hard silt layer underlying the site in order to achieve the estimated pile capacities.

No scour data was available at the time the DRIVEN pile capacity analyses were performed. After reviewing the material types in the borings at this bridge and observing the Piney Run channel scour in the field, it was assumed that approximately 8 feet of scour could occur at this location. This scour depth was specified in the DRIVEN computer analyses for the pier piles and is reflected in the capacities stated above.

Estimated pile lengths are generally expected to be on the order of 95 feet at Abutment A, 75 feet at the pier (not including the freeboard length above the existing ground line), and 75 feet at Abutment B. Pile length variations on the order of +/- 5 feet should be expected.

Additionally, the estimated axial capacities are based on no negative skin friction, which implies that settlement of the foundation soils must be complete prior to driving the abutment piles. Negative skin friction would occur with as little as ½" of settlement of the surrounding soils due to the proposed embankment loading. The impacts of designing for negative skin friction on the piles were considered. However, due to the depth of the lower soft clay layer, the magnitude of the negative skin friction would be very significant. This situation would be compounded by the

fact that not only is there negative skin friction, but the same amount of positive skin friction would also not available as part of the ultimate pile capacity. This would result in very low allowable pile capacities, or having to use very long piles, neither of which is desirable.

The use of skin friction reducing materials on the piles was also considered, but it is believed that the presence of sand and gravel layers above the clay layers could render this technique ineffective. It is therefore necessary that pile driving not commence until approach embankment settlement has essentially ceased.

Settlement of driven pile foundations bearing in the very stiff to hard silts underlying the bridge site is expected to be less than ½".

At the abutments, lateral loads can be resisted by either battering the front row of piles at a batter of 1(H):4(V) or 1(H):6(V), or by the lateral resistance provided by the embankment fill material against vertical piles

Lateral pile capacity analyses for the abutment piles were performed using the computer program LPile Plus (version 5.0.7). A fixed head condition was assumed for the piles. Based on the analyses, an applied lateral load of 24 kips on a 12-inch square pile will result in a lateral deflection of approximately ½ inch, and an applied lateral load of 48 kips on an 18-inch square pile will result in a lateral deflection of approximately ½ inch. With a safety factor of 2.0, the allowable lateral load is 12 kips per pile for 12-inch square piles and 24 kips per pile for 18-inch square piles. These allowable lateral capacities may also be utilized for the 12-inch and 18-inch diameter closed-end pipe piles, respectively. The output data files and graphs of lateral deflection and bending moment versus pile depth from the LPile analyses are presented in Appendix G. All soil strength and unit weight parameters and pile properties specified in the analyses are presented in the output data files.

The center pier for this bridge will be constructed as a bent with the piles extending approximately 12 feet above existing ground up to the bridge superstructure. Based on this and the potential for significant scour at the pier location due to the proximity of Piney Run, the lateral capacity for the pier piles should be developed solely by battering the piles in both directions parallel to the roadway centerline as opposed to relying on lateral soil resistance in the upper portion of the piles.

Settlement monitoring points should be installed at the top of the embankments upon their completion to full height. The settlement points should be monitored on a weekly basis. The abutment piles should not be driven until the monitoring program indicates that embankment settlement is essentially complete.

Pile driving and construction at the pier location may commence at any time during construction.

4.3.4 Wildlife Crossing Box Culvert

Due to the anticipated light foundation loads and the generally stiff to medium dense consistency of the natural soils at the box culvert location, spread footing foundations are recommended for

support of this structure. A net allowable soil bearing pressure of 3,000 pounds per square foot (psf) should be available from the native soils.

The box culvert and wingwalls will be subjected to lateral earth pressures imparted by the backfill placed behind and above them. The culvert and walls should be designed to resist these loads.

Adequate drainage measures should be installed to prevent the build-up of hydrostatic pressures on the box culvert and wingwalls.

5.0 RECOMMENDATIONS

The recommendations section of this report addresses only the components of the project that are to be constructed in Phase I. Recommendations for the Phase II components of the project will be submitted under separate cover at a later date.

5.1 Pavements

5.1.1 Mulligan Road and Shared Use Path

For the proposed new Mulligan Road alignment, the following conventional AC and aggregate base pavement section should be utilized:

3 inches of AC surface (SACP, 3/8" NMSA, 0.3<3M ESAL, type III pavement smoothness)
6 inches of AC base course (SACP, 3/8" NMSA, 0.3<3M ESAL)
9 inches of aggregate base course (grading C or D)

For the Shared Use Path, the following conventional AC and aggregate base pavement section should be utilized:

2 inches of AC surface (SACP, 3/8" NMSA, 0.3<3M ESAL, type III pavement smoothness)
6 inches of aggregate base course (grading C or D)

All pavement materials, including asphalt prime coats and tack coats, should be placed and compacted as required in accordance with the FP-03 Specifications. Pavement subgrades should be properly moisture-conditioned and compacted prior to placing the aggregate base material.

Since only the aggregate base course is to be placed in Phase I of the project, consideration should be given to placing a heavy prime coat or a surface treatment (chip seal, slurry seal etc.) to help protect the aggregate base course until the final asphalt pavement section can be placed. Adequate interim drainage measures should also be implemented to ensure that surface drainage is diverted from the aggregate base course as quickly as possible.

5.2 Earthwork

5.2.1 Site Clearing/UXO

Prior to starting earthwork operations, the proposed widening areas and the new Mulligan Road alignment should be cleared, grubbed, and stripped of all topsoil and vegetation. Clearing and grubbing should be performed in accordance with Section 201 of the FP-03 Specifications. It is recommended that a slightly conservative stripping depth of 12 inches be included in the contract document. The topsoil should be stockpiled and then placed on the project cut and fill slopes to help establish vegetation.

The grading contractor should have qualified UXO personnel on-site or available to assist with UXO avoidance and detection throughout the duration of the contract. While the majority of the UXO that will be encountered will likely be small arms rounds, it is possible that more substantial ordnance may be encountered during site earthwork operations.

5.2.2 Excavations/Cut Slopes

The on-site soils to be excavated from the cuts should be utilized as fill material for the embankments to the extent possible. Excavated soils should be placed at moisture contents in accordance with FP-03 specifications. The majority of the soils to be excavated will likely have to be dried back prior to being utilized as embankment fill material. The fine-grained soils (clays and silts) will require considerably more manipulation and time to dry back than will the coarse-grained soils (sands and gravels). If earthwork operations are performed during a period of wet weather, it will be extremely difficult to properly moisture-condition the on-site soils.

It is recommended to include approximately 4,000 cubic yards of subexcavation and replacement with granular backfill material to address wet subgrade conditions encountered in the roadway cuts for the project. Additionally, a quantity of 8,000 square yards of Type-IIIA stabilization geotextile should be included in the contract documents.

Standard heavy-duty excavation equipment should be utilized to excavate these materials from open cuts and in utility excavations and other confined excavations. No weathered rock or rock excavation is expected on the project.

All cut slopes for the project should be excavated to a geometry of 2(H):1(V) or flatter.

5.2.3 Embankments/Fill Slopes

Embankments should be constructed using the on-site soils excavated from the project cuts. To the extent practical, any high plasticity clays and silts (CH,MH) excavated from the cuts should be blended with more granular soils and placed in the lower, interior portions of fills, or they should be utilized as clay liner material for SWM basins which are designed as retention facilities.

All fill material should be placed and compacted in accordance with Section 204 of the FP-03 Specifications. The soils should be placed at moisture contents that will allow for the required

compaction specifications to be met. This will likely require that the majority of the soils be dried back prior to being placed as fill material. If earthwork operations are performed during a period of wet weather, drying the on-site soils out will be very difficult and may necessitate other alternatives (such as the application of lime) to dry the soils out to the point that they can be properly placed and compacted.

If off-site borrow material is required, it should classify as CL or better and should have a minimum CBR value of 6.0.

All fill slopes for the project should be constructed to a geometry of 2(H):1(V) or flatter.

For the approaches to the Piney Run Bridge at HEC, it is conservatively estimated that the time for 90% consolidation settlement of the underlying foundation soils to occur is approximately 150 days at Abutment A and 30 days at Abutment B. However, it should be noted that these are strictly estimates based on correlations to soil index properties and there may be some variability with these time estimates. The project construction schedule should include the above waiting periods for abutment construction. Construction of the abutments should not commence until the settlement has slowed to an acceptable rate as determined by surveying settlement points as described below. Construction of the center bridge pier will not be affected by the embankment settlement and may commence at any time.

Settlement of the approach embankments for the Piney Run Bridge at HEC should be monitored via surface settlement monuments on the tops of the approach embankments. The settlement monuments should consist of vertical 4-foot long pieces of steel rebar (No. 5), the lower 3 feet of which are concreted or grouted into the top surfaces of the fills. The settlement monuments should be surrounded by construction fencing material to protect them and they should be monitored twice a week until it can be determined that the settlement has essentially ceased. The recommended settlement monument locations are shown in Table 11. A detail for the settlement monuments is included in Appendix H.

TABLE 11 – SETTLEMENT MONUMENT LOCATIONS

Approach Embankment	Station	Right Offset	Left Offset
Southern	217+70	40 feet	40 feet
Southern	218+70	40 feet	40 feet
Southern	219+70	40 feet	40 feet
Northern	221+85	40 feet	40 feet
Northern	222+85	40 feet	40 feet
Northern	223+85	40 feet	40 feet

If the project construction schedule cannot accommodate the estimated settlement waiting periods, one option to decrease the time for settlement is to install prefabricated vertical wick drains. Preliminary estimates indicate that a total of approximately 90,000 linear feet of wick drains would be required for both approach embankments. This estimate is based on a 5 foot center-to-center triangular drain spacing. The estimated cost of the wick drains is on the order of $125,000. It is estimated that the wick drains would reduce the settlement period to less than two weeks.

The construction plans should include pay items and quantities for subexcavation, replacement with granular material, and stabilization geotextile beneath embankments. It is anticipated that subexcavation and replacement and possibly the use of a stabilization geotextile may be required beneath the majority of the approach embankment footprints at the Piney Run bridge at HEC. The exact amount of subexcavation will have to be determined during construction by the use of proofrolling and/or test pits. For quantity estimation purposes for the plans, it is recommended to include 4,000 cubic yards of subexcavation and replacement with granular backfill and 8,000 square yards of Type III-A stabilization geotextile. These quantities are in addition to the quantities in Section 5.2.2 for cuts.

Bench all sidehill fills in accordance with Section 204 of the FP-03 specifications. Refer to the fill benching detail in Appendix H.

5.2.4 Stormwater Management Basins and Culverts

The stormwater management basin boring logs and laboratory test results should be reviewed in conjunction with the grading plans to determine if any special design measures will be required for the basins (i.e. a clay or geosynthetic liners, infiltration trenches, etc.).

Earthen embankments for SWM basins should be constructed with slopes of 2(H):1(V) or flatter using the on-site clays or silts. Compaction should be performed in accordance with the requirements of Section 204 of the FP-03. Special attention will be required around drainage structures within the embankments to ensure that proper compaction is attained.

Generally, standard pipe bedding details will be suitable for the majority of the pipe culverts on the project. However, if pipe inverts are located within or below water-bearing sand or gravel layers, basic dewatering measures (pumping from sumps and possibly shallow wellpoints) as well as some overxecvavation and replacement of saturated bearing soils may be necessary.

Culvert material selection should include consideration of corrosion potential of the on-site soils, which are considered to be of average corrosiveness using the Overall Corrosiveness Index as described in Appendix G. The laboratory pH and resistivity test values presented in Appendix D should be utilized in the selection of culvert materials and gauges (metal).

5.2.5 Underdrains

VDOT Standard UD-4 underdrains should be installed along the edges of on all roadway pavements throughout the project. The underdrains should extend to the bottom of the 6-inch layer of aggregate base that is included beneath the actual pavement section for frost protection.

VDOT standard CD-1 combination underdrains should be installed at each cut-to-fill transition (grade point) on the project.

Due to the potential for encountering springs in water-bearing sand and gravel layers that may be encountered, an additional pay item and quantity for standard groundwater underdrains should be included in the contract documents. A quantity of 500 linear feet of underdrain is recommended for this purpose. Additionally, a quantity of riprap should be included in the contract documents

to address minor areas of instability that may be created by excessive groundwater flow. A quantity of 500 tons of riprap is recommended for this purpose.

A spring box (porous) and outlet pipe should be installed to provide an outlet for the seepage area that is located beneath the proposed embankment footprint between stations 217+00 and 217+50, right of centerline. An additional quantity of 10 spring boxes (porous) should be included in the contract documents to address any similar seepage areas that may be encountered. FHWA Standard Detail E604-7 is included in Appendix H.

5.2.6 Utility Excavations

All utility and other confined excavations should be sloped, shored, and/or and braced in accordance with all applicable federal (OSHA), state and local excavation guidelines. The on-site soils are generally considered to be Class C in accordance with current OSHA excavation guidelines.

Any utility excavations that traverse the low-lying floodplain areas adjacent to Piney Run are expected to encounter significant groundwater and will require dewatering. It is expected that pumping from sumps will adequately address dewatering for relatively shallow excavations. Additionally, any utility excavations that intercept water-bearing sand or gravel layers may also require dewatering. Deeper utility excavations (i.e. deeper than approximately 10 feet) may require shallow wellpoint systems to adequately control groundwater.

5.3 Structure Foundations

5.3.1 General

The recommended foundation system for the two bridges in Phase I of the project is driven piles. Precast, prestressed, concrete piles are the recommended pile type. Depending on the loading conditions, the pile sizes will range from 12-inch square to 24-inch square.

A wave equation analysis of the contractor's proposed hammer and driving system should be submitted for review prior to mobilization of the equipment to the site. The proposed hammer should have adequate energy to efficiently install the piles to the specified capacities without inducing excessive driving stresses.

Due to the presence of medium dense to dense sand and gravel layers overlying loose, soft soil layers at the Piney Run bridge at HEC, it is recommended that driveability analyses be performed to determine if any precautionary measures are required for pile installation. It should be anticipated that predilling and/or short-stroking the hammer through these upper materials will be required.

Dynamic pile testing using a pile driving analyzer (PDA) is recommended. It is recommended to dynamically test one pile at each bridge substructure unit. CAPWAP analyses should be performed for each dynamic test. Each pile should also be tested during restrike after a minimum 48 hour waiting period. All dynamic testing should be performed in accordance with Section 551 of the FP-03 Specifications.

A minimum center-to-center pile spacing of three pile widths is recommended.

Pile pick-up and handling procedures should be in accordance with Section 551 of the FP-03 Specifications.

Based on the laboratory chemical tests conducted, no special corrosion protection or design considerations are required for the concrete piles.

The recommended foundation system for the proposed precast Wildlife Crossing box culvert to be located at station 168+00 of Mulligam Road is conventional spread footings bearing on undisturbed natural soil.

5.3.2 Kingman Road Bridge

It is recommended to support the two abutments of the Kingman Road bridge with 12-inch or 18-inch square prestressed concrete piles.

The pile embedment lengths are estimated to be 60 feet at abutment A and 65 feet at abutment B. Pile length variations on the order of +/- 5 feet should be expected. The above pile lengths should result in allowable axial capacities on the order of 100 tons per pile (12-inch square piles) and 190 tons per pile (18-inch square piles). The dynamic testing will determine the actual pile lengths required.

The allowable lateral load provided by the soil resistance of the embankment fill material is 12 kips per pile for the 12-inch square piles and 24 kips per pile for the 18-inch square piles. If additional lateral load resistance is required, it can be obtained by battering the front row of piles at each abutment at a batter of 1(H):6(V). The lateral capacity is the horizontal component of the total pile axial capacity based on the batter angle. The remaining portion of the axial capacity is the vertical component.

Pile driving at the abutments of the Kingman Road bridge may commence as soon as the embankments are constructed to their full height.

5.3.3 Piney Run Bridge at HEC

It is recommended to support the two abutments of the Piney Run bridge at HEC with 12-inch or 18-inch square prestressed concrete piles and the pier with 24-inch square prestressed concrete piles.

The pile embedment lengths are estimated to be 95 feet at abutment A, 75 feet at the pier (not including the freeboard length above the existing ground line), and 75 feet at abutment B. Pile length variations on the order of +/- 5 feet should be expected. The above pile lengths should result in allowable axial capacities on the order of 85 tons per pile (12-inch square piles) and 160 tons per piles (18-inch square piles) at the abutments, and 180 tons per pile (24-inch square piles) at the pier. The dynamic testing will determine the actual pile lengths required.

The allowable lateral load provided by the soil resistance of the embankment fill material is 12 kips per pile for the 12-inch square abutment piles and 24 kips per pile for the 18-inch square abutment piles. If additional lateral load resistance is required, it can be obtained by battering the front row of piles at each abutment at a batter of 1(H):6(V). The lateral capacity is the horizontal component of the total pile axial capacity based on the batter angle. The remaining portion of the axial capacity is the vertical component.

Due to the potential for significant scour at the pier, the lateral load resistance should be developed by battering the 24-inch square piles at a batter of 1(H):6(V).

Pile driving at the abutments of the Piney Run bridge at HEC may commence only after embankment settlement due to consolidation of the foundation soils has essentially ceased. It is recommended to include embankment settlement waiting periods of 150 days for Abutment A and 30 days for Abutment B. These waiting periods should be built into the project construction schedule. Embankment settlement should be monitored by surveying settlement points as described in Section 5.2.3 until the settlement has essentially ceased.

Pile driving and construction at the pier will not be affected by embankment settlement and may commence at any time.

5.3.4 Wildlife Crossing Box Culvert

Spread (strip) footing foundations are recommended to support the proposed wildlife crossing precast bottomless box culvert structure at station 168+00. A net allowable soil bearing pressure of 3,000 pounds per square foot (psf) is recommended for the undisturbed natural soils.

In order to provide a uniform bearing surface and uniform load distribution along the length of the two strip footings (each approximately 130 feet long), it is recommended to subexcavate 2 feet below the proposed footing bearing elevations and backfill the subexcavations with 2 feet of compacted aggregate base course material (grading C or D). The aggregate base material should be compacted to at least 98% of the maximum dry density per ASTM-D698 (standard Proctor).

Backfill behind the box culvert structure and the wingwalls should meet the criteria for structural backfill in the FP-03.

The box culvert and the wingwalls will be subjected to lateral earth pressure imparted by the backfill placed behind them. The lateral earth pressure design criteria for structural backfill meeting the minimum requirements of the FP-03 are summarized in Table 12.

TABLE 12 – LATERAL EARTH PRESSURE DESIGN CRITERIA

Parameter	Value
Moist unit weight	120 pcf
Active earth pressure coefficient	0.33
At-rest earth pressure coefficient	0.50
Passive earth pressure coefficient	3.00
Coefficient of friction	0.57

The lateral earth pressure criteria presented in Table 12 are based on a friction angle of 30° and zero cohesion. Walls which are not restrained from movement at the top should be designed using active earth pressure criteria. Walls which are restrained from movement at the top should be designed using at-rest earth pressure criteria. Surcharge loads should be included in the structural design of the box culvert and the wingwalls.

The box culvert design should include adequate drainage measures to prevent the build-up of hydrostatic pressures behind the structure and the wingwalls. Weepholes should be installed at intervals not exceeding 10 feet along the length of the structure and the wingwalls. Footing drains should be installed on top of the footings at the base of the structure walls and should be outletted by at the low end of the structure.

6.0 LIMITATIONS

This report has been prepared for the use of the Eastern Federal Lands Highway Division for specific application to project VA-A-AD-48(1) in accordance with generally accepted geotechnical and pavement evaluation engineering practice. No warranty, expressed or implied is made. The analyses and recommendations submitted are based upon the data available to HDR at the time of this study and on the data collected during the investigations. This report does not reflect variations that may occur in the pavement or subsurface conditions between test boring or NDT test locations. Variations may become evident during construction, at which time re-evaluation of the conclusions and recommendations may become necessary. In the event of design or location changes in the project after the final report is submitted, the recommendations should be reviewed and revised as necessary.

7.0 BIBLIOGRAPHY

American Association of State Highway Transportation Officials, *Guide for Design of Pavement Structures,* 1993.

Commonwealth of Virginia, Department of Mines, Minerals, and Energy, Division of Mineral Resources, *Geologic Map of Virginia and Expanded Explanation,* 1993.

Das, Braja M., *Principles of Foundation Engineering, Fifth Edition, 2004.*

Department of the Army, U.S. Army Corps of Engineers, *Engineering and Design – Settlement Analysis EM 1110-1-1904,* 1990.

Sowers, George F., Introductory Soil Mechanics and Foundations: Geotechnical Engineering, Fourth Edition, 1979.

Strategic Highway Research Program, National Research Council, *SHRP-P-338, Distress Identification Manual for the Long-Term Pavement Performance Project,* 1993.

United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Fairfax County, Virginia,* 1963.

United States Department of Transportation, Federal Highway Administration, *Design and Construction of Driven Pile Foundations, Workshop Manual - Volume I,* 1996.

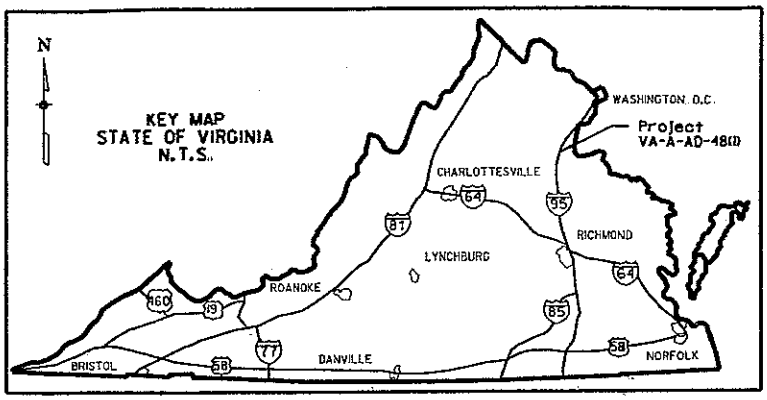
United States Department of Transportation, Federal Highway Administration, *Federal Lands Highway Project Development and Design Manual,* 1996.

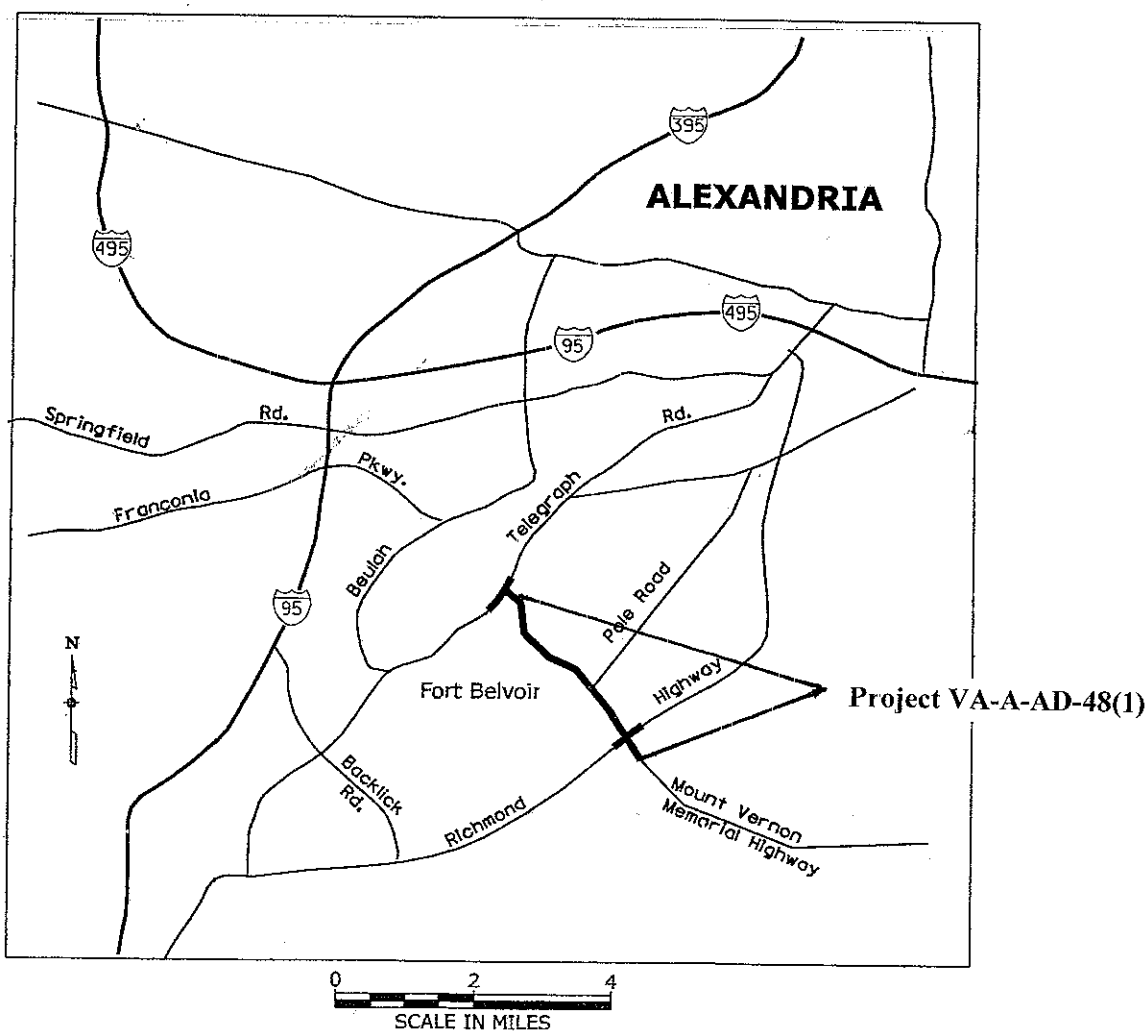
United States Department of Transportation, Federal Highway Administration, *Recommendations Clouterre 1991 (Soil Nailing Recommendations - 1991),* 1991.

United States Department of Transportation, Federal Highway Administration, *Soils and Foundations Workshop Manual - Second Edition,* 1993.

United States Department of Transportation, Federal Highway Administration, *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-03, U.S. Customary Units,* 2003.

APPENDIX A
FIGURES

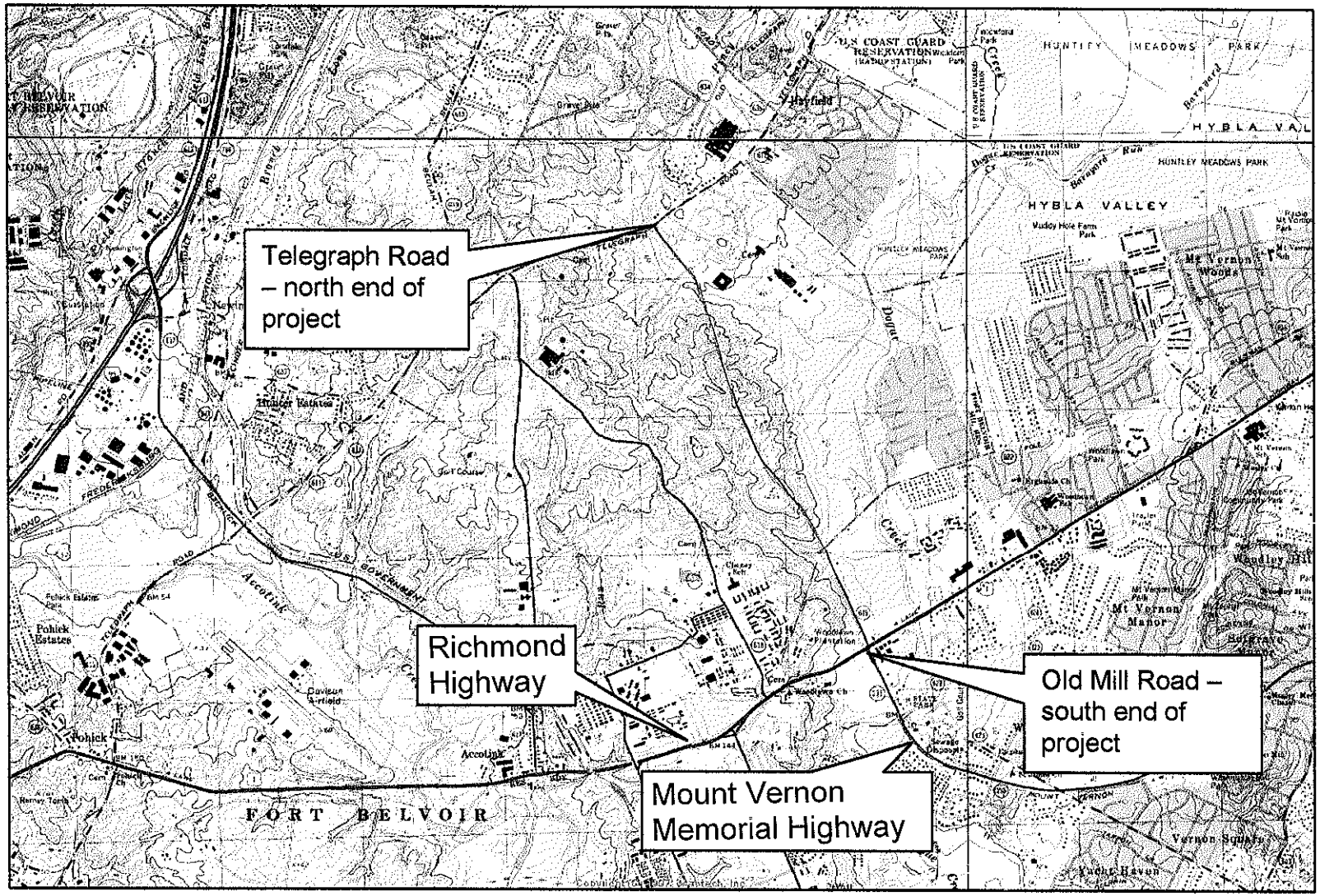




Site Location Map
VA-A-AD-48(1)
Fairfax County, Virginia

Date
9/07

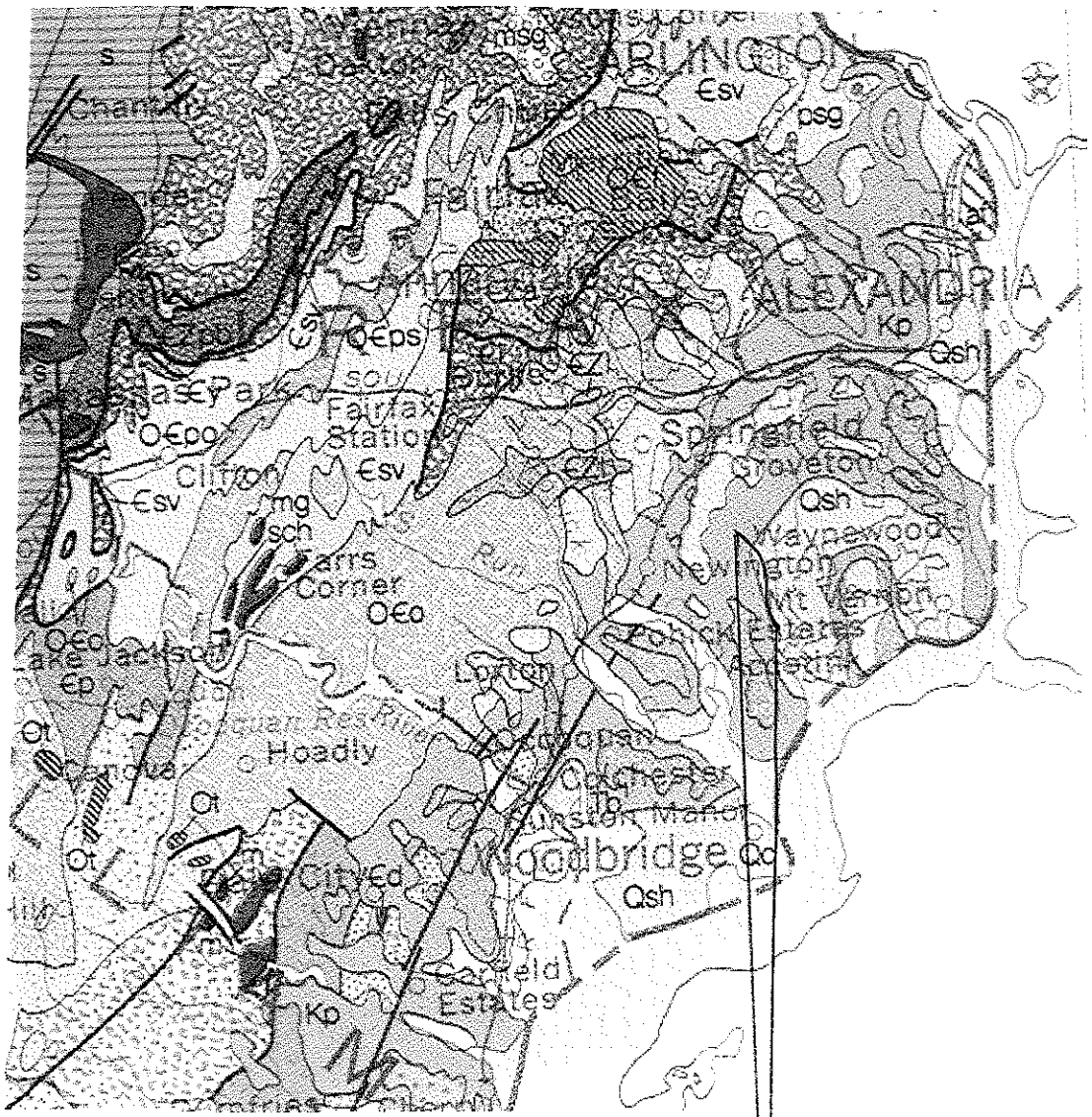
Figure
1



USGS topographic Map / Fort Belvoir, VA Quadrangle

Figure 2 - Site Topographic Map

HDR



VA-A-AD-48(1) PROJECT LIMITS

Qsh

SHIRLEY FORMATION

Interbedded gravel, sand, silt, clay, and peat; at altitudes to 35-45 ft.

Ko

POTOMAC FORMATION

Pebbly, poorly sorted quartzo-feldspathic sand interbedded with sandy clay and silt; minor organic-rich clay and silt.

1" = 4 MILES

Geologic Map
VA-A-AD-48(1)
Fairfax County, Virginia

Date
9/07

Figure
3

RICHMOND HIGHWAY
PAVEMENT BORING SUMMARY

Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
RH-1	15+53	RT WB	2.0/0.0/6.5	Not enc.	6+" PCC below AC (hit rebar and could not drill through)
RH-1A	17+39	RT WB	4.0/0.0/3.0	None	8" PCC below AC; Sandy clay subgrade
RH-2	19+15	LT WB	5.0/0.0/0.0	None	8.5" PCC below AC; Silty clay subgrade
RH-3	22+33	RT WB	3.0/0.0/11.0	2.0	Sandy silt
RH-4	25+58	LT EB	3.5/4.0/0.0	6.0	7" PCC below AC; Silty sand subgrade
RH-5	28+00	RT EB	5.5/3.5/0.0	None	8" PCC below AC; Silty sand subgrade
RH-6	32+00	RT EB	6.5/0.0/0.0	7.0	Silty clay subgrade
RH-7	34+65	LT EB	4.5/4.5/0.0	3.0	7" PCC below AC; Fine sand subgrade
RH-8	36+84	LT WB	5.0/3.0/0.0	None	8.5" PCC below AC; Silty clay subgrade
RH-9	38+45	LT WB	4.5/0.0/6.5	5.0	Silty clay subgrade
RH-10	40+44	RT WB	3.5/0.0/7.0	None	10" PCC below AC, Silty clay subgrade

- Indicates surface course/intermediate course/base course

MOUNT VERNON MEMORIAL HIGHWAY
PAVEMENT BORING SUMMARY

Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
MV-1	120+70	SB	8.0/0.0/0.0	4.0	Clayey sand subgrade
MV-2	120+20	LT NB	3.5/4.5/0.0	2.0	Silty clay subgrade
MV-3	118+08	Gore Area	2.0/6.5/0.0	5.0	Sandy clay subgrade
MV-4	116+43	RT NB	2.5/6.5/0.0	10.0	Silty clay subgrade
MV-5	115+12	SB	1.5/2.5/1.5	6.0	Silty clay subgrade

* Indicates surface course/intermediate course/base course

OLD MILL ROAD
PAVEMENT BORING SUMMARY

Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
OM-1	143+34	NB	5.0/0.0/0.0	7.0	Silty sand subgrade
OM-2	140+03	SB	4.5/0.0/4.5	6.0	Silty sand subgrade
OM-3	136+68	NB	3.5/5.5/0.0	7.0	Sandy silt subgrade
OM-4	133+33	SB	3.0/0.0/5.0	None	Silty clay subgrade
OM-5	130+00	NB	1.0/0.0/5.0	7.0	Sandy silt subgrade
OM-6	126+67	SB	2.0/0.0/6.0	6.0	Clayey gravel subgrade

* Indicates surface course/intermediate course/base course

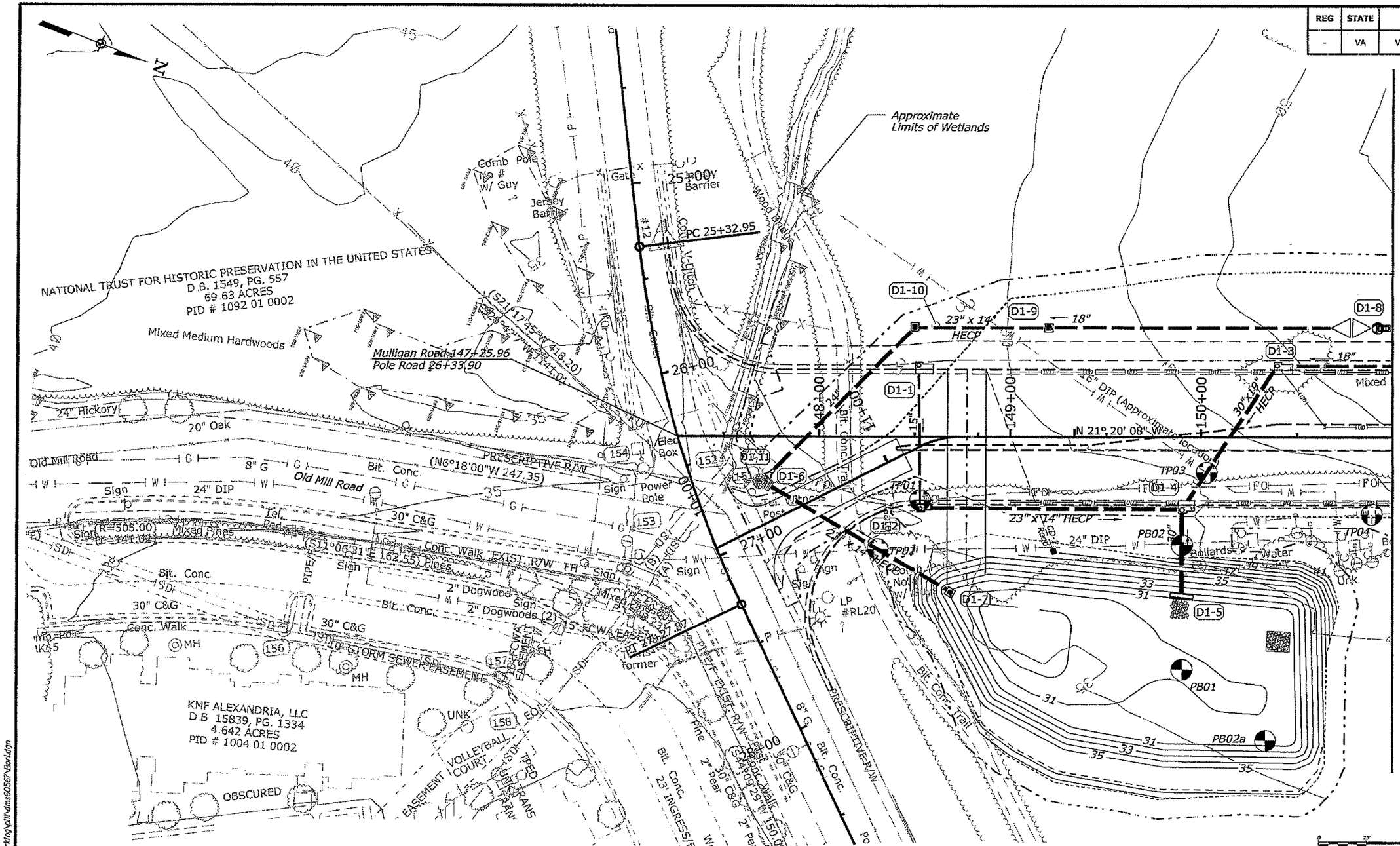
TELEGRAPH ROAD
PAVEMENT BORING SUMMARY

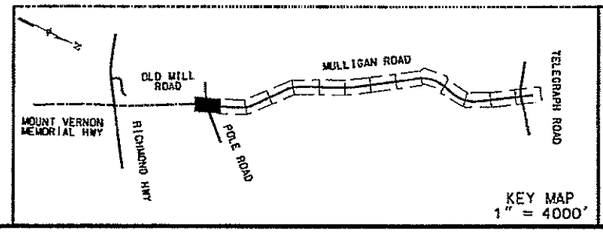
Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
T-1	52+86	EB	1.5/1.5/7.0	None	Sand with gravel subgrade
T-2	61+84	WB	3.5/3.0/0.0	None	Clayey sand with gravel subgrade
T-3	67+96	EB	5.0/4.0/0.0	None	Sand with gravel subgrade
T-4	74+57	WB	3.0/0.0/5.5	None	Silty sand with gravel subgrade
T-5	78+07	EB	5.0/4.0/0.0	None	Clayey sand subgrade
T-6	85+34	WB	N/A	None	8.5" AC/aggregate/AC, Sand with gravel subgrade

* Indicates surface course/intermediate course/base course

APPENDIX B
BORING LOCATION PLANS

REG	STATE	PROJECT	SHEET NO.
-	VA	VA-A-AD-48(1)	BOR1





U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
144+00 to 151+00

Sheet of

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REG	STATE	PROJECT	SHEET NO.
-	VA	VA-A-AD-48(1)	BOR2

Matchline 151+00

Matchline 158+00

D2-1

D2-2

D2-3

18"

15"

152+00

153+00

154+00

155+00

157+00

Utility Pole No #

B-35

B-34

TP05

TP06

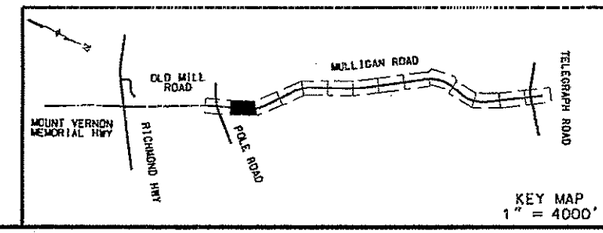
24" DIP

TS 155+03.60

SC 156+38.60

Spiral = CRBSC4B
PI 155+93.63
θs = 4° 04' 16"
Ls = 135.00'

0 25' 50
Scale In Feet



U S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
151+00 to 158+00

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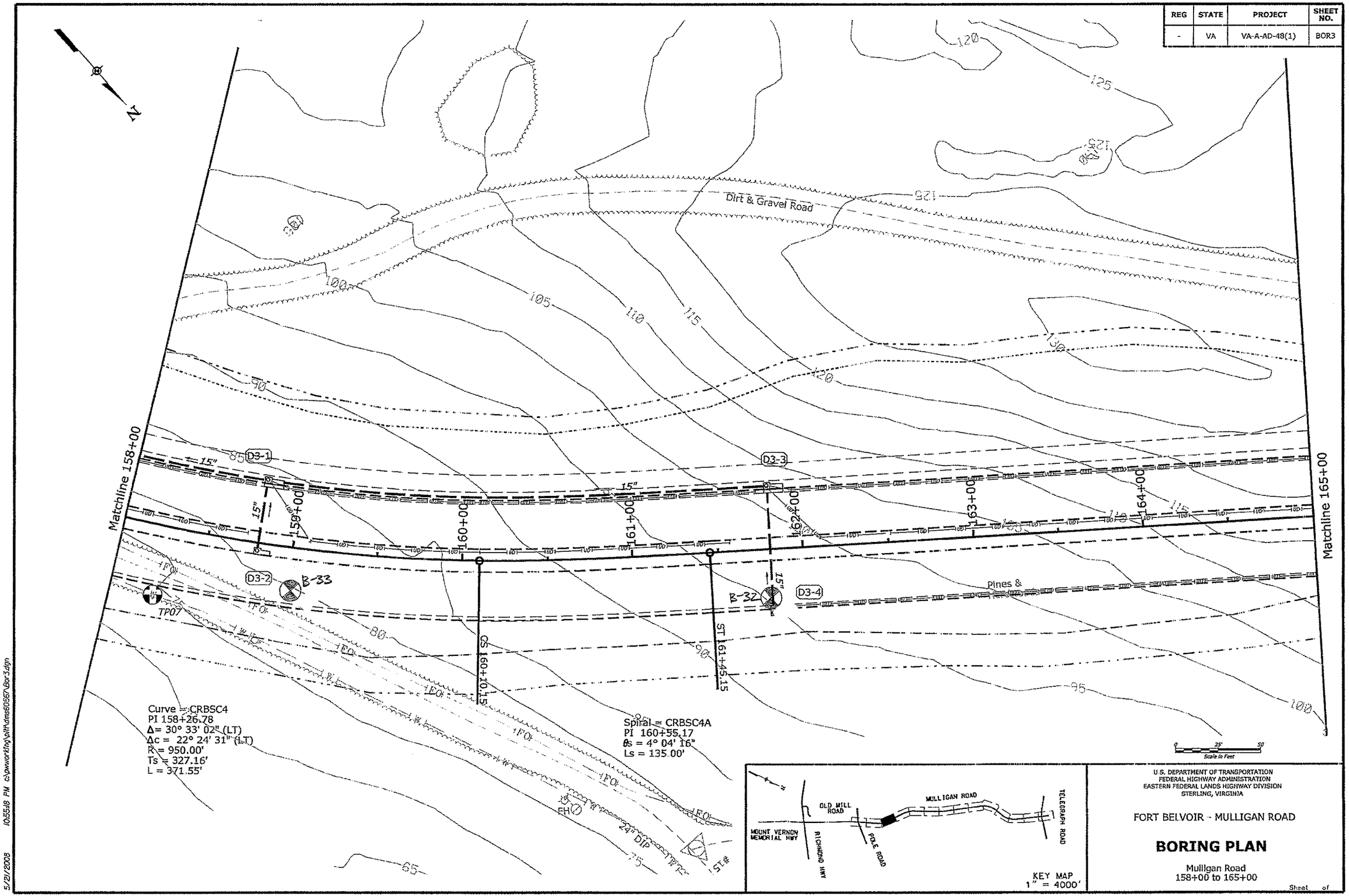

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
158+00 to 165+00

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REG	STATE	PROJECT	SHEET NO.
-	VA	VA-A-AD-48(1)	BOR4

Matchline 165+00

Matchline 172+00

N 51° 53' 10" W.

Dirt & Gravel Road

PB03

PB04

PB05

B-31

B-30

B-29

D4-1 D4-2 D4-3 D4-4 D4-5 D4-6 D4-7 D4-8 D4-9 D4-10 D4-11 D4-12

TS 168+80.08

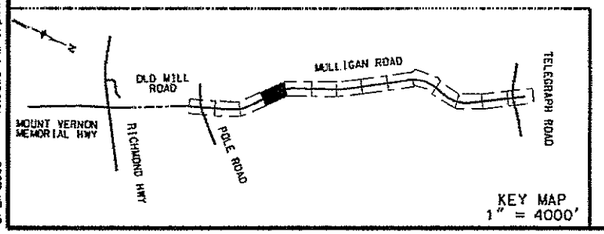
SCS 170+15.08

SWM Basin #2
Extended detention
enhanced

Spiral = CRBSC5B
PI 169+70.11
θs = 4° 04' 16"
Ls = 135.00'

Curve = CRBSC5
PI 171+76.20
Δ = 27° 23' 35" (RT)
Δc = 19° 15' 03" (RT)
R = 950.00'
Ts = 299.21'
L = 319.19'

Scale In Feet



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
165+00 to 172+00

Sheet of

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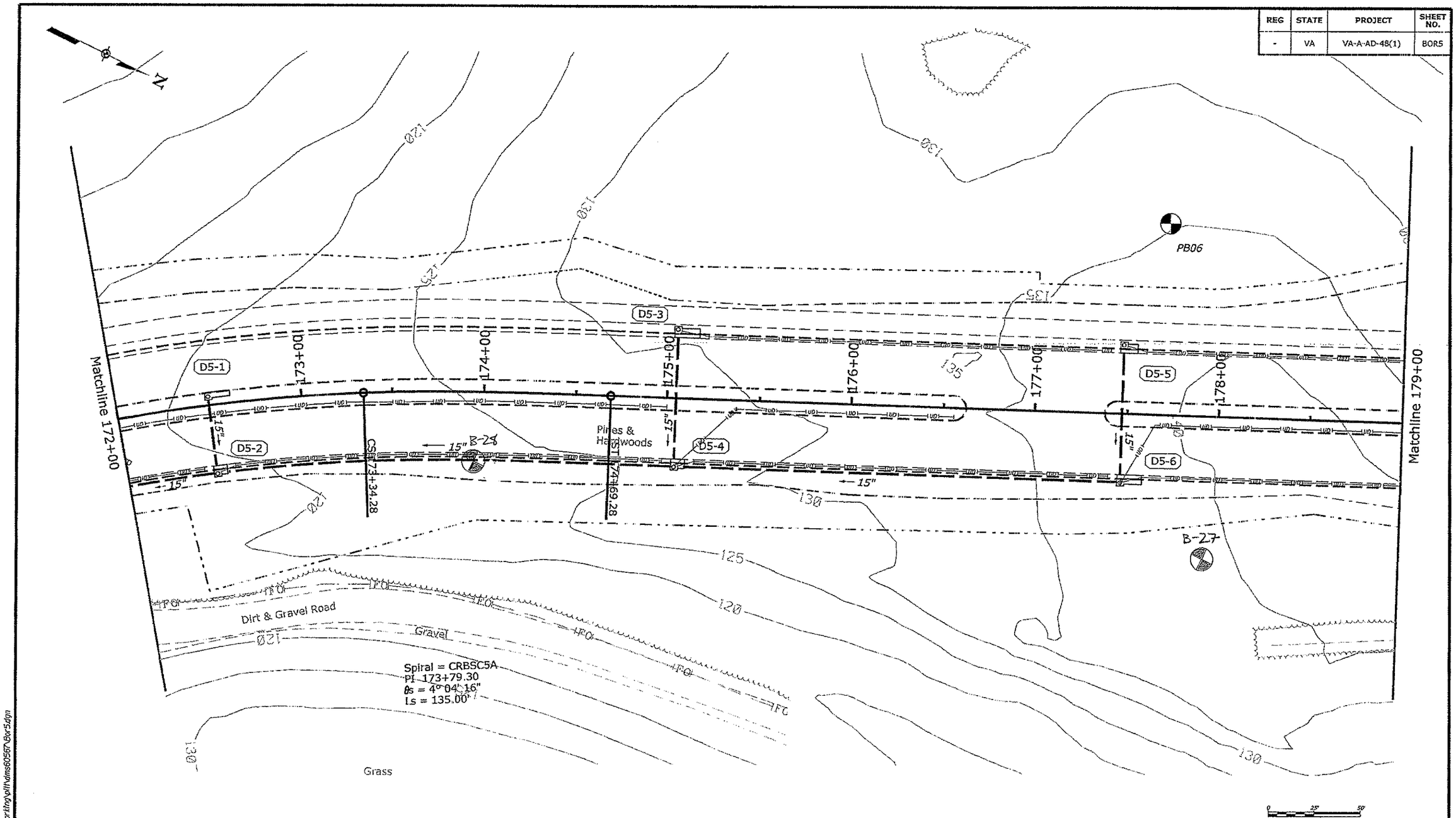

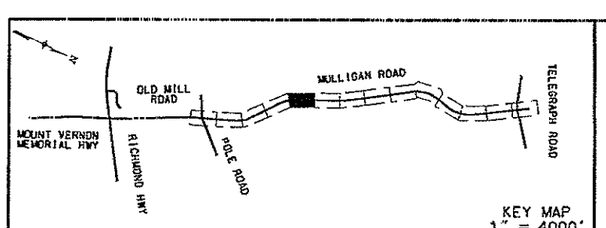

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
172+00 to 179+00

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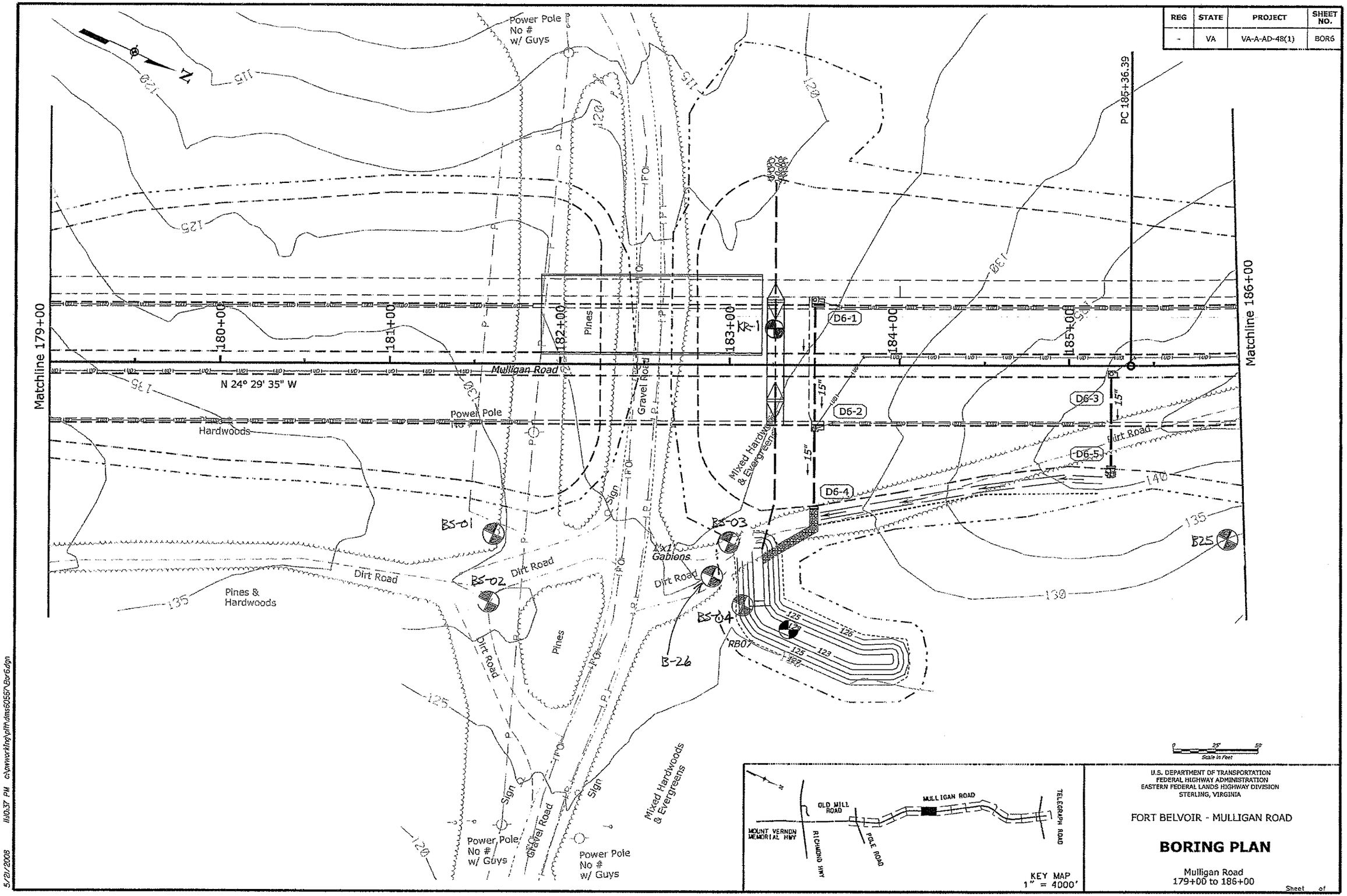
-	VA	VA-A-AD-48(1)	BOR6



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
179+00 to 186+00

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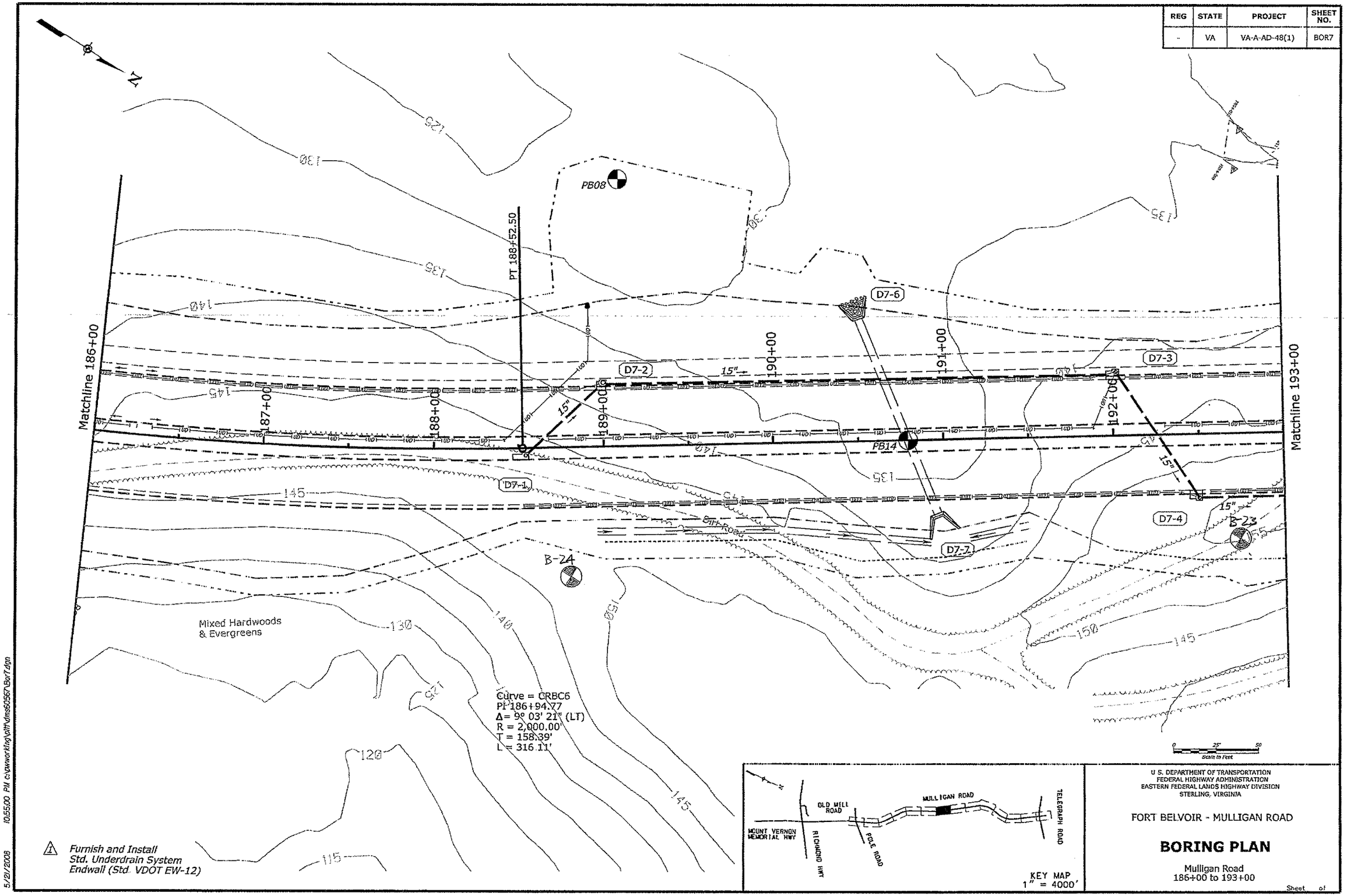
-	VA	VA-A-AD-48(1)	BOR7



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
186+00 to 193+00

Sheet of

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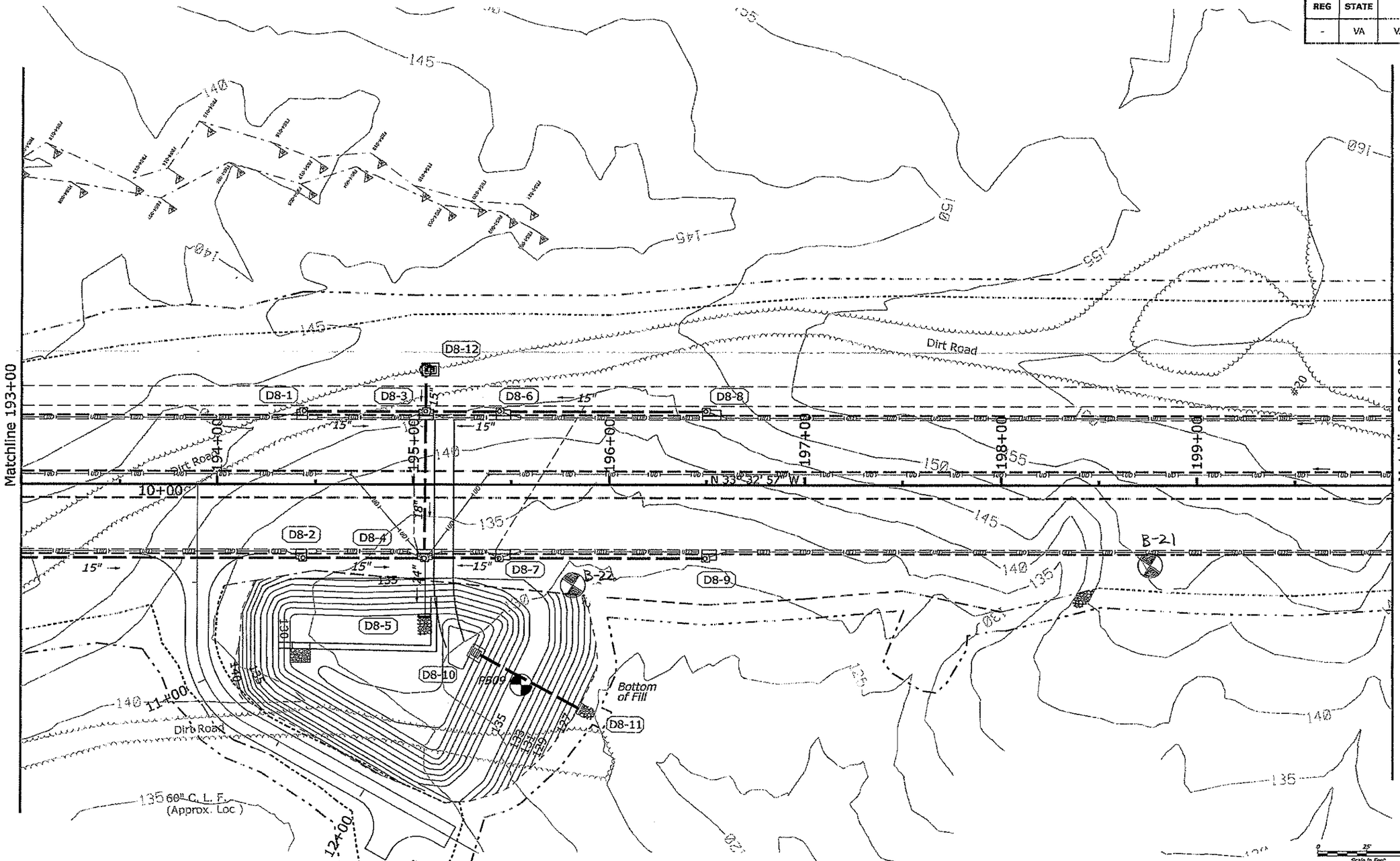
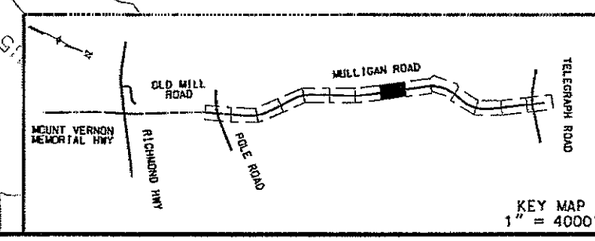
REG	STATE	PROJECT	SHEET NO.
-	VA	VA-A-AD-48(1)	BORS





KEY MAP
1" = 4000'

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
193+00 to 200+00

Sheet of

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REG	STATE	PROJECT	SHEET NO.
-	VA	VA-A-AD-48(1)	BOR9

Matchline 200+00

Matchline 207+00

201+00

202+00

203+00

204+00

205+00

206+00

Mixed Hardwoods & Evergreens

Conc. & Steel Bunker

CD-1 Reqd.

D9-1

D9-2

D9-3

B-20A

B-20B

B-19

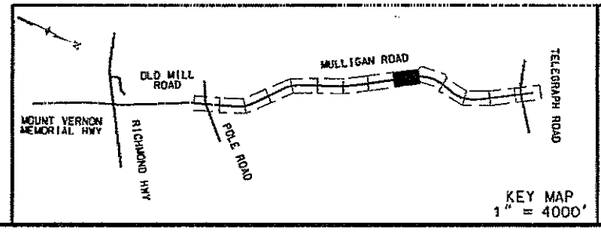
15"

TS 205+39.04

SC 206+74.04

Spiral = CRBSC7B
PI 206+29.06
θs = 4° 04' 16"
Ls = 135.00'

Scale in Feet



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
200+00 to 207+00

Sheet of

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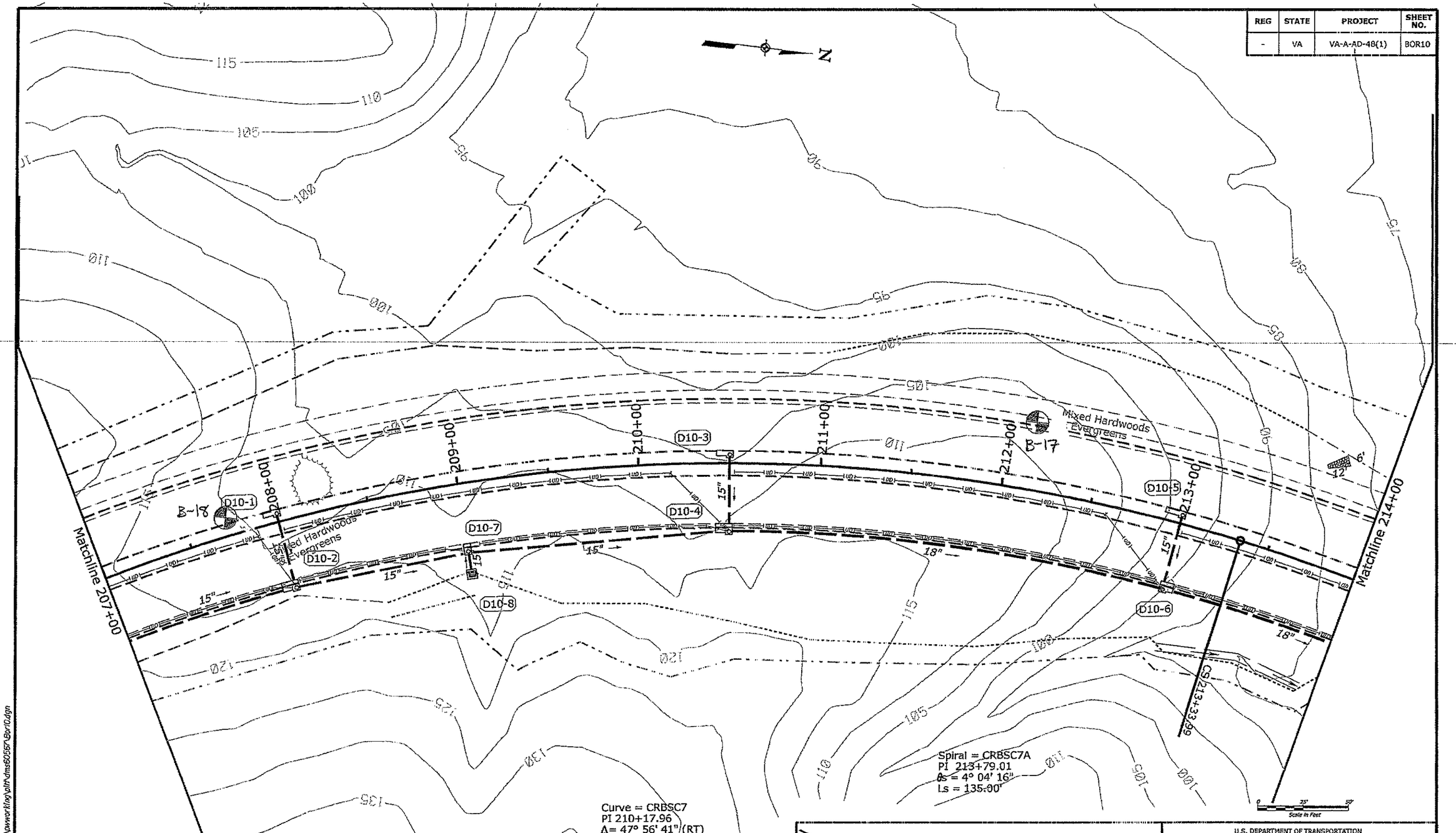
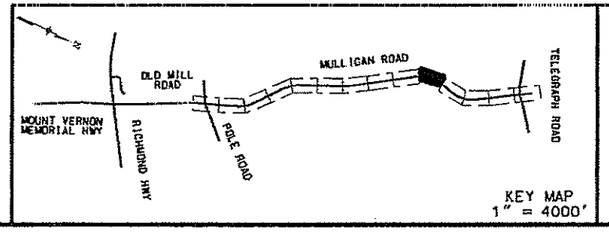
-	VA	VA-A-AD-48(1)	BOR10





KEY MAP
1" = 4000'

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
207+00 to 214+00

Sheet of

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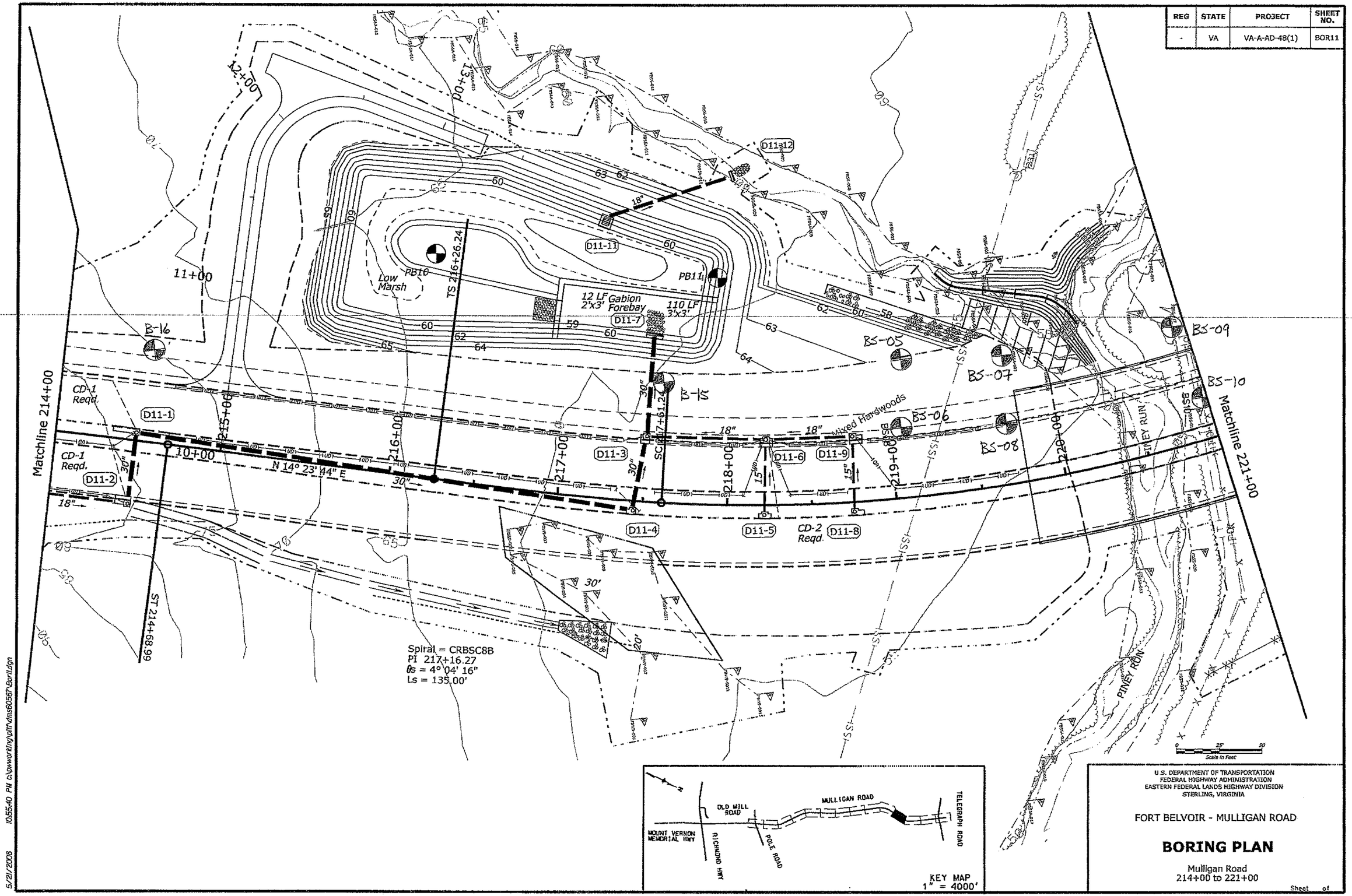
-	VA	VA-A-AD-48(1)	BOR11



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
214+00 to 221+00

Sheet of

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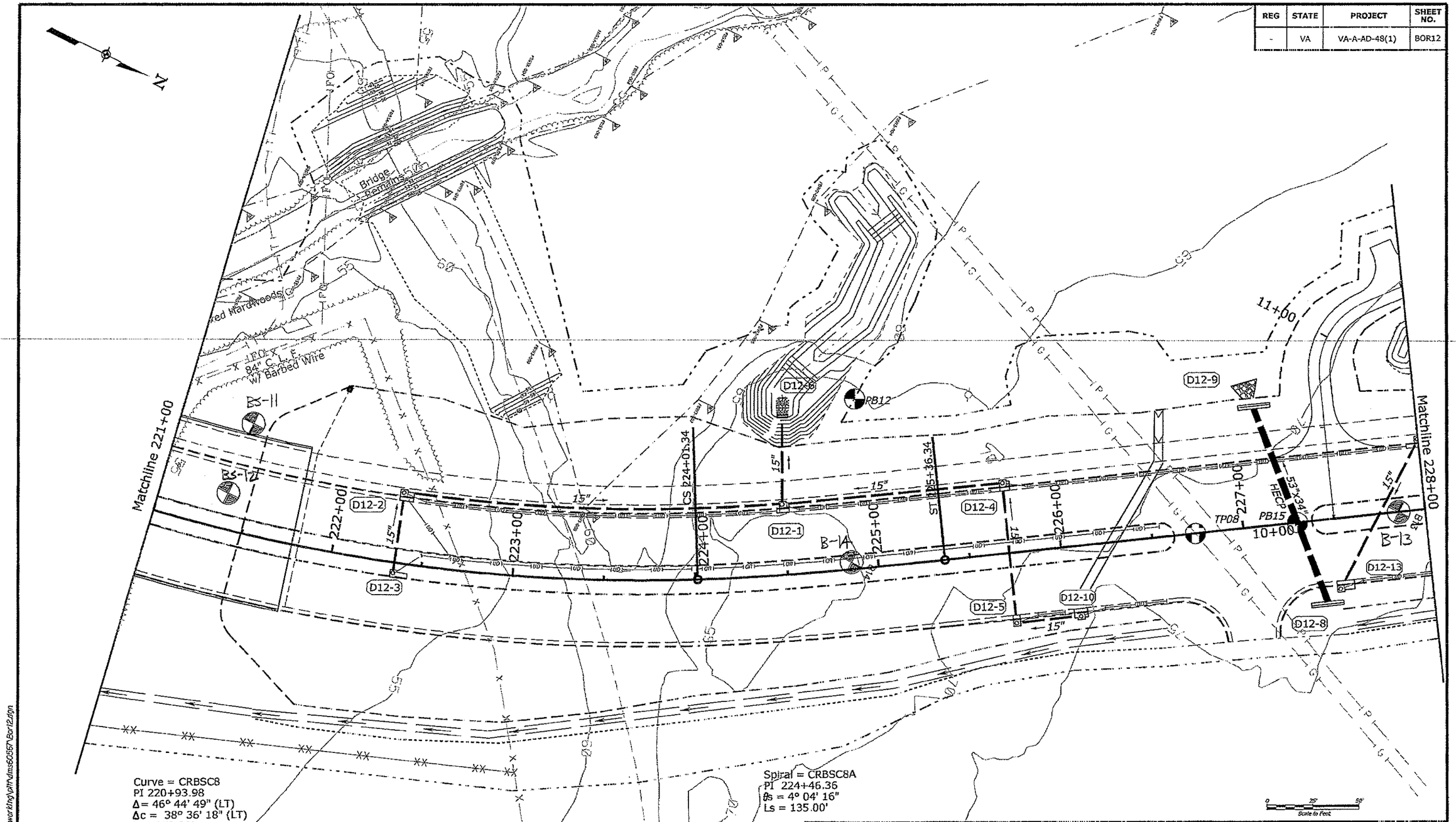
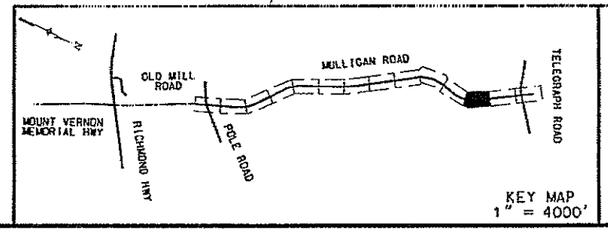
-	VA	VA-A-AD-48(1)	BOR12



1 Furnish and Install
Std. Underdrain System
Endwall (Std. VDOT EW-12)



KEY MAP
1" = 4000'

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
221+00 to 228+00

Sheet of

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REG	STATE	PROJECT	SHEET NO.
-	VA	VA-A-AD-48(1)	BOR13

PINEY RUN

Approximate Limits of Wetlands

Future Shared Use Path

Limits of Disturbance

Construction Limits

D13-4 PB13

D13-2

D13-3

Matchline 228+00

Matchline 235+00

Mixed Hardwoods & Evergreens

229+00 230+00 231+00 232+00 233+00 234+00

B-11

B-12

N 32° 21' 05" W

Mulligan Road

PB16

End full width grading 234+50

Mulligan Road Construction Centerline

Future Roadway

D13-5

D13-1

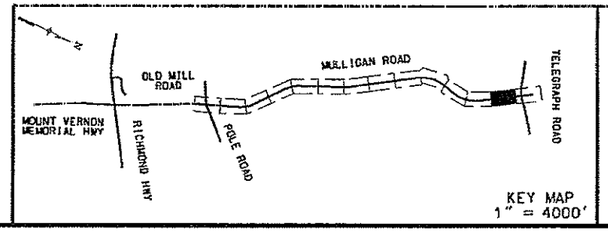
D13-6

Construction Limits

Limits of Disturbance

Construction Limits

Scale in Feet



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
228+00 to 235+00

Sheet of

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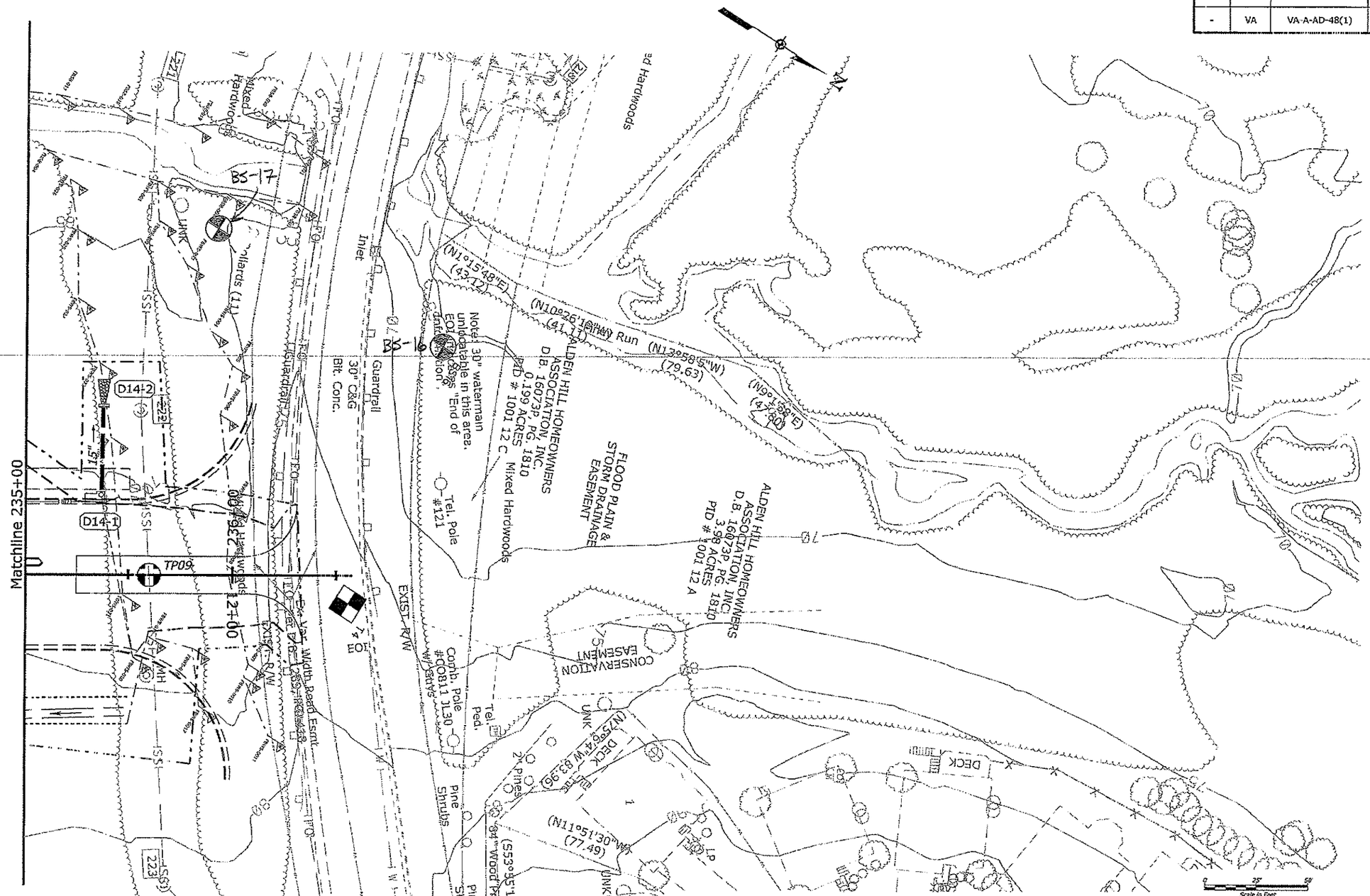

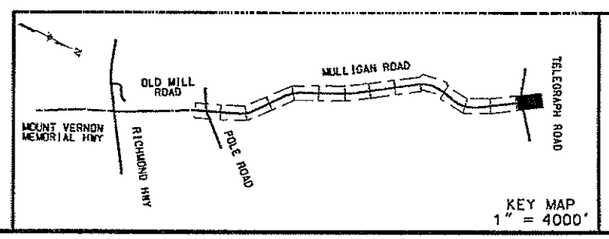

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FORT BELVOIR - MULLIGAN ROAD

BORING PLAN

Mulligan Road
235+00 to 236+57.67

Sheet of

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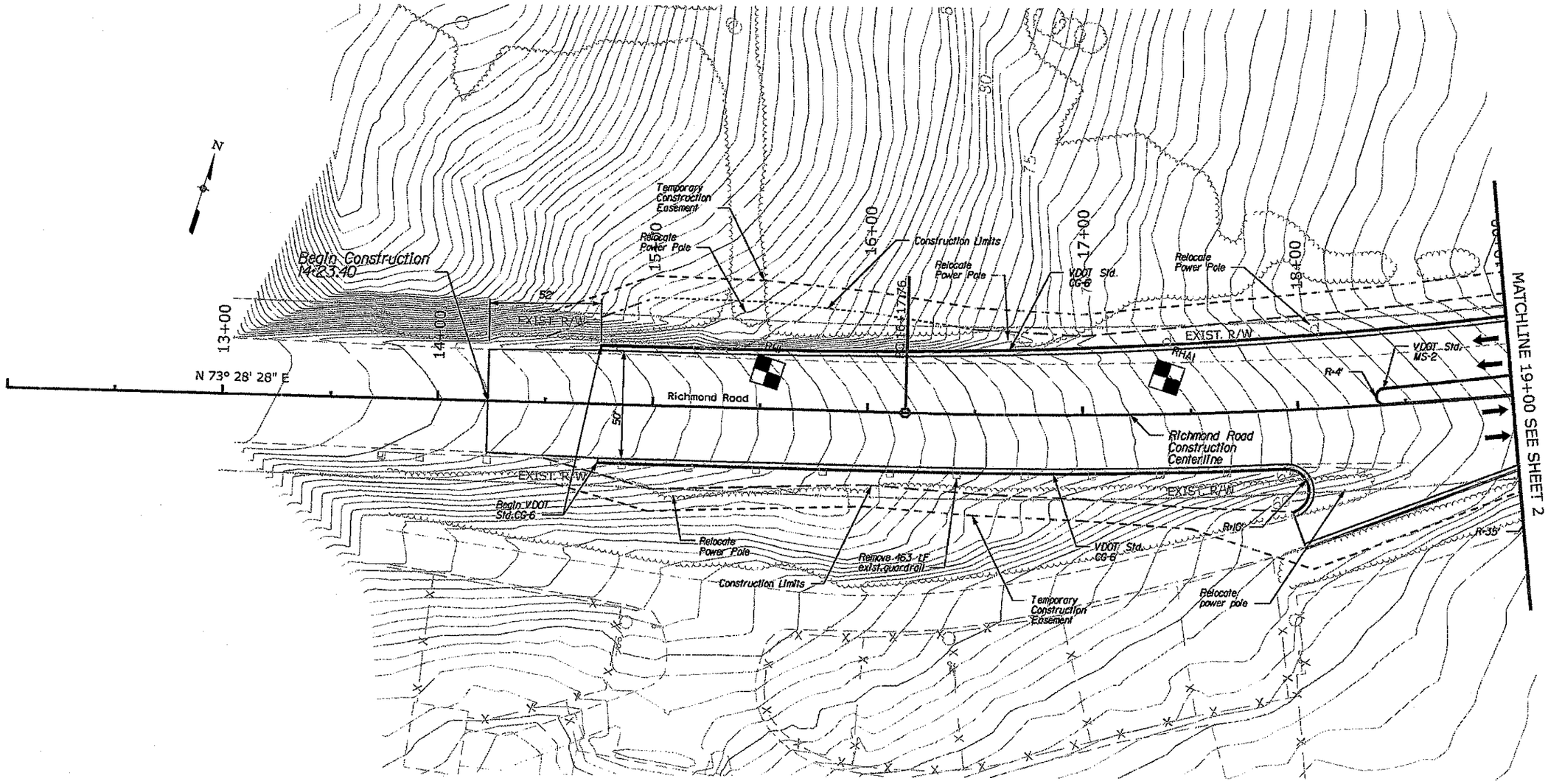
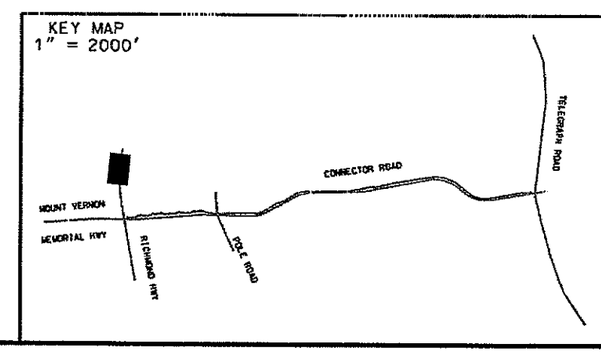




0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

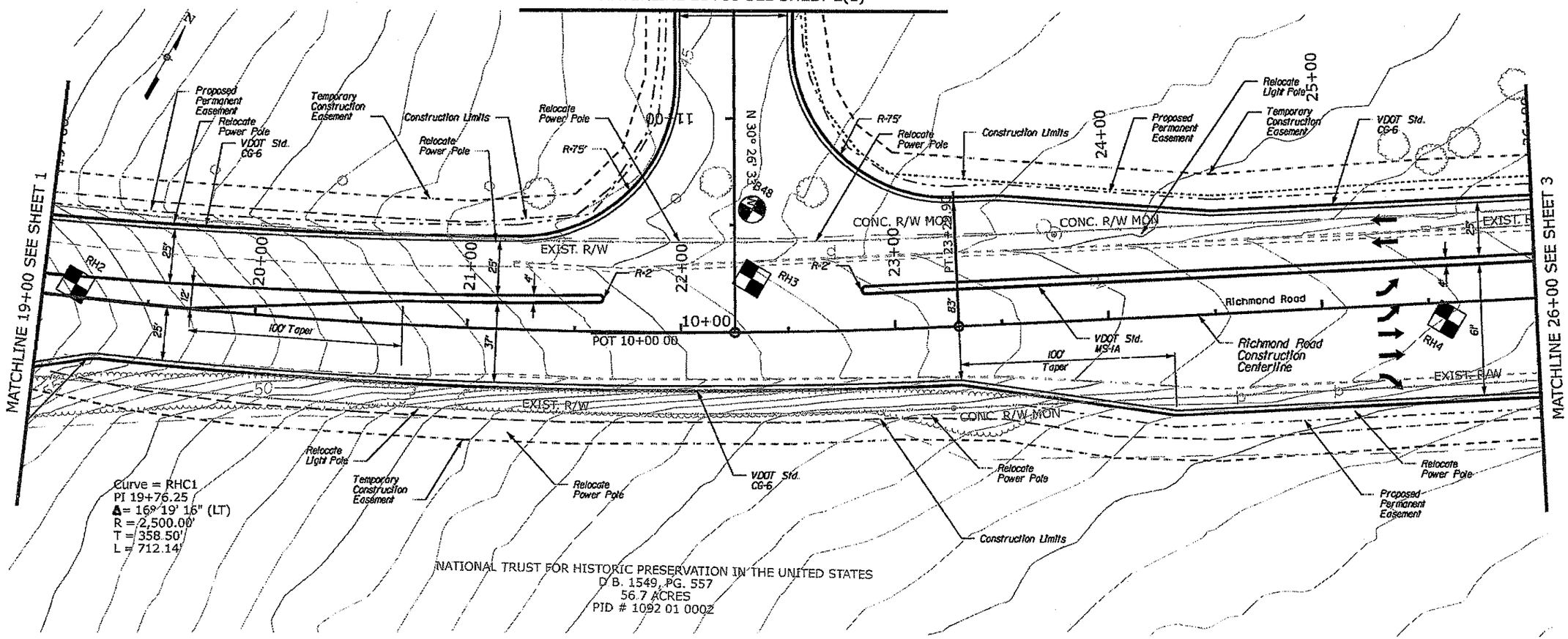
PLAN SHEET

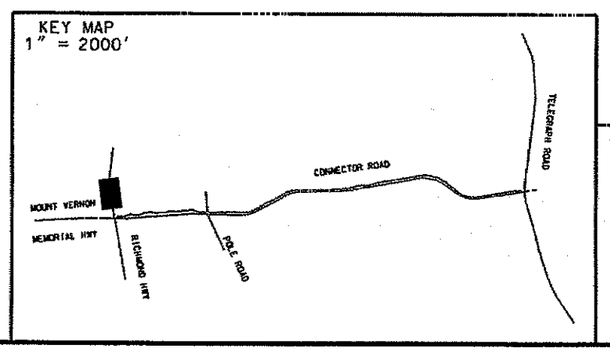
Richmond Road
14+23.98 TO 19+00

6/18/2007 12:44:12 PM C:\Pltworking\PITT\dms50567\Plansheet1.dgn

REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	2

MATCHLINE 11+50 SEE SHEET 2(1)





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET
Richmond Road
19+00 TO 26+00

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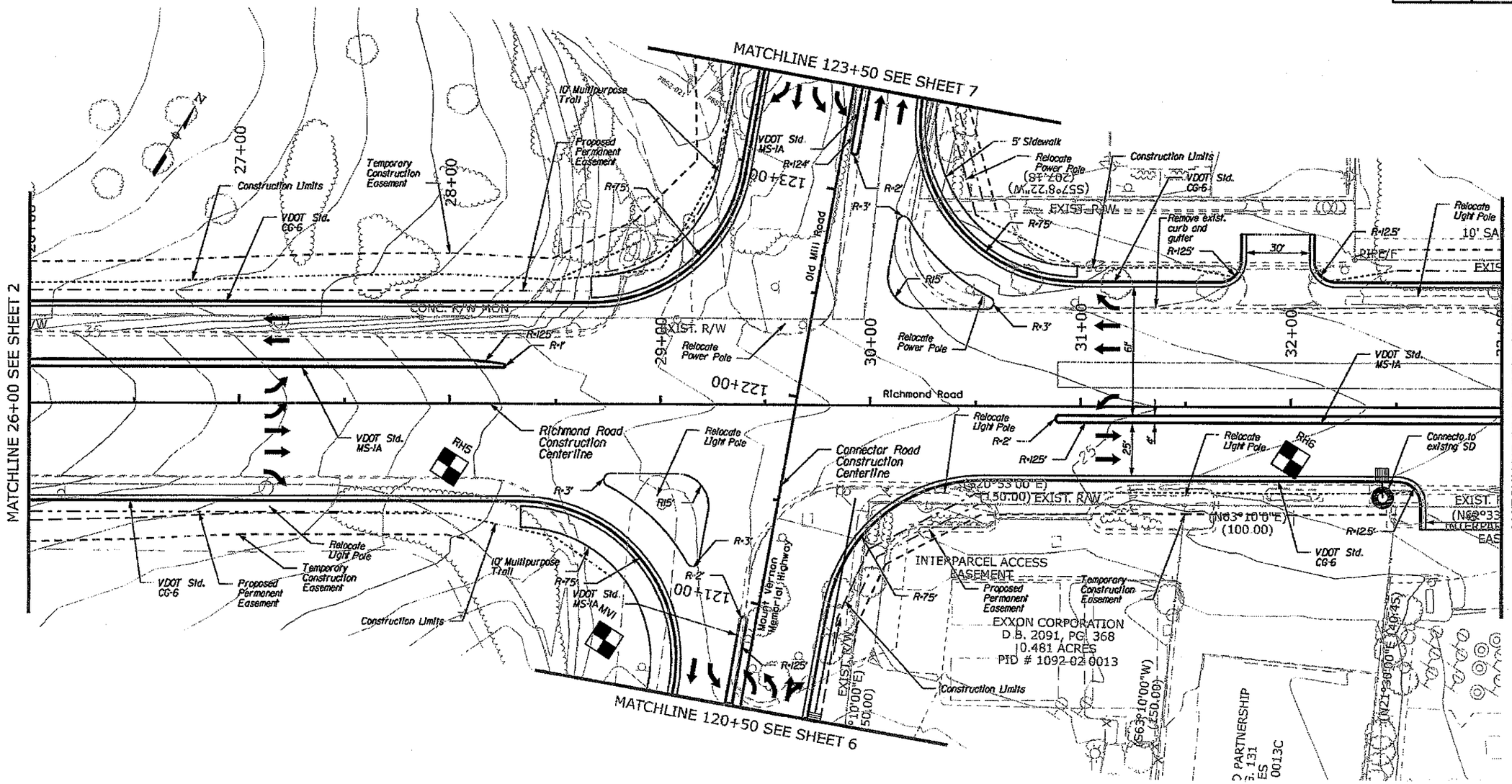
REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	3



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Richmond Road
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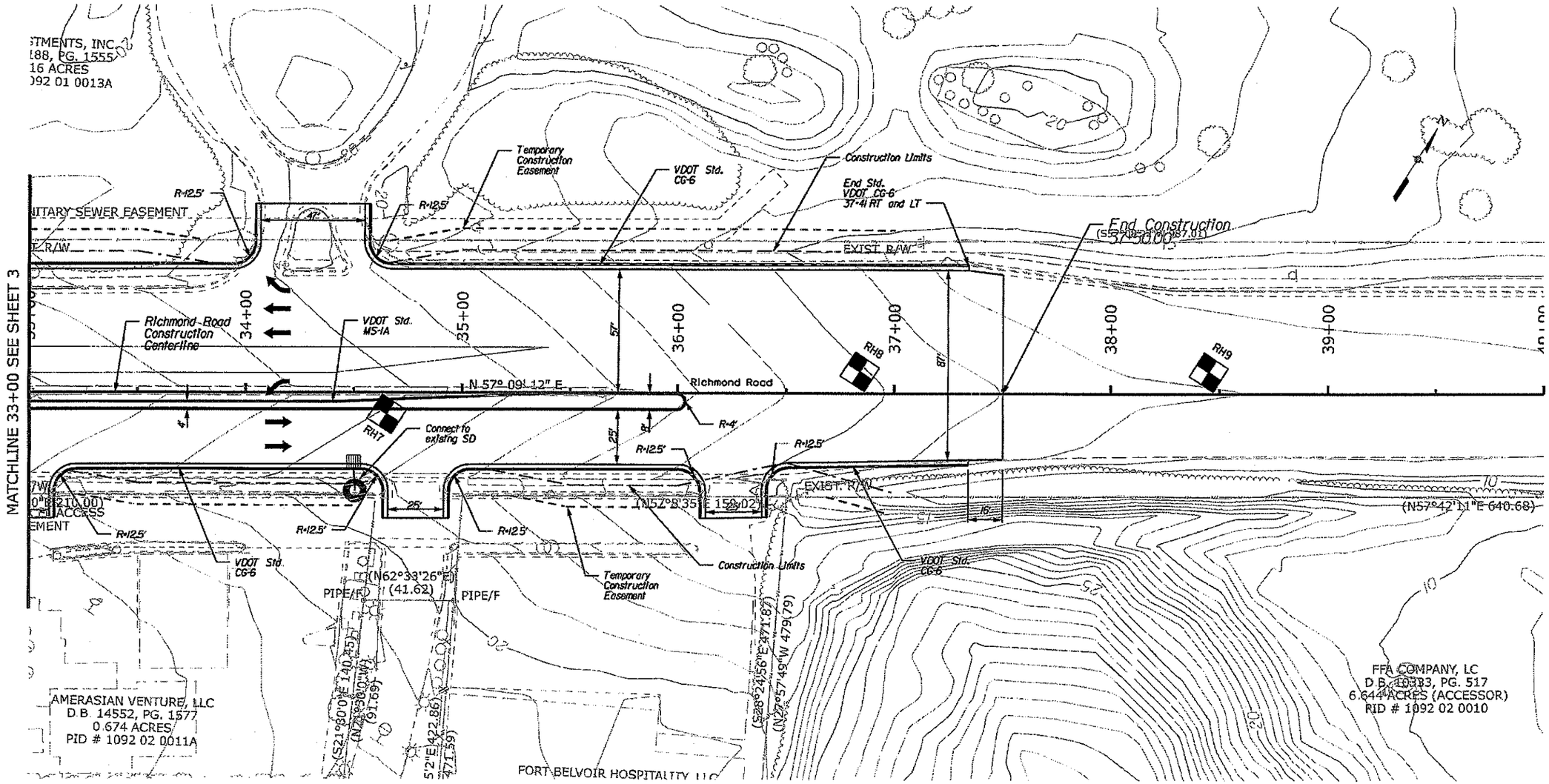
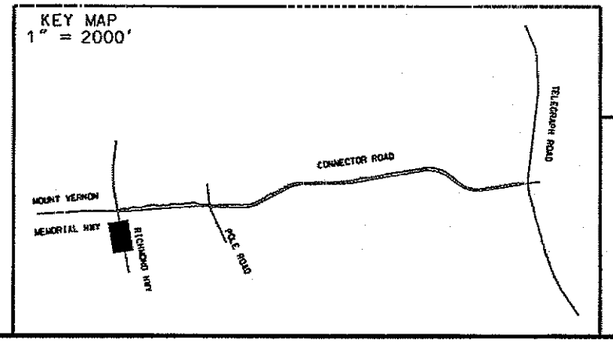
	VA	VA-A-AD-48(1)	4





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Richmond Road
33+00 TO 37+50

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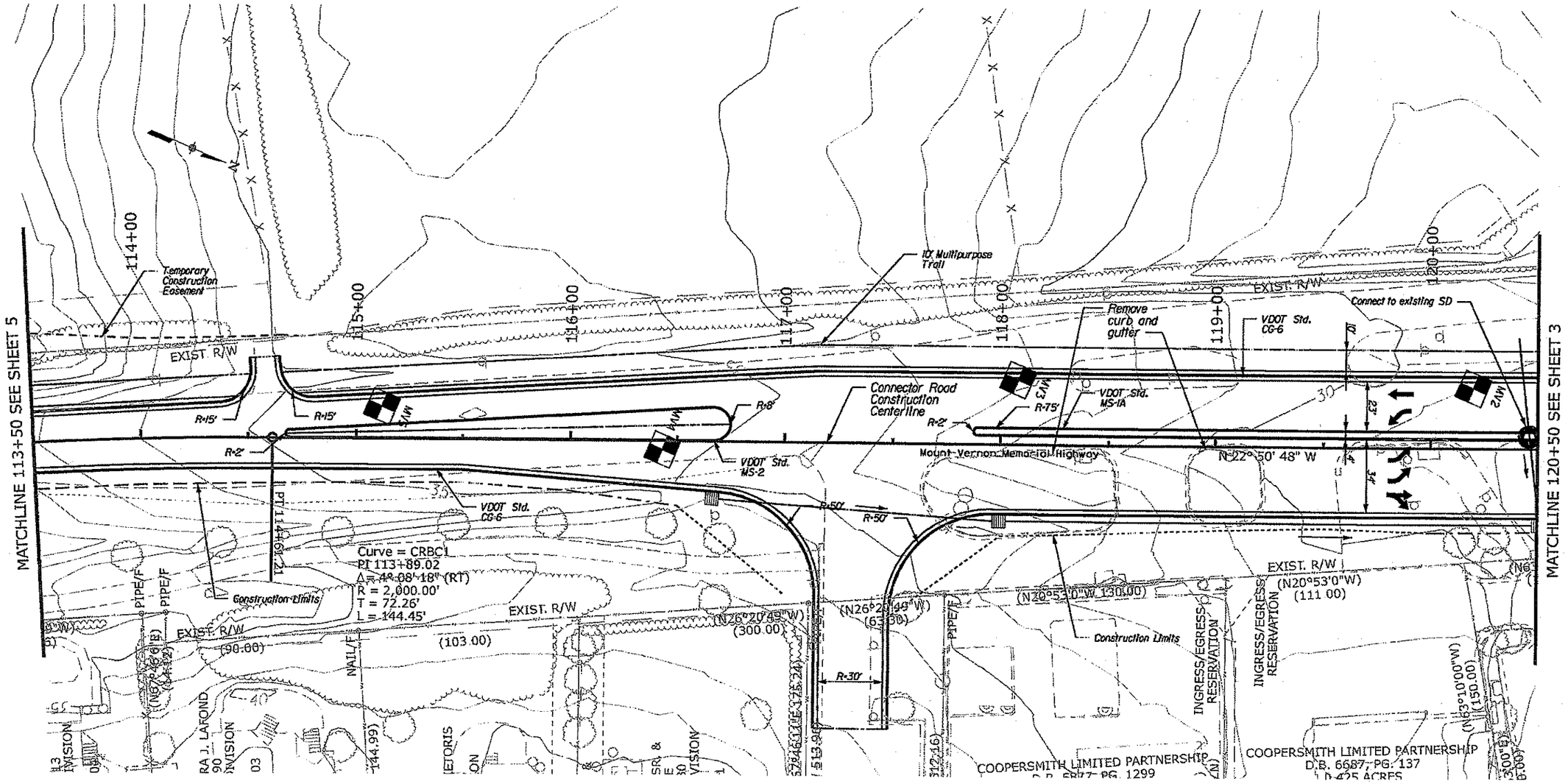
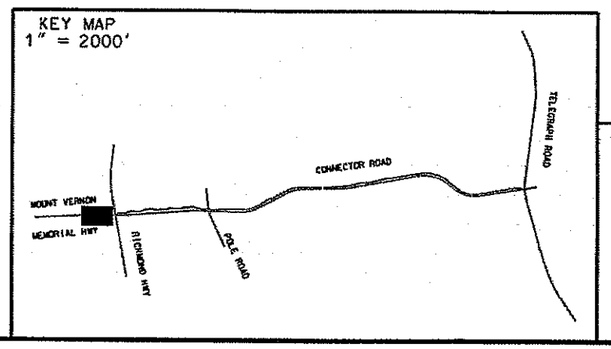
	VA	VA-A-AD-48(1)	6





0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Connector Road
113+50 TO 120+50

6/18/2007 12:44:40 PM C:\PWworking\PITT\dms60567\Plansheet6.dgn

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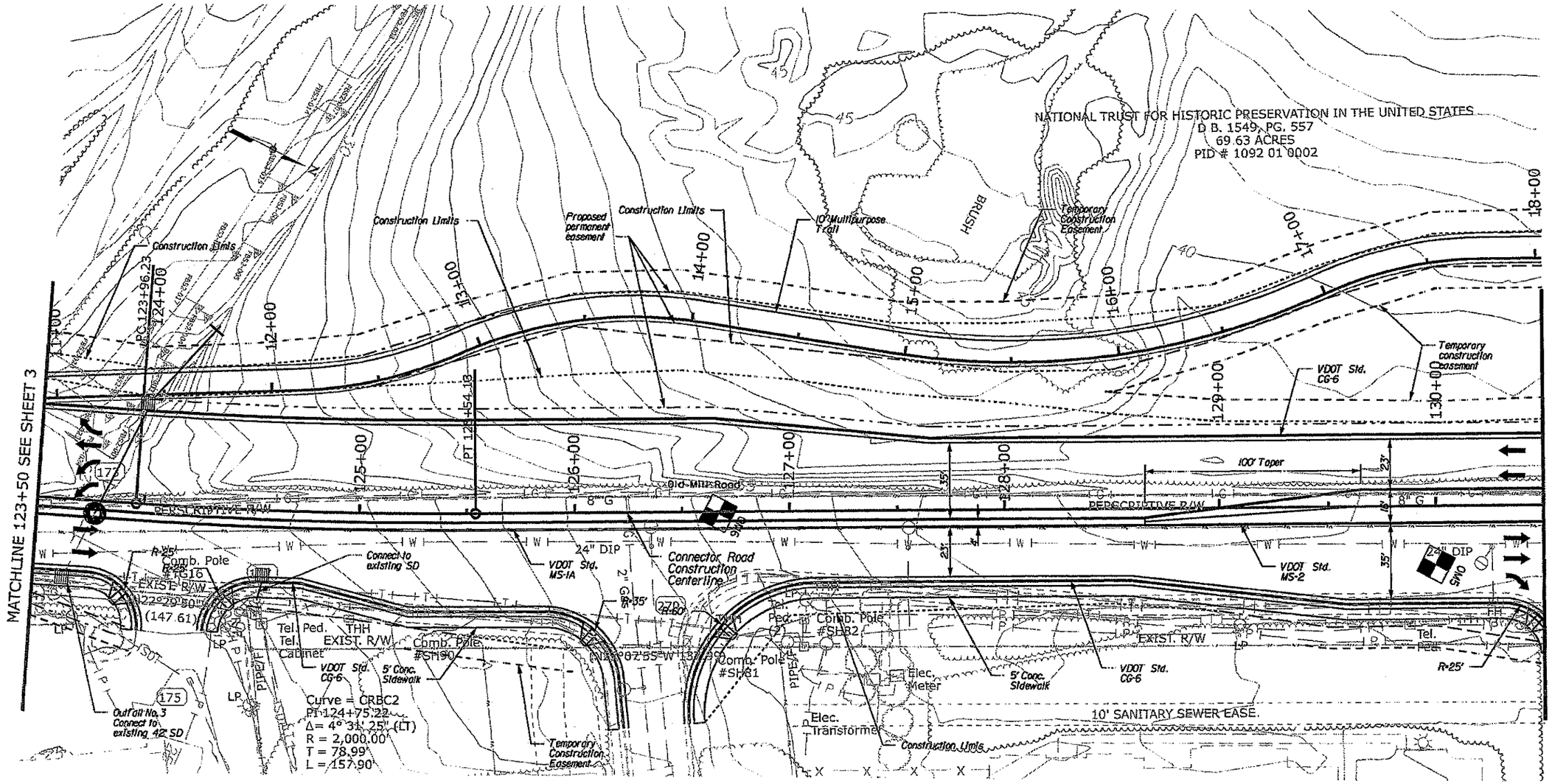

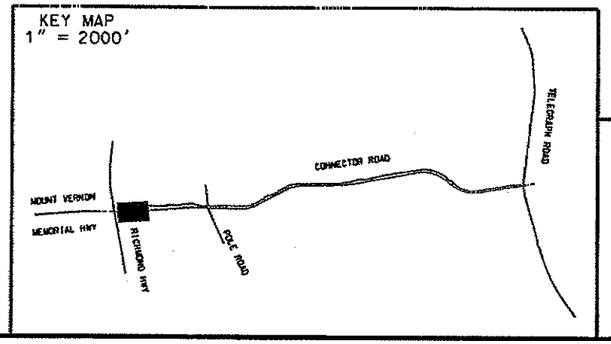

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Connector Road
123+50 TO 130+50

6/18/2007 12:51:55 PM C:\PWworking\PITT\dmorris\dms60567\Plansheet7.dgn

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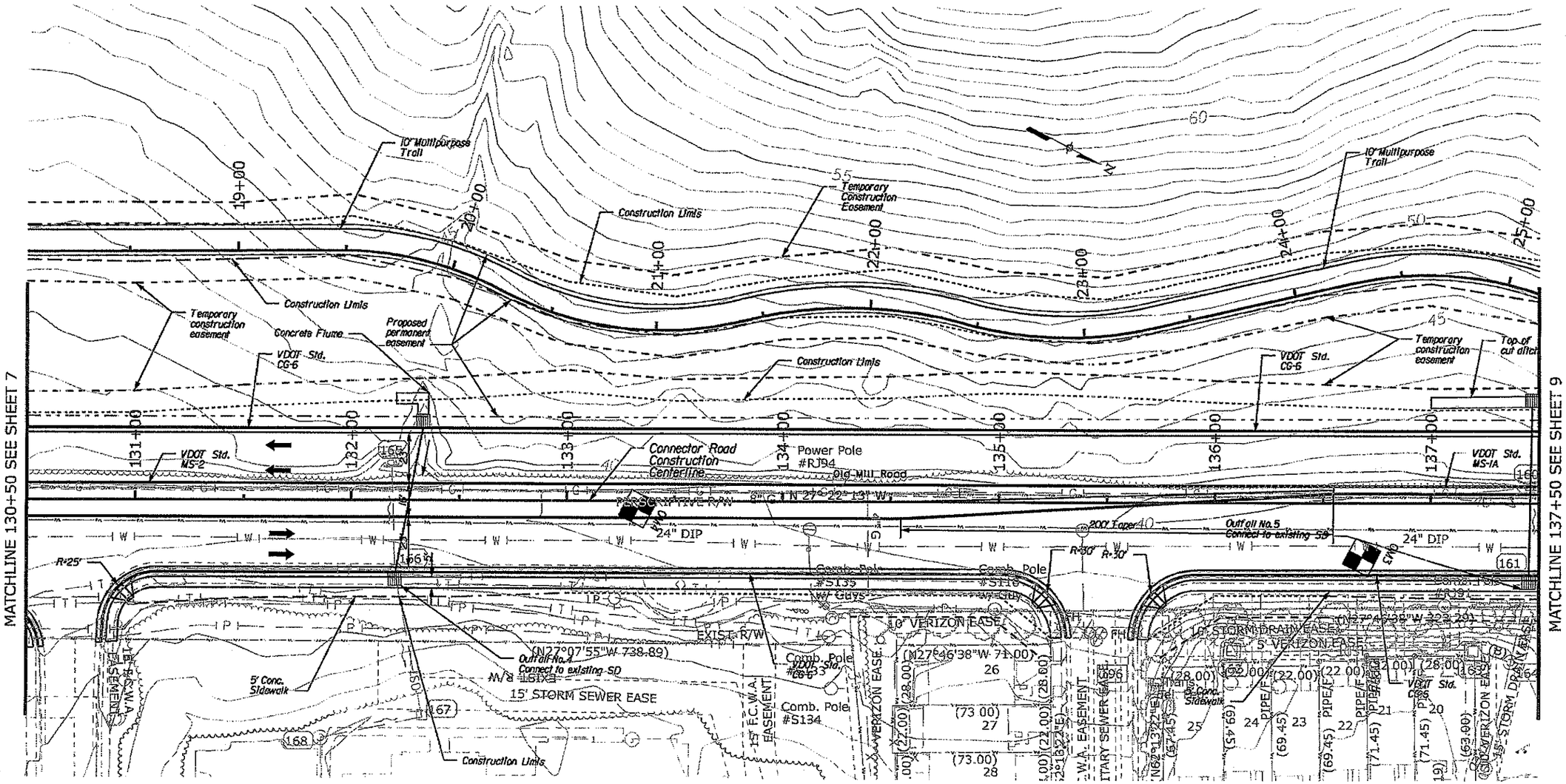
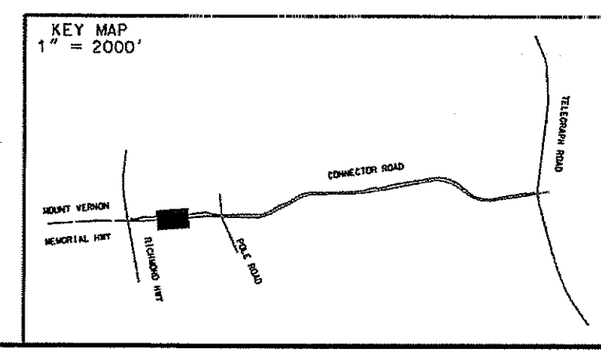
	VA	VA-A-AD-48(1)	8





0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Connector Road
130+50 TO 137+50

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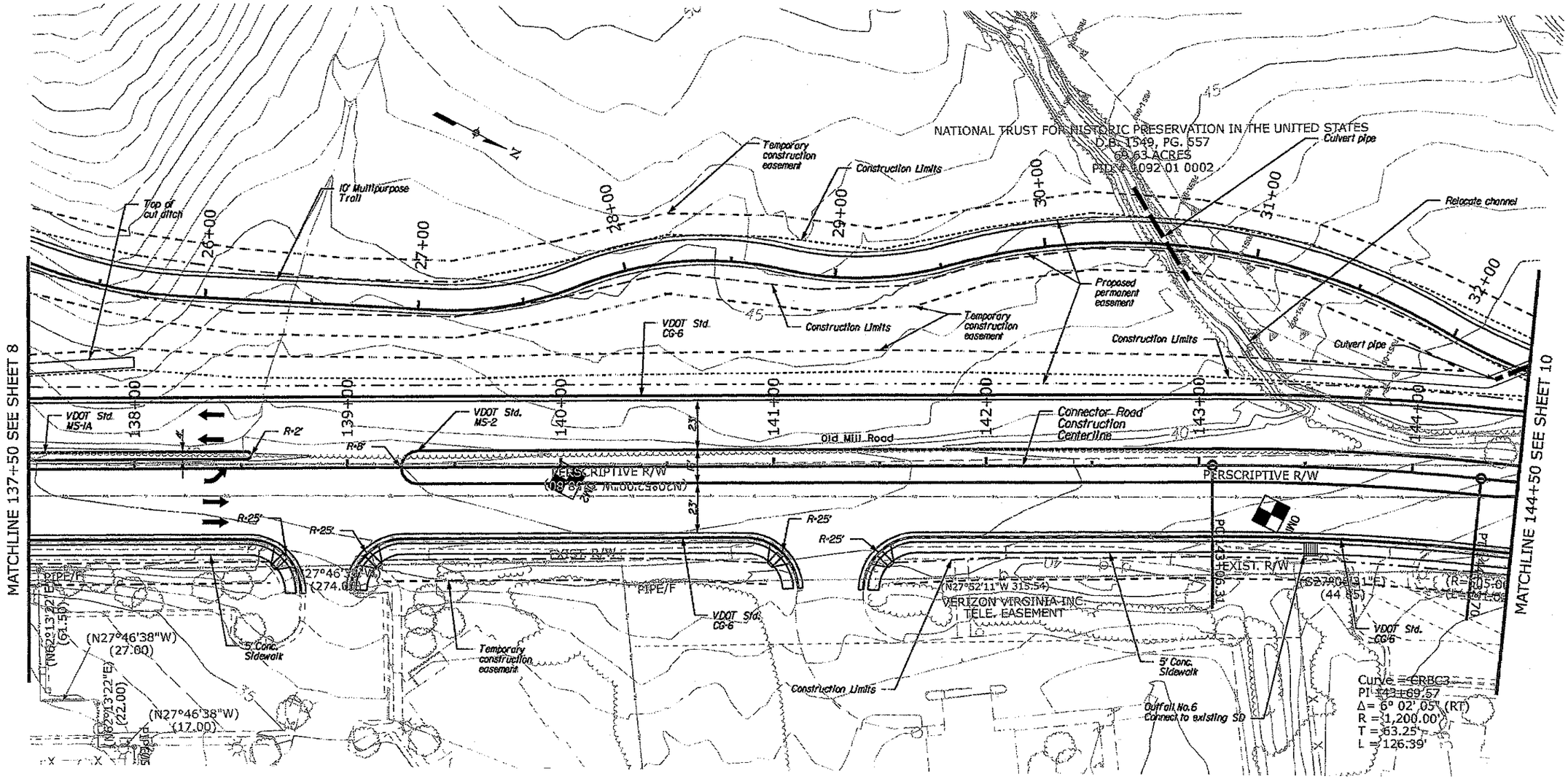
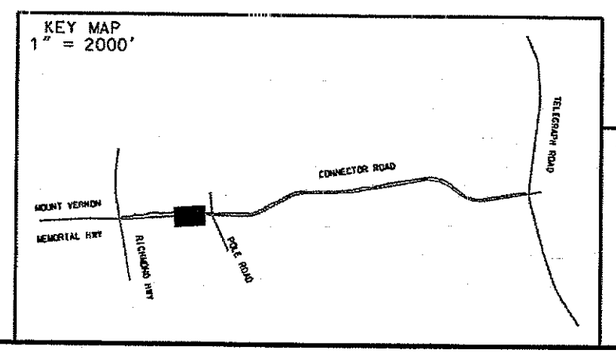
REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	9





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

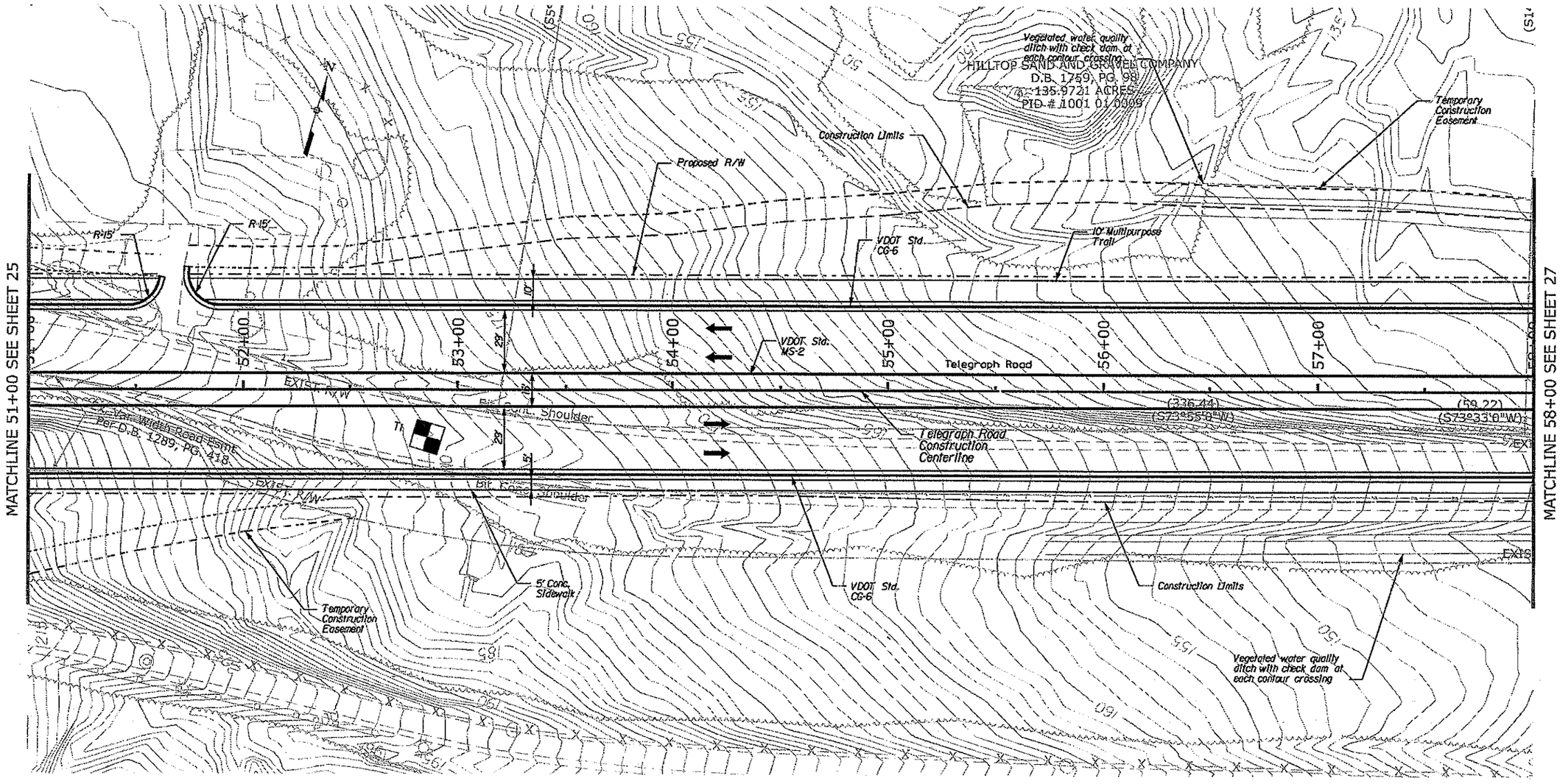
RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

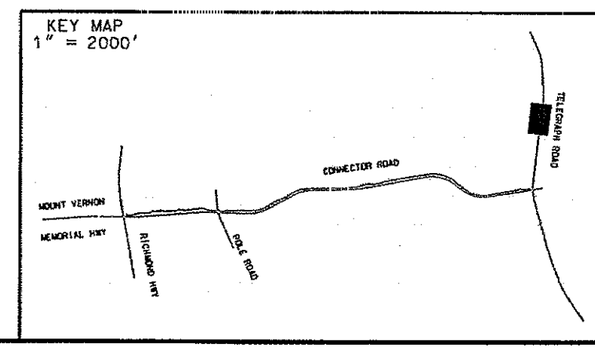
PLAN SHEET

Connector Road
137+50 TO 144+50

6/18/2007 12:44:53 PM G:\PWworking\FITT\dms60567\Plansheet9.dgn

REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	26





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

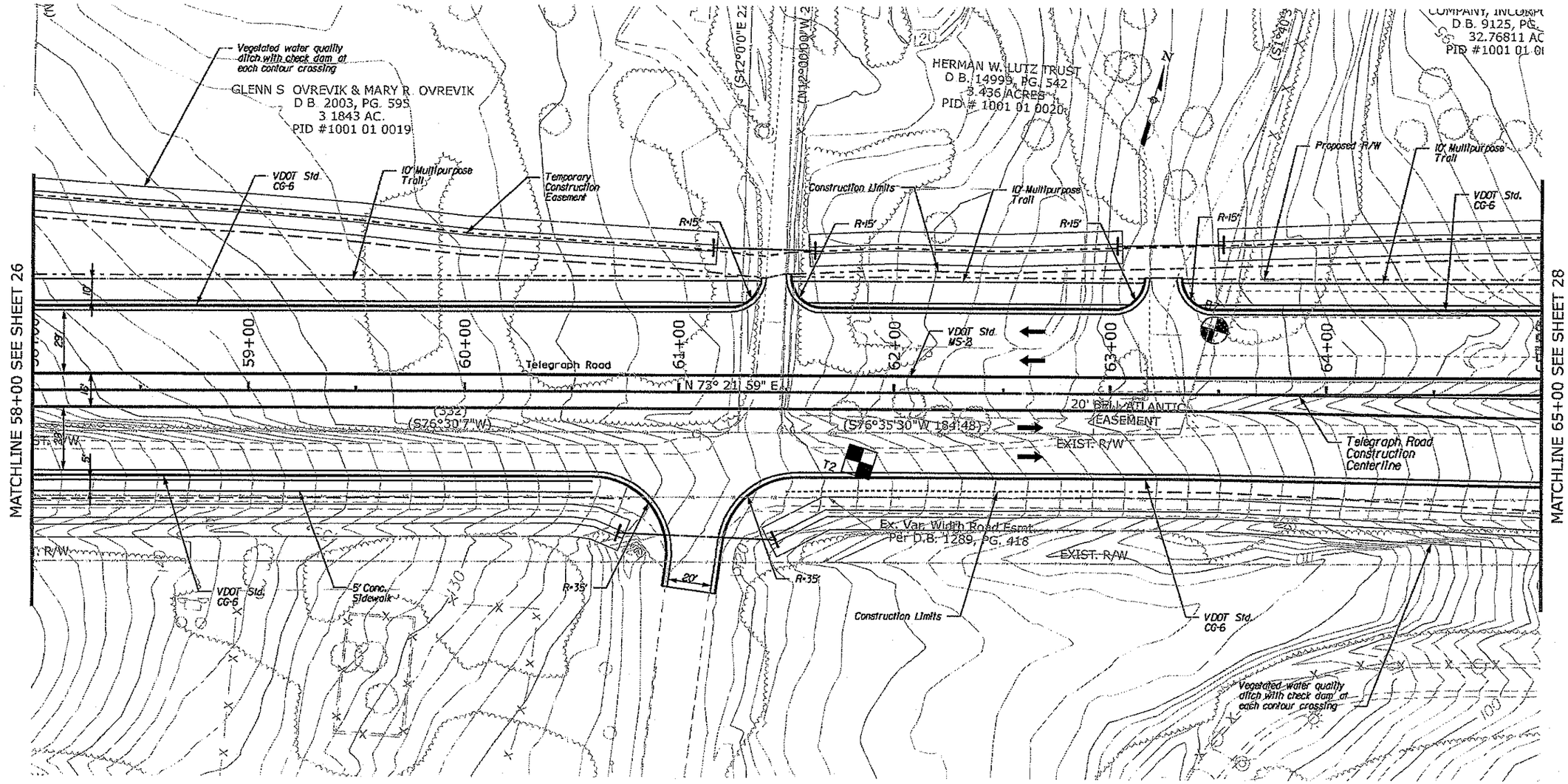
RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

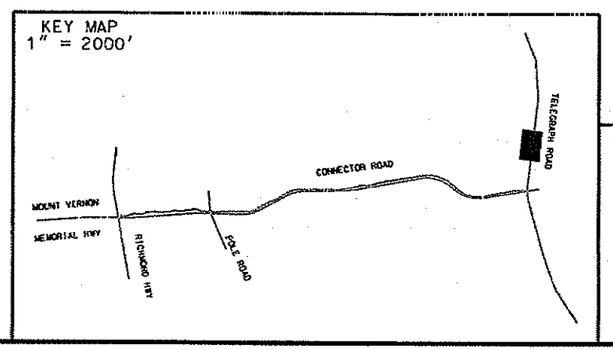
PLAN SHEET

Telegraph Road
51+00 TO 58+00

6/18/2007 12:45:06 PM C:\PWworking\PITT\dms50567\Plan_25.dgn

REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	27





0 25 50
SCALE IN FEET

U S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

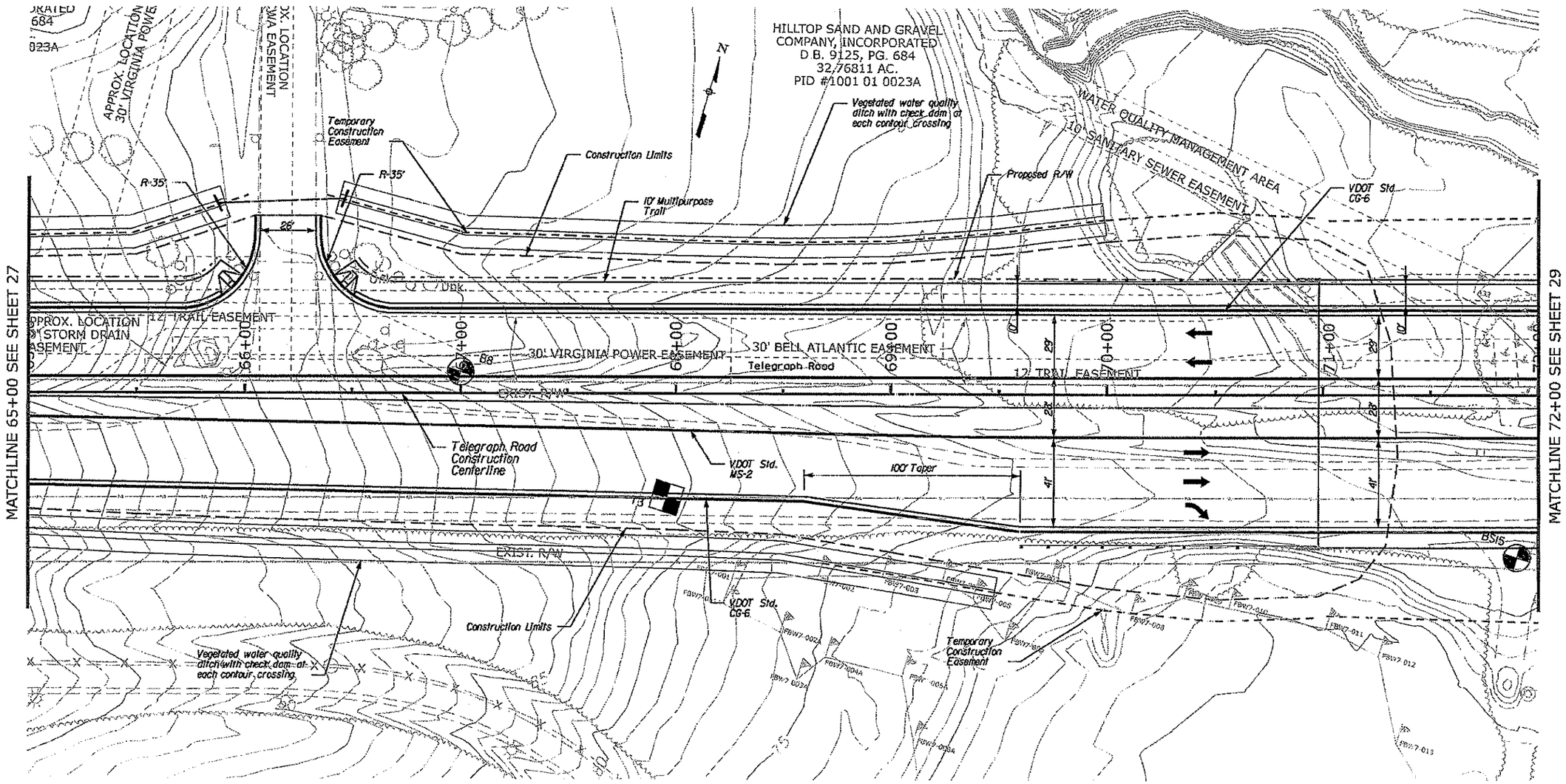
RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

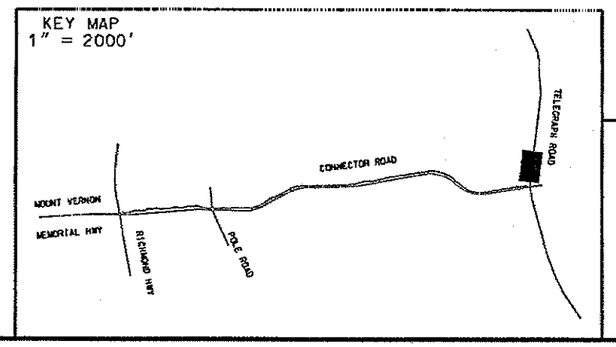
PLAN SHEET

Telegraph Road
58+00 TO 65+00

6/18/2007 12:43:55 PM C:\PWworking\FITT\dms60255\27.dgn

REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	28





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
65+00 TO 72+00

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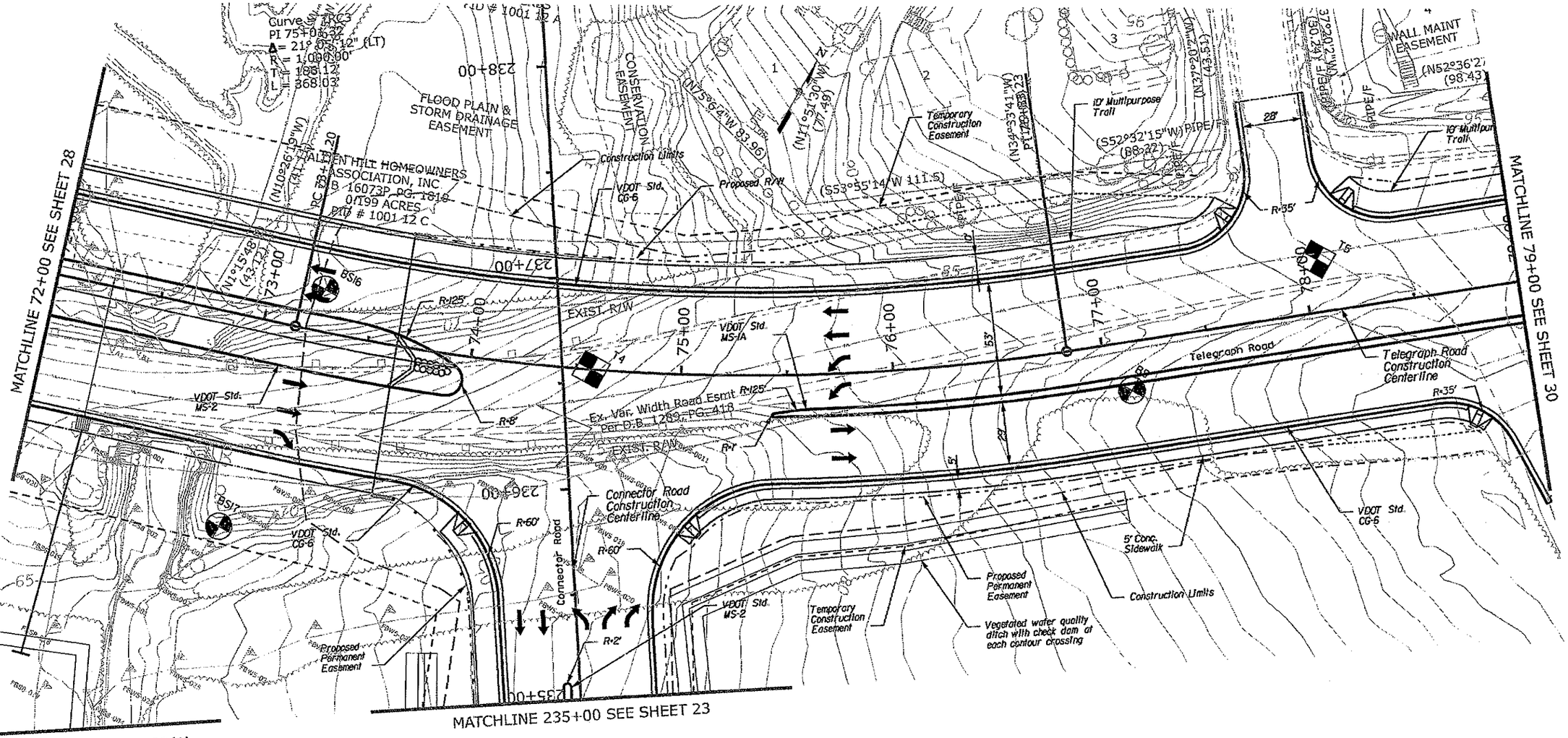
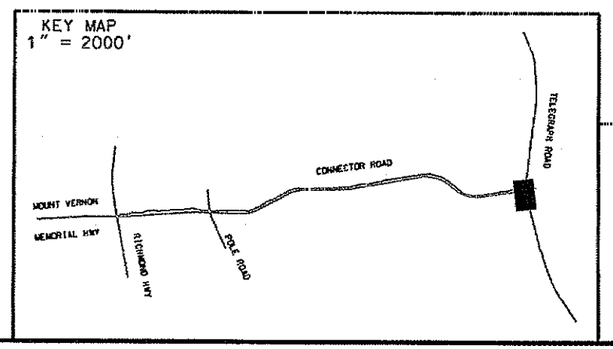
REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	29





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
72+00 TO 79+00

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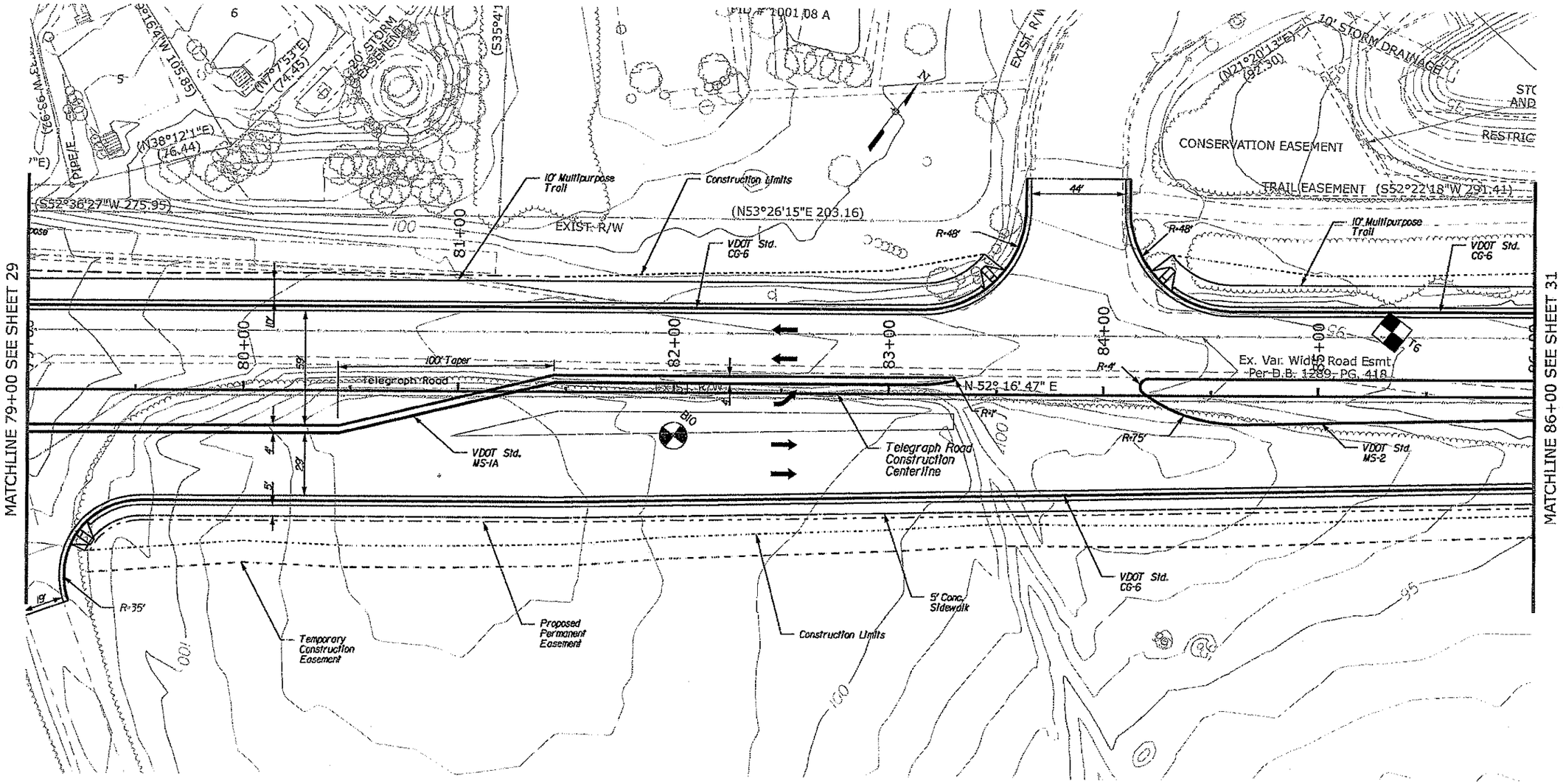
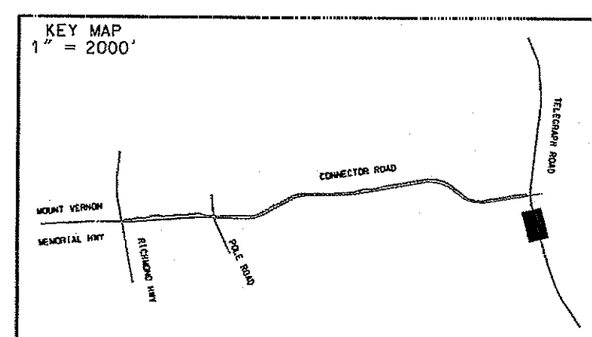
REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	30





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
79+00 TO 86+00

6/18/2007 12:56:03 PM C:\PWworking\PITT\dms60567\Plan_30.dgn

APPENDIX C
TEST BORING LOGS

PAVEMENT BORINGS

BORING RH1 - STA. 15+53 - RTWB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/19/07 - 4/19/07

DRILLING METHOD(S):
4' Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 82.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		X							8.5" Asphaltic Concrete (2" SM, 6.5" BM)
		X							6" Concrete to Rebar (Rebar at 1.2 feet)
		X							Boring Terminated at 1.2 Bit destroyed due to concrete and rebar

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RHA1 - STA. 17+39 - RT WB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/19/07 - 4/19/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION:

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									7" Asphaltic Concrete (4" SM, 3" BM)
									8" Concrete
			N = 8 REC = 60	25	57	19	38		Very Moist, Gray and Brown Fine Grained Sandy CLAY (CH); medium stiff
			N = 16 REC = 40						Wet, Red and Brown Silty SAND, trace gravel (sm); medium dense
	5								Boring Terminated at 5 2 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RH2 - STA. 19+15 - LTWB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/20/07 - 4/20/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 56.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									5" Asphaltic Concrete (5" SM)
									8 5" Concrete
									Very moist, Gray Silty CLAY (cl); stiff
			N = 11 REC = 60						
									Very moist to wet, Clayey SILT (ml); stiff
			N = 14 REC = 55						
	5								Boring Terminated at 5.2 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

BORING RH3 - STA. 22+33 - RT WB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/19/07 - 4/19/07

DRILLING METHOD(S):
4' Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 43.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									14" Asphaltic Concrete (3" SM, 11" BM)
									Aggregate Base
			N = 14						Very moist, Gray and Brown Sandy SILT (ml); stiff
			N = 16						Very moist, Brown and Orange Coarse Grained SAND (sw); medium dense
	5								Boring Terminated at 5.3 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RH4 - STA. 25+58 - LT EB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/20/07 - 4/20/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 36.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									7.5" Asphaltic Concrete (3.5" SM, 4" IM)
									7" Concrete
									Aggregate Base / Silty SAND (SM); medium dense
			N = 22 REC = 65	12	NP	NP	NP		Very moist, Gray Silty SAND (sm); medium dense
			N = 36 REC = 80						Very moist, Brown Sandy SILT, trace Clay (ml); hard
	5								Boring Terminated at 5.5 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RH5 - STA. 28+00 - RT EB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/20/07 - 4/20/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 30.4

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									9" Asphaltic Concrete (5.5" SM, 3.5" BM)
									8" Concrete
			N = 11 REC = 90	23	32	23	9		Very moist, Brown and Gray Lean CLAY with sand (CL); medium stiff
			N = 15 REC = 65						Very moist, Gray (trace brown) Fine Grained Sandy SILT (ml); very stiff
	5								Boring Terminated at 5.4 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RH6 - STA. 32+00 - RT EB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648.6630
804 648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/20/07 - 4/20/07

DRILLING METHOD(S):
4' Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 23.3

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									6.5" Asphaltic Concrete (6.5" SM)
									7" Aggregate Base
			N = 19 REC = 65						Moist, Red Brown Silty CLAY (cl); very stiff
			N = 8 REC = 55						Very moist, Clayey SILT, trace fine grained sand (ml); soft
									Boring Terminated at 5.5 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RH7 - STA. 34+65 - LT EB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/20/07 - 4/20/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 21.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									9" Asphaltic Concrete (4.5" SM, 2.5 IM, 2" BM)
									7" Concrete
									3" Aggregate Base
			N = 14 REC = 85	11	NP	NP	NP		Very moist, Tan Fine Grained Silty SAND (SM) medium dense
			N = 6 REC = 70						
	5								
									Boring Terminated at 5.3 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNN.01 7/25/07

BORING RH8 - STA. 36+84 - LT WB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/20/07 - 4/20/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 14.8

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8" Asphaltic Concrete (5" SM, 3" BM)
									8.5" Concrete
			N = 14 REC = 55	14	22	14	8		Moist, Brown and Tan Clayey SAND with gravel (SC); medium dense
	5		N = 54 REC = 100						Very moist, Brown and Tan Silty SAND, some gravel (sm); very dense
									Boring Terminated at 5.4 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RH9 - STA. 38+45 - LTWB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/19/07 - 4/19/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 11.7

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									11" Asphaltic Concrete (4.5" SM, 6.5" BM)
									5" Aggregate Base
			N = 13 REC = 65						Very moist, Brown and Gray Silty, Sandy CLAY (cl); stiff
			N = 7 REC = 80						Very moist, Brown and Gray Clayey, Silty SAND (sm); loose
									Boring Terminated at 4.9

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING RH10 - STA. 40+44 - RTWB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/18/07 - 4/20/07

DRILLING METHOD(S):
4' Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 11.4

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									10 5" Asphaltic Concrete (3.5" SM, 7" BM)
									10" Concrete
			N = 8 REC = 70	17	34	18	16		Moist, Gray Sandy Lean CLAY (CL); medium stiff
	5		N = 12 REC = 90						Very moist, Gray Silty SAND (sm); medium dense
									Boring Terminated at 5.7 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING MV1 - STA. 120+70 - CL SB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4 Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 29.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8" Asphaltic Concrete (6" IM, 1" Slurry, 1" old asphalt)
									Aggregate Base / Clayey SAND with gravel (SC)
			N = 42 REC = 35	11	26	15	11		Moist, Tan and Brown Clayey Fine Grained SAND (sc); dense
			N = 12 REC = 35						Very moist Tan and Brown Silty CLAY (cl), stiff
									Boring Terminated at 4.7 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING MV2 - STA. 120+20 - LT NB Lane

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/18/07 - 4/18/07

DRILLING METHOD(S):
4 Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 29.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8" Asphaltic Concrete (4.5" SM, 3.5 IM)
									2" Aggregate Base
			N = 12 REC = 40						Wet, Gray and Brown Silty CLAY, some sand (cl); stiff
			N = 9 REC = 75						Very moist Gray SILT, trace Sand (ml); stiff
									Boring Terminated at 4.7 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING MV3 - STA. 118+08 - Gore Area

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 33.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8.5" Asphaltic Concrete (2" SM, 6.5" IM)
									2" Aggregate Base
			N = 25 REC = 50	26	68	21	47		Moist, Brown, and Gray Fine Sandy CLAY, trace gravel (CH), medium stiff
			N = 44 REC = 35						Very moist, Brown and Gray Silty CLAY (ch); stiff
									Boring Terminated at 4.7 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING MV4 - STA. 116+43 - CL RT NB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/18/07 - 4/18/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 34.9

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									9" Asphaltic Concrete (2.5 SM, 6.5" IM)
									10" Aggregate Base
			N = 12 REC = 65	20	47	18	29		Moist, Gray Brown CLAY (CL); stiff
			N = 30 REC = 60						
									Boring Terminated at 4.8

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING MV5 - STA. 115+12 - CL SB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/18/07 - 4/18/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION:

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									5.5" Asphaltic Concrete (1.5" SM, 1.5" IM, 1" SM, 1.5" BM))
									6" Aggregate Base
			N = 11 REC = 60						Very moist, Gray Brown Silty CLAY (cl); medium stiff
			N = 32 REC = 80						
									Boring Terminated at 4.4 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING OM1 - STA. 143+34 - CL NB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 39.3

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									5" Asphaltic Concrete (5.5" SM)
									7" Aggregate Base
			N = 39 REC = 50	13	NP	NP	NP		Moist, Tan Silty Fine Grained SAND (sm); dense
			N = 9 REC = 50						Very moist, Brown and Gray Fine Grained Sandy CLAY (cl); stiff
									Boring Terminated at 4.4 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/26/07

BORING OM2 - STA. 140+03 - CL SB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 41.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	PL	PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									9" Asphaltic Concrete (4.5" SM, 4.5" BM)
									2" Aggregate Base
			N = 30 REC = 25						Very moist, Brown and Gray Silty Fine Grained SAND (sm); medium dense
			N = 8 REC = 50						Moist, Brown Gray Silty CLAY trace Fine Sand (ch); medium stiff
									Boring Terminated at 4.8 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING OM3 - STA. 136+68 - CL NB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4' Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 40.6

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									9" Asphaltic Concrete (2. SM, 5.5" BM)
									7" Aggregate Base
			N = 47 REC = 50						Moist, Tan Fine Grained Sandy SILT (ml); hard
									Very moist, Brown and Gray Silty CLAY (cl); medium stiff
			N = 8 REC = 50						

Boring Terminated at 4.8 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING OM4 - STA. 133+33 - CL SB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 38.1

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8" Asphaltic Concrete (3" SM, 5" BM)
			N = 19 REC = 65	15	43	16	27		Very moist, Gray Sandy Lean CLAY (CL); very stiff
			N = 16 REC = 65						
									Boring Terminated at 4.7 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING OM5 - STA. 130+00 - CL NB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 38.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									6" Asphaltic Concrete (1" SM, 5" BM)
									7" Aggregate Base
			N = 29 REC = 50						Moist, Brown and Tan Fine Grained Sandy SILT (ml); very stiff
			N = 15 REC = 65						Very moist, Brown and Gray Silty CLAY (ch); stiff
									Boring Terminated at 4 5 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING OM6 - STA. 126+67 - SB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/17/07 - 4/17/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 34.1

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8" Asphaltic Concrete (2" SM, 6" BM)
									6" Aggregate Base
			N = 17 REC = 50	8	25	16	9		Moist, Clayey SAND with Gravel (SC); medium dense
			N = 15 REC = 50						Moist, Silty Fine Grained SAND (sm); medium dense

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING T1 - STA. 52+86 - CL EB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/23/07 - 4/23/07

FIELD DATA LABORATORY DATA

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION:

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									10" Asphaltic Concrete (1.5" SM, 1.5" IM, 7.0" BM)
			N = 24 REC = 5						Very Moist, Tan and Brown Clayey Coarse Grained SAND and GRAVEL (sp); medium dense
			N = 15 REC = 50						Very Moist, Red and Brown Sandy CLAY (cl); stiff
									Boring Terminated at 4.8 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING T2 - STA. 61+84 - CL WBLane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648 6630
804 648 6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/23/07 - 4/23/07

DRILLING METHOD(S):
4' Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 115.7

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									6.5" Asphaltic Concrete (3.5" SM, 3.0" IM)
			N = 38 REC = 70						Very Moist, Red and Brown Clayey SAND, trace gravel (sc); dense
			N = 6 REC = 35						Very Moist, Red and Brown Sandy CLAY (cl); medium stiff
									Boring Terminated at 4 6 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING T3 - STA. 67+96 - CL EB Lane

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804 648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/23/07 - 4/23/07

DRILLING METHOD(S):
4' Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION:

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									9" Asphaltic Concrete (5.0" SM, 4.0" IM)
			N = 39 REC = 60	7	26	15	11		Very Moist, Brown Clayey Coarse Fine SAND and Gravel (SC); dense
			N = 26 REC = 45						Very Moist, Brown Fine SAND with trace gravel (sp); medium dense
									Boring Terminated at 4.8 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING T4 - STA. 74+57 - CL WBLane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/23/07 - 4/23/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION:

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8 5" Asphaltic Concrete (3 0" SM, 5.5" BM)
			N = 7 REC = 40						Very Moist, Brown and Gray Silty SAND, some gravel (sm); loose
			N = 7 REC = 50						Very Moist, Gray and Brown SILT, trace clay (ml); medium stiff
									Boring Terminated at 4.7 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNN.01 7/25/07

BORING T5 - STA. 78+07 - CL EB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/23/07 - 4/23/07

DRILLING METHOD(S):
4 Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION:

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									9" Asphaltic Concrete (6 5" SM, 2 5" IM)
									6" Aggregate Base / Clayey SAND (SC)
			N = 20 REC = 95	13	40	23	17		Very Moist, Yellowish Brown Medium Grained SAND, trace clay (sc); medium dense to dense
			N = 31 REC = 55						
									Boring Terminated at 4.8 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

BORING T6 - STA. 85+34 - CL WB Lane

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 4/23/07 - 4/23/07

DRILLING METHOD(S):
4" Dia Pavement Core - Continuous Standard Penetration Test

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION:

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									8.5" Asphaltic Concrete with Aggregate layer
			N = 14 REC = 40	13	25	14	11		Very Moist, Brown and Red Clayey Coarse SAND with gravel (SC); medium dense
			N = 14 REC = 85						Very Moist, Gray and Brown Silty SAND (sm); medium dense

Boring Terminated at 4.7 feet

Note: Driller felt 4" gap between bottom of asphalt and top of soil

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Brandon Harrison

LOG A GNNL01 7/25/07

NEW ROADWAY BORINGS

BORING B7 - STA. 63+48 - 30 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804 648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/23/07 - 5/23/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Wet at bottom of boring

SURFACE ELEVATION: 93

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 9 REC = 15	24	56	19	37		Damp, Brown Sandy Fat CLAY (CH); soft
			N = 10 P = 1.5 REC = 60						Moist, Brown fine sandy CLAY (cl); stiff
	5		N = 6 P = .5 REC = 100						more gray, less sandy; soft
			N = 15 P = 1.75 REC = 95						gray, trace sand
			N = 17 REC = 15						Wed, Brown, Tan and Reddish Fine to Coarse Grained SAND and GRAVEL (gp-gm); medium dense
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 6.6 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B8 - STA. 67+00 - 10 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804 648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/23/07 - 5/23/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Wet at bottom of boring

SURFACE ELEVATION: 84.1

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 13 REC = 40						Damp, Brown Fine Grained SAND and Small GRAVEL, trace asphalt (fill); medium dense
			N = 10 P = 2.0 REC = 75						Moist, Brown and Gray mottled Fine Grained Sandy CLAY (fill); stiff
	5		N = 10 REC = 55						Damp to Moist, Brown, Tan and Gray Silty SAND, some angular gravel (fill); loose
			N = 17 REC = 55						Wet, Brown/Reddish Brown, Silty SAND and GRAVEL (gp-gm); medium dense
			N = 13 REC = 45						
	10								Boring Terminated at 10.0 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 6.0 ft after augers were removed
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B9 - STA. 77+11 - 23 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/25/07 - 5/25/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 89.7

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 8 REC = 10						Damp, Brown SILT and SAND, trace root material (sm); loose
			N = 12 P = 2.5 REC = 70						Moist, Gray and Reddish Brown mottled Sandy Fat CLAY, trace fine to medium grained sand (CH); very stiff
	5		N = 11 P = 2.5 REC = 30	21	95	22	73		
			N = 19 P = 4.5 REC = 100						trace root materials; iron staining at 5.9-6.5 feet
			N = 22 P = 3.75 REC = 100						Moist, Blue Gray Sandy SILT (sp-sm); very stiff
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 6.5 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B10 - STA. 82+00 - 20 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/25/07 - 5/25/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry to TOB

SURFACE ELEVATION: 101.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with leaves, silt, roots, and topsoil
			N = 7 REC = 65						Moist, Tan Clayey SAND, trace gravel (SC); loose
			N = 13 REC = 35						Medium dense
	5		N = 11 REC = 80	17	57	17	40		
			N = 24 P = 2.25 REC = 80						
									Quartz Fragments
									Moist, Brown to Red Fine Grained Sandy SILT (ml); very stiff
			N = 18 P = 3.25 REC = 100						Moist to Wet, light Gray Medium Grained SAND (sw); medium dense
	10								Boring Terminated at 10.0 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 6.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B11 - STA. 234+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/17/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 72.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 7 P = 2.5 REC = 50						Moist, Brown Fine Sandy SILT (ml) with Roots and Wood; very stiff
			N = 14 REC = 60						Moist, Tan Silty Fine Grained SAND (sm); medium dense
	5		N = 12 REC = 85	27	61	25	36		Moist, Tan Sandy Fat CLAY (CH); medium stiff
			N = 17 P = 3.25 REC = 100						Moist, Gray and Rust Mottled Clayey SILT (ml); very stiff
			N = 16 P = 3.75 REC = 100						Blue Gray
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B12 - STA. 231+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/17/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 75.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 8 P = 3.0 REC = 75						Damp to Moist, Reddish Brown Fine Grained Sandy SILT (ml); very stiff
			N = 13 REC = 60						Moist, Tan Silty Clayey Fine Grained SAND (SC); medium dense
	5		N = 12 REC = 85	17	50	25	25		Moist to Wet, Coarser Sand
			N = 22 P = 2.75 REC = 100						Moist, Gray SILT (ml); very stiff
	10		N = 17 REC = 100						Moist, Brownish Gray Fine Grained SAND (sp); medium dense
									Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 6.0 ft after augers were removed
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B13 - STA. 228+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/17/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/17/2007): 5 0 ft

SURFACE ELEVATION: 73.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 5 REC = 35						Damp, Dark Brown Silty SAND (sm); loose
			N = 7 REC = 70						Moist, Grayish Tan Silty Fine Grained SAND (sm); loose
	5		N = 19 REC = 100	▽					Zones of Gray and Rust Silty Clay; medium dense
			N = 25 REC = 100						Gravel (quartz fragments) ~0.1 ft thick
			N = 24 REC = 100						Wet, Grayish Tan Medium to Coarse Grained SAND (sp); medium dense
	10								Boring Terminated at 10 0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 6.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B14 - STA. 225+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/16/07 - 5/16/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 65.4

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Brown Silty SAND, trace organics (fill); very loose
			N = 5 REC = 30 P = 1.75						Damp, Brown Sandy CLAY, trace sand (fill); stiff
			N = 11 REC = 20						Fill with some Clay and Silt and piece of Plastic
	5		N = 8 P = 2.0 REC = 65	26	55	19	36		Damp to Slightly Moist, Brown and Orange Mottled Fine Grained Sandy Fat CLAY (CH); stiff
			N = 8 P = 2.5 REC = 65						
			N = 9 P = 2.5 REC = 100						Gray with Orangey Brown Mottles
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 6.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B15 - STA. 218+00 - CL

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/4/07 - 5/4/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 59.7

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 3 REC = 45						Damp, Dark Brown Silty Fine Grained SAND with tree roots (sm); very loose
			N = 22 REC = 75						Damp, Mottled Red, Brown, Tan and Gray Sand, some rounded pebbles and quartz (gc-gm); dense
	5		N = 50 REC = 70						Damp, Brown to Tan to Orange Sandy SILT, trace gravel (ml); dense
			N = 40 REC = 75						Dense, Moist to Wet at 6 feet
			N = 43 REC = 45						
	10								Boring Terminated at 10 0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 4.7 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B16 - STA. 215+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648 6630
804 648 6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/4/07 - 5/4/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 75.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Roots, leaf rot (forest floor)
			N = 4 P = 0.75 REC = 55						Moist, Brown Clayey SILT (ml) with iron staining; medium stiff
			N = 9 P = 3.0 REC = 100	24	49	19	30		Brown and Gray CLAY, trace of fine grained sand (CL); very stiff
	5		N = 18 P = >4 5 REC = 95						Grayer, less mottling
									Moist, Gray and Brown SAND and Rounded GRAVEL (gm); loose to dense
			N = 24 REC = 50						
			N = 6 REC = 25						
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 3 8 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNLD1 7/25/07

BORING B17 - STA. 212+50 - CL

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/4/07 - 5/4/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: ~108

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with topsoil and leaf matter
			N = 6 P = 1.25 REC = 40						Moist, Brown Fine Sandy SILT, trace gravel (ml); stiff
			N = 8 REC = 5						Rock in shoe; moist
	5		N = 14 P = 2.5 REC = 80						Moist, Brown Sandy CLAY, trace organic material (cl); very stiff
			N = 14 P = 3.75 REC = 85	21	50	28	22		Moist to Wet, Coarse Grained Brown to Rust Clayey SAND (SC); medium dense
			N = 14 REC = 90						Finer Grained Silty Sand with Depth Turns; Gray at end of spoon
	10								
			N = 13 REC = 75						Moist, Gray Silty Fine Grained Sand; medium dense
	15								
			N = 10 REC = 100 P = 2.5						Wet, Medium Grained Brown to Rust Silty Sand; loose
	20								Moist, Gray and Rust Silty CLAY (CH) with Iron Staining along small channels and heavy zones of oxidation at the top of the unit; very stiff
			N = 23 REC = 100	31	92	31	61		Less iron staining
	25								Boring Terminated at 25.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 14.5 ft after augers were removed
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B18 - STA. 208+00 - 11 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/4/07 - 5/4/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 111.3

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor, topsoil, root mat, and leaves
			N = 4 REC = 45						Moist to Wet, Brown Silty SAND with trace roots and gravel; (gm) very loose
			N = 4 REC = 40						Large quartz rock in shoe; oxidized root channels
	5		N = 9 REC = 45						Moist to Wet, Brown, Gray, and Tan Silty SAND and rounded GRAVEL (gm); loose
			N = 94 REC = 69						Wet, iron staining and gravel; very dense
			N = 39 REC = 60						
	10								Boring Terminated at 10 0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 5 6 ft after augers were removed

HDR Inspector – Sue Young

LOG A:GNNL01 7/25/07

BORING B19 - STA. 206+00 - CL

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB at 13.8 ft; Left boring open and water entered BOH
24 hr (05/04/2007): 9.5 ft

SURFACE ELEVATION: 132.7

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with root mat, leaves, and soil
			N = 4 P = 1.25 REC = 60						Damp, Brown Sandy SILT (ml)); stiff
			N = 13 P = 2.75 REC = 60						Dry, Mottled Gray and Brown CLAY, some silt and fine sand (CH); very stiff
	5		N = 10 P = 4.0 REC = 65	21	58	18	40		Some Organic Material
			N = 10 P = 1.0 REC = 85						Moist, Light Brown Sandy SILT (ml); stiff
			P = 1.0						Moist, Brown Fine Grained SAND (sw); loose
	10		N = 11 P = 2.0 REC = 65						Moist, Light Brown SAND and SILT, trace gravel (gw); stiff
	15		N = 8 REC = 100						Moist, Orange to Light Brown Silty Fine Grained SAND (sm); loose
			N = 7 P = 1.75 REC = 100						Damp, Orangey Brown Clayey SILT, trace gravel (ml); stiff
	20								Boring Terminated at 20.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Sue Young

LOG A GNNLD1 7/25/07

BORING B-20A-STA. 202+50 - 5 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
23.5 ft at TOB
24 hr (05/04/2007): 21.6 ft

SURFACE ELEVATION: 164.5

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 25 REC = 55						Damp, Brown to Tan SAND and SILT, trace gravel and wood fragments (sm); medium dense
			N = 28 REC = 90						Damp to Moist, Brown and Reddish Brown Silty Fine SAND (sm) with iron staining and roots; medium dense
	5		N = 20 P = 4.5 REC = 75						Damp, Orange, Brown and Gray Grading to Fine Sandy CLAY (CL); very stiff
			N = 18 P = 3.0 REC = 100	19	45	18	27		
			N = 36 REC = 45						Slightly Moist, Tan to Gray to Brown GRAVEL, SAND and SILT (gm); dense
	10								
									Damp, Brown SAND and SILT (sm); loose
									Moist, Red Fine SAND (sw); medium dense
			N = 20 REC = 95						Damp, Tan and Gray GRAVEL, SILT and SAND (gm); medium dense
	15								
	20		N = 28 REC = 60						
									Wet, Orange CLAY, trace fine sand and silt (CL); medium stiff
	25		N = 6 REC = 100	27	42	17	25		

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING B-20A-STA. 202+50 - 5 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
23 5 ft at TOB
24 hr (05/04/2007): 21 6 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			P = 0.75						Wet, Orange CLAY, trace fine sand and silt (CL); medium stiff *(continued)*
	30		N = 7 REC = 100						Wet, Gray, Pink, Brown, and Red Silty Fine Grained SAND (sm); loose
	35		N = 6 REC = 95						Trace gravel
			N = 4 P = 0.25 REC = 100						Wet, Brownish Gray with Orange Mottles Sandy CLAY (cl); very soft
	40								Boring Terminated at 40 0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING B-20B-STA. 202+50 - 50 RT

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648 6630
804 648 6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 163.5

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 9 P = 4.5 REC = 60						Damp, Brown Sandy SILT (ml) trace clay, gravel and roots; very stiff
			N = 28 P = >4 5 REC = 55						
	5		N = 27 REC = 85						Damp, Brown, Reddish Brown, Tan and Gray SAND, SILT, GRAVEL and CLAY (gm): medium dense
			N = 10 REC = 95						Moist, Redder and Sandier with depth; loose
			N = 14 REC = 80						Moist, Brownish Red Sand, trace silt and gravel (sm); medium dense
	10								
									Moist to Wet, Brownish Pink Silty SAND, trace gravel (sm); loose
			N = 15 REC = 80						Dry, Gray, Tan, Reddish SAND, trace GRAVEL (quartz fragments) (gm); medium dense
	15								
			N = 6 REC = 100 P = 0.75	14	27	18	9		Moist to Wet, Brownish Pink Clayey SAND (SC); loose to medium stiff Gray
	20								Moist, Light Brown to Orangey Fine Grained SAND (sm); medium dense
									Wet to Moist, Orange Fine Grained SAND (sm); loose
			N = 9 REC = 70 P = 0.75						Wet, Orange Silty CLAY (cl); medium stiff
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 22.0 ft; Offset 54 ft from boring BA20'
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B-20B-STA. 202+50 - 50 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Orange Silty CLAY (cl); medium stiff *(continued)*
	30		N = 4 P = 0.75 REC = 100						Moist, Gray and Pinkish Gray Silty CLAY (cl); medium stiff
			N = 7 REC = 100 P = 0.75						Wet, Orangey Brown Silty Fine Grained SAND (sm); loose
	35								Wet, Brown Silty CLAY (cl); medium stiff
			N = 22 REC = 70						Wet, Gray and Brown Interbedded Silty Fine Grained SAND and Fine SAND (sm); medium dense
	40								Boring Terminated at 40.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 22.0 ft; Offset 54 ft from boring 'BA20'

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B21 - STA. 199+03 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 150.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with root mat, leaves, and soil
			N = 5 REC = 60	12	23	16	7		Damp, Brown Silty CLAY (CL-ML); soft
			N = 8 REC = 70						Moist, Brown to Tan to Dark Brown SILT, SAND, and GRAVEL, trace roots (gm); loose
	5		N = 32 REC = 35						Dry, Gray to Tan to Brown GRAVEL and SAND (gm); dense
			N = 13 REC = 60 P = 2.0 N = 8 P = 3.0 REC = 80						Damp, Brown Fine Grained Sandy SILT (ml); stiff Slightly Moist, with Gray Mottles
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 7.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B22 - STA. 196+08 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB
24 hr (05/04/2007): DTW 11.7 ft; caved to 12.0

SURFACE ELEVATION: 128.5

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Brown SILT, Fine Grained SAND, and GRAVEL (gm); medium dense
			N = 13 REC = 50						Damp to Slightly Moist, Brown Sandy SILT, some thin and layers (<0.1 ft thick) (ml); very stiff
			N = 15 P = 3.25 REC = 80						
	5		N = 13 REC = 60						
									Moist, Brown Silty Fine Grained SAND, trace gravel (sc); medium dense
			N = 17 REC = 85						
									Moist, Orangey Brown Fine to Coarse Grained SAND, SILT, and GRAVEL (gm); medium dense
			N = 17 REC = 75						
	10								
									Moist to Wet; very dense
			N = 73 REC = 45						
	15								Boring Terminated at 15.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B23 - STA. 193+00 - CL

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/3/07 - 5/3/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 155.6

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with root mat, leaves, and silt
			N = 15 REC = 75						Damp, Brown Silty CLAY (cl), trace gravel and roots m); medium dense
									Less gravel
			N = 21 REC = 65	16	45	16	29		
									Gray and Red Mottling (iron staining), Finer Grained Sand
	5		N = 13 REC = 80						
			N = 11 REC = 100						
									Moist, Reddish Brown Fine Grained SAND (sm); medium dense
									Moist, Reddish Brown Silty Fine Grained SAND (sm); loose
			N = 8 REC = 100						
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 7.0 ft after augers were removed
HDR Inspector – Sue Young

BORING B24 - STA. 189+06 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/2/07 - 5/2/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 147.8

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forst floor with root mat, leaves, and silt
			N = 4 P = 2.5 REC = 75						Damp, Brown Clayey SILT, trace fine grained sand (ml); very stiff
			N = 7 P = 2.25 REC = 55						Damp to Slightly Moist, Brown SILT, trace fine grained sand (ml); very stiff
	5		N = 4 P = 2.75 REC = 50						Damp to Slightly Moist, Orangey Brown Sandy SILT (ml); very stiff
			N = 8 P = 3.0 REC = 85						Damp to Slightly Moist, Orangey Brown SILT, trace clay (ml); very stiff
			N = 9 P = 3.25 REC = 80						
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 8 5 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B25 - STA. 186+04 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648.6630
804 648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/2/07 - 5/2/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB
24 hr (05/03/2007): dry; caved to 11.6 ft

SURFACE ELEVATION: 130.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with root mat, leaves, and silt
			N = 4 P = 1.25 REC = 75						Slightly Moist, Light Brown Clayey SILT (ml) with traces of fine grained sand; stiff
			N = 8 P = 2.75 REC = 75						Trace roots and wood fragments; very stiff
	5		N = 12 P = 4.5 REC = 65						Damp, Gray and Brown Mottling, More Clay
			N = 15 P = >4.5 REC = 95						Damp, Gray and Brown Mottling Silty CLAY (cl); very stiff
	10		N = 13 P = 3.75 REC = 100						Grading to Silt with Fine Grained Sand Layers
			N = 11 REC = 80						Damp, Brown to Tan SAND, SILT, and GRAVEL (gm); medium dense
	15								Boring Terminated at 15.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 12.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B26 - STA. 183+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/2/07 - 5/2/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB
24 hr (05/02/2007): DTW 15.1 ft; caved to 16.7 ft

SURFACE ELEVATION: ~125

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 22 REC = 70						Dry, Brown and Tan SAND, SILT and GRAVEL (fill); medium dense
			N = 9 P = 2.25 REC = 70						Damp, Brown SILT, trace clay and fine grained sand (ml); very stiff
	5		N = 10 P = 2.75 REC = 85						Some gravel
			N = 22 REC = 90						Slightly Moist, Reddish Brown SAND, some silt (sm); medium dense
			N = 52 REC = 80						GRAVEL (quartz fragments)
	10								Wet, Brown Fine Grained SAND (sm); medium dense
	15		N = 63 REC = 75						Moist, brown and tan SAND and GRAVEL (quartz fragments) (gm); very dense
			N = 10 P = 3.5 REC = 100						Wet, Gray and Reddish Brown Mottles, Silty CLAY (cl); very stiff
	20								Boring Terminated at 20.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Relocated 200 ft to get to deepest part of fill; Located on a dirt turn-around spot, not surveyed
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B27 - STA. 178+00 - 1 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/2/07 - 5/2/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 139.3

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 21 REC = 85						Damp, Brown Silty Fine SAND, trace roots (sm); medium dense
			N = 32 REC = 70						Trace gravel
	5		N = 14 P = 3.0 REC = 90						Damp, Reddish Brown Clayey SILT, trace fine grained sand (ml); very stiff
			N = 15 P = 3.25 REC = 90						Trace gravel
			N = 16 REC = 80						Damp, Reddish Brown Silty Fine Grained SAND (sm); medium dense
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Boring located on edge of old road bed; Caved at 6 5 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B28 - STA. 174+00 - 7 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/2/07 - 5/2/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 123.6

FIELD DATA . LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with root mat, leaves, and soil
			N = 8 P = 2.5 REC = 75						Damp, Brown Fine Grained Sandy CLAY (CL); very stiff
			N = 18 P = 3.5 REC = 90	16	42	19	23		
	5		N = 40 P = 3.5 REC = 100 N = 59 REC = 95						Damp, Brown, Tan and Reddish SAND, GRAVEL, and SILT (gm); very dense Quartz fragments from 6.0 to 8.0 ft
			N = 47 REC = 85						
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 5.5 ft after augers were removed
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B29 - STA. 172+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/2/07 - 5/2/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 116.5

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Topsoil
			N = 17 REC = 20						Damp, Brown SILT, SAND, and GRAVEL, trace roots (gm); medium dense
			N = 17 REC = 50						
									Damp, Tan and Brown SILT, SAND, and GRAVEL (gm); medium dense
	5		N = 24 REC = 55						
									Slightly Moist
			N = 27 REC = 60						
			N = 19 REC = 40						Wet
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 5.1 ft after augers were removed; area around boring disturbed and hummocky

HDR Inspector – Sue Young

BORING B30 - STA. 169+05 - 8 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/2/07 - 5/2/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 118.3

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 15 REC = 10						Damp, Brown and Tan SAND and GRAVEL (gm); medium dense
			N = 13 REC = 75						Damp, Brown Silty Fine SAND, some gravel (sm) medium dense
	5		N = 8 REC = 70						Less Gravel
			N = 8 REC = 20						
			N = 4 REC = 35						Moist
	10								
			N = 7 P = 2.75 REC = 85						Moist to Wet, Brown Clayey SILT, trace fine grained sand (ml); very stiff
	15								Boring Terminated at 15.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Relocated to edge of road; Caved at 9.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B31 - STA. 165+20 - 5 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/1/07 - 5/1/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 116.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	PL	PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 4 P = 1.5 REC = 60						Slightly Moist, Brown SILT, trace fine grained sand (ml); stiff
			N = 16 REC = 70						Moist, Brown Silty Fine Grained SAND (SC-SM); medium dense
	5		N = 14 REC = 100	13	21	17	4		
			N = 23 REC = 40						Damp to Moist, Brown to Tan Silty SAND, trace gravel (gm); medium dense
			N = 22 REC = 35						
	10								
			N = 19 REC = 50						Moist
	15								Boring Terminated at 15.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 9.8 ft after augers were removed
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B32 - STA. 161+92 - 10 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/1/07 - 5/1/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
18 hr (5/ 2/2007): 3 2 ft

SURFACE ELEVATION: 96.8

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 3 REC = 70						Topsoil Gravel (gm)
	5		N = 14 REC = 20 N = 11 REC = 35 N = 9 REC = 50						Wet, Brown SAND and GRAVEL (gm); medium dense to loose
			P = 2 0 N = 5 REC = 0						Wet, Gray and Brown Mottled Silty CLAY (cl); stiff No Recovery; Second attempt - Drilled 0.4 feet: Wet, Silty Clay with Gravel
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Offset from Centerline 10 ft RT due to large diameter trees; Had to clear all small trees < 6" DBH
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B33 - STA. 159+10 - 2 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/1/07 - 5/1/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 77.9

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	PL	PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Topsoil
			N = 3 REC = 65						Moist, Brown Silty Fine Grained SAND, some roots and gravel (gm); loose
			N = 7 P = 1.25 REC = 70						Moist, Brownish Red and Gray Silty CLAY, trace roots (cl); stiff to very stiff
	5		N = 7 P = 1.5 REC = 70						
			N = 13 P = 3.0 REC = 80						Brown and Brownish Red Mottles; very stiff
			N = 12 P = 3.75 REC = 85						
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Offset from Centerline 2 ft RT due to overhead and underground utilities; Caved at 6 5 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B34 - STA. 156+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/1/07 - 5/1/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 67.1

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 5 P = 1.5 REC = 45						Slightly Moist, Brown Silty CLAY, trace rounded gravel and roots (cl); medium stiff (possible fill)
			N = 7 P = 1.0 REC = 60						More Gravel
	5		N = 9 P = 1.75 REC = 55						Damp, Gray and Brownish Red Silty CLAY, some gravel (cl); stiff
			N = 7 REC = 15						
									Gravel layer
									Slightly Moist, Gray and Brown Silty CLAY (cl); stiff
			N = 9 P = 1.5 REC = 70						
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 5.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING B35 - STA. 153+00 - CL

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/1/07 - 5/1/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 54.7

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 16 P = 2.25 REC = 80						Damp, Brown Sandy CLAY, trace clay pockets, roots and gravel (FILL); very stiff (fill)
			N = 9 P = 2.0 REC = 75	19	32	18	14		Slightly moist, less sand and more clay
	5		N = 14 P = 2.25 REC = 75						More sand, trace brick fragments
			N = 11 P = 3.0 REC = 80						Slightly Moist, Red and Gray Mottled Silty CLAY (cl); very stiff
			N = 8 P = 2.5 REC = 85						
	10								Boring Terminated at 10.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Sue Young

LOG A GNNL01 7/26/07

BRIDGE BORINGS

BORING BS1 - STA. 181+70 - 20 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/14/07 - 5/14/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/14/2007): 39.0 ft
24 hr (05/15/2007): DTW 21.0 ft; caved to 26.0 ft

SURFACE ELEVATION: 127.4

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Dark Brown Sandy SILT Topsoil with Roots (tops); medium stiff
			N = 4 P = 1.0 REC = 85						Damp, Brown Fine Sandy Lean CLAY (CL); very stiff
			P = 3.0						
			N = 25 P = >5.0 REC = 90						
									Slightly Moist
	5		N = 10 P = 4.5 REC = 95	18	38	14	24		
			N = 15 P = 2.75 REC = 100						Orangey Brown
			N = 11 P = 2.0 REC = 100						Moist to Wet; stiff
	10								Moist, Orangey Brown Silty Fine Grained SAND, trace gravel (quartz fragments) (sm); medium dense
									Moist, Brown Silty CLAY (cl) with iron stained zones; stiff
	15		N = 15 P = 2.0 REC = 65						Slightly Moist, Brown, Tan, Gray, White, and Red SAND and GRAVEL (gm); medium dense
	20		N = 13 REC = 90						Wet, Orangey Brown Silty SAND (sm); medium dense
			N = 8 REC = 100						Wet, Tan, Gray, and Brown SAND and Small GRAVEL (gm); loose
	25								Moist, Brown, Gray, Red, and Orange Silty CLAY (cl); stiff

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 47.0 ft after augers were removed;
24-hour: caved to 26.0 feet; water at 21.0 feet

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS1 - STA. 181+70 - 20 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/14/07 - 5/14/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/14/2007): 39.0 ft
24 hr (05/15/2007): DTW 21.0 ft; caved to 26.0 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			P = 2.0						Moist, Brown, Gray, Red, and Orange Silty CLAY (cl); stiff *(continued)*
	30		N = 10 P = 2.5 REC = 100						
	35		N = 16 P = 2.75 REC = 100						Moist, Brown, Gray, Red, and Orange Silty CLAY (cl); stiff
	40		N = 23 P = 3.25 REC = 100	▽					Little to Some Sand with Depth (Fine Grained Sand Layers <0.1 ft thick at depths of 38.2, 38.4, 38.9, 39.6, 40.0 ft)
	45		N = 16 REC = 80						Moist, Gray Silty Fine Grained SAND (sm); medium dense
	50		N = 51 REC = 100						Wet, Gray Clayey Medium/Fine-Grained SAND (sc); very dense

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 47.0 ft after augers were removed;
24-hour: caved to 26.0 feet; water at 21.0 feet

HDR Inspector – Sue Young

LOG A GNNL.01 7/25/07

BORING BS1 - STA. 181+70 - 20 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804 648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/14/07 - 5/14/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/14/2007): 39.0 ft
24 hr (05/15/2007): DTW 21.0 ft; caved to 26.0 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray Clayey Medium/Fine-Grained SAND (sc); very dense *(continued)*
	55		N = 43 REC = 90						
									Wet, Gray and Brown Clayey SILT (ml); very stiff
	60		N = 32 P = 3.75 REC = 100						
									Boring Terminated at 60.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 47.0 ft after augers were removed;
24-hour: caved to 26.0 feet; water at 21.0 feet

HDR Inspector – Sue Young

BORING BS2 - STA. 181+70 - 20 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/11/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 131.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 10 P = 3.0 REC = 100						Damp, Brown and Tan SAND, SILT, and GRAVEL (Fill)
			N = 22 P = 2.5 REC = 80						Damp, Brown Sandy CLAY (cl); very stiff
									Stiff
	5		N = 18 P = 1.25 REC = 65						Moist, Brown and Tan SAND and GRAVEL (gm); medium dense
			N = 12 P = 3.25 REC = 95						Damp to Moist, Brown Silty CLAY with trace Fine Sand (cl); very stiff
									Stiff
			N = 13 P = 2.0 REC = 85						Moist, Fine Brown Sand Layers: ~6.9 to 7.2, 9.6 to 9.7, 9.9 to 10.0
	10								
			N = 57 REC = 75						Damp to Slightly Moist, Brown, Tan, and Red SAND and GRAVEL (gm); very dense
	15								
			N = 68 REC = 55						Wet, Brown, Tan, and Red GRAVEL; very dense
	20								
			N = 20 REC = 90	29	50	19	31		Wet, Brown and Gray Clayey SAND (SC); medium dense
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Moved 20 ft back station; Offset due to power line; Location on a small knoll

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS2 - STA. 181+70 - 20 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/11/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Dry at TOB

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Brown and Gray Clayey SAND (SC); medium dense *(continued)*
	30		N = 28 REC = 55						
									Moist, Tan Fine Grained Sandy CLAY (cl); very stiff
	35		N = 18 P = 2.25 REC = 100						
									Moist, Tannish Gray Clayey Fine Grained SAND (sc); very dense
	40		N = 36 REC = 100						
									Moist, Tannish Gray Silty Fine Grained SAND (sm); dense
	45		N = 41 REC = 100						
									Wet, Brownish Gray Fine Grained Sandy SILT (ml); very stiff
	50		N = 38 P = 4.5 REC = 35						

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Moved 20 ft back station; Offset due to power line; Location on a small knoll

HDR Inspector – Sue Young

BORING BS2 - STA. 181+70 - 20 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804 648.6630
804 648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/11/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Dry at TOB

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Brownish Gray Fine Grained Sandy SILT (ml); very stiff *(continued)*
	55		N = 60 REC = 90						Moist to Wet, Tannish Gray Clayey Medium Grained SAND (sc); very dense
									Damp, Brownish Gray Fine Grained Sandy SILT (ml); very stiff
	60		N = 40 P = 4.5 REC = 100						
									Boring Terminated at 60 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Moved 20 ft back station; Offset due to power line; Location on a small knoll

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS3 - STA. 183+10 - 20 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/14/07

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									See log for B-26; BS-03 was drilled adjacent to B-26 therefore no sampling was conducted to a depth of 18 feet; drilling was performed by hollow-stem auger
	5								
	10								
	15								
	20		N = 9 P = 3.25 REC = 100						Damp, Gray and Brown Silty Fat CLAY (CH); very stiff
	25		N = 13 P = 4.25 REC = 100						Gray with Brown Globules

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 125.2

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 48.7 ft after augers were removed
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS3 - STA. 183+10 - 20 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648 6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/14/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Gray and Brown Silty Fat CLAY (CH); very stiff *(continued)*
	30		N = 22 P = >5 0 REC = 100						Damp to Moist, Blue Gray; very stiff
	35		N = 24 P = >5 0 REC = 100	25	68	22	46		Damp
	40		N = 35 REC = 100						Damp, Brownish Gray Fine SAND (sm); medium dense to dense
	45		N = 33 REC = 100 P = >5.0						Damp, Gray and Red Mottled Clayey SILT (ml); very stiff
	50		N = 29 P = 4.5 REC = 100						Gray with Rust Mottles trace Fine Grained Sand

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 48.7 ft after augers were removed

HDR Inspector – Sue Young

BORING BS3 - STA. 183+10 - 20 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/14/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Dry at TOB

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Gray and Red Mottled Clayey SILT (ml); very stiff *(continued)*
			N = 36 P = 4.0 REC = 100						
	55		P = 2.75						Moist, Brownish Gray Fine Grained Sandy CLAY (cl); very stiff
									Moist, Gray Fine Grained SAND (sp); very dense
			N = 51 REC = 100						
	60								Boring Terminated at 60.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 48.7 ft after augers were removed

HDR Inspector – Sue Young

BORING BS4 - STA. 183+18 - 17 LT

HDR Engineering Inc
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/11/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Dry at TOB

SURFACE ELEVATION: 125.8

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Brown Silty SAND (Topsoil)
									Gravel (quartz fragments)
			N = 8 REC = 60						Dry, Brown Silty SAND (sm); medium dense
			N = 6 P = 1.25 REC = 60						Moist, Light Brown Fine Grained Sandy SILT (ml); stiff
	5		N = 10 REC = 65						Moist, Orangey Brown Silty Fine Grained SAND (sp); loose
									Damp, Gray Gravel (gp)
			N = 27 REC = 65						Moist, Orangey Brown Clayey Fine Grained SAND (SC); medium dense
			N = 23 REC = 75	14	32	13	19		Moist, Orangey Brown Silty Fine SAND and GRAVEL (gm); medium dense
	10								
									Wet, Tan, Brown, and Pink Coarse SAND and GRAVEL (gm); dense
			P = 2.5 N = 33 REC = 45						Moist, Brown Silty CLAY (cl); very stiff
	15								
									Brown and Gray
			N = 15 P = 3.5 REC = 80						
	20								
									Moist, Gray CLAY (cl); very stiff
			N = 18 P = 4.5 REC = 100						
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 56.5 ft after augers were removed
8 ft Upstream 3 ft to Left

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS4 - STA. 183+18 - 17 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/11/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Dry at TOB

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Gray CLAY (cl); very stiff *(continued)*
	30		N = 25 P = 5.0 REC = 100						Moist, Brown, Gray, and Red Silty CLAY (cl-ml); very stiff
	35		P = 3.5 N = 32 REC = 90						Moist, Gray Clayey SAND (sc); medium dense
									Damp, Brown, Black, and Tan Fine Grained SAND (sp); medium dense
	40		N = 44 REC = 100						Damp, Brown and Gray Silty SAND (sm); very dense
	45		N = 44 P = 4.25 REC = 100						Damp, Brown, Red, and Gray Fine Grained Sandy CLAY (cl); very stiff
	50		N = 46 P = 4.0 REC = 100						Damp, Brownish Gray Silty CLAY, trace of Fine SAND (cl); very stiff

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 56.5 ft after augers were removed
8 ft Upstream 3 ft to Left

HDR Inspector – Sue Young

LOG A GNNLD1 7/25/07

BORING BS4 - STA. 183+18 - 17 LT

HDR Engineering Inc.
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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/11/07 - 5/11/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Dry at TOB

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Brownish Gray Silty CLAY, trace of Fine SAND (cl); very stiff *(continued)*
	55		N = 32 P = 3.0 REC = 100						Few Thin Sandy Layers (<0.1 ft thick)
									Damp, Gray Fine Grained SAND (sp); very dense
	60		N = 50 REC = 100						Boring Terminated at 60.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 56.5 ft after augers were removed
8 ft Upstream, 3 ft to Left
HDR Inspector -- Sue Young

PROJECT #: 53410 **LOCATION:** Fort Belvoir, Fairfax, VA **STRUCTURE:** Kingman Rd Bridge		**KR-1** **PAGE 1 OF 3**
STATION: 183+25 LATITUDE: °N SURFACE ELEVATION: 123.9 ft	OFFSET: 20 LT LONGITUDE: °W COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 5/1/08 - 5/1/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP STRATA	ROCK: DIP JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
				0 5						0.0 / 123.9 ORGANICS / TOPSOIL **TOPS**			
2		6 6 5	60	2						0 2 / 123.7 Brown SAND, SILT, and GRAVEL Fill, medium dense, moist **FL**			
2 75		8 14 14	80	2 5						2.6 / 121.3 Brown and gray fine SANDY SILT, trace gravel very stiff, moist **ML**			
4	120			4									
		9 15 18	80	4 5						3 9 / 120 0 Red-brown fine to medium SAND dense to medium dense, moist **SW**			
6				6									
		15 14 19	80	6 5						Trace gravel below 6 5 feet			
8				8									
	115	16 12 8	55	8 5									
10				10						10 0 / 113 9 Light gray and tan GRAVEL with sand and silt, very dense, moist **GP-GM**			
12													
14	110	25 50	90	13 5 14 5									
16													
18										17.0 / 106.9 Tan and gray fine sandy CLAY, stiff to very stiff, moist **CL**			
3 5	105	4 5 7	100	18 5 20									
20													
22													
4 5 24	100	6 8 11	100	23 5									

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Tried to get 0 and 24 hour water level but could not Caved to about 10 feet after 24 hours

SPT_LOG:BELVOIR 2008.GPJ:8.1.015.081505:5/22/08
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PROJECT #: 53410 **LOCATION:** Fort Belvoir, Fairfax, VA **STRUCTURE:** Kingman Rd Bridge	**KR-1**	**PAGE 2 OF 3**

STATION: 183+25 OFFSET: 20 LT
LATITUDE: °N LONGITUDE: °W
SURFACE ELEVATION: 123.9 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 5/1/08 - 5/1/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
26					25									
28											Dark gray below 27 feet			
4.5	95	7 13 15	100		28.5 – 30									
30														
32											Dark gray and red-brown below 32 feet			
4.5 34	90	9 13 17	100		33.5 – 35									
36														
38											38.0 / 85.9 Blue-gray and brown fine sandy SILT,hard to very stiff, moist **ML**			
4.5	85	11 16 17	100		38.5 – 40									
40														
42														
4.5 44	80	12 13 18	100		43.5 – 45									
46														
48														
4.5	75	13 20 24	100		48.5									
50														

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Tried to get 0 and 24 hour water level, but could not Caved to about 10 feet after 24 hours.

SPT_LOG:BELVOIR 2008.GPJ:8.1.015:081505:5/22/08
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PROJECT #: 53410 **LOCATION:** Fort Belvoir, Fairfax, VA **STRUCTURE:** Kingman Rd Bridge		**KR-1** **PAGE 3 OF 3**
STATION: 183+25 LATITUDE: °N SURFACE ELEVATION: 123.9 ft	OFFSET: 20 LT LONGITUDE: °W COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 5/1/08 - 5/1/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
					50						Greenish gray below 52 feet			
52														
3 75 54	70	12 14 14	100		53 5 55									
56														
58											57 0 / 66 9 Light gray SILTY fine SAND, very dense, moist **SM**			
60	65	17 28 37	80		58 5 60									
62														
3 75 64	60	18 24 30	80		63 5 65									
66														
68											68 0 / 55.9 Gray and orange-brown fine sandy CLAY, hard, moist **CL**			
3 25 70	55	12 14 19	100		68 5 70									
72														
74	50	19 20 23	100		73 5						Bottom of boring at 75 feet			

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Tried to get 0 and 24 hour water level, but could not Caved to about 10 feet after 24 hours.

PAGE 3 OF 4
KR-1

SPT_LOG:BELVOIR 2008.GPJ:8.1.015:081505:5/22/08

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BORING BS5 - STA. 219+40 - 20 LT

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Suite 103
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804 648 6630
804 648 6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/8/07 - 5/9/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 5.0 ft
DTW at 24 hrs (05/09/2007): 3.2 ft

SURFACE ELEVATION: 56.9

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with root material, leaves, and silt
			N = 6 REC = 85						Moist, Brown Silty SAND, trace roots and gravel (sc-sm) ; loose
			N = 25 REC = 50						
	5		N = 32 REC = 100						Moist, Tan, Brown, and Gray SAND and GRAVEL (gm); medium dense
			N = 19 REC = 40						Wet
	10		N = 11 REC = 60						
			N = 14 P = <0.25 REC = 25						Wet, Brown Sandy CLAY, some gravel (sc-sm); very soft
	15								
			N = 10 REC = 50						Wet, Gray to Tan to Brown Coarse SAND and GRAVEL (gm); loose
	20								
			N = 15 REC = 80						
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS5 - STA. 219+40 - 20 LT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/8/07 - 5/9/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 5.0 ft
DTW at 24 hrs (05/09/2007): 3.2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Tannish Brown Fine SAND (gm); medium dense
			N = 21 P = <0 25 REC = 95						
	30								Wet, Gray Sandy CLAY (cl); very soft
			N = 8 P = <0 25 REC = 100						
	35								
									Wet, Gray Sandy Fat CLAY (CH); very soft
			REC = 0	31	54	21	33		
	40								
	45								Wet, Gray Sandy CLAY (cl); very soft
			N = 6 P = 0.25 REC = 95						
									Moist, Blue Gray CLAY, some fine grained sand (cl); stiff
			N = 5 P = 1.25 REC = 95						
	50								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS5 - STA. 219+40 - 20 LT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/8/07 - 5/9/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 5.0 ft
DTW at 24 hrs (05/09/2007): 3 2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Blue Gray CLAY, some fine grained sand (cl); stiff *(continued)*
			N = 7 P = 1.5 REC = 100						Trace Shell Fragments
	55								Wet, Blue Gray Clayey SAND, trace shell fragments (gw-gc); medium dense
			N = 4 P = 0.75 REC = 55						Moist, Blue Gray Medium Grained Sandy CLAY (cl); medium stiff
	60								
			N = 7 P = 0.75 REC = 100						
	65								
			N = 7 P = 0.75 REC = 100						
	70								
			N = 8 P = 1.25 REC = 65						
	75								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS5 - STA. 219+40 - 20 LT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/8/07 - 5/9/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 5.0 ft
DTW at 24 hrs (05/09/2007): 3.2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp to Moist, Brown, Red, and Gray Clayey SILT (ml); very stiff
			N = 14 P = 3.0 REC = 80						
	80								
			N = 18 P = 3.0 REC = 40						
	85								
									Damp to Moist, Gray, Blue, and Brown SILT, trace fine grained sand (ml); stiff
			N = 26 REC = 80						
	90								Boring Terminated at 90.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS6 - STA. 219+40 -20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/7/07 - 5/8/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 4.0 ft
DTW after augers removed: 4.1 ft
DTW at 24+ hrs (05/10/2007): 4 2 ft

SURFACE ELEVATION: 56.2

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest floor with root mat, leaves, and silt
			N = 6 REC = 45						Damp, Orangey Brown Silty Fine SAND, some roots (sm); loose
			N = 8 P = 1.5 REC = 65						Moist, Brown and Gray Fine Sandy SILT, some gravel (ml); stiff
	5		N = 6 REC = 15						More Gravel
			N = 32 REC = 80						Wet, Brown, Tan, and Gray GRAVEL and SAND (gm); dense
	10		N = 14 REC = 55						
			N = 6 REC = 5						Wet, Brown Silty SAND (sm); loose
	15								Wet, Tan, Brown, and Gray GRAVEL and SAND (gm); dense
	20		N = 32 REC = 100						
			N = 9 REC = 35						Loose
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 22 5 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS6 - STA. 219+40 -20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/7/07 - 5/8/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 4.0 ft
DTW after augers removed: 4.1 ft
DTW at 24+ hrs (05/10/2007): 4 2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Tan, Brown, and Gray GRAVEL and SAND (gm); dense *(continued)*
									Wet, Gray Sandy CLAY (cl); medium stiff
	30		N = 4 P = 0.75 REC = 45						
	35		N = 5 P = 2.0 REC = 50						Less Sand; stiff
									Sandier Zone
	40		N = 4 P = 0.75 REC = 100 P = 0.75						
									Wet, Gray CLAY (cl); very soft
	45		N = 4 P = 0.25 REC = 100						
									Wet, Gray Sandy CLAY, (sand Layers < 0.1 ft thick) (cl); very soft
	50		N = 4 P = 0.25 REC = 100						

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 22.5 ft after augers were removed

HDR Inspector – Sue Young

BORING BS6 - STA. 219+40 -20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/7/07 - 5/8/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 4.0 ft
DTW after augers removed: 4.1 ft
DTW at 24+ hrs (05/10/2007): 4.2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray Sandy CLAY, (sand Layers < 0.1 ft thick) (cl); very soft *(continued)*
									Wet, Gray SAND and GRAVEL (gm); medium dense
	55		N = 16 REC = 100						Running Sands
	60		N = 5 P = 0.25 REC = 90						Wet, Gray Clayey Sand (SC); loose
	65		N = 8 P = 0.25 REC = 90	31	66	24	42		
	70		N = 6 P = 0.5 REC = 95						
									Wet, Gray Silty SAND (sm); loose
									GRAVEL (quartz fragments) (gm); medium dense
	75		N = 12 REC = 100						Moist, Brown SILT (ml); very stiff

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 22.5 ft after augers were removed

HDR Inspector – Sue Young

BORING BS6 - STA. 219+40 -20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/7/07 - 5/8/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/08/2007): 4.0 ft
DTW after augers removed: 4.1 ft
DTW at 24+ hrs (05/10/2007): 4.2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			P = 3.75						Moist, Brown SILT (ml); very stiff *(continued)*
			N = 13 P = 2.75 REC = 85						some Fine Sand
	80								
			N = 14 P = 3.5 REC = 70						
	85								Boring Terminated at 85.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 22.5 ft after augers were removed

HDR Inspector – Sue Young

BORING BS7 - STA. 220+00 - 20 LT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/9/07 - 5/10/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/11/2007): 6 5 ft

SURFACE ELEVATION: 56.6

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Forest Floor with root mat, leaves, and wood
			N = 8 REC = 50						Moist, Tan and Brown SAND and GRAVEL (gm); loose
			N = 10 REC = 50						
	5		N = 2 P = <0 25 REC = 35						Moist to Wet, Brown to Gray Brown Sandy SILT, trace roots (ml); very soft
			N = 3 REC = 70	▽					Wet, Gray Fine to Medium Grained SAND, trace gravel (sw); very loose
			N = 23 REC = 40						Wet, Dark to Light Gray and Tan SAND and GRAVEL (gm); medium dense
	10								
			N = 7 REC = 55						Trace Silt/Clay
	15								
			N = 18 REC = 90						
	20								
			N = 12 REC = 70						
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS7 - STA. 220+00 - 20 LT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/9/07 - 5/10/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/11/2007): 6.5 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Dark to Light Gray and Tan SAND and GRAVEL (gm); medium dense *(continued)*
									Moist to Wet, Blue Gray Silty CLAY, trace fine grained sand (cl); very soft
	30		N = 3 P = 0.5 REC = 80						
									Moist, Blue Gray CLAY, trace shell fragments (cl); stiff
	35		N = 4 P = 1.25 REC = 95						
			REC = 0						
			N = 2 P = 0.25 REC = 100						Very soft
	40								Wet, Blue Gray Fine Grained Sandy SILT (ml); soft
									Wet, Blue Gray CLAY (cl); very soft
			N = 10 P = 0.25 REC = 100						
	45								Wet, Blue Gray Fine Grained SAND (sw); loose
			REC = 0						
	50								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

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DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/11/2007): 6.5 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Blue Gray Fine Grained SAND (sw); loose *(continued)*
									Wet, Gray Clayey SAND, some gravel (gw-gc); loose
			N = 8 REC = 40						
	55								
									Wet, Gray Silty SAND, some gravel (sm); medium dense
			N = 13						
	60								
									Wet, Blue Gray Silty CLAY, trace fine sand and gravel (cl); very soft
			N = 5 P = <0.25 REC = 20						
	65								
			N = 5 P = <0.25 REC = 100						Trace Shell Fragments
	70								
			N = 22 P = <0.25 REC = 65	11	41	21	20		Wet, Tan, Brown, Gray, and Red Clayey GRAVELwith sand (GC); medium dense
	75								

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REMARKS:

HDR Inspector – Sue Young

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LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/9/07 - 5/10/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/11/2007): 6 5 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Tan and White GRAVEL (gp); dense
	80		N = 31 REC = 25						
									Moist, Brown Clayey SILT, trace Fine Grained Sand (ml); stiff
	85		N = 9 P = 1.0 REC = 100						
									Moist, Blue Gray, and Brown Clayey SILT (ml); very stiff
	90		N = 30 P = 4.0 REC = 100						
									Boring Terminated at 90.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS8 - STA. 220+00 - 20 RT

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804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/9/07 - 5/10/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/10/2007): 6.2 ft

SURFACE ELEVATION: 55.4

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 6 REC = 40						Damp, Brown Sandy SILT (ml); loose
			N = 7 REC = 70						Moist, Brown and Rust Medium Grained SAND (sp); loose
	5		N = 8 REC = 30						Trace Gravel
				▽					Moist to Wet, Brown Sandy SILT (ml); very soft
			N = 9 P = <0.25 REC = 60						Wet, Tan and Gray SAND and Small GRAVEL (gm); loose
	10		N = 10 REC = 40						
			N = 21 REC = 100						Medium dense
	15								
			N = 23 REC = 80						Larger, rounded Gravel
	20								
			N = 21 REC = 100						Wet, Gray Medium Grained SAND (sp); loose
	25								Wet, Brown Sandy CLAY (cl) ; very soft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
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REMARKS:

HDR Inspector – Sue Young

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PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/9/07 - 5/10/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/10/2007): 6.2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			P = 0.25						Wet, Gray, Tan, and Brown SAND and GRAVEL (gm); dense *(continued)*
			P = 0.25						Wet, Gray Fat CLAY with sand (CH); soft
	30		N = 5 REC = 90	29	22	43	NP		Moist, Blue Gray Fat CLAY with Sand (CH); very soft
	35		N = 5 P = 0.5 REC = 100						Moist, Blue Gray Fine Sandy CLAY (cl); soft
	40		N = 5 P = 1.0 REC = 100						Moist, Blue Gray CLAY (cl); stiff
	45		N = 5 P = 0.5 REC = 45						Medium stiff
	50		N = 2						Moist, Blue Gray Fine Sandy CLAY (cl); very soft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
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REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

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LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/9/07 - 5/10/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/10/2007): 6 2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Blue Gray Fine Sandy CLAY (cl); very soft *(continued)*
									Wet, Gray Medium to Coarse SAND, trace gravel (sp); loose
	55		N = 7 REC = 100						
									Trace Shell Fragments
	60		N = 4 REC = 90 P = <0.25						Wet, Blue Gray Sandy SILT (ml); very soft
									Wet, Gray SAND, trace gravel (sw); loose
	65		N = 7 REC = 85 P = 0.5						Moist to Wet, Brown and Gray Clayey SILT (ml); soft
									Moist to Wet, Gray and Brown Fine Sandy SILT, trace gravel (ml); soft
	70		N = 9 P = 0.25 REC = 100						
	75		N = 17 P = 0.25 REC = 100						

N - STANDARD PENETRATION TEST RESISTANCE
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REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

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LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/9/07 - 5/10/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/10/2007): 6 2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray and Brown Silty SAND, trace gravel (sm); medium dense *(continued)*
			N = 16 P = 2.5 REC = 35						Moist to Wet, Gray and Brown Fine Sandy SILT, trace gravel (ml); very stiff
	80								Boring Terminated at 80.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS9 - STA. 221+04 - 24 LT

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804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/16/07 - 5/17/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 15 hrs (05/17/2007): 2.6 ft

SURFACE ELEVATION: 54.5

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 10 REC = 65						Damp, Brown Silty SAND (sm); loose
			N = 8 REC = 65						Trace Clay and Gravel
	5		N = 6 REC = 75						Moist, Gray Silty Fine SAND (sm); loose
			N = 5 REC = 55						
			N = 17 REC = 55						Wet, Brown, Gray, and Tan SILT, SAND, and GRAVEL (gm); loose
	10								
			N = 26 REC = 45						
	15								
			N = 20 REC = 100						
	20								
			N = 19 REC = 50						
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Offset 6 ft West, 4 ft Left due to underground utilities

HDR Inspector – Sue Young

BORING BS9 - STA. 221+04 - 24 LT

HDR Engineering Inc.
4480 Cox Road
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804.648.6630
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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/16/07 - 5/17/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 15 hrs (05/17/2007): 2.6 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Brown, Gray, and Tan SILT, SAND, and GRAVEL (gm); loose *(continued)*
			N = 6 P = <0 25 REC = 75	40	59	21	38		Moist, Blue Gray and Brown Fat CLAY (CH); very soft
	30								
			N = 4 P = <0 25 REC = 55						
	35								
			N = 7 P = <0 25 REC = 35						Trace Fine Sand
	40								
			N = 5 P = <0 25 REC = 100						
	45								
			N = 9 REC = 100						Wet, Brown, Gray, and Tan Medium and Coarse Grained SAND and GRAVEL (gm); loose
	50								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Offset 6 ft West, 4 ft Left due to underground utilities

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS9 - STA. 221+04 - 24 LT

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LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/16/07 - 5/17/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 15 hrs (05/17/2007): 2.6 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Brown, Gray, and Tan Medium and Coarse Grained SAND and GRAVEL (gm); loose *(continued)*
	55		N = 7 P = <0 25 REC = 70						Damp, Blue Gray and Brown Fine Sandy SILT (ml); very soft
	60		N = 13 P = <0.25 REC = 100						Moist
	65		N = 13 REC = 75						Wet, Gray, Tan, and Brown Medium to Coarse Grained SAND, SILT, and GRAVEL (gm); medium dense
	70		N = 7 P = 0.5 REC = 25						Moist to Wet, Brownish Gray Fine Sandy SILT (ml); soft
	75		N = 16 P = 1.0 REC = 65						Medium stiff

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Offset 6 ft West, 4 ft Left due to underground utilities

HDR Inspector – Sue Young

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NUMBER: 53410
DATE(S) DRILLED: 5/16/07 - 5/17/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 15 hrs (05/17/2007): 2 6 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist to Wet, Brownish Gray Fine Sandy SILT (ml); soft *(continued)*
			N = 23 P = 0.25 REC = 50						Trace Gravel
	80								
									Damp to Moist, Blue Gray and Brown Clayey SILT (ml); very stiff
			N = 40 P = >4.5 REC = 100						
	85								Boring Terminated at 85 0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Offset 6 ft West 4 ft Left, due to underground utilities

HDR Inspector – Sue Young

BORING BS10 - STA. 221+14 - 20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 6.5 ft
24 hr (05/16/2007): DTW 5.1 ft; caved to 6.9 ft

SURFACE ELEVATION: 53.8

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 4 REC = 45						Damp, Brown SAND and Silty SAND (sm); loose; Located on Bank of Piney Run - Sand on Surface due to Flooding
			N = 5 P = 0.25 REC = 20						Moist, Brown Clayey SILT (ml) with trace Sand; very soft
									Moist, Brown Sandy CLAY (cl); stiff
	5		N = 5 P = 2.0 REC = 50	▽					Wet, Tan, Brown, and Gray Coarse SAND and GRAVEL (gm); medium dense
			N = 17 REC = 55						
			N = 16 REC = 65						Medium Grained Sand
	10								
			N = 21 REC = 75						
	15								
			N = 13 REC = 40						
	20								
									Wet, Gray Silty SAND (sm); very loose
			P = <0.25 N = 2						Wet, Silty CLAY, trace fine grained sand (cl); very soft
	25		REC = 75						Wet, Gray Clayey SAND (sp-sc); very loose

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 7.5 ft after augers were removed
Offset 4 ft towards creek (West) due to underground utility 0.5 ft higher in elevation
HDR Inspector – Sue Young

BORING BS10 - STA. 221+14 - 20 RT

HDR Engineering Inc.
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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 6.5 ft
24 hr (05/16/2007): DTW 5 1 ft; caved to 6 9 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray Clayey SAND (sp-sc); very loose *(continued)*
	30		N = 11 REC = 50						Wet, Gray Coarse SAND, trace gravel (sp); medium dense
									Wet, Gray Fine Sandy CLAY (cl); very soft
	35		N = 9 P = <0 25 REC = 50						Wet, Gray Medium Grained SAND (sp); medium dense
	40		N = 8 P = <0.25 REC = 35						Wet, Gray Sandy CLAY (cl); very soft
									Wet, Gray Clayey SILT, trace sand (ml); very soft
	45		N = 14 P = <0.25 REC = 50						Wet, Gray Fine to Medium Grained SAND (sw); medium dense
	50		N = 7 P = <0.25 REC = 65	36	72	26	46		Moist, Blue Gray Fat CLAY, trace fine grained sand (CH); very soft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 7.5 ft after augers were removed
Offset 4 ft towards creek (West) due to underground utility 0 5 ft higher in elevation
HDR Inspector – Sue Young

BORING BS10 - STA. 221+14 - 20 RT

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DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 6.5 ft
24 hr (05/16/2007): DTW 5 1 ft; caved to 6 9 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Blue Gray Fat CLAY, trace fine grained sand (CH); very soft *(continued)*
	55		N = 5 REC = 55						Wet, Blue Gray Silty Fine SAND, trace shell fragments and wood (sm); loose
	60		N = 6 P = <0 25 REC = 30						Slightly Moist, Blue Gray Clayey SILT, trace fine grained sand (ml); very soft
	65		N = 9 P = <0 25 REC = 90						Moist, Blue Gray SILT, trace fine grained sand and shell fragments (ml); very soft
	70		N = 10 P = <0 25 REC = 100						Slightly more fine grained sand and gravel
	75		N = 6 REC = 50						Wet, Gray Medium Grained SAND (sp); loose

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 7.5 ft after augers were removed
Offset 4 ft towards creek (West) due to underground utility 0 5 ft higher in elevation
HDR Inspector – Sue Young

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 6.5 ft
24 hr (05/16/2007): DTW 5 1 ft; caved to 6 9 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray Medium Grained SAND (sp); loose *(continued)*
	80		N = 11 P = 0.75 REC = 45						Wet, Gray with some Brown Mottles Fine Grained Sandy CLAY, trace shell fragments (cl); stiff
	85		N = 23 P = 3.0 REC = 100						Moist, Gray and Brown Mottles Clayey SILT (ml); very stiff
	90		N = 38 P = 3.75 REC = 100						Boring Terminated at 90.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 7.5 ft after augers were removed
Offset 4 ft towards creek (West) due to underground utility 0 5 ft higher in elevation
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS11 - STA. 221+60 - 20 LT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/16/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 4.5 ft

SURFACE ELEVATION: 54.5

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Brown Forest Floor with Roots and SILT and SAND; very loose
			N = 3 REC = 60						Damp, Brown Silty Fine Grained SAND (sm); very loose
			N = 7 REC = 60						Gray and Brown; loose
	5		N = 7 REC = 75	▽					
			N = 25 REC = 50						Wet, Tan, Brown, and Gray SAND and GRAVEL (gm); medium dense
			N = 17 REC = 15						Gravel
	10								Wet, Tan, Brown, and Gray SAND and GRAVEL (gm); medium dense
	15		N = 16 REC = 50						
	20		N = 24 REC = 70						
	25		N = 9 REC = 40						

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 8.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/16/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 4.5 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Tan, Brown, and Gray SAND and GRAVEL (gm); medium dense *(continued)*
			N = 5 P = 1.5 REC = 45						Wet, Gray Silty CLAY, trace fine grained sand (cl); stiff
	30								Wet, Gray Fine Grained SAND (sp); loose
			N = 2 P = 0.5 REC = 65	31	62	20	42		Wet, Gray Fine Grained Sandy Fat CLAY (CH); stiff
	35								Wet, Gray Clayey Fine Grained SAND, some gravel (sp-sc); loose
			N = 7 REC = 45						
	40								Wet, Gray Silty Fine Grained SAND (sm); medium dense
			N = 16 REC = 40						
	45								Wet, Gray Fine Grained Sandy SILT (ml); very soft
			N = 6 P = 0.25 REC = 40						
	50								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 8.0 ft after augers were removed

HDR Inspector – Sue Young

BORING BS11 - STA. 221+60 - 20 LT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/16/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 4.5 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray Fine Grained Sandy SILT (ml); very soft *(continued)*
									Wet, Gray Fine to Coarse Grained SAND and GRAVEL (gm); medium dense
			N = 16 REC = 40						
	55								
			N = 12 REC = 55						
	60								
			N = 17 REC = 15						
	65								
									Moist, Blue Gray and Brown Clayey SILT (ml); very soft
			N = 9 P = 0.25 REC = 90						
	70								
			N = 25 P = 4.5 REC = 100						
	75								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 8.0 ft after augers were removed

HDR Inspector – Sue Young

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/16/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (05/15/2007): 4.5 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Blue Gray and Brown Clayey SILT (ml); very soft *(continued)*
									Damp, Gray SILT, trace fine grained sand and some fine grained sand layers <0.01 ft thick (ml); very stiff
									Damp, Gray SILT (ml); very stiff
	80		N = 43 P = >4.5 REC = 75						
									Damp, Blue/Brown and Blue SILT (ml); very stiff
			N = 32 P = >4.5 REC = 100						
	85								Boring Terminated at 85.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved at 8.0 ft after augers were removed

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS12 - STA. 221+60 - 20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (5/15/2007): 3.0 feet
24 hr (05/19/2007): DTW 4.2 ft; caved to 10.2 ft

SURFACE ELEVATION: 53.3

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Topsoil with Roots and SAND and SILT
			N = 7 REC = 60 P = 2.0						Damp, Gray and Brown Clayey SILT, trace roots (ml); stiff
			N = 6 P = 0.75						Damp, Brown and Rust Mottled Sandy CLAY (cl); medium stiff
	5		N = 8 REC = 65						Moist, Brown, Gray, and Tan SILT and GRAVEL (gm); loose
			N = 11 REC = 70						Moist, Gray Silty SAND (sm); medium dense
	10		N = 17 REC = 40						Wet, Gray SAND and GRAVEL (gm); medium dense
	15		N = 11 REC = 75						
	20		N = 16 REC = 100						Wet, Gray Medium to Coarse Grained SAND (sw); medium dense
	25		N = 7 REC = 75						Moist to Wet, Gray Silty SAND (sm); loose

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 12.0 ft after augers were removed;

HDR Inspector – Sue Young

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (5/15/2007): 3.0 feet
24 hr (05/19/2007): DTW 4 2 ft; caved to 10 2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist to Wet, Gray Silty SAND (sm); loose *(continued)*
			N = 6 REC = 90						Wet
	30								
			N = 7 P = 0.25 REC = 60						Moist to Wet, Grayish Brown Silty CLAY, trace fine grained sand (cl); very soft
	35								
			N = 14 REC = 100						Wet, Gray, Tan, and Brown GRAVEL and Fine to Coarse Grained SAND (gm); medium dense
	40								
			N = 7 P = <0 25 REC = 90						Wet, Brownish Gray Fine Sandy SILT (ml); very soft
	45								
			N = 7 P = 0.25						Moist, Brownish Gray SILT (ml); very soft
	50								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 12 0 ft after augers were removed;

HDR Inspector – Sue Young

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (5/15/2007): 3.0 feet
24 hr (05/19/2007): DTW 4.2 ft; caved to 10.2 ft

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Brownish Gray SILT (ml); very soft *(continued)*
	55		N = 10 REC = 75						Wet, Gray, Tan, and Brown SILT, SAND and GRAVEL (gm); loose
	60		N = 21 REC = 50						
	65		N = 26 REC = 90						Damp, Black and Gray SILT and WOOD fragments (ml); medium stiff
	70		N = 26 P = 4.75 REC = 100						Moist, Gray Sandy CLAY (cl); very stiff
	75		N = 46 P = 2.25 REC = 100						Moist to Wet, Gray Clayey Fine SAND (sc); dense

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 12.0 ft after augers were removed;

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/15/07 - 5/15/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
DTW at 0 hrs (5/15/2007): 3.0 feet
24 hr (05/19/2007): DTW 4 2 ft; caved to 10 2 ft

FIELD DATA				LABORATORY DATA					DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	
									Boring Terminated at 75.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
Caved to 12 0 ft after augers were removed;

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS15 - STA. 71+90 - 75 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/21/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Artesian Conditions

SURFACE ELEVATION: 70.8

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 22 REC = 50						Damp, Brown and Tan SAND, SILT, and GRAVEL, trace brick fragments (FL); medium dense
			N = 12 REC = 60						
	5		N = 5 REC = 50						
			N = 2 REC = 15						Damp, Brown, Black, and Tan SAND, SILT, and GRAVEL (gm); medium dense (possibly fill material)
			N = 4 REC = 10						
	10								
			N = 29 REC = 40						Wet, Gray and Tan Medium to Coarse Grained SAND and GRAVEL (gm); medium dense
	15								
			N = 90 REC = 25						Wet, Tan, Pink, Gray, and Brown Well Graded Coarse Grained SAND some silt and and rounded and angular gravel (SW-SM); very dense
	20								
			N = 24 REC = 30	9	NP	NP	NP		
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS15 - STA. 71+90 - 75 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/21/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Artesian Conditions

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Tan, Pink, Gray, and Brown Well Graded Coarse Grained SAND some silt and and rounded and angular gravel (SW-SM); very dense *(continued)*
									Wet, Coarse to Medium Grained SAND (sw); loose
	30		N = 5 REC = 70						
									Wet, Grayish Brown Silty Fine Grained SAND (sm); very loose to loose
	35		N = 4 REC = 100						Ground water present at ground surface before drilling on 5/18/07
									May not be a true sample; may be washings from upper strata
	40		N = 4 REC = 35						Artesian conditions measured at about 3 gpm
									May not be a true sample; may be washings from upper strata
	45		N = 7 REC = 50						
									Wet, Gray Fine Grained Sandy CLAY (cl); very soft
	50		N = 8 P = <0.25 REC = 100						

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS15 - STA. 71+90 - 75 RT

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PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/21/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Artesian Conditions

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray Fine Grained Sandy CLAY (cl); very soft *(continued)*
									Wet, Tan, Blue Gray, and Yellow Small GRAVEL (gm); loose
	55		N = 7 REC = 35						
									Wet, Blue Gray Silty CLAY (cl); very soft
			P = <0.25 N = 10 REC = 100						
	60								Wet, Blue Gray, Gray, and Tan Silty Fine Grained SAND (sm); medium dense
									Wet, Gray and Light Gray SAND and GRAVEL (gm); medium dense
	65		N = 25 REC = 50						
	70		N = 23 REC = 25						
									Wet, Gray, Tan, and Brown Silty Fine Grained SAND (sm); dense (note: sample may be wash from above)
	75		N = 32 REC = 10						

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS15 - STA. 71+90 - 75 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/21/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 rubber tired ATV

GROUNDWATER INFORMATION:
Artesian Conditions

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Blue Gray SILT, trace fine grained sand (ml); very stiff
			N = 37 P = >4 5 REC = 50						
	80								Boring Terminated at 75.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS16 - STA. 73+25 - 20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/24/07 - 5/24/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Artesian Conditions

SURFACE ELEVATION: 66.0

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Damp, Brown, SILT and SAND; (TOPS); loose
			N = 2 REC = 45						Wet, Dark Brown Silty SAND (sm); very loose
			N = 5 REC = 45						Wet, Dark Brown Medium Grained SAND (sp); loose
	5		N = 2 REC = 45						
			N = 4 REC = 40						Wet, Gray, Tan, Red, and Yellow Medium to Coarse SAND and Small GRAVEL (gm); very loose (note: may be wash from above strata)
			N = 2 REC = 10						Moist to Wet Silty CLAY, trace fine grained sand (cl); very soft
	10								
			N = 2 REC = 45						Wet, Gray Silty Fine Grained SAND (sm); very loose
	15								
			N = 2 REC = 45						
	20								
									Wet, Blue Gray Fine Grained Sandy SILT (ml); stiff
			N = 15 REC = 100						
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

BORING BS16 - STA. 73+25 - 20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/24/07 - 5/24/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Artesian Conditions

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	PL	PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Blue Gray Fine Grained Sandy SILT (ml); stiff *(continued)*
									Wet, Blue Gray Clayey Fine Grained SAND (SC); medium dense
	30		N = 22 REC = 100	27	49	18	31		
	35		N = 25 REC = 65						Very thin layers with alternating colors (blue gray, gray, brown, rust, and green)
	40		N = 40 REC = 60						Very thin layers with alternating colors (blue gray, gray, and rust)
									Moist, Blue Gray and Gray Fine Sandy SILT (ml); very stiff
	45		N = 35 P = 2.25 REC = 90						
	50		No Sample						

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Sue Young

BORING BS16 - STA. 73+25 - 20 RT

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CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/24/07 - 5/24/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Artesian Conditions

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Blue Gray and Gray Fine Sandy SILT (ml); very stiff *(continued)*
									Damp, Blue Gray SILT trace Fine Sand (ml); very stiff
	55		N = 41 P = 4.0 REC = 100						
	60		N = 29 P = 3.75 REC = 90						
	65		N = 33 P = 3.75 REC = 65						
									Boring Terminated at 65.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:

HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS17 - STA. 73+00 - 100 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/23/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Artesian Conditions

SURFACE ELEVATION: 68.5

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 4						Damp, Dark Brown CLAY, SILT, and SAND (cl); loose
			N = 4						Wet, Gray Fine SAND (sp); loose
	5		N = 4 P = 1.5						Moist, Blue Gray Sandy CLAY (cl); stiff
									Wet, Brown Silty CLAY (cl); stiff
			N = 5 P = 1.5 P = 0.5 N = 1 P = <0.25						Moist, Blue Gray Clayey SILT (ml); soft to very soft
	10								
									Moist to Wet, Dark Brown Clayey SILT (ml); very soft
			N = 3 P = <0 25						
	15								
									Wet, Gray, Tan, and Brown Medium to Coarse Grained SAND and GRAVEL (some rounded) (gm); medium dense
			N = 12						
	20								
			N = 11						
	25								

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS17 - STA. 73+00 - 100 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/23/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Artesian Conditions

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Wet, Gray Clayey Fine Grained SAND (sp); medium dense
	30		N = 11						Artesian condition first encountered at a depth of about 29 feet
	35		N = 4 P = <0 25	41	85	25	60		Wet, Gray Silty Fat CLAY, trace fine grained sand (CH); very soft to stiff
	40		N = 4 P = 1.75						
	45		N = 14						Wet, Light Brown Silty SAND (sm); medium dense
	50		N = 15 P = 1.75						Moist, Blue Gray Fine Grained Sandy Silt (ml); stiff

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Sue Young

LOG A GNNL01 7/25/07

BORING BS17 - STA. 73+00 - 100 RT

HDR Engineering Inc.
4480 Cox Road
Suite 103
Glen Allen VA 23060
804.648.6630
804.648.6124 fax

CLIENT: FHWA-EFLHD
PROJECT: Fort Belvoir Connector Road
LOCATION: Fairfax County, VA
NUMBER: 53410
DATE(S) DRILLED: 5/17/07 - 5/23/07

DRILLING METHOD(S):
Continuous Flight Hollow Stem Auger - Standard Penetration Test - CME 55 track rig

GROUNDWATER INFORMATION:
Artesian Conditions

FIELD DATA LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT REC: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
									Moist, Blue Gray Fine Grained Sandy Silt (ml); stiff *(continued)*
	55		N = 21 P = 2.5	22	53	31	22		Moist, Blue Gray and Brown Fine Grained Sandy Elastic SILT (MH); very stiff
	60		N = 23						Moist to Wet, Blue Gray Silty Fine Grained SAND (sm); medium dense
	65		N = 32						
	70		N = 31 P = >4.5						Damp to Moist, Blue Gray Clayey SILT (ml); very stiff
									Boring Terminated at 70.0 feet

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
REC - PERCENT SOIL RECOVERY

REMARKS:
HDR Inspector – Sue Young

STORMWATER MANAGEMENT BASIN AND CULVERT BORINGS

HDR	**PROJECT #:** 53410 **LOCATION:** Fort Belvoir, Fairfax, VA **STRUCTURE:** SWM-1	**PB-01** **PAGE 1 OF 1**
	STATION: 149+90 OFFSET: 121 RT LATITUDE: °N LONGITUDE: °W SURFACE ELEVATION: 36.1 ft COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 4/29/08 - 4/29/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
											0.0 / 36.1 ORGANICS (leaves and root mat) **OL**				
	35	4 6 6	65		0.5						0.4 / 35 7 Brown silty fine to medium SAND, trace gravel, medium dense to dense, moist **SM**				
2					2 2 5										
		27 20 20	85												
4					4 4.5										
		10 9 8	70								5.0 / 31 1 Gravel layer **GW**	34	14	15 7	38
6	30				6 6 5						5.2 / 30 9 Brown clayey fine to medium SAND, medium dense, moist **SC**				
1 75		8 10 11	95												
8					8 8.5						6 0 / 30 1 Brown and gray fine sandy lean CLAY very stiff, dry **CL** Grading to red-brown trace fine sand below 8 5 feet				
2 75		9 12 14	100												
10					10						Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Installed well in boring; 2 feet of PVC Riser, 5 feet Solid PVC Casing, 5 feet of Slotted PVC Screen, 3 2 feet of Bentonite, 6 2 feet of Filter Sand

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HDR	PROJECT #: 53410 LOCATION: Fort Belvoir, Fairfax, VA STRUCTURE: SWM-1	**PB-02A** PAGE 1 OF 1
	STATION: 150+34 OFFSET: 56 RT LATITUDE: °N LONGITUDE: °W SURFACE ELEVATION: 35.7 ft COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 5/2/08 - 5/2/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
	35	3			0 5						0.0 / 35.7 ORGANICS (leaves and root mat) **OL**				
		7	60								0.4 / 35 3 Brown silty GRAVEL, medium dense, slightly moist **GP-GM**				
2		6			2										
		5			2 5						1 8 / 33.9 Brown fine SANDY SILT, very stiff, slightly moist **ML**				
2		7	100												
4		13			4										
		15			4 5						4.5 / 31.2 Brown GRAVEL with sand and silt medium dense, slightly moist **GP-GM**	57	28	24 1	58
1 5	30	6	75												
6		5			6						5.0 / 30 7 Gray and orange-brown mottled fine sandy CLAY, very stiff, dry **CL**				
		5			6 5										
2 25		8	95												
8		10			8										
		8			8 5										
3 5		11	90												
10		13			10						9.8 / 25 9 Gray and brown clayey fine SAND, medium dense moist **SC** Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Caved to 6 1 feet

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PROJECT #: 53410
LOCATION: Fort Belvoir, Fairfax, VA
STRUCTURE: Pipe

PB-03

STATION: 168+33 OFFSET: 57 LT
LATITUDE: °N LONGITUDE: °W
SURFACE ELEVATION: 117.3 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 4/29/08 - 4/29/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
		6 4 3	45		0.5						0.0 / 117.3 Brown GRAVEL with sand and silt, loose, dry **GP-GM**				
2	115	4 4 4	85		2 2.5 4						2.0 / 115.3 Red brown fine sandy silty CLAY, medium stiff, moist **CL-ML** Trace gravel	22	6	13.0	60
4		2 2 3	60		4.5 6						4.6 / 112.7 Red-brown SILTY fine SAND, loose to medium dense, moist **SM** Trace well-rounded gravel below 6 feet				
6	110	6 10 11	60		6.5 8										
8		10 8 9	75		8.5 10						9.1 / 108.2 Brown and red-brown CLAYEY fine to medium SAND medium dense, moist **SC** Bottom of boring at 10.0 feet				
10															

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV

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PROJECT #: 53410 **LOCATION:** Fort Belvoir, Fairfax, VA **STRUCTURE:** Pipe		**PB-04** **PAGE 1 OF 1**
STATION: 167+67 LATITUDE: °N SURFACE ELEVATION: 104.3 ft	OFFSET: 57 RT LONGITUDE: °W COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 5/2/08 - 5/2/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP STRATA	ROCK: DIP JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
0 25		1 2 2	65	0 5						0 0 / 104.3 Root Mat **PT**				
2				2 2 5						0.2 / 104.1 Brown fine SANDY SILT soft, moist **ML**				
4	100	4 6 12	80	4 4 5						3 0 / 101.3 Brown GRAVEL with sand and silt, medium dense, moist **GP**				
1 75		4 4 6	55							5 0 / 99.3 Brown fine SANDY elastic SILT, stiff to very stiff slightly moist **MH**	74	36	20 9	51
6				6 6 5										
2 25		6 8 8	55											
8				8 8 5										
	95	7 8 9	70							9.0 / 95.3 Brown fine to coarse SAND with SILT and GRAVEL, medium dense, moist **SW**				
10				10						Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Caved to 7.6 feet

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HDR	PROJECT #: 53410 LOCATION: Fort Belvoir, Fairfax, VA STRUCTURE: SWM-2	**PB-05** PAGE 1 OF 1
	STATION: 168+56 OFFSET: 124 RT LATITUDE: °N LONGITUDE: °W SURFACE ELEVATION: 96.1 ft COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 5/2/08 - 5/2/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
4 0 FEET AT 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
0.25	95	1 1 3	75		0 5						0.0 / 96.1 Root Mat **PT**				
2					2 2 5						0.2 / 95.9 Brown SILT, soft, wet **ML**				
0 75		2 6 23	100								1.8 / 94.3 Brown CLAY, stiff, moist **CL**				
4		25 17 14	50		4 4 5						3 6 / 92.5 Brown GRAVEL with sand and silt, dense, wet **GP-GM**				
6	90	8 9 13	35		6 6 5						6.0 / 90 1 Fine to coarse SAND to trace SILT, medium dense, wet **SW-SM**	NP	NP	13 6	10
8		10 11 9	55		8 8 5										
10					10						Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Caved to 5 6 feet

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PROJECT #: 53410	**PB-06**
LOCATION: Fort Belvoir, Fairfax, VA	PAGE 1 OF 1
STRUCTURE: Infiltration Basin 3	

STATION: 177+70 OFFSET: 104 LT
LATITUDE: °N LONGITUDE: °W
SURFACE ELEVATION: 134.8 ft COORD. DATUM: NAD 83

Date(s) Drilled: 5/2/08 - 5/2/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
		1 5 14	75		0 5						0 0 / 134.8 Root Mat **PT**				
2					2						0.2 / 134 6 Brown SILTY SAND, trace gravel, medium dense, moist **SM**				
2 75		12 16 16	95		2 5						2.0 / 132 8 Gray-brown fine sandy CLAY hard to very stiff, moist **CL**				
4					4										
3 75	130	7 9 12	90		4 5						More sand with depth	34	14	13 8	72
6					6						6 0 / 128.8 Brown SILTY Fine SAND, medium dense moist **SM**				
		11 13 16	75		6 5						Gravel layer at 7.7 feet				
8					8										
		16 11 8	80		8 5						8.4 / 126.4 Orange-brown fine SAND, medium dense, moist **SP**				
10	125				10						Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Installed well in boring; 2 feet of PVC Riser 5 feet Solid PVC Casing 5 feet of Slotted PVC Screen, 2 feet of Bentonite 6 feet of Filter Sand

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PROJECT #: 53410
LOCATION: Fort Belvoir, Fairfax, VA
STRUCTURE: Infiltration Basin 4

PB-07

STATION: 183+36 OFFSET: 155 RT
LATITUDE: °N LONGITUDE: °W
SURFACE ELEVATION: 125.5 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 4/30/08 - 4/30/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
8 2 FEET AT 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
	125	2 2 1	85		0 5						0.0 / 125.5 Root Mat **PT**				
2					2						0 2 / 125.3 Brown SILTY Fine SAND, very loose, moist **SM**				
		1 2 3	90		2 5 4						2 3 / 123.2 Brown Fine SANDY CLAY, medium stiff, moist **CL**	27	9	16 3	55
4		5 7 7	75		4 5										
	120										5.0 / 120 5 Red-brown fine SAND trace rounded gravel, medium dense, very moist **SP**				
6		5 5 6	60		6 6 5										
8		10 23 19	65		8 8 5										
10					10						9 4 / 116.1 Brown GRAVEL with sand and silt, dense, moist **GP-GM** Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Installed well in boring; 2 feet of PVC Riser 5 feet Solid PVC Casing 5 feet of Slotted PVC Screen 3 7 feet of Bentonite 5.8 feet of Filter Sand.

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HDR	PROJECT #: 53410 LOCATION: Fort Belvoir, Fairfax, VA STRUCTURE: SWM-5	**PB-08** PAGE 1 OF 1
	STATION: 189+11 OFFSET: 156 LT LATITUDE: °N LONGITUDE: °W SURFACE ELEVATION: 126.7 ft COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 4/30/08 - 4/30/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
0.6 FEET AT 1.5 HOURS
NO LONG TERM MEASUREMENTS TAKEN

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)	LAB DATA: Percent Fines (%)
		1 1 1	40		0.5						0.0 / 126.7 Root Mat **PT**				
2	125				2						0.2 / 126.5 Brown fine SILTY SAND, very loose, wet **SM**				
2		3 7 7	65		2.5 4						2.0 / 124.7 Brown, orange and gray, CLAY, trace fine sand, stiff to very stiff, moist **CL**				
4.5		6 9 11	80		4.5							40	20	17.4	88
	120	21 47 50	77		6 7.3						6.2 / 120.5 Brown, red-brown and tan GRAVEL with silt and sand, very dense to dense, wet **GP-GM**				
		18 24 22	80		8.5 10						Bottom of boring at 10.0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Dry when measured through augers; water started flowing when augers were removed from boring

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HDR	PROJECT #: 53410 LOCATION: Fort Belvoir, Fairfax, VA STRUCTURE: SWM-6	**PB-09** PAGE 1 OF 1
	STATION: 195+55 OFFSET: 102 RT LATITUDE: °N LONGITUDE: °W SURFACE ELEVATION: 126.8 ft COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 4/30/08 - 4/30/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
		6 2 3	55		0 5 2						0.0 / 126.8 ORGANICS (root mat and leaves) **OL**				
2	125				2 5						0.2 / 126.6 Brown SAND and GRAVEL, loose, moist to wet **GP-GM**				
2 25 4 7 9			100		4 4.5						0 9 / 125.9 Brown CLAY, trace fine sand, very stiff, moist **CL**	33	14	16 4	85
2 5 7 9 10			70		6 6 5										
6	120	14 17 13	70		8 8 5						6.0 / 120.8 Brown CLAYEY fine to medium SAND, medium dense, moist **SC**				
8		15 14 16									7.0 / 119.8 Brown, tan, and red-brown GRAVEL with sand and silt, medium dense, moist to wet **GP-GM**				
10					10						Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Caved to 7.2 feet

PAGE 1 OF 1
PB-09

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PROJECT #: 53410 **LOCATION:** Fort Belvoir, Fairfax, VA **STRUCTURE:** SWM-7		**PB-10** **PAGE 1 OF 1**
STATION: 216+10 LATITUDE: °N SURFACE ELEVATION: 63.2 ft	OFFSET: 131 LT LONGITUDE: °W COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 4/30/08 - 4/30/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
8 1 FEET INSIDE AUGERS AT 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
0 25		1 2 3	25		0 5						0.0 / 63.2 ORGANICS (root mat and leaves) **OH**				
2					2						0 2 / 63.0 Brown fine sandy CLAY, medium stiff, moist **CL**				
1	60	4 5 7	75		2 5						2 3 / 60.9 Brown and gray silty fine SAND, medium dense, very moist to wet **SM**				
4					4										
1 75		8 6 7	70		4 5							29	6	21 8	35
6					6										
1		5 5 5	75		6 5										
8	55				8						7.8 / 55 4 Gray and brown fine SAND, very loose, wet **SP**				
		2 1 2	70		8 5										
10					10						9.8 / 53 4 Gray fine sandy CLAY, soft, wet **CL** Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Caved to 7 7 feet

SPT_LOG:BELVOIR 2008.GPJ 8.1.015:081505:5/22/08
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HDR	PROJECT #: 53410 LOCATION: Fort Belvoir, Fairfax, VA STRUCTURE: SWM-7	**PB-11** PAGE 1 OF 1
	STATION: 217+91 OFFSET: 133 LT LATITUDE: °N LONGITUDE: °W SURFACE ELEVATION: 60.2 ft COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 4/30/08 - 4/30/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
9 1 FEET INSIDE AUGERS AT 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
	60										0.0 / 60.2 ORGANICS (root mat and leaves) **OL**				
0 75		1 2 1	55		0 5 2 2 5						0.2 / 60.0 Brown Clayey Fine to medium SAND with gravel, very loose to medium dense, very moist **SC**				
2															
0 75		2 7 14	75		4 4 5							31	9	18 8	24 6
4											3 5 / 56.7 Brown fine to medium SAND, trace gravel, medium dense **SW**				
	55	20 24 23	65		6 6 5						4 4 / 55.8 Brown and gray GRAVEL with sand and silt, dense, moist **GP-GM**				
6															
		22 20 19	55		8 8 5										
8															
		19 20 18	60		10										
10											Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Installed well in boring; 2 feet of PVC Riser 5 feet Solid PVC Casing 5 feet of Slotted PVC Screen 3.1 feet of Bentonite 5.9 feet of Filter Sand.

SPT_LOG BELVOIR 2008.GPJ:8.1.015:081505:5/22/08
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PROJECT #: 53410
LOCATION: Fort Belvoir, Fairfax, VA
STRUCTURE: Infiltration Basin 8

PB-12

STATION: 224+96 OFFSET: 92 LT
LATITUDE: °N LONGITUDE: °W
SURFACE ELEVATION: 66.6 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 5/5/08 - 5/5/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
		2 2 4	70		0 5 – 2						0.0 / 66.6 ORGANICS (root mat and leaves) **OL**				
2	65	4 5 6	75		2 5 – 4						0.2 / 66.4 Brown fine sandy CLAY, medium stiff to stiff, slightly moist **CL**				
4		6 8 10	85		4 5 – 6						4.0 / 62.6 Brown Fine sandy elastic SILT, stiff to very stiff, moist **MH**	54	22	25 5	80 4
6	60	6 7 8	85		6 5 – 8										
8		4 7 9	85		8 5 – 10										
10											Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Installed well in boring; 2 feet of PVC Riser 5 feet Solid PVC Casing 5 feet of Slotted PVC Screen 2 4 feet of Bentonite, 6 6 feet of Filter Sand

SPT_LOG:BELVOIR 2008.GPJ:8.1.015:081505:5/22/08
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PROJECT #: 53410
LOCATION: Fort Belvoir, Fairfax, VA
STRUCTURE: Infiltration Basin 9

PB-13

STATION: 228+76 OFFSET: 89 LT
LATITUDE: °N LONGITUDE: °W
SURFACE ELEVATION: 71.9 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 5/5/08 - 5/5/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
4 3 FEET INSIDE AUGERS AT 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
		3 5 3	60		0 5 – 2						0.0 / 71.9 ORGANICS (root mat and leaves) **OL**				
2	70										0.2 / 71.7 Brown fine sandy CLAY, medium stiff, moist **CL**				
		4 2 3	65		2 5 – 4						2.4 / 69.5 Tan SILTY Fine to medium SAND with gravel loose to dense very moist **SM**	NP	NP	20 3	10 7
4															
		8 12 13	75		4 5 – 6										
6															
	65	8 10 14	80		6 5 – 8						Slightly coarser sand, no gravel below 7 feet				
8															
		15 16 16	55		8 5 – 10										
10											9 7 / 62.2 Tan CLAYEY Fine SAND, medium dense, wet **SC**				
											Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV.
Installed well in boring; 2 feet of PVC Riser 5 feet Solid PVC Casing 5 feet of Slotted PVC Screen 2.5 feet of Bentonite, 7 feet of Filter Sand

SPT_LOG:BELVOIR 2008.GPJ 8.1.015.081505.5/22/08
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HDR	PROJECT #: 53410 LOCATION: Fort Belvoir, Fairfax, VA STRUCTURE: Pipe	**PB-14** PAGE 1 OF 1
	STATION: 190+79 OFFSET: CL LATITUDE: °N LONGITUDE: °W SURFACE ELEVATION: 133.9 ft COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 5/5/08 - 5/5/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
DRY AFTER 0HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
											0.0 / 133.9 ORGANICS (root mat and leaves) **OL**				
0 75		1 1 2	50		0 5						0.2 / 133.7 Brown fine SANDY SILT, soft, wet **ML**				
2					2						1.5 / 132.4 Brown and gray Fine sandy CLAY, very stiff, moist **CL**				
4 5		7 10 11	100		2 5										
4	130				4										
		7 10 13	80		4 5							32	12	18 3	90
6					6						Gravel below 6 feet **CL**				
3 75		9 15 14	80		6 5										
8					8										
4 5	125	8 13 15	80		8 5										
10					10						Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Caved to 7 2 feet

PAGE 1 OF 1
PB-14

SPT_LOG:BELVOIR 2008.GPJ:8.1.015:081505:5/22/08

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PROJECT #: 53410 **LOCATION:** Fort Belvoir, Fairfax, VA **STRUCTURE:** Pipe		**PB-15** **PAGE 1 OF 1**
STATION: 227+30 LATITUDE: °N SURFACE ELEVATION: 71.7 ft	OFFSET: CL LONGITUDE: °W COORD. DATUM: NAD 83	

FIELD DATA

Date(s) Drilled: 5/5/08 - 5/5/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
3 3 FEET INSIDE AUGERS AT 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP STRATA	ROCK: DIP JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
2 1 5 0 25 2 75	2 4 6 8 10	70 65	2 2 4 2 3 5 5 7 10 11 19 20 9 10 11	60 80 95 95 75	0 5 2 2 5 4 4 5 6 6 5 8 8 5 10					0.0 / 71.7 ORGANICS (root mat and leaves) **OL** 0.2 / 71 5 Brown, gray, and orange Fine sandy CLAY, medium stiff, moist **CL** 4.6 / 67.1 Brown and gray silty fine SAND, medium dense, moist **SM** 6.2 / 65 5 Gray-brown and orange fine SANDY SILT, hard, slightly moist **ML** 7.9 / 63.8 Brown and gray SILTY Fine SAND, medium dense, wet **SM** Bottom of boring at 10 0 feet	37	12	24 0	46 7

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Caved to 4 3 feet

SPT_LOG:BELVOIR 2008.GPJ;8.1.015;081505;5/22/08

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PROJECT #: 53410
LOCATION: Fort Belvoir, Fairfax, VA
STRUCTURE: Pipe

PB-16

STATION: 234+08 OFFSET: CL
LATITUDE: °N LONGITUDE: °W
SURFACE ELEVATION: 71.9 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 5/5/08 - 5/5/08
Drilling Method(s): HSAs with SPTs
SPT Method: Manual Hammer
Other Test(s):
Driller: Blaine Scott/F&R
Logger: Sue Young/HDR

GROUND WATER
5.1 FEET INSIDE AUGERS AT 0 HRS
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: Core Recovery	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	Percent Fines (%)
0 75		3 4 4	60		0 5						0.0 / 71.9 ORGANICS (root mat and leaves) **OL**				
1 75	70	6 8 9	85		2 2 5						0 2 / 71.7 Brown fine SANDY elastic SILT medium stiff to very stiff slightly moist **MH**	55	22	29 3	69 1
2 25		9 12 16	80		4 4 5										
3 5	65	9 10 18	95		6 6 5						5.6 / 66 3 Gray-brown and orange SILTY Fine SAND medium dense, wet **SM**				
4 5		10 13 16	80		8 8 5						7 0 / 64 9 Blue-gray and brown silty CLAY, very stiff, moist **CL**				
					10						Bottom of boring at 10 0 feet				

REMARKS: RIG TYPE: CME-55 Rubber Tired ATV
Caved to 6 1 feet

SPT_LOG:BELVOIR 2008.GPJ:8.1.015:0815 05:5/22/08

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APPENDIX D
LABORATORY TEST RESULTS

Laboratory Test Summary Sheet

Boring/ Sample No.	Depth	LL	PL	PI	% Moisture Content	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
B- 7	0.0	56	19	37	24.2	1.7	32.8	65.5	CH	A-7-6			
B- 9	4.0	95	22	72	21.3	0.3	36.3	63.5	CH	A-7-6			
B-10	4.0	57	17	40	17.2	0.0	52.8	47.2	SC	A-7-6			
B-11	4.0	61	25	36	26.8	0.0	32.3	67.7	CH	A-7-6			
B-12	4.0	50	25	25	16.8	8.4	71.5	20.1	SC	A-2-7			
B-14	4.0	55	19	35	26.0	0.0	33.7	66.3	CH	A-7-6			
B-15	23.0	NP	NP	NP	8.6	42.7	46.3	11.1	SW-SM	A-1-a			
BS-01	4.0	38	14	24	17.7	0.4	26.0	73.6	CL	A-6			
BS-02	23.0	50	19	31	29.0	0.0	65.1	34.9	SC	A-2-7			
BS-03	33.0	68	22	46	25.1	0.0	4.1	95.9	CH	A-7-6			
BS-04	8.0	32	13	19	14.2	8.0	69.0	23.0	SC	A-2-6			
BS-05	38.0	54	21	33	31.4	0.0	23.4	76.6	CH	A-7-6			
BS-06	63.0	66	24	42	30.5	0.2	50.4	49.4	SC	A-7-6			
BS-07	73.0	41	21	19	11.0	57.5	28.6	14.0	GC	A-2-7			
BS-08	28.0	65	22	43	29.2	0.0	19.5	80.5	CH	A-7-6			
BS-09	28.0	59	21	37	40.3	0.0	8.5	91.5	CH	A-7-6			
BS-10	48.0	72	26	46	35.6	0.0	16.5	83.5	CH	A-7-6			
BS-11	33.0	62	20	43	30.9	0.0	43.5	56.5	CH	A-7-6			
BS-16	28.0	49	18	30	26.9	0.0	53.7	46.3	SC	A-7-6			
BS-17	33.0	85	25	60	41.1	0.0	8.5	91.5	CH	A-7-6			
BS-17A	53.0	53	31	22	28.1	0.0	22.5	77.5	MH	A-7-5			
MV- 1	0.7	26	15	11	10.7	22.1	40.3	37.7	SC	A-6			
MV- 3	0.7	68	21	47	25.7	0.0	1.0	99.0	CH	A-7-6			

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Lab Test Summary — Sheet 1 of 2

Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

LAB SUMMARY J60-0036T.GPJ F&R.GDT 6/28/07

Laboratory Test Summary Sheet

Boring/ Sample No.	Depth	LL	PL	PI	% Moisture Content	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
MV -4	0.8	47	18	29	19.5	11.3	4.0	84.7	CL	A-7-6			
OM- 1	0.4	NP	NP	NP	13.2	8.6	58.0	33.4	SM	A-2-4			
OM- 4	0.7	43	16	27	15.4	5.6	37.4	57.1	CL	A-7-6			
OM- 6	0.7	25	16	9	8.1	40.2	44.6	15.2	SC	A-2-4			
RH- 1	1.6	57	19	39	25.0	0.0	27.6	72.4	CH	A-7-6			
RH- 4	1.2	NP	NP	NP	11.9	14.7	48.2	37.1	SM	A-4			
RH- 5	1.5	32	23	9	22.8	0.0	25.4	74.6	CL	A-4			
RH- 7	1.3	NP	NP	NP	10.5	0.0	75.3	24.7	SM	A-2-4			
RH- 8	1.5	22	14	8	13.5	17.4	43.5	39.2	SC	A-4			
RH-10	1.7	34	18	16	17.3	1.7	37.4	60.9	CL	A-6			
T - 3	0.8	26	15	11	6.6	39.0	45.3	15.7	SC	A-2-6			
T - 5	0.8	40	23	17	12.7	0.0	80.4	19.6	SC	A-2-6			
T - 6	0.8	25	14	11	13.3	32.6	46.7	20.6	SC	A-2-6			

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Lab Test Summary — Sheet 2 of 2

Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

Laboratory Test Summary Sheet

Boring/ Sample No.	Depth	LL	PL	PI	% Moisture Content	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
B-16	2.0	49	19	30	23.7	0.0	11.4	88.6	CL	A-7-6			
B-17	6.0	50	28	22	21.4	0.4	67.3	32.2	SC	A-2-7			
B-17	23.0	92	31	61	30.8	0.0	6.9	93.1	CH	A-7-5			
B-19	4.0	58	18	39	20.7	0.0	5.0	94.2	CH	A-7-6			
B-20A	6.0	45	18	27	18.7	0.0	28.9	71.1	CL	A-7-6			
B-20A	23.0	42	17	25	26.9	2.9	33.8	63.3	CL	A-7-6			
B-20B	18.0	27	18	9	13.5	1.9	69.7	28.5	SC	A-2-4			
B-21	0.0	23	16	7	11.8	14.1	33.4	52.5	CL-ML	A-4			
B-23	2.0	45	16	29	16.1	0.0	42.5	57.5	CL	A-7-6			
B-28	2.0	42	19	22	18.2	3.1	32.8	64.2	CL	A-7-6			
B-31	4.0	21	17	4	12.8	0.0	54.6	45.4	SC-SM	A-4			
B-35	2.0	32	18	14	18.6	5.0	29.6	65.4	CL	A-6			

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Lab Test Summary — Sheet 1 of 1

Report No.: J60-0036
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: May 2007

Laboratory Test Summary Sheet

Boring/ Sample No.	Depth	LL	PL	PI	% Natural Moisture	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
PB-01	4.5	34	20	14	15.7	18.3	43.8	37.8	SC	A-6			
PB-02A	4.5	57	29	28	24.1	19.9	22.3	57.8	CH	A-7-6			
PB-03	2.5	22	16	6	13.0	7.8	32.7	59.5	CL-ML	A-4			
PB-04	4.5	74	38	36	20.9	28.9	20.6	50.5	MH	A-7-5			
PB-05	6.5	NP	NP	NP	13.6	8.7	81.7	9.6	SW-SM	A-1-b			
PB-06	4.5	34	20	14	13.8	5.9	22.0	72.1	CL	A-6			
PB-07	2.5	27	18	9	16.3	6.1	38.7	55.2	CL	A-4			
PB-08	4.5	40	20	20	17.4	0.0	11.9	88.1	CL	A-6			
PB-09	2.5	33	19	14	16.4	0.0	15.4	84.6	CL	A-6			
PB-10	4.5	29	23	6	21.8	0.0	64.8	35.2	SM	A-2-4			
PB-11	2.5	31	22	9	18.8	36.9	38.5	24.6	SC	A-2-4			
PB-12	4.5	54	32	22	25.5	0.0	19.6	80.4	MH	A-7-5			
PB-13	2.5	NP	NP	NP	20.3	22.0	67.3	10.7	SW-SM	A-1-b			
PB-14	4.5	32	20	12	18.3	0.0	10.0	90.0	CL	A-6			
PB-15	4.5	37	25	12	24.0	0.0	53.3	46.7	SM	A-6			
PB-16	2.5	55	33	22	29.3	0.0	30.9	69.1	MH	A-7-5			

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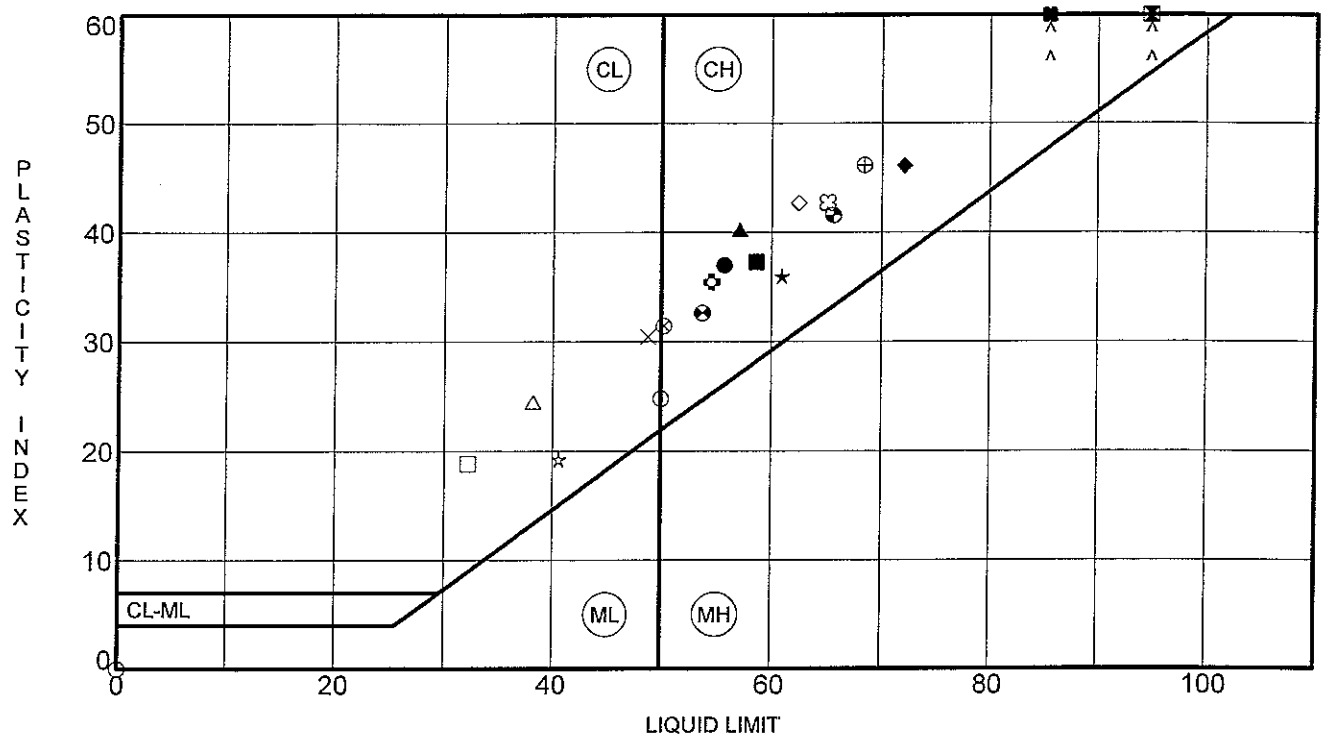
Lab Test Summary — Sheet 1 of 1

Report No.: K72-015D
Client: HDR ENGINEERING
Project: FORT BELVIOR
Location: FAIRFAX COUNTY, VA
Date: MAY 2008



Boring No.		Depth	LL	PL	PI	Fines	Classification
●	B- 7	at 0.0	56	19	37	66	SANDY FAT CLAY (CH),{A-7-6}
⊠	B- 9	at 4.0	95	22	73	63	SANDY FAT CLAY (CH),{A-7-6}
▲	B-10	at 4.0	57	17	40	47	CLAYEY SAND (SC),{A-7-6}
★	B-11	at 4.0	61	25	36	68	SANDY FAT CLAY (CH),{A-7-6}
⊙	B-12	at 4.0	50	25	25	20	CLAYEY SAND (SC),{A-2-7}
✿	B-14	at 4.0	55	19	36	66	SANDY FAT CLAY (CH),{A-7-6}
○	B-15	at 23.0	NP	NP	NP	11	WELL-GRADED SAND with SILT and GRAVEL (SW-SM),{A-1-a}
△	BS-01	at 4.0	38	14	24	74	LEAN CLAY with SAND (CL),{A-6}
⊗	BS-02	at 23.0	50	19	31	35	CLAYEY SAND (SC),{A-2-7}
⊕	BS-03	at 33.0	68	22	46	96	FAT CLAY (CH),{A-7-6}
□	BS-04	at 8.0	32	13	19	23	CLAYEY SAND (SC),{A-2-6}
⊖	BS-05	at 38.0	54	21	33	77	FAT CLAY with SAND (CH),{A-7-6}
◕	BS-06	at 63.0	66	24	42	49	CLAYEY SAND (SC),{A-7-6}
☆	BS-07	at 73.0	41	21	20	14	CLAYEY GRAVEL with SAND (GC),{A-2-7}
✿	BS-08	at 28.0	65	22	43	81	FAT CLAY with SAND (CH),{A-7-6}
■	BS-09	at 28.0	59	21	38	92	FAT CLAY (CH),{A-7-6}
◆	BS-10	at 48.0	72	26	46	83	FAT CLAY with SAND (CH),{A-7-6}
◇	BS-11	at 33.0	62	20	42	57	SANDY FAT CLAY (CH),{A-7-6}
×	BS-16	at 28.0	49	18	31	46	CLAYEY SAND (SC),{A-7-6}
⊠	BS-17	at 33.0	85	25	60	91	FAT CLAY (CH),{A-7-6}

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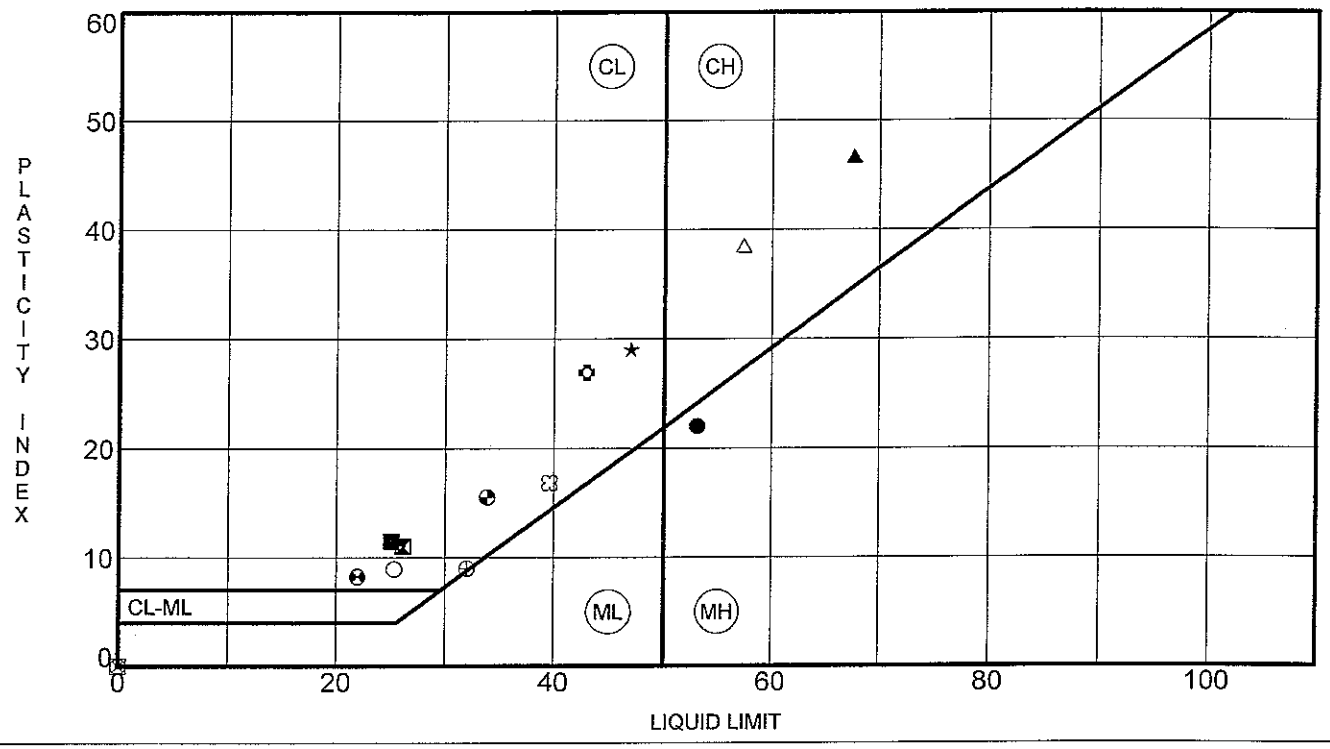
ATTERBERG LIMITS' RESULTS

Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007



Boring No.		Depth	LL	PL	PI	Fines	Classification
●	BS-17A	at 53.0	53	31	22	77	ELASTIC SILT with SAND (MH),{A-7-5}
⊠	MV- 1	at 0.7	26	15	11	38	CLAYEY SAND with GRAVEL (SC),{A-6}
▲	MV- 3	at 0.7	68	21	47	99	FAT CLAY (CH),{A-7-6}
★	MV -4	at 0.8	47	18	29	85	LEAN CLAY with GRAVEL (CL),{A-7-6}
⊙	OM- 1	at 0.4	NP	NP	NP	33	SILTY SAND (SM),{A-2-4}
✿	OM- 4	at 0.7	43	16	27	57	SANDY LEAN CLAY (CL),{A-7-6}
○	OM- 6	at 0.7	25	16	9	15	CLAYEY SAND with GRAVEL (SC),{A-2-4}
△	RH- 1	at 1.6	57	19	38	72	FAT CLAY with SAND (CH),{A-7-6}
⊗	RH- 4	at 1.2	NP	NP	NP	37	SILTY SAND (SM),{A-4}
⊕	RH- 5	at 1.5	32	23	9	75	LEAN CLAY with SAND (CL),{A-4}
□	RH- 7	at 1.3	NP	NP	NP	25	SILTY SAND (SM),{A-2-4}
⊖	RH- 8	at 1.5	22	14	8	39	CLAYEY SAND with GRAVEL (SC),{A-4}
◕	RH-10	at 1.7	34	18	16	61	SANDY LEAN CLAY (CL),{A-6}
☆	T - 3	at 0.8	26	15	11	16	CLAYEY SAND with GRAVEL (SC),{A-2-6}
⊠	T - 5	at 0.8	40	23	17	20	CLAYEY SAND (SC),{A-2-6}
■	T - 6	at 0.8	25	14	11	21	CLAYEY SAND with GRAVEL (SC),{A-2-6}

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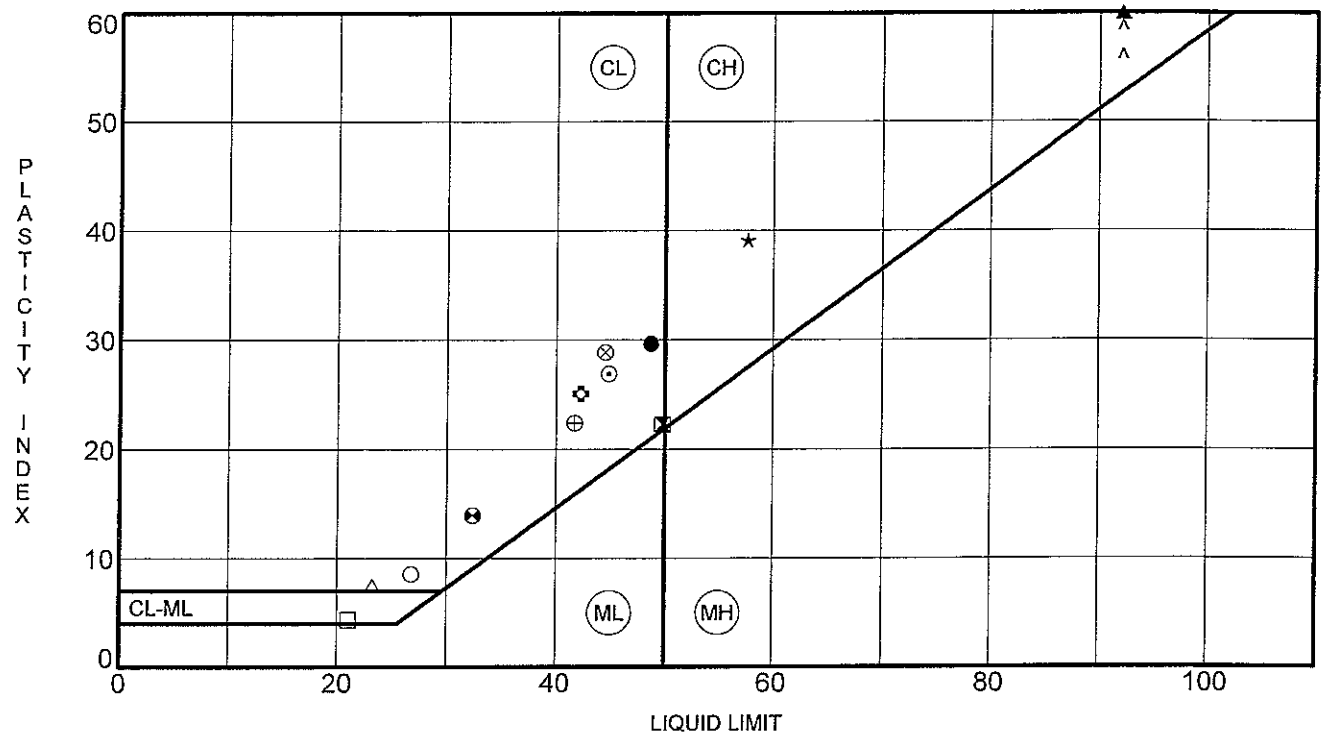
"OVER 125 YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: J60-0036T
Client: HDR, Inc
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US ATTERBERG LIMITS J60-0036T.GPJ F&R.GDT 6/28/07



Boring No.		Depth	LL	PL	PI	Fines	Classification
●	B-16	at 2.0	49	19	30	89	LEAN CLAY (CL),{A-7-6}
⊠	B-17	at 6.0	50	28	22	32	CLAYEY SAND (SC),{A-2-7}
▲	B-17	at 23.0	92	31	61	93	FAT CLAY (CH),{A-7-5}
★	B-19	at 4.0	58	18	40	94	FAT CLAY (CH),{A-7-6}
⊙	B-20A	at 6.0	45	18	27	71	LEAN CLAY with SAND (CL),{A-7-6}
✿	B-20A	at 23.0	42	17	25	63	SANDY LEAN CLAY (CL),{A-7-6}
○	B-20B	at 18.0	27	18	9	28	CLAYEY SAND (SC),{A-2-4}
△	B-21	at 0.0	23	16	7	53	SANDY SILTY CLAY (CL-ML),{A-4}
⊗	B-23	at 2.0	45	16	29	57	SANDY LEAN CLAY (CL),{A-7-6}
⊕	B-28	at 2.0	42	19	23	64	SANDY LEAN CLAY (CL),{A-7-6}
□	B-31	at 4.0	21	17	4	45	SILTY, CLAYEY SAND (SC-SM),{A-4}
⊖	B-35	at 2.0	32	18	14	65	SANDY LEAN CLAY (CL),{A-6}

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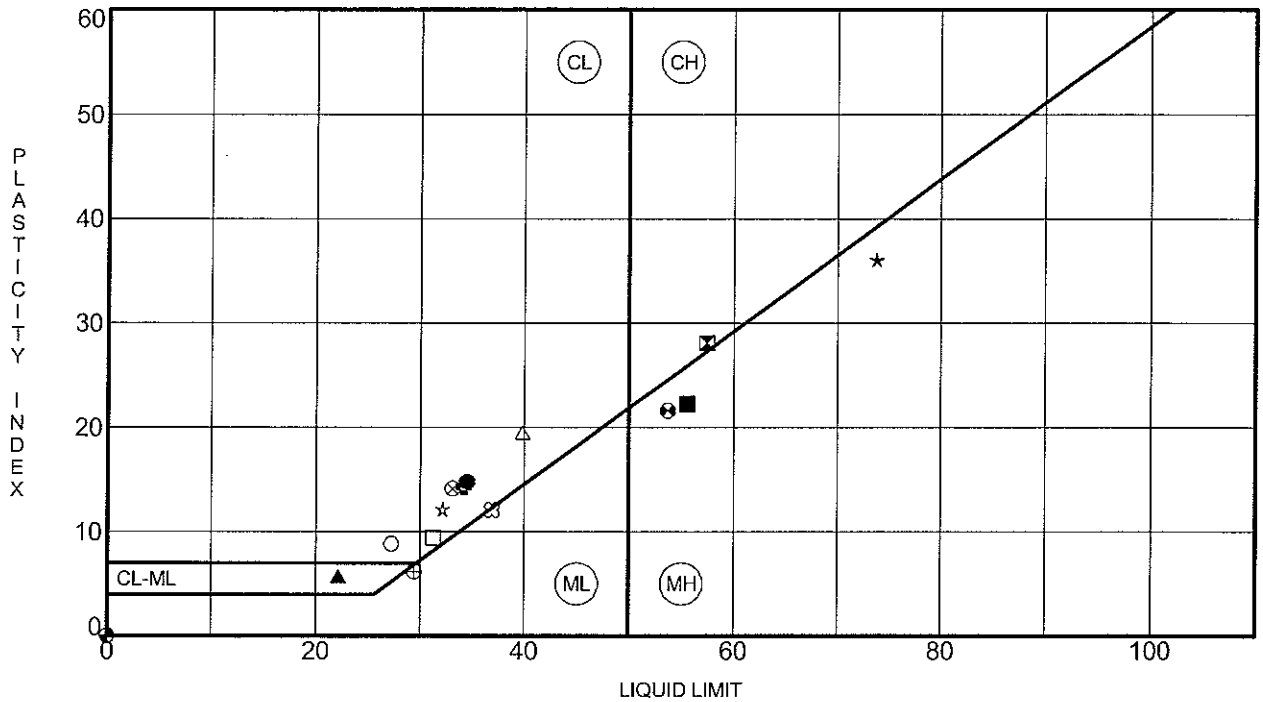
ATTERBERG LIMITS' RESULTS

Report No.: J60-0036
Client: HDR, Inc
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: May 2007

US ATTERBERG LIMITS J60-0036.GPJ F&R.GDT 6/28/07



Boring No.		Depth	LL	PL	PI	Fines	Classification
●	PB-01	at 4.5	34	20	14	38	CLAYEY SAND with GRAVEL(SC),{A-6}
⊠	PB-02A	at 4.5	57	29	28	58	SANDY FAT CLAY with GRAVEL(CH),{A-7-6}
▲	PB-03	at 2.5	22	16	6	59	SANDY SILTY CLAY(CL-ML),{A-4}
★	PB-04	at 4.5	74	38	36	51	GRAVELLY ELASTIC SILT with SAND(MH),{A-7-5}
⊙	PB-05	at 6.5	NP	NP	NP	10	WELL-GRADED SAND with SILT(SW-SM),{A-1-b}
✿	PB-06	at 4.5	34	20	14	72	LEAN CLAY with SAND(CL),{A-6}
○	PB-07	at 2.5	27	18	9	55	SANDY LEAN CLAY(CL),{A-4}
△	PB-08	at 4.5	40	20	20	88	LEAN CLAY(CL),{A-6}
⊗	PB-09	at 2.5	33	19	14	85	LEAN CLAY with SAND(CL),{A-6}
⊕	PB-10	at 4.5	29	23	6	35	SILTY SAND(SM),{A-2-4}
□	PB-11	at 2.5	31	22	9	25	CLAYEY SAND with GRAVEL(SC) {A-2-4}
⊖	PB-12	at 4.5	54	32	22	80	ELASTIC SILT with SAND(MH),{A-7-5}
◕	PB-13	at 2.5	NP	NP	NP	11	WELL-GRADED SAND with SILT and GRAVEL(SW-SM),{A-1-b}
☆	PB-14	at 4.5	32	20	12	90	LEAN CLAY(CL),{A-6}
⊠	PB-15	at 4.5	37	25	12	47	SILTY SAND(SM),{A-6}
■	PB-16	at 2.5	55	33	22	69	SANDY ELASTIC SILT(MH),{A-7-5}

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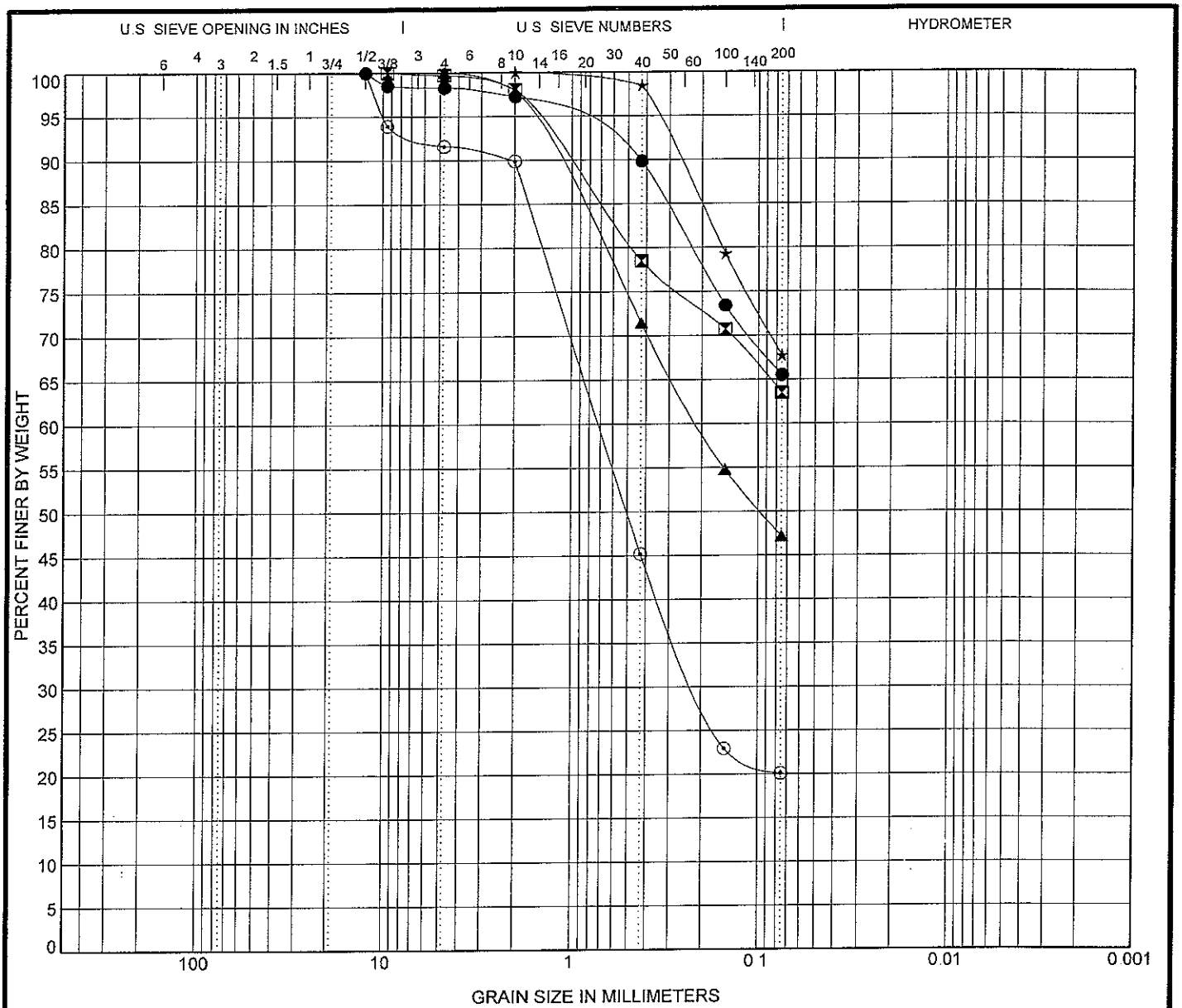
ATTERBERG LIMITS' RESULTS

Report No.: K72-015D
Client: HDR ENGINEERING
Project: FORT BELVIOR
Location: FAIRFAX COUNTY, VA
Date: MAY 2008

US ATTERBERG LIMITS LAB TEST.GPJ F&R.GDT 5/16/08



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	B- 7	at	0.0	SANDY FAT CLAY (CH)	56	19	37		
⊠	B- 9	at	4.0	SANDY FAT CLAY (CH)	95	22	73		
▲	B-10	at	4.0	CLAYEY SAND (SC)	57	17	40		
★	B-11	at	4.0	SANDY FAT CLAY (CH)	61	25	36		
⊙	B-12	at	4.0	CLAYEY SAND (SC)	50	25	25		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B- 7	at	0.0	12.5				1.7	32.8	65.5	
⊠	B- 9	at	4.0	9.5				0.3	36.3	63.5	
▲	B-10	at	4.0	4.75	0.208			0.0	52.8	47.2	
★	B-11	at	4.0	2				0.0	32.3	67.7	
⊙	B-12	at	4.0	12.5	0.709	0.209		8.4	71.5	20.1	

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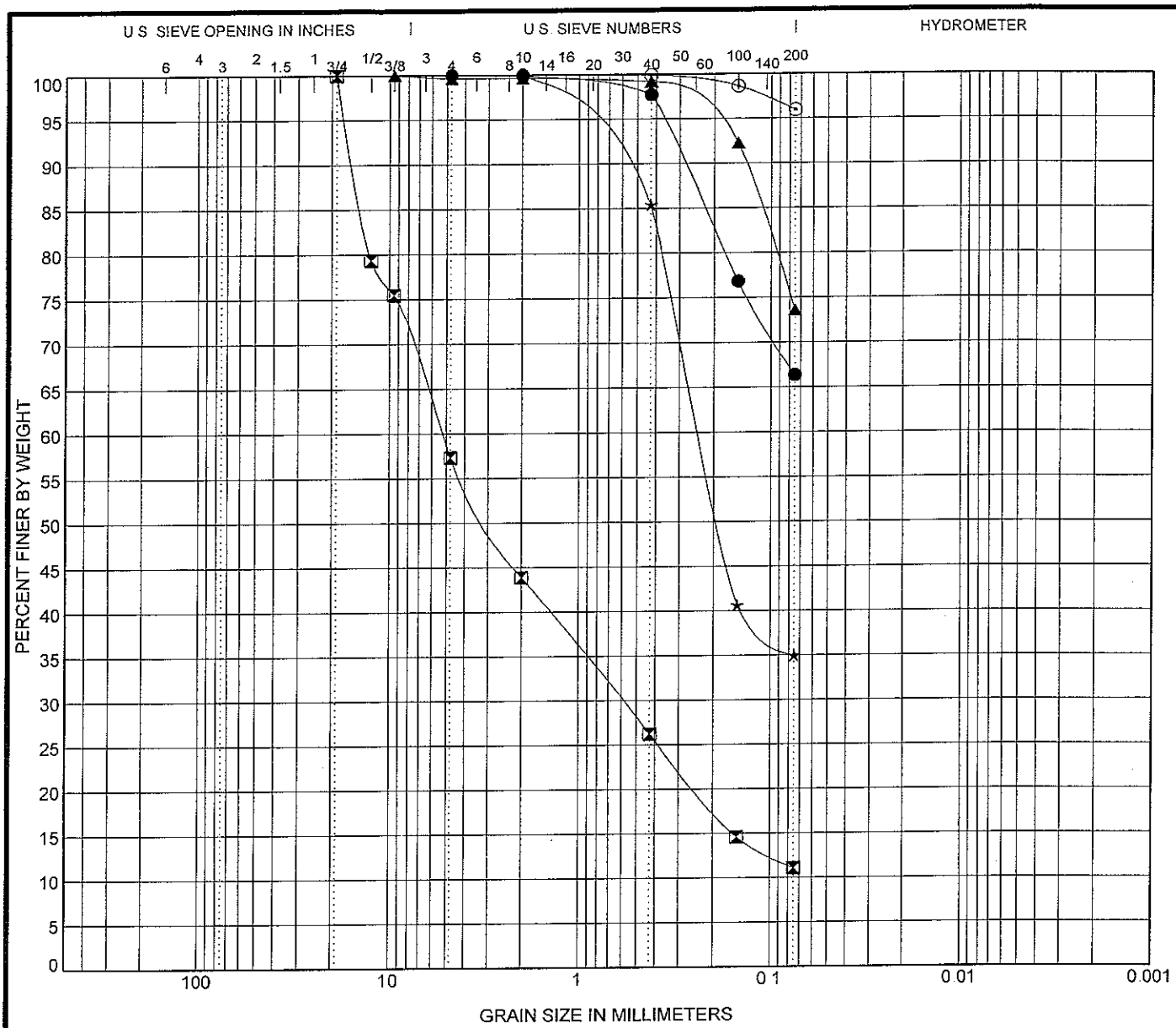
GRAIN SIZE DISTRIBUTION

Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US GRAIN SIZE J60-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	B-14	at	4.0	SANDY FAT CLAY (CH)	55	19	36		
⊠	B-15	at	23.0	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)	NP	NP	NP	1.10	86.41
▲	BS-01	at	4.0	LEAN CLAY with SAND (CL)	38	14	24		
★	BS-02	at	23.0	CLAYEY SAND (SC)	50	19	31		
⊙	BS-03	at	33.0	FAT CLAY (CH)	68	22	46		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-14	at	4.0	4.75				0.0	33.7	66.3	
⊠	B-15	at	23.0	19	5.265	0.593		42.7	46.3	11.1	
▲	BS-01	at	4.0	9.5				0.4	26.0	73.6	
★	BS-02	at	23.0	4.75	0.235			0.0	65.1	34.9	
⊙	BS-03	at	33.0	2				0.0	4.1	95.9	

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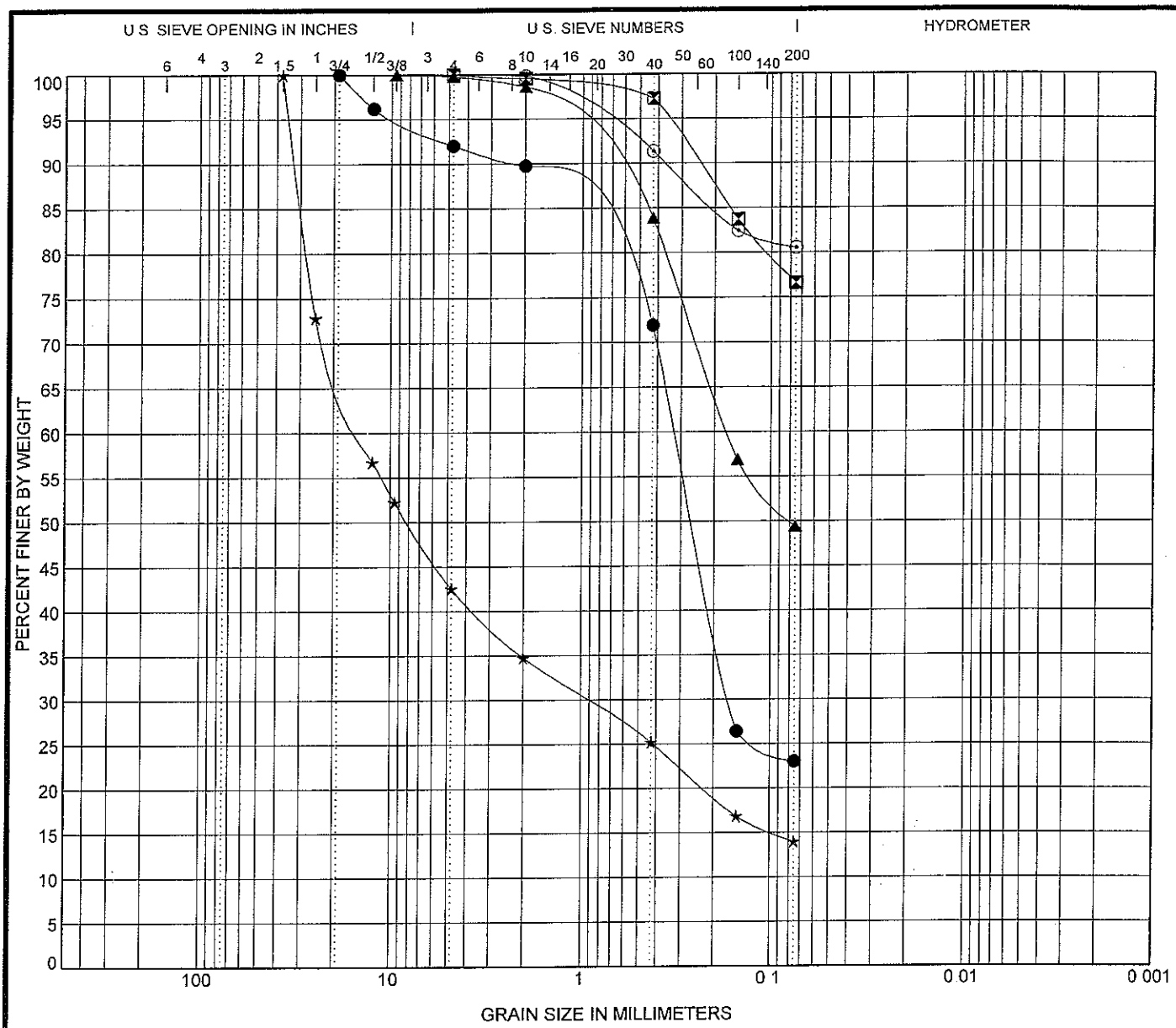
US GRAIN SIZE J60-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	BS-04	at	8.0	CLAYEY SAND (SC)	32	13	19		
⊠	BS-05	at	38.0	FAT CLAY with SAND (CH)	54	21	33		
▲	BS-06	at	63.0	CLAYEY SAND (SC)	66	24	42		
★	BS-07	at	73.0	CLAYEY GRAVEL with SAND (GC)	41	21	20		
⊙	BS-08	at	28.0	FAT CLAY with SAND (CH)	65	22	43		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BS-04	at	8.0	19	0.324	0.163		8.0	69.0	23.0	
⊠	BS-05	at	38.0	4.75				0.0	23.4	76.6	
▲	BS-06	at	63.0	9.5	0.169			0.2	50.4	49.4	
★	BS-07	at	73.0	37.5	14.39	0.928		57.5	28.6	14.0	
⊙	BS-08	at	28.0	4.75				0.0	19.5	80.5	

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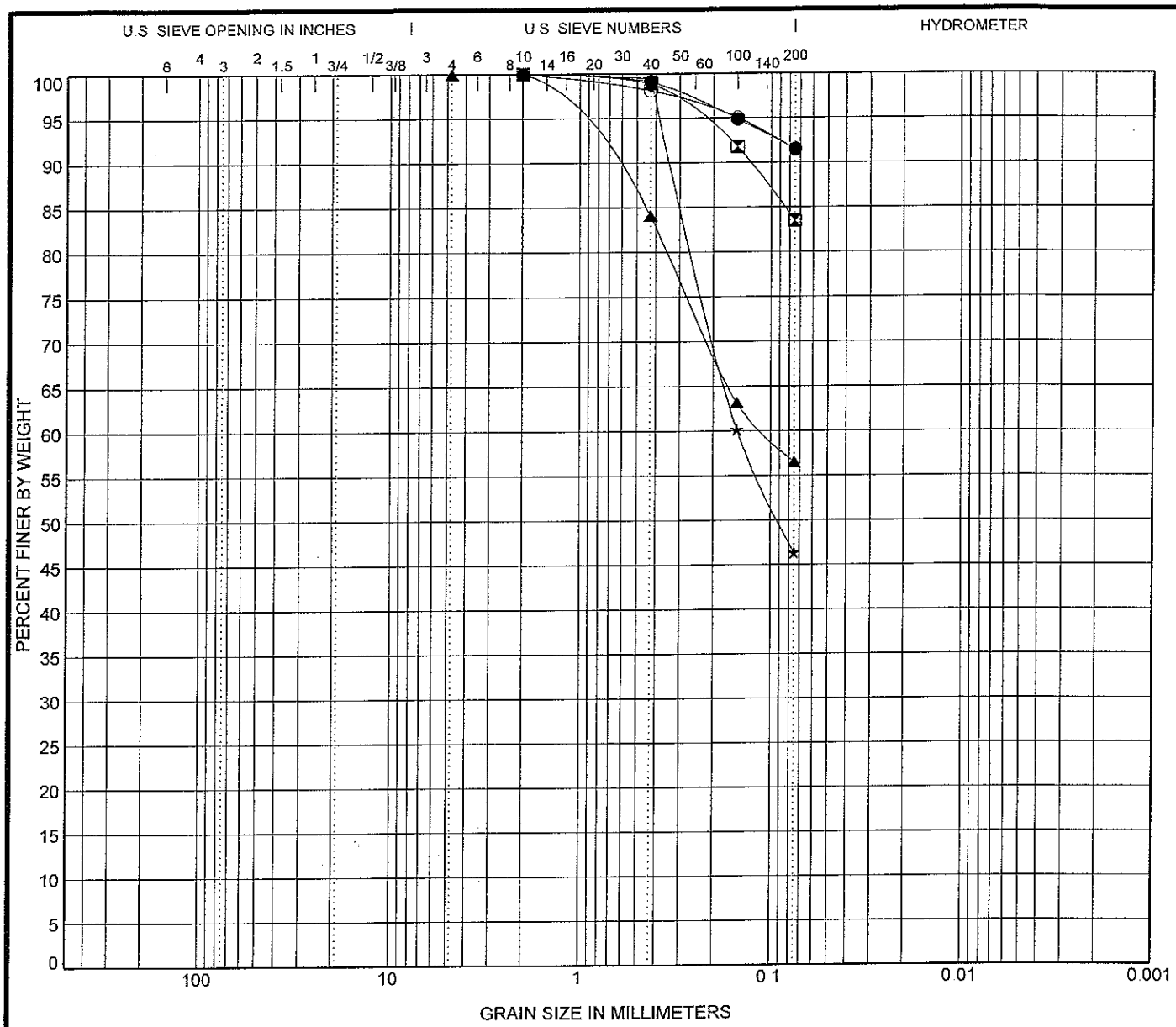
Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US GRAIN SIZE J60-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	BS-09	at	28.0	FAT CLAY (CH)	59	21	38		
⊠	BS-10	at	48.0	FAT CLAY with SAND (CH)	72	26	46		
▲	BS-11	at	33.0	SANDY FAT CLAY (CH)	62	20	42		
★	BS-16	at	28.0	CLAYEY SAND (SC)	49	18	31		
⊙	BS-17	at	33.0	FAT CLAY (CH)	85	25	60		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BS-09	at	28.0	2				0.0	8.5	91.5	
⊠	BS-10	at	48.0	2				0.0	16.5	83.5	
▲	BS-11	at	33.0	4.75	0.108			0.0	43.5	56.5	
★	BS-16	at	28.0	2	0.149			0.0	53.7	46.3	
⊙	BS-17	at	33.0	2				0.0	8.5	91.5	

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GRAIN SIZE DISTRIBUTION

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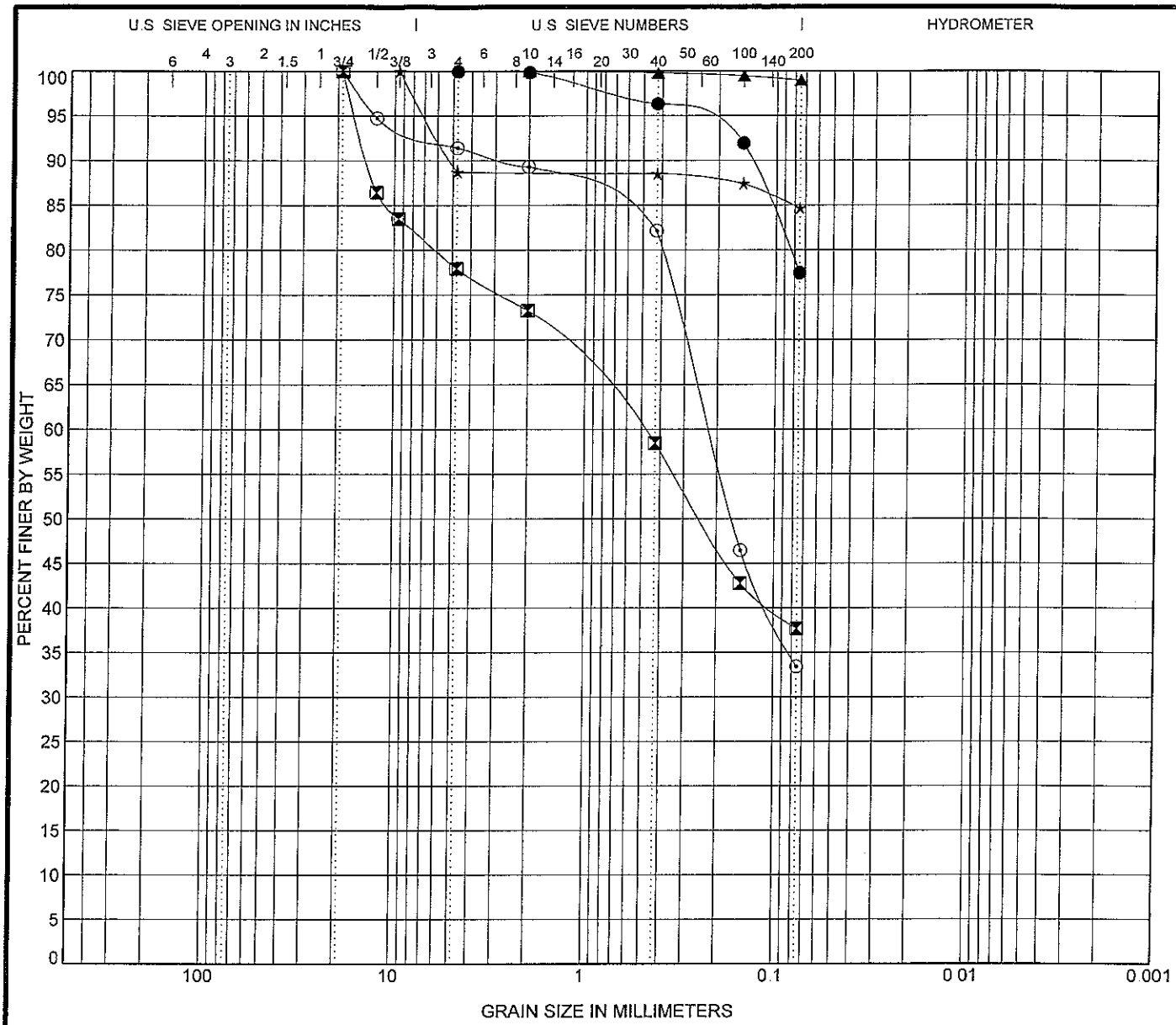
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US GRAIN SIZE J60-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	BS-17A	at	53.0	ELASTIC SILT with SAND (MH)	53	31	22		
⊠	MV- 1	at	0.7	CLAYEY SAND with GRAVEL (SC)	26	15	11		
▲	MV- 3	at	0.7	FAT CLAY (CH)	68	21	47		
★	MV -4	at	0.8	LEAN CLAY with GRAVEL (CL)	47	18	29		
⊙	OM- 1	at	0.4	SILTY SAND (SM)	NP	NP	NP		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BS-17A	at	53.0	4.75				0.0	22.5	77.5	
⊠	MV- 1	at	0.7	19	0.499			22.1	40.3	37.7	
▲	MV- 3	at	0.7	2				0.0	1.0	99.0	
★	MV -4	at	0.8	9.5				11.3	4.0	84.7	
⊙	OM- 1	at	0.4	19	0.223			8.6	58.0	33.4	

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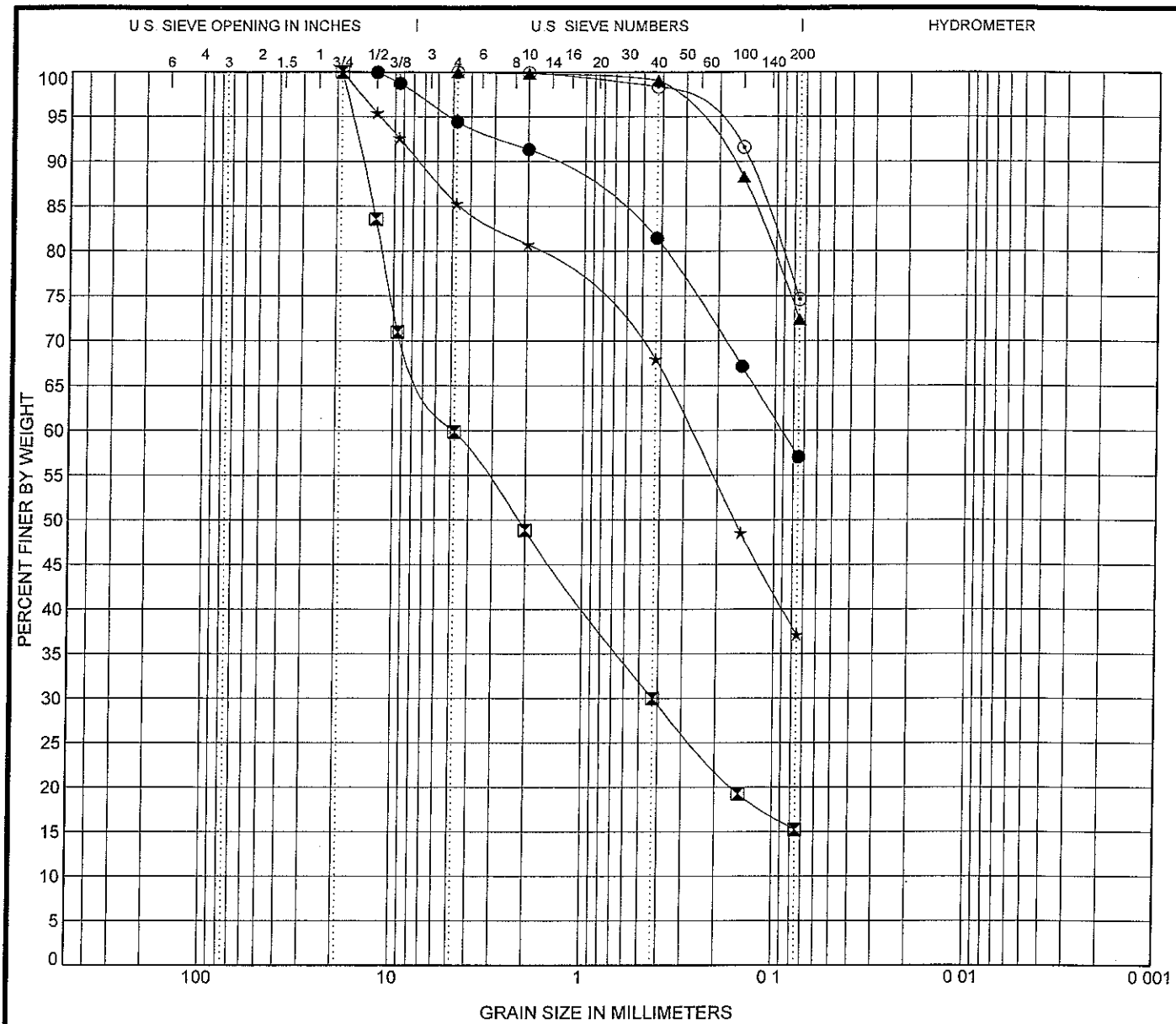
Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US GRAIN SIZE J60-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	OM- 4	at	0.7	SANDY LEAN CLAY (CL)	43	16	27		
⊠	OM- 6	at	0.7	CLAYEY SAND with GRAVEL (SC)	25	16	9		
▲	RH- 1	at	1.6	FAT CLAY with SAND (CH)	57	19	38		
★	RH- 4	at	1.2	SILTY SAND (SM)	NP	NP	NP		
⊙	RH- 5	at	1.5	LEAN CLAY with SAND (CL)	32	23	9		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	OM- 4	at	0.7	12.5	0.092			5.6	37.4	57.1	
⊠	OM- 6	at	0.7	19	4.798	0.426		40.2	44.6	15.2	
▲	RH- 1	at	1.6	4.75				0.0	27.6	72.4	
★	RH- 4	at	1.2	19	0.277			14.7	48.2	37.1	
⊙	RH- 5	at	1.5	4.75				0.0	25.4	74.6	

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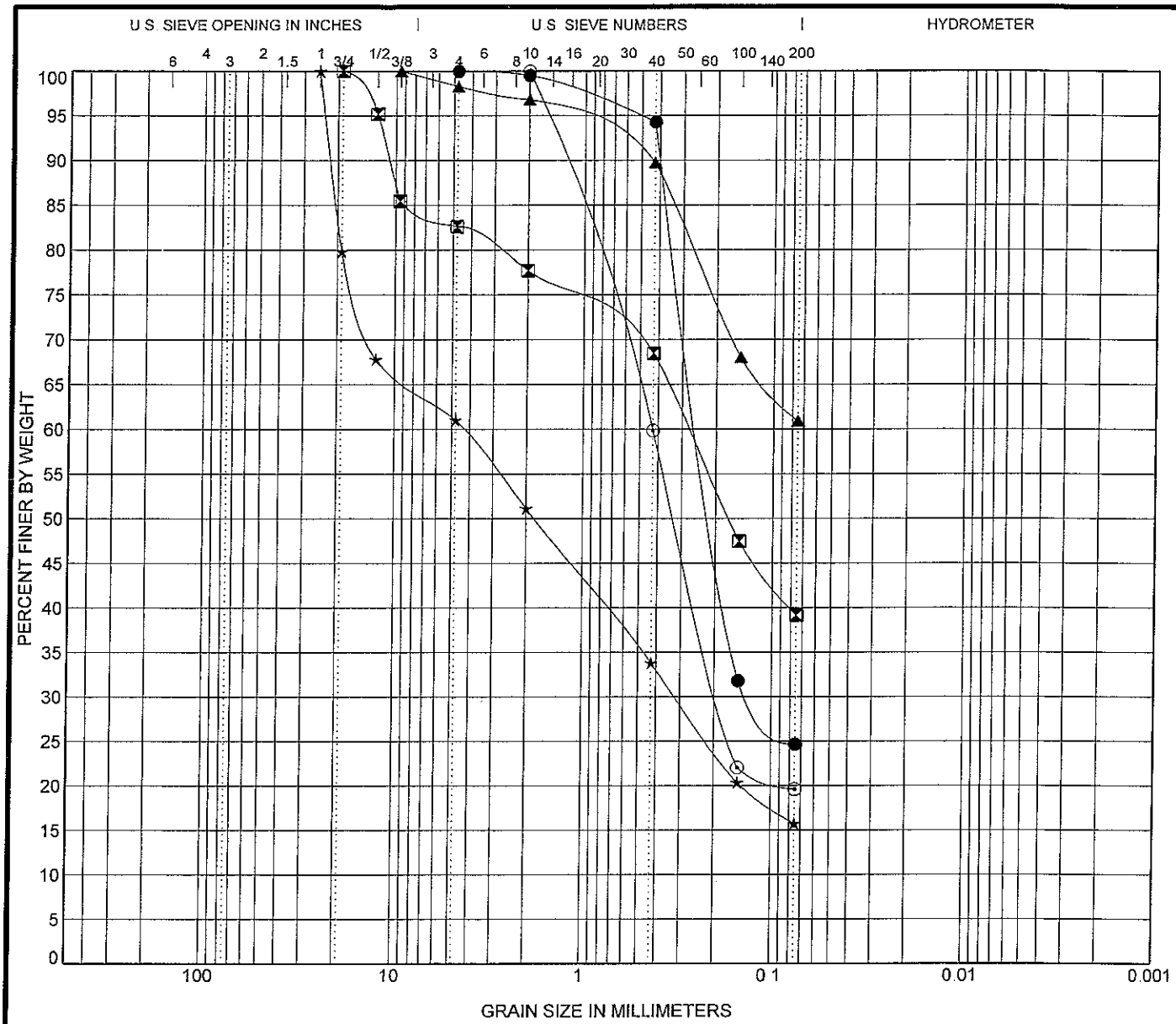
GRAIN SIZE DISTRIBUTION

Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US GRAIN SIZE 160-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	RH- 7	at	1.3	SILTY SAND (SM)	NP	NP	NP		
⊠	RH- 8	at	1.5	CLAYEY SAND with GRAVEL (SC)	22	14	8		
▲	RH-10	at	1.7	SANDY LEAN CLAY (CL)	34	18	16		
★	T - 3	at	0.8	CLAYEY SAND with GRAVEL (SC)	26	15	11		
⊙	T - 5	at	0.8	CLAYEY SAND (SC)	40	23	17		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RH- 7	at	1.3	4.75	0.24	0.126		0.0	75.3	24.7	
⊠	RH- 8	at	1.5	19	0.279			17.4	43.5	39.2	
▲	RH-10	at	1.7	9.5				1.7	37.4	60.9	
★	T - 3	at	0.8	25	4.343	0.317		39.0	45.3	15.7	
⊙	T - 5	at	0.8	4.75	0.428	0.187		0.0	80.4	19.6	

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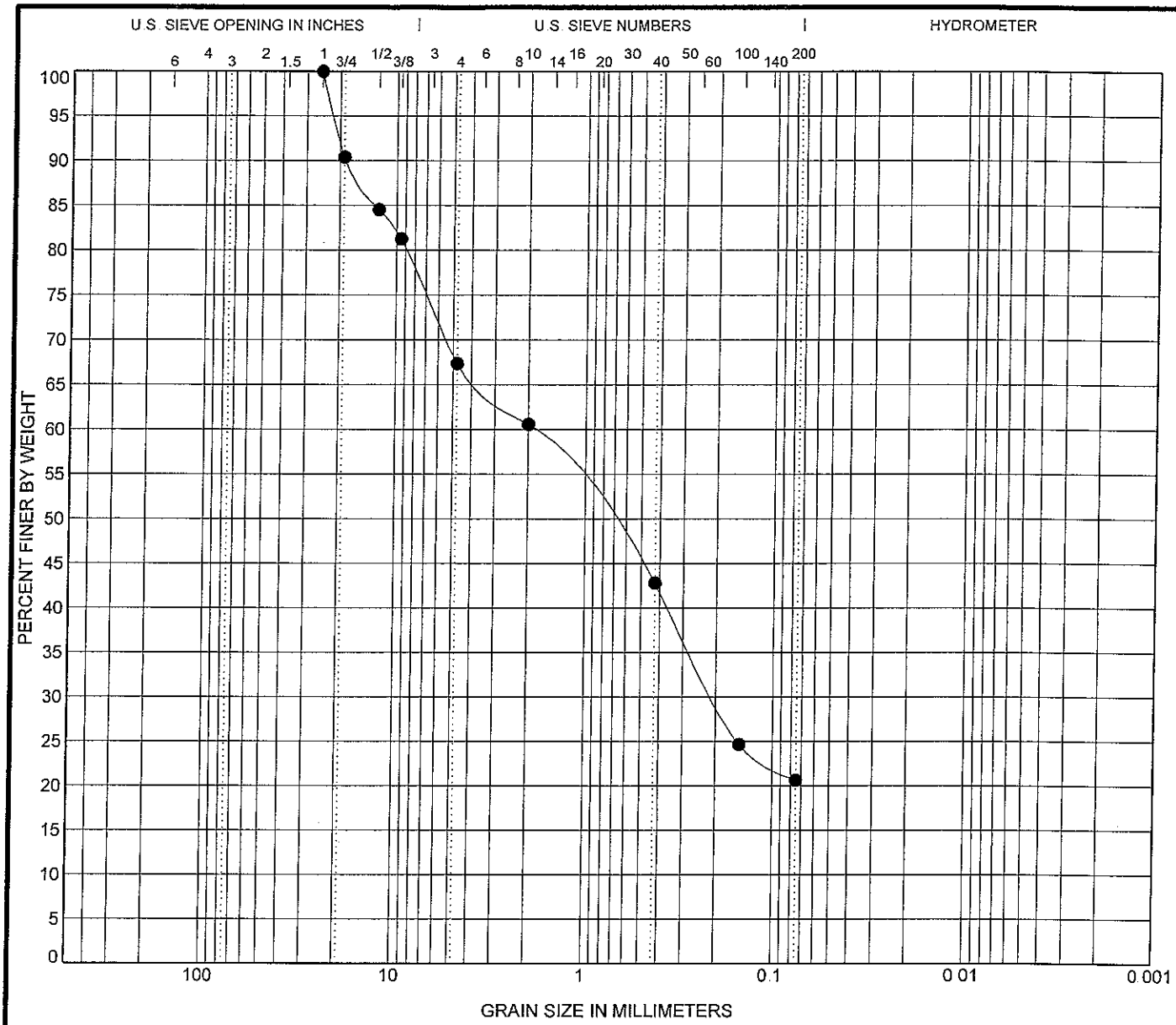
Report No.: J60-0036T
Client: HDR, Inc
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US GRAIN SIZE J60-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	T - 6	at	0.8	CLAYEY SAND with GRAVEL (SC)	25	14	11		
		at							
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	T - 6	at	0.8	25	1.902	0.204		32.6	46.7	20.6	
		at									
		at									
		at									
		at									

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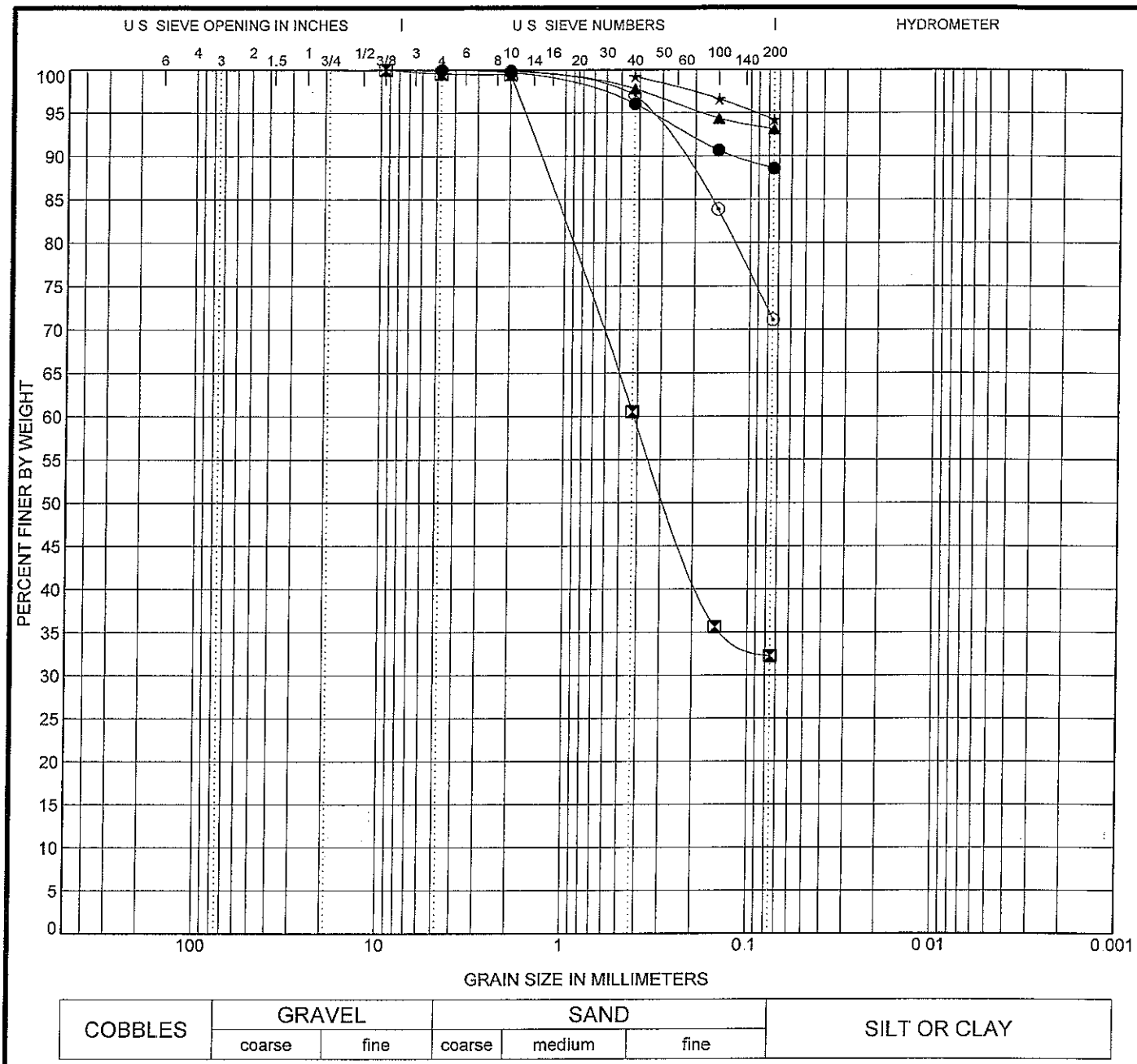
GRAIN SIZE DISTRIBUTION

Report No.: J60-0036T
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: June 2007

US GRAIN SIZE J60-0036T.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	B-16	at	2.0	LEAN CLAY (CL)	49	19	30		
⊠	B-17	at	6.0	CLAYEY SAND (SC)	50	28	22		
▲	B-17	at	23.0	FAT CLAY (CH)	92	31	61		
★	B-19	at	4.0	FAT CLAY (CH)	58	18	40		
⊙	B-20A	at	6.0	LEAN CLAY with SAND (CL)	45	18	27		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-16	at	2.0	4.75				0.0	11.4	88.6	
⊠	B-17	at	6.0	9.5	0.416			0.4	67.3	32.2	
▲	B-17	at	23.0	2				0.0	6.9	93.1	
★	B-19	at	4.0	0.425				0.0	5.0	94.2	
⊙	B-20A	at	6.0	4.75				0.0	28.9	71.1	

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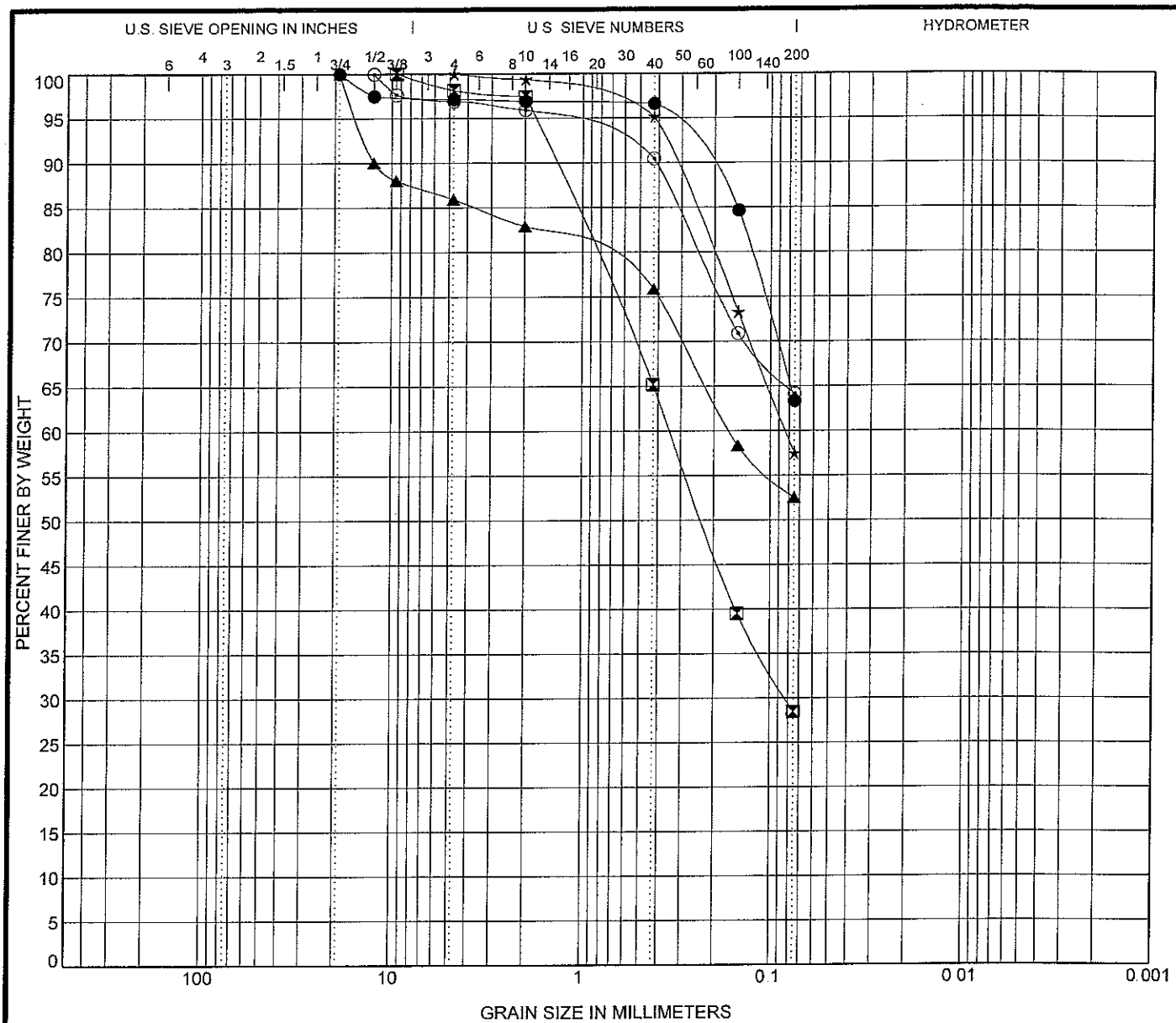
GRAIN SIZE DISTRIBUTION

Report No.: J60-0036
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: May 2007

US GRAIN SIZE J60-0036.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	B-20A	at	23.0	SANDY LEAN CLAY (CL)	42	17	25		
⊠	B-20B	at	18.0	CLAYEY SAND (SC)	27	18	9		
▲	B-21	at	0.0	SANDY SILTY CLAY (CL-ML)	23	16	7		
★	B-23	at	2.0	SANDY LEAN CLAY (CL)	45	16	29		
⊙	B-28	at	2.0	SANDY LEAN CLAY (CL)	42	19	23		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-20A	at	23.0	19				2.9	33.8	63.3	
⊠	B-20B	at	18.0	9.5	0.344	0.083		1.9	69.7	28.5	
▲	B-21	at	0.0	19	0.165			14.1	33.4	52.5	
★	B-23	at	2.0	4.75	0.084			0.0	42.5	57.5	
⊙	B-28	at	2.0	12.5				3.1	32.8	64.2	

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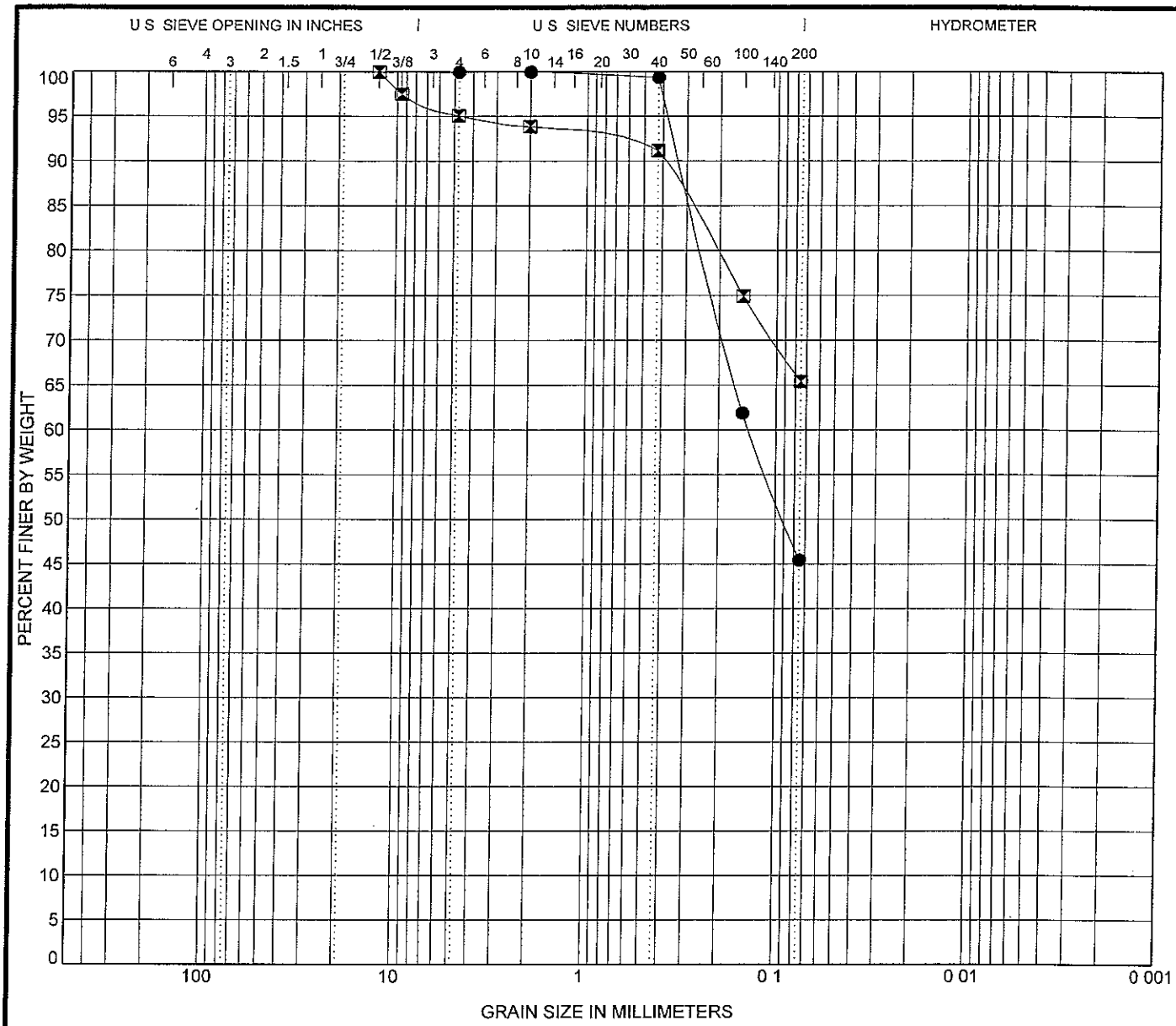
GRAIN SIZE DISTRIBUTION

Report No.: J60-0036
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: May 2007

US GRAIN SIZE J60-0036.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	B-31	at	4.0	SILTY, CLAYEY SAND (SC-SM)	21	17	4		
⊠	B-35	at	2.0	SANDY LEAN CLAY (CL)	32	18	14		
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-31	at	4.0	4.75	0.139			0.0	54.6	45.4	
⊠	B-35	at	2.0	12.5				5.0	29.6	65.4	
		at									
		at									
		at									

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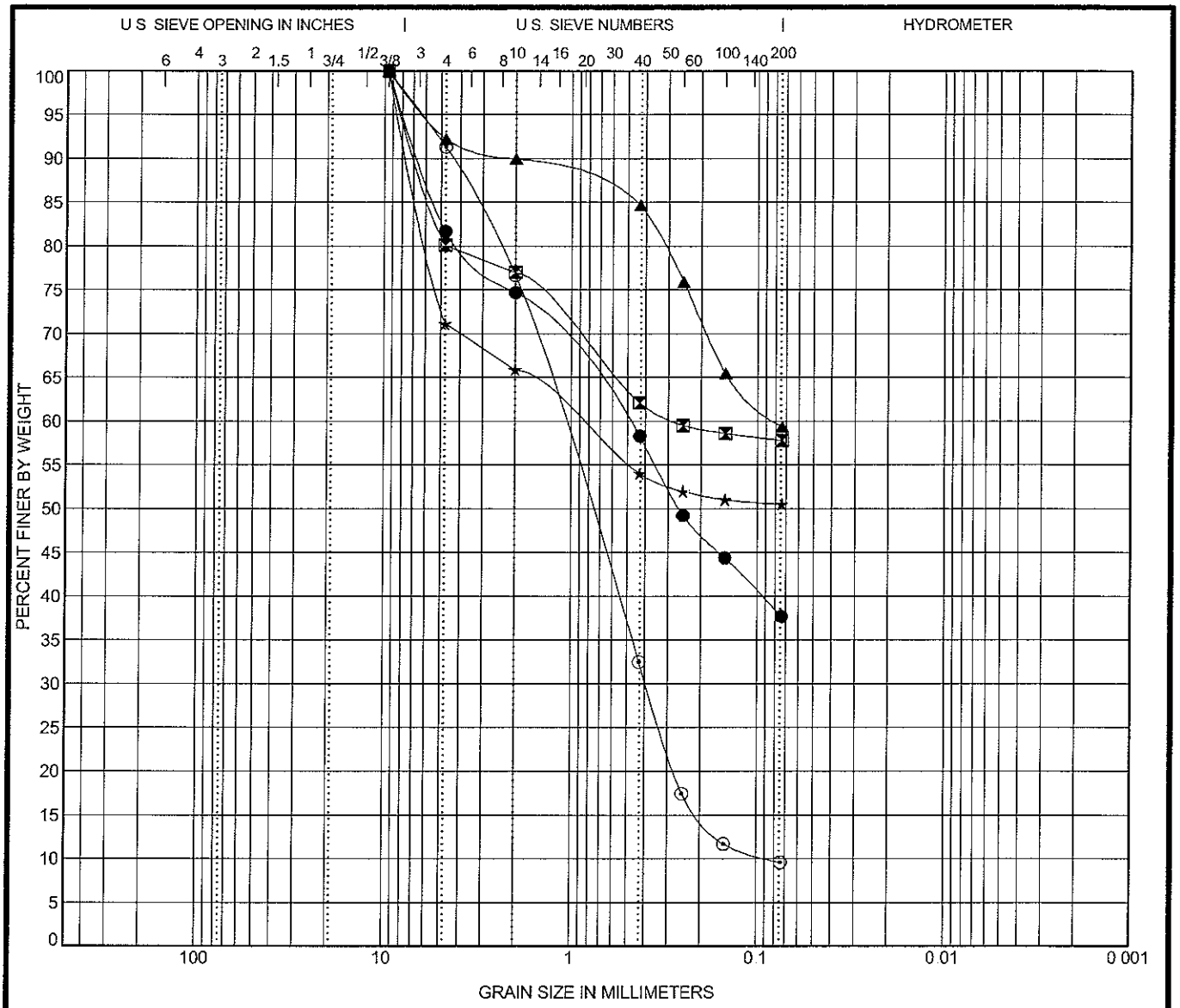
GRAIN SIZE DISTRIBUTION

Report No.: J60-0036
Client: HDR, Inc.
Project: Fort Belvoir Connector Road
Location: Fairfax County, Virginia
Date: May 2007

US GRAIN SIZE J60-0036.GPJ F&R.GDT 6/28/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	PB-01	at	4.5	CLAYEY SAND with GRAVEL(SC)	34	20	14		
⊠	PB-02A	at	4.5	SANDY FAT CLAY with GRAVEL(CH)	57	29	28		
▲	PB-03	at	2.5	SANDY SILTY CLAY(CL-ML)	22	16	6		
★	PB-04	at	4.5	GRAVELLY ELASTIC SILT with SAND(MH)	74	38	36		
⊙	PB-05	at	6.5	WELL-GRADED SAND with SILT(SW-SM)	NP	NP	NP	1.63	13.20

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	PB-01	at	4.5	9.52	0.503			18.3	43.8	37.8	
⊠	PB-02A	at	4.5	9.52	0.276			19.9	22.3	57.8	
▲	PB-03	at	2.5	9.52	0.08			7.8	32.7	59.5	
★	PB-04	at	4.5	9.52	0.931			28.9	20.6	50.5	
⊙	PB-05	at	6.5	9.52	1.119	0.393	0.085	8.7	81.7	9.6	

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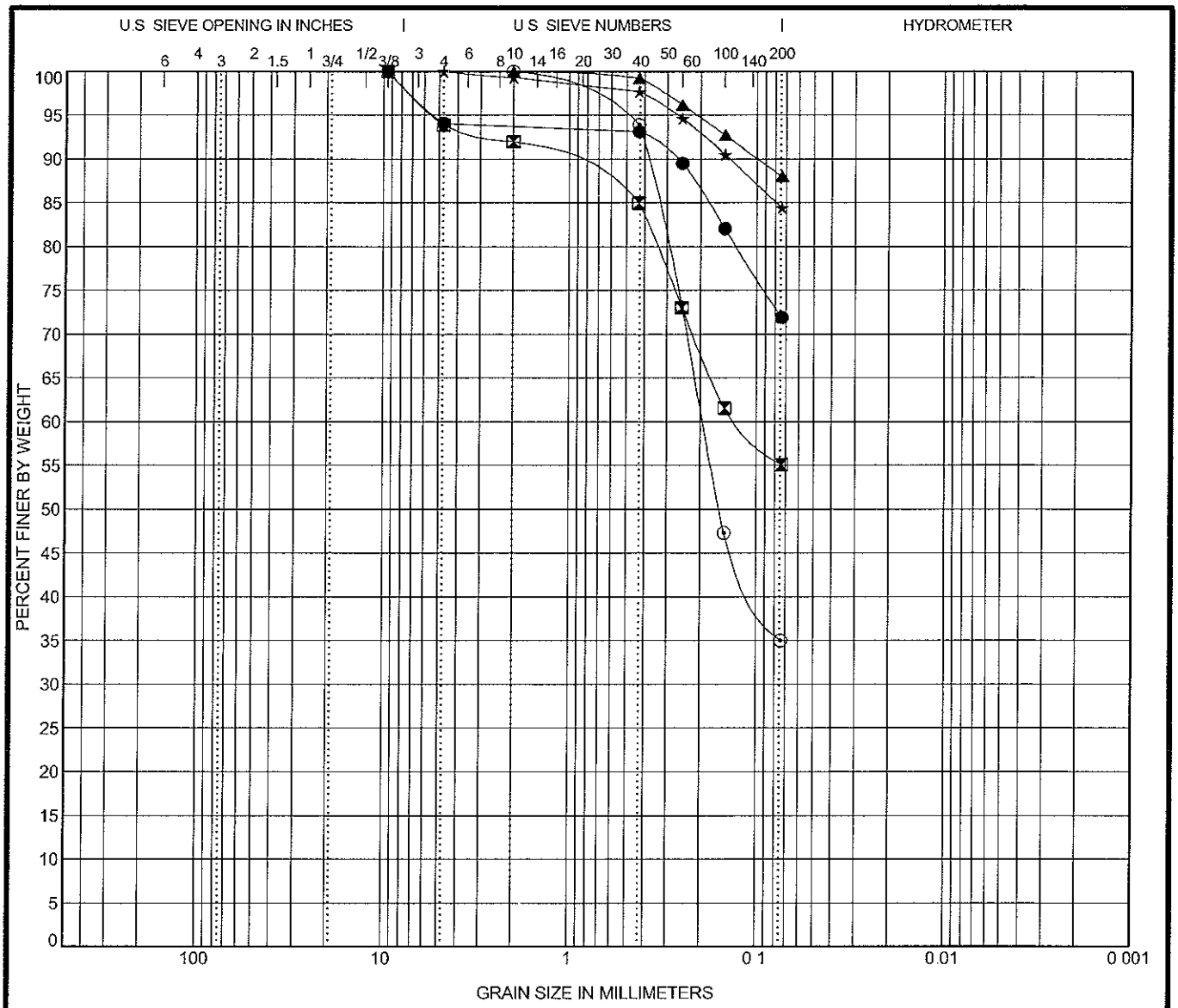
GRAIN SIZE DISTRIBUTION

Report No.: K72-015D
Client: HDR ENGINEERING
Project: FORT BELVIOR
Location: FAIRFAX COUNTY, VA
Date: MAY 2008

US GRAIN SIZE LAB TEST.GPJ F&R.GDT 5/16/08



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	PB-06	at	4.5	LEAN CLAY with SAND(CL)	34	20	14		
⊠	PB-07	at	2.5	SANDY LEAN CLAY(CL)	27	18	9		
▲	PB-08	at	4.5	LEAN CLAY(CL)	40	20	20		
★	PB-09	at	2.5	LEAN CLAY with SAND(CL)	33	19	14		
⊙	PB-10	at	4.5	SILTY SAND(SM)	29	23	6		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	PB-06	at	4.5	9.52				5.9	22.0	72.1	
⊠	PB-07	at	2.5	9.52	0.126			6.1	38.7	55.2	
▲	PB-08	at	4.5	2				0.0	11.9	88.1	
★	PB-09	at	2.5	4.76				0.0	15.4	84.6	
⊙	PB-10	at	4.5	2	0.192			0.0	64.8	35.2	

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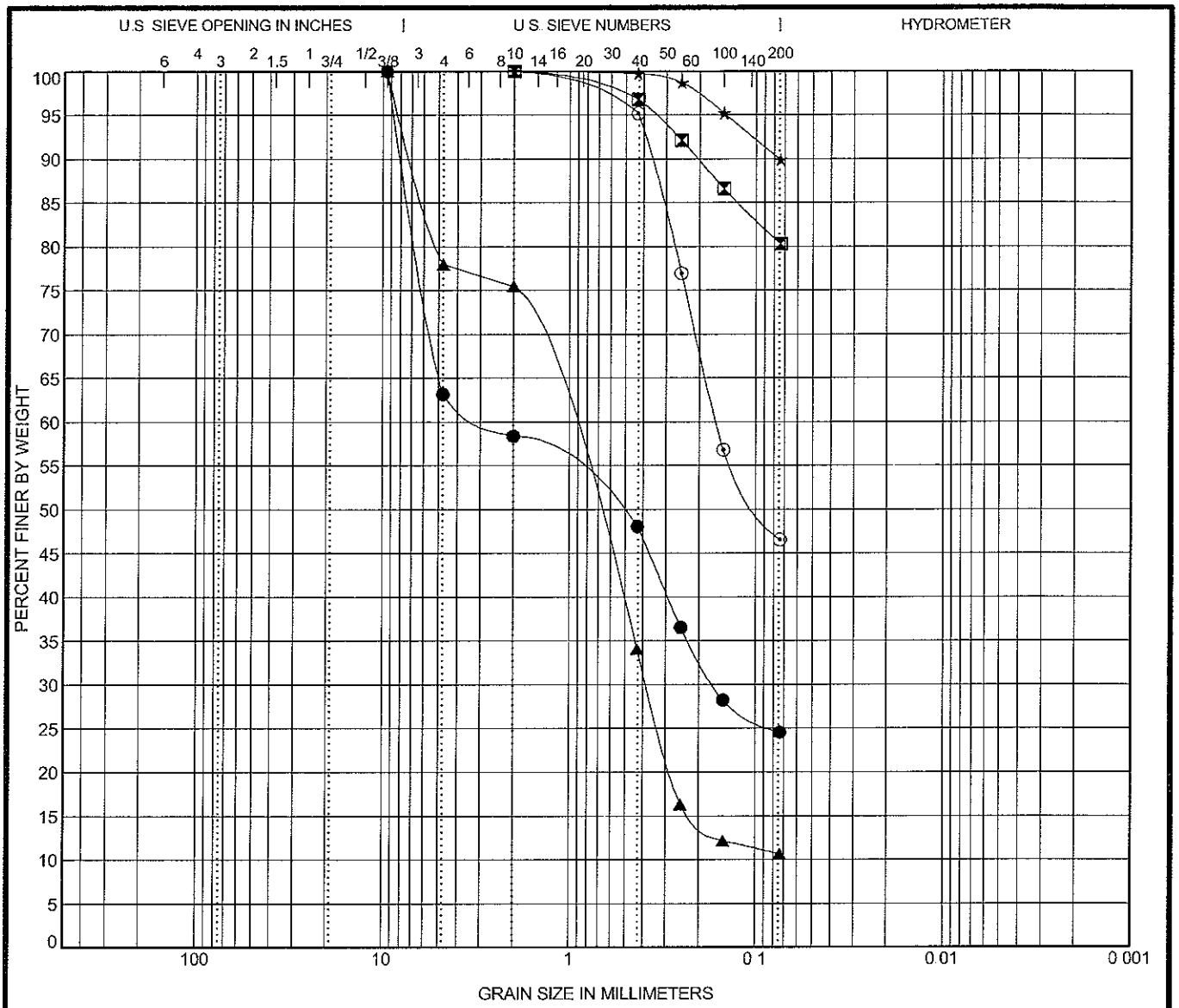
Location: FAIRFAX COUNTY, VA
Date: MAY 2008

US GRAIN SIZE LAB TEST.GPJ F&R.GDT 5/16/08



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	PB-11	at	2.5	CLAYEY SAND with GRAVEL(SC)	31	22	9		
⊠	PB-12	at	4.5	ELASTIC SILT with SAND(MH)	54	32	22		
▲	PB-13	at	2.5	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	2.31	20.32
★	PB-14	at	4.5	LEAN CLAY(CL)	32	20	12		
⊙	PB-15	at	4.5	SILTY SAND(SM)	37	25	12		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	PB-11	at	2.5	9.52	2.677	0.166		36.9	38.5	24.6	
⊠	PB-12	at	4.5	2				0.0	19.6	80.4	
▲	PB-13	at	2.5	9.52	1.126	0.38		22.0	67.3	10.7	
★	PB-14	at	4.5	2				0.0	10.0	90.0	
⊙	PB-15	at	4.5	2	0.162			0.0	53.3	46.7	

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GRAIN SIZE DISTRIBUTION

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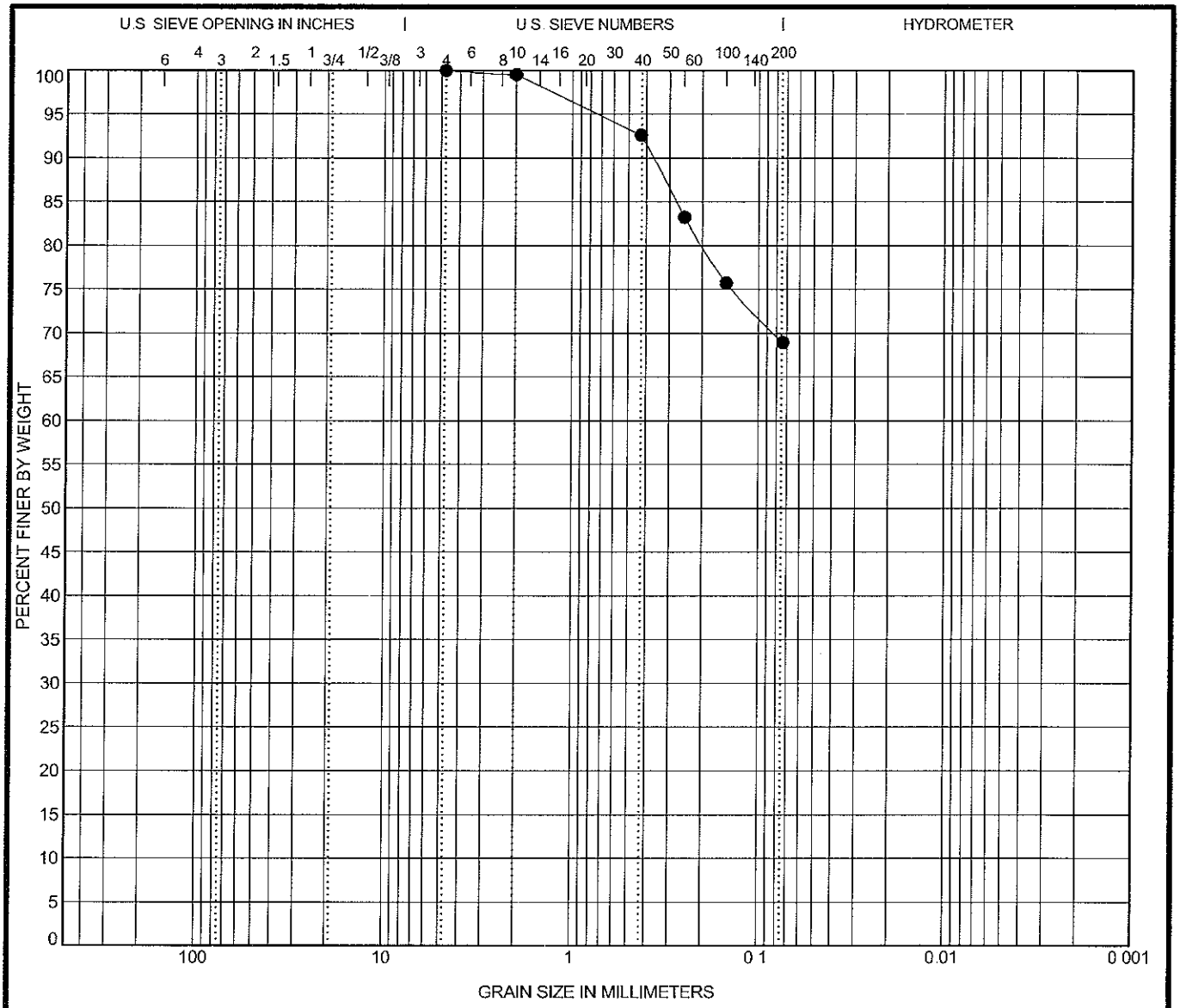
Client: HDR ENGINEERING
Project: FORT BELVIOR
Location: FAIRFAX COUNTY, VA
Date: MAY 2008

US GRAIN SIZE LAB TEST.GPJ F&R.GDT 5/16/08



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	PB-16	at	2.5	SANDY ELASTIC SILT(MH)	55	33	22		

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	PB-16	at	2.5	4.76				0.0	30.9	69.1	

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GRAIN SIZE DISTRIBUTION

Report No.: K72-015D
Client: HDR ENGINEERING
Project: FORT BELVIOR
Location: FAIRFAX COUNTY, VA
Date: MAY 2008

US GRAIN SIZE LAB TEST.GPJ F&R.GDT 5/16/08

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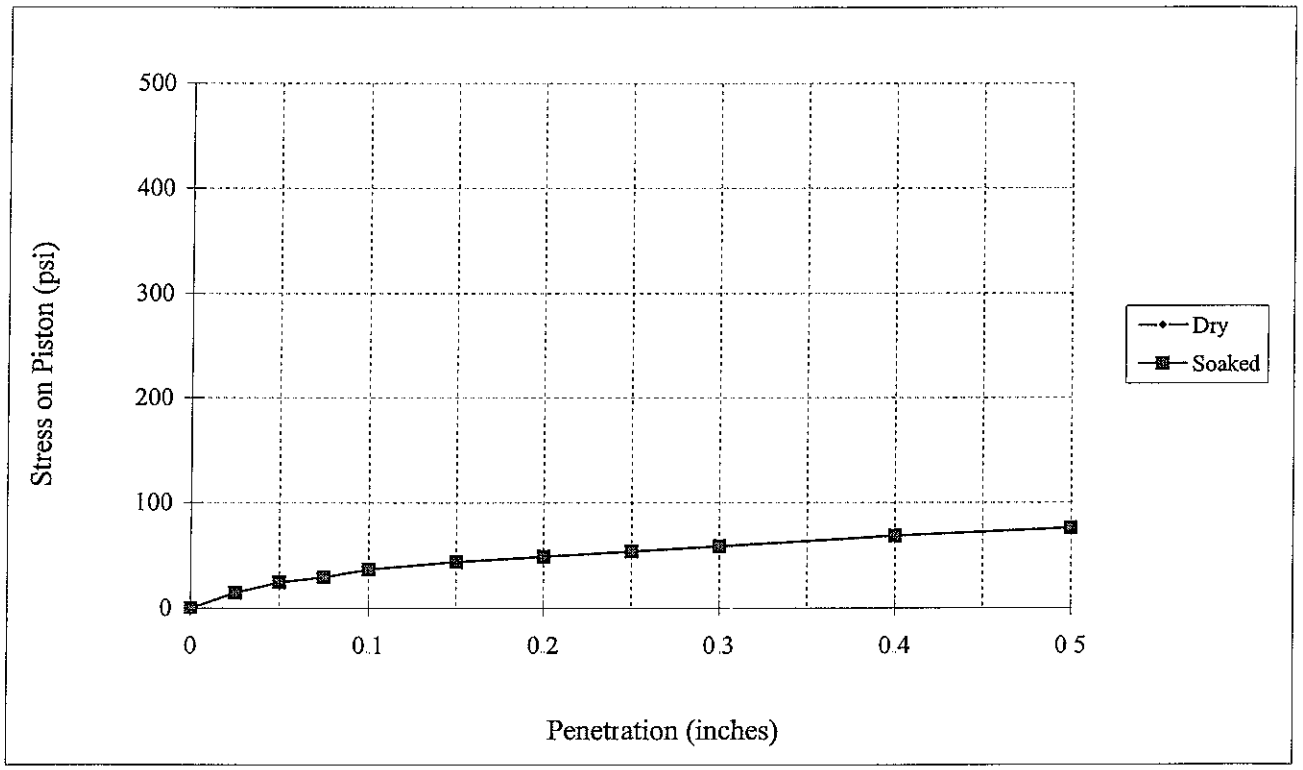
California Bearing Ratio

Project No.:	J60-0036I	Test Date:	6/18/2007
Client:	HDR Engineering, Inc	Tested By:	C.M
Project:	New Road Project - Fort Belvoir	Compaction method:	AASHTO T 193
Location:	Fort Belvoir	X	Soaked CBR
			Unsoaked CBR



CBR @ 0.1 in. penetration (dry):	0.0	Maximum Dry Density (pcf):	101.5
CBR @ 0.1 in. penetration (wet):	3.7	Optimum Moisture Content (%):	20.4
Swell (%):	0.6		
Dry Density Before Soaking (pcf):	101.3		
Dry Density After Soaking (pcf):	101.4	Visual Description:	
Retained on 3/4 inch sieve (%):	0.0	Reddish Sandy Clay	
Surcharge Weight (pounds):	10.0		
		F&R Lab No.:	102090
Moisture Content Before Soaking (%):	20.1%		
Moisture Content After Soak, Top in. (%):	24.8%	Source:	S-4
Moisture Content After Soak, Ave. (%):	21.2%		B-7 (0-6')

FROEHLING & ROBERTSON, INC.

By: _____

COMPACTION TEST REPORT

Project No.: J60-0036D **Date:** 6-11-07

Project: New Road Project - Fort Belvoir

Location: Fort Belvoir

Elev./Depth: 0-6' **Sample No.** 4 [Control #102090]

Remarks: HDR Engineering, Inc. 4480 Cox Road, Suite 103 Glen Allen, VA 230606751

MATERIAL DESCRIPTION

Description: Brown Sandy Clay [B-7 Bulk Sample]

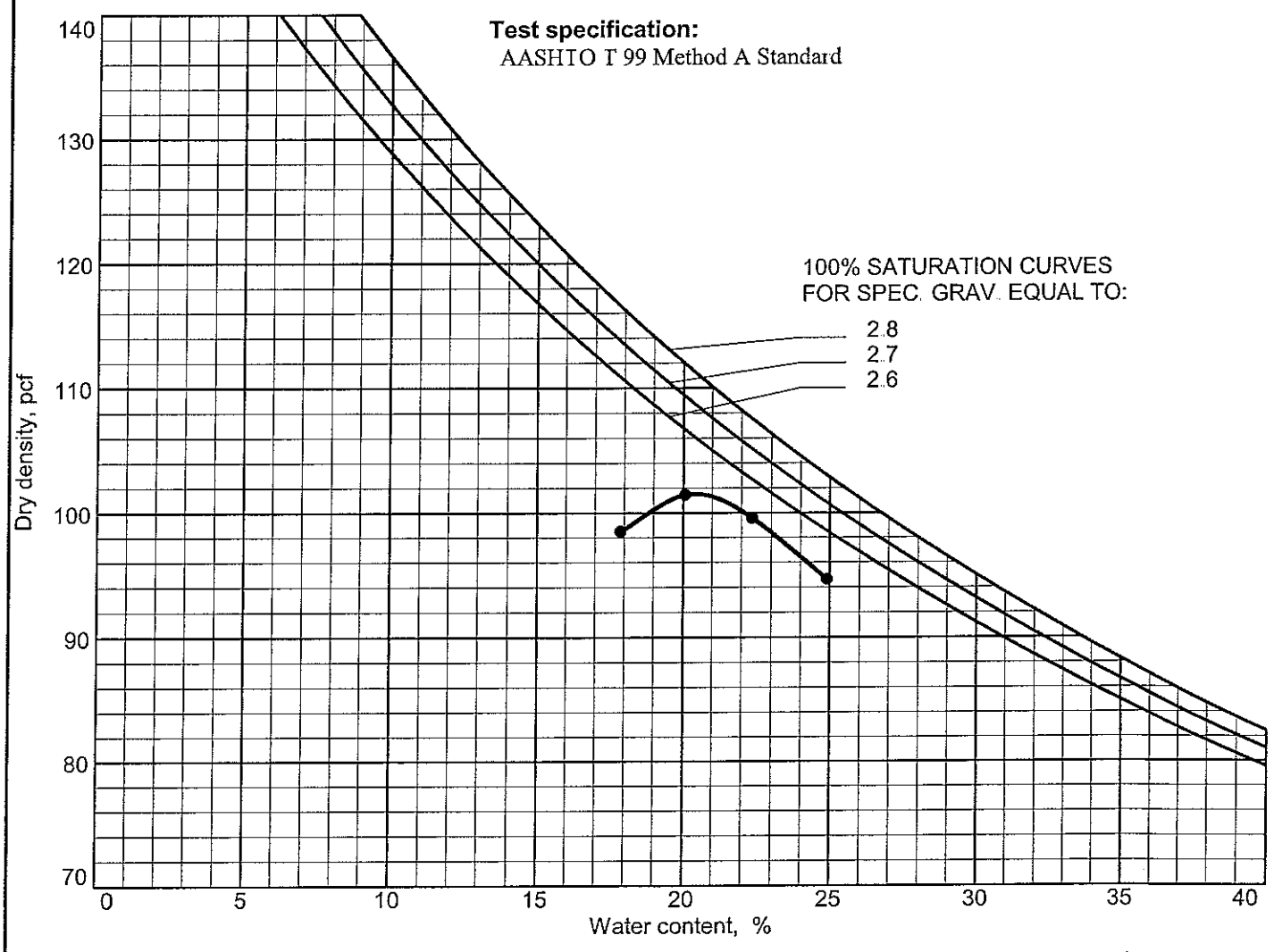
Classifications - **USCS:** **AASHTO:**

Nat. Moist. = **Sp.G. =**

Liquid Limit = **Plasticity Index =**

% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 101.5 pcf
Optimum moisture = 20.4 %



Plate

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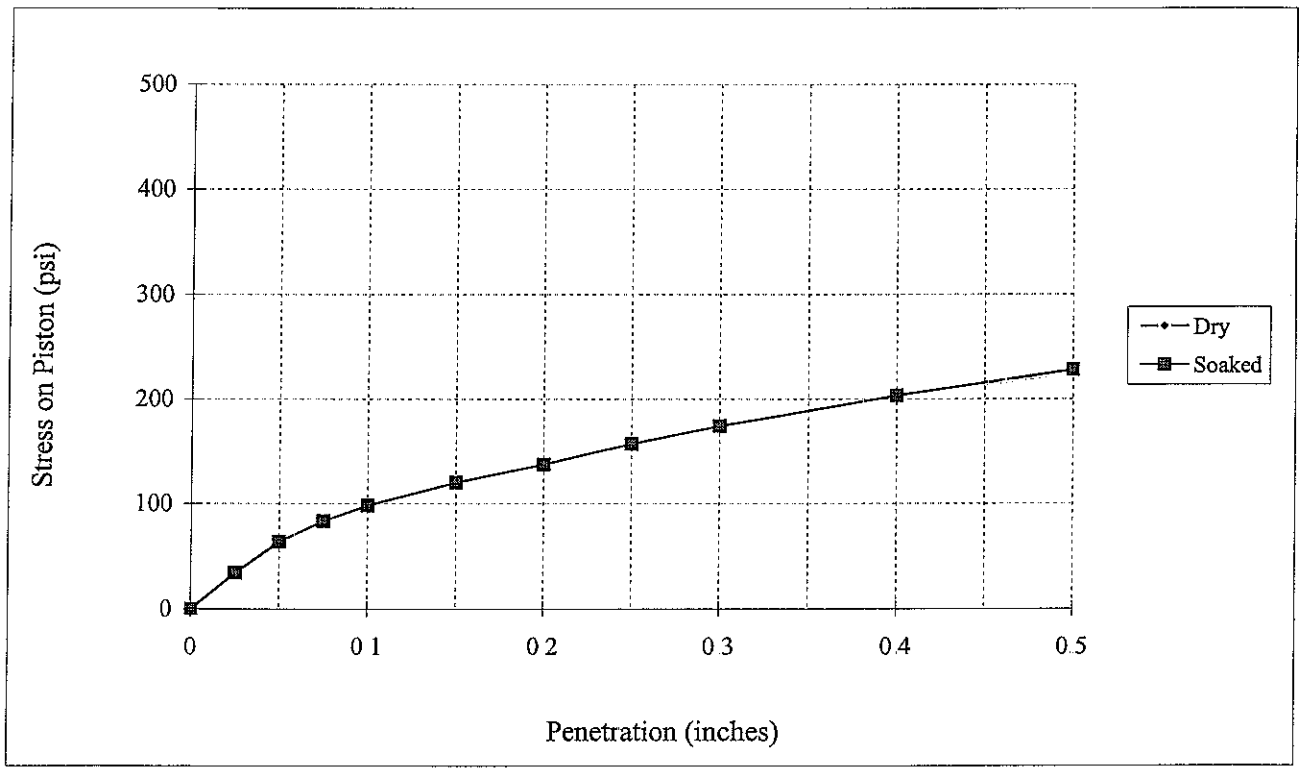
California Bearing Ratio

Project No.:	J60-00361	Test Date:	6/19/2007
Client:	HDR Engineering, Inc	Tested By:	C.M.
Project:	New Road Project - Fort Belvoir	Compaction method: AASHTO T 193	
Location:	Fort Belvoir	X	Soaked CBR
			Unsoaked CBR



CBR @ 0.1 in. penetration (dry):	0.0		
CBR @ 0.1 in. penetration (wet):	9.8	Maximum Dry Density (pcf):	118.0
Swell (%):	0.5	Optimum Moisture Content (%):	13.3
Dry Density Before Soaking (pcf):	117.0		
Dry Density After Soaking (pcf):	116.9	Visual Description:	
Retained on 3/4 inch sieve (%):	0.0	Reddish Sandy Clay	
Surcharge Weight (pounds):	10.0		
		F&R Lab No.:	102090
Moisture Content Before Soaking (%):	12.2%		
Moisture Content After Soak, Top in. (%):	15.1%	Source:	S-5
Moisture Content After Soak, Ave. (%):	12.9%		B-10 (4'-8')

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By: _____

COMPACTION TEST REPORT

Project No.: J60-0036D **Date:** 6-13-07

Project: New Road Project - Fort Belvoir

Location: Fort Belvoir

Elev./Depth: 4'-8' **Sample No.** 5 [Control #102090]

Remarks: HDR Engineering, Inc. 4480 Cox Road, Suite 103 Glen Allen, VA 230606751

MATERIAL DESCRIPTION

Description: Brown Sandy Clay [B-10 Bulk Sample]

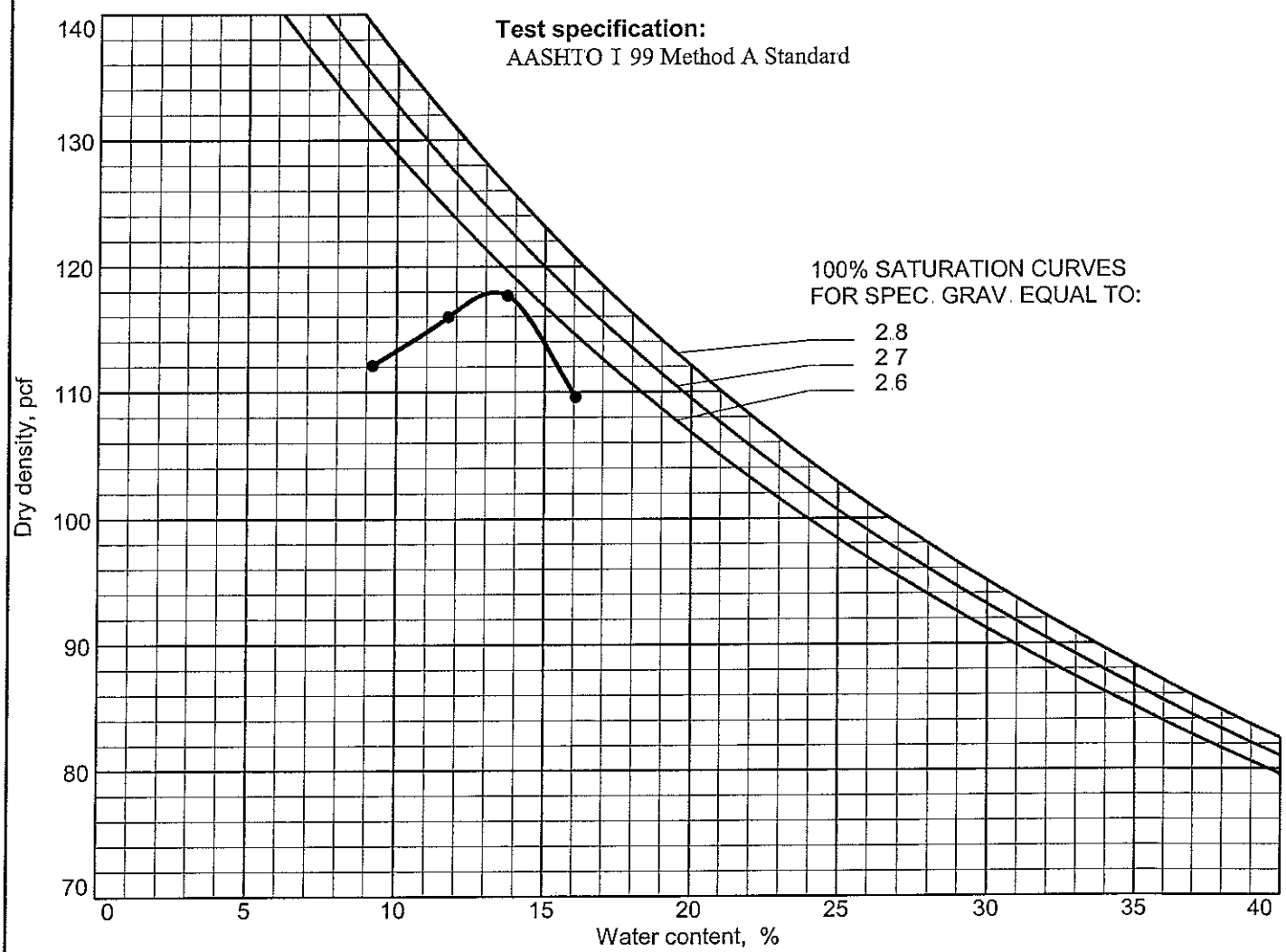
Classifications - **USCS:** **AASHTO:**

Nat. Moist. = **Sp.G. =**

Liquid Limit = **Plasticity Index =**

% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 118.0 pcf
Optimum moisture = 13.3 %



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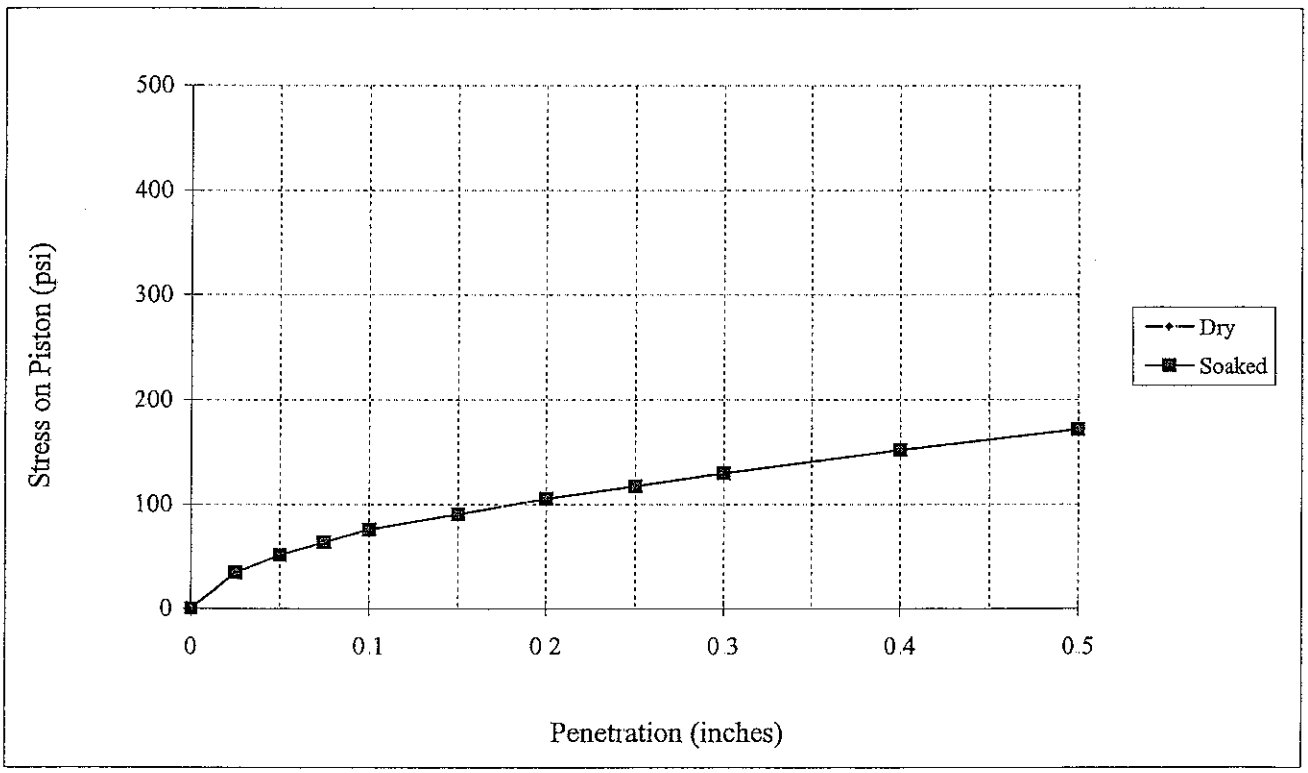
California Bearing Ratio

Project No.:	J60-0036I	Test Date:	5/18/2007
Client:	HDR Engineering, Inc.	Tested By:	C.M
Project:	New Road Project - Fort Belvoir	Compaction method:	AASHTO T 193
Location:	Fort Belvoir	X	Soaked CBR
			Unsoaked CBR



CBR @ 0.1 in. penetration (dry):	0.0		
CBR @ 0.1 in. penetration (wet):	7.6	Maximum Dry Density (pcf):	110.4
Swell (%):	0.6	Optimum Moisture Content (%):	16.9
Dry Density Before Soaking (pcf):	109.3		
Dry Density After Soaking (pcf):	111.6	Visual Description:	
Retained on 3/4 inch sieve (%):	0.0	Brownish Clayey Sand	
Surcharge Weight (pounds):	10.0		
		F&R Lab No.:	102054
Moisture Content Before Soaking (%):	15.5%		
Moisture Content After Soak, Top in. (%):	18.9%	Source:	S-1
Moisture Content After Soak, Ave. (%):	15.7%		B-17 - 0-13'

FROEHLING & ROBERTSON, INC.

By: _____

COMPACTION TEST REPORT

Project No.: J60-0036D **Date:** 5-16-07

Project: New Road Project - Fort Belvoir

Location: Fort Belvoir

Elev./Depth: 0-13' **Sample No.** 1 [Control #102054]

Remarks: HDR Engineering, Inc. 4480 Cox Road, Suite 103 Glen Allen, VA 230606751

MATERIAL DESCRIPTION

Description: Brownish Clayey Sand [B-17 Bulk Sample]

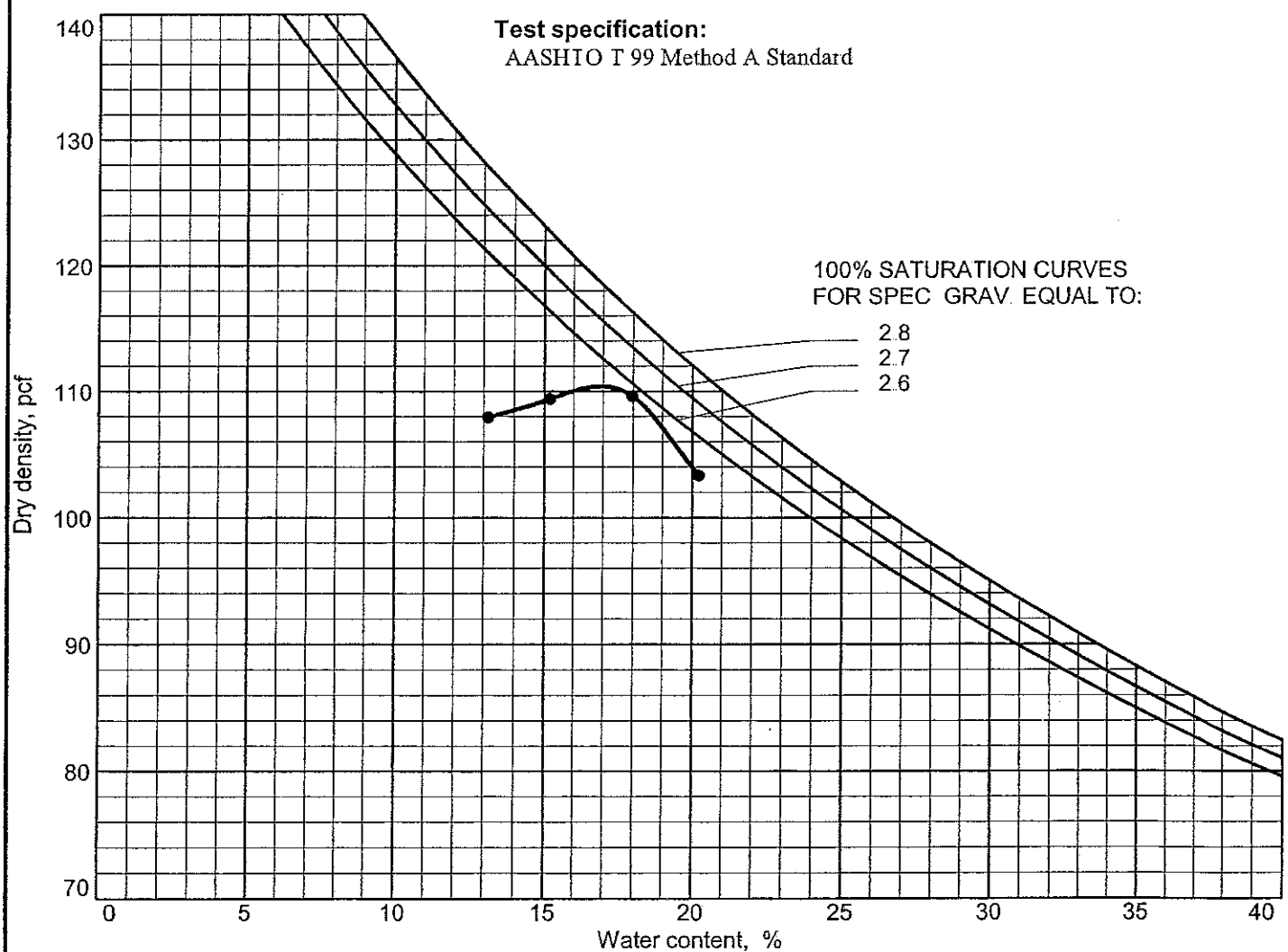
Classifications - **USCS:** **AASHTO:**

Nat. Moist. = **Sp.G. =**

Liquid Limit = **Plasticity Index =**

% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 110 4 pcf
Optimum moisture = 16.9 %



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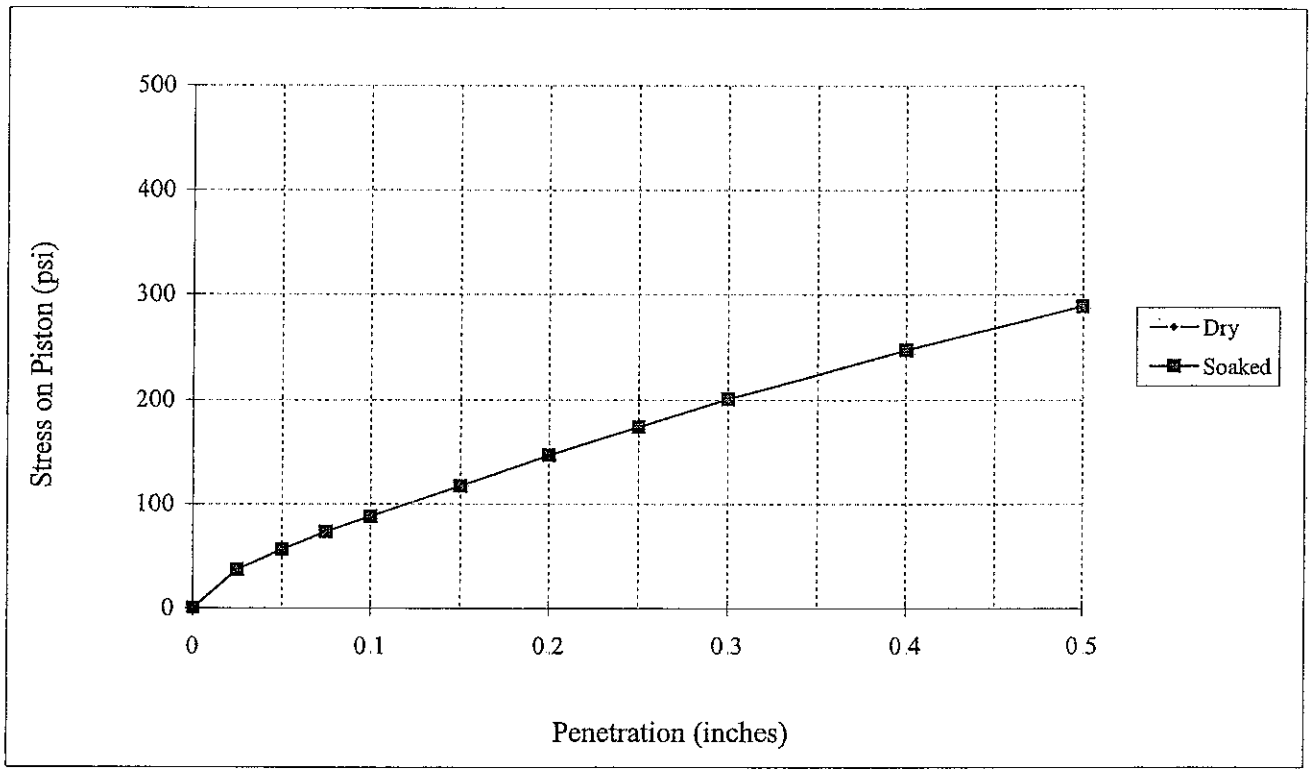
California Bearing Ratio

Project No.:	J60-0036T	Test Date:	5/18/2007
Client:	HDR Engineering, Inc.	Tested By:	C.M.
Project:	New Road Project - Fort Belvoir	Compaction method:	AASHTO T 193
Location:	Fort Belvoir	X	Soaked CBR
			Unsoaked CBR



CBR @ 0.1 in. penetration (dry):	0.0		
CBR @ 0.1 in. penetration (wet):	8.8	Maximum Dry Density (pcf):	113.7
Swell (%):	0.3	Optimum Moisture Content (%):	15.6
Dry Density Before Soaking (pcf):	113.3		
Dry Density After Soaking (pcf):	114.0	Visual Description:	
Retained on 3/4 inch sieve (%):	0.0	Red/Brown Clayey Sand	
Surcharge Weight (pounds):	10.0		
		F&R Lab No.:	102054
Moisture Content Before Soaking (%):	15.6%		
Moisture Content After Soak, Top in. (%):	15.8%	Source:	S-2
Moisture Content After Soak, Ave. (%):	15.8%		B-31 - 0-6'

FROEHLING & ROBERTSON, INC.

By: _____

COMPACTION TEST REPORT

Project No.: J60-0036D **Date:** 5-16=07

Project: New Road Project - Fort Belvoir

Location: Fort Belvoir

Elev./Depth: 0-6' **Sample No.** 2 [Control #102054]

Remarks: HDR Engineering, Inc. 4480 Cox Road, Suite 103 Glen Allen, VA 230606751

MATERIAL DESCRIPTION

Description: Red/Brown Clayey Sand [B-31 Bulk Sample]

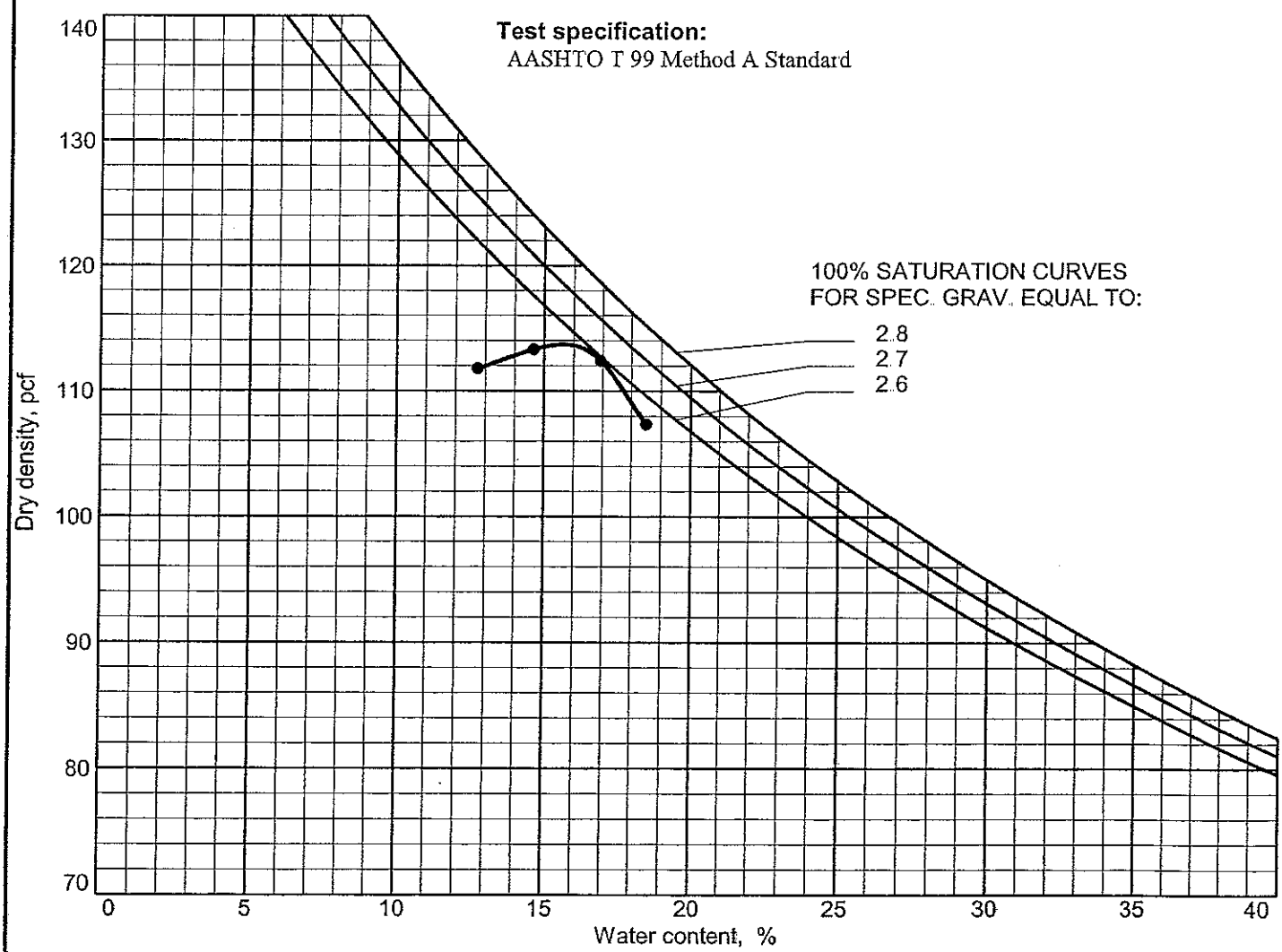
Classifications - **USCS:** **AASHTO:**

Nat. Moist. = **Sp.G. =**

Liquid Limit = **Plasticity Index =**

% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 113 7 pcf
Optimum moisture = 15.6 %



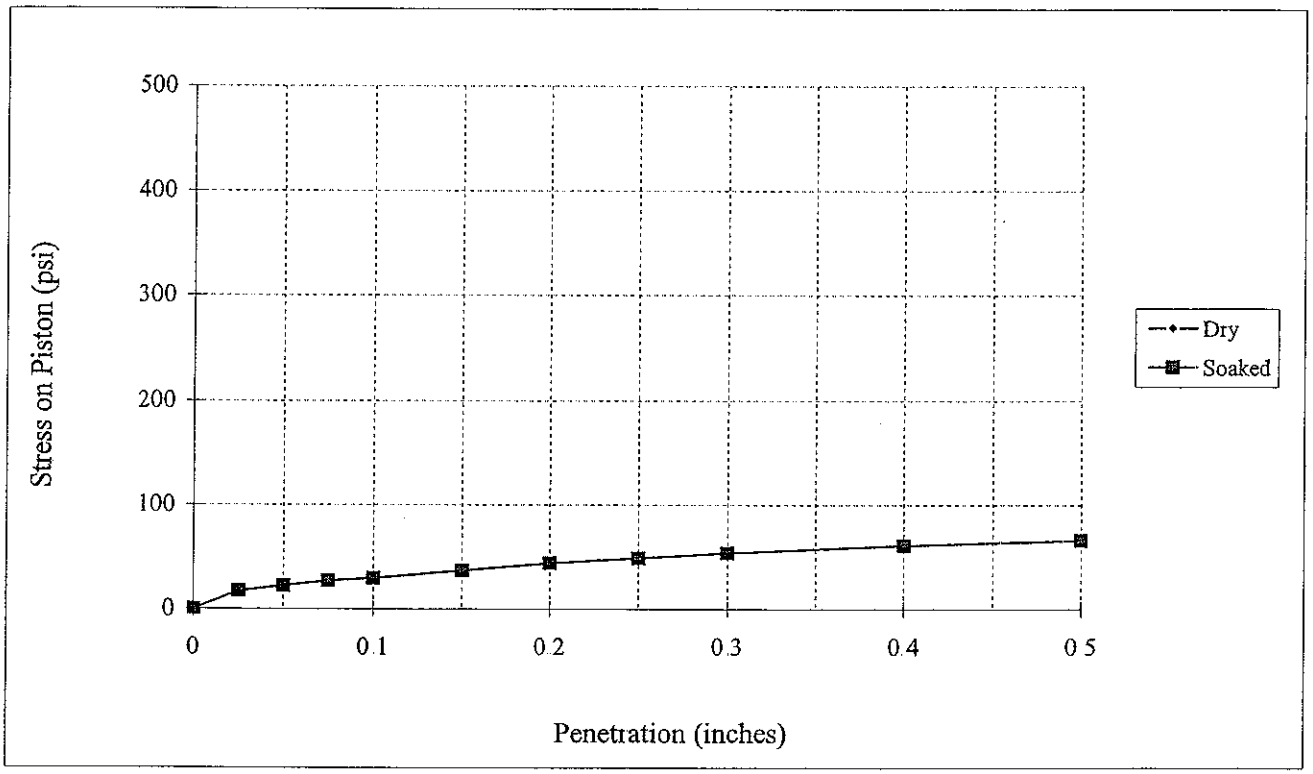
Plate

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL - ENVIRONMENTAL - MATERIALS
ENGINEERS - LABORATORIES
"Over One Hundred Years of Service"
3015 Dumbarton Road, Richmond, VA 23228
Telephone: (804) 264-2701 Fax: (804) 264-1201

California Bearing Ratio

Project No.:	J60-0036I	Test Date:	5/18/2007
Client:	HDR Engineering, Inc	Tested By:	CM
Project:	New Road Project - Fort Belvoir	Compaction method:	AASHTO T 193
Location:	Fort Belvoir	X	Soaked CBR
			Unsoaked CBR



CBR @ 0.1 in. penetration (dry):	0.0		
CBR @ 0.1 in. penetration (wet):	2.9	Maximum Dry Density (pcf):	107.4
Swell (%):	1.1	Optimum Moisture Content (%):	16.8
Dry Density Before Soaking (pcf):	106.2		
Dry Density After Soaking (pcf):	109.4	Visual Description:	
Retained on 3/4 inch sieve (%):	0.0	Reddish Sandy Clay	
Surcharge Weight (pounds):	10.0		
		F&R Lab No.:	102054
Moisture Content Before Soaking (%):	17.5%		
Moisture Content After Soak, Top in. (%):	27.6%	Source:	S-3
Moisture Content After Soak, Ave. (%):	18.9%		B-34 - 0-10'

FROEHLING & ROBERTSON, INC.

By: _____

COMPACTION TEST REPORT

Project No.: J60-0036D **Date:** 5-17-07
Project: New Road Project - Fort Belvoir

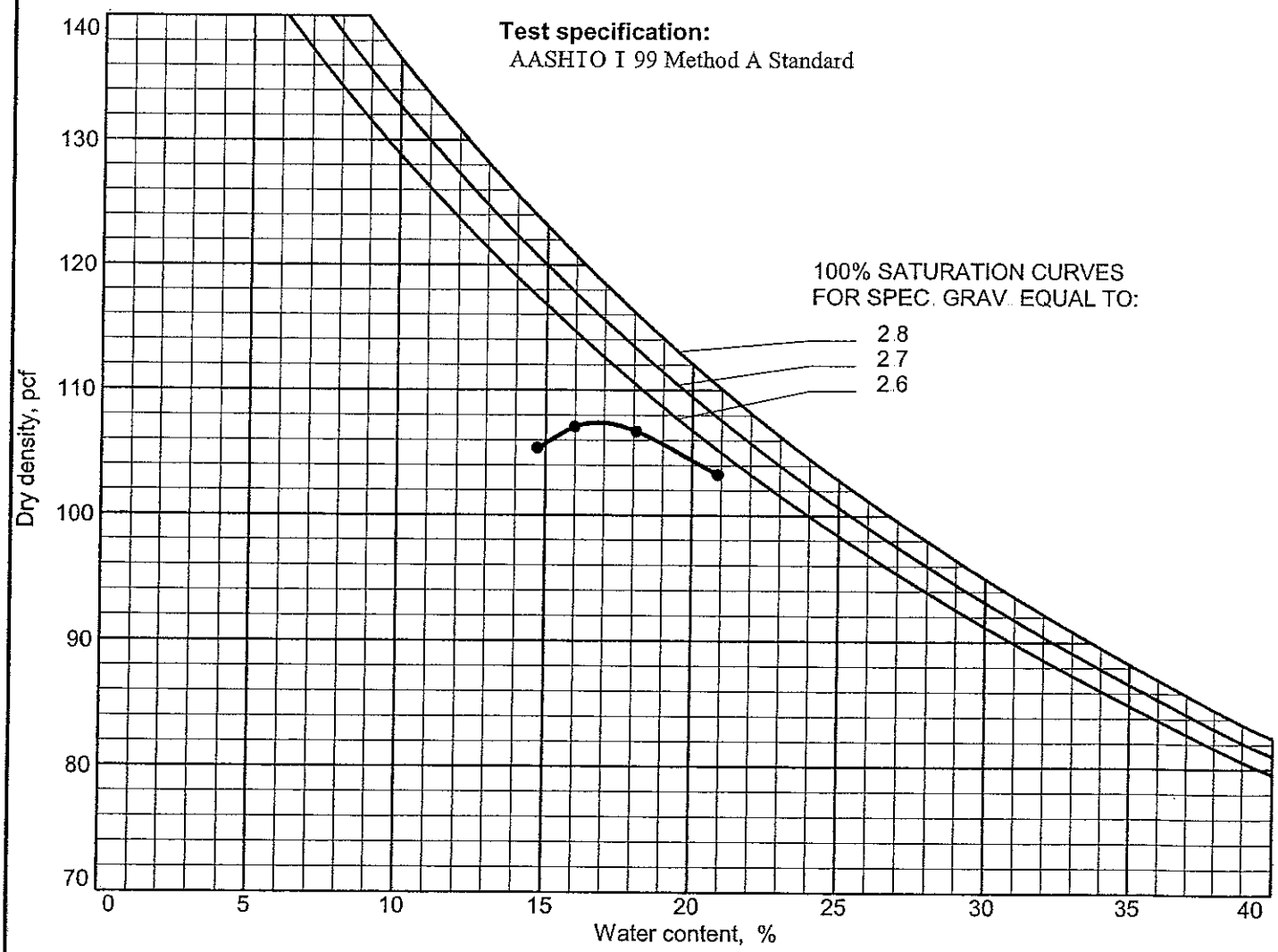
Location: Fort Belvoir
Elev./Depth: 0-10' **Sample No.** 3 [Control #102054]
Remarks: HDR Engineering, Inc 4480 Cox Road, Suite 103 Glen Allen, VA 230606751

MATERIAL DESCRIPTION

Description: Reddish Sandy Clay [B-34 Bilk Sample]

Classifications - **USCS:** **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = **Plasticity Index =**
% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 107.4 pcf
Optimum moisture = 16.8 %



Plate

Microbac®

CERTIFICATE OF ANALYSIS

May 09, 2007

LAB#: 0705220

CLIENT: F&R-CMT
Richmond Office
Richmond VA, 23228
Fred Proper

PROJECT: Fort Belvoir
PROJECT NO.:
SAMPLED BY: Ray Colvard
RECEIVED: 05/08/07

PARAMETER	PREP DATE/TIME	ANALYSIS DATE/TIME	METHOD	ANALYST
pH	5/9/07 11:00	5/9/07 13:00	ASTM D4972	AT
Resistivity	5/9/07 11:00	5/9/07 13:00	In House	AT

LAB #	0705220-01	0705220-02	0705220-03	-		
SAMPLE ID	B-17 (0-13)	B-31 (0-6)	B-34 (0-10)	-		
DATE/TIME	05/08/07	05/08/07	05/08/07	-	Quant	
MATRIX	Soil	Soil	Soil	-	Limit:	Units
Materials Testing (Soil)						
pH	**4.18**	**4.44**	**4.75**	-		su
Resistivity	**11200**	**27200**	**6340**	-		ohm-cm

Notes and Definitions

mg/L = milligrams per Liter
µg/L = micrograms per Liter
BQL = Below the Quantitation Limit

mg/kg = milligrams per kilogram
ppm = parts per million
CFU/mL = Colony forming units per milliliter

su = standard units
NTU = Nephelometric Turbidity Units
MPN/100 mL = Most Probable Number per 100 milliliters

Audrey N Brubeck
SFM
For **Audrey Brubeck**
Technical Manager

3015 DUMBARTON ROAD • RICHMOND, VA 23228
TELEPHONE (804) 264-2701 • FAX (804) 264-1202 • www.microbac.com
elab: www.fandr.com/e-lab/

CERTIFICATIONS: VIRGINIA DRINKING WATER - 00150
NORTH CAROLINA DENR - 432
SOUTH CAROLINA DHEC- 93010001 & 93010

Microbac®

CERTIFICATE OF ANALYSIS

June 14, 2007

LAB#: 0706067

CLIENT: F&R-CMT
Richmond Office
Richmond VA, 23228
Fred Proper

PROJECT: HDR Engineers Inc.
PROJECT NO.: J60-0036
SAMPLED BY: Fred Proper
RECEIVED: 06/05/07

PARAMETER	PREP DATE/TIME	ANALYSIS DATE/TIME	METHOD	ANALYST
pH	6/13/07 11:15	6/13/07 13:15	ASTM D4972	AT
Resistivity	6/13/07 11:15	6/13/07 13:15	In House	AT

LAB #	0706067-01	0706067-02	-	-		
SAMPLE ID	B-7 (0-6')	B-10 (4-8')	-	-		
DATE/TIME	06/05/07	06/05/07	-	-	**Quant**	
MATRIX	Soil	Soil	-	-	**Limit:**	**Units**
Materials Testing (Soil)						
pH	**3.37**	**4.38**	-	-		su
Resistivity	**2680**	**6920**	-	-		ohm-cm

Notes and Definitions

mg/L = milligrams per Liter
µg/L = micrograms per Liter
BQL = Below the Quantitation Limit
mg/kg = milligrams per kilogram
ppm = parts per million
CFU/mL = Colony forming units per milliliter
su = standard units
NTU = Nephelometric Turbidity Units
MPN/100 mL = Most Probable Number per 100 milliliters

Audrey N Brubeck

Audrey Brubeck
Technical Manager

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elab: www fandr com/e-lab/

CERTIFICATIONS:
VIRGINIA DRINKING WATER - 00150
NORTH CAROLINA DENR - 432
SOUTH CAROLINA DHEC- 93010001 & 93010
MARYLAND DRINKING WATER - 279

APPENDIX E
PAVEMENT CONDITION SURVEY FIELD SHEETS

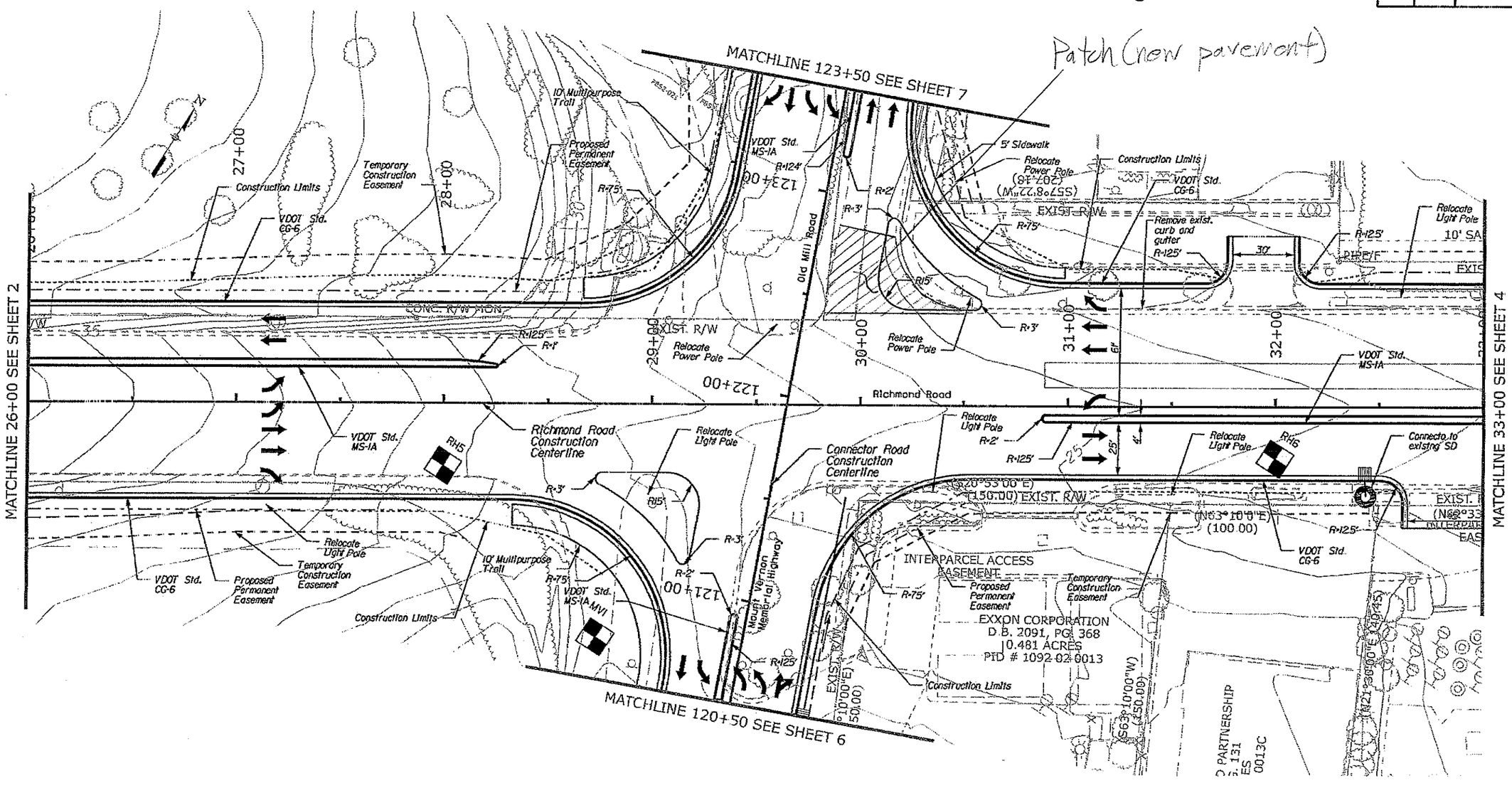
Asphalt Concrete Condition Survey Legend

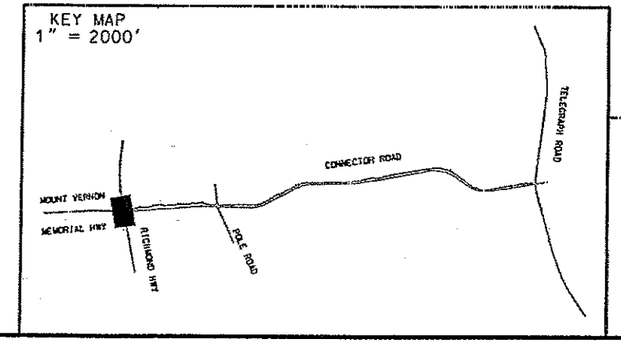
Distress		
Description	**Type**	**Severity**
Fatigue (Alligator) Cracking	1	Low
		Moderate
		High
Block Cracking	2	Low
		Moderate
		High
Edge Cracking	3	Low
		Moderate
		High
Longitudinal Cracking ('a' wheel path/'b' non-wheel path)	4a/4b	Low
		Moderate
		High
Reflection Cracking at Joints ('T' transverse/'L' longitudinal)	5T/5L	Low
		Moderate
		High
Transverse Cracking	6	Low
		Moderate
		High
Patch/Patch Deterioration	7	Low
		Moderate
		High
Potholes	8	Low
		Moderate
		High
Rutting	9	NA
Shoving	10	NA
Bleeding	11	Low
		Moderate
		High
Polished Aggregate	12	NA
Raveling (Weathering)	13	Low
		Moderate
		High
Lane-to-Shoulder Dropoff	14	NA
Water Bleeding and Pumping	15	NA

(Ref: SHRP-P-38 "Distress Identification Manual for L-T Pavement Performance Project")
Rev 9/13/99

*L, M 2 throughout entire road

REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	3





0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Richmond Road
26+00 TO 33+00

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REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	7

M.H 1.4a (outer wheelpath) EB lane

NATIONAL TRUST FOR HISTORIC PRESERVATION IN THE UNITED STATES
D.B. 1549, PG. 557
69.63 ACRES
PID # 1092 01 0002

MATCHLINE 123+50 SEE SHEET 3

MATCHLINE 130+50 SEE SHEET 8

Construction Limits
Proposed permanent easement
10' Multipurpose Trail
BRUSH
Temporary Construction Easement
PC 123+96.23
PT 128+54.18
Old Mill Road
PERSCRIPTIVE R/W
100' Taper
Temporary construction easement
VDOT Std. CG-6
Connect to existing SD
VDOT Std. MS-1A
Connector Road Construction Centerline
VDOT Std. MS-2
Comb. Pole #FG16
EXIST. R/W
Tel. Ped.
THH
Tel. Cabinet
Comb. Pole #SH90
Comb. Pole #SH82
Comb. Pole #SH81
Elec. Meter
Elec. Transformer
5' Conc. Sidewalk
10' SANITARY SEWER EASE.
Outfall No. 3 Connect to existing 42" SD
Curve = CRBC2
PT 124+75.22
Δ = 4° 31' 25" (LT)
R = 2,000.00'
T = 78.99'
L = 157.90'
Temporary Construction Easement
R=25'
24" DIP
8" G
SOT
LP
PIPE

#LM 2 throughout entire road

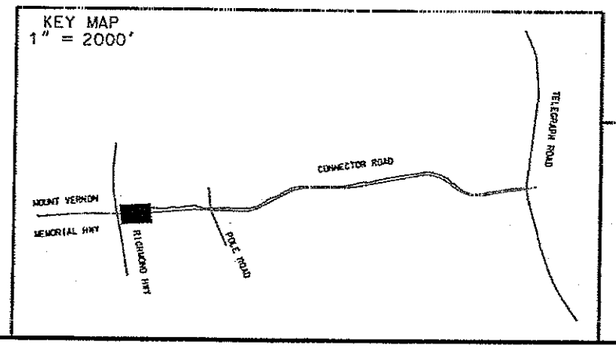
pavement change (now to north)

H5 (paving joint)

Loop Detector Cut (W.L. cut?)

Patch (≈5' wide)

KEY MAP
1" = 2000'



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SCALE IN FEET

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EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET
Connector Road
123+50 TO 130+50

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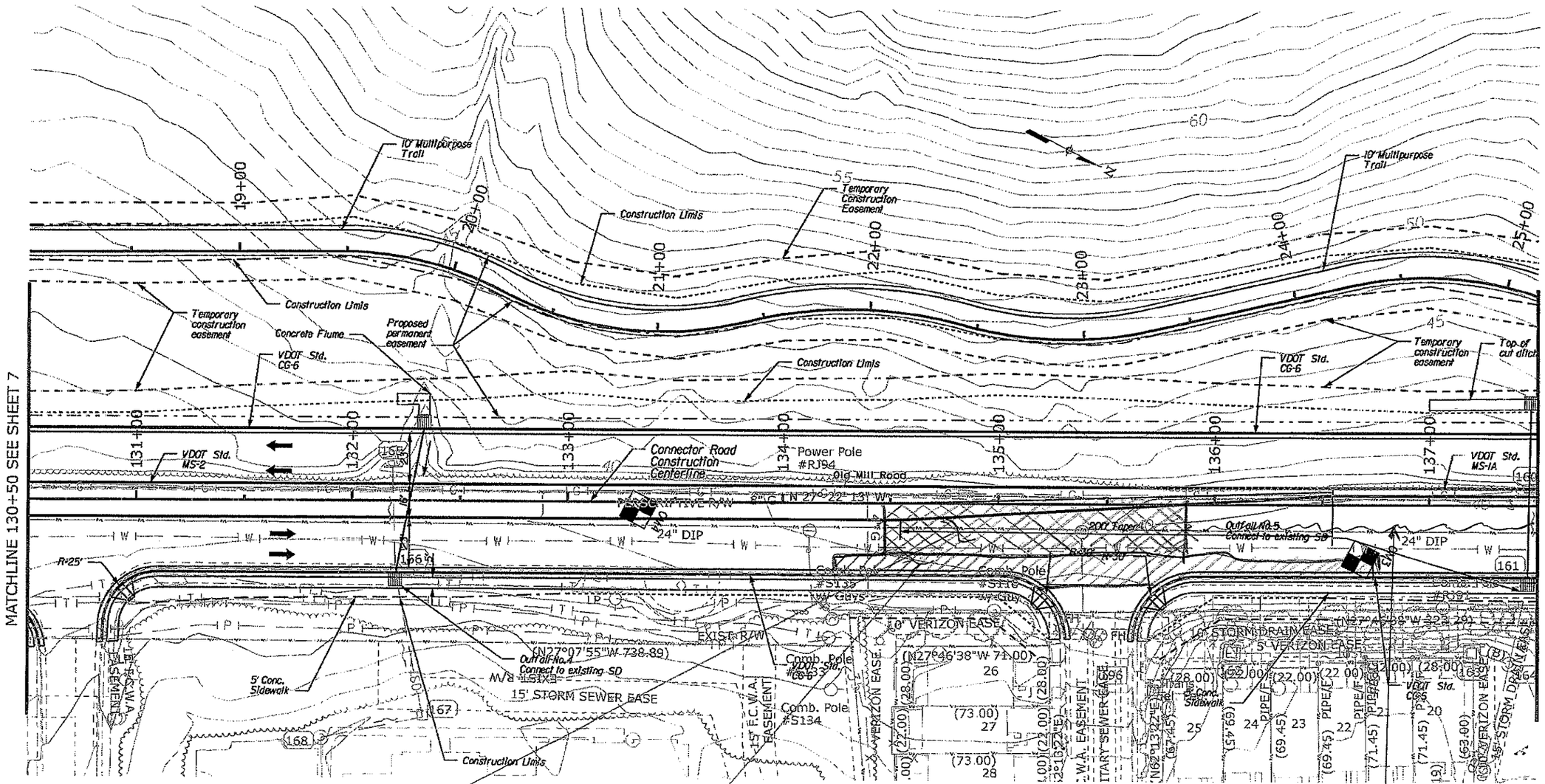

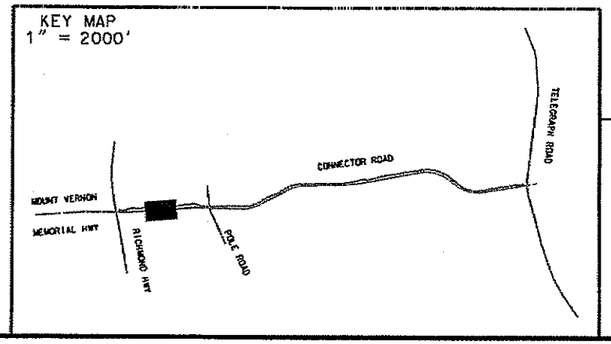

SCALE IN FEET 0 25 50

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STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Connector Road
130+50 TO 137+50

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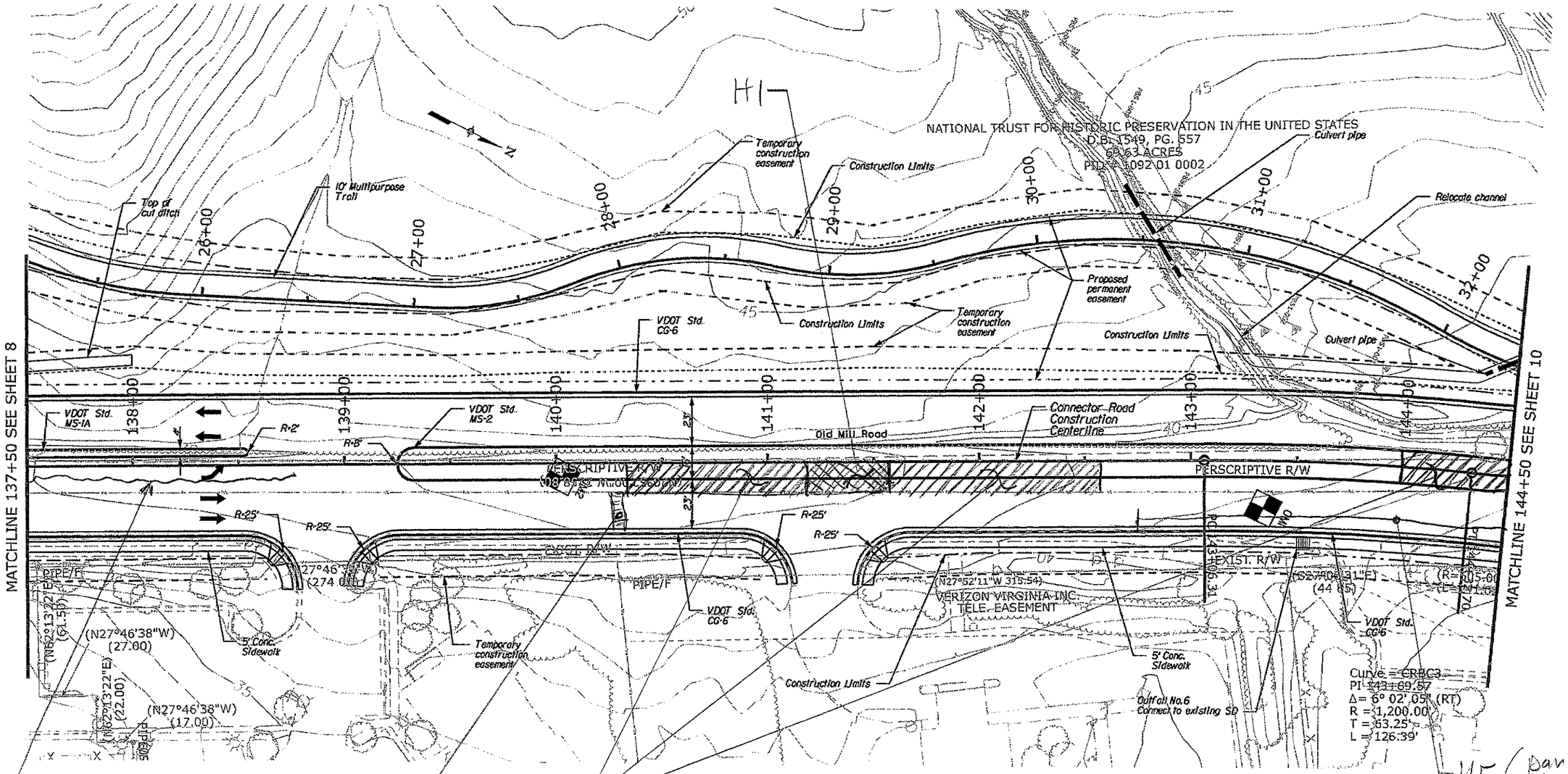

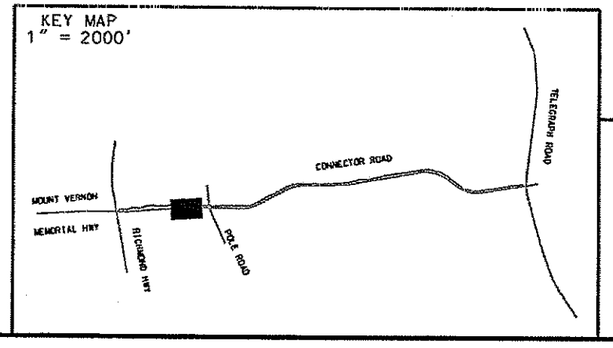

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SCALE IN FEET

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EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Connector Road
137+50 TO 144+50

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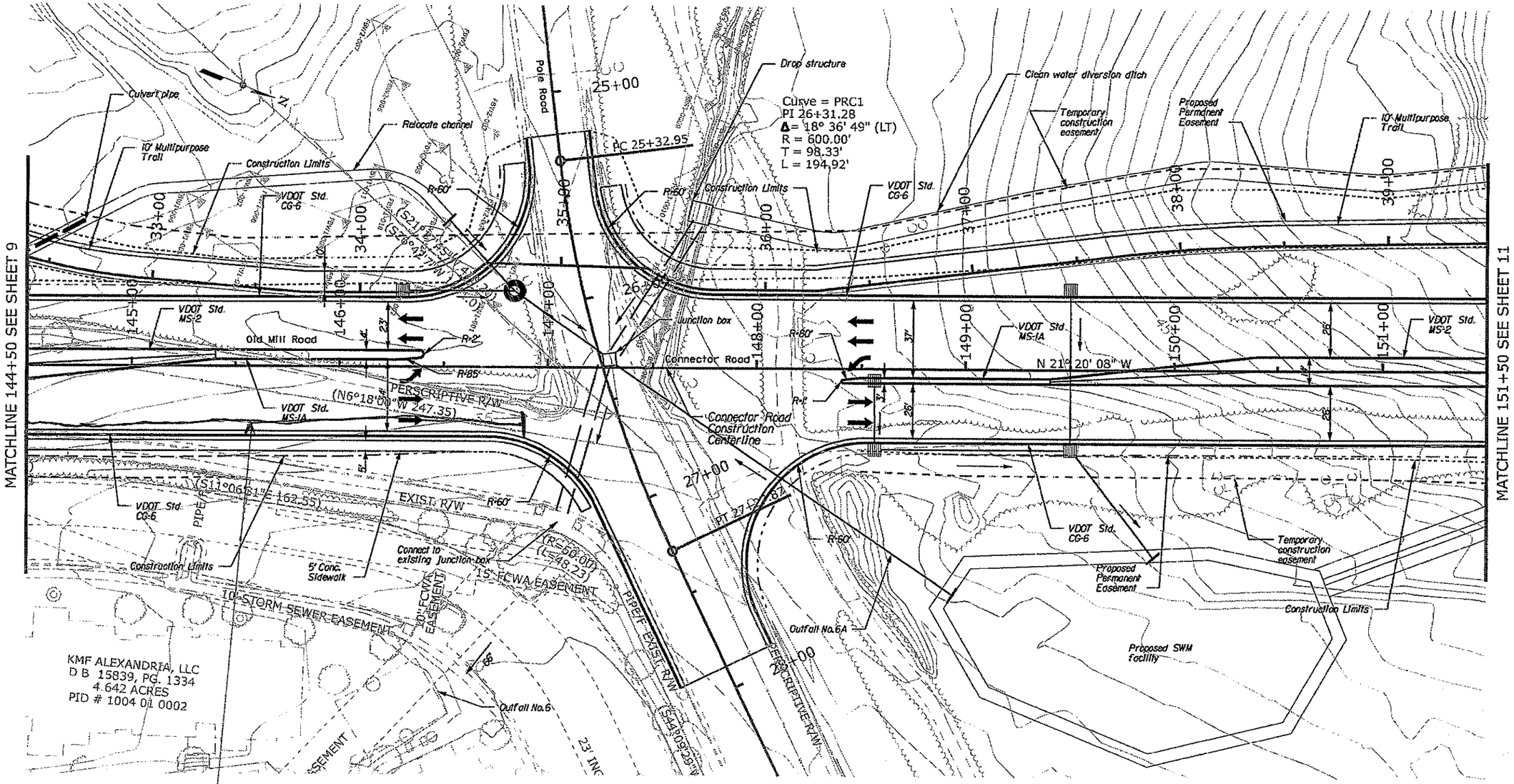

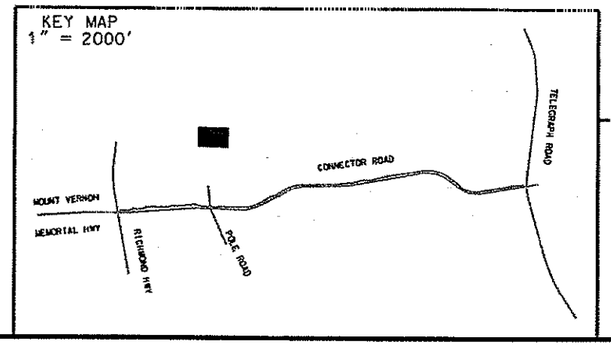

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SCALE IN FEET

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EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Connector Road
144+50 TO 151+50

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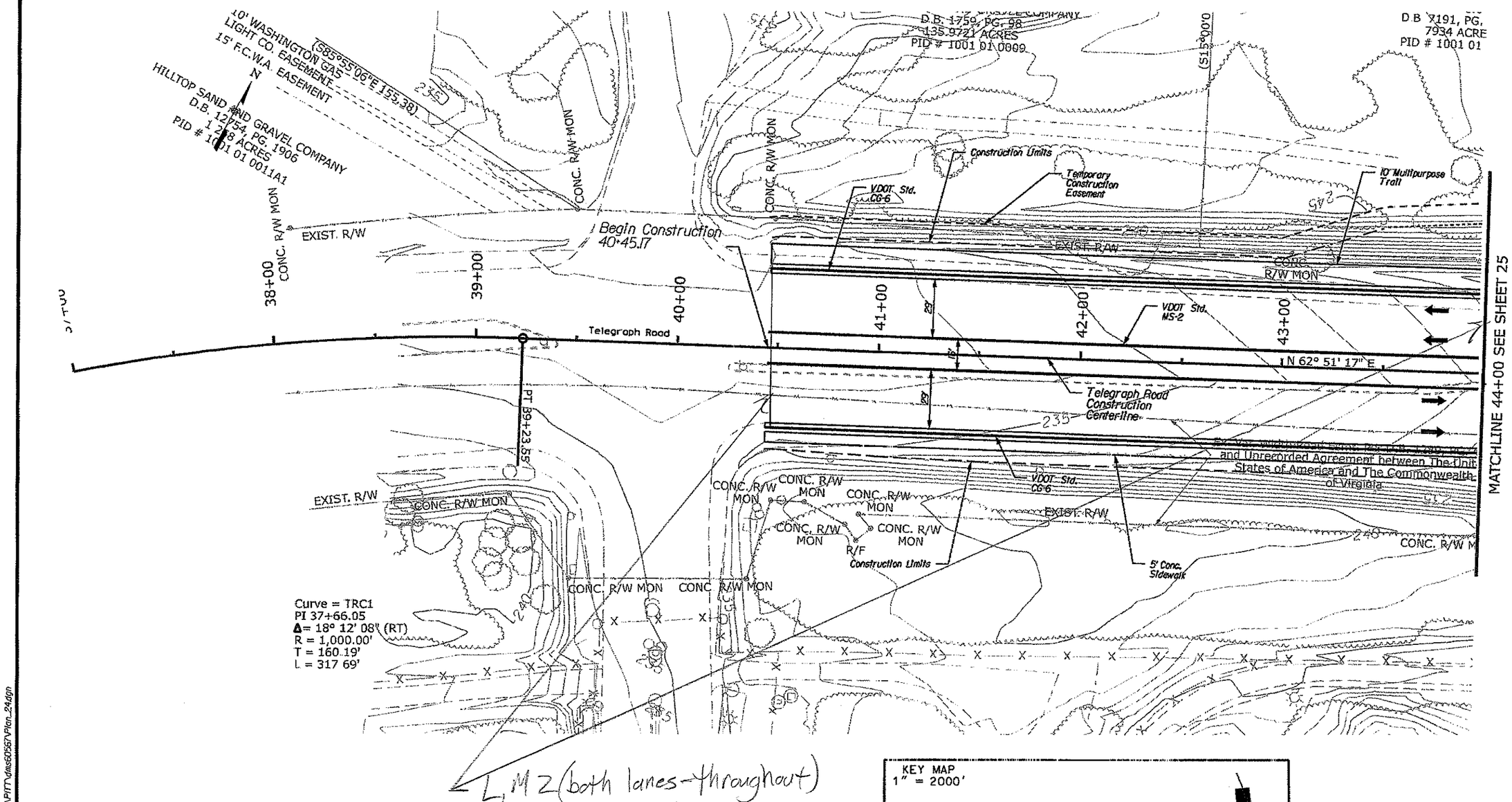

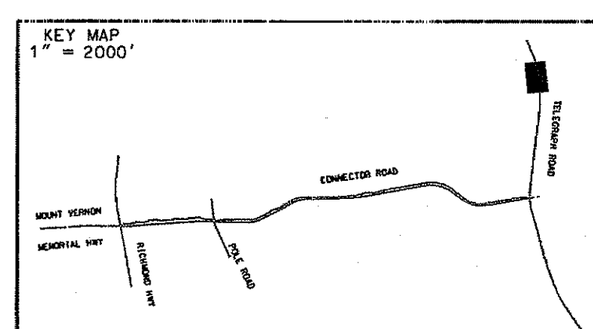

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SCALE IN FEET

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EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
BEGIN TO 44+00

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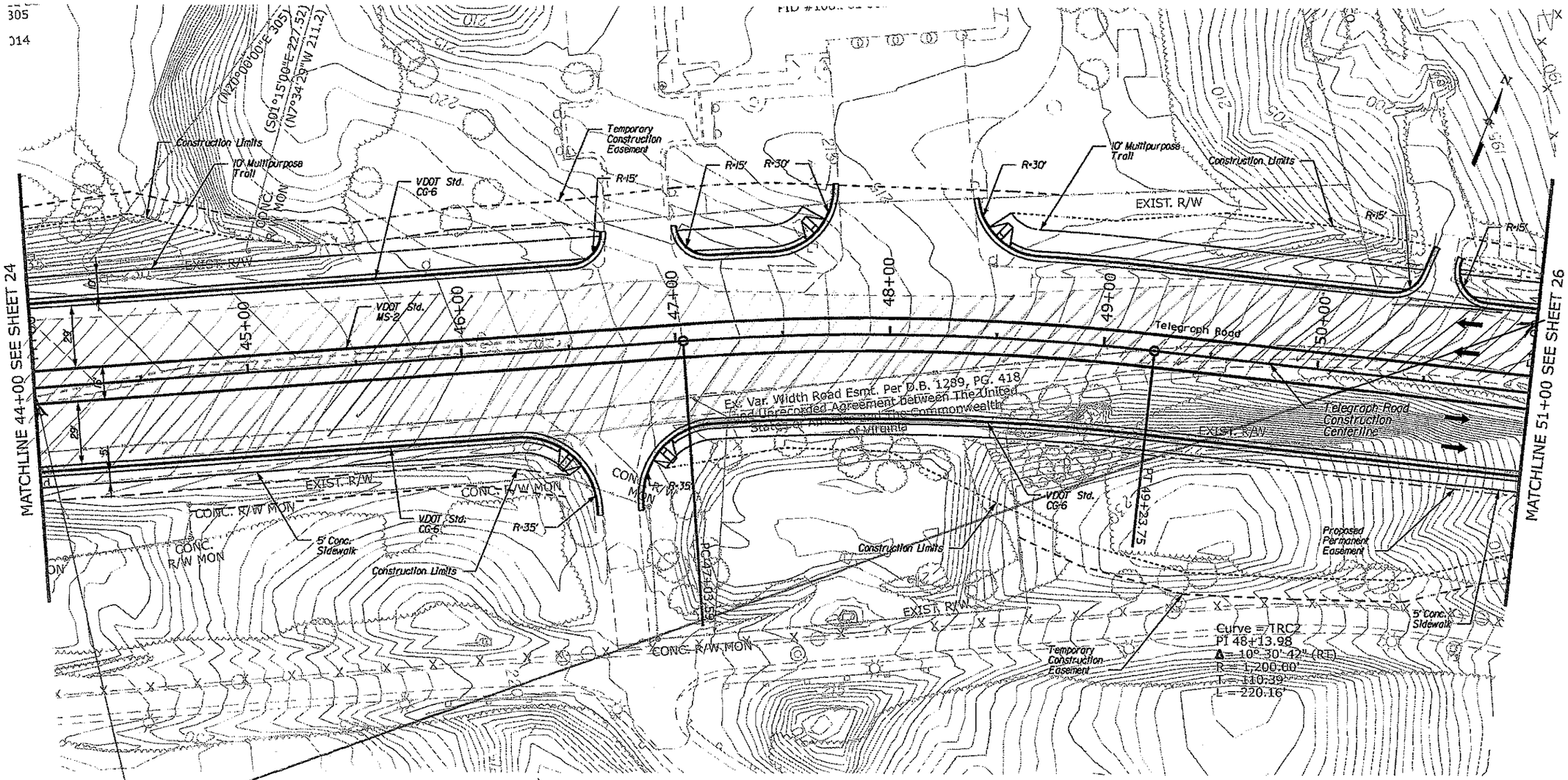
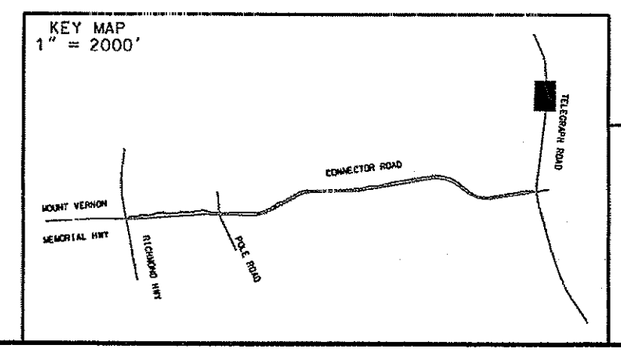


LM2 (both lanes-throughout)



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SCALE IN FEET

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FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
44+00 TO 51+00

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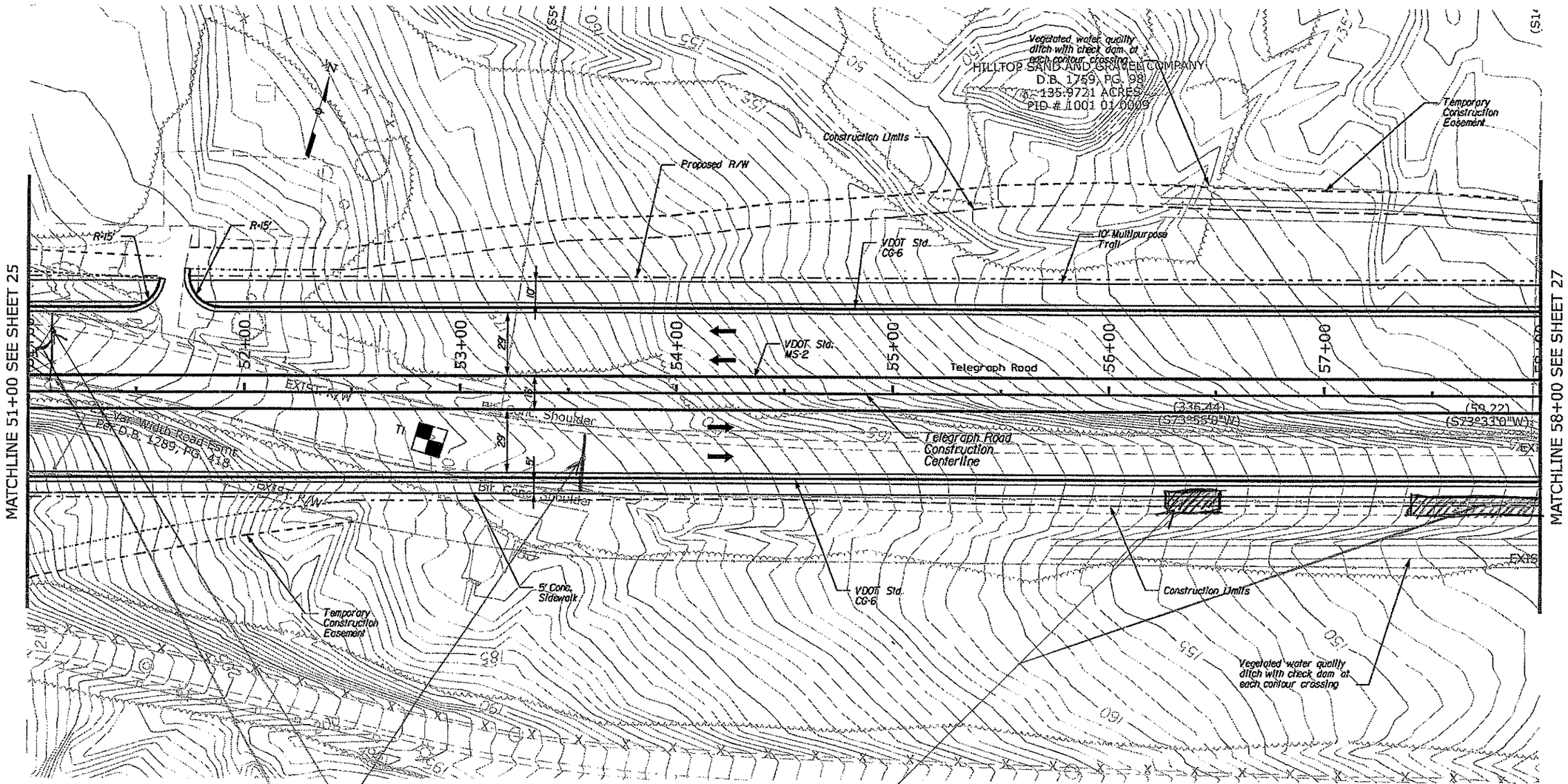

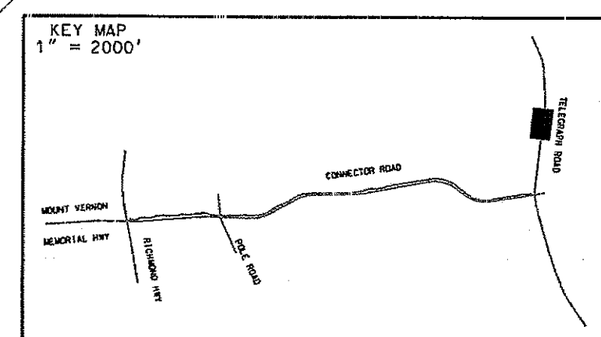

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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
51+00 TO 58+00

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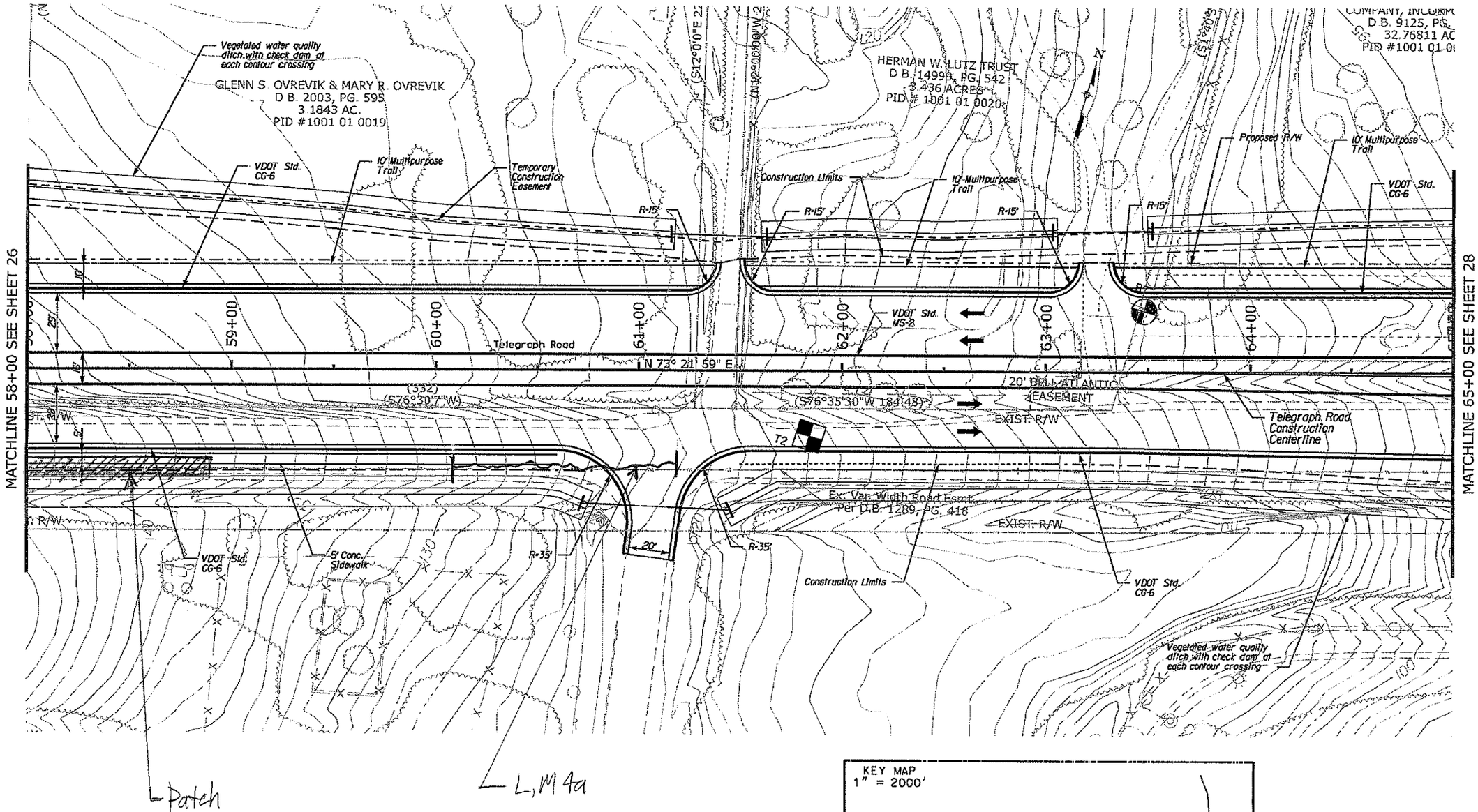

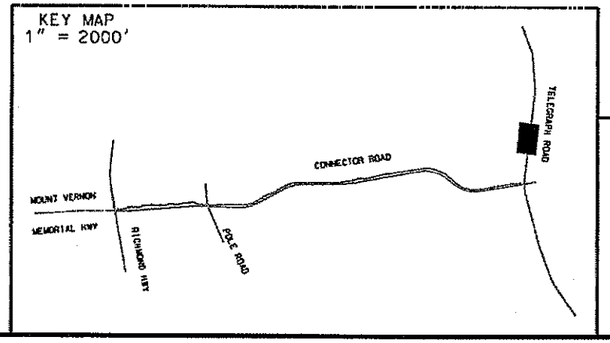

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SCALE IN FEET

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STERLING, VIRGINIA

**RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR**

PLAN SHEET

Telegraph Road
58+00 TO 65+00

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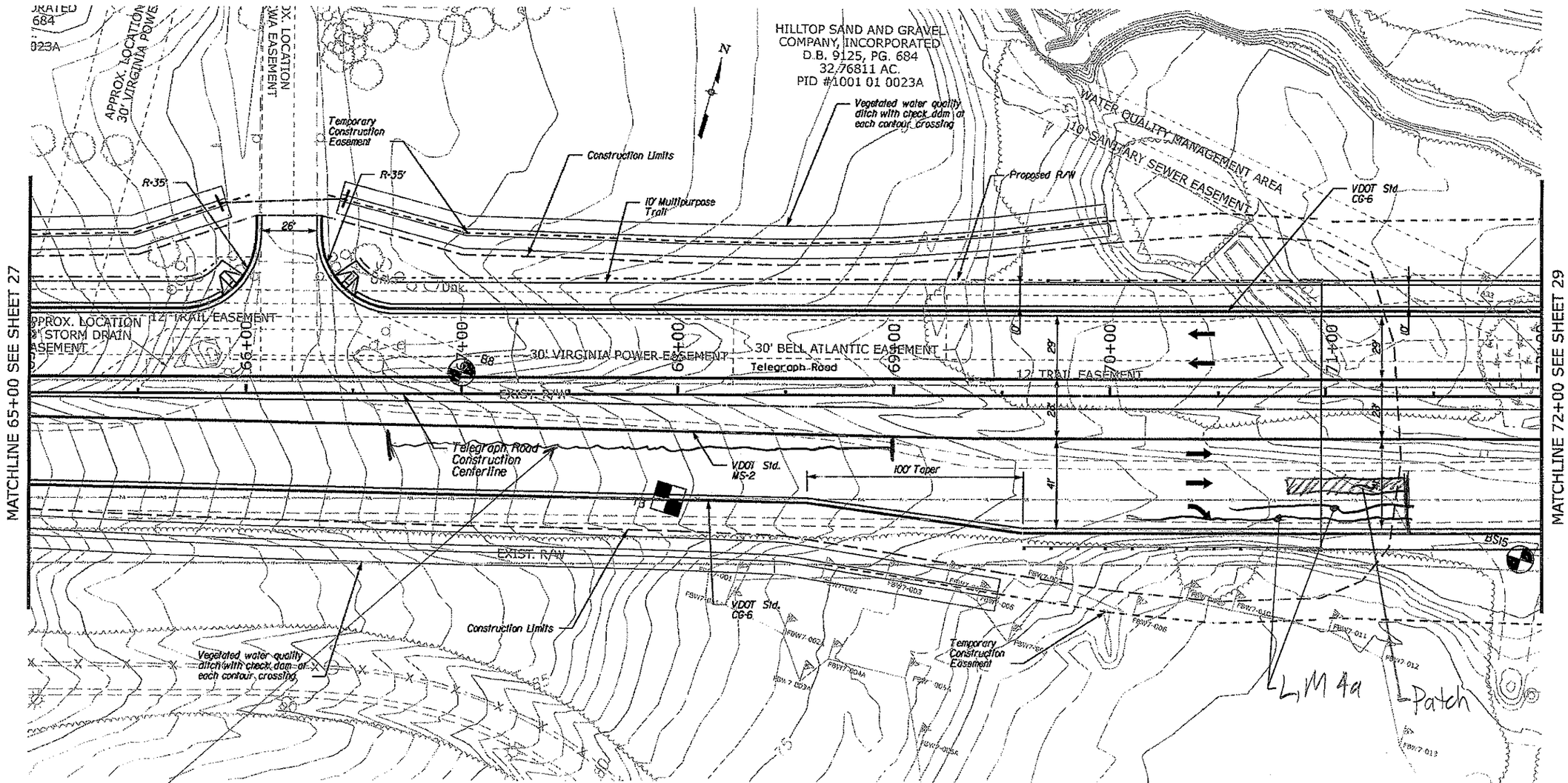
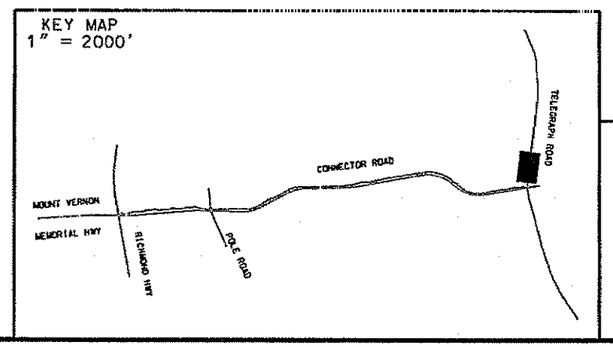
REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	28



M5 (Reflective crack @ joint)

*LM 4a (both wheel paths EB-throughout sheet)



0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
65+00 TO 72+00

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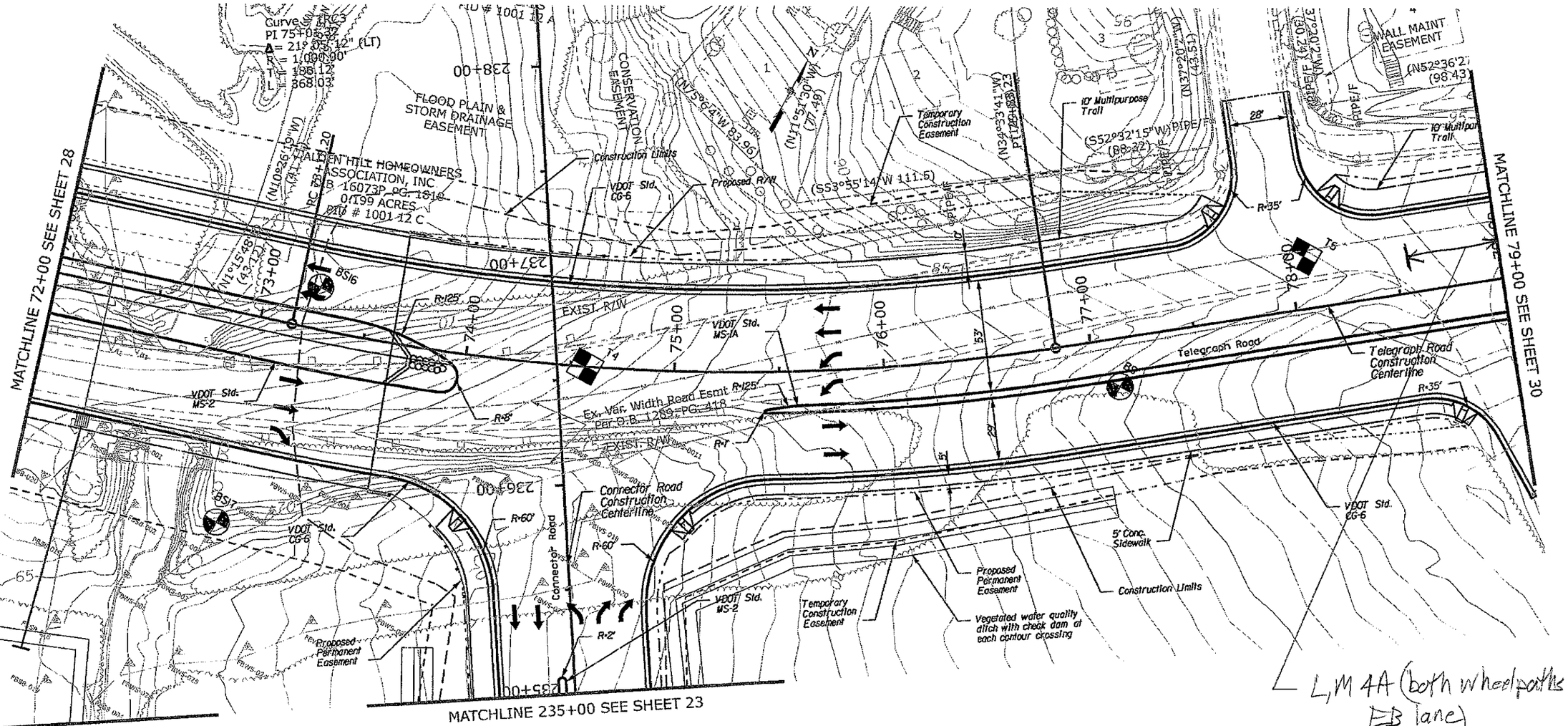
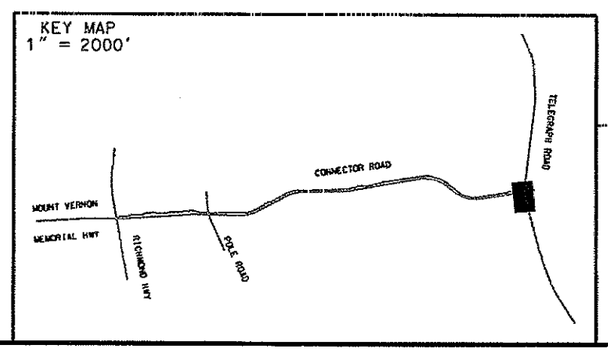
REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	29





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SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR

PLAN SHEET

Telegraph Road
72+00 TO 79+00

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REG	STATE	PROJECT	SHEET NO.
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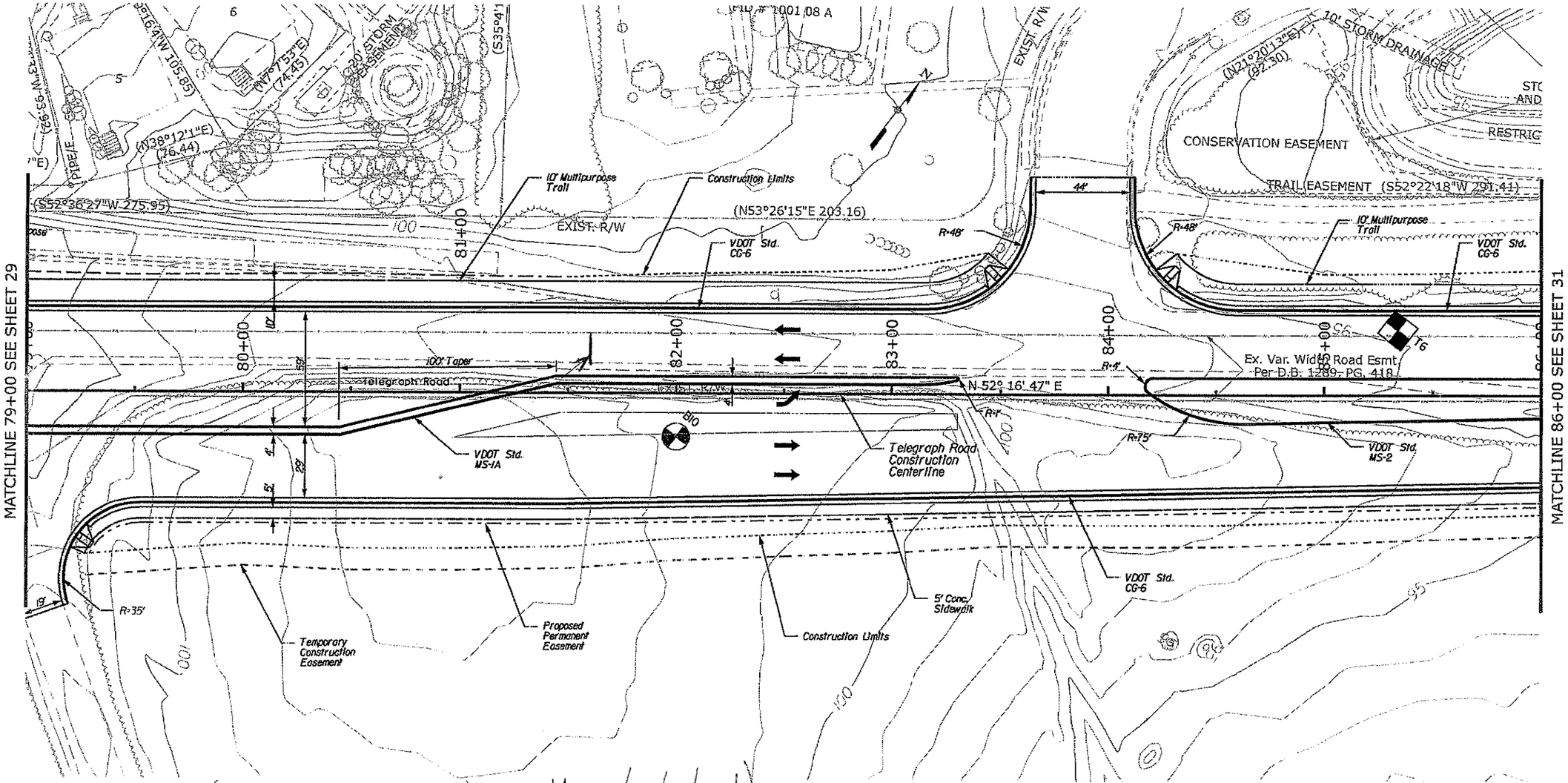
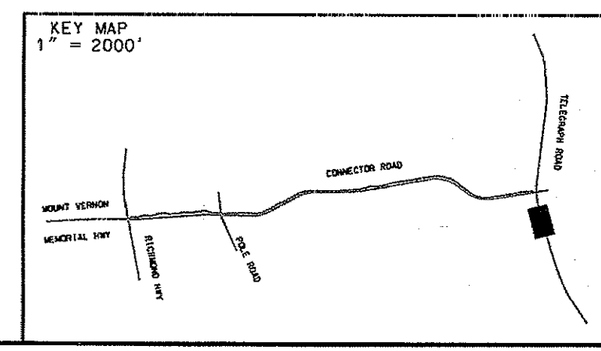


* L,M 4A (both wheelpaths, both lanes—throughout sheet)



0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

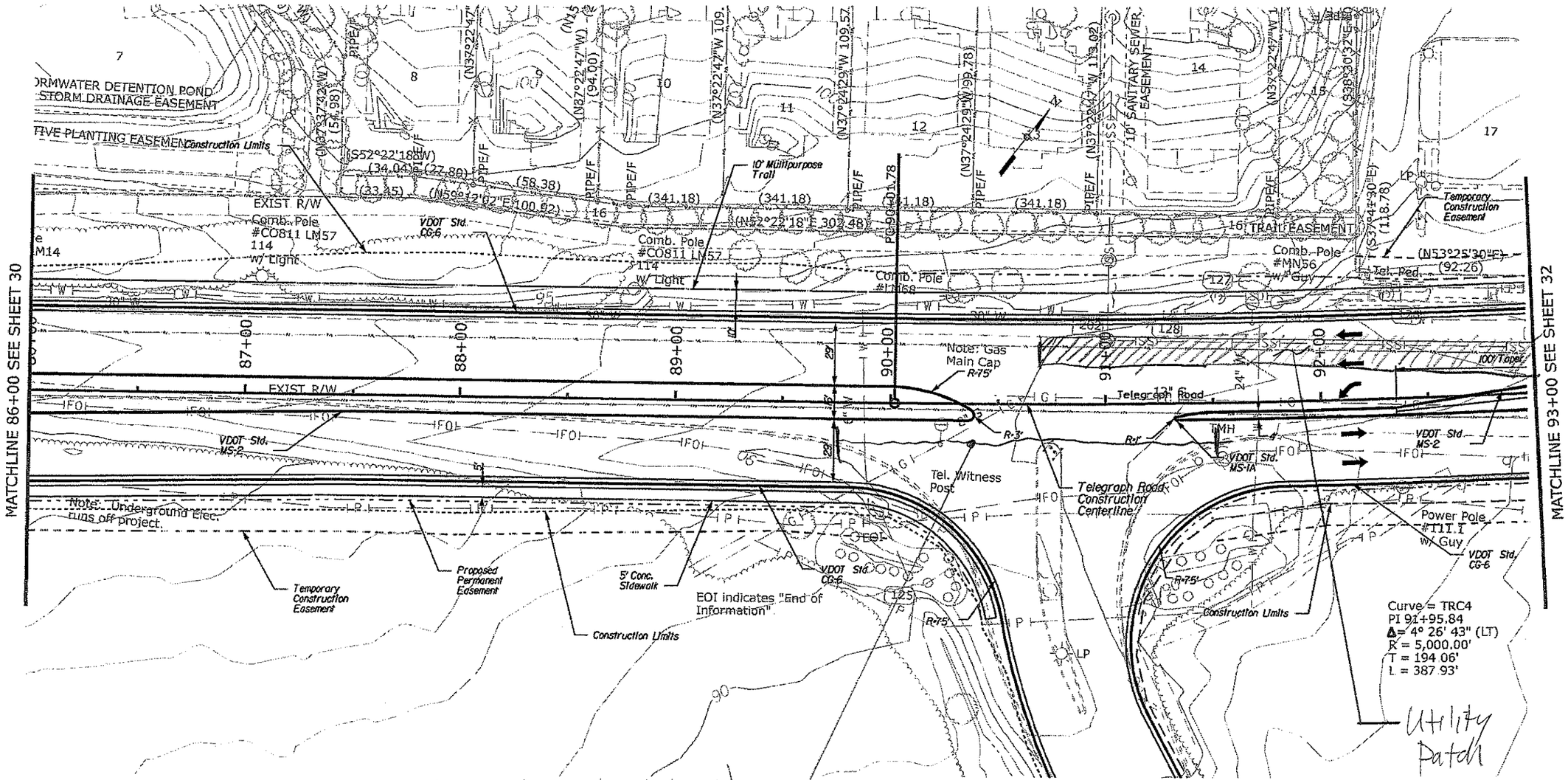
**RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR**

PLAN SHEET

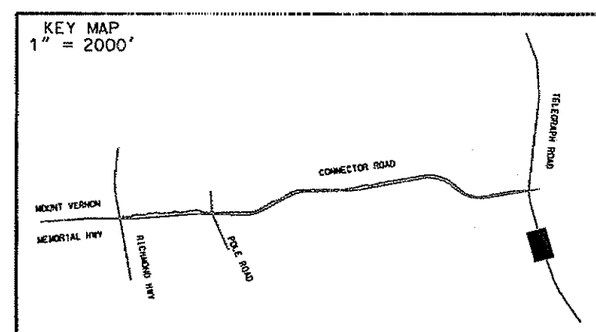
Telegraph Road
79+00 TO 86+00

6/18/2007 12:56:03 PM C:\PWworking\PITT\dms60567\Plan_30.dgn

REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	31



*LM 4A (both wheelpaths, both lanes throughout sheet)



0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

RICHMOND HIGHWAY-TELEGRAPH ROAD CONNECTOR

PLAN SHEET
Telegraph Road
86+00 TO 93+00

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REG	STATE	PROJECT	SHEET NO.
	VA	VA-A-AD-48(1)	32

MATCHLINE 93+00 SEE SHEET 31

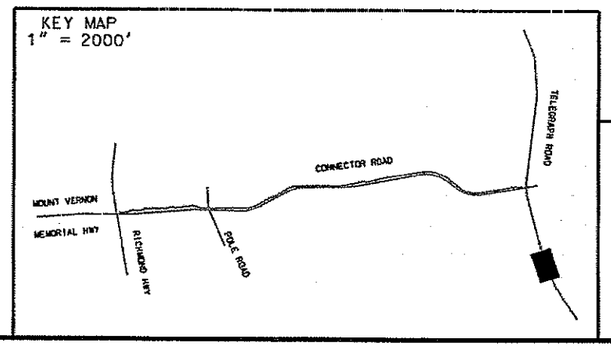
THE COUNTY SCHOOL BOARD OF FAIRFAX COUNTY
D.B. 2789, PG. 558
57.495 ACRES
PID # 0914 01 0028

Construction Limits
10' Multipurpose Trail
VDOT Std. CG-6
Temporary Construction Easement
PT 93+89.71
(N45°06'40"W) (172.60)
(S37°41'30"E) (164.15)
(N53°25'30"E) (98.15)
(N53°25'30"E) (7.82)
EXIST. R/W
Water
Comb. Pole #MN48
Comb. Pole #NO64 Guys
End Construction 96+20.00
(R=2824.79) (L=189.96)
(R=2834.79) (L=45.46)
VDOT Std. MS-2
Ex. Var. Width Road Eemt. Per D.B. 1289, PG. 418
N 47° 50' 04" E
Telegraph Road
Bollard w/ Sign
(S48°33'30"W 224.59)
PC 99+34.78
12" G
217'
Comb. Pole #NO22 w/ Guy
Comb. Pole #NO61
Comb. Pole #MN19
Telegraph Road Construction Centerline
Comb. Pole #MN95 w/ Guys
Proposed Permanent Easement
Construction Limits
Temporary Construction Easement
Curve = TRC5
PI 102+86.72
Δ = 14° 26' 56" (LT)
R = 2,800.00'
T = 354.93'
L = 706.10'

Utility Patch

*L,M 4A (both wheelpaths, both lanes to end of costruction)

KEY MAP
1" = 2000'



0 25 50
SCALE IN FEET

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

**RICHMOND HIGHWAY-
TELEGRAPH ROAD CONNECTOR**

PLAN SHEET
Telegraph Road
93+00 TO 96+20.00

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APPENDIX F
RDM NONDESTRUCTIVE TESTING AND PAVEMENT EVALUATION REPORT

NONDESTRUCTIVE TESTING AND STRUCTURAL PAVEMENT EVALUATION REPORT

for

Mulligan Road
Project No. VA-A-AD-48(1)
Fairfax, Virginia

Submitted to:

HDR Engineering, Inc.
Glen Allen, Virginia

May 31, 2008

By:

Roy D. McQueen & Associates, Ltd.
22863 Bryant Court; Suite 101
Sterling, Virginia 20166
Telephone 703-709-2540 • Fax 703-709-2535
www.rdmcqueen.com

TABLE OF CONTENTS

Sections

1.0 Introduction

2.0 Methods of Analysis

- 2.1 Nondestructive Testing
- 2.2 Pavement Coring and Boring
- 2.3 Traffic Analysis
- 2.4 Pavement Analysis

3.0 Nondestructive Testing

- 3.1 NDT Procedures
  - 3.1.1 Deflection Basin
  - 3.1.2 Impulse Stiffness Modulus (ISM)
- 3.2 Equipment Requirements
- 3.3 Conventional Testing
  - Table 2 Summary of Pavement Borings
- 3.4 Data Analysis
  - 3.4.1 Impulse Stiffness Modulus (ISM)
  - 3.4.2 NDT Data Reductions

Table 3-1 (1 of 4)	Summary of Pavement Borings - U.S. Route 1
Table 3-1 (2 of 4)	Summary of Pavement Borings - Telegraph Road
Table 3-1 (3 of 4)	Summary of Pavement Borings - Mt. Vernon Hwy
Table 3-1 (4 of 4)	Summary of Pavement Borings - Old Mill Road
Table 3-2 (1 of 4)	Subgrade Resilient Modulus Summary - U.S. Route 1
Table 3-2 (2 of 4)	Subgrade Resilient Modulus Summary - Telegraph Road
Table 3-2 (3 of 4)	Subgrade Resilient Modulus Summary - Mt. Vernon Hwy

Sections

Table 3-2 (4 of 4) Subgrade Resilient Modulus Summary - Old Mill Road

4.0 Traffic

Table 4-1 ESAL Computation

5.0 Design Concepts

5.1 AASHTO Design Procedures

5.1.1 AASHTO Flexible Pavement Design
5.1.2 AASHTO Rigid Pavement Design

6.0 Structural Analysis

6.1 Structural Requirements

6.2 U.S. Route 1

6.3 Telegraph Road

Table 6-1 Overlay Computation Summary - Telegraph Road

6.4 Mount Vernon Memorial Highway

6.5 Old Mill Road

Table 6-2 Overlay Computation Summary - Mount Vernon Memorial Highway
Table 6-3 Overlay Computation Summary - Old Mill Road

6.6 Lane Widening

6.7 Frost Design Adjustments

7.0 Summary

Appendix A NDT Field Data

Appendix B ISM Plots

Appendix C AASHTO DARWIN Calculation

SECTION 1.0

INTRODUCTION

SECTION 1.0 INTRODUCTION

During April 2007, Roy D. McQueen & Associates, Ltd. (RDM), under contract to HDR Engineering, Inc. (HDR), performed nondestructive testing (NDT) and pavement evaluation services for approximately 2.2 miles of two-lane and four-lane, high-volume traffic roadway at Ft. Belvoir Connector in Virginia. The Ft. Belvoir Connector consists of 650 feet of Mt. Vernon Highway (Stations 112+50 to 119+00), 2,710 feet of Route 1 (Stations 14+20 to 41+30), 2,300 feet of Old Mill Road (Stations 124+00 to 147+00), and 5,550 feet of Telegraph Road (Stations 40+50 to 96+00). The project was originally referred to as the Richmond Highway-Telegraph Road Connector Road; however, in June 2007, the project name was changed to Mulligan Road. This road will connect Richmond Highway to Telegraph Road and provide a new access route through Fort Belvoir.

The primary objective of this study was to investigate pavement rehabilitation and/or strengthening requirements to accommodate future traffic demands. To meet this overall objective, the following multi-phased program of testing and analysis was implemented to provide an integrated basis for developing the rehabilitation program:

- Measure existing pavement and subgrade strength by nondestructive testing (NDT).
- Verify as-built pavement thickness and composition by selective coring by HDR.
- Compute equivalent 18-kip single axle loads (ESAL's) from data provided by HDR.
- Develop rehabilitation requirements from results of structural analyses.

RDM's work scope only included structural analysis and did not include condition survey to determine functional pavement condition or the condition of pavement materials. It is assumed that this work is being conducted by others and will be used with the structural evaluation results included herein in determining final rehabilitation methods.

The observations, comments, and recommendations contained in this report have been prepared for the exclusive use of HDR and the Eastern Federal Lands Highway Division (EFLHD) for this project in accordance with generally accepted engineering practice. No other warranty is expressed or implied

Performance of any engineering investigation is subject to many qualifications inherent to the practice of that profession and to the accuracy of data obtained. Although a reasonable effort was made to interpret data, correctly depict existing conditions, and identify causes of current problems, variations could exist between tested locations. Additionally the historical documents provided by others could contain discrepancies

SECTION 2.0

METHODS OF ANALYSIS

SECTION 2.0 METHODS OF ANALYSIS

The technical approach to the pavement investigation study for the roadways consisted of the following basic elements:

- **Nondestructive Testing (NDT)** - to measure existing pavement and subgrade strength.
- **Pavement Coring and Boring** - to verify as-built pavement thickness and composition and investigate subsurface conditions.
- **Traffic Analysis** - to compute equivalent 18-kip single axle loads.
- **Pavement Analysis** - to determine rehabilitation needs utilizing comprehensive computer analysis.

A brief description of each element is included below with details provided in subsequent sections.

2.1 Nondestructive Testing

A series of nondestructive tests (NDT) were performed to quantify the load/deformation properties of the road pavements. The NDT data were reduced to yield the elastic moduli of pavement layers and subgrade using closed-form solutions detailed in the American Association State Highway and Transportation Officials (AASHTO) pavement design guide. The test sequences performed, as well as the Heavy Falling Weight Deflectometer (HWD) used for testing, conformed to Federal Highway Administration (FHWA) requirements for nondestructive testing.

2.2 Pavement Coring and Boring

HDR conducted twenty eight (28) pavement corings to investigate pavement compositions, thickness, and soil conditions for this study.

Based on the coring data, U.S. Route 1 Highway is composed of asphalt overlay on Portland cement concrete (APC) pavement while Old Mill Road, Mount Vernon Highway, and Telegraph Road consists of asphalt concrete (AC) pavements. Pavement thickness and composition are used for back-calculation and for structural evaluation and design.

2.3 Traffic Analysis

Estimates of current traffic by average daily traffic (ADT) and projected growth were provided by HDR. These data were used to compute equivalent 18-kip axle loads for pavement evaluation and design.

2.4 Pavement Analysis

The processed NDT data and traffic projections were used in comprehensive structural analysis to identify alternatives for rehabilitation using the 1993 AASHTO design guide and 1998 Supplement.

SECTION 3.0

NONDESTRUCTIVE TESTING

SECTION 3.0 NONDESTRUCTIVE TESTING

During April 2007, approximately 70 nondestructive tests (NDT) were conducted over the total 2.2 miles of roadways. NDTs were generally located on a 500-ft. longitudinal spacing over the length of the roadways. NDT field data is included in Appendix A.

The primary purpose of NDT is to determine the structural properties of pavement systems. The load response data resulting from the dynamic force simulates the effect of moving vehicle loads. These data can be used as reliable input for pavement analysis that utilizes both conventional and elastic theories for pavement design and evaluation.

Additional advantages of NDT include:

- minimal interference with roadway traffic;
- measurement of in-situ structural response;
- rapid data acquisition; and
- low unit testing and data processing costs.

Generally speaking, about 50 NDTs can be performed for a cost approximately equivalent to one California Bearing Ratio (CBR) test. A primary value of NDT, then, is the ability to economically evaluate much broader areas of pavement in a short time to better define variability in pavement strength.

The NDT equipment used for the testing program was designed to generate a dynamic load on the pavement surface and measure the resultant vertical response of the pavement system, including subgrade, base courses, and surface layers. The equipment's microcomputer allows rapid data processing in the field. Thus, NDT results can be directly referenced to field conditions, improving the reliability and speed of data acquisition.

3.1 NDT Procedures

To provide a meaningful database for evaluation, the following NDT sequence was utilized:

- Deflection Basin
- Impulse Stiffness Modulus

All tests were conducted under an impulse (i.e., Falling Weight Deflectometer type) forcing function at a nominal amplitude of 10,500 lbs. The tests were conducted in April 2007, when ambient temperatures ranged primarily between 51 degrees F to 78 degrees F.

3.1.1 DEFLECTION BASIN This test method involves measuring deflection at the center of the machine loading plate and at radial offset distances from center. After pavement thickness and composition is determined, closed-form solutions contained in the AASHTO Design Guide were used to process deflection basin data to determine the elastic moduli (E-value) of the subgrade for asphalt concrete (AC) pavements and Modulus of Subgrade Reaction (*k*) of asphalt overlay on Portland cement concrete (APC) pavements. Deflection basins at each test point were processed to obtain design inputs for E and *k*. The AASHTO closed-form solution also resulted in computation of the elastic modulus of AC and Portland cement concrete (PCC) layers for APC pavements.

3.1.2 IMPULSE STIFFNESS MODULUS (ISM) The ISM is defined as dynamic force divided by pavement deflection. As such, it is a measure of overall support conditions from all influencing pavement and subgrade layers. For this study, the ISM data were used to segment the roadway pavement into statistically equivalent areas for structural analysis. The ISM data are also used to identify patterns of variability in pavement support conditions. Plots of ISM versus location are contained in Appendix B.

3.2 Equipment Requirements

RDM's Heavy Falling Weight Deflectometer (HWD) was used for the testing program. The machine is well capable of exceeding the minimum pavement deflection referenced in U.S. Departments of Defense (DOD) and Transportation (DOT) publications. The equipment has a force range of 3,000 lbs. to 55,000 lbs. and records pavement responses on seven sensors extending outward from the center of the loading plate.

3.3 Conventional Testing

Geotechnical investigation was performed by HDR to measure existing pavement thickness and composition.

Twenty-eight (28) pavement cores and borings were taken along the roadway. The borings indicate that the subgrade is mostly a silty clay, clayey sand, silty sand material based on the boring data provided by HDR. A summary of the coring results is contained in Table 3-1, "Summary of Pavement Borings".

HDR also performed CBR tests using subgrade soil and the soaked CBR values for soils SC, SC-SM, and CL at the 0.1 inch penetration were 7.6%, 8.8%, and 2.9, respectively.

3.4 Data Analysis

For this study, the primary purpose of the NDT program was to develop inputs on the strength of pavement and subgrade layers for structural analysis. For the AASHTO procedure used for the pavement analysis, the primary strength characterization is the elastic modulus (E) of pavement layers and subgrade *k* for the APC pavements. The ISM is used to qualitatively evaluate variability in pavement support conditions.

3.4.1 IMPULSE STIFFNESS MODULUS (ISM) Based on the computed ISM, the NDT field data were used to segment the road into analytical sections, based on the recorded variability in the ISM along the length of the roadway. Although pavement thicknesses were relatively consistent, the roadway pavements were segmented into several analytical sections, as necessary, based on the ISM for structural analysis. A plot of ISM along the roadway alignment depicts patterns of variability in pavement strength.

3.4.2 NDT DATA REDUCTIONS Standard AASHTO closed-form back-calculation procedures were used to reduce the APC data to subgrade *k* and elastic moduli of asphalt and concrete, and subgrade resilient modulus (M_r) and effective pavement modulus (E_p) of the AC pavements.

The APC reductions are based on the AREA method. This method recognizes the unique relationship between normalized area under the deflection basin and the radius of relative stiffness, "ℓ". Once ℓ is known, subgrade *k* and pavement moduli are readily computed. The SHRP outer 5-sensor method for AREA computation was used to eliminate any effects of compression in the AC layer.

FORT BELVOIR CONNECTOR
SUMMARY OF PAVEMENT BORINGS

U.S. ROUTE 1

Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
RH-1	15+53	RT WB	2.0/0.0/6.5	Not enc.	6+" PCC below AC (hit rebar and could not drill through it)
RH-1A	17+39	RT WB	4.0/0.0/3.0	None	8" PCC below AC; Sandy clay subgrade
RH-2	19+15	LT WB	5.0/0.0/0.0	None	8.5" PCC below AC; Silty clay subgrade
RH-3	22+33	RT WB	3.0/0.0/11	2.0	Sandy silt
RH-4	25+58	LT EB	3.5/4.0/0.0	6.0	7" PCC below AC; Silty sand subgrade
RH-5	28+00	RT EB	5.5/3.5/0.0	None	8" PCC below AC; Silty sand subgrade
RH-6	32+00	RT EB	6.5/0.0/0.0	7.0	Silty clay subgrade
RH-7	34+65	LT EB	4.5/4.5/0.0	3.0	7" PCC below AC; Fine sand subgrade
RH-8	36+84	LT WB	5.0/3.0/0.0	None	8.5" PCC below AC; Silty clay subgrade
RH-9	38+45	LT WB	4.5/0.0/6.5	5.0	Silty clay subgrade
RH-10	40+44	RT WB	3.5/0.0/7.0	None	10" PCC below AC; Silty clay subgrade

* Indicates surface course/intermediate course/base course as provided by HDR

FORT BELVOIR CONNECTOR
SUMMARY OF PAVEMENT BORINGS

TELEGRAPH ROAD

Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
T-1	52+86	EB	1.5/1.5/7.0	None	Sandy clay subgrade
T-2	61+84	WB	3.5/3.0/0.0	None	Clayey sand with gravel subgrade
T-3	67+96	EB	5.0/4.0/0.0	None	Sand/gravel subgrade
T-4	74+57	WB	3.0/0.0/5.5	None	Silty sand/gravel subgrade
T-5	78+07	EB	5.0/4.0/0.0	None	Clayey sand subgrade
T-6	85+34	WB	N/A	None	8.5" AC/aggregate/AC; Sand/gravel subgrade

* Indicates surface course/intermediate course/base course as provided by HDR.

FORT BELVOIR CONNECTOR
SUMMARY OF PAVEMENT BORINGS

MOUNT VERNON HIGHWAY

Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
MV-1	120+70	SB	8.0/0.0/0.0	4.0	Clayey sand subgrade
MV-2	120+20	LT NB	3.5/4.5/0.0	2.0	Silty clay subgrade
MV-3	118+08	Gore Area	2.0/6.5/0.0	5.0	Sandy clay subgrade
MV-4	116+43	RT NB	2.5/6.5/0.0	10.0	Silty clay subgrade
MV-5	115+12	SB	1.5/2.5/1.5	6.0	Silty clay subgrade

* Indicates surface course/intermediate course/base course as provided by HDR

FORT BELVOIR CONNECTOR
SUMMARY OF PAVEMENT BORINGS

OLD MILL ROAD

Boring No.	Station	Lane	AC (in)*	Agg Base (in)	Comments
OM-1	143+34	SB	5.0/0.0/0.0	7.0	Silty sand subgrade
OM-2	140+03	NB	4.5/0.0/4.5	6.0	Silty sand subgrade
OM-3	136+68	SB	3.5/5.5/0.0	7.0	Sandy silt subgrade
OM-4	133+33	NB	3.0/0.0/5.0	None	Silty clay subgrade
OM-5	130+00	SB	1.0/0.0/5.0	7.0	Sandy silt subgrade
OM-6	126+67	NB	2.0/0.0/6.0	6.0	Clayey gravel subgrade

* Indicates surface course/intermediate course/base course as provided by HDR

For AC pavements, the resilient modulus of the subgrade was computed using the AASHTO closed-form solution:

$$M_r = C\,(0.24P / d_r r)$$

Where:

M_r	=	subgrade resilient modulus
C	=	correction factor of 0.33 to correlate back to the AASHTO road test results
P	=	NDT applied load (lbs.)
d_r	=	deflection at distance r from center of load (inches)
r	=	distance from center of load (inches)

The AASHTO back-calculation results are summarized in Table 3-2, "Subgrade Resilient Modulus Summary".

For the structural evaluation and design of APC pavement for U.S. Route 1, the subgrade *k* of 100 psi/in. is recommended. From the NDT back-calculations, the PCC elastic modulus, Ec, of 3,300,000 psi resulted. The modulus of rupture, R, was then estimated from the elastic modulus of the concrete, Ec, according to:

$$R = (43.5\,Ec / 10^6) + 488.5$$

This relationship is documented in "Pavement Analysis and Design" by Huang. Application of this equation resulted in an estimated modulus of rupture of 632 psi. However, the modulus of rupture should be confirmed by split tensile testing of concrete cores and application of a suitable correlation.

In considering seasonal variation and environmental effects, the representative resilient moduli for the Telegraph Road, Old Mill Road, and Mount Vernon Highway were computed as follows:

- Telegraph Road E = 6,000 psi
- Mount Vernon Highway E = 6,000 psi
- Old Mill Road E = 4,500 psi

From the back-calculated subgrade resilient modulus and its empirical CBR relationship, the in-situ CBR ranges from 3 to 6. Based on engineering experience and documented research results, it is believed that the back-calculated moduli from NDT are a reasonably conservative measure of pavement layer and subgrade support conditions, suitable for use as inputs for structural analysis. The results of the NDT back-calculation for each segment of road are also summarized in Table 3-2.

FORT BELVOIR CONNECTOR
SUBGRADE RESILIENT MODULUS SUMMARY

U.S. ROUTE 1

Station From	Station To	Existing Pavements AC (in.)	PCC (in.)	AGBS (in.)	Model for Existing Pavements	Subgrade *k* (pci)
Right West Bound						
40+30	36+30	10.5	10	0	7"AC/8"PCC on Subgrade	155
36+30	31+30	N/A	N/A	N/A		155
31+30	16+30	N/A	N/A	N/A		171
16+30	14+20	7	8	0		119
AVG						150
STD						22
C.V (%)						15
Left West Bound						
33+80	27+30	8	8.5	0	5"AC/8.5"PCC on Subgrade	61
27+30	23+80	N/A	N/A	N/A		159
23+80	18+80	N/A	N/A	N/A		155
18+80	14+20	5	8.5	0		153
AVG						132
STD						48
C.V (%)						36
Left East Bound						
38+80	33+80	N/A	N/A	N/A	7.5"AC/7"PCC/6"AGBS on Subgrade	276
33+80	29+30	9	7	3		195
29+30	23+30	N/A	N/A	N/A		255
23+30	18+80	7.5	7	6		164
18+80	14+20	N/A	N/A	N/A		197
AVG						217
STD						47
C.V (%)						21
Right East Bound						
41+30	36+30	N/A	N/A	N/A	9"AC/8"PCC on Subgrade	83
36+30	27+30	N/A	N/A	N/A		93
27+30	21+30	9	8	0		104
21+30	16+30	N/A	N/A	N/A		110
16+30	14+20	N/A	N/A	N/A		103
AVG						99
STD						10
C.V (%)						11

Legend:
AC = Asphalt
AGBS = Aggregate Base
PCC = Portland Cement Concrete
k = Modulus of Subgrade Reaction

FORT BELVOIR CONNECTOR
SUBGRADE RESILIENT MODULUS SUMMARY

TELEGRAPH ROAD

Station From	Station To	Existing Pavements AC (in.)	Existing Pavements AGBS (in.)	Model of Existing Pavements	Subgrade M_r (psi)
East Bound					
43+00	48+00	N/A	N/A	9"AC on Subgrade	15,075
48+00	53+00	N/A	N/A		14,448
53+00	58+00	10"AC	0		9,189
58+00	63+00	N/A	N/A		8,300
63+00	68+00	9"AC	0		9,180
68+00	73+00	N/A	N/A		9,917
73+00	78+00	N/A	N/A		10,370
78+00	83+00	9"AC	0		8,420
83+00	88+00	N/A	N/A		6,367
88+00	93+00	N/A	N/A		7,089
93+00	98+00	N/A	N/A		6,913
AVG					9,570
STD					2,856
C.V (%)					30
West Bound					
41+00	45+50	N/A	N/A	8"AC on Subgrade	15,732
45+50	50+50	N/A	N/A		10,537
50+50	55+50	N/A	N/A		6,625
55+50	60+50	N/A	N/A		8,492
60+50	70+50	6.5"AC	0		10,290
70+50	75+50	N/A	N/A		8,327
75+50	80+50	8.5"AC	0		4,623
80+50	85+50	N/A	N/A		4,719
85+50	90+50	8.5"AC	0		6,331
90+50	95+50	N/A	N/A		6,129
AVG					8,180
STD					3,364
C V (%)					41

Legend:
AC = Asphalt
AGBS = Aggregate Base
M_r = Design Subgrade Resilient Modulus

TABLE 3-2 (2 of 4)

FORT BELVOIR CONNECTOR
SUBGRADE RESILIENT MODULUS SUMMARY

MOUNT VERNON HIGHWAY

Station From	Station To	Existing Pavements AC (in.)	Existing Pavements AGBS (in.)	Model for Existing Pavements	Subgrade M_r (psi)
South Bound					
116+50	114+00	8	4	5.5"AC/6"AGBS on Subgrade	8,929
114+00	111+50	5.5	6		6,333
111+50	109+00	N/A	N/A		6,054
AVG					7,105
STD					1,585
C V (%)					22
North Bound					
113+50	118+50	N/A	N/A	8"AC/2"AGBS on Subgrade	6,480
118+50	119+80	9	10		8,832
119+80	120+00	8	2		7,977
AVG					7,763
STD					1,191
C V (%)					15

Legend:
AC = Asphalt
AGBS = Aggregate Base
M_r = Design Subgrade Resilient Modulus

TABLE 3-2 (3 of 4)

FORT BELVOIR CONNECTOR
SUBGRADE RESILIENT MODULUS SUMMARY

OLD MILL ROAD

Station From	Station To	Existing Pavements AC (in.)	Existing Pavements AGBS (in.)	Model for Existing Pavements	Subgrade M_r (psi)
North Bound					
142+00	137+00	9	6	8"AC/3"AGBS on Subgrade	6,454
137+00	132+00	N/A	N/A		5,720
132+00	127+00	8	0		6,126
127+00	122+00	8	6		8,040
AVG					6,585
STD					1,015
C.V (%)					15
South Bound					
144+50	134+50	5	7	5"AC/7"AGBS on Subgrade	3,597
134+50	129+50	9	7		3,943
129+50	124+50	6	7		5,627
AVG					4,389
STD					1,086
C.V (%)					25

Legend:
AC = Asphalt
AGBS = Aggregate Base
M_r = Design Subgrade Resilient Modulus

TABLE 3-2 (4 of 4)

SECTION 4.0

TRAFFIC

SECTION 4.0 TRAFFIC

HDR provided traffic data in terms of the average daily traffic (ADT), frequency, and directional split. Based upon the traffic information, RDM converted ADT data into ESAL for the pavement design as shown in Table 4-1, "ESAL Computation".

The following assumptions were made:

- The percentage of trucks in the ADT was assumed as 5% as directed by HDR.
- The truck factor of 0.23 was estimated from data supplied by the Highway Statistics Division, U.S. Federal Highway Administration. Urban systems/other freeways category was selected for truck factor of 0.23.
- The growth factor was calculated based on an annual growth rate of 3.5% and a design period of 20 years.
- Lane distribution factor was provided by the Virginia Department of Transportation (VDOT).
- The directional split in traffic was provided by HDR.

FORT BELVOIR CONNECTOR

ESAL COMPUTATION

2010 ADT (vpd)	% of Trucks	Truck Factor	days/yr	GF	Lane Distribution Factor	Directional Traffic Split	ESALs
Route 1							
40800	5	0 23	365	28.3	0.9	0 52	2,266,581
Telegraph Road							
25900	5	0.23	365	28.3	0.9	0 52	1,438,834
Mt. Vernon Memorial							
12630	5	0.23	365	28 3	0.9	0.54	728,626
Old Mill Road							
20300	5	0.23	365	28 3	0.9	0.62	1,344,607

TABLE 4-1

SECTION 5.0

DESIGN CONCEPTS

SECTION 5.0 DESIGN CONCEPTS

In accordance with the project work scope, the procedures contained in the 1993 AASHTO Guide for the Design of Pavement Structures and the 1998 Supplement were employed to evaluate the expected performance of existing pavements and to design pavement strengthening for anticipated future loading conditions.

5.1 AASHTO Design Procedures

AASHTO details separate design procedures for flexible and rigid pavements as described below.

5.1.1 AASHTO FLEXIBLE PAVEMENT DESIGN The effective structural number (SN_{eff}) of existing pavements was computed for the AC section of pavement on Telegraph Road, Mt. Vernon Highway, and Old Mill Road. The structural capacity of a flexible pavement can be estimated by comparing the effective structural number of the existing pavement with the structural number required for future traffic. The effective structural number is a measure of the in-situ structural capacity of flexible pavements.

When NDT is part of the evaluation process, SN_{eff} can be computed from the nondestructive testing results. This assumes that the structural capacity of the pavement section is a function of total thickness (D) and the effective elastic modulus (E_p) of all pavement layers above the subgrade. The effective structural number is then computed from the following equation:

$$SN_{eff} = 0.0045\ D\ (E_p)^{1/3}$$

E_p can be computed from the center plate NDT deflection, computed M_r of the subgrade, plate radius (a), and total thickness of pavement above the subgrade. E_p can either be computed directly or from charts included in the AASHTO Design Guide.

The required, or design, structural number can be computed from the AASHTO nomograph contained in Figure 3.1 of the 1993 Design Guide, or from AASHTO's DARWIN program.

The design structural number is a function of the following inputs that were used for the roadways:

- reliability (90%)
- overall standard deviation (0.49)
- estimated 18-kip axle loads as described in Section 4.0
- effective subgrade resilient modulus from NDT
- Initial Serviceability = 4.2
- Terminal Serviceability = 2.8

The difference between the design and effective structural numbers relates to the requirements for strengthening the existing pavement. For asphalt overlay, the required thickness of the overlay is computed by dividing the difference in the structural numbers (i.e., $SN - SN_{eff}$) by the layer coefficient for new asphalt, which, for this project was estimated at 0.44.

5.1.2 AASHTO RIGID PAVEMENT DESIGN AASHTO's rigid pavement design method indicates the structural capacity of the existing pavement is computed as the effective slab thickness, D_{eff}. D_{eff} can be computed by the following equation that incorporates the pavement condition:

$$D_{eff} = F_{jc} * F_{dur} * F_{fat} * D$$

Where:

D	=	existing slab thickness
F	=	adjustment factors based on joint condition ($_{jc}$), durability ($_{dur}$), and fatigue damage ($_{fat}$)

D_{eff} was computed based on the following factors:

F_{jc}	=	1.0, assuming joint rehabilitation be a part of the project
F_{dur}	=	0.96, Durability cracking exists, but no spalling
F_{fat}	=	0.95, mid-range

D_f is the slab thickness required to carry future traffic and was computed using the procedures contained in the 1998 Supplement to the 1993 AASHTO Guide for rigid pavements for climatic conditions in the Virginia area and *k* from the NDT back-calculation.

Initial and Terminal Serviceability Indexes of 4.5 and 2.8, respectively were used, along with 90% reliability and 0.49 standard deviation. As discussed in Section 3.0, a flexural strength of 632 psi was approximated. For evaluation, a 30-ft. slab length was used.

To establish structural condition or overlay thickness, D_{eff} is compared to D_f from the AASHTO design equation. If D_{eff} is greater than D_f, the rigid pavement is structurally sufficient; if not, strengthening is required.

SECTION 6.0

STRUCTURAL ANALYSIS

SECTION 6.0 STRUCTURAL ANALYSIS

Using the analytical methodology described in Section 5.0, the AASHTO analysis was performed to:

- Evaluate the structural sufficiency of existing pavements;
- Design asphalt overlays for structurally inadequate pavements;
- Design milling off existing asphalt layer and replacing with design asphalt overlay for structurally inadequate pavements.
- Design reconstruction sections for badly deteriorated pavements or lane widening.

A 20-year design life was assumed for the structural analysis.

6.1 General Structural Requirements

Structural evaluation and rehabilitation designs were performed for the roadways. The rehabilitation requirements were based on the following:

- design inputs such as existing pavement thickness and subgrade resilient modulus (M_r);
- effective elastic modulus of existing pavement (E_p);
- effective AASHTO structural number SN_{eff} (S2) of existing pavement section from NDT back-calculations; and
- required AASHTO structural number, SN_{req} (S1) from AASHTO Design Guide;

The difference between effective structural number and the required structural number (Δ) also indicates whether the existing pavement section is structurally adequate for the forecasted traffic. Asphalt overlay thicknesses were computed using a layer coefficient of 0.44 for new hot mix asphalt (HMA) and 0.30 for existing HMA.

6.2 U.S. Route 1

From the pavement coring data provided by HDR, the representative pavement composition and thickness of U.S. Route 1 consists of approximately 7.5 inches AC on 7 inches PCC. Using a slab thickness of 7.5 inches and an adjustment factor of 0.91, D_{eff} = 6.8 inches. Using the inputs established previously, D_f = 8.5 inches, indicating the underlying slab is structurally insufficient, without considering the asphalt overlay.

Based on an existing 7.5 inches of AC overlay on 7 inches of PCC from the composition model, rehabilitation requirements for the APC pavements on U.S. Route 1 should be governed by functional, rather than structural considerations.

Based upon the localized block cracking on the AC surface from the pictures taken during the NDT testing and the various core information provided in Section 3.0 of this report, a mill and replace option is recommended for the APC pavement on U.S. Route 1. The mill and replacement depth should be a minimum of 2¼ inches but should be adjusted to prevent against potential scabbing between layers.

Milling the existing pavement will remove the oxidized and distressed asphalt surface. The milling should be deep enough so as not to leave a thin wedge of an existing lift that could delaminate. The mill and replace will also result in a net increase in the effective structural number, since the existing surface will be replaced with higher quality material. After milling, the pavement surface needs to be checked for repairs such as crack sealing, patching, etc., before replacing with the new HMA. The new asphalt overlay can be constructed in single 2¼-inch lift. The lift can consist of a surface course material with a 0.50-inch (12.5mm) maximum size aggregate.

Due to the high traffic volume on U.S. Route 1, hot mix asphalt for surface lift should use PG70-22 performance grade asphalt cement.

6.3 Telegraph Road

From the pavement coring and boring data provided by HDR, the representative pavement composition and thickness of Telegraph Road consist of approximately 8 inches AC.

The rehabilitation requirements were calculated based on both methods as described in Section 6.1 and AASHTO's DARWIN program and the recommendation from DARWIN was utilized for conservatism.

The milling and overlay recommendation is summarized in Table 6-1, "Overlay Computation Summary – Telegraph Road". A 4-inch existing AC layer from Stations 43+00 to 98+00 in East Bound and Stations 41+00 to 50+50 in West Bound should be milled off and replaced with a 4-inch new AC without a net increase in thickness. From Stations 50+50 to 75+50 and from Stations 85+50 to 95+50 in West Bound lane, it should be milled approximately 4 inches and replaced with 6 inches new AC with a net 2-inch increase in thickness. Given the existing pavement from Stations 75+50 to 85+50 in West Bound lane is structurally insufficient, it should be milled approximately 4 inches and replaced with 7 inches new AC with a net 3-inch increase in thickness. After milling, the pavement surface needs to be checked for repairs such as crack sealing, patching, etc., before placing the new AC. The new asphalt overlay can be constructed in 2-inch base lift and 2-inch surface lift for the 4 inches mill and overlay section. The 4 inches mill and 6 inches overlay section can be constructed of 4-inch base lift and 2-inch surface lift. The 4 inches mill and 7 inches overlay section can be constructed of 5-inch base lift and 2-inch surface lift.

The base lift material should consist of a 1-inch (25mm) maximum size aggregate, followed by a surface lift consisting of 0.50-inch (12.5mm) maximum size aggregate. PG70-22 performance grade asphalt cement should be used in surface lifts while a PG64-22 may be utilized in the base lifts.

Given the strengthening of Stations 50+50 to 95+50 in the West Bound lanes a transition area must be considered by HDR.

FORT BELVOIR CONNECTOR

OVERLAY COMPUTATION SUMMARY

TELEGRAPH ROAD

Station (feet) From	To	Existing Pavements AC	AGBS	Subgrade Mr	SNreq.	Ep	Repair/Overlay SN_{eff}	Δ	hcal.	hrec.	Mill/Overlay SN_{eff}	Δ	hcal.	hrec.	Rehab. Requirement	AASHTO DARWIN	Rehab. Recommendation
		in.	in.	psi	S1		S2	S1-S2	in.	in.	S3	S1-S3	in.	in.			
East Bound																	
43+00	48+00	N/A	N/A	15,075	2.95	1,155,593	4.25	-1.30	0.0	0.0	4.81	-1.86	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
48+00	53+00	N/A	N/A	14,448	3.01	2,505,174	5.50	-2.49	0.0	0.0	6.06	-3.05	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
53+00	58+00	10"AC	0	9,189	3.63	436,710	3.07	0.56	1.3	1.0	3.63	0.00	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
58+00	63+00	N/A	N/A	8,300	3.78	607,820	3.43	0.35	0.8	1.0	3.99	-0.21	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
63+00	68+00	9"AC	0	9,180	3.63	887,948	3.89	-0.26	0.0	0.0	4.45	-0.82	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
68+00	73+00	N/A	N/A	9,917	3.51	874,657	3.87	-0.36	0.0	0.0	4.43	-0.92	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
73+00	78+00	N/A	N/A	10,370	3.45	981,619	4.03	-0.58	0.0	0.0	4.59	-1.14	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
78+00	83+00	9"AC	0	8,420	3.76	716,167	3.62	0.14	0.0	0.0	4.18	-0.42	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
83+00	88+00	N/A	N/A	6,367	4.20	597,897	3.41	0.79	1.8	1.0	3.97	0.23	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
88+00	93+00	N/A	N/A	7,089	4.02	764,631	3.70	0.32	0.7	1.0	4.26	-0.24	0.0	0.0	mill 4", replace 4"	mill 4", replace 5"	mill 4", replace 5"
93+00	98+00	N/A	N/A	6,913	4.06	603,323	3.42	0.64	1.4	1.0	3.98	0.08	0.0	0.0	mill 4", replace 4"	mill 4", replace 5"	mill 4", replace 5"
West Bound																	
41+00	45+50	N/A	N/A	15,732	2.90	1,368,421	4.00	-1.10	0.0	0.0	4.56	-1.66	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
45+50	50+50	N/A	N/A	10,537	3.43	3,186,944	5.30	-1.87	0.0	0.0	5.86	-2.43	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 4"
50+50	55+50	10"AC	0	6,625	4.13	742,877	3.26	0.87	2.0	1.5	3.82	0.31	0.7	0.0	mill 4", replace 4"	mill 4", replace 6"	mill 4", replace 6"
55+50	60+50	N/A	N/A	8,492	3.74	1,172,640	3.80	-0.06	0.0	0.0	4.36	-0.62	0.0	0.0	mill 4", replace 4"	mill 4", replace 5"	mill 4", replace 6"
60+50	70+50	9"AC	0	10,290	3.46	712,600	3.22	0.24	0.6	1.0	3.78	-0.32	0.0	0.0	mill 4", replace 4"	mill 4", replace 4"	mill 4", replace 6"
70+50	75+50	N/A	N/A	8,327	3.77	870,610	3.44	0.33	0.8	1.0	4.00	-0.23	0.0	0.0	mill 4", replace 4"	mill 4", replace 6"	mill 4", replace 6"
75+50	80+50	N/A	N/A	4,623	4.76	748,682	3.27	1.49	3.4	3.0	3.83	0.93	2.1	2.0	mill 4", overlay 6"	mill 4", overlay 7"	mill 4", replace 7"
80+50	85+50	9"AC	0	4,719	4.69	456,641	2.77	1.92	4.4	4.0	3.33	1.36	3.1	2.0	mill 4", overlay 7"	mill 4", overlay 7"	mill 4", replace 7"
85+50	90+50	N/A	N/A	6,331	4.20	889,666	3.46	0.74	1.7	1.5	4.02	0.18	0.0	2.0	mill 4", overlay 4"	mill 4", overlay 6"	mill 4", replace 6"
90+50	95+50	N/A	N/A	6,129	4.26	691,421	3.18	1.08	2.4	2.0	3.74	0.52	1.2	2.0	mill 4", overlay 6"	mill 4", overlay 6"	mill 4", replace 6"

Legend: AC= Asphalt
AGBS = Aggregate Base

Mr = Design Subgrade Resilient Modulus
SN_{eff} = Effective Structural Number

TABLE 6-1

6.4 Mount Vernon Memorial Highway

Based upon the pavement coring data provided by HDR, the representative pavement composition and thickness of Mount Vernon Memorial Highway consist of approximately 5.5 inches AC on 6 inches subbase.

The milling and overlay recommendation is summarized in Table 6-2, "Overlay Computation Summary – Mount Vernon Memorial Highway". A 4-inch of the existing AC pavement should be milled off and overlaid with a 6-inch new AC, for a net 2-inch increase in thickness. After milling, the pavement surface needs to be checked for repairs such as seal crack, patching, etc., before replacing the new AC. As mentioned previously, the new asphalt overlay can be constructed in a 4-inch base lift and a 2-inch surface lift. For consistency and economics, the new surface should be consistent with other adjacent roadway, i.e., PG70-22 performance grade asphalt cement.

6.5 Old Mill Road

Based upon the pavement coring data provided by HDR, the representative pavement composition and thickness of Old Mill Road consist of approximately 5 inches AC on 7 inches subbase. The structural condition of Old Mill Road pavement in South Bound lanes was poorer than the pavement in North Bound lanes.

The rehabilitation recommendations are summarized in Table 6-3, "Overlay Computation Summary – Old Mill Road". Strengthening is required from Stations 122+00 to 142+00 in North Bound lanes and 3.5 inches of the existing AC layer should be milled off and replaced with 5.5 inches new AC, for a net 2-inch increase in thickness. The new AC can be constructed in 3½-inch lift consisting of base material with 1-inch (19mm) maximum size aggregate and PG 64-22, followed by a 2-inch surface lift consisting of 0.50 (12.5mm) maximum size aggregate.

For the South Bound direction, due to grade constraints, a thick overlay (approximately 7+ inches) would not be practical. Therefore, a reconstruction of the South Bound pavement of Old Mill Road is recommended. Based on a required structural number, the reconstruction requirement is:

2" AC (12.5mm max. size aggregate) / 7" AC (25mm max. size aggregate) / 9" AGBS

The lower 7 inches of the new AC can be constructed with two 3.5-inch asphalt base lifts (PG64-22 asphalt cement). The base course material will consist of 1-inch (25mm) maximum size aggregate, followed by a 2-inch surface lift consisting of 0.50 (12.5mm) maximum size aggregate.

For aggregate base course, 1½ inches maximum size aggregate and EFLHD's Section 301 should be used. The main requirement for granular base or subbase materials is limiting the amount of fine material passing the 0.02-mm sieve to 3% to ensure non-frost susceptibility.

To ensure non-frost susceptibility, the top 6 inches of the frost susceptible roadbed soils should be replaced with a granular fill material. The frost design adjustments will be discussed in detail in Section 6.7

FORT BELVOIR CONNECTOR

OVERLAY COMPUTATION SUMMARY

MOUNT VERNON MEMORIAL HIGHWAY

Station (feet)		Existing Pavements		Subgrade	SNreq.	Ep	Repair/Overlay				Mill/Overlay				Rehab.
From	To	AC	AGBS	Mr			SN_{eff}	Δ	hcal.	hrec.	SN_{eff}	Δ	hcal.	hrec.	Requirement
		in.	in	psi	S1		S2	S1-S2	in	in.	S3	S1-S3	in.	in.	
East Bound															
116+50	114+00	8	4	8 929	3 67	486,200	4 07	-0.40	0 0	0 0	4.63	-0.96	0.0	0 0	mill 4', overlay 6"
114+00	111+50	5.5	6	6.333	3 74	56.117	1 98	1 76	4 0	4.0	2.54	1.20	2.7	2 0	mill 4" overlay 6"
111+50	109+00	N/A	N/A	6.054	3 81	88,087	2 30	1 51	3 4	3.0	2 86	0.95	2.2	2 0	mill 4", overlay 6"
West Bound															
113+50	118+50	N/A	N/A	6,480	3 71	221.185	3 55	0 16	0.0	0 0	4 11	-0.40	0 0	0 0	mill 4" overlay 6"
118+50	119+80	9	10	8,832	3 26	185.620	3 15	0 11	0.0	0 0	3 71	-0 45	0.0	0 0	mill 4" overlay 6"
119+80	120+00	8	2	7.977	3.40	334 866	3 28	0 12	0.0	0 0	3 84	-0 44	0 0	0 0	mill 4", overlay 6"

Legend: AC= Asphalt
AGBS = Aggregate Base

Mr = Design Subgrade Resilient Modulus
SN_{eff} = Effective Structural Number

TABLE 6-2

FORT BELVOIR CONNECTOR

OVERLAY COMPUTATION SUMMARY

OLD MILL ROAD

Station (feet)		Existing Pavements		Subgrade	SNreq	Ep	Repair/Overlay				Mill/Overlay				Rehab.
From	To	AC	AGBS	Mr			SN_{eff}	Δ	hcal.	hrec.	SN_{eff}	Δ	hcal.	hrec.	Recommendation
		in.	in.	psi	S1		S2	S1-S2	in.	in.	S3	S1-S3	in.	in.	
West Bound															
142+00	137+00	9	6	6,454	4.13	187,547	2.83	1.30	2.9	3.0	3.32	0.81	1.8	2.0	mill 3.5", replace 5.5"
137+00	132+00	N/A	N/A	5,720	4.32	140,070	2.57	1.75	4.0	4.0	3.06	1.26	2.9	2.0	mill 3.5", replace 5.5"
132+00	127+00	8	0	6,126	4.21	241,097	3.08	1.13	2.6	3.0	3.57	0.64	1.5	2.0	mill 3.5", replace 5.5"
127+00	122+00	8	6	8,040	3.78	191,596	2.85	0.93	2.1	2.0	3.34	0.44	1.0	2.0	mill 3.5", replace 5.5"
East Bound															
144+50	134+50	5	7	3,597	5.11	81,658	2.34	2.77	6.3	6.0	2.83	2.28	5.2	5.0	Reconstruction
134+50	129+50	9	7	3,943	4.95	60,003	2.11	2.84	6.4	6.0	2.60	2.35	5.3	5.0	Reconstruction
129+50	124+50	6	7	5,627	4.35	165,424	2.96	1.39	3.1	3.0	3.45	0.90	2.0	2.0	Reconstruction

Legend: AC= Asphalt
AGBS = Aggregate Base

Mr = Design Subgrade Resilient Modulus
SN_{eff} = Effective Structural Number

TABLE 6-3

6.6 Lane Widening

HDR requested RDM to design new pavement sections for lane widening for the Connector roadways. RDM understands the new pavement sections will be additional full width lanes. New flexible pavement for the roadways at the Fort Belvoir Connector was designed based on primary inputs in Sections 3.0 and 4.0 in accordance with the AASHTO design procedure. The following new pavement sections are recommended for lane widening at the Fort Belvoir Connector:

- U.S. Route 1

  2" AC (12.5mm max. size aggregate) / 6.5" AC (25mm max. size aggregate) / 9" AGBS

- Telegraph Road

  2" AC (12.5mm max. size aggregate) / 5" AC (25mm max. size aggregate) / 9" AGBS

- Mount Vernon Memorial Highway

  2" AC (12.5mm max. size aggregate) / 4" AC (25mm max. size aggregate) / 9" AGBS

- Old Mill Road

  2" AC (12.5mm max. size aggregate) / 7" AC (25mm max. size aggregate) / 9" AGBS

Where:

AC = asphalt concrete
AGBS = aggregate base

Hot mix asphalt for the flexible pavement section should conform to EFLHD's Section 401. A PG70-22 should be specified for the asphalt cement surface course to ensure adequate mix stability for the high volume traffic roadway.

For aggregate base course, 1½ inches maximum size aggregate and EFLHD's Section 301 should be used. The main requirement for granular base or subbase materials is limiting the amount of fine material passing the 0.02-mm sieve to 3% to ensure non-frost susceptibility.

Further, to ensure non-frost susceptibility, the top 6 inches of the frost susceptible roadbed soils should be also replaced with a granular fill material. The frost design adjustments will be discussed in detail in Section 6.7.

6.7 Frost Design Adjustments

From the soil types provided by HDR, the in-situ subgrade soils are clayey and silty sand (SM-SC, SC) or sandy clay (CL), which is classified as high frost susceptible soil.

The most accepted procedure to minimize the effect of frost heave is to replace the frost-susceptible material with non-frost-susceptible material to a depth of one-half or more of the frost depth. Using a design air freezing index of 350, a design frost depth of 32 inches was computed.

Generally, accepted criteria for frost design are normally based on the Limited Frost Protection (LFP) when the subgrade is reasonably uniform. This generally results in the use of the LFP design at 65% of frost depth, or for this project, approximately 21 inches of LFP. As described in Section 6.6, the thicknesses of new pavement sections in each road show approximately 16 inches. To ensure non-frost susceptibility, the top 6 inches of the frost susceptible roadbed soils should be replaced with a granular fill material with fine passing the 0.02-mm sieve not more than 3%.

SECTION 7.0

SUMMARY

SECTION 7.0 SUMMARY

Roy D. McQueen & Associates, Ltd. (RDM) was retained by HDR to perform NDTs and pavement evaluation services for approximately 2.2 miles of roadway at Ft. Belvoir Connector in Virginia. The basic objective is to investigate pavement rehabilitation and/or strengthening requirements to accommodate future traffic demands.

RDM's work scope only included structural analysis and did not include condition survey to determine functional pavement condition or the condition of pavement materials. It is assumed that this work is being conducted by others and will be used with the structural evaluation results included herein in determining final rehabilitation methods.

Based on the coring information provided by HDR, the pavement composition consists of asphalt overlay on concrete (APC) and asphalt concrete (AC) pavements. NDTs were conducted at nominal amplitude of 10,500 lbs.

Using NDT Data, the AASHTO design guide for pavement structures were used for the back-calculation for elastic modulus and modulus of subgrade *k* for AC and APC pavement, respectively.

For the structural evaluation and design of APC pavement on U.S. Route 1, the subgrade *k* of 100 psi/in. was recommended. Further, the representative resilient moduli for the Telegraph Road, Old Mill Road, and Mount Vernon Highway were estimated as follows:

- Telegraph Road M_r = 6,000 psi
- Mount Vernon Highway M_r = 6,000 psi
- Old Mill Road M_r = 4,500 psi

Considering the structural condition of the roadways, rehabilitation options are required to improve some portions of each roadway. Rehabilitation options include: AC overlay, milling and overlay, and reconstruction.

For U.S. Route 1, the rehabilitation should consist of milling 2¼ inches of the existing AC layer and replacing with 2¼ inches of new AC.

For Telegraph Road, the existing pavement should be milled, approximately, 4 inches and replaced with a 4-inch new AC without a net increase in thickness for Stations 43+00 to 98+00 in East Bound and Stations 41+00 to 50+50 in West Bound. From Stations 50+50 to 75+50 and from Stations 85+50 to 95+50 in West Bound lane, it should be milled approximately 4 inches and replaced with 6-inch new AC with a net 2-inch increase in thickness. Given the existing pavement from Stations 75+50 to 85+50 in West Bound lane is structurally insufficient, it should be milled approximately 4 inches and replaced with 7-inch new AC with a net 3-inch increase in thickness. After milling, the pavement surface needs to be checked for repairs such as crack sealing, patching, etc., before placing the new AC. The new asphalt overlay can be constructed in 2-inch base lift and 2-inch surface lift for the 4 inches mill and overlay section. The 4-inch mill and 6-inche overlay section can be constructed of 4-inch base lift and 2-inch surface lift. The 4 inches mill and 7 inches overlay section can be constructed of 5-inch base lift and 2-inch surface lift.

For Mount Vernon Memorial Highway, in the South Bound direction, 4 inches of the existing AC pavement sections should be milled off and replaced with a 6-inch new AC, for a net 2-inch increase in thickness.

For Old Mill Road, approximately, 3.5 inches of the existing pavement sections from Stations 122+00 to 142+00 in the North Bound direction should be milled off and replaced with 5.5 inches new AC, for a net 2-inch increase in thickness. For the South Bound direction, due to grade constraints, a thick overlay would not be practical. Therefore, reconstruction of the South Bound pavement of Old Mill Road is recommended. The reconstruction requirement is:

2" AC (12.5mm max. size aggregate) / 7" AC (25mm max. size aggregate) / 9" AGBS

Requirements for additional full width lane are also designed and the new pavement sections are:

- U.S. Route 1
  2" AC (12.5mm max. size aggregate) / 6.5" AC (25mm max. size aggregate) / 9" AGBS

- Telegraph Road
  2" AC (12.5mm max. size aggregate) / 5" AC (25mm max. size aggregate) / 9" AGBS

- Mount Vernon Memorial Highway
  2" AC (12.5mm max. size aggregate) / 4" AC (25mm max. size aggregate) / 9" AGBS

- Old Mill Road
  2" AC (12.5mm max. size aggregate) / 7" AC (25mm max. size aggregate) / 9" AGBS

Further, the in-situ subgrade soils are clayey and silty sand (SM-SC, SC) or sandy clay (CL), which is classified as high frost susceptible soil. To ensure non-frost susceptibility, the top 6 inches of the frost susceptible roadbed soils should be replaced with a granular fill material with fine passing the 0.02-mm sieve not more than 3%.

APPENDIX A

NDT FIELD DATA

Ft. Belvoir Connector, VA
NDT Field Data - Route 1

NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	ISM (k/in)	Remarks
RT WB														
1	2	40+30	0	10.5	4.90	4.47	4.03	3.03	2.45	2.05	1.60	59	2145	10.5'AC/10'PCC
2	2	36+30	0	10.5	5.18	5.04	4.59	3.56	2.72	2.03	1.44	60	2026	
3	2	31+30	0	10.5	8.06	7.75	6.74	4.35	2.97	2.18	1.55	59	1302	
5	2	21+30	0	10.5	5.71	5.61	5.04	4.06	3.37	2.83	2.17	59	1838	14'AC/2'AGBS
6	2	16+30	0	10.5	7.11	6.52	5.64	4.30	3.40	2.69	1.96	57	1477	7"AC/8"PCC
AVE.					6.19	5.88	5.21	3.86	2.98	2.35	1.74	59	1758	
STD.					1.35	1.29	1.04	0.56	0.41	0.38	0.31		358.55	
CV.					22	22	20	15	14	16	18		20	
LT WB														
1	3	38+80	0	10.5	4.06	3.46	2.93	2.39	2.08	1.78	1.41	64	2588	11'AC/5"AGBS
2	3	33+80	0	10.5	4.62	4.22	3.73	3.35	3.02	2.71	2.22	69	2271	8'AC/8.5"PCC
3	3	27+30	0	10.5	3.62	3.27	2.78	2.30	1.94	1.63	1.21	68	2897	
4	3	23+80	0	10.5	4.06	3.37	2.74	2.29	1.94	1.62	1.21	67	2585	
5	3	18+80	0	10.5	3.95	3.73	3.06	2.47	2.09	1.76	1.36	66	2659	5"AC/8.5"PCC
AVE.					4.06	3.61	3.05	2.56	2.22	1.90	1.48	67	2600	
STD.					0.36	0.38	0.40	0.45	0.46	0.46	0.42		224	
CV					9	11	13	18	21	24	28		9	
LT EB														
1	4	38+80	0	10.5	4.27	3.25	2.64	1.93	1.53	1.21	0.91	68	2461	
2	4	33+80	0	10.5	3.81	2.92	2.46	1.99	1.68	1.38	1.05	72	2753	9"AC/7'PCC/3'AGBS
3	4	29+30	0	10.5	4.23	3.77	3.29	2.46	1.78	1.29	0.93	74	2481	
4	4	23+30	0	10.5	4.54	4.12	3.69	2.92	2.32	1.83	1.34	72	2314	7.5'AC/7"PCC/6'AGBS
5	4	18+80	0	10.5	7.26	7.13	5.83	3.51	2.58	2.04	1.59	67	1446	
AVE.					4.82	4.24	3.58	2.56	1.98	1.55	1.16	71	2291	
STD.					1.39	1.68	1.35	0.66	0.45	0.37	0.29		498	
CV.					29	40	38	26	23	24	25		22	
RT EB														
1	5	41+30	0	10.5	5.33	5.22	4.72	3.98	3.41	2.87	2.22	61	1972	
2	5	36+30	0	10.5	7.00	6.32	5.81	4.64	3.76	3.11	2.30	61	1500	
3	5	31+30	0	10.5	4.63	4.43	4.03	3.09	2.41	1.86	1.38	65	2266	6.5'AC/7'AGBS
4	5	27+30	0	10.5	6.49	5.94	5.30	4.21	3.45	2.80	2.08	65	1617	9"AC/8"PCC
5	5	21+30	0	10.5	13.51	12.61	10.82	6.63	4.67	3.55	2.68	67	777	
6	5	16+30	0	10.5	7.36	7.01	6.29	4.70	3.81	3.12	2.38	62	1426	
AVE.					7.39	6.92	6.16	4.54	3.58	2.89	2.17	64	1593	
STD.					3.17	2.93	2.42	1.18	0.73	0.57	0.44		510	
CV.					43	42	39	26	20	20	20		32	

Ft. Belvoir Connector, VA
NDT Field Data - Telegraph Road

NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	ISM (k/in)	Remarks
East Bound														
1	1	43+00	0	10.5	4.54	3.47	3.17	2.30	1.76	1.35	0.97	59	2310	
2	1	48+00	0	10.5	3.58	3.54	3.24	2.40	1.87	1.46	1.12	59	2930	
3	1	53+00	0	10.5	7.81	7.48	6.41	3.77	2.34	1.54	1.06	56	1345	10'AC
4	1	58+00	0	10.5	7.71	7.66	6.50	4.17	2.79	1.98	1.38	56	1362	
5	1	63+00	0	10.5	6.56	6.49	5.62	3.77	2.69	1.98	1.43	57	1601	
6	1	68+00	0	10.5	6.28	5.90	5.09	3.49	2.49	1.78	1.19	55	1672	9'AC
7	1	73+00	0	10.5	5.85	5.71	4.88	3.34	2.38	1.74	1.26	58	1796	
8	1	78+00	0	10.5	7.15	6.96	6.18	4.12	2.73	1.84	1.25	65	1468	9'AC
9	1	83+00	0	10.5	9.34	9.04	7.92	5.44	3.74	2.60	1.75	60	1124	
10	1	88+00	0	10.5	8.08	7.62	6.93	4.89	3.43	2.46	1.67	59	1299	
11	1	93+00	0	10.5	8.78	8.28	7.35	5.01	3.42	2.36	1.55	62	1196	
AVE.					**6.88**	**6.56**	**5.75**	**3.88**	**2.69**	**1.92**	**1.33**	**59**	**1646**	**9"AC**
STD.					**1.75**	**1.80**	**1.55**	**1.00**	**0.63**	**0.41**	**0.25**		**540**	
CV					**25**	**27**	**27**	**26**	**23**	**21**	**19**		**33**	
West Bound														
11	2	41+00	0	10.5	4.29	3.99	3.46	2.20	1.47	1.01	0.69	74	2447	
10	2	45+50	0	10.5	4.62	4.62	4.19	3.29	2.58	2.00	1.47	75	2270	
9	2	50+50	0	10.5	9.28	9.03	7.93	5.23	3.47	2.46	1.70	75	1132	
8	2	55+50	0	10.5	7.28	6.67	5.71	4.08	3.05	2.33	1.71	78	1443	
7	2	60+50	0	10.5	6.90	6.63	5.56	3.37	2.15	1.49	1.09	76	1522	6.5'AC
6	2	65+50	0	10.5	4.80	4.70	4.19	2.72	1.80	1.21	0.87	70	2187	
5	2	70+50	0	10.5	7.75	7.27	6.24	4.16	2.86	2.03	1.39	64	1355	
4	2	75+50	0	10.5	12.38	11.96	10.81	7.50	5.42	4.03	2.84	62	848	8.5'AC
3	2	80+50	0	10.5	13.86	13.24	11.45	7.34	4.95	3.42	2.32	62	758	
2	2	85+50	0	10.5	9.37	8.82	7.72	5.47	3.87	2.73	1.86	61	1121	8.5'AC
1	2	90+50	0	10.5	9.89	9.70	8.56	5.65	3.68	2.39	1.52	65	1062	
AVE.					**8.22**	**7.88**	**6.89**	**4.64**	**3.21**	**2.28**	**1.59**	**69**	**1468**	**8"AC**
STD.					**3.12**	**3.00**	**2.66**	**1.76**	**1.24**	**0.90**	**0.62**		**585**	
CV					**38**	**38**	**39**	**38**	**39**	**40**	**39**		**40**	

Ft. Belvoir Connector, VA

NDT Field Data - MT. Vernon Mem. Hwy

NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	ISM (k/in)	Remarks
South Bound														
1	1	116+50	0	10.5	6.23	6.20	5.48	3.88	2.72	1.89	1.25	54	1685	8"AC/4"AGBS
2	1	114+00	0	10.5	15.82	14.05	11.94	5.47	2.14	1.13	0.95	53	664	5.5"AC/6"AGBS
3	1	111+50	0	10.5	14.80	13.23	10.76	5.72	3.21	1.93	1.34	53	709	
AVE.					12.29	11.16	9.39	5.03	2.69	1.65	1.18	53	1019	5.5"AC/6"AGBS
STD.					5.27	4.31	3.44	1.00	0.54	0.45	0.21		577	
CV.					42.87	38.66	36.64	19.88	19.95	27.23	17.39		57	
North Bound														
1	3	113+50	0	10.5	11.29	10.34	8.96	5.35	3.11	1.96	1.35	56	930	
2	3	118+50	0	10.5	9.85	8.69	7.28	3.92	2.15	1.37	1.05	58	1066	
3	3	119+80	0	10.5	8.53	8.26	7.18	4.34	2.58	1.57	0.95	57	1231	8"AC/2"AGBS
AVE					9.89	9.10	7.80	4.54	2.61	1.63	1.12	57	1076	8"AC/2"AGBS
STD.					1.38	1.10	1.00	0.73	0.48	0.30	0.21		151	
CV					13.94	12.07	12.80	16.12	18.53	18.22	18.38		14	

Ft. Belvoir Connector, VA
NDT Field Data - Old Mill

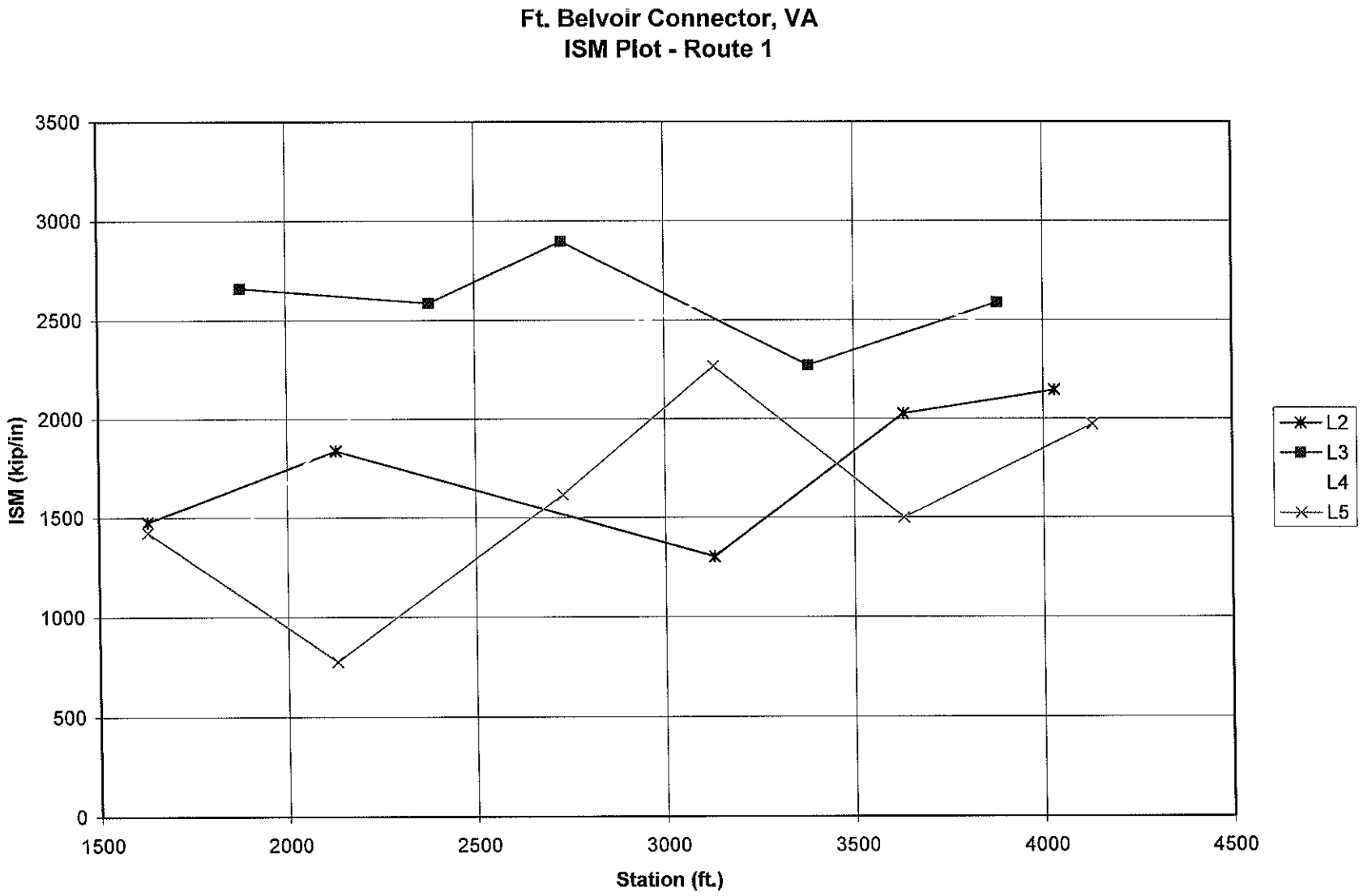
NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	ISM (k/in)	Remarks
North Bound														
1	1	142+00	0	10.5	10.25	10.23	9.10	5.37	3.17	1.98	1.31	51	1025	9"AC/6"AGBS
2	1	137+00	0	10.5	12.91	11.45	10.29	6.06	3.80	2.57	1.83	51	813	
3	1	132+00	0	10.5	10.07	9.67	8.83	5.66	3.72	2.39	1.55	51	1043	8"AC/0"AGBS
4	1	127+00	0	10.5	9.12	8.10	7.30	4.31	2.61	1.69	1.18	54	1152	8"AC/6"AGBS
AVE.					10.59	9.86	8.88	5.35	3.32	2.16	1.47	52	1008	8"AC/0"AGBS
STD.					1.63	1.39	1.23	0.75	0.55	0.40	0.29		142	
CV.					15.39	14.08	13.83	13.98	16.65	18.46	19.72		14	
South Bound														
1	2	144+50	0	10.5	19.78	18.47	16.96	9.63	5.52	3.57	2.69	51	531	5"AC/7"AGBS
3	2	134+50	0	10.5	20.91	18.65	16.20	8.79	4.51	2.57	1.81	54	502	9"AC/7"AGBS
4	2	129+50	0	10.5	11.67	10.83	9.88	6.16	3.81	2.42	1.59	52	900	6"AC/7"AGBS
AVE.					17.45	15.98	14.34	8.19	4.61	2.85	2.03	52	644	5"AC/7"AGBS
STD					7.88	7.00	6.22	3.11	1.46	0.82	0.65		1066	
CV.					45.15	43.81	43.35	37.98	31.62	28.84	32.05		166	

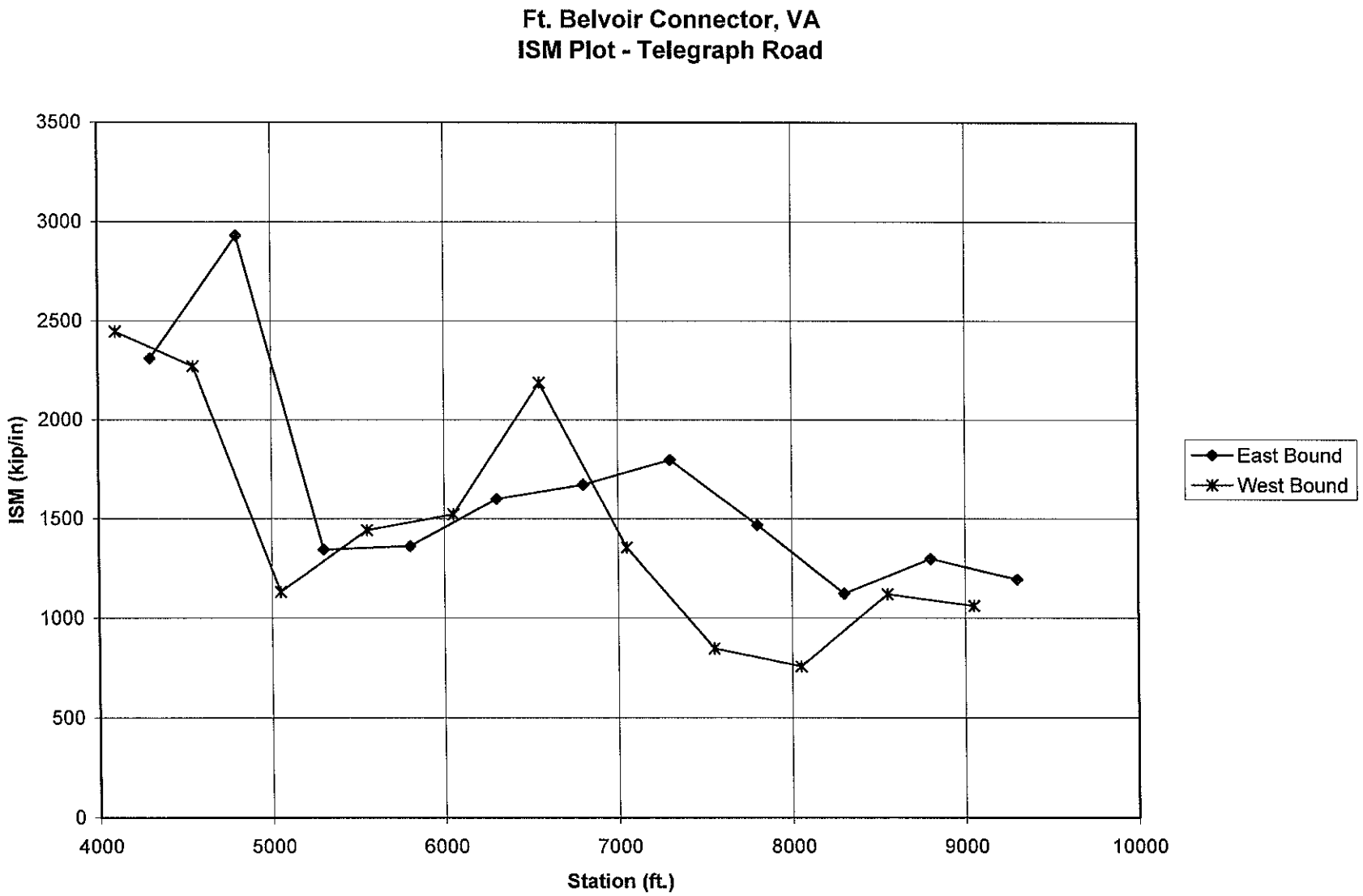
APPENDIX B

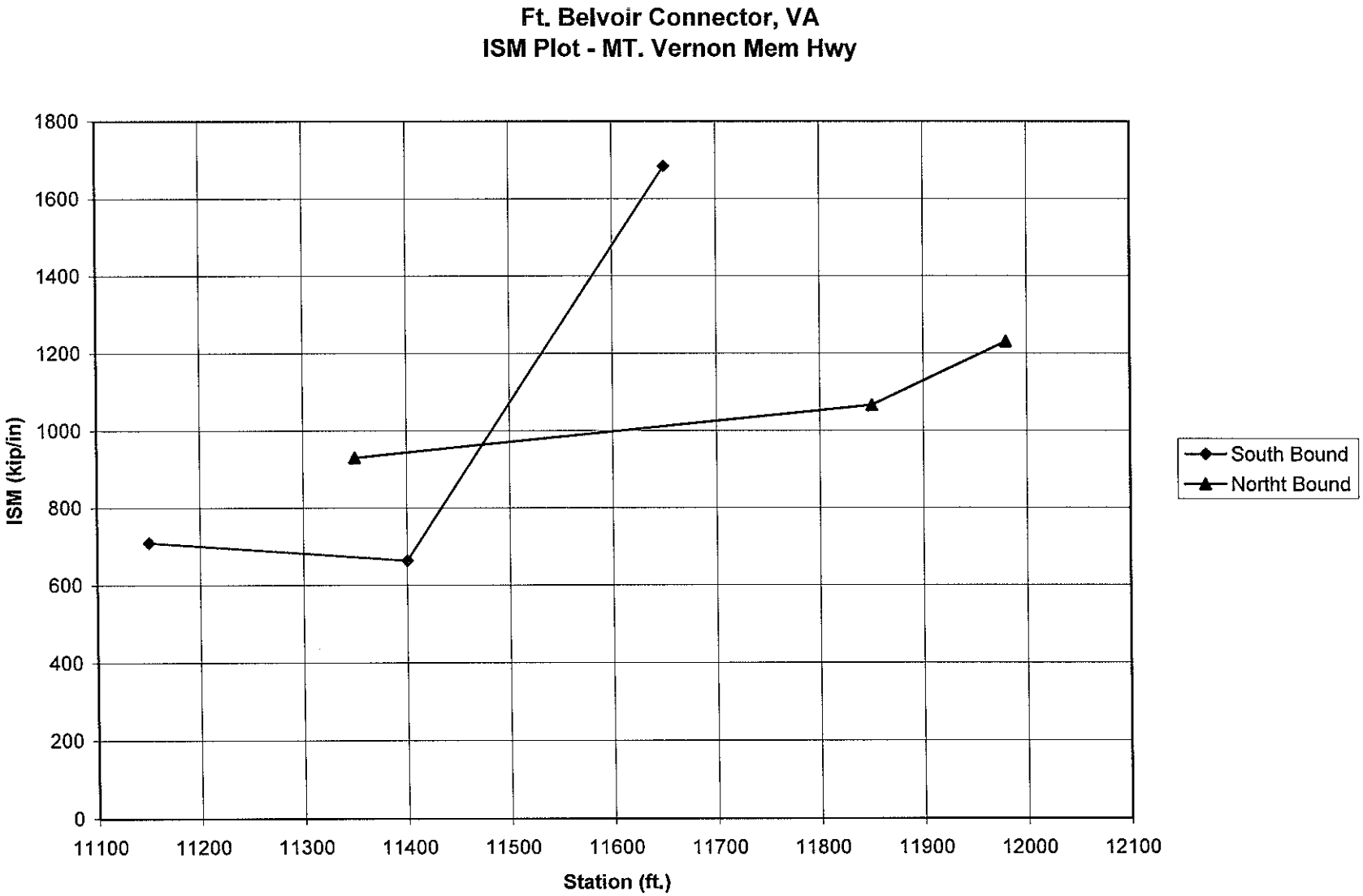
ISM PLOTS

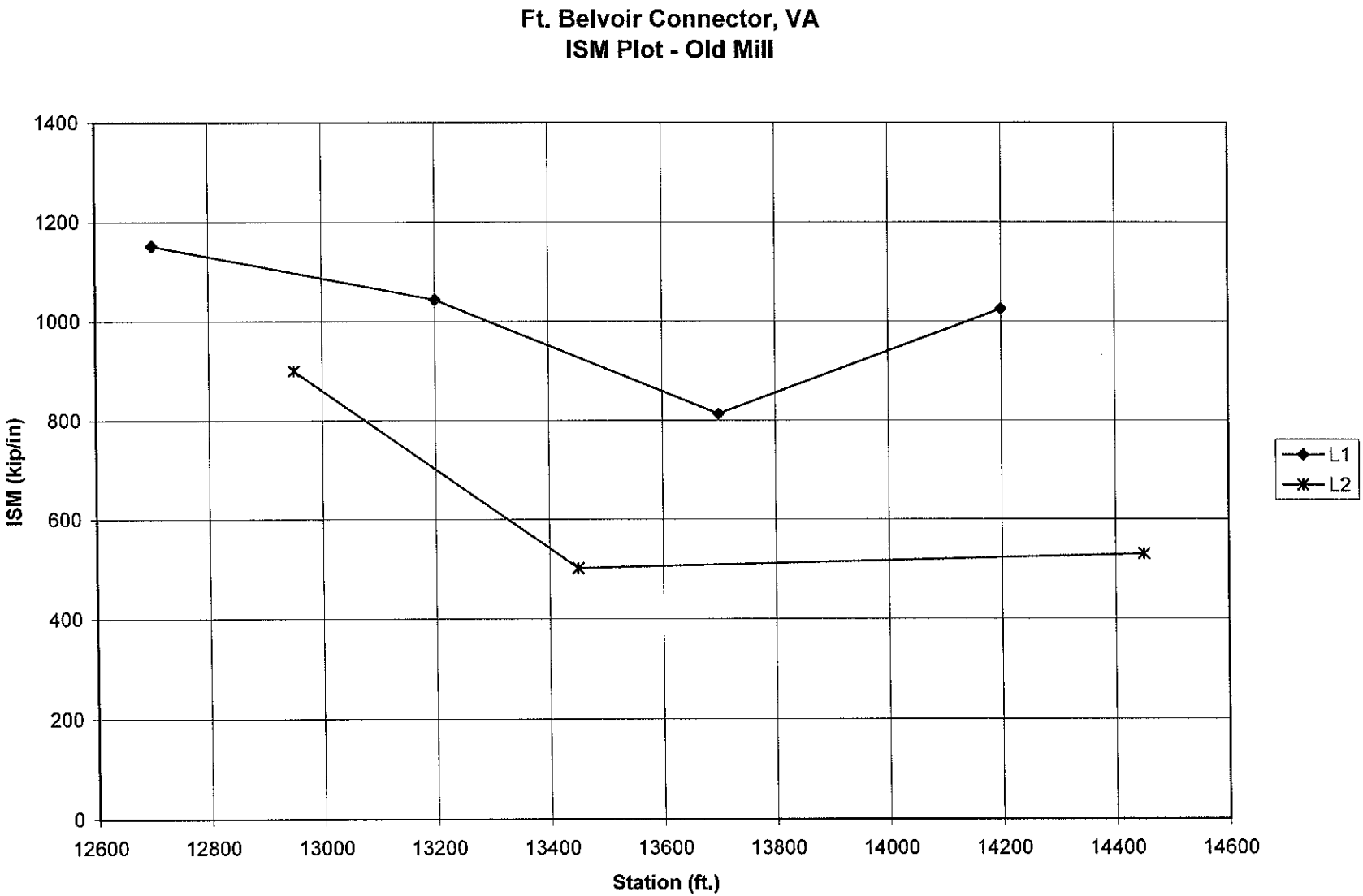
APPENDIX B

ISM PLOTS


Ft. Belvoir Connector, VA
ISM Plot - Route 1
ISM (kip/in)
3500
3000
2500
2000
1500
1000
500
0
1500
2000
2500
3000
3500
4000
4500
Station (ft.)
L2
L3
L4
L5


Ft. Belvoir Connector, VA
ISM Plot - Telegraph Road
ISM (kip/in)
3500
3000
2500
2000
1500
1000
500
0
4000
5000
6000
7000
8000
9000
10000
Station (ft.)
East Bound
West Bound


Ft. Belvoir Connector, VA
ISM Plot - MT. Vernon Mem Hwy
ISM (kip/in)
1800
1600
1400
1200
1000
800
600
400
200
0
11100
11200
11300
11400
11500
11600
11700
11800
11900
12000
12100
Station (ft.)
South Bound
Northt Bound


Ft. Belvoir Connector, VA
ISM Plot - Old Mill
ISM (kip/in)
1400
1200
1000
800
600
400
200
0
12600
12800
13000
13200
13400
13600
13800
14000
14200
14400
14600
Station (ft.)
L1
L2

Fort Belvoir Connector

U.S. Route 1

Mile Post-Station From	To	Model for Existing Pavements	Subgrade k (pci)	Pavement Thickness Required	Pavement Thickness Existing (effective)	Previous Rehab. Requirement	Current Rehab. Requirement w/ updated parameters
Right West Bound							
40+30	36+30	7"AC/8"PCC on Subgrade	155	8.69	11.01	mill 2.25" replace 2.25"	same as previous rehab
36+30	31+30		155	8.69	11.01	mill 2.25" replace 2.25"	same as previous rehab
31+30	16+30		171	8.64	11.01	mill 2.25" replace 2.25"	same as previous rehab
16+30	14+20		119	8.82	11.01	mill 2.25" replace 2.25"	same as previous rehab
Left West Bound							
33+80	27+30	5"AC/8.5"PCC on Subgrade	61	9.09	10.54	mill 2.25" replace 2.25"	same as previous rehab
27+30	23+80		159	8.68	10.54	mill 2.25" replace 2.25"	same as previous rehab
23+80	18+80		155	8.69	10.54	mill 2.25" replace 2.25"	same as previous rehab
18+80	14+20		153	8.70	10.54	mill 2.25" replace 2.25"	same as previous rehab
Left East Bound							
38+80	33+80	7.5"AC/7"PCC/6"AGBS on Subgrade	276	8.34	10.28	mill 2.25" replace 2.25"	same as previous rehab
33+80	29+30		195	8.57	10.28	mill 2.25" replace 2.25"	same as previous rehab
29+30	23+30		255	8.40	10.28	mill 2.25" replace 2.25"	same as previous rehab
23+30	18+80		164	8.66	10.28	mill 2.25" replace 2.25"	same as previous rehab
18+80	14+20		197	8.56	10.28	mill 2.25" replace 2.25"	same as previous rehab
Right East Bound							
41+30	36+30	9" AC/8"PCC on Subgrade	83	8.98	11.96	mill 2.25" replace 2.25"	same as previous rehab
36+30	27+30		93	8.93	11.96	mill 2.25" replace 2.25"	same as previous rehab
27+30	21+30		104	8.88	11.96	mill 2.25" replace 2.25"	same as previous rehab
21+30	16+30		110	8.86	11.96	mill 2.25" replace 2.25"	same as previous rehab
16+30	14+20		103	8.89	11.96	mill 2.25" replace 2.25"	same as previous rehab

Legend:
AC = Asphalt
AGBS = Aggregate Base
PCC = Portland Cement Concrete
Mr = Design Subgrade Resilient Modulus

Fort Belvoir Connector

Telegraph Road

Mile Post-Station From	To	Model for Existing Pavements	Subgrade Modulus (psi)	SN Required	SN Existing	Previous Rehab. Requirement	Current Rehab. Requirement w/ updated parameters
East Bound							
43+00	48+00	9" AC on Subgrade	15 075	2 95	3 96	mill 4", replace 4"	same as previous rehab
48+00	53+00		14,448	3 01	3 96	mill 4", replace 4"	same as previous rehab
53+00	58+00		9 189	3 63	3 96	mill 4", replace 4"	same as previous rehab
58+00	63+00		8 300	3 78	3 96	mill 4", replace 4"	same as previous rehab
63+00	68+00		9 180	3 63	3 96	mill 4", replace 4"	same as previous rehab
68+00	73+00		9,917	3 51	3 96	mill 4", replace 4"	same as previous rehab
73+00	78+00		10,370	3 45	3 96	mill 4", replace 4"	same as previous rehab
78+00	83+00		8 420	3 76	3 96	mill 4", replace 4"	same as previous rehab
83+00	88+00		6 367	4 20	3 96	mill 4", replace 4"	mill 4" replace 5"
88+00	93+00		7 089	4 02	3 96	mill 4", replace 4"	mill 4" replace 5"
93+00	98+00		6 913	4 06	3 96	mill 4", replace 4"	mill 4" replace 5
West Bound							
41+00	45+50	8" AC on Subgrade	15 732	2 90	3 52	mill 4" replace 4"	same as previous rehab
45+50	50+50		10,537	3 43	3 52	mill 4" replace 4"	same as previous rehab
50+50	55+50		6 625	4 13	3 52	mill 4" replace 4"	mill 4" replace 6"
55+50	60+50		8,492	3 74	3 52	mill 4" replace 4"	mill 4" replace 5"
60+50	70+50		10,290	3 46	3 52	mill 4" replace 4"	same as previous rehab
70+50	75+50		8 327	3 77	3 52	mill 4", replace 4"	mill 4" replace 6"
75+50	80+50		4 623	4 73	4 40	mill 4", replace 6"	mill 4" replace 7"
80+50	85+50		4 719	4 69	4 40	mill 4", replace 6"	mill 4" replace 7"
85+50	90+50		6 331	4 20	4 40	mill 4", replace 6"	same as previous rehab.
90+50	95+50		6,129	4.26	4.40	mill 4", replace 6"	same as previous rehab.

Legend:
AC = Asphalt
AGBS = Aggregate Base
Mr = Design Subgrade Resilient Modulus

Fort Belvoir Connector

Mount Vernon Highway

Mile Post-Station From	To	Model for Existing Pavements	Subgrade Modulus (psi)	SN Required	SN Existing	Previous Rehab. Requirement	Current Rehab. Requirement w/ updated parameters
South Bound							
116+50	114+00	5 5' AC/6' AGBS on Subgrade	8 929	3 67	4 14	mill 4', replace 6'	same as previous rehab.
114+00	111+50		6 333	3 74	4 14	mill 4', replace 6'	same as previous rehab
111+50	109+00		6.054	3 81	4 14	mill 4', replace 6	same as previous rehab
							same as previous rehab
North Bound							
113+50	118+50	8' AC/2" AGBS on Subgrade	6 480	3 71	4 68	mill 4" replace 6'	same as previous rehab
118+50	119+80		8 832	3.26	4 68	mill 4" replace 6"	same as previous rehab
119+80	120+00		7.977	3.40	4.68	mill 4", replace 6"	same as previous rehab.

Legend:
AC = Asphalt
AGBS = Aggregate Base
Mr = Design Subgrade Resilient Modulus

Fort Belvoir Connector

Old Mill Road

Mile Post-Station From	To	Model for Existing Pavements	Subgrade Modulus (psi)	SN Required	SN after Rehab.	Previous Rehab. Requirement	Current Rehab. Requirement w/ updated parameters
North Bound							
142+00	137+00	8"AC/3"AGBS on Subgrade	6,454	4 13	4 82	mill 3 5' replace 5 5'	same as previous rehab
137+00	132+00		5,720	4 32	4 82	mill 3 5" replace 5 5"	same as previous rehab
132+00	127+00		6,126	4 21	4 82	mill 3 5" replace 5 5'	same as previous rehab
127+00	122+00		8 040	3 78	4 82	mill 3 5" replace 5 5'	same as previous rehab
South Bound							
144+50	134+50	5"AC/7"AGBS on Subgrade	3,597	5 11	4 64	Reconstruction 2"AC/6"AC/8"AGBS	3'AC/6'AC/9'AGBS
134+50	129+50		3,943	4 95	4 64	Reconstruction 2"AC/6"AC/8"AGBS	3'AC/6'AC/9'AGBS
129+50	124+50		5,627	4.35	4.64	Reconstruction 2"AC/6"AC/8"AGBS	3"AC/6"AC/9"AGBS

Legend:
AC = Asphalt
AGBS = Aggregate Base
Mr = Design Subgrade Resilient Modulus

U.S.Route 1

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

Roy D. McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector

U.S.Route 1
Right West Bound 40+30 - 31+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.69 (Required)
Effective Thickness of Existing Pavement . : 11.01

Calculated Overlay Ihickness: .00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 155
Reliability Ievel (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic ....: 8.69

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8
Existing AC Ihickness (in): 7
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment ....: 1.00
Calculated Effective Pavement Ihickness: 11.01

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

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Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector

U.S. Route 1
Right West Bound 31+30 - 16+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.64 (Required)
Effective Thickness of Existing Pavement. .: 11.01

Calculated Overlay Thickness: .00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 171
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Iransfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic . .: 8.64

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8
Existing AC Ihickness (in): 7
Durability Adjustment Factor: 96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment . .: 1.00
Calculated Effective Pavement Ihickness: 11.01

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

Roy D. McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S Route 1
Right West Bound 16+30 - 14+20

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.82 (Required)
Effective Thickness of Existing Pavement....: 11.01

Calculated Overlay Thickness: .00

Ihickness for Future Traffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 119
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic ....: 8.82

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8
Existing AC Ihickness (in): 7
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment ....: 1.00
Calculated Effective Pavement Ihickness: 11.01

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Left West Bound 33+80 - 27+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 9.09 (Required)
Effective Thickness of Existing Pavement ...: 10 54

Calculated Overlay Thickness: .00

Thickness for Future Traffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Terminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 61
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Thickness for Future Traffic ...: 9.09

Effective Pavement Thickness--Condition Survey Method

Existing PCC Thickness (in): 8.5
Existing AC Thickness (in): 5
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W...: 0

Calculated Joints and Cracks Adjustment ... : 1.00
Calculated Effective Pavement Thickness: 10.54

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Left West Bound 27+30 - 23+80

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.68 (Required)
Effective Thickness of Existing Pavement....: 10.54

Calculated Overlay Thickness: .00

Thickness for Future Traffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Terminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 159
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Thickness for Future Traffic .. : 8.68

Effective Pavement Thickness--Condition Survey Method

Existing PCC Thickness (in): 8.5
Existing AC Thickness (in): 5
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W.. : 0

Calculated Joints and Cracks Adjustment ...: 1.00
Calculated Effective Pavement Thickness: 10.54

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Ieft West Bound 23+80 - 18+80

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.69 (Required)
Effective Thickness of Existing Pavement....: 10.54

Calculated Overlay Ihickness: 00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 155
Reliability Level (%): 90
Overall Standard Deviation: .49
Iload Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic .. .: 8.69

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8.5
Existing AC Ihickness (in): 5
Durability Adjustment Factor: 96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W. ..: 0

Calculated Joints and Cracks Adjustment .. . : 1.00
Calculated Effective Pavement Ihickness: 10.54

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Left West Bound 18+80 - 14+20

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.70 (Required)
Effective Thickness of Existing Pavement... : 10.54

Calculated Overlay Ihickness: .00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 153
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Iransfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic ....: 8.70

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8.5
Existing AC Ihickness (in): 5
Durability Adjustment Factor: 96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No of Expansion Joints, Expectionally W... : 0

Calculated Joints and Cracks Adjustment ...: 1.00
Calculated Effective Pavement Ihickness: 10.54

1986 AASHTO Pavement Design

DARWin(tm) Pavement Design System

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McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Left East Bound 38+80 - 33+80

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.34 (Required)
Effective Thickness of Existing Pavement....: 10.28

Calculated Overlay Thickness: .00

Thickness for Future Traffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Terminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 276
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Thickness for Future Traffic ....: 8.34

Effective Pavement Thickness--Condition Survey Method

Existing PCC Thickness (in): 7
Existing AC Thickness (in): 7.5
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment ....: 1.00
Calculated Effective Pavement Thickness: 10.28

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U S.Route 1
Left East Bound 33+80 - 29+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.57 (Required)
Effective Thickness of Existing Pavement.. : 10 28

Calculated Overlay Ihickness: .00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 195
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic ....: 8.57

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Thickness (in): 7
Existing AC Ihickness (in): 7.5
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment ..: 1.00
Calculated Effective Pavement Thickness: 10 28

1986 AASHTO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Left East Bound 29+30 - 23+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.40 (Required)
Effective Thickness of Existing Pavement....: 10.28

Calculated Overlay Thickness: .00

Thickness for Future Traffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Terminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 255
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Thickness for Future Traffic ....: 8.40

Effective Pavement Thickness--Condition Survey Method

Existing PCC Thickness (in): 7
Existing AC Thickness (in): 7.5
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment ....: 1.00
Calculated Effective Pavement Thickness: 10.28

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Left East Bound 23+30 - 18+80

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.66 (Required)
Effective Thickness of Existing Pavement. .: 10 28

Calculated Overlay Ihickness: .00

Ihickness for Future Traffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Terminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 164
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Traffic ....: 8.66

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 7
Existing AC Ihickness (in): 7.5
Durability Adjustment Factor: 96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No of Expansion Joints, Expectionally W. .: 0

Calculated Joints and Cracks Adjustment .. : 1.00
Calculated Effective Pavement Thickness: 10 28

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

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Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U S. Route 1
Left East Bound 18+80 - 14+20

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.56 (Required)
Effective Thickness of Existing Pavement . . : 10.28

Calculated Overlay Ihickness: 00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 197
Reliability Level (%): 90
Overall Standard Deviation: .49
Ioad Iransfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic . . : 8.56

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 7
Existing AC Ihickness (in): 7.5
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W. . : 0

Calculated Joints and Cracks Adjustment . . . : 1.00
Calculated Effective Pavement Ihickness: 10 28

1986 AASHTO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Right East Bound 41+30 - 36+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.98 (Required)
Effective Thickness of Existing Pavement....: 11.96

Calculated Overlay Thickness: .00

Thickness for Future Traffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Terminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 83
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Thickness for Future Traffic ....: 8.98

Effective Pavement Thickness--Condition Survey Method

Existing PCC Thickness (in): 8
Existing AC Thickness (in): 9
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment ....: 1.00
Calculated Effective Pavement Thickness: 11.96

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
REB 36+30 - 27+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.93 (Required)
Effective Thickness of Existing Pavement. ..: 11.96

Calculated Overlay Ihickness: .00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 93
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic .. : 8.93

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8
Existing AC Ihickness (in): 9
Durability Adjustment Factor: 96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W.. : 0

Calculated Joints and Cracks Adjustment ....: 1.00
Calculated Effective Pavement Ihickness: 11.96

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Right East Bound 27+30 - 21+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.88 (Required)
Effective Thickness of Existing Pavement. ..: 11.96

Calculated Overlay Ihickness: 00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 104
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Traffic ....: 8.88

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8
Existing AC Ihickness (in): 9
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W ..: 0

Calculated Joints and Cracks Adjustment ..: 1.00
Calculated Effective Pavement Ihickness: 11.96

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

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Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Right East Bound 21+30 - 16+30

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.86 (Required)
Effective Thickness of Existing Pavement....: 11.96

Calculated Overlay Ihickness: .00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Terminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 110
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Traffic ..: 8.86

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8
Existing AC Ihickness (in): 9
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W....: 0

Calculated Joints and Cracks Adjustment ....: 1.00
Calculated Effective Pavement Ihickness: 11.96

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

McQueen & Associates

Overlay Design Module

AC Overlay of AC/PCC Pavement

Fort Belvoir Connector
U.S.Route 1
Right East Bound 16+30 - 14+20

Overlay Design Module Data

Pavement Thickness for Future Traffic: 8.89 (Required)
Effective Thickness of Existing Pavement....: 11 96

Calculated Overlay Ihickness: .00

Ihickness for Future Iraffic

Future 18-kip ESALs Over Design period: 2,266,581
Initial Serviceability: 4.5
Ierminal Serviceability: 2.8
PCC Modulus of Rupture (psi): 631
PCC Elastic Modulus (psi): 3,300,000
Static k-value (psi/in): 103
Reliability Level (%): 90
Overall Standard Deviation: .49
Load Transfer Factor, J: 3.2
Overall Drainage Coefficient, Cd: 1

Calculated Ihickness for Future Iraffic ....: 8.89

Effective Pavement Ihickness--Condition Survey Method

Existing PCC Ihickness (in): 8
Existing AC Ihickness (in): 9
Durability Adjustment Factor: .96
Fatigue Damage Adjustment Factor:
AC Quality Adjustment Factor: .95
No. of Unrepaired Deteriorated Cracks/mile: 0
No. of Unrepaired Punchouts/mile: 0
No. of Expansion Joints, Expectionally W.. .: 0

Calculated Joints and Cracks Adjustment . : 1.00
Calculated Effective Pavement Ihickness: 11.96

TELEGRAPH ROAD

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHTOWARE(tm)
Computer Software Product

McQueen & Associates

Flexible Structural Design Module

Fort Belvoir Connector
Ielegraph Road
EB 43+00 - 48+00

Flexible Structural Design Module Data

18-kip ESAIs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Ierminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 15,075
Stage Construction: 1

Calculated Design Structural Number: 2.95 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	9		3.96
Total				**9.00**		**3.96**

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

McQueen & Associates

Flexible Structural Design Module

Fort Belvoir Connector
Telegraph Road
EB 48+00 - 53+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 14,448
Stage Construction: 1

Calculated Design Structural Number: 3.01 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	44	1	9		3.96
Total				**9.00**		**3.96**

1986 AASHIO Pavement Design

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McQueen & Associates

Flexible Structural Design Module

Fort Belvoir Connector
Telegraph Road
EB 53+00 - 58+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 9,189
Stage Construction: 1

Calculated Design Structural Number: 3.63 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	9		3.96
Total				**9.00**		**3.96**

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Flexible Structural Design Module

Fort Belvoir Connector
Telegraph Road
EB 58+00 - 63+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 8,300
Stage Construction: 1

Calculated Design Structural Number: 3.78 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	9		3.96
Total				**9.00**		**3.96**

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Flexible Structural Design Module

Fort Belvoir Connector
Telegraph Road
EB 63+00 - 68+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 9,180
Stage Construction: 1

Calculated Design Structural Number: 3.63 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	44	1	9		3.96
Total				**9.00**		**3.96**

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Flexible Structural Design Module

Fort Belvoir Connector
Telegraph Road
EB 68+00 - 73+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 9,917
Stage Construction: 1

Calculated Design Structural Number: 3.51 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	9		3.96
Total				**9.00**		**3.96**

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Flexible Structural Design Module

Fort Belvoir Connector
Telegraph Road
EB 73+00 - 78+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 10,370
Stage Construction: 1

Calculated Design Structural Number: 3.45 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	9		3.96
Total				**9.00**		**3.96**

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Flexible Structural Design Module

Fort Belvoir Connector
Ielegraph Road
EB 78+00 - 83+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Ierminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 8,420
Stage Construction: 1

Calculated Design Structural Number: 3.76 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	9		3.96
Total				**9.00**		**3.96**

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Flexible Structural Design Module

Fort Belvoir Connector
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EB 83+00 - 88+00

Flexible Structural Design Module Data

18-kip ESAIs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,367
Stage Construction: 1

Calculated Design Structural Number: 4 20 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	9		3.96
Total				9 00		3.96

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Flexible Structural Design Module

Fort Belvoir Connector
Ielegraph Road
EB 88+00 - 93+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 7,089
Stage Construction: 1

Calculated Design Structural Number: 4.02 (Required)

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	44	1	9		3.96
Total				9.00		3.96

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Flexible Structural Design Module

Fort Belvoir Connector
Telegraph Road
EB 93+00 - 98+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,913
Stage Construction: 1

Calculated Design Structural Number: 4.06 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	44	1	9		3.96
Total				9.00		3.96

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WB 41+00 - 45+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 15,732
Stage Construction: 1

Calculated Design Structural Number: 2.90 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
Total				**8.00**		**3.52**

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Fort Belvoir Connector
Ielegraph Road
WB 45+50 - 50+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4 2
Ierminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 10,537
Stage Construction: 1

Calculated Design Structural Number: 3.43 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	44	1	8		3.52
Total				**8.00**		**3.52**

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WB 50+50 - 55+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,625
Stage Construction: 1

Calculated Design Structural Number: 4.13 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
Total				**8.00**		**3.52**

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WB 55+50 - 60+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 8,492
Stage Construction: 1

Calculated Design Structural Number: 3.74 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
Total				8.00		3.52

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Telegraph Road
WB 60+50 - 70+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 10,290
Stage Construction: 1

Calculated Design Structural Number: 3.46 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
Total				**8.00**		**3.52**

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WB 70+50 - 75+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Ierminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 8,327
Stage Construction: 1

Calculated Design Structural Number: 3.77 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
Total				8.00		3.52

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WB 75+50 - 80+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 4,623
Stage Construction: 1

Calculated Design Structural Number: 4.73 (Required)

Specified Layer Design

Iayer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
Total				**10.00**		**4.40**

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WB 80+50 - 85+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Ierminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 4,719
Stage Construction: 1

Calculated Design Structural Number: 4.69 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
Total				**10.00**		**4.40**

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Fort Belvoir Connector
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WB 85+50 - 90+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Ierminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,331
Stage Construction: 1

Calculated Design Structural Number: 4.20 (Required)

Specified Layer Design

Iayer	Material Description	Struct. Coef. (Ai)	Drain Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
Total				**10.00**		**4.40**

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Fort Belvoir Connector
Ielegraph Road
WB 90+50 - 95+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Ierminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,129
Stage Construction: 1

Calculated Design Structural Number: 4 26 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
Total				**10 00**		**4.40**

MOUNT VERNON HIGHWAY

1986 AASHIO Pavement Design

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Flexible Structural Design Module

Fort Belvoir Connector
Mount Vernon Memorial Highway
SB 116+50 - 114+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,438,834
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 8,929
Stage Construction: 1

Calculated Design Structural Number: 3 67 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	7.5		3.30
2	AGBS	.14	1	6		.84
Total				**13.50**		**4.14**

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Fort Belvoir Connector
Mount Vernon Memorial Highway
SB 114+00 - 111+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 728,626
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,333
Stage Construction: 1

Calculated Design Structural Number: 3.74 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	44	1	7.5		3.30
2	AGBS	.14	1	6		.84
Total				**13.50**		**4.14**

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Fort Belvoir Connector
Mount Vernon Memorial Highway
SB 111+50 - 109+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 728,626
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,054
Stage Construction: 1

Calculated Design Structural Number: 3.81 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	7.5		3.30
2	AGBS	14	1	6		.84
Total				**13.50**		**4.14**

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Fort Belvoir Connector
Mount Vernon Memorial Highway
NB 113+50 - 118+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 728,626
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,480
Stage Construction: 1

Calculated Design Structural Number: 3.71 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
2	AGBS	.14	1	2		.28
Total				**12.00**		**4.68**

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Fort Belvoir Connector
Mount Vernon Memorial Highway
NB 118+50 - 119+80

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 728,626
Initial Serviceability: 4 2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 8,832
Stage Construction: 1

Calculated Design Structural Number: 3.26 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
2	AGBS	.14	1	2		.28
Total				**12.00**		**4.68**

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Flexible Structural Design Module

Fort Belvoir Connector
Mount Vernon Memorial Highway
NB 119+80 - 120+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 728,626
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 7,977
Stage Construction: 1

Calculated Design Structural Number: 3.40 (Required)

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
2	AGBS	.14	1	2		.28
Total				**12.00**		**4.68**

OLD MILL ROAD

1986 AASHIO Pavement Design

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Flexible Structural Design Module

Fort Belvoir Connector
OLD MILL ROAD
NB 142+00 - 137+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,344,607
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,454
Stage Construction: 1

Calculated Design Structural Number: 4.13 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
2	AGBS	.14	1	3		.42
Total				**13.00**		**4.82**

1986 AASHTO Pavement Design

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Flexible Structural Design Module

Fort Belvoir Connector
OLD MILL ROAD
NB 137+00 - 132+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,344,607
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 5,720
Stage Construction: 1

Calculated Design Structural Number: 4.32 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
2	AGBS	14	1	3		.42
Total				**13.00**		**4.82**

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Flexible Structural Design Module

Fort Belvoir Connector
OLD MILL ROAD
NB 132+00 - 127+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,344,607
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 6,126
Stage Construction: 1

Calculated Design Structural Number: 4 21 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Ihickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
2	AGBS	.14	1	3		.42
Total				**13.00**		**4.82**

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Flexible Structural Design Module

Fort Belvoir Connector
OLD MILL ROAD
NB 127+00 - 122+00

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,344,607
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 8,040
Stage Construction: 1

Calculated Design Structural Number: 3.78 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	10		4.40
2	AGBS	.14	1	3		.42
Total				**13.00**		**4.82**

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Fort Belvoir Connector
OLD MILL ROAD
SB 144+50 - 134+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,344,607
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 3,597
Stage Construction: 1

Calculated Design Structural Number: 5.11 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
2	AGBS	.14	1	8		1.12
Total				**16.00**		**4.64**

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

McQueen & Associates

Flexible Structural Design Module

Fort Belvoir Connector
OLD MILL ROAD
SB 134+50 - 129+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,344,607
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 3,943
Stage Construction: 1

Calculated Design Structural Number: 4 95 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
2	AGBS	.14	1	8		1.12
Total				16.00		4.64

1986 AASHIO Pavement Design

DARWin(tm) Pavement Design System

A Proprietary AASHIOWARE(tm)
Computer Software Product

McQueen & Associates
Michael Coffey, P.E.

Flexible Structural Design Module

Fort Belvoir Connector
OLD MILL ROAD
SB 129+50 - 124+50

Flexible Structural Design Module Data

18-kip ESALs Over
Initial Performance Period: 1,344,607
Initial Serviceability: 4.2
Terminal Serviceability: 2.8
Reliability Level (%): 90
Overall Standard Deviation: .49
Roadbed Soil Resilient Modulus (PSI): 5,627
Stage Construction: 1

Calculated Design Structural Number: 4 35 (Required)

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Drain. Coef. (Mi)	Thickness (Di) (in)	Width (ft)	Calculated SN
1	AC	.44	1	8		3.52
2	AGBS	.14	1	8		1.12
Total				**16.00**		**4.64**

APPENDIX G
ANALYSES

AXIAL PILE CAPACITY

SUMMARY OF PILE CAPACITIES

BRIDGE OVER KINGMAN ROAD

Substructure Unit	Pile Type [1]	Pile Size	Pile Length (feet)	Q_{ULT} (kips)	Q_{ALL} (kips)[2]	Q_{ALL} (tons)
Abutments	PCP	12"	60	496	220	110
Abutments	CEP	12"	60	327	145	73
Abutments	PCP	18"	60	933	415	207
Abutments	CEP	18"	60	653	290	145

1) PCP = Prestressed Concrete Pile; CEP = Closed-End Pipe
2) Safety factor = 2.25

BRIDGE OVER PINEY RUN AT HEC

Substructure Unit	Pile Type [1]	Pile Size	Pile Length (feet)	Q_{ULT} (kips)	Q_{ALL} (kips)[2]	Q_{ALL} (tons)
Abutments	PCP	12"	90	289	128	64
Abutments	CEP	12"	90	183	81	41
Abutments	PCP	18"	90	542	241	120
Abutments	CEP	18"	90	371	165	82
Pier	PCP	18"	90	380	169	84
Pier	CEP	18"	90	266	118	59
Pier	PCP	24"	90	556	247	124
Pier	CEP	24"	90	394	175	88

1) PCP = Prestressed Concrete Pile; CEP = Closed-End Pipe
2) Safety factor = 2.25

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\JJK12.DVN
Project Name: Kingman Road Bridge
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Kingman Rd Bridge – Abutments (12" square PCP)

PILE INFORMATION

Pile Type: Concrete Pile
Top of Pile: 0.00 ft
Length of Square Side: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	20.00 ft
	- Driving/Restrike	20.00 ft
	- Ultimate:	20.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	10.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
2	Cohesive	10.00 ft	0.00%	115.00 pcf	1900.00 psf	T-79 Concrete
3	Cohesionless	15.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
4	Cohesive	18.00 ft	0.00%	115.00 pcf	2200.00 psf	T-79 Concrete
5	Cohesionless	5.00 ft	0.00%	120.00 pcf	32.0/0.0	Nordlund
6	Cohesionless	2.00 ft	0.00%	125.00 pcf	36.0/36.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	23.01	N/A	0.00 Kips
9.01 ft	Cohesionless	540.60 psf	23.01	N/A	8.06 Kips
9.99 ft	Cohesionless	599.40 psf	23.01	N/A	9.91 Kips
10.01 ft	Cohesive	N/A	N/A	1365.13 psf	9.98 Kips
19.01 ft	Cohesive	N/A	N/A	1481.38 psf	63.32 Kips
19.99 ft	Cohesive	N/A	N/A	1494.04 psf	69.63 Kips
20.01 ft	Cohesionless	2350.29 psf	23.01	N/A	69.73 Kips
29.01 ft	Cohesionless	2609.49 psf	23.01	N/A	108.60 Kips
34.99 ft	Cohesionless	2781.71 psf	23.01	N/A	138.69 Kips
35.01 ft	Cohesive	N/A	N/A	1735.17 psf	138.81 Kips
44.01 ft	Cohesive	N/A	N/A	1820.00 psf	204.33 Kips
52.99 ft	Cohesive	N/A	N/A	1820.00 psf	269.71 Kips
53.01 ft	Cohesionless	4161.09 psf	24.54	N/A	269.87 Kips
57.99 ft	Cohesionless	4304.51 psf	24.54	N/A	314.81 Kips
58.01 ft	Cohesionless	4449.11 psf	27.61	N/A	315.05 Kips
59.99 ft	Cohesionless	4511.09 psf	27.61	N/A	344.29 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	4.80	13.32 Kips	0.00 Kips
9.01 ft	Cohesionless	1081.20 psf	4.80	13.32 Kips	1.89 Kips
9.99 ft	Cohesionless	1198.80 psf	4.80	13.32 Kips	2.10 Kips
10.01 ft	Cohesive	N/A	N/A	N/A	17.10 Kips
19.01 ft	Cohesive	N/A	N/A	N/A	17.10 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	17.10 Kips
20.01 ft	Cohesionless	2350.58 psf	4.80	13.32 Kips	4.12 Kips
29.01 ft	Cohesionless	2868.98 psf	4.80	13.32 Kips	3.67 Kips
34.99 ft	Cohesionless	3213.42 psf	4.80	13.32 Kips	3.54 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	19.80 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	19.80 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	19.80 Kips
53.01 ft	Cohesionless	4161.38 psf	4.80	13.32 Kips	3.54 Kips
57.99 ft	Cohesionless	4448.22 psf	4.80	13.32 Kips	3.78 Kips
58.01 ft	Cohesionless	4449.43 psf	77.60	151.60 Kips	151.60 Kips
59.99 ft	Cohesionless	4573.37 psf	77.60	151.60 Kips	151.60 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0 01 ft	0.00 Kips	0 00 Kips	0.00 Kips
9 01 ft	8.06 Kips	1.89 Kips	9.95 Kips
9.99 ft	9 91 Kips	2.10 Kips	12.01 Kips
10.01 ft	9.98 Kips	17.10 Kips	27.08 Kips
19.01 ft	63.32 Kips	17.10 Kips	80.42 Kips
19.99 ft	69.63 Kips	17.10 Kips	86.73 Kips
20.01 ft	69.73 Kips	4.12 Kips	73.85 Kips
29.01 ft	108 60 Kips	3.67 Kips	112.27 Kips
34.99 ft	138.69 Kips	3.54 Kips	142.23 Kips
35.01 ft	138.81 Kips	19.80 Kips	158.61 Kips
44.01 ft	204.33 Kips	19.80 Kips	224.13 Kips
52.99 ft	269 71 Kips	19.80 Kips	289.51 Kips
53.01 ft	269.87 Kips	3.54 Kips	273.40 Kips
57.99 ft	314.81 Kips	3.78 Kips	318.59 Kips
58.01 ft	315.05 Kips	151.60 Kips	466.65 Kips
59.99 ft	344 29 Kips	151 60 Kips	495.89 Kips

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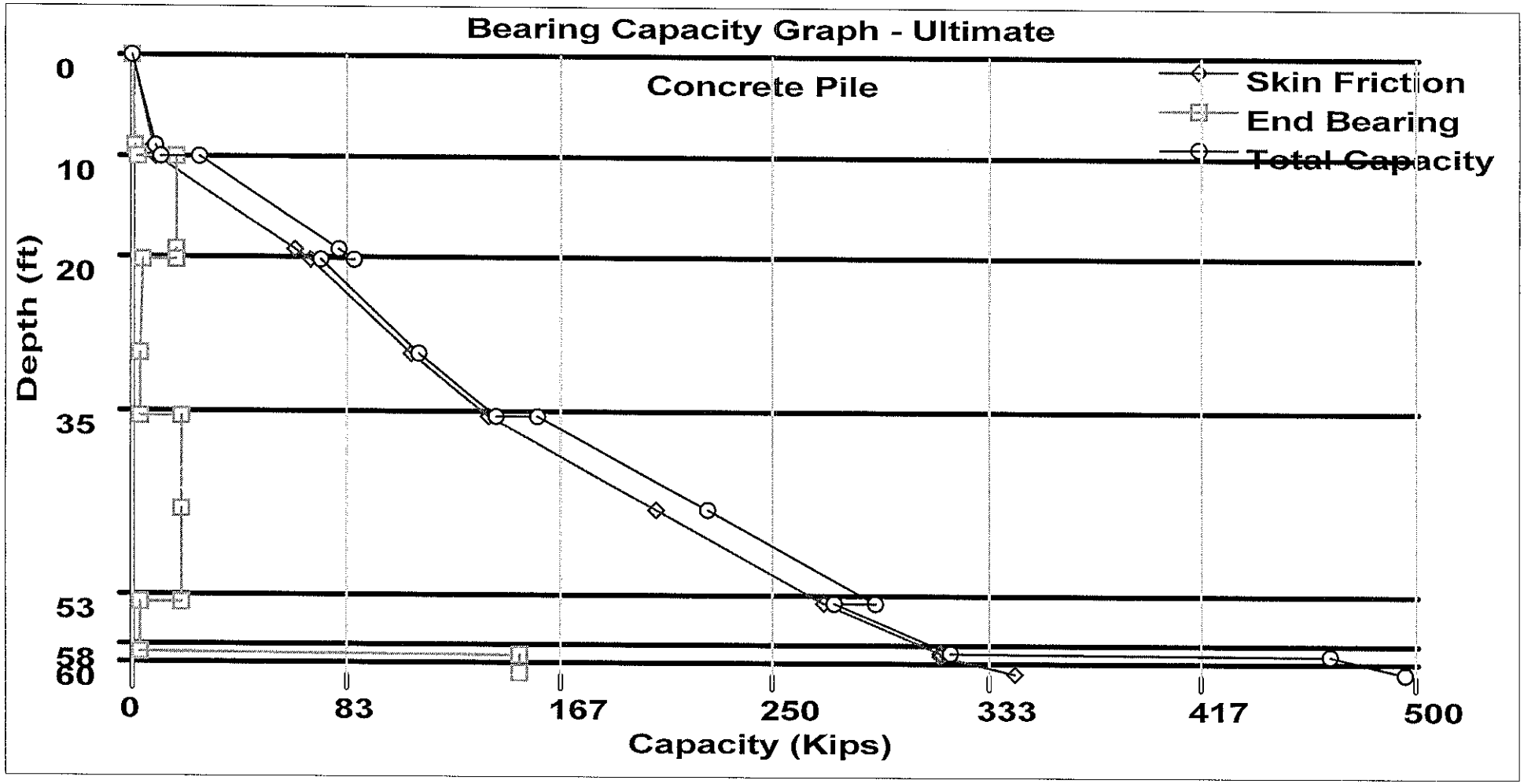

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\JJK12.DVN
Project Name: Kingman Road Bridge
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Kingman Rd Bridge - Abutments

PILE INFORMATION

(12" closed-end pipe pile)

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	20.00 ft
	- Driving/Restrike	20.00 ft
	- Ultimate:	20.00 ft
Ultimate Considerations:	- Local Scour:	0 00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	10.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
2	Cohesive	10.00 ft	0.00%	115.00 pcf	1900.00 psf	T-79 Steel
3	Cohesionless	15.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
4	Cohesive	18.00 ft	0.00%	115 00 pcf	2200.00 psf	T-79 Steel
5	Cohesionless	5.00 ft	0.00%	120.00 pcf	32.0/0.0	Nordlund
6	Cohesionless	2.00 ft	0.00%	125.00 pcf	36.0/36.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	17.64	N/A	0.00 Kips
9.01 ft	Cohesionless	540.60 psf	17.64	N/A	4.21 Kips
9.99 ft	Cohesionless	599.40 psf	17.64	N/A	5.18 Kips
10.01 ft	Cohesive	N/A	N/A	1162.61 psf	5.23 Kips
19.01 ft	Cohesive	N/A	N/A	1259.36 psf	40.84 Kips
19.99 ft	Cohesive	N/A	N/A	1269.89 psf	45.04 Kips
20.01 ft	Cohesionless	2350.29 psf	17.64	N/A	45.11 Kips
29.01 ft	Cohesionless	2609.49 psf	17.64	N/A	65.42 Kips
34.99 ft	Cohesionless	2781.71 psf	17.64	N/A	81.15 Kips
35.01 ft	Cohesive	N/A	N/A	1503.49 psf	81.23 Kips
44.01 ft	Cohesive	N/A	N/A	1580.00 psf	125.91 Kips
52.99 ft	Cohesive	N/A	N/A	1580.00 psf	170.48 Kips
53.01 ft	Cohesionless	4161.09 psf	18.82	N/A	170.57 Kips
57.99 ft	Cohesionless	4304.51 psf	18.82	N/A	193.58 Kips
58.01 ft	Cohesionless	4449.11 psf	21.17	N/A	193.70 Kips
59.99 ft	Cohesionless	4511.09 psf	21.17	N/A	208.04 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	4.80	10.46 Kips	0.00 Kips
9.01 ft	Cohesionless	1081.20 psf	4.80	10.46 Kips	1.49 Kips
9.99 ft	Cohesionless	1198.80 psf	4.80	10.46 Kips	1.65 Kips
10.01 ft	Cohesive	N/A	N/A	N/A	13.43 Kips
19.01 ft	Cohesive	N/A	N/A	N/A	13.43 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	13.43 Kips
20.01 ft	Cohesionless	2350.58 psf	4.80	10.46 Kips	3.23 Kips
29.01 ft	Cohesionless	2868.98 psf	4.80	10.46 Kips	2.89 Kips
34.99 ft	Cohesionless	3213.42 psf	4.80	10.46 Kips	2.78 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	15.55 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	15.55 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	15.55 Kips
53.01 ft	Cohesionless	4161.38 psf	4.80	10.46 Kips	2.78 Kips
57.99 ft	Cohesionless	4448.22 psf	4.80	10.46 Kips	2.97 Kips
58.01 ft	Cohesionless	4449.43 psf	77.60	119.07 Kips	119.07 Kips
59.99 ft	Cohesionless	4573.37 psf	77.60	119.07 Kips	119.07 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0 01 ft	0 00 Kips	0 00 Kips	0.00 Kips
9.01 ft	4.21 Kips	1.49 Kips	5.70 Kips
9.99 ft	5.18 Kips	1.65 Kips	6.83 Kips
10.01 ft	5.23 Kips	13.43 Kips	18 66 Kips
19.01 ft	40.84 Kips	13.43 Kips	54.27 Kips
19.99 ft	45.04 Kips	13.43 Kips	58.47 Kips
20.01 ft	45.11 Kips	3.23 Kips	48.34 Kips
29.01 ft	65.42 Kips	2.89 Kips	68 31 Kips
34.99 ft	81.15 Kips	2.78 Kips	83.94 Kips
35.01 ft	81.23 Kips	15.55 Kips	96.78 Kips
44 01 ft	125.91 Kips	15.55 Kips	141.46 Kips
52.99 ft	170.48 Kips	15.55 Kips	186.03 Kips
53.01 ft	170 57 Kips	2.78 Kips	173.35 Kips
57.99 ft	193 58 Kips	2 97 Kips	196.55 Kips
58.01 ft	193.70 Kips	119 07 Kips	312.77 Kips
59.99 ft	208.04 Kips	119.07 Kips	327.11 Kips

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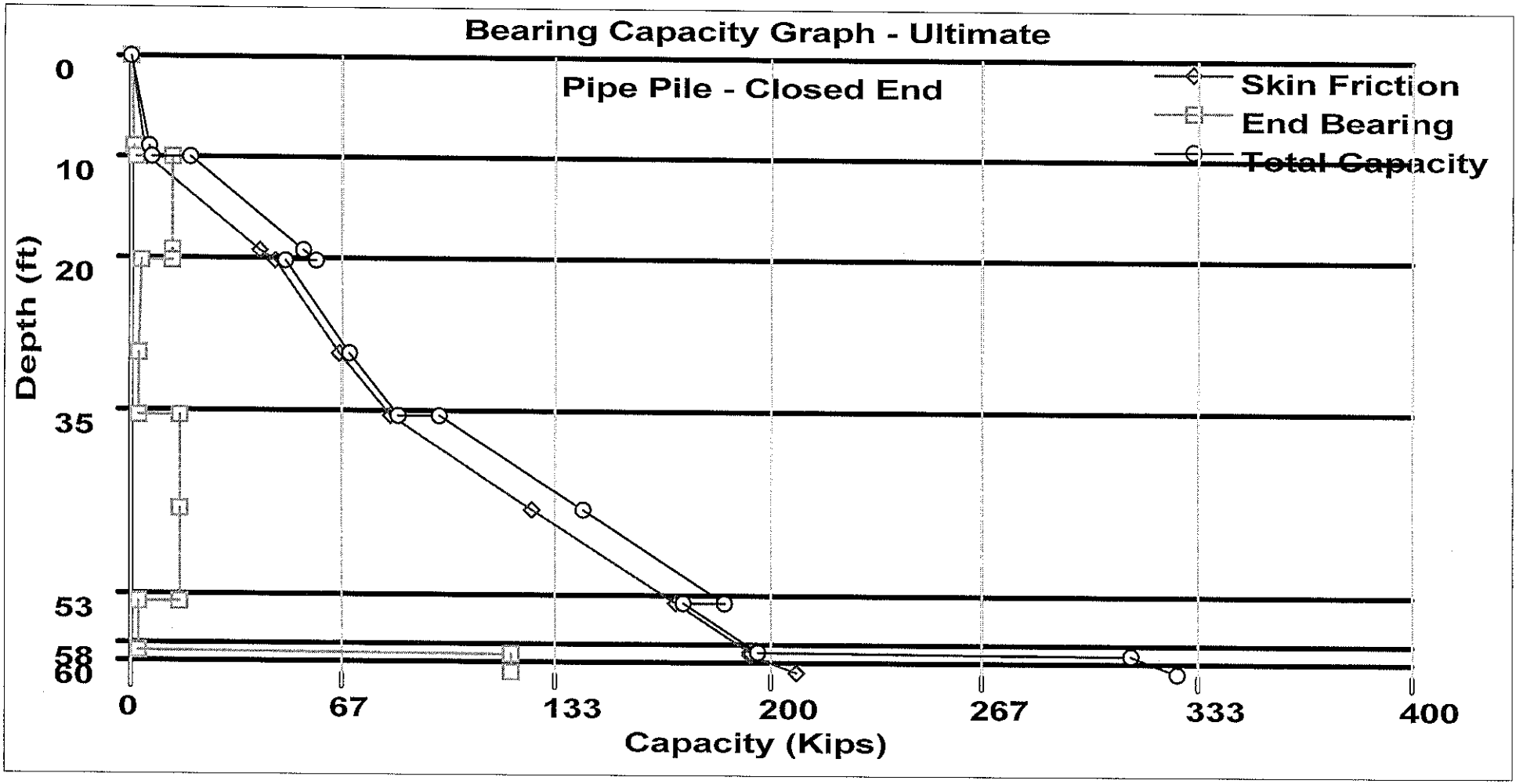

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\JJK18.DVN
Project Name: Kingman Road Bridge
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Kingman Rd Bridge-Abutments
(18" square PCP)

PILE INFORMATION

Pile Type: Concrete Pile
Top of Pile: 0.00 ft
Length of Square Side: 18.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	20.00 ft
	- Driving/Restrike	20.00 ft
	- Ultimate:	20.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	10.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
2	Cohesive	10.00 ft	0.00%	115.00 pcf	1900.00 psf	T-79 Concrete
3	Cohesionless	15.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
4	Cohesive	18.00 ft	0.00%	115.00 pcf	2200.00 psf	T-79 Concrete
5	Cohesionless	5.00 ft	0.00%	120.00 pcf	32.0/0.0	Nordlund
6	Cohesionless	2.00 ft	0.00%	125.00 pcf	36.0/36.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	27.42	N/A	0.00 Kips
9.01 ft	Cohesionless	540.60 psf	27.42	N/A	16.46 Kips
9.99 ft	Cohesionless	599.40 psf	27.42	N/A	20.24 Kips
10.01 ft	Cohesive	N/A	N/A	1365.00 psf	20.36 Kips
19.01 ft	Cohesive	N/A	N/A	1399.53 psf	95.94 Kips
19.99 ft	Cohesive	N/A	N/A	1407.97 psf	104.67 Kips
20.01 ft	Cohesionless	2350.29 psf	27.42	N/A	104.84 Kips
29.01 ft	Cohesionless	2609.49 psf	27.42	N/A	184.23 Kips
34.99 ft	Cohesionless	2781.71 psf	27.42	N/A	245.70 Kips
35.01 ft	Cohesive	N/A	N/A	1536.78 psf	245.90 Kips
44.01 ft	Cohesive	N/A	N/A	1638.78 psf	334.40 Kips
52.99 ft	Cohesive	N/A	N/A	1740.55 psf	433.68 Kips
53.01 ft	Cohesionless	4161.09 psf	29.25	N/A	433.98 Kips
57.99 ft	Cohesionless	4304.51 psf	29.25	N/A	527.72 Kips
58.01 ft	Cohesionless	4449.11 psf	32.90	N/A	528.23 Kips
59.99 ft	Cohesionless	4511.09 psf	32.90	N/A	591.50 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	4.80	29.97 Kips	0.00 Kips
9.01 ft	Cohesionless	1081.20 psf	4.80	29.97 Kips	4.26 Kips
9.99 ft	Cohesionless	1198.80 psf	4.80	29.97 Kips	4.73 Kips
10.01 ft	Cohesive	N/A	N/A	N/A	38.47 Kips
19.01 ft	Cohesive	N/A	N/A	N/A	38.47 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	38.47 Kips
20.01 ft	Cohesionless	2350.58 psf	4.80	29.97 Kips	9.27 Kips
29.01 ft	Cohesionless	2868.98 psf	4.80	29.97 Kips	11.31 Kips
34.99 ft	Cohesionless	3213.42 psf	4.80	29.97 Kips	11.41 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	44.55 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	44.55 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	44.55 Kips
53.01 ft	Cohesionless	4161.38 psf	4.80	29.97 Kips	10.24 Kips
57.99 ft	Cohesionless	4448.22 psf	4.80	29.97 Kips	10.11 Kips
58.01 ft	Cohesionless	4449.43 psf	77.60	341.10 Kips	341.10 Kips
59.99 ft	Cohesionless	4573.37 psf	77.60	341.10 Kips	341.10 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0 00 Kips	0.00 Kips
9.01 ft	16.46 Kips	4.26 Kips	20.73 Kips
9.99 ft	20.24 Kips	4.73 Kips	24.96 Kips
10.01 ft	20.36 Kips	38.47 Kips	58.84 Kips
19.01 ft	95.94 Kips	38.47 Kips	134.41 Kips
19.99 ft	104.67 Kips	38.47 Kips	143.15 Kips
20.01 ft	104.84 Kips	9.27 Kips	114.11 Kips
29.01 ft	184 23 Kips	11.31 Kips	195.54 Kips
34.99 ft	245.70 Kips	11.41 Kips	257.11 Kips
35.01 ft	245.90 Kips	44.55 Kips	290.45 Kips
44 01 ft	334.40 Kips	44.55 Kips	378.95 Kips
52.99 ft	433.68 Kips	44.55 Kips	478.23 Kips
53.01 ft	433 98 Kips	10.24 Kips	444.22 Kips
57.99 ft	527 72 Kips	10.11 Kips	537.83 Kips
58.01 ft	528.23 Kips	341.10 Kips	869.33 Kips
59.99 ft	591.50 Kips	341.10 Kips	932.60 Kips

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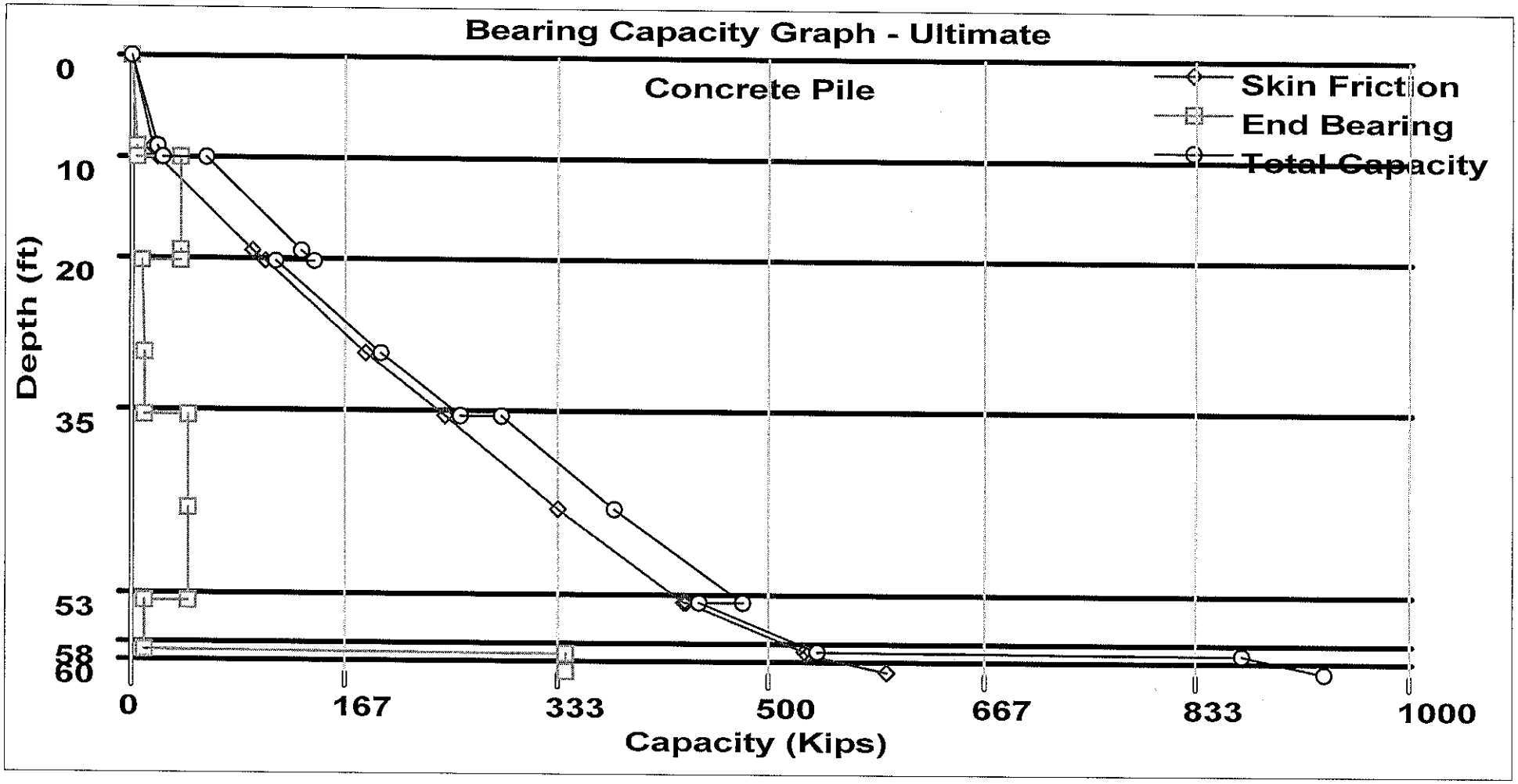

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\JJK18.DVN
Project Name: Kingman Road Bridge
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Kingman Rd Bridge - Abutments
(18" closed-end pipe pile)

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 18.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	20.00 ft
	- Driving/Restrike	20.00 ft
	- Ultimate:	20.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	10.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
2	Cohesive	10.00 ft	0.00%	115.00 pcf	1900.00 psf	T-79 Steel
3	Cohesionless	15.00 ft	0.00%	120.00 pcf	30.0/0.0	Nordlund
4	Cohesive	18.00 ft	0.00%	115.00 pcf	2200.00 psf	T-79 Steel
5	Cohesionless	5.00 ft	0.00%	120.00 pcf	32.0/0.0	Nordlund
6	Cohesionless	2.00 ft	0.00%	125.00 pcf	36.0/36.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	23.52	N/A	0.00 Kips
9.01 ft	Cohesionless	540.60 psf	23.52	N/A	10.43 Kips
9.99 ft	Cohesionless	599.40 psf	23.52	N/A	12.82 Kips
10.01 ft	Cohesive	N/A	N/A	1162.50 psf	12.90 Kips
19.01 ft	Cohesive	N/A	N/A	1191.24 psf	63.43 Kips
19.99 ft	Cohesive	N/A	N/A	1198.26 psf	69.26 Kips
20.01 ft	Cohesionless	2350.29 psf	23.52	N/A	69.37 Kips
29.01 ft	Cohesionless	2609.49 psf	23.52	N/A	119.67 Kips
34.99 ft	Cohesionless	2781.71 psf	23.52	N/A	158.62 Kips
35.01 ft	Cohesive	N/A	N/A	1324.55 psf	158.75 Kips
44.01 ft	Cohesive	N/A	N/A	1416.55 psf	218.83 Kips
52.99 ft	Cohesive	N/A	N/A	1508.34 psf	286.55 Kips
53.01 ft	Cohesionless	4161.09 psf	25.08	N/A	286.75 Kips
57.99 ft	Cohesionless	4304.51 psf	25.08	N/A	345.56 Kips
58.01 ft	Cohesionless	4449.11 psf	28.22	N/A	345.87 Kips
59.99 ft	Cohesionless	4511.09 psf	28.22	N/A	384.83 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	4.80	23.54 Kips	0.00 Kips
9.01 ft	Cohesionless	1081.20 psf	4.80	23.54 Kips	3.35 Kips
9.99 ft	Cohesionless	1198.80 psf	4.80	23.54 Kips	3.71 Kips
10.01 ft	Cohesive	N/A	N/A	N/A	30.22 Kips
19.01 ft	Cohesive	N/A	N/A	N/A	30.22 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	30.22 Kips
20.01 ft	Cohesionless	2350.58 psf	4.80	23.54 Kips	7.28 Kips
29.01 ft	Cohesionless	2868.98 psf	4.80	23.54 Kips	8.88 Kips
34.99 ft	Cohesionless	3213.42 psf	4.80	23.54 Kips	8.96 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	34.99 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	34.99 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	34.99 Kips
53.01 ft	Cohesionless	4161.38 psf	4.80	23.54 Kips	8.04 Kips
57.99 ft	Cohesionless	4448.22 psf	4.80	23.54 Kips	7.94 Kips
58.01 ft	Cohesionless	4449.43 psf	77.60	267.90 Kips	267.90 Kips
59.99 ft	Cohesionless	4573.37 psf	77.60	267.90 Kips	267.90 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.01 ft	10.43 Kips	3.35 Kips	13.78 Kips
9.99 ft	12.82 Kips	3.71 Kips	16.53 Kips
10.01 ft	12.90 Kips	30.22 Kips	43.12 Kips
19.01 ft	63.43 Kips	30.22 Kips	93.65 Kips
19.99 ft	69.26 Kips	30.22 Kips	99.48 Kips
20.01 ft	69.37 Kips	7.28 Kips	76.65 Kips
29.01 ft	119.67 Kips	8.88 Kips	128.55 Kips
34.99 ft	158.62 Kips	8.96 Kips	167.58 Kips
35.01 ft	158.75 Kips	34.99 Kips	193.74 Kips
44.01 ft	218.83 Kips	34.99 Kips	253.82 Kips
52.99 ft	286.55 Kips	34.99 Kips	321.54 Kips
53.01 ft	286.75 Kips	8.04 Kips	294.79 Kips
57.99 ft	345.56 Kips	7.94 Kips	353.49 Kips
58.01 ft	345.87 Kips	267.90 Kips	613.77 Kips
59.99 ft	384.83 Kips	267.90 Kips	652.73 Kips

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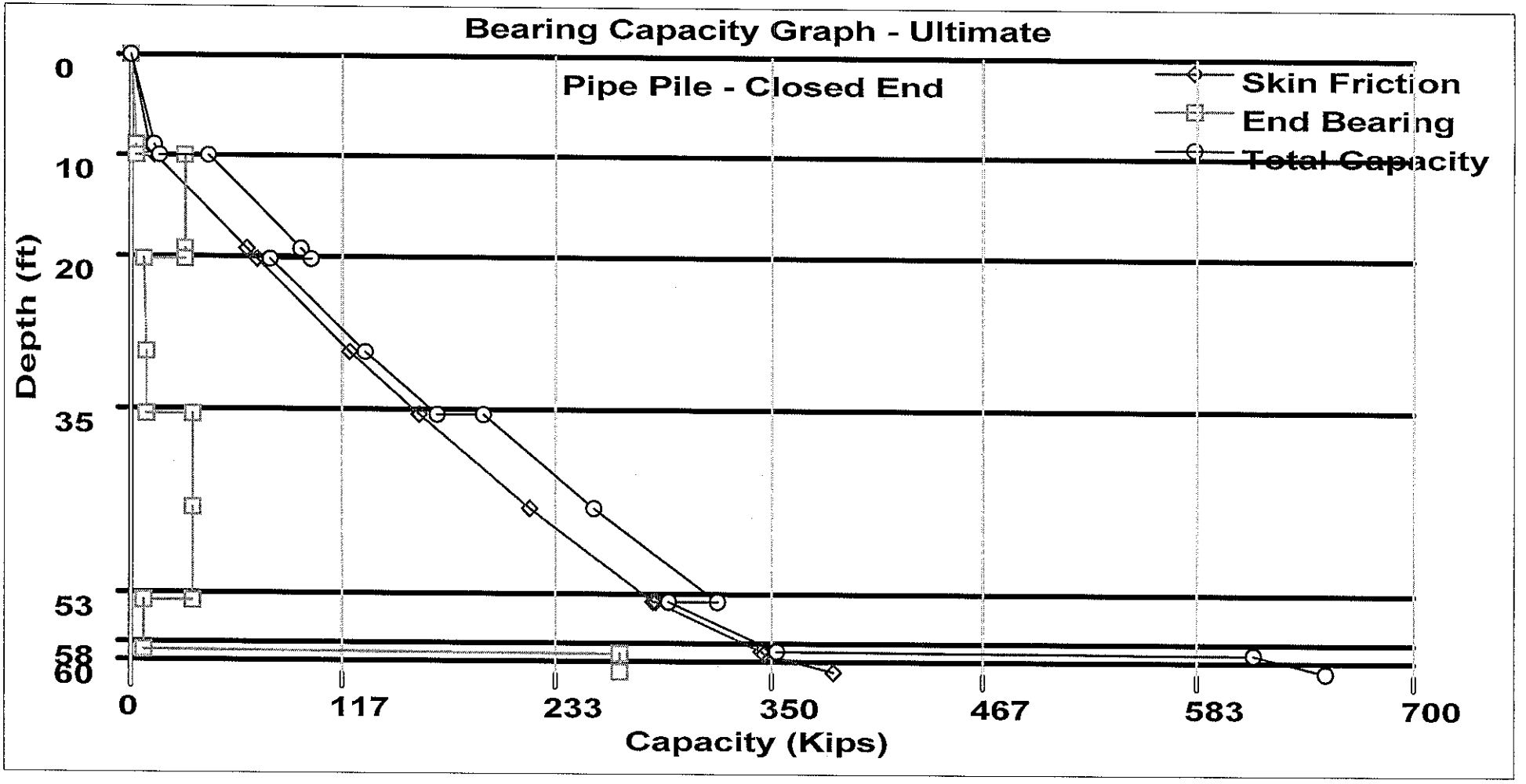

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC12.DVN
Project Name: Piney Run @ HEC - Abuts
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney Run @ HEC - Abutments (12" square PCP)

PILE INFORMATION

Pile Type: Concrete Pile
Top of Pile: 0 00 ft
Length of Square Side: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	4 00 ft
	- Driving/Restrike	4.00 ft
	- Ultimate:	4.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0 00 ft
	- Soft Soil:	0 00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.00 ft	0.00%	120.00 pcf	30 0/30.0	Nordlund
2	Cohesionless	12.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
3	Cohesionless	17.00 ft	0.00%	120 00 pcf	32.0/32.0	Nordlund
4	Cohesive	22.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Concrete
5	Cohesionless	8.00 ft	0.00%	115.00 pcf	29.0/29.0	Nordlund
6	Cohesive	15.00 ft	0.00%	110.00 pcf	300.00 psf	T-79 Concrete
7	Cohesionless	4.00 ft	0.00%	120 00 pcf	32.0/32.0	Nordlund
8	Cohesive	8.00 ft	0.00%	120 00 pcf	3400.00 psf	T-79 Concrete

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	23.01	N/A	0.00 Kips
3.99 ft	Cohesionless	239.40 psf	23.01	N/A	1.58 Kips
4.01 ft	Cohesionless	480.26 psf	23.01	N/A	1.60 Kips
13.01 ft	Cohesionless	716.96 psf	23.01	N/A	12.28 Kips
15.99 ft	Cohesionless	795.34 psf	23.01	N/A	17.37 Kips
16.01 ft	Cohesionless	1111.49 psf	24.54	N/A	17.41 Kips
25.01 ft	Cohesionless	1370.69 psf	24.54	N/A	43.28 Kips
32.99 ft	Cohesionless	1600.51 psf	24.54	N/A	74.39 Kips
33.01 ft	Cohesive	N/A	N/A	500.00 psf	74.46 Kips
42.01 ft	Cohesive	N/A	N/A	500.00 psf	92.46 Kips
51.01 ft	Cohesive	N/A	N/A	500.00 psf	110.46 Kips
54.99 ft	Cohesive	N/A	N/A	500.00 psf	118.42 Kips
55.01 ft	Cohesionless	3137.86 psf	22.24	N/A	118.49 Kips
62.99 ft	Cohesionless	3347.74 psf	22.24	N/A	159.21 Kips
63.01 ft	Cohesive	N/A	N/A	300.00 psf	159.27 Kips
72.01 ft	Cohesive	N/A	N/A	300.00 psf	170.07 Kips
77.99 ft	Cohesive	N/A	N/A	300.00 psf	177.25 Kips
78.01 ft	Cohesionless	4272.69 psf	24.54	N/A	177.35 Kips
81.99 ft	Cohesionless	4387.31 psf	24.54	N/A	213.96 Kips
82.01 ft	Cohesive	N/A	N/A	1375.94 psf	214.11 Kips
89.99 ft	Cohesive	N/A	N/A	1375.94 psf	258.03 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0 01 ft	Cohesionless	1.20 psf	30.00	13 32 Kips	0.02 Kips
3.99 ft	Cohesionless	478.80 psf	30.00	13.32 Kips	8.33 Kips
4.01 ft	Cohesionless	480 53 psf	30.00	13.32 Kips	8.36 Kips
13.01 ft	Cohesionless	953.93 psf	30.00	13.32 Kips	13.32 Kips
15.99 ft	Cohesionless	1110.67 psf	30.00	13.32 Kips	13.32 Kips
16.01 ft	Cohesionless	1111.78 psf	40.40	33 00 Kips	28.10 Kips
25.01 ft	Cohesionless	1630.18 psf	40.40	33.00 Kips	33 00 Kips
32.99 ft	Cohesionless	2089.82 psf	40.40	33.00 Kips	33.00 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	4.50 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	4.50 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	4.50 Kips
54.99 ft	Cohesive	N/A	N/A	N/A	4.50 Kips
55.01 ft	Cohesionless	3138.13 psf	26.40	13.32 Kips	13.32 Kips
62.99 ft	Cohesionless	3557.87 psf	26.40	13.32 Kips	13.32 Kips
63.01 ft	Cohesive	N/A	N/A	N/A	2.70 Kips
72.01 ft	Cohesive	N/A	N/A	N/A	2.70 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	2.70 Kips
78.01 ft	Cohesionless	4272.98 psf	40.40	33.00 Kips	33.00 Kips
81.99 ft	Cohesionless	4502.22 psf	40.40	33.00 Kips	33.00 Kips
82.01 ft	Cohesive	N/A	N/A	N/A	30.60 Kips
89.99 ft	Cohesive	N/A	N/A	N/A	30 60 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
3.99 ft	1.58 Kips	8.33 Kips	9.91 Kips
4.01 ft	1.60 Kips	8.36 Kips	9.96 Kips
13.01 ft	12.28 Kips	13.32 Kips	25.60 Kips
15.99 ft	17.37 Kips	13.32 Kips	30.69 Kips
16.01 ft	17.41 Kips	28.10 Kips	45.51 Kips
25.01 ft	43.28 Kips	33.00 Kips	76.28 Kips
32.99 ft	74.39 Kips	33.00 Kips	107.39 Kips
33.01 ft	74.46 Kips	4.50 Kips	78.96 Kips
42.01 ft	92.46 Kips	4.50 Kips	96.96 Kips
51.01 ft	110.46 Kips	4.50 Kips	114.96 Kips
54.99 ft	118.42 Kips	4.50 Kips	122.92 Kips
55.01 ft	118.49 Kips	13.32 Kips	131.81 Kips
62.99 ft	159.21 Kips	13.32 Kips	172.53 Kips
63.01 ft	159.27 Kips	2.70 Kips	161.97 Kips
72.01 ft	170.07 Kips	2.70 Kips	172.77 Kips
77.99 ft	177.25 Kips	2.70 Kips	179.95 Kips
78.01 ft	177.35 Kips	33.00 Kips	210.35 Kips
81.99 ft	213.96 Kips	33.00 Kips	246.96 Kips
82.01 ft	214.11 Kips	30.60 Kips	244.71 Kips
89.99 ft	258.03 Kips	30.60 Kips	288.63 Kips

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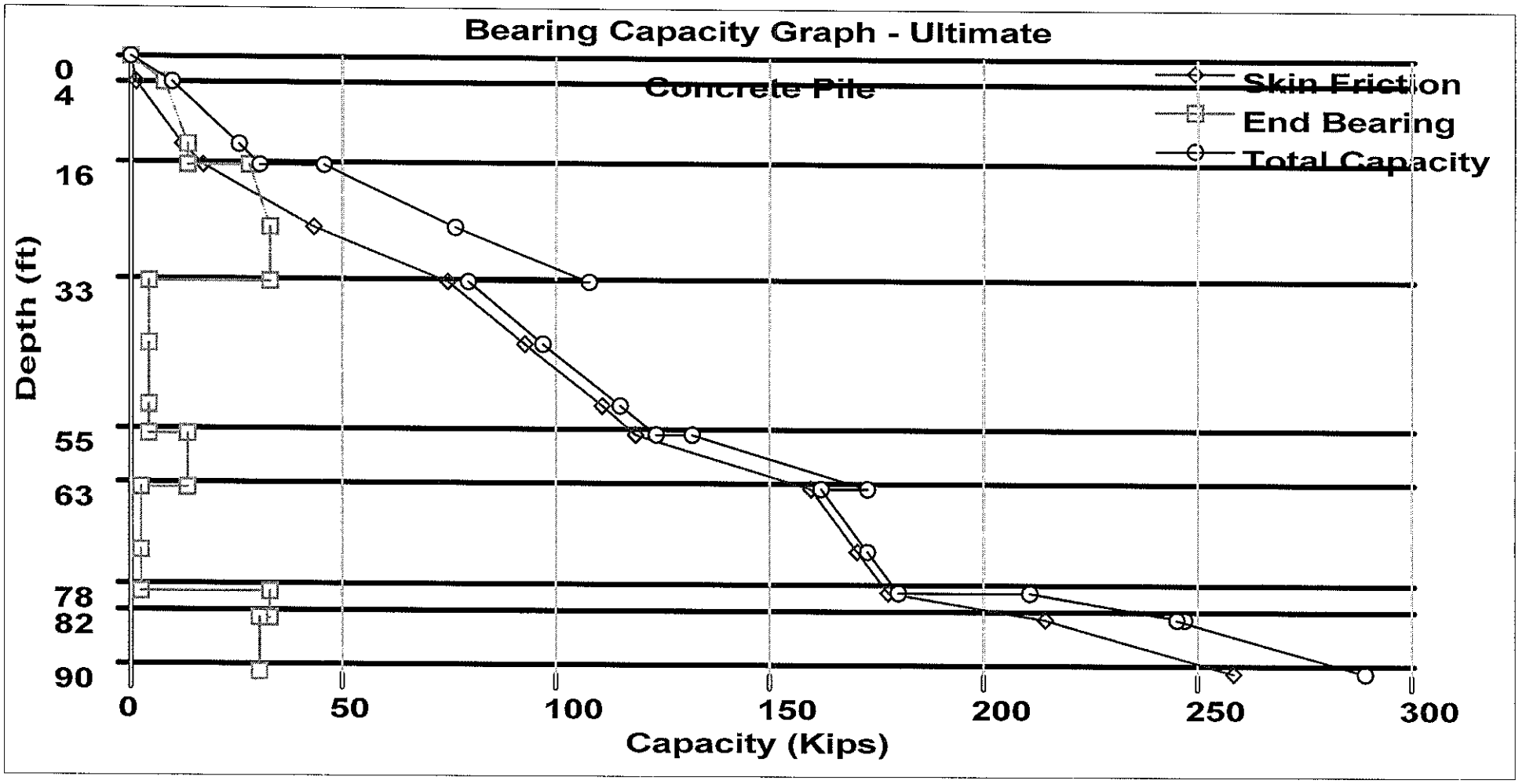

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC12.DVN
Project Name: Piney Run @ HEC - Abuts
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney Run @ HEC - Abutments
(12" closed-end pipe pile)

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	4.00 ft
	- Driving/Restrike	4.00 ft
	- Ultimate:	4.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.00 ft	0.00%	120.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	12.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
3	Cohesionless	17.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
4	Cohesive	22.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Steel
5	Cohesionless	8.00 ft	0.00%	115.00 pcf	29.0/29.0	Nordlund
6	Cohesive	15.00 ft	0.00%	110.00 pcf	300.00 psf	T-79 Steel
7	Cohesionless	4.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
8	Cohesive	8.00 ft	0.00%	120.00 pcf	3400.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	17.64	N/A	0.00 Kips
3.99 ft	Cohesionless	239.40 psf	17.64	N/A	0.83 Kips
4.01 ft	Cohesionless	480.26 psf	17.64	N/A	0.83 Kips
13.01 ft	Cohesionless	716.96 psf	17.64	N/A	6.42 Kips
15.99 ft	Cohesionless	795.34 psf	17.64	N/A	9.08 Kips
16.01 ft	Cohesionless	1111.49 psf	18.82	N/A	9.10 Kips
25.01 ft	Cohesionless	1370.69 psf	18.82	N/A	22.34 Kips
32.99 ft	Cohesionless	1600.51 psf	18.82	N/A	38.27 Kips
33.01 ft	Cohesive	N/A	N/A	479.03 psf	38.31 Kips
42.01 ft	Cohesive	N/A	N/A	500.00 psf	52.45 Kips
51.01 ft	Cohesive	N/A	N/A	500.00 psf	66.59 Kips
54.99 ft	Cohesive	N/A	N/A	500.00 psf	72.84 Kips
55.01 ft	Cohesionless	3137.86 psf	17.05	N/A	72.88 Kips
62.99 ft	Cohesionless	3347.74 psf	17.05	N/A	94.31 Kips
63.01 ft	Cohesive	N/A	N/A	300.00 psf	94.34 Kips
72.01 ft	Cohesive	N/A	N/A	300.00 psf	102.83 Kips
77.99 ft	Cohesive	N/A	N/A	300.00 psf	108.46 Kips
78.01 ft	Cohesionless	4272.69 psf	18.82	N/A	108.52 Kips
81.99 ft	Cohesionless	4387.31 psf	18.82	N/A	127.26 Kips
82.01 ft	Cohesive	N/A	N/A	1260.00 psf	127.35 Kips
89.99 ft	Cohesive	N/A	N/A	1260.00 psf	158.94 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	30.00	10.46 Kips	0.02 Kips
3.99 ft	Cohesionless	478.80 psf	30.00	10.46 Kips	6.54 Kips
4.01 ft	Cohesionless	480.53 psf	30.00	10.46 Kips	6.57 Kips
13.01 ft	Cohesionless	953.93 psf	30.00	10.46 Kips	10.46 Kips
15.99 ft	Cohesionless	1110.67 psf	30.00	10.46 Kips	10.46 Kips
16.01 ft	Cohesionless	1111.78 psf	40.40	25.92 Kips	22.07 Kips
25.01 ft	Cohesionless	1630.18 psf	40.40	25.92 Kips	25.92 Kips
32.99 ft	Cohesionless	2089.82 psf	40.40	25.92 Kips	25.92 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	3.53 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	3.53 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	3.53 Kips
54.99 ft	Cohesive	N/A	N/A	N/A	3.53 Kips
55.01 ft	Cohesionless	3138.13 psf	26.40	10.46 Kips	10.46 Kips
62.99 ft	Cohesionless	3557.87 psf	26.40	10.46 Kips	10.46 Kips
63.01 ft	Cohesive	N/A	N/A	N/A	2.12 Kips
72.01 ft	Cohesive	N/A	N/A	N/A	2.12 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	2.12 Kips
78.01 ft	Cohesionless	4272.98 psf	40.40	25.92 Kips	25.92 Kips
81.99 ft	Cohesionless	4502.22 psf	40.40	25.92 Kips	25.92 Kips
82.01 ft	Cohesive	N/A	N/A	N/A	24.03 Kips
89.99 ft	Cohesive	N/A	N/A	N/A	24.03 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0 01 ft	0 00 Kips	0 02 Kips	0.02 Kips
3.99 ft	0.83 Kips	6 54 Kips	7.37 Kips
4.01 ft	0.83 Kips	6.57 Kips	7.40 Kips
13.01 ft	6.42 Kips	10.46 Kips	16.88 Kips
15.99 ft	9.08 Kips	10.46 Kips	19 54 Kips
16.01 ft	9.10 Kips	22.07 Kips	31 17 Kips
25.01 ft	22.34 Kips	25.92 Kips	48.26 Kips
32 99 ft	38.27 Kips	25.92 Kips	64.19 Kips
33.01 ft	38.31 Kips	3.53 Kips	41.84 Kips
42.01 ft	52.45 Kips	3.53 Kips	55 98 Kips
51.01 ft	66.59 Kips	3.53 Kips	70 12 Kips
54.99 ft	72.84 Kips	3.53 Kips	76.37 Kips
55 01 ft	72.88 Kips	10.46 Kips	83.34 Kips
62.99 ft	94.31 Kips	10.46 Kips	104.77 Kips
63.01 ft	94.34 Kips	2.12 Kips	96.47 Kips
72.01 ft	102.83 Kips	2.12 Kips	104.95 Kips
77.99 ft	108 46 Kips	2.12 Kips	110.58 Kips
78.01 ft	108.52 Kips	25.92 Kips	134.44 Kips
81.99 ft	127.26 Kips	25.92 Kips	153.18 Kips
82.01 ft	127.35 Kips	24.03 Kips	151.38 Kips
89.99 ft	158.94 Kips	24.03 Kips	182.97 Kips

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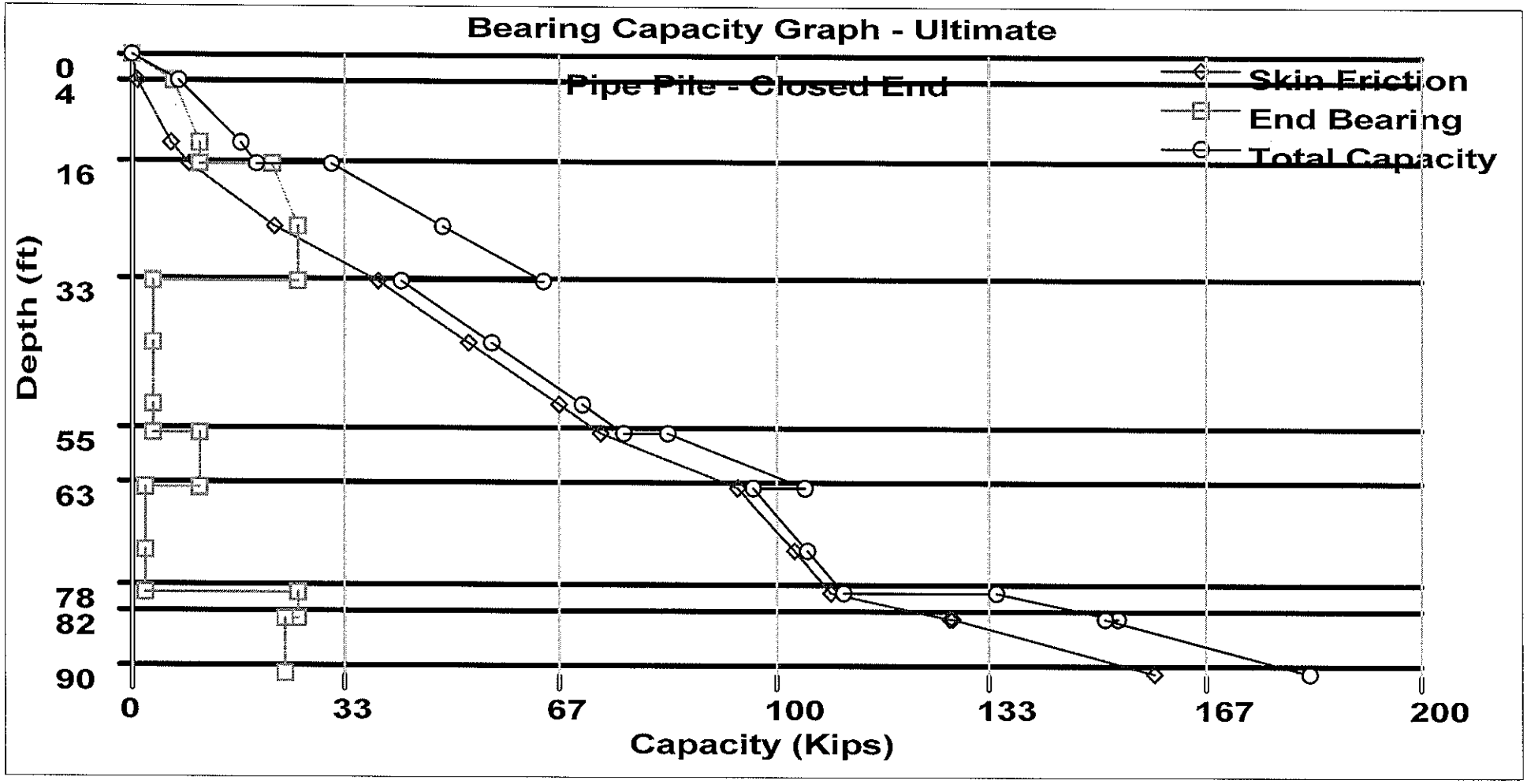

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC18A.DVN
Project Name: Piney Run @ HEC - Abuts
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney Run @ HEC - Abutments (18" square PCP)

PILE INFORMATION

Pile Type: Concrete Pile
Top of Pile: 0.00 ft
Length of Square Side: 18.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	4.00 ft
	- Driving/Restrike	4.00 ft
	- Ultimate:	4.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.00 ft	0.00%	120.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	12.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
3	Cohesionless	17.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
4	Cohesive	22.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Concrete
5	Cohesionless	8.00 ft	0.00%	115.00 pcf	29.0/29.0	Nordlund
6	Cohesive	15.00 ft	0.00%	110.00 pcf	300.00 psf	T-79 Concrete
7	Cohesionless	4.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
8	Cohesive	8.00 ft	0.00%	120.00 pcf	3400.00 psf	T-79 Concrete

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	27.42	N/A	0.00 Kips
3.99 ft	Cohesionless	239.40 psf	27.42	N/A	3.23 Kips
4.01 ft	Cohesionless	480.26 psf	27.42	N/A	3.26 Kips
13.01 ft	Cohesionless	716.96 psf	27.42	N/A	25.08 Kips
15.99 ft	Cohesionless	795.34 psf	27.42	N/A	35.48 Kips
16.01 ft	Cohesionless	1111.49 psf	29.25	N/A	35.56 Kips
25.01 ft	Cohesionless	1370.69 psf	29.25	N/A	89.52 Kips
32.99 ft	Cohesionless	1600.51 psf	29.25	N/A	154.42 Kips
33.01 ft	Cohesive	N/A	N/A	500.00 psf	154.54 Kips
42.01 ft	Cohesive	N/A	N/A	500.00 psf	181.54 Kips
51.01 ft	Cohesive	N/A	N/A	500.00 psf	208.54 Kips
54.99 ft	Cohesive	N/A	N/A	500.00 psf	220.48 Kips
55.01 ft	Cohesionless	3137.86 psf	26.51	N/A	220.61 Kips
62.99 ft	Cohesionless	3347.74 psf	26.51	N/A	303.30 Kips
63.01 ft	Cohesive	N/A	N/A	300.00 psf	303.42 Kips
72.01 ft	Cohesive	N/A	N/A	300.00 psf	319.62 Kips
77.99 ft	Cohesive	N/A	N/A	300.00 psf	330.39 Kips
78.01 ft	Cohesionless	4272.69 psf	29.25	N/A	330.59 Kips
81.99 ft	Cohesionless	4387.31 psf	29.25	N/A	406.95 Kips
82.01 ft	Cohesive	N/A	N/A	1375.94 psf	407.23 Kips
89.99 ft	Cohesive	N/A	N/A	1375.94 psf	473.11 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	30.00	29.97 Kips	0.05 Kips
3.99 ft	Cohesionless	478.80 psf	30.00	29.97 Kips	18.75 Kips
4.01 ft	Cohesionless	480.53 psf	30.00	29.97 Kips	18.81 Kips
13.01 ft	Cohesionless	953.93 psf	30.00	29.97 Kips	29.97 Kips
15.99 ft	Cohesionless	1110.67 psf	30.00	29.97 Kips	29.97 Kips
16.01 ft	Cohesionless	1111.78 psf	40.40	74.25 Kips	63.22 Kips
25.01 ft	Cohesionless	1630.18 psf	40.40	74.25 Kips	74.25 Kips
32.99 ft	Cohesionless	2089.82 psf	40.40	74.25 Kips	74.25 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	10.12 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	10.12 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	10.12 Kips
54.99 ft	Cohesive	N/A	N/A	N/A	10.12 Kips
55.01 ft	Cohesionless	3138.13 psf	26.40	29.97 Kips	29.97 Kips
62.99 ft	Cohesionless	3557.87 psf	26.40	29.97 Kips	29.97 Kips
63.01 ft	Cohesive	N/A	N/A	N/A	6.07 Kips
72.01 ft	Cohesive	N/A	N/A	N/A	6.07 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	6.07 Kips
78.01 ft	Cohesionless	4272.98 psf	40.40	74.25 Kips	74.25 Kips
81.99 ft	Cohesionless	4502.22 psf	40.40	74.25 Kips	74.25 Kips
82.01 ft	Cohesive	N/A	N/A	N/A	68.85 Kips
89.99 ft	Cohesive	N/A	N/A	N/A	68.85 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.05 Kips	0.05 Kips
3.99 ft	3.23 Kips	18.75 Kips	21.97 Kips
4.01 ft	3.26 Kips	18.81 Kips	22.07 Kips
13.01 ft	25.08 Kips	29.97 Kips	55.05 Kips
15.99 ft	35.48 Kips	29.97 Kips	65.45 Kips
16.01 ft	35.56 Kips	63.22 Kips	98.79 Kips
25.01 ft	89.52 Kips	74.25 Kips	163.77 Kips
32.99 ft	154.42 Kips	74.25 Kips	228.67 Kips
33.01 ft	154.54 Kips	10.12 Kips	164.67 Kips
42.01 ft	181.54 Kips	10.12 Kips	191.67 Kips
51.01 ft	208.54 Kips	10.12 Kips	218.67 Kips
54.99 ft	220.48 Kips	10.12 Kips	230.61 Kips
55.01 ft	220.61 Kips	29.97 Kips	250.58 Kips
62.99 ft	303.30 Kips	29.97 Kips	333.27 Kips
63.01 ft	303.42 Kips	6.07 Kips	309.50 Kips
72.01 ft	319.62 Kips	6.07 Kips	325.70 Kips
77.99 ft	330.39 Kips	6.07 Kips	336.46 Kips
78.01 ft	330.59 Kips	74.25 Kips	404.84 Kips
81.99 ft	406.95 Kips	74.25 Kips	481.20 Kips
82.01 ft	407.23 Kips	68.85 Kips	476.08 Kips
89.99 ft	473.11 Kips	68.85 Kips	541.96 Kips

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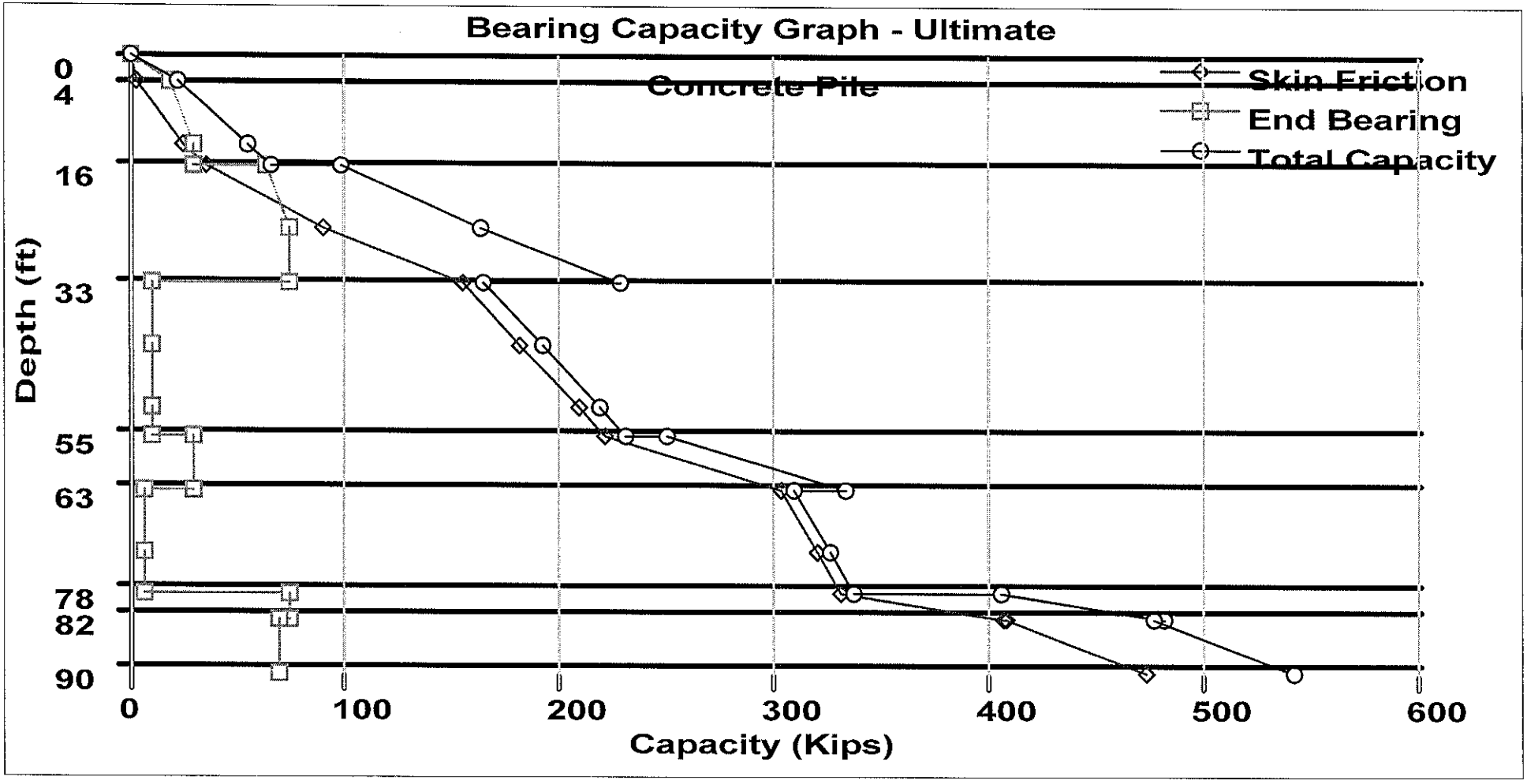

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC18A.DVN
Project Name: Piney Run @ HEC - Abuts
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney Run@HEC-Abutments (18" closed-end pipepile)

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 18.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	4.00 ft
	- Driving/Restrike	4.00 ft
	- Ultimate:	4.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.00 ft	0.00%	120.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	12.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
3	Cohesionless	17.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
4	Cohesive	22.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Steel
5	Cohesionless	8.00 ft	0.00%	115.00 pcf	29.0/29.0	Nordlund
6	Cohesive	15.00 ft	0.00%	110.00 pcf	300.00 psf	T-79 Steel
7	Cohesionless	4.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
8	Cohesive	8.00 ft	0.00%	120.00 pcf	3400.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	23.52	N/A	0.00 Kips
3.99 ft	Cohesionless	239.40 psf	23.52	N/A	2.05 Kips
4.01 ft	Cohesionless	480.26 psf	23.52	N/A	2.07 Kips
13.01 ft	Cohesionless	716.96 psf	23.52	N/A	15.89 Kips
15.99 ft	Cohesionless	795.34 psf	23.52	N/A	22.48 Kips
16.01 ft	Cohesionless	1111.49 psf	25.08	N/A	22.53 Kips
25.01 ft	Cohesionless	1370.69 psf	25.08	N/A	56.38 Kips
32.99 ft	Cohesionless	1600.51 psf	25.08	N/A	97.09 Kips
33.01 ft	Cohesive	N/A	N/A	446.02 psf	97.17 Kips
42.01 ft	Cohesive	N/A	N/A	464.02 psf	116.85 Kips
51.01 ft	Cohesive	N/A	N/A	482.02 psf	138.06 Kips
54.99 ft	Cohesive	N/A	N/A	489.98 psf	147.93 Kips
55.01 ft	Cohesionless	3137.86 psf	22.73	N/A	148.01 Kips
62.99 ft	Cohesionless	3347.74 psf	22.73	N/A	200.53 Kips
63.01 ft	Cohesive	N/A	N/A	300.00 psf	200.62 Kips
72.01 ft	Cohesive	N/A	N/A	300.00 psf	213.34 Kips
77.99 ft	Cohesive	N/A	N/A	300.00 psf	221.80 Kips
78.01 ft	Cohesionless	4272.69 psf	25.08	N/A	221.93 Kips
81.99 ft	Cohesionless	4387.31 psf	25.08	N/A	269.83 Kips
82.01 ft	Cohesive	N/A	N/A	1260.00 psf	270.01 Kips
89.99 ft	Cohesive	N/A	N/A	1260.00 psf	317.39 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	30.00	23.54 Kips	0.04 Kips
3.99 ft	Cohesionless	478.80 psf	30.00	23.54 Kips	14.72 Kips
4.01 ft	Cohesionless	480.53 psf	30.00	23.54 Kips	14.78 Kips
13.01 ft	Cohesionless	953.93 psf	30.00	23.54 Kips	23.54 Kips
15.99 ft	Cohesionless	1110.67 psf	30.00	23.54 Kips	23.54 Kips
16.01 ft	Cohesionless	1111.78 psf	40.40	58.32 Kips	49.66 Kips
25.01 ft	Cohesionless	1630.18 psf	40.40	58.32 Kips	58.32 Kips
32.99 ft	Cohesionless	2089.82 psf	40.40	58.32 Kips	58.32 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	7.95 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	7.95 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	7.95 Kips
54.99 ft	Cohesive	N/A	N/A	N/A	7.95 Kips
55.01 ft	Cohesionless	3138.13 psf	26.40	23.54 Kips	23.54 Kips
62.99 ft	Cohesionless	3557.87 psf	26.40	23.54 Kips	23.54 Kips
63.01 ft	Cohesive	N/A	N/A	N/A	4.77 Kips
72.01 ft	Cohesive	N/A	N/A	N/A	4.77 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	4.77 Kips
78.01 ft	Cohesionless	4272.98 psf	40.40	58.32 Kips	58.32 Kips
81.99 ft	Cohesionless	4502.22 psf	40.40	58.32 Kips	58.32 Kips
82.01 ft	Cohesive	N/A	N/A	N/A	54.07 Kips
89.99 ft	Cohesive	N/A	N/A	N/A	54.07 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0 04 Kips	0.04 Kips
3 99 ft	2.05 Kips	14.72 Kips	16 77 Kips
4.01 ft	2.07 Kips	14.78 Kips	16 84 Kips
13.01 ft	15.89 Kips	23.54 Kips	39.43 Kips
15.99 ft	22.48 Kips	23.54 Kips	46.02 Kips
16.01 ft	22.53 Kips	49.66 Kips	72.19 Kips
25.01 ft	56.38 Kips	58 32 Kips	114.69 Kips
32.99 ft	97.09 Kips	58.32 Kips	155.41 Kips
33.01 ft	97.17 Kips	7.95 Kips	105.12 Kips
42.01 ft	116.85 Kips	7 95 Kips	124.81 Kips
51.01 ft	138.06 Kips	7.95 Kips	146.01 Kips
54.99 ft	147 93 Kips	7.95 Kips	155.88 Kips
55.01 ft	148.01 Kips	23.54 Kips	171.55 Kips
62.99 ft	200.53 Kips	23.54 Kips	224.07 Kips
63.01 ft	200.62 Kips	4.77 Kips	205.39 Kips
72.01 ft	213.34 Kips	4.77 Kips	218.11 Kips
77.99 ft	221 80 Kips	4.77 Kips	226.57 Kips
78.01 ft	221.93 Kips	58.32 Kips	280.24 Kips
81.99 ft	269.83 Kips	58.32 Kips	328.15 Kips
82.01 ft	270.01 Kips	54.07 Kips	324.09 Kips
89.99 ft	317.39 Kips	54.07 Kips	371.47 Kips

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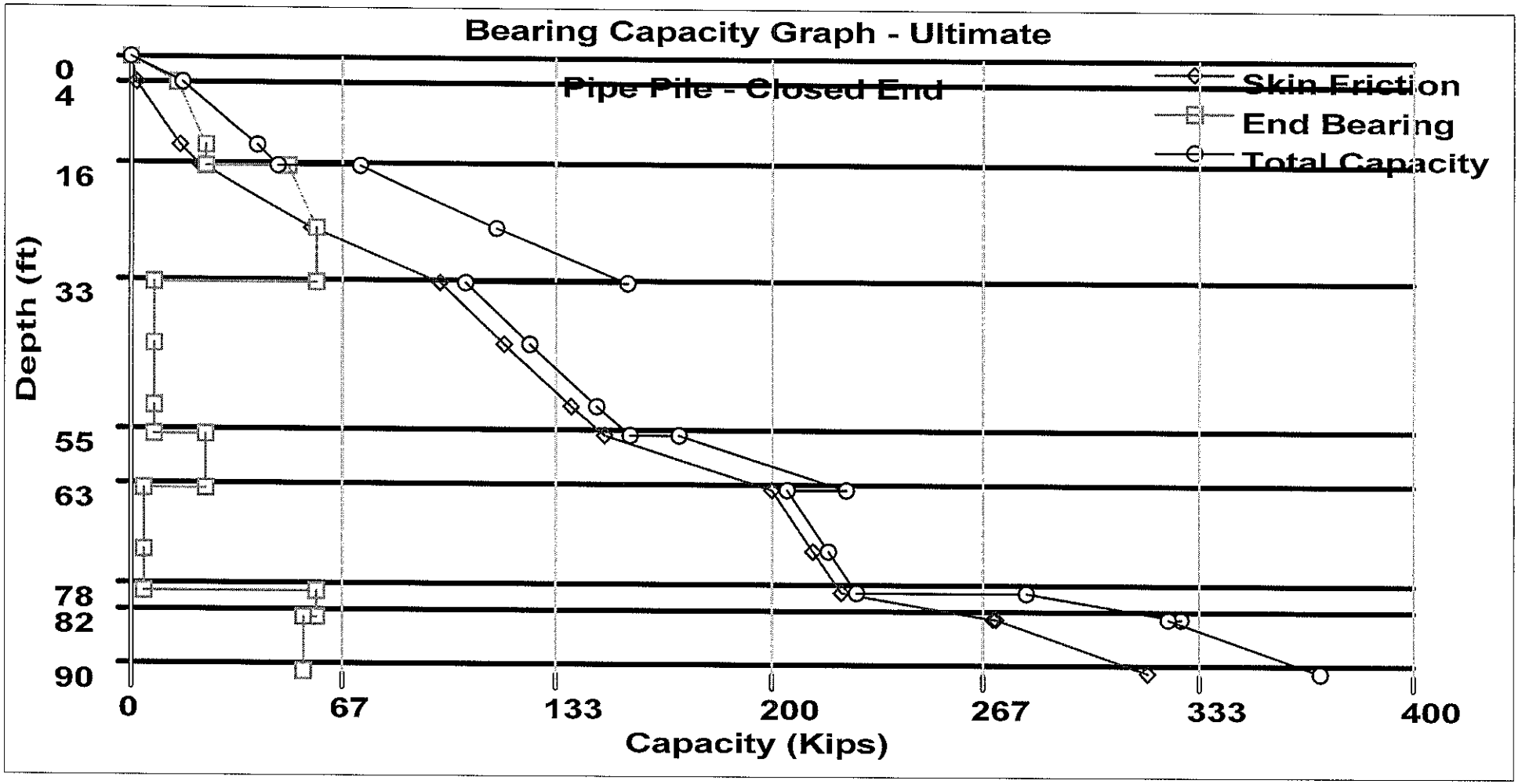

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC18.DVN
Project Name: Piney Run @ HEC - Piers
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney @ HEC - Pier (18" square PCP)

PILE INFORMATION

Pile Type: Concrete Pile
Top of Pile: 0.00 ft
Length of Square Side: 18.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	8.00 ft
	- Long Term Scour:	8.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	20.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
3	Cohesive	18.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Concrete
4	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
5	Cohesive	9.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Concrete
6	Cohesionless	5.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
7	Cohesive	16.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Concrete
8	Cohesive	5.00 ft	0.00%	120.00 pcf	3400.00 psf	T-79 Concrete

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0 00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.01 ft	Cohesionless	0 00 psf	0.00	N/A	0.00 Kips
15.99 ft	Cohesionless	0 00 psf	0.00	N/A	0.00 Kips
16.00 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
17.01 ft	Cohesionless	489 89 psf	30.16	N/A	2.42 Kips
26.01 ft	Cohesionless	749 09 psf	30.16	N/A	36.73 Kips
27.99 ft	Cohesionless	806.11 psf	30.16	N/A	47 35 Kips
28.01 ft	Cohesive	N/A	N/A	269.95 psf	47 42 Kips
37.01 ft	Cohesive	N/A	N/A	264.34 psf	61.69 Kips
45.99 ft	Cohesive	N/A	N/A	258.74 psf	75.33 Kips
46.01 ft	Cohesionless	2009.06 psf	27.42	N/A	75.41 Kips
53.99 ft	Cohesionless	2218.94 psf	27.42	N/A	135.27 Kips
54.01 ft	Cohesive	N/A	N/A	253.74 psf	135.37 Kips
62.99 ft	Cohesive	N/A	N/A	250.00 psf	148.84 Kips
63.01 ft	Cohesionless	2858.29 psf	30.16	N/A	148.99 Kips
67.99 ft	Cohesionless	3001.71 psf	30.16	N/A	222.22 Kips
68.01 ft	Cohesive	N/A	N/A	500.00 psf	222.41 Kips
77.01 ft	Cohesive	N/A	N/A	500.00 psf	249.41 Kips
83.99 ft	Cohesive	N/A	N/A	500.00 psf	270.35 Kips
84.01 ft	Cohesive	N/A	N/A	1375.94 psf	270.46 Kips
88.99 ft	Cohesive	N/A	N/A	1375.94 psf	311.57 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0 01 ft	Cohesionless	0.00 psf	0 00	0.00 Kips	0.00 Kips
7 99 ft	Cohesionless	0.00 psf	0 00	0.00 Kips	0.00 Kips
8.01 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
15.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
16 00 ft	Cohesionless	460.80 psf	47.20	112.50 Kips	31.59 Kips
17.01 ft	Cohesionless	518.98 psf	47.20	112.50 Kips	35.58 Kips
26.01 ft	Cohesionless	1037.38 psf	47.20	112.50 Kips	71 13 Kips
27.99 ft	Cohesionless	1151.42 psf	47.20	112.50 Kips	78.94 Kips
28.01 ft	Cohesive	N/A	N/A	N/A	5.06 Kips
37 01 ft	Cohesive	N/A	N/A	N/A	5.06 Kips
45.99 ft	Cohesive	N/A	N/A	N/A	5.06 Kips
46.01 ft	Cohesionless	2009.33 psf	30.00	29.97 Kips	29.97 Kips
53.99 ft	Cohesionless	2429.07 psf	30.00	29.97 Kips	29.97 Kips
54.01 ft	Cohesive	N/A	N/A	N/A	5.06 Kips
62 99 ft	Cohesive	N/A	N/A	N/A	5.06 Kips
63.01 ft	Cohesionless	2858.58 psf	47.20	112.50 Kips	112.50 Kips
67.99 ft	Cohesionless	3145.42 psf	47.20	112.50 Kips	112.50 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	10.12 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	10.12 Kips
83.99 ft	Cohesive	N/A	N/A	N/A	10 12 Kips
84.01 ft	Cohesive	N/A	N/A	N/A	68.85 Kips
88.99 ft	Cohesive	N/A	N/A	N/A	68.85 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0 00 Kips	0.00 Kips	0.00 Kips
7 99 ft	0 00 Kips	0 00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0 00 Kips	0.00 Kips
15.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
16 00 ft	0.00 Kips	31.59 Kips	31.59 Kips
17.01 ft	2.42 Kips	35.58 Kips	38.01 Kips
26.01 ft	36.73 Kips	71.13 Kips	107.86 Kips
27.99 ft	47.35 Kips	78.94 Kips	126.29 Kips
28.01 ft	47.42 Kips	5.06 Kips	52 48 Kips
37.01 ft	61.69 Kips	5.06 Kips	66.75 Kips
45.99 ft	75.33 Kips	5.06 Kips	80.39 Kips
46.01 ft	75.41 Kips	29.97 Kips	105.38 Kips
53.99 ft	135.27 Kips	29.97 Kips	165.24 Kips
54.01 ft	135.37 Kips	5 06 Kips	140.43 Kips
62.99 ft	148.84 Kips	5 06 Kips	153.90 Kips
63.01 ft	148 99 Kips	112.50 Kips	261.49 Kips
67.99 ft	222.22 Kips	112.50 Kips	334.72 Kips
68.01 ft	222.41 Kips	10.12 Kips	232.53 Kips
77.01 ft	249.41 Kips	10 12 Kips	259.53 Kips
83.99 ft	270.35 Kips	10.12 Kips	280.47 Kips
84.01 ft	270 46 Kips	68.85 Kips	339.31 Kips
88.99 ft	311.57 Kips	68.85 Kips	380.42 Kips

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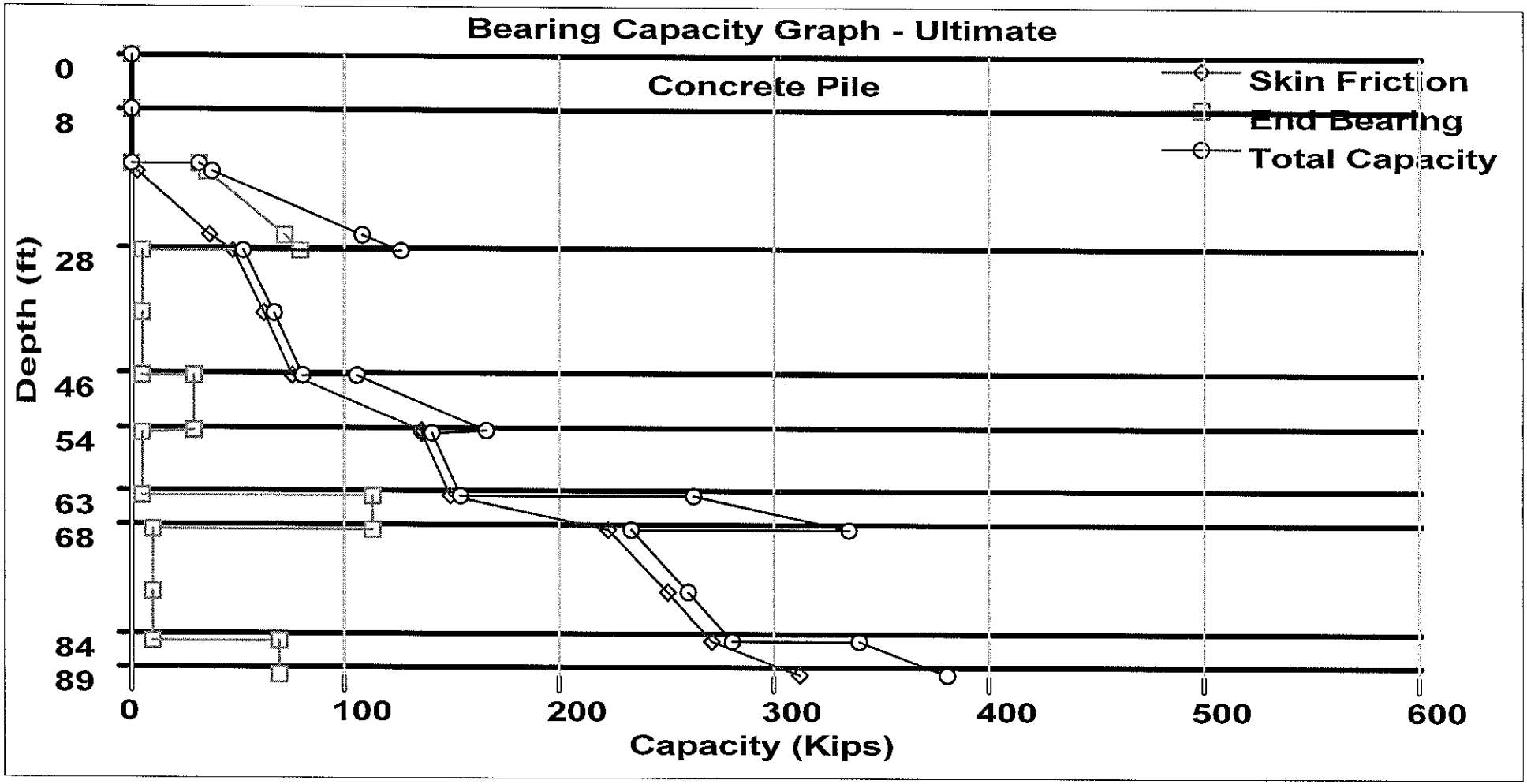

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC18.DVN
Project Name: Piney Run @ HEC - Piers
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney Run @ HEC-Pier

PILE INFORMATION

(18" closed-end pipe pile)

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 18.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	8.00 ft
	- Long Term Scour:	8.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	20.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
3	Cohesive	18.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Steel
4	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
5	Cohesive	9.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Steel
6	Cohesionless	5.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
7	Cohesive	16.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Steel
8	Cohesive	5.00 ft	0.00%	120.00 pcf	3400.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0 01 ft	Cohesionless	0 00 psf	0.00	N/A	0.00 Kips
7 99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.01 ft	Cohesionless	0.00 psf	0 00	N/A	0.00 Kips
15.99 ft	Cohesionless	0.00 psf	0 00	N/A	0.00 Kips
16.00 ft	Cohesionless	0.00 psf	0.00	N/A	0 00 Kips
17.01 ft	Cohesionless	489.89 psf	25.87	N/A	1.51 Kips
26.01 ft	Cohesionless	749 09 psf	25.87	N/A	22.94 Kips
27.99 ft	Cohesionless	806.11 psf	25.87	N/A	29.57 Kips
28.01 ft	Cohesive	N/A	N/A	243.12 psf	29.61 Kips
37.01 ft	Cohesive	N/A	N/A	245.06 psf	40 01 Kips
45.99 ft	Cohesive	N/A	N/A	246.99 psf	50.54 Kips
46.01 ft	Cohesionless	2009.06 psf	23.52	N/A	50.60 Kips
53.99 ft	Cohesionless	2218.94 psf	23.52	N/A	88.52 Kips
54.01 ft	Cohesive	N/A	N/A	248.71 psf	88.58 Kips
62.99 ft	Cohesive	N/A	N/A	250.00 psf	99.16 Kips
63.01 ft	Cohesionless	2858.29 psf	25.87	N/A	99.26 Kips
67.99 ft	Cohesionless	3001.71 psf	25.87	N/A	145.00 Kips
68.01 ft	Cohesive	N/A	N/A	500.00 psf	145.12 Kips
77.01 ft	Cohesive	N/A	N/A	500.00 psf	166.32 Kips
83.99 ft	Cohesive	N/A	N/A	500.00 psf	182.77 Kips
84.01 ft	Cohesive	N/A	N/A	1260.00 psf	182.85 Kips
88.99 ft	Cohesive	N/A	N/A	1260.00 psf	212.42 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
8.01 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
15.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
16.00 ft	Cohesionless	460.80 psf	47.20	88.36 Kips	24.81 Kips
17.01 ft	Cohesionless	518.98 psf	47.20	88.36 Kips	27.95 Kips
26.01 ft	Cohesionless	1037.38 psf	47.20	88.36 Kips	55.86 Kips
27.99 ft	Cohesionless	1151.42 psf	47.20	88.36 Kips	62.00 Kips
28.01 ft	Cohesive	N/A	N/A	N/A	3.98 Kips
37.01 ft	Cohesive	N/A	N/A	N/A	3.98 Kips
45.99 ft	Cohesive	N/A	N/A	N/A	3.98 Kips
46.01 ft	Cohesionless	2009.33 psf	30.00	23.54 Kips	23.54 Kips
53.99 ft	Cohesionless	2429.07 psf	30.00	23.54 Kips	23.54 Kips
54.01 ft	Cohesive	N/A	N/A	N/A	3.98 Kips
62.99 ft	Cohesive	N/A	N/A	N/A	3.98 Kips
63.01 ft	Cohesionless	2858.58 psf	47.20	88.36 Kips	88.36 Kips
67.99 ft	Cohesionless	3145.42 psf	47.20	88.36 Kips	88.36 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	7.95 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	7.95 Kips
83.99 ft	Cohesive	N/A	N/A	N/A	7.95 Kips
84.01 ft	Cohesive	N/A	N/A	N/A	54.07 Kips
88.99 ft	Cohesive	N/A	N/A	N/A	54.07 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
15.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.00 ft	0.00 Kips	24.81 Kips	24.81 Kips
17.01 ft	1.51 Kips	27.95 Kips	29.46 Kips
26.01 ft	22.94 Kips	55.86 Kips	78.80 Kips
27.99 ft	29.57 Kips	62.00 Kips	91.57 Kips
28.01 ft	29.61 Kips	3.98 Kips	33.59 Kips
37.01 ft	40.01 Kips	3.98 Kips	43.98 Kips
45.99 ft	50.54 Kips	3.98 Kips	54.52 Kips
46.01 ft	50.60 Kips	23.54 Kips	74.13 Kips
53.99 ft	88.52 Kips	23.54 Kips	112.06 Kips
54.01 ft	88.58 Kips	3.98 Kips	92.56 Kips
62.99 ft	99.16 Kips	3.98 Kips	103.14 Kips
63.01 ft	99.26 Kips	88.36 Kips	187.62 Kips
67.99 ft	145.00 Kips	88.36 Kips	233.35 Kips
68.01 ft	145.12 Kips	7.95 Kips	153.07 Kips
77.01 ft	166.32 Kips	7.95 Kips	174.27 Kips
83.99 ft	182.77 Kips	7.95 Kips	190.72 Kips
84.01 ft	182.85 Kips	54.07 Kips	236.92 Kips
88.99 ft	212.42 Kips	54.07 Kips	266.49 Kips

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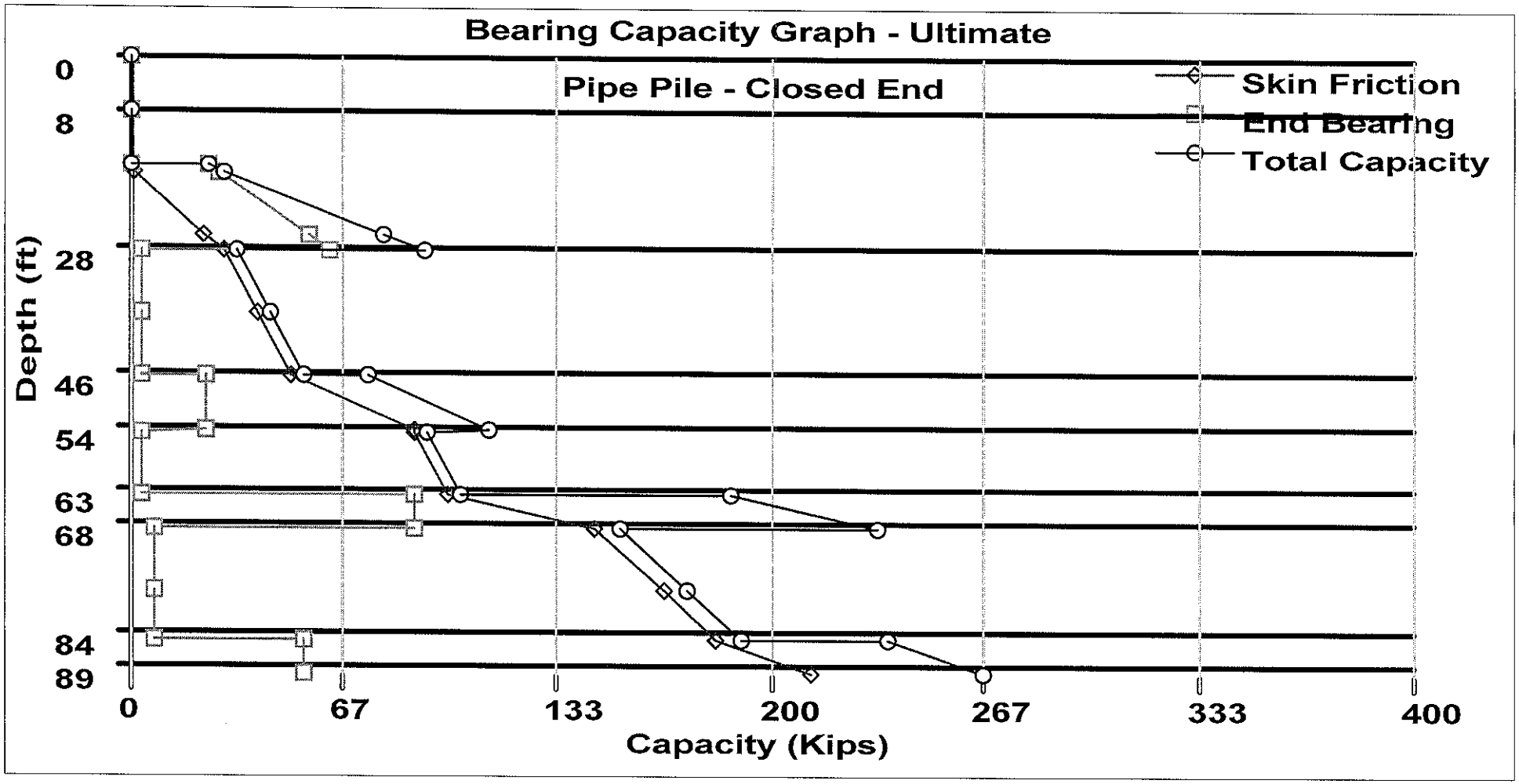

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC24.DVN
Project Name: Piney Run @ HEC - Piers
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney Run @ HEC - Pier (24" square PCP)

PILE INFORMATION

Pile Type: Concrete Pile
Top of Pile: 0.00 ft
Length of Square Side: 24.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	8.00 ft
	- Long Term Scour:	8.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	20.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
3	Cohesive	18.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Concrete
4	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
5	Cohesive	9.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Concrete
6	Cohesionless	5.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
7	Cohesive	16.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Concrete
8	Cohesive	5.00 ft	0.00%	120.00 pcf	3400.00 psf	T-79 Concrete

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
15.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
16.00 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
17.01 ft	Cohesionless	489.89 psf	30.16	N/A	3.46 Kips
26.01 ft	Cohesionless	749.09 psf	30.16	N/A	52.47 Kips
27.99 ft	Cohesionless	806.11 psf	30.16	N/A	67.64 Kips
28.01 ft	Cohesive	N/A	N/A	274.32 psf	67.74 Kips
37.01 ft	Cohesive	N/A	N/A	270.11 psf	87.19 Kips
45.99 ft	Cohesive	N/A	N/A	265.91 psf	105.99 Kips
46.01 ft	Cohesionless	2009.06 psf	27.42	N/A	106.10 Kips
53.99 ft	Cohesionless	2218.94 psf	27.42	N/A	190.68 Kips
54.01 ft	Cohesive	N/A	N/A	262.16 psf	190.81 Kips
62.99 ft	Cohesive	N/A	N/A	257.96 psf	209.34 Kips
63.01 ft	Cohesionless	2858.29 psf	30.16	N/A	209.56 Kips
67.99 ft	Cohesionless	3001.71 psf	30.16	N/A	314.18 Kips
68.01 ft	Cohesive	N/A	N/A	500.00 psf	314.44 Kips
77.01 ft	Cohesive	N/A	N/A	500.00 psf	350.44 Kips
83.99 ft	Cohesive	N/A	N/A	500.00 psf	378.36 Kips
84.01 ft	Cohesive	N/A	N/A	1375.94 psf	378.51 Kips
88.99 ft	Cohesive	N/A	N/A	1375.94 psf	433.33 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
8.01 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
15.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
16.00 ft	Cohesionless	460.80 psf	47.20	200.00 Kips	56.17 Kips
17.01 ft	Cohesionless	518.98 psf	47.20	200.00 Kips	63.26 Kips
26.01 ft	Cohesionless	1037.38 psf	47.20	200.00 Kips	126.45 Kips
27.99 ft	Cohesionless	1151.42 psf	47.20	200.00 Kips	140.35 Kips
28.01 ft	Cohesive	N/A	N/A	N/A	9.00 Kips
37.01 ft	Cohesive	N/A	N/A	N/A	9.00 Kips
45.99 ft	Cohesive	N/A	N/A	N/A	9.00 Kips
46.01 ft	Cohesionless	2009.33 psf	30.00	53.28 Kips	53.28 Kips
53.99 ft	Cohesionless	2429.07 psf	30.00	53.28 Kips	53.28 Kips
54.01 ft	Cohesive	N/A	N/A	N/A	9.00 Kips
62.99 ft	Cohesive	N/A	N/A	N/A	9.00 Kips
63.01 ft	Cohesionless	2858.58 psf	47.20	200.00 Kips	200.00 Kips
67.99 ft	Cohesionless	3145.42 psf	47.20	200.00 Kips	200.00 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	18.00 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	18.00 Kips
83.99 ft	Cohesive	N/A	N/A	N/A	18.00 Kips
84.01 ft	Cohesive	N/A	N/A	N/A	122.40 Kips
88.99 ft	Cohesive	N/A	N/A	N/A	122.40 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0 00 Kips	0 00 Kips	0 00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
15.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.00 ft	0.00 Kips	56.17 Kips	56.17 Kips
17.01 ft	3.46 Kips	63.26 Kips	66.72 Kips
26.01 ft	52.47 Kips	126.45 Kips	178.92 Kips
27.99 ft	67.64 Kips	140.35 Kips	207.98 Kips
28.01 ft	67.74 Kips	9.00 Kips	76.74 Kips
37.01 ft	87.19 Kips	9.00 Kips	96 19 Kips
45.99 ft	105 99 Kips	9.00 Kips	114.99 Kips
46.01 ft	106.10 Kips	53.28 Kips	159.38 Kips
53.99 ft	190.68 Kips	53.28 Kips	243.96 Kips
54.01 ft	190.81 Kips	9 00 Kips	199.81 Kips
62.99 ft	209.34 Kips	9.00 Kips	218.34 Kips
63.01 ft	209 56 Kips	200.00 Kips	409.56 Kips
67.99 ft	314.18 Kips	200.00 Kips	514.18 Kips
68.01 ft	314.44 Kips	18.00 Kips	332.44 Kips
77.01 ft	350.44 Kips	18.00 Kips	368.44 Kips
83.99 ft	378.36 Kips	18.00 Kips	396.36 Kips
84.01 ft	378.51 Kips	122.40 Kips	500.91 Kips
88.99 ft	433 33 Kips	122 40 Kips	555.73 Kips

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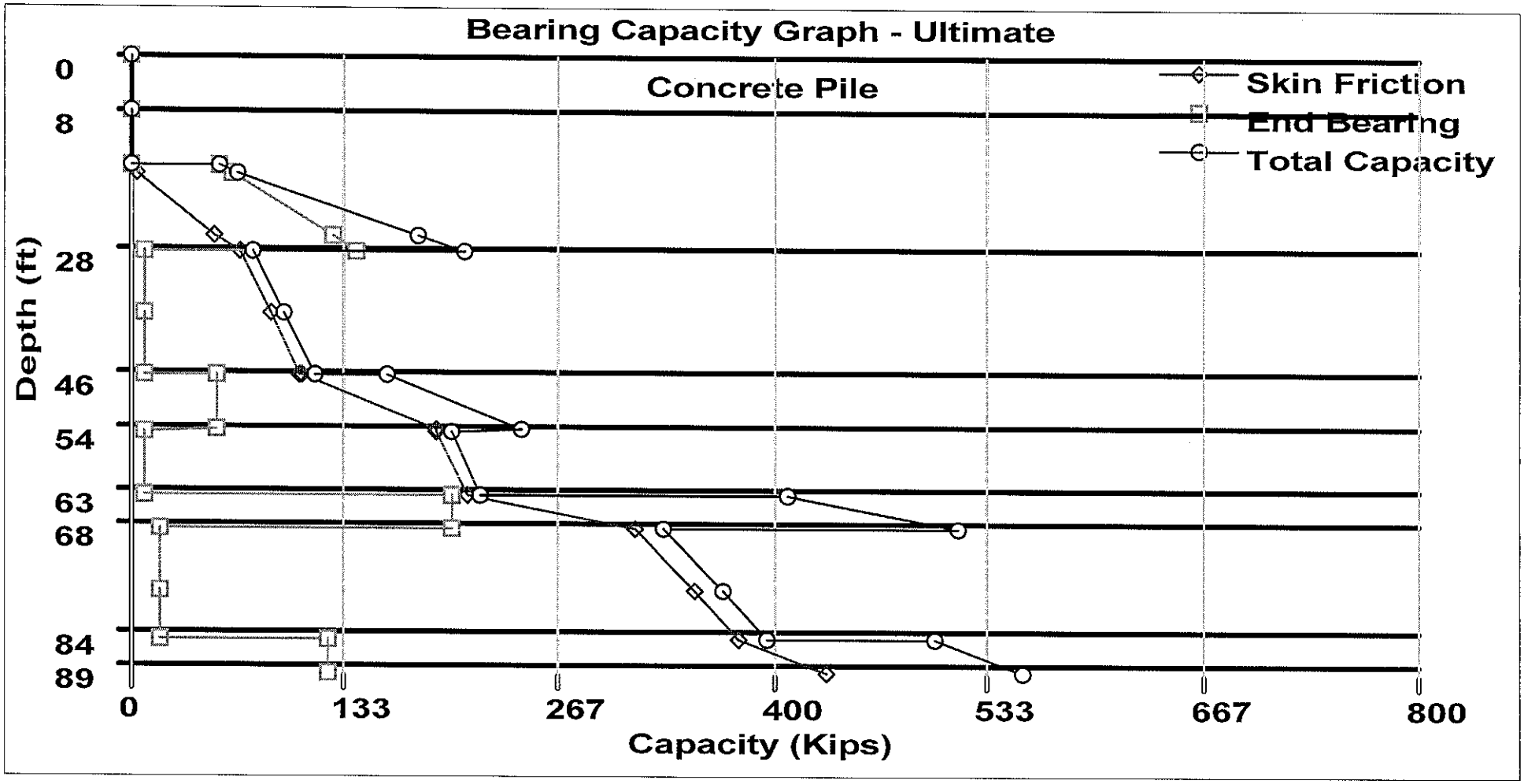

DRIVEN 1.2

GENERAL PROJECT INFORMATION

5/14/08

Filename: C:\PROGRA~1\DRIVEN\PRHEC24.DVN
Project Name: Piney Run @ HEC - Piers
Project Client: FHWA-EFLHD
Computed By: WWB
Project Manager:

Bridge over Piney Run @ HEC - Pier

PILE INFORMATION

(24" closed-end pipe pile)

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	8.00 ft
	- Long Term Scour:	8.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	20.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
3	Cohesive	18.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Steel
4	Cohesionless	8.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
5	Cohesive	9.00 ft	0.00%	110.00 pcf	250.00 psf	T-79 Steel
6	Cohesionless	5.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
7	Cohesive	16.00 ft	0.00%	110.00 pcf	500.00 psf	T-79 Steel
8	Cohesive	5.00 ft	0.00%	120.00 pcf	3400.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0 00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0 00	N/A	0.00 Kips
8.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
15.99 ft	Cohesionless	0 00 psf	0.00	N/A	0.00 Kips
16.00 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
17.01 ft	Cohesionless	489.89 psf	26.33	N/A	2.23 Kips
26.01 ft	Cohesionless	749.09 psf	26.33	N/A	33.75 Kips
27.99 ft	Cohesionless	806.11 psf	26.33	N/A	43.51 Kips
28.01 ft	Cohesive	N/A	N/A	241.61 psf	43 57 Kips
37.01 ft	Cohesive	N/A	N/A	243.07 psf	57.32 Kips
45.99 ft	Cohesive	N/A	N/A	244.51 psf	71.20 Kips
46.01 ft	Cohesionless	2009.06 psf	23.94	N/A	71.28 Kips
53.99 ft	Cohesionless	2218.94 psf	23.94	N/A	126.34 Kips
54.01 ft	Cohesive	N/A	N/A	245.81 psf	126.43 Kips
62.99 ft	Cohesive	N/A	N/A	247.26 psf	140.39 Kips
63.01 ft	Cohesionless	2858.29 psf	26.33	N/A	140.53 Kips
67.99 ft	Cohesionless	3001.71 psf	26.33	N/A	207.82 Kips
68.01 ft	Cohesive	N/A	N/A	482.02 psf	208.00 Kips
77.01 ft	Cohesive	N/A	N/A	495.52 psf	236.02 Kips
83.99 ft	Cohesive	N/A	N/A	500.00 psf	258.20 Kips
84.01 ft	Cohesive	N/A	N/A	1260 00 psf	258.31 Kips
88.99 ft	Cohesive	N/A	N/A	1260.00 psf	297.74 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
8.01 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
15.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
16.00 ft	Cohesionless	460.80 psf	47.20	157.08 Kips	44.11 Kips
17.01 ft	Cohesionless	518.98 psf	47.20	157.08 Kips	49.68 Kips
26.01 ft	Cohesionless	1037.38 psf	47.20	157.08 Kips	99.31 Kips
27.99 ft	Cohesionless	1151.42 psf	47.20	157.08 Kips	110.23 Kips
28.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
37.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
45.99 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
46.01 ft	Cohesionless	2009.33 psf	30.00	41.85 Kips	41.85 Kips
53.99 ft	Cohesionless	2429.07 psf	30.00	41.85 Kips	41.85 Kips
54.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
62.99 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
63.01 ft	Cohesionless	2858.58 psf	47.20	157.08 Kips	157.08 Kips
67.99 ft	Cohesionless	3145.42 psf	47.20	157.08 Kips	157.08 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
83.99 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
84.01 ft	Cohesive	N/A	N/A	N/A	96.13 Kips
88.99 ft	Cohesive	N/A	N/A	N/A	96.13 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0 01 ft	0.00 Kips	0 00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
15.99 ft	0 00 Kips	0.00 Kips	0.00 Kips
16.00 ft	0.00 Kips	44.11 Kips	44.11 Kips
17.01 ft	2.23 Kips	49.68 Kips	51.91 Kips
26.01 ft	33.75 Kips	99.31 Kips	133.06 Kips
27.99 ft	43.51 Kips	110.23 Kips	153.73 Kips
28.01 ft	43.57 Kips	7 07 Kips	50.64 Kips
37.01 ft	57.32 Kips	7.07 Kips	64 39 Kips
45.99 ft	71.20 Kips	7.07 Kips	78.27 Kips
46.01 ft	71.28 Kips	41.85 Kips	113.12 Kips
53.99 ft	126 34 Kips	41.85 Kips	168.19 Kips
54.01 ft	126.43 Kips	7 07 Kips	133.50 Kips
62.99 ft	140.39 Kips	7.07 Kips	147.45 Kips
63.01 ft	140.53 Kips	157.08 Kips	297.61 Kips
67.99 ft	207.82 Kips	157 08 Kips	364.90 Kips
68.01 ft	208.00 Kips	14.14 Kips	222.13 Kips
77.01 ft	236.02 Kips	14.14 Kips	250.16 Kips
83.99 ft	258.20 Kips	14.14 Kips	272.34 Kips
84.01 ft	258 31 Kips	96.13 Kips	354.44 Kips
88.99 ft	297.74 Kips	96.13 Kips	393.87 Kips

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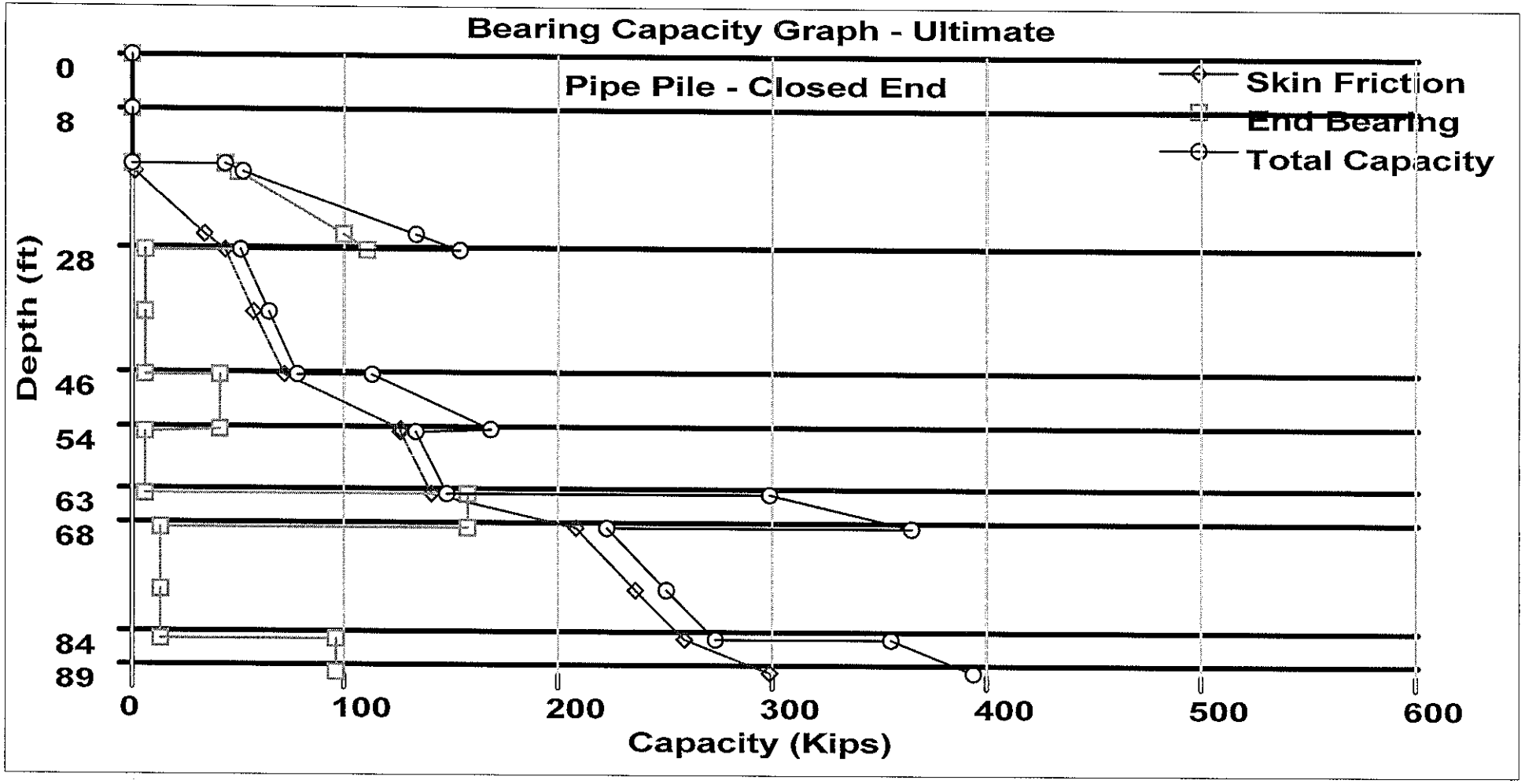
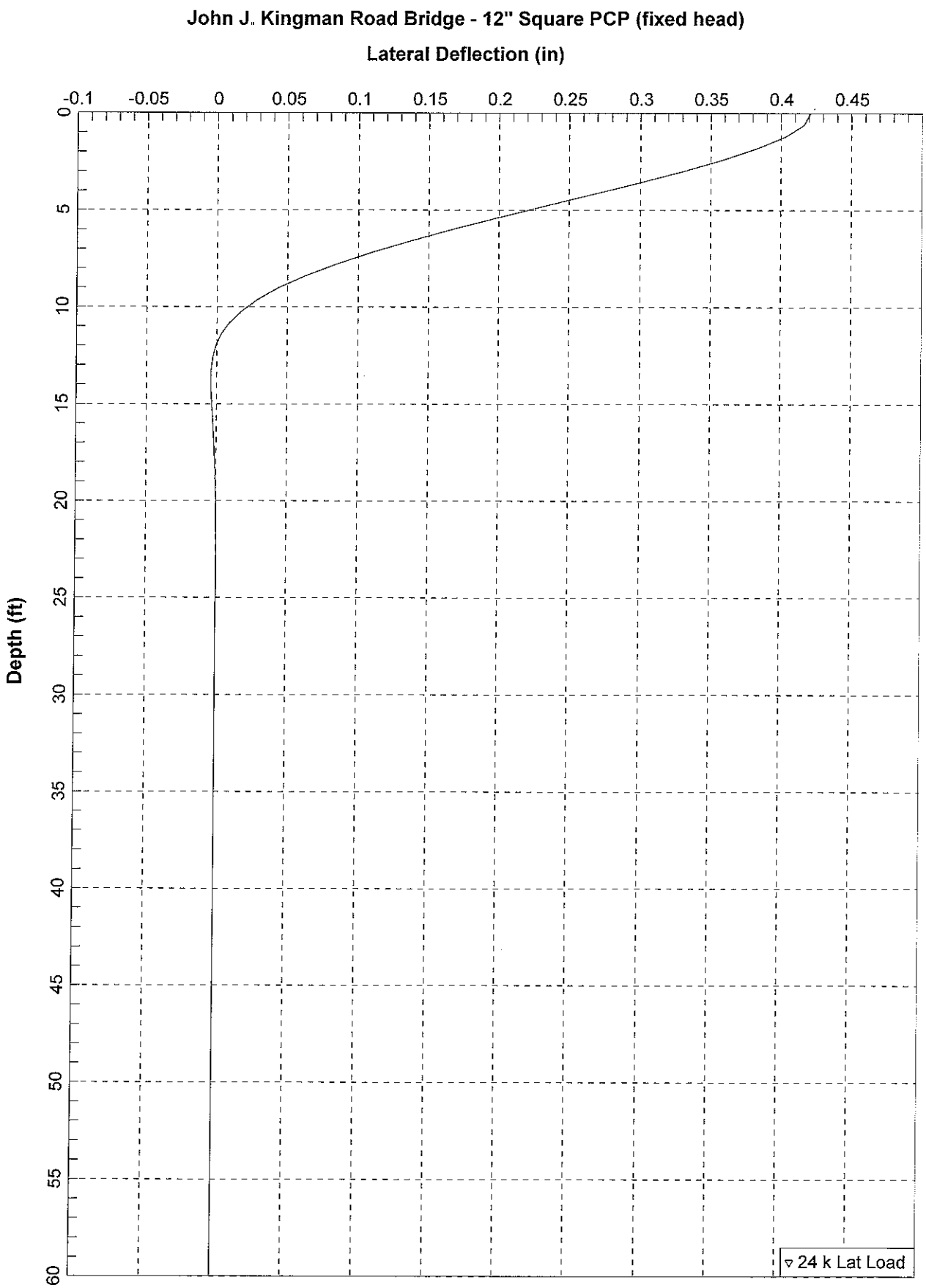


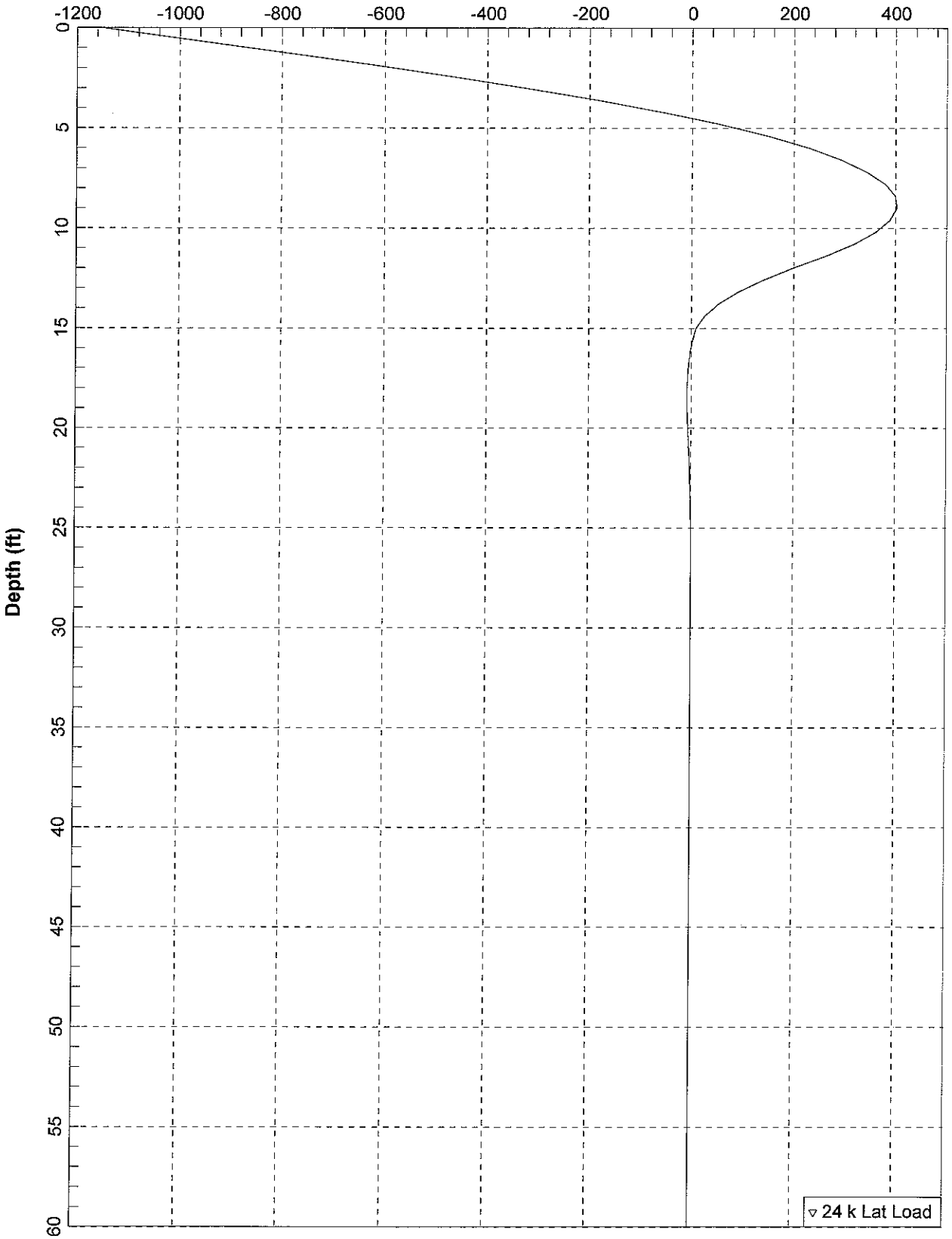
LATERAL PILE CAPACITY


John J. Kingman Road Bridge - 12" Square PCP (fixed head)
Lateral Deflection (in)
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
24 k Lat Load

JDP
10-11-07

John J. Kingman Road Bridge - 12" Square PCP (fixed head)

Unfactored Bending Moment (in-kips)



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LPILE Plus for Windows, Version 5.0 (5.0.7)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Will Bassett
HDR Engineering, Inc.

Path to file locations: C:\Program Files\Ensoft\LpileP5\
Name of input data file: JJK 12.lpd
Name of output file: JJK 12.lpo
Name of plot output file: JJK 12.lpp
Name of runtime file: JJK 12.lpr

Time and Date of Analysis

Date: October 15, 2007 Time: 14:59:57

Problem Title

John J. Kingman Road Bridge - 12" square PCP (fixed head)

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	12.00000000	1728.0000	144.0000	3600000.
2	720.0000	12.00000000	1728.0000	144.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 90.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 90.000 in
Distance from top of pile to bottom of layer = 185.000 in

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 185.000 in
Distance from top of pile to bottom of layer = 720.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 6 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	90.00	.06900
3	90.00	.06900
4	185.00	.06900
5	185.00	.06900
6	720.00	.06900

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	30.00	------	------
2	90.000	.00000	30.00	------	------
3	90.000	10.40000	.00	------	------
4	185.000	10.40000	.00	------	------
5	185.000	.00000	33.00	------	------
6	720.000	.00000	33.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

---

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Shear force at pile head = 24000.000 lbs
Slope at pile head = .000 in/in
Axial load at pile head = 180000.000 lbs

(Zero slope for this load indicates fixed-head condition)

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Specified shear force at pile head = 24000.000 lbs
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 180000.000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.421039	-1150632.	24000.0000	5.3969E-17	5245.2503	0.0000
7.200	.416245	-976969.	23810.0778	-.0012313	4642.2539	-52.7562
14.400	.403309	-804576.	23222.0735	-.0022622	4043.6652	-110.5784
21.600	.383669	-636708.	22245.3059	-.0030963	3460.7901	-160.7460
28.800	.358722	-476218.	20956.2949	-.0037404	2903.5331	-197.3126
36.000	.329808	-325242.	19441.9923	-.0042042	2379.3120	-223.3270
43.200	.298182	-185356.	17722.9753	-.0044997	1893.5959	-254.1777
50.400	.265012	-58367.9078	15810.4882	-.0046407	1452.6663	-277.0687
57.600	.231356	54344.1129	13687.7538	-.0046430	1438.6948	-312.5797
64.800	.198153	150770.	11406.8394	-.0045243	1773.5086	-321.0076
72.000	.166206	230330.	9174.1980	-.0043038	2049.7558	-299.1706
79.200	.136178	294034.	7126.5050	-.0040003	2270.9526	-269.6330
86.400	.108601	343320.	5311.3444	-.0036315	2442.0841	-234.5782
93.600	.083885	379931.	3324.5082	-.0032129	2569.2033	-317.3207
100.800	.062335	399521.	1063.8242	-.0027619	2637.2260	-310.6470
108.000	.044114	402408.	-1133.1783	-.0022978	2647.2514	-299.6314
115.200	.029246	389159.	-3233.0093	-.0018397	2601.2473	-283.6549
122.400	.017622	360622.	-5196.0580	-.0014058	2502.1584	-261.6364
129.600	.009003	317980.	-6970.1354	-.0010131	2354.0967	-231.1629
136.800	.003033	262878.	-8464.4372	-.0006770	2162.7695	-183.9209
144.000	-.000746	197847.	-8646.5884	-.0004103	1936.9674	133.3234
151.200	-.002876	139430.	-7476.5031	-.0002152	1734.1331	191.7003
158.400	-.003844	90742.6564	-6043.8286	-8.1951E-05	1565.0787	206.2648
165.600	-.004056	52611.6261	-4548.5150	1.0085E-06	1432.6793	209.1001
172.800	-.003829	25241.4258	-3053.6499	4.6062E-05	1337.6438	206.1402
180.000	-.003392	8519.6733	-1591.5255	6.5600E-05	1279.5822	200.0054
187.200	-.002885	2153.4237	-748.1586	7.1777E-05	1257.4772	34.2631
194.400	-.002359	-2439.8556	-518.4429	7.1611E-05	1258.4717	29.5468
201.600	-.001853	-5497.7687	-324.1733	6.7017E-05	1269.0895	24.4169
208.800	-.001394	-7281.6604	-166.9173	5.9622E-05	1275.2835	19.2653
216.000	-.000995	-8055.9171	-45.7366	5.0746E-05	1277.9719	14.3960
223.200	-.000663	-8071.8014	42.1774	4.1413E-05	1278.0271	10.0246
230.400	-.000399	-7555.9042	100.8869	3.2369E-05	1276.2358	6.2836
237.600	-.000197	-6702.9306	135.1478	2.4117E-05	1273.2741	3.2333
244.800	-5.13E-05	-5672.2875	149.9371	1.6956E-05	1269.6954	.8748086
252.000	4.72E-05	-4587.7859	150.0789	1.1018E-05	1265.9298	-.8354239
259.200	.000107	-3539.7110	139.9743	6.3147E-06	1262.2907	-1.9714
266.400	.000138	-2588.5238	123.4280	2.7683E-06	1258.9879	-2.6248
273.600	.000147	-1769.5229	103.5602	2.4627E-07	1256.1442	-2.8940
280.800	.000142	-1097.8946	82.7889	-1.4131E-06	1253.8121	-2.8758
288.000	.000127	-573.6994	62.8653	-2.3805E-06	1251.9920	-2.6586
295.200	.000107	-186.4641	44.9460	-2.8204E-06	1250.6474	-2.3190
302.400	8.63E-05	80.8337	29.6872	-2.8815E-06	1250.2807	-1.9196

309.600	6.59E-05	248.5000	17.3472	-2.6909E-06	1250.8628	-1.5082
316.800	4.75E-05	337.6077	7.8886	-2.3517E-06	1251.1722	-1.1192
324.000	3.20E-05	368.1912	1.0717	-1.9433E-06	1251.2784	-.7744097
331.200	1.96E-05	358.0770	-3.4648	-1.5230E-06	1251.2433	-.4857373
338.400	1.01E-05	322.2451	-6.1386	-1.1293E-06	1251.1189	-.2569687
345.600	3.29E-06	272.6086	-7.3736	-7.8505E-07	1250.9466	-.0861012
352.800	-1.22E-06	218.0997	-7.5658	-5.0107E-07	1250.7573	.0327227
360.000	-3.92E-06	164.9599	-7.0608	-2.7939E-07	1250.5728	.1075466
367.200	-5.25E-06	117.1480	-6.1435	-1.1614E-07	1250.4068	.1472708
374.400	-5.59E-06	76.7948	-5.0349	-3.9022E-09	1250.2666	.1606683
381.600	-5.30E-06	44.6555	-3.8959	6.6382E-08	1250.1551	.1557190
388.800	-4.64E-06	20.5217	-2.8341	1.0410E-07	1250.0713	.1392195
396.000	-3.80E-06	3.5742	-1.9131	1.1804E-07	1250.0124	.1166144
403.200	-2.94E-06	-7.3333	-1.1621	1.1587E-07	1250.0255	.0919944
410.400	-2.13E-06	-13.4608	-.5854098	1.0384E-07	1250.0467	.0682070
417.600	-1.44E-06	-16.0323	-.1705338	8.6767E-08	1250.0557	.0470364
424.800	-8.84E-07	-16.1414	.1046855	6.8148E-08	1250.0560	.0294134
432.000	-4.61E-07	-14.7015	.2668370	5.0299E-08	1250.0510	.0156287
439.200	-1.60E-07	-12.4293	.3430042	3.4599E-08	1250.0432	.0055289
446.400	3.73E-08	-9.8519	.3581767	2.1705E-08	1250.0342	-.0013143
453.600	1.53E-07	-7.3279	.3337544	1.1763E-08	1250.0254	-.0054697
460.800	2.07E-07	-5.0763	.2869004	4.5841E-09	1250.0176	-.0075453
468.000	2.19E-07	-3.2084	.2305063	-2.1025E-10	1250.0111	-.0081197
475.200	2.04E-07	-1.7565	.1735597	-3.0834E-09	1250.0061	-.0076988
482.400	1.74E-07	-.7011195	.1217388	-4.5057E-09	1250.0024	-.0066959
489.600	1.39E-07	.0082077	.0780989	-4.9067E-09	1250.0000	-.0054263
496.800	1.04E-07	.4362227	.0437552	-4.6495E-09	1250.0015	-.0041136
504.000	7.18E-08	.6503337	.0184990	-4.0207E-09	1250.0023	-.0029020
511.200	4.56E-08	.7130295	.0013134	-3.2317E-09	1250.0025	-.0018718
518.400	2.53E-08	.6776236	-.0092237	-2.4269E-09	1250.0024	-.0010552
525.600	1.07E-08	.5864994	-.0146475	-1.6954E-09	1250.0020	-.0004514
532.800	9.00E-10	.4710947	-.0164118	-1.0833E-09	1250.0016	-3.8682E-05
540.000	-4.94E-09	.3529781	-.0157755	-6.0645E-10	1250.0012	.0002154
547.200	-7.83E-09	.2454988	-.0137515	-2.6011E-10	1250.0009	.0003468
554.400	-8.68E-09	.1556306	-.0110987	-2.7974E-11	1250.0005	.0003901
561.600	-8.24E-09	.0857507	-.0083432	1.1171E-10	1250.0003	.0003753
568.800	-7.07E-09	.0351995	-.0058148	1.8171E-10	1250.0001	.0003270
576.000	-5.62E-09	.0015459	-.0036896	2.0297E-10	1250.0000	.0002634
583.200	-4.15E-09	-.0184570	-.0020314	1.9319E-10	1250.0001	.0001973
590.400	-2.84E-09	-.0282063	-.0008293	1.6618E-10	1250.0001	.0001367
597.600	-1.76E-09	-.0308290	-2.8306E-05	1.3202E-10	1250.0001	8.5827E-05
604.800	-9.36E-10	-.0289561	.0004474	9.7421E-11	1250.0001	4.6305E-05
612.000	-3.55E-10	-.0246394	.0006782	6.6405E-11	1250.0001	1.7809E-05
619.200	2.01E-11	-.0193625	.0007386	4.0941E-11	1250.0001	-1.0180E-06
626.400	2.34E-10	-.0141093	.0006916	2.1571E-11	1250.0000	-1.2037E-05
633.600	3.31E-10	-.0094590	.0005863	7.9315E-12	1250.0000	-1.7213E-05
640.800	3.48E-10	-.0056867	.0004583	-8.3332E-13	1250.0000	-1.8360E-05
648.000	3.19E-10	-.0028577	.0003310	-5.7780E-12	1250.0000	-1.7001E-05
655.200	2.65E-10	-.0009058	.0002182	-7.9560E-12	1250.0000	-1.4318E-05
662.400	2.04E-10	.0003053	.0001265	-8.3034E-12	1250.0000	-1.1154E-05
669.600	1.46E-10	.0009377	5.7390E-05	-7.5841E-12	1250.0000	-8.0504E-06
676.800	9.49E-11	.0011514	9.2974E-06	-6.3751E-12	1250.0000	-5.3086E-06
684.000	5.38E-11	.0010881	-2.0772E-05	-5.0791E-12	1250.0000	-3.0440E-06
691.200	2.18E-11	.0008654	-3.6214E-05	-3.9486E-12	1250.0000	-1.2452E-06
698.400	-3.07E-12	.0005769	-4.0057E-05	-3.1140E-12	1250.0000	1.7763E-07
705.600	-2.31E-11	.0002967	-3.4553E-05	-2.6084E-12	1250.0000	1.3513E-06
712.800	-4.06E-11	8.6075E-05	-2.1032E-05	-2.3869E-12	1250.0000	2.4046E-06
720.000	-5.75E-11	0.0000	0.0000	-2.3371E-12	1250.0000	3.4376E-06

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.42103938	in
Computed slope at pile head	=	5.396917E-17	
Maximum bending moment	=	-1150632.	lbs-in
Maximum shear force	=	24000.00000	lbs
Depth of maximum bending moment	=	0.00000	in
Depth of maximum shear force	=	0.00000	in
Number of iterations	=	19	
Number of zero deflection points	=	7	

Summary of Pile-Head Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = pile-head moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = pile-head shear force lbs
Type 4 = Deflection and Moment, S = pile-head slope, radians
Type 5 = Deflection and Slope, R = rotational stiffness of pile-headin-lbs/rad

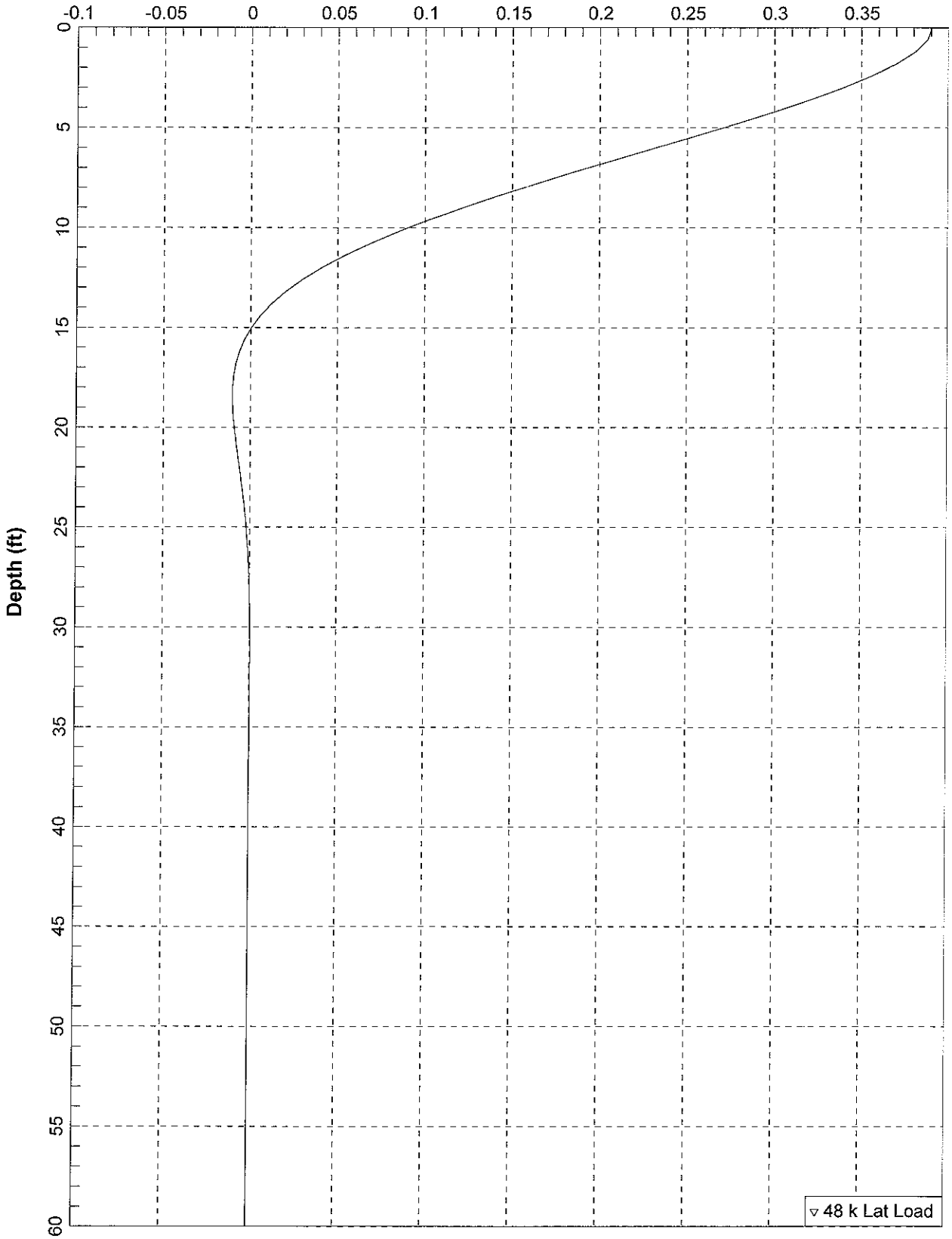
Load Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
2	V= 24000.	S= 0.000	180000.	.4210394	-1150632.	24000.0000

The analysis ended normally.

JDP
10-11-07

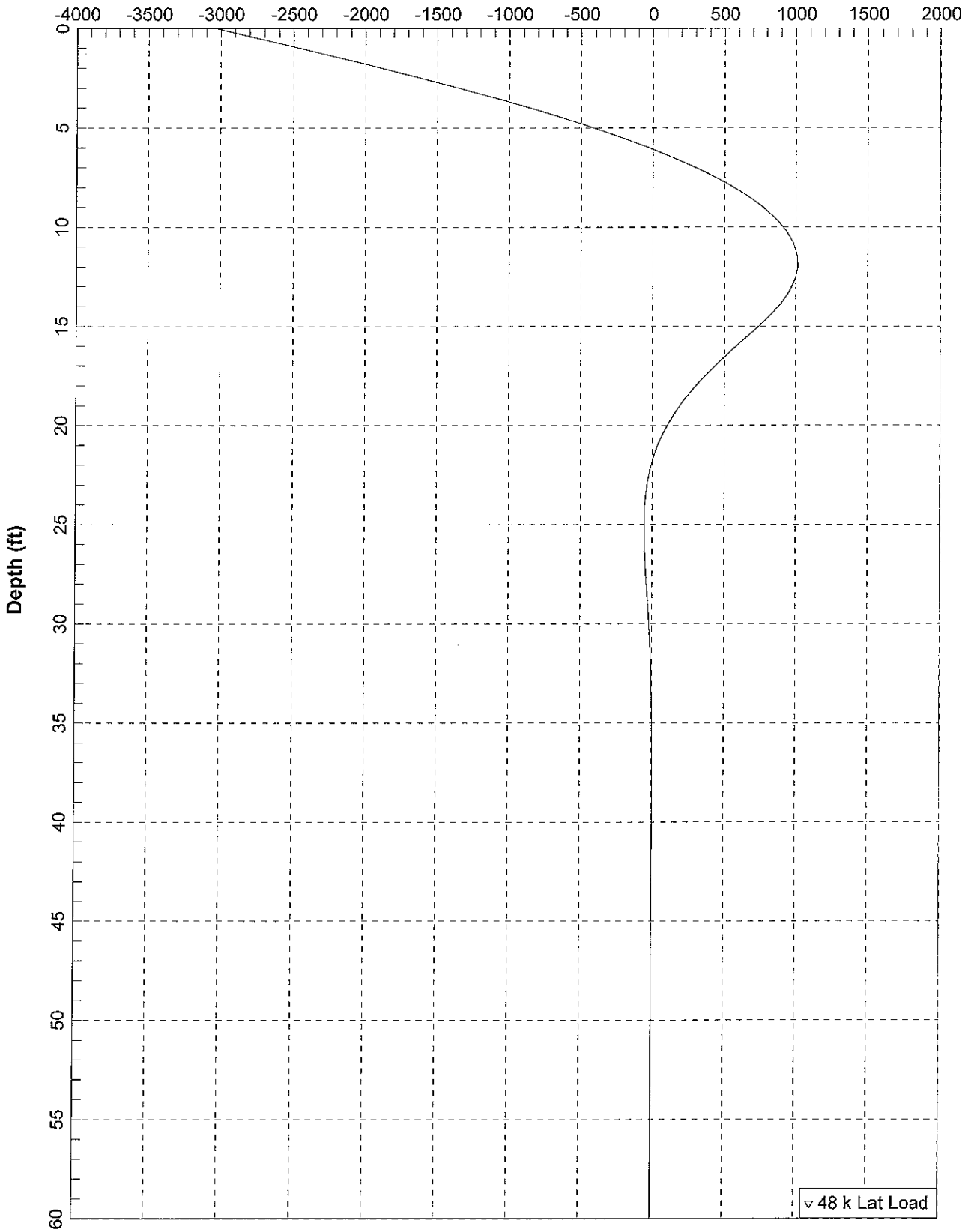
John J. Kingman Road Bridge - 18" Square PCP (fixed head)

Lateral Deflection (in)



John J. Kingman Road Bridge - 18" Square PCP (fixed head)

Unfactored Bending Moment (in-kips)



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LPILE Plus for Windows, Version 5.0 (5.0.7)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Will Bassett
HDR Engineering, Inc.

Path to file locations: C:\Program Files\Ensoft\LpileP5\
Name of input data file: JJK 18.lpd
Name of output file: JJK 18.lpo
Name of plot output file: JJK 18.lpp
Name of runtime file: JJK 18.lpr

Time and Date of Analysis

Date: October 15, 2007 Time: 15: 9:19

Problem Title

John J. Kingman Road Bridge - 18" square PCP (fixed head)

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	18.00000000	8748.0000	324.0000	3600000.
2	720.0000	18.00000000	8748.0000	324.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 90.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 90.000 in
Distance from top of pile to bottom of layer = 185.000 in

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 185.000 in
Distance from top of pile to bottom of layer = 720.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 6 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	90.00	.06900
3	90.00	.06900
4	185.00	.06900
5	185.00	.06900
6	720.00	.06900

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	30.00	------	------
2	90.000	.00000	30.00	------	------
3	90.000	10.40000	.00	------	------
4	185.000	10.40000	.00	------	------
5	185.000	.00000	33.00	------	------
6	720.000	.00000	33.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

---

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Shear force at pile head = 48000.000 lbs
Slope at pile head = .000 in/in
Axial load at pile head = 340000.000 lbs

(Zero slope for this load indicates fixed-head condition)

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Specified shear force at pile head = 48000.000 lbs
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 340000.000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.390433	-3025425.	48000.0000	1.1565E-17	4161.9604	0.0000
7.200	.387942	-2678979.	47773.9538	-.0006521	3805.5338	-62.7906
14.400	.381043	-2334288.	47065.3653	-.0012252	3450.9135	-134.0395
21.600	.370300	-1995239.	45862.9593	-.0017201	3102.0980	-199.9621
28.800	.356274	-1665440.	44219.6346	-.0021385	2762.7982	-256.5170
36.000	.339505	-1348006.	42196.1762	-.0024830	2436.2204	-305.5548
43.200	.320518	-1045658.	39850.0037	-.0027566	2125.1627	-346.1597
50.400	.299810	-760670.	37243.8908	-.0029631	1831.9647	-377.7605
57.600	.277849	-494839.	34443.5814	-.0031066	1558.4760	-400.1032
64.800	.255074	-249472.	31515.6159	-.0031917	1306.0412	-413.2206
72.000	.231889	-25387.1811	28525.3829	-.0032231	1075.5012	-417.3997
79.200	.208661	177074.	25535.4065	-.0032058	1231.5575	-413.1493
86.400	.185725	358018.	22603.8695	-.0031446	1417.7143	-401.1666
93.600	.163379	517966.	19648.1735	-.0030445	1582.2693	-419.8601
100.800	.141885	655858.	16609.1479	-.0029103	1724.1335	-424.3137
108.000	.121470	771386.	13546.4736	-.0027472	1842.9901	-426.4292
115.200	.102325	864377.	10477.5718	-.0025602	1938.6596	-426.0436
122.400	.084604	934798.	7421.1541	-.0023545	2011.1091	-422.9614
129.600	.068421	982769.	4397.5232	-.0021353	2060.4623	-416.9361
136.800	.053855	1008577.	1429.0572	-.0019077	2087.0132	-407.6378
144.000	.040950	1012688.	-1458.9665	-.0016766	2091.2426	-394.5910
151.200	.029712	995776.	-4236.8656	-.0014470	2073.8440	-377.0476
158.400	.020113	958762.	-6867.5057	-.0012236	2035.7629	-353.6858
165.600	.012092	902875.	-9299.0583	-.0010108	1978.2665	-321.7455
172.800	.005557	829804.	-11441.8043	-.0008127	1903.0905	-273.4617
180.000	.000389	742092.	-12952.4539	-.0006330	1812.8520	-146.1632
187.200	-.003558	646388.	-13320.4202	-.0004743	1714.3909	43.9503
194.400	-.006441	552600.	-12860.7529	-.0003373	1617.9016	83.7351
201.600	-.008415	462844.	-12145.8751	-.0002212	1525.5601	114.8421
208.800	-.009626	378783.	-11237.0290	-.0001250	1439.0769	137.6152
216.000	-.010215	301643.	-10192.1067	-4.7196E-05	1359.7151	152.6410
223.200	-.010306	232247.	-9064.1248	1.3834E-05	1288.3204	160.6873
230.400	-.010015	171052.	-7900.1327	5.9936E-05	1225.3620	162.6438
237.600	-.009443	118192.	-6740.5280	9.3000E-05	1170.9795	159.4686
244.800	-.008676	73532.9724	-5618.7372	.0001149	1125.0339	152.1400
252.000	-.007788	36719.6386	-4561.2140	.0001275	1087.1601	141.6165
259.200	-.006840	7227.1532	-3587.7001	.0001325	1056.8181	128.8040
266.400	-.005880	-15592.1760	-2711.6949	.0001316	1065.4240	114.5307
273.600	-.004945	-32465.5049	-1941.0778	.0001261	1082.7834	99.5296
280.800	-.004064	-44161.0515	-1278.8327	.0001173	1094.8159	84.4274
288.000	-.003255	-51455.1659	-723.8279	.0001064	1102.3201	69.7406
295.200	-.002532	-55105.1292	-271.6098	9.4223E-05	1106.0752	55.8755
302.400	-.001899	-55827.6651	84.8218	8.1542E-05	1106.8186	43.1333

309.600	-.001357	-54282.9276	354.2863	6.8955E-05	1105.2293	31.7180
316.800	-.000906	-51063.5488	546.7613	5.6913E-05	1101.9172	21.7473
324.000	-.000538	-46688.2120	672.8024	4.5739E-05	1097.4159	13.2641
331.200	-.000247	-41599.1324	743.0521	3.5647E-05	1092.1802	6.2497
338.400	-2.45E-05	-36162.7884	767.8397	2.6758E-05	1086.5872	.6357922
345.600	.000138	-30673.2458	756.8717	1.9117E-05	1080.9396	-3.6825
352.800	.000251	-25357.4348	719.0065	1.2712E-05	1075.4706	-6.8357
360.000	.000321	-20381.7924	662.1068	7.4839E-06	1070.3516	-8.9698
367.200	.000359	-15859.7379	592.9600	3.3410E-06	1065.6993	-10.2376
374.400	.000370	-11859.5259	517.2561	1.7240E-07	1061.5839	-10.7912
381.600	.000361	-8412.0944	439.6125	-2.1449E-06	1058.0371	-10.7764
388.800	.000339	-5518.6051	363.6354	-3.7373E-06	1055.0603	-10.3283
396.000	.000307	-3157.4465	292.0077	-4.7291E-06	1052.6311	-9.5683
403.200	.000271	-1290.5406	226.5937	-5.2376E-06	1050.7104	-8.6023
410.400	.000232	131.1463	168.5542	-5.3701E-06	1049.5176	-7.5198
417.600	.000193	1162.9316	118.4633	-5.2222E-06	1050.5791	-6.3943
424.800	.000157	1862.5854	76.4237	-4.8763E-06	1051.2990	-5.2834
432.000	.000123	2287.3066	42.1741	-4.4019E-06	1051.7359	-4.2304
439.200	9.32E-05	2491.4446	15.1880	-3.8557E-06	1051.9459	-3.2658
446.400	6.75E-05	2524.8907	-5.2407	-3.2822E-06	1051.9803	-2.4089
453.600	4.60E-05	2432.0487	-19.9231	-2.7156E-06	1051.8848	-1.6696
460.800	2.84E-05	2251.2937	-29.7152	-2.1802E-06	1051.6989	-1.0504
468.000	1.46E-05	2014.8241	-35.4694	-1.6926E-06	1051.4556	-.5479530
475.200	4.04E-06	1748.8211	-37.9981	-1.2623E-06	1051.1819	-.1544595
482.400	-3.61E-06	1473.8321	-38.0478	-8.9395E-07	1050.8990	.1406403
489.600	-8.84E-06	1205.3090	-36.2828	-5.8770E-07	1050.6227	.3496604
496.800	-1.21E-05	954.2378	-33.2756	-3.4083E-07	1050.3644	.4856606
504.000	-1.37E-05	727.8091	-29.5052	-1.4856E-07	1050.1315	.5616722
511.200	-1.42E-05	530.0902	-25.3588	-4.7637E-09	1049.9281	.5901138
518.400	-1.38E-05	362.6661	-21.1378	9.7289E-08	1049.7558	.5823778
525.600	-1.28E-05	225.2295	-17.0664	1.6449E-07	1049.6144	.5485656
532.800	-1.14E-05	116.1045	-13.3011	2.0351E-07	1049.5022	.4973476
540.000	-9.88E-06	32.6970	-9.9413	2.2052E-07	1049.4164	.4359255
547.200	-8.27E-06	-28.1304	-7.0397	2.2104E-07	1049.4117	.3700719
554.400	-6.70E-06	-69.7575	-4.6123	2.0985E-07	1049.4545	.3042279
561.600	-5.25E-06	-95.5744	-2.6471	1.9095E-07	1049.4810	.2416389
568.800	-3.95E-06	-108.8113	-1.1130	1.6759E-07	1049.4947	.1845124
576.000	-2.83E-06	-112.4221	.0343148	1.4230E-07	1049.4984	.1341859
583.200	-1.90E-06	-109.0139	.8460384	1.1699E-07	1049.4949	.0912929
590.400	-1.15E-06	-100.8120	1.3760	9.3002E-08	1049.4864	.0559201
597.600	-5.63E-07	-89.6547	1.6772	7.1229E-08	1049.4750	.0277510
604.800	-1.24E-07	-77.0087	1.7994	5.2178E-08	1049.4619	.0061911
612.000	1.88E-07	-63.9987	1.7874	3.6059E-08	1049.4486	-.0095257
619.200	3.95E-07	-51.4466	1.6802	2.2862E-08	1049.4356	-.0202500
626.400	5.18E-07	-39.9155	1.5107	1.2418E-08	1049.4238	-.0268492
633.600	5.74E-07	-29.7539	1.3054	4.4543E-09	1049.4133	-.0301555
640.800	5.82E-07	-21.1389	1.0855	-1.3634E-09	1049.4045	-.0309307
648.000	5.54E-07	-14.1156	.8667468	-5.3934E-09	1049.3972	-.0298428
655.200	5.04E-07	-8.6314	.6604784	-7.9936E-09	1049.3916	-.0274540
662.400	4.39E-07	-4.5656	.4744640	-9.5022E-09	1049.3874	-.0242167
669.600	3.67E-07	-1.7526	.3135689	-1.0224E-08	1049.3845	-.0204764
676.800	2.92E-07	-.0001035	.1805262	-1.0425E-08	1049.3827	-.0164799
684.000	2.17E-07	.8980466	.0766088	-1.0322E-08	1049.3836	-.0123861
691.200	1.43E-07	1.1536	.0022099	-1.0088E-08	1049.3839	-.0082803
698.400	7.18E-08	.9792575	-.0426831	-9.8438E-09	1049.3837	-.0041900
705.600	1.73E-09	.5871587	-.0581338	-9.6647E-09	1049.3833	-.0001019
712.800	-6.74E-08	.1894501	-.0440307	-9.5760E-09	1049.3829	.0040194
720.000	-1.36E-07	0.0000	0.0000	-9.5543E-09	1049.3827	.0082114

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .39043256 in
Computed slope at pile head       =   1.156482E-17
Maximum bending moment            =      -3025425. lbs-in
Maximum shear force               =    48000.00000 lbs
Depth of maximum bending moment   =        0.00000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             16
Number of zero deflection points  =              5
```

Summary of Pile-Head Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = pile-head moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = pile-head shear force lbs
Type 4 = Deflection and Moment,     S = pile-head slope, radians
Type 5 = Deflection and Slope,      R = rotational stiffness of pile-headin-lbs/rad
```

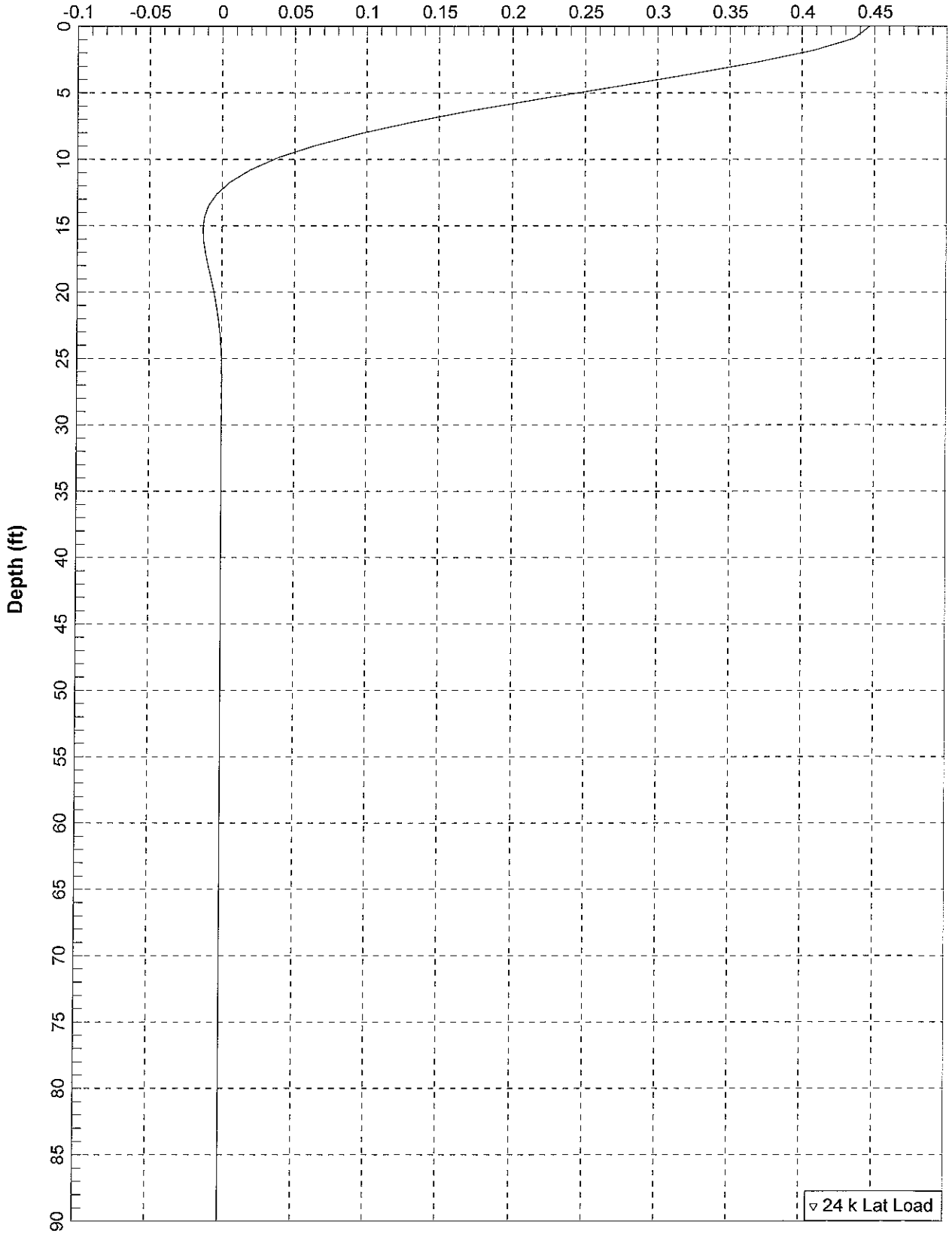
Load Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
2	V= 48000.	S= 0.000	340000.	.3904326	-3025425.	48000.0000

The analysis ended normally.

JDP
10-11-07

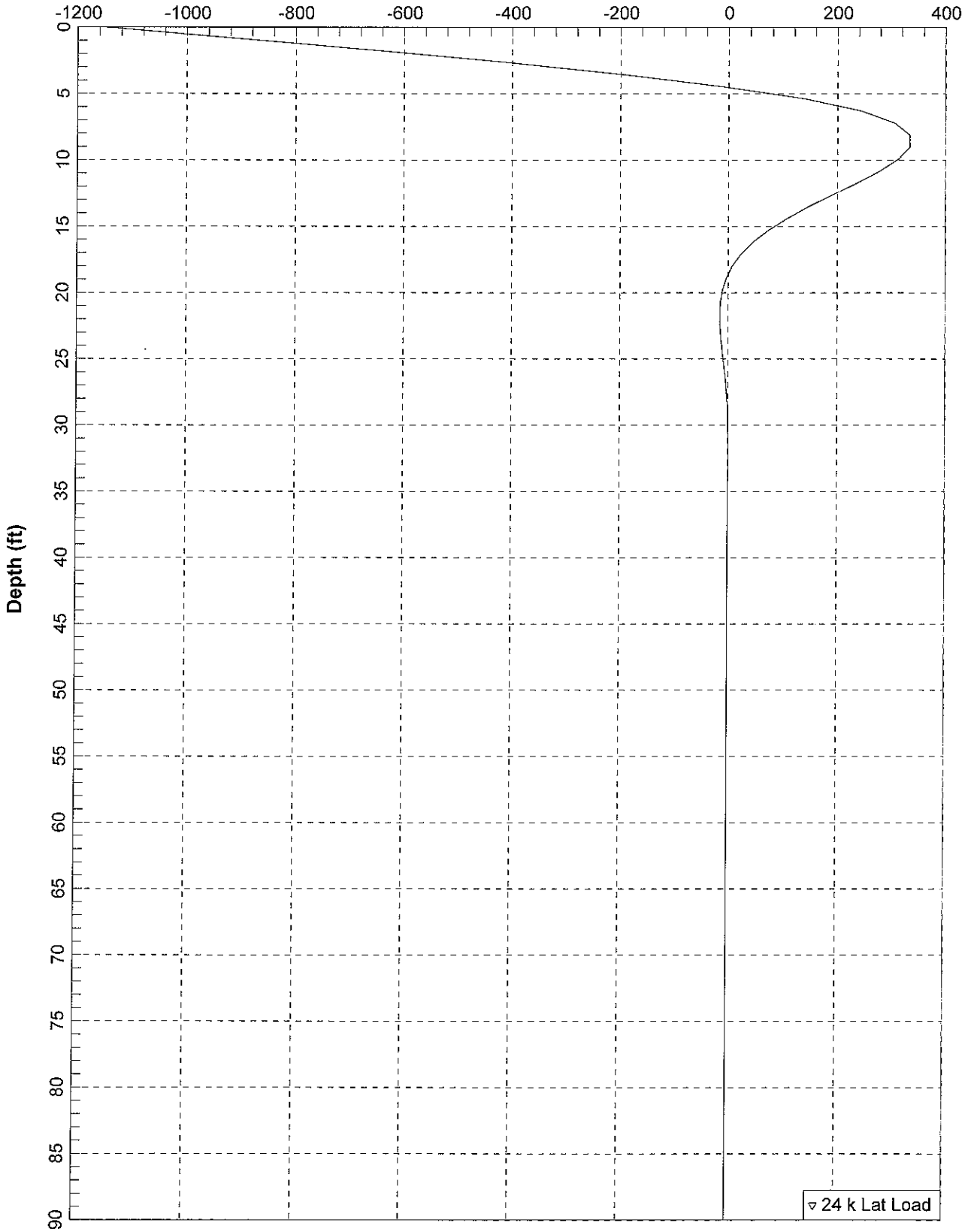
Piney Run Bridge at HEC - 12" Square PCP (abutments; fixed head)

Lateral Deflection (in)



Piney Run Bridge at HEC- 12" Square PCP (abutments; fixed head)

Unfactored Bending Moment (in-kips)



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LPILE Plus for Windows, Version 5.0 (5.0.7)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Will Bassett
HDR Engineering, Inc.

Path to file locations:	C:\Program Files\Ensoft\LpileP5\
Name of input data file:	PR HEC 12.lpd
Name of output file:	PR HEC 12.lpo
Name of plot output file:	PR HEC 12.lpp
Name of runtime file:	PR HEC 12.lpr

Time and Date of Analysis

Date: October 15, 2007 Time: 15:37:56

Problem Title

Piney Run Bridge at HEC - 12" square PCP (abutments;fixed head)

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 1080.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	12.00000000	1728.0000	144.0000	3600000.
2	1080.0000	12.00000000	1728.0000	144.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 60.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 60.000 in
Distance from top of pile to bottom of layer = 300.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 300.000 in
Distance from top of pile to bottom of layer = 900.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 900.000 in
Distance from top of pile to bottom of layer = 1080.000 in

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	60.00	.06900
3	60.00	.03500
4	300.00	.03500
5	300.00	.02900
6	900.00	.02900
7	900.00	.03500
8	1080.00	.03500

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	30.00	------	------
2	60.000	.00000	30.00	------	------
3	60.000	.00000	30.00	------	------
4	300.000	.00000	30.00	------	------
5	300.000	1.70000	.00	------	------
6	900.000	1.70000	.00	------	------
7	900.000	13.90000	.00	------	------
8	1080.000	13.90000	.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Shear force at pile head = 24000.000 lbs
Slope at pile head = .000 in/in
Axial load at pile head = 160000.000 lbs

(Zero slope for this load indicates fixed-head condition)

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Specified shear force at pile head = 24000.000 lbs
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 160000.000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.446441	-1148064.	24000.0000	-1.2850E-17	5097.4443	0.0000
10.800	.435678	-887142.	23544.4213	-.0017667	4191.4648	-84.3664
21.600	.408281	-633399.	22194.4497	-.0030866	3310.4126	-165.6283
32.400	.369007	-397075.	20115.2736	-.0039811	2489.8420	-219.4043
43.200	.322289	-185150.	17493.5515	-.0044865	1753.9940	-266.0998
54.000	.272099	-3708.4629	14361.0644	-.0046504	1123.9877	-313.9904
64.800	.221840	141121.	10704.7413	-.0045312	1601.1133	-363.1065
75.600	.174226	243174.	6950.0113	-.0041976	1955.4640	-332.2139
86.400	.131172	305748.	3614.1664	-.0037211	2172.7349	-285.5352
97.200	.093851	334100.	832.2518	-.0031656	2271.1793	-229.6342
108.000	.062794	334665.	-1329.0066	-.0025851	2273.1416	-170.5988
118.800	.038012	314327.	-2863.3282	-.0020218	2202.5253	-113.5348
129.600	.019124	279804.	-3812.7441	-.0015060	2082.6532	-62.2830
140.400	.005482	237177.	-4253.4769	-.0010573	1934.6418	-19.3342
151.200	-.003713	191583.	-4281.7601	-.0006851	1776.3295	14.0966
162.000	-.009315	147058.	-4001.0657	-.0003911	1621.7306	37.8839
172.800	-.012161	106512.	-3511.7043	-.0001710	1480.9429	52.7386
183.600	-.013009	71796.5751	-2903.2962	-1.6216E-05	1360.4048	59.9296
194.400	-.012511	43856.3938	-2250.2036	8.4178E-05	1263.3903	61.0135
205.200	-.011191	22901.2590	-1671.9147	.0001421	1190.6294	46.0770
216.000	-.009441	7251.8464	-1202.1731	.0001683	1136.2911	40.9121
226.800	-.007555	-3647.3295	-795.6344	.0001714	1123.7754	34.3728
237.600	-.005738	-10526.3212	-462.3598	.0001591	1147.6608	27.3447
248.400	-.004118	-14184.2439	-203.9183	.0001377	1160.3620	20.5148
259.200	-.002764	-15406.7668	-15.5545	.0001120	1164.6068	14.3674
270.000	-.001699	-14907.2595	111.7031	8.5676E-05	1162.8724	9.1988
280.800	-.000914	-13290.0766	189.1529	6.1199E-05	1157.2572	5.1437
291.600	-.000377	-11033.0603	228.8406	4.0085E-05	1149.4203	2.2058
302.400	-4.79E-05	-8485.6549	248.0383	2.3142E-05	1140.5752	1.3493
313.200	.000123	-5755.4106	236.6811	1.0780E-05	1131.0952	-3.4525
324.000	.000185	-3410.5977	189.8878	2.8233E-06	1122.9535	-5.2129
334.800	.000183	-1663.5907	133.8138	-1.5814E-06	1116.8875	-5.1711
345.600	.000151	-514.7551	82.9382	-3.4723E-06	1112.8985	-4.2503
356.400	.000108	139.8746	43.4771	-3.7978E-06	1111.5968	-3.0574
367.200	6.88E-05	437.4743	16.5001	-3.2966E-06	1112.6301	-1.9384

378.000	3.73E-05	507.6693	.3597904	-2.4761E-06	1112.8739	-1.0506
388.800	1.53E-05	453.8033	-7.6408	-1.6415E-06	1112.6868	-.4310227
399.600	1.82E-06	348.3014	-10.2452	-9.4526E-07	1112.3205	-.0512819
410.400	-5.12E-06	235.7731	-9.7424	-4.3826E-07	1111.9298	.1444065
421.200	-7.65E-06	139.3811	-7.7988	-1.1260E-07	1111.5951	.2155057
432.000	-7.56E-06	67.7074	-5.4852	6.7164E-08	1111.3462	.2129519
442.800	-6.20E-06	20.6694	-3.3923	1.4388E-07	1111.1829	.1746197
453.600	-4.45E-06	-6.0630	-1.7724	1.5656E-07	1111.1322	.1253651
464.400	-2.81E-06	-18.1546	-.6670901	1.3554E-07	1111.1741	.0793144
475.200	-1.52E-06	-20.9405	-.0073641	1.0160E-07	1111.1838	.0428571
486.000	-6.20E-07	-18.6648	.3183771	6.7220E-08	1111.1759	.0174654
496.800	-6.87E-08	-14.2959	.4231480	3.8609E-08	1111.1607	.0019367
507.600	2.14E-07	-9.6582	.4010025	1.7815E-08	1111.1446	-.0060377
518.400	3.16E-07	-5.6958	.3202939	4.4870E-09	1111.1309	-.0089083
529.200	3.11E-07	-2.7554	.2248355	-2.8491E-09	1111.1207	-.0087691
540.000	2.55E-07	-.8295381	.1387429	-5.9611E-09	1111.1140	-.0071739
550.800	1.82E-07	.2620465	.0722457	-6.4537E-09	1111.1120	-.0051404
561.600	1.15E-07	.7532735	.0269634	-5.5723E-09	1111.1137	-.0032453
572.400	6.20E-08	.8637135	-1.3778E-06	-4.1687E-09	1111.1141	-.0017482
583.200	2.51E-08	.7676507	-.0132626	-2.7526E-09	1111.1138	-.0007076
594.000	2.58E-09	.5867532	-.0174755	-1.5769E-09	1111.1131	-7.2589E-05
604.800	-8.95E-09	.3956287	-.0165049	-7.2411E-10	1111.1125	.0002523
615.600	-1.31E-08	.2327504	-.0131539	-1.7864E-10	1111.1119	.0003682
626.400	-1.28E-08	.1121220	-.0092157	1.2073E-10	1111.1115	.0003611
637.200	-1.05E-08	.0332748	-.0056743	2.4694E-10	1111.1112	.0002947
648.000	-7.48E-09	-.0112964	-.0029447	2.6602E-10	1111.1112	.0002108
658.800	-4.71E-09	-.0312501	-.0010896	2.2909E-10	1111.1112	.0001328
669.600	-2.53E-09	-.0356227	1.2509E-05	1.7104E-10	1111.1112	7.1308E-05
680.400	-1.02E-09	-.0315710	.0005523	1.1271E-10	1111.1112	2.8661E-05
691.200	-9.57E-11	-.0240816	.0007217	6.4400E-11	1111.1112	2.6963E-06
702.000	3.74E-10	-.0162055	.0006793	2.9428E-11	1111.1112	-1.0543E-05
712.800	5.40E-10	-.0095105	.0005402	7.1053E-12	1111.1111	-1.5218E-05
723.600	5.28E-10	-.0045620	.0003777	-5.1104E-12	1111.1111	-1.4868E-05
734.400	4.30E-10	-.0013340	.0002321	-1.0228E-11	1111.1111	-1.2107E-05
745.200	3.07E-10	.0004859	.0001200	-1.0965E-11	1111.1111	-8.6415E-06
756.000	1.93E-10	.0012963	4.4018E-05	-9.4175E-12	1111.1111	-5.4325E-06
766.800	1.03E-10	.0014692	-1.0241E-06	-7.0168E-12	1111.1111	-2.9086E-06
777.600	4.12E-11	.0012984	-2.3000E-05	-4.6144E-12	1111.1111	-1.1610E-06
788.400	3.53E-12	.0009884	-2.9808E-05	-2.6293E-12	1111.1111	-9.9605E-08
799.200	-1.56E-11	.0006637	-2.7972E-05	-1.1952E-12	1111.1111	4.3954E-07
810.000	-2.23E-11	.0003883	-2.2207E-05	-2.8202E-13	1111.1111	6.2798E-07
820.800	-2.17E-11	.0001850	-1.5516E-05	2.1562E-13	1111.1111	6.1122E-07
831.600	-1.76E-11	5.2417E-05	-9.5327E-06	4.2170E-13	1111.1111	4.9672E-07
842.400	-1.26E-11	-2.2376E-05	-4.9361E-06	4.4778E-13	1111.1111	3.5451E-07
853.200	-7.95E-12	-5.5751E-05	-1.8114E-06	3.7996E-13	1111.1111	2.2413E-07
864.000	-4.37E-12	-6.2816E-05	6.4170E-08	2.7704E-13	1111.1111	1.2321E-07
874.800	-1.97E-12	-5.5322E-05	1.0291E-06	1.7449E-13	1111.1111	5.5480E-08
885.600	-6.03E-13	-4.1191E-05	1.4204E-06	9.0713E-14	1111.1111	1.6986E-08
896.400	-9.18E-15	-2.4955E-05	1.5135E-06	3.3295E-14	1111.1111	2.5860E-10
907.200	1.16E-13	-8.6138E-06	1.1216E-06	4.1552E-15	1111.1111	-7.2843E-08
918.000	8.06E-14	-7.4337E-07	4.5605E-07	-3.9673E-15	1111.1111	-5.0401E-08
928.800	3.08E-14	1.2506E-06	7.9986E-08	-3.5271E-15	1111.1111	-1.9241E-08
939.600	4.39E-15	9.9651E-07	-3.8750E-08	-1.5765E-15	1111.1111	-2.7473E-09
950.400	-3.29E-15	4.1902E-07	-4.2468E-08	-3.4772E-16	1111.1111	2.0588E-09
961.200	-3.12E-15	8.0407E-08	-2.0817E-08	8.5813E-17	1111.1111	1.9506E-09
972.000	-1.44E-15	-3.0929E-08	-5.4273E-09	1.2876E-16	1111.1111	8.9939E-10
982.800	-3.37E-16	-3.7268E-08	5.6830E-10	6.9564E-17	1111.1111	2.1091E-10
993.600	6.47E-17	-1.8894E-08	1.4886E-09	2.0813E-17	1111.1111	-4.0484E-11
1004.	1.12E-16	-5.1859E-09	8.9044E-10	-9.0142E-20	1111.1111	-7.0286E-11
1015.	6.28E-17	3.3974E-10	2.9886E-10	-4.2969E-18	1111.1111	-3.9266E-11
1026.	1.96E-17	1.2844E-09	2.0780E-11	-2.8871E-18	1111.1111	-1.2231E-11
1037.	4.15E-19	7.9857E-10	-4.6670E-11	-1.0789E-18	1111.1111	-2.5969E-13
1048.	-3.75E-18	2.8005E-10	-3.5404E-11	-1.4262E-19	1111.1111	2.3460E-12

```
1058. -2.67E-18  3.4329E-11 -1.3733E-11  1.3028E-19   1111.1111  1.6672E-12
1069. -9.37E-19 -1.7028E-11 -1.5661E-12  1.4530E-19   1111.1111  5.8585E-13
1080.  4.73E-19      0.0000      0.0000  1.3052E-19   1111.1111 -2.9583E-13
```

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .44644073 in
Computed slope at pile head       =  -1.284980E-17
Maximum bending moment            =      -1148064. lbs-in
Maximum shear force               =    24000.00000 lbs
Depth of maximum bending moment   =        0.00000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =              8
Number of zero deflection points  =             12
```

Summary of Pile-Head Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = pile-head moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = pile-head shear force lbs
Type 4 = Deflection and Moment,     S = pile-head slope, radians
Type 5 = Deflection and Slope,      R = rotational stiffness of pile-headin-lbs/rad
```

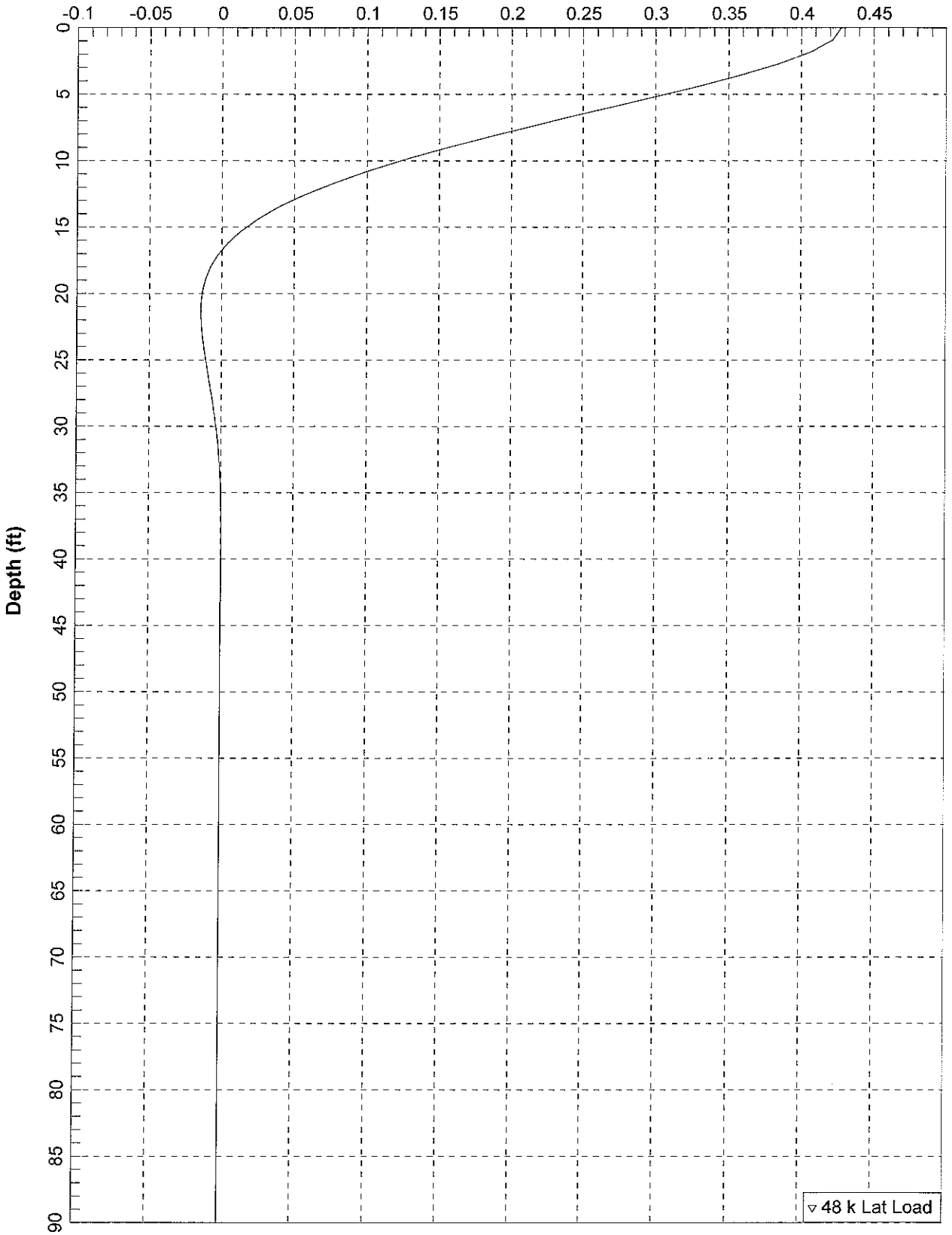
Load Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
2	V= 24000.	S= 0.000	160000.	.4464407	-1148064.	24000.0000

The analysis ended normally.

JDP
10-11-07

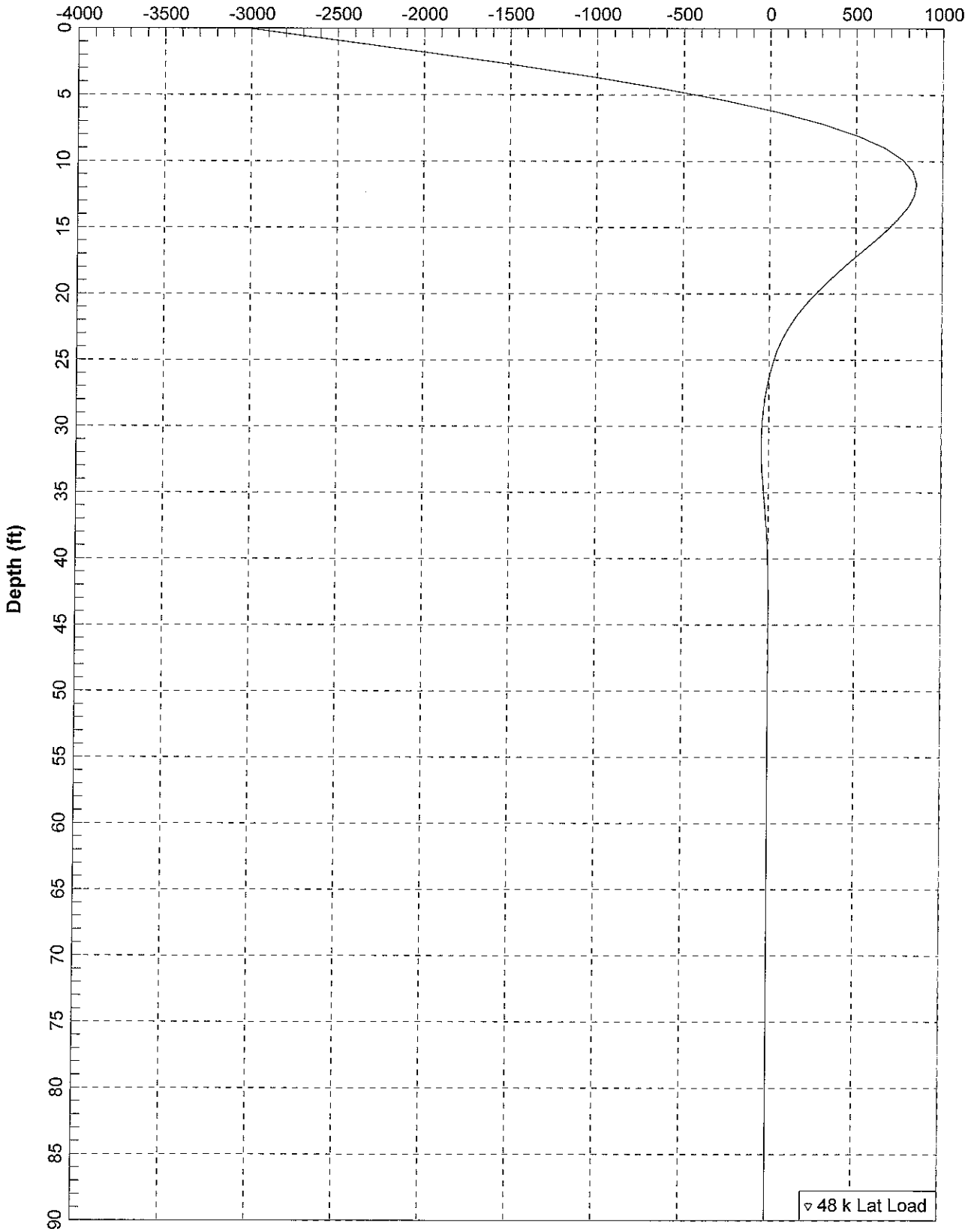
Piney Run Bridge at HEC - 18" Square PCP (abutments; fixed head)

Lateral Deflection (in)



Piney Run Bridge at HEC- 18" Square PCP (abutments; fixed head)

Unfactored Bending Moment (in-kips)



==========

LPILE Plus for Windows, Version 5.0 (5.0.7)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Will Bassett
HDR Engineering, Inc.

Path to file locations: C:\Program Files\Ensoft\LpileP5\
Name of input data file: PR HEC 18.lpd
Name of output file: PR HEC 18.lpo
Name of plot output file: PR HEC 18.lpp
Name of runtime file: PR HEC 18.lpr

Time and Date of Analysis

Date: October 15, 2007 Time: 15:34:18

Problem Title

Piney Run Bridge at HEC - 18" square PCP (abutments; fixed head)

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 1080.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	18.00000000	8748.0000	324.0000	3600000.
2	1080.0000	18.00000000	8748.0000	324.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 60.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 60.000 in
Distance from top of pile to bottom of layer = 300.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 300.000 in
Distance from top of pile to bottom of layer = 900.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 900.000 in
Distance from top of pile to bottom of layer = 1080.000 in

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	60.00	.06900
3	60.00	.03500
4	300.00	.03500
5	300.00	.02900
6	900.00	.02900
7	900.00	.03500
8	1080.00	.03500

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	30.00	------	------
2	60.000	.00000	30.00	------	------
3	60.000	.00000	30.00	------	------
4	300.000	.00000	30.00	------	------
5	300.000	1.70000	.00	------	------
6	900.000	1.70000	.00	------	------
7	900.000	13.90000	.00	------	------
8	1080.000	13.90000	.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Shear force at pile head = 48000.000 lbs
Slope at pile head = .000 in/in
Axial load at pile head = 280000.000 lbs

(Zero slope for this load indicates fixed-head condition)

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Slope (BC Type 2)
Specified shear force at pile head = 48000.000 lbs
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 280000.000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.427253	-3020161.	48000.0000	3.3409E-17	3971.3588	0.0000
10.800	.421660	-2500195.	47453.6846	-.0009466	3436.4143	-101.1695
21.600	.406807	-1989436.	45768.1489	-.0017164	2910.9428	-210.9667
32.400	.384586	-1501222.	42982.6406	-.0023149	2408.6646	-304.8681
43.200	.356804	-1047011.	39327.1661	-.0027519	1941.3690	-372.0716
54.000	.325145	-635112.	35086.1349	-.0030403	1517.6049	-413.3046
64.800	.291134	-270762.	30465.4192	-.0031956	1142.7597	-442.3835
75.600	.256120	42268.2475	25709.8463	-.0032348	907.6834	-438.2781
86.400	.221262	304134.	20854.9090	-.0031754	1177.0929	-460.7843
97.200	.187531	511939.	15887.5116	-.0030355	1390.8839	-459.1041
108.000	.155696	665663.	11123.0423	-.0028336	1549.0362	-423.2050
118.800	.126326	769334.	6799.3323	-.0025875	1655.6936	-377.4820
129.600	.099806	828178.	3004.9404	-.0023136	1716.2324	-325.1831
140.400	.076353	848233.	-205.7289	-.0020261	1736.8657	-269.3853
151.200	.056042	835988.	-2809.8265	-.0017373	1724.2677	-212.8551
162.000	.038827	798049.	-4812.1885	-.0014572	1685.2352	-157.9527
172.800	.024567	740858.	-6240.6472	-.0011933	1626.3969	-106.5767
183.600	.013052	670468.	-7140.9436	-.0009513	1553.9790	-60.1449
194.400	.004020	592367.	-7571.6108	-.0007347	1473.6283	-19.6083
205.200	-.002819	511365.	-7614.8082	-.0005455	1390.2927	11.6088
216.000	-.007763	431186.	-7370.4163	-.0003839	1307.8045	33.6490
226.800	-.011110	354485.	-6915.6982	-.0002492	1228.8942	50.5581
237.600	-.013145	283314.	-6304.3468	-.0001398	1155.6727	62.6552
248.400	-.014130	219157.	-5585.8328	-5.3639E-05	1089.6675	70.4030
259.200	-.014303	162984.	-4804.1301	1.1886E-05	1031.8768	74.3568
270.000	-.013873	115316.	-3996.9715	5.9605E-05	982.8351	75.1170
280.800	-.013016	76289.1920	-3195.5912	9.2459E-05	942.6844	73.2867
291.600	-.011876	45731.7336	-2424.8989	.0001134	911.2466	69.4341
302.400	-.010567	23225.6411	-1880.9104	.0001252	888.0922	31.3045
313.200	-.009172	4346.8236	-1550.6053	.0001299	868.6696	29.8631
324.000	-.007760	-11053.2721	-1236.8084	.0001288	875.5692	28.2474
334.800	-.006390	-23147.1229	-941.2881	.0001229	888.0114	26.4785
345.600	-.005105	-32128.5128	-665.6106	.0001134	897.2516	24.5729
356.400	-.003940	-38210.4067	-411.1874	.0001014	903.5086	22.5426
367.200	-.002915	-41623.3108	-179.3272	8.7692E-05	907.0199	20.3945

378.000	-.002045	-42614.2337	28.6913	7.3248E-05	908.0393	18.1274
388.800	-.001333	-41446.5823	211.4903	5.8834E-05	906.8380	15.7243
399.600	-.000775	-38401.8711	367.3065	4.5143E-05	903.7056	13.1306
410.400	-.000358	-33785.7846	492.7306	3.2765E-05	898.9566	10.0961
421.200	-6.69E-05	-27957.0508	557.4374	2.2178E-05	892.9599	1.8866
432.000	.000121	-21879.2685	549.2399	1.3633E-05	886.7071	-3.4047
442.800	.000228	-16175.9178	496.2288	7.1073E-06	880.8394	-6.4122
453.600	.000274	-11203.7110	419.8541	2.4126E-06	875.7240	-7.7313
464.400	.000280	-7121.6602	335.5486	-7.2959E-07	871.5243	-7.8809
475.200	.000259	-3951.4495	253.6414	-2.6283E-06	868.2628	-7.2871
486.000	.000223	-1627.1111	180.3739	-3.5848E-06	865.8715	-6.2809
496.800	.000181	-33.6914	118.8907	-3.8696E-06	864.2322	-5.1049
507.600	.000139	964.3314	70.1278	-3.7100E-06	865.1896	-3.9253
518.400	.000101	1503.5068	33.5606	-3.2869E-06	865.7443	-2.8464
529.200	6.83E-05	1709.1194	7.7982	-2.7360E-06	865.9559	-1.9244
540.000	4.19E-05	1688.4945	-8.9704	-2.1534E-06	865.9347	-1.1809
550.800	2.18E-05	1528.3834	-18.6601	-1.6018E-06	865.7699	-.6135331
561.600	7.30E-06	1295.1248	-23.0842	-1.1177E-06	865.5300	-.2057436
572.400	-2.37E-06	1036.5252	-23.8341	-7.1789E-07	865.2639	.0668595
583.200	-8.21E-06	784.6491	-22.2242	-4.0561E-07	865.0048	.2312692
594.000	-1.11E-05	558.9346	-19.2810	-1.7523E-07	864.7726	.3137766
604.800	-1.20E-05	369.2394	-15.7617	-1.6080E-08	864.5774	.3379418
615.600	-1.15E-05	218.5788	-12.1896	8.4712E-08	864.4224	.3235654
626.400	-1.02E-05	105.4322	-8.8959	1.4027E-07	864.3060	.2863736
637.200	-8.45E-06	25.5788	-6.0633	1.6273E-07	864.2238	.2381768
648.000	-6.65E-06	-26.5201	-3.7657	1.6257E-07	864.2248	.1873099
658.800	-4.94E-06	-56.7437	-2.0025	1.4829E-07	864.2559	.1392113
669.600	-3.44E-06	-70.6709	-.7267602	1.2645E-07	864.2702	.0970356
680.400	-2.21E-06	-73.2065	.1333100	1.0178E-07	864.2728	.0622366
691.200	-1.24E-06	-68.4069	.6588146	7.7495E-08	864.2679	.0350790
702.000	-5.34E-07	-59.4448	.9295749	5.5572E-08	864.2587	.0150618
712.800	-4.43E-08	-48.6642	1.0177	3.7035E-08	864.2476	.0012494
723.600	2.66E-07	-37.6874	.9839925	2.2229E-08	864.2363	-.0074833
734.400	4.36E-07	-27.5444	.8772588	1.1043E-08	864.2259	-.0122822
745.200	5.04E-07	-18.8054	.7342228	3.0959E-09	864.2169	-.0142060
756.000	5.03E-07	-11.7039	.5810098	-2.1355E-09	864.2096	-.0141668
766.800	4.58E-07	-6.2427	.4348167	-5.2127E-09	864.2040	-.0129060
777.600	3.90E-07	-2.2803	.3057592	-6.6742E-09	864.1999	-.0109936
788.400	3.14E-07	.4020729	.1986412	-6.9962E-09	864.1979	-.0088431
799.200	2.39E-07	2.0526	.1145216	-6.5753E-09	864.1996	-.0067346
810.000	1.72E-07	2.9155	.0520168	-5.7235E-09	864.2005	-.0048404
820.800	1.15E-07	3.2108	.0083263	-4.6730E-09	864.2008	-.0032505
831.600	7.08E-08	3.1236	-.0200028	-3.5868E-09	864.2007	-.0019957
842.400	3.79E-08	2.8004	-.0365411	-2.5711E-09	864.2004	-.0010670
853.200	1.53E-08	2.3499	-.0446277	-1.6880E-09	864.1999	-.0004306
864.000	1.40E-09	1.8467	-.0471656	-9.6838E-10	864.1994	-3.9426E-05
874.800	-5.64E-09	1.3370	-.0465202	-4.2248E-10	864.1989	.0001589
885.600	-7.73E-09	.8443955	-.0444860	-4.8453E-11	864.1984	.0002178
896.400	-6.69E-09	.3763551	-.0422925	1.6087E-10	864.1979	.0001884
907.200	-4.25E-09	-.0700958	-.0269129	2.1338E-10	864.1976	.0026596
918.000	-2.08E-09	-.2062537	-.0055343	1.6600E-10	864.1977	.0012994
928.800	-6.67E-10	-.1906397	.0037336	9.7941E-11	864.1977	.0004169
939.600	3.82E-11	-.1261996	.0058559	4.3613E-11	864.1977	-2.3895E-05
950.400	2.76E-10	-.0644157	.0047963	1.0929E-11	864.1976	-.0001723
961.200	2.74E-10	-.0226664	.0029393	-4.0030E-12	864.1976	-.0001716
972.000	1.89E-10	-.0009033	.0013743	-8.0445E-12	864.1975	-.0001183
982.800	1.01E-10	.0070675	.0003963	-6.9875E-12	864.1975	-6.2864E-05
993.600	3.81E-11	.0076987	-7.1953E-05	-4.4556E-12	864.1975	-2.3847E-05
1004.	4.26E-12	.0055403	-.0002151	-2.1855E-12	864.1975	-2.6654E-06
1015.	-9.08E-12	.0030653	-.0001988	-7.0993E-13	864.1975	5.6811E-06
1026.	-1.11E-11	.0012498	-.0001308	2.9970E-14	864.1975	6.9263E-06
1037.	-8.44E-12	.0002408	-6.4862E-05	2.8556E-13	864.1975	5.2762E-06
1048.	-4.91E-12	-.0001530	-1.9803E-05	3.0062E-13	864.1975	3.0682E-06

1058.	-1.94E-12	-.0001887	3.3238E-06	2.4202E-13	864.1975	1.2146E-06
1069.	3.23E-13	-8.2651E-05	8.7931E-06	1.9549E-13	864.1975	-2.0175E-07
1080.	2.28E-12	0.0000	0.0000	1.8131E-13	864.1975	-1.4266E-06

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .42725264 in
Computed slope at pile head       =   3.340949E-17
Maximum bending moment            =      -3020161. lbs-in
Maximum shear force               =    48000.00000 lbs
Depth of maximum bending moment   =        0.00000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             10
Number of zero deflection points  =              8
```

Summary of Pile-Head Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = pile-head moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = pile-head shear force lbs
Type 4 = Deflection and Moment,     S = pile-head slope, radians
Type 5 = Deflection and Slope,      R = rotational stiffness of pile-headin-lbs/rad
```

Load Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
2	V= 48000.	S= 0.000	280000.	.4272526	-3020161.	48000.0000

The analysis ended normally.

SLOPE STABILITY

HDR | ONE COMPANY *Many Solutions*

Project: Rt-TR Connector		Computed: WWB	Date: 5/22/07
Subject: Fill Slope Stability		Checked: JDP	Date: 10-11-07
Task:		Page: 1	of:
Job #: 53410		No:	

JDP 10-11-07

- Critical fill on project is @ approx sta 196+00 (Fill height = 25')
- Use Boring B-22, sta 196+08, ℄
- Assume fill material will come from the adjacent cut located between stations 199+50 to 207+00

Boring No.	Station	Cut Depth	Material
B-20A	202+50	28'	SM (0-28')
B-20B	202+50	28'	ML, SM, SC (0-28')
B-19	206+00	12'	ML, SP-SM (0-12')

- For compacted fill, assume:

① $\gamma_m = 120$ pcf
$\phi = 30°$
$c = 50$ psf

- For existing natural soils @ B-22

0-5' = Fine sandy silt (ML)

② $\gamma_m = 115$ pcf, $\phi = 30°$, $c = 0$ (LT) } $N_{AVG} = 14$ bpf { $\phi = 0$, $c = 1500$ psf (ST)

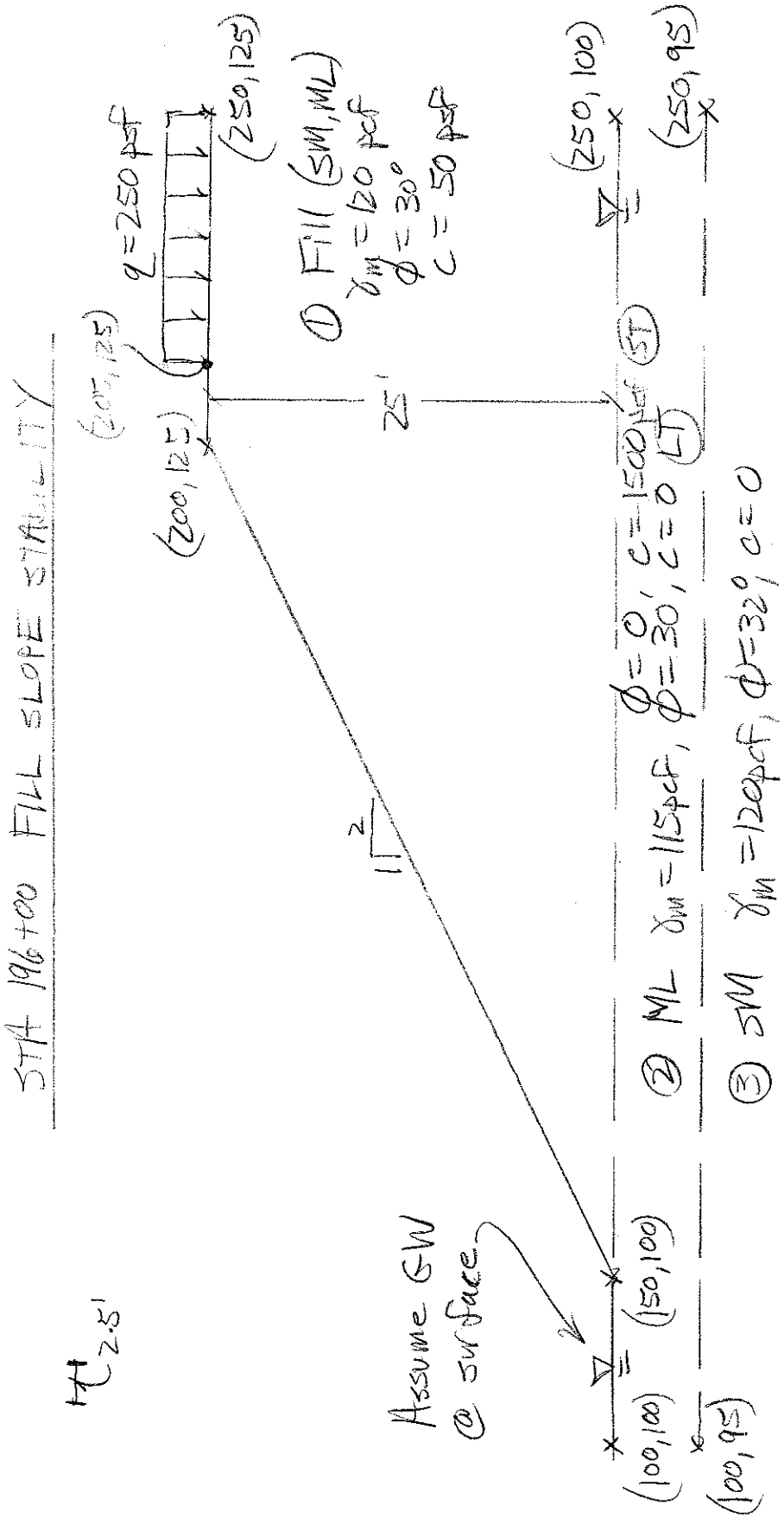
5-15' = Silty fine sand / Fine to coarse sand w/ gravel

③ $\gamma_m = 120$ pcf, $\phi = 32°$, $c = 0$ } $N_{AVG} = 17$ bpf

HDR | ONE COMPANY *Many Solutions*

Project: RH - TR Connector		Computed: WWB	Date: 5/23/07
Subject: Fill Slope Stability		Checked: JDP	Date: 10-11-07
Task:		Page: 2	of:
Job #: 53410		No:	

JDP 10-11-07



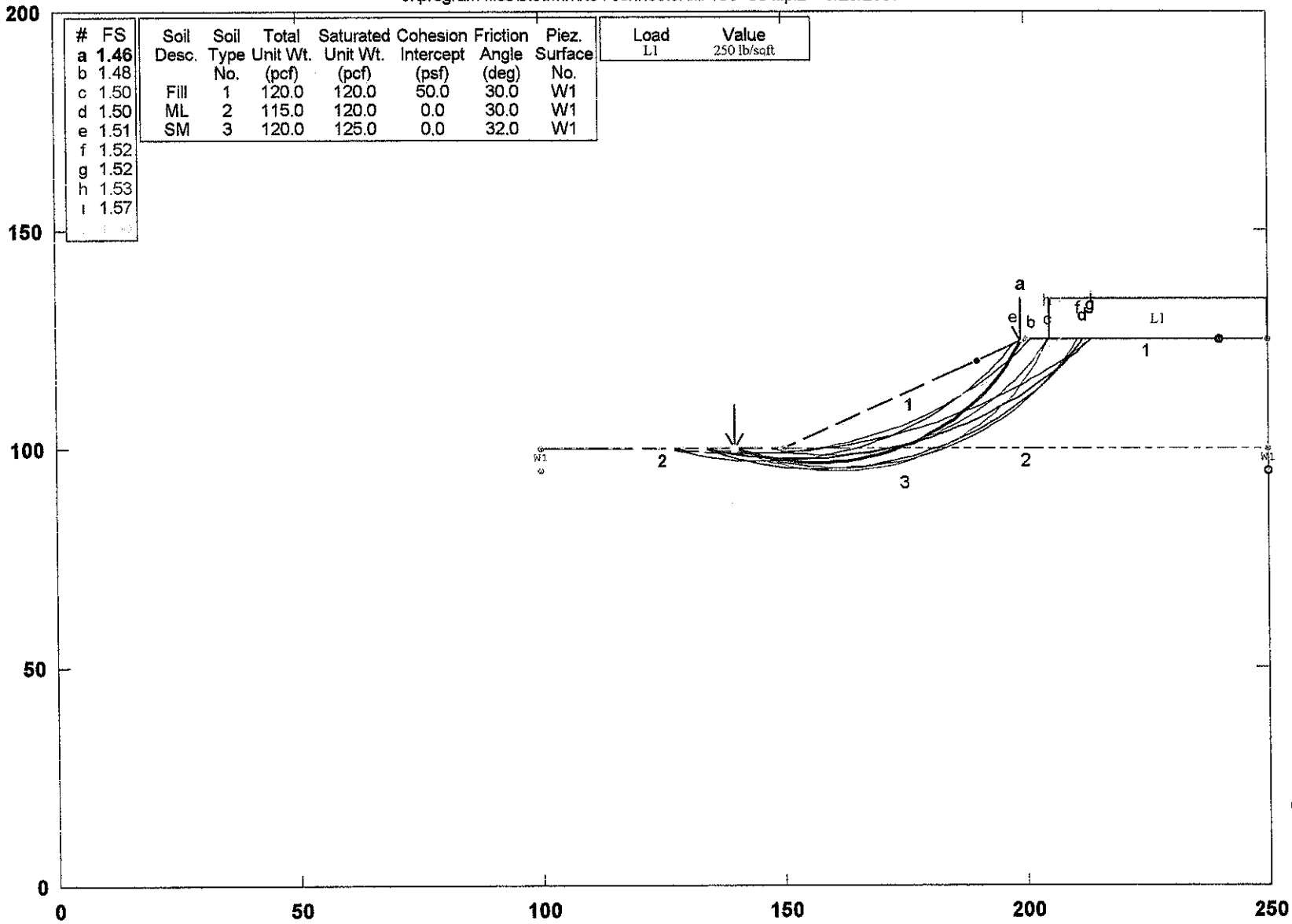
Richmond Highway-Telegraph Rd Connector Fill Slope Sta 196+00 - 2(H):1(V), LT

c:\program files\stedwin\rte i connector\fill 196+00 lt.pl2 5/23/2007

#	FS
a	**1.46**
b	1.48
c	1.50
d	1.50
e	1.51
f	1.52
g	1.52
h	1.53
i	1.57

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Fill	1	120.0	120.0	50.0	30.0	W1
ML	2	115.0	120.0	0.0	30.0	W1
SM	3	120.0	125.0	0.0	32.0	W1

Load	Value
L1	250 lb/sqft



STABL6H FSmin=1.46

Safety Factors Are Calculated By The Modified Bishop Method

HDR

JDP 10-11-07

JDP
10-11-07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                    ** STABL6H  **
                          by
                   Purdue University
              --Slope Stability Analysis--
           Simplified Janbu, Simplified Bishop
              or Spencer`s Method of Slices
Run Date:                  5/23/2007
Time of Run:
Run By:
Input Data Filename:       C:fill 196+00 lt.in
Output Filename:           C:fill 196+00 lt.OUT
Plotted Output Filename:   C:fill 196+00 lt.PLT
PROBLEM DESCRIPTION   Richmond Highway-Telegraph Rd Connector
                      Fill Slope Sta 196+00 - 2(H):1(V), LT
BOUNDARY COORDINATES
    3 Top   Boundaries
    5 Total Boundaries
Boundary     X-Left     Y-Left     X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1        100.00     100.00     150.00     100.00        2
    2        150.00     100.00     200.00     125.00        1
    3        200.00     125.00     250.00     125.00        1
    4        150.00     100.00     250.00     100.00        2
    5        100.00      95.00     250.00      95.00        3
ISOTROPIC SOIL PARAMETERS
  3 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt.  Intercept  Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)    No.
  1   120.0    120.0     50.0      30.0    0.00      0.0      1
  2   115.0    120.0      0.0      30.0    0.00      0.0      1
  3   120.0    125.0      0.0      32.0    0.00      0.0      1
1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water =  62.40
Piezometric Surface No.  1 Specified by  2 Coordinate Points
  Point      X-Water     Y-Water
   No.         (ft)        (ft)
    1        100.00      100.00
    2        250.00      100.00
BOUNDARY LOAD(S)
    1 Load(s) Specified
Load        X-Left      X-Right     Intensity     Deflection
 No.         (ft)        (ft)       (lb/sqft)       (deg)
  1         205.00      250.00        250.0          0.0
NOTE - Intensity Is Specified As A Uniformly Distributed
       Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
100 Trial Surfaces Have Been Generated.
 10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between  X = 120.00 ft.
                              and  X = 180.00 ft.
Each Surface Terminates Between   X = 190.00 ft.
                              and  X = 240.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y = 80.00 ft.
 2.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
      Failure Surfaces Examined.  They Are Ordered - Most Critical
      First.
      * * Safety Factors Are Calculated By The Modified Bishop Method * *
      Failure Surface Specified By 37 Coordinate Points
        Point      X-Surf      Y-Surf
         No.        (ft)        (ft)
          1        140.00      100.00
          2        141.88       99.31
          3        143.78       98.70
```

JDP
10-11-07

4	145.71	98.17
5	147.66	97.72
6	149.63	97.37
7	151.61	97.10
8	153.60	96.91
9	155.60	96.81
10	157.60	96.80
11	159.60	96.87
12	161.59	97.04
13	163.57	97.29
14	165.55	97.62
15	167.50	98.04
16	169.44	98.55
17	171.35	99.14
18	173.23	99.81
19	175.09	100.56
20	176.90	101.39
21	178.68	102.30
22	180.42	103.29
23	182.12	104.35
24	183.76	105.49
25	185.36	106.69
26	186.90	107.97
27	188.39	109.31
28	189.81	110.71
29	191.17	112.18
30	192.47	113.70
31	193.70	115.27
32	194.86	116.90
33	195.95	118.58
34	196.97	120.31
35	197.90	122.07
36	198.76	123.88
37	199.04	124.52

Circle Center At X = 156.9 ; Y = 142.7 and Radius, 46.0

*** 1.460 ***

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	133.33	100.00
2	135.31	99.71
3	137.30	99.46
4	139.29	99.28
5	141.28	99.14
6	143.28	99.07
7	145.28	99.04
8	147.28	99.07
9	149.28	99.16
10	151.28	99.30
11	153.27	99.49
12	155.25	99.74
13	157.23	100.04
14	159.20	100.40
15	161.15	100.81
16	163.10	101.27
17	165.03	101.78
18	166.95	102.35
19	168.85	102.97
20	170.74	103.64
21	172.60	104.36
22	174.45	105.14
23	176.27	105.96
24	178.07	106.83
25	179.84	107.75
26	181.59	108.72
27	183.32	109.73
28	185.01	110.80

JDP 10-11-07

29	186.68	111.91
30	188.31	113.06
31	189.91	114.26
32	191.48	115.50
33	193.02	116.78
34	194.52	118.10
35	195.98	119.47
36	197.40	120.87
37	198.79	122.31
38	200.14	123.79
39	201.18	125.00

Circle Center At X = 145.2 ; Y = 172.5 and Radius, 73.4
*** 1.482 ***
Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	146.67	100.00
2	148.61	99.54
3	150.58	99.16
4	152.55	98.86
5	154.54	98.63
6	156.54	98.48
7	158.54	98.41
8	160.54	98.42
9	162.53	98.50
10	164.53	98.66
11	166.51	98.89
12	168.49	99.21
13	170.45	99.60
14	172.40	100.06
15	174.32	100.60
16	176.22	101.22
17	178.10	101.90
18	179.95	102.66
19	181.77	103.49
20	183.56	104.39
21	185.31	105.36
22	187.02	106.40
23	188.69	107.50
24	190.31	108.67
25	191.89	109.89
26	193.42	111.18
27	194.90	112.53
28	196.33	113.93
29	197.70	115.38
30	199.01	116.89
31	200.27	118.45
32	201.46	120.05
33	202.59	121.70
34	203.66	123.40
35	204.58	125.00

Circle Center At X = 159.4 ; Y = 150.1 and Radius, 51.7
*** 1.500 ***
Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	133.33	100.00
2	135.20	99.29
3	137.10	98.64
4	139.01	98.05
5	140.93	97.52
6	142.88	97.04
7	144.83	96.63
8	146.80	96.27
9	148.78	95.98
10	150.77	95.75
11	152.76	95.57

JDP
10-11-07

12	154.76	95.46
13	156.75	95.41
14	158.75	95.42
15	160.75	95.50
16	162.75	95.63
17	164.74	95.83
18	166.72	96.08
19	168.70	96.40
20	170.66	96.78
21	172.61	97.22
22	174.55	97.71
23	176.47	98.27
24	178.37	98.88
25	180.26	99.56
26	182.12	100.29
27	183.96	101.07
28	185.77	101.92
29	187.56	102.82
30	189.32	103.77
31	191.05	104.77
32	192.74	105.83
33	194.41	106.94
34	196.04	108.10
35	197.63	109.31
36	199.18	110.57
37	200.70	111.88
38	202.17	113.23
39	203.61	114.62
40	204.99	116.06
41	206.34	117.54
42	207.64	119.06
43	208.89	120.62
44	210.09	122.22
45	211.24	123.86
46	212.00	125.00

Circle Center At X = 157.4 ; Y = 160.6 and Radius, 65.2
*** 1.502 ***

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	126.67	100.00
2	128.58	99.43
3	130.52	98.92
4	132.47	98.47
5	134.43	98.08
6	136.40	97.76
7	138.38	97.49
8	140.37	97.29
9	142.37	97.15
10	144.37	97.08
11	146.37	97.06
12	148.37	97.12
13	150.36	97.23
14	152.36	97.41
15	154.34	97.64
16	156.32	97.95
17	158.29	98.31
18	160.24	98.73
19	162.18	99.22
20	164.10	99.77
21	166.01	100.38
22	167.89	101.04
23	169.76	101.77
24	171.60	102.55
25	173.41	103.40
26	175.20	104.30
27	176.96	105.25

JDP
10-11-07

28	178.68	106.26
29	180.38	107.32
30	182.04	108.44
31	183.66	109.61
32	185.24	110.83
33	186.79	112.10
34	188.30	113.41
35	189.76	114.77
36	191.18	116.18
37	192.56	117.63
38	193.89	119.13
39	195.17	120.66
40	196.40	122.24
41	197.51	123.75

Circle Center At X = 145.8 ; Y = 160.6 and Radius, 63.5
*** 1.507 ***
Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	140.00	100.00
2	141.86	99.26
3	143.74	98.58
4	145.65	97.98
5	147.57	97.44
6	149.52	96.97
7	151.48	96.57
8	153.45	96.24
9	155.43	95.98
10	157.42	95.80
11	159.42	95.68
12	161.42	95.64
13	163.42	95.66
14	165.42	95.76
15	167.41	95.93
16	169.40	96.17
17	171.37	96.48
18	173.33	96.87
19	175.28	97.32
20	177.21	97.84
21	179.12	98.43
22	181.01	99.09
23	182.88	99.82
24	184.71	100.61
25	186.52	101.46
26	188.29	102.39
27	190.04	103.37
28	191.74	104.42
29	193.41	105.52
30	195.03	106.69
31	196.62	107.91
32	198.15	109.19
33	199.65	110.52
34	201.09	111.90
35	202.48	113.34
36	203.82	114.82
37	205.11	116.35
38	206.34	117.93
39	207.51	119.55
40	208.63	121.21
41	209.68	122.91
42	210.68	124.65
43	210.86	125.00

Circle Center At X = 161.7 ; Y = 151.6 and Radius, 55.9
*** 1.522 ***
Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

JDP 10-11-07

1	133.33	100.00
2	135.28	99.55
3	137.24	99.15
4	139.21	98.80
5	141.19	98.49
6	143.17	98.24
7	145.16	98.03
8	147.15	97.87
9	149.15	97.76
10	151.15	97.70
11	153.15	97.69
12	155.15	97.73
13	157.15	97.81
14	159.14	97.95
15	161.14	98.13
16	163.12	98.37
17	165.10	98.65
18	167.07	98.98
19	169.04	99.36
20	170.99	99.78
21	172.94	100.26
22	174.87	100.78
23	176.78	101.35
24	178.69	101.96
25	180.57	102.62
26	182.44	103.33
27	184.30	104.08
28	186.13	104.88
29	187.94	105.73
30	189.74	106.61
31	191.51	107.54
32	193.25	108.52
33	194.98	109.53
34	196.67	110.59
35	198.34	111.69
36	199.99	112.83
37	201.60	114.01
38	203.19	115.23
39	204.74	116.49
40	206.27	117.79
41	207.76	119.12
42	209.22	120.49
43	210.64	121.89
44	212.03	123.33
45	213.38	124.80
46	213.56	125.00

Circle Center At X = 152.6 ; Y = 179.3 and Radius, 81.6

*** 1.523 ***

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	140.00	100.00
2	141.80	99.12
3	143.63	98.33
4	145.50	97.61
5	147.39	96.97
6	149.32	96.42
7	151.26	95.94
8	153.22	95.56
9	155.20	95.26
10	157.19	95.04
11	159.18	94.91
12	161.18	94.86
13	163.18	94.91
14	165.18	95.03
15	167.17	95.25
16	169.14	95.55

JDP 10-11-07

17	171.11	95.93
18	173.05	96.40
19	174.97	96.95
20	176.87	97.59
21	178.74	98.30
22	180.57	99.10
23	182.37	99.97
24	184.13	100.93
25	185.85	101.95
26	187.52	103.05
27	189.14	104.22
28	190.71	105.46
29	192.22	106.77
30	193.68	108.14
31	195.08	109.57
32	196.41	111.06
33	197.68	112.60
34	198.88	114.20
35	200.01	115.85
36	201.07	117.55
37	202.05	119.29
38	202.96	121.07
39	203.79	122.89
40	204.54	124.75
41	204.63	125.00

Circle Center At X = 161.2 ; Y = 141.2 and Radius, 46.4

*** 1.525 ***

Failure Surface Specified By 48 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	126.67	100.00
2	128.65	99.73
3	130.64	99.50
4	132.63	99.30
5	134.62	99.14
6	136.61	99.01
7	138.61	98.92
8	140.61	98.87
9	142.61	98.85
10	144.61	98.87
11	146.61	98.92
12	148.61	99.02
13	150.60	99.14
14	152.60	99.31
15	154.59	99.51
16	156.57	99.75
17	158.56	100.02
18	160.53	100.33
19	162.50	100.67
20	164.46	101.05
21	166.42	101.47
22	168.37	101.92
23	170.31	102.41
24	172.24	102.93
25	174.16	103.48
26	176.07	104.08
27	177.97	104.70
28	179.86	105.36
29	181.73	106.06
30	183.60	106.78
31	185.45	107.55
32	187.28	108.34
33	189.10	109.17
34	190.91	110.03
35	192.70	110.93
36	194.47	111.85
37	196.22	112.81

JDP
10-11-07

38	197.96	113.80
39	199.68	114.82
40	201.38	115.88
41	203.06	116.96
42	204.72	118.07
43	206.36	119.22
44	207.98	120.39
45	209.58	121.59
46	211.16	122.83
47	212.71	124.09
48	213.80	125.00

Circle Center At X = 142.5 ; Y = 209.0 and Radius, 110.2
*** 1.574 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.00	105.00
2	161.99	105.24
3	163.97	105.52
4	165.94	105.84
5	167.91	106.21
6	169.86	106.62
7	171.81	107.08
8	173.75	107.57
9	175.67	108.12
10	177.58	108.70
11	179.48	109.33
12	181.37	110.00
13	183.24	110.72
14	185.09	111.47
15	186.92	112.27
16	188.74	113.10
17	190.54	113.98
18	192.31	114.90
19	194.07	115.85
20	195.81	116.85
21	197.52	117.88
22	199.20	118.96
23	200.87	120.07
24	202.51	121.21
25	204.12	122.40
26	205.70	123.62
27	207.26	124.87
28	207.41	125.00

Circle Center At X = 150.5 ; Y = 193.8 and Radius, 89.3
*** 1.582 ***

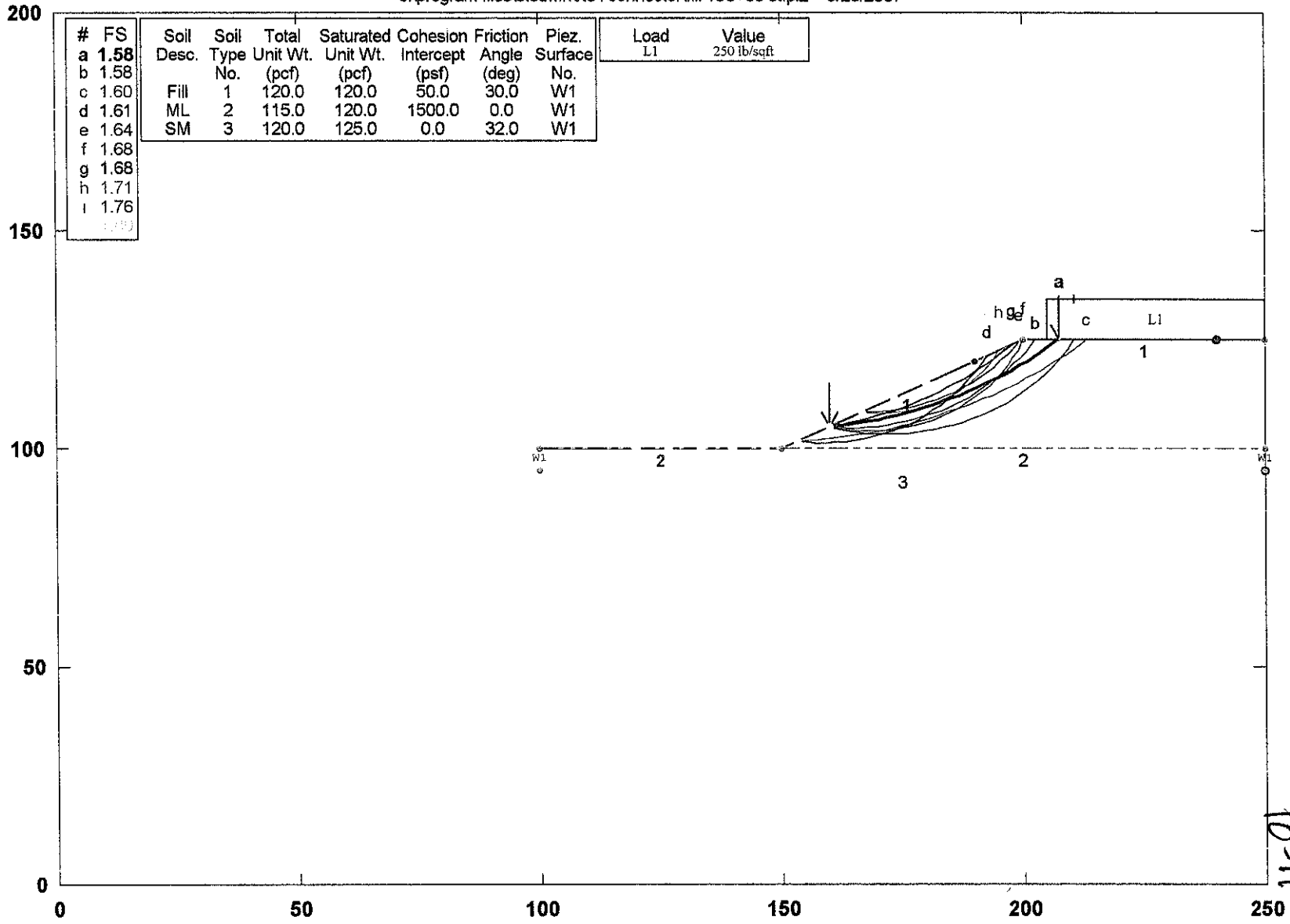
Richmond Highway-Telegraph Rd Connector Fill Slope Sta 196+00 - 2(H):1(V), ST

c:\program files\stedwin\rte i connector\fill 196+00 st.pl2 5/23/2007

#	FS
a	1.58
b	1.58
c	1.60
d	1.61
e	1.64
f	1.68
g	1.68
h	1.71
i	1.76

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Fill	1	120.0	120.0	50.0	30.0	W1
ML	2	115.0	120.0	1500.0	0.0	W1
SM	3	120.0	125.0	0.0	32.0	W1

Load	Value
L1	250 lb/sqft



STABL6H FSmin=1.58

Safety Factors Are Calculated By The Modified Bishop Method

HDR

10-11-07
JDP

JDP
10-11-07

** STABL6H **
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 5/23/2007
Time of Run:
Run By:
Input Data Filename: C:fill 196+00 st.in
Output Filename: C:fill 196+00 st.OUT
Plotted Output Filename: C:fill 196+00 st.PLT
PROBLEM DESCRIPTION Richmond Highway-Telegraph Rd Connector
Fill Slope Sta 196+00 - 2(H):1(V), ST

BOUNDARY COORDINATES
3 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	100.00	100.00	150.00	100.00	2
2	150.00	100.00	200.00	125.00	1
3	200.00	125.00	250.00	125.00	1
4	150.00	100.00	250.00	100.00	2
5	100.00	95.00	250.00	95.00	3

ISOTROPIC SOIL PARAMETERS
3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	50.0	30.0	0.00	0.0	1
2	115.0	120.0	1500.0	0.0	0.00	0.0	1
3	120.0	125.0	0.0	32.0	0.00	0.0	1

1 PIEZOMEIRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	100.00	100.00
2	250.00	100.00

BOUNDARY LOAD(S)
1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	205.00	250.00	250.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
100 Trial Surfaces Have Been Generated.
10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 120.00 ft.
and X = 180.00 ft.
Each Surface Terminates Between X = 190.00 ft.
and X = 240.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 80.00 ft.
2.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of Ihe Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.00	105.00
2	161.99	105.24
3	163.97	105.52
4	165.94	105.84
5	167.91	106.21
6	169.86	106.62

JDP 10-11-07

7	171.81	107.08
8	173.75	107.57
9	175.67	108.12
10	177.58	108.70
11	179.48	109.33
12	181.37	110.00
13	183.24	110.72
14	185.09	111.47
15	186.92	112.27
16	188.74	113.10
17	190.54	113.98
18	192.31	114.90
19	194.07	115.85
20	195.81	116.85
21	197.52	117.88
22	199.20	118.96
23	200.87	120.07
24	202.51	121.21
25	204.12	122.40
26	205.70	123.62
27	207.26	124.87
28	207.41	125.00

Circle Center At X = 150.5 ; Y = 193.8 and Radius, 89.3

*** 1.582 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.00	105.00
2	162.00	104.85
3	163.99	104.79
4	165.99	104.82
5	167.99	104.93
6	169.98	105.13
7	171.96	105.41
8	173.93	105.78
9	175.87	106.24
10	177.80	106.78
11	179.70	107.40
12	181.57	108.10
13	183.41	108.89
14	185.21	109.75
15	186.98	110.69
16	188.70	111.71
17	190.38	112.80
18	192.00	113.97
19	193.58	115.20
20	195.10	116.50
21	196.56	117.86
22	197.96	119.29
23	199.30	120.77
24	200.58	122.32
25	201.78	123.91
26	202.53	125.00

Circle Center At X = 164.4 ; Y = 150.9 and Radius, 46.1

*** 1.582 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.33	101.67
2	155.33	101.79
3	157.32	101.96
4	159.31	102.17
5	161.30	102.41
6	163.28	102.69
7	165.25	103.01
8	167.22	103.37
9	169.18	103.76

JDP 10-11-07

10	171.13	104.20
11	173.08	104.67
12	175.01	105.18
13	176.93	105.73
14	178.85	106.31
15	180.75	106.93
16	182.64	107.59
17	184.51	108.28
18	186.37	109.02
19	188.22	109.78
20	190.05	110.58
21	191.87	111.42
22	193.67	112.29
23	195.45	113.20
24	197.21	114.14
25	198.96	115.12
26	200.69	116.13
27	202.39	117.17
28	204.08	118.25
29	205.74	119.36
30	207.39	120.50
31	209.01	121.67
32	210.61	122.87
33	212.18	124.11
34	213.28	125.00

Circle Center At X = 147.8 ; Y = 204.7 and Radius, 103.1

*** 1.603 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.33	101.67
2	155.32	101.45
3	157.32	101.33
4	159.32	101.32
5	161.32	101.41
6	163.31	101.61
7	165.29	101.90
8	167.25	102.30
9	169.18	102.79
10	171.09	103.39
11	172.97	104.08
12	174.81	104.87
13	176.60	105.75
14	178.35	106.72
15	180.05	107.78
16	181.69	108.92
17	183.27	110.15
18	184.78	111.46
19	186.22	112.84
20	187.60	114.30
21	188.89	115.82
22	190.11	117.41
23	191.24	119.06
24	192.28	120.76
25	192.57	121.28

Circle Center At X = 158.6 ; Y = 140.3 and Radius, 39.0

*** 1.613 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	108.33
2	168.67	108.33
3	170.66	108.44
4	172.65	108.65
5	174.63	108.96
6	176.59	109.38
7	178.52	109.89

JDP
10-11-07

8	180.42	110.51
9	182.29	111.22
10	184.12	112.03
11	185.90	112.94
12	187.64	113.93
13	189.31	115.02
14	190.94	116.19
15	192.49	117.44
16	193.98	118.78
17	195.40	120.19
18	196.75	121.67
19	198.01	123.22
20	198.93	124.46

Circle Center At X = 167.6 ; Y = 146.7 and Radius, 38.4
*** 1.640 ***
Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.00	105.00
2	161.96	104.58
3	163.93	104.27
4	165.92	104.08
5	167.92	104.01
6	169.92	104.04
7	171.92	104.20
8	173.90	104.47
9	175.86	104.85
10	177.80	105.35
11	179.70	105.96
12	181.57	106.67
13	183.39	107.49
14	185.17	108.42
15	186.88	109.45
16	188.54	110.57
17	190.12	111.79
18	191.64	113.10
19	193.07	114.49
20	194.42	115.97
21	195.69	117.51
22	196.86	119.13
23	197.94	120.82
24	198.92	122.56
25	199.79	124.36
26	200.06	125.00

Circle Center At X = 168.2 ; Y = 138.6 and Radius, 34.6
*** 1.676 ***
Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.00	105.00
2	161.96	105.38
3	163.92	105.80
4	165.86	106.29
5	167.79	106.82
6	169.70	107.41
7	171.59	108.04
8	173.47	108.73
9	175.33	109.47
10	177.17	110.26
11	178.98	111.10
12	180.78	111.99
13	182.54	112.93
14	184.28	113.91
15	186.00	114.94
16	187.68	116.02
17	189.34	117.14
18	190.96	118.31

JDP 10-11-07

19	192.55	119.52
20	194.11	120.78
21	195.63	122.07
22	197.12	123.41
23	197.46	123.73

Circle Center At X = 147.2 ; Y = 177.5 and Radius, 73.7
*** 1.678 ***
Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	108.33
2	168.66	108.12
3	170.65	108.04
4	172.65	108.11
5	174.64	108.33
6	176.61	108.69
7	178.55	109.18
8	180.44	109.82
9	182.29	110.60
10	184.07	111.50
11	185.78	112.53
12	187.42	113.68
13	188.96	114.95
14	190.42	116.33
15	191.76	117.80
16	193.00	119.38
17	194.12	121.03
18	194.96	122.48

Circle Center At X = 170.7 ; Y = 135.7 and Radius, 27.7
*** 1.710 ***
Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.00	105.00
2	161.94	104.51
3	163.90	104.10
4	165.87	103.78
5	167.86	103.54
6	169.85	103.40
7	171.85	103.34
8	173.85	103.37
9	175.85	103.49
10	177.84	103.70
11	179.81	104.00
12	181.78	104.38
13	183.72	104.85
14	185.64	105.40
15	187.54	106.04
16	189.40	106.77
17	191.23	107.57
18	193.03	108.46
19	194.78	109.42
20	196.49	110.46
21	198.15	111.58
22	199.76	112.76
23	201.31	114.02
24	202.81	115.35
25	204.25	116.74
26	205.62	118.19
27	206.93	119.70
28	208.17	121.27
29	209.34	122.89
30	210.44	124.56
31	210.70	125.00

Circle Center At X = 172.1 ; Y = 148.5 and Radius, 45.2
*** 1.762 ***
Failure Surface Specified By 13 Coordinate Points

JDP 10-11-07

Point No.	X-Surf (ft)	Y-Surf (ft)
1	173.33	111.67
2	175.33	111.72
3	177.32	111.95
4	179.28	112.35
5	181.20	112.91
6	183.06	113.65
7	184.85	114.54
8	186.55	115.58
9	188.16	116.77
10	189.66	118.09
11	191.04	119.54
12	192.29	121.11
13	192.33	121.16

Circle Center At X = 173.7 ; Y = 134.6 and Radius, 23.0

*** 1.887 ***

HDR | ONE COMPANY *Many Solutions*™

Project: RH-TR Connector		Computed: WWE	Date: 6/14/07
Subject: Fill Slope Stability		Checked:	Date:
Task: Piney Run Bridge		Page: 1	of:
Job #: 53410		No:	

JDP 10-11-07

- Check fill slope stability @ Abutment A of Piney Run Bridge. This is the critical location
- Use Boring BS-8, sta 220+00, 20' RT
- For compacted fill, assume:

① $\gamma_m = 120$ pcf
$\phi = 30°$
$c = 50$ psf

HDR | ONE COMPANY *Many Solutions*

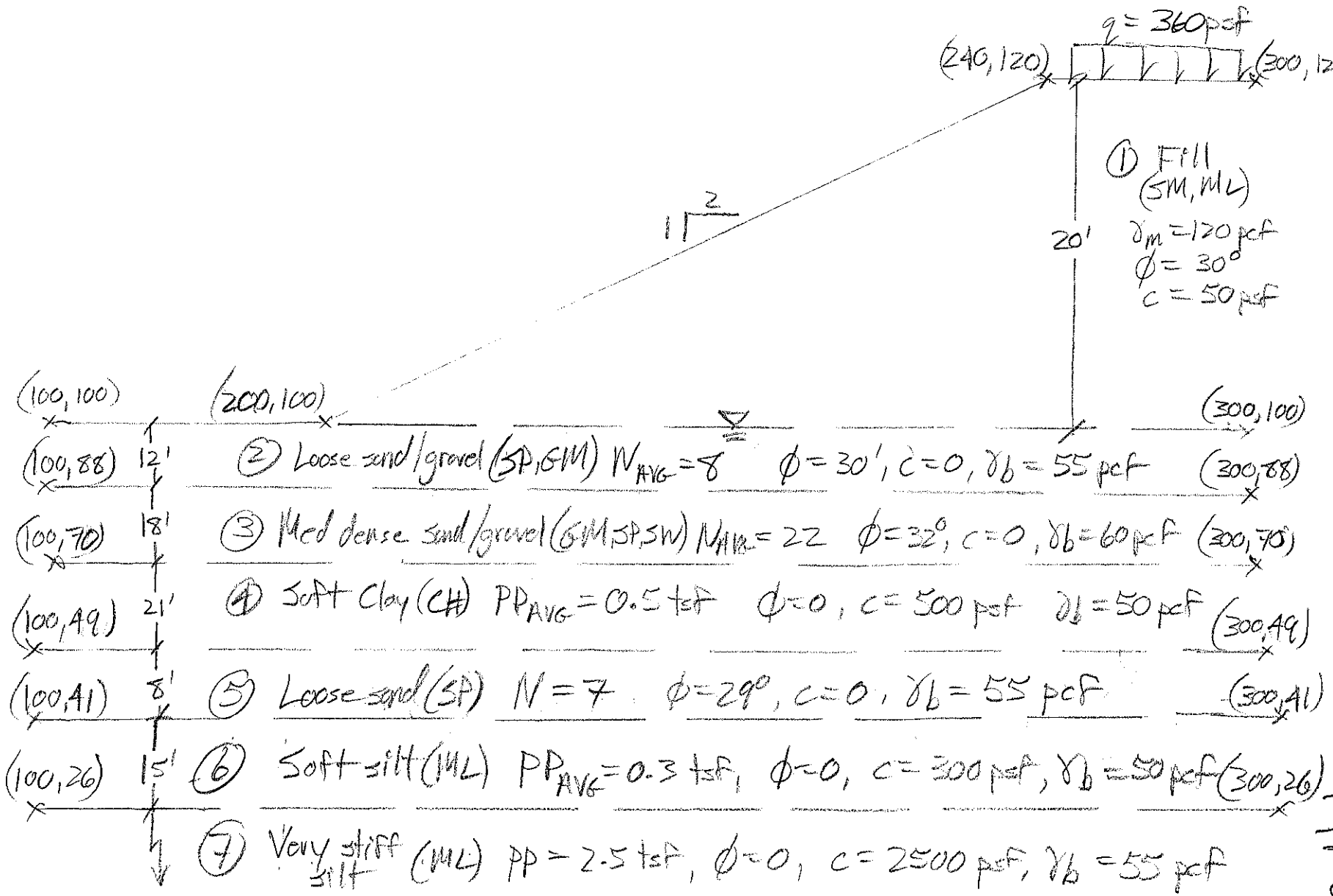
Project: RH-TR Connector | Computed: MWB | Date: 6/14/07

Subject: Fill Slope Stability | Checked: | Date:

Task: Piney Run Bridge | Page: 2 | of:

Job #: 53410 | No.

JDP 10-1-07



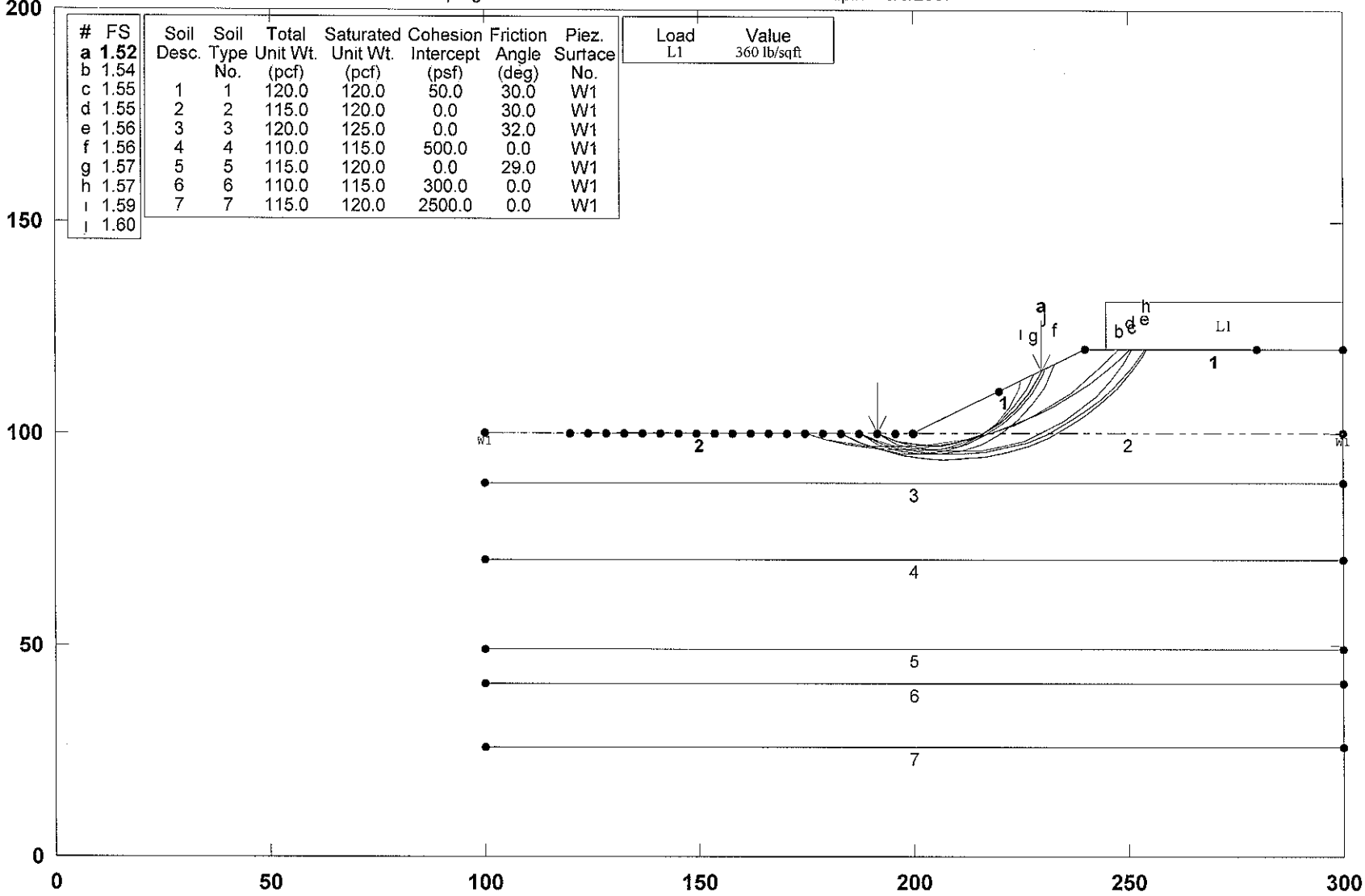
Richmond Highway-Telegraph Rd Connector Fill Slope Sta 220+00 - 2(H):1(V)

c:\program files\stedwin\rte ı connector\fill 220+00 st.pl2 8/8/2007

#	FS
a	**1.52**
b	1.54
c	1.55
d	1.55
e	1.56
f	1.56
g	1.57
h	1.57
ı	1.59
ı	1.60

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
1	1	120.0	120.0	50.0	30.0	W1
2	2	115.0	120.0	0.0	30.0	W1
3	3	120.0	125.0	0.0	32.0	W1
4	4	110.0	115.0	500.0	0.0	W1
5	5	115.0	120.0	0.0	29.0	W1
6	6	110.0	115.0	300.0	0.0	W1
7	7	115.0	120.0	2500.0	0.0	W1

Load	Value
L1	360 lb/sqft



STABL6H FSmin=1.52

Safety Factors Are Calculated By The Modified Bishop Method

HDR

JDP 10-11-07

JDP
10-11-07

**** STABL6H ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 8/8/2007
Time of Run:
Run By:
Input Data Filename: C:fill 220+00 st.in
Output Filename: C:fill 220+00 st.OUT
Plotted Output Filename: C:fill 220+00 st.PLT
PROBLEM DESCRIPTION Richmond Highway-Telegraph Rd Connector
Fill Slope Sta 220+00 - 2(H):1(V)

BOUNDARY COORDINATES
3 Top Boundaries
9 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	100.00	100.00	200.00	100.00	2
2	200.00	100.00	240.00	120.00	1
3	240.00	120.00	300.00	120.00	1
4	200.00	100.00	300.00	100.00	2
5	100.00	88.00	300.00	88.00	3
6	100.00	70.00	300.00	70.00	4
7	100.00	49.00	300.00	49.00	5

JDP 10-11-07

8	100.00	41.00	300.00	41.00	6
9	100.00	26.00	300.00	26.00	7

ISOIROPIC SOIL PARAMETERS
7 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	50.0	30.0	0.00	0.0	1
2	115.0	120.0	0.0	30.0	0.00	0.0	1
3	120.0	125.0	0.0	32.0	0.00	0.0	1
4	110.0	115.0	500.0	0.0	0.00	0.0	1
5	115.0	120.0	0.0	29.0	0.00	0.0	1
6	110.0	115.0	300.0	0.0	0.00	0.0	1
7	115.0	120.0	2500.0	0.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	100.00	100.00
2	300.00	100.00

BOUNDARY LOAD(S)
1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	245.00	300.00	360.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
200 Trial Surfaces Have Been Generated.
10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 120.00 ft.
and X = 200.00 ft.
Each Surface Terminates Between X = 220.00 ft.
and X = 280.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.
5.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	191.58	100.00
2	196.26	98.23
3	201.17	97.32
4	206.17	97.30
5	211.10	98.18
6	215.79	99.91
7	220.09	102.45
8	223.88	105.72
9	227.02	109.60
10	229.43	113.99
11	229.72	114.86

Circle Center At X = 203.8 ; Y = 125.2 and Radius, 28.0
*** 1.517 ***
Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	174.74	100.00
2	179.53	98.59
3	184.42	97.53
4	189.37	96.83
5	194.36	96.50

JDP 10-11-07

6	199.36	96.54
7	204.34	96.94
8	209.28	97.70
9	214.16	98.83
10	218.93	100.32
11	223.58	102.14
12	228.09	104.31
13	232.43	106.80
14	236.57	109.60
15	240.49	112.70
16	244.18	116.08
17	247.61	119.72
18	247.84	120.00

Circle Center At X = 196.4 ; Y = 164.5 and Radius, 68.1

*** 1.538 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	191.58	100.00
2	196.23	98.18
3	201.06	96.87
4	206.00	96.10
5	211.00	95.87
6	215.99	96.18
7	220.91	97.04
8	225.72	98.42
9	230.34	100.32
10	234.73	102.72
11	238.83	105.57
12	242.60	108.86
13	245.99	112.54
14	248.96	116.56
15	250.96	120.00

Circle Center At X = 210.6 ; Y = 141.7 and Radius, 45.9

*** 1.550 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	174.74	100.00
2	179.58	98.76
3	184.50	97.84
4	189.46	97.24
5	194.45	96.97
6	199.45	97.03
7	204.44	97.42
8	209.39	98.14
9	214.28	99.18
10	219.09	100.54
11	223.80	102.21
12	228.39	104.19
13	232.84	106.47
14	237.14	109.03
15	241.25	111.87
16	245.17	114.97
17	248.88	118.33
18	250.50	120.00

Circle Center At X = 196.0 ; Y = 173.0 and Radius, 76.0

*** 1.554 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	187.37	100.00
2	192.00	98.13
3	196.80	96.70
4	201.71	95.75
5	206.68	95.26
6	211.68	95.25

JDP 10-11-07

7	216.66	95.72
8	221.57	96.66
9	226.37	98.06
10	231.01	99.92
11	235.46	102.21
12	239.66	104.91
13	243.59	108.00
14	247.21	111.46
15	250.48	115.24
16	253.37	119.32
17	253.77	120.00

Circle Center At X = 209.3 ; Y = 147.6 and Radius, 52.4
*** 1.559 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	187.37	100.00
2	191.76	97.60
3	196.48	95.97
4	201.41	95.13
5	206.41	95.12
6	211.34	95.94
7	216.07	97.56
8	220.47	99.94
9	224.41	103.02
10	227.79	106.70
11	230.52	110.89
12	232.51	115.48
13	232.73	116.37

Circle Center At X = 204.0 ; Y = 125.2 and Radius, 30.1
*** 1.560 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	187.37	100.00
2	191.88	97.85
3	196.71	96.53
4	201.69	96.08
5	206.67	96.51
6	211.50	97.81
7	216.02	99.93
8	220.11	102.82
9	223.62	106.38
10	226.45	110.50
11	228.05	114.03

Circle Center At X = 201.8 ; Y = 124.4 and Radius, 28.4
*** 1.566 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.16	100.00
2	187.69	97.89
3	192.40	96.21
4	197.25	94.98
5	202.18	94.19
6	207.17	93.87
7	212.17	94.01
8	217.14	94.60
9	222.02	95.66
10	226.79	97.16
11	231.40	99.10
12	235.81	101.45
13	239.99	104.20
14	243.89	107.32
15	247.49	110.80
16	250.75	114.59
17	253.65	118.66

JDP
10-11-07


```
   18        254.43      120.00
Circle Center At X =  208.2 ; Y =  147.9  and Radius,   54.1
      ***     1.570   ***
Failure Surface Specified By 10 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        191.58      100.00
    2        196.00       97.66
    3        200.83       96.38
    4        205.83       96.23
    5        210.73       97.22
    6        215.28       99.29
    7        219.24      102.35
    8        222.40      106.22
    9        224.61      110.71
   10        225.02      112.51
Circle Center At X =  204.0 ; Y =  118.0  and Radius,   21.9
      ***     1.592   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        183.16      100.00
    2        187.63       97.77
    3        192.39       96.23
    4        197.32       95.42
    5        202.32       95.36
    6        207.28       96.05
    7        212.07       97.47
    8        216.60       99.60
    9        220.75      102.38
   10        224.45      105.75
   11        227.59      109.63
   12        230.12      113.94
   13        230.68      115.34
Circle Center At X =  200.2 ; Y =  128.6  and Radius,   33.3
      ***     1.596   ***
```

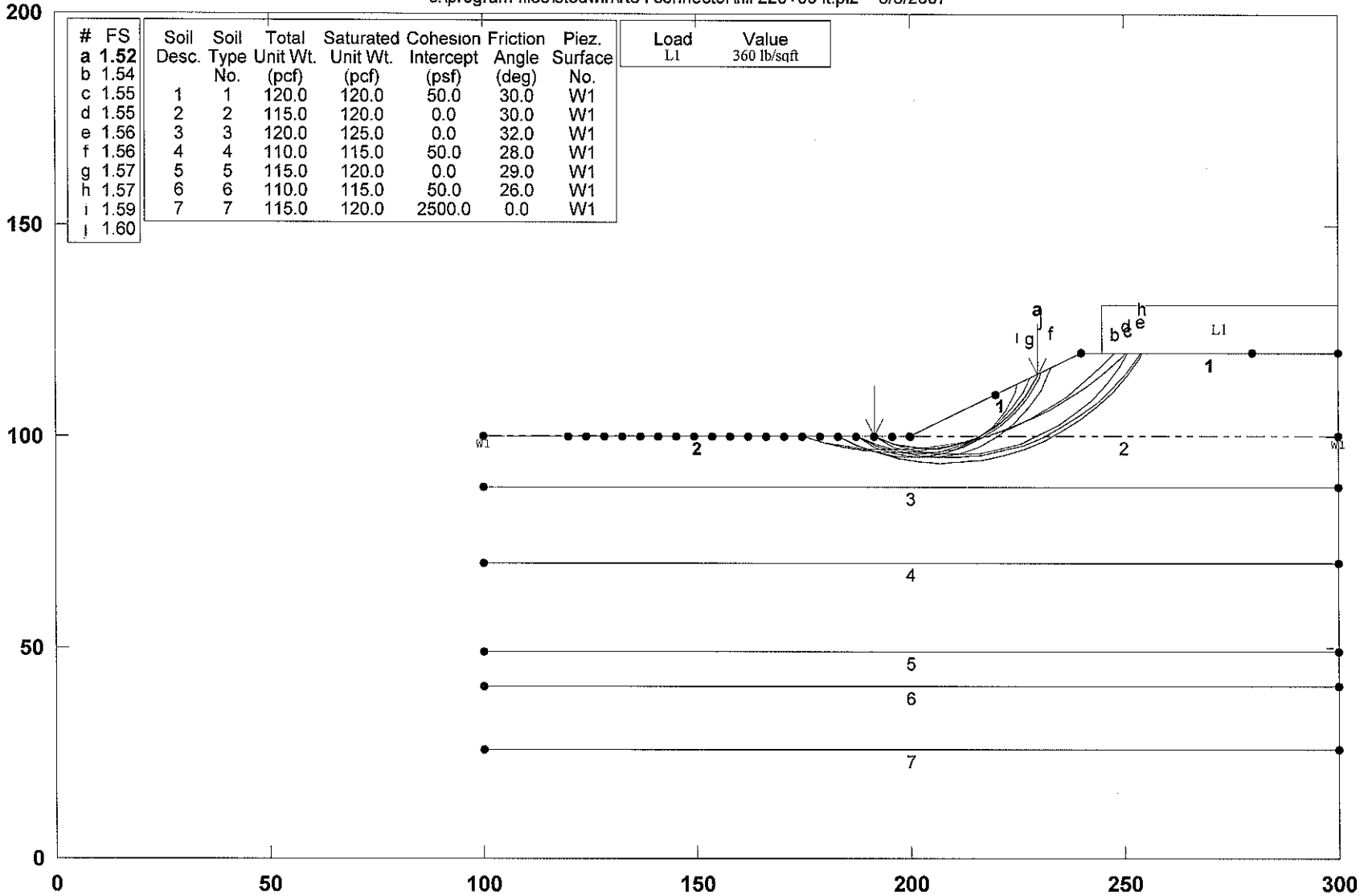
Richmond Highway-Telegraph Rd Connector Fill Slope Sta 220+00 - 2(H):1(V)

c:\program files\stedwin\rte i connector\fill 220+00 lt.pl2 8/8/2007

#	FS
a	1.52
b	1.54
c	1.55
d	1.55
e	1.56
f	1.56
g	1.57
h	1.57
i	1.59
j	1.60

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
1	1	120.0	120.0	50.0	30.0	W1
2	2	115.0	120.0	0.0	30.0	W1
3	3	120.0	125.0	0.0	32.0	W1
4	4	110.0	115.0	50.0	28.0	W1
5	5	115.0	120.0	0.0	29.0	W1
6	6	110.0	115.0	50.0	26.0	W1
7	7	115.0	120.0	2500.0	0.0	W1

Load	Value
L1	360 lb/sqft



STABL6H FSmin=1.52

Safety Factors Are Calculated By The Modified Bishop Method

HDR

JDP 10-11-07

JDP
10-11-07

**** STABL6H ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 8/8/2007
Time of Run:
Run By:
Input Data Filename: C:fill 220+00 lt.
Output Filename: C:fill 220+00 lt.OUT
Plotted Output Filename: C:fill 220+00 lt.PLT
PROBLEM DESCRIPTION Richmond Highway-Telegraph Rd Connector
Fill Slope Sta 220+00 - 2(H):1(V)

BOUNDARY COORDINATES
3 Top Boundaries
9 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	100.00	100.00	200.00	100.00	2
2	200.00	100.00	240.00	120.00	1
3	240.00	120.00	300.00	120.00	1
4	200.00	100.00	300.00	100.00	2
5	100.00	88.00	300.00	88.00	3
6	100.00	70.00	300.00	70.00	4
7	100.00	49.00	300.00	49.00	5
8	100.00	41.00	300.00	41.00	6
9	100.00	26.00	300.00	26.00	7

ISOTROPIC SOIL PARAMETERS
7 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	50.0	30.0	0.00	0.0	1
2	115.0	120.0	0.0	30.0	0.00	0.0	1
3	120.0	125.0	0.0	32.0	0.00	0.0	1
4	110.0	115.0	50.0	28.0	0.00	0.0	1
5	115.0	120.0	0.0	29.0	0.00	0.0	1
6	110.0	115.0	50.0	26.0	0.00	0.0	1
7	115.0	120.0	2500.0	0.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	100.00	100.00
2	300.00	100.00

BOUNDARY LOAD(S)
1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	245.00	300.00	360.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
200 Trial Surfaces Have Been Generated.
10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 120.00 ft.
and X = 200.00 ft.
Each Surface Terminates Between X = 220.00 ft.
and X = 280.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.
5.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical

JDP 10-11-07

First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	191.58	100.00
2	196.26	98.23
3	201.17	97.32
4	206.17	97.30
5	211.10	98.18
6	215.79	99.91
7	220.09	102.45
8	223.88	105.72
9	227.02	109.60
10	229.43	113.99
11	229.72	114.86

Circle Center At X = 203.8 ; Y = 125.2 and Radius, 28.0
*** 1.517 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	174.74	100.00
2	179.53	98.59
3	184.42	97.53
4	189.37	96.83
5	194.36	96.50
6	199.36	96.54
7	204.34	96.94
8	209.28	97.70
9	214.16	98.83
10	218.93	100.32
11	223.58	102.14
12	228.09	104.31
13	232.43	106.80
14	236.57	109.60
15	240.49	112.70
16	244.18	116.08
17	247.61	119.72
18	247.84	120.00

Circle Center At X = 196.4 ; Y = 164.5 and Radius, 68.1
*** 1.538 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	191.58	100.00
2	196.23	98.18
3	201.06	96.87
4	206.00	96.10
5	211.00	95.87
6	215.99	96.18
7	220.91	97.04
8	225.72	98.42
9	230.34	100.32
10	234.73	102.72
11	238.83	105.57
12	242.60	108.86
13	245.99	112.54
14	248.96	116.56
15	250.96	120.00

Circle Center At X = 210.6 ; Y = 141.7 and Radius, 45.9
*** 1.550 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	174.74	100.00
2	179.58	98.76
3	184.50	97.84

JDP
10-11-07

4	189.46	97.24
5	194.45	96.97
6	199.45	97.03
7	204.44	97.42
8	209.39	98.14
9	214.28	99.18
10	219.09	100.54
11	223.80	102.21
12	228.39	104.19
13	232.84	106.47
14	237.14	109.03
15	241.25	111.87
16	245.17	114.97
17	248.88	118.33
18	250.50	120.00

Circle Center At X = 196.0 ; Y = 173.0 and Radius, 76.0

*** 1.554 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	187.37	100.00
2	192.00	98.13
3	196.80	96.70
4	201.71	95.75
5	206.68	95.26
6	211.68	95.25
7	216.66	95.72
8	221.57	96.66
9	226.37	98.06
10	231.01	99.92
11	235.46	102.21
12	239.66	104.91
13	243.59	108.00
14	247.21	111.46
15	250.48	115.24
16	253.37	119.32
17	253.77	120.00

Circle Center At X = 209.3 ; Y = 147.6 and Radius, 52.4

*** 1.559 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	187.37	100.00
2	191.76	97.60
3	196.48	95.97
4	201.41	95.13
5	206.41	95.12
6	211.34	95.94
7	216.07	97.56
8	220.47	99.94
9	224.41	103.02
10	227.79	106.70
11	230.52	110.89
12	232.51	115.48
13	232.73	116.37

Circle Center At X = 204.0 ; Y = 125.2 and Radius, 30.1

*** 1.560 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	187.37	100.00
2	191.88	97.85
3	196.71	96.53
4	201.69	96.08
5	206.67	96.51
6	211.50	97.81
7	216.02	99.93

JDP
10-11-07


```
     8        220.11      102.82
     9        223.62      106.38
    10        226.45      110.50
    11        228.05      114.03
Circle Center At X =  201.8 ; Y =  124.4  and Radius,   28.4
      ***     1.566   ***
Failure Surface Specified By 18 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
     1        183.16      100.00
     2        187.69       97.89
     3        192.40       96.21
     4        197.25       94.98
     5        202.18       94.19
     6        207.17       93.87
     7        212.17       94.01
     8        217.14       94.60
     9        222.02       95.66
    10        226.79       97.16
    11        231.40       99.10
    12        235.81      101.45
    13        239.99      104.20
    14        243.89      107.32
    15        247.49      110.80
    16        250.75      114.59
    17        253.65      118.66
    18        254.43      120.00
Circle Center At X =  208.2 ; Y =  147.9  and Radius,   54.1
      ***     1.570   ***
Failure Surface Specified By 10 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
     1        191.58      100.00
     2        196.00       97.66
     3        200.83       96.38
     4        205.83       96.23
     5        210.73       97.22
     6        215.28       99.29
     7        219.24      102.35
     8        222.40      106.22
     9        224.61      110.71
    10        225.02      112.51
Circle Center At X =  204.0 ; Y =  118.0  and Radius,   21.9
      ***     1.592   ***
Failure Surface Specified By 13 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
     1        183.16      100.00
     2        187.63       97.77
     3        192.39       96.23
     4        197.32       95.42
     5        202.32       95.36
     6        207.28       96.05
     7        212.07       97.47
     8        216.60       99.60
     9        220.75      102.38
    10        224.45      105.75
    11        227.59      109.63
    12        230.12      113.94
    13        230.68      115.34
Circle Center At X =  200.2 ; Y =  128.6  and Radius,   33.3
      ***     1.596   ***
```

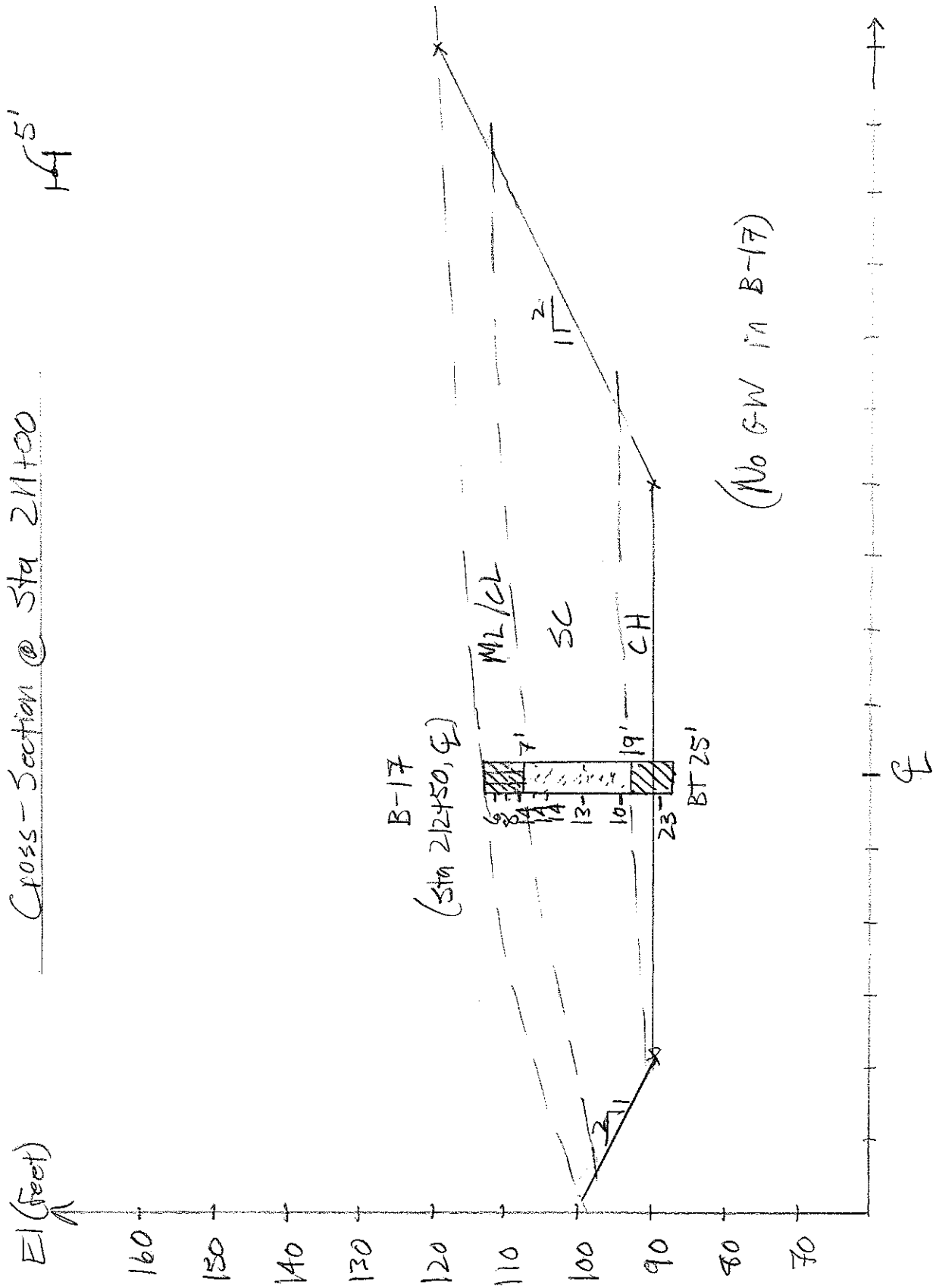
HDR | ONE COMPANY *Many Solutions*

Project: RH-TR Connector		Computed: WMB	Date: 8/8/07
Subject: Cut Slope Stability		Checked: JDP	Date: 10-11-07
Task:		Page: 1	of.
Job #: 53410		No:	

- Critical Cut Section on project is @ sta 211+00 of Connector Road (cut height = 30')
- Use boring B-17 (sta 212+50)
- See attached cross-section @ sta 211+00

HDR | ONE COMPANY *Many Solutions*™

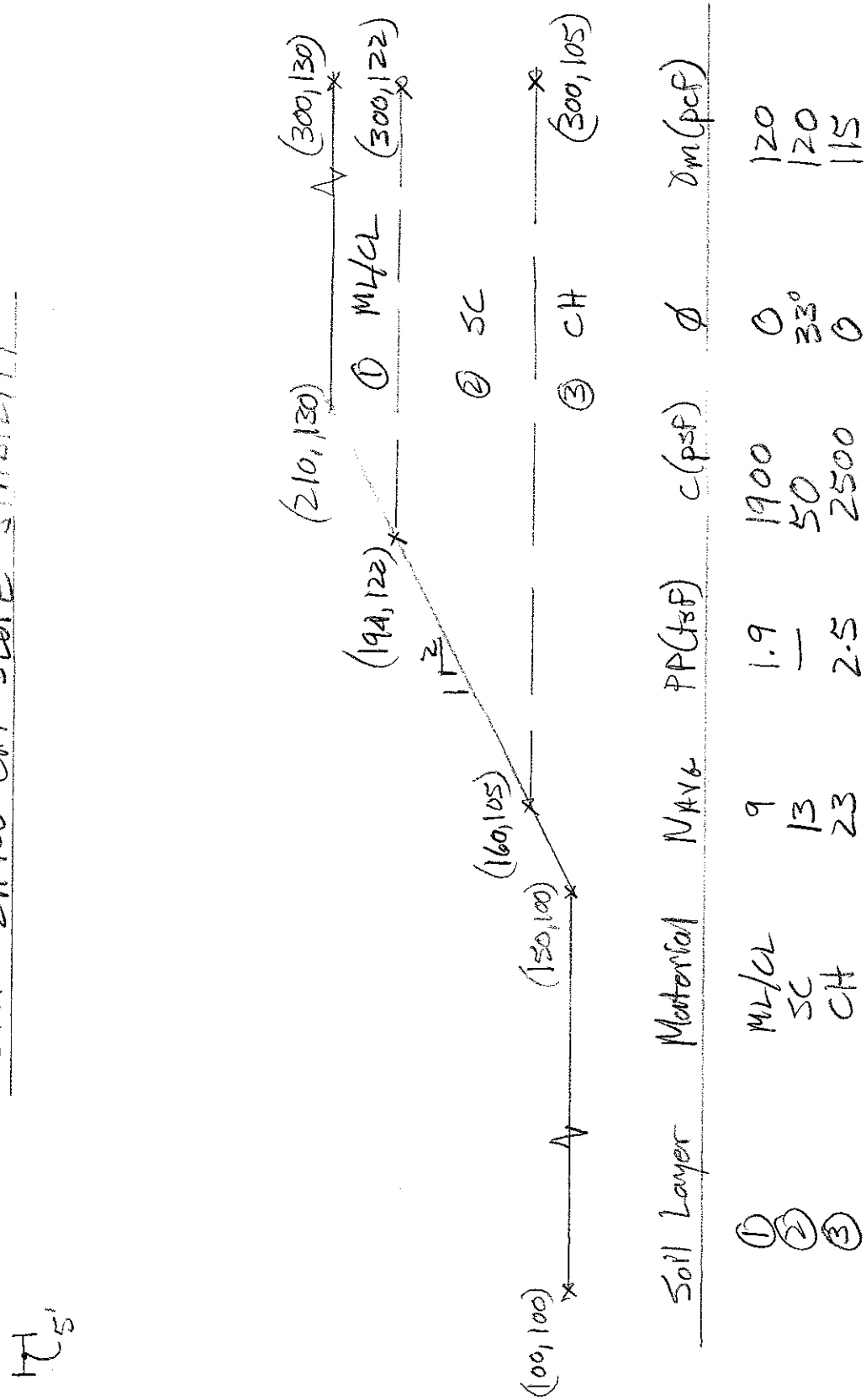
Project: RH-TR Connector		Computed: NWB	Date: 8/8/07
Subject: Cut Slope Stability		Checked: JDP	Date: 10-11-07
Task:		Page: 2	of:
Job #: 53410		No:	



HDR | ONE COMPANY *Many Solutions*™

Project: RH-TR Connector		Computed: NHB	Date: 8/8/07
Subject: Cut Slope Stability		Checked: JDP	Date: 10-11-07
Task:		Page: 3	of:
Job #: 53410		No:	

STA 211+00 CUT SLOPE STABILITY



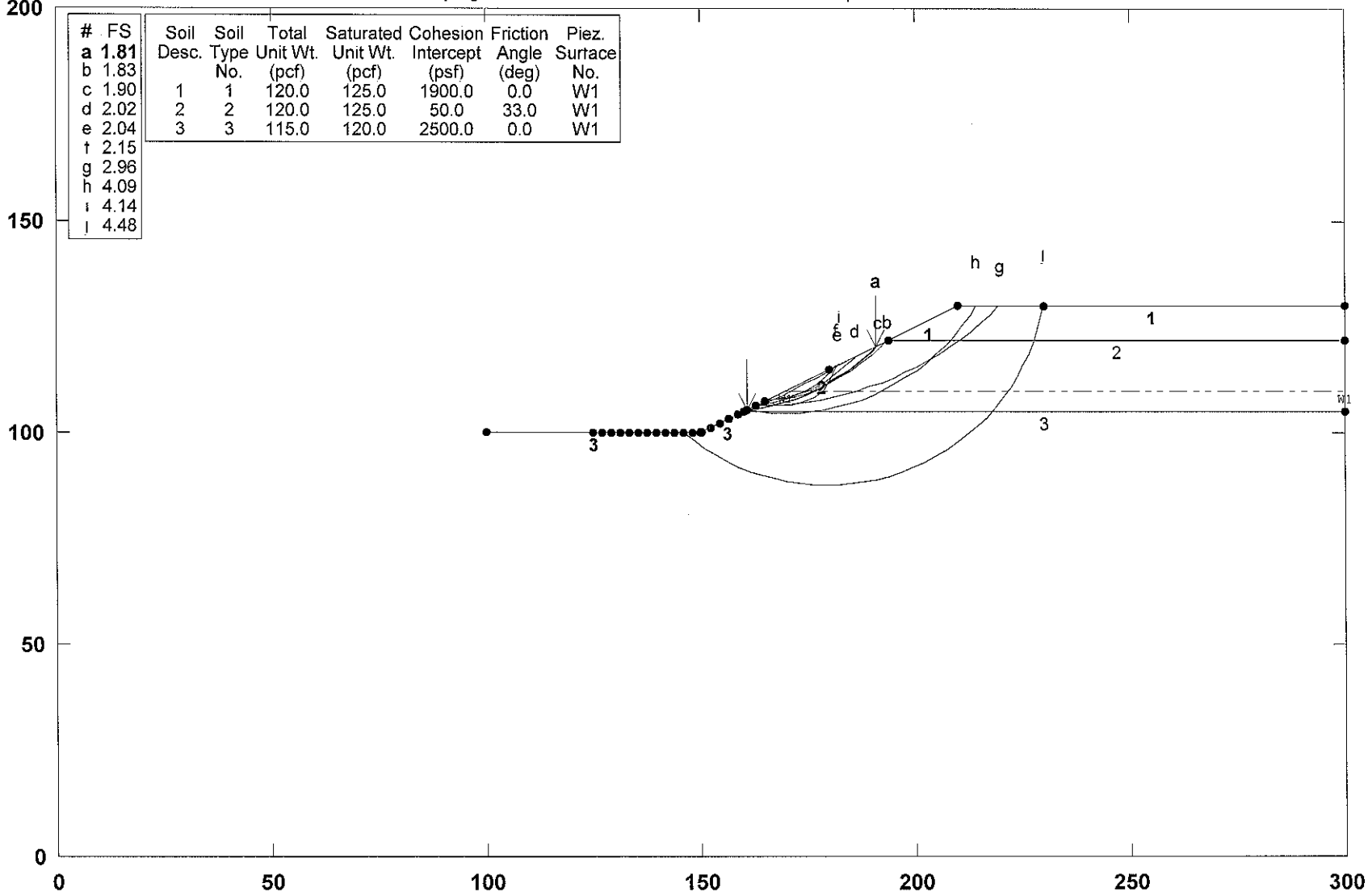
Soil Layer	Material	N_{AVG}	PP (tsf)	c (psf)	ϕ	γ_m (pcf)
①	ML/CL	9	1.9	1900	0	120
②	SC	13	—	50	33°	120
③	CH	23	2.5	2500	0	115

RichmondHighway-Telegraph Rd Connector Cut Slope Sta 211+00 - 2(H):1(V), ST

c:\program files\stedwin\rte ı connector\cut 211+00 st.pl2 8/8/2007

#	FS
a	**1.81**
b	1.83
c	1.90
d	2.02
e	2.04
f	2.15
g	2.96
h	4.09
i	4.14
j	4.48

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
1	1	120.0	125.0	1900.0	0.0	W1
2	2	120.0	125.0	50.0	33.0	W1
3	3	115.0	120.0	2500.0	0.0	W1



STABL6H FSmin=1.81

Safety Factors Are Calculated By The Modified Bishop Method

HDR

JDP 10-11-07

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10-11-07

**** STABL6H ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 8/8/2007
Time of Run:
Run By:
Input Data Filename: C:cut 211+00 st.in
Output Filename: C:cut 211+00 st.OUT
Plotted Output Filename: C:cut 211+00 st.PLI
PROBLEM DESCRIPIION RichmondHighway-Ielegraph Rd Connector
Cut Slope Sta 211+00 - 2(H):1(V), ST

BOUNDARY COORDINATES
5 Top Boundaries
7 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	100.00	100.00	150.00	100.00	3
2	150.00	100.00	160.00	105.00	3
3	160.00	105.00	194.00	122.00	2
4	194.00	122.00	210.00	130.00	1
5	210.00	130.00	300.00	130.00	1
6	194.00	122.00	300.00	122.00	2
7	160.00	105.00	300.00	105.00	3

JDP
10-11-07

ISOIROPIC SOIL PARAMETERS
3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	1900.0	0.0	0.00	0.0	1
2	120.0	125.0	50.0	33.0	0.00	0.0	1
3	115.0	120.0	2500.0	0.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	170.00	110.00
2	300.00	110.00

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
200 Trial Surfaces Have Been Generated.
10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 125.00 ft.
and X = 165.00 ft.
Each Surface Terminates Between X = 180.00 ft.
and X = 230.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.
3.00 ft. Line Segments Define Each Irial Failure Surface.
Following Are Displayed Ihe Ten Most Critical Of Ihe Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.79	105.40
2	163.76	105.79
3	166.71	106.37
4	169.61	107.14
5	172.45	108.08
6	175.24	109.21
7	177.94	110.51
8	180.56	111.97
9	183.08	113.60
10	185.49	115.38
11	187.79	117.31
12	189.96	119.38
13	190.98	120.49

Circle Center At X = 156.0 ; Y = 152.7 and Radius, 47.6
*** 1.811 ***
Failure Surface Specified By 13 Coordinate Points

Point No	X-Surf (ft)	Y-Surf (ft)
1	162.90	106.45
2	165.86	106.90
3	168.79	107.53
4	171.69	108.33
5	174.53	109.29
6	177.31	110.42
7	180.01	111.71
8	182.64	113.16
9	185.18	114.76
10	187.62	116.50
11	189.96	118.39
12	192.18	120.40
13	193.50	121.75

Circle Center At X = 156.6 ; Y = 157.4 and Radius, 51.3
*** 1.830 ***
Failure Surface Specified By 11 Coordinate Points

JDP
10-11-07

Point No.	X-Surf (ft)	Y-Surf (ft)
1	165.00	107.50
2	167.97	107.91
3	170.91	108.54
4	173.79	109.38
5	176.60	110.43
6	179.33	111.68
7	181.96	113.12
8	184.48	114.75
9	186.87	116.55
10	189.13	118.53
11	191.15	120.57

Circle Center At X = 160.8 ; Y = 148.6 and Radius, 41.4

*** 1.898 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	165.00	107.50
2	167.97	107.90
3	170.90	108.57
4	173.74	109.52
5	176.48	110.74
6	179.10	112.21
7	181.56	113.93
8	183.85	115.87
9	185.86	117.93

Circle Center At X = 162.3 ; Y = 138.9 and Radius, 31.6

*** 2.023 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	165.00	107.50
2	167.87	106.63
3	170.87	106.49
4	173.81	107.09
5	176.51	108.40
6	178.81	110.33
7	180.56	112.76
8	181.66	115.55
9	181.70	115.85

Circle Center At X = 169.9 ; Y = 118.6 and Radius, 12.1

*** 2.044 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	162.90	106.45
2	165.87	106.85
3	168.78	107.56
4	171.60	108.59
5	174.29	109.92
6	176.83	111.52
7	179.17	113.39
8	181.30	115.50
9	181.50	115.75

Circle Center At X = 160.7 ; Y = 134.2 and Radius, 27.8

*** 2.150 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	162.90	106.45
2	165.90	106.48
3	168.89	106.62
4	171.88	106.88
5	174.86	107.25
6	177.82	107.74
7	180.76	108.34

JDP
10-11-07

8	183.67	109.06
9	186.56	109.88
10	189.41	110.81
11	192.22	111.86
12	194.99	113.01
13	197.71	114.26
14	200.39	115.62
15	203.01	117.08
16	205.57	118.64
17	208.07	120.30
18	210.51	122.05
19	212.87	123.90
20	215.17	125.83
21	217.39	127.85
22	219.53	129.95
23	219.57	130.00

Circle Center At X = 163.6 ; Y = 184.7 and Radius, 78.2
*** 2.956 ***
Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.79	105.40
2	163.76	104.97
3	166.75	104.72
4	169.75	104.65
5	172.75	104.74
6	175.73	105.01
7	178.70	105.46
8	181.64	106.07
9	184.53	106.86
10	187.38	107.81
11	190.17	108.92
12	192.88	110.19
13	195.52	111.62
14	198.07	113.20
15	200.53	114.92
16	202.88	116.79
17	205.12	118.78
18	207.24	120.90
19	209.23	123.15
20	211.09	125.50
21	212.81	127.96
22	214.08	130.00

Circle Center At X = 169.6 ; Y = 156.4 and Radius, 51.8
*** 4.088 ***
Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	160.79	105.40
2	163.58	106.49
3	166.35	107.66
4	169.08	108.90
5	171.78	110.20
6	174.44	111.58
7	177.07	113.02
8	179.67	114.54
9	182.18	116.09

Circle Center At X = 119.5 ; Y = 214.7 and Radius, 116.9
*** 4.141 ***
Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	146.05	100.00
2	148.38	98.11
3	150.82	96.36
4	153.36	94.76
5	155.98	93.31

JDP
10-11-07

6	158.69	92.01
7	161.47	90.88
8	164.30	89.91
9	167.19	89.11
10	170.13	88.47
11	173.09	88.02
12	176.08	87.73
13	179.08	87.63
14	182.08	87.70
15	185.07	87.94
16	188.04	88.36
17	190.98	88.95
18	193.88	89.72
19	196.73	90.65
20	199.52	91.75
21	202.24	93.01
22	204.89	94.43
23	207.44	96.00
24	209.90	97.71
25	212.26	99.57
26	214.50	101.57
27	216.62	103.69
28	218.61	105.93
29	220.47	108.28
30	222.19	110.74
31	223.76	113.30
32	225.18	115.95
33	226.44	118.67
34	227.53	121.46
35	228.47	124.31
36	229.23	127.21
37	229.79	130.00

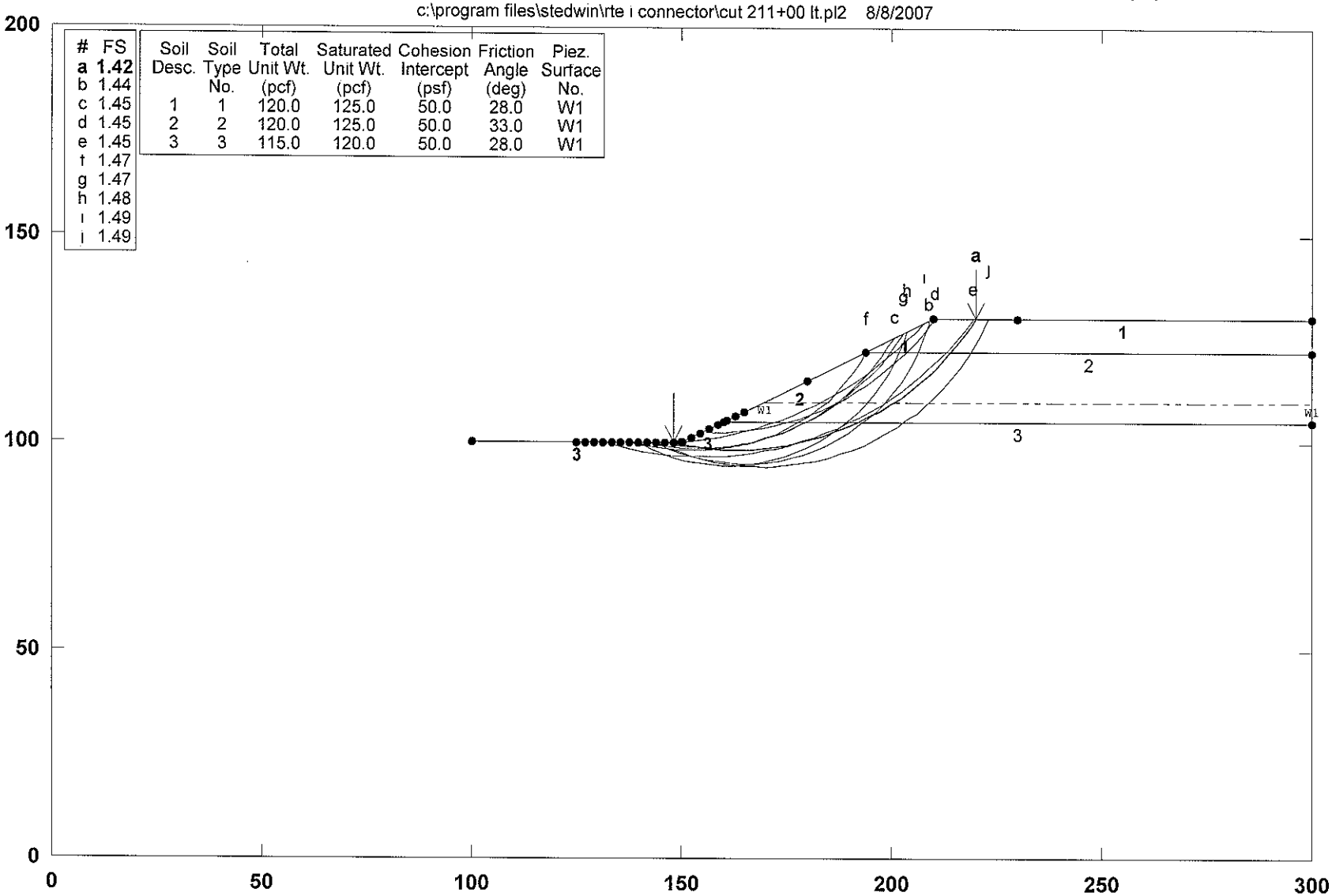
Circle Center At X = 179.4 ; Y = 138.8 and Radius, 51.1
*** 4.476 ***

RichmondHighway-Telegraph Rd Connector Cut Slope Sta 211+00 - 2(H):1(V), LT

c:\program files\stedwin\rte i connector\cut 211+00 lt.pl2 8/8/2007

#	FS
a	**1.42**
b	1.44
c	1.45
d	1.45
e	1.45
f	1.47
g	1.47
h	1.48
i	1.49
j	1.49

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
1	1	120.0	125.0	50.0	28.0	W1
2	2	120.0	125.0	50.0	33.0	W1
3	3	115.0	120.0	50.0	28.0	W1



STABL6H FSmin=1.42

Safety Factors Are Calculated By The Modified Bishop Method

HDR

JDP 10-11-07

JDP
10-11-07


```
                    ** STABL6H  **
                          by
                   Purdue University
             --Slope Stability Analysis--
          Simplified Janbu, Simplified Bishop
             or Spencer`s Method of Slices
 Run Date:                  8/8/2007
 Time of Run:
 Run By:
 Input Data Filename:       C:cut 211+00 lt.in
 Output Filename:           C:cut 211+00 lt.OUT
 Plotted Output Filename:   C:cut 211+00 lt.PLI
 PROBLEM DESCRIPTION   RichmondHighway-Telegraph Rd Connector
                       Cut Slope Sta 211+00 - 2(H):1(V), LT
 BOUNDARY COORDINATES
     5 Top   Boundaries
     7 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
     1        100.00     100.00     150.00     100.00        3
     2        150.00     100.00     160.00     105.00        3
     3        160.00     105.00     194.00     122.00        2
     4        194.00     122.00     210.00     130.00        1
     5        210.00     130.00     300.00     130.00        1
     6        194.00     122.00     300.00     122.00        2
     7        160.00     105.00     300.00     105.00        3
ISOTROPIC SOIL PARAMETERS
  3 Type(s) of Soil
 Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
 Type Unit Wt. Unit Wt. Intercept  Angle  Pressure Constant Surface
  No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)    No.
   1   120.0    125.0     50.0      28.0    0.00      0.0      1
   2   120.0    125.0     50.0      33.0    0.00      0.0      1
   3   115.0    120.0     50.0      28.0    0.00      0.0      1
 1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
 Unit Weight of Water =  62.40
 Piezometric Surface No.  1 Specified by  2 Coordinate Points
   Point      X-Water     Y-Water
    No.        (ft)        (ft)
     1        170.00      110.00
     2        300.00      110.00
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
 200 Trial Surfaces Have Been Generated.
  10 Surfaces Initiate From Each Of 20 Points Equally Spaced
 Along The Ground Surface Between  X = 125.00 ft.
                                and  X = 165.00 ft.
 Each Surface Terminates Between   X = 180.00 ft.
                               and   X = 230.00 ft.
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =  0.00 ft.
  3.00 ft. Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Examined.  They Are Ordered - Most Critical
       First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Failure Surface Specified By 29 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        148.16      100.00
           2        151.10       99.41
           3        154.06       98.95
           4        157.05       98.62
           5        160.04       98.43
           6        163.04       98.37
           7        166.04       98.44
           8        169.03       98.64
```

JDP
10-11-07

9	172.01	98.98
10	174.98	99.45
11	177.92	100.05
12	180.83	100.78
13	183.70	101.64
14	186.53	102.62
15	189.32	103.73
16	192.06	104.96
17	194.73	106.31
18	197.35	107.78
19	199.90	109.37
20	202.37	111.06
21	204.77	112.87
22	207.08	114.78
23	209.31	116.79
24	211.45	118.89
25	213.49	121.09
26	215.43	123.38
27	217.27	125.75
28	219.00	128.20
29	220.15	130.00

Circle Center At X = 162.9 ; Y = 166.0 and Radius, 67.6
*** 1.424 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	143.95	100.00
2	146.66	98.72
3	149.45	97.62
4	152.31	96.70
5	155.22	95.98
6	158.17	95.45
7	161.15	95.11
8	164.15	94.97
9	167.15	95.03
10	170.14	95.28
11	173.10	95.73
12	176.03	96.38
13	178.92	97.21
14	181.74	98.24
15	184.48	99.44
16	187.14	100.83
17	189.71	102.38
18	192.16	104.11
19	194.50	105.99
20	196.71	108.02
21	198.78	110.19
22	200.71	112.49
23	202.47	114.91
24	204.08	117.45
25	205.51	120.08
26	206.77	122.80
27	207.85	125.60
28	208.74	128.47
29	208.99	129.49

Circle Center At X = 164.8 ; Y = 140.6 and Radius, 45.6
*** 1.441 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	141.84	100.00
2	144.78	99.40
3	147.75	98.97
4	150.74	98.70
5	153.74	98.60
6	156.74	98.66
7	159.73	98.90

JDP
10-11-07

8	162.70	99.29
9	165.65	99.86
10	168.56	100.58
11	171.42	101.47
12	174.24	102.52
13	176.98	103.72
14	179.66	105.07
15	182.26	106.57
16	184.77	108.21
17	187.19	109.99
18	189.50	111.90
19	191.70	113.94
20	193.79	116.09
21	195.75	118.36
22	197.59	120.74
23	199.29	123.21
24	200.54	125.27

Circle Center At X = 154.1 ; Y = 152.5 and Radius, 53.9
*** 1.446 ***
Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	154.47	102.24
2	157.47	102.21
3	160.47	102.33
4	163.46	102.58
5	166.44	102.96
6	169.39	103.48
7	172.32	104.13
8	175.21	104.92
9	178.07	105.84
10	180.88	106.89
11	183.64	108.06
12	186.35	109.36
13	188.99	110.78
14	191.57	112.32
15	194.07	113.97
16	196.49	115.74
17	198.84	117.61
18	201.09	119.59
19	203.25	121.67
20	205.32	123.85
21	207.28	126.12
22	209.14	128.47
23	210.24	130.00

Circle Center At X = 156.5 ; Y = 168.1 and Radius, 65.9
*** 1.452 ***
Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	131.32	100.00
2	134.21	99.19
3	137.12	98.50
4	140.07	97.91
5	143.03	97.43
6	146.00	97.06
7	148.99	96.81
8	151.99	96.66
9	154.99	96.63
10	157.99	96.71
11	160.98	96.90
12	163.97	97.21
13	166.94	97.62
14	169.89	98.15
15	172.82	98.78
16	175.73	99.52
17	178.61	100.37

JDP
10-11-07

18	181.45	101.33
19	184.26	102.40
20	187.02	103.56
21	189.74	104.83
22	192.41	106.20
23	195.02	107.67
24	197.58	109.24
25	200.08	110.90
26	202.52	112.65
27	204.88	114.49
28	207.18	116.42
29	209.41	118.43
30	211.55	120.53
31	213.62	122.70
32	215.61	124.95
33	217.51	127.27
34	219.32	129.66
35	219.56	130.00

Circle Center At X = 154.4 ; Y = 177.0 and Radius, 80.4
*** 1.453 ***
Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	146.05	100.00
2	148.99	99.40
3	151.97	99.01
4	154.96	98.83
5	157.96	98.86
6	160.95	99.10
7	163.92	99.55
8	166.85	100.21
9	169.72	101.07
10	172.53	102.13
11	175.25	103.38
12	177.88	104.83
13	180.40	106.45
14	182.81	108.25
15	185.08	110.21
16	187.21	112.32
17	189.18	114.58
18	190.99	116.97
19	192.63	119.49
20	194.03	122.02

Circle Center At X = 156.0 ; Y = 141.5 and Radius, 42.7
*** 1.465 ***
Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	137.63	100.00
2	140.56	99.36
3	143.52	98.87
4	146.50	98.53
5	149.50	98.34
6	152.50	98.29
7	155.50	98.40
8	158.49	98.65
9	161.46	99.05
10	164.41	99.60
11	167.33	100.29
12	170.21	101.13
13	173.04	102.11
14	175.83	103.22
15	178.55	104.48
16	181.21	105.87
17	183.80	107.39
18	186.31	109.03
19	188.73	110.80

JDP
10-11-07

20	191.06	112.69
21	193.30	114.69
22	195.43	116.80
23	197.46	119.01
24	199.37	121.32
25	201.17	123.72
26	202.85	126.21
27	203.04	126.52

Circle Center At X = 151.9 ; Y = 158.7 and Radius, 60.4
*** 1.465 ***
Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	139.74	100.00
2	142.42	98.66
3	145.19	97.50
4	148.03	96.53
5	150.93	95.76
6	153.87	95.18
7	156.85	94.80
8	159.84	94.63
9	162.84	94.66
10	165.83	94.89
11	168.80	95.32
12	171.73	95.95
13	174.62	96.77
14	177.44	97.79
15	180.19	99.00
16	182.84	100.39
17	185.40	101.95
18	187.85	103.69
19	190.18	105.59
20	192.37	107.63
21	194.42	109.83
22	196.31	112.15
23	198.05	114.60
24	199.61	117.16
25	201.00	119.82
26	202.21	122.56
27	203.23	125.39
28	203.64	126.82

Circle Center At X = 160.9 ; Y = 139.1 and Radius, 44.4
*** 1.480 ***
Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.26	100.13
2	153.25	100.46
3	156.21	100.89
4	159.17	101.42
5	162.10	102.06
6	165.01	102.78
7	167.89	103.61
8	170.75	104.54
9	173.57	105.56
10	176.35	106.67
11	179.10	107.88
12	181.80	109.18
13	184.46	110.57
14	187.07	112.05
15	189.63	113.62
16	192.13	115.27
17	194.58	117.00
18	196.97	118.82
19	199.29	120.72
20	201.55	122.69
21	203.74	124.74

JDP
10-11-07

22	205.86	126.87
23	207.72	128.86

Circle Center At X = 142.0 ; Y = 188.5 and Radius, 88.8
*** 1.485 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	143.95	100.00
2	146.69	98.78
3	149.49	97.70
4	152.34	96.77
5	155.23	95.98
6	158.16	95.34
7	161.13	94.85
8	164.11	94.52
9	167.10	94.34
10	170.10	94.31
11	173.10	94.44
12	176.09	94.72
13	179.05	95.15
14	182.00	95.73
15	184.91	96.47
16	187.77	97.35
17	190.59	98.38
18	193.35	99.55
19	196.05	100.86
20	198.68	102.30
21	201.23	103.88
22	203.70	105.59
23	206.07	107.42
24	208.35	109.37
25	210.53	111.44
26	212.59	113.61
27	214.55	115.89
28	216.38	118.27
29	218.09	120.73
30	219.67	123.28
31	221.12	125.91
32	222.43	128.61
33	223.02	130.00

Circle Center At X = 169.1 ; Y = 152.9 and Radius, 58.5
*** 1.485 ***

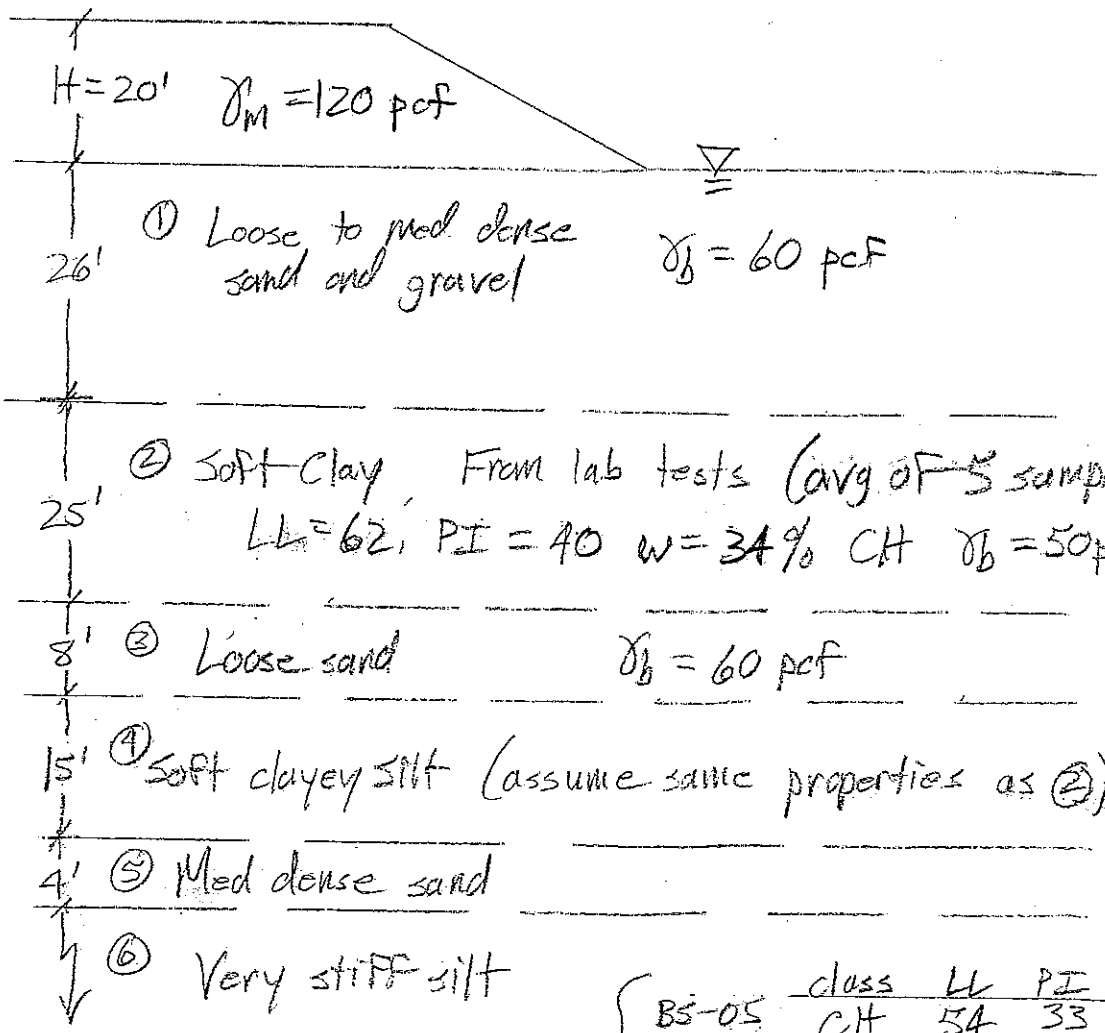
EMBANKMENT SETTLEMENT

HDR | ONE COMPANY *Many Solutions*

Project: RH-TR Connector Road	Computed: WWB	Date: 6/15/07	
Subject: Piney Run Bridge (HPC)	Checked: JDP	Date: 10-11-07	
Task: Settlement	Page: 1	of: 9	
Job #: 53410	No:		

JDP
10-11-07

- Check embankment settlement @ Abutment A
- Use FHWA Soils & Foundations Manual p. 175 (attached)
- Several Shelby tubes attempted, no recovery. Use lab index tests to estimate properties
- Use boring BS-8 as most conservative (sta 220+00)



Layer ②	class	LL	PI	w
BS-05	CH	54	33	31.4
BS-08	CH	65	43	29.2
BS-09	CH	59	37	40.3
BS-10	CH	72	46	35.6
BS-11	CH	62	43	30.9

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10-11-07

- Evaluate consolidation settlement of layers ② & ④
- Assume settlement of sand layers occurs as fill is constructed
- Moisture content of clay is 34% << PI = 64 indicating pre-consolidated clays
- Per S&F manual

$$LI = \frac{w - PL}{LL - PL} = \frac{34-22}{62-22} = 0.30 << 0.7$$

⇒ pre-consolidated

- Additional load from embankment

$$(20')(120\ pcf) = 2400\ psf$$

- $$\Delta H = H \frac{C_r}{1+e_0} \log \frac{P_F}{P_o'}$$

$$GW = se$$

$$e_0 \doteq \frac{GW}{S} = \frac{(2.65)(34)}{100} = 0.90$$

JDP
10-11-07

- Estimate C_r using correlations

Per FHWA SEF Workshop Manual (p. 175)

$$C_r \approx \frac{w}{1000} = \frac{34}{1000} = 0.034$$

(Note: divide all by 10 to convert C_c to C_r)

Per EM-1110 (p. 3-34) for clays:

$$C_r = \frac{1.15(e_0 - 0.35)}{10} = \frac{1.15(0.90 - 0.35)}{10} = 0.063$$

or $$C_r = \frac{0.012\,w}{10} = \frac{0.012(34)}{10} = 0.041$$

or $$C_r = \frac{0.01(LL - 13)}{10} = \frac{0.01(62 - 13)}{10} = 0.049$$

$\Rightarrow$ use 0.049 for C_r

(A) Layer (2)

$H = 25'$ $\quad p_o'_{center} = (26')(60) + (12.5')(50) = 2185$ psf

$p_f = p_o' + \Delta p$

$\Delta p = 2400$ psf (p. 2)

$p_f = 2185 + 2400 = 4585$ psf

JDP
10-11-07

(A) Layer (2)

$$\Delta H_2 = H \frac{C_r}{1+e_0} \log \frac{P_f}{P_o'} = (25')\left(\frac{0.049}{1+0.90}\right)\log\left(\frac{4585}{2185}\right)$$

$$\Delta H_2 = 0.21' = \underline{\underline{2.5''}}$$

(B) Layer (4)

$$P_{o\,center}' = (26')(60) + (25')(50) + (8')(60) + (7.5')(50) = 3665 \text{ psf}$$

$$P_f = P_o' + \Delta p = 3665 + 2400 = 6065 \text{ psf}$$

$$\Delta H_4 = (15')\frac{0.049}{(1+0.90)}\log\left(\frac{6065}{3665}\right)$$

$$\Delta H_4 = 0.085' = \underline{\underline{1.0''}}$$

Total consolidation settlement = 2.5" + 1.0" = 3.5"

say 3.5"

JDP 10-11-07 5/9

Settlement Computation For Cohesive Soils

1. Analyze consolidation test data to determine:

   a. Preconsolidation pressure (P_c)

   b. Initial void ratio (e_0) at P_o

   c. Compression and recompression indices (C_c and C_r)

1. (ALT.) In the absence of consolidation test data, settlement may be approximated using Atterberg limit and moisture content data. This method is only recommended for use in final design if soils exist which are not suited for lab testing, i.e., surface muck deposits.

   a. Soil may be assumed to be preconsolidated to pressures above typical embankment loadings if the liquidity index ([moisture content minus plastic limit] divided by plastic index) is less than 0.7.

   b. Initial void ratio, e_o, may be determined by multiplying the moisture content by the specific gravity and dividing by 100.

   c. C_c and C_r may be determined by dividing the moisture content by 100 and 1,000 respectively.

   Example: moisture content 30, liquid limit 50, plastic limit = 25
   specific gravity 2.75

   $$\text{Liquidity index} = \frac{30 - 25}{50 - 25} = 0.2 \text{ (preconsolidated, see "a" above)}$$

   $$e_o = \frac{(2.75)\ (30)}{100} = 0.825$$

   $$C_r = \frac{30}{1000} = 0.03$$

   $$C_c = \frac{30}{100} = 0.30$$

2. Compute settlement in 10' ± increments of depth or at soil layer boundaries using:

$$\Delta H = H\ \left(\frac{C_c}{1 + e_o}\right)\ Log\frac{P_F}{P_o}$$

(For normally consolidated soils only, see later sections for preconsolidated soils)

JDP 10-11-07 6/9

Table 3-7

Estimates of the Virgin Compression Index, C_c

Soil	C_c
Organic soils with sensitivity less than 4	0.009(LL - 10)
Organic soils, peat	$0.0115W_n$
Clays	$1.15(e_o - 0.35)$ $0.012W_n$ 0.01(LL - 13)
Varved clays	$(1 + e_o) \cdot [0.1 + 0.006(W_n - 25)]$
Uniform silts	0.20
Uniform sand	
Loose	0.05 to 0.06
Dense	0.02 to 0.03

Note: LL = liquid limit, percent
W_n = natural water content, percent
e_o = initial void ratio

final effective vertical applied pressure σ'_f exceeding the preconsolidation stress σ'_p. Reloading a specimen in the consolidometer will give the laboratory curve shown in Figure 3-12b.

(a) Reconstruction of the field virgin consolidation curve with slope C_c may be estimated by the procedure in Table 3-6b. Refer to Table 3-7 for methods of estimating C_c.

(b) The rebound loop in the laboratory curve is needed to develop the recompression line BF. Evaluation of the recompression index C_r is illustrated in Figure 3-13. The recompression index is equal to or slightly smaller than the swelling index, C_s. Approximate correlations of the swelling index are shown in Figure 3-14.

(c) Settlement ρ_{cj} of stratum j in inches may be estimated as the sum of recompression and virgin consolidation settlements. The final void ratio is found graphically from Figure 3-12b. The change in void ratio may be calculated by

$$\Delta e_j = C_r \cdot \log_{10}\frac{\sigma'_{pj}}{\sigma'_{oj}} + C_c \cdot \log_{10}\frac{\sigma'_{fj}}{\sigma'_{pj}} \qquad (3\text{-}23)$$

where C_r is the average slope of the recompression line BF. If $\sigma'_{fj} < \sigma'_{pj}$, ignore the right-hand term of Equation 3-23 containing C_c and substitute σ'_{fj} for σ'_{pj} in the term containing C_r. Settlement of stratum j is

JDP 10-11-07

- Calculate time rate of settlement

Layer ② will govern since it is thicker

$$t = \frac{TH^2}{c_v}$$

For 90% consolidation $T = 0.848$

$H = \frac{25'}{2} = 12.5'$ (double drainge - sand & gravel layers above and below)

Use EM-1110 (p. 3-44) to estimate c_{v_r}

For avg $LL = 62$, $c_{v_r} = 0.029\ cm^2/sec$

$$c_{v_r} = \frac{0.029\ cm^2}{sec} \times \frac{86{,}400\ sec}{day} \times \frac{1\ ft^2}{929\ cm^2} = 2.7\ ft^2/day$$

(60×60×24) (30.48²)

$$t_{90_r} = \frac{(0.848)(12.5')^2}{2.7\ \frac{ft^2}{day}} = 49\ days \quad \underline{say\ 50\ days}$$

$$c_{v_v} = 0.009\ \frac{cm^2}{sec} \times \frac{86{,}400\ sec}{day} \times \frac{1\ ft^2}{929\ cm^2} = 0.84\ ft^2/day$$

$$t_{90_v} = \frac{(0.848)(12.5')^2}{0.84\ \frac{ft^2}{day}} = 158\ days \quad \underline{say\ 150\ days}$$

- Calculate time rate of settlement @ Abutment B

Max. thickness of soft clay layers is 10'

$$t = \frac{TH^2}{C_v}$$

For 90% consolidation $T = 0.848$

$$H = \frac{10'}{2} = 5'$$

$$t_{90_r} = \frac{0.848(5')^2}{2.7\frac{ft^2}{day}} = 8 \text{ days} \qquad \underline{\text{Say 10 days}}$$

$$t_{90_v} = \frac{0.848(5')^2}{0.84\frac{ft^2}{day}} = 25 \text{ days} \qquad \underline{\text{say 30 days}}$$

JDP 10-11-07 9/9

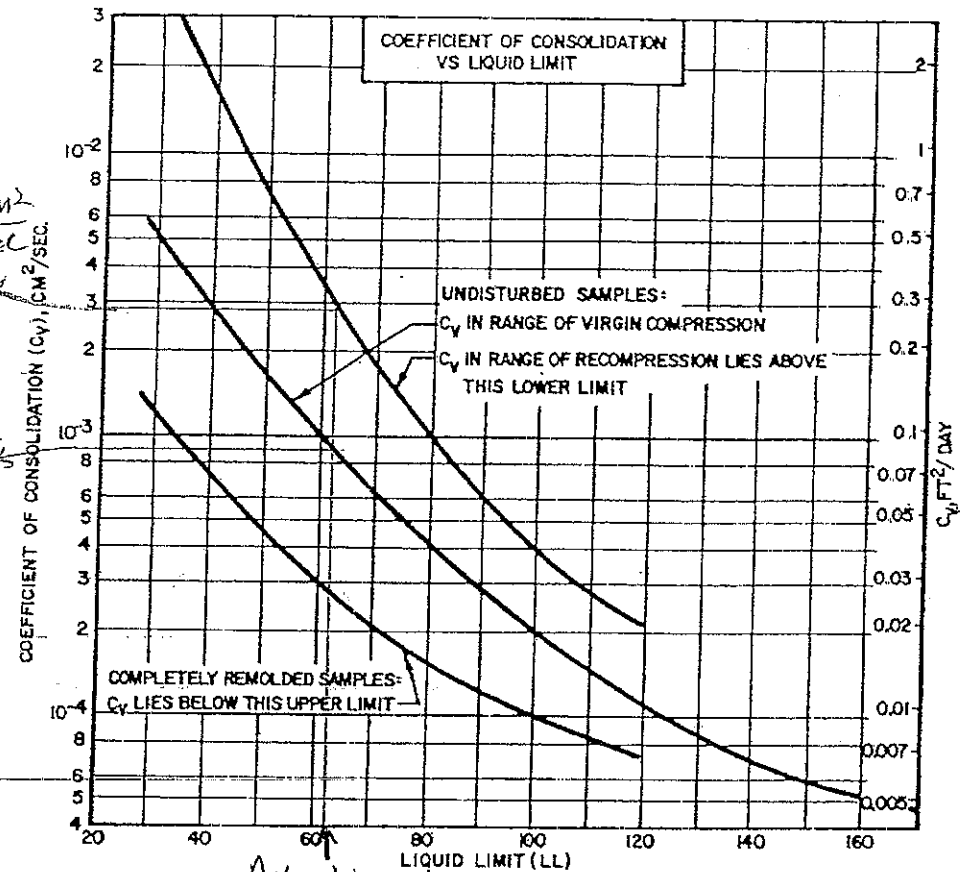


Figure 3-18. Correlations between coefficient of consolidation and liquid limit (NAVFAC DM 7.1)

(e) The procedure shown in Table 3-12 should be used to transform a compressible soil profile with variable coefficients of consolidation to a stratum of equivalent thickness H' and coefficient of consolidation c_v. T_v may be calculated from Equation 3-26 with $H_e = H'$. Refer to 3-13d, "Internal Drainage Layers", to estimate U_t of a soil profile with pervious incompressible sand seams interspersed between compressible soil.

b. Superposition of Excess Pore Pressure Distribution. An initial pore pressure distribution that is not modeled by any of the four cases in Table 3-10 and Figure 3-16 may sometimes be approximated by superposition of any of the four cases and the overall or weighted degree of consolidation found by

$$U_t = \frac{U_{t1}A_1 + U_{t2}A_2 + \ldots U_{ti}A_i}{A} \qquad (3\text{-}28)$$

where A represents the areas of the initial pore pressure distributions. Subscripts 1, 2, ..., i indicate each pore pressure distribution. Linearity of the differential equations describing consolidation permits this assumption.

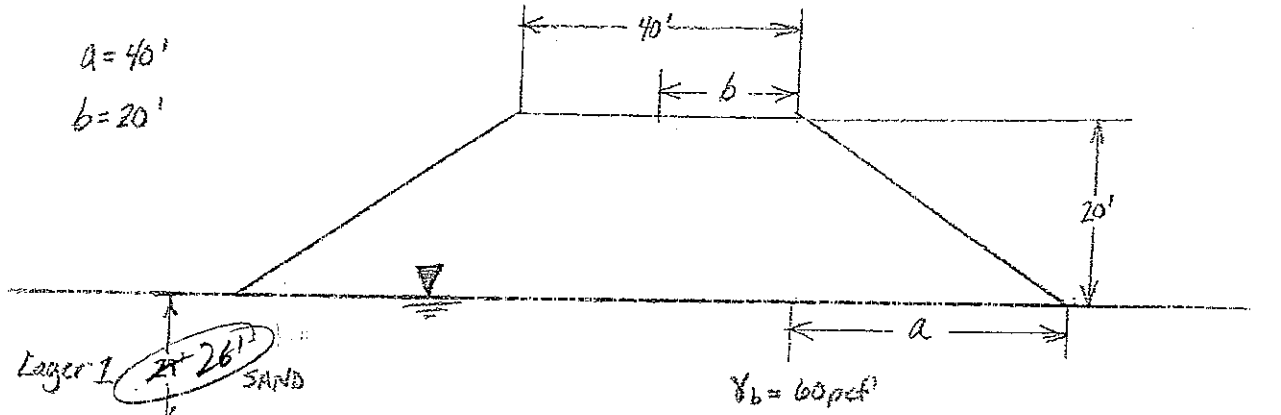
(1) Example excess pore water pressure distributions. Some example complex excess pore water pressure distributions are shown in Figure 3-19.

Project: RH - TR Connector Road	Computed: JDP	Date: 10/17/07	
Subject: Piney Run Bridge (HEC)	Checked: RLD	Date: 10/17/07	
Task: Settlement	Page: 1	of: 2	
Job #:	No:		

HDR | ONE COMPANY Many Solutions℠

$a = 40'$

$b = 20'$



Layer 1 ~~21'~~ 26' SAND

Layer 2 ~~22'~~ 25' CLAY ① Z_1 : $\gamma_b = 50$ pcf, $w = 34\%$, $C_s = 0.049$, $C_c = 0.34$

Layer 3 8' SAND $\gamma_b = 60$ pcf

Layer 4 15' CLAY ② Z_2 : (SAME AS LAYER 2)

Layer 5 SAND

CLAY ①

$z_1 = 40'$

$a = 40'$ $\quad \frac{a}{z} = 1$

$b = 20'$ $\quad \frac{b}{z} = 0.5$ $\Rightarrow$ From NAVFAC 7.1-170 $\quad I = 0.397$

$\gamma H = 120(20) = 2400$ psf

$\Delta\sigma = 2400(0.397 + 0.397) = 1906$ psf

CLAY ②

$z_2 = 66.5'$

$a = 40'$ $\quad \frac{a}{z} = 0.6$

$b = 20'$ $\quad \frac{b}{z} = 0.3$ $\Rightarrow$ From NAVFAC 7.1-170 $\quad I = 0.18$

$\gamma H = 2400$ psf

$\Delta\sigma = 2400(0.18 + 0.18) = 864$ psf

HDR ONE COMPANY *Many Solutions*	Project: RH-TR Connector Road		Computed: JDP	Date: 10/17/07	
	Subject: Piney Run Bridge (HEC)		Checked: RLP	Date: 10/17/07	
	Task: Settlement		Page: 2	of: 2	
	Job #:		No:		

Preconsolidation Pressure (σ_c') assumed to be 4000 psf (DAS 5th Ed p. 32)

CLAY ① $\sigma_o = (\cancel{29}\ 26')(60) + (\cancel{11}\ 12.5')(50) = \cancel{2290}\ 2185$ psf

CLAY ② $\sigma_o = (\cancel{29}\ 26')(60) + (\cancel{22}\ 25')(50) + (8)(60) + (7.5)(50) = \cancel{3695}\ 3665$ psf

CLAY ① $\Delta\sigma = 1906$ psf

CLAY ② $\Delta\sigma = 864$ psf

$C_c = \frac{w\%}{100} = \frac{34}{100} = 0.34$

$C_s = C_r = 0.049$

$Gw = Se$

$e_o = \frac{Gw}{S} = \frac{(2.65)(34)}{100} = 0.90$

$\sigma_o < \sigma_c < \sigma_o + \sigma_c \Rightarrow$ overconsolidated

CLAY ① $S_c = \frac{C_s H_c}{1+e_o} \log \frac{\sigma_c'}{\sigma_o'} + \frac{C_c H_c}{1+e_o} \log \frac{\sigma_o' + \Delta\sigma}{\sigma_c}$ (DAS 5th Ed p. 230)

$= (\cancel{26}\ 25') \frac{0.049}{1+0.9} \log \frac{4000}{\cancel{2290}\ 2185} + (\cancel{22}\ 25) \frac{0.34}{1+0.9} \log \frac{\cancel{2290}\ 2185 + 1906}{4000}$

$= \cancel{0.187'} + \cancel{0.052} = 0.219' = 2.6'' \approx 3$ inches

$0.169 \quad 0.044 = 0.213' = 2.6''$

CLAY ② $S_c = (15) \frac{(0.049)}{1.9} \log \frac{4000}{3695} + (15) \frac{0.34}{1.9} \log \frac{3695 + 864}{4000}$ (DAS 5th Ed p. 230)

$= 0.013 + 0.15 = 0.163' = 1.96'' \approx 2$ inches

Total Estimated Consolidation = 3" + 2" = 5 inches

JDP 10-11-07

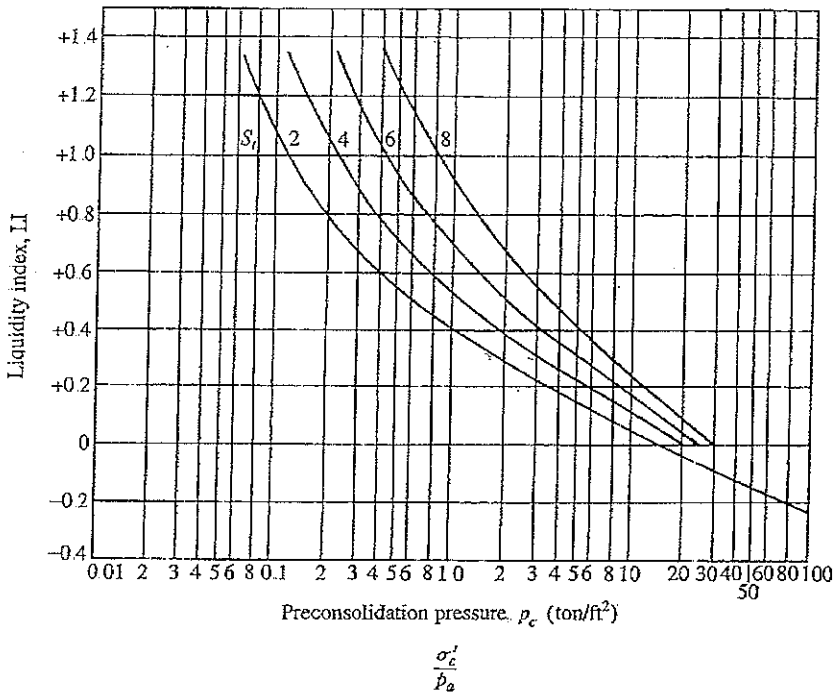


Figure 1.17 Variation of σ'_c with LI (after U.S. Department of the Navy, 1982)
Note: p_a = atmospheric pressure [≈100 kN/m²(1 U.S. ton/ft²)]

2. The *compression index,* C_c, is the slope of the straight-line portion (the latter part) of the loading curve, or

$$C_c = \frac{e_1 - e_2}{\log \sigma'_2 - \log \sigma'_1} = \frac{e_1 - e_2}{\log \frac{\sigma'_2}{\sigma'_1}} \tag{1.48}$$

where e_1 and e_2 are the void ratios at the end of consolidation under effective stresses σ'_1 and σ'_2, respectively

The *compression index,* as determined from the laboratory e–$\log \sigma'$ curve, will be somewhat different from that encountered in the field. The primary reason is that the soil remolds itself to some degree during the field exploration. The nature of variation of the e–$\log \sigma'$ curve in the field for a normally consolidated clay is shown in Figure 1.18. The curve, generally referred to as the *virgin compression curve,* approximately intersects the laboratory curve at a void ratio of $0.42e_o$ (Terzaghi and Peck, 1967). Note that e_o is the void ratio of the clay in the field. Knowing the values of e_o and σ'_c, you can easily construct the virgin curve and calculate its compression index by using Eq. (1.48).

WAVE EQUATION ANALYSES

12" sq PCP

```
Kingman Road - 12" Sq PCP                    VER. 2004 1 0
   6   0 124   0   1   0   0   0   0   3  67   0   0   0   0   0   0   0
0.000
   32.1850   32.1850  144.0000   12.0000              Unknown
      5.17    491.00     175.0      2.00    0.9200    0.0100         0
    144.00      30.0      4.50    0.5000    0.0100         0
     60.00    144.00    5000.0   150.000     4.000     4.000    1.0000
0.0098
     6.760     0.800    1102.0      0.00    0.0000     0.000    0.0100
0.000
    0.1000    0.1000    0.2000    0.1500    0.0000    0.0000    0.0000
0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.00   0.000  60.000  60.000   0.000   0.000   0.000   0.000    0.00
0.00
    0.00   0.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
L=  60.00'  1.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
Qult= 496.0k   0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0
```

HDR Engineering Inc
Kingman Road - 12" Sq PCP

23-May-2008
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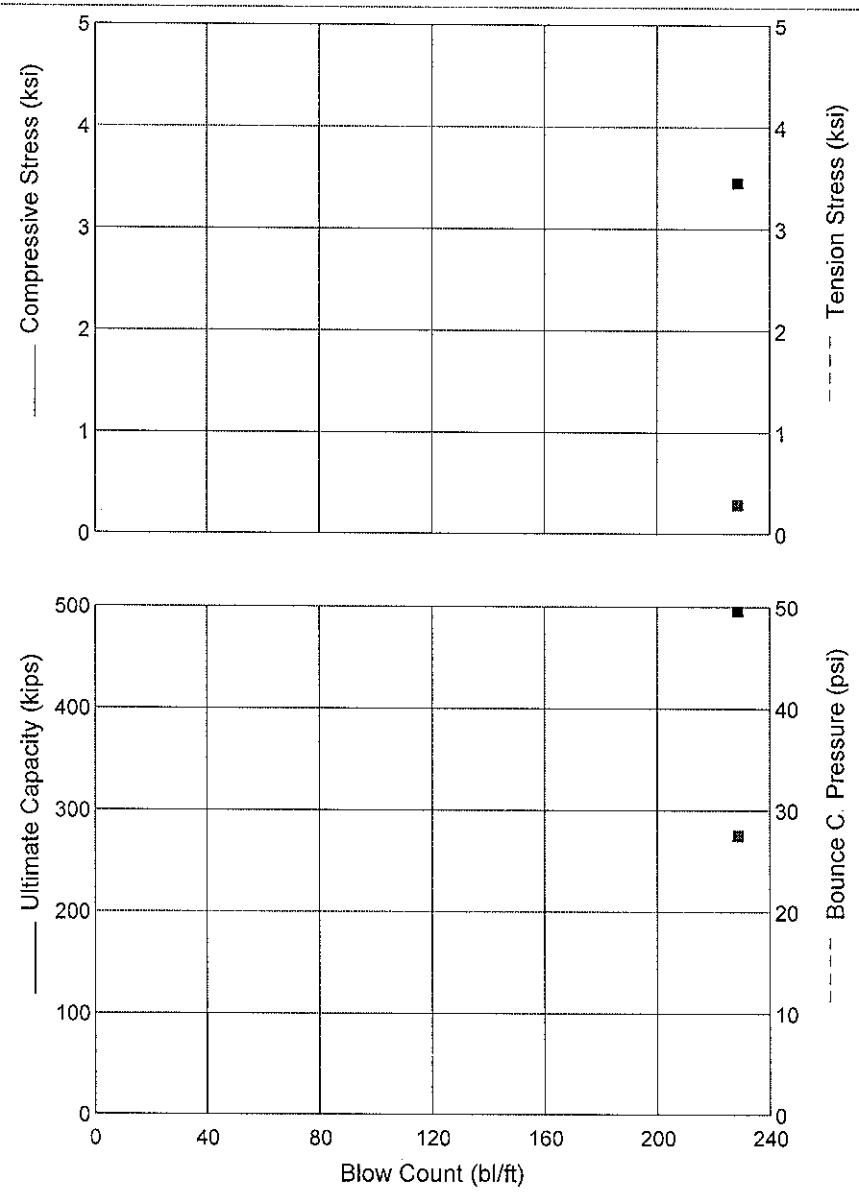
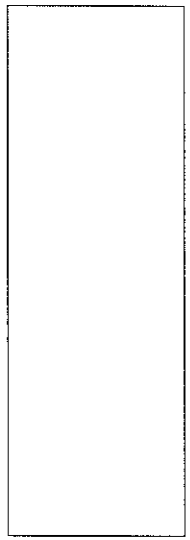


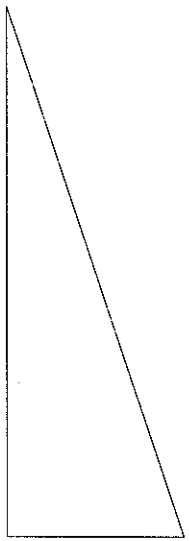
ICE 640

Efficiency	0.800	
Helmet	5.17	kips
Hammer Cushion	42963	kips/in
Pile Cushion	960	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.200	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	60.00	ft
Pile Penetration	60.00	ft
Pile Top Area	144.00	in2

Pile Model



Skin Friction Distribution



Res. Shaft = 67 %
(Proportional)

HDR Engineering Inc
Kingman Road - 12" Sq PCP

23-May-2008
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Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Bounce Chamber Pressure psi	Energy kips-ft
496.0	3.46 1)	0.30 2)	228.9	27.47	14.34

19 bpi (little high, but ok)

1) Limit $= 0.85 f_c' - f_{pc} = 0.85(5000) - 750 = 3500$ psi > 3.46 ksi ✓

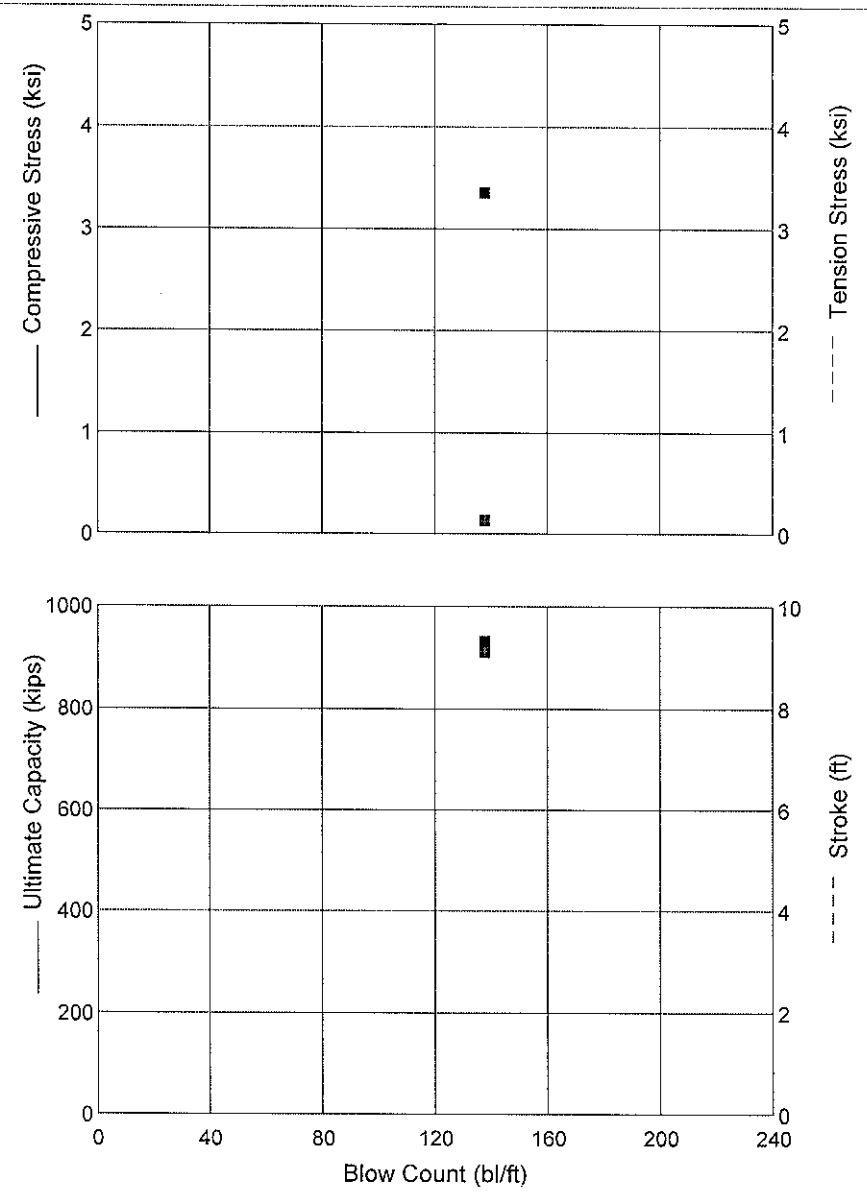
2) Limit $= 0.25\sqrt{f_c'} + f_{pc} = 0.25\sqrt{5000} + 750 = 768$ psi > 0.30 ksi ✓

18" sq PCP

```
Kingman Road - 18" Sq PCP                    VER. 2004 1 0
   6   0 133   0   1   0   0   0   0   3  67   0   0   0   0   0   0   0
0.000
   32.1850   32.1850  324.0000    0.0000              Unknown
      3.66    491.00     175.0      2.00    0.9200    0.0100         0
    324.00      30.0      4.00    0.5000    0.0100         0
     60.00    324.00    5000.0   150.000     6.000     4.000    1.0000
0.0098
    10.000     0.800    1032.0      0.00    0.0000     0.000    0.0100
0.000
    0.1000    0.1000    0.2000    0.1500    0.0000    0.0000    0.0000
0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.00   0.000  60.000  60.000   0.000   0.000   0.000   0.000    0.00
0.00
    0.00   0.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
L = 60.00'  1.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
Qult = 933.0 K   0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0
```

HDR Engineering Inc
Kingman Road - 18" Sq PCP

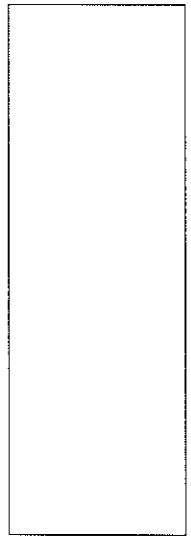
23-May-2008
GRLWEAP (TM) Version 2005



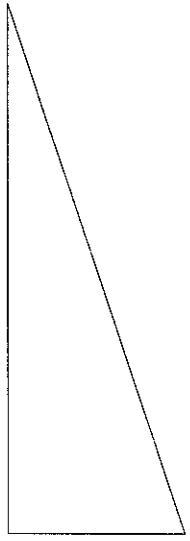
ICE 90-S

Efficiency	0.800	
Helmet	3.66	kips
Hammer Cushion	42963	kips/in
Pile Cushion	2430	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.200	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	60.00	ft
Pile Penetration	60.00	ft
Pile Top Area	324.00	in2

Pile Model



Skin Friction Distribution



Res. Shaft = 67 %
(Proportional)

HDR Engineering Inc
Kingman Road - 18" Sq PCP

23-May-2008
GRLWEAP (TM) Version 2005

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
933.0	3.35 1)	0.13 2)	137.9	9.11	26.91

≈ 12 bpi ✓

1) $\text{Limit} = 0.85 f_c' - f_{pc} = 0.85(5000) - 750 = 3500 \text{ psi} > 3.35 \text{ ksi}$ ✓

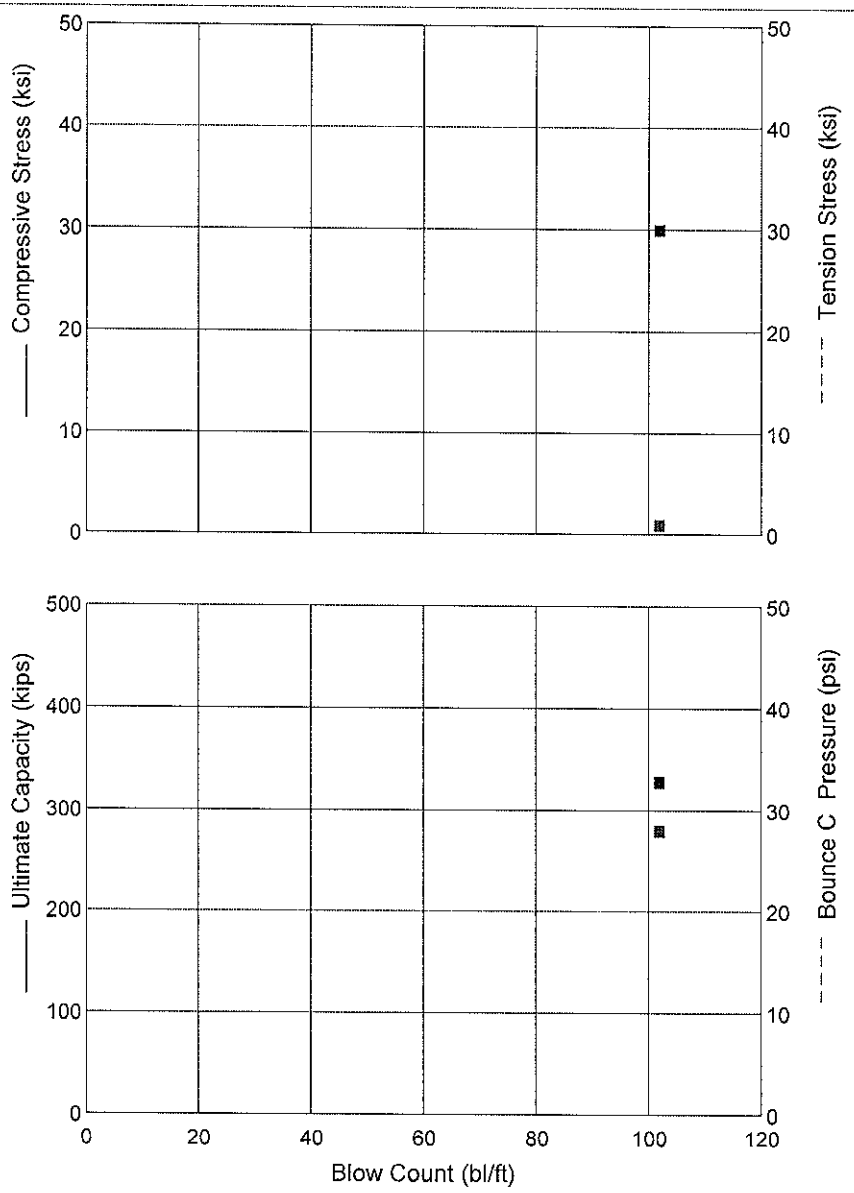
2) $\text{Limit} = 0.25\sqrt{f_c'} + f_{pc} = 0.25\sqrt{5000} + 750 = 768 \text{ psi} > 0.13 \text{ ksi}$ ✓

12" ϕ CEP

```
Kingman Road - 12" Dia CEP, 3/8" wall      VER. 2004 1 0
    6   0 123   0   1   0   0   0   0   1  67   0   0   0   0   0   0   0
0.000
   32.1850   32.1850  113.0000   12.0000              Unknown
      5.17    491.00     175.0      2.00    0.9200    0.0100          0
      0.00       0.0      0.00    0.0000    0.0000         0
     60.00     13.70   30000.0   492.000     3.142    36.000    0.8500
0.0098
     5.990     0.800     998.0      0.00    0.0000     0.000    0.0100
0.000
    0.1000    0.1000    0.2000    0.1500    0.0000    0.0000    0.0000
0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.00   0.000  60.000  60.000   0.000   0.000   0.000   0.000    0.00
0.00
    0.00   0.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
L = 60.00'  1.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
Qult = 327.0 K   0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0
```

HDR Engineering Inc
Kingman Road - 12" Dia CEP, 3/8" wall

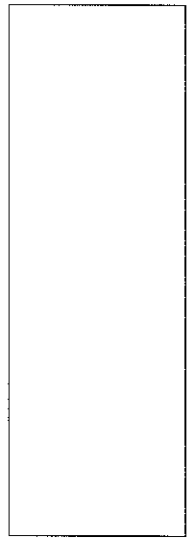
23-May-2008
GRLWEAP (TM) Version 2005



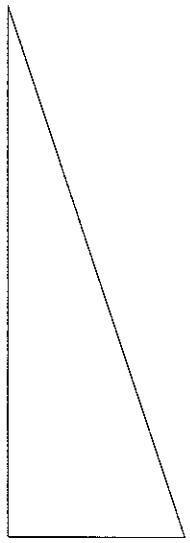
ICE 520

Efficiency	0.800	
Helmet	5.17	kips
Hammer Cushion	42963	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.200	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	60.00	ft
Pile Penetration	60.00	ft
Pile Top Area	13.70	in2

Pile Model



Skin Friction Distribution



Res. Shaft = 67 %
(Proportional)

HDR Engineering Inc
Kingman Road - 12" Dia CEP, 3/8" wall

23-May-2008
GRLWEAP (TM) Version 2005

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Bounce Chamber Pressure psi	Energy kips-ft
327.0	29.94 1)	0.93	102.0	27.98	15.05

≈ 9 bpi ✓

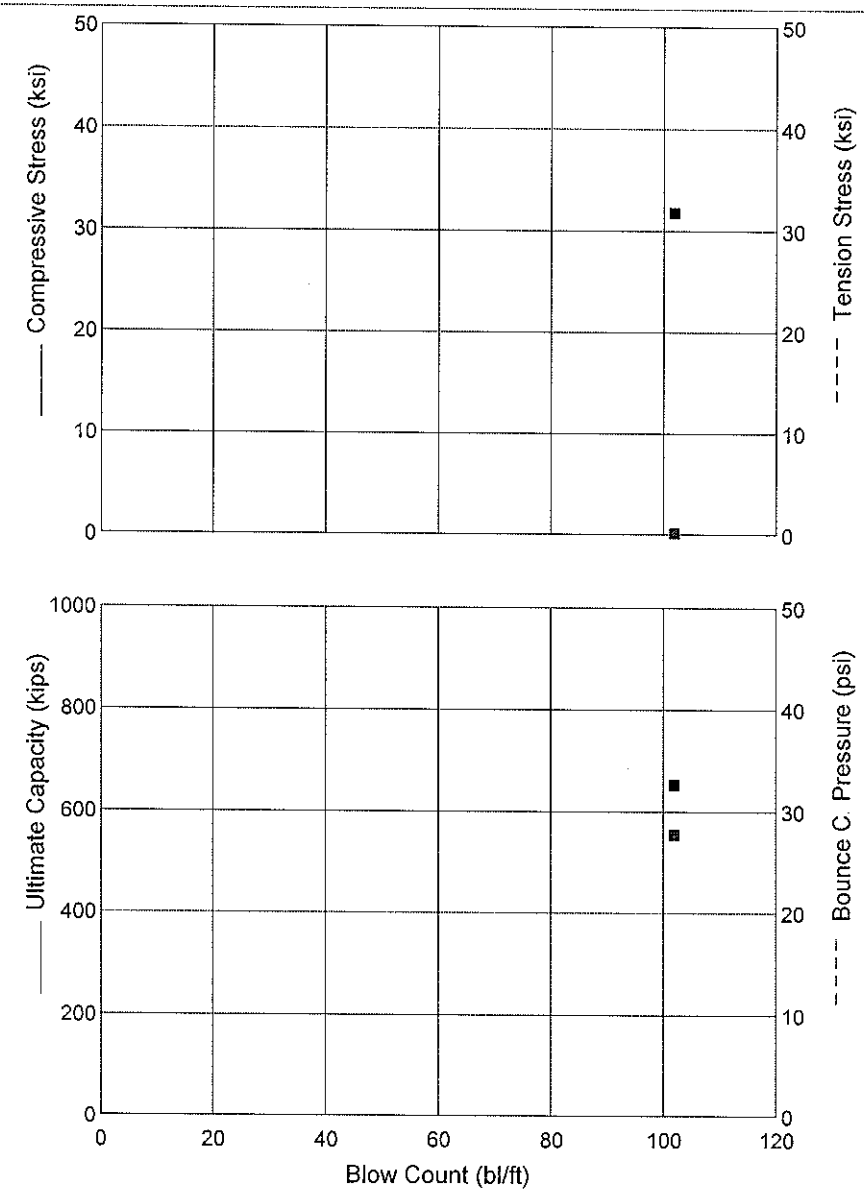
1) Limit = 0.9 f_y = 0.9 (36 ksi) = 32.4 ksi > 29.9 ksi ✓

18" ϕ CEP

```
Kingman Road - 18" Dia CEP, 1/2" wall        VER. 2004 1 0
    6   0 126   0   1   0   0   0   0   1  67   0   0   0   0   0   0   0
0.000
   32.1850   32.1850  254.5000   18.0000              Unknown
      3.66    491.00     175.0      2.00    0.9200    0.0000          0
      0.00       0.0      0.00    0.0000    0.0000         0
     60.00     27.50   30000.0   492.000     4.700    36.000    0.8500
0.0098
     7.260     0.800    1130.0      0.00    0.0000     0.000    0.0100
0.000
    0.1000    0.1000    0.2000    0.1500    0.0000    0.0000    0.0000
0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.00   0.000  60.000  60.000   0.000   0.000   0.000   0.000    0.00
0.00
    0.00   0.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
L=  60.00'  1.000   0.000   0.000   0.000   0.000   0.000   0.000    0.00
0.00
Qult= 653.0k   0.0     0.0     0.0     0.0     0.0     0.0     0.0      0.0
0.0
```

HDR Engineering Inc
Kingman Road - 18" Dia CEP, 1/2" wall

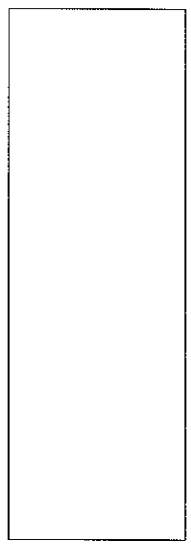
23-May-2008
GRLWEAP (TM) Version 2005



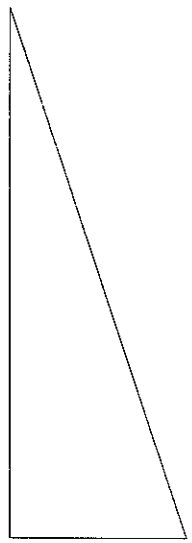
ICE 1070

Efficiency	0.800	
Helmet	3.66	kips
Hammer Cushion	42963	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.200	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	60.00	ft
Pile Penetration	60.00	ft
Pile Top Area	27.50	in2

Pile Model



Skin Friction Distribution



Res. Shaft = 67 %
(Proportional)

HDR Engineering Inc
Kingman Road - 18" Dia CEP, 1/2" wall

23-May-2008
GRLWEAP (TM) Version 2005

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Bounce Chamber Pressure psi	Energy kips-ft
653.0	31.78 1)	0.21	102.1	27.65	34.81

≈ 9 bpi ✓

1) Limit = 0.9 f_y = 0.9 (36 ksi) = 32.4 ksi > 31.78 ksi ✓

OVERALL CORROSIVENESS INDEX

JDP 10-11-07

3.3. Evaluating the corrosiveness of the soil

3.3.1. Overall corrosiveness index

The table given below specifies the weighing ascribed to each of the four main assessment parameters used to evaluate the corrosiveness of soils. It was compiled on the findings from an analysis of buried metal culverts (reference CEFRACOR).

TABLE I. Overall corrosiveness index.

Criterion	Features	Weight A of Criterion
Type of Soil	• Texture	
	- heavy, plastic, sticky impermeable	
	- clayey-sand	2
	- light, permeable, sandy, cohesionless soils	1
	• Peat and bog/marshlands	0
	• Industrial waste	
	- clinker, cinders, coal	8
	- builders' waste (plaster, bricks)	8
	• Polluted liquids	4
	- waste water, industrial	6
	- water containing de-icing salts	8
Resistivity	p < 1000 Ω cm	5
	1 000 < p < 2 000	3
	2 000 < p < 5 000	2
	5 000 < p	0
Moisture Content	Water table - brackish water (variable or permanent)	8
	Water table - pure water (variable or permanent)	4
	Above water table moist soil (water content > 20%)	2
	Above water table - dry soil (water content < 20%)	0
pH	< 4	4 (1 test)
	4 à 5	3 (4 tests)
	5 à 6	2
	> 6	0
	Global index	Sum of above: ΣA

ΣA = 7 to 8

JDP 10-11-07

The value of the weight of criterion "A" chosen in "Types of Soil," for example, would be the maximum value applicable to that soil from the subgroups "Texture," "Peat," "Industrial Waste," or "Polluted Liquids." The maximum weight for each of the four criteria is less or equal to eight.

The corrosiveness of the soil is shown as a global index ΣA, which is obtained from adding together the weighing values set for each of the four evaluation criteria.

3.3.2. Electrolytic effect of electric currents: "stray" currents

Some electric currents, direct or alternating with very low frequencies (16.67 Hz = 50/3), circulate in the soil. These may come from industrial installations, neighboring cathodic protection installations, etc., and can result in corrosion caused by electrolytic action. This risk must be evaluated in a special study.

3.4. Determining which characteristics will be used when assessing the corrosiveness of soils

3.4.1. Type of soil

This is first looked at from the point of view of the local geology. Examination will be limited to distinguishing between fine soils, typified by a high percentage of clay present (plastic, heavy, sticky or impermeable soils), and primarily granular soils that have few colloids and have weak cohesion, and are permeable and friable.

As a first breakdown, "heavy" textured soils are fine grained soils classified by the LPC as having more than 50 percent by weight of the particles smaller than 80 μm). "Light" textured or granular soils are those with less than 50 percent by weight of the particles smaller than 80 μm.

If no identification tests have been carried out, one simple method for assessing the texture of a soil and its level of compaction is to manually form a sample of slightly damp soil into a small ball: Heavy textured soil will form a cohesive ball.

3.4.2. Resistivity

Resistivity measurements use the classical methods for measuring the global resistivity of the soil through a depth more or less equivalent to the distance between the electrodes (see appendix of this chapter). The inspection depth should correspond to the height of the soil nailed wall.

Other measuring methods can also be used (for example, penetration using a probe, the magneto-acid method, etc.).

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3.5. Phreatic water table

The presence of a permanent or variable phreatic water table affects the corrosion process because of its effect on the permeability to air, resistivity, etc. Geotechnical investigations (see chapter 4) will generally identify their presence. In addition, during the soil sampling operation, it will usually be possible to observe water infiltration into the boring after 10 or more minutes.

If there is no water table, the water content in the soil will be measured from the sample taken.

The water content in a soil sample is found using the standard methods:

— Either in a laboratory using the oven dried moisture content test.
— Or, on site using alcohol drying.

3.6. pH

The pH level in most natural soils is between 5 and 9. Natural soils, where the pH is lower than 6, will only be found in peats or siliceous soils from primary geological formation stages. Highly acid or highly alkaline pHs values are usually an indication of pollution originating from industrial processes (cinders, slag, clinker, industrial tipping, and miscellaneous waste, etc.).

The pH measurement will be found in accordance with the test procedure shown in the appendix.

3.7. Interpreting the results

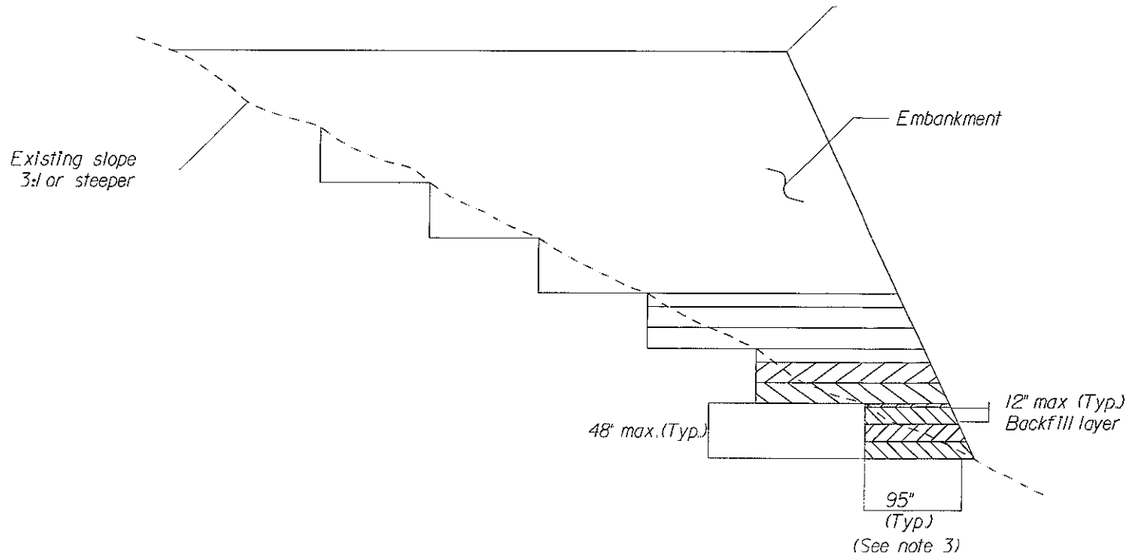
On the basis of the overall corrosiveness index ΣA obtained from table I, soils can be classified as follows:

TABLE II

Index ΣA	Soil Features	Classification
> 13	Highly corrosive	I
9 to 12	Corrosive	II
5 to 8	Average corrosiveness	III
< 4	Slightly corrosive	IV

APPENDIX H
DETAILS

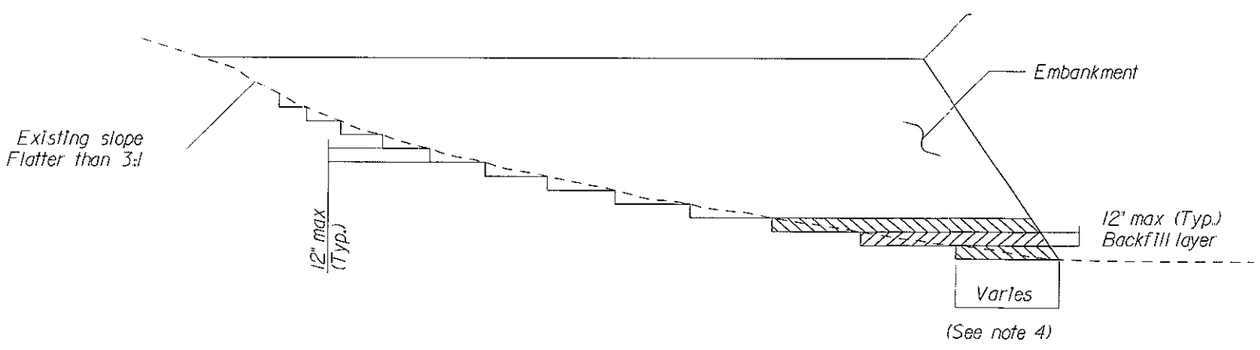
REG	STATE	PROJECT	SHEET NO.



BENCHING DETAIL A
SLOPES STEEPER THAN 1:3

NOTES:

1. Where the embankment foundation is a hillside or another existing embankment, the foundation must be benched while the embankment is being constructed.
2. For slopes 3:1 or steeper, refer to Benching Detail A. Cut 8 ft wide horizontal benches in the existing slope. Bench the slope as the embankment is placed and compacted in 1 ft thick layers until a backfill height of 4 ft is reached. Excavate and backfill in a similar manner until the top of slope is reached.
3. For slopes flatter than 3:1, refer to Benching Detail B. Cut into the existing slope until a maximum heigth of 1 ft is reached, allowing the horizontal distance to vary. Place embankment material. Excavate and backfill in a similar manner until the top of slope is reached.
4. Benching is considered incidental to the item of roadway excavation and no additional measurement of quantity or payment will be made for benching.
5. Refer to Section 204 for benching specifications.



BENCHING DETAIL B
SLOPES FLATTER THAN 3:1

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

DETAIL

BENCHING DETAIL

DETAIL APPROVED FOR USE --/----

REVISED:

DETAIL
E204-2

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REG	STATE	PROJECT	SHEET NO.
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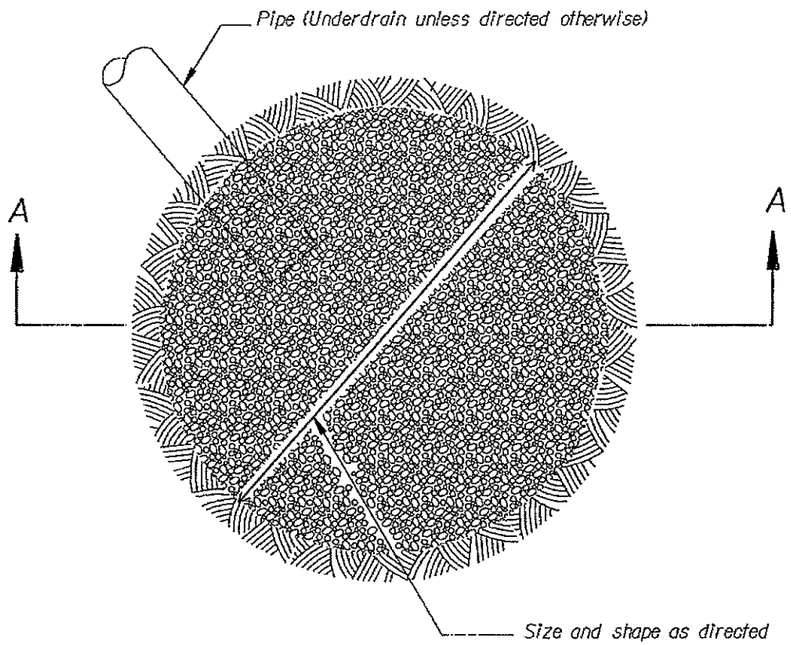
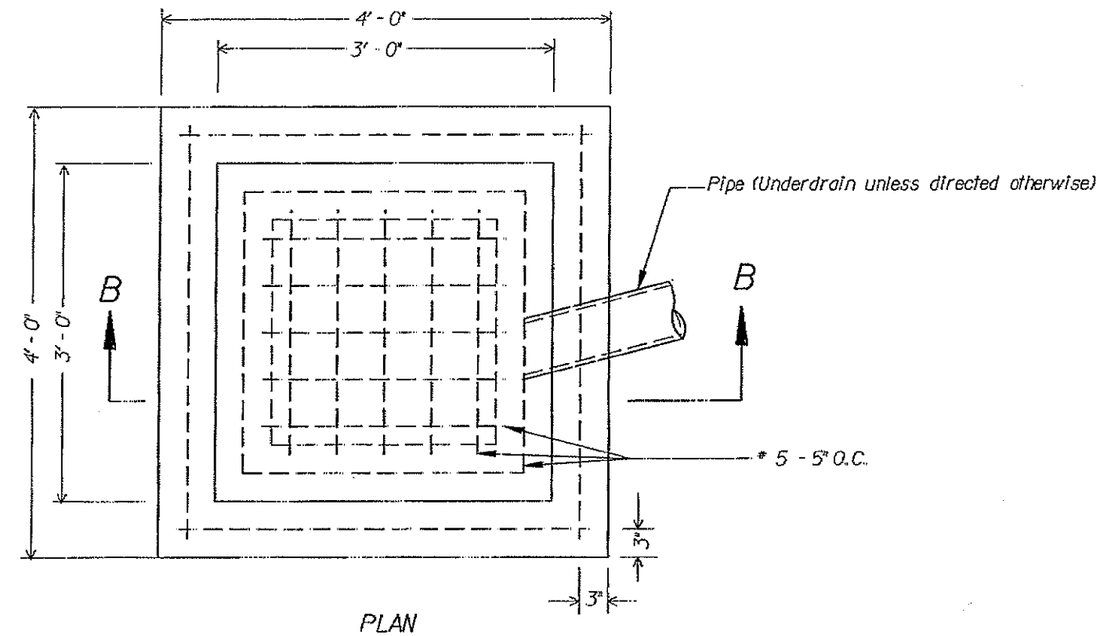


PLAN



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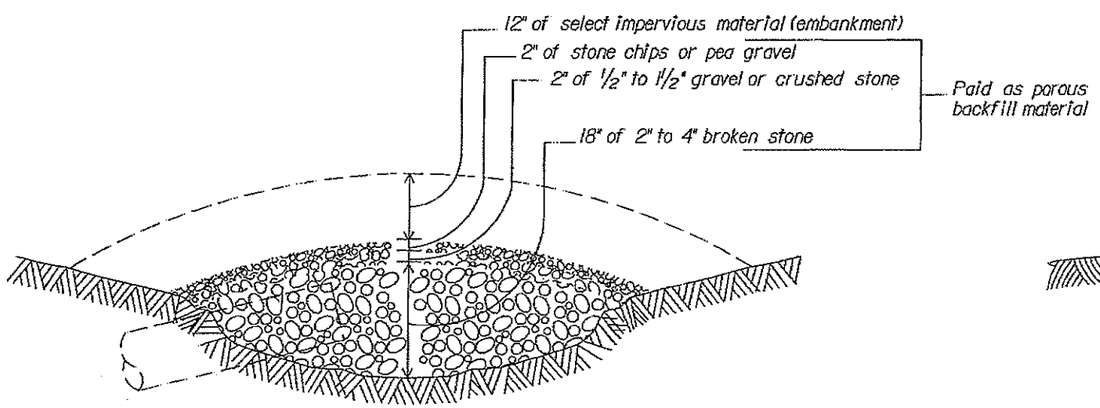
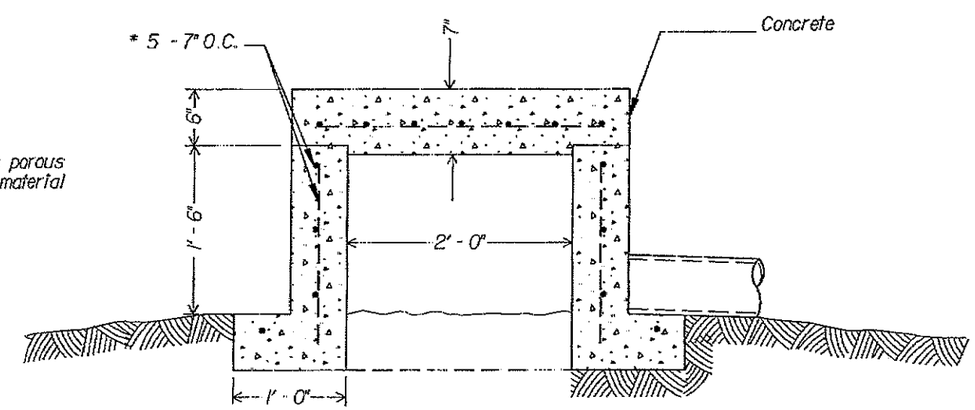


SECTION A-A

POROUS



SECTION B-B

REINFORCED CONCRETE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

DETAIL

SPRING BOX

DETAIL APPROVED FOR USE --/----

REVISED:

DETAIL
E604-7

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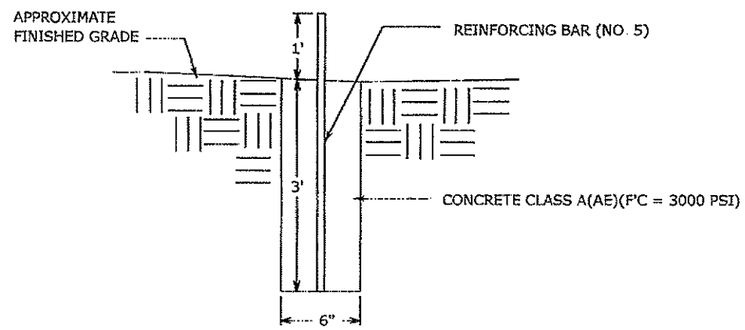
REG	STATE	PROJECT	SHEET NO.
-	VA	VA-A-AD-48(1)	S69



SETTLEMENT MONITORING MONUMENTS DETAIL

1. INSTALL MONUMENTS AT THE LOCATIONS SHOWN ON PLANS OR AS DIRECTED OTHERWISE.
2. EACH MONUMENT TO BE PROTECTED BY 3 FOOT HIGH, FLOURESCENT ORANGE PLASTIC, MESHED FENCE PLACED AT A 3 FOOT RADIUS FROM THE MONUMENT.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
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DETAIL

SETTLEMENT MONITORING MONUMENTS DETAIL

DETAIL APPROVED FOR USE --/----

REVISED:

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