Geotechnical Engineering Report

Proposed Cincinnati VAMC Research Facility Retaining Wall
Cincinnati, Ohio

January 11, 2011
Terracon Project No. N1105260

Prepared for:
John Poe Architects
Dayton, Ohio

Prepared by:

HCN
A Terracon COMPANY
Cincinnati, Ohio

A Terracon COMPANY

January 11, 2011

John Poe Architects, LLC
116 East Third Street
Dayton, Ohio 45402

Attn: Mr. Ken Raiteri, AIA
Architect
P: (937) 461-3290
F: (937) 461-0260
E: kraiteri@johnpoe.com

Re: Geotechnical Engineering Report
Proposed Research Facility Retaining Wall
Veterans Affairs Medical Center
3200 Vine Street
Cincinnati, Ohio
Terracon Project Number: N1105260

Dear Mr. Raiteri:

H.C. Nutting, a Terracon Company (HCN) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number PN1101070 dated December 15, 2010. Preliminary recommendations were provided for the retaining wall in an e-mail on January 4, 2011, which are confirmed in this report. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning foundation recommendations, lateral earth pressure recommendations, recommended retaining wall type and other geotechnical related items deemed appropriate.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
H.C. Nutting, a Terracon Company

Jeffrey D. Dunlap, P.E.
Senior Geotechnical Engineer

Swaminathan Srinivasan, P.E
Senior Vice President- Division Manager

Copies To: Mr. Frank Ellert, P.E. – THP Limited, LLC (1)

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EXECUTIVE SUMMARY

A geotechnical study has been performed for the proposed retaining wall on the east side of the proposed Research Facility at the VAMC located at 3200 Vine Street in Cincinnati, Ohio. A total of two test borings were drilled along the approximate retaining wall alignment to approximately 25 to 26 feet below the existing ground surface. Based on the information obtained from our subsurface exploration the following geotechnical considerations were identified:

- Due to the existing slope and presence of existing underground utilities and an existing wall above the retaining wall location, we recommend that the proposed retaining wall consist of a cantilevered drilled pier wall. The drilled pier wall will provide support to the existing slope while the excavation is being performed and reduces the potential for undermining and damaging the existing utilities and the building during the construction process.
- Our LPILE analyses indicate that drilled shafts with soldier beams will need to extend between 11 feet and 13 feet below the proposed grades at the toe of the retaining wall to limit deflection at the top of the soldier piles to less than 2.5 inches.

Close monitoring of the construction operations discussed herein will be critical in achieving the design retaining wall performance. We recommend that HCN be retained to perform construction testing and inspection for this project to confirm our design assumptions for the retaining wall construction.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
PROPOSED VAMC RESEARCH FACILITY RETAINING WALL
CINCINNATI, OHIO

Project No. N1105260

January 11, 2011

1.0 INTRODUCTION

A geotechnical study has been performed for the proposed retaining wall on the east side of the proposed Research Facility at the VAMC located at 3200 Vine Street in Cincinnati, Ohio. A total of two test borings were drilled along the approximate retaining wall alignment to approximately 25 to 26 feet below the existing ground surface. The subsurface data was supplemented with test boring R-4, which was performed during the geotechnical study for the proposed Research Facility. Logs of the borings along with a vicinity map, and boring location plans are included in Appendix A of this report.

The proposed retaining wall was added to the project after a geotechnical study was completed for the VAMC Research Facility project. The geotechnical engineering report for the Research Facility was dated November 22, 2010. The field study and engineering work performed for the proposed retaining wall was performed as an addition to our original scope of work for the VAMC Research Facility Project.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- retaining wall type recommendations
- foundation design and construction
- lateral earth pressures
- LPILE analysis results

2.0 PROJECT INFORMATION

The following tables provide information regarding the proposed retaining wall and existing site conditions in the vicinity of the proposed retaining wall alignment. The information is based upon the provided site grading plan developed by Kleingers & Associates (e-mailed to us on January 3, 2011), e-mail and telephone conversations with the project architect and structural engineer and our reconnaissance of the site.

2.1 Project Description

ITEM	DESCRIPTION
Retaining Wall	■ Approximate length 102 feet. ■ L-Shaped, east and south legs ■ Maximum exposed wall height approximately 10 feet. ■ Wall height relatively constant along east leg, wall height varies along south leg. ■ Existing slope above the east leg is approximately 5H:1V, slope above the south leg approximately level. ■ Wall to match existing grade above wall by cutting into existing slope. ■ Relatively level grade at bottom of wall.
Grading	■ Cut up to approximately 10 feet
Other features	■ Existing building upslope of proposed retaining wall along crest of existing slope. Reportedly building supported on drilled shaft foundations bearing in gray shale and limestone bedrock. Existing underground gas line upslope of proposed retaining wall.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	Near northeast corner of Cincinnati VAMC property and located on the east side of the proposed Animal Research Facility building, see Exhibit A-1
Current ground cover	Grass and sparse trees. Picnic shelter located downslope of proposed retaining wall. Existing Fisher House is located south of the proposed retaining wall. Existing segmental retaining wall is located at the north terminus of the proposed retaining wall.
Existing topography	Existing slope is approximately 5H:1V and extends in elevation approximately 3 to 4 feet above the top of the proposed wall. Grades then become level east of existing property line.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of Borings RW-1, RW-2 and R-4, subsurface conditions along the approximate retaining wall alignment can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Consistency/Density
Surface	0.2 to 0.7	Topsoil	N/A
Stratum 1	2.5 to 5	Existing Fill, lean clay with various amounts of shale and rock pieces, gravel and sand[1]	Very Stiff to Hard
Stratum 2	5 to 10	Natural Lean clay with various sand, gravel, rock pieces and fine roots	Stiff to Very Stiff
Stratum 3	12.5 to 17.5	Natural brown lean clay to fat clay, with various shale and limestone layers or seams (Residual Clay)	Very Stiff to Hard
Stratum 4	24.5 to 25	Severe to moderately severe weathered brown interbedded shale and limestone bedrock	Shale Very Soft to Soft, Limestone Hard[2]
Stratum 5	24.8 to 25.9 (all three borings terminated in this stratum)	Fresh gray shale and limestone bedrock	Shale Soft, Limestone Hard[2]

1. Existing fill may be associated with previous construction at the site. No records have been reviewed indicating this fill was placed as structural fill.
2. In terms of bedrock hardness

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

3.3 Groundwater

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Due to safety reasons, the boreholes were backfilled with soil cuttings upon completion and no long-term water levels were recorded. Groundwater was not observed in the borings while drilling, or immediately after completion. However, this does not necessarily mean these borings terminated above groundwater, or that the water levels summarized above are stable groundwater levels. Due to the low permeability of the soils encountered in the borings, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a borehole in these materials. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. Groundwater seepage is oftentimes observed at the soil/bedrock interface and within bedrock within fractures and at the interface of shale and limestone seams. In addition, groundwater seepage can occur in overburden soils within sand, silt or gravel seams or above shale of limestone seams located within the soil structure.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Borings for the proposed retaining wall encountered existing fill soils, native lean clay, lean to fat clay residual soils, underlain by weathered then unweathered shale bedrock. The depth to the weathered shale and limestone bedrock is relatively shallow along the east retaining wall leg. The depth to weathered shale and limestone bedrock is relatively shallow at the east end of the south leg of the retaining wall and increases to the west end of the south leg.

Due to the existing slope conditions and the presence of existing underground utilities and an existing building upslope of the proposed retaining wall, a cantilevered drilled pier wall utilizing top down construction is recommended. Please refer to our geotechnical engineering report dated November 22, 2010, regarding recommendations regarding site preparation, excavation and other earthwork operations.

4.2 Cantilevered Drilled Pier Retaining Wall

A cantilevered drilled pier wall is recommended for the proposed retaining wall located east of the proposed Research Facility building. A cantilevered drilled pier wall utilizes top-down construction methods that will allow construction of the proposed retaining wall while supporting the existing slope with limited lateral deflection.

A cantilevered drilled pier wall consists of a drilled shaft which is drilled before any excavation takes place. The shaft is filled with structural concrete below the proposed wall toe. It is extremely important that the drilled shaft elements and soldier piles be in-place before any excavation is performed. A steel soldier pile is placed in the drilled shaft prior to placing the concrete. Oftentimes, controlled density fill is placed from the proposed bottom wall grade to the existing ground surface within the drilled shaft, which allows for future excavation around the soldier piles. The proposed cut is then supported by temporary wood lagging installed behind or between the steel soldier piles protruding from the drilled shafts. Once the temporary wood lagging is installed, the soil in front of the soldier piles can be excavated. Permanent concrete lagging is then installed behind the front flanges of the steel soldier piles or connected to the face of the steel beams. Cast-in-place or precast panel decorative wall facing constructed using one-sided slip forms or segmental retaining wall units structurally attached to the soldier pile members can be constructed in front of the drilled pier wall for aesthetics, if desired; however, these aesthetic facing methods add significant cost to the retaining wall construction. Since the retained earth is supported by the cantilevered steel soldier beams protruding from the drilled piers, some deflection occurs at the top of the wall. The zone between the temporary lagging and the permanent lagging should be backfilled with No. 57 or No. 67 crushed stone. The zone between any aesthetic facing and the concrete lagging should be also be backfilled with No. 57 or No. 67 crushed stone.

Drainage should also be provided by such means as drainage panels placed on the front face of the temporary lagging connected to weep holes.

4.2.1 Design Recommendations

Utilizing the encountered soil conditions and slope geometries, we have performed LPILE analyses to analyze the proposed cantilevered drilled piers along the east and south legs of the proposed retaining walls. An active earth pressure coefficient of 0.43 was used to analyze the east leg (Case 1), and an active earth pressure coefficient of 0.39 was used to analyze the south wall leg (Case 2). During construction, the analyses assumed that grades at the toe may be disturbed up to 1 foot below the proposed finish grades. We recommend the following for proposed cantilevered retaining wall design assuming a maximum top of soldier pile lateral deflection of 2.5 inches. We have included the plots of unfactored bending moment and shear force plots with depth from the LPILE analyses for both Cases 1 and 2.

- 30 inch diameter drilled shafts should be used with HP12x53 Grade 50 steel soldier piles centered within the shafts. The drilled shafts would be drilled from a temporary bench cut at or near the proposed top of wall grade. Structural concrete consisting of at least 4000 psi concrete at 28 days would be placed to the proposed bottom of the concrete lagging elevation. Controlled density fill (CDF) having a 28 day compression strength of 100 psi should be placed to the top of the drilled shaft excavations. The drilled shafts should be located at 8 feet maximum center to center spacing.

- Along the east leg of the retaining wall the drilled shafts should be extended to at least 11 feet below the proposed finish toe grade or approximately to elevation 719 feet. Along the south retaining wall leg, the drilled shafts should be installed to at least 13 feet below the proposed finish toe grade, which is estimated to be between elevations 717 to 716 feet.

- After the drilled shafts and soldier beams are installed, excavation of the soil and CDF in the drilled shafts can commence. Temporary wood lagging should be placed behind the back soldier beam flanges between the soldier beams as the excavation progresses from the top to the bottom of the proposed excavation. Geocomposite drainage materials should be installed on the front face of the temporary lagging between each soldier beam and connected to a permanent drainage collection system to drain any groundwater seepage that may be encountered over the life of the retaining wall.

- After the excavation is complete and the wood lagging is installed, precast concrete lagging panels can be installed behind the front flanges of the steel soldier beams. This will require removing the CDF material between the flanges of the steel soldier piles. The annulus between the temporary wood lagging and the permanent concrete lagging can be backfilled with No. 57 or No. 67 crushed stone. The analyses assume that the concrete lagging will extend to approximately 1 foot below the proposed design wall toe grade.

- A 12 to 18 inch thick cap of compacted cohesive fill or concrete cap should be placed at the top of the wall to prevent direct surface water infiltration into the retaining wall. Vegetation should be established above the wall to prevent erosion above the retaining wall. A drainage swale or shallow ditch should be considered above the wall to collect and drain any surface water runoff that is directed toward the retaining wall.

4.2.2 Construction Considerations

We recommend that the services of a qualified geotechnical technician under the direct supervision of the geotechnical engineer be employed to represent the owner during cantilevered drilled pier wall construction. It is recommended that the following construction-related items be addressed:

1. The drawings and specifications should clearly state that no excavation should be allowed until the drilled shafts are installed. The excavation should take place as temporary lagging is installed (from top-down).
2. The actual bottom elevation of each drilled shaft will be determined in the field during construction, through inspection by a geotechnical technician, under the supervision of the Project Geotechnical Engineer. It is recommended that the construction testing and inspection services be under the authorization of the owner, not the contractor.
3. The specifications should be clear that the bottom of drilled shaft elevation shown on the plans are for estimating purposes only. The actual determination will be made from examination of materials brought to the surface on the augers of the drilling machine.
4. The specifications should require that no concrete be placed until the dimensions, bottom elevation and excavation of each drilled shaft has been approved by the geotechnical technician. It is expected that groundwater may enter some of the shafts. Any water that has entered the pier hole should be removed (pumped or mucked) prior to concreting. It is recommended that the specification's state that the depth of water at the bottom of the shaft at the time of concreting shall not be greater

than 2 inches. Also, the bottom of the excavation should be mucked of soft materials.

5. Temporary steel casing may be required to prevent shaft collapse during drilling and concrete placement. The specifications should state that casing shall be placed wherever required to stabilize loose or caving materials, or to seal off any water bearing zones.
6. It is recommended that the specifications state that the structural steel and shaft concrete be placed the same day that the shaft is drilled. No completed shaft excavation should be allowed to remain open overnight.
7. It is recommended that the shaft excavation be bid on an unclassified basis; that is, the contractor should be required to remove anything encountered to reach the design bearing material described above. The weathered shale materials and the natural clay materials contain limestone seams, layers and floaters that will be difficult to drill through. Drilling into the unweathered gray shale and limestone bedrock, which will be harder to drill through than the weathered bedrock, is not anticipated based upon the test boring data.
8. The structural engineer will need to develop a termination detail for the cantilevered drilled pier wall where it meets the existing segmental retaining wall. Though not encountered in the test borings, granular backfill soils associated with the existing segmetnal retaining wall may be encountered that require temporary casing to keep the drilled shaft excavations from collapsing.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

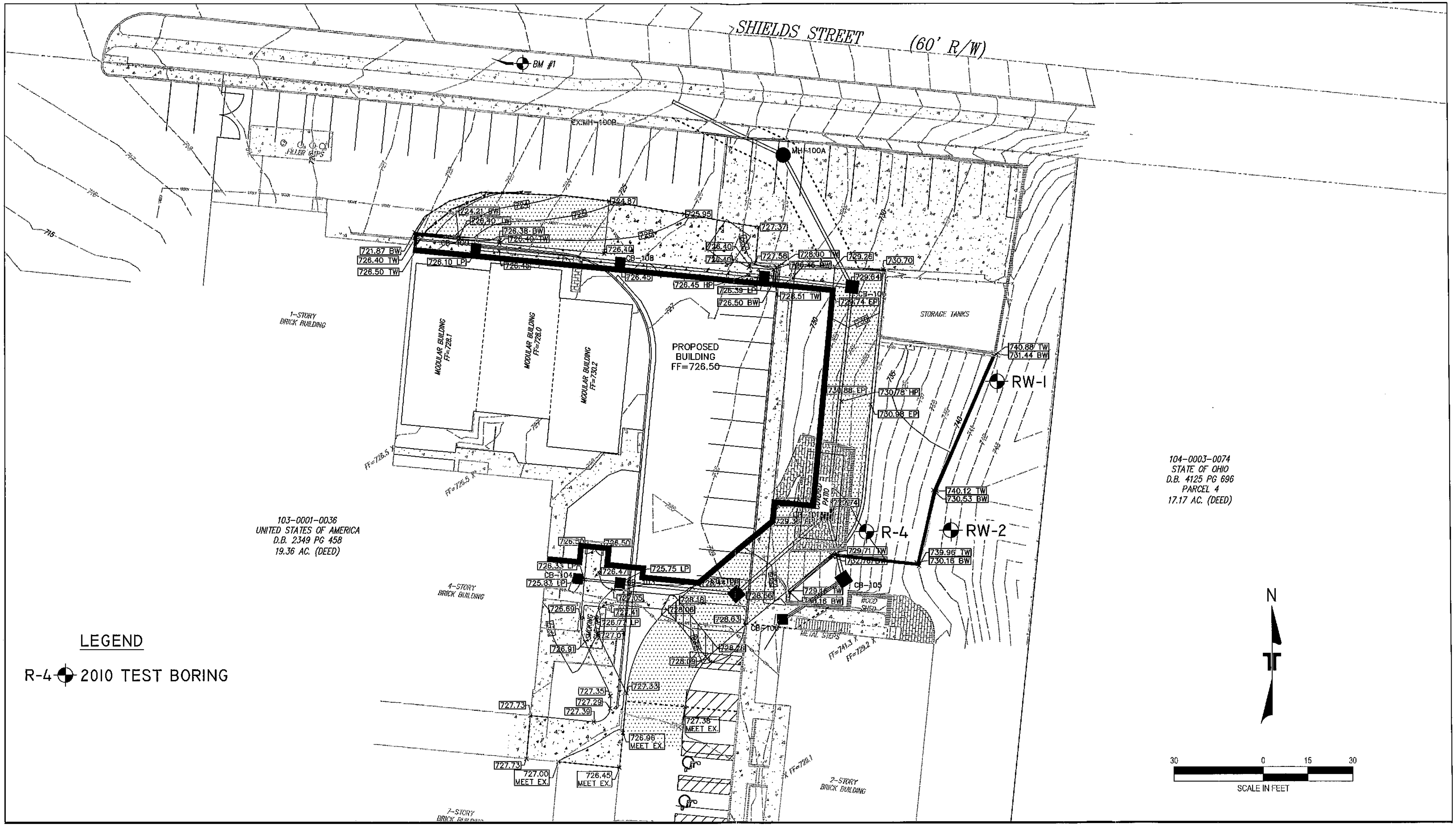
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION



REV.	DATE	BY	DESCRIPTION

HCN
A Terracon COMPANY
611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226
PH. (513) 321-5816 FAX. (513) 321-4540

TEST BORING LOCATION PLAN

PROPOSED CINCINNATI VAMC RESEARCH FACILITY

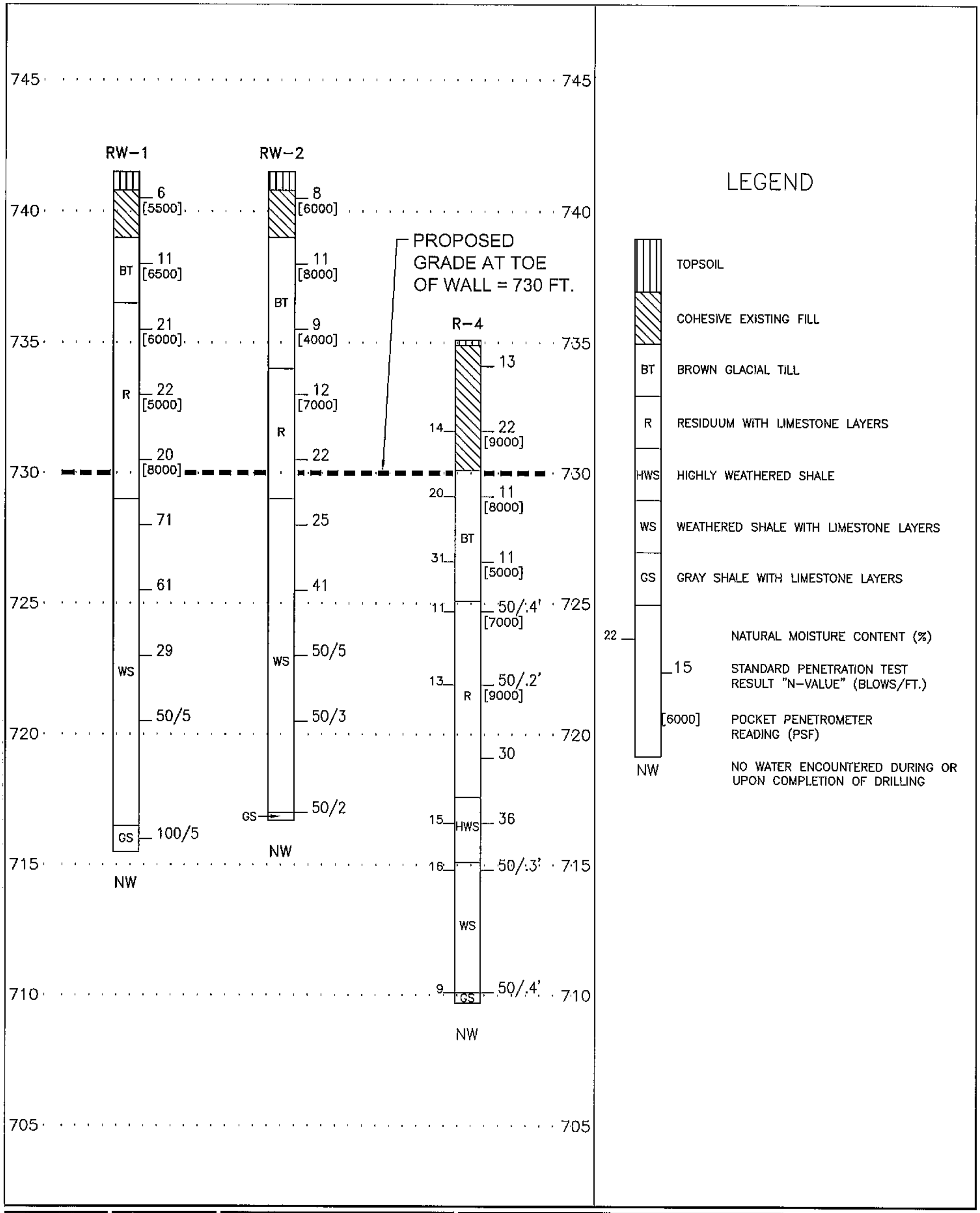
JOHN POE ARCHITECTS

3200 VINE STREET

CINCINNATI OHIO

EXHIBIT A-1

DESIGNED BY:	JDD
DRAWN BY:	KM
APPVD. BY:	JDD
SCALE:	1" = 30'
DATE:	11/04/2010
JOB NO.	N1105260
ACAD NO.	JPA BL.DWG
SHEET NO.:	A-1



Project Mngr: JDD	Project No. N1105260		
Drawn By: KM	Scale: 1"=5'V		
Checked By: JDD	File No. JPA PR.DWG		
Approved By: JDD	Date: 12/28/2010		

HCN
A Terracon COMPANY
611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226
PH. (513) 321-5816 FAX. (513) 321-4540

SUMMARY OF GEOTECHNICAL DATA

CINCINNATI VAMC RESEARCH FACILITY RETAINING WALL

JOHN POE ARCHITECTS

3200 VINE STREET

CINCINNATI OHIO

EXHIBIT

A-2

Field Exploration Description

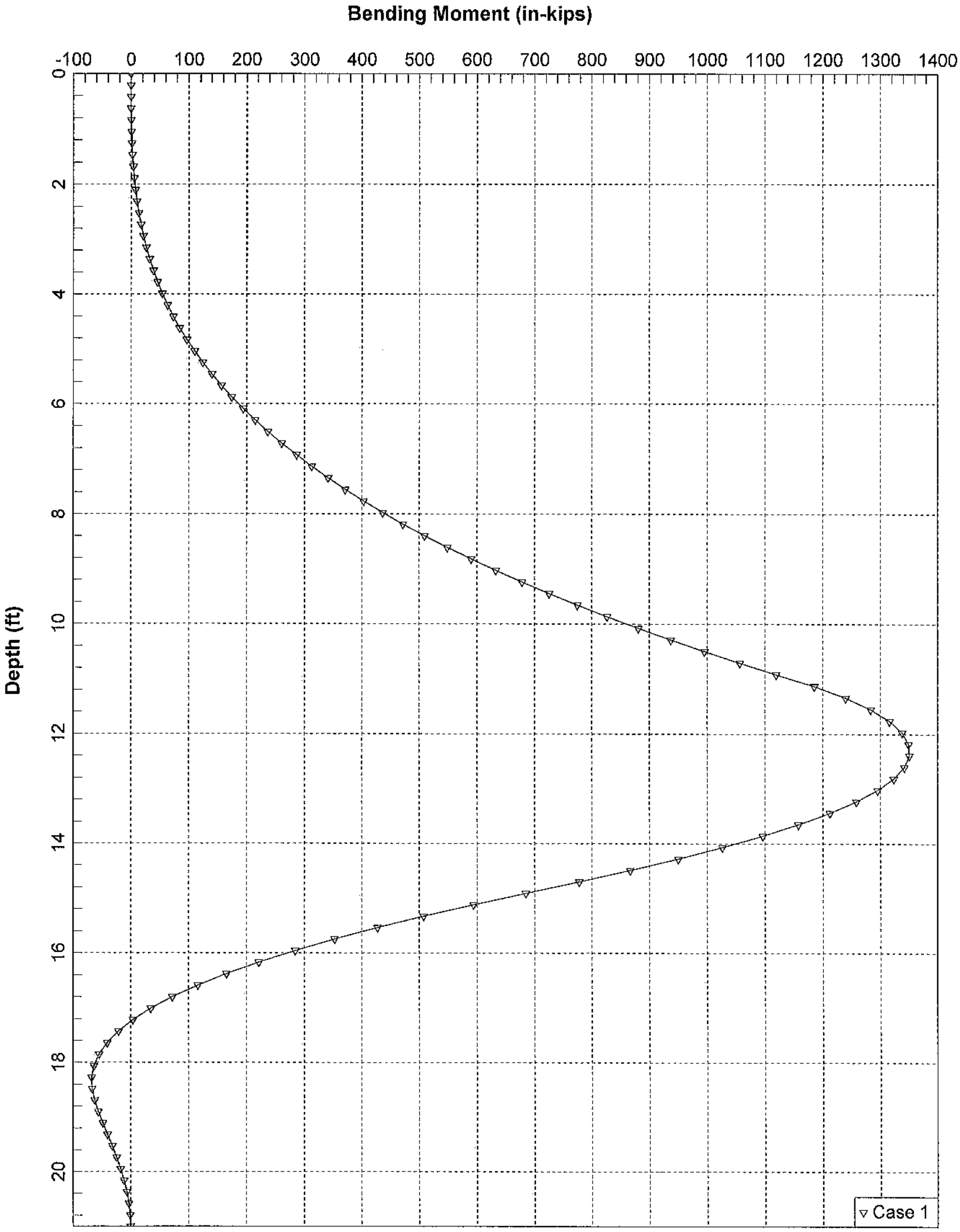
The boring locations were laid out on the site by HCN personnel using a scaled sketch of the retaining wall location provided by the project architect. After the test borings were drilled a site plan was provided where the location and alignment of the retaining wall was adjusted. Ground surface elevations at the test boring elevations were interpolated from the provided Site Grading Plan, developed by Kleingers & Associates. The borings were drilled with a track-mounted rotary drill rig using continuous flight hollow-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using the split-barrel sampling procedures. Underground utilities at the test boring locations were checked by a private underground utility location subcontractor.

In the split barrel sampling procedure, the number of blows required to advance a standard 2 inch O.D. split barrel sampler the last 12 inches of the typical total 18 inch penetration by means of a rope and cathead manual safety hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils. No rock coring was performed. All encountered shale and limestone bedrock was sampled by overdriving the split-barrel sampler.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

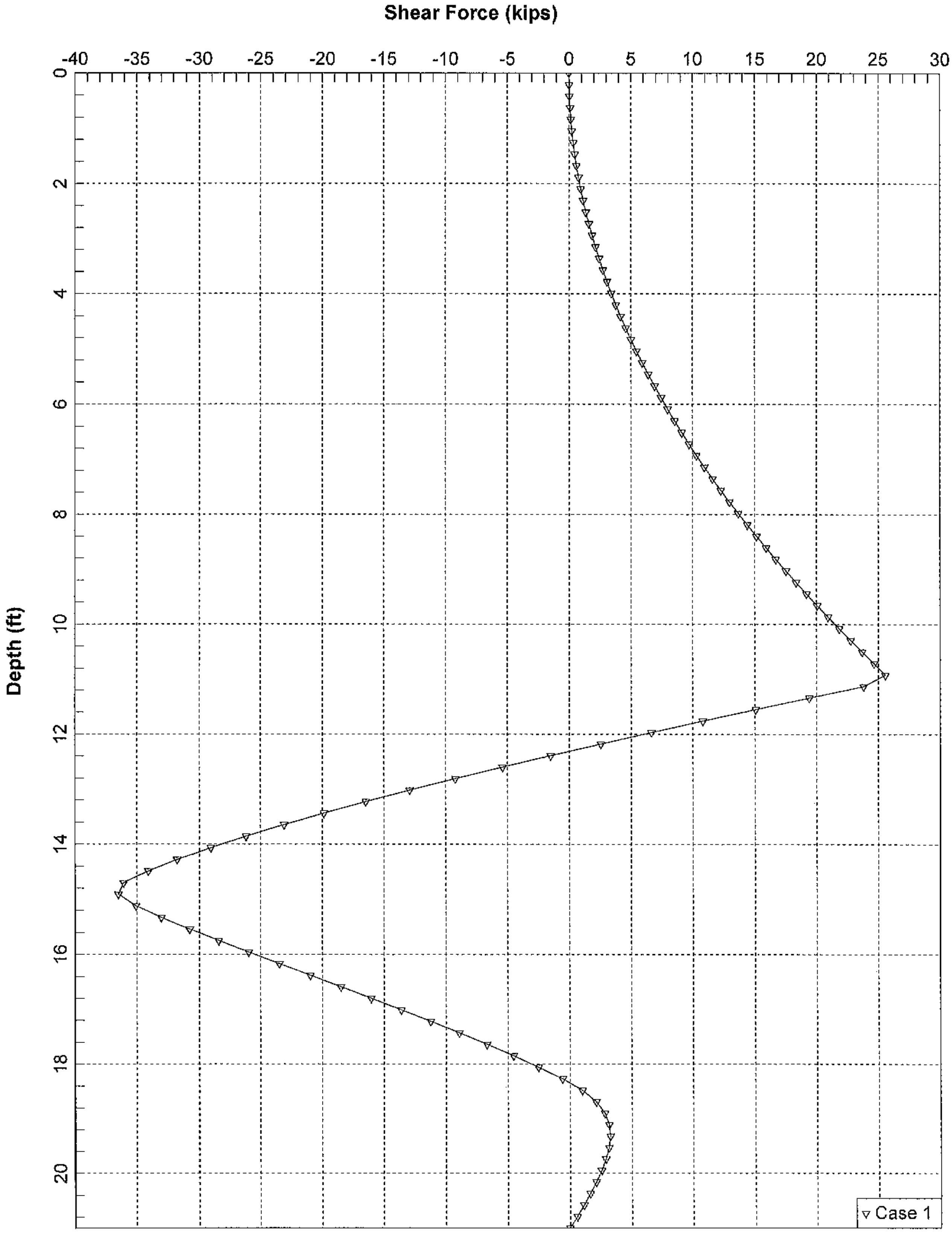
The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings prior to the drill crew leaving the site.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's review of obtained soil samples and driller's field logs. Due to the accelerated project schedule, no laboratory testing was performed on any of the collected soil and bedrock samples.



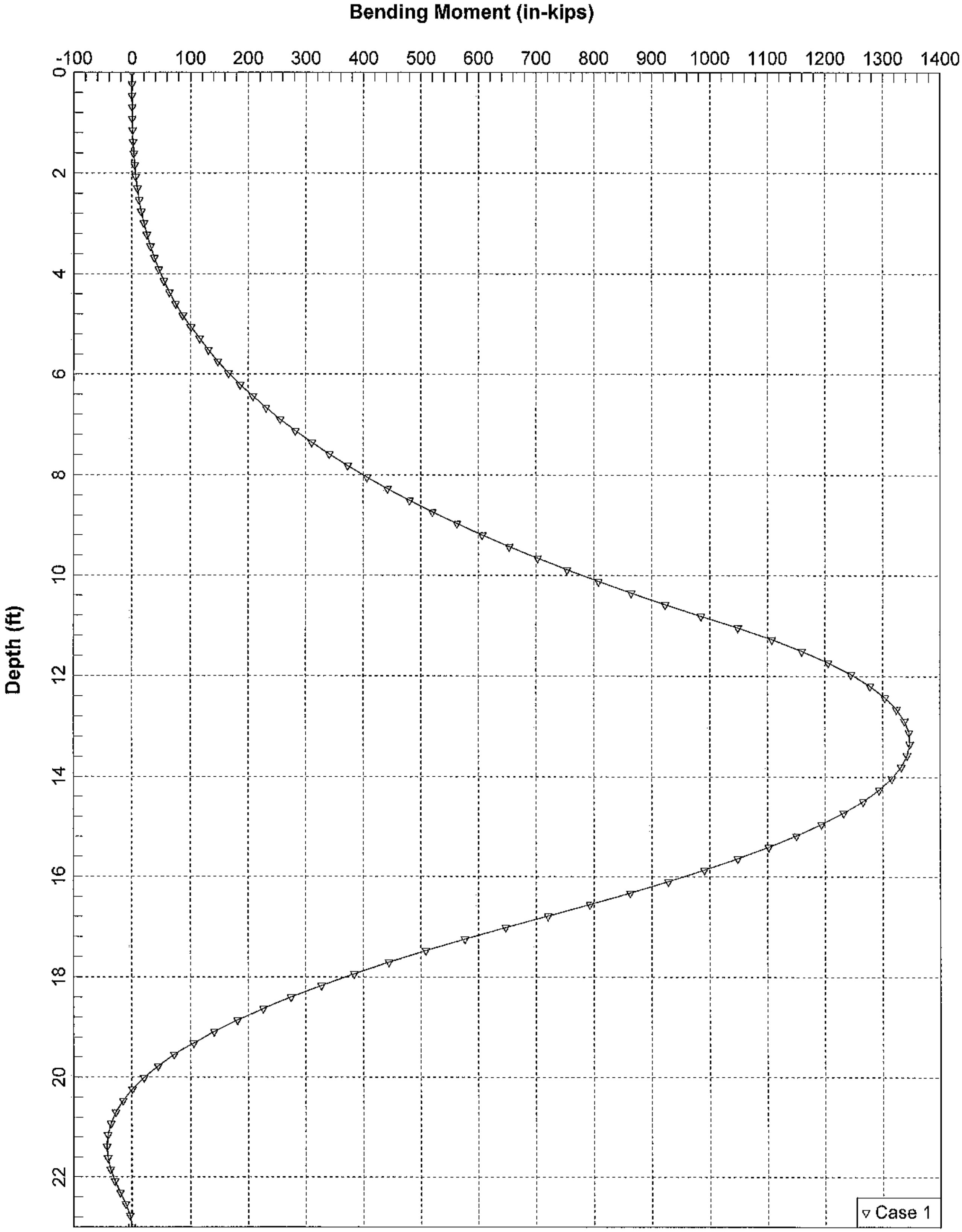
Case 1 - 30" Dia. Pier w/ HP 12X53 @ 8' Spacing (11' Retained) East Leg

EXHIBIT A-4



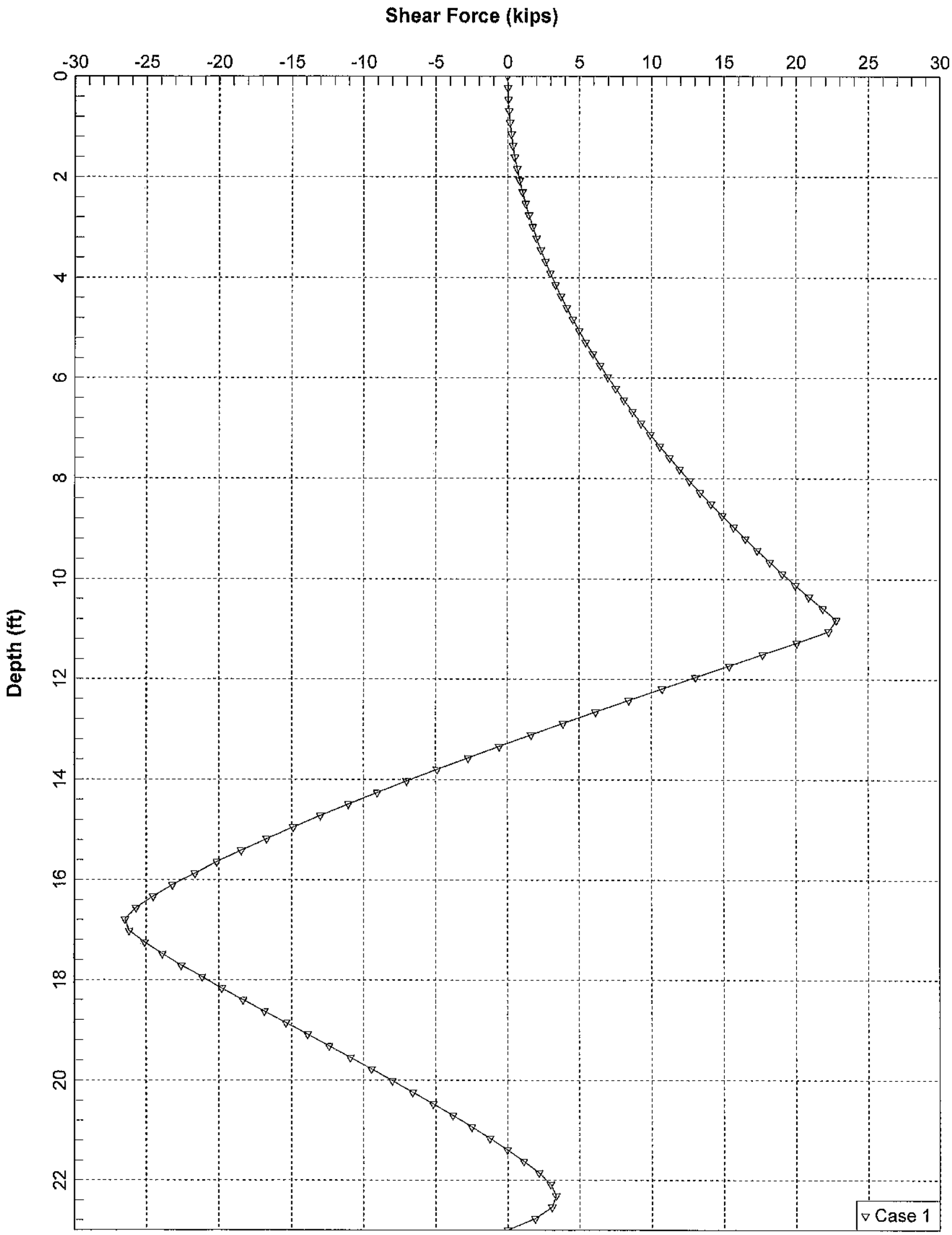
Case 1 - 30" Dia. Pier w/ HP 12X53 @ 8' Spacing (11' Retained) East Leg

EXHIBIT A-5



Case 2 - 30" Dia. Pier w/ HP 12X53 @ 8' Spacing (11' Retained) South Leg

EXHIBIT A-6



Case 2 - 30" Dia. Pier w/ HP 12X53 @ 8' Spacing (11' Retained) South Leg

EXHIBIT A-7

LOG OF BORING NO. RW-1

CLIENT: **John Poe Architects**

SITE: **3200 Vine Street, Cincinnati, Ohio**

ELEVATION REFERENCE: **Interpolated from Site Grading Plan**

PROJECT: **Cincinnati VAMC Research Facility**

Boring Location: As Shown on Test Boring Location Plan

Approx. Surface Elev.: 741.5 ft

Depth, ft	Description	Elev., ft
0.7	**TOPSOIL**	740.8
2.5	**FILL**, lean clay, brown and dark brown, trace sand, fine gravel and fine roots, very stiff	739
5	**LEAN CLAY**, brown, trace sand, silt pockets, and fine roots, very stiff	736.5
12.5	**LEAN CLAY**, brown and olive brown, little interbedded shale seams, trace limestone floaters or fragments and seams (RESIDUUM), very stiff	729
25	**SHALE**, brown, severe to moderately severe weathering, very soft to soft	716.5
25.9	**SHALE**, gray, fresh, soft, with interbedded limestone layers	715.6

Boring Completed at 25.9 ft.

Number	Type	Recovery, %	Blows / 6in. (SPT - N)	Water Content, %	Dry Unit Wt pcf	Unconfined Strength, psf
1	SS	61	2			
1A	SS	61	2-4			5500*
2	SS	56	4-5-6 (11)			6500*
3	SS	100	6-9-12 (21)			6000*
4	SS	100	30-11-11 (22)			5000*
5	SS	100	8-7-13 (20)			8000*
6	SS	100	14-11-60 (71)			
7	SS	100	16-33-28 (61)			
8	SS	100	19-12-17 (29)			
9	SS	100	16-50/5"			
10	SS	100	69-100/5"			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft

WL	▽ N/E	WD	▼ BF	at 0 hrs
WL	▼ N/E	AB	▽	
WL				

A Terracon COMPANY

BORING STARTED	12-23-10		
BORING COMPLETED	12-23-10		
RIG	Track	FOREMAN	AM
LOGGED	JDD	JOB #	N1105260

LOG OF BORING NO. RW-2

CLIENT	ELEVATION REFERENCE
John Poe Architects	Interpolated from Site Grading Plan
SITE: 3200 Vine Street, Cincinnati, Ohio	PROJECT: Cincinnati VAMC Research Facility

Boring Location: As Shown on Test Boring Location Plan

Approx. Surface Elev.: 741.5 ft

Depth (ft)	DESCRIPTION	Elev.	Sample NUMBER	TYPE	RECOVERY, %	BLOWS / 6in. (SPT - N)	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
0.7	**TOPSOIL**	740.8	1	SS	89	2			
2.5	**POSSIBLE FILL**, lean clay, brown, trace limestone and shale pieces, trace fine gravel, very stiff	739	1A	SS	89	3-5 (8)			6000*
7.5	**LEAN CLAY**, brown, trace limestone pieces, sand, and fine roots, stiff to very stiff	734	2	SS	100	5-5-6 (11)			8000*
			3	SS	100	5-5-4 (9)			4000*
10	**LEAN CLAY TO FAT CLAY**, brown, trace gray, trace shale seams (RESIDUUM), very stiff	731.5	4	SS	100	3-5-7 (12)			7000*
12.5	**LEAN CLAY**, brown, with shale seams, trace limestone floaters and layers (RESIDUUM), very stiff	729	5	SS	100	7-10-12 (22)			
24.5	**SHALE**, brown, severe to moderately severe weathering, trace limestone and clay seams, soft to very soft	717	6	SS	100	8-13-12 (25)			
			7	SS	100	19-22-19 (41)			
			8	SS	100	21-50/5"			
			9	SS	100	50/3"			
24.8	**SHALE**, gray, fresh, soft, with interbedded limestone layers	716.7	10	SS	100	50/2"			

Boring Completed at 24.8 ft.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	N/E	WD	BF at 0 hrs
WL	N/E	AB	
WL			

HCN A Terracon COMPANY

BORING STARTED	12-23-10		
BORING COMPLETED	12-23-10		
RIG	Track	FOREMAN	AM
LOGGED	JDD	JOB #	N1105260

BOREHOLE 99 RW1 AND RW2.GPJ TERRACON TEST.GDT 1/11/11

LOG OF BORING NO. R-4

CLIENT John Poe Architects	ELEVATION REFERENCE Sanitary MH Rim, Elev. = 725.49
SITE 3200 Vine Street Cincinnati, Ohio	PROJECT Cincinnati VAMC Research Facility

Boring Location: As Shown on Test Boring Location Plan

Approx. Surface Elev.: 735.1 ft

Depth, ft	DESCRIPTION	Elev.
0.2	**TOPSOIL** (2")	734.9
5	**FILL**, lean clay, trace sand and rock pieces, brown, very stiff to hard	730.1
10	**LEAN CLAY**, trace sand, gravel and sand lenses (GLACIAL TILL), brown, trace gray, very stiff -trace silt seams	725.1
17.5	**LEAN CLAY TO FAT CLAY**, trace interbedded weathered shale and limestone seams and limestone floaters (RESIDUUM), brown, very stiff to hard	717.6
20	**SHALE**, severe weathering, very soft, trace interbedded clay and limestone seams	715.1
25	**SHALE**, moderately severe weathering, soft, gray and brown	710.1
25.4	**SHALE**, fresh, soft, gray, trace interbedded hard limestone layers to seams	709.7
	Boring Completed at 25.4 ft.	

USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, %	BLOWS / 6in. (SPT - N)	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
	1	SS	67	5-6-7 (13)			
	2	SS	33	10-12-10 (22)	14		9000
CL	3	SS	67	8-6-5 (11)	20		8000
CL	4	SS	100	3-6-5 (11)	31		5000
CL CH	5	SS	55	20-50/5"	11		7000
CL CH	6	SS	86	12-23-50/2"	13		9000
CL CH	7	SS	100	6-7-23 (30)			
	8	SS	100	10-12-24 (36)	15		
	9	SS	67	15-50/3"	16		
	10	SS	100	50/5"	9		

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	N/E	WD	BF at 0 hrs
WL	N/E	AB	
WL			

HCN — A Terracon COMPANY

BORING STARTED			10-12-10
BORING COMPLETED			10-12-10
RIG	Truck	FOREMAN	HH
LOGGED	JDD	JOB #	N1105260

BOREHOLE 99 TEST BORING LOGS.GPJ TERRACON TEST.GDT 1/11/11

APPENDIX B

SUPPORTING INFORMATION

Laboratory Testing

No laboratory testing was performed on any of the recently collected soil samples due to the accelerated project schedule. A calibrated hand penetrometer was used to estimate the approximate unconfined compressive strength of some of the soil samples. The calibrated hand penetrometer has been correlated with unconfined compression tests and provides a better estimate of soil consistency than visual examination alone. The hand penetrometer results are provided on the boring logs included in Appendix A.

Descriptive classifications of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report. All classification was by visual manual procedures.

APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-$^3/_8$" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube – 2" O.D., 3" O.D., unless otherwise noted	PA:	Power Auger (Solid Stem)
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	BCR:	Before Casing Removal
WCI:	Wet Cave in	WD:	While Drilling	ACR:	After Casing Removal
DCI:	Dry Cave in	AB:	After Boring	N/E:	Not Encountered

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 – 1,000	2 - 4	Soft
1,000 – 2,000	4 - 8	Medium Stiff
2,000 – 4,000	8 - 15	Stiff
4,000 – 8,000	15 - 30	Very Stiff
8,000+	> 30	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 50	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	≥ 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75 to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	$PI > 7$ and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			$PI < 4$ or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

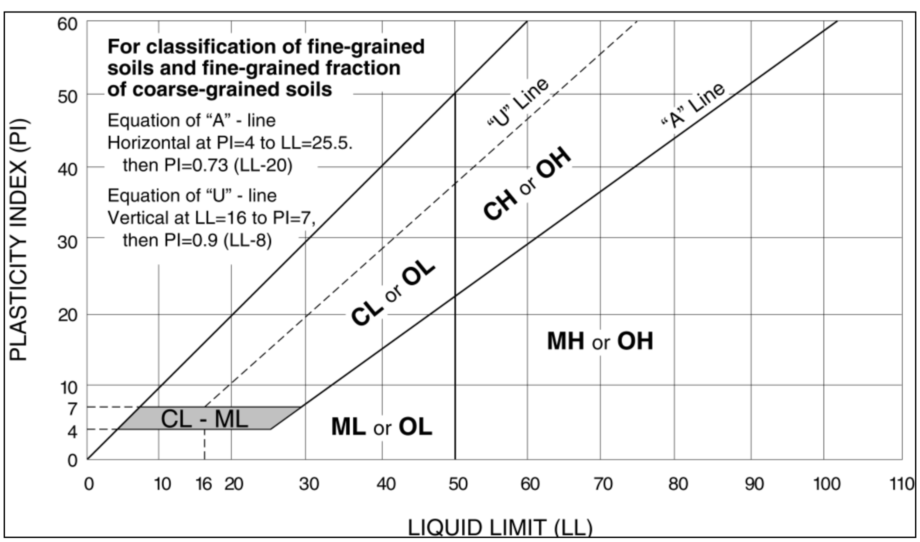
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ and plots on or above "A" line.

[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



GENERAL NOTES

Description of Rock Properties

WEATHERING

Fresh Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.

Very slight — Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.

Slight Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.

Moderate — Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.

Moderately severe — All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.

Severe — All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.

Very severe — All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.

Complete — Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard — Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.

Hard — Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.

Moderately hard — Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.

Medium — Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.

Soft — Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.

Very soft — Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding and Foliation Spacing in Rock[a]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

Rock Quality Designator (RQD)[b]

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

b. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976.

U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

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