Materials Testing
Geotechnical Engineering
Environmental
Building Sciences & Safety
Inspections & Code Compliance
Virtual Design Consulting

March 24, 2025

Mr. Daniel Clifton
Lakeside Landing, LLC
1177 Louisiana Avenue, Suite #213
Winter Park, Florida 32789

Reference: **GEOTECHNICAL EVALUATION**
Lakeside Landing Pavement and Stormwater Evaluation
Deland, Volusia County, Florida
UES Project No. 0430.2500048.0000
UES Report No. 2133801

Dear Mr. Clifton:

UES Professional Solutions, LLC (UES) has completed the geotechnical evaluation for the subject project. This report contains the results of our evaluation, an engineering interpretation of these with respect to the project characteristics described to us, and recommendations for pavement support, site preparation, and stormwater management design.

We appreciate the opportunity to have worked with you on this project and look forward to a continued association. Please do not hesitate to contact us if you should have any questions, or if we may further assist you as your plans proceed.

Respectfully Submitted,
UES Professional Solutions, LLC
Certificate of Authorization No. 549

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Ms. Erin Bryenton, E.I. – Zev Cohen & Associates, Inc.

GEOTECHNICAL EVALUATION

Lakeside Landing Pavement and Stormwater Evaluation
Deltona, Volusia County, Florida

UES Project No. 0430.2500048.0000
UES Report No. 2133801

March 24, 2025

Prepared For:

Mr. Daniel Clifton
Lakeside Landing, LLC
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TABLE OF CONTENTS

APPENDICES

1.0 PROJECT DESCRIPTION

Project information has been provided to us in correspondence with you. We have been provided with a conceptual site plan which shows the layout of the proposed subdivision. We have also reviewed the roadway grading plan and profiles. We understand the project will consist of developing a residential subdivision with one- and two-story single family homes, flexible asphalt roads and associated stormwater management facilities. Based on our review of the roadway profiles, we understand that grading cuts will be on the order of five to seven feet within some areas and fill heights will be on the order of four to five feet above existing grade in some areas.

Our recommendations are based upon the above considerations. If any of this information is incorrect, or if you anticipate any changes, inform UES so that we may review our recommendations.

2.0 PURPOSE AND SCOPE

2.1 PURPOSE

The purposes of this investigation were:

- to investigate the general subsurface conditions at the site;
- to interpret and review the subsurface conditions with respect to the proposed construction;
- to provide geotechnical engineering recommendations for pavement design and site preparation; and,
- to provide recommendations for stormwater management design.

This report presents an evaluation of site conditions on the basis of traditional geotechnical procedures for site characterization. The recovered samples were not examined, either visually or analytically, for chemical composition or environmental hazards. UES would be pleased to perform these services, at your request.

Our investigation was confined to the zone of soil likely to be influenced by the proposed construction. Our work did not address the potential for surface expression of deep geological conditions, such as sinkhole development related to karst activity. A deep geological evaluation requires a more extensive range of field services than performed in this study.

2.2 FIELD INVESTIGATION

2.2.1 BORINGS

During our most recent investigation, the subsurface conditions were investigated with:

- Five (5) Standard Penetration Test (SPT) borings, R-1, R-5, R-7, R-8 and R-10, advanced to a depth of approximately 15 feet each below existing grade and five (5) auger borings, R-2 through R-4, R-6 and R-9 advancing to 6 feet each below existing grade within the proposed roadway alignments, and
- Eight (8) SPT borings, P-1 through P-8, advanced to a depth of approximately 20 feet each below existing grade within the proposed stormwater management areas.

We performed the SPT and auger borings according to the procedures of ASTM D-1586 and ASTM D-1452, respectively.

The borings were located using handheld Global Positioning System (GPS) Unit. The approximate locations of the borings are presented on the attached Boring Location Plan in Appendix A.

Samples obtained from the borings were transported to our laboratory for further evaluation. Samples of the soils encountered will be held in our laboratory for your inspection for 60 days unless we are notified otherwise.

2.3 LABORATORY TESTING

2.3.1 INDEX TESTING

The soil samples recovered from the soil borings were returned to our laboratory and then a UES Engineer visually examined and reviewed the field descriptions. The soils were classified in accordance with the Unified Soil Classification System (USCS). Tests consisting of percent passing a No. 200 sieve determination were performed to aid in classification of the soils.

2.4.2 PERMEABILITY TESTS

Ten (10) permeability tests were performed on the relatively undisturbed soil samples obtained from the retention pond borings. The permeability is a measure of the degree to which water can flow through the soil under varying hydraulic gradients.

3.0 FINDINGS

3.1 SUBSURFACE CONDITIONS

The boring locations and detailed subsurface conditions are illustrated in Appendix A: Boring Location Plan and Subsurface Profiles. The classifications and descriptions shown on the profiles are based upon visual characterizations of the recovered soil samples. Also, see Appendix A: Key to Boring Log, for further explanation of the symbols and placement of data on the Subsurface Profiles. The following discussion summarizes the soil conditions encountered.

The results of the SPT Borings, P-1 through P-8, R-1, R-5, R-7, R-8 and R-10, generally indicated approximately 12 inches of topsoil underlain by intermittent layers of very loose to medium dense fine sand with trace silt (SP), fine sand with silt (SP-SM), silty fine sand (SM), clayey fine sand (SC) and clay (CH) to the deepest boring termination depth of approximately 20 feet below existing grade.

The results of the auger borings, R-2 through R-4, R-6 and R-9, generally indicated approximately 6 to 12 inches of topsoil underlain by intermittent layers of fine sand with trace silt (SP), fine sand with silt (SP-SM) and clayey fine sand (SC) to the deepest boring termination depth of approximately 20 feet below existing grade.

3.2 GROUNDWATER

We recorded groundwater subsequent to drilling at depths varying between approximately 5.0 and 14.0 feet below existing grade at our boring locations. As an exception, groundwater was not encountered at Boring Locations R-2, R-4, R-6 and R-9. It should be noted that groundwater may perch above the clayey fine sand (SC) after significant rainfall activity. Based on available published literature, existing site features, and the results of the borings, we estimate the normal seasonal high groundwater level to be approximately two to three feet above the measured levels. We recommend that our borings be surveyed so we can provide detailed seasonal high estimates at our boring locations. Based on our experience with other projects in this area, our understanding of the site being located within a closed basin and available published monitoring well data, we understand that this area of Volusia County experiences a yearly ("short-term") normal seasonal high groundwater level and an extreme ("long-term") high and low groundwater level that is dependent on long-term rainfall and drought activity. This is different from other areas in Volusia County that experience similar "long-term" seasonal high and seasonal low groundwater levels. It is our opinion that this variation is caused by the closed basin nature of the area and the presence of relatively shallow clayey soils. Based on published monitoring well data from the St. Johns River Water Management District (SJRWMD), we estimate that the current groundwater levels are near the "long-term" high groundwater levels experienced within this area. It should be anticipated that during periods of extended drought, groundwater levels may drop 6 to 8 feet below the currently measured groundwater levels. Groundwater levels may stay within this range until significant rainfall occurs. Upon which a significant rise in groundwater levels should be anticipated. It should be noted that the estimated seasonal high water level does not provide any assurance that groundwater levels will not exceed these estimated levels during any given year in the future. Should impediments to surface water drainage be present, or should rainfall intensity and duration, or total rainfall quantities, exceed the normally anticipated rainfall quantities, groundwater levels might once again exceed our seasonal high estimates. The depth of the groundwater level encountered at the boring location is presented on the Subsurface Profiles.

4.0 PAVEMENT RECOMMENDATIONS

4.1 GENERAL

We anticipate a flexible asphaltic concrete pavement section will be utilized for the subject project. As discussed, we have reviewed the proposed roadway profiles. We understand that grading cuts on the order of five to seven feet in some areas.

The clayey fine sand (SC) as encountered does not provide uniform bearing characteristics. Based on the results of our borings and the proposed grades, we recommend that a two-foot separation be maintained between the pavement base bearing levels and the top of the clayey soils. This separation may be maintained by raising the proposed grade or over excavating the clayey soils.

Additionally, we recommend that the vertical distance between the proposed grade, groundwater level and top of the clayey fine sand (SC) be carefully considered during design. A cut within close proximity to these features may promote groundwater seepage through the ground surface where significant cuts occur. If a significant cut occurs permanent dewatering may be necessary to preclude seepage through the ground surface within these areas. UES will gladly provide services to evaluate the separation between the proposed grades, groundwater and clayey soils. We can also provide services to help identify areas where seepage may occur.

4.2 FLEXIBLE ASPHALTIC PAVEMENT

Because traffic loadings are commonly unavailable, we have generalized our pavement design into two groups. The group descriptions and the recommended component thicknesses are presented in Table 1 below.

TABLE I
Pavement Component Recommendations

Traffic Group	Component Thickness		
	Stabilized Subgrade	Base Course	Surface Course
Roadway – light duty	12	6	1.5
Roadway – heavy duty	12	8	2.0

4.3 STABILIZED SUBGRADE

We recommend that subgrade materials be compacted in place according to the requirements in the "Site Preparation" section of this report. Further, stabilize the subgrade materials to a minimum Limerock Bearing Ratio (LBR) of 40 percent as specified by Florida Department of Transportation (FDOT) requirements for Type B Stabilized Subgrade.

Further, the stabilized subgrade can be imported material or a blend of on-site soils and imported materials. If a blend is proposed, we recommend that the contractor perform a mix design to find the optimum mix proportions.

The primary function of stabilized subgrade beneath the base course is to provide a stable and firm subgrade so that the base course can be properly placed and compacted. Depending upon the soil type, the subgrade material may have sufficient stability to provide the needed support without additional stabilizing material. Generally speaking, sands with silt or clay typically have sufficient stability and may not require additional stabilizing material. Conversely, relatively "clean" sands may not provide sufficient stability in order to adequately construct the base course.

4.4 Base Course

We recommend that the base course consist of either limerock or graded crushed aggregate (crushed concrete).

4.4.1 Limerock

Limerock should have a minimum LBR of 100 percent and should be mined from an FDOT approved source. Place limerock in maximum 6-inch lifts and compact each lift to a minimum density of 98 percent of the Modified Proctor maximum dry density.

4.4.2 Crushed Concrete Base

Crushed concrete should be supplied by an approved plant with quality control procedures. The crushed concrete stockpiled should be free of sandy pockets, foreign materials, and uncrushed particles. We recommend the following specifications be enforced.

a) Crushed concrete shall not contain lumps, balls or pockets of sand or clay sized material in sufficient quantity as to be detrimental to the proper binding, finishing or strength of the crushed concrete base.

b) Samples of base course materials shall be supplied to the engineer prior to use in the work. Additional samples shall be furnished during construction, as necessary.

At least 97 percent (by weight) of the material shall pass a 3-1/2 inch sieve and the material shall be graded uniformly down to dust. The fine material shall consist entirely of dust or fracture. All crushing or breaking-up which might be necessary in order to meet such size requirements shall be done before the material is placed on the road.

c) The base shall be bladed and shaped to conform to the typical sections shown on the plans. Then the base shall be compacted by rolling with a combination of steel wheel and rubber tired rollers until an average density of 98 percent of the maximum density obtainable under AASHTO Method T-180 is reached. The base shall have an average LBR of not less than 150. The LBR value of material produced at a particular source shall be determined in accordance with an approved quality control procedure.

Testing shall be performed at the following frequency:

1) Perform in-place density tests on crushed concrete base at a minimum frequency of 2 tests per pavement area or 1 test per 300 linear feet whichever is greater.

2) Perform Limerock Bearing Ratio tests at a frequency of 1 test per visual change in material and a minimum of 1 test per pavement area or every 15,000 square feet whichever is greater.

3) Engineer should perform a final visual base inspection prior to placement of prime or tack coat and paving.

4.5 Surface Course

In light duty areas where there is occasional truck traffic, but primarily passenger cars, we recommend using an asphaltic concrete, FDOT Type SP 9.5 mix. In heavy duty areas where truck traffic is predominant, we recommend using an asphaltic concrete, FDOT Type SP 12.5 mix.

It should be noted that if a more aesthetically pleasing asphalt surface is required a layer of Friction Course (FC) (finer aggregate) can be placed. A ½ inch layer of FC asphalt can be placed above the SP asphaltic concrete. However this may result in increased costs.

Asphaltic concrete mixes should be a current FDOT approved design of the materials actually used. Samples of the materials delivered to the project should be tested to verify that the aggregate gradation and asphalt content satisfies the mix design requirements. Compact the asphalt to a minimum of 90 percent of the Gmm (maximum voidless specific gravity).

After placement and field compaction, core the wearing surface to evaluate material thickness and to perform laboratory densities. Obtain cores at frequencies of at least one core per 3,000 square feet of placed pavement or a minimum of two cores per day's production.

In roadways, for extended life expectancy of the surface course, we recommend applying a coal tar emulsion sealer at least six months after placement of the surface course. The seal coat will help to patch cracks and voids, and protect the surface from damaging ultraviolet light and automobile liquid spillage. Please note that applying the seal coat prior to six months after placement may hinder the "curing" of the surface course, leading to its early deterioration.

4.6 CURBING

We recommend that curbing around landscaped sections adjacent to the parking roadways and driveways be constructed with full-depth curb sections. Using extruded curb sections which lie directly on top of the final asphalt level, or eliminating the curbing entirely, may not significantly impede the migration of irrigation water from the landscape areas to the interface between the asphalt and the base. This migration often causes separation of the wearing surface from the base and subsequent rippling and pavement deterioration. It is recommended that the subgrade below the curbing be stabilized to a minimum LBR of 40.

4.7 CONSTRUCTION TRAFFIC

Light duty roadways and incomplete pavement sections will not perform satisfactorily under construction traffic loadings. We recommend that construction traffic (construction equipment, concrete trucks, sod trucks, garbage trucks, dump trucks, etc.) be re-routed away from these roadways or that the pavement section be designed for these loadings.

4.8 EFFECTS OF GROUNDWATER

We recommend that all pavement sections analyses incorporate the seasonal high groundwater conditions. Based on the groundwater level at the site, the below separations will be maintained.

TABLE II
Recommended Minimum Clearance Between Pavement Base and Wet Season Water Table

Type of Base	Separation (inches)
Limerock	18
Crushed Concrete	12

One of the most critical influences on the pavement performance in Central Florida is the relationship between the pavement subgrade and the seasonal high groundwater level. Many roadways and parking areas have been destroyed as a result of deterioration of the base and the base/surface course bond resulting from a high water table. **Regardless of the type of base selected, we recommend that the seasonal high groundwater and the bottom of the base course be separated by at least the amount presented in Table 2 above.**

4.9 Site Preparation For Pavement Areas

We recommend the following site preparation procedures:

1) Strip the proposed construction limits of all grass, roots, topsoil and other deleterious materials within, and 3 feet beyond, the proposed pavement limits. Expect initial clearing and grubbing to a depths of approximately 6 inches.

2) Proof-compact the exposed surface with the light to medium roller until you maintain density of at least 98 percent should be obtained in the upper 12 inches below base course. **Vibratory equipment should be operated in static mode within 100 feet of adjacent structures.** We recommend the compacted soils exhibit moisture content within 2 percent of the soils optimum moisture content as determined by the Modified Proctor Test (ASTM D-1557).

3) Should the soils experience pumping and soil strength loss during the compaction operations, compaction work should be immediately terminated and (1) the disturbed soils removed and backfilled with dry structural fill soils which are then compacted, or (2) the excess moisture content within the disturbed soils allowed to dissipate before recompacting.

4) Test the compacted surface for density at a frequency of not less than one test per 10,000 square feet of pavement area (minimum three locations per pavement area).

5) Place and compact backfill material, as required. The fill should consist of "clean," fine sand with less than 5 percent soil fines. You may use fill materials with soil fines between 5 percent and 10 percent, but strict moisture control may be required. Place fill in uniform 10 to 12-inch loose lifts and compact each lift to a minimum density of 95 percent of the Modified Proctor maximum dry density with the exception that densities of at least 98 percent should be obtained within the upper one foot below base course. We recommend the compacted soils exhibit moisture content within 2 percent of the soils optimum moisture content as determined by the Modified Proctor Test (ASTM D-1557).

6) Perform compliance tests within each lift of fill at a frequency of not less than one test per 10,000 square feet of pavement area (minimum of three locations per pavement area).

5.0 STORMWATER MANAGEMENT RECOMMENDATIONS

5.1 General

For a dry bottom retention facility, performance will be significantly influenced by the soil permeability and the vertical separation between the bottom and the seasonal high groundwater level. A wet retention facility should be excavated to a depth necessary to obtain a sufficient water depth to limit growth of aquatic vegetation.

Based on review of the proposed grading plan and our measured groundwater levels, seepage should be anticipated in Dry Pond 2. We recommend that a berm stability analysis be performed on this pond berm.

If requested, UES can assist in evaluating the facility design exfiltration rates, underdrains and/or groundwater baseflow as pond geometry and stormwater volume requirements become available.

5.2 Soil Permeability

Ten (10) Laboratory Falling-head Saturated Vertical Permeability Tests were performed on relatively undisturbed soil samples. The samples were obtained using thin-walled tube sampling techniques (Shelby Tube). The results of the tests, in feet per day, describe the coefficients of hydraulic conductivity (Permeability) of the soils and are presented on the attached Subsurface Profiles. The measured permeability rates should not be construed to represent the actual pond exfiltration rates.

Upon evaluation of regional and local geology, we have evaluated that the characteristics of the soils within the vicinity of this project are comprised of sedimentary soils which often exhibit thin, alternating layers. Generally, in relatively homogeneous natural deposits where stratification may result from particle orientation, the Permeability in the Horizontal direction can be somewhat greater than that in the Vertical direction. Based on our experience, the estimated coefficient of Horizontal Permeability typically is on the order of 1.5 and 2.0 times greater than the Vertical Permeability for SP-SM and SP soil types, respectively. The clayey fine sand (SC) encountered should be considered a confining layer. The base of aquifer should be assumed at the top of the clayey soils for pond modeling. Partial removal of these soils may be required for pond recovery purposes. All pond backfill material should be clean sandy soils having 5 percent or less fines passing the No. 200 sieve.

5.3 Borrow Suitability

The borings were performed to provide an indication of the suitability of excavated soils for use as structural fill soil. Based on the boring results and classification of the soil samples, the fine sand (SP) and fine sand with silt (SP-SM) are suitable for use as structural fill soil. Because the fine sand with silt (SP-SM) significantly retains moisture, strict moisture control may be required during placement and compaction operations to avoid moisture related instability. The silty fine sand (SM), clayey fine sand (SC) and clay (CH) encountered is generally not considered suitable for use as fill due to the fines content making it difficult to place and compact. The clayey fine sand (SC), as encountered, can be used for road base stabilization material (LBR 40); however, this is not recommended in areas where the road base elevation is in close proximity to the groundwater table. It should be anticipated the soils in the proposed borrow pit areas that are below the groundwater level will have moisture contents in excess of the Modified Proctor optimum moisture content and will require stockpiling or spreading to bring the moisture content within 2 percent of the soil’s optimum moisture content corresponding to the required degree of compaction.

6.0 CONSTRUCTION RELATED SERVICES

We recommend the owner retain UES to perform construction materials tests and observations on this project. Field tests and observations include verification of foundation subgrades by monitoring filling operations and performing quality assurance tests on the placement of compacted natural soils and structural fill. We can also perform concrete testing, pavement section testing, structural steel testing and other construction materials testing services.

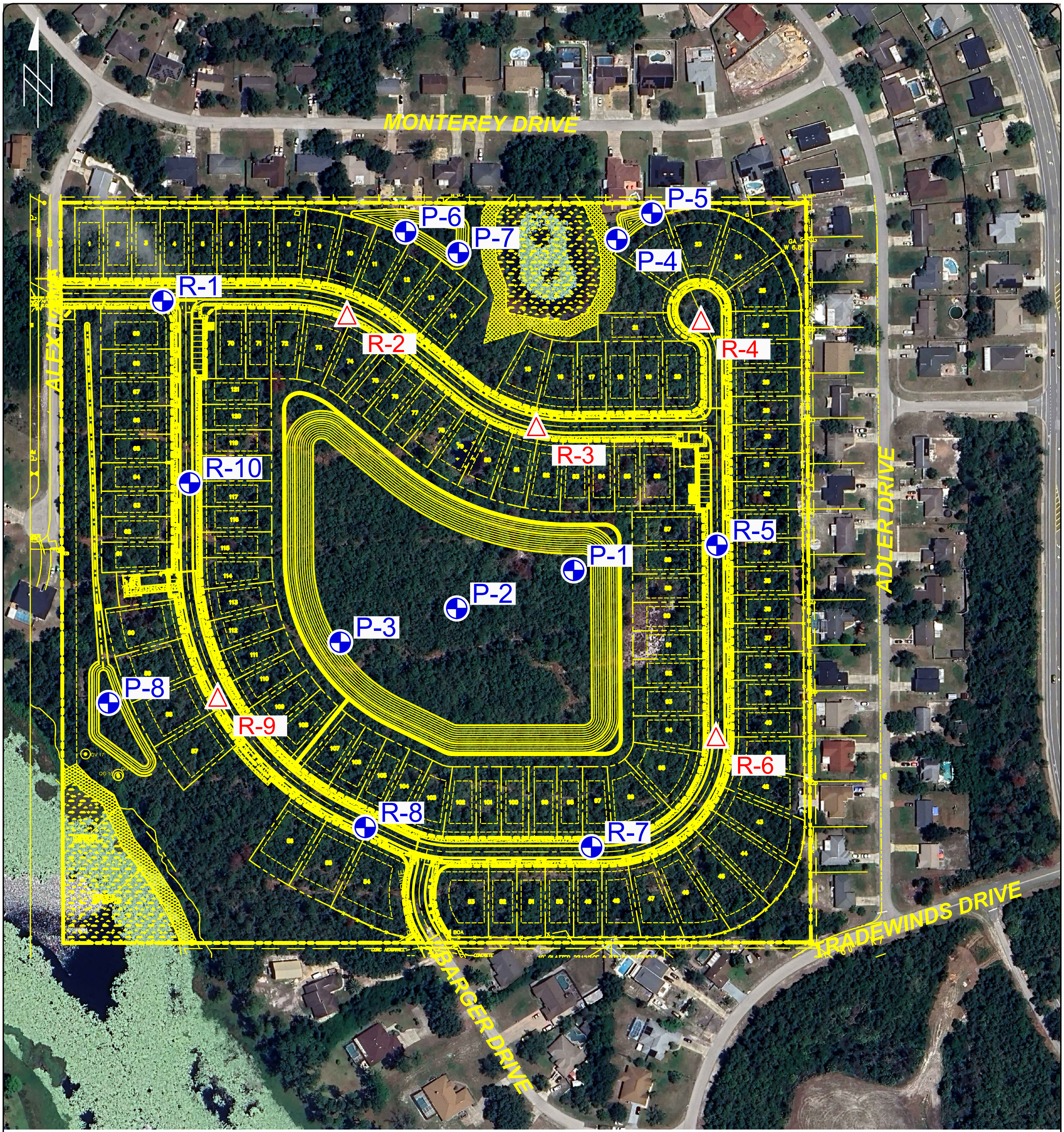
The geotechnical engineering design does not end with the advertisement of the construction documents. The design is an on-going process throughout construction. Because of our familiarity with the site conditions and the intent of the engineering design, we are most qualified to address problems that might arise during construction in a timely and cost-effective manner.

7.0 LIMITATIONS

During the early stages of most construction projects, geotechnical issues not addressed in this report may arise. Because of the natural limitations inherent in working with the subsurface, it is not possible for a geotechnical engineer to predict and address all possible problems. An Association of Engineering Firms Practicing in the Geosciences (ASFE) publication, "Important Information about Your Geotechnical Engineering Report" appears in Appendix B, and will help explain the nature of geotechnical issues. Further, we present documents in Appendix B: Constraints and Restrictions, to bring to your attention the potential concerns and the basic limitations of a typical geotechnical report.

* * * * * * * * *

APPENDIX A



LEGEND

△ APPROXIMATE LOCATION OF AUGER BORING

● APPROXIMATE LOCATION OF STANDARD PENETRATION TEST (SPT) BORING

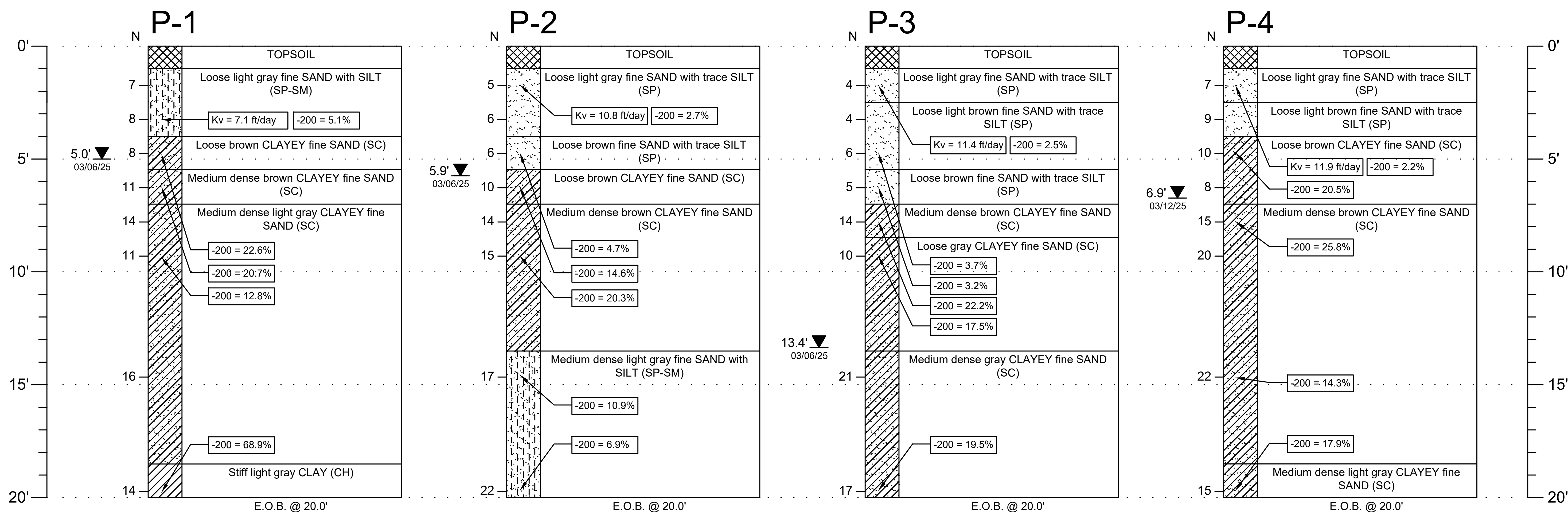
GRAPHIC SCALE

0 125 250

(IN FEET)

1 INCH ≈ 250 ft.

UES			
TITLE:	BORING LOCATION PLAN		SCALE: 1" ≈ 250'
PROJECT:	GEOTECHNICAL EVALUATION LAKESIDE LANDINGS ROADWAY AND STORMWATER DELTONA, FLORIDA		PAGE/FIG. NO.: A-1
DRAWN BY: MKL	DATE: 03/24/25	PROJECT NO.: 0430.2500048.0000	
CHECKED BY: BP	DATE: 03/24/25	REPORT NO.: 2133801	



Fine SAND (SP)

Fine SAND with SILT (SP-SM)

CLAYEY fine SAND (SC)

Topsoil (PT) ... some to many ORGANICS (PT), sometimes DEBRIS

NOTES:

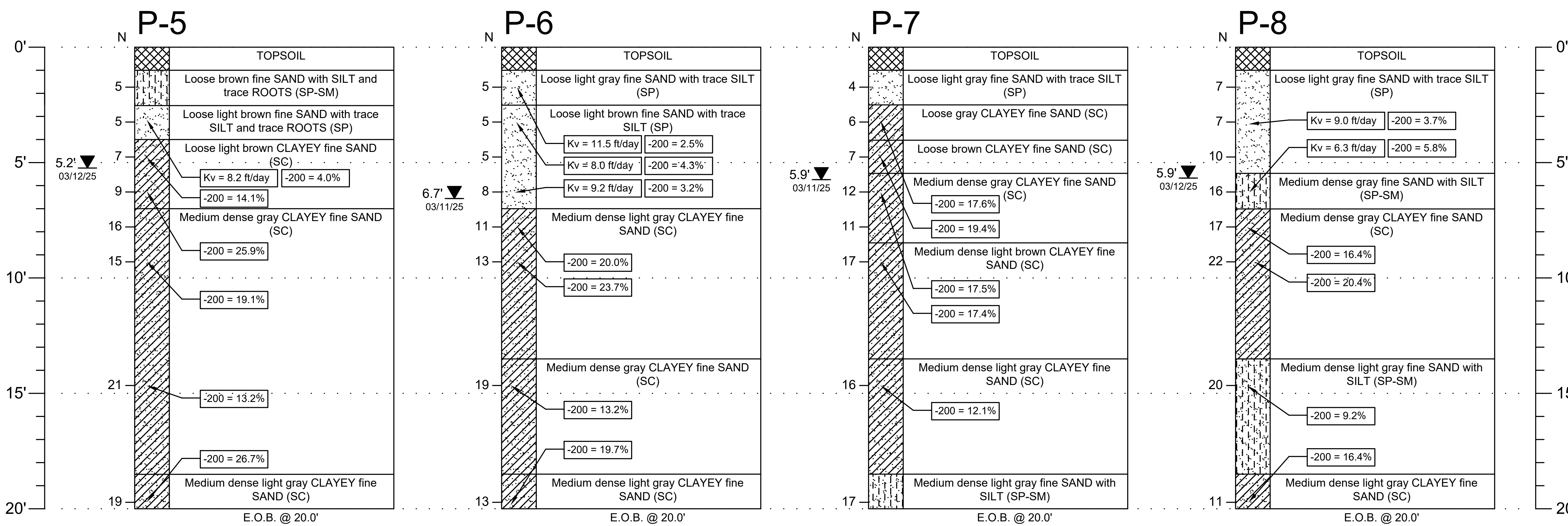
▼	Measured Groundwater Level 24 (+) Hours Subsequent to Time of Drilling
(SP)	Unified Soil Classification System
EOB	End of Boring
N	Penetr. Resistance, Blows/ft.
NE	Groundwater Not Encountered
HA	Hand Auger Method
WOH	Weight of Hammer
Kv	Coefficient of Permeability, (ft/day)
-200	% Passing No. 200 Sieve

UES™

PROJECT:
GEOTECHNICAL EVALUATION
LAKESIDE LANDINGS ROADWAY AND STORMWATER
DELTONA, FLORIDA

TITLE:
SUBSURFACE PROFILE

DRAWN BY: MKL	DATE: 03/24/25	PROJECT NO.: 0430.2500048.0000	SCALE: NA (in feet)	PAGE/FIG. NO.: A-2
CHECKED BY: BP	DATE: 03/24/25	REPORT NO.: 2133801		



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PROJECT:
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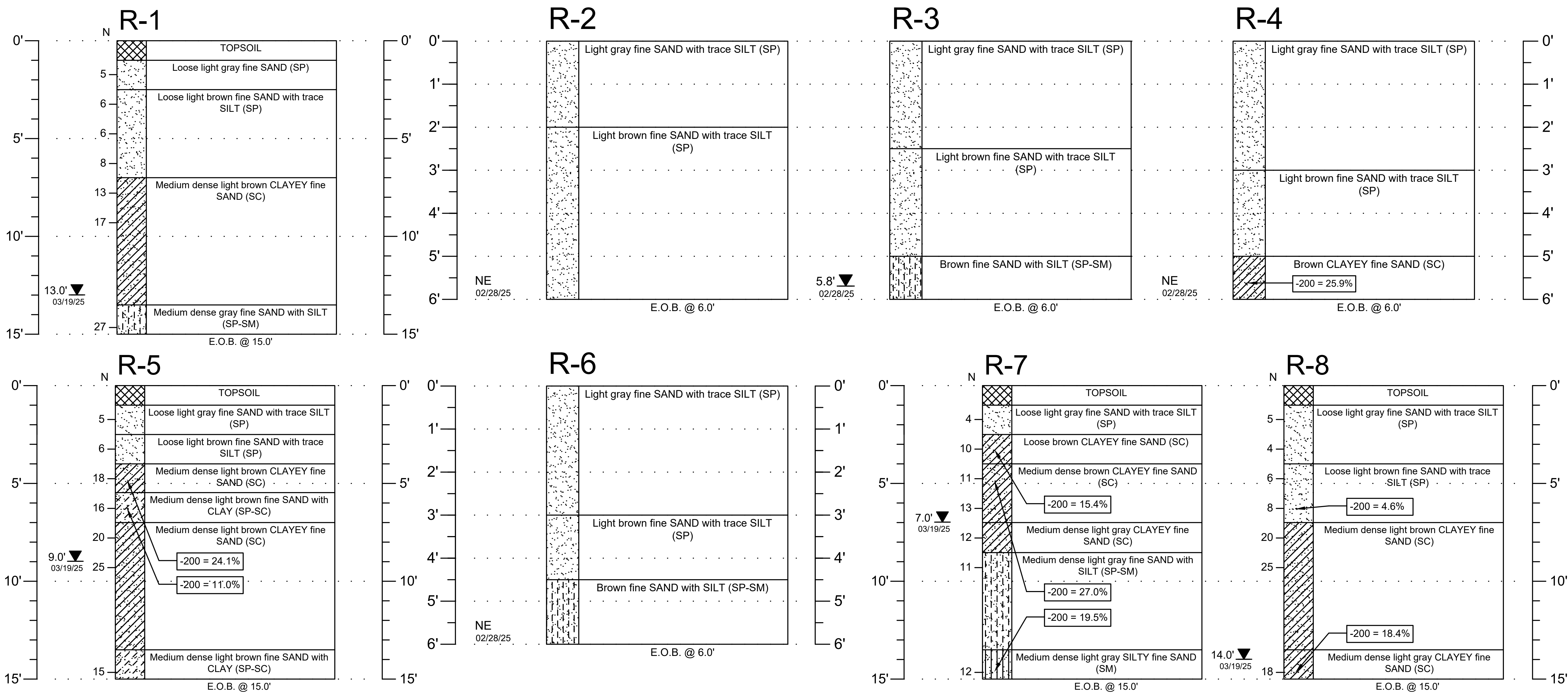
DRAWN BY: MKL	DATE: 03/24/25	PROJECT NO.: 0430.2500048.0000	SCALE: NA (in feet)
CHECKED BY: BP	DATE: 03/24/25	REPORT NO.: 2133801	PAGE/FIG. NO.: A-3



Fine SAND (SP)

Fine SAND with SILT (SP-SM)

SILTY fine SAND (SM)

Fine SAND with CLAY (SP-SC)

CLAYEY fine SAND (SC)

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NOTES:

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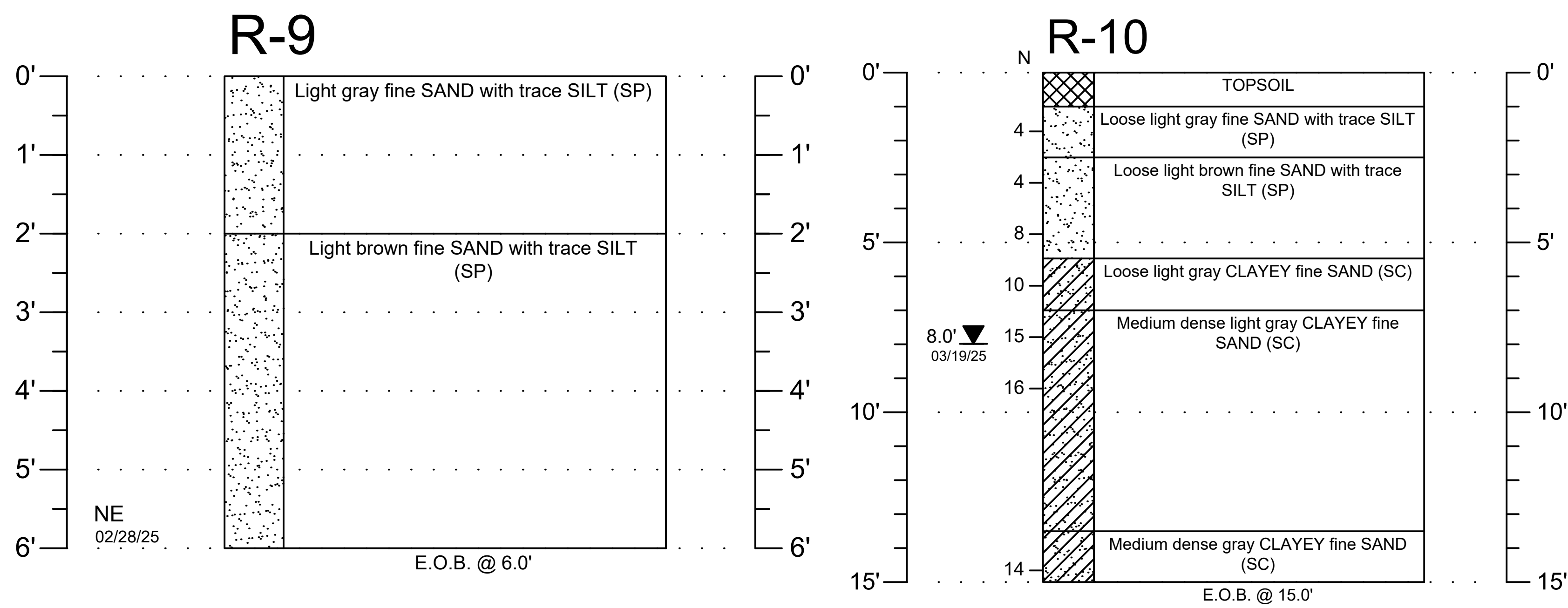
DRAWN BY: MKL	DATE: 03/24/25	PROJECT NO.: 0430.2500048.0000	SCALE: NA (in feet)
CHECKED BY: BP	DATE: 03/24/25	REPORT NO.: 2133801	PAGE/FIG. NO.: A-4



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DRAWN BY: MKL	DATE: 03/24/25	PROJECT NO.: 0430.2500048.0000	SCALE: NA (in feet)	PAGE/FIG. NO.: A-5
CHECKED BY: BP	DATE: 03/24/25	REPORT NO.: 2133801		

UES

KEY TO BORING LOGS

SYMBOLS AND ABBREVIATIONS

SYMBOL	DESCRIPTION
N-Value	No. of Blows of a 140-lb. Weight Falling 30 Inches Required to Drive a Standard Spoon 1 Foot
WOR	Weight of Drill Rods
WOH	Weight of Drill Rods and Hammer
	Sample from Auger Cuttings
	Standard Penetration Test Sample
	Thin-wall Shelby Tube Sample (Undisturbed Sampler Used)
RQD	Rock Quality Designation
	Stabilized Groundwater Level
	Seasonal High Groundwater Level (also referred to as the W.S.W.T.)
NE	Not Encountered
GNE	Groundwater Not Encountered
BT	Boring Terminated
-200 (%)	Fines Content or % Passing No. 200 Sieve
MC (%)	Moisture Content
LL	Liquid Limit (Atterberg Limits Test)
PI	Plasticity Index (Atterberg Limits Test)
NP	Non-Plastic (Atterberg Limits Test)
K	Coefficient of Permeability
Org. Cont.	Organic Content
G.S. Elevation	Ground Surface Elevation

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS More than 50% retained on the No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	GM	Silty gravels and gravel-sand-silt mixtures
			GC	Clayey gravels and gravel-sand-clay mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS 5% or less passing No. 200 sieve	SW**	Well-graded sands and gravelly sands, little or no fines
			SP**	Poorly graded sands and gravelly sands, little or no fines
		SANDS with 12% or more passing No. 200 sieve	SM**	Silty sands, sand-silt mixtures
			SC**	Clayey sands, sand-clay mixtures
FINE-GRAINED SIOLS 50% or more passes the No. 200 sieve*	SILTS AND CLAYS Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diamicaceous fine sands or silts, elastic silts
			CH	Inorganic clays or clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
			PT	Peat, muck and other highly organic soils

*Based on the material passing the 3-inch (75 mm) sieve
** Use dual symbol (such as SP-SM and SP-SC) for soils with more than 5% but less than 12% passing the No. 200 sieve

RELATIVE DENSITY
(Sands and Gravels)
Very loose – Less than 4 Blow/Foot
Loose – 4 to 10 Blows/Foot
Medium Dense – 11 to 30 Blows/Foot
Dense – 31 to 50 Blows/Foot
Very Dense – More than 50 Blows/Foot

CONSISTENCY
(Silts and Clays)
Very Soft – Less than 2 Blows/Foot
Soft – 2 to 4 Blows/Foot
Firm – 5 to 8 Blows/Foot
Stiff – 9 to 15 Blows/Foot
Very Stiff – 16 to 30 Blows/Foot
Hard – More than 30 Blows/Foot

RELATIVE HARDNESS
(Limestone)
Soft – 100 Blows for more than 2 Inches
Hard – 100 Blows for less than 2 Inches

MODIFIERS

These modifiers Provide Our Estimate of the Amount of Minor Constituents (Silt or Clay Size Particles) in the Soil Sample
Trace – 5% or less
With Silt or With Clay – 6% to 11%
Silty or Clayey – 12% to 30%
Very Silty or Very Clayey – 31% to 50%

These Modifiers Provide Our Estimate of the Amount of Organic Components in the Soil Sample
Trace – Less than 3%
Few – 3% to 4%
Some – 5% to 8%
Many – Greater than 8%

These Modifiers Provide Our Estimate of the Amount of Other Components (Shell, Gravel, Etc.) in the Soil Sample
Trace – 5% or less
Few – 6% to 12%
Some – 13% to 30%
Many – 31% to 50%

APPENDIX B

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Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

CONSTRAINTS & RESTRICTIONS

The intent of this document is to bring to your attention the potential concerns and the basic limitations of a typical geotechnical report.

WARRANTY

Universal Engineering Sciences has prepared this report for our client for his exclusive use, in accordance with generally accepted soil and foundation engineering practices, and makes no other warranty either expressed or implied as to the professional advice provided in the report.

UNANTICIPATED SOIL CONDITIONS

The analysis and recommendations submitted in this report are based upon the data obtained from soil borings performed at the locations indicated on the Boring Location Plan. This report does not reflect any variations which may occur between these borings.

The nature and extent of variations between borings may not become known until excavation begins. If variations appear, we may have to re-evaluate our recommendations after performing on-site observations and noting the characteristics of any variations.

CHANGED CONDITIONS

We recommend that the specifications for the project require that the contractor immediately notify Universal Engineering Sciences, as well as the owner, when subsurface conditions are encountered that are different from those present in this report.

No claim by the contractor for any conditions differing from those anticipated in the plans, specifications, and those found in this report, should be allowed unless the contractor notifies the owner and Universal Engineering Sciences of such changed conditions. Further, we recommend that all foundation work and site improvements be observed by a representative of Universal Engineering Sciences to monitor field conditions and changes, to verify design assumptions and to evaluate and recommend any appropriate modifications to this report.

MISINTERPRETATION OF SOIL ENGINEERING REPORT

Universal Engineering Sciences is responsible for the conclusions and opinions contained within this report based upon the data relating only to the specific project and location discussed herein. If the conclusions or recommendations based upon the data presented are made by others, those conclusions or recommendations are not the responsibility of Universal Engineering Sciences.

CHANGED STRUCTURE OR LOCATION

This report was prepared in order to aid in the evaluation of this project and to assist the architect or engineer in the design of this project. If any changes in the design or location of the structure as outlined in this report are planned, or if any structures are included or added that are not discussed in the report, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions modified or approved by Universal Engineering Sciences.

USE OF REPORT BY BIDDERS

Bidders who are examining the report prior to submission of a bid are cautioned that this report was prepared as an aid to the designers of the project and it may affect actual construction operations.

Bidders are urged to make their own soil borings, test pits, test caissons or other investigations to determine those conditions that may affect construction operations. Universal Engineering Sciences cannot be responsible for any interpretations made from this report or the attached boring logs with regard to their adequacy in reflecting subsurface conditions which will affect construction operations.

STRATA CHANGES

Strata changes are indicated by a definite line on the boring logs which accompany this report. However, the actual change in the ground may be more gradual. Where changes occur between soil samples, the location of the change must necessarily be estimated using all available information and may not be shown at the exact depth.

OBSERVATIONS DURING DRILLING

Attempts are made to detect and/or identify occurrences during drilling and sampling, such as: water level, boulders, zones of lost circulation, relative ease or resistance to drilling progress, unusual sample recovery, variation of driving resistance, obstructions, etc.; however, lack of mention does not preclude their presence.

WATER LEVELS

Water level readings have been made in the drill holes during drilling and they indicate normally occurring conditions. Water levels may not have been stabilized at the last reading. This data has been reviewed and interpretations made in this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, tides, and other factors not evident at the time measurements were made and reported. Since the probability of such variations is anticipated, design drawings and specifications should accommodate such possibilities and construction planning should be based upon such assumptions of variations.

LOCATION OF BURIED OBJECTS

All users of this report are cautioned that there was no requirement for Universal Engineering Sciences to attempt to locate any man-made buried objects during the course of this exploration and that no attempt was made by Universal Engineering Sciences to locate any such buried objects. Universal Engineering Sciences cannot be responsible for any buried man-made objects which are subsequently encountered during construction that are not discussed within the text of this report.

TIME

This report reflects the soil conditions at the time of exploration. If the report is not used in a reasonable amount of time, significant changes to the site may occur and additional reviews may be required.

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