Geotechnical Engineering Report

Proposed Fitness Center
Franklin, Tennessee
October 12, 2015
Terracon Project No. 18155050

Prepared for:
Temple Fitness, LLC
Franklin, Tennessee

Prepared by:
Terracon Consultants, Inc.
Nashville, Tennessee

October 12, 2015

Temple Fitness, LLC
114 Southeast Parkway Court
Franklin, TN 37064

Attn: Mr. Joseph Barbera

Re: Geotechnical Engineering Report
Proposed Fitness Center
Franklin, TN
Terracon Project Number: 18155050

Dear Mr. Barbera:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number P18150244 dated August 10, 2015.

This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

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,
Terracon Consultants, Inc.

Nancy Gregory for

Patrick L. Kuykendall, EI
Staff Geotechnical Engineer

J. Samuel Vance, P.E.
Geotechnical Manger
TN: PE-102042

Enclosures
cc: 1 – Client (PDF)
1 – File

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EXECUTIVE SUMMARY

A geotechnical investigation has been performed for the proposed fitness center to be constructed at 472 Down Boulevard in Franklin, Tennessee. Eleven (11) test pits were excavated within the proposed development area, and the following geotechnical considerations were identified:

- Test pit excavations typically encountered existing fill overlying natural lean clay. The existing fill stratum had a high organic content and ranged in thickness from ½ to 6 feet. The natural lean clay stratum ranged in thickness from 1 ½ to 4 ½ feet. Refusal depths across the proposed development ranged from ½ feet to 10 ½ feet.
- The undocumented existing fill presents a risk for excessive building settlement due to unknown aspects and the uncertainties associated with the fill composition and its placement. To mitigate this risk, we recommend the existing fill within the proposed building footprint be undercut in its entirety and replaced with new engineered fill. After the site is properly prepared, the proposed building may be founded on shallow spread footings bearing on engineer approved subgrades.
- Existing fill may remain in pavement areas provided the pavements are constructed upon a minimum of 18 inches of shot rock or other engineered fill and Terracon is allowed to evaluate and approve the related subgrades at the time of site development.
- Refusal depths as shallow as ½ feet on weathered bedrock suggest that some excavations may engage the bedrock surface.
- Because portions of building foundations might engage the bedrock surface, footings might bear on dissimilar materials (bedrock and engineered fill) across a short distance. To help mitigate the adverse effects resulting from this condition, we recommend where bedrock is exposed at foundation bearing in isolated areas, the bedrock be over-excavated 18 inches below the foundation depth and backfilled with engineered fill.
- The 2012 IBC/Chapter 20 ASCE 7-05 seismic site classification for this site is B.
- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

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 FITNESS CENTER
FRANKLIN, TENNESSEE

Terracon Project No. 18155050
October 12, 2015

1.0 INTRODUCTION

A geotechnical engineering report has been completed for the proposed fitness center to be located at 472 Downs Boulevard in Franklin, Tennessee. Eleven (11) test pits were excavated to depths of approximately ½ to 10 ½ feet below the existing ground surface within the area proposed for construction. Logs of the test pits along with a test pit location plan are included in Appendix A.

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

- subsurface soil conditions
- groundwater conditions
- earthwork
- foundation design and construction
- seismic considerations
- slab design and construction
- pavement section thickness

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	Unknown, final design and grading plans are incomplete
Proposed Improvements	A one story 5,000± square foot (sf) fitness center that will likely include an office mezzanine
Building Construction	Light gauge metal framing and trusses, load bearing concrete masonry walls, slab-on-grade
Finished floor elevation	About El. 695.0 feet (assumed)
Maximum loads (assumed)	Columns: 75 kips Walls: 2 klf Slab: 200 psf
Grading	Minimal cut and up to about 5 feet of fill (assumed)

2.2 Site Location and Description

Item	Description
Location	Undeveloped Parcel, 472 Downs Boulevard, Franklin, TN Latitude/Longitude: N 35° 54.53' / W 86° 53.17'
Existing improvements	None besides storm water drainage easement on north perimeter of property
Current ground cover	Grass, weeds, cluster of trees along center of property, asphalt pavement on southeast corner
Existing topography	Gently slopes downward to the north from approximately El. 700 on south side of property to approximately El. 690 on north side of property.

Based on our review of available internet-based aerial images dating back to about 1997, the site experienced some disturbance about 2006. Current grades within the subject property at the locations explored were created with typically thin intervals of fill. In addition, adjacent property to the east was developed for an existing business between about 2008 and 2014. An existing pavement entrance from Downs Boulevard was built at the southeast corner of the subject site in a apparent common access easement in about 2014.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

Formation	Description
Bigby-Cannon Limestone [1]	Microcrystalline to medium grained, thin to medium bedded limestone.

1. *Geologic Map of the Liepers Fork Quadrangle, Tennessee* published by the State of Tennessee Department of Conservation, Division of Geology (1963).

The site is underlain by carbonate limestone that is highly susceptible to dissolution along joints and bedding planes in the rock mass. This results in voids and solution channels within the rock strata and a highly irregular bedrock surface. The weathering of the bedrock and subsequent collapse or erosion of the overburden into these openings results in what is referred to as karst topography. Any construction in karst topography is accompanied by some degree of risk for future internal soil erosion and ground subsidence that could affect the stability of the proposed structures. Our review of the available topographic and geologic mapping did not note any sinkholes on or around the site, or within a 1 mile radius of the property. Furthermore, the test pits dug at the site did not disclose any obvious signs of impending overburden collapse.

3.2 Typical Profile

Each of the test pits encountered approximately ½ to 4 ½ feet of existing fill at the ground surface. The existing fill was dark brown, friable and contained significant organic matter. In some cases, the existing fill contained limestone cobbles to boulders ranging from 3 inches to 2 feet in diameter.

Underlying the existing fill in all test pits except TP-1, TP-5, TP-8, and TP-9 was stiff or firmer lean clay. The lean clay was medium brown with occasional gray mottling and black nodules. Correlations with measured unconfined strengths (using a hand penetrometer) ranged from 1.5 to 2.5 tons per square foot (tsf), and moisture content of this stratum ranged from 20 to 30 percent.

The upper native clay was classified as lean clay, was of moderate plasticity and yielded the following Atterberg Limits values.

Sample Location, Depth	Liquid Limit, (%)	Plastic Limit, (%)	Plasticity Index, (%)
Test Pit TP-6, 6 ft.	44	24	20

The test pits were extended to machine refusal on the surface of weathered bedrock at depths ranging from ½ to 10 ½ feet below the ground surface. The following table summarizes the refusal depth at each test pit location and gives a summary of the individual subsurface conditions.

Test Pit Summary		
Test Pit	**Refusal Depth (ft.)**	**Description (see attached logs and photos for details)**
TP-1	2 ½	2 ½ feet of existing fill
TP-2	6	4 feet of existing fill overlying 2 feet of lean clay
TP-3	10 ½	6 feet of existing fill overlying 4 ½ feet of lean clay
TP-4*	2 ½ and 4 ½	2 feet of existing fill overlying ½ to 2 feet of lean clay
TP-5	½	½ foot of existing fill
TP-6	6	4 ½ feet of existing fill overlying 1 ½ feet of lean clay
TP-7	7 ½	3 ½ feet of existing fill overlying 4 feet of lean clay
TP-8	1	1 foot of existing fill
TP-9	½	½ foot of existing fill
TP-10	4	2 feet of existing fill overlying 2 feet of lean clay
TP-11	6 ½	3 ½ feet of existing fill overlying 3 feet of lean clay
*Refused on perceived bedrock ledge with upper end at 2 feet and lower end at 4 ½ feet		

Conditions encountered at each test pit location are indicated on the individual logs. Stratification boundaries on the test pit logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the test pits can be found on the logs in Appendix A. A discussion of field sampling procedures is included in Appendix A and laboratory testing procedures are presented in Appendix B.

3.3 Groundwater

The test pits were observed while digging and after completion for the presence and level of groundwater. Groundwater was not observed in the test pits during excavation, or for the short duration that the test pits were allowed to remain open. At this site we expect the permanent groundwater table is below the bedrock surface. 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 test pits were performed. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The results of our study indicate the site can be developed for the proposed fitness center. The following geotechnical considerations were identified by our exploration:

Existing Fill – The undocumented existing fill presents a risk for excessive building settlement due to the unknown aspects and the uncertainties associated with the fill composition and its placement. To mitigate this risk, we recommend the existing fill be undercut in its entirety from the proposed building footprint and replaced with new engineered fill. The lateral limits of undercutting should extend beyond the proposed building footprint a distance equal to the depth of fill at that location. Existing fill may remain in pavement areas provided the pavements are constructed upon a minimum of 18 inches of shot rock or other engineered fill and Terracon is allowed to evaluate and approve the related subgrades at the time of site development.

Support of pavements above existing fill soils is discussed in the following sections. However, even with the recommended construction testing services, there is an inherent risk for the owner that compressible fill or unsuitable materials within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by performing additional testing and evaluation.

Excavation – Relatively shallow refusal depths across the site suggest that some excavations may engage the bedrock surface and will require rock excavation techniques. In areas where rock excavation is required to accommodate building foundations, we recommend over-excavating an additional 18 inches below the foundation depth and backfilling with engineered fill to mitigate the effects of differential settlement due to dissimilar foundation bearing surfaces. Rock excavation techniques and difficulty are discussed in Section 4.2.2.

4.2 Earthwork

4.2.1 Site Preparation

Prior to placing any fill, all vegetation and any otherwise unsuitable material should be removed from the construction areas. Wet or dry material should either be removed or moisture conditioned and recompacted. After stripping and grubbing, the subgrade should be proof-rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with a loaded tandem axle dump truck. Soft, dry and low-density soil should be removed or compacted in place prior to placing fill. Excavations resulting from removal of buried features should be repaired and backfilled with engineered fill as described hereinafter.

The Terracon engineer should be present to observe undercut of existing fill from within and near the building footprint to confirm the limits of undercut of the material. In addition, existing fill should be undercut as necessary within pavement areas to accommodate the minimum 18 inch thick interval of new engineered fill. Where at least 18 inches of new fill is required in pavement areas, the Terracon engineer should review subgrades to receive new fill via proofroll and additional test pits to confirm suitability of the subgrade to receive the required fill. The contractor should be prepared to conduct additional undercut as directed by the engineer. Based on the observed organic fraction in the existing fill, it is not considered suitable for reuse as engineered fill for this project.

4.2.2 Excavation

Rippability of the host bedrock will vary across the site depending on rock quality and depth of excavation. Experience has indicated that conventional heavy duty excavation equipment such as backhoes equipped with rock teeth or bulldozers equipped with ripping attachments can sometimes excavate highly weathered bedrock. However, below the zone of intense bedrock weathering, excavation often becomes much more difficult and could require the use of jackhammers, rock splitters, rock trenchers, or possibly light blasting. Estimating the quantity of rock excavation is difficult; however linear interpolation of apparent bedrock elevations based on the test pit data is often used but can misrepresent actual rock removal quantities.

Published geologic literature indicates the Bigby-Cannon Formation has an excavation difficulty rating of 2 to 4. An explanation of the ratings is shown in the following table.

Excavation Difficulty Rating	
Rating	**Description of Excavation Condition**
1	Very thick bedded limestone with cutter-pinnacle development. Rock breaks with difficulty even by blasting, large rock left after initial blast require secondary drilling and blasting
2	Medium bedded limestone with moderately even bedrock surface, blast transmitted uniformly
3	Thin bedded limestone, rock breaks readily with minimal blasting
4	Semi-consolidated or otherwise weak material that can be ripped (shale, chert beds in residuum, some thin bedded siltstone)
5	Unconsolidated material, blasting unnecessary, ordinary digging required.

All excavations should be sloped or braced as required by OSHA regulations to provide stability and safe working conditions. The contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current Occupational Health and Safety Administration (OSHA) Excavation and Trench Safety Standards.

4.2.3 Material Requirements

Compacted structural fill should meet the following material property requirements:

Engineered Fill Description and Recommended Uses		
Fill Type [1]	**USCS Classification**	**Acceptable Location for Placement**
Lean clay	CL (LL<45)	All locations and elevations
Well graded granular	GW [2]	All locations and elevations
Clean shot rock, < 5% soil; max. particle size is 1 ft. [3]	-	All locations and elevations
Existing Fill	-	Not suitable for reuse

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.
2. Similar to TDOT Section 903.05 Type A, Grading D crushed limestone aggregate, limestone screenings, or granular material such as well graded gravel or crushed stone.
3. Shot rock described is colloquially known at local quarries and by most local grading contractors as surge stone. Approval of any shot rock material should be made prior to placement to verify gradation and maximum particle size.

4.2.4 Compaction Requirements

Item	Description
Fill Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used
	4 to 6 inches in loose thickness when hand-guided equipment (*i.e.* jumping jack or plate compactor) is used
	Shot rock can be placed in 12 to 18 inch thick horizontal layers, depending on particle size and compaction equipment weight
Compaction Requirements	At least 98% of the materials standard Proctor maximum dry density (ASTM D 698)
Moisture Content Cohesive Soil	Within the range of 1% below to 2% above the optimum moisture content value as determined by the standard Proctor test at the time of placement and compaction
Moisture Content Granular Material	Moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proof-rolled.

We recommend that engineered soil and granular fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

Shot rock fill should be compacted in lifts not exceeding 18 inches using a D-8 class Dozer (10 ton class vibratory roller) or equivalent. Each lift of fill should be compacted using a minimum of ten passes, five in one direction and five that are at a right angle to the initial passes. A complete pass consists of complete coverage of the surface with the tracks or rollers.

4.2.5 Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the building.

4.2.6 Grading and Drainage

Final surrounding grades should be sloped away from the structure on all sides to prevent ponding of water. Gutters and downspouts that drain water a minimum of 10 feet beyond the footprint of the proposed structures are recommended. This can be accomplished through the use of splash-blocks, downspout extensions, and flexible pipes that are designed to attach to the end of the downspout. Flexible pipe should only be used if it is daylighted in such a manner that it gravity-drains collected water. Splash-blocks should also be considered below hose bibs and water spigots. All surface water runoff should be collected in storm water systems and discharged off property

4.2.7 Earthwork Construction Considerations

Although the exposed subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Should unstable subgrade conditions develop, stabilization measures will need to be employed.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over completed and working subgrades should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared soil subgrades or in excavations. If soil subgrades should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab and pavement construction.

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade; and just prior to construction of building floor slabs.

4.3 Foundations

After addressing the existing fill within the building footprint and necessary subgrade preparation and grading, the proposed fitness center building can be supported by shallow spread footings bearing on new engineered fill or stiff natural soils. Design recommendations for shallow foundations for the proposed structure are presented in the following paragraphs.

4.3.1 Foundation Design Recommendations

Description	Column	Wall
Net allowable bearing pressure [1]	3,000 psf	2,500 psf
Minimum dimensions	30 inches	18 inches
Minimum embedment below finished grade for frost protection [2]	18 inches	18 inches
Approximate total settlement [3]	<1 inch	<1 inch
Estimated differential settlement	<¾ inch between columns	<¾ inch over 40 feet
Allowable passive pressure [4]	750 psf (below 2 feet)	
Ultimate coefficient of sliding friction [4]	0.35	

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable fill or soft soils, if encountered, will be undercut and replaced with engineered fill.
2. For perimeter footing and footings beneath unheated areas. Also to reduce the effects of seasonal moisture variations in the subgrade soils.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations. This value does not include any movement resulting from karst activity.
4. The sides of the excavation for spread footings must be nearly vertical and the concrete should be placed neat against these vertical faces for the passive earth pressure value to be valid. If the loaded side is sloped or benched, and then backfilled, the allowable passive pressure will be significantly reduced. Passive resistance in the upper 2 feet of the soil profile should be neglected.

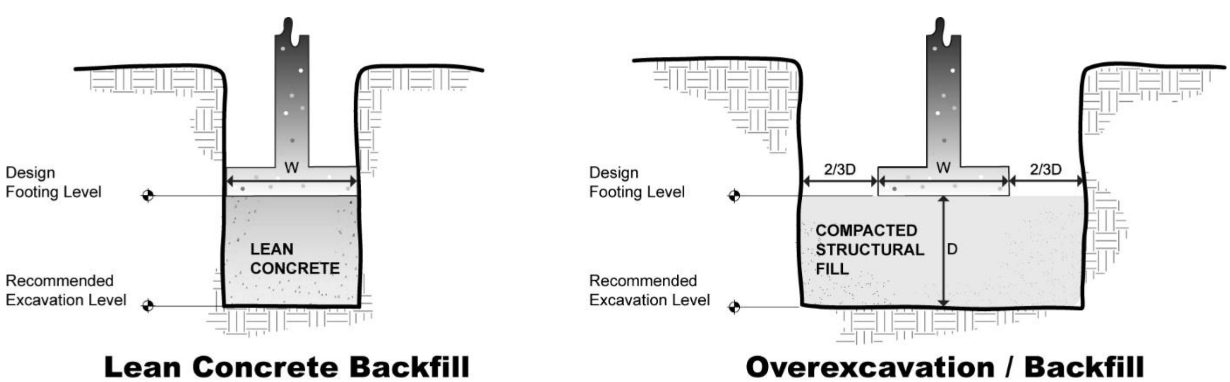
To resist lateral loads, the ultimate friction factor values recommended in the above table can be taken between the foundation and underlying bearing material. Lateral resistance due to friction at the base of the footing should be ignored where uplift also occurs. If the footing is formed, cohesive backfill around the footing should be compacted to a minimum of 98 percent of standard Proctor maximum dry density.

Uplift forces can be resisted by the dead weight of the footing and the effective weight of any soil above the footing. A unit weight of soil not exceeding 115 pcf is appropriate for new engineered fill placed above the foundation, assuming that it is compact to at least 98 percent of standard Proctor maximum dry density (ASTM D-698).

4.3.2 Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose soil and rock prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed or saturated, or frozen, the affected soil should be removed prior to placing concrete. A lean concrete mud-mat should be placed over the bearing soils if the excavations must remain open for an extended period of time. We recommend that the geotechnical engineer be retained to observe and test the soil foundation bearing materials.

If unsuitable bearing soils are encountered in footing excavations, the excavation could be extended deeper to suitable soils and the footing could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. As an alternative, the footings could also bear on properly compacted structural backfill extending down to the suitable soils. Overexcavation for compacted structural fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation. The overexcavation should then be backfilled up to the footing base elevation with well graded granular material placed in lifts of 9 inches or less in loose thickness (6 inches or less if using hand-guided compaction equipment) and compacted to at least 98 percent of the material's standard proctor maximum dry density (ASTM D 698). The overexcavation and backfill procedure is described in the following figure.



NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

4.4 Floor Slabs

4.4.1 Floor Slab Design Recommendations

Item	Description
Floor slab support	Engineered fill [1]
Modulus of subgrade reaction	100 pounds per square inch per in (psi/in) for point loading conditions
Aggregate base course/capillary break [2]	4 inches of free draining granular material
Vapor barrier	Project Specific [3]

1. The slab subgrade should be prepared as directed in this report.
2. The floor slab design should include a capillary break, comprised of free-draining, compacted, granular material, at least 4 inches thick. Free-draining granular material should have less than 5 percent fines (material passing the #200 sieve). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.
3. The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Floor slabs should be structurally independent of any building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation. Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates that any differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks that occur beyond the length of the structural dowels. The structural engineer should account for this potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

4.4.2 Floor Slab Construction Considerations

Prior to construction of grade supported slabs, varying levels of remediation may be required to reestablish stable subgrades within slab areas due to construction traffic, rainfall, disturbance, desiccation, etc. As a minimum, the following measures are recommended.

- Confirm that interior trench backfill placed beneath slabs is compacted in accordance with recommendations outlined in Section 4.2 of this report.

- All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the stone base and concrete.

4.5 Seismic Considerations

Code Used	Site Classification
2012 International Building Code (IBC) [1]	B [2, 3]

1. In general accordance with the *2012 International Building Code,* Section 1613.3.2, which gives specific reference to Chapter 20 of ASCE 7-10 for site class definition.
2. Chapter 20 of ASCE 7-05 requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil profile determination. Test pits were extended to maximum depth of 10 ½ feet and this seismic site class definition considers that limestone bedrock continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to attain a higher site class.
3. Site Class B is defined by the IBC as the “Rock” Category. The IBC does not permit the use of Site Class B if more than 10 feet of soil is between the rock surface and the bottom of the spread footing. However, based on our understanding of the project and subsurface conditions encountered in borings, we believe foundations will be supported on less than 10 feet of overburden, allowing the use of this site class. If building or foundation bearing grades are changed resulting in greater than 10 feet of overburden, a site class C is applicable.

4.6 Pavements

We understand that the traffic loads will be produced primarily by automobile traffic and a limited number of delivery and trash removal trucks. Two pavement section alternatives have been provided. Light-duty pavement traffic is assumed to include 300 automobiles per day. The heavy-duty pavement traffic will include automobiles plus 4 delivery trucks per day and two trash removal trucks per week. If heavier traffic loading is expected, this office should be provided with the information and allowed to review these pavement sections. A California Bearing Ratio (CBR) value of 3 has been estimated for the on-site materials and similar engineered soil fill.

The pavement sections provided herein should conform to all applicable specifications presented in the Tennessee Department of Transportation’s (TDOT) “*Standard Specifications for Road and Bridge Construction.”* The recommended pavement sections represent minimum thicknesses and not averages.

4.6.1 Design Recommendations

Minimum Recommended Pavement Section Thickness (inches) [1]						
Traffic Area	**Alternative**	**Asphalt Concrete Surface Course**	**Asphalt Concrete Leveling Course**	**Portland Cement Concrete [2]**	**Aggregate Base Course [3]**	**Total Thickness**
Light Duty	ACC	2 ½	--	--	8	10 ½
	PCC	--	--	5	4	9
Heavy Duty	ACC	1 ½	2	--	8	11 ½
	PCC	--	--	6	4	10

1. Asphalt concrete aggregates and base course materials should conform to the following TDOT specifications;
   - Section 903.11 for Surface Course, Grading E
   - Section 903.06 for Hot Mix Asphalt Leveling Course, Grading B-M
   - Section 903.05 for Aggregate Base Course material, Class A, Grading D
2. Portland concrete should be 4,000 psi compressive strength at 28 days, 4-inch maximum slump and 5 to 7 percent air entrained, 6-sack min. mix. PCC pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic such as entrance aprons.
3. Crushed mineral aggregate base

This pavement criterion represents the minimum design thickness and, as such, periodic maintenance should be anticipated. Prior to placement of the crushed stone the areas should be thoroughly proof-rolled. For dumpster pads, the concrete pavement area should be large enough to support the container and tipping axle of the refuse truck.

An adequate number of longitudinal and transverse control joints should be placed in the rigid pavement in accordance with ACI and/or AASHTO requirements. Control joints should be ¼ of the depth of the concrete, and should be cut as soon as the slab can support the weight of a man and saw (usually 24 hours). Expansion (isolation) joints must be full depth and should only be used to isolate fixed objects abutting or within the paved area.

Sealing of construction joints is essential to long term performance of concrete pavement. Joints should be sealed with a sealant designed especially for pavements subject to truck and car traffic to protect subgrade. The joints should be sealed as soon as possible (in accordance with sealant manufacturer’s instructions) to minimize infiltration of water into the soil.

Long term performance of pavements constructed on the site will be dependent upon maintaining stable moisture content of the subgrade soils, and providing for a planned program of preventative maintenance. The performance of all pavements can be enhanced by minimizing excess moisture that can reach the subgrade soils. The following recommendations should be considered at a minimum:

- Final grade adjacent to parking lots and drives should slope down from pavement edges at a minimum 2%;
- The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote proper surface drainage;
- Install pavement drainage surrounding areas anticipated for frequent wetting;
- Seal all landscaped areas in, or adjacent to, pavements to reduce moisture migration to subgrade soils;
- Place compacted, low permeability backfill against the exterior side of curb and gutter; and,
- Place curb, gutter, and/or sidewalk directly on a lean clay subgrade soils rather than on unbound granular base course materials to minimize water infiltration.

4.6.2 Construction Considerations

Pavement subgrades prepared early in the project should be carefully evaluated as the time for pavement construction approaches. We recommend the pavement areas be rough graded and then thoroughly proof-rolled with a loaded tandem-axle dump truck. Particular attention should be paid to high traffic areas that were rutted and disturbed and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by replacing the materials with properly compacted fill.

5.0 GENERAL COMMENTS

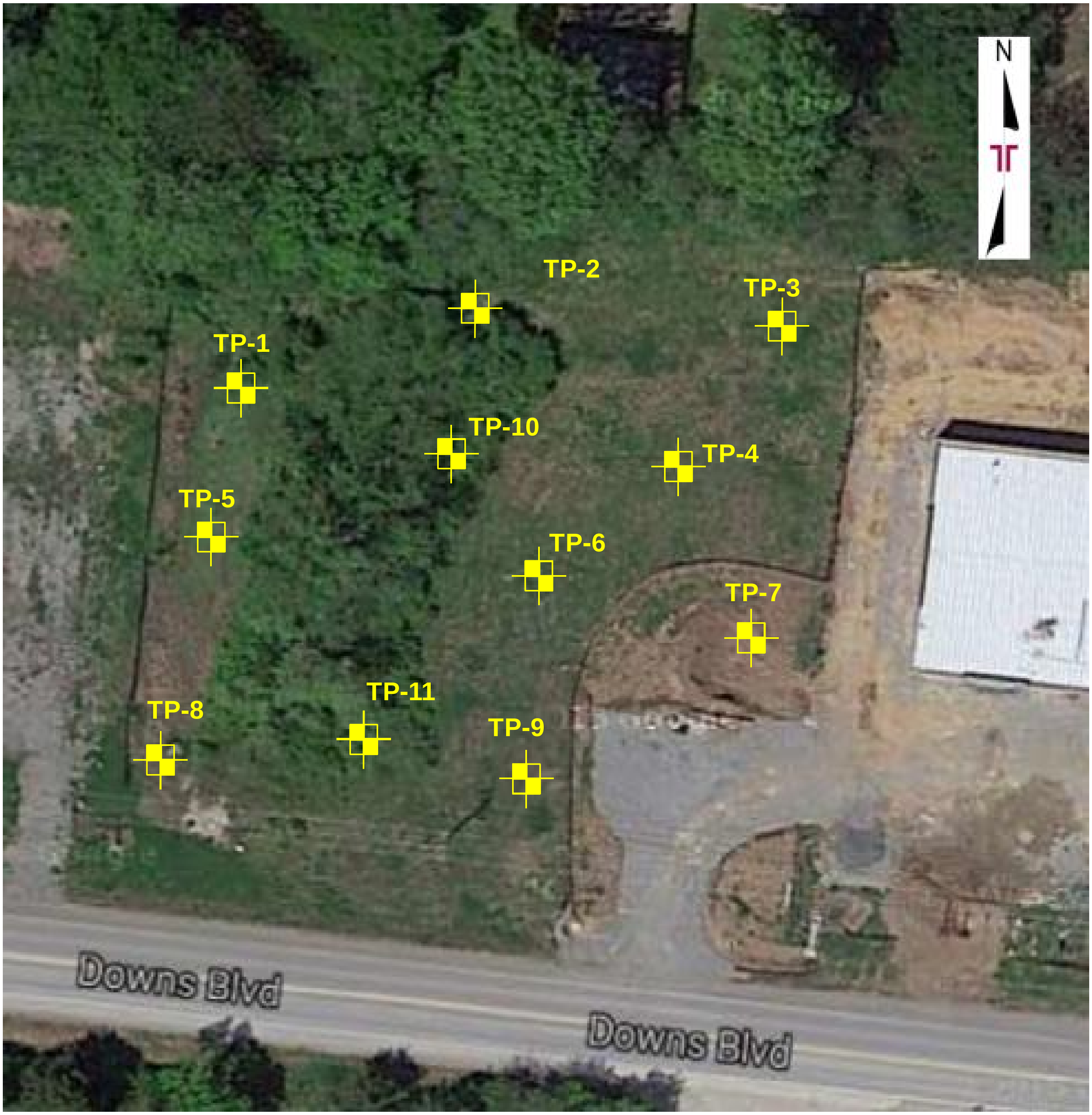
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during 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 test pits performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between test pits, across the site, or due to the modifying effects of construction, time, 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 express 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 AND LABORATORY TESTING DESCRIPTION



Legend

Approximate test pit location

Diagram is for general location only and is not intended for construction purposes.

Project Manager:	SV
Drawn by:	PK
Checked by:	SV
Source:	Google
Project No.	18155050
Scale:	None
File Name:	Exh. A-1
Date:	12Oct2015

Terracon
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TEST PIT LOCATION PLAN

Proposed Fitness Center
472 Downs Blvd.
Franklin, TN

Exhibit

A-1

Field Exploration Description

The test pit locations were determined onsite during our exploration by the Terracon engineer. A rubber-tired backhoe was used to excavate test pits across the site at approximate locations shown on the enclosed test pit location plan. Subsurface conditions encountered in each test pit were logged and documented in the field by a Terracon engineer. In addition, a hand penetrometer was used to estimate the approximate unconfined compressive strength of some soil horizons. The hand penetrometer has been correlated with unconfined compression tests and provides a better estimate of soil consistency than visual examination alone. Upon completion, the test pits were backfilled with exploration-generated spoil. Samples obtained in the field were sealed and returned to the laboratory for classification and testing.

Laboratory Testing

The laboratory testing program consisted of performing water content tests and an Atterberg Limits test on representative soil samples. Information from these tests was used in conjunction with field test data to evaluate soil strength in-situ, volume change potential, and soil classification. Lab and field test results are provided on the test pit logs included in Appendix A.

Test Pit TP-1 (N 35°54.546’ W 86°53.187’)

FILL: Clay with organics

-2.5’

- Refused at -2.5’ on ~level bedrock
- Dry on completion

Test Pit TP-2 (N 35°54.550’ W 86°53.171’)

FILL: Clay with topsoil, roots, and limestone cobbles between 3” and 12” in diameter

-4’

CL, lean clay with trace roots, medium brown with gray mottling and black nodules, w% = 21%

-6‘

- Refused at -6’ on ~level bedrock
- Dry on completion

Test Pit TP-3 (N 35°54.551’ W 86°53.151’)

FILL: Clay with organics and limestone particles between 3” and 2’ in diameter.

-6 ’

CL, lean clay with trace roots, medium brown with gray mottling and black nodules, w% = 20%, HP = 2.0 tsf

-10.5’

- Refused at -10.5 ’ on ~level bedrock
- Dry on completion

Test Pit TP-4 (N 35°54.544’ W 86°53.162’)

FILL: Clay with organics

-2’

-2.5’

CL, lean clay with trace roots, medium brown with gray mottling and black nodules, w% = 30%, HP = 1.5 tsf

-4.5’

- Refused at -2.5’ and -4.5’ on bedrock ledge
- Dry on completion

Test Pit TP-5 (N 35°54.534’ W 86°53.189’)

-0.5’

FILL: Clay with organics and trace limestone cobbles around 3” in diameter.

- Terminated at 0.5’ on ~level bedrock
- Dry on completion

Test Pit TP-6 (N 35°54.533’ W 86°53.168’)

FILL: Clay with organics and limestone particles between 3” and 2’ in diameter.

-4.5’

CL, lean clay, medium brown with gray mottling and black nodules, w% = 24%, HP = 2.5 tsf, LL = 44, PI = 20

-6’

- Refused at -6’ on ~level bedrock
- Dry on completion

Legend

W% = Moisture content
HP = Hand penetrometer
LL = Liquid limit
PI = Plasticity index

Note: test pits excavated with a rubber tire backhoe

Project Manager: SV	Project No. 18155050	Terracon Consulting Engineers & Scientists	TEST PIT LOGS TP-1 through TP-6	Exhibit
Drawn by: PK	Scale: NTS	5217 Linbar Drive, Suite 309 Nashville, Tennessee 37211	Proposed Fitness Center	A-3
Checked by:	File Name: Exh. A-3	PH. (615) 333-6444 FAX (615) 333-6443	472 Downs Blvd.	
Approved by:	Date: 12Oct2015		Franklin, TN	

Test Pit TP-7 (N 35°54.533’ W 86°53.152’)

FILL: Clay with organics and trace roots and occasional rock fragments between up to 6” in diameter

-3.5’

CL, lean clay, medium brown with gray mottling and black nodules, w% = 25%, HP = 2.0 tsf

-7.5’

- Refused at -7.5’ on ~level bedrock
- Wet on completion

Test Pit TP-8 (N 35°54.522’ W 86°53.191’)

FILL: Clay with organics and occasional limestone cobbles around 3” in diameter

-1’

- Refused at -1’ on ~level bedrock
- Dry on completion

Test Pit TP-9 (N 35°54.521’ W 86°53.168’)

-0.5 ’ FILL: Clay with organics

- Refused at -0.5 ’ on level bedrock
- Dry on completion

Test Pit TP-10 (N 35°54.542’ W 86°53.173’)

FILL: Clay with organics and occasional limestone cobbles between 3” and 12” in diameter

-2’

CL, lean clay, medium brown with gray mottling and black nodules

-4’

- Refused at 4’ on ~level bedrock
- Dry on completion

Test Pit TP-11 (N 35°54.527’ W 86°53.178’)

FILL: Clay with organics

-3.5’

CL, lean clay, medium brown with gray mottling and black nodules, w% = 28%, HP = 1.75 tsf

-6.5’

- Terminated at 6.5’ on ~level bedrock
- Dry on completion

Legend

W% = Moisture content
HP = Hand penetrometer

Note: test pits excavated with a rubber tire backhoe

Project Manager: SV	Project No. 18155050	Terracon Consulting Engineers & Scientists	TEST PIT LOGS TP-7 through TP-11	Exhibit
Drawn by: PK	Scale: NTS		Proposed Fitness Center 472 Downs Blvd. Franklin, TN	A-4
Checked by:	File Name: Exh. A-4			
Approved by:	Date: 12Oct2015	5217 Linbar Drive, Suite 309 Nashville, Tennessee 37211 PH. (615) 333-6444 FAX (615) 333-6443		

APPENDIX B
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	5 – 8	Medium Stiff
2,000 – 4,000	9 – 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

Rev. 4/10

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 / Liquid limit - not dried < 0.75	OL	Organic clay [K,L,M,N]
					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 / Liquid limit - not dried < 0.75	OH	Organic clay [K,L,M,P]
					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-inch (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] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[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.