Geotechnical Engineering Report

Proposed Taco Bell Restaurant
Bedford Township, Pennsylvania

June 22, 2015

Terracon Project No. N6155031, Task 2

Prepared for:

Charter Foods, Inc.
Talbott, Tennessee

Prepared by:

Terracon Consultants, Inc.
Cleveland, Ohio

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Terracon

Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

June 22, 2015

Terracon

Charter Foods, Inc.
P.O. Box 430
Talbott, TN 37877

Attn: Mr. Bob Rave
New Projects – Facility Manager
P: [423] 254-5553
E: brave@charterfoods.net

Re: Geotechnical Engineering Report
Proposed Taco Bell Restaurant
Bedford Township, Pennsylvania
Terracon Project Number: N6155031. Task 2

Dear Mr. Rave:

Terracon Consultants, Inc. (Terracon) has completed a subsurface exploration and geotechnical engineering evaluation for the above referenced project. These services were performed in general accordance with our proposal dated April 7, 2015 (Terracon Proposal No. PN6150109) and our Agreement for Services, which was executed on April 24, 2015.

The purpose of this exploration was to obtain information on subsurface conditions at the proposed project site and based on this information provide recommendations for the design and construction of foundations, floor slabs, and pavements for the proposed Taco Bell restaurant.

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

Sincerely,
Terracon Consultants, Inc.

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
LYNTON LEONARD PRICE
ENGINEER
No. PE075230

Lynton L. Price, P.E.
Manager – Geotechnical Services

for Kevin M. Ernst, P.E.
Senior Associate

Copies to: Addressee (1 via e-mail)

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EXECUTIVE SUMMARY

A geotechnical exploration has been performed for the proposed construction of a Taco Bell Restaurant on a site located on US Route 220 Business in Bedford Township, Pennsylvania.

Based on the information obtained from our subsurface exploration, the following geotechnical considerations were identified:

- The native soils encountered within the test borings were found to consist of medium stiff to stiff, lean clays and silty clays, and loose to medium dense, silty to clayey sands and/or rock fragments. These soils extended to depths ranging between about 5½ and 8½ feet below the existing site grades and were underlain by shale bedrock. No groundwater was encountered in the test borings during the drilling operations.

- Site stripping operations should include the removal of the existing asphalt pavement, concrete slabs, grass and topsoil and any other unsuitable materials which may be encountered. At test borings B-2, B-4 and B-5, surficial fill materials consisting of topsoil intermixed with sand, gravel and rock fragments was encountered to depths of about 18, 11 and 10 inches, respectively. Existing fill materials that are found to contain topsoil or other unsuitable materials should be stripped from the site.

- The native soils are considered suitable for the support of spread footing foundations. They are also considered suitable for pavement and floor sab support provided they are properly compacted.

- Support of floor slabs and pavements on or above existing non-organic fill soils is discussed in this report. However, even with the recommended construction testing services, there is an inherent risk for the owner that compressible fill or unsuitable material 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.

- 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 TACO BELL RESTAURANT
BEDFORD TOWNSHIP, PENNSYLVANIA
Terracon Project No. N6155031, Task 2
June 22, 2015

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed in connection with the proposed construction of a Taco Bell Restaurant on a currently vacant parcel located on the east side of US Route 220 Business, directly east of the entrance/exit ramp to I-99 in Bedford Township, Pennsylvania.

Our geotechnical engineering scope of work for this project included the advancement of six (6) test borings to depths ranging between about 5 and 15 feet below existing site grades, laboratory testing on selected soil samples, and development of geotechnical design and construction recommendations relative to the proposed building and pavement construction.

The purpose of this Geotechnical Engineering Report is to describe the subsurface conditions encountered at the test borings, present the test data, and provide recommendations with respect to:

- Earthwork construction
- Foundation design
- Seismic Site Class
- Subgrade preparation
- Floor slab and pavement design

Logs of the borings, along with Site Location, Exploration, and Layout Plans, are included in Appendix A of this report. The results of the laboratory testing performed on selected soil samples obtained from the site during the field exploration are included on the test boring logs. Descriptions of the field exploration and laboratory testing are included in Appendix A and B, respectively.

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-3, Layout Plan
Building	A single-story, slab-on-grade, restaurant building with a plan area of approximately 2,527 square feet.

Item	Description
Finished floor elevation	The building's finished floor elevation has not been provided to us as of the date of this report. It is assumed that the finished floor elevation will be within about 1 foot of the average existing surface grade (1194 feet) within the proposed building area.
Maximum loads	Structural loads were not provided. The following maximum loads were assumed. Column: 50 kips Walls: 4 kips per lineal foot
Grading	It is anticipated that only minor grade alterations (less than 1 foot) will be required to achieve finished subgrade elevations.
Pavement	New paved parking lots and drives will be constructed. No specific traffic information was provided (e.g., anticipated vehicle types, axle loads, and traffic volumes). For our analysis, we considered that traffic in the pavement areas will consist primarily of cars and pickup trucks with a maximum of 5 trucks (delivery trucks/trash collection trucks) per week.

2.2 Site Location and Description

Item	Description
Location	See Appendix A, Exhibit A-1, Site Location Plan
Existing improvements	The site is currently vacant.
Current ground cover	Asphalt pavement, former building slab, and grass.
Existing topography	Based on Google Earth, it appears the site is relatively level with elevations ranging between about 1193 and 1195 feet.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Subsurface Profile

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

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum[1]	Material Encountered	Density/Consistency
Pavement[2]	2 to 10 inches	Asphalt	Not Applicable
Fill[3]	10 inches to 3 feet	Topsoil intermixed with sand and gravel	Not Applicable
Native Soils	5½ to 8½ feet	Silty to Clayey Rock Fragments with Sand and Lean Clays and Silty Clays containing sand and rock fragments	Granular Soils – Loose to Medium Dense Cohesive Soils – Medium Stiff to Stiff
Bedrock	Undetermined[4]	Shale	Very Weak to Moderately Strong Rock Hardness

1. Below the existing surface grades.
2. Asphalt pavement was encountered at test boring locations B-1, B-3 and B-6.
3. Fill materials were encountered at test boring locations B-2, B-3, B-4, and B-5. At test boring location B-3, the fill did not contain any topsoil and consisted of medium dense, silty rock fragments with sand.
4. Test borings B-1 through B-4 terminated in bedrock at depths ranging between about 8½ and 10 feet below the existing surface grades.

3.2 Groundwater

No groundwater was encountered within the test borings during the drilling operations; however, due to the low permeability of the soils, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a bore hole in these materials. Long term observations using piezometers or observation wells sealed from the infiltration of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The native soils are considered suitable for the support of spread footing foundations. They are also considered suitable for pavement and floor sab support provided they are properly compacted. The native soils are considered suitable for the support of spread footing foundations.

In addition to the native soils, the existing fill materials encountered to a depth of about 3 feet below the existing ground surface are considered suitable for the support of the proposed pavements provided the suitability of the fill is confirm during the site stripping operations.

Specific geotechnical engineering recommendations for foundation systems and other earth related phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (which are presented in Appendices A and B), engineering analyses and our current understanding of the proposed project.

4.2 Earthwork

The following sections present recommendations for site subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth supported elements, including foundations, slabs and pavements are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

4.2.1 Site Preparation

Initial site work should include the complete removal of the existing asphalt pavement, concrete slabs, existing grass and topsoil. Existing building foundations, if encountered, should be removed in their entirety from proposed foundation areas and to a depth of at least 1½ feet below the finished subgrade elevations within proposed floor slab and pavement areas.

Existing underground utilities that are to be abandoned should also be removed from the proposed construction areas. Alternatively, abandoned sewers or water lines may be plugged and fully grouted; provided they do not interfere with the new construction and the existing trench backfill is found to be properly compacted and suitable for floor slab or pavement subgrade support.

All excavations resulting from the removal of slabs, utilities, foundations, etc., should be backfilled with approved engineered fill in accordance with the recommendations contained in sections **4.2.2 Fill Material Types** and **4.2.3 Compaction Requirements**.

Subsequent to completion of the site stripping operations, the exposed subgrade materials should be visually examined and proof-rolled in the presence of the geotechnical engineer. Proof-rolling can be performed with a loaded tandem axle dump truck (minimum weight 20 tons). Yielding subgrade areas observed at this time may be stabilized using any or all of the following methods:

- Scarifying, aerating, and moisture conditioning the soil to near optimum moisture condition followed by compaction.
- Undercutting and replacing the materials with suitable, engineered fill.

The decision as to which method would be most cost effective will depend on the subsoil condition evidenced when the stripping operations are conducted, the prevailing weather conditions, availability of suitable replacement materials and construction schedule. Based on the field standard penetration test results encountered in the test borings and the results from laboratory water content tests, it appears likely that little or no subgrade stabilization will be required within the site provided the subgrade is properly graded and maintained during construction to prevent ponding of surface water on the exposed subgrade soils. The need for stabilization will also depend on the time of year the site work is performed. Additional measures are generally required in wet weather conditions as compared to drier weather conditions.

4.2.2 Fill Material Types

Compacted engineered fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Native Soils	CL-ML, CL, SM, GM, GC	All locations and elevations
Imported granular fill [2]	GW, GM, SW, SM	All locations and elevations

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 and approval prior to use.
2. Imported granular fill should consist of natural sand and/or gravel or durable, crushed stone with a maximum dimension of 3 inches.

4.2.3 Compaction Requirements

Item	Description
Fill Lift Thickness	8 inches or less in loose thickness when heavy, tamping foot compaction equipment is used 4 inches or less in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1]	98% of the material's standard Proctor maximum dry density (ASTM D 698)
Moisture Content – Granular Material	Workable moisture levels. [2]

Item	Description

1. We recommend that compacted structural 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.
2. Sufficient to achieve satisfactory compaction without the material pumping when proof-rolled.

4.2.4 Earthwork Construction Considerations

Upon completion of grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade 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.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Safety and Health Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will be required during foundation and utility construction. The excavation contractor, by his contract, is 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 OSHA Excavation and Trench Safety Standards.

4.3 Foundations

The building structure can be supported by a spread footing foundation system. Foundation design recommendations are presented in the following report sections.

4.3.1 Foundation Design Recommendations

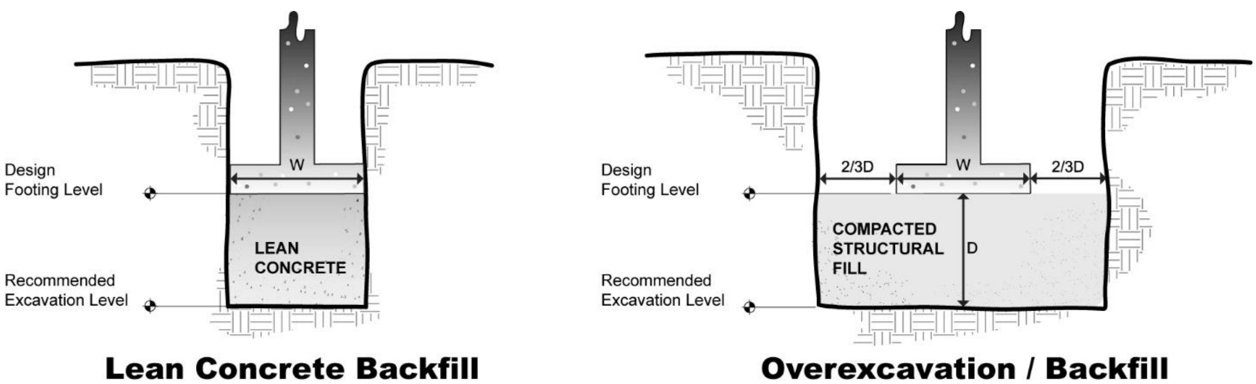
Description	Column	Wall
Net allowable bearing pressure [1] ■ **medium dense/stiff native soils or new engineered fill extending down to suitable materials**	3,000 psf	3,000 psf
Minimum embedment below finished grade [2]	42 inches	42 inches
Minimum footing width	30 inches	18 inches
Anticipated total settlement [3]	<1 inch	<1 inch

Description	Column	Wall

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.
2. To provide frost protection and to reduce effects of seasonal moisture variations in subgrade soils for perimeter footings and footings beneath unheated areas.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions and the embedment depth of the footings.

4.3.2 Foundation Construction Considerations

Foundation excavations should be observed by the geotechnical engineer. If unsuitable bearing soils are encountered in footing excavations, the excavations should be extended deeper to suitable soils and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The footings could also bear on properly compacted backfill extending down to the suitable soils. Over excavation for compacted backfill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of over excavation depth below footing base elevation. The over excavation 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 and compacted to at least 98 percent of the material's maximum standard effort maximum dry density (ASTM D 698). The over excavation and backfill procedures are described in the figures below.



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

The base of all footing excavations should be free of water and loose soil prior to placing concrete. Concrete placement should take place as soon as practical following excavation and placement of steel reinforcement to avoid bearing soil disturbance. Should bearing soils be disturbed, or become saturated or frozen, the affected soil should be removed prior to concrete placement. To protect the bearing surfaces from disturbance, we recommend placement of a 2 to 3-inch thick lean concrete mud mat over the bearing surfaces if the footing excavations are to remain open overnight.

Footings, foundations, and masonry walls should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

4.4 Floor Slabs

Item	Description
Floor slab subgrade	Properly prepared and compacted subgrade [1]
Modulus of subgrade reaction	100 pounds per square inch per in (psi/in) for point loading conditions
Aggregate base course/capillary break [2]	Minimum 4 inches of free draining granular material

1. The subgrade should be maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become desiccated or wet prior to construction of the floor slabs, the affected material should be removed or the materials scarified, moisture conditioned to near optimum and recompacted. Upon completion of grading operations in the building areas, care should be taken to maintain the recommended subgrade moisture content and density prior to construction of the building floor slabs.
2. The floor slab design should include a capillary break, comprised of free-draining, compacted, granular material. 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.

Positive separations and/or isolation joints should be provided between slabs and all foundations, columns or utility lines to allow independent movement. Interior trench backfill placed beneath slabs should be compacted in accordance with recommendations outlined in the Earthwork section of this report.

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 and slab contractor should refer to ACI 302 and 360 for procedures and cautions regarding its use and placement.

4.5 Seismic Considerations

Code	Site Class
International Building Code (IBC)	C[1]

1. The IBC Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile. The current scope does not include the required 100-foot soil profile determination. Borings for this report were extended to a maximum depth of about 12 feet and this site class assignment is based on the anticipation that competent bedrock is present below the terminal depth of the test borings conducted in the proposed building area. Additional exploration to deeper depths or surface shear wave velocity testing would be required to confirm the conditions below the current depth of exploration.

4.6 Pavements

4.6.1 Pavement Design Recommendations

Pavement thickness design is dependent upon:

- the anticipated traffic conditions,
- subgrade and paving material characteristics, and
- climate conditions at the project site.

Specific information regarding anticipated vehicle types, axle loads and traffic volumes was not provided. In developing our recommendations, we have considered that traffic will consist primarily of automobile traffic and a limited number of delivery trucks and trash removal trucks. The "Parking Areas" pavement section is for automobile traffic only. The "Drives" pavement section considers a maximum of five delivery trucks/trash collection trucks per week. If heavier vehicle types or higher traffic volumes are expected, Terracon should review these recommendations.

Provided the existing subgrade soils are tested, evaluated and prepared in accordance with the recommendations provided in this report, these materials should provide suitable pavement support. The subgrade materials within the proposed pavement areas are expected to be variable and include silty clay, and silty to clayey sand and gravel. These soils would be expected to have an estimated minimum CBR value of 5. We recommend that CBR tests be performed to confirm this value.

Estimates of minimum thicknesses for new asphalt pavement sections for this project have been based on the procedures outlined in the 1993 Guideline for Design of Pavement structures by the American Association of State Highway and Transportation Officials (AASHTO-1993). Portland Cement Concrete (PCC) pavement thicknesses were based on the American Concrete Institute (ACI) design recommendations.

Based on the design criteria noted above and our experience with similar projects and soil conditions, the asphalt concrete (AC) and Portland cement concrete (PCC) pavement sections listed on the following table are recommended minimum thicknesses.

Minimum Pavement Section Thickness (inches)

Traffic Area	Alternative	Asphalt Concrete Surface Course [1]	Asphalt Concrete Binder Course [2]	Portland Cement Concrete [3]	Aggregate Base Course [4]	Total Thickness
Light Duty (Car Parking)	PCC	--	--	5.0	4.0	9.0
	AC	1.5	2.5	--	6.0	10.0
Heavy Duty (Drive Areas)	PCC	--	--	6.0	4.0	10.0
	AC	1.5	3.5	--	6.0	11.0
Trash Container Pad [3]	PCC	--	--	8.0	4.0	12.0

1. Approved PENNDOT Superpave HMA, 9.5 mm Wearing Course, PG 64-22
2. Approved PENNDOT Superpave HMA, 19 mm Binder Course, PG 64-22
3. PENNDOT Class AA Cement Concrete.
4. Well graded, crushed limestone base material, such as PENNDOT No. 2A.
5. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

For PCC pavement, 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. The following comments should be considered for the concrete pavement design options.

- Control joints should have a maximum spacing of about 30 times the thickness of the concrete slab but not exceeding 15 feet, as per ACI.
- At construction joints, an adequately designed, keyed construction joint or a butt end construction joint is recommended. For a butt end construction joint, an adequate number of deformed tie bars should be provided.
- Isolation joints are recommended for concrete pavement areas that abut fixed objects such as around light poles, curbs, inlets, etc.

Refer to ACI 330 "Guide for Design and Construction of Concrete Parking Lots" for additional information.

For both rigid and flexible pavement, the recommended granular base course should be compacted to at least 98% of the maximum dry density, as determined by ASTM D698 or evaluated in the field in a test strip subjected to repeated passes of a 10-ton, or heavier, roller.

4.6.2 Pavement Construction Considerations

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted, and the initial surface is prepared in a relatively uniform manner. However, as construction proceeds, excavations will be made into these areas, rainfall and surface water may saturate some areas, heavy traffic from construction equipment disturbs the subgrade, and surface irregularities are often filled with loose materials. As a result, the pavement subgrades should be carefully evaluated as the time for pavement construction approaches. Within a few days of planned paving, we recommend the pavement areas be rough graded and then proof-rolled with a loaded tandem axle dump truck (minimum weight 20 tons). Particular attention should be given to high traffic areas that have been rutted and disturbed, and to areas where backfilled trenches are located. Any areas found to be unstable should be repaired by removing and replacing the materials with properly compacted fill, or by scarifying, air drying and recompacting the soils to the specified density and moisture limits.

Base course and pavement materials should not be placed when the surface is wet. Surface drainage should be directed away from the edges of paved areas to minimize lateral moisture transmission into the subgrade.

Subdrainage should be a primary consideration in the proposed pavement areas to prevent water from accumulating within the aggregate base course. To this end, we recommend the installation of pipe underdrains radiating from catch basins under low points of pavements. Subgrade surfaces should be fine graded so that water seepage under the pavements will flow to the underdrains or to other suitable drainage outlets. Establishing subgrade slopes during site grading to promote rapid surface and base course drainage away from the pavement will extend its useful life.

A regular pavement maintenance program should be implemented to repair occasional pavement defects and distress that may develop over time and extend the useful life of the pavement. Pavement maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing).

5.0 GENERAL COMMENTS

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

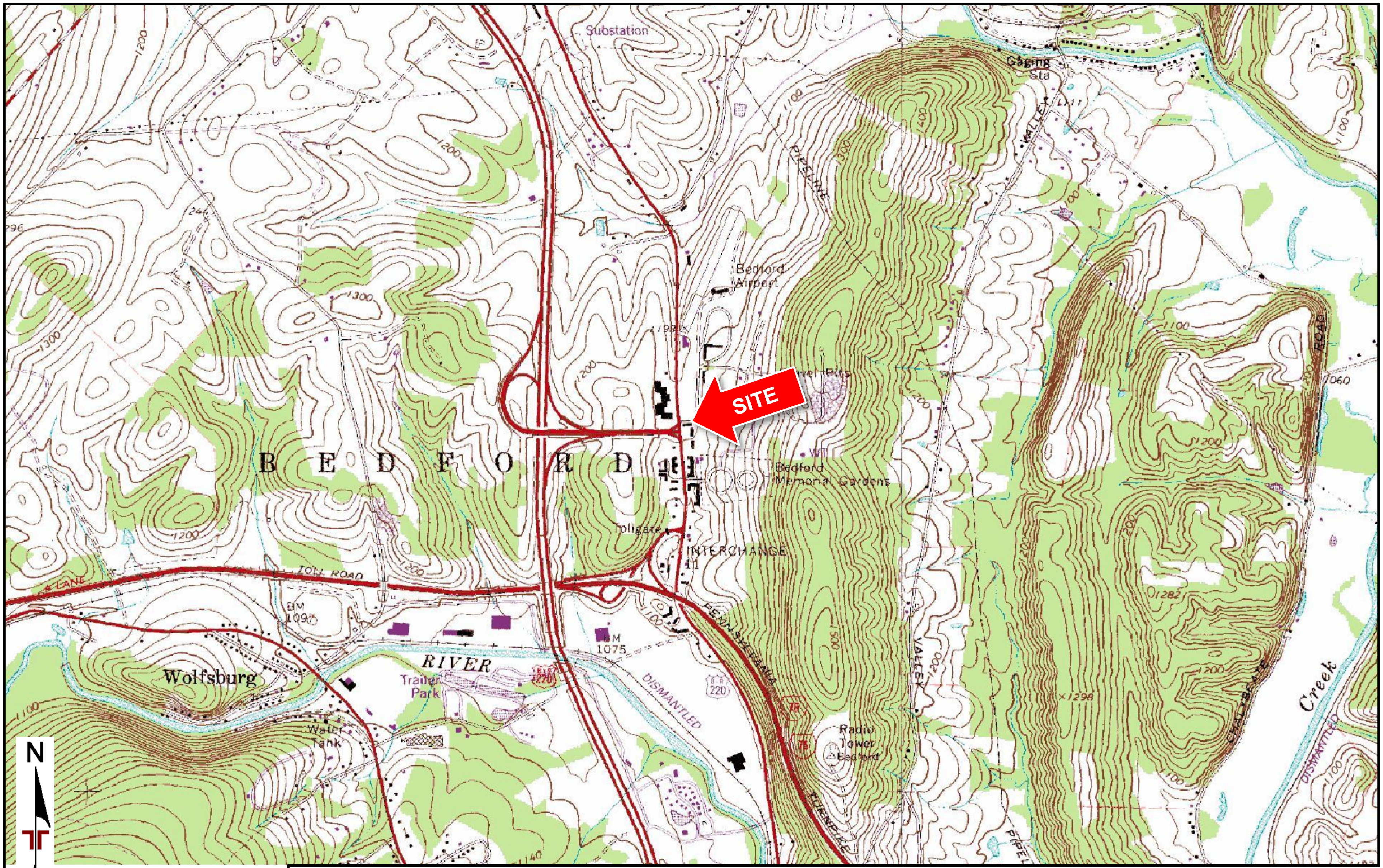
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the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

Support of floor slabs and pavements on or above existing non-organic fill soils is discussed in this report. However, even with the recommended construction testing services, there is an inherent risk for the owner that compressible fill or unsuitable material 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.

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



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: BEDFORD, PA (1/1/1987) and EVERETT WEST, PA (1/1/1987).

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	N6155031
Drawn by:	MB
Checked by:	I.I.P
Approved by:	KME

Project No.	N6155031
Scale:	1:24,000
File Name:	N6155031
Date:	6/9/15

Terracon

12460 Plaza Dr.
Cleveland, OH 44130

SITE LOCATION

Proposed Taco Bell Restaurants
4444 Route 220 business
Bedford Township, PA

Exhibit
A-1

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

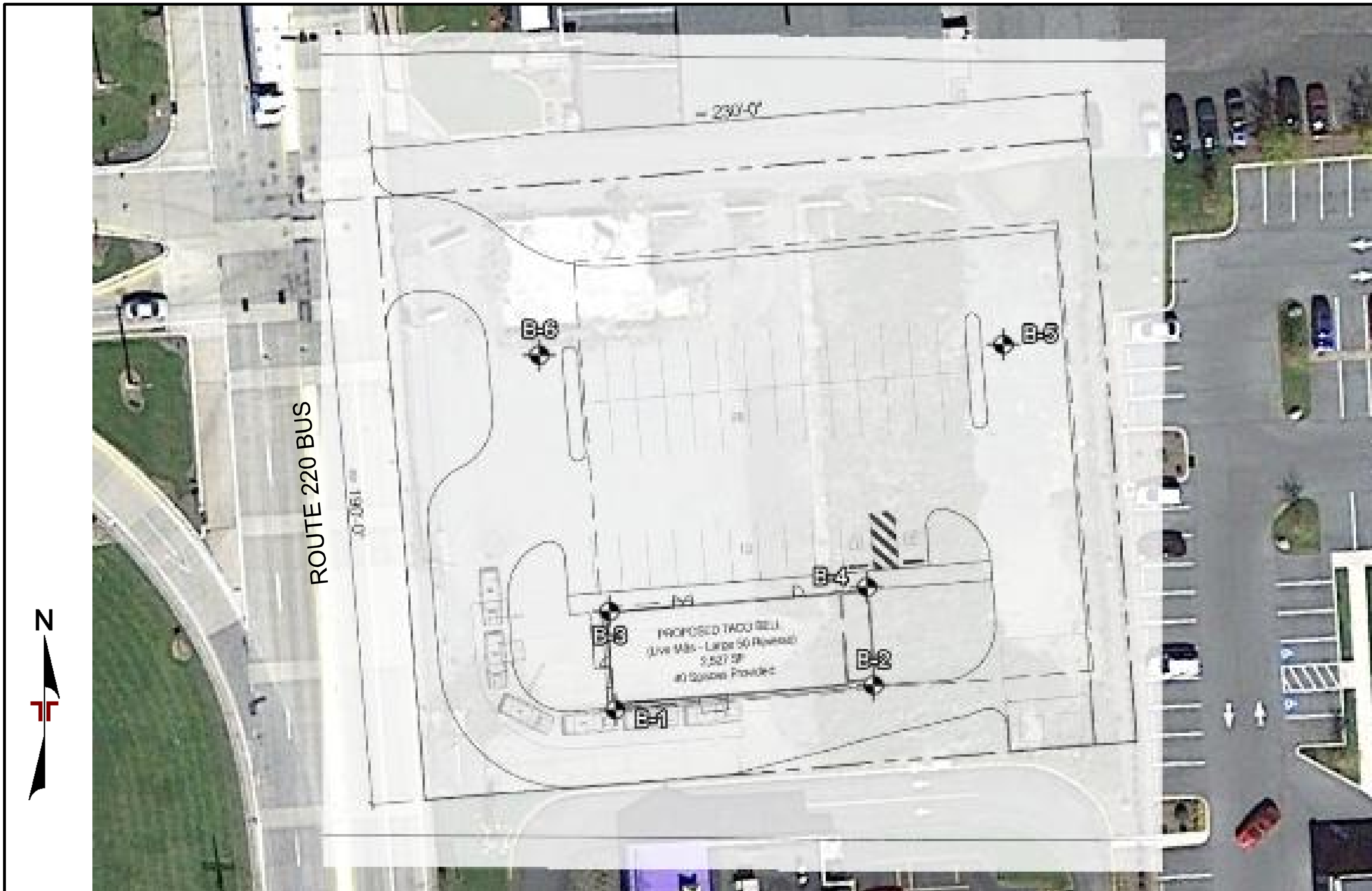
Project Manager: N6155031	Project No. N6155031
Drawn by: MB	Scale: AS SHOWN
Checked by: LLP	File Name: N6155031
Approved by: KME	Date: 6/9/15

Terracon
12460 Plaza Dr.
Cleveland, OH 44130

EXPLORATION PLAN

Proposed Taco Bell Restaurants
4444 Route 220 business
Bedford Township, PA

Exhibit
A-2



AERIAL PHOTOGRAPHY PROVIDED BY GOOGLE EARTH

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: LLP	Project No. N6155031
Drawn by: MB	Scale: 1" ≈ 46'
Checked by: TFM	File Name: 55031A3
Approved by: KME	Date: 6/9/15

Terracon

12460 Plaza Dr.
Cleveland, OH 44130

LAYOUT PLAN

Proposed Taco Bell Restaurant
US Route 220 Business
Bedford Township, PA

Exhibit

A-3

Field Exploration Description

Six (6) test borings were completed for the project on June 5, 2015. The test boring locations were laid out in the field by the drill crew using existing site features for reference. The elevations of the test borings were obtained using Google Earth. The locations and elevations of the borings should be considered accurate only to the degree implied by the methods used to define them.

The borings were drilled with a track mounted drill rig using continuous flight hollow-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using split-barrel sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in situ relative density of cohesionless soils and consistency of cohesive soils.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. Following the drilling operations, the bore holes were backfilled with auger cuttings. Bore holes located in existing pavement were patched with premixed asphaltic cold patch.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller’s interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: Proposed Taco Bell Restaurant

CLIENT: Charter Foods, Inc.
Talbott, Tennessee

SITE: US Route 220 BUS
Bedford Township, Pennsylvania

LOCATION See Exhibit A-2

Latitude: 40.055772° Longitude: -78.510724°

Approximate Surface Elev: 1194 (Ft.) +/-

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)
	0.2	**2" ASPHALT**	1194+/-							
		CLAYEY ROCK FRAGMENTS WITH SAND (GC), brown, medium dense				X	18	7-8-8 N=16		24
				5		X	16	6-15-8 N=23		14
	6.0		1188+/-							
		SEDIMENTARY BEDROCK - SHALE, with bands of lean clay, brown and gray, completely weathered, extremely weak, calcareous				X	18	7-8-10 N=18		
						X	16	8-30-50/5"		
	9.6		1184.5+/-							
		SEDIMENTARY BEDROCK - SHALE, dark gray, slightly weathered, weak to medium strong, calcareous		10	Dry cave-in					
	12.1		1182+/-			X	1	50/1"		
		Split-Barrel Refusal at 12.1 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

The surface elevation was obtained using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Dry cave-in @ 10.0'

Terracon
12460 Plaza Drive
Cleveland, Ohio

Boring Started: 6/5/2015	Boring Completed: 6/5/2015
Drill Rig: Track	Driller: J. Minchak
Project No.: N6155031B	Exhibit: A-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N6155031B.GPJ TERRACON2012.GDT 6/15/15

BORING LOG NO. B-2

PROJECT: Proposed Taco Bell Restaurant

CLIENT: Charter Foods, Inc.
Talbott, Tennessee

SITE: US Route 220 BUS
Bedford Township, Pennsylvania

LOCATION See Exhibit A-2

Latitude: 40.055798° Longitude: -78.510432°

Approximate Surface Elev: 1193 (Ft.) +/-

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)
	FILL - TOPSOIL INTERMIXED WITH SAND AND GRAVEL								
1.5		1191.5+/-							
	SILTY ROCK FRAGMENTS WITH SAND (GM), brown, loose to medium dense				X	10	5-3-8 N=11		7
					X	3	4-3-3 N=6		10
			5						
					X	15	14-4-2 N=6		6
8.5		1184.5+/-		Dry cave-in					
	SEDIMENTARY BEDROCK - SHALE, brown to dark gray, slightly weathered, weak to moderately strong, calcareous				X	2	50/4"		10
10.0		1183+/-	10						
	Auger Refusal at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

The surface elevation was obtained using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Dry cave-in @ 8.5'

Terracon
12460 Plaza Drive
Cleveland, Ohio

Boring Started: 6/5/2015	Boring Completed: 6/5/2015
Drill Rig: Track	Driller: J. Minchak
Project No.: N6155031B	Exhibit: A-6

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N6155031B.GPJ TERRACON2012.GDT 6/15/15

BORING LOG NO. B-3

PROJECT: Proposed Taco Bell Restaurant

**CLIENT: Charter Foods, Inc.
Talbott, Tennessee**

**SITE: US Route 220 BUS
Bedford Township, Pennsylvania**

LOCATION See Exhibit A-2

Latitude: 40.055857° Longitude: -78.510733°

Approximate Surface Elev: 1195 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)
0.3	**3" ASPHALT**	1195+/-							
	FILL - SILTY ROCK FRAGMENTS WITH SAND, trace asphalt fragments, brown, medium dense				X	2	5-9-6 N=15		7
3.0		1192+/-							
	LEAN CLAY WITH SAND AND ROCK FRAGMENTS (CL), brown, stiff, residual soil				X	18	5-6-5 N=11	4.0 (HP)	
6.0		1189+/-	5						
	SEDIMENTARY BEDROCK - SHALE, dark gray, highly weathered, very weak to weak, calcareous			Dry cave-in	X	6	50/6"		
8.6		1186.5+/-			X	1	50/1"		
	Split-Barrel Refusal at 8.6 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

The surface elevation was obtained using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Dry cave-in @ 6.5'

Terracon
12460 Plaza Drive
Cleveland, Ohio

Boring Started: 6/5/2015	Boring Completed: 6/5/2015
Drill Rig: Track	Driller: J. Minchak
Project No.: N6155031B	Exhibit: A-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N6155031B.GPJ TERRACON2012.GDT 6/15/15

BORING LOG NO. B-4

PROJECT: Proposed Taco Bell Restaurant

CLIENT: Charter Foods, Inc.
Talbott, Tennessee

SITE: US Route 220 BUS
Bedford Township, Pennsylvania

LOCATION See Exhibit A-2

Latitude: 40.055883° Longitude: -78.510442°

Approximate Surface Elev: 1195 (Ft.) +/-

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)
	0.9	**FILL - TOPSOIL INTERMIXED WITH SAND AND GRAVEL**	1194+/-							
	5.5	**SILTY ROCK FRAGMENTS WITH SAND (GM)**, brown, medium dense, residual soil	1189.5+/-			X	18	7-8-8 N=16		
						X	18	8-7-7 N=14		
	8.0	**SEDIMENTARY BEDROCK - SHALE**, brown and gray, highly weathered, very weak, calcareous	1187+/-	5						
					Dry cave-in	X	11	28-50/5"		
	8.8	**SEDIMENTARY BEDROCK - SHALE**, dark gray, moderately weathered, weak rock, calcareous	1186+/-			X	4	50/4"		
		Split-Barrel Refusal at 8.83 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

The surface elevation was obtained using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Dry cave-in @ 6.5'

Terracon
12460 Plaza Drive
Cleveland, Ohio

Boring Started: 6/5/2015	Boring Completed: 6/5/2015
Drill Rig: Track	Driller: J. Minchak
Project No.: N6155031B	Exhibit: A-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N6155031B.GPJ TERRACON2012.GDT 6/15/15

BORING LOG NO. B-5

PROJECT: Proposed Taco Bell Restaurant

CLIENT: Charter Foods, Inc.
Talbott, Tennessee

SITE: US Route 220 BUS
Bedford Township, Pennsylvania

LOCATION See Exhibit A-2

Latitude: 40.056096° Longitude: -78.510294°

Approximate Surface Elev: 1196 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)
	FILL - TOPSOIL INTERMIXED WITH ROCK FRAGMENTS								
	0.8	1195+/-							
	SILTY CLAY WITH SAND (CL-ML), with bands of rock fragments, brown, stiff, residual soil				X	16	5-8-5 N=13	4.5 (HP)	18
				Dry cave-in					
					X	18	5-6-7 N=13	4.5+ (HP)	23
	5.0	1191+/-	5						
	Boring Terminated at 5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

The surface elevation was obtained using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Dry cave-in @ 3.0'

Terracon
12460 Plaza Drive
Cleveland, Ohio

Boring Started: 6/5/2015	Boring Completed: 6/5/2015
Drill Rig: Track	Driller: J. Minchak
Project No.: N6155031B	Exhibit: A-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N6155031B.GPJ TERRACON2012.GDT 6/15/15

BORING LOG NO. B-6

PROJECT: Proposed Taco Bell Restaurant

CLIENT: Charter Foods, Inc.
Talbott, Tennessee

SITE: US Route 220 BUS
Bedford Township, Pennsylvania

LOCATION See Exhibit A-2

Latitude: 40.05608° Longitude: -78.51082°

Approximate Surface Elev: 1195 (Ft.) +/-

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)
	0.8	**10" ASPHALT**	1194+/-							
		SILTY CLAY WITH SAND AND ROCK FRAGMENTS (CL-ML), brown, medium stiff				X	15	4-2-2 N=4	3.0 (HP)	25
	3.0		1192+/-		Dry cave-in					
		SILTY CLAYEY ROCK FRAGMENTS WITH SAND (GC-GM), brown, medium dense				X	16	5-10-10 N=20		12
	5.0		1190+/-	5						
		Boring Terminated at 5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

The surface elevation was obtained using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Dry cave-in @ 3.0'

Terracon
12460 Plaza Drive
Cleveland, Ohio

Boring Started: 6/5/2015	Boring Completed: 6/5/2015
Drill Rig: Track	Driller: J. Minchak
Project No.: N6155031B	Exhibit: A-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL N6155031B.GPJ TERRACON2012.GDT 6/15/15

APPENDIX B
LABORATORY TESTING

Laboratory Testing Program

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer and were classified in accordance with the General Notes, Unified Soil Classification System (USCS), and Description of Rock Properties described in Exhibits C-1, C-2, and C-3 in Appendix C. At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program formulated to determine engineering properties of the subsurface materials.

Selected soil samples obtained from the borings were subjected to the following tests.

- Hand Penetrometer
- Water Content (ASTM D2216)

The hand penetrometer and water content test results are noted on the test boring logs in Appendix A.

Procedural standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING		WATER LEVEL		FIELD TESTS		
	Standard Penetration Test		▽ Water Initially Encountered		N	Standard Penetration Test Resistance (Blows/Ft.)
			▽ Water Level After a Specified Period of Time		(HP)	Hand Penetrometer
			▼ Water Level After a Specified Period of Time		(T)	Torvane
			Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.		(DCP)	Dynamic Cone Penetrometer
					(PID)	Photo-Ionization Detector
					(OVA)	Organic Vapor Analyzer

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.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

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. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

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

PLASTICITY DESCRIPTION

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

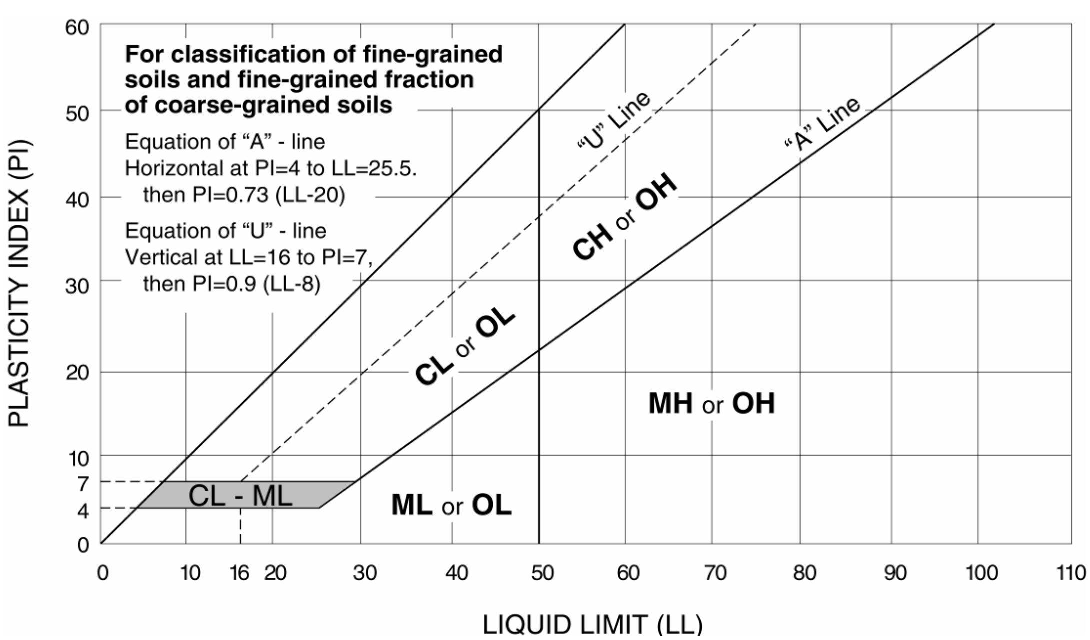
UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried / 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] $Cu = D_{60}/D_{10} \qquad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 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 ≥ 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 ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 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.



Terracon