Geotechnical Investigation

Proposed Townhome Development

SW Corner of Coolidge Hwy. and Oxford Rd.
Berkley, Michigan

Mr. John DePorre
DePorre Building, LLC
6400 Telegraph Road – Suite 2500
Bloomfield Hills, MI 48301

September 12, 2019

PEA Project No. 2019-366

Civil Engineers | Land Surveyors | Landscape Architects

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September 12, 2019
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via email: john@deporrebuilding.com

Mr. John DePorre
DePorre Building, LLC
6400 Telegraph Road
Suite 2500
Bloomfield Hills, MI 48301

RE: Geotechnical Investigation
Proposed Townhome Development
Southwest Corner of Coolidge Highway and Oxford Road
Berkley, Oakland County, Michigan

Dear Mr. DePorre:

PEA, Inc. has performed a geotechnical investigation for the proposed residential townhome development located in Berkley, Michigan. The purpose of our investigation was to determine the general subsurface conditions throughout the proposed development in order to provide foundation and related site preparation recommendations.

Based on our investigation, the site soils generally consist of a pavement section of asphalt and aggregate base overlying native cohesive soils. Fill was encountered below the pavement section at one boring location, and extended to approximately 6 feet below the existing ground surface.

A minimal amount of earthwork will be needed to achieve final design grades. We anticipate cuts and fills on the order of 4 to 5 feet. Following successful completion of earthwork operations, we recommend that the proposed buildings be supported by shallow foundations bearing on engineered fill or on the native soils. We recommend that earthwork be performed in the dry season. We caution that if site conditioning and earthwork operations are during wet or cold weather (i.e. any time other that late spring to early fall) significant difficulty should be anticipated.

The data obtained during this investigation along with our evaluations, analysis and recommendations are presented in the subsequent portions of this report.

SITE CONDITIONS AND PROPOSED CONSTRUCTION

The site for the proposed townhome development is located at the southwest corner of Coolidge Highway and Oxford Road, and currently serves as the parking lot for the Our Lady of La Salette Roman Catholic Church in Berkley, Michigan.

Underground storm sewers currently exist throughout the existing parking lot. The ground surface is generally flat in both the north-south and east-west directions. Refer to the Test Boring Location Plan for the existing site features.

We understand present plans include constructing townhomes in the existing parking lot. No conceptual site plan has been provided, and no detailed information regarding the buildings is available at this time. Therefore, it has been assumed that the proposed structures will be two stories, with slab on grade floors and no basements. We anticipate loads will not exceed 50 kips for interior columns/posts, and 3,000 pounds per lineal foot for walls. It has also been assumed that the finish grade elevations for the proposed structures will be at or near the existing site grade and that only modest cuts and fills (ie. on the order of 4 to 5 feet) will be required to establish the finished grade elevation.

REGIONAL GEOLOGY AND SEISMIC ACTIVITY

A review of available sources indicates that several ice sheets (i.e. glaciers) advanced and retreated over the site with the most recent being during the late Wisconsin period. Based on the 1982 Quaternary Geology Map of Southern Michigan and the Oakland County Surficial Geology Map, the site soils were generally deposited as lake or lacustrine sediments in areas formerly inundated by glacial great lakes. According to the 1981 Oakland County Bedrock Topography map, the top of rock is at about elevation 425 or about 250 feet below the surface. Any sand and gravel strata are generally attributed to a succession of gradually receding lakes creating beach ridges.

Southern Michigan and Berkley are considered to have a relatively low seismic risk. The appropriate geotechnical design considerations for seismic conditions should be applied based on the Michigan Building Code. Based on our interpretation of the test borings and understanding of the soil conditions below the depth of exploration, we recommend the site be classified as a Class D Site.

FIELD INVESTIGATION

We investigated subsurface conditions at the existing facility site by drilling six test borings designated TB-1 to TB-6. Strata Drilling Company drilled the test borings on September 10, 2019. Test borings TB-1 to TB-3 were all drilled within proposed townhome footprint, and TB-4 to TB-6 were drilled within planned pavement areas. The test borings were located in the field by measuring from existing surface features. The locations are shown on the Test Boring Location Plan. Ground surface elevations were estimated from Google Earth.

The test borings were extended to depths ranging from 10 to 25 feet. The borings were advanced with 4-inch nominal diameter solid stem augers. Soil samples were taken at intervals of generally 2.5 feet within the upper 10 feet and at 5-foot intervals below 10 feet. These test boring samples were taken by the Standard Penetration Test method (ASTM D-1586).

Geotechnical engineers generally accept that auto hammers are more efficient that the traditional manual hammer. Therefore, the “N” value obtained in the field by using the auto hammer will generally be 2/3 to ¾ of the blows using a manual hammer. The “N” values on the boring logs represent the actual blows from the auto hammer. However, the relative density description is based on both the auto hammer blow counts and an expected equivalent N from a manual hammer.

The soil samples obtained with the split-barrel sampler were sealed in containers and transported to our laboratory for further classification and testing. We will retain these soil samples for 60 days after the date of this report. At that time, we will dispose of the samples unless otherwise instructed.

PRESENTATION OF DATA

We evaluated the soil and groundwater conditions encountered in the test borings and have presented these conditions in the form of individual Logs of Test Borings on Figures 1 through 6. The nomenclature used on the boring logs and elsewhere are presented on the Soil Terminology sheet, Figure 7. The stratification shown on the test boring logs represents the soil conditions at the actual boring locations. Variations may occur between the borings. The stratigraphic lines represent the approximate boundary between the soil types, however, the transition may be more gradual than what is shown. We have prepared the logs included with this report on the basis of field classification supplemented by laboratory classification and testing.

The thickness of existing pavements and base courses should be considered approximate. Mixing of these materials occur in the drilling process as well as deteriorated asphalt can appear as base. Pavement cores should be performed to obtain accurate thicknesses and condition of asphalt pavement and base courses, if needed. We have prepared the logs included with the report on the basis of field classification supplemented by laboratory classification and testing.

LABORATORY TESTING

The soil samples obtained from the test borings were also classified in our laboratory. Selected samples were tested to determine natural moisture contents. Testing was performed in accordance with current ASTM standards. The results of these tests are presented on the individual Logs of Test Borings.

In addition to the laboratory testing, pocket penetrometer measurements of the unconfined compressive strengths of cohesive soils were determined in the field. The strength values determined by the penetrometer are also presented on the test boring logs.

SOIL CONDITIONS AND EVAULATIONS

From the information developed during this investigation, subsoil conditions are generally similar throughout the site. Asphalt pavement overlies a layer of granular fill which in turns overlies native soils consisting of very stiff to hard silty clays.

The existing pavement section at the boring locations consists of approximately 4 inches of bituminous concrete over approximately 4 to 6 inches of brown gravelly sand base. The existing base material is considered suitable to support floor slabs and pavements, or for re-use as common fill.

At TB-4, within the planned parking lot for the townhome development, fill consisting of very loose silty sand extended to approximately 6 feet below the existing ground surface elevation.
The silty sand fill encountered at TB-4 is not considered suitable for the support of building foundations. Providing that the procedures outlined in the section of “Recommended Earthwork Operations” are followed, and providing that some settlement can be tolerated, most of the existing fill may be left in place below interior floor slabs and pavement where encountered, or re-used as compacted fill.

Underlying the sand fill at TB-4, and below the pavement base material at the rest of the soil borings, native silty clay was encountered. The very stiff to hard native clays extended to the the termination depth at each boring location. The native soils underlying the pavement section, and existing fill are considered suitable for the direct support of foundations, floor slabs, and pavement.

SITE PREPARATION

On the basis of available data, we anticipate a minimal amount of earthwork will be required to achieve final design grades. We recommend that all earthwork operations be performed under adequate specifications and be properly monitored in the field. We expect the earthwork to consist of minimal cuts and fills to bring the site to grade preparing for floor slabs and pavement. We recommend the following earthwork operations be performed.

- Any surface vegetation should be cleared. Topsoil or any other organic soils, if encountered, should be removed in their entirety from the building and parking areas.

- The existing pavement should be removed in its entirety within the proposed building area.

- Abandoned utilities inside the proposed buildings should be removed in their entirety. Outside the buildings, the abandoned utilities should either be removed or plugged.

- Where cohesive soils are present prior to fill placement in fill areas, and after rough grade has been achieved in cut areas, the cohesive subgrade should be thoroughly proof-rolled. A heavy rubber-tired vehicle such a loaded dump truck should be used for proof-rolling.

- We expect that some areas of the site will not proof-roll satisfactorily. Any areas that exhibit excessive pumping and yielding during proof-rolling and compaction should be stabilized by aeration, drying, and compaction if weather conditions are favorable or removal and replacement with engineered fill (undercutting).

- Undercutting also can include the use of geotextiles and geogrids. In general, removing wet pumping soils to find suitable stable soil may not work on this site. Thus, in order to backfill an excavation, 1 by 3 concrete or a geogrid is recommended to stabilize the bottom and begin the refilling process.

- Following proof-rolling and repair of unsuitable areas, the upper foot of the subgrade should be compacted to 90 percent of the maximum dry density as determined by the Modified Proctor Compaction Test, (ASTM D-1557) prior to placement of fill.

We recommend materials meeting the following criteria be used for backfill or engineered fill to achieve design grades:

- The material should be non-organic and free of debris.

- Frozen material should not be used as fill nor should fill be placed on a frozen subgrade.

- The on-site soils may be used for engineered fill provided that they are approximately at the optimum moisture content. The silty clay soils encountered at the soil boring locations may require aeration and drying before they can be properly compacted.

- Free-draining granular soils should be used for trench backfill and in confined spaces.

- Pea gravel is not recommended as engineered fill. Although pea gravel can easily be compacted, since it is rounded and very narrowly graded, it is unstable under wheel loads. In order to support loads, it must be confined laterally.

- Common Fill: The on-site soils may be used for common fill material. Common fill should be used in large areas that can be compacted by large earth moving equipment.

- Granular Fill: Granular fill should be used in confined areas such as trenches and backfill around foundations. Granular fill should meet the following gradation:

Sieve Size	**Percent Passing**
6 inch	100
3 inch	95-100
Loss by Wash	0-15

MDOT Class III meets the requirements for Granular Fill.

Alternately the following also can be used:

Sieve Size	**Percent Passing**
3 inch	100
1 inch	60-100
No. 30	0-30
Loss by Wash	0-10

MDOT Class II meets the requirements for Granular Fill. Some restriction apply to some applications

- Sand-Gravel Fill: Sand-gravel fill should be used where free-draining material is required. Free-draining material is recommended for underfloor fill and retaining wall backfill. Sand and gravel fill should meet the following gradation:

Sieve Size	**Percent Passing**
2 inch	100
1/2 inch	45-85
No. 4	20-85
No. 30	5-30
Loss by Wash	0-5

MDOT Class I material meets the requirements for sand and gravel.

- Crushed Stone Fill: Crushed stone fill should be used for aggregate base and for any over-excavated foundations. Crushed stone should meet the following gradations:

Sieve Size	**Percent Passing**
1-1/2 inch	100
1 inch	85-100
1/2 inch	50-75
No. 8	20-45
Loss by Wash	0-10

MDOT 21AA meets the gradation.

The fill should be placed in uniform horizontal layers. The thickness of each layer should be in accordance with the following:

Compaction Method	**Maximum Loose Lift Thickness**
Hand-operated vibratory plate or light roller In confined areas	4 inches
Hand-operated vibratory roller weighing at Least 1,000 pounds	6 inches
Vibratory roller drum roller, minimum dynamic Force, 2,000 pounds	9 inches
Vibratory drum roller, minimum dynamic force, 30,000 pounds	12 inches
Sheeps-foot roller	8 inches

The vibrating roller thicknesses are for compacting granular soils. If vibrating drum rollers are used for cohesive soils, the recommended lift thickness is one-third the tabulated value. The lift thicknesses may be increased if field compaction testing demonstrate the specified compaction is achieved throughout the lift.

The fill should be compacted to achieve the specified maximum dry density as determined by the Modified Proctor compaction test (ASTM D-1557). The specified compaction for fill placed in various area should be as follows:

Area	**Percent Compaction**
Within building envelope	95
Below foundations	95
Pavement base	95
Within one foot of pavement subgrade	95
Below one foot of pavement subgrade	92
Landscaped area	88

Trench backfill shall be compacted to above standards. The building is considered to extend 10 feet beyond the foundations of the structure. Pavement is considered to extend 5 feet beyond the edge plus a one-on-one slope to the original grade.

The site conditioning procedures discussed above are expected to result in fairly stable subgrade conditions throughout most of the site. However, the on-site silty cohesive soils are sensitive to softening when wet or disturbed by construction traffic. Depending on weather conditions and the type of equipment and construction procedures used, surface instability may develop in parts of the site. If this occurs, additional corrective procedures may be required, such as in-place stabilization or undercutting. Surface instability during pavement preparation commonly results from poor surface water management as the building is constructed and underground utilities installed, and when sensitive subgrades are not protected from excessive construction traffic. Corrective procedures can be limited by careful attention to water management and construction traffic.

If site conditioning and earthwork operations are to be performed during wet or cold weather (i.e. any time other than late spring to early fall), significant difficulty should be anticipated in drying or stabilizing the on-site silty cohesive clay soils. Under such circumstances, it may become necessary to undercut the wet soils and backfill with clean granular soils to achieve proper stabilization. If site preparation operations are performed during the summer months, it may be possible to stabilize wet soils in place and to use cohesive soils as fill with proper conditioning and moisture control in the field.

FOUNDATION RECOMMENDATIONS

Based on an evaluation of the subsurface data developed and successful completion of the earthwork procedures previously outlined, we recommend that the proposed residential units be supported on shallow spread and/or strip footings. Foundation excavations adjacent to utilities, streets, driveways, and sidewalks require caution, and care shall be given.

Exterior footings should be founded at a depth of at least 3.5 feet below the exposed finished grade for protection against frost penetration. Interior footings not exposed to frost penetration during or after construction can be installed at shallower depths provided that suitable bearing soils are present. Also, footings cast against earthen sidewalls should be vertical and not allowed to be larger at the top to help mitigate frost heave.

Adjacent spread footings at different levels should be designed and constructed so that the least lateral distance between them is equivalent to or more than the difference in their bearing levels.

To achieve a change in the level of a strip footing, the footing should be gradually stepped at a grade no steeper than two units horizontal to one unit vertical.

We recommend a uniform net allowable soil bearing pressure of 3,000 pounds per square foot (psf) be used for the design of footings bearing on undisturbed native soil and engineered fill. In using a net allowable soil pressure, the weight of the footing, backfill over the footing, or floor slabs need not be included in the structural loads for sizing footings. For both the vertical load and the horizontal load, the allowable bearing may be increased by one third for transient loads resulting from wind or seismic loads. However, strip footings should be at least 12 inches in width, and isolated spread footings should be at least 18 inches in their dimension, regardless of the resulting bearing pressure. All foundation excavations should be observed and tested to verify that adequate in-situ bearing pressures, compatible with the design value, are achieved.

If the recommendations outlined in this report are adhered to, total and differential settlements for the completed structures should be within approximately 1 inch and 1/2 inches, respectively. We recommend that all strip footings be suitably reinforced to minimize the effects of differential settlements associated with local variations in subsoil conditions.

GROUNDWATER CONDITIONS AND CONTROL

Water level observations were made at each of the test borings during and following the completion of drilling operations. During drilling, groundwater was encountered at approximately 3.5 to 19 feet below the ground surface at four of the six boring locations. The 3.5 foot groundwater reading was obtained with the sandy fill at TB-4. At completion, water was noted at a depth of 9.6 feet below the ground surface at TB-4, while the other borings were dry at drilling completion. The results of the individual water level measurements are shown on the respective Logs of Test Borings. Fluctuations in groundwater levels should be anticipated due the seasonal variations and following periods of prolonged precipitation or drought.

Groundwater observations during drilling operations in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the low permeability of such soils and the tendency of drilling operations to seal off the natural paths of groundwater flow. Considering the predominantly cohesive character of the subsoils and groundwater levels about 10 feet below the ground surface, no significant groundwater accumulations are anticipated in construction excavations. We expect that accumulations of groundwater or surface runoff water in such excavations should be controllable with normal pumping from properly constructed sumps.

FLOOR SLABS

The subgrade resulting from the satisfactory completion of site preparation operations can be used for the support of concrete floor slabs. Based on the proposed / anticipated finish floor grade, the slab will likely be supported by native cohesive soils. A modulus of subgrade reaction, k, of 125 pounds per cubic inch may be used for design. We recommend that all concrete floor slabs be suitably reinforced and separated from the foundation system to allow for independent movement.

We recommend a porous granular blanket consisting of MDOT Class I sand at least 4 inches thick under the floor slab. We also recommend a vapor barrier as required by code in residential living areas.

PAVEMENT CONSIDERATIONS

The subgrade resulting from the satisfactory completion of site preparation operations can also be used for the support of pavements. The cohesive subgrade soils consist of low plasticity silty clays which can be classified as CL or CL-ML, according to the Unified Soil Classification System (USCS). Soils of these types tend to have poor drainage characteristics, are frost susceptible, and are generally unstable under repeated loading. Based on the results of our investigation and the anticipated frost and moisture conditions, these soils may be assigned an estimated California Bearing Ratio (CBR) value of 3 for the design of pavements.

Criteria for an engineered design has not been furnished. In addition to traffic loads, required criteria also includes the design life, reliability and defining the condition at the end of the design period. We anticipate that both a light and heavy duty conventional pavement of asphalt with aggregate base will be used.

We understand the following to be the required pavement thicknesses for residential roads on granular subgrade in Oakland County:

Deep Strength Bituminous Asphalt: 1.5 inches of Asphalt Surface Course (1300T)
3 inches of Asphalt 3C
7 inches of 21AA Aggregate Base

OR

1.5 inches of Asphalt Surface Course (1300T)
3 inches of Asphalt (3C)
1.5 inches of Asphalt (2C or 11A)
Existing subgrade

Portland Cement Concrete: 7 inches of Concrete
Existing subgrade

The Road Commission of Oakland County requires that the asphalt meet Michigan Department of Transportation (MDOT) specifications for the mixes listed above. The aggregate base is required meet criteria for RCOC Modified MDOT 21AA.

For pavements, we recommend that “stub” or “finger” drains be provided around catch basins and other low parts of the site to minimize the accumulation of water above and within the frost susceptible subgrade soils. We also recommend edge drains along parking perimeters where upgrade surface water can flow onto or under pavement. Consideration should also be given to providing sub-drains around the perimeter of any proposed landscaped islands within the parking area since they can become a source of water infiltration into the pavement. Such sub-drains could be connected to nearby catch basins. The pavement should be properly sloped to promote effective surface drainage and prevent water ponding.

The pavement recommendations provided in this report are intended to provide serviceable pavement for about 20 years. However, all pavements require regular maintenance and occasional repairs. The need for such maintenance is not necessarily indicative of premature pavement failure. If such activities are not performed in a timely manner, the service life of the pavement can be substantially reduced. Most pavements require preservation treatments about 15 years into their life from environmental causes.

In truck loading zones and trash dumpster pick-up areas within the asphalt pavement areas, heavy concentrated wheel loads will be subjected upon the pavement. This type of activity frequently results in rutting of asphalt pavement and ultimately can lead to premature failure. Therefore, we recommend that suitably reinforced concrete pavement at least 8 inches in thickness be given consideration in these areas.

FIELD MONITORING

Soil conditions at the site could vary from those generalized on the basis of test borings made at specific locations. We recommend that a qualified geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations. Also, this allows modifications to the made in the event that subsurface conditions differ from those anticipated prior to the start of construction.

GENERAL COMMENTS

We have formulated the evaluations and recommendations presented in this report, relative to site preparation and building foundations, on the basis of data provided to us relating to the location of the proposed building significant change is this data should be brought to our attention for review and evaluation with respect to the prevailing subsurface conditions.

The scope of the present investigation was limited to evaluation of subsurface conditions for the support of building foundations, pavements, and other related aspects of development. No chemical, environmental, or hydrogeological testing or analysis was included in the scope of this investigation.

If you have any questions regarding this report, or if we may be of further assistance to you in any respect, please feel free to contact us. We appreciate the opportunity to have been of service to you.

Sincerely,

PEA, Inc.

Rebecca E. Bentley

Rebecca Bentley, PE
Project Manager

D. Jack Sattelmeier, PE
Director of Geotechnical Engineering

Attachments:
- Log of Test Boring
- Soil Terminology
- Grain Size Distribution Curve
- Location Plan

LOG OF TEST BORING NO. TB-1

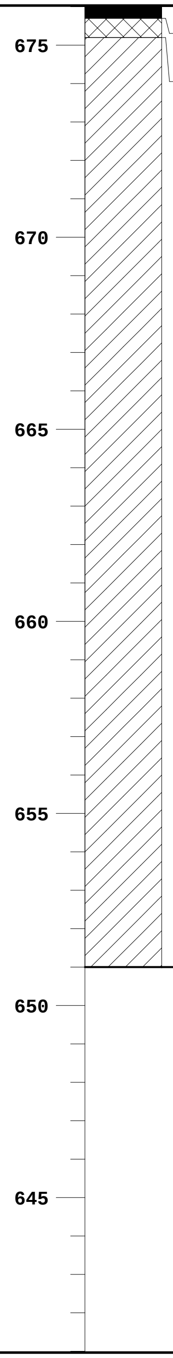
PROJECT NAME: *Coolidge Highway and Oxford Road*
LOCATION: *Berkley, MI*

PEA Job No.: *2019-366*

Reviewed by: *REB*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 676.0



Asphalt Pavement

0.3

Brown, gravelly Sand pavement base

0.8

Hard, brown, silty Clay, little sand, trace gravel

Wet, silty sand seam noted

Hard, gray, silty Clay, little sand, trace gravel

Very stiff, occasional wet sand partings noted

Stiff, gray, silty Clay, little sand, trace gravel

End of Boring

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0							
		2 3 9	12	15.2		*9000	
5		7 10 14	24	13.5		*9000	
		7 13 20	33	14.8		*9000	
10		10 14 19	33	12.6		*9000	
15		6 7 12	19			*6000	
20		5 7 11 18				*4000	
25		5 7 9	16			*3000	
30							
35							

Total Depth: *25* **Drilling Method:** *2 1/2" Solid Stem Augers*

Drilling Date: *09/10/19*

Inspector: *Jonathan Andare* **Plugging procedure:** *Soil Cuttings*

Client: *DePorre Building, LLC*

Water Level Observation:
During drilling: *During Drilling - 7.0 ft.*
After drilling: *At Completion - Dry*

Notes: **Pocket Penetrometer*

LOG OF TEST BORING NO. TB-2

PROJECT NAME: *Coolidge Highway and Oxford Road*
LOCATION: *Berkley, MI*

PEA Job No.: *2019-366*

Reviewed by: *REB*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 676.0

Elevation	Description	Depth
	Asphalt Pavement	0.3
675	Brown, gravelly Sand pavement base	0.6
	Very stiff, brown, silty Clay, little sand, trace gravel	
670	Hard, brown, silty Clay, trace sand and gravel	
665		
660	Hard, gray, silty Clay, trace sand and gravel	
655	Very stiff, gray, silty clay, trace sand and gravel. Wet sand seam noted at 19.0 ft	
650	End of Boring	
645		

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0							
		3 5 8	13	18.7		*4000	
5		5 7 12	19	14.2		*9000	
		8 12 17	29	13.9		*9000	
10		11 14 19	33	13.8		*9000	
15		8 10 15	25			*9000	
20		5 7 10	17			*5000	
25		6 8 12	20			*4000	
30							
35							

Total Depth: *25* **Drilling Method:** *2 1/2" Solid Stem Augers*

Drilling Date: *09/10/19*

Inspector: *Jonathan Andare* **Plugging procedure:** *Soil Cuttings*

Client: *DePorre Building, LLC*

Water Level Observation:
During drilling: *During Drilling - 19.0 feet*
After drilling: *At Completion - Dry*

Notes: ** Pocket Penetrometer*

LOG OF TEST BORING NO. TB-3

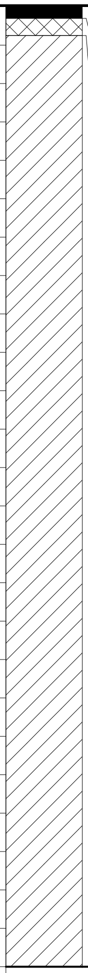
PROJECT NAME: *Coolidge Highway and Oxford Road*
LOCATION: *Berkley, MI*

PEA Job No.: *2019-366*

Reviewed by: *REB*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 676.0



Elevation	Description	Depth
	Asphalt Pavement	0.3
675	Brown, clayey Sand pavement base	.75
	Very stiff, brown, silty Clay, little sand, trace gravel, occasional sand partings	
670	Hard, brown, silty Clay, trace sand and gravel	
665		
660	Very stiff, gray, silty Clay, trace sand and gravel	
655		
650	End of Boring	
645		

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0							
		2 3 6	9	15.4		*6000	
5		5 9 13	22	14.2		*9000	
		9 14 20	34	12.5		*9000	
10		12 18 26	46	9.9		*9000	
15		7 9 11	20			*7000	
20		6 8 11	19			*7000	
25		6 8 12	20			*5000	
30							
35							

Total Depth: *25* **Drilling Method:** *2 1/2' Solid Stem Augers*

Drilling Date: *09/10/19*

Inspector: *Jonathan Andare* **Plugging procedure:** *Soil Cuttings*

Client: *DePorre Building, LLC*

Water Level Observation:
During drilling: *During Drilling - 19.0 ft*
After drilling: *At Completion - Dry*

Notes: ** Pocket Penetrometer*

LOG OF TEST BORING NO. TB-4

PROJECT NAME: *Coolidge Highway and Oxford Road*
LOCATION: *Berkley, MI*

PEA Job No.: *2019-366*

Reviewed by: *REB*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 676.0

Elevation	Depth (ft)	Description
676.0	0	Asphalt Pavement
	0.3	Black, clayey Sand pavement base Very loose, brown, silty Sand, little clay, trace to little gravel
670	6	Hard, brown, silty Clay, little to some sand, trace gravel
	10	End of Boring

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
		2 2 3	5	15.4			
5		1 2 3	5	15.4			
		7 15 18	33	9.4		*9000	
10		12 15 18	33			*9000	

Total Depth: *10*
Drilling Method: *201/2" Solid Stem Augers*

Drilling Date: *09/10/19*

Inspector: *Jonathan Andare* **Plugging procedure:** *Soil Cuttings*

Client: *DePorre Building, LLC*

Water Level Observation:
During drilling: *During Driling - 3.5 ft*
After drilling: *At Completion - 9.6 ft*

Notes: ** Pocket Penetrometer*

LOG OF TEST BORING NO. TB-5

PROJECT NAME: *Coolidge Highway and Oxford Road*
LOCATION: *Berkley, MI*

PEA Job No.: *2019-366*

Reviewed by: *REB*

SUBSURFACE PROFILE		SOIL SAMPLE DATA							
GROUND SURFACE ELEVATION 676.0		DEPTH FEET	SAMPLE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
	Asphalt Pavement	0							
675	0.3 Brown, clayey Sand pavement base			4 2 4	6	19.2		*4000	
	.75 Stiff, gray, silty Clay, little sand, trace gravel								
		5		5 6 9	15	14.0		*9000	
670	Hard, brown, silty Clay, trace sand and gravel			6 10 14	24	13.4		*9000	
		10		8 12 20	32			*9000	
	End of Boring								
665									
		15							
660									
		20							
655									
		25							
650									
		30							
645									
		35							

Total Depth: *10* **Drilling Method:** *2 1/2" Solid Stem Augers*

Drilling Date: *09/10/19*

Inspector: *Jonathan Andare* **Plugging procedure:** *Soil Cuttings*

Client: *DePorre Building, LLC*

Water Level Observation:
During drilling: *During Drilling - Dry*
After drilling: *At Completion - Dry*

Notes: * *Pocket Penetrometer*

LOG OF TEST BORING NO. TB-6

PROJECT NAME: *Coolidge Highway and Oxford Road*
LOCATION: *Berkley, MI*

PEA Job No.: *2019-366*

Reviewed by: *REB*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 676.0

Asphalt Pavement	0.3
Brown, gravelly Sand pavement base	0.8
Very stiff, brown and gray silty Clay, little sand, trace gravel Hard, brown, silty Clay, trace sand and gravel	
End of Boring	10

Elevation: 675, 670, 665, 660, 655, 650, 645

SOIL SAMPLE DATA

Depth feet: 0, 5, 10, 15, 20, 25, 30, 35

SAMPLE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
	2 4 8	12	12.1		*5000	
	4 6 10	16	14.6		*9000	
	8 14 18	32	13.5		*9000	
	8 9 15	24			*9000	

Total Depth: *10* **Drilling Method:** *2 1/2" Solid Stem Augers*

Drilling Date: *09/10/19*

Inspector: *Jonathan Andare* **Plugging procedure:** *Soil Cuttings*

Client: *DePorre Building, LLC*

Water Level Observation:
During drilling: *During Drilling - Dry*
After drilling: *At Completion - Dry*

Notes: * *Pocket Penetrometer*

SOIL TERMINOLOGY

Unless otherwise noted, all terms utilized herein refer to the Standard Definitions presented in ASTM D-653.

PARTICLE SIZES

Boulders - Greater than 12 inches (305 mm)

Cobbles - 3 inches (76.2 mm) to 12 inches (305 mm)

Gravel:

- < Coarse - 3/4 inches (9.05 mm) to 3 inches (76.2 mm)
- < Fine - No. 4 (4.75 mm) to 3/4 inches (19.05 mm)

Sand:

- < Coarse - No. 10 (2.00 mm) to No. 4 (4.74 mm)
- < Medium - No. 40 (0.425 mm) to No. 10 (2.00 mm)
- < Fine - No .200 (0.074 mm) to No. 40 (0.425 mm)

Silt - 0.005 mm to 0.074 mm

Clay - Less than 0.005 mm

CLASSIFICATION

The major soil constituent is the principal noun (i.e., clay, silt, sand, gravel). The minor constituents are reported as follows:

Modifiers to Main Constituent
(Percent by Weight)

Trace - 01 to 10%
Little - 10 to 20%
Some - 20 to 30%
Adjective - Over 30%

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier (i.e., silty clay). Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils (i.e., silty clay, trace of sand, little gravel).

Consistency	Unconfined Compressive Strength (PSF)	Approximate Range of N
Very Soft	Below 500	0 to 2
Soft	500 to 1,000	3 to 4
Medium	1,000 to 2,000	5 to 8
Stiff	2,000 to 4,000	9 to 15
Very Stiff	4,000 to 8,000	16 to 30
Hard	8,000 to 16,000	31 to 50
Very Hard	Over 16,000	Over 50

Consistency of cohesive soils is based upon as elevation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

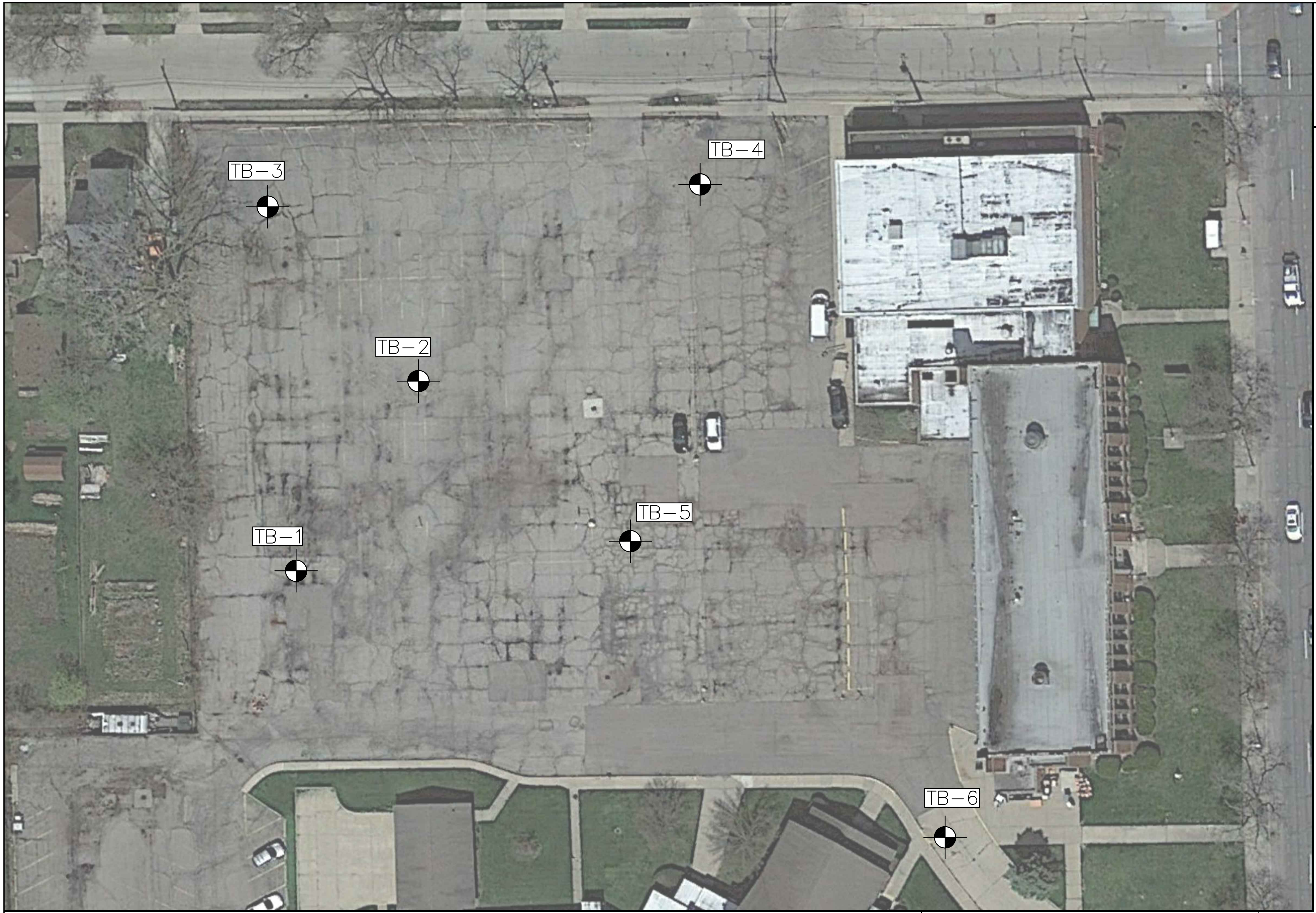
Density Classification	Relative Density %	Approximate Range of N
Very Loose	0 to 15	0 to 4
Loose	16 to 35	5 to 10
Medium Compact	36 to 65	11 to 30
Compact	66 to 85	31 to 50
Very Compact	86 to 100	Over 50

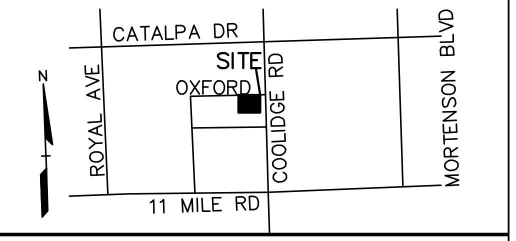
Relative Density of Cohesionless Soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

C - Core
D - Directly from Auger Flight or Miscellaneous Sample
S - Split Spoon Sample - ASTM D-1586
LS - S - Sample with liner insert
ST - Shelby Tube Sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted

STANDARD PENETRATION TEST (ASTM D-1586) - a 2.0-inch outside diameter, 1-3/8-inch inside diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely.





N

BORING LEGEND

TB-1 ⊕ TEST BORING BY PERFORMED BY STRATA DRILLING ON SEPTEMBER 10, 2019 UNDER TECHNICAL SUPERVISION OF PEA.

DATE: 09/11/2019

PEA JOB NO. 2019-366

PEA

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Troy, MI 48083-1872
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COOLIDGE & OXFORD ROAD

TEST BORING LOCATION MAP

CITY OF BERKLEY, OAKLAND COUNTY, MICHIGAN

S:\PROJECTS\2019\2019-366 COOLIDGE AND OXFORD - JS2\FIELD SERVICES\GEO\DWG\2019-366 Boring Location Map.dwg