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October 8, 2019
PEA Project No: 2018-355

Mr. Paul Schyck
Pulte Group
100 Bloomfield Hills Parkway
Suite 150
Bloomfield Hills, MI 48304

RE: Slope Stability Review
Rochester University Townhomes
Rochester Hills, MI

Dear Mr. Schyck:

PEA, Inc (PEA) has performed a slope stability analysis on two representative sections identified by the Atwell Group in their site plans for the proposed Rochester College Residential development dated July 25, 2019.

The steep slopes identified by the Atwell Group are present along the north and east sides of the proposed development. We understand that most of these fall under the Rochester Hills Ordnance for steep slopes and include moderate, very steep and bluff sections.

PEA performed a slope stability analysis using the cross sections provided in the Atwell site plans. PEA drilled an additional 75-foot-deep soil boring on September 23, 2019 we used this information along with the PEA soils investigation dated October 30, 2018 and an addition hand boring performed near the toe of the slope to perform the slope stability analysis. We modeled the slopes as cross section 1 and cross section 5 from the site plans to perform the analysis using GeoStudio 2019R2 Slope W in 2D.

The soils encountered in the borings on the top side of the slope were similar brown and gray clays which were modeled as silty clay. The boring performed at a lower elevation and near the toe of the slope shows sandy soils and was modeled as such. The deeper boring TB-101 transitioned from silt clay to sand at approximately 30 below ground surface. The building at the top of the slope was set back 25 feet and modelled as 55 feet long with a 2000 psf load placed on the soils.

The results of the slope stability analysis through the critical section indicated a factor of safety from of approximately 2.7 for both models. The minimum industry standard factor of safety is 1.3. Based on our analysis these slopes exceed the industry standards for global stability. Where fill soils are placed on slopes with a grade exceeding 1:10, the slope should be benched prior to the placement of the fill in order to prevent the fill soils from sliding down the slope face.

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.

D. Jack Sattelmeier, PE
Director of Geotechnical Engineering

LOG OF TEST BORING NO. TB-101

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by: *JLN*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION

Depth (ft)	Description
0	TOPSOIL: Dark Brown Sand
1.1	Brown Medium Compact SILTY SAND, Trace Gravel, Trace fine roots
6.0	Brown Hard SILTY CLAY, Trace Gravel & Sand
14.0	Grey Stiff SILTY CLAY, Trace Sand; Occasional Silty Sand seams
28.0	Brown Compact SAND
29.5	Brown to Grey Hard SILTY CLAY, Trace Sand
31.0	

SOIL SAMPLE DATA

SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
1-S	6 5 7	12				
2-S	6 8 10	18				
3-S	7 7 9	16			9000*	
4-S	9 9 13	22			9000*	
5-S	6 5 7	12			3500*	
6-S	4 4 6	10			3500*	
7-S	3 4 5	9			2000*	
8-S	7 15 24	39			9000*	

DEPTH FEET: 0, 5, 10, 15, 20, 25, 30

Total Depth: *75*

Drilling Date: *9/23/19*

Inspector: *CJK*

Contractor: *Strata Drilling Company*

Drilling Method: *Hollow stem augers*
Aute-hammer

Plugging procedure: *Soil cuttings*

Water Level Observation: *During drilling: 68 ft.*

Notes: ** Pocket penetrometer*

LOG OF TEST BORING NO. TB-101

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by: *JLN*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION

SUBSURFACE PROFILE	Depth to bottom of stratum
Brown Very Compact fine SAND, Trace Gravel	42.0
Brown Compact SANDY GRAVEL, Trace Silt	47.0
Brown Medium Compact GRAVELLY SAND, Trace Silt	52.0
Brown Very Compact SAND, Little Silt, Trace Gravel	62.0

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
35	9-S	20 29 50/4	79+				
	10-S	70/5	70+				
40							
45	11-S	7 12 21	33				
50	12-S	9 9 3	12				
55	13-S	23 23 36	59				
60	14-S	24 34 35	69				
65	15-S	20 30 32	62				

Total Depth: *75*

Drilling Date: *9/23/19*

Inspector: *CJK*

Contractor: *Strata Drilling Company*

Drilling Method: *Hollow stem augers*
Aute-hammer

Plugging procedure: *Soil cuttings*

Water Level Observation: *During drilling: 68 ft.*

Notes: ** Pocket penetrometer*

LOG OF TEST BORING NO. TB-101

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by: *JLN*

SUBSURFACE PROFILE		SOIL SAMPLE DATA							
GROUND SURFACE ELEVATION		DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
	Brown Compact SAND, Trace Silt								
		70	16-S	17 21 24	45				
	71.0								
	Grey Compact SAND, Trace Silt								
		75	17-S	7 19 26	45				
	End of Boring								
		80							
		85							
		90							
		95							

Total Depth: *75*

Drilling Date: *9/23/19*

Inspector: *CJK*

Contractor: *Strata Drilling Company*

Drilling Method: *Hollow stem augers*
Aute-hammer

Plugging procedure: *Soil cuttings*

Water Level Observation: *During drilling: 68 ft.*

Notes: ** Pocket penetrometer*

LOG OF TEST BORING NO. HA-1

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

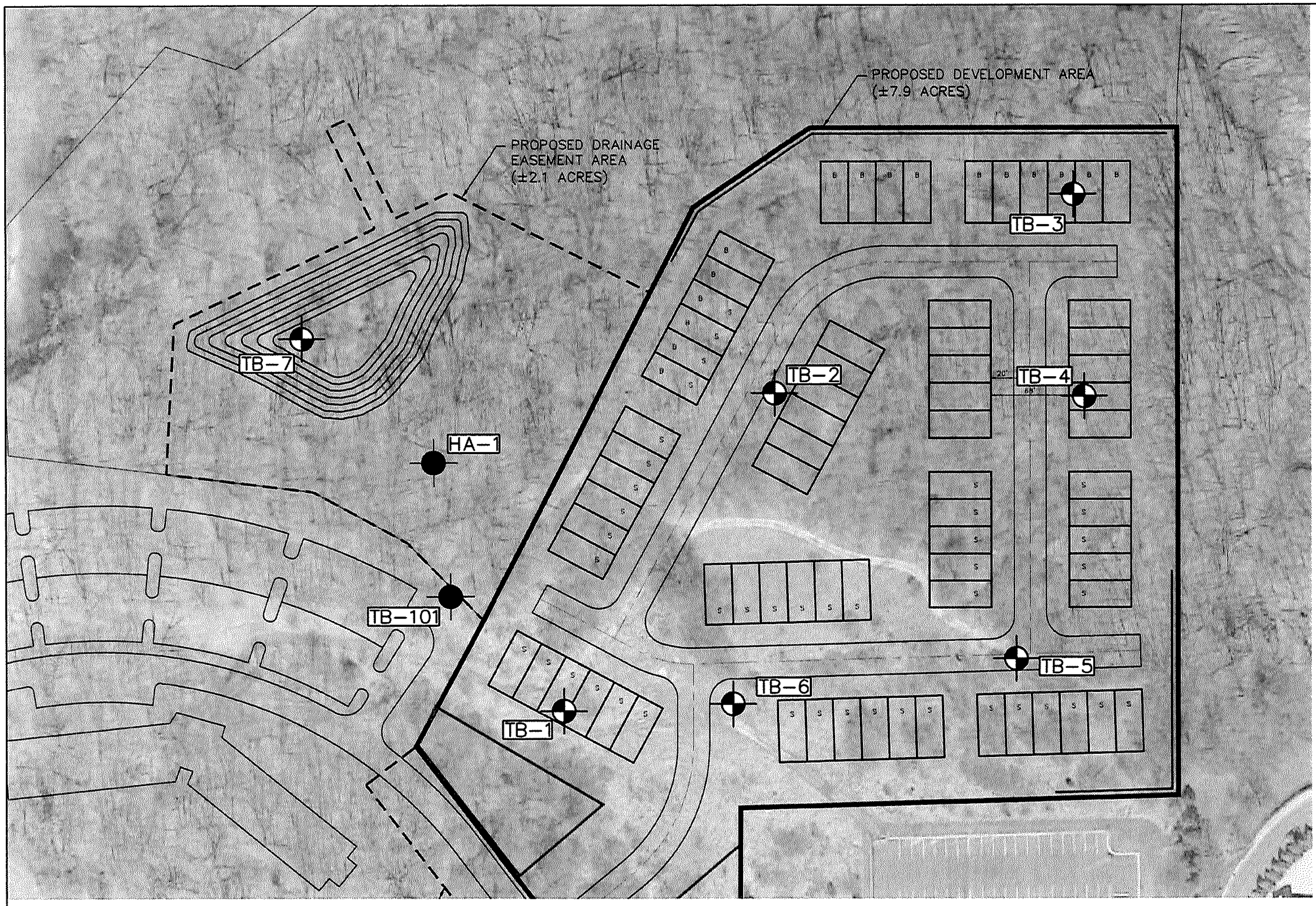
PEA Job No.: *2018-355*
Reviewed by: *JLN*

SUBSURFACE PROFILE			SOIL SAMPLE DATA							
GROUND SURFACE ELEVATION			DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
		TOPSOIL: Dark Brown Clayey Sand	0							
		Dark Brown CLAYEY SAND, Trace Gravel & Roots 0.5	1							
		Dark Brown GRAVELLY SAND, Trace Clay 2.0	2 3 4							
		End of Hand Auger	5 6							

Total Depth: *4.3*
Drilling Method: *Hand Auger*
Drilling Date: *10/2/19*
Inspector: *CK*
Plugging procedure: *Spoils*
Contractor: *PEA*

Water Level Observation: *None encountered*

Notes:



0 100
50 200
GRAPHIC SCALE
1" = 100'

N

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ROCHESTER COLLEGE RESIDENTIAL MULTI-TENANT DEVLOPMENT

BORING LOCATION MAP

CITY OF ROCHESTER HILLS, OAKLAND COUNTY, MICHIGAN

BORING LEGEND

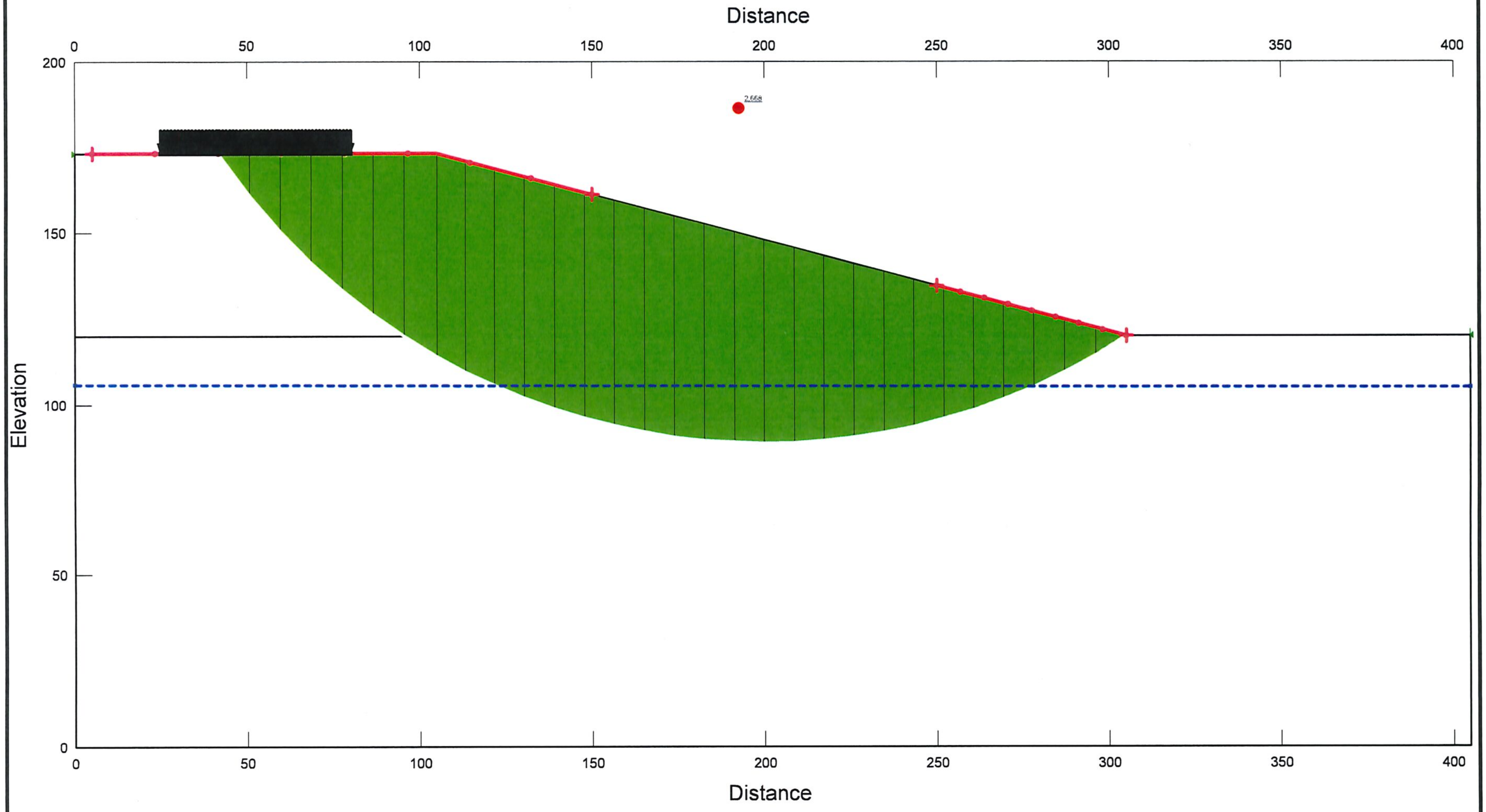
TB-1 TEST BORING BY PERFORMED BY STRATA DRILLING SERVICES ON SEPTEMBER 23, 2019 UNDER TECHNICAL SUPERVISION OF PEA.

BORING LEGEND

TB-1 TEST BORING BY PERFORMED BY STRATA DRILLING SERVICES ON OCTOBER 19, 2018 UNDER TECHNICAL SUPERVISION OF PEA.

DATE: 10/3/2019

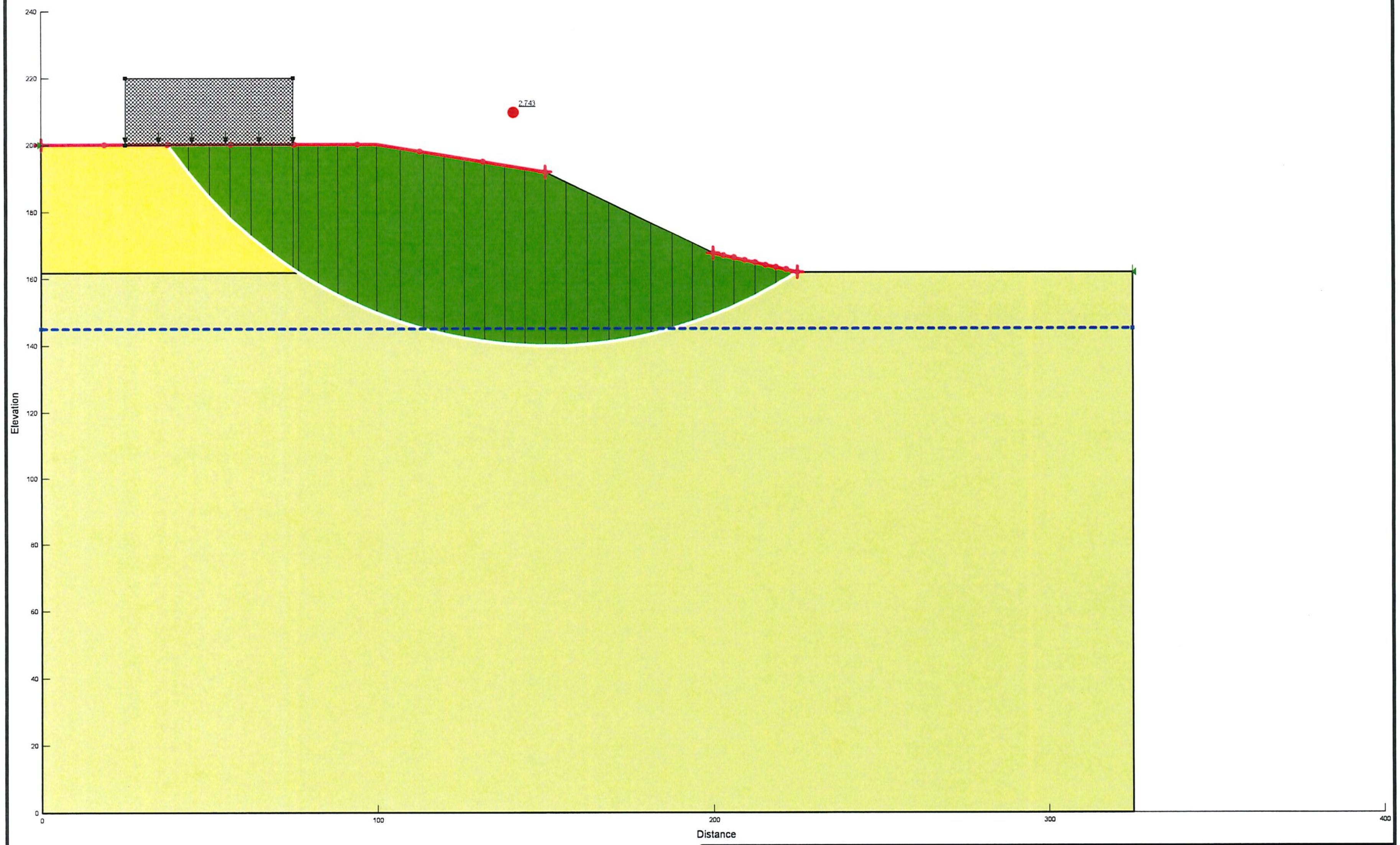
PEA JOB NO. 2018-355



Slope Stability

Rochester College 2018-355

Silty Clay over Silty Sand Model Cross Section 5



Slope Stability

Rochester College 2018-355

Silty Clay over Silty Sand Model Cross Section 1

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October 30, 2018
PEA Project No: 2018-355

Ms. Karen Brown
Pulte Group
100 Bloomfield Hills Parkway
Suite 150
Bloomfield Hills, MI 48304

RE: Geotechnical Investigation
Rochester College Residential
Rochester Hills, MI

Dear Ms. Brown:

PEA, Inc (PEA) has performed a geotechnical investigation for the proposed Rochester College residential development located in Rochester Hills, Michigan. The purpose of our investigation was to determine the general subsurface conditions at the building and storm water retention pond locations in order to provide foundation and related site preparation recommendations.

Based on our investigation, the site soils generally consist of black clayey sand topsoil 8" to 14" thick that overlies a very stiff to hard brown silty clay. This in turn overlies a stiff to very stiff gray silty clay which was present to the termination depths of the borings.

A minor amount of earthwork will be needed to achieve final design grades. We anticipate cuts and fills of 1 to 4 feet will be needed during site preparation. Following successful completion of earthwork operations, we recommend that the proposed building 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 performed 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.

Proposed Construction

We understand present plans include the construction of a 72-unit multi-tenant residential development at the northeast end of the Rochester College's campus located in Rochester Hills, Michigan. This development will include structures up to two-stories above grade in height with basements and a storm water retention pond located northwest of the building structures.

Although no specific loading information was available for the proposed multi-tenant residential development, we anticipate slab-on-grade construction and loads not exceeding 150 kips for interior columns and 3,000 pounds per linear foot for walls. It is understood at this time that the proposed finish first floor elevation for the structure will be near the existing site grade. We anticipate minimal cuts and fills to achieve design grades for the area where the proposed buildings will be constructed. Bituminous concrete pavement will be added to the site for parking areas, as well as concrete pavement for the proposed trash loading areas.

Site Conditions

The site for the proposed Rochester College Residential development is located to the northwest of the Rochester Road and Avon Road intersection. The proposed site is bordered to the north and west by the Clinton River, east by Life Time Fitness, and south by the Rochester College athletic complex and Rochester Church of Christ.

Underground utilities, such as storm and sanitary sewers, water mains and gas lines do not currently exist throughout the proposed development location. The ground surface generally appears to slope from the south to the north edge of the site where a ridgeline is present and the ground surface elevation quickly falls away.

Refer to the Test Boring Location Plan for the existing site features.

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 formally inundated by glacial Great Lakes. According to the 1981 Oakland County Bedrock Topography map, the top of rock is at about elevation 600 or about 225 feet below the surface. Any sand and gravel strata are generally attributed to a succession of gradually receding lakes creating beach ridges.

The seasonal changes during the artic conditions affected the structure of the sediments. In the summer the suspended material consisted of silt and clay. The silt particles settled out during the summer. During the winter no new material was carried to the lakes since the rivers were completely frozen. Thus, only clay particles, which do not settle out during the summer, were deposited. This resulted in layers of mostly silt with some clay and darker winter layers of mostly clay. The alternating layers of silt and clay are known as varved clay. Prior to melting, the glacier ice exerted tremendous pressure on the underlying soils creating very dense strata locally known as hardpan.

Southern Michigan and Oakland County 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 proposed development site by drilling 7 test borings designated TB-1 to TB-7. Strata Drilling Company drilled the test borings on October 19, 2018. TB-1 through TB-6 were drilled within the proposed buildings while TB-7 was drilled at the proposed storm water retention pond. The locations are shown on the Test Boring Location Plan.

The test borings were extended to depths of 15 to 20 feet. The borings were advanced with 4-inch 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 lower than those found using the manual hammer. We consider the blows from the automatic hammer will be about 2/3 to 3/4 of the blows using a cathead and rope. The actual blows from the auto hammer and the "N" value are presented. However, the relative density description is based on both the actual auto hammer 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 Figure 1 through 7. The nomenclature used on the boring logs and elsewhere are presented on the Soil Terminology sheet, Figure 8. 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.

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 and grain-size distribution. Testing was performed in accordance with current ASTM standards. The results of these tests are presented on the individual Logs of Test Borings. The granular soil gradations are presented as Grain Size Distribution Curves on Figure 9 through Figure 13.

In addition to the laboratory testing, pocket penetrometer measurements of the 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 Evaluations

From the information obtained during this investigation, subsoil conditions are generally similar throughout the site. Topsoil overlies native soils consisting of very stiff to hard silty clays. Very loose to medium compact granular soil strata were encountered at three of the test boring locations.

The surface is blanketed with moderately organic topsoil. The topsoil generally consists of black clayey and silty sand and ranges between 8 to 14 inches thick at the boring locations. We do not consider the topsoil suitable for the support of building foundations, floor slabs, pavements or for use as engineered fill material. However, this material can be reused for landscaping.

Very stiff to hard, brown, silty clay was encountered below the topsoil at boring locations TB-1 through TB-4, and at TB-6. The clay extended to termination depths of these borings.

At TB-3 and TB-5, a loose to medium compact silty to clayey sand layer was encountered within the upper clay soils. At TB-3, a layer of clayey sand was encountered between 3.0 and 5.5 feet below the existing ground surface elevation. At TB-5. the silty sand was encountered below the surficial topsoil, and extended to 2.0 feet below the existing ground surface elevation.

In TB-3&5 the silty clay is present below layers of brown sandy clay and clayey sand at TB-3 and a brown silty sand layer at TB-5. The very stiff to hard brown silty clay is considered suitable for the direct support of foundations, floor slabs, and pavement and for the reuse as fill material. Underlying the brown silty clay in TB-1 through 5, a gray silty clay is present for the remaining depth explored. This gray silty clay ranges from hard to stiff and it decreases in density as you increase in depth.

The native granular and cohesive soils encountered at the proposed building locations are considered suitable for the direct support of building foundations, floor slabs and pavement.

TB-7 was drilled in the area of the proposed storm water retention pond where the existing ground surface elevation is approximately60 feet below the other 6 boring locations. The soil profile encountered at TB-7 primarily consists of a surficial layer of topsoil underlain by granular, cohesionless soil with varying amount of silt and gravel to the termination depth of the boring.

Site Preparation

On the basis of available data, we anticipate a minimal amount of earthwork will be required to achieve final design grades preparing for floor slabs and pavement for the proposed development. We recommend that all earthwork operations be performed under adequate specifications and be properly monitored in the field. 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.
- 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.
- Where granular soils are exposed prior to fill placement in fill areas, and after rough grade has been achieved in cut areas (if any), the subgrade should be thoroughly compacted with vibratory roller by making a minimum of 10 passes in each of two perpendicular directions covering the proposed floor area. In addition to detecting unstable areas, the proof-compaction operation should serve to densify the shallow granular deposits that were encountered at the site.

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.
- The on-site soils may be used for engineered fill provided that they are approximately at the optimum moisture content. The silty/sandy clay soils 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.
- 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. 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.

We recommend placing fill in accordance with the following:

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

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 for pavement preparation commonly results from poor surface water management as the building is constructed and underground utilities installed. Also, surface instability can result when sensitive subgrades are not protected from excessive construction traffic. Corrective procedures can be limited by careful attention to water management and construction traffic.

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 buildings be supported on shallow spread and/or strip footings bearing on the native granular or cohesive soils encountered at the buildings' test boring locations.

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, to help prevent frost heave, the sides of footing, both trenched strip or wall footings and shallow foundations, should be placed "neat". "Neat" footings should have a constant width and vertical sidewalls (i.e. not larger at the top than the bottom). We point out the existing native sands may not allow vertical side walls.

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. 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 inch, 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 the test borings during and following the completion of drilling operations. Groundwater was encountered at approximately 14 to 15 feet below the ground surface at test borings TB1 and TB-7 during drilling activities. At completion, water was noted at depths of 15.5 to 16 feet. The observed water level elevation at TB-1 was approximately 783 feet. At TB-7, the water level elevation was approximately 729 feet. 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 anticipated finish floor grades, the slab will likely be supported by native granular or 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 retarder when moisture sensitive material or items are in contact with the slab. These could include: wood, tile, carpet, other moisture sensitive coverings, moisture sensitive equipment and even moisture sensitive material stored on the slab. Where warranted, the slab designer and contractor should refer to ACI 302 and 360 for guidance in use and placement.

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 a very stiff to hard brown silty clay which can be classified as CL, 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 pavement design have not been furnished. In addition to traffic loads, 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. In addition, a concrete pavement may be used for parking and truck traffic areas.

Typical pavements for similar projects have included:

For design purposes and projected traffic conditions of three trucks and 500 cars per day in the parking area, 20 trucks per day and unlimited cars in the drive aisles, and a 20-year pavement life, the following pavement cross-sections are recommended:

Conventional Asphalt on Aggregate Base

Parking:	3 inches of Asphalt Surface Course 8 inches of Aggregate Base
Heavy Duty Drive Areas:	4 inches of Asphalt Surface Course 12 inches of Aggregate Base

We recommend that the asphalt meet Michigan Department of Transportation (MDOT) specifications for MDOT 13A, 36A, 3C or 4C. The aggregate base should meet criteria for 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 subdrains 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 subdrains could be connected to nearby catch basins. The pavement should be properly sloped to promote effective surface drainage and prevent water ponding.

We further point out that when designing pavement using the 1993 AASHTO Design Method not only is the CBR value above required but the traffic loads, the design life, reliability and defining the condition at the end of the design period are needed. Once the Design Structural Number is determined, the pavement structural number can be determined by using a layer coefficient of 0.14 for MDOT 21AA and drainage coefficient of 0.6. If commercial 21 AA crushed concrete is used for the base, we recommend reducing the layer coefficient to 0.12 and the drainage coefficient to 0.5. These changes result in a one third increase in the base thickness for the same structural number. In addition, because of the frost susceptibility of the subgrade and the recommendation for underdrains, using crushed concrete will require filter layers to protect against clogging by leachate, Due to the increase in thickness and leachate considerations, we recommend using natural aggregates.

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. Asphalt pavement in truck unloading areas may also experience rutting due to forklift traffic and/or truck turning movements. We further recommend that concrete pavement be placed in such 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 buildings. Any 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.

Eric Labelle

Rebecca E. Bentley

Eric Labelle
Staff Engineer

Rebecca Bentley, P.E.
Project Manager

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

LOG OF TEST BORING NO. TB-1

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by:

SUBSURFACE PROFILE

GROUND SURFACE
ELEVATION 799

Elevation	Depth	Description
798		TOPSOIL: Black SANDY CLAY
795	1.2	Very Stiff Brown SILTY CLAY, Trace Sand & Plant Roots
792, 789, 786	6.5	Hard Brown SILTY CLAY, Trace Sand & Gravel
783, 780	13.5	Very Stiff Gray SILTY CLAY, Trace Sand
		End of Boring

▼ 783

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0							
3	1-S	2 2 4	6			*4500	
6	2-S	3 4 5	9	21.2		*5500	
9	3-S	4 6 8	14	12.5		*9000	
12	4-S	5 7 8	15			*9000	
15	5-S	4 8 9	17	15.1		*5000	
18	6-S	4 7 10	17			*5000	

Total Depth: *20*

Drilling Method: *4 In. Solid-Stem Auger Autohammer*

Drilling Date: *10-19-18*

Inspector: *ERL*

Plugging procedure: *Excavated Spoil*

Contractor: *Strata Drilling Company*

Water Level Observation: 16 Ft. at Completion

Notes: * Pocket Penetrometer

LOG OF TEST BORING NO. TB-2

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by:

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 801.0

Elevation	Depth (ft)	Profile
801	0	TOPSOIL: Black CLAYEY SAND
	0.3	Very Stiff to Hard Brown SILTY CLAY, Trace Sand
798	3	
795	6	
792	9	
789	12	
	12.5	Stiff Gray SILTY CLAY, Trace Sand and Gravel
786	15	End of Boring
783	18	

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
	1-S	2 3 3	6	12.6		*5000	
	2-S	5 8 11	19	14.1		*9000	
	3-S	5 11 12	23			*9000	
	4-S	3 9 13	22			*9000	
	5-S	2 4 4	8	14.2		*3000	

Total Depth: *15*
Drilling Method: *4 In. Solid-Stem Auger Autohammer*
Drilling Date: *10-19-18*
Inspector: *ERL*
Plugging procedure: *Excavated Spoil*
Contractor: *Strata Drilling Company*

Water Level Observation: Dry at Completion

Notes: * Pocket Penetrometer

LOG OF TEST BORING NO. TB-3

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by:

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 798.8

798	TOPSOIL: Black CLAYEY SAND	0.75
	Stiff Brown SANDY CLAY, Little Silt, Trace Plant Roots	3.0
795	Medium Compact Brown CLAYEY SAND, Little Gravel	5.5
792 789	Hard Brown SILTY CLAY, Trace Sand	12.0
786 783	Hard Gray SILTY CLAY, Trace Sand	19.0
780	Very Stiff Gray SILTY CLAY, Little Sand	
	End of Boring	

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0							
	1-S	1 2 4	6	16.8		*2500	
3							
	2-S	5 5 7	12	7.1			
6							
	3-S	5 7 8	15	12.4		*9000	
9	4-S	5 8 9	17			*9000	
12							
	5-S	5 8 9	17	12.8		*9000	
15							
18							
	6-S	5 6 8	14	10.7		*4000	

Total Depth: *20*

Drilling Method: *4 In. Solid-Stem Auger Autohammer*

Drilling Date: *10-19-18*

Inspector: *ERL*

Plugging procedure: *Excavated Spoil*

Contractor: *Strata Drilling Company*

Water Level Observation: Dry at Completion

Notes: * Pocket Penetrometer

LOG OF TEST BORING NO. TB-4

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by:

SUBSURFACE PROFILE		
GROUND SURFACE ELEVATION 814.9		
TOPSOIL: Black SILTY SAND	0.9	
813		
810	Hard Brown SILTY CLAY, Trace Sand & Gravel	
807		8.5
804	Very Stiff to Stiff Gray SILTY CLAY, Trace Sand	
801		
	End of Boring	
798		
795		

SOIL SAMPLE DATA							
DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0							
	1-S	2 4 7	11			*6000	
3							
	2-S	6 13 14	27	9.9		*9000	
6							
	3-S	6 11 12	23	12.5		*9000	
9	4-S	6 10 14	24	11.3		*8000	
12							
	5-S	4 4 6	10			*2000	
15							
18							

Total Depth: *15*

Drilling Method: *4 In. Solid-Stem Auger Autohammer*

Drilling Date: *10-19-18*

Inspector: *ERL*

Plugging procedure: *Excavated Spoil*

Contractor: *Strata Drilling Company*

Water Level Observation: Dry at Completion

Notes: * Pocket Penetrometer

LOG OF TEST BORING NO. TB-5

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by:

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 818.8

TOPSOIL: Black SAND	0.7
Loose Brown SILTY SAND, Trace Plant Roots	2.0
Hard Brown SILTY CLAY, Trace Sand	10.5
Very Stiff Gray SILTY CLAY, Trace Sand & Gravel	14.0
Stiff Gray CLAY, Trace Sand	
End of Boring	

816
813
810
807
804
801
798

SOIL SAMPLE DATA

DEPTH FEET: 0, 3, 6, 9, 12, 15, 18

SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
1-S	1 2 5	7	5.5			
2-S	4 9 10	19			*9000	
3-S	5 9 10	19			*9000	
4-S	5 9 11	20	13.2		*8000	
5-S	5 7 10	17	11.9		*8000	
6-S	2 4 4	8	14.7		*2000	

Total Depth: *20*

Drilling Method: *4 In. Solid-Stem Auger Autohammer*

Drilling Date: *10-19-18*

Inspector: *ERL*

Plugging procedure: *Excavated Spoil*

Contractor: *Strata Drilling Company*

Water Level Observation: Dry at Completion

Notes: * Pocket Penetrometer

LOG OF TEST BORING NO. TB-6

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by:

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 821.9

Elevation	Profile	Depth
	TOPSOIL: Black CLAYEY SAND	0.6
819		
816		
813	Hard Brown SILTY CLAY, Trace Sand	
810		
807	End of Boring	
804		
801		

SOIL SAMPLE DATA

DEPTH FEET: 0, 3, 6, 9, 12, 15, 18

SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
1-S	4 5 5	10			*9000	
2-S	3 5 6	11	16.7		*9000	
3-S	4 7 9	16	11.7		*9000	
4-S	6 11 14	25	14.0		*9000	
5-S	6 13 17	30			*9000	

Total Depth: *15*
Drilling Method: *4 In. Solid-Stem Auger Autohammer*
Drilling Date: *10-19-18*
Inspector: *ERL*
Plugging procedure: *Excavated Spoil*
Contractor: *Strata Drilling Company*

Water Level Observation: Dry at Completion

Notes: * Pocket Penetrometer

LOG OF TEST BORING NO. TB-7

PROJECT NAME: *Rochester College Residential*
LOCATION: *Rochester Hills, MI*

PEA Job No.: *2018-355*
Reviewed by:

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 744.8

Elevation	Description	Depth (ft)
	TOPSOIL: Black SILTY SAND	0.8
744	Loose Brown SAND, Some Gravel, Trace Silt	3.0
	Loose Brown CLAYEY SILT	3.5
741 738 735 732	Very Loose to Loose Brown SAND, Little Silt, Trace Gravel	13.0
729	Medium Compact Brown SILTY SAND, Little Gravel	17.0
726	Compact Brown SAND, Some Gravel, Trace Silt	
	End of Boring	

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0							
	1-S	1 3 5	8	8.0			
3	2-S	2 2 2	4	6.6			
6	3-S	2 3 3	6				
9	4-S	4 5 4	9				
12							
15	5-S	5 9 8	17	17.2			
18	6-s	14 19 18	37	8.4			

Total Depth: *20*

Drilling Method: *4 In. Solid-Stem Auger Autohammer*

Drilling Date: *10-19-18*

Inspector: *ERL*

Plugging procedure: *Excavated Spoil*

Contractor: *Strata Drilling Company*

Water Level Observation: 15.5 Ft. Wet Cave

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

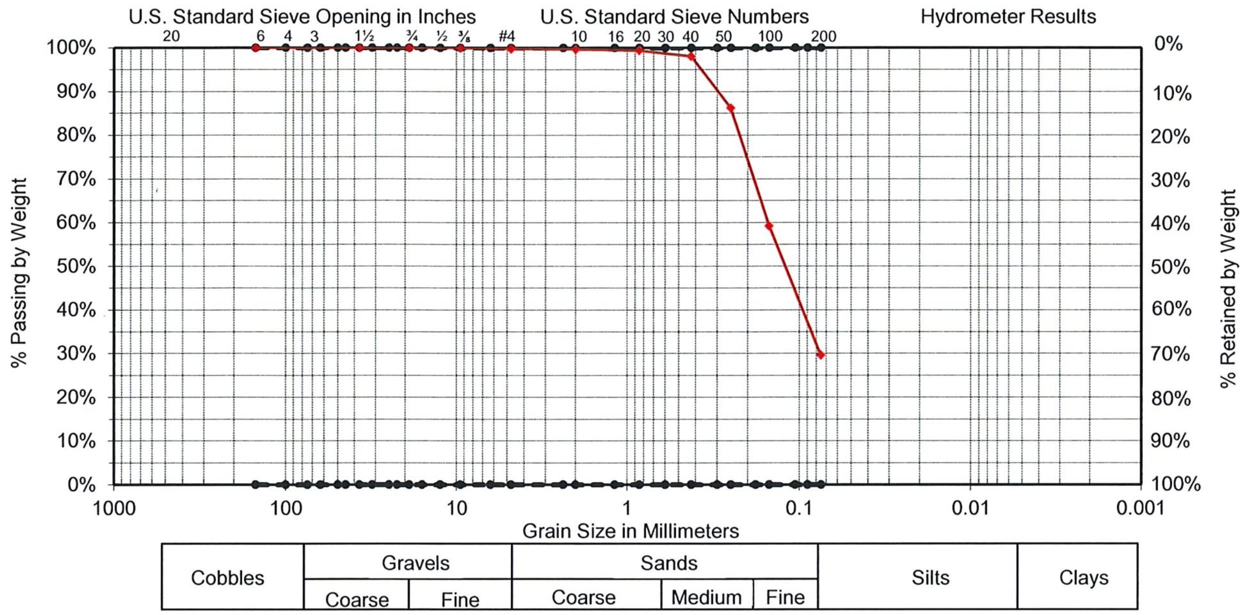
Relative Density of Cohesionless Soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

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.

Figure 6



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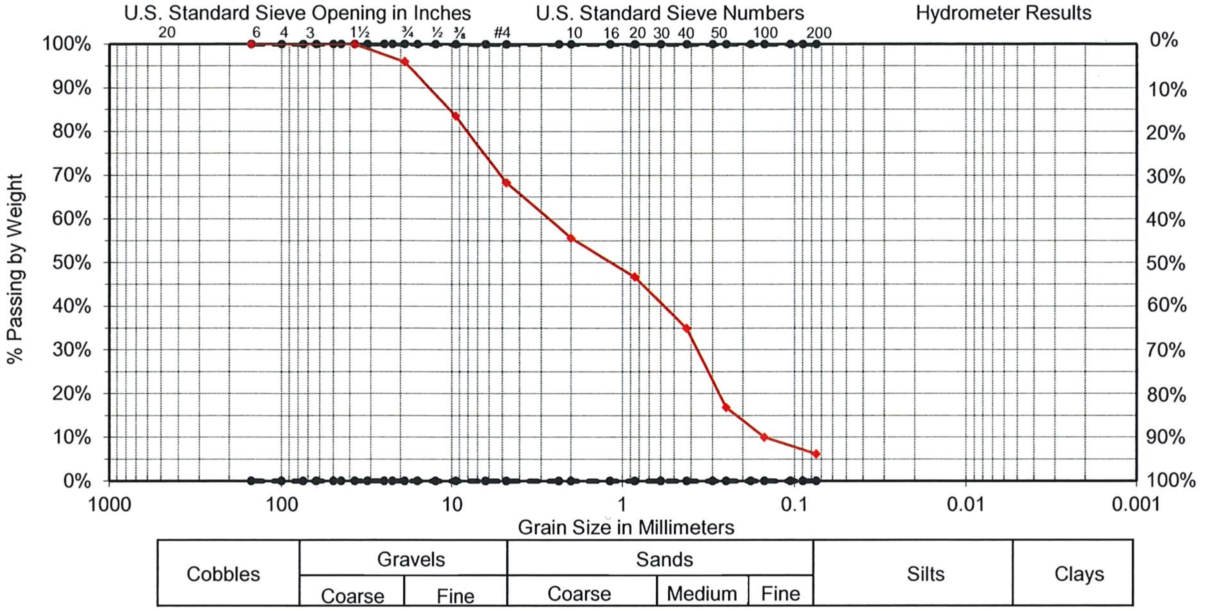
Date : *10/19/2018*
Project #: *2018-355* Boring: *TB-5* Depth: *1.0'*
Project: Rochester Hills Residential
Location / Use: Rochester Hills, MI

Specifications

Sample Meets Specs Loss by Wash
n/a **29.7%**

Coarse Section		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
Sieve Size					
US	Metric				
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50	100.0%	100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.9%		
#4	4.75	99.8%	99.8%		

Fines Section		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
Sieve Size					
US	Metric				
#4	4.750	99.8%	99.8%		
#8	2.360		99.7%		
#10	2.000	99.7%	99.7%		
#16	1.180		99.5%		
#20	0.850	99.4%	99.4%		
#30	0.600		98.6%		
#40	0.425	98.0%	98.0%		
#50	0.300		89.6%		
#60	0.250	86.2%	86.2%		
#80	0.180		67.3%		
#100	0.150	59.2%	59.2%		
#140	0.106		41.9%		
#170	0.090		35.6%		
#200	0.075	29.7%	29.7%		
#270	0.053				



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Date : *10/19/2018*

Project #: *2018-355* Boring: *TB-7* Depth: *1.0'*

Project: Rochester Hills Residential

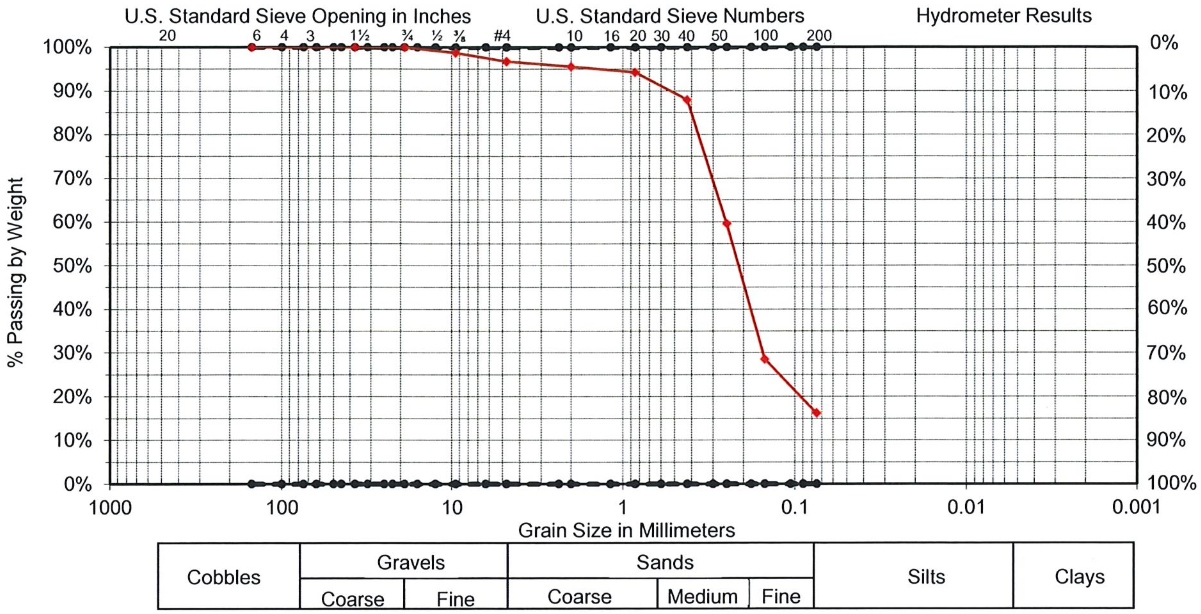
Location / Use: Rochester Hills, MI

Specifications

Sample Meets Specs Loss by Wash
n/a **6.2%**

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50	100.0%	100.0%		
1.25"	31.50		98.7%		
1.00"	25.00		97.3%		
7/8"	22.40		96.7%		
3/4"	19.00	96.0%	96.0%		
5/8"	16.00		92.1%		
1/2"	12.50		87.5%		
3/8"	9.50	83.5%	83.5%		
1/4"	6.30		73.3%		
#4	4.75	68.3%	68.3%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	68.3%	68.3%		
#8	2.360		57.3%		
#10	2.000	55.6%	55.6%		
#16	1.180		49.3%		
#20	0.850	46.7%	46.7%		
#30	0.600		39.8%		
#40	0.425	34.9%	34.9%		
#50	0.300		22.0%		
#60	0.250	16.9%	16.9%		
#80	0.180		12.1%		
#100	0.150	10.0%	10.0%		
#140	0.106		7.8%		
#170	0.090		7.0%		
#200	0.075	6.2%	6.2%		
#270	0.053				



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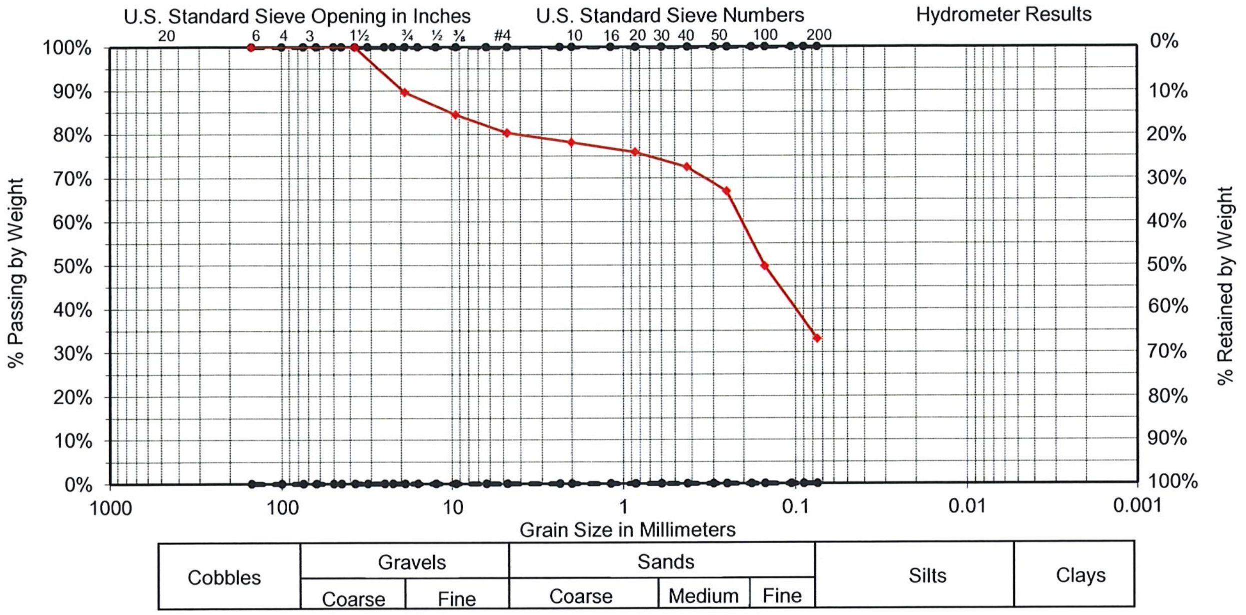
Date : *10/19/2018*
Project #: *2018-355* Boring: *TB-7* Depth: *3.5'*
Project: Rochester Hills Residential
Location / Use: Rochester Hills, MI

Specifications

Sample Meets Specs Loss by Wash
n/a **16.2%**

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50	100.0%	100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		99.6%		
1/2"	12.50		99.1%		
3/8"	9.50	98.7%	98.7%		
1/4"	6.30		97.4%		
#4	4.75	96.7%	96.7%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	96.7%	96.7%		
#8	2.360		95.7%		
#10	2.000	95.5%	95.5%		
#16	1.180		94.6%		
#20	0.850	94.3%	94.3%		
#30	0.600		90.6%		
#40	0.425	88.0%	88.0%		
#50	0.300		67.7%		
#60	0.250	59.6%	59.6%		
#80	0.180		37.9%		
#100	0.150	28.6%	28.6%		
#140	0.106		21.3%		
#170	0.090		18.7%		
#200	0.075	16.2%	16.2%		
#270	0.053				



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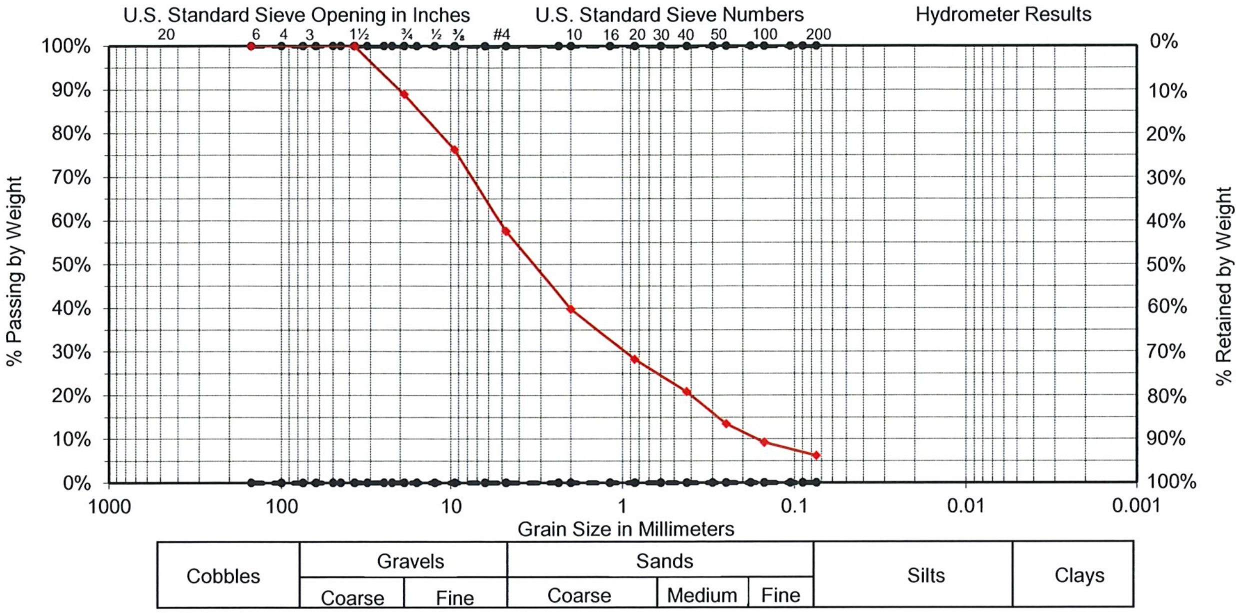
Date : *10/19/2018*
Project #: *2018-355* Boring: *TB-7* Depth: *13.5'*
Project: Rochester Hills Residential
Location / Use: Rochester Hills, MI

Specifications

Sample Meets Specs Loss by Wash
n/a **33.1%**

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50	100.0%	100.0%		
1.25"	31.50		96.6%		
1.00"	25.00		93.0%		
7/8"	22.40		91.5%		
3/4"	19.00	89.6%	89.6%		
5/8"	16.00		88.0%		
1/2"	12.50		86.2%		
3/8"	9.50	84.6%	84.6%		
1/4"	6.30		81.7%		
#4	4.75	80.4%	80.4%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	80.4%	80.4%		
#8	2.360		78.4%		
#10	2.000	78.1%	78.1%		
#16	1.180		76.5%		
#20	0.850	75.9%	75.9%		
#30	0.600		73.9%		
#40	0.425	72.5%	72.5%		
#50	0.300		68.5%		
#60	0.250	67.0%	67.0%		
#80	0.180		54.9%		
#100	0.150	49.8%	49.8%		
#140	0.106		40.0%		
#170	0.090		36.4%		
#200	0.075	33.1%	33.1%		
#270	0.053				



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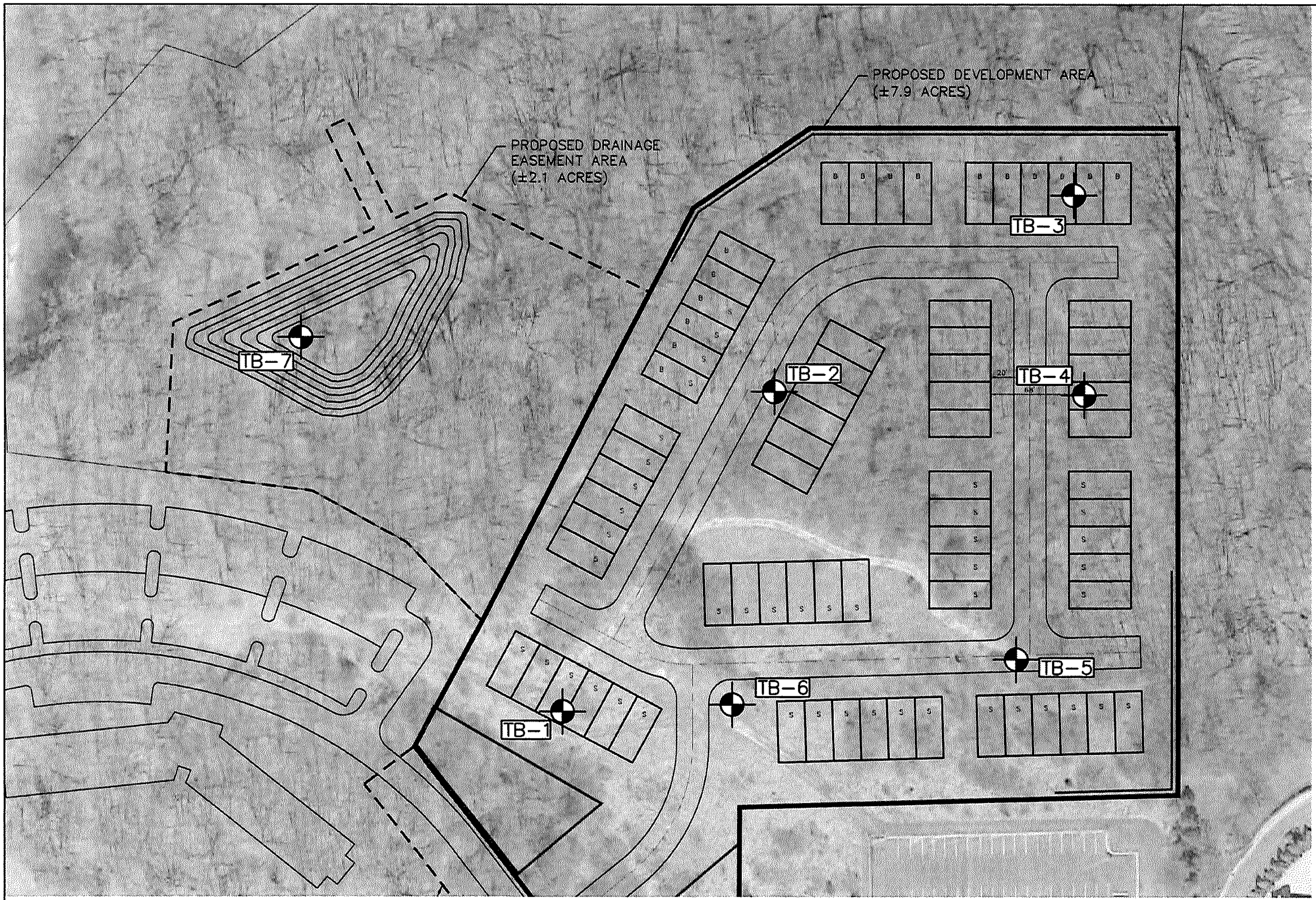
Date : *10/19/2018*
Project #: *2018-355* Boring: *TB-7* Depth: *18.5'*
Project: Rochester Hills Residential
Location / Use: Rochester Hills, MI

Specifications

Sample Meets Specs Loss by Wash
n/a **6.2%**

Coarse Section		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs	Specs
Sieve Size US	Metric			Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50	100.0%	100.0%		
1.25"	31.50		96.4%		
1.00"	25.00		92.6%		
7/8"	22.40		91.0%		
3/4"	19.00	89.0%	89.0%		
5/8"	16.00		85.0%		
1/2"	12.50		80.3%		
3/8"	9.50	76.3%	76.3%		
1/4"	6.30		63.7%		
#4	4.75	57.6%	57.6%		

Fines Section		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs	Specs
Sieve Size US	Metric			Max	Min
#4	4.750	57.6%	57.6%		
#8	2.360		42.1%		
#10	2.000	39.8%	39.8%		
#16	1.180		31.6%		
#20	0.850	28.3%	28.3%		
#30	0.600		23.9%		
#40	0.425	20.8%	20.8%		
#50	0.300		15.6%		
#60	0.250	13.5%	13.5%		
#80	0.180		10.5%		
#100	0.150	9.3%	9.3%		
#140	0.106		7.5%		
#170	0.090		6.8%		
#200	0.075	6.2%	6.2%		
#270	0.053				



N

0 100 50 200

GRAPHIC SCALE
1" = 100'

N

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ROCHESTER COLLEGE RESIDENTIAL
MULTI-TENANT DEVELOPMENT
BORING LOCATION MAP
CITY OF ROCHESTER HILLS, OAKLAND COUNTY, MICHIGAN

BORING LEGEND

TB-1 TEST BORING BY PERFORMED BY STRATA DRILLING SERVICES ON OCTOBER 19, 2018 UNDER TECHNICAL SUPERVISION OF PEA.

DATE: 10/19/2018

PEA JOB NO. 2018-355