

SOILS INVESTIGATION
PROPOSED 37-ACRE SUBDIVISION
WELCH AND MAPLE ROADS
COMMERCE TOWNSHIP, MICHIGAN

PULTEGROUP, INC.
100 BLOOMFIELD HILLS PARKWAY
SUITE 150
BLOOMFIELD HILLS, MICHIGAN 48304-2950

MAY 24, 2018
BY
McDOWELL & ASSOCIATES

McDowell & Associates

Geotechnical, Environmental & Hydrogeological Services • Materials Testing & Inspection

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May 24, 2018

PulteGroup, Inc.
100 Bloomfield Hills Parkway
Suite 150
Bloomfield Hills, Michigan 48304-2950

Job No. 18-155

Attention: Mr. Joe Skore

Subject: Soils Investigation
Proposed 37-Acre Subdivision
Welch and Maple Roads
Commerce Township, Michigan

Gentlemen:

In accordance with your request, we have made a Soils Investigation at the subject project.

Fifteen (15) Soil Test Borings, designated as 1, 2, 2A, 3, 3A and 4 through 13, were performed at the site. The approximate locations of the borings are shown on the Soil Boring Location Plan which accompanies this report. Borings 1, 2, 3 and 4 through 13 were advanced to a depth of about twenty feet (20') below the existing ground surface at these boring locations. Borings 2A and 3A were advanced to a depth of thirty-five feet (35'). Borings 1, 2, 3, 4 and 5 were drilled with our all-terrain track-mounted drill rig. Borings 2A, 3A and 6 were drilled with a truck-mounted drill rig. The other borings were drilled with our all-terrain balloon-tired drill rig. Piezometers were installed at Borings 4, 5 and 9 through 13. Details of the piezometer installations are noted on the logs of these borings. It is suggested that you have your surveyors determine the top of casing elevation at the piezometers so that periodic water level elevation readings can be taken to better ascertain long-term groundwater conditions at the site.

Soil descriptions, groundwater observations and the results of field and laboratory tests are to be found on the accompanying Logs of Soil Test Borings and summary sheet of Sieve Analysis results.

The borings encountered variable soil conditions. Some of the borings encountered topsoil and shallow fill conditions. Borings 1, 4, 6, 8, 9, 10, 12 and 13 encountered five inches (5") to four feet (4') of topsoil and fill soils followed by medium compact to extremely compact brown to gray silt to sand and gravel and firm to extremely stiff brown to blue silty clay to sandy clay which were found throughout the remainder of these borings. Deeper fill and buried organic soils were found in Borings 5, 7 and 11. Specifically, these borings encountered six feet (6') to

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eight feet six inches (8'6") of fill soils and buried organic soils, followed by stiff to extremely stiff brown to blue silty clay and compact to extremely compact brown to blue clayey silt to sand. Buried peat and dark brown organic silty clay were found in Boring 11 between the depths of three feet six inches (3'6") and six feet (6'). Very loose sand soils were found in Borings 2, 2A, 3 and 3A. These borings encountered three feet three inches (3'3") and six feet four inches (6'4") of fill and possible fill soils, six feet eight inches (6'8") and nine feet one inch (9'1") of soft to very stiff brown and variegated silty clay and medium compact to compact brown sand, five feet six inches (5'6") and five feet eight inches (5'8") of very loose to slightly compact brown silt and fine sand to sand, followed by compact to very compact brown to gray fine sand to sand and gravel and stiff blue silty clay. Fill and possible fill soils were found in Borings 2, 2A, 3, 3A, 4, 5, 6 and 8 through 13 and consisted of surficial topsoil, buried topsoil, broken concrete, soft to stiff brown and discolored brown silty clay to sandy clay and medium compact to very compact brown and discolored brown clayey fine sand to sand. Buried topsoil was found in Boring 3 between the depths of one foot eight inches (1'8") and two feet five inches (2'5").

Soil descriptions and depths shown on the boring logs are approximate indications of change from one soil type to another and are not intended to represent an area of exact geological change or stratification. Also, the site contains the building pads of several buildings and the foundations of a hospital building which was never completed and the site shows significant signs of modification which could indicate fill and soil conditions different from those encountered at the boring locations.

Water was encountered in all borings except Boring 1 at depths ranging from one foot (1') to thirteen feet (13') below the existing ground surface. Water was measured upon completion of the drilling operation in Borings 2, 3, 4 through 11 and 13 at depths ranging from three feet eight inches (3'8") to eighteen feet (18'). Boring 12 was found to cave in upon completion at a depth of eight feet five inches (8'5"). No water was encountered in Boring 1. It should be noted that short-term groundwater observations may not provide a reliable indication of the depth of the water table. In clay and highly organic soils this is due to the slow rate of infiltration of water into the borehole as well as the potential for water to become trapped in overlying layers of granular soils during periods of heavy rainfall. Water levels in granular soils fluctuate with seasonal and climatic changes, with the amount of rainfall in the area immediately prior to the measurements, as well as any changes in the water levels of nearby wetlands and streams. It should be expected that groundwater level fluctuations could occur on a seasonal basis and that seams of water-bearing sands or silts could be found within the various clay strata at the site. Water levels in the piezometers installed in Borings 4, 5 and 9 through 13 should be read periodically to better ascertain long-term groundwater conditions at the site.

Standard Penetration Tests were made during sampling using an automatic hammer in Borings 2A, 3A and 6 and a conventional drop hammer with cat head and rope in the other borings. These tests indicate the site native soils have very poor strengths and densities in Borings 2, 2A, 3 and 3A and poor to very good strengths and densities in the other borings. Very low blow counts were found in Borings 2, 2A, 3 and 3A with results ranging from the weight of the

hammer sinking eighteen inches (18") into the soil to five (5) blows per foot. The other borings had test results ranging from four (4) to fifty-six (56) blows per foot.

Google Earth images of the site show an existing floor slab of a demolished building near the northwest corner of the site. An existing auto mechanic shop building is located near the southwest corner of the site. Foundations for a hospital building which was never completed can be seen near the center of the site. A detention pond is located near the northeast corner of the site. Stockpiles, building rubble and evidence of construction activities are visible over the majority of the site. A previous soils investigation report containing fifty-three (53) borings was prepared for a Beaumont medical center facility by Soil and Material Engineers, Inc. (SME Project No. PG52339A), dated November 7, 2007. That report encountered similar soil and groundwater conditions as our borings.

It is understood that the site will be developed as a residential subdivision containing one- to two-story houses with attached garages and basements. It is assumed that the structures will transmit relatively light loads to the supporting soils and basements will be about seven feet (7') to nine feet (9') below the existing ground surface at the boring locations. Commercial-type buildings may be constructed along the west side of the site. No specific information has been provided to us. We have assumed one- to two-story slab-on-grade structures which will transmit relatively light loads to the supporting soils.

Based on the project information provided and the results of field and laboratory tests, it is believed that house and building structures could be supported by conventional spread and/or strip footings at many areas of the site. However, in deeper fill areas, buried organic soil areas, and very loose sand soil areas found at Borings 2, 2A, 3, 3A, 5, 7 and 11 it may be economical to support structures in these area on properly installed and compacted engineered fill. Special dewatering will probably be needed to install engineered fill at Borings 2, 2A, 7 and 11. If installing relatively deep footings or installing engineered fill proves to be too difficult, then structures could be supported on systems of deep foundations. It would appear that deep foundations may be needed at Borings 2/2A and 3/3A. Deep foundations could consist of driven timber piles, auger cast piles, mini piles, helical piles, or possibly "stone column" geopiers. Installing basements may be very difficult in the vicinity of Borings 9, 10, 11 and 13 and difficult in the vicinity of Borings 4, 7 and 12 due to shallow groundwater conditions at the site.

If conventional footings for the structures are installed to rest on competent native non-organic soils at the site, then all exterior footings and footings for non-heated structures should be constructed at or below a minimum frost penetration depth of three feet six inches (3'6") below finished grade. All footings should extend through non-engineered fill soils, soils containing a significant amount of organic substances or excessively weak soils. All strip footings should be continuously reinforced in order to minimize the noticeable effects of differential settlement.

Footings could be proportioned for the design soil pressures shown below provided this results in footings bearing on suitable native non-organic soils.

<u>Boring</u>	<u>Depth</u>	<u>Soil Pressure (psf)</u>
1	1'6" to 7'0"	1,500
	7'6" to 8'6"	2,500
	9'0" to 12'0"	4,000
3/3A	6'6" to 8'6"	2,000
	9'0" to 10'0"	1,000
4	4'0" to 12'0"	4,000
5	6'6" to 12'0"	4,000
6	1'6" to 4'6"	4,000
	5'0" to 9'0"	3,000
	9'6" to 12'0"	4,000
7	8'6" to 12'0"	4,000
8	4'0" to 12'0"	4,000
9	3'6" to 12'0"	4,000
10	1'6" to 12'0"	4,000
11	6'0" to 12'0"	4,000
12	1'6" to 12'0"	4,000
13	1'6" to 5'0"	2,500
	5'6" to 12'0"	4,000

Based on the above chart, it appears that lower strength soils may be encountered in the vicinity of Borings 1 and 3/3A which may necessitate larger than normal frost depth footing sizes. Note that footings should not be installed deeper than a ten-foot (10') depth at Boring 3/3A.

It should be noted that footing and basement excavations may be near or below the level at which water was encountered in Borings 4 through 13. Depending upon the depth of the footings relative to the existing ground surface and the actual conditions at the time of construction, it may be necessary to depress the water table in these locations to allow for footings to be constructed. Water seepage in sand soils above clay or in sand seams in clay soils in the vicinity of Borings 5 and 8 should be manageable with construction pumping and sumps. However, this is not known for certain. If large volumes of water or saturated granular soils are encountered, special dewatering techniques may be required. Wet silt, sand and gravel soils

were encountered in Borings 4, 6, 7 and 9 through 13. It is sometimes possible to construct strip footings a foot or so below the water table in coarser granular soils using a rapid sequence of excavation and placement of concrete. If this is not possible, it may be necessary to use special dewatering techniques to depress the water table in the vicinity of these borings. Extreme care must be exercised during any dewatering operation if any nearby houses or utilities are sensitive to settlement. Care must be taken to minimize the removal of soil fines during the pumping operation. It is very difficult to dewater silt soils.

As an alternative to relatively deep footings, the structures' spread or strip footings could be supported on engineered fill. All existing fill, highly organic soils, soft soils, and very loose granular soils should be excavated and removed from the proposed structure areas. Based on soil conditions encountered in the borings, we would anticipate existing soils will need to be excavated and removed to the following approximate depths:

<u>Boring</u>	<u>Excavation Depth</u>
2/2A	18'
3/3A	6'4"
5	6'3"
7	8'6"
11	6'

Excavations should extend beyond the edge of the structures' footings one foot (1') for every foot below the footing. Groundwater flow into the excavation will probably require special dewatering techniques in order to facilitate the excavation of the unsuitable soils, especially in the vicinity of Borings 2/2A, 7 and 11. Extreme caution should be practiced during the dewatering operation if nearby structures or utilities are sensitive to settlement. The removal of the unsuitable soils should be done in the presence of a qualified soils engineer to ensure that no uncontrolled fill or highly organic soils are left behind before the placement of the engineered fill. After the unsuitable soils have been removed, the excavation should be backfilled with compacted bank run sand similar to MDOT Type I or II granular soils. If the bottom of the excavation is not sufficiently stable to install the bank run sand, then a layer of coarse stone fill such as MDOT 6AA could be installed. Geotextile fabric should be placed between the coarse stone engineered fill material and lower native granular soils and upper granular engineered fill materials to minimize the amount of fines infiltrating into the aggregate material. The granular MDOT Type I or II soil should be deposited in horizontal lifts not to exceed nine inches (9") in thickness with each lift being compacted uniformly to a minimum density of 95% of its maximum value as determined by the Modified Proctor Test (AASHTO T-180 or ASTM D-1557). Engineered fill should be placed and compacted up to footing and floor invert elevations.

One-inch by three-inch (1" x 3") size crushed stone or crushed concrete could be used in lieu of the MDOT Type 6AA aggregate and bank run sand that we recommended above. The crushed material would need to be placed and compacted in lifts not exceeding nine inches (9") up to about one foot (1') below the planned structures' footings and floor slabs. About a one-foot (1') thick layer of MDOT 21AA dense aggregate could then be placed above the crushed material in an effort to choke off the stone. The crushed stone or crushed concrete material should not contain significant amounts of brick and should be relatively clean of lime or cement dust which could potentially foul up or clog the drain tiles. We suggest that the brick content should be less than 5% and cement/lime dust should be less than 3%. The large crushed material will need to be separated from the existing site granular soils by a geotextile fabric. We suggest that a Mirafi 500 type fabric or equivalent be placed along the bottom and sides of the engineered fill excavation in an effort to minimize fines from migrating into the voids within the crushed material. It should be noted that the use of crushed concrete could cause problems for basements or below-grade drains and sump pumps. When water percolates through crushed concrete, the pH of the water can increase and minerals can precipitate out of the solution (mostly calcium salts and in some cases calcium hydroxide). Mineral deposits precipitating from the solution can shorten the life of sump pumps and plug drain tiles. High pH water can also corrode metal pipes. See AASHTO M 319-02 for discussion of these problems.

Foundations placed on the engineered fill material can be proportioned for a design soil pressure of three thousand pounds per square foot (3,000 psf) provided the design soil pressure is not limited by the strength of the underlying soils. All exterior footings should be constructed at or below a minimum frost penetration depth of three feet six inches (3'6") below finished grade.

If groundwater conditions are difficult to control, if excavations do not remain stable to allow the installation of footings or engineered fill, or if excavations are limited by site conditions, then an alternative foundation support system consisting of driven piles could be used to support the planned structures. It is anticipated that a Class B wood pile would realize the following allowable carrying capacities per foot of penetration:

<u>Borings</u>	<u>Depth</u>			<u>Allowable Supporting Capacity Per Foot of Penetration</u>
2/2A	18'0"	to	23'0"	½ Ton/Foot
	23'6"	to	27'0"	2 Tons/Foot
	27'6"	to	32'6"	1¼ Tons/Foot
	33'0"	to	35'0"	¾ Ton/Foot
3/3A	18'6"	to	23'0"	1 Ton/Foot
	23'6"	to	27'0"	1½ Tons/Foot
	27'6"	to	35'0"	¾ Ton/Foot

Based on the above chart, we would anticipate that piles driven to a depth of about twenty-seven feet (27') at these boring locations could develop an allowable carrying capacity of about 10

tons. If piles are driven to a depth of about thirty-three feet (33'), they could develop about 15 tons. Actual pile capacities must be evaluated in the field either through the use of a dynamic pile driving formula or static load test. Any resistance of fill soils or upper soft and loose soils should be subtracted when evaluating pile capacities as these soils should not be counted on to provide long-term support. If the existing fill soils are younger than about 15 years or if additional fill is planned to be placed over buried highly organic soils, then pile capacities should be reduced by a suitable negative friction value which could be large depending on the depth of the existing fill soils. Vibrations from the pile driving operation may be harmful to nearby buildings, structures or utilities.

As noted earlier, additional deep foundation systems could consist of auger cast piles, mini piles or helical-type piles. We understand that manufacturers who install these piles have qualified engineering staff who could help you. We understand that specialty contractors such as AA Spartan Specialties have experience in installing mini piles. Hardman Construction out of Ludington, Michigan installs auger cast piles. Kent Company and Calculus Foundations install helical piles. Finally, GeoPier Foundation Company installs rammed aggregate "stone column" geopiers. We have a concern that mini piles or helical piles could buckle in the soft and loose soils found in these borings.

As noted earlier, it appears that excavating and installing basements may be difficult to very difficult at many lots in this subdivision. Based on water conditions observed in the borings, it appears installing basements three feet (3') to six feet (6') below the existing ground surface will be very difficult at Borings 9, 10, 11 and 13. Installing basements six feet (6') to nine feet (9') below the existing ground surface will be difficult at Borings 4, 7 and 12. Excavating and maintaining dry basements below the long-term water table in the vicinity of these borings may be difficult. It is suggested that consideration be given to installing storm sewers at a sufficient depth in the vicinity of these borings so that auxiliary drains could be installed, if necessary, around or between houses to depress the water table. It would be prudent to gravity drain the footing drains to daylight if low grading permits it. Consideration should also be given to raising the grades for houses in these areas several feet above existing grade to facilitate the installation of basements. Also, raising the basement floors and lowering the brick ledges may be possible.

We typically recommend that basements be kept at least one foot (1') above the long-term groundwater levels. If the basements are constructed in close proximity to the groundwater level, then it is suggested that a fairly elaborate drainage system be provided. We suggest the following:

1. In order to lessen the possibility of soil fines affecting the perimeter drain system, it is recommended that exterior footing drains would be nominally four-inch (4") diameter slotted or perforated pipe wrapped with a filter sock. These would be embedded in at least four inches (4"), and preferably six inches (6"), of MDOT Specification 2NS sand. The 2NS sand should be maintained at a width of at least twelve inches (12") measured perpendicular to the walls and footings. The accompanying

Figure 1 depicts the recommended minimum cross-section requirements for the exterior drains. The accompanying Figure 2 depicts the gradation requirements for MDOT Specification 2NS sand.

2. Interior underfloor drains should be provided and should be nominally four-inch (4") diameter slotted or perforated pipe wrapped with a filter sock. These should be placed at ten-foot (10') to fifteen-foot (15') centers and along the inside of the footing. The drain tiles should be surrounded by about three inches (3") or four inches (4") of clean pea gravel. The pea gravel and wrapped drain tile should be underlain and enclosed by a punched non-woven geotextile such as Mirafi 140 or equivalent. Cleanouts should be provided for the underfloor drains. A good moisture barrier should be placed between the floor slab and pea gravel.
3. Note that under no circumstances are crushed concrete materials allowed since they have a tendency to clog/plug drain tiles and ruin sump pumps.
4. The drain tiles should be pitched downward toward the sumps so that standing water will not collect in the pipes.
5. The interior drain tiles should be connected to a second sump and pump which is capable of operating on backup power in case of power outages.
6. It would be preferable to provide an overflow connection between the two sumps as an additional precaution.

Silt soils were found at or near possible basement invert and footings elevations at Boring 4. Pure silt soils with relatively low blow counts above the site groundwater table could become unstable if water is allowed to saturate the silt, causing possible loss of bearing strength. It appears the silt soils found in this boring have good blow counts and are already saturated. Thus, these soils probably will not become unstable. However, this is not known for certain. The invert soils of excavations in the vicinity of this boring should be inspected by our field technicians to determine if pure silt soils are present. If moist silt is found in the excavations, then the silt should be protected from wetting even after the footings have been installed. Perimeter footing drain tiles should be installed and made operational immediately after the footings have been installed. Construction pumps and/or field drain tiles may be required before, during and after the installation of the footings to minimize any water collection in these excavations.

Concrete floors or floor-supporting backfill could be placed at or near the present grade in the vicinity of Borings 1, 6, 12 and 13. Any topsoil, organic soil, fill soil, soft or loose soil or other obviously objectionable material should be removed and the subgrade thoroughly proof-compacted with heavy, rubber-tired equipment. If during the proof-compaction operation areas

are found where the soils yield excessively, the yielding materials should be scarified, dried and recompacted or removed and replaced with engineered fill as outlined above.

Fill and possible fill soils were found in Borings 2/2A, 3/3A, 4, 5, and 7 through 10. If the possibility of more than normal differential movement can be tolerated, slab-on-grade floors or floor supporting backfill could be placed at or near the present grade in the vicinity of these borings. Any topsoil, organic soft, loose or other obviously objectionable material should be removed and the subgrade thoroughly proof-compacted with heavy, rubber-tired equipment. Buried topsoil found at Boring 3 should be removed in its entirety from planned structures at this location. If during the proof-compaction operation areas are found where the soils yield excessively, the yielding materials should be scarified, dried and recompacted or removed and replaced with engineered fill as outlined above.

If the possibility of more than normal differential movement cannot be tolerated, all existing fill material in the vicinity of these borings should be removed and replaced with engineered fill meeting the requirements outlined above or floor slabs should be structurally supported.

Highly organic peat and clay soils were found at Boring 11. These unacceptable soils should be removed in their entirety from structures, pavements, sidewalks and patio areas and replaced with engineered fill or these structures, pavements, sidewalks and patio area should be structurally supported.

If any existing structure foundations, slabs or buried utilities are encountered in planned structure areas, they should be entirely removed. In lawns, sidewalk or pavement areas any existing structure foundations should be removed to a minimum depth of three feet (3') below finished grade. The resulting excavations should be backfilled with engineered fill meeting the requirements outlined above. If any existing basement floors are found outside of proposed structures, then they can remain but should be broken up.

Significant dewatering may be needed to install utilities in the vicinity of most of the borings depending on the depth of the utilities.

Moisture contents greater than 20% were found in shallow soils at Boring 2. High moistures may tend to make these soils unstable under vehicular loading. During periods of wet weather in the spring and fall, these soils could rut and pump under construction traffic. Undercutting and compacted crushed stone may be required in various areas to stabilize subgrades or entail the complete removal of these soils. Edge drains should be installed in shallow groundwater areas, such as possibly in the vicinity of Borings 8, 9 and 11.

Experience indicates that the actual subsoil conditions at the site could vary from those found at the test borings made at specific locations. It is, therefore, essential that McDowell & Associates be notified of any variation of soil conditions to determine their effects on the recommendations presented in this report. The evaluations and recommendations presented in this report have been formulated on the basis of reported or assumed data relating to the proposed project. Any



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LOG OF SOIL BORING NO. 1

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist dark brown sandy TOPSOIL						
A	2	1'5"	Medium compact moist brown fine SAND with traces of silt and gravel	2					
UL	3	2'2"	Firm moist brown sandy CLAY with sand and pebbles	3	14.6	131	*	(2000)	
	4	3'6"							
B	5		Firm moist brown silty CLAY with sand and pebbles and occasional moist fine sand seams	2	16.3	124	*	(1500)	
UL	6			3					
	7								
C	8	7'0"		3					
UL	9			4	17.3	129	*	(2500)	
	10		Stiff moist brown silty CLAY with sand and pebbles	5					
D	11			6					
UL	12			6					
	13			8					
	14	12'6"							
E	15		Very compact moist brown fine to medium SAND with trace of gravel	6					
UL	16			10					
	17	16'0"		10					
	18								
	19		Extremely compact moist brown medium SAND and GRAVEL						
F	20			15					
UL	21	20'6"		20					
	22								
	23								
	24								
	25								

NOTE: Used track rig

<p>TYPE OF SAMPLE D. - DISTURBED U.L. - UNDIST. LINER S.T. - SHELBY TUBE S.S. - SPLIT SPOON R.C. - ROCK CORE () - PENETROMETER</p>	<p>REMARKS: *Calibrated Penetrometer</p> <p>Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals</p>	<p>GROUND WATER OBSERVATIONS</p> <p>G.W. ENCOUNTERED AT _____ FT. INS. G.W. ENCOUNTERED AT _____ FT. INS. G.W. AFTER COMPLETION _____ FT. None INS. G.W. AFTER _____ HRS. FT. INS. G.W. VOLUMES _____</p>
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LOG OF SOIL BORING NO. 2

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			0'4" Moist dark brown sandy TOPSOIL, fill						
	1		1'0" Broken CONCRETE, fill						
A UL	2		Medium compact moist brown fine SAND with trace of gravel, possible fill	2					
	3			2	11.2	120			
				3					
	4		3'3" Soft moist brown silty CLAY with sand and pebbles and moist fine sand seams						
B UL	5			2					
				2	20.5	124			
	6		6'0" Stiff moist brown silty CLAY with sand and pebbles and moist fine sand seams						
C UL	7								
				4					
	8		8'6" Stiff moist variegated silty CLAY with sand and pebbles	6					
	9			7					
D UL	10								
	11		12'4" Very loose wet brown fine to medium SAND with trace of silt	4					
	12			5	17.0	131			
	13			7				*	(3500)
	14		18'0" Compact wet brown fine to medium SAND with trace of gravel and occasional stones						
E UL	15			W.o.H.**	20.1	123			
	16								
	17		20'6" Note: Used track rig.						
	18								
	19								
F UL	20			8					
	21			3					
	22			5					
	23								
	24								
	25								

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer
 **Weight of Hammer.

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 12 FT. 4 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION 13 FT. 7 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Medium - Heavy



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LOG OF SOIL BORING NO. 2A

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION Proposed 37-Acre Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-18-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
	11								
	12								
	13		12'6"						
	14								
A	15		Very loose wet fine to medium SAND with traces of silt and gravel	W.o.H.**	24.8				
SS	16								
	17								
	18		18'0"						
	19								
B	20		Compact wet brown fine to medium SAND with trace of gravel and occasional sand and gravel seams	1					
SS	21			4	14.9				
	22			7					
	23								
	24		23'0"						
C	25		Very compact wet brown SAND & GRAVEL with wet sand seams	6					
SS				8					
				9					

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: ****Weight of Hammer**

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 12 FT. 4 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION FT. INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Wash Boring



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LOG OF SOIL
 BORING NO. 2A cont.

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION Proposed 37-Acre Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-18-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %	
	26		Very compact wet brown SAND & GRAVEL with wet sand seams							
	27									
	28									
	29									
	30									
D SS	30		Compact wet gray SAND & GRAVEL with occasional stones	3						
	31			5						
	32			6						
	33									
	34									
	34		Compact wet gray fine SAND							
E SS	35		Stiff moist blue silty CLAY with sand and pebbles	3						
	36			4						
	37			4						
	38									
	39									
	40		Notes:							
	41		1) Boring located 3' west of Boring 2.							
	42		2) Drilled to 15' and started sampling. Advanced boring with rotary drilling methods using bentonite slurry.							
	43		3) Used automatic hammer.							
	44									
	45									
	46									
	47									
	48									
	49									
	50									

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 12 FT. 4 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION FT. INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Wash Boring



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LOG OF SOIL BORING NO. 3

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist brown fine SAND with trace of gravel, and topsoil streaks, fill						
A UL	2	1'8"	Stiff moist dark brown clayey TOPSOIL with vegetation, sand and pebbles, and moist fine sand lenses, fill	2					
	3	2'5"		6	15.7	133			
		3'2"	Stiff moist discolored brown silty CLAY with sand and pebbles and trace of vegetation, fill	9			*	(4500)	
	4	3'6"							
B UL	5		Compact moist brown clayey fine SAND with trace of gravel, fill	3					
			Stiff moist brown silty CLAY with sand and pebbles, moist fine sand lenses, occasional discolored brown silty clay seams, fill	7	13.7	137			
	6			9			*	(5500)	
		6'4"							
C UL	7		Very stiff moist brown silty CLAY with traces of sand and pebbles, and moist fine sand and silt lenses	6					
	8			9					
		8'3"		10					
	9	8'7"	Compact moist brown fine SAND						
D UL	10								
			Compact moist brown fine to medium SAND with trace of gravel and moist fine sand seams	4					
	11			4	3.0	113			
				6					
	12								
	13								
		13'0"							
E UL	14								
	15		Slightly compact wet brown SILT & fine SAND with moist clayey silt lenses	1	18.4				
	16			1					
				2					
	17								
	18								
		18'6"							
F UL	19		Compact wet gray fine to medium SAND with trace of gravel	4					
	20			6					
		20'6"		7					
	21								
	22								
	23		Note: Used track rig.						
	24								
	25								

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 13 FT. 0 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION 13 FT. 5 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Medium - Heavy



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LOG OF SOIL BORING NO. 3A

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION Proposed 37-Acre Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-18-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
A	10	SS	9'0"	2					
	11		Medium compact moist brown fine to medium SAND with trace of gravel and moist fine sand lenses	3	15.6				
	12			4					
	13								
	14		13'0"						
B	15	SS		1					
	16		Slightly compact wet brown SILT & fine SAND with moist variegated silty clay seams	1	24.2				
	17			1					
	18								
	19		18'6"						
C	20	SS		2					
	21		Compact wet gray fine to medium SAND with trace of gravel	4	15.0				
	22			5					
	23								
	24		23'0"						
D	25	SS		4					
			Very compact wet gray fine to medium SAND with trace of gravel	6					
				7					

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 13 FT. 0 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION FT. INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Wash Boring



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LOG OF SOIL
 BORING NO. 3A cont.

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION Proposed 37-Acre Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-18-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	26		Very compact wet gray fine to medium SAND with trace of gravel						
	27			27'0"					
	28		Compact wet gray SAND & GRAVEL						
	29			30'0"					
D SS	30				4				
	31		Compact wet gray fine SAND with trace of silt						
	32				4				
	33				4				
	34								
E SS	35		34'6"	6					
	36		35'0"	4					
	37		35'6"	4					
	38		Stiff moist blue silty CLAY with traces of sand and pebbles						
	39								
	40								
	41								
	42								
	43								
	44								
	45								
	46								
	47								
	48								
	49								
	50								

- Notes:
- 1) Boring located 14' north of Boring 3.
 - 2) Drilled to 15' and started sampling. Advanced boring with rotary drilling methods using bentonite slurry.
 - 3) Used automatic hammer.

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS:
 Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS
 G.W. ENCOUNTERED AT 13 FT. 9 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION FT. INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Wash Boring



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LOG OF SOIL
 BORING NO. 4

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		0'3" Moist dark brown clayey TOPSOIL, fill						
A	2		Stiff moist brown silty CLAY with sand and pebbles, occasional discolored brown silty clay seams, fill	4	11.8	132	*	(4000)	
UL	3			5					
	4			9					
B	5		3'8" Stiff moist variegated silty CLAY with sand and pebbles	4	12.2	138	*	(4500)	
UL	6			7					
	7			8					
C	8		6'0" Very stiff moist brown silty CLAY with traces of sand and pebbles and moist fine sand lenses	4					
UL	9			10					
	10			10					
D	11		9'0" Extremely compact wet brown and gray SILT	9	21.1	124			
UL	12			12					
	13			16					
	14		12'0" Very compact wet brown fine to medium SAND with trace of gravel, and occasional moist clay seams						
	15								
	16								
E	17		14'2" Very stiff moist blue silty CLAY	4					
UL	18			5					
	19			18					
	20		15'5" Very compact wet brown SAND and GRAVEL						
	21								
	22								
F	23		18'0" Extremely compact wet gray SAND and GRAVEL with occasional stones	12					
UL	24			14					
	25			16					

Notes:
 1) Used track rig.
 2) Installed 1½" diameter PVC piezometer in boring with screen bottom at 10' and 3' stick up.

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer
 Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30". Count Made at 6" Intervals

GROUND WATER OBSERVATIONS
 G.W. ENCOUNTERED AT 9 FT. 2 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION 5 FT. 8 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Heavy



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LOG OF SOIL BORING NO. 5

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		0'4" Moist dark brown clayey TOPSOIL with trace of gravel, fill						
A	2		Stiff moist brown silty CLAY with sand and pebbles, moist fine sand seams and occasional topsoil streaks, fill	3					
UL	3	4		11.2					
	4	4		*	(9000+)				
B	5		3'6" Stiff moist brown silty CLAY with sand and pebbles and discolored brown clay streaks, fill	5					
UL	6	5		12.3	129				
	7	5		*	(2500)				
C	7		6'3" Compact wet brown fine SAND						
UL	8	6'7"							
	9		Stiff moist variegated silty CLAY with sand and pebbles	5					
	10			8	13.6	136			
D	11			8	*	(6000)			
UL	12		9'6" Very stiff moist brown silty CLAY with traces of sand and pebbles and wet fine sand lenses	5					
	13			9					
	14			10					
E	15		14'2" Extremely compact wet brown clayey SILT	8					
UL	16	14'7"		13					
	17			19					
	18		Extremely compact wet gray fine SAND with trace of gravel						
	19								
F	20			18'0" Stiff moist blue silty CLAY with sand and pebbles	4				
UL	21			7					
	22			9					
	23		20'6"						
	24								
	25								

- Notes:
- Used track rig.
 - Installed 1 1/2" diameter PVC piezometer in boring with screen bottom at 10' and 3' stick up.

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 6 FT. 3 INS.
 G.W. ENCOUNTERED AT 9 FT. 7 INS.
 G.W. AFTER COMPLETION 8 FT. 3 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Heavy



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LOG OF SOIL BORING NO. 6

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-18-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			0'5" Moist dark brown clayey TOPSOIL						
	1								
A	2		1'6" Moist brown silty CLAY with sand and pebbles and moist silt lenses	7					
UL				9					
	3		2'10" Extremely stiff moist variegated silty CLAY with sand and pebbles	9					
	4								
B	5		Very compact moist brown fine to medium SAND	5	6.4	132			
UL				7					
	6			9					
	7		6'0" Stiff moist brown silty CLAY with little sand and pebbles						
C	8			2					
UL				3	14.9				
	9		7'6" Compact moist brown SILT & SAND with trace of gravel	5					
	10								
D	11		9'8" Compact wet gray fine SAND with trace of silt	2					
UL				4	19.7				
	12			6					
	13		11'0" Stiff moist blue silty CLAY with traces of sand and pebbles						
	14								
E	15		14'6" Very compact wet brown fine SAND	4					
UL				6	22.1				
	16			7					
	17								
	18		17'6" Very compact wet brown SAND & GRAVEL						
	19								
F	20			6					
UL				7					
	21		20'6" Note: Used automatic hammer.	8					
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS:
 Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS
 G.W. ENCOUNTERED AT 9 FT. 8 INS.
 G.W. ENCOUNTERED AT 14 FT. 6 INS.
 G.W. AFTER COMPLETION 13 FT. 11 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Medium - Heavy



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LOG OF SOIL BORING NO. 7

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-17-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist discolored brown silty CLAY with traces of topsoil and vegetation, fill						
A UL	2		Stiff moist brown sandy CLAY with discolored brown streaks, fill	5					
	3			7	8.6	135			
	4			8			*	(4000)	
B UL	5		Firm moist discolored brown to dark brown sandy CLAY with topsoil, pebbles and vegetation and moist to wet discolored brown sand seams, fill	2					
	6			3	15.3	125			
	7			3			*	(2000)	
C UL	8		Stiff moist discolored brown silty CLAY with sand, pebbles and vegetation, wet discolored brown fine sand seams and topsoil streaks, fill	2					
	9			4	12.8	136			
	10			8			*	(3500)	
D UL	11		Extremely compact wet discolored brown fine to medium SAND with topsoil and trace of clay, fill	10					
	12			15	11.6	137			
	13			19			*	(6000)	
E UL	14		Stiff moist variegated sandy CLAY with moist to wet brown sand seams	4					
	15			6	18.1	123			
	16			6			*	(3500)	
F UL	17		Extremely stiff moist brown silty CLAY with sand and pebbles and wet brown sand seams						
	18			7					
	19			12					
	20			18					
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 4 FT. 6 INS.
 G.W. ENCOUNTERED AT 8 FT. 6 INS.
 G.W. AFTER COMPLETION 18 FT. 0 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Light - Medium



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LOG OF SOIL BORING NO. 8

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
Welch and Maple Roads
Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-17-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist discolored brown silty CLAY with trace of topsoil, fill						
			Wet brown fine SAND with trace of clay, fill						
A UL	2		Stiff moist brown silty CLAY with moist brown fine to medium sand seams and moist dark brown topsoil lenses, fill	7 5 4	14.1	121	*	(2500)	
	3								
	4								
B UL	5		Very stiff moist variegated silty CLAY with sand and pebbles	7 11 13	11.0		*	(6000)	
	6								
C UL	7								
	8		Extremely compact moist brown fine to medium SAND	7 11 34					
	9								
D UL	10		Extremely stiff variegated silty CLAY with sand and pebbles and moist sand seams	6 7 12					
	11								
	12								
	13								
	14								
E UL	15		Extremely compact wet brown fine to medium SAND with moist blue silty clay seams	10 18 12					
	16								
	17								
	18								
	19								
F UL	20		Extremely compact wet brown fine to medium SAND	26 26 25					
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 1 FT. 0 INS.
 G.W. ENCOUNTERED AT 14 FT. 0 INS.
 G.W. AFTER COMPLETION 15 FT. 3 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Light - Medium



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LOG OF SOIL BORING NO. 9

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-17-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist discolored brown silty CLAY with trace of topsoil, fill						
A UL	2		Soft moist brown sandy CLAY with wet brown fine sand seams and trace of vegetation, fill	1					
	3			2	17.7	129			
	4			2			*	(1000)	
B UL	5		Compact wet brown fine to medium SAND	3					
	6			5	15.1	135			
	7			9			*	(4500)	
C UL	8		Stiff moist brown silty clay with sand and pebbles	5					
	9			8	12.3	140			
	10			9			*	(6000)	
D UL	11			9					
	12			14					
	13			21					
E UL	14		Very compact wet gray fine SAND with moist blue clay seams	6					
	15			10					
	16			10					
	17								
	18		Extremely compact wet fine to medium SAND with trace of gravel						
F UL	19			7					
	20			22					
	21		21						
	22								
	23								
	24								
	25								

Note: Moved 3' west of boring, redrilled to 10' and installed 1½ diameter PVC piezometer with screen bottom at 10' and 3' stickup.

<p>TYPE OF SAMPLE D. - DISTURBED U.L. - UNDIST. LINER S.T. - SHELBY TUBE S.S. - SPLIT SPOON R.C. - ROCK CORE () - PENETROMETER</p>	<p>REMARKS: *Calibrated Penetrometer</p> <p>Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30". Count Made at 6" Intervals</p>	<p>GROUND WATER OBSERVATIONS</p> <p>G.W. ENCOUNTERED AT 2 FT. 0 INS. G.W. ENCOUNTERED AT 9 FT. 6 INS. G.W. AFTER COMPLETION 4 FT. 8 INS. G.W. AFTER HRS. FT. INS. G.W. VOLUMES Heavy</p>
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LOG OF SOIL
 BORING NO. 10

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist discolored brown silty CLAY with some topsoil, fill						
A	2		Very stiff moist brown silty CLAY with sand and pebbles	6	11.0	142	*	(5000)	
UL	3			7					
	4			10					
B	5		Extremely compact wet brown SAND and GRAVEL with occasional stone	20	8.7	125			
UL	6			26					
	7			--					
C	8		Very stiff moist variegated sandy CLAY with pebbles	7	10.2	139			
UL	9			8					
	10			16					
D	11		Very compact wet brown fine to medium SAND	6	16.6	130			
UL	12			7					
	13			10					
	14		Extremely stiff moist blue silty CLAY						
E	15			14					
UL	16			15					
	17		Extremely compact wet brown fine to medium SAND with trace of gravel and occasional stones	23					
	18								
	19								
F	20		Very compact wet brown SAND and GRAVEL						
UL	21			10					
	22			13					
	23		Very compact wet gray fine to medium SAND	12					
	24								
	25								

Note: Moved 3' east of boring, redrilled to 10' and installed 1½" diameter PVC piezometer with screen bottom at 10' and 3' stick up.

- TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 4 FT. 0 INS.
 G.W. ENCOUNTERED AT 9 FT. 0 INS.
 G.W. AFTER COMPLETION 4 FT. 0 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Heavy



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LOG OF SOIL BORING NO. 11

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist discolored brown fine to medium SAND with vegetation and traces of clay and topsoil, fill						
A UL	2		Very compact moist discolored brown clayey fine to medium SAND with dark brown streaks and wet sand seams, fill	9					
	3			10	9.9	135			
				7					
	4		Moist dark brown clayey PEAT						
B UL	5			2					
	6			3	30.5	109			
			Firm moist dark brown organic silty CLAY with wet gray fine sand seams	3					
	7								
C UL	8			10					
			Very compact wet brownish gray fine to medium SAND with traces of silt and gravel	12	15.0	129			
	9			13					
D UL	10			13					
			Extremely compact wet brown fine to medium SAND with trace of gravel	26					
	11			30					
	12								
			Extremely stiff moist brown silty CLAY						
	13								
	14								
E UL	15		Extremely stiff moist blue silty CLAY with sand and pebbles, wet gray fine sand seams and occasional stones	12					
	16			13					
				24					
	17		Very compact wet gray fine to medium SAND						
	18								
F UL	20			8					
			Note: Moved 3' north of boring, redrilled to 10' and installed 1½" diameter PVC piezometer with screen bottom at 10' and 3' stick up.	8					
	21			11					
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 2 FT. 0 INS.
 G.W. ENCOUNTERED AT 5 FT. 0 INS.
 G.W. AFTER COMPLETION 3 FT. 8 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Heavy



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LOG OF SOIL BORING NO. 12

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
 Welch and Maple Roads
 Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist dark brown clayey TOPSOIL with sand and pebbles and vegetation						
A UL	2		Very stiff moist brown silty CLAY with sand and pebbles, occasional stones and moist brown fine to medium sand seams	6					
	3			10	10.6	132			
				12			*	(7000)	
B UL	4		Very compact moist brown fine to medium SAND with trace of gravel	8					
	5			11	4.4	109			
	6			12					
C UL	7		Very compact moist brown fine to medium SAND	8					
	8			9	4.6	110			
	9			10					
D UL	10		Extremely compact wet brown gravelly SAND with trace of silt	10					
	11			18	9.2				
	12			15					
E UL	14		Very compact wet brown fine to medium SAND with trace of gravel and occasional stones	9					
	15			10					
	16			10					
F UL	17		Extremely compact wet brown fine to medium SAND						
	18								
	19								
	20			10					
	21			15					
	22			18					
	23								
	24								
	25								

Note: Moved 3' south of boring, redrilled to 10' and installed 1 1/2" diameter PVC piezometer with screen bottom at 10' and 3' stick up.

- TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1" With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 9 FT. 0 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION 8 FT. 5 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Heavy Cave-in at 8'5"



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LOG OF SOIL BORING NO. 13

PROJECT Soils Investigation

JOB NO. 18-155

LOCATION 37 Acres Subdivision
Welch and Maple Roads
Commerce Township, Michigan

SURFACE ELEV. _____ DATE 5-16-18

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist dark brown clayey TOPSOIL with sand and pebbles and vegetation						
A	2	[Hatched Pattern]	Stiff moist brown silty CLAY with sand and pebbles and moist fine sand seams	4	12.0	138	*	(3000)	
UL	3			5					
	4			6					
	5								
B	5	[Dotted Pattern]	Compact wet brown fine to medium SAND	2	16.3	120			
UL	6			3					
	7			5					
	8								
C	7	[Dotted Pattern]	Very compact wet brown gravelly SAND with trace of silt	6	9.2	131			
UL	8			10					
	9			13					
	10								
D	10	[Dotted Pattern]	Extremely compact wet brown fine to medium SAND with trace of pebbles and occasional moist sandy clay lenses	11					
UL	11			13					
	12			15					
	13								
E	14	[Dotted Pattern]	Compact wet brown fine to medium SAND	7					
UL	15			6					
	16			7					
	17								
	18	[Dotted Pattern]	Compact wet brown fine SAND with traces of silt and gravel						
	19			4					
F	20			5					
UL	21			6					
	22								
	23								
	24		Note: Moved 3' west of boring, redrilled to 10' and installed 1½" diameter PVC piezometer with screen bottom at 10' and 3' stick up.						
	25								

TYPE OF SAMPLE
 D. - DISTURBED
 U.L. - UNDIST. LINER
 S.T. - SHELBY TUBE
 S.S. - SPLIT SPOON
 R.C. - ROCK CORE
 () - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With
 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 5 FT. 0 INS.
 G.W. ENCOUNTERED AT FT. INS.
 G.W. AFTER COMPLETION 5 FT. 8 INS.
 G.W. AFTER HRS. FT. INS.
 G.W. VOLUMES Heavy

SIEVE ANALYSIS

Boring	Sample	% Passing #4 Sieve	% Passing #10 Sieve	% Passing #40 Sieve	% Passing #100 Sieve	% Passing #200 Sieve
2	E	99.6	97.3	81.5	12.0	6.1
2A	A	98.2	95.3	41.1	15.2	12.1
3	E	100.0	100.0	99.3	57.4	33.5
3A	B	100.0	100.0	100.0	93.1	57.3
4	D	100.0	100.0	100.0	92.1	72.2
6	C	95.3	87.8	72.9	44.0	34.6
11	C	98.6	95.8	78.3	25.8	10.1
12	D	70.8	55.7	31.6	14.0	10.8
13	C	74.3	53.0	23.2	11.3	8.7

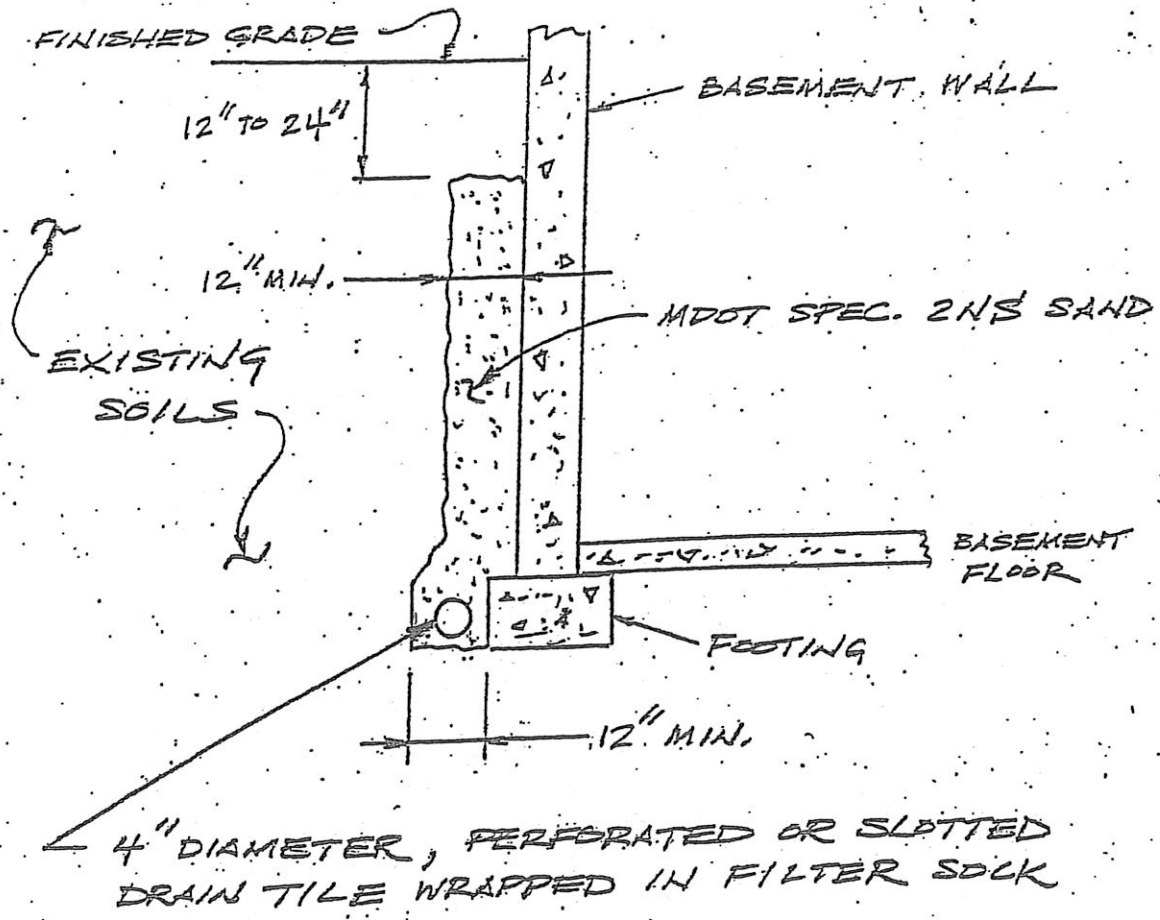


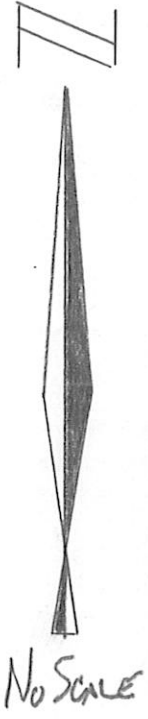
FIGURE 1 - CROSS SECTION EXTERIOR DRAIN

Table 902.4 Grading Requirements for Fine Aggregates

Material	Sieve Analysis (MTM 109) Total % Passing (a)										Loss by Washing % Passing No. 200 (a)(b)	Fineness Modulus Variation (c)
	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100					
k	100	95-100	65-95	35-75	20-55	10-30	0-10	0-3.0	±0.20 (d)			
2SS (e)	100	95-100	65-95	35-75	20-55	10-30	0-10	0-4.0	±0.20 (d)			
2MS		100	95-100			15-40	0-10	0-3.0	±0.20 (d)			
2FA (f)	100	90-100	65-90	45-70	30-50	18-30	10-21	5-15 (g)				
3FA (f)	100	70-90	45-70	28-50	19-34	12-25	7-18	5-15 (g)				

a. Test results based on dry weights.
 b. Use test method MTM 108 for Loss by Washing.
 c. Aggregate having a fineness modulus differing from the base fineness modulus of the source by the amount exceeding the maximum variation specified in the table will be rejected. Use ASTM C 136.
 d. The base fineness modulus will be supplied by the aggregate producer at the start of each construction season and be within the range of 2.50-3.35. The base FM, including the permissible variation, will be within the 2.50-3.35 range.
 e. Not for any application subject to vehicular traffic.
 f. Gradation represents the final blended product.
 g. The limits for Loss by Washing of Fine Aggregates, 2FA and 3FA are significant to the nearest whole percent.

Figure 2 - MDOT Specification 2NS Sand



Soil Boring Location Plan

#18-155