Report of Geotechnical Engineering Investigation
Houchens Industries
5502 Billtown Road
Louisville, Kentucky
Patriot Project No. 05-15-1742

Prepared For:

Arnold Consulting Engineering Services
2125 P.O. Box 1338
Bowling Green, Kentucky 42101

Attention: Mr. Brian Shirley, RLA

Prepared By:

Patriot Engineering and Environmental, Inc.
400 Production Court
Louisville, Kentucky 40299

December 9, 2015

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

December 9, 2015

Arnold Consulting Engineering Services
2125 P.O. Box 1338
Bowling Green, Kentucky 42101

Attention: Mr. Brian Shirley, RLA

Re: Report of Geotechnical Engineering Investigation
Houchens Industries
5502 Billtown Road
Louisville, Kentucky
Patriot Project No. 05-15-1742

Dear Brian:

Attached is the report of our subsurface investigation for the above referenced project. This investigation was completed in general accordance with our Proposal No. PLG15-0079 dated November 16, 2015.

This report includes detailed and graphic logs of eight (8) soil borings drilled at the proposed project site. Also included in the report are the results of laboratory tests performed on samples obtained from the site, and geotechnical recommendations pertinent to the site development, foundation design, and construction.

We appreciate the opportunity to perform this geotechnical engineering investigation and are looking forward to working with you during the construction phase of the project. If you have any questions regarding this report or if we may be of any additional assistance regarding any geotechnical aspect of the project, please do not hesitate to contact our office.

Respectfully submitted,
Patriot Engineering and Environmental, Inc.

Jamie M. Coffman

Jamie M. Coffman, E.I.
Geotechnical Engineer

Wesley J. Hemp, P.E., LEED AP
Director, Louisville Geotechnical Services

STATE OF KENTUCKY
WESLEY J. HEMP
25731
LICENSED
PROFESSIONAL ENGINEER

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15 ZONE 1059

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REPORT OF GEOTECHNICAL ENGINEERING INVESTIGATION

Houchens Industries
5502 Billtown Road
Louisville, Kentucky
Patriot Project No.: 05-15-1742

1.0 INTRODUCTION

1.1 General

Arnold Consulting Engineering Services is planning the construction of a new Houchens Industries facility in Louisville, Kentucky. The results of our geotechnical engineering investigation for the project are presented in this report.

1.2 Purpose and Scope

The purpose of this investigation was to determine the general near surface and subsurface conditions within the project area and to develop the geotechnical engineering recommendations necessary for the design and construction of the proposed facility. This was achieved by drilling soil borings, and by conducting laboratory tests on samples taken from the borings within the project area. This report contains the results of our findings, an engineering interpretation of these results with respect to the available project information, and recommendations to aid in the design and construction of the proposed facility.

2.0 PROJECT INFORMATION

The project includes the development of a new Houchens Industries facility located at 5502 Billtown Road in Louisville, Kentucky. We understand that the proposed facility will be located in an approximately two (2)-acre lot on the south side of the Lovers Lane and Billtown Road intersection. The proposed site plan indicates that the proposed construction will include a new high one (1)-story facility of slab-on-grade construction having an approximate building footprint of 14,000 to 15,000 square feet (ft^2). We additionally understand that the facility will include drives, parking, and loading docks.

Structural data for the proposed facility were not provided to *Patriot* at the time that this report was written. Therefore, we have assumed that the proposed structure will have wall loads not exceeding 3,000 pounds per lineal feet (plf), isolated column loads not exceeding 150 kips, and that floor loads will not exceed 250 pounds per square foot (psf). It is also assumed that any grade raise building pad fill will not exceed 2 feet above the existing ground surface.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Conditions

The project site is currently an undeveloped grass and tree covered lot located on immediately to the south of the intersection of Billtown Road and Lovers Lane. The surrounding area is generally an area of residential and commercial developments. The topography in the area proposed for construction is relatively flat and poorly drained. The ground surface was very soft at the time of our investigation

3.2 General Site Geology

Information pertaining to soil characteristics in the project area was obtained through the Kentucky Geological Survey and experience with previous geotechnical investigations in the area.

The project site is located in the Blue Grass Physiographic Region, in the Outer Bluegrass Area. Bedrock underlying the site is Silurian Age limestone and dolomite of the Louisville Limestone Formation. The dolomitic limestone tends to be yellowish gray to light olive gray, very fine-grained and very thin to thinly bedded in the upper portion to more thickly bedded in the lower portion. The formation is generally considered to be karstic, meaning that development of sinkholes and other solution features have been documented within this formation.

3.3 Subsurface Conditions

Our interpretation of the subsurface conditions is based upon eight (8) soil borings drilled at the approximate locations shown on the Boring Location Map (Figure No. 2) in Appendix A. The following discussion is general; for more specific information, please refer to the boring logs presented in Appendix A. It should be noted that the dashed stratification lines shown on the soil boring logs indicate approximate transitions between soil types. In-situ stratification changes could occur gradually or at different depths. All depths discussed below refer to depths below the existing ground surface.

Seven (7) of the borings were drilled in areas covered with topsoil, a surficial layer of material that is a blend of silts, sands, and clays, with varying amounts of organic matter. The topsoil layer was 3 to 9 inches thick at the boring locations. One (1) soil boring (Boring B-8) was drilled in an area covered with asphalt. The asphalt was 4 inches thick in the boring.

Brown medium stiff to very stiff silty clay (CL) was encountered at depths just underlying the surficial layer and extended to depths of 3.5 to 6 feet below the existing ground surface in Borings B-1, B-3, B-4, B-5, B-6, B-7, and B-8. The natural moisture content of the silty clay soil ranges from 15 to 24 percent (%), with an average of about 21 percent (%). The silty clay soil layer has unconfined compressive strengths, as determined by a hand penetrometer, of 1.0 to 4.0 tons per square foot (tsf). Standard Penetration Test N-values in this material varied from 8 to 25 bpf, with an average of about 13 bpf.

The silty clay layer was primarily underlain by orangish to reddish brown, stiff to very stiff plastic clay (CH) which was encountered at various depths throughout the borings until the termination depth, 14 to 17 feet below the existing ground surface. The natural moisture content of the plastic clay soil ranges from 19 to 39 percent (%), with an average of about 25 percent (%). The plastic clay soil layer has unconfined compressive strengths, as determined by a hand penetrometer, of 1.0 to greater than 4.5 tons per square foot (tsf). Standard Penetration Test N-values (blow counts) in this material varied from 9 to 17 blows per foot (bpf), with an average of about 13 bpf.

Finally, tan medium dense to very dense silty sand (SM) was encountered in Borings B-1, B-2, and B-6 around the termination depths of the borings, just before encountering auger refusal. The Standard Penetration Test N-values in this sand were all greater than 50 bpf.

The following table presents the depths in which auger refusal occurred in each of the borings:

TABLE 1. SUMMARY OF AUGER REFUSAL IN BORINGS

Boring No.	Approximate Depth of Auger Refusal* (feet)
B-1	14
B-2	14
B-3	16
B-4	17
B-5	17
B-6	17
B-7	17
B-8	17

Note: * - Depth below existing ground surface at borings.

3.4 Groundwater Conditions

The term groundwater pertains to any water that percolates through the soil found on site. This includes any overland flow that permeates through a given depth of soil, perched water, and water that occurs below the "water table", a zone that remains saturated and water-bearing year round.

Groundwater was observed during drilling in six (6) of the eight (8) borings at depths ranging from 14 to 17 feet below the existing ground surface. Immediately after the borings were completed and the augers were removed from the boreholes, groundwater was observed in six (6) of the eight (8) borings at depths ranging from 10 to 14 feet below the existing ground surface. Refer to the table below for more information in regards to groundwater depths.

TABLE 2. SUMMARY OF GROUNDWATER TABLE DEPTHS BELOW EXISTING GRADE

Boring No.	Encountered Groundwater Table Depth Below Existing Grade (feet)	
	During Drilling	After Drilling
B-1	NE	10
B-2	14	10
B-3	16	13
B-4	17	NE
B-5	17	10
B-6	17	14
B-7	NE	NE
B-8	17	12

Note: NE = Not Encountered

It should be recognized that fluctuations in the groundwater level should be expected over time due to variations in rainfall and other environmental or physical factors. ***The true static groundwater level can only be determined through observations made in cased holes over a long period of time, the installation of which was beyond the scope of this investigation.***

4.0 DESIGN RECOMMENDATIONS

4.1 Basis

Our recommendations are based on data presented in this report, which include soil borings, laboratory testing and our experience with similar projects. Subsurface variations that may not be indicated by a dispersive exploratory boring program can exist on any site. If such variations or unexpected conditions are encountered during construction, or if the project information is incorrect or changed, we should be informed immediately since the validity of our recommendations may be affected.

4.2 Foundations

Five (5) soil borings (B-1, B-2, B-3, B-5, & B-6) were drilled in areas of the proposed building. The proposed building facility can be supported on shallow spread footings bearing on medium stiff to very stiff silty clay or new well compacted structural fill overlying the same. These footings should be proportioned using a net allowable soil bearing pressure not exceeding 2,500 pounds per square foot (psf) for column footings or 2,000 psf for strip (wall) footings.

Please note that foundations should not be supported directly on the high plasticity clay soil (CH) similar to that encountered in the all of the borings drilled on site. These plastic clays have the potential to undergo relatively large shrink-swell with moisture fluctuations. Therefore, we recommend these soils be undercut at least 2 feet below the proposed foundation bearing elevation and backfilled with approved structural fill, if encountered below bearing depths.

For proper performance at the recommended bearing pressure, foundations must be constructed in compliance with the recommendations for footing excavation inspection that are discussed in Section 5.0 "*Construction Considerations*".

In using the above net allowable soil bearing pressure, the weight of the foundation and backfill over the foundation need not be considered. Hence, only loads applied at or above the minimum finished grade adjacent to the footing need to be used for dimensioning the foundations.

All exterior foundations and foundations in unheated areas should be located at a depth of at least 24 inches below final exterior grade for frost protection. However, interior foundations in heated areas can bear at depths of approximately 24 inches below the finished floor. Additionally, for bearing capacity considerations, we recommend that strip footings be at least 18 inches wide and column footings be at least 24 inches wide for bearing capacity considerations.

We estimate that the total foundation settlement should not exceed approximately 1 inch and that differential settlement should not exceed about ½ to ¾ inch. Careful field control during construction is necessary to minimize the actual settlement that will occur.

Positive drainage of surface water, including downspout discharge, should be maintained away from structure foundations to avoid wetting and weakening of the foundation soils both during construction and after construction is complete.

4.3 Floor Slabs

The near surface or shallow subgrade soils encountered within the proposed building area (Borings B-1, B-2, B-3, B-5, & B-6) generally consist of stiff silty clay or stiff plastic clay. ***Please note that undercutting of plastic clays (area of Boring B-2) of approximately 2 feet will be necessary prior to floor slab construction. Based on this investigation, we estimate that the near surface soil within the proposed building addition area should be expected to be about 5 to 8 percent (%) wetter than the optimum moisture content. Therefore, prior to the placement of floor slabs or any grade raise fill, scarifying and drying, over-excavation and replacement or lime modification may be necessary to manage soils with high moisture contents in order to achieve the necessary subgrade soil support.***

We recommend that all floor slabs be designed as "floating", that is, fully ground supported and not structurally connected to walls or foundations. This is to minimize the possibility of cracking and displacement of the floor slab because of differential movements between the slab and the foundation. Although the movements are estimated to be within the tolerable limits for the structural safety, such movements could be detrimental to the slabs if they were rigidly connected to the foundations. Additionally, all slabs should be liberally jointed and designed with the appropriate reinforcement for the anticipated loading conditions.

The building floor slabs should be supported on a minimum 6 inch thick granular base course (i.e. Kentucky Transportation Cabinet (KYTC) DGA) bearing on a suitably prepared subgrade (Refer to Section 5.0 "*Construction Considerations*"). The granular base course is expected to help distribute loads and equalize moisture conditions beneath the slab.

Provided that the recommendations above for floor slab design and construction are followed, a modulus of subgrade reaction, "K_{30}" value of 150 pounds per cubic inch (pci), is recommended for the design of ground supported floor slabs. It should be noted that the "K_{30}" modulus is based on a 30 inch diameter plate load empirical relationship.

4.4 Pavements

Three (3) soil borings (B-4, B-7, & B-8) were performed in the areas of the proposed parking and drive areas. Medium stiff to very stiff silty clay was encountered within the pavement areas, which if properly prepared are suitable for pavement support. ***Some ground improvement (i.e. over excavation and replacement, mechanical stabilization or lime stabilization) will likely be required prior to construction of pavements or placement of grade raise fill to remove soft soils. Furthermore, occasional undercutting to remove plastic clay (CH) soils may be necessary where encountered.*** If construction is performed during a wet or cold period, the contractor will need to exercise care during the grading and fill placement activities in order to achieve the necessary subgrade soil support for the pavement system (See Section 5.0 for *"Construction Considerations"*). The base soil for the pavement section will need to be firm and dry. The subgrade should be sloped properly in order to provide good base drainage. To minimize the effects of groundwater or surface water conditions, the base section for the roadway should be sufficiently high above adjacent ditches and properly graded to provide pavement surface and pavement base drainage.

Based upon the near surface soil encountered in the borings, we recommend using a CBR value of 3 for pavement design purposes. It should be recognized though, that the recommended CBR value is based on empirical relationships only, and laboratory CBR tests may determine a higher allowable CBR value.

Our recommendations are based on the assumption that the paved areas will be constructed on proofrolled natural soil, or on structural fill overlying the same. Serviceable pavements can be achieved by different combinations of materials and thicknesses, varied to provide roughly equivalent strengths.

4.5 Seismic Considerations

For structural design purposes, we recommend using a **Site Classification of "C"** as defined by the 2014 Indiana Building Code (in accordance with 2012 International Building Code) for structural design purposes.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Site Preparation

All areas that will support foundations, floors, pavements or newly placed structural fill must be properly prepared. All loose surficial soil or "topsoil" and other unsuitable materials must be removed. Unsuitable materials include: frozen soil, relatively soft material, relatively wet soils, deleterious material, or soils that exhibit a high organic content.

Three (3) to nine (9) inches of loose surficial topsoil was encountered in the borings. The topsoil was measured at discrete locations as shown on the Boring Location Map (Figure No. 2) in Appendix A. The topsoil thickness measured at the boring locations may or may not be representative of the overall average topsoil thickness at the site. Therefore, it is possible that the actual stripping depth could significantly vary from this data. The data presented should be viewed only as a guide to the minimum stripping depth that will be required to remove organic material at the surface. Additional field exploration by *Patriot* would be required to provide an accurate estimate of the stripping depth. This limited data indicates that a minimum stripping depth will be required to remove the organic material at the surface, followed by the potential for additional stripping and/or scarification and recompaction as may be required to achieve suitable subgrade support.

Prior to construction of floor slabs or the placement of new structural fill, the exposed subgrade must be evaluated by a Patriot representative; which will include proofrolling of the subgrade. Proofrolling should consist of repeated passes of a loaded, pneumatic-tired vehicle such as a tandem-axle dump-truck or scraper. The proofrolling operations should be observed by a *Patriot* representative, and the proofrolling vehicle should be loaded as directed by *Patriot*. Any area found to rut, pump, or deflect excessively should be compacted in-place or, if necessary, undercut and replaced with structural fill, compacted as specified below.

Care must be exercised during grading and fill placement operations. ***The combination of heavy construction equipment traffic and excess surface moisture can cause pumping and deterioration of the near surface soils. The severity of this potential problem depends to a great extent on the weather conditions prevailing during construction.*** The contractor must exercise discretion when selecting equipment sizes and also make a concerted effort to control construction traffic and surface water while the subgrade soils are exposed. We recommend that heavy construction equipment (i.e., dump trucks, scrapers, etc.) be rerouted away from the building addition area. If such problems do arise, the operations in the affected area should be halted and the *Patriot* representative contacted to evaluate the condition.

5.2 Foundation Excavations

Upon completion of the foundation excavations and prior to the placement of reinforcing steel, a *Patriot* representative should check the exposed subgrade to confirm that a bearing surface of adequate strength has been reached. Any localized soft soil zones encountered at the bearing elevations should be further excavated until adequate support soils are encountered. The cavity should be backfilled with structural fill as defined below, or the footing can be poured at the excavated depth (provided footings are not bearing on highly plastic clay soils). Structural fill used as backfill beneath footings should be limited to lean clay, lean concrete, well-graded sand and gravel, or crushed stone placed and compacted in accordance with Section 5.3 "*Structural Fill and Fill Placement Control*".

If it is necessary to support spread footings on structural fill, the fill pad must extend laterally a minimum distance beyond the edge of the footing. The minimum structural pad width would correspond with a point at which an imaginary line extending downward from the outside edge of the footing at a 1H:2V slope intersects the surface of the natural soils. For example, if the depth to the bottom of excavation is 4 feet below the bottom of the foundation, the excavation would need to extend laterally beyond the edge of the footing at least 2 feet, as shown in Illustration A found at the conclusion of this report.

Excavation slopes should be maintained within Occupational Safety and Health Administration (OSHA) requirements, but specifically Section 1926 Subpart "P" – "Sloping and Benching". Furthermore, we recommend that any surcharge fill or heavy equipment be kept at least 5 feet away from the edge of the excavation.

Construction traffic on the exposed surface of the bearing soil will potentially cause some disturbance of the subgrade and consequently loss of bearing capacity.

However, the degree of disturbance can be minimized by proper protection of the exposed surface.

5.3 Structural Fill and Fill Placement Control

Structural fill, defined as any fill which will support structural loads, should be clean and free of organic material, debris, deleterious materials and frozen soils. Samples of the proposed fill materials should be tested prior to initiating the earthwork and backfilling operations to determine the classification, the natural and optimum moisture contents and maximum dry density and overall suitability as a structural fill. ***Structural fill should have a liquid limit less than 40 and a plasticity index less than 20.***

In regards to the suitability of on-site soils for use as structural fill, the on-site silty clays (CL) are generally suitable for use as a structural fill for this project. However, there were highly plastic clays (CH) encountered throughout the borings. Therefore, screening of unsuitable materials, scarifying, and drying may be needed to achieve proper fill placement and adequate compaction of portions of the on-site soils.

All structural fill beneath floor slabs, adjacent to foundations and over foundations, should be compacted to at least 95 percent (%) of its maximum Standard Proctor dry density (ASTM D-698). This minimum compaction requirement should be increased to 100 percent (%) of the maximum Standard Proctor dry density for fill supporting footings, provided these are designed as outlined in Section 4.0 "*Design Recommendations*".

In cut areas, where pavement sections are planned, the upper 10 inches of subgrade should be scarcified and compacted to a dry density of at least 100 percent (%) of the Standard Proctor maximum dry density (ASTM D-698). Any grade-raise fill placed within 1 foot of the base of the pavement section should also be compacted to at least 100 percent (%) of the Standard Proctor maximum dry density. This can be reduced to 95 percent (%) for engineered fill placed more than 1 foot below the base of the pavement section.

Structural fill supporting, around and over utilities should be compacted to at least 95 percent (%) of its maximum Standard Proctor dry density (ASTM D-698) for utilities underlying structural areas (i.e. buildings, pavements, sidewalks, etc...). However, the minimum compaction requirement can be reduced for backfill around and over the utilities to 90 percent (%) of the maximum Standard Proctor dry density where utilities underlie greenbelt areas (i.e. grassy lawns, landscaping, etc...). It is recommended that a clean well-graded granular material be utilized as the bedding material, as well as the backfill material around and over the utility lines. The upper eighteen (18) inches of trench backfill should be soil in landscape areas.

To achieve the recommended compaction of the structural fill, we suggest that the fill be placed and compacted in layers not exceeding 8 inches in loose thickness and within the range of 2 percentage (%) points below or above the optimum moisture content value. Additionally, all fill placement should be monitored by a *Patriot* representative.

5.4 Groundwater Considerations

Groundwater was observed during drilling activities between 10 and 17 feet below the existing ground surface, which is below the anticipated foundation excavation depths. Groundwater inflow into shallow excavations **above** the groundwater table is expected to be adequately controlled by conventional methods such as gravity drainage and/or pumping from sumps. More significant inflow can be expected in deeper excavations **below** the groundwater table requiring more aggressive dewatering techniques, such as well or wellpoint systems. ***For groundwater to have minimal effects on the construction, the foundation excavation should be constructed and poured in the same day.***

6.0 INVESTIGATIONAL PROCEDURES

6.1 Field Work

A total of eight (8) soil borings were drilled, sampled, and tested at the project site on November 24, 2015, at the approximate locations shown on the Boring Location Map (Figure No. 2) in Appendix A. The soil borings were drilled to auger refusal depths ranging from 14 to 17 feet below the existing ground surface in the proposed building and parking areas.

The borings were advanced using $3\frac{1}{4}$ inch inside diameter hollow-stem augers. Samples were recovered in the undisturbed material below the bottom of the augers using the standard drive sample technique in accordance with ASTM D 1586. A 2 inch outside diameter by $1\frac{3}{8}$ inch inside diameter split-spoon sampler was driven a total of

18 inches with the number of blows of a 140-pound hammer falling 30 inches recorded for each 6 inches of penetration. The sum of blows for the final 12 inches of penetration is the Standard Penetration Test result commonly referred to as the N-value (or blow-count). Split-spoon samples were recovered at 2.5 feet intervals, beginning at a depth of 1 foot below the existing surface grade, extending to a depth of 10 feet, and at 5 feet intervals thereafter to the termination of the boring. Water levels were monitored at each borehole location during drilling and upon completion of the boring. The boreholes were backfilled with auger cuttings prior to demobilization for safety considerations.

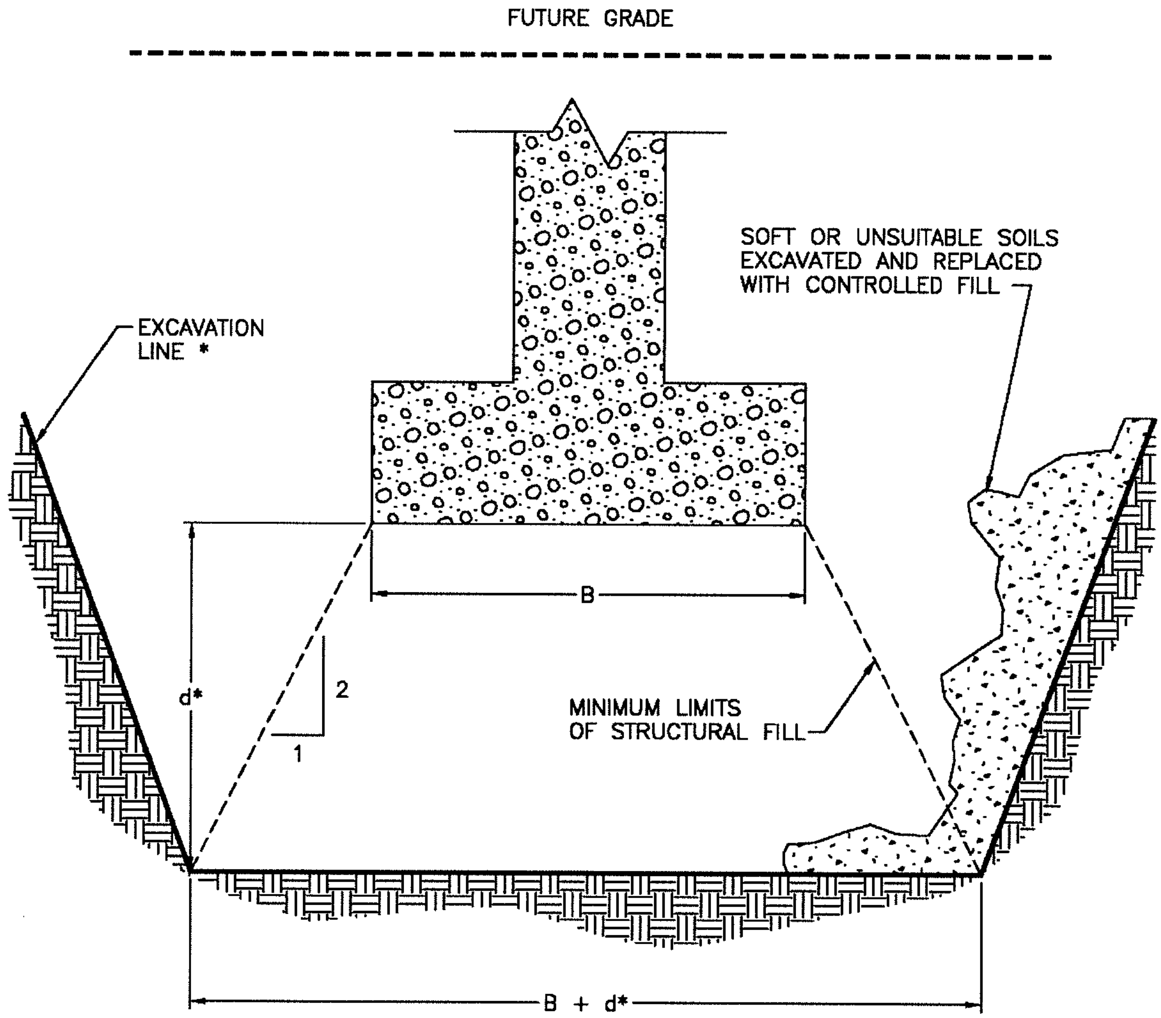
Upon completion of the boring program, all of the samples retrieved during drilling were returned to *Patriot*'s soil testing laboratory where they were visually examined and classified. A laboratory-generated log of each boring was prepared based upon the driller's field log, laboratory test results, and our visual examination. Test boring logs and a description of the classification system are included in Appendix A in this report. Indicated on each log are: the primary strata encountered, the depth of each stratum change, the depth of each sample, the Standard Penetration Test results, groundwater conditions, and selected laboratory test data. The laboratory logs were prepared for each boring giving the appropriate sample data and the textural description and classification.

6.2 Laboratory Testing

Representative samples recovered in the borings were selected for testing in the laboratory to evaluate their physical properties and engineering characteristics. Laboratory analyses included natural moisture content determinations (ASTM D 2216), and an estimate of the unconfined compressive strength (q_u) of the cohesive soil samples utilizing a calibrated hand penetrometer (q_p). The results of all laboratory tests are summarized in Section 3.3 "*Subsurface Conditions*".

7.0 ILLUSTRATION

See Illustration A on the following page. This illustration is presented to further visually clarify the construction considerations presented in Section 5.2 "*Foundation Excavations*".



*d IS DEPTH TO SUITABLE SOILS

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Excavation for Footings In an Area of Fill
ILLUSTRATION A

job. no.: 15
figure: ZONE 1059

APPENDIX A

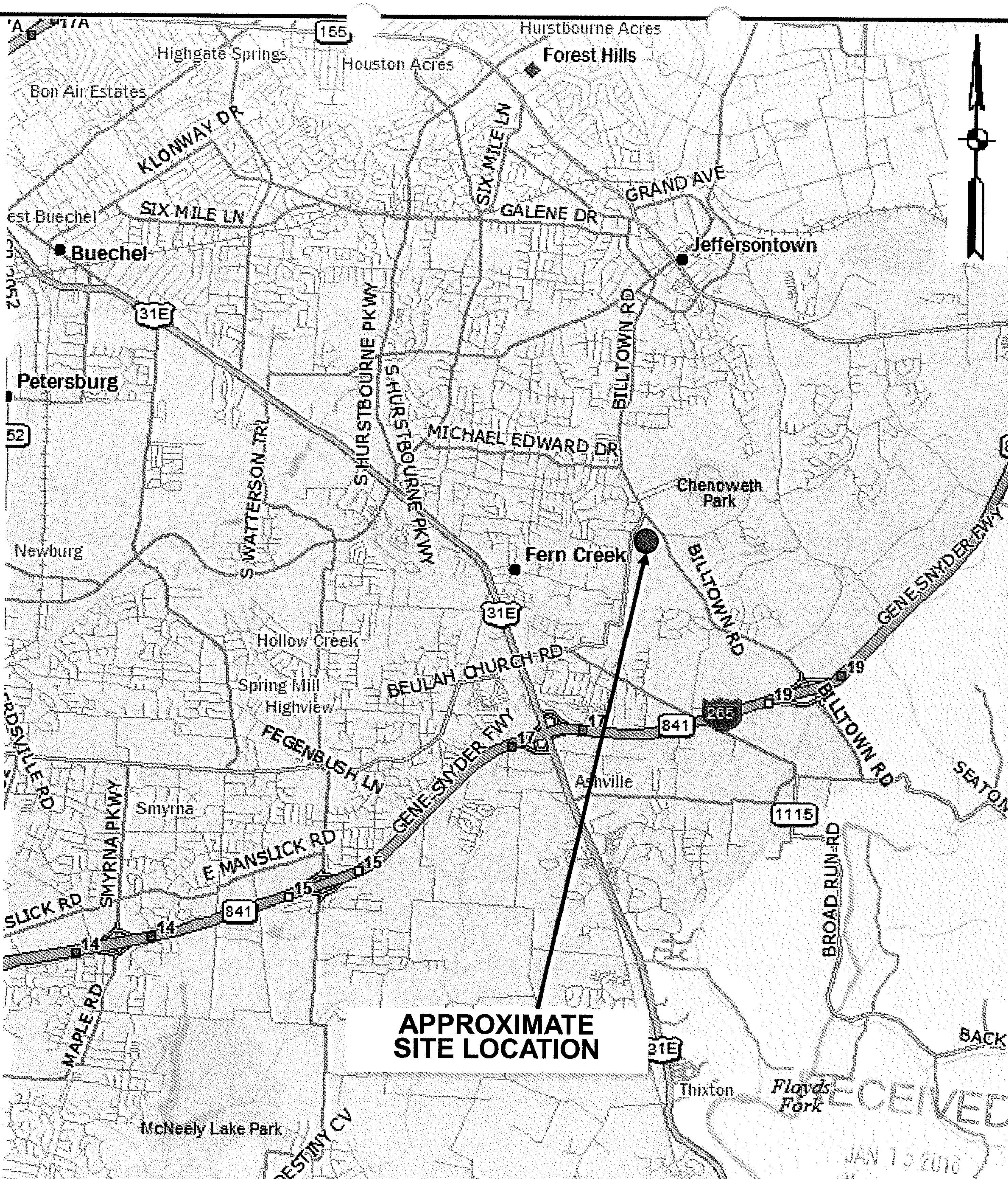
Site Vicinity Map (Figure No. 1)

Boring Location Map (Figure No. 2)

Boring Logs

Boring Log Key

Unified Soil Classification System (USCS)



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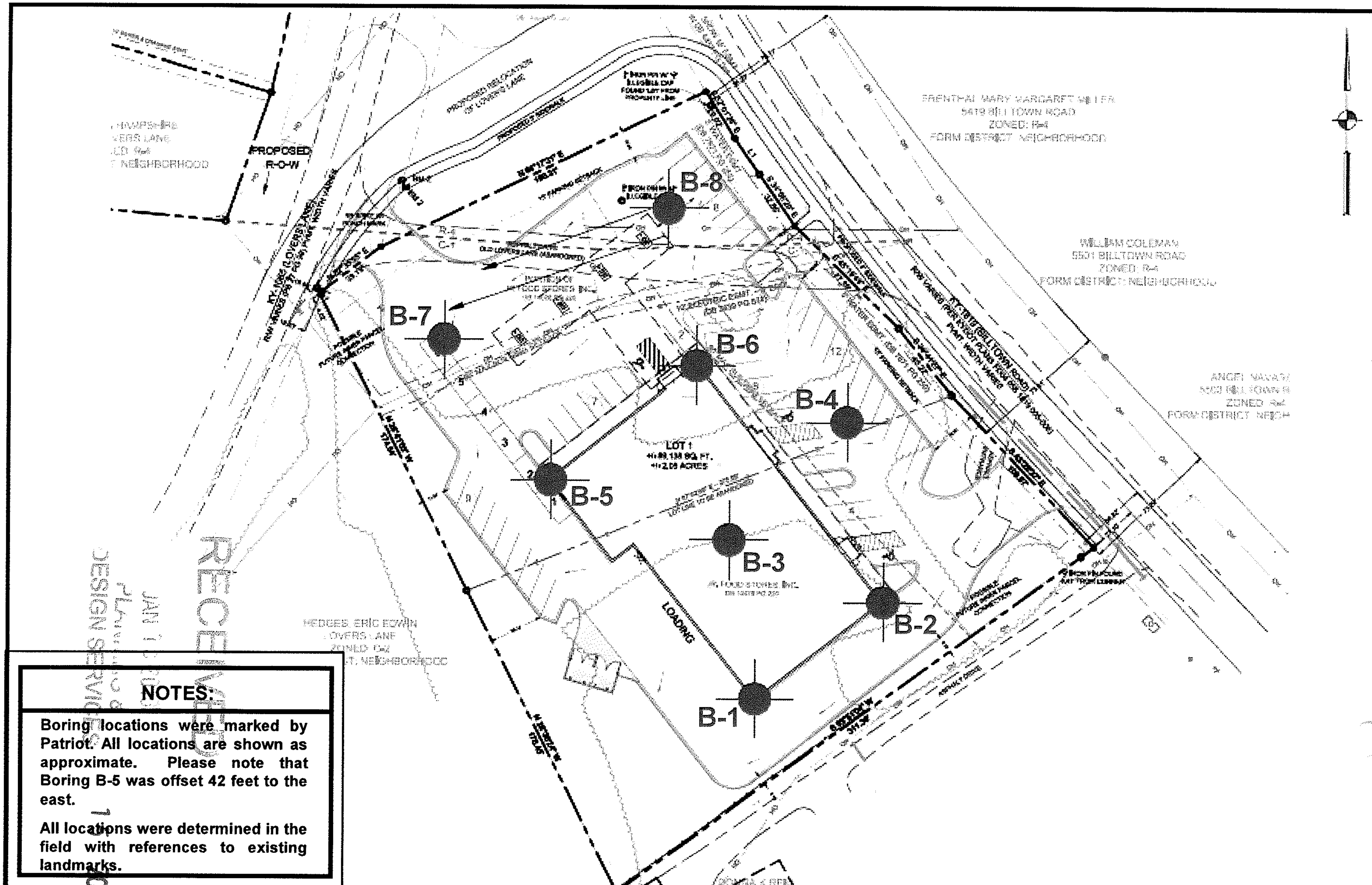
Louisville, Kentucky 40299

Site Vicinity Map
Houches Industries
5502 Billtown Road
Louisville, Kentucky

ZONE 1059

Project No. 05-15-1742	**Figure No. 1**



NOTES:

Boring locations were marked by Patriot. All locations are shown as approximate. Please note that Boring B-5 was offset 42 feet to the east.

All locations were determined in the field with references to existing landmarks.

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Louisville, Kentucky 40299

Soil Boring Location Map
Houchens Industries
5502 Billtown Road
Louisville, Kentucky

Project No. 05-15-1742

Figure No. 2

PATRIOT ENGINEERING and Environmental Inc.

Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Bloomington, Louisville KY, Dayton OH, Nashville TN, Carmi IL, New Orleans LA

LOG OF BORING B-1

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name	: Arnold Consulting Eng. Serv.	Driller	: Alan T.
Project Number	: 5-15-1742	Sampling	: Splitspoon
Logged By	: A. Billharz	Drill Rig	: Geoprobe 7822DT
Start Date	: 11/24/15		
Drilling Method	: HSA		

Water Levels
- ▼ During Drilling
- ▽ After Completion
- ◆ After 24 Hours

Depth in Feet	Water Level	USCS	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0			Topsoil (8")						
		CL	medium brown to grey, slightly moist, stiff, SILTY CLAY	1	100	2-2-8	1.0	21	
5		CL	medium brown to grey, slightly moist, stiff, SILTY CLAY, trace of rock fragments	2	100	4-5-8	3.0	18	
		CH	orangish brown to black, slightly moist, very stiff, CLAY	3	100	8-8-8	1.0	22	
10	▽	CH	orangish brown, slightly moist, stiff, CLAY	4	100	4-6-6	1.75	22	Groundwater encountered at 10 feet upon completion of drilling. Boring caved to 12 feet upon auger removal.
		SM	tan, wet, medium dense, SILTY SAND, trace of rock fragments	5	67	12-8-(50/1")		23	
15			Auger Refusal at 14 feet. Boring Terminated at 14 feet.						
20									
25									

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LOG OF BORING B-2

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name	: Arnold Consulting Eng. Serv.	Driller	: Alan T.
Project Number	: 5-15-1742	Sampling	: Splitspoon
Logged By	: A. Billharz	Drill Rig	: Geoprobe 7822DT
Start Date	: 11/24/15		
Drilling Method	: HSA		

Water Levels
▼ During Drilling
▽ After Completion
◆ After 24 Hours

Depth in Feet	Water Level	USCS	GRAPHIC	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0				Topsoil (9")						
		CH		orangish brown to grey, slightly moist, stiff, CLAY, trace of sand	1	100	3-3-7	3.75	24	
5		CH		orangish brown to grey, dry, stiff, CLAY	2	100	6-6-8	4.0	20	
		CH		orangish brown to grey, slightly moist, stiff, CLAY	3	100	5-6-6	2.0	21	
10	▽	CH		orangish brown to black, slightly moist, very stiff, CLAY, trace of fragments	4	100	5-8-9	>4.5	20	Groundwater encountered at 14 feet during drilling and 10 feet upon completion of drilling. Boring caved to 12 feet upon auger removal.
	▼	SM		tan, wet, very dense, SILTY SAND, trace of rock fragments	5	22	(50/4")		12	
15				Auger Refusal at 14 feet. Boring Terminated at 14 feet.						
20										
25										

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Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Bloomington, Louisville KY, Dayton OH, Nashville TN, Carmi IL, New Orleans LA

LOG OF BORING B-3

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name : Arnold Consulting Eng. Serv.
Project Number : 5-15-1742
Logged By : A. Billharz
Start Date : 11/24/15
Drilling Method : HSA
Driller : Alan T.
Sampling : Splitspoon
Drill Rig : Geoprobe 7822DT

Water Levels
▼ During Drilling
▽ After Completion
◆ After 24 Hours

Depth in Feet	Water Level	USCS	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0			Topsoil (8")						
		CL	medium brown, slightly moist, stiff, SILTY CLAY	1	100	4-4-6	2.25	20	
		CL	reddish brown, slightly moist, stiff, SILTY CLAY, trace of sand	2	100	4-5-6	1.75	24	
5		CH	reddish brown, slightly moist, stiff, CLAY, trace of rock fragments	3	100	5-5-9	4.5	21	
10	▽	CH	orangish brown, dry, stiff to very stiff, CLAY, trace of sand	4	100	5-6-9	3.75	22	Groundwater encountered at 16 feet during drilling and 13 feet upon completion of drilling.
15	▼	CH	medium brown, moist, stiff, CLAY	5	100	3-4-6	1.0	37	Boring caved to 14 feet upon auger removal.
20			Auger Refusal at 16 feet. Boring Terminated at 16 feet.						
25									

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LOG OF BORING B-4

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name	: Arnold Consulting Eng. Serv.	Driller	: Alan T.
Project Number	: 5-15-1742	Sampling	: Splitspoon
Logged By	: A. Billharz	Drill Rig	: Geoprobe 7822DT
Start Date	: 11/24/15		
Drilling Method	: HSA		

Water Levels
- ▼ During Drilling
- ▽ After Completion
- ◆ After 24 Hours

Depth in Feet	Water Level	USCS	GRAPHIC	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0				Topsoil (3")						
0–3.5		CL		medium brown to grey, slightly moist, medium stiff, SILTY CLAY, trace of organics	1	100	2-3-5	1.5	24	
3.5–6		CH		reddish brown, slightly moist, stiff, CLAY, trace of sand	2	100	3-4-5	3.0	28	
6–8.5		CH		reddish brown, slightly moist, stiff, CLAY	3	100	3-6-3	3.5	29	
8.5–13.5		CH		reddish brown, dry, stiff to very stiff, CLAY, trace of sand	4	100	5-5-10	4.0	30	
13.5–17	▼ (17 ft)	CH		medium brown, slightly moist, stiff, CLAY	5	100	6-5-6	3.5	37	Boring caved to 15 feet upon auger removal. Groundwater encountered at 17 feet during drilling.

Auger Refusal at 17 feet.
Boring Terminated at 17 feet.

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LOG OF BORING B-5

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name	: Arnold Consulting Eng. Serv.	Driller	: Alan T.
Project Number	: 5-15-1742	Sampling	: Splitspoon
Logged By	: A. Billharz	Drill Rig	: Geoprobe 7822DT
Start Date	: 11/24/15		
Drilling Method	: HSA		

Water Levels
- ▼ During Drilling
- ▽ After Completion
- ◆ After 24 Hours

Depth in Feet	Water Level	USCS	GRAPHIC	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0				Topsoil (9")						
		CL		medium brown, slightly moist, stiff, SILTY CLAY, trace of sand	1	100	3-3-6	1.25	20	Boring offset 42 feet to the east.
5		CL		medium brown to reddish brown, slightly moist, very stiff, SILTY CLAY, trace of sand	2	100	6-13-12	4.0	15	
		CH		reddish brown, slightly moist, stiff, CLAY	3	100	4-6-7	2.5	23	
10	▽	CH		reddish brown, slightly moist, stiff, CLAY, trace of sand	4	100	4-6-6	2.25	22	Boring caved to 12 feet upon auger removal.
15	▼	CH		reddish brown, slightly moist, stiff, CLAY, trace of rock fragments	5	67	4-6-8	1.25	20	Groundwater encountered at 17 feet during drilling and 10 feet upon completion of drilling.
20				Auger Refusal at 17 feet. Boring Terminated at 17 feet.						
25										

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LOG OF BORING B-6

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name	: Arnold Consulting Eng. Serv.	Driller	: Alan T.
Project Number	: 5-15-1742	Sampling	: Splitspoon
Logged By	: A. Billharz	Drill Rig	: Geoprobe 7822DT
Start Date	: 11/24/15		
Drilling Method	: HSA		

Water Levels
▼ During Drilling
▽ After Completion
◆ After 24 Hours

Depth in Feet	Water Level	USCS	GRAPHIC	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0				Topsoil (8")						
		CL		medium brown, slightly moist, stiff, SILTY CLAY, trace of sand	1	100	3-3-7	4.0	21	
5		CL		medium brown, slightly moist, stiff, SILTY CLAY	2	100	5-5-5	2.25	23	
		CH		reddish brown, slightly moist, stiff, CLAY	3	100	5-4-5	2.0	23	
10		CH		reddish brown, slightly moist, stiff, CLAY, trace of sand	4	100	6-5-7	2.75	34	
15	▽	CH		medium brown, slightly moist, stiff, CLAY, trace of sand	5	100	5-4-7	1.75	39	Boring caved to 16 feet upon auger removal.
	▼	SM		tan, dry, very dense, SILTY SAND	6	1	(50/1")	-	10	Groundwater encountered at 17 feet during drilling and 14 feet upon completion of drilling.
20				Auger Refusal at 17 feet. Boring Terminated at 17 feet.						
25										

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LOG OF BORING B-7

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name	: Arnold Consulting Eng. Serv.	Driller	: Alan T.
Project Number	: 5-15-1742	Sampling	: Splitspoon
Logged By	: A. Billharz	Drill Rig	: Geoprobe 7822DT
Start Date	: 11/24/15		
Drilling Method	: HSA		

Water Levels
- ▼ During Drilling
- ▽ After Completion
- ◆ After 24 Hours

Depth in Feet	Water Level	USCS	GRAPHIC	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0				Topsoil (8")						
		CL		dark brown, slightly moist, stiff, SILTY CLAY	1	100	4-6-8	2.25	22	
5		CL		medium brown to reddish brown, slightly moist, stiff, SILTY CLAY	2	100	4-6-7	3.0	22	
		CH		dark brown, slightly moist, very stiff, CLAY	3	100	6-7-10	4.5	19	
10		CH		medium brown to grey, slightly moist, stiff, CLAY	4	100	6-7-8	1.75	21	
15		CH		orangish brown, slightly moist, very stiff, CLAY	5	100	7-7-10	3.75	22	Boring caved to 14 feet upon auger removal. Groundwater not encountered during or upon completion of drilling
20				Auger Refusal at 17 feet. Boring Terminated at 17 feet.						
25										

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LOG OF BORING B-8

Houchens Industries
5502 Billtown Road
Louisville, KY

Client Name	: Arnold Consulting Eng. Serv.	Driller	: Alan T.
Project Number	: 5-15-1742	Sampling	: Splitspoon
Logged By	: A. Billharz	Drill Rig	: Geoprobe 7822DT
Start Date	: 11/24/15		
Drilling Method	: HSA		

Water Levels
▼ During Drilling
▽ After Completion
◆ After 24 Hours

Depth in Feet	Water Level	USCS	GRAPHIC	DESCRIPTION	Sample	Rec %	SPT Results	qp tsf	w %	REMARKS
0				Asphalt (4")						
		CL		dark brown, slightly moist, stiff to very stiff, SILTY CLAY	1	100	5-5-7	3.0	20	
5					2	-	7-9-10	-	-	
		CH		reddish brown, slightly moist, stiff, CLAY	3	100	5-5-6	2.5	23	
10	▽ (12)	CH		reddish brown, slightly moist, stiff, CLAY, trace of sand	4	100	5-6-7	2.75	21	Boring caved to 13 feet upon auger removal.
15	▼ (17)	CH		orangish brown, slightly moist to dry, very stiff, CLAY	5	100	5-7-9	4.25	29	Groundwater not encountered at 17 feet during and 12 feet upon completion of drilling.
20				Auger Refusal at 17 feet. Boring Terminated at 17 feet.						
25										

PATRIOT ENGINEERING and Environmental, Inc.
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Consulting Environmental, Geotechnical and Materials Engineers

BORING LOG KEY

UNIFIED SOIL CLASSIFICATION SYSTEM
FIELD CLASSIFICATION SYSTEM
FOR SOIL EXPLORATION

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	-4 blows/ft. or less
Loose	-5 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

Grain Size Terminology

Soil Fraction		Particle Size	US Standard Sieve Size
Boulders		Larger than 12"	Larger than 12"
Cobbles		3" to12"	3" to 12"
Gravel:	Coarse	¾" to 3"	¾" to 3"
	Small	4.76mm to ¾"	#4 to ¾"
Sand:	Coarse	2.00mm to 4.76mm	#10 to #4
	Medium	0.42mm to 2.00mm	#40 to #10
	Fine	0.074mm to 0.42mm	#200 to #40
Silt		0.005mm to 0.074 mm	Smaller than #200
Clay		Smaller than 0.005mm	Smaller than #200

RELATIVE PROPORTIONS FOR SOILS

Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency	Unconfined Compressive Strength (tons/sq. ft.)	Field Identification (Approx.) SPT Blows/ft.
Very Soft	Less than 0.25	0 - 2
Soft	0.25 – < 0.5	3 - 4
Medium Stiff	0.5 - < 1.0	5 - 8
Stiff	1.0 - < 2.0	9 -15
Very Stiff	2.0 - < 4.0	16 - 30
Hard	Over 4.0	> 30

Classification on logs are made by visual inspection.

Standard Penetration Test - Driving a 2.0" O.D., 1$^{3/8}$" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary for **Patriot** to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the drill log (Example - 6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8 + 9 = 17 blows/ft.).

Strata Changes - In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (———) represents an actually observed change, a dashed line (- - - - - -) represents an estimated change.

Groundwater observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

Groundwater symbols: ▼-observed groundwater elevation, encountered during drilling; ∇-observed groundwater elevation upon completion of boring.

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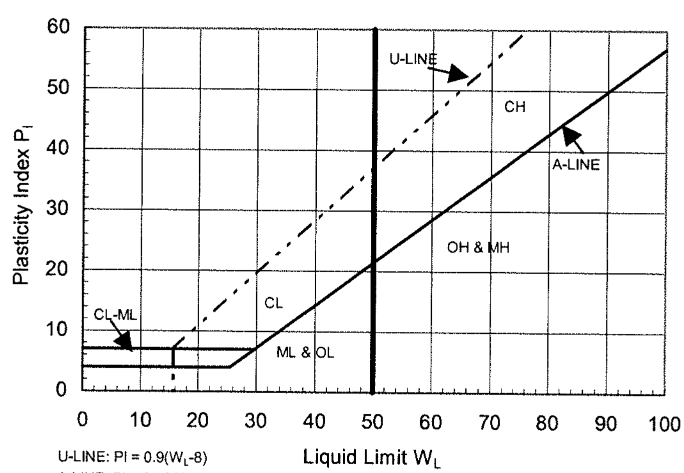
Unified Soil Classification System

Major Divisions			Group Symbol	Typical Names	Classification Criteria for Coarse-Grained Soils		
Coarse-grained soils (more than half of material is larger than No. 200)	Gravels (more than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_U \geq 4$ $1 \leq C_C \leq 3$	$C_U = \frac{D_{60}}{D_{10}}$	$C_C = \frac{D^2_{30}}{D_{10} D_{60}}$
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW ($C_U < 4$ or $1 > C_C > 3$)		
		Gravels with fines (appreciable amount of fines)	GM d/u	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below A line or $P_I < 4$	Above A line with $4 < P_I < 7$ are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above A line or $P_I > 7$		
	Sands (more than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_U \geq 6$ $1 \leq C_C \leq 3$	$C_U = \frac{D_{60}}{D_{10}}$	$C_C = \frac{(D_{30})^2}{D_{10} D_{60}}$
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW ($C_U < 6$ or $1 > C_c > 3$)		
		Sands with fines (appreciable amount of fines)	SM d/u	Silty sands, sand-silt mixtures	Atterberg limits below A line or $P_I < 4$	Limits plotting in hatched zone with $4 \leq P_I \leq 7$ are borderline cases requiring use of dual symbols	
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above A line with $P_I > 7$		
Fine-grained soils (more than half of material is smaller than No. 200)	Silt and clays (liquid limit <50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	1. Determine percentages of sand and gravel from grain size curve. 2. Depending on percentages of fines (fraction smaller than 200 sieve size), coarse-grained soils are classified as follows: Less than 5% - GW, GP, SW, SP More than 12% - GM, GC, SM, SC 5-12% - Borderline cases requiring dual symbols		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (liquid limit >50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays or high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		PT	Peat and other highly organic soils			



U-LINE: $PI = 0.9(W_L-8)$
A-LINE: $PI = 0.73(W_L-20)$

Plasticity Chart

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APPENDIX B

General Qualifications

Standard Clause for Unanticipated Subsurface Conditions

GENERAL QUALIFICATIONS

of Patriot Engineering's Geotechnical Engineering Investigation

This report has been prepared at the request of our client for his use on this project. Our professional services have been performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, groundwater, or surface water within or beyond the site studied. Any statements in this report or on the test borings logs regarding vegetation types, odors or staining of soils, or other unusual conditions observed are strictly for the information of our client and the owner.

This report may not contain sufficient information for purposes of other parties or other uses. This company is not responsible for the independent conclusions, opinions or recommendations made by others based on the field and laboratory data presented in this report. Should there be any significant differences in structural arrangement, loading or location of the structure, our analysis should be reviewed.

The recommendations provided herein were developed from the information obtained in the test borings, which depict subsurface conditions only at specific locations. The analysis, conclusions, and recommendations contained in our report are based on site conditions as they existed at the time of our exploration. Subsurface conditions at other locations may differ from those occurring at the specific drill sites. The nature and extent of variations between borings may not become evident until the time of construction. If, after performing on-site observations during construction and noting the characteristics of any variation, substantially different subsurface conditions from those encountered during our explorations are observed or appear to be present beneath excavations, we must be advised promptly so that we can review these conditions and reconsider our recommendations where necessary.

If there is a substantial lapse of time between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we urge that our report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

We urge that Patriot be retained to review those portions of the plans and specifications that pertain to earthwork and foundations to determine whether they are consistent with our recommendations. In addition, we are available to observe construction, particularly the compaction of structural backfill and preparation of the foundations, and such other field observations as may be necessary.

In order to fairly consider changed or unexpected conditions that might arise during construction, we recommend the following verbiage (Standard Clause for Unanticipated Subsurface Conditions) be included in the project contract.

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STANDARD CLAUSE FOR UNANTICIPATED SUBSURFACE CONDITIONS

"The owner has had a subsurface exploration performed by a soils consultant, the results of which are contained in the consultant's report. The consultant's report presents his conclusions on the subsurface conditions based on his interpretation of the data obtained in the exploration. The contractor acknowledges that he has reviewed the consultant's report and any addenda thereto, and that his bid for earthwork operations is based on the subsurface conditions as described in that report. It is recognized that a subsurface exploration may not disclose all conditions as they actually exist and further, conditions may change, particularly groundwater conditions, between the time of a subsurface exploration and the time of earthwork operations. In recognition of these facts, this clause is entered in the contract to provide a means of equitable additional compensation for the contractor if adverse unanticipated conditions are encountered and to provide a means of rebate to the owner if the conditions are more favorable than anticipated.

At any time during construction operations that the contractor encounters conditions that are different than those anticipated by the soils consultant's report, he shall immediately (within 24 hours) bring this fact to the owner's attention. If the owner's representative on the construction site observes subsurface conditions which are different than those anticipated by the consultant's report, he shall immediately (within 24 hours) bring this fact to the contractor's attention. Once a fact of unanticipated conditions has been brought to the attention of either the owner or the contractor, and the consultant has concurred, immediate negotiations will be undertaken between the owner and the contractor to arrive at a change in contract price for additional work or reduction in work because of the unanticipated conditions. The contract agrees that the following unit prices would apply for additional or reduced work under the contract. For changed conditions for which unit prices are not provided, the additional work shall be paid for on a time and materials basis."

Another example of a changed conditions clause can be found in paper No. 4035 by Robert F. Borg, published in ASCE Construction Division Journal, No. CO2, September 1964, page 37.