Geotechnical Investigation

Iron-Belle Trail Pedestrian Bridge

Van Buren Township, Wayne County, Michigan

Jennifer Wright
Van Buren Township
46425 Tyler Road
Van Buren Township, Wayne County, Michigan

October 31, 2019

PEA Project No. 2019-369

Civil Engineers | Land Surveyors | Landscape Architects

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October 31, 2019
PEA Project No: 2019-369

via email: JAWright@vanburen-mi.org

Ms. Jennifer Wright
Director of Parks and Recreation
Van Buren Township
46425 Tyler Road
Van Buren Township, Wayne County, Michigan

RE: Geotechnical Investigation
Iron-Belle Trail Pedestrian Bridge
Van Buren Township, Wayne County, Michigan

Dear Ms. Wright:

PEA, Inc. has performed a geotechnical investigation for the proposed improvements to the Iron-Belle Trail located in Van Buren Township, Michigan. A pedestrian bridge over the Willow Run Creek is planned as well as a new boardwalk for the pathways leading to the bridge from the east and west. The purpose of our investigation was to determine the general subsurface conditions at the pedestrian bridge and select locations of the boardwalk in order to provide foundation and related site preparation recommendations.

Based on our investigation, the site soils are varied. Both granular and cohesive soils were encountered, both with varying strengths/relative densities. Fill soil was encountered in TB-1 to a depth of 17 feet below the existing ground surface. Organic soils were encountered in both soil borings also to a depth of 17 feet below the existing ground surface

Groundwater was encountered in TB-2 during drilling activities at a depth of 13.5 feet below the existing ground surface. The water was encountered in a sand layer. Heavy groundwater should be expected if excavations extend below the groundwater table due to the proximity to the adjacent creek and lake.

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

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

SITE CONDITIONS AND PROPOSED CONSTRUCTION

The Iron-Belle Trail is an in-progress trail system that is intended to span the lower and upper peninsulas in Michigan. The section in question for this report is a stretch between the Soop Cemetery on Old Denton Road and the Van Buren Park to the west. This stretch is tree lined and crosses the Willow Run Creek where it discharges to Belleville Lake. Based on a review of historical topographic

maps and aerial photographs the path appears to have been constructed between 1920 and 1936. There was a bridge over the creek but it appears to have been removed between 2005 and 2009. We understand present plans include constructing a pedestrian bridge over the creek and replacing the path with a boardwalk at some sections.

No specific information was available for the proposed pedestrian bridge including bridge type and proposed foundation loading. For the purposes of this report we assumed the bridge type would be designed for use with a shallow foundation with loads not exceeding 150 kips for isolated footings and 3,000 pounds per linear foot for strip footings. It is assumed at this time that the bridge deck elevation will be between 620 and 625. We anticipate minimal cuts and fills to achieve design grades for the pathway.

REGIONAL GEOLOGY AND SEISMIC ACTIVITY

A review of available sources indicates that several ice sheets (i.e. glaciers) advanced and retreated over the site with the most recent being during the late Wisconsin period. Based on the 1982 Quaternary Geology Map of Southern Michigan, the site soils were generally deposited as lacustrine sand and gravel.

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

FIELD INVESTIGATION

We investigated subsurface conditions at the proposed bridge site by drilling 2 test borings designated TB-1 and TB-2. Strata Drilling Company drilled the test borings on October 4, 2019. TB-1 was drilled on the east side of the creek and TB-2 was drilled from the west side at the anticipated bridge abutment locations. Additionally, five hand augers were conducted at select locations for the boardwalk. The test borings were located in the field by measuring from existing surface features. The locations are shown on the Test Boring Location Plan. Ground surface elevations were estimated from the in progress topographic survey of the site by PEA dated October 28, 2019.

The test borings were extended to a depth of 30 or 40 feet. The borings were advanced with 2 ¼ inch inside-diameter hollow-stem augers. Soil samples were taken at intervals of generally 2.5 feet within the upper 10 feet and at 5-foot intervals below 10 feet. These test boring samples were taken by the Standard Penetration Test method (ASTM D-1586). The drill rigs used on this project utilized an automatic hammer, which typically results in blow counts that are about 2/3 to 3/4 of the blow counts obtained using a manual hammer.

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

PRESENTATION OF DATA

We evaluated the soil and groundwater conditions encountered in the test borings and have presented these conditions in the form of individual Logs of Test Borings on Figures 1 and 2. The Log of Hand Augers is presented on Figure 3. The nomenclature used on the boring logs and elsewhere are presented on the Soil Terminology sheet, Figure 4. The stratification shown on the test boring logs represents the soil conditions at the actual boring locations. Variations may occur between the borings. The stratigraphic lines represent the approximate boundary between the soil types, however, the

transition may be more gradual than what is shown. We have prepared the logs included with this report on the basis of field classification supplemented by laboratory classification and testing.

LABORATORY TESTING

The soil samples obtained from the test borings were also classified in our laboratory. Selected samples were tested to determine natural moisture contents, organic content, and grain-size distribution. Testing was performed in accordance with current ASTM standards. The results of these tests are presented on the individual Logs of Test Borings and as Figure 5.

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

SOIL CONDITIONS AND EVAULATIONS

No borings were conducted within the existing paved pathway. The borings and hand augers were drilled within topsoil or gravel surfaces. Where encountered, the topsoil ranged from about 0.2 to 0.6 feet thick. We do not consider the topsoil suitable for the support of foundations, pavements or for use as engineered fill material; however, this material can be reused for landscaping. The gravel surface ranged in thickness from about 0.7 to 3 feet.

In TB-1, fill was encountered to a depth of about 17 feet below ground surface (bgs), or about Elevation 647. Varying fill soils were encountered to about 8 feet bgs. The shallow fill soils include sand, silty sand, silt and silty clay. At about 8 feet bgs, silty clay with gravel, concrete and organics was encountered. The silty clay was tested to have an organic content of 6.9%. Underlying the fill, native silty clay, clayey silt and silt were encountered with strengths ranging from soft to hard. The boring was terminated in a hard-silty clay.

In TB-2 the surface soils consist of medium compact sandy gravel that extends to 3 feet bgs. Hard silty clay extends to about 12 feet bgs. A silty sand stratum about 1 foot thick was encountered within the silty clay. At about 12 feet bgs grey/black loose silty sand with 3.6% organic content was encountered. Underlying the silty sand lies a dark grey loose to medium compact sand with little clay and trace silt. At about 27 feet bgs, a grey hard silty clay was encountered similar to TB-1. The boring was terminated in a hard-silty clay.

The hand augers generally encountered sand, silty sand or silty clay underlying the surface materials. Notably, buried topsoil was encountered in HA-1 from about 3.5 to 4 feet bgs.

The existing fill encountered at this site is quite variable in composition and consistency and contains considerable amounts of debris and organic matter. This material is not considered suitable for the support of foundations. Providing that the procedures outlined in the section of “Recommended Earthwork Operations” are followed and providing that some settlement can be tolerated, most of the existing fill may be left in place below pavement and reused as compacted fill.

GROUNDWATER CONDITIONS AND CONTROL

Water level observations were made at each of the test borings during and following the completion of drilling operations. Groundwater was encountered in just TB-2 at a depth of 13.5 feet below the ground surface. At completion, water was noted at a depth of 13 feet. The observed water level is about Elevation 643. The results of the individual water level measurements are shown on the respective Logs of Test Borings. Fluctuations in groundwater levels should be anticipated due the seasonal variations and following periods of prolonged precipitation or drought.

Groundwater observations were limited to areas where granular soils were encountered. In view of these high permeability soils and proximity to the creek and lake we anticipate that heavy volumes of groundwater could be encountered if excavations extend below the groundwater level. A “quick” condition may develop as groundwater migrates towards the excavation. This may result in the disturbance of the soils and a reduction of their supporting capability. Based on these considerations, we recommend that groundwater control measures be employed before making any excavations below the groundwater table. Any dewatering efforts should be in accordance with local and project environmental regulations.

SITE PREPARATION

We recommend that all earthwork operations be performed under adequate specifications and be properly monitored in the field. We expect the earthwork to consist of minimal cuts and fills to bring the site to grade; preparing for the boardwalk, pedestrian bridge and pavement. We recommend the following earthwork operations be performed.

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

- Should any remnants of the former bridge be discovered during construction, it should be removed in its entirety from within the proposed bridge area. These excavations should be backfilled with engineered backfill to the level of the surrounding area in accordance with recommendations provided in the following sections. Within areas of proposed pavement, should be removed to a depth of not less than 3 feet below proposed finished grade.

- Abandoned utilities, if any, within the influence zone of foundations should be removed in their entirety. Outside of this zone, the abandoned utilities should either be removed or plugged.

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

- Where granular soils are exposed prior to fill placement in fill areas, and after rough grade has been achieved in cut areas (if any), the subgrade should be thoroughly compacted with vibratory roller by making a minimum of 10 passes in each of two perpendicular directions covering the proposed floor area. In addition to detecting unstable areas, the proof-compaction operation should serve to densify the shallow granular deposits that overlie the site.

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

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

- Following proof-rolling and repair of unsuitable areas, the upper foot of the subgrade should be compacted to 95 percent of the maximum dry density as determined by the Modified Proctor Compaction Test, (ASTM D-1557) prior to placement of fill.

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

- The material should be non-organic and free of debris.
- Frozen material should not be used as fill nor should fill be placed on a frozen subgrade.
- The on-site soils may be used for engineered fill provided that they are approximately at the optimum moisture content. The clay soils may require aeration and drying before they can be properly compacted.
- Free-draining granular soils should be used for trench backfill and in confined spaces.
- Pea gravel is not recommended as engineered fill. Although pea gravel can easily be compacted, since it is rounded and very narrowly graded, it is unstable under wheel loads. In order to support loads, it must be confined laterally.
- Common Fill: The on-site soils may be used for common fill material. Common fill should be used in large areas that can be compacted by large earth moving equipment.
- Granular Fill: Granular fill should be used in confined areas such as trenches and backfill around foundations. Granular fill should meet the following gradation:

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

MDOT Class III meets the requirements for Granular Fill.

Alternately the following also can be used:

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

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

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

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

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

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

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

MDOT 21AA meets the gradation.

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

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

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

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

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

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

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

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

FOUNDATION RECOMMENDATIONS

Pedestrian Bridge

Based on an evaluation of the subsurface data obtained and successful completion of the earthwork procedures previously outlined, we recommend that the proposed pedestrian bridge be supported on a medium depth foundation system. Excavations adjacent to utilities, pavement and slopes require caution, and care shall be given. All OSHA regulations should be followed for excavations.

We do not recommend that shallow footings be used due to the fill and organic soil encountered in TB-1 and organic soil encountered in TB-2. Additionally, in TB-1 the fill soil was underlain by varying strength soils including soft clayey silt. Due to this, we expect a foundation system to bear on the hard-silty clay encountered in both borings at about Elevation 630.

Examples of acceptable foundation systems include rammed aggregate piers, helical piers, rigid inclusion piers and micro-piles. Design of these systems is typically proprietary and done by the manufacturer. For this situation we recommend that helical piers or rigid inclusion piers be utilized. Contractor experience on similar projects should be evaluated as the conditions at this project site are challenging. Ultimate foundation system selection should consider the soil conditions, buried concrete, proximity to the water and space limitations.

Helical Piers

Helical piers consist of a central steel shaft with helices attached. The piers and helices can vary widely in length, diameter, and number of helices per section. The helical piers are typically installed like a screw to a specified depth below grade or to a specified torque resistance which is measured by the installation equipment. A grade beam is then constructed over the helical piers tying the system together.

Helical piers can be installed in tight spaces due to the small equipment required. Helical piers can be installed with low vibrations to adjacent structures and utilities, and can support varying loads based on

the shaft size and number of helices designed. Helical piers can be installed in varying soil conditions, however, buried debris, like the concrete encountered in TB-1, can cause problems during construction.

Rigid Inclusion Piers

Rigid inclusion piers (RIP) generally consist of predrilled piers are extended to a stiff soil layer, in this case likely the hard-silty clay encountered in both borings at about Elevation 630. The piers are non-reinforced and typically built with concrete or grout. There are many options for the exact design of the pier although the piers are diameter of each element generally ranges from 15 to 36 inches. After each element is constructed a grade beam is then constructed tying the system together.

Difficulty may be encountered when drilling through the fill soil with concrete that was encountered in TB-1. Additionally, the piers are likely to extend below the groundwater table. If the foundation excavation cannot be pumped dry prior to concrete or grout placement, the concrete will need to be placed by the tremie method. As the concrete is placed, the casing should be pulled along with the tremie rod.

Boardwalk

As noted previously, hand augers were conducted at select locations along the proposed boardwalk. Buried topsoil was noted in HA-1. Additionally, buried fill and deeper organic soils were encountered in the soil borings for the pedestrian bridge. Due to these conditions we highly recommend that soil borings be conducted to a depth of at least 15 feet bgs at the proposed footing locations. Due to the presence of underlying fill and organic soils within the project area, we cannot recommend that shallow footings be utilized until the underlying soils are investigated.

FIELD MONITORING

Soil conditions at the site could vary from those generalized on the basis of test borings made at specific locations. We recommend that a qualified geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations. Also, this allows modifications to the made in the event that subsurface conditions differ from those anticipated prior to the start of construction. Additionally, material testing should be done prior to and during subgrade preparation and utility construction (i.e. materials suitability assessment of on-site and imported fill, compaction testing, asphalt and concrete testing, etc.).

The foundation installations should also be monitored and evaluated by a qualified engineer or soils technician to ensure that the bearing material is consistent with the design bearing intended by the geotechnical report engineer. The on-site review of the condition of the bearing soils as the foundations are constructed is an integral part of the geotechnical design function.

LIMITATIONS OF THE REPORT

This report is intended solely for the use of Van Buren Township and other parties explicitly identified in this report. It is prohibited for others to use this report without the explicit written consent of PEA. Any unauthorized reuse, redistribution of or reliance on this report shall be at the Client and recipient's sole risk without liability to PEA. Client shall defend, indemnify and hold PEA harmless from any liability arising from or related to Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and attachments.

The recommendations made in this report are in accordance with our present understanding of the project and the current site use, conditions and ground surface elevations. Our recommendations are based on the work scope approved by the Client and described in this report. The services were performed in a manner consistent with the level of analysis typically exercised by geotechnical engineering professionals currently practicing under similar conditions in the same locality. No other representations and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

By issuing this report, PEA is the geotechnical engineer of record. It is recommended the PEA be retained during construction and earthwork operations to confirm the conditions of the subsoil are actually similar to those observed during construction and our interpolations were correct. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.

It is important to emphasize that a subsurface investigation is a random sampling of the site and the comments included in this report are based on the results obtained at the test locations only. The subsurface conditions may vary at other locations than what was observed in our soil borings. The subsurface conditions can be significantly altered due to construction activities or by exposing the soils to humidity, dry periods or frost. Soil and groundwater conditions between and beyond the soil boring locations may differ both horizontally and vertically from those encountered at the soil borings; these conditions may become apparent during construction which could not be detected or anticipated at the time of our investigation. Should any conditions at the site encountered during construction differ than those encountered during this investigation, we request that we be notified immediately in order to reassess our recommendations. If changed conditions are encountered during construction, no matter how minor, the recommendations in this report shall be considered invalid until a sufficient review is completed by PEA and is documented in a written form.

GENERAL COMMENTS

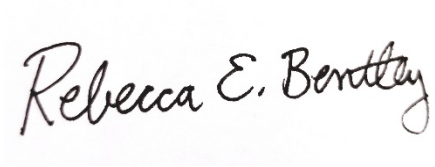
We have formulated the evaluations and recommendations presented in this report, relative to site preparation and building foundations, on the basis of data provided to us relating to the location of the proposed building. Any significant change to this data should be brought to our attention for review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

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

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

Sincerely,

PEA, Inc.



Jessica Nibert, PE
Staff Engineer

Rebecca Bentley, PE Senior
Project Manager

Attachments:
Log of Test Boring
Log of Hand Augers
Soil Terminology
Lab Testing Results
Location Plan

LOG OF TEST BORING NO. TB-1

PROJECT NAME: *Iron-Belle Trail*
LOCATION: *Van Buren Twp, MI*

PEA Job No.: *2019-369*
Reviewed by: *JLN*

GROUND SURFACE ELEVATION 664.5

DEPTH FEET	Elevation	Description	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
0	664	TOPSOIL							
0.2		FILL: Brown Medium Compact SANDY GRAVEL, Trace Silt & Clay	1-S	15 14 11	25	9			
1.5		FILL: Brown Medium Compact SAND, Trace Gravel & Silt							
3.0	660	FILL: Dark Brown Medium Compact SILTY SAND; Occasional seams of Gravelly Sand	2-S	7 6 7	13	10			
5.5		FILL: Brown Medium Compact SILT, Little Sand							
6.5		FILL: Brown Very Stiff SILTY CLAY, Trace Sand	3-S	7 5 4	9	24		7000*	
8.0	656	FILL: Grey Stiff SILTY CLAY with Gravel (Concrete) and Trace Organics LOI 6.9%	4-S	7 11 8	19	18			
	652		5-S	3 4 7	11	12			
17.0	648	Brown Very Stiff SILTY CLAY, Trace Sand	6-S	4 5 6	11	26		4500*	
21.0	644	Grey Soft CLAYEY SILT, Trace Sand	7-S	2 3 3	6	24		500*	
	640								

Total Depth: *40*
Drilling Date: *10/4/19*
Inspector: *CK*
Contractor: *Strata Drilling Company*

Drilling Method: *Hollow Stem Augers*
Auto-hammer
Plugging procedure: *Soil Cuttings*

Water Level Observation: *None Encountered*

Notes: * *Pocket penetrometer*

LOG OF TEST BORING NO. TB-1

PROJECT NAME: *Iron-Belle Trail*
LOCATION: *Van Buren Twp, MI*

PEA Job No.: *2019-369*
Reviewed by: *JLN*

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION 664.5

636	632	628	624	620	616	612

27.0 — Grey Loose SILT, Little Sand

29.0 — Grey Medium SILTY CLAY, Trace Sand

34.0 — Grey Hard SILTY CLAY, Trace Gravel & Sand

End of Boring

SOIL SAMPLE DATA

DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
28							
	8-S	3 4 3	7	28		2000*	
32							
	9-S	2 34 52	86	7		9000*	
36							
	10-S	25 35 40	75	10		9000*	
40							
44							
48							
52							

Total Depth: *40*

Drilling Method: *Hollow Stem Augers*
Auto-hammer

Drilling Date: *10/4/19*

Inspector: *CK*

Plugging procedure: *Soil Cuttings*

Contractor: *Strata Drilling Company*

Water Level Observation: *None Encountered*

Notes: ** Pocket penetrometer*

LOG OF TEST BORING NO. TB-2

PROJECT NAME: *Iron-Belle Trail*
LOCATION: *Van Buren Twp, MI*

PEA Job No.: *2019-369*
Reviewed by: *JLN*

SUBSURFACE PROFILE | **SOIL SAMPLE DATA**

GROUND SURFACE ELEVATION 660.0

Elevation	Depth (ft)	Description	Sample	Type	Blows /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
660	0	TOPSOIL								
	0.3	Brown Medium Compact SANDY GRAVEL, Trace Silt & Clay	1-S		5 6 6	12	7			
	3.0	Brown & Grey Hard SILTY CLAY, Little Sand	2-S		5 5 4	9	14		9000*	
	5.5	Brown Loose SILTY SAND	3-S		4 4 5	9	12		9000*	
	6.4	Grey Hard SILTY CLAY, Little Sand	4-S		4 5 7	12	16		9000*	
652	8.0	Brown Hard SILTY CLAY, Little Sand, Trace fine Roots	5-S		WH 1 2	3	22			
648	12.0	Grey/Black Very Loose SILTY SAND, Trace Organics LOI 3.6%	6-S		2 2 3	5	9			
644	17.0	Dark Grey Loose to Medium Compact SAND, Little Clay, Trace Silt	7-S		3 6 9	15	27			
640										
636										

Total Depth: *30*
Drilling Date: *10/4/19*
Inspector: *CK*
Contractor: *Strata Drilling Company*

Drilling Method: *Hollow Stem Augers Auto-hammer*
Plugging procedure: *Soil Cuttings*

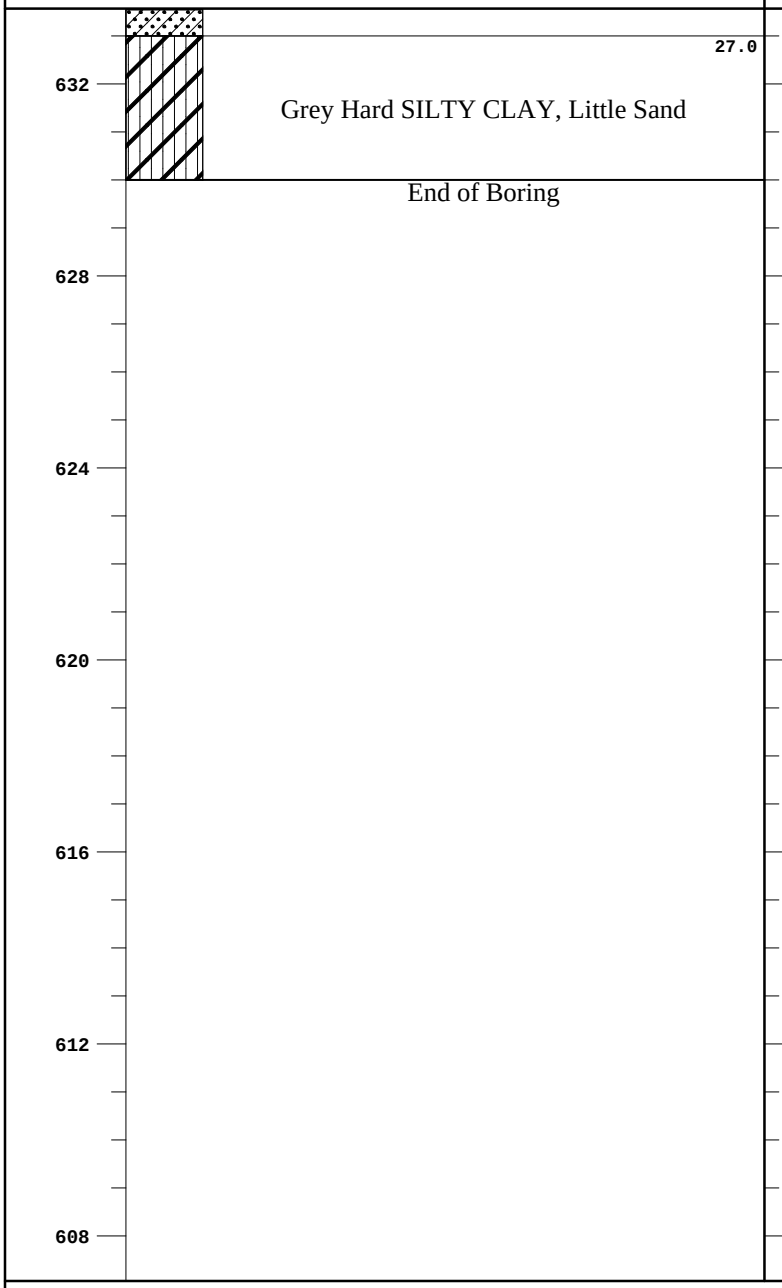
Water Level Observation: *During drilling: 13.5 ft. After drilling: 13 ft.*

Notes: * *Pocket penetrometer*

LOG OF TEST BORING NO. TB-2

PROJECT NAME: *Iron-Belle Trail*
LOCATION: *Van Buren Twp, MI*

PEA Job No.: *2019-369*
Reviewed by: *JLN*



SUBSURFACE PROFILE	SOIL SAMPLE DATA						
GROUND SURFACE ELEVATION 660.0	DEPTH FEET	SAMPLE TYPE	BLOWS /6"	SPT "N"	Moisture Content (%)	Dry Density (pcf)	Unconf. Comp. Str. (psf)	Failure Strain (%)
	28							
		8-S	29 42 50	92			9000*	
	32							
	36							
	40							
	44							
	48							
	52							

Total Depth: *30*
Drilling Date: *10/4/19*
Inspector: *CK*
Contractor: *Strata Drilling Company*

Drilling Method: *Hollow Stem Augers*
Auto-hammer
Plugging procedure: *Soil Cuttings*

Water Level Observation: *During drilling: 13.5 ft.*
After drilling: 13 ft.

Notes: ** Pocket penetrometer*

PEA, INC.

LOG OF HAND AUGER BORING

PEA JOB NO: 2019-369

HAB #	ELEV. (Feet)	DEPTH (Feet)	DESCRIPTION	REMARKS
HA-1		0-0.5 0.5-3.5 3.5-4.0 4.0-5.0	TOPSOIL: Brown Clayey Sand FILL: Brown SAND, Little Silt, Trace Clay Buried TOPSOIL Brown SILTY SAND, Trace Gravel	
HA-2		0-0.6 0.6-3.0 3.0-4.0 4.0	TOPSOIL: Brown Clayey Sand Grey Hard SILTY CLAY, Little Sand, Trace Gravel Grey SILTY SAND Refusal: apparent cobble	9000*
HA-3		0-0.3 0.3-3.5 3.5-5.0	TOPSOIL: Dark Brown Sandy Gravel Brown GRAVELLY SAND Brown & Grey Hard SILTY CLAY, Little Sand, Trace Gravel	9000*
HA-4		0-0.7 0.7-4.3	Crushed GRAVEL, Some Sand Brown SAND, Trace Gravel	
HA-5		0-1.3 1.3	Crushed GRAVEL (Some Concrete), Some Sand Refusal	
NOTES: * Estimated unconfined compressive strength from pocket penetrometer				
DRILLED BY: CK		DATE: 10/4/19 & 10/10/19		FIGURE: 3

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SOIL TERMINOLOGY

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

PARTICLE SIZES

Boulders - Greater than 12 inches (305 mm)

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

Gravel:

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

Sand:

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

Silt - 0.005 mm to 0.074 mm

Clay - Less than 0.005 mm

CLASSIFICATION

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

Modifiers to Main Constituent
(Percent by Weight)

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

COHESIVE SOILS

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

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

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

COHESIONLESS SOILS

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

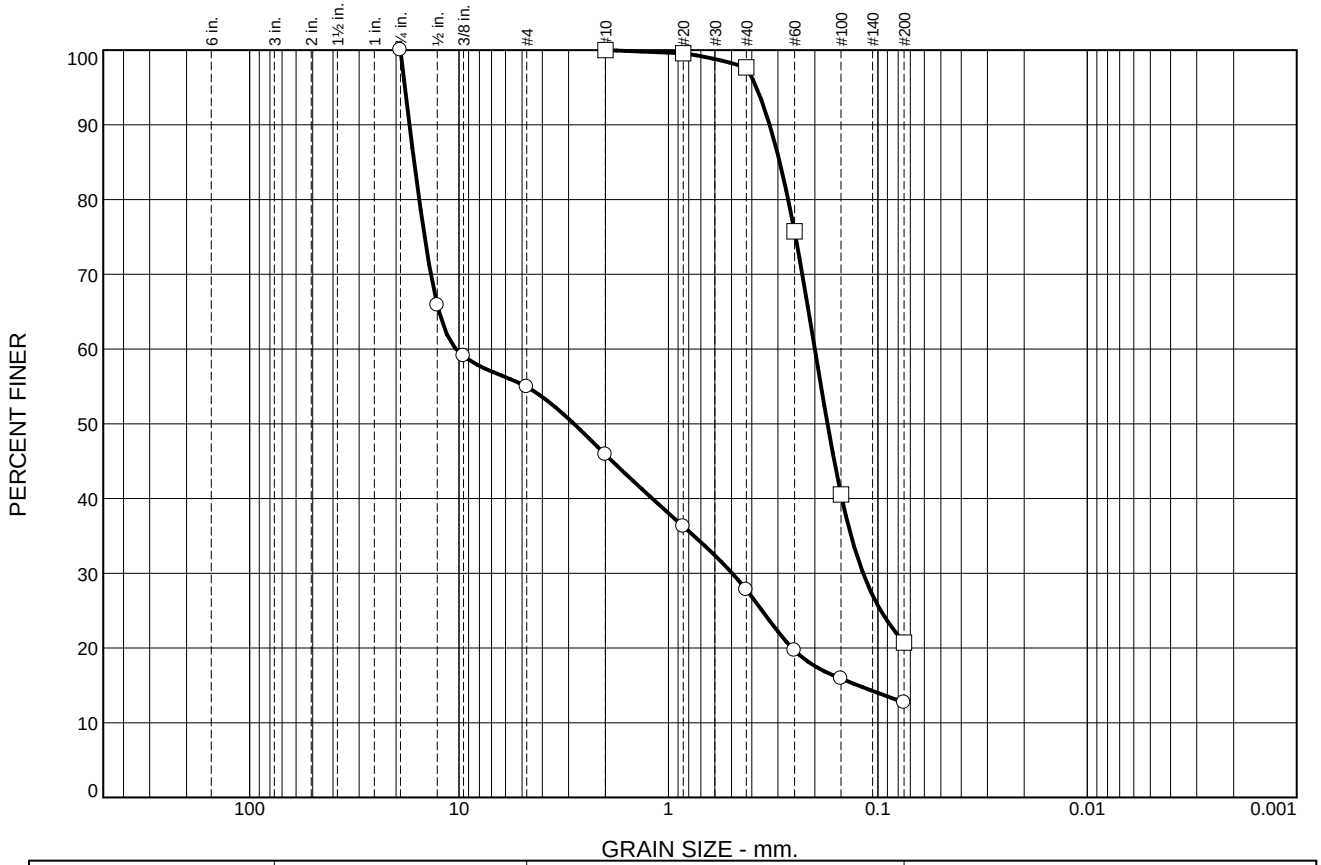
Relative Density of Cohesionless Soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

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

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

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	45.1	9.0	18.1	15.1	12.7	
□	0.0	0.0	0.0	0.0	2.3	77.0	20.7	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	TB-2	1-S	1.0	FILL: Brown Sandy Gravel, Trace Silt & Clay	
□	TB-2	6-S	18.5	Dark Grey Sand, Little Clay, Trace Silt	

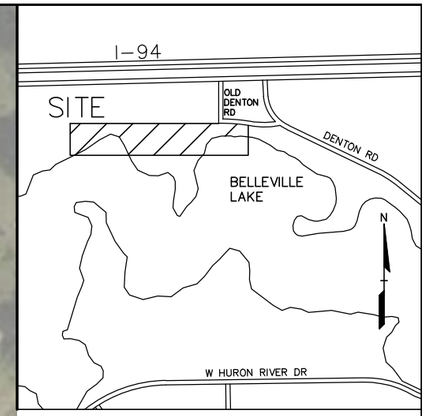
Professional Engineering Associates, Inc.

Client: Van Buren Twp

Project: Iron-Belle Trail
Van Buren Twp, MI

Project No.: 2019-369 **Figure** 5

Tested By: JB **Checked By:** JLN



0 100

50 200

GRAPHIC SCALE
1" = 100'

N

BORING LEGEND

TB–1 TEST BORING BY PERFORMED BY STRATA DRILLING SERVICES ON OCTOBER 4, 2019 UNDER TECHNICAL SUPERVISION OF PEA.

DATE: 10/29/2019

PEA JOB NO. 2019–369

PEA, Inc.
2430 Rochester Ct, Ste 100
Troy, MI 48083-1872
t: 248.689.9090
f: 248.689.1044
www.peainc.com

IRON-BELLE TRAIL PEDESTRIAN BRIDGE

BORING LOCATION MAP

VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN

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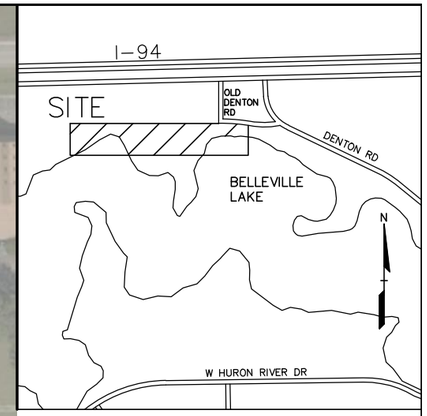

0 200
100 400
GRAPHIC SCALE
1" = 200'

N

BORING LEGEND

HA–1 HAND AUGERS BY PERFORMED BY PEA ON OCTOBER 4 & 10, 2019

DATE: 10/29/2019

PEA JOB NO. 2019–369

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2430 Rochester Ct, Ste 100
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IRON-BELLE TRAIL PEDESTRIAN BRIDGE

HAND AUGER LOCATION MAP

VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN

S:\PROJECTS\2019-369 Van Buren\FIELD SERVICES\2019\2019-369 Boring Location Map.dwg