GEOTECHNICAL ENGINEERING REPORT

LITTLE BENNETT TRAIL
CLARKSBURG, MARYLAND

KIM ENGINEERING, INC.

Consulting Geotechnical Engineers

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KIM ENGINEERING, INC.

June 11, 2014

Ms. Gabrielle Myers
Charles P. Johnson & Associates, Inc
910 Clopper Road
Suite 215
Gaithersburg, MD 20878

Project: **Geotechnical Services Report**
Little Bennett Trail
Clarksburg, Maryland
KEI Project Number: G14146BC

Dear Ms. Myers:

Kim Engineering Inc. (KEI) is pleased to submit a copy of our report for the above referenced project. This investigation was conducted in accordance with our proposal and your subsequent approval.

Services performed include the drilling of six (6) test borings, one (1) infiltration test, laboratory testing, and preparation of a geotechnical service report.

Our geotechnical services report includes the following:

- An evaluation of the estimated subsurface soil conditions and groundwater conditions at the proposed site.
- Shallow and deep foundation design recommendations.
- Stormwater management infiltration rate information and associated testing depth information, if feasible, for the stormwater management area.
- Comments on excavation and construction related information for the substrate conditions encountered in the specified test borings.

Services with respect to surveying for line and grade, specific dewatering recommendations, environmental matters, temporary slopes, earth retaining walls, pavement design, seepage analysis, slope stability, erosion control, cost or quantity estimates, plans, specifications, and construction observation and testing were not included in the scope of services.

Soil samples will be held for a period of thirty (30) days after the date of this report and then disposed of, unless an alternate disposition is requested.

We appreciate the opportunity to be of service to you for this project. If you have any questions regarding this project please do not hesitate to contact either of the undersigned.

KIM
ENGINEERING, INC.

Very truly yours,

KIM ENGINEERING, INC.

Andre Browne

Andre Browne
Project Engineer

Ronald L Pyles

Ron Pyles, P.E.
Principal Engineer

GEOTECHNICAL SERVICES REPORT
LITTLE BENNETT TRAIL
CLARKSBURG, MARYLAND

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KIM ENGINEERING, INC.

KIM ENGINEERING, INC.

1.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The following is a summary of our conclusions and recommendations:

a. Subsurface conditions in the proposed construction areas generally indicate naturally occurring clayey sand of stratum A.

b. The naturally occurring clayey sand of stratum A is suitable for support of spread footings. We recommend a design soil bearing pressure of 3,000 psf for footings founded on approved soil or on new compacted fill placed over approved soil.

c. The naturally occurring clayey sand of stratum A is also suitable for support of deep helical pier foundation system. Recommended allowable single-helix pier capacities ranged generally from 940 pounds to 5340 pounds based on recommended minimum depth of installation and varying helix diameters.

d. The naturally occurring clayey sand of stratum A is suitable for infiltration purposes at the point and at the depth tested.

e. Pavement may be supported on the natural soils of stratum A or new compacted fill.

f. Compacted fill should typically be classified as sandy silt (ML) or more granular per ASTM D2487, and compacted to 95 percent of maximum dry density per ASTM D698. The majority of the on-site soils of stratum A may be considered suitable for reuse as fill and backfill; however, some importing or substitution may be necessary.

g. Variations in soil conditions may be encountered during construction. Determination of such variations will permit correlation between the subsurface exploration data of this report and actual conditions encountered during construction and verification of conformance with the plans and specifications. We recommend that Kim Engineering, Inc. be retained to perform professional observations of foundation subgrades.

This report is based on information available to us on the proposed construction. If the project characteristics are changed from those indicated herein, our recommendations may require some modifications. Please advise us of any changes in the proposed construction.

We recommend that the project specifications include the following statement:

> "A geotechnical report has been prepared for this project by Kim Engineering, Inc. and is available to prospective bidders and/or contractors for informational purposes only. The report has been prepared for design purposes only and may not be sufficient to prepare an accurate bid for construction.

Contractors wishing copies of this report may secure them from Kim Engineering Inc. at a nominal charge with the understanding that its scope is limited solely to generalized design considerations."

We have prepared this report in accordance with contemporary geotechnical engineering practices and make no warranties, either expressed or implied, as to the professional services provided under the terms of our agreement and included in this report.

2.0 SITE DESCRIPTION AND PROPOSED CONSTRUCTION

The site is located at the Little Bennett Regional Park in Clarksburg Maryland and consists of a moderately dense wooded area with trees and grass covered lawn areas. The entire fieldwork was done in moderately accessible areas. The test borings were located in the field by Kim Engineering Inc. Accurate drawings of the site and surrounding areas were provided by our Client.

Kim Engineering understands that the proposed construction will primarily include an 8-foot wide, ADA accessible, hard surface trail approximately 1 mile long, to be located on the east side of Frederick Road, MD Route 355 in Clarksburg Maryland.

It is further understood that other proposed construction will include stormwater management facilities and raised boardwalks with concrete footing and deep helical pier foundation.

3.0 SUBSURFACE CONDITION

3.1 Test Boring

In order to approximate the subsurface conditions of the site for the study, a total of six (6) standard penetration tests (SPT) borings were drilled in the moderately accessible areas of the site. The approximate locations of the test borings are depicted in plan on the illustration of Appendix A.

The test borings were each drilled to a predetermined depth of approximately 15 feet. The table below summarizes the test boring schedule.

Boring Location	Boring Identification	Depth of Boring (ft)
Removal and Replanting of Existing Parking Lot	B-1	15
Proposed Raised Boardwalk supported by Concrete Footings	B-2	15
Proposed Raised Boardwalk across Wetland supported by Concrete Footings and Helical Piers	B-3	15
Edge of Guardrail and Potential Infiltration Facility	B-4	15
Proposed Raised Boardwalk supported by Concrete Footings	B-5	15
Start of Trail	B-6	15

Table 1: Summary of Test Borings

The test borings were accomplished using a 4-wheel ATV mounted drill rig. The exploration program was performed in the field from Tuesday June 10th to Wednesday June 18th, 2014. The borings were field located by KEI in the approximate locations depicted on the illustration of Appendix A.

A rotary drill rig was used to drill the test borings. Hollow-stem augers were advanced to pre-selected depths and representative soil samples were recovered with a standard split-spoon sampler in general accordance with ASTM D-1586.

Disturbed representative soil samples were recovered while performing the Standard Penetration Test (SPT). This test consists of a 140 pound (lb) hammer falling over a distance of 30 inches. The number of blows required to drive the standard split spoon sampler (2 inch O.D., 1-3/8 inch I.D.) a distance of 12 inches after an initial set of 6 inches to ensure the sampler is in undisturbed material, is recorded as the Standard Penetration Resistance (N-Value) of the soil. Standard Penetration Tests were accomplished using a cathead apparatus.

The N-value, for the majority of subsurface situations, provides a generalized indication of in-situ soil conditions when reviewed by individuals with established geotechnical backgrounds. Various individuals and institutions have correlated the N-values with approximations of certain engineering properties of the soils.

The test borings were advanced using auger techniques to depths indicated in table 1 above. Subsurface water level readings were taken in each of the test borings during and immediately upon completion of the drilling process. Upon completion of drilling, the boreholes were backfilled with auger cuttings (soil). The backfill material was compacted to the extent feasible; however, some subsidence of the backfill could occur at a future date. As a result, it is recommended that the boreholes be monitored periodically.

Representative portions of the split-spoon soil samples obtained throughout the exploration program were placed in glass jars and transported to our laboratory. In the laboratory, the soil samples were evaluated by a member of our professional staff in general accordance with techniques outlined in the visual-manual identification procedure (ASTM D-2488) and the Unified Soil Classification System. The soil descriptions and classifications discussed in this report and shown on the attached boring logs are based on visual observation and, as previously noted, should be considered approximate.

Split-spoon soil samples recovered on this project will be stored at Kim Engineering, Inc. for a period of thirty (30) days from the date of this report. After thirty (30) days, the samples will be discarded unless prior notification for an alternate disposition is provided to us in writing.

3.2 General Stratification

The subsurface conditions discussed below and those shown on the boring logs represent an estimate of the subsurface conditions based on an interpretation of the boring data using geotechnical engineering judgment. In most instances the relatively small sample obtained in the field may be insufficient to definitely describe the possible origin of the subsurface material. Transitions between different soil strata are usually less distinct than those shown on the boring logs. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

More comprehensive descriptions of the materials encountered are included on the attached test boring logs. The subsurface investigation indicated that the following generalized strata underlie the site in the areas and to the depths investigated:

Stratum A: Light brown, brown, red, black, gray and silver, damp, loose to very dense, clayey sand (SC) with varying amounts of silt, fine gravel and pieces of stone was encountered in all of the borings. This naturally occurring material was encountered underlying the topsoil layer. This stratum extended to the end of all the borings at depths indicated in table 1. The consistency of this stratum was determined by performing standard penetration tests. Standard Penetration Resistance (N-Value) of this material ranged generally from 6 to in excess of 50 blows per foot.

Up to 8 inches of topsoil was encountered at the top of the borings.

The soil symbols indicated in the stratum descriptions and on the boring logs represent the Unified Soil Classification (ASTM D-2488) group symbols and are based primarily on visual observation of the specimens recovered. Criteria for visual-manual classification of soil samples are given in Appendix B of this report.

3.3 Geology

The Geological Map of Maryland relating to the location of this project site was used to determine the historical geologic interpretation of the subsurface conditions. The project site is located in the Ijamville Formation and the Marburg Schist. The deposit of the Ijamville Formation is characterized by blue, green or purple phyllite slate with interbedded metasiltstone and metagraywacke. Flattened pumiceous blebs occur locally. The deposit of the Marburg Schist is characterized by bluish-gray to silvery-green, fine-grained, muscovite chlorite albite quartz schist. It is intensely cleaved and closely folded. It contains interbedded quartzites.

Boring at all locations confirm the occurrence of the formations.

3.4 Groundwater

Groundwater observations were performed at the test boring locations. Groundwater level readings were recorded during the drilling process and at the end of the drilling operation. Groundwater was encountered in boring B-3 at a depth of approximately 7.5 feet. No groundwater was encountered in the remaining borings during the drilling operation or to the cave depth at the end of the drilling operation.

Groundwater level readings are considered to be reliable indication of the water levels at the time indicated. Fluctuations of groundwater levels, as well as perched water, may be expected with variations in precipitation, evaporation, surface runoff, and related factors.

3.5 Soil Laboratory Testing

Laboratory testing was performed on jar samples obtained from selected test borings for soil classification and determination of the moisture content. All tests were performed in accordance with ASTM Standards. Results of these tests are included in the Summary of Lab Test Results in Appendix C.

Classification tests were performed on selected samples recovered from the boreholes. The tests that were performed and the associated ASTM methods are presented below:

ASTM Method	Description
D-2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D-422	Standard Test Method for Particle-Analysis (Grain Size Distribution)

D-4318	Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils

The results confirmed the high strength, low compressibility nature of the soils underlying the site. The results of the classification tests indicate that primarily low to medium plasticity clayey sand underlie the site.

Laboratory test results revealed that the approximate composition of the clayey sands of stratum A ranged generally as follows:

- 60% to 86% sand,
- 1% to 5% fine gravel,
- 13% to 36% fines inclusive of silt and/or clay.

This material is classified as a clayey sand (SC). The natural moisture content of this material ranged generally between 5% and 16%.

4.0 GEOTECHNICAL ENGINEERING ANALYSIS

Geotechnical engineering analyses were based on the subsurface exploration data resulting from our field investigation and soil laboratory testing as well as the structural data supplied to us.

4.1 Foundation Design Considerations

The site is typically underlain by what appears to be naturally occurring deposits of clayey sand all of which, based upon the results of our test borings, are currently judged to have sufficient strength to support conventional shallow spread concrete footing foundations and deep helical pier foundations for moderately loaded structures similar to the configuration of the proposed constructions. Accordingly, it is the opinion of Kim Engineering that the proposed constructions may be supported on a shallow spread concrete footing foundation system bearing on approved naturally occurring materials or, if necessary, on limited quantities of structural fill placed over approved natural soils. Also, it is the opinion of Kim Engineering that the proposed constructions may be supported on a deep helical pier foundation system installed within approved naturally occurring materials.

4.1.1 Allowable Soil Design Bearing Capacity

Our current study, incorporating the SPT N-values and the soil classifications, indicates that conventional spread concrete footing foundations should be designed using a maximum net allowable soil design bearing pressure not in excess of 3,000 pounds per square foot for foundations bearing on approved residual soil deposits or denser materials. To reduce the possibility of localized shear failures strip footings should be a minimum of 18 inches wide, while column footings should be a minimum of 30 inches square. Perimeter footing subgrade foundation should be at least 30 inches below the final exterior grade for frost protection. Variable bearing conditions may occur at the project site; therefore, we recommend that the footings be properly reinforced to provide them with greater bending capacity.

4.1.2 Deep Helical Pier Foundation System

Our current study, incorporating the SPT N-values and the soil classifications, indicates that helical pier foundation systems can be designed for axial capacities ranging from approximately 940 pounds to 5340 pounds per single-helix pier foundation. This recommended range of axial capacities is based on a minimum recommended depth of installation of 5 feet and varying diameters of single-helix pier foundation. Multiple helix foundation anchoring systems (4 maximum) should have the helix spaced at a distance at least equal to three times the diameter of the helix. The table below presents a summary of the capacities of single-helix piers.

Minimum Recommended Depth of Installation (Feet)	Diameter of Helix (inch)	Allowable Axial Pier Capacity (pound)	Allowable Axial Pier Capacity (kips)
5	6	946	0.95
5	8	1714	1.71
5	10	2706	2.71
5	12	3931	3.93
5	14	5348	5.35

Table 2: Summary of Helical Pier Capacities

Additional helix and/or combinations of the above would increase the capacity of the piers. Field testing should be done to verify the accuracy of the predicted foundation pier capacities. All work should be done by a licensed specialty contractor willing to guarantee his work and the end product. Also, a structural engineer should review the final plans and specifications.

4.1.3 Settlement

Based on the boring data and the anticipated structural loads, we estimate that total settlements for the foundations should not exceed one inch with differential settlement expected to be less than half the total settlement. The magnitude of differential settlements will be influenced by the distribution of loads and the variability of underlying materials. Quality control during construction is considered to be extreme importance to ensure that subsequent settlements, following the construction process, are kept to a minimum.

4.2 Stormwater Management Facilities and Infiltration Testing

An infiltration test was performed in infiltration test boring INF-4.

The infiltration test was performed in a 5 inch diameter standpipe placed in the continuous flight auger drilled hole. The standpipe was filled with water to presoak the soil for 24 hours. When the 24 hour presoak was complete the standpipe was refilled with a 24-inch head of water. Infiltration rates were then estimated by measuring the water level in the standpipe every 1/2 hour for 4 hours. Final depth selection should ensure that infiltration testing is not attempted in any fill. Estimated infiltration rate and test depth for the boring is presented in Table 3 below.

Site Location	Boring Identification	Depth of Boring (ft)	Infiltration Rate (inch/hour)
Proposed Stormwater Management Infiltration Facility	INF-4	8	0.92

Table 3: Estimated Infiltration Rate

Based on the fact that neither groundwater nor bedrock was encountered in the test boring, stormwater management is judged to be feasible for the location. As indicated, the flow rate obtained in the area and to the depth tested at boring INF-4 is considered by Montgomery County to be suitable for infiltration purposes.

4.3 Pavement Cross Section

The following findings and recommendations are based on our observation at the site, an interpretation of the field data obtained during the subsurface exploration, and our experience with similar subsurface conditions and projects. Subsurface conditions in unexplored locations may vary from those encountered. If locations, traffic loadings, or elevations are changed, we request that we be advised so that we may re-evaluate our recommendations.

Determination of an appropriate pavement cross section is dependent on the proposed traffic loads, traffic frequencies, soil/subsurface conditions, and construction constraints. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for pavement support. This determination includes considerations with regard to both allowable support and compressibility of the soil strata. In addition, since the method of construction greatly affects the soils intended for pavement support, consideration must be given to the implementation of suitable methods of site preparation, fill compaction, and other aspects of construction.

All pavement subgrade areas should be prepared in accordance with the recommendations provided in applicable sections of this report. In particular, pavement subgrades should be heavily proof-rolled directly prior to construction of the cross section to locate any isolated areas of soft or loose soils requiring undercutting and/ or stabilization.

It is understood that the proposed construction will primarily include an 8-foot wide, ADA accessible, hard surface trail approximately 1 mile long, to be located on the east side of Frederick Road, MD Route 355 in Clarksburg Maryland. Traffic loading will generally be lightly loaded non vehicular traffic.

It is anticipated that the proposed pavement areas will be underlain by approved naturally occurring soil or newly placed, controlled compacted fill materials. It is anticipated that the prevalent subgrade materials will mainly consist of clayey sand materials and as a result, a CBR value of 10 is used to establish the pavement cross section.

4.3.1 Recommended Light Duty Flexible Pavement Cross Section for Proposed Trail

Using the aforementioned CBR value and anticipated non vehicular traffic volume, the following light duty pavement cross section is recommended for the proposed trail:

- 1.5-inch Asphaltic concrete Surface/Wearing Course (9.5 mm Super Pave)
- 2-inch Asphaltic Concrete base Course (19.0 mm Super Pave)
- 3-inch CR-6 Subbase Course

The pavement section presented above is based on the prevalent on-site sandy subgrade materials. The recommended pavement sections require construction upon a subgrade compacted to at least 98% of the maximum dry density as determined by the standard Proctor (ASTM D698).

The pavement sections provided above have been developed for post construction traffic conditions. Since the supportive qualities of these pavement sections for their respective uses are reliant on full construction of the subbase, base, and surface courses as presented, partial construction of any pavement section may result in pavement and subgrade failures. All pavement materials, pavement cross sections where applicable, and construction should comply with requirements of Maryland State Highway Administration.

The flexible pavement sections may not be suitable for the support of heavy static loads nor does the design account for dynamic loading, such as those produced in areas where stopping, starting, and turning are performed by relative heavy vehicles.

The above noted pavement sections are applicable provided that the existing subgrade soils for all proposed pavement areas are similar to the materials encountered during our study and tested in our laboratory. If different materials are encountered during stripping and excavation operations, or should the pavement subgrade consist of imported fill materials different from those tested, then Kim Engineering Inc should be contacted to re-evaluate the proposed pavement sections.

5.0 Earthworks and Subgrade Preparations

Site development may require fill placement at this site. Before placing new fills, all topsoil, organic matter and other deleterious materials shall be removed from the ground surface. The exposed subgrade shall then be proof rolled to check whether any unstable areas exist. If any soft areas are detected by proof rolling, the unstable area shall be removed and be replaced with compacted granular fill.

Materials for compacted fill and backfill should consist of soils classified as sandy SILT (ML) or more granular per ASTM D2487. Compacted fill and backfill should be placed in 8 inch maximum loose thicknesses. All fills shall be compacted to not less than 95% of the laboratory determined maximum dry density and to within 3% of the optimum moisture content in accordance with ASTM Method D-698. This may require the contractor to dry soils during wet weather or add water during dry, hot weather.

Backfill should be free of boulders and should have a maximum particle size no greater than 4 inches.

Fill material should be placed in horizontal lifts. New fill should be adequately keyed into a stripped and scarified subgrade and should, where applicable, be properly benched into slopes or laid back portions of the excavation. During fill operations, positive surface drainage should be maintained to prevent accumulation of water. In confined areas, portable compaction equipment and thinner lifts of 3 to 4 inches may be required to achieve adequate degrees of compaction.

We recommend that the contractor have equipment on site during earthwork for both drying and wetting of the soils as moisture alterations could very well be necessary at the time of the construction. Moisture control may be especially difficult during winter months or extended periods of rain. Attempts to work the soils when wet can be expected to result in deterioration of otherwise suitable soil conditions of previously placed and properly compacted fill.

The natural soil of stratum A is generally considered suitable for use as new compacted fill. All materials for fill should be approved by the geotechnical engineer prior to use.
The naturally occurring soils at the site are susceptible to disturbance when exposed to water or to construction activities. Care should be exercised after preparing fill subgrade that it does not remain exposed for long periods or be subjected to unnecessary construction traffic prior to placement of compacted fill.

6.0 Subsurface Water Conditions and Site Drainage

Subsurface water for the purposes of this report is defined as water encountered below the existing ground surface (groundwater). Based on the results of our exploration program, we generally would not anticipate that a phreatic ground water level would be encountered during construction. However fluctuations in subsurface water levels and soil moisture can be anticipated with seasonal changes, as well as changes in precipitations amounts and rainfall runoff characteristics of influential land.

If rain water or shallow perched (trapped) water is encountered during construction, pumping from sump pits to acceptable outfalls will have to be used to control the water flow. The pumping process may have to be supplemented with ditching and a number of sump pits and pumps (or other stabilization techniques) so as to permit the construction process to continue in a satisfactory manner.

It is considered essential that adequate drainage is provided at the site at all times to minimize any increase in moisture content of the subsurface materials. This is considered to be critical for the project due to the fine-grained nature of the on-site soils. The site drainage should also be such that the run-off onto adjacent properties is properly controlled.

7.0 Construction Considerations

7.1 Footing Subgrade

Footing excavations should be observed by Kim Engineering Inc. to determine whether footings are placed on suitable bearing soils as recommended herein. These observations should include visual identification of the bearing soils and correlation with the test boring logs. Field testing by probing with a penetrometer at selected locations will also be necessary.

Care should be taken during excavation for footings to minimize disturbance of the subgrade. The footings should be excavated and poured the same day to minimize disturbance of the subgrade from surface runoff into the footing excavations. Disturbed or frozen soil should be removed prior to placement of concrete. The footing excavations should be essentially free of ponded water for observation by the geotechnical engineer during placement of concrete.

7.2 Earthwork Requirements

We recommend that placement and compaction of fill and backfill materials be scheduled during the months of April through October. It is likely that considerable difficulty in compaction of soils will be encountered if fill operations are scheduled outside of this time period. The on-site soils are susceptible to moisture and will become soft if exposed to water, high moisture levels, and equipment loadings.

8.0 Continuation of Services

Additional engineering, testing, and consulting services recommended for this project is summarized below:

General Review

It is recommended that Kim Engineering Inc. be given the opportunity to review the final design drawings and specifications when construction documents approach completion.

Site Preparation

Kim Engineering Inc. should observe the site after it has been stripped and excavated. The geotechnical engineer should determine if any undercutting or in-place densification is necessary to prepare a subgrade for structural fill placement or footing/floor slab support.

Fill Placement and Compaction

The geotechnical engineer should witness any required fill operations and should verify that an adequate degree of compaction is achieved. The individual should observe and approve all on-site or borrow materials used and should determine if they are suitable.

Foundation Excavations and Pavement Subgrades

The geotechnical engineer should observe foundation excavations and should verify that the design bearing pressure is available and that no loose or soft areas exist directly beneath the bearing surfaces of the footing excavations. A similar observation should be conducted for the pavement areas directly prior to constructing the trail cross section.

9.0 Limitations

This report has been prepared for the exclusive use by our Client for specific application to the proposed construction as presented herein. Our services were performed in accordance with contemporary soil and foundation engineering practices. No warranty, either expressed or implied, is made. Our conclusions and recommendations are based on the preliminary design information furnished to us, the data obtained from the subsurface exploration program, and current geotechnical engineering practices. The findings and recommendations do not reflect variations in subsurface conditions that could exist between the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to re-evaluate our conclusions and recommendations based upon on-site observations of the conditions.

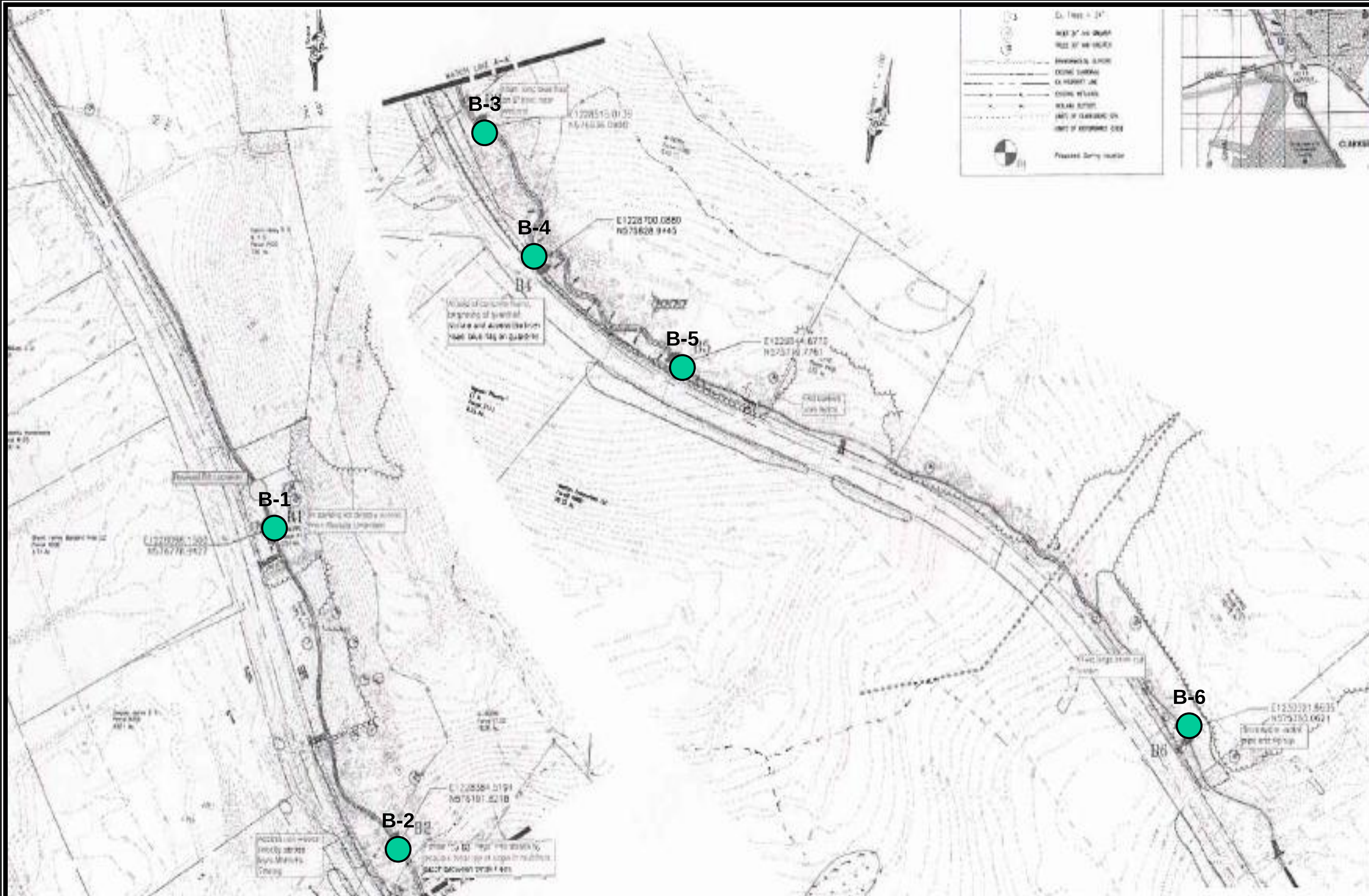
Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions in other areas will differ from those at the boring locations and the conditions may not be as anticipated by the designers. Additionally, the construction process may alter the soil conditions. Therefore, experienced geotechnical engineers should evaluate earthwork and foundation construction to verify that the conditions anticipated in design actually exist in the field at the time of construction. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or recommendations.

In the event that changes are made in the design or location of the proposed facilities, the recommendations presented in the report shall not be considered valid unless the changes are reviewed by our firm and conclusions of this report modified and/or verified in writing. If this report is copied or transmitted to a third party, it must be copied or transmitted in its entirety, including text, attachments, and enclosures. Interpretations based on only a part of this report may not be valid.

It is important to note that our study was done in an effort to assist planning and design personnel in the preparation of generalized drawings and specifications for the project. As a result of this, potential contractors should be encouraged to conduct their own individually tailored studies to assess soils conditions, rock levels, excavation slope gradients, temporary excavation support methods, and groundwater/perched water levels and conditions. Specifically, our report has been prepared for generalized purposes of planning and design and may not be sufficiently comprehensive for bid preparation purposes.

APPENDIX A

Site and Approximate Boring Location Map



Kim Engineering, Inc.

GEOTECHNICAL & MATERIALS ENGINEERS

Project No.: G141646BC

SCALE: NTS

DATE: June 10, 2014

Boring Location Plan, Little Bennett Trail, Clarksburg, MD

DRAWING NO.

1

APPENDIX B

Identification of Soil

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IDENTIFICATION OF SOIL

Soil Classification- ASTM D-2847

Coarse Grained Soils, More than 50% is retained on the No. 200 sieve	**Gravels-** More than 50% of the coarse fraction is retained on the No. 4 sieve. Coarse = 1" - 3" Medium= 1/2" - 1" Fine= 1/4" - 1/2"	Clean Gravels <5% Passing No. 200 sieve	**GW**	Well Graded Gravel
			GP	Poorly Graded Gravel
		Gravels with fines >12% passing No. 200 seive	**GM**	Silty Gravel
			GC	Clayey Gravel
	Sands- More than 50% of the coarse fraction passes the No. 4 sieve Coarse= No 10 to No. 4 Medium= No. 10 to No. 40 Fine= No. 40 to No. 200	Clean Sands <5 % passings No. 200 sieve	**SW**	Well Graded Sand
			SP	Poorly Graded Sand
		Sands with fines >12% passing No. 200 sieve	**SM**	Silty Sand
			SC	Clayey Sand
Fine Grained Soils, More than 50% passes the No. 200 Sieve	**Silts and Clays** Liquid Limit of 50 or less Low to medium plasticity	Inorganic	**ML**	Silt
			CL	Lean Clay
		Organic	**OL**	Organic Silt
				Organic Clay
	Silts and Clays Liquid Limit of 50 or greater Medium to high plasticity	Inorganic	**MH**	Elastic Silt
			CH	Fat Clay
		Organic	**OH**	Organic Silt
				Organic Clay
Highly Organic	Primarily Organic matter, dark color, organic odor		**PT**	Peat

Terminology and Definitions:

Portions of Soil Components		
Component Form	Description	Label
Noun	Gravel, Sand, Silt, Clay	50% or more
Adjective	Sandy, Silty, Clayey	35% to 49%
Some	some Sand, some Silt	12% to 34%
Trace	trace Sand, trace Clay	1% to 11 %
With	with Sand, with Silt	Presence only

Particle Size Identification	
Particle Size	Particle Dimension
Boulder	12" diameter or more
Cobble	3" to 12" diameter
Gravel	1/4" to 3" diameter
Sand	0.005" to 1/4" diameter
Silt/ Clay (fines)	Cannot See Particle

Cohesive Soils		
Field Description	N-Value	Consistency
Easily Molded in Hands	0-3	Very Soft
Easily Penetrated Several Inches by Thumb	4-5	Soft
Penetrated by Thumb with Moderate Effort	6-10	Medium
Penetrated by Thumb with Great Effort	11-30	Stiff
Indented by Thumb only with Great Effort	> 30	Hard

Granular Soils	
N- Values	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
Greater Than 50	Very Dense

Fill: Man made deposit of soil, rock and waste material.
Probable Fill: Soils which contain no visually detected foreign matter but which may be man made deposit.
Rock Fragments: Angular Pieces of rock, distinguished from transported gravel, which have separated from original vein or strata and are present in soil matrix.
Disintegrated Rock: Residual rock material with SPT of more than 60 blows per ft. and less than refusal.
Karst: Descriptive term which denotes the potential for solutioning of limestone rock and the development of sink holes.
Alluvium: Recently deposited soils placed by water action, typically stream or river flood plain soils.
Ironite: Iron oxide deposited within a soil layer forming cemented deposits.
Quartz: A hard silica mineral often found in residual soils.
Mica: A soft plate of silica mineral found in many rocks. and in residual or transported soil derived there from.
Layers: 1/2 to 12 inch seam of minor soil component.
Lenses: 0 to 1/2 inch seam of minor soil component.
Pocket: Discontinuous body of minor soil component.

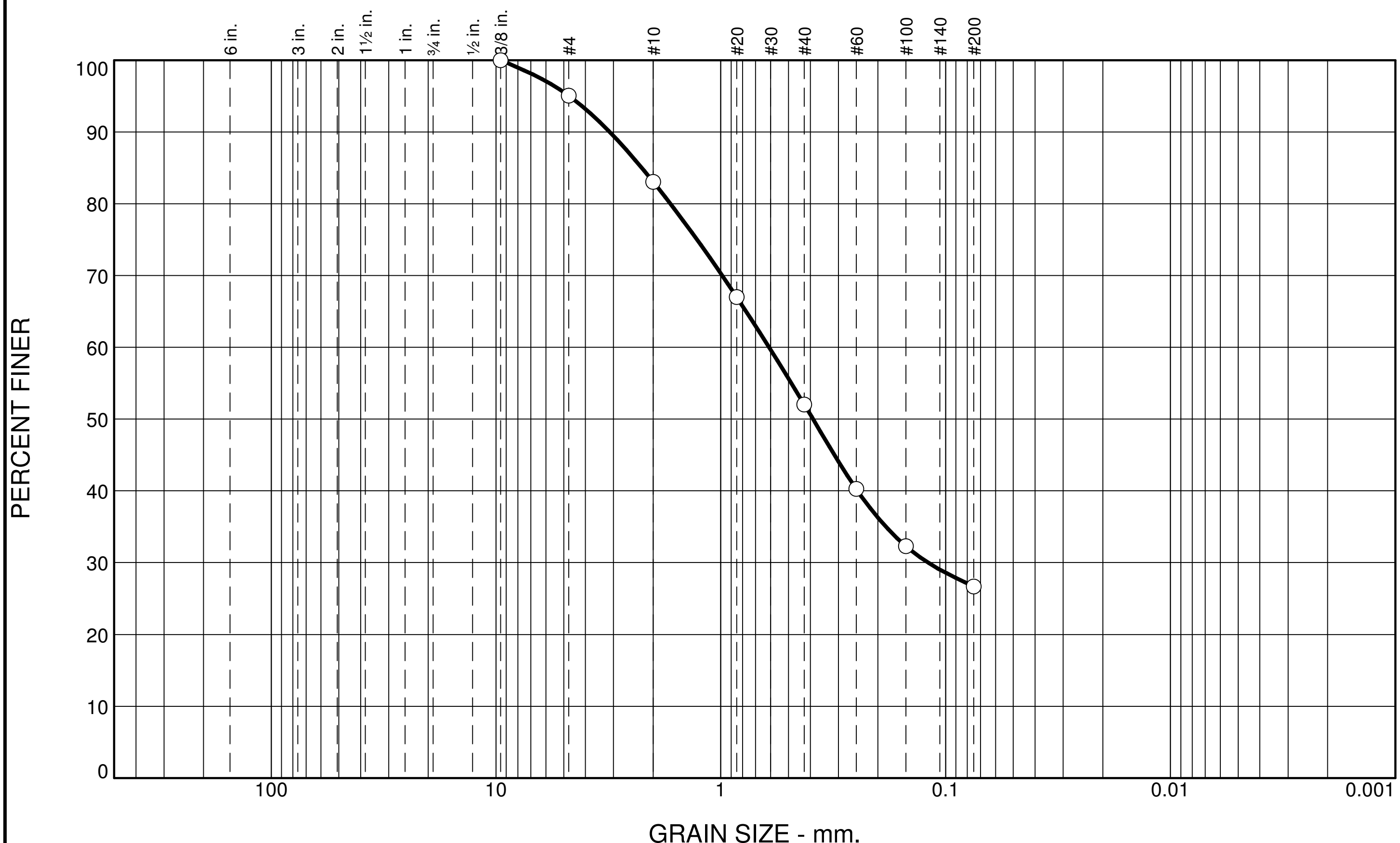
APPENDIX C
Summary of Laboratory Tests

- Natural Moisture Content
- Particle Size Distribution
- Atterberg Limits

Kim Engineering Inc
Little Bennett Trail
Laboratory Test Results
Natural Moisture Content

Borehole ID	Depth (ft)	Moisture Content (%)
B-1	2.5	8
B-3	2.5	16
B-4	7.5	14
B-5	5	8
B-6	10	5

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.0	12.0	31.0	25.3	26.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	95.0		
#10	83.0		
#20	67.0		
#40	52.0		
#60	40.3		
#100	32.3		
#200	26.7		

* (no specification provided)

Material Description

Clayey Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.1242 D_{85}= 2.2492 D_{60}= 0.6089
D_{50}= 0.3894 D_{30}= 0.1195 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Source of Sample: B-1 **Depth:** 2.5
Sample Number: 2

Date: 06-20-2014

KIM ENGINEERING, INC.

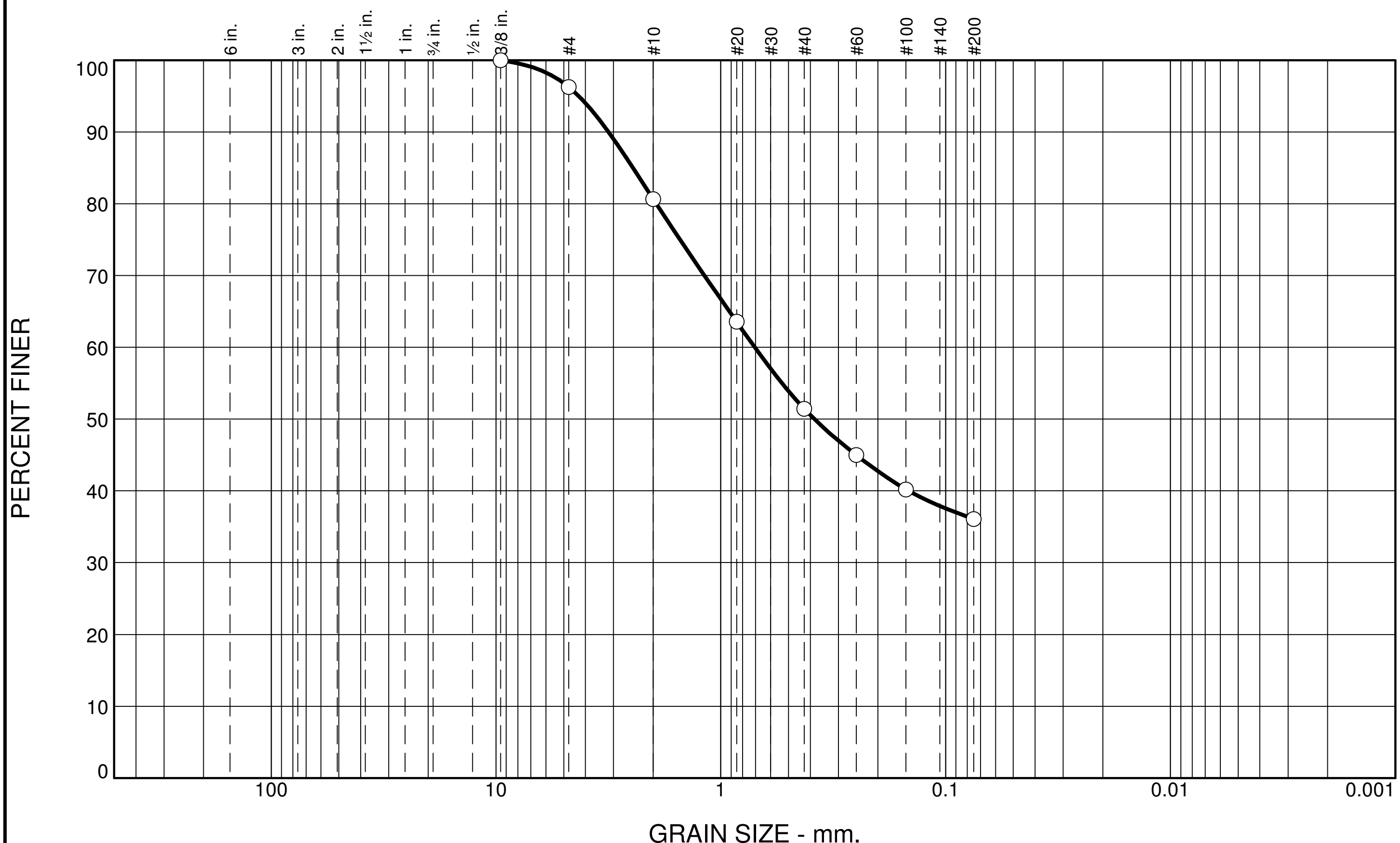
Gaithersburg, MD

Client: Charles P. Johnson & Associates, Inc.
Project: Little Bennett Trail Connector

Project No: G14146BC **Figure**

Tested By: Kim Engineering, Inc **Checked By:** Kim Engineering, Inc

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.7	15.6	29.3	15.3	36.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	96.3		
#10	80.7		
#20	63.6		
#40	51.4		
#60	45.0		
#100	40.2		
#200	36.1		

* (no specification provided)

Material Description

Clayey Sand

Atterberg Limits

PL= 25 LL= 44 PI= 19

Coefficients

D_{90}= 3.1627 D_{85}= 2.4609 D_{60}= 0.7051
D_{50}= 0.3840 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(2)

Remarks

Source of Sample: B-3 **Depth:** 2.5
Sample Number: 2

Date: 06-20-2014

KIM ENGINEERING, INC.

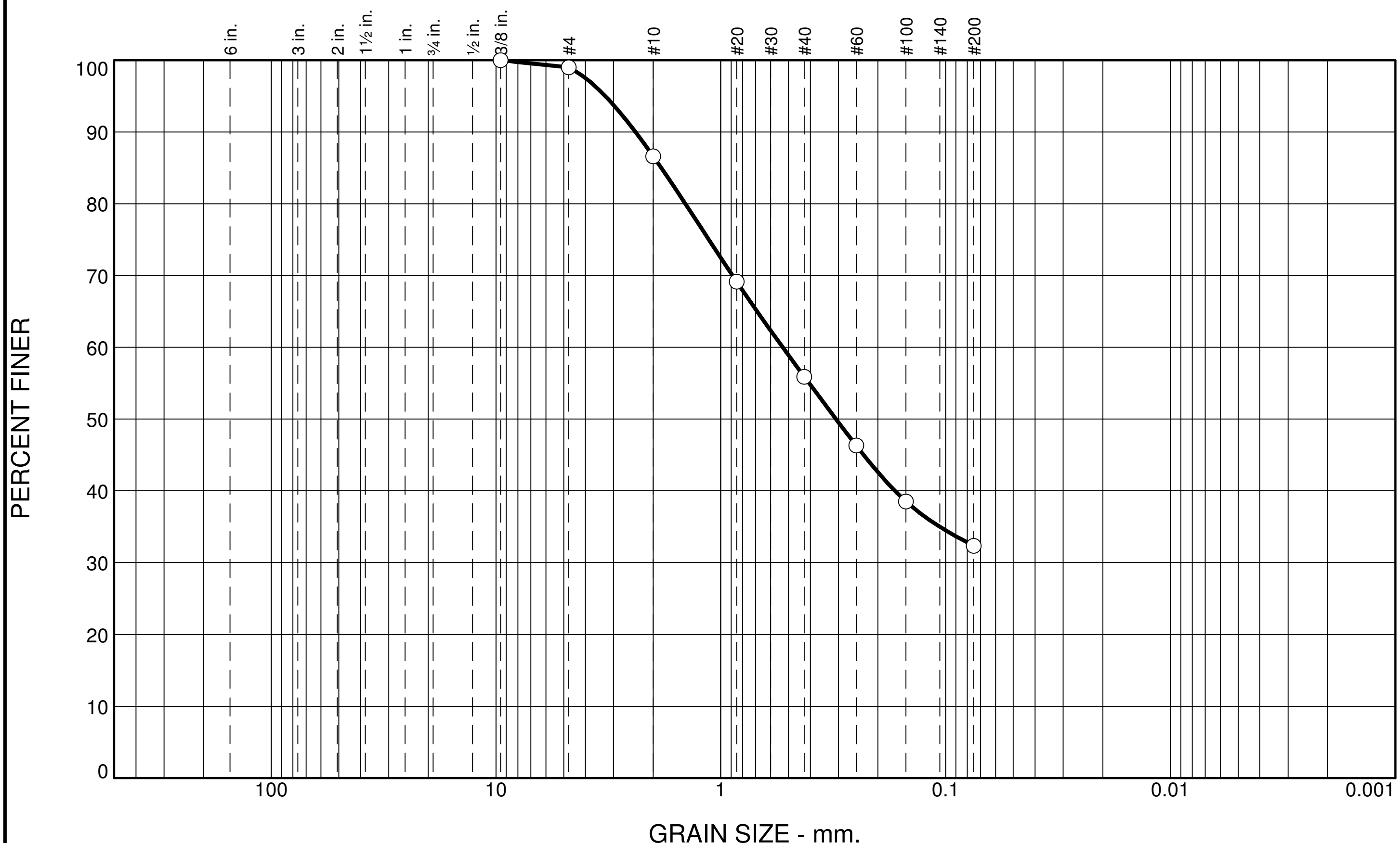
Gaithersburg, MD

Client: Charles P. Johnson & Associates, Inc.
Project: Little Bennett Trail Connector

Project No: G14146BC **Figure**

Tested By: Kim Engineering, Inc **Checked By:** Kim Engineering, Inc

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.0	12.4	30.7	23.5	32.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.0		
#10	86.6		
#20	69.1		
#40	55.9		
#60	46.3		
#100	38.5		
#200	32.4		

* (no specification provided)

Material Description

Clayey Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.3980 D_{85}= 1.8421 D_{60}= 0.5297
D_{50}= 0.3079 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Source of Sample: B-4 **Depth:** 7.5
Sample Number: 4

Date: 06-20-2014

KIM ENGINEERING, INC.

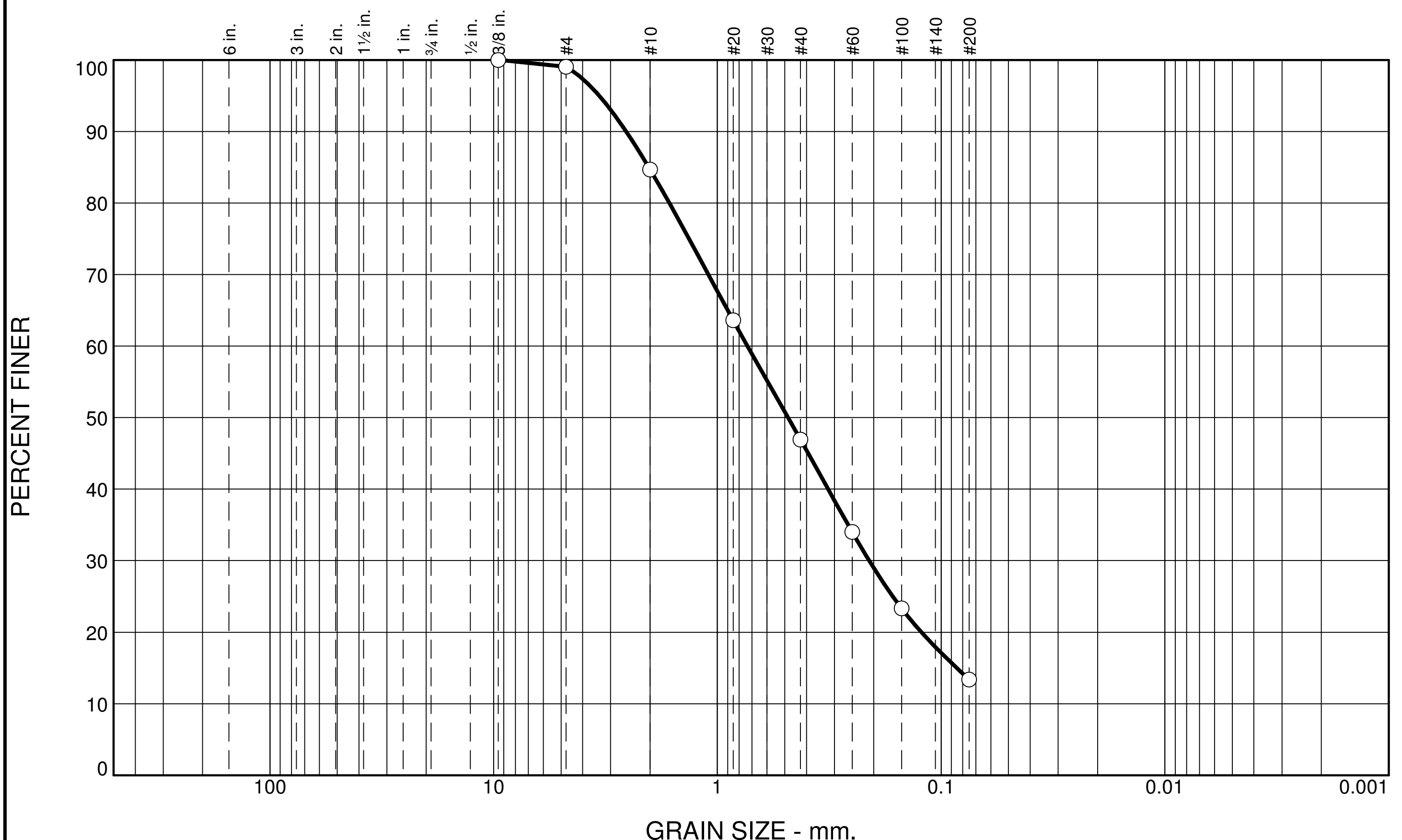
Gaithersburg, MD

Client: Charles P. Johnson & Associates, Inc.
Project: Little Bennett Trail Connector

Project No: G14146BC **Figure**

Tested By: Kim Engineering, Inc **Checked By:** Kim Engineering, Inc

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.0	14.3	37.8	33.5	13.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.0		
#10	84.7		
#20	63.6		
#40	46.9		
#60	34.0		
#100	23.3		
#200	13.4		

* (no specification provided)

Material Description

Clayey Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.5590 D_{85}= 2.0295 D_{60}= 0.7331
D_{50}= 0.4828 D_{30}= 0.2094 D_{15}= 0.0852
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Source of Sample: B-5 **Depth:** 5.0
Sample Number: 4

Date: 06-20-2014

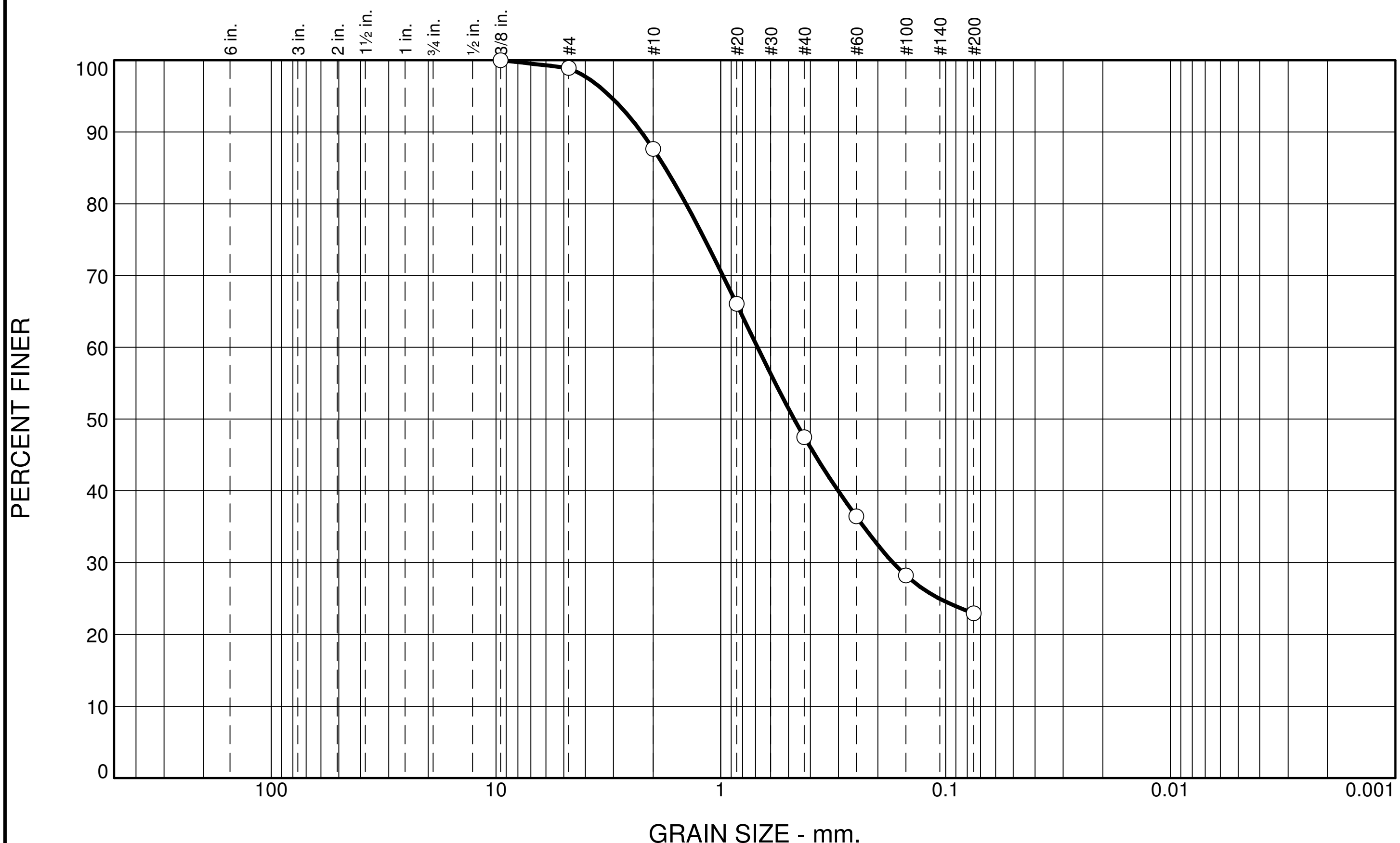
KIM ENGINEERING, INC.

Gaithersburg, MD

Client: Charles P. Johnson & Associates, Inc.
Project: Little Bennett Trail Connector
Project No: G14146BC **Figure**

Tested By: Kim Engineering, Inc **Checked By:** Kim Engineering, Inc

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	11.3	40.1	24.6	22.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	98.9		
#10	87.6		
#20	66.0		
#40	47.5		
#60	36.5		
#100	28.2		
#200	22.9		

* (no specification provided)

Material Description

Clayey Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.2593 D_{85}= 1.7663 D_{60}= 0.6854
D_{50}= 0.4713 D_{30}= 0.1712 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Source of Sample: B-6 **Depth:** 10.0
Sample Number: 5

Date: 06-20-2014

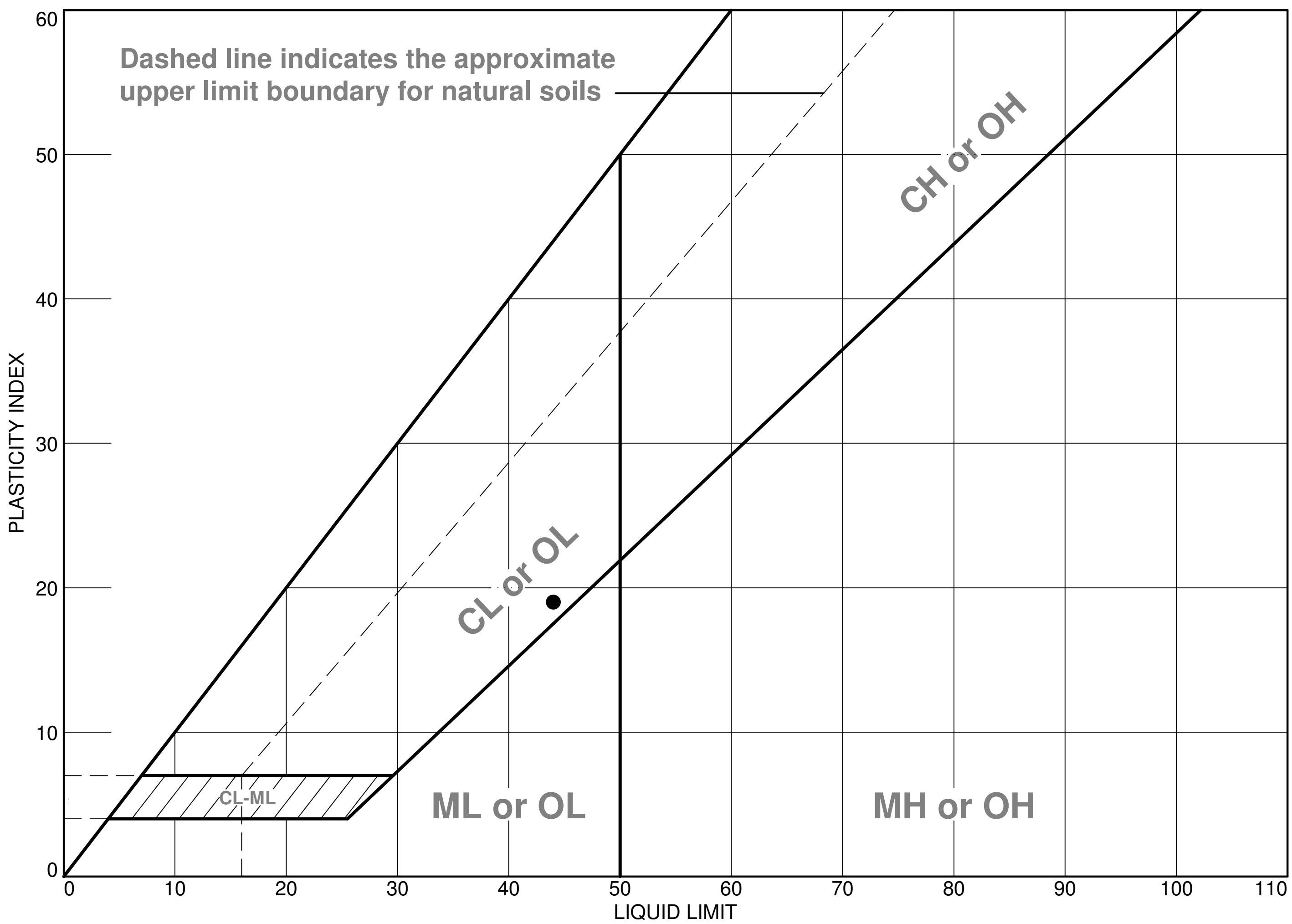
KIM ENGINEERING, INC.

Gaithersburg, MD

Client: Charles P. Johnson & Associates, Inc.
Project: Little Bennett Trail Connector
Project No: G14146BC **Figure**

Tested By: Kim Engineering, Inc **Checked By:** Kim Engineering, Inc

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Clayey Sand	44	25	19	51.4	36.1	SC

Project No. G14146BC **Client:** Charles P. Johnson & Associates, Inc.

Project: Little Bennett Trail Connector

● **Source of Sample:** B-3 **Depth:** 2.5 **Sample Number:** 2

KIM ENGINEERING, INC.

Gaithersburg, MD

Remarks:

Figure

Tested By: Kim Engineering, Inc **Checked By:** Kim Engineering, Inc

APPENDIX D

Subsurface Investigation Report

- General Notes
- Test Boring Logs

SUBSURFACE INVESTIGATION REPORT

General Notes
Test Boring Logs

Descriptions of Subsurface Investigation Procedures:

1. Boring Locations and Grades

Test boring layout in field was approximated by KEI

2. Test Borings – Hollow Stem Augers

The borings are advanced by turning 6-inch diameter augers. Cuttings are brought to the surface by the auger flights. Sampling is performed in the drilled hole by standard methods. Usually, no water is introduced into the boring using this procedure.

3. Standard Penetration Tests

Testing is performed by driving a 2 inch O. D., 1-3/8 I.D. sampling spoon through three 6 inch intervals or as indicated, using a 140 pound hammer falling 30 inches, according to ASTM D-1586.

GENERAL NOTES

1. Numbers in the sampling data column indicated the number of blows required to drive a 2 inch O.D., 1-3/8 I.D. sampling spoon through three 6 inch intervals or as indicated, using a 140 pound hammer falling 30 inches, according to ASTM D-1586.

2. Strata descriptions are based on visual inspection and are in accordance with the Unified Soil Classification System (ASTM D-2488).

3. The boring logs and related information depict subsurface conditions at these specific locations and the time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in changes in the subsurface soil and groundwater conditions at these boring locations.

4. The stratification lines represent the approximate boundary between soils typed as determined in the drilling and sampling operation. Some variation may also be expected vertical between samples taken. The soil profiles, water level observation, and penetration resistances presented o boring logs have been made with reasonable care and accuracy and must be considered only as approximate representations of subsurface conditions to be encountered at these locations.

5. Groundwater levels, if encountered, are indicated on the logs. These are only estimates from available data and may vary with precipitations, porosity of the soil, site topography and similar factors.

6. Elevations, if listed on the test boring logs, were estimated from a site topographical drawing, as such actual grades may differ from the values given.

7. Disintegrated rock is defined as residual earth material with a standard penetration resistance between 60 blows per foot and refusal which is defined as 100 blows per 2 inches or less penetration. This material may exhibit certain rock-like qualities. Some denser portions of this material could possess characteristics of soft rock and may require rock excavation methods for removal.

KIM

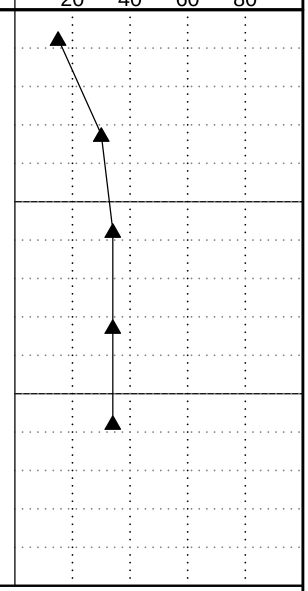
KIM ENGINEERING, INC.
Consulting Geotechnical Engineers
Silver Spring, Maryland

BORING NUMBER B-1

CLIENT Charles P. Johnson & Associates, Inc
PROJECT NAME Little Bennett Trail Connector
PROJECT NUMBER G14146BC
PROJECT LOCATION Clarksburg, Maryland
DATE STARTED 6/10/14 **COMPLETED** 6/10/14
GROUND ELEVATION **HOLE SIZE** 8
DRILLING CONTRACTOR Kim Engineering, Inc
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY I.T **CHECKED BY** A.B
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	Topsoil	SS 1	67	3-7-8 (15)		
	(SC) Light brown, gray and silver, damp, medium dense to dense, clayey sand with varying amounts of silt, fine gravel and pieces of stone.	SS 2	67	10-16-14 (30)		
5		SS 3	67	10-17-17 (34)		
		SS 4	56	17-17-17 (34)		
10		SS 5	67	10-17-17 (34)		
15						

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



Bottom of borehole at 15.0 feet.

KIM

KIM ENGINEERING, INC.
Consulting Geotechnical Engineers
Silver Spring, Maryland

BORING NUMBER B-2

CLIENT Charles P. Johnson & Associates, Inc
PROJECT NAME Little Bennett Trail Connector
PROJECT NUMBER G14146BC
PROJECT LOCATION Clarksburg, Maryland
DATE STARTED 6/11/14 **COMPLETED** 6/11/14
GROUND ELEVATION **HOLE SIZE** 8
DRILLING CONTRACTOR Kim Engineering, Inc
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY I.T **CHECKED BY** A.B
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		Topsoil						
		(SC) Light brown, brown, red and gray, damp, medium dense to very dense, clayey sand with varying amounts of silt, fine gravel and pieces of stone.	SS 1	44	1-7-7 (14)			
			SS 2	33	50-50-50 (100)			
5			SS 3	33	50-50-50 (100)			
10								
15		Bottom of borehole at 15.0 feet.						

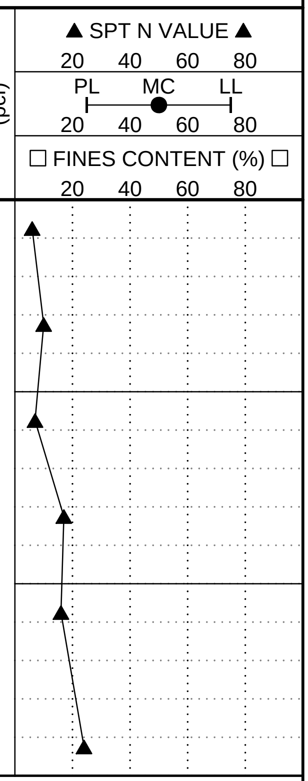
KIM ENGINEERING, INC.
Consulting Geotechnical Engineers
Silver Spring, Maryland

BORING NUMBER B-3

CLIENT Charles P. Johnson & Associates, Inc
PROJECT NAME Little Bennett Trail Connector
PROJECT NUMBER G14146BC
PROJECT LOCATION Clarksburg, Maryland
DATE STARTED 6/11/14 **COMPLETED** 6/11/14
GROUND ELEVATION **HOLE SIZE** 8
DRILLING CONTRACTOR Kim Engineering, Inc
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 7.50 ft
LOGGED BY I.T **CHECKED BY** A.B
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	Topsoil					
	(SC) Light brown, red, black, gray and silver, damp to moist, loose to medium dense, clayey sand with varying amounts of silt, fine gravel and pieces of stone.	SS 1	67	2-3-3 (6)		
		SS 2	67	2-3-7 (10)		
5		SS 3	67	2-3-4 (7)		
		SS 4	44	6-7-10 (17)		
10		SS 5	67	8-8-8 (16)		
15		SS 6	67	8-9-15 (24)		

Bottom of borehole at 15.0 feet.



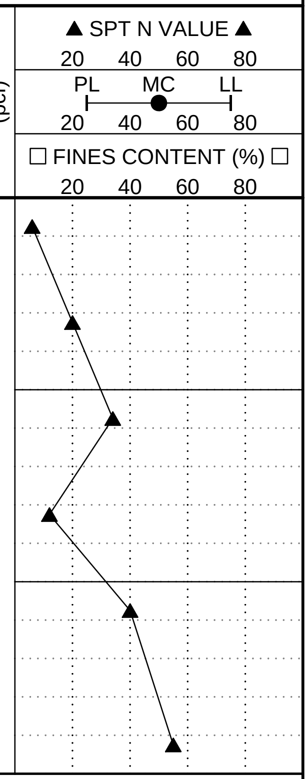
KIM

KIM ENGINEERING, INC.
Consulting Geotechnical Engineers
Silver Spring, Maryland

BORING NUMBER B-4

CLIENT Charles P. Johnson & Associates, Inc
PROJECT NAME Little Bennett Trail Connector
PROJECT NUMBER G14146BC
PROJECT LOCATION Clarksburg, Maryland
DATE STARTED 6/18/14 **COMPLETED** 6/18/14
GROUND ELEVATION **HOLE SIZE** 8
DRILLING CONTRACTOR Kim Engineering, Inc
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY I.T **CHECKED BY** A.B
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Topsoil	SS 1	67	1-3-3 (6)		
		(SC) Light brown, red and gray, damp, loose to very dense, clayey sand with varying amounts of silt, fine gravel and pieces of stone.	SS 2	67	5-7-13 (20)		
5			SS 3	67	10-17-17 (34)		
			SS 4	44	3-5-7 (12)		
10			SS 5	67	11-15-25 (40)		
15			SS 6	67	15-25-30 (55)		



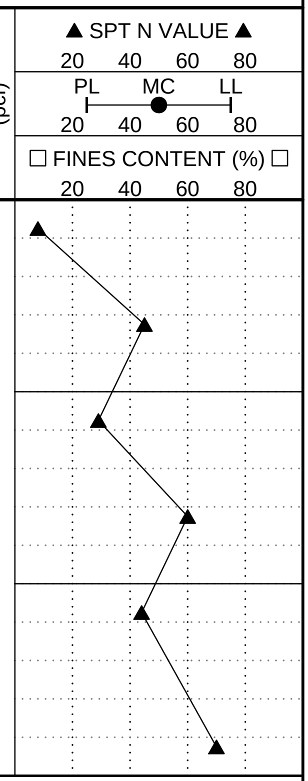
Bottom of borehole at 15.0 feet.

KIM ENGINEERING, INC.
Consulting Geotechnical Engineers
Silver Spring, Maryland

BORING NUMBER B-5

CLIENT Charles P. Johnson & Associates, Inc
PROJECT NAME Little Bennett Trail Connector
PROJECT NUMBER G14146BC
PROJECT LOCATION Clarksburg, Maryland
DATE STARTED 6/10/14 **COMPLETED** 6/10/14
GROUND ELEVATION **HOLE SIZE** 8
DRILLING CONTRACTOR Kim Engineering, Inc
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY I.T **CHECKED BY** A.B
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Topsoil					
		(SC) Light brown, gray and silver, damp, loose to very dense, clayey sand with varying amounts of silt, fine gravel and pieces of stone.	SS 1	67	2-3-5 (8)		
			SS 2	67	8-22-23 (45)		
5			SS 3	56	2-8-21 (29)		
			SS 4	67	10-30-30 (60)		
10			SS 5	67	12-20-24 (44)		
15			SS 6	56	15-20-50 (70)		



Bottom of borehole at 15.0 feet.

KIM ENGINEERING, INC.
Consulting Geotechnical Engineers
Silver Spring, Maryland

BORING NUMBER B-6

CLIENT Charles P. Johnson & Associates, Inc
PROJECT NAME Little Bennett Trail Connector
PROJECT NUMBER G14146BC
PROJECT LOCATION Clarksburg, Maryland
DATE STARTED 6/18/14 **COMPLETED** 6/18/14
GROUND ELEVATION **HOLE SIZE** 8
DRILLING CONTRACTOR Kim Engineering, Inc
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY I.T **CHECKED BY** A.B
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		Topsoil	SS 1	44	1-3-3 (6)			
		(SC) Light brown, brown, gray and silver, damp, loose to medium dense, clayey sand with varying amounts of silt, fine gravel and pieces of stone.	SS 2	67	2-4-5 (9)			
5			SS 3	67	7-7-7 (14)			
			SS 4	67	5-5-7 (12)			
10			SS 5	67	7-12-22 (34)			
15			SS 6	33	50-50-50 (100)			

Bottom of borehole at 15.0 feet.