GEOTECHNICAL ENGINEERING REPORT
SOMERSET COUNTY GAS MAIN EXPANSION
PHASE 2: HORIZONTAL DIRECTION DRILL (HDD) CROSSINGS
OCEAN HIGHWAY
SOMERSET COUNTY, MARYLAND

KLEINFELDER PROJECT NO. 20202452.001A

FEBRUARY 21, 2020

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FIGURES

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A Report Prepared for:

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PHASE 2: HORIZONTAL DIRECTION DRILL (HDD) CROSSINGS
OCEAN HIGHWAY
SOMERSET COUNTY, MARYLAND

Prepared by:

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Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland, License No. 44154, Expiration Date: June 16, 2021.

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February 21, 2020
Kleinfelder Project No. 20202452.001A

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02-21-2020

TABLES

APPENDICES

1 INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical engineering evaluation of the second phase of the proposed Somerset County Gas Main Expansion project in Somerset County, Maryland. The geotechnical evaluation targeted the proposed trenchless installation locations that are being considered to avoid existing wetlands and infrastructure. Figure 1, Site Location Plan, shows the approximate location of the project and geotechnical explorations. This report includes a description of the work performed, a discussion of the geotechnical conditions observed at the site, and recommendations developed from our engineering analyses of field and laboratory data. An information sheet prepared by GBA (the Geoprofessional Business Association) is also included in Appendix C. We recommend that all individuals utilizing this report read the limitations (Section 6) along with the attached GBA document.

1.2 PROJECT UNDERSTANDING

The proposed project consists of the expansion of the existing Somerset County gas main. Our understanding of the project is based on the “Concept Somerset County Gas Main Expansion Schematic Design Drawing” prepared by Chesapeake Utilities Company (Chesapeake) dated May 20, 2019. The proposed gas main expansion consists of approximately 9.7 miles of underground 8-inch diameter cast-steel pipe, which will be installed within Maryland State Highway Administration’s (SHA’s) right-of-way parallel to Route 13 (Ocean Highway). The pipe will be located approximately 5 feet off the western edge of pavement of the southbound lanes. We understand that the majority of the pipeline will be installed using open trench excavation. Trenchless installation methods are being considered at the 3 water crossings summarized in Table 1-1.

Table 1-1. Water Crossing Summary.

Water Crossing	Approx. Crossing Length (ft)
Manokin River	2,000
Taylor Branch	500
Kings Creek	1,300

1.3 SCOPE OF SERVICES

Our proposal dated January 3, 2020 summarizes the Scope of Services performed for this geotechnical evaluation including:

- Site reconnaissance,
- A subsurface exploration program,
- Laboratory testing of selected soil samples,
- Engineering analysis of the field and laboratory data, and
- The preparation of this written report.

The scope of the exploration and engineering analysis for this evaluation, as well as the conclusions and recommendations in this report, are based on our understanding of the project as described above and Chesapeake Utilities' current needs. If pertinent details of the project have changed or otherwise differ from our descriptions, we should be notified and engaged to review the changes and modify our recommendations, as necessary.

2 SITE EXPLORATION

2.1 SUBSURFACE EXPLORATION

Kleinfelder's subsurface exploration program consisted of 6 borings. Kleinfelder located the explorations in the field with a handheld GPS unit with an accuracy of 5 meters. Ground surface elevations were approximated from the National Elevation Dataset. The boring locations were not surveyed. Figure 1, Site Location Plan, shows the approximate locations of our explorations.

2.1.1 Borings

Kleinfelder explored the subsurface conditions along the proposed alignment with 6 borings. John D. Hynes & Associates (Hynes) drilled the borings from January 30, 2020 to February 3, 2020 using a Geoprobe 3230DT drill rig. Hynes advanced Borings MC-1, MC-2, TC-1, and KC-1 through the overburden soils using 3.25-inch inner diameter hollow stem auger for the upper 10 feet and continued with 2.875-inch outer diameter mud rotary drilling techniques to the termination depths. Kleinfelder representative observed a significant loss of mud drilling fluid in Borings MC-1, MC-2, and KC-1. Kleinfelder noted the approximate volume and associated depth range on the boring logs. Hynes advanced Borings KC-2 and TC-2 using hollow stem augers to termination depth due to the unavailability of water for mud rotary drilling. The borings were terminated at the depths summarized in Table 2-1. The borings were backfilled with grout to help mitigate risk of inadvertent fluid return during construction.

Table 2-1. Boring Depth Summary.

Crossing	Boring	Final Depth (feet)
Manokin River	MC-1	70
	MC-2	65*
Taylor Branch	TC-1	50
	TC-2	50
Kings Creek	KC-1	60
	KC-2	60

*Target depth of 70 feet. Borehole collapsed to an approximate depth of 30 feet after retrieving sample from 63 to 65 feet. Kleinfelder terminated boring at depth of 65 feet.

Soil was sampled in the borings using the Standard Penetration Test (SPT) in general accordance with ASTM D1586. The SPT involves advancing a 2-inch outer diameter, 1.375-inch inner diameter, split-barrel sampler with a 140-pound weight (known as the hammer) falling 30 inches. The sampler is advanced up to 24 inches and the number of blows to advance the sampler each 6-inch interval is recorded. If the sampler is advanced less than 6 inches in 50 blows, the test is stopped and the distance the spoon was driven with 50 blows is recorded. The number of blows to advance the split spoon from 6 to 18 inches (the second and third intervals) is commonly referred to as the N-value. We used an automatic hammer for the SPT sampling.

A Kleinfelder geo-professional provided technical oversight during the borings, maintained boring logs, and classified the soils in general accordance with ASTM D2488. Descriptions of the soil encountered in the explorations are included in the Boring Logs provided in Appendix A. A key to the symbols used on the logs and a soil description key are also provided in Appendix A.

2.2 LABORATORY TESTING

Laboratory testing was performed on selected samples to evaluate physical and engineering properties of the soils. The laboratory testing included the following tests performed in general accordance with the referenced standards:

- Moisture Content (ASTM D2216),
- Grain Size Distribution (ASTM D6913), and
- Atterberg Limits (ASTM D4318).

A summary table and laboratory test results are also included in Appendix B.

3 SUBSURFACE CONDITIONS

3.1 SUBSURFACE CONDITIONS

The major soil groups encountered in the borings are described in the following sections, in the general order of their occurrence. Detailed descriptions of the soil are included in the logs in Appendix A.

3.1.1 Surficial Materials

The borings advanced as part of this subsurface were drilled within grass-covered landscaped areas and encountered approximately 4 to 5 inches of topsoil.

3.1.2 Coastal Plain Deposits

Beneath the surface materials, the borings encountered coastal plain deposits. The soils predominantly consisted of interlayered poorly to well graded sand with varying amounts of silt and clay (SP, SW, SC, SM, SP-SC, SP-SM, SW-SM, SW-SC). The borings also encountered lean clay (CL) with varying amounts of sand. Layers of sandy silt (ML) and elastic silt (MH) with varying amounts of sand were encountered in Borings MC-2 and TC-2, respectively. The consistency of the cohesive soils ranged from very soft to stiff. The relative density of the cohesionless soils generally ranged from very loose to dense. Very dense well graded sand with silt (SW-SM) was encountered in Boring TC-2 from 48 to 50 feet.

3.1.3 Groundwater

Groundwater was observed during drilling in the borings. Where mud rotary drilling was used, the groundwater was measured prior to introduction of the drilling mud. Groundwater was measured upon completion of drilling. While the measured groundwater level may have been influenced by the mud fluid, where used, the measurements during drilling and after completion were within 1 foot and likely representative of groundwater conditions at the time of drilling. It should be noted that groundwater is known to fluctuate due to local and regional factors including, but not limited to, precipitation events, site topography, seasonal changes, well pumping, and periods of wet or dry weather.

A summary of the groundwater readings along the alignment are summarized in Table 3-1.

Table 3-1. Summary of Groundwater Readings

Boring	Depth to Groundwater (feet)	Time of Reading
MC-1	9	During drilling (prior to introduction of drilling mud)
	9.4	Upon completion (after introduction of drilling mud)
MC-2	8.5	During drilling (prior to introduction of drilling mud)
	9	Upon completion (after introduction of drilling mud)
TC-1	9	During drilling (prior to introduction of drilling mud)
	9.3	Upon completion (after introduction of drilling mud)
TC-2	5.5	During drilling, drilling mud not used
	8.8	Upon completion, drilling mud not used
KC-1	9	During drilling (prior to introduction of drilling mud)
	8.9	Upon completion (after introduction of drilling mud)
KC-2	10	During drilling (drilling mud not used)
	10.5	Upon Completion (drilling mud not used)

4 HDD RECOMMENDATIONS AND CONSIDERATIONS

Based on our geotechnical evaluation of the data discussed in this report, it is our professional opinion that the proposed HDD crossings are feasible. Consideration should be given to the very loose granular soils, very soft cohesive soils, side wall collapsing, and loss of mud drilling fluids observed in the borings. There are soil present that pose a risk of difficult steering and hole instability. Specific recommendation regarding the geotechnical aspects of project design and construction are presented in this report.

4.1 HDD CONSIDERATIONS

When considering the subsurface setting at this project site, site-specific conditions that generally could affect design, equipment selection, and/or cause difficult conditions or delays for HDD construction include:

- Potential for hydraulic fracturing or fluid loss as evidenced by loss of fluids during drilling;
- Borehole instability in poorly graded and well graded sand;
- Borehole swelling due to clays;
- Difficulty steering in very soft clays and silts;
- Hydraulic fracturing near the exit point;
- Difficulty in steering due to the presence of horizontal layering and variation in soil density/consistency;
- High pullback loads or stuck pipe due to caving sands; and
- Changed conditions claims or failure to complete the bore due to variation in subsurface conditions between the locations explored.

4.1.1 Anticipated Drilling Conditions

Kleinfelder summarized the generalized subsurface conditions in Table 4-1 per crossing based on soils encountered in the borings. Although some minor variances were encountered, general consistent layering was present at each crossing. The soil layering encountered at Taylor Branch were staggered about 5 feet downward from Boring TC-1 to Boring TC-2.

Table 4-1. Generalized Subsurface Summary per Crossing.

Crossing	Borings	Approx. Depth Range (ft)	Generalized Subsurface Conditions
Manokin River	MC-1, MC-2	0 to 10	Predominantly very loose to loose silty sand to non-plastic sandy silt; minor seam of lean clay
		10 to 50	Predominantly medium dense to dense poorly to well graded sand with varying amounts of silt and some trace gravel; minor seams of silty and clayey sand
		50 to 70	Interlayered loose to dense poorly to well graded sand with clay to clayey sand and stiff lean clay
Taylor Branch	TC-1, TC-2	0 to 2 (TC-1) 0 to 6 (TC-2)	Loose to very loose silty sand
		2 to13 (TC-1) 6 to18 (TC-2)	Loose to medium dense poorly to well graded sand with varying amounts of silt
		13 to 38 (TC-1) 18 to 43 (TC-2)	Soft to medium stiff lean clay and elastic silt with varying amounts of sand and loose clayey sand
		Previous depth-50 ft	Medium dense to very dense well to poorly graded sand with varying amounts of silt and clay
Kings Creek	KC-1, KC-2	0 to 33	Predominantly very loose to medium dense poorly graded sand with varying amounts of silt, silty to clayey sand; minor seam of very soft lean clay with sand from 8 to 13 ft in KC-2 and 13 to 18 ft in KC-1
		33 to 60	Predominantly medium dense to dense poorly graded sand with silt; minor seam of medium stiff to stiff lean clay in KC-2 from 33 to 38 ft

The contractor should carefully evaluate the ground conditions identified in this report before selecting drilling equipment and tooling.

4.1.2 Borehole stability

Layers of sands and silts were encountered during our investigation. The poorly graded and well graded sand units at the proposed crossing location may be unstable during HDD drilling operations and are prone to collapse in an HDD borehole. Boring KC-1 collapsed at an approximate depth of 53 feet up to 40 feet bgs. Boring MC-2 collapsed at an approximate depth of 63 feet up to 30 feet bgs. Proper drilling fluid makeup is needed to maintain hole stability in granular soils. The contractor should carefully evaluate the ground conditions identified in this report and should use drilling fluids appropriate for these ground conditions.

4.1.3 Steering

The density/consistency and gradation of soils encountered at the proposed HDD crossings were highly variable, as summarized in Table 4-1. These variations are likely to cause difficulty steering the drilling tools.

4.2 INADVERTENT RETURNS OF DRILLING FLUID

Hydraulic fracturing occurs when borehole pressure causes plastic deformation of the soil surrounding the borehole, initiating and propagating fractures in the soil mass. The resistance to plastic deformation and fracturing is a function of soil strength, overburden pressure, and pore water pressure. Hydraulic fracturing can result in drilling fluid inadvertently returning to the ground surface or running horizontally away from the borehole.

The contractor’s equipment and methods of construction as well as the final bore path configuration will affect the analysis results. It is recommended that a final hydraulic fracturing analysis be performed once the contractor has been selected and the drilling equipment and approach has been established.

Borehole instability issues can result from the contactor not maintaining a clean borehole, which result in poor drilling returns and partial or complete plugging of the borehole. This will result in higher fluid pressures within the bore and can lead to hydraulic fracturing and inadvertent fluid returns to the ground surface. Depending on the contractor’s means and methods, a minimum cover depth of 25 feet below the lowest elevation of the water feature should be maintained while drilling to minimize the risk of hydraulic fracturing where a relatively clean borehole is maintained with good drilling returns.

Hydraulic fracturing could occur and would be expected to occur near the bore exit point as the drill bit approaches the ground surface. This is common and countermeasures should be in place to mitigate this condition. These may include countermeasures to contain and manage releases in the area before the exit pit, digging a deeper exit pit, or reducing the drilling fluid pressure near the exit pit.

A pressure sensing sub several feet behind the drill bit can also be used to monitor drilling fluid pressures in the bore hole and compare them to the maximum predicted allowable pressures. This can be used to help avoid inadvertent fluid releases in critical applications. The pressure sub provides real-time monitoring of fluid pressures within the borehole and is useful in detecting a spike in drilling pressure that may result from a borehole that is not well cleaned and/or becomes blocked with the drilling solids. Furthermore, the pressure data allows the driller to understand when modifications to the drilling method may be needed to avoid a fluid release. We recommend that Kleinfelder be retained to monitor HDD operations and provide consultation based on the conditions encountered during drilling.

If the contractor feels there is too much risk of inadvertent fluid releases at the planned depth based on their equipment and experience, a deeper bore path should be considered.

Contingency planning to handle potential inadvertent fluid releases to the ground surface should be performed. Remedial measures in anticipation of cleanup of inadvertent fluid returns to the ground surface often include soil, straw bale, and/or waddle containment berms in high risk areas, vacuum trucks on stand-by, full-time observers, and similar approaches.

4.2.1 Drilling Fluid Losses

Loss of drilling fluid returns typically occurs when the drill bit encounters fractures or large interstitial pore spaces in coarse materials (i.e. medium- to coarse-grained sand and gravel). Loss of returns is recognized by a decrease of drilling fluid returns, or a drop in drilling fluid pressure.

Hynes advanced Borings KC-1, MC-1, MC-2, and TC-1 using mud rotary drilling techniques. Kleinfelder observed significant drilling fluid loss in Borings KC-1, MC-1, and MC-2 amounting to approximate total volumes of 50, 85, and 70 gallons, respectively. The amount of fluid loss varied with depth. Kleinfelder noted the approximate volume and depth ranges on the boring logs.

If fractures or interstitial pore spaces are small or discontinuous, they may fill with solids contained in the drilling fluid returns as drilling progresses beyond them. Once the fractures or pore spaces are filled, fluid will return up the bore hole again and fluid pressure will increase until another fracture or gravel layer is encountered. If fractures or gravel/cobble layers are continuous to the surface, drilling fluid may inadvertently return to the surface.

4.3 DRILLING FLUIDS

4.3.1 General

The drilling contractor should develop a Drilling Fluid Program (DFP) as part of the HDD Bore Plan. A properly designed drilling fluid program can substantially reduce losses due to inadvertent return, stuck product pipe, or loss of tooling. The drilling fluid program should consider anticipated soil conditions, fluid selection, drill bit and reamer selection, and volume calculations.

4.3.2 Soil Conditions for Drilling Fluid Design

For the purpose of drilling fluid design, earth materials are generally divided into two categories: inert, including silt, sand and gravel; and reactive, including clay and shale. Information regarding subsurface conditions likely to be encountered along the proposed HDD bore is provided in Sections 3.1 and 4.1.1 of this report. In addition, detailed descriptions of the subsurface conditions are provided on the boring logs contained in Appendix A. Geotechnical laboratory test results are contained in Appendix B. Site soils are anticipated to be primarily loose to medium dense poorly graded to well graded sand with varying amounts of silt and clay interlayered with lesser amounts of very soft to medium stiff clays and silts. There is a potential for the elastic silts encountered to react with drilling fluids and to swell. This should be managed by adequately designing the drilling fluid to reduce or eliminate potential filtrate from the drilling fluid.

4.3.3 Drilling Fluid Selection

The drilling fluid should be designed for site specific soil conditions. The drilling fluid may consist of either a bentonite or polymer base and water, with additives to achieve specific fluid properties. The additives selected need to address requirements for an increased filter-cake thickness and reduced exfiltration requirements.

The drilling contractor should submit a fluid design with a list of additives, loss of circulation materials, and grouting materials that may be used on the project and Material Safety Data Sheets (MSDS) for approval at least two weeks prior to mobilization. Assistance with drilling fluid selection can be obtained from reputable drilling fluid suppliers.

4.3.4 Borehole Slurry Density

The density of the slurry in the borehole directly affects the buoyancy force and therefore the normal force between the pipe and the wall of the borehole. The density of drilling returns is a function of ground conditions, penetration rate, mud flow rate, drilling fluid composition, and efficiency of the mud cleaning system. In general, drilling return density varies between 9 and 11 pounds per gallon in most fine-grained soils but can be slightly higher in gravel and in bedrock. This can result in relatively high drilling fluid pressures compared to typical mud weights. Therefore, we recommend the drilling fluid weight be monitored during construction.

4.3.5 Drill Bit and Reamer Selection

Drill bits and reamers should be selected based on anticipated subsurface conditions and experience. The drilling contractor should be prepared with a variety of bits and reamers that have worked well in similar soil conditions.

4.3.6 Soil and Fluid Volume

The volume of soil to be removed can be estimated as follows:

$$\frac{(\text{Hole Diameter in Inches})^2}{25} = \text{Volume in Gallons per Foot}$$

Sufficient fluid should be pumped during drilling and reaming operations to maintain flow. Drilling rates and drilling fluid flow rates may be adjusted in the field to match varying site conditions. An estimate of drilling fluid demand is useful when sizing drilling equipment, mud pumps, and solids removal systems, and can be particularly helpful in determining realistic drilling rates. Drilling fluid demand can be estimated based on the bore hole volume and the following ratios:

Fluid Volume: Soil Volume	Ratio
Sand, Gravel	1:1
Above, mixed with Clay	2:1
Clay	3-5:1

Drilling rates can be estimated based on the drilling fluid demand and the pump output at the design base fluid viscosity.

4.4 SOLIDS SEPARATION PLANT

Fine grained silts and clays are generally the most difficult to remove from drilling fluids. The presence of these soils along the proposed bore path may require use of desilters/centrifuge equipment to remove the fine soils from the drilling fluids. These conditions should be considered when selecting the solids separation plant equipment.

4.5 PIPE PULLBACK

If borehole instability occurs, pullback loads could greatly exceed predicted values. Good drilling and fluid management practices can reduce risk. If the pipe becomes stuck, the maximum capacity of the drill rig should be checked to see if it may be exerted on the pipe. Accordingly, the pipe should be designed to withstand the maximum anticipated rig capacity, or a maximum pullback load should be specified.

4.6 BOREHOLE FRICTION FACTOR AND ABRASION

A large portion of the pullback load is generated from friction between the pipe and the wall of the borehole. The pipe rubs against the borehole as it goes around corners and is pushed against the top of the borehole by buoyancy and capstan forces. The friction factor is an expression of the ratio of the normal force between the pipe and the borehole wall and the axial force needed to drag the pipe along the wall. ASTM Standard F1962-99 recommends a friction factor of 0.3 for steel pipe.

4.7 FLUIDIC PIPE DRAG COEFFICIENT

A fluidic drag coefficient of 0.050 psi (345 Pa) was recommended in the original Pipeline Research Council International (PRCI) design guidelines and is still routinely used by pipeline designers. Recently, literature has been suggested the coefficient could be decreased to 0.025 psi (172 Pa) for a stable borehole with good solids removal (Puckett 2003). The higher value (0.050 psi) is recommended for routine calculations. The lower value (0.025 psi) may be appropriate for long bores in stable formations where significant cost saving could be realized by using a lower grade of steel or thinner pipe wall.

4.8 DRILL PAD SUPPORT

The proposed workspace locations were not available at the time of this report. Near-surface soils in the vicinity of our borings consist of very loose to loose silty sand. These soils were able to support our drilling rig but there may be some soft locations present within the work areas. A gravel course or timber matting may be needed in areas containing fine-grained surficial soils especially during wet weather and near the mud pit. A gravel course is also likely to be required as a storm water pollution prevention measure to reduce track-out on adjacent roadways by construction equipment. The contractor should conduct a pre-bid site visit to determine the suitability of site conditions for their equipment.

4.9 UTILITIES CLEARANCE

The location of existing utilities and water wells was beyond the scope of this report. Nearby underground utilities exist and must be located and protected by the contractor to prevent being impacted by underground construction. The bore profile should be designed to allow sufficient clearance from underground utilities and wells. In general, wells located within about 100 feet of the HDD bore path may be affected by inadvertent releases of drilling fluids. This can damage a well and necessitate construction of a new replacement well.

5 ADDITIONAL SERVICES

Kleinfelder is available to provide additional services to help with this project as it goes through final design and into construction. A description of these services is below.

5.1 HDD DESIGN OR THIRD-PARTY REVIEW

Kleinfelder can design the proposed HDD drill paths and associated work spaces or perform a third-party review of the design by others. The third-party review typically includes a high level review of the proposed path and providing our professional opinion on the constructability of the design. Kleinfelder can also perform inadvertent returns or hydrofracture analysis or pipe stress analysis to estimate pull loads.

5.2 CONTRACTOR SELECTION

The success of the project will be substantially determined by the experience and performance of the specialty contractor retained to perform the work. We recommend the use of a specialty contractor with a minimum of 3 years construction experience in the field of horizontal directional drilling in similar drilling conditions on projects of similar scope (i.e., diameter, length, and depth). HDD contractors should be familiar with the use of drilling mud additives and conductor casing. Contractors should provide examples of projects they have successfully completed installing similar utilities in similar conditions using similar methods.

5.3 CONSTRUCTION OBSERVATION AND TESTING

Variations in soil types, rock, and groundwater conditions from those encountered in the explorations performed at the site are possible and may be encountered during construction. In order to permit correlation between the subsurface data obtained during the geotechnical evaluations and the actual subsurface conditions encountered during construction, we recommend Kleinfelder be retained to provide full-time observation and testing services during earthwork and foundation construction. This will allow us the opportunity to compare actual conditions exposed during construction with those encountered in our evaluation and to expedite supplemental recommendations if warranted by the exposed conditions. Monitoring during construction by experienced personnel is critical to the efficiency and integrity of the geotechnical aspects of construction.

6 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder’s profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by Chesapeake Utilities and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The work performed was based on project information provided by Chesapeake Utilities. If Chesapeake Utilities does not retain Kleinfelder to review any plans and specifications, including any revisions or modifications to the plans and specifications, Kleinfelder assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Chesapeake Utilities must obtain written approval from Kleinfelder’s engineer that such changes do not affect our recommendations. Failure to do so will vitiate Kleinfelder’s recommendations.

Kleinfelder offers various levels of investigative and engineering services to suit the varying needs of different clients. Although risk can never be eliminated, more detailed and extensive studies yield more information, which may help understand and manage the level of risk. Since detailed study and analysis involves greater expense, our clients participate in determining levels of service, which provide information for their purposes at acceptable levels of risk. Chesapeake Utilities and key members of the design team should discuss the issues covered in this report with Kleinfelder, so that the issues are understood and applied in a manner consistent with the owner’s budget, tolerance of risk and expectations for future performance and maintenance.

This report, and any future addenda or reports regarding this site, may be made available to bidders to supply them with only the data contained in the report regarding subsurface conditions and laboratory test results at the point and time noted. Bidders may not rely on interpretations, opinions, recommendations, or conclusions contained in the report. Because of the limited nature of any subsurface study, the contractor may encounter conditions during construction which differ from those presented in this report. In such event, the contractor should promptly notify the owner so that Kleinfelder's Geotechnical Engineer can be contacted to confirm those conditions. We recommend the contractor describe the nature and extent of the differing conditions in writing and that the construction contract include provisions for dealing with differing conditions. Contingency funds should be reserved for potential problems during foundation construction.

7 REFERENCES

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FIGURES

PLOTTED: 2/10/2020 6:24:10 PM BY: CHamrick

GIS FILE PATH: \\azrgisstorp01\Working_clients_Automated_Exploration Plans

N

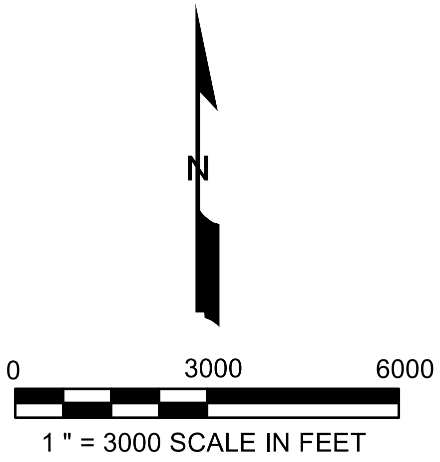
VICINITY MAP

NOT TO SCALE

NOTE:
BASE MAPPING AND VICINITY MAP CREATED FROM LAYERS COMPILED BY ESRI PRODUCTS AND 2020 MICROSOFT CORPORATION.
COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE MARYLAND FIPS 1900

LEGEND

⊕ BORING



1 " = 3000 SCALE IN FEET

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PROJECT NO.
20202452.001A

DRAWN BY: C. Hamrick

CHECKED BY: K. Backlund

DATE: 02-10-2020

EXPLORATION LOCATION PLAN
AND VICINITY MAP

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

FIGURE

1

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BORING LOGS

SAMPLE/SAMPLER TYPE GRAPHICS

- ■ COMPOSITE SAMPLE
- ▥ SHELBY TUBE SAMPLER
- ◩ STANDARD PENETRATION SPLIT SPOON SAMPLER (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)
- ◩ STANDARD PENETRATION SPLIT SPOON SAMPLER (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)

GROUND WATER GRAPHICS

- ▽ WATER LEVEL (level where first observed)
- ▼ WATER LEVEL (level after exploration completion)
- ▼ WATER LEVEL (additional levels after exploration)
- ≋ OBSERVED SEEPAGE

NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

ABBREVIATIONS

PID - Photoionization Detector

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	**GRAVELS** (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu≥4 and 1≤Cc≤3	▨	**GW**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			Cu<4 and/ or 1>Cc>3	▨	**GP**	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	Cu≥4 and 1≤Cc≤3	▨	**GW-GM**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				▨	**GW-GC**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			Cu<4 and/ or 1>Cc>3	▨	**GP-GM**	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				▨	**GP-GC**	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES		▨	**GM**	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
				▨	**GC**	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				▨	**GC-GM**	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (Half or more of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	Cu≥6 and 1≤Cc≤3	▨	**SW**	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			Cu<6 and/ or 1>Cc>3	▨	**SP**	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	Cu≥6 and 1≤Cc≤3	▨	**SW-SM**	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				▨	**SW-SC**	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			Cu<6 and/ or 1>Cc>3	▨	**SP-SM**	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				▨	**SP-SC**	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES		▨	**SM**	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
				▨	**SC**	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
				▨	**SC-SM**	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES

FINE GRAINED SOILS (Half or more of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)	▨	**ML**	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
		▨	**CL**	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		▨	**CL-ML**	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		▨	**OL**	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit 50 or greater)	▨	**MH**	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
		▨	**CH**	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		▨	**OH**	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

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PROJECT NO.:
20202452.001A

DRAWN BY: CH
CHECKED BY: KLB
DATE: 2/10/2020

GRAPHICS KEY

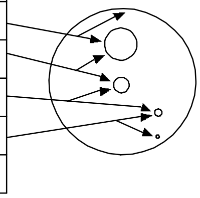
Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

LEGEND

KEY-1

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		>12 in. (304.8 mm.)	>12 in. (304.8 mm.)	Larger than basketball-sized
Cobbles		3 - 12 in. (76.2 - 304.8 mm.)	3 - 12 in. (76.2 - 304.8 mm.)	Fist-sized to basketball-sized
Gravel	coarse	3/4 -3 in. (19 - 76.2 mm.)	3/4 -3 in. (19 - 76.2 mm.)	Thumb-sized to fist-sized
	fine	#4 - 3/4 in. (#4 - 19 mm.)	0.19 - 0.75 in. (4.8 - 19 mm.)	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19 in. (2 - 4.9 mm.)	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079 in. (0.43 - 2 mm.)	Sugar-sized to rock salt-sized
	fine	#200 - #40	0.0029 - 0.017 in. (0.07 - 0.43 mm.)	Flour-sized to sugar-sized
Fines		Passing #200	<0.0029 in. (<0.07 mm.)	Flour-sized and smaller



SECONDARY CONSTITUENT

	AMOUNT	
Term of Use	Secondary Constituent is Fine Grained	Secondary Constituent is Coarse Grained
Trace	<5%	<15%
With	≥5 to <15%	≥15 to <30%
Modifier	≥15%	≥30%

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT - N_{60} (# blows / ft)	Pocket Pen (tsf)	UNCONFINED COMPRESSIVE STRENGTH (Q_u)(psf)	VISUAL / MANUAL CRITERIA
Very Soft	<2	PP < 0.25	<500	Thumb will penetrate more than 1 inch (25 mm). Extrudes between fingers when squeezed.
Soft	2 - 4	0.25 ≤ PP <0.5	500 - 1000	Thumb will penetrate soil about 1 inch (25 mm). Remolded by light finger pressure.
Medium Stiff	4 - 8	0.5 ≤ PP <1	1000 - 2000	Thumb will penetrate soil about 1/4 inch (6 mm). Remolded by strong finger pressure.
Stiff	8 - 15	1 ≤ PP <2	2000 - 4000	Can be imprinted with considerable pressure from thumb.
Very Stiff	15 - 30	2 ≤ PP <4	4000 - 8000	Thumb will not indent soil but readily indented with thumbnail.
Hard	>30	4 ≤ PP	>8000	Thumbnail will not indent soil.

FROM TERZAGHI AND PECK, 1948; LAMBE AND WHITMAN, 1969; FHWA, 2002; AND ASTM D2488

REACTION WITH HYDROCHLORIC ACID

DESCRIPTION	FIELD TEST
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT-N_{60} (# blows/ft)	MODIFIED CA SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)	RELATIVE DENSITY (%)
Very Loose	<4	<4	<5	0 - 15
Loose	4 - 10	5 - 12	5 - 15	15 - 35
Medium Dense	10 - 30	12 - 35	15 - 40	35 - 65
Dense	30 - 50	35 - 60	40 - 70	65 - 85
Very Dense	>50	>60	>70	85 - 100

FROM TERZAGHI AND PECK, 1948

PLASTICITY

DESCRIPTION	LL	FIELD TEST
Non-plastic	NP	A 1/8-in. (3 mm.) thread cannot be rolled at any water content.
Low (L)	< 30	The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit.
Medium (M)	30 - 50	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit.
High (H)	> 50	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit.

STRUCTURE

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness.
Laminated	Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.

ANGULARITY

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

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PROJECT NO.:
20202452.001A

DRAWN BY: CH
CHECKED BY: KLB
DATE: 2/10/2020

SOIL DESCRIPTION KEY

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

LEGEND

KEY-2

BORING LOG KC-1

Date Begin - End: 1/30/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 38°F Clear
Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger / Mud Rotary
Exploration Diameter: 3.25 in. I.D.
Hammer Type - Drop: 140 lb. Auto - 30 in.

FIELD EXPLORATION / LABORATORY RESULTS

Latitude: 38.16666° N
Longitude: -75.68964° E
Ground Surface Elevation (ft.): 8
Surface Condition: Grass

Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			~4 inches TOPSOIL **Coastal Plain Deposit:** **Silty SAND (SM)**: fine-grained, subrounded, low plasticity, yellowish brown, moist, very loose	S-1		BC=1 2 1 1	24"								
5				S-2		BC=WOH WOH WOH 2	24"								
	5		**Poorly graded SAND (SP)**: fine-grained, subrounded, non-plastic, olive yellow, moist to wet, very loose to medium dense	S-3		BC=3 6 5 3	18"								
				S-4		BC=3 2 1 1	24"								
0 ▽▼			**Clayey SAND (SC)**: low plasticity, gray, moist, very loose, trace gravel wet below 9 ft	S-5		BC=WOH WOH 2 2	24"	SC	17.9		87	39	23	11	
	10														Switch to 2.875 in. O.D. roller bit mud rotary at 10 ft. Fluid loss of ~25 gallons from 10 to 23 ft.
-5			**Lean CLAY with Sand (CL)**: low plasticity, gray, wet, very soft	S-6		BC=WOH WOH WOH 2	24"								
	15			U-7		PP=0.5									
-10			**Clayey SAND (SC)**: fine-grained, subrounded, low plasticity, light gray, wet, loose	S-8		BC=2 2 3 3	18"								
	20														
-15				S-9		BC=3 4 3 6	18"								
	25														
-20			**Poorly graded SAND with Silt (SP-SM)**: fine-grained, subrounded, non-plastic, light gray, wet, medium dense	S-10		BC=3 4 8 10	18"	SP-SM	21.4		100	6.9			
	30														
-25			dense	S-11		BC=13 22 28 25	18"								

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PROJECT NO.: 20202452.001A
DRAWN BY: TB
CHECKED BY: KB
DATE: 2/4/2020

BORING LOG KC-1

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
KC-1

gINT FILE: Klf_gint_master_2020 PROJECT NUMBER: 20202452.001A OFFICE FILTER: BALTIMORE PLOTTED: 02/21/2020 12:07 PM BY: CHamrick
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2020.GLB [__KLF_BORING/TEST PIT SOIL LOG]

Date Begin - End:	1/30/2020	**Drilling Company:**	J. D. Hynes & Associates	**BORING LOG KC-1**
Logged By:	T. Boswell	**Drill Crew:**	E. Walters	
Hor.-Vert. Datum:	WGS 1984 - NAVD88	**Drilling Equipment:**	Geoprobe 3230DT	**Hammer Type - Drop:** 140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger / Mud Rotary	
Weather:	38°F Clear	**Exploration Diameter:**	3.25 in. I.D.	

Elevation (feet)	Depth (feet)	Latitude: 38.16666° N Longitude: -75.68964° E Ground Surface Elevation (ft.): 8 Surface Condition: Grass Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		Poorly graded SAND with Silt (SP-SM): fine-grained, subrounded, non-plastic, light gray, wet, dense												
-30		fine to medium-grained	S-12	◣	BC=20 18 27 29	18"								
	40													
-35		fine to coarse-grained, gray	S-13	◣	BC=10 18 23 26	18"								
	45													Fluid loss of ~20 gallons from 23 to 50 ft.
-40		medium dense	S-14	◣	BC=5 10 6 10	18"	SP-SM	20.1		99	7.8			
	50													
-45			S-15	◣	BC=6 9 15 18	18"								Borehole collapsed from ~40 to 53 ft, redrilled this length to collect S-15
	55													Fluid loss of ~5 gallons from 50 to 58 ft.
-50			S-16	◣	BC=8 8 14 17	18"								
	60	The boring was terminated at approximately 60 ft. below ground surface. The boring was backfilled with grout on January 30, 2020.												
-55														
	65													
-60														

GROUNDWATER LEVEL INFORMATION:

▼ Groundwater was observed at approximately 8.9 ft. below ground surface 10 minutes after drilling completion.

▽ Groundwater was observed at approximately 9 ft. below ground surface during drilling.

GENERAL NOTES:

Elevation of the boring locations were estimated from National Elevation Dataset.

An iPad integrated GPS unit was used to locate the exploration with an accuracy of 5 meters.

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PROJECT NO.: 20202452.001A		BORING LOG KC-1	BORING
DRAWN BY:	TB	Somerset County Gas Main Expansion Phase 2: HDD Crossings Ocean Highway Somerset County, Maryland	KC-1
CHECKED BY:	KB		
DATE:	2/4/2020		PAGE: 2 of 2

BORING LOG KC-2

Date Begin - End: 1/31/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 42°F Clear

Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger
Exploration Diameter: 3.25 in. I.D.

Hammer Type - Drop: 140 lb. Auto - 30 in.

Latitude: 38.16327° N
Longitude: -75.68989° E
Ground Surface Elevation (ft.): 14
Surface Condition: Grass

			FIELD EXPLORATION					LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncor Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			~4 inches TOPSOIL **Coastal Plain Desosit:** **Silty SAND (SM)**: fine-grained, subrounded, low plasticity, yellowish brown, moist, loose	S-1		BC=2 1 4 7	24"								
			Poorly graded SAND (SP): fine-grained, subrounded, non-plastic, olive yellow, moist to wet, medium dense	S-2		BC=2 4 6 7	24"								
10															
				S-3		BC=2 5 7 6	18"								
	5														
			very loose	S-4		BC=WOH WOH 1 2	18"								
			Lean CLAY with Sand (CL): fine-grained, subrounded, medium plasticity, gray, moist to wet, very soft	S-5		BC=WOH WOH 2 2 PP=<0.25	24"								
5															
	10														
			Poorly Graded SAND with Silt (SP-SM): fine to coarse-grained, subrounded, non-plastic, gray, wet, medium dense, trace gravel	S-6		BC=2 5 9 13	18"	SP-SM	15.4		96	6.1			
0															
	15														
				S-7		BC=1 3 14 25	18"								
-5															
	20														
			Clayey SAND (SC): fine-grained, subrounded, low plasticity, gray, wet, loose	S-8		BC=4 4 3 3	18"								
-10															
	25														
			very loose	S-9		BC=3 1 3 9	18"								
-15															
	30														
			Sandy Lean CLAY (CL): medium plasticity, gray, wet, stiff	S-10		BC=3 4 4 5	12"	CL	58.7		100	64	42	21	
-20															

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PROJECT NO.: 20202452.001A
DRAWN BY: TB
CHECKED BY: KB
DATE: 2/4/2020

BORING LOG KC-2

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
KC-2

Date Begin - End: 1/31/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 42°F Clear
Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger
Exploration Diameter: 3.25 in. I.D.
Hammer Type - Drop: 140 lb. Auto - 30 in.

BORING LOG KC-2

			FIELD EXPLORATION					LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Latitude: 38.16327° N Longitude: -75.68989° E Ground Surface Elevation (ft.): 14 Surface Condition: Grass Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		▨	**Sandy Lean CLAY (CL)**: medium plasticity, gray, wet, stiff			PP=1.5									
-25	40		**Poorly graded SAND with Silt (SP-SM)**: fine-grained, subrounded, non-plastic, gray, wet, medium dense	S-11	◣	BC=1 7 17 22	18"								
-30	45			S-12	◣	BC=2 4 11 17	24"	SP-SM	24.2		100	7.1			
-35	50		dense	S-13	◣	BC=3 12 30 33	24"								
-40	55		medium dense	S-14	◣	BC=1 4 17 27	24"								
-45	60		**Well graded SAND with Silt (SW-SM)**: fine to coarse-grained, subrounded, non-plastic, gray, wet, medium dense	S-15	◣	BC=2 9 18 23	24"								
-50	65														
-55															

The boring was terminated at approximately 60 ft. below ground surface. The boring was backfilled with grout on January 31, 2020.

GROUNDWATER LEVEL INFORMATION:
∇ Groundwater was observed at approximately 10 ft. below ground surface during drilling.
▼ Groundwater was observed at approximately 10.5 ft. below ground surface 10 minutes after drilling completion.

GENERAL NOTES:
Elevation of the boring locations were estimated from National Elevation Dataset.
An iPad integrated GPS unit was used to locate the exploration with an accuracy of 5 meters.

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CHECKED BY: KB
DATE: 2/4/2020

BORING LOG KC-2

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
KC-2

BORING LOG MC-1

Date Begin - End: 1/29/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 38°F Cloudy
Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger / Mud Rotary
Exploration Diameter: 3.25 in. I.D.
Hammer Type - Drop: 140 lb. Auto - 30 in.

Latitude: 38.20512° N
Longitude: -75.69963° E
Ground Surface Elevation (ft.): 12
Surface Condition: Grass

FIELD EXPLORATION								LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			~4 inches TOPSOIL **Coastal Plain Desosit:** **Silty SAND (SM)**: fine to coarse-grained, subrounded to rounded, low plasticity, yellow, moist, very loose to loose	S-1	◣	BC=2 1 3 6	24"								
10				S-2	◣	BC=2 2 5 8	24"								
	5			S-3	◣	BC=3 4 6 8	24"								
5				S-4	◣	BC=3 3 4 3	24"								
	▽ ▼		wet	S-5	◣	BC=1 1 3 3	24"								
	10														Switch to 2.875 in. O.D. roller bit mud rotary at 10 ft.
0															Fluid loss of ~20 gallons from 10 to 30 ft.
			Well-graded SAND (SW): fine to coarse-grained, subrounded, non-plastic, yellow, wet, medium dense	S-6	◣	BC=4 7 10 14	24"								
	15														
-5															
			Well-graded SAND with Silt and Gravel (SW-SM): medium to coarse-grained, subrounded, non-plastic, reddish yellow, wet, dense, iron oxide staining	S-7	◣	BC=9 16 22 22	20"	SW-SM	10.2		78	6.9			
	20														
-10															
			Silty SAND (SM): fine-grained, subrounded, non-plastic, reddish yellow, wet, medium dense, iron oxide staining, trace gravel	S-8	◣	BC=2 4 6 7	18"								
	25														
-15															
			Well-graded SAND (SW): medium to coarse-grained, subrounded, light brown, wet, medium dense, trace gravel	S-9	◣	BC=1 4 9 7	24"								

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PROJECT NO.: 20202452.001A
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DATE: 2/4/2020

BORING LOG MC-1

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
MC-1

Date Begin - End:	1/29/2020	**Drilling Company:**	J. D. Hynes & Associates		**BORING LOG MC-1**
Logged By:	T. Boswell	**Drill Crew:**	E. Walters		
Hor.-Vert. Datum:	WGS 1984 - NAVD88	**Drilling Equipment:**	Geoprobe 3230DT	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger / Mud Rotary		
Weather:	38°F Cloudy	**Exploration Diameter:**	3.25 in. I.D.		

Latitude: 38.20512° N
Longitude: -75.69963° E
Ground Surface Elevation (ft.): 12
Surface Condition: Grass

FIELD EXPLORATION								LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
-20			**Well-graded SAND (SW)**: medium to coarse-grained, subrounded, light brown, wet, medium dense, trace gravel												Fluid loss of ~15 gallons from 30 to 38 ft.
	35		fine to medium-grained, light brownish gray	S-10		BC=5 6 9 9	12"								
-25															
	40		**Well-Graded SAND with Silt (SW-SM)**: fine to coarse-grained, subrounded, non-plastic, light gray, wet, medium dense	S-11		BC=4 4 7 11	18"								Fluid loss of ~30 gallons from 38 to 43 ft.
-30															
	45		**Poorly Graded SAND with Silt (SP-SM)**: fine-grained, subrounded, non-plastic, light gray, wet, dense	S-12		BC=11 13 23 26	18"								
-35															
	50		medium dense	S-13		BC=9 12 15 15	12"	SP-SM	22.5		100	7.9	NP	NP	
-40															
	55		fine to medium-grained, dense	S-14		BC=10 10 21 24	18"								
-45															
			Clayey SAND (SC): fine-grained, low to medium plasticity, gray, wet, medium dense	S-15		BC=8 6 6 9	18"								

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PROJECT NO.:
20202452.001A

DRAWN BY: TB
CHECKED BY: KB
DATE: 2/4/2020

BORING LOG MC-1

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
MC-1

Date Begin - End: 1/29/2020
Drilling Company: J. D. Hynes & Associates
BORING LOG MC-1
Logged By: T. Boswell
Drill Crew: E. Walters
Hor.-Vert. Datum: WGS 1984 - NAVD88
Drilling Equipment: Geoprobe 3230DT
Hammer Type - Drop: 140 lb. Auto - 30 in.
Plunge: -90 degrees
Drilling Method: Hollow Stem Auger / Mud Rotary
Weather: 38°F Cloudy
Exploration Diameter: 3.25 in. I.D.

FIELD EXPLORATION

Latitude: 38.20512° N
Longitude: -75.69963° E
Ground Surface Elevation (ft.): 12
Surface Condition: Grass

LABORATORY RESULTS

Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
-50		▨	**Clayey SAND (SC)**: fine-grained, low to medium plasticity, gray, wet, medium dense												
-55	65	▨	**Poorly graded SAND with Clay (SP-SC)**: fine-grained, subrounded, low plasticity, gray, wet, loose	S-16	◣	BC=2 4 5 6	18"								
	70	▨	**Clayey SAND (SC)**: fine-grained, subrounded, low plasticity, gray, wet, medium dense	S-17	◣	BC=4 8 10 15	18"								Fluid loss of ~20 gallons from 43 to 68 ft.
-60															
	75														
-65															
	80														
-70															
	85														
-75															

The boring was terminated at approximately 70 ft. below ground surface. The boring was backfilled with grout on January 29, 2020.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 9 ft. below ground surface during drilling.
▼ Groundwater was observed at approximately 9.4 ft. below ground surface 10 minutes after drilling completion.
GENERAL NOTES:
Elevation of the boring locations were estimated from National Elevation Dataset.
An iPad integrated GPS unit was used to locate the exploration with an accuracy of 5 meters.

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BORING LOG MC-1

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
MC-1

Date Begin - End: 1/30/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 38°F Clear

Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger / Mud Rotary
Exploration Diameter: 3.25 in. I.D.

Hammer Type - Drop: 140 lb. Auto - 30 in.

BORING LOG MC-2

Latitude: 38.20066° N
Longitude: -75.69831° E
Ground Surface Elevation (ft.): 12
Surface Condition: Grass

FIELD EXPLORATION								LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			~4 inches TOPSOIL **Coastal Plain Deposit:** **Sandy SILT (ML)**: non-plastic, dark brown, moist, medium dense	S-1		BC=4 6 8 8	24"								
10			loose	S-2		BC=3 5 5 5	24"	ML	16.0		100	65	NP	NP	
	5			S-3		BC=3 2 3 3	24"								
5			**Lean CLAY (CL)**: medium plasticity, brown, moist to wet, medium stiff, trace sand	S-4		BC=2 2 3 4 PP=1.0	24"								
▽ ▼			**Poorly graded SAND (SP)**: fine-grained, subrounded, non-plastic, light greenish gray, wet, very loose	S-5		BC=1 1 2 3	24"								
	10														Switch to 2.875 in. O.D. roller bit mud rotary at 10 ft.
0															No apparent fluid loss from 10 to 23 ft
			Clayey SAND (SC): fine-grained, subrounded, low plasticity, light gray, wet, very loose	S-6		BC=WOH WOH WOH 1	24"								
-5	15														
			Well-graded SAND (SW): fine to medium-grained, subrounded, non-plastic, light gray, wet, dense	S-7		BC=14 17 22 19	18"								
-10	20														
			Poorly graded SAND with Silt (SP-SM): fine-grained, subrounded, non-plastic, light gray, wet, dense	S-8		BC=11 17 23 22	18"								
-15	25														
				S-9		BC=13 10 20 32	18"	SP-SM	18.7		100	6.2			

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PROJECT NO.: 20202452.001A
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DATE: 2/4/2020

BORING LOG MC-2

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
MC-2

Date Begin - End: 1/30/2020
Drilling Company: J. D. Hynes & Associates
BORING LOG MC-2
Logged By: T. Boswell
Drill Crew: E. Walters
Hor.-Vert. Datum: WGS 1984 - NAVD88
Drilling Equipment: Geoprobe 3230DT
Hammer Type - Drop: 140 lb. Auto - 30 in.
Plunge: -90 degrees
Drilling Method: Hollow Stem Auger / Mud Rotary
Weather: 38°F Clear
Exploration Diameter: 3.25 in. I.D.

Latitude: 38.20066° N
Longitude: -75.69831° E
Ground Surface Elevation (ft.): 12
Surface Condition: Grass

			FIELD EXPLORATION					LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			Poorly graded SAND with Silt (SP-SM): fine-grained, subrounded, non-plastic, light gray, wet, dense												
-20															
				S-10		BC=10 17 19 20	24"								
	35														
-25															
				S-11		BC=14 21 17 16	18"								
	40														
-30															
			Poorly graded SAND (SP): fine-grained, subrounded, non-plastic, light greenish gray, wet, dense	S-12		BC=12 17 17 17	18"								Fluid loss of ~20 gallons from 20 to 43 ft.
	45														
-35															
			Clayey SAND (SC): fine to coarse-grained, subrounded, low plasticity, gray, wet, medium dense, trace gravel	S-13		BC=3 5 6 7	18"								
	50														
-40															
			Lean CLAY (CL): medium plasticity, gray, moist to wet, stiff, trace sand	S-14		BC=1 4 6 6 PP=2.0	18"	CL	49.1		100	87			
	55														Fluid loss of ~20 gallons from 43 to 58 ft.
-45															
			Clayey SAND (SC): medium-grained, subrounded, low plasticity, gray, wet, medium dense	S-15		BC=1 4 6 5	18"								

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PROJECT NO.: 20202452.001A
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CHECKED BY: KB
DATE: 2/4/2020

BORING LOG MC-2

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
MC-2
PAGE: 2 of 3

Date Begin - End: 1/30/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 38°F Clear

Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger / Mud Rotary
Exploration Diameter: 3.25 in. I.D.

Hammer Type - Drop: 140 lb. Auto - 30 in.

BORING LOG MC-2

			FIELD EXPLORATION					LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Latitude: 38.20066° N Longitude: -75.69831° E Ground Surface Elevation (ft.): 12 Surface Condition: Grass Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
-50		▨	**Clayey SAND (SC)**: medium-grained, subrounded, low plasticity, gray, wet, medium dense												Fluid loss of ~30 gallons from 58 to 63 ft.
	65	▨	**Well-graded SAND with Clay (SW-SC)**: fine to coarse-grained, subrounded, low plasticity, gray, wet, dense	S-16	◣	BC=5 9 23 31	18"								Borehold collapsed up to ~30 ft. while retrieving S-16 sample. Boring was terminated at 65 ft.
-55															
	70														
-60															
	75														
-65															
	80														
-70															
	85														
-75															

The boring was terminated at approximately 65 ft. below ground surface. The boring was backfilled with grout on January 30, 2020.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 8.5 ft. below ground surface during drilling.
▼ Groundwater was observed at approximately 9 ft. below ground surface 10 minutes after drilling completion.

GENERAL NOTES:
Elevation of the boring locations were estimated from National Elevation Dataset.
An iPad integrated GPS unit was used to locate the exploration with an accuracy of 5 meters.

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PROJECT NO.: 20202452.001A
DRAWN BY: TB
CHECKED BY: KB
DATE: 2/4/2020

BORING LOG MC-2

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
MC-2

Date Begin - End: 1/30/2020
Drilling Company: J. D. Hynes & Associates
BORING LOG TC-1
Logged By: T. Boswell
Drill Crew: E. Walters
Hor.-Vert. Datum: WGS 1984 - NAVD88
Drilling Equipment: Geoprobe 3230DT
Hammer Type - Drop: 140 lb. Auto - 30 in.
Plunge: -90 degrees
Drilling Method: Hollow Stem Auger / Mud Rotary
Weather: 38°F Clear
Exploration Diameter: 3.25 in. I.D.

Latitude: 38.18503° N
Longitude: -75.69096° E
Ground Surface Elevation (ft.): 12
Surface Condition: Grass

FIELD EXPLORATION								LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			~5 inches TOPSOIL **Coastal Plain Desosit:** **Silty SAND (SM)**: fine to medium-grained, low plasticity, yellowish brown, moist, loose	S-1	◣	BC=1 1 7 8	12"								
10			**Well-graded SAND with Silt (SW-SM)**: fine to coarse-grained, subrounded, non-plastic, yellowish brown, moist, medium dense, trace gravel	S-2	◣	BC=1 10 19 22	18"								
	5			S-3	◣	BC=4 9 14 8	12"								
5			light gray, moist to wet	S-4	◣	BC=4 7 9 8	18"								
∇ ▼			loose wet	S-5	◣	BC=2 3 7 8	18"	SW-SM	15.0		83	8.3			
0	10														Switch to 2.875 in. O.D. roller bit mud rotary at 10 ft.
			Lean CLAY (CL): low to medium plasticity, gray, wet, soft, trace sand	S-6	◣	BC=1 1 2 4 PP=0.5	18"								
-5	15														
			medium stiff	S-7	◣	BC=1 2 3 5 PP=1.5	24"								
-10	20														
			Sandy Lean CLAY (CL): low plasticity, gray, wet, soft	S-8	◣	BC=1 1 2 4 PP=1.5	24"								
-15	25														
				S-9	◣	BC=1 WOH 2 3	18"								

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PROJECT NO.: 20202452.001A
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CHECKED BY: KB
DATE: 2/4/2020

BORING LOG TC-1

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
TC-1

Date Begin - End: 2/03/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 55°F Clear

Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger
Exploration Diameter: 3.25 in. I.D.

Hammer Type - Drop: 140 lb. Auto - 30 in.

BORING LOG TC-2

Latitude: 38.18333° N
Longitude: -75.69047° E
Ground Surface Elevation (ft.): 9
Surface Condition: Grass

FIELD EXPLORATION								LABORATORY RESULTS								
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			~5 inches TOPSOIL **Coastal Plain Deposit:** **Silty SAND (SM)**: fine-grained, subrounded, non-plastic, yellowish brown, dry to moist, loose	S-1		BC=2 3 3 3	18"								
			very loose	S-2		BC=1 1 1 1	18"								
5	5 ▽ ▼			S-3		BC=1 1 3 3	18"								
			Well-graded SAND (SW): fine to coarse-grained, subrounded, non-plastic, yellowish brown, wet, loose, trace gravel	S-4		BC=1 2 2 5	12"								
0				S-5		BC=2 3 5 6	18"								
	10														
-5			**Poorly graded SAND (SP)**: fine-grained, subrounded, non-plastic, light gray, wet, loose, trace gravel	S-6		BC=4 3 2 1	18"								
	15														
-10			**Sandy Elastic SILT (MH)**: high plasticity, gray, wet, soft	S-7		BC=2 1 1 2 PP=1.0	24"								
	20			U-8			24"	MH	56.7		100	52	63	27	
-15			**Elastic SILT with Sand (MH)**: high plasticity, gray, wet, medium stiff	S-9		BC=2 1 3 4 PP=1.5	24"								
	25														
-20				S-10		BC=2 3 4 7	18"								

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PROJECT NO.: 20202452.001A
DRAWN BY: TB
CHECKED BY: KB
DATE: 2/4/2020

BORING LOG TC-2

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
TC-2

Date Begin - End:	1/30/2020	**Drilling Company:**	J. D. Hynes & Associates		**BORING LOG TC-1**
Logged By:	T. Boswell	**Drill Crew:**	E. Walters		
Hor.-Vert. Datum:	WGS 1984 - NAVD88	**Drilling Equipment:**	Geoprobe 3230DT	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger / Mud Rotary		
Weather:	38°F Clear	**Exploration Diameter:**	3.25 in. I.D.		

			FIELD EXPLORATION					LABORATORY RESULTS							
Elevation (feet)	Depth (feet)	Graphical Log	Latitude: 38.18503° N Longitude: -75.69096° E Ground Surface Elevation (ft.): 12 Surface Condition: Grass Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
-20		▨	**Sandy Lean CLAY (CL)**: low plasticity, gray, wet, soft			PP=2.0									
-25	35	▨	**Clayey SAND (SC)**: fine-grained, subrounded, low plasticity, gray, wet, loose	S-10	◣	BC=1 3 6 8	24"								
-30	40	▨	**Poorly graded SAND with Clay (SP-SC)**: fine-grained, subrounded, low plasticity, gray, wet, medium dense	S-11	◣	BC=5 6 10 14	18"								
-35	45	▨	**Poorly Graded SAND with Silt and Gravel (SP-SM)**: fine to coarse-grained, subrounded, non-plastic, gray, wet, medium dense	S-12	◣	BC=4 5 13 18	18"	SP-SM	15.0		74	5.9			
	50	▨		S-13	◣	BC=8 8 10 23	18"								
-40 -45	55														

The boring was terminated at approximately 50 ft. below ground surface. The boring was backfilled with grout on January 30, 2020.

GROUNDWATER LEVEL INFORMATION:

∇ Groundwater was observed at approximately 9 ft. below ground surface during drilling.

▼ Groundwater was observed at approximately 9.3 ft. below ground surface 10 minutes after drilling completion.

GENERAL NOTES:

Elevation of the boring locations were estimated from National Elevation Dataset.

An iPad integrated GPS unit was used to locate the exploration with an accuracy of 5 meters.

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 20202452.001A	BORING LOG TC-1	BORING
	DRAWN BY: TB CHECKED BY: KB DATE: 2/4/2020	Somerset County Gas Main Expansion Phase 2: HDD Crossings Ocean Highway Somerset County, Maryland	TC-1 PAGE: 2 of 2

BORING LOG TC-2

Date Begin - End: 2/03/2020
Logged By: T. Boswell
Hor.-Vert. Datum: WGS 1984 - NAVD88
Plunge: -90 degrees
Weather: 55°F Clear
Drilling Company: J. D. Hynes & Associates
Drill Crew: E. Walters
Drilling Equipment: Geoprobe 3230DT
Drilling Method: Hollow Stem Auger
Exploration Diameter: 3.25 in. I.D.
Hammer Type - Drop: 140 lb. Auto - 30 in.

Latitude: 38.18333° N
Longitude: -75.69047° E
Ground Surface Elevation (ft.): 9
Surface Condition: Grass

		FIELD EXPLORATION					LABORATORY RESULTS								
Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Number	Sample Type	Blow Counts(BC)= Uncorr Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			Elastic SILT with Sand (MH): high plasticity, gray, wet, medium stiff			PP=2.5									
-25	35		**Lean CLAY (CL)**: medium plasticity, gray, wet, medium stiff, trace sand	S-11		BC=3 3 3 5 PP=1.5	18"								
-30	40		**Sandy Lean CLAY (CL)**: low plasticity, gray, wet, stiff, trace gravel	S-12		BC=3 4 6 6 PP=1.0	18"								
-35	45		**Well-graded SAND with Silt (SW-SM)**: fine to coarse-grained, subrounded, light greenish gray, wet, medium dense, trace gravel	S-13		BC=8 8 18 24	18"	SW-SM	17.0		95	7.9			
-40	50		very dense	S-14		BC=15 22 45 35	24"								
-45	55														
-50															

The boring was terminated at approximately 50 ft. below ground surface. The boring was backfilled with grout on February 03, 2020.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 5.5 ft. below ground surface during drilling.
▼ Groundwater was observed at approximately 5.8 ft. below ground surface 10 minutes after drilling completion.

GENERAL NOTES:
Elevation of the boring locations were estimated from National Elevation Dataset.
The drillers could not switch to mud rotary at 10 ft. and the boring was completed using hollow stem augers.
An iPad integrated GPS unit was used to locate the exploration with an accuracy of 5 meters.

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PROJECT NO.: 20202452.001A
DRAWN BY: TB
CHECKED BY: KB
DATE: 2/4/2020

BORING LOG TC-2

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

BORING
TC-2

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LABORATORY TESTING

APPENDIX B

Exploration ID	Depth (ft.)	Sample No.	Sample Description	Water Content (%)	Dry Unit Wt. (pcf)	Sieve Analysis (%)			Atterberg Limits			Additional Tests
						Passing 3/4"	Passing #4	Passing #200	Liquid Limit	Plastic Limit	Plasticity Index	
KC-1	8.0	S-5	CLAYEY SAND (SC)	17.9		100	87	39	23	12	11	
KC-1	28.0	S-10	POORLY GRADED SAND WITH SILT (SP-SM)	21.4		100	100	6.9				
KC-1	48.0	S-14	POORLY GRADED SAND WITH SILT (SP-SM)	20.1		100	99	7.8				
KC-2	13.0	S-6	POORLY GRADED SAND WITH SILT (SP-SM)	15.4		100	96	6.1				
KC-2	33.0	S-10	SANDY LEAN CLAY (CL)	58.7		100	100	64	42	21	21	
KC-2	43.0	S-12	POORLY GRADED SAND WITH SILT (SP-SM)	24.2		100	100	7.1				
MC-1	18.0	S-7	WELL GRADED SAND WITH SILT (SW-SM)	10.2		100	78	6.9				
MC-1	48.0	S-13	POORLY GRADED SAND WITH SILT (SP-SM)	22.5		100	100	7.9	NP	NP	NP	
MC-2	2.0	S-2	SANDY SILT (ML)	16.0		100	100	65	NP	NP	NP	
MC-2	28.0	S-9	POORLY GRADED SAND WITH SILT (SP-SM)	18.7		100	100	6.2				
MC-2	53.0	S-14	LEAN CLAY (CL)	49.1		100	100	87				
TC-1	8.0	S-5	WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)	15.0		100	83	8.3				
TC-1	43.0	S-12	POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)	15.0		100	74	5.9				
TC-2	20.0	U-8	SANDY ELASTIC SILT (MH)	56.7		100	100	52	63	36	27	
TC-2	43.0	S-13	WELL GRADED SAND WITH SILT (SW-SM)	17.0		100	95	7.9				

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic
NA = Not Available

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PROJECT NO.:
20202452.001A

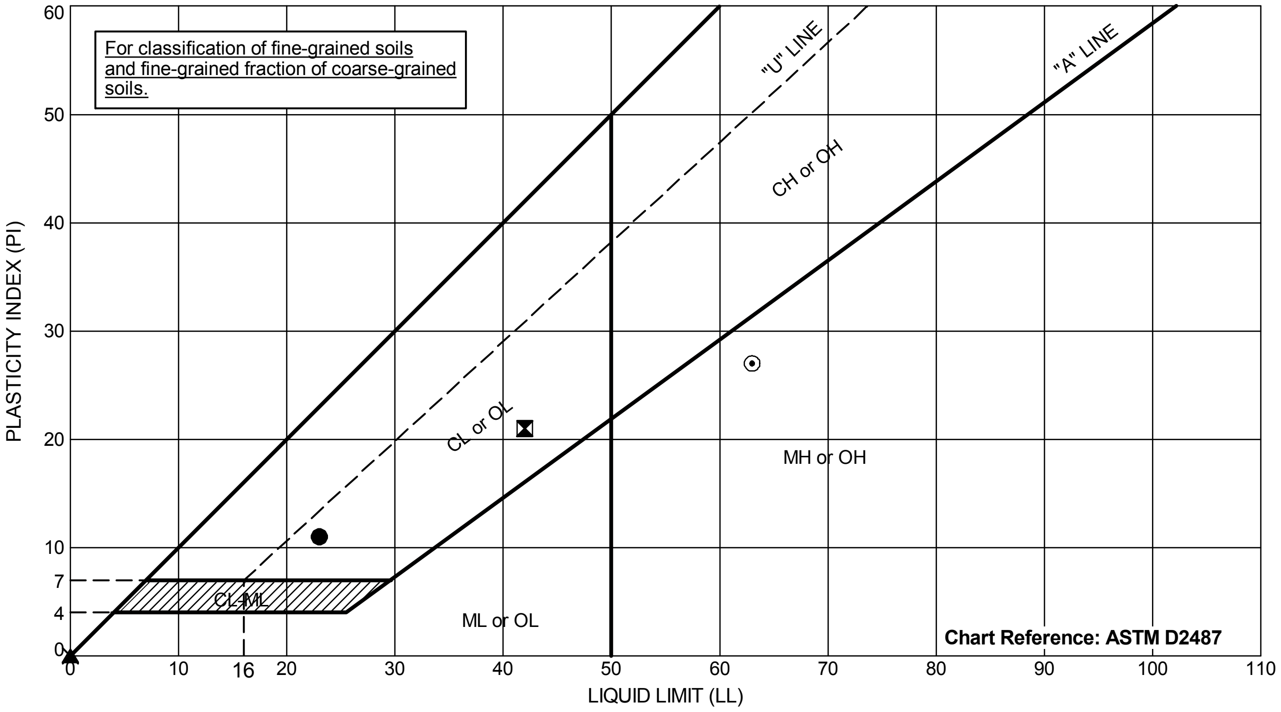
DRAWN BY: CH
CHECKED BY: KLB
DATE: 2/10/2020

LABORATORY TEST
RESULT SUMMARY

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

APPENDIX

B-1



Exploration ID		Depth (ft.)	Sample Number	Sample Description	Passing #200	LL	PL	PI
●	KC-1	8 - 10	S-5	CLAYEY SAND (SC)	39	23	12	11
⧗	KC-2	33 - 35	S-10	SANDY LEAN CLAY (CL)	64	42	21	21
▲	MC-1	48 - 50	S-13	POORLY GRADED SAND with SILT (SP-SM)	7.9	NP	NP	NP
×	MC-2	2 - 4	S-2	SANDY SILT (ML)	65	NP	NP	NP
⊙	TC-2	20	U-8	SANDY ELASTIC SILT (MH)	52	63	36	27

Testing performed in general accordance with ASTM D4318.
NP = Nonplastic
NA = Not Available
NM = Not Measured

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ATTERBERG LIMITS

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

APPENDIX

B-5

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PROJECT NUMBER: 20202452.001A
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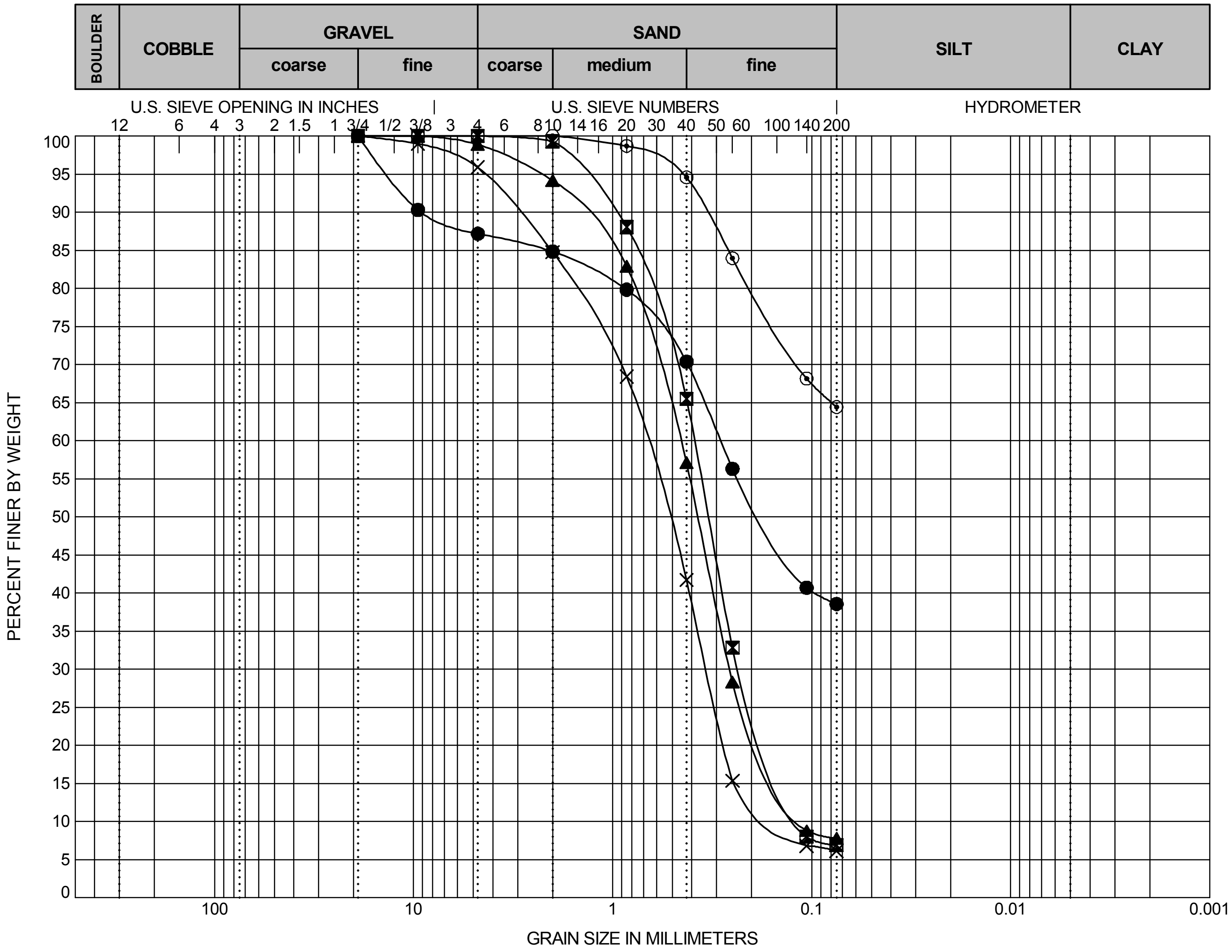
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2020.GLB [_KLF_ATTERBERG (ASTM)]



	Exploration ID	Depth (ft.)	Sample Number	Sample Description	LL	PL	PI
●	KC-1	8 - 10	S-5	CLAYEY SAND (SC)	23	12	11
⧗	KC-1	28 - 30	S-10	POORLY GRADED SAND WITH SILT (SP-SM)	NM	NM	NM
▲	KC-1	48 - 50	S-14	POORLY GRADED SAND WITH SILT (SP-SM)	NM	NM	NM
×	KC-2	13 - 15	S-6	POORLY GRADED SAND WITH SILT (SP-SM)	NM	NM	NM
⊙	KC-2	33 - 35	S-10	SANDY LEAN CLAY (CL)	42	21	21

	Exploration ID	Depth (ft.)	D_{100}	D_{60}	D_{30}	D_{10}	Cc	Cu	Passing 3/4"	Passing #4	Passing #200	%Silt	%Clay
●	KC-1	8 - 10	19	0.288	NM	NM	NM	NM	100	87	39	NM	NM
⧗	KC-1	28 - 30	19	0.389	0.227	0.114	1.16	3.42	100	100	6.9	NM	NM
▲	KC-1	48 - 50	19	0.459	0.258	0.112	1.30	4.11	100	99	7.8	NM	NM
×	KC-2	13 - 15	19	0.684	0.336	0.146	1.13	4.67	100	96	6.1	NM	NM
⊙	KC-2	33 - 35	19	NM	NM	NM	NM	NM	100	100	64	NM	NM

Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D6913(Sieve Analysis) and ASTM D7928 (Hydrometer Analysis).
NP = Nonplastic
NA = Not Available
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60} D_{10}$
D_{60} = Grain diameter at 60% passing
D_{30} = Grain diameter at 30% passing
D_{10} = Grain diameter at 10% passing

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SIEVE ANALYSIS

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

APPENDIX

B-2

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PROJECT NUMBER: 20202452.001A
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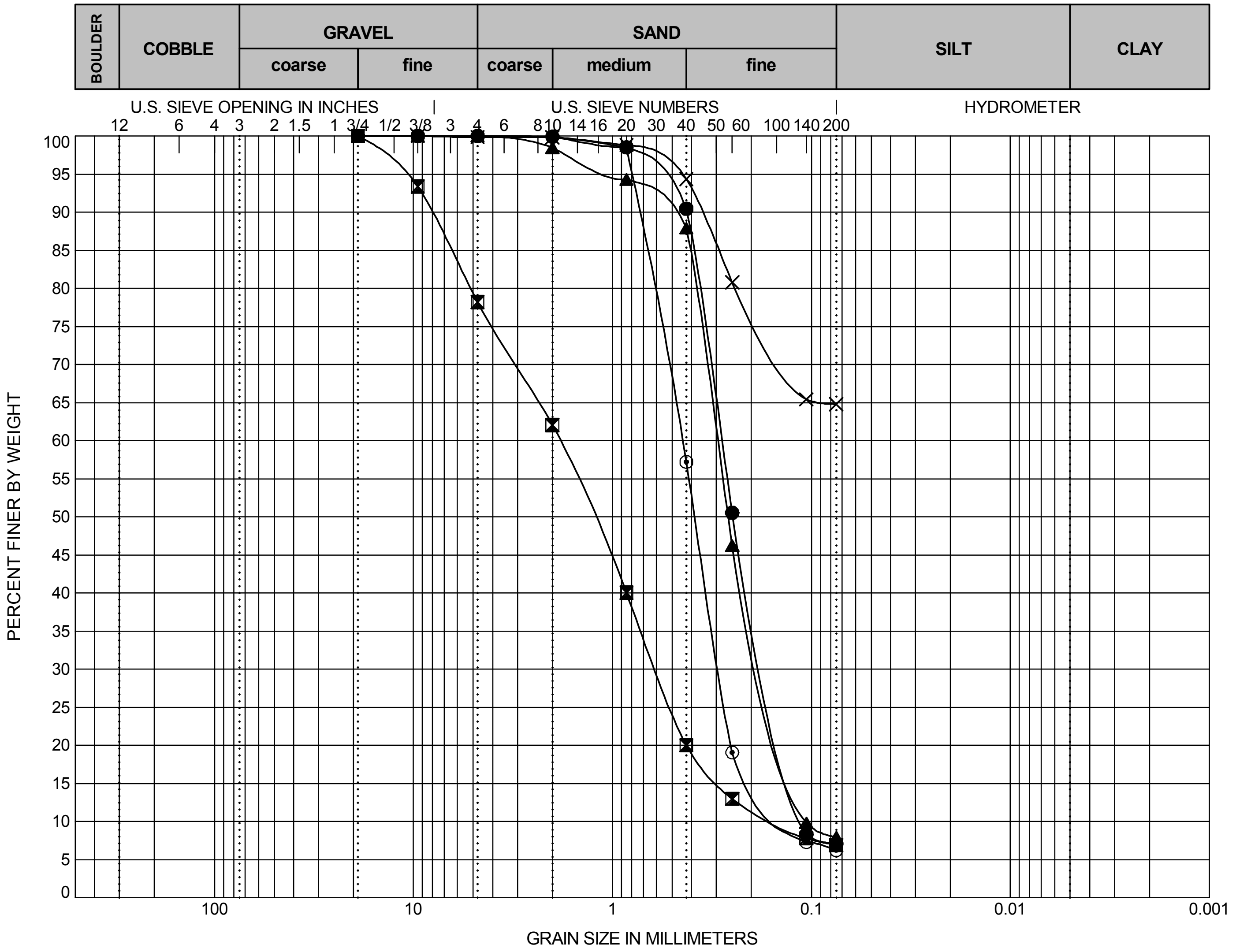
PROJECT NUMBER: 20202452.001A

gINT FILE: Klf_gint_master_2020 [_KLF_SIEVE ANALYSIS]

gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2020.GLB



Exploration ID		Depth (ft.)	Sample Number	Sample Description	LL	PL	PI
●	KC-2	43 - 45	S-12	POORLY GRADED SAND WITH SILT (SP-SM)	NM	NM	NM
⧗	MC-1	18 - 20	S-7	WELL GRADED SAND WITH SILT (SW-SM)	NM	NM	NM
▲	MC-1	48 - 50	S-13	POORLY GRADED SAND with SILT (SP-SM)	NP	NP	NP
×	MC-2	2 - 4	S-2	SANDY SILT (ML)	NP	NP	NP
⊙	MC-2	28 - 30	S-9	POORLY GRADED SAND WITH SILT (SP-SM)	NM	NM	NM

Exploration ID		Depth (ft.)	D_{100}	D_{60}	D_{30}	D_{10}	Cc	Cu	Passing 3/4"	Passing #4	Passing #200	%Silt	%Clay
●	KC-2	43 - 45	19	0.284	0.165	0.11	0.87	2.58	100	100	7.1	NM	NM
⧗	MC-1	18 - 20	19	1.848	0.6	0.153	1.27	12.05	100	78	6.9	NM	NM
▲	MC-1	48 - 50	19	0.298	0.171	0.106	0.92	2.80	100	100	7.9	NM	NM
×	MC-2	2 - 4	19	NM	NM	NM	NM	NM	100	100	65	NM	NM
⊙	MC-2	28 - 30	19	0.445	0.291	0.129	1.47	3.44	100	100	6.2	NM	NM

Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D6913(Sieve Analysis) and ASTM D7928 (Hydrometer Analysis).
NP = Nonplastic
NA = Not Available
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60}\ D_{10}$
D_{60} = Grain diameter at 60% passing
D_{30} = Grain diameter at 30% passing
D_{10} = Grain diameter at 10% passing

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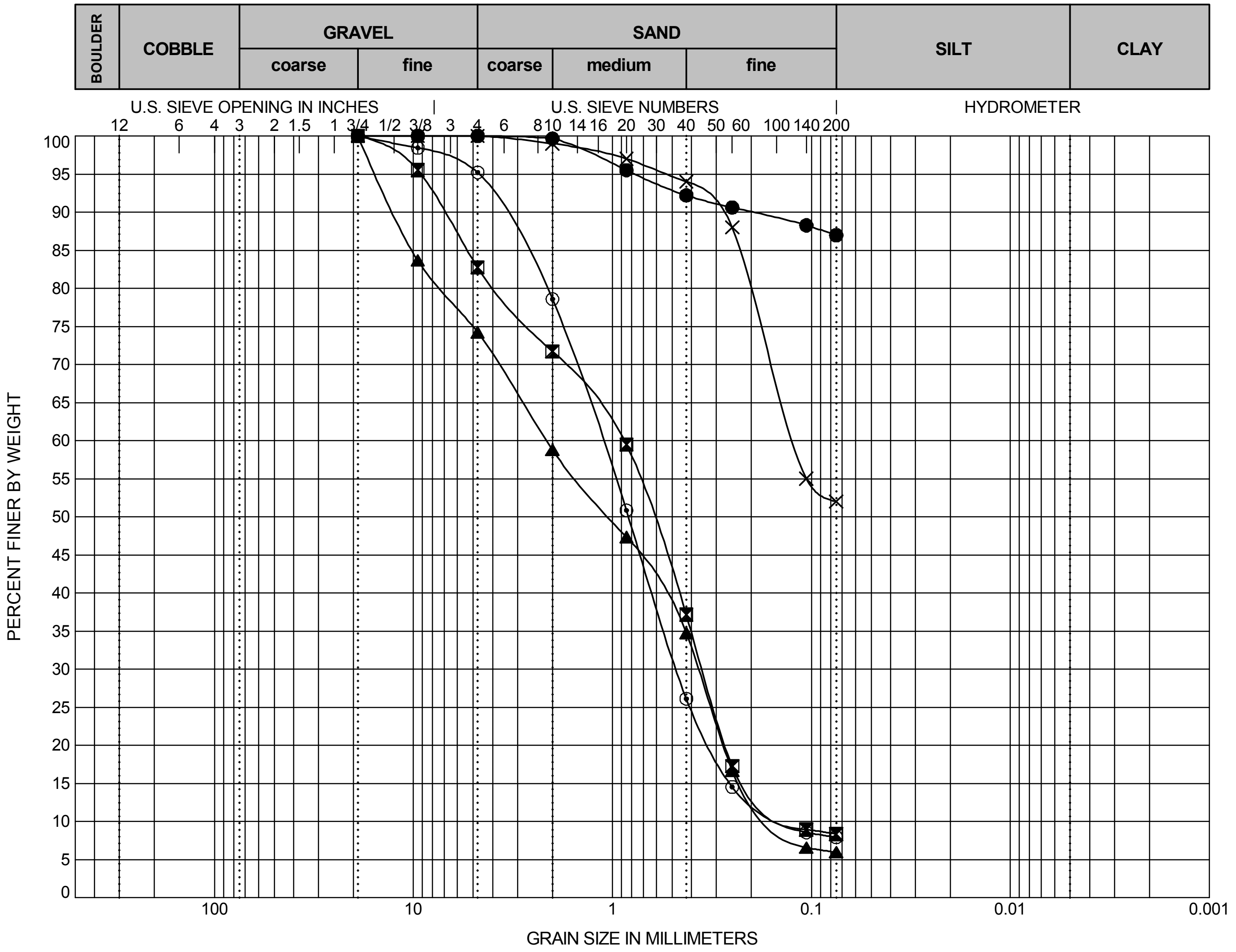
SIEVE ANALYSIS

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

APPENDIX

B-3



Exploration ID		Depth (ft.)	Sample Number	Sample Description	LL	PL	PI
●	MC-2	53 - 55	S-14	LEAN CLAY (CL)	NM	NM	NM
☒	TC-1	8 - 10	S-5	WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)	NM	NM	NM
▲	TC-1	43 - 45	S-12	POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)	NM	NM	NM
×	TC-2	20	U-8	SANDY ELASTIC SILT (MH)	63	36	27
⊙	TC-2	43 - 45	S-13	WELL GRADED SAND WITH SILT (SW-SM)	NM	NM	NM

Exploration ID		Depth (ft.)	D_{100}	D_{60}	D_{30}	D_{10}	Cc	Cu	Passing 3/4"	Passing #4	Passing #200	%Silt	%Clay
●	MC-2	53 - 55	19	NM	NM	NM	NM	NM	100	100	87	NM	NM
☒	TC-1	8 - 10	19	0.881	0.351	0.118	1.18	7.44	100	83	8.3	NM	NM
▲	TC-1	43 - 45	19	2.143	0.37	0.142	0.45	15.10	100	74	5.9	NM	NM
×	TC-2	20	19	0.121	NM	NM	NM	NM	100	100	52	NM	NM
⊙	TC-2	43 - 45	19	1.127	0.474	0.13	1.53	8.64	100	95	7.9	NM	NM

Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D6913(Sieve Analysis) and ASTM D7928 (Hydrometer Analysis).
NP = Nonplastic
NA = Not Available
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60} D_{10}$
D_{60} = Grain diameter at 60% passing
D_{30} = Grain diameter at 30% passing
D_{10} = Grain diameter at 10% passing

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DATE: 2/4/2020

SIEVE ANALYSIS

Somerset County Gas Main Expansion
Phase 2: HDD Crossings
Ocean Highway
Somerset County, Maryland

APPENDIX

B-4

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PROJECT NUMBER: 20202452.001A

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APPENDIX C

GBA GEOTECHNICAL REPORT

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GBA
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ASSOCIATION

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