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REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ANALYSIS

4354 TODDSBURY DRIVE SLOPE
ROANOKE COUNTY, VIRGINIA

ECS REPORT NO. 12:8820-B

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4354 Toddsbury Drive Slope
Roanoke County, Virginia

ECS Project No. 12:8820-B

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ECS MID-ATLANTIC, LLC
"Setting the Standard for Service"
Geotechnical • Construction Materials • Environmental • Facilities

February 25, 2019

Mr. David Henderson, P.E.
Roanoke County
PO Box 29800
Roanoke, Virginia 24018

ECS Project No. 12:8820-B

Reference: Report of Subsurface Exploration and Slope Evaluation
4354 Toddsburry Drive Slope
Roanoke County, Virginia

Dear Mr. Henderson:

ECS Mid-Atlantic, LLC (ECS) respectfully submits this Report of Subsurface Exploration and Slope Evaluation for the above-referenced project. Our services have been provided in accordance with ECS Proposal No. 12:13459-P, dated December 7, 2018. This report includes the results of subsurface exploration, slope stability analysis, and recommendations for this project.

SCOPE OF SERVICES

The conclusions and recommendations contained in this report are based upon the results of our field exploration. Our exploration consisted of multiple site visits by geotechnical engineering staff and four soil test borings drilled to depths of up to 26.5 feet below the existing ground surface. Laboratory testing performed on several representative samples obtained during the field exploration aided in the evaluation of the field data. The borings were located in the field by a geotechnical engineer from our office by utilizing Trimble GPS equipment and estimating angles from existing site features. The boring locations shown on the Boring Location Diagram and the existing ground surface elevations depicted on the boring logs, which are provided in the Appendix of this report, should be considered approximate.

The recommendations contained herein were developed from our interpretation of the subsurface data obtained from the soil test borings. The borings indicate subsurface conditions at specific locations at the time of the exploration. If, during the course of construction, variations appear evident, the geotechnical engineer should be informed so that the conditions can be addressed.

Design recommendations were developed based on design criteria considered typical for this type of structure and the specific information provided. Should project characteristics differ from those discussed herein, ECS should be contacted for review of these conditions and possible revisions to the recommendations of this report.

PROJECT CHARACTERISTICS

The project site is located at 4354 Toddsbury Drive in the Vinton area of Roanoke County, Virginia, as depicted on the Site Location Diagram provided in the Appendix. As you are aware, ECS provided cursory slope observations and preliminary recommendations for the property owner in 2017 (ECS Project No. 12:8820, dated July 28, 2017). At that time, the slope behind the house was showing signs of distress.

Subsequent to disturbance of the subject slope by the owner and heavy rains, catastrophic failure of the slope (i.e. landslide) occurred on May 18, 2018, resulting in significant damage to the residence at the toe of the slope and condemnation by the County. ECS provided preliminary recommendations to the County in our letter report dated September 12, 2018 (ECS Project No. 12:8820-A).

ECS has participated in multiple meetings with the County and Caldwell White Associates (CWA) regarding the slope repair. We received preliminary civil plans prepared by CWA, dated November 18, 2018 which provide topographic data for the site after the catastrophic failure and depict a preliminary concept for repairing the slope by partially regrading the slope. The concept includes starting fill placement for a 3H:1V gradient extending from the new toe roughly 15 feet east of the current location of the house back wall up to the face of the head escarpment. The preliminary concept cross-section is provided in the Appendix of this report. It is noted that the concept would still result in over 15 feet of the near vertical escarpment face remaining exposed.

We understand that the County performed some regrading activities after the topographic survey was completed by CWA, in order to improved stormwater and erosion and sediment control for the site.

Based on discussions with the County, we understand the initial goal of future regrading activities is to initially allow for reasonably safe access for demolition of the existing house. Immediately following demolition activities, the County desires to regrade the slope in order to establish erosion and sediment control measures and slope conditions sufficiently stable to not negatively impact the neighboring properties. It is understood that establishment of vegetation on the upper-most portion of the existing near-vertical escarpment may not be possible, and that slope stability conditions which would allow for construction of future structures on the property are not required.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

To characterize the general subsurface conditions, four soil test borings (B-1 through B-4) were performed perpendicular to the previous slope failure. The borings were performed with a CME-55 ATV-mounted drilling equipment utilizing continuous-flight, hollow stem augers (HSA) to advance the boreholes to their hard material or auger refusal. Drilling fluid was not used in this process.

Representative samples were obtained by means of the split-barrel sampling procedure in accordance with ASTM Specification D 1586. In this procedure, a 2-inch O.D., split-barrel sampler is driven into the soil a distance of 24 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through a 12-inch interval is termed the Standard Penetration Test (SPT) N-value and is indicated for each sample on the boring logs. This N-value can be used as a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the Standard Penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod sampler assemblies. Samples were obtained continuously until hard material was encountered and then at 5-foot intervals until termination depth.

Undisturbed (Shelby tube) soil samples were not taken as soil conditions were not conducive to obtain quality samples.

After recovery, representative portions of each soil sample were removed from the sampler and sealed in glass jars. The samples were taken to our laboratory in Roanoke, Virginia for visual classification and laboratory testing.

Laboratory Testing Program

Representative soil samples were selected and tested in our laboratory to substantiate visual classifications and to aid in the estimation of pertinent engineering properties. The laboratory testing program included natural moisture content tests (ASTM D 2216), grain size analyses tests (ASTM D 422), and Atterberg Limits tests (ASTM D 4318). The results of all laboratory testing conducted are included in the Appendix of this report.

An experienced geotechnical engineer visually classified each soil sample in the field on the basis of texture and plasticity (ASTM D 2488) and identified each soil sample using the classification group symbols and names as prescribed in the Unified Soil Classification System (USCS) (ASTM D 2487). A brief reference for the boring logs is included with this report. The engineer grouped the various soil types into the major strata noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs are approximate; in-situ, the transitions may be gradual.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received as to their disposition.

SITE AND SUBSURFACE CONDITIONS

Site Conditions

At the time of our exploration, the area of the previous failure and resulting landslide had recently been regraded by the County. The surface of the majority of the colluvial deposits from the landslide had smoothed and tracked in with grading equipment in order to reduce the likelihood of erosion and shed water to two temporary sediment basins constructed on the western and eastern side of the colluvial deposits, near the terminus of deposited material. An access road with surge stone surface had been constructed from the eastern access drive to near the center of the property in order for construction vehicles to enter the area. We understand that the ground surface had been hydroseeded; however, vegetation did not appear to have germinated. No grading was performed at the near vertical escarpment; however, some additional soils and woody vegetation appeared to have collapsed. Seepage and/or standing water was observed in both temporary basins.

Prior to regrading by the County, the deposited colluvium was noted to be loose, irregular, and cracked at the surface, readily allowing infiltration of water into the deposits. A near vertical escarpment was present at the northern side of the slide with near vertical height between 15 to 20 feet in height, with steep gradient immediately below, leading to shallower gradient colluvial deposits below. During multiple site visits, seepage water was observed on the lower portion of the escarpment face on the western edge. Seepage was also observed at the toe of the colluvial deposit.

Site Geology

Based on the “Geology of the Roanoke and Stewartsville Quadrangles, Virginia”, (Department of Mines, Minerals, and Energy / Division of Mineral Resources, 1981), the subject site is located in Virginia’s Blue Ridge Physiographic and Geologic Province. More specifically, the project site is mapped with the Blue Ridge Basement Complex. This formation is composed of leucocratic granulite gneiss, granitic gneiss, and massive granulite gneiss. Soils which typically weather from these soils consist of micaceous sandy silts and silty sands.

The boundary between soil and rock is not sharply defined. A transitional zone from residual soil to bedrock termed "highly weathered rock" (HWR hereafter) is normally found overlying the parent bedrock. Because weathering is facilitated by fractures, joints, and the presence of less resistant rock types, the profile of the HWR and hard rock is typically irregular and erratic, even over short horizontal distances. Also, it is not unusual to find lenses and natural, floating boulders of hard rock in zones of HWR within the soil mantle, well above the general bedrock level.

Soil Conditions

Based on the borings, the subsurface conditions at the site primarily consist of colluvium deposits from the slope failure underlain by a thin layer of residual soils and rock of variable weathering.

No topsoil or ground covering were encountered in the boring locations.

Stratum I – Colluvial Deposits: Colluvial deposits, which consisted of Sandy CLAY (CL), Sandy SILT (ML, MH), and Silty and Clayey SAND (SM, SC) with variable amounts of rock fragments, were encountered to depths ranging from 5 to 15.5 feet below existing grades. N-values in these materials ranged from 2 blows per foot (bpf) to 10 bpf, with the higher N-values likely attributable to rock fragments within the soil matrix. These soils were generally very loose to loose in consistency.

Stratum II – Residuum: Residual soils were encountered below the colluvial deposits to depths ranging from 5 to 16 feet below the existing ground surface. The residuum consisted of Sandy SILT (ML) and Sandy CLAY (SC) with variable amounts of rock fragments. SPT N-values in this layer generally ranged from 9 bpf to over 50 bpf, indicating loose to very hard consistencies.

Stratum III – IGM: Intermediate geomaterials (IGM), which is defined for engineering purposes as residual material with Standard Penetration resistance greater than 100 blows per foot (bpf), was encountered at depths ranging from 10 to 16 feet below the existing ground surface in the borings.

Stratum IV – Hard Rock: Hard rock, which is defined by the depth of auger refusal on naturally-occurring mass stratigraphy not deposited by man or stream processes, was encountered in all of the borings, at depths from 10.5 to 26.5 feet below existing grades.

Atterberg Limits testing performed on several representative soil samples indicated Liquid Limits ranging from non-plastic (NP) to 47, with corresponding Plasticity Indices ranging from NP to 21. Percent passing the No. 200 sieve ranged from 12% to 77%. Natural moisture contents varied from 8.9% to 45.4%.

Boring logs describing the soil conditions encountered in the soil test borings are included in the Appendix of this report.

Groundwater Observations

Groundwater observations were made during soil sampling and through temporary wells placed in the boreholes. In auger drilling operations, water is not introduced into the borehole, and the groundwater position can often be determined by observing water flowing into or out of the borehole. Furthermore, visual observations of the soil samples retrieved during the auger drilling exploration can often be used in evaluating the groundwater conditions.

Generally, the soil samples were moist to wet. Groundwater was encountered in the temporary wells at depths ranging from 2.5 to 20 feet below the existing ground surface at the time of measurements. We anticipated that groundwater elevation will vary over time based on infiltration of up-gradient water and perching above or within the IGM or other low permeability layer.

ANALYSIS AND RECOMMENDATIONS

Global Stability Analysis

Global stability analyses were completed for several slope scenarios, based on pre-failure, current, and proposed slope gradients, as well as soil and groundwater conditions encountered in the borings. Specifically, analysis was performed based on the following slope scenarios:

Pre-Failure Condition Scenario: The previous slope gradient conditions estimated from GIS data available from the County and depicted in the cross-section provide by CWA and included in the Appendix.

Failure Condition Scenario: Analysis was performed based on the current slope condition, based on topographic data surveyed by CWA and depicted in the cross-section.

Temporary Demolition Slope Scenario: Analysis was performed based on the failed condition cross-section, modified to demonstrate temporary removal of the colluvial deposits surrounding the house to permit for demolition and removal of the house.

Proposed Repair Condition Scenario: Analysis was performed based on the proposed reconstructed 3H:1V slope, with fill placed directly over the colluvial deposits, provided by CWA and depicted in the cross-section.

Proposed Repair Condition with Replacement of Colluvium Scenario: Analysis was performed based on the proposed reconstructed 3H:1V slope, with removal and replacement of the colluvial deposits by all new fill, provided by CWA and depicted in the cross-section.

Soil profiles were developed at the chosen sections based on the available boring data. Soil properties were estimated based on our experience with the soil conditions. Table 1 below summarizes the soil properties interpreted for the various strata.

Table 1 – Estimated Engineering Properties of Soil Strata

Stratum	Cohesion c[1] (psf)	Friction Angle, φ (degrees)	Moist Unit Weight (pcf)
Stratum I – Colluvium	0	23	120
Stratum II – Residuum	60	30	120
Stratum III – IGM	50	38	130
Stratum IV – Rock	N/A	N/A	140
Stratum V – Loose Residuum	20	25	120
Stratum VI – Compacted Fill	50	32	120

New compacted fill noted in Table 1 is anticipated to consist of reused excavation spoils. Due to the nature of colluvial deposits to remain in place beneath new fill placement, as well as the potential for these soils to not be at optimum moisture conditions, we have assumed the new fill will be compacted to a marginal level on the order of 85% of the maximum dry density as determined utilizing the Standard Proctor method (ASTM D 698).

Water table elevations in the analyses are based on the water levels noted in the temporary wells.

The slopes were analyzed in accordance with the simplified Bishop and Spencer methods. Circular and block analyses were performed. The purpose of the block analyses was to identify the critical failure paths along weak layers within the existing underlying materials. Both circular and block analyses are compared to determine the critical failure path.

Given the goals conveyed by the County for the repair work, as noted previously, we have evaluated the slope scenarios based on Factors of Safety (FS) of 1.0 or less indicating failure or eminent failure, FS of 1.2 to 1.5 indicating reasonable stability which will not negatively impact neighboring properties, and FS of 1.5 or greater indicating stability which will allow for future construction on the subject property. The results of our evaluations are summarized in Table 2.

Table 2 – Results of Global Stability Analyses for Selected Scenarios

Scenario	Factor of Safety		Remarks
	Circular	Block	
Pre-Failure Condition	0.97	0.98	
Failure Condition	1.0	1.0	FS excludes localized stability at head scarp
Temporary Demolition Slope	1.0	1.0	FS excludes localized stability at head scarp
Proposed Repair Condition	1.2	1.2	FS excludes localized stability at head scarp
Replacement of Colluvium	1.4	1.5	FS excluded localized stability at head scarp
Head Escarpment	0.7	N/A	

Based on the results of our soil borings and analysis for the pre-failure condition, a FS of less than 0.97 was estimated. In our opinion, the pre-failure condition was excessively steep for the soil type and groundwater regime noted in the temporary wells and evidence of seepage that would be expected to achieve a FS of 1.5 or greater. Moreover, we believe the pre-failure conditions progressively worsened due to multiple conditions during the life of the slope. Based on historical aerial photographs, the slope was excavated several years before construction of the house on the residence and had chronic problems with establishment of vegetation on the slope face. Due to poor stabilization of the slope face, we anticipate that progressive surface failures occurred over time allowing for deep infiltration of water into the slope face through tension cracks and weakened zones at escarpments. Prior to catastrophic failure of the slope, the property owner reportedly regraded the slope face with loose material, although an escarpment near the crest was not sealed from moisture intrusion. The regrading reportedly also included removal of a significant volume of soils from the slope face, also steepening the slope face. This would result in further decrease in the FS for the modeling pre-failure condition. These progressively worsening conditions, coupled with significant precipitation over a prolonged period of time, resulted in the catastrophic period. However, based on our borings and analysis, the failure occurred as a wedge along the slope face, but deep seated failure does not appear to have occurred beyond the toe of the original slope.

Our analysis of the current failed condition indicates a global FS of 1.0. In our opinion, the global stability results present excessive risk of future slope failure which could negatively impact adjacent properties.

Global stability analysis including a temporary slope excavated approximately 15 feet north of the existing house, sufficient to allow for demolition activities, results in a FS of 1.0. The temporary excavation should only be allowed for a short period of time sufficiently long to allow for demolition, and then reconstruction of the slope should commence immediately. The excavation should be performed in accordance with OSHA requirements assuming loose soils with seepage conditions.

Our analysis of the proposed regrading activities, with construction of a 3H:1V slope extending up to the head scarp, results in an estimated FS of 1.2, excluding failure through the head scarp. While the resulting FS does not indicate construction of a structure on the property is permissible, the proposed does not indicate unreasonable risk of future instability that would be expected to negatively impact neighboring properties. However, the recommendations for grading activities and stabilization provided in the section below should be followed.

Ideally, removal and replacement of the colluvial deposits would be performed with compacted fill, ultimately achieving a final 3H:1V slope extending to the head scarp. Our analysis indicates a FS of 1.4 would be achievable in this case. However, we anticipate that removal and replacement of all of the colluvial material would be logistically difficult based on site constraints, and therefore would be cost prohibitive. We also anticipate that removal and replacement would expose the base of the head scarp with an increased likelihood of failure during the repair period.

As previously noted, the proposed 3H:1V regrading activities does not include regrading of the near-vertical head escarpment at the crest. Localized analysis resulted in a FS on the order of 0.7, indicating future failure should be expected. Moreover, establishment of vegetation on the face of the escarpment would be very difficult to achieve due to the nature of the exposed soils and their steep gradient. However, we anticipate that failure of the upper section of the escarpment will likely occur gradually due to wetting cycles and freeze-thaw cycles with sloughing soils moving partially down the new 3H:1V slope face, but not outside of the property limits.

We considered layback of the head scarp to a shallower gradient that the current condition. However, it is anticipated that excavation of the head scarp would require difficult access conditions, as well as removal of trees, which would likely be impractical and cost prohibitive for the noted County goals.

Recommendations

Based on the noted goals of the County, we recommend that a temporary excavation be performed as noted above in order to allow for demolition of the house, followed immediately by construction of a 3H:1V slope up to the head scarp, placed over the colluvium. More specific recommendations are provided below.

Portions of the soils at the site are moisture-sensitive, and are excessively wet in the current condition. When wet they could be difficult to adequately compact. To reduce the potential for moisture-related soil problems, we recommend that site grading operations be performed during the typically drier months of the year (generally May through October), if possible. If this is not possible, substantial difficulty in establishing reasonably stable subgrades for receiving fill and difficulty during placement and compaction should be anticipated.

Prior to proceeding with construction, woody debris should be removed from the proposed construction limits. Removal of the colluvial deposits in areas to receive fill is not planned. However, after removal of woody debris, colluvial deposit surfaces shallower than 4H:1V in gradient should be trafficked with compaction equipment in order to increase density of the near-surface soils to receive new fill. Where colluvial deposit surfaces are steeper than 4H:1V in gradient, we recommend that benches be cut into the existing soils a horizontal distance of at least 4 feet and at least 1 foot deep on the upgradient side. Compaction equipment should then traffic the bench to increase density of the near-surface soils to receive new fill.

Fill soils, consisting of the on-site soils free of organics, should be placed in lifts not exceeding 12 inches in loose thickness, moisture conditioned sufficiently to prevent significant rutting and/or pumping, and compacted to at least 85% of the maximum dry density obtained in accordance with ASTM D 698, Standard Proctor Method. In lieu of compaction testing for verification, we recommend that fill soils be trafficked with compaction equipment a minimum of 6 passes. We recommend that no new fill slopes exceed 3H:1V in gradient.

Due to the erodibility of the on-site soils and lack of organic content, we recommend that the final subgrade surfaces be covered at least 4 inches of topsoil, tracked onto the fill surface. To reduce erosion and to provide slope protection, all permanent cut and fill slopes should be seeded and mulched immediately after grading. A common method of seeding is by hydro-seeding. The hydro-seeder can generally prepare appropriate mixtures of seed, lime, fertilizer, and mulch. Seed types that produce plants that can grow on steep slopes and resist drought conditions should be used. We recommend that cut slopes in excessive of 2H:1V should be further stabilized with EC-2 mat, where practical.

Construction of stormwater ditches are anticipated to be warranted for conveyance of surface water from the slope to the street level. We recommend that the toe of the proposed new 3H:1V slope be started as far south as practical to result in a crest elevation which reduces the exposed escarpment face as much as practical, while still allowing for construction of required erosion and sediment control and stormwater control measures along the slope and at the toe. If excess spoil soils are available on-site, these soils may be utilized to create a fill bench near the toe of the 3H:1V slope.

We recommend that access to the crest of the slope be limited by fencing and/or warning measures, due to the steep nature of the escarpment which will remain.

As previously described, we do not recommend any structures be built in the area of the previous house without improvements beyond those recommended herein, as the proposed slope repair will not result in a sufficient reduction in the risk of future failure to allow such construction.

CLOSING

It is noted that the recommendations provided herein should not be considered a warrantee against future movement of the subject slope and slope repair. In particularly, it is anticipated that some degree of failure will occur in the exposed head scarp which will remain. The recommendations contained herein were developed from the data obtained in the soil test borings, which indicate subsurface conditions at specific locations at the time of exploration. Parameters utilized in our analysis were based on generally accepted correlations with soil types and our experience; however, sampling of soils within the escarpment face for strength testing was not practical or safe. Soil conditions may vary between the borings. If, during the course of repair, variations appear evident, the geotechnical engineer should be informed so that the conditions can be addressed. Design recommendations were developed based on the information provided and on design criteria considered typical. Should characteristics differ from those discussed herein, ECS should be contacted for review of these conditions and possible revisions to the recommendations of this report.

We have appreciated the opportunity to be of service to you. If you have any questions with regard to the information and recommendations contained in this report, or if we can be of further assistance to you during construction, please do not hesitate to contact us.

Respectfully,

ECS MID-ATLANTIC, LLC

Brandon Quinn

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APPENDIX

Site Location Map

Boring Location Diagram

Preliminary Proposed Cross Section

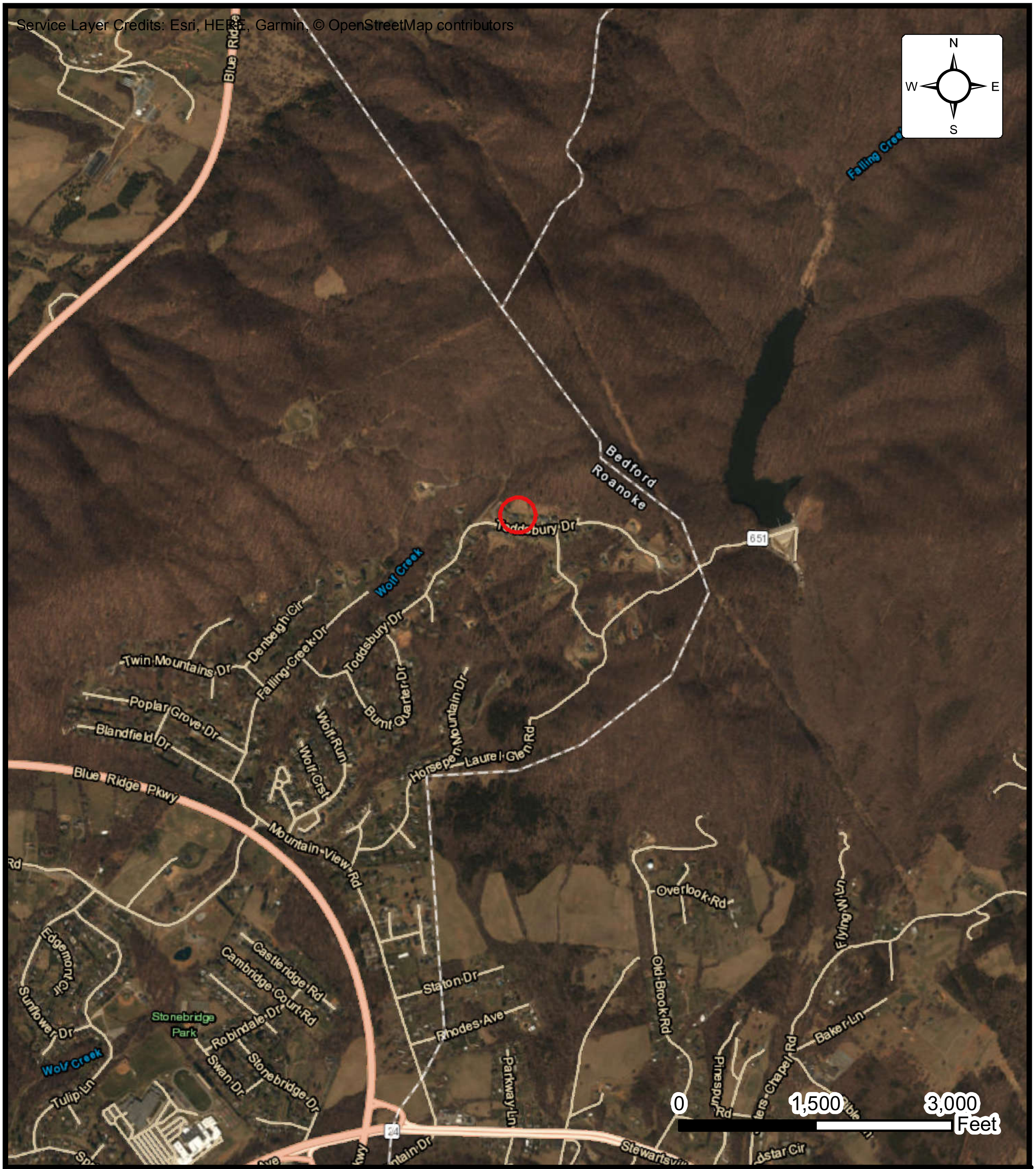
Reference Notes for Boring Logs

Boring Logs B-1 through B-4

Generalized Soil Profile

Summary of Laboratory Test Data

Slope Stability Analyses Results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SITE LOCATION DIAGRAM
TODDSBURY DRIVE SLOPE

4354 TODDSBURY DRIVE, VINTON, VA

ROANOKE COUNTY PROCUREMENT

ENGINEER
BSW

SCALE
1 " = 1500 '

PROJECT NO.
12:8820-B

SHEET
1 OF 1

DATE
2/19/2019

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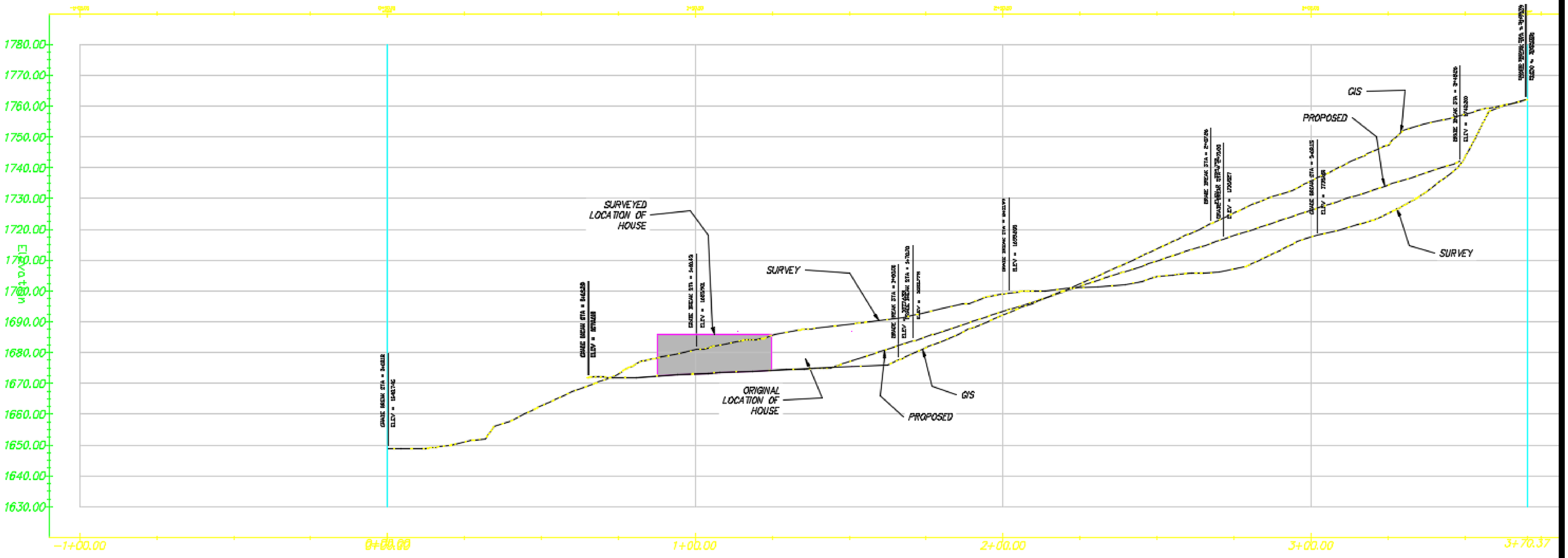
BORING LOCATION DIAGRAM
TODDSBURY DRIVE SLOPE

4354 TODDSBURY DRIVE, VINTON, VA

ROANOKE COUNTY PROCUREMENT

ENGINEER	BSW
SCALE	1 " = 50 '
PROJECT NO.	12:8820-B
SHEET	1 OF 1
DATE	2/19/2019



PRELIMINARY PROPOSED CROSS SECTION
TODDSBURY DRIVE SLOPE EXPLORATION

4354 TODDSBURY DRIVE, VINTON, VA

ROANOKE COUNTY PROCUREMENT

ENGINEER
BSW
SOURCE
CALDWELL WHITE ASSOCIATES
PROJECT NO.
12:8820-B
SHEET
1 OF 1
DATE
2/21/2019

REFERENCE NOTES FOR BORING LOGS

MATERIAL[1,2]			
■		**ASPHALT**	
▒		**CONCRETE**	
▨		**GRAVEL**	
▨		**TOPSOIL**	
□		**VOID**	
▦		**BRICK**	
▨		**AGGREGATE BASE COURSE**	
▒	**FILL[3]**	**MAN-PLACED SOILS**	
▨	**GW**	**WELL-GRADED GRAVEL**	gravel-sand mixtures, little or no fines
▨	**GP**	**POORLY-GRADED GRAVEL**	gravel-sand mixtures, little or no fines
▨	**GM**	**SILTY GRAVEL**	gravel-sand-silt mixtures
▨	**GC**	**CLAYEY GRAVEL**	gravel-sand-clay mixtures
▨	**SW**	**WELL-GRADED SAND**	gravelly sand, little or no fines
▨	**SP**	**POORLY-GRADED SAND**	gravelly sand, little or no fines
▨	**SM**	**SILTY SAND**	sand-silt mixtures
▨	**SC**	**CLAYEY SAND**	sand-clay mixtures
▥	**ML**	**SILT**	non-plastic to medium plasticity
▥	**MH**	**ELASTIC SILT**	high plasticity
▨	**CL**	**LEAN CLAY**	low to medium plasticity
▨	**CH**	**FAT CLAY**	high plasticity
▨	**OL**	**ORGANIC SILT or CLAY**	non-plastic to low plasticity
■	**OH**	**ORGANIC SILT or CLAY**	high plasticity
▒	**PT**	**PEAT**	highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS

SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION

DESIGNATION		PARTICLE SIZES
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay (“Fines”)		<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS

UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	SPT[5] (BPF)	CONSISTENCY[7] (COHESIVE)
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS

SPT[5]	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)[8]	FINE GRAINED (%)[8]
Trace	≤5	≤5
Dual Symbol *(ex: SW-SM)*	10	10
With	15 - 20	15 - 25
Adjective *(ex: “Silty”)*	≥25	≥30

WATER LEVELS[6]

▽	WL	Water Level (WS)(WD) (WS) While Sampling (WD) While Drilling
▽	SHW	Seasonal High WT
▼	ACR	After Casing Removal
▽	SWT	Stabilized Water Table
	DCI	Dry Cave-In
	WCI	Wet Cave-In

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[1] *Classifications and symbols per ASTM D 2488-09 (Visual-Manual Procedure) unless noted otherwise.*

[2] *To be consistent with general practice, “POORLY GRADED” has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.*

[3] *Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-**FILL**)].*

[4] *Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).*

[5] *Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). “N-value” is another term for “blow count” and is expressed in blows per foot (bpf).*

[6] *The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.*

[7] *Minor deviation from ASTM D 2488-09 Note 16.*

[8] *Percentages are estimated to the nearest 5% per ASTM D 2488-09.*

CLIENT
Roanoke County Planning/Engineering

Job #: 12:8820-B

BORING # B-1

SHEET 1 OF 1

PROJECT NAME
Toddsbury Drive Slope Exploration

ARCHITECT-ENGINEER
CWA

SITE LOCATION
4354 Toddsbury Drive, Vinton, Roanoke County, VA

NORTHING

EASTING

STATION

-○- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% ✕ — WATER CONTENT% ● — LIQUID LIMIT% △

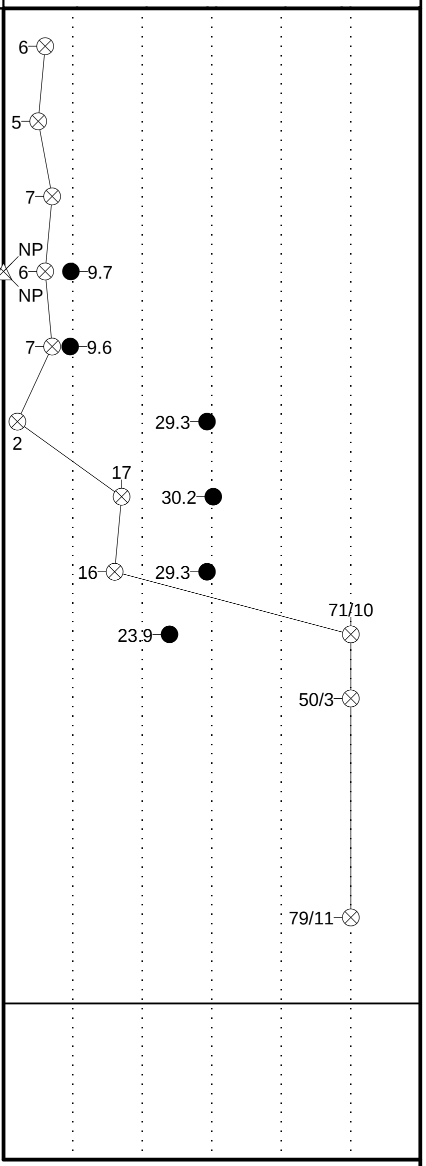
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➡ LOSS OF CIRCULATION

SURFACE ELEVATION 1704

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	20.4	COLLUVIUM: (SC) CLAYEY SAND, contains rock fragments, tan- red- brown, moist, loose			3 3 3 3
	S-2	SS	24	15.6				4 2 3 3
							1700	
5	S-3	SS	24	19.2	(SP-SM) MEDIUM TO COARSE SAND WITH SILT, contains rock fragments, tan- white-brown, moist, loose			3 3 4 4
	S-4	SS	24	14.4				4 3 3 3
	S-5	SS	24	13.2			1695	4 4 3 3
10								
	S-6	SS	24	12	(SM) SILTY SAND, contains rock fragments, tan-brown, wet, very loose			2 2 WOH WOH
	S-7	SS	24	13.2	RESIDUUM: (ML) SILT, trace sand, green-brown, moist, very stiff			WOH 7 10 11
							1690	
15	S-8	SS	24	24				5 7 9 16
	S-9	SS	16	16	IGM: (ML) SANDY SILT, contains rock fragments, tan-brown, moist, very hard			12 21 50/4
						▽		
	S-10	SS	9	6				22 50/3
							1685	
20								
	S-11	SS	17	16.8			1680	15 29 50/5
25								
					AUGER REFUSAL @ 26.5'			
							1675	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL WS ☐ WD ☒	BORING STARTED 01/17/19	CAVE IN DEPTH
▽ WL(SHW) ▼ WL(ACR)	BORING COMPLETED 01/17/19	HAMMER TYPE Auto
▽ WL 18'	RIG ATV FOREMAN BRD/JB	DRILLING METHOD 3.25" HSA

CLIENT: Roanoke County Planning/Engineering
Job #: 12:8820-B
BORING #: B-2
SHEET: 1 OF 1
PROJECT NAME: Toddsbury Drive Slope Exploration
ARCHITECT-ENGINEER: CWA
SITE LOCATION: 4354 Toddsbury Drive, Vinton, Roanoke County, VA
NORTHING:
EASTING:
STATION:

-○- CALIBRATED PENETROMETER TONS/FT^2

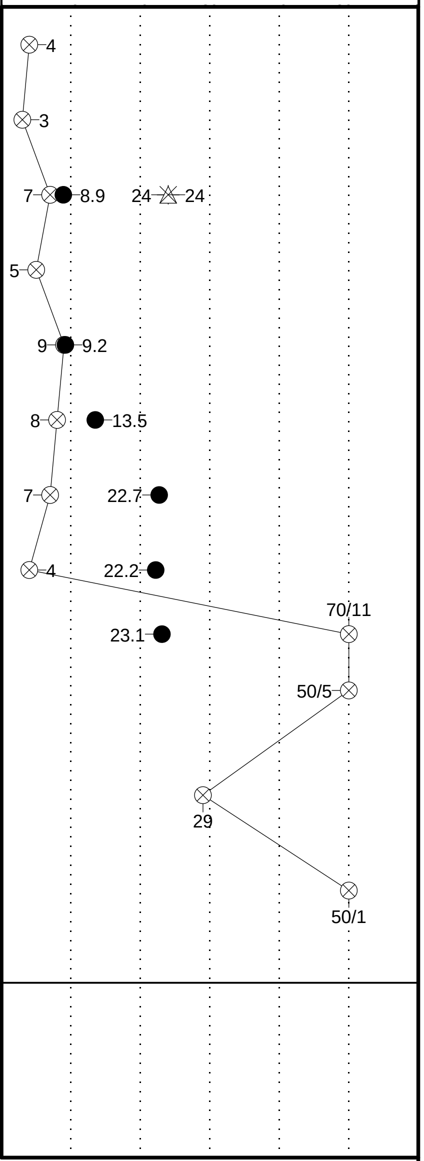
ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — –   REC% ———

PLASTIC LIMIT% ✕   WATER CONTENT% ●   LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING
LOSS OF CIRCULATION
SURFACE ELEVATION 1699

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					COLLUVIUM: (CL) SANDY LEAN CLAY, contains rock fragments, tan- red- brown, moist, soft			
	S-1	SS	24	22.8				2 2 2 3
	S-2	SS	24	19.2	(MH) ELASTIC SILT, trace clay, tan- brown, moist, soft			WOH 2 1 2
							1695	
5	S-3	SS	24	20.4	(SM) SILTY SAND, contains rock fragments, red- brown- tan, moist, loose			5 4 3 4
	S-4	SS	24	16.8				4 3 2 4
	S-5	SS	24	18			1690	WOH 4 5 4
10								
	S-6	SS	24	20.4	(SM) SILTY SAND, tan- brown, moist to wet, loose to very loose			4 4 4 5
	S-7	SS	24	18				4 3 4 5
							1685	
15	S-8	SS	24	9.6				WOH 2 2 2
	S-9	SS	17	10.8	RESIDUUM: (ML) SANDY SILT, contains rock fragments, tan- brown, moist, very hard to hard			7 20 50/5
	S-10	SS	5	2.4				50/5
							1680	
20						▽		
	S-11	SS	24	18				9 10 19 22
	S-12	SS	1	1				50/1
							1675	
25								
					AUGER REFUSAL @ 26'			
							1670	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL WS ☐ WD ☒	BORING STARTED 01/17/19	CAVE IN DEPTH
▽ WL(SHW) ▼ WL(ACR)	BORING COMPLETED 01/18/19	HAMMER TYPE Auto
▽ WL 20'	RIG ATV FOREMAN BRD/JB	DRILLING METHOD 3.25" HSA

CLIENT
Roanoke County Planning/Engineering

Job #: 12:8820-B

BORING # B-3

SHEET 1 OF 1

PROJECT NAME
Toddsbury Drive Slope Exploration

ARCHITECT-ENGINEER
CWA

SITE LOCATION
4354 Toddsbury Drive, Vinton, Roanoke County, VA

NORTHING

EASTING

STATION

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 1687

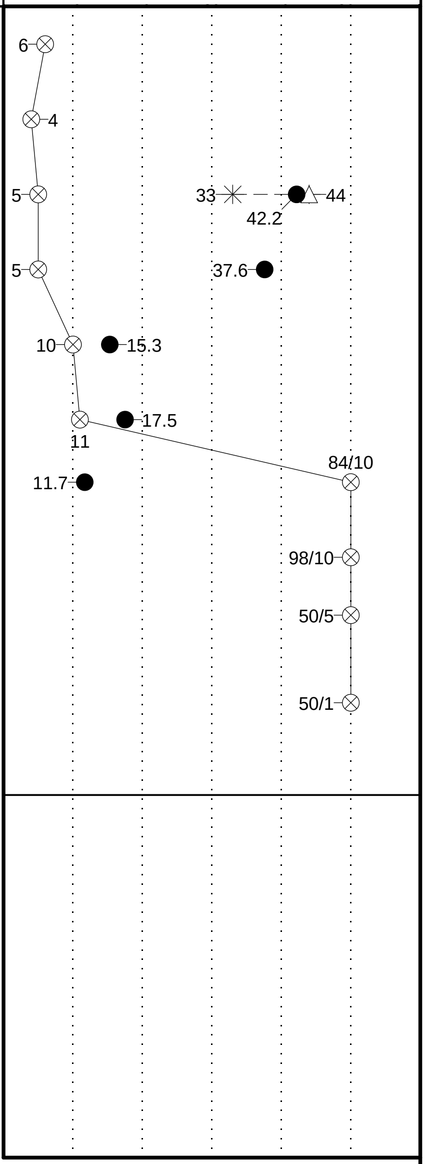
—○— CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% × WATER CONTENT% ● LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	19.2	COLLUVIUM: (CL) SANDY LEAN CLAY, contains rock fragments, tan- red- brown, moist, firm		1685	3 3 3 4
	S-2	SS	24	14.4	(ML) SILT WITH SAND, tan-brown, moist, soft to firm			WOH 2 2 2
5	S-3	SS	24	15.6				WOH 2 3 2
	S-4	SS	24	14.4			1680	WOH 2 3 6
10	S-5	SS	24	10.8	(SM) SILTY SAND, contains rock fragments, tan- white- brown, moist, medium dense			5 4 6 4
	S-6	SS	24	13.2	RESIDUUM: (ML) SANDY SILT, contains rock fragments, brown, moist, stiff		1675	3 4 7 5
	S-7	SS	16	12	IGM: (ML) SANDY SILT, contains rock fragments, gray- tan- brown, moist, very hard			15 34 50/4
15	S-8	SS	16	16	(SM) SILTY SAND, contains rock fragments, tan- brown, moist, very dense			20 48 50/4
	S-9	SS	5	4.8			1670	50/5
	S-10	SS	1	1				50/1
20						▽		
					AUGER REFUSAL @ 21'		1665	
25							1660	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL WS ☐ WD ☒

BORING STARTED 01/18/19

CAVE IN DEPTH

▽ WL(SHW) ▼ WL(ACR)

BORING COMPLETED 01/18/19

HAMMER TYPE Auto

▽ WL 20'

RIG ATV

FOREMAN BRD/JB

DRILLING METHOD 3.25" HSA

CLIENT
Roanoke County Planning/Engineering

Job #: 12:8820-B

BORING # B-4

SHEET 1 OF 1

PROJECT NAME
Toddsbury Drive Slope Exploration

ARCHITECT-ENGINEER
CWA

SITE LOCATION
4354 Toddsbury Drive, Vinton, Roanoke County, VA

NORTHING

EASTING

STATION

—○— CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% ✕ WATER CONTENT% ● LIQUID LIMIT% △

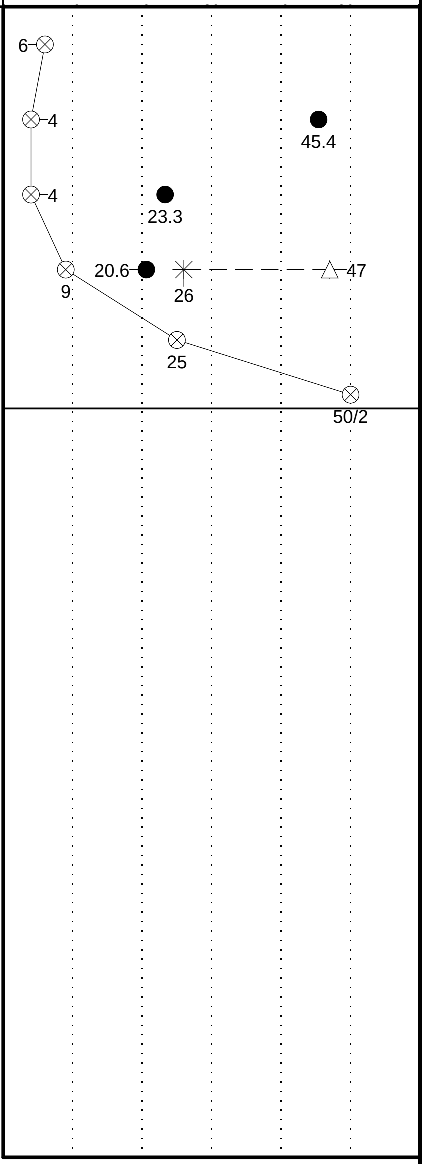
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING LOSS OF CIRCULATION

SURFACE ELEVATION 1676

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	21.6	COLLUVIUM: (SP-SM) MEDIUM TO COARSE SAND WITH SILT, contains rock fragments, tan- red- brown, moist, loose		1675	2 3 3 3
	S-2	SS	24	14.4		▽		3 2 2 2
					(MH) ELASTIC SILT, trace sand, tan- brown, moist, soft			
5	S-3	SS	24	24	RESIDUUM: (SC) CLAYEY SAND, trace organics, contains roots, tan-brown, moist, very loose to medium dense		1670	WOH 2 2 5
	S-4	SS	24	8.4				4 3 6 6
	S-5	SS	21	4.8				5 5 20 50/3
10	S-6	SS	8	0.4	IGM: (ML) SANDY SILT, contains rock fragments, tan- brown, moist, very hard		1665	31 50/2
					AUGER REFUSAL @ 10.7'			
					Offset 3', AUGER REFUSAL @ 10.5'			
15							1660	
20							1655	
25							1650	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL WS ☐ WD ☒	BORING STARTED 01/18/19	CAVE IN DEPTH 8.3
▽ WL(SHW) ▼ WL(ACR)	BORING COMPLETED 01/18/19	HAMMER TYPE Auto
▽ WL 2.5'	RIG ATV FOREMAN BRD/JB	DRILLING METHOD 3.25" HSA

SOIL CLASSIFICATION LEGEND

ST - SHELBY TUBE

RC - ROCK CORE

PM - PRESSURE METER

NOTE: NUMBERS IMMEDIATELY TO THE LEFT OF THE BORING PROFILE ARE SPT-N VALUES.

- GW - WELL GRADED GRAVEL
- GM - SILTY GRAVEL
- GP - POORLY GRADED GRAVEL
- GC - CLAYEY GRAVEL
- SW - WELL GRADED SAND
- ML - LOW PLASTICITY SILT
- CL - LOW PLASTICITY CLAY
- MH - HIGH PLASTICITY SILT
- SM - SILTY SAND
- SP - POORLY GRADED SAND
- SC - CLAYEY SAND
- CH - HIGH PLASTICITY CLAY
- OH - HIGH PLASTICITY ORGANIC SILTS AND CLAYS
- OL - LOW PLASTICITY ORGANIC SILTS AND CLAY
- PT - PEAT
- WR - WEATHERED ROCK
- PWR - PARTIALLY WEATHERED ROCK
- 🟥 - FILL
- 🟪 - POSSIBLE FILL
- 🟪 - PROBABLE FILL

SURFACE MATERIALS

- TOPSOIL
- ASPHALT
- GRAVEL
- CONCRETE
- VOID

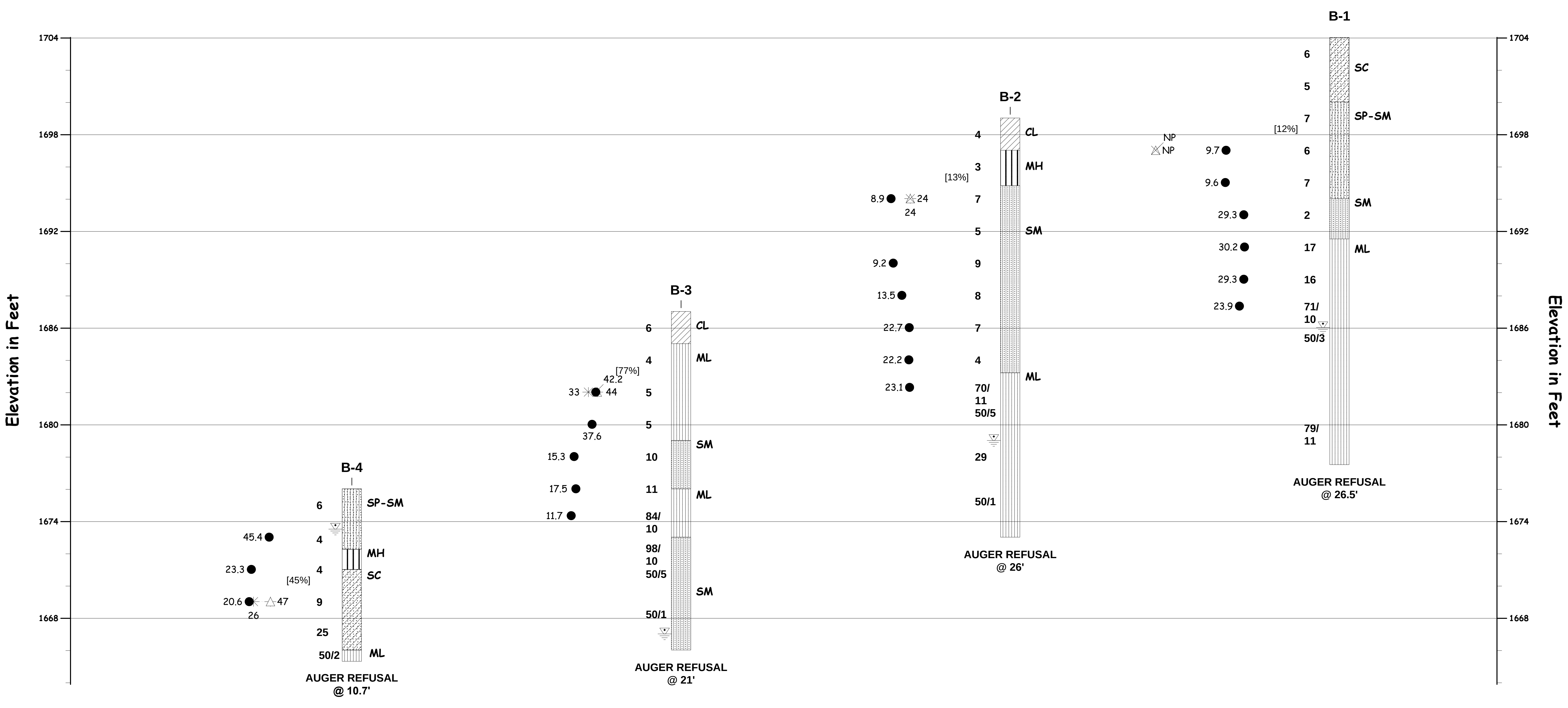
ROCK TYPES

- IGNEOUS
- METAMORPHIC
- SEDIMENTARY

SYMBOL LEGEND

- ▽ WATER LEVEL - DURING DRILLING/SAMPLING
- ▽ WATER LEVEL - SEASONAL, HIGH WATER
- ▼ WATER LEVEL - AFTER CASING REMOVAL
- ▽ WATER LEVEL - AFTER 24 HOURS

PLASTIC LIMIT% × WATER CONTENT% ● % PASSING #200 SIEVE [88%] LIQUID LIMIT% △



NOTES:

1 SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL REPORT FOR ADDITIONAL INFORMATION.

2 PENETRATION TEST RESISTANCE IN BLOWS PER FOOT (ASTM D1586).

ECS™

Subsurface Soil Profile

Toddsbury Drive Slope Exploration
Roanoke County Planning/Engineering
4354 Toddsbury Drive, Vinton, Roanoke County, VA

PROJECT NO.: 8820-B | DATE: 2/19/2019 | VERTICAL SCALE: 1"=6'

Laboratory Testing Summary

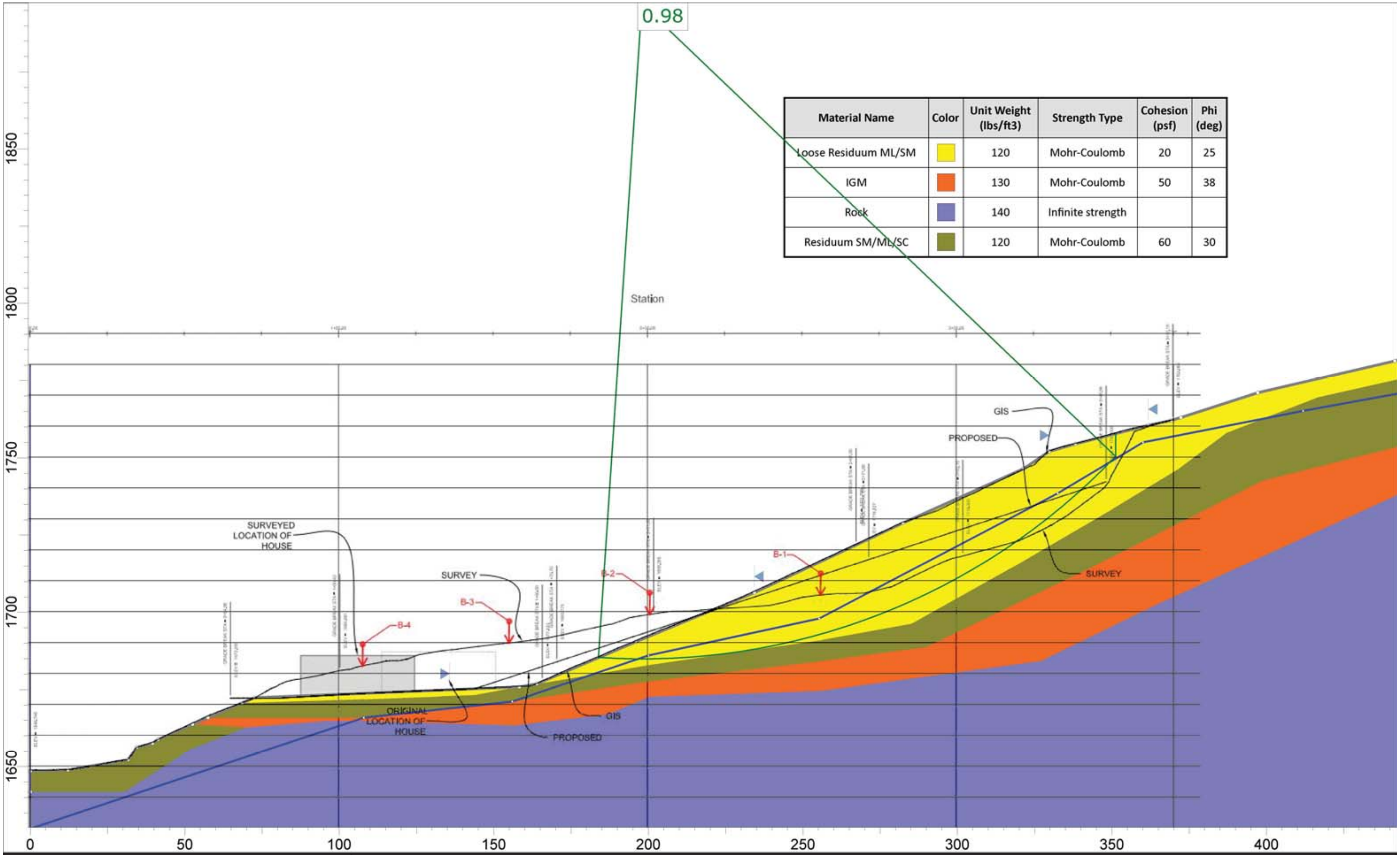
Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-1												
	S-4	6.0 - 8.0	9.7	SP-SM	NP	NP	NP	12				
	S-5	8.0 - 10.0	9.6									
	S-6	10.0 - 12.0	29.3									
	S-7	12.0 - 14.0	30.2									
	S-8	14.0 - 16.0	29.3									
	S-9	16.0 - 17.3	23.9									
B-2												
	S-3	4.0 - 6.0	8.9	SM	24	24	NP	13				
	S-5	8.0 - 10.0	9.2									
	S-6	10.0 - 12.0	13.5									
	S-7	12.0 - 14.0	22.7									
	S-8	14.0 - 16.0	22.2									
	S-9	16.0 - 17.4	23.1									
B-3												
	S-3	4.0 - 6.0	42.2	ML	44	33	11	77				
	S-4	6.0 - 8.0	37.6									
	S-5	8.0 - 10.0	15.3									
	S-6	10.0 - 12.0	17.5									
	S-7	12.0 - 13.3	11.7									
B-4												
	S-2	2.0 - 4.0	45.4									
	S-3	4.0 - 6.0	23.3									
	S-4	6.0 - 8.0	20.6	SC	47	26	21	45				

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 12:8820-B
Project Name: Toddsbury Drive Slope Exploration
PM: Brandon M. Quinn
PE: Brian S. Wyatt
Printed On: Monday, February 04, 2019

ECS MID-ATLANTIC, LLC
7670 Enon Drive, Suite 101
Roanoke, VA 24019
Phone: (540) 362-2000
Fax: (540) 362-1202



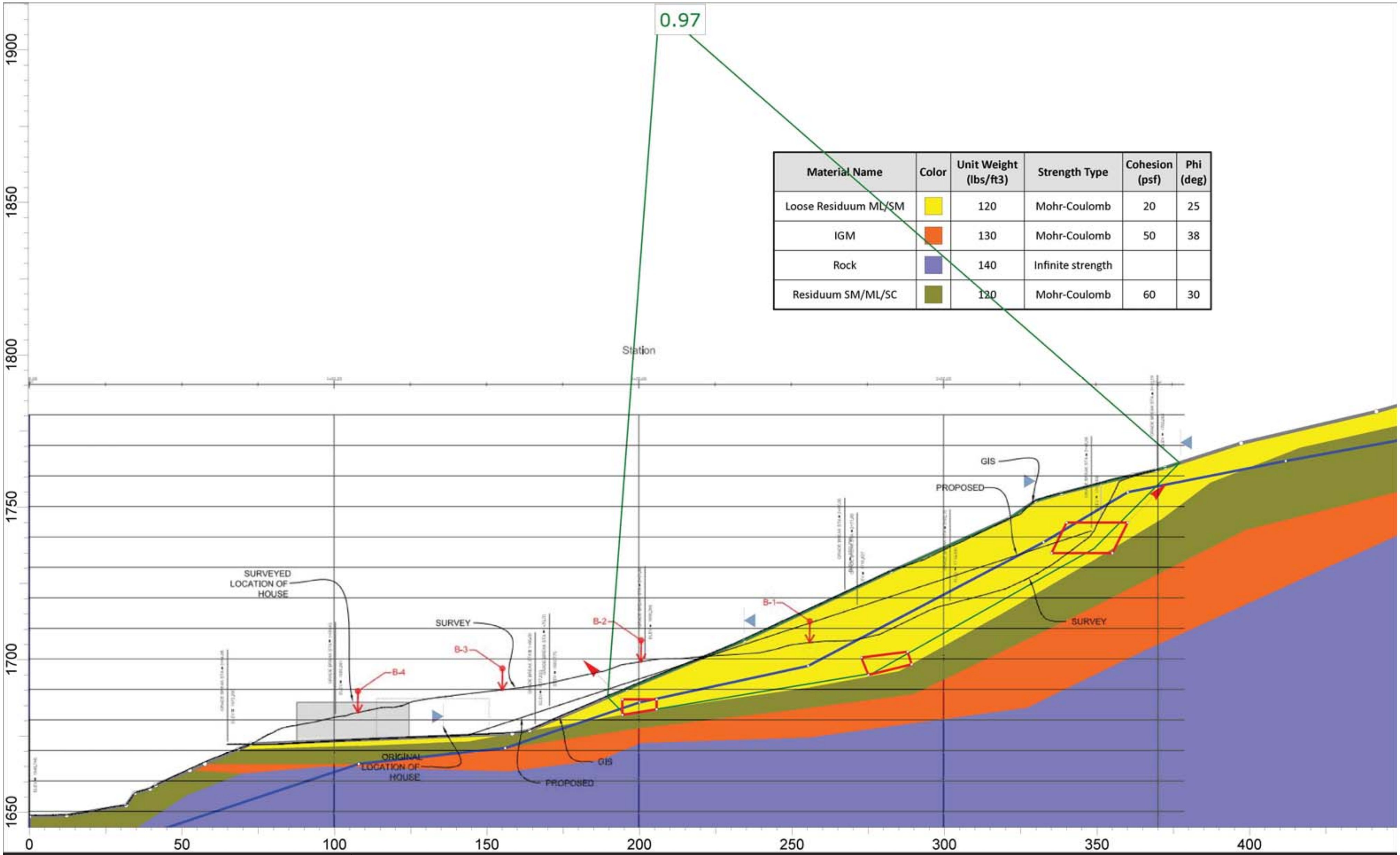
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟩	120	Mohr-Coulomb	60	30

Project
Toddsbury Drive Slope Exploration

Analysis Description
Pre-Failure Condition Scenario

Drawn By B.Quinn
Scale 1:516
Company ECS Mid-Atlantic
Date
File Name GIS Section - Circular.slmd

SLIDEINTERPRET 8.021



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟩	120	Mohr-Coulomb	60	30

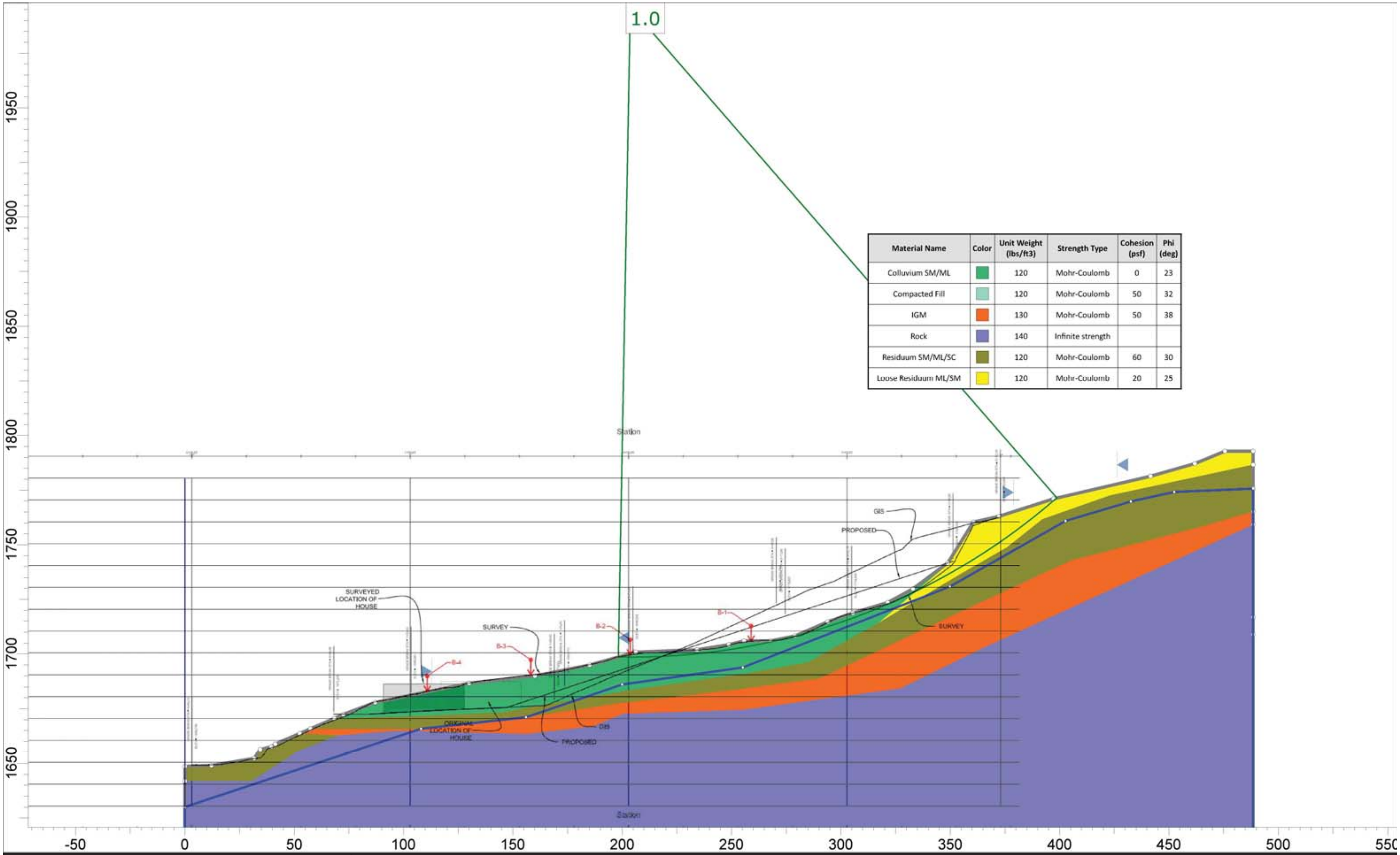
SLIDEINTERPRET 8.021

Project
Toddsbury Drive Slope Exploration

Analysis Description
Pre-Failure Condition Scenario

Drawn By B.Quinn
Scale 1:523
Company ECS Mid-Atlantic

Date
File Name GIS Section - Block.slmd

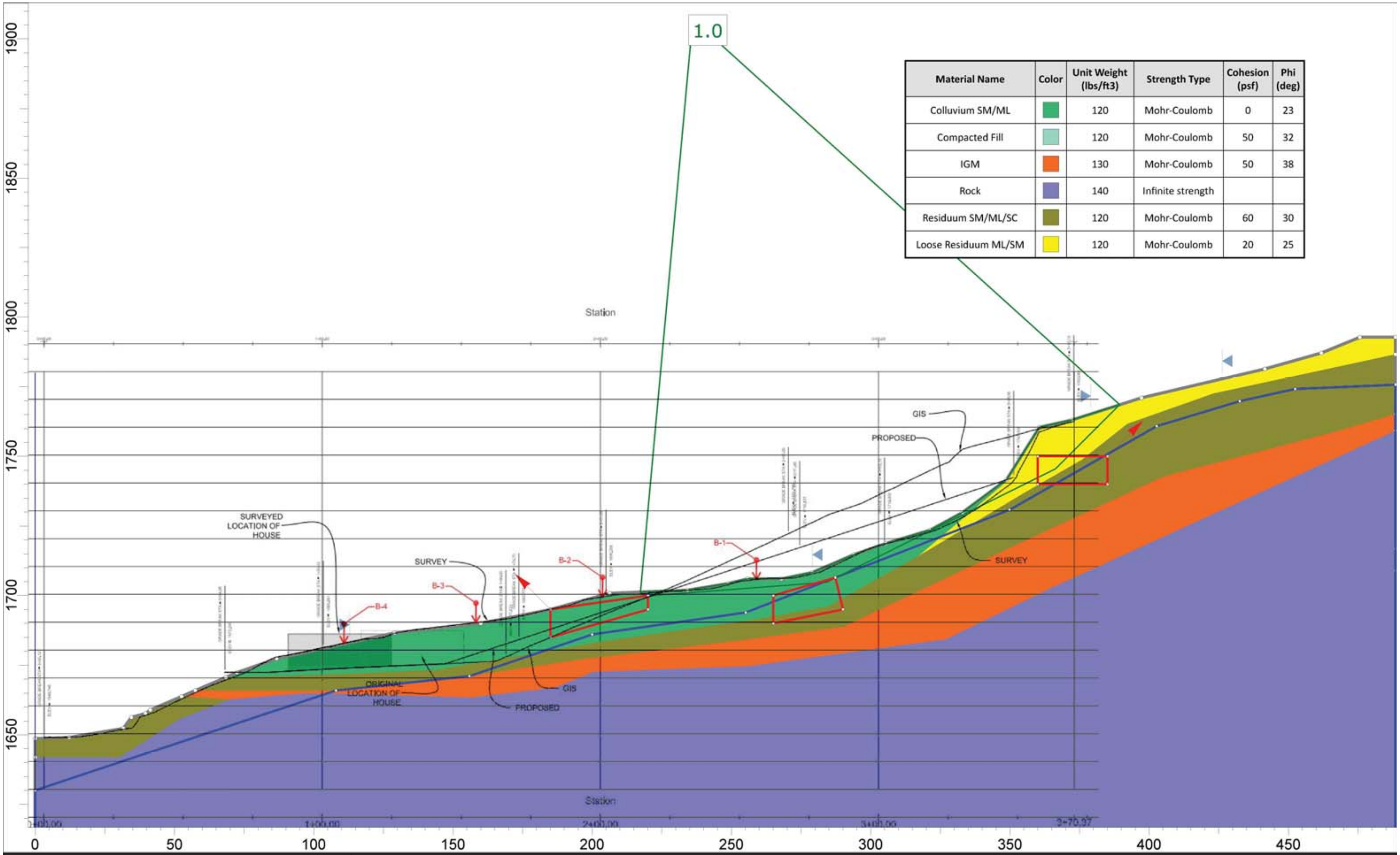


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟩	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

SLIDEINTERPRET 8.021

Project	Toddsbury Drive Slope Exploration
Analysis Description	Failure Condition Scenario

Drawn By	B.Quinn	*Scale*	1:729	*Company*	ECS Mid-Atlantic
Date	2/19/2019			*File Name*	Failure Section - Circular.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟩	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

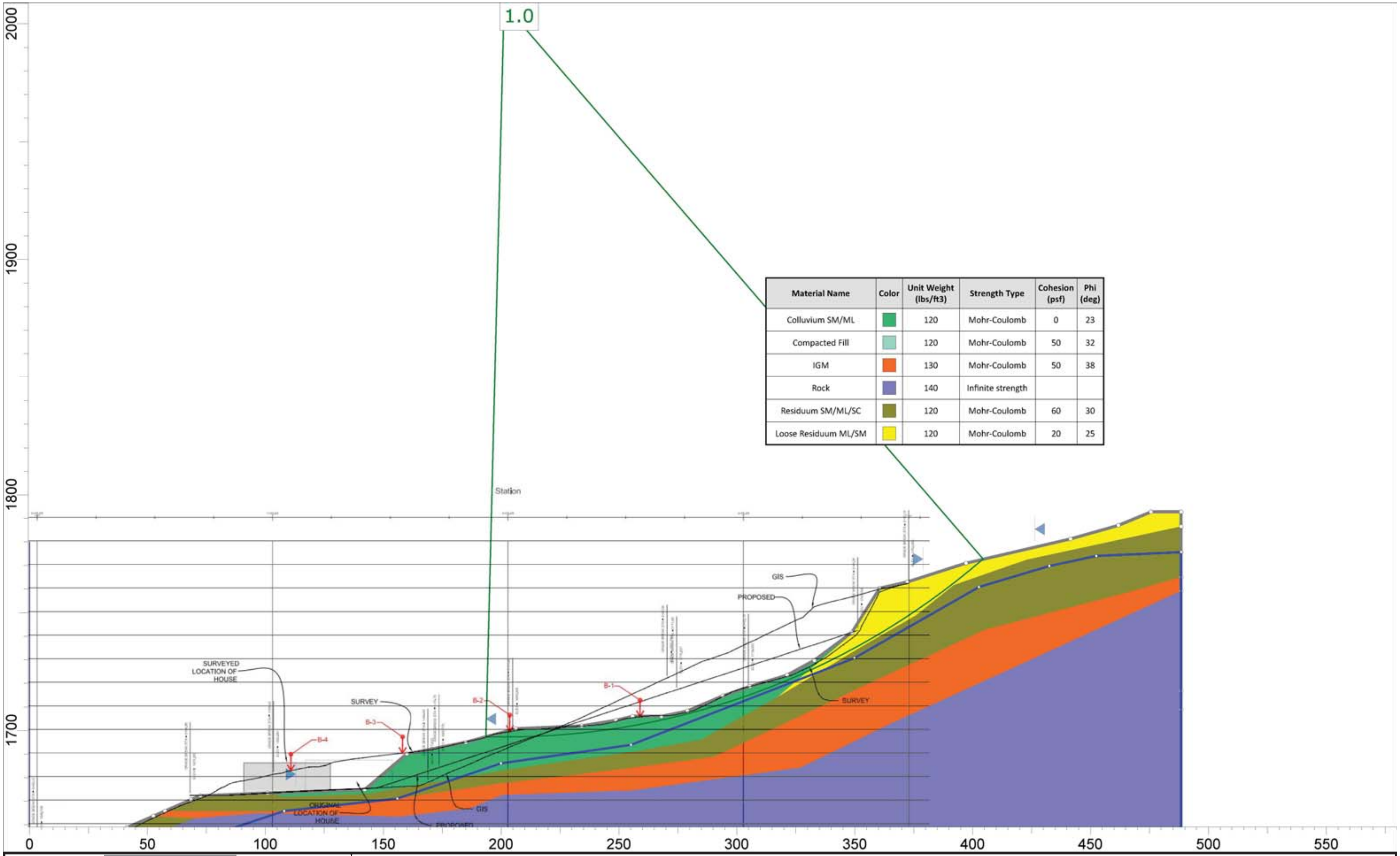
SLIDEINTERPRET 8.021

Project
Toddsbury Drive Slope Exploration

Analysis Description
Failure Condition Scenario

Drawn By B.Quinn
Scale 1:573
Company ECS Mid-Atlantic

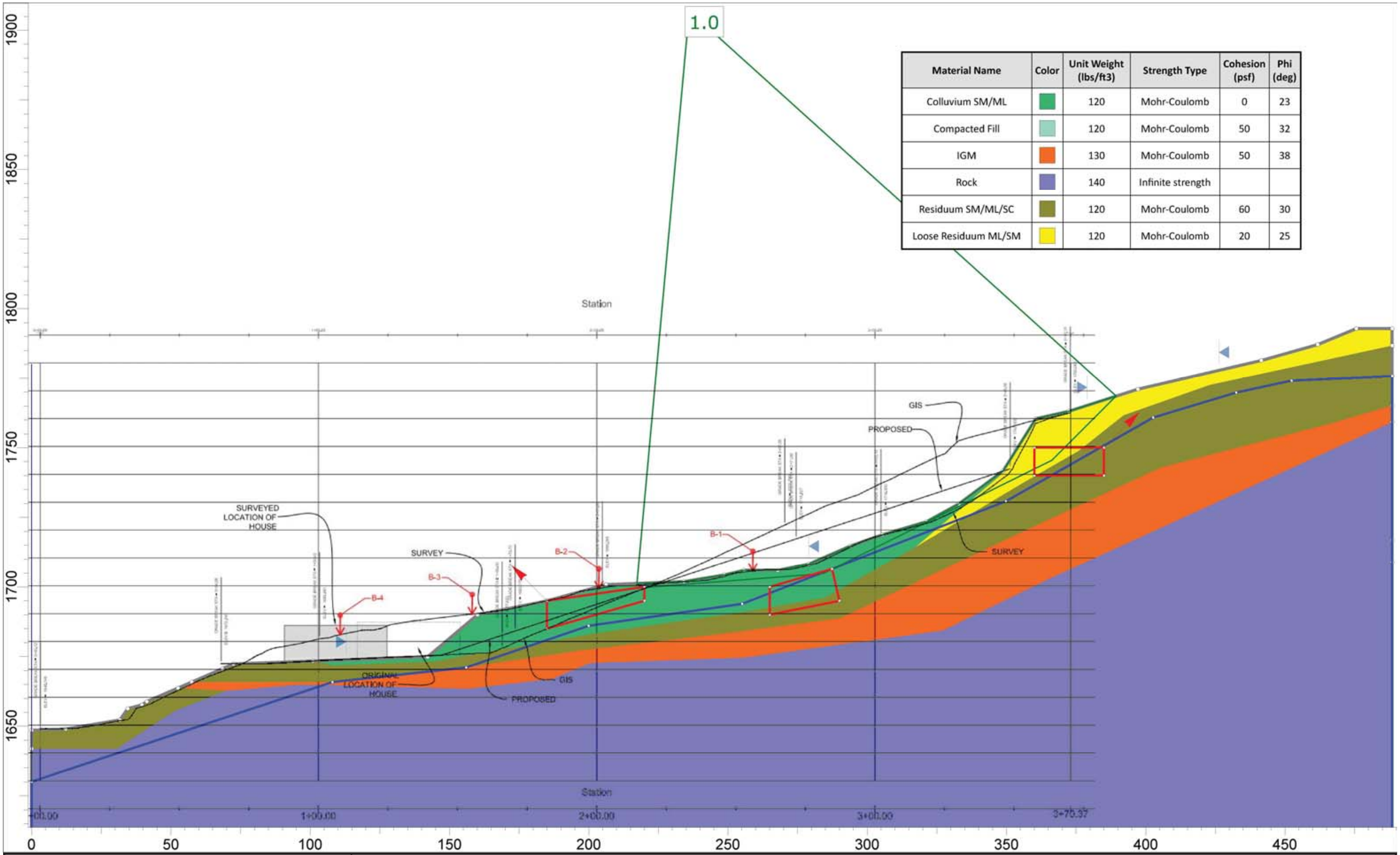
Date 2/19/2019
File Name Failure Section - Block.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟩	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

Project	Toddsbury Drive Slope Exploration
Analysis Description	Temporary Demolition Slope Scenario
Drawn By	B.Quinn
Scale	1:676
Company	ECS Mid-Atlantic
Date	2/19/2019
File Name	Demolition Section - Circular.slmd

SLIDEINTERPRET 8.021



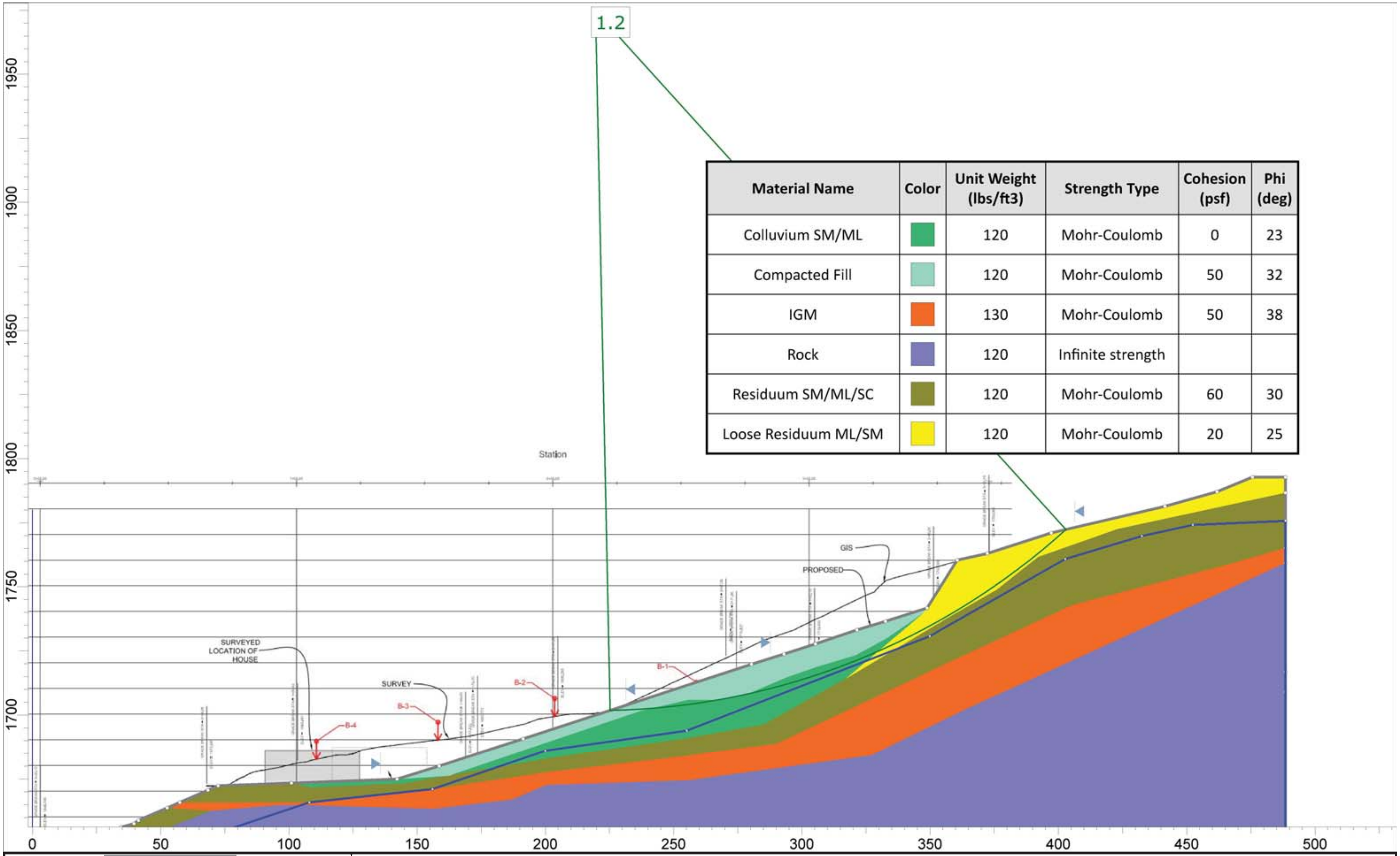
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟦	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

SLIDEINTERPRET 8.021

Project
Toddsbury Drive Slope Exploration

Analysis Description
Temporary Demolition Slope Scenario

Drawn By B.Quinn
Scale 1:573
Company ECS Mid-Atlantic
Date 2/19/2019
File Name Demolition Section - Block.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟩	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	120	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

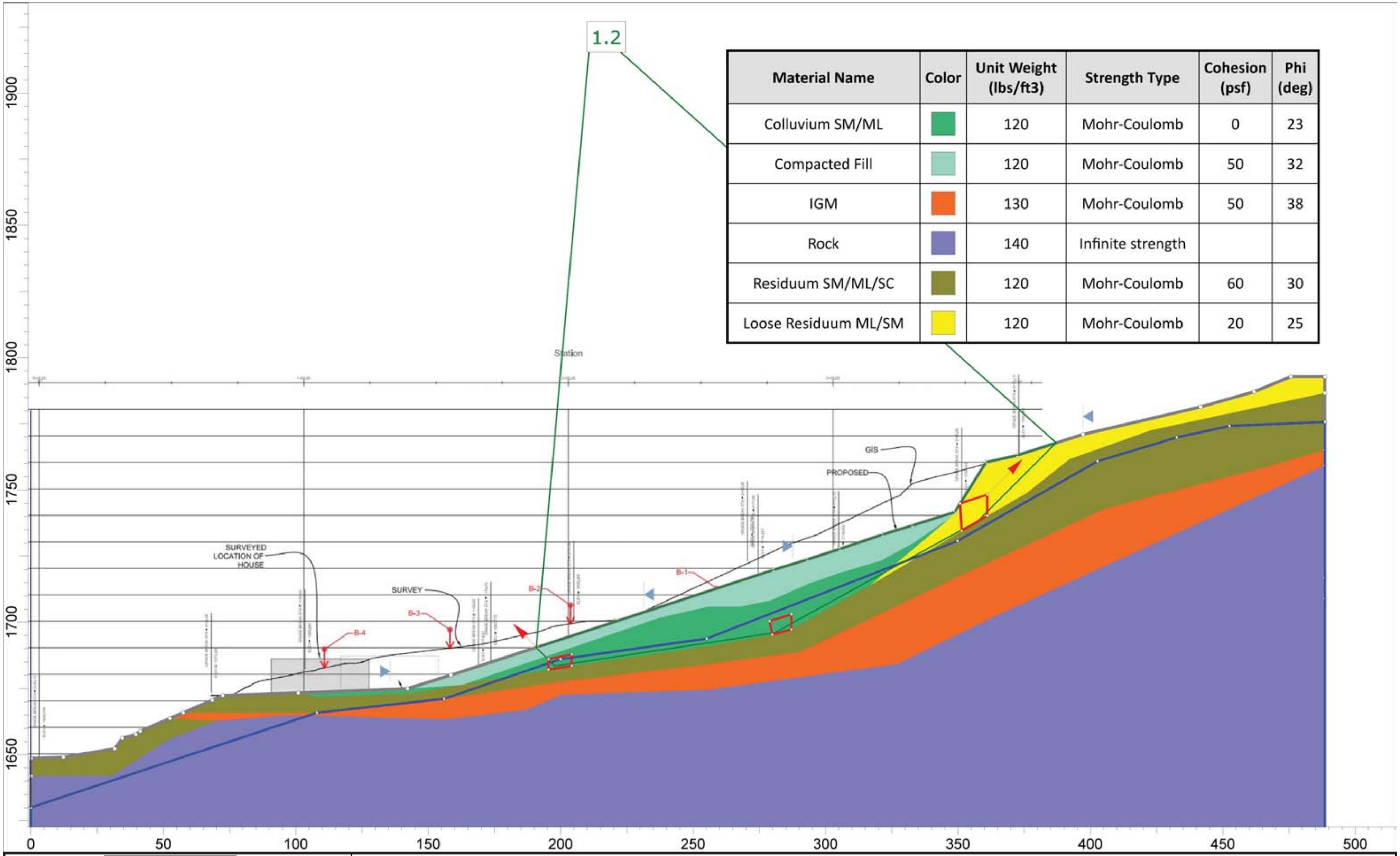
Project
Toddsbury Drive Slope Exploration

Analysis Description
Proposed Repair Condition Senario

Drawn By B.Quinn
Scale 1:622
Company ECS Mid-Atlantic

Date 2/19/2019
File Name Proposed Section - Circular.slmd

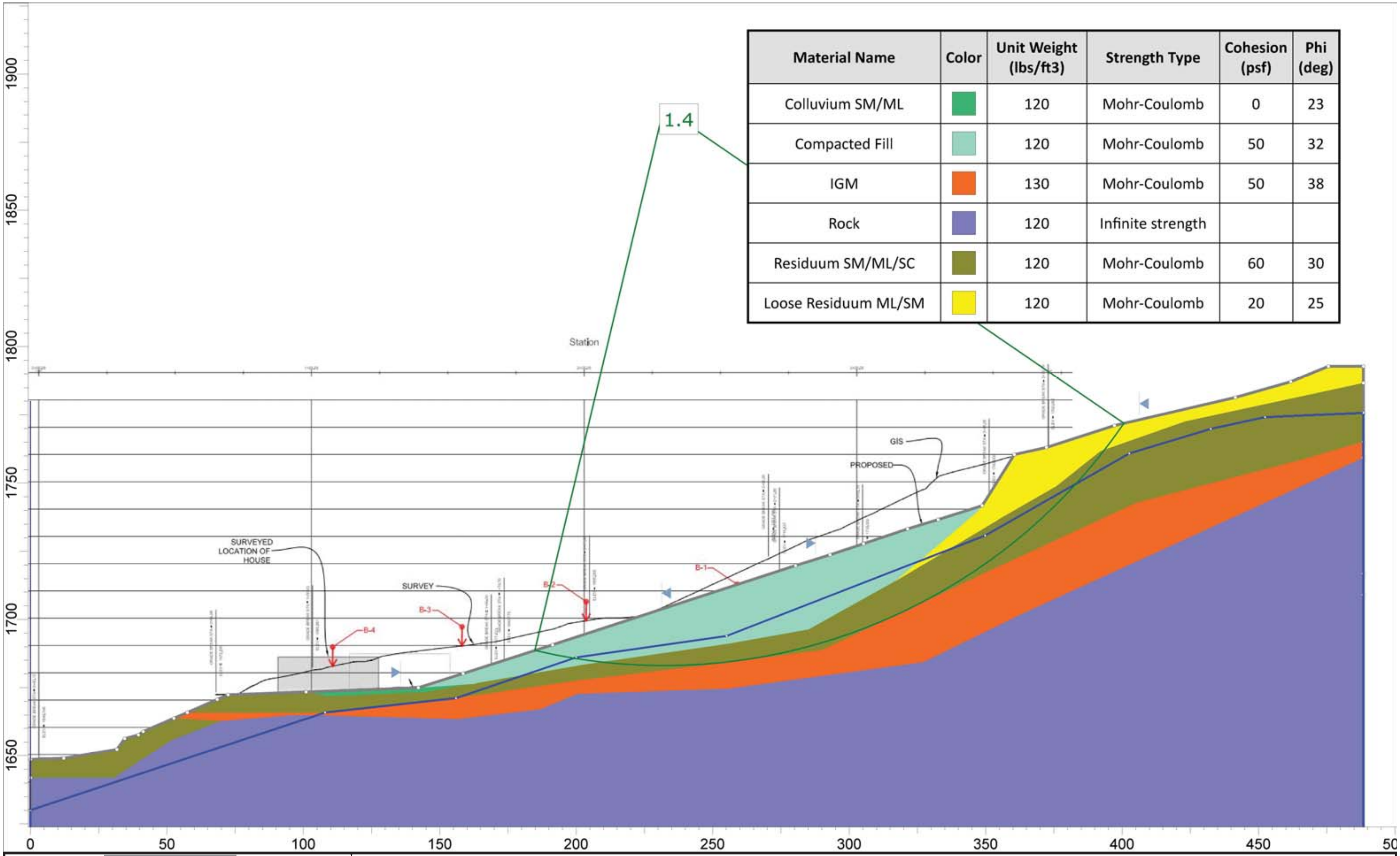
SLIDEINTERPRET 8.021



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟩	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

Project	Toddsbury Drive Slope Exploration
Analysis Description	Proposed Repair Condition Scenario
Drawn By	B.Quinn
Scale	1:602
Company	ECS Mid-Atlantic
Date	2/19/2019
File Name	Proposed Section - Block.slmd

SLIDEINTERPRET 8.021

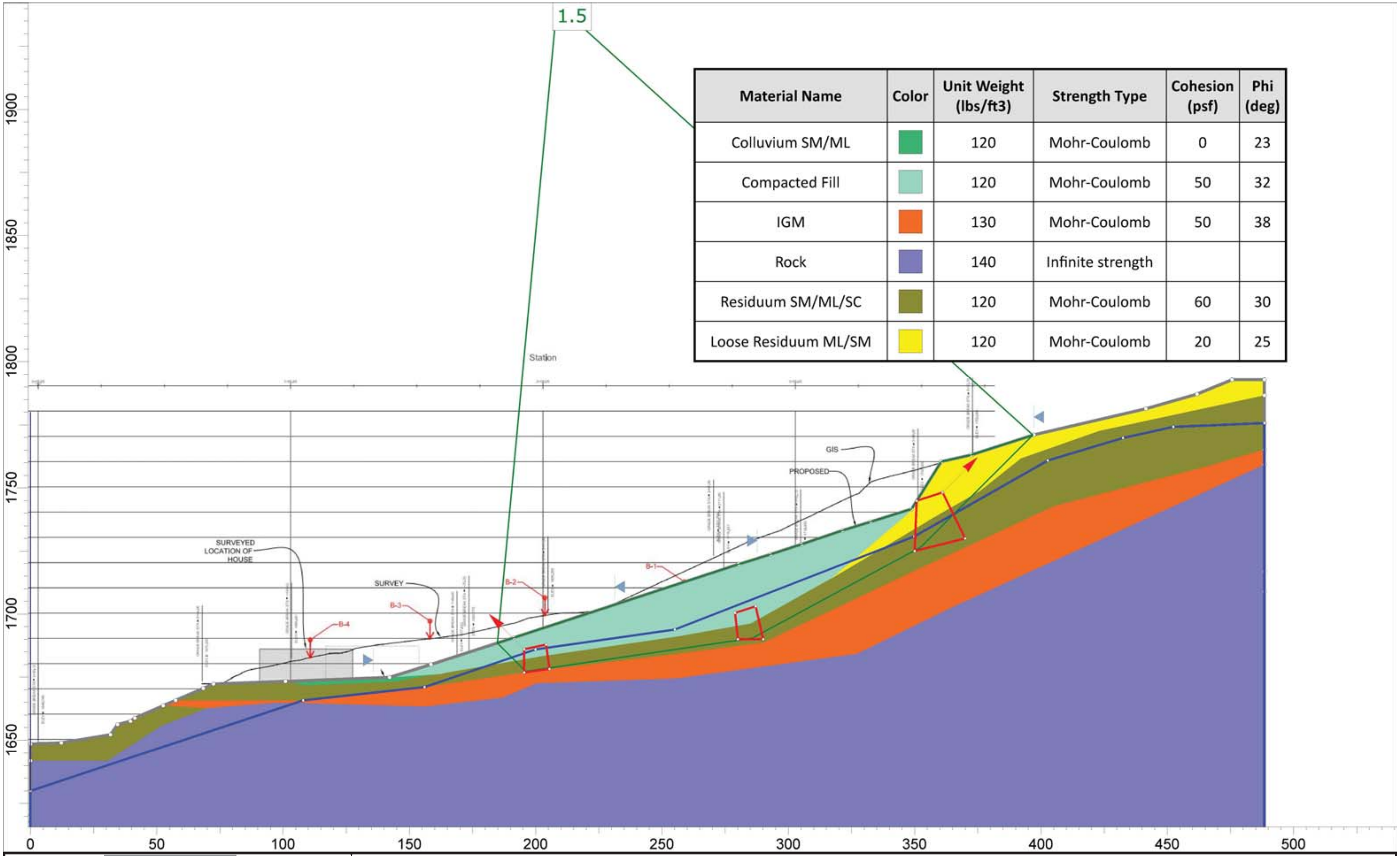


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟩	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	120	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

Project	Toddsbury Drive Slope Exploration
Analysis Description	Complete Colluvium Removal Scenario

Drawn By B.Quinn
Scale 1:584
Company ECS Mid-Atlantic
Date 2/19/2019
File Name Proposed All Fill Section - Circular.slmd

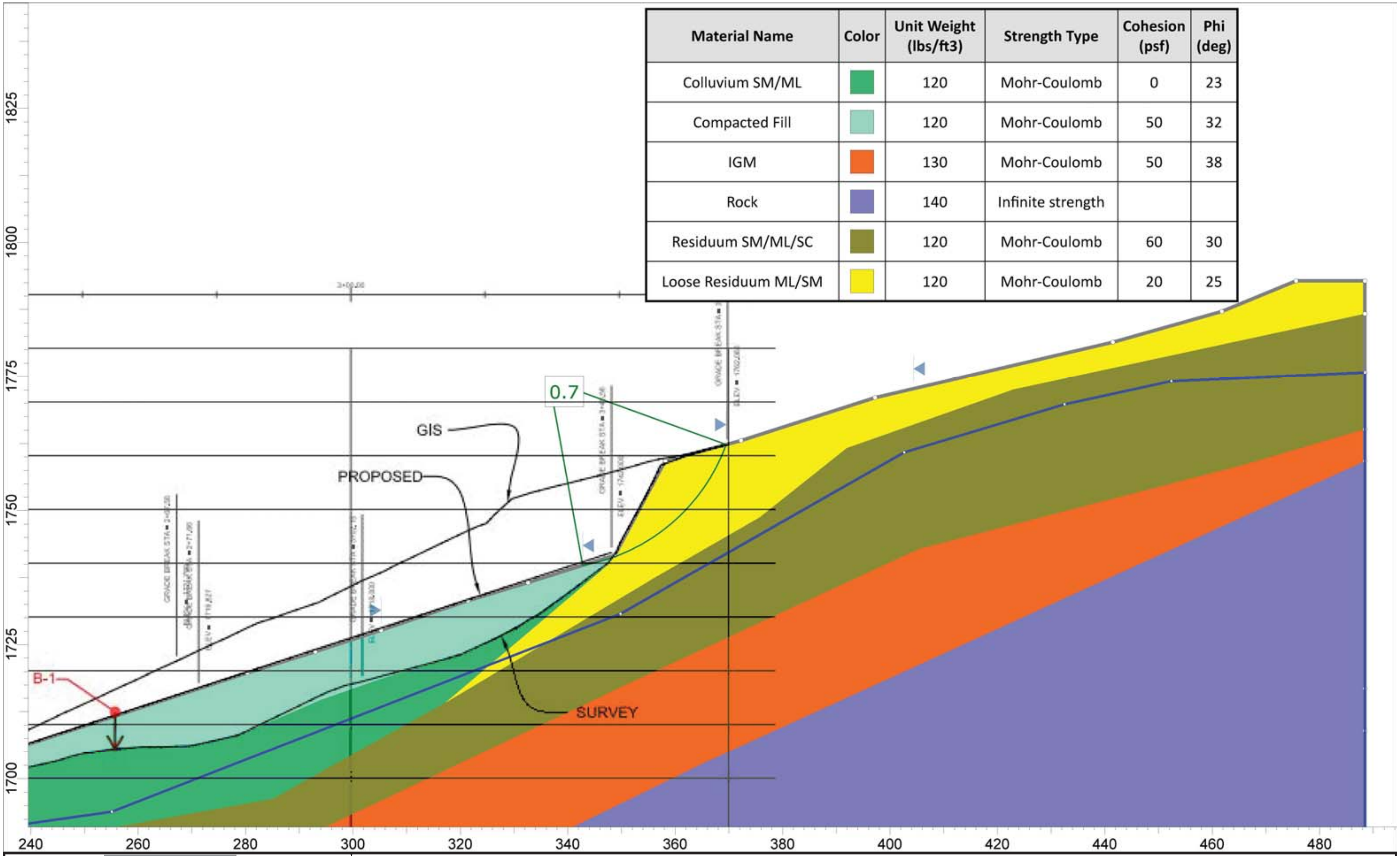
SLIDEINTERPRET 8.021



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟦	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

SLIDEINTERPRET 8.021

Project	Toddsbury Drive Slope Exploration		
Analysis Description	Complete Colluvium Removal Scenario		
Drawn By B.Quinn	*Scale* 1:631	*Company*	ECS Mid-Atlantic
Date 2/19/2019		*File Name*	Proposed All Fill Section - Block.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Colluvium SM/ML	🟩	120	Mohr-Coulomb	0	23
Compacted Fill	🟩	120	Mohr-Coulomb	50	32
IGM	🟧	130	Mohr-Coulomb	50	38
Rock	🟪	140	Infinite strength		
Residuum SM/ML/SC	🟫	120	Mohr-Coulomb	60	30
Loose Residuum ML/SM	🟨	120	Mohr-Coulomb	20	25

SLIDEINTERPRET 8.021

Project	Toddsbury Drive Slope Exploration		
Analysis Description	Head Escarpment Senario		
Drawn By	B.Quinn	*Scale*	1:297
Company	ECS Mid-Atlantic		
Date	2/19/2019	*File Name*	Existing Scarp.slmd