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REPORT STRUCTURE

VOLUME I	VOLUME II	VOLUME III:
FIELD OPERATIONS & PRELIMINARY RESULTS	FIELD MEASURED & DERIVED GEOTECHNICAL PARAMETERS AND FINAL RESULTS	DATA INTEGRATION AND ENGINEERING REPORT
(BS EN ISO 19901)	(BS EN ISO 19901)	(BS EN ISO 19901)
Executive Summary 1. Scope of Project 2. Offshore Activities 3. Drilling Operations 4. InSitu Testing-CPTU 5. InSitu Testing-PS Logging 6. Sampling Operations 7. Field Laboratory 8. Preliminary Geotechnical logs and Soil profiles 9. Classification Laboratory results 10. CPTU Analysis 11. Laboratory Testing Procedures 12. Geodetic Information and Water Depths 13. Health Safety and Environment 14. References	Executive Summary 1. Scope of Project 2. Soil Description and Profiles 3. Triaxial Laboratory Test Results 4. Chemical Results 5. Laboratory Testing Procedures 6. CPTU Analysis 7. In Situ Testing – PS Logging 8. List of Symbols and Abbreviations 9. References	Executive Summary 1. Scope of Project 2. Summary of Soil Conditions 3. Assessment of Data 4. Ground Model 5. Representative Basic Soil Parameters 6. Stress History Parameters 7. Deformation Parameters 8. Static Soil Strength Parameters 9. Cyclic Soil Strength Parameters 10. Recommended Soil Parameters 11. Comment on quality of samples 12. List of Symbols and Abbreviations 13. References

EXECUTIVE SUMMARY

The purpose of this report is the presentation and interpretation of geotechnical information acquired at the proposed location for the installation of a 148 Wind Turbine Generator (WTG) array and associated meteorological (MET) tower in the Maryland Wind Energy Area (MD WEA), approximately 10km off the coast of Maryland.

Six composite boreholes across the WTG array and one at the MET tower location, all comprising of CPTU, sample and PS Logging, were completed down to maximal depths between 64.9m and 75.2m to determine the geotechnical properties of the underlying soils enabling to perform engineering analyses in connection with conceptual foundation design.

This report presents the interpreted geotechnical results as well as proposed representative profiles for soil parameters. Geophysical data acquired at the MD WEA in 2013 by Coastal Planning & Engineering Inc. was provided by US Wind Inc. The sub-bottom profile data was interpreted and correlated with the geotechnical soil units.

Representative profiles for basic geotechnical parameters (such as relative density, friction angle, undrained shear strength, moisture content, effective unit weight and particle density) for each soil unit, as well as the assessment of small deformation stiffness and cyclic behaviour for the main units are presented.

A summary of the identified geotechnical units on the site is shown in Table 1 below, this progression being highly disrupted by lenses and possible channels.

Table 1 Stratigraphic Progression

Identified Geophysical Context	Soil Type
Superficial Sediments	Silty SAND with CLAY lenses
Channel Complex	SAND locally gravelly. Sand is medium to coarse. Sand is dense to very dense. Light brown becoming dark grey.
	Sandy CLAY with some stratifications of clayey SAND, especially in NW (tidal complex). Stiff to very stiff, grey.
Sub-parallel beds	Sandy CLAY, disappearing in NW.
	Sandy CLAY with some stratifications of clayey sand
	Clayey to Silty SAND
	Sandy CLAY. Very stiff to hard.

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1. Scope of Project

1.1 General

Gardline was commissioned by US Wind Inc. to carry out a geotechnical survey across the Maryland Wind Energy Area (MD WEA) situated approximately 10km off the coast of Maryland.

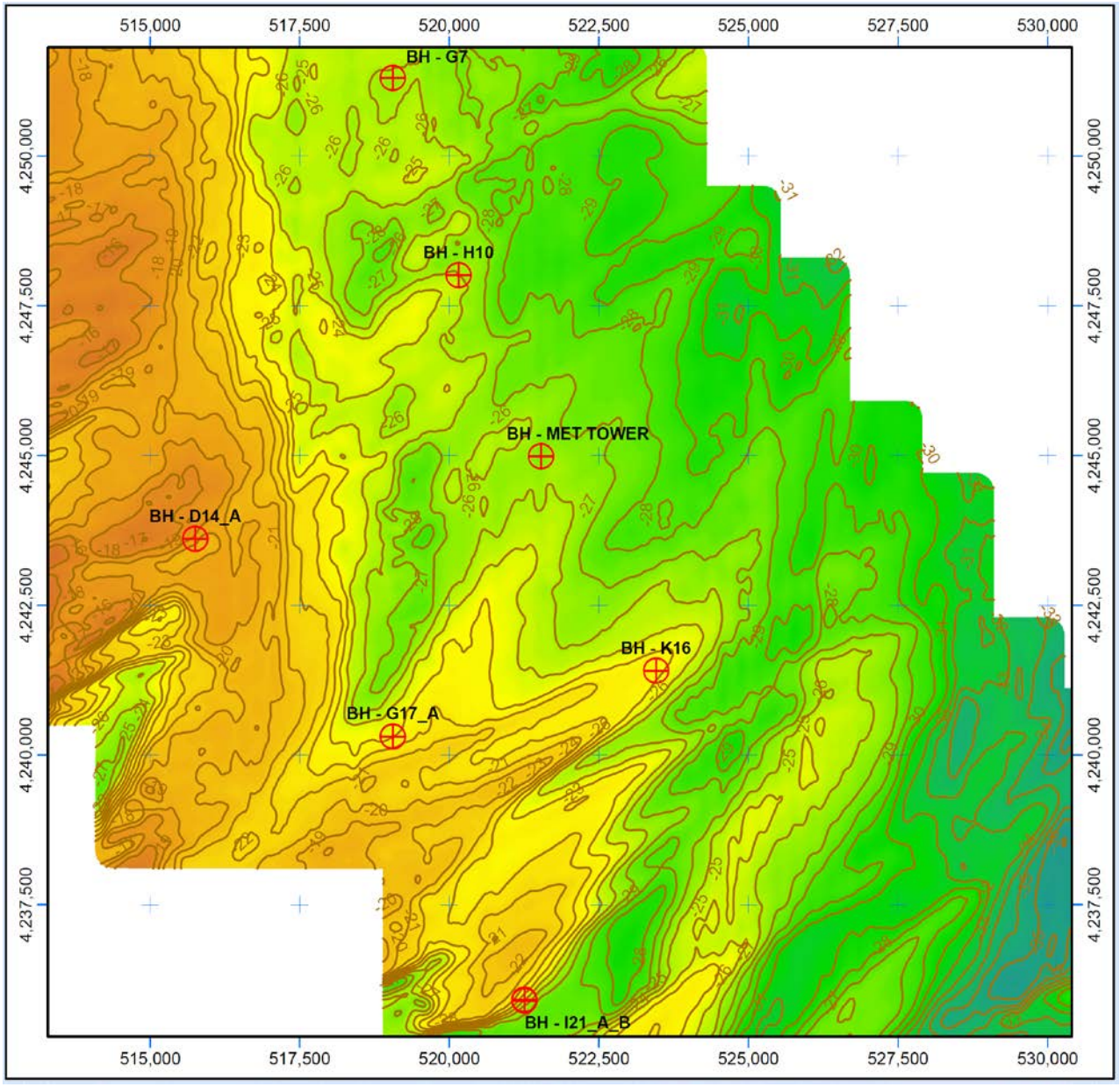
The purpose of this report is the presentation and interpretation of geotechnical information acquired at the proposed location for the installation of a 148 Wind Turbine Generator (WTG) array and associated meteorological (MET) tower in the Maryland Wind Energy Area (MD WEA), at a water depth varying between 19.0m and 27.7m.

Six composite boreholes across the WTG array and one at the MET tower location were completed. The boreholes consisted of alternative sampling and CPTU testing. In addition PS Logging operations were completed down to maximal depths between 64.9m and 75.2m to determine propagation velocity characteristics of shear and pressure waves.

The scope of the report is to provide a ground model by the integration of geophysical and geotechnical data. The model defines and describes the morphologies of soil units and soil provinces. Geophysical data acquired at the MD WEA in 2013 by Coastal Planning & Engineering Inc. was provided by US Wind Inc. for this purpose. In addition the report defines representative geotechnical parameters that can be used for geotechnical assessment and design across the WTG array and at the Met Tower location.

Representative profiles for basic geotechnical parameters (such as relative density, friction angle, undrained shear strength, moisture content, effective unit weight and particle density) for each soil unit, as well as the assessment of small deformation stiffness and cyclic behaviour for the main units are presented.

Figure 1.1 Overview Map



2. Summary of Soil Conditions

2.1 General

The proposed WTG array and Met Tower location are situated within US Waters, approximately 10km off the coast of Maryland immediately southwest of the Delaware outwash basin.

The geophysical results clearly show high degree of spatial variability both lateral and vertical on the shallow sediments. The geophysical interpretations were validated with the geotechnical results and allowed to describe the shallow geology in detail, the correlation of the two datasets are described in chapter 4.

Charts presented in Appendix 1.2 present the geophysical line showing geological conditions and formation boundaries identified at each location. Full details of the geophysical interpretation are presented in the Maryland Energy Administration High Resolution Geophysical Resource Survey Final Report of Investigations Project Number DEXR240005.

A summary of the identified geotechnical units on the site is shown in Table 2.1 below, this progression being highly disrupted by lenses and possible channels. Units were selected based on CPTU and sample data and correlated with geophysical profiles.

Table 2.1 General Stratigraphic Progression

Superficial Sediments	Unit 1	Silty SAND with CLAY lenses
Channel Complex	Unit 2	SAND locally gravelly. Sand is medium to coarse. Sand is dense to very dense. Light brown becoming dark grey.
	Unit 3	Sandy CLAY with some stratifications of clayey SAND, especially in NW (tidal complex). Stiff to very stiff, grey.
Sub-parallel beds	Unit 4	Sandy CLAY, disappearing in NW.
	Unit 5	Sandy CLAY with some stratifications of clayey sand
	Unit 6	Clayey to Silty SAND
	Unit 7	Sandy CLAY. Very stiff to hard.

At the locations closest to the shore (NW), for instance on boreholes BH-D14 and BH-G7, profiles present highly disrupted stratigraphy, featuring highly interbedded materials as part of a tidal complex, described in Coastal Planning & Engineering Inc. Geophysical report as “multiple, nested or multi-generational fluvial incisions and subsequent fluvial, transgressive, and tidal deposition”.

Tables 2.2 to 2.8 provide a summary of the encountered soil units and general soil type for each borehole. Local features such as channels or lenses are mentioned with an additional letter to the unit number.

Table 2.2 Stratigraphic Progression – BH-D14 location

Superficial Sediments	Unit 1a	Localised poorly graded SAND locally gravelly. Sand is medium to coarse. Sand is dense to very dense. Light brown becoming dark grey.
Channel Complex	Unit 1	Sandy CLAY with some stratifications of clayey sand. Stiff to very stiff, grey.
	Unit 2	SAND, medium dense to very dense.
	Unit 3	Poorly graded SAND with gravel to Clayey SAND.
Sub-parallel beds	Unit 4	Sandy CLAY. Very stiff.
	Unit 5	Clayey SAND to sandy CLAY.
	Unit 6	Silty SAND. Sand is fine, loose becoming dense, dark grey.
	Unit 7	Sandy CLAY. Very stiff to hard.

Table 2.3 Stratigraphic Progression – BH-G7 location

Superficial Sediments	Unit 1	Poorly graded SAND locally with clay and gravel. Sand is medium, medium dense to compact, dark grey, wet with black organic staining and lenses of sandy clay. Mostly shelly.
Channel Complex	Unit 2	Poorly graded SAND locally with clay and gravel. Sand is medium, medium dense to compact, dark grey, wet with black organic staining and lenses of sandy clay. Mostly shelly.
	Unit 3	CLAY, Stiff to very stiff, dark grey to dark greyish brown.
Sub-parallel beds	Unit 5	CLAY with sand, locally sandy clay with gravel, very stiff to hard, dark greyish brown. Few lenses and laminations of sand and silt. Few fine to coarse gravel size shell. Few gravel.
	Unit 6	Clayey SAND to poorly graded SAND with silt.
	Unit 7	Sandy CLAY. Sand is fine. Very stiff to hard, grey becoming greyish brown and dry with some fine shell and micaceous. Few to some shell. Stratified with clayey sand. Some laminations of silt and clay.

Table 2.4 Stratigraphic Progression – BH-G17 location

Identified Geophysical Context	Geotechnical Units	Soil Type
Superficial Sediments	Unit 1	Poorly graded SAND with gravel.
Channel Complex	Unit 2	Well graded SAND locally with gravel. Sand is fine to coarse.
	Unit 3	CLAY with sand stratified with sandy clay. Sand is fine. Very stiff to hard, dark grey to dark greyish brown, dry, micaceous. Locally some shell. Trace gravel.
Sub-parallel beds	Unit 4	Silty SAND to Sandy CLAY
	Unit 5	Sandy CLAY. Very stiff to hard with few gravel/shell. Interbedded SAND layers
	Unit 6	SAND, Compact, to Silty SAND.

Table 2.5 Stratigraphic Progression – BH-H10 location

Identified Geophysical Context	Geotechnical Units	Soil Type
Superficial Sediments	Unit 1	Well graded SAND. Fine to coarse, loose becoming dense, olive brown to dark grey. Locally poorly graded sand with gravel. CLAY from 5.10. Firm to stiff.
Channel Complex	Unit 2	Semi graded SAND becoming well graded. Sand is medium to coarse, dense to very dense, olive grey to olive, lenses of gravelly clay.
	Unit 2a	Poorly graded SAND with silt. Sand is fine, light olive grey and moist. Trace laminations of clayey sand.
	Unit 2b	Sandy CLAY to silty SAND
	Unit 3	Sandy CLAY to Clayey SAND
Sub-parallel beds	Unit 5	Sandy CLAY. Sand is fine, very stiff to hard, olive grey to brownish grey. Laminated with clay with few stratifications of sand.
		Poorly graded SAND with silt. Sand is fine, loose to medium dense, grey with some gravel. Locally some shell.
		Sandy CLAY. Sand is fine to coarse, very stiff to hard, dark grey. Stratified with clayey sand. Sand is fine to coarse, dark grey. Few lenses of clay and trace laminations of coarse sand. Locally some shell
	Unit 6	Clayey SAND, Sand is fine to coarse, dark grey. Little to some shell.
		Silty SAND. Fine to coarse, dark grey, few lenses and few laminations of clay. Few fine gravel and shell.
	Unit 7	CLAY. Very stiff to hard, dark grey and moist. Few weakly cemented lenses of silt. Few black organic staining.
		CLAY with sand. Sand is fine, very stiff to hard, dark grey, moist, mostly laminated with greysilt and fine sand. Little bioturbation infilled with grey silt. Locally mostly shelly.

Table 2.6 Stratigraphic Progression – BH-I21 location

Identified Geophysical Context	Geotechnical Units	Soil Type
Superficial Sediments	Unit 1	Poorly graded SAND. Sand is subangular, medium dense. Sand is light brown becoming dark grey, dry, little shell. Few lenses of black organic staining with mild to strong organic odour.
Channel Complex		Well graded SAND with silt. Sand is fine becoming coarse at 5.90m. Dark grey, with lenses of black organic staining. Sand becomes coarse at 5.90m, with few laminations of clay. Few fine gravel sized shell.
	Unit 2	Well graded SAND. Fine to coarse, dense to compact, dark olive grey, with trace shell fragments. Locally poorly graded. Stratified with poorly graded sand with gravel. Sand is angular and coarse.
	Unit 3	Sandy CLAY. Very stiff, dark greyish brown, few laminations and lenses of silt. Micaceous.
		Silty SAND. Sand is fine. Medium to dense, grey. Stratified with sandy silt.
		Sandy CLAY. Very stiff to hard, firm, grey, dry. Stratified with sandy silt, medium dense. Micaceous.
Sub-parallel beds	Unit 4	Poorly sorted SAND with silt. Sand is coarse and medium dense, grey. Some laminations and stratifications of elastic silt and sandy clay.
		Sandy CLAY. Hard, light grey stratified dark olive grey. Dry, some laminations and lenses of silty sand. Some shell.
	Unit 5	Poorly graded SAND with silt. Sand is fine becoming medium, grey, medium dense to dense, with few shell.
		Sandy CLAY. Very stiff becoming hard. Gravel at base.

Table 2.7 Stratigraphic Progression – BH-K16 location

Identified Geophysical Context	Geotechnical Units	Soil Type
Superficial Sediments	Unit 1	Poorly graded SAND locally with gravel. Sand is angular, medium, medium dense to compact. Light olive grey. Trace organic staining.
Channel Complex	Unit 2	Poorly graded SAND locally with gravel. Sand is angular, medium, medium dense to compact. Light olive grey. Trace organic staining.
	Unit 2d	Well graded SAND with gravel. Sand is coarse, very dense to compact.
	Unit 3	CLAY with sand, locally sandy clay. Very stiff to hard, dark olive grey, micacious, few laminations of sandy silt. Few lenses of greyish brown clay.
Sub-parallel beds	Unit 3a	CLAY with sand, locally sandy clay. Laminations of SAND with silt to silty SAND.
	Unit 4	CLAY. Hard, dark greenish grey, locally laminated with silt and sandy silt, Micaceous and friable.
	Unit 5	Clayey SAND, sand is fine, loose to medium dense, dark grey, little fine gravel size shell becoming mostly coarse gravel size shell at 66.90m. Trace lenses of clay, trace lenses of coarse sand.
	Unit 6	Sandy CLAY. Very stiff to hard with some laminations of clayey sand.
		Silty SAND becoming poorly graded sand with silt. Sand is coarse, medium dense to dense, grey, with few lenses of sandy clay.

Table 2.8 Stratigraphic Progression – BH-MET TOWER location

Identified Geophysical Context	Geotechnical Units	Soil Type
Superficial Sediments	Unit 1	Poorly graded SAND with silt. Dense to compact. Few stratifications of GRAVEL, Few pockets of clayey SAND. Few laminations of black organic staining. Micaceous.
Channel Complex	Unit 2	Poorly graded SAND. Very dense to compact. Few laminations of black organic staining. Micaceous.
	Unit 2c	Sandy SILT. Medium dense to dense locally loose.
	Unit 3	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous.
		Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.
Sub-parallel beds	Unit 4	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.
	Unit 4a	Poorly graded SAND with silt. Compact.
	Unit 5	Sandy CLAY. Hard.
	Unit 6	Poorly graded SAND with silt. Compact.
		Sandy CLAY. Hard.
		Clayey SAND becoming SAND with silt.

Geotechnical units are discussed further in Chapter 4.

2.2 Water Depth

The seabed depth was determined by Multibeam echosounder. Water depth at boreholes locations is between 19.0 and 27.7m MSL. Over the Maryland Wind Energy Area the water depth varied between 12.2m and 42.0m MSL.

2.3 Seafloor Conditions

Table 2.8 presents seafloor conditions across the Maryland Wind Energy Area. Assessments of seafloor conditions are based on data acquired during the geophysical survey conducted in 2013. Note that seafloor conditions may change over time.

Table 2.8 Seafloor Conditions across MD WEA

Seafloor Topography and Gradient	- Sand ridges trending northeast. Mainly present in the west and south of the site. - Seabed generally flat, however maximum gradients of 10° on ridges mainly present to west and southwest of the surveyed area - Areas showing potential scour
Seabed Sediments	- The seabed is characterised by SAND with gravel.

2.4 Potential Hazards

Potential Hazards are listed in the Table 2.9. It is important to note that the extent of this section is limited to Hazards that were identified on the basis of available information.

Table 2.9 Potential Hazards

Geohazard	Locations	Geotechnical Unit(s)	Description	Possible Impact
Sediment Transport	All	Units 1 and 2	Geophysical data shows spatial trends related to sediment movement.	Removal of sediments around foundations – scour. Additional deposition of sediments on or around foundations.
Steep Slopes	West and South	Units 1 and 2	Steep slopes identified as part of sand ridges present across site	Potential to cause issues during installation of foundations.
Debris / Shipwrecks	All	Seabed	Well documented potential for shipwreck remain. Numerous sidescan sonar contacts and magnetic anomalies indicate possible debris and shipwrecks	Debris could cause damage to equipment and foundations during installation operations.

3. Assessment of Data

3.1 General

Geophysical and geotechnical data was obtained across the Maryland Wind Energy Area. The geotechnical and geophysical data acquired at the borehole locations is generally of good quality and fit for purpose. Further details about quality are provided below.

3.2 Geophysical Data

Geophysical data was collected using multi-beam hydrographic data, sidescan sonar, magnetometer, shallow-penetration chirp sub-bottom profiler, and medium-penetration multi-channel sparker seismic-reflection geophysical systems.

More information can be found in the Coastal Planning & Engineering Inc. Maryland Energy Administration High Resolution Geophysical Resource Survey Final Report of Investigations Project Number DEXR240005.

3.3 Geotechnical Data

Between 20 and 35 CPTU tests were conducted in downhole mode at each location.

The CPTUs were within accuracy Class 1 to 3, the appropriate classes for the tested soils as set out by ISO 22476-1:2012. In general, the zero reading offsets were consistent before and after testing and there is no evidence of possible sensor drift effects.

Between 15 and 23 push samples were acquired during composite borehole operations at each location.

Push samples were subjected to a variety of testing during offshore operations. Samples were then sent back to Gardline onshore laboratory facility where further testing was carried out.

All CPTU, push sample and laboratory data was used for the engineering analyses.

4. Ground Model

4.1 General

Geotechnical and geophysical datasets were combined to build a three-dimensional ground model of the site. This enabled correlations between datasets and provided visual representations of the site survey.

4.2 Integration of Geotechnical and Geophysical Data

Geotechnical and geophysical datasets were combined to build a three-dimensional ground model. The geophysical and geotechnical results correlates relatively well at the different borehole locations. Coastal Planning and Engineering Inc. report identifies three main geophysical units or contexts as presented in Table 2.1. These seem to match reasonably well with the geotechnical records. The geotechnical records depicts further detail of the sedimentary sequence and allowed the identification of additional soil units here referred as Geotechnical Units.

SEG-Y files from the 2013 geophysical campaign were processed by Gardline and additional horizons were identified along the lines nearby the borehole locations.

The five horizons identified within the geophysical data are as follows:

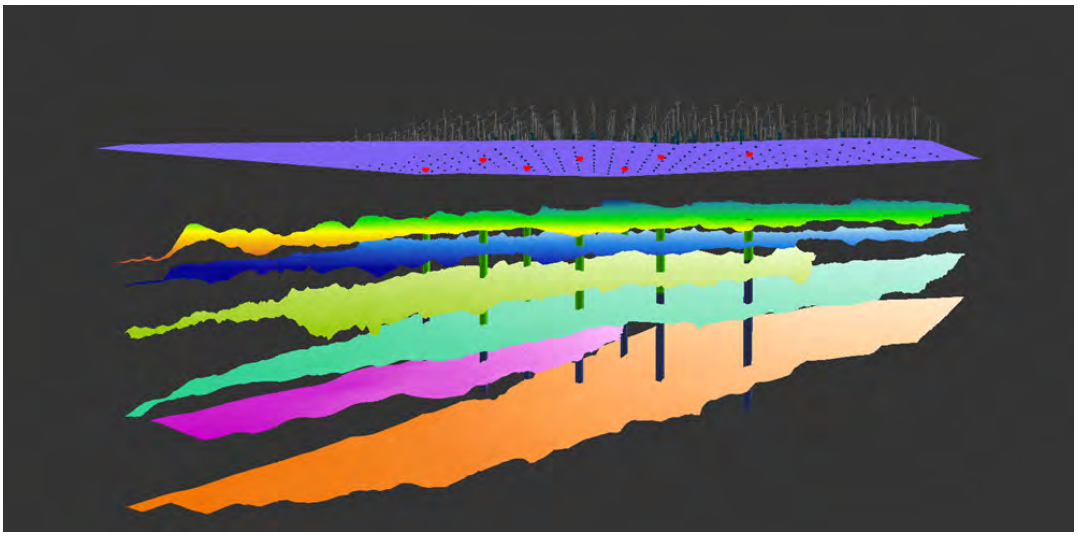
- Horizon 10 was identified as a the boundary between the Superficial Sediments context identified by the Geophysical survey and the Channel Complex.
- Horizon 15 was identified as an internal boundary in the Channel Complex .
- Horizon 20 was identified as the base of the Channel Complex and the boundary with the “Sub-parallel beds of sand and clay” context as identified by the Geophysical survey.
- Horizon 25 and 30 both thicken to the south of the site. These horizons are internal horizons within the “Sub-parallel beds” context. Horizon 25 pinches out north of Met Tower and mark a transition from succession of clays and silts to a predominantly sandy material

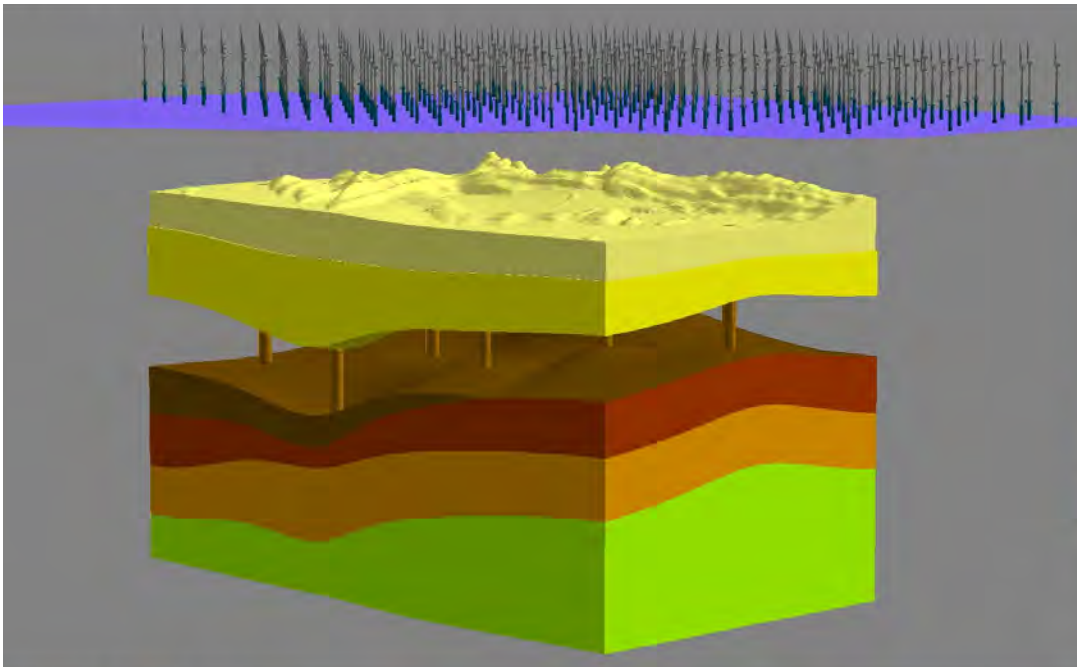
Charts presenting bathymetry data and geophysical and geotechnical integration cross sections at each location are shown in Appendix 1.2 where the comparisons between the datasets are shown.

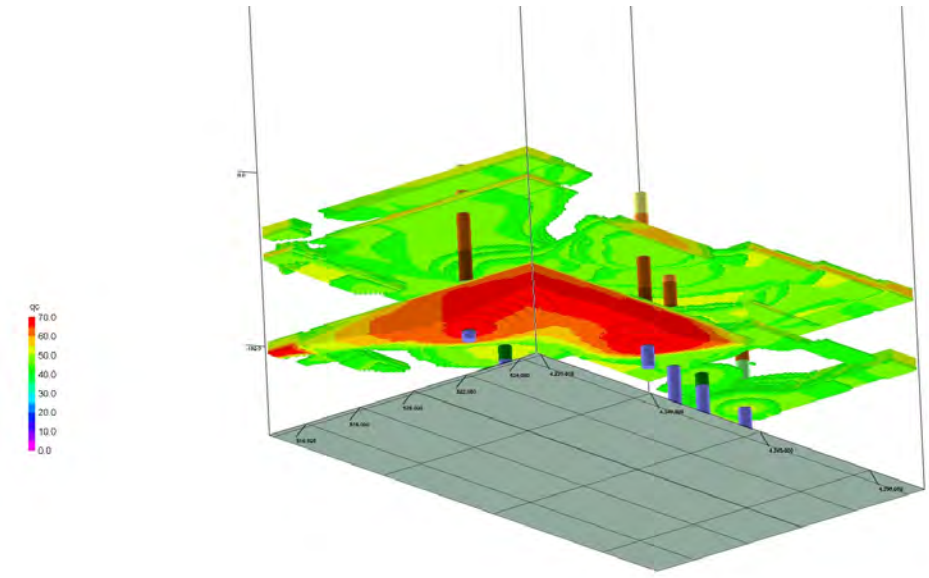
Seabed multiples were identified and marked on the geophysical image as a black line.

Figure 4.1 shows overviews of the produced 3D ground model.

Figure 4.1 3D Ground Model Overviews







4.3 Geotechnical Units

Table 4.1 provides a summary of the units identified and a brief soil description. It should be noted that the base depths reflect maximum reach of the geotechnical data.

Table 4.1 Identified Units – BH-D14 location

Identified Geophysical Context	Geotechnical Units	Depths (m)		Soil Type
		Top	Base	
Superficial Sediments	Unit 1a	0.00	8.50	Poorly graded SAND locally gravelly. Sand is medium to coarse. Sand is dense to very dense. Light brown becoming dark grey.
Channel Complex	Unit 1	8.50	14.53	Sandy CLAY with some stratifications of clayey sand. Stiff to very stiff, grey.
	Unit 2	14.53	17.80	SAND, medium dense to very dense interbedded with sandy CLAY and clayey SAND
	Unit 3	17.80	27.15	Poorly graded SAND with gravel and locally silt. Sand is coarse, medium dense to dense, light grey.
		27.15	30.10	Clayey SAND mostly stratified and laminated with sandy clay and trace gravel. Sand is fine grained, grey.
Sub-parallel beds	Unit 4	30.10	32.02	Sandy CLAY. Very stiff.
	Unit 5	32.02	43.31	Clayey SAND mostly stratified and laminated with sandy clay and trace gravel.
		43.31	45.00	Sandy SILT. Medium dense.
		45.00	48.90	Clayey SAND mostly stratified and laminated with sandy clay and trace gravel. Sand is fine grained, grey.
		48.90	61.50	Sandy CLAY. Very stiff to hard, dark grey. Little laminations of clay. Little to mostly shelly, fine to coarse gravel size. Sand is fine to medium.
	Unit 6	61.50	68.36	Silty SAND. Sand is fine, loose becoming dense, dark grey.
	Unit 7	68.36	71.30	Sandy CLAY. Very stiff to hard.

Table 4.2 Identified Units – BH-G7 location

Identified Geophysical Context	Geotechnical Units	Depths (m)		Soil Type
		Top	Base	
Superficial Sediments	Unit 1	0.00	7.52	Poorly graded SAND locally with clay and gravel. Sand is medium, medium dense to compact, dark grey, wet with black organic staining and lenses of sandy clay. Mostly shelly.
Channel Complex	Unit 2	7.52	16.50	Poorly graded SAND. Sand is medium, very dense to compact, light grey, moist with few lenses of sandy CLAY.
	Unit 3	16.50	31.62	CLAY, Stiff to very stiff, dark grey to dark greyish brown. Few coarse shell. Stratified with sandy elastic silt and silty sand with gravel. Micaceous with trace lenses of weakly cemented greyish brown silt. Few laminations of grey silt.
Sub-parallel beds	Unit 5	31.62	36.06	CLAY with sand, locally sandy clay with gravel, very stiff to hard, dark greyish brown. Few lenses and laminations of sand and silt. Few fine to coarse gravel size shell. Few gravel.
		36.06	37.96	Silty SAND. Medium dense to dense.
		37.96	43.92	Sandy CLAY. Very stiff to hard, dark grey, dry, few grey silt laminations and few locally some fine to coarse gravel size shell.
	Unit 6	43.92	51.62	Clayey SAND. Sand is fine to coarse, medium dense, dark grey. Stratified with silty sand. Trace to locally mostly shelly. Few lenses of sand, sand is medium to coarse, dark greenish grey sand. Trace lenses of sandy clay.
		51.62	58.67	Poorly graded SAND with silt. Sand is medium, very dense to compact, grey, mostly shelly, shell is fine gravel size.
	Unit 7	58.67	75.24	Sandy CLAY. Sand is fine. Very stiff to hard, grey becoming greyish brown and dry with some fine shell and micaceous. Few to some shell. Stratified with clayey sand. Some laminations of silt and clay.

Table 4.3 Identified Units – BH-G17 location

Identified Geophysical Context	Geotechnical Units	Depths (m)		Soil Type
		Top	Base	
Superficial Sediments	Unit 1	0.00	10.61	Poorly graded SAND with silt. Sand is fine grained, dense to compact, grey becoming light olive brown.
Channel Complex	Unit 2	10.61	25.50	Well graded SAND locally with gravel. Sand is fine to coarse.
	Unit 3	25.50	31.41	Well graded SAND locally with gravel. Sand is fine to coarse.
		31.41	43.11	CLAY with sand stratified with sandy clay. Sand is fine. Very stiff to hard, dark grey to dark greyish brown, dry, micaceous. Locally some shell. Trace gravel.
Sub-parallel beds	Unit 4	43.11	54.78	Silty SAND, sand is fine, loose to medium dense, grey, dry. Locally mostly shelly.
	Unit 5	54.78	66.29	Sandy CLAY. Very stiff to hard with few gravel/shell.
	Unit 6	66.29	71.50	SAND. Compact.
		71.50	73.98	Silty SAND. Medium dense.

Table 4.4 Identified Units – BH-H10 location

Identified Geophysical Context	Geotechnical Units	Depths (m)		Soil Type
		Top	Base	
Superficial Sediments	Unit 1	0.00	8.15	Well graded SAND. Fine to coarse, loose becoming dense, olive brown to dark grey. Locally poorly graded sand with gravel. CLAY from 5.10. Firm to stiff.
Channel Complex	Unit 2	8.15	13.50	Semi graded SAND becoming well graded. Sand is medium to coarse, dense to very dense, olive grey to olive, lenses of gravelly clay.
	Unit 2a	13.50	21.26	Poorly graded SAND with silt. Sand is fine, light olive grey and moist. Trace laminations of clayey sand.
	Unit 2b	21.26	24.80	Sandy CLAY to silty SAND
	Unit 3	24.80	31.02	Sandy CLAY to Clayey SAND
Sub-parallel beds	Unit 5	31.02	37.80	Sandy CLAY. Sand is fine, very stiff to hard, olive grey to brownish grey. Laminated with clay with few stratifications of sand.
		37.80	43.00	Poorly graded SAND with silt. Sand is fine, loose to medium dense, grey with some gravel. Locally some shell.
		43.00	45.93	Sandy CLAY. Sand is fine to coarse, very stiff to hard, dark grey. Stratified with clayey sand. Sand is fine to coarse, dark grey. Few lenses of clay and trace laminations of coarse sand. Locally some shell
	Unit 6	45.93	48.69	Clayey SAND, Sand is fine to coarse, dark grey. Little to some shell.
		48.69	64.07	Silty SAND. Fine to coarse, dark grey, few lenses and few laminations of clay. Few fine gravel and shell.
	Unit 7	64.07	67.00	CLAY. Very stiff to hard, dark grey and moist. Few weakly cemented lenses of silt. Few black organic staining.
		67.00	74.90	CLAY with sand. Sand is fine, very stiff to hard, dark grey, moist, mostly laminated with greysilt and fine sand. Little bioturbation infilled with grey silt. Locally mostly shelly.

Table 4.5 Identified Units – BH-I21 location

Identified Geophysical Context	Geotechnical Units	Depths (m)		Soil Type
		Top	Base	
Superficial Sediments	Unit 1	0.00	4.00	Poorly graded SAND. Sand is subangular, medium dense. Sand is light brown becoming dark grey, dry, little shell. Few lenses of black organic staining with mild to strong organic odour.
Channel Complex	Unit 1	4.00	7.81	Well graded SAND with silt. Sand is fine becoming coarse at 5.90m. Dark grey, with lenses of black organic staining. Sand becomes coarse at 5.90m, with few laminations of clay. Few fine gravel sized shell.
	Unit 2	7.81	26.80	Well graded SAND. Fine to coarse, dense to compact, dark olive grey, with trace shell fragments. Locally poorly graded. Stratified with poorly graded sand with gravel. Sand is angular and coarse.
	Unit 3	26.80	33.68	Sandy CLAY. Very stiff, dark greyish brown, few laminations and lenses of silt. Micaceous.
		33.68	40.53	Silty SAND. Sand is fine. Medium to dense, grey. Stratified with sandy silt.
		40.53	49.00	Sandy CLAY. Very stiff to hard, firm, grey, dry. Stratified with sandy silt, medium dense. Micaceous.
Sub-parallel beds	Unit 4	49.00	53.85	Poorly sorted SAND with silt. Sand is coarse and medium dense, grey. Some laminations and stratifications of elastic silt and sandy clay.
		53.85	66.42	Sandy CLAY. Hard, light grey stratified dark olive grey. Dry, some laminations and lenses of silty sand. Some shell.
	Unit 5	66.42	72.00	Poorly graded SAND with silt. Sand is fine becoming medium, grey, medium dense to dense, with few shell.
		72.00	73.76	Sandy CLAY. Very stiff becoming hard. Gravel at base.

Table 4.6 Identified Units – BH-K16 location

Identified Geophysical Context	Geotechnical Units	Depths (m)		Soil Type
		Top	Base	
Superficial Sediments	Unit 1	0.00	12.62	Poorly graded SAND locally with gravel. Sand is angular, medium, medium dense to compact. Light olive grey. Trace organic staining.
Channel Complex	Unit 2	12.62	27.00	Poorly graded SAND locally with gravel. Sand is angular, medium, medium dense to compact. Light olive grey. Trace organic staining.
	Unit 2d	27.00	37.00	Well graded SAND with gravel. Sand is coarse, very dense to compact.
	Unit 3	37.00	49.69	CLAY with sand, locally sandy clay. Very stiff to hard, dark olive grey, micaceous, few laminations of sandy silt. Few lenses of greyish brown clay.
Sub-parallel beds	Unit 3a	49.69	54.99	CLAY with sand, locally sandy clay. Laminations of SAND with silt to silty SAND.
	Unit 4	54.99	64.00	CLAY. Hard, dark greenish grey, locally laminated with silt and sandy silt, Micaceous and friable.
	Unit 5	64.00	68.03	Clayey SAND, sand is fine, loose to medium dense, dark grey, little fine gravel size shell becoming mostly coarse gravel size shell at 66.90m. Trace lenses of clay, trace lenses of coarse sand.
	Unit 6	68.03	69.84	Sandy CLAY. Very stiff to hard with some laminations of clayey sand.
		69.84	73.20	Silty SAND becoming poorly graded sand with silt. Sand is coarse, medium dense to dense, grey, with few lenses of sandy clay.

Table 4.7 Identified Units – BH-MET TOWER location

Identified Geophysical Context	Geotechnical Units	Depths (m)		Soil Type
		Top	Base	
Superficial Sediments	Unit 1	0.00	12.50	Poorly graded SAND with silt. Dense to compact. Few stratifications of GRAVEL, Few pockets of clayey SAND. Few laminations of black organic staining. Micaceous.
Channel Complex	Unit 2	12.50	20.16	Poorly graded SAND. Very dense to compact. Few laminations of black organic staining. Micaceous.
	Unit 2c	20.16	23.30	Sandy SILT. Medium dense to dense locally loose.
	Unit 3	23.30	26.50	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous.
		26.50	37.00	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.
Sub-parallel beds	Unit 4	37.00	44.01	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.
	Unit 4a	44.01	50.77	Poorly graded SAND with silt. Compact.
	Unit 5	50.77	53.50	Sandy CLAY. Hard.
	Unit 6	53.50	55.30	Poorly graded SAND with silt. Compact.
		55.30	57.30	Sandy CLAY. Hard.
		57.30	64.94	Clayey SAND becoming SAND with silt.

5. Representative Basic Soil Parameters

5.1 General

Geotechnical data has been presented on soil profiles, where derived geotechnical parameters are plotted against depth. The soil profiles and composite CPTU profiles are presented in the following appendices:

- Relative Density (Appendix 2.1)
- Friction Angle (Appendix 2.2)
- Remoulded Undrained Shear Strength (Appendix 2.3)
- Sensitivity (Appendix 2.4)
- Effective Unit Weight (Appendix 2.5)
- Moisture Content (Appendix 2.6)
- Plasticity index (Appendix 2.7)
- Unit weight of solid particles (Appendix 2.8)
- CPTU (Appendix 5.1)

5.2 Relative Density

Outlined below is the method used to calculate the relative density presented in the plots found in Appendix 2. The relative density estimates were calculated using the Jamiolkowski et al. (1988) equation. Relative Density provides a relationship between the in situ voids ratio, e, to the minimum and maximum densities, e_{min} and e_{max}, of the soil.

For a list of all symbols relating to this formula and all subsequent formulae within this report please refer to Section 12.

$$D_r = \left[\frac{1}{2.93}\right] \ln\left[\frac{q_c}{205\left(\sigma_m{}'^{0.51}\right)}\right] x100,$$

With $\sigma_m{}' = \left[\frac{\sigma'_{vo}\left(1+2K_0\right)}{3}\right]$ the estimated mean effective stress at test depth

K_0 (coefficient of lateral earth pressure) values of 0.5 for the upper bound calculation and 3.0 for the lower bound calculation were used. It is important to note the derived values for relative density are subject to a certain degree of uncertainty due to the empiric nature of the equation proposed by Jamiolkowski et al. (1988). Most of the existing methods for deriving relative density from CPTU data were obtained using a calibration chamber filled with clean medium sand, predominantly silica sand. Thus if the equations are used in a natural sand layer with a different composition to the sand used in the calibration chamber the level of uncertainty in the estimation will inevitably increase. The sands encountered during this investigation may display a significant percentage of silt. Relative densities should then be considered as a low estimate.

5.3 Friction Angle

Friction angles were derived from CPTU data. Plots showing the results and recommended design lines are presented in Appendix 2.2. Friction angle values were obtained based on the calculated relative density following guidelines from API (2000). The derived friction angles are listed in Table 5.1 below.

Relative density (shown in Table 5.1) values derived from CPTU data are based on the assumptions that the material is clean sand, i.e. has no silt or clay content (as discussed in Section 5.2). Sands of differing properties can result in the derivation of higher or lower than anticipated friction angles using this correlation with relative density. Therefore care is required when using this methodology.

Table 5.1 API (2000) Internal Friction Angles

Relative Density	Soil Description	Equivalent Internal Friction Angle, φ' (°)
Very Loose Loose Medium	Sand Sand – Silt Silt	20
Loose Medium Dense	Sand Sand – Silt Silt	25
Medium Dense	Sand Sand – Silt	30
Dense Very Dense	Sand Sand – Silt	35
Dense Very Dense	Gravel Sand	40

5.4 Remoulded Undrained Shear Strength

Remoulded shear strength has been determined on a number of samples by laboratory vanes and fall cone tests. Since the remoulded state of the clay is sought before testing, sample disturbance does not have any incidence on the remoulded shear strength obtained as far as water content remains unchanged.

Shear strength from DSS-test s_{uD} can be used divided by sensitivity S_t. Shear strength s_{uD} profile is itself derived from s_{uC}-profile by means of the anisotropy ratio $a = s_{uD}/s_{uC}$ to be determined per unit due the heterogeneity of the site (see Section 8.2). Then with an average value of 3.5 for sensitivity, we have:

$$s_{u,rem} = a.\ s_{uC}\ /3.5$$

Low and high profiles thus calculated with the common value a=0.9 are presented for guidance in Appendix 2.3 for all locations together with measured values of remoulded shear strength.

5.5 Sensitivity

Remoulded and intact shear strength has been determined on a number of samples by laboratory vanes and fall cone tests.
The sensitivity can then be found by the formula $S_t = s_{u,intact} / s_{u,rem}$, where $s_{u,intact}$ and $s_{u,rem}$ are shear strengths measured on intact and remoulded samples respectively.

Sensitivity plots, as presented in Appendix 2.4 for all locations, shows very scattered values. An average value of 3.5 can be used. Volume II of this report presents more details on results on samples.

5.6 Effective Unit Weight

Effective unit weight data was obtained using the following methodologies:

1. Bulk Density Test (BS1377: Part 7: 1990 – Section 7)
2. Derived from Moisture Content (BS1377: Part 7: 1990 – Section 3)

Theoretical unit weights were calculated under the assumption the soils were 100 percent saturated in-situ using the following equation:

$$\gamma' = \gamma_{wsea}\left[\frac{G_s(1+w)}{1+wG_s} - 1\right]$$

Where: G_s = specific gravity (an average value of 2.65 is considered representative)

The results are presented in the plots found in Appendix 2.5.

5.7 Moisture Content

Composite plots for moisture (or water) content are presented in Appendix 2.6 for each location.

5.8 Plasticity index

Atterberg classification tests were performed on clay samples from the site to determine the liquid and platic limits, respectively w_L and w_P. The plasticity index can then be deduced by the formula $I_P = w_L - w_P$.

The plasticity indices I_P obtained per location are presented versus depth as well as suggested profiles when possible in Appendix 2.7.

The plasticity indices generally stand between 10 and 30% on the project locations.

5.9 Unit weight of solid particles

The unit weight of solid particles obtained per location are presented versus depth as well as suggested profiles in Appendix 2.8.

The unit weight of solid particles stand between 26.00 and 27.17 kN/m^3 on the project locations.

The unit weight of solid particles plots show an average value of 26.5 kN/m^3 can be taken.

5.10 Fine and Clay Content

Composite plot for fine and clay contents is presented in Appendix 2.9.

5.11 CPTU

Composite plots of the Corrected Cone End Resistance (CER), sleeve friction and pore water pressure are presented in Appendix 5.1 for the proposed borehole locations.

6. Stress History Parameters

6.1 Effective Vertical Stress

The recommended profile for the effective vertical stress, p'_0, is derived from the recommended unit weight profiles given in Tables 10.1 to 10.7 or Appendix 2.5. The effective stresses are derived assuming hydrostatic pore pressure in-situ.

Composite plots for the effective vertical stress profile at the proposed locations are presented in Appendix 3.1.

7. Deformation Parameters

7.1 Small strain shear modulus

The small strain shear modulus G_0 has been investigated using PS-logging *in situ* and Bender Elements (BE) tests performed on triaxial specimens in Gardline onshore laboratory.

Using the PS-logging, shear (v_s) and compression (v_p) wave velocities were determined at nominal 1 m intervals from 44m, 68m, 74m and 65m depth below seabed respectively for BH-D14A, BH-G17, BH-I21B and BH-MET TOWER to the shallowest practicable depth. Further details of these tests are given in Volume II.

Appendix 4.1 presents a plot of v_s versus depth determined from both the Bender Elements tests and the PS-logging. Note that the PS logger records a vertically–propagating, horizontally-polarised shear wave velocity (denoted v_{svh}).

G_0 values have been determined from the measured shear wave velocities following the relationship:

$$G_0 = \rho v_s^2$$

where ρ is the bulk density of the soil.

Appendix 4.2 presents the G_0 values versus depth determined from both Bender Element results and PS-logging. Normalised plots of G_0/p'_0 and G_0/s_{uC} from Bender Elements are presented in Appendices 4.3 and 4.4 respectively.

Appendix 4.5 presents all PS-logging results including pressure wave measurements.

8. Static Soil Strength Parameters

8.1 Interpretation of Undrained Shear Strength, total stresses

The design undrained shear strength (Su) profiles are presented in Appendix 5. The shear strength has been inferred from the CPTU data based on the corrected cone end resistance (q_{net}). The following relationship has been used:

$$\text{Undrained Shear Strength} = q_{net} / N_{kt}$$

The N_{kt} factor has been evaluated by comparison with shear strengths obtained from Triaxial CAUC tests. Upper and lower bound of 15 and 20 have been retained as shown on the plots presented in Appendix 5.4. The chart also show values obtained from DSS and triaxial UU tests for comparison. Figures 8.1 and 8.2 show how N_{kt} values range for the different tests.

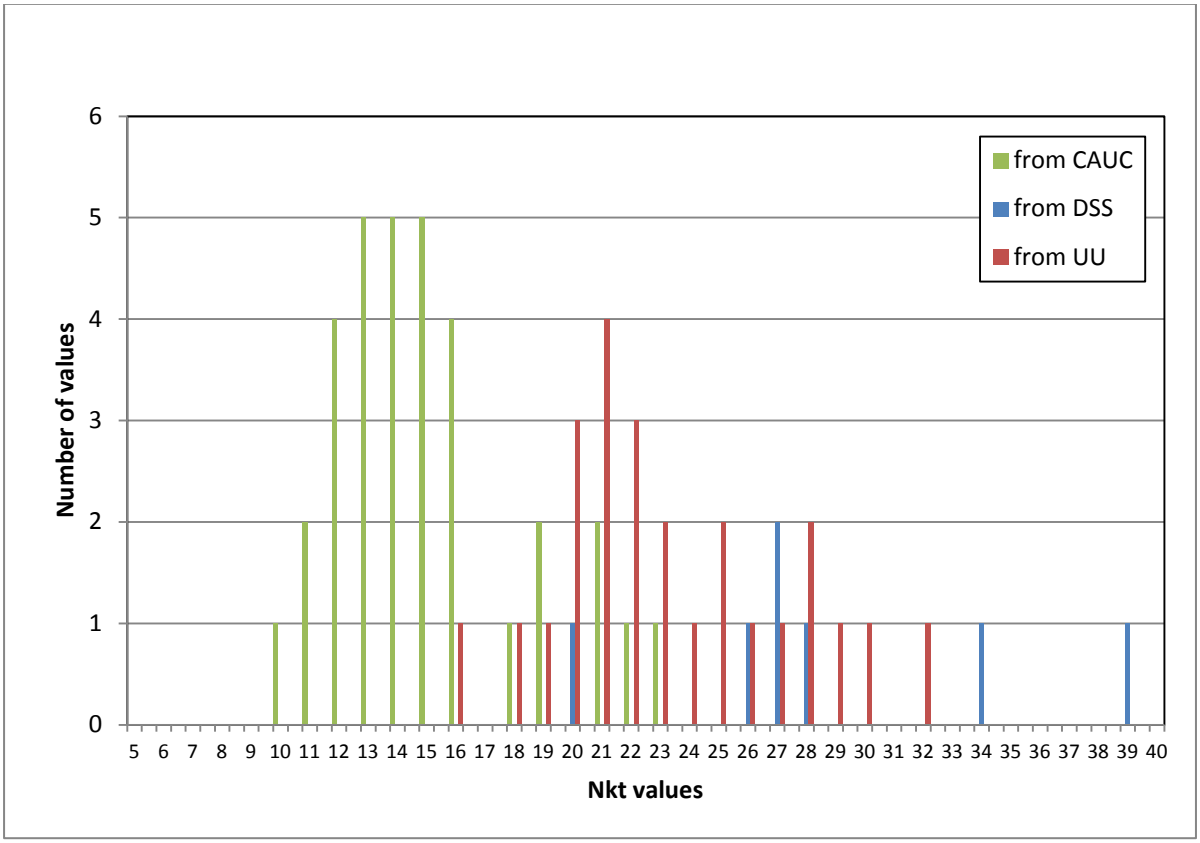


Figure 8.1 N_{kt} values per test

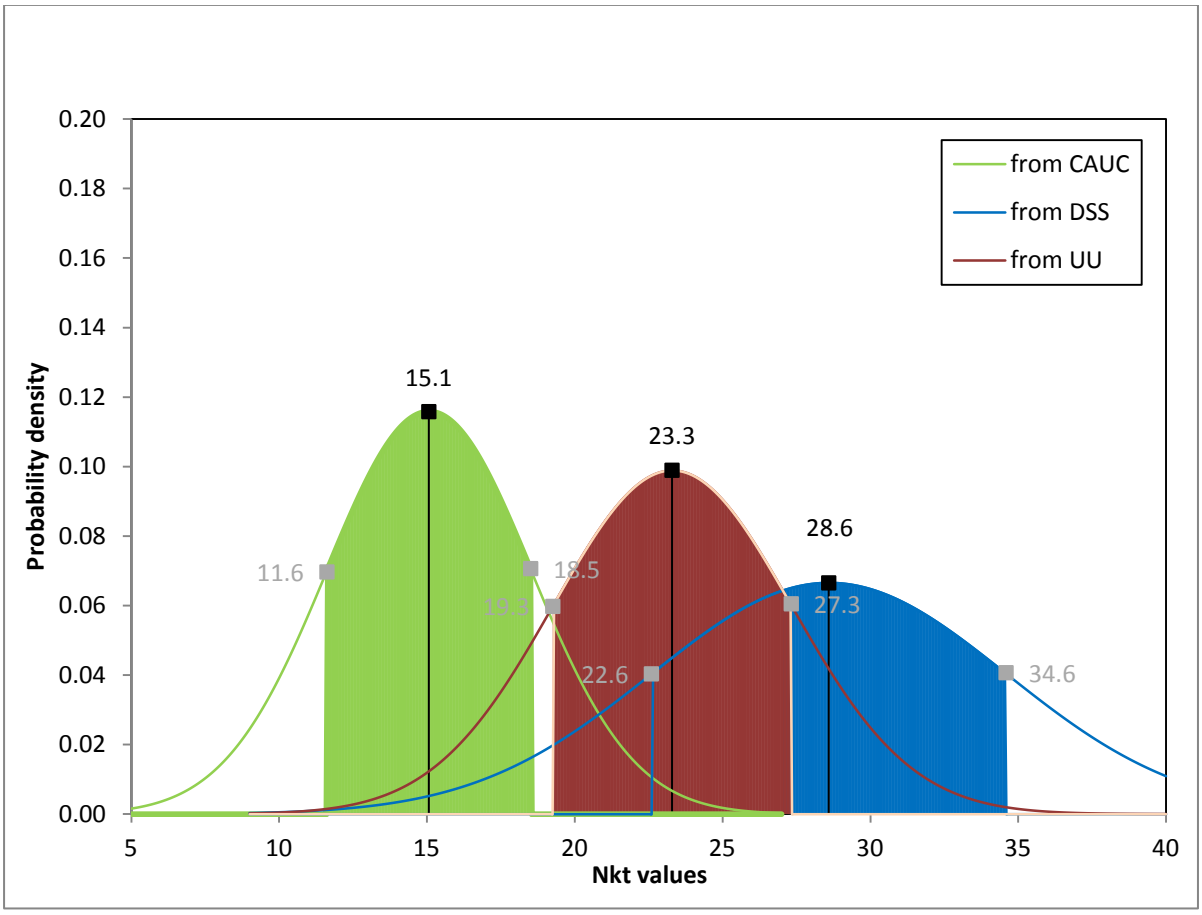


Figure 8.2 Probability density functions for N_{kt} per test
(Shaded areas show values within the range [Average ±1 Standard Deviation])

CPTU data often shows variations that provide more detailed shear strength profiles than those that can be obtained from laboratory results. The depths below seabed to the tested soil units can also be determined more accurately from the CPTU measurements. The adopted N_{kt} values (displayed above) are considered to be reasonable to infer the shear strengths across the site.

8.2 Interpretation of static triaxial (CAUC, CAUE and UU) and DSS tests, total stresses

The following program was scheduled for static undrained shear strength determination:

- 37 static triaxial tests in compression (CAUC),
- 2 static triaxial tests in compression (CADC),
- 2 static triaxial tests in compression (CIDC),
- 2 static triaxial tests in extension (CAUE),
- 12 static direct simple shear tests (DSS),
- 27 unconsolidated undrained tests (UU) performed offshore,
- the CPTUs

- The CPTU derived s_u-profiles together with laboratory results and suggested profiles are presented in Appendix 5.2 for each location.

Suggested profiles include a high estimate and a low estimate, that can be used respectively when a low shear strength is conservative and when a high shear strength is conservative.

- DSS tests and triaxial CAUE tests were performed at nearby depths with CAUC tests.

  The anisotropy ratio for Simple Shear referring to the Compression for the overall site can be deduced from the Nkt-plot presented in Appendix 5.4 for example but a this ratio should be sought for per unit to take better account of the heterogeneity of the site.

  The anisotropy ratio for Extension Triaxial to Compression s_{UE}/s_{uC} has been found at MET TOWER site between 0.46 and 0.54.

- UU-tests generally lead to lower values than CAUC-tests for undrained shear strength due to sample disturbance. During CAUC-test, the sample is to some extent repaired by consolidation stresses applied to re-establish the *in situ* conditions. Appendix 5.3 presents normalised s_{UU}/p'_0 and s_{uC}/p'_0 versus depths.

  In the light of these data or from the Nkt-chart presented in Figure 8.1, a ratio of s_{UU}/s_{uC} = 0.65 can be proposed.

Summary tables for CAUC / CADC / CIDC / CAUE and DSS tests are provided in Appendices 5.5 and 5.6 respectively.

9. Cyclic soil strength parameters

9.1 General

The behaviour of soils subjected to cyclic loading has been investigated by cyclic triaxial and DSS tests.

For both types of tests, behaviour against both symmetrical and non-symmetrical loading, i.e. with and without a non-null average shear stress. A representative period of 10s has been retained for all testing. Loading stresses have been defined with regards to an estimate of the shear strength based on a nearby associated static test (either CAUC or DSS) for clay or to *in situ* vertical effective stress for more sandy material where a drained behaviour was considered more conservative.

After consolidation as performed for associated static tests, the chosen average shear stress is applied to the sample in either drained conditions if a drained behaviour is considered more representative and conservative for the tested material or undrained otherwise. In case the average loading is applied with drainage on a reconstituted sample, this latter is previously pre-sheared after consolidation with 400 cycles at a cyclic stress of 4% of the estimated effective vertical stress. Cyclic loading is then applied on the specimen.

The test is completed (and failure reached) when either:

- Average strain γ_a reaches 15%
- Cyclic strain γ_{cy} reaches 15%
- Number of cycles N reaches 1500

Definition of average shear strain, cyclic shear strain and permanent shear strain are as follows:

$\gamma_a = (\gamma_{max} + \gamma_{min}) / 2$
$\gamma_{cy} = (\gamma_{max} - \gamma_{min}) / 2$
γ_p (permanent shear strain) is equal to the shear strain at $\tau_{cy} = 0$

For undrained triaxial tests, the shear strain is computed as $\gamma = 1.5\ \varepsilon_a$, where ε_a is the axial strain.

9.2 Cyclic test results

Cyclic tests have been performed on the different Units across the site as summarized in Table 9.1.

Table 9.1 Cyclic testing program per Unit

1	3		X			U	BH-D14-P7/8
		3	X		X	U	BH-G7-P2/3
1a		3	X		X	U	BH-D14-P4/5
2		3	X(*)		X	D	BH-G17-P10
		3	X(*)	X	X	D	BH-I21A-P1/3/5
3	3	3	X		X	U	BH-G7-P11/12/13
	3	3	X		X	U	BH-G17-P14/15 BH-G17A-P1
		3	X		X	U	BH-H10-P9
	3	3	X		X	U	BH-K16-P15/16/17
		3	X	X	X	U	BH-MET TOWER-P9/10/11
4	3	3	X		X	U	BH-K16-P20/21/22
	3	3	X		X	U	BH-I21B-P9/10/11
5	3		X			U	BH-D14-P5/6
			X			U	BH-H10-P11
6	3		X			U	BH-G7-P17/18
		3	X		X	U	BH-H10-P16

(*): CIDC or CADC

Summary tables of the results are provided for CAUcy and DSScy in Appendices 6.1 and 6.2 respectively.

9.3 Cyclic Triaxial test interpretation

Design contours, as largely described in literature and as extensively detailed in Andersen's 2015 McClelland Lecture, have been produced from the test results and are presented in Appendix 6.1.

For units where no reference CAUE test was carried out, contours have been limited to the compression stress field, ie for positive average shear stress.

9.4 Cyclic DSS test interpretation

Design contours, as largely described in literature and as extensively detailed in Andersen's 2015 McClelland Lecture, have been produced from the test results and are presented in Appendix 6.2.

For sand material, the procedure described in Andersen 2015 has provided very good consistency with static tests results when predicted failure stress was taken at the lowest value between estimation based on water content and mean estimation based on a range of relative density (based on CPTU data). Results are presented in the summary table in Appendix 5.6.

10. Recommended Soil Parameters

Recommended geotechnical parameters for the proposed locations are shown in Appendices 2 to 5. Table 10.1 to 10.7 present a summary of the recommended geotechnical parameters.

Table 10.1 Recommended Soil Parameter Summary – D14 location

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 1a	Poorly graded SAND locally gravelly. Sand is medium to coarse. Sand is dense to very dense. Light brown becoming dark grey.	*4.60m – 7.00m* UB = 105 LB = 80 *7.00m – 8.30m* UB = 80 LB = 55	*4.60m – 7.00m* UB = 42 LB = 37 *7.00m – 8.30m* UB = 36 LB = 31	-	*0.00m – 4.60m* 11-10 *4.60m – 8.50m* 10	*0.00m – 4.60m* 23 *4.60m – 8.50m* 23-34
Unit 1	Sandy CLAY with some stratifications of clayey sand. Stiff to very stiff, grey.	*11.42m – 12.42m* UB = 60 LB = 35	*11.42m – 12.42m* UB = 32 LB = 27	*8.50m – 14.53m* UB = 80 LB = 40	8.5	34
Unit 2	SAND, medium dense to very dense.	*14.53m – 17.80m* UB = 60 LB = 35	*14.53m – 17.80m* UB = 34 LB = 26	-	-	-
Unit 3	Poorly graded SAND with gravel and locally silt. Sand is coarse, medium dense to dense, light grey.	*18.00m – 22.00m* UB = 97 LB = 72 *22.00m – 24.00m* UB = 70 LB = 45 *24.00m – 27.15m* UB = 90 LB = 70	*18.00m – 22.00m* UB = 40 LB = 35 *22.00m – 24.00m* UB = 33 LB = 28 *24.00m – 27.15m* UB = 40 LB = 35	-	10.4	25

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
	Clayey SAND mostly stratified and laminated with sandy clay and trace gravel. Sand is fine grained, grey.	*27.15m – 30.10m* UB = 35 LB = 25	*27.15m – 30.10m* UB = 25 LB = 20	-	9.7	25
Unit 4	Sandy CLAY. Very stiff.	*30.10m – 32.00m* UB = 35 LB = 25	*30.10m – 32.00m* UB = 25 LB = 20	-	No data	No data
Unit 5	Clayey SAND mostly stratified and laminated with sandy clay and trace gravel	*32.02m – 42.00m* UB = 35 LB = 25 *42.38m – 43.31m* UB = 75 LB = 50	*32.02m – 42.00m* UB = 25 LB = 20 *42.38m – 43.31m* UB = 35 LB = 30	-	9.0	32
	Sandy SILT. Medium dense.	*43.31m – 45.00m* UB = 50 LB = 25	*43.31m – 45.00m* UB = 29 LB = 24	-	No data	No data
	Clayey SAND mostly stratified and laminated with sandy clay and trace gravel. Sand is fine grained, grey.	*45.00m – 48.90m* UB = 50 LB = 25	*45.00m – 48.90m* UB = 29 LB = 24	-	9.5	29

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
	Sandy CLAY. Very stiff to hard, dark grey. Little laminations of clay. Little to mostly shelly, fine to coarse gravel size(<60mm). Sand is fine to medium.	-	-	*48.90m – 61.50m* UB = 200-240 LB = 140-180	*48.90m – 56.00m* 8.0 *56.00m – 61.50m* 9.5	*48.90m – 56.00m* 36 *56.00m – 61.50m* 26
Unit 6	Silty SAND. Sand is fine, loose becoming dense, dark grey.	*61.50m – 63.00m* UB = 44 LB = 19 *63.00m – 68.36m* UB = 73 LB = 48	*61.50m – 63.00m* UB = 28 LB = 23 *63.00m – 68.36m* UB = 34 LB = 29	-	9.5	30
Unit 7	Sandy CLAY. Very stiff to hard.	-	-	*68.36m – 71.30m* UB = 220-240 LB = 160-180	No data	No data

Table 10.2 Recommended Soil Parameter Summary – G7 location

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 1	Poorly graded SAND locally with clay and gravel. Sand is medium, medium dense to compact, dark grey, wet with black organic staining and lenses of sandy clay. Mostly shelly.	*1.50m – 5.00m* UB = 115 LB = 95 *5.00m – 6.41m* UB = 65 LB = 40	*1.50m – 5.00m* UB = 44 LB = 39 *5.00m – 6.41m* UB = 33 LB = 28	-	11.0	18
Unit 2	Poorly graded SAND. Sand is medium, very dense to compact, light grey, moist with few lenses of sandy CLAY.	*7.52m – 16.50m* UB = 95 LB = 75	*7.52m – 16.50m* UB = 40 LB = 35	-	11.0	18
Unit 3	CLAY, Stiff to very stiff, dark grey to dark greyish brown. Few coarse shell. Stratified with sandy elastic silt and silty sand with gravel. Micaceous with trace lenses of weakly cemented greyish brown silt. Few laminations of grey silt.	16.50*m – 18.40m* UB = 50 LB = 25 20.54*m – 21.37m* UB = 85 LB = 60	16.50*m – 18.40m* UB = 30 LB = 25 20.54*m – 21.37m* UB = 37 LB = 32 21.37*m – 22.66m* UB = 32 LB = 27	*22.66m – 30.00m* UB = 160-200 LB = 80-120	9.5	30
Unit 5	CLAY with sand, locally sandy clay with gravel, very stiff to hard, dark greyish brown. Few lenses and laminations of sand and silt. Few fine to coarse gravel size shell. Few gravel.	-	-	*31.62m – 36.06m* UB = 180-240 LB = 100-160	9.5	30

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
	Silty SAND. Medium dense to dense.	36.06*m –37.96m* UB = 70 LB = 45	36.06*m –37.96m* UB = 35 LB = 30	-	9.5	30
	Sandy CLAY. Very stiff to hard, dark grey, dry, few grey silt laminations and few locally some fine to coarse gravel size shell.	-	-	*37.96m – 43.92m* UB = 260-320 LB = 150-180	9.5	30
Unit 6	Clayey SAND. Sand is fine to coarse, medium dense, dark grey. Stratified with silty sand. Trace to locally mostly shelly. Few lenses of sand, sand is medium to coarse, dark greenish grey sand. Trace lenses of sandy clay.	43.92*m –51.62m* UB = 45 LB = 20	43.92*m –51.62m* UB = 28 LB = 23	-	10.0	25
	Poorly graded SAND with silt. Sand is medium, very dense to compact, grey, mostly shelly, shell is fine gravel size.	51.62*m –57.00m* UB = 86 LB = 62 57.00*m –58.67m* UB = 66 LB = 42	51.62*m –57.00m* UB = 38 LB = 33 57.00*m –58.67m* UB = 33 LB = 28	-	10.0	25

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 7	Sandy CLAY. Sand is fine. Very stiff to hard, grey becoming greyish brown and dry with some fine shell and micaceous. Few to some shell. Stratified with clayey sand. Some laminations of silt and clay.	-	-	*58.67m – 75.24m* UB = 240-280 LB = 160-200	9.5	32

Table 10.3 Recommended Soil Parameter Summary – G17 location

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 1	Poorly graded SAND with silt. Sand is fine grained, dense to compact, grey becoming light olive brown.	0.00*m –8.00m* UB = 110 LB = 85 8.00*m –10.61m* UB = 62 LB = 38	0.00*m –8.00m* UB = 43 LB = 38 8.00*m –10.61m* UB = 32 LB = 27	-	10.0	24
Unit 2	Well graded SAND locally with gravel. Sand is fine to coarse.	10.61*m –18.50m* UB = 105 LB = 80 18.50*m –25.50m* UB = 100 LB = 75	10.61*m –18.50m* UB = 42 LB = 37 18.50*m –25.50m* UB = 41 LB = 36		11.0	20
Unit 3	Well graded SAND locally with gravel. Sand is fine to coarse.	28.50*m –30.53m* UB = 90 LB = 65 30.53*m –31.40m* UB = 30 LB = 10	28.50*m –30.53m* UB = 38 LB = 33 30.53*m –31.40m* UB = 28 LB = 23	-	11.0	20
	CLAY with sand stratified with sandy clay. Sand is fine. Very stiff to hard, dark grey to dark greyish brown, dry, micaceous. Locally some shell. Trace gravel.	-	-	*31.41m – 37.00m* UB = 180-280 LB = 140-200 *37.00m – 43.11m* UB = 240-420 LB = 160-240	*31.41m – 40.00m* 9.5 *40.00m – 43.11m* 10.0	*31.41m – 40.00m* 30 *40.00m – 43.11m* 25

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 4	Silty SAND, sand is fine, loose to medium dense, grey, dry. Locally mostly shelly.	43.11*m –48.00m* UB = 65 LB = 40	43.11*m –48.00m* UB = 33 LB = 28	*49.00m – 54.78m* UB = 260 LB = 200	9.5	25-35
Unit 5	Sandy CLAY. Very stiff to hard with few gravel/shell.	61.62*m –63.10m* UB = 35 LB = 10	61.62*m –63.10m* UB = 26 LB = 21	*54.78m – 61.62m* UB = 260-380 LB = 200-280 *63.10m – 66.29m* UB = 300-360 LB = 200-260	*54.78m – 60.00m* 8.5 *60.00m – 66.29m* 10.5	*54.78m – 60.00m* 37 *60.00m – 66.29m* 24
Unit 6	SAND. Compact.	66.29*m –71.50m* UB = 75 LB = 50	66.29*m –71.50m* UB = 34 LB = 29	-	No data	No data
	Silty SAND. Medium dense.	71.50*m –74.00m* UB = 55 LB = 30	71.50*m –74.00m* UB = 32 LB = 27	-	No data	No data

Table 10.4 Recommended Soil Parameter Summary – H10 location

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 1	Well graded SAND. Fine to coarse, loose becoming dense, olive brown to dark grey. Locally poorly graded sand with gravel.	1.60*m –4.30m* UB = 92 LB = 68 4.30*m –5.10m* UB = 68 LB = 43	1.60*m –4.30m* UB = 39 LB = 34 4.30*m –5.10m* UB = 34 LB = 29	-	10.5	21
	CLAY. Firm to stiff, dark greyish brown, stratified with clayey sand. Sand is coarse, dark grey	-	-	5.10*m –8.15m* UB = 100 LB = 50	10.5	21
Unit 2	Semi graded SAND becoming well graded. Sand is medium to coarse, dense to very dense, olive grey to olive, lenses of gravelly clay.	8.15*m –9.00m* UB = 55 LB = 30 9.00*m –13.50m* UB = 92 LB = 68	8.15*m –9.00m* UB = 32 LB = 27 9.00*m –13.50m* UB = 38.5 LB = 33.5	-	10.5	21
Unit 2a	Poorly graded SAND with silt. Sand is fine, light olive grey and moist. Trace laminations of clayey sand.	13.50*m –21.30m* UB = 110 LB = 85	13.50*m –21.30m* UB = 42.5 LB = 37.5	-	10.5	14
Unit 2b	Sandy CLAY to silty SAND	22.35*m –24.80m* UB = 60 LB = 35	22.35*m –24.80m* UB = 32 LB = 27	-	11.0	19

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 3	Sandy CLAY to clayey SAND	28.42*m –31.02m* UB = 60 LB = 35	28.42*m –31.02m* UB = 32 LB = 27	24.80*m –28.42m* UB = 160-200 LB = 120-130	11.0	19
Unit 5	Sandy CLAY. Sand is fine, very stiff to hard, olive grey to brownish grey. Laminated with clay with few stratifications of sand.	-	-	31.02*m –37.80m* UB = 220-240 LB = 160	8.5	33
	Poorly graded SAND with silt. Sand is fine, loose to medium dense, grey with some gravel. Locally some shell.	37.80*m –43.00m* UB = 40 LB = 15	37.80*m –43.00m* UB = 27 LB = 22	-	9.5	30
	Sandy CLAY. Sand is fine to coarse, very stiff to hard, dark grey. Stratified with clayey sand. Sand is fine to coarse, dark grey. Few lenses of clay and trace laminations of coarse sand. Locally some shell	-	-	43.00*m –45.93m* UB = 200-220 LB = 140-160	No data	No data
Unit 6	Clayey SAND, Sand is fine to coarse, dark grey. Little to some shell.	-	-	47.00*m –47.97m* UB = 260 LB = 200	10.0	25

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
	Silty SAND. Fine to coarse, dark grey, few lenses and few laminations of clay. Few fine gravel and shell.	*47.97m –55.10m* UB = 40 LB = 15 *55.10m –62.00m* UB = 62 LB = 38 *62.00m –64.07m* UB = 75 LB = 50	*47.97m –55.10m* UB = 28 LB = 23 *55.10m –62.00m* UB = 32 LB = 27 *62.00m –64.07m* UB = 35 LB = 30	-	*47.97m–55.10m* 10.0 *55.10m –64.07m* 9.0	*47.97m–55.10m* 25 *55.10m –64.07m* 31
Unit 7	CLAY. Very stiff to hard, dark grey and moist. Few weakly cemented lenses of silt. Few black organic staining.	-	-	64.07*m –67.00m* UB = 240-260 LB = 160-180	9.0	31-33
	CLAY with sand. Sand is fine, very stiff to hard, dark grey, moist, mostly laminated with greysilt and fine sand. Little bioturbation infilled with grey silt. Locally mostly shelly.	-	-	67.00*m –74.90m* UB = 240-280 LB = 160-180	9.0	33-37

Table 10.5 Recommended Soil Parameter Summary – I21 location

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 1	Poorly graded SAND. Sand is subangular, medium dense. Sand is light brown becoming dark grey, dry, little shell. Few lenses of black organic staining with mild to strong organic odour.	No data			11.0	23-20
	Well graded SAND with silt. Sand is fine becoming coarse at 5.90m. Dark grey, with lenses of black organic staining. Sand becomes coarse at 5.90m, with few laminations of clay. Few fine gravel sized shell.	*4.00m –6.50m* UB = 105 LB = 80 *6.50m –7.81m* UB = 75 LB = 50	*4.00m –6.50m* UB = 42 LB = 37 *6.50m –7.81m* UB = 35 LB = 30	-	11.0	20-16
Unit 2	Well graded SAND. Fine to coarse, dense to compact, dark olive grey, with trace shell fragments. Locally poorly graded. Stratified with poorly graded sand with gravel. Sand is angular and coarse.	*7.81m –15.0m* UB = 105 LB = 80 *15.00m –23.00m* UB = 85 LB = 60 *23.00m –26.80m* UB = 95 LB = 70	*7.81m –15.0m* UB = 42 LB = 37 *15.00m –23.00m* UB = 38 LB = 33 *23.00m –26.80m* UB = 40 LB = 35	-	*7.81m –20.81m* 10.5 *20.81m –26..80m* 9.5	*7.81m –20.81m* 20 *20.81m –26..80m* 28

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 3	Sandy CLAY. Very stiff, dark greyish brown, few laminations and lenses of silt. Micaceous.	-	-	*26.80m –33.68m* UB = 180-200 LB = 120-140	10.0	25
	Silty SAND. Sand is fine. Medium to dense, grey. Stratified with sandy silt.	*33.70m –37.00m* UB = 70 LB = 45 *37.00m –40.53m* UB = 55 LB = 30	*33.70m –37.00m* UB = 34 LB = 29 *37.00m –40.53m* UB = 30.5 LB = 25.5	-	9.5	30
	Sandy CLAY. Very stiff to hard, firm, grey, dry. Stratified with sandy silt, medium dense. Micaceous.	*40.53m –42.81m* UB = 45 LB = 20	*40.53m –42.81m* UB = 30 LB = 25	*40.53m –49.00m* UB = 220-240 LB = 140-160	9.0	32
Unit 4	Poorly sorted SAND with silt. Sand is coarse and medium dense, grey. Some laminations and stratifications of elastic silt and sandy clay.	*49.00m –51.00m* UB = 70 LB = 45 *51.00m –53.85m* UB = 42 LB = 18	*49.00m –51.00m* UB = 35 LB = 30 *51.00m –53.85m* UB = 29 LB = 24	-	10.0	25
	Sandy CLAY. Hard, light grey stratified dark olive grey. Dry, some laminations and lenses of silty sand. Some shell.	-	-	*53.85m –63.00m* UB = 240-420 LB = 180-300 *63.00m –66.42m* UB = 300-320 LB = 220-240	8.0	40

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 5	Poorly graded SAND with silt. Sand is fine becoming medium, grey, medium dense to dense, with few shell.	*68.00m –69.61m* UB = 72 LB = 48 *69.61m –71.00m* UB = 48 LB = 22	*68.00m –69.61m* UB = 34 LB = 29 *69.61m –71.00m* UB = 29 LB = 24	-	10.0	24
	Sandy CLAY. Very stiff becoming hard. Gravel at base.	-	-	*72.00m –73.76m* UB = 220-300 LB = 140-220	10.0	24

Table 10.6 Recommended Soil Parameter Summary – K16 location

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 1	Poorly graded SAND locally with gravel. Sand is angular, medium, medium dense to compact. Light olive grey. Trace organic staining.	*0.00m –3.88m* UB = 115 LB = 95 *3.88m –7.50m* UB = 80 LB = 55 *7.50m –11.62m* UB = 95 LB = 70	*0.00m –3.88m* UB = 44 LB = 39 *3.88m –7.50m* UB = 36 LB = 31 *7.50m –11.62m* UB = 41 LB = 36	-	11.0	20
Unit 2	Poorly graded SAND locally with gravel. Sand is angular, medium, medium dense to compact. Light olive grey. Trace organic staining.	*12.62m –27.00m* UB = 70 LB = 45	*12.62m –27.00m* UB = 33 LB = 28	-	10.0	25
Unit 2d	Well graded SAND with gravel. Sand is coarse, very dense to compact.	*27.00m –37.00m* UB = 85 LB = 65	*27.00m –37.00m* UB = 40 LB = 35	-	11.0	18
Unit 3	CLAY with sand, locally sandy clay. Very stiff to hard, dark olive grey, micacious, few laminations of sandy silt. Few lenses of greyish brown clay.	-	-	*37.00m –45.00m* UB = 180-220 LB = 120-160 *45.00m –49.69m* UB = 200-180 LB = 140-120	9.5	28

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 3a	CLAY with sand, locally sandy clay. Laminations of SAND with silt to silty SAND.	-	-	*51.58m –54.99m* UB = 180-240 LB = 140-160	10.0	25
Unit 4	CLAY. Hard, dark greenish grey, locally laminated with silt and sandy silt, Micaceous and friable.	-	-	*54.99 m –59.00m* UB = 260-340 LB = 200-260 *59.00m –64.00m* UB = 340-320 LB = 260-240	7.0	50
Unit 5	Clayey SAND, sand is fine, loose to medium dense, dark grey, little fine gravel size shell becoming mostly coarse gravel size shell at 66.90m. Trace lenses of clay, trace lenses of coarse sand.	*64.00m –68.03m* UB = 40 LB = 15	*64.00m –68.03m* UB = 29 LB = 24	-	10.2	23
Unit 6	Sandy CLAY. Very stiff to hard with some laminations of clayey sand.	-	-	*68.03m –69.84m* UB = 260-280 LB = 160-180	No data	No data
	Silty SAND becoming poorly graded sand with silt. Sand is coarse, medium dense to dense, grey, with few lenses of sandy clay.	*69.84m –73.20m* UB = 75 LB = 50	*69.84m –73.20m* UB = 36 LB = 31	-	11.0	20

Table 10.7 Recommended Soil Parameter Summary – MET TOWER location

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 1	Poorly graded SAND with silt. Dense to compact. Few stratifications of gravel, Few pockets of clayey sand. Few laminations of black organic staining. Micaceous.	*1.03m – 9.50m* UB = 100 LB = 80 *9.50m – 12.50m* UB = 75 LB = 55	*0.10m – 9.50m* UB = 42 LB = 37 *9.50m – 12.50m* UB = 36 LB = 31	<u>Bed of CLAY</u> *6.67m – 7.74m* UB = 90 LB = 70	10.0	*0.00m – 6.67m* 30 *7.74m – 12.50m* 19
Unit 2	Poorly graded SAND. Very dense to compact. Few laminations of black organic staining. Micaceous.	*12.50m – 20.16m* UB = 100 LB = 80	*12.50m – 20.16m* UB = 42 LB = 37	-	9.5	28
Unit 2c	Sandy SILT. Medium dense to dense locally loose.	*20.16m – 23.30m* UB = 65 - 45 LB = 45 - 25	*20.16m – 23.30m* UB = 33 - 28 LB = 28 – 23	-	No Data	No Data
Unit 3	CLAY with sand. Sand is fine. Very stiff to hard, dark olive grey. Dry. Some laminations and lenses of silt. Micaceous.	-	-	*23.30m – 26.50m* UB = 160-200 LB = 120-140	9.5	32

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics.	-	-	*26.50m – 29.00m* UB = 280 LB = 180 *29.00m – 35.00m* UB = 200-240 LB = 140-160 *35.00m – 37.00m* UB = 280-360 LB = 180-240	9.5	29
Unit 4	Sandy CLAY. Very hard to hard. Some laminations and lenses of sand and silt. Micaceous with trace organics	-	-	*37.00m – 39.00m* UB = 280 LB = 180 *39.00m - 44.01m* UB = 180-300 LB = 120-200	7.0	51
Unit 4a	Poorly graded SAND with silt. Compact.	*44.01m – 50.77m* UB = 100 LB = 80	*44.01m – 50.77m* UB = 41 LB = 36	-	9.5	26
Unit 5	Sandy CLAY. Hard	-	-	*50.77m – 53.50m* UB = 320 LB = 200	9.5	-

Geotechnical Unit	Soil Description	Relative Density, D_r (%)	Friction Angle ϕ' (°)	Undrained Shear Strength, Su (kPa)	Effective Unit Weight, γ' (kN/m^3)	Moisture Content, W (%)
Unit 6	Poorly graded SAND with silt. Compact.	*Bed of SAND* *53.5m – 55.30m* UB = 65 LB = 45	*Bed of SAND* *53.5m – 55.30m* UB = 33 LB = 28	-	9.5	27
	Sandy CLAY. Hard	-	-	*55.30m – 57.30m* UB = 320 LB = 200	9.5	32
	Clayey SAND becoming SAND with silt.	*57.30m – 64.90m* UB = 85 LB = 65	*57.30m – 64.90m* UB = 37 LB = 32	-	9.5	23

11. Comment on quality of samples

As proposed by ISO standards, the quality of samples is evaluated using Lunne et al. (2006) relating on measurements of volume change at the estimated in situ stress state (σ'_{v0}, σ'_{h0}) during laboratory consolidation (triaxial CAUC and CAUE testing). The normalized sample quality parameter $\Delta e/e_0$ is computed as:

$$\Delta e/e_0 = \varepsilon_{vol}.(1 + e_0)/e_0$$

where

Δe is the change in void ratio;
e_0 is the void ratio of the prepared specimen;
ε_{vol} is the volumetric strain (= $\Delta V/V_0$) from reconsolidation to (σ'_{v0}, σ'_{h0});

A category of sample quality is then assigned following the criteria reminded in Table 10.1.

Table 11.1 Evaluation of Intact Sample Quality

OCR	Δe/e0 at σ'v0			
1 to 2	< 0.04	0.04 to 0.07	0.07 to 0.14	> 0.14
2 to 4	< 0.03	0.03 to 0.05	0.05 to 0.10	> 0.10
>4	< 0.02	0.02 to 0.035	0.035 to 0.07	> 0.07
Sample Quality	1 (very good to excellent)	2 (fair to good)	3 (poor)	4 (very poor)

On the MD WEA site, the samples used for CAUC testing have been evaluated of “Very Good to Excellent” quality for 14% of them, “Good to fair” quality for 4%, “Poor” for 54%, “Very Poor” for 29%, as shown on Appendix 7.1.

On the MD WEA project, in the absence of oedometer testing, OCR values have been evaluated from correlations with CPTU data, leaving some uncertainty on the stress history of the soils. Moreover, it is to be bore in mind that the method had been calibrated for soft clays that exhibit an apparent OCR due to aging. For stiffer clays, the method should be considered as indicative only.

12. List of Symbols and Abbreviations

°	Degrees
<	Less Than
>	Greater Than
”	Inches
%	Percentage
φ'	Angle of Internal Friction
≈	Approximately
γ	Total Unit Weight
$\gamma_{w\ sea}$	Unit Weight of Sea Water
σ_m’	Mean Effective Stress
σ'_{v0}	Effective Vertical Overburden Stress
cm	Centimetres
d	Depth
D_r	Relative Density
e	Voids Ratio
e_{max}	Maximum Density
e_{min}	Minimum Density
G_s	Specific Gravity
k_0	Coefficient of Lateral Earth Pressure
ln	Natural Log
m	Metres
N_{kt}	Factor for calculating Undrained Shear Strength
P'_0	Effective Vertical Overburden Stress
q_c	Measured Cone Tip Resistance
q_{net}	Net Cone End Resistance
q_t	Corrected Cone End Resistance
s_u	Undrained Shear Strength
w	Natural Water Content
API	American Petroleum Institute
BSF	Below Sea Floor
CER	Cone End Resistance
CPTU	Cone Penetration Test with pore pressure reading (u2 position)
E	East
MSL	Mean Sea Level
N	North
NE	North East
NNE	North North East
NW	North West
NNW	North North West
OCR	Overconsolidation Ratio
R	Radius
RD	Relative Density
S	South
SE	South East
SSE	South South East
SW	South West
SSW	South South West
UK	United Kingdom

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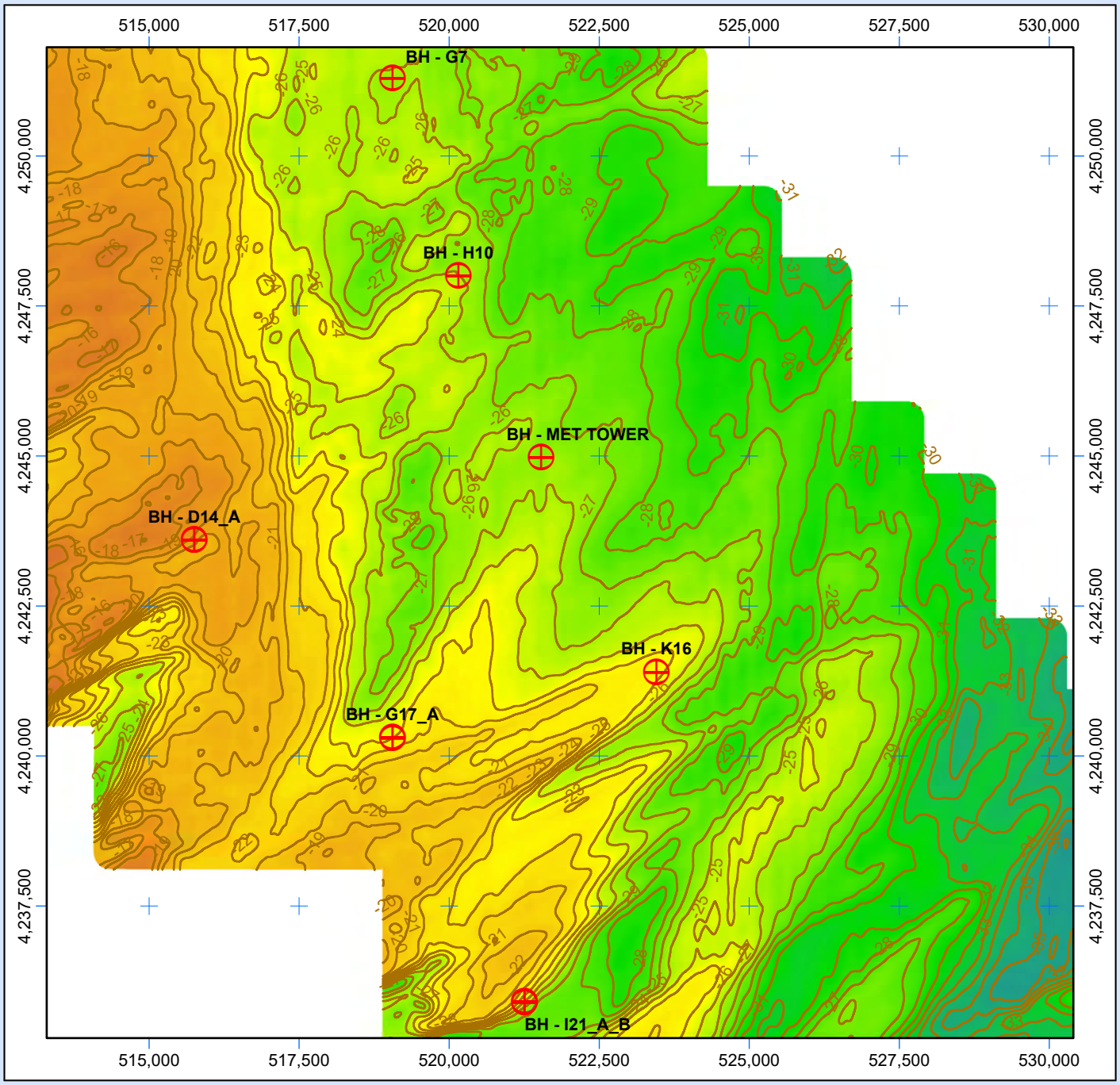
APPENDIX 1

1.1 Location Summary



Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Overview Map

Legend & Map Scale (A4)

Borehole Locations

1.0m Contours

Bathymetry

-12m

-42m

Kilometers

0 1 2 3 4 5

1:100,000

Gardline

US Wind Inc. sea energy

Coordinate Reference System

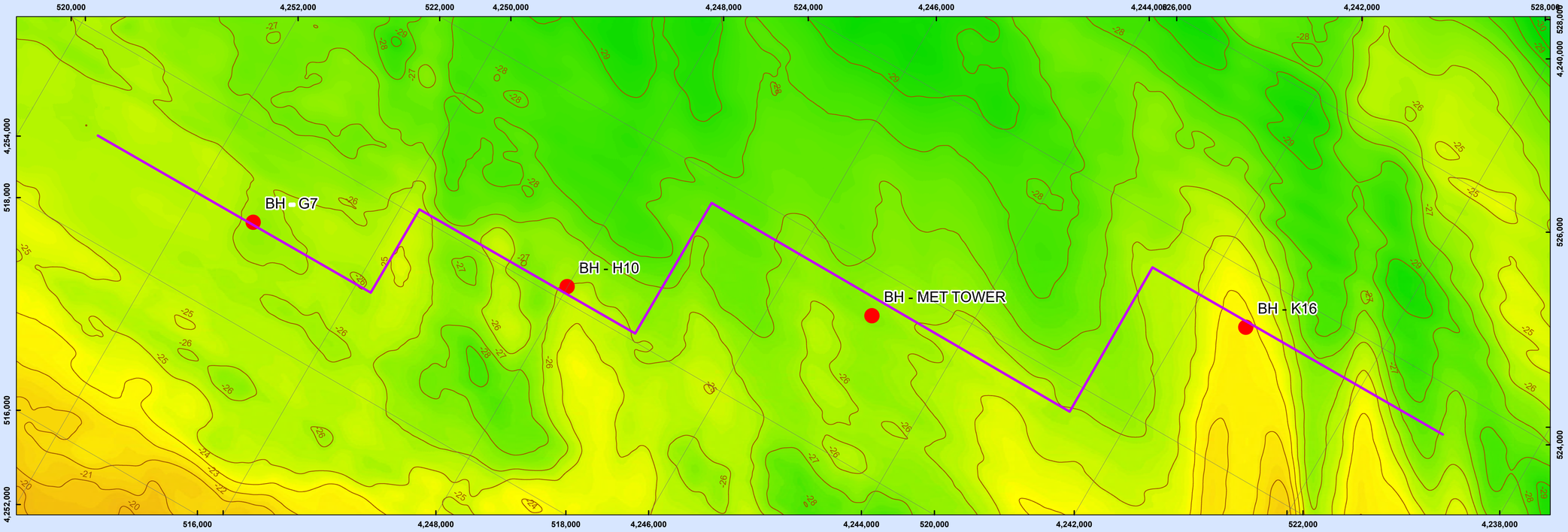
Datum	NAD 83
Ellipsoid	GRS 80
Projection	UTM Zone 18N (75W)
Overview Data	ESRI

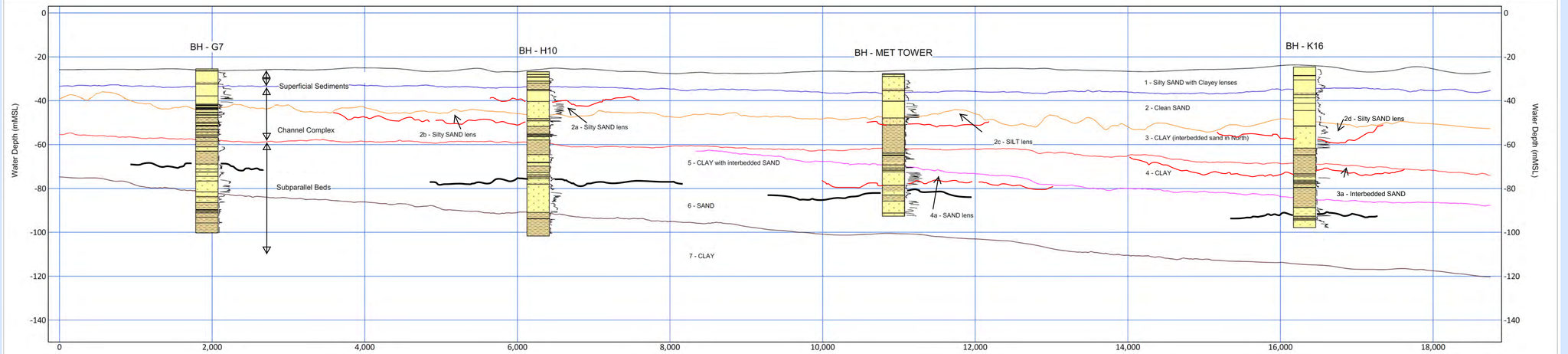
Contract Information

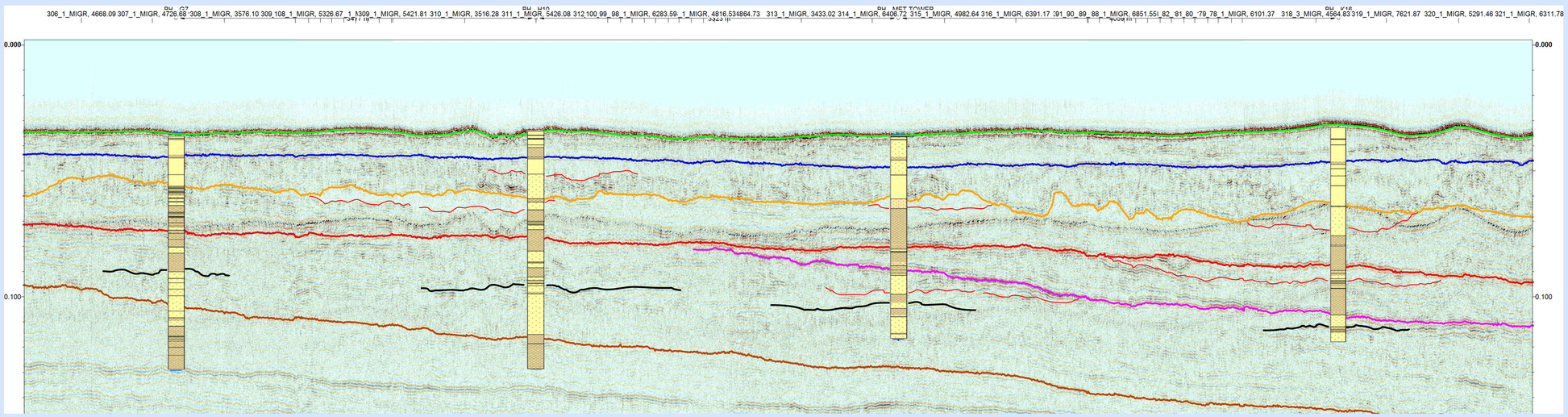
Gardline Job	10451
Client	US Wind Inc.
Client Ref	REF11449
Vessel	MV Ocean Discovery

Gardline Geosciences Ltd, Hewett Park, Hewett Road, Great Yarmouth, Norfolk. United Kingdom. NR31 0NN.

1.2 Integration Charts







Client	
US Wind Inc.	

Project Title

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Drawing Title

Integration of Geotechnical and Geophysical Data Chart 1

Legend

- Borehole Locations
- Geophysical and Cross Section Line
- 1.0m Contours

Bathymetry

High : -12

Low : -42

Soil Identification Symbology

CLAY	COBBLES
SILT	VOID
SAND	CHALK
GRAVEL	Mixed Soil

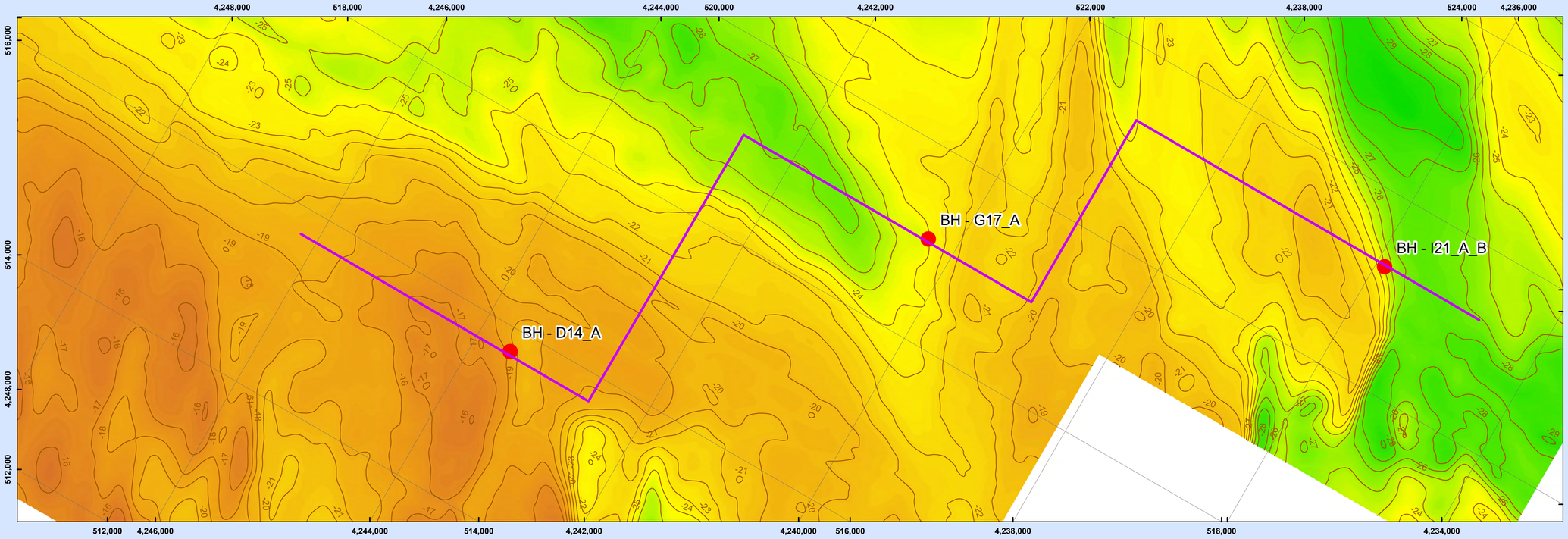
Produced By

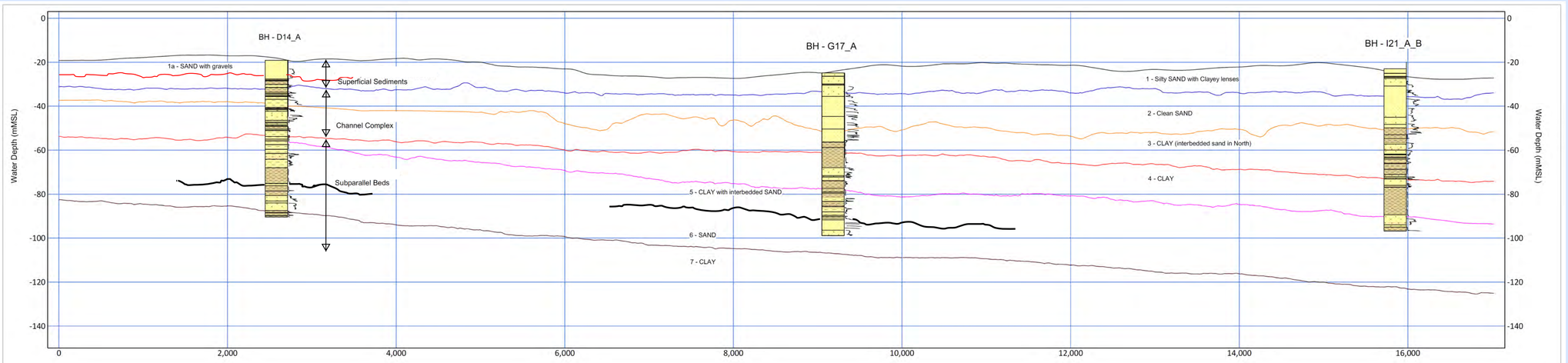
1 Hewett Park
Hewett Road
Great Yarmouth
Norfolk
NR31 0NN
United Kingdom

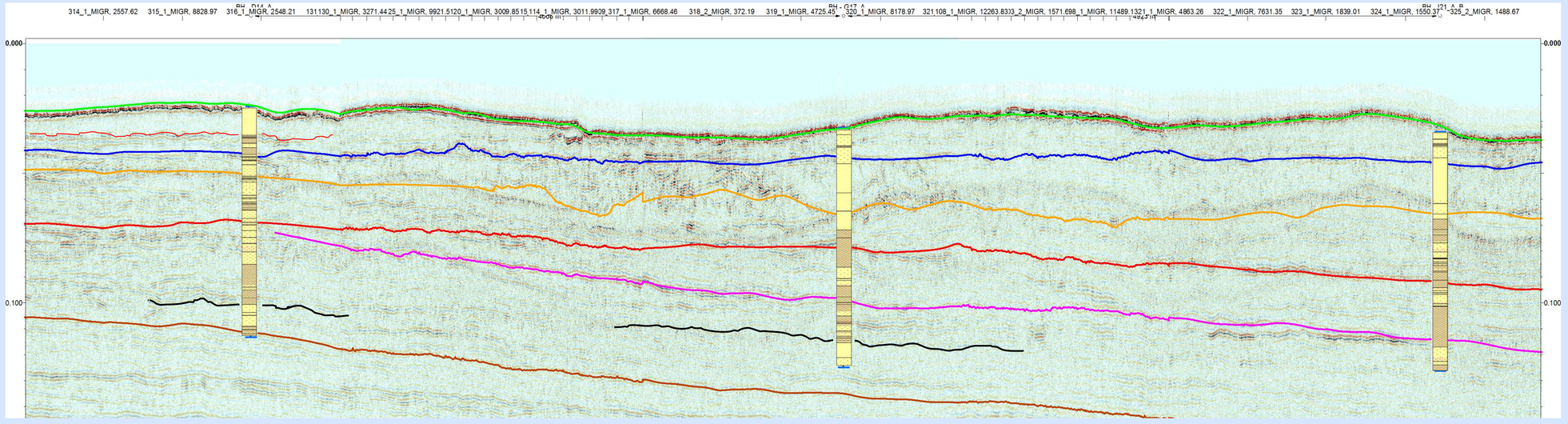
Tel: +44 (0)1493 845600
Fax: +44 (0)1493 852106
Web: www.gardline.com

Coordinate Reference System	Country/ Area	Drawing Scale/ Drawn At
NAD 83 UTM Zone 18N	USA / Maryland	1:25,000 / A1

Date	Revision No.	Author	Revision Remarks
15/12/15	Rev 0	RB	Drawn
26/01/16	Rev 1	SK	Additional geophysical horizons picked







Client

US Wind Inc.

Project Title

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Drawing Title

Integration of Geotechnical and Geophysical Data Chart 2

Legend

- Borehole Locations
- Geophysical Section
- 1.0m Contours

Bathymetry

High : -12

Low : -42

Soil Identification Symbology

CLAY	COBBLES
SILT	VOID
SAND	CHALK
GRAVEL	Mixed Soil

Produced By

Gardline

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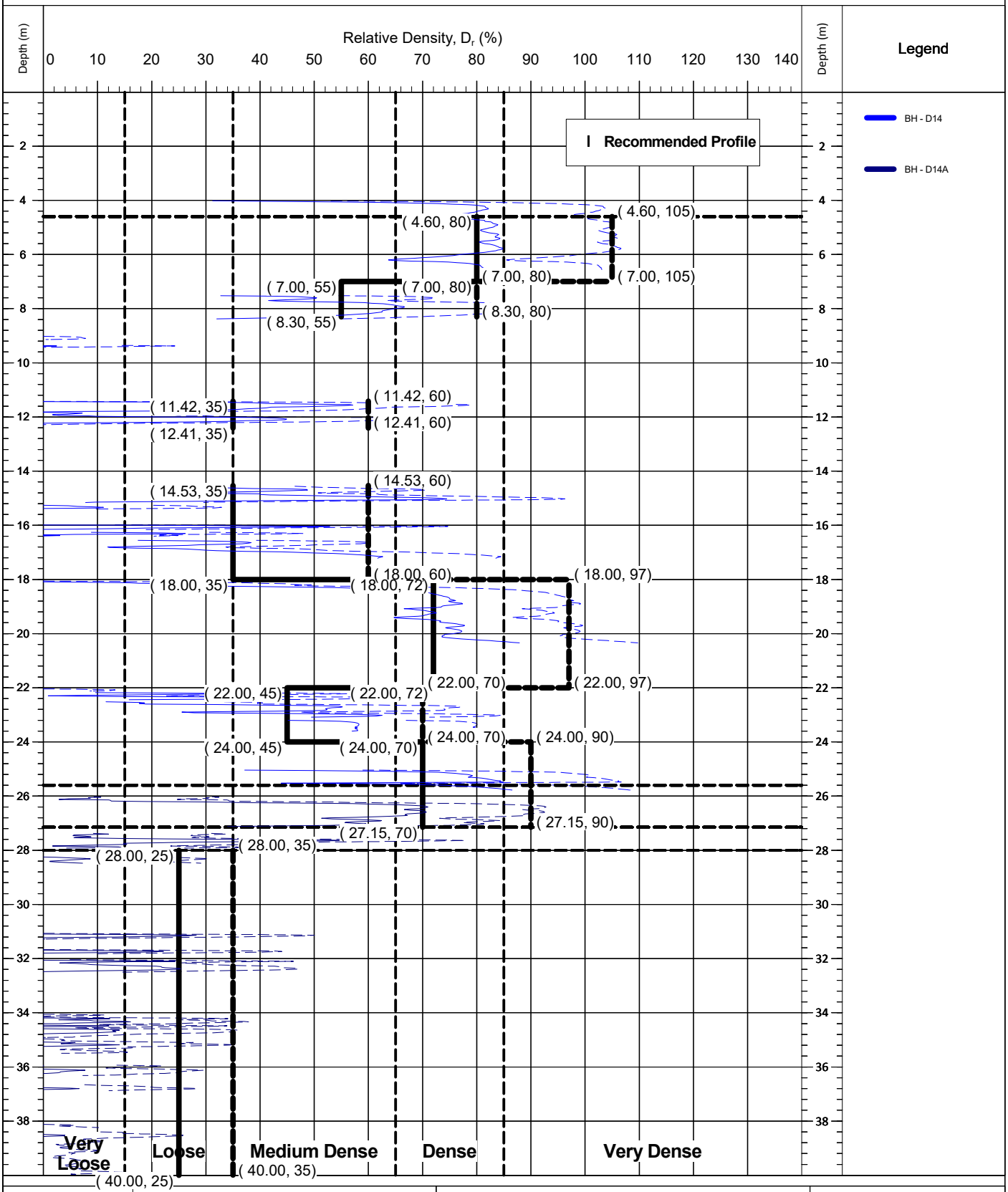
RELATIVE DENSITY



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

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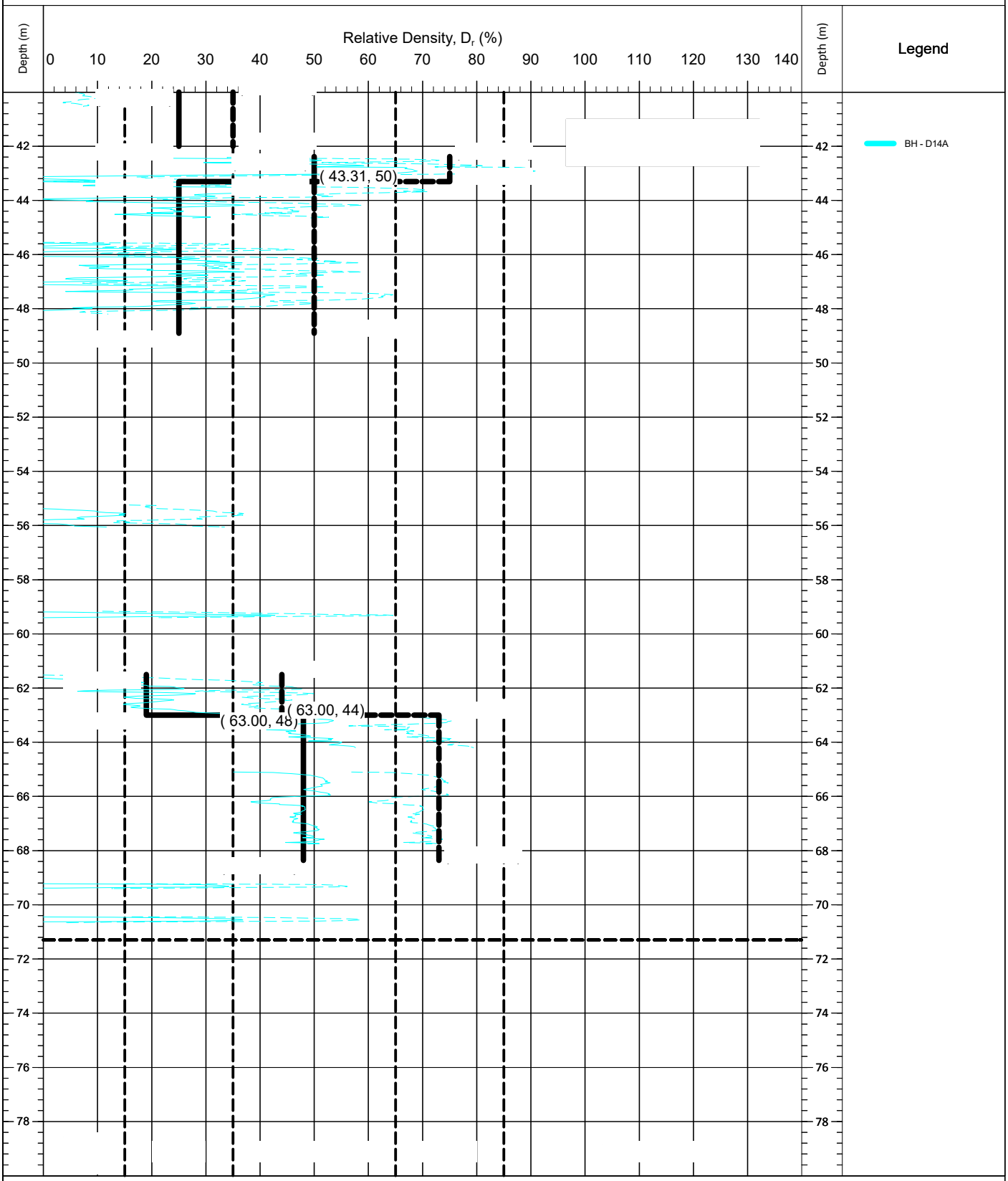
RELATIVE DENSITY



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SMc 28/09/2015	**JG** 21/01/2016	

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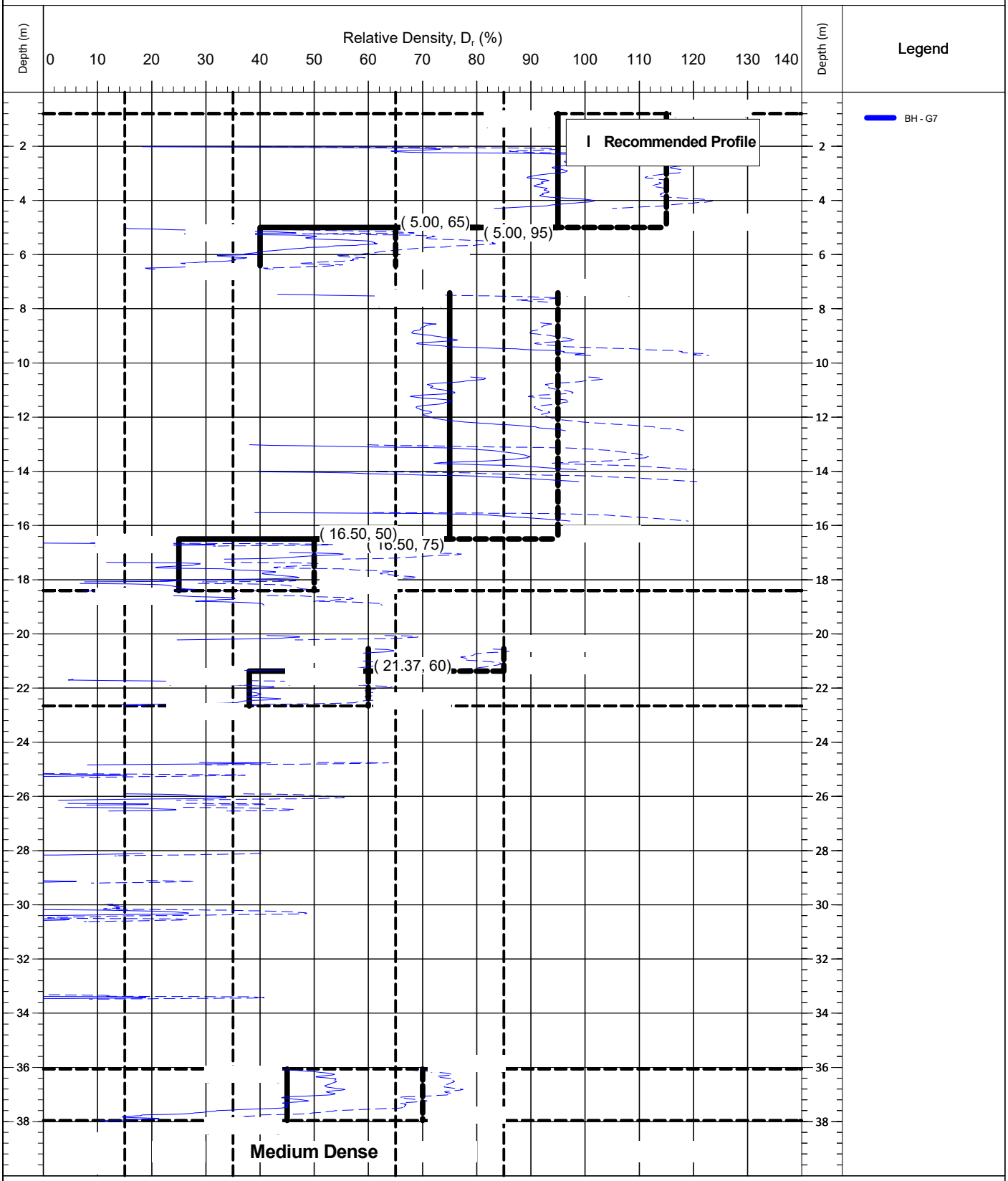

Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
Vessel	**MV Ocean Discovery**		
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SMc 28/09/2015	**JG** 21/01/2016	

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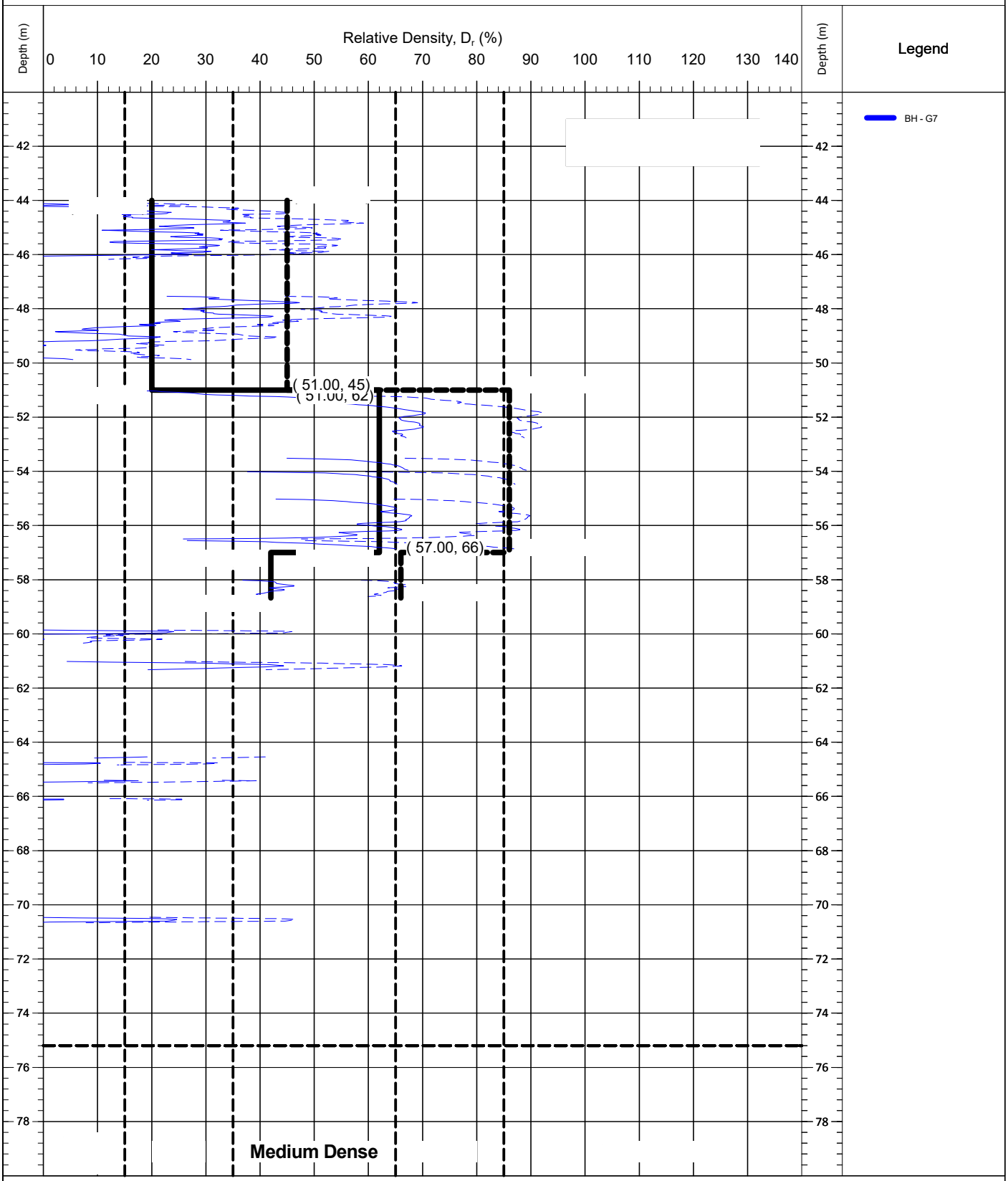

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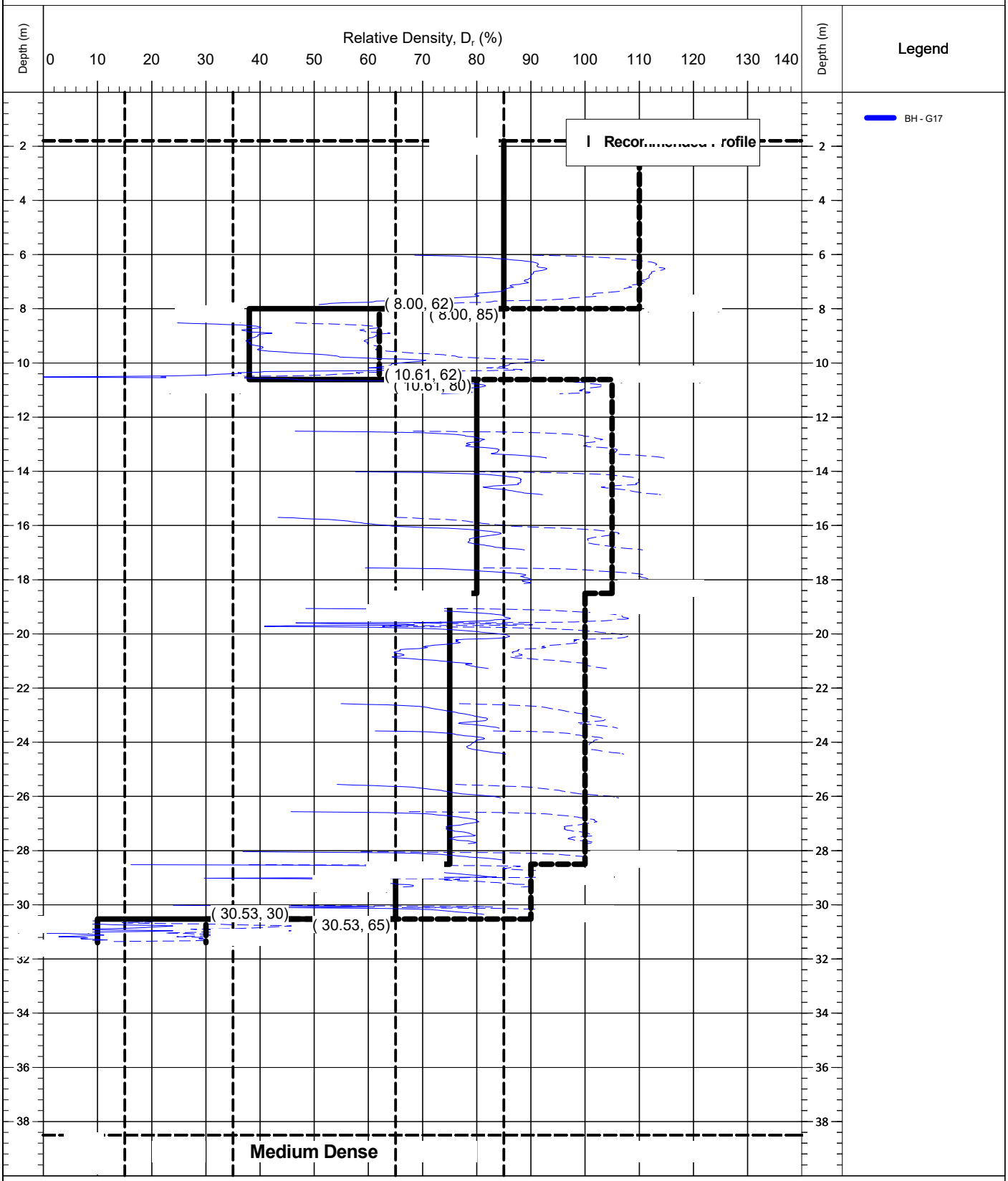

Area	**Maryland USA**
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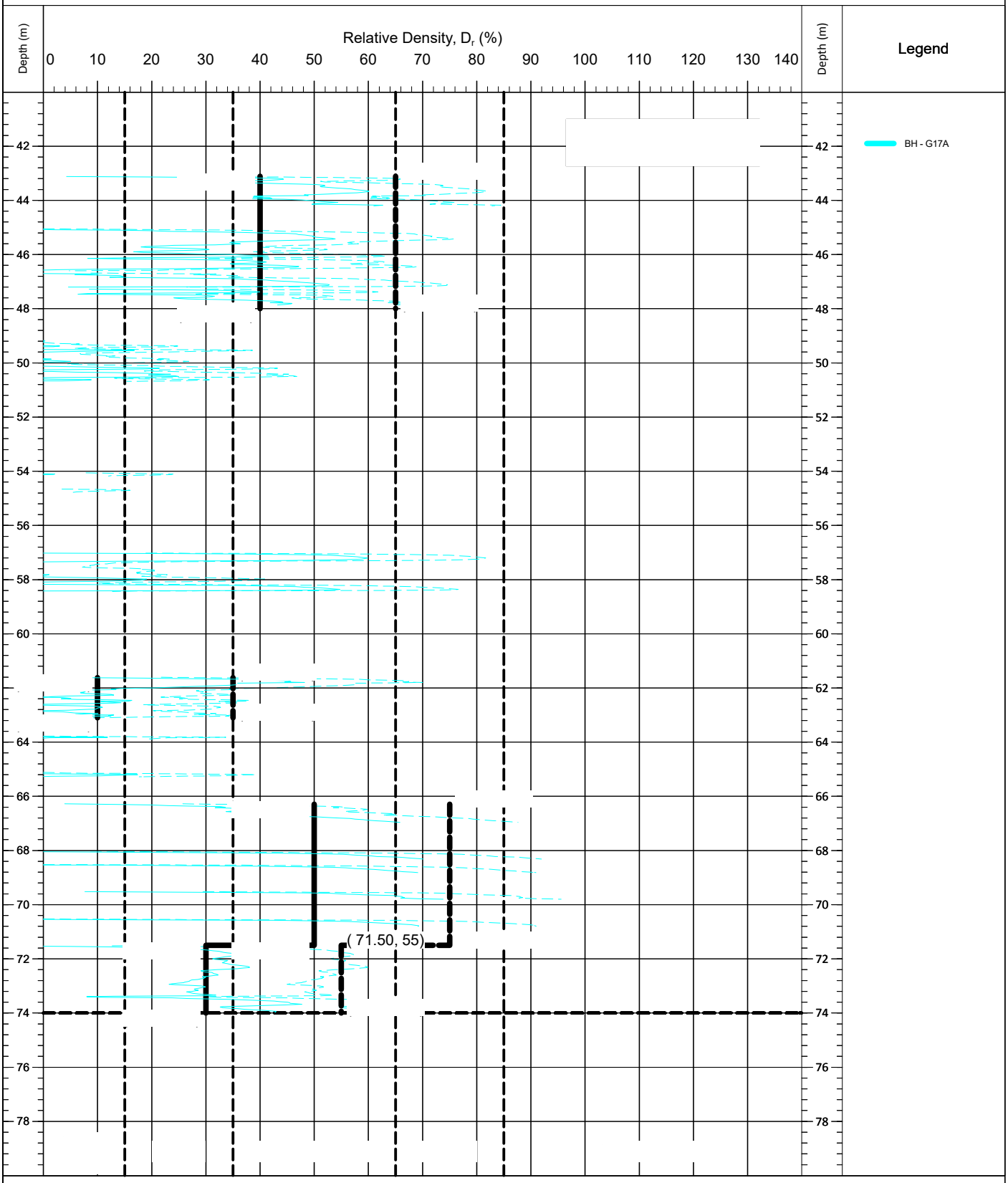

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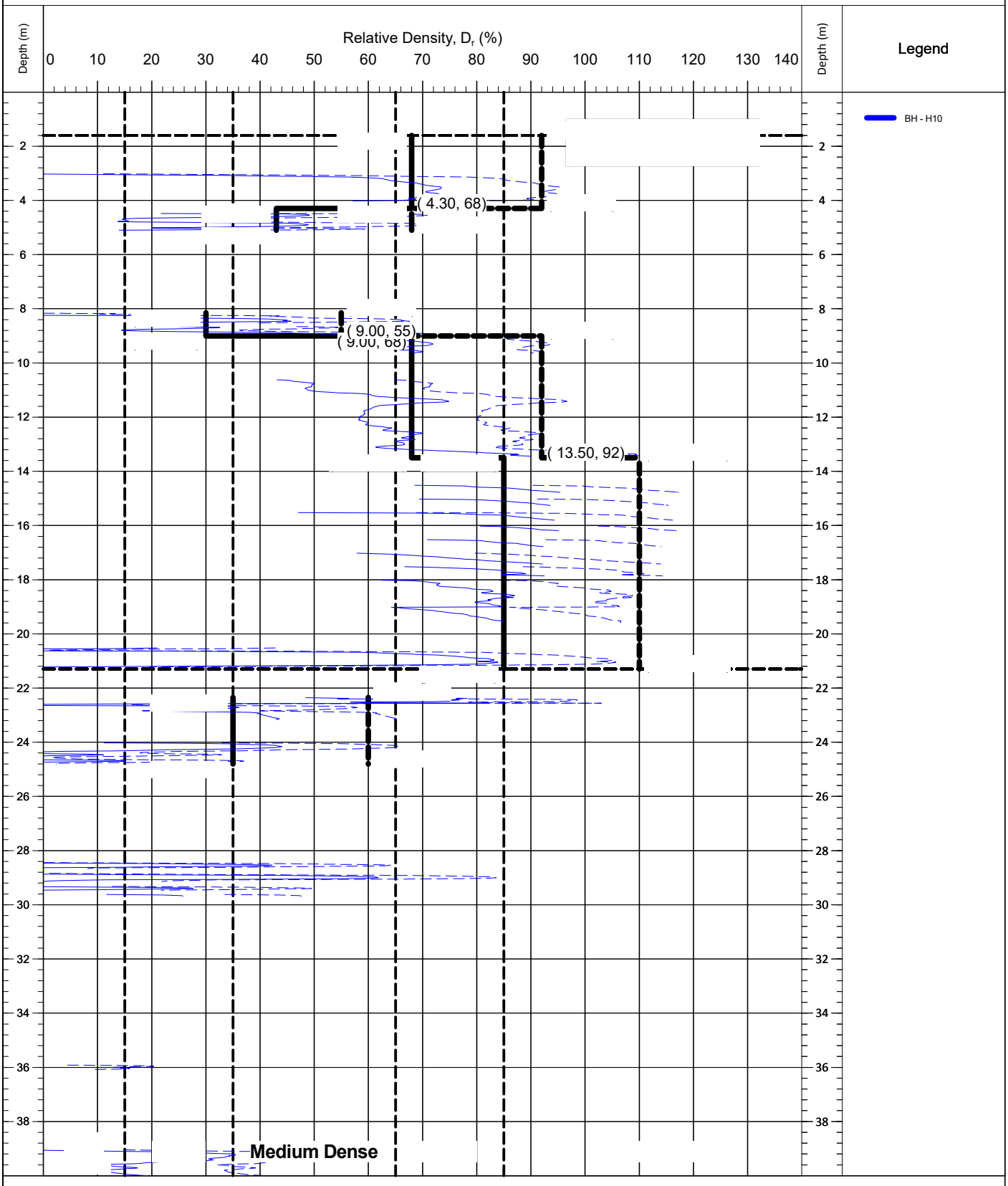

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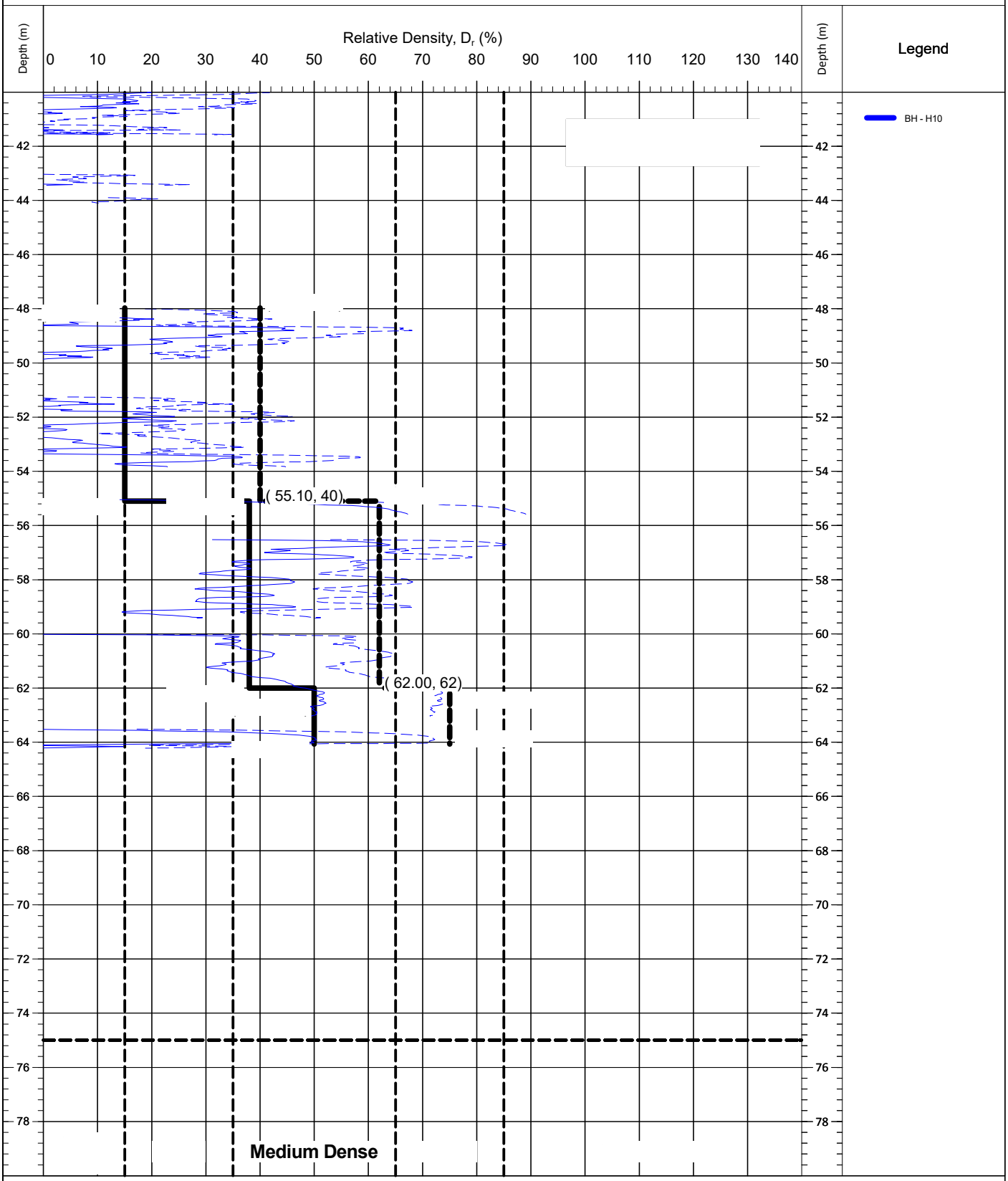

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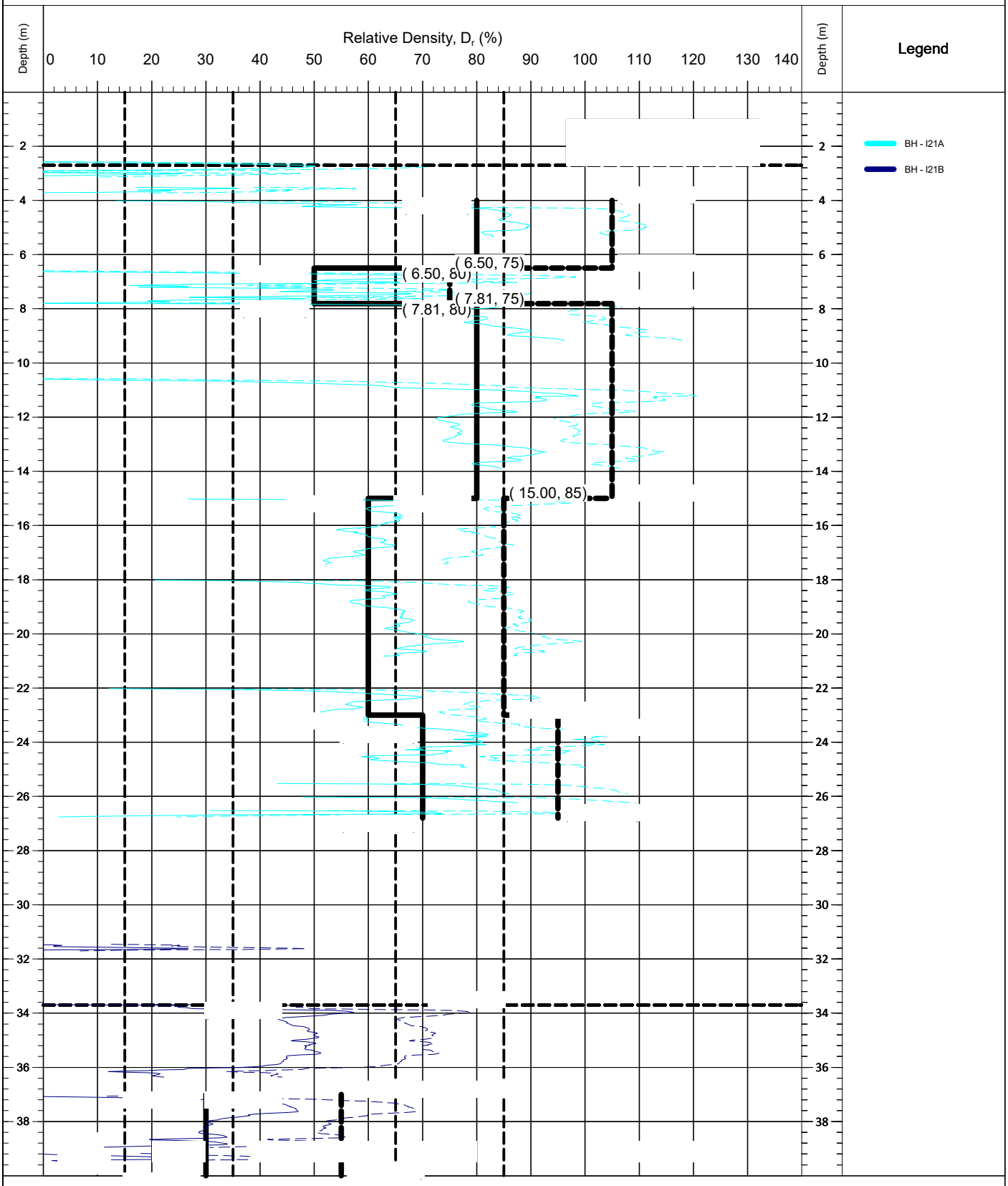

Area	..laryland USA
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Comments:

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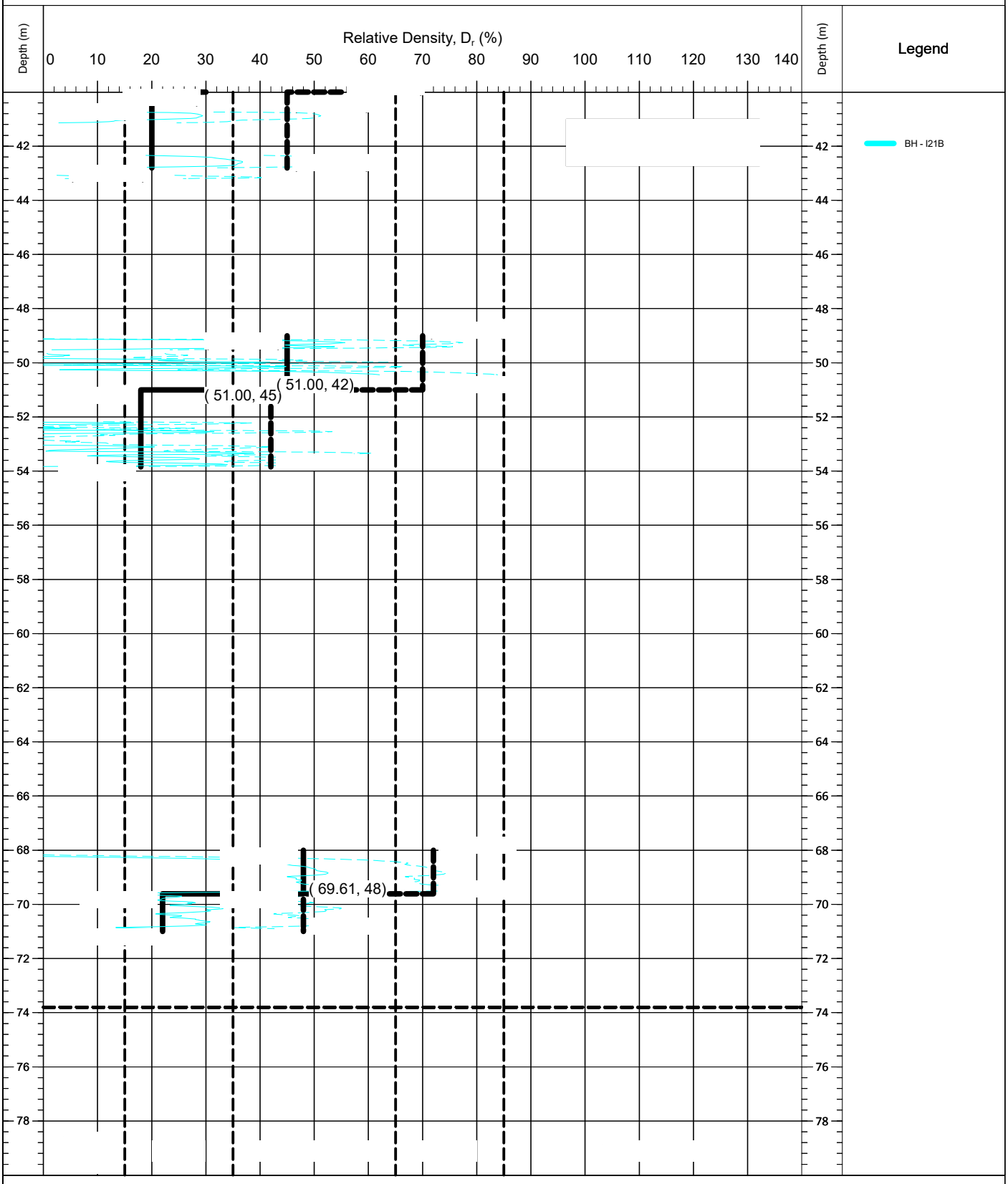

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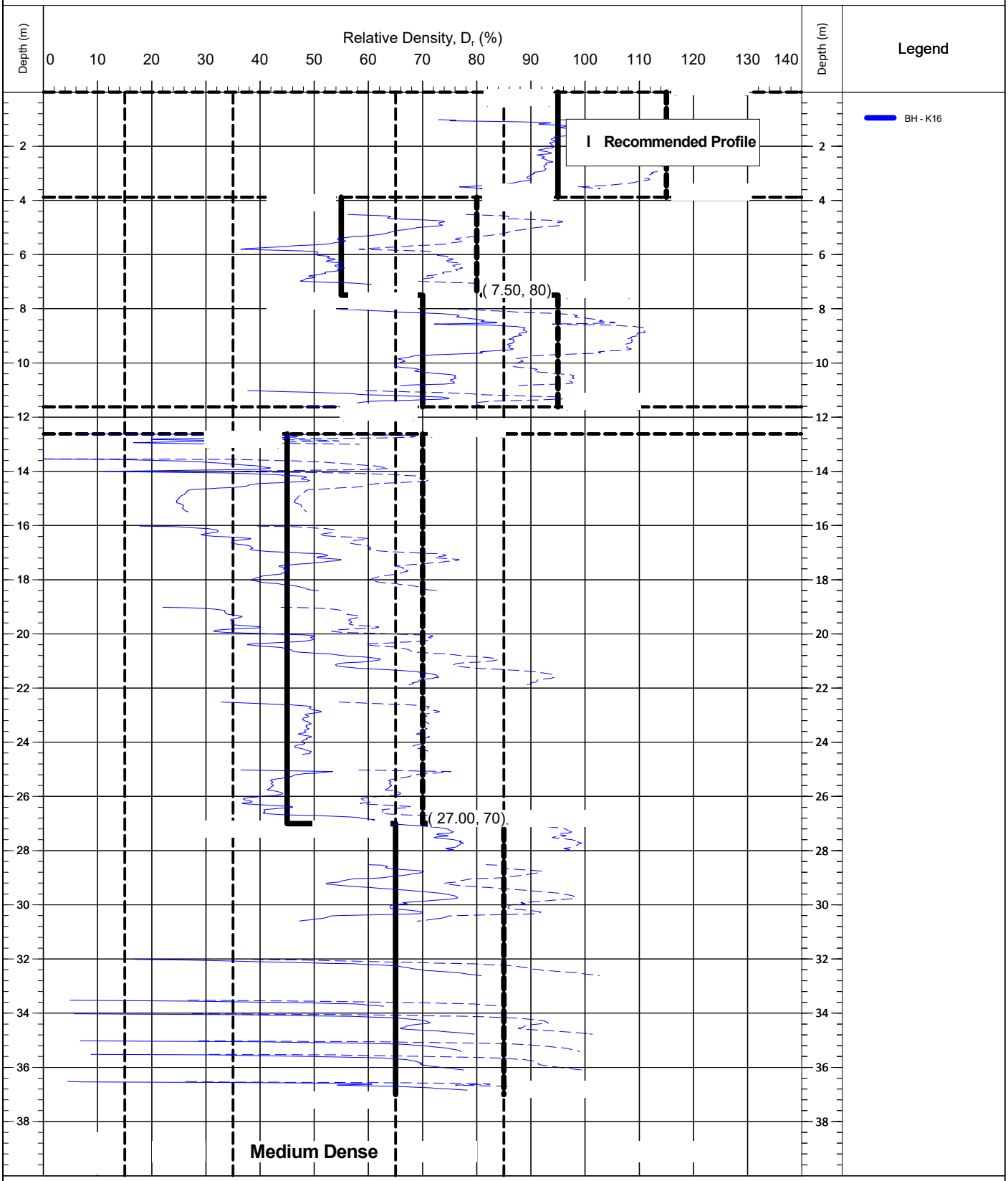

Area	Maryland USA
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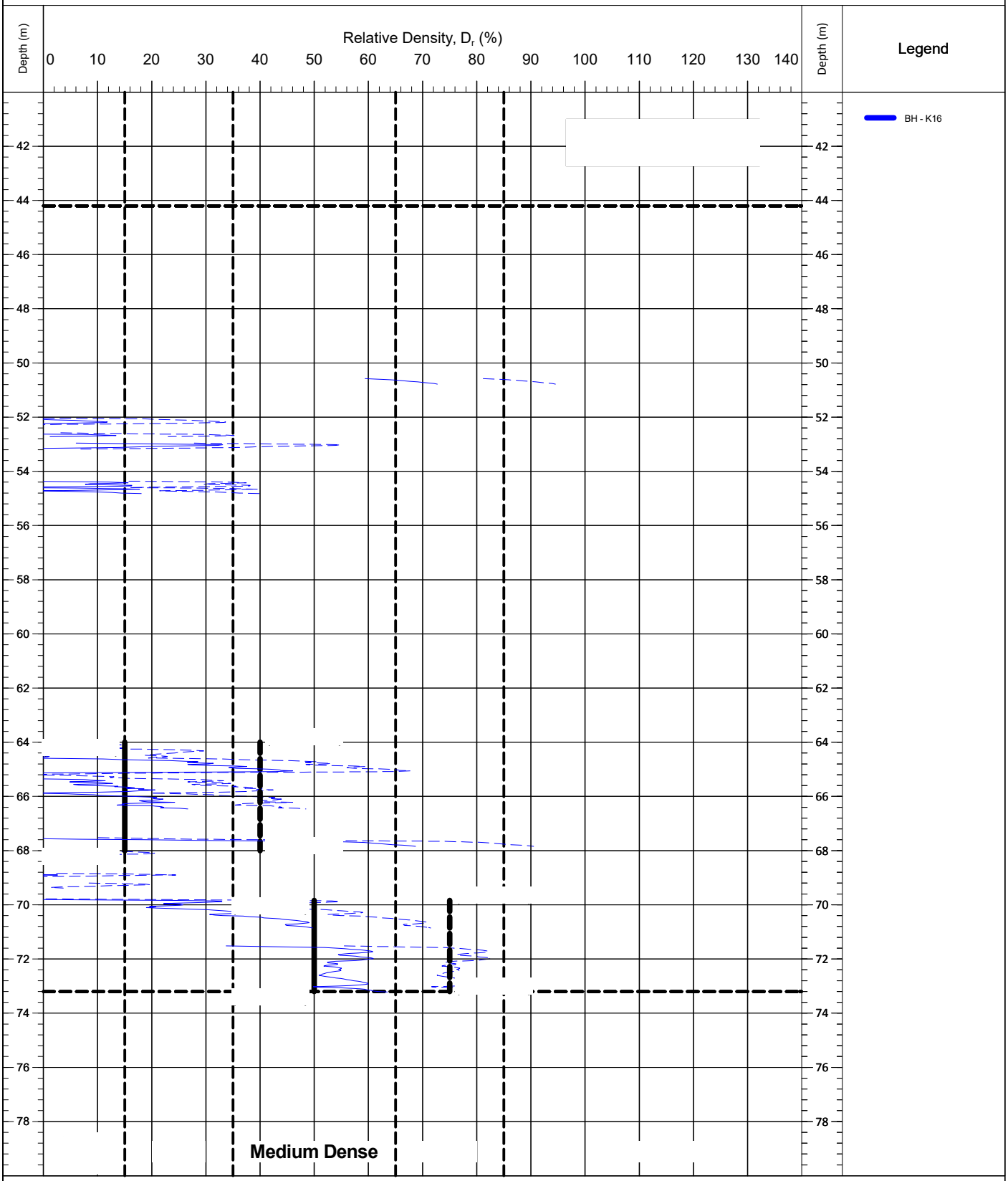

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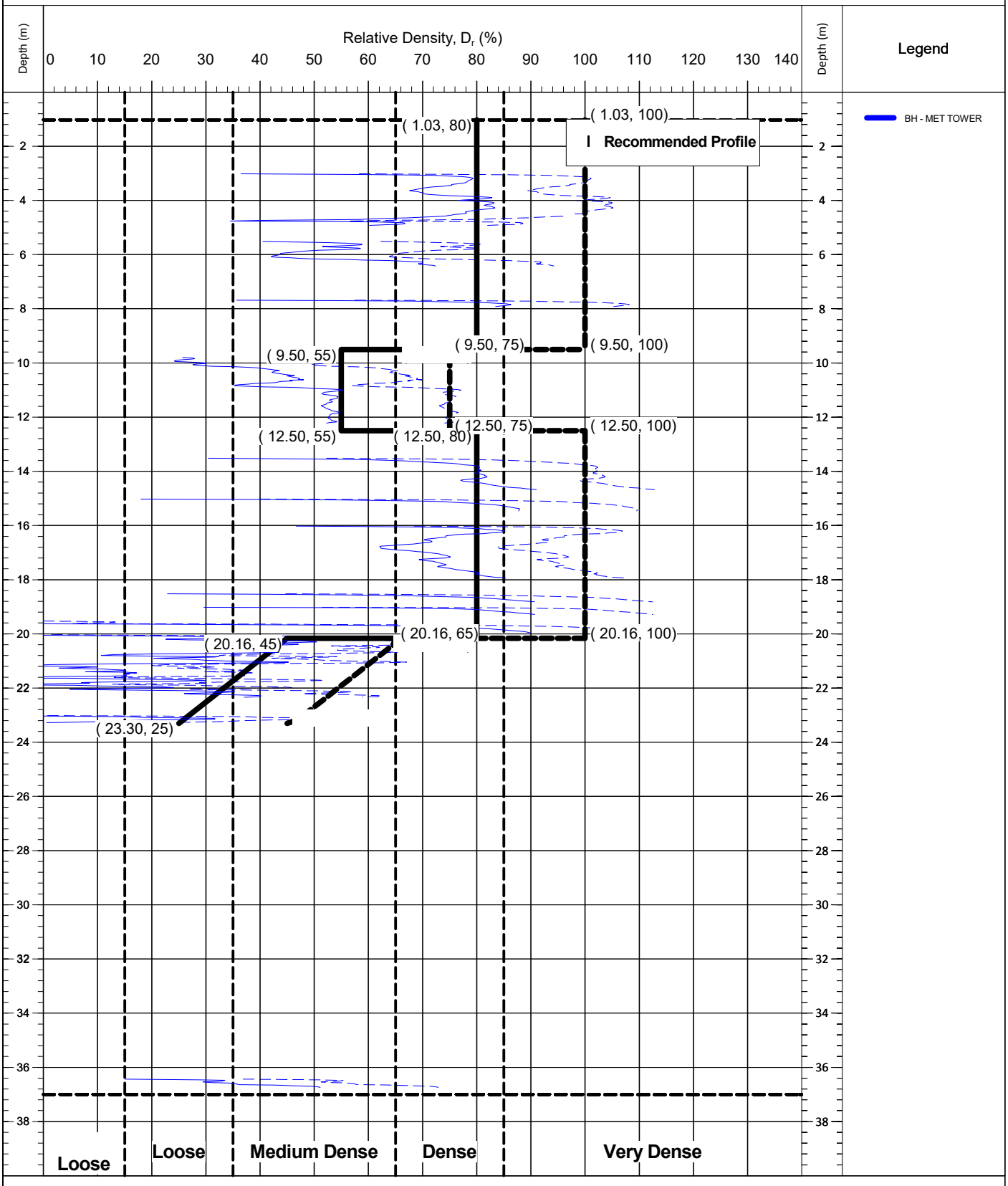

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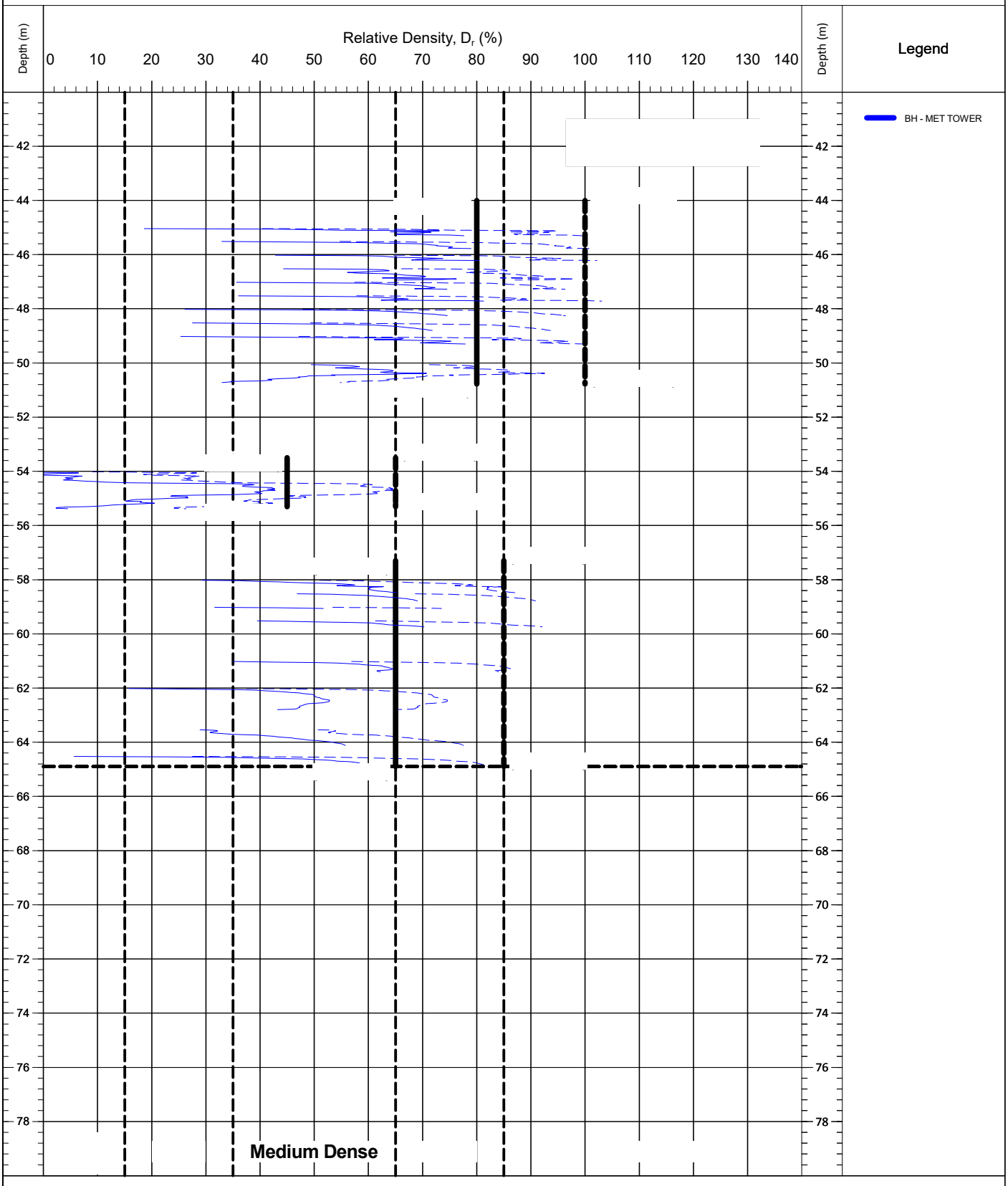

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Comments:

QC Status		
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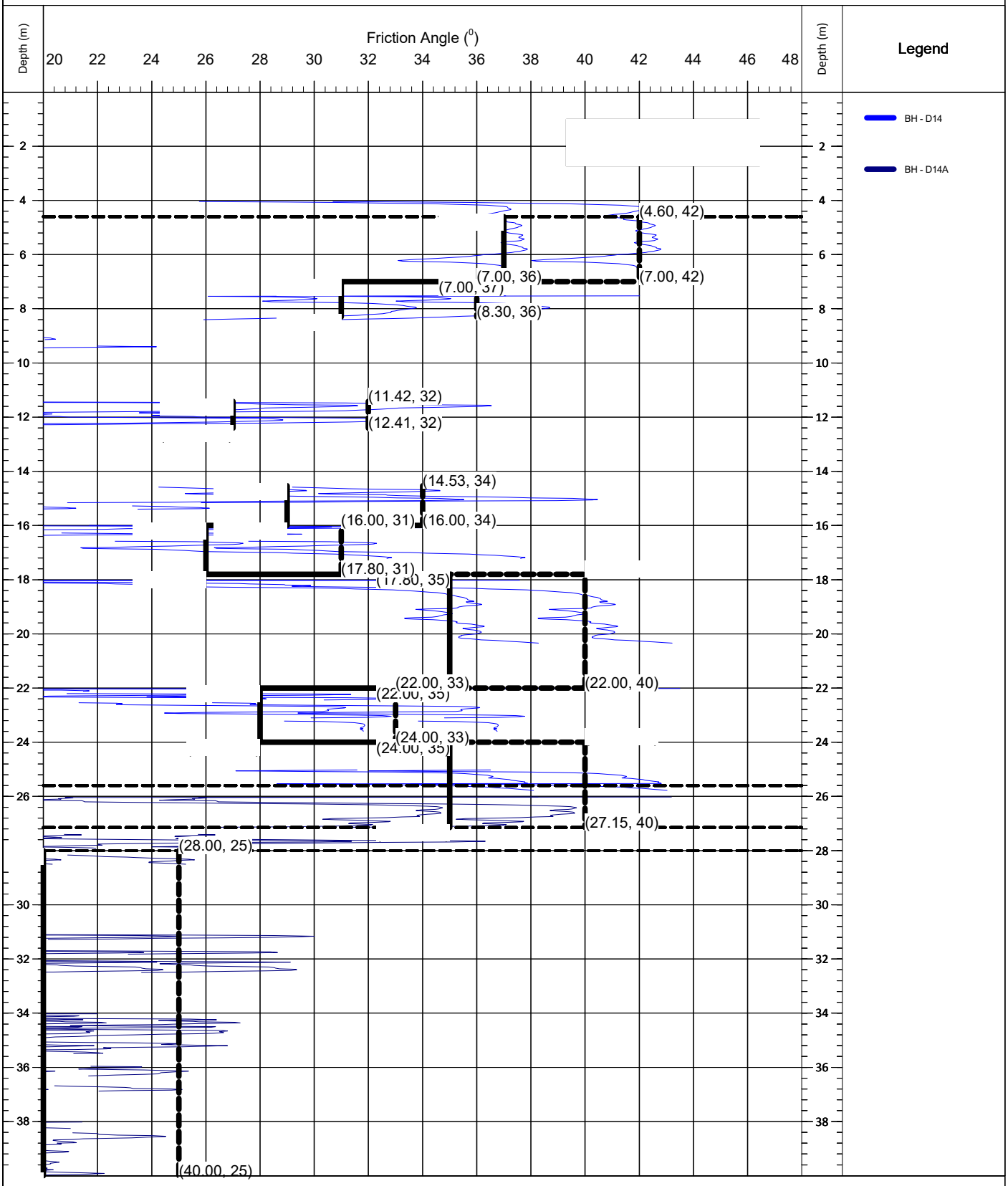
SMc 28/09/2015	**JG** 21/01/2016	

2.2 Friction Angle

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
FRICTION ANGLE PROFILE



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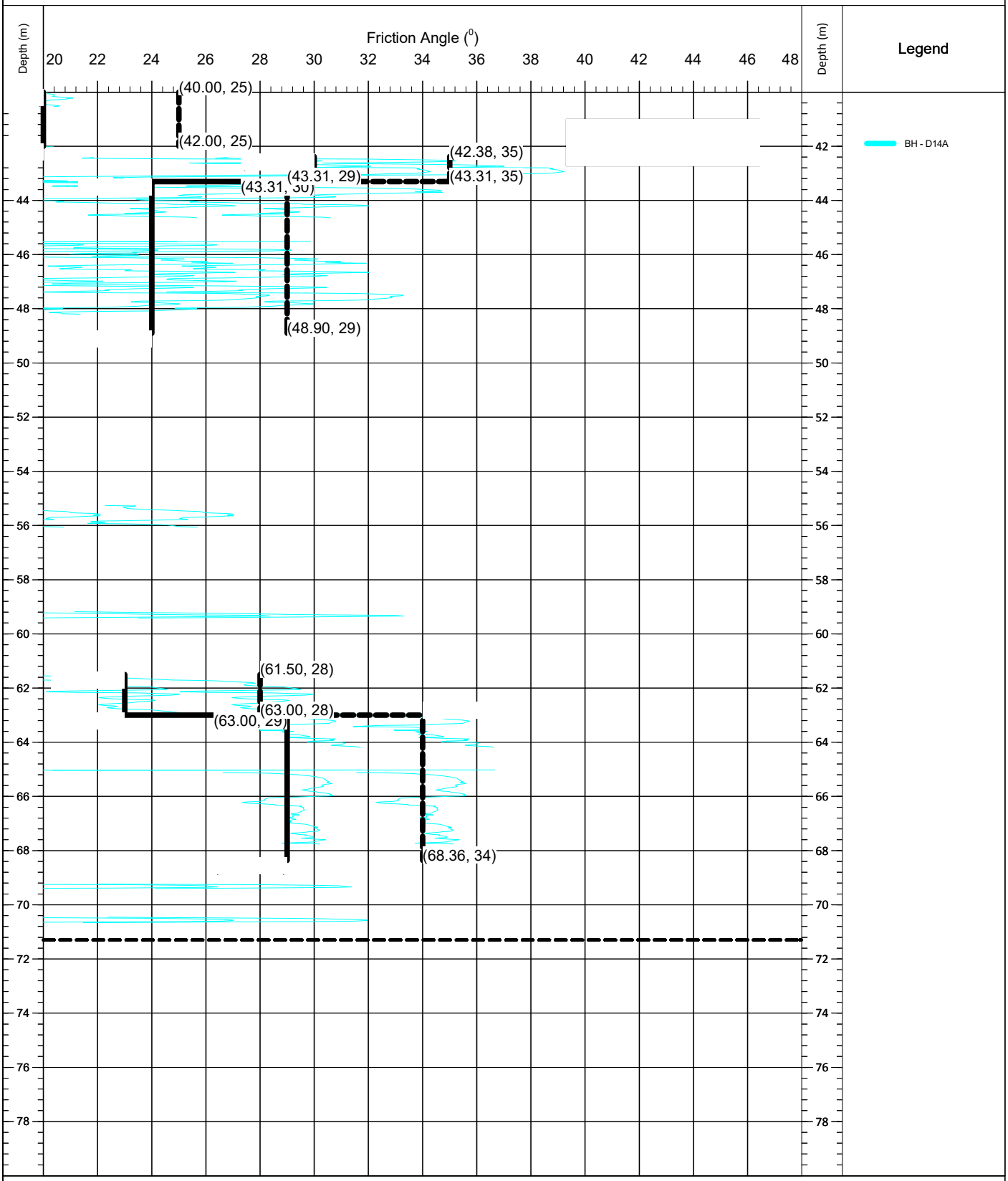

Area	**Maryland USA**	**Comments:**
Contract	**10451**	
Client Name/Ref	**US Wind Inc./ REF11449**	
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SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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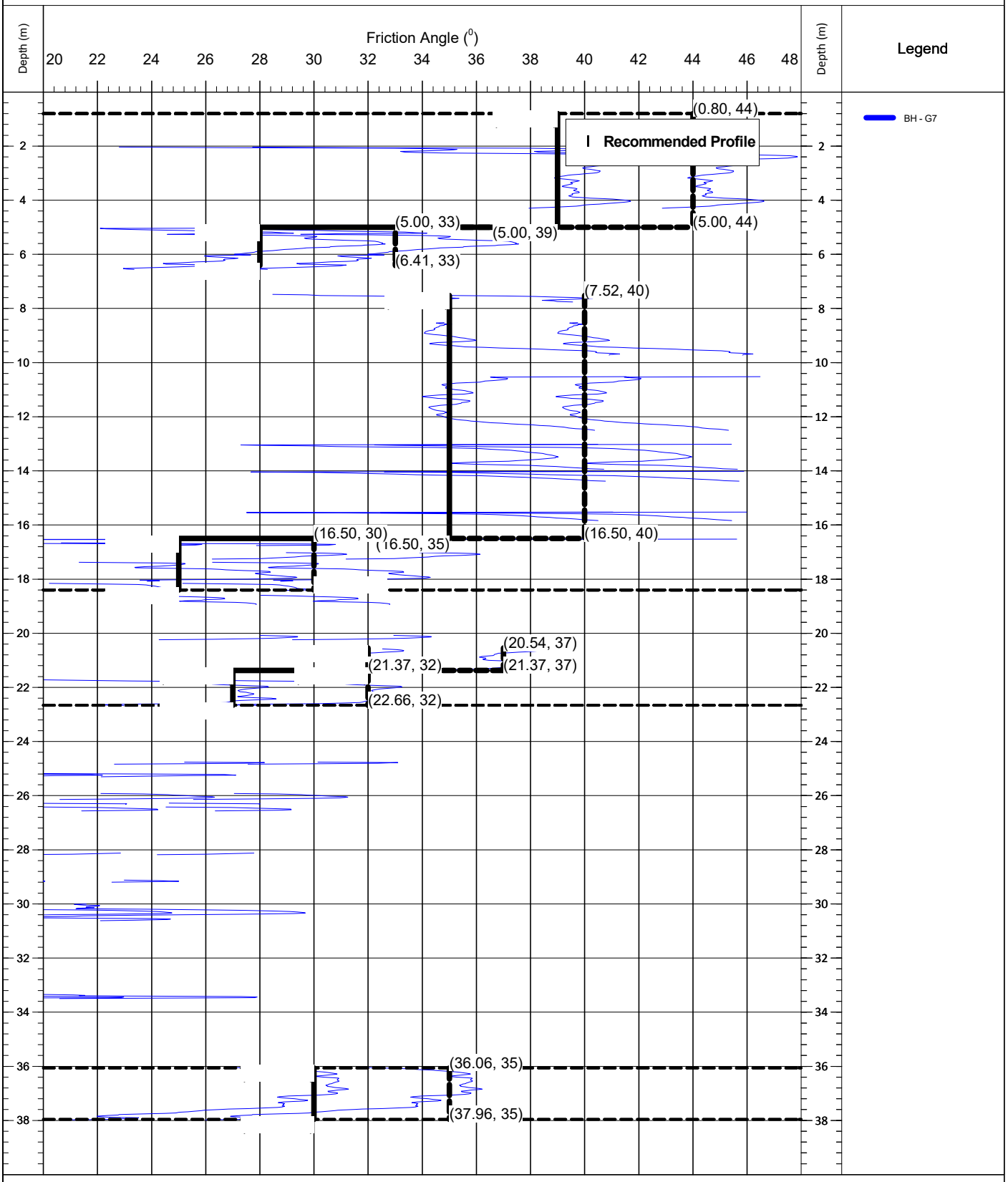

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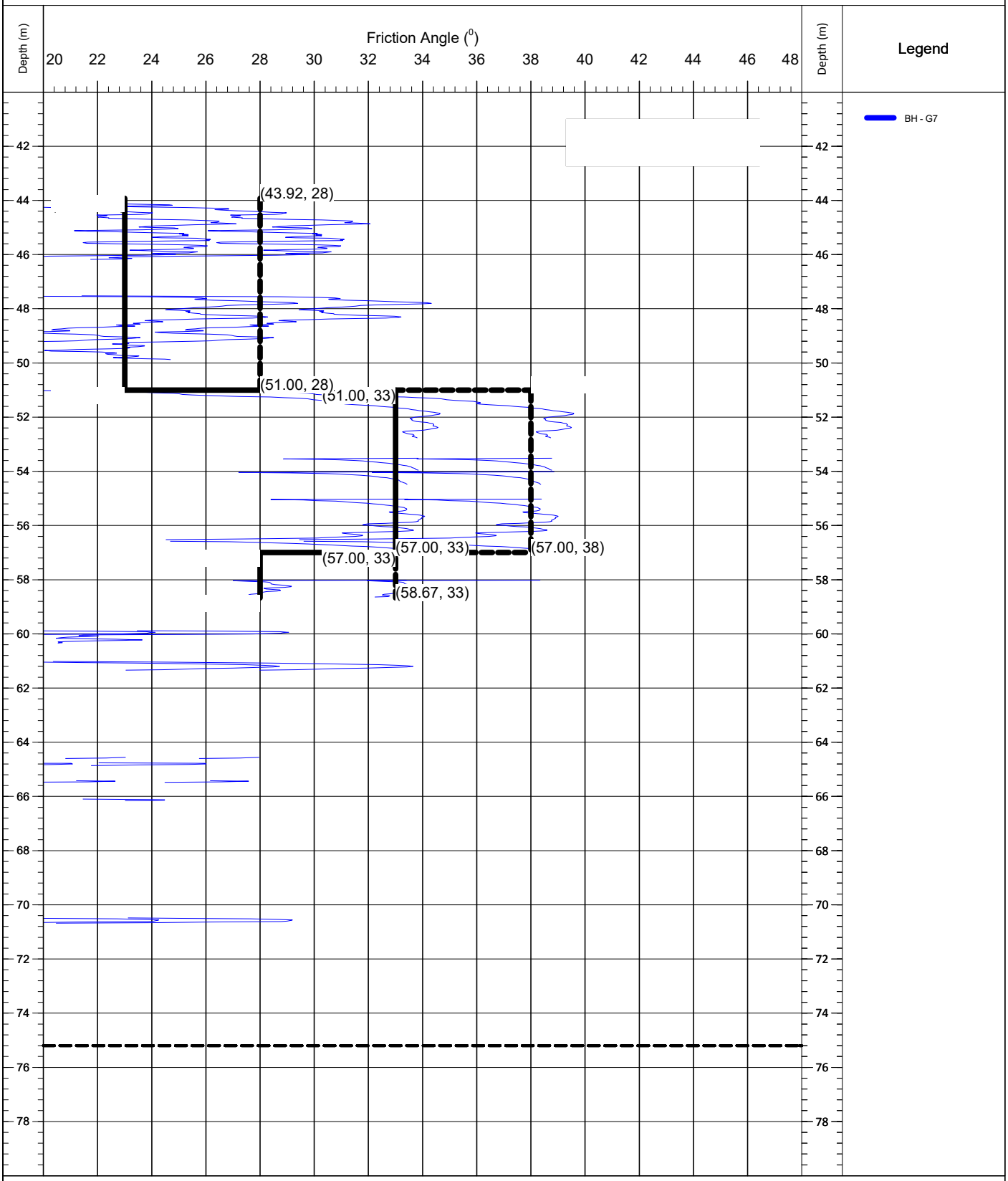

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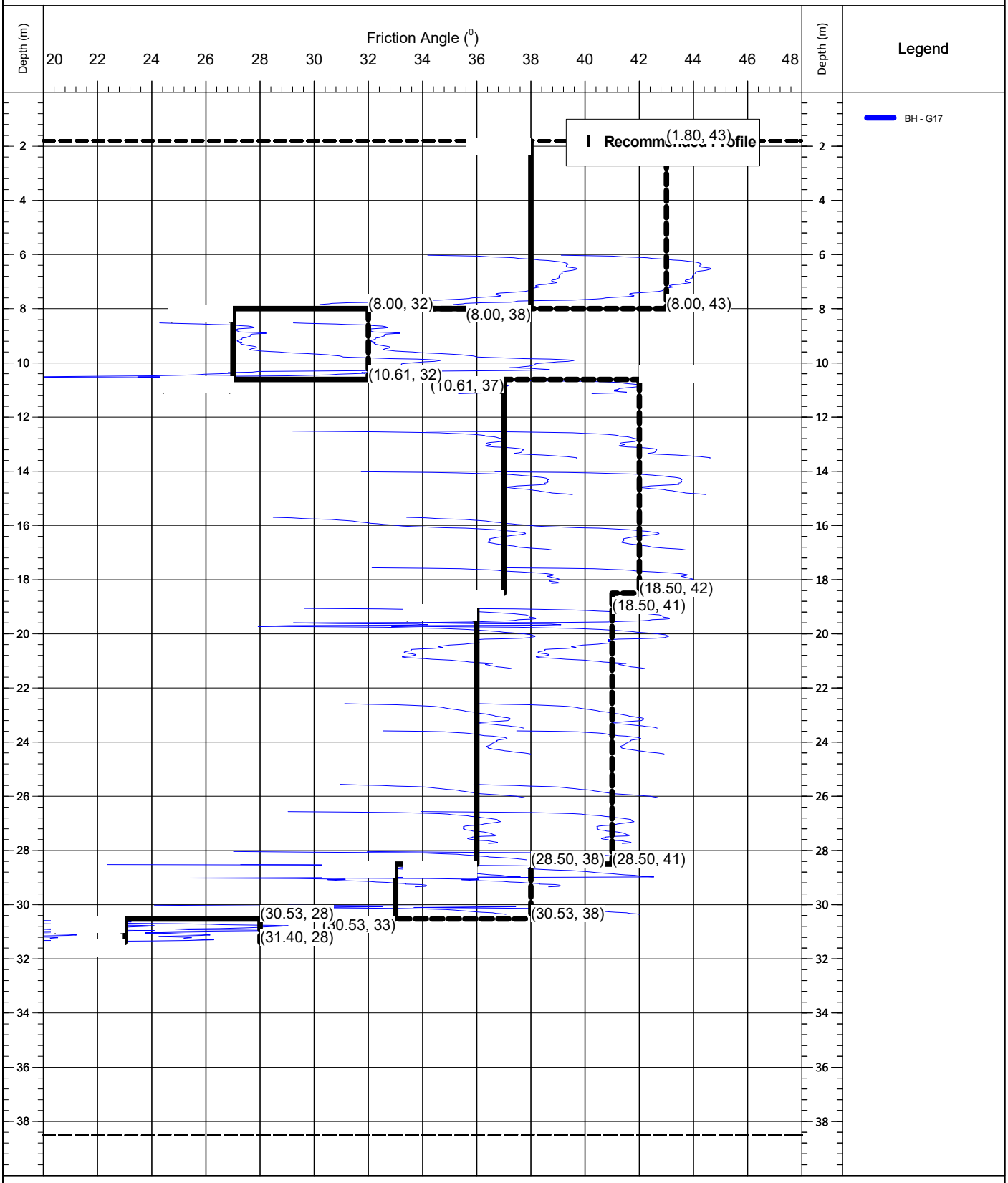

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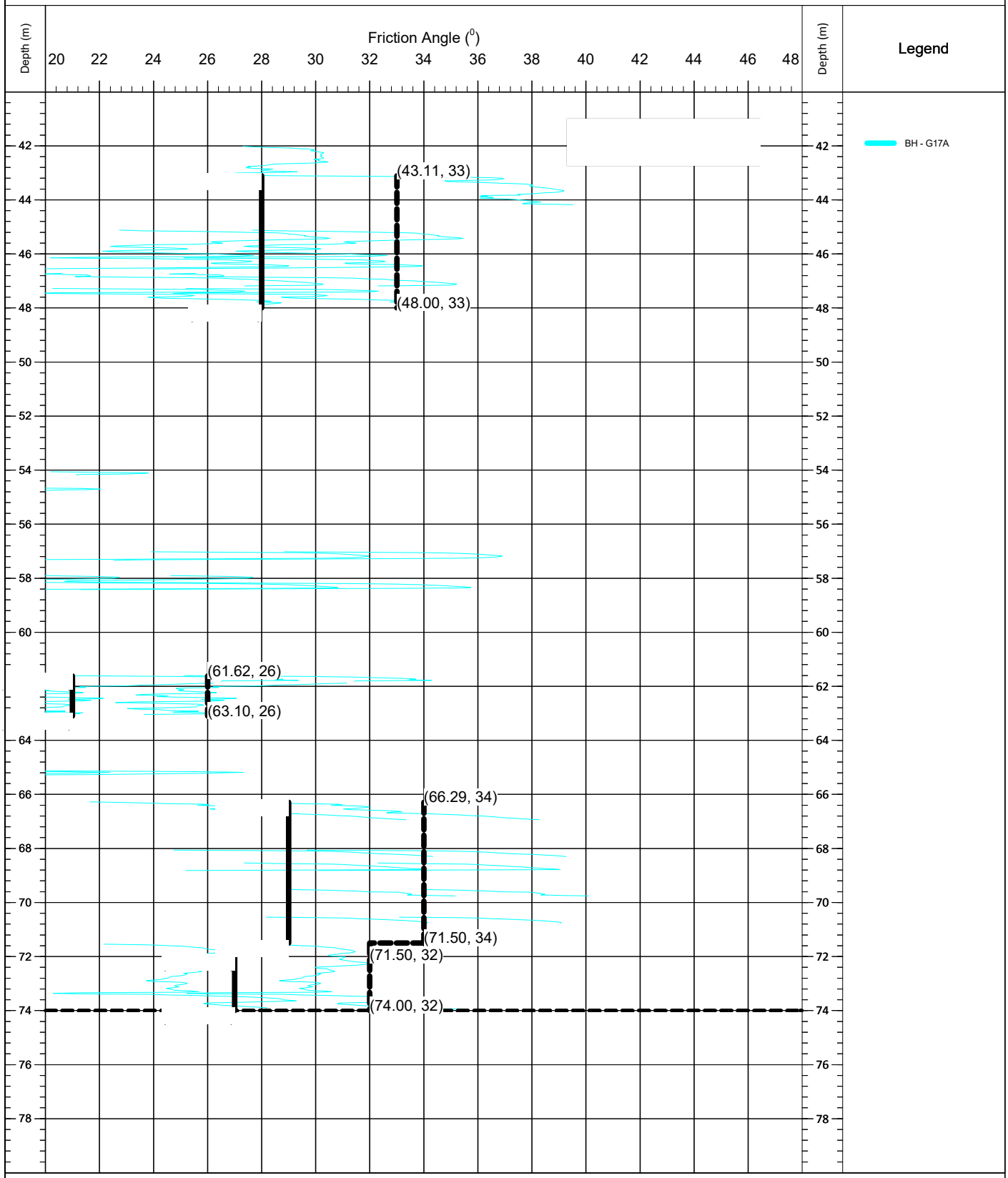

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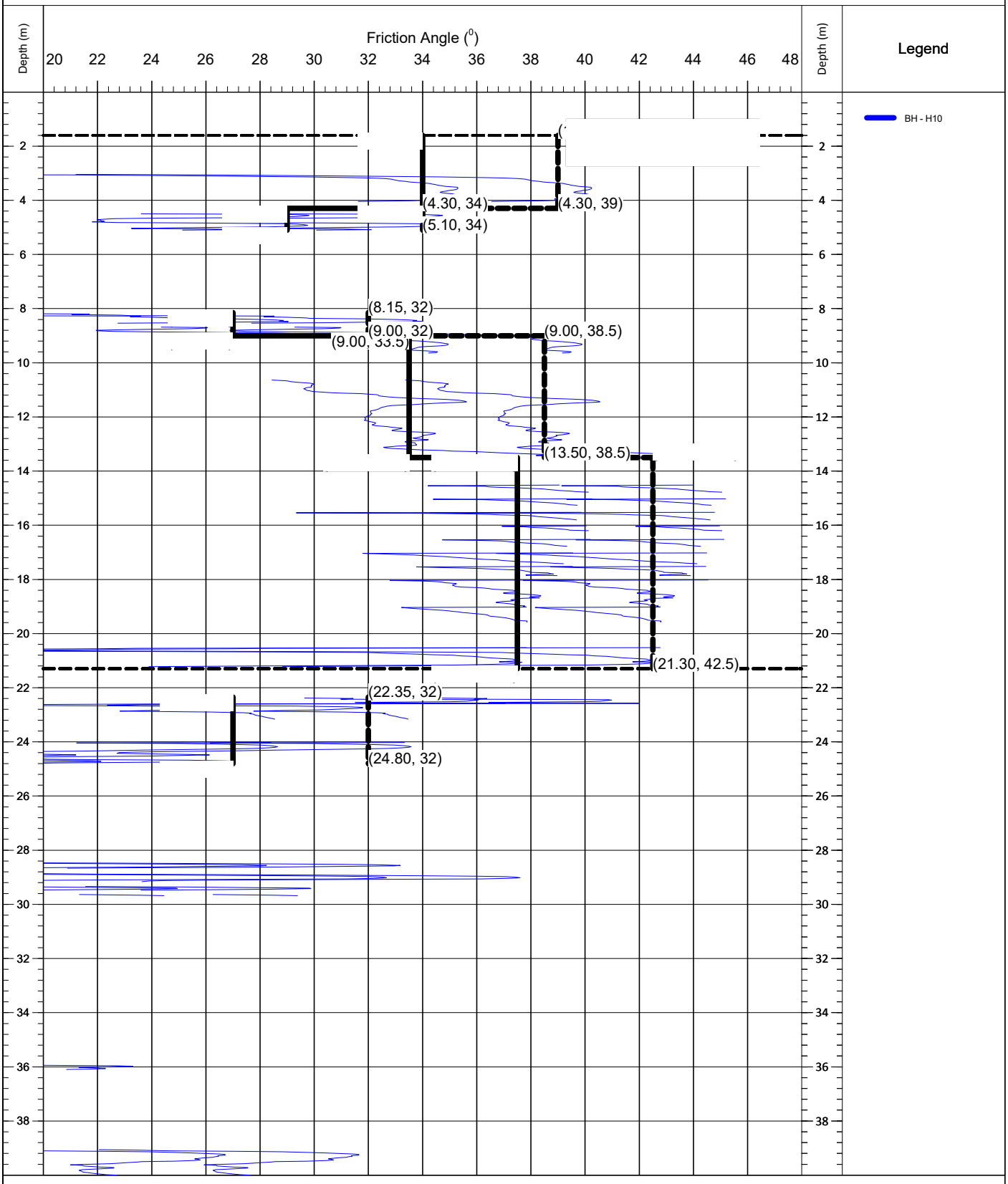

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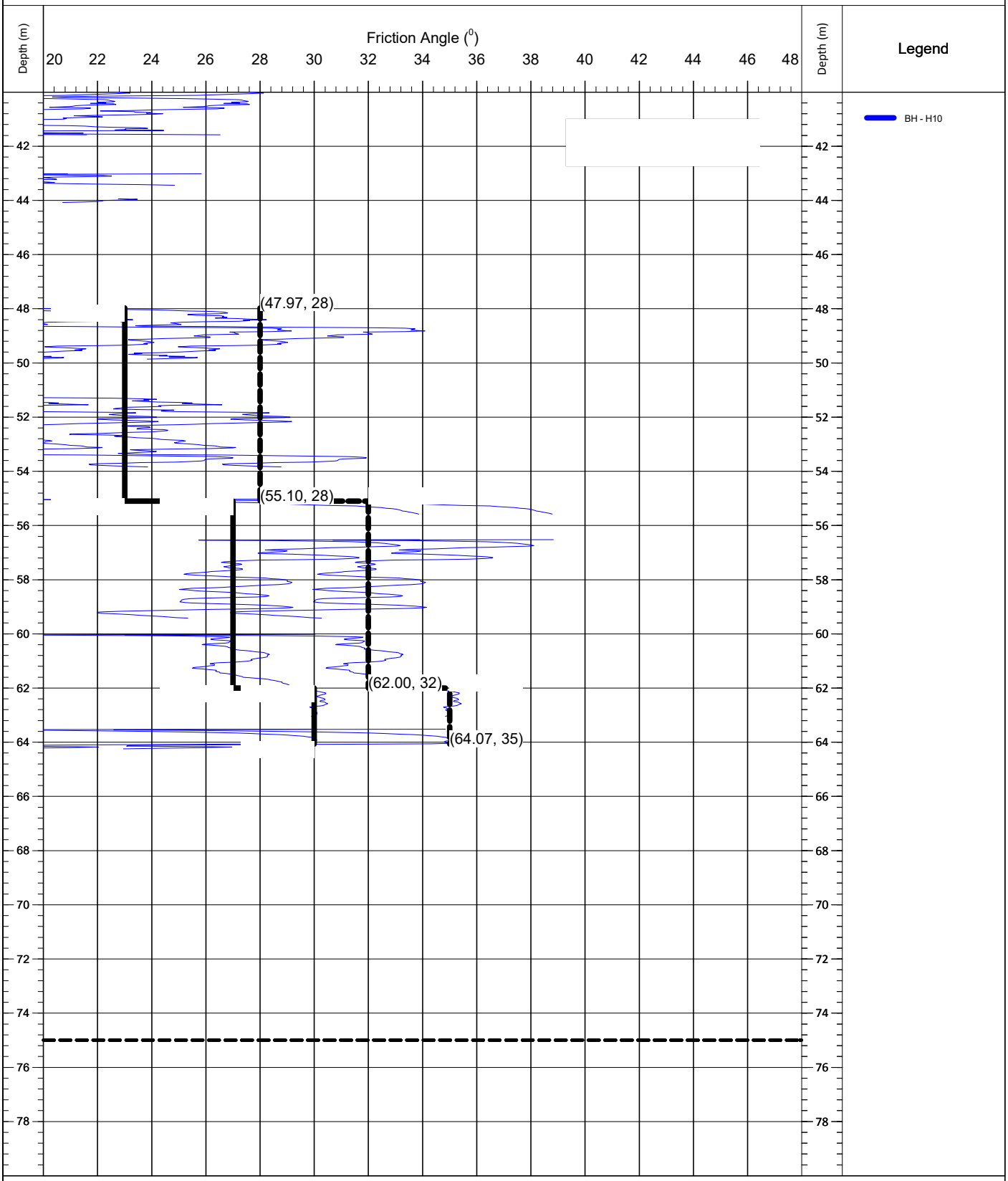

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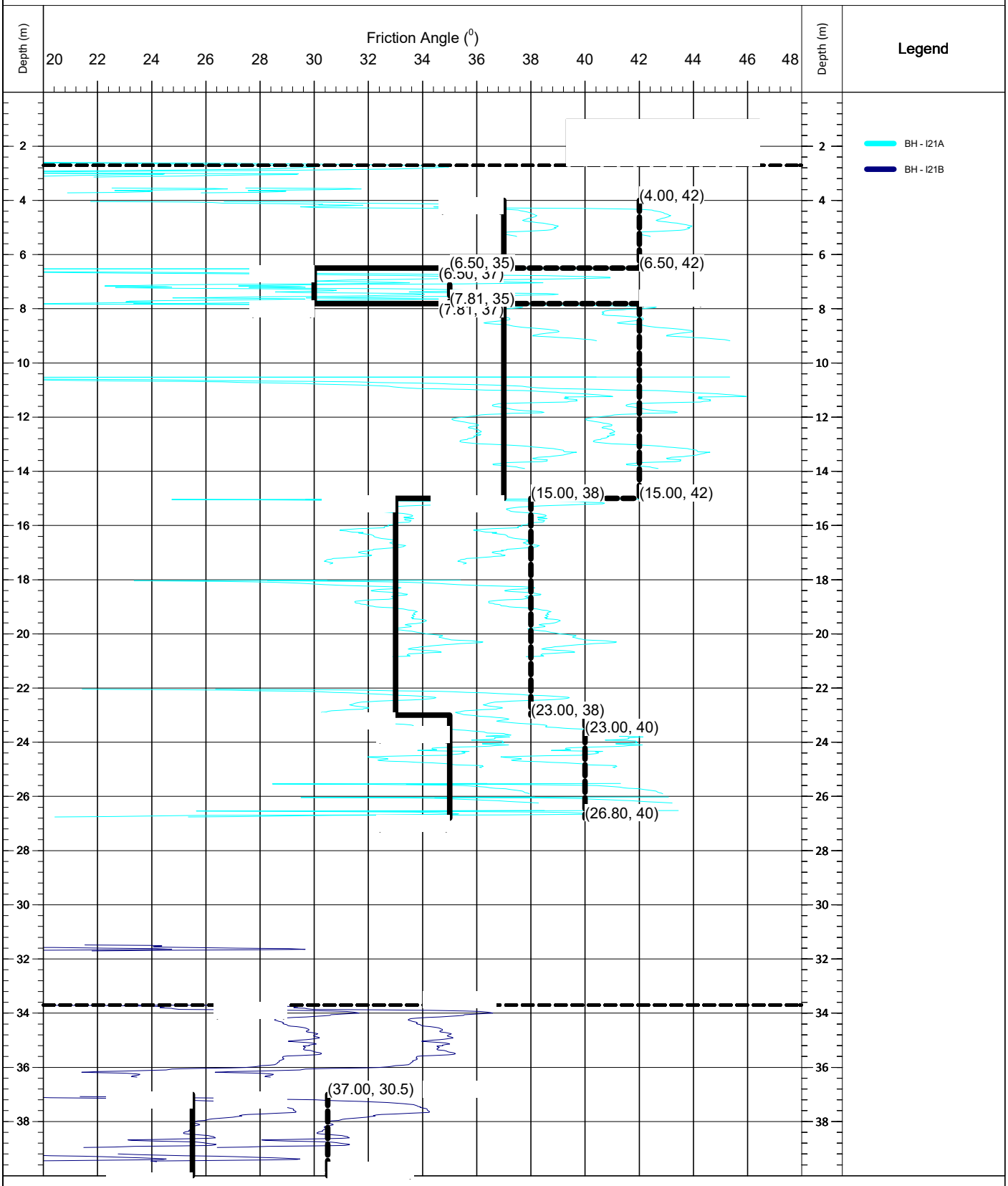

Area	nd USA
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Comments:

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Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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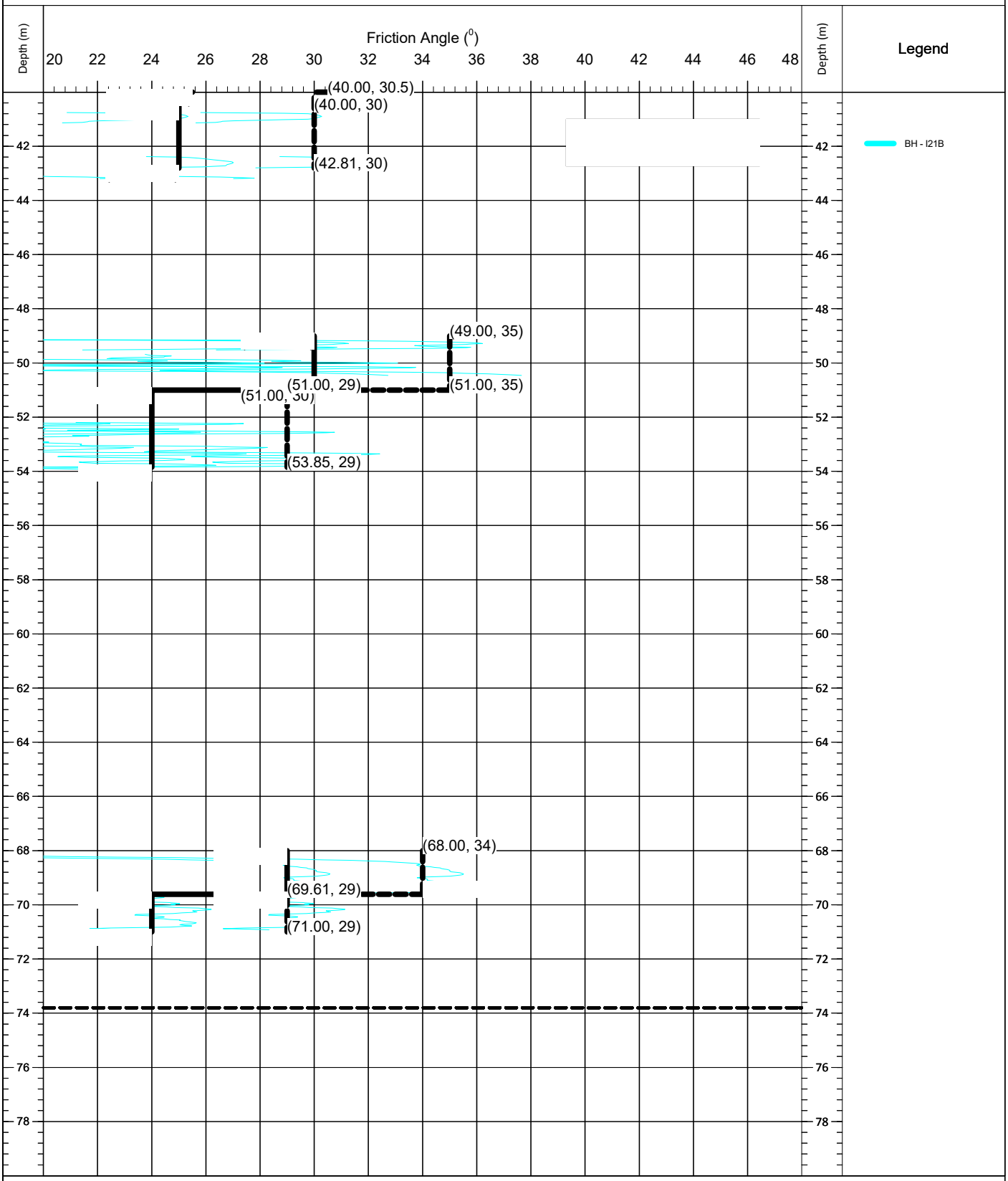

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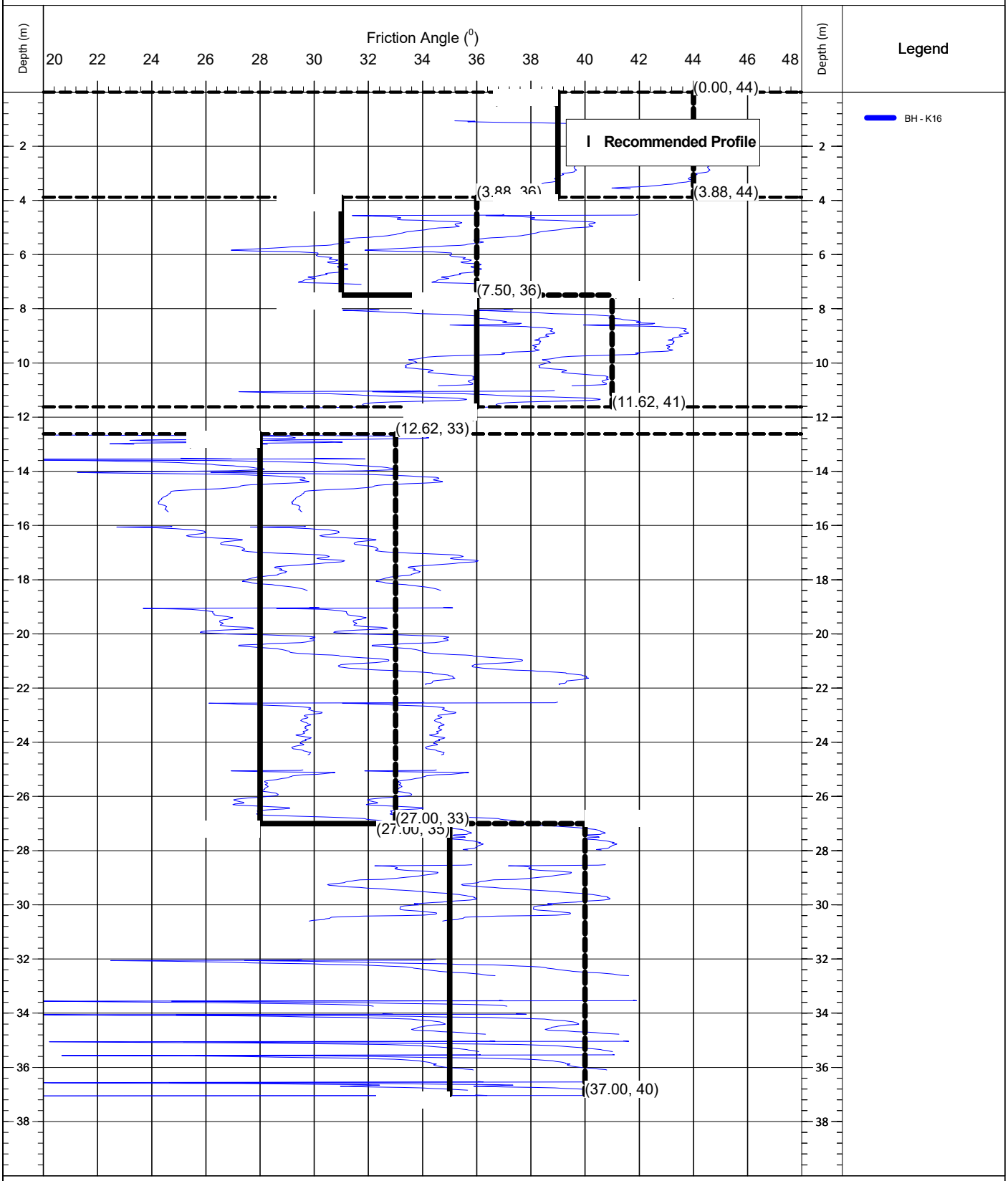

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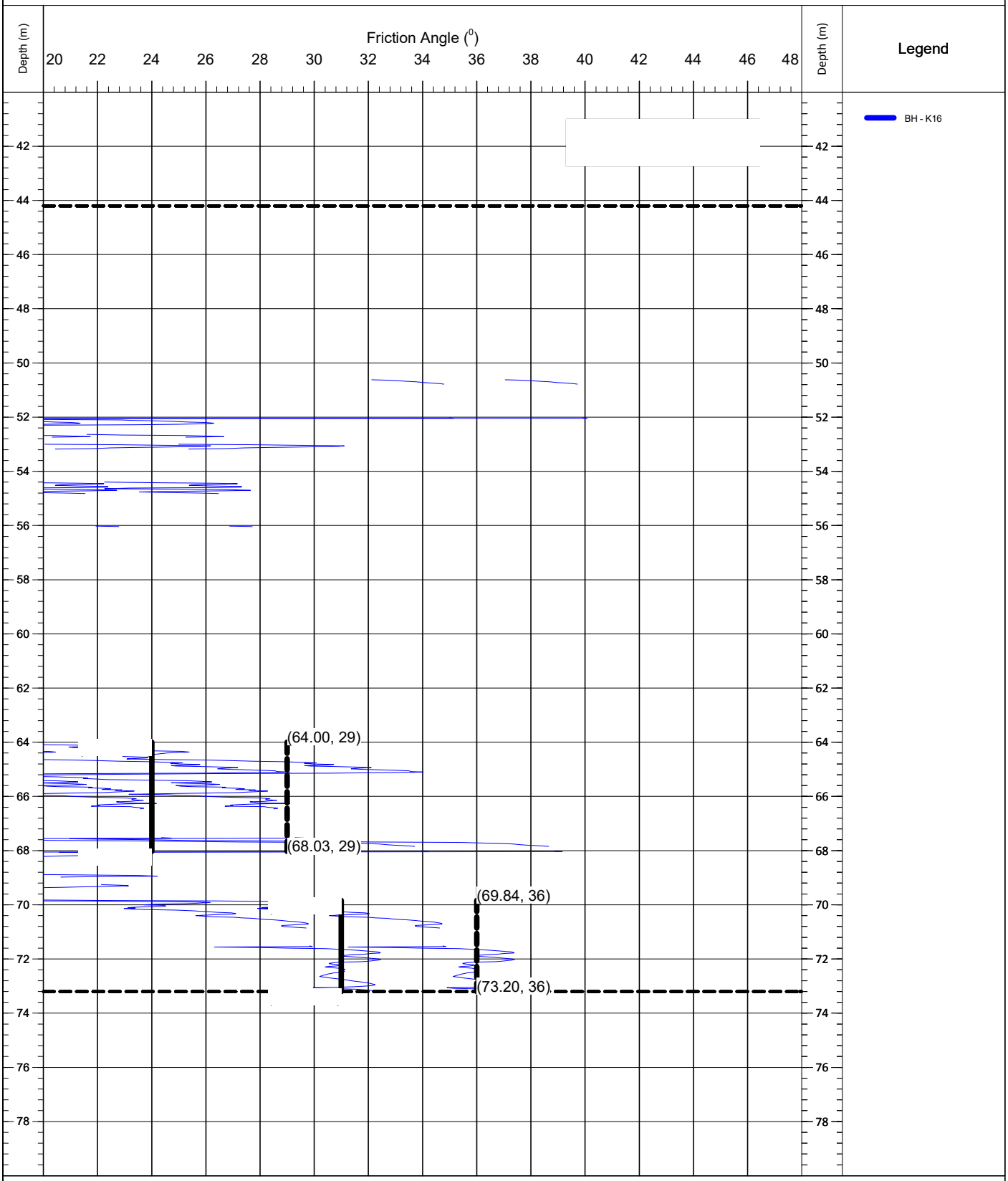

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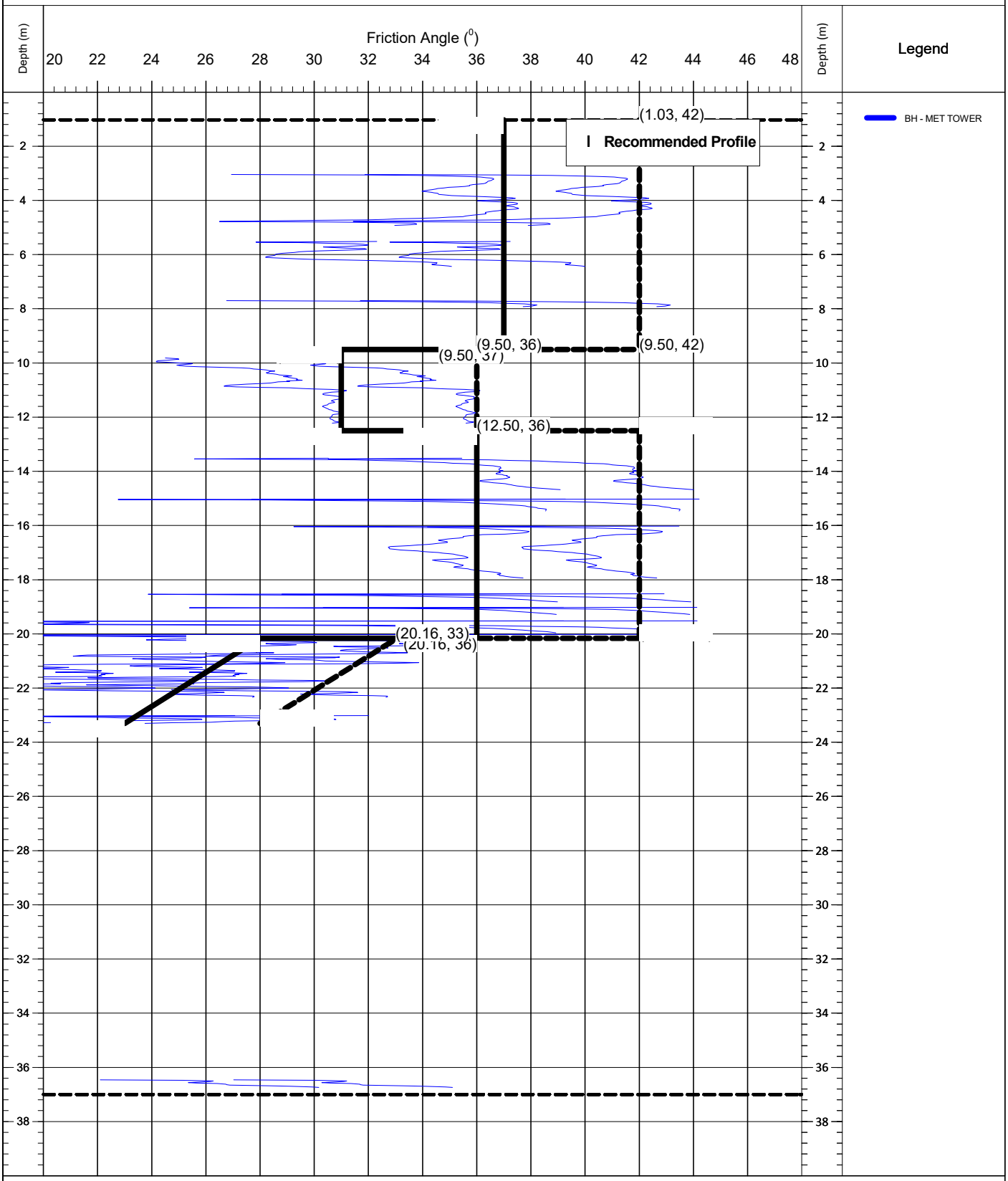

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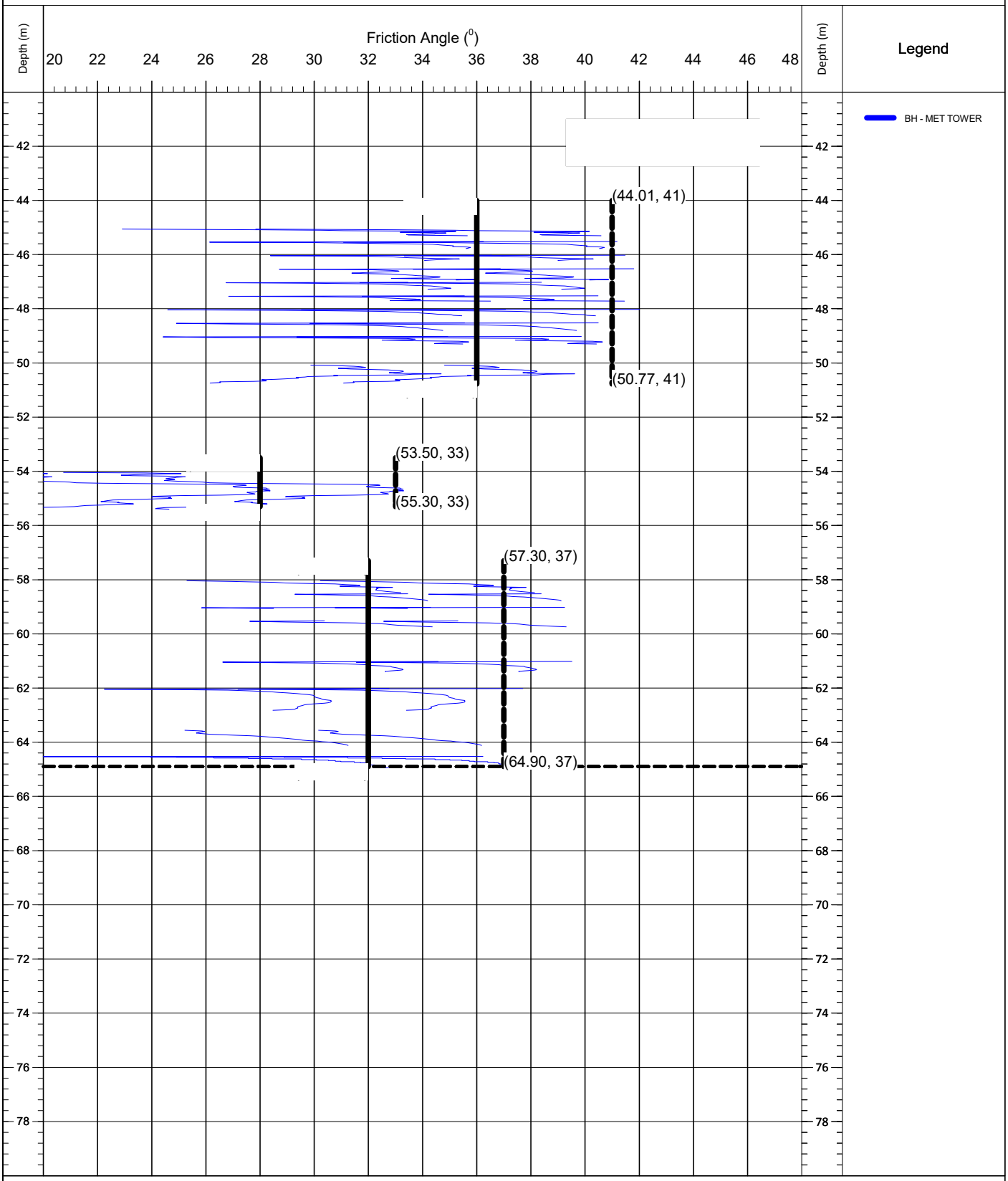

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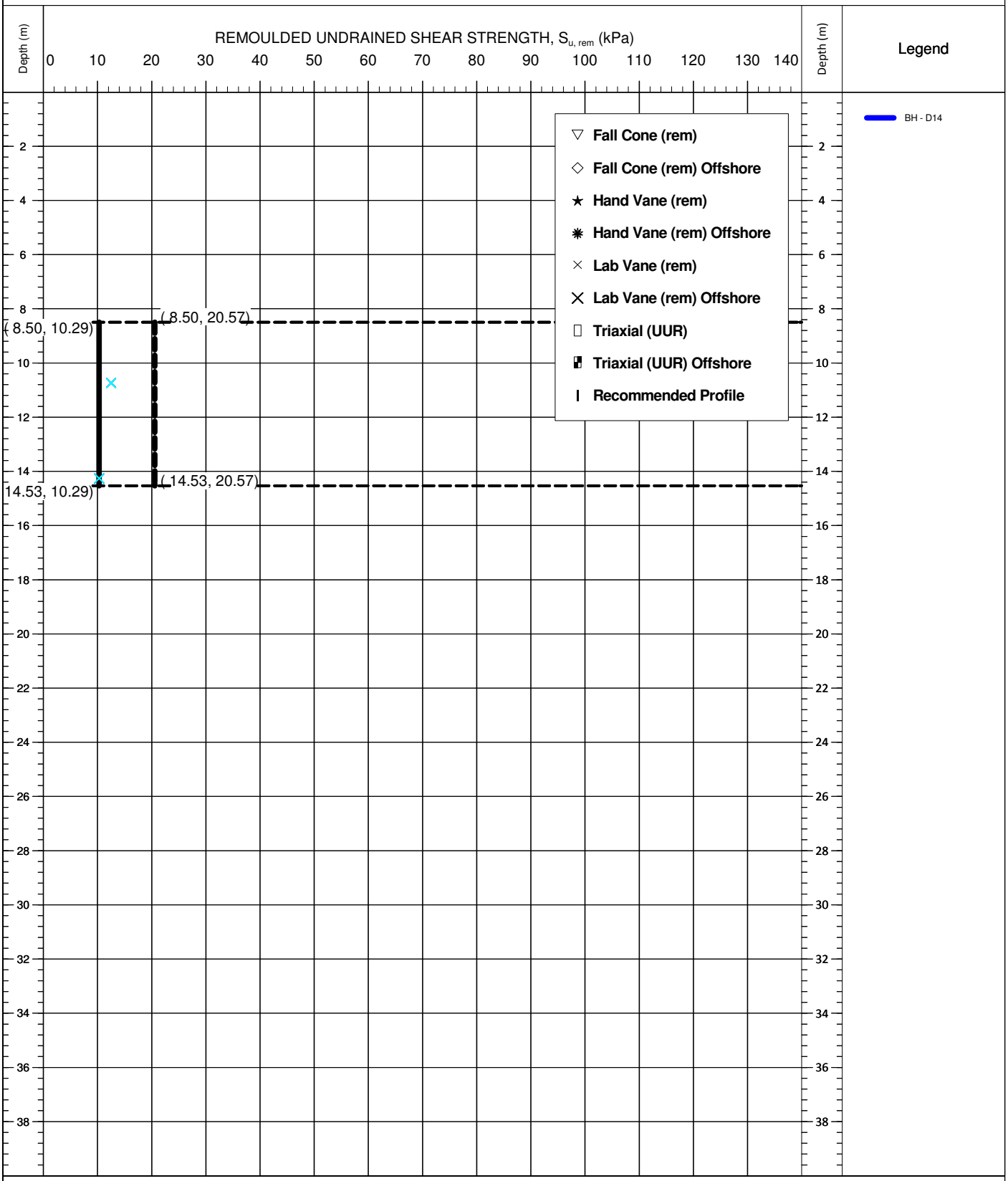
Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

2.3 Remoulded Undrained Shear Strength

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
REMOULDED UNDRAINED SHEAR STRENGTH PROFILE

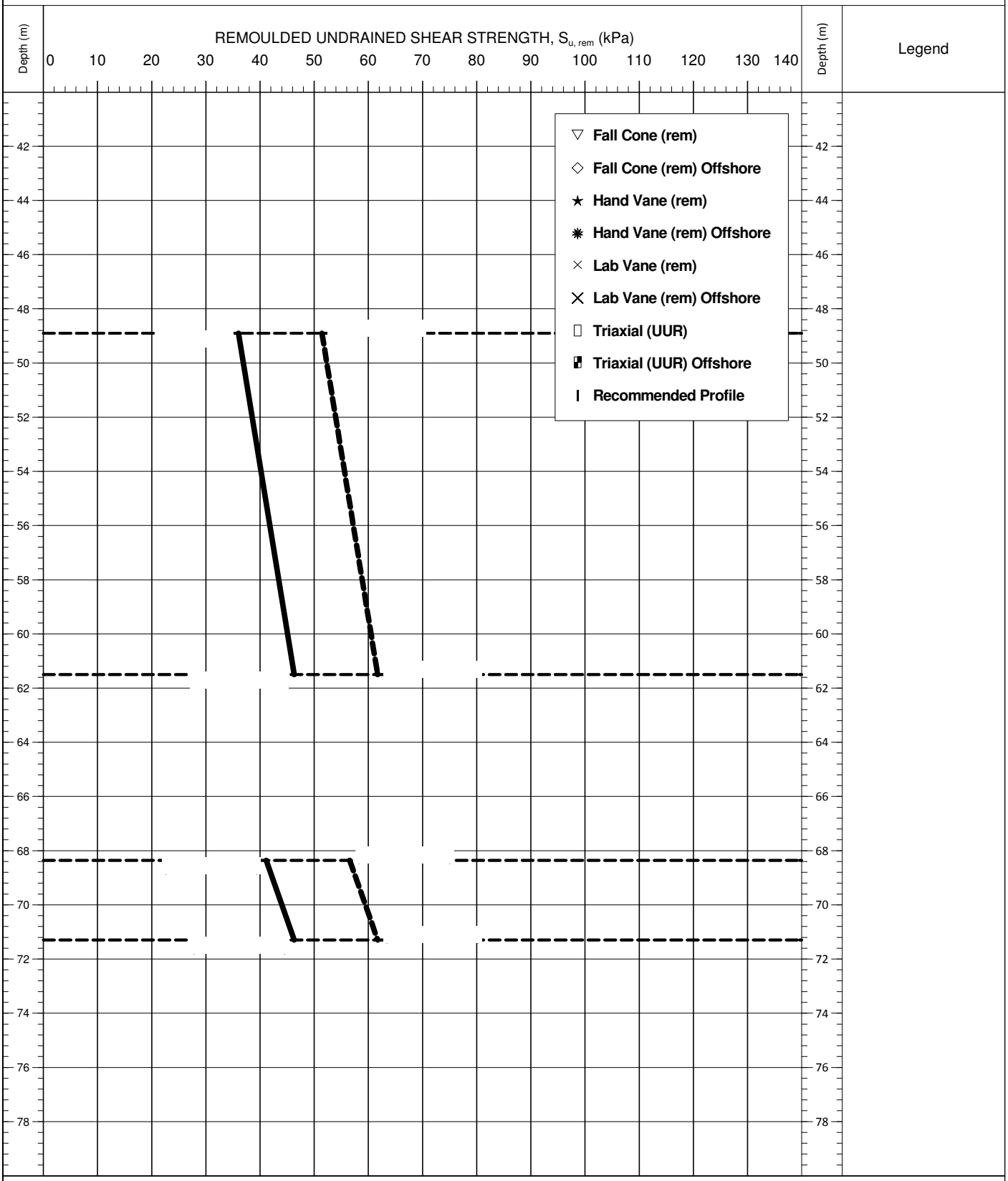


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments: Profiles infered from intact shear strength, anisotropy and sensitivity.

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
REMOULDED UNDRAINED SHEAR STRENGTH PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
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QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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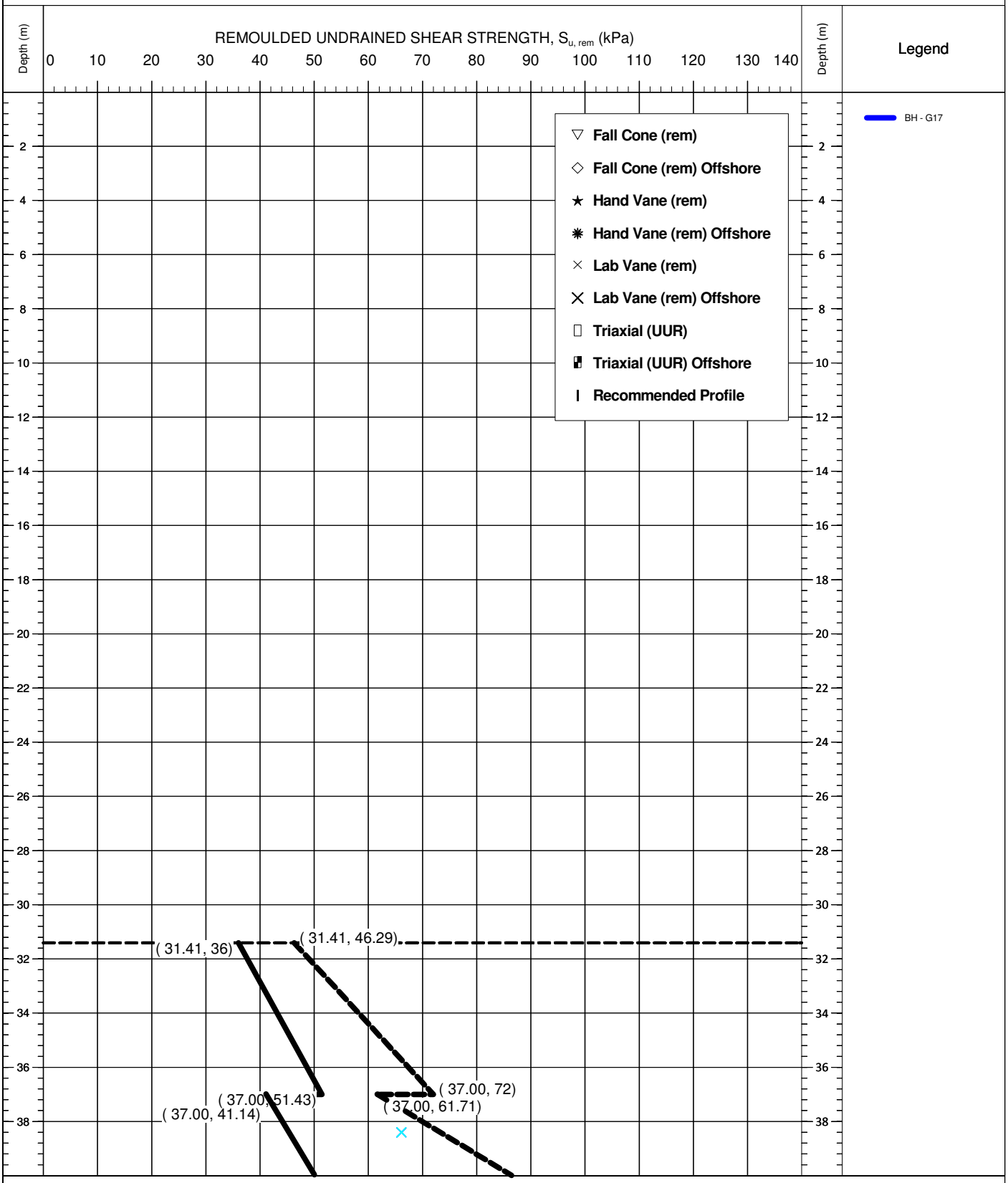

Area	**Maryland USA**
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SMc 28/09/2015	**JG** 21/01/2016	

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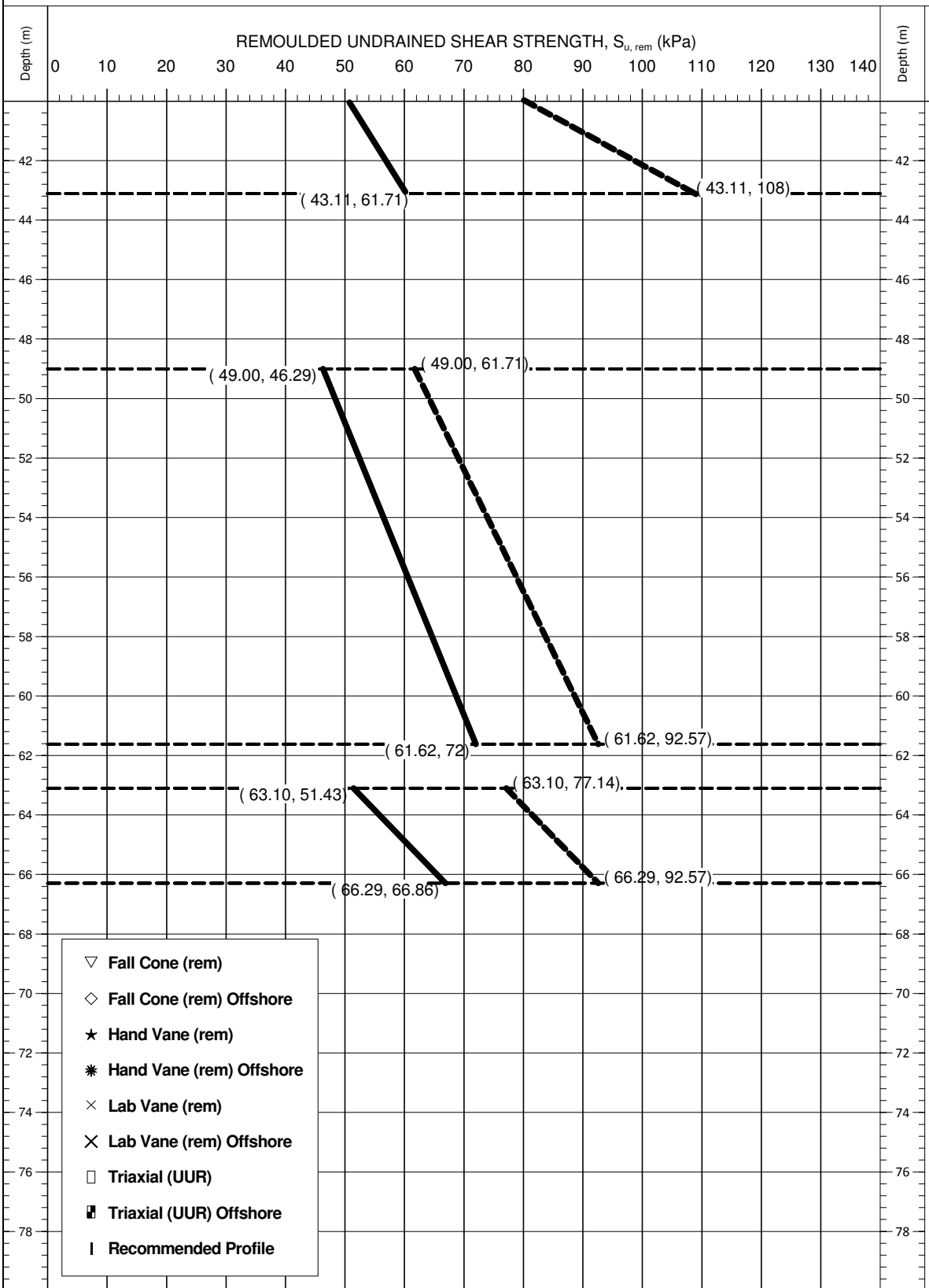

Area	**Maryland USA**
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SMc 28/09/2015	**JG** 21/01/2016	

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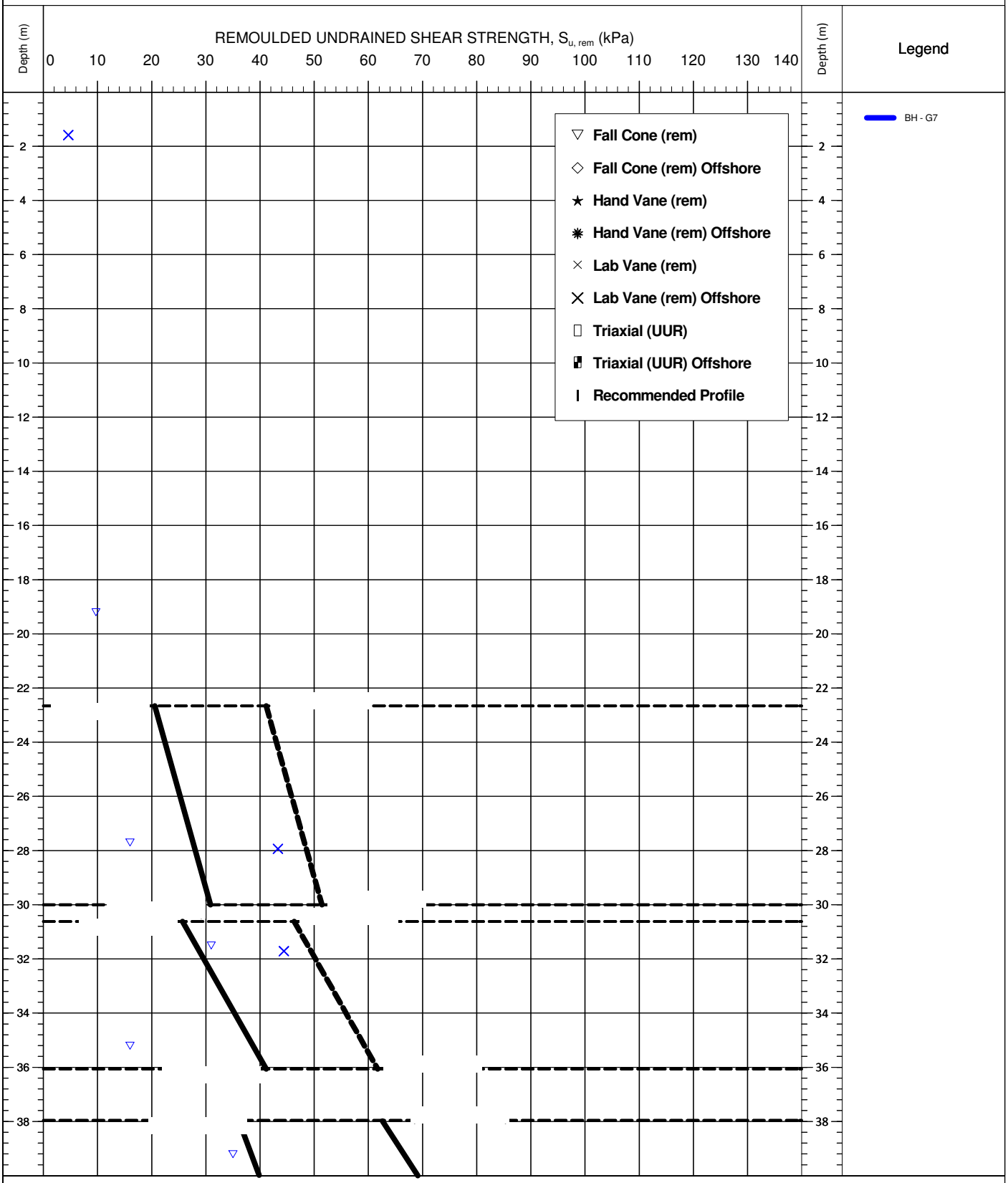

Area	**Maryland USA**
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SMc 28/09/2015	**JG** 21/01/2016	

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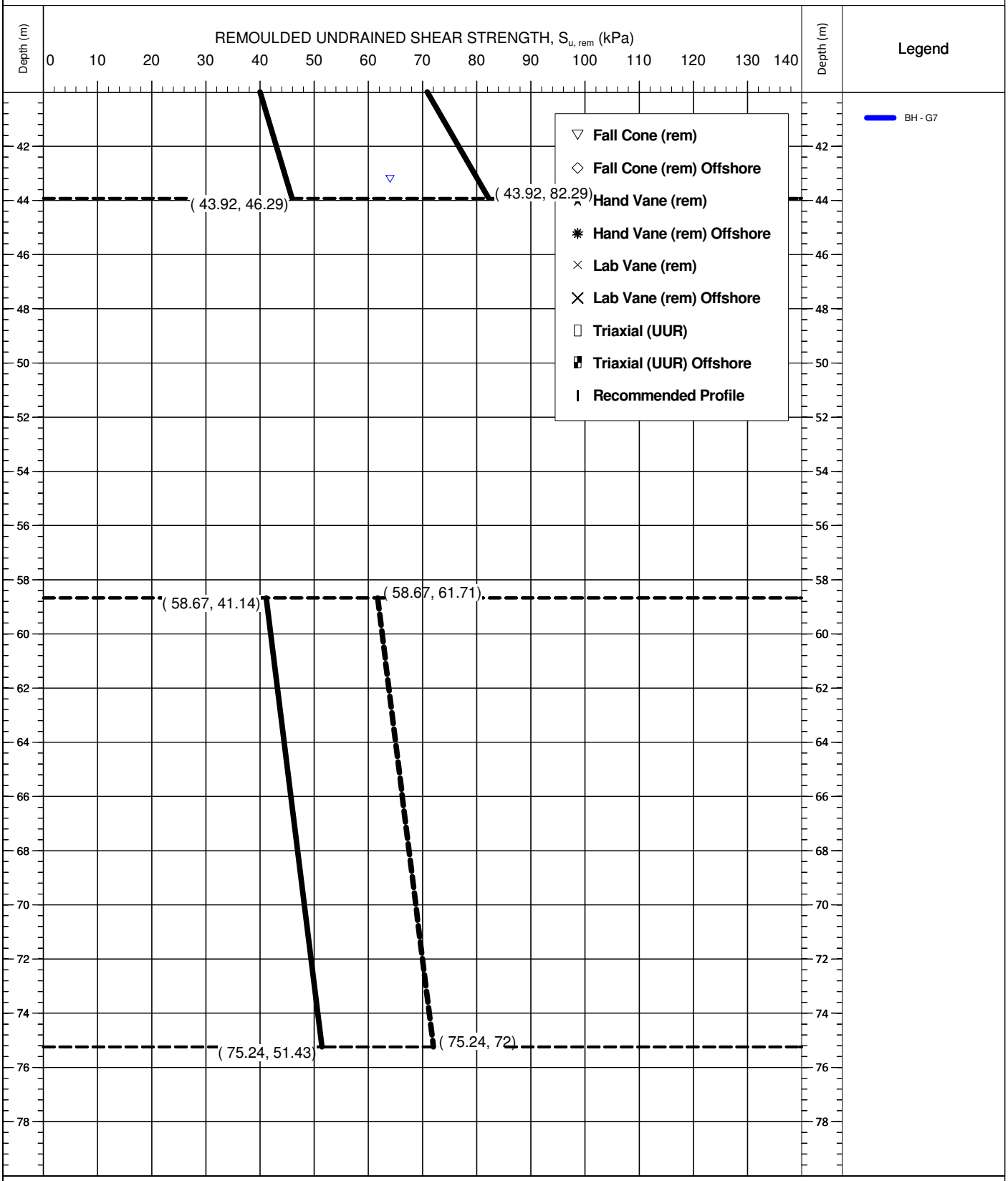

Area	**Maryland USA**
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SMc 28/09/2015	**JG** 21/01/2016	

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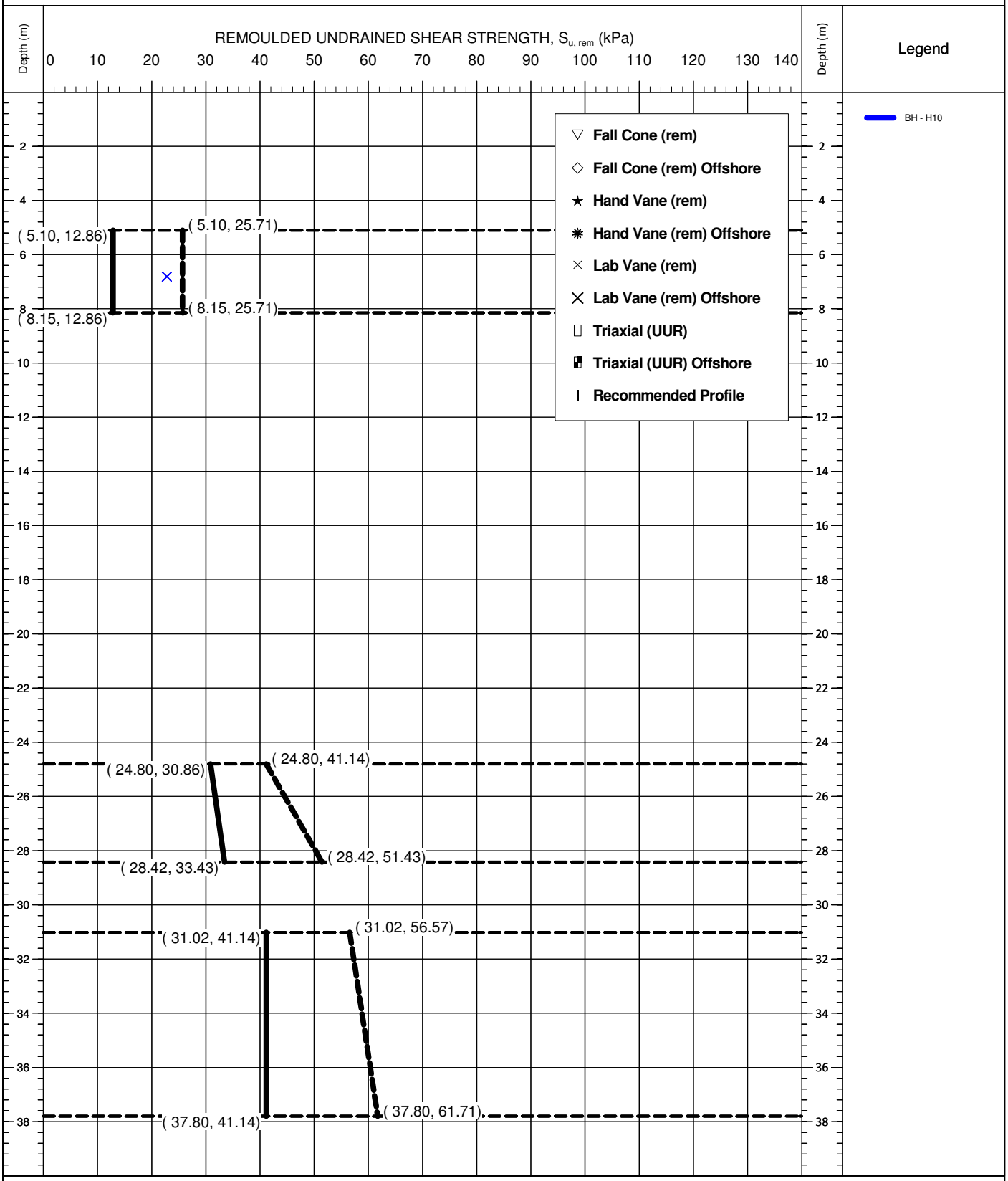

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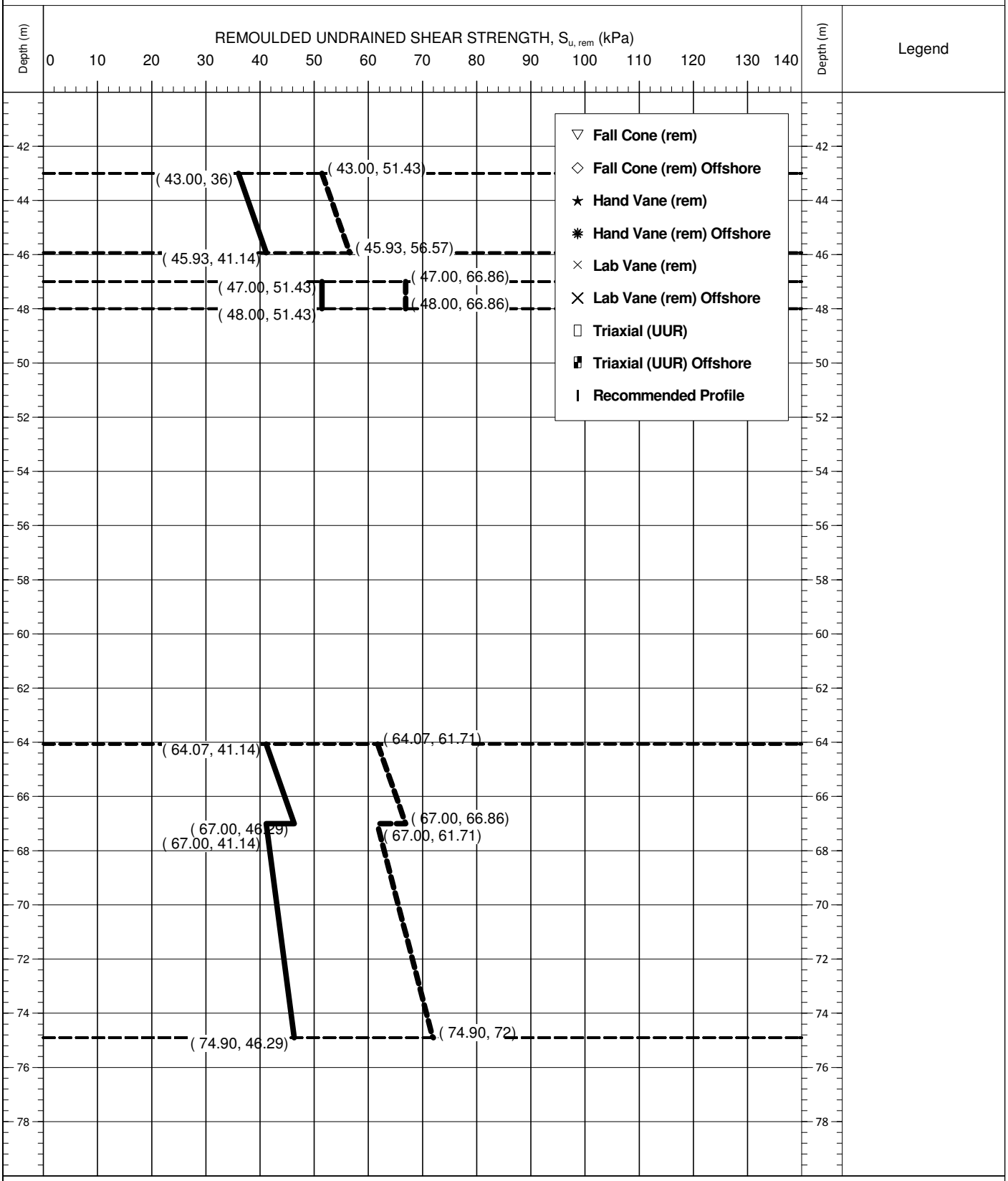

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SMc 28/09/2015	**JG** 21/01/2016	

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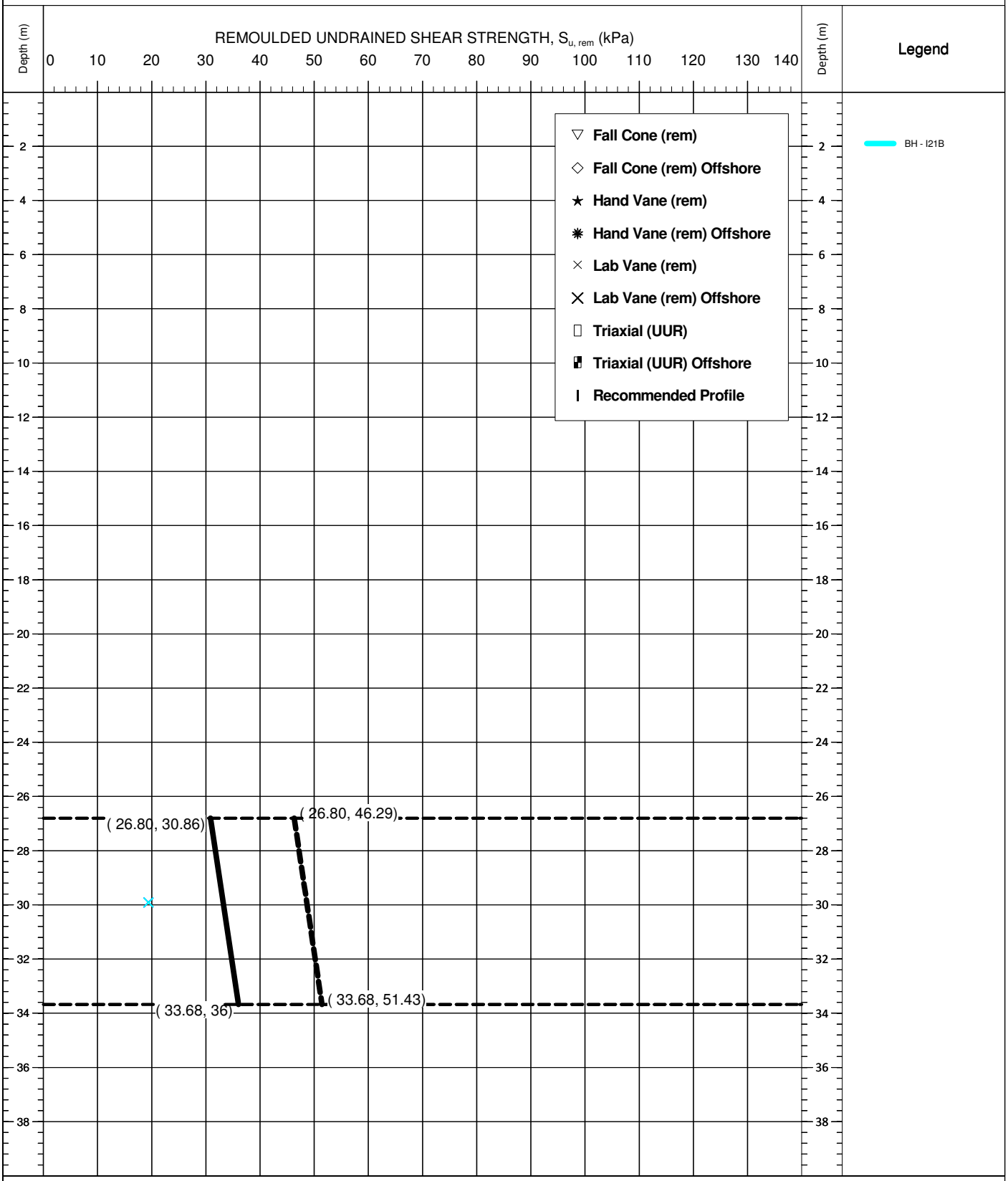

Area	**Maryland USA**
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SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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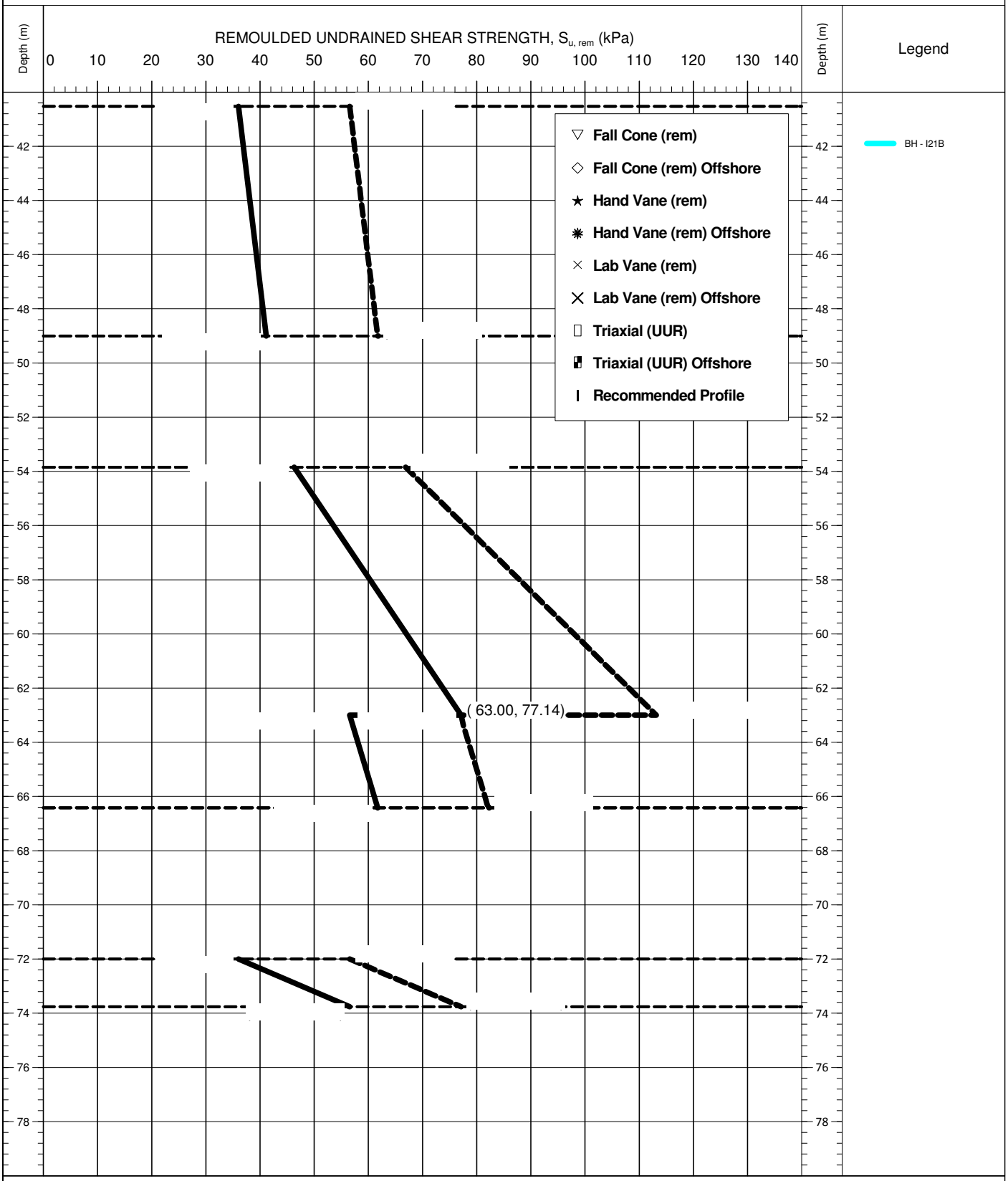

Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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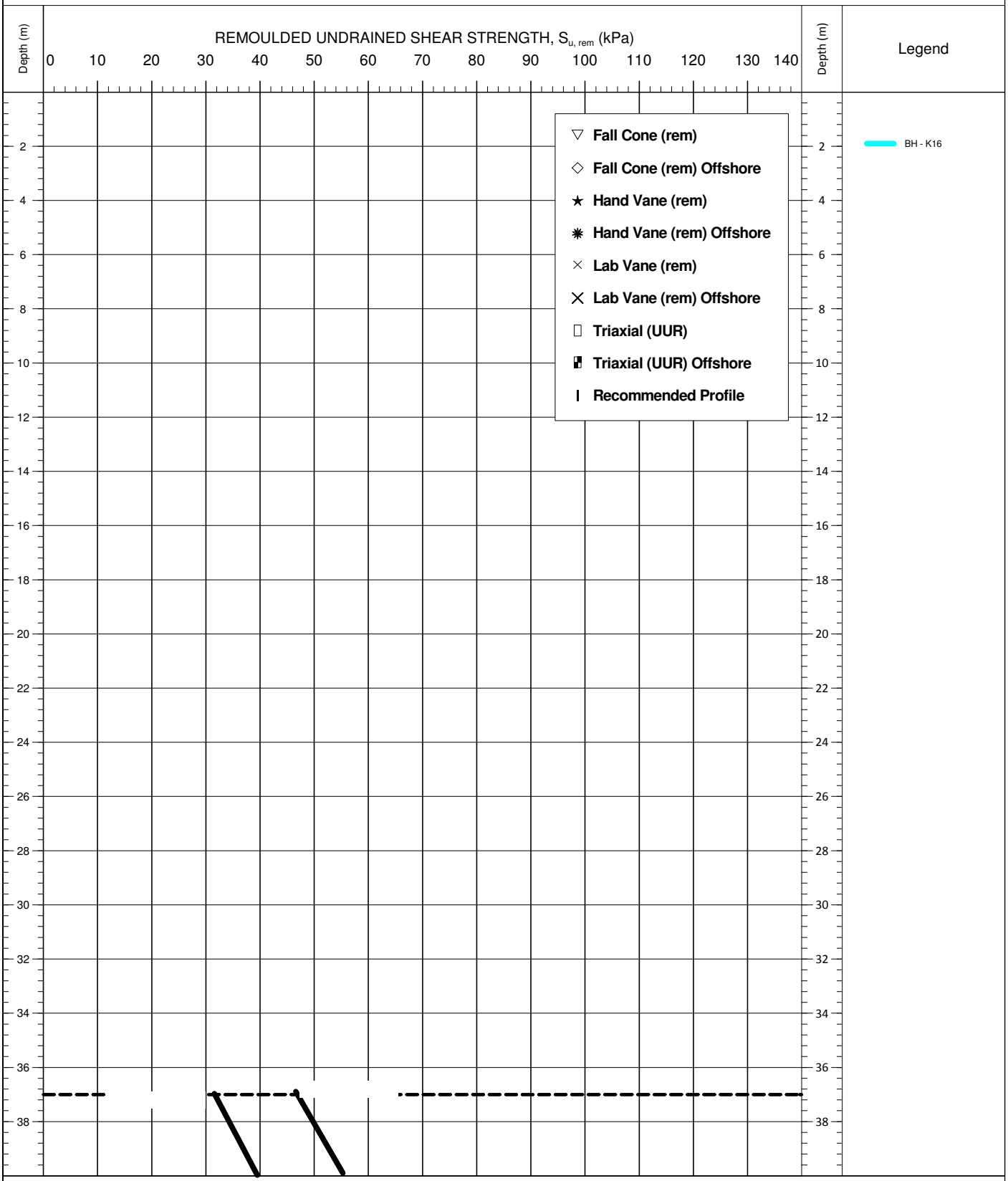
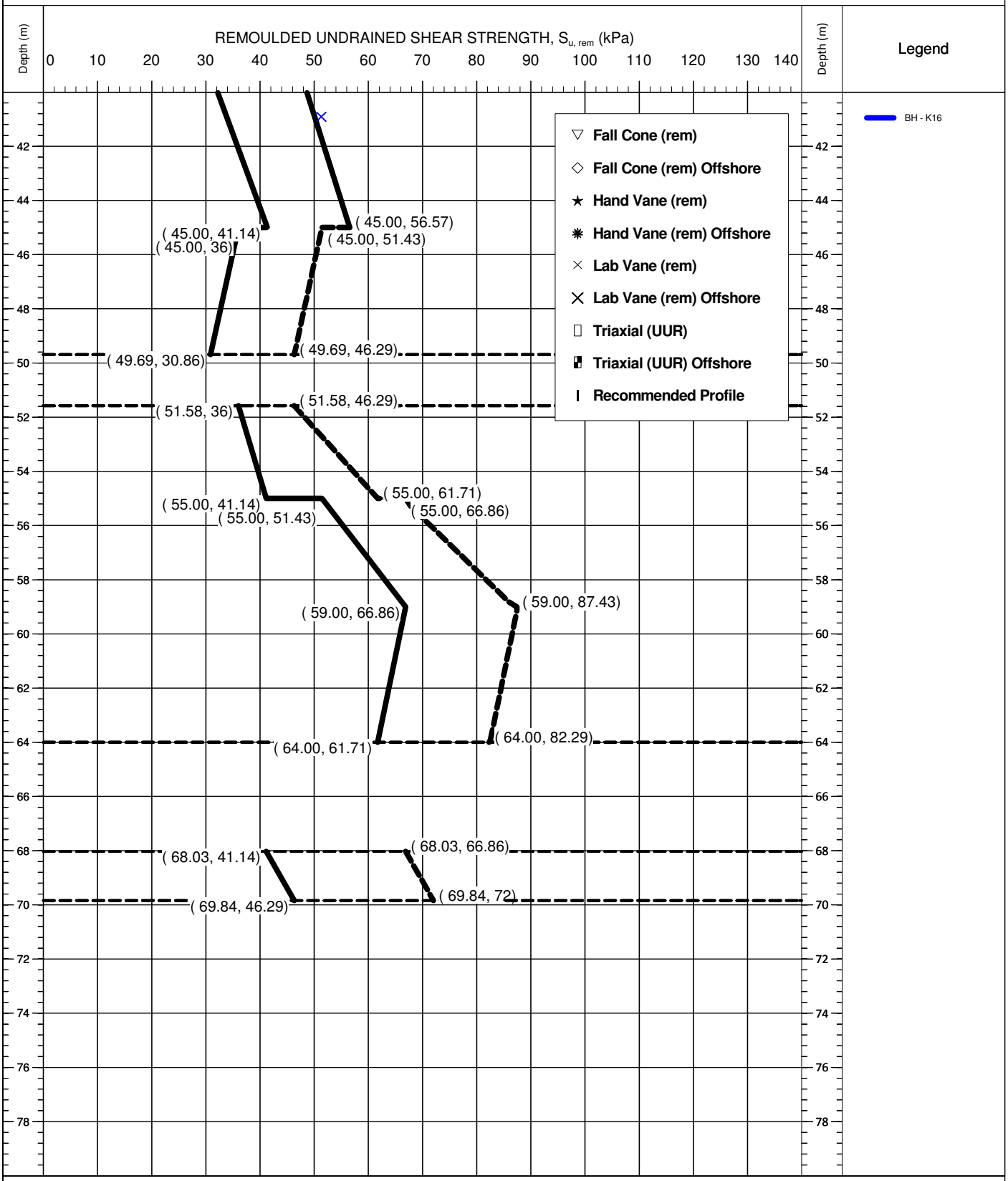


Area	Maryland USA
Contract	10451
Client Name/Ref	US Wind Inc./ REF11449
Vessel	MV Ocean Discovery
CRS	GRS 80 UTM ZONE 18 N (75 W)

Comments: Profiles infered from intact shear strength, anisotropy and sensitivity.

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	JG 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
REMOULDED UNDRAINED SHEAR STRENGTH PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

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SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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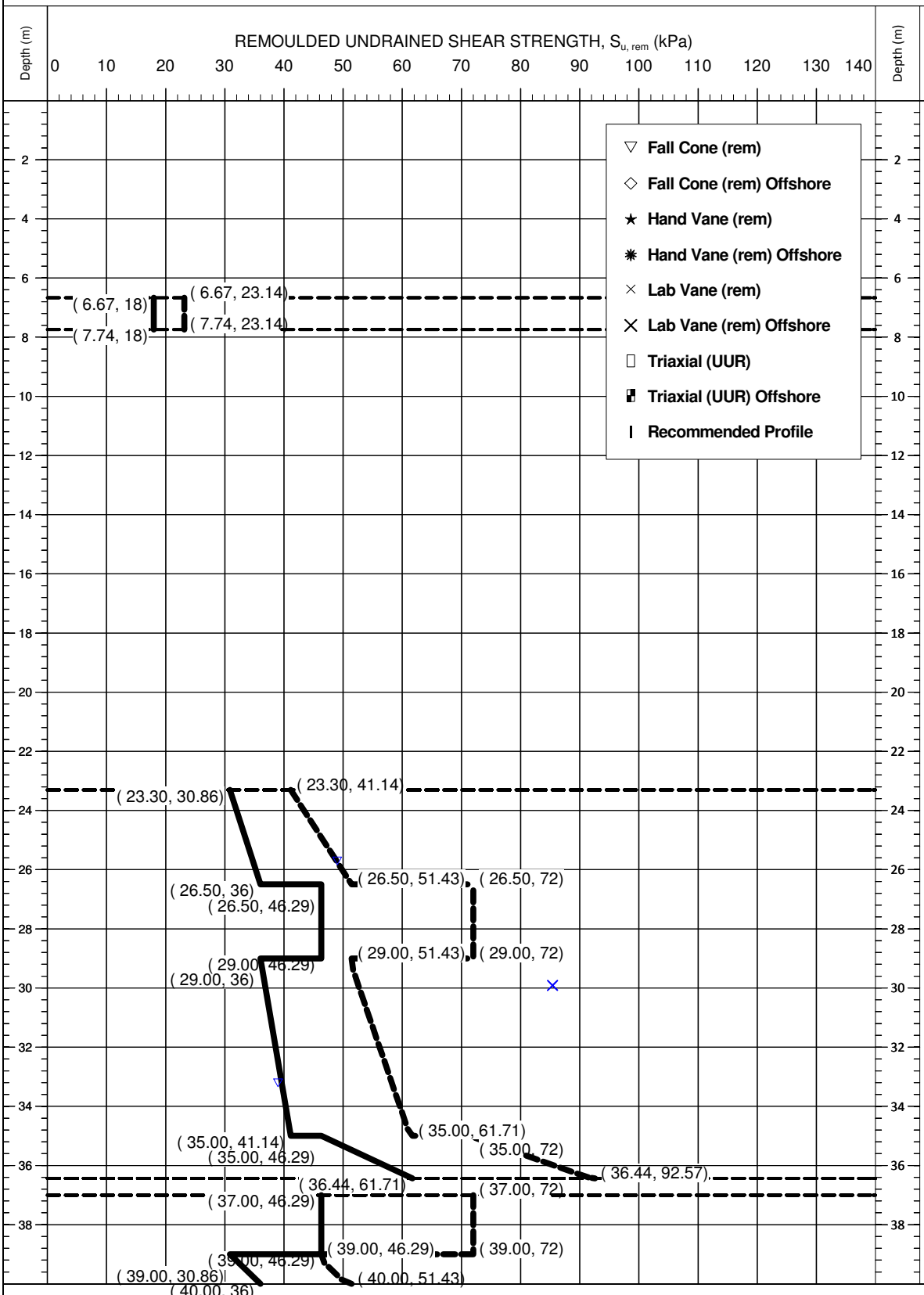

Area	**Maryland USA**
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SMc 28/09/2015	**JG** 21/01/2016	

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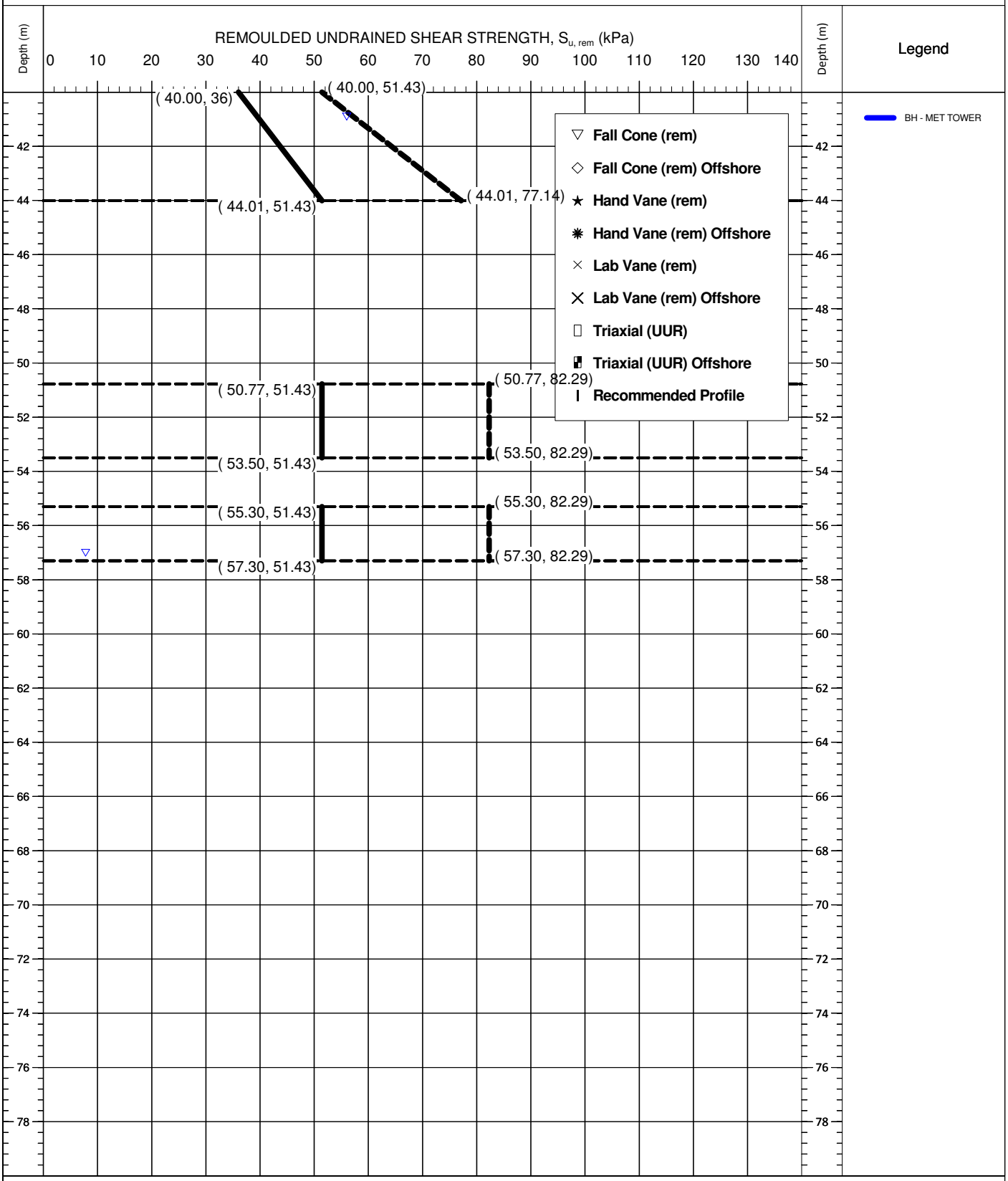

Area	**Maryland USA**
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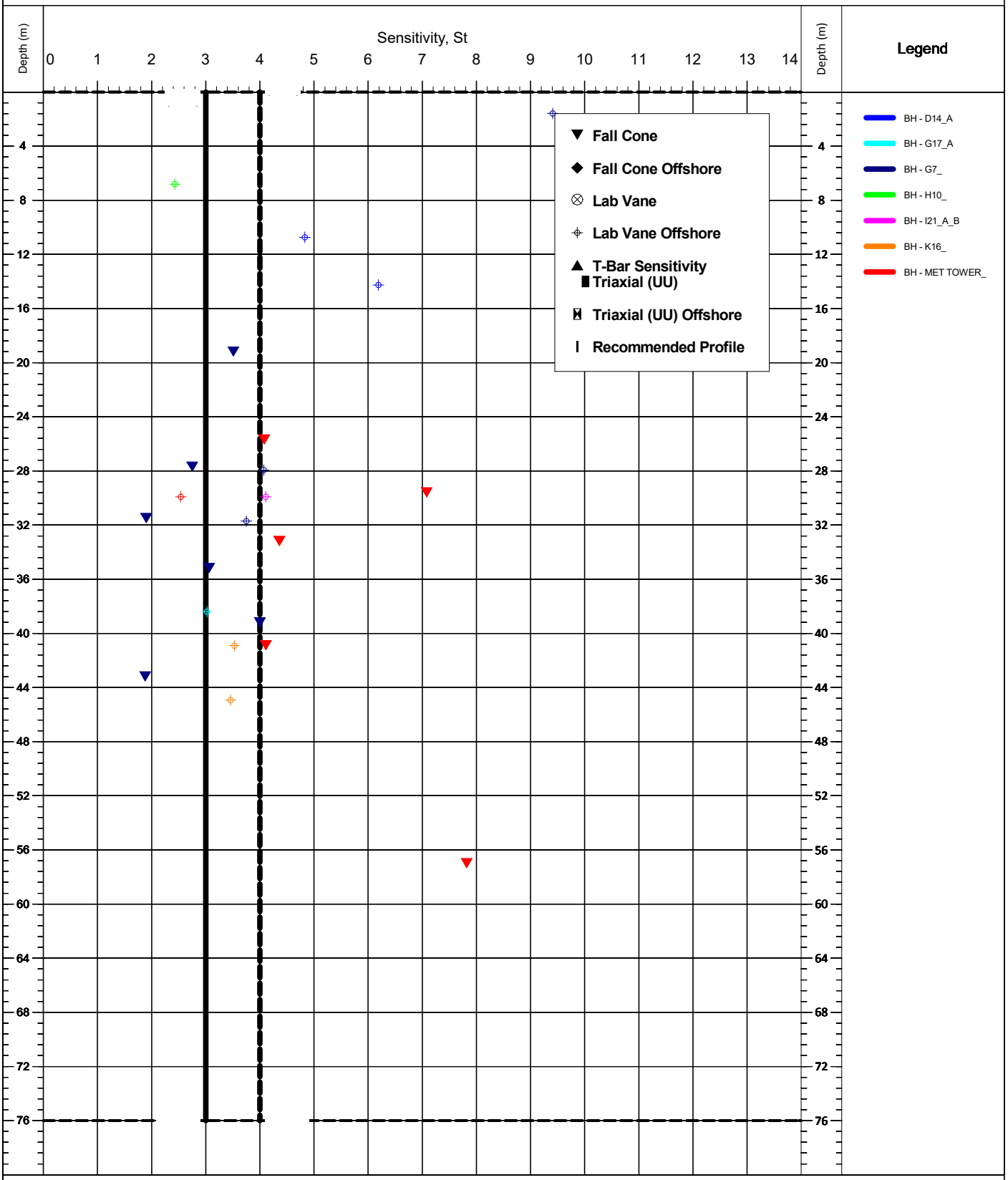
QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

2.4 Sensitivity

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
SENSITIVITY PROFILE



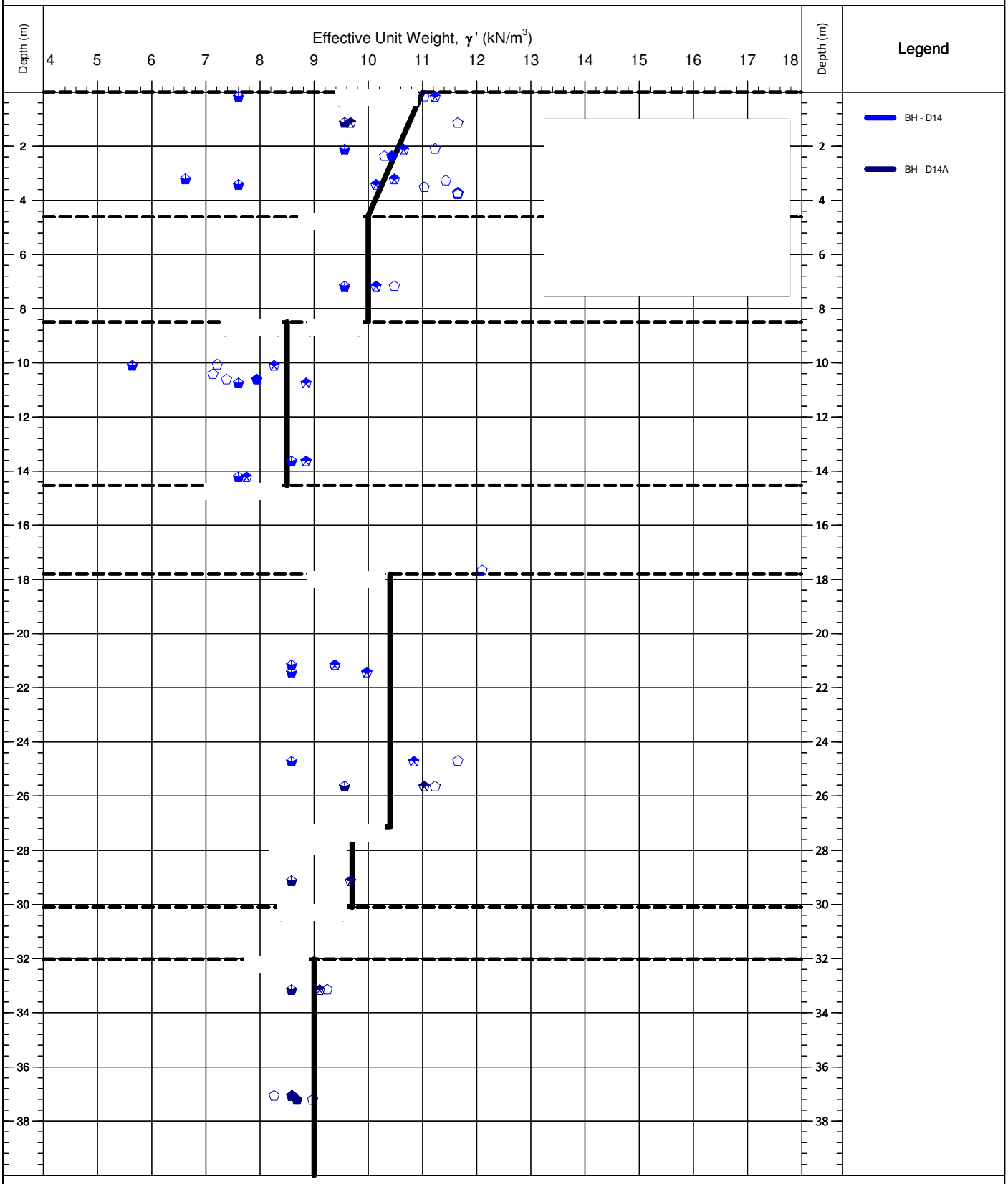
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

2.5 Effective Unit Weight

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE

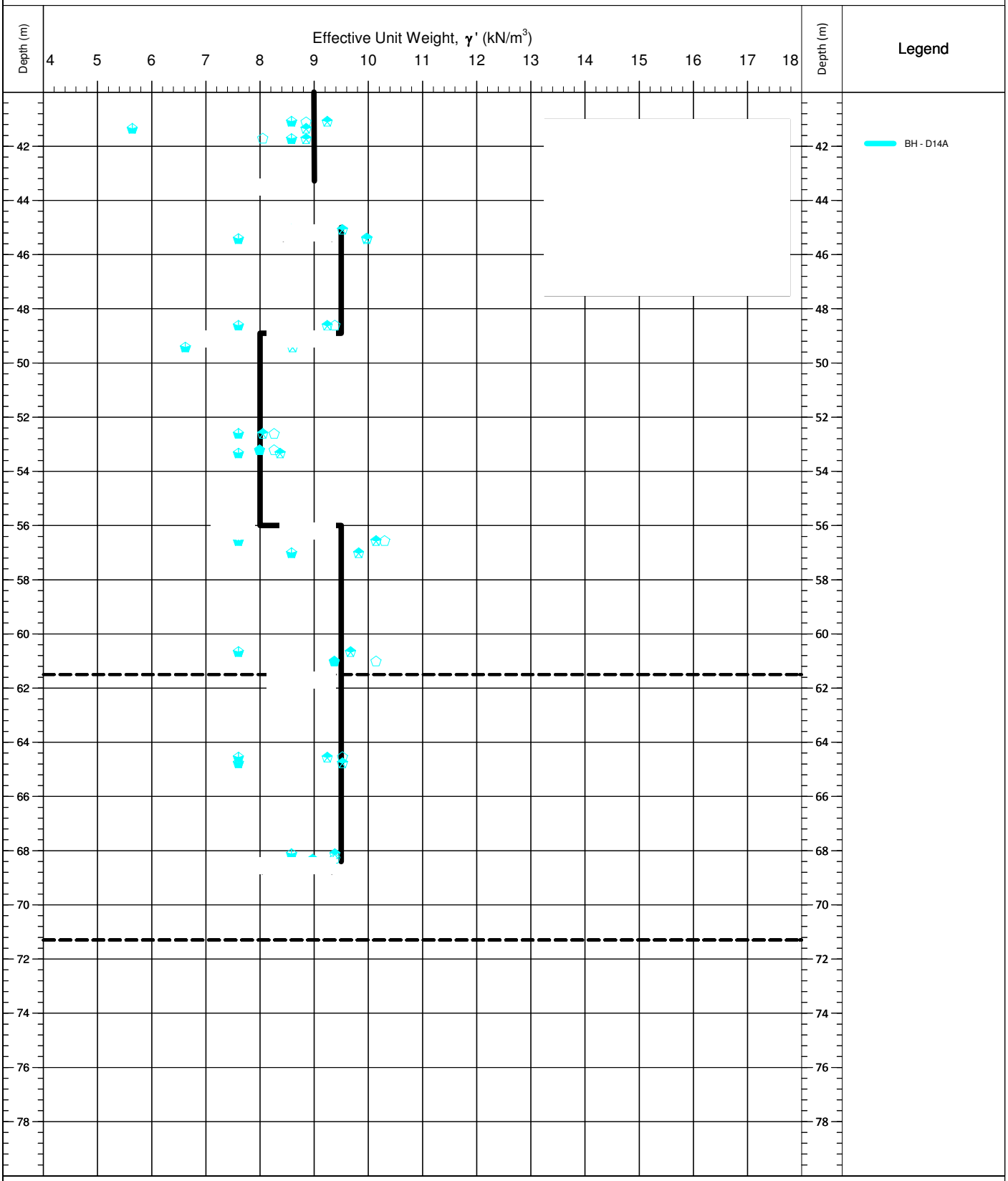


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



Area	**Maryland USA**
Contract	**10451**
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Comments:

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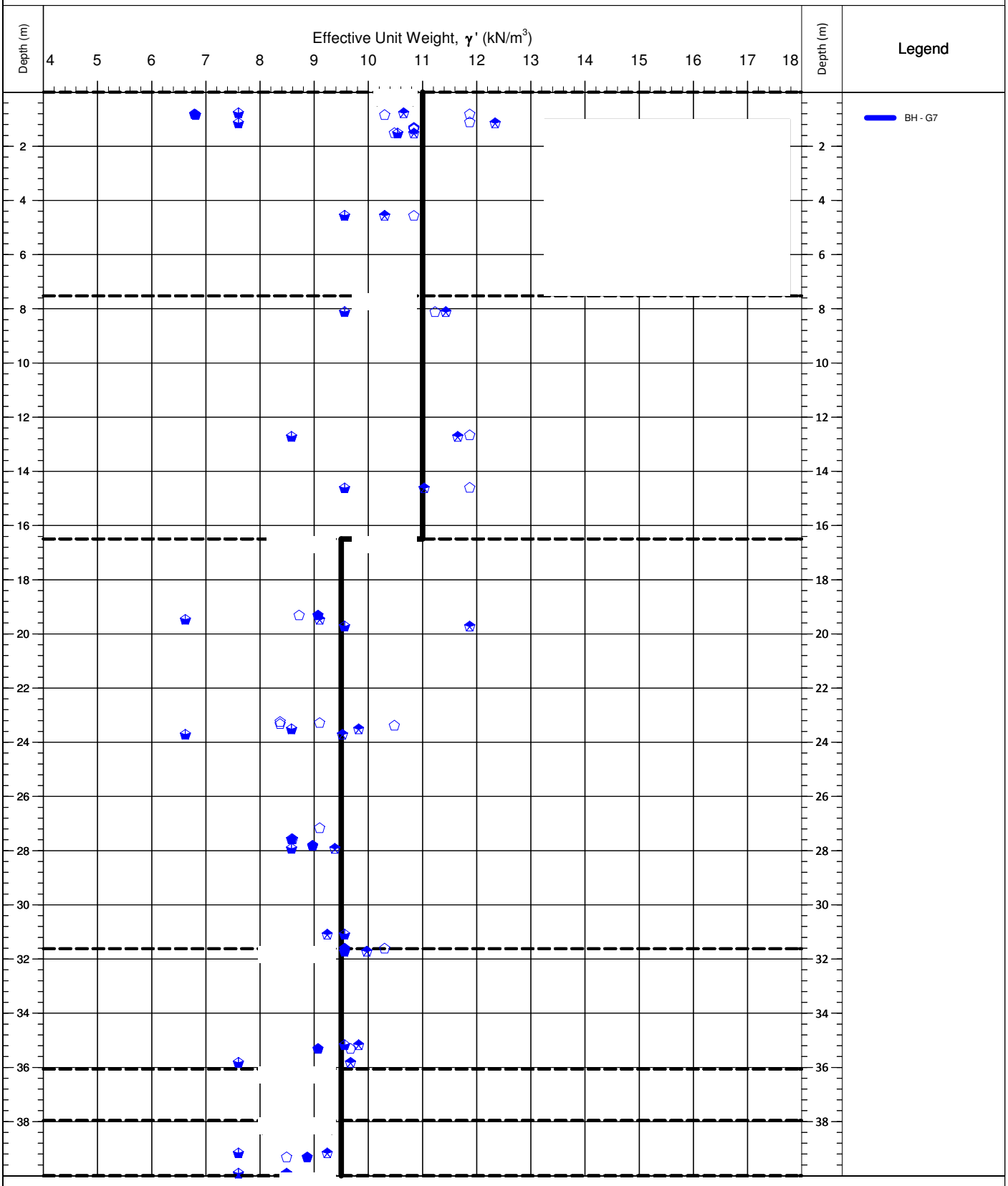
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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Comments:

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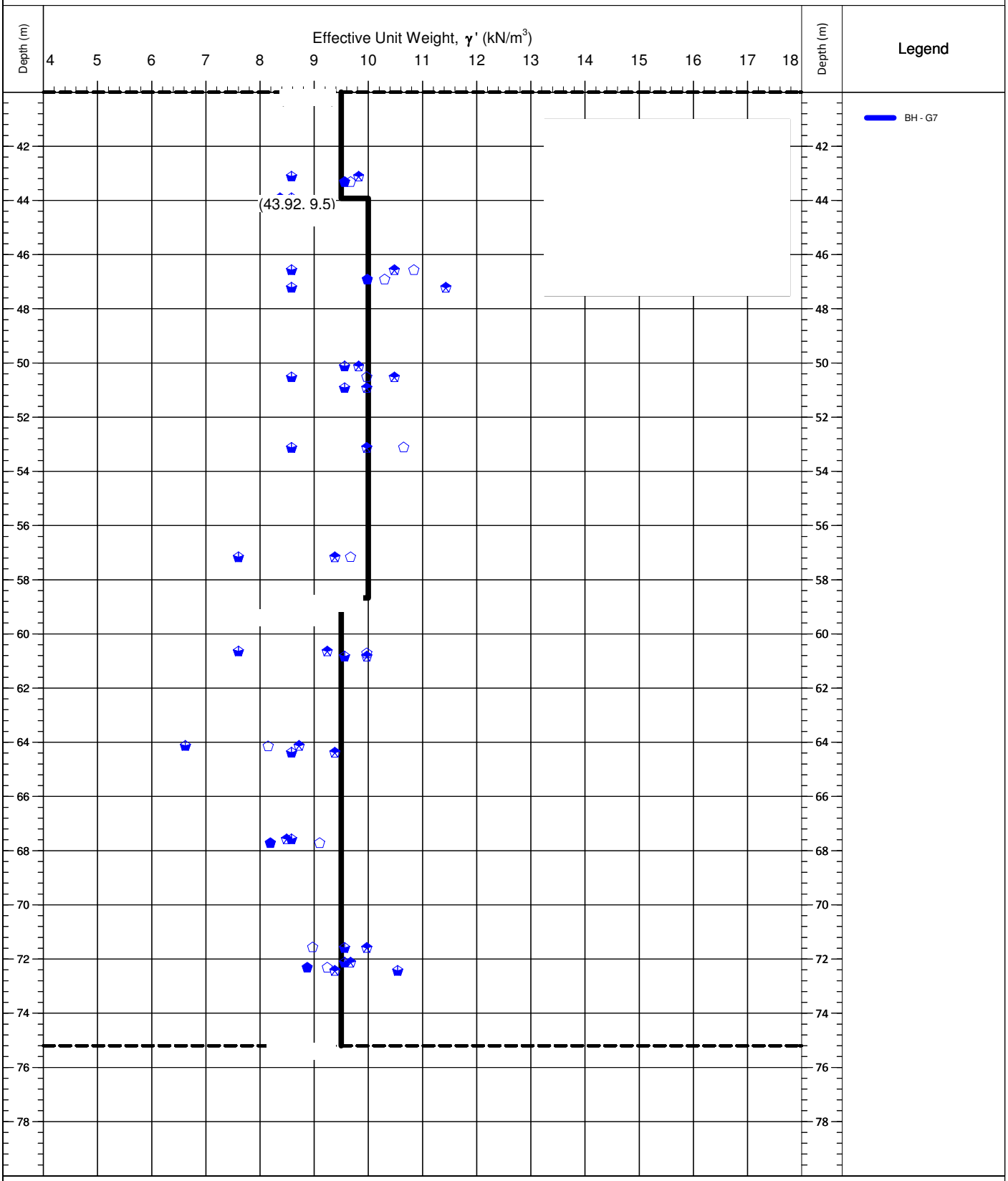
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



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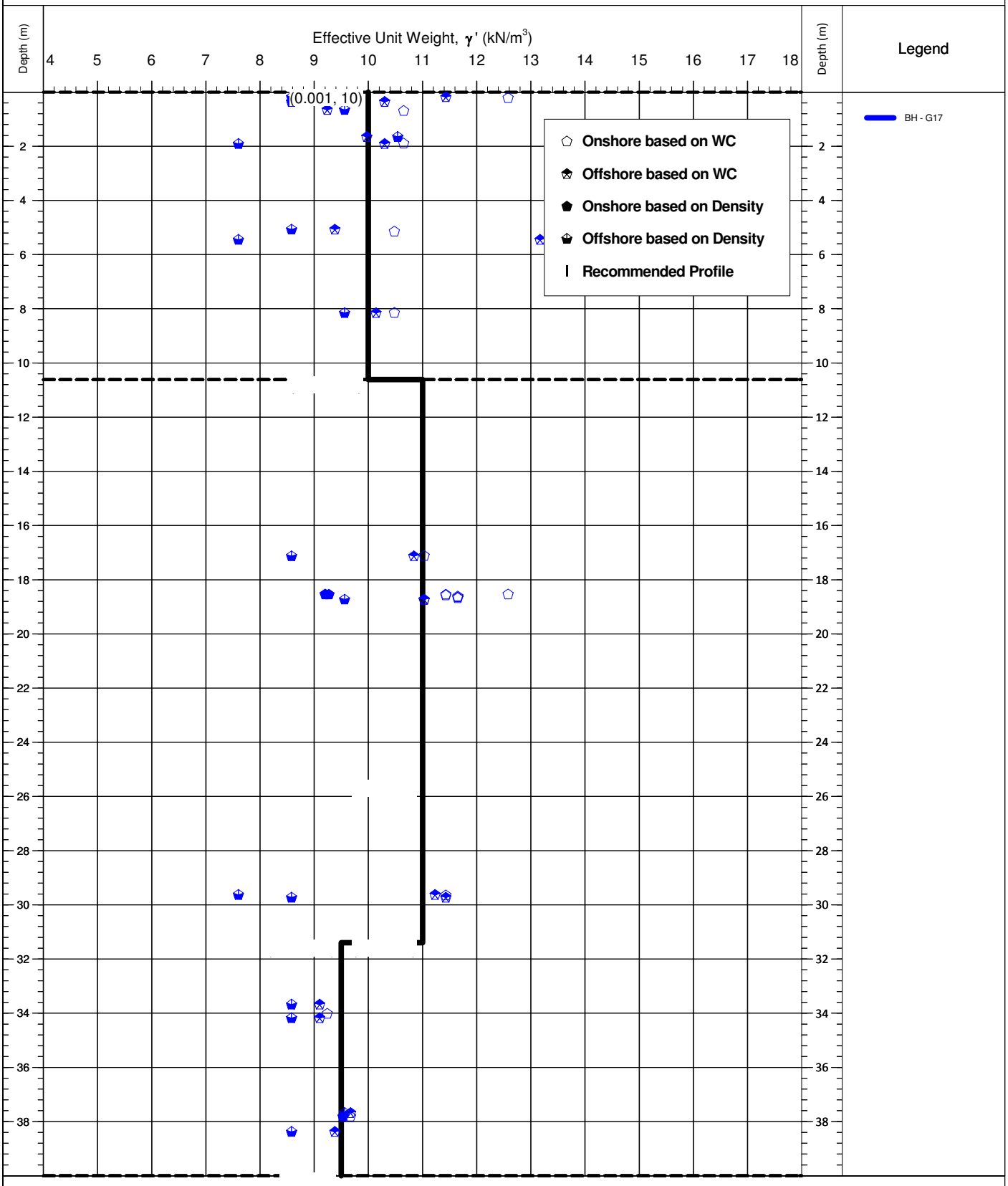
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



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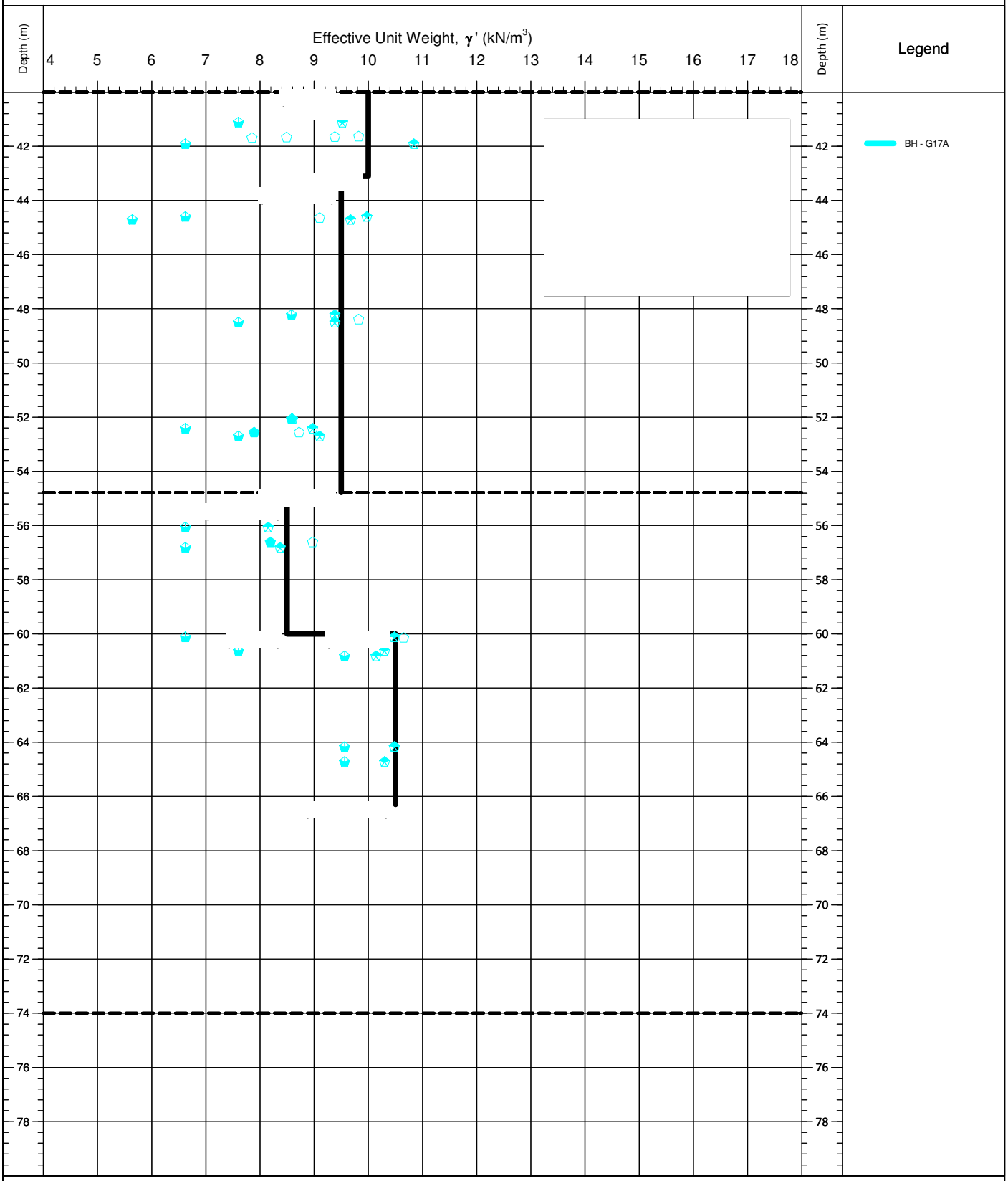
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



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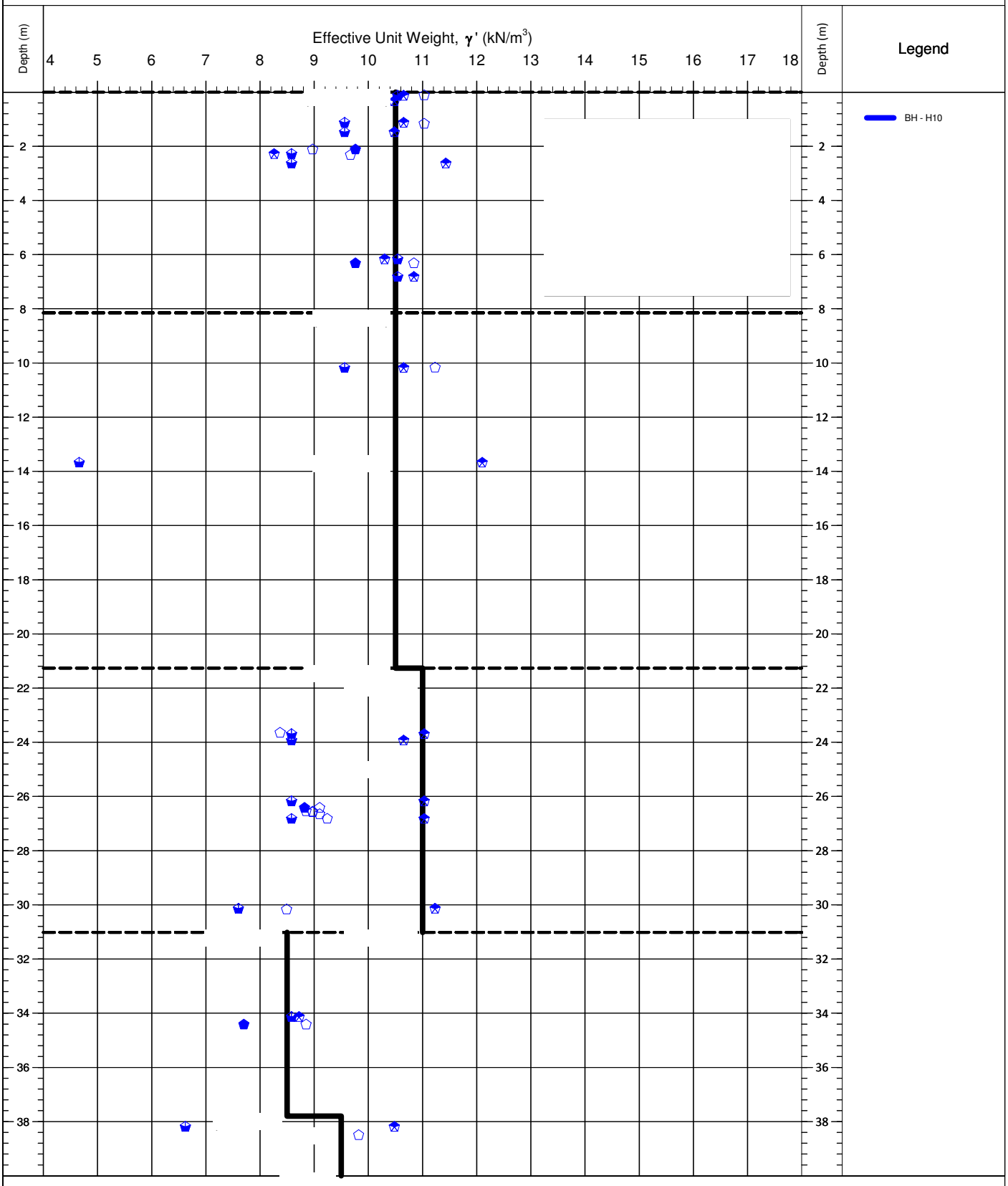
Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



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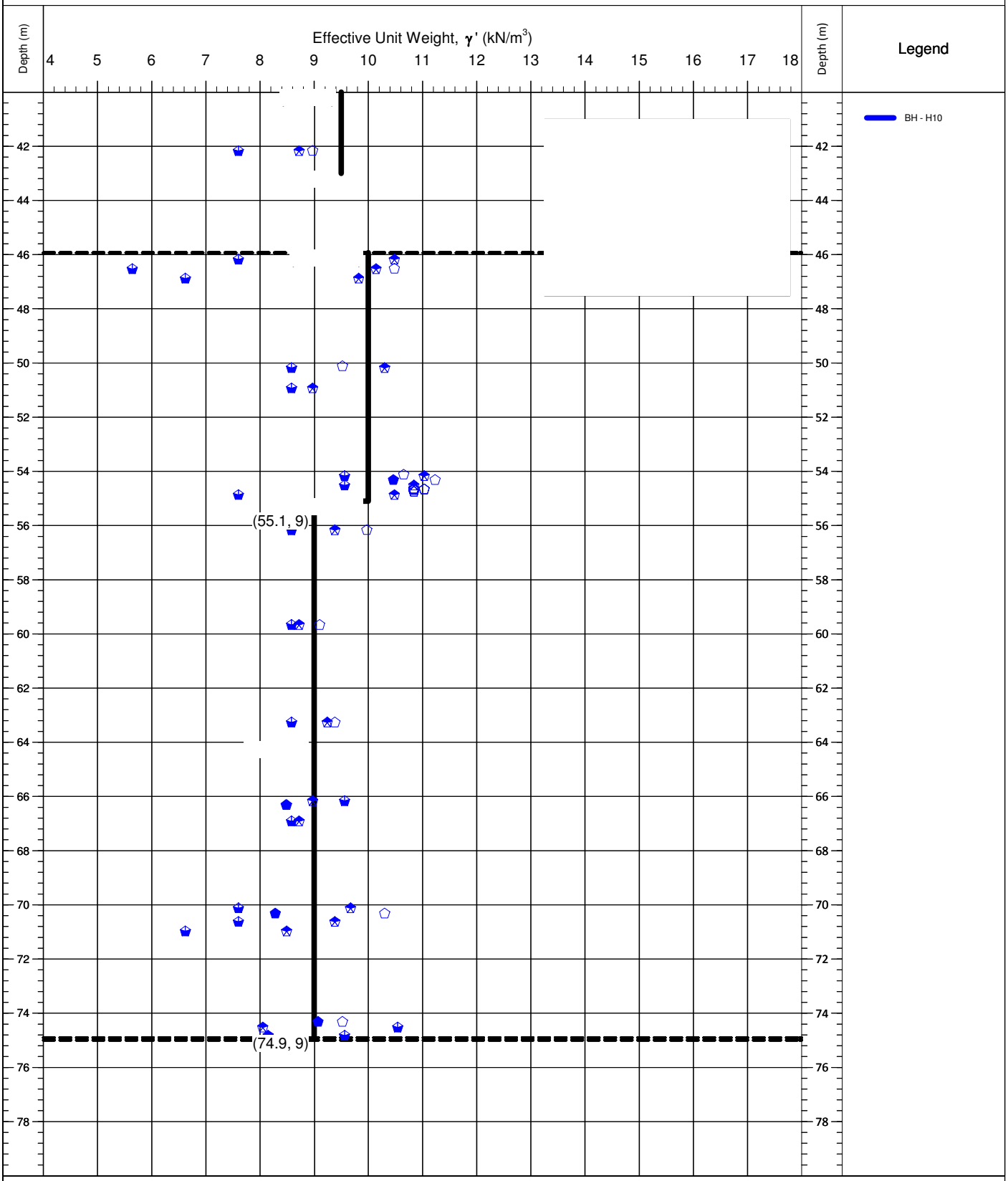
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



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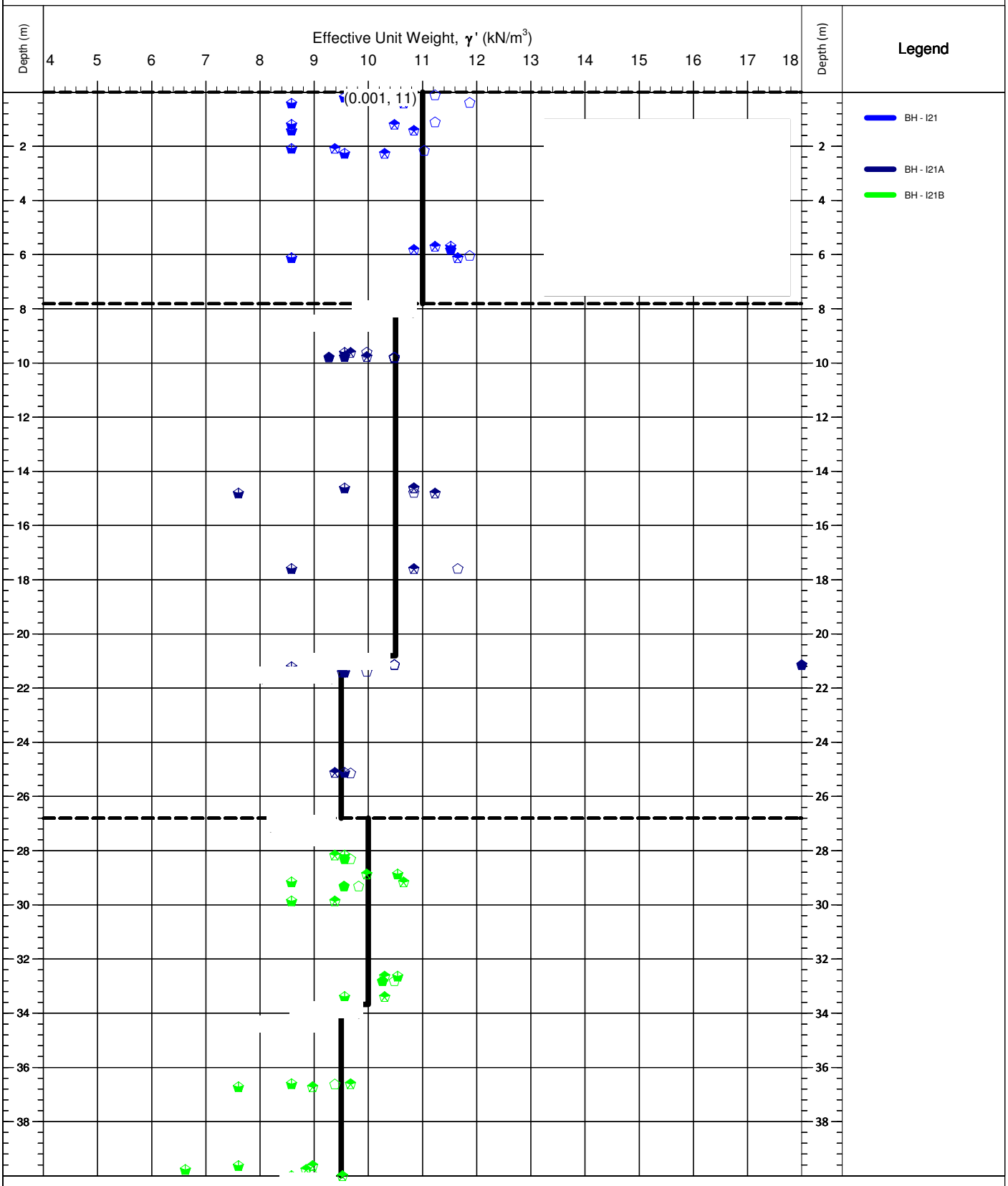
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



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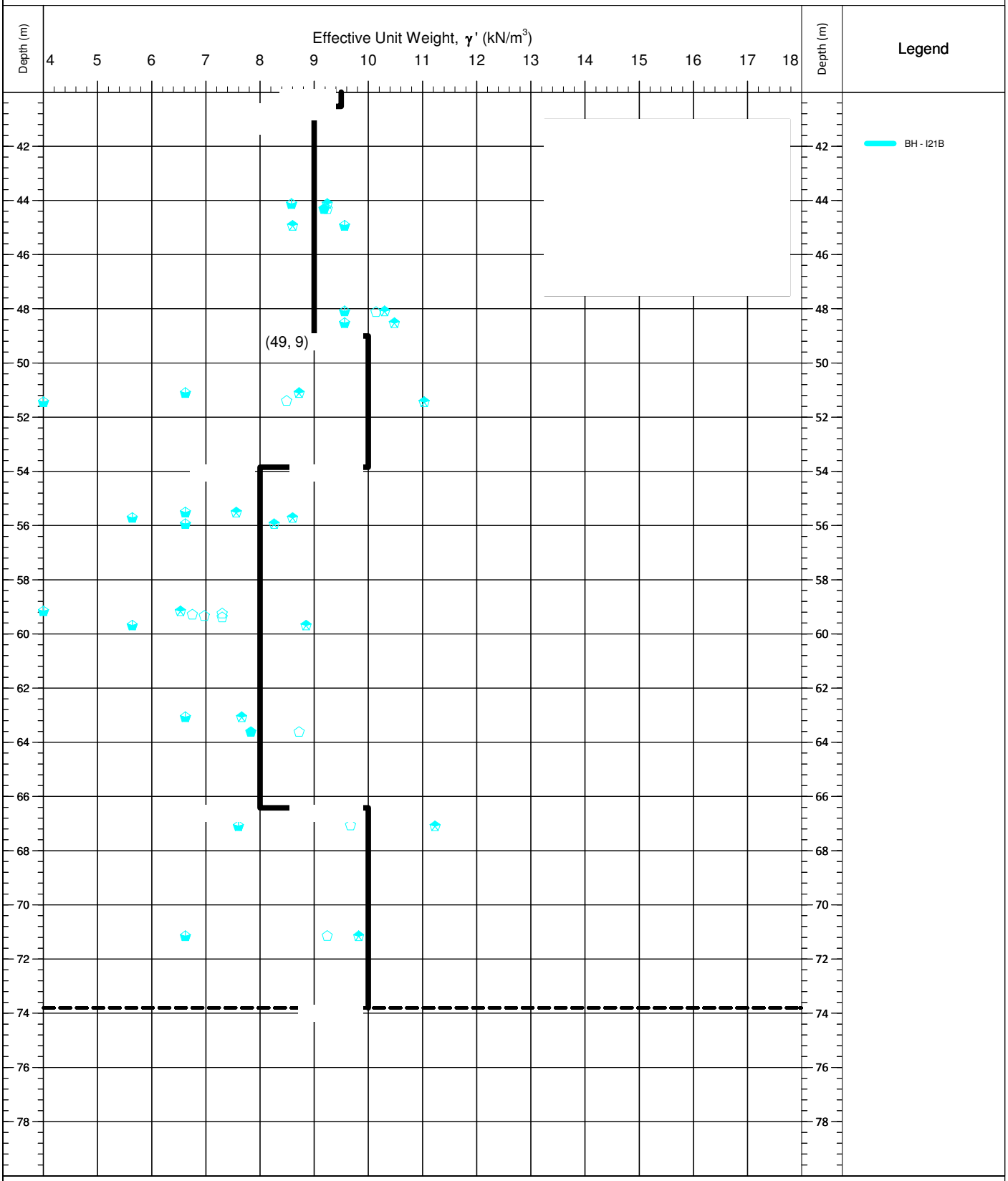
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



Area	**Maryland USA**
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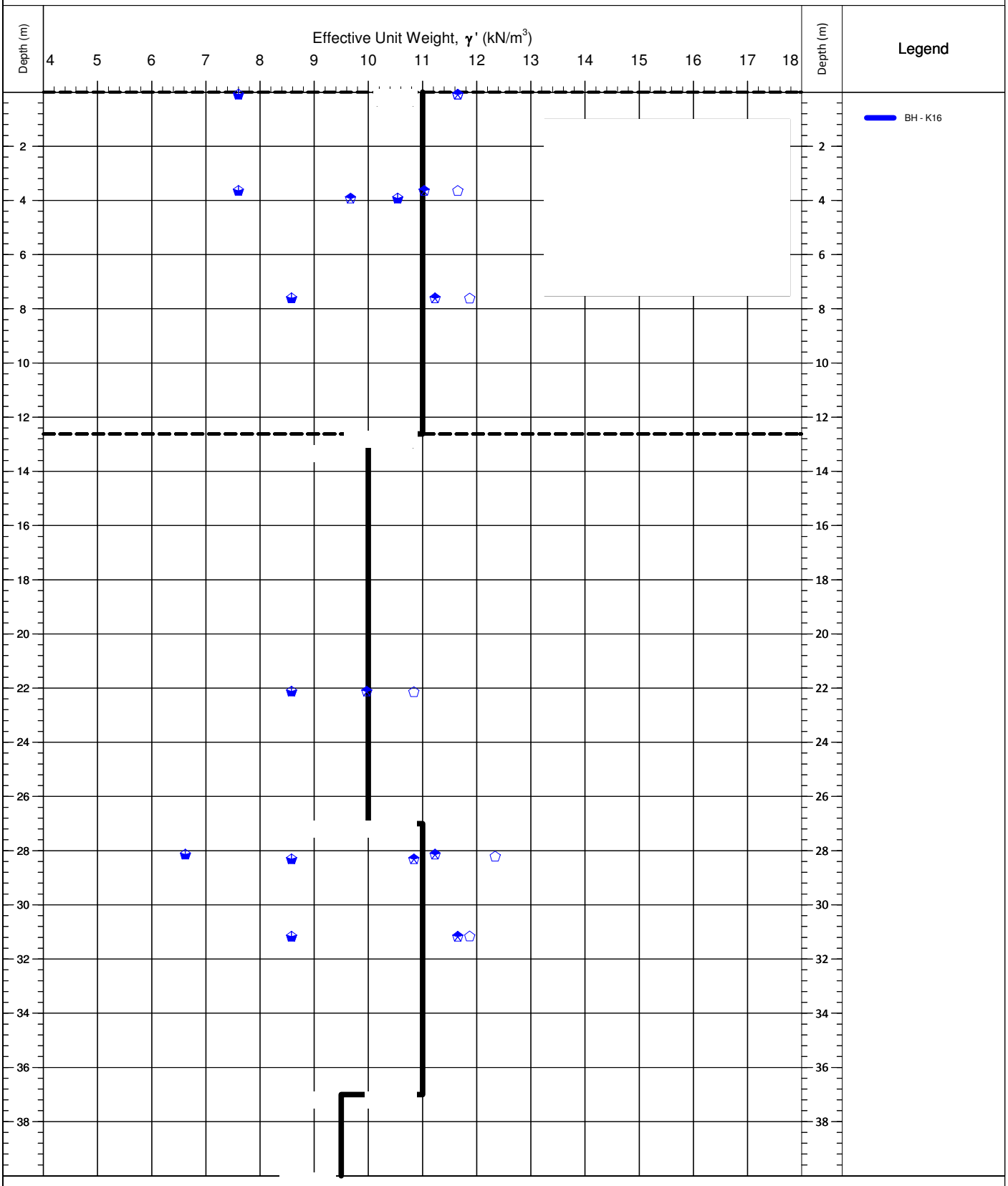

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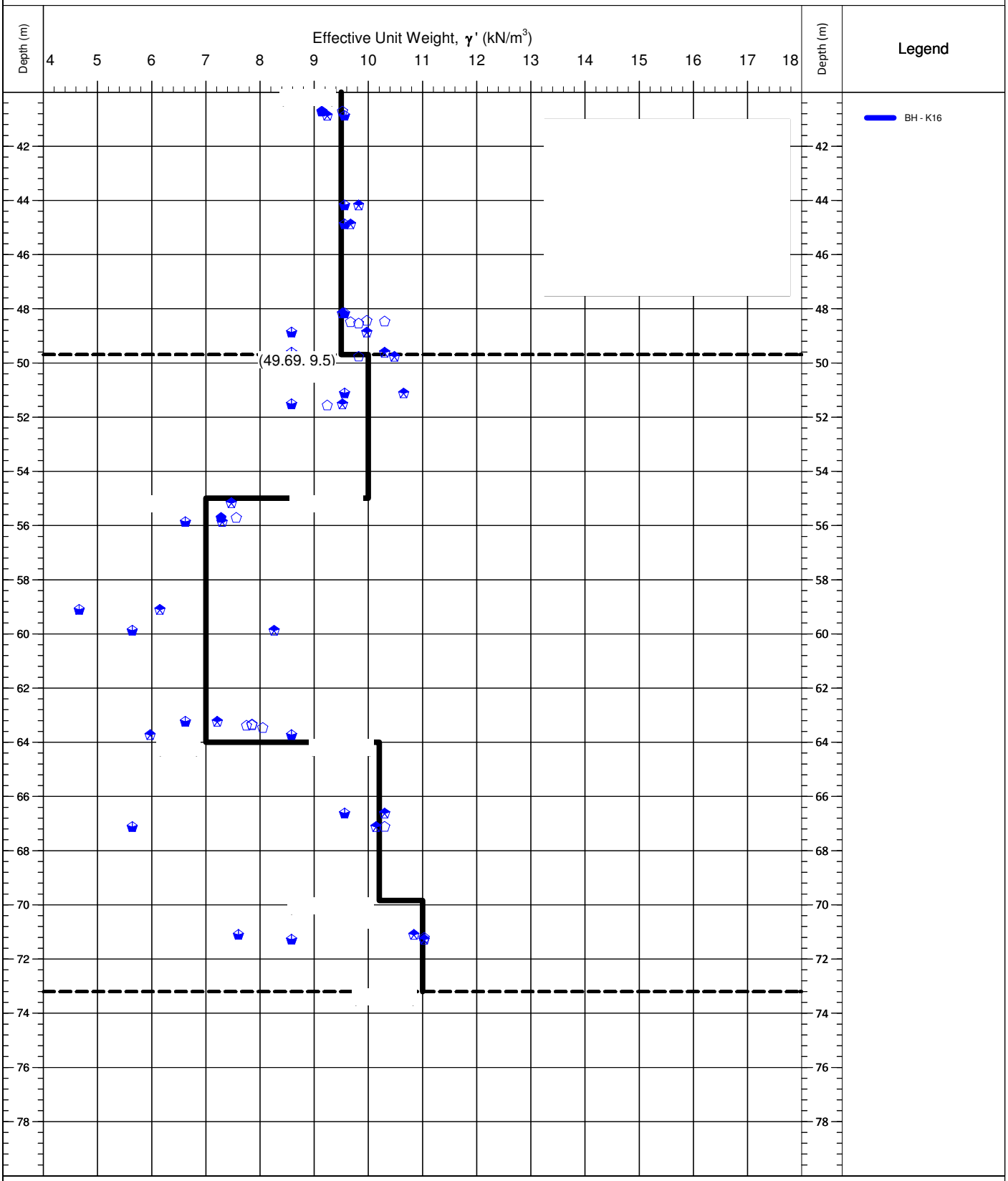
UNIT WEIGHT PROFILE



Area	**Maryland USA**
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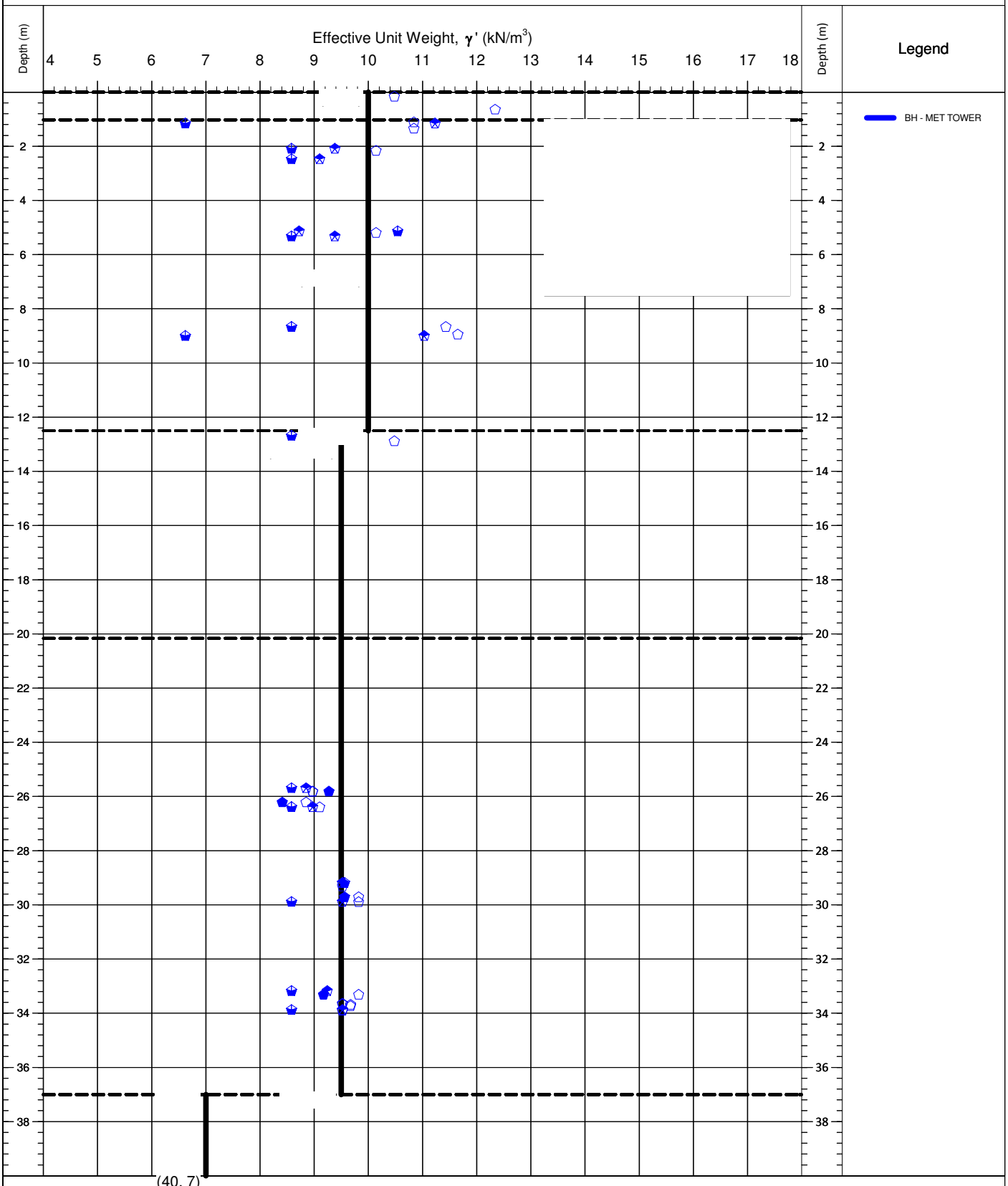

Area	**Maryland USA**
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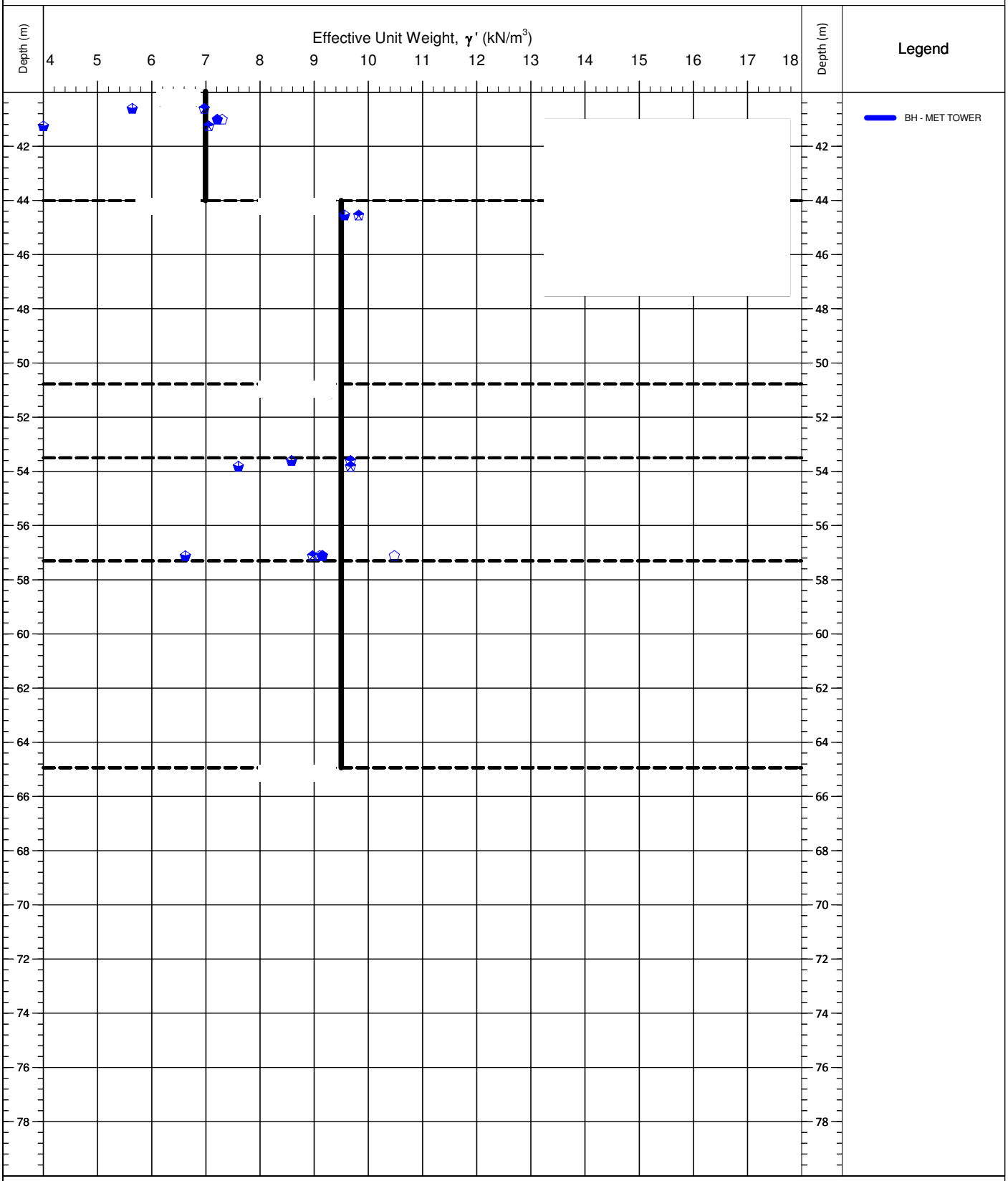
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT PROFILE



Area	**Maryland USA**
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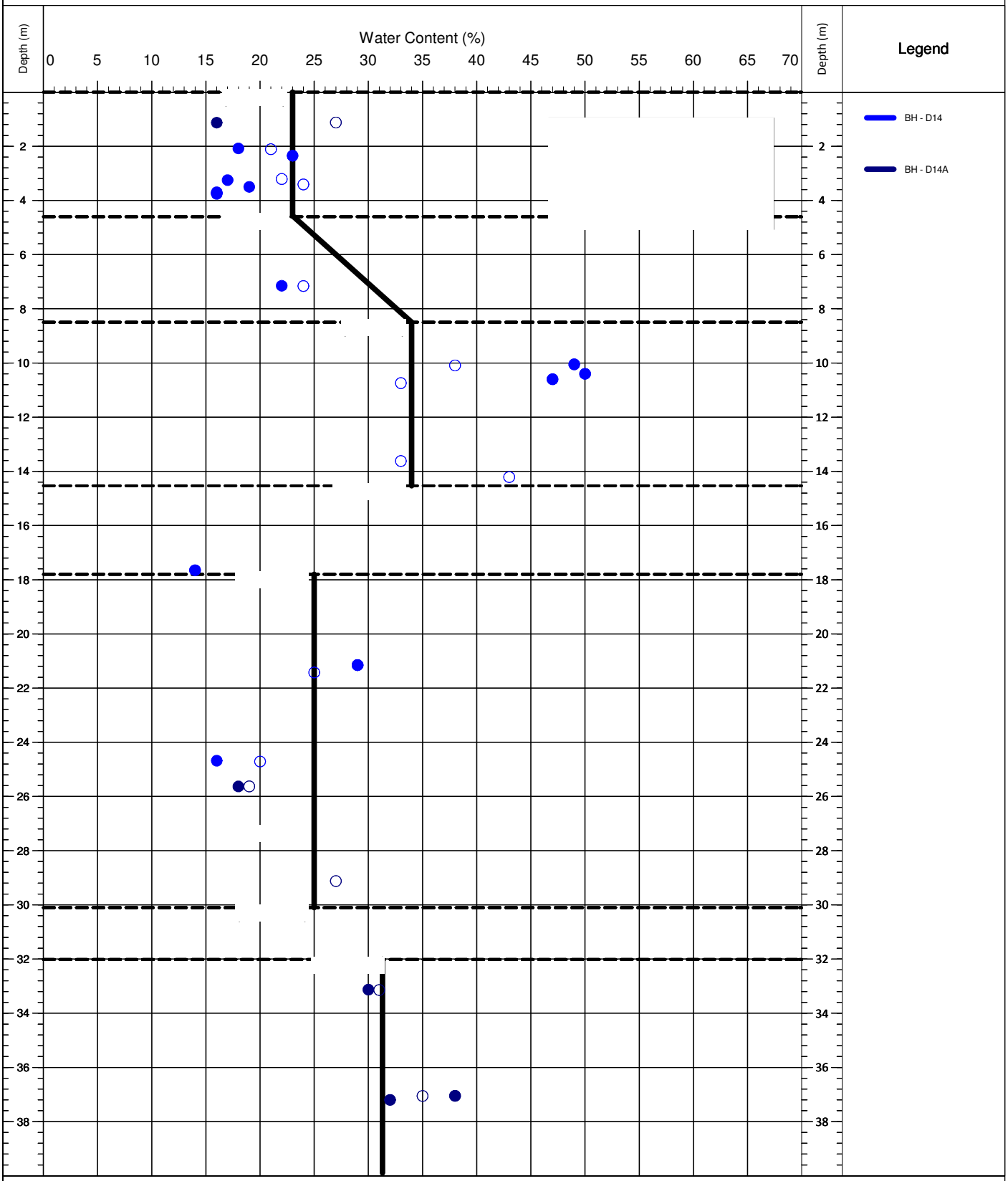
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

2.6 Moisture Content

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



Area	**Maryland USA**
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Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

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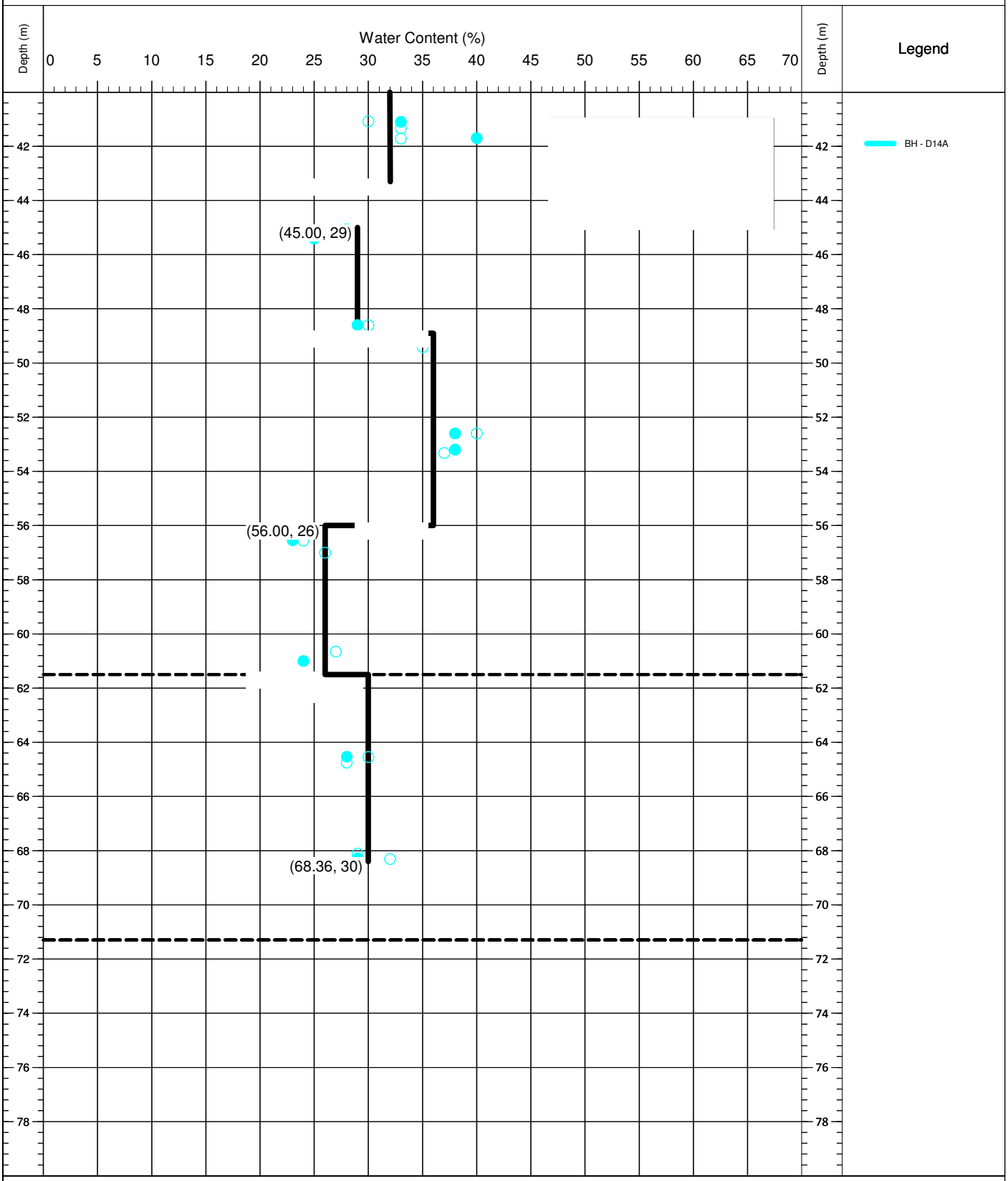
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



Area	**Maryland USA**
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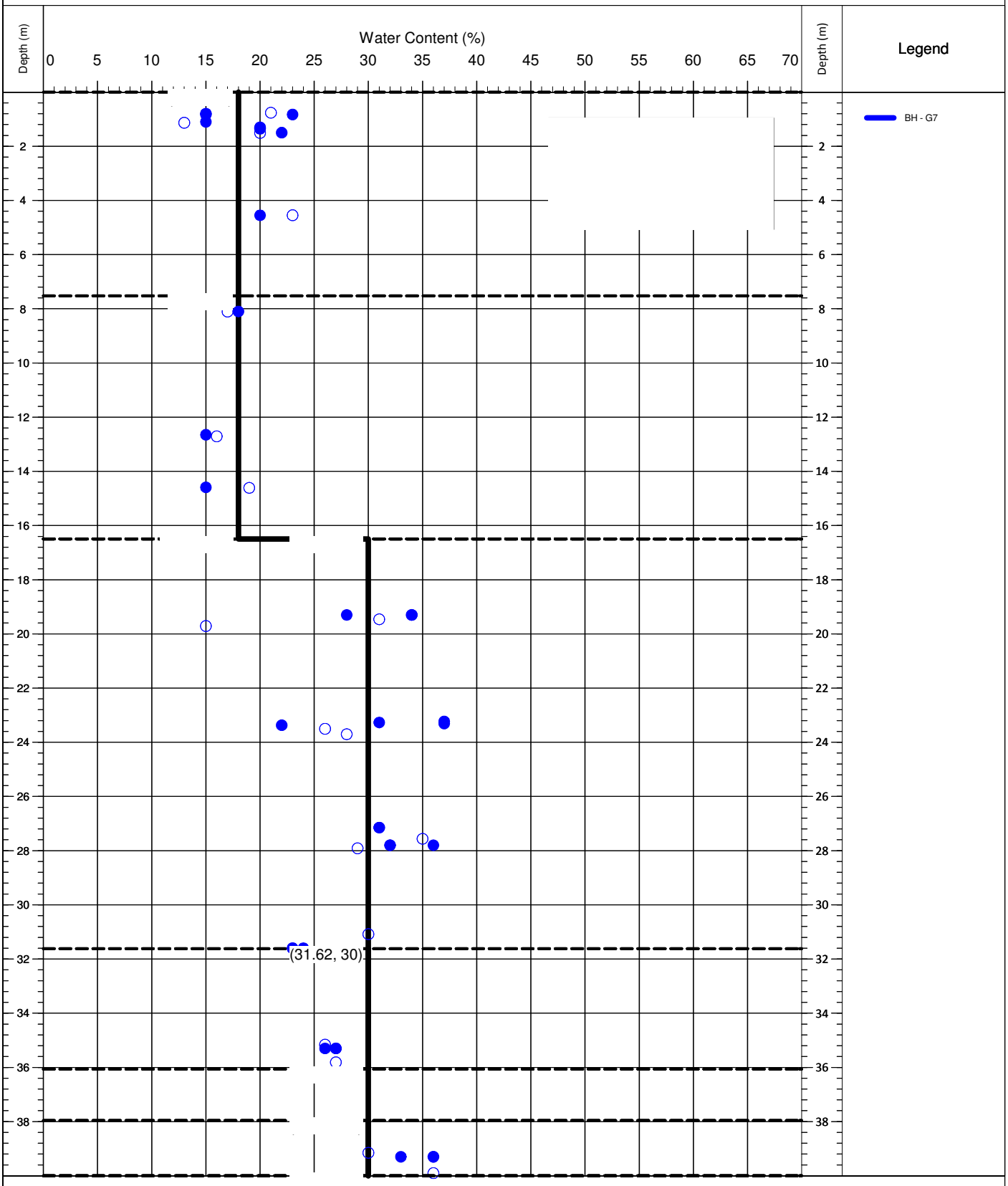
Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE

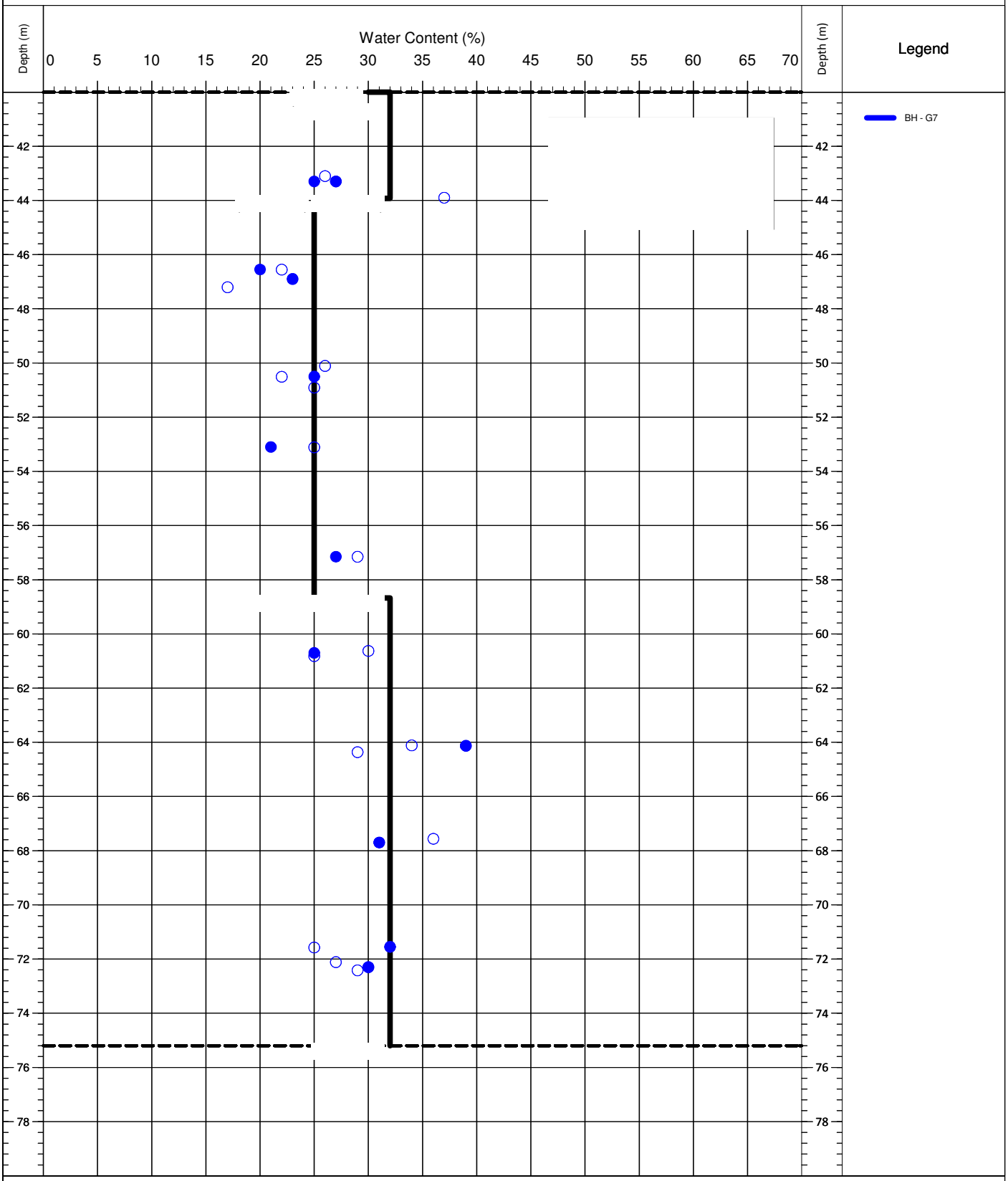


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
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Comments:

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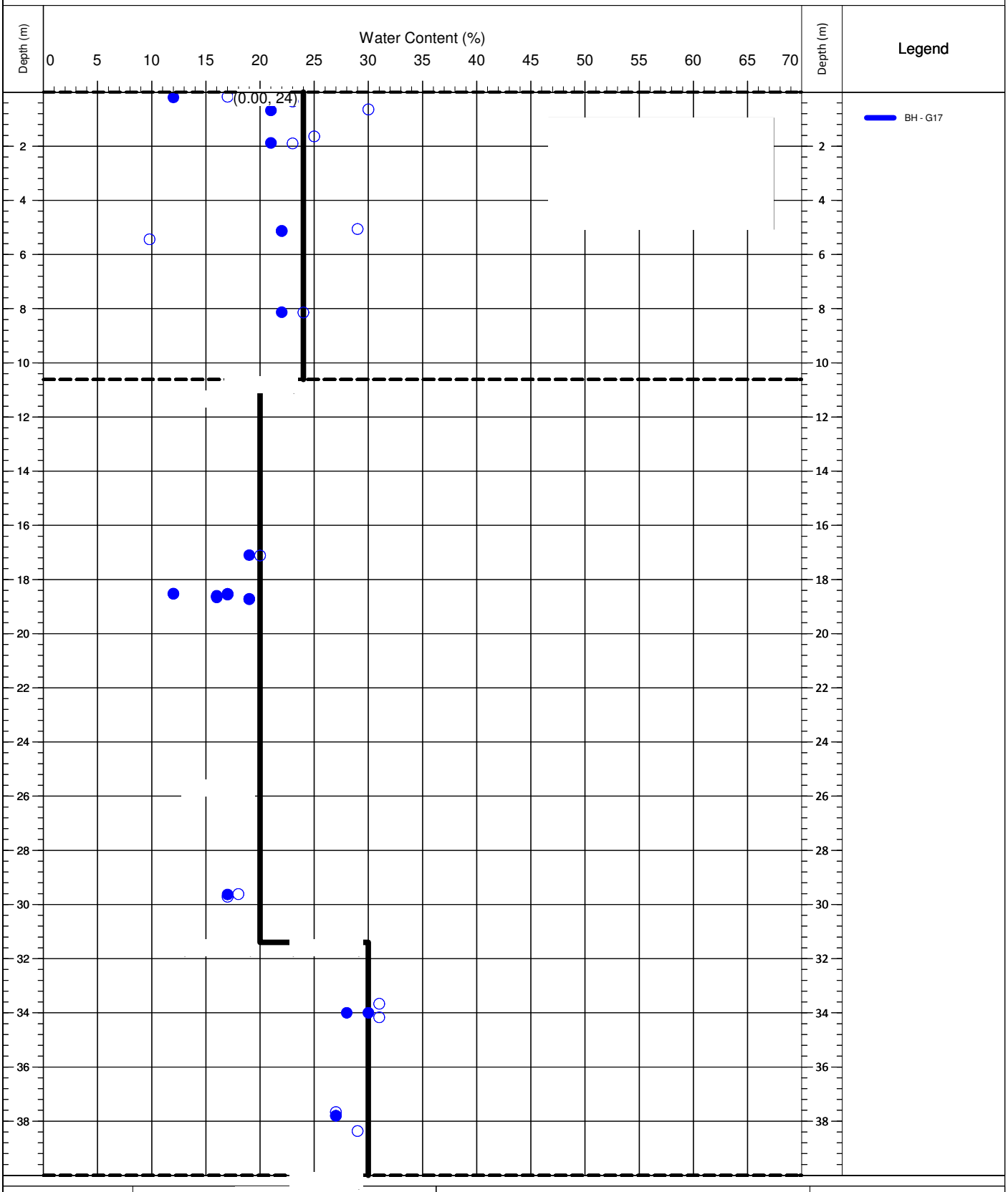
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE

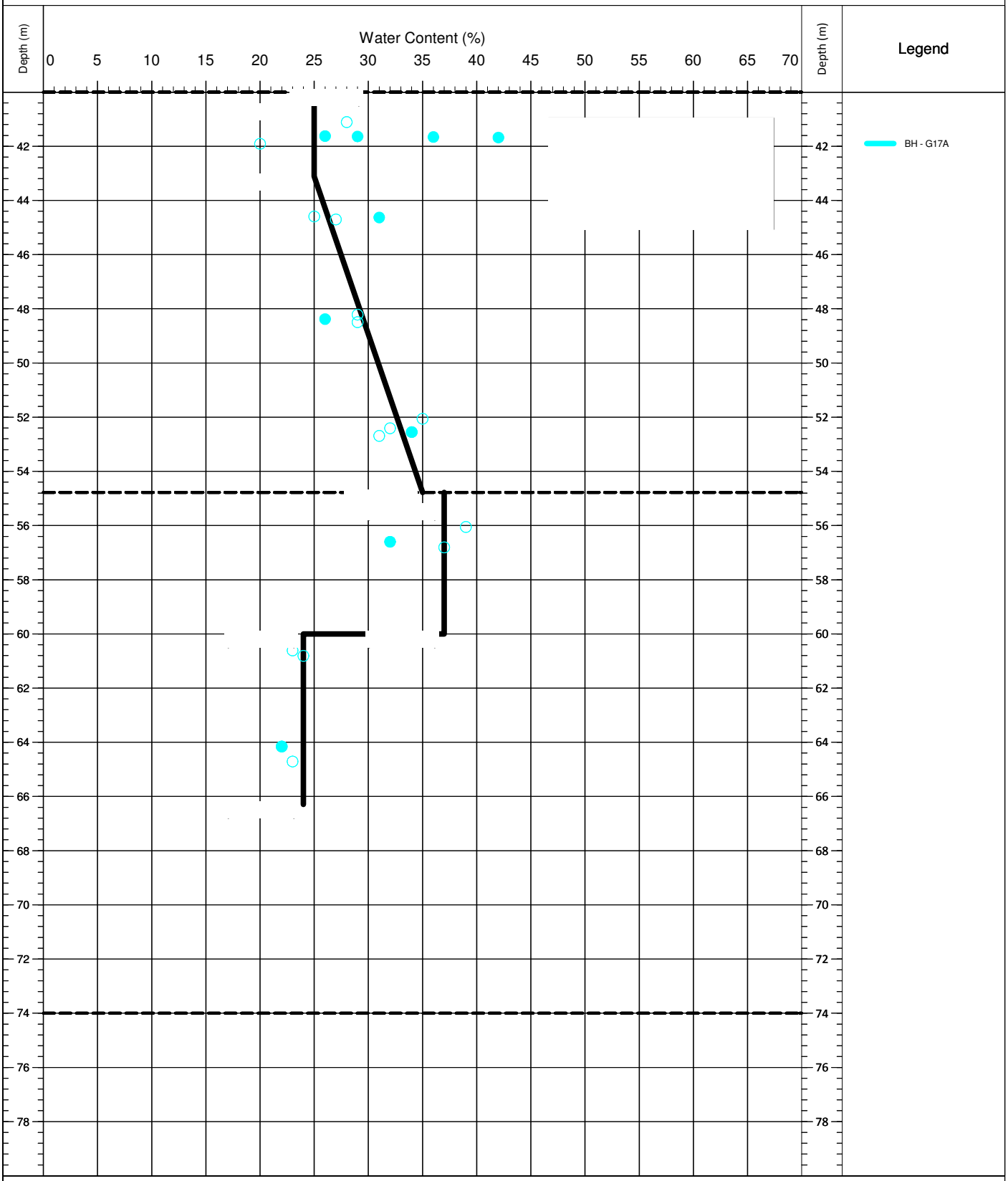


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

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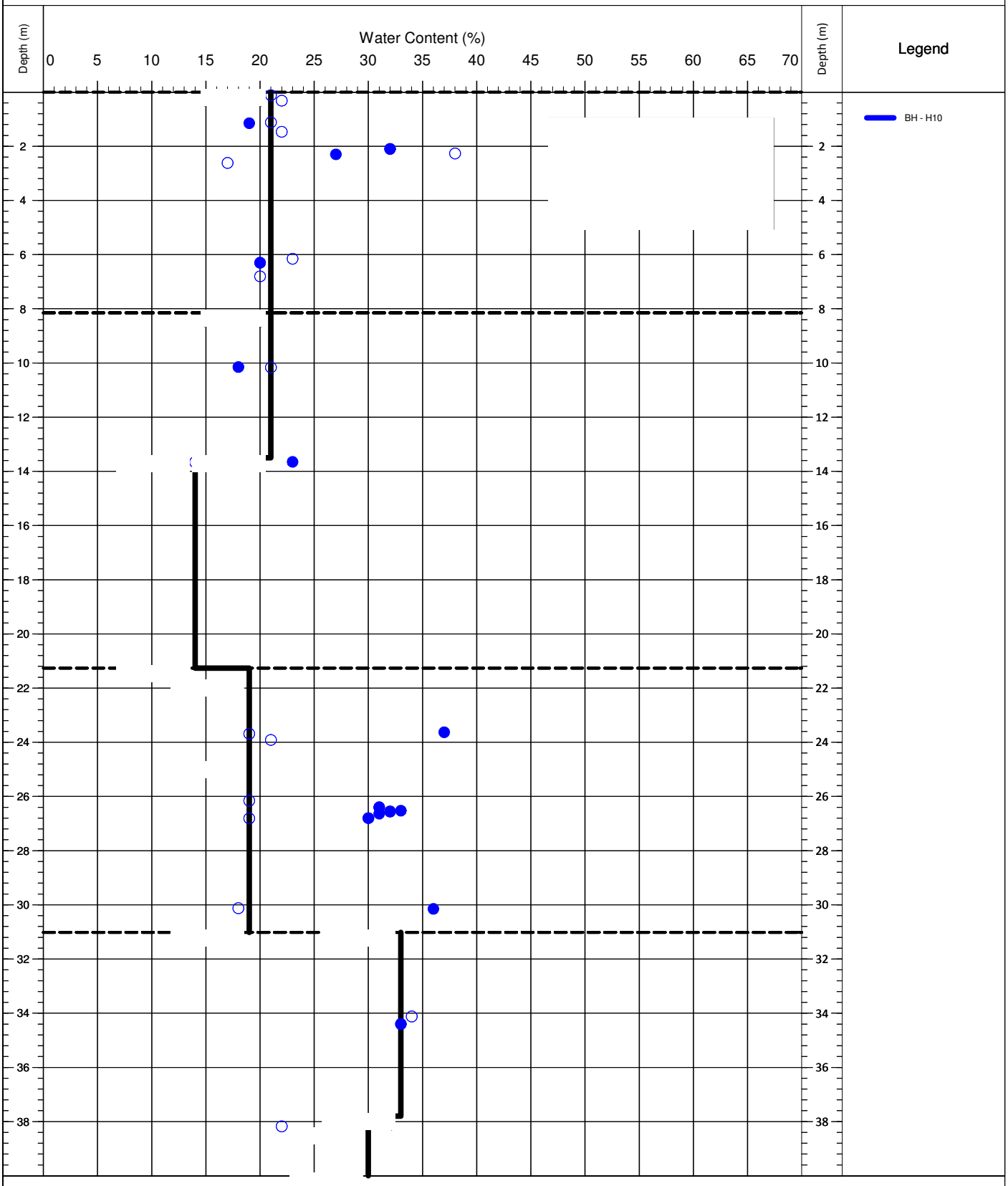
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



Area	**Maryland USA**
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SMc 28/09/2015	**JG** 17/02/2016	

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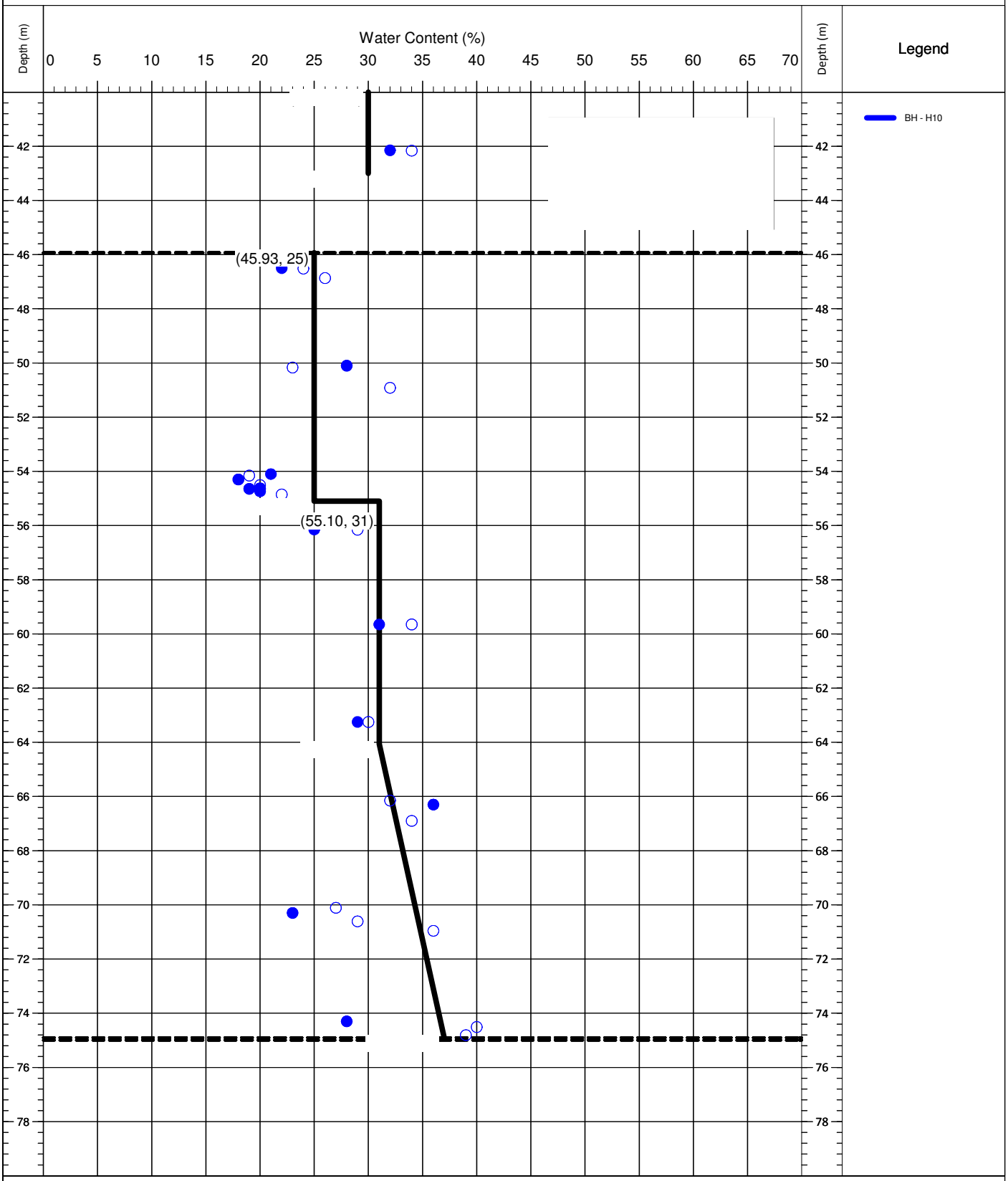
WATER CONTENT PROFILE



Area	**Maryland USA**
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Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

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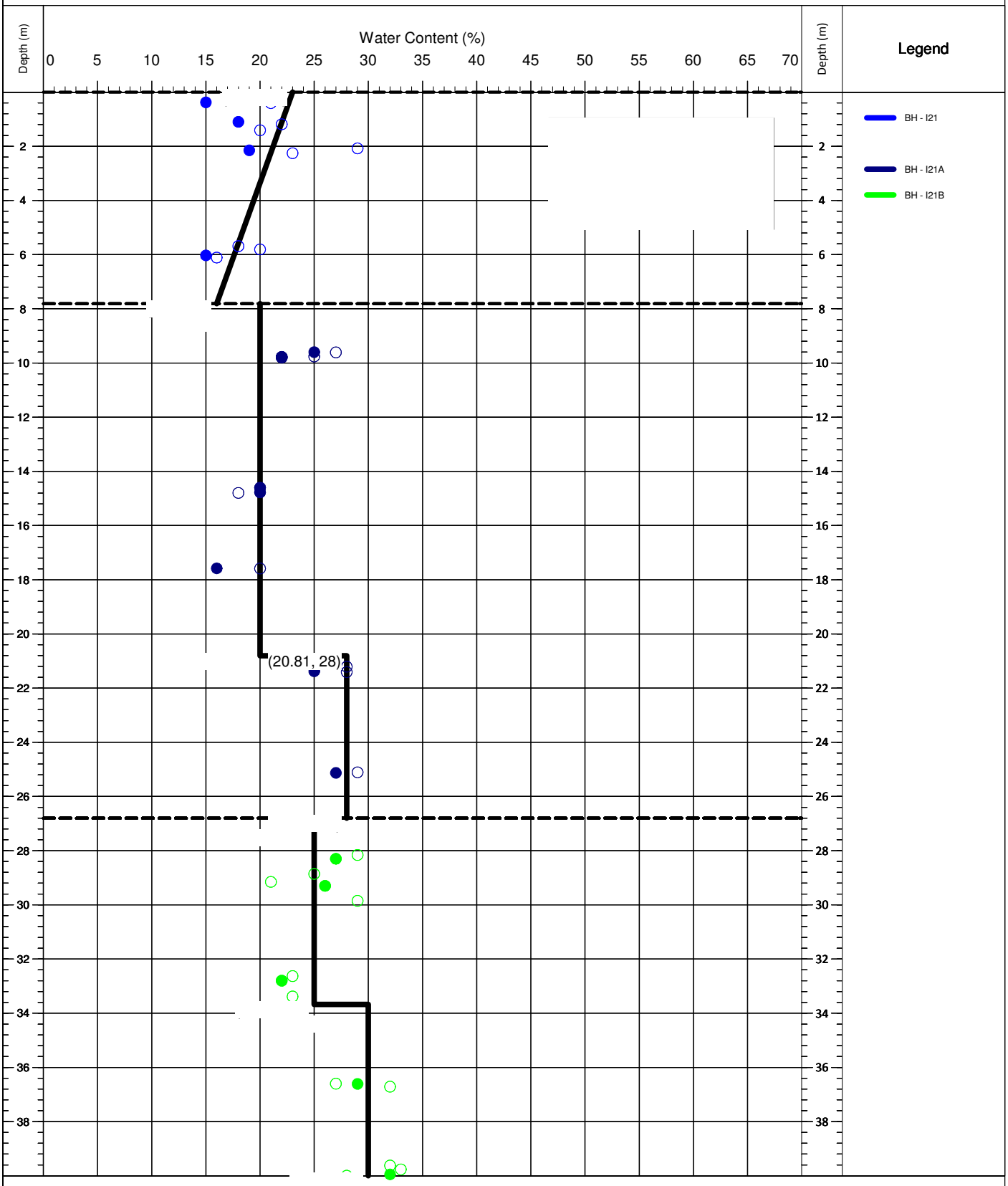
WATER CONTENT PROFILE



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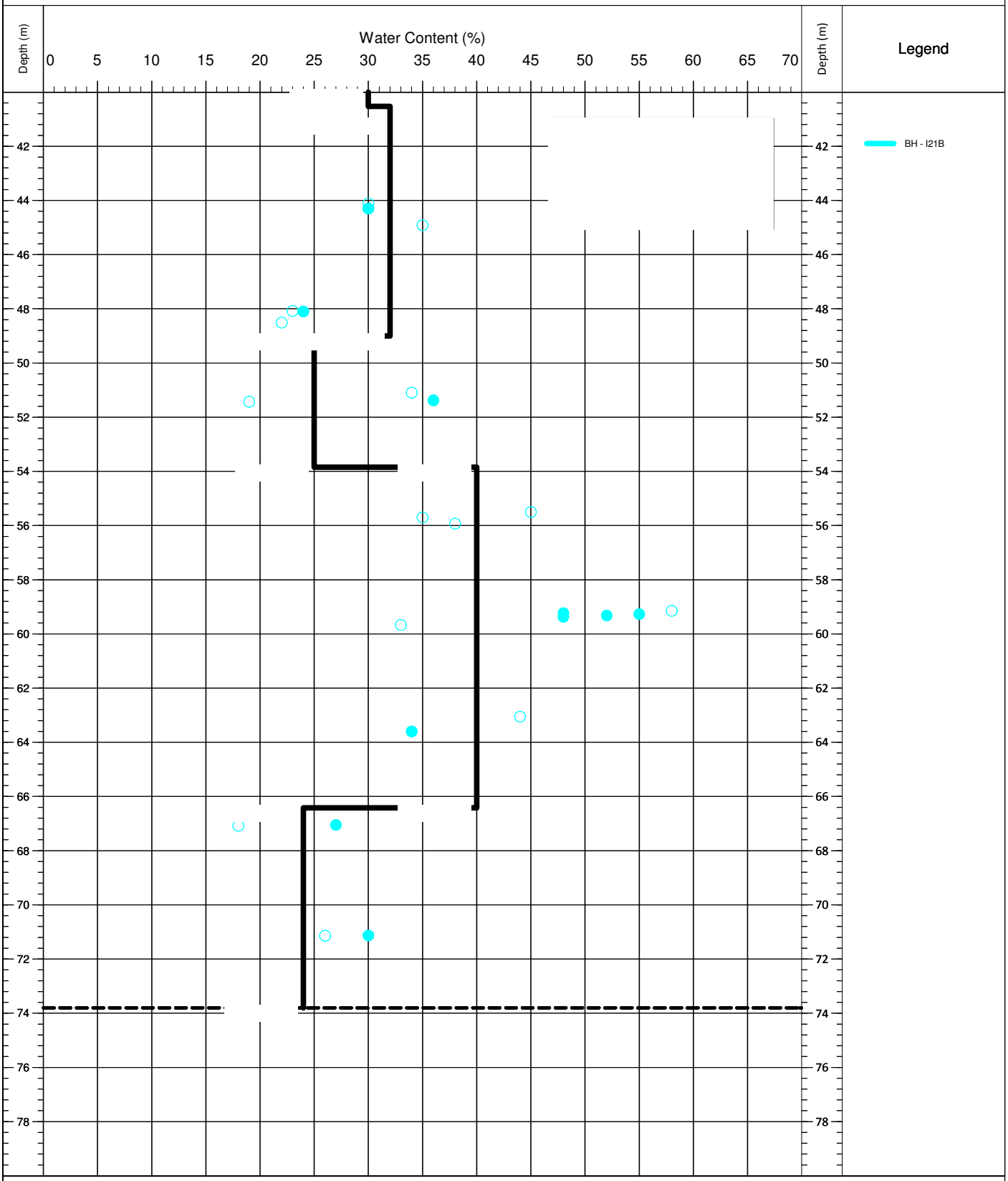
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



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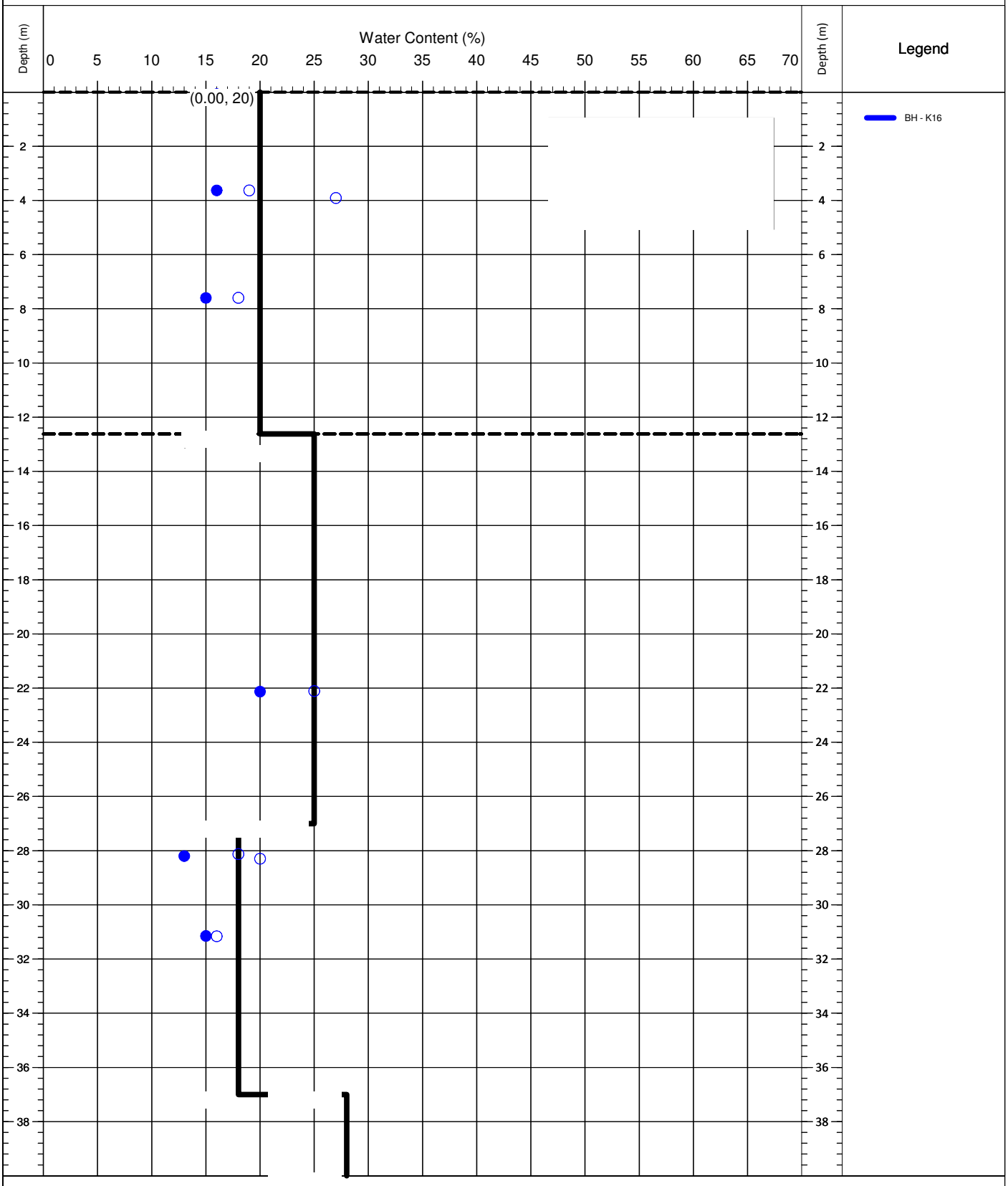
WATER CONTENT PROFILE



Area	**Maryland USA**
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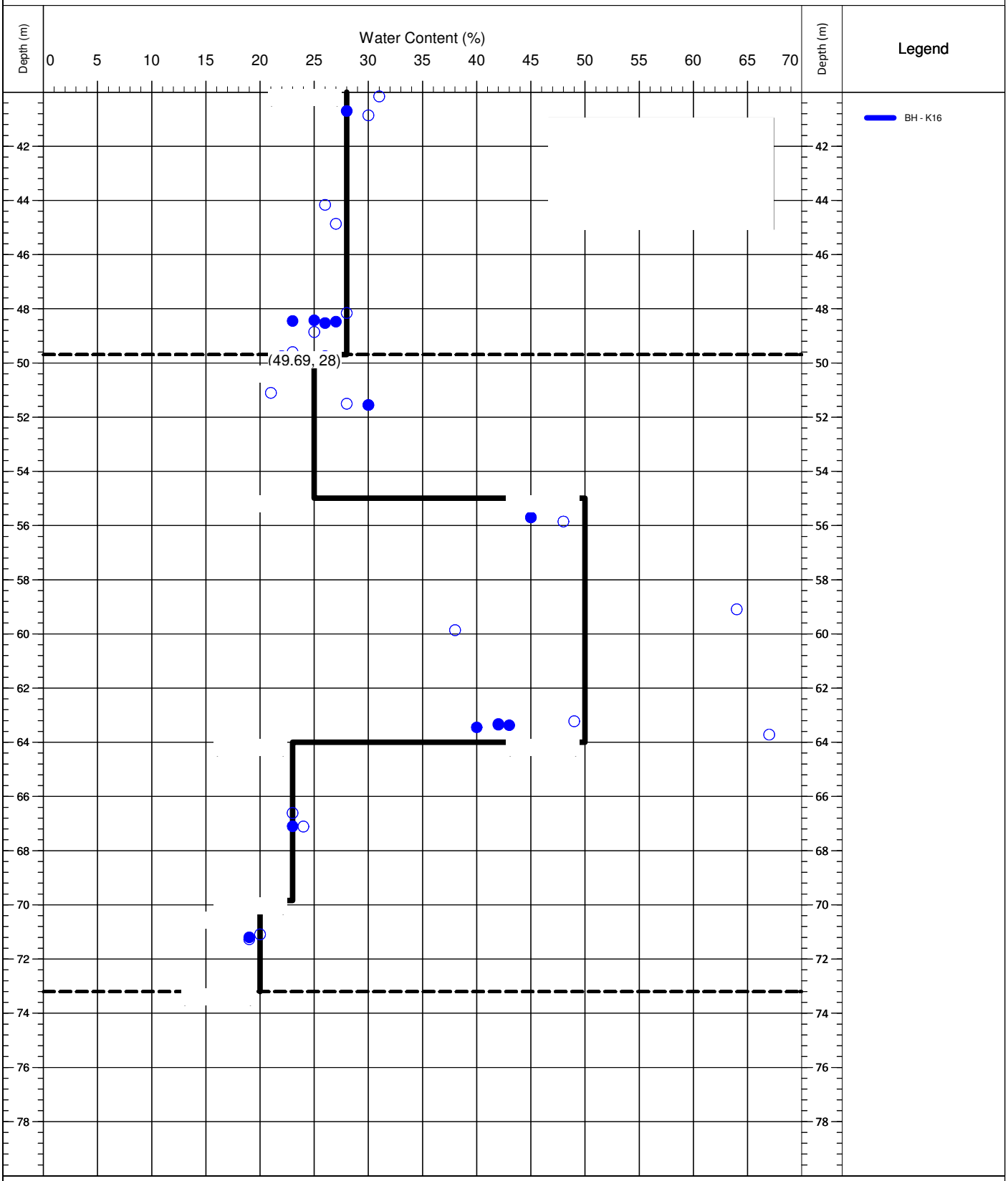
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
WATER CONTENT PROFILE



Area	**Maryland USA**
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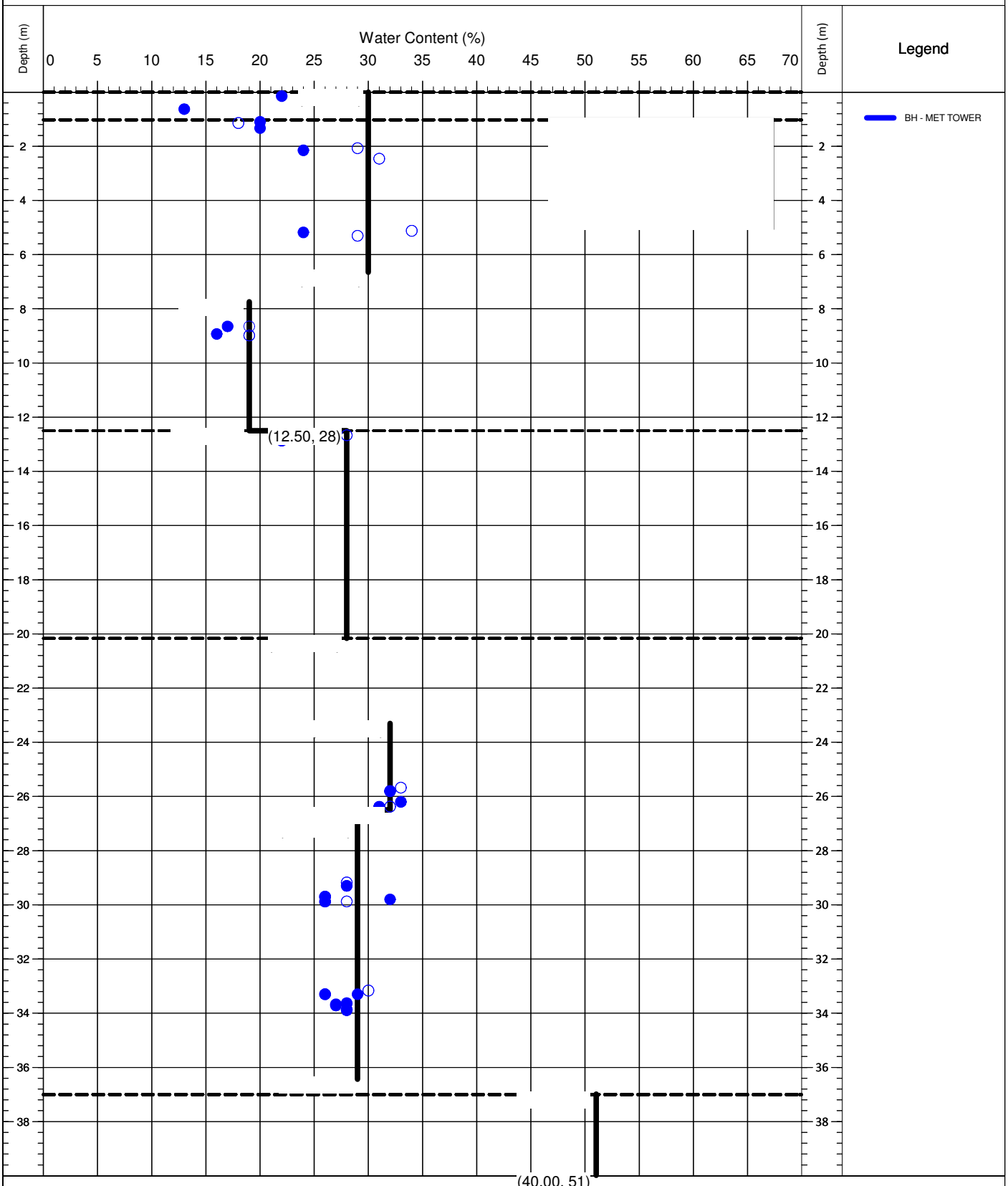

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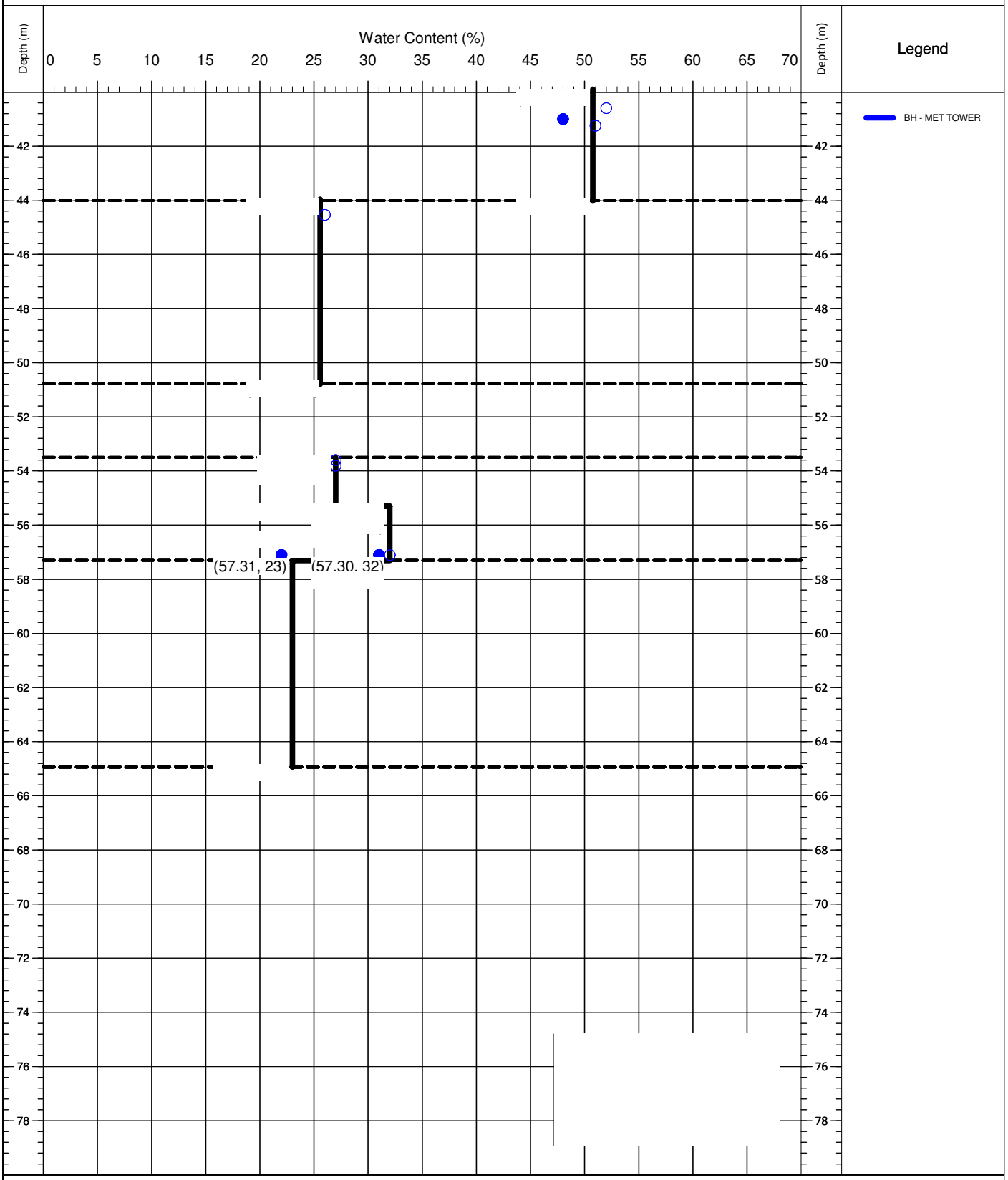
WATER CONTENT PROFILE



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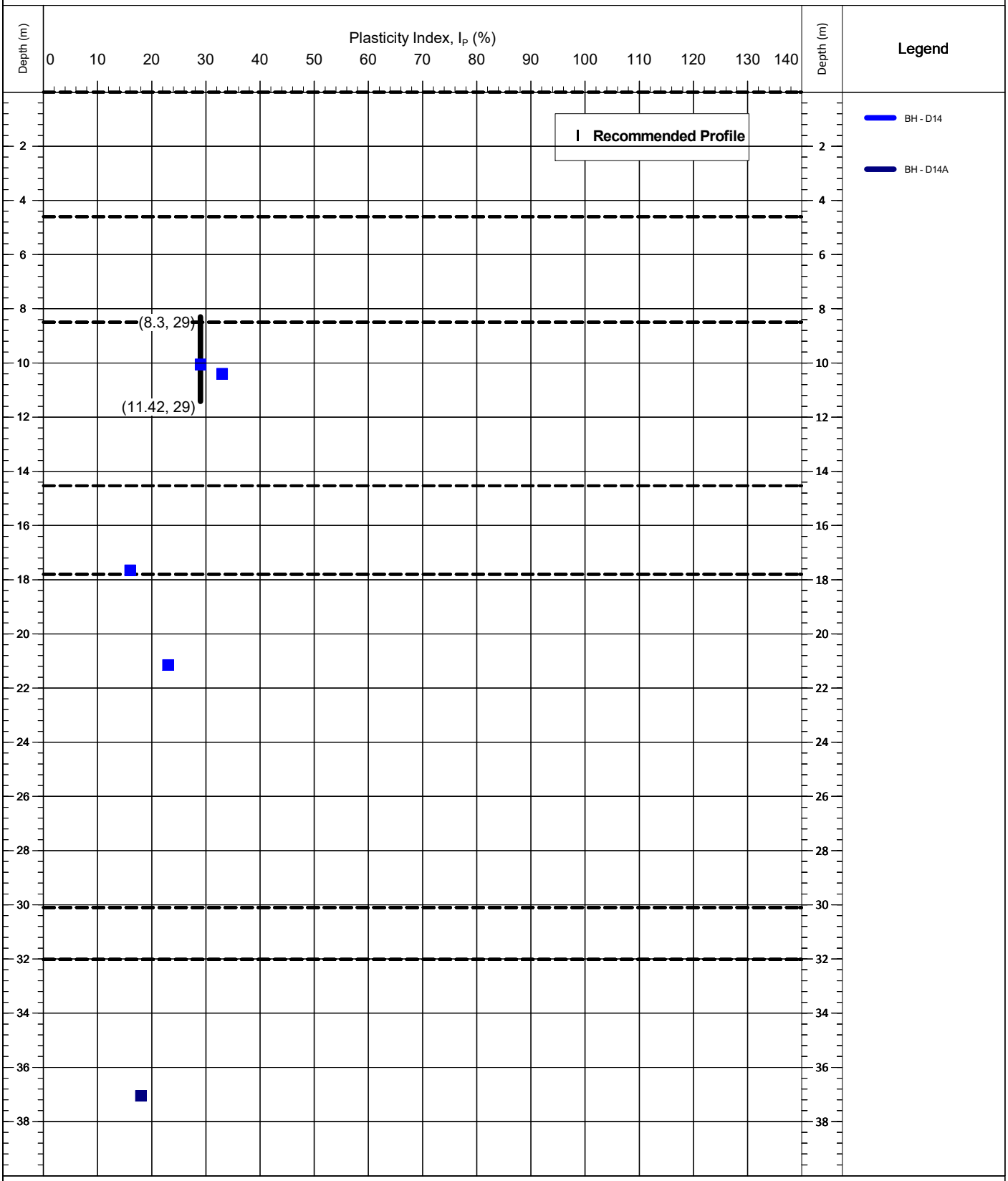
SMc 28/09/2015	**JG** 17/02/2016	

2.7 Plasticity Index

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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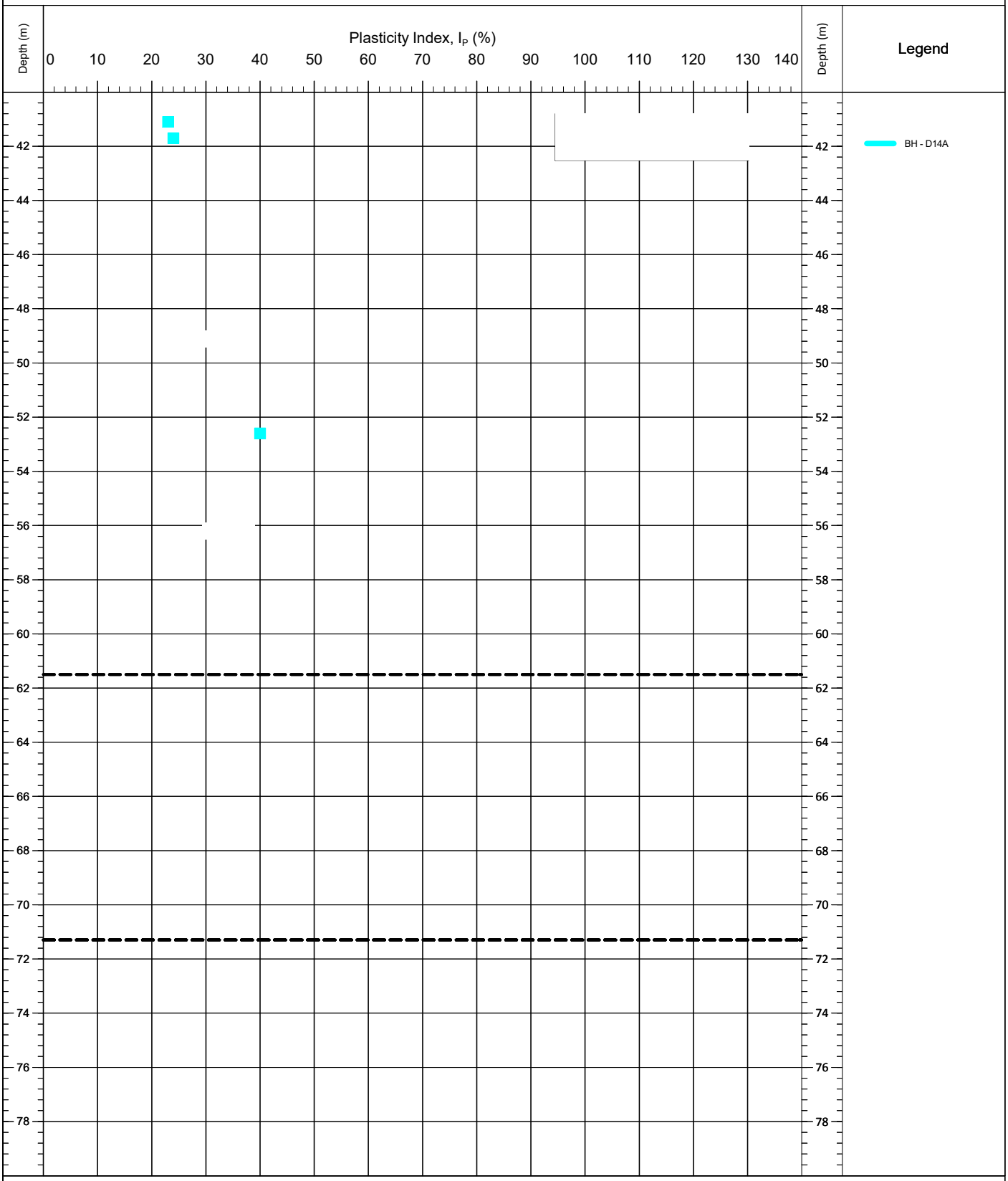
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



Area	**Maryland USA**
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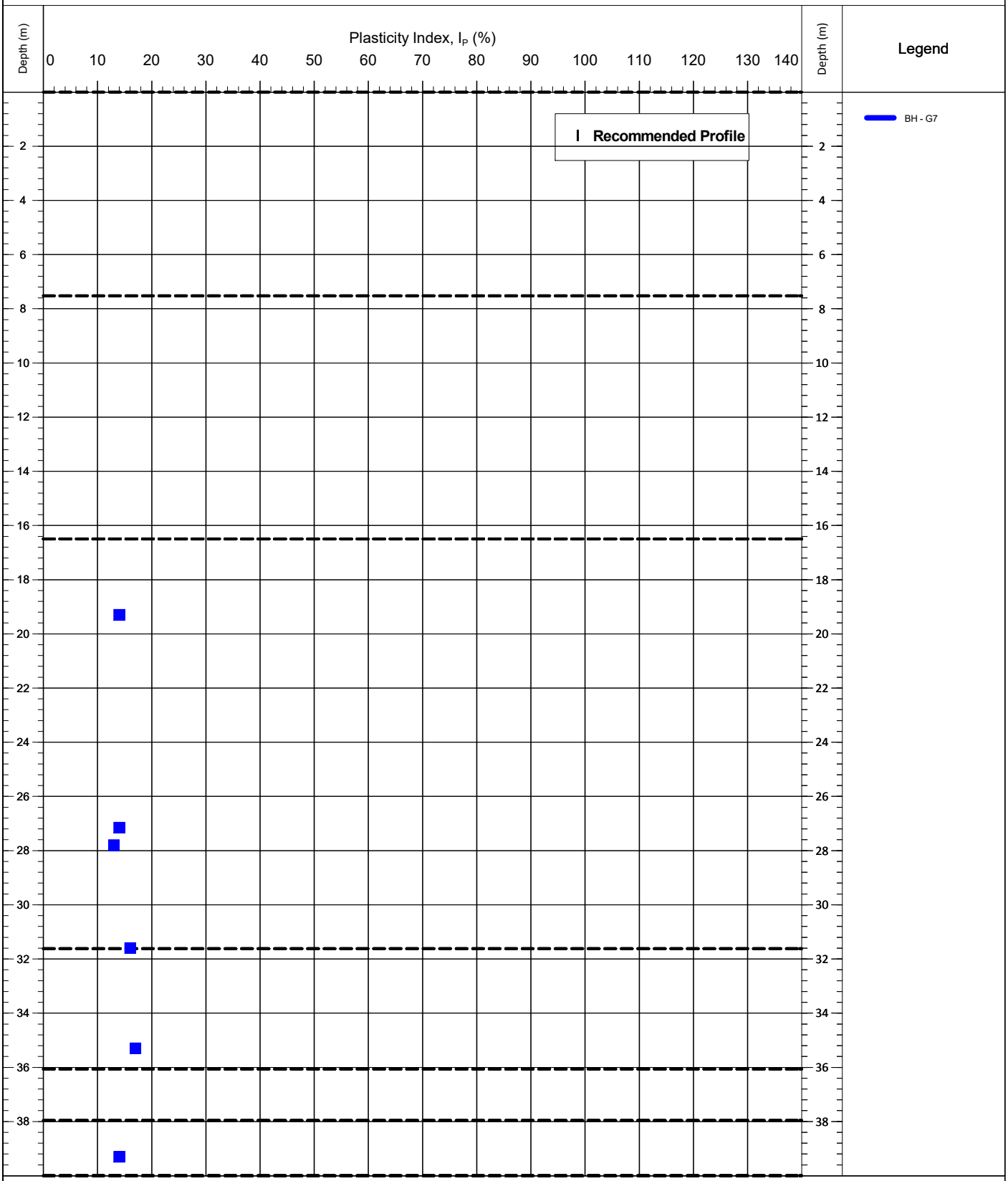
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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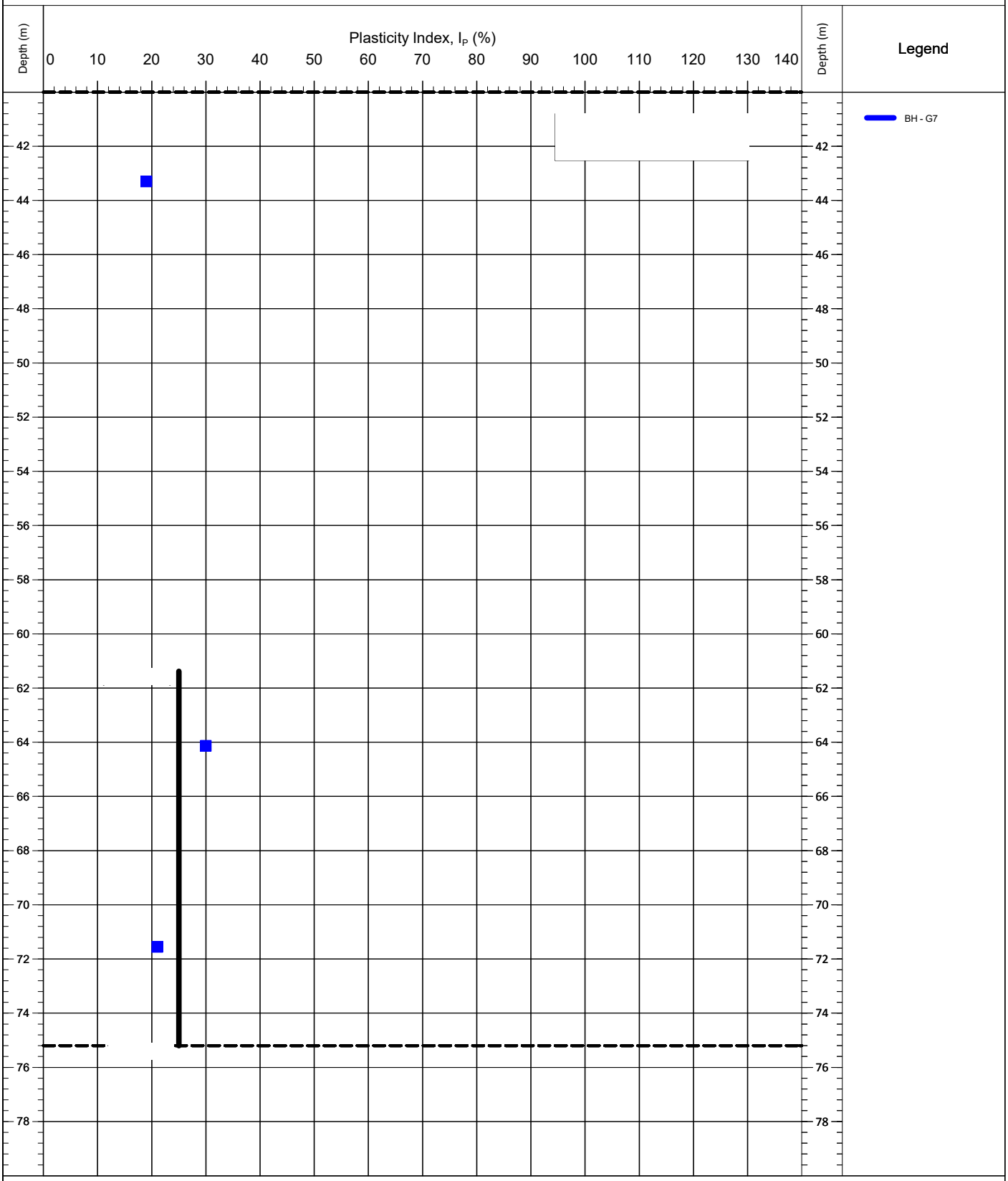
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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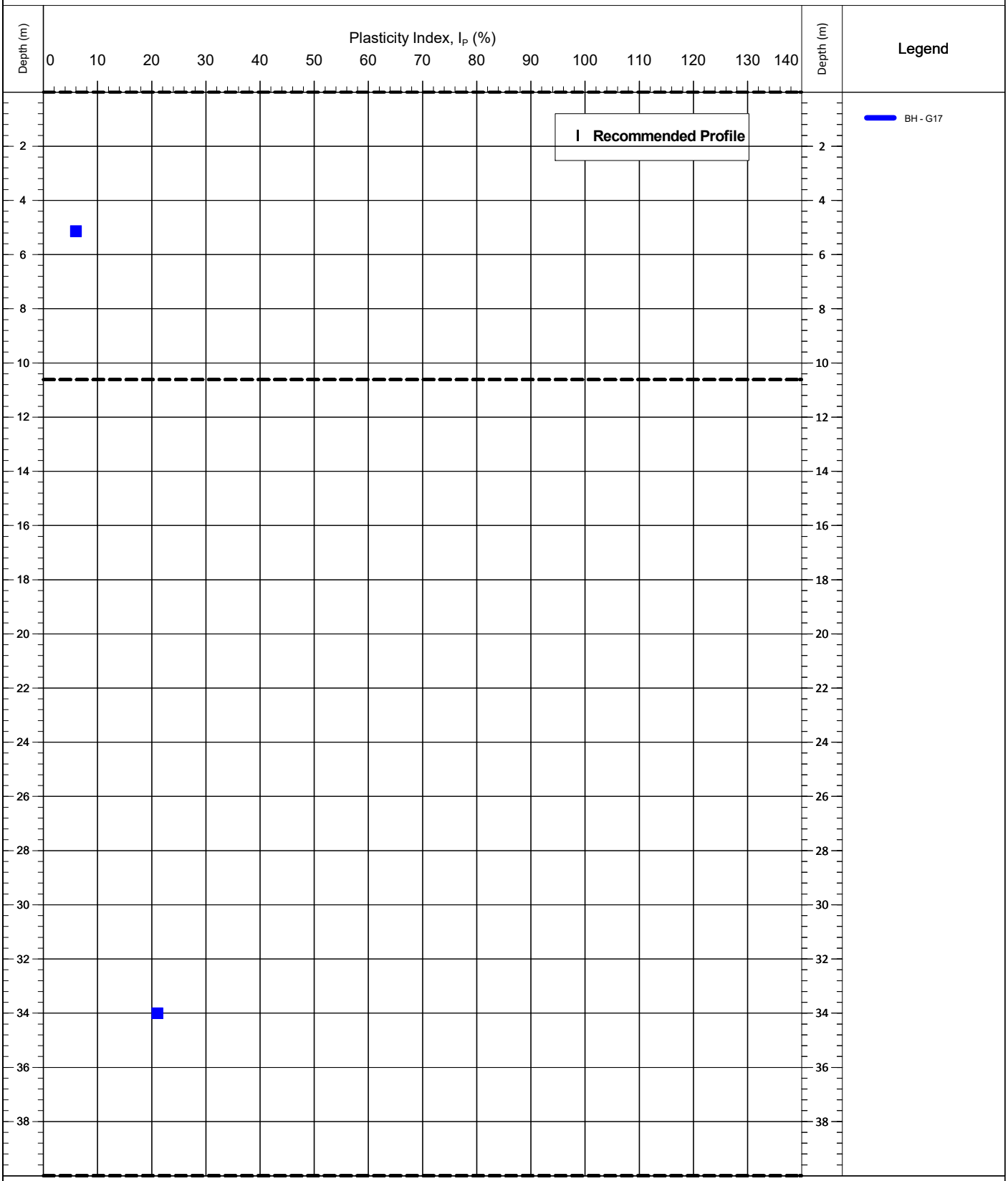
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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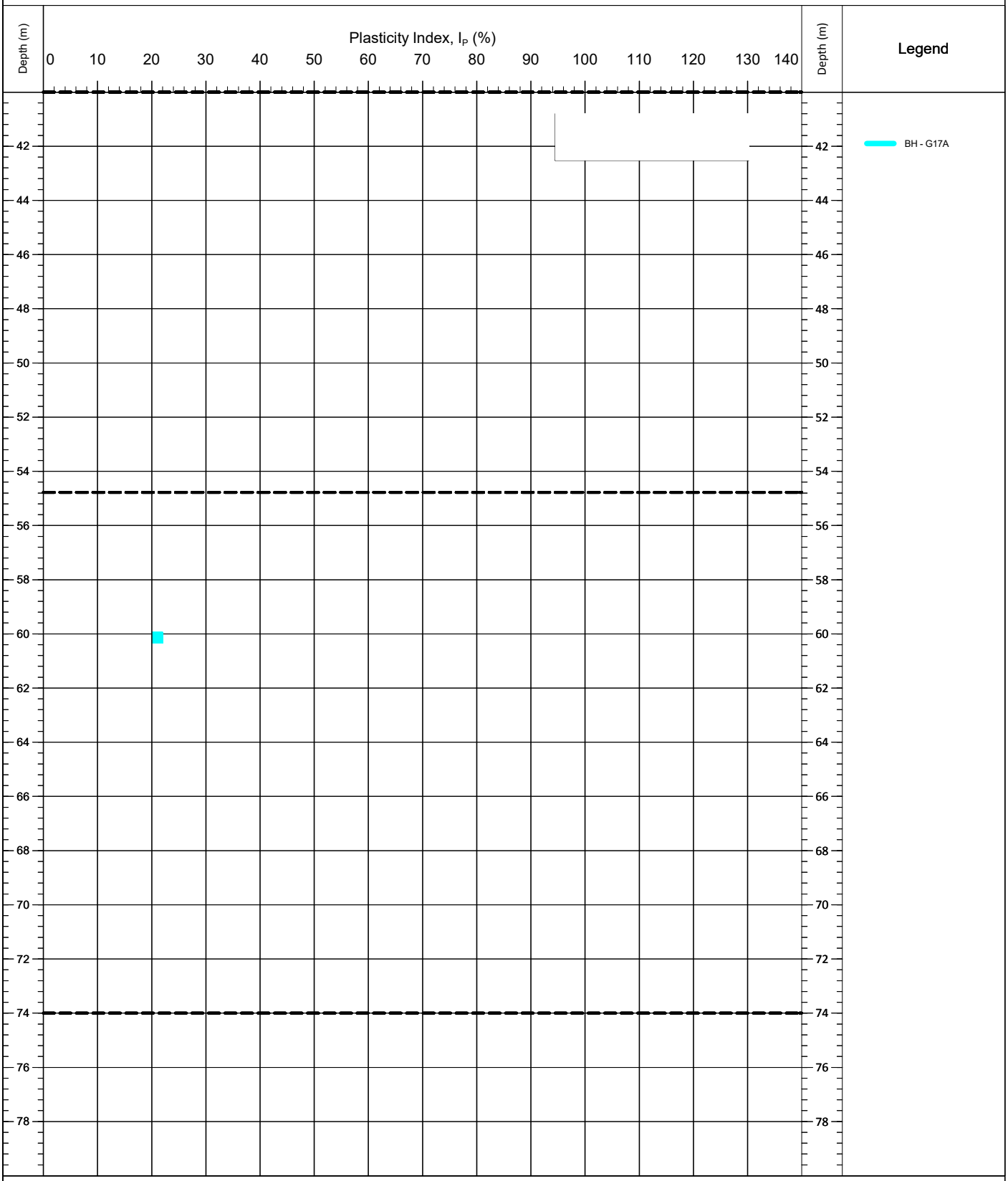
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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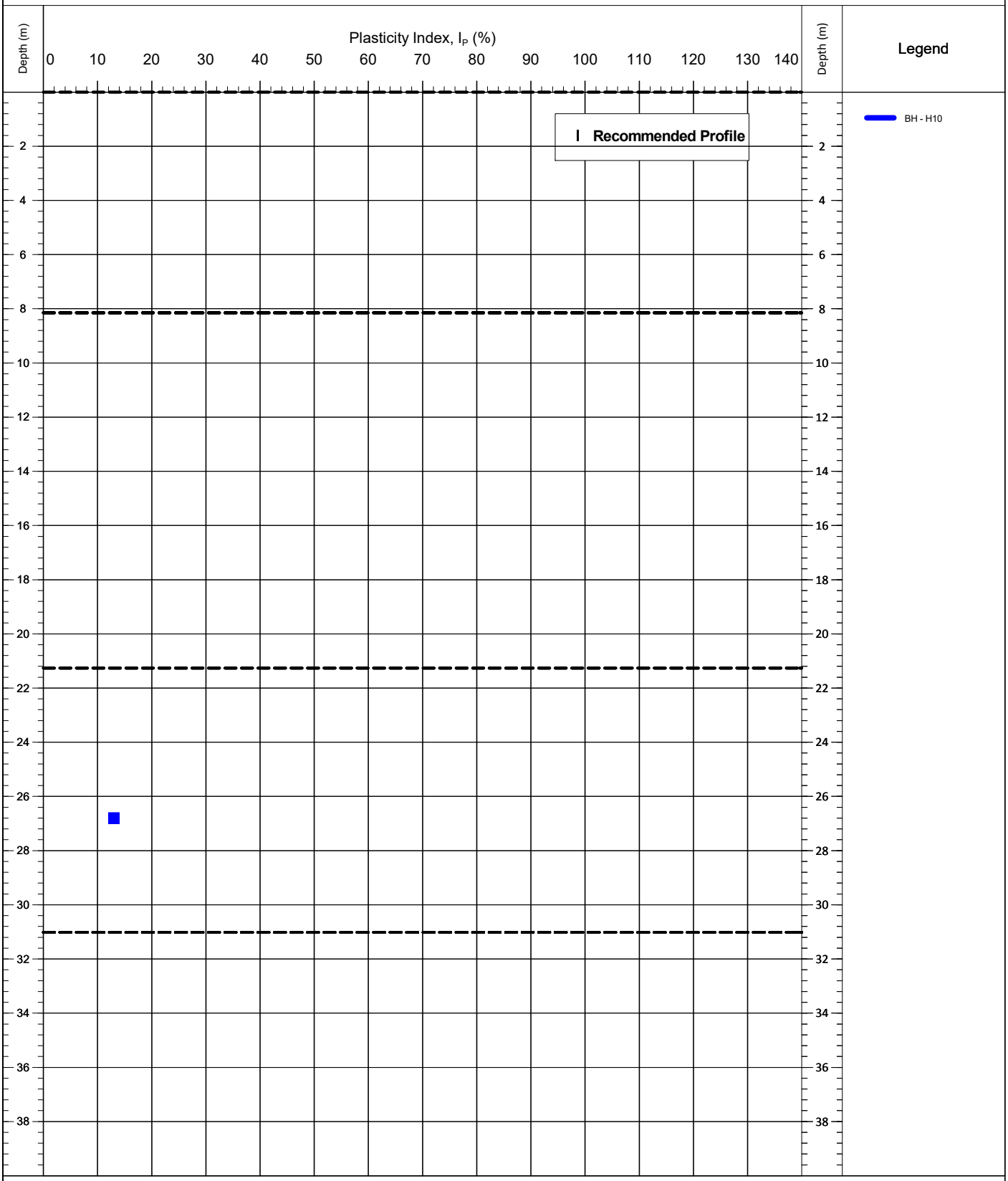
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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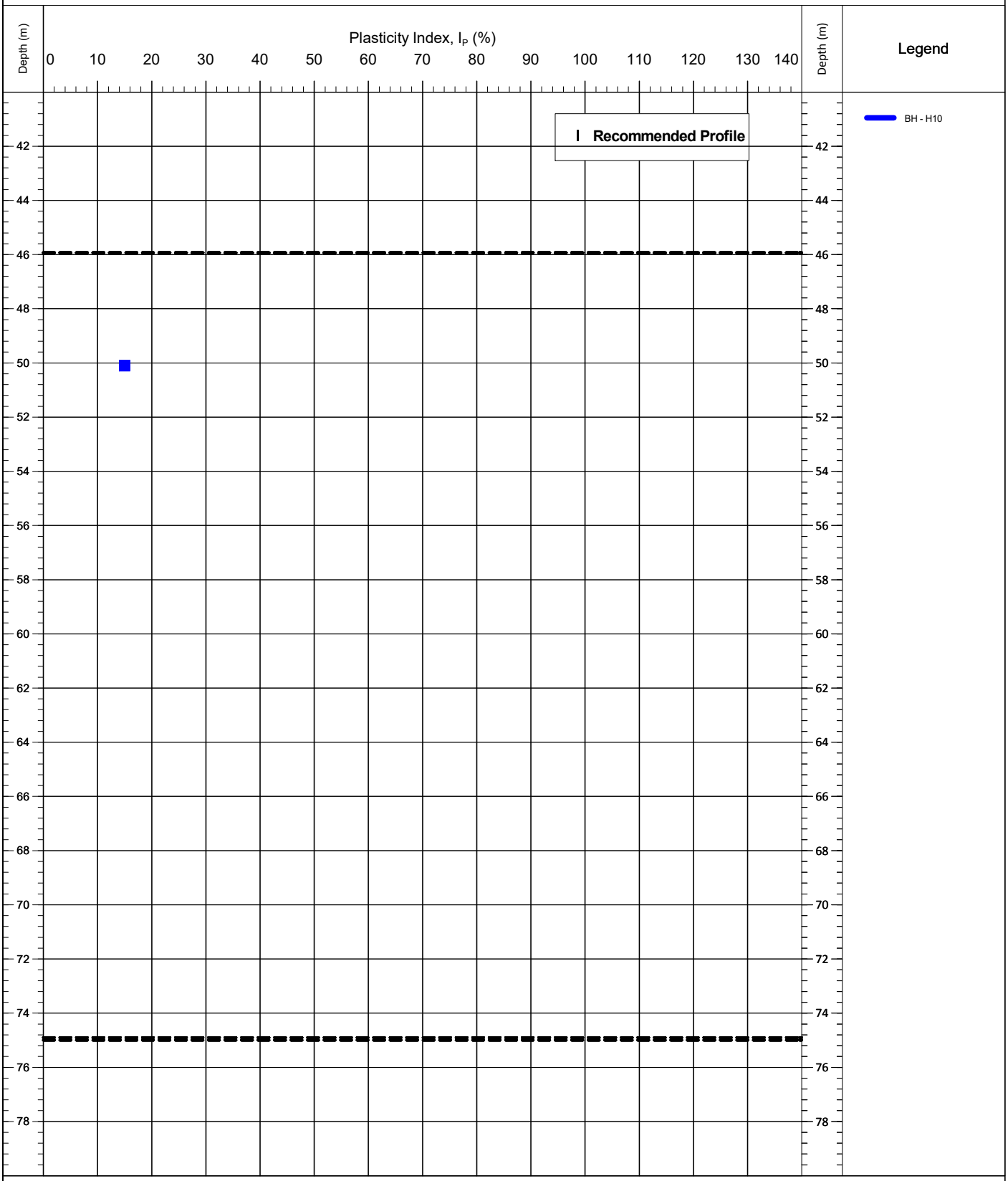
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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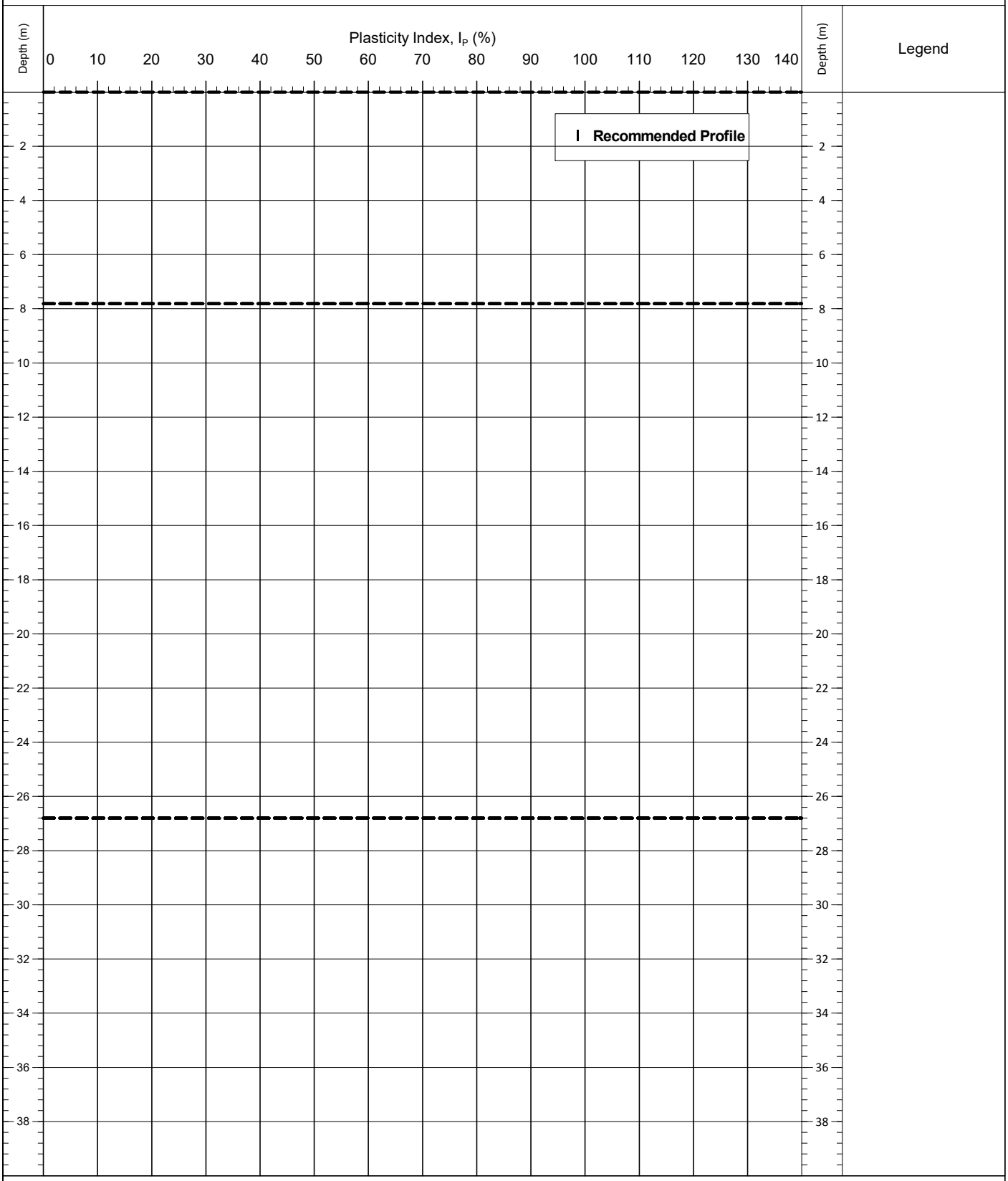
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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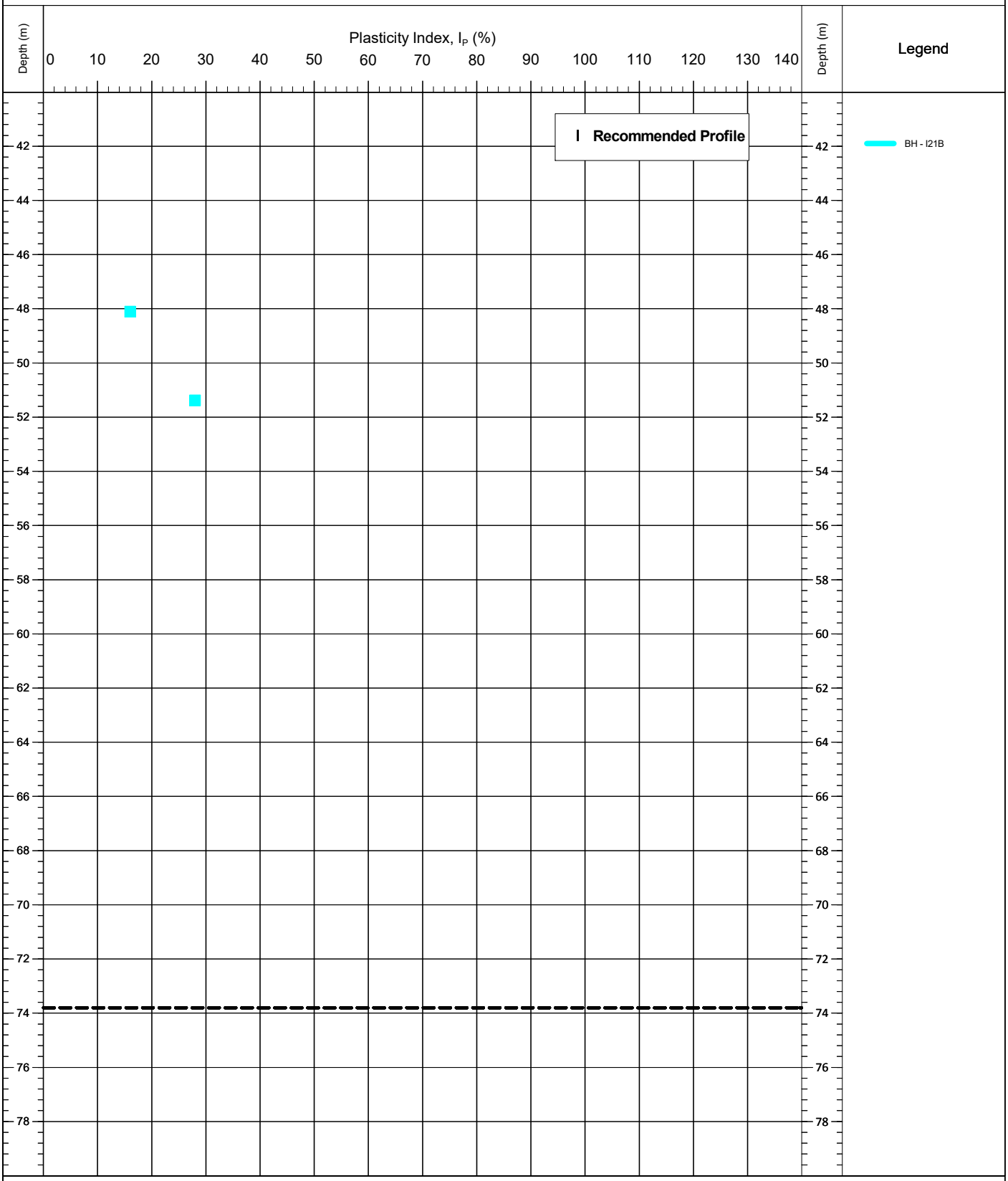
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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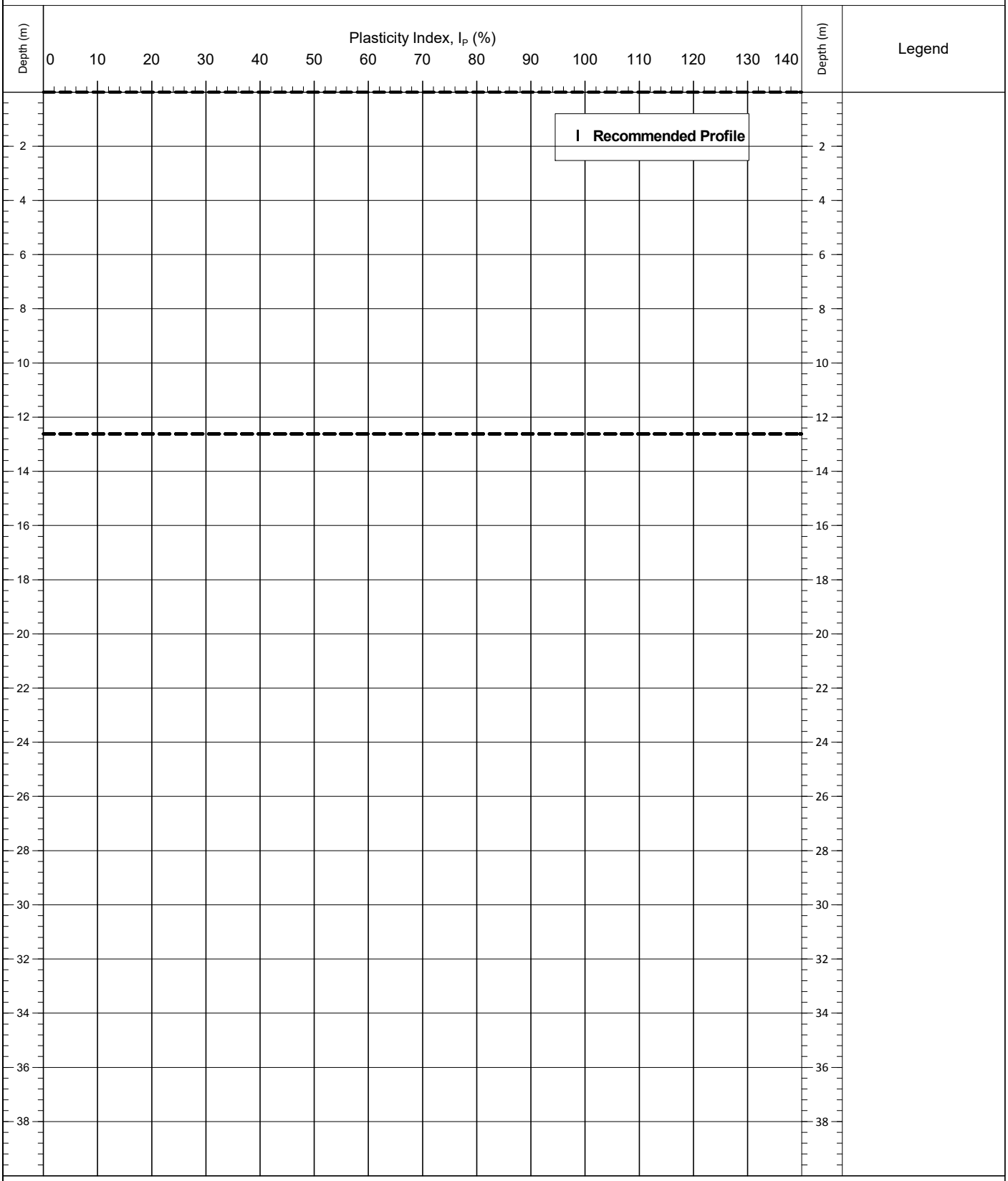
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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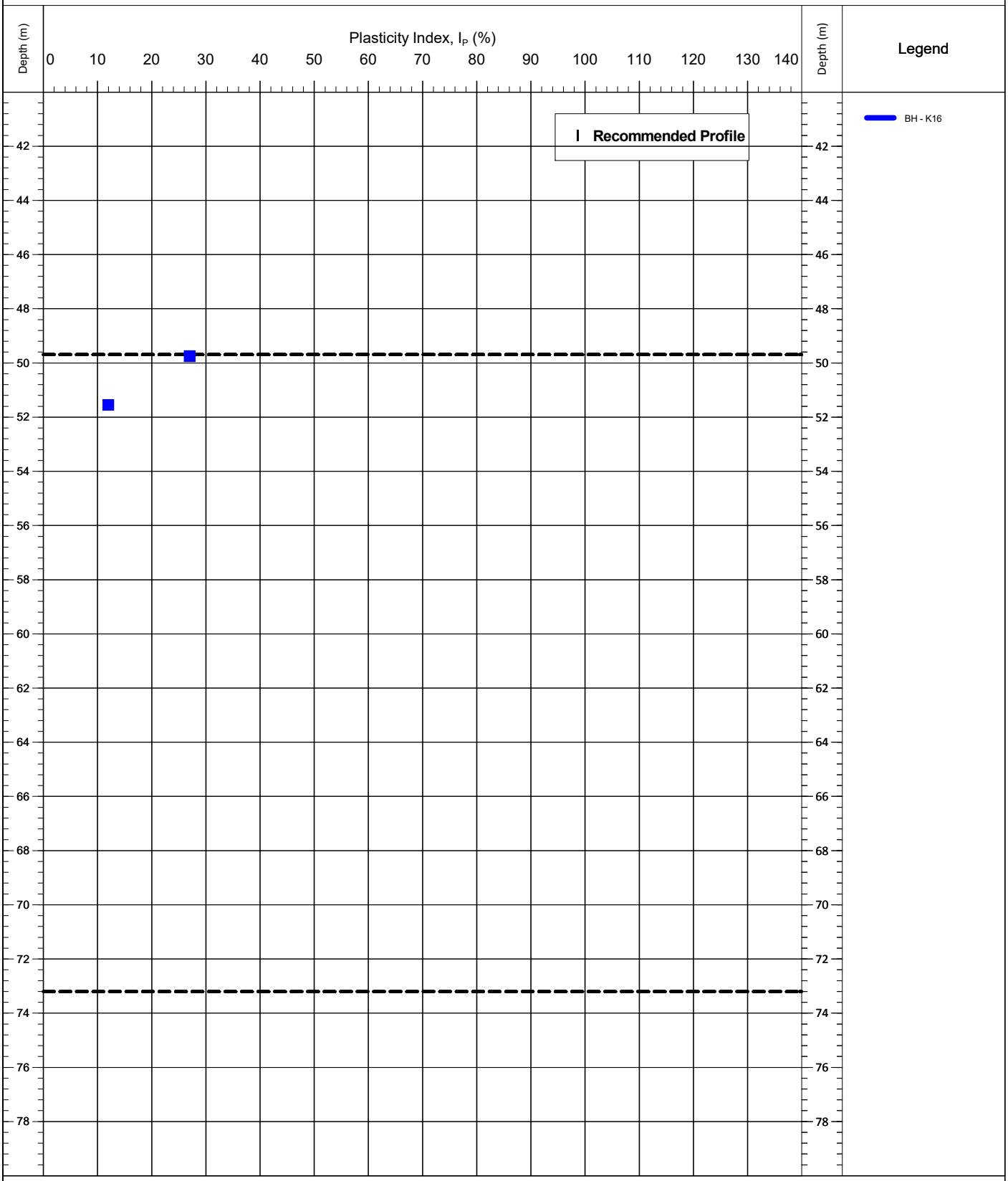

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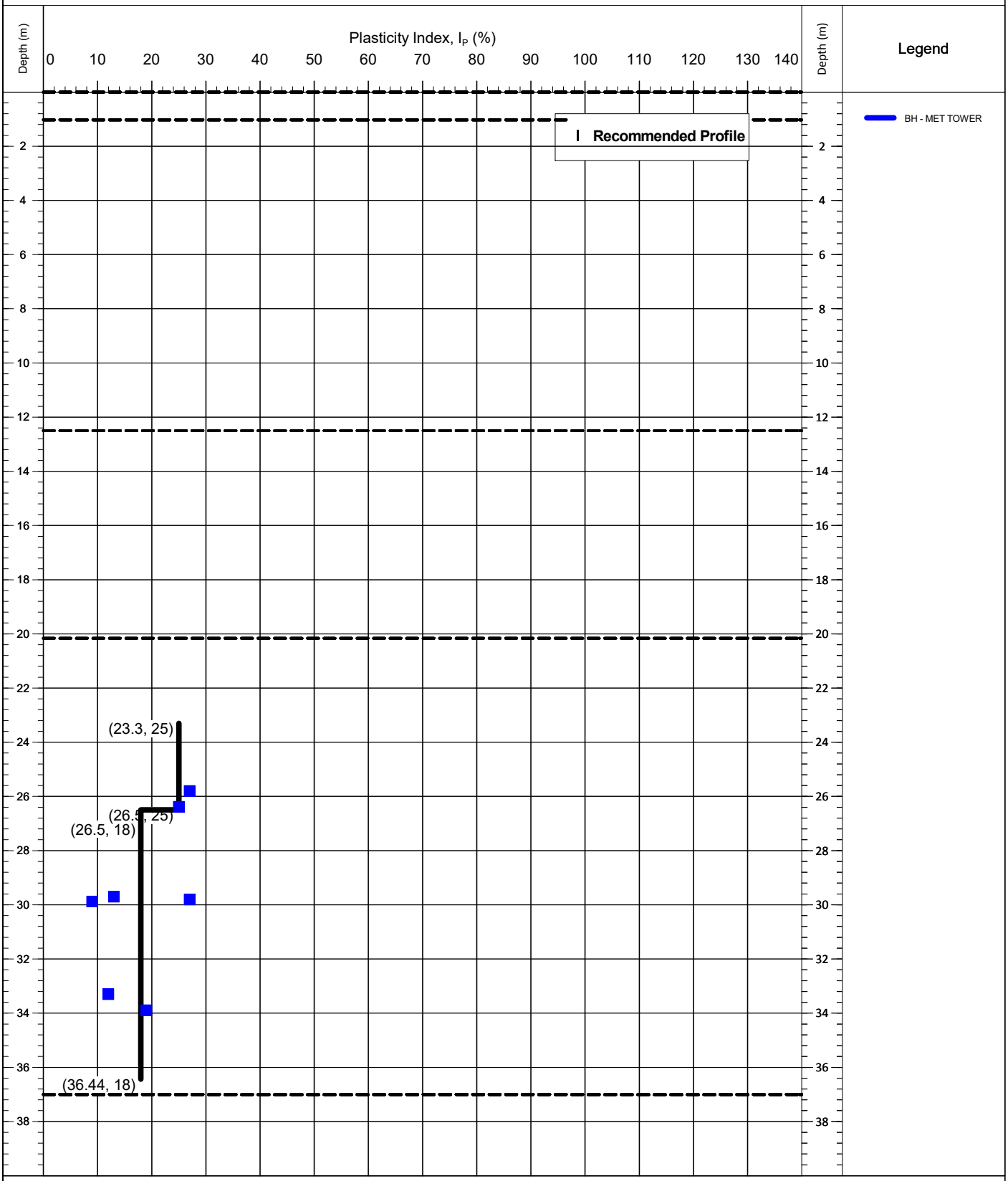
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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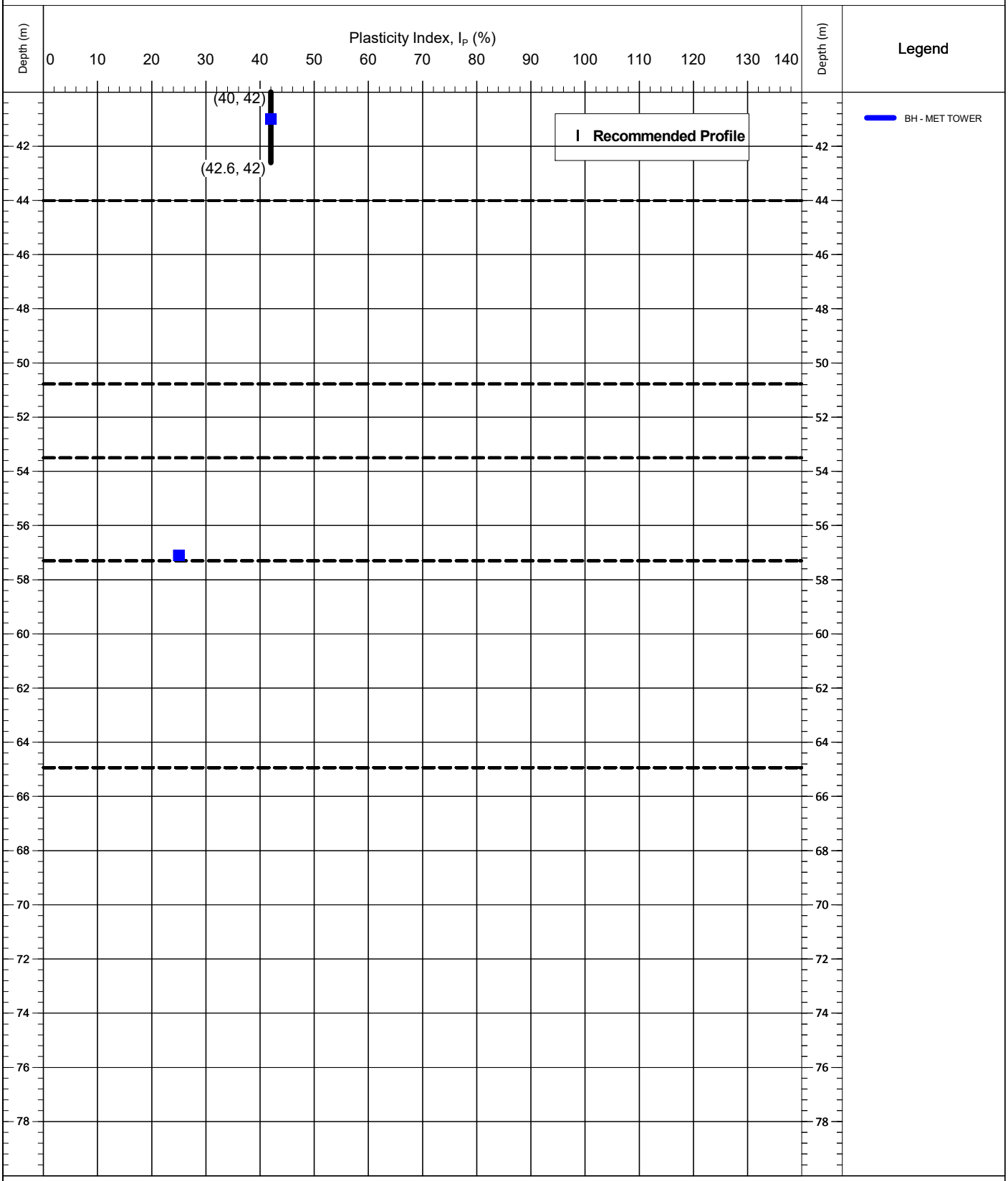
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PLASTICITY INDEX PROFILE



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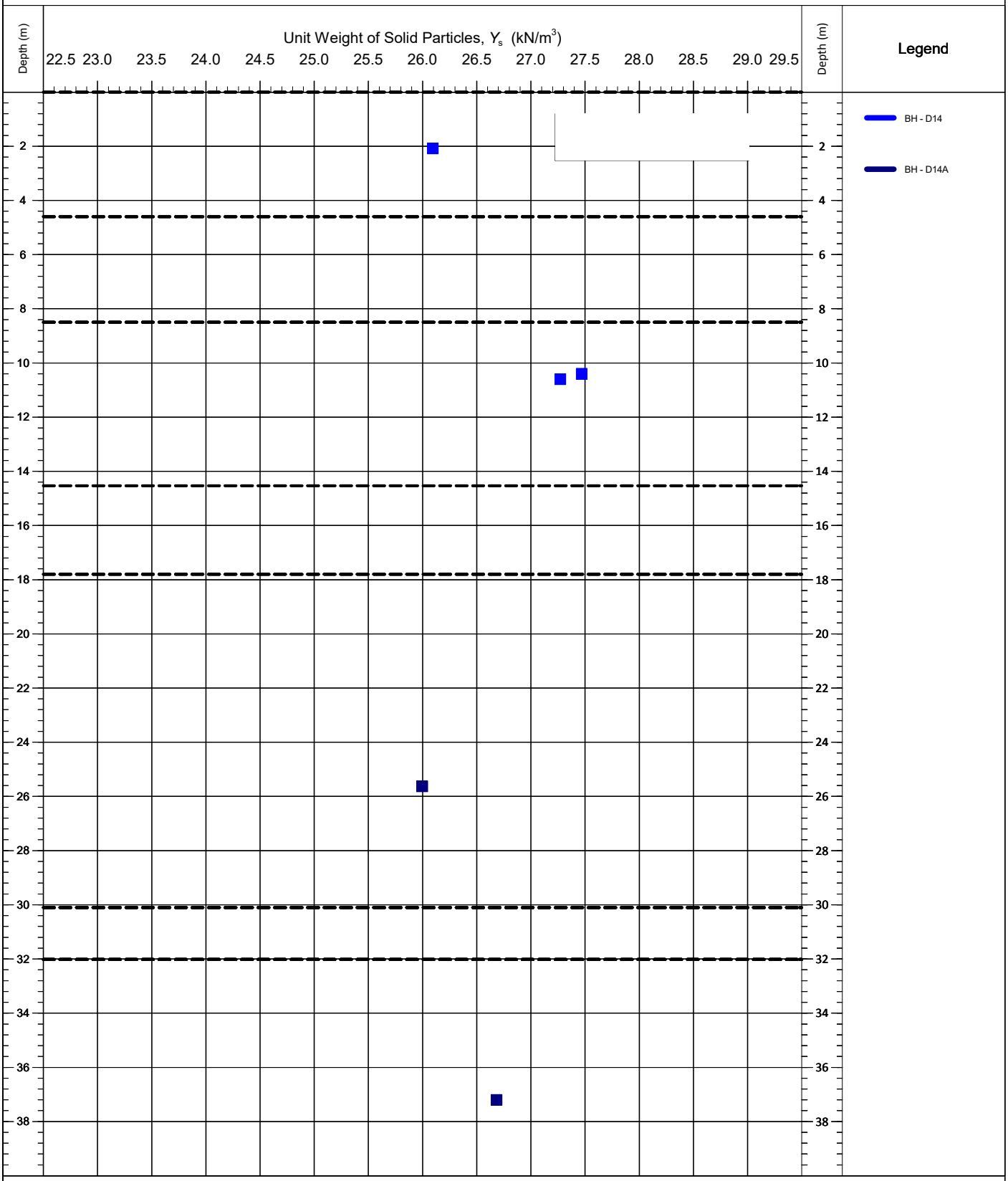
2.8 Unit weight of Solid Particles

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE



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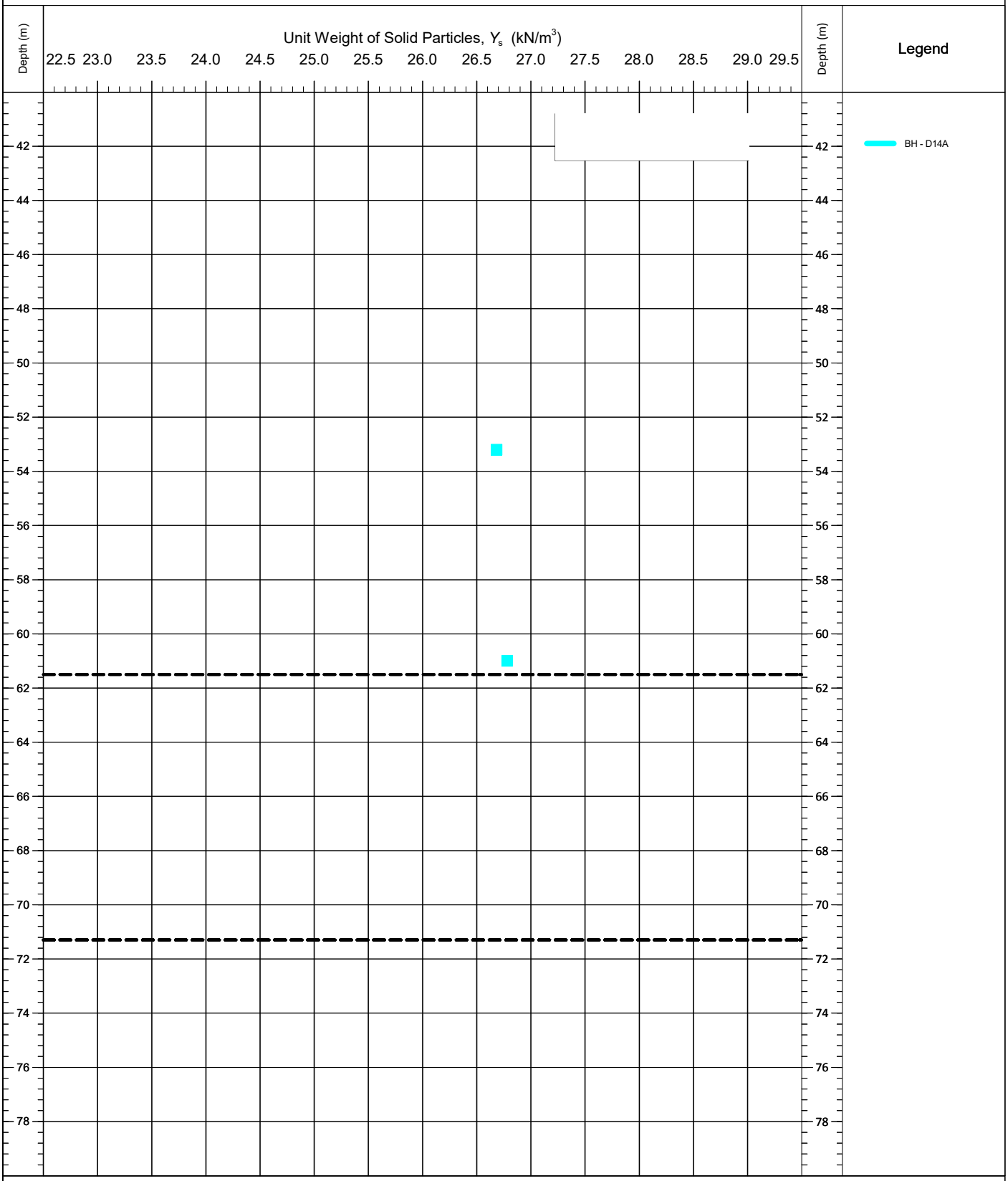
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE



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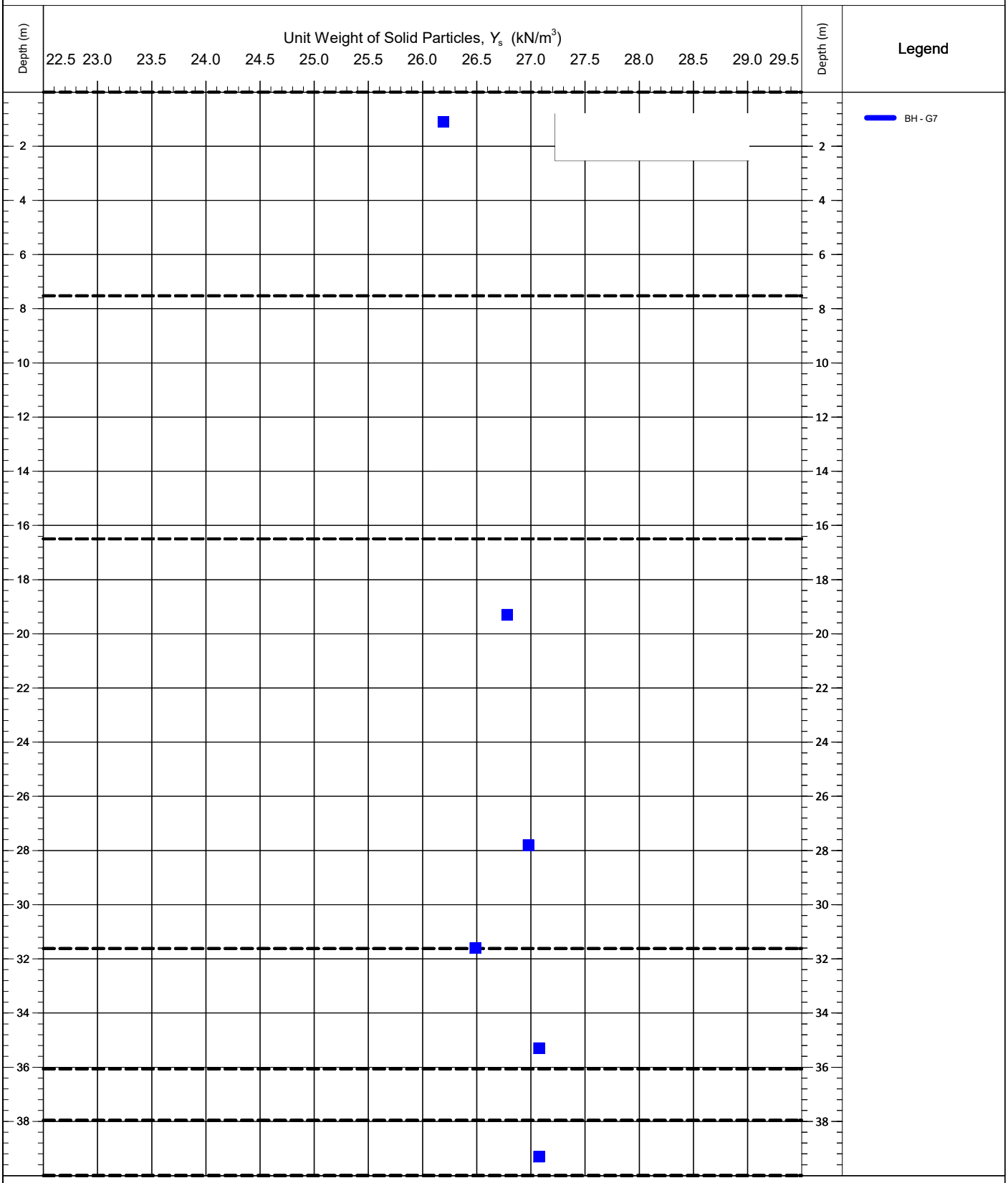
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE



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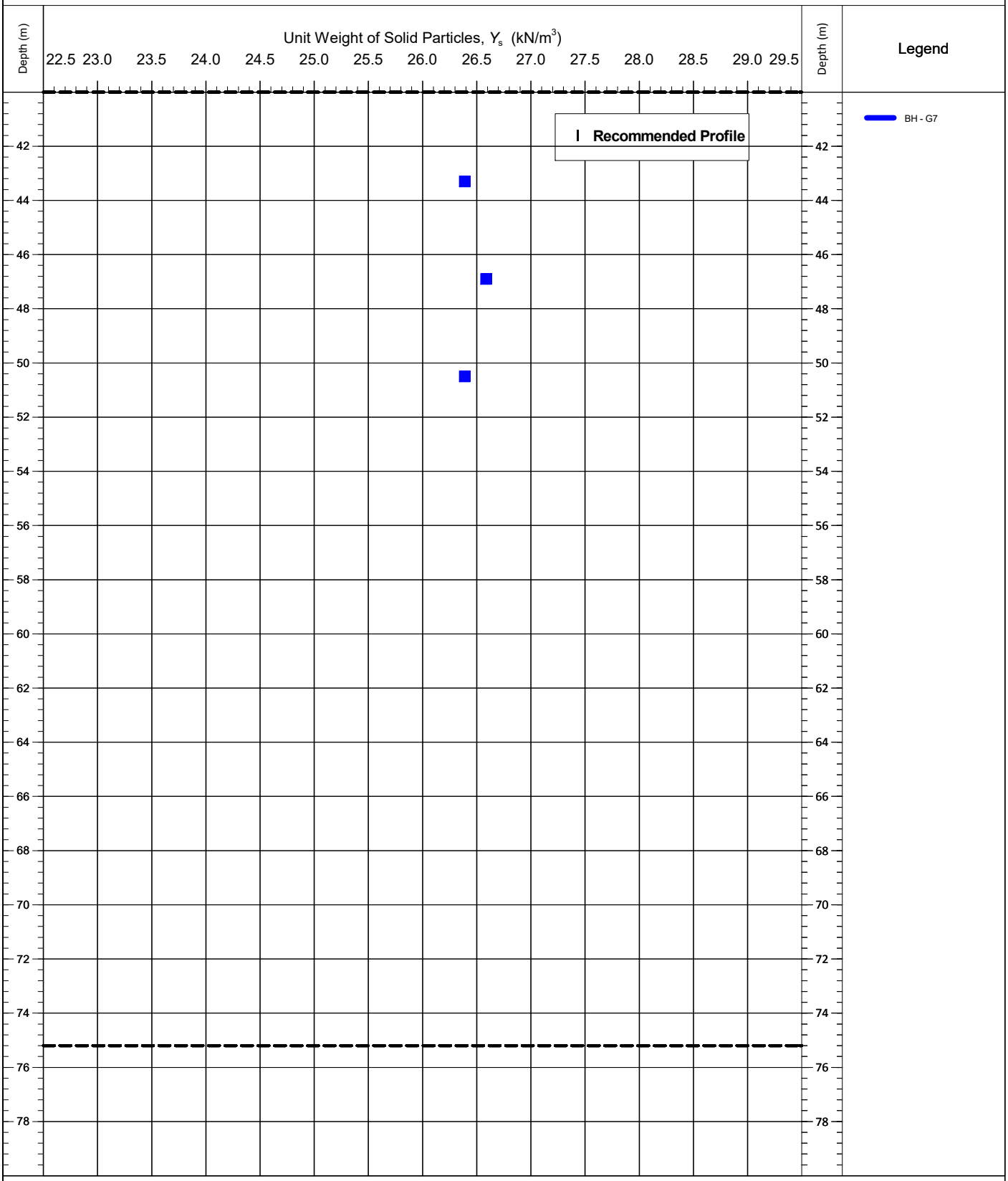
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE



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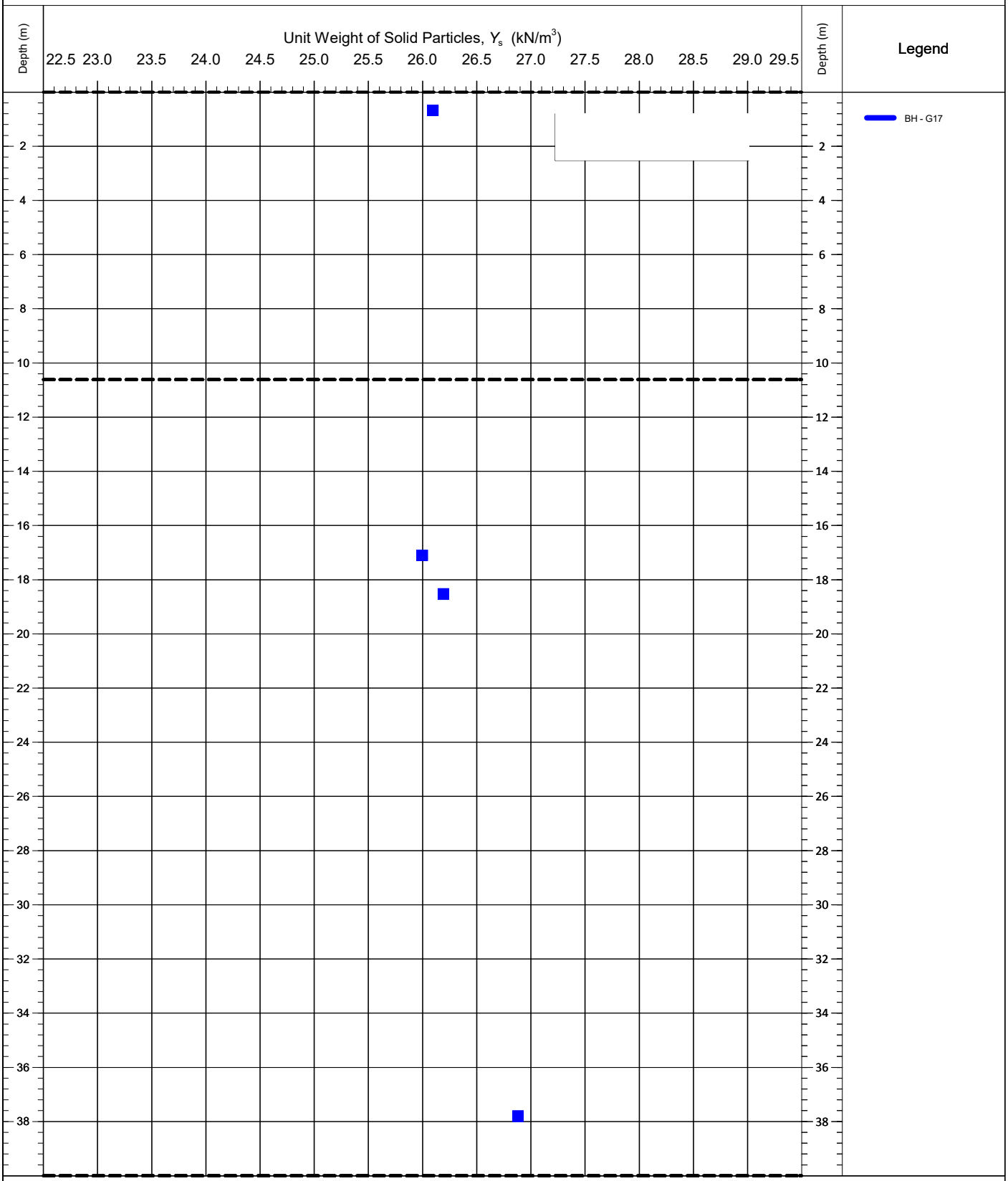
UNIT WEIGHT OF SOLID PARTICLES PROFILE



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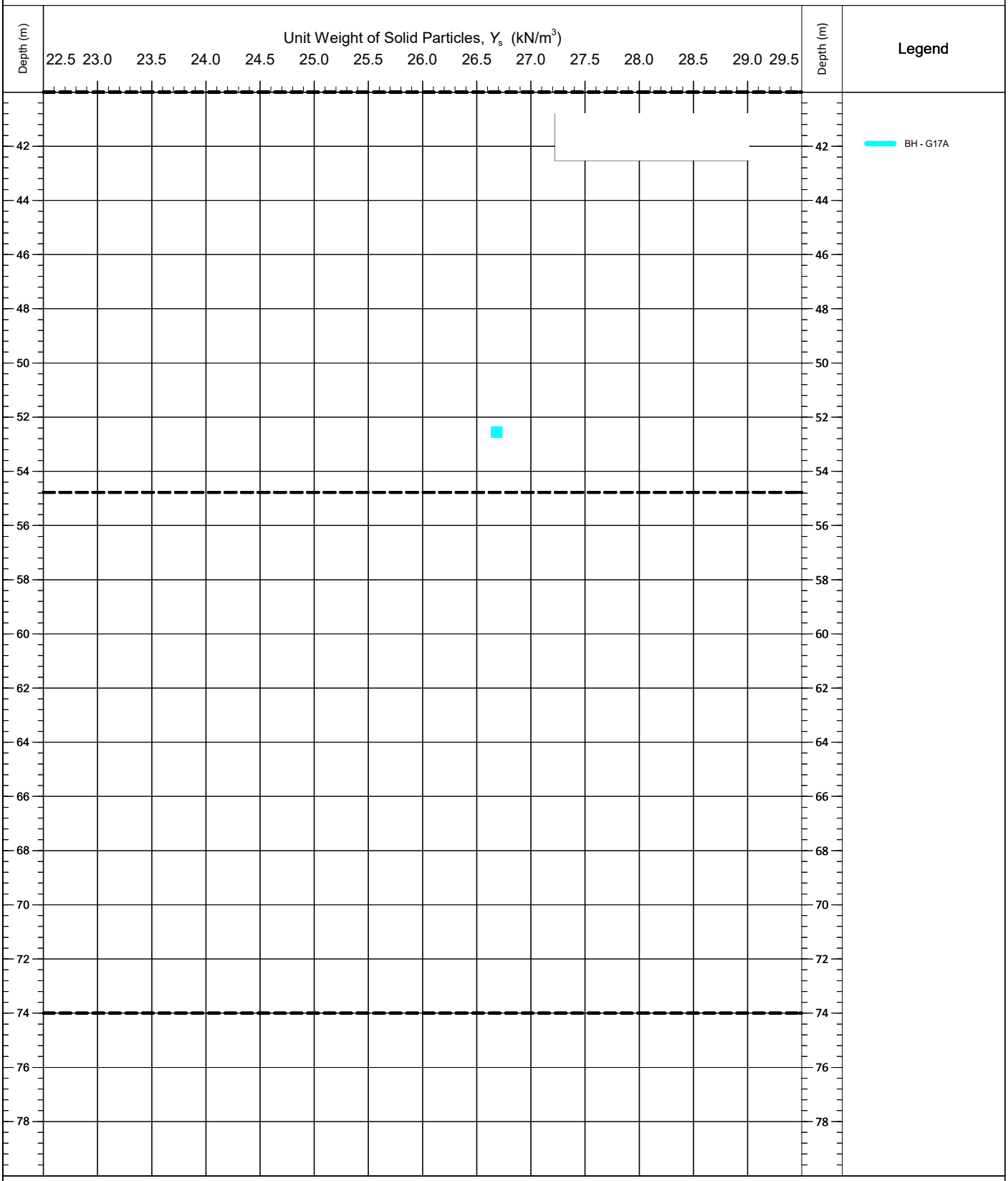
UNIT WEIGHT OF SOLID PARTICLES PROFILE



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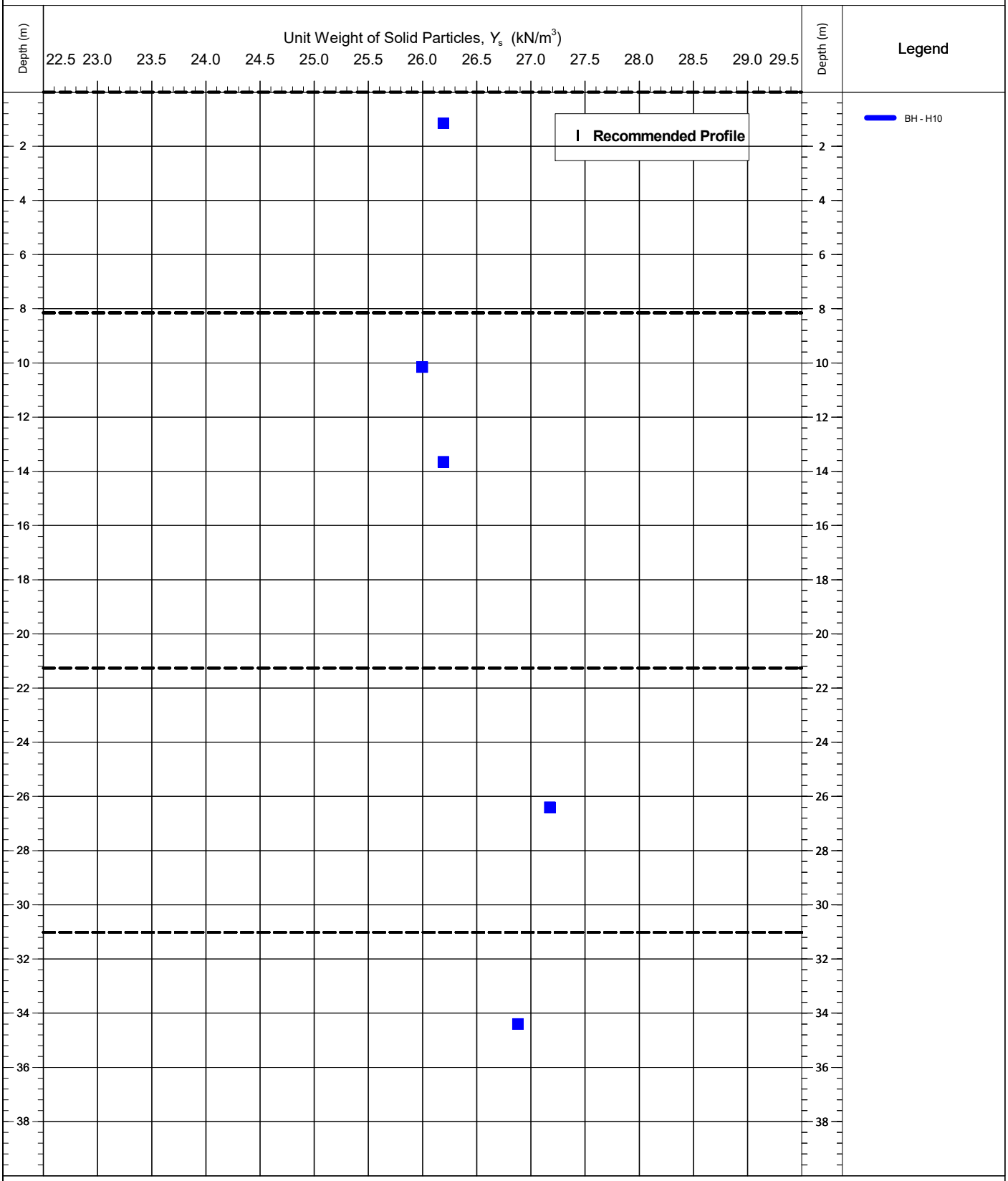
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE

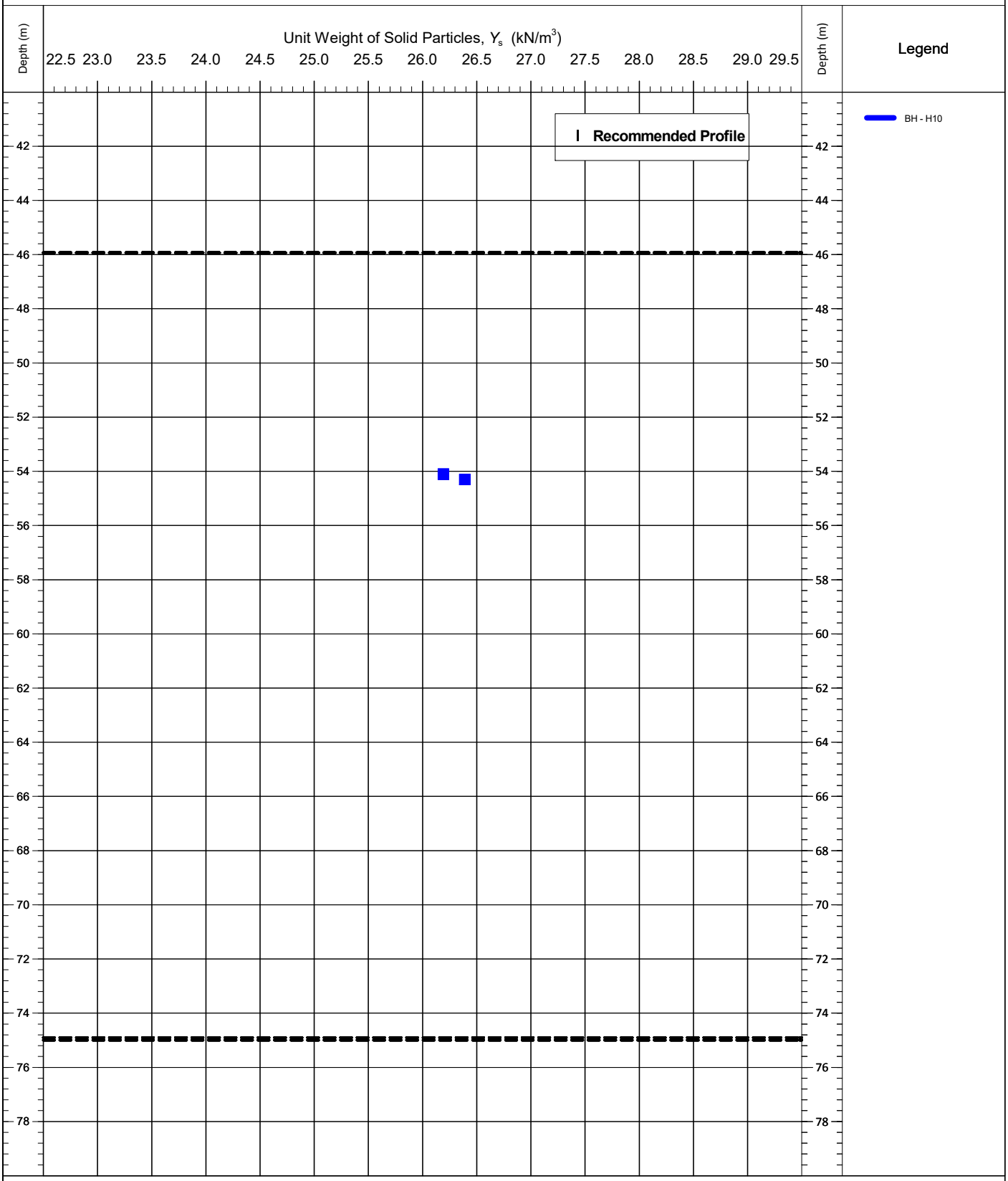


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE

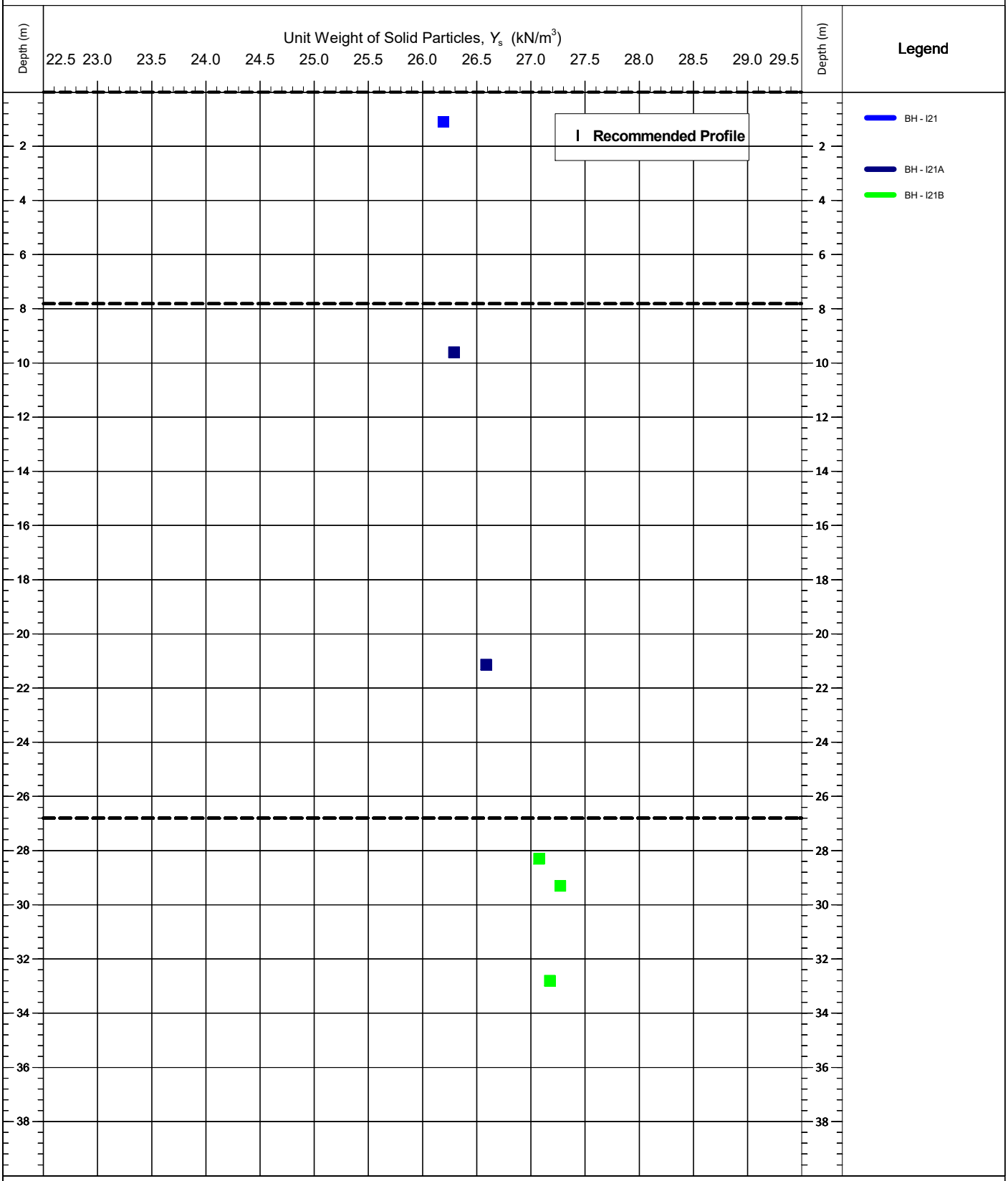


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE

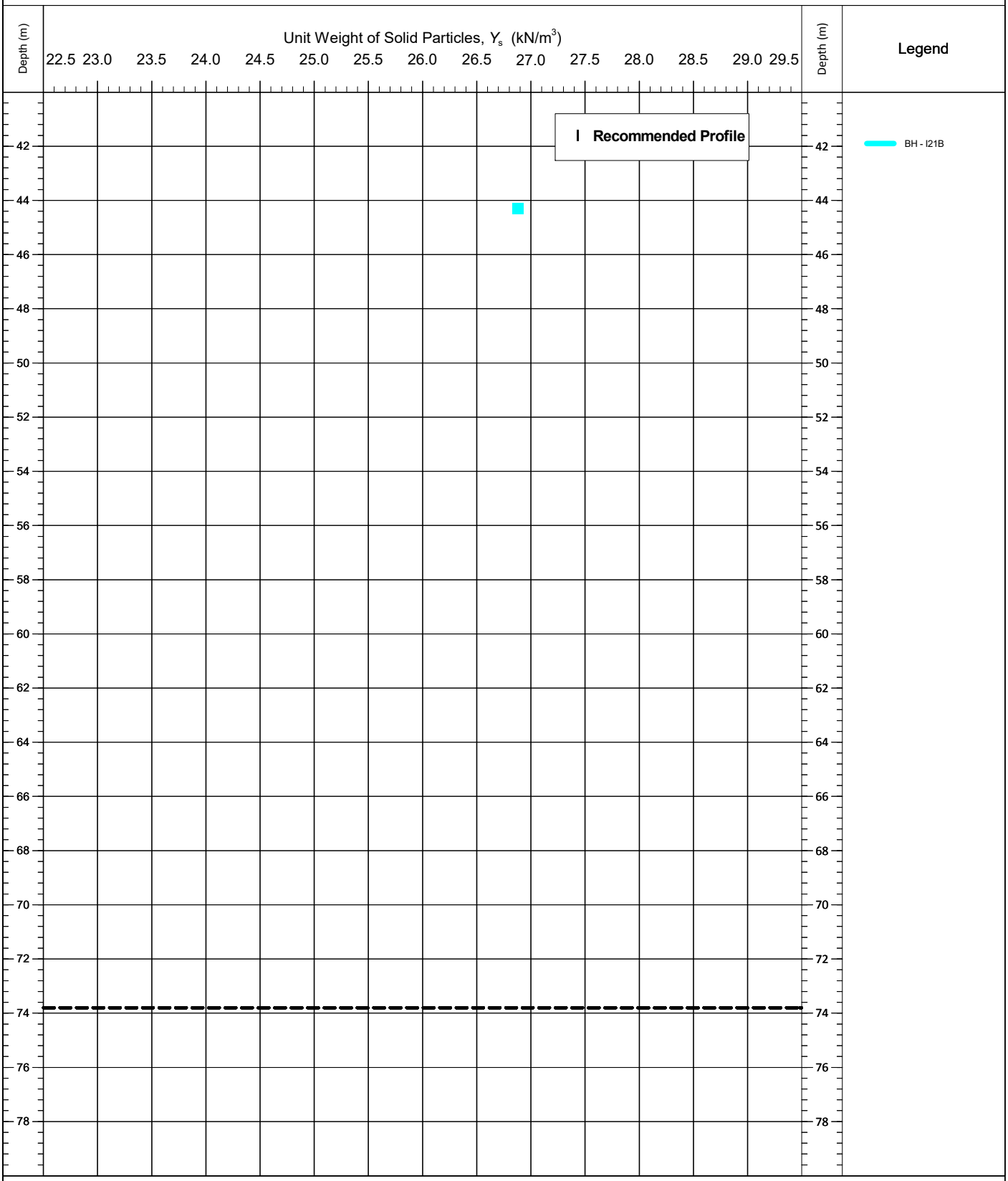


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE

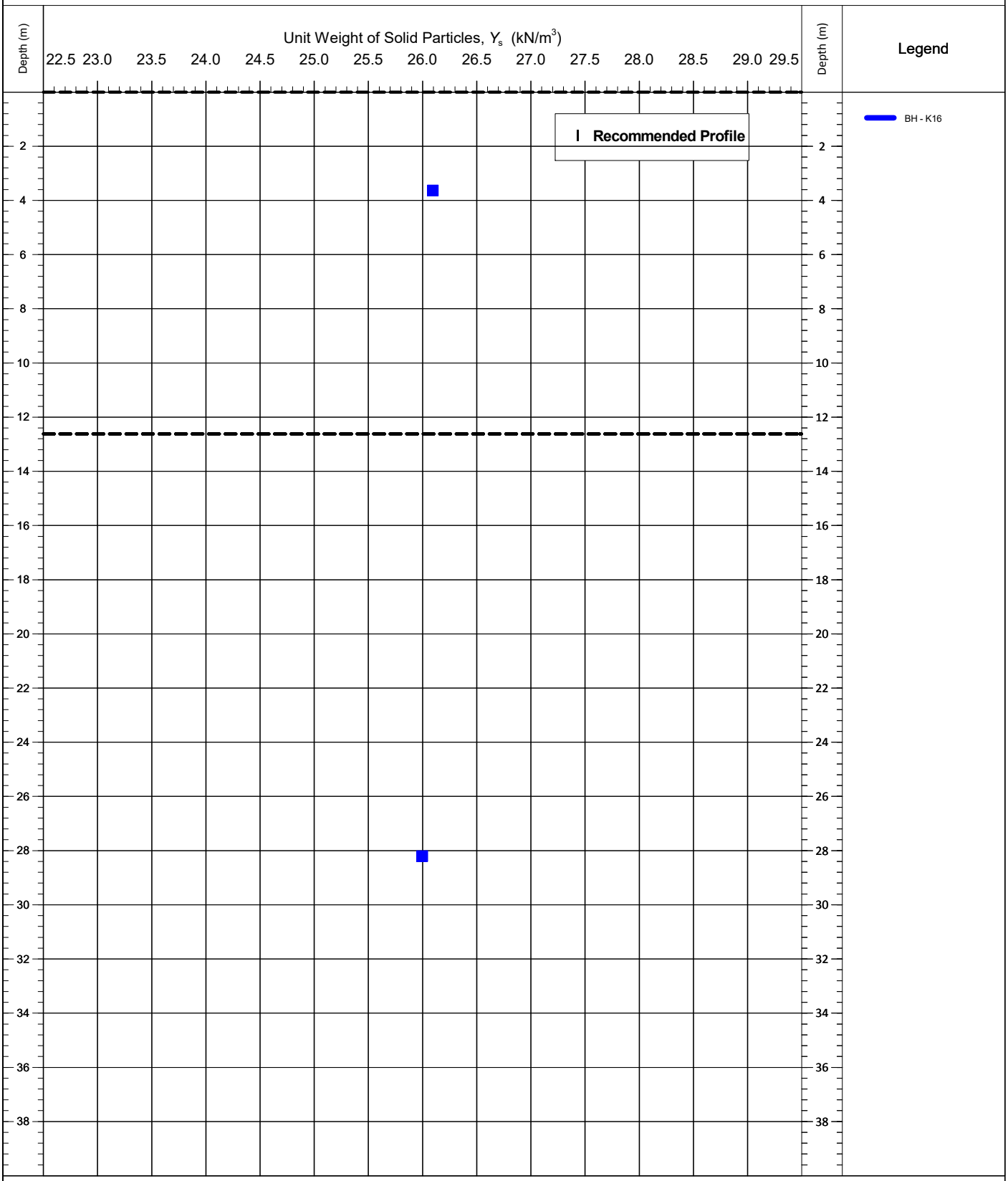


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE

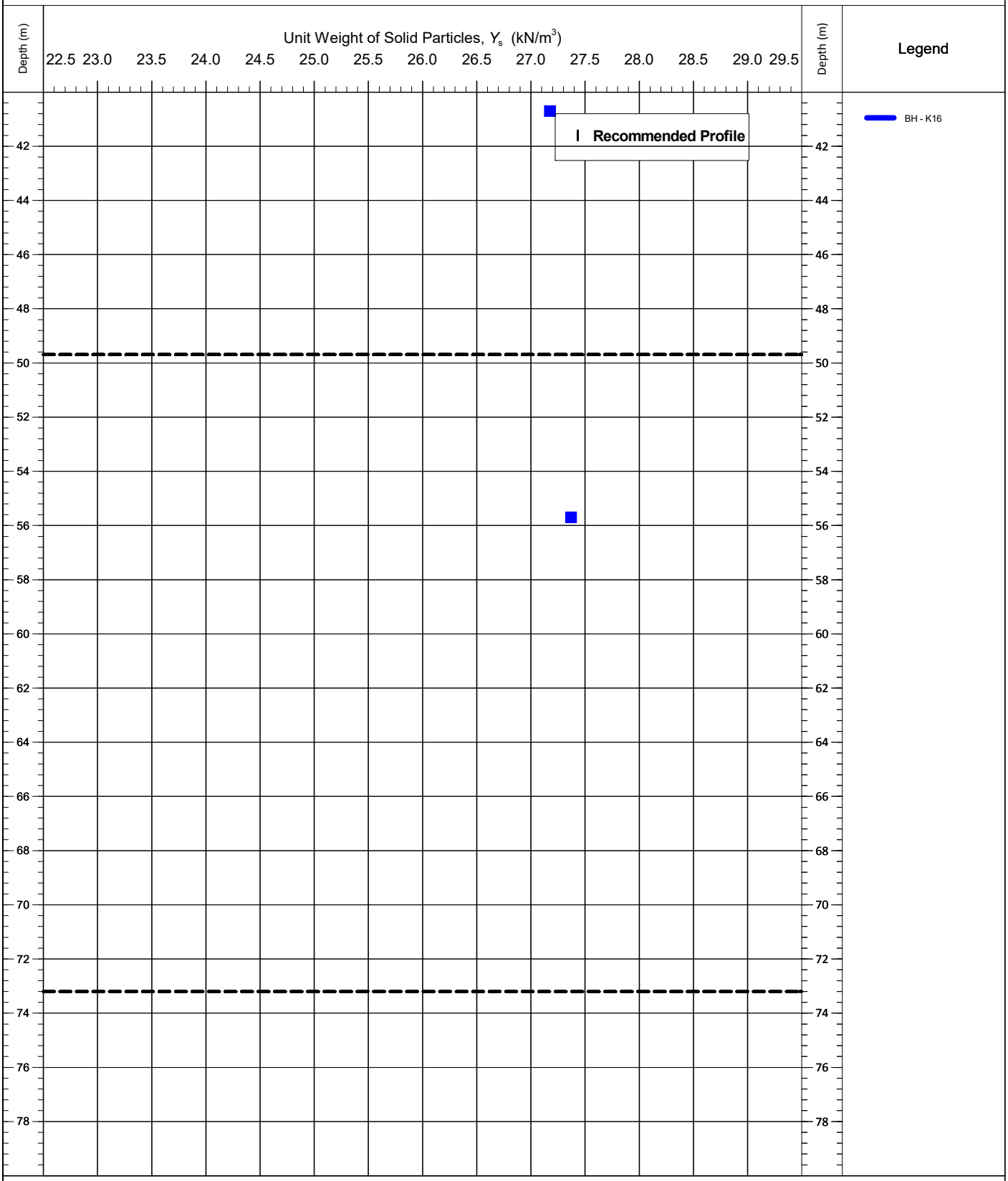


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE

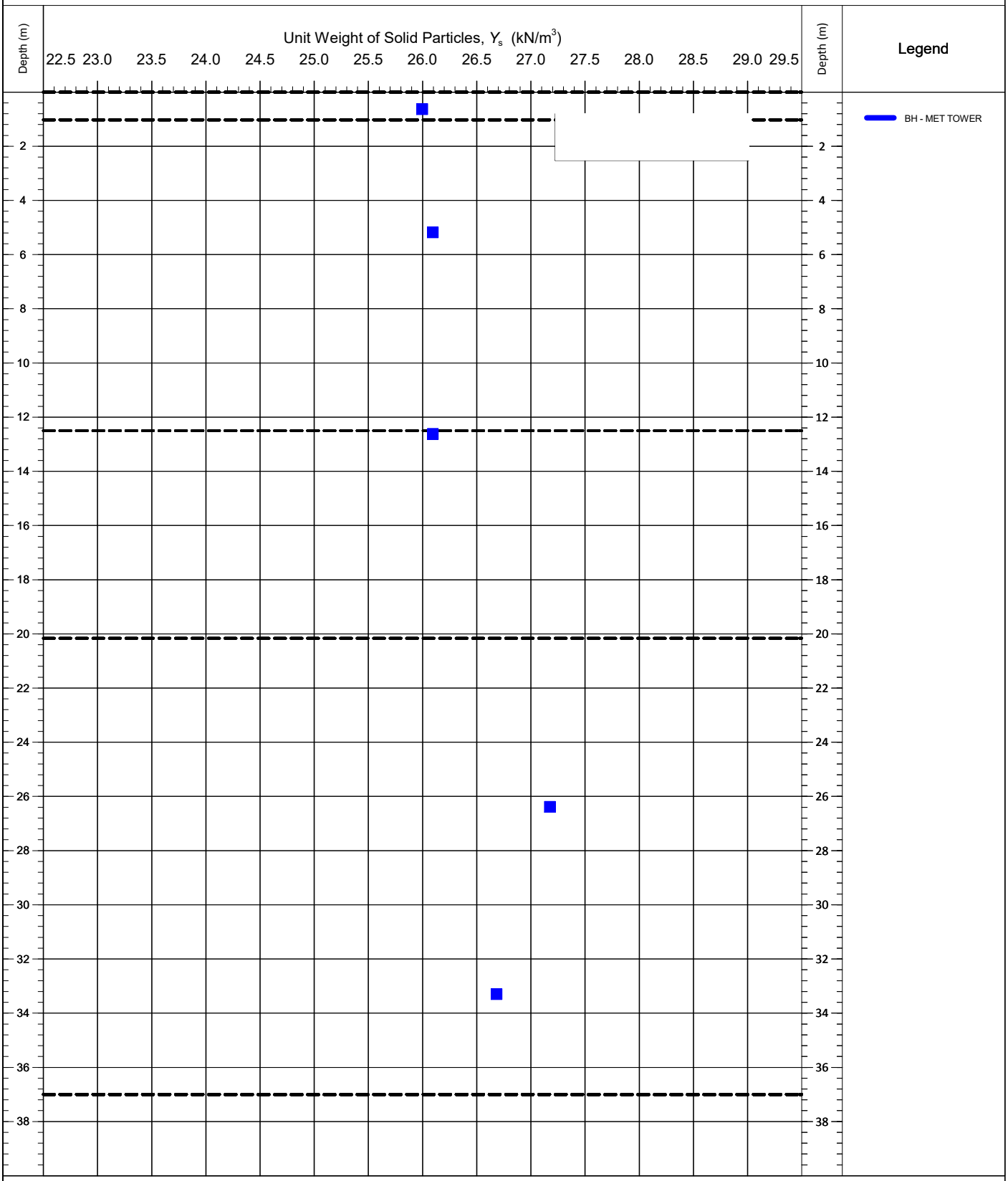


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE

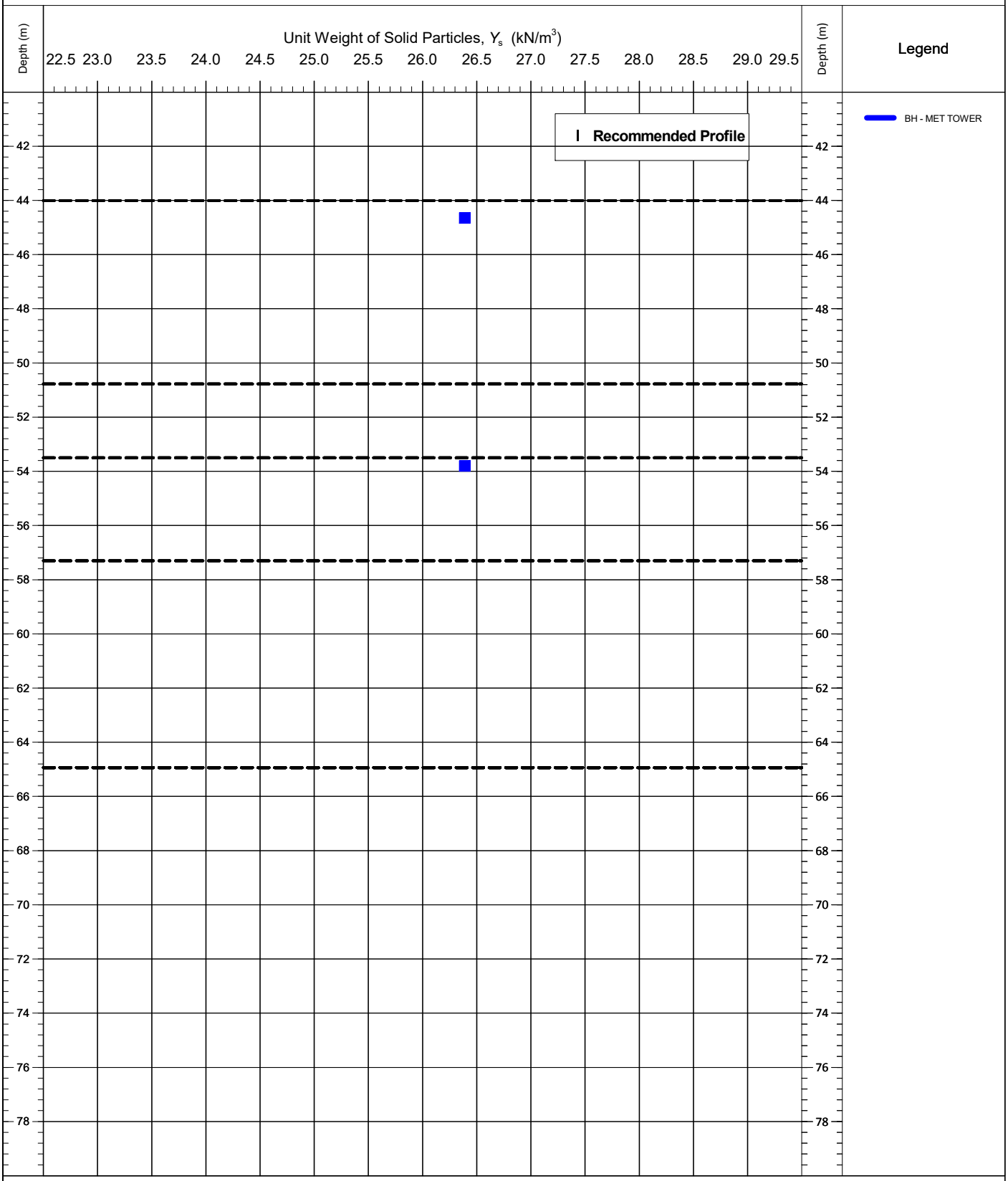


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNIT WEIGHT OF SOLID PARTICLES PROFILE



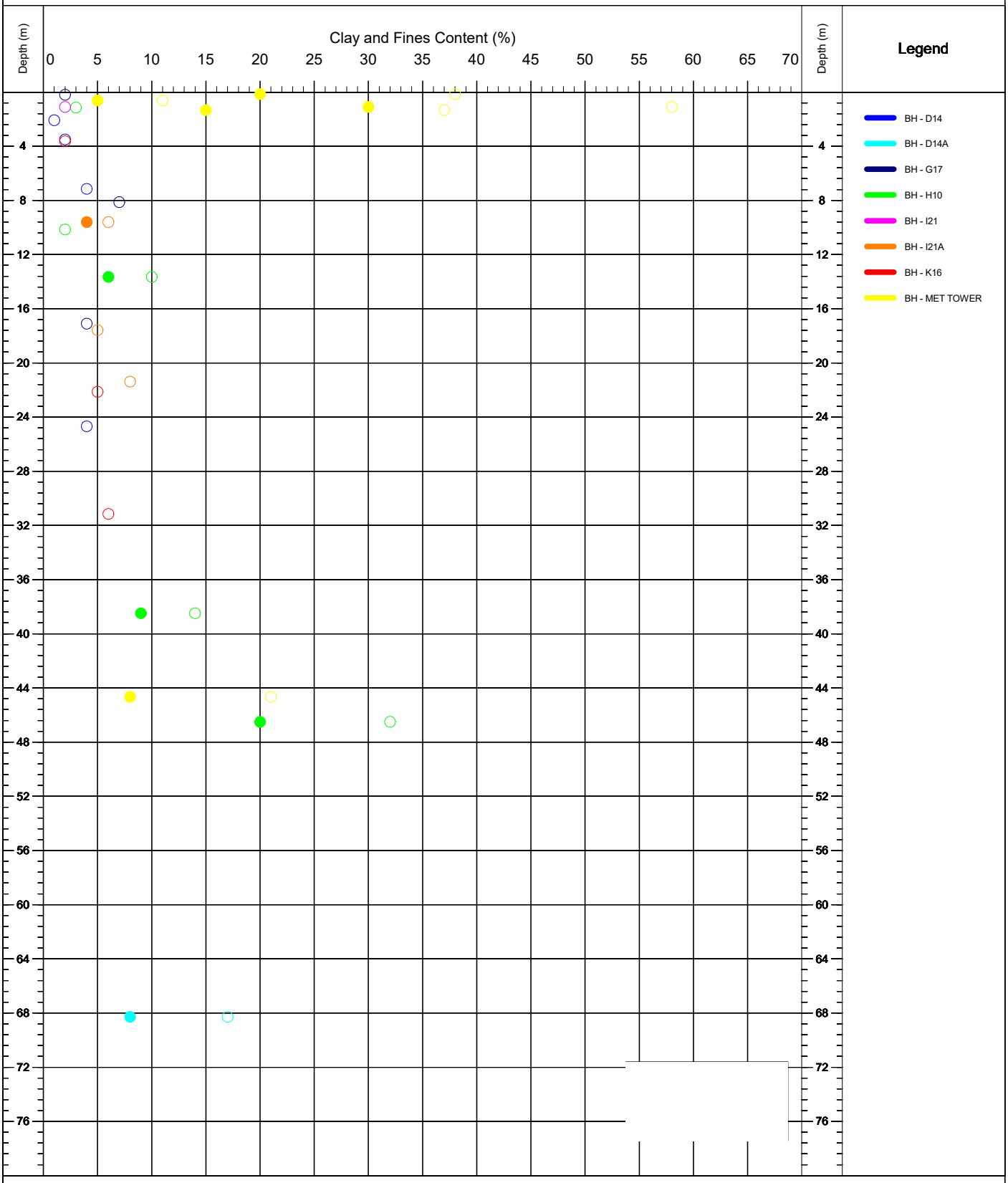
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

2.9 Fine and Clay content

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CLAY AND FINES CONTENT



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

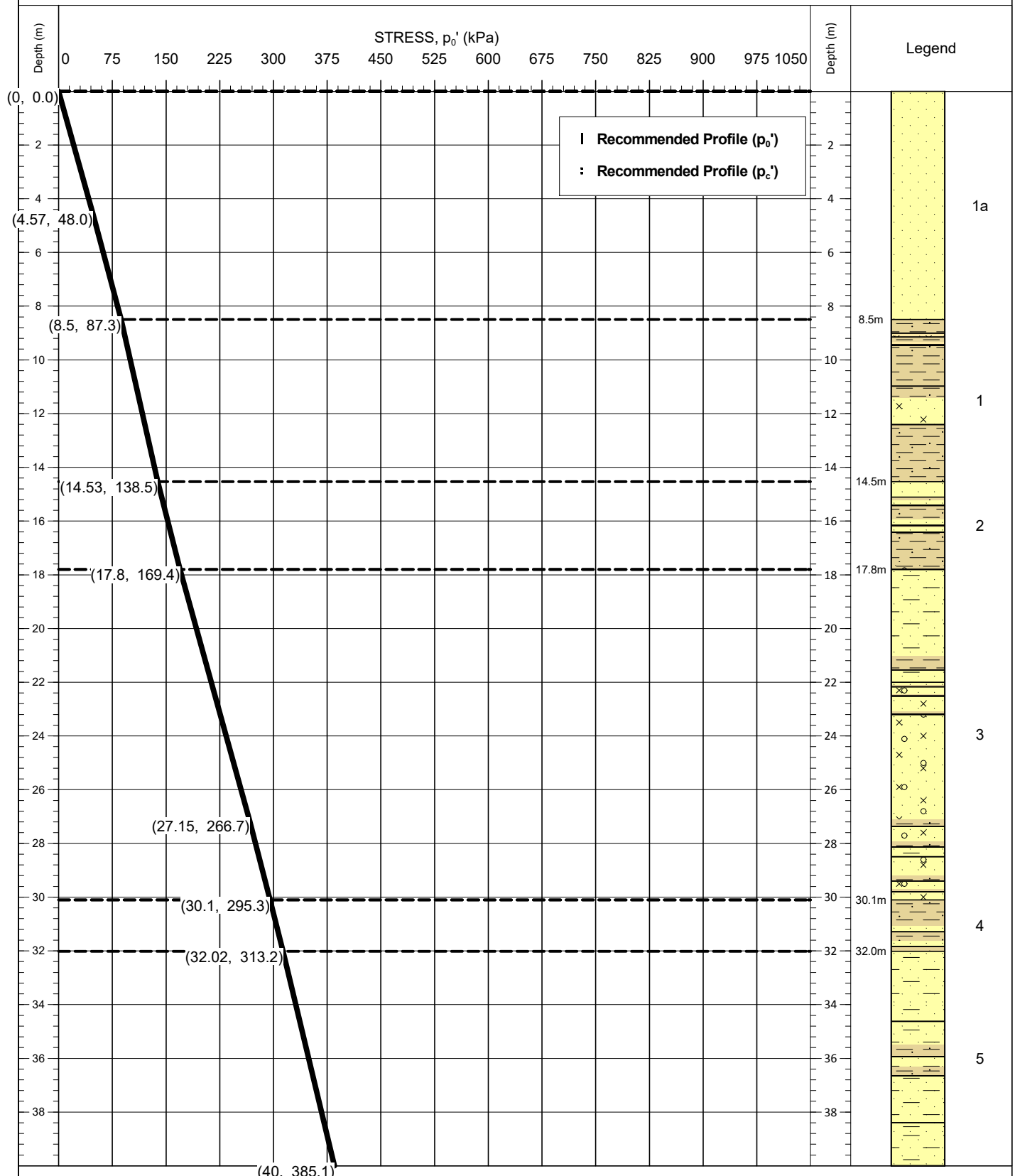
Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

APPENDIX 3

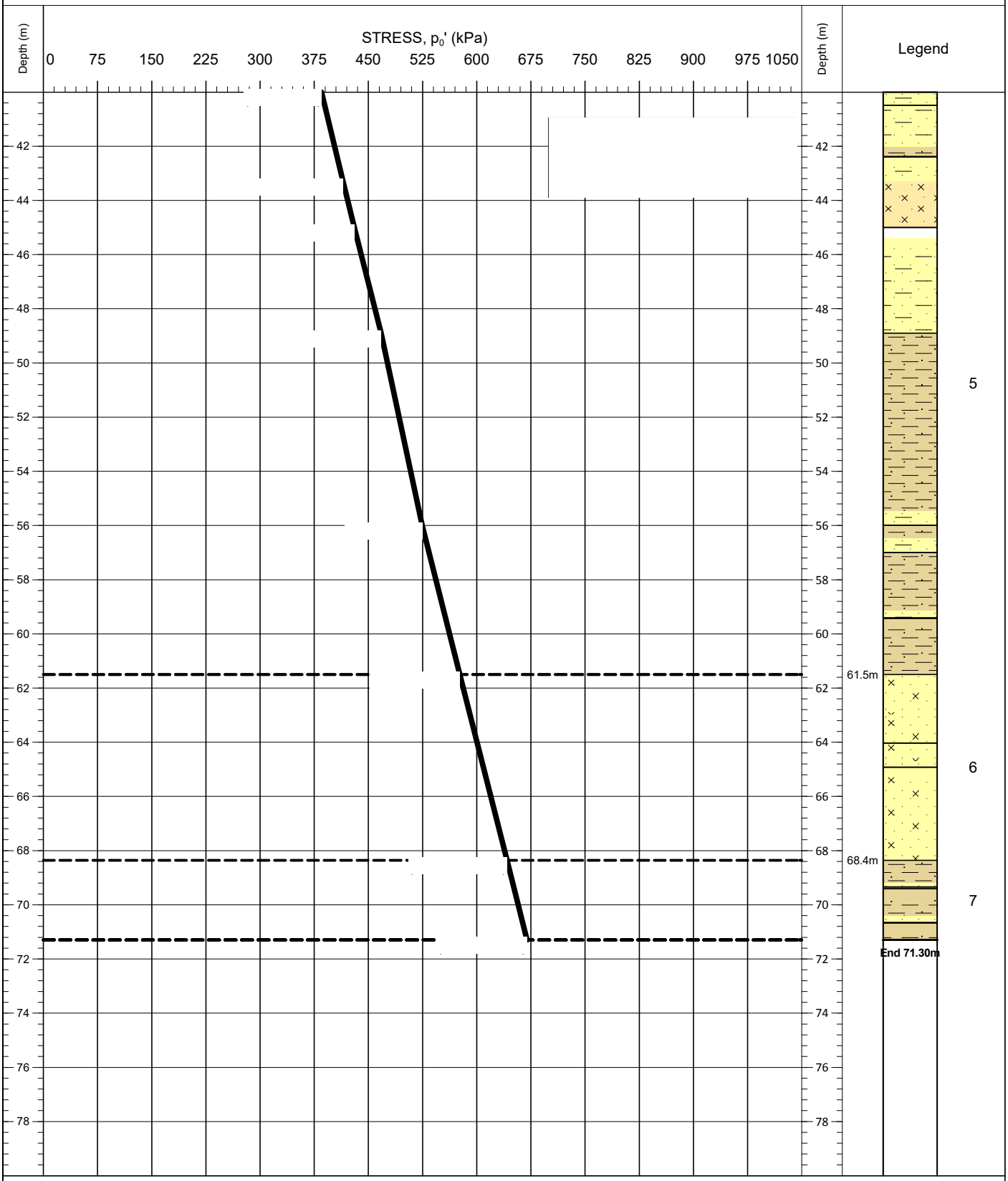
3.1 Effective Vertical Stress

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



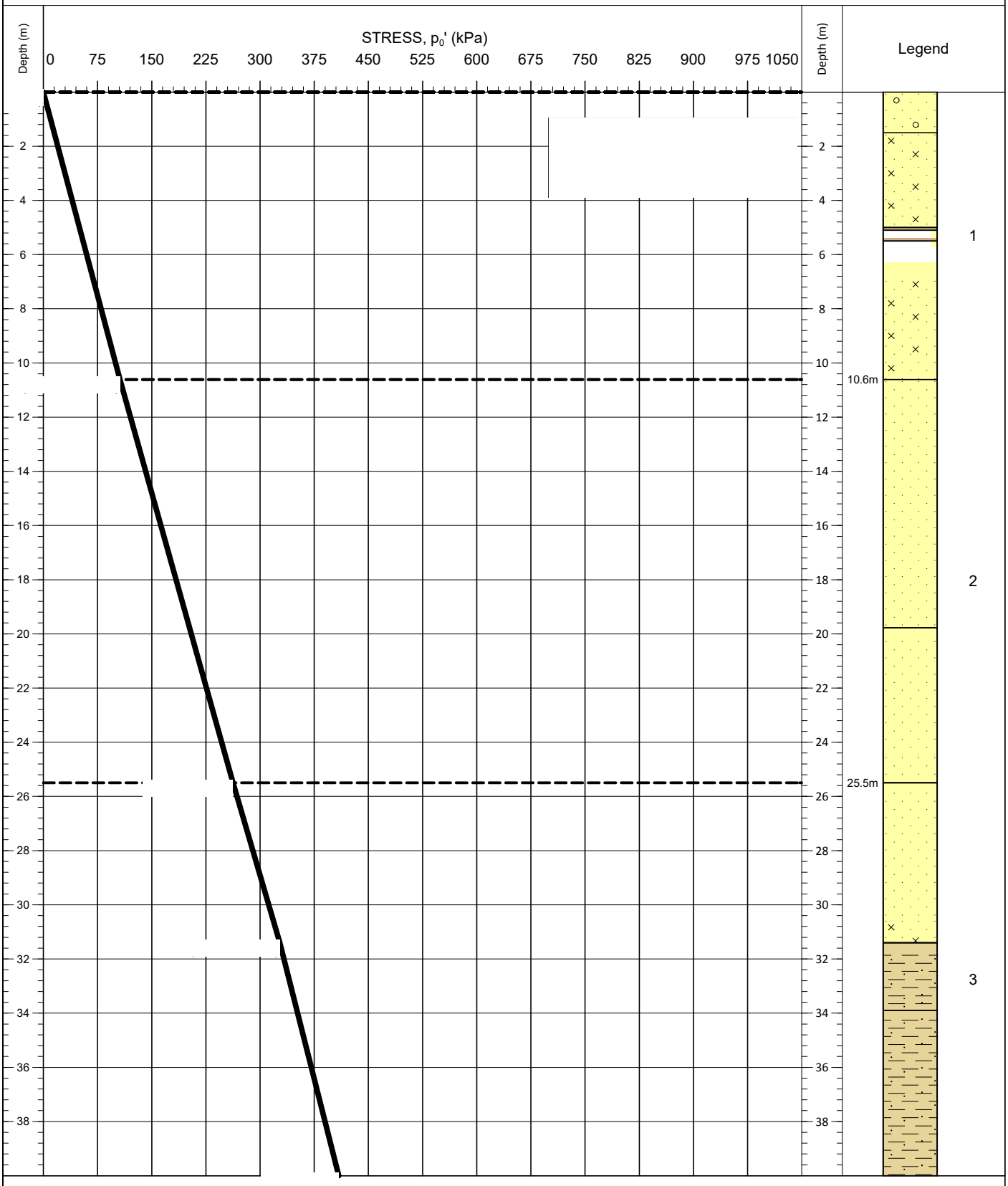
Area	**Maryland USA**	Coordinates	**515755.1E 4243612.0N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**19.1**	BH - D14_A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**30/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**71.30m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



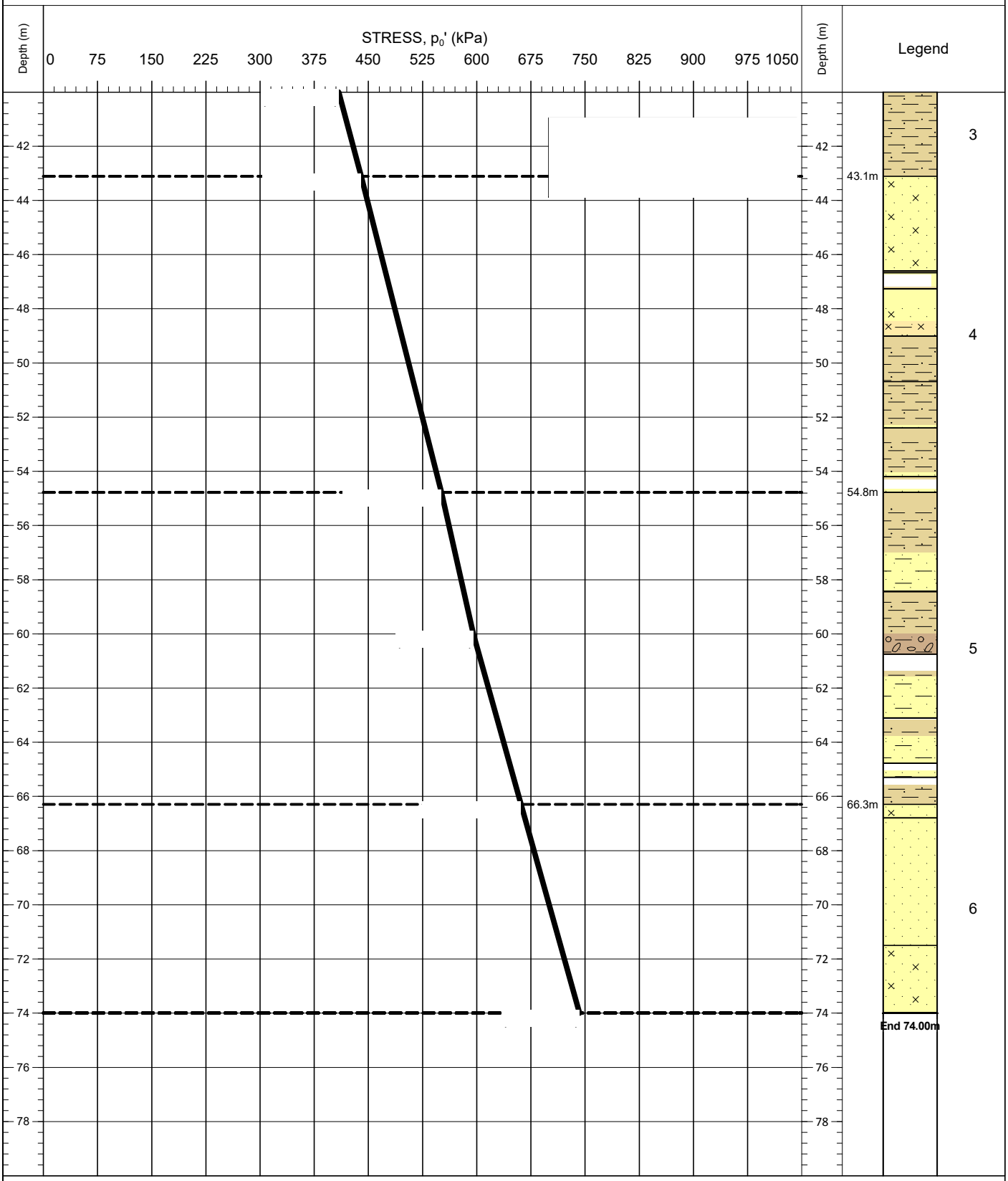
Area	**Maryland USA**	Coordinates	**515755.1E 4243612.0N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**19.1**	BH - D14_A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**30/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**71.30m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



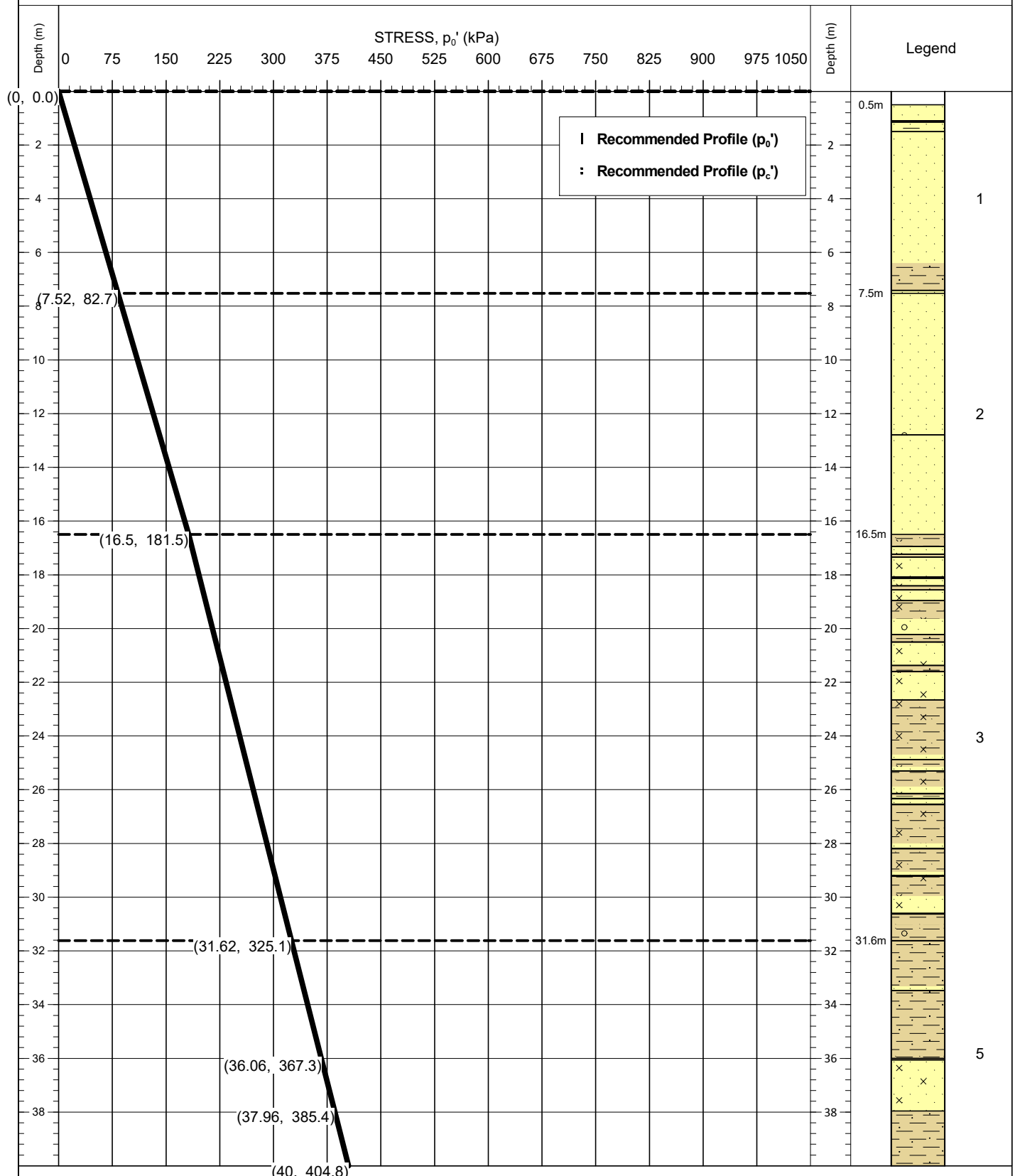
Area	**Maryland USA**	Coordinates	**519056.4E 4240311.6N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**24.9**	BH - G17_A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**02/07/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**74.00m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



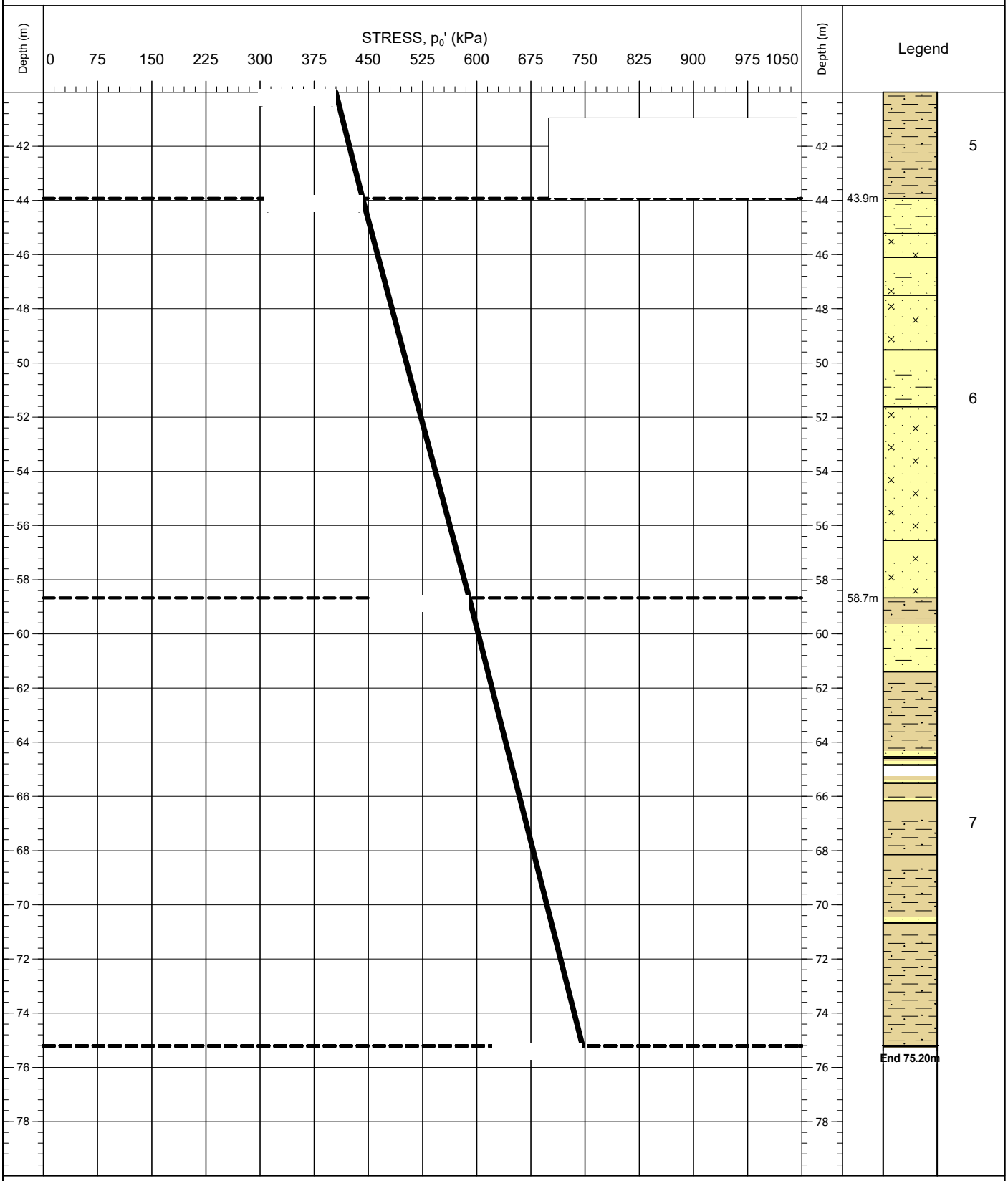
Area	**Maryland USA**	Coordinates	**519056.4E 4240311.6N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**24.9**	BH - G17_A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**02/07/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**74.00m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



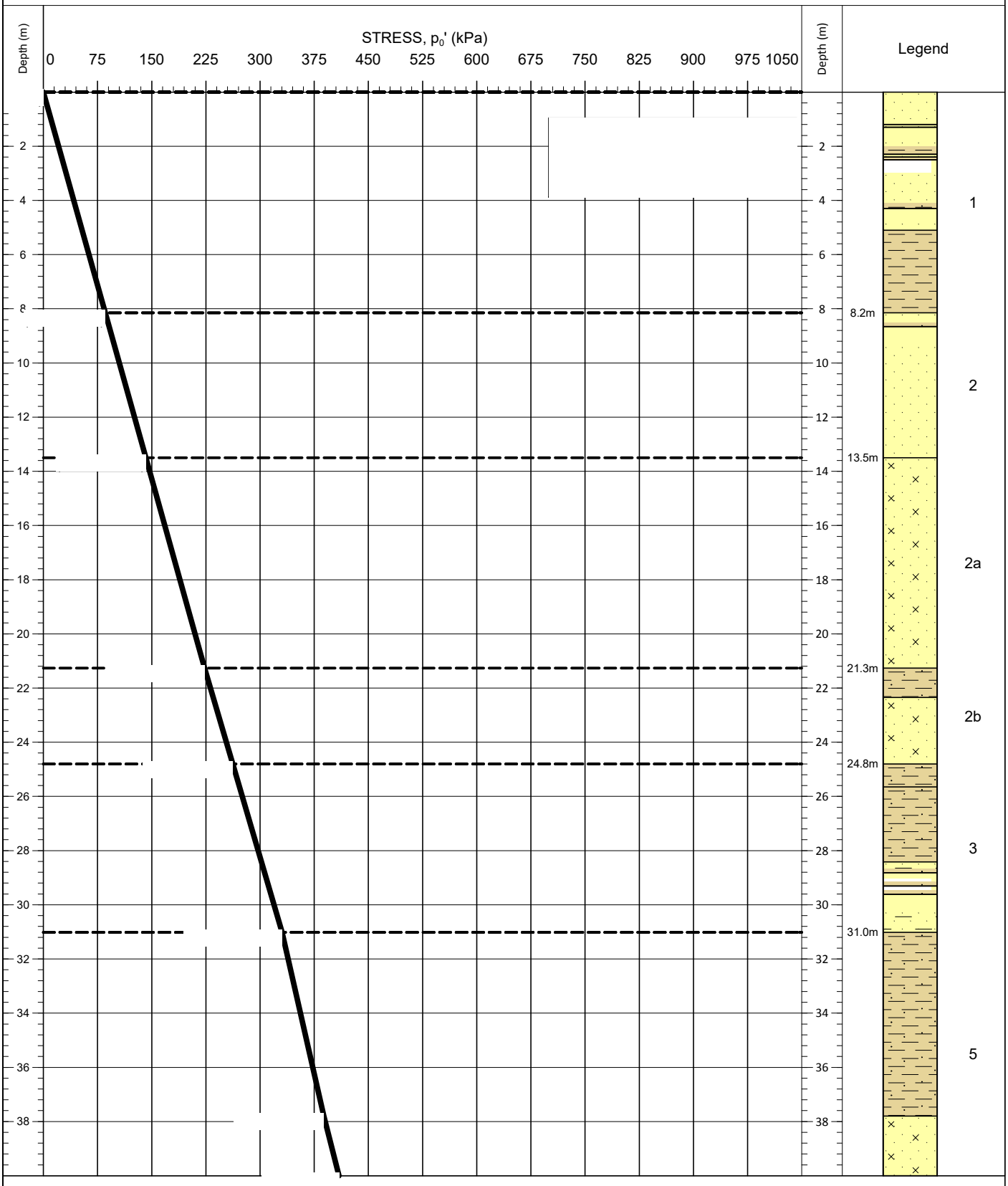
Area	**Maryland USA**	Coordinates	**519055.0E 4251306.0N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**25.0**	BH - G7_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test		Filename -
Vessel	**MV Ocean Discovery**	Final Depth	**75.20m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary / Draft / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	**SMc** (28/09/2015) / **JG** (21/01/2016) / ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



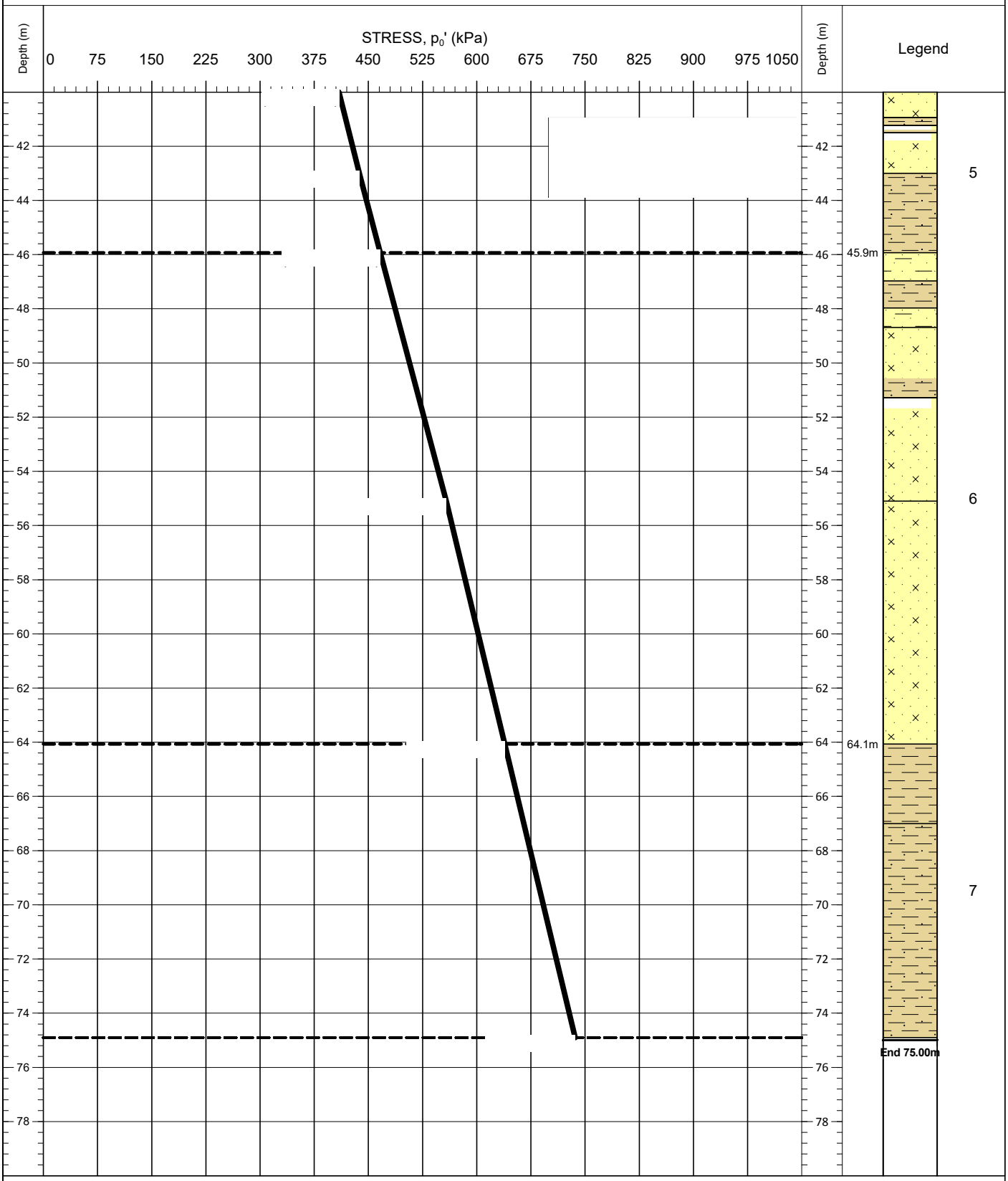
Area	**Maryland USA**	Coordinates	**519055.0E 4251306.0N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**25.0**	BH - G7_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test		
Vessel	**MV Ocean Discovery**	Final Depth	**75.20m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



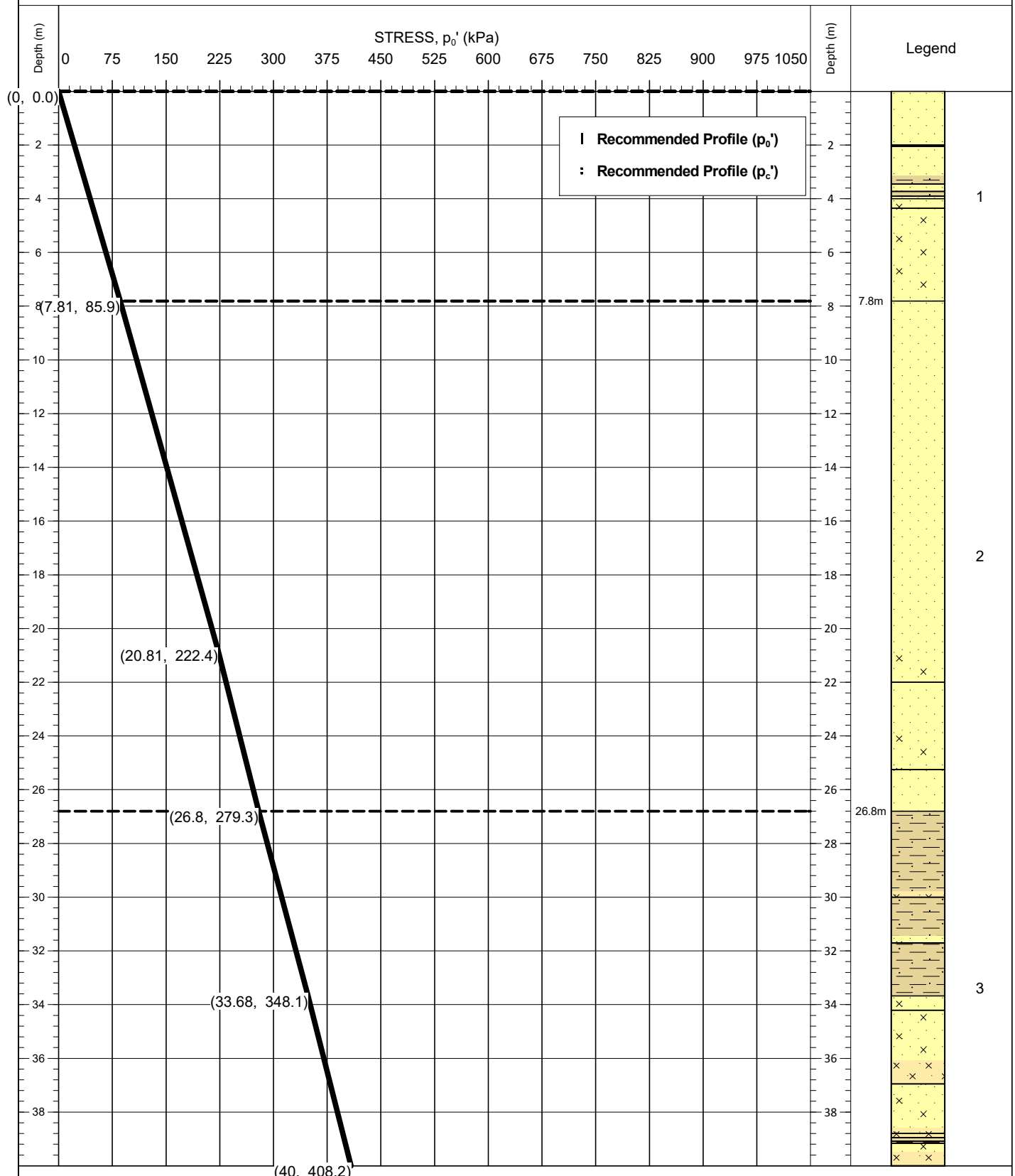
Area	**Maryland USA**	Coordinates	**520154.3E 4248006.5N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**26.8**	BH - H10_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test		Filename -
Vessel	**MV Ocean Discovery**	Final Depth	**75.00m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary / Draft / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	**SMc** (28/09/2015) / **JG** (21/01/2016) / ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



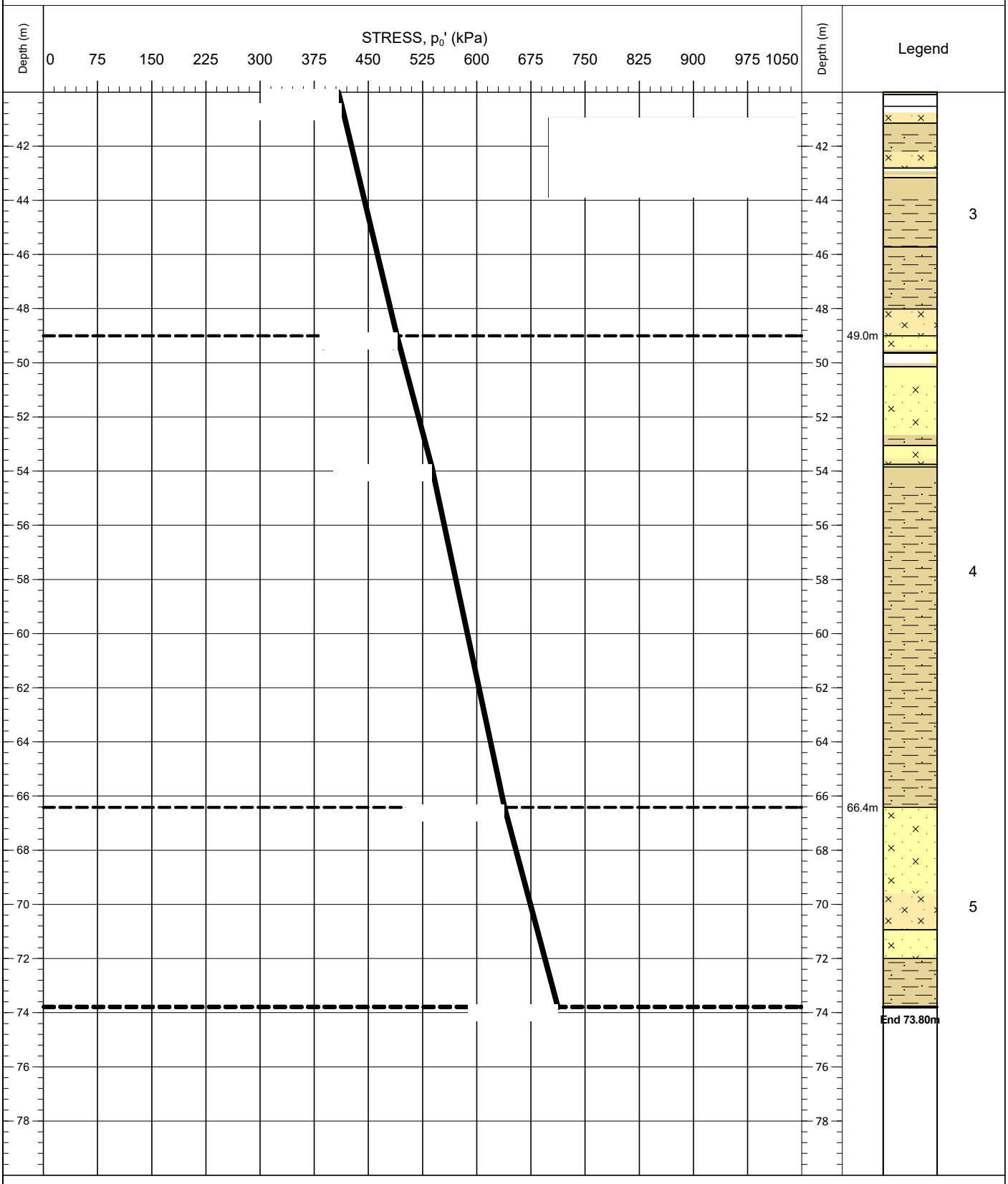
Area	**Maryland USA**	Coordinates	**520154.3E 4248006.5N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**26.8**	BH - H10_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test		
Vessel	**MV Ocean Discovery**	Final Depth	**75.00m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



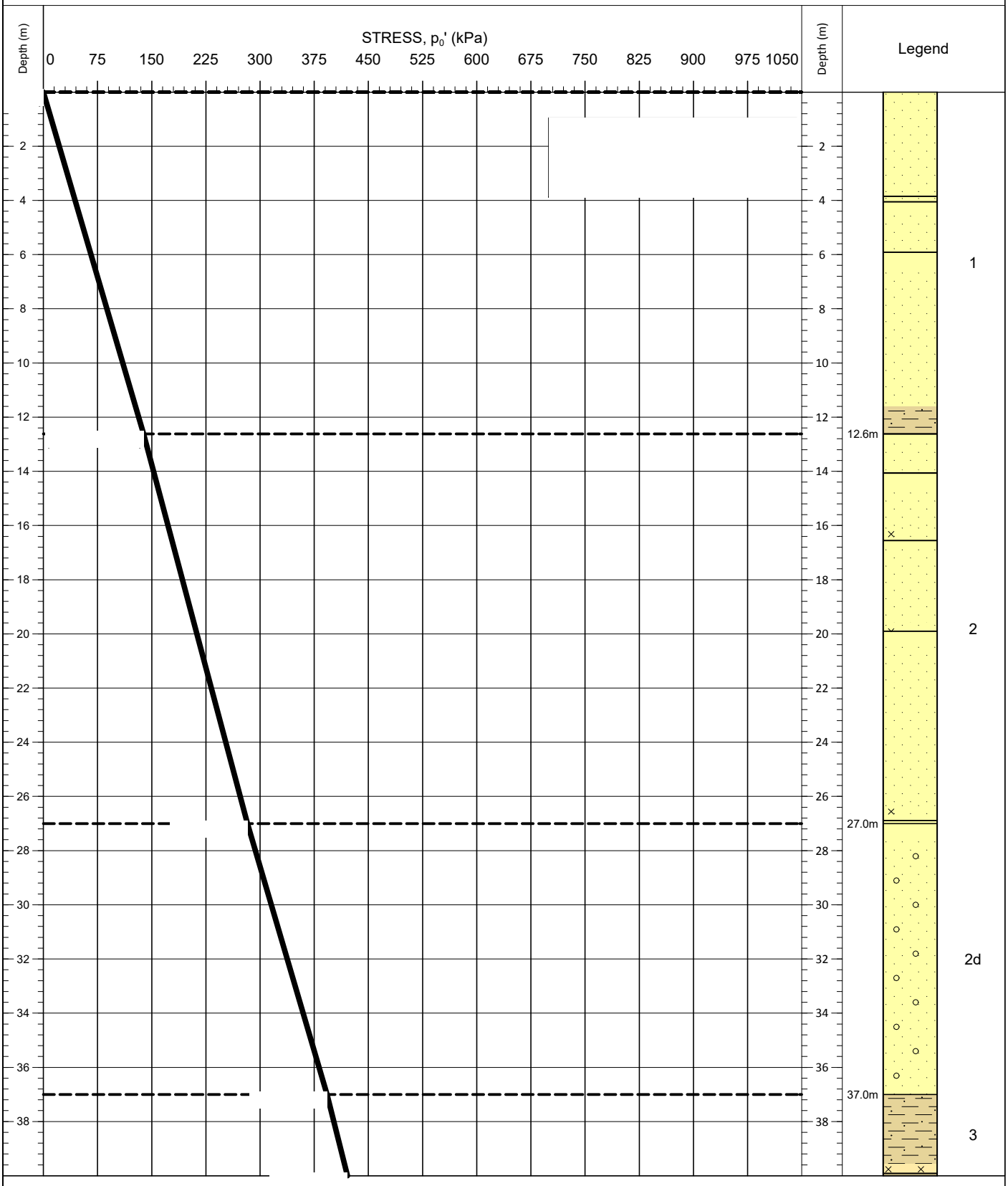
Area	**Maryland USA**	Coordinates	**521255.0E 4235906.0N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**23.0**	BH - I21_A_B
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**24/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**73.80m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



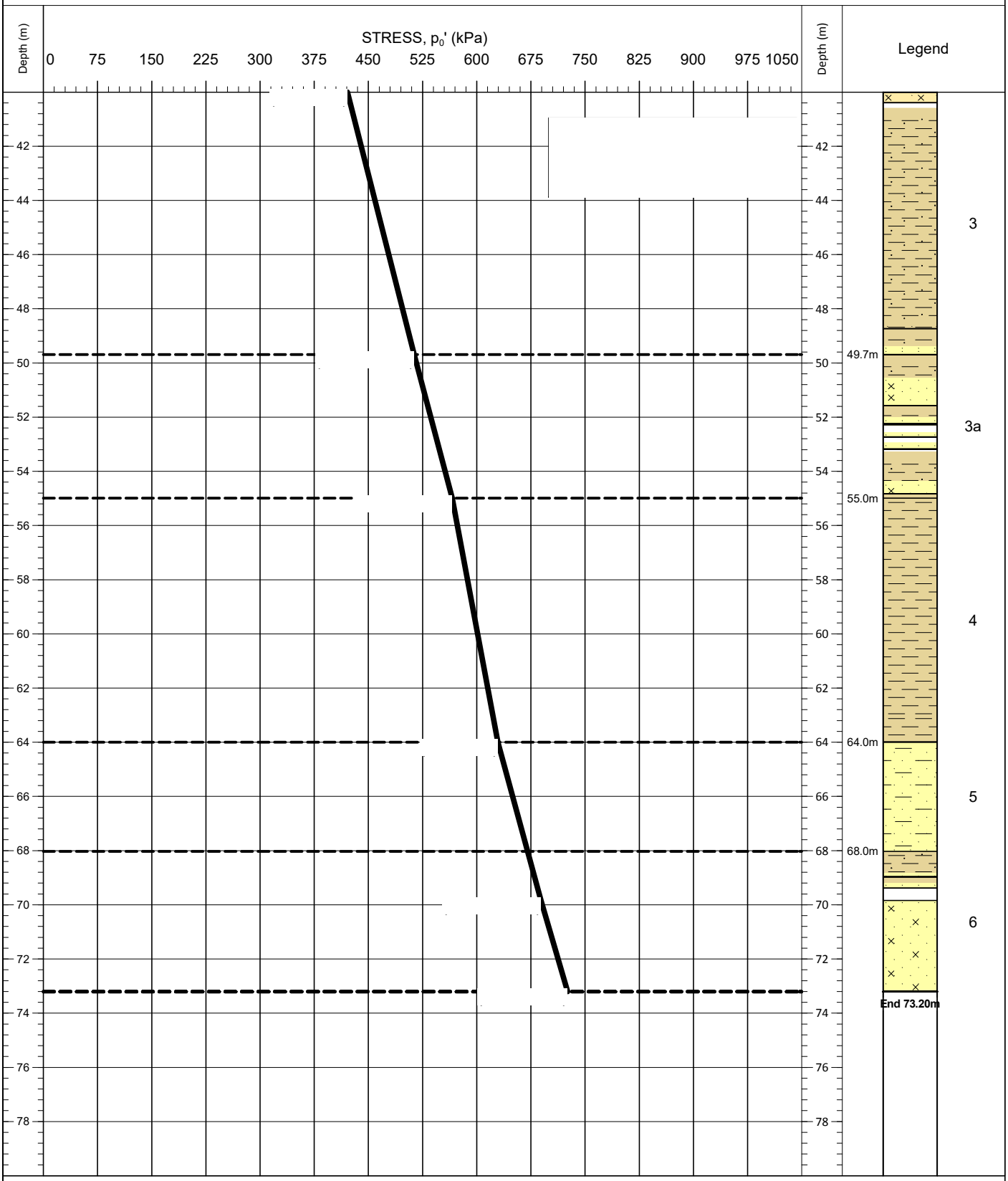
Area	**Maryland USA**	Coordinates	**521255.0E 4235906.0N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**23.0**	BH - I21_A_B
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**24/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**73.80m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



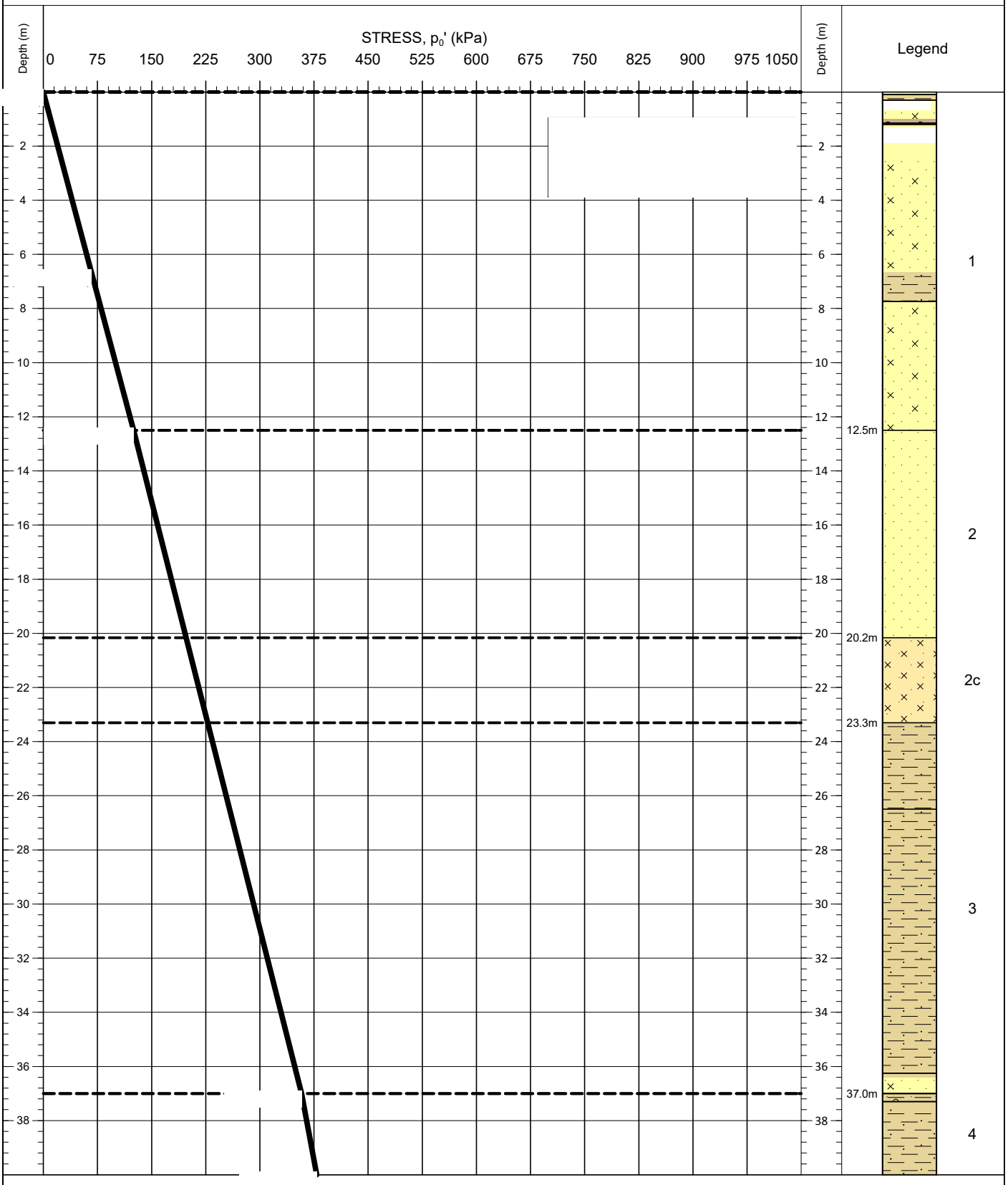
Area	**Maryland USA**	Coordinates	**523454.4E 4241406.3N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**24.6**	BH - K16_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test		
Vessel	**MV Ocean Discovery**	Final Depth	**73.20m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



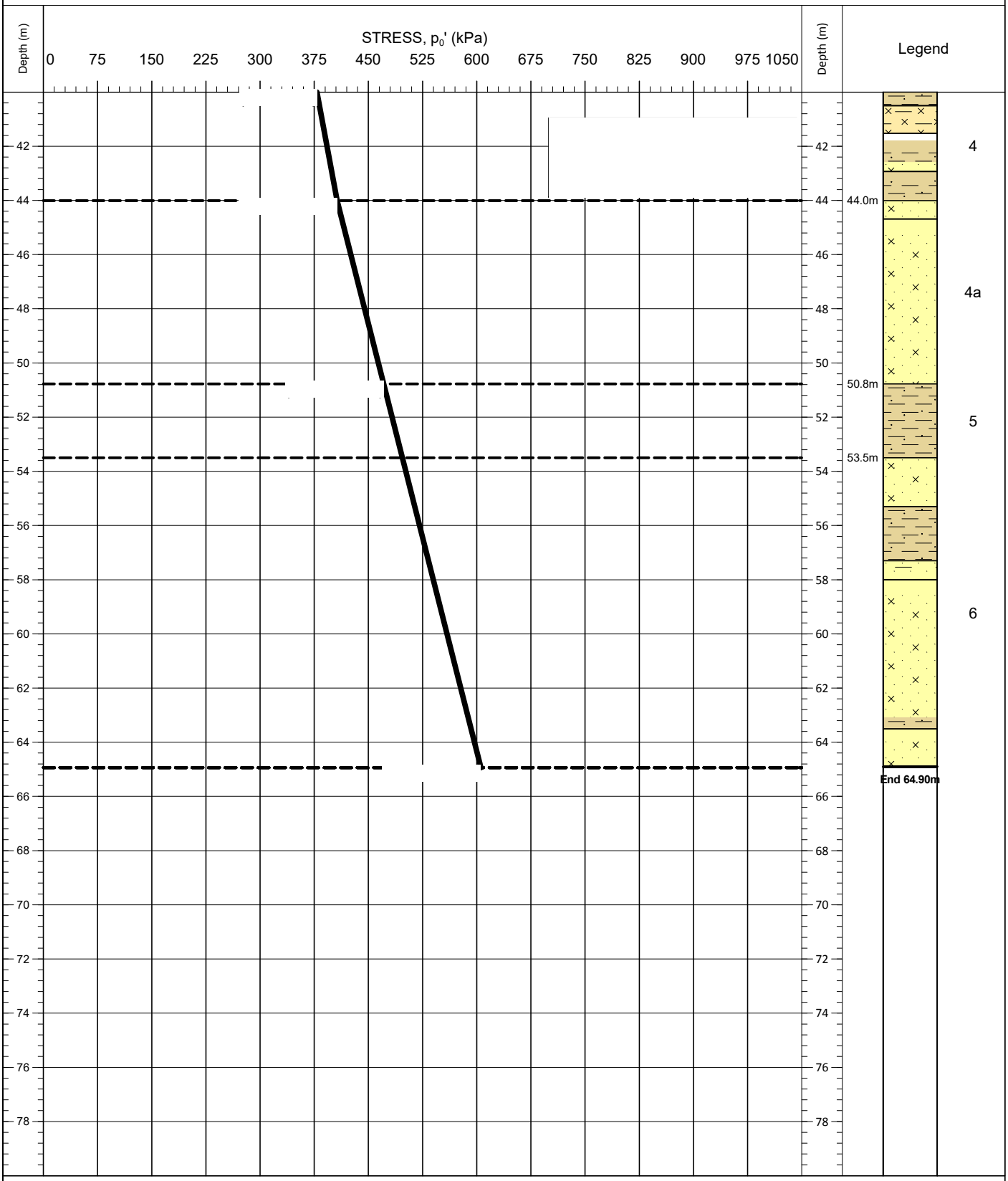
Area	**Maryland USA**	Coordinates	**523454.4E 4241406.3N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**24.6**	BH - K16_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test		Filename -
Vessel	**MV Ocean Discovery**	Final Depth	**73.20m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**27.7**	BH - MET TOWER_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**19/06/2015 - 20/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
VERTICAL EFFECTIVE STRESS

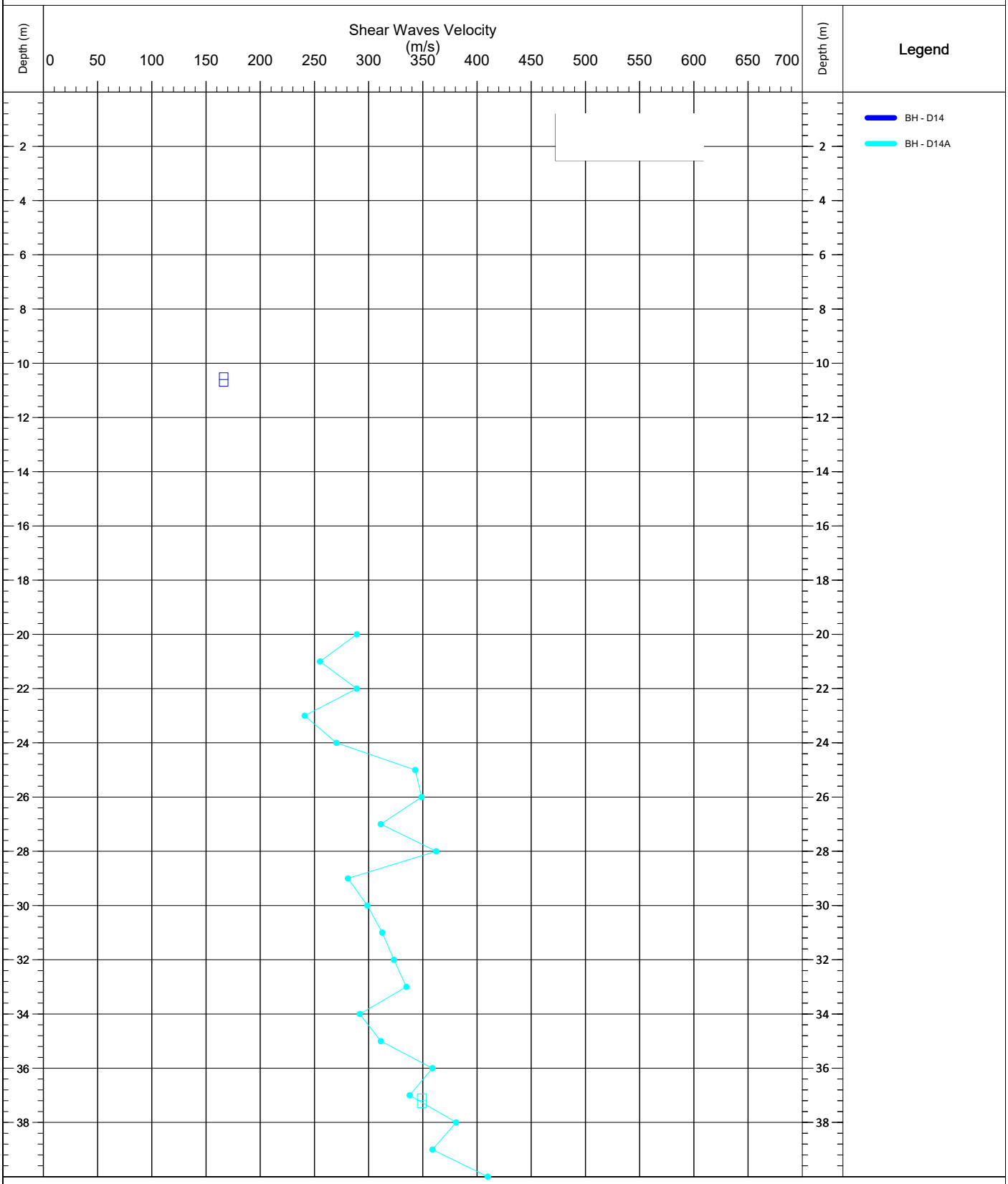


Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	CPT Name
Contract	**10451**	Water Depth (mLAT)	**27.7**	BH - MET TOWER_
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**19/06/2015 - 20/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename -
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()

APPENDIX 4

4.1 Shear waves velocities

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

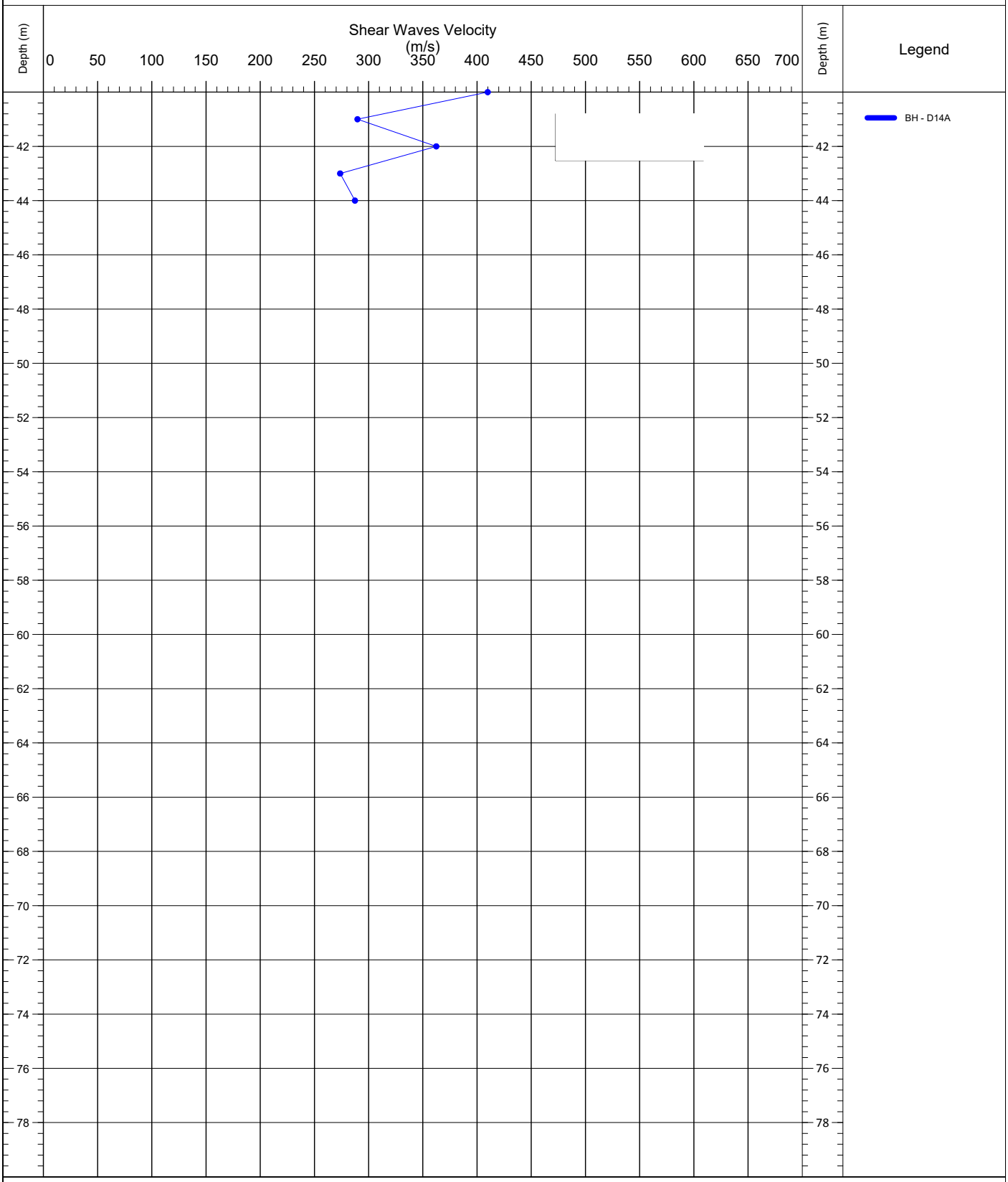


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

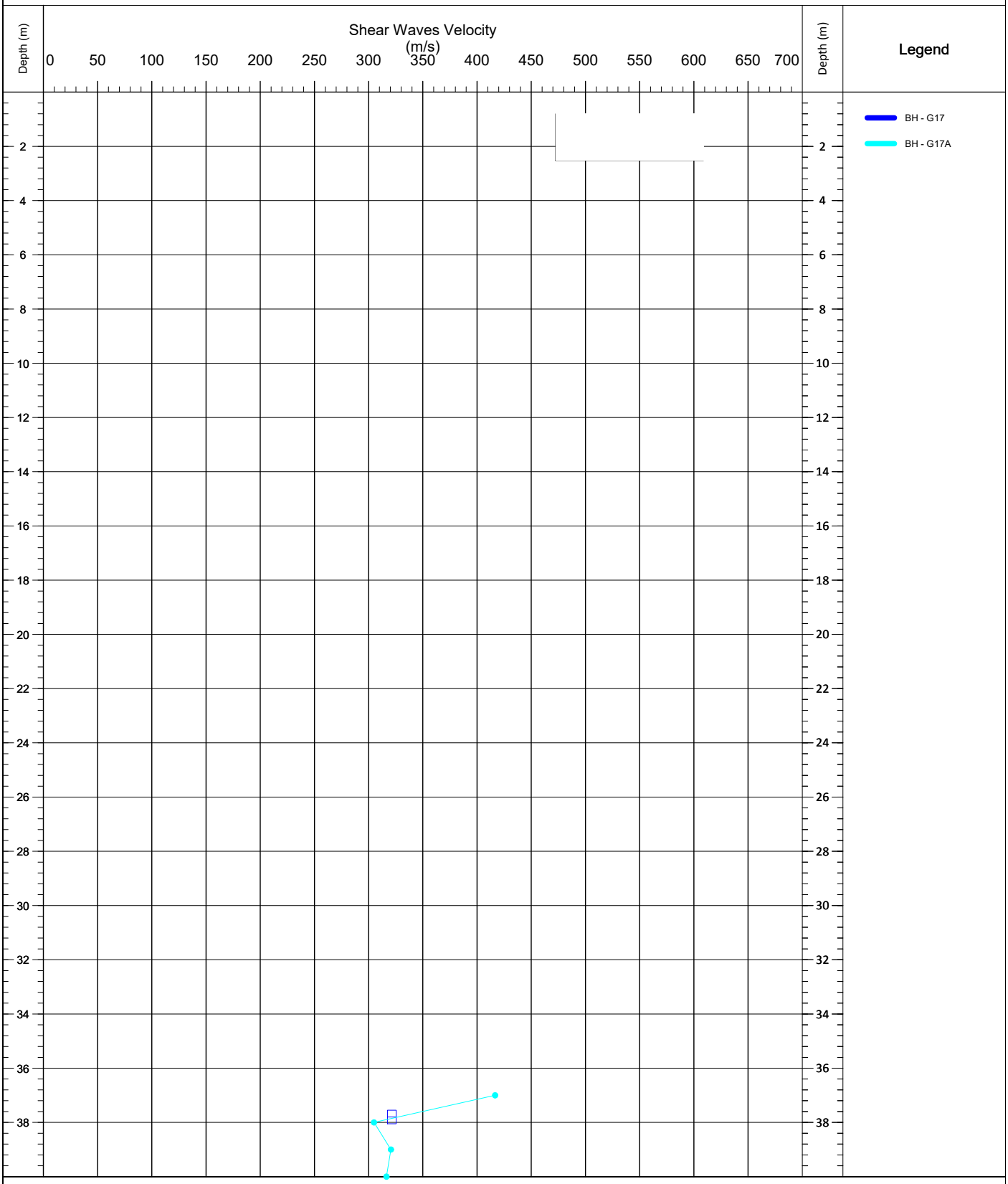


Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
Vessel	**MV Ocean Discovery**		
CRS	**GRS 80 UTM ZONE 18 N (75 W)**		

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

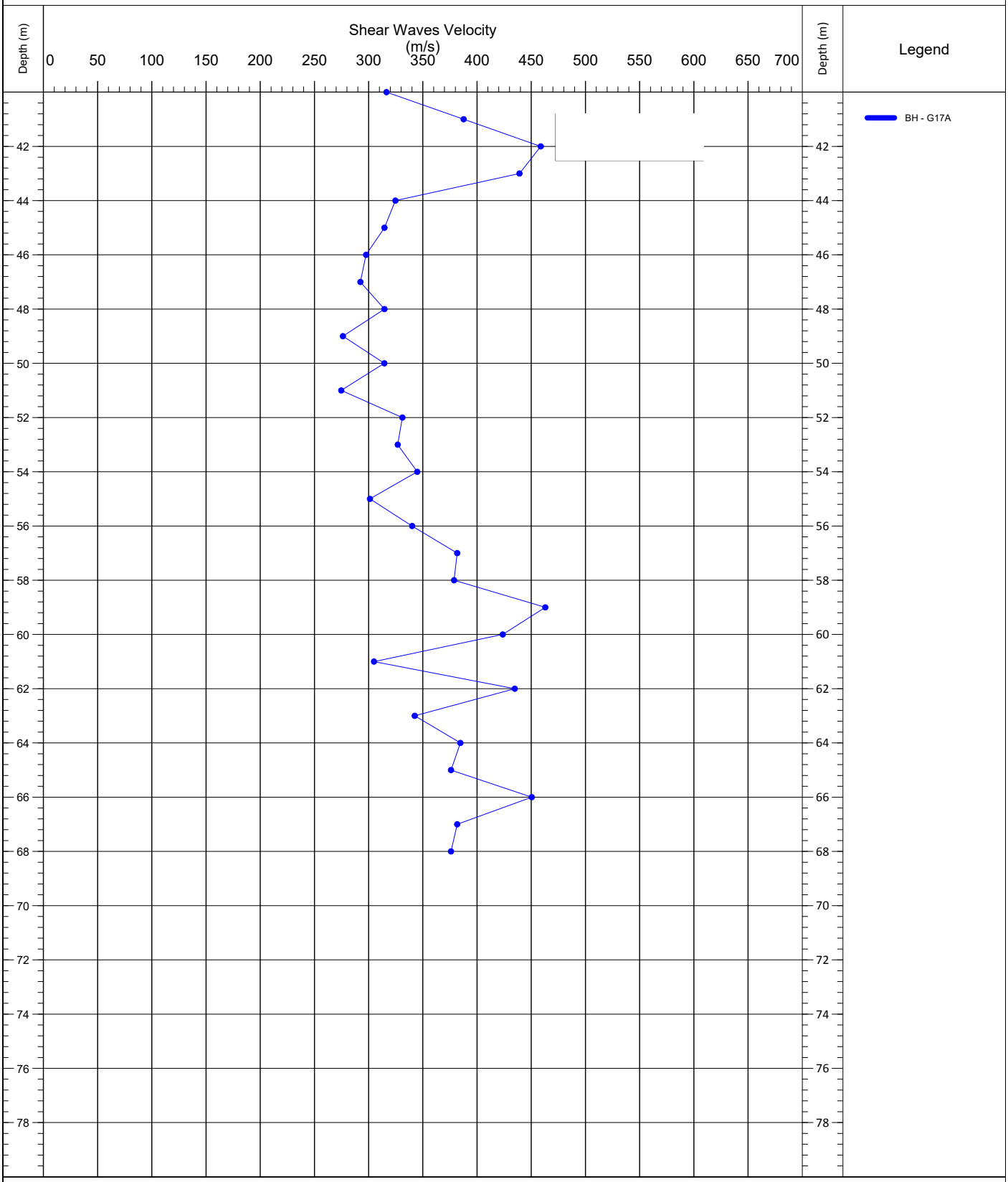


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

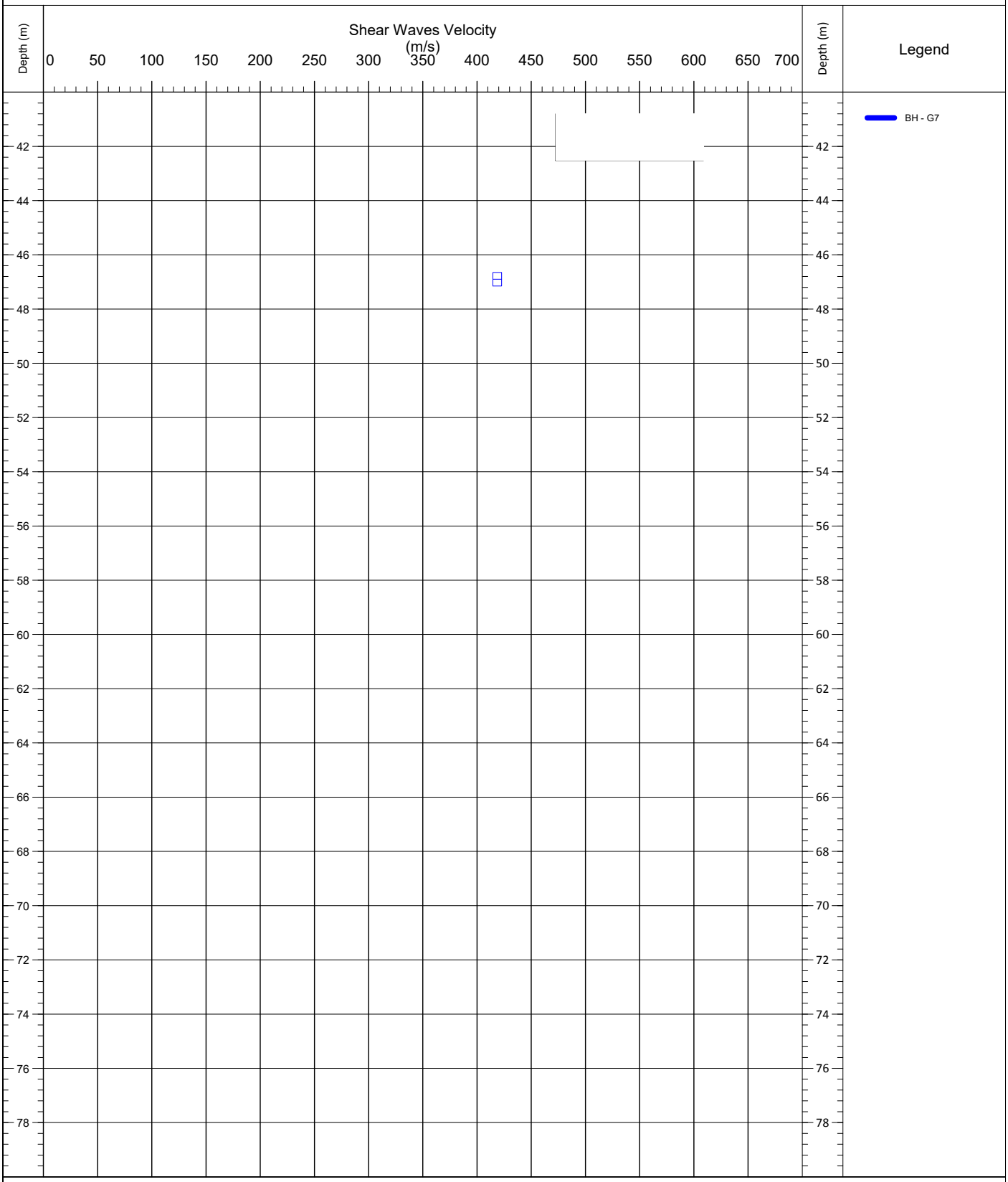


Area	**Maryland USA**	**Comments:**
Contract	**10451**	
Client Name/Ref	**US Wind Inc./ REF11449**	
Vessel	**MV Ocean Discovery**	
CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

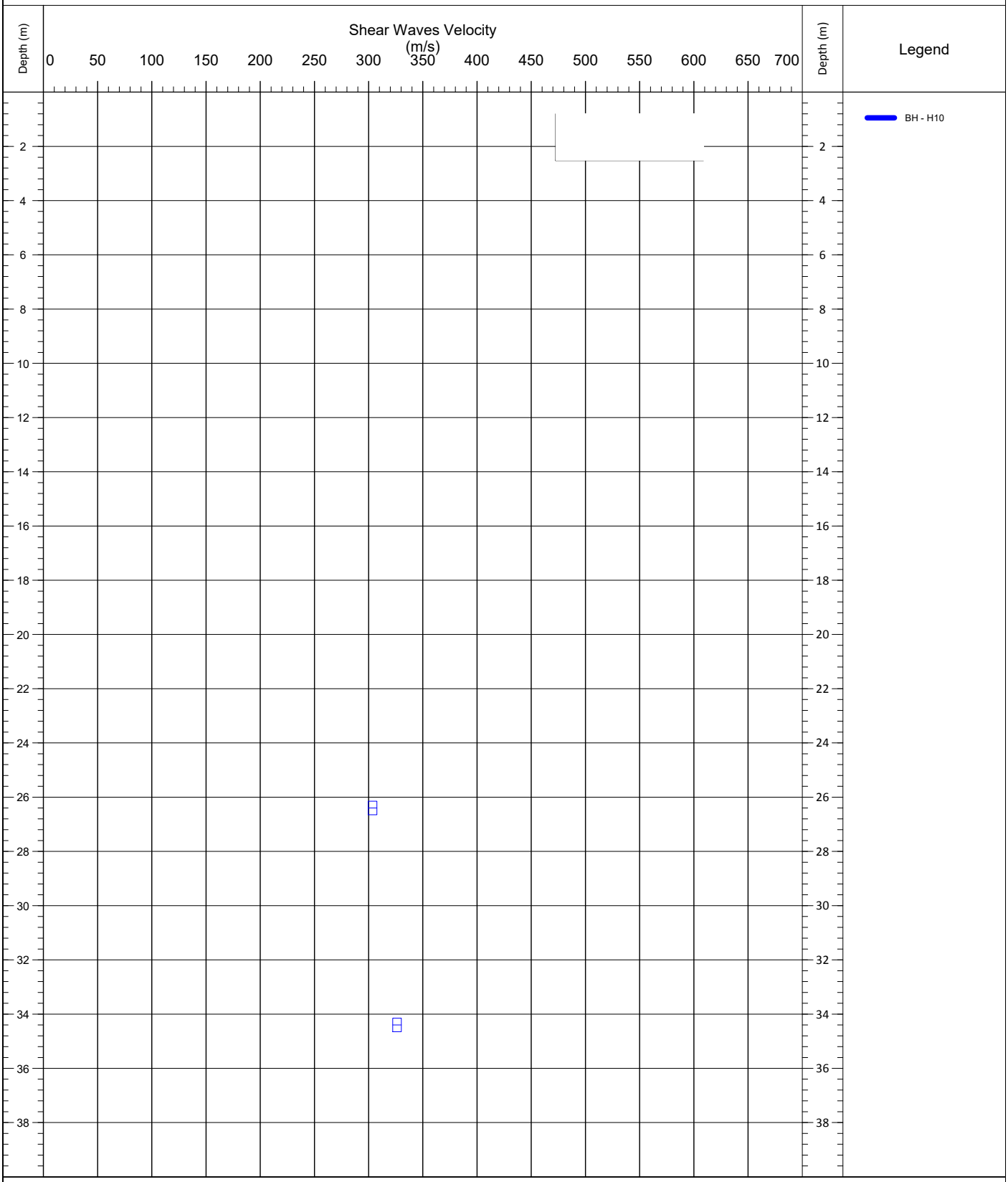


Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
Vessel	**MV Ocean Discovery**		
CRS	**GRS 80 UTM ZONE 18 N (75 W)**		

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



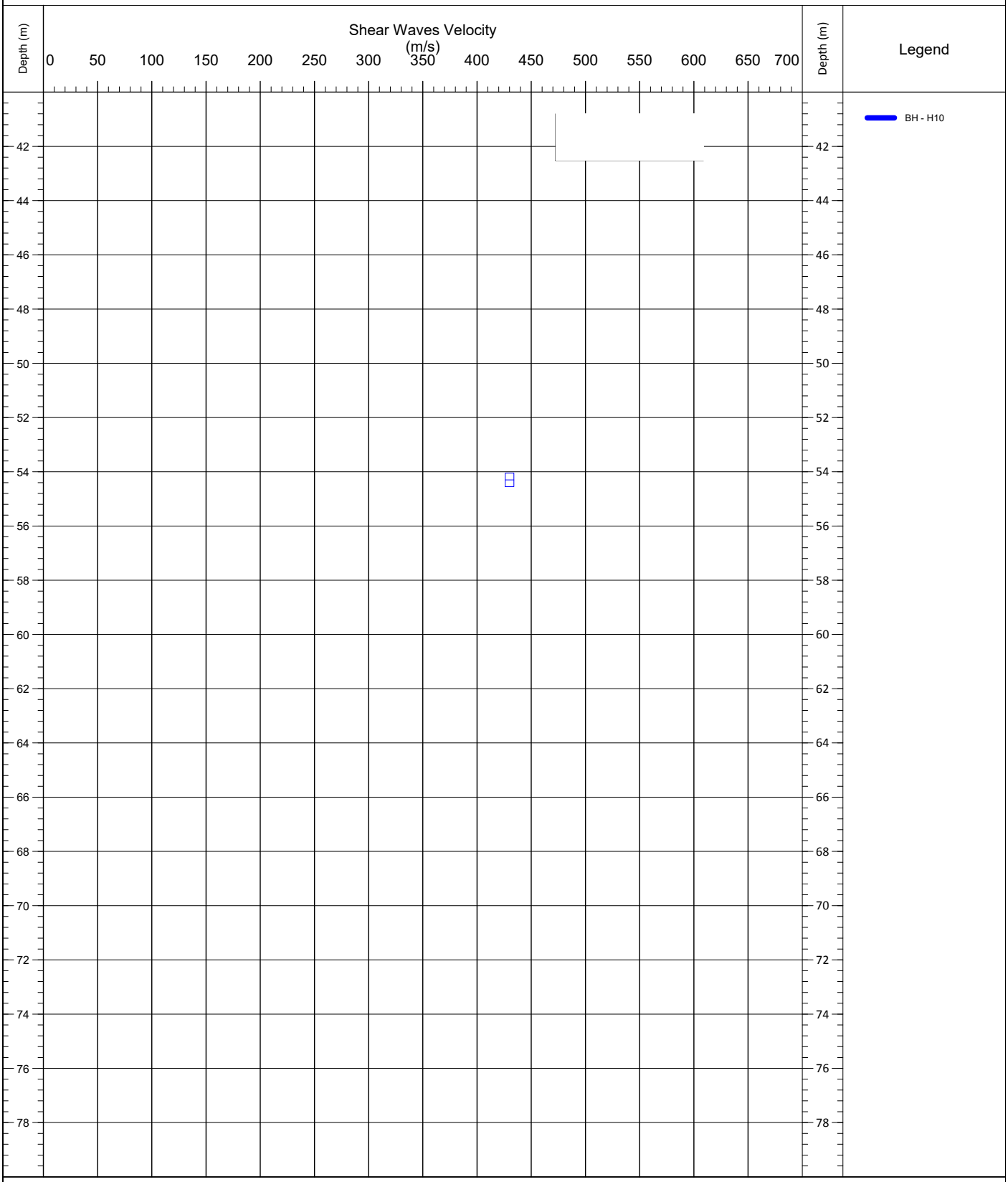
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

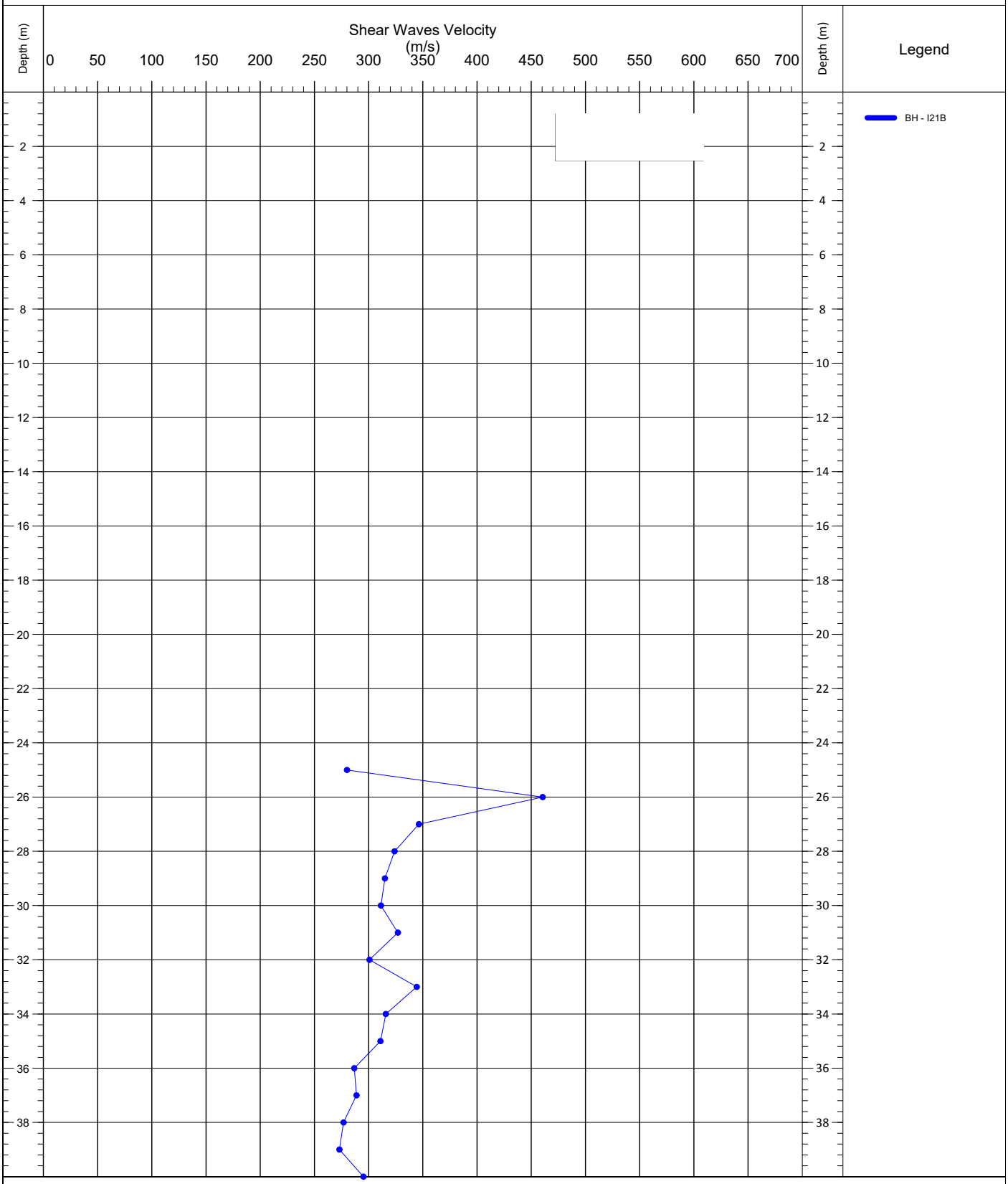


Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
Vessel	**MV Ocean Discovery**		
CRS	**GRS 80 UTM ZONE 18 N (75 W)**		

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

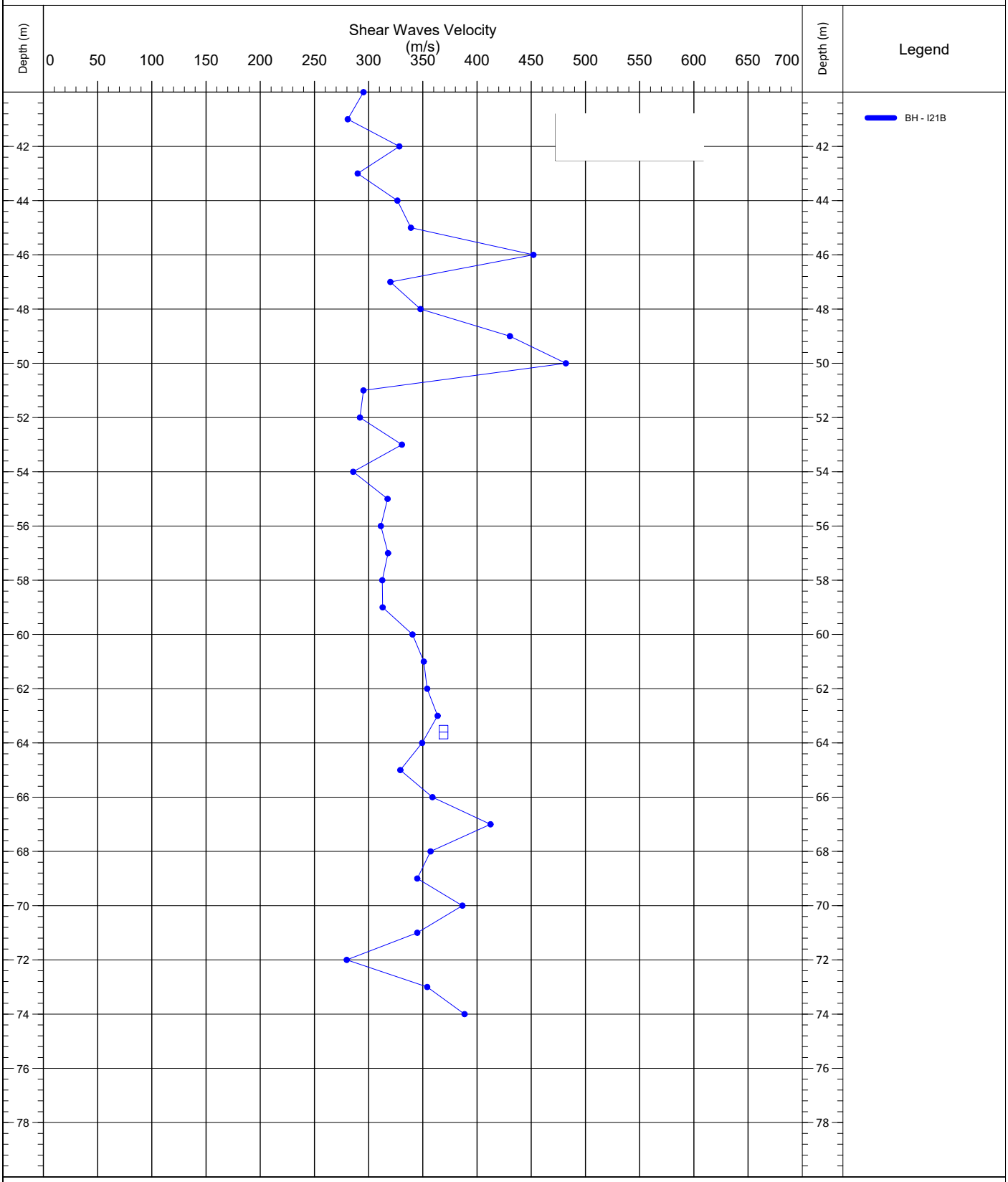


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
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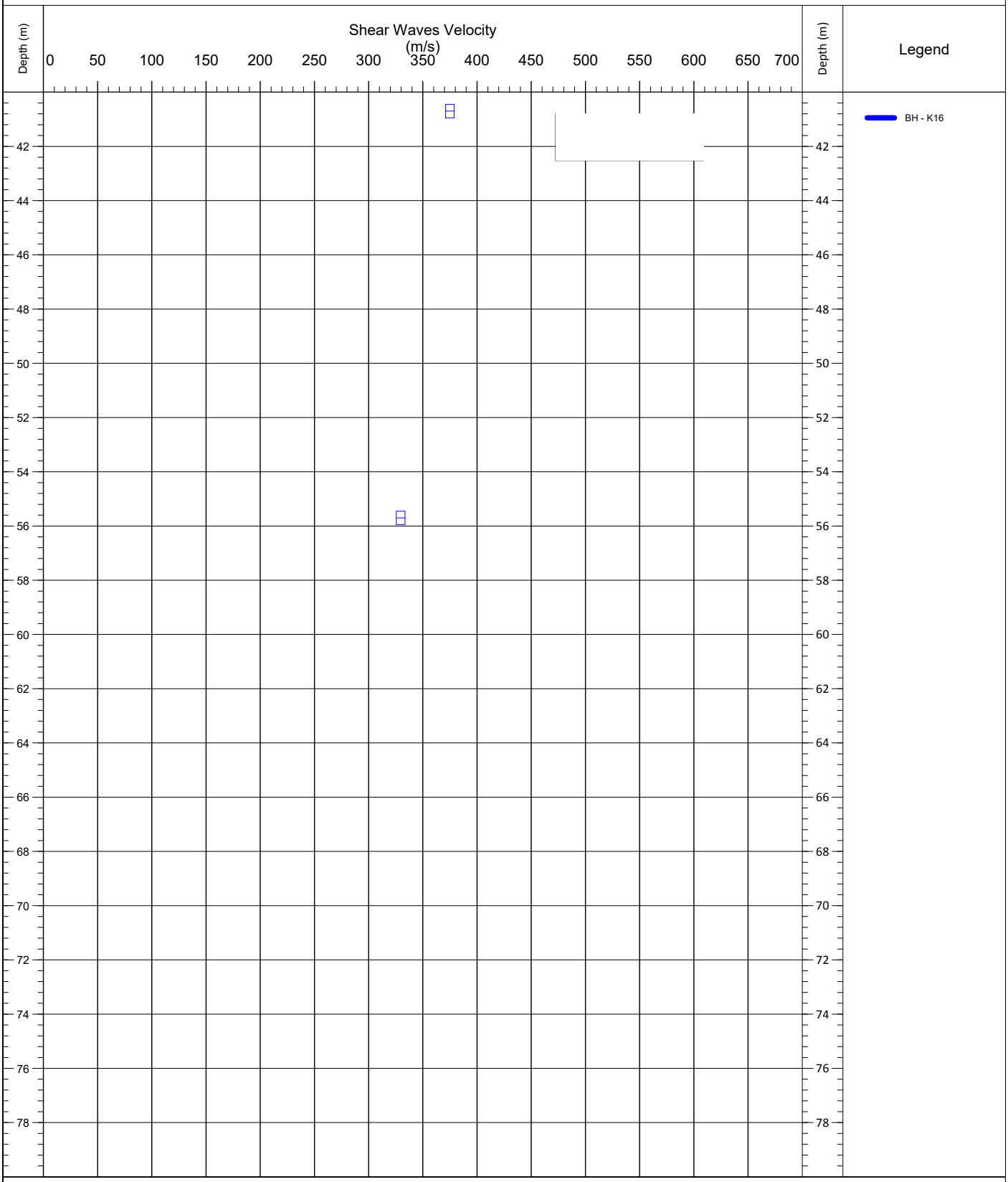
QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
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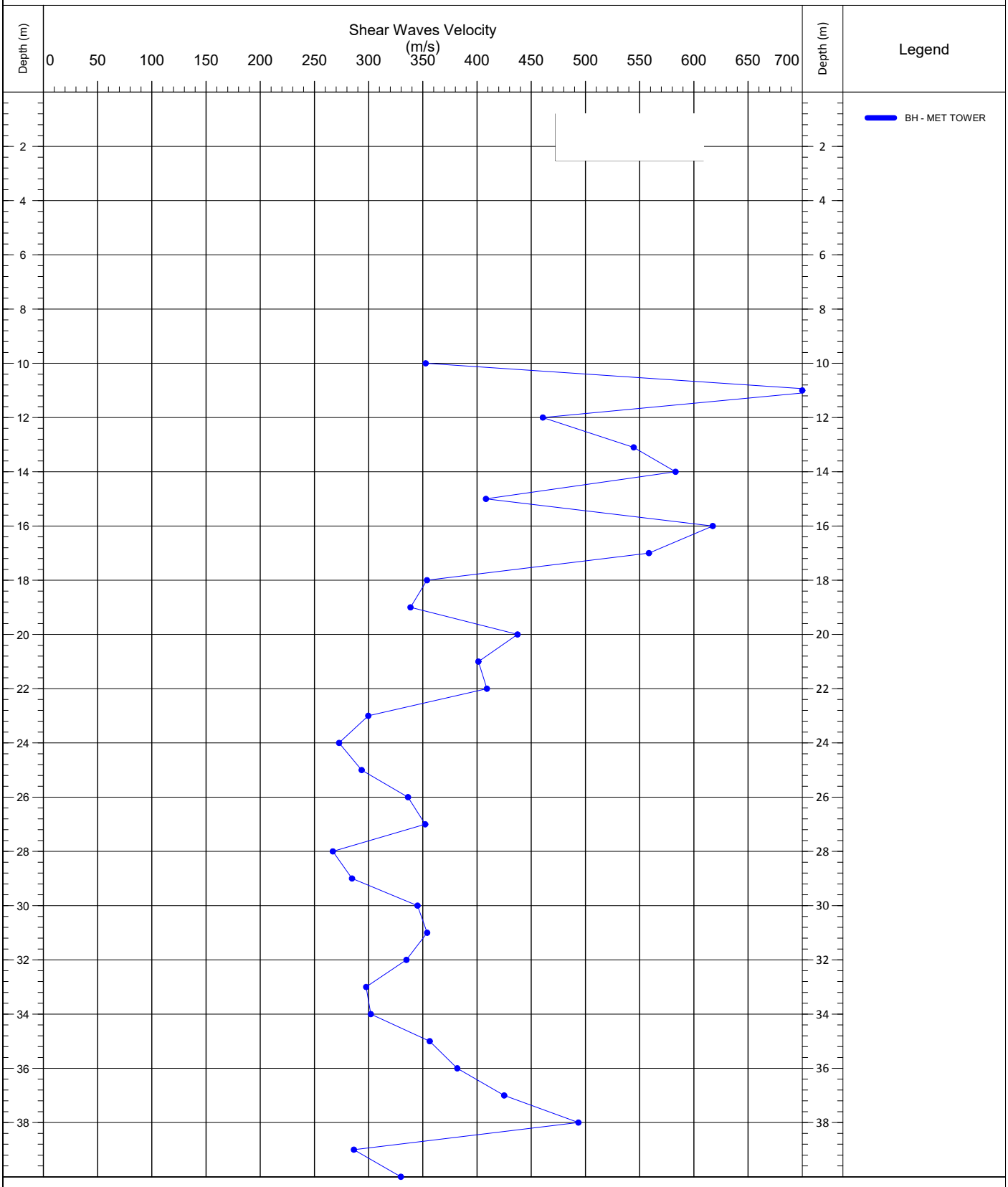
Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
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Comments:

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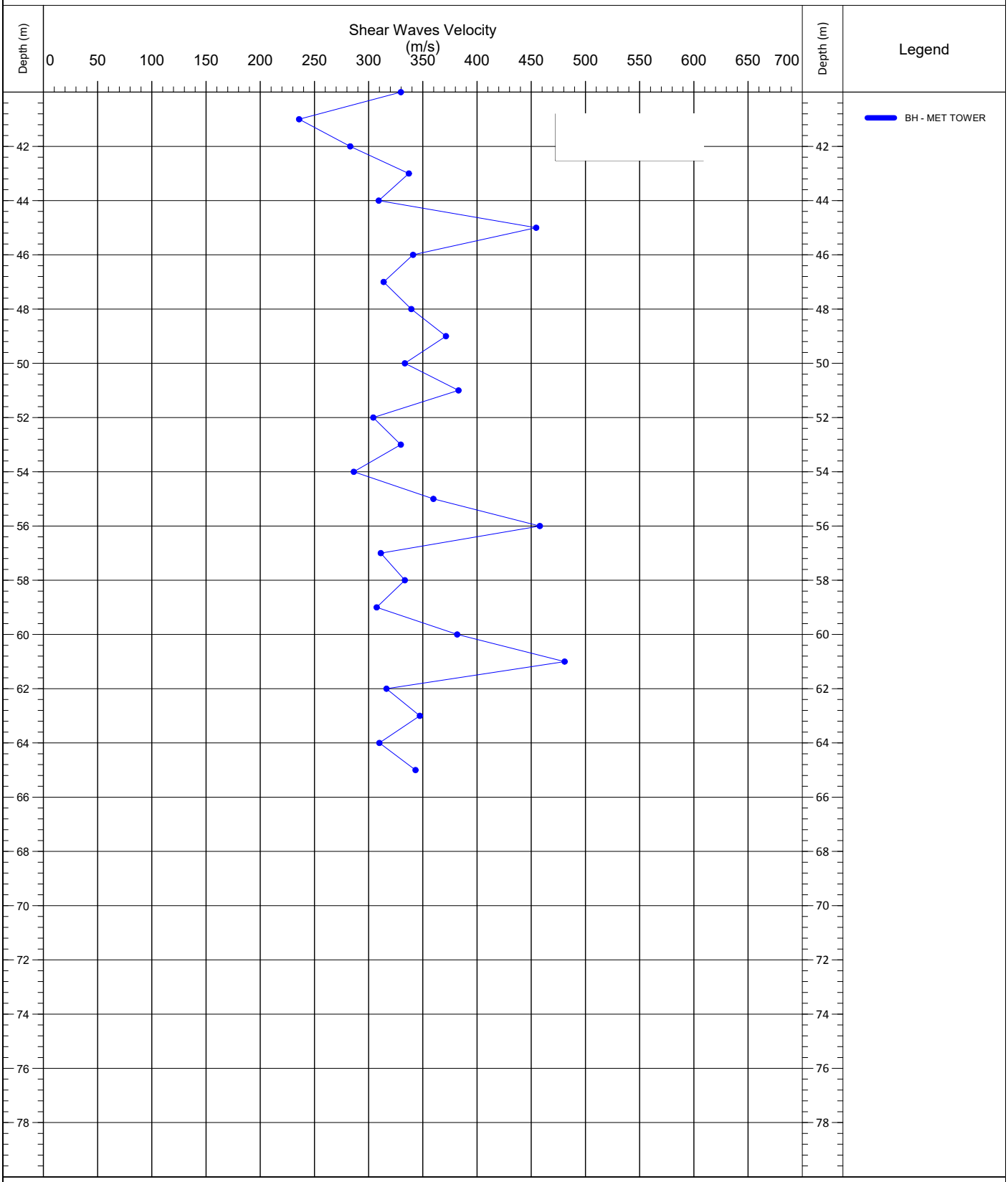
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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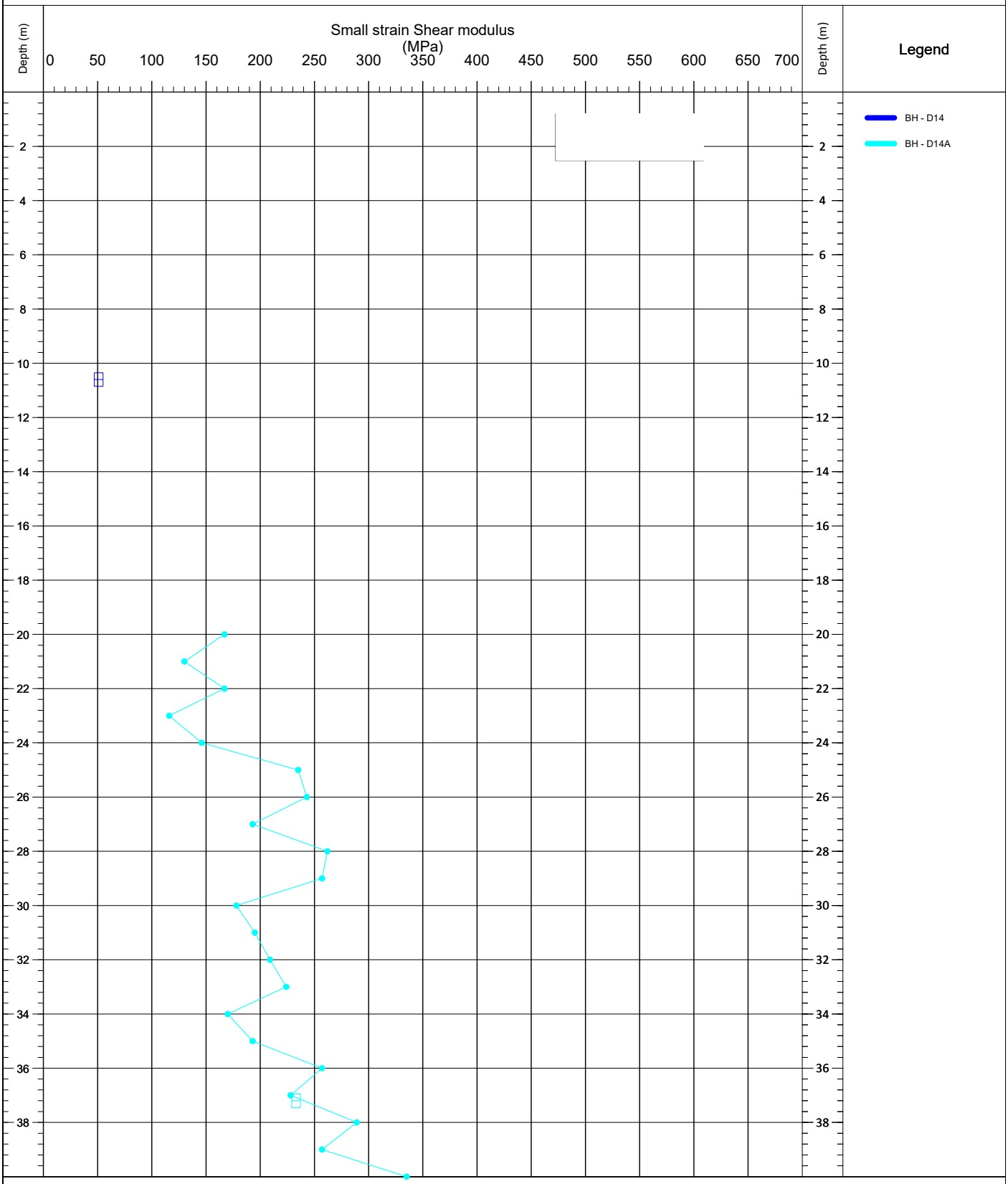
Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

4.2 Maximal Shear Modulus G_0

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
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Vessel	**MV Ocean Discovery**
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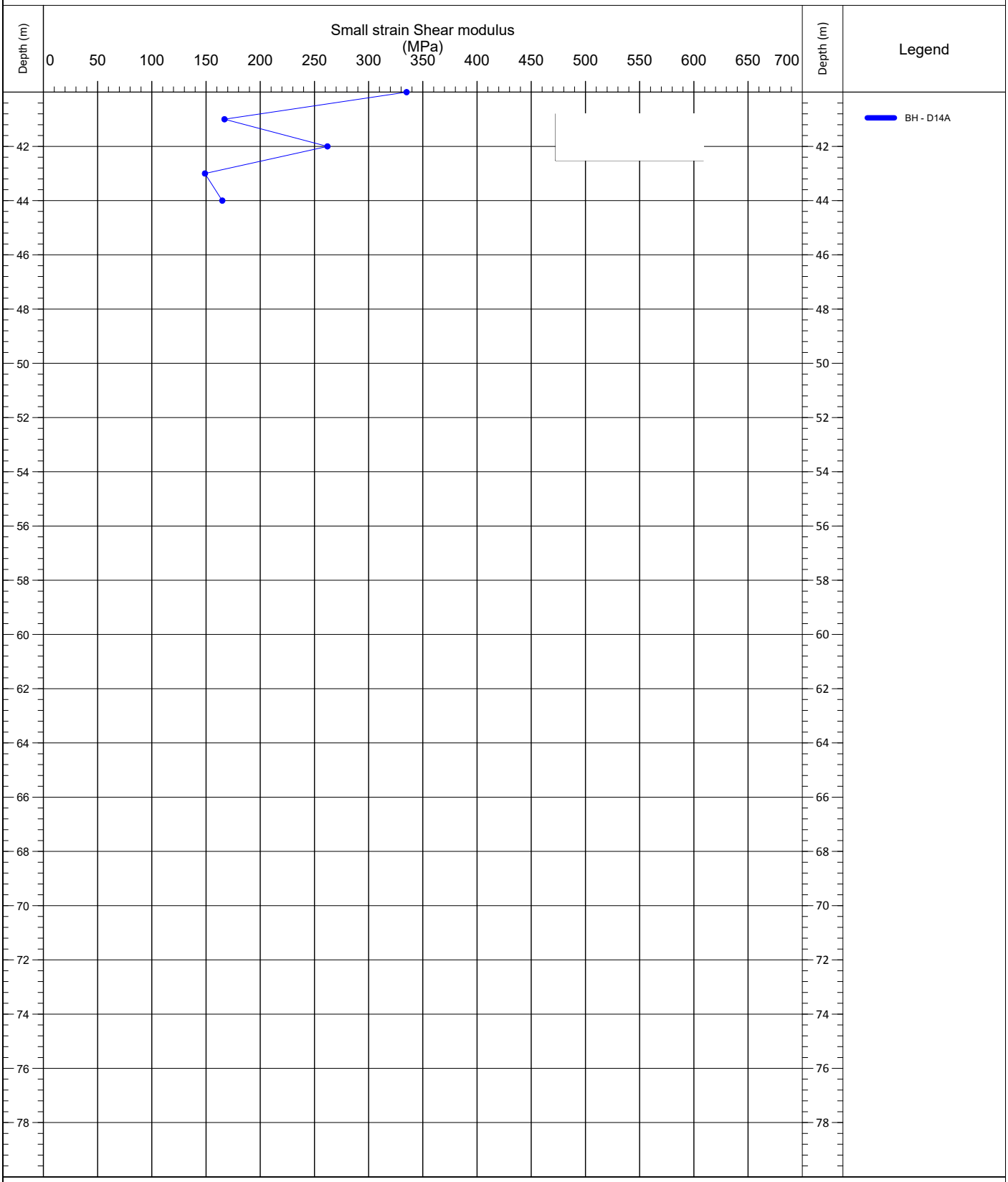
Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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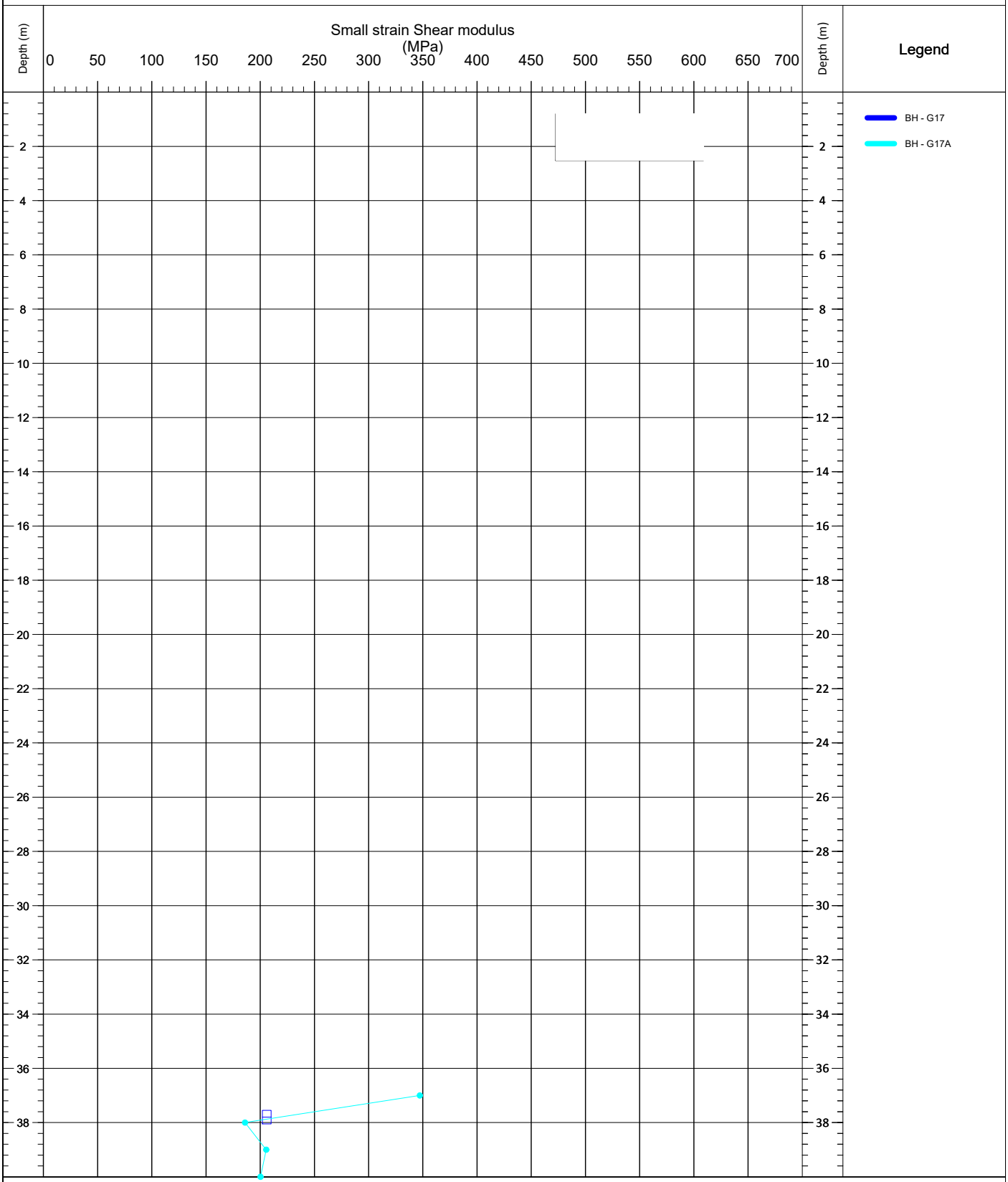
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
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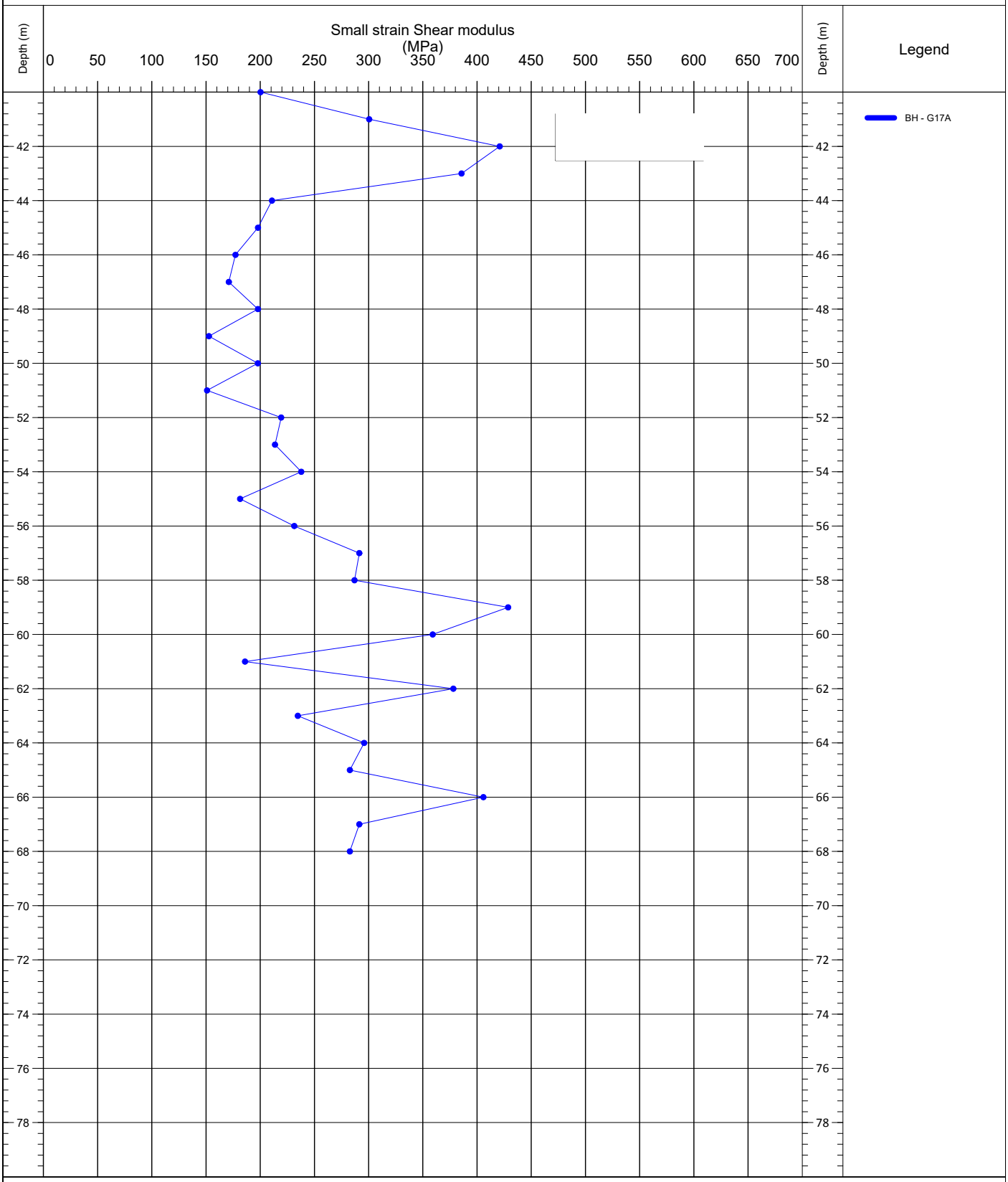
Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
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CRS	**GRS 80 UTM ZONE 18 N (75 W)**		

QC Status

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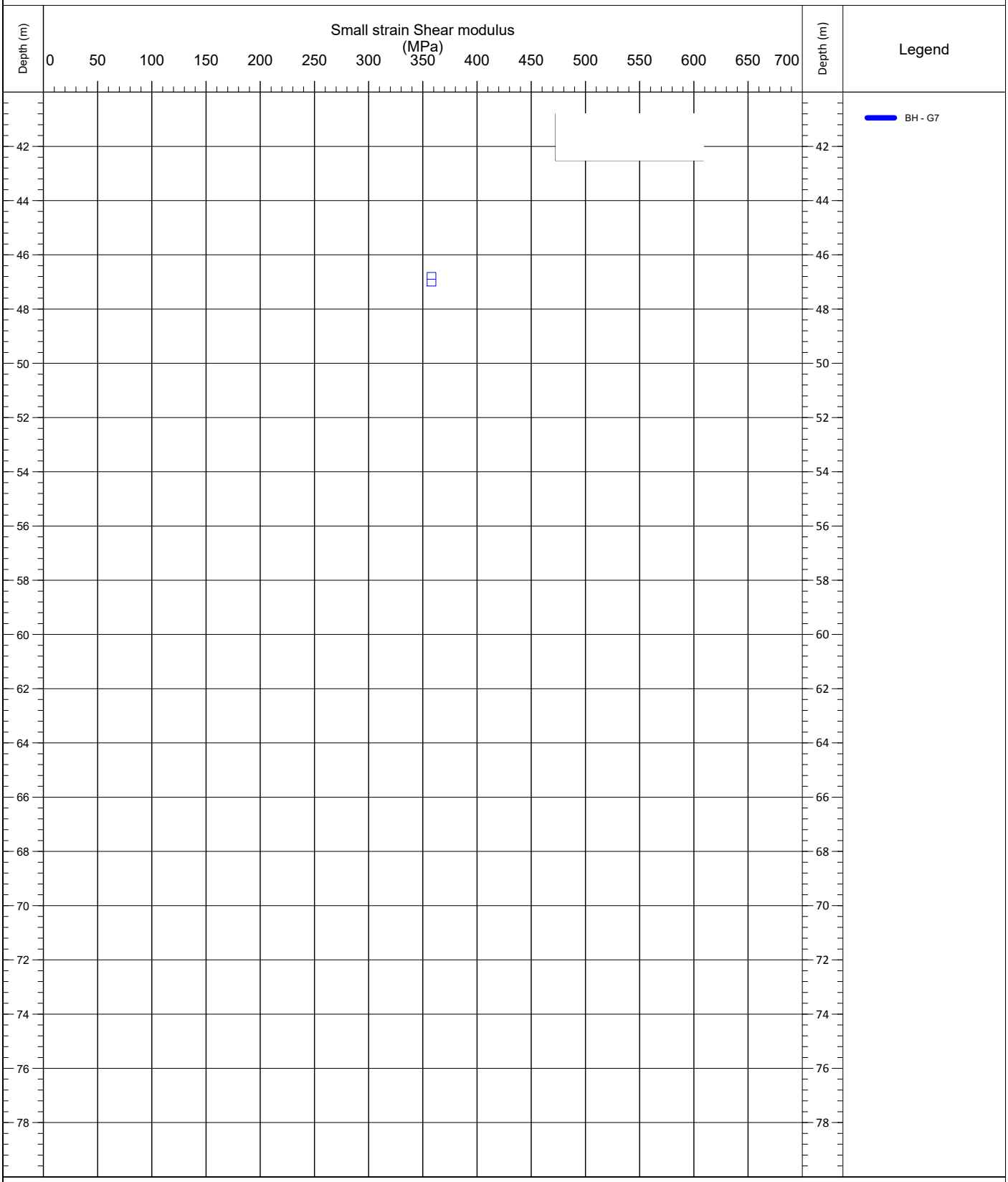
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
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Client Name/Ref	**US Wind Inc./ REF11449**
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Comments:

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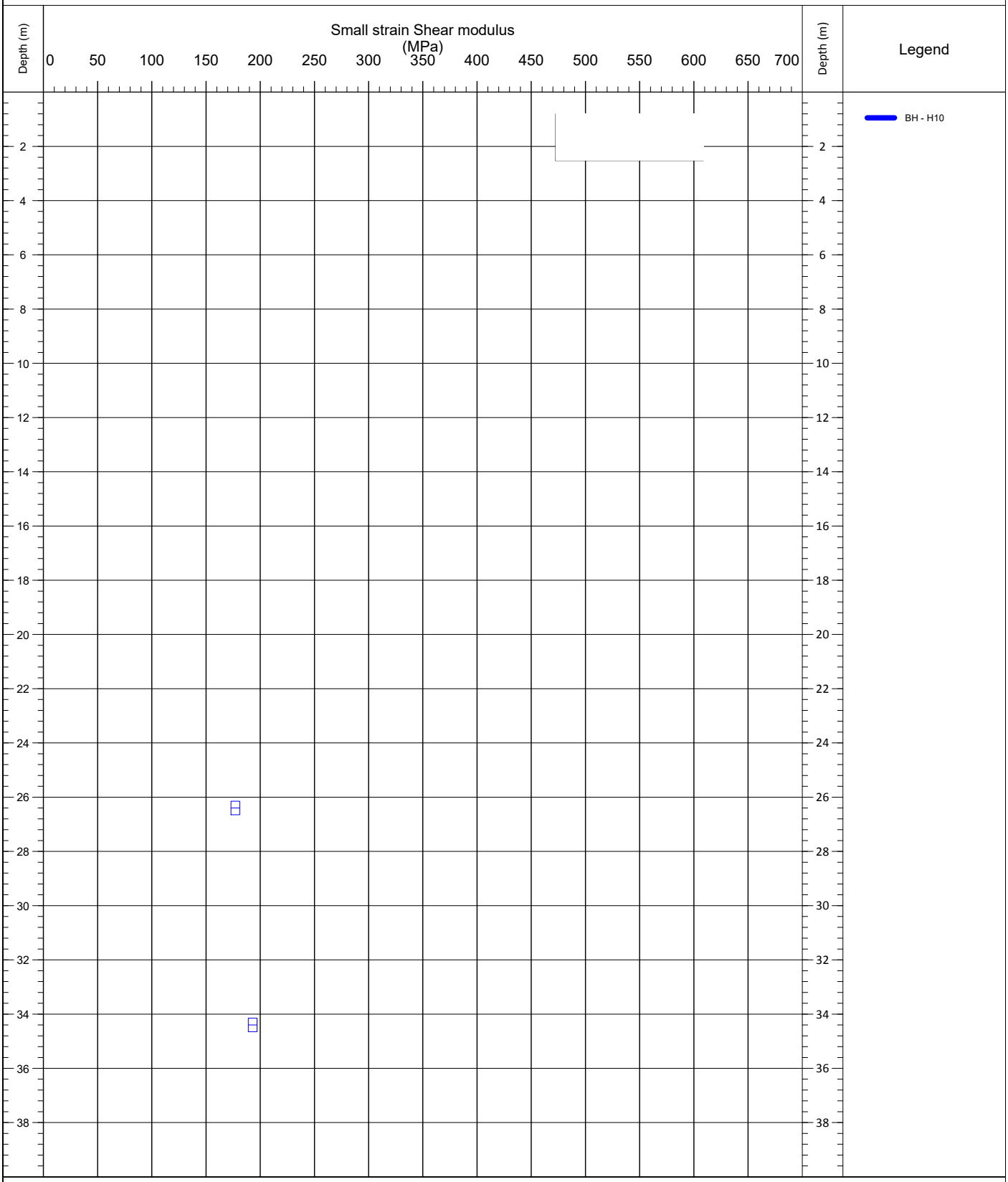
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
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Comments:

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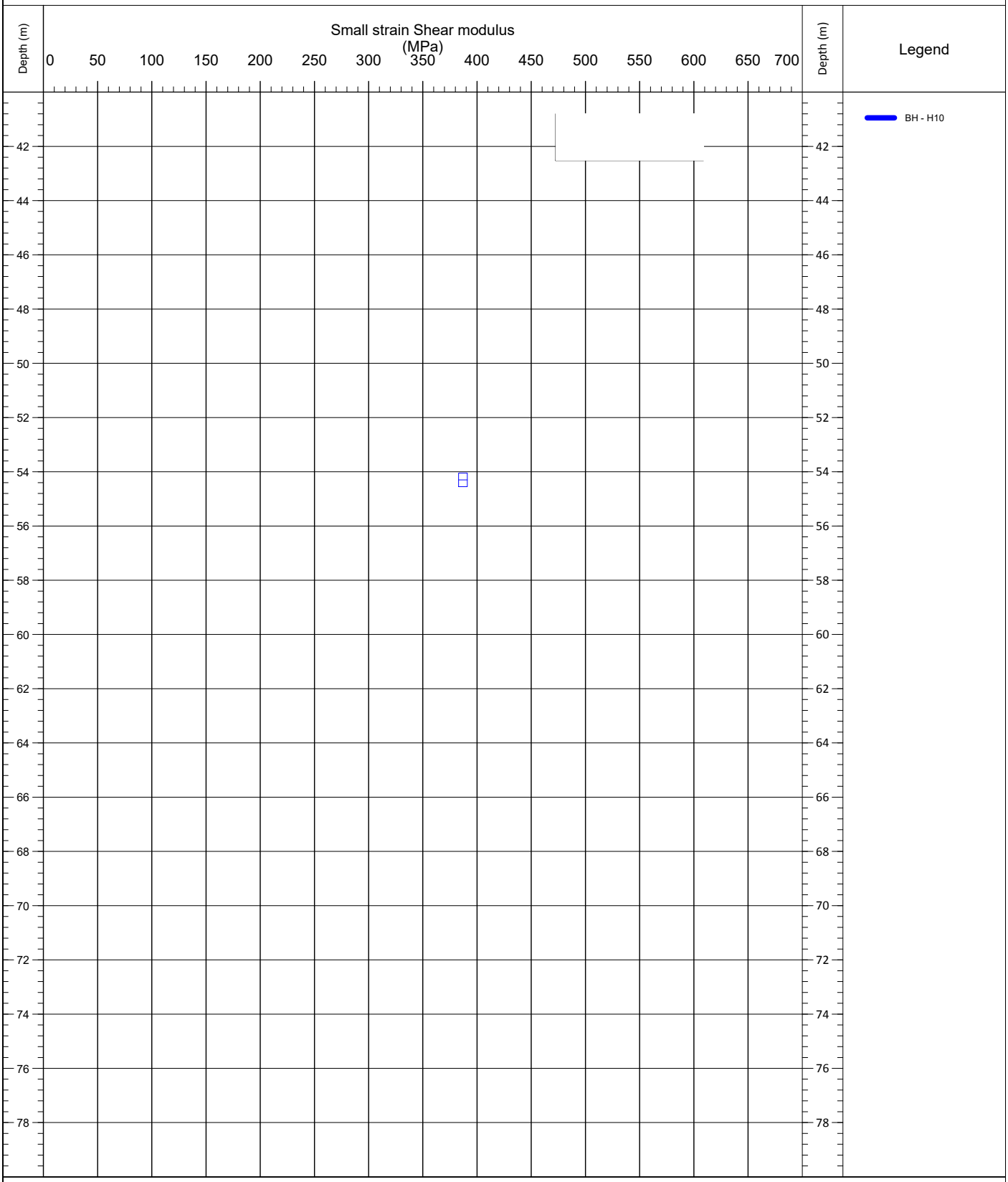
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
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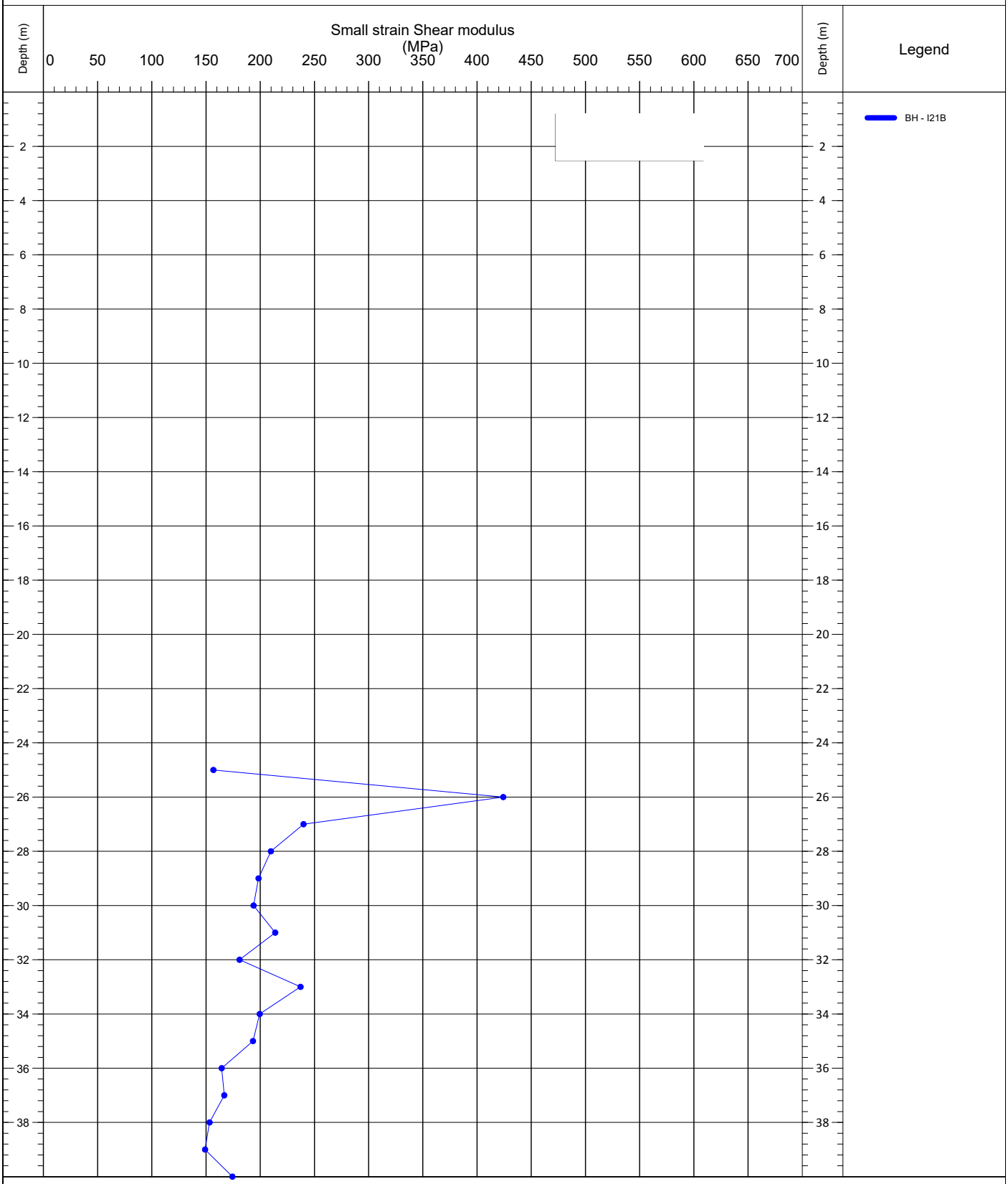
QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
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Comments:

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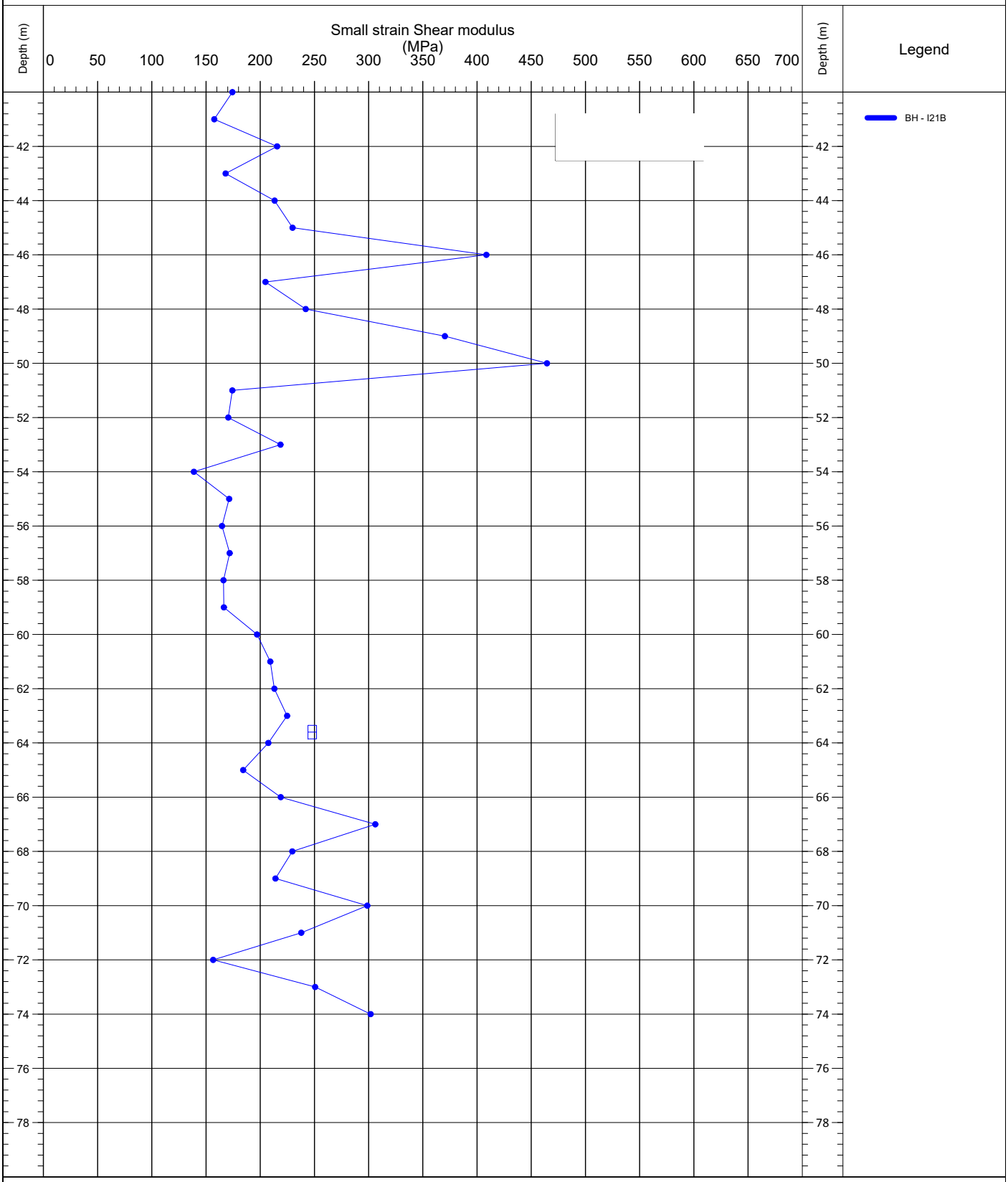
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

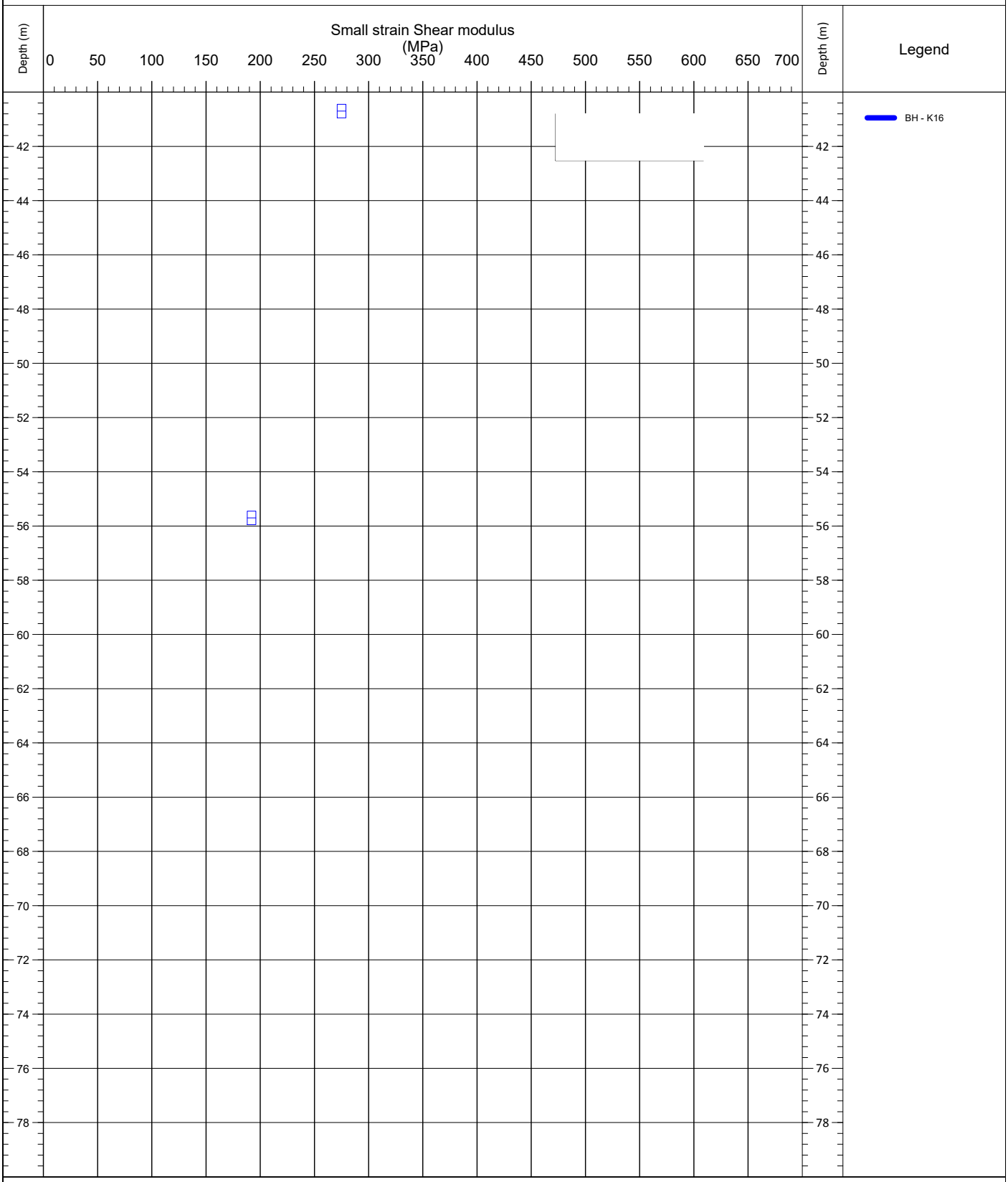


Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
Vessel	**MV Ocean Discovery**		
CRS	**GRS 80 UTM ZONE 18 N (75 W)**		

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
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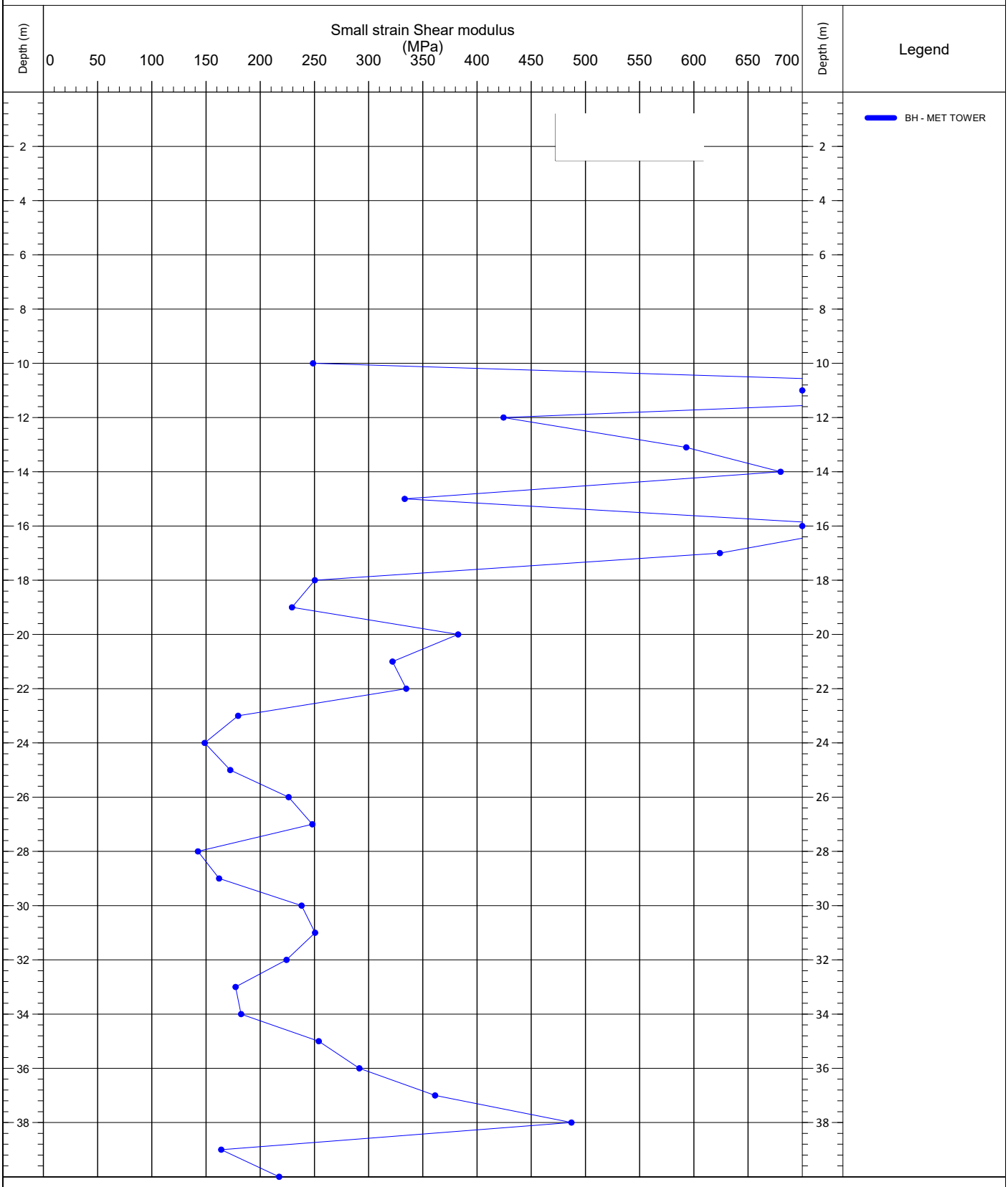
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

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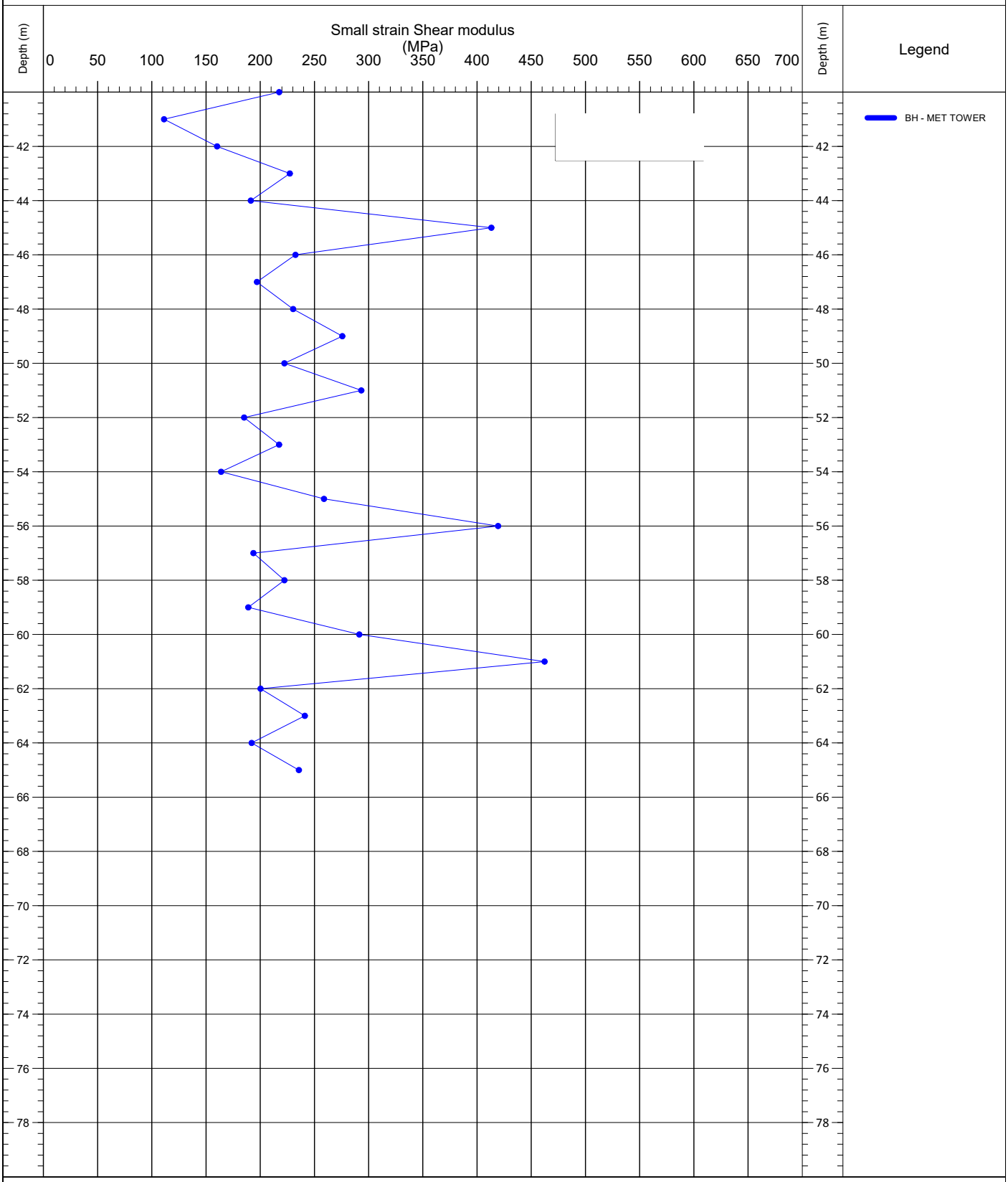
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



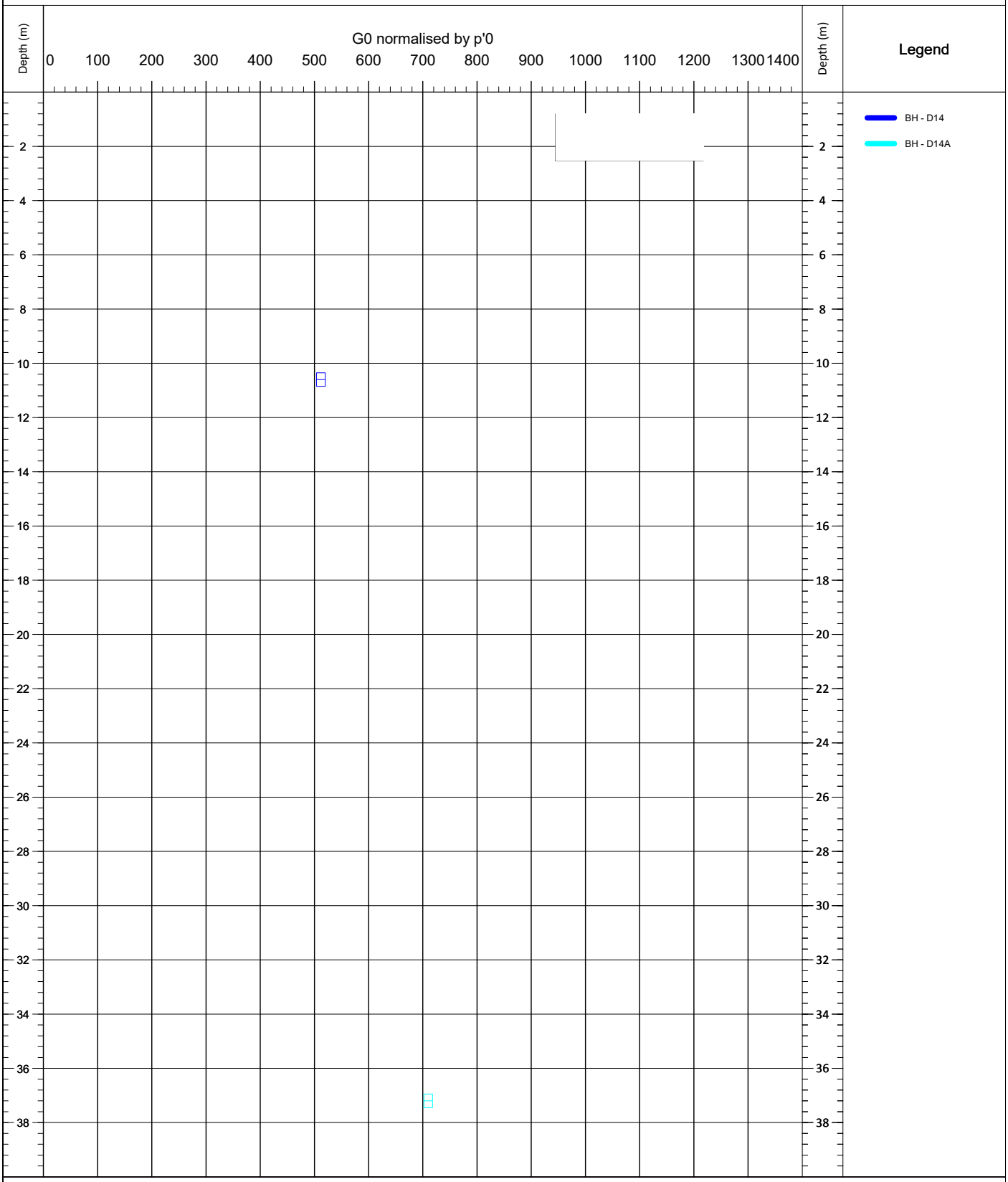
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

4.3 Maximal Shear Modulus G_0 normalised by p'_0

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

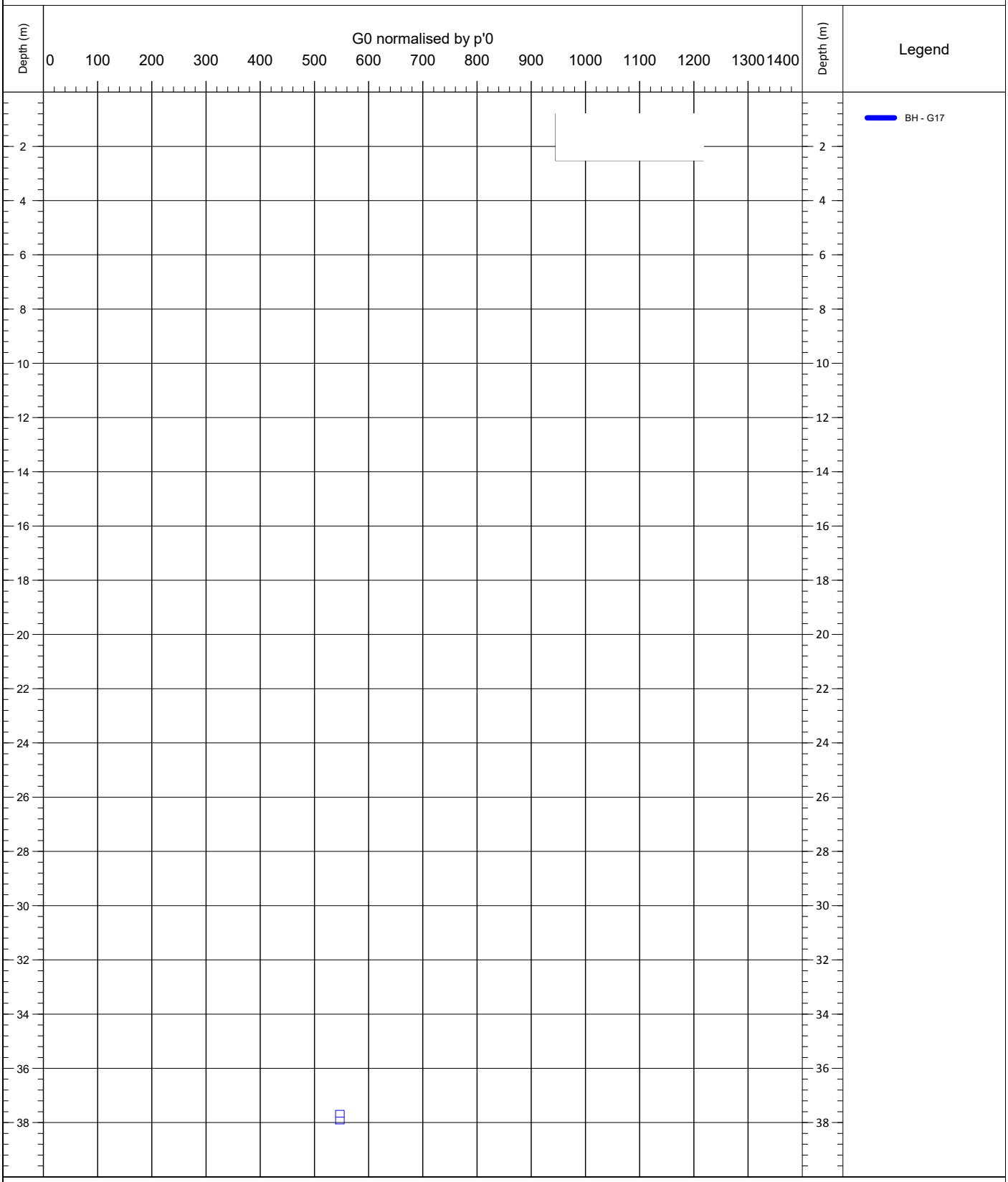


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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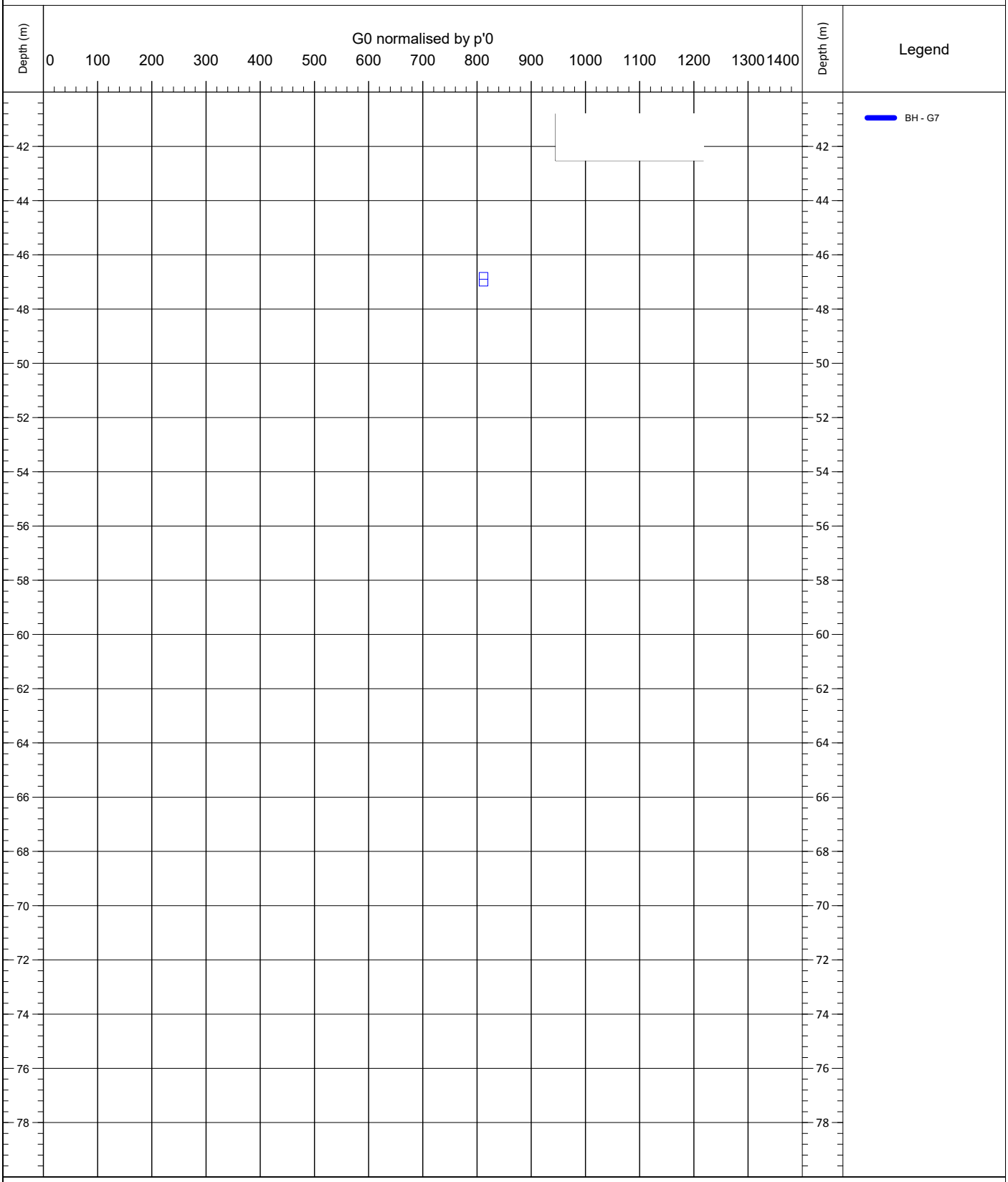
Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
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Comments:

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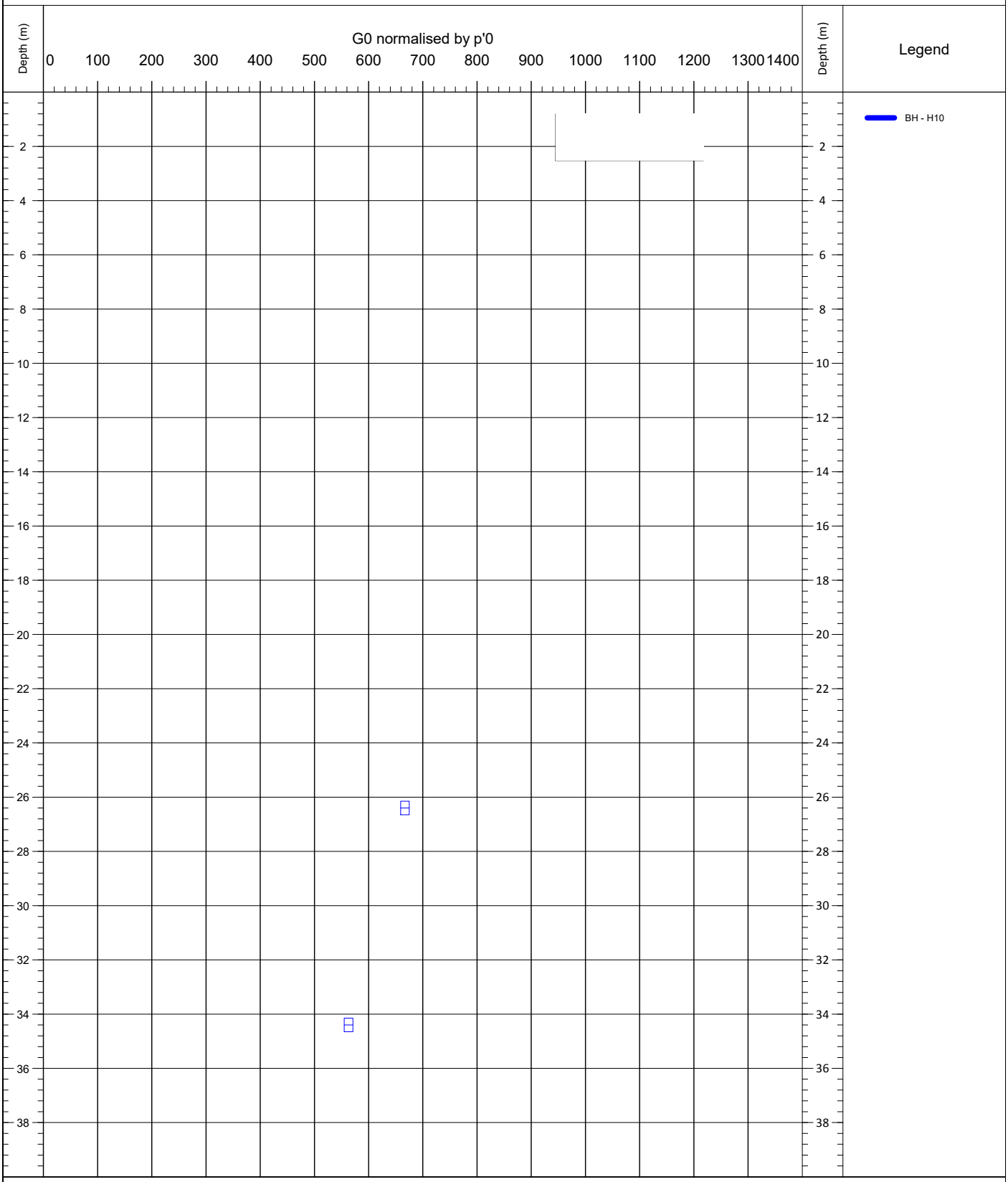
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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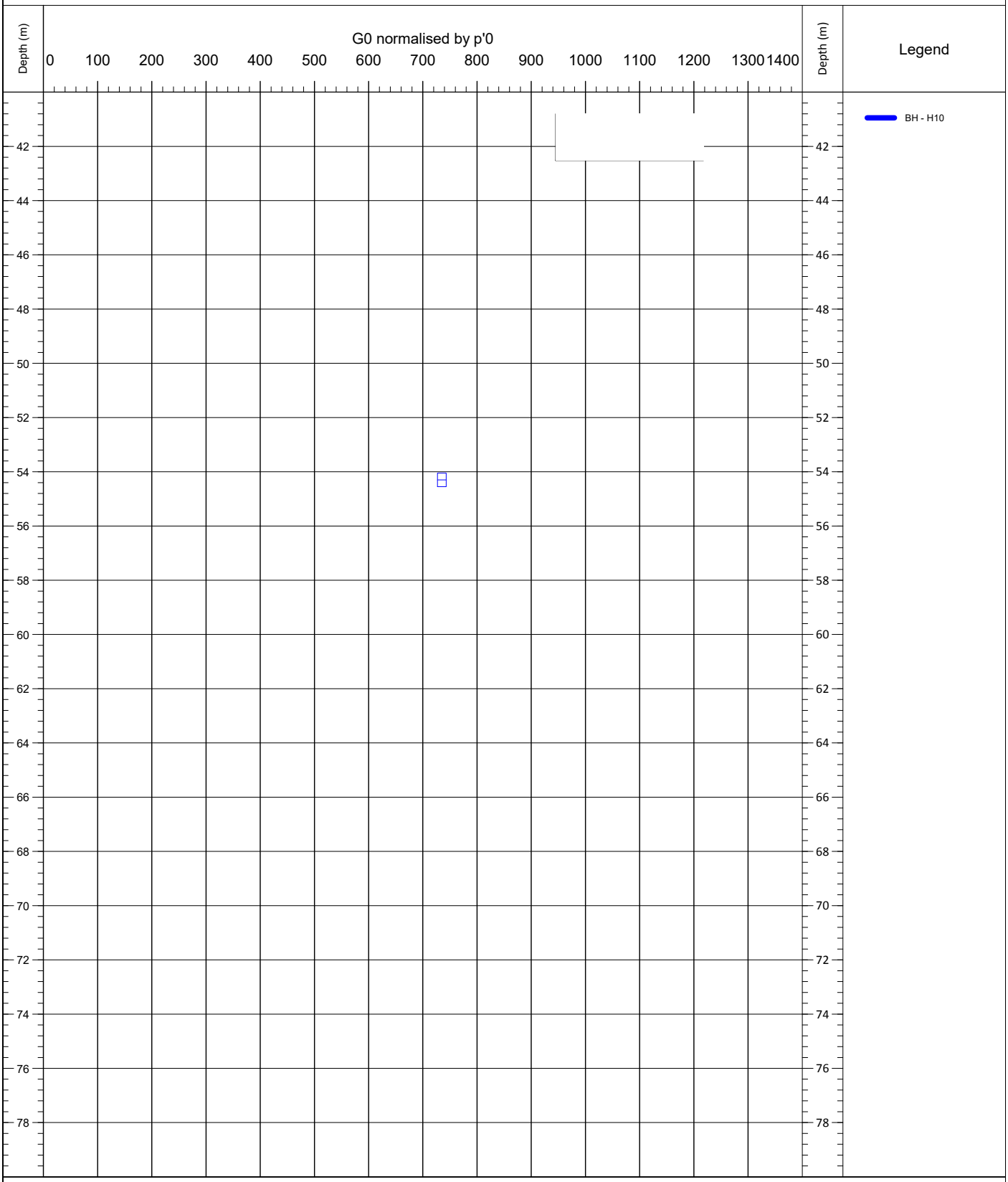
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
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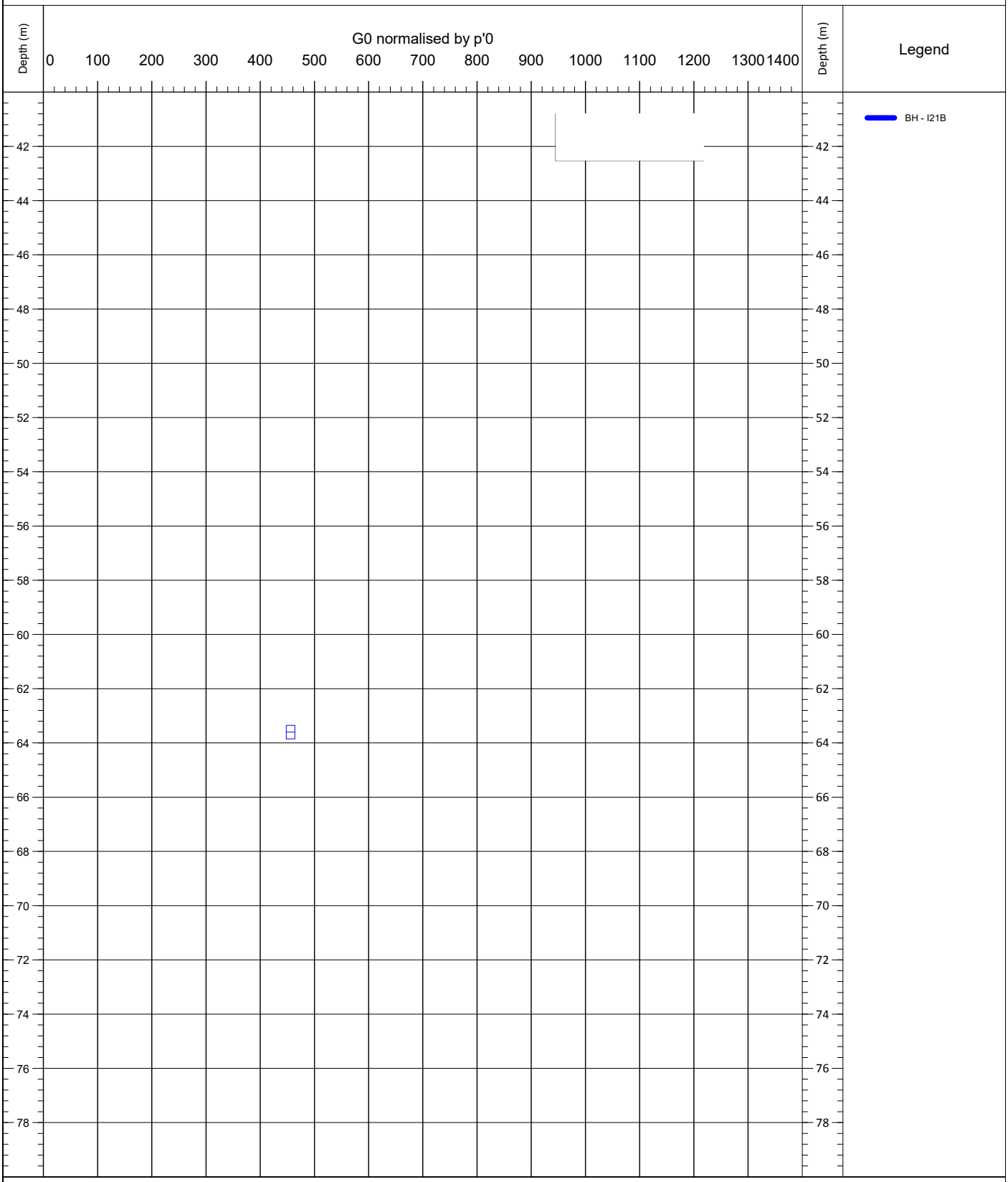
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
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Client Name/Ref	**US Wind Inc./ REF11449**
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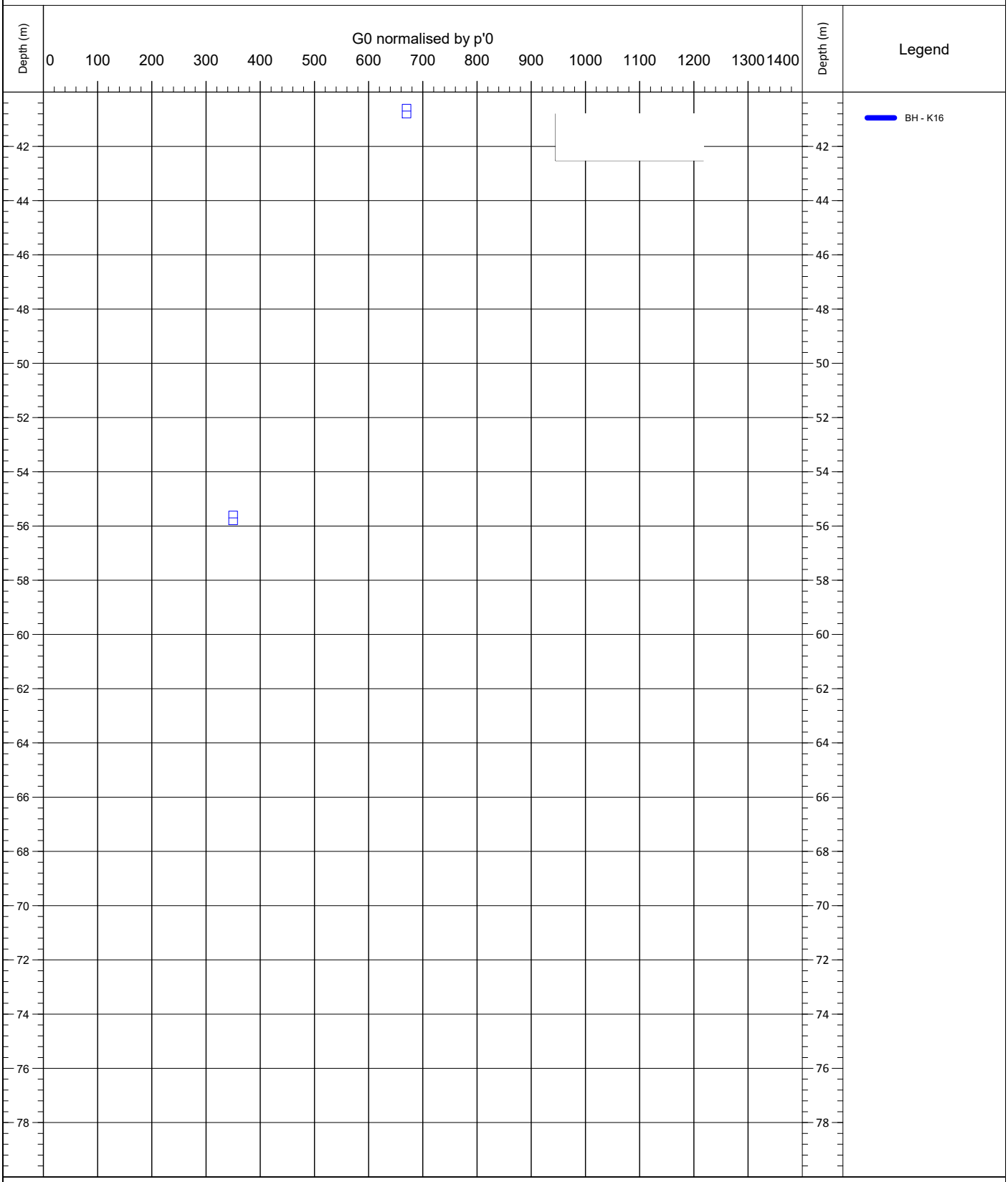
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**	**Comments:**	
Contract	**10451**		
Client Name/Ref	**US Wind Inc./ REF11449**		
Vessel	**MV Ocean Discovery**		
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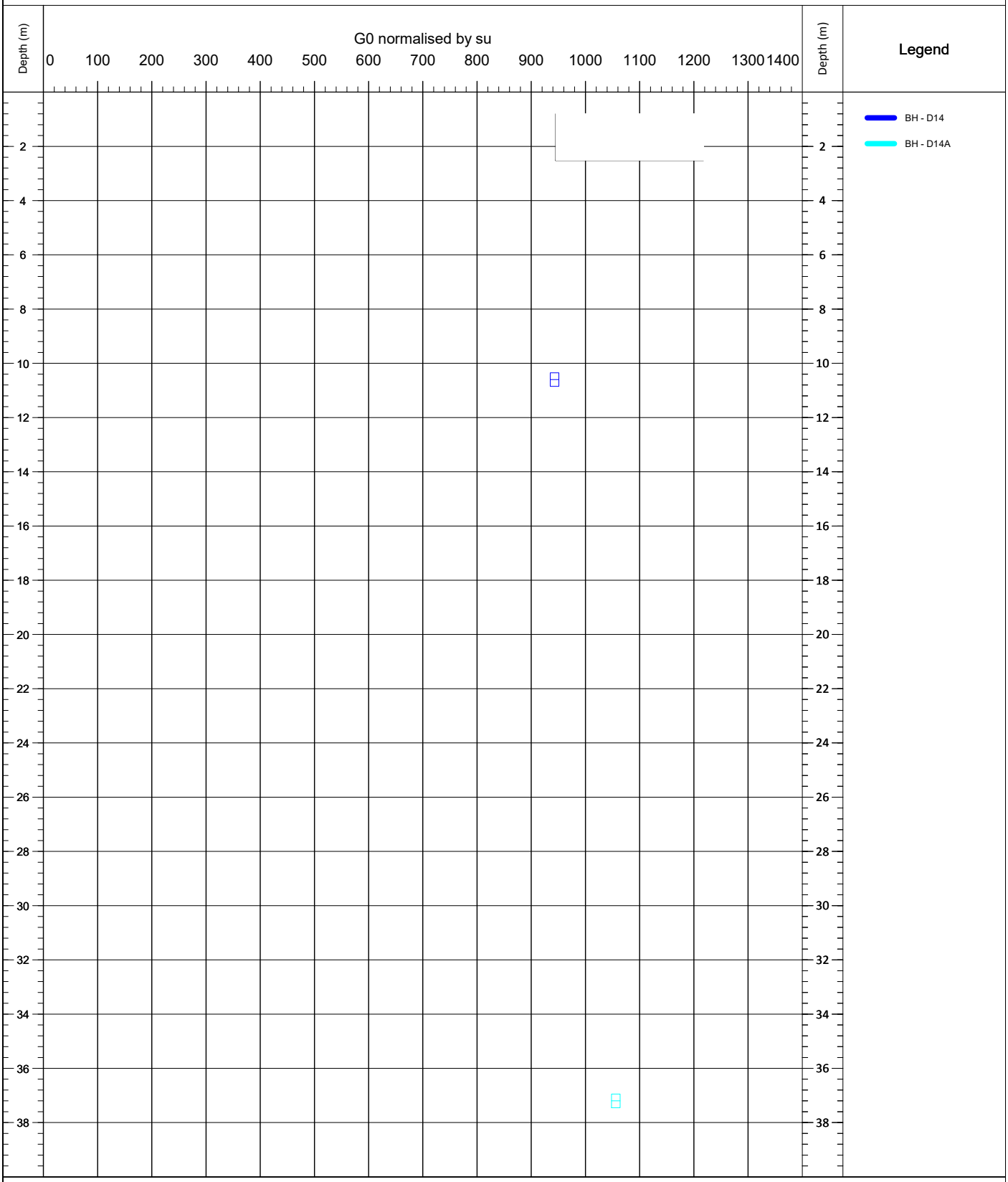
QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

4.4 Maximal Shear Modulus G_0 normalised by s_{uC}

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



Area	**Maryland USA**
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Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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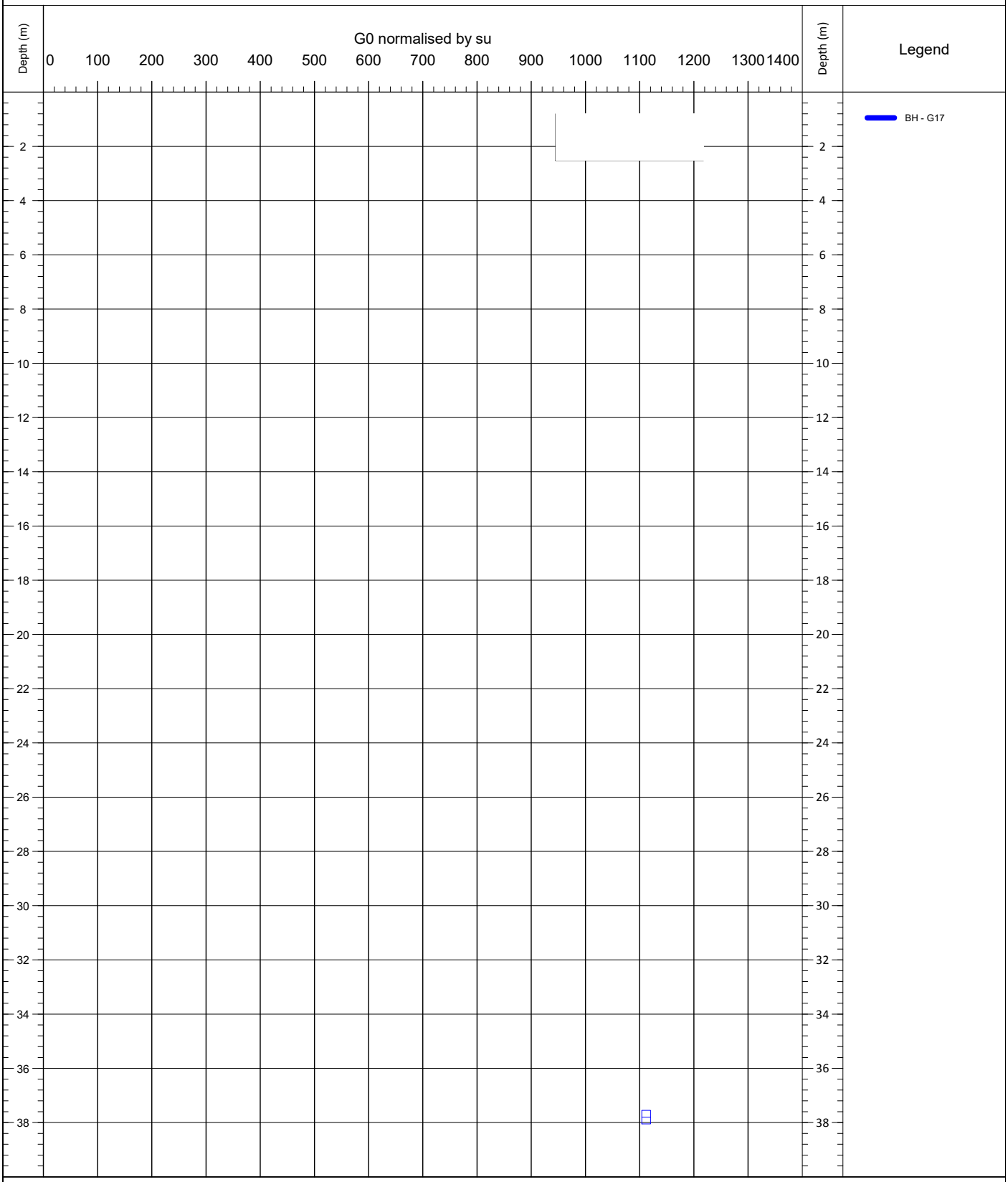

Area	**Maryland USA**
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Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
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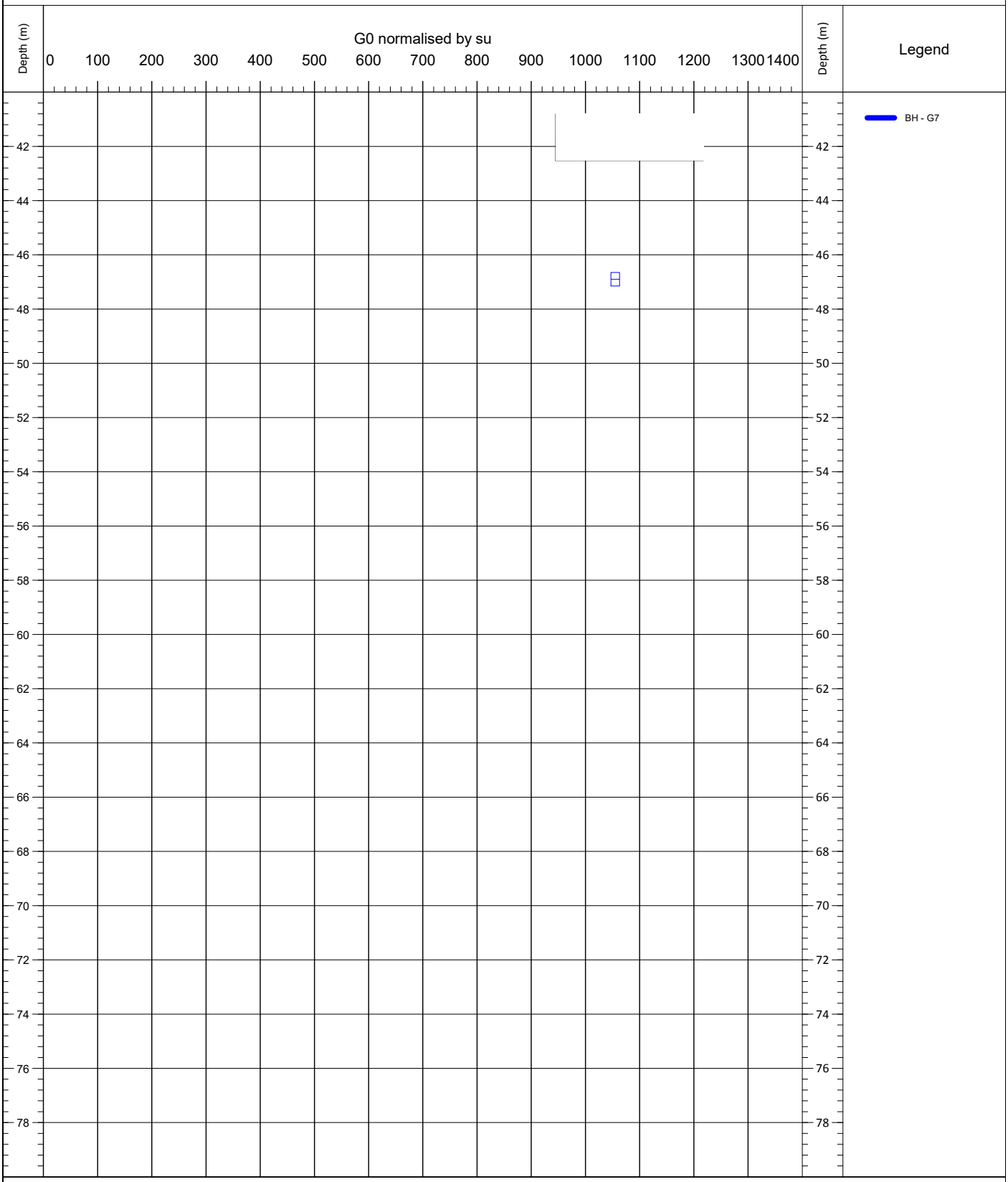

Area	**Maryland USA**
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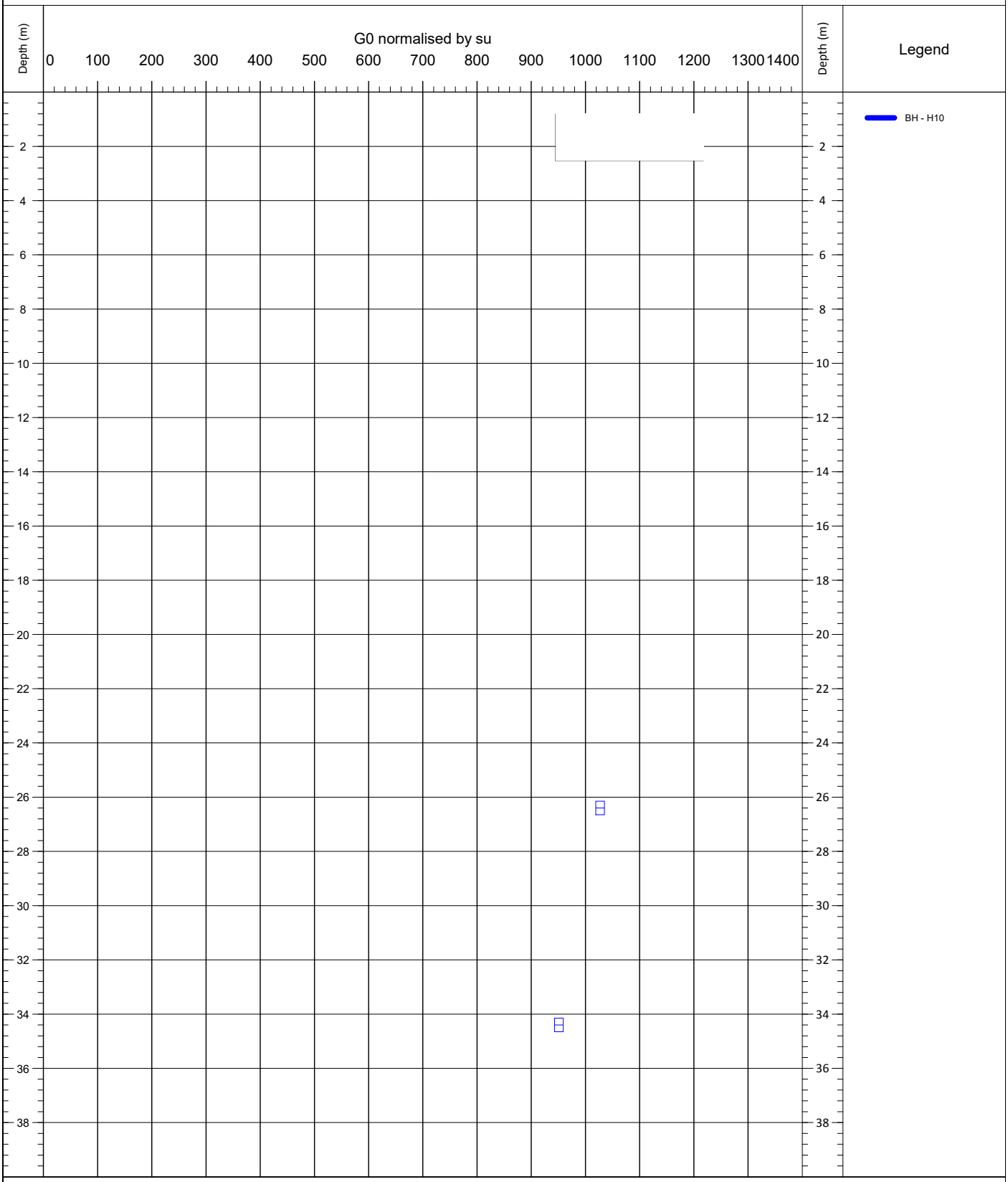
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

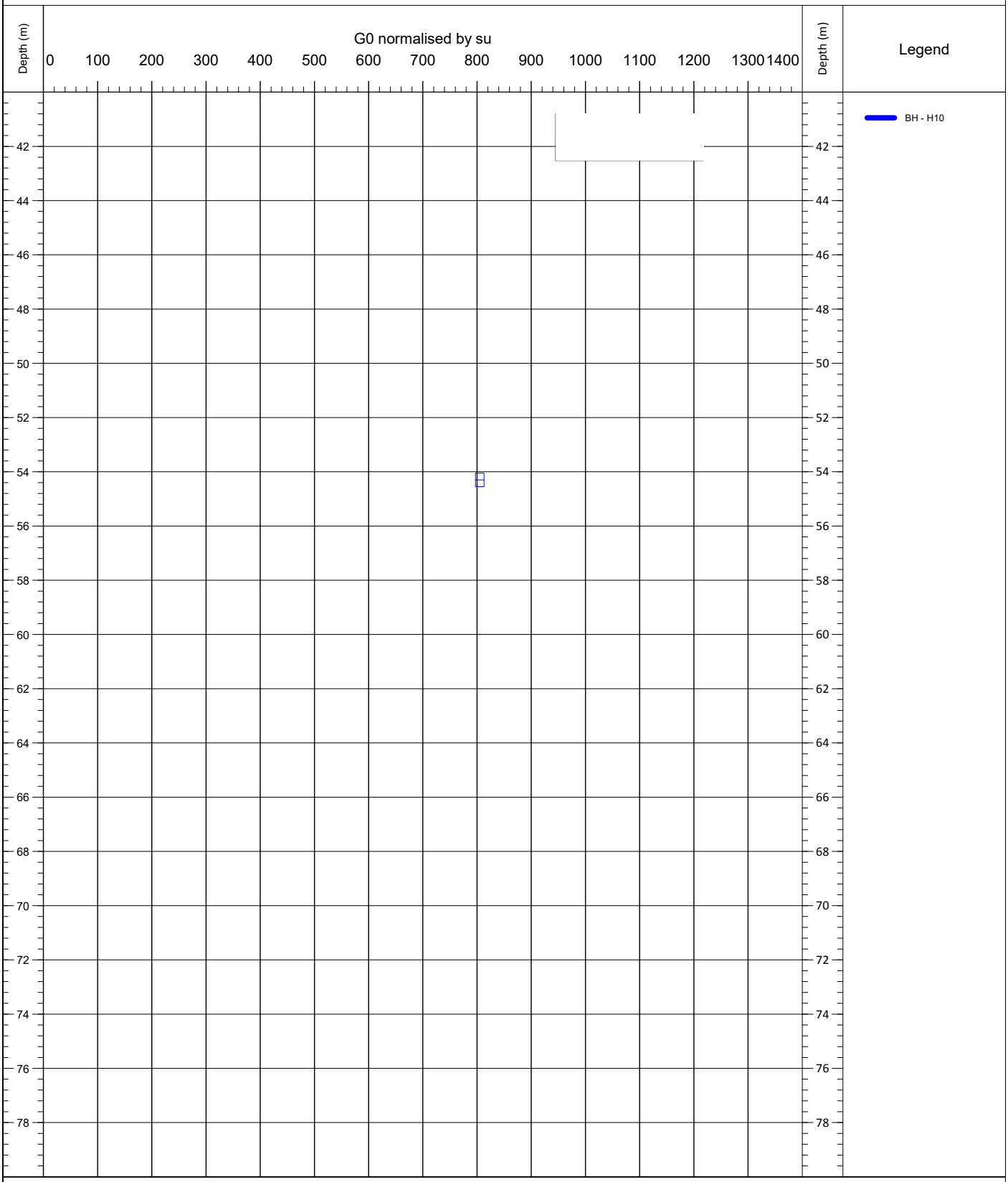


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

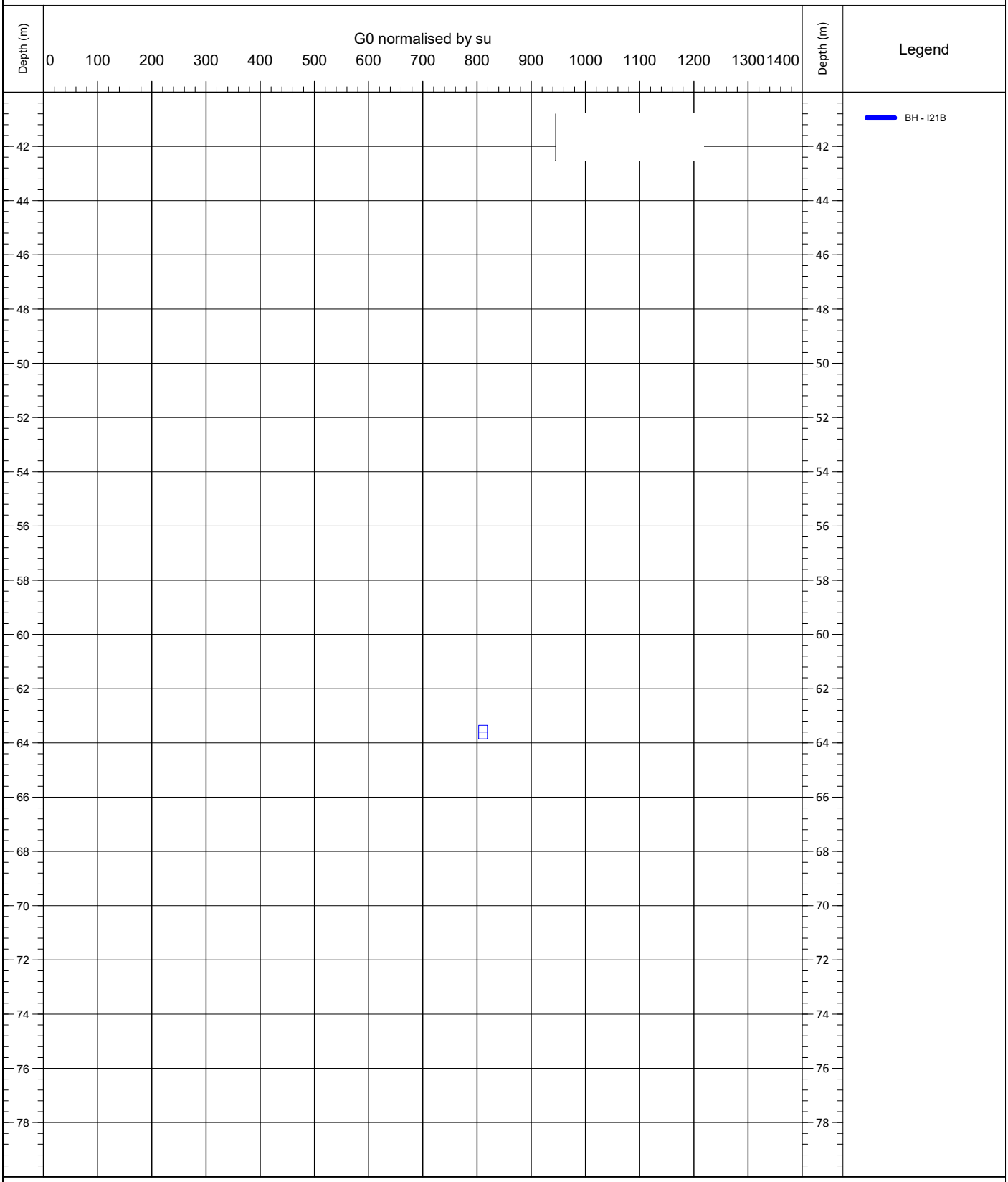


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE

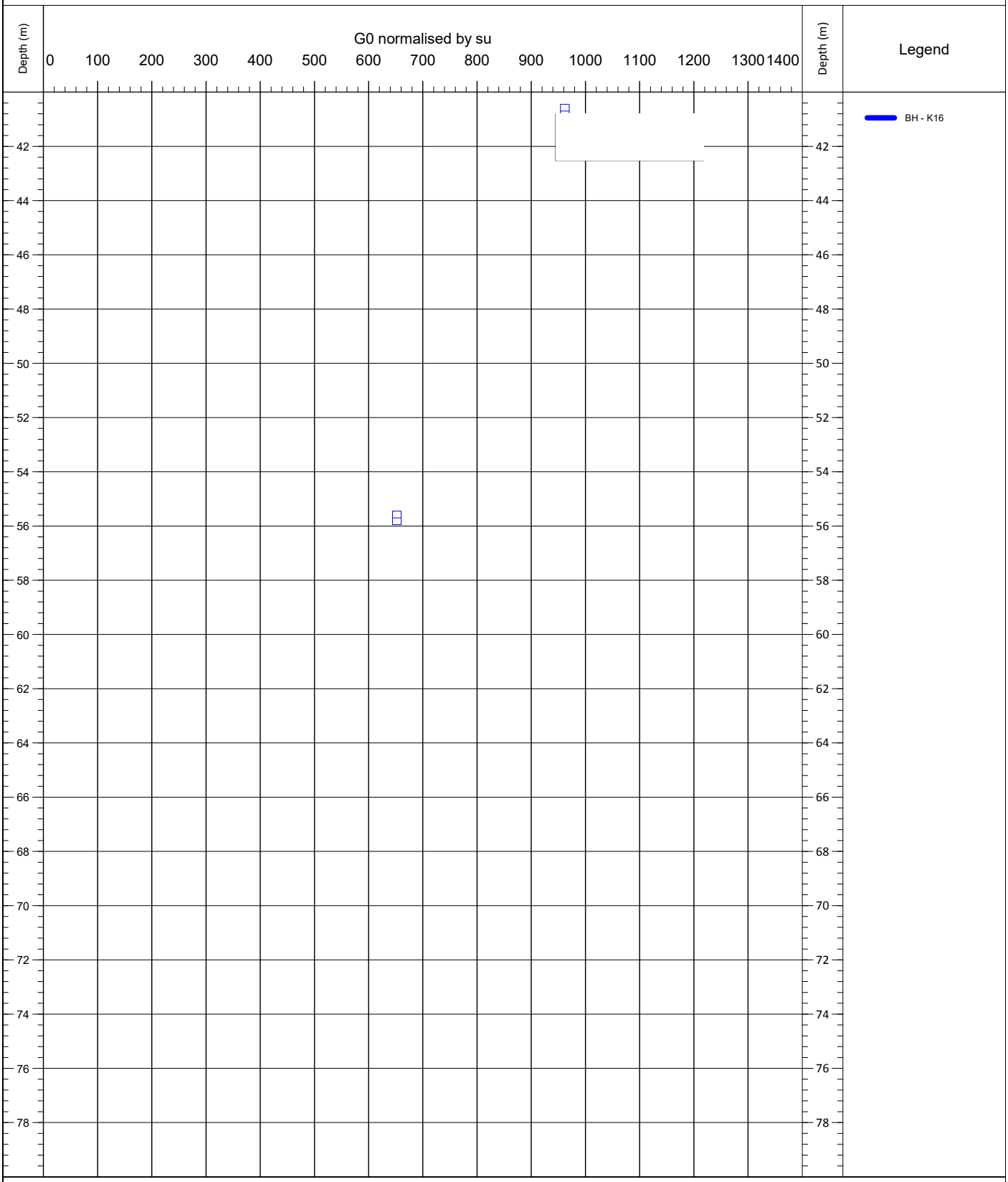


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
BENDER ELEMENTS PROFILE



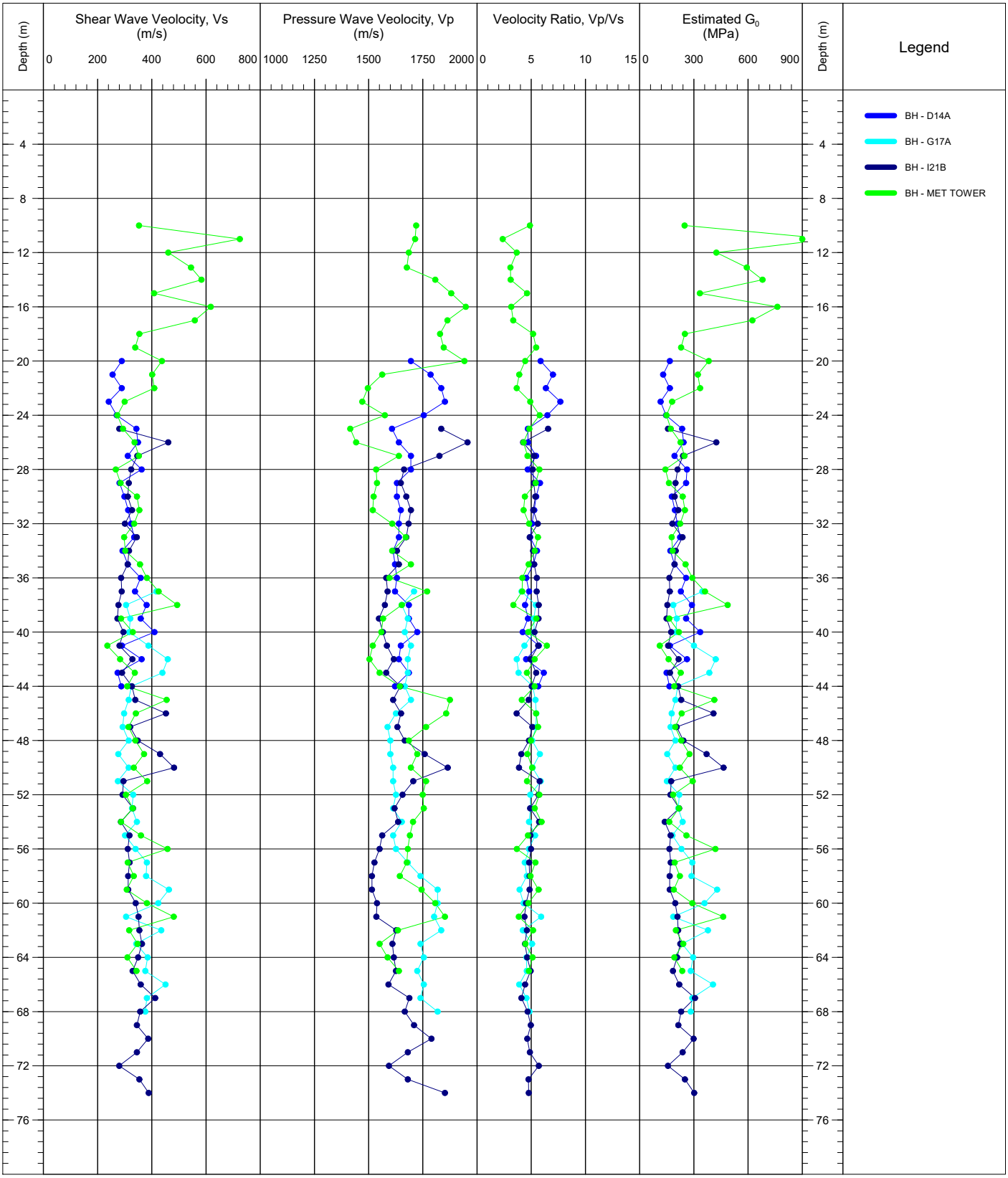
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

4.5 PS-logging results

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
PS LOGGING



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

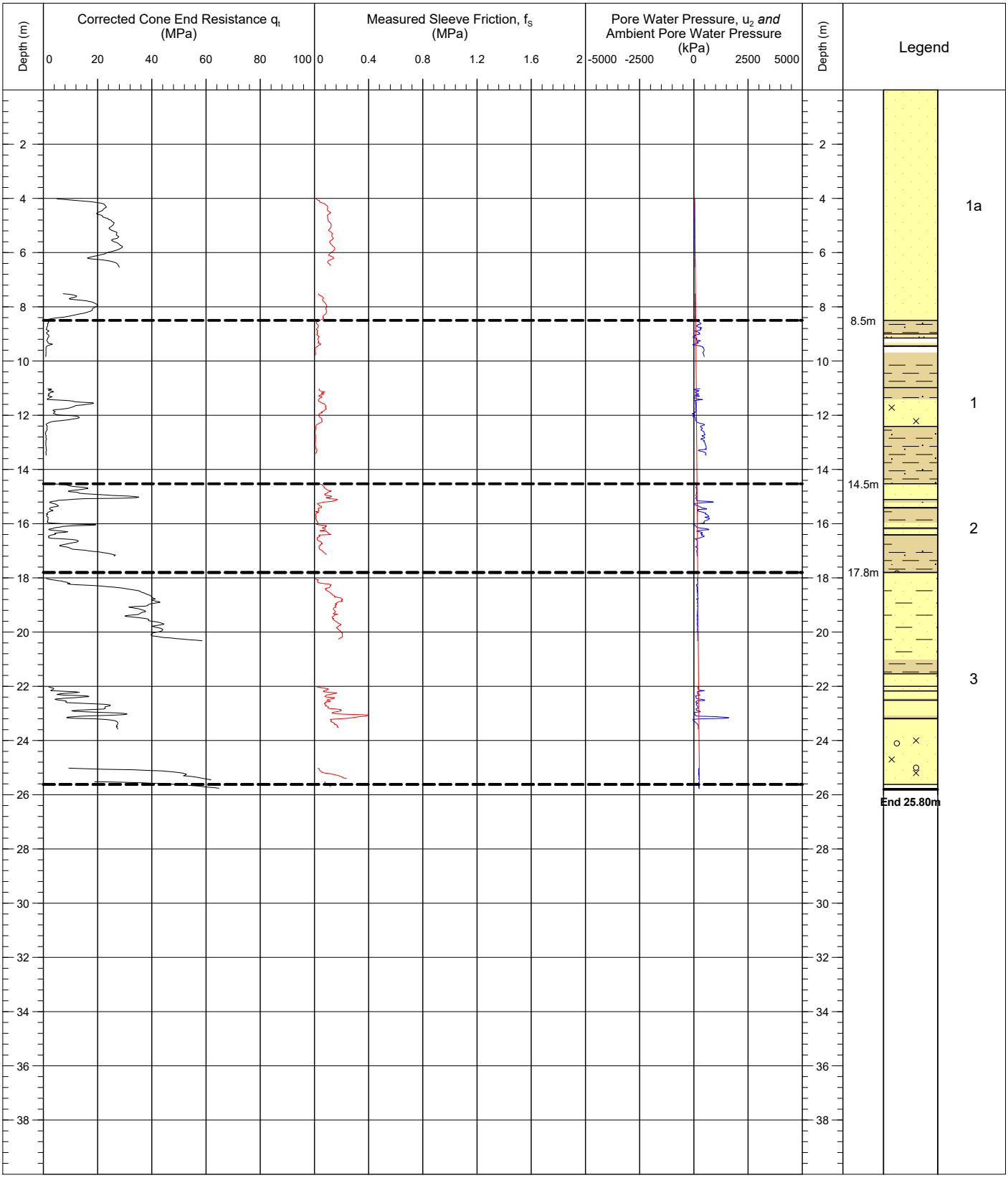
Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 21/01/2016	

APPENDIX 5

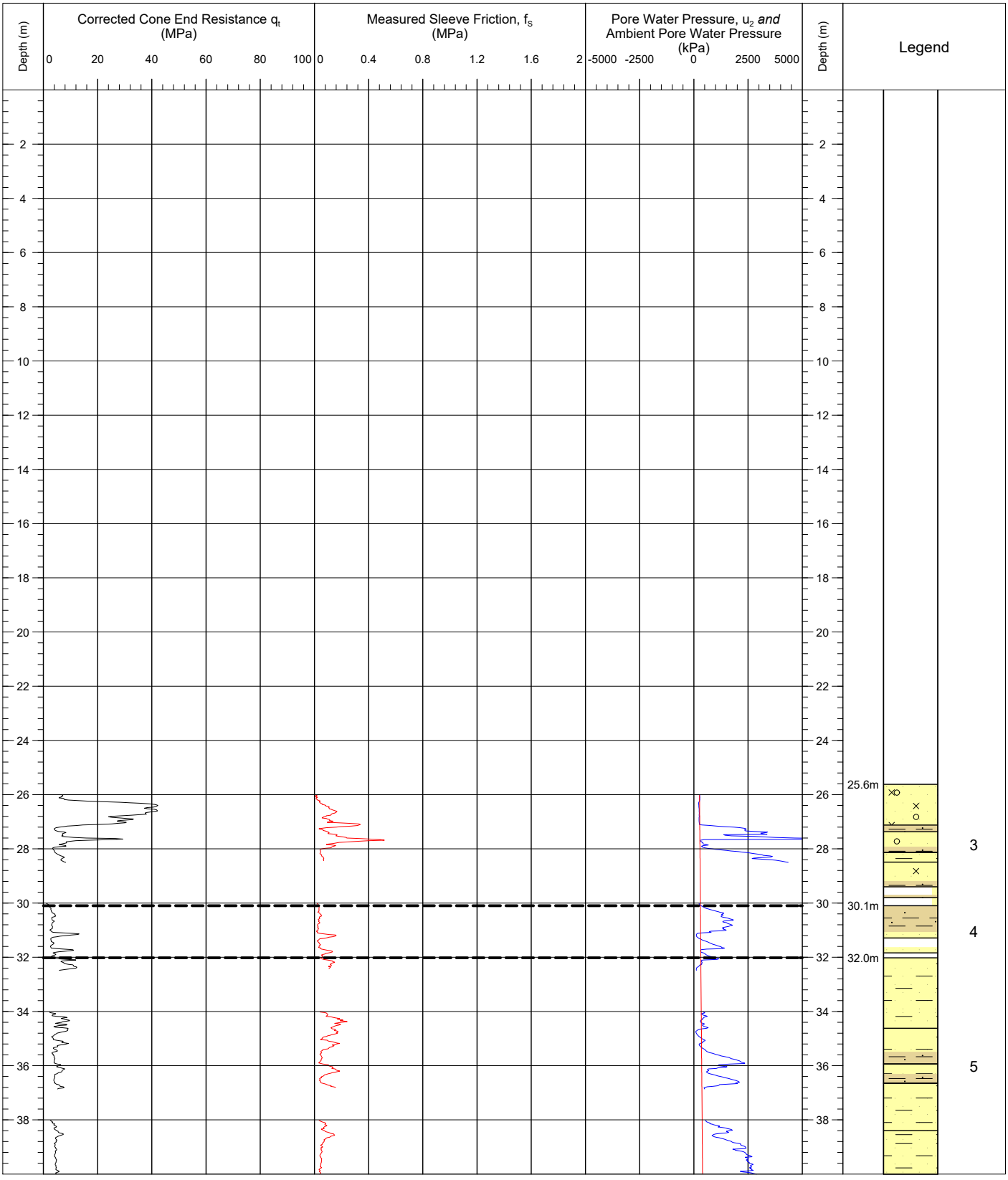
5.1 CPTU data

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



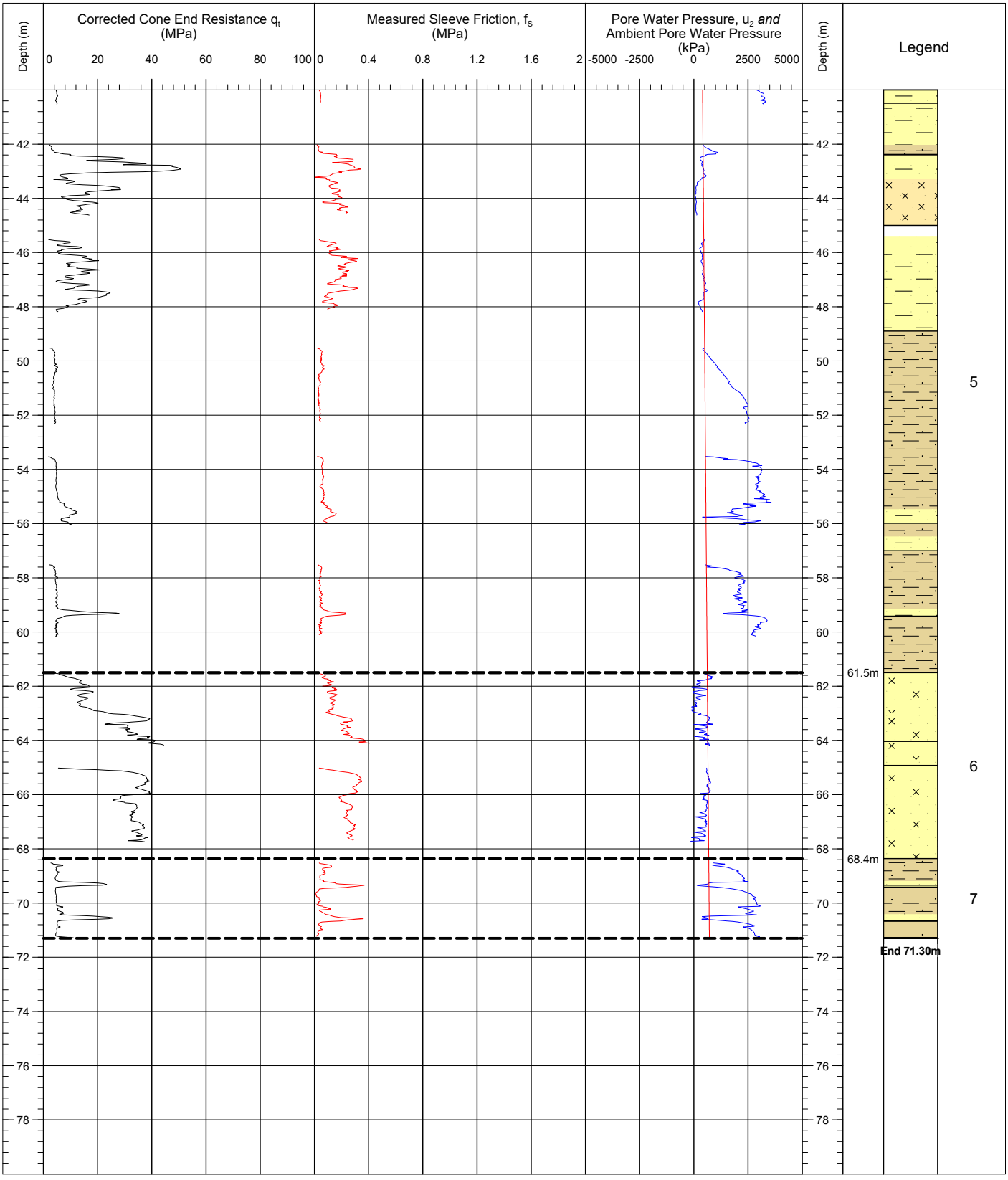
Area	**Maryland USA**	Coordinates	**515755.0E 4243606.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**19.0**	BH - D14
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**28/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**25.80m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



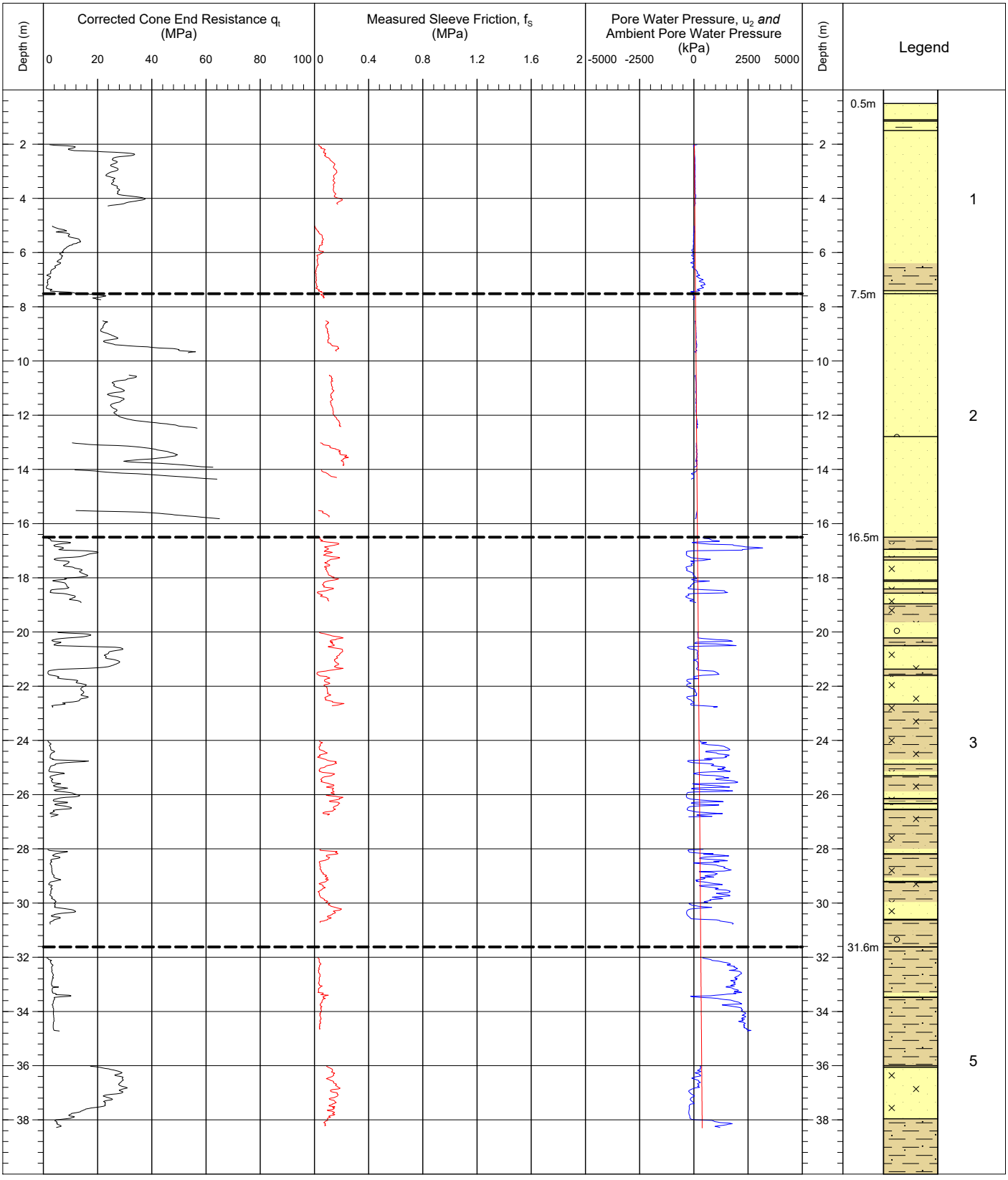
Area	**Maryland USA**	Coordinates	**515755.1E 4243612.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**19.1**	BH - D14A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**30/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**71.30m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



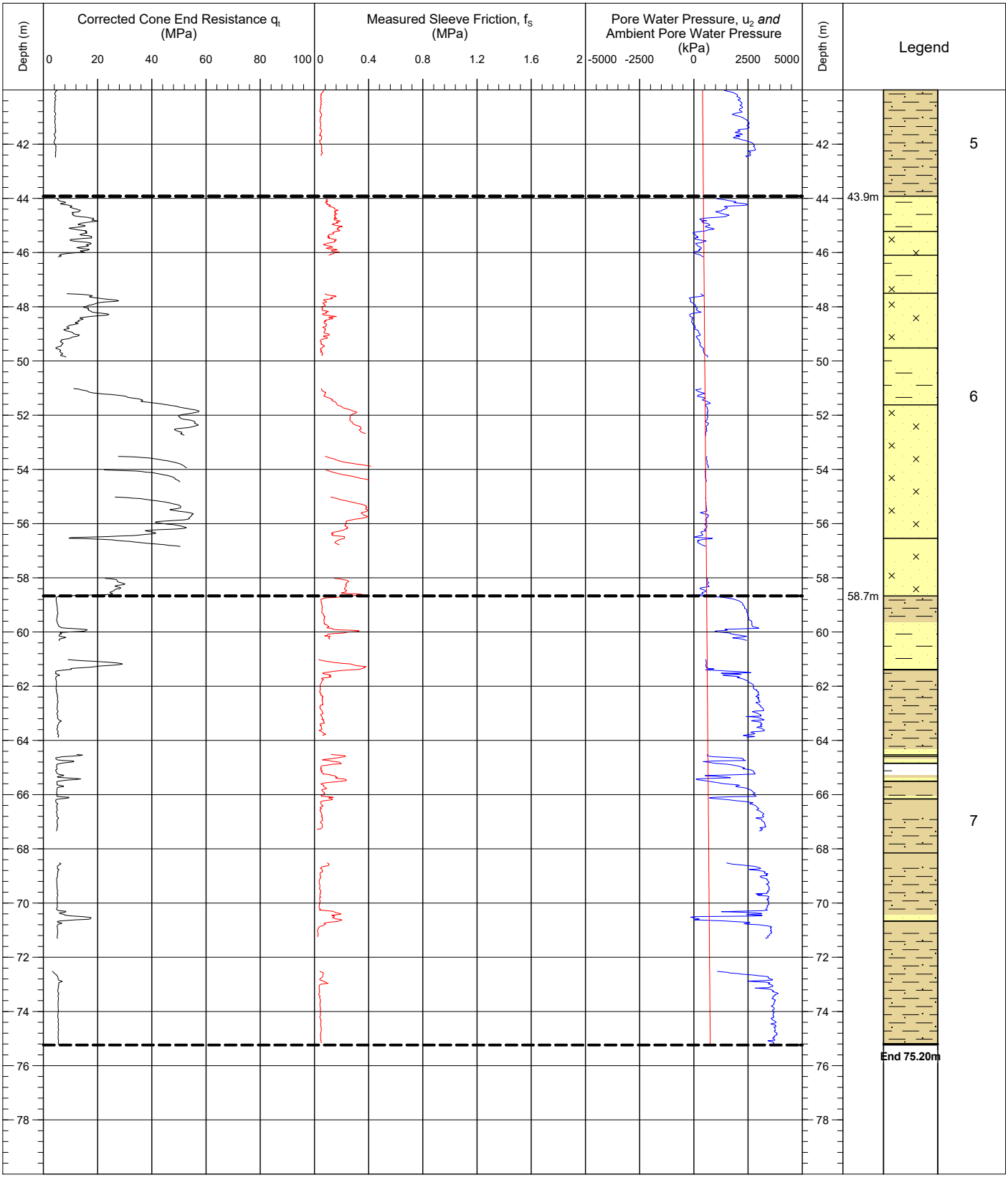
Area	**Maryland USA**	Coordinates	**515755.1E 4243612.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**19.1**	BH - D14A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**30/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**71.30m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



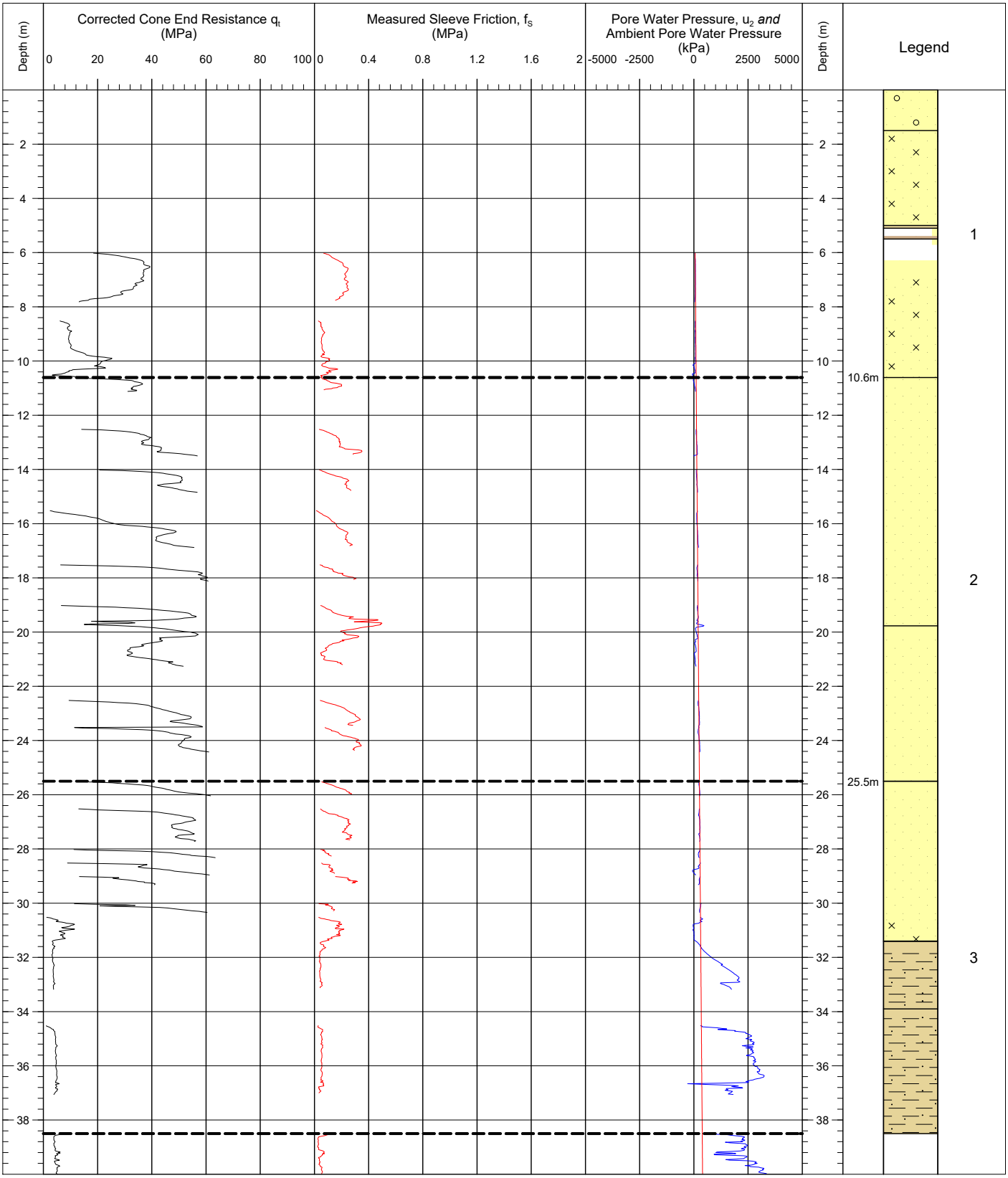
Area	**Maryland USA**	Coordinates	**519055.0E 4251306.0N**	Borehole Number	
Contract	**10451**	Water Depth (0)	**25.0**	BH - G7	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**06/07/2015 - 07/07/2015**		
Vessel	**MV Ocean Discovery**	Final Depth	**75.20m**	Filename - 1.001	
Comments:		Hole Type	**Borehole (Sampling)**	QC Status	
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



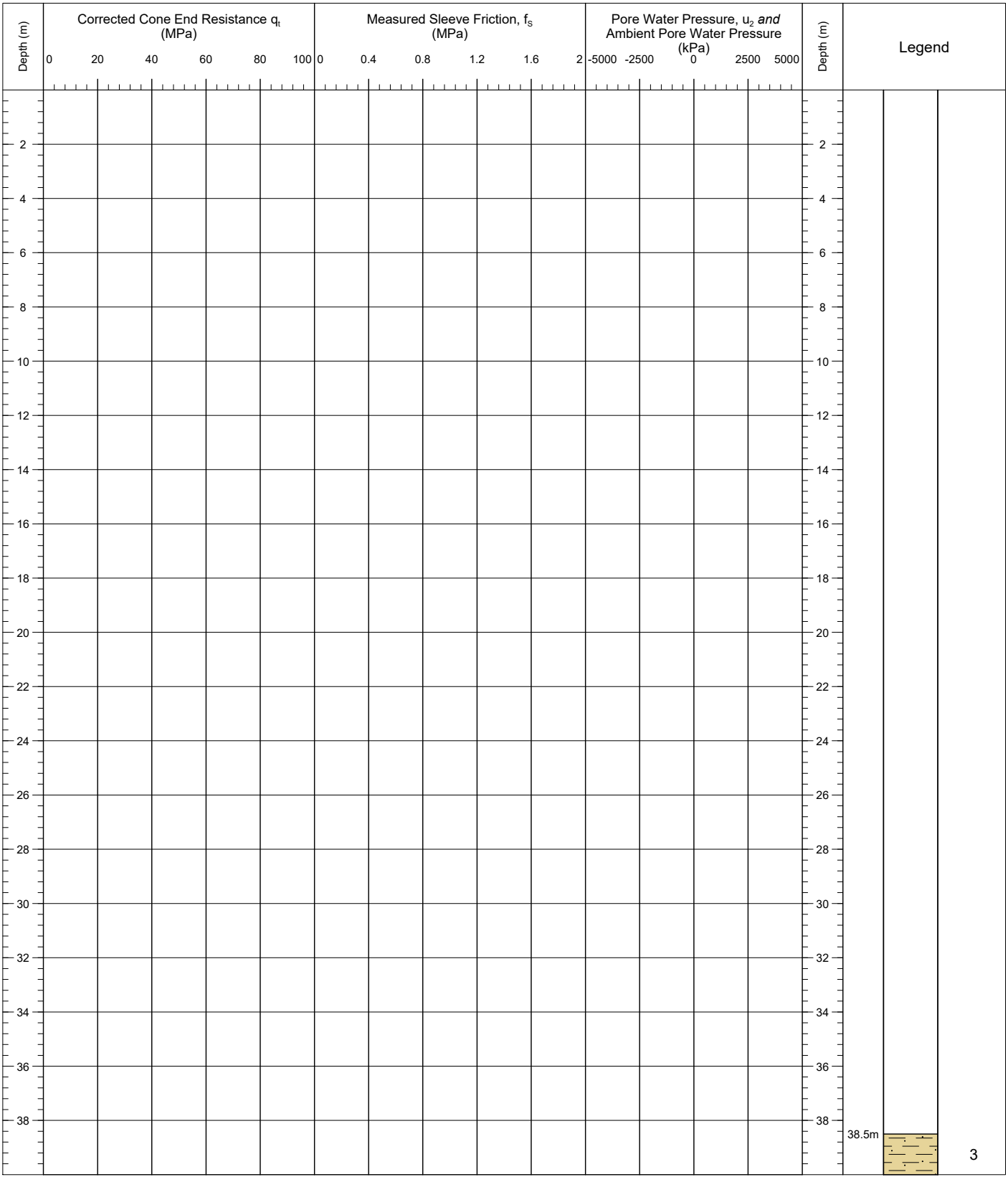
				Borehole Number
Area	**Maryland USA**	Coordinates	**519055.0E 4251306.0N**	BH - G7
Contract	**10451**	Water Depth (0)	**25.0**	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**06/07/2015 - 07/07/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**75.20m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



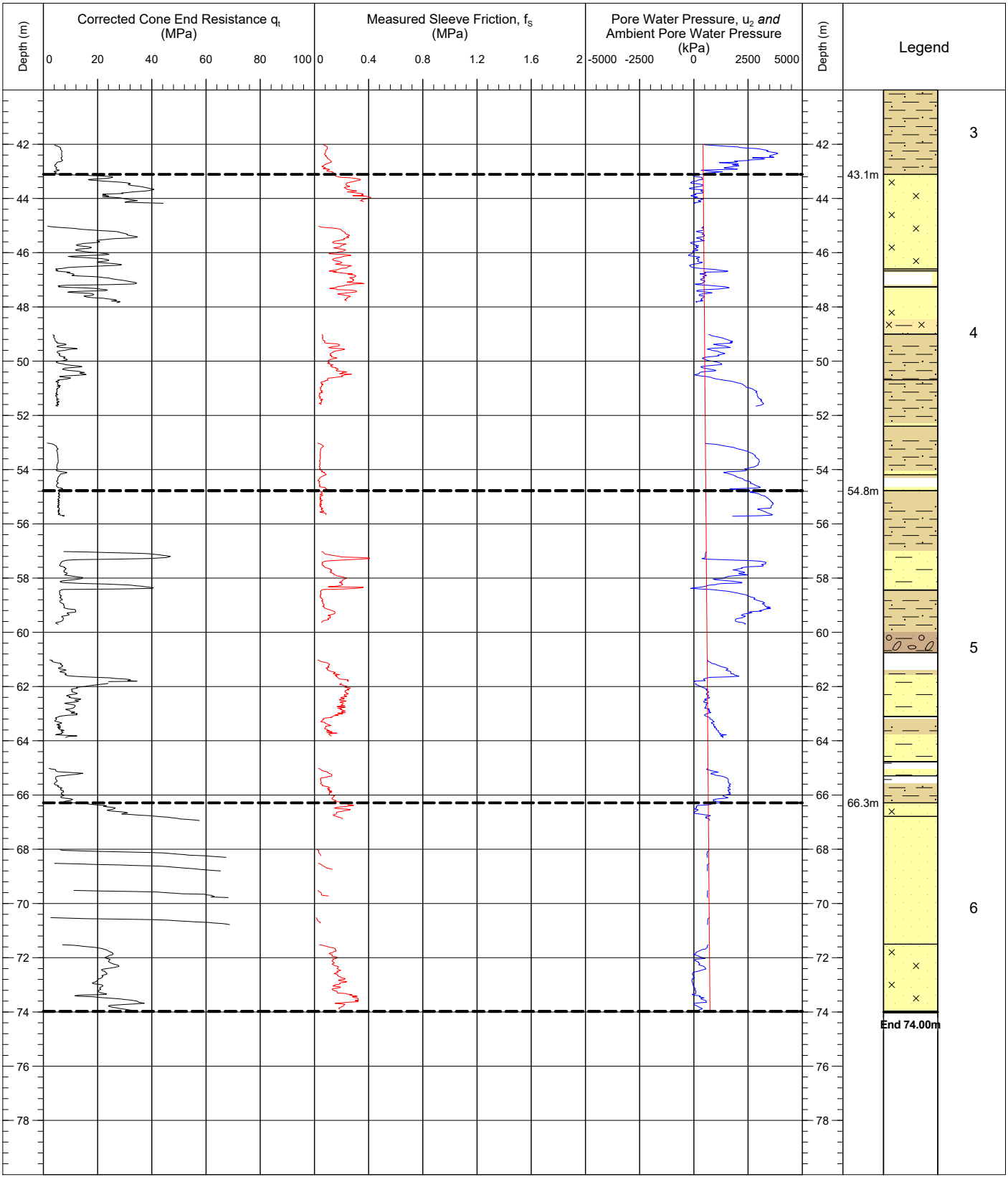
Area	**Maryland USA**	Coordinates	**519055.0E 4240306.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**25.0**	BH - G17
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**01/07/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**41.00m**	Filename - 1.001
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) · Draft: **JG** (21/01/2016) · Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



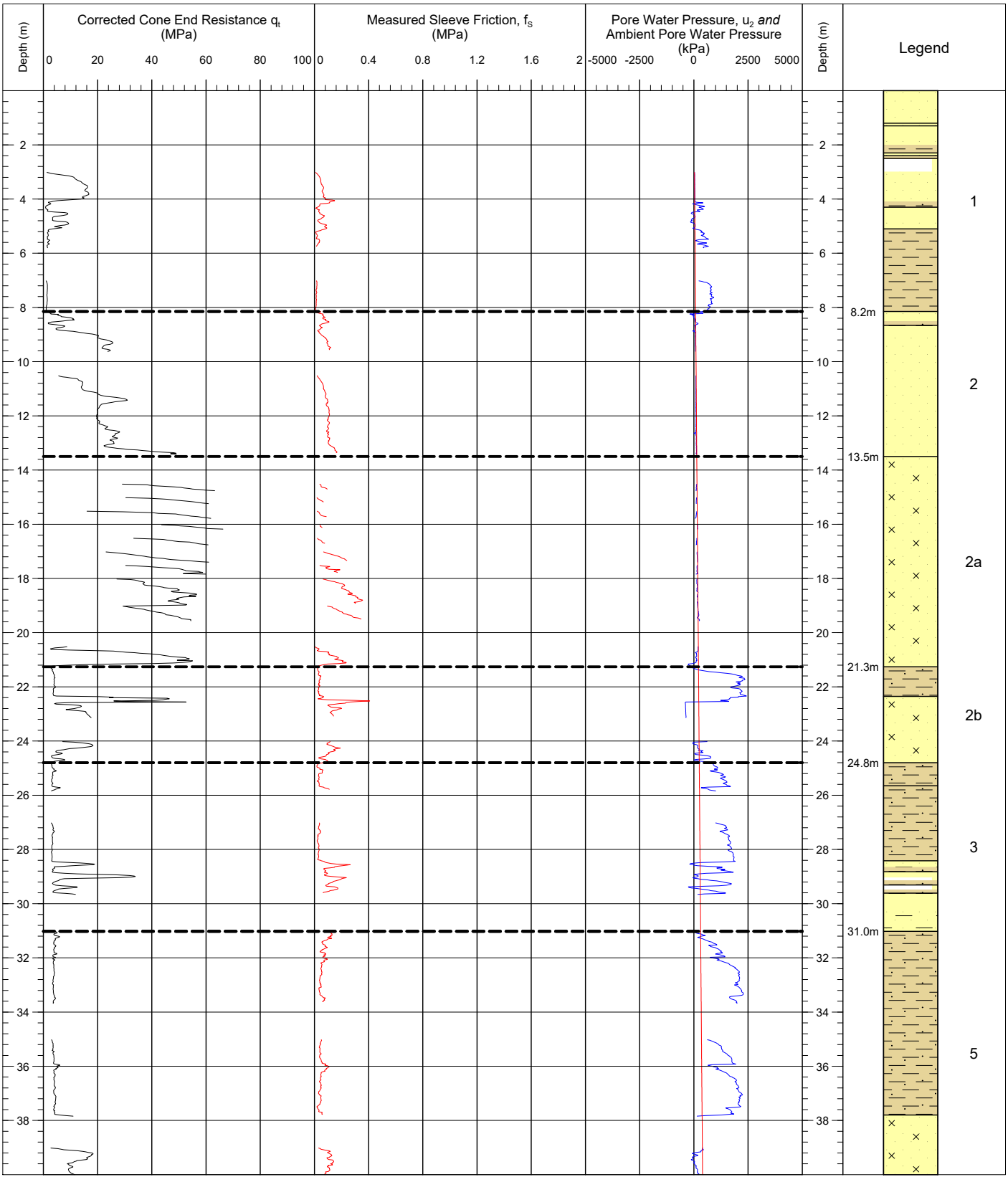
Area	**Maryland USA**	Coordinates	**519056.4E 4240311.6N**	Borehole Number
Contract	**10451**	Water Depth (0)	**24.9**	BH - G17A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**02/07/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**74.00m**	Filename - 1.001
Comments: BH-G17 abandoned at 41.02m due to weather. Location details are taken from BH-G17A.		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc (28/09/2015)** / Draft: **JG (21/01/2016)** / Final: **()**

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



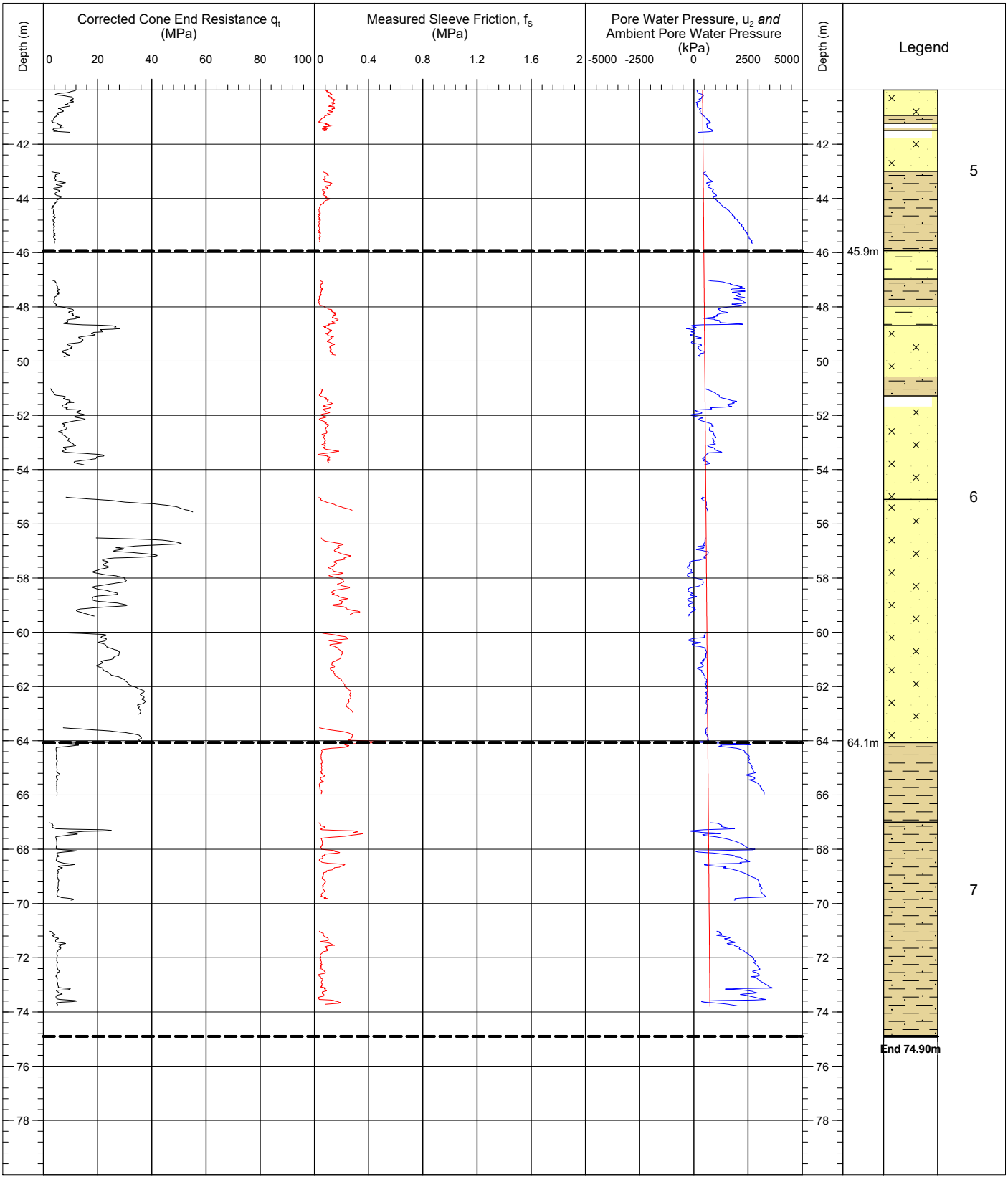
Area	**Maryland USA**	Coordinates	**519056.4E 4240311.6N**	Borehole Number	
Contract	**10451**	Water Depth (0)	**24.9**	BH - G17A	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**02/07/2015**		
Vessel	**MV Ocean Discovery**	Final Depth	**74.00m**	Filename - 1.001	
Comments: BH-G17 abandoned at 41.02m due to weather. Location details are taken from BH-G17A.		Hole Type	**Borehole (Sampling)**	QC Status	
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



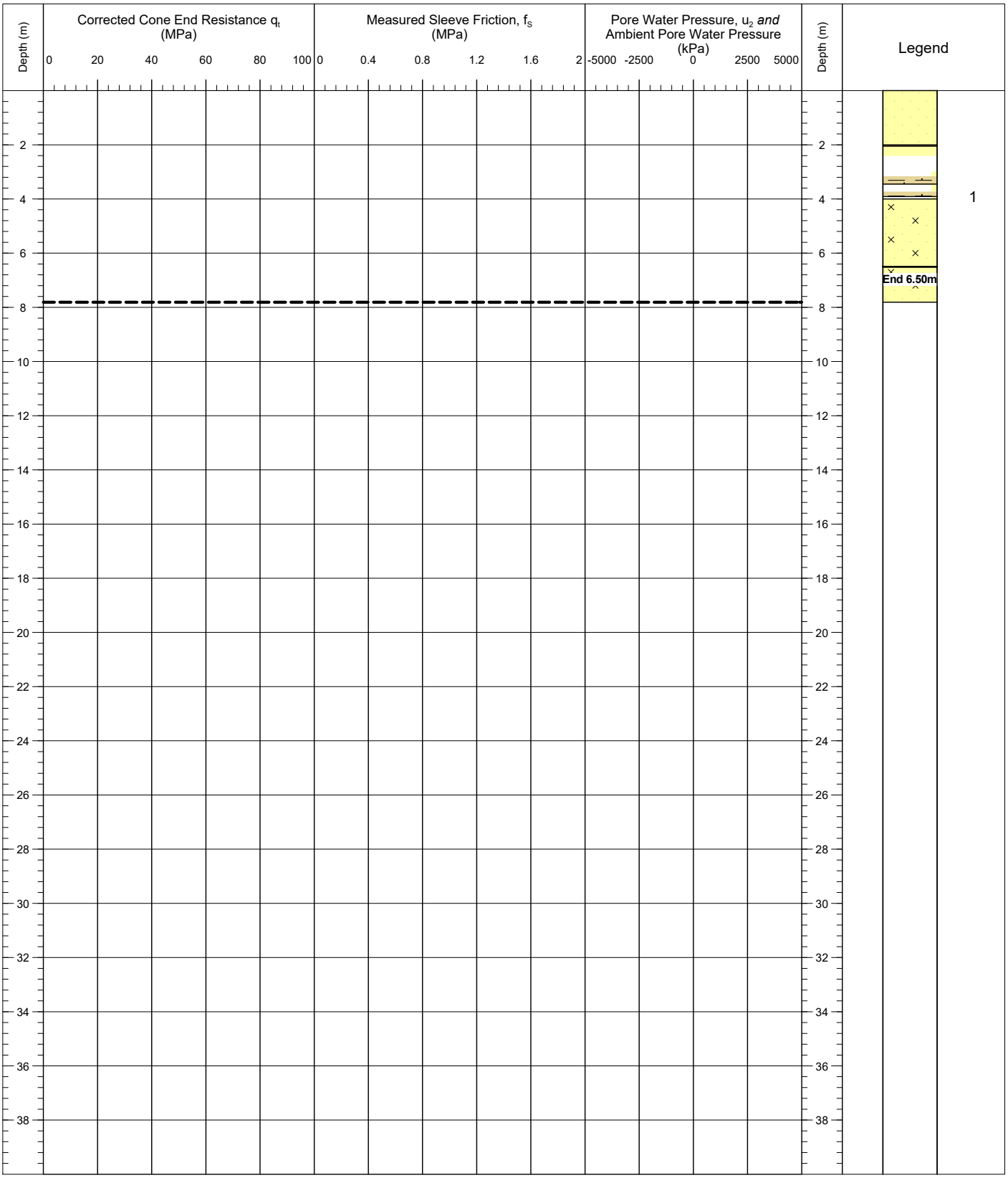
Area	**Maryland USA**	Coordinates	**520154.3E**	**4248006.5N**	Borehole Number
Contract	**10451**	Water Depth (0)	**26.8**		BH - H10
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**05/07/2015**		Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**74.90m**		QC Status
Comments:		Hole Type	**Borehole (Sampling)**		Preliminary / Draft / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**		**SMc** (28/09/2015) / **JG** (21/01/2016) / ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



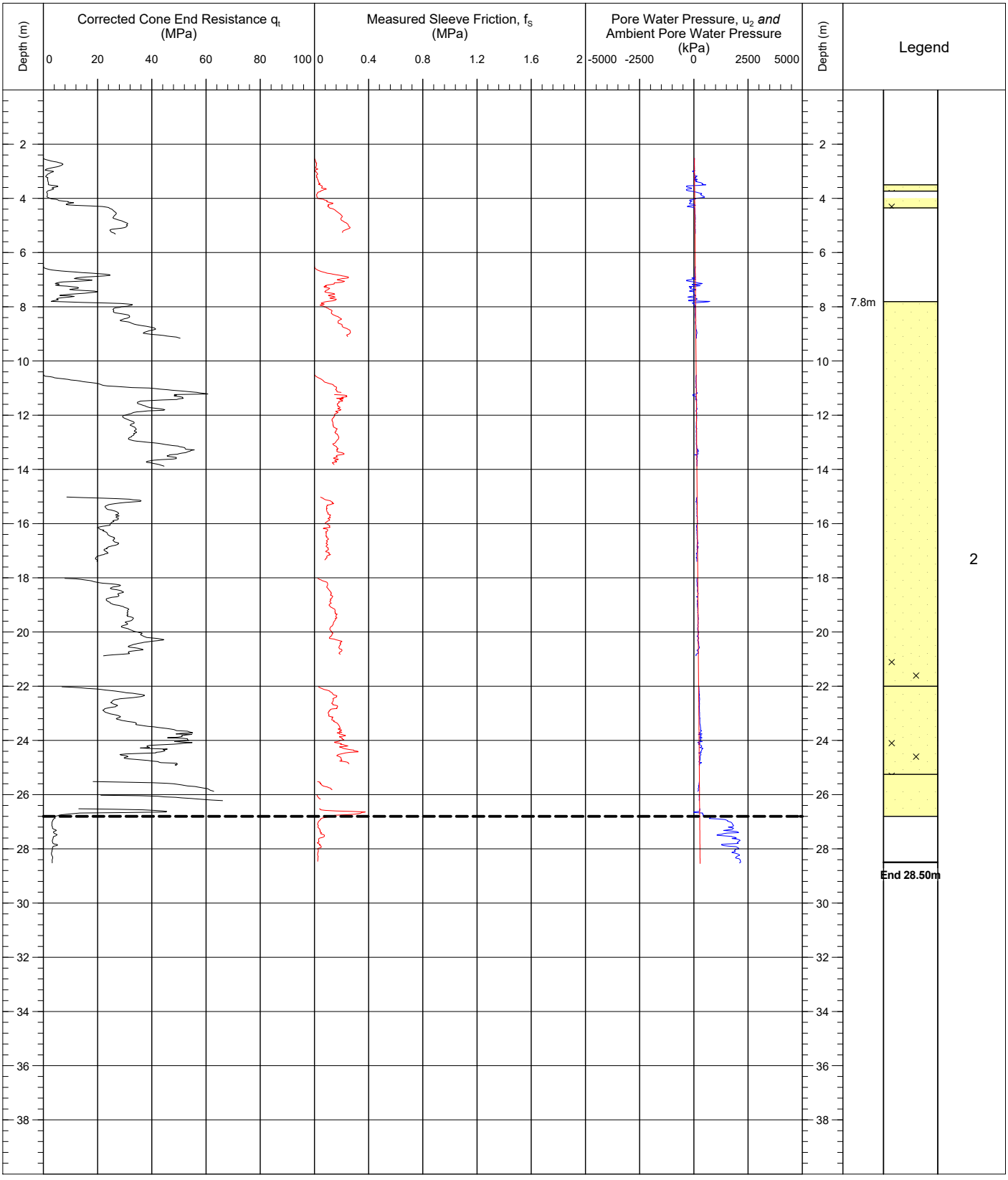
Area	**Maryland USA**	Coordinates	**520154.3E 4248006.5N**	Borehole Number
Contract	**10451**	Water Depth (0)	**26.8**	BH - H10
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**05/07/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**74.90m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



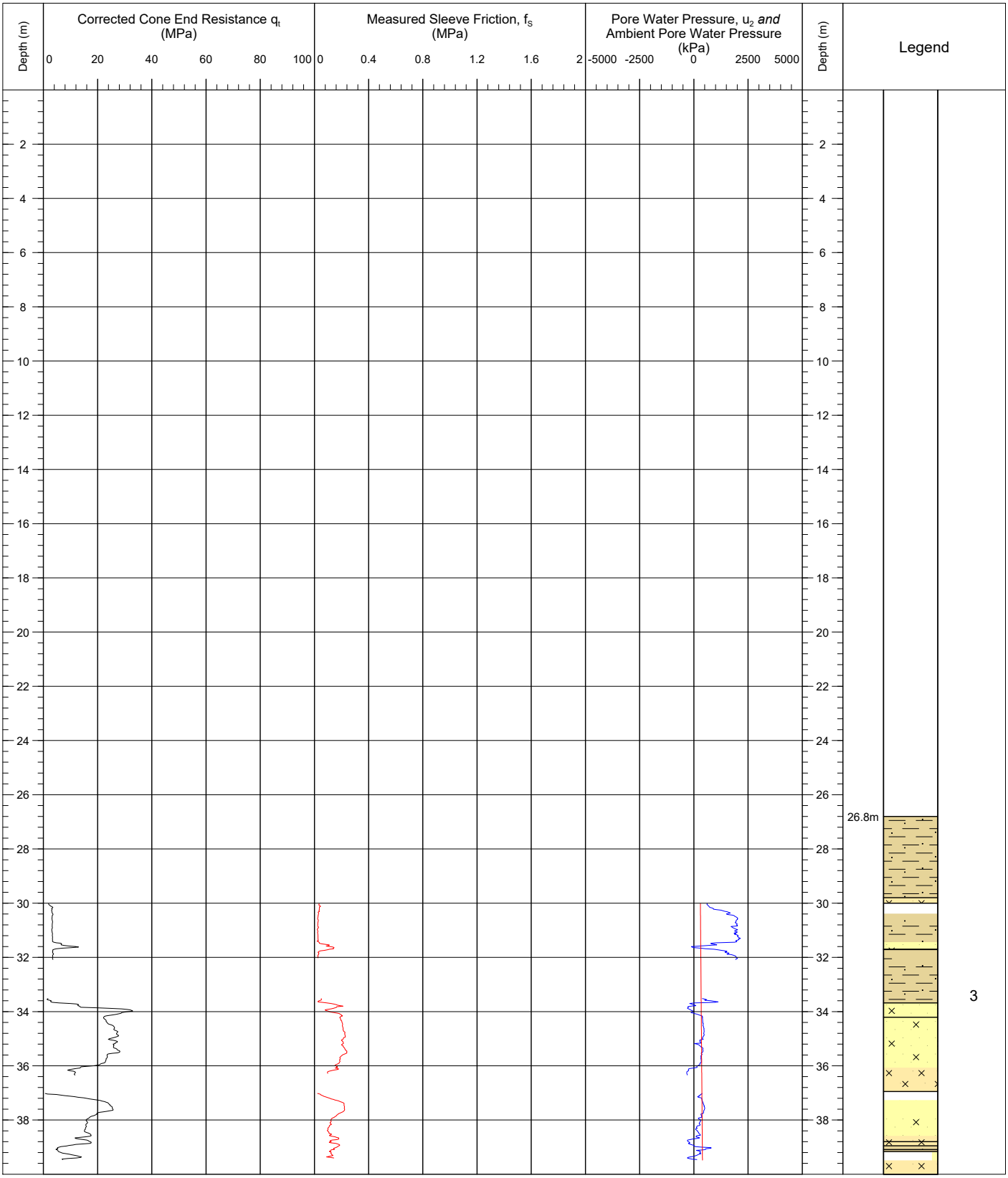
Area	**Maryland USA**	Coordinates	**521255.0E 4235906.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**20.0**	BH - I21
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**22/06/2015 - 23/06/2015**	Filename -
Vessel	**MV Ocean Discovery**	Final Depth	**6.50m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary / Draft / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	**SMc** (28/09/2015) / **JG** (21/01/2016) / ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



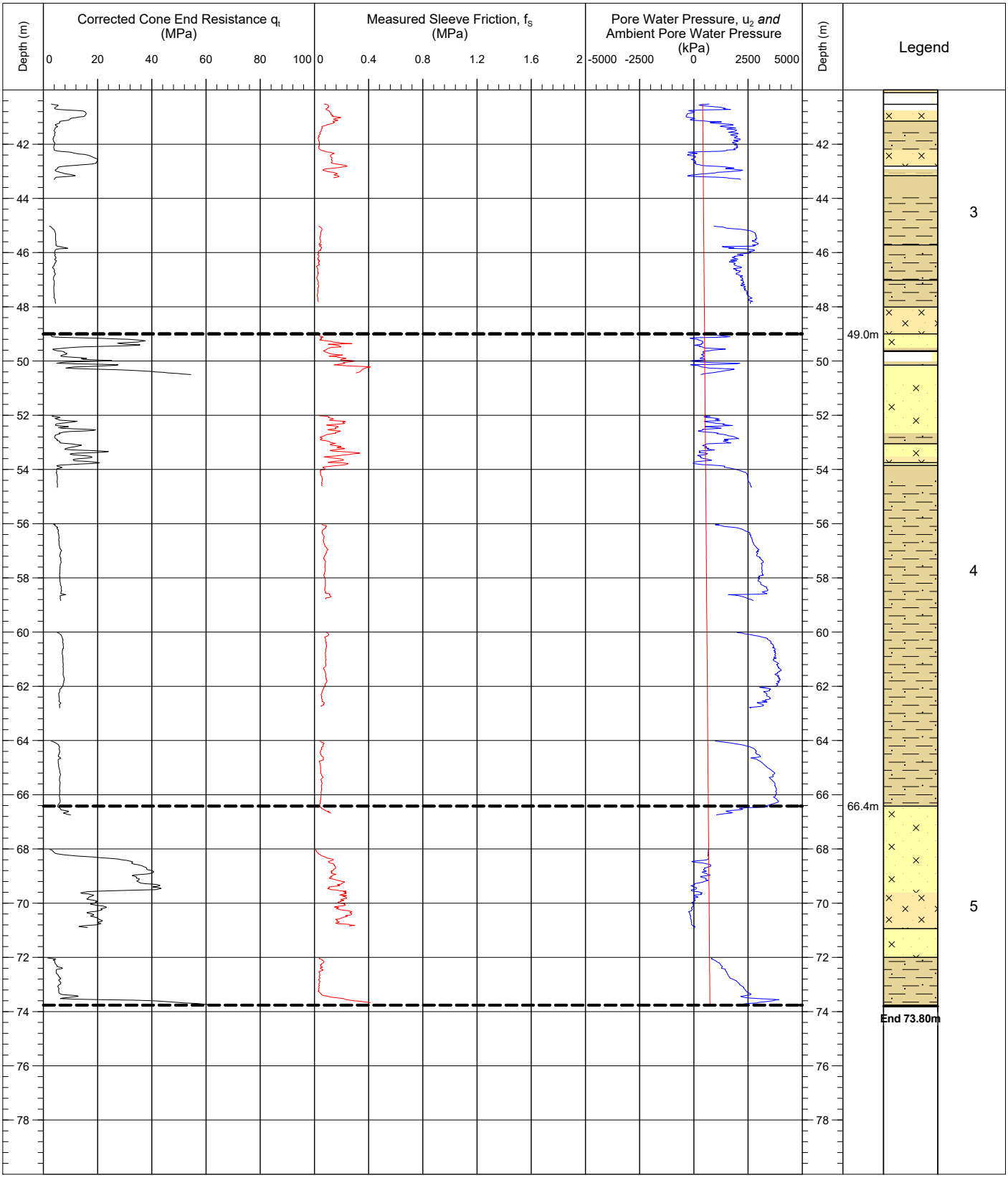
Area	**Maryland USA**	Coordinates	**521255.0E 4235906.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**26.0**	BH - I21A
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**23/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**28.50m**	Filename - 1.001
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) · Draft: **JG** (21/01/2016) · Final: ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



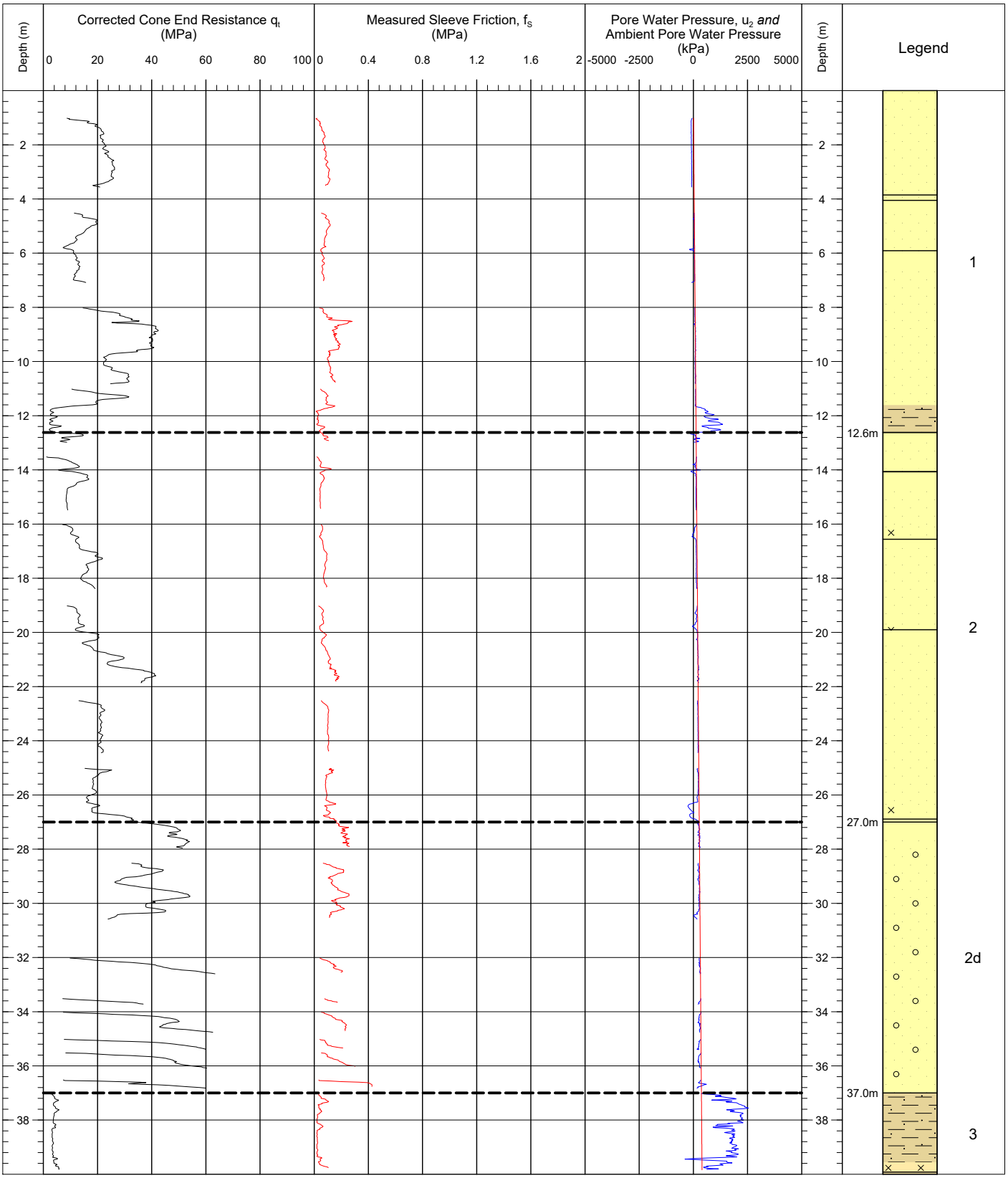
Area	**Maryland USA**	Coordinates	**521255.0E 4235906.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**23.0**	BH - I21B
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**24/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**73.80m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



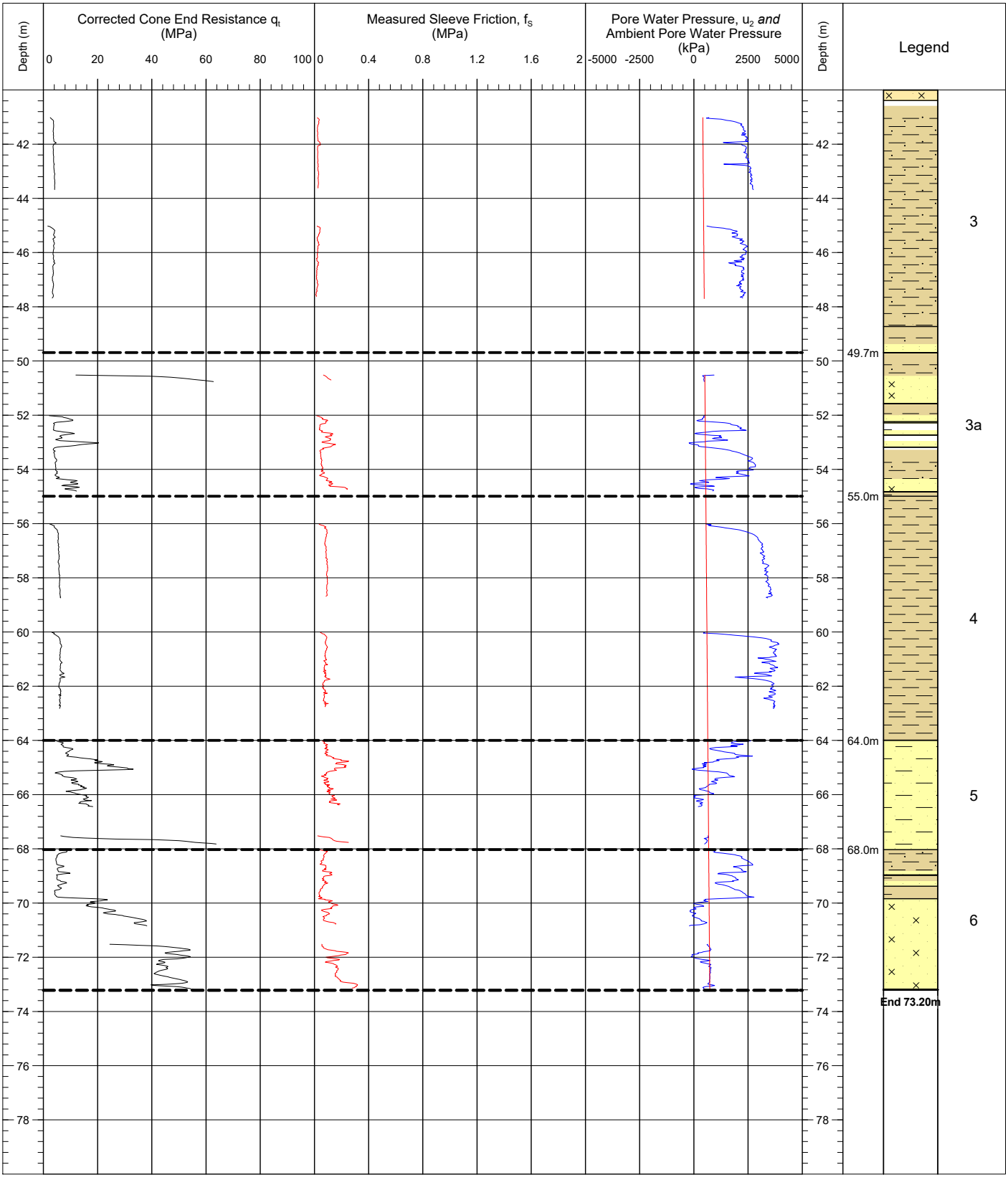
Area	**Maryland USA**	Coordinates	**521255.0E 4235906.0N**	Borehole Number
Contract	**10451**	Water Depth (0)	**23.0**	BH - I21B
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test	**24/06/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**73.80m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



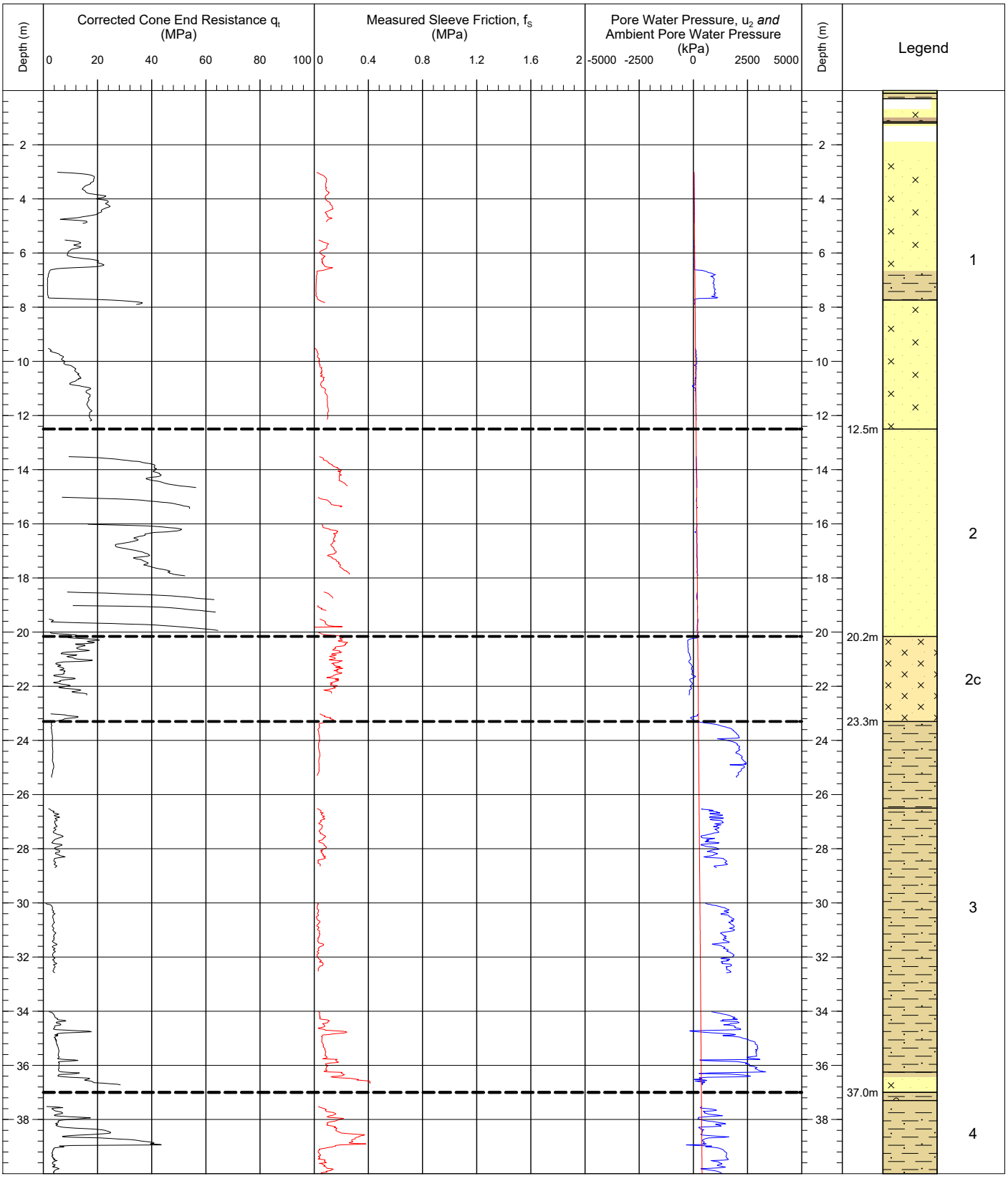
Area	**Maryland USA**	Coordinates	**523454.4E 4241406.3N**	Borehole Number
Contract	**10451**	Water Depth (0)	**24.6**	BH - K16
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**03/07/2015 - 04/07/2015**	Filename - 1.001
Vessel	**MV Ocean Discovery**	Final Depth	**73.20m**	QC Status
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary / Draft / Final
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	**SMc** (28/09/2015) / **JG** (21/01/2016) / ()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



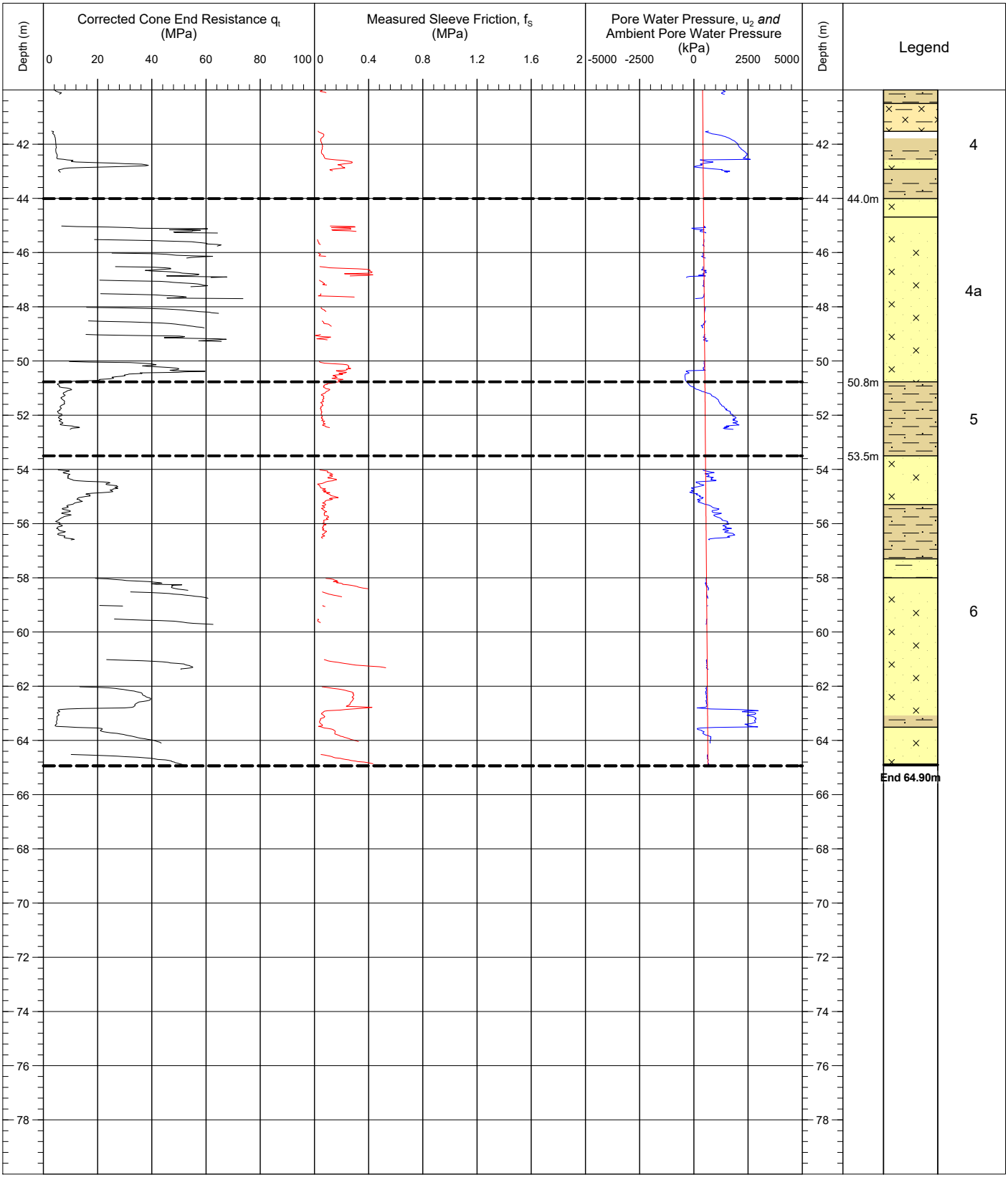
Area	**Maryland USA**	Coordinates	**523454.4E 4241406.3N**	Borehole Number	
Contract	**10451**	Water Depth (0)	**24.6**	BH - K16	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**03/07/2015 - 04/07/2015**	Filename - 1.001	
Vessel	**MV Ocean Discovery**	Final Depth	**73.20m**	QC Status	
Comments:		Hole Type	**Borehole (Sampling)**	Preliminary / Draft / Final	
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	**SMc** (28/09/2015) / **JG** (21/01/2016) / ()	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number
Contract	**10451**	Water Depth (0)	**27.7**	BH - MET TOWER
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**19/06/2015 - 20/06/2015**	
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename - 1.001
Comments:		Hole Type	**Borehole (Sampling)**	QC Status
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) · Draft: **JG** (21/01/2016) · Final: ()

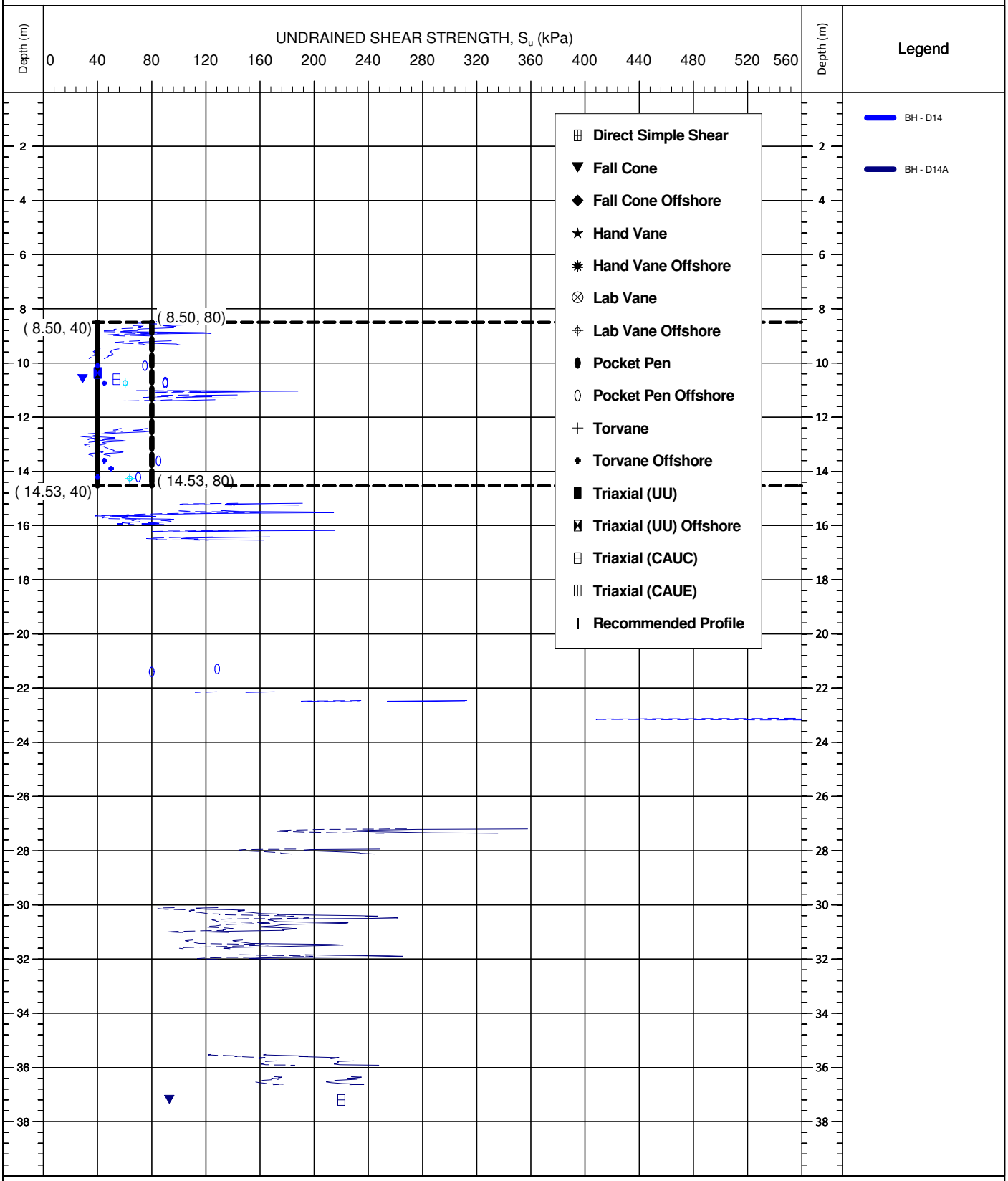
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CPTU COMPOSITE PLOT



Area	**Maryland USA**	Coordinates	**521533.9E 4244983.3N**	Borehole Number	
Contract	**10451**	Water Depth (0)	**27.7**	BH - MET TOWER	
Client Name/Ref	**US Wind Inc./REF11449**	Date of Test (Start-End)	**19/06/2015 - 20/06/2015**		
Vessel	**MV Ocean Discovery**	Final Depth	**64.90m**	Filename - 1.001	
Comments:		Hole Type	**Borehole (Sampling)**	QC Status	
		CRS	**GRS 80 UTM ZONE 18 N (75 W)**	Preliminary: **SMc** (28/09/2015) / Draft: **JG** (21/01/2016) / Final: ()	

5.2 Undrained Shear Strength

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE

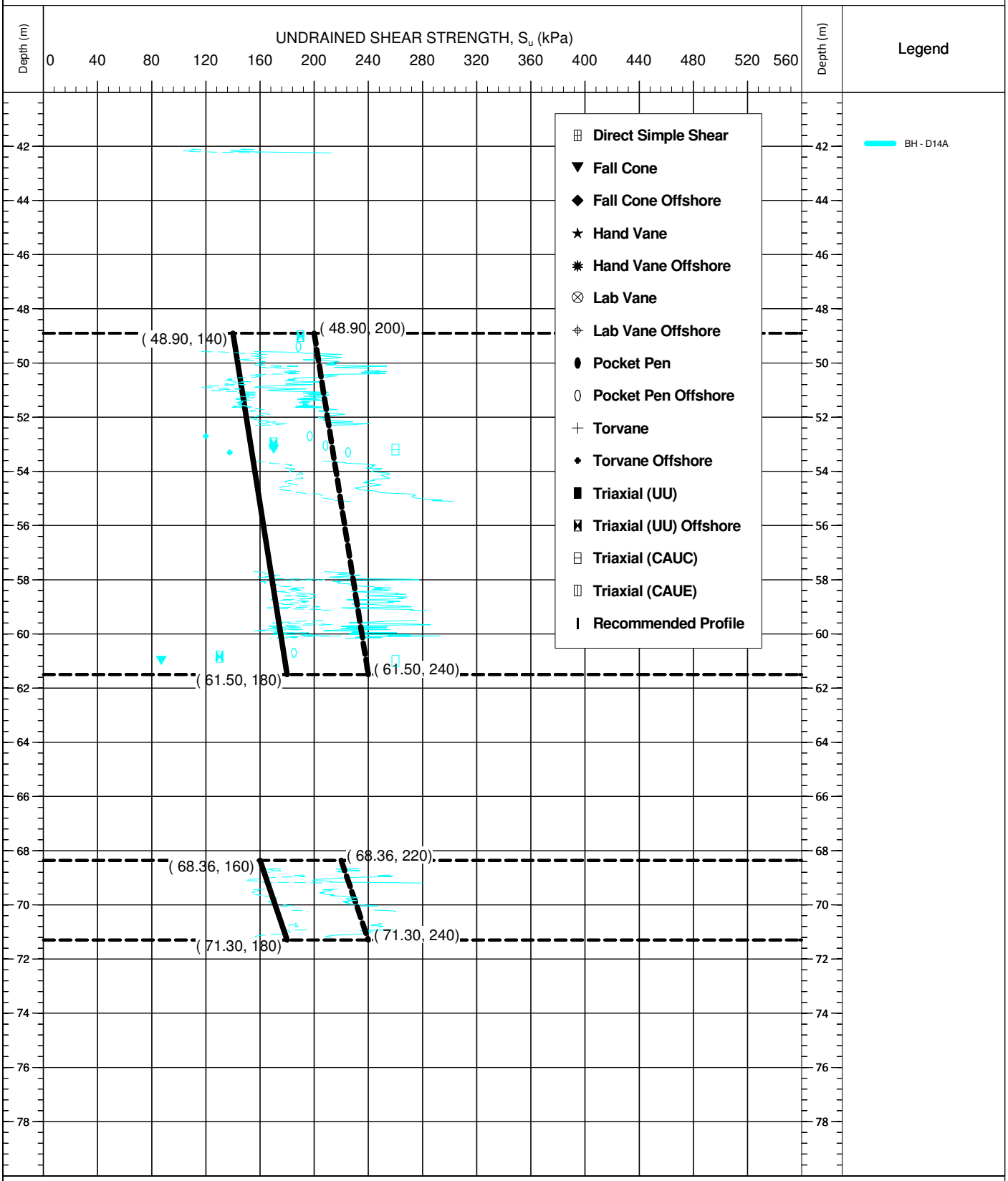


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



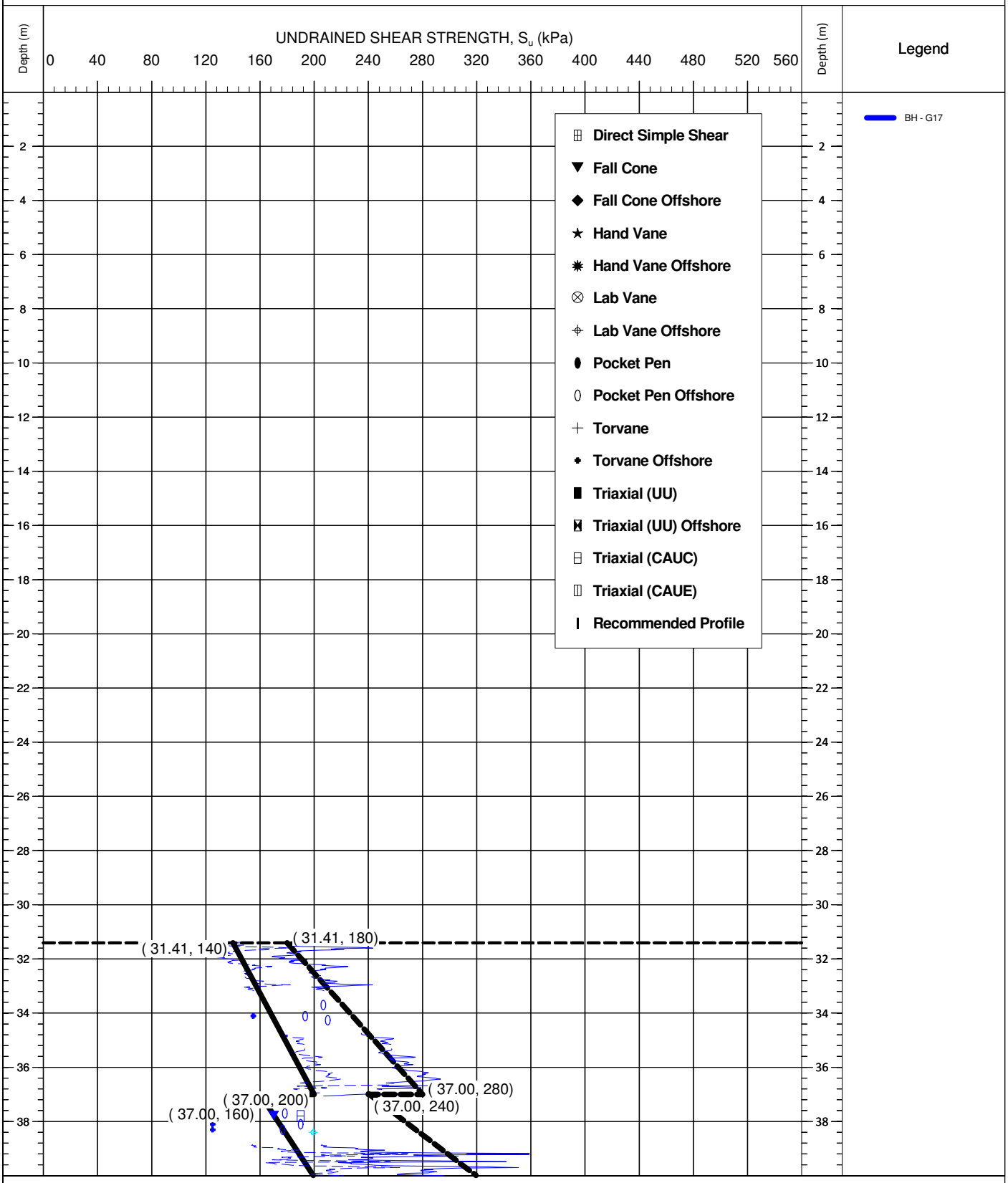
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE

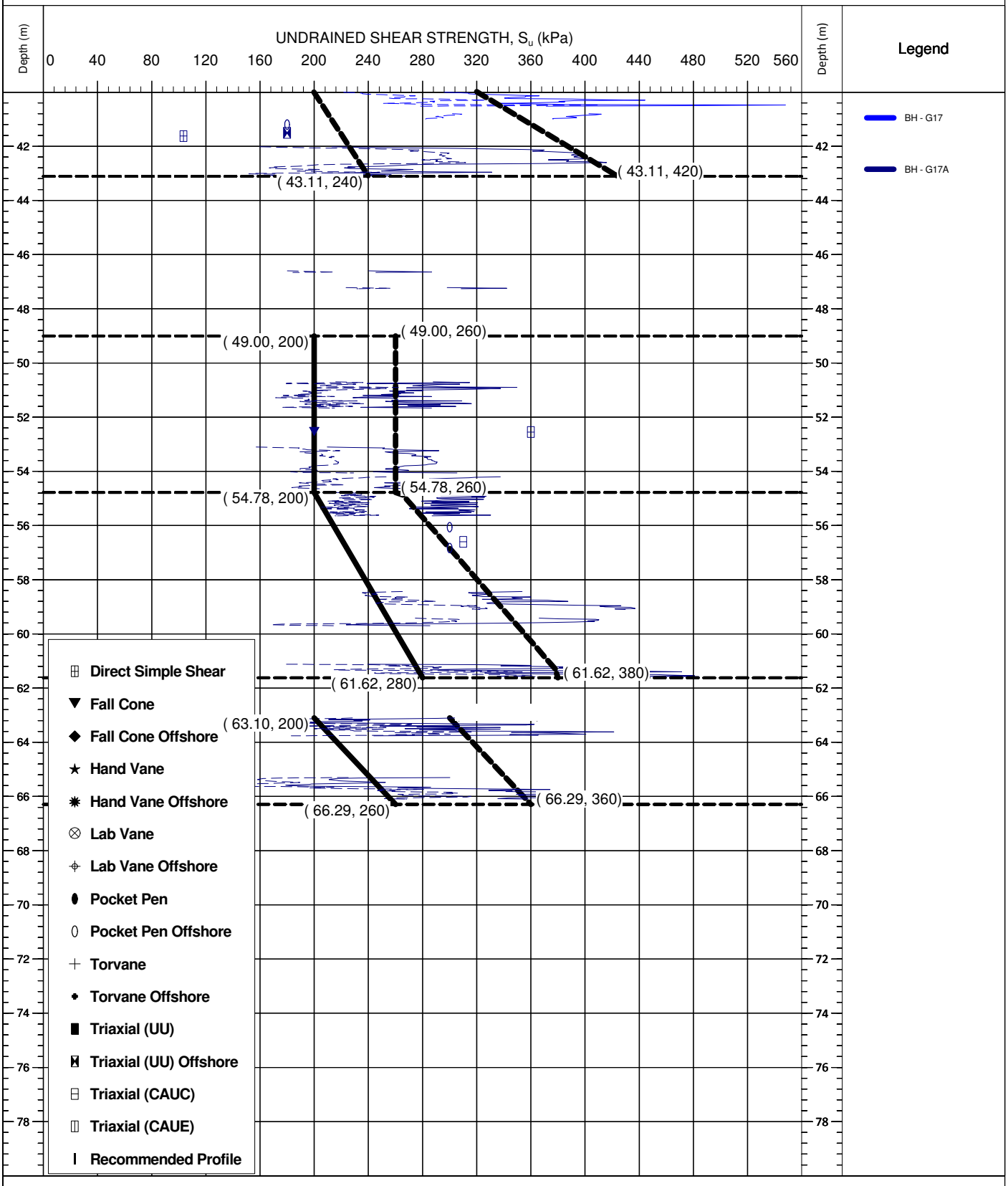


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



Area	**Maryland USA**
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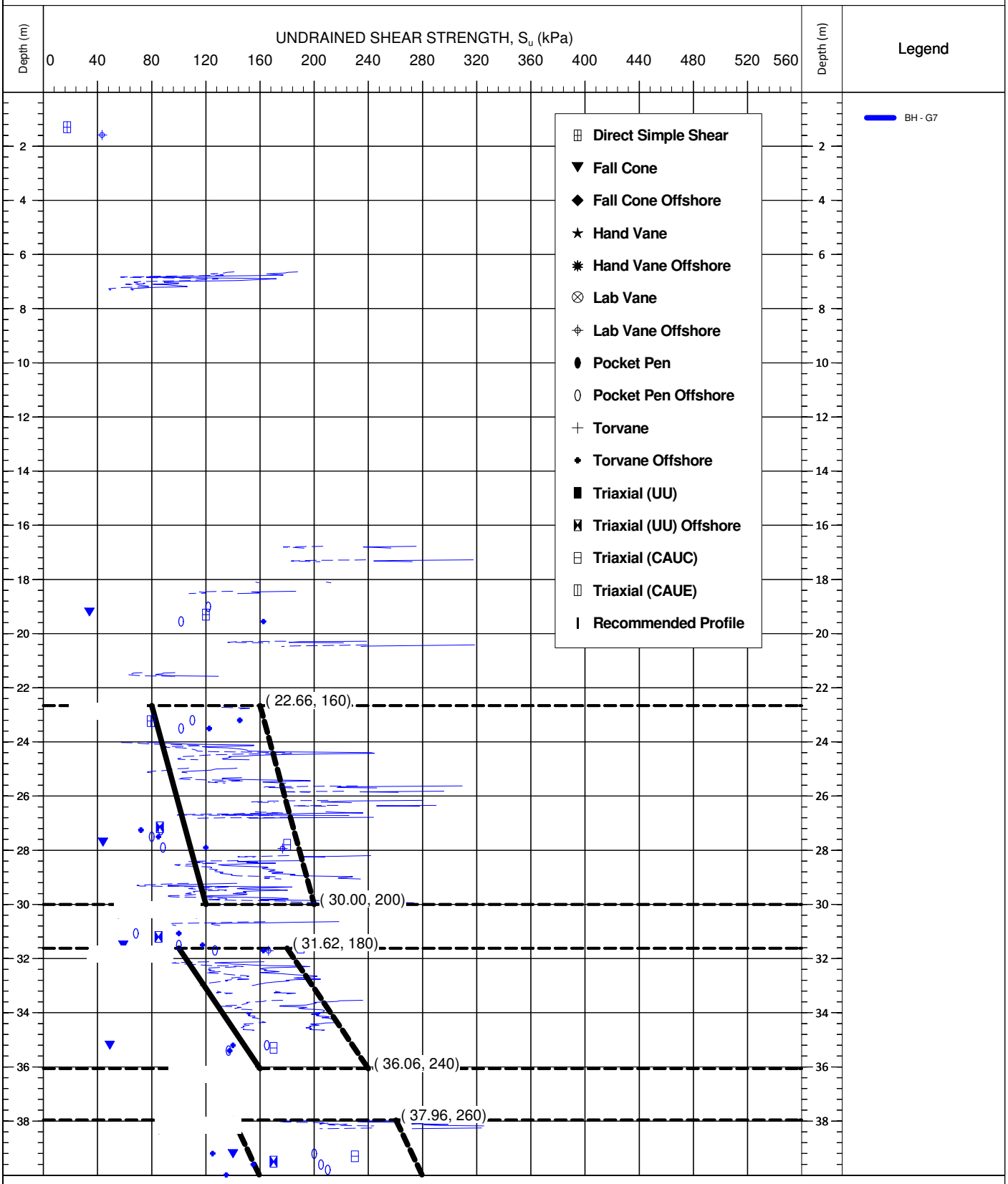
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



Area	**Maryland USA**
Contract	**10451**
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Comments:

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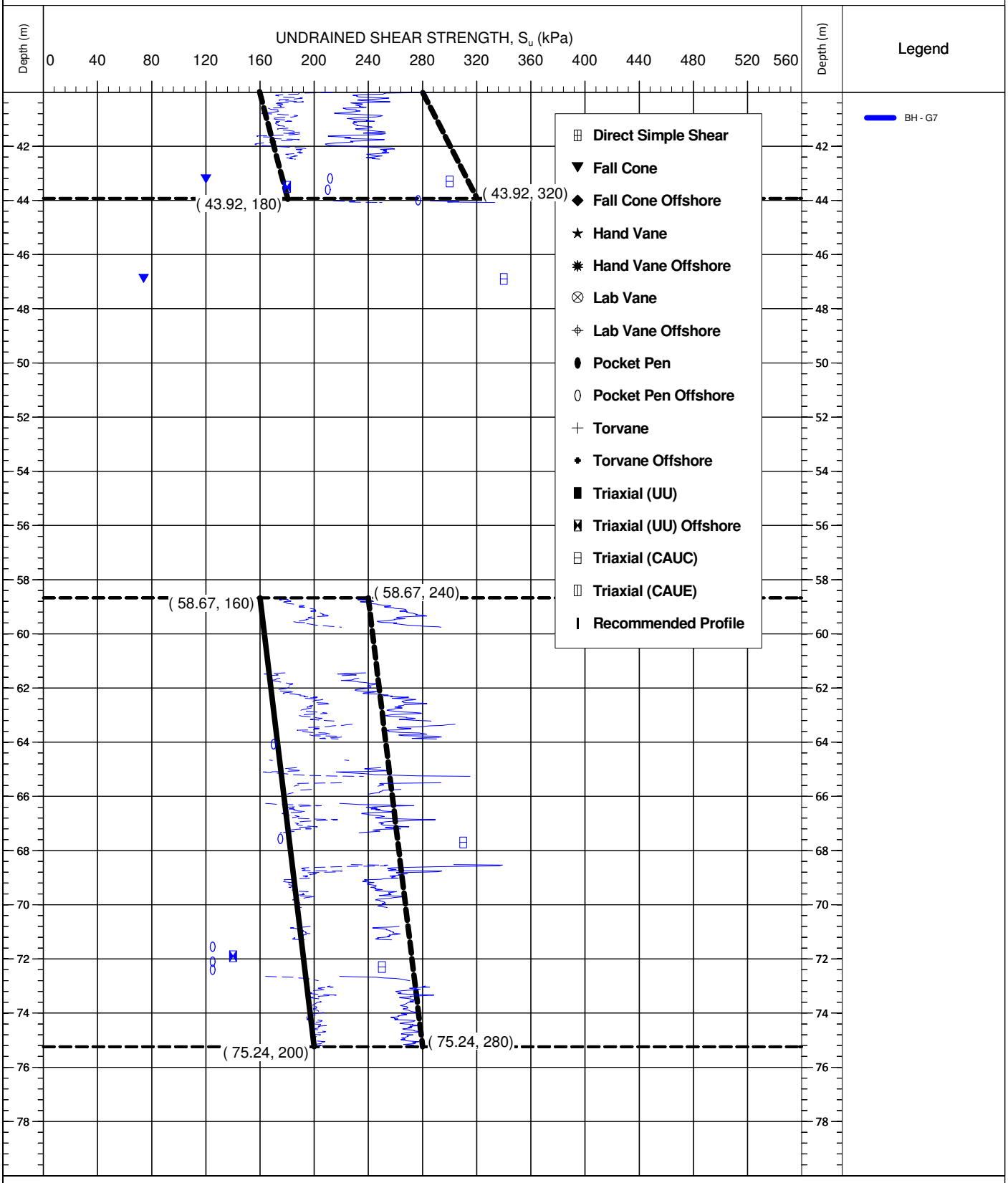
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



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Contract	**10451**
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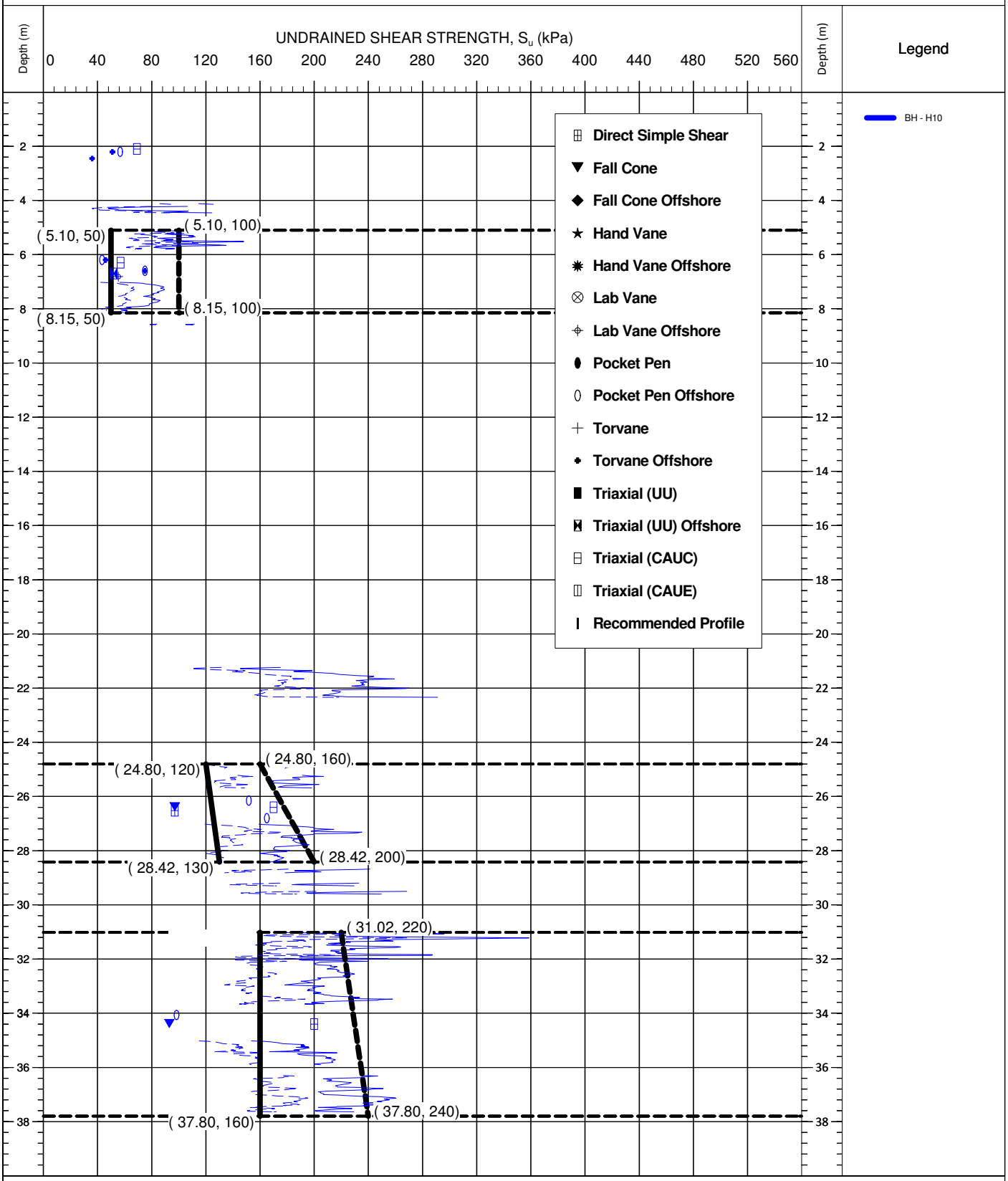
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



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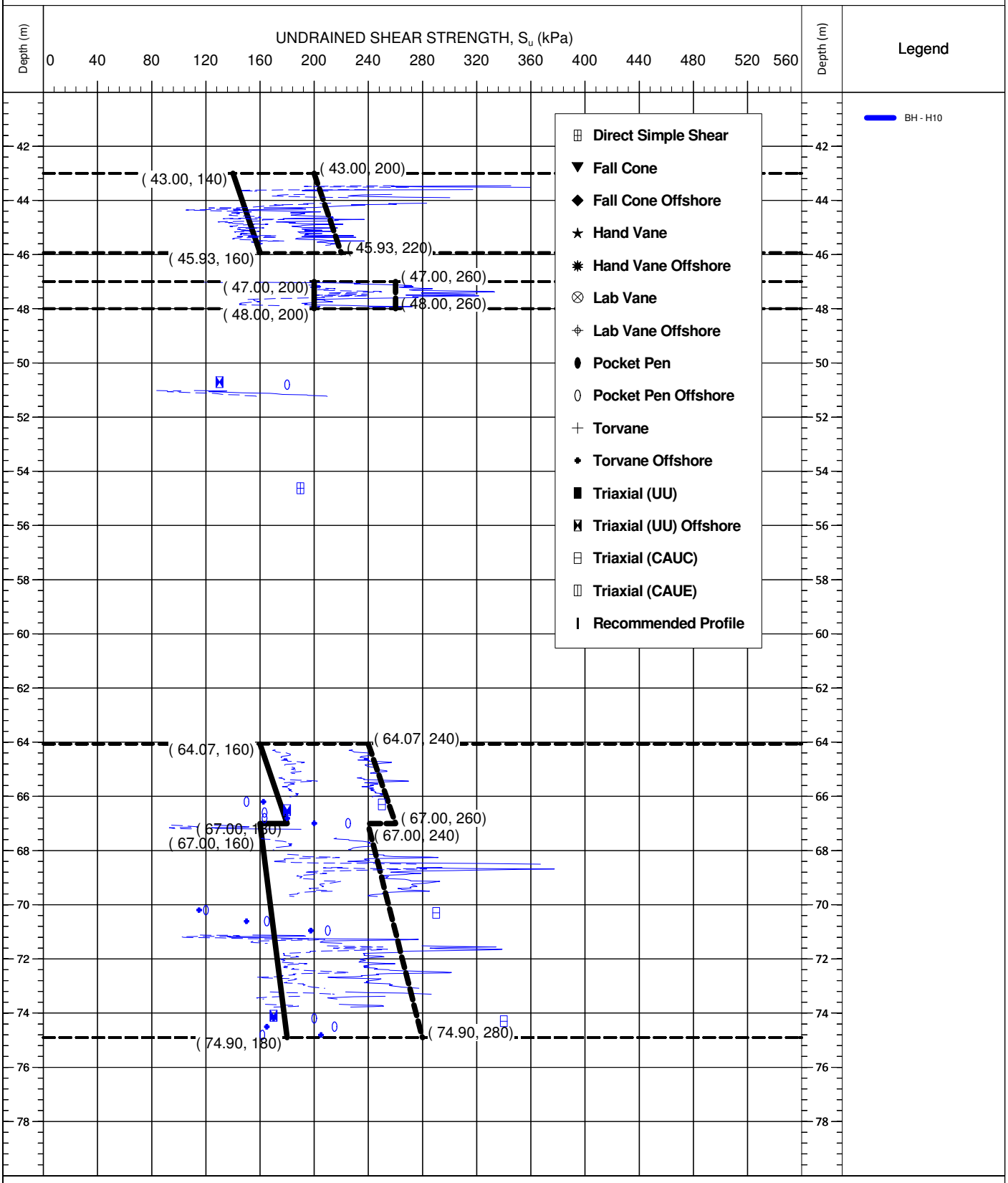
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



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Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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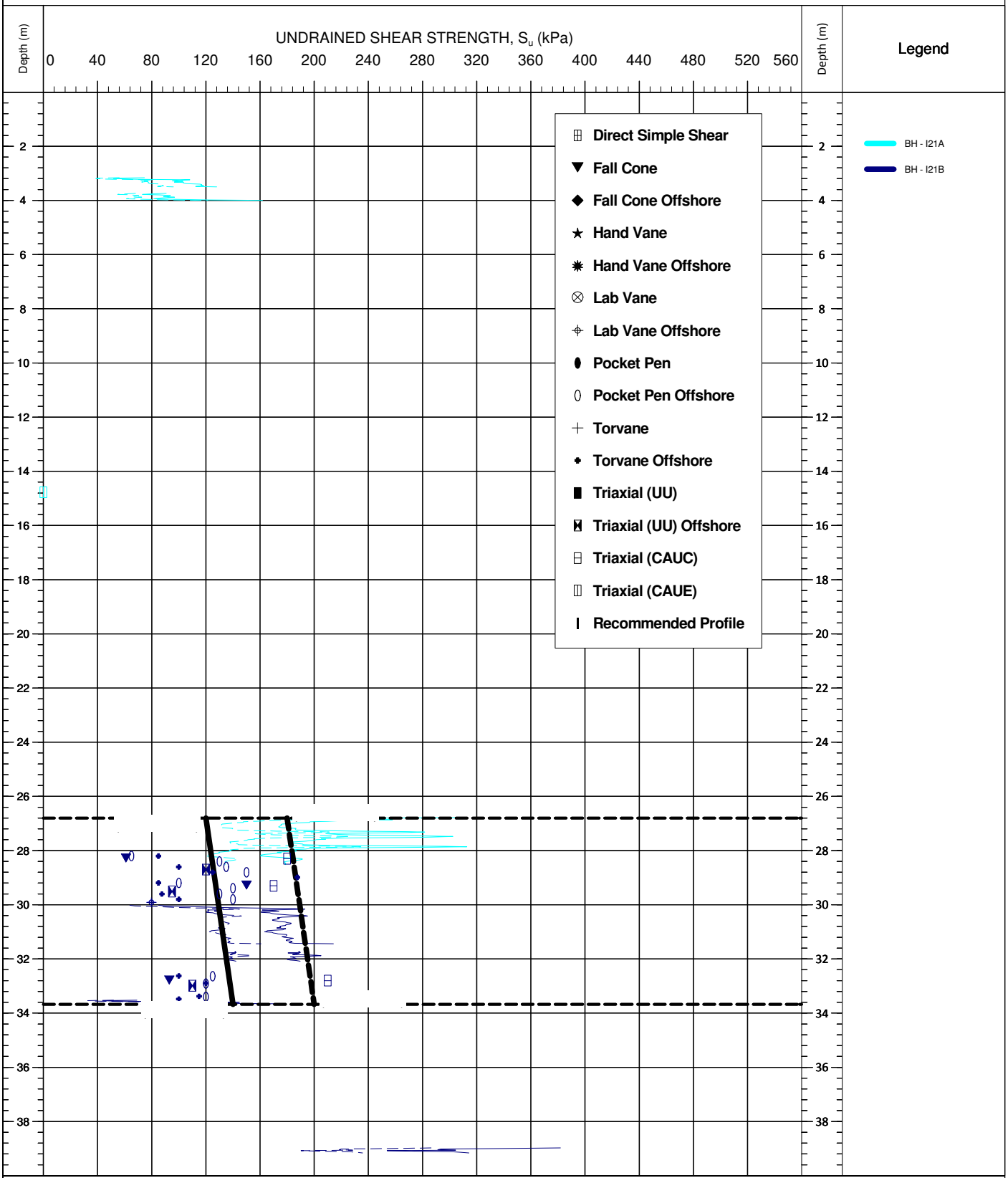
Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



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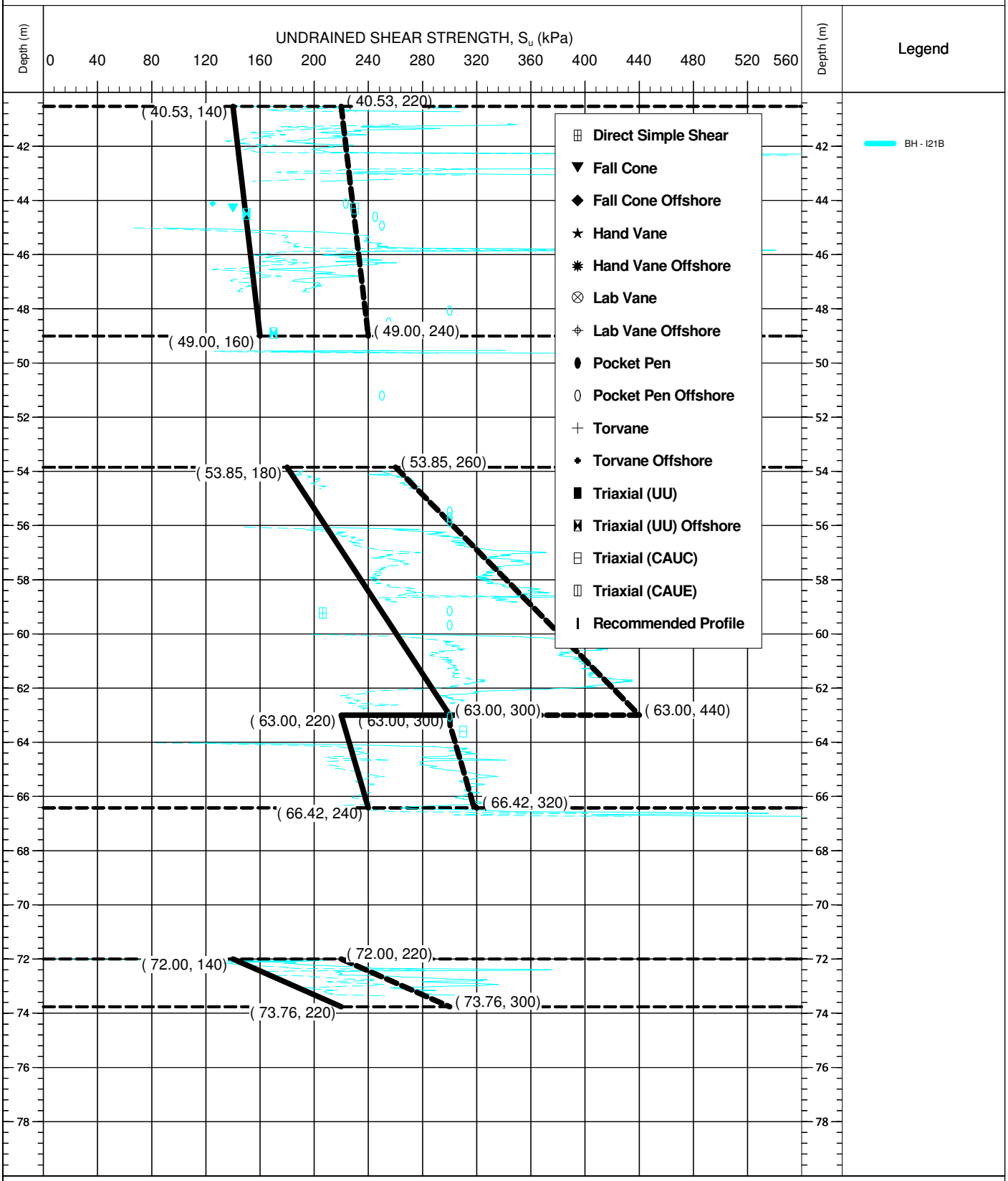
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



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Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
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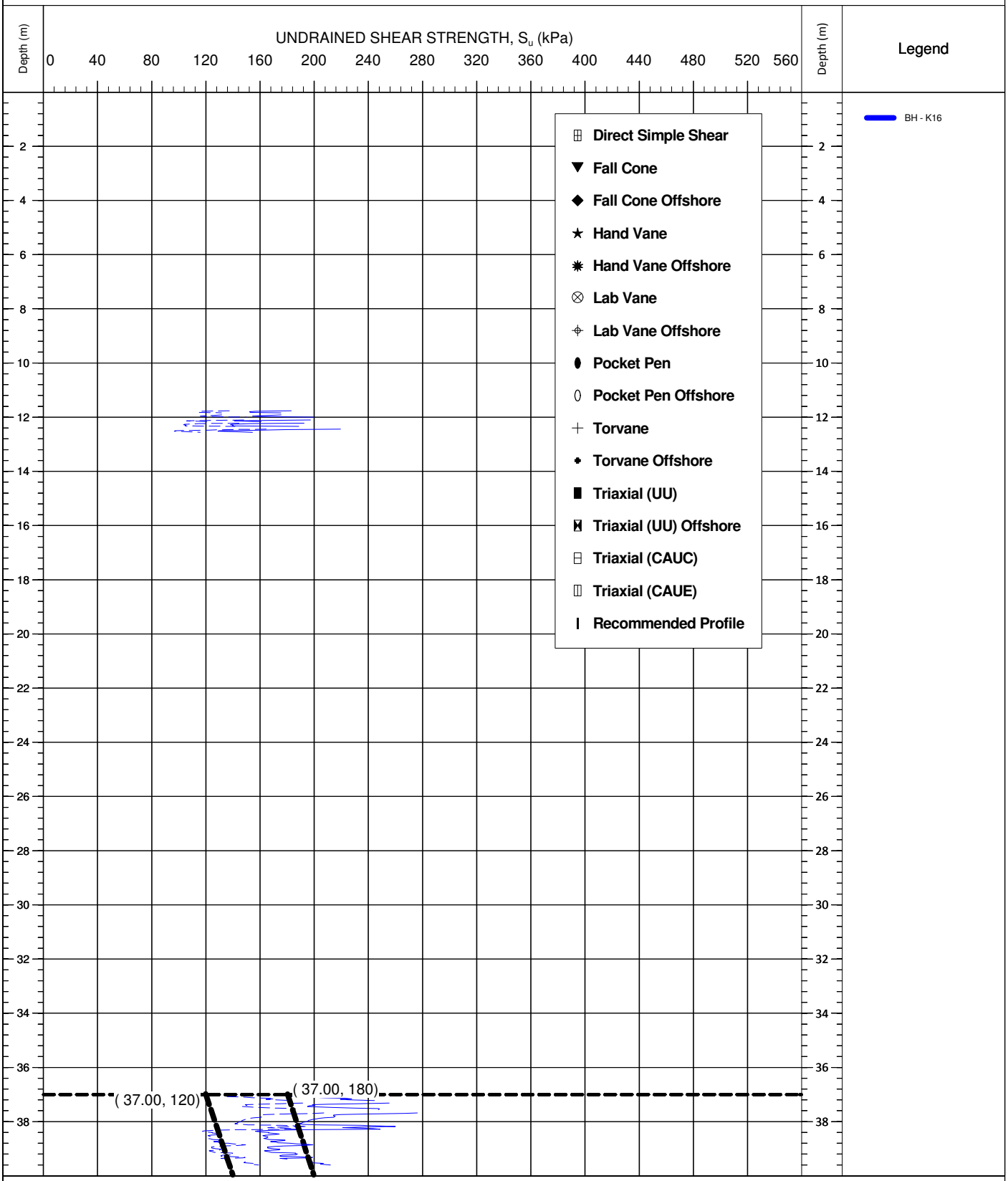
Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE

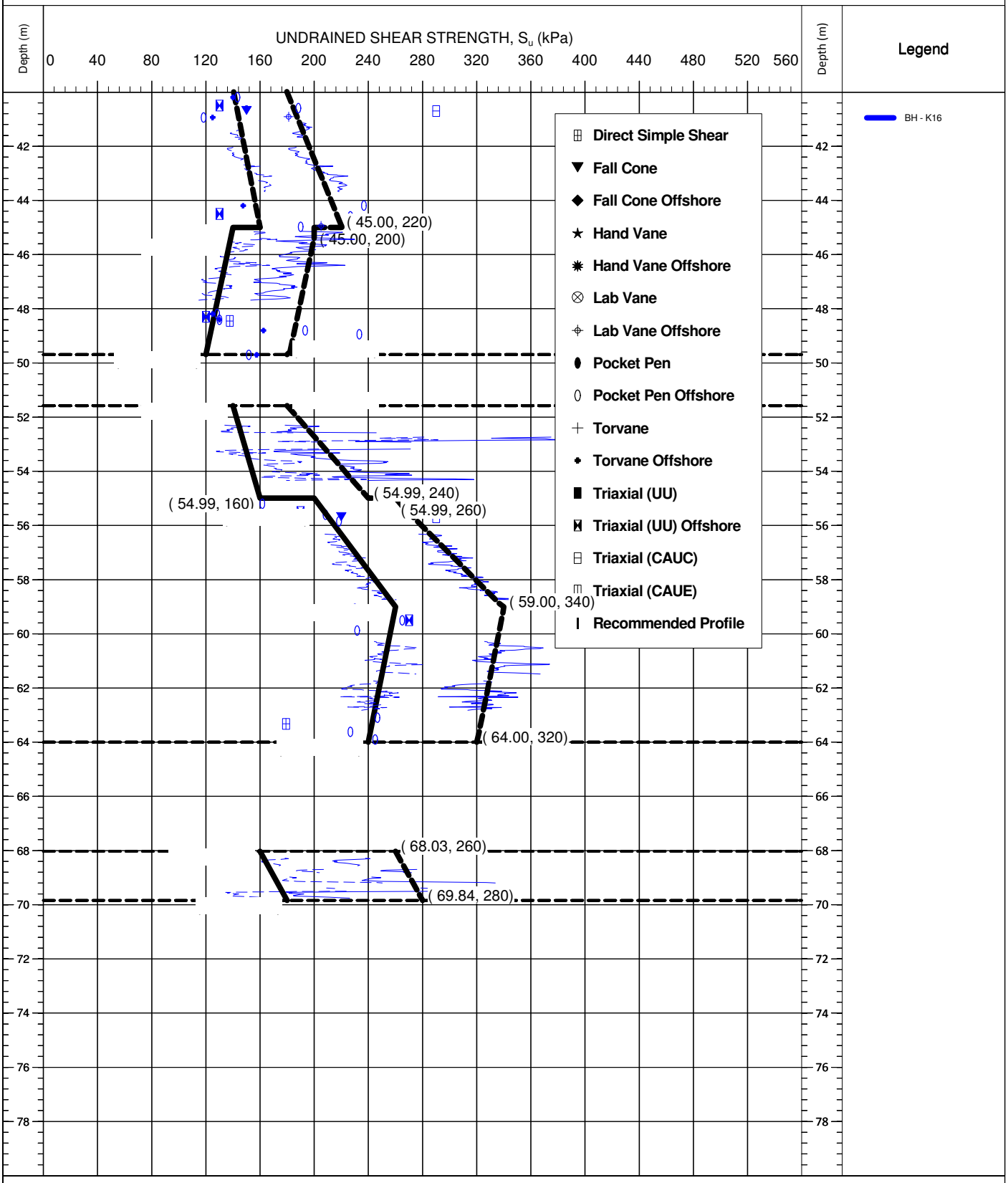


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE

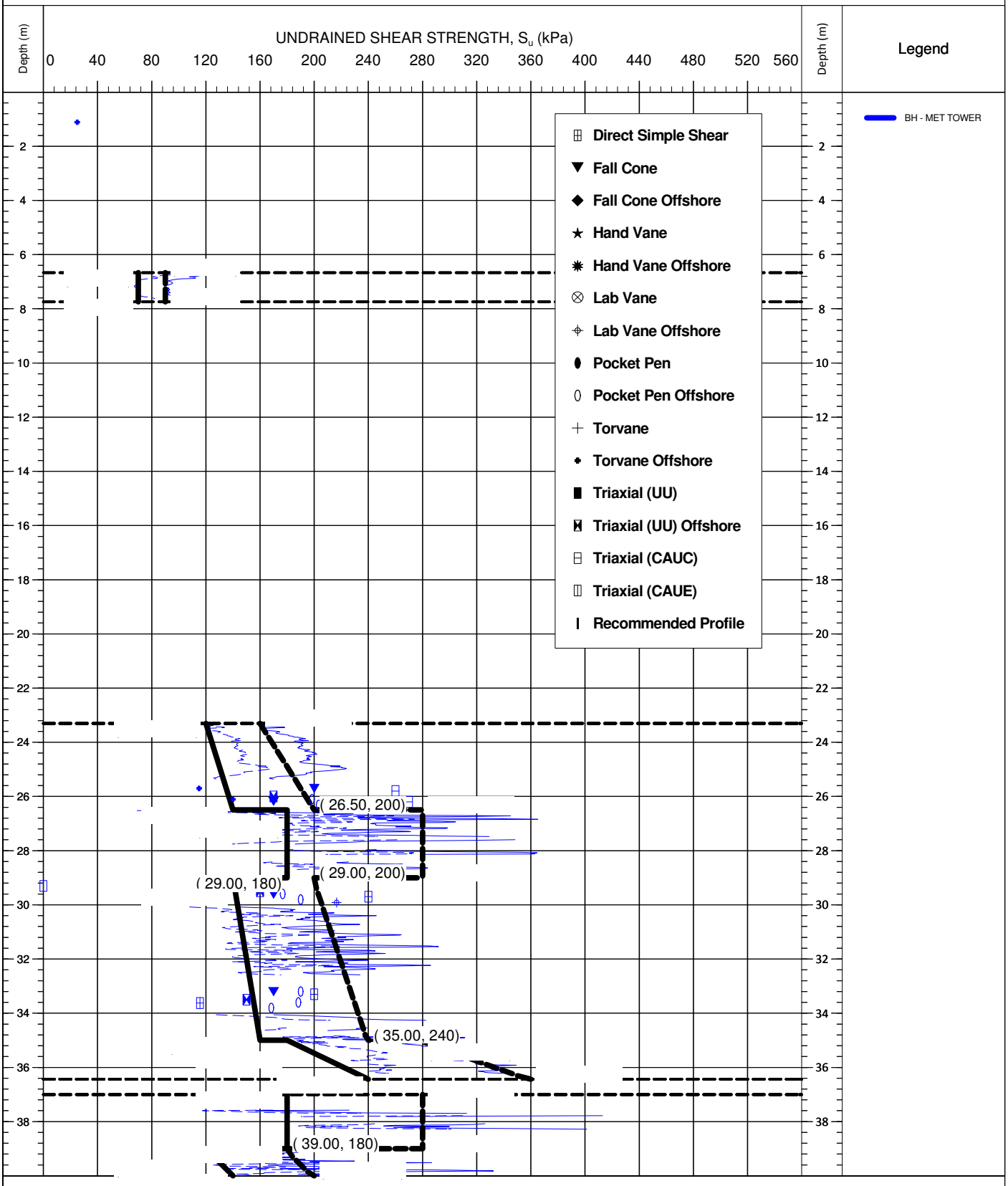


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE

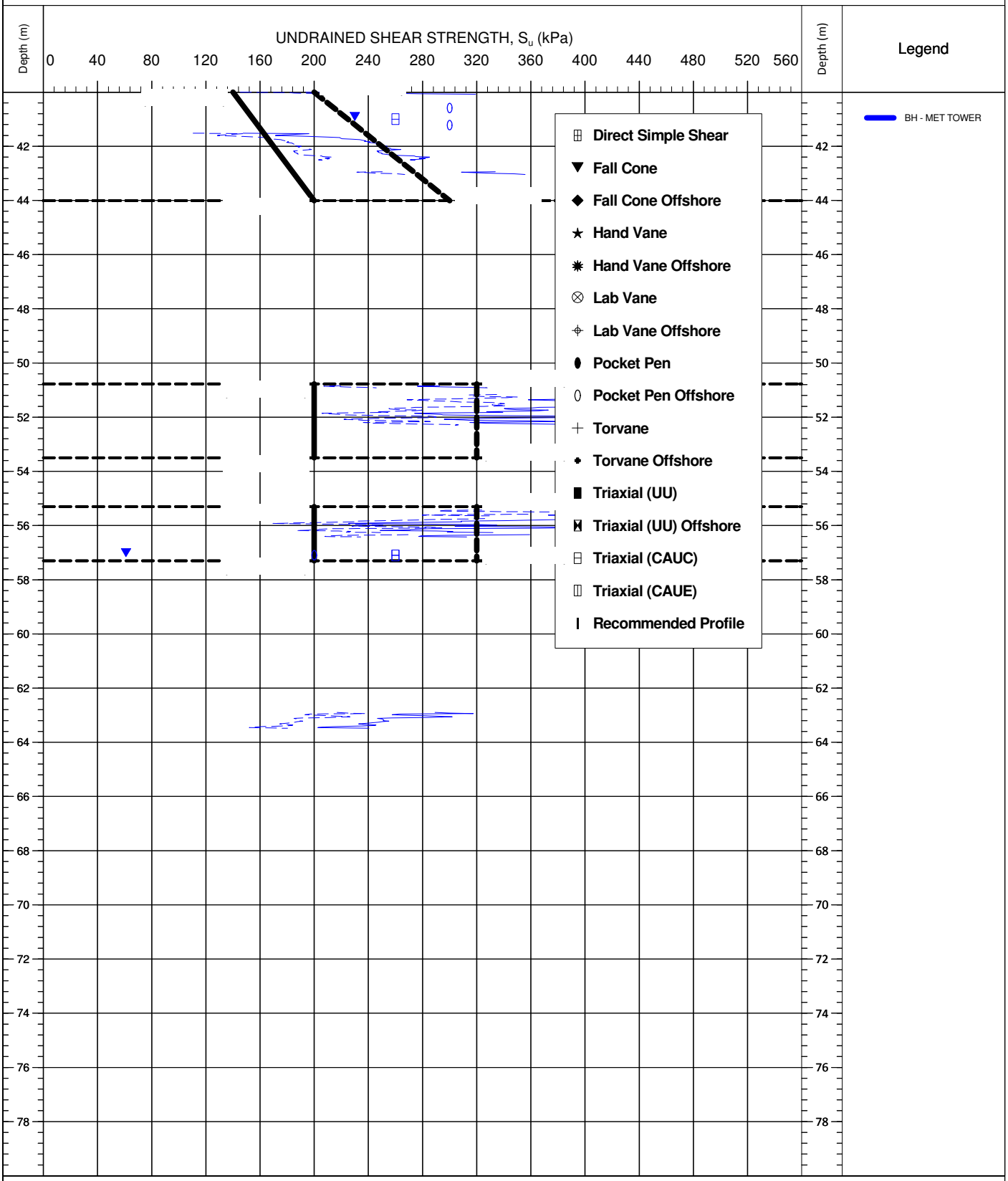


Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
UNDRAINED SHEAR STRENGTH PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

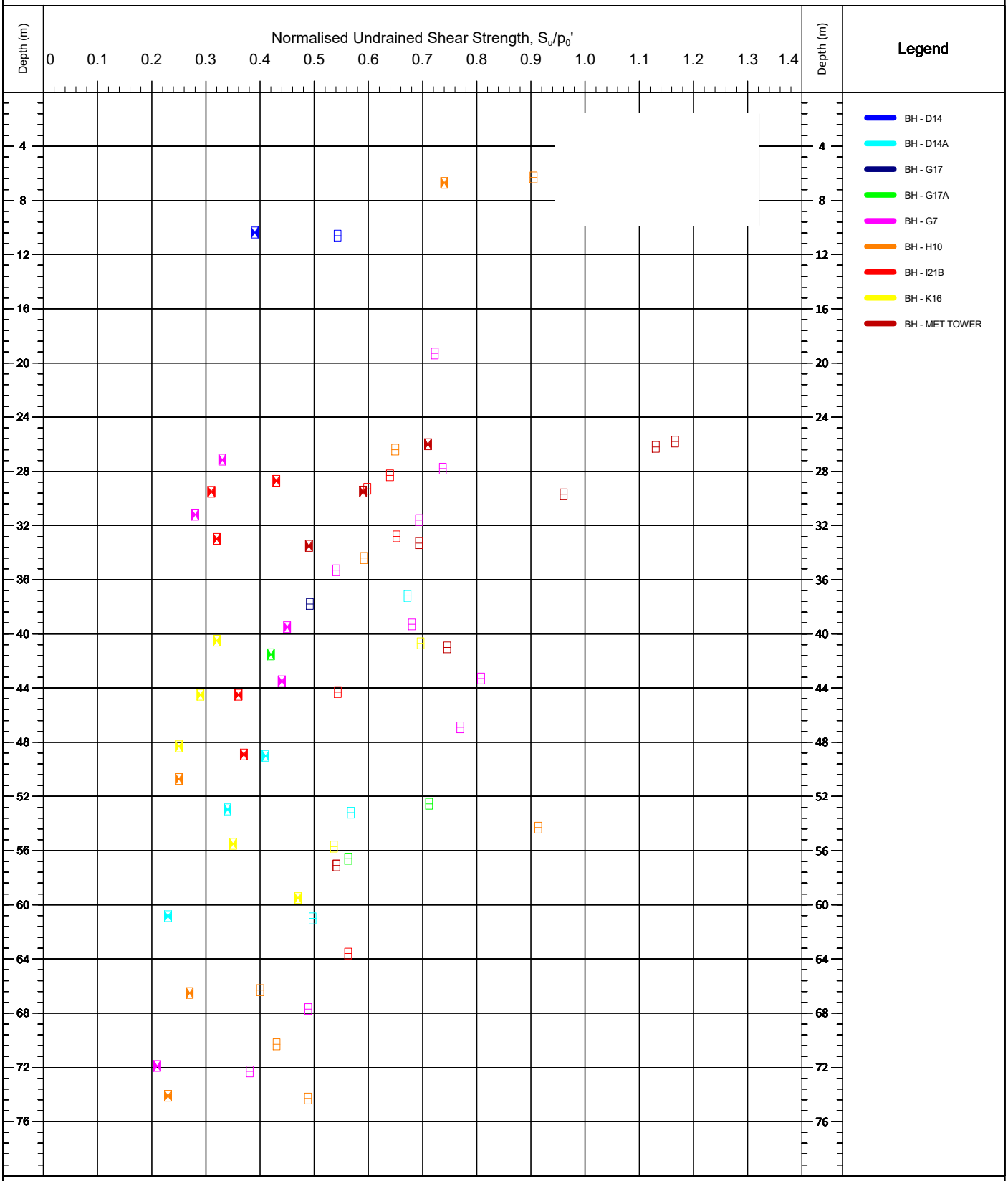
Comments:

QC Status

Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

5.3 s_u/p'_0 profiles (CAUC / UU tests)

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
NORMALISED SHEAR STRENGTH



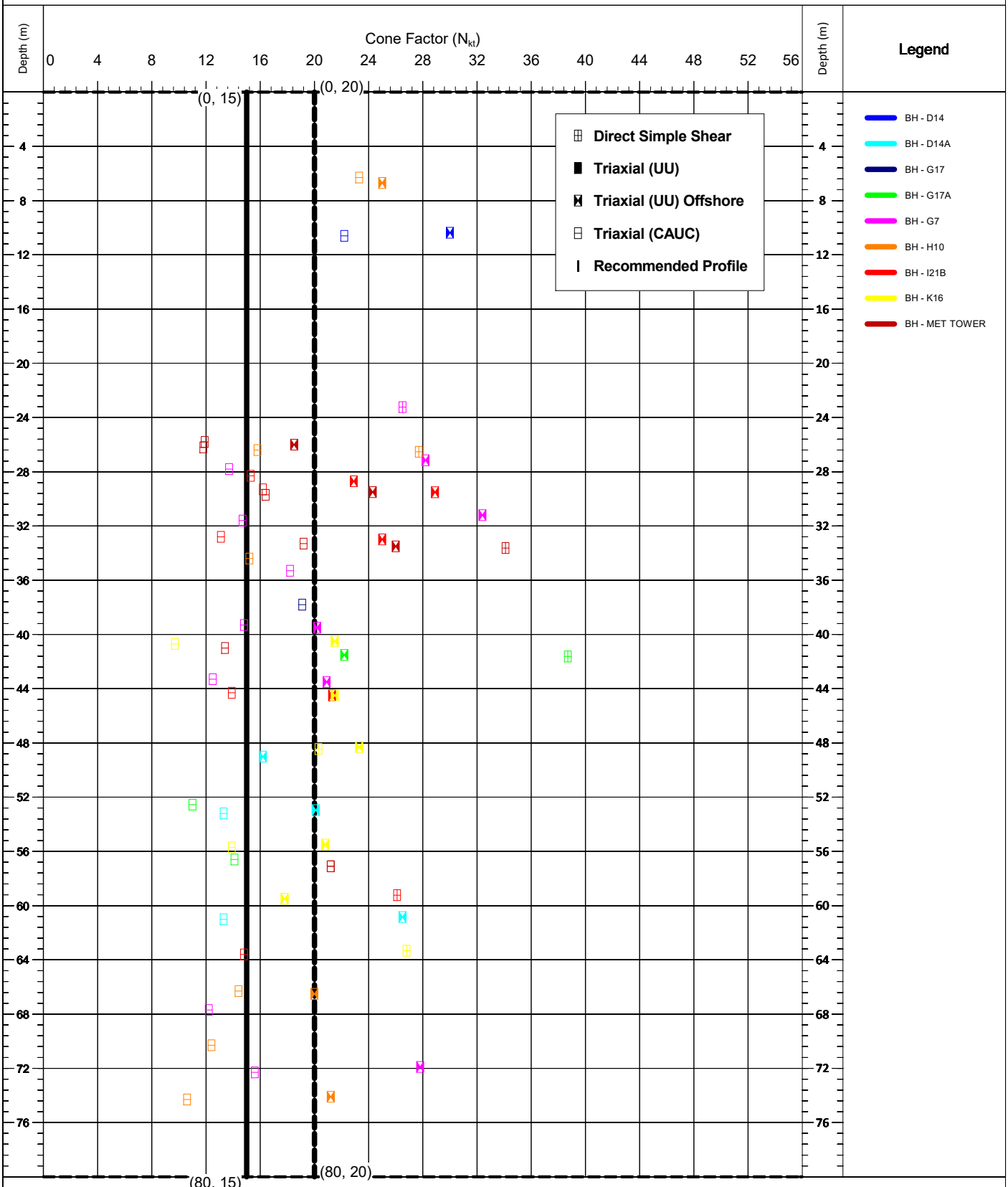
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments:

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

5.4 Nkt assessment

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
CONE FACTOR, N_{kt}



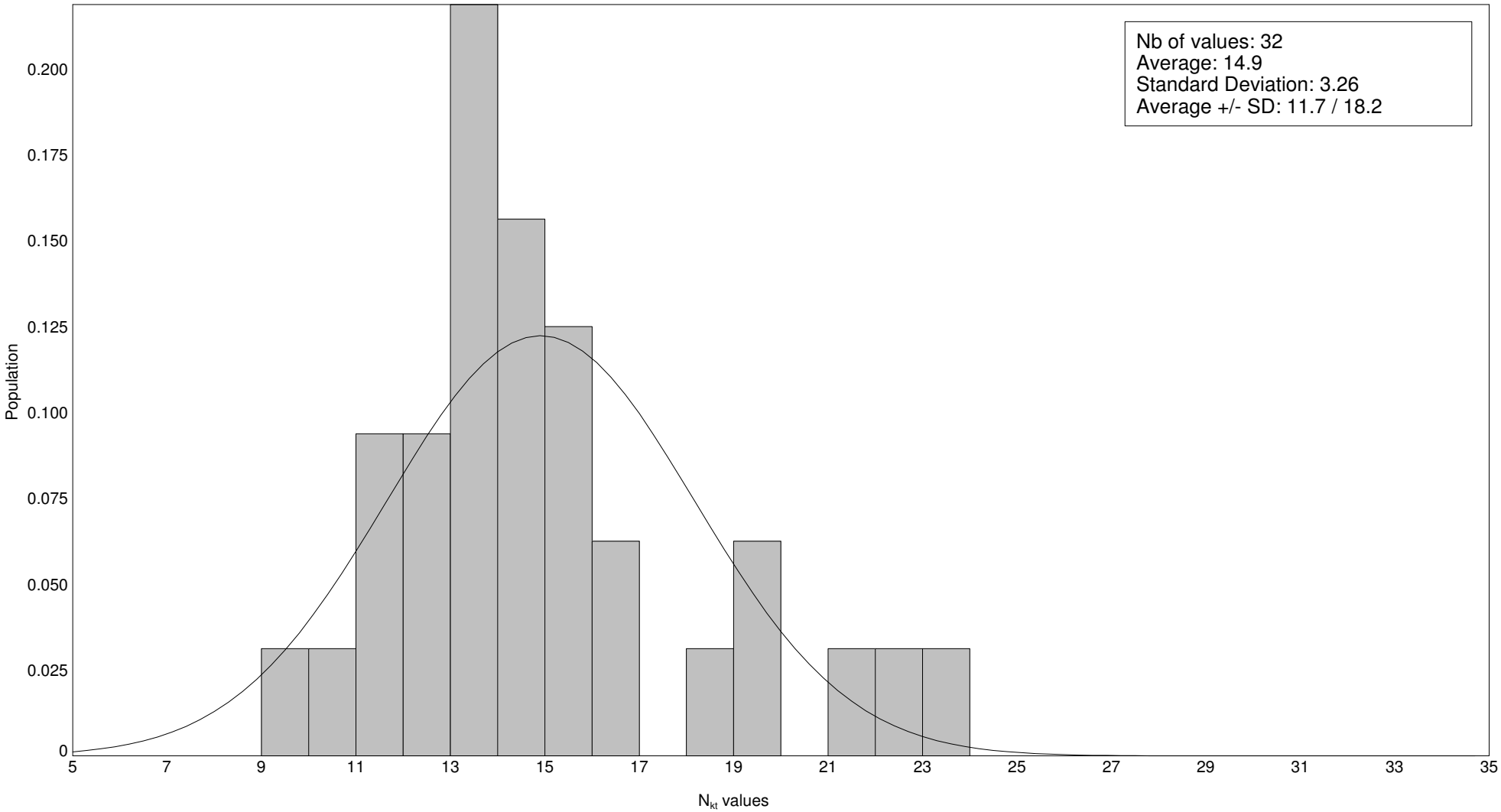
Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments: Nkt assessment from CAUC. DSS and UU test values are also presented for comparison.

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

NKT VALUES DISTRIBUTION FROM CAUC TESTING

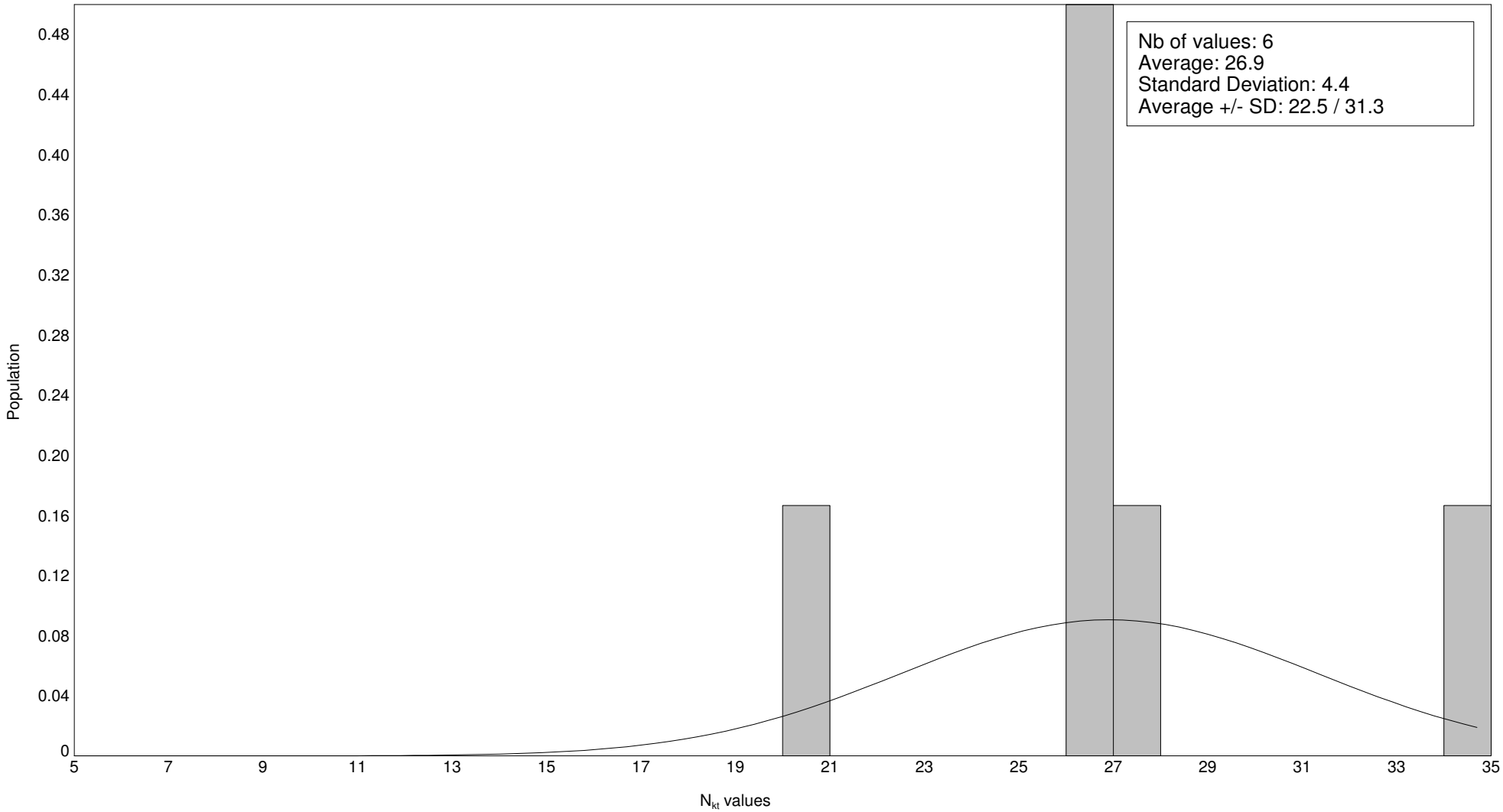


Contract No.	10451		Comment:
Client Name	US Wind Inc.		
Location	Maryland USA		

QC Status		
Preliminary	Draft	Final
SMc (28/09/2015)	**JG** (17/02/2016)	()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

NKT VALUES DISTRIBUTION FROM DSS TESTING

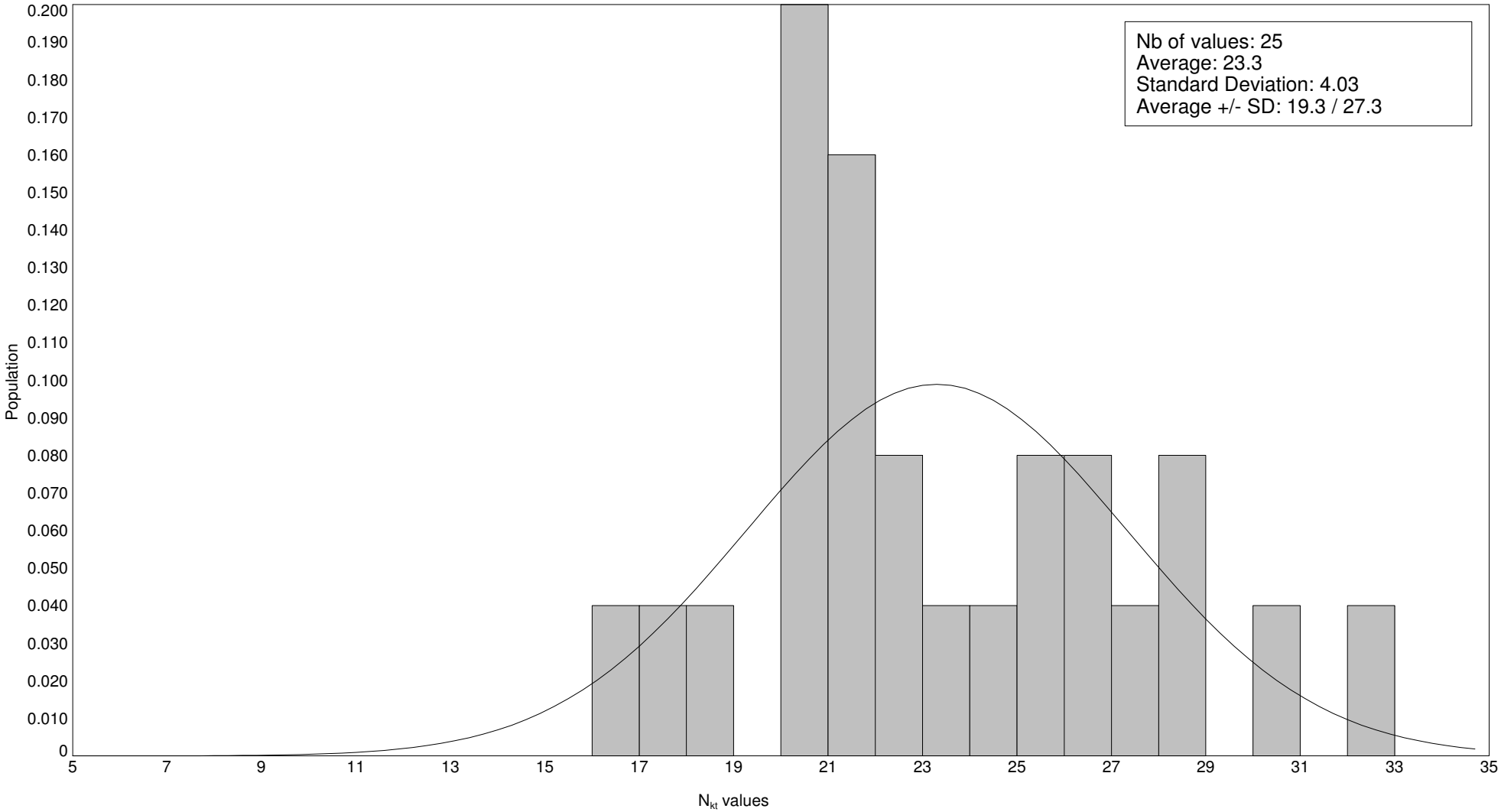


Contract No.	10451		Comment:
Client Name	US Wind Inc.		
Location	Maryland USA		

QC Status		
Preliminary	Draft	Final
SMc (28/09/2015)	**JG** (17/02/2016)	()

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

NKT VALUES DISTRIBUTION FROM UU TESTING



Contract No.	10451		Comment:
Client Name	US Wind Inc.		
Location	Maryland USA		

QC Status		
Preliminary	Draft	Final
SMc (28/09/2015)	**JG** (17/02/2016)	()

5.5 CAUC / CAUE triaxial test summary

Gardline

CONSOLIDATED TRIAXIAL TESTING

US Wind inc. sea energy

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	Contract No.	10451

Borehole	Sample No.	Depth	Test type	Sample description								Consolidation					Undr. Static testing				Cyclic testing											Sample Quality	
				estimated p'_0	IP	Moisture Content %		Bulk Density P (Mg/m^3)		Dry Density P_d (Mg/m^3)		σ_{vc}'	σ_{hc}'	ε_{vol}	ε_{ac}	B	s_u	U_f	ε_f	s_u/σ'_{ac}	s_u corrected	τ_a	τ_{cy}	τ_a/s_{uC}	τ_{cy}/s_{uC}	N	γ_a	γ_p	γ_{cy}	U_f	SQ Index $\Delta e/e_0$	Sample Quality Category
		m		kPa	%	*I*	*F*	*I*	*F*	*I*	*F*	kPa	kPa	%	%	%	kPa	kPa	%	-	kPa	kPa	kPa	-	-	-	%	%	%	kPa		
BH - D14	P4B2	2.35	CADC	14.12		22.7	22.7	2.09		1.702		14.12	28	0.42			40.66		3.213													
BH - D14	P7Q1	10.2	CAUcy	96	29.0	53.0	50.4					95.9	91.2								52.13	2.365	31.27	0.045	0.6	102	-7.35	-21.2	13.9	60.21		
BH - D14	P7Q2	10.6	CAUC	99		47.2	47.8	1.83	1.88	1.246	1.269	99	99	3.59			53.76	53	2.82	0.543												
BH - D14	P8Q1	13.8	CAUcy	125	29.0	36.8	34.2					125.1	118.8								60	3.554	54.17	0.059	0.903	7	-7.27	-17.2	14.53	105.8		
BH - D14	P8Q2	14	CAUcy	126	29.0	39.1	36.0					126	119.7								54	3.156	30.75	0.058	0.569	99	-6.37	-22.8	16.43	54.52		
BH - D14A	P5Q1	37.2	CAUC	328		31.6	32.6	1.91	2.07	1.452	1.558	328	252.6	8.569			220.4	129	8.421	0.672											0.184	4
BH - D14A	P5Q2	37.6	CAUcy	331	18.0	33.5	31.6					331	251.6								222.4	39.7	133.1	0.178	0.598	25	12.25	10.3	10.34	229.3		
BH - D14A	P6Q1	41.5	CAUcy	363	24.0	35.4	32.5					362.9	275.9								243.9	43.5	194.4	0.178	0.797	2	3.557	2.809	12.62	267.7		
BH - D14A	P6Q2	41.9	CAUcy	366	24.0	39.9	37.1					365.9	278.2								246	43.85	110.3	0.178	0.448	31	18.09	17.34	3.69	267.9		
BH - D14A	P9Q1	53.2	CAUC	461		38.5	34.9	1.84	1.89	1.325	1.402	461	327.3	4.231			261.6	232	3.164	0.567											0.082	3
BH - D14A	P11Q1	61	CAUC	528		23.6	24.6	1.98	2.06	1.602	1.654	528	364.3	6.31			262.3	262	10.25	0.497											0.160	4
BH - G17	P10B1	18.525	CIDC	184		11.8	18.0	1.96	1.97	1.755	1.672	184	184	-0.36			261.6		0.033													
BH - G17	P14AQ1	33.8	CAUcy	341	?	31.5	28.7					340.9	272.8								167.7	83.5	83.5	0.498	0.498	10001	14.81	15.21	0.567	178.1		
BH - G17	P15Q1	37.8	CAUC	377		26.8	25.5	2.00	2.08	1.575	1.655	377	305.4	2.712			185.4	184	11.33	0.492											0.064	3
BH - G17	P15Q2	38.2	CAUcy	380	?	28.4	26.0					380	304								186.9	93.5	131	0.5	0.701	11	15.45	18.6	4.741	241.3		
BH - G17A	P1Q1	41.3	CAUcy	410	?	36.2	33.7					409.9	328								201.7	100.5	59.5	0.498	0.295	10	15.7	15.62	1.089	222		
BH - G17A	P4Q2	52.55	CAUC	512		32.5	34.6	1.83	1.87	1.378	1.388	512	378.9	3.613			364.5	251	9.335	0.712											0.077	3
BH - G17A	P5Q2	56.6	CAUC	547.6		31.7	32.6	1.86		1.41		673.1	484.9	2.866			308.2	283.5	5.669	0.563											0.062	
BH - G7	P2B2	0.8	CADC	4.231		14.7	16.7	1.72		1.498		4.231	9.7	0.166			10.82		14.96													
BH - G7	P10Q2	19.3	CAUC	173		27.6	35.3	1.95	1.97	1.528	1.456	173	173	2.507			125	60	8.663	0.722											0.058	3
BH - G7	P11Q1	23.1	CAUcy	226	14.0	32.1	29.9					225.9	203.4								155	11.26	87.29	0.073	0.563	14	4.053	-6.39	16.98	193.7		
BH - G7	P12Q1	27.4	CAUcy	265	14.0	35.2	31.5					264.9	238.5								170	14.08	138	0.083	0.812	3	-6.86	-29	22.11	206.9		
BH - G7	P12Q2	27.8	CAUC	240		35.6	28.4	1.93	1.94	1.42	1.507	240	192	1.334			177	67	10.64	0.737											0.027	1
BH - G7	P13Q1	31.4	CAUcy	301	14.0	24.1	21.6					300.9	270.9								167	14.86	77.34	0.089	0.463	44	15.15	10.26	12.49	37.23		
BH - G7	P13Q2	31.6	CAUC	274		24.0	25.9	2.00	2.03	1.612	1.61	274	178.1	2.719			190	125	11.21	0.694											0.068	3
BH - G7	P14Q1	35.3	CAUC	311		26.5	24.5	1.95	2.01	1.544	1.614	311	248.8	3.913			168.1	154	6.062	0.54											0.093	3
BH - G7	P15Q1	39.3	CAUC	341		33.1	30.8	1.93	1.92	1.447	1.466	341	286.4	1.202			231.9	171	10.93	0.68											0.025	1
BH - G7	P16Q1	43.3	CAUC	375		25.0	23.6	2.00	2.03	1.599	1.645	375	288.8	3.045			303	201	10.12	0.808											0.075	3
BH - G7	P17Q1	46.7	CAUcy	439	?	22.1	20.5					438.9	316.1								337.8	61.4	202.8	0.182	0.6	8	11.11	18.43	16.13	302.5		
BH - G7	P17Q2	46.9	CAUC	441		22.8	21.7	2.04	2.12	1.663	1.743	441	321.9	5.228			339.3	149	15.26	0.769											0.136	4
BH - G7	P18Q1	50.3	CAUcy	471	?	25.1	23.1					471	339.1								362.4	65.9	254	0.182	0.701	2	6.357	11.22	16.13	324		
BH - G7	P18Q2	50.7	CAUcy	475	?	26.7	24.3					474.8	342								365.5	66.5	146.4	0.182	0.401	8	18.39	24.02	9.175	324.6		
BH - G7	P23Q1	67.7	CAUC	628.3		31.4	28.0	1.86		1.417		798.4	543.2	5.962			307.3	294.8	16.54	0.489											0.129	
BH - G7	P24Q2	72.3	CAUC	667		29.5	28.9	1.93		1.494		846.4	577.3	8.183			254	236.6	5.439	0.381											0.183	
BH - H10	P3Q1	2.1	CAUC	21		32.8	31.6	2.02		1.523		52.46	68.3	2.6			68.53	27.5	8.406	1.087											0.055	
BH - H10	P4Q1	6.3	CAUC	62.55		20.4	18.7	2.02		1.678		51.66	68	2.142			56.6	21.1	18.15	0.905											0.060	
BH - H10	P9Q1	26.4	CAUC	266		31.0	31.1	1.92	1.94	1.469	1.479	266	242.1	2.354			172.8	127	10.17	0.65											0.051	3
BH - H10	P11Q1	34.402	CAUC	343		33.4	36.8	1.81	1.86	1.359	1.362	343	284.7	3.854			203	141	9.379	0.592											0.080	3
BH - H10	P16Q1	54.3	CAUC	526		17.8	19.6	2.09	2.14	1.775	1.787	526	384	3.901			480.5	75	12.86	0.914											0.119	4
BH - H10	P20Q1	66.3	CAUC	629.7		35.8	34.7	1.89		1.391		787.7	550.7	3.992			252	193.3	5.86	0.4											0.080	
BH - H10	P21Q1	70.3	CAUC	663.2		22.8	19.7	1.87		1.521		835.6	577	4.382			285.4	303.3	9.103	0.43											0.114	
BH - H10	P22Q1	74.3	CAUC	697.2		28.4	26.0	1.95		1.517		878.3	606.7	4.69			340.5	326	9.29	0.488											0.107	

Borehole	Sample No.	Depth	Test type	Sample description								Consolidation					Undr. Static testing				Cyclic testing											Sample Quality	
				estimated p'_0	IP	Moisture Content %		Bulk Density P (Mg/m^3)		Dry Density P_d (Mg/m^3)		σ_{vc}'	σ_{hc}'	ε_{vol}	ε_{ac}	B	s_u	U_f	ε_f	s_u/σ'_{ac}	s_u corrected	τ_a	τ_{cy}	τ_a/s_{uC}	τ_{cy}/s_{uC}	N	γ_a	γ_p	γ_{cy}	U_f	SQ Index $\Delta e/e_0$	Sample Quality Category
		m		kPa	%	*I*	*F*	*I*	*F*	*I*	*F*	kPa	kPa	%	%	%	kPa	kPa	%	-	kPa	kPa	kPa	-	-	-	%	%	%	kPa		
BH - I21A	P3B2	14.775	CAUE	146.9		19.6	19.3					147.8	176.1				-385	-889	-3.91	-2.62												
BH - I21A	P5B1	21.125	CIDC	211		21.6	25.3	1.94	2.00	1.598	1.596	211	211	-0.34			325.7		0.122													
BH - I21B	P1Q1	28.3	CAUC	277		26.6	26.8	2.00	2.04	1.579	1.608	277	243.8	3.758			177.2	115	7.94	0.64											0.089	3
BH - I21B	P2Q1	29.3	CAUC	287		26.0	23.6	2.00	2.19	1.587	1.773	287	252.6	10.25			171.6	130	7.864	0.598											0.246	4
BH - I21B	P3Q1	32.8	CAUC	321		22.1	21.6	2.07	2.10	1.696	1.726	321	282.5	2.784			209.2	122	10.61	0.652											0.074	3
BH - I21B	P6AQ1	44.3	CAUC	420		30.3	29.1	1.96	2.02	1.505	1.563	420	369.6	4.313			228.3	203	11.15	0.544											0.095	3
BH - I21B	P9Q1	55.1	CAUcy	514	27.0	35.1	31.5					513.8	411.2								280	51.3	164.4	0.183	0.587	11	16.16	14.49	4.365	286.5		
BH - I21B	P9Q2	55.3	CAUcy	516	27.0	42.1	39.8					516	412.7								290	51.65	205.5	0.178	0.709	8	12.41	0.358	16.01	328.3		
BH - I21B	P11Q1	63.2	CAUcy	574	27.0	35.2	31.0					573.9	459.1								305	57.4	122	0.188	0.4	431	15.2	17.85	5.202	393.5		
BH - I21B	P11Q2	63.6	CAUC	577		34.3	32.8	1.82	1.97	1.358	1.487	545	479.6	8.533			306.5	334	6.547	0.562											0.176	4
BH - K16	P15Q1	40.3	CAUcy	407	?	31.1	27.9					407	325.6								283.4	71	142	0.251	0.501	9	15.18	20.33	9.24	282		
BH - K16	P15Q2	40.7	CAUC	411		28.4	27.4	1.96	2.00	1.525	1.569	411	324.7	3.59			286.2	157	15.18	0.696											0.082	3
BH - K16	P16Q1	44.3	CAUcy	442	?	30.8	27.7					442	353.7								307.8	77	185	0.25	0.601	2	10.67	10.59	5.061	253		
BH - K16	P16Q2	44.7	CAUcy	446	?	27.2	24.3					445.9	356.8								310.5	77.75	93.3	0.25	0.3	459	12.23	12.58	0.891	290.1		
BH - K16	P20Q1	55.3	CAUcy	546	?	49.3	46.6					545.9	436.8								292.7	146.5	146.5	0.5	0.5	2	26.34	27.83	0.965	205		
BH - K16	P20Q2	55.7	CAUC	549		45.0	39.1	1.77	1.85	1.219	1.329	549	400.8	5.083			294.4	266	3.973	0.536											0.092	3
BH - K16	P21Q1	59.3	CAUcy	573	?	53.2	50.6					573	458.4								307.2	153.5	122.8	0.5	0.4	416	22.75	23.04	0.025	161.2		
BH - K16	P21Q2	59.7	CAUcy	576	?	42.7	40.5					575.9	460.8								308.8	154.5	92.7	0.5	0.3	459	5.063	5.036	0.221	213.4		
BH - MET TOWER	P9Q1	25.8	CAUC	219		31.8	32.8	1.97	1.98	1.495	1.489	219	197.1	0.865			255.4	36	5.945	1.166											0.019	1
BH - MET TOWER	P9Q2	26.2	CAUC	243		33.1	36.3	1.88	1.94	1.415	1.422	243	218.7	3.234			274.7	97	5.864	1.13											0.068	3
BH - MET TOWER	P10Q1	29.3	CAUE	270.8		27.5	25.7					270.8	216.7				-142	-153	-3.99	-0.52												
BH - MET TOWER	P10Q2	29.7	CAUC	252		26.5	27.6	2.00	2.08	1.583	1.629	252	226.8	4.726			242.1	65	13	0.961											0.112	4
BH - MET TOWER	P11Q1	33.3	CAUC	283		29.4	28.5	1.96	1.96	1.515	1.521	283	254.7	1.29			196.2	122	10.74	0.693											0.029	1
BH - MET TOWER	P13Q2	41	CAUC	349		47.6	43.9	1.76	1.78	1.195	1.237	349	279.2	2.15			260.2	228	7.115	0.746											0.038	2
BH - MET TOWER	P17Q1	57.1015	CAUC	485		30.9	24.1	1.96	2.03	1.495	1.637	485	388	5.248			262.4	238	10.13	0.541											0.114	4

I = initial *F = Final*

5.6 DSS test summary

Direct Simple Shear TESTING (Drained)

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	Contract No.	10451

Borehole	Sample No.	Depth	Test type	Drainage conditions (except cyclic stress)	Sample description					Consolidation					Drained Static testing						Cyclic testing										Comment
					Dr	Fine cont.	Unit weight	Moisture Content %		estimated p'_0	$\sigma'_{v,max}$	$\sigma'_{v,cons}$	ε_{ac}	σ'_{ref}	α' measured	α' estimated (1)	γ_f	τ_a	τ_a/σ'_{ref} measured	τ_a/σ'_{ref} estimated (1)	τ_a	τ_{cy}	$\sigma'_{ref,a}$	$\sigma'_{ref,cy}$	τ_a/σ'_{ref}	$\tau_{cy}/\sigma'_{ref,cy}$	N	γ_a	γ_p	γ_{cy}	
		m			%	%	kN/m^3	*I*	*F*	kPa	kPa	kPa	%	kPa	°	°	%	kPa	-	-	kPa	kPa	kPa	kPa	-	-	-	%	%	%	
BH - G17	P10Q1	18.56	DSS	Drained			19.7	16.6	16.5	185	185	185	5.56	174.0	36.5	36.0	20.0	137.1	0.79	0.77											
BH - G17	P10Q1	18.6	DSScy	Drained			19.8	16.1	16.0	185	185	185	3.39	174.0							0.0	185.0	174.0	174.0	0	1.06	1	0.45	-0.17	15.20	
BH - G17	P10Q1	18.63	DSScy	Drained			19.3	16.1	16.0	185	185	185	4.00	174.0							0.0	87.0	174.0	174.0	0	0.5	6	0.43	-10.48	15.52	
BH - G17	P10Q1	18.66	DSScy	Drained			19.4	16.1	16.0	185	185	185	5.85	174.0							0.0	52.2	174.0	174.0	0	0.3	19	-0.18	-12.16	15.13	
BH - I21A	P1B2	9.775	DSS	Drained			19.3	22.1	21.0	98	98	98	5.49	98.198	41.0	41.0	20.0	85.1	0.87	0.87											
BH - I21A	P1B2	9.785	DSScy	Drained			19.4	22.0	19.3	98	98	98	3.02	98							24.5	39.3	98.2	98.2	0.25	0.4	7	13.26	22.39	15.28	
BH - I21A	P1B2	9.795	DSScy	Drained			19.3	22.0	18.0	98	98	98	2.81	98							24.5	19.6	98.0	98.0	0.25	0.2	53	15.05	15.00	0.32	
BH - I21A	P1B2	9.805	DSScy	Drained			19.1	21.5	17.4	98	98	98	2.57	98.198							24.5	14.7	98.2	98.2	0.25	0.15	377	15.01	14.99	0.13	
BH - D14	P5B4	3.7	DSS	Drained			16.3	18.5	17.9	36	36	36	0.23	36.4	48.3	46.5	16.8	40.8	1.12	1.06											
BH - D14	P5B4	3.72	DSScy	Drained			16.3	18.5	14.9	36	36	36	0.94	36.4							8.8	17.5	36.4	36.4	0.24	0.48	11	10.40	-4.48	15.24	
BH - D14	P5B4	3.74	DSScy	Drained			16.3	18.5	18.5	36	36	36	1.79	36.4							9.2	10.5	36.4	36.4	0.25	0.29	22	15.14	2.16	13.37	
BH - D14	P5B4	3.76	DSScy	Drained			16.3	18.5	15.5	36	36	36	0.53	36.4							8.5	6.6	36.4	36.4	0.23	0.18	146	15.02	14.97	0.12	

I = initial
F = Final

(1): Andersen 2015

Gardline

Direct Simple Shear TESTING (Undrained)

US Wind inc sea energy

Location	Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area	Contract No.	10451

Borehole	Sample No.	Depth	Test type	Sample description					Consolidation				Undr. Static testing				Cyclic testing										Comment
				IP	Clay cont.	Unit weight	Moisture Content %		estimated p'_0	$\sigma'_{v,max}$	$\sigma'_{v,cons}$	ε_{ac}	s_u	U_f	γ_f	s_u/σ'_{ac}	τ_a	τ_{cy}	σ_{ref}	τ_a/σ_{ref}	τ_{cy}/σ_{ref}	N	γ_a	γ_p	γ_{cy}	U_f	
		m		%	%	kN/m^3	*I*	*F*	kPa	kPa	kPa	%	kPa	kPa	%	-	kPa	kPa	kPa	-	-	-	%	%	%	kPa	
BH - G17A	P1Q2	41.625	DSS			17.7	25.6	29.9	482	482	482	8.2	103.4	219.8	3.3	0.215											
BH - G17A	P1Q2	41.64	DSScy			17.6	29.1	32.5	482	482	482	7.2					52.2	61.4	103.4	0.5	0.6	398	13.38	15.00	1.62	298.1	
BH - G17A	P1Q2	41.66	DSScy			17.2	36.2	36.7	482	482	482	7.5					52.2	102.0	103.4	0.5	1	63	15.01	17.56	4.12	261.5	
BH - G17A	P1Q2	41.68	DSScy			17.2	42.2	41.1	482	482	482	7.8					52.1	45.7	103.4	0.5	0.45	1500	1.56	2.08	0.52	123.8	
BH - G7	P3B2	1.3	DSS	-		20.0	20.3	17.0	13	13	13	2.0	17.5	-3.0	19.9	1.370											Clayey SAND
BH - G7	P3B2	1.32	DSScy	-		20.0	20.3	17.3	13	13	13	3.9					0.3	6.1	12.8	0.02	0.47	31	-15.25	-8.73	7.73	15.1	Clayey SAND
BH - G7	P3B2	1.34	DSScy	-		20.0	20.3	17.0	13	13	13	2.9					0.4	8.2	12.8	0.03	0.64	10	-11.88	2.57	15.16	15.3	Clayey SAND
BH - G7	P3B2	1.36	DSScy	-		20.0	20.3	17.3	13	13	13	3.0					0.6	11.0	12.8	0.04	0.86	6	-1.49	13.39	15.60	0.4	Clayey SAND
BH - G7	P11Q2	23.23	DSS			18.3	36.8	37.1	228	228	228	11.8	79.3	80.5	19.3	0.348											
BH - G7	P11Q2	23.27	DSScy			18.1	31.0	28.8	228	228	228	11.8					0.0	63.4	79.3	0	0.8	1500	1.29	2.06	1.87	156.7	
BH - G7	P11Q2	23.31	DSScy			18.1	36.6	33.6	228	228	228	18.8					0.0	87.2	79.3	0	1.1	3	1.88	-5.27	16.31	161.6	
BH - G7	P11Q2	23.37	DSScy			18.9	21.6	25.9	228	228	228	7.9					39.7	47.6	79.3	0.5	0.6	18	15.27	15.64	1.69	176.2	
BH - H10	P9Q2	26.525	DSS			18.3	32.8	31.6	268	268	268	5.7	97.0	120.7	16.8	0.362											
BH - H10	P9Q2	26.545	DSScy			18.6	32.0	30.4	268	268	268	4.3					24.8	72.0	97.0	0.25	0.8	16	17.56	29.58	15.77	147.9	
BH - H10	P9Q2	26.565	DSScy			18.6	32.0	30.4	268	268	268	4.4					24.8	52.0	97.0	0.25	0.55	70	15.62	24.76	9.97	164.6	
BH - H10	P9Q2	26.635	DSScy			18.4	31.1	31.5	268	268	268	6.5					24.7	38.2	97.0	0.25	0.4	277	15.14	20.48	5.50	178.9	
BH - H10	P16Q2	54.625	DSS			19.4	20.0	20.9	531	531	531	3.0	189.8	205.2	20.0	0.357											
BH - H10	P16Q2	54.645	DSScy			19.8	19.1	17.3	531	531	531	3.0					4.6	138.2	189.8	0	0.73	3	-0.27	-12.17	16.45	462.8	
BH - H10	P16Q2	54.735	DSScy			20.0	20.5	19.9	531	531	531	3.6					0.1	74.7	189.8	0	0.39	20	1.02	16.50	16.24	433.9	
BH - H10	P16Q2	54.665	DSScy			19.6	20.2	18.9	531	531	531	3.6					0.1	56.0	189.8	0	0.30	32	-2.77	12.45	15.38	460.3	
BH - I21B	P10Q1	59.23	DSS			15.7	48.3	46.8	545	545	545	14.5	206.3	535.9	5.5	0.378											
BH - I21B	P10Q1	59.27	DSScy			15.6	55.0	55.9	545	545	545	13.8					103.1	103.1	206.3	0.5	0.5	12	19.65	15.55	4.23	215.0	
BH - I21B	P10Q1	59.32	DSScy			16.0	52.4	52.0	545	545	545	16.9					103.0	82.4	206.0	0.5	0.4	441	15.07	14.86	0.40	253.8	
BH - I21B	P10Q1	59.37	DSScy			15.7	48.1	46.5	545	545	545	15.4					103.0	185.4	206.0	0.5	0.9	1	20.03	0.37	19.66	379.4	
BH - K16	P17Q1	48.45	DSS			18.8	23.5	25.6	482	482	482	14.7	137.7	261.8	19.5	0.286											
BH - K16	P17Q1	48.425	DSScy			18.9	25.4	23.6	413	413	413	6.1					0.9	107.8	137.7	0	0.8	22	-2.53	-14.55	16.55	345.3	
BH - K16	P17Q1	48.455	DSScy			18.5	26.8	24.6	413	413	413	6.3					2.5	149.3	137.7	0	1.1	6	-11.50	14.77	26.27	339.8	
BH - K16	P17Q1	48.525	DSScy			18.8	25.9	24.8	413	413	413	5.6					0.3	68.9	137.7	0	0.5	1500	0.37	2.14	1.78	321.5	
BH - K16	P22Q1	63.325	DSS			16.5	42.1	46.9	601	601	601	7.9	179.2	292.6	7.4	0.298											
BH - K16	P22Q1	63.35	DSScy			16.8	42.1	41.4	601	601	601	9.4					0.6	142.3	179.2	0	0.8	519	-1.88	10.04	12.36	376.2	
BH - K16	P22Q1	63.37	DSScy			16.8	43.0	42.1	601	601	601	8.8					0.6	193.7	179.2	0	1.1	17	-0.95	12.12	13.54	351.3	
BH - K16	P22Q1	63.45	DSScy			16.6	40.1	39.9	601	601	601	7.7					0.6	124.6	179.2	0	0.7	972	-6.84	12.80	20.46	408.1	
BH - MET T	P11-Q2	33.625	DSS			18.6	28.1	28.6	310	310	310	4.3	115.6	137.4	18.4	0.373											
BH - MET T	P11-Q2	33.65	DSScy			18.8	27.5	27.5	310	310	310	4.9					46.2	65.5	115.6	0.4	0.6	31	15.36	18.14	3.24	131.7	
BH - MET T	P11-Q2	33.65	DSScy			18.8	27.4	27.3	310	310	310	5.0					45.9	45.3	115.6	0.4	0.4	379	15.05	15.84	0.85	152.2	
BH - MET T	P11-Q2	33.72	DSScy			18.7	27.1	27.2	310	310	310	5.3					46.6	95.8	115.6	0.4	0.9	5	20.74	8.61	12.13	243.6	

I = initial
F = Final

APPENDIX 6

6.1 Cyclic triaxial tests (CAUcy)

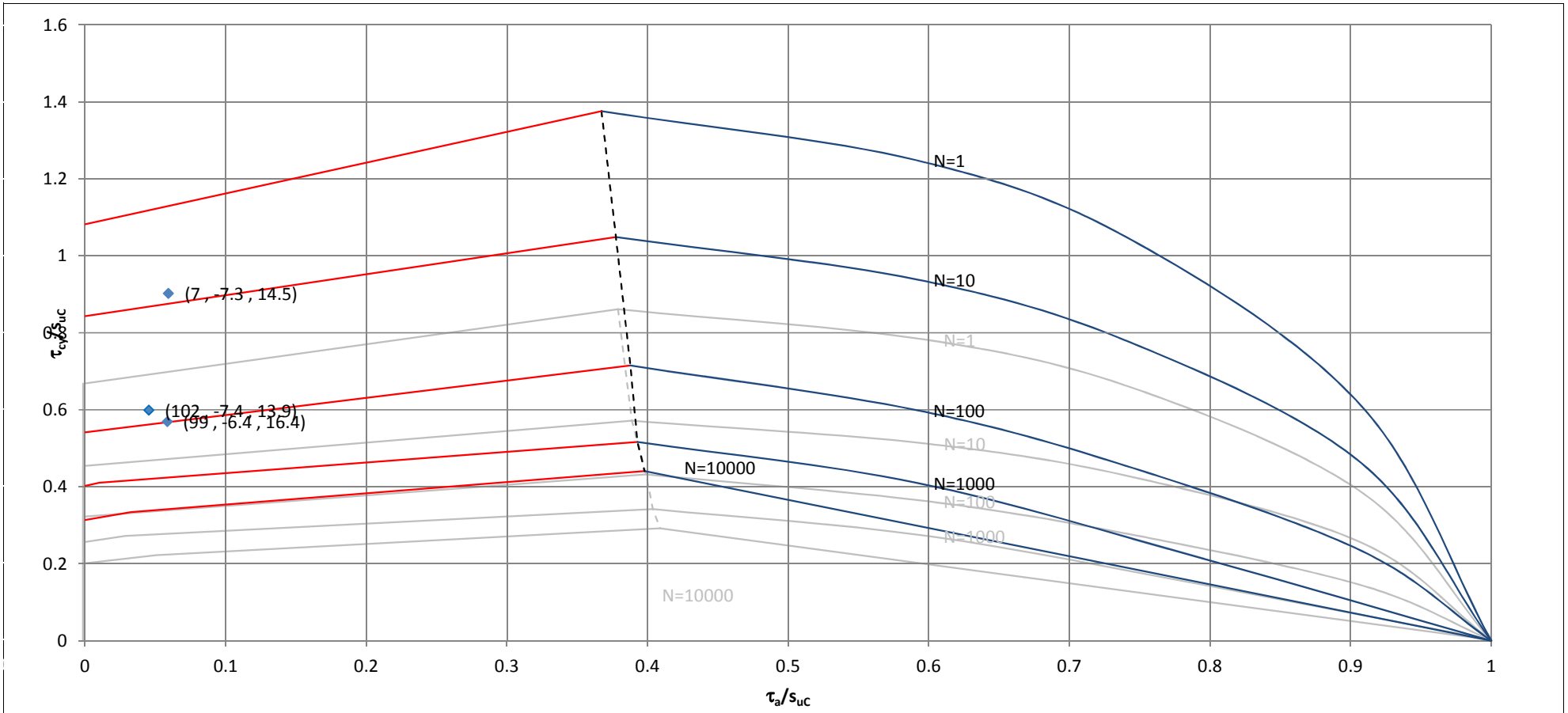
Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-1a - CYCLIC TRIAXIAL CAU TESTING - Normalised average and cyclic stress

Unit 1

US Wind



Key legend for failure points: **"Number of cycles, average strain, cyclic strain" at failure**
in Grey: Drammen Clay reference (OCR=1, Andersen 2004)

Area	**Maryland USA**
Contract	**10451**
Borehole/Samp.	**BH - D14-P7/8**
Vessel	**MV Ocean Discovery**

Comments:
The extension part of the curves could not have been assessed in absence of triaxial extension test (CAUE) in this unit.

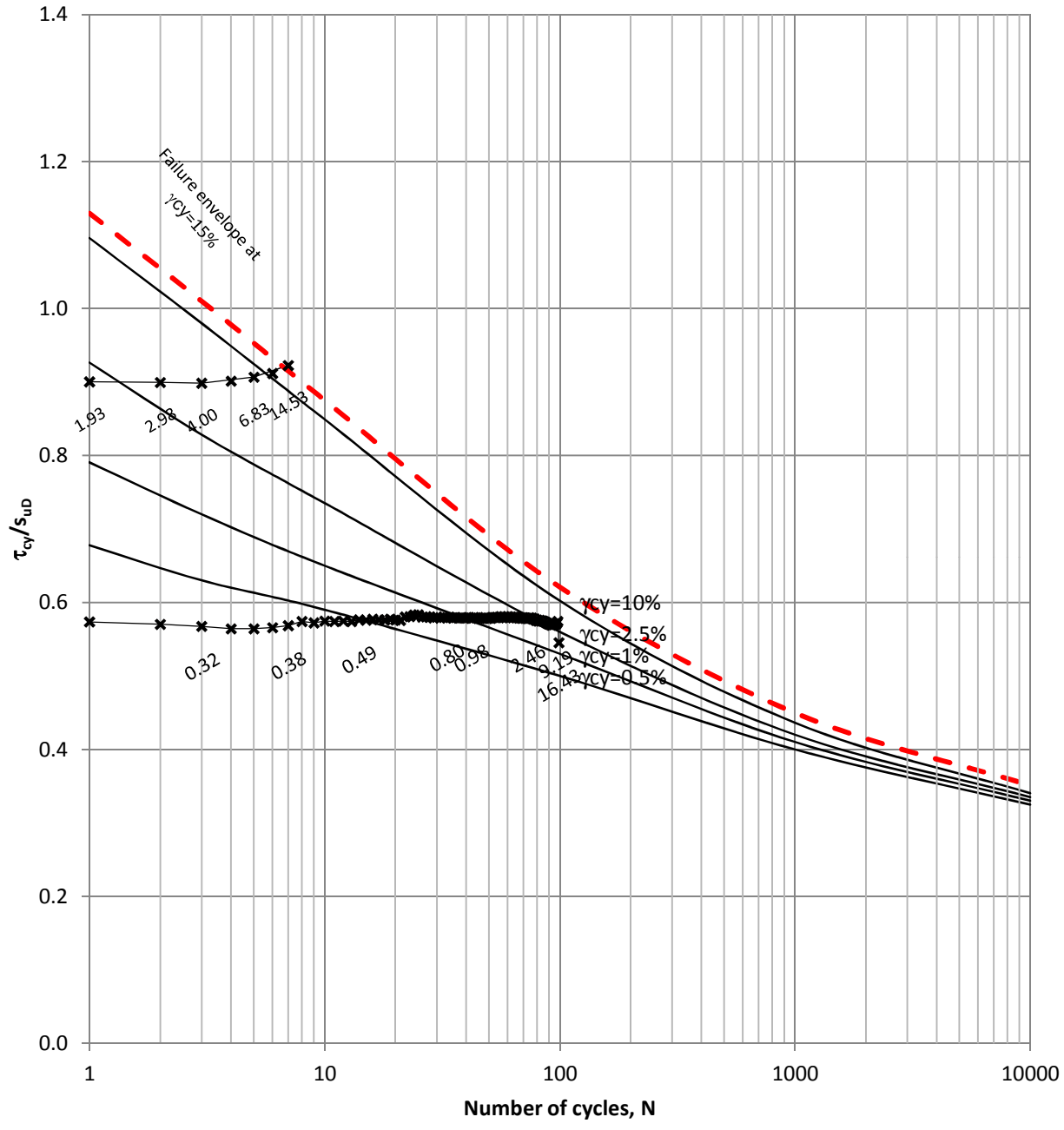
QC Status		
Preliminary	Draft	Final
	JG 04/03/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-1b - CYCLIC TRIAXIAL TESTING in CLAY

Cyclic shear strain contours for τ_a/s_{uD} = 0.1

Unit 1



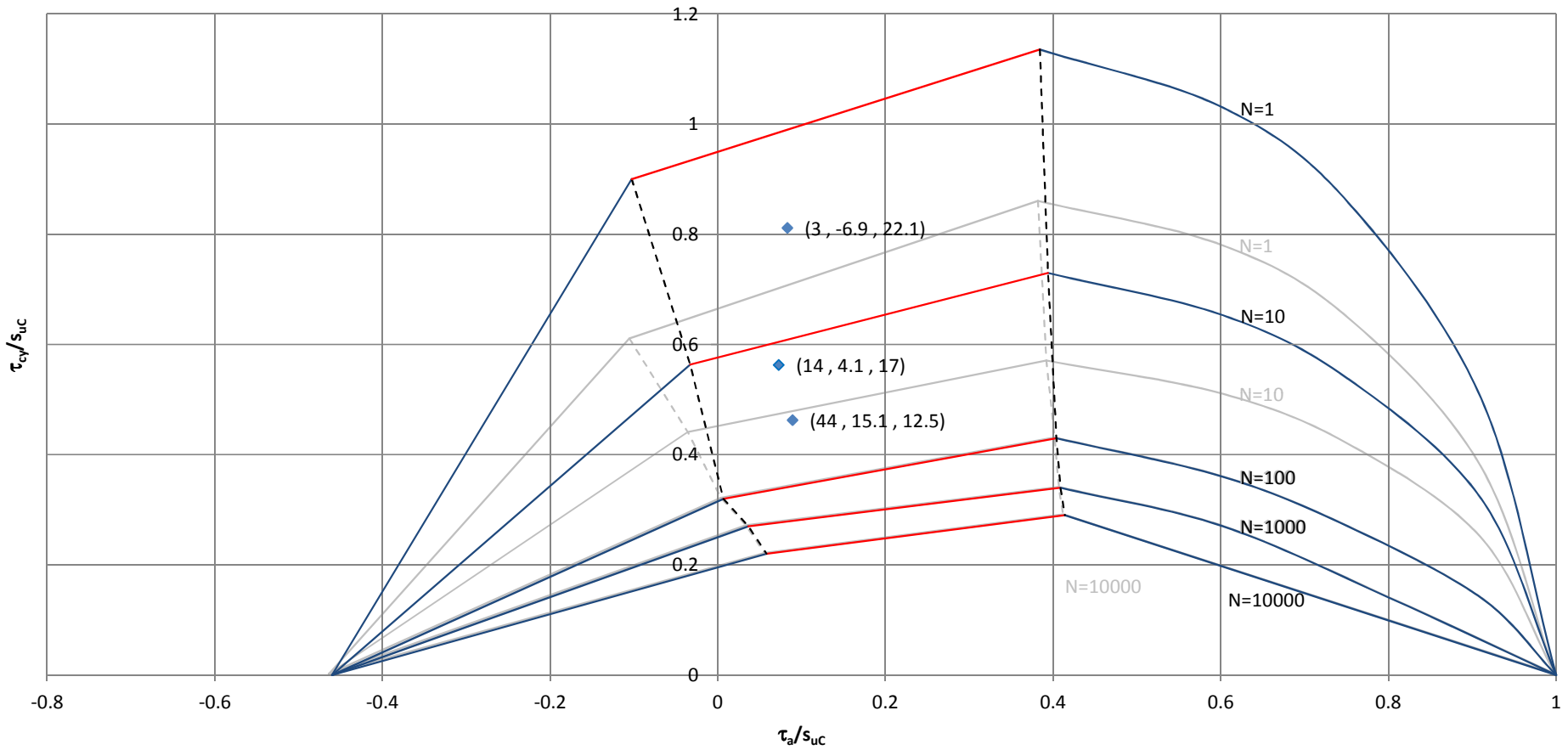
Labels and contours: Cyclic shear strain

Area	Maryland USA	Comments:	QC Status		
Contract	Contract No.		Preliminary	Draft	Final
Borehole/Samp.	BH - D14-P7/8			JG	
Vessel	MV Ocean Discovery			04/03/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-3a - CYCLIC TRIAXIAL CAU TESTING - Normalised average and cyclic stress

Unit 3 - BH-G7/BH-G17



Key legend for failure points: **"Number of cycles, average strain, cyclic strain" at failure**
in Grey: Drammen Clay reference (OCR=1, Andersen 2004)

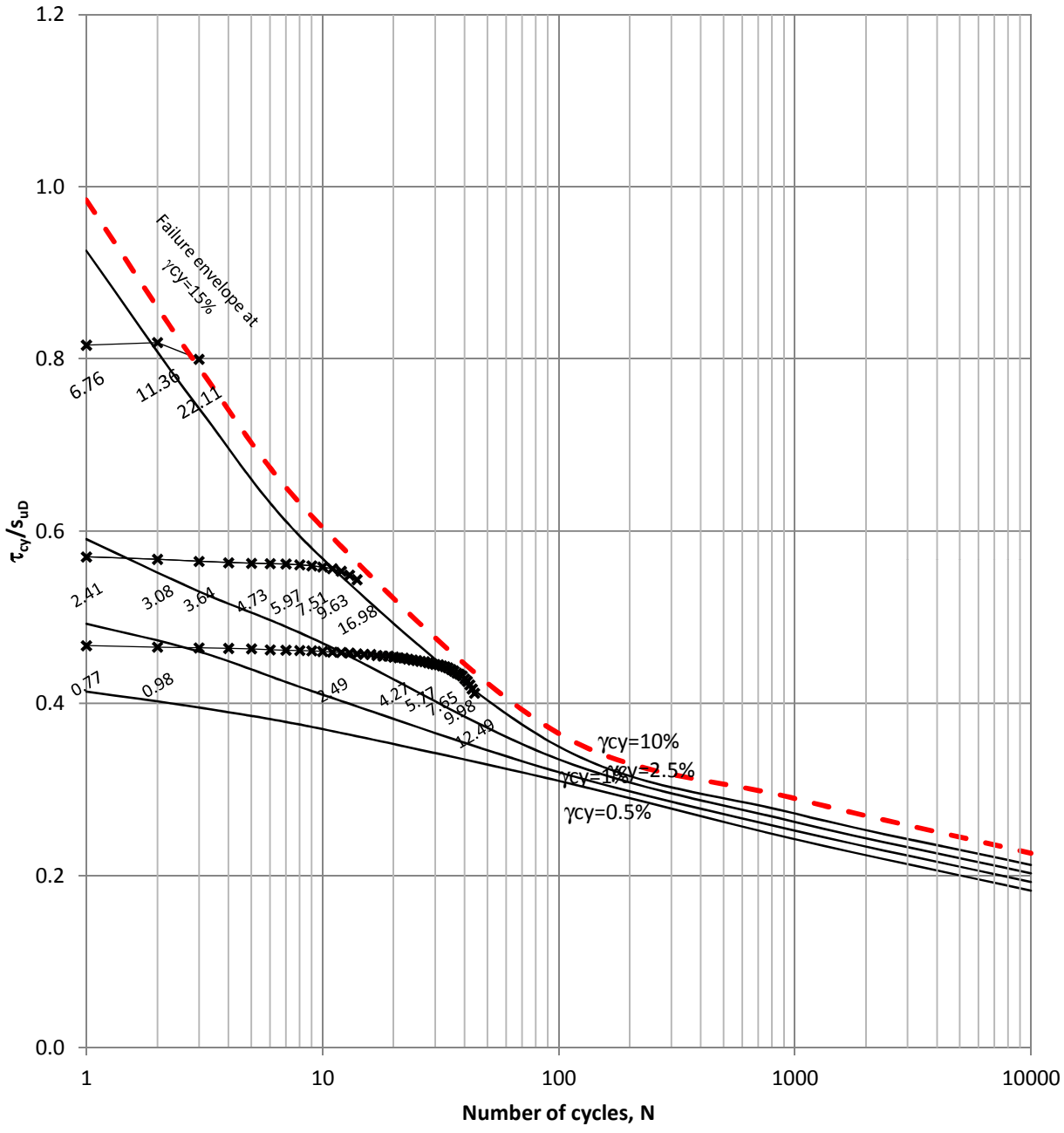
Area	**Maryland USA**	Comments:	QC Status		
Contract	**10451**	Failure occured on P13Q1 after 44 cycles unexpectedly following average strain criterion.	Preliminary	Draft	Final
Borehole/Samp.	**BH - G7-P11/12/13, BH - G17-P15**			**JG** 04/03/2016	
Vessel	**MV Ocean Discovery**				

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-3b - CYCLIC TRIAXIAL TESTING in CLAY

Cyclic shear strain contours for τ_a/s_{uD} = 0.1

Unit 3 - BH-G7/BH-G17



Labels and contours: Cyclic shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**Contract No.**		Preliminary	Draft	Final
Borehole/Samp.	**BH - G7-P11**			**JG**	
Vessel	**MV Ocean Discovery**			04/03/2016	

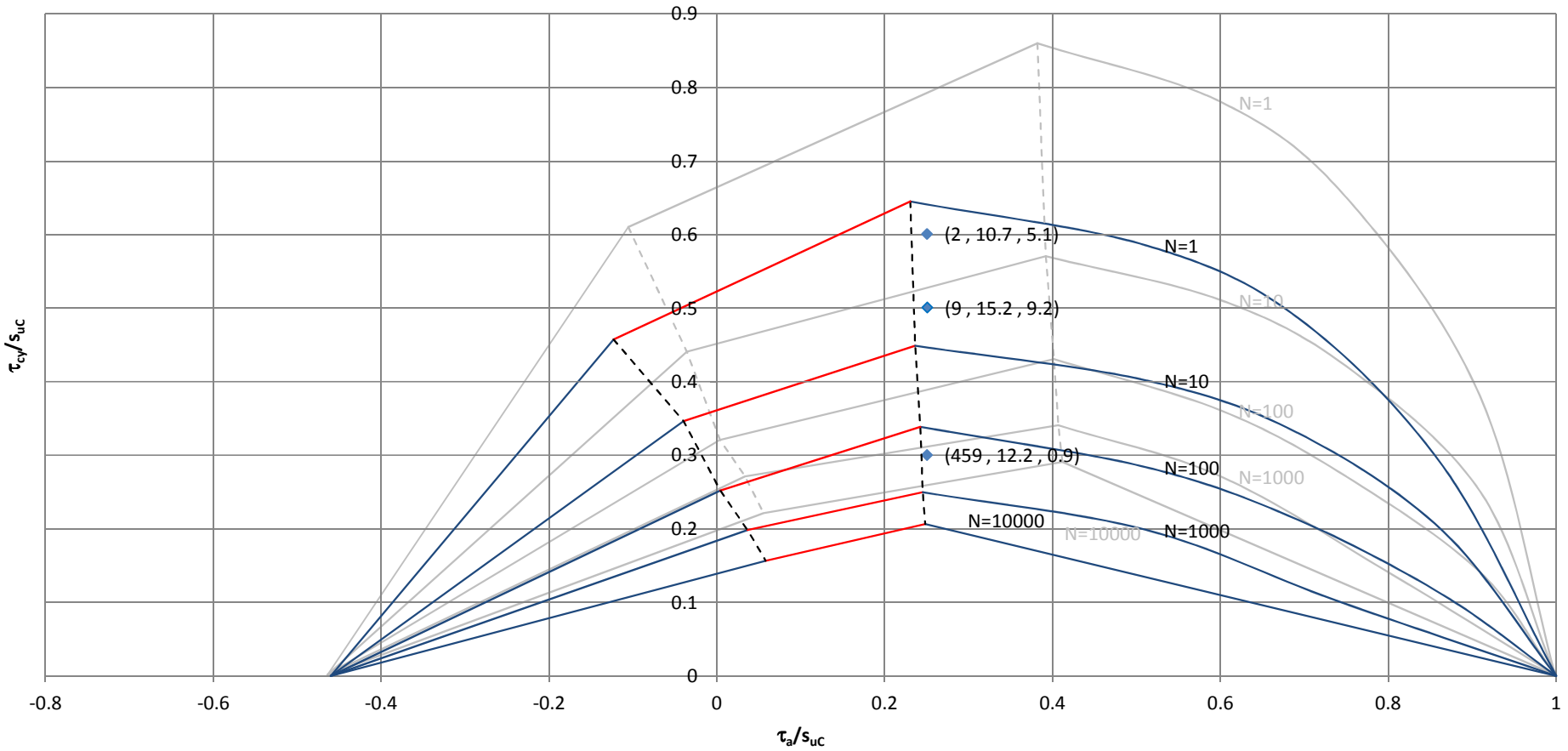
Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-3c - CYCLIC TRIAXIAL CAU TESTING - Normalised average and cyclic stress

Unit 3 - BH-K16

US Wind



Key legend for failure points: **"Number of cycles, average strain, cyclic strain" at failure**
in Grey: Drammen Clay reference (OCR=1, Andersen 2004)

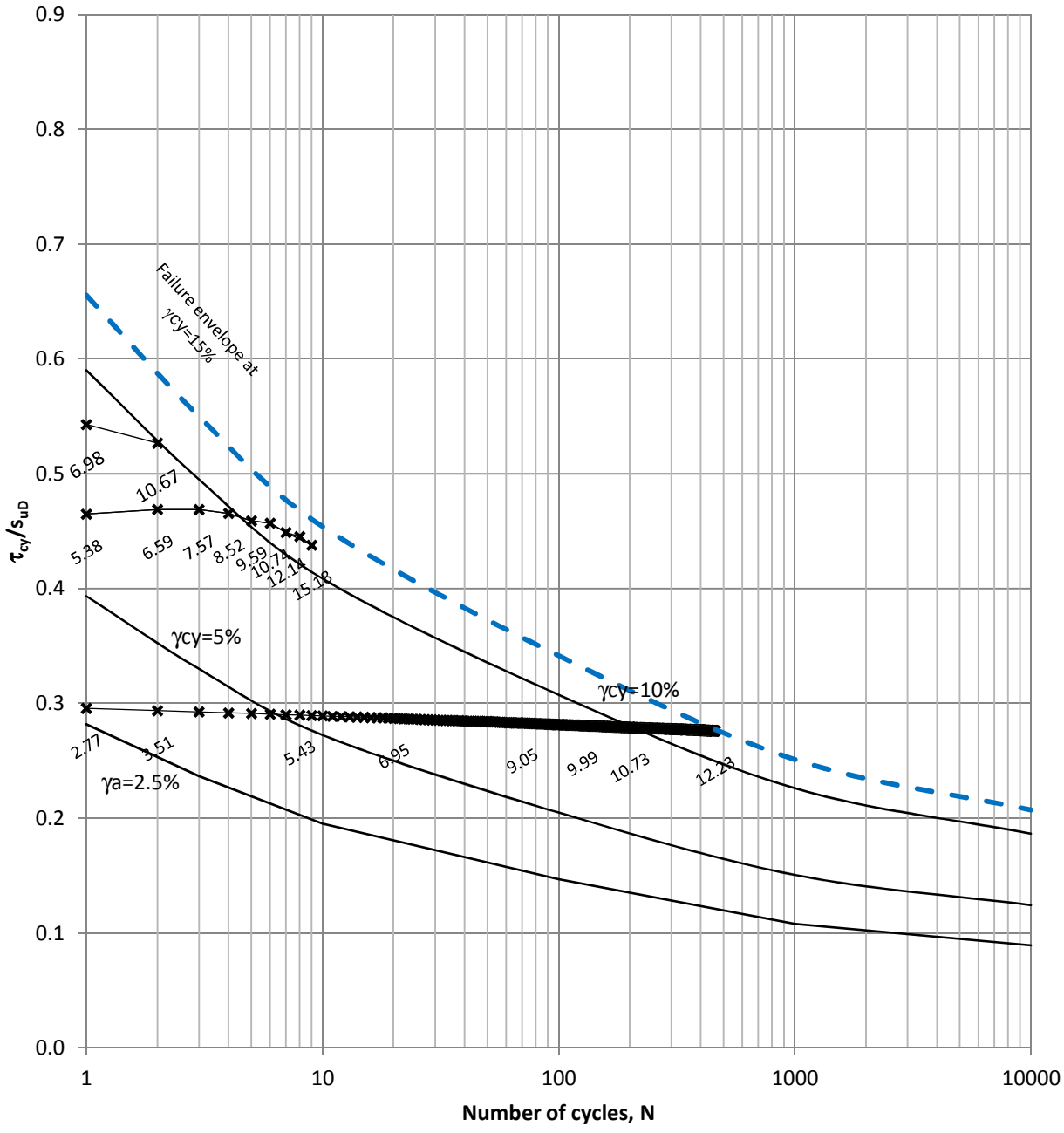
Area	**Maryland USA**	Comments:	QC Status		
Contract	**10451**		Preliminary	Draft	Final
Borehole/Samp.	**BH - G7-P11/12/13, BH - K16-P15/16**			**JG** 04/03/2016	
Vessel	**MV Ocean Discovery**				

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-3d - CYCLIC TRIAXIAL TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.25

Unit 3 - BH-K16



Labels and contours: Average shear strain

Area	Maryland USA	Comments:	QC Status		
Contract	Contract No.		Preliminary	Draft	Final
Borehole/Samp.	BH - K16 -P15			JG	
Vessel	MV Ocean Discovery			04/03/2016	

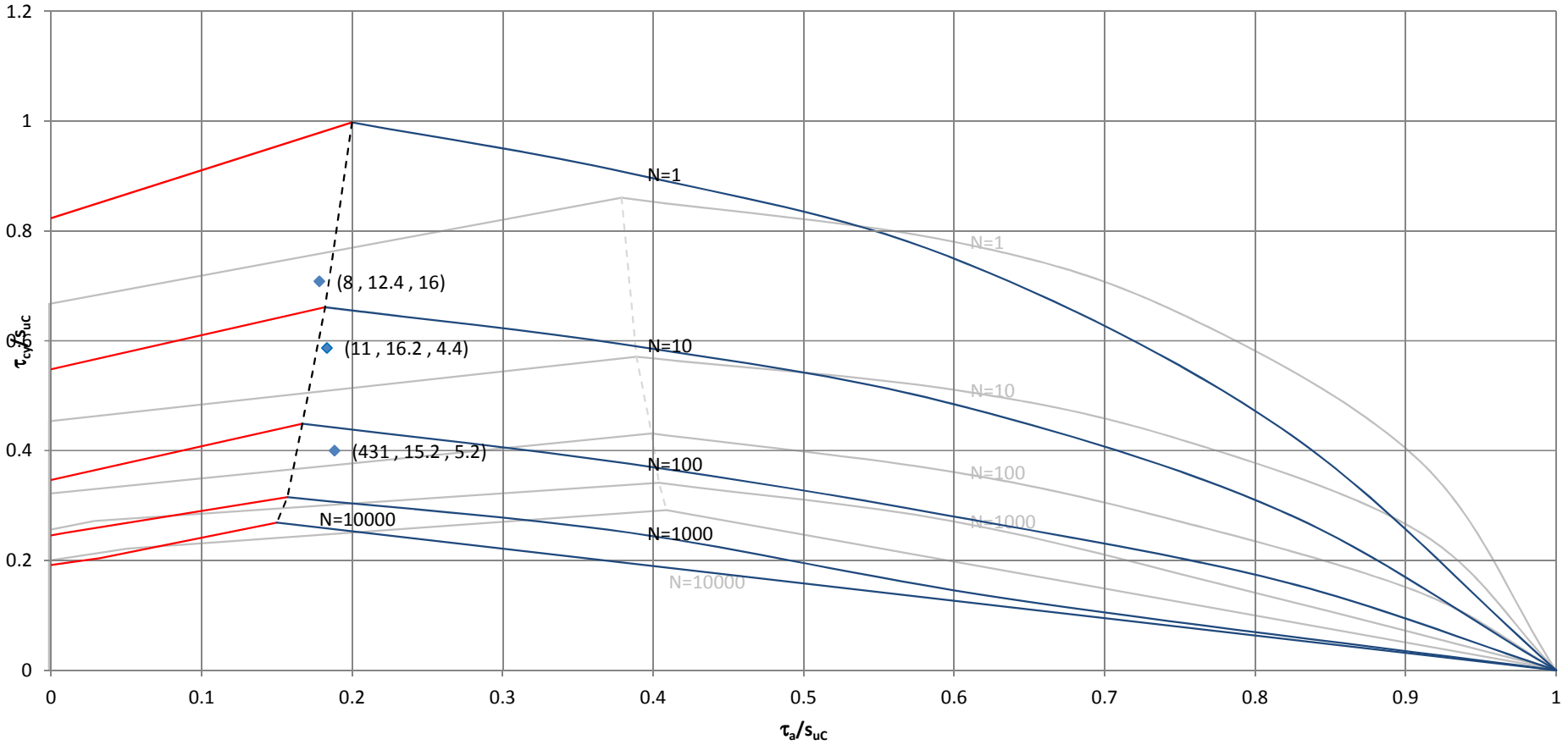
Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-4a - CYCLIC TRIAXIAL CAU TESTING - Normalised average and cyclic stress

Unit 4

US Wind



Key legend for failure points: **"Number of cycles, average strain, cyclic strain" at failure**
in Grey: Drammen Clay reference (OCR=1, Andersen 2004)

Area	**Maryland USA**
Contract	**10451**
Borehole/Samp.	**BH - I21B -P9/11**
Vessel	**MV Ocean Discovery**

Comments:
The extension part of the curves could not have been assessed in absence of triaxial extension test (CAUE) in this unit.

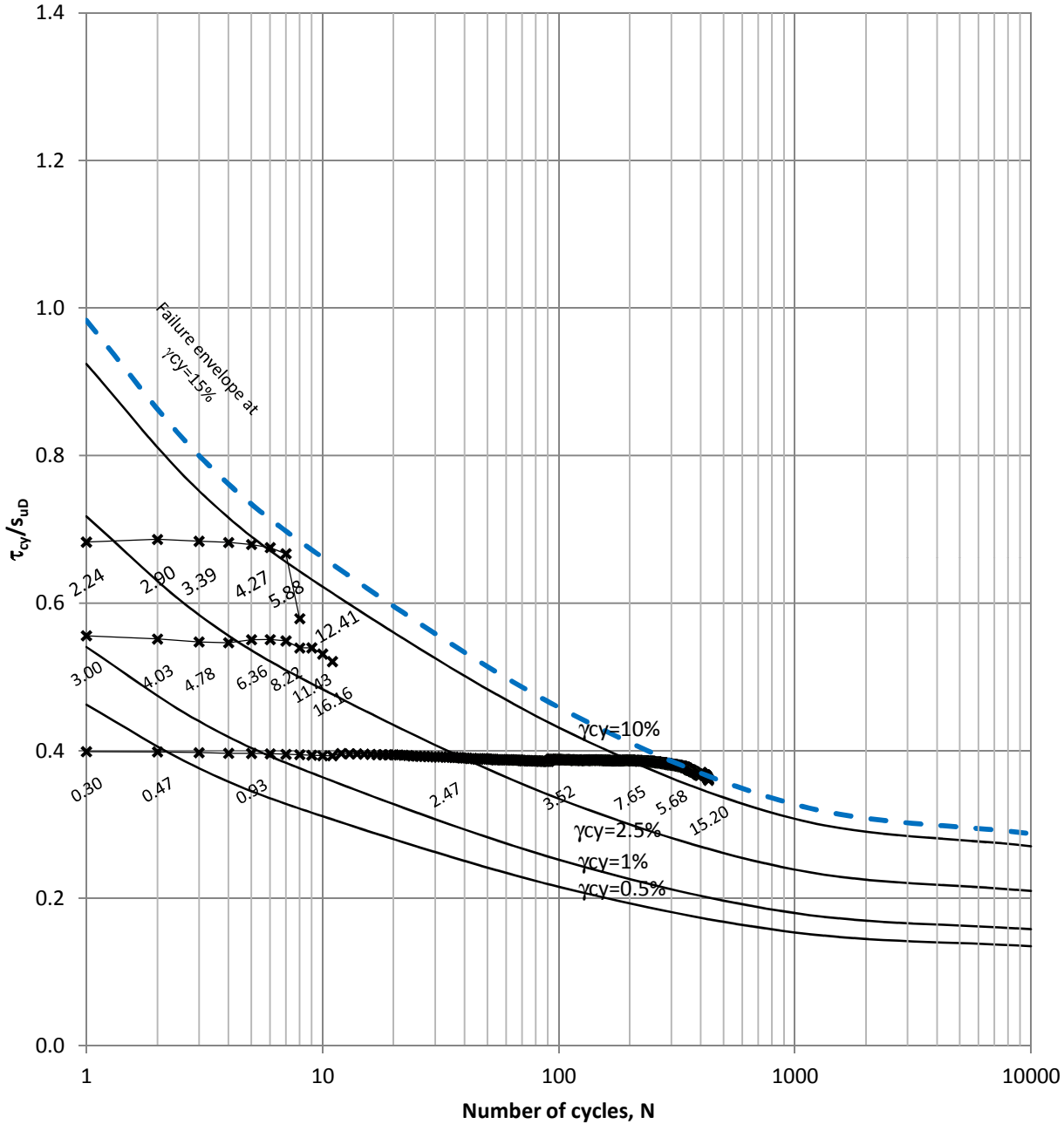
QC Status		
Preliminary	Draft	Final
	JG 04/03/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-4b - CYCLIC TRIAXIAL TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.2

Unit 4



Labels and contours: Average shear strain

Area	Maryland USA	Comments:	QC Status		
Contract	Contract No.		Preliminary	Draft	Final
Borehole/Samp.	BH - I21B -P9			JG	
Vessel	MV Ocean Discovery			04/03/2016	

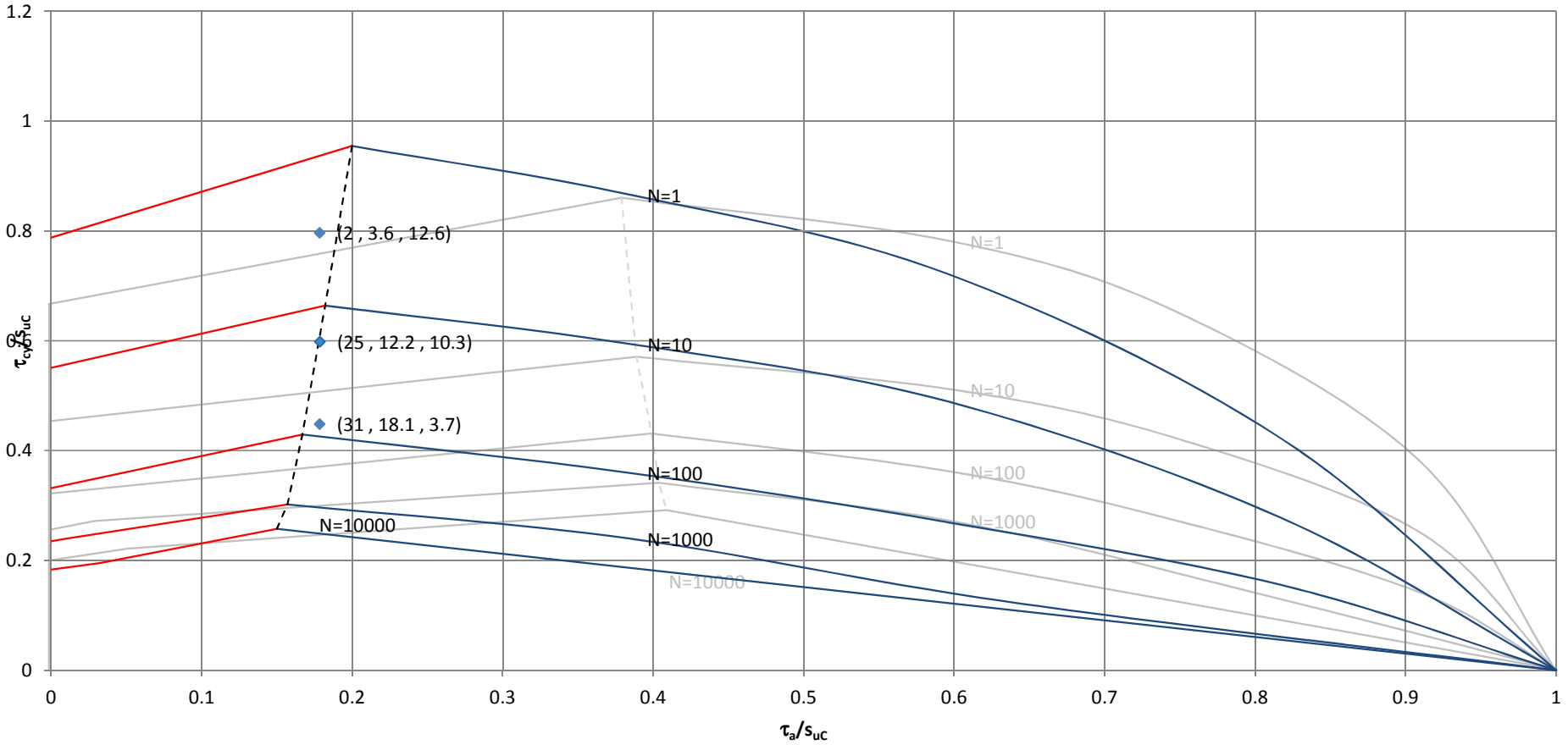
Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-5a - CYCLIC TRIAXIAL CAU TESTING - Normalised average and cyclic stress

Unit 5

US Wind



Key legend for failure points: **"Number of cycles, average strain, cyclic strain" at failure**
in Grey: Drammen Clay reference (OCR=1, Andersen 2004)

Area	**Maryland USA**
Contract	**10451**
Borehole/Samp.	**BH - D14A -P5/6**
Vessel	**MV Ocean Discovery**

Comments:
The extension part of the curves could not have been assessed in absence of triaxial extension test (CAUE) in this unit. Possible overestimation of su for P6Q2.

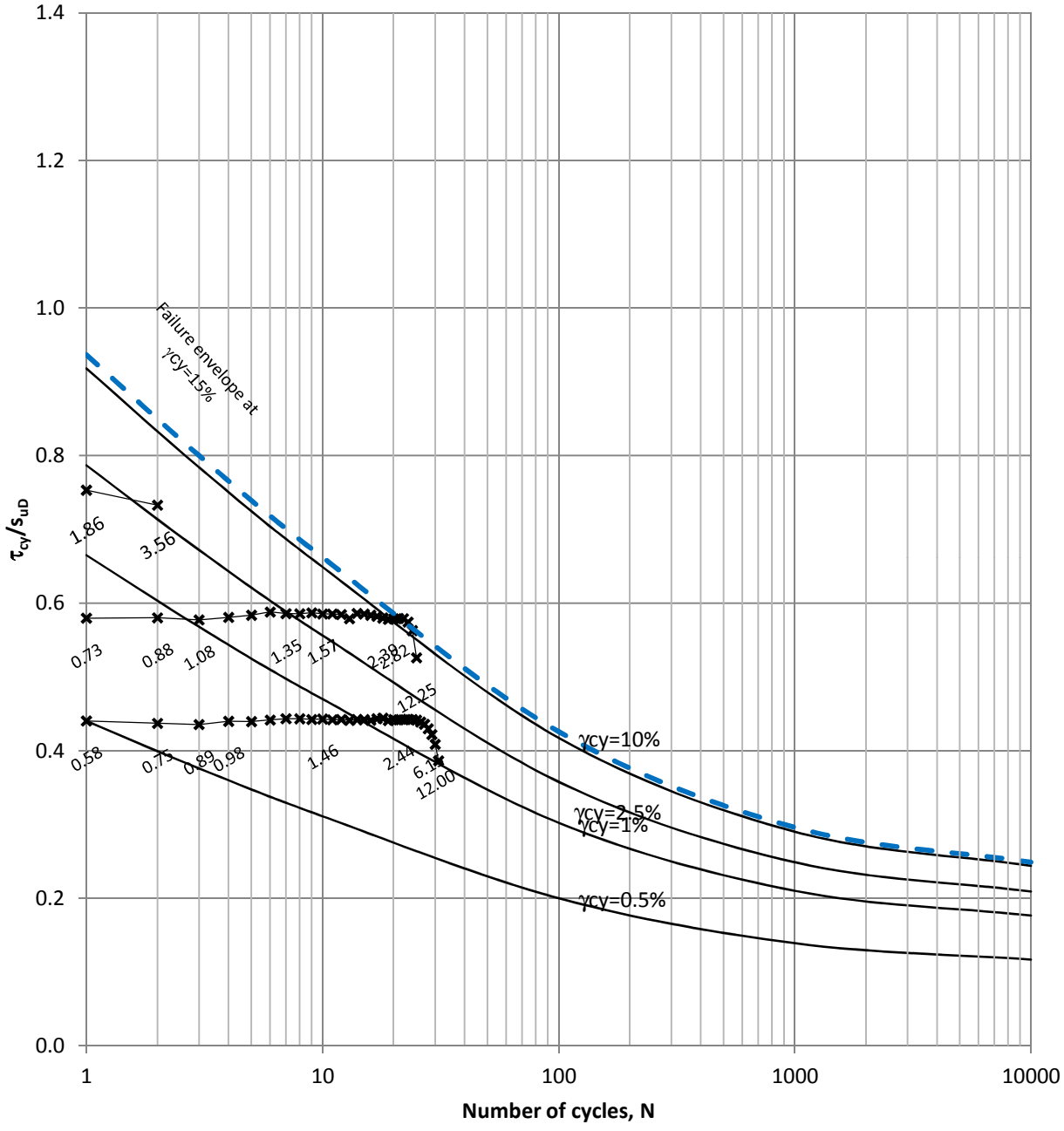
QC Status		
Preliminary	Draft	Final
	JG 04/03/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-5b - CYCLIC TRIAXIAL TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.2

Unit 5



Labels and contours: Average shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**Contract No.**	Possible overestimation of su for P6Q2.	Preliminary	Draft	Final
Borehole/Samp.	**BH - D14A -P5**			**JG**	
Vessel	**MV Ocean Discovery**			04/03/2016	

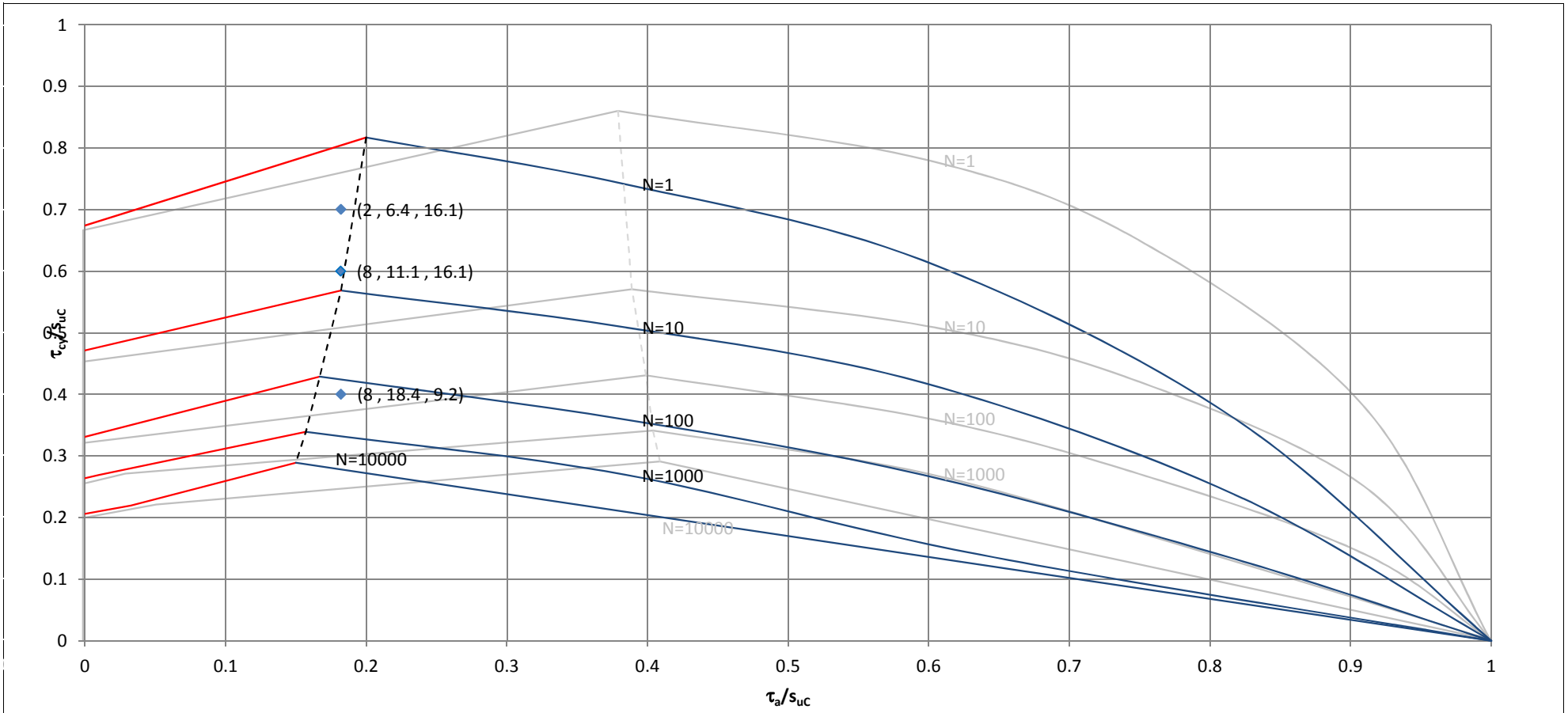
Gardline

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-6a - CYCLIC TRIAXIAL CAU TESTING - Normalised average and cyclic stress

Unit 6

US Wind



Key legend for failure points: **"Number of cycles, average strain, cyclic strain" at failure**
in Grey: Drammen Clay reference (OCR=1, Andersen 2004)

Area	**Maryland USA**
Contract	**10451**
Borehole/Samp.	**BH - G7 -P17/18**
Vessel	**MV Ocean Discovery**

Comments:
The extension part of the curves could not have been assessed in absence of triaxial extension test (CAUE) in this unit. Possible overestimation of su for P18Q2.

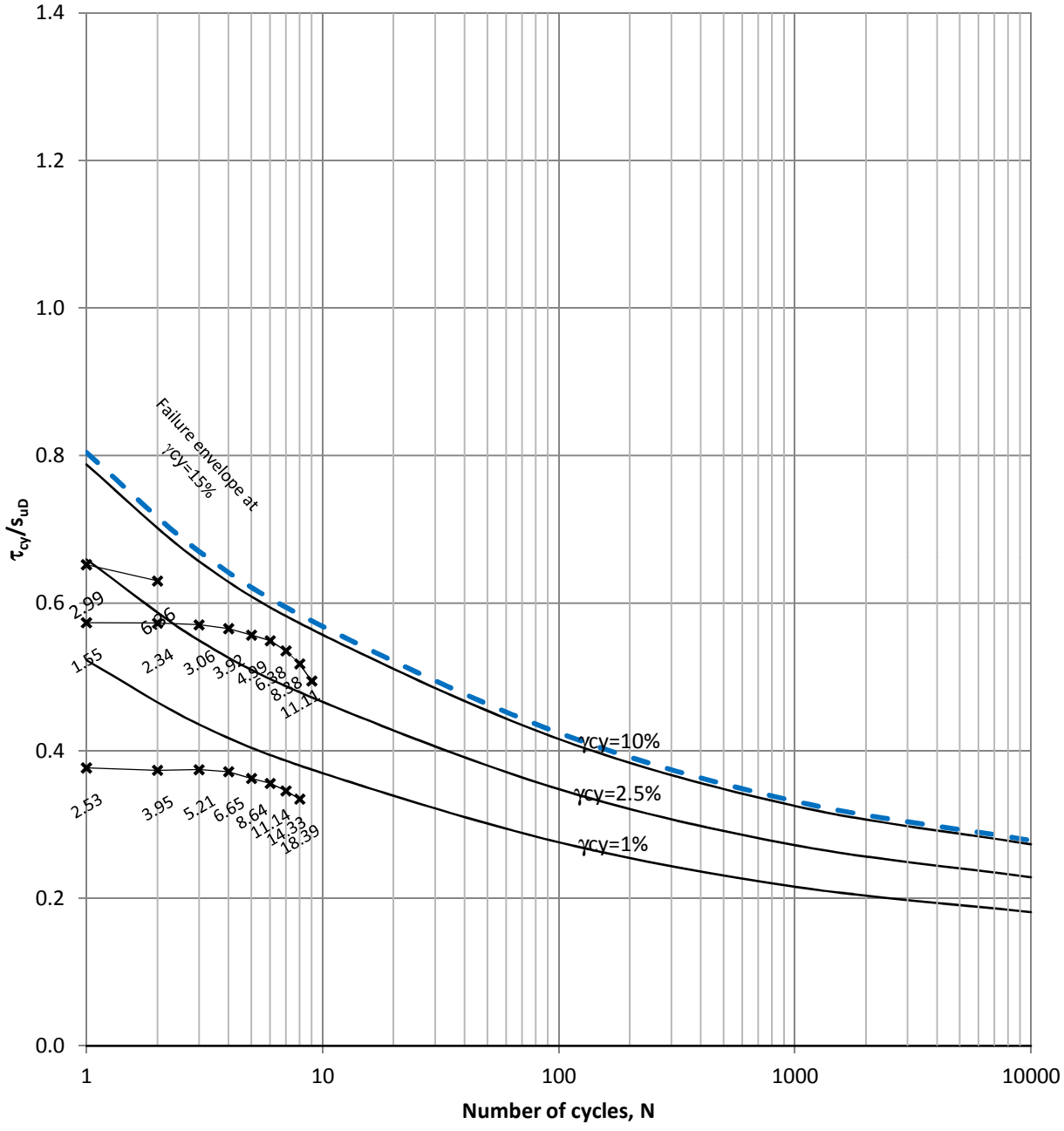
QC Status		
Preliminary	Draft	Final
	JG 04/03/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.1-6b - CYCLIC TRIAXIAL TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.2

Unit 6



Labels and contours: Average shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**Contract No.**	Possible overestimation of su for P18Q2.	Preliminary	Draft	Final
Borehole/Samp.	**BH - G7-P17**			**JG**	
Vessel	**MV Ocean Discovery**			04/03/2016	

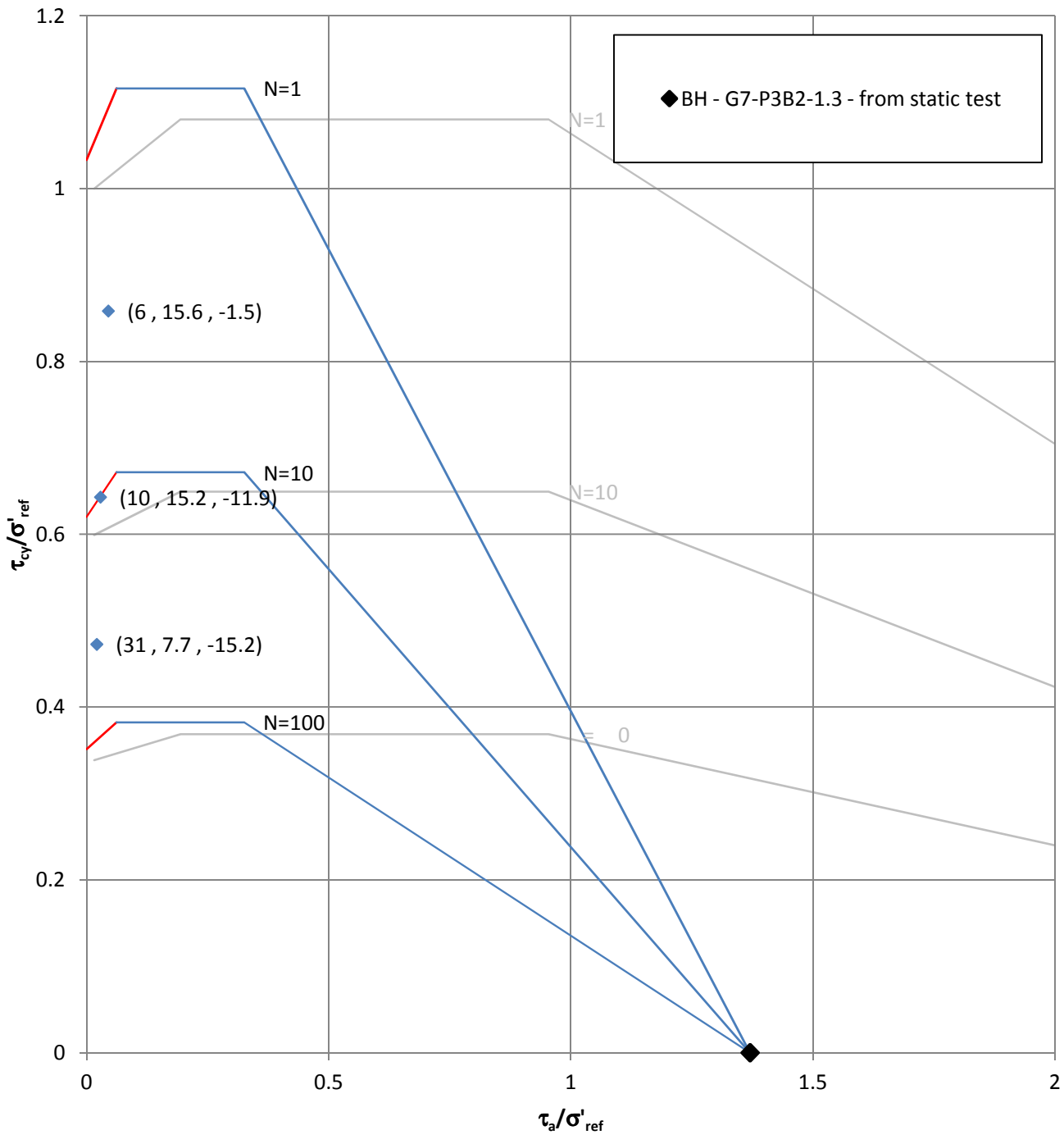
6.2 Cyclic DSS tests (DSScy)

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-1a - CYCLIC DSS TESTING in SAND (Undrained)

Normalised average and cyclic stress

Unit 1



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Sand reference with $\tau_{cy}/\sigma'_{ref}(N=10) = 0.6$, Blue: Average strain failure, Red: Cyclic strain failure

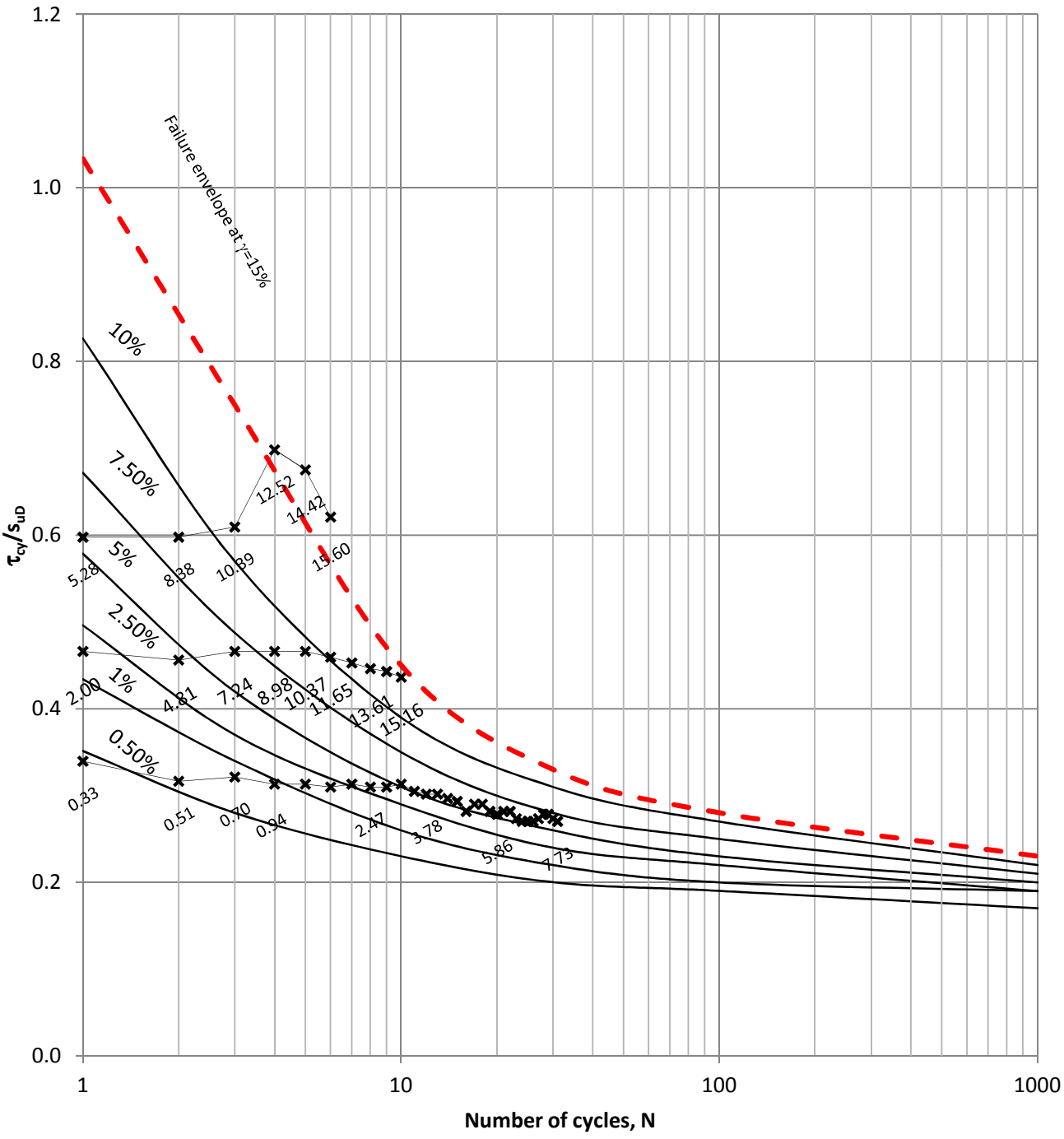
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH - G7-P3B2-1.34. Reference contours from Andersen 2015.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-1b - CYCLIC DSS TESTING in SAND

Cyclic shear strain contours for τ_a/σ'_{ref} = 0.0

Unit 1



Labels and contours: Cyclic shear strain

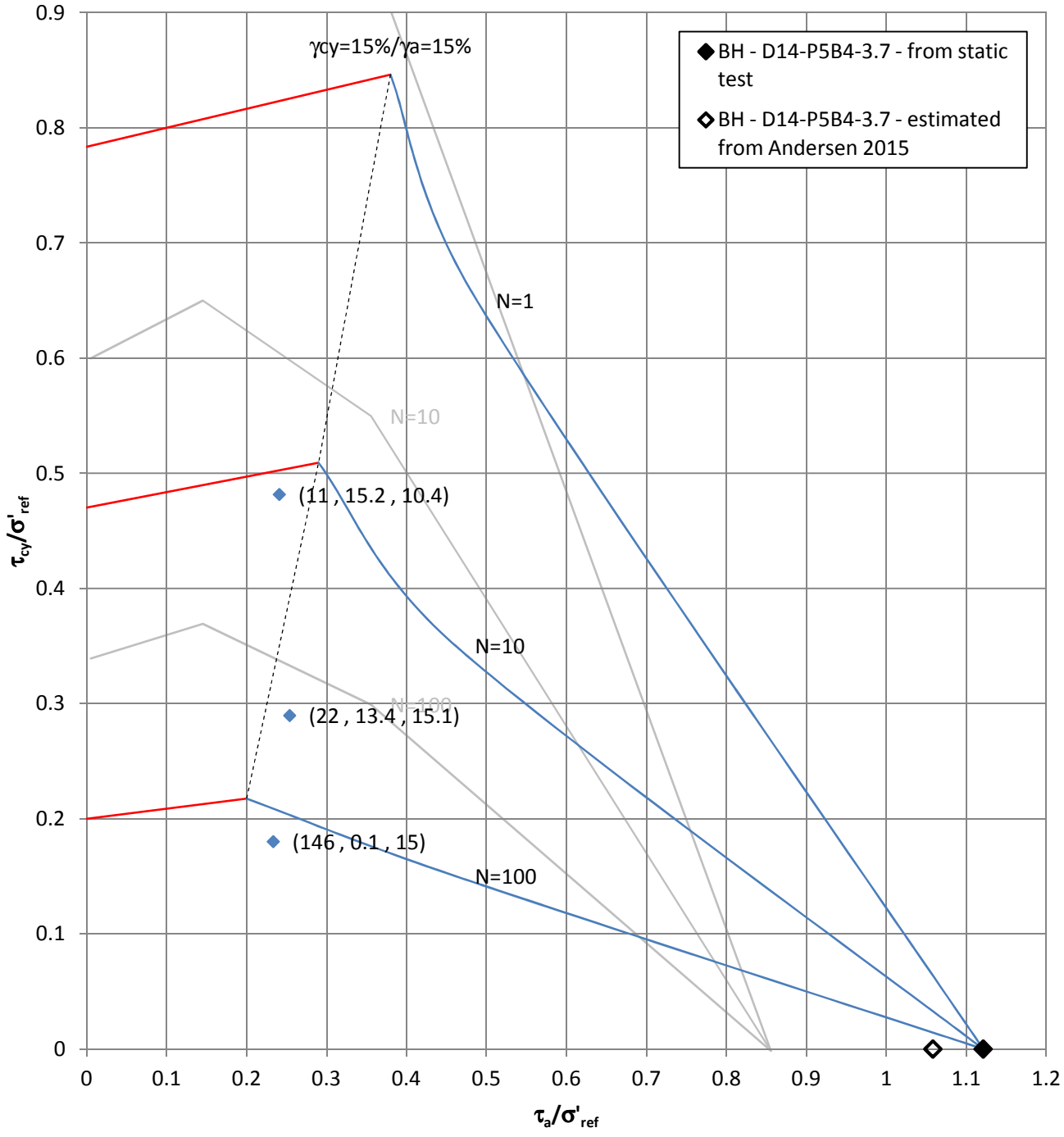
Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on sample BH - G7-P3B2-1.34.	Preliminary	Draft	Final
Client Name / Ref	**0**			**JG**	
Vessel	**MV Ocean Discovery**			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-1c - CYCLIC DSS TESTING in SAND (Drained)

Normalised average and cyclic stress

Unit 1a



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Sand reference with $\tau_{cy}/\sigma'_{ref}(N=10) = 0.6$, Blue: Average strain failure, Red: Cyclic strain failure

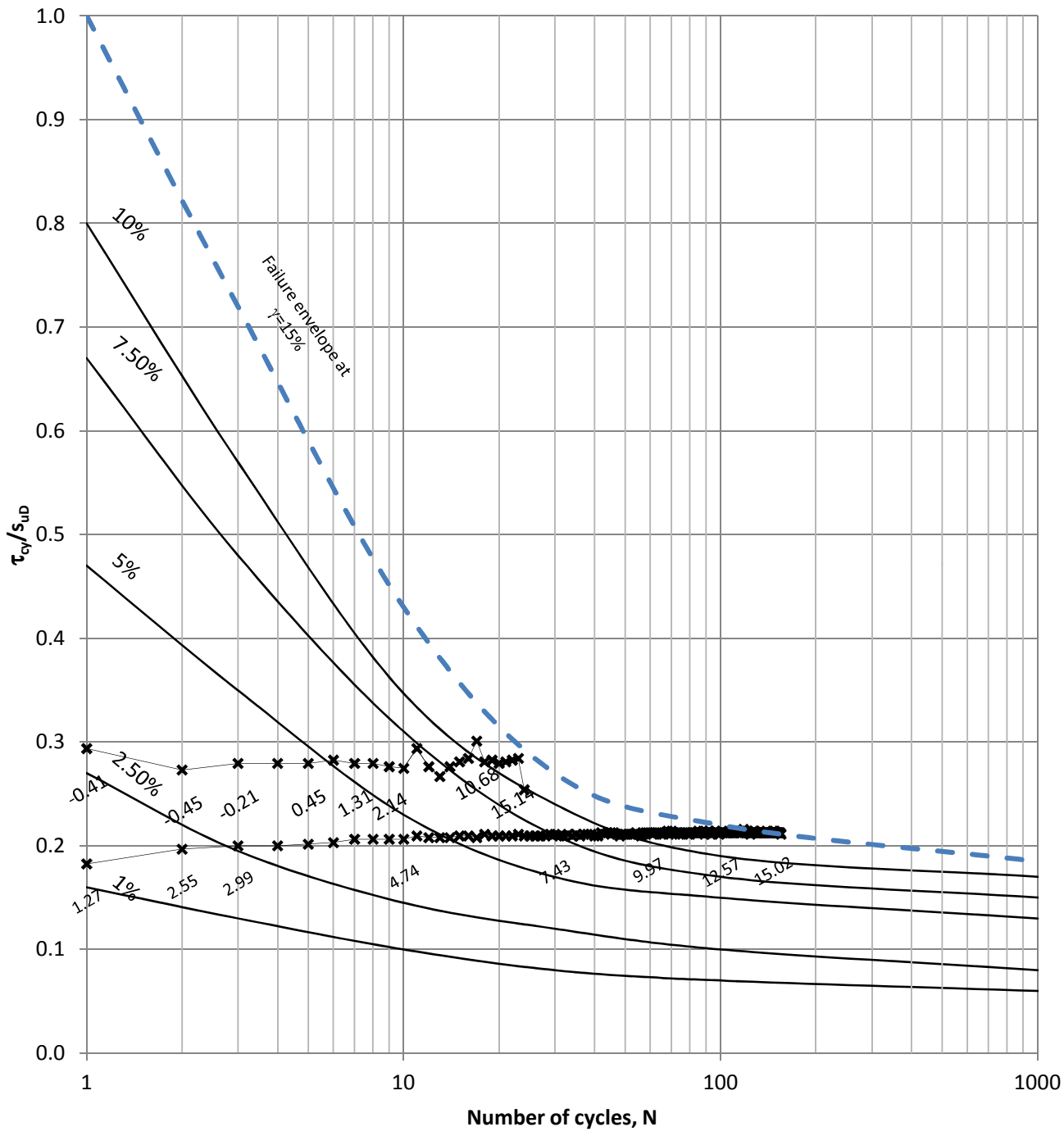
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH - D14-P5B4-3.74. Reference contours from Andersen 2015.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-1d - CYCLIC DSS TESTING in SAND

Average shear strain contours for τ_a/σ'_{ref} = 0.25

Unit 1a



Labels and contours: Average shear strain

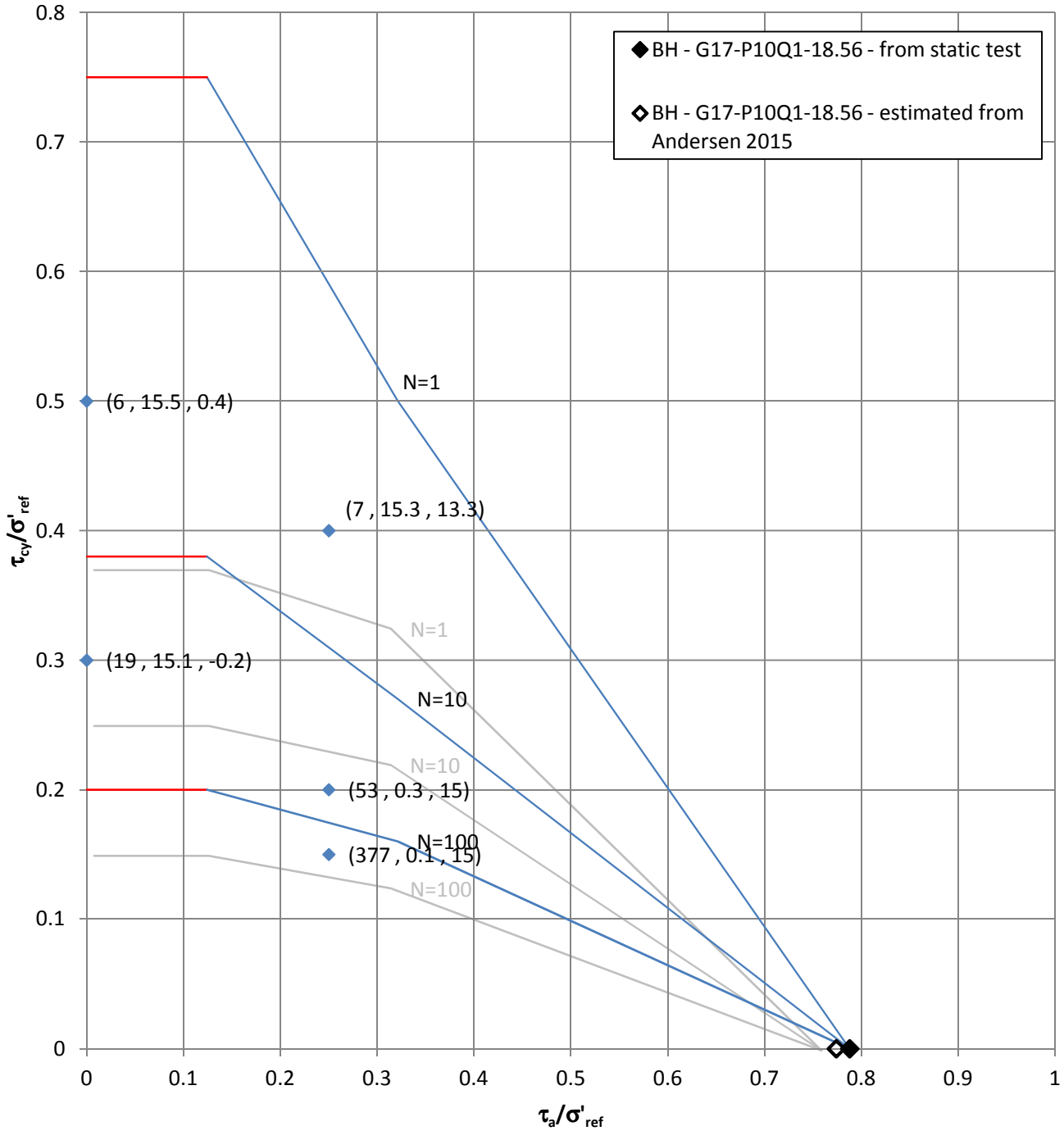
Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on sample BH-D14 - P5B4. Contours are given only for guidance since all three specimens underwent different failure mecanisms.	Preliminary	Draft	Final
Client Name / Ref	**0**			**JG**	
Vessel	**MV Ocean Discovery**			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-2a - CYCLIC DSS TESTING in SAND (Drained)

Normalised average and cyclic stress

Unit 2



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Sand reference with $\tau_{cy}/\sigma'_{ref}(N=10) = 0.25$, Blue: Average strain failure, Red: Cyclic strain failure

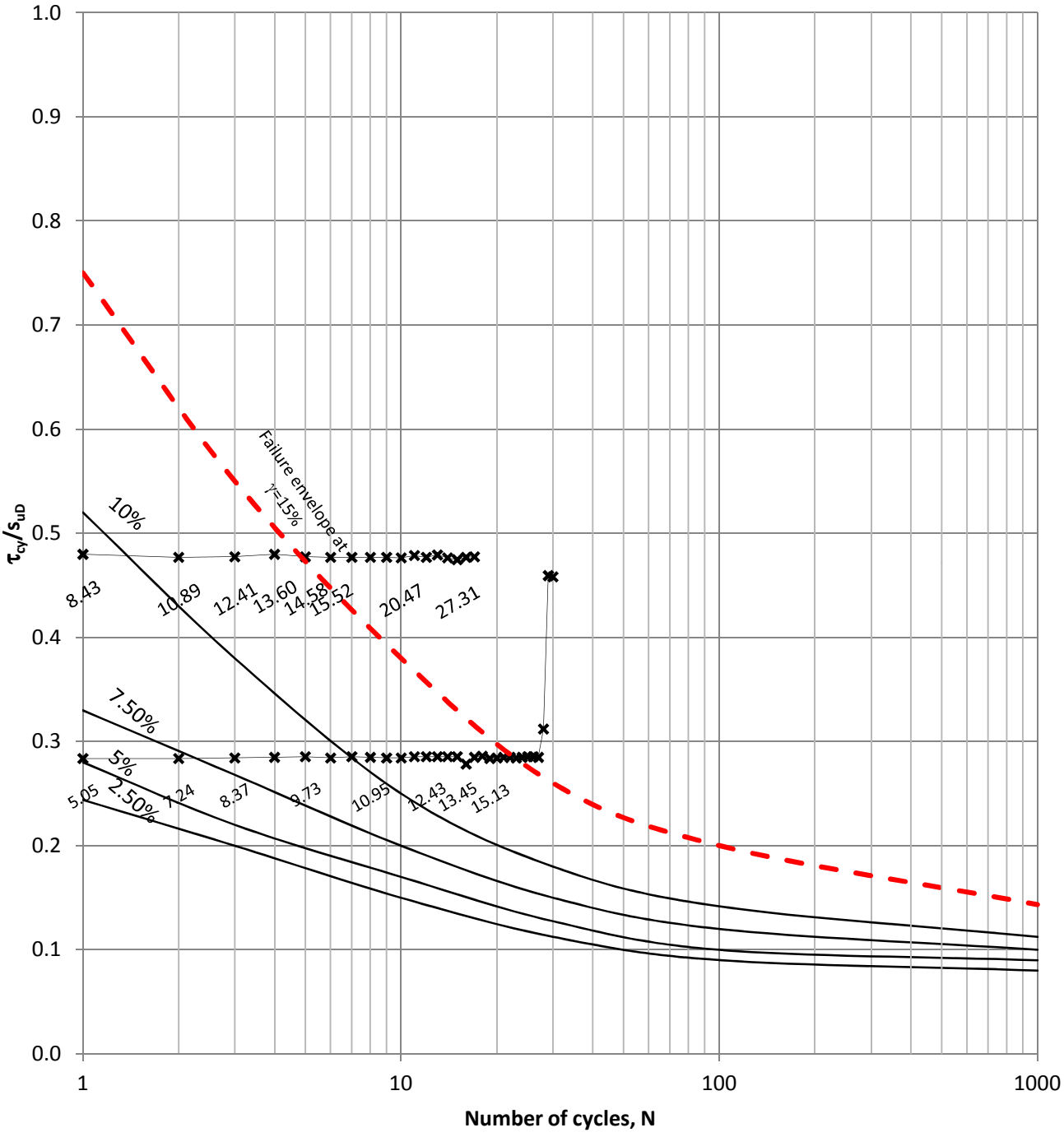
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on samples BH - G17-P10Q1-18.63 and BH - I21A-P1B2-9.795. Reference contours from Andersen 2015.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-2b - CYCLIC DSS TESTING in SAND

Cyclic shear strain contours for τ_a/σ'_{ref} = 0.0

Unit 2



Labels and contours: Cyclic shear strain

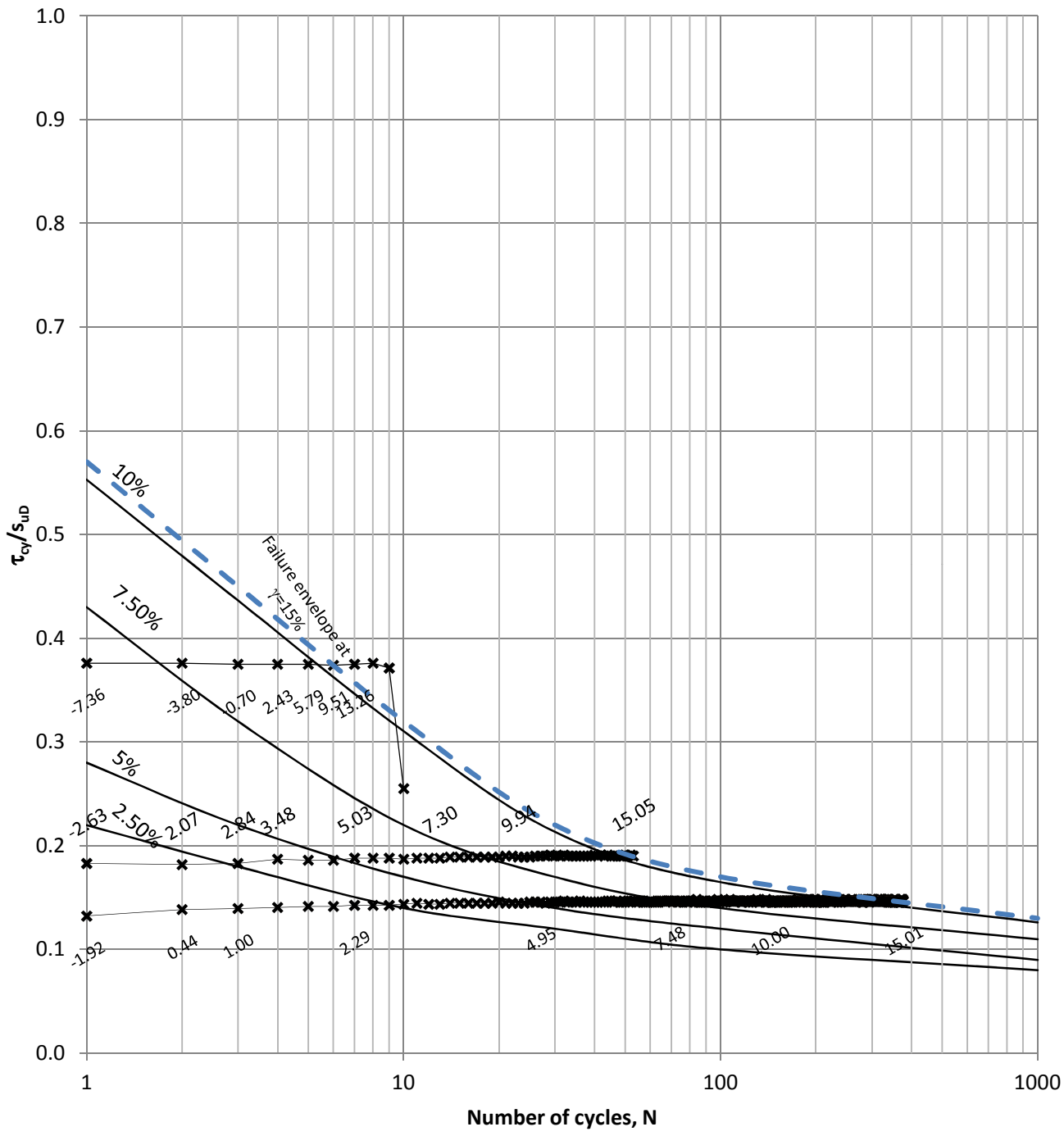
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH - G17-P10Q1-18.63.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-2b - CYCLIC DSS TESTING in SAND

Average shear strain contours for τ_a/σ'_{ref} = 0.25

Unit 2



Labels and contours: Average shear strain

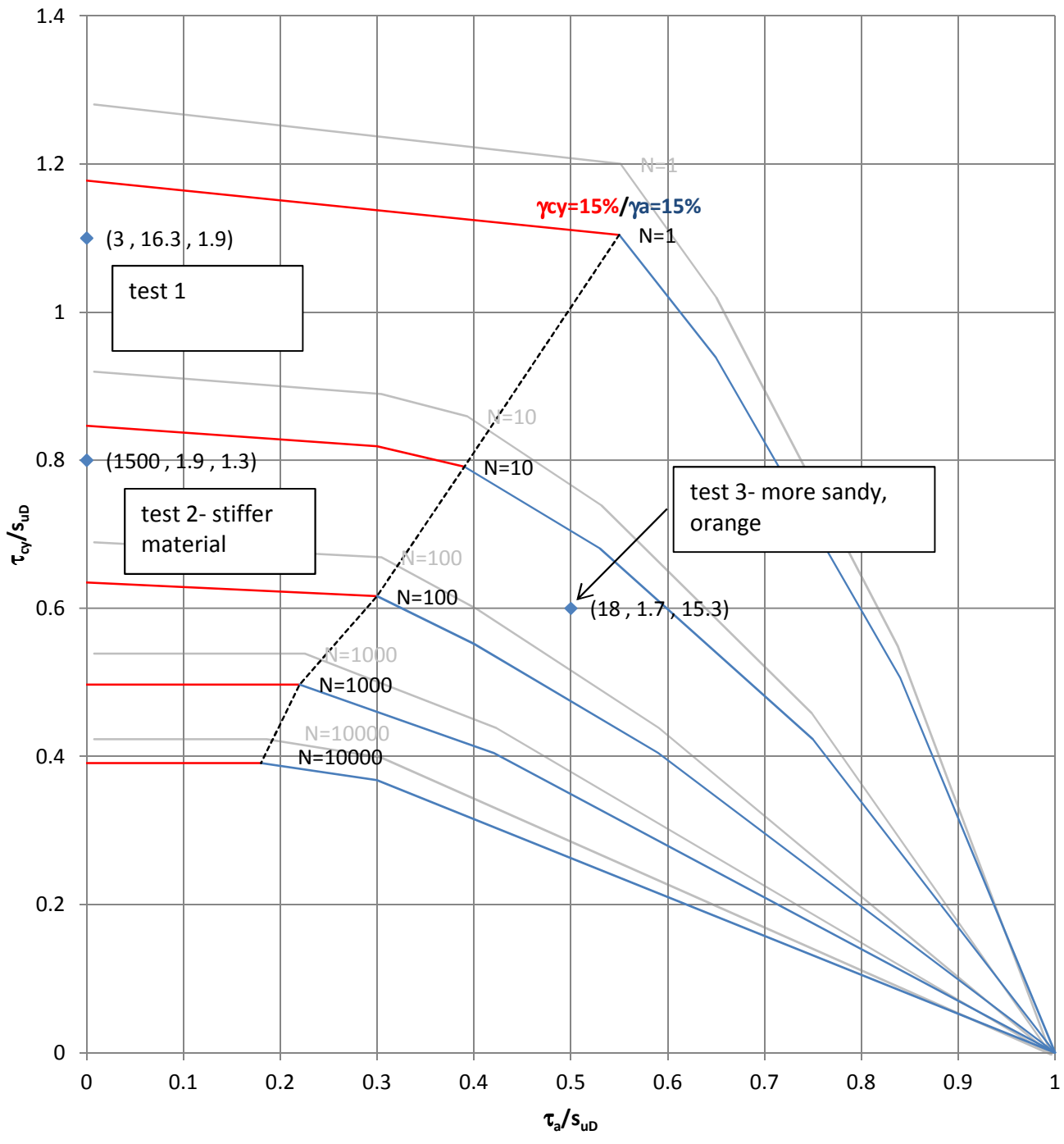
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH - I21A-P1B2-9.795.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3a - CYCLIC DSS TESTING in CLAY

Normalised average and cyclic stress

Unit 3 - BH-G7



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Drammen Clay reference (OCR=1), Red: Cyclic strain failure, Blue: Average strain failure

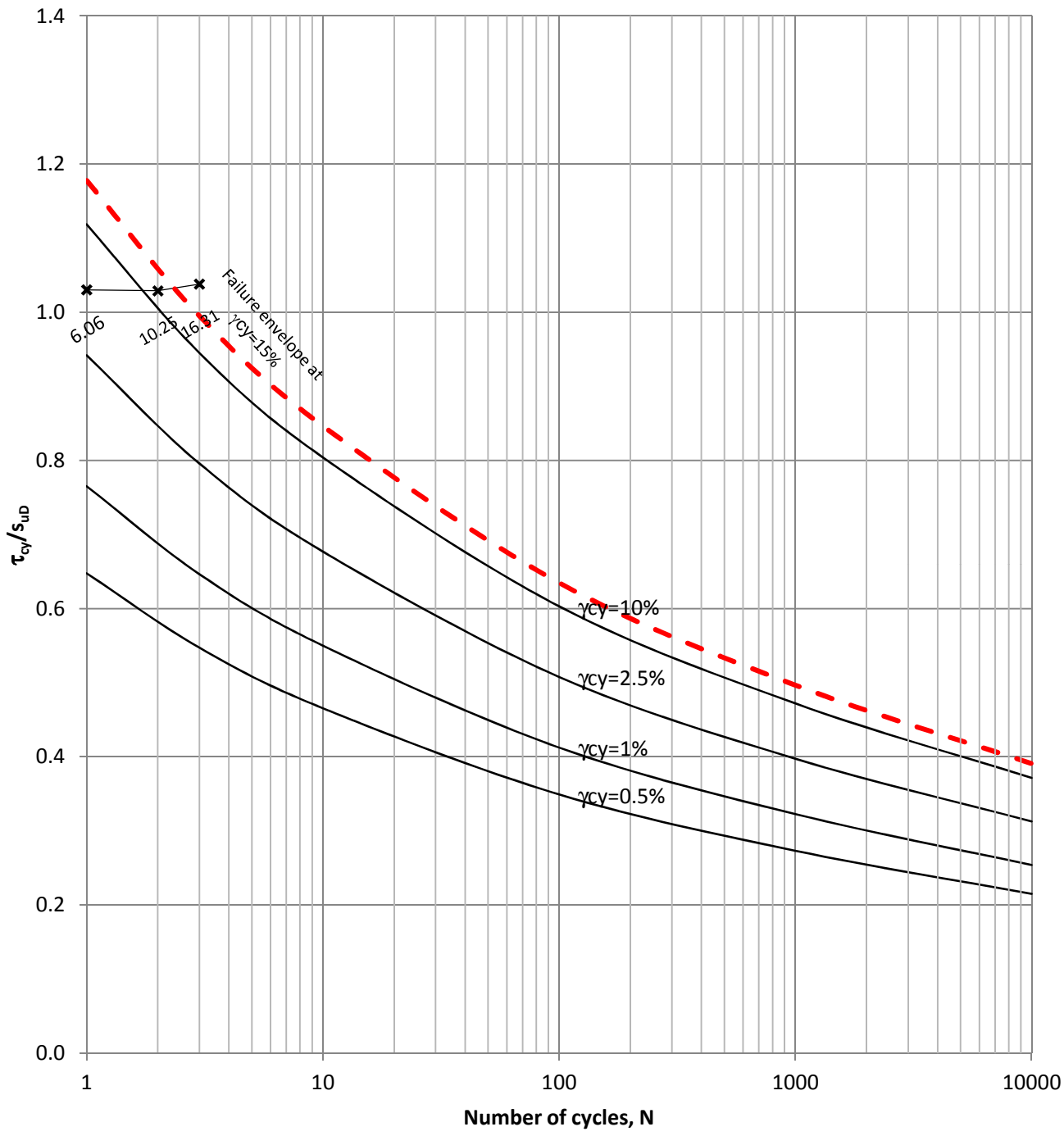
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on borehole BH-G7. Specimens tested are from P11-Q2. High heterogeneity within the sample. Tests 1 and 3 provide nevertheless good consistency with the reference Drammen Clay (Andersen 2004).	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3b - CYCLIC DSS TESTING in CLAY

Cyclic shear strain contours for τ_a/s_{uD} = 0.0

Unit 3 - BH-G7



Labels and contours: Cyclic shear strain

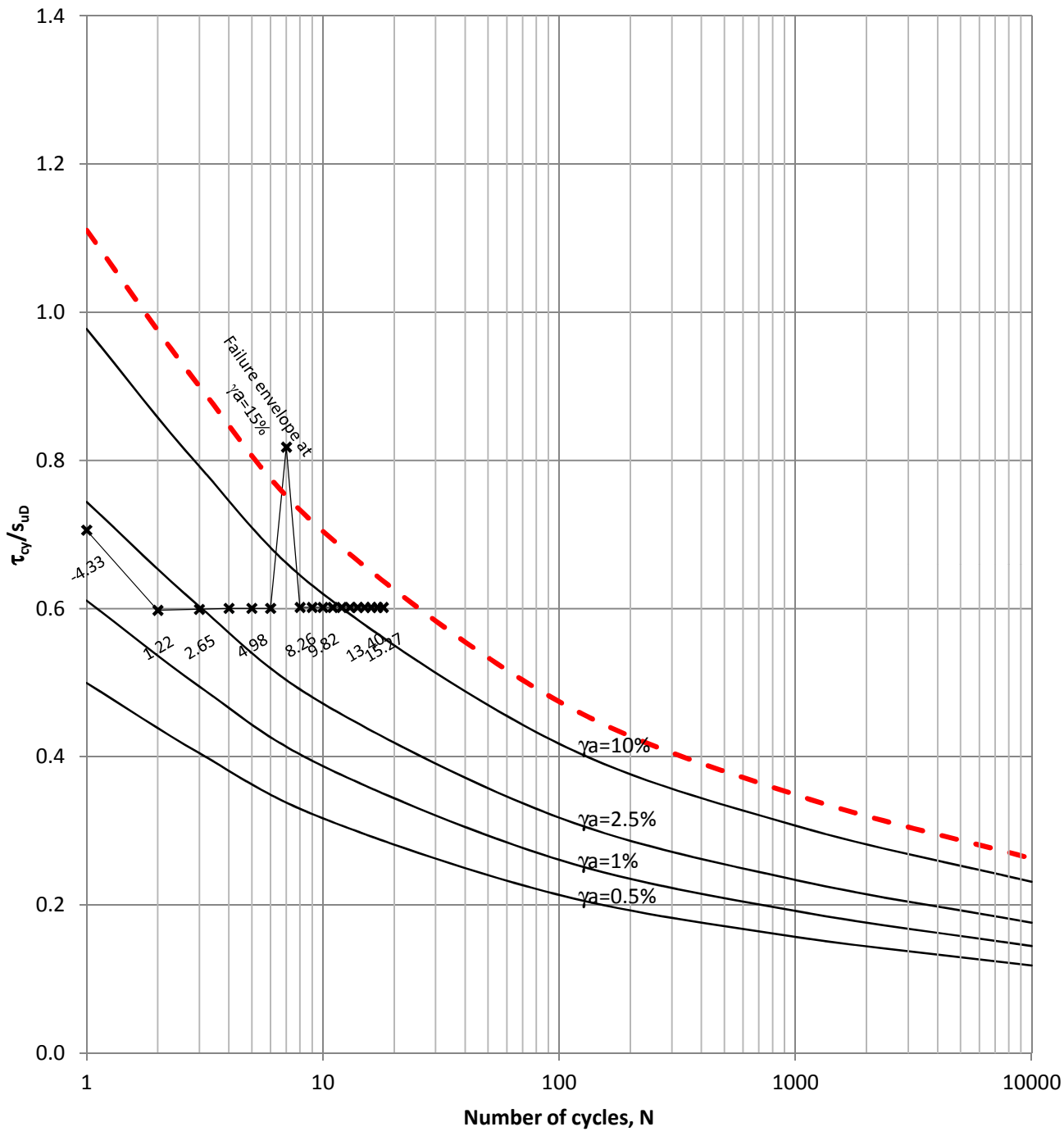
Area	Maryland USA	**Comments:**	QC Status		
Contract	10451	Cyclic tests results on sample BH-G7_P11Q2. Contours are given only for guidance, not enough homogeneous data being collected.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3c - CYCLIC DSS TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.5

Unit 3 - BH-G7



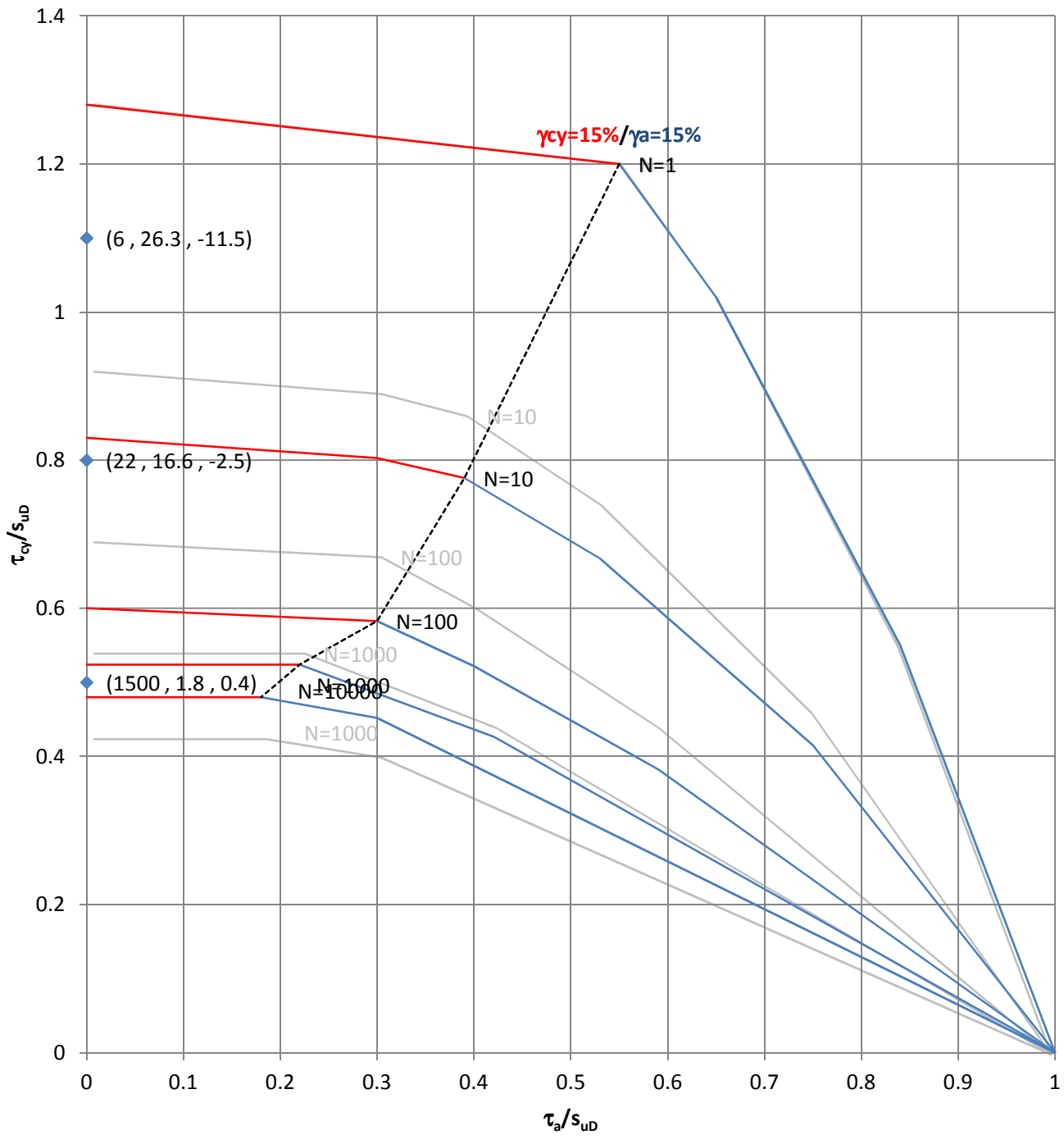
Labels and contours: Average shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on sample BH-G7_P11Q2. Contours are given only for guidance, not enough homogeneous data being collected.	Preliminary	Draft	Final
Client Name / Ref	**0**			**JG**	
Vessel	**MV Ocean Discovery**			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3d - CYCLIC DSS TESTING in CLAY
Normalised average and cyclic stress

Unit 3 - BH-K16



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Drammen Clay reference (OCR=1), Red: Cyclic strain failure, Blue: Average strain failure

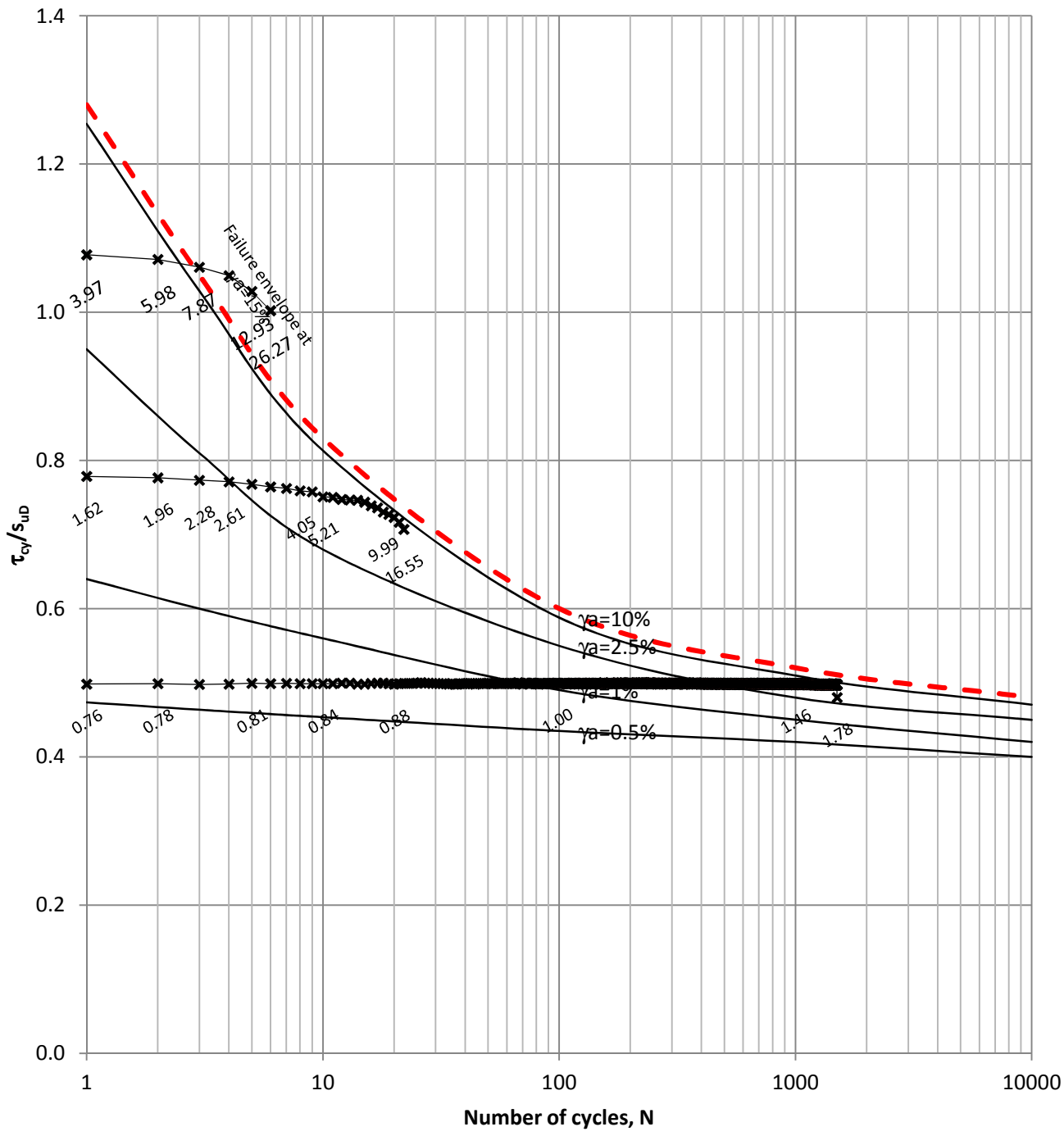
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on samples BH - K16 -P17Q1-48.455. Reference contours from Andersen 2004.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3e - CYCLIC DSS TESTING in CLAY

Cyclic shear strain contours for τ_a/s_{uD} = 0.0

Unit 3 - BH-K16



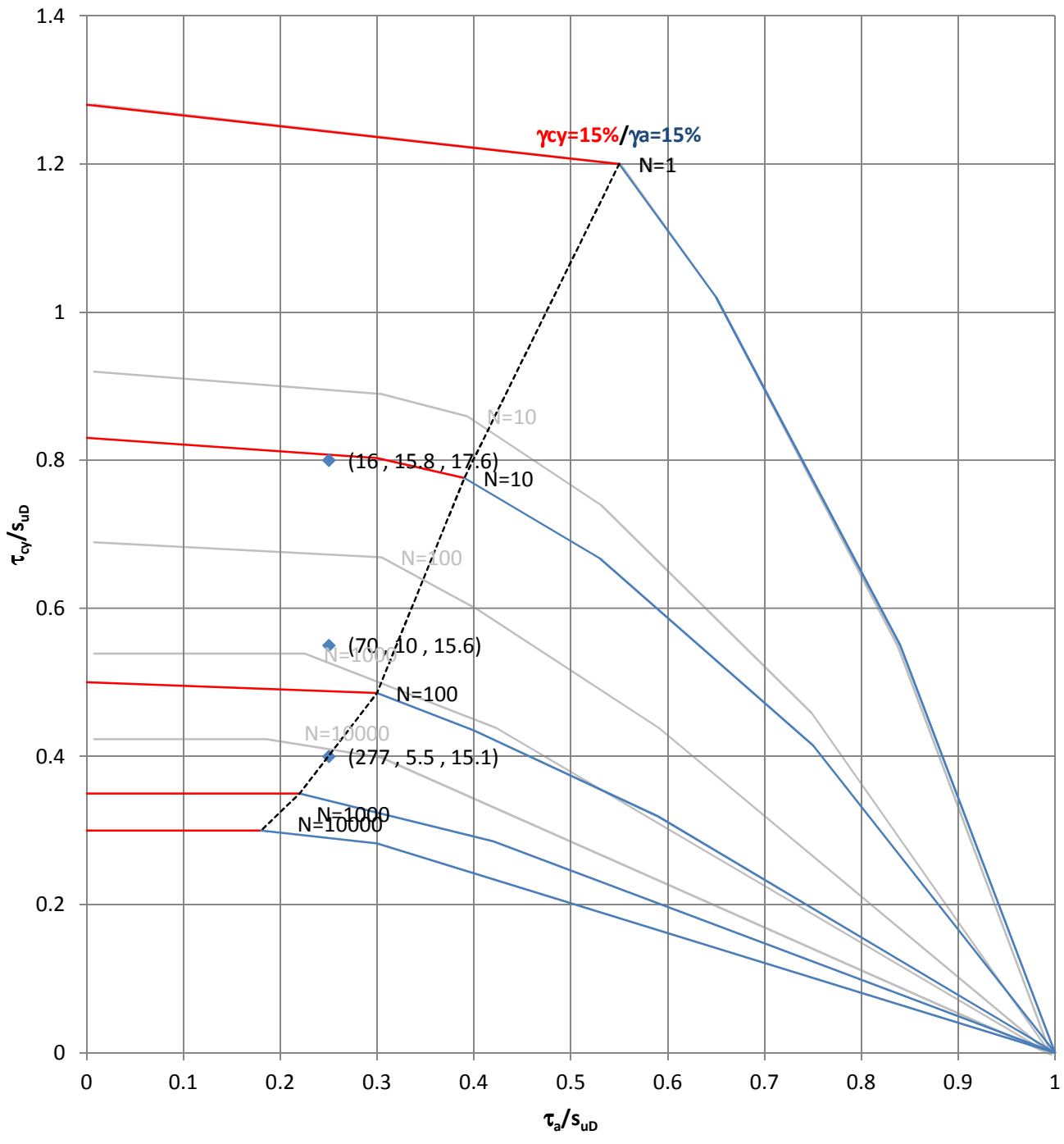
Labels and contours: Cyclic shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on boreholes BH-K16. Specimens tested are from P17-Q1.	Preliminary	Draft	Final
Client Name / Ref	**0**			**JG**	
Vessel	**MV Ocean Discovery**			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3f - CYCLIC DSS TESTING in CLAY
Normalised average and cyclic stress

Unit 3 - BH-H10



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Drammen Clay reference (OCR=1), Red: Cyclic strain failure, Blue: Average strain failure

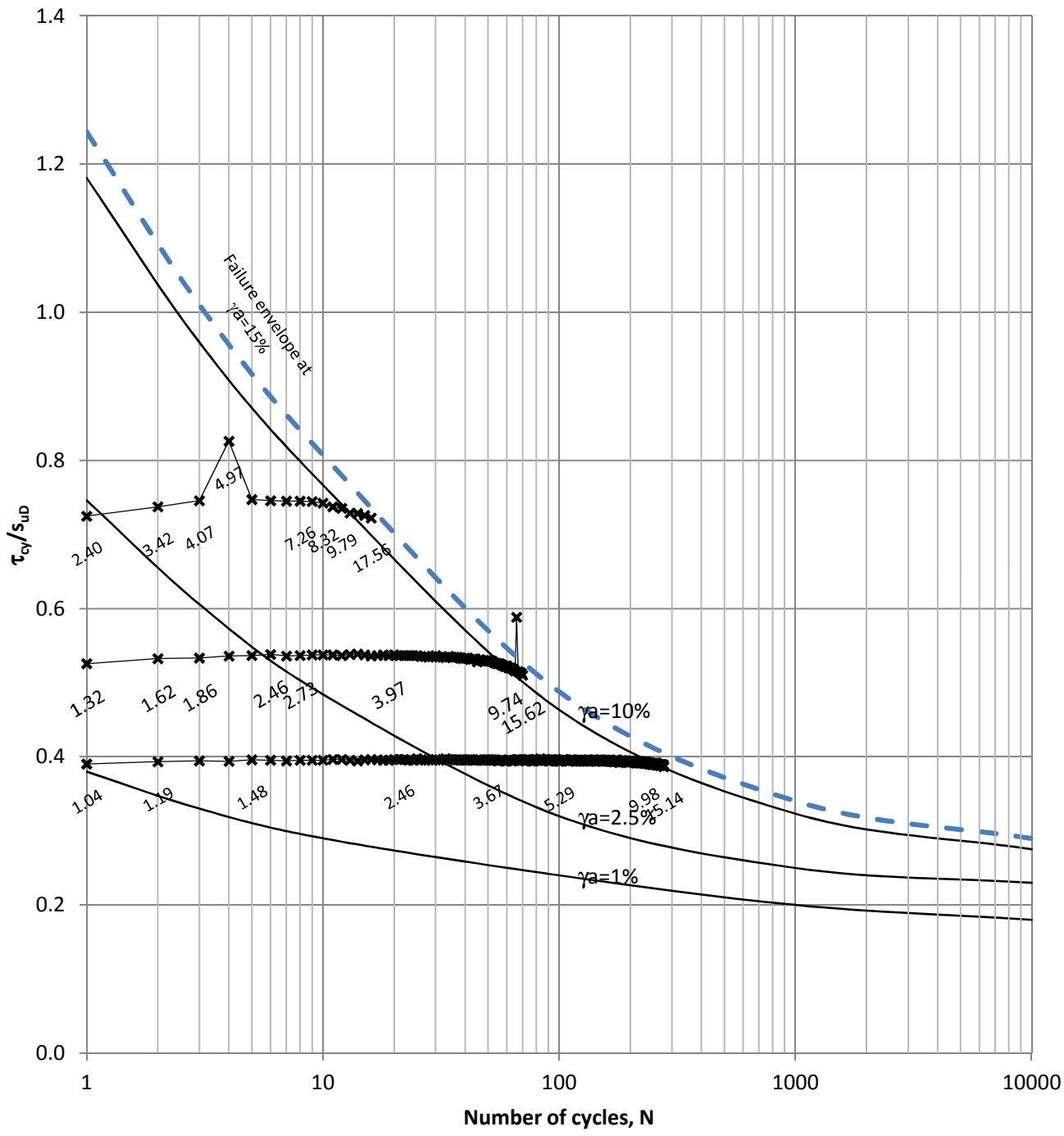
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on samples BH - H10-P9Q2-26.565. Reference contours from Andersen 2004.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3g - CYCLIC DSS TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.25

Unit 3 - BH-H10



Labels and contours: Average shear strain

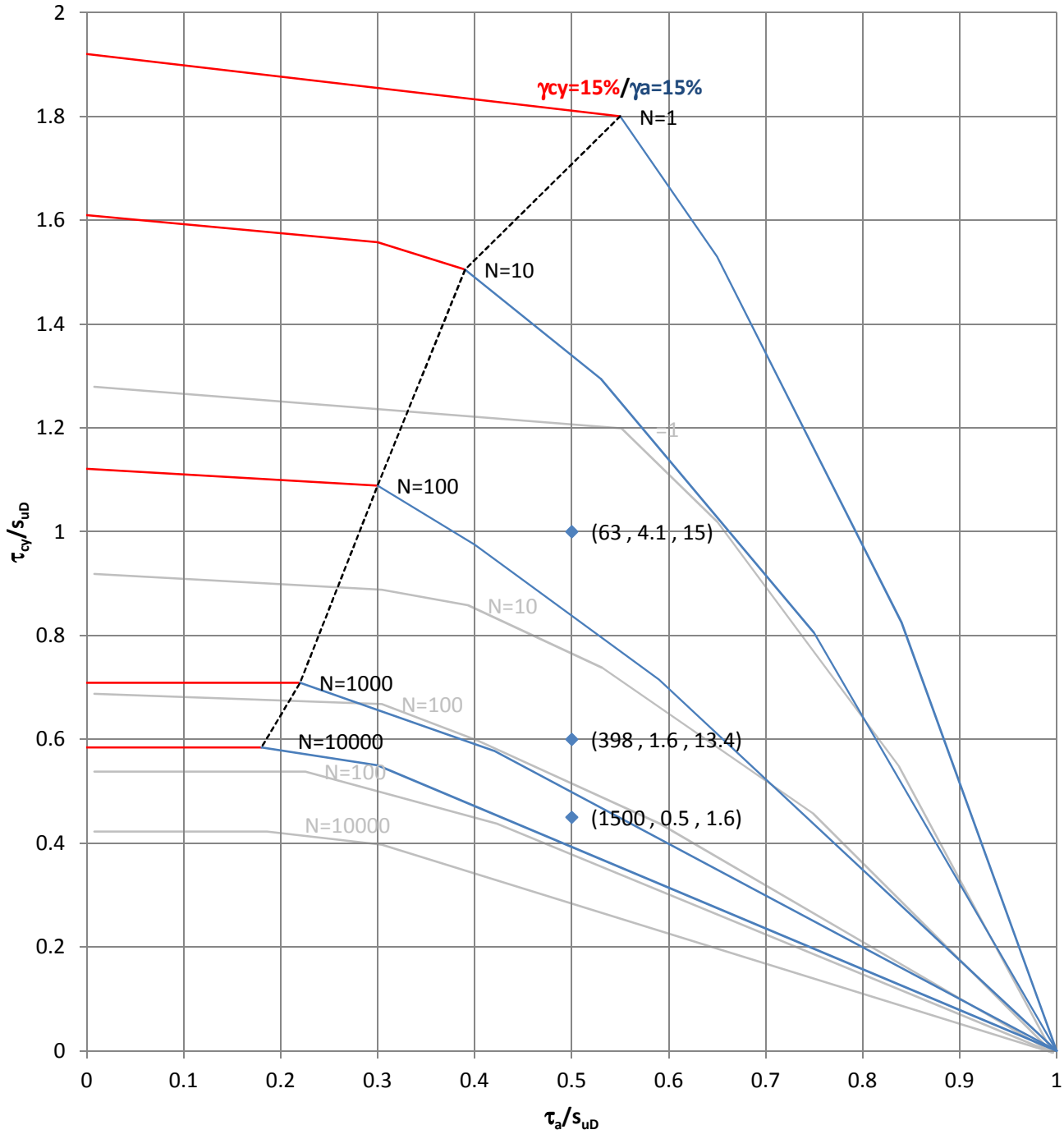
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on boreholes BH-K16. Specimens tested are from P17-Q1.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3h - CYCLIC DSS TESTING in CLAY

Normalised average and cyclic stress

Unit 3 - BH-G17A



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Drammen Clay reference (OCR=1), Red: Cyclic strain failure, Blue: Average strain failure

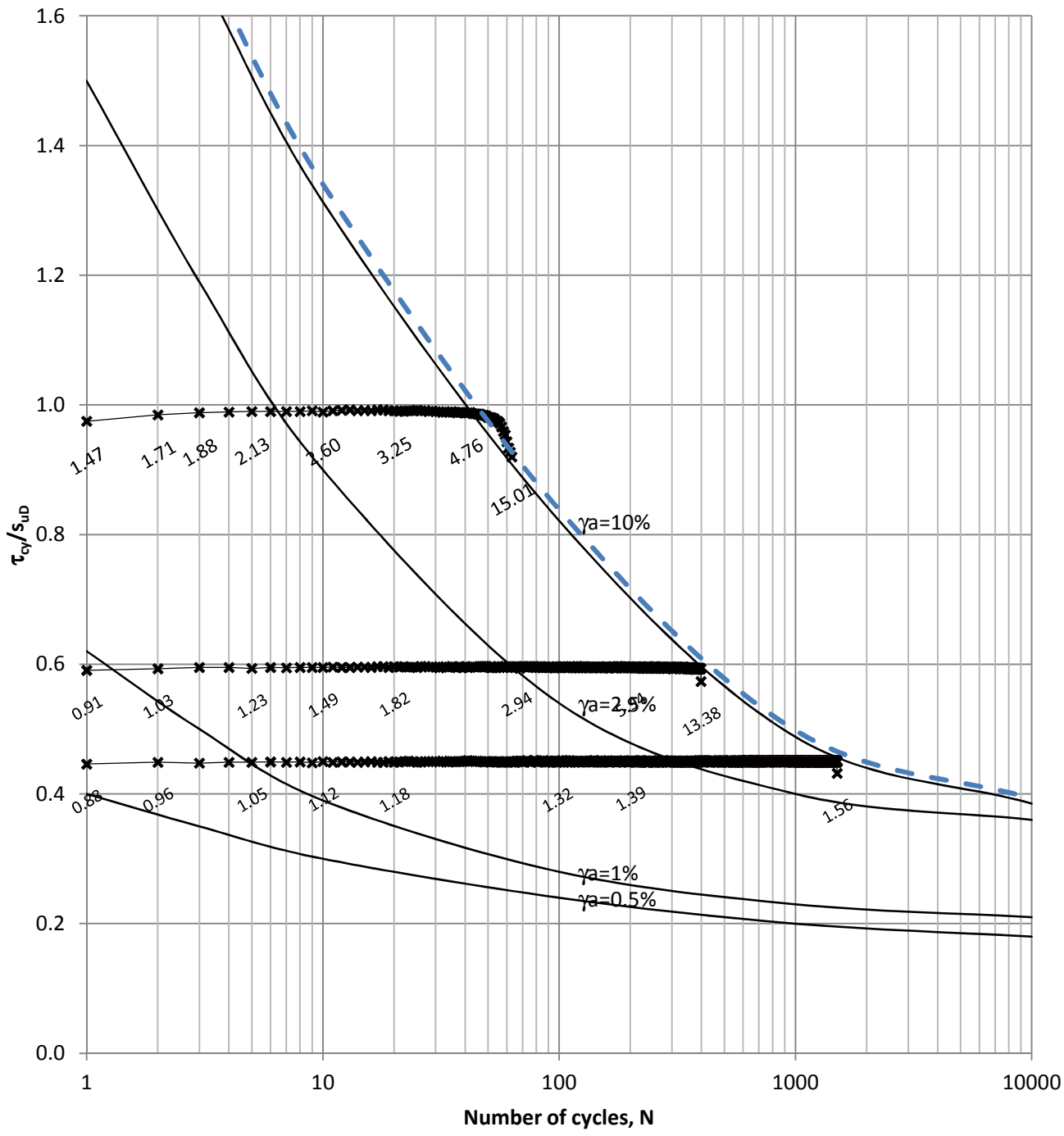
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH-G17-P1Q2. Reference contours from Andersen 2004.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-3i - CYCLIC DSS TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.5

Unit 3 - BH-G17A



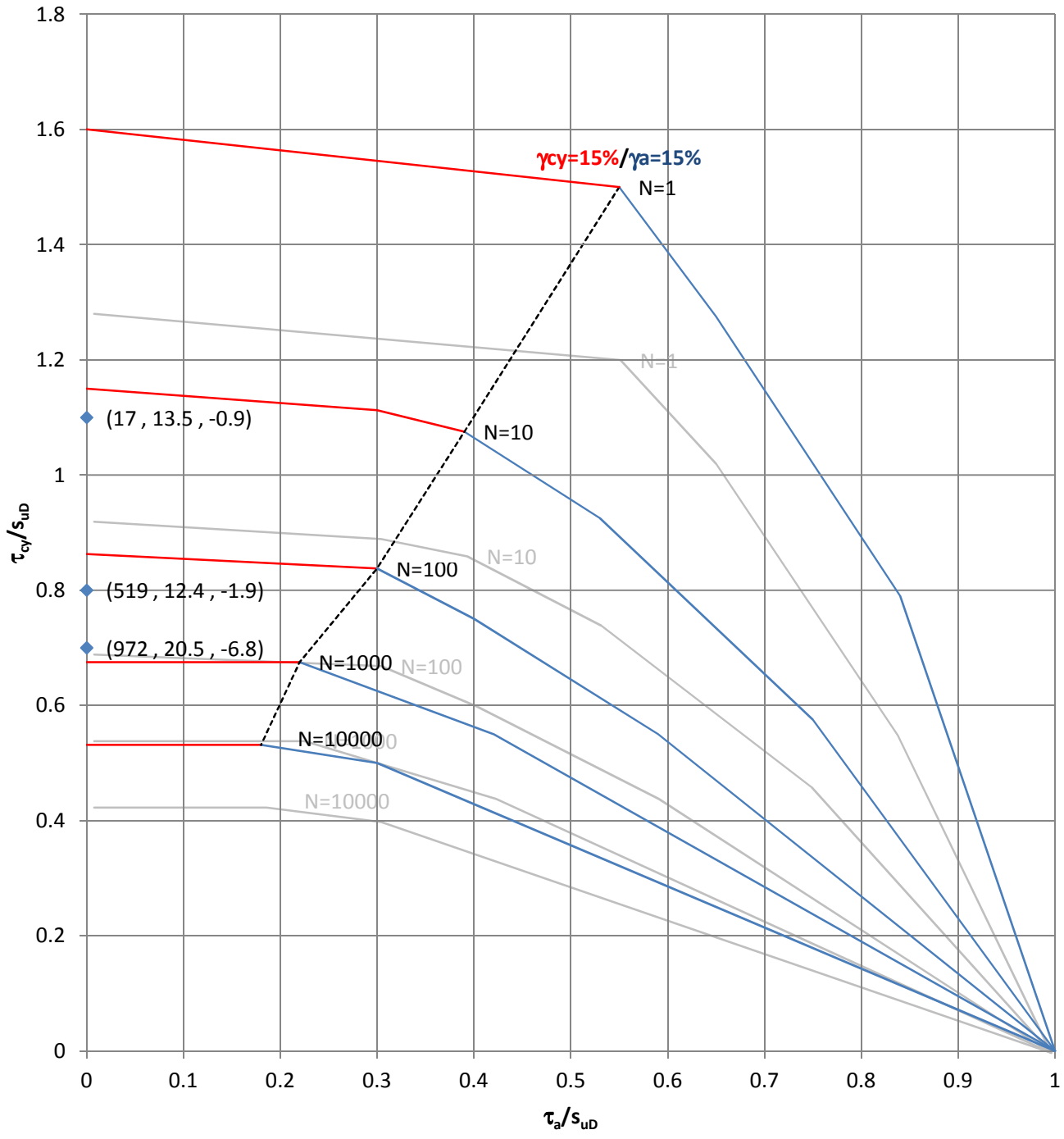
Labels and contours: Average shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on boreholes BH-G17A. Specimens tested are from P1-Q2.	Preliminary	Draft	Final
Client Name / Ref	**0**			**JG**	
Vessel	**MV Ocean Discovery**			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-4a - CYCLIC DSS TESTING in CLAY
Normalised average and cyclic stress

Unit 4 - BH-K16



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Drammen Clay reference, Red: Cyclic strain failure, Blue: Average strain failure

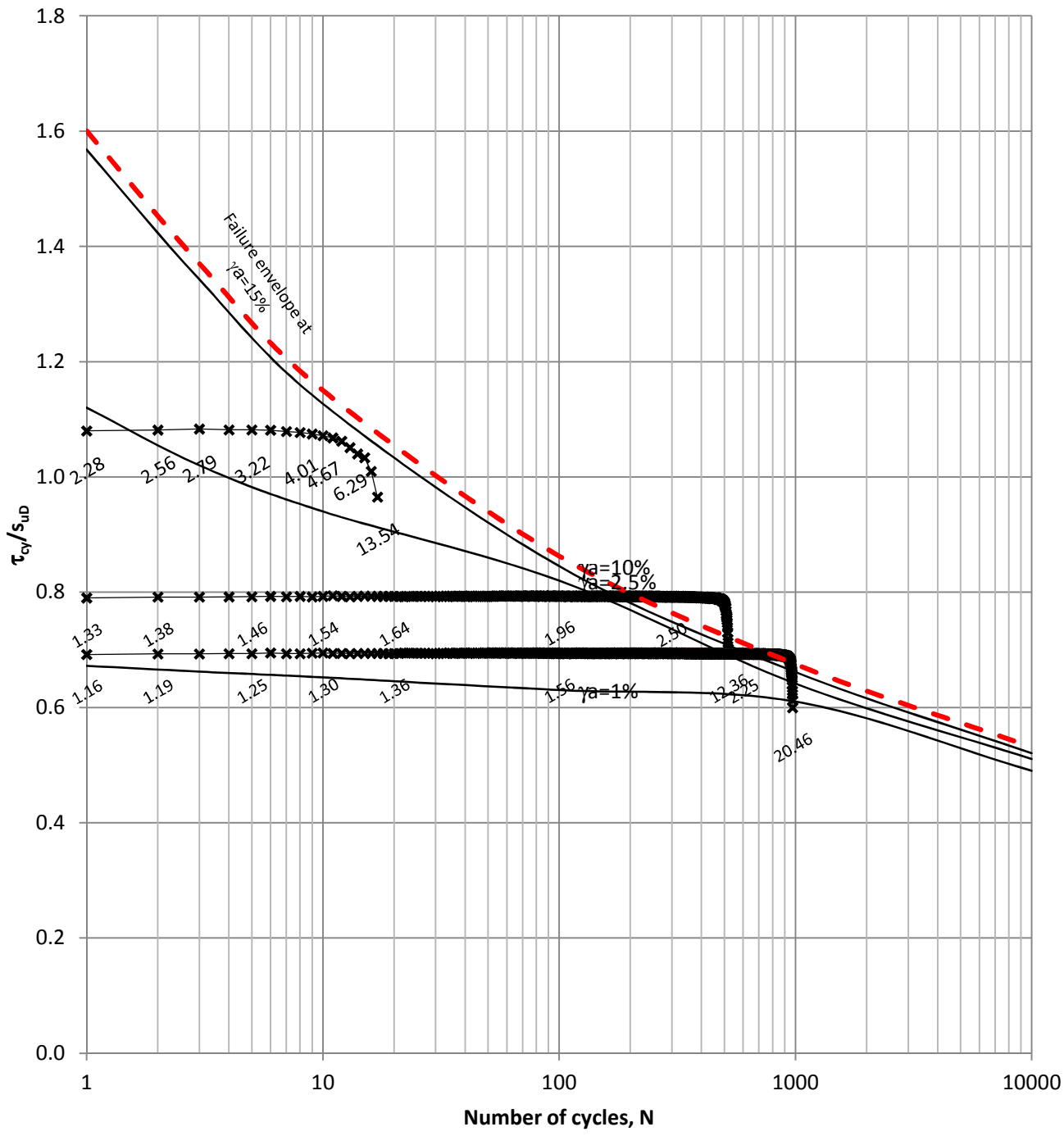
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH-K16-P22Q1. Reference contours from Andersen 2004.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-4b - CYCLIC DSS TESTING in CLAY

Cyclic shear strain contours for τ_a/s_{uD} = 0.0

Unit 4 - BH-K16



Labels and contours: Cyclic shear strain

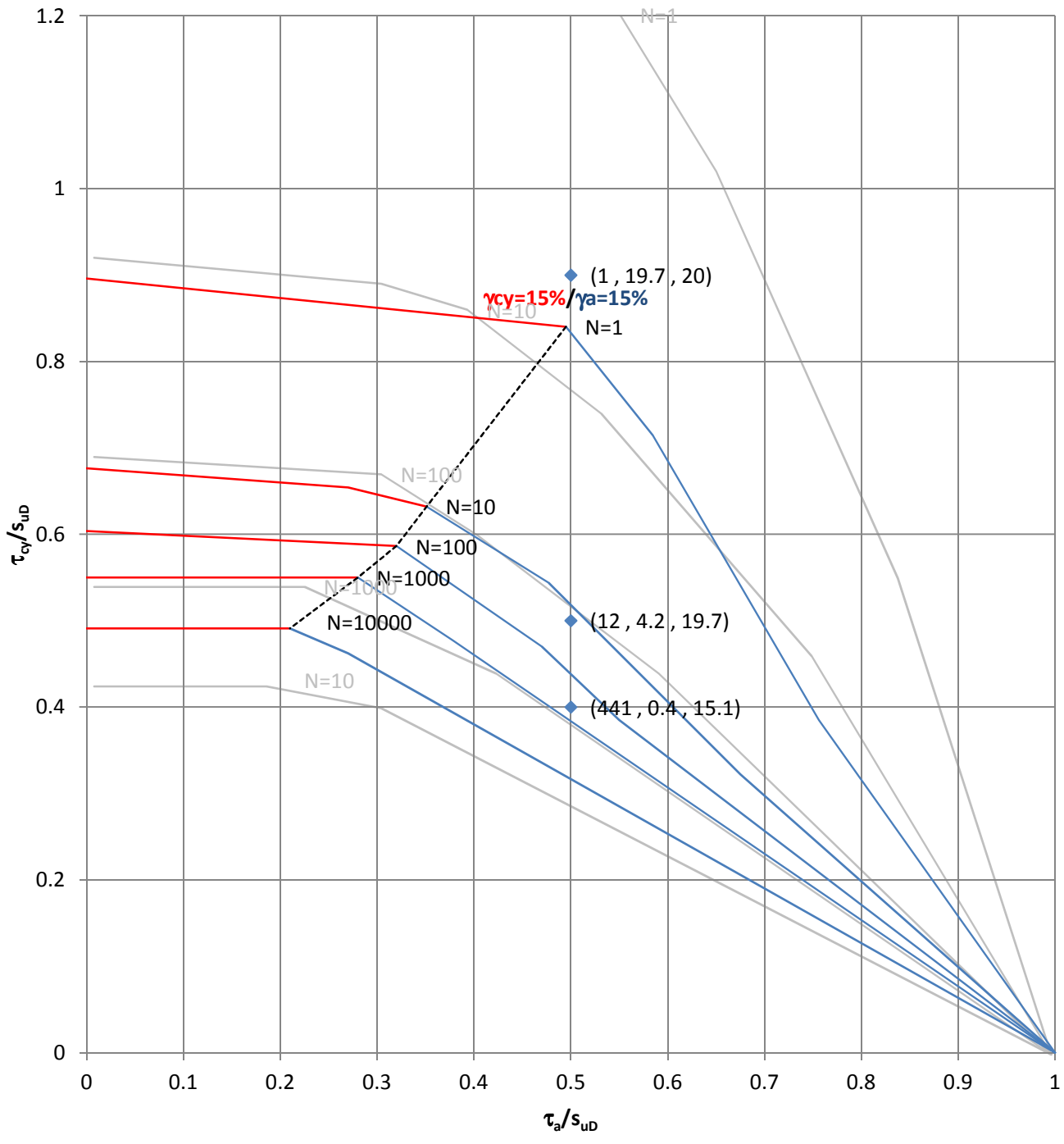
Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on boreholes BH-K16. Specimens tested are from P22-Q1.	Preliminary	Draft	Final
Client Name / Ref	**0**			**JG**	
Vessel	**MV Ocean Discovery**			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-4c - CYCLIC DSS TESTING in CLAY

Normalised average and cyclic stress

Unit 4 - BH-I21B



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Drammen Clay reference, Red: Cyclic strain failure, Blue: Average strain failure

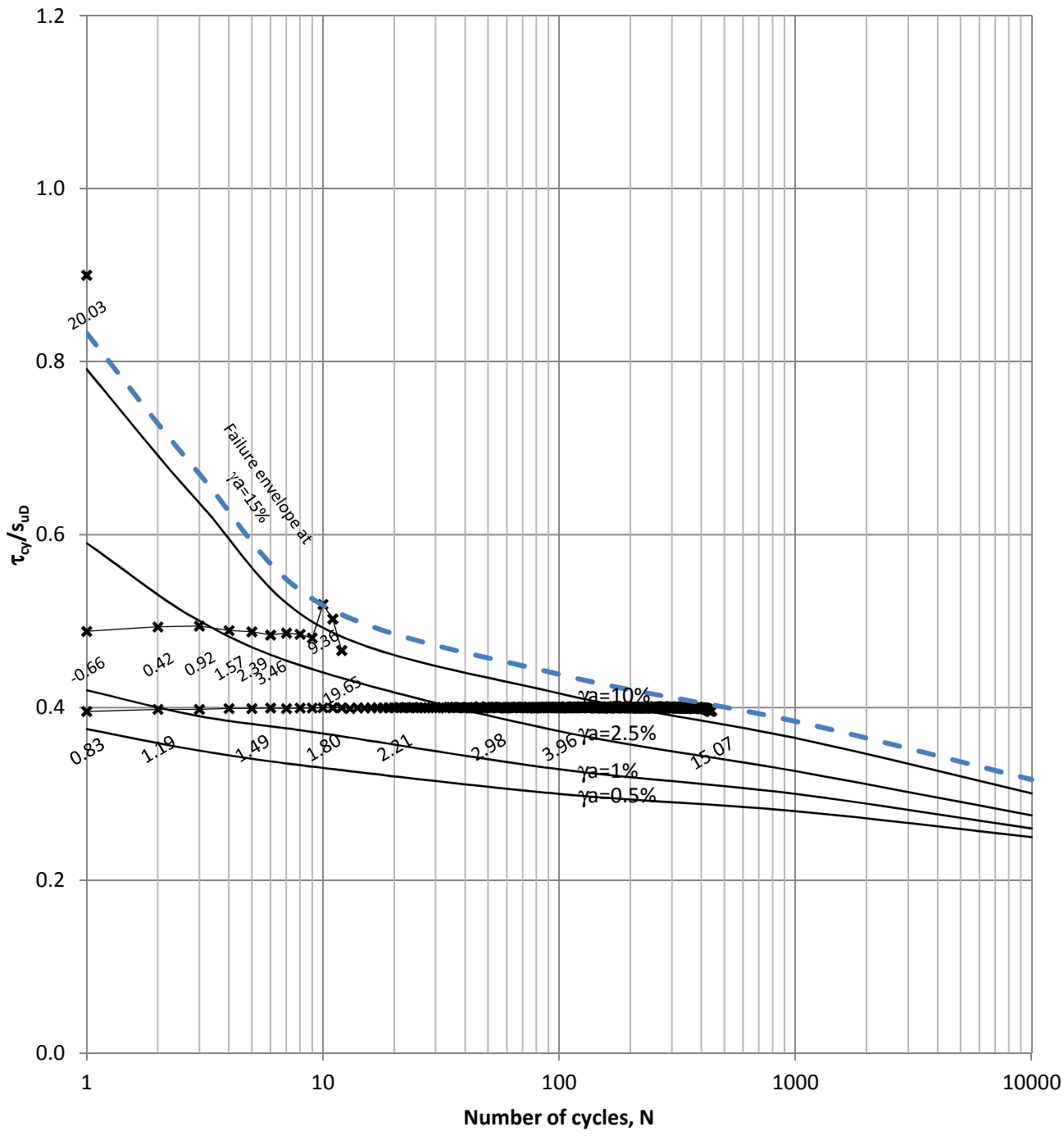
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH-I21B-P10Q1. Reference contours from Andersen 2004.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-4d - CYCLIC DSS TESTING in CLAY

Average shear strain contours for τ_a/s_{uD} = 0.5

Unit 4 - BH-I21B



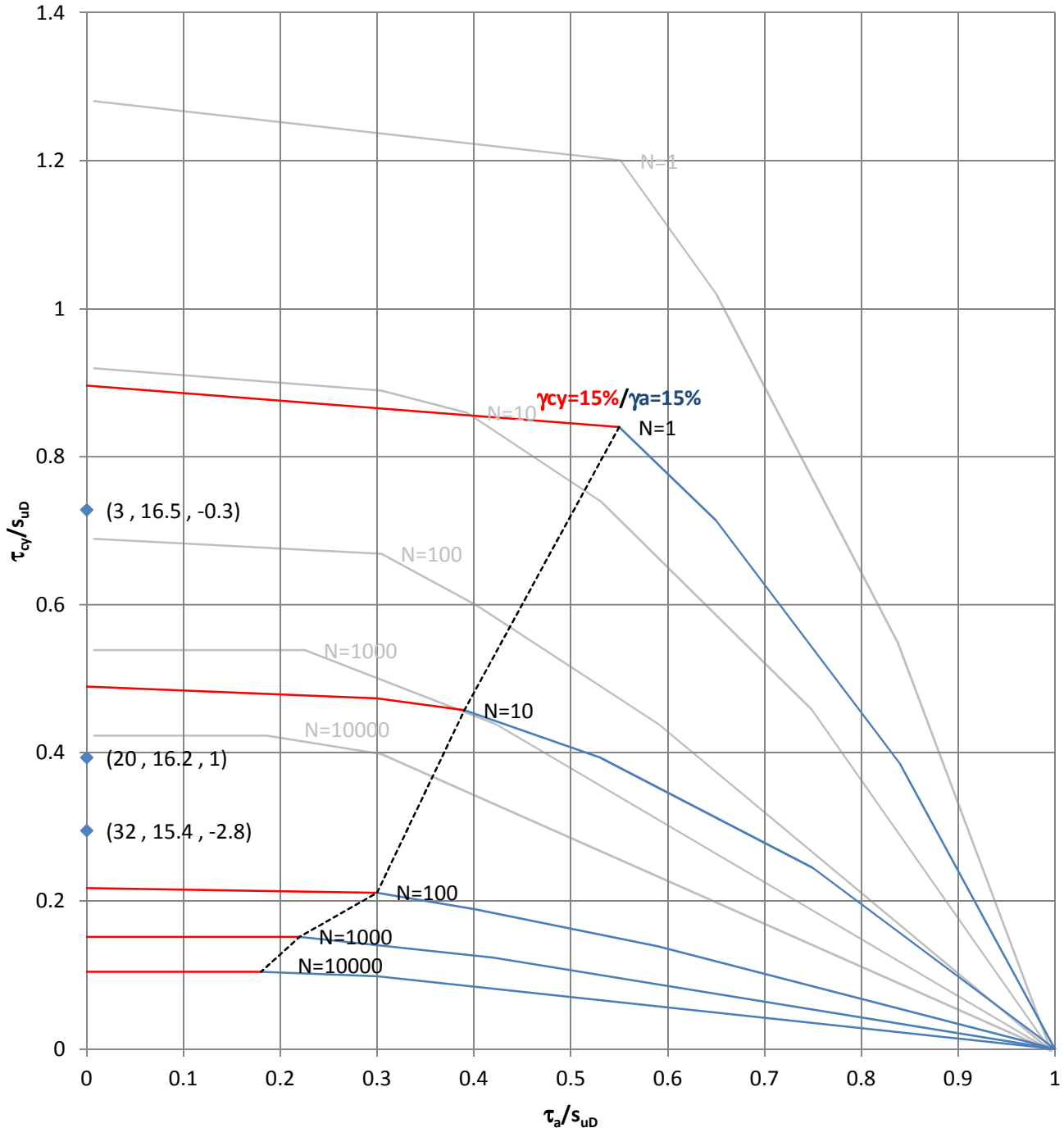
Labels and contours: Average shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on boreholes BH-I21B. Specimens tested are from P10-Q1.	Preliminary	Draft	Final
Client Name / Ref	**0**			**JG**	
Vessel	**MV Ocean Discovery**			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-6a - CYCLIC DSS TESTING in CLAY
Normalised average and cyclic stress

Unit 6



Key legend for failure points: "Number of cycles, cyclic strain, average strain" at failure

Grey: Drammen Clay reference, Red: Cyclic strain failure, Blue: Average strain failure

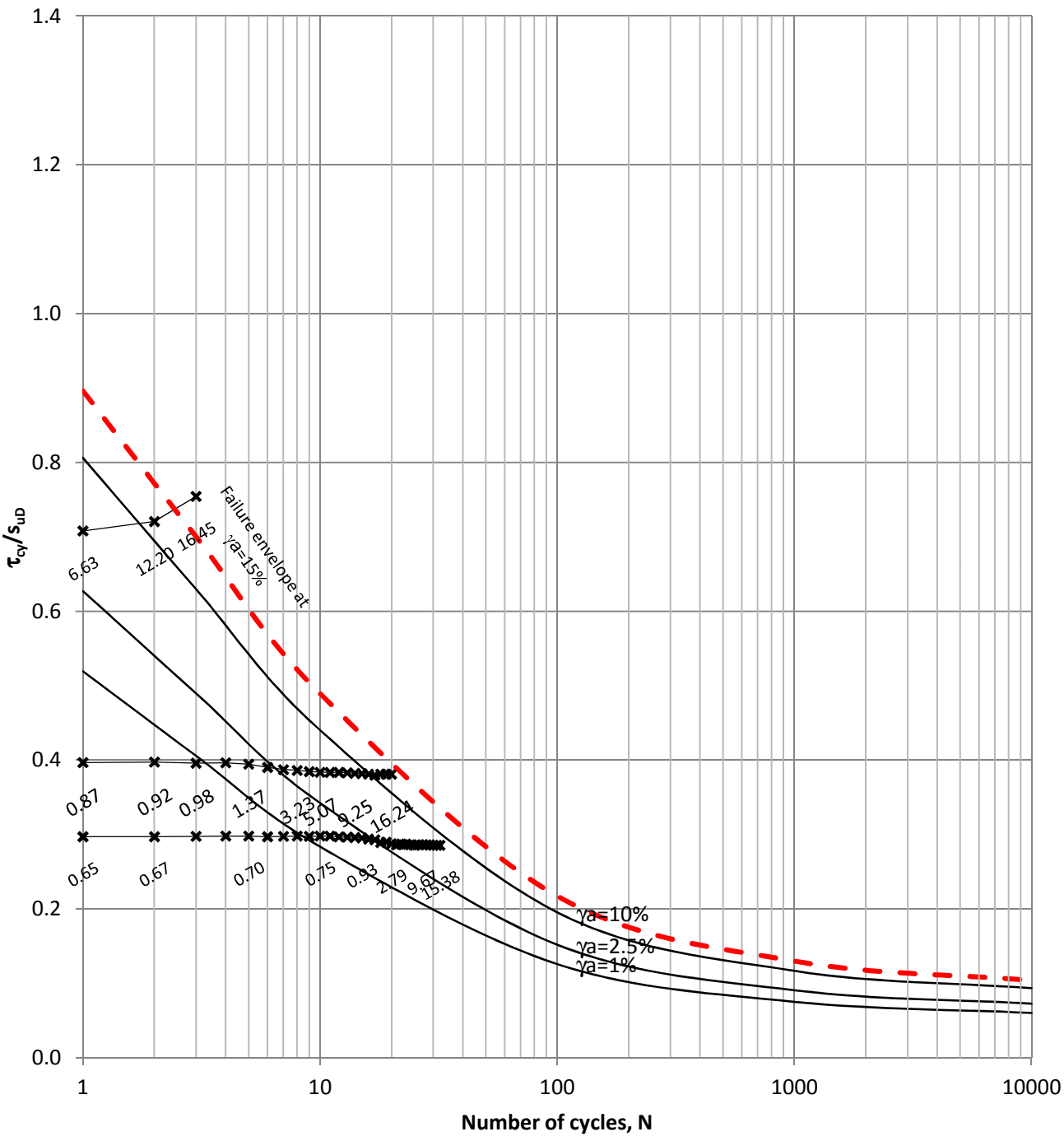
Area	Maryland USA	Comments:	QC Status		
Contract	10451	Cyclic tests results on sample BH-H10-P16Q2. Reference contours from Andersen 2004.	Preliminary	Draft	Final
Client Name / Ref	0			JG	
Vessel	MV Ocean Discovery			16/02/2016	

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area

Fig. 6.2-6b - CYCLIC DSS TESTING in CLAY

Cyclic shear strain contours for τ_a/s_{uD} = 0.0

Unit 6



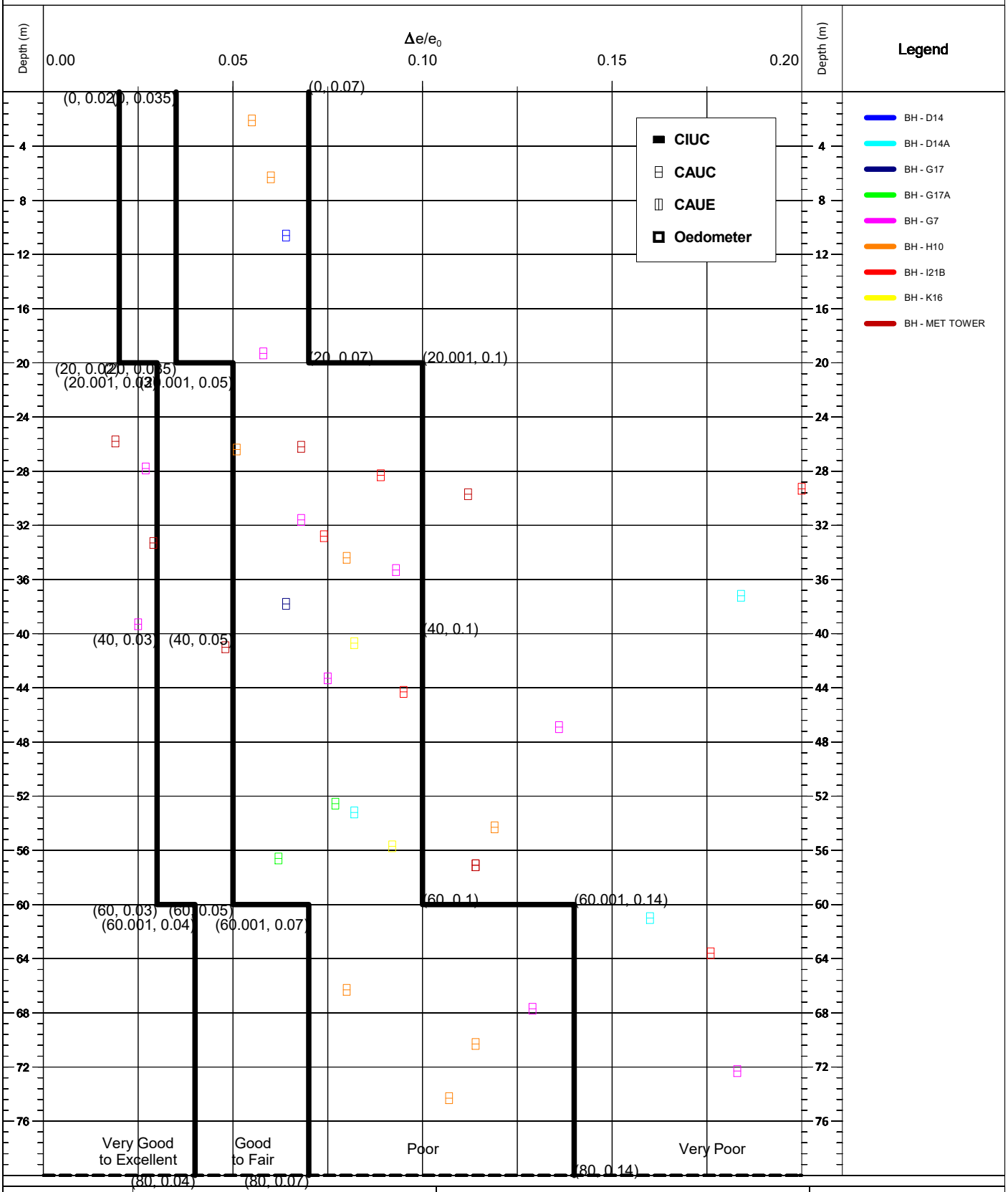
Labels and contours: Cyclic shear strain

Area	**Maryland USA**	**Comments:**	QC Status		
Contract	**10451**	Cyclic tests results on boreholes BH-H10. Specimens tested are from P16-Q2.	Preliminary	Draft	Final
Client Name / Ref	**0**				
Vessel	**MV Ocean Discovery**			**JG** 16/02/2016	

APPENDIX 7

7.1 Sample quality assessment

Geotechnical Marine Survey Investigation for the Maryland Wind Energy Area
SAMPLE QUALITY PROFILE



Area	**Maryland USA**
Contract	**10451**
Client Name/Ref	**US Wind Inc./ REF11449**
Vessel	**MV Ocean Discovery**
CRS	**GRS 80 UTM ZONE 18 N (75 W)**

Comments: Lunne, 2007. Sample quality criteria are based on OCR values, which evaluation have been limited here.

QC Status		
Preliminary	Draft	Final
SMc 28/09/2015	**JG** 17/02/2016	