TULLOCH
ENGINEERING

GEOTECHNICAL REPORT

Nation Rise Wind Farm

Overhead and Underground Collection System

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1 INTRODUCTION AND SCOPE

Tulloch Engineering Inc. (Tulloch) was retained by EDP Renewables North America LLP (EDPR) to conduct geotechnical site investigations for the proposed Nation Rise Wind Project located in the Township of North Stormont, United Counties of Stormont, Dundas, and Glengarry, Ontario, Canada. The site location is shown in Appendix A.

A geotechnical program was undertaken at the Nation Rise Project site to investigate the subsurface conditions for three proposed utility crossings at the South Nation River, Payne River and a railway line located at the southwest end of the project area. This report provides factual data from the geotechnical drilling, and the results of soil and rock laboratory testing, electrical resistivity testing and thermal resistivity testing. The report provides soil parameters and recommendations for the design and construction of the underground power lines crossing under the rivers and railway line.

2 SITE DESCRIPTION AND GEOLOGY

Based on the Surficial Geology of Southern Ontario Maps as published by the Ontario Geological Survey (i.e. OGS Map 2140A), the site surficial geology varies from exposed bedrock, to glacial till and fine-textured glaciomarine deposits. The bedrock consists of limestone, dolomite, shale, arkose, and sandstone of the Ottawa Group (OGS 2011). The bedrock is exposed (i.e. outcropping) mainly along the western boundaries of the project in an area roughly bounded by Crysler, Cannamore and Connaught, ON. Bedrock is also locally exposed east of the South Nation River near the Payne Crossing and along Berwick Rd. The glaciomarine deposits primarily consist of silt and clay, with minor sand and gravel; These sediments are massive to well laminated in structure and are found mainly along the South Nation River (OGS 2010) and its tributaries. The glacial till consists of poorly sorted clay, silt, sand and gravel with occasional cobbles and boulders.

3 SITE INVESTIGATIONS AND METHODOLOGY

3.1 Drilling Investigations

The geotechnical investigations were completed from August 27th to September 4th, 2018. The investigations consisted of advancing six (6) boreholes to 9.1 m below the existing ground surface. Four (4) boreholes were drilled at the river crossings; South Nation River and Payne River. Two (2) boreholes were drilled at the location of the railway line crossing at the South West end of the project site. The boreholes were advanced using a CME 55 track-mounted drill rig equipped with 200 mm diameter continuous flight hollow stem augers and standard soil sampling equipment. The rig was carried out by Marathon Drilling Co. Ltd.

Soil samples were obtained with a 51 mm outside diameter split spoon sampler in conjunction with Standard Penetration Tests (SPT) continuously in the upper 3.0 m, and at 1.52 m intervals thereafter. The corresponding SPT 'N' values were recorded by a TULLOCH representative. Field vane tests (ATSM D2573) were also conducted in all boreholes using a standard 125 mm MTO (Ministry of Transportation of Ontario) vane to assess the undrained shear strength of the cohesive soil encountered at the sites. Thin-walled Shelby tube samples were retrieved in accordance with ATSM Standard D1587 to collect undisturbed samples of cohesive soils in the boreholes. The bedrock was cored using an NQ core barrel and upon the completion of the drilling, the boreholes were backfilled and sealed with bentonite pellets.

The drilling and soil and rock core sampling were completed under the full-time supervision of a Tulloch representative, who logged the drilling operations and identified the soil and rock samples as they were retrieved. The recovered soil samples were sealed in plastic bags or core boxes and transported to TULLOCH's Geotechnical Laboratory for detailed examination and testing. All samples will be stored in our laboratory for six (6) months and then disposed of unless directed otherwise.

3.2 Laboratory Testing

Table 3-1 summarizes the soil and rock laboratory tests conducted for this geotechnical investigation program and the corresponding ASTM standards. Detailed laboratory test reports are attached in Appendix D.

Table 3-1: Summary of Soil/Rock Laboratory Testing Program

Item No.	Test	Number of Tests	ASTM Standard
1	Sieve Analysis	3	ASTM D422
2	Hydrometer Analysis	15	ASTM D422
3	Atterberg Limits	15	ASTM D4318
4	Moisture Content	42	ASTM D2216
6	Unconfined Compressive Strength on Rock	6	ASTM D2166

4 SUBSURFACE CONDITIONS

4.1 General

Detailed subsurface profiles at each of the boreholes are summarized in the borehole logs attached in Appendix C. The Unified Soil Classification System (USCS) was used for soil classification. Additionally, the soil boundaries indicated on the borehole logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones to support geotechnical design and they should not be interpreted as exact planes of geological change. Third parties relying on the data presented in the logs should account for the approximate nature of these boundaries during design.

4.2 Rail Crossings

Table 4-1 summarizes the stratigraphy at the rail crossing location. At this crossing, the depth to bedrock varies from 6.20 meters below the ground surface (mbgs) to 6.30 mbgs. The overburden soils overlying bedrock are comprised of a layer of Clay (CL) and/or Silt (ML) overlying a find-grained Silt to Clayey Silt Till (CL or ML). Atterberg limits test results for samples collected at the rail crossings are summarized in Table 4-2 below. The grain size distribution test results are summarized in Table 4-3. The bedrock is generally of fair to good rock mass quality; detailed rock properties are discussed in Section 4.4.

Table 4-1: Summary of Soil and Rock Parameters

Borehole	Bedrock			Overburden Soil			
	Depth (m)	RQD	Rock Mass Quality	Type[1]	'N' Values	W_N (%)	Consistency
RAIL-01A	6.30	48-100	Poor – Excellent	CL over Till (ML)	0-49	6-38	v. soft to v. stiff
RAIL-01B	6.20	81-96	Good to Excellent	Silt (ML) over CL over Till (CL)	3-50	6-34	Firm

Note: [1]CL - Intermediate Plasticity Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silty Till

Table 4-2: Atterberg Limit Results

Borehole	Sample	Depth (m)	Moisture	Liquid Limit	Plastic Limit	Plasticity Index
RAIL-01A	SS3	1.52	37.2	70	28	42
RAIL-01A	SS5	3.05	37.2	36	21	15
RAIL-01B	SS3	1.52	28.8	59	25	34
RAIL-01B	SS5	3.05	24.6	37	20	17

Table 4-3: Grainsize Distribution Results

Borehole	Sample	Material	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
RAIL-01A	SS3	Clay (CL)	1.52	0	0.9	12.6	86.5
RAIL-01A	SS5	Clay (CL)	3.05	0	1.2	22.7	76.1
RAIL-01A	SS7	Silty Till (ML)	6.10	16.4	26.9	56.7	
RAIL-01B	SS3	Clay (CL)	1.52	0	3.6	18.2	78.2
RAIL-01B	SS5	Clay (CL)	3.05	0	0.3	26.7	73

4.3 River Crossings

Table 4-4 summarizes the stratigraphy the South Nation River (RC-01) and Payne River (RC-02) crossing locations. At the South Nation River site, the depth to bedrock varies from 4.95 meters below ground surface (mbgs) to 6.85 mbgs. At the Payne River crossing site, the bedrock depth varies from 6.60 mbgs to 7.80 mbgs. The overburden soils overlying bedrock at the South Nation Crossing is comprised of a thin veneer of intermediate plasticity Clay (CI) over Granular Till (SG) and Silt Till (ML). At the Payne River, the overburden is comprised of a Granular Till (SG) that is interbedded with a layer of Silt Till (ML) at RC-02A. At RC-02B, the overburden is comprised of Clay (CL) over Silt and Clay Till (ML/CL) which transitions to a Silt/Granular Till (ML/SG) overlying bedrock. The bedrock is generally of very poor to good rock mass quality; the detailed rock properties are discussed in Section 4.4.

Table 4-4: Summary of Soil and Rock Parameters

Borehole	Bedrock			Overburden Soil			
	Depth (m)	RQD	Rock Mass Quality	Type[1]	'N' Values	W_N (%)	Consistency
RC-01A	4.95	21-81	Very poor to Good	CL/ML over SG over Till (ML)	8 -133	7-23	Stiff to Hard
RC-01B	6.85	19-94	Very poor to Excellent	CL over SG	6-24	5-37	Firm to Very Stiff
RC-02A	6.60	63-66	Fair	SG over Till (ML) over SG	2-55	5-24	Firm to Hard
RC-02B	7.80	0-78	Very Poor to Good	CL over ML/CL over Till (ML)/SG	3-62	4-35	Firm to Hard

Note: [1]CL - Intermediate Plasticity Clay; ML – Silt; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) Silty Till.

Table 4-5: Atterberg Limit Results

Borehole	Sample	Depth (m)	Moisture	Liquid Limit	Plastic Limit	Plasticity Index
RC-01A	SS3	1.52	20.7	37	19	18
RC-01A	SS6	4.57	7.1	17	11	6
RC-01B	SS4	2.29	29.4	50	26	24
RC-01B	SS7	6.10	6.3	14	11	3
RC-02A	SS5	3.05	22.3	30	19	11
RC-02B	SS3	1.52	34.7	50	30	20
RC-02B	SS7	6.10	7	19	14	5
RC-02B	SS8	7.62	6.1	18	13	5

Table 4-6: Grainsize Distribution Results

Borehole	Sample	Material	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
RC-01A	SS3	Clay (CL)/Silt (ML)	1.52	0	2.5	46.7	50.8
RC-01A	SS5	Till (SG)	3.05	28	34	38	
RC-01A	SS6	Till (ML)	4.57	11.7	17.7	47.7	22.9
RC-01B	SS4	Clay (CL)	2.29	0	0.7	15.9	83.3
RC-01B	SS7	Till (SG)	6.10	37.4	25.9	30.6	6.1
RC-02A	SS2	Sand (SW)	0.76	11.3	71.8	16.9	
RC-02A	SS5	Clayey Silt (ML)	3.05	0.3	3.4	59.4	36.9
RC-02A	SS6	Till (ML)	4.57	5.7	28.2	50.3	15.8
RC-02A	SS7	Gravel Till	6.10	25.5	32.8	41.7	
RC-02B	SS3	Clay (CL)	1.52	0	2.9	17	80.1
RC-02B	SS5	Silt (ML)	3.05	0.3	1	74.6	24.1
RC-02B	SS7	Till (ML)	6.10	25.4	19.5	38.9	16.2
RC-02B	SS8	Till (SG)	7.62	51.4	30.6	12.5	5.5

4.4 Bedrock Properties

The bedrock at the site consists of grey to black, thinly bedded, fine grained Shaly Limestone. Based on the rock core logs in Appendix C, the Rock Quality Designation (RQD) values vary significantly but are generally between 19-81% in the upper meter of the bedrock and between 21-100% below that. The intact uniaxial compressive strength

(UCS) of the bedrock is in the range of 45 MPa to 92 MPa with an average value of 64 MPa based on the test results listed in Table 4-7.

TULLOCH also conducted falling head tests in the bedrock to assess bedrock hydraulic conductivity. The hydraulic conductivity was measured in the upper 3 m of the bedrock with RQD ranging from 21 to 100. A higher RQD and lower hydraulic conductivity are expected with an increase in bedrock depth. Table 4-8 summarizes the falling head test results, refer to Appendix F for further details.

Table 4-7: Uniaxial Compressive Strength (UCS) Tests on Rock

Sample	Measured Peak Load (kN)	Sample Diameter (mm)	Intact Compressive Strength σ_c(MPa)
BH-RAIL-1A	97.97	47.45	55.3
BH-RC-1B	80.07	47.48	45.2
BH-RC-1A	128.11	47.32	72.8
BH-RC-1A	110.7	47.5	62.5
BH-RC-1B	97.86	47.45	55.3
BH-RC-2A	162.80	47.48	92
BH-RC-2B	97.42	47.54	54.9
BH-RC-2B	130.8	47.5	73.8

Table 4-8: Hydraulic Conductivity Test results for rail crossing boreholes

Borehole	K (cm/sec)
BH-RC-1A	2.7×10^{-4}
BH-RC-2A	5.5×10^{-4}
BH-RC-1B	4.8×10^{-4}
BH-RAIL-1A	6×10^{-4}
BH-RAIL-1B	1.8×10^{-3}

4.5 Electrical Resistivity

Geophysics GPR International (GPR) was retained by TULLOCH as a sub-consultant to complete soil electrical resistivity testing for the Nation Rise wind farm project. Resistivity soundings were conducted between September 14th and September 17th, 2018. In total twenty-eight (28) electrical resistivity soundings were performed at fourteen (14) locations with two (2) soundings per location throughout the site. The site plan in Appendix A shows the locations of each site where electrical resistivity soundings were conducted. Upon completion of the field work, one-dimensional inversion models were generated from the sounding results.

4.6 Thermal Resistivity

Geotherm USA (Geotherm) was retained by TULLOCH as a sub-consultant to complete soil thermal resistivity testing. In-situ testing was completed at ten (10) test pit locations on May 23rd, 2018. Locations were provided by EDP, and work was supervised by a TULLOCH technician. With the usage of a backhoe 1.2m deep test-pits were excavated and resistivity tests were performed at 0.6, 0.9 and 1.2 mbgs. Soil samples were also taken from the test pit locations for further laboratory testing to obtain density, moisture content, and thermal resistivity values.

Based on the Geotherm's testing, it was identified that there were three non-classified visual soil types of similar description and thermal characteristics. Table 4-9 summarizes the thermal conductivity test results. For further details including thermal resistivity design recommendations and thermal dry out curves, please see Appendix F.

Table 4-9: Thermal Resistivity Test Results

Material	Single Point Dry Density (kg/m^3)	Thermal Resistivity (°C-cm/W)
Clay with Silt	1489.72	64
Silty Clay with Gravel	1681.94	56
Sandy Silt with trace Clay, trace Gravel	1649.90	59

4.7 Groundwater Condition

There was no groundwater encountered during the test petting for thermal resistivity testing. Ground water was observed at the river and rail crossing boreholes at a depth of 2.1m to 2.8m below the existing ground surface. Table 4-10 summarizes the water levels observed in each borehole at the time of the investigation.

Table 4-10: Groundwater Measurements

Borehole	Crossing	Elevation (m)	Depth (m)
BH-RC-1A	South Nation River	64.00	2.1
BH-RC-1B	South Nation River	66.32	2.8
BH-RC-2A	Payne River	70.14	2.6
BH-RC-2B	Payne River	70.65	2.6
BH-RAIL-1A	Rail Crossing	70.12	2.1
BH-RAIL-1B	Rail Crossing	70.25	2.2

5 GEOTECHNICAL RECOMMENDATIONS

5.1 Background

Three electrical line crossings are proposed at the South Nation River, Payne River, and railway sites. A conduit will be installed under the river channel and the existing railway embankment and the powerlines will be fed through the conduit. This section provides design parameters and construction recommendations for the proposed work.

5.2 Design Parameters

Based on the site geotechnical investigation, Table 5-1 and Table 5-2 summarize the geotechnical parameters required for the crossing design for the overburden and rock encountered at the Project Site, respectively.

Table 5-1: Geotechnical Parameters for various soil types

Soil Property	Symbol	Unit	Clay	Silt Till	Sand & Gravel Till
Undrained Shear Strength	s_u	kPa	20	N/A	N/A
Effective Internal Friction Angle	ϕ'	degree	28	32	36
Unit Weight,		kN/m^3	18.3	21	21
Earth Pressure Coefficient at Rest,	K_0	-	0.5	0.47	0.41
Passive Lateral Earth Pressure Coefficient,	K_p	-	0.692	3.25	3.85
Active Lateral Earth Pressure Coefficient,	K_a	-	0.45	0.31	0.26
Vertical Modulus of Subgrade Reaction	K	kN/m^3	10,000	60,000	90,000
Drained Young's Modulus,	E'	MPa	5	18	28

Table 5-2: Rock Mass Properties

Rock Property	Symbol	Parameters	Unit
Intact Rock Strength[1]	σ_{ci}	52	MPa
Hoek-Brown Constant	m_i	12	-
Geological Strength Index	GSI	50	-
Rock Mass Compressive Strength[2]	σ_{cm}	8	MPa
Deformation Modulus[3]	E_m	9000	MPa
Poisson's Ratio	v	0.25	-

Rock Property	Symbol	Parameters	Unit
In-situ Rock Mass Initial Stress ratio	k	0.88	-
Friction Angle	ϕ'	38	degree

Notes:[1]- the intact rock strength is estimated from the unconfined compression testing on the rock core considering a coefficient of variation of 23%; [2] $\sigma_{cm} = (0.0034m_i^{0.8})\sigma_c[1.029 + 0.025e^{(-0.1m_i)}]^{GSI}$ (Eberhardt, 2003); [3]- k is in-situ horizontal to vertical stress ratio of rock mass, whthe ich is estimated based on Sheorey Equation (1994), $k = 0.25 + 7E_h\ (0.001 + {}^{1}/_{z})$, where E_h is the average deformation modulus of the rock mass in horizontal directthe ion, z is the depth of the rock mass.

5.3 Horizontal Directional Drilling (HDD)

Based on the geotechnical condition at the site, Horizontal Directional Drilling (HDD) is recommended for the underground collection line conduit at the South Nation River and Payne River crossings.

HDD involves the boring and enlargement of an uncased near horizontal borehole which is kept open through the use of drilling fluids. Upon completion of the boring, a conduit pipe is pulled through the borehole. The process starts by advancing a relatively small diameter hole, a pilot hole, along the proposed path. During the pilot bore, the cutter head at the lead of the drilling string is steered by the drilling, forming a curved boring path. After the pilot hole has been completed, the borehole is enlarged using a reamer either in a single path or multiple passes until the desired bore diameter is achieved. The conduit is typically pulled through the borehole on the final reaming pass. Water based drilling fluids containing bentonite and/or polymers are used during the pilot bore and reaming process to convey cuttings out of the borehole and to stabilize the borehole.

The South Nation River and Payne River crossings are situated in Leda clay deposits. These deposits are susceptible to liquefaction and retrogressive slides. In light of this, and based on the site geotechnical conditions, the HDD installations for the river crossings should be advanced well below the riverbed in the fair to good bedrock under the river channel. There does not appear to be sufficient overburden thickness from the riverbed to the bedrock level to support an HDD installation. Furthermore, attempting to install the crossing in the overburden could trigger riverbank instability.

TULLOCH recommends that a minimum cover depth of 10m from the existing ground surface is maintained (see Dwg 18-4022-C-01 in Appendix A). The maximum pressure of the drilling fluid must be controlled to prevent the drilling fluid from migrating into the river channel or groundwater system during construction. Preventing and mitigation of inadvertent drilling fluid returns should be part of the planning and construction for an

HDD installation. HDD borings are typically done from the ground surface without the use of deep staging excavations, reducing the extent of ground water control required. Launch and receiving pits should be kept to a minimum at this site to avoid triggering instability. The pits should be reviewed by a qualified geotechnical engineer to ensure they have satisfactory safety factors against failure.

It is noted that Glacial Till deposits are present at both sites. Such deposits increase the likelihood of encountering large cobbles and boulders during the installation, which could make the HDD installation difficult. Contractors should plan to mobilize with enough specialized tooling and/or larger HDD drill rigs to penetrate cobbles and boulders. HDD installations should be carried out in accordance with OPSS 450, Construction Specifications for Pipeline and Utility Installation in Soil by Horizontal Directional Drilling.

5.4 Jack and Bore

A Jack and Bore installation was evaluated at the Railway Crossing site. Such an installation would need to conform to Transport Canada TC E-10 Standards Respecting to Pipeline Crossing Under Railways, the American Railway Engineering and Maintenance-of-Way Associates (AREMA) Manual for Railway Engineering and the Ontario Provincial Standard Specification (OPSS) 416 Construction Specification for Pipeline and Utility Installation by Jack and Boring.

However, jacking and receiving pits for this type of installation will need to be 4 to 5m deep. These excavations will penetrate the upper fine-grained soils at the railway site and extend into the granular till deposits overlying permeable bedrock. The excavations will extend significantly below the groundwater table and Contractors will need to actively lower the groundwater prior to excavation by installing pumped well systems. The quantity of water required to be handled during the installation will be significant and will require a permit to take water from the MNRCC. In addition, the jack bored pipe will be installed in dense granular glacial till (Gravel, Sand, and Silt with cobbles and boulders). The presence of cobbles and boulders in this material could present significant problems for jack and bore construction.

Considering the preceding discussion, a jack and bore installation is not recommended. An HDD installation is recommended at the railway crossing.

5.5 Temporary Excavations

The trench excavations for the entry and exit pit should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act (OHSA), Ontario Regulation

213/9, Construction Projects, January 1, 2010, Par III – Excavations, Section 226. Alternatively, the excavation walls should be supported by engineered close shoring, bracing, or trench boxes complying with sections 235 to 239 and 241 under 0. Reg. 231/91, s. 234(1).

Based on the OHSA, the in-situ clayey soils can be classified as Type 2 above the groundwater table and Type 3 below the groundwater table; the sand and gravel fill on the site is Type 2 above the water table and Type 3 below the groundwater table. Excavated material from launch and receiving pits should be placed at least twice the pit depth away from the pit to lower risk of slope instability. The zone of influence for the railway is 4.6 m from the rail centreline and sloping down at 2H:1V (See Appendix A). For any excavation work within the zone of influence where a slope of 2H:1V cannot be maintained, shoring of the rail berm will be required. For any excavation outside the zone of influence, OHSA requirements apply.

Temporary excavation side slopes in Type 2 soils should remain stable at a slope of 1H:1V commencing at the base of the excavation. Temporary excavation side slopes in Type 3 soils should remain stable at a slope of 3H:1V. The in-situ soils can be excavated using conventional earthmoving equipment. In addition to compliance with the OHSA, the excavation procedures must also comply with with other regulatory authorities, such as federal and municipal safety standards. There shall be no excavations within 8 m from the rail centreline.

5.6 Support System for Excavations

If open cut excavation is not feasible and a support system is required for deep excavations, the support system must be designed by a Professional Engineer to resist lateral soil earth pressures and hydrostatic pressures. The HDD contractor should retain an engineering consultant who specializes in the design and installation of such systems.

5.7 Trench Backfill

Due to a high composition of fines in the native soil, it will be challenging to work in the deep launch and receiving pits, which will be subject to water seepage. It is recommended to use compacted granular fill or a mud mat at the base of these pits to create a working platform for workers and the drilling rig at the base of the excavation. The excavated material may be stored temporarily on site and protected against precipitation for use as backfill at the end of drilling. Backfill material should be compacted to 95% of the Standard Proctor Maximum Dry Density using a vibratory plate compactor.

5.8 Settlement Monitoring

5.8.1 Rail Crossing

The constructor is required to monitor ground movement within the railway right of way during the crossing construction. Conventional settlement monitors must be installed along the centreline of the railway track and along the alignment of the proposed collector within the rail right of way to monitor the ground surface to ensure the settlement does not exceed the allowable threshold (generally 8 mm). Uncased Surface Settlement Marker points (SSM’s) should be installed at a maximum 2 m interval for 10 m on either side of the proposed installation along both sides of the track (approximately 0.5 m to the outside of the tie, unless otherwise specified). In addition, three (3) cased In-ground Monitoring Points (IMP’s) shall be installed at a typical interval of 3 m along the alignment of the proposed duct bank casing within the zone of influence.

The points are to consist of a Standard Iron Bar (SIB) installed in a borehole with the base of the bar grouted in place and the remaining portion sleeved in an HDPE casing and backfilled with sand. Alternatively, electronic based settlement monitors can also be considered but must be designed and installed by a contractor specialized in such an installation and monitoring work.

Prior to installation of the settlement monitors, the alignment of the services must be properly staked out by a qualified legal surveyor in order to ensure that the monitors are installed within the proper service alignments. A set of predetermined settlement limits and a set of preplanned remedial measures in agreement with the rail authorities must be established prior to any work. Baseline readings of the installed monitors should be taken on two separate occasions prior to the commencement of the trenchless crossings. The monitors must be surveyed by a qualified legal surveyor. All parties should recognize and accept the baseline readings prior to the commencement of the work.

An average of at least two readings shall be taken to establish the initial conditions. The reading and collection of data from the surface monitoring points shall be read and recorded by the contractor during the construction period and after construction for a period of at least 2 weeks provided that further settlement has stopped.

A minimum of three sets of readings must be taken daily if the movement is within anticipated limits. Otherwise, the frequencies should increase according to a pre-planned interval. Monitoring of movements is required during work stoppages, such as during non-operation period or weekends. A minimum of three (3) sets of readings should be taken daily. Measurements of the monitoring points shall be reported daily to the rail authorities for review.

If the settlement exceeds alarm levels (generally 8 mm), the rail authorities and TULLOCH should be consulted for technical support to the project engineer interpretation and assessment of the settlements. If necessary, the preplanned remedial measures should be executed to secure the site and to ensure the safety of the public and roadway function.

5.8.2 River Crossing

An extensive monitoring program should be designed and implemented for the South Nation River crossing due to the presence of Leda Clay. The monitoring program should include slope inclinometers adjacent to the river banks to monitor slope movement, vibrating wire piezometers in the river bank materials and bedrock to detect excessive excess pore pressures and an array of surface settlement monuments. The inclinometers should be monitored every hour during the drilling and construction operations in proximity to the river banks. The set up, baselining and monitoring of this system should be similar to that described above for the railway crossing. The inclinometer shall be installed a maximum of 0.5 m offset from the top of the river bank.In addition, appropriate alarm levels should be established for excess pore pressures and slope movement, which will enable the monitoring engineer to halt construction activities if adverse effects are detected.

5.9 Ground Water Control

Trenches for the installation of buried transmission lines are expected to be relatively shallow (i.e. less than 1.8 m depth) and to occur predominantly within fine-grained SILTY Clay or SILT Till materials. As a result, groundwater ingress into shallow excavations is expected to be minor and easily handled using a standard sump and pump techniques, if water is encountered.

Excavations for launch and receiving pits, however, may extend deeper and below the water table. If these excavations are below about 4m depth, they will likely require advanced ground water control measures if permeable Sandy and Gravelly soil layers are encountered. The extent of ground water control will depend on the depth of excavation below the ground water level. The Ontario Water Resources Act, the Water Taking and Transfer Regulation 87/04, a Permit to Take Water (PTTW) from the Ministry of Environment (MOE) is required if the dewatering discharges greater than 50,000

L/day. The dewatering of excavations shall comply with OPSS 517 and control of water from dewatering operations shall be in accordance with OPSS 518.

Ideally, based on the borehole data, launch and receiving pits for HDD installations should be kept less than 2.5m depth to avoid major dewatering.

5.10 Frost Protection

The estimated frost penetration depth at the site is 1.8 m. All buried utilities should be installed below the frost depth. Insulation may be required to raise the frost line in areas where a shallower depth of installation is required. For utility connections to buildings, non-frost susceptible engineered fill or swivel joints may be utilized to mitigate problems due to frost heave.

5.11 Site Classification for Seismic Response

The 2015 National Building Code of Canada (NBCC) stipulates the methodology for earthquake design analysis. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification for seismic site response.

The parameters for determination of Site Classification for Seismic Site Response are set out the 2015 NBCC. The site classification is based on the average shear wave velocity in the top 30 metres of the site stratigraphy. If the average shear wave velocity is not known, the site class can estimated from energy corrected Standard Penetration Resistance (N60) and/or the average undrained shear strength of the soil in the top 30 metres. Based on the 2015 NBCC, this site has been classified as a Class E, soft soil site. These seismic design parameters should be reviewed in detail by the structural engineer and incorporated into the design as required by 2015 NBCC.

5.12 Soil Corrosivity

Based on the soil resistivity values (Appendix E), the measured resistivity at the Site ranges from 1 Ω.m to 3,490 Ω.m for various electrode spacing. Electrical resistivity values for half of the in-situ electrical resistivity (7) tests indicate mildly corrosive to corrosive and the other half (7) indicate non-corrosive soils. The corrosion potential is rated based on the publication by FHWA referenced in section 7. For design purposes the surficial soils should be considered corrosive based on the high variance in test results.

Based on test results from the report entitled,” Nation Rise Wind Project – Substation” prepared for EDPR by RRC Engineering, the sulfate and chloride content in the soils on the project is negligible and therefore sulphate resistant concrete will not be required.

6 CLOSURE

TULLOCH has prepared this geotechnical report for the exclusive use of EDPR and their authorized agents for the construction of the proposed electrical lines crossing at the South Nation River, Payne River, and railway Sites.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practises in the field of geotechnical engineering, for the above noted location. Classification and identification of soils and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. No warranty or other conditions, expressed or implied, should be understood. Please refer to Appendix G, Report Limitations and Guidelines for Use, which pertains to this report.

We trust that the information and recommendations in this draft report will be sufficient to allow EDPR and their consultant to proceed with the substation design until detailed laboratory results become available. Should further elaboration be required for any portion of this project, we would be pleased to assist.

7 REFERENCES

Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release---Data 126 Revision 1.

Tulloch Engineering 2018. Wind Turbine Generator Foundations, Rev 0, November 2, 2018.

US Department of Transportation, Federal Highway Administration, “Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes”, Publication No. FHWA-NHI-00-044, September, 2000.

RRC Engineering, “Nation Rise Wind Project- Substation”, Township of North Stormont, ON, 2017.

APPENDIX A

SITE LOCATION PLAN & TYPICAL CROSS SECTIONS

LOCATION	X(EASTING) (m)	Y(NORTHING) (m)
ELECTRICAL RESISTIVITY TESTING LOCATIONS ON COLLECTOR SYSTEM		
E-1	480992.000	5007313.000
E-2	484160.000	5007567.000
E-3	483097.083	5003468.045
E-4	486716.687	5003432.285
E-5	488426.000	5001668.000
E-6	490720.917	5004543.955
E-7	485047.000	4999775.000
E-8	488115.000	4998329.000
E-9	491182.000	5000208.000
E-10 C	494279.000	5001837.000
E-11	491382.000	4997145.000
E-12	488444.000	4995522.000
E-13	487994.000	4993166.000
E-14	492803.000	4996220.000
C LOCATION	X(EASTING) (m)	Y(NORTHING) (m)
THERMAL RESISTIVITY TESTING LOCATIONS ON COLLECTOR SYSTEM		
T-1	487185.464	5005284.653
T-2	482206.956	5004170.507
T-3	484097.283	5007915.896
T-4	487497.810	5002209.478
T-5	492466.238	5004300.556
T-6	488144.194	4999481.679
T-7	490836.440	5000962.104
T-8	486920.001	4996610.578
T-9	490778.236	4997494.532
T-10	490707.770	4995920.619

LEGEND

— —	UNDERGROUND CABLE
XX ○	WIND TURBINE (WTG)
-·-·-	WTG ACCESS ROAD
▞ E-X	ELECTRICAL RESISTIVITY TESTING LOCATIONS
⊗ T-X	THERMAL RESISTIVITY TESTING LOCATIONS

FOR INFORMATION

VER.	DATE	DRAWN	CHECKED	APPROVED	MODIFICATION
C	01/24/2019	NPT	SJP	SJP	COORDINATE AND TEXT REVISIONS
B	05/08/2018	RML	HEH	HEH	GENERAL REVISIONS
A	05/08/2018	RML	HEH	HEH	ISSUED FOR REVIEW

VER.	DATE	DRAWN	CHECKED	APPROVED	MODIFICATION

DATE	SCALE 1:25000
05/18	DRAWN RML
05/18	CHECKED HEH
05/18	APPROVED HEH
Format ANSI D	

NATION RISE WIND FARM
NORTH STORMONT, ONTARIO, CANADA

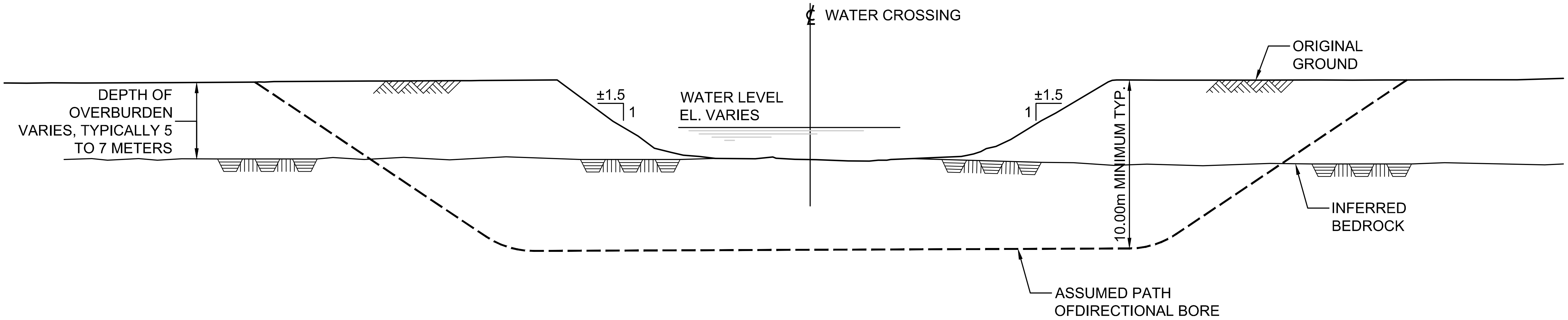
COLLECTION GEOTECHNICAL TESTING LOCATIONS

Proj. Nº: 18001-02
Doc. Nº: NRS1-SK-002

NORDMIN
RESOURCE & INDUSTRIAL
ENGINEERING

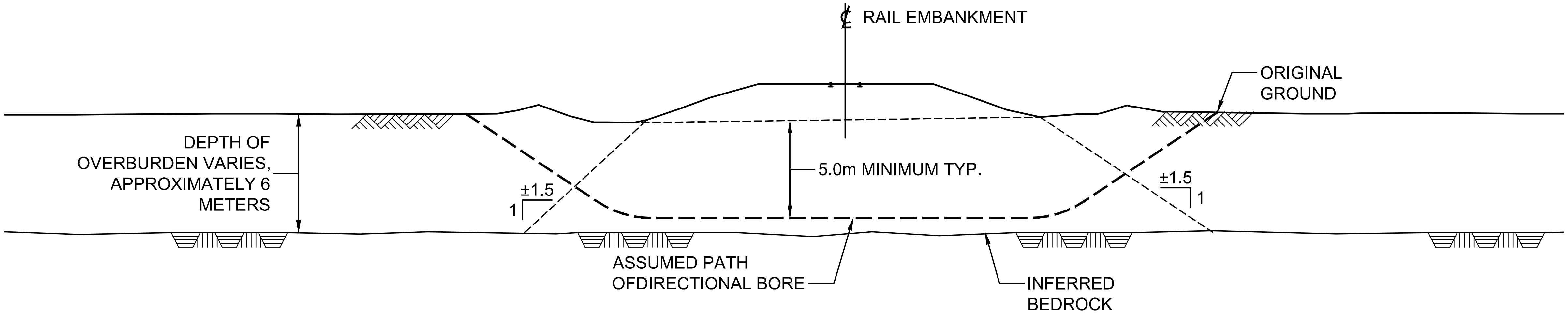
Rev. C
Page: 01 of 01
Drawing Nº: SK-002

P:\2018\THUNDER BAY\18002-01 EDP Renewables Nation Rise Windfarm\DRAWINGS_2D CAD\NRS1-SK-002_RC COLLECTION GEOTECHNICAL TESTING LOCATIONS.dwg - Jan 24, 2019 - 2:48pm



TYPICAL HDD AT RIVER CROSSING

N.T.S



TYPICAL HDD AT RAIL CROSSING

N.T.S

A	2018-11-30	KK	ISSUED FOR INTERNAL REVIEW
No.	DATE	BY	ISSUES / REVISIONS

TULLOCH ENGINEERING

DRAWING:
TYPICAL HDD CROSSINGS
SECTIONS

edp renewables

PROJECT:
NATION RISE
WIND FARM

DRAWN BY: K KORTEKAAS	CHECKED BY: U KHAN	DESIGNED BY: U KHAN
APPROVED BY: S HINCHBERGER	SCALE: AS NOTED	DATE: 2018-11-14
DRAWING No. 18-4022-C-01		REVISION No. A

P:\Projects\18-4022 Nation Rise Geotechnical\03 - CAD Drawings\18-4022-C-01.dwg

APPENDIX B

ABBREVIATIONS, TERMINOLOGY, AND PRINCIPAL SYMBOLS USED

ABBREVIATIONS, TERMINOLOGY AND PRINCIPAL SYMBOLS USED IN REPORT AND BOREHOLE LOGS

BOREHOLES AND TEST PIT LOGS

AA	Auger Sample	W	Washed Sample
SS	Split Spoon	HQ	Rock Core (63.5 mm dia.)
ST	Thin-walled Tube Sample	NQ	Rock Core (36.5 mm dia.)
BS	Block Sample	BQ	Rock Core (36.5 mm dia.)

IN SITU SOIL TESTING

Standard Penetration Test (SPT) "N" value. The number of blows required to drive a 51 mm OD split barrel sampler into the soil a distance of 300 mm with a 63.5kg weight free falling a distance of 760mm after an initial penetration of 150mm has been achieved.

Dynamic Cone Penetration Test (DCPT) is the number of blows required to drive a cone with a 60 degree apex attached to "A" size drill rods continuously into the soil for each 300mm penetration with a 63.5 kg weight free falling a distance of 760mm.

Cone Penetration Test (CPT) is an electronic cone point with a 10 cm' base area with a 60 degree apex pushed through the soil at a penetration rate of 2cm/s.

Field Vane Test (FVT) consists of a vane blade, a set of rods and torque measuring apparatus used to determine the undrained shear strength of cohesive soils.

SOIL DESCRIPTIONS

The soil descriptions and classifications are based on an expanded Unified Soil Classification System (USCS). The USCS classifies soils on the basis of engineering properties. The system divides soils into three major categories; coarse grained and highly organrc soils. The soil is then subdivided based on either gradation or plasticity characteristics. The classification excludes particles larger than 75mm. To aid in quantifying materal amounts by eight within the respective grain size fractions the following terms have been included to expand the USCS:

Soil Classification		Terminology	Proportion
Clay	<0.002 mm	“trace”	1%to 10%
Silt	0.002 to 0.06 mm	"some"	10% to 20%
Sand	0.075 to 4.75 mm	Sandy, Gravelly, etc.	20% to 35%
Gravel	4.751o 75 mm	“and”	>35%
Cobbles	75 to 200 mm	Noun, SAND, SILT, etc.	>35%
Boulders	>200 mm		

Notes:

1. Soil properties, such as strength, gradation, plasticity, structure, etc. dictate the soils engineering behaviour over the grain size fractions;
2. With the exception of soil samples tested for grain size distribution or plasticity, all soil samples have been classified based on visual and tactile observations and is therefore an approximate description.

The following table outlines the qualitative terms used to describe the relative density condition of cohesionless soil:

Cohesionless Soils

Compactness	SPT “N” Value (blows/30cm)
Very Loose	0 to 4
Loose	5 to 10
Compact	11 to 30
Dense	31 to 50
Very Dense	>50

The following table outlines the qualitative terms used to describe the consistency of cohesive soils related to undrained shear strength and SPT, N-Index:

Cohesive Soils

Consistency	Undrained Shear Strength (kPa)	SPT “N” Value (blows/30 cm)
Very Soft	<12.5	< 2
Soft	12.5 to 25	2 to 4
Firm	25 to 50	5 to 8
Stiff	50 to 100	9 to 15
Very Stiff	100 to 200	16 to 30
Hard	> 200	>30

Note: Utilizing the SPT, “N” value to correlate the consistency and undrained shear strength of cohesive soils is very approximate and needs to be used with caution.

ROCK CORING

Rock Quality Designation (RQD) is an indirect measure of the number of fractures within a rock mass, Deere et al. (1967). It is the sum of sound pieces of rock core equal to or greater than 100 mm recovered from the core run, divided by the total length of the core run, expressed as a percentage. If the core section rs broken due to mechanical or handling, the pieces are fitted together and if 100 mm or greater included in the total sum.

Intact Rock Strength

Intact Strength (Mpa)	Description
< 1	Extremely low strength
1-5	Very low strength
5-25	Low strength
25-50	Medium strength
50-100	High strength
100-250	Very high strength
>250	Extremely high strength

Rock Mass Quality

RQD Classification	RQD Value (%)
Very poor quality	<25
Poor Quality	25 to 50
Fair Qualty	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

Rock Mass Weathering

Term	Grade	Description
Unweathered (Fresh)	I	No visible sign of material weathering to discoloration on major discontinuity surfaces.
Slightly Weathered	II	Discoloration indicates weathering of rock material and discontinuity of surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than its fresh condition.
Moderatly Weathered	III	Less than half the rock material is decomposed and/or disintegrates to soil. Fresh or discolored rock is present either as a continuous frame work of as core stones.
Highly Weathered	IV	More than half the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a discontinuous frame work or as core stones.
Completely Weathered	V	All rock material is decomposed and/or disintegrated to soil. The original mass structure is largely intact.
Residual Soil	VI	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

SYMBOLS

General

w_N	Natural water content within the soil sample
γ	Unit weight
γ'	Effective unit weight
γ_D	Dry unit weight
γ_{SAT}	Saturated unit weight
ρ	Density
ρ_s	Density of solid particles
ρ_w	Density of water
ρ_D	Dry density
ρ_{SAT}	Saturated density
e	Void ratio
n	Porosity
S	Degree of saturation
E_{50}	Fifty percent secant modulus

Consistency

w_L	Liquid Limit
w_P	Plastric Limit
I_P	Plasticity Index
w_S	Shrinkage limit
I_L	Liquidity index
I_C	Consistency index
e_{max}	Void ratio in loosest state
e_{min}	Void ratio in densest state
I_D	Density index (formerly relative density)

Shear Strength

S_u	Undrained shear strength parameter (total stress)
c'	Effective cohesion intercept
ϕ'	Effective friction angle
τ_R	Peak shear strength
τ_R	Residual shear strength
δ	Angle of interface friction
μ	Coefficient of friction = tan ϕ'

Consolidation

C_c	Compression index (normally consolidated range)
C_r	Recompression index (over consolidated range)
m_v	Coefficient of volume change
c_v	Coefficient of consolidation
T_v	Time factor (vertical direction)
U	Degree of consolidation
σ_v'	Effictive overburden pressure
OCR	Overconsolidation ratio

APPENDIX C

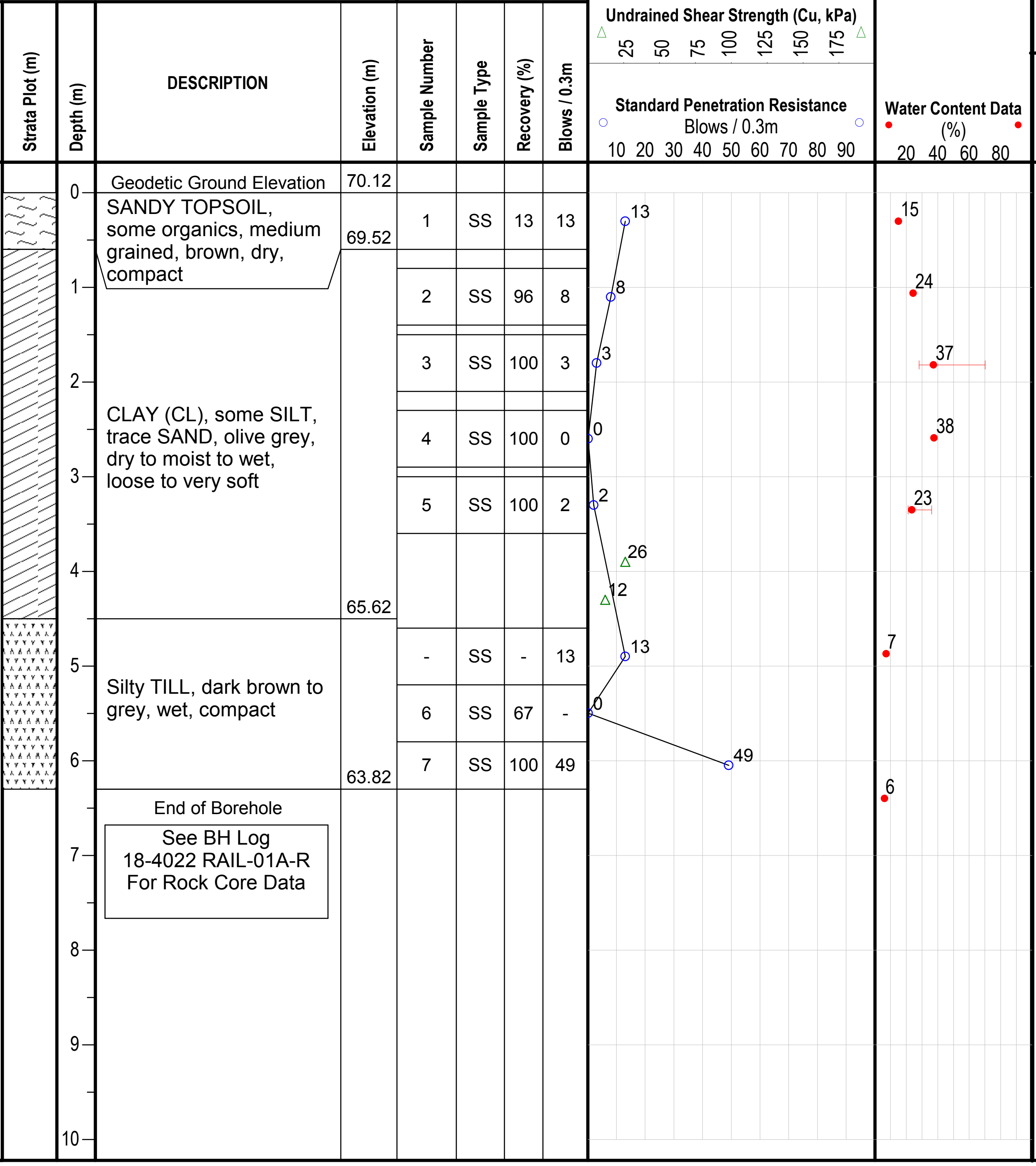
BOREHOLE LOGS

Borehole Log: RAIL-01A

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=4996017, E=487306 UTM 18T
Client: EDPR

Logged By: S. Khan
Compiled By: K. Kortekaas
Reviewed By: S. deBortoli

SUBSURFACE PROFILE		SAMPLE				Remarks				
DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Gr	Sa	Si	Cl	
Geodetic Ground Elevation	70.12									
SANDY TOPSOIL, some organics, medium grained, brown, dry, compact	69.52	1	SS	13	13					
CLAY (CL), some SILT, trace SAND, olive grey, dry to moist to wet, loose to very soft		2	SS	96	8					
		3	SS	100	3	0	0.9	12.8	86.3	
		4	SS	100	0					
	65.62	5	SS	100	2	0	0.8	22.2	76.6	
Silty TILL, dark brown to grey, wet, compact		-	SS	-	13					
		6	SS	67	-					
	63.82	7	SS	100	49	16.4	26.9	56.7		
End of Borehole See BH Log 18-4022 RAIL-01A-R For Rock Core Data										@6.8 spoon refusal



Drilled By: Marathon Drilling

Drill Method: CME 75

Drill Date: 2018-08-29

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum: UTM 18T

Location: -

Sheet: 1 of 1

Borehole Log: RAIL-01A-R

TULLOCH ENGINEERING

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=4996017, E=487306 UTM 18T
Client: EDPR

Logged By: S.Khan
Compiled By: K.Kortekaas
Reviewed By: S.deBortoli

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa)	Remarks
			Geodetic Rock Elevation	63.82							
		0	LIMESTONE, grey / black, very thinly bedded to laminated, moderately weathered, corestones present, horizontal and angular fractures	63.13	1	68	48	68	63.13	55.4	
		1	LIMESTONE, grey / black, thinly bedded to laminated, silghtly weathered, horizontal fractures present		2	99	100	101	62.12		
		2 3		60.60	3	147	100	152	60.60		
		4	End of Rock Core								

Drilled By: Marathon Drilling

Drill Method: Casing / NQ Core

Drill Date: 2018-08-29

Sample Type
- AS - Auger Sample
- SS - Split Spoon
- TWS - Thin Walled Shelby Tube
- BS - Block Sample
- NQ- Rock Core
- W - Water Content
- WL - Liquid Limit
- WP - Plastic Content
- +s Field Vane, S - Sensitivity
- - Lab Vane

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum: UTM 18T

Location: -

Sheet: 1 of 1

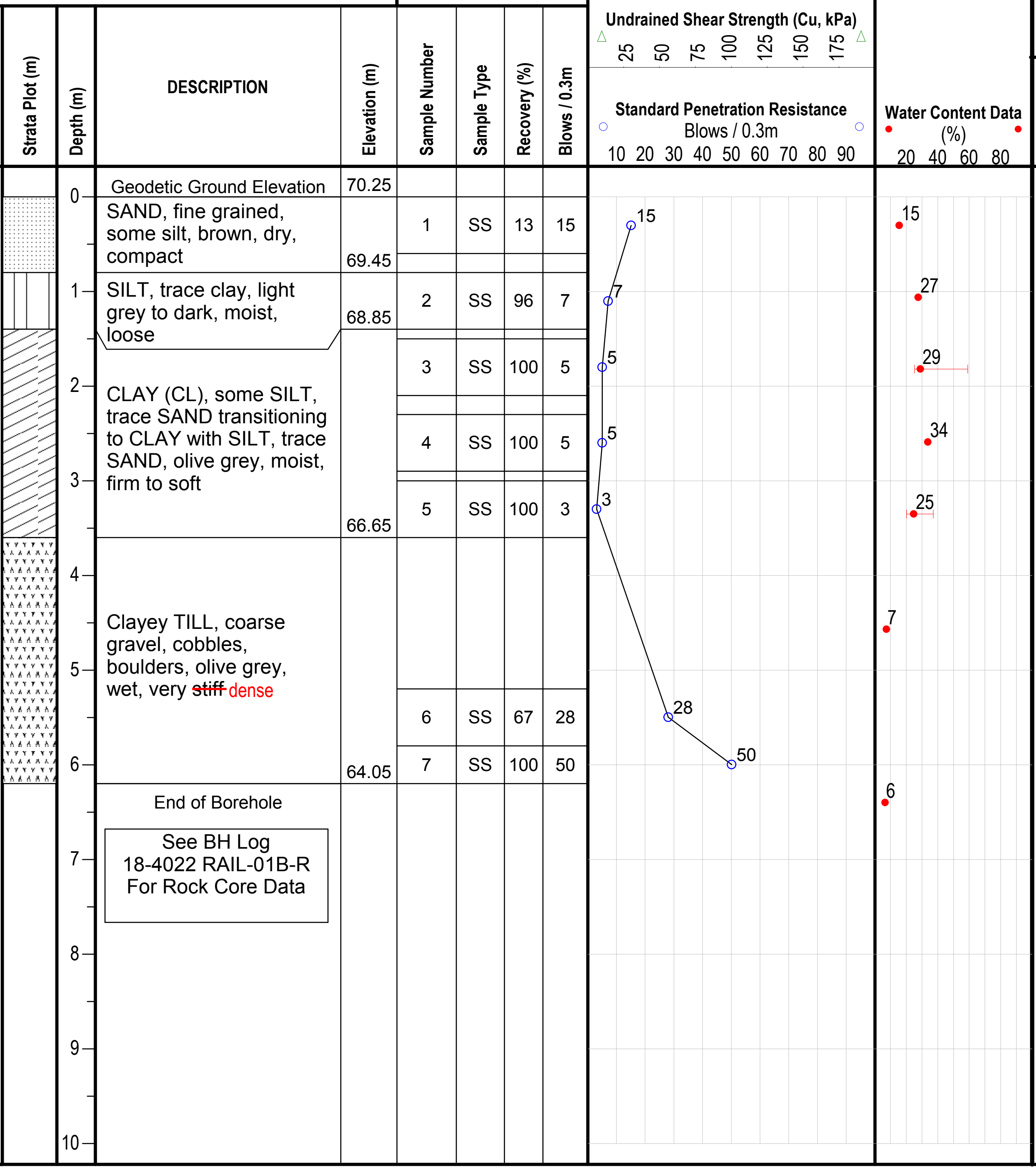
Borehole Log: RAIL-01B

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=4995963, E=487331 UTM 18T
Client: EDPR

Logged By: S. Khan
Compiled By: K. Kortekaas
Reviewed By: S. deBortoli

SUBSURFACE PROFILE		SAMPLE				Grain Size (%)				Remarks
DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Gr	Sa	Si	Cl	
Geodetic Ground Elevation	70.25									
SAND, fine grained, some silt, brown, dry, compact	69.45	1	SS	13	15					
SILT, trace clay, light grey to dark, moist, loose	68.85	2	SS	96	7					
CLAY (CL), some SILT, trace SAND transitioning to CLAY with SILT, trace SAND, olive grey, moist, firm to soft	66.65	3	SS	100	5	0	2.8	18.2	78.2	
		4	SS	100	5					
		5	SS	100	3	0	0.3	26.7	73.0	
Clayey TILL, coarse gravel, cobbles, boulders, olive grey, wet, very ~~stiff~~ dense	64.05	6	SS	67	28					
		7	SS	100	50					@6.2 spoon refusal
End of Borehole										

See BH Log
18-4022 RAIL-01B-R
For Rock Core Data



Drilled By: Marathon Drilling

Drill Method: CME 75

Drill Date: 2018-08-27

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum: UTM 18T

Location: -

Sheet: 1 of 1

Borehole Log: RAIL-01B-R

TULLOCH ENGINEERING

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=4995963, E=487331 UTM 18T
Client: EDPR

Logged By: S.Khan
Compiled By: K.Kortekaas
Reviewed By: S.deBortoli

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa) 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150	Remarks
			Geodetic Rock Elevation	64.05							
		0	LIMESTONE, grey / black, broken and moderately weathered, corestones present, very thinly bedding to thinly laminated, horizontal fracturing	63.90	1	78	76	78	63.90		
		1			2	144	81	144	63.90		
		2 3	LIMESTONE, grey / black, very thinly bedded to thinly laminated, slightly weathered, angular and horizontal fracturing	60.82	3	152	96	152	60.82	45.2	
		4	End of Rock Core								

Drilled By: Marathon Drilling

Drill Method: Casing / NQ Core

Drill Date: 2018-08-27

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
$+_s$ Field Vane, S - Sensitivity
- Lab Vane

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum: -

Location: -

Sheet: 1 of 1

Borehole Log: RC-01A

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=5006023, E=487620 UTM 18T
Client: EDPR

Logged By: S. Khan
Compiled By: K. Kortekaas
Reviewed By: S. deBortoli

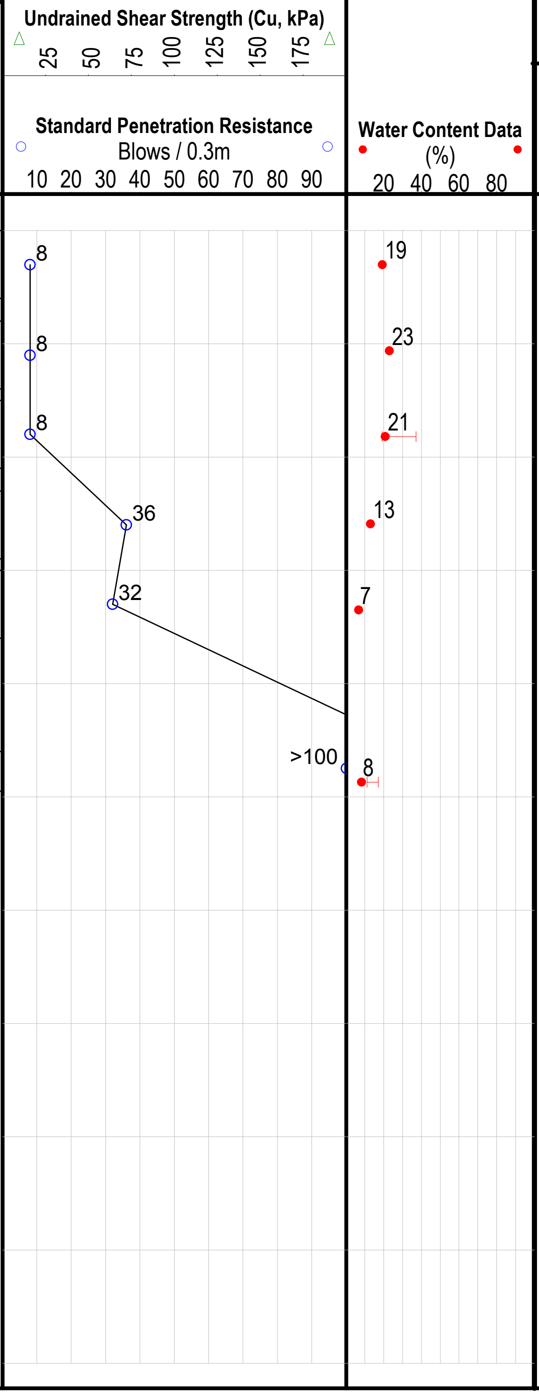
SUBSURFACE PROFILE

Depth (m)	DESCRIPTION	Elevation (m)
0	Geodetic Ground Elevation	64.00
0 – 0.6	SANDY TOPSOIL, medium grained, some gravel, dark brown, dry, loose	63.40
0.6 – 2.15	CLAY and SILT (CL/ML), trace SAND, dark brown, dry, loose	61.85
2.15 – 3.65	SAND (SW) and SILT with GRAVEL, fine to medium grained, fragmented rocks, cobbles, boulders, oxidated, light brown, dry, dense	60.35
3.65 – 4.95	CLAYEY SILT (ML) (Till), some SAND, some GRAVEL, olive grey, wet, very dense	59.05
	End of Borehole	

See BH Log
18-4022 RC-01A-R
For Rock Core Data

SAMPLE

Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Water Content Data (%)	Gr	Sa	Si	Cl	Remarks
1	SS	83	8	19					
2	SS	63	8	23					
3	SS	100	8	21	0	2.5	46.7	50.8	
4	SS	79	36	13					
5	SS	50	32	7	28.0	34.0	38.0		
6	SS	100	133	8	11.7	17.7	47.7	22.9	@4.95 spoon refusal



Drilled By: Marathon Drilling

Drill Method: CME 75

Drill Date: 2018-08-30

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum: UTM 18T

Location: -

Sheet: 1 of 1

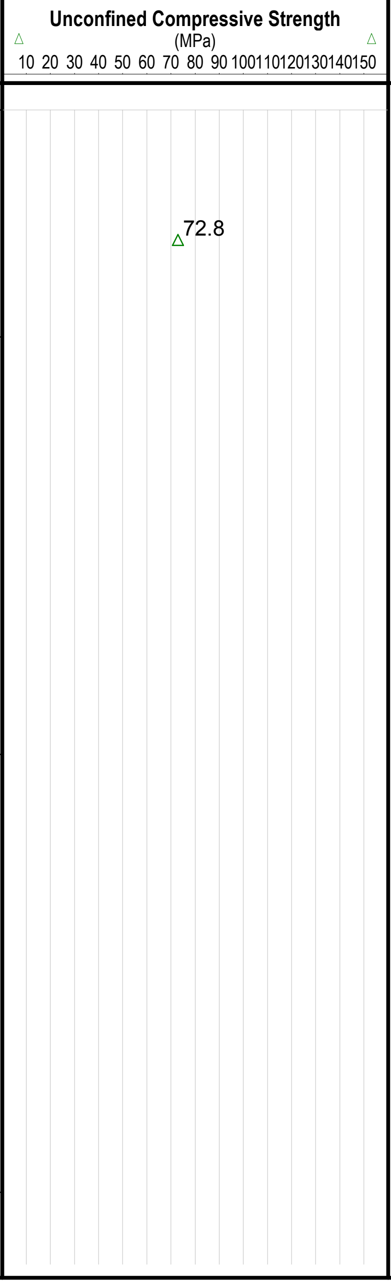
Borehole Log: RC-01A-R

TULLOCH ENGINEERING

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=5006023, E=487620 UTM 18T
Client: EDPR

Logged By: S.Khan
Compiled By: K.Kortekaas
Reviewed By: S.deBortoli

SUBSURFACE PROFILE					SAMPLE					
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Remarks
			Geodetic Rock Elevation	59.05						
		0	LIMESTONE, grey / black, moderately weathered with corestones, horizontal, angular and vertical fractures present throughout run, thinly laminated, fragmented sections present throughout run	58.26	1	58	56	78	58.26	
		1			2	96	21	144	56.82	
		2	LIMESTONE, grey / black, slightly weathered horzintal fracturing, very thinly bedded to thinly laminated							
		3		55.30	3	152	81	152	55.30	
		4	End of Rock Core							



Drilled By: Marathon Drilling

Drill Method: Casing / NQ Core

Drill Date: 2018-08-30

Sample Type
- AS - Auger Sample
- SS - Split Spoon
- TWS - Thin Walled Shelby Tube
- BS - Block Sample
- NQ- Rock Core
- W - Water Content
- WL - Liquid Limit
- WP - Plastic Content
- $+_s$ Field Vane, S - Sensitivity
- - Lab Vane

- w - Wash
- o - SPT(Standard Penetration Test)
- TCR - Total Core Recovery
- RQD - Rock Quality Designation

Datum: UTM 18T

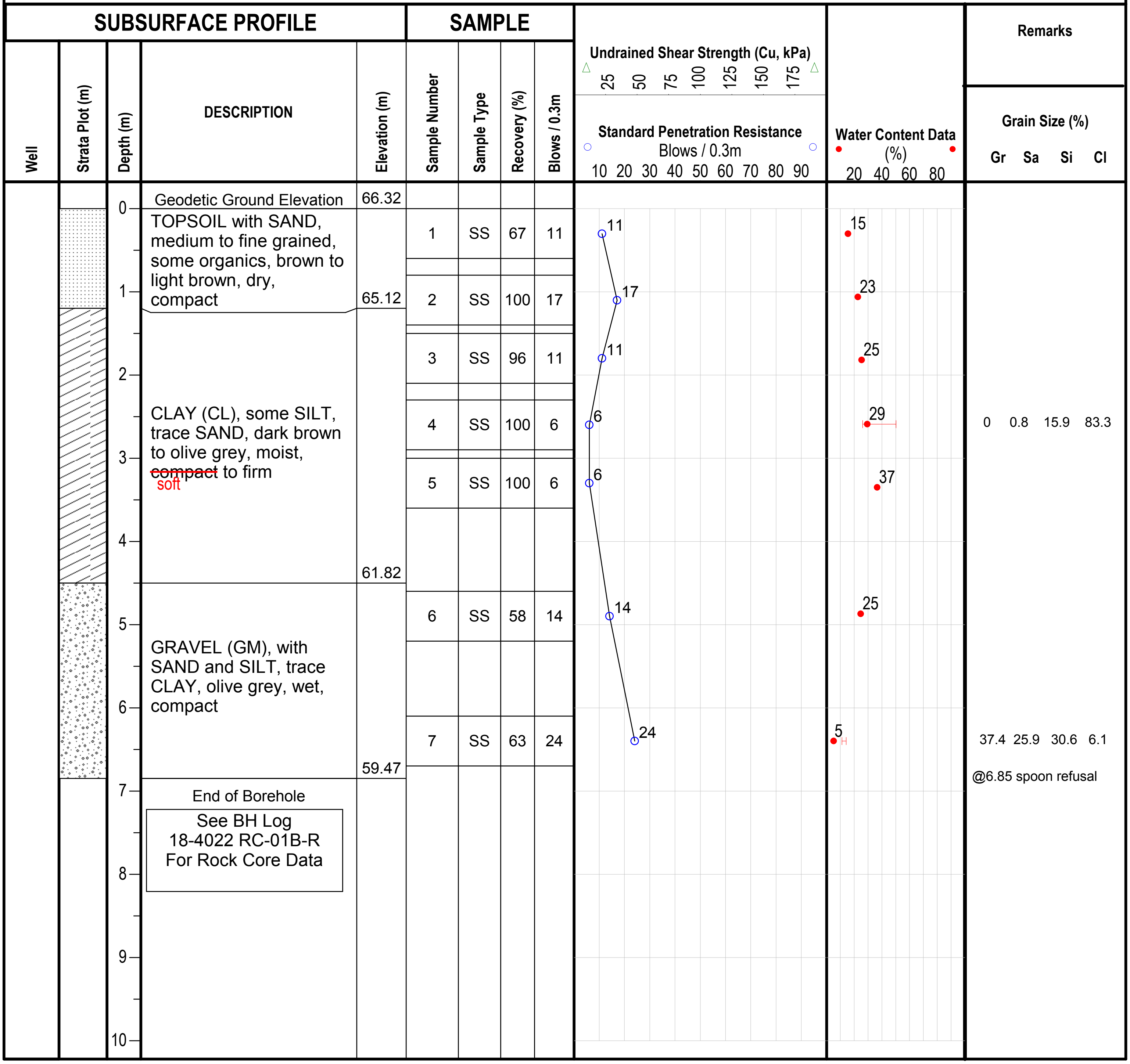
Location: -

Sheet: 1 of 1

Borehole Log: RC-01B

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **N=5007012, E=487705 UTM 18T**
Client: **EDPR**

Logged By: **S. Khan**
Compiled By: **K. Kortekaas**
Reviewed By: **S. deBortoli**



DESCRIPTION	Elevation (m)
Geodetic Ground Elevation	66.32
TOPSOIL with SAND, medium to fine grained, some organics, brown to light brown, dry, compact	65.12
CLAY (CL), some SILT, trace SAND, dark brown to olive grey, moist, ~~compact~~ soft to firm	61.82
GRAVEL (GM), with SAND and SILT, trace CLAY, olive grey, wet, compact	59.47
End of Borehole See BH Log 18-4022 RC-01B-R For Rock Core Data	

Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Water Content (%)	Gr	Sa	Si	Cl	Remarks
1	SS	67	11	15					
2	SS	100	17	23					
3	SS	96	11	25					
4	SS	100	6	29	0	0.8	15.9	83.3	
5	SS	100	6	37					
6	SS	58	14	25					
7	SS	63	24	5	37.4	25.9	30.6	6.1	@6.85 spoon refusal

Drilled By: **Marathon Drilling**

Drill Method: **CME 75**

Drill Date: **2018-08-31**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum: **UTM 18T**

Location: **-**

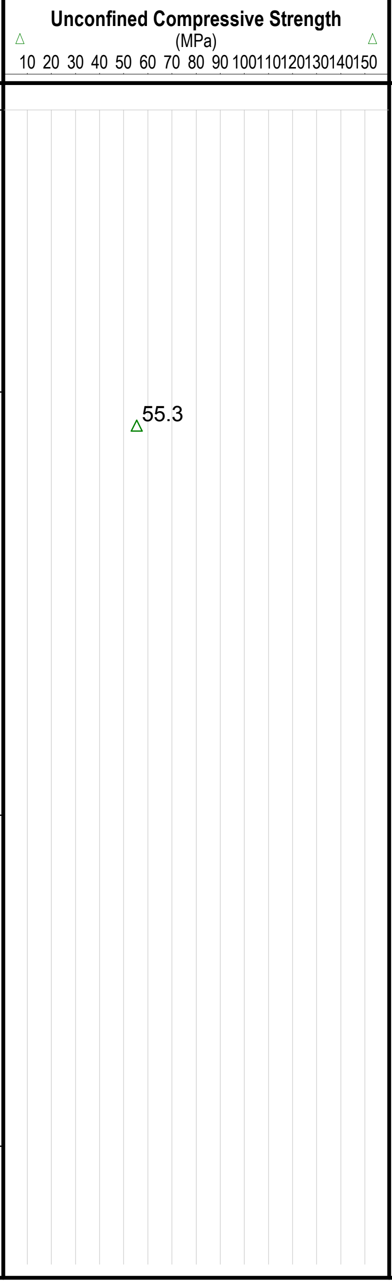
Sheet: **1 of 1**

Borehole Log: RC-01B-R

TULLOCH ENGINEERING

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **N=5002012, E=487705 UTM 18T**
Client: **EDPR**

Logged By: **S.Khan**
Compiled By: **K.Kortekaas**
Reviewed By: **S.deBortoli**



SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa)	Remarks
			Geodetic Rock Elevation	59.47							
		0 – 1	LIMESTONE, grey / black, moderately weathered with corestones, horizontal and angular fracturing present, laminated to thinly laminated	58.37	1	66	19	111	58.37		
		1 – 4	LIMESTONE, grey / black, slightly weathered, thinly laminated to very thinly bedded, horiztonal fracturing present	55.43	2	160	73	165	56.72	55.3	
					3	134	94	129	55.43		
			End of Rock Core								

Drilled By: **Marathon Drilling**

Drill Method: **Casing / NQ Core**

Drill Date: **2018-08-31**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
$+_s$ Field Vane, S - Sensitivity
 - Lab Vane

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum: **UTM 18T**

Location: **-**

Sheet: **1 of 1**

Borehole Log: RC-02A

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=5004228, E=491746 UTM 18T
Client: EDPR

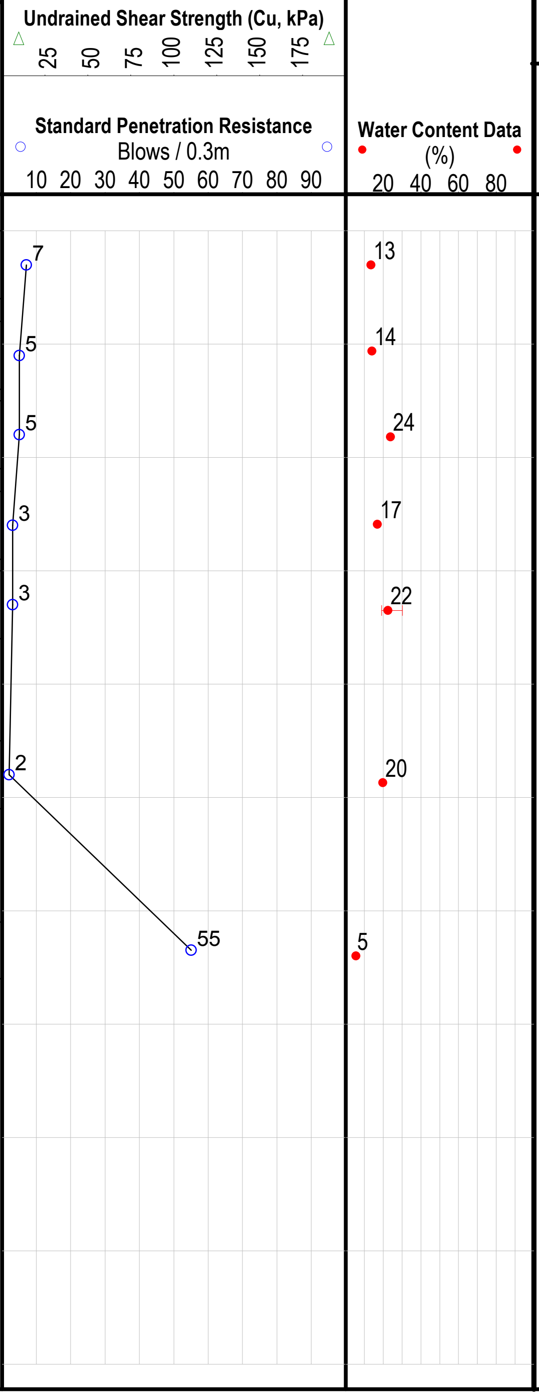
Logged By: S. Khan
Compiled By: K. Kortekaas
Reviewed By: S. deBortoli

SUBSURFACE PROFILE

Depth (m)	DESCRIPTION	Elevation (m)
0	Geodetic Ground Elevation	70.14
	ASPHALT	
	SAND, fine to medium grained, some gravel, oxidated, dark brown, dry, loose	69.54
1	SAND (SW), some GRAVEL, some FINES, dark brown, dry to moist, loose	67.94
3	CLAYEY SILT (ML), trace SAND, trace GRAVEL, oxidated, dark brown, dry to moist, very ~~loose to~~ soft	65.64
5	SANDY SILT (ML), some CLAY, trace GRAVEL, dark grey to olive grey, wet to moist, very ~~soft~~ to loose. loose	64.04
6	GRAVEL, fragmented rocks, cobbles, boulders, light grey, dry, very dense	63.54
7	End of Borehole	
8	See BH Log 18-4022 RC-02A-R For Rock Core Data	

SAMPLE

Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Gr	Sa	Si	Cl	Remarks
1	SS	83	4					
2	SS	63	5	11.3	71.8	16.9		
3	SS	54	5					
4	SS	75	3					
5	SS	100	3	0.3	3.4	59.4	36.9	
6	SS	83	2	5.7	28.2	50.3	15.8	
7	SS	79	55	25.5	32.8	41.7		@6.6 spoon refusal



Drilled By: Marathon Drilling

Drill Method: CME 75

Drill Date: 2018-09-04

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum: UTM 18T

Location: -

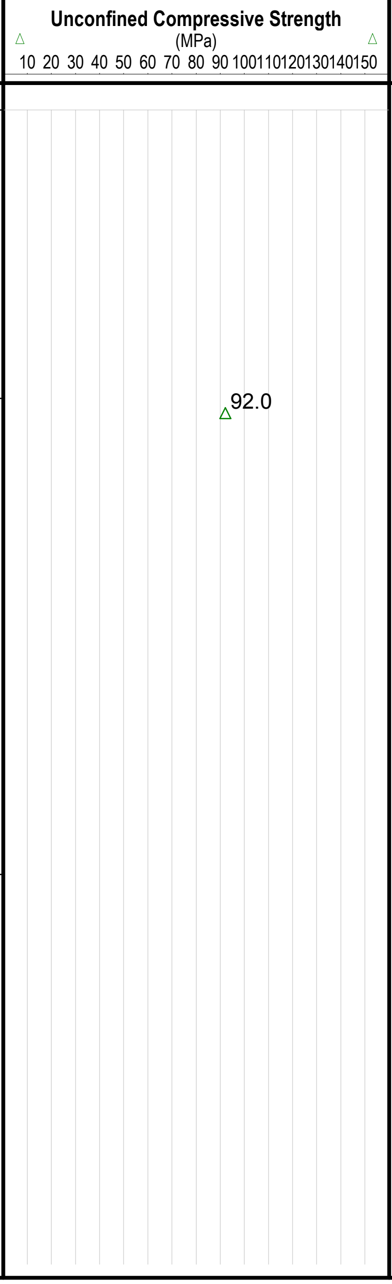
Sheet: 1 of 1

Borehole Log: RC-02A-R

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=5004228, E=491746 UTM 18T
Client: EDPR

Logged By: S.Khan
Compiled By: K.Kortekaas
Reviewed By: S.deBortoli

DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Remarks
Geodetic Rock Elevation	60.90						
LIMESTONE, grey / black, moderately weathered with corestones, laminated, horizontal fractures present	59.90	1	157	63	109	59.90	
LIMESTONE, grey / black, slightly weathered, very thinly bedded to thinly laminated horizontal fractures present	58.25	2	154	66	157	58.25	
End of Rock Core							



Drilled By: Marathon Drilling

Drill Method: Casing / NQ Core

Drill Date: 2018-09-04

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
$+_s$ Field Vane, S - Sensitivity
- Lab Vane

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum: UTM 18T

Location: -

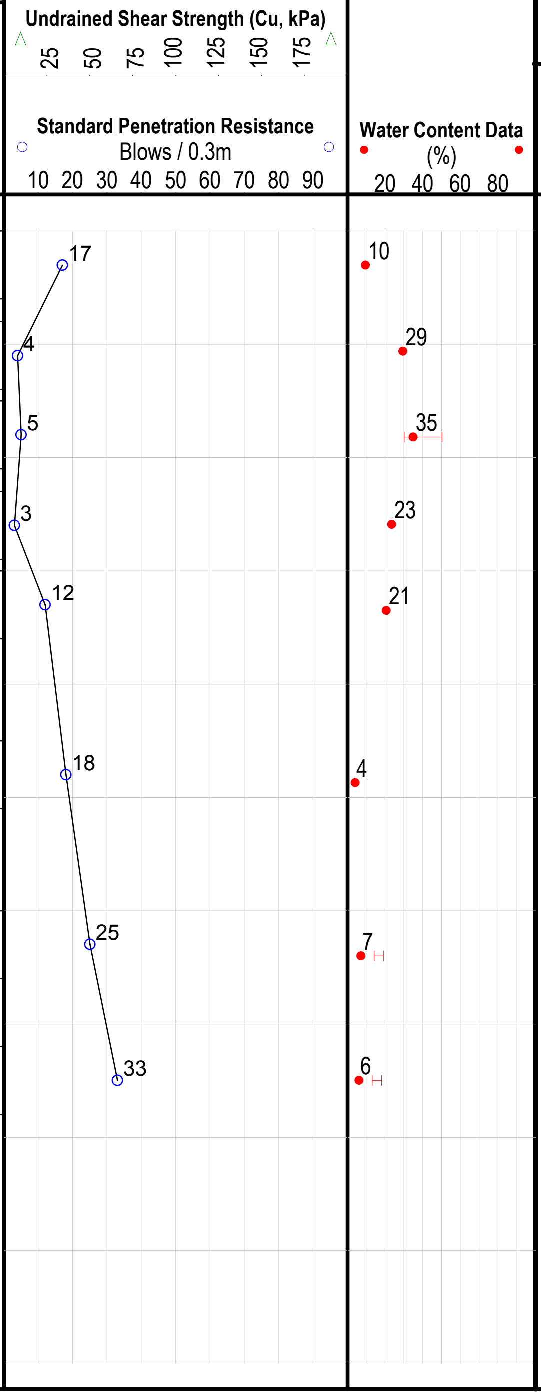
Sheet: 1 of 1

Borehole Log: RC-02B

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **N=5004280, E=491847 UTM 18T**
Client: **EDPR**

Logged By: **S. Khan**
Compiled By: **K. Kortekaas**
Reviewed By: **S. deBortoli**

SUBSURFACE PROFILE		SAMPLE				Remarks
DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Grain Size (%) Gr Sa Si Cl
Geodetic Ground Elevation	70.65					
ASPHALT						
GRANULAR		1	SS	83	17	
SAND, fine sand, dark grey, dry, compact						
CLAY (CL), some SILT, trace SAND, oxidated, light brown to light grey, dry to moist to wet, very ~~loose~~ soft to ~~compact~~ soft		2	SS	75	4	
		3	SS	100	5	0 2.9 17.0 80.1
	67.65	4	SS	100	3	
SILT with CLAY (ML), trace SAND, trace GRAVEL		5	SS	79	12	0.3 1.0 74.6 24.1
	66.15					
SILT with GRAVEL (ML), some SAND, some CLAY, olive grey, dry to moist, compact to very dense		6	SS	67	18	
	64.05	7	SS	75	25	25.4 19.5 38.9 16.2
SANDY GRAVEL (GM), some SILT, trace CLAY	62.85	8	SS	33	62	51.4 30.6 12.5 5.5 @7.8 spoon refusal
End of Borehole See BH Log 18-4022 RC-02B-R For Rock Core Data						



Drilled By: **Marathon Drilling**

Drill Method: **CME 75**

Drill Date: **2018-09-04**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum: **UTM 18T**

Location: **-**

Sheet: **1 of 1**

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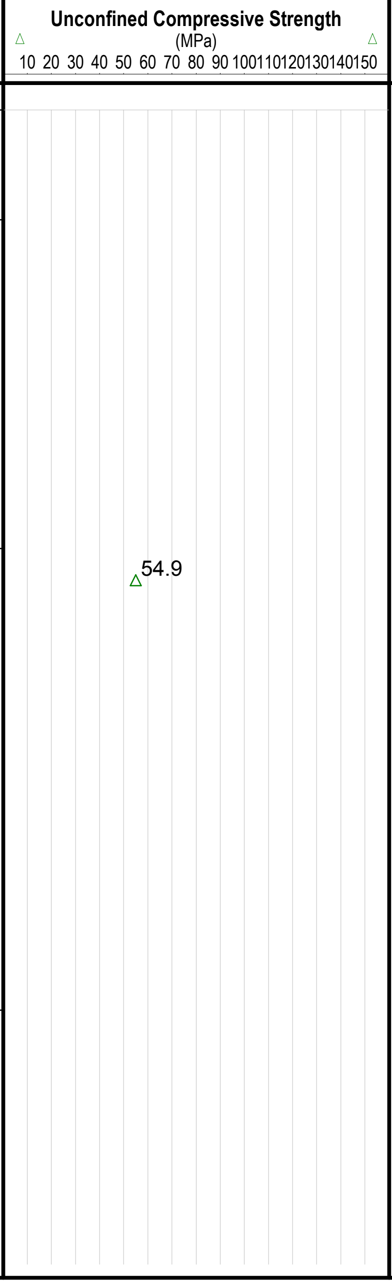
Borehole Log: RC-02B-R

Project No: 18-4022
Project: Nation Rise Wind Farm
Site Location: N=5004280, E=491847 UTM 18T
Client: EDPR

Logged By: S.Khan
Compiled By: K.Kortekaas
Reviewed By: S.deBortoli

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa)	Remarks
			Geodetic Rock Elevation	59.70							
	▨	0	LIMESTONE, grey / black, moderately to highly weathered with corestones, thinly laminated, horizontal and angular fracturing present	59.32	1	27	0	40	59.32		
	▨	1			2	157	56	157	38.18		
	▨	2 3	LIMESTONE, grey / black, slightly weathered, laminated to thinly laminated, horizontal fracturing present	56.58	3	116	78	116	56.58	54.9	
		4	End of Rock Core								



Drilled By: Marathon Drilling

Drill Method: Casing / NQ Core

Drill Date: 2018-09-04

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
$+_s$ Field Vane, S - Sensitivity
 - Lab Vane

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum: UTM 18T

Location: -

Sheet: 1 of 1

APPENDIX D

LAB RESULTS

CSA A283 Certified Laboratory for Concrete Testing
CCIL Certified Laboratory for Aggregates and Asphalt Testing
CSA/CCIL Certified Technicians

WATER CONTENT TEST

TEST METHOD: LS 701 / ASTM C 566 / D 2216

CONTRACT NO: 18-4022
DATE SAMPLED: Refer to BH logs
PROJECT: Nation Rise
SOURCE: Boreholes
DATE TESTED: 01-Oct-18
TESTED BY: D. Watts

			Gross (inc. Tare) (g)				
Tare ID	Sample ID	Depth (m)	Wet Weight	Dry Weight	TARE	Mass Lost	Water %
	BH-RAIL-1A-SS1	0.00-0.61	55.61	49.56	14.69	6.05	17.4%
	BH-RAIL-1A-SS2	0.76-1.37	50.77	42.09	14.95	8.68	32.0%
	BH-RAIL-1A-SS3	1.52-2.13	450.60	343.61	162.99	106.99	59.2%
	BH-RAIL-1A-SS4	2.29-2.90	41.50	31.56	15.01	9.94	60.1%
	BH-RAIL-1A-SS5	3.05-3.66	462.75	393.58	166.53	69.17	30.5%
	BH-RAIL-1A-SS6	4.57-5.18	55.52	52.53	13.59	2.99	7.7%
	BH-RAIL-1A-SS7	6.10-6.70	445.46	427.61	150.03	17.85	6.4%
	BH-RAIL-1B-SS1	0.00-0.61	32.62	29.70	13.71	2.92	18.3%
	BH-RAIL-1B-SS2	0.76-1.37	42.67	34.73	13.72	7.94	37.8%
	BH-RAIL-1B-SS3	1.52-2.13	456.42	369.19	153.25	87.23	40.4%
	BH-RAIL-1B-SS4	2.29-2.90	41.00	31.81	13.64	9.19	50.6%
	BH-RAIL-1B-SS5	3.05-3.66	477.65	397.56	151.67	80.09	32.6%
	BH-RAIL-1B-SS6	4.57-5.18	56.23	53.27	15.11	2.96	7.8%
	BH-RAIL-1B-SS7	6.10-6.17	36.32	34.91	13.90	1.41	6.7%
	BH-RC-1A-SS1	0.00-0.61	43.74	38.03	13.79	5.71	23.6%
	BH-RC-1A-SS2	0.76-1.37	46.16	38.78	13.74	7.38	29.5%
	BH-RC-1A-SS3	1.52-2.13	444.39	385.37	159.11	59.02	26.1%
	BH-RC-1A-SS4	2.29-2.90	53.83	48.66	13.76	5.17	14.8%
	BH-RC-1A-SS5	3.05-3.66	573.40	547.54	173.80	25.86	6.9%
	BH-RC-1A-SS6	4.57-5.18	463.93	439.18	155.61	24.75	8.7%
	BH-RC-1B-SS1	0.00-0.61	38.54	34.72	13.74	3.82	18.2%
	BH-RC-1B-SS2	0.76-1.37	33.85	29.32	13.69	4.53	29.0%
	BH-RC-1B-SS3	1.52-2.13	57.29	46.33	13.75	10.96	33.6%

REMARKS: Continued on next page…

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CSA A283 Certified Laboratory for Concrete Testing
CCIL Certified Laboratory for Aggregates and Asphalt Testing
CSA/CCIL Certified Technicians

Canadian Council of Independent Laboratories
Conseil canadien des laboratoires indépendants

WATER CONTENT TEST

TEST METHOD: LS 701 / ASTM C 566 / D 2216

CONTRACT NO:	18-4022	DATE SAMPLED:	Refer to BH logs
PROJECT:	Nation Rise	SOURCE:	Boreholes
DATE TESTED:	01-Oct-18	TESTED BY:	D. Watts

			Gross (inc. Tare) (g)				
Tare ID	**Sample ID**	**Depth (m)**	**Wet Weight**	**Dry Weight**	**TARE**	**Mass Lost**	**Water %**
	BH-RC-1B-SS4	2.29-2.90	485.09	390.10	161.57	94.99	41.6%
	BH-RC-1B-SS5	3.05-3.66	35.03	27.27	13.79	7.76	57.6%
	BH-RC-1B-SS6	4.57-5.18	37.51	31.63	13.63	5.88	32.7%
	BH-RC-1B-SS7	6.10-6.70	492.56	475.29	156.76	17.27	5.4%
	BH-RC-2A-SS1	0.00-0.61	41.13	37.48	13.73	3.65	15.4%
	BH-RC-2A-SS2	0.76-1.37	576.89	518.64	157.19	58.25	16.1%
	BH-RC-2A-SS3	1.52-2.13	52.38	43.25	13.90	9.13	31.1%
	BH-RC-2A-SS4	2.29-2.90	37.09	33.22	13.93	3.87	20.1%
	BH-RC-2A-SS5	3.05-3.66	465.68	396.92	157.82	68.76	28.8%
	BH-RC-2A-SS6	4.57-5.18	476.64	413.90	157.03	62.74	24.4%
	BH-RC-2A-SS7	6.10-6.70	591.50	568.72	161.18	22.78	5.6%
	BH-RC-2B-SS1	0.00-0.61	41.69	39.02	13.73	2.67	10.6%
	BH-RC-2B-SS2	0.76-1.37	33.15	27.77	14.86	5.38	41.7%
	BH-RC-2B-SS3	1.52-2.13	537.90	407.62	161.99	130.28	53.0%
	BH-RC-2B-SS4	2.29-2.90	55.78	45.92	13.65	9.86	30.6%
	BH-RC-2B-SS5	3.05-3.66	468.53	407.76	172.55	60.77	25.8%
	BH-RC-2B-SS6	4.57-5.18	44.40	43.22	14.81	1.18	4.2%
	BH-RC-2B-SS7	6.10-6.70	463.02	441.81	161.24	21.21	7.6%
	BH-RC-2B-SS8	7.62-8.23	466.69	448.13	162.00	18.56	6.5%

REMARKS:

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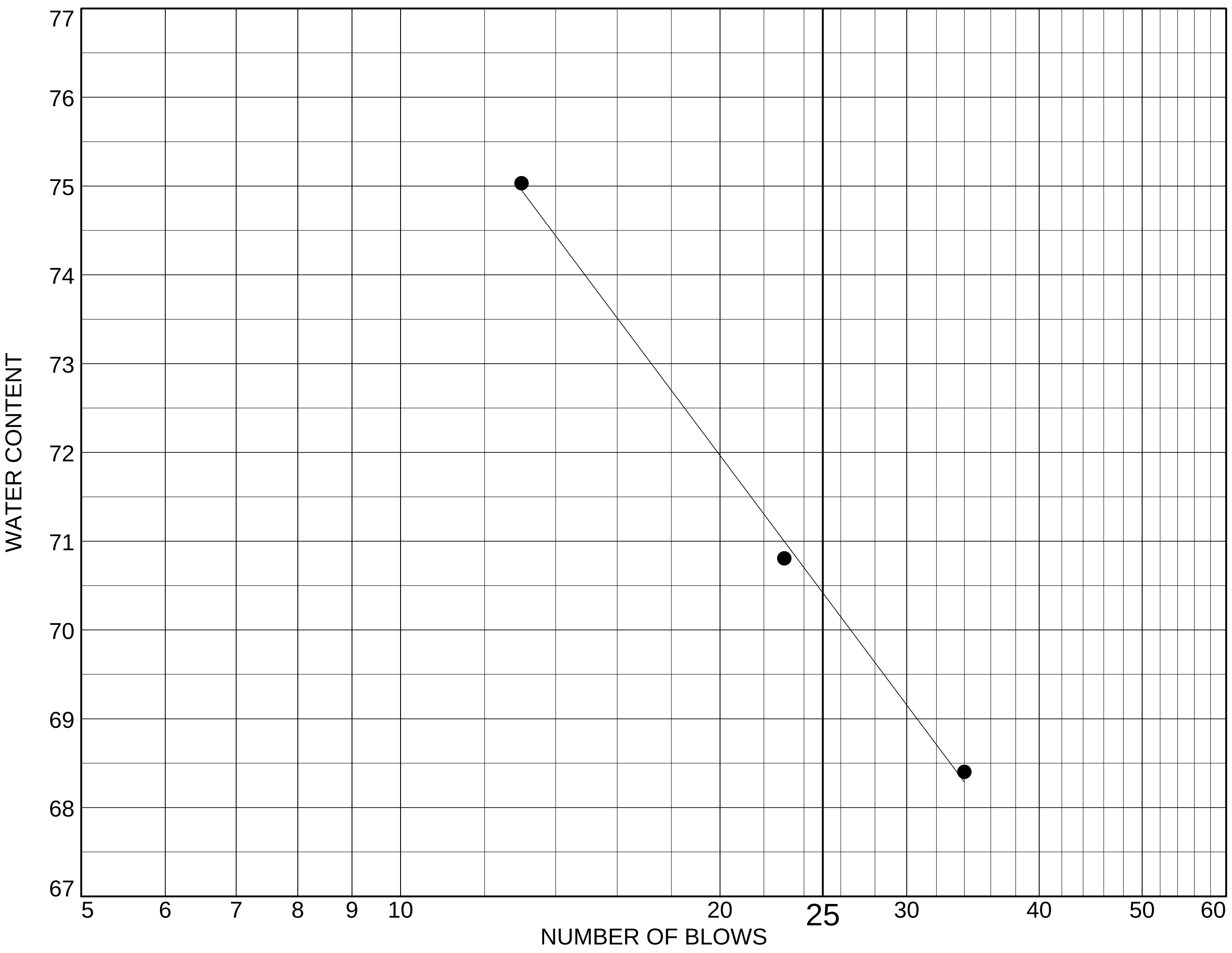
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH Rail 1A SS3	3	1.52-2.13m	37.2	28	70	42	CH

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman

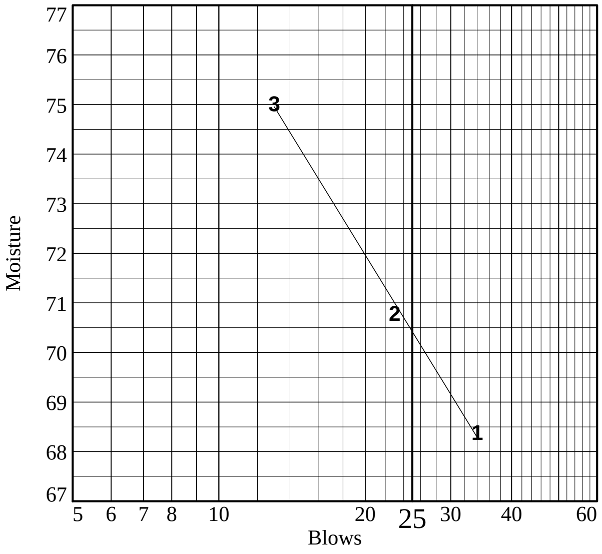
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Rail 1A SS3
Depth: 1.52-2.13m **Sample Number:** 3
USCS: CH **AASHTO:** A-7-6(49)
Tested by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	31.57	30.02	30.42			
Dry+Tare	25.92	24.49	24.56			
Tare	17.66	16.68	16.75			
# Blows	34	23	13			
Moisture	68.4	70.8	75.0			

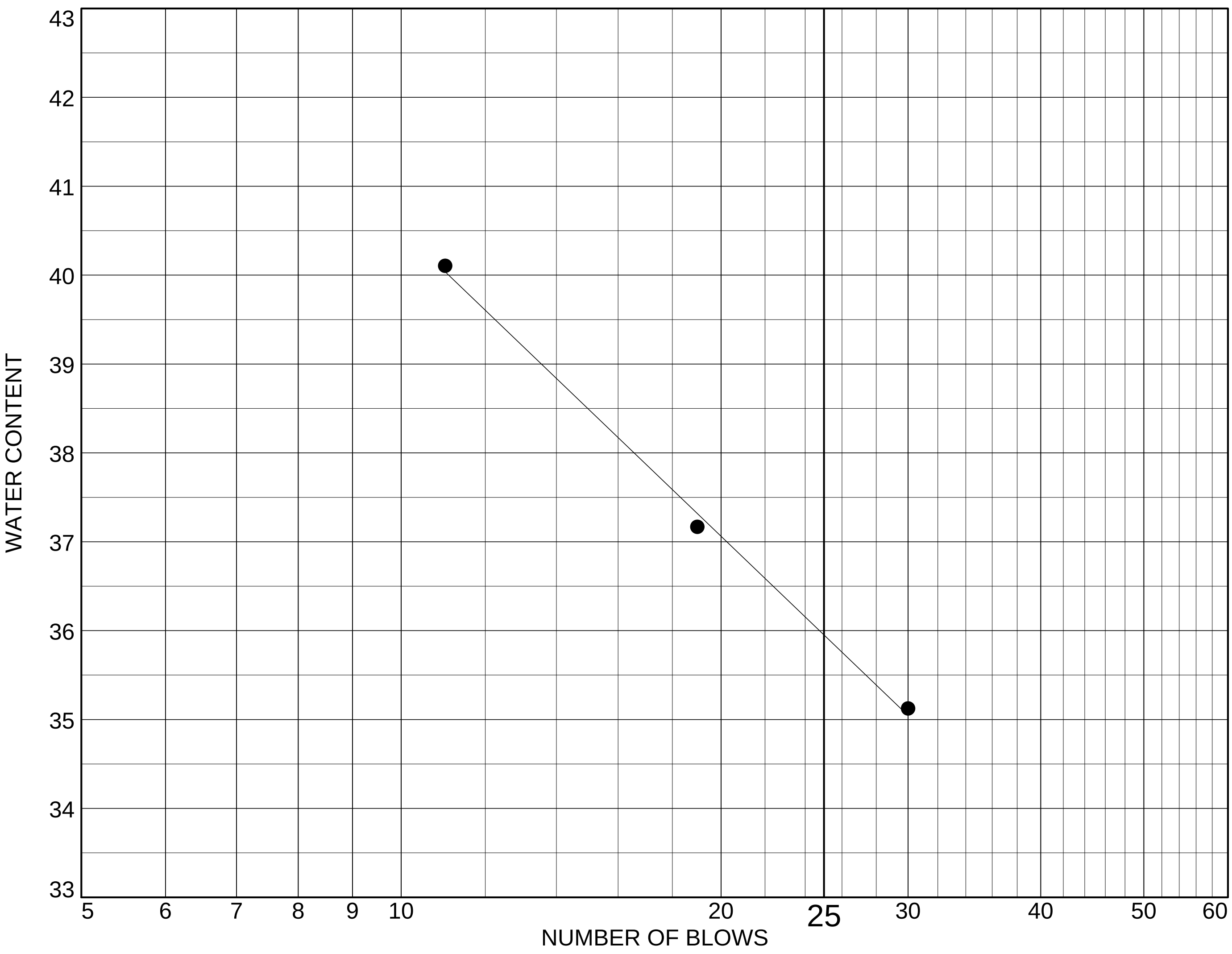


Liquid Limit= 70
Plastic Limit= 28
Plasticity Index= 42
Natural Moisture= 37.2
Liquidity Index= 0.2

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	18.99	20.90			
Dry+Tare	17.86	19.31			
Tare	13.72	13.59			
Moisture	27.3	27.8			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH Rail 1A SS5	5	3.05-3.66m	37.2	21	36	15	

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Client: EDP

Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman

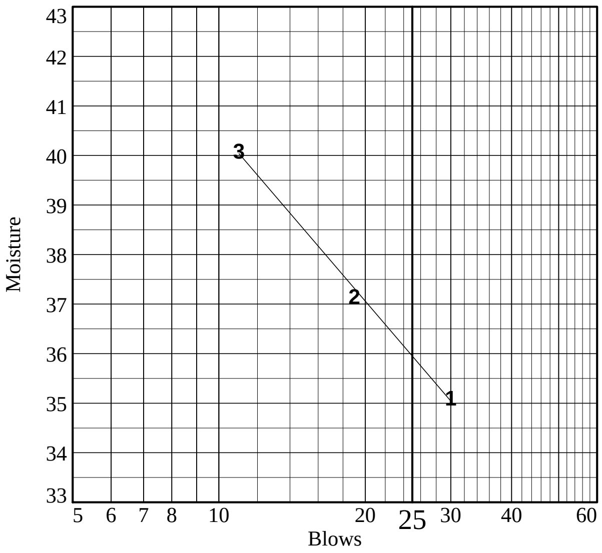
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Rail 1A SS5
Depth: 3.05-3.66m **Sample Number:** 5
AASHTO: A-6(16)
Tested by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	27.31	27.24	32.51			
Dry+Tare	23.78	23.59	27.14			
Tare	13.73	13.77	13.75			
# Blows	30	19	11			
Moisture	35.1	37.2	40.1			



Liquid Limit= 36
Plastic Limit= 21
Plasticity Index= 15
Natural Moisture= 37.2
Liquidity Index= 1.1

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.22	21.04			
Dry+Tare	20.75	19.76			
Tare	13.91	13.69			
Moisture	21.5	21.1			

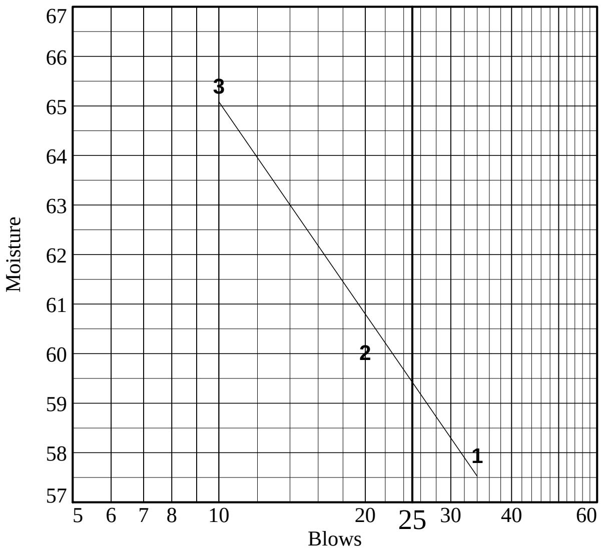
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Rail 1B SS3
Depth: 1.52-2.13m
Sample Number: 3
USCS: CH
AASHTO: A-7-6(37)
Tested by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	26.71	30.43	27.38			
Dry+Tare	21.94	24.15	21.99			
Tare	13.71	13.69	13.75			
# Blows	34	20	10			
Moisture	58.0	60.0	65.4			

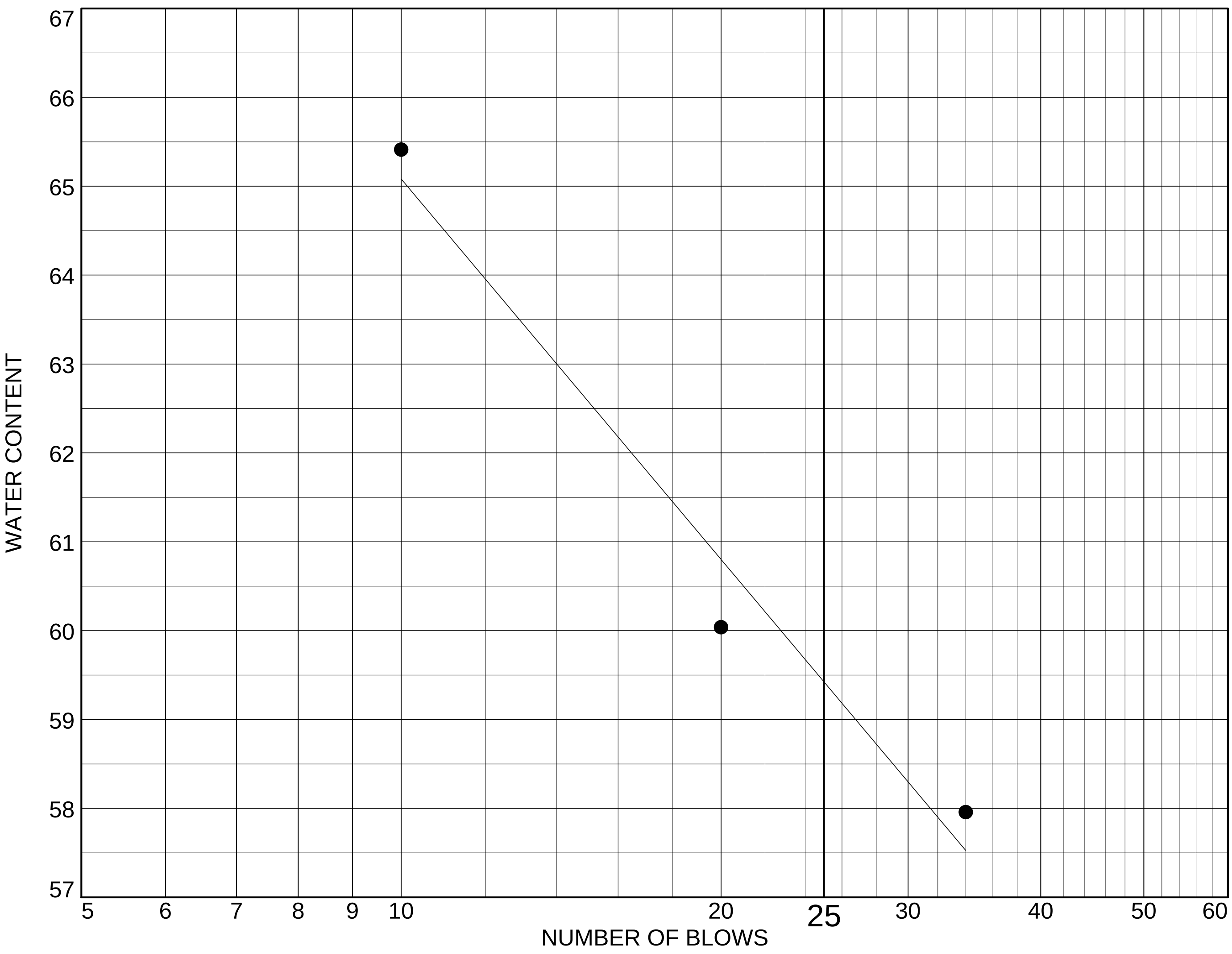


Liquid Limit= 59
Plastic Limit= 25
Plasticity Index= 34
Natural Moisture= 28.8
Liquidity Index= 0.1

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	19.40	18.32			
Dry+Tare	18.27	17.40			
Tare	13.80	13.77			
Moisture	25.3	25.3			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH Rail 1B SS3	3	1.52-2.13m	28.8	25	59	34	CH

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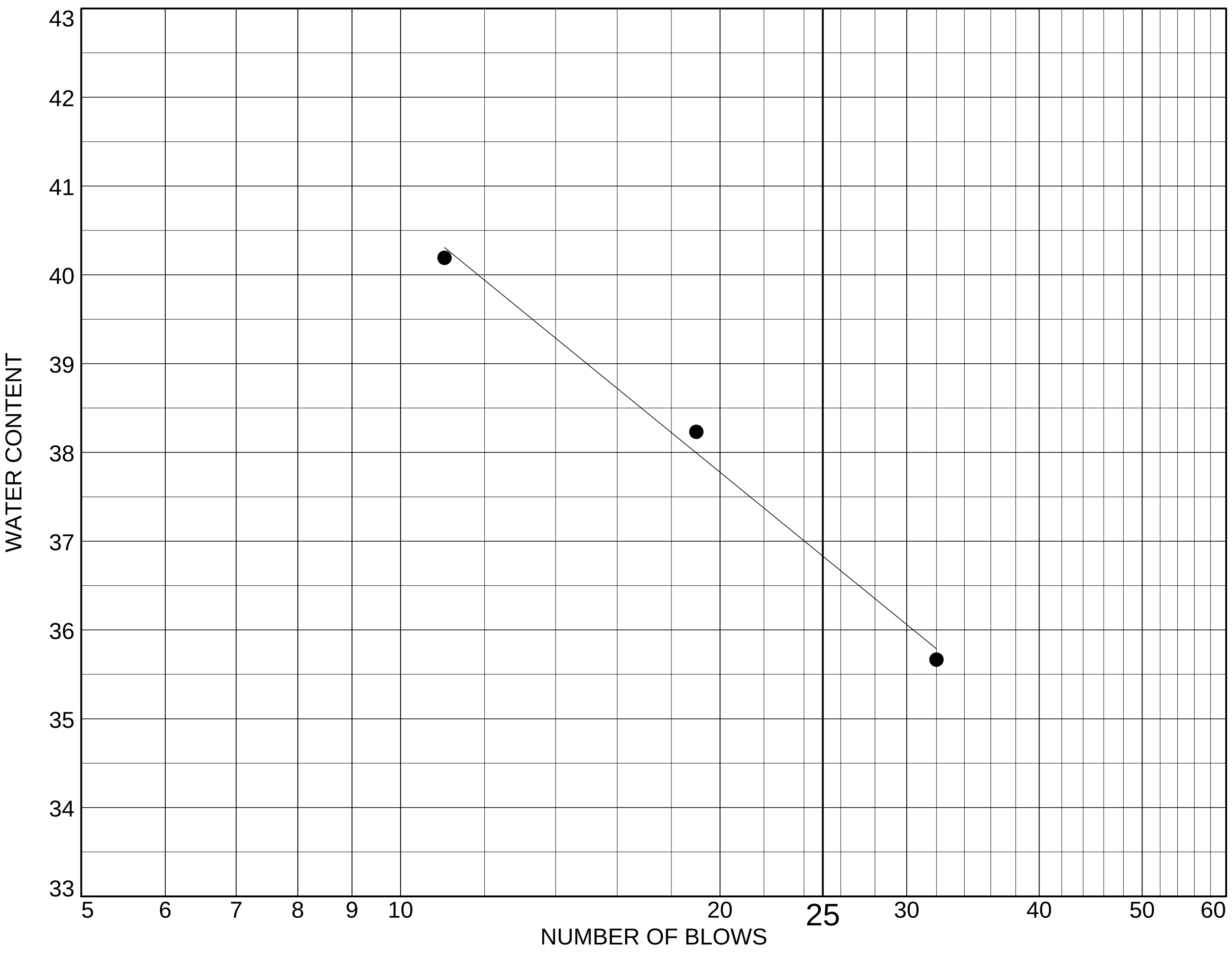
adam.byers@TULLOCH.ca

Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH Rail 1B SS5	5	3.05-3.66	24.6	20	37	17	CL

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adam.byers@TULLOCH.ca

Client: EDP

Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman

LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH Rail 1B SS5

Depth: 3.05-3.66 **Sample Number:** 5

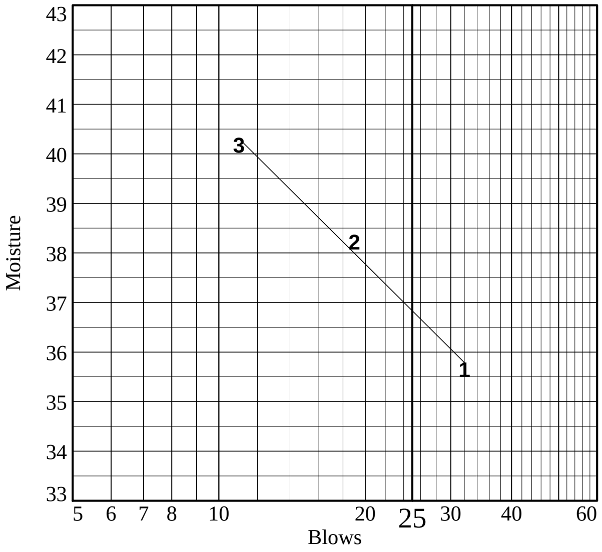
Material Description: Unable to perfrom atterburg limits test

USCS: CL **AASHTO:** A-6(18)

Tested by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	32.50	31.18	31.60			
Dry+Tare	28.22	27.20	27.40			
Tare	16.22	16.79	16.95			
# Blows	32	19	11			
Moisture	35.7	38.2	40.2			



Liquid Limit= 37

Plastic Limit= 20

Plasticity Index= 17

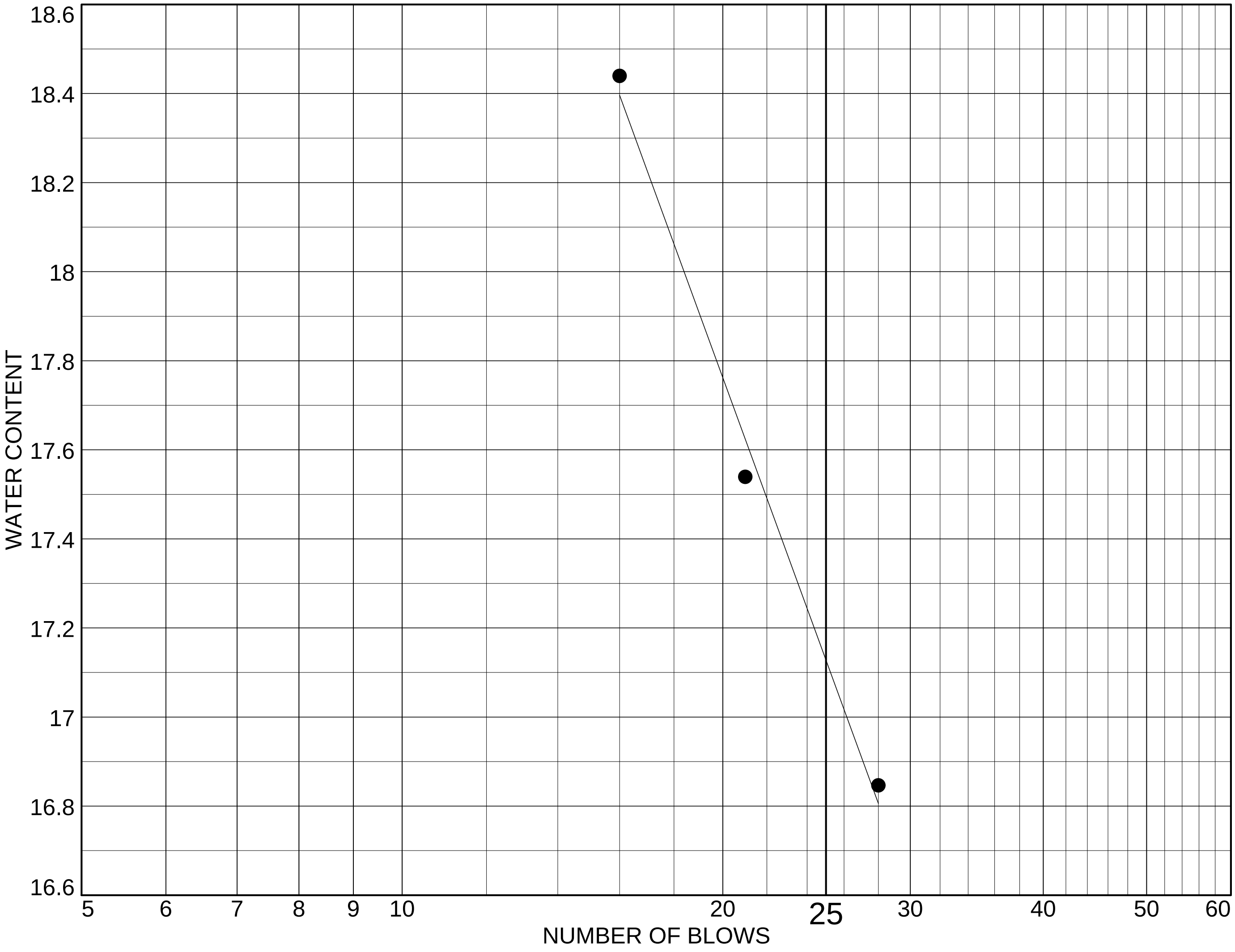
Natural Moisture= 24.6

Liquidity Index= 0.3

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	24.05	21.96			
Dry+Tare	22.78	20.81			
Tare	16.36	15.03			
Moisture	19.8	19.9			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 1A SS6	6	4.57-5.18m	7.1	11	17	6	CL-ML

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Client: EDP

Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: D.Stadnisky

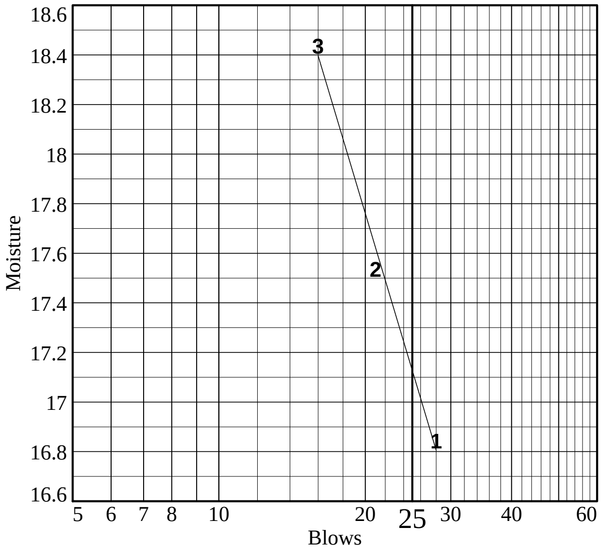
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 1A SS6
Depth: 4.57-5.18m **Sample Number:** 6
USCS: CL-ML **AASHTO:** A-4(1)
Tested by: D.Stadnisky

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	24.47	22.73	23.78			
Dry+Tare	22.91	21.39	22.22			
Tare	13.65	13.75	13.76			
# Blows	28	21	16			
Moisture	16.8	17.5	18.4			

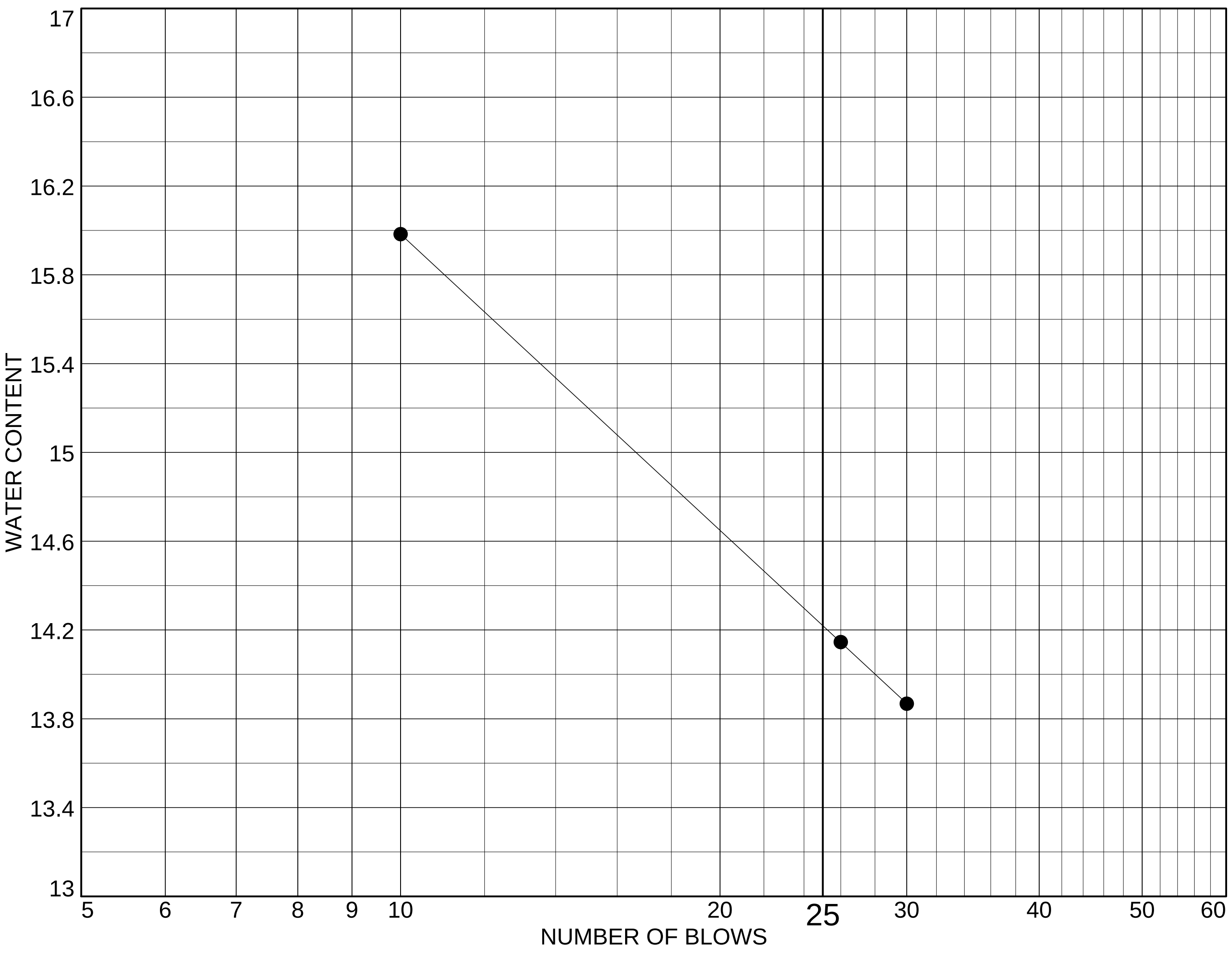


Liquid Limit= 17
Plastic Limit= 11
Plasticity Index= 6
Natural Moisture= 7.1
Liquidity Index= -0.7

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	15.93	15.91			
Dry+Tare	15.71	15.68			
Tare	13.73	13.59			
Moisture	11.1	11.0			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 1B SS7	7	6.10-6.70m	6.3	11	14	3	GM

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: D.Stadnisky

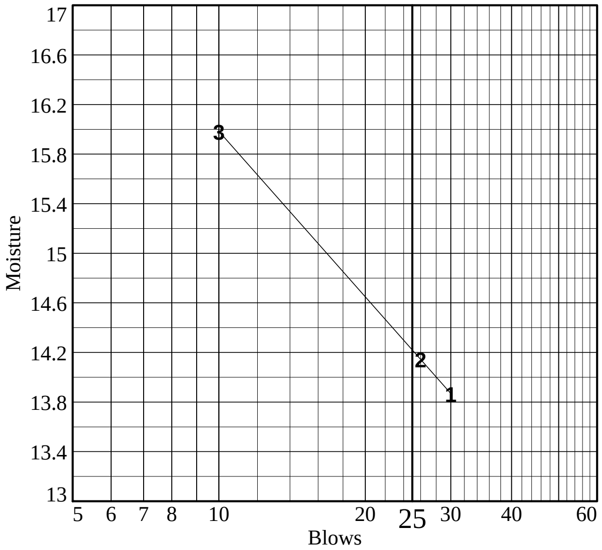
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 1B SS7
Depth: 6.10-6.70m
Sample Number: 7
USCS: GM
AASHTO: A-4(0)
Tested by: D.Stadnisky

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	24.21	34.98	26.56			
Dry+Tare	22.93	33.54	25.04			
Tare	13.70	23.36	15.53			
# Blows	30	26	10			
Moisture	13.9	14.1	16.0			

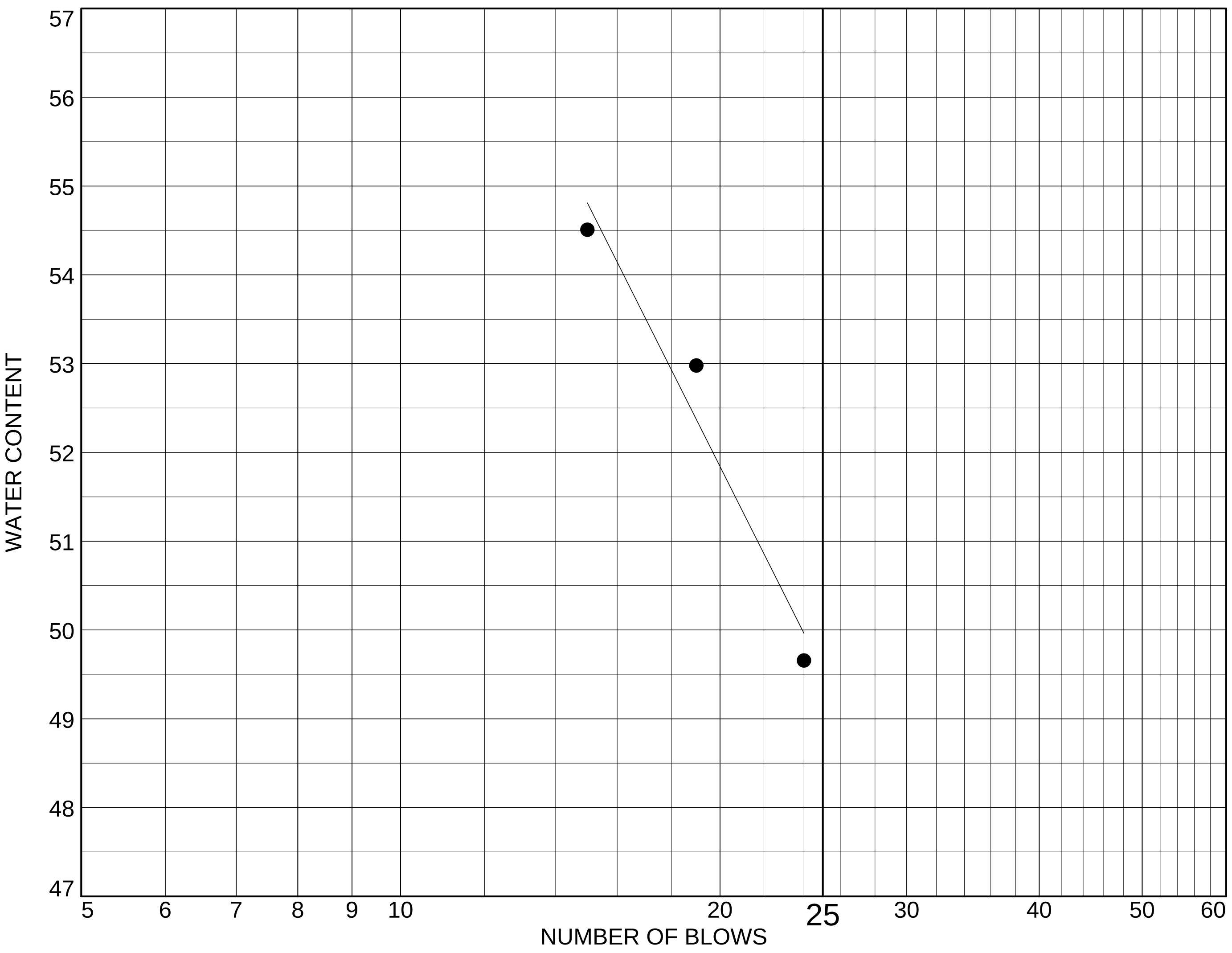


Liquid Limit= 14
Plastic Limit= 11
Plasticity Index= 3
Natural Moisture= 6.3
Liquidity Index= -1.6

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	17.50	23.44			
Dry+Tare	17.13	23.06			
Tare	13.61	19.58			
Moisture	10.5	10.9			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 1B SS4	4	2.29-2.90	29.4	26	50	24	CH

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Client: EDP

Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: D.Stadnisky **Checked By:** S.Hoffman

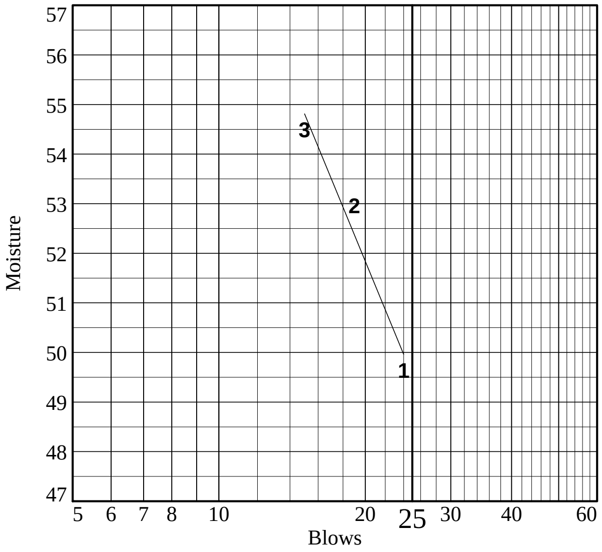
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 1B SS4
Depth: 2.29-2.90 **Sample Number:** 4
USCS: CH **AASHTO:** A-7-6(28)
Tested by: D.Stadnisky **Checked by:** S.Hoffman

Liquid Limit Data

Run No.	**1**	**2**	**3**	**4**	**5**	**6**
Wet+Tare	23.53	22.20	22.46			
Dry+Tare	20.64	19.71	19.74			
Tare	14.82	15.01	14.75			
# Blows	24	19	15			
Moisture	49.7	53.0	54.5			

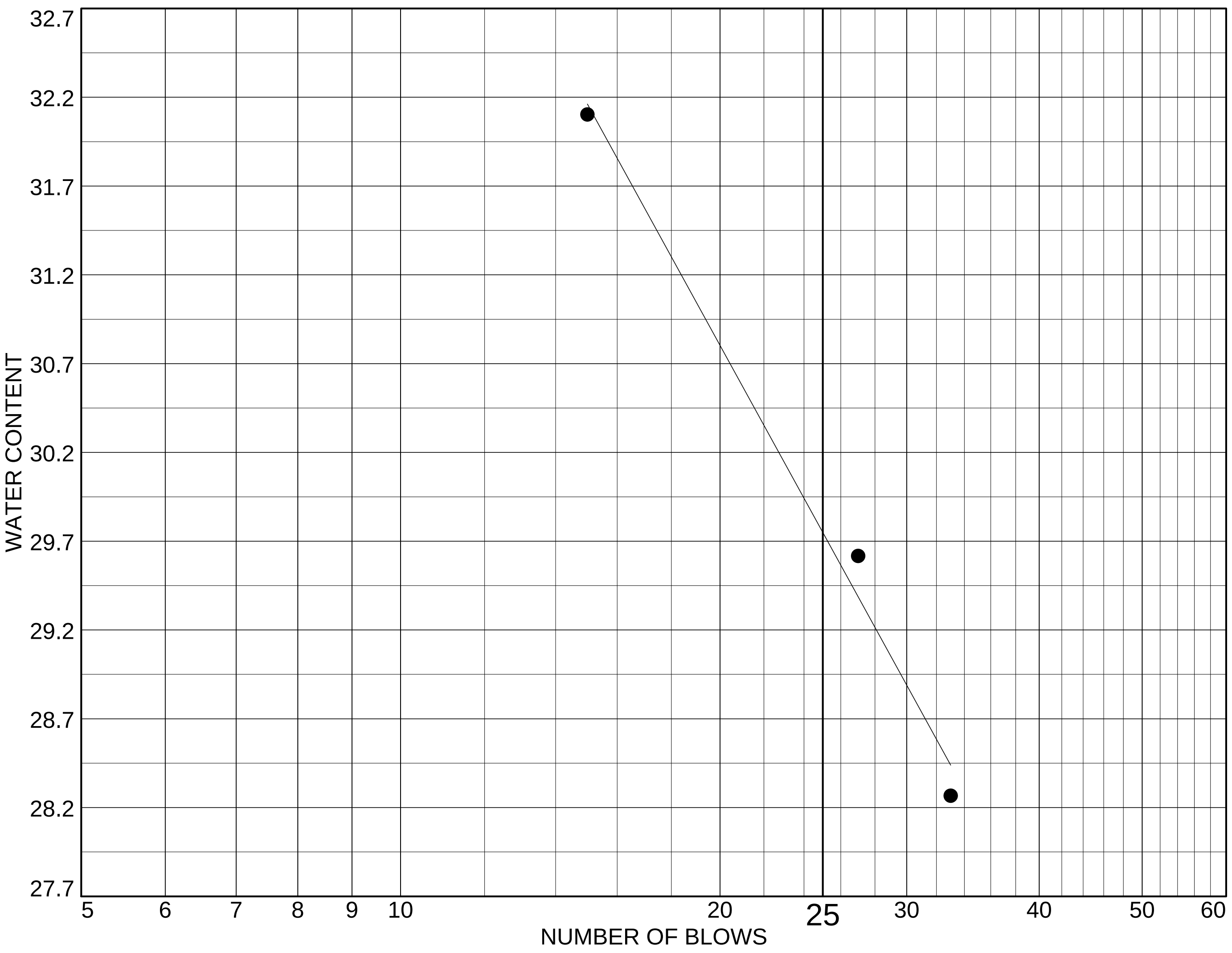


Liquid Limit= 50
Plastic Limit= 26
Plasticity Index= 24
Natural Moisture= 29.4
Liquidity Index= 0.1

Plastic Limit Data

Run No.	**1**	**2**	**3**	**4**	
Wet+Tare	17.14	16.28			
Dry+Tare	16.71	16.01			
Tare	14.89	15.07			
Moisture	23.6	28.7			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 2A SS5	5	3.05-3.66m	22.3	19	30	11	CL

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Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: D.Stadnisky

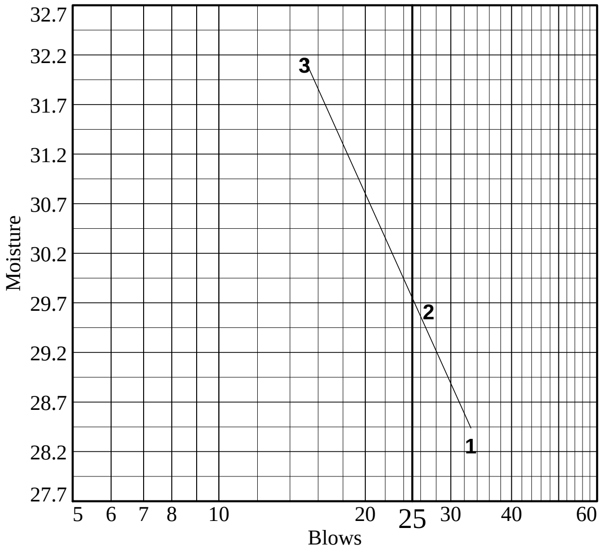
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 2A SS5
Depth: 3.05-3.66m
Sample Number: 5
USCS: CL
AASHTO: A-6(10)
Tested by: D.Stadnisky

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	22.96	21.34	20.96			
Dry+Tare	20.97	19.64	19.22			
Tare	13.93	13.90	13.80			
# Blows	33	27	15			
Moisture	28.3	29.6	32.1			

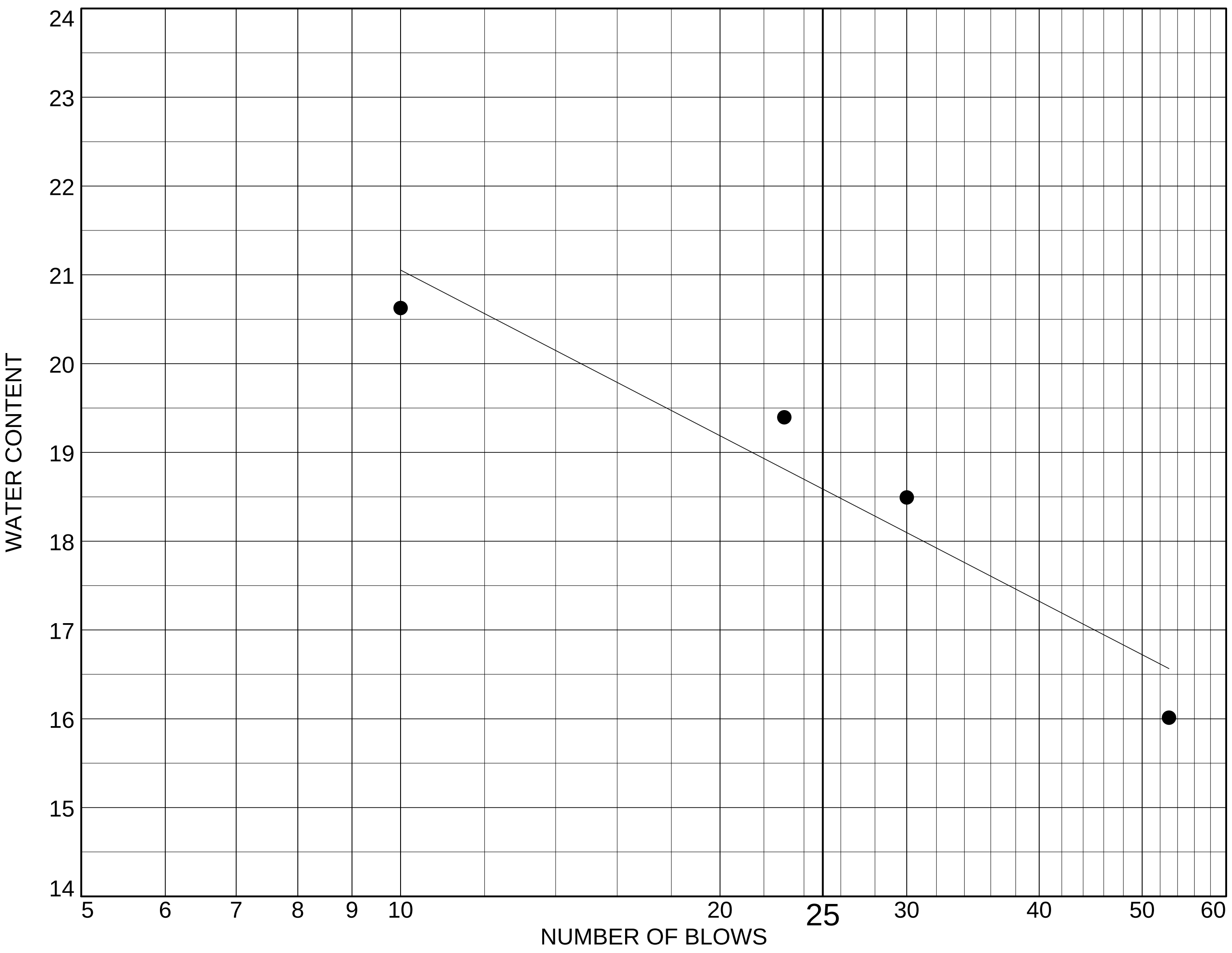


Liquid Limit= 30
Plastic Limit= 19
Plasticity Index= 11
Natural Moisture= 22.3
Liquidity Index= 0.3

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	16.73	16.27			
Dry+Tare	16.27	15.86			
Tare	13.79	13.64			
Moisture	18.5	18.5			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 2B SS7	7	6.10-6.70m	7	14	19	5	CL-ML

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman

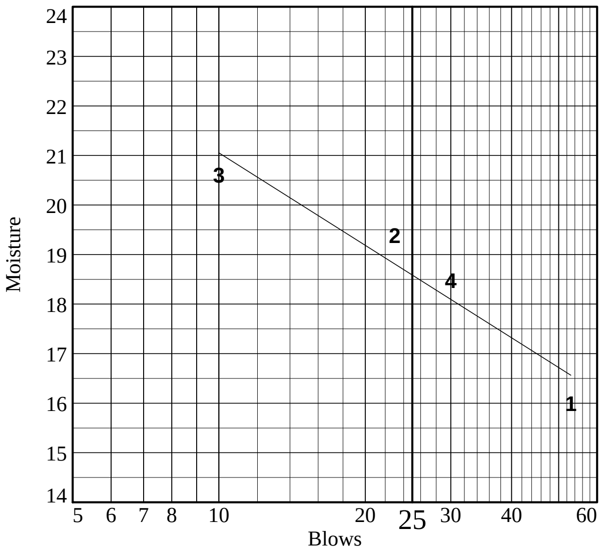
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 2B SS7
Depth: 6.10-6.70m
Sample Number: 7
USCS: CL-ML
AASHTO: A-4(0)
Tested by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.77	29.77	27.97	31.50		
Dry+Tare	27.73	27.33	25.73	28.90		
Tare	14.99	14.75	14.87	14.84		
# Blows	53	23	10	30		
Moisture	16.0	19.4	20.6	18.5		

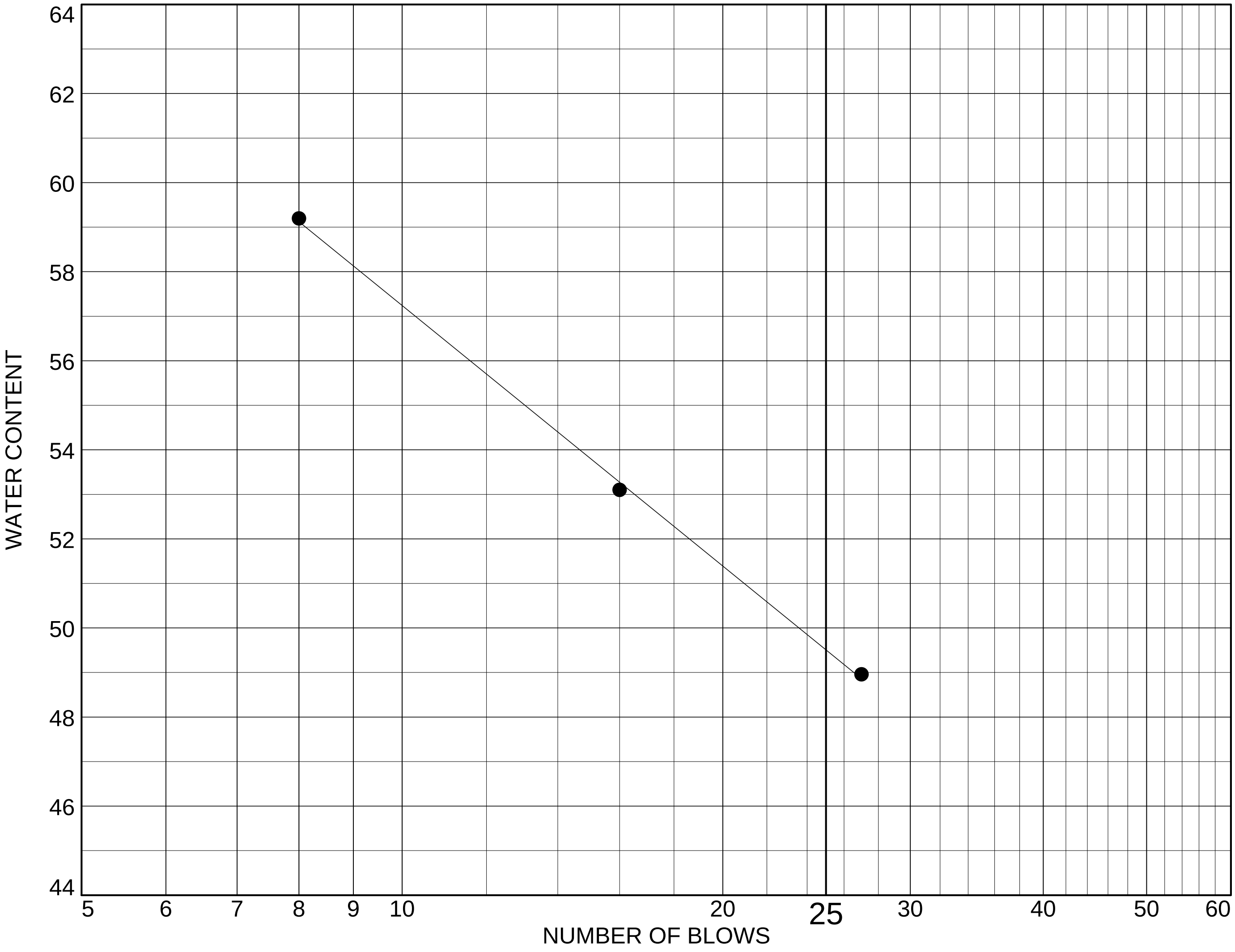


Liquid Limit= 19
Plastic Limit= 14
Plasticity Index= 5
Natural Moisture= 7
Liquidity Index= -1.4

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	20.93	20.55			
Dry+Tare	20.03	19.69			
Tare	13.69	13.61			
Moisture	14.2	14.1			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 2B SS3	3	1.52-2.13m	34.7	30	50	20	MH

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman

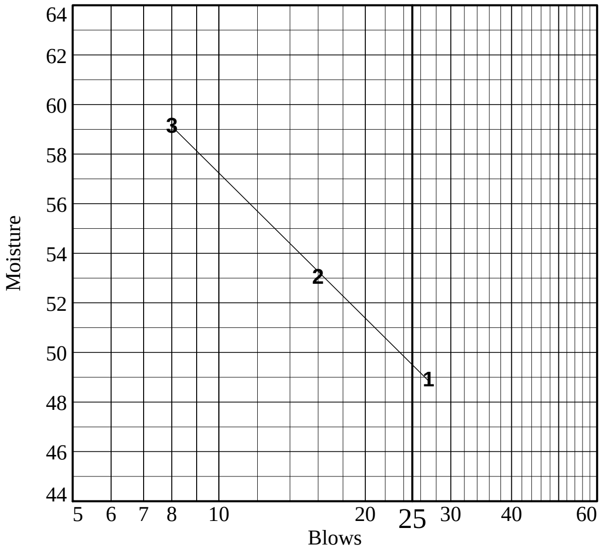
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 2B SS3
Depth: 1.52-2.13m
Sample Number: 3
USCS: MH
AASHTO: A-7-5(24)
Tested by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	37.24	40.95	35.89			
Dry+Tare	31.60	36.50	30.29			
Tare	20.08	28.12	20.83			
# Blows	27	16	8			
Moisture	49.0	53.1	59.2			

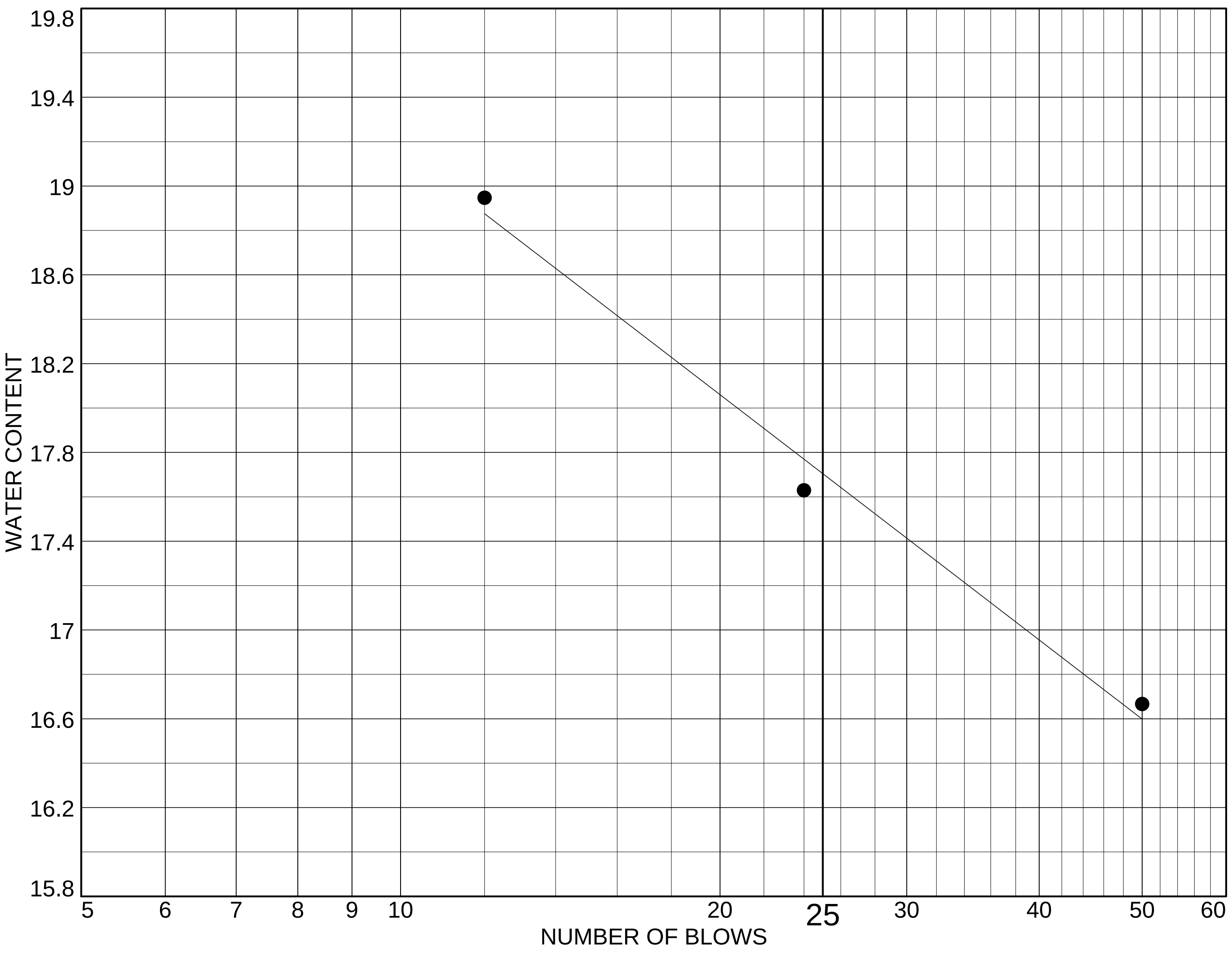


Liquid Limit= 50
Plastic Limit= 30
Plasticity Index= 20
Natural Moisture= 34.7
Liquidity Index= 0.2

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	21.55	20.40			
Dry+Tare	20.55	19.58			
Tare	17.30	16.83			
Moisture	30.8	29.8			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 2B SS8	8	7.62-8.23m	6.1	13	18	5	GC-GM

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman

LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2B SS8

Depth: 7.62-8.23m

Sample Number: 8

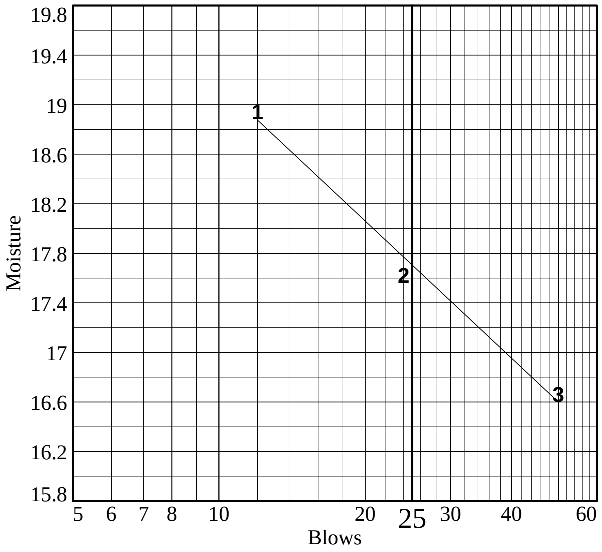
USCS: GC-GM

AASHTO: A-1-b

Tested by: S.Hoffman

Liquid Limit Data

Run No.	**1**	**2**	**3**	**4**	**5**	**6**
Wet+Tare	24.97	22.44	22.20			
Dry+Tare	23.35	21.28	21.55			
Tare	14.80	14.70	17.65			
# Blows	12	24	50			
Moisture	18.9	17.6	16.7			



Liquid Limit= 18

Plastic Limit= 13

Plasticity Index= 5

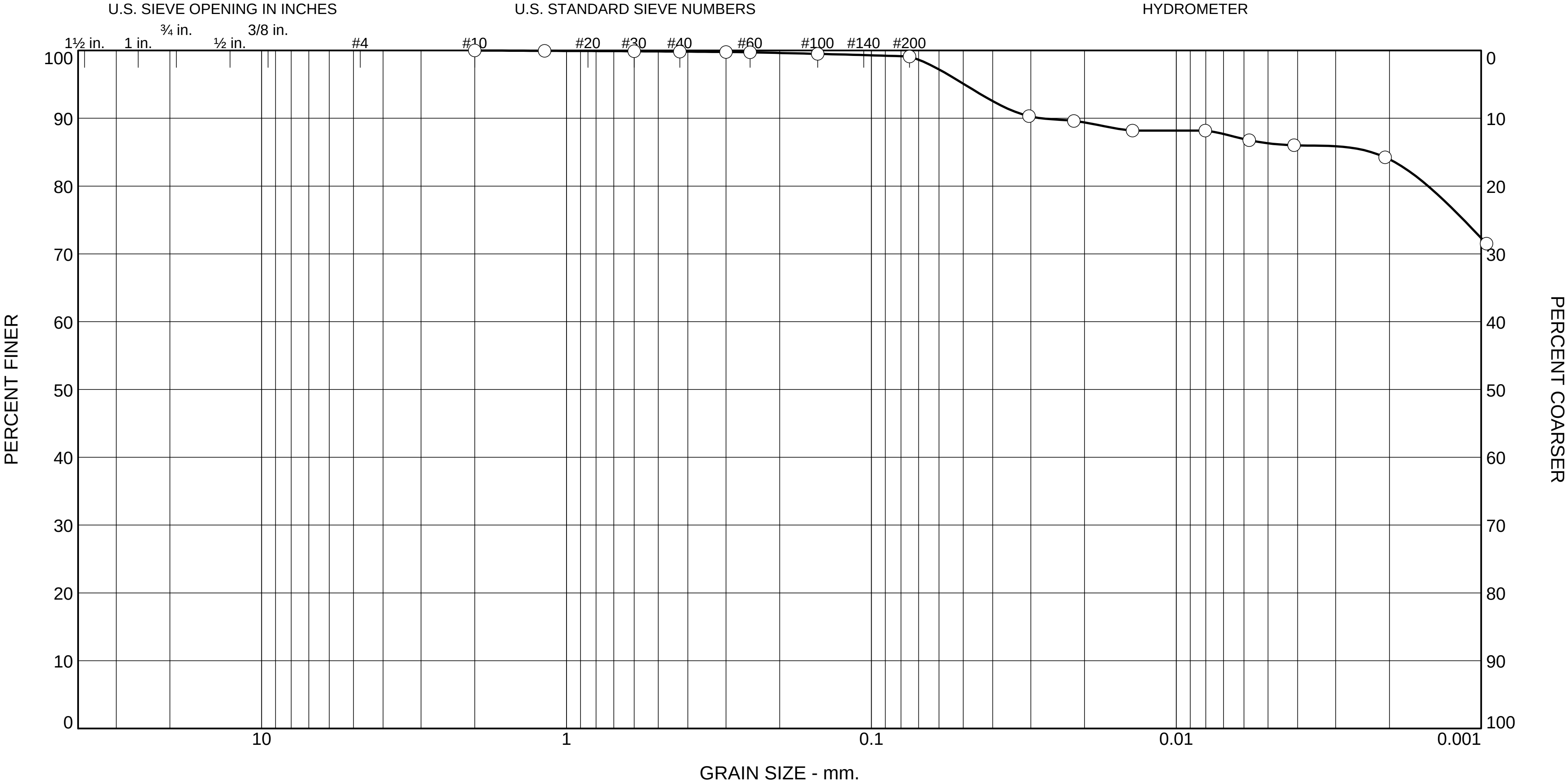
Natural Moisture= 6.1

Liquidity Index= -1.4

Plastic Limit Data

Run No.	**1**	**2**	**3**	**4**	
Wet+Tare	24.05	23.06			
Dry+Tare	22.99	22.14			
Tare	14.96	15.11			
Moisture	13.2	13.1			

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.2	0.7	12.8	86.3

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH Rail 1A SS3 Depth: 1.52-2.13m Sample Number: 3			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T.Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

2018-10-18

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH Rail 1A SS3

Depth: 1.52-2.13m **Sample Number:** 3

Liquid Limit: 70 **Plastic Limit:** 28

USCS Classification: CH **AASHTO Classification:** A-7-6(49)

Tested by: T.Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
343.61	162.99	#10	0.00	0.00	100.0
		#16	0.10	0.00	99.9
		#30	0.10	0.00	99.9
		#40	0.10	0.00	99.8
		#50	0.10	0.00	99.8
		#60	0.10	0.00	99.7
		#100	0.40	0.00	99.5
		#200	0.70	0.00	99.1

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =70.4
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	22.7	68.0	63.6	0.0132	67.0	5.3	0.0304	90.3
2.00	22.7	67.5	63.1	0.0132	66.5	5.4	0.0217	89.6
5.00	22.7	66.5	62.1	0.0132	65.5	5.6	0.0139	88.2
15.00	22.7	66.5	62.1	0.0132	65.5	5.6	0.0080	88.2
30.00	22.7	65.5	61.1	0.0132	64.5	5.7	0.0058	86.8
60.00	22.6	65.0	60.6	0.0132	64.0	5.8	0.0041	86.0
250.00	21.6	64.0	59.3	0.0134	63.0	6.0	0.0021	84.3
1440.00	21.7	55.0	50.3	0.0134	54.0	7.4	0.0010	71.5

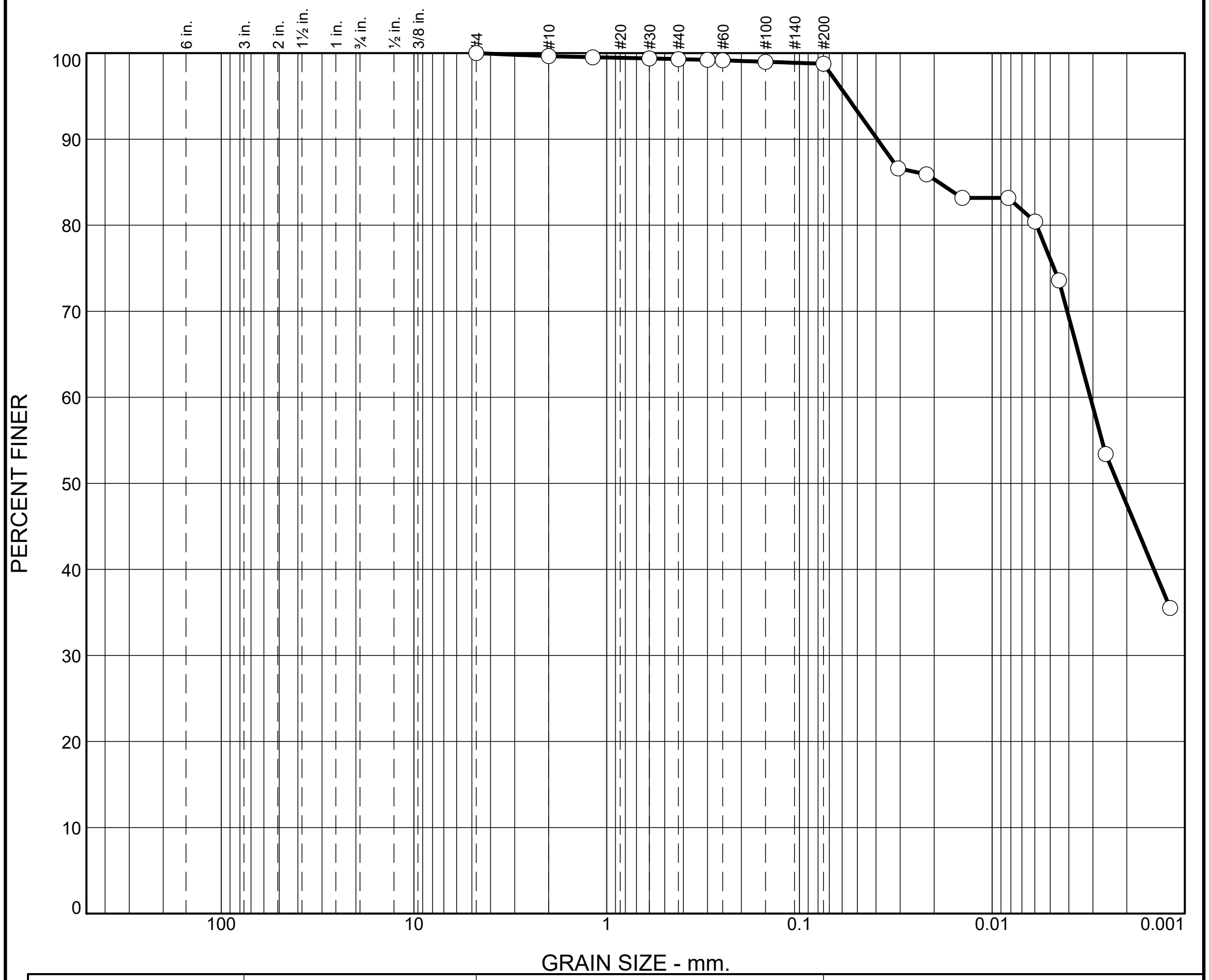
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.2	0.7	0.9	12.6	86.5	99.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
								0.0016	0.0028	0.0261	0.0492

Fineness Modulus
0.01

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.4	0.3	0.5	22.7	76.1

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	36	21	0.0190	0.0031	0.0022					

Material Description	USCS	AASHTO
○	CL	A-6(16)

Project No. 18-4022 **Client:** EDP

Project: Nation Rise Wind Farm

○ **Source:** BH Rail 1A SS5 **Depth:** 3.05-3.66m **Sample No.:** 5

Remarks:

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Figure

Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

2018-10-22

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Rail 1A SS5
Depth: 3.05-3.66m
Sample Number: 5
Liquid Limit: 36
Plastic Limit: 21
USCS Classification: CL
AASHTO Classification: A-6(16)
Tested by: T. Linley
Checked by: D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
393.58	166.53	#4	0.00	0.00	100.0
		#10	0.80	0.00	99.6
		#16	0.30	0.00	99.5
		#30	0.30	0.00	99.4
		#40	0.20	0.00	99.3
		#50	0.20	0.00	99.2
		#60	0.10	0.00	99.2
		#100	0.40	0.00	99.0
		#200	0.50	0.00	98.8

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.6
Weight of hydrometer sample =72.5
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	22.4	67.5	63.0	0.0132	66.5	5.4	0.0308	86.6
2.00	22.4	67.0	62.5	0.0132	66.0	5.5	0.0219	85.9
5.00	22.4	65.0	60.5	0.0132	64.0	5.8	0.0143	83.2
15.00	22.4	65.0	60.5	0.0132	64.0	5.8	0.0082	83.2
30.00	22.4	63.0	58.5	0.0132	62.0	6.1	0.0060	80.4
60.00	22.5	58.0	53.5	0.0132	57.0	6.9	0.0045	73.6
250.00	21.8	43.5	38.9	0.0133	42.5	9.3	0.0026	53.4
1440.00	21.7	30.5	25.8	0.0134	29.5	11.5	0.0012	35.5

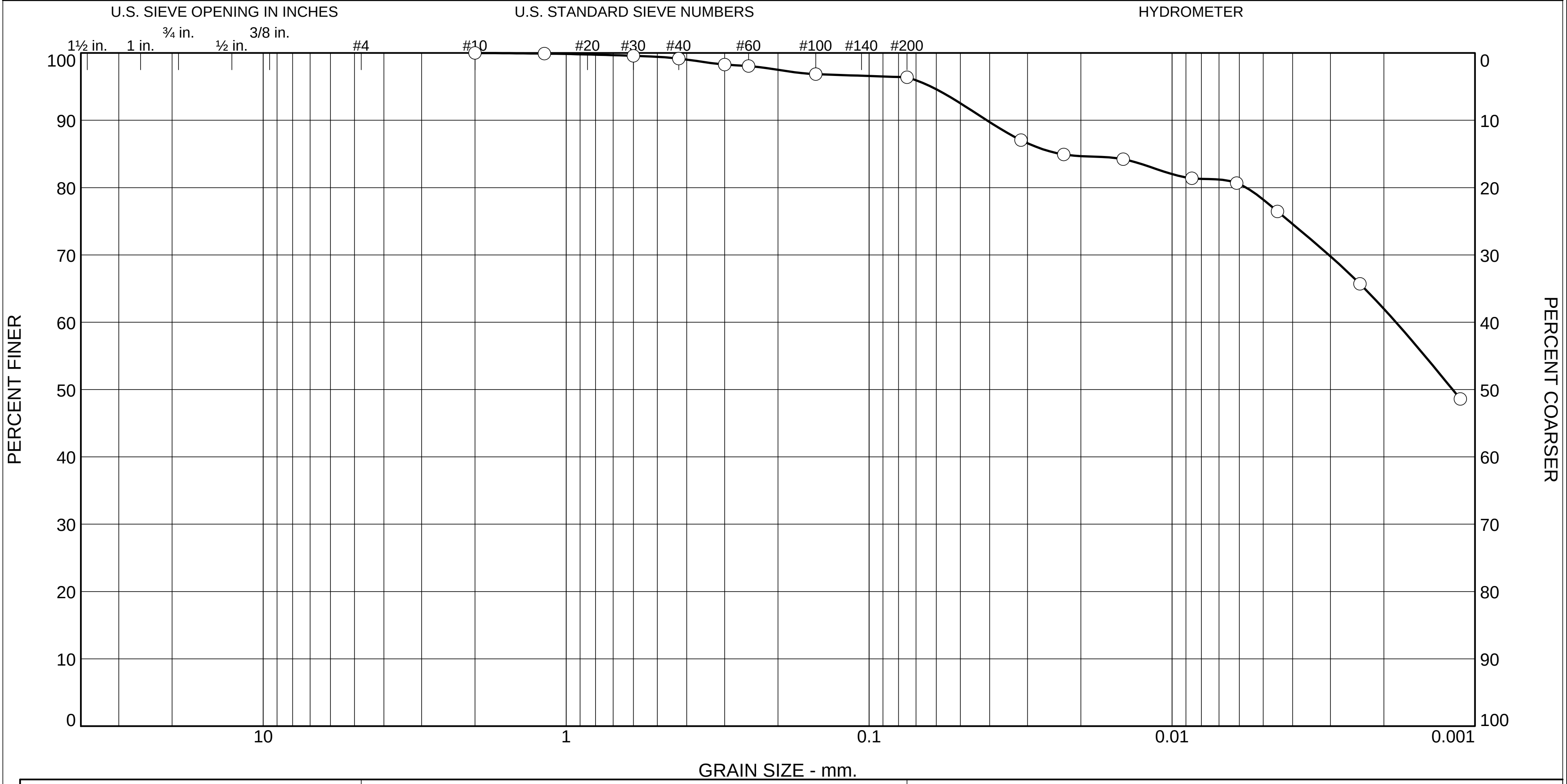
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.4	0.3	0.5	1.2	22.7	76.1	98.8

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0014	0.0022	0.0031	0.0059	0.0190	0.0395	0.0569

Fineness Modulus
0.03

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.8	2.8	18.2	78.2

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH Rail 1B SS3 Depth: 1.52-2.13m Sample Number: 3			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Rail 1B SS3
Depth: 1.52-2.13m **Sample Number:** 3
Tested by: T. Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
369.19	153.25	#10	0.00	0.00	100.0	0.0
		#16	0.20	0.00	99.9	0.1
		#30	0.70	0.00	99.6	0.4
		#40	0.90	0.00	99.2	0.8
		#50	1.90	0.00	98.3	1.7
		#60	0.50	0.00	98.1	1.9
		#100	2.60	0.00	96.9	3.1
		#200	1.00	0.00	96.4	3.6

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =70.6
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.2	66.0	61.5	0.0133	65.0	5.6	0.0315	87.1	12.9
2.00	22.2	64.5	60.0	0.0133	63.5	5.9	0.0228	84.9	15.1
5.00	22.2	64.0	59.5	0.0133	63.0	6.0	0.0145	84.2	15.8
15.00	22.2	62.0	57.5	0.0133	61.0	6.3	0.0086	81.4	18.6
30.00	22.2	61.5	57.0	0.0133	60.5	6.4	0.0061	80.7	19.3
60.00	22.3	58.5	54.0	0.0133	57.5	6.9	0.0045	76.5	23.5
250.00	21.9	51.0	46.4	0.0133	50.0	8.1	0.0024	65.7	34.3
1440.00	21.6	39.0	34.3	0.0134	38.0	10.1	0.0011	48.6	51.4

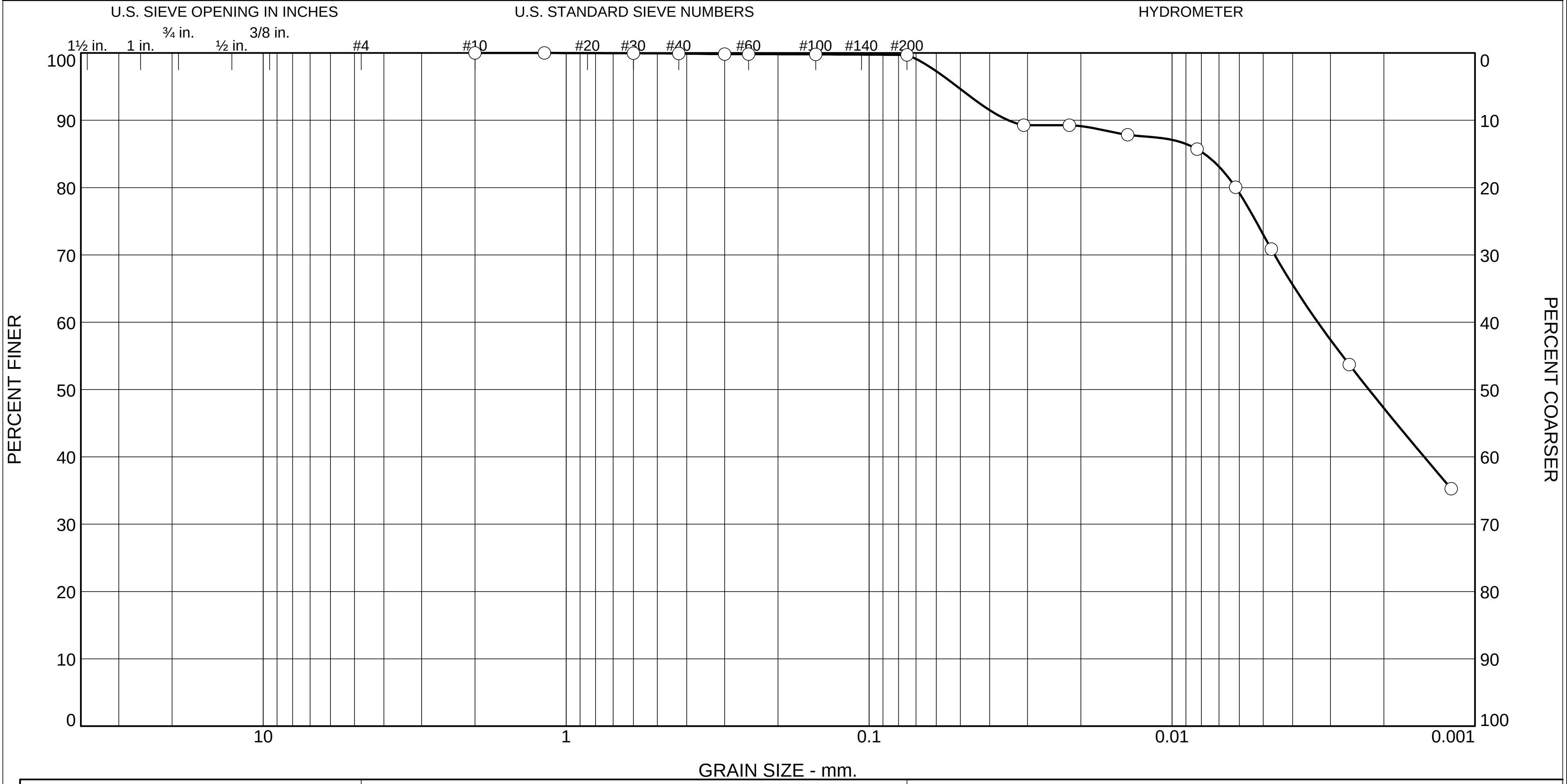
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.8	2.8	3.6	18.2	78.2	96.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.0012	0.0018	0.0057	0.0233	0.0409	0.0625

Fineness Modulus
0.05

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.2	26.7	73.0

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH Rail 1B SS5 Depth: 3.05-3.66 Sample Number: 5			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH Rail 1B SS5
Depth: 3.05-3.66 **Sample Number:** 5
Material Description: Unable to perfrom atterburg limits test
Tested by: T. Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
397.56	151.67	#10	0.00	0.00	100.0	0.0
		#16	0.00	0.00	100.0	0.0
		#30	0.10	0.00	100.0	0.0
		#40	0.10	0.00	99.9	0.1
		#50	0.20	0.00	99.8	0.2
		#60	0.00	0.00	99.8	0.2
		#100	0.10	0.00	99.8	0.2
		#200	0.20	0.00	99.7	0.3

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =70.5
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.1	67.5	62.9	0.0133	66.5	5.4	0.0309	89.3	10.7
2.00	22.1	67.5	62.9	0.0133	66.5	5.4	0.0218	89.3	10.7
5.00	22.1	66.5	61.9	0.0133	65.5	5.6	0.0140	87.8	12.2
15.00	22.1	65.0	60.4	0.0133	64.0	5.8	0.0083	85.7	14.3
30.00	22.1	61.0	56.4	0.0133	60.0	6.5	0.0062	80.0	20.0
60.00	22.2	54.5	50.0	0.0133	53.5	7.5	0.0047	70.9	29.1
250.00	21.8	42.5	37.9	0.0133	41.5	9.5	0.0026	53.7	46.3
1440.00	21.8	29.5	24.9	0.0133	28.5	11.6	0.0012	35.3	64.7

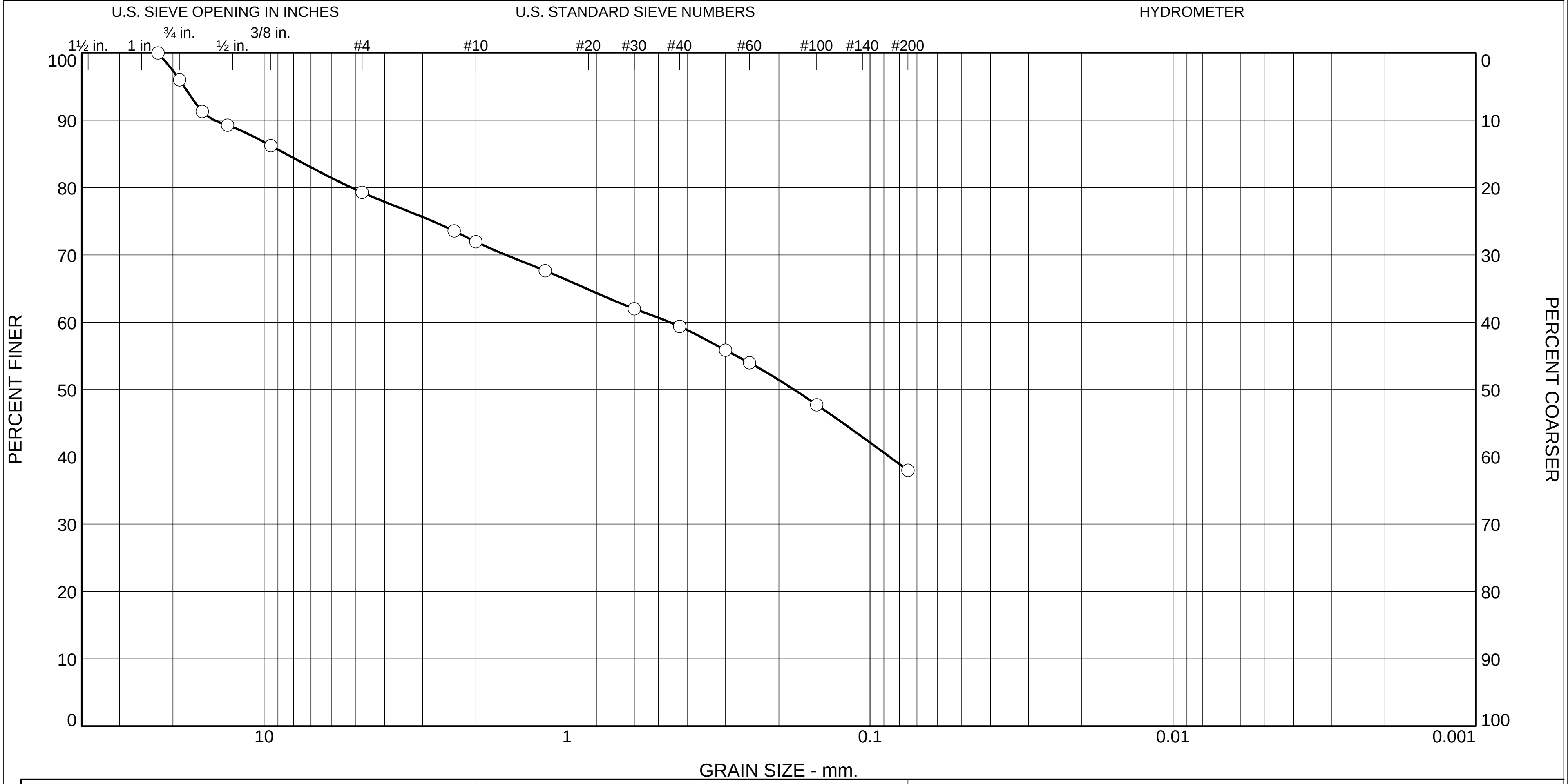
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	26.7	73.0	99.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0015	0.0022	0.0033	0.0062	0.0078	0.0347	0.0512

Fineness Modulus
0.00

Particle Size Distribution Report



	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
○	28.0	12.6	21.4	38.0	

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 1A SS5 Depth: 3.05 - 3.66m Sample Number: 5			10/9/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: D.Watts

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 1A SS5
Depth: 3.05 - 3.66m **Sample Number:** 5
Date Tested: 10/9/18
Tested by: D.Watts

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
373.70	0.00	22.4mm	0.00	0.00	100.0	0.0
		19mm	14.90	0.00	96.0	4.0
		16mm	17.60	0.00	91.3	8.7
		13.2mm	7.60	0.00	89.3	10.7
		9.5mm	11.40	0.00	86.2	13.8
		#4	25.90	0.00	79.3	20.7
		#8	21.40	0.00	73.6	26.4
		#10	6.00	0.00	72.0	28.0
		#16	16.10	0.00	67.6	32.4
		#30	21.10	0.00	62.0	38.0
		#40	9.80	0.00	59.4	40.6
		#50	13.20	0.00	55.8	44.2
		#60	7.00	0.00	54.0	46.0
		#100	23.30	0.00	47.7	52.3
		#200	36.40	0.00	38.0	62.0

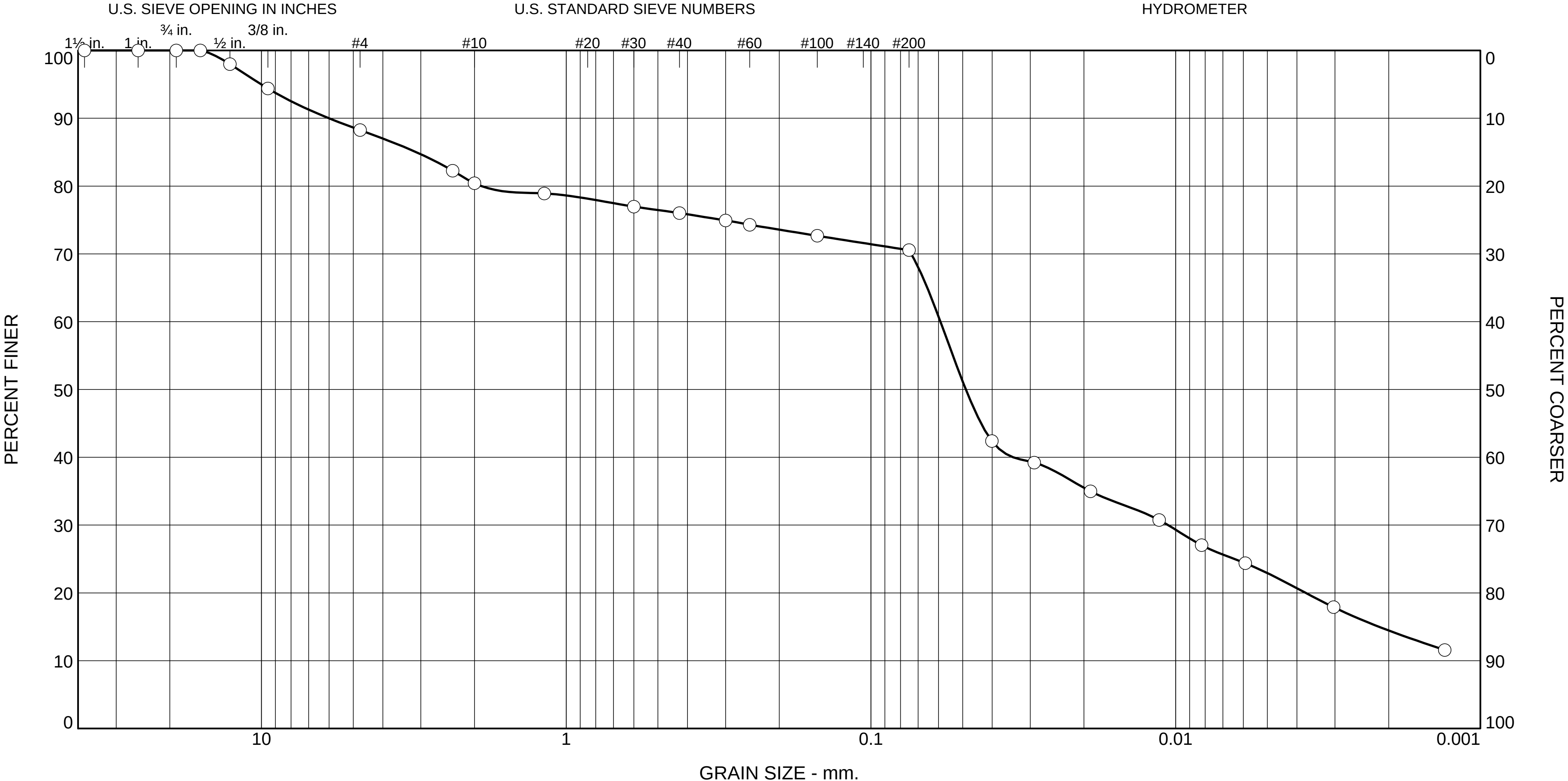
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	28.0	12.6	21.4	34.0			38.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0862	0.1783	0.4576	5.1466	8.4659	14.5877	18.3473

Fineness Modulus
2.32

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	11.7	7.9	4.4	5.4	47.7	22.9

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 1A SS6 Depth: 4.57-5.18m Sample Number: 6			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T.Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 1A SS6
Depth: 4.57-5.18m
Sample Number: 6
Tested by: T.Linley
Checked by: D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
439.18	155.61	1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4"	0.00	0.00	100.0	0.0
		5/8"	0.00	0.00	100.0	0.0
		1/2"	5.70	0.00	98.0	2.0
		3/8"	10.20	0.00	94.4	5.6
		#4	17.40	0.00	88.3	11.7
		#8	17.00	0.00	82.3	17.7
		#10	5.20	0.00	80.4	19.6
		#16	4.30	0.00	78.9	21.1
		#30	5.50	0.00	77.0	23.0
		#40	2.70	0.00	76.0	24.0
		#50	3.10	0.00	74.9	25.1
		#60	1.80	0.00	74.3	25.7
		#100	4.60	0.00	72.7	27.3
		#200	6.00	0.00	70.6	29.4

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 80.4
Weight of hydrometer sample =75.9
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.4	44.5	40.0	0.0132	43.5	9.2	0.0401	42.4	57.6
2.00	22.4	41.5	37.0	0.0132	40.5	9.7	0.0291	39.2	60.8
5.00	22.4	37.5	33.0	0.0132	36.5	10.3	0.0190	35.0	65.0
15.00	22.4	33.5	29.0	0.0132	32.5	11.0	0.0113	30.7	69.3
30.00	22.4	30.0	25.5	0.0132	29.0	11.5	0.0082	27.0	73.0
60.00	22.4	27.5	23.0	0.0132	26.5	11.9	0.0059	24.4	75.6
250.00	21.9	21.5	16.9	0.0133	20.5	12.9	0.0030	17.9	82.1
1440.00	22.0	15.5	10.9	0.0133	14.5	13.9	0.0013	11.6	88.4

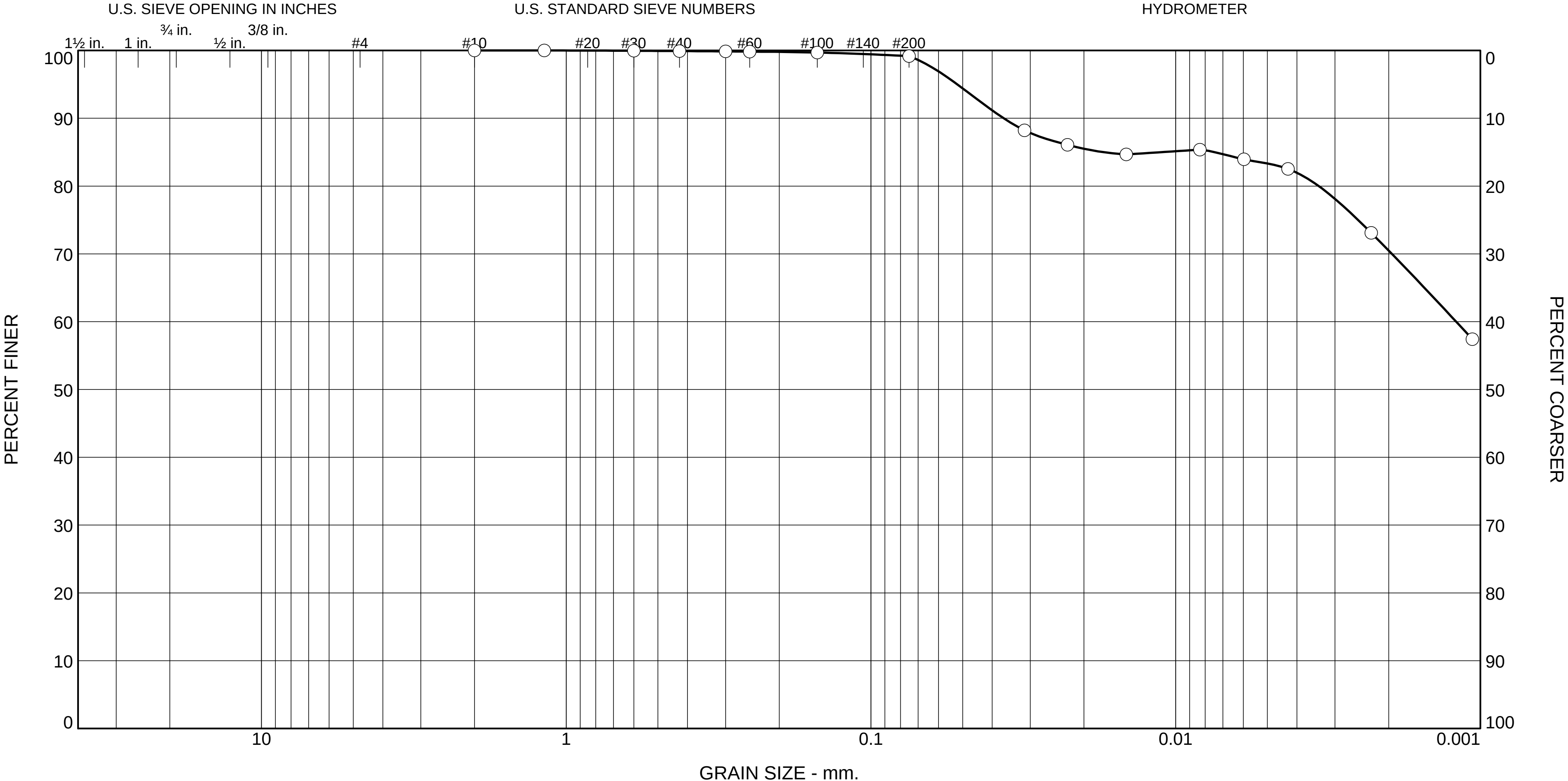
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	11.7	11.7	7.9	4.4	5.4	17.7	47.7	22.9	70.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0022	0.0037	0.0106	0.0341	0.0488	0.0591	1.8976	3.1059	6.0004	10.0174

Fineness Modulus
1.32

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.7	15.9	83.3

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 1B SS4 Depth: 2.29-2.90 Sample Number: 4			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 1B SS4

Depth: 2.29-2.90 **Sample Number:** 4

Tested by: T. Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
390.10	161.57	#10	0.00	0.00	100.0	0.0
		#16	0.00	0.00	100.0	0.0
		#30	0.10	0.00	100.0	0.0
		#40	0.10	0.00	99.9	0.1
		#50	0.10	0.00	99.9	0.1
		#60	0.10	0.00	99.8	0.2
		#100	0.30	0.00	99.7	0.3
		#200	1.20	0.00	99.2	0.8

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =70.2
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.1	66.5	61.9	0.0133	65.5	5.6	0.0313	88.2	11.8
2.00	22.1	65.0	60.4	0.0133	64.0	5.8	0.0226	86.1	13.9
5.00	22.1	64.0	59.4	0.0133	63.0	6.0	0.0145	84.7	15.3
15.00	22.1	64.5	59.9	0.0133	63.5	5.9	0.0083	85.4	14.6
30.00	22.1	63.5	58.9	0.0133	62.5	6.0	0.0060	84.0	16.0
60.00	22.1	62.5	57.9	0.0133	61.5	6.2	0.0043	82.5	17.5
250.00	21.6	56.0	51.3	0.0134	55.0	7.3	0.0023	73.1	26.9
1440.00	21.6	45.0	40.3	0.0134	44.0	9.1	0.0011	57.4	42.6

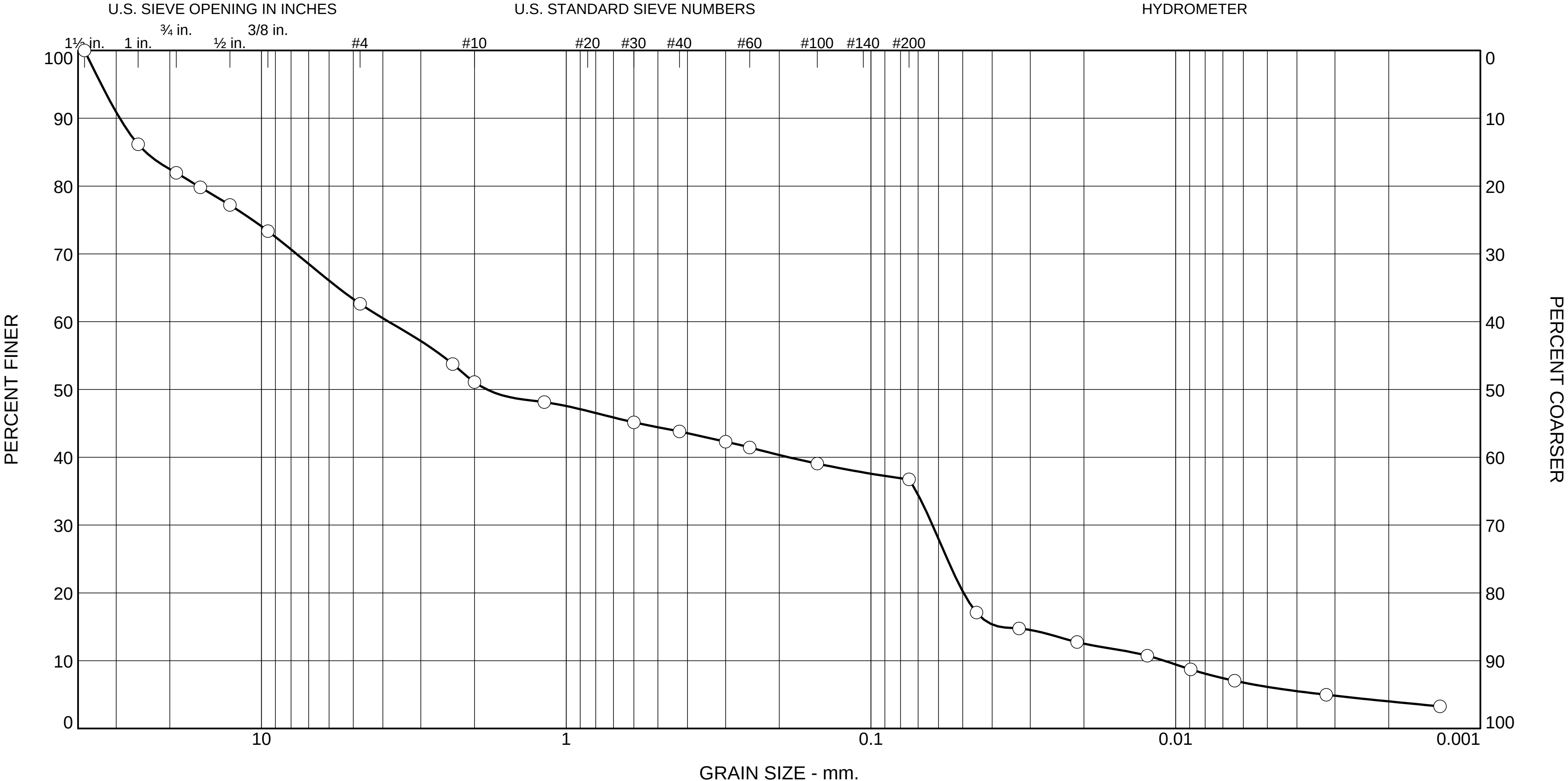
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.8	15.9	83.3	99.2

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0012	0.0034	0.0172	0.0367	0.0521

Fineness Modulus
0.00

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	18.1	19.3	11.5	7.3	7.1	30.6	6.1

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 1B SS7 Depth: 6.10-6.70m Sample Number: 7			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 1B SS7

Depth: 6.10-6.70m

Sample Number: 7

Tested by: T. Linley

Checked by: D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
475.29	156.76	1.5"	0.00	0.00	100.0	0.0
		1"	44.10	0.00	86.2	13.8
		3/4"	13.40	0.00	81.9	18.1
		5/8"	6.80	0.00	79.8	20.2
		1/2"	8.30	0.00	77.2	22.8
		3/8"	12.30	0.00	73.3	26.7
		#4	34.10	0.00	62.6	37.4
		#8	28.30	0.00	53.8	46.2
		#10	8.50	0.00	51.1	48.9
		#16	9.40	0.00	48.1	51.9
		#30	9.50	0.00	45.2	54.8
		#40	4.30	0.00	43.8	56.2
		#50	4.80	0.00	42.3	57.7
		#60	2.70	0.00	41.4	58.6
		#100	7.60	0.00	39.1	60.9
		#200	7.40	0.00	36.7	63.3

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 51.1
Weight of hydrometer sample =76.1
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.3	30.0	25.5	0.0133	29.0	11.5	0.0451	17.1	82.9
2.00	22.3	26.5	22.0	0.0133	25.5	12.1	0.0326	14.8	85.2
5.00	22.3	23.5	19.0	0.0133	22.5	12.6	0.0211	12.7	87.3
15.00	22.3	20.5	16.0	0.0133	19.5	13.1	0.0124	10.7	89.3
30.00	22.3	17.5	13.0	0.0133	16.5	13.6	0.0089	8.7	91.3
60.00	22.3	15.0	10.5	0.0133	14.0	14.0	0.0064	7.0	93.0
250.00	22.0	12.0	7.4	0.0133	11.0	14.5	0.0032	5.0	95.0
1440.00	21.8	9.5	4.9	0.0133	8.5	14.9	0.0014	3.3	96.7

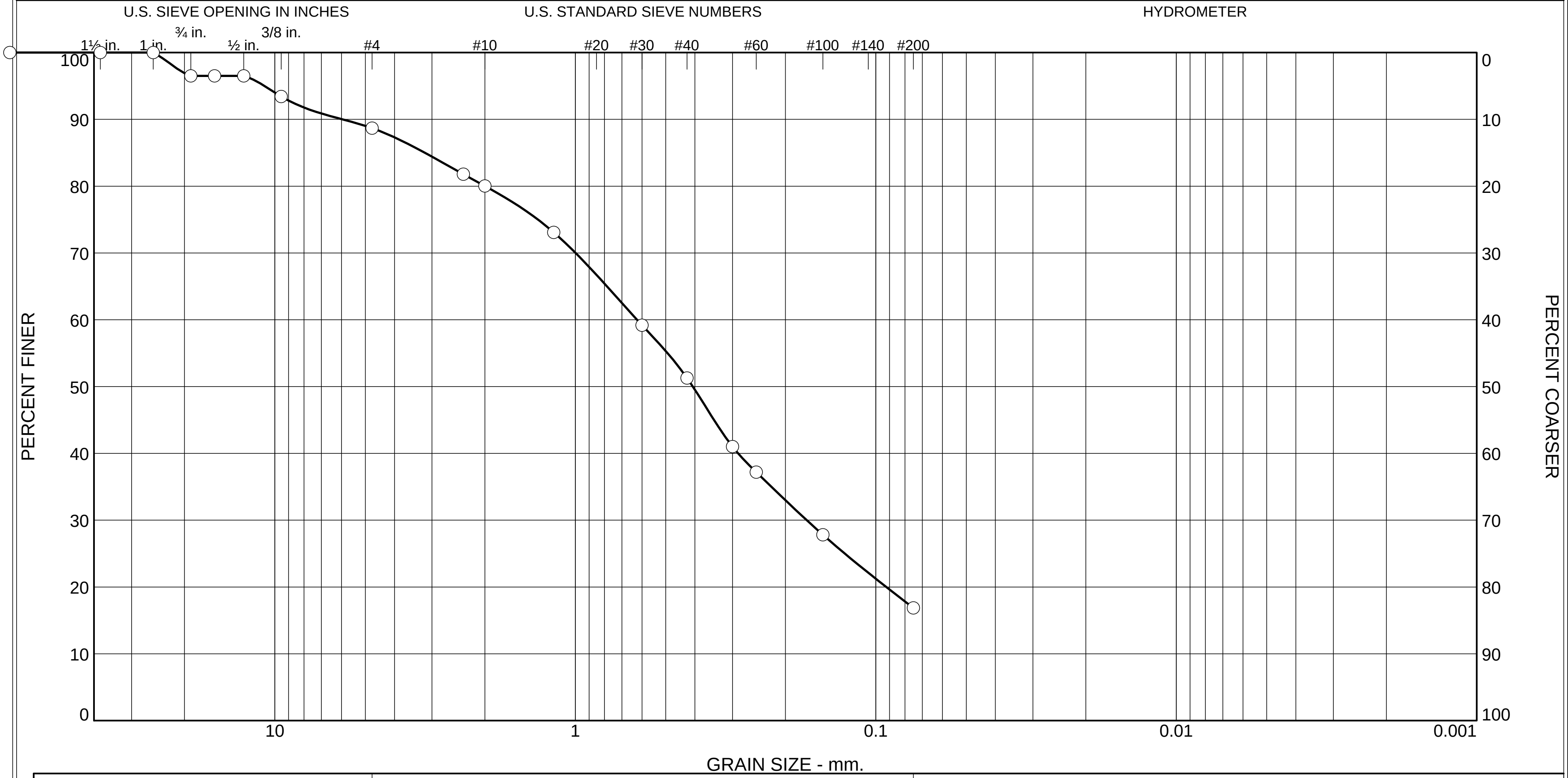
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	18.1	19.3	37.4	11.5	7.3	7.1	25.9	30.6	6.1	36.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0032	0.0109	0.0377	0.0497	0.0628	0.1860	1.8210	3.8265	16.1294	23.9878	29.1710	33.5599

Fineness Modulus	C_u	C_c
3.54	350.49	0.09

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	3.5	7.8	8.7	28.7	34.4	16.9	

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2A SS2 Depth: 0.76-1.37 Sample Number: 2			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 2A SS2
Depth: 0.76-1.37
Sample Number: 2
Tested by: T. Linley
Checked by: D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
518.64	157.20	3"	0.00	0.00	100.0	0.0
		1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4#	12.60	0.00	96.5	3.5
		5/8"	0.00	0.00	96.5	3.5
		1/2"	0.00	0.00	96.5	3.5
		3/8"	11.20	0.00	93.4	6.6
		#4	17.10	0.00	88.7	11.3
		#8	24.90	0.00	81.8	18.2
		#10	6.40	0.00	80.0	20.0
		#16	25.10	0.00	73.1	26.9
		#30	50.20	0.00	59.2	40.8
		#40	28.60	0.00	51.3	48.7
		#50	37.10	0.00	41.0	59.0
		#60	13.80	0.00	37.2	62.8
		#100	33.90	0.00	27.8	72.2
		#200	39.60	0.00	16.9	83.1

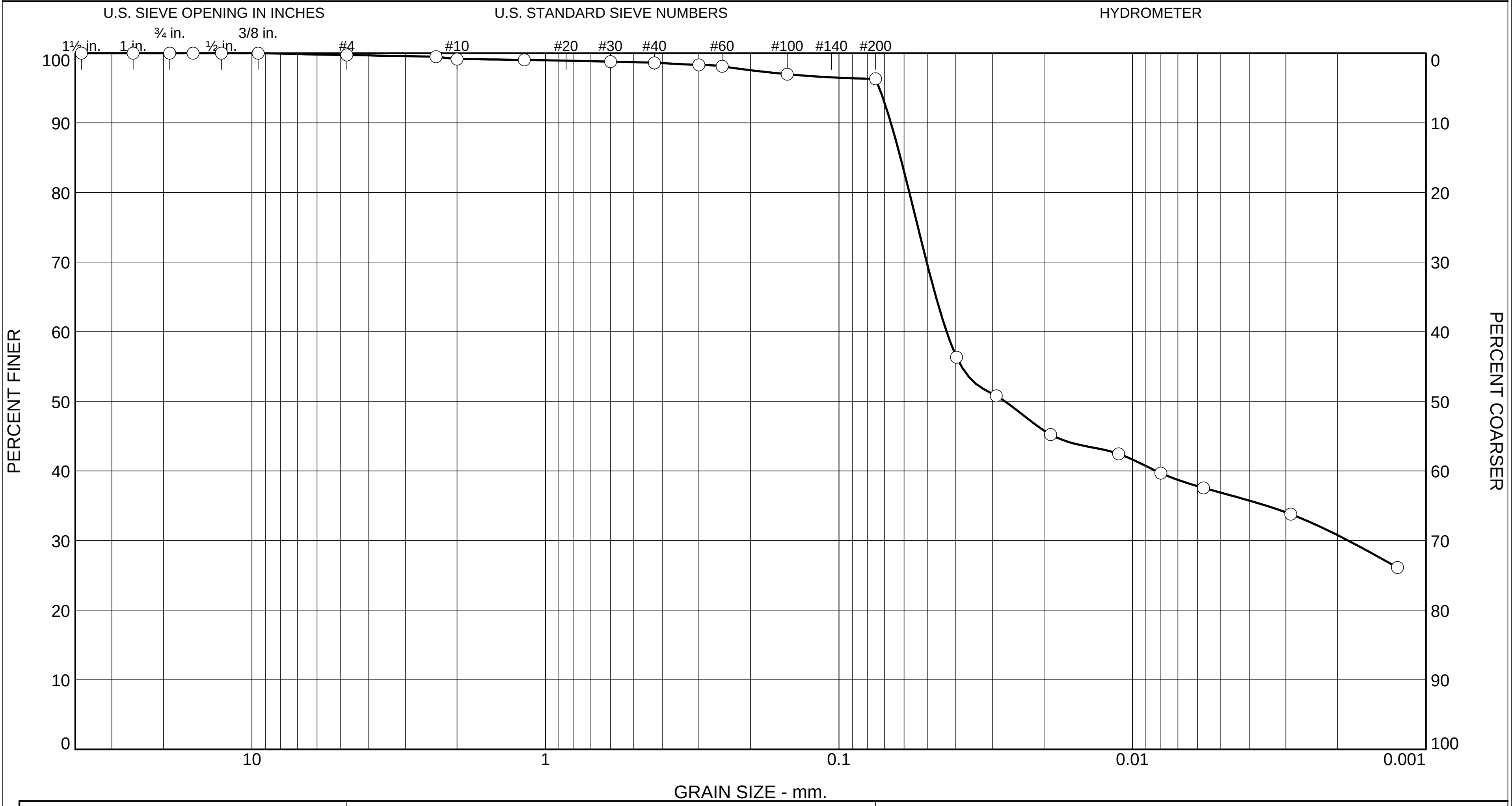
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	3.5	7.8	11.3	8.7	28.7	34.4	71.8			16.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
			0.0923	0.1698	0.2874	0.4065	0.6233	1.9955	3.1689	5.9559	10.8307

Fineness Modulus
2.38

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.3	0.5	0.6	2.3	59.4	36.9

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2A SS5 Depth: 3.05-3.66m Sample Number: 5			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2A SS5

Depth: 3.05-3.66m **Sample Number:** 5

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
396.92	157.82	1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4"	0.00	0.00	100.0	0.0
		5/8"	0.00	0.00	100.0	0.0
		1/2"	0.00	0.00	100.0	0.0
		3/8"	0.00	0.00	100.0	0.0
		#4	0.60	0.00	99.7	0.3
		#8	0.60	0.00	99.5	0.5
		#10	0.80	0.00	99.2	0.8
		#16	0.30	0.00	99.0	1.0
		#30	0.60	0.00	98.8	1.2
		#40	0.40	0.00	98.6	1.4
		#50	0.70	0.00	98.3	1.7
		#60	0.50	0.00	98.1	1.9
		#100	2.70	0.00	97.0	3.0
		#200	1.60	0.00	96.3	3.7

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.2
Weight of hydrometer sample =71.5
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.8	45.0	40.6	0.0132	44.0	9.1	0.0397	56.3	43.7
2.00	22.8	41.0	36.6	0.0132	40.0	9.7	0.0291	50.8	49.2
5.00	22.8	37.0	32.6	0.0132	36.0	10.4	0.0190	45.2	54.8
15.00	22.8	35.0	30.6	0.0132	34.0	10.7	0.0111	42.5	57.5
30.00	22.8	33.0	28.6	0.0132	32.0	11.0	0.0080	39.7	60.3
60.00	22.7	31.5	27.1	0.0132	30.5	11.3	0.0057	37.6	62.4
250.00	21.8	29.0	24.4	0.0133	28.0	11.7	0.0029	33.8	66.2
1440.00	21.7	23.5	18.8	0.0134	22.5	12.6	0.0013	26.1	73.9

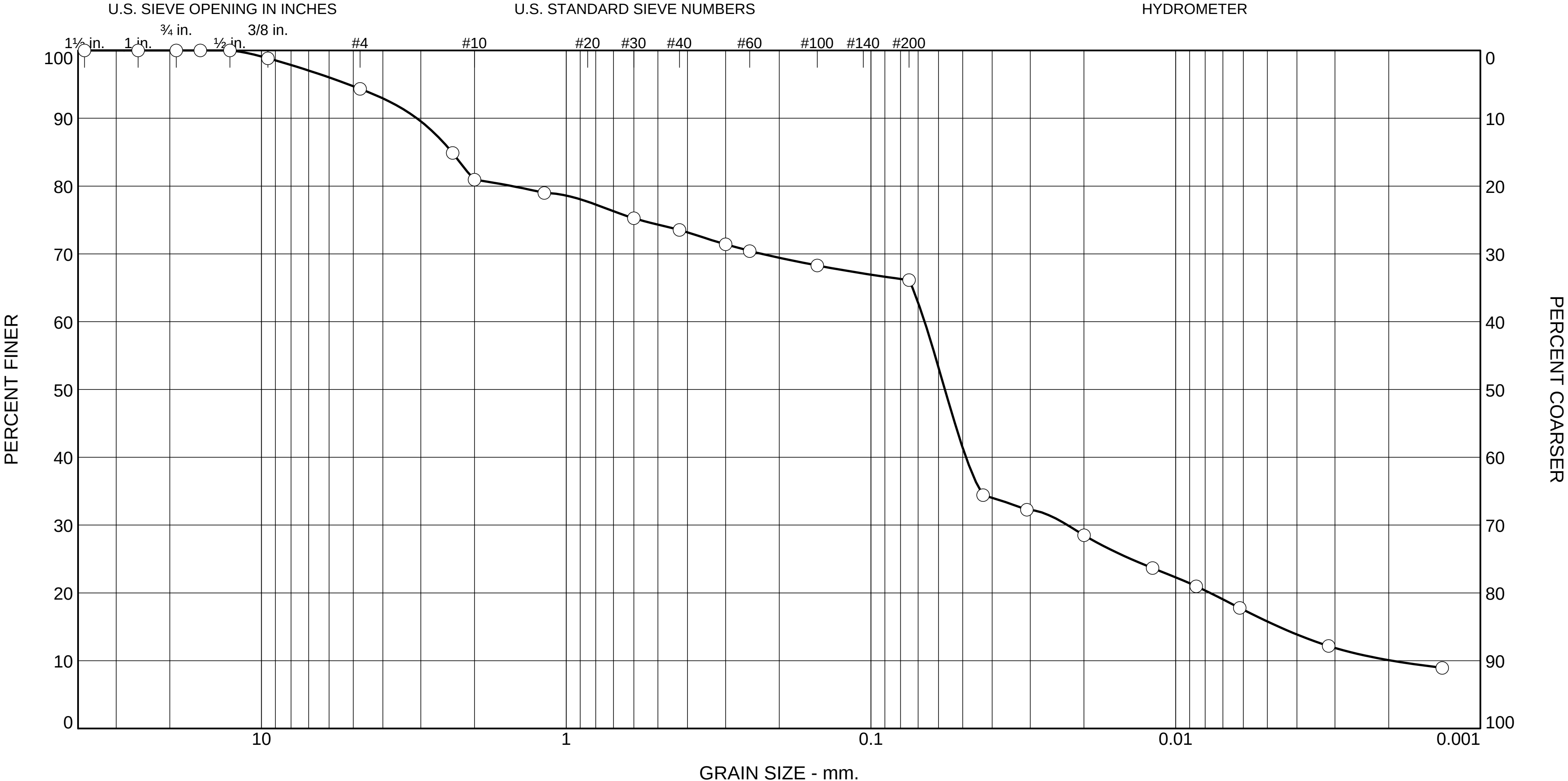
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.3	0.3	0.5	0.6	2.3	3.4	59.4	36.9	96.3

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0018	0.0083	0.0272	0.0430	0.0575	0.0617	0.0665	0.0728

Fineness Modulus
0.08

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	5.7	13.3	7.5	7.4	50.3	15.8

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2A SS6 Depth: 4.57-5.18m Sample Number: 6			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: BH RC 2A SS6
Depth: 4.57-5.18m **Sample Number:** 6
Material Description: Unable to perform Atterburg Limits test due to lack of plasticity
Tested by: T. Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
416.90	157.03	1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4"	0.00	0.00	100.0	0.0
		5/8"	0.00	0.00	100.0	0.0
		1/2"	0.00	0.00	100.0	0.0
		3/8"	3.00	0.00	98.8	1.2
		#4	11.70	0.00	94.3	5.7
		#8	24.60	0.00	84.9	15.1
		#10	10.20	0.00	81.0	19.0
		#16	5.10	0.00	79.0	21.0
		#30	9.70	0.00	75.3	24.7
		#40	4.50	0.00	73.5	26.5
		#50	5.50	0.00	71.4	28.6
		#60	2.60	0.00	70.4	29.6
		#100	5.50	0.00	68.3	31.7
		#200	5.60	0.00	66.1	33.9

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 81.0
Weight of hydrometer sample =75.3
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.4	36.5	32.0	0.0132	35.5	10.5	0.0429	34.4	65.6
2.00	22.4	34.5	30.0	0.0132	33.5	10.8	0.0308	32.3	67.7
5.00	22.4	31.0	26.5	0.0132	30.0	11.4	0.0200	28.5	71.5
15.00	22.4	26.5	22.0	0.0132	25.5	12.1	0.0119	23.7	76.3
30.00	22.4	24.0	19.5	0.0132	23.0	12.5	0.0086	21.0	79.0
60.00	22.5	21.0	16.5	0.0132	20.0	13.0	0.0062	17.8	82.2
250.00	21.6	16.0	11.3	0.0134	15.0	13.8	0.0031	12.2	87.8
1440.00	21.6	13.0	8.3	0.0134	12.0	14.3	0.0013	8.9	91.1

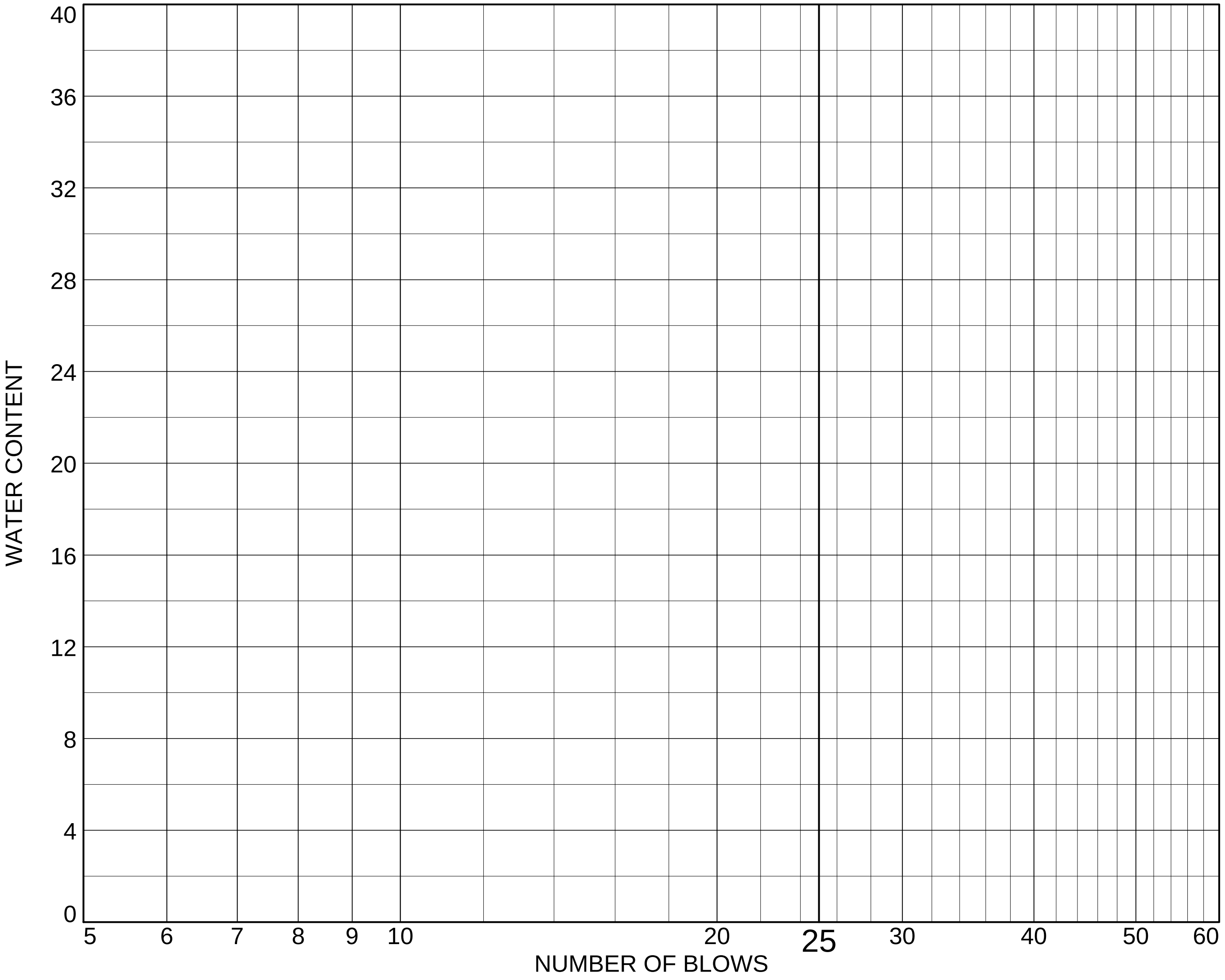
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	5.7	5.7	13.3	7.5	7.4	28.2	50.3	15.8	66.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0020	0.0046	0.0077	0.0227	0.0488	0.0572	0.0667	1.5059	2.3721	3.0933	5.1878

Fineness Modulus	C_u	C_c
1.28	34.15	3.95

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 2A SS6	6	4.57-5.18m	19.6				

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Project: Nation Rise Wind Farm

Project No.: 18-4022

LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP

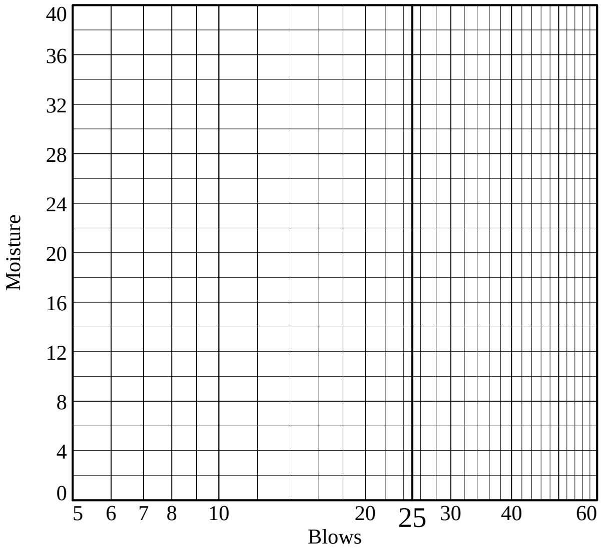
Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2A SS6

Depth: 4.57-5.18m **Sample Number:** 6

Material Description: Unable to perform Atterburg Limits test due to lack of plasticity



Liquid Limit= ________

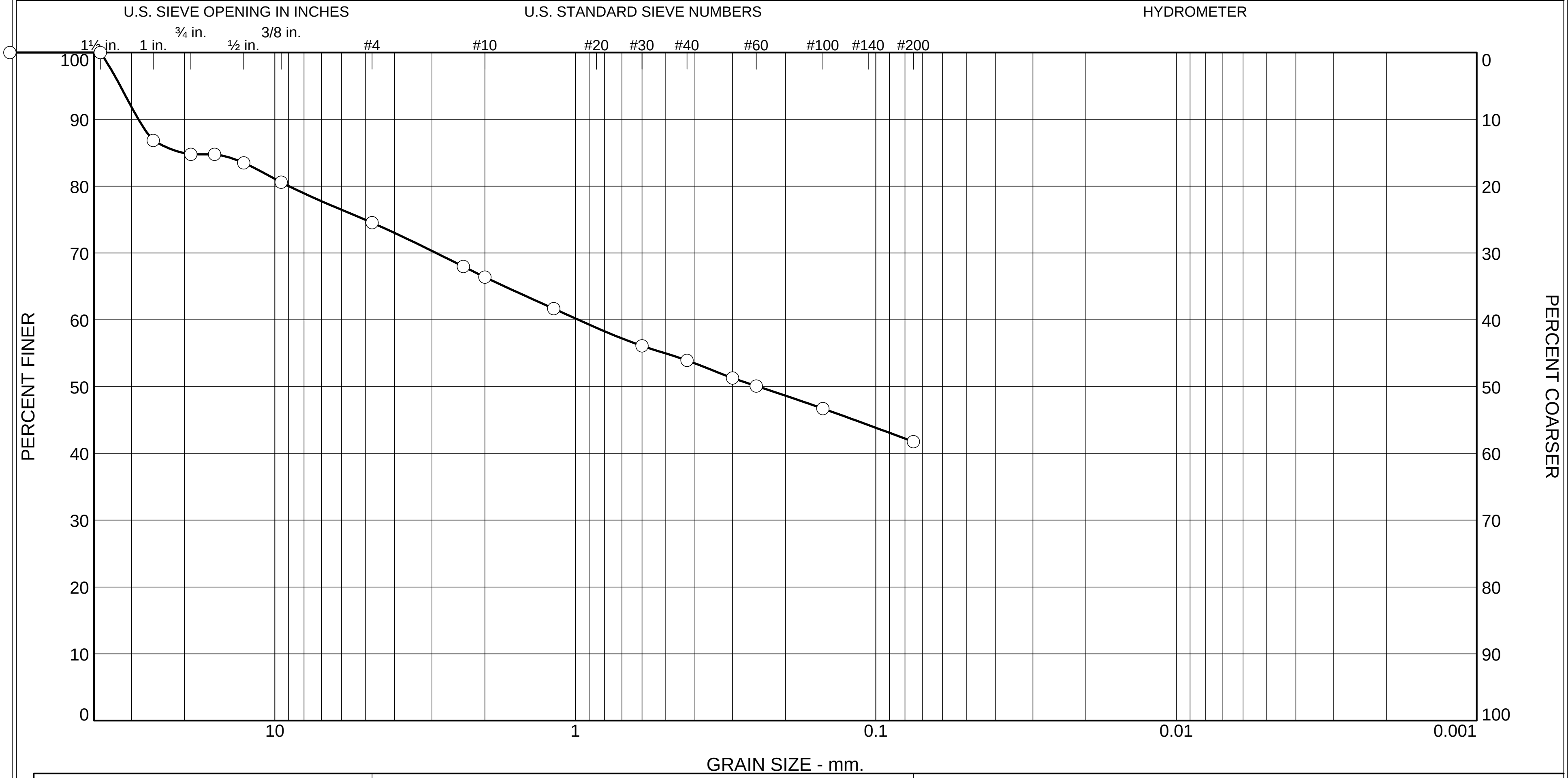
Plastic Limit= ________

Plasticity Index= ________

Natural Moisture= 19.6

Tulloch Engineering Inc.

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	15.2	10.3	8.1	12.5	12.2	41.7	

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2A SS7 Depth: 6.10-6.70m Sample Number: 7			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2A SS7

Depth: 6.10-6.70m **Sample Number:** 7

Tested by: T. Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
568.72	161.20	3"	0.00	0.00	100.0	0.0
		1.5"	0.00	0.00	100.0	0.0
		1"	53.60	0.00	86.8	13.2
		3/4#	8.50	0.00	84.8	15.2
		5/8"	0.00	0.00	84.8	15.2
		1/2"	5.20	0.00	83.5	16.5
		3/8"	11.80	0.00	80.6	19.4
		#4	24.70	0.00	74.5	25.5
		#8	26.70	0.00	68.0	32.0
		#10	6.50	0.00	66.4	33.6
		#16	19.20	0.00	61.7	38.3
		#30	22.70	0.00	56.1	43.9
		#40	8.90	0.00	53.9	46.1
		#50	10.70	0.00	51.3	48.7
		#60	4.90	0.00	50.1	49.9
		#100	13.80	0.00	46.7	53.3
		#200	20.20	0.00	41.7	58.3

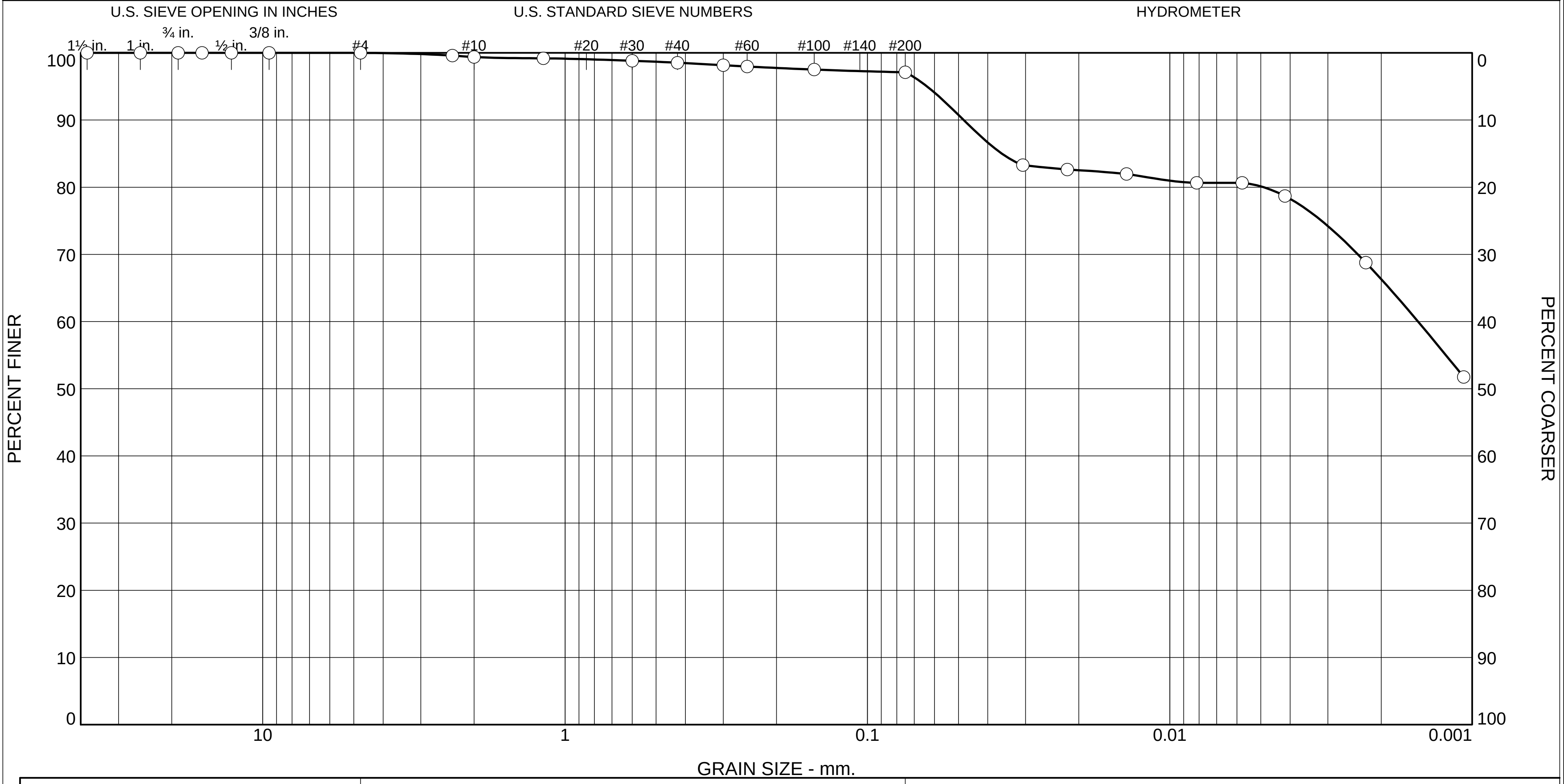
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	15.2	10.3	25.5	8.1	12.5	12.2	32.8			41.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.2466	0.9772	8.9778	20.2892	28.4475	32.7043

Fineness Modulus
2.76

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.6	0.9	1.4	17.0	80.1

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2B SS3 Depth: 1.52-2.13m Sample Number: 3			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2B SS3

Depth: 1.52-2.13m **Sample Number:** 3

Tested by: T. Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
407.62	161.99	1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4"	0.00	0.00	100.0	0.0
		5/8"	0.00	0.00	100.0	0.0
		1/2"	0.00	0.00	100.0	0.0
		3/8"	0.00	0.00	100.0	0.0
		#4	0.00	0.00	100.0	0.0
		#8	1.00	0.00	99.6	0.4
		#10	0.50	0.00	99.4	0.6
		#16	0.50	0.00	99.2	0.8
		#30	0.90	0.00	98.8	1.2
		#40	0.70	0.00	98.5	1.5
		#50	0.90	0.00	98.2	1.8
		#60	0.50	0.00	98.0	2.0
		#100	1.10	0.00	97.5	2.5
		#200	1.00	0.00	97.1	2.9

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.4
Weight of hydrometer sample =75.7
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.1	68.0	63.4	0.0133	67.0	5.3	0.0306	83.3	16.7
2.00	22.1	67.5	62.9	0.0133	66.5	5.4	0.0218	82.6	17.4
5.00	22.1	67.0	62.4	0.0133	66.0	5.5	0.0139	82.0	18.0
15.00	22.1	66.0	61.4	0.0133	65.0	5.6	0.0082	80.7	19.3
30.00	22.1	66.0	61.4	0.0133	65.0	5.6	0.0058	80.7	19.3
60.00	22.1	64.5	59.9	0.0133	63.5	5.9	0.0042	78.7	21.3
250.00	21.9	57.0	52.4	0.0133	56.0	7.1	0.0022	68.8	31.2
1440.00	22.0	44.0	39.4	0.0133	43.0	9.2	0.0011	51.7	48.3

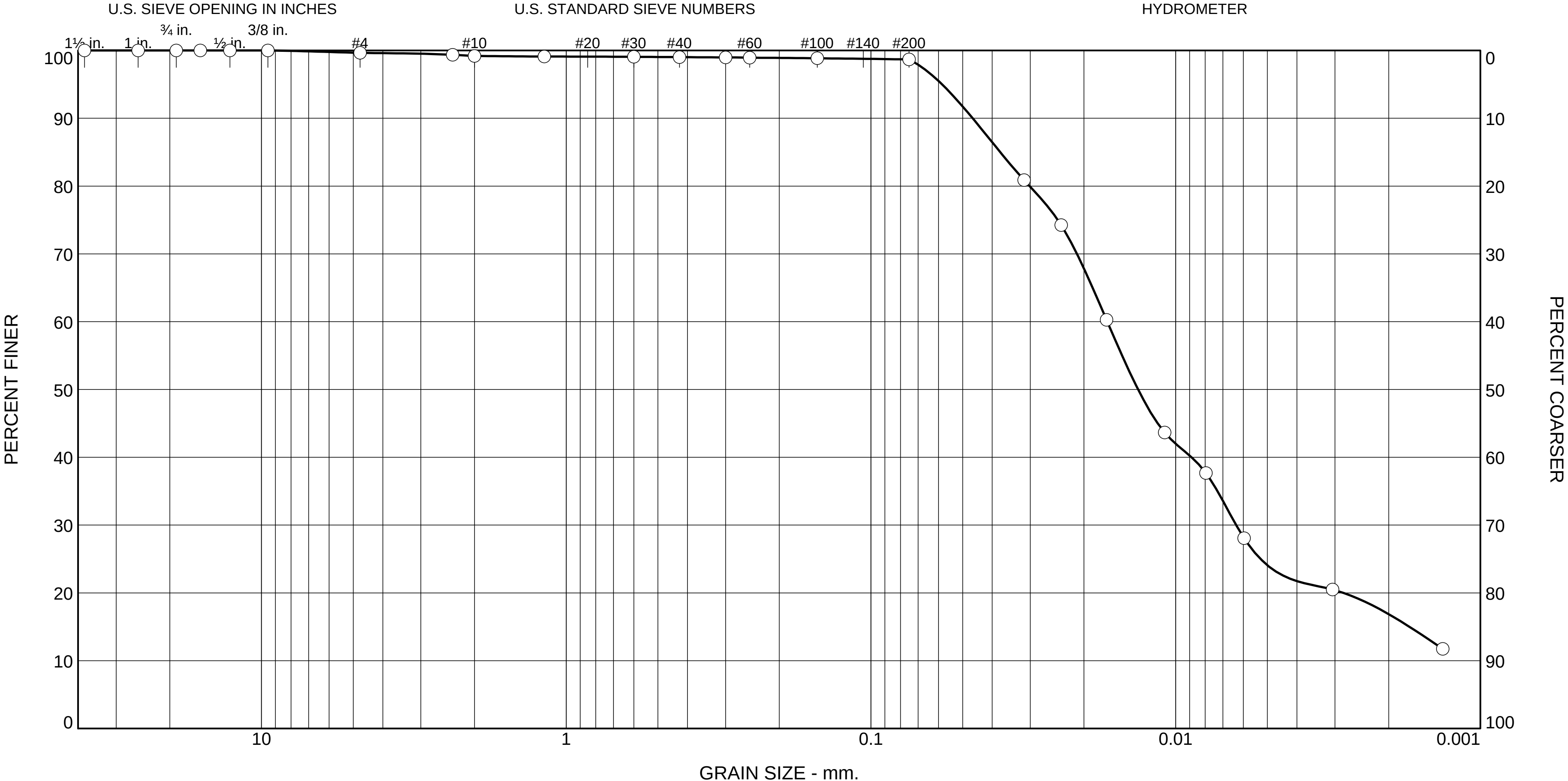
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.6	0.9	1.4	2.9	17.0	80.1	97.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0015	0.0049	0.0359	0.0481	0.0635

Fineness Modulus
0.07

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.3	0.5	0.2	0.3	74.6	24.1

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2B SS5 Depth: 3.05-3.66 Sample Number: 5			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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adam.byers@TULLOCH.ca

Tested By: T. Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2B SS5

Depth: 3.05-3.66 **Sample Number:** 5

Material Description: Unable to perform Atterburg Limits test due to lack of plasticity

Tested by: T. Linley **Checked by:** D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
407.76	172.55	1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4"	0.00	0.00	100.0	0.0
		5/8"	0.00	0.00	100.0	0.0
		1/2"	0.00	0.00	100.0	0.0
		3/8"	0.00	0.00	100.0	0.0
		#4	0.80	0.00	99.7	0.3
		#8	0.70	0.00	99.4	0.6
		#10	0.40	0.00	99.2	0.8
		#16	0.20	0.00	99.1	0.9
		#30	0.10	0.00	99.1	0.9
		#40	0.10	0.00	99.0	1.0
		#50	0.10	0.00	99.0	1.0
		#60	0.10	0.00	98.9	1.1
		#100	0.20	0.00	98.9	1.1
		#200	0.40	0.00	98.7	1.3

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.2
Weight of hydrometer sample =74.6
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	23.6	65.0	60.8	0.0131	64.0	5.8	0.0314	80.9	19.1
2.00	23.6	60.0	55.8	0.0131	59.0	6.6	0.0238	74.2	25.8
5.00	23.6	49.5	45.3	0.0131	48.5	8.3	0.0169	60.3	39.7
15.00	23.6	37.0	32.8	0.0131	36.0	10.4	0.0109	43.7	56.3
30.00	23.6	32.5	28.3	0.0131	31.5	11.1	0.0080	37.7	62.3
60.00	22.8	25.5	21.1	0.0132	24.5	12.3	0.0060	28.1	71.9
250.00	22.0	20.0	15.4	0.0133	19.0	13.2	0.0031	20.5	79.5
1440.00	21.7	13.5	8.8	0.0134	12.5	14.2	0.0013	11.7	88.3

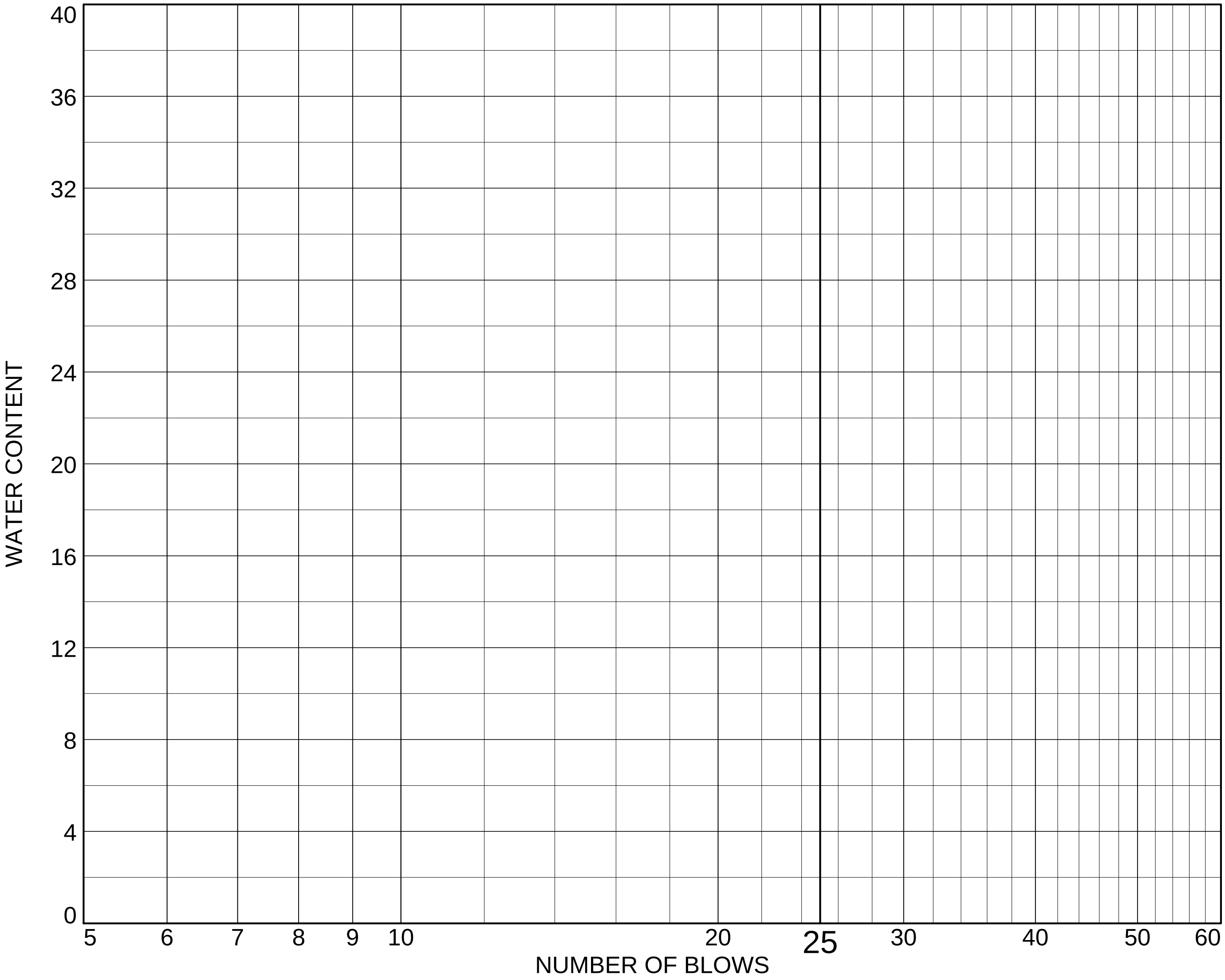
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.3	0.3	0.5	0.2	0.3	1.0	74.6	24.1	98.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0017	0.0028	0.0063	0.0089	0.0133	0.0168	0.0302	0.0376	0.0464	0.0584

Fineness Modulus
0.05

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	BH RC 2B SS5	5	3.05-3.66	20.5				

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2018

Client: EDP

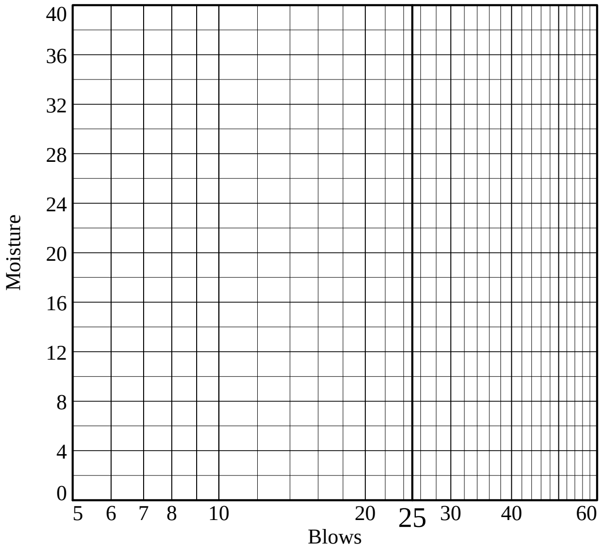
Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2B SS5

Depth: 3.05-3.66 **Sample Number:** 5

Material Description: Unable to perform Atterburg Limits test due to lack of plasticity



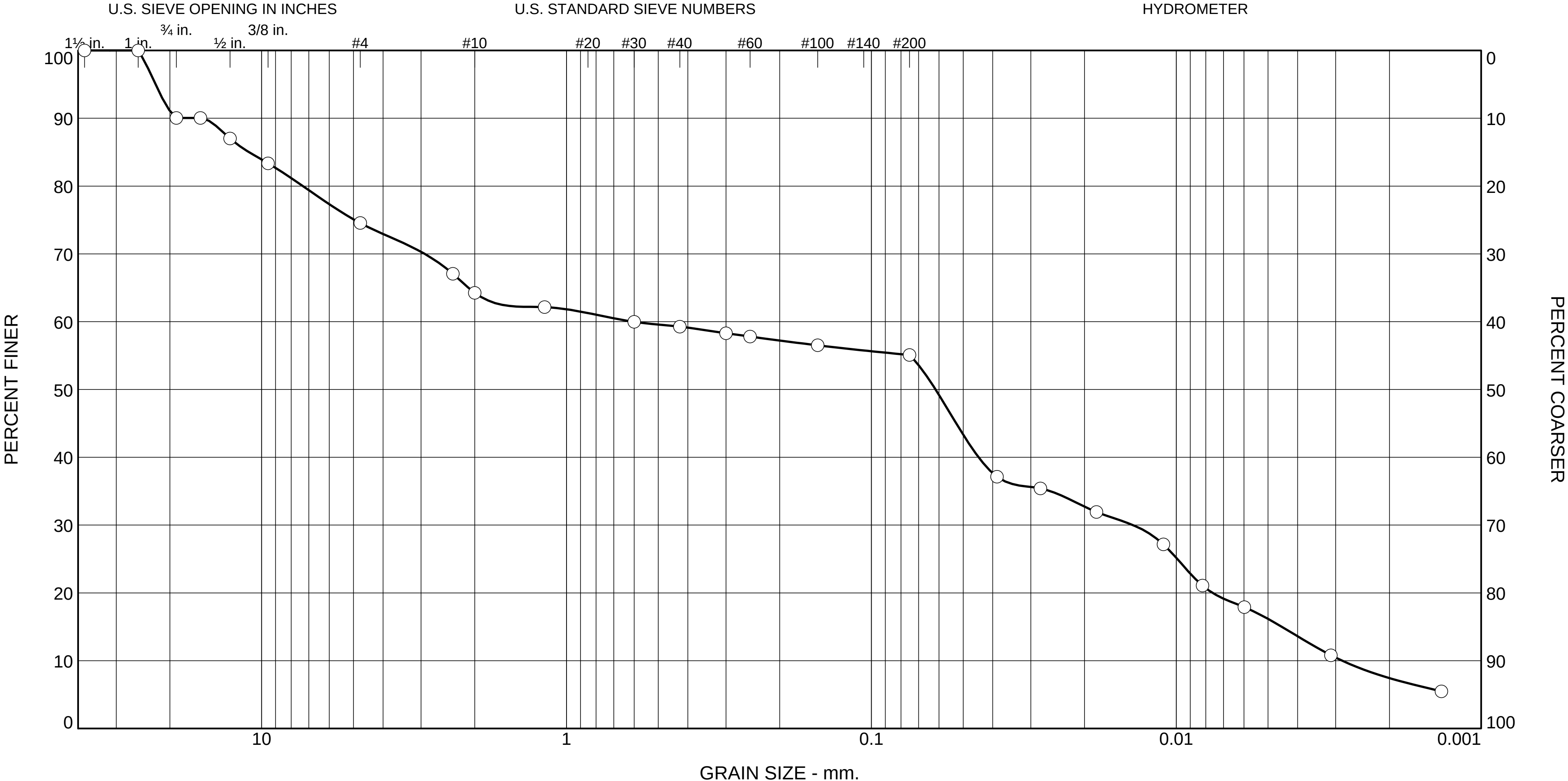
Liquid Limit= ______

Plastic Limit= ______

Plasticity Index= ______

Natural Moisture= 20.5

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	9.9	15.5	10.3	5.0	4.2	38.9	16.2

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2B SS7 Depth: 6.10-6.70m Sample Number: 7			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T.Linely **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2B SS7

Depth: 6.10-6.70m

Sample Number: 7

Tested by: T.Linely

Checked by: D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
441.81	161.24	1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4"	27.90	0.00	90.1	9.9
		5/8"	0.00	0.00	90.1	9.9
		1/2"	8.50	0.00	87.0	13.0
		3/8"	10.30	0.00	83.4	16.6
		#4	24.70	0.00	74.6	25.4
		#8	21.00	0.00	67.1	32.9
		#10	7.90	0.00	64.3	35.7
		#16	5.90	0.00	62.1	37.9
		#30	6.10	0.00	60.0	40.0
		#40	2.00	0.00	59.3	40.7
		#50	2.70	0.00	58.3	41.7
		#60	1.40	0.00	57.8	42.2
		#100	3.60	0.00	56.5	43.5
		#200	4.00	0.00	55.1	44.9

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 64.3
Weight of hydrometer sample =74
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	23.4	47.0	42.8	0.0131	46.0	8.8	0.0387	37.1	62.9
2.00	23.4	45.0	40.8	0.0131	44.0	9.1	0.0279	35.4	64.6
5.00	23.4	41.0	36.8	0.0131	40.0	9.7	0.0183	31.9	68.1
15.00	23.4	35.5	31.3	0.0131	34.5	10.6	0.0110	27.2	72.8
30.00	23.4	28.5	24.3	0.0131	27.5	11.8	0.0082	21.1	78.9
60.00	22.8	25.0	20.6	0.0132	24.0	12.4	0.0060	17.9	82.1
250.00	22.1	17.0	12.4	0.0133	16.0	13.7	0.0031	10.8	89.2
1440.00	21.6	11.0	6.3	0.0134	10.0	14.7	0.0013	5.5	94.5

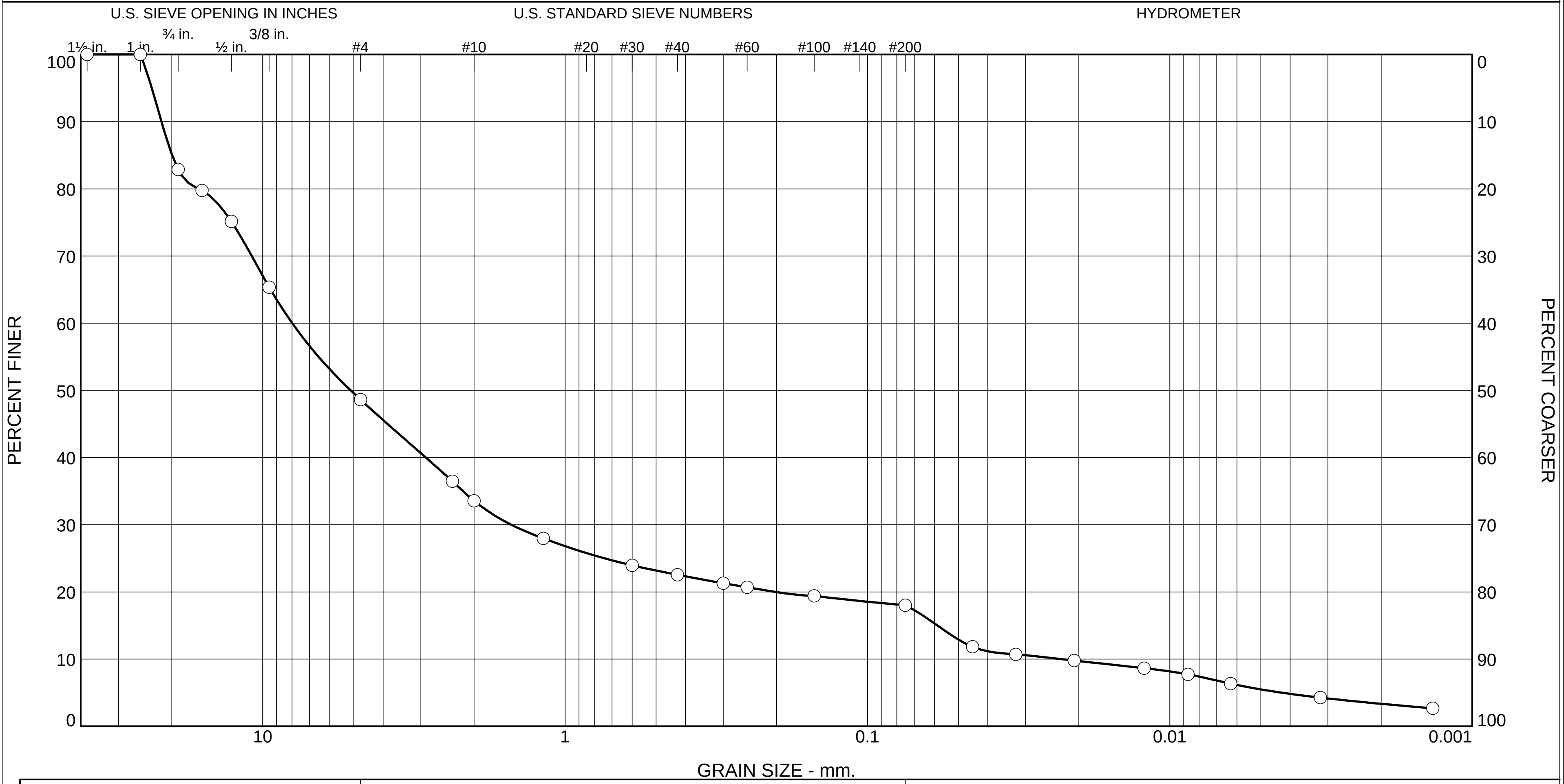
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	9.9	15.5	25.4	10.3	5.0	4.2	19.5	38.9	16.2	55.1

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0029	0.0045	0.0076	0.0139	0.0445	0.0616	0.6055	7.3256	10.9969	15.5939	22.2771

Fineness Modulus	C_u	C_c
2.48	211.76	0.11

Particle Size Distribution Report



	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	17.1	34.3	15.0	11.0	4.6	12.5	5.5

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: BH RC 2B SS8 Depth: 7.62-8.23m Sample Number: 8			

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T.Linley **Checked By:** D.Stadnisky

GRAIN SIZE DISTRIBUTION TEST DATA

10/10/2018

Client: EDP

Project: Nation Rise Wind Farm

Project Number: 18-4022

Location: BH RC 2B SS8

Depth: 7.62-8.23m

Sample Number: 8

Tested by: T.Linley

Checked by: D.Stadnisky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
448.13	162.00	1.5"	0.00	0.00	100.0	0.0
		1"	0.00	0.00	100.0	0.0
		3/4"	49.00	0.00	82.9	17.1
		5/8"	8.90	0.00	79.8	20.2
		1/2"	13.20	0.00	75.2	24.8
		3/8"	28.00	0.00	65.4	34.6
		#4	47.90	0.00	48.6	51.4
		#8	34.80	0.00	36.5	63.5
		#10	8.30	0.00	33.6	66.4
		#16	16.00	0.00	28.0	72.0
		#30	11.50	0.00	24.0	76.0
		#40	4.00	0.00	22.6	77.4
		#50	3.60	0.00	21.3	78.7
		#60	1.70	0.00	20.7	79.3
		#100	3.70	0.00	19.4	80.6
		#200	4.00	0.00	18.0	82.0

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 33.6
Weight of hydrometer sample =73.7
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	22.3	30.5	26.0	0.0133	29.5	11.5	0.0449	11.8	88.2
2.00	22.3	28.0	23.5	0.0133	27.0	11.9	0.0323	10.7	89.3
5.00	22.3	26.0	21.5	0.0133	25.0	12.2	0.0207	9.8	90.2
15.00	22.3	23.5	19.0	0.0133	22.5	12.6	0.0122	8.6	91.4
30.00	22.3	21.5	17.0	0.0133	20.5	12.9	0.0087	7.7	92.3
60.00	22.1	18.5	13.9	0.0133	17.5	13.4	0.0063	6.3	93.7
250.00	21.8	14.0	9.4	0.0133	13.0	14.2	0.0032	4.3	95.7
1440.00	21.8	10.5	5.9	0.0133	9.5	14.7	0.0014	2.7	97.3

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	17.1	34.3	51.4	15.0	11.0	4.6	30.6	12.5	5.5	18.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0043	0.0228	0.0587	0.2018	1.5073	2.8874	5.1174	7.9890	16.2503	19.9466	21.6259	23.2817

Fineness Modulus	C_u	C_c
4.74	349.94	12.46

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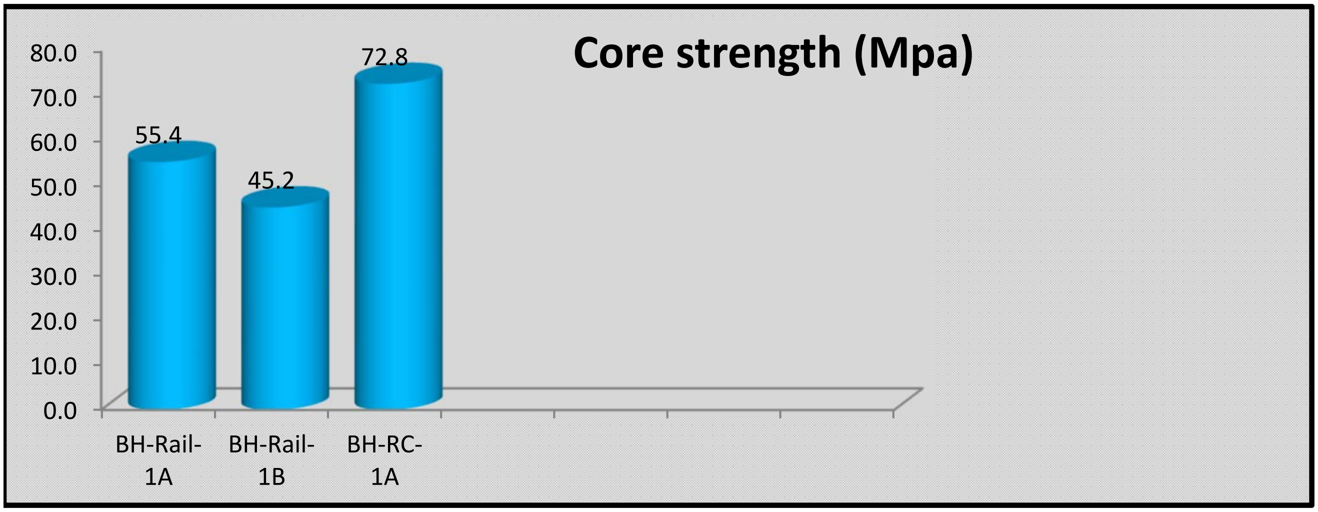
Rock Core Compressive Strength Report

PROJECT: Nation Rise
DATE SAMPLED: Refer to Sample Log
DATE TESTED: October1/18

CONTRACT: **18-4022**
RUN BY: **T.Linley**
SOURCE: **BH**

Sample Location	Run #	Distance from top of run (cm)	Height (mm)	Diameter (mm)	Peak Load (lbs)	Compressive Stength (Mpa)
BH-Rail-1A	1	20	47.48	47.22	21800	55.4
BH-Rail-1B	3	30	94.96	47.48	18000	45.2
BH-RC-1A	1	45	47.52	47.32	28800	72.8



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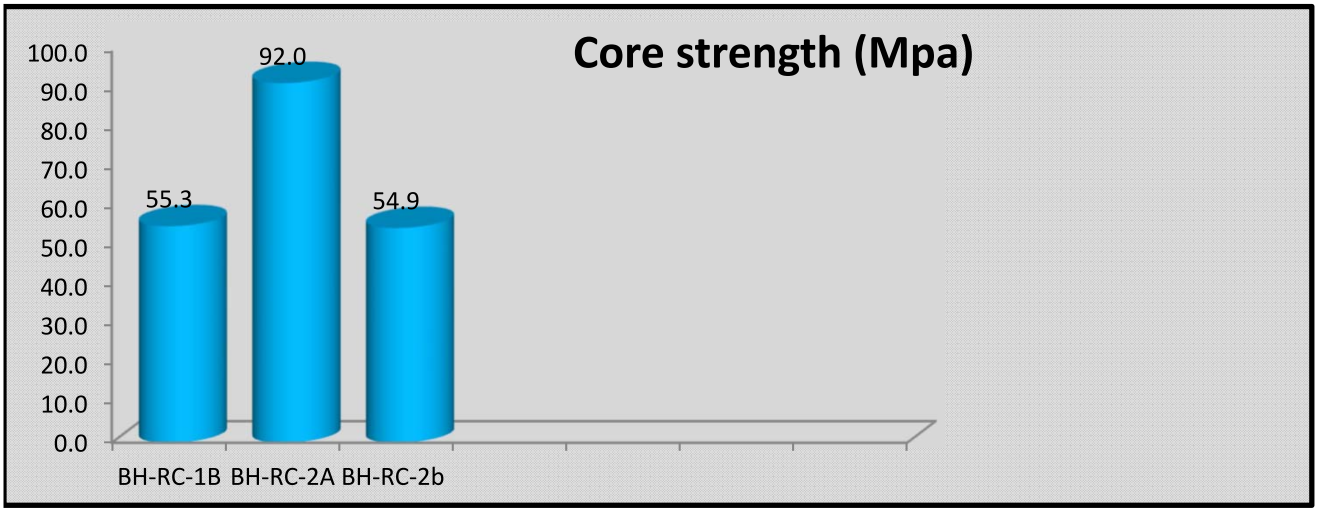
Canadian Council of Independent Laboratories
Conseil canadien des laboratoires indépendants

Rock Core Compressive Strength Report

PROJECT: Nation Rise
DATE SAMPLED: Refer to Sample Log
DATE TESTED: October1/18

CONTRACT:	**18-4022**
RUN BY:	**T.Linley**
SOURCE:	**BH**

Sample Location	Run #	Distance from top of run (cm)	Height (mm)	Diameter (mm)	Peak Load (lbs)	Compressive Stength (Mpa)
BH-RC-1B	2	130	94.90	47.45	22000	55.3
BH-RC-2A	2	50	95.00	47.48	36600	92.0
BH-RC-2b	3	110	95.08	47.54	21900	54.9



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Canadian Council of Independent Laboratories
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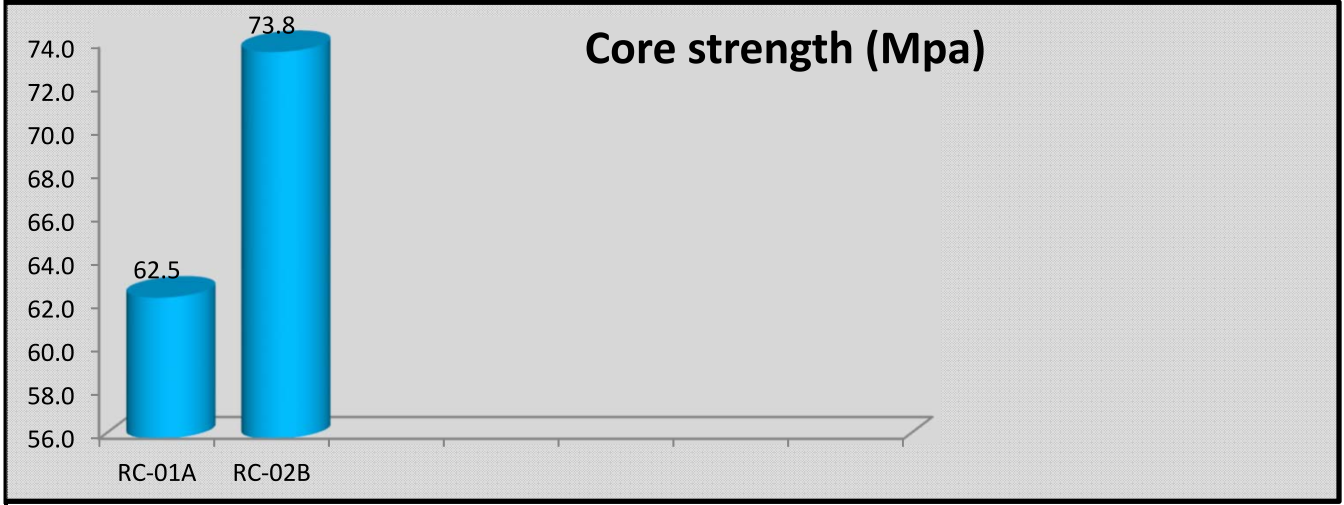
Rock Core Compressive Strength Report

PROJECT: Nation Rise
DATE SAMPLED: Refer to BH logs
DATE TESTED: 11/28/2018

CONTRACT: 18-4022
RUN BY: S.Hoffman
SOURCE: refer to BH logs

Sample Location	Run #	Distance from top of run (meters)	Height (mm)	Diameter (mm)	Peak Load (lbs)	Compressive Stength (Mpa)
RC-01A	1	3.1	95	47.5	24900	62.5
RC-02B	1	3.1	95	47.5	29400	73.8

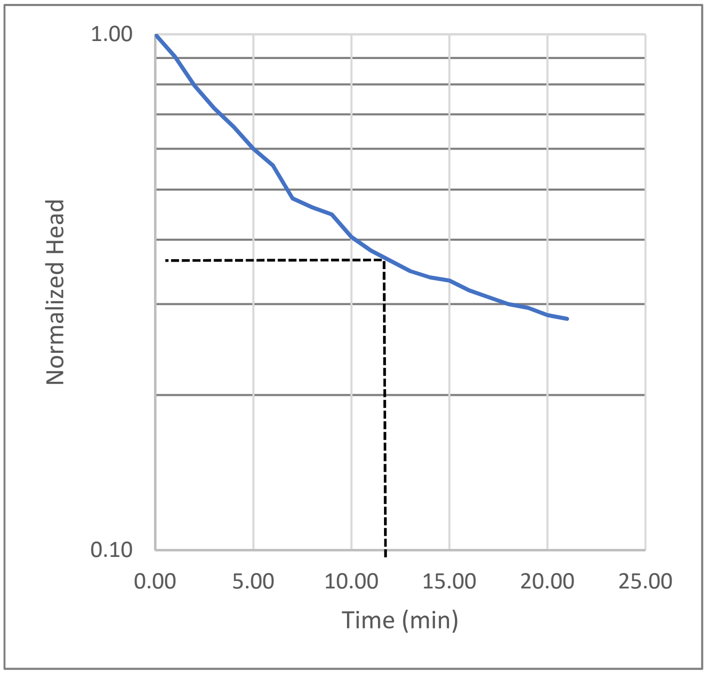


APPENDIX E

HYDRAULIC CONDUCTIVITY TESTING

Slug Test Interpretation

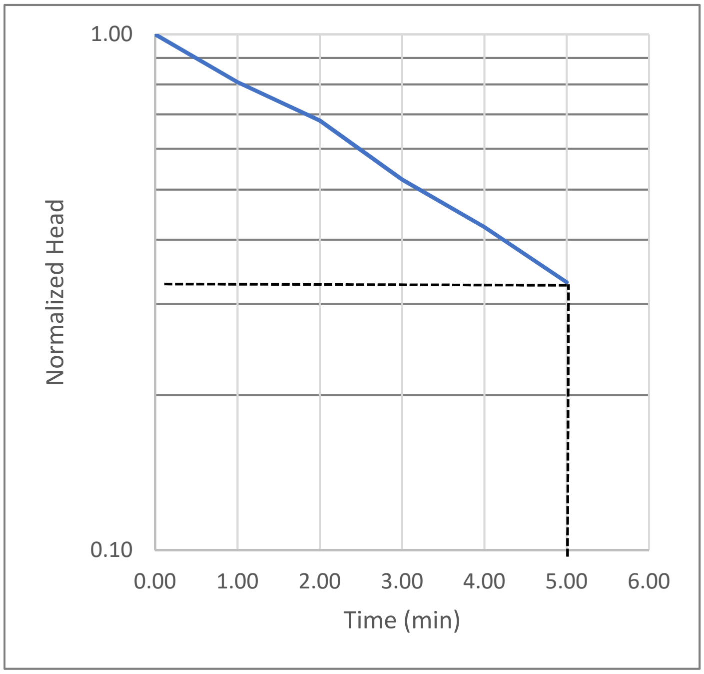
Project ID:		
184022		
Location:		
Nation Rise BH-RC-1A		
LEVEL	2.1	
UNIT: m		
Offset: -10.331000 m		
TEMPERATURE		
UNIT: °C		
Ho	6.4598	m
T_L (s)	660	
L (cm)	855.98	
r (cm)	7.79	
R (cm)	6	
K (cm/s)	2.7E-04	



Date	Time	Elapsed Time (min)	LEVEL	Normalized Head
2018-08-30	12:42:00 PM	0.00	8.5598	1.00
2018-08-30	12:43:00 PM	1.00	8.3598	0.90
2018-08-30	12:44:00 PM	2.00	8.1298	0.80
2018-08-30	12:45:00 PM	3.00	7.9698	0.72
2018-08-30	12:46:00 PM	4.00	7.8498	0.66
2018-08-30	12:47:00 PM	5.00	7.7198	0.60
2018-08-30	12:48:00 PM	6.00	7.6298	0.56
2018-08-30	12:49:00 PM	7.00	7.4698	0.48
2018-08-30	12:50:00 PM	8.00	7.4298	0.46
2018-08-30	12:51:00 PM	9.00	7.3998	0.45
2018-08-30	12:52:00 PM	10.00	7.3098	0.40
2018-08-30	12:53:00 PM	11.00	7.2598	0.38
2018-08-30	12:55:00 PM	13.00	7.1898	0.35
2018-08-30	12:56:00 PM	14.00	7.1698	0.34
2018-08-30	12:57:00 PM	15.00	7.1598	0.33
2018-08-30	12:58:00 PM	16.00	7.1298	0.32
2018-08-30	12:59:00 PM	17.00	7.1098	0.31
2018-08-30	1:00:00 PM	18.00	7.0898	0.30
2018-08-30	1:01:00 PM	19.00	7.0798	0.30
2018-08-30	1:02:00 PM	20.00	7.0598	0.29
2018-08-30	1:03:00 PM	21.00	7.0498	0.28

Slug Test Interpretation

Project ID:		
184022		
Location:		
Nation Rise BH-RC-2A		
LEVEL	2.6	
UNIT: m		
Offset: -10.331000 m		
TEMPERATURE		
UNIT: °C		
Ho	6.6456	m
T_L (s)	300	
L (cm)	924.56	
r (cm)	7.79	
R (cm)	6	
K (cm/s)	5.5E-04	



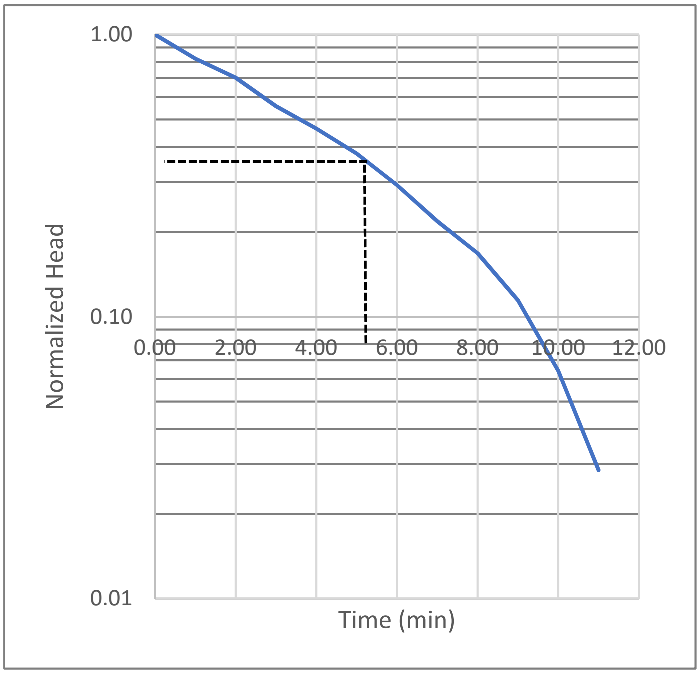
Date	**Time**	**Elapsed Time (min)**	**LEVEL**	**Normalized Head**
2018-09-04	12:09:00 PM	0.00	9.2456	1.00
2018-09-04	12:10:00 PM	1.00	8.7456	0.81
2018-09-04	12:11:00 PM	2.00	8.4156	0.68
2018-09-04	12:12:00 PM	3.00	8.0056	0.52
2018-09-04	12:13:00 PM	4.00	7.7456	0.42
2018-09-04	12:14:00 PM	5.00	7.5056	0.33

Notes:

K is the hydraulic conductivity
r is the radius of the well casing
R is the radius of the well screen
L is the length of the well screen
T is the time it takes for the water level to rise or fall to 37% of the initial change

Slug Test Interpretation

Project ID:		
184022		
Location:		
Nation Rise BH-RC-1B		
LEVEL	2.8	
UNIT: m		
Offset: -10.331000 m		
TEMPERATURE		
UNIT: °C		
Ho	8.0966	m
T_L (s)	300	
L (cm)	1089.66	
r (cm)	7.79	
R (cm)	6	
K (cm/s)	4.8E-04	



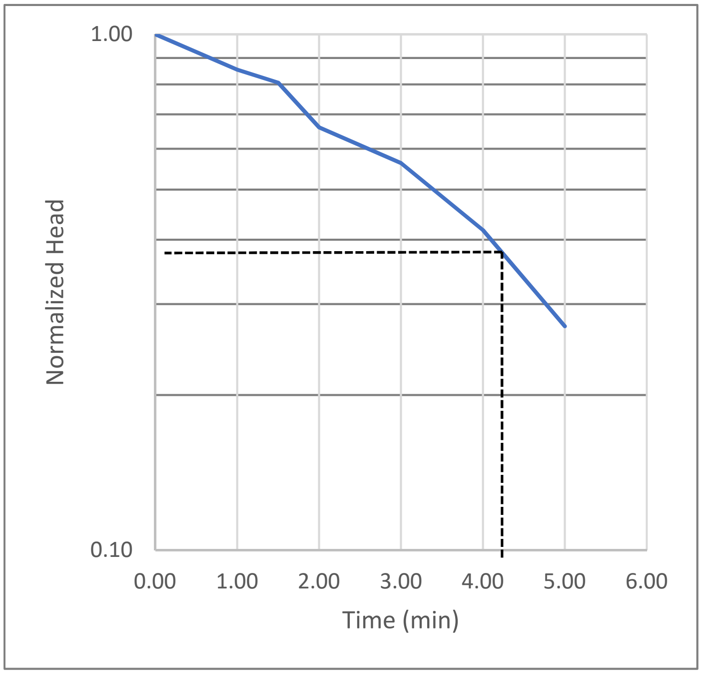
Date	Time	Elapsed Time (min)	LEVEL	Normalized Head
2018-07-09	12:42:00 PM	0.00	10.8966	1.00
2018-07-09	12:43:00 PM	1.00	10.3966	0.82
2018-07-09	12:44:00 PM	2.00	10.0666	0.70
2018-07-09	12:45:00 PM	3.00	9.6566	0.56
2018-07-09	12:46:00 PM	4.00	9.3966	0.46
2018-07-09	12:47:00 PM	5.00	9.1566	0.38
2018-07-09	12:48:00 PM	6.00	8.9166	0.29
2018-07-09	12:49:00 PM	7.00	8.7066	0.22
2018-07-09	12:50:00 PM	8.00	8.5666	0.17
2018-07-09	12:51:00 PM	9.00	8.4166	0.11
2018-07-09	12:52:00 PM	10.00	8.2766	0.06
2018-07-09	12:53:00 PM	11.00	8.1766	0.03

Notes:

K is the hydraulic conductivity
r is the radius of the well casing
R is the radius of the well screen
L is the length of the well screen
T is the time it takes for the water level to rise or fall to 37% of the initial change

Slug Test Interpretation

Project ID:		
184022		
Location:		
Nation Rise BH-RAIL-1A		
LEVEL	2.06	
UNIT: m		
Offset: -10.331000 m		
TEMPERATURE		
UNIT: °C		
Ho	7.4396	m
T_L (s)	270	
L (cm)	949.96	
r (cm)	7.79	
R (cm)	6	
K (cm/s)	6.0E-04	

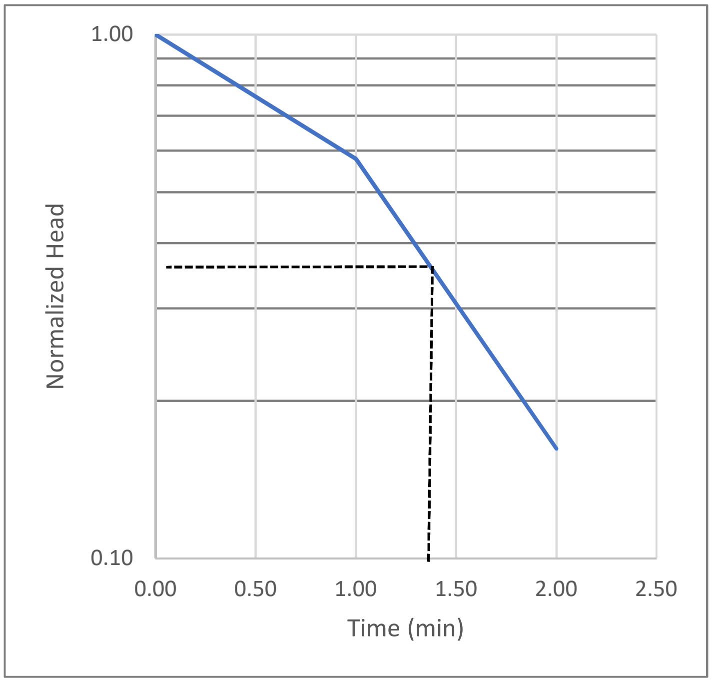


Date	Time	Elapsed Time (min)	LEVEL	Normalized Head
2018-08-29	3:04:00 PM	0.00	9.4996	1.00
2018-08-29	3:05:00 PM	1.00	9.1996	0.85
2018-08-29	3:05:30 PM	1.50	9.0996	0.81
2018-08-29	3:06:00 PM	2.00	8.7996	0.66
2018-08-29	3:07:00 PM	3.00	8.5996	0.56
2018-08-29	3:08:00 PM	4.00	8.2996	0.42
2018-08-29	3:09:00 PM	5.00	7.9996	0.27

Notes:
K is the hydraulic conductivity
r is the radius of the well casing
R is the radius of the well screen
L is the length of the well screen
T is the time it takes for the water level to rise or fall to 37% of the initial change

Slug Test Interpretation

Project ID:		
184022		
Location:		
Nation Rise BH-RAIL-1B		
LEVEL	2.16	
UNIT: m		
Offset: -10.331000 m		
TEMPERATURE		
UNIT: °C		
Ho	7.0602	m
T_L (s)	90	
L (cm)	922.02	
r (cm)	7.79	
R (cm)	6	
K (cm/s)	1.8E-03	



Date	Time	Elapsed Time (min)	LEVEL	Normalized Head
2018-08-27	11:11:00 AM	0.00	9.2202	1.00
2018-08-27	11:12:00 AM	1.00	8.3102	0.58
2018-08-27	11:13:00 AM	2.00	7.4102	0.16

Notes:

K is the hydraulic conductivity

r is the radius of the well casing

R is the radius of the well screen

L is the length of the well screen

T is the time it takes for the water level to rise or fall to 37% of the initial change

APPENDIX F

GPR SOIL ELECTRICAL RESISTIVITY REPORT

GEOPHYSICS GPR INTERNATIONAL INC.

6741 Columbus Road
Unit 14
Mississauga, Ontario
Canada L5T 2G9

Tel.: (905) 696-0656
Fax: (905) 696-0570
gprtor@gprtor.com
www.geophysicsgpr.com

September 21, 2018 GPR File: T18743

Usman Khan
Geotechnical Engineer
Tulloch Engineering Inc.
1100 South Service Road, Suite 420
Stoney Creek ON
L8E 0C5

RE: Soil Electrical Resistivity Testing at the Nation Rise Wind Farm, Ottawa Region, Ontario

Dear Mr. Khan:

Geophysics GPR International Inc. was requested by Tulloch Engineering Inc. to conduct soil resistivity soundings, for the Nation Rise Wind Farm project, at different locations in Crysler and Finch towns near Ottawa, Ontario. The survey was conducted from September 14 to 17, 2018.

Twenty eight electrical resistivity soundings were performed at this project with 2 soundings at each site. Figure 1 shows the approximate locations of the sites and soundings.

The following letter will outline the theory and methodology of the soil electrical resistivity survey. Included in this letter is a summary of the results for each sounding with the following:

- Site map with survey locations
- Data table with plot
- Inversion model
- Summary table of inversion model

Electrical Resistivity Soundings Theory and Methodology

Electrical resistivity sounding measurements involve placing four electrodes (stainless steel probes) in a straight line. A current (I) is injected into the outer two probes and the potential difference (ΔV) is measured across the inner two probes. The resistance (R) is calculated from the known current and the measured voltage,

$$R = \Delta V / I$$

The measured resistance (R) is then converted into an apparent resistivity (ρ_a). This apparent resistivity is an average of the different true resistivities crossed by the current over the investigated volume. It provides a good indication of the variation of soil and/or rock resistivity with depth as the electrode spacing increases.

The data were recorded with an ABEM Terrameter LS and used a standard Wenner array configuration. This array has an even spacing, called a-spacing, between electrodes. Ideally a total of 24 readings were taken for each sounding in 12 different configurations. Two readings were recorded in order to observe the repeatability at each setup. The apparent resistivity for a Wenner array at each station is given by

$$\rho_a = 2\pi a \left(\frac{V}{I}\right)$$

where 'a' is the distance between electrodes, ΔV is the measured voltage and I is the injected current.

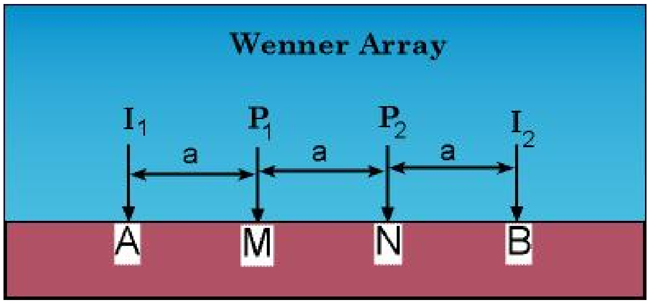


Figure 1: Wenner Array Electrode Schmatic

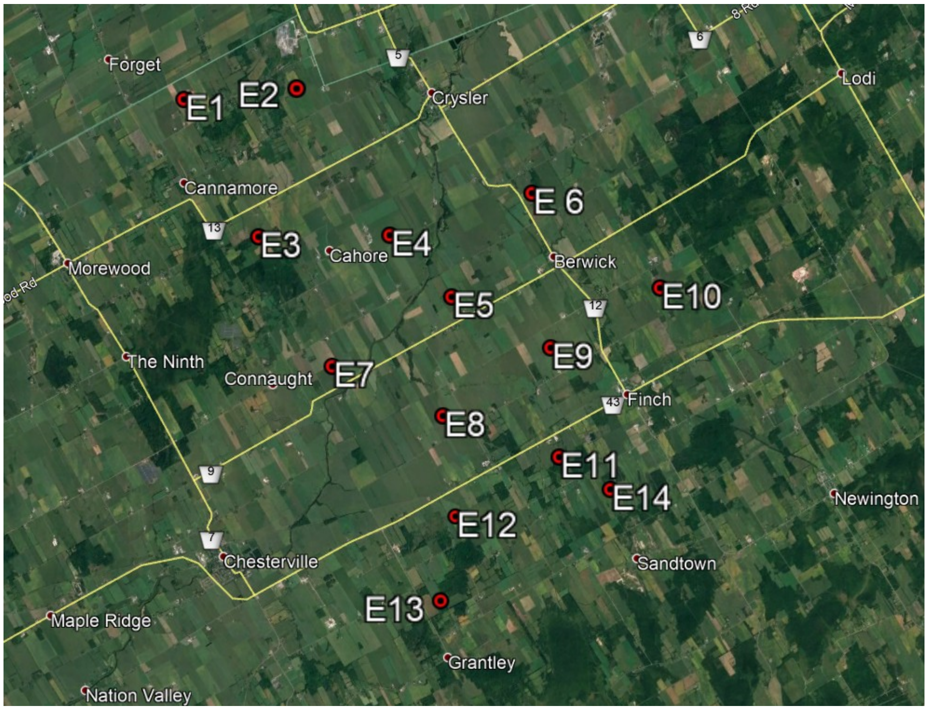


Figure 2: Approximate Locations of Soundings

Site	Test Orientation	Central Location
E1	North-South	480984, 5007308
	East-West	480984, 5007308
E2	North-South	484157, 5007570
	East-West	484157, 5007570
E3	North-South	483029, 5003431
	East-West	483029, 5003431
E4	North-South	486713, 5003424
	East-West	486173, 5003424
E5	North-South	488427, 5001671
	East-West	488444, 5001745
E6	North-South	490720, 5004543
	East-West	490720, 5004543
E7	North-South	485043, 4999773
	East-West	485044, 4999776
E8	North-South	488133, 4998342
	East-West	488133, 4998342
E9	North-South	491184, 5000205
	East-West	491184, 5000205
E10	North-South	494279, 5001838
	East-West	494279, 5001838
E11	North-South	491381, 4997145
	East-West	491381, 4997145
E12	North-South	488441, 4995522
	East-West	488441, 4995522
E13	North-South	487994, 4993168
	East-West	487994, 4993168
E14	North-South	487994, 4993168
	East-West	492803, 4996219

Table 1: UTM Coordinates of Soundings

RESULTS

The locations of the resistivity soundings are presented in Figure 1 and Table 1. The results of the twenty eight resistivity soundings are summarized in the Tables and Figures below.

The collected resistivity values were observed to have an average error mostly below 0.05% which is considered good. The readings at site E1 and E2 were noisier with higher error.

In order to determine the resistivity of the underlying layers and the approximate layer thickness, the data can be modeled by inversion. 1D inversion models were generated for the sounding using IPI2win software package. The resulting layered model derived from the 1D inversion is non-unique, implying that different models can arrive at the same solution. No borehole data was available as a reference to calibrate the layer depths of the created multi layer. The models produced for the soundings were limited to 2 to 3 layers.

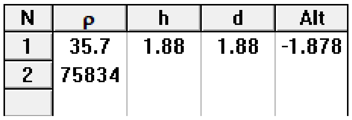
The RMS error measures how well simulated data created by the simulated model matches the actual data. All the sounding locations have models with an RMS error of less than 10%, which is considered excellent. Higher RMS could indicate irregularities in the underground or something in the vicinity and possible steels and pipes in the underground.

The results of the simplified multi-layer 1D inversion models are presented in tabular form.

Table 2: Resistivity Sounding Results for Sounding T1-EW

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E1 – N/S
GPS	18T – 480984, 5007308

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	2.36	11.8	37.15
1	199	1.33	6.67	41.89
3	199	0.963	4.83	6.66
4.5	199	1.01	5.04	126.76
6	199	0.978	4.91	184.97
10	199	0.969	4.86	305.32
15	199	0.932	4.67	440.34
25	199	0.869	4.36	684.15
35	199	0.835	4.19	920.95
50	199	0.728	3.65	1147.3



N	ρ	h	d	Alt
1	35.7	1.88	1.88	-1.878
2	75834			

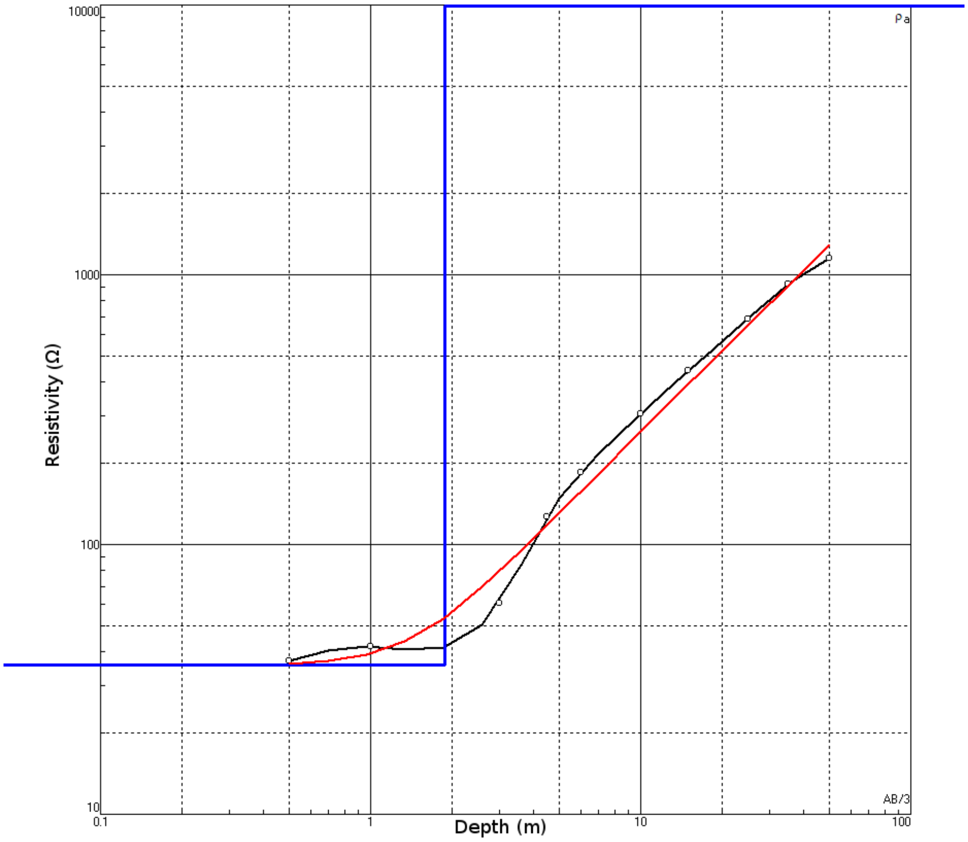


Figure 3: 1D Inversion Model for E-1 N/S. RMS error of 4.3%

Table 3: Resistivity Sounding Results for Sounding T1-EW

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E1 – E/W
GPS	18T – 480984, 5007308

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	2.31	11.6	36.42
1	199	1.69	8.49	53.32
3	199	1.33	6.67	83.82
4.5	199	1.21	6.04	151.9
6	199	1.27	6.35	239.49
10	199	1.17	5.89	370.06
15	199	2.35	1.1	111.15
25	199	0.368	1.84	289.76
35	199	0.166	0.833	183.19
50	199	0.396	1.98	623.46

N	ρ	h	d	Alt
1	37.2	1.09	1.09	-1.086
2	334			

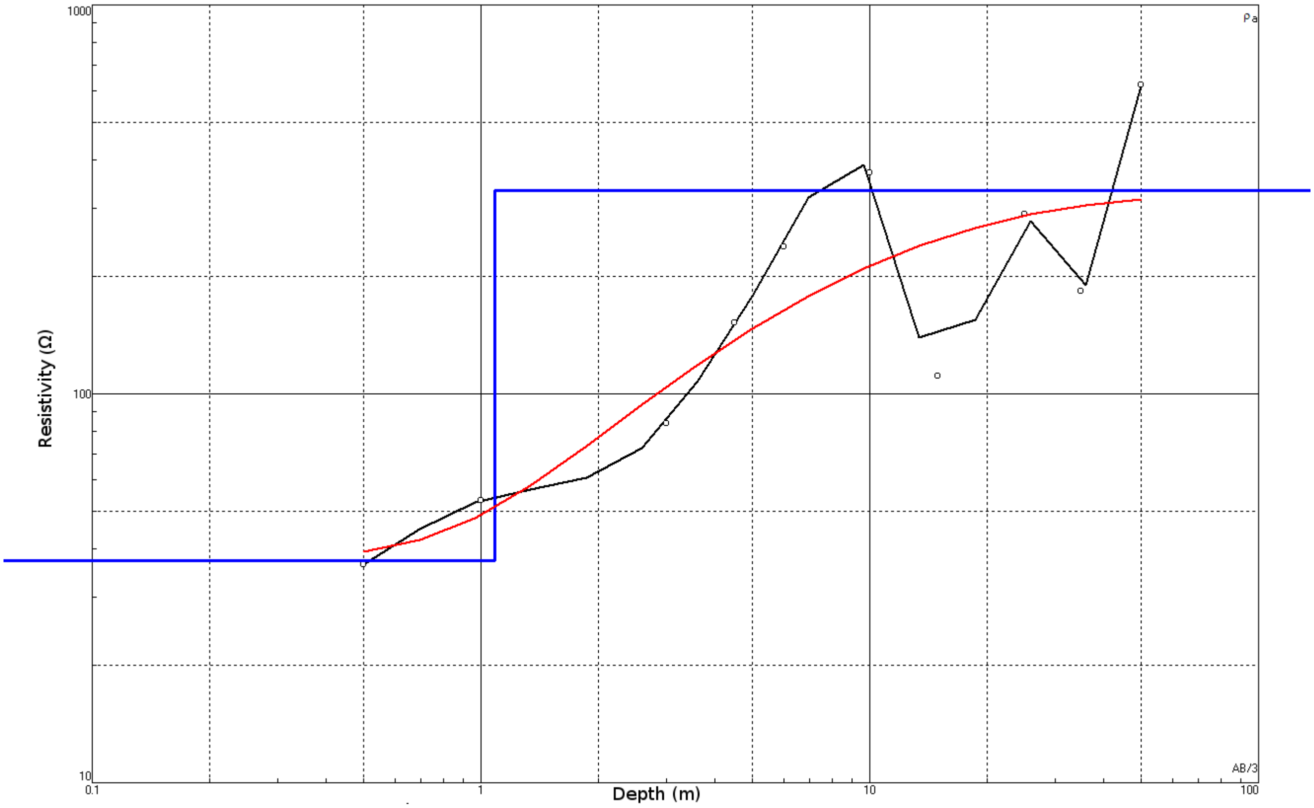
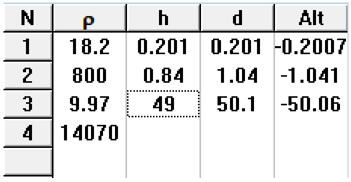


Table 4: 1D Inversion Model for E-1 E/W. RMS error of 36.1%

Table 4: Resistivity Sounding Results for Sounding T2-NS

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E2 – N/S
GPS	18T – 484157, 5007570

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	1.25	6.24	19.613
1	199	4.85	24.3	152.75
3	200	1.43	7.15	89.879
4.5	200	2.52	12.6	317.37
6	200	5.82	29.1	1.0988
10	200	25.9	0.13	8.1653
15	200	42.3	0.212	19.97
25	200	12.2	0.613	9.623
35	200	40.6	0.204	44.755
50	200	13.3	0.665	20.882



N	ρ	h	d	Alt
1	18.2	0.201	0.201	-0.2007
2	800	0.84	1.04	-1.041
3	9.97	49	50.1	-50.06
4	14070			

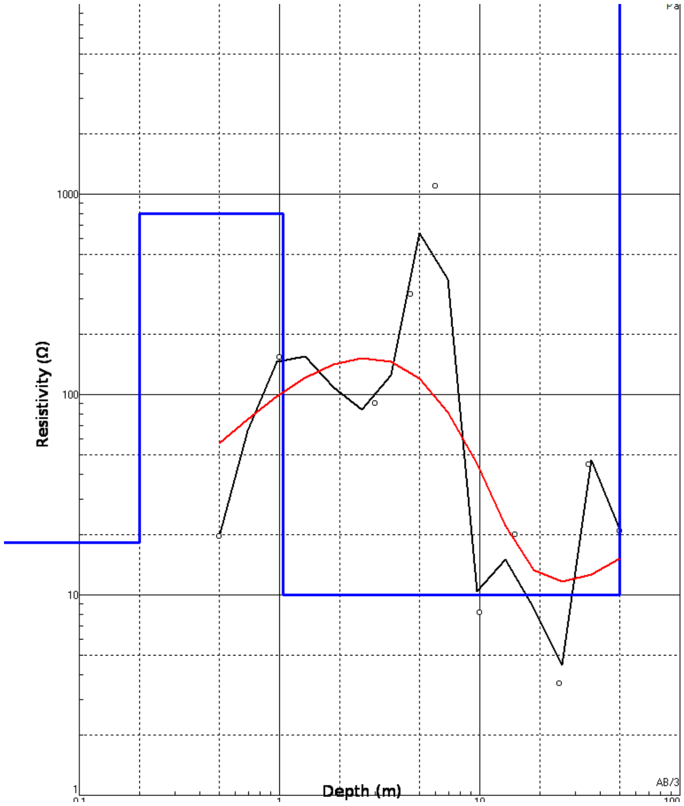
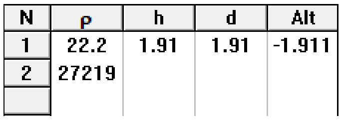


Table 5: 1D Inversion Model for E-2 N/S. RMS error of 90.1%

Table 5: Resistivity Sounding Results for Sounding T2 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E2 – E/W
GPS	18T – 484157, 5007570

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	1.53	7.65	24.045
1	199	0.786	3.94	24.762
3	199	0.659	3.31	41.553
4.5	199	0.634	3.18	79.912
6	199	0.595	2.98	112.39
10	199	0.547	2.74	172.41
15	199	0.513	2.57	242.6
25	199	0.516	2.59	406.58
35	199	0.503	2.52	554.26
50	199	0.476	2.39	749.6



N	ρ	h	d	Alt
1	22.2	1.91	1.91	-1.911
2	27219			

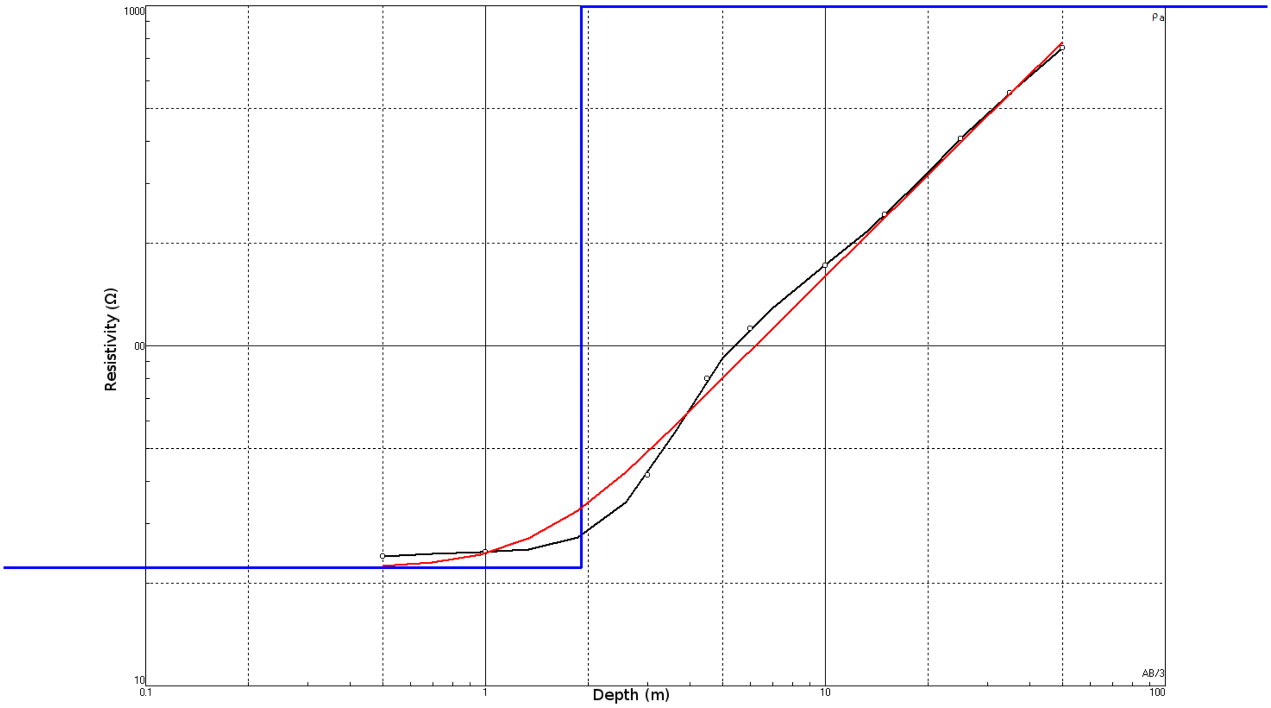
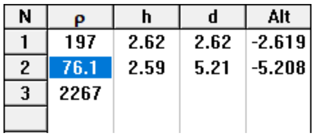


Table 6: 1D Inversion Model for E-2 W/E. RMS error of 9.68 %

Table 6: Resistivity Sounding Results for Sounding T3 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E3 – N/S
GPS	18T – 483029, 5003431

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	10.6	53	166.47
1	199	6.65	33.3	209.41
3	200	2.78	13.9	175.23
4.5	200	1.3	6.53	164.02
6	200	0.969	4.86	183.22
10	200	0.839	4.21	264.34
15	200	0.808	4.05	381.52
25	200	0.755	3.79	594.69
35	200	0.635	3.18	700.3
50	200	0.587	2.94	924.82



N	ρ	h	d	Alt
1	197	2.62	2.62	-2.619
2	76.1	2.59	5.21	-5.208
3	2267			

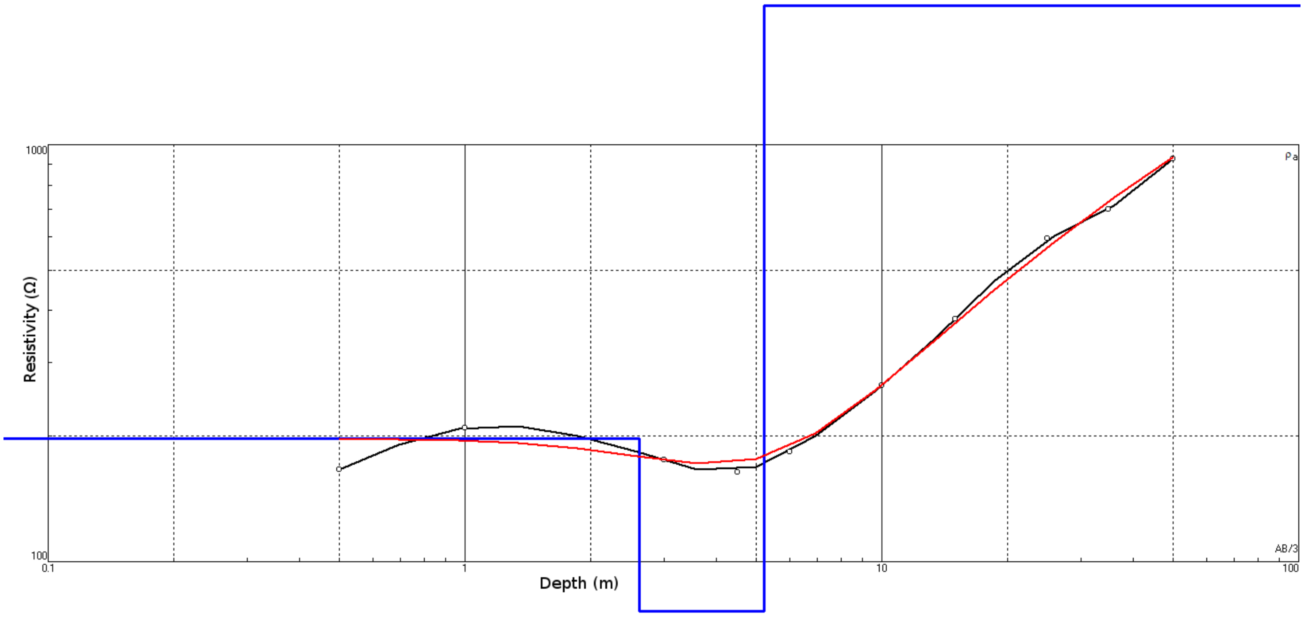
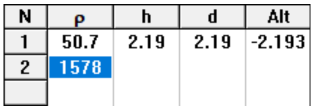


Table 7: 1D Inversion Model for E-3 N/S. RMS error of 6.15 %

Table 7: Resistivity Sounding Results for Sounding T3 – E/W

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E3 – E/W
GPS	18T – 483029, 5003431

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	3.34	16.8	52.682
1	199	1.71	8.58	53.893
3	199	1.45	7.26	91.25
4.5	199	1.16	5.82	146.34
6	199	0.986	4.94	186.38
10	199	0.825	4.14	260.1
15	199	0.724	3.63	342.43
25	199	0.739	3.7	581.9
35	199	0.614	3.08	676.73
50	199	0.549	2.75	865.07



N	ρ	h	d	Alt
1	50.7	2.19	2.19	-2.193
2	1578			

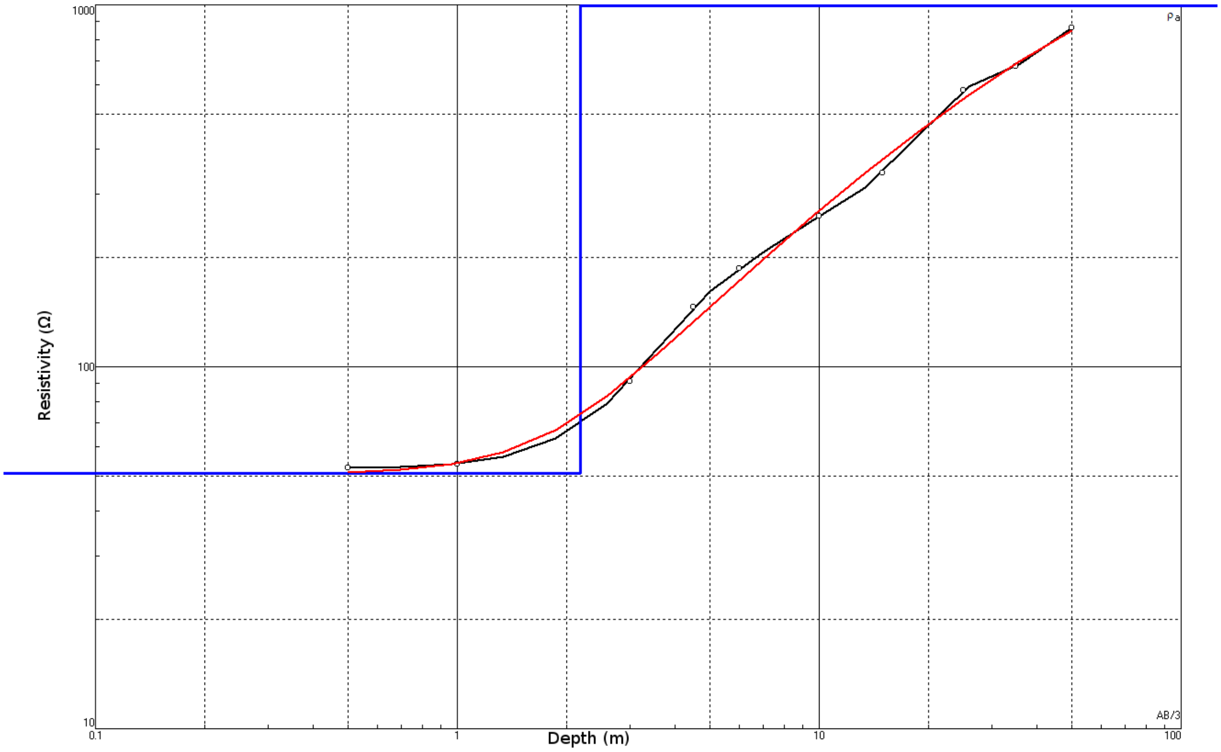
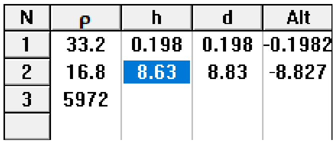


Table 8: 1D Inversion Model for E-3 W/E. RMS error of 4.77 %

Table 8: Resistivity Sounding Results for Sounding T4 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E4 – N/S
GPS	18T – 486713, 5003424

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	1.33	6.67	20.94
1	200	0.57	2.86	17.93
3	200	0.268	1.34	16.84
4.5	200	0.154	0.769	19.339
6	200	0.121	0.606	22.832
10	200	0.894	0.448	28.157
15	200	0.814	0.408	38.417
25	200	0.811	0.406	63.811
35	200	0.824	0.413	90.753
50	200	0.852	0.427	134.17



N	ρ	h	d	Alt
1	33.2	0.198	0.198	-0.1982
2	16.8	8.63	8.83	-8.827
3	5972			

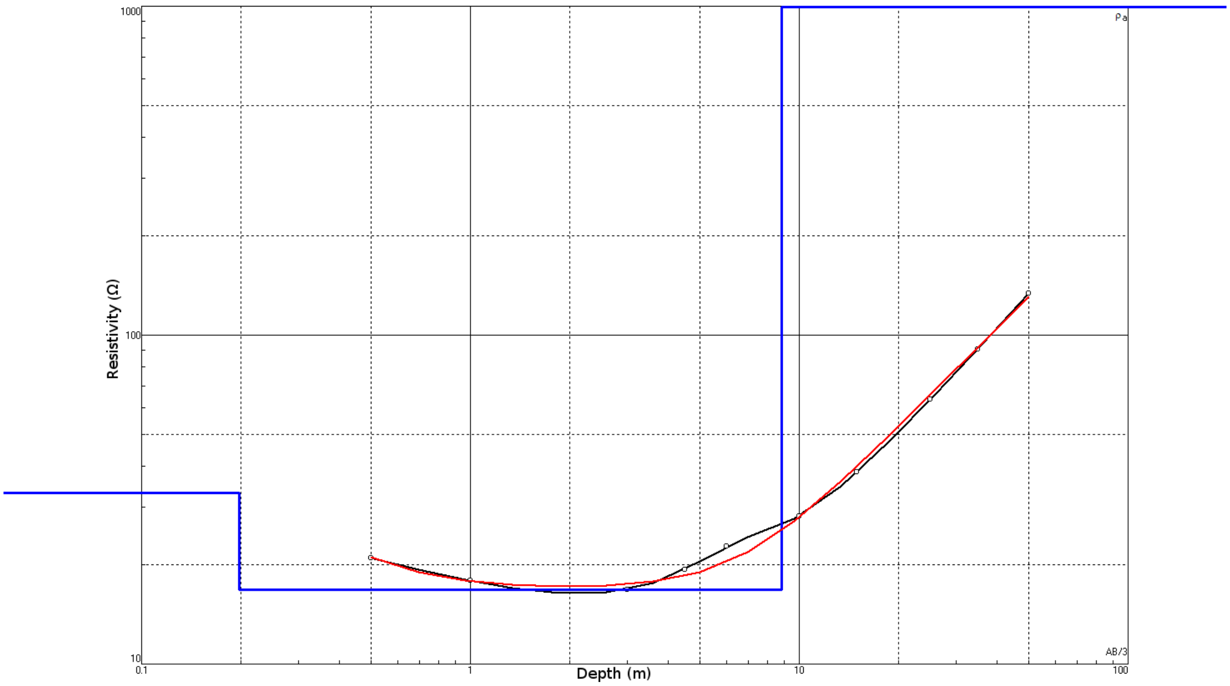
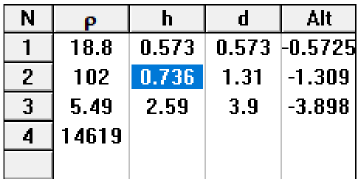


Table 9: 1D Inversion Model for E-4 N/S. RMS error of 4.34 %

Table 9: Resistivity Sounding Results for Sounding T4 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E4 – W/E
GPS	18T –486173, 5003424

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	1.47	7.35	23.088
1	200	0.875	4.38	27.532
3	200	0.494	2.47	31.101
4.5	200	0.163	0.818	20.553
6	200	0.112	0.562	21.195
10	200	0.869	0.435	27.345
15	200	0.828	0.415	39.073
25	200	0.967	0.484	76.075
35	200	0.828	0.415	91.188
50	200	0.846	0.424	131.16



N	ρ	h	d	Alt
1	18.8	0.573	0.573	-0.5725
2	102	0.736	1.31	-1.309
3	5.49	2.59	3.9	-3.898
4	14619			

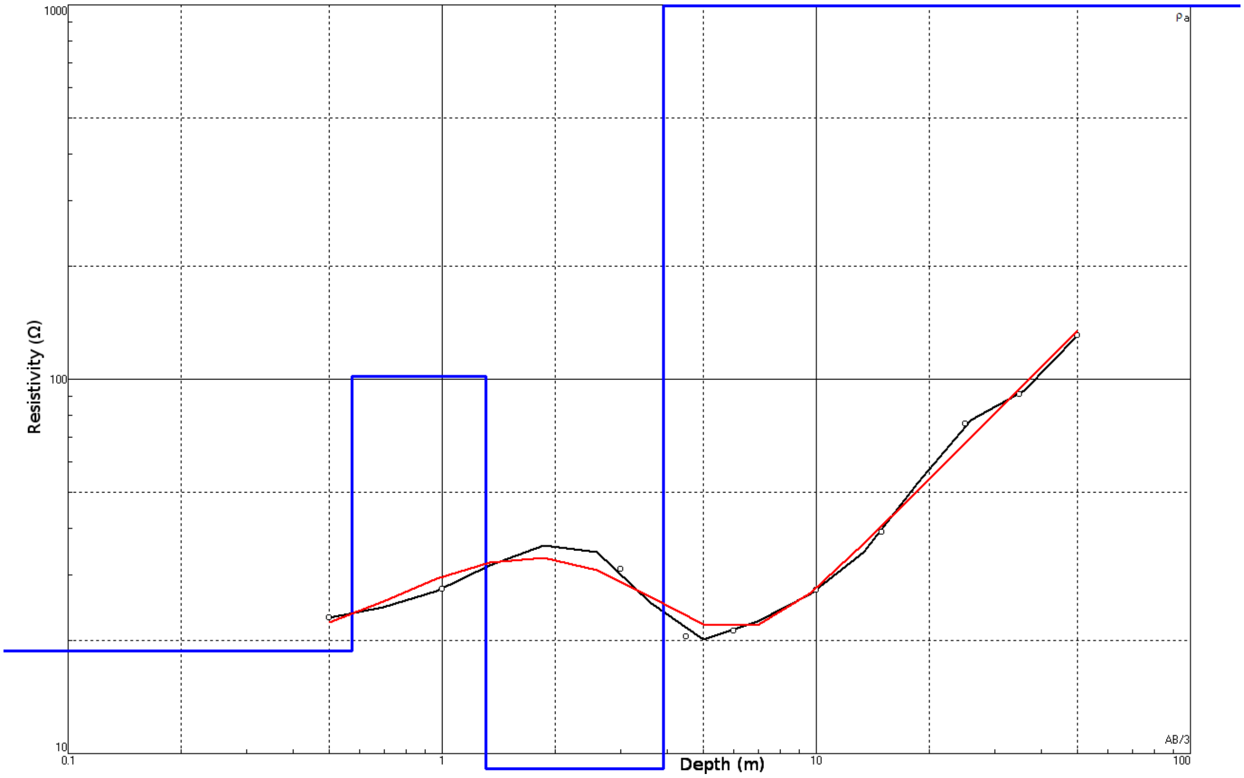
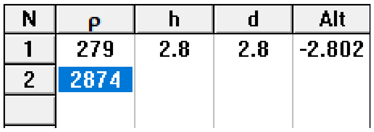


Table 10: 1D Inversion Model for E-4 W/E. RMS error of 6.06 %

Table 10: Resistivity Sounding Results for Sounding T5 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E5 – N/S
GPS	18T – 488427, 5001671

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	16.7	83.7	262.92
1	200	9.71	48.6	305.55
3	200	5.9	29.6	371.56
4.5	200	4.16	20.8	523.96
6	200	3.66	18.4	691.89
10	200	3.26	16.3	1026.1
15	200	2.82	14.1	1332.2
25	200	2	10	1573.3
35	200	1.7	8.53	1875.5
50	200	1.48	7.42	2332.5



N	ρ	h	d	Alt
1	279	2.8	2.8	-2.802
2	2874			

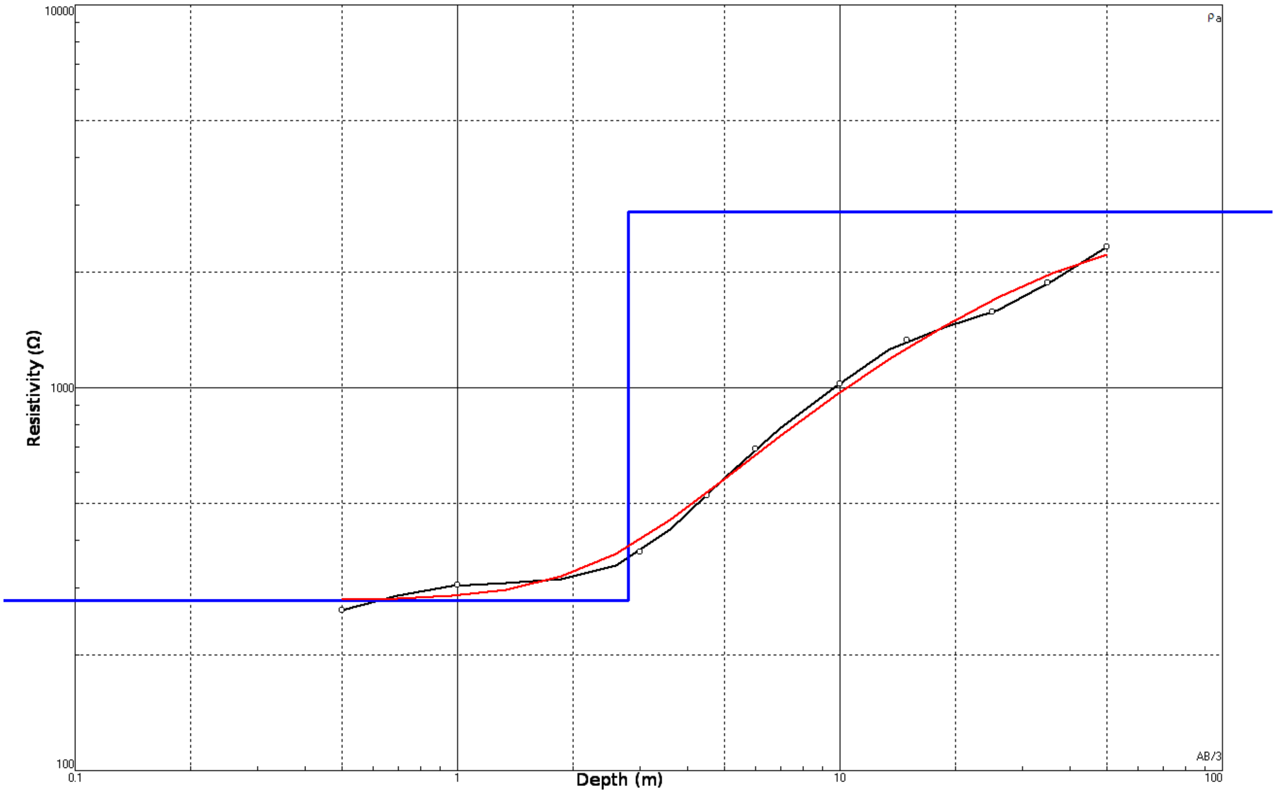
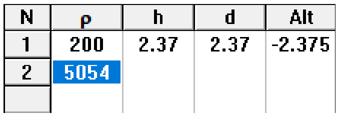


Table 11: 1D Inversion Model for E-5 N/S. RMS error of 4.94 %

Table 11: Resistivity Sounding Results for Sounding T5 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E5 – W/E
GPS	18T – 488444, 5001745

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	11.1	55.8	175.42
1	200	7.32	36.7	230.43
3	200	5.16	25.9	325.09
4.5	200	3.77	18.9	474.95
6	200	3.23	16.2	610.68
10	200	3.11	15.6	977.79
15	200	2.92	14.6	1376.8
25	200	2.5	12.5	1963.6
35	200	2.1	10.5	2310.4



N	ρ	h	d	Alt
1	200	2.37	2.37	-2.375
2	5054			

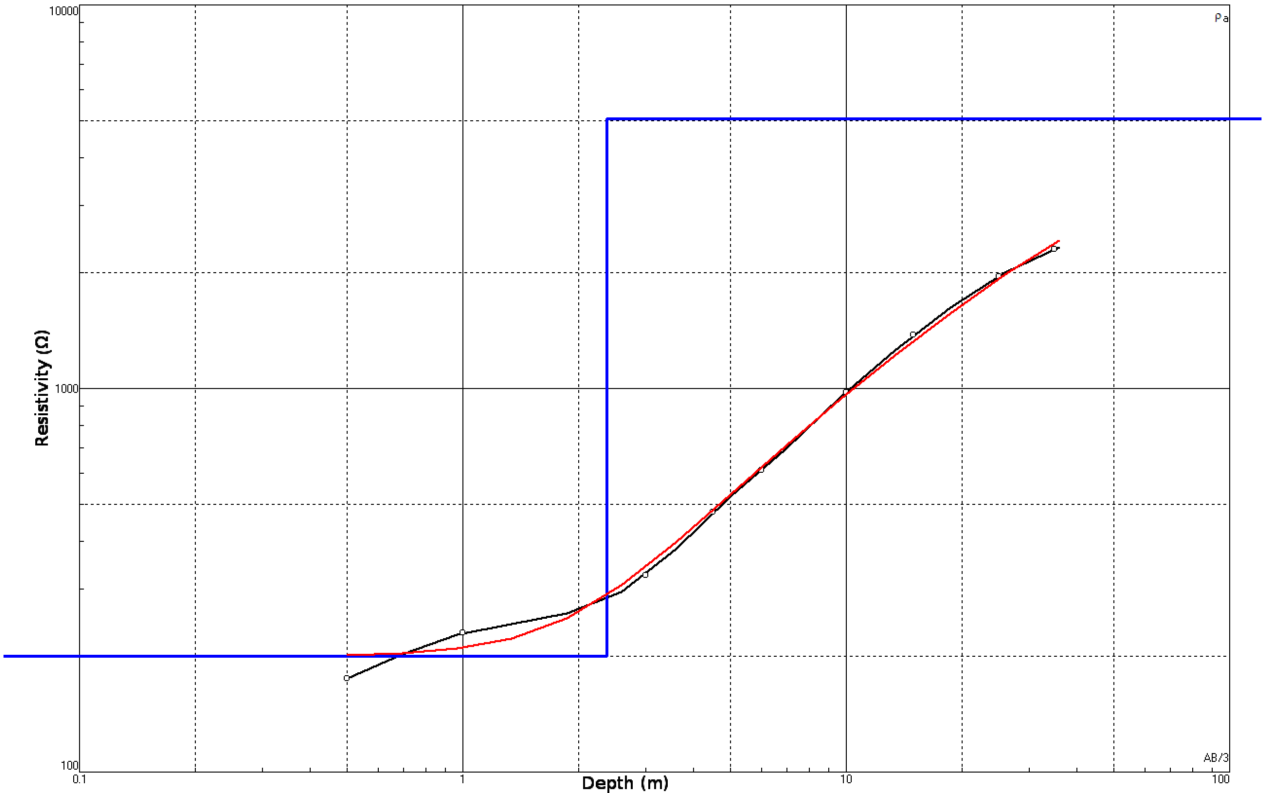
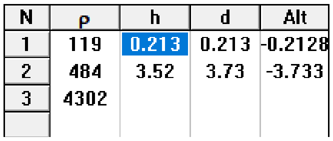


Table 12: 1D Inversion Model for E-5 W/E. RMS error of 5.49 %

Table 12: Resistivity Sounding Results for Sounding T6 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E6 – N/S
GPS	18T – 490720, 5004543

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	14.8	74.3	233.33
1	200	10.7	53.4	335.77
3	199	8	40.1	504
4.5	200	4.57	22.9	575.87
6	200	4.41	22.1	833.91
10	200	3.72	18.6	1170.4
15	179	3.01	16.8	1579.9
25	193	2.8	14.5	2275.8
35	186	2.29	12.3	2707.9
50	115	1.01	8.79	2761.8



N	ρ	h	d	Alt
1	119	0.213	0.213	-0.2128
2	484	3.52	3.73	-3.733
3	4302			

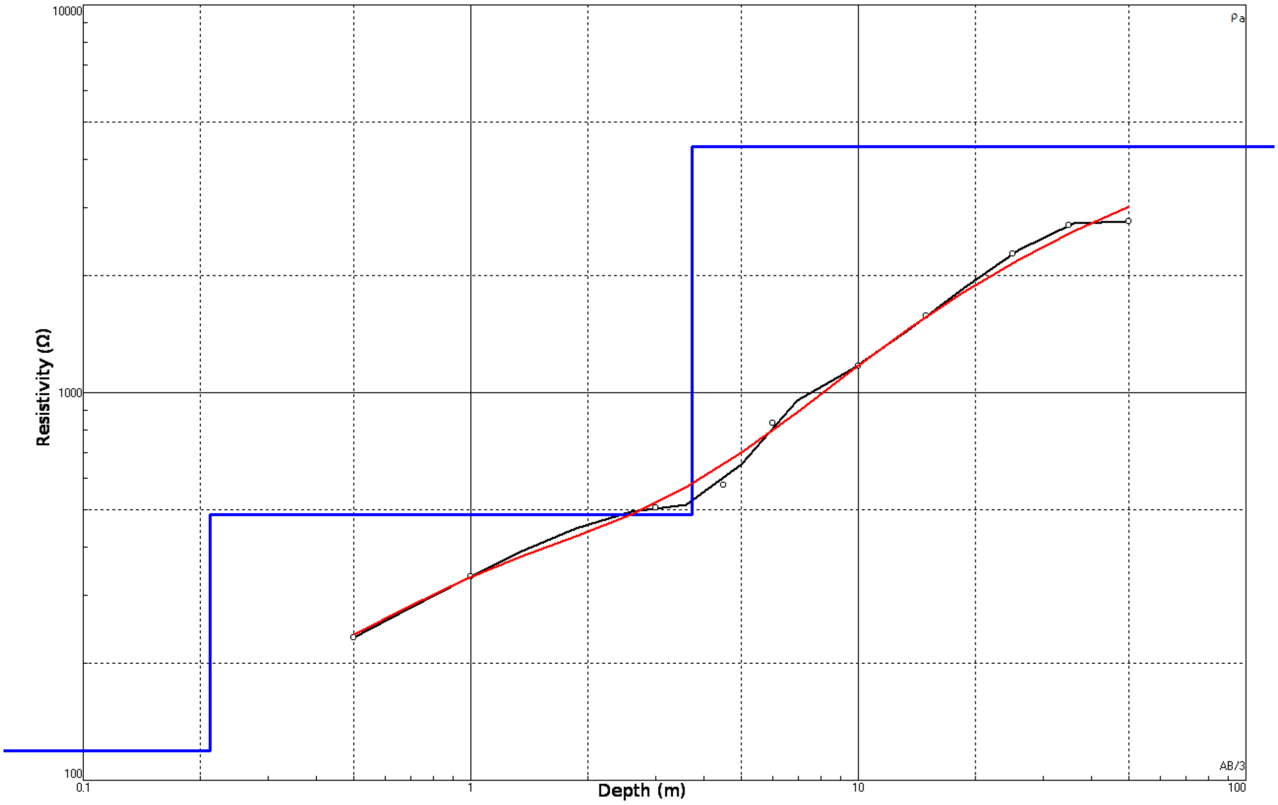
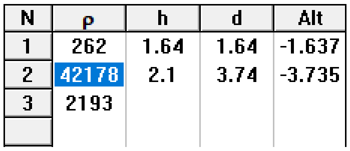


Table 13: 1D Inversion Model for E-6 N/S. RMS error of 5.01 %

Table 13: Resistivity Sounding Results for Sounding T6 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E6 – W/E
GPS	18T – 490720, 5004543

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	16.6	83.2	261.52
1	200	9.7	48.6	305.39
3	200	9.32	16.7	587.06
4.5	200	5.84	29.3	735.3
6	200	6.55	32.8	1237.4
10	200	6.7	33.6	2109.7
15	144	4.26	29.6	2791.1
25	188	2.23	3.11	2607.3
35	123	1.46	11.8	2605.9
50	176	1.96	11.1	3490.4



N	ρ	h	d	Alt
1	262	1.64	1.64	-1.637
2	42178	2.1	3.74	-3.735
3	2193			

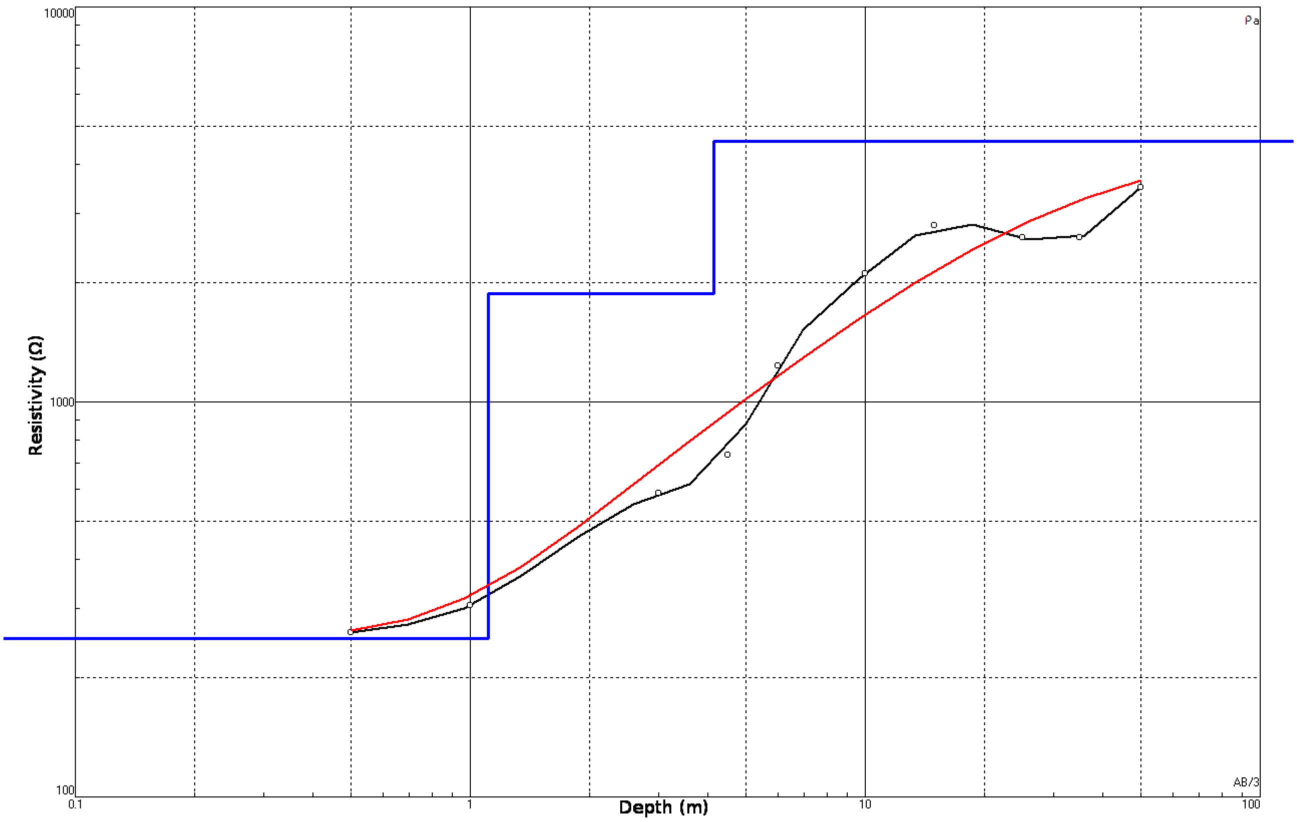
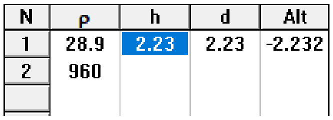


Table 14: 1D Inversion Model for E-6 W/E. RMS error of 15.2 %

Table 14: Resistivity Sounding Results for Sounding T7 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E7 – N/S
GPS	18T – 485043, 4999773

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	1.77	8.89	27.942
1	199	1	5.03	31.578
3	199	0.806	4.04	50.771
4.5	199	0.599	3	75.51
6	199	0.572	2.87	108.03
10	199	0.504	2.53	158.83
15	199	0.41	2.05	193.65
25	200	0.364	1.83	286.85
35	200	0.367	1.84	404.93
50	200	0.342	1.71	532.33



N	ρ	h	d	Alt
1	28.9	2.23	2.23	-2.232
2	960			

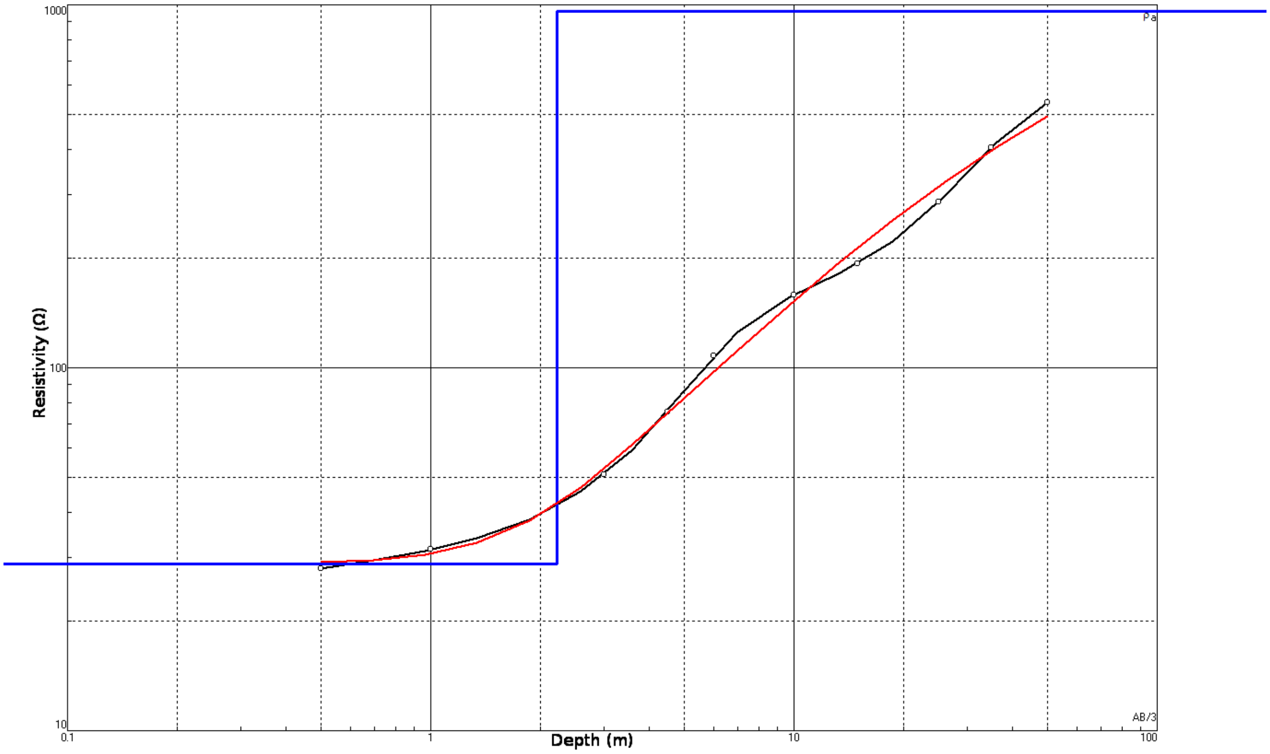
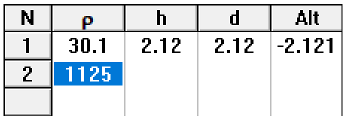


Table 15: 1D Inversion Model for E-7 N/S. RMS error of 6.36 %

Table 15: Resistivity Sounding Results for Sounding T7 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E7 – W/E
GPS	18T – 485044, 4999776

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	2.12	10.6	33.336
1	200	1.03	5.14	32.324
3	200	0.798	4	50.258
4.5	200	0.746	3.74	94.004
6	200	0.718	3.6	135.69
10	200	0.572	2.87	180.06
15	200	0.463	2.32	218.56
25	200	0.424	2.12	333.41
35	200	0.402	2.01	442.97
50	200	0.366	1.83	576.38



N	ρ	h	d	Alt
1	30.1	2.12	2.12	-2.121
2	1125			

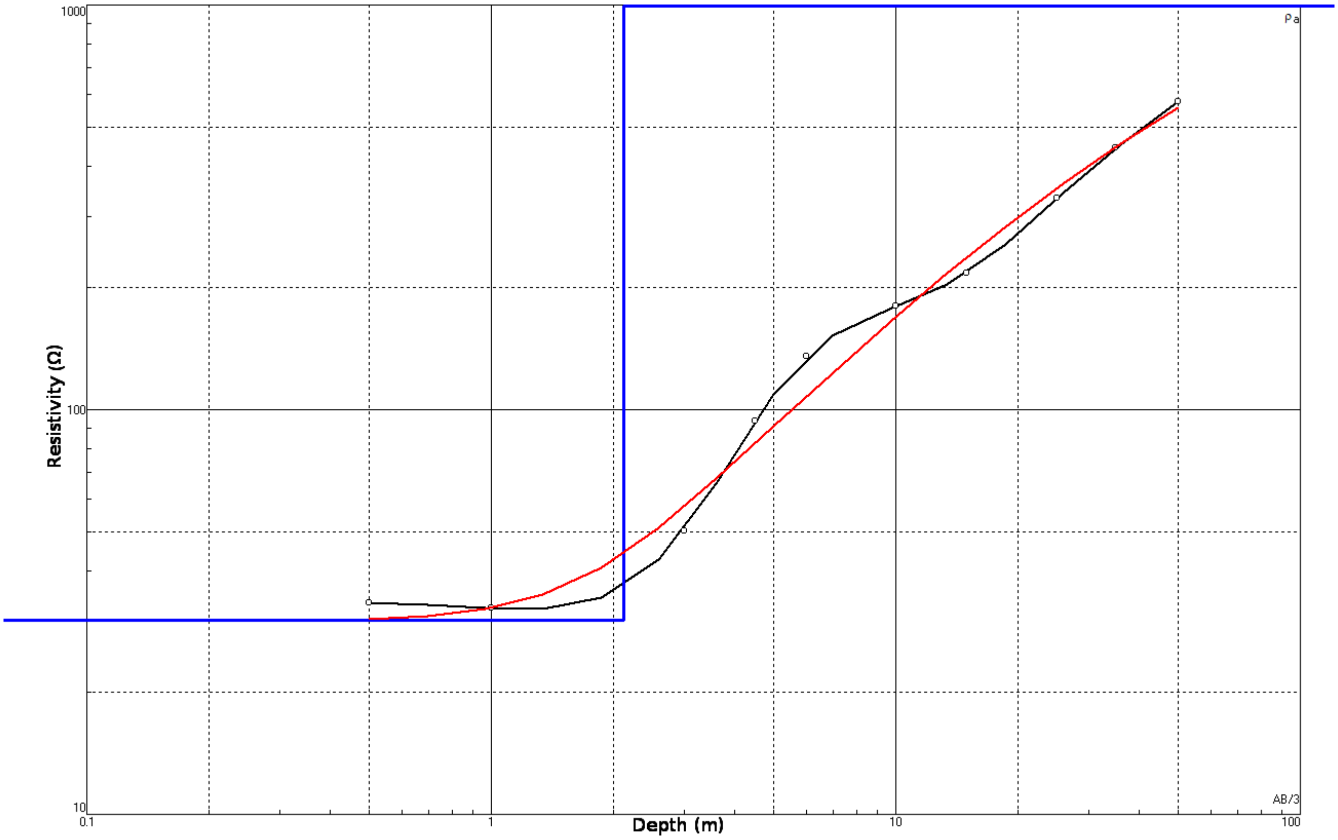
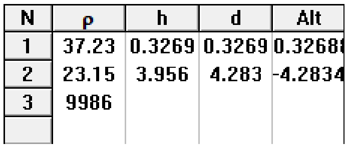


Table 16: 1D Inversion Model for E-7 W/E. RMS error of 11.1 %

Table 16: Resistivity Sounding Results for Sounding T8 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E8 – N/S
GPS	18T – 488133, 4998342

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	2.14	10.7	33.747
1	200	0.886	4.44	27.888
3	200	0.408	2.04	25.686
4.5	200	0.23	1.15	28.977
6	200	0.193	0.967	36.471
10	200	0.175	0.879	55.205
15	200	0.172	0.861	81.148
25	200	0.174	0.869	136.58
35	200	0.173	0.864	190.09
50	200	0.177	0.884	277.83



N	ρ	h	d	Alt
1	37.23	0.3269	0.3269	0.3268
2	23.15	3.956	4.283	-4.2834
3	9986			

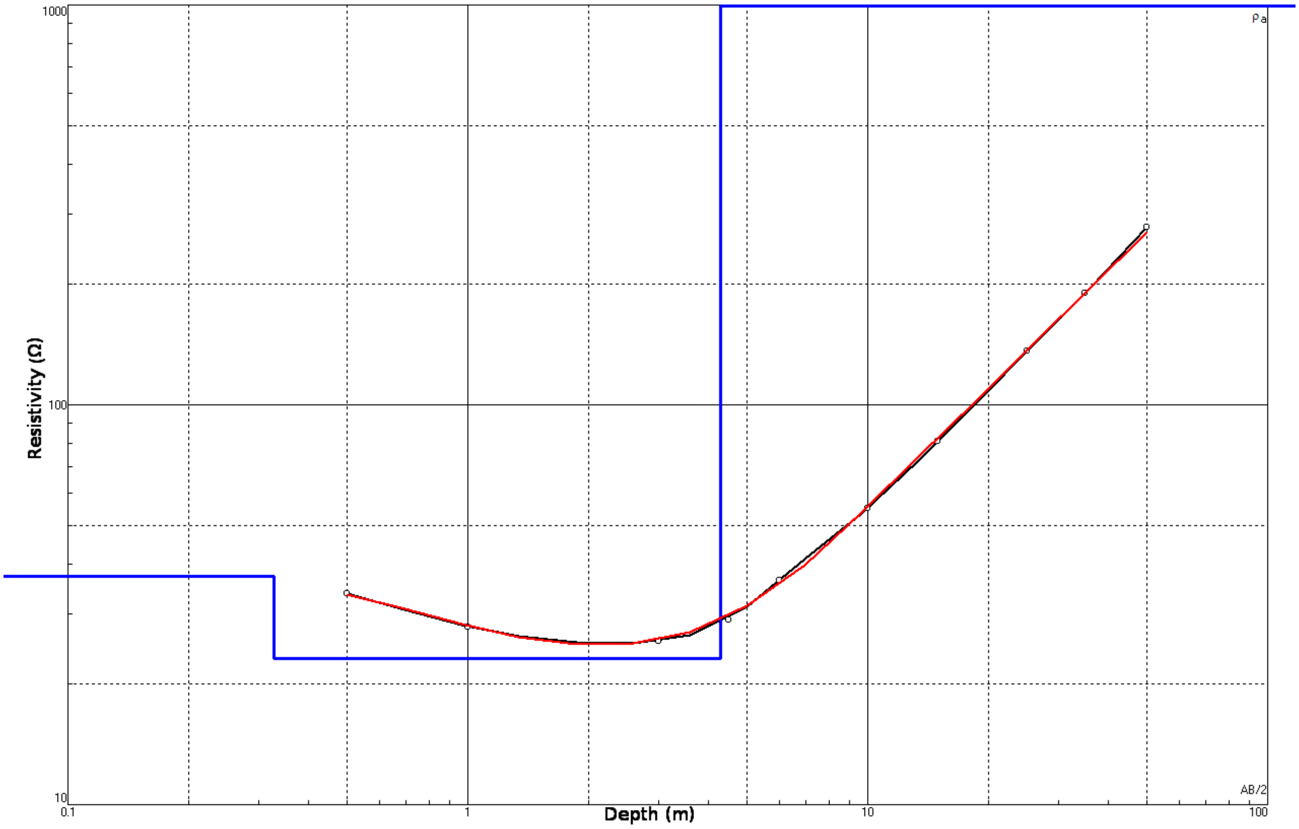
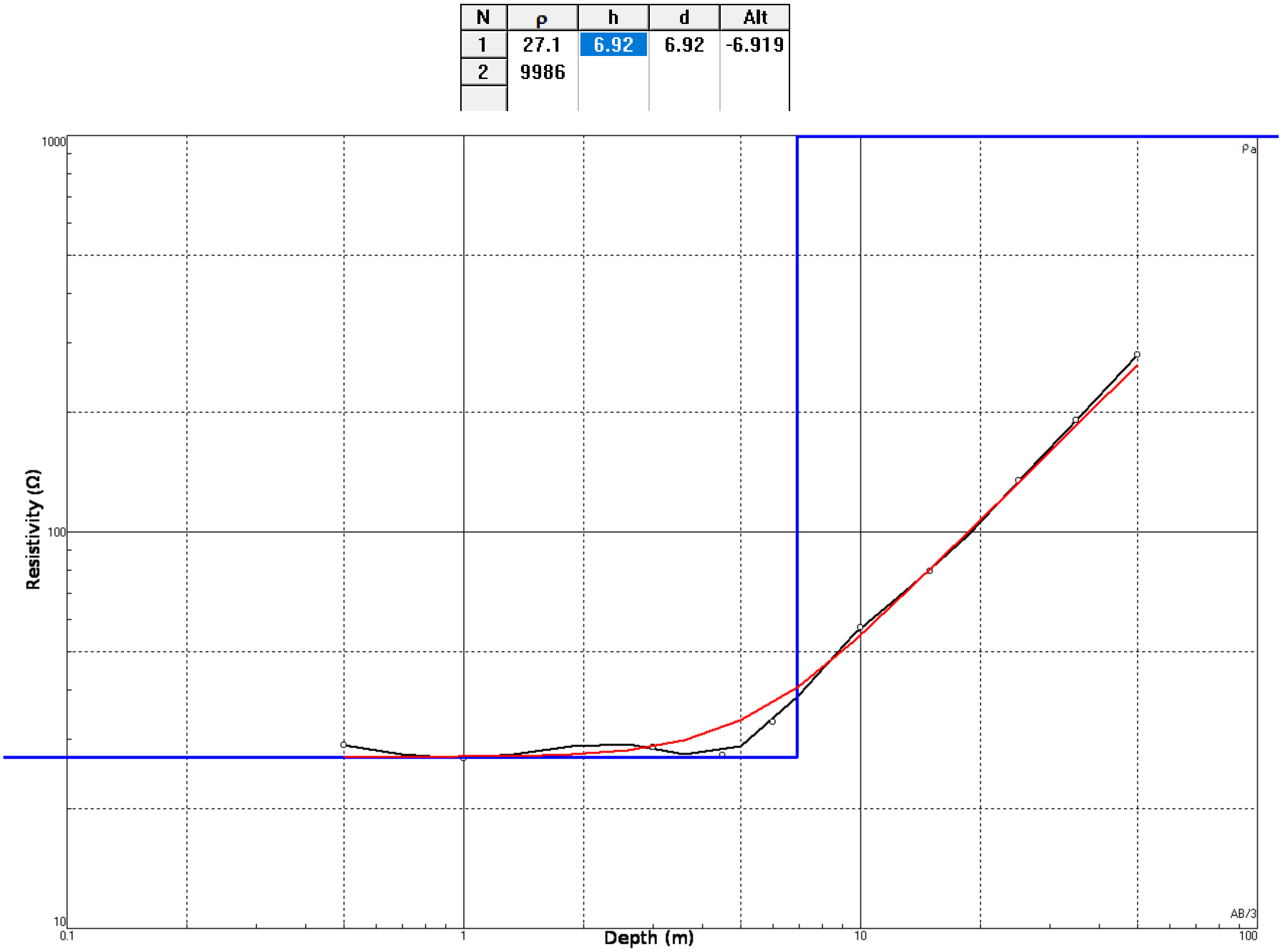


Table 17: 1D Inversion Model for E-8 N/S. RMS error of 1.44 %

Table 17: Resistivity Sounding Results for Sounding T8 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E8 – W/E
GPS	18T – 488133, 4998342

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	1.84	9.21	28.94
1	200	0.852	4.27	26.831
3	200	0.454	2.28	28.6
4.5	200	0.218	1.09	27.392
6	200	0.176	0.88	33.18
10	200	0.182	0.914	57.424
15	200	0.169	0.845	79.631
25	200	0.171	0.856	134.43
35	200	0.174	0.87	191.42
50	200	0.178	0.89	279.48



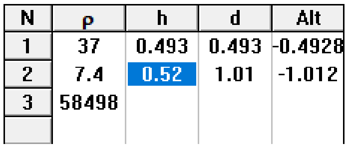
N	ρ	h	d	Alt
1	27.1	6.92	6.92	-6.919
2	9986			

Table 18: 1D Inversion Model for E-8 W/E. RMS error of 5.63 %

Table 18: Resistivity Sounding Results for Sounding T9 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E9 – N/S
GPS	18T – 491184, 5000205

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	1.99	9.97	31.312
1	200	0.879	4.4	27.653
3	200	0.97	1.85	23.268
4.5	200	0.353	1.77	44.478
6	200	0.402	2.01	75.917
10	200	0.432	2.16	135.89
15	200	0.423	2.12	199.75
25	200	0.443	2.22	348.92
35	200	0.444	2.23	489.32
50	200	0.444	2.22	698.44



N	ρ	h	d	Alt
1	37	0.493	0.493	-0.4928
2	7.4	0.52	1.01	-1.012
3	58498			

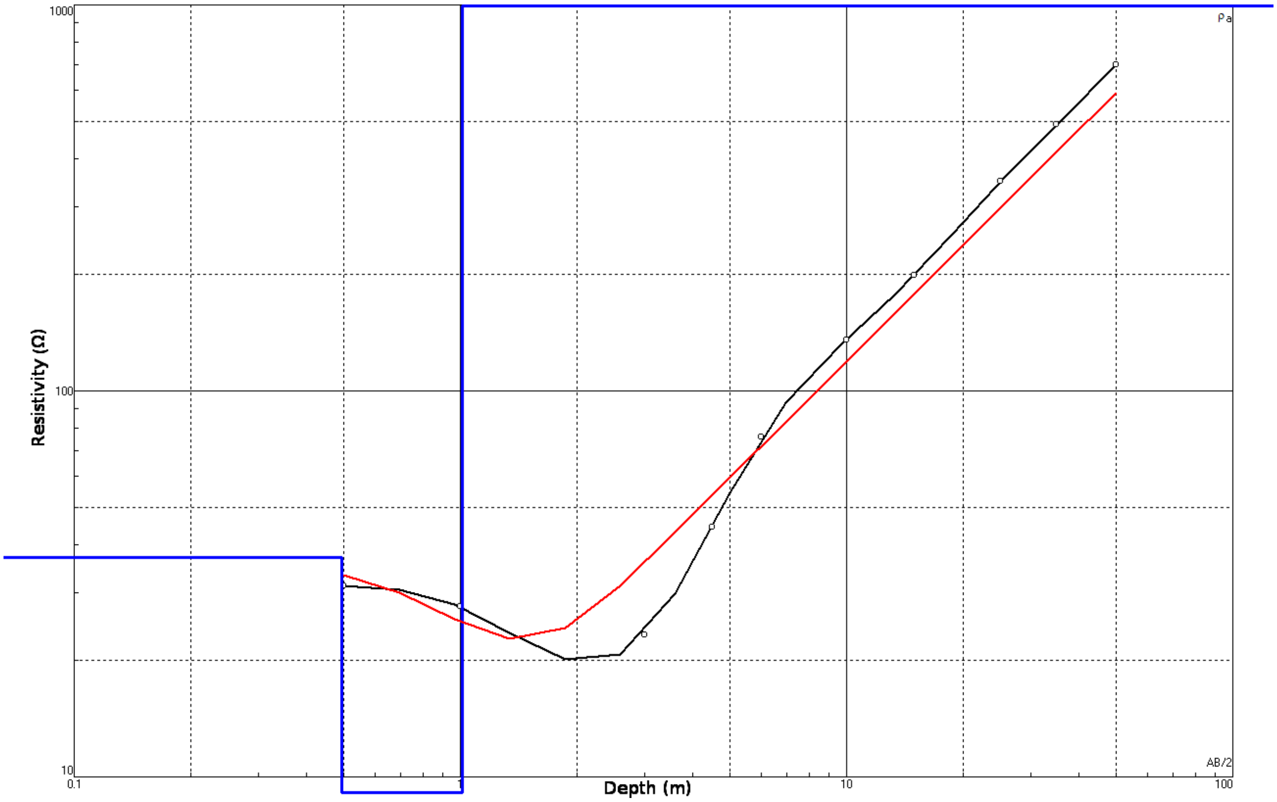
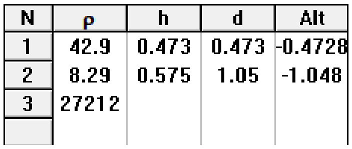


Table 19: 1D Inversion Model for E-9 N/S. RMS error of 18.3 %

Table 20: Resistivity Sounding Results for Sounding T9 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E9 – W/E
GPS	18T – 491184, 5000205

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	2.36	11.8	37.12
1	200	0.916	4.59	28.859
3	200	0.428	2.14	26.95
4.5	200	0.381	1.91	48.017
6	200	0.403	2.02	76.097
10	200	0.407	2.04	127.98
15	200	0.412	2.07	194.69
25	200	0.456	2.28	358.92
35	200	0.461	2.31	507.78
50	200	0.46	2.31	724.58



N	ρ	h	d	Alt
1	42.9	0.473	0.473	-0.4728
2	8.29	0.575	1.05	-1.048
3	27212			

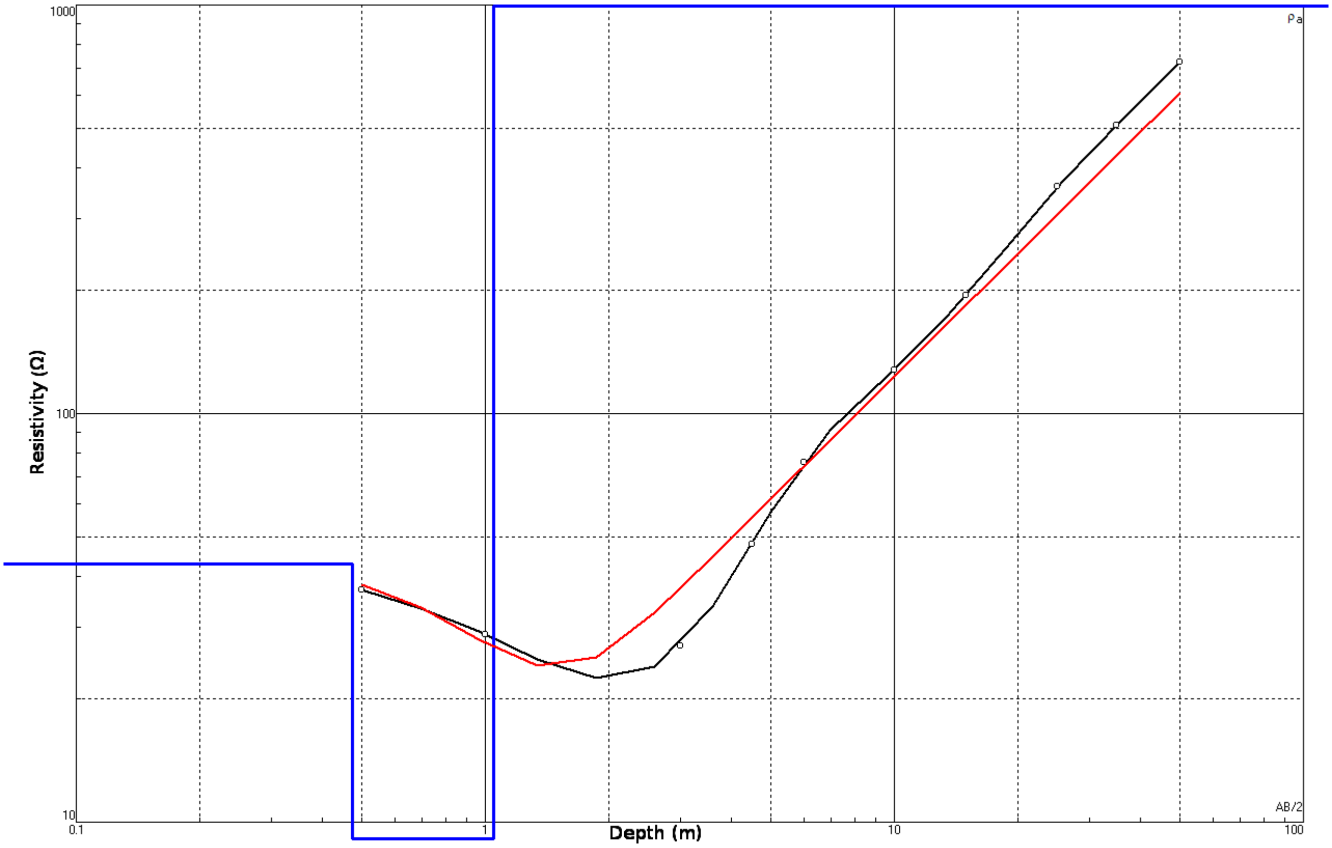
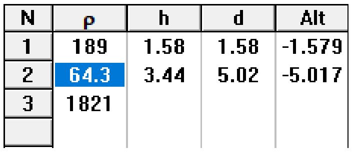


Table 21: 1D Inversion Model for E-9 W/E. RMS error of 14 %

Table 21: Resistivity Sounding Results for Sounding T10 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E10 – N/S
GPS	18T – 494279, 5001838

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	10.9	54.4	170.93
1	200	6.11	30.96	192.54
3	159	1.55	9.71	121.96
4.5	129	0.641	4.98	125.19
6	200	0.681	3.41	128.6
10	173	0.55	3.17	199.27
15	180	0.562	3.13	295.04
25	200	0.585	2.93	460.32
35	84.2	0.215	2.56	562.45
50	163	0.363	2.23	701.43



N	ρ	h	d	Alt
1	189	1.58	1.58	-1.579
2	64.3	3.44	5.02	-5.017
3	1821			

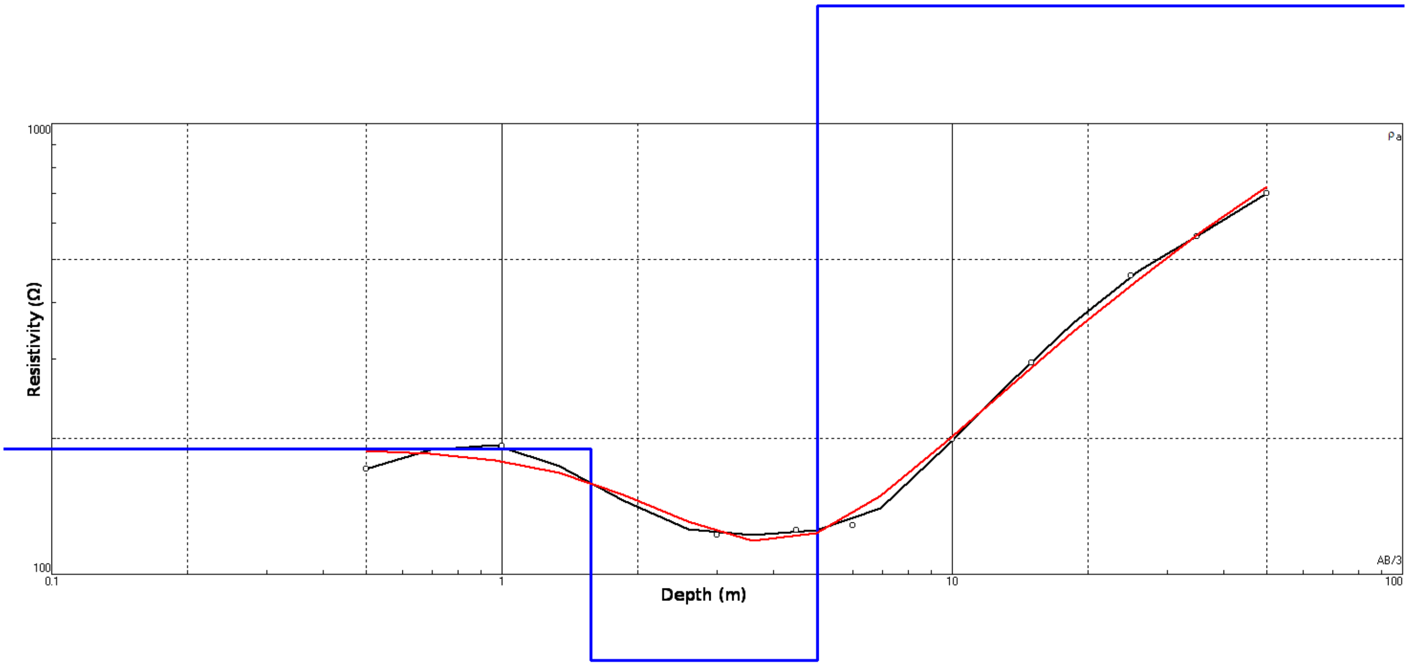
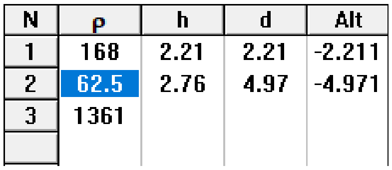


Table 22: 1D Inversion Model for E-10 N/S. RMS error of 4.52 %

Table 22: Resistivity Sounding Results for Sounding T10 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E10 – W/E
GPS	18T – 494279, 5001838

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	9.63	48.2	151.5
1	179	4.59	25.7	161.28
3	174	1.92	11	138.66
4.5	140	0.585	4.16	104.63
6	157	0.532	3.59	135.23
10	173	0.634	3.65	229.48
15	200	0.673	3.37	317.52
25	200	0.535	2.68	421.16
35	200	0.485	2.43	534.4
50	187	0.405	2.19	679.04



N	ρ	h	d	Alt
1	168	2.21	2.21	-2.211
2	62.5	2.76	4.97	-4.971
3	1361			

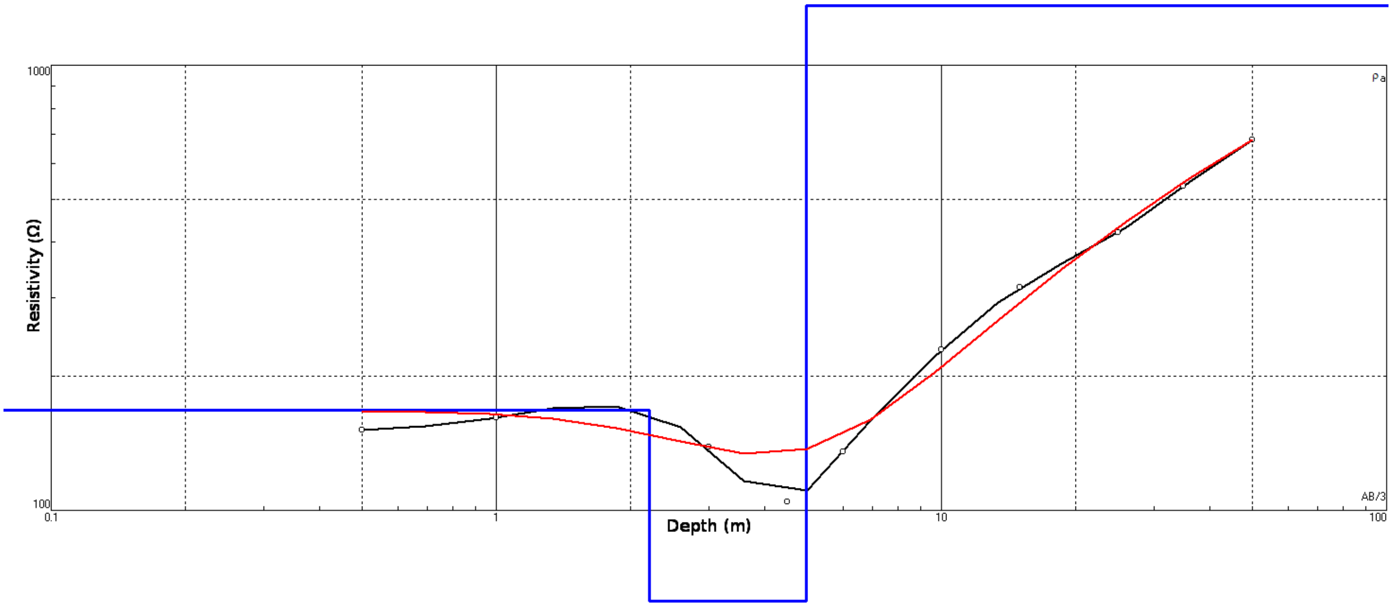
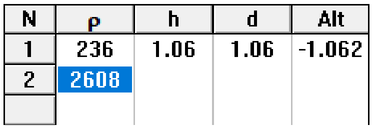


Table 23: 1D Inversion Model for E-10 W/E. RMS error of 9.01 %

Table 23: Resistivity Sounding Results for Sounding T11 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E11 – N/S
GPS	18T – 491381, 4997145

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	119	8.2	69.1	216.95
1	164	9.75	59.4	373.22
3	158	7.96	50.4	633.23
4.5	157	6.82	43.4	1089.7
6	162	5.11	31.5	1187.6
10	199	4.6	23.1	1449.9
15	173	3.29	19.1	1799.7
25	172	2.4	14	2192.6
35	198	2.11	10.7	2352.1
50	199	1.53	7.65	2403.2



N	ρ	h	d	Alt
1	236	1.06	1.06	-1.062
2	2608			

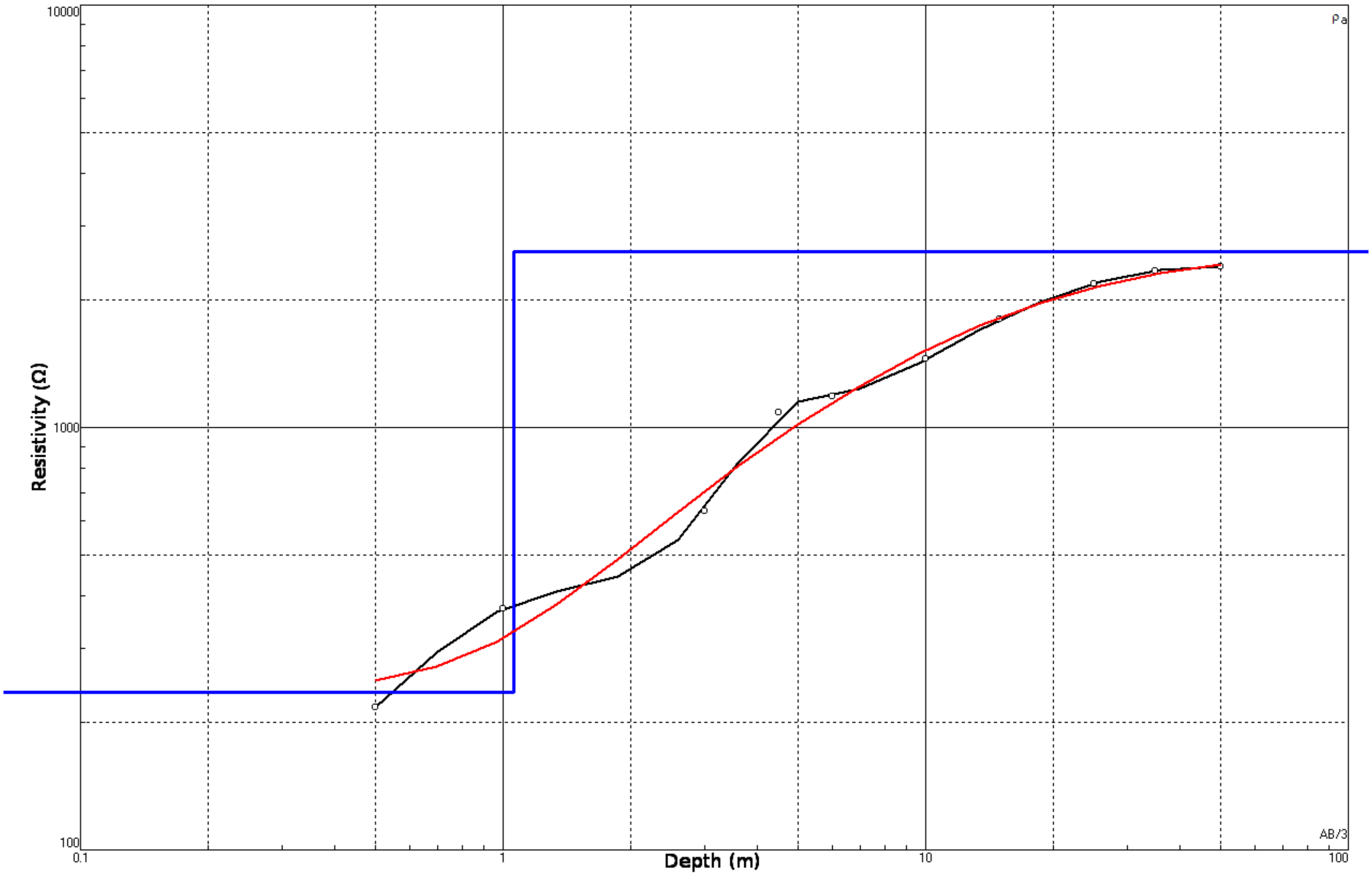
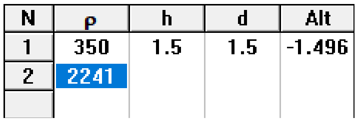


Table 24: 1D Inversion Model for E-11 N/S. RMS error of 8.59 %

Table 24: Resistivity Sounding Results for Sounding T11 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E11 – W/E
GPS	18T – 491381, 4997145

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	21.4	107	337.13
1	196	13.4	68.6	430.82
3	193	9.59	49.6	623.68
4.5	125	5.36	42.8	1074.6
6	175	5.92	33.9	1278.9
10	200	5.07	25.4	1599.5
15	200	3.81	19.1	1800.9
25	175	2.05	11.7	1837.8
35	165	1.38	8.34	1833.8
50	200	1.32	6.6	2074.8



N	ρ	h	d	Alt
1	350	1.5	1.5	-1.496
2	2241			

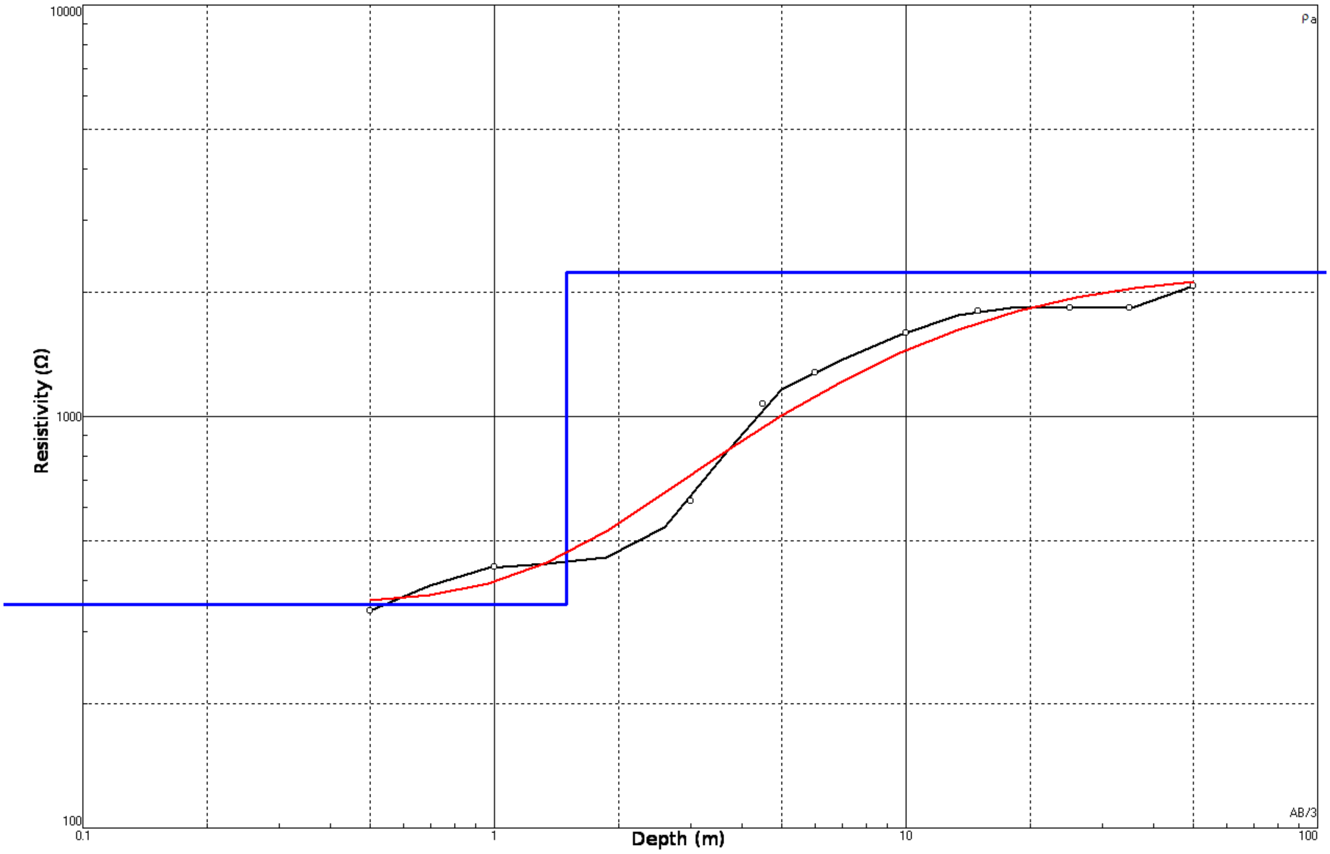
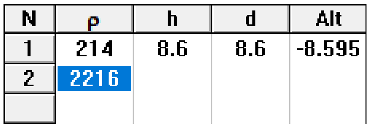


Table 25: 1D Inversion Model for E-11 W/E. RMS error of 9.74 %

Table 25: Resistivity Sounding Results for Sounding T12 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E12 – N/S
GPS	18T – 488441, 4995522

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	11.3	56.7	178.13
1	200	7.64	38.3	240.43
3	191	3.17	16.6	208.88
4.5	198	1.63	8.21	206.34
6	129	0.841	6.53	246
10	191	1	5.24	328.96
15	200	0.923	4.62	435.62
25	200	0.838	4.2	659.45
35	200	0.739	3.7	813.81
50	200	0.649	3.24	1016.3



N	ρ	h	d	Alt
1	214	8.6	8.6	-8.595
2	2216			

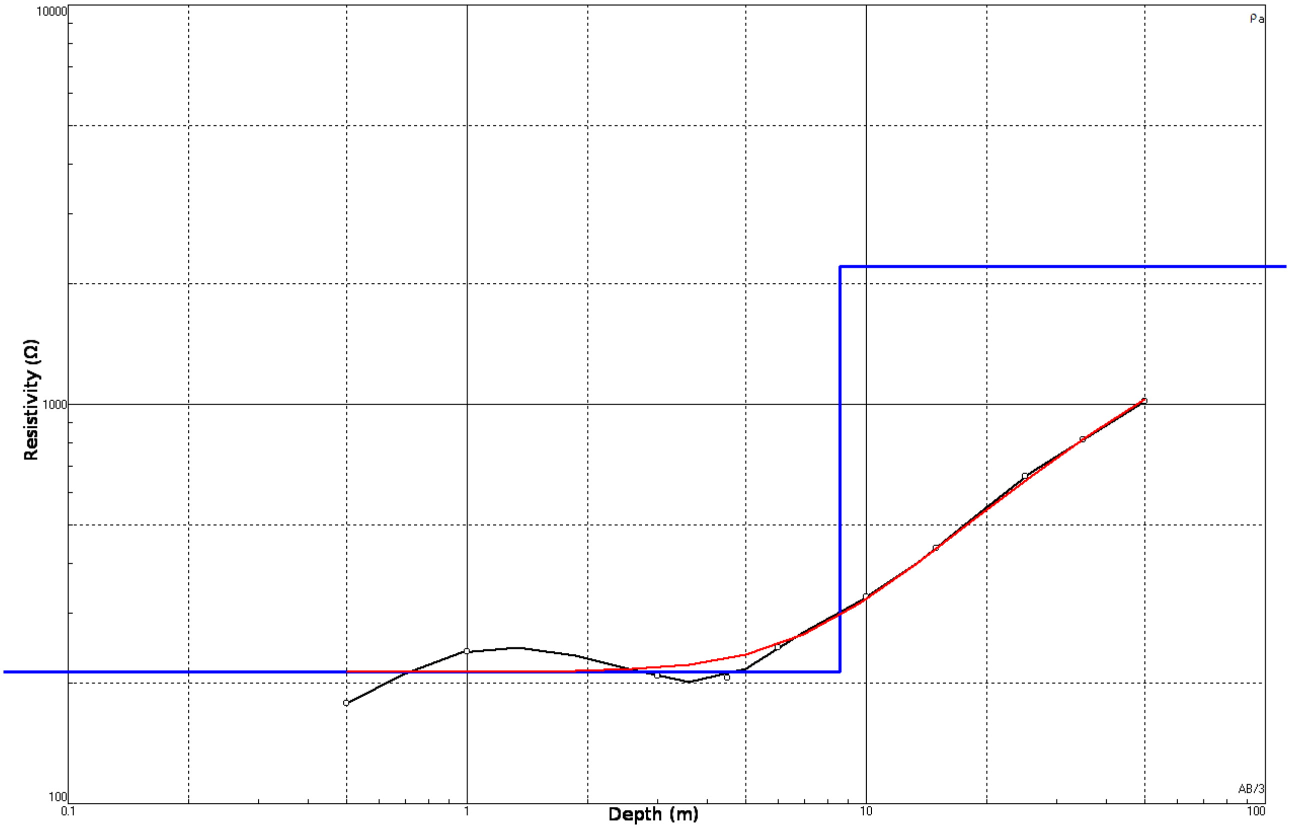
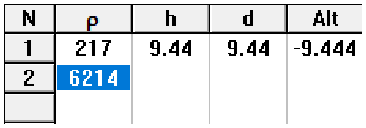


Table 26: 1D Inversion Model for E-12 N/S. RMS error of 7.73 %

Table 26: Resistivity Sounding Results for Sounding T12 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E12 – W/E
GPS	18T – 488441, 4995522

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	175	12.1	69.5	218.24
1	160	5.41	33.8	212.65
3	1868	3.01	17.9	224.72
4.5	170	1.53	9.05	227.43
6	191	1.32	6.89	259.74
10	184	0.976	5.31	333.92
15	200	0.913	4.57	431.13
25	200	0.913	4.58	718.63
35	162	0.745	4.61	1013.7
50	119	0.476	3.99	1253.3



N	ρ	h	d	Alt
1	217	9.44	9.44	-9.444
2	6214			

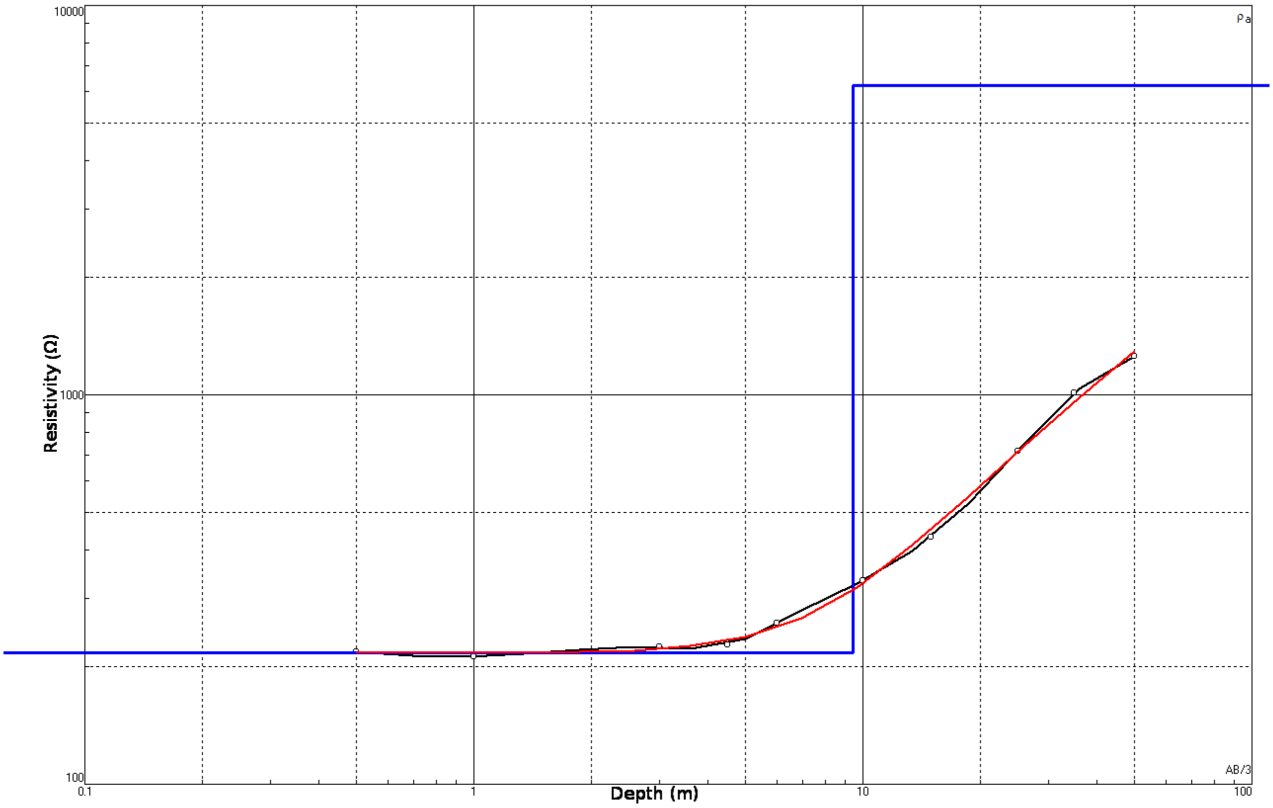
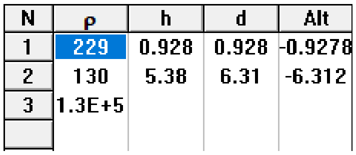


Table 27: 1D Inversion Model for E-12 W/E. RMS error of 2.82 %

Table 27: Resistivity Sounding Results for Sounding T13 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E13 – N/S
GPS	18T – 487994, 4993168

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	199	13.7	68.6	215.67
1	157	5.27	33.7	211.44
3	110	1.37	12.4	155.34
4.5	120	0.836	6.98	175.42
6	101	0.555	5.48	206.43
10	74.5	0.38	5.1	320.29
15	115	0.565	4.94	465.18
25	95.6	0.463	4.84	760.14
35	113	0.525	4.62	1017
50	105	0.465	4.42	1389.8



N	ρ	h	d	Alt
1	229	0.928	0.928	-0.9278
2	130	5.38	6.31	-6.312
3	1.3E+5			

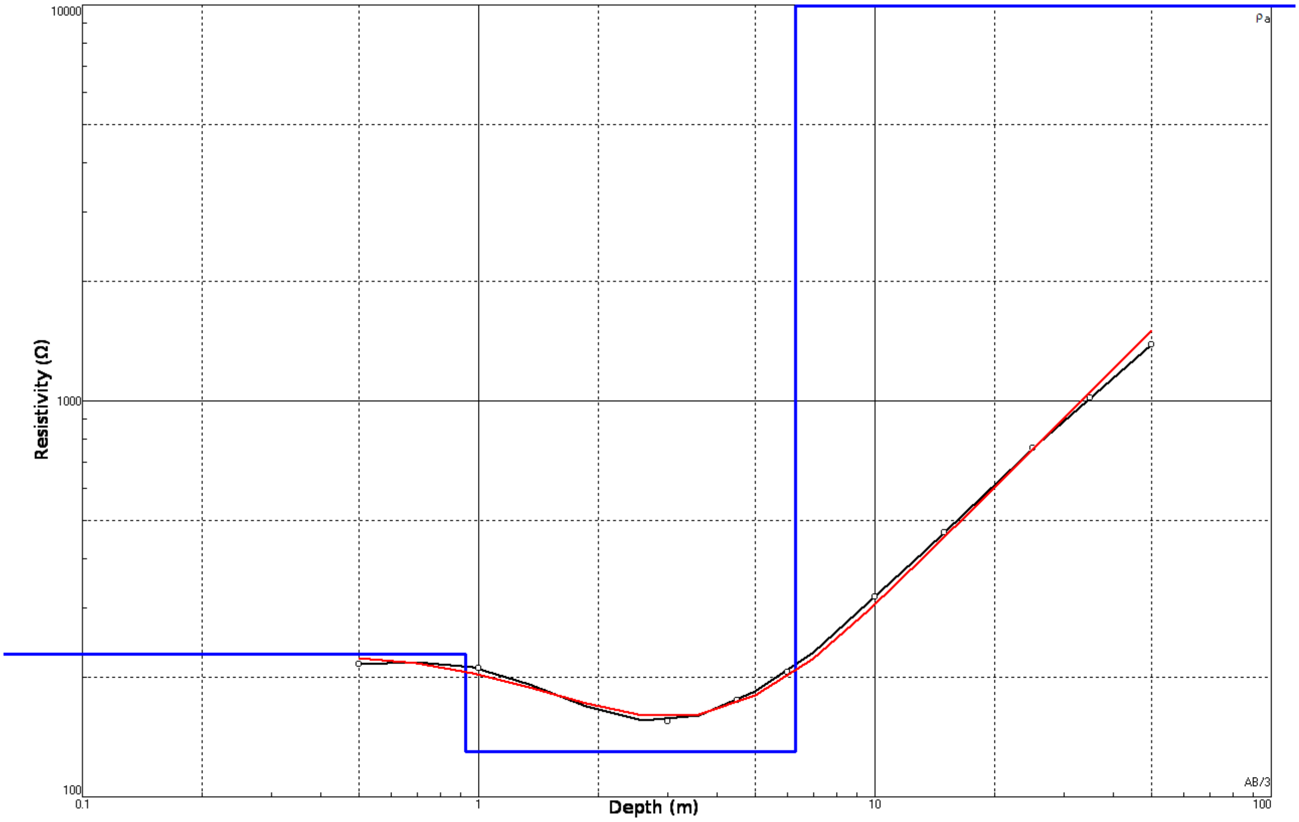
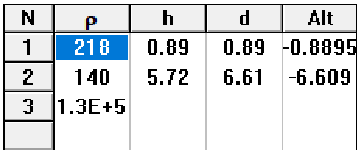


Table 28: 1D Inversion Model for E-13 N/S. RMS error of 3.41 %

Table 28: Resistivity Sounding Results for Sounding T13 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E13 – W/E
GPS	18T – 487994, 4993168

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	200	13.8	69	216.8
1	145	4.48	30.8	193.81
3	124	1.63	13.1	164.06
4.5	54.5	0.365	6.7	168.41
6	9.93	0.568	5.752	215.51
10	92.6	0.481	5.19	326.22
15	134	0.659	4.91	463.03
25	198	0.964	4.87	765.48
35	200	0.945	4.74	1041.6
50	118	0.532	4.49	1411



N	ρ	h	d	Alt
1	218	0.89	0.89	-0.8895
2	140	5.72	6.61	-6.609
3	1.3E+5			

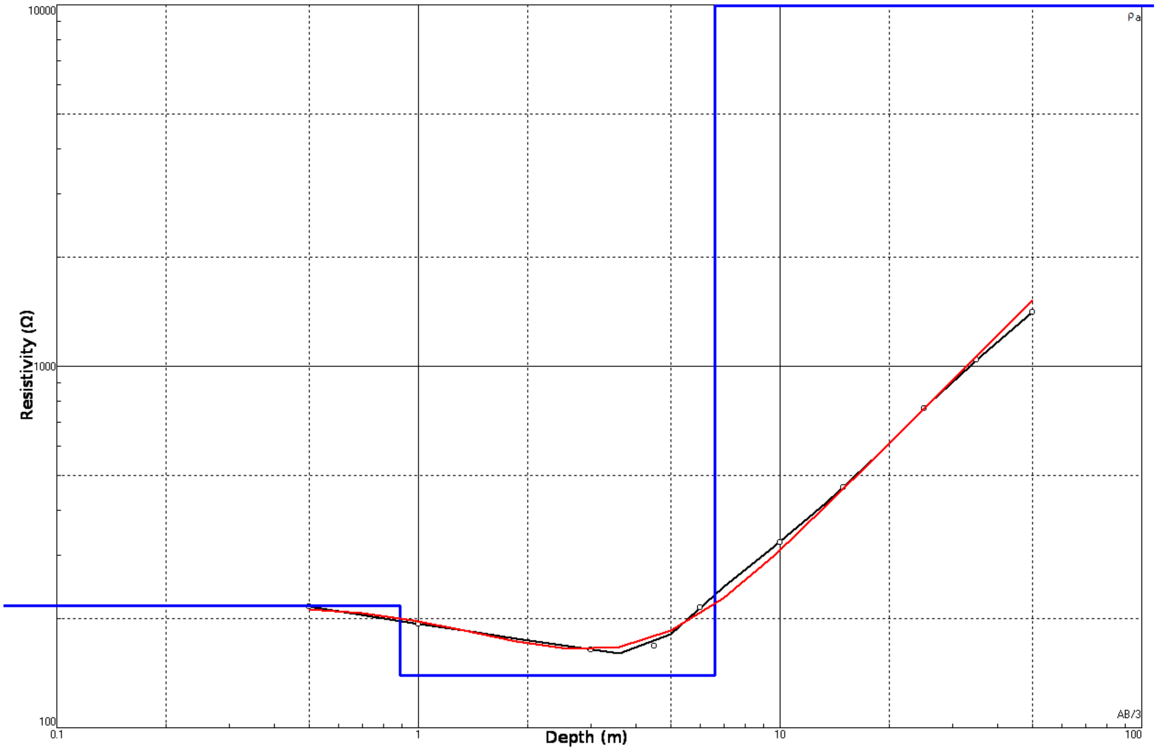
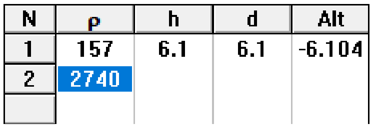


Table 29: 1D Inversion Model for E-13 W/E. RMS error of 3.5 %

Table 29: Resistivity Sounding Results for Sounding T14 – N/S

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E14 – N/S
GPS	18T – 492803, 4996219

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	143	5.64	39.5	124.21
1	89	2.32	26.1	164
3	78.9	1.13	14.3	180.32
4.5	62.3	0.636	8.58	215.64
6	39.5	0.245	6.19	233.22
10	49	0.231	4.71	296.19
15	89.7	0.429	4.78	450.87
25	94.9	0.323	4.31	677.15
35	61.7	0.249	4.04	889
50	71.4	0.264	3.07	1161.1



N	ρ	h	d	Alt
1	157	6.1	6.1	-6.104
2	2740			

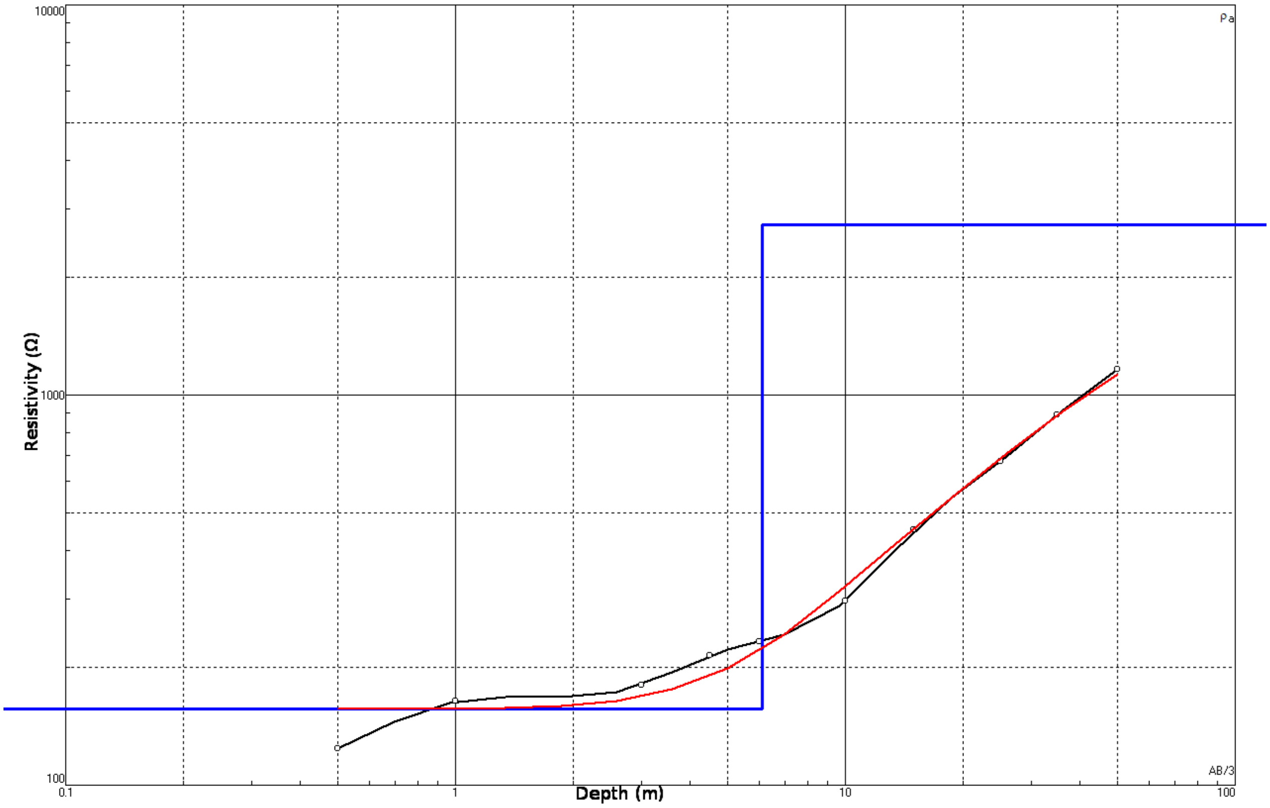
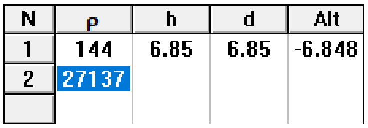


Table 30: 1D Inversion Model for E-14 N/S. RMS error of 8.26 %

Table 30: Resistivity Sounding Results for Sounding T14 – W/E

Client	Tulloch Engineering Inc
Site	Crysler
Date	Sept 21, 2018
Sounding	E14 – E/W
GPS	18T – 492803, 4996219

A-spacing (m)	Current (mA)	Voltage (V)	Resistance (rho)	App. Res (Rho*m)
0.5	192	9.47	49.2	154.65
1	85.8	1.94	22.6	141.74
3	88	1.1	12.5	157.45
4.5	72.4	0.492	6.79	170.61
6	56.7	0.28	4.76	179.34
10	43.1	0.182	4.23	265.91
15	55	0.287	5.21	190.95
25	109	0.532	4.87	765.54
35	97.2	0.439	4.51	992.66
50	103	0.422	4.1	1289



N	ρ	h	d	Alt
1	144	6.85	6.85	-6.848
2	27137			

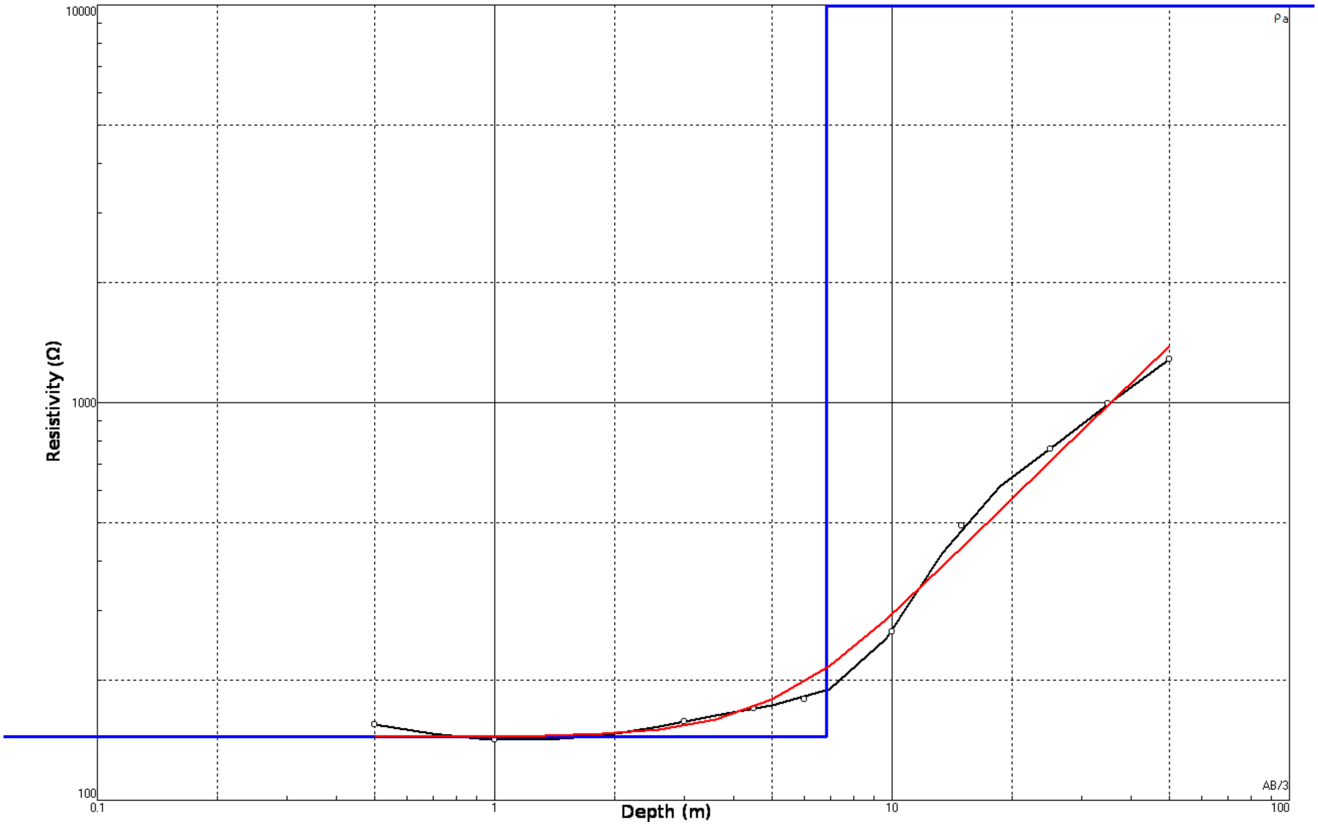


Table 31: 1D Inversion Model for E-14 W/E. RMS error of 8.64 %

CONCLUSIONS

A total of twenty eight resistivity soundings were performed at the Nation Rise Wind Farm project in Ottawa, Ontario From September 14th to 18th, 2018 (Figure 2 and Table 1).

The results of the twenty eight resistivity soundings are presented in Tables 2 to 30 along with the apparent resistivity and the inversion models shown in Figures 3 to 31.

There were two soundings completed at each of the ten sites on the property. Most soundings contained 9 to 10 readings. The RMS error, which is the how close the data from the calculated model matches the actual data, was less than 10% on most soundings. The only exception is site E1 and E2 with higher error.

There is often a high resistivity value for the first one or two readings of a sounding which is simply the result of a very dry topsoil or a hard to compact surface ground and not indicative of any particular material type. There is increased conductivity (lower resistivity) values with depth which is typical for clay overburden. The bottom layer has a high resistivity and could be indicative of bedrock.

The results are non-unique; different values of resistivity and layer thickness may produce a similarly plausible conclusion.

My duties with regards to this project do not necessarily end here. If you have any additional questions, please do not hesitate to call.

Sincerely,

Milan Situm

____
Milan Situm P.Geo
Manager

APPENDIX G

GEOTHERM THERMAL SOIL RESISTIVITY REPORT

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SOIL THERMAL SURVEY
EDP RENEWABLES
NATION RISE WIND FARM PROJECT
NORTH STORMONT, ONTARIO CANADA

JUNE 2018

Prepared for:

TULLOCH ENGINEERING INC
1100 SOUTH SERVICE ROAD, SUITE 420
STONEY CREEK, ON L8E 0C5

Submitted by:

GEOTHERM USA, LLC

COOL SOLUTIONS FOR UNDERGROUND POWER CABLES
THERMAL SURVEYS, CORRECTIVE BACKFILLS & INSTRUMENTATION

Serving the electric power industry since 1978

Introduction: A field thermal resistivity survey of the native soils was performed for the proposed underground power cables at the **Nation Rise Wind Farm Project in North Stormont, Ontario Canada.** Thermal resistivity testing was carried out at ten (10) locations along the cable routes. The fieldwork was carried out on May 23rd, 2018. ***Tulloch*** provided the support services through a local contractor and their field personnel. This included identifying the test locations, obtaining permits, clearing underground services and providing a backhoe with operator to excavate all test pits.

Field Testing and Soil Sampling: In-situ thermal testing was carried out at ten (10) locations **(Table 1)**. A backhoe was used to dig 4-foot deep test-pits and thermal resistivity tests were performed at depths of 2, 3 and 4-feet below grade. Samples for visual description, moisture content and thermal dryout characterization were collected. Co-ordinates of the test locations were provided by ***Tulloch***.

In-situ thermal resistivity and ambient temperature measurements were made using field thermal probes and the *Geotherm* **TPA-2000** run off a portable power source. Thermal testing was performed in accordance with the IEEE Standard (**IEEE-442-2017**). Laboratory geotechnical testing was conducted in accordance with **ASTM**.

The field thermal resistivity values were measured at the given soil moisture on that particular day. Depending on weather and environmental conditions; i.e. drying due to cable heat or other heat source, seasonal drying (drought), artificial draining, water demand of crops, drying due to frost (formation of ice lenses), etc., the soil may be drier at certain times of the year. Therefore, the design thermal resistivity for the native soils should be based on the driest expected conditions.

The attached Tables present factual information on the subsurface conditions at the specific test pit locations; no warrantee is expressed or implied that materials or conditions other than those described may not be encountered along the cable routes.

Laboratory Testing: Visual soil description, density, moisture content and thermal resistivity measurements were made in the laboratory on all 10 retrieved samples to characterize the soils and correlate the field results (**Table 2**). The thermal resistivity measurements were conducted in accordance with the IEEE Standard 442-2017. The results in Table 2 and Table 3 represent the average value for each given soil type. Stage drying tests were performed to develop the thermal dryout curves (thermal resistivity as a function of moisture content). Bulk samples from 2-ft to 4-ft were reconstituted at the field (in-situ) moisture content and at 95% single-point standard Proctor density. The thermal dryout curves for the native soil **at 95% of this Proctor density** are given in **Figure 1.**

We understand the native soil may be used as the cable trench backfill (with or without the inclusion of topsoil) and installed at **85% of the standard Proctor** density. The thermal dryout curves for the native soil **without topsoil** and **with top-soil** are also given in **Figure 1.**

The selected design thermal resistivity must mitigate potential soil drying due to cable heat. For very poor conditions, a corrective thermal backfill placed around the cable will reduce the heat flux experienced by the native soil so that it may not dry out. The backfill should be better able to resist total drying and have a lower dry resistivity if it is completely dried.

Based on the test results, three non-classified visual soil types of similar description and thermal characteristics were identified as described below:

1. **Clay with Silt**: Average single-point dry density ~93 lb/ft^3 and average thermal resistivity of ~64 °C-cm/W.

2. **Silty Clay with Gravel (TILL):** Average single-point dry density ~105 lb/ft^3 and average thermal resistivity of ~56 °C-cm/W.

3. **Sandy Silt with trace Clay, trace gravel**: Average single-point dry density ~103 lb/ft^3 and average thermal resistivity of ~59 °C-cm/W.

COMMENTS

Figure 1 depicts the thermal dryout curves. The thermal resistivities can be estimated for similar soils; i.e. if the soils are less dense than the typical density, then the resistivity will be higher than for the typical curve, more so at the lower moisture levels. Similarly, a denser soil will have a lower resistivity than the typical curve. These resistivity values, along with estimates of the driest expected soil moistures can be used to determine the design resistivity of the native soil. This applies to the native soil at the field density of ~95% and for the native soil backfill at density of ~ 85%.

Table 2 lists the suggested design thermal resistivity for the native soils that should keep the cable heat from drying out the soil. Values are given for moderate and high cable heat loads.

Similarly, **Table 3** lists the suggested design thermal resistivity for soil backfill. For critical cable runs (very high and constant heat generation) higher design thermal resistivities may be used to provide an additional safety factor.

In order to improve the thermal performance of the backfill (maximize the density), it should be installed in thin layers of 6 to 8-inch thickness and compacted to the specified density.

Ambient Temperature: Most of the test locations were in thick vegetation (corn) and thus the effect of solar radiation on subsurface temperature was minimal. Ambient soil temperatures were measured to be between **7 - 14 °C**. If the cable route crosses roads with asphalt cover, the ambient temperature at the cable burial depth of 4-ft will be about **4 °C higher** as a result of the solar radiation absorption by asphalt surface.

Design Thermal Resistivity Recommendations:

- **Native Soil:** The recommendations provided in **Table 2** are for the native soil and taking into consideration some soil drying due to the heat front from the energized cables.

- **Native Soil used as Backfill:** The recommendations provided in **Table 3** are for the native soil when used as backfill for direct buried cables in a tri-foil configuration. Depending on the trench excavation process, some areas may have limited top-soil, or the top-soil may be removed prior to full-depth excavation. Therefore, recommendations for both cases are provided.

- Recommendations are based on the maximum heat output of the cables - total losses (W/ft.), trench geometry, and compaction effort and in-situ moisture contents at the time of testing.

- A 5% safety factor is already built in, and therefore no additional safety factor is required unless EDPR or the design engineer deems necessary.

- ***Moderate Load*** is an estimated total load of no higher than 25 W/ft. per trench.

- ***High Load*** is an estimated total load of no higher than 50 W/ft. per trench.

- Based on your estimated design loads for various cable sizes, the total heat output will be ***>25 W/ft***. and thus falls into the "moderate" load recommendation.

Taking into consideration the design resistivity of the native soils and backfill, a cable ampacity program can be used to determine allowable ampacities for various cable (and thermal backfill) configurations.

Please contact us if you or your client(s) have any questions, wish to discuss this report or require additional information.

Geotherm USA

Nimesh Patel

Test Pit Coordinates - UTMS (provided by Tulloch)

Test Pit	Easting	Northing
T-1	487185	5005284
T-2	482206	5004170
T-3	484097	5007915
T-4	488327	5002340
T-5	492466	5004300
T-6	488669	4998334
T-7	490836	5000962
T-8	486920	4996611
T-9	491152	4997667
T-10	491055	4996057

Table 1 (Field Test Results Test Pits)

Location ID	Test Depth (ft)	Ambient Temp. (°C)	In-situ Thermal Resistivity (°C-cm/W)	Moisture Content (%)	Soil Type	Topsoil (inches)	Visual Description
T-1	2	12.6	101	33	1	12	CLAY, SOME SILT
	3	10.5	105				
	4	7.0	95				
T-2	2	14.0	70	27	2	9	SILTY CLAY WITH GRAVEL (TILL)
	3	12.7	55				
	4	9.6	50				
T-3	2	12.2	49	17	1	12	CLAY, SOME SILT
	3	11.0	58				
	4	8.1	52				
T-4	2	12.4	107	25	2	10	SILTY CLAY WITH GRAVEL (TILL)
	3	10.9	92				
	4	7.9	90				
T-5	2	14	80	24	1	8	SILTY CLAY
	3	12.5	73				
	4	9.0	80				
T-6	2	13.3	82	28	1	8	SILTY CLAY
	3	11.8	84				
	4	8.9	80				
T-7	2	11.9	85	27	1	10	CLAY, SOME SILT
	3	10.3	74				
	4	7.9	70				
T-8	2	13.1	90	22	1	8	CLAY, SOME SILT
	3	11.2	90				
	4	8.8	95				
T-9	2	13.8	75	15	2	6	SILTY CLAY WITH GRAVEL (TILL)
	3	13.1	63				
	4	10.3	63				
T-10	2	14.1	78	42	3	12	SANDY SILT, TRACE CLAY, TRACE ORGANICS, TRACE GRAVEL
	3	12.6	83				
	4	9.3	86				

Table 2 - Suggested Design Thermal Resistivity - Native Soil (in-situ)

Soil Type	Dry Density (lb/ft^3)	Water Content (%)	Thermal Resistivity			Design Thermal Resistivity (°C-cm/W)	
			Field	Lab			
			In-situ	Wet	Dry	[1]Moderate Load	[2]High Load
1	92	28	76	79	203	110	140
2	111	16	57	60	154	75	90
3	76	42	85	94	264	110	130

Table 3 - Suggested Design Thermal Resistivity - Native Soil (Backfill @ 85%)

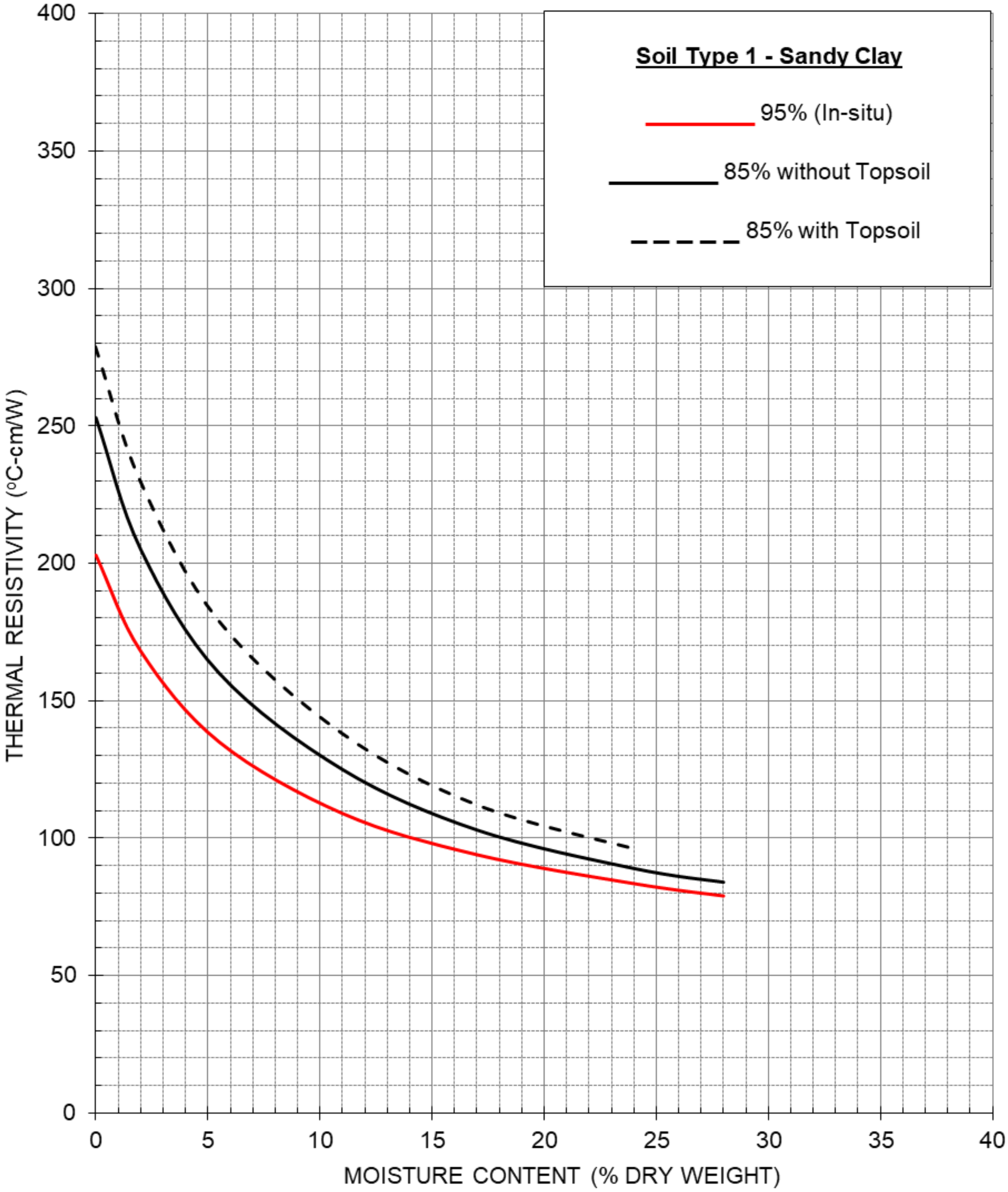
Soil Type	Dry Density (lb/ft^3)		Water Content (%)		Thermal Resistivity Lab (°C-cm/W)				Design Thermal Resistivity (°C-cm/W)			
					Without topsoil		With Topsoil		Without topsoil		With Topsoil	
	Without topsoil	With 25% topsoil	Without topsoil	With 25% topsoil	Wet	Dry	Wet	Dry	[1]Moderate Load	[2]High Load	[1]Moderate Load	[2]High Load
1	82	82	28	24	84	253	96	279	130	165	145	185
2	99	98	16	21	69	195	80	226	90	120	110	150
3	68	70	42	38	114	324	118	348	125	140	130	155

Please Note:

[1]**Moderate load** is estimated total load of no higher than 30 W/ft. per trench

[2]**High load** is estimated total load of no higher than 50 W/ft. per trench

THERMAL DRYOUT CURVES

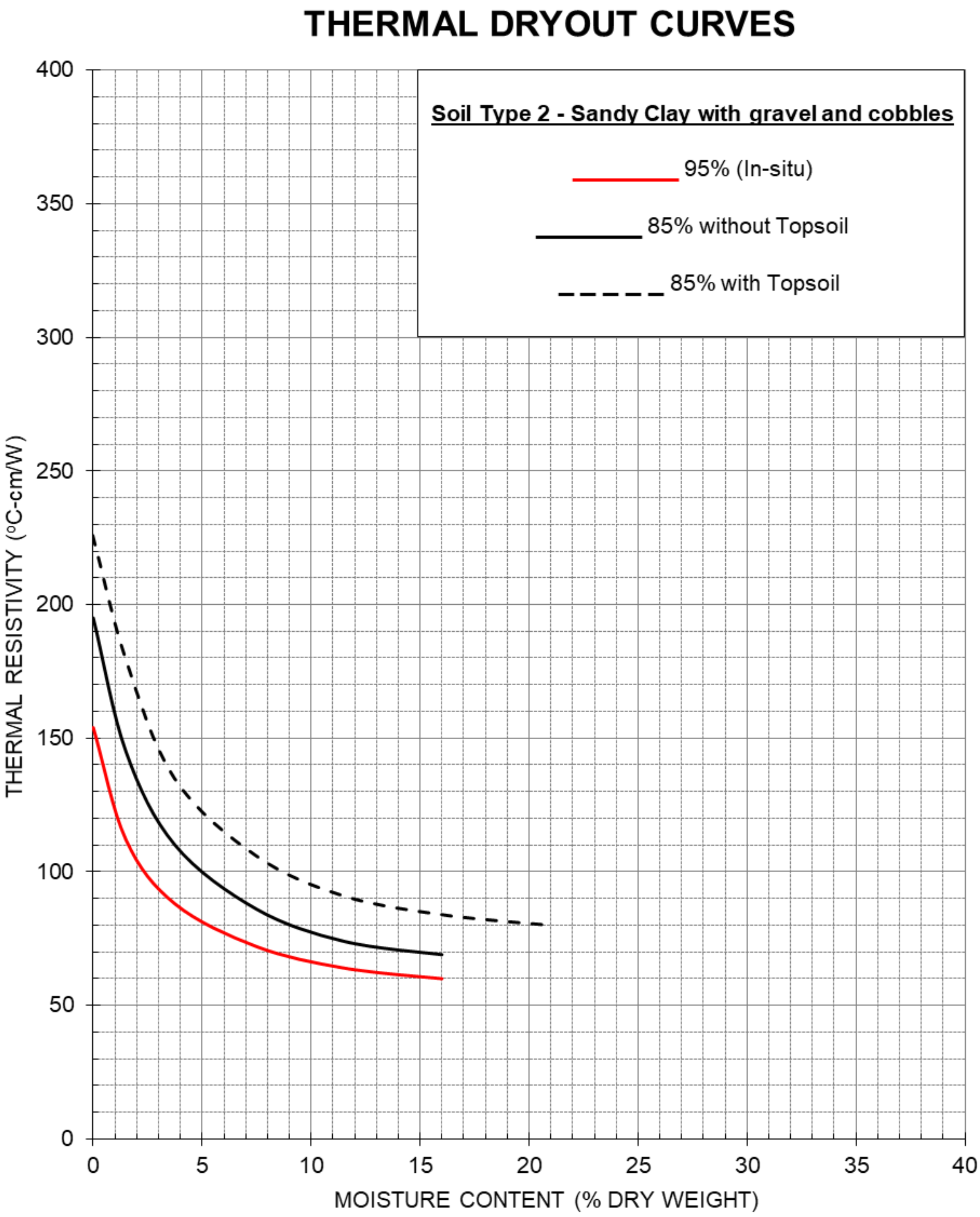


Tulloch Engineering, Inc.

Thermal Analysis of Native Soil

EDPR - Nation Rise Wind Project - North Stromont, Ontario Canada

June 2018 **Figure 1**



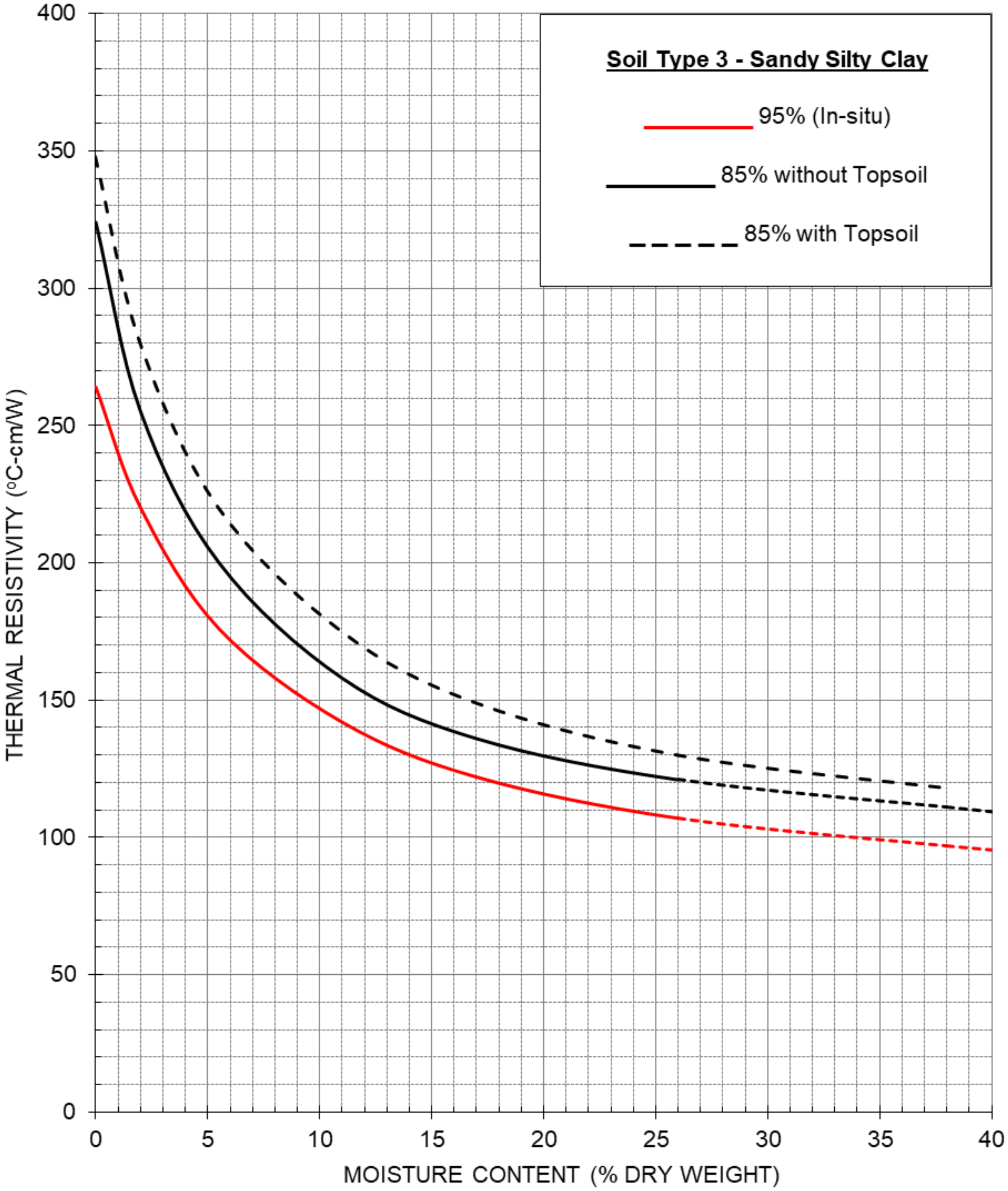
Terracon

Thermal Analysis of Native Soil

EDPR - Broadlands I Wind Project - Douglas County, IL

June 2018 **Figure 2**

THERMAL DRYOUT CURVES



Terracon

Thermal Analysis of Native Soil

EDPR - Broadlands I Wind Project - Douglas County, IL

June 2018

Figure 3

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SOIL THERMAL SURVEY
EDP RENEWABLES
NATION RISE WIND FARM PROJECT
NORTH STORMONT, ONTARIO CANADA

SEPTEMBER 2018

Prepared for:

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Submitted by:

GEOTHERM USA, LLC

COOL SOLUTIONS FOR UNDERGROUND POWER CABLES
THERMAL SURVEYS, CORRECTIVE BACKFILLS & INSTRUMENTATION

Serving the electric power industry since 1978

Introduction:

A field thermal resistivity survey of the native soils was performed for the proposed underground power cables at the **Nation Rise Wind Farm Project in North Stormont, Ontario, Canada.** Thermal resistivity testing was performed at five (5) location **(Table 1)** along the cable route. The fieldwork was carried out on September 13th & 14th, 2018. ***Tulloch*** provided all the support services through a local contractor and their field personnel. This included identifying the test locations, obtaining permits, clearing underground services and providing a drill rig with operator to conduct downhole borings.

Field Testing and Soil Sampling:

A truck mounted drill rig was used to advance boreholes to conduct ambient temperature and thermal resistivity measurements (TR) at various depths. Samples for visual description, moisture content and thermal dryout characterization were collected. Test location co-ordinates were provided by ***Tulloch***.

In-situ thermal resistivity and ambient temperature measurements were made using field thermal probes and the *Geotherm* **TPA-2000** run off a portable power source. Thermal testing was performed in accordance with the IEEE Standard (**IEEE 442-2017**). Laboratory geotechnical testing was conducted in accordance with **ASTM**.

The field thermal resistivity values were measured at the in-situ soil moisture on that particular day. Depending on weather and environmental conditions; i.e. drying due to cable heat or other heat source, seasonal drying (drought), artificial draining, water demand of crops, drying due to frost (ice lenses), etc., the soil may be drier at certain times of the year. Therefore, the design thermal resistivity for the native soils should be based on the driest expected conditions.

The attached Tables present factual information on the subsurface conditions at the specific test locations; no warrantee is expressed or implied that materials or conditions other than those described may not be encountered along the cable route.

Laboratory Testing:

Visual soil description, density, moisture content and thermal resistivity measurements were made in the laboratory on all 11 retrieved samples in order to characterize the soils and correlate the field results (**Table 1**). Stage drying tests were performed on undisturbed tube samples to develop the thermal dryout curves (thermal resistivity as a function of moisture content). The thermal dryout curves for the native soils are given in **Figures 1 to 3.**

The selected design thermal resistivity must mitigate potential soil drying by the cable heat. For very poor conditions, a corrective thermal backfill placed around the cable will reduce the heat flux experienced by the native soil so that it may not dry out. The backfill should be better able to resist total drying and have a lower dry resistivity if it is completely dried.

COMMENTS

Figures 1 to 3 depicts the thermal dryout curves, and these along with estimates of the driest expected soil moistures can be used to determine the design resistivity of the native soil.

Ambient Temperature: Ambient soil temperatures were measured to be between **10 - 18 °C**. If the cable route crosses roads with asphalt cover, the ambient temperature at the cable burial depth of 4-ft will be about **4 °C higher** as a result of the solar radiation absorption by asphalt surface.

Design Thermal Resistivity Recommendations:

- **Native Soil:** The recommendations provided below are for the native soil; taking into consideration some soil drying due to the heat front from the energized cables.
    - Recommendations are based on the maximum heat output of the cables (total losses - W/ft.), trench geometry, soil/backfill density, and in-situ moisture contents at the time of testing.
    - A 5% safety factor is already built in, and therefore no additional safety factor is required unless EDPR or the design engineer deems necessary.
    - Based on your estimated design loads of 32-40 W/ft. for various cable sizes, thermal resistivity of 120 ºC-cm/W is suggested for the cable rating.

Based on the design resistivity of the native soils, a cable design program can be used to determine allowable ampacities for various cable configurations.

Please contact us if you or your client(s) have any questions, wish to discuss this report or require additional information.

Geotherm USA

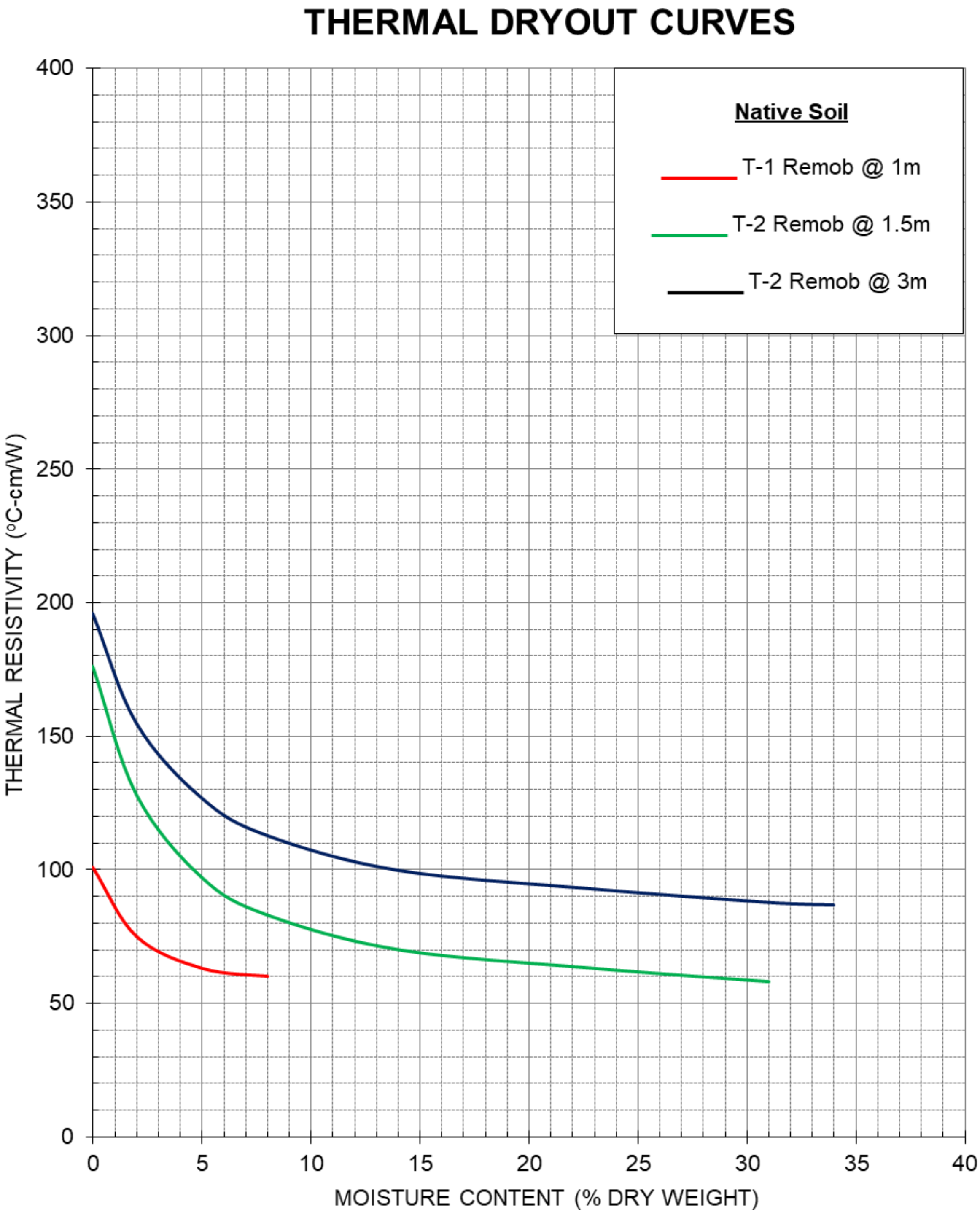
Nimesh Patel

Borehole Coordinates - UTMS (provided by Tulloch)

Borehole	Easting	Northing
T-1 Remob	486532	5006071
T-2 Remob	486844	5003169
T-3 Remob	487581	5002040
T-4 Remob	487689	5000253
T-5 Remob	488142	4996042

Table 1 – Field and Laboratory Test Results

Location ID	Test Depth (m)	Ambient Temp. (°C)	Thermal Resistivity (°C-cm/W)			Moisture Content (%)	Dry Density (lb/ft^3)	Visual Description
			Field	Lab				
			In-situ	Wet	Dry			
T-1 Remob	1.5	UNABLE TO INSTALL PROBE		60	101	8	130	sandy clay with gravel/rock
	3							
T-2 Remob	1.5	18.6	56	58	176	31	81	Clay with organics
	3	13.1	85	87	196	34	80	
T-3 Remob	1.5	18.2	84	87	~550	58	63	Clay with organics
	3	14.5	77	78	193	34	82	
	4.5	10.6	92	101	~680	68	53	
	6	9.9	61	62	339	32	88	
T-4 Remob	1.5	18.0	88	83	342	31	86	Clay with organics
	3	13.0	69	71	450	42	77	
T-5 Remob	1.5	17.5	71	74	183	23	90	Clay with organics
	3	11.5	81	84	~560	63	64	



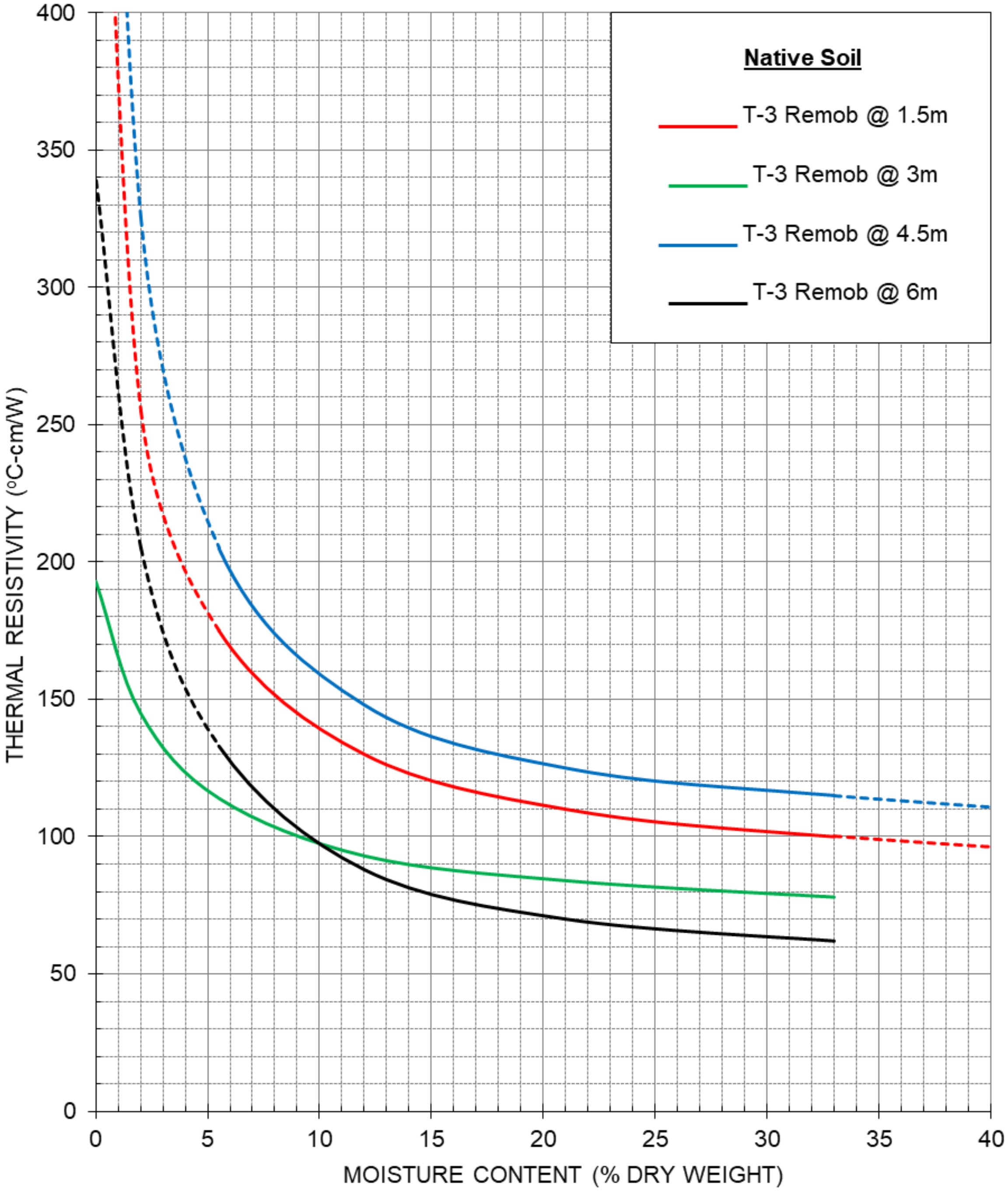
Tulloch Engineering, Inc.

Thermal Analysis of Native Soil

EDPR - Nation Rise Wind Project Crossings - North Stromont, Ontario Canada

September 2018 **Figure 1**

THERMAL DRYOUT CURVES

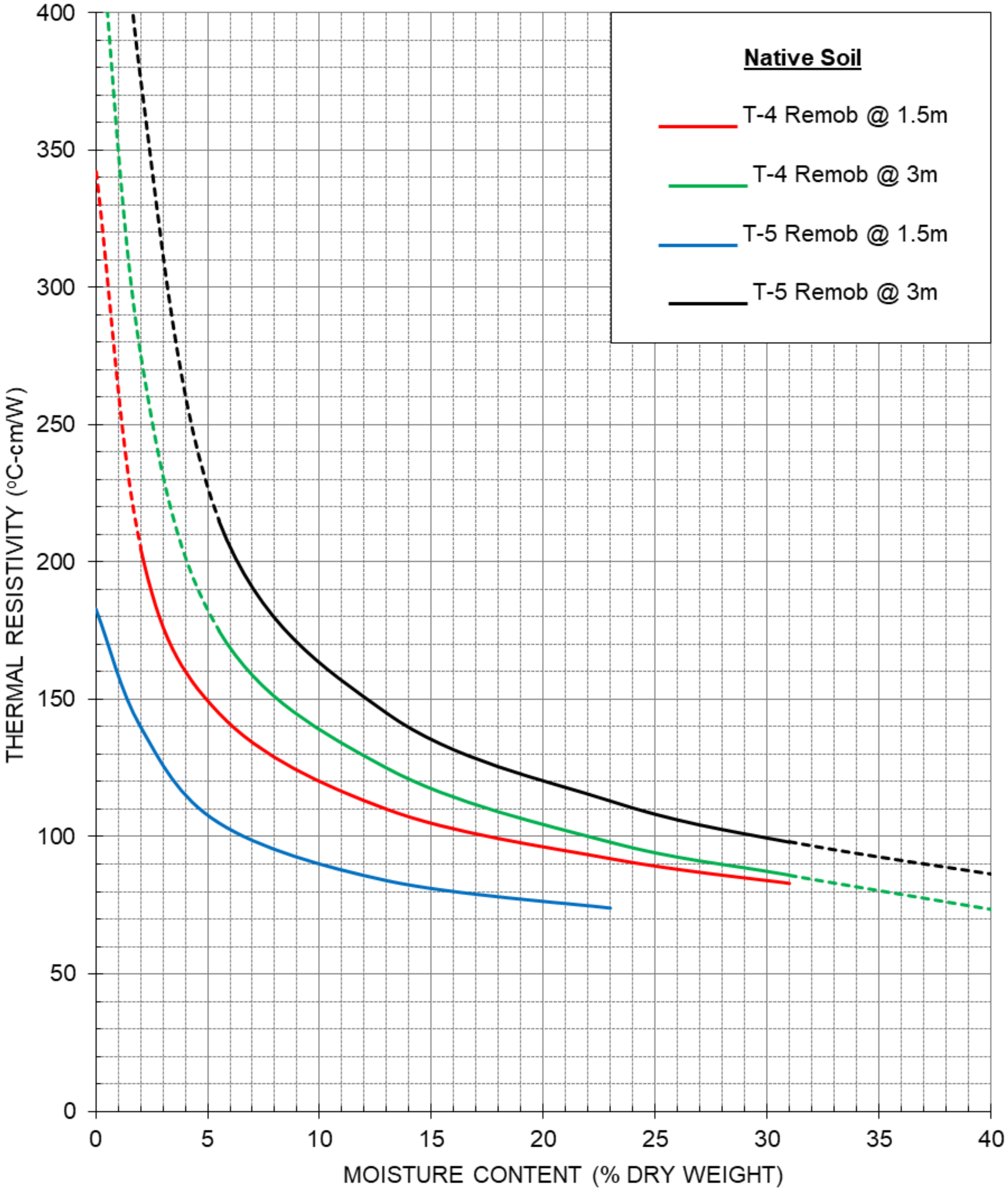


Tulloch Engineering, Inc.
Thermal Analysis of Native Soil
EDPR - Nation Rise Wind Project Crossings - North Stromont, Ontario Canada

September 2018

Figure 2

THERMAL DRYOUT CURVES



Tulloch Engineering, Inc.

Thermal Analysis of Native Soil

EDPR - Nation Rise Wind Project Crossings - North Stromont, Ontario Canada

September 2018

Figure 3

APPENDIX H

REPORT LIMITATIONS AND GUIDELINES FOR USE

REPORT LIMITATIONS AND GUIDELINES FOR USE

This information has been provided to help manage risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This geotechnical report has been prepared for the exclusive use of the client, their authorized agents, and other members of the design team. It is not intended for use by others, and the information contained herein is not applicable to other sites, or for purposes other than those specified in the report.

Tulloch Engineering (Tulloch) cannot be held responsible for reliance on the information contained in this report, by persons other than the client or 'authorized' agent without prior written approval.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical investigation report is based on existing conditions at the time the study was performed, and our opinion of soil conditions are strictly based on soil samples collected at specific borehole locations. The findings and conclusions of our reports may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations.

LIMITATIONS TO PROFESSIONAL OPINIONS

Interpretations of subsurface conditions are based on field observations from boreholes and/or test pits that were spaced to capture a 'representative' snap shot of subsurface conditions. Site exploration identifies subsurface conditions only at points of sampling. Tulloch reviews field and laboratory data and then applies our professional judgment to formulate an opinion of subsurface conditions throughout the site. Actual subsurface conditions may differ, between sampling locations, from those indicated in this report.

LIMITATIONS OF RECOMMENDATIONS

Subsurface soil conditions should be verified by a qualified geotechnical engineer during construction. Tulloch should be notified if any discrepancies to this report or unusual conditions are found during construction.

Sufficient monitoring, testing and consultation should be provided by Tulloch during construction and/or excavation activities, to confirm that the conditions encountered are consistent with those indicated by the borehole and/or test pit investigation, and to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated. In addition, monitoring, testing and consultation by Tulloch should be completed to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Tulloch for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions. However, please be advised that any construction/excavation observations by Tulloch is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

MISINTERPRETATION OF GEOTECHNICAL ENGINEERING REPORT

Misinterpretation of our report by other design team members can result in costly problems. You could lower that risk by having Tulloch confer with appropriate members of the design team after submitting the report. Also retain Tulloch to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Tulloch participate in pre-bid and preconstruction conferences, and by providing construction observation. Please be advised that retaining Tulloch to participation in any ‘other’ activities associated with this project is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

CONTRACTORS RESPONSIBILITY FOR SITE SAFETY

This geotechnical report is not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties. It is ultimately the contractor’s responsibility that the Alberta Occupational Health & Safety Act is adhered to, and site conditions satisfy all ‘other’ acts, regulations and/or legislation that may be mandated by federal, provincial and/or municipal authorities.

SUBSURFACE SOIL AND/OR GROUNDWATER CONTAMINATION

This report is geotechnical in nature and specifically excludes the investigation, detection, prevention or assessment of the presence of subsurface contaminants. Accordingly, the scope of services does not include any interpretations, recommendations, findings, or conclusions regarding the detection, assessment, prevention or abatement of contaminants, and no conclusions or inferences should be drawn regarding contamination, as they may relate to this project. The term "contamination" includes, but is not limited to, molds, fungi, spores, bacteria, viruses, PCBs, petroleum hydrocarbons, inorganics, pesticides/insecticides, volatile organic compounds, polycyclic aromatic hydrocarbons and/or any of their byproducts.