

ANNEX IV: Geotechnical Investigation and Earth Resistivity Study Report

Geo Technical Investigation Report

FOR 150 MW PV POWER PROJECT BY SINDH SOLAR IN DEH METHA GHAR, SINDH, PAKISTAN

Prepared for:

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SOIL TESTING SERVICES



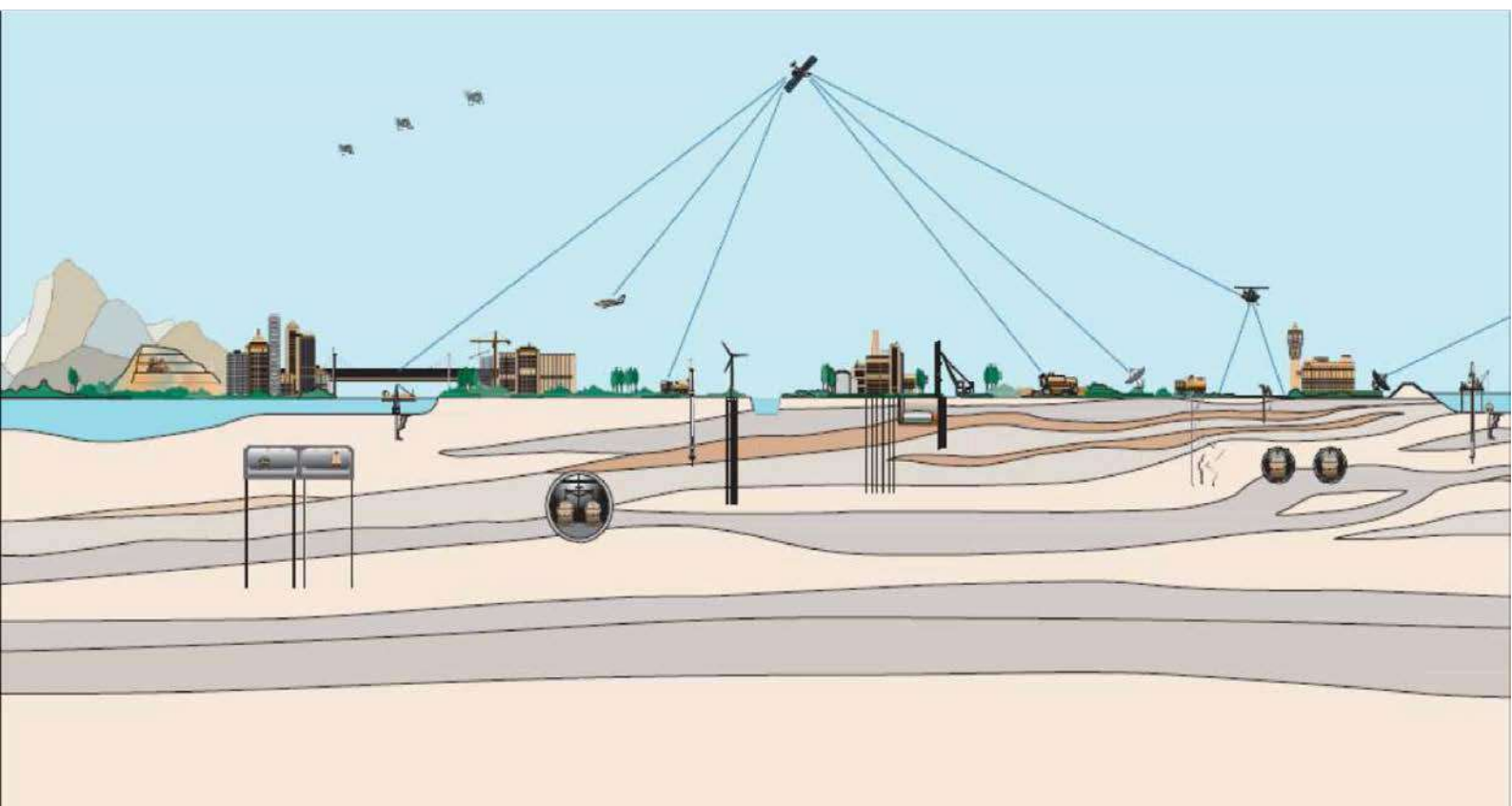
Geotechnical Engineers and Testing Laboratory

Report No. K22-1245-101

GEOTECHNICAL INVESTIGATION REPORT FOR INSTALLATION OF SOLAR POWER PLANT AT DEH MITHAGHAR, GADAP TOWN, KARACHI

(REV. 0.0, DATED: JANUARY 13, 2023)

CLIENT: M/s. Renewable Resources (Pvt.) Ltd.





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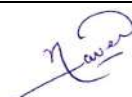
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SOIL TESTING SERVICES 	Geotechnical Investigation Report		Revision	
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	Report No.: Vol I		00	13/01/2023

PROJECT: Geotechnical Investigation Report for Installation of Solar Power Plant at Deh Mithaghar, Gadap Town, Karachi

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Issue Codes: RC = Released for Construction, RD = Released for Design, RF = Released for Fabrication, RI = Released for Information, RP = Released for Purchase, RPA = Released for Permit Application, RQ = Released for Quotation, RR = Released for Review and Comments.

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EXECUTIVE SUMMARY

Geotechnical Investigation:

Geotechnical Investigation for Installation of Solar Power Plant at Deh Mithaghar, Gadap Town, Karachi was carried out in order to determine geotechnical parameters of subsurface deposits. Scope of field work included drilling of thirty one (31) boreholes up to the depth of 5.0 meters below the existing ground level. Soil and rock samples were collected during field investigation. Laboratory testing of these samples has been carried out in the Soil Testing Services laboratory, Karachi.

Ground Conditions:

The deposition of the area mainly consists of '*medium dense to very dense, fine to coarse grained, silty, sand*', '*very stiff to hard, sandy, clayey, silt*', '*very stiff to hard, sandy, silty, clay*' and '*distinctly weathered, sandstone*'. Groundwater table was not encountered up to the explored depth of 5.0 meters in any of the boreholes drilled at the site, during this investigation.

Design Soil Parameters:

The design soil parameters are based on grain size, material type, SPT N-values, field and laboratory testing data and design water table. For the purpose of analysis, considering similar soil condition and field investigated locations, two (02) design profiles are made for analysis as shown in table below:

Table A: List of Design Soil Profiles

Profile	Borehole(s) Covered	Proposed Foundation Type
01	BH-01 to BH-21, BH-24 to BH-31	Pad foundation / Piles
02	BH-22 & BH-23	Pad foundation / Piles

Allowable Bearing Pressure

This report addresses general design recommendations of shallow foundations. Allowable net bearing pressures have been given for shallow pad foundations at the depth of 1.5 meters below the existing ground level as presented in table below: / Chapter 4 of the report.

Table B: Net Allowable Bearing Pressures for Shallow Foundation

Profile	Minimum Embedment Below Existing Ground Level (meter)	Net Allowable Bearing Pressure for Pad Foundation (KPa)
01	1.5	210
02	1.5	170

Modulus of subgrade reaction values for the shallow foundations are provided.

Pile Capacity Analysis

The report presents allowable pile capacities calculated for 0.20m, 0.30 & 0.40m diameter bored cast in-situ concrete piles to the maximum depth of 3.0 to 5.0 meters below existing ground level as presented in table C. For pile capacity calculations, refer to appendix E of the report.

Table C: Allowable Pile Capacities

Profile	Diameter (mm)	Length (m) below EGL	Q_{Shaft} (kN)	$Q_{\text{Total}} = Q_{\text{Shaft}} + Q_{\text{Tip}}$ (kN)
01	200.0	3.0	6	20
		4.0	10	31
		5.0	16	43
	300.0	3.0	8	42
		4.0	15	62

Profile	Diameter (mm)	Length (m) below EGL	Q_{Shaft} (kN)	$Q_{\text{Total}} = Q_{\text{Shaft}} +$
				Q_{Tip} (kN)
01	300.0	5.0	23	84
		3.0	11	71
	400.0	4.0	20	104
		5.0	31	139
02	200.0	3.0	21	26
		4.0	28	33
		5.0	35	40
	300.0	3.0	32	42
		4.0	42	53
		5.0	53	64
	400.0	3.0	42	61
		4.0	57	75
		5.0	71	90

Seismicity

As per Building Code of Pakistan (BCP), Seismic Provisions-2007 following earthquake data can be considered for the project site:

- Seismic Zone, as per table 2.2 of BCP - 2007: 2B
- Seismic soil profile has been taken as 'S_C' for the foundations in accordance with UBC-97 based on SPT N method approach.

Other Considerations

- Earth pressure parameters for excavation support system and earth retention have been provided.
- The exposure of underground concrete to aggressive chemicals is found to be ‘negligible’ for sulphates and chlorides which have influenced the selection of cement for underground concreting and it is recommended to use *Ordinary Portland Cement* for all underground concrete works.

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1. INTRODUCTION

Planning for the Installation of Solar Power Plant at Deh Mithaghar, Gadap Town, Karachi is underway. In order to determine the geotechnical parameters of the subsurface deposits, *M/s. Soil Testing Services (STS)* were entrusted by *M/s. Renewable Resources Private Limited* to perform the geotechnical investigation at the project site.

Scope of field work included drilling of thirty one (31) boreholes up to the depth of 5.0 meters below the existing ground level. Elevation of drilling platform at each borehole point was noted and is mentioned in the borehole logs attached in Appendix B. Standard Penetration tests were carried out at regular intervals in the boreholes along with the collection of soil samples via split spoon sampler. Boreholes in rock was advanced through continuous coring. Rock core samples were extracted with the help of double tube core barrels. The samples retrieved from the field work were tested in the laboratory and this report is prepared from the information obtained from the field and laboratory tests.

The report consists of five chapters with *Chapter 2* describing the site's existing condition, *Chapter 3* discusses the subsurface deposits in detail, *Chapter 4* includes the recommendations for foundation design, and *Chapter 5* contains a summary of conclusions regarding the ground conditions, with respect to geotechnical engineering for this project.

2. THE SITE

The project site is located in Deh Mithaghar, Karachi on Hub Dam Road.

The topography of the area is not plain with significant changes in elevation observed across the site. Bushes and wild plants were found at most of the site area. Figure 2.1 shows the google image of the site.



Fig 2.1: Google image of the the Neighbourhood area (Courtesy: Google Earth)

3. GROUND CONDITIONS

The subsurface deposits up to the explored depth consist of the following units:

- Sand
- Silt
- Clay
- Sandstone

Following sub-sections describe the strength characteristics of the geological unit and the groundwater conditions.

3.1 SAND

Deposits of fine to coarse grained, silty sand were encountered in almost all the boreholes drilled at site. State of compactness according to SPT 'N' counts has been determined to be '*medium dense to very dense*'. The grain size analysis has been carried out on samples collected from these deposits. Unified Classification System (UCS) classifies these deposits as 'SM', 'SP' and 'SP-SM'. Table 3.2 summarizes the details of these deposits.

Table 3.1 Deposits of Sand

Borehole No.	Depth (meters)
BH-01	0.0 - 5.0
BH-02	0.0 - 5.0
BH-03	0.0 - 5.0
BH-04	0.0 - 5.0
BH-05	0.0 - 5.0
BH-06	0.0 - 5.0
BH-07	0.0 - 5.0
BH-08	0.0 - 5.0
BH-09	0.0 - 5.0

Borehole No.	Depth (meters)
BH-10	0.0 - 5.0
BH-11	0.0 - 5.0
BH-12	0.0 - 5.0
BH-13	0.0 - 5.0
BH-14	0.0 - 5.0
BH-15	0.0 - 5.0
BH-16	0.0 - 2.0
BH-17	0.0 - 2.0
BH-18	0.0 - 2.0
BH-19	0.0 - 1.0
	3.5 - 5.0
BH-21	0.0 - 1.8
BH-23	0.0 - 1.0
BH-24	0.0 - 3.5
BH-25	0.0 - 5.0
BH-26	0.0 - 5.0
BH-27	0.0 - 1.8
BH-28	0.0 - 1.0
BH-29	0.0 - 3.5
BH-30	0.0 - 5.0
BH-31	0.0 - 5.0

3.2 SILT

Deposits of sandy, clayey, silt were encountered in five of the boreholes drilled at site. State of compactness according to SPT 'N' counts has been determined to be '*very stiff to hard*'. The grain size analysis has been carried out on samples collected from these deposits. Unified Classification System (UCS) classifies these deposits as 'ML'. Table 3.2 summarizes the details of these deposits.

Table 3.2 Deposits of Silt

Borehole No.	Depth (meters)
BH-16	2.0 - 5.0
BH-18	2.0 - 5.0
BH-20	2.0 - 5.0
BH-21	1.8 - 5.0
BH-22	0.0 - 2.0

3.3 CLAY

Deposits of sandy, silty clay were encountered in four of the boreholes drilled at site. State of compactness according to SPT 'N' counts has been determined to be '*very stiff to hard*'. The grain size analysis has been carried out on samples collected from these deposits. Unified Classification System (UCS) classifies these deposits as 'CL' and 'CL-ML'. Table 3.3 summarizes the details of these deposits.

Table 3.3 Deposits of Silt

Borehole No.	Depth (meters)
BH-19	1.0 - 3.5
BH-20	0.0 - 2.0
BH-22	2.0 - 5.0

Borehole No.	Depth (meters)
BH-23	1.0 - 5.0

3.4 SANDSTONE

Deposits of sandstone were encountered in two of the boreholes drilled at the site. The rock is classified as 'very poor' based on RQD values which corresponds to NIL. Table 3.4 summarizes the details of these deposits.

Table 3.4 Deposits of Sandstone

Borehole No.	Depth (meter)
BH-17	2.0 - 5.0
BH-24	3.5 - 5.0

3.5 GROUNDWATER CONDITIONS

Groundwater was not encountered up to the maximum explored depth of 5.0 meters below the existing ground level in the boreholes drilled at site during this investigation.

4. ENGINEERING DESIGN CONSIDERATIONS

Foundation type for a structure depends on the expected loads taken by the foundation and the type of soil underlying it. The characteristics of subsurface soil deposits have been discussed in the previous section. As per the information provided by the client, following areas are proposed for construction at the project site:

Table 4.1: Details of proposed building types and foundations

Profile	Borehole(s) Covered	Proposed Foundation Type
01	BH-01 to BH-21, BH-24 to BH-31	Pad foundation / Piles
02	BH-22 & BH-23	Pad foundation / Piles

Keeping in view the subsoil conditions prevailing at the site and the loads expected to be transferred to the foundations, recommendations for pad and pile foundations are provided. Following sections discusses recommendations for both shallow and deep foundations, in detail.

4.1 DESIGN PARAMETERS

Design soil parameters are based on grain size, laboratory test results, material type and SPT N-values. The design parameters for the profiles used in our analysis are tabulated below:

Table 4.2: Engineering Design Parameters (for profile 01)

Layer Depth Below EGL (m)		Layer Thickness (m)	Design SPT-N	Material Type	Cohesion, C, (KPa)	Angle of Internal friction (Φ), (degree)	Unit Weight co-related with SPT N (kN/m^3)	Modulus of Elasticity, E (kN/m^2)
Top	Bottom							
0.0	5.0	5.0	35	Sand	0	30	18.5	25,000

Table 4.3: Engineering Design Parameters (for profile 2)

Layer Depth Below EGL (m)		Layer Thickness (m)	Design SPT-N	Material Type	Cohesion, C, (KPa)	Angle of Internal friction (Φ), (degree)	Unit Weight co-related with SPT N (kN/m^3)	Modulus of Elasticity, E (kN/m^2)
Top	Bottom							
0.0	5.0	5.0	40	Silt / Clay	50	15	18.5	16,500

4.2 DESIGN CRITERIA FOR SHALLOW FOUNDATIONS

A suitable shallow foundation for any structure must satisfy two basic independent criteria with respect to the underlying foundation soils. First, the foundation must have an adequate factor of safety against exceeding the bearing capacity of the foundation soils. Second the vertical movements of the foundation due to settlement or swelling of the foundation soils must be within tolerable limits for the structure.

Dynamically loaded foundations, such as those supporting vibrating machinery, must satisfy additional criteria as follows:

- vibrations transmitted to the foundation soils must not cause excessive settlement of the structures or its surroundings;
- vibrations of the dynamically loaded structure, and its surroundings, must not interfere with planned operations and adjacent structures.

The foundation bearing pressures should be limited so that settlements do not exceed tolerable limits for the structures.

4.3 ALLOWABLE BEARING PRESSURES FOR SHALLOW FOUNDATION

The allowable bearing pressure for shallow pad footings supported on natural soils/rocks at the site will be limited either by the settlement tolerance of individual structures, or by the bearing capacity of the soil, depending on the foundation width and depth of influence. Typically, for shallow pad footings, the bearing pressure should be limited so that the total foundation settlement does not exceed 25 mm, with differential settlements of about 50 percent of the total settlement, or so that the bearing capacity is not exceeded, whichever is the lower of the two values.

We estimated the allowable bearing pressure of planned foundations as the lower of the two values calculated based on settlement and shear criteria. Table 4.4 gives the allowable bearing pressures for shallow foundations at depth of 1.5 meters from existing ground level.

Table 4.4: Net Allowable Bearing Pressures for Shallow Foundation

Profile	Minimum Embedment Below Existing Ground Level (meter)	Net Allowable Bearing Pressure for Pad Foundation (KPa)
01	1.5	210
02	1.5	170

Proper drainage shall be provided to avoid infiltration of water into foundation soil. It should be ensured that the foundation is not placed on the fill material. The settlement of isolated pad foundation due to net allowable pressure has been estimated to be within the allowable limit of 25mm (1-inch).

4.4 MODULUS OF SUBGRADE REACTION

The modulus of subgrade reaction, k_s , may be required to design raft foundations. The modulus principally depends on the soil stiffness, raft foundation stiffness and foundation size.

We recommend computing the modulus of subgrade reaction values for raft foundations at the site using the allowable bearing pressures that could be obtained from the bearing pressures presented in this report and the following equation:

$$k_s = \frac{1}{A} (SF) q_a$$

where:

- k_s = Modulus of subgrade reaction, kN/m²/m;
- SF = Factor of safety;
- q_a = Allowable bearing pressure, kPa; and
- A = Allowable settlement, m.

The above equation assumes that the rafts will tend towards flexible rather than rigid behaviour. For perfectly rigid rafts the modulus values obtained from the above equation should be doubled.

Mat foundations will behave as:

Perfectly rigid if $h/B > 1/5$

Perfectly flexible if $h/B < 1/5$

where:

h = thickness of raft foundation; and

B = width of raft foundation

Table 4.5: Modulus of subgrade reaction based on allowable bearing pressure

Profile	Minimum Embedment Below Existing Ground Level (meter)	Modulus of subgrade reaction, K_s (MN/m ³)
01	1.5	25.2
02	1.5	20.4

4.5 EARTH RETAINING STRUCTURE

All measures shall be taken to provide safety to adjacent structures. Properly designed excavation support system should be constructed prior to deep excavation.

Earth pressure parameters required for the design of structure to retain the excavation are given in *Table 4.6*.

Table 4.6: Earth Pressure Parameters

Strata	Φ' (Undisturbed)	k_a (Coefficient of active earth pressure)	k_p (Coefficient of passive earth pressure)
Silt / Clay	15°	0.589	1.700

Strata	Φ' (Undisturbed)	k_a (Coefficient of active earth pressure)	k_p (Coefficient of passive earth pressure)
Sand	30°	0.333	3.000

4.6 DEEP FOUNDATIONS - ALLOWABLE PILE CAPACITIES

The ultimate compressive capacity, Q , for a given driven pile penetration is taken as the sum of the skin friction on the pile wall, Q_s , and the end bearing on the pile tip, Q_p , so that:

$$Q = Q_s + Q_p = \sum f A_s + q A_p$$

Where A_s and A_p represent, respectively, the embedded surface and pile end area; f and q represent, respectively, the unit skin friction and unit end bearing. When computing ultimate tensile capacity, the end bearing term in the above equation is neglected. Therefore, the value of the ultimate tensile capacity is the same value as the ultimate compression capacity due to skin friction Q_s .

The design parameters for calculating pile capacities have been derived from shear strength determination, through in-situ field tests and laboratory tests of collected soil samples. The results of analysis for 0.2, 0.3 and 0.4 meter diameter drilled concrete piles are presented below in *Table 4.7*.

Table 4.7: Allowable Pile Capacities

Profile	Diameter (mm)	Length (m) below EGL	Q_{Shaft} (kN)	$Q_{\text{Total}} = Q_{\text{Shaft}} + Q_{\text{Tip}}$ (kN)
01	200.0	3.0	6	20
		4.0	10	31
		5.0	16	43
	300.0	3.0	8	42
		4.0	15	62

Profile	Diameter (mm)	Length (m) below EGL	Q_{Shaft} (kN)	$Q_{\text{Total}} = Q_{\text{Shaft}} +$
				Q_{Tip} (kN)
01	300.0	5.0	23	84
		3.0	11	71
	400.0	4.0	20	104
		5.0	31	139
02	200.0	3.0	21	26
		4.0	28	33
		5.0	35	40
	300.0	3.0	32	42
		4.0	42	53
		5.0	53	64
	400.0	3.0	42	61
		4.0	57	75
		5.0	71	90

The design approach followed is based on FOS and as per this design approach, the settlement criteria of “Net settlement not to exceed 1% of the pile diameter at working load and total penetration of the base not to exceed 10% of the pile diameter at test load” shall be fulfilled.

4.7 SOIL PROFILE TYPE (ACCORDING TO UBC-97)

Chapter 16, Division V, Section 1636 of UBC-97 deals with the determination of Soil Profile Types. Design practice involves using seismic parameters of zone 2B for the area under consideration.

4.7.1 SEISMIC ZONE FACTOR

Table 16-I of UBC-97 defines the seismic zone factor to be used in choosing seismic coefficients for a location. The seismic zone factor “**Z**” will be taken as 0.20.

4.7.2 SOIL PROFILE TYPE

Table 16-J of UBC-97 defines the soil profile types to be used for determining seismic coefficients. Based on the field data obtained from sub-soil exploration, the soil profile will be taken as “**S_c**”.

4.7.3 SEISMIC COEFFICIENTS

Seismic coefficients are as under:

For S_c : $C_a = 0.24$ & $C_v = 0.32$

4.8 TYPE OF CEMENT

Tests on soil samples obtained from the boreholes indicate ‘*negligible*’ exposure to sulphate and chloride. Under these conditions it is recommended to use *Ordinary Portland Cement (OPC)* for all underground concrete works.

5. CONCLUSIONS

Geotechnical Investigation:

Geotechnical Investigation for Installation of Solar Power Plant at Deh Mithaghar, Gadap Town, Karachi was carried out in order to determine geotechnical parameters of subsurface deposits. Scope of field work included drilling of thirty one (31) boreholes up to the depth of 5.0 meters below the existing ground level. Soil and rock samples were collected during the field investigation. Laboratory testing on these samples has been carried out in the lab and includes determination of index and strength properties through grain size analysis, Atterberg limits, density, direct shear test etc. Chemical characteristics of soil samples have also been assessed through determination of total dissolved solids, sulphate content, chloride content and pH.

Design Soil Parameters / Profiles:

The design soil parameters are based on grain size, material type, SPT N-values, field and laboratory testing data and design water table. For the purpose of analysis, considering similar soil condition and field investigated locations, two (02) design profiles are made for analysis as shown in table below:

Table 5.1: List of Design Soil Profiles

Profile	Borehole(s) Covered	Proposed Foundation Type
01	BH-01 to BH-21, BH-24 to BH-31	Pad foundation / Piles
02	BH-22 & BH-23	Pad foundation / Piles

Allowable Bearing Pressure

This report addresses general design recommendations of shallow foundations. Allowable net bearing pressures have been given for shallow pad foundations at the depth of 1.5 meters below the existing ground level as presented in table below: / Chapter 4 of the report.

Table 5.2: Net Allowable Bearing Pressures for Shallow Foundation

Profile	Minimum Embedment Below Existing Ground Level (meter)	Net Allowable Bearing Pressure for Pad Foundation (KPa)
01	1.5	210
02	1.5	170

Modulus of subgrade reaction values for the shallow foundations are provided.

Pile Capacity Analysis

The report presents allowable pile capacities calculated for 0.20m, 0.30 & 0.40m diameter bored cast in-situ concrete piles to the maximum depth of 3.0 to 5.0 meters below existing ground level as presented in table 5.3. For pile capacity calculations, refer to appendix E of the report.

Table 5.3: Allowable Pile Capacities

Profile	Diameter (mm)	Length (m) below EGL	Q_{Shaft} (kN)	$Q_{\text{Total}} = Q_{\text{Shaft}} + Q_{\text{Tip}}$ (kN)
01	200.0	3.0	6	20
		4.0	10	31
		5.0	16	43
	300.0	3.0	8	42
		4.0	15	62
		5.0	23	84
	400.0	3.0	11	71
		4.0	20	104
		5.0	31	139

Profile	Diameter (mm)	Length (m) below EGL	Q_{Shaft} (kN)	$Q_{\text{Total}} = Q_{\text{Shaft}} +$
				Q_{Tip} (kN)
02	200.0	3.0	21	26
		4.0	28	33
		5.0	35	40
	300.0	3.0	32	42
		4.0	42	53
		5.0	53	64
	400.0	3.0	42	61
		4.0	57	75
		5.0	71	90

Other Considerations

- Earth pressure parameters for excavation support system and earth retention have been provided.
- The exposure of underground concrete to aggressive chemicals is found to be 'negligible' for sulphates and chlorides which have influenced the selection of cement for underground concreting and it is recommended to use *Ordinary Portland Cement* for all underground concrete works.

Appendix A

Borehole Location Plan

BOREHOLES LOCATION PLAN

G.I. For Installation of Solar Power Plant, Deh Mithaghar, Gadap Town, Karachi



Borehole Location Plan

K22-1244-101

Geotechnical Investigation for Installation of Solar Power
Plant at Deh Mithaghar, Gadap Town, Karachi



Soil Testing Services

Appendix B

Borehole Logs

Mud Rotary Log BH-01

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 303133.91				
	Location : Deh Mithaghar		Drill Date: 12.12.2022	Northing: 2782361.70				
	Job No.: K22-1245-101		Logged By: ARH	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3)		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Dry	Bulk	Test Type	C (kg/cm2)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, dense, silty, little clay & traces of gravel at places	* SPT 10 20 30 40 50		0																				0	
1		U				1	SM A-4(0)	3.2	60.7	36.1		NLL	-	NPI	1.6	7.88	8						6.9	0.098	0.38	1	SPT - 1
2						2																				2	
3		U				3																				3	SPT - 2
4						4																				4	
5		U	End of Log @ 5 (m)			5	SM A-4(0)	0.8	53.8	32.4	13	NLL	-	NPI	12.5	1.61	1.8									5	SPT - 3

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
Abbreviations	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter		NPI : None PI				
				C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-02

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 03.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303451.27
Northing: 2782778.18
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test	qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments				
				10	20	* SPT 30	40	50				Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL				
0		U	SAND Multi colour, dense, silty, fine grained, little gravel & clay							0																						0	
1										1																					1		
2										2	SM A-4(0)	12	46	30	12	NLL	-	NPI	10.3	1.6	1.8							7.2		0.36	2	SPT - 1	
3		U	SAND Yellowish brown, very dense, fine to coarse grained, traces of silt & gravel							3																						3	SPT - 2 SPT Drive - 275mm
4										4																					4		
5		U	End of Log @ 5 (m)							5	SP-SM A-2-4(0)	3	91.6	5.4		NLL	-	NPI	9.4	1.62	1.8											5	SPT - 3

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-03

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 302901.23				
	Location : Deh Mithaghar		Drill Date: 10.12.2022	Northing: 2781976.57				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments	
				* SPT 10 20 30 40 50								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type	C (kg/cm2)		FI (o)	Cc	Cs	Pc (kg/cm2)	PH	SO3		CL
0			SAND <i>Greyish brown, medium dense to dense, fine grained, traces of silt & gravel at places</i>																									0			
1		U										SP-SM A-1-b(0)		91.6	8.4		NLL	-	NPI	13.2	1.6	1.8					7.3	0.01	0.42	1	SPT - 1
2																													2		
3		U																										3	SPT - 2		
4																												4			
5		U	End of Log @ 5 (m)									SP-SM A-2-4(0)	0.5	94.2	5.3		NLL	-	NPI	11.1	1.62	1.8							5	SPT - 3	

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
Abbreviations	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter	Groundwater Level	NPI : None PI				
				C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)			
					K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-04

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 13.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303414.48
Northing: 2782140.53
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50				Gravel (%)		Sand (%)		Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type	C (kg/cm2)			FI (o)	Cc		Cs	Pc (kg/cm2)	PH	SO3	CL		
0			SAND <i>Yellowish brown, dense, little silt, traces of gravel</i>																								0	SPT - 1		
1		U																											1	
2																													2	
3		U																									3	SPT - 2		
4																											4			
5		U	End of Log @ 5 (m)																								5	SPT - 3		

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-05

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 303109.21				
	Location : Deh Mithaghar		Drill Date: 12.12.2022	Northing: 2784021.80				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation			Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type		C (kg/cm2)	FI (o)	Cc	Cs		Pc (kg/cm2)	PH	SO3	CL				
0			SAND <i>Yellowish brown, medium dense, silty, traces of gravel & clay at places</i>																										0	SPT - 1		
1		U										SM A-4(0)	1.3	55.2	33.5	10	NLL	-	NPI	10.9	1.6	1.8					7.3	0.011	0.42		1	
2																													2			
3		U																											3	SPT - 2		
4																													4			
5		U	End of Log @ 5 (m)									SM A-4(0)		56.2	33.4	10.4	NLL	-	NPI	14.7	1.59	1.8						5	SPT - 3			

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
Abbreviations	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter		NPI : None PI				
	Σ Groundwater Level			C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-06

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 13.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303280.20
Northing: 2781809.07
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
				* SPT				Gravel (%)		Sand (%)		Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type	C (kg/cm2)		FI (o)	Cc	Cs	Pc (kg/cm2)		PH	SO3	CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
0			SAND Yellowish brown, dense, little to some silt, traces of gravel																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-07

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 303538.61				
	Location : Deh Mithaghar		Drill Date: 09.12.2022	Northing: 2783043.60				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit-Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation			Chemical Tests			Depth (m)	Remarks & Comments	
												Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type	C (kg/cm2)		FI (o)	Cc	Cs	Pc (kg/cm2)	PH	SO3	CL		
				10	20	30	40	50																								
0			SAND <i>Yellowish brown, very dense, fine to coarse grained, some gravel, traces of silt</i>							0																		0	SPT - 1 SPT Drive - 125mm			
1		U																												1		
2		U											SP-SM A-2-4(0)	21.3	70.2	8.5		NLL	-	NPI	8.6	1.69	1.8					6.8		0.099	0.36	2
3		U																										3	SPT - 2 SPT Drive - 225mm			
4																												4				
5		U	End of Log @ 5 (m)								SP-SM A-2-4(0)	21.6	72.2	6.2		NLL	-	NPI	7.3	1.7	1.8							5	SPT - 3 SPT Drive - 100mm			

Sample Types	● Disturbed	U SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed						
Abbreviations	Water Sample	PL : Plastic Limit	Phi : Friction Angle	C' : Cohesion (CU)	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	Groundwater Level						
	Shelby / U4	PI : Plastic Index	Phi' : Friction Angle (CU)	K : Permeability Coeff.	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
	Core Cutter						
		NPI : None PI				S : Slow	

Mud Rotary Log BH-08

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 11.12.2022
Logged By: ARH

Elevation: Equal to Exist. R/L
Easting: 303305.80
Northing: 2782292.86
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
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www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type	C (kg/cm2)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, dense to very dense, little to some silt, traces of gravel	* SPT 10 20 30 40 50		0																			0	
1		U				1	SM A-2-4(0)	2.1	81	16.9		NLL	-	NPI	12.1	1.65	1.8					7.4	0.01	0.45	1	SPT - 1
2						2																			2	
3		U				3																			3	SPT - 2
4						4																			4	
5		U	End of Log @ 5 (m)			5	SM A-2-4(0)	3.9	73	23.1		NLL	-	NPI	13.2	1.61	1.8								5	SPT - 3 SPT Drive - 300mm

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-09

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 07.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 302962.72
Northing: 2782448.93
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit-Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50					Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)		PI (%)	Test Type	C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND <i>Yellowish brown, medium dense to very dense, silty, fine grained, traces of gravel & clay at places</i>			0	SM A-4(0)																	0	SPT - 1		
1		U						1		58.9	31.1	10	NLL	-	NPI	13.7	1.62	1.8				7.2	0.01	0.4		1	
2								2																			2
3		U				3																		3	SPT - 2		
4						4																		4			
5		U	End of Log @ 5 (m)			5	SM A-4(0)	0.5	51.2	35.5	12.8	NLL	-	NPI	10.4	1.63	1.8							5	SPT - 3 SPT Drive - 225mm		

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-10

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 07.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 302943.87
Northing: 2782121.10
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3)		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Dry	Bulk	Test Type	C (kg/cm2)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, dense, fine to coarse grained, little silt, traces of gravel	* SPT 10 20 30 40 50		0																				0	
1		U				1	SM A-2-4(0)	6.3	79.5	14.2		NLL	-	NPI	9.1	1.62	1.8						7.4	0.011	0.45	1	SPT - 1
2						2																				2	
3		U	SAND Yellowish brown, dense to very dense, fine to medium grained, little silt			3																				3	SPT - 2
4						4																				4	
5		U	End of Log @ 5 (m)			5	SP-SM A-1-b(0)	88.2	11.8			NLL	-	NPI	14.9	1.6	1.8									5	SPT - 3 SPT Drive - 350mm

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

LL : Liquid Limit
PL : Plastic Limit
PI : Plastic Index
NPI : None PI

C : Cohesion
Phi : Friction Angle
C' : Cohesion (CU)
Phi' : Friction Angle (CU)

Cc : Cc
Cs : Cs
Pc : Pre-Consolidation Pressure
K : Permeability Coeff.

w : Moisture Content
qu : Unconfined Comp. Qu
F : Fast
S : Slow

CD : Consolidated, Drained
UU : Unconsolidated, Undrained
CU : Consolidated, Undrained

Mud Rotary Log BH-11

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 11.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303226.49
Northing: 2781984.59
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit-Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments		
				* SPT								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type	C (kg/cm2)		FI (o)	Cc	Cs	Pc (kg/cm2)	PH	SO3		CL	
				10	20	30	40	50																								
0			SAND <i>Yellowish brown, dense to very dense, traces to little silt, traces of gravel</i>							0	SP-SM A-2-4(0)																	0	SPT - 1 SPT - 2 SPT - 3 SPT Drive - 100mm			
1		U										1	1	91.4	7.6		NLL	-	NPI	10.1	1.64	1.8					7.1	0.01		0.36	1	
2												2																		2		
3		U								3																		3				
4										4																		4				
5		U	End of Log @ 5 (m)							5	SP-SM A-2-4(0)	0.9	87.9	11.2		NLL	-	NPI	9.3	1.66	1.8						5					

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-12

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 12.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303453.78
Northing: 2781888.55
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3)		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Dry	Bulk	Test Type	C (kg/cm2)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, medium dense to dense, some silt, traces of gravel	* SPT 10 20 30 40 50		0																				0	
1		U				1	SM A-2-4(0)	5.8	71.1	23.1		NLL	-	NPI	6.3	1.67	1.8						7.2	0.011	0.4	1	SPT - 1
2						2																				2	
3		U				3																				3	SPT - 2
4						4																				4	
5		U	End of Log @ 5 (m)			5	SM A-2-4(0)	1.2	70.9	27.9		NLL	-	NPI	9	1.65	1.8									5	SPT - 3

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-13

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 12.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303387.10
Northing: 2781639.65
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Test Type	Direct Shear Test	qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments			
				* SPT 10 20 30 40 50								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)				C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL			
0			SAND <i>Yellowish brown, dense to very dense, some silt, traces of gravel</i>							0																					0		
1		U									1	SM A-2-4(0)	1.9	78	20.1		NLL	-	NPI	11.5	1.61	1.8							6.8	0.099	0.39		SPT - 1
2											2																					2	
3		U								3																					3	SPT - 2	
4										4																					4		
5		U	End of Log @ 5 (m)							5	SM A-2-4(0)	1.2	83.4	15.4		NLL	-	NPI	10.6	1.62	1.8									5	SPT - 3		

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-14

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 07.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303021.42
Northing: 2781805.01
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)		Dry Unit Weight (gr/cm3) Bulk	Test Type	Direct Shear Test		qu (kg/cm2)	Consolidation			Chemical Tests			Depth (m)	Remarks & Comments	
				* SPT								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)				C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL				
0			SAND <i>Greyish to yellowish brown, medium dense, fine to medium grained, some silt, traces of gravel</i>							0																						0		
1		U									1	SM A-2-4(0)	4.2	67.4	28.4		NLL	-	NPI	10.5	1.63	1.8								6.8	0.01	0.38	1	SPT - 1
2											2																					2		
3		U									3																					3	SPT - 2	
4											4																					4		
5		U	End of Log @ 5 (m)							5	SM A-2-4(0)	6.4	66.8	26.8		NLL	-	NPI	6.8	1.65	1.8										5	SPT - 3		

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-15

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 09.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 302724.50
Northing: 2781971.93
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Test Type	C (kg/cm2)	FI (o)	Cc		Cs	Pc (kg/cm2)	PH	SO3	CL		
				10	20	30	40	50																							
0			SAND <i>Greyish to yellowish brown, medium dense to dense, fine to medium grained, silty, traces of gravel & clay at places</i>							0																		0	SPT - 1		
1		U									1	SM A-4(0)	7.2	52.6	30.8	9.4	NLL	-	NPI	15	1.59	1.8				6.9	0.01	0.35		1	
2											2																			2	
3		U								3																		3	SPT - 2		
4										4																		4			
5		U	End of Log @ 5 (m)							5	SM A-4(0)	5.5	52.8	30.4	11.3	NLL	-	NPI	10.4	1.61	1.8						5	SPT - 3			

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-16

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 09.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 302737.42
Northing: 2782232.94
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type		C (kg/cm2)	FI (o)	Cc	Cs		Pc (kg/cm2)	PH	SO3	CL			
0		U	SAND Greyish brown, medium dense, fine grained, silty, traces of gravel							0	SM A-2-4(0)																	0	SPT - 1		
1																															1
2		U	SILT Greyish brown, very stiff, little sand & clay, traces of gravel							2		0.5	65.3	34.2		NLL	-	NPI	7	1.65	1.8					7.2	0.01	0.42		2	
3																														3	SPT - 2
4		U								4																		4			
5				End of Log @ 5 (m)								5	ML A-4(0)	4.1	12.4	63.5	20	NLL	-	NPI	10.3	1.58	1.7						5	SPT - 3	

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-17

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 09.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 302758.09
Northing: 2782564.98
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments				
				* SPT								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type	C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL				
				10	20	30	40	50																										
0			SAND Greyish brown, medium dense, fine grained, some silt, little gravel																														0	
1		U																															1	
2		■	SANDSTONE Brownish grey, distinctly weathered, loosely compacted, poorly cemented, very poor quality of friable, interbedded with thin layers of clay at places								SM A-2-4(0)	13	59.2	27.8		NLL	-	NPI	7.3	1.66	1.8												2	SPT - 1 Run - 1 CR - 18% / RQD - Nil
3		U																															3	SPT(C) - 1 SPT(C) Drive - 75mm
4		■																															4	Run - 2 CR - 21% / RQD - Nil
5		U	End of Log @ 5 (m)																														5	SPT(C) - 2 SPT(C) Drive - 25mm

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- △ Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-18

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 14.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 302793.60
Northing: 2783305.65
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit-Weight (gr/cm3) Bulk	Direct Shear Test	qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments			
				* SPT 10 20 30 40 50								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL			
0		■	SAND Yellowish brown, very dense, cemented, silty, little gravel, traces of clay							0																				0	Run - 1 CR - 20% / RQD - Nil	
1										1																				1	SPT(C) - 1 SPT(C) Drive - 100mm	
2		■	SILT Yellowish brown, hard, cemented sandy, little clay, traces of gravel							2	SM A-4(0)	16	37	38	9	NLL	-	NPI	6.4	1.71	1.8							7.2	0.01	0.34	2	Run - 2 CR - 21% / RQD - Nil
3										3																				3	SPT(C) - 2 SPT(C) Drive - 75mm	
4		■								4																				4	Run - 3 CR - 25% / RQD - Nil	
5			End of Log @ 5 (m)							5	ML A-4(0)	2.6	41.8	42.2	13.4	NLL	-	NPI	13.2	1.68	1.9									5	SPT(C) - 3 SPT(C) Drive - 125mm	

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-19

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 302828.96				
	Location : Deh Mithaghar		Drill Date: 12.12.2022	Northing: 2784036.73				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				10	20	* SPT 30	40	50			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type		C (kg/cm2)	FI (o)	Cc	Cs		Pc (kg/cm2)	PH	SO3	CL			
0			SAND Yellowish brown, sand with silt							0																		0			
1		U	SILT / CLAY Yellowish brown, very stiff, sandy, traces of gravel			* 29				1	CL-ML A-4(1)	0.7	37.7	30.3	31.3	24.8	19.5	5.3	13.2	1.58	1.8				7.1	0.098	0.38	1	SPT - 1		
2										2																		2			
3		U				* 28				3																		3	SPT - 2		
4			SAND Yellowish brown, dense, silty, traces of clay & gravel at places							4																		4			
5		U	End of Log @ 5 (m)			* 38				5	SM A-4(0)	0.7	58.2	30.7	10.4	NLL	-	NPI	11.1	1.61	1.8						5	SPT - 3			

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed						
Abbreviations	Water Sample	PL : Plastic Limit	Phi : Friction Angle	C' : Cohesion (CU)	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	Groundwater Level						
	Shelby / U4	PI : Plastic Index	Phi' : Friction Angle (CU)	K : Permeability Coeff.	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
	Core Cutter						
		NPI : None PI				S : Slow	

Mud Rotary Log BH-20

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 302865.08				
	Location : Deh Mithaghar		Drill Date: 09.12.2022	Northing: 2784623.03				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidati on		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type		C (kg/cm2)	FI (o)	Cc	Cs		Pc (kg/cm2)	PH	SO3	CL			
0		U	SILT / CLAY <i>Yellowish brown, hard, little sand, traces of gravel</i>							0	CL-ML A-4(3)	4.5	13.1	40.3	42.1	27.1	21.6	5.5	12.5	1.57	1.8										
1																															1
2		U	SILT <i>Yellowish brown, very stiff to hard, gravelly, little clay & traces of sand at places</i>							2																					
3																															
4		U								4																					
5																															
			End of Log @ 5 (m)								ML A-4(0)	35.9	3.7	44.2	16.2	NLL	-	NPI	10.1	1.68	1.8										

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed						
	Water Sample	Groundwater Level	PL : Plastic Limit	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	Shelby / U4						
	Core Cutter		PI : Plastic Index	C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
Abbreviations	NPI : None PI			Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-21

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 12.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303200.82
Northing: 2784586.70
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3)		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Dry	Bulk	Test Type	C (kg/cm2)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, dense, some silt	* SPT 10 20 30 40 50		0																				0	
1		U				1																				1	
2			SILT Yellowish brown, very stiff to hard, sandy, little clay			2	SM A-2-4(0)	79.7	20.3		NLL	-	NPI	9.9	1.61	1.8							6.9	0.098	0.33	2	SPT - 1
3		U				3																				3	SPT - 2
4						4																				4	
5		U	End of Log @ 5 (m)			5	ML A-4(0)	40.5	40.7	18.8	NLL	-	NPI	13.1	1.63	1.8										5	SPT - 3

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-22

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 303011.85				
	Location : Deh Mithaghar		Drill Date: 13.12.2022	Northing: 2783523.21				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments		
				* SPT								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type	C (kg/cm2)		FI (o)	Cc	Cs	Pc (kg/cm2)	PH			SO3	CL
				10	20	30	40	50																								
0		■	SILT Yellowish brown, hard, clayey, traces of sand																								0	Run - 1 CR - 19% / RQD - Nil				
1																											1	SPT(C) - 1 SPT(C) Drive - 125mm				
2		■	CLAY Yellowish brown, hard, silty, traces of sand																								2	Run - 2 CR - 21% / RQD - Nil				
3																											3	SPT(C) - 2 SPT(C) Drive - 150mm				
4		■																									4	Run - 3 CR - 20% / RQD - Nil				
5			End of Log @ 5 (m)																								5	SPT(C) - 3 SPT(C) Drive - 75mm				

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
Abbreviations	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter		NPI : None PI				
	Δ Groundwater Level			C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-23

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 06.12.2022
Logged By: SA

Elevation: Equal to exist. R/L
Easting: 302915.17
Northing: 2782849.28
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
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Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type		C (kg/cm2)	FI (o)	Cc	Cs		Pc (kg/cm2)	PH	SO3	CL			
0			SAND Yellowish brown, fine grained, sand with silt							0																					
1		U	CLAY Brownish grey, very stiff to hard, silty, traces of sand							1	CL A-4(8)	1.2	48.1	50.7	31.1	22.9	8.2	10.2	1.58	1.7					7.2	0.01	0.4		SPT - 1		
2										2																					
3		U								3																			SPT - 2		
4										4																					
5		U	End of Log @ 5 (m)							5	CL A-4(6)	3.4	47.1	49.5	23.2	14.7	8.5	9.9	1.59	1.7								SPT - 3			

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-24

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 07.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303113.21
Northing: 2782764.00
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation			Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type		C (kg/cm2)	FI (o)	Cc	Cs		Pc (kg/cm2)	PH	SO3	CL				
0			SAND Yellowish brown, medium dense to dense, silty, traces of clay & gravel at places								SM A-4(0)																			0	SPT - 1	
1		U											3.5	54.6	32	9.9	NLL	-	NPI	12	1.61	1.8					6.8	0.098	0.33	1		
2																														2		
3		U																												3	SPT - 2	
4		■	SANDSTONE Yellowish brown, distinctly weathered, loosely cemented, poorly compacted, very poor quality of rock																											4	Run - 1 CR - 38% / RQD - Nil	
5		U	End of Log @ 5 (m)																											5	SPT(C) - 1 SPT Drive - 25mm	

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-25

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 303273.61				
	Location : Deh Mithaghar		Drill Date: 10.12.2022	Northing: 2782539.83				
	Job No.: K22-1245-101		Logged By: ARH	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type			C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, medium dense, little silt, traces of gravel							0																			0	
1		U								1																			1	
2										2	SM A-2-4(0)	0.8	82.2	17		NLL	-	NPI	8.2	1.59	1.7					7.2	0.01	0.37		SPT - 1
3		U	SAND Yellowish brown, dense, traces of silt & gravel							3																			3	SPT - 2
4										4																			4	
5		U	End of Log @ 5 (m)							5	SP A-2-4(0)	2.9	94.5	2.6		NLL	-	NPI	9.6	1.63	1.8								5	SPT - 3

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter		NPI : None PI				
Abbreviations	Δ Groundwater Level			C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-26

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 303524.17				
	Location : Deh Mithaghar		Drill Date: 13.12.2022	Northing: 2782321.29				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Test Type	C (kg/cm2)	FI (o)	Cc		Cs	Pc (kg/cm2)	PH	SO3	CL		
				10	20	30	40	50																							
0			SAND <i>Yellowish brown, medium dense to dense, some silt, traces of gravel at places</i>							0																		0	SPT - 1		
1		U									1	SM A-2-4(0)		76.9	23.1		NLL	-	NPI	14	1.6	1.8				7.3	0.011	0.43		1	
2											2																			2	
3		U								3																		3	SPT - 2		
4										4																		4			
5		U	End of Log @ 5 (m)							5	SM A-2-4(0)	0.4	73.6	26		NLL	-	NPI	12.4	1.62	1.8						5	SPT - 3			

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter		NPI : None PI				
Abbreviations	⚡ Groundwater Level			C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-27

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 09.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303650.42
Northing: 2782726.40
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
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Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3)		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Dry	Bulk	Test Type	C (kg/cm2)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, very dense, fine to medium grained, silty, little gravel	* SPT 10 20 30 40 50		0																				0	
1		U				1	SM A-4(0)	15.5	38.5	46		NLL	-	NPI	6	1.67	1.8						7.3	0.01	0.41	1	SPT - 1 SPT Drive - 100mm
2			SAND Yellowish brown, medium dense to dense, fine to medium grained, traces of silt & gravel			2																				2	
3		U				3																				3	SPT - 2
4						4																				4	
5		U	End of Log @ 5 (m)			5	SP-SM A-2-4(0)	9.6	83.9	6.5		NLL	-	NPI	8.3	1.65	1.8									5	SPT - 3

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-28

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 07.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303300.26
Northing: 2782926.29
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
Material Testing Laboratory
www.sts.com.pk



Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3)		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)		Dry	Bulk	Test Type	C (kg/cm2)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND Yellowish brown, medium dense, fine grained, little gravel, traces of silt	* SPT 10 20 30 40 50		0																				0	
1		U				1	SP-SM A-2-4(0)	13.9	79.3	6.8		NLL	-	NPI	8.6	1.67	1.8						7.2	0.01	0.39	1	SPT - 1
2						2																				2	
3		U	SAND Yellowish brown, medium dense, fine to medium grained, little silt & gravel			3																				3	SPT - 2
4						4																				4	
5		U	End of Log @ 5 (m)			5	SM A-2-4(0)	10.5	73.7	15.8		NLL	-	NPI	10.1	1.68	1.8									5	SPT - 3

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-29

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth:5 (m)	Elevation:Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL:- (m)	Easting:303405.07				
	Location :Deh Mithaghar		Drill Date:08.12.2022	Northing:2783369.90				
	Job No.:K22-1245-101		Logged By:SA	Method:Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests	Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk		Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments	
				* SPT 10 20 30 40 50					Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)		PI (%)	Test Type	C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL		
0			SAND <i>Yellowish brown, medium dense to dense, fine grained, silty, traces to little clay & traces of gravel at places</i>			0																		0				
1		U					1	SM A-4(0)	0.8	60.5	27.2	11.5	NLL	-	NPI	14.4	1.62	1.9						7.3	0.01	0.42	1	SPT - 1
2							2																				2	
3		U				3																				3	SPT - 2	
4						4																				4		
5		U	End of Log @ 5 (m)			5	SM A-4(0)	54.1	36.2	9.7	NLL	-	NPI	16.3	1.61	1.9									5	SPT - 3		

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
Abbreviations	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter		NPI : None PI				
	Δ Groundwater Level			C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Mud Rotary Log BH-30

Project Info.

Project : Geotechnical Investigation Works
Client : Renewable Resources
Location : Deh Mithaghar
Job No.: K22-1245-101

Borehole Info.

Depth: 5 (m)
GWL: - (m)
Drill Date: 08.12.2022
Logged By: SA

Elevation: Equal to Exist. R/L
Easting: 303816.70
Northing: 2783439.59
Method: Mud Rotary

Company Info.

Geotechnical Engineering &
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Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT 10 20 30 40 50							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Test Type			C (kg/cm2)	FI (o)		Cc	Cs	Pc (kg/cm2)	PH	SO3	CL	
0			SAND <i>Yellowish brown, medium dense to dense, fine to coarse grained, little silt & taces of gravel</i>							0																	0			
1		U									1	SM A-2-4(0)	10.1	70.8	19.1		NLL	-	NPI	9.1	1.63	1.8				6.8	0.098	0.35	1	SPT - 1
2											2																	2		
3		U								3																	3	SPT - 2		
4										4																	4			
5		U	End of Log @ 5 (m)							5	SM A-2-4(0)	9.2	75.1	15.7		NLL	-	NPI	7.5	1.66	1.8						5	SPT - 3		

Sample Types

- Disturbed
- + Undisturbed
- Shelby / U4
- Core Cutter
- U SPT Sample
- Water Sample
- Groundwater Level

Abbreviations

- LL : Liquid Limit
- PL : Plastic Limit
- PI : Plastic Index
- NPI : None PI

- C : Cohesion
- Phi : Friction Angle
- C' : Cohesion (CU)
- Phi' : Friction Angle (CU)

- Cc : Cc
- Cs : Cs
- Pc : Pre-Consolidation Pressure
- K : Permeability Coeff.

- w : Moisture Content
- qu : Unconfined Comp. Qu
- F : Fast
- S : Slow

- CD : Consolidated, Drained
- UU : Unconsolidated, Undrained
- CU : Consolidated, Undrained

Mud Rotary Log BH-31

Project Info.	Project : Geotechnical Investigation Works	Borehole Info.	Depth: 5 (m)	Elevation: Equal to Exist. R/L		Company Info.	Geotechnical Engineering & Material Testing Laboratory www.sts.com.pk	
	Client : Renewable Resources		GWL: - (m)	Easting: 303603.46				
	Location : Deh Mithaghar		Drill Date: 10.12.2022	Northing: 2783741.60				
	Job No.: K22-1245-101		Logged By: SA	Method: Mud Rotary				

Depth (m)	GWL (m)	Sample Type	Lithology Description	Field Tests					Symbol	Depth (m)	USCS / AASHTO	Sieve Analysis Test				Atterberg Limits			w (%)	Dry Unit Weight (gr/cm3) Bulk	Direct Shear Test		qu (kg/cm2)	Consolidation		Chemical Tests			Depth (m)	Remarks & Comments
				* SPT								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)			Test Type	C (kg/cm2)		FI (o)	Cc	Cs	Pc (kg/cm2)	PH	SO3	
0			SAND <i>Yellowish brown, medium dense to very dense, fine to coarse grained, traces to some gravel, little silt</i>																									0	SPT - 1 SPT Drive - 125mm	
1		U										SP-SM A-2-4(0)	3.4	85.9	10.7		NLL	-	NPI	10.5	1.64	1.8				7.3	0.01	0.45		1
2																												2		
3		U																										3	SPT - 2	
4																												4		
5		U	End of Log @ 5 (m)									SP-SM A-2-4(0)	24.9	63.2	11.9		NLL	-	NPI	9.6	1.69	1.9						5	SPT - 3	

Sample Types	● Disturbed	SPT Sample	LL : Liquid Limit	C : Cohesion	Cc : Cc	w : Moisture Content	CD : Consolidated, Drained
	+ Undisturbed		PL : Plastic Limit				
Abbreviations	□ Shelby / U4	Water Sample	PI : Plastic Index	Phi : Friction Angle	Cs : Cs	qu : Unconfined Comp. Qu	UU : Unconsolidated, Undrained
	■ Core Cutter		NPI : None PI				
	Σ Groundwater Level			C' : Cohesion (CU)	Pc : Pre-Consolidation Pressure	F : Fast	CU : Consolidated, Undrained
				Phi' : Friction Angle (CU)	K : Permeability Coeff.	S : Slow	

Appendix C

Laboratory Test Results

Summary of Lab. Tests

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



Sieve Analysis Test

Borehole	Sample Depth (m)	Soil Class	D10 mm	D30 mm	D60 mm	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Cobble (%)	LL	PL
BH-01	1.5	SM A-4(0)			0.201		36.1	60.7	3.2			
BH-01	5	SM A-4(0)			0.155	13	32.4	53.8	0.8			
BH-02	1.5	SM A-4(0)			0.128	12	30	46	12			
BH-02	5	SP-SM A-2-4(0)	0.216	1.238	2.066		5.4	91.6	3			
BH-03	1.5	SP-SM A-1-b(0)	0.082	0.165	0.226		8.4	91.6				
BH-03	5	SP-SM A-2-4(0)	0.1	0.173	0.237		5.3	94.2	0.5			
BH-04	1.5	SM A-2-4(0)		0.119	0.853		18	73.9	8.1			
BH-04	5	SM A-2-4(0)		0.123	0.212		13.7	84.2	2.1			
BH-05	1.5	SM A-4(0)			0.154	10	33.5	55.2	1.3			
BH-05	5	SM A-4(0)			0.159	10.4	33.4	56.2				
BH-06	1.5	SM A-2-4(0)		0.092	0.18		22.3	77.5	0.2			
BH-06	5	SM A-2-4(0)		0.133	0.209		18.9	79	2.1			
BH-07	1.5	SP-SM A-2-4(0)	0.084	0.213	1.525		8.5	70.2	21.3			
BH-07	5	SP-SM A-2-4(0)	0.103	0.351	2.76		6.2	72.2	21.6			
BH-08	1.5	SM A-2-4(0)		0.109	0.205		16.9	81	2.1			
BH-08	5	SM A-2-4(0)		0.113	0.619		23.1	73	3.9			
BH-09	1.5	SM A-4(0)			0.12	10	31.1	58.9				
BH-09	5	SM A-4(0)			0.104	12.8	35.5	51.2	0.5			
BH-10	1.5	SM A-2-4(0)		0.107	0.189		14.2	79.5	6.3			
BH-10	5	SP-SM A-1-b(0)		0.113	0.187		11.8	88.2				
BH-11	1.5	SP-SM A-2-4(0)	0.08	0.137	0.235		7.6	91.4	1			
BH-11	5	SP-SM A-2-4(0)		0.136	0.225		11.2	87.9	0.9			
BH-12	1.5	SM A-2-4(0)		0.101	0.612		23.1	71.1	5.8			
BH-12	5	SM A-2-4(0)		0.082	0.271		27.9	70.9	1.2			
BH-13	1.5	SM A-2-4(0)		0.09	0.162		20.1	78	1.9			
BH-13	5	SM A-2-4(0)		0.099	0.174		15.4	83.4	1.2			

Summary of Lab. Tests

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



Borehole	Sample Depth (m)	Soil Class	D10 mm	D30 mm	D60 mm	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Cobble (%)	LL	PL
BH-14	1.5	SM A-2-4(0)		0.079	0.19		28.4	67.4	4.2			
BH-14	5	SM A-2-4(0)		0.084	0.201		26.8	66.8	6.4			
BH-15	1.5	SM A-4(0)			0.158	9.4	30.8	52.6	7.2			
BH-15	5	SM A-4(0)			0.157	11.3	30.4	52.8	5.5			
BH-16	1.5	SM A-2-4(0)			0.15		34.2	65.3	0.5			
BH-16	5	ML A-4(0)				20	63.5	12.4	4.1			
BH-17	1.5	SM A-2-4(0)		0.078	0.137		27.8	59.2	13			
BH-18	1.5	SM A-4(0)			0.136	9	38	37	16			
BH-18	5	ML A-4(0)			0.093	13.4	42.2	41.8	2.6			
BH-19	1.5	CL-ML A-4(1)				31.3	30.3	37.7	0.7		24.8	19.5
BH-19	5	SM A-4(0)			0.149	10.4	30.7	58.2	0.7			
BH-20	1.5	CL-ML A-4(3)				42.1	40.3	13.1	4.5		27.1	21.6
BH-20	5	ML A-4(0)				16.2	44.2	3.7	35.9			
BH-21	1.5	SM A-2-4(0)					20.3	79.7				
BH-21	5	ML A-4(0)				18.8	40.7	40.5				
BH-22	1.5	ML A-4(5)				41.8	52.6	5.6			28.6	22.4
BH-22	5	CL A-4(7)				51.9	44.5	3.6			26.5	18.2
BH-23	1.5	CL A-4(8)				50.7	48.1	1.2			31.1	22.9
BH-23	5	CL A-4(6)				49.5	47.1	3.4			23.2	14.7
BH-24	1.5	SM A-4(0)				9.9	32	54.6	3.5			
BH-25	1.5	SM A-2-4(0)		0.132	0.208		17	82.2	0.8			
BH-25	5	SP A-2-4(0)	0.101	0.172	0.258		2.6	94.5	2.9			
BH-26	1.5	SM A-2-4(0)		0.104	0.196		23.1	76.9				
BH-26	5	SM A-2-4(0)		0.084	0.176		26	73.6	0.4			
BH-27	1.5	SM A-4(0)			0.234		46	38.5	15.5			
BH-27	5	SP-SM A-2-4(0)	0.088	0.178	0.399		6.5	83.9	9.6			
BH-28	1.5	SP-SM A-2-4(0)	0.107	0.271	2.044		6.8	79.3	13.9			

Summary of Lab. Tests

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



Borehole	Sample Depth (m)	Soil Class	D10 mm	D30 mm	D60 mm	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Cobble (%)	LL	PL
BH-28	5	SM A-2-4(0)		0.272	2.237		15.8	73.7	10.5			
BH-29	1.5	SM A-4(0)			0.163	11.5	27.2	60.5	0.8			
BH-29	5	SM A-4(0)			0.126	9.7	36.2	54.1				
BH-30	1.5	SM A-2-4(0)		0.158	1.098		19.1	70.8	10.1			
BH-30	5	SM A-2-4(0)		0.185	1.435		15.7	75.1	9.2			
BH-31	1.5	SP-SM A-2-4(0)		0.177	0.298		10.7	85.9	3.4			
BH-31	5	SP-SM A-2-4(0)		0.225	2.74		11.9	63.2	24.9			

ATTERBERG LIMITS TEST

Borehole	Sample Depth (m)	Soil Class	Liquid Limit (LL)	Plastic Limit (PL)
BH-19	1.5	CL-ML A-4(1)	24.8	19.5
BH-20	1.5	CL-ML A-4(3)	27.1	21.6
BH-22	1.5	ML A-4(5)	28.6	22.4
BH-22	5	CL A-4(7)	26.5	18.2
BH-23	1.5	CL A-4(8)	31.1	22.9
BH-23	5	CL A-4(6)	23.2	14.7

Density & Moisture Test

Borehole	Sample Depth (m)	Soil Class	Moisture Content (%)	Dry Density (gr/cm3)
BH-01	1.5	SM A-4(0)	1.598	7.88
BH-01	5	SM A-4(0)	12.49	1.608
BH-02	1.5	SM A-4(0)	10.33	1.602
BH-02	5	SP-SM A-2-4(0)	9.38	1.622
BH-03	1.5	SP-SM A-1-b(0)	13.2	1.598
BH-03	5	SP-SM A-2-4(0)	11.09	1.618
BH-04	1.5	SM A-2-4(0)	13.22	1.625
BH-04	5	SM A-2-4(0)	9.87	1.622
BH-05	1.5	SM A-4(0)	10.85	1.599
BH-05	5	SM A-4(0)	14.69	1.587

Summary of Lab. Tests

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



Borehole	Sample Depth (m)	Soil Class	Moisture Content (%)	Dry Density (gr/cm3)
BH-06	1.5	SM A-2-4(0)	8.23	1.646
BH-06	5	SM A-2-4(0)	6.21	1.662
BH-07	1.5	SP-SM A-2-4(0)	8.56	1.689
BH-07	5	SP-SM A-2-4(0)	7.29	1.701
BH-08	1.5	SM A-2-4(0)	12.14	1.649
BH-08	5	SM A-2-4(0)	13.21	1.608
BH-09	1.5	SM A-4(0)	13.67	1.618
BH-09	5	SM A-4(0)	10.43	1.634
BH-10	1.5	SM A-2-4(0)	9.07	1.622
BH-10	5	SP-SM A-1-b(0)	14.89	1.597
BH-11	1.5	SP-SM A-2-4(0)	10.09	1.639
BH-11	5	SP-SM A-2-4(0)	9.32	1.66
BH-12	1.5	SM A-2-4(0)	6.33	1.671
BH-12	5	SM A-2-4(0)	8.99	1.65
BH-13	1.5	SM A-2-4(0)	11.54	1.608
BH-13	5	SM A-2-4(0)	10.58	1.618
BH-14	1.5	SM A-2-4(0)	10.49	1.628
BH-14	5	SM A-2-4(0)	6.85	1.646
BH-15	1.5	SM A-4(0)	14.97	1.588
BH-15	5	SM A-4(0)	10.41	1.607
BH-16	1.5	SM A-2-4(0)	6.99	1.648
BH-16	5	ML A-4(0)	10.29	1.582
BH-17	1.5	SM A-2-4(0)	7.32	1.662
BH-18	1.5	SM A-4(0)	6.39	1.705
BH-18	5	ML A-4(0)	13.2	1.685
BH-19	1.5	CL-ML A-4(1)	13.22	1.581
BH-19	5	SM A-4(0)	11.06	1.613

Summary of Lab. Tests

Project : Geotechnical Investigation Works

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Location : Deh Mithaghar



Borehole	Sample Depth (m)	Soil Class	Moisture Content (%)	Dry Density (gr/cm3)
BH-20	1.5	CL-ML A-4(3)	12.46	1.574
BH-20	5	ML A-4(0)	10.14	1.683
BH-21	1.5	SM A-2-4(0)	9.87	1.613
BH-21	5	ML A-4(0)	13.08	1.634
BH-22	1.5	ML A-4(5)	15.32	1.586
BH-22	5	CL A-4(7)	16.98	1.608
BH-23	1.5	CL A-4(8)	10.22	1.578
BH-23	5	CL A-4(6)	9.87	1.593
BH-24	1.5	SM A-4(0)	12.03	1.609
BH-25	1.5	SM A-2-4(0)	8.22	1.594
BH-25	5	SP A-2-4(0)	9.63	1.632
BH-26	1.5	SM A-2-4(0)	14.03	1.599
BH-26	5	SM A-2-4(0)	12.41	1.617
BH-27	1.5	SM A-4(0)	5.97	1.668
BH-27	5	SP-SM A-2-4(0)	8.27	1.65
BH-28	1.5	SP-SM A-2-4(0)	8.62	1.671
BH-28	5	SM A-2-4(0)	10.1	1.681
BH-29	1.5	SM A-4(0)	14.36	1.618
BH-29	5	SM A-4(0)	16.33	1.608
BH-30	1.5	SM A-2-4(0)	9.08	1.635
BH-30	5	SM A-2-4(0)	7.46	1.658
BH-31	1.5	SP-SM A-2-4(0)	10.48	1.639
BH-31	5	SP-SM A-2-4(0)	9.58	1.686

Chemical Test Results

Borehole	Sample Depth (m)	Soil Class	#	Value
BH-01	1.5	SM A-4(0)	9	0.38
BH-01	1.5	SM A-4(0)	2	6.88

Summary of Lab. Tests

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



Borehole	Sample Depth (m)	Soil Class	#	Value
BH-01	1.5	SM A-4(0)	6	0.098
BH-02	1.5	SM A-4(0)	2	7.15
BH-02	1.5	SM A-4(0)	4	0.098
BH-02	1.5	SM A-4(0)	9	0.36
BH-03	1.5	SP-SM A-1-b(0)	2	7.3
BH-03	1.5	SP-SM A-1-b(0)	9	0.42
BH-03	1.5	SP-SM A-1-b(0)	6	0.01
BH-04	1.5	SM A-2-4(0)	6	0.01
BH-04	1.5	SM A-2-4(0)	9	0.34
BH-04	1.5	SM A-2-4(0)	2	7.1
BH-05	1.5	SM A-4(0)	9	0.42
BH-05	1.5	SM A-4(0)	2	7.35
BH-05	1.5	SM A-4(0)	6	0.011
BH-06	1.5	SM A-2-4(0)	9	0.39
BH-06	1.5	SM A-2-4(0)	2	6.8
BH-06	1.5	SM A-2-4(0)	6	0.01
BH-07	1.5	SP-SM A-2-4(0)	2	6.85
BH-07	1.5	SP-SM A-2-4(0)	9	0.36
BH-07	1.5	SP-SM A-2-4(0)	6	0.099
BH-08	1.5	SM A-2-4(0)	2	7.4
BH-08	1.5	SM A-2-4(0)	6	0.01
BH-08	1.5	SM A-2-4(0)	9	0.45
BH-09	1.5	SM A-4(0)	2	7.25
BH-09	1.5	SM A-4(0)	9	0.4
BH-09	1.5	SM A-4(0)	6	0.01
BH-10	1.5	SM A-2-4(0)	2	7.4
BH-10	1.5	SM A-2-4(0)	9	0.45

Summary of Lab. Tests

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



Borehole	Sample Depth (m)	Soil Class	#	Value
BH-10	1.5	SM A-2-4(0)	6	0.011
BH-11	1.5	SP-SM A-2-4(0)	6	0.01
BH-11	1.5	SP-SM A-2-4(0)	9	0.36
BH-11	1.5	SP-SM A-2-4(0)	2	7.14
BH-12	1.5	SM A-2-4(0)	9	0.4
BH-12	1.5	SM A-2-4(0)	6	0.011
BH-12	1.5	SM A-2-4(0)	2	7.23
BH-13	1.5	SM A-2-4(0)	2	6.82
BH-13	1.5	SM A-2-4(0)	9	0.39
BH-13	1.5	SM A-2-4(0)	6	0.099
BH-14	1.5	SM A-2-4(0)	2	6.8
BH-14	1.5	SM A-2-4(0)	9	0.38
BH-14	1.5	SM A-2-4(0)	6	0.01
BH-15	1.5	SM A-4(0)	9	0.35
BH-15	1.5	SM A-4(0)	2	6.9
BH-15	1.5	SM A-4(0)	6	0.01
BH-16	1.5	SM A-2-4(0)	9	0.42
BH-16	1.5	SM A-2-4(0)	6	0.01
BH-16	1.5	SM A-2-4(0)	2	7.25
BH-17	1.5	SM A-2-4(0)	9	0.44
BH-17	1.5	SM A-2-4(0)	2	7.35
BH-17	1.5	SM A-2-4(0)	6	0.011
BH-18	1.5	SM A-4(0)	2	7.2
BH-18	1.5	SM A-4(0)	6	0.01
BH-18	1.5	SM A-4(0)	9	0.34
BH-19	1.5	CL-ML A-4(1)	2	7.13
BH-19	1.5	CL-ML A-4(1)	9	0.38

Summary of Lab. Tests

Project : Geotechnical Investigation Works

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Borehole	Sample Depth (m)	Soil Class	#	Value
BH-19	1.5	CL-ML A-4(1)	6	0.098
BH-20	1.5	CL-ML A-4(3)	2	7.4
BH-20	1.5	CL-ML A-4(3)	6	0.011
BH-20	1.5	CL-ML A-4(3)	9	0.44
BH-21	1.5	SM A-2-4(0)	2	6.88
BH-21	1.5	SM A-2-4(0)	6	0.098
BH-21	1.5	SM A-2-4(0)	9	0.33
BH-22	1.5	ML A-4(5)	2	7.28
BH-22	1.5	ML A-4(5)	6	0.01
BH-22	1.5	ML A-4(5)	9	0.4
BH-23	1.5	CL A-4(8)	9	0.4
BH-23	1.5	CL A-4(8)	6	0.01
BH-23	1.5	CL A-4(8)	2	7.2
BH-24	1.5	SM A-4(0)	2	6.85
BH-24	1.5	SM A-4(0)	6	0.098
BH-24	1.5	SM A-4(0)	9	0.33
BH-25	1.5	SM A-2-4(0)	6	0.01
BH-25	1.5	SM A-2-4(0)	9	0.37
BH-25	1.5	SM A-2-4(0)	2	7.25
BH-26	1.5	SM A-2-4(0)	9	0.43
BH-26	1.5	SM A-2-4(0)	6	0.011
BH-26	1.5	SM A-2-4(0)	2	7.32
BH-27	1.5	SM A-4(0)	9	0.41
BH-27	1.5	SM A-4(0)	2	7.3
BH-27	1.5	SM A-4(0)	6	0.01
BH-28	1.5	SP-SM A-2-4(0)	6	0.01
BH-28	1.5	SP-SM A-2-4(0)	2	7.2

Summary of Lab. Tests

Project : Geotechnical Investigation Works

Client : Renewable Resources

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Location : Deh Mithaghar



Borehole	Sample Depth (m)	Soil Class	#	Value
BH-28	1.5	SP-SM A-2-4(0)	9	0.39
BH-29	1.5	SM A-4(0)	2	7.3
BH-29	1.5	SM A-4(0)	6	0.01
BH-29	1.5	SM A-4(0)	9	0.42
BH-30	1.5	SM A-2-4(0)	2	6.8
BH-30	1.5	SM A-2-4(0)	6	0.098
BH-30	1.5	SM A-2-4(0)	9	0.35
BH-31	1.5	SP-SM A-2-4(0)	9	0.45
BH-31	1.5	SP-SM A-2-4(0)	6	0.01
BH-31	1.5	SP-SM A-2-4(0)	2	7.28

Sieve Analysis Test

Project : Geotechnical Investigation Works

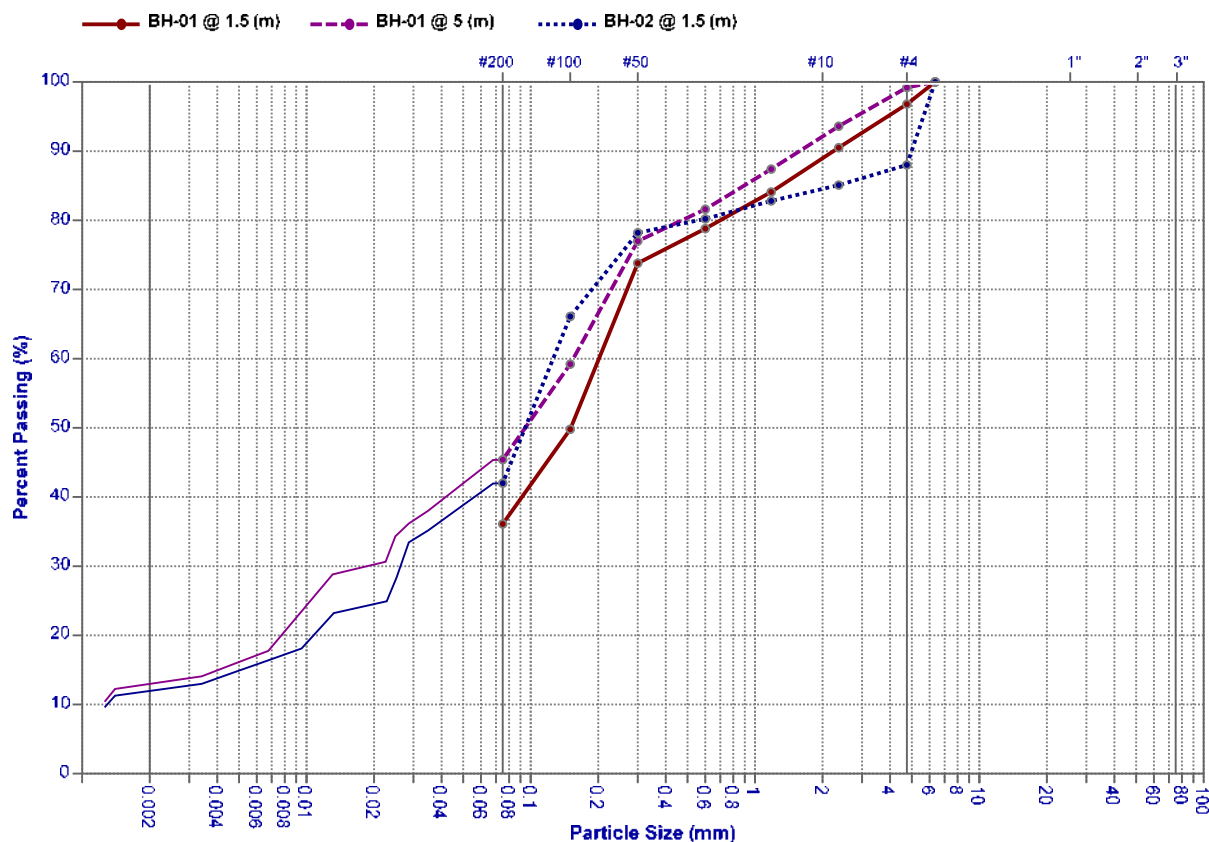
Client : Renewable Resources

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ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	36.1	60.7	3.2	-
13	32.4	53.8	0.8	-
12	30	46	12	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-01	1.5	-	-	0.151	0.201	-	-	-	-	N/A	SM	A-4(0)
BH-01	5	0.001	0.019	0.094	0.155	2.329	155	-	-	N/A	SM	A-4(0)
BH-02	1.5	0.001	0.026	0.094	0.126	5.365	126	-	-	N/A	SM	A-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

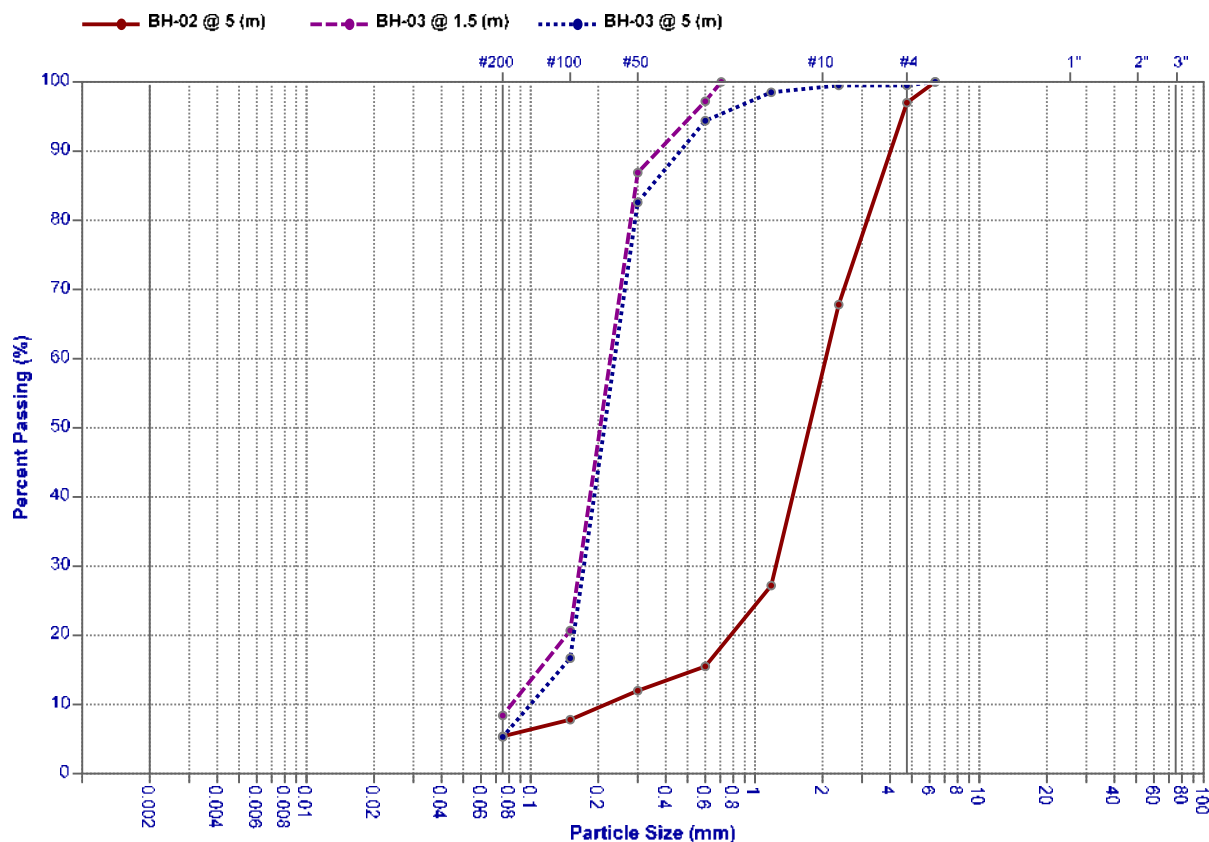
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	5.4	91.6	3	-
-	8.4	91.6	-	-
-	5.3	94.2	0.5	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-02	5	0.216	1.238	1.742	2.066	3.434	9.565	-	-	N/A	SP-SM	A-2-4(0)
BH-03	1.5	0.082	0.165	0.204	0.226	1.469	2.756	-	-	N/A	SP-SM	A-1-b(0)
BH-03	5	0.1	0.173	0.213	0.237	1.263	2.37	-	-	N/A	SP-SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

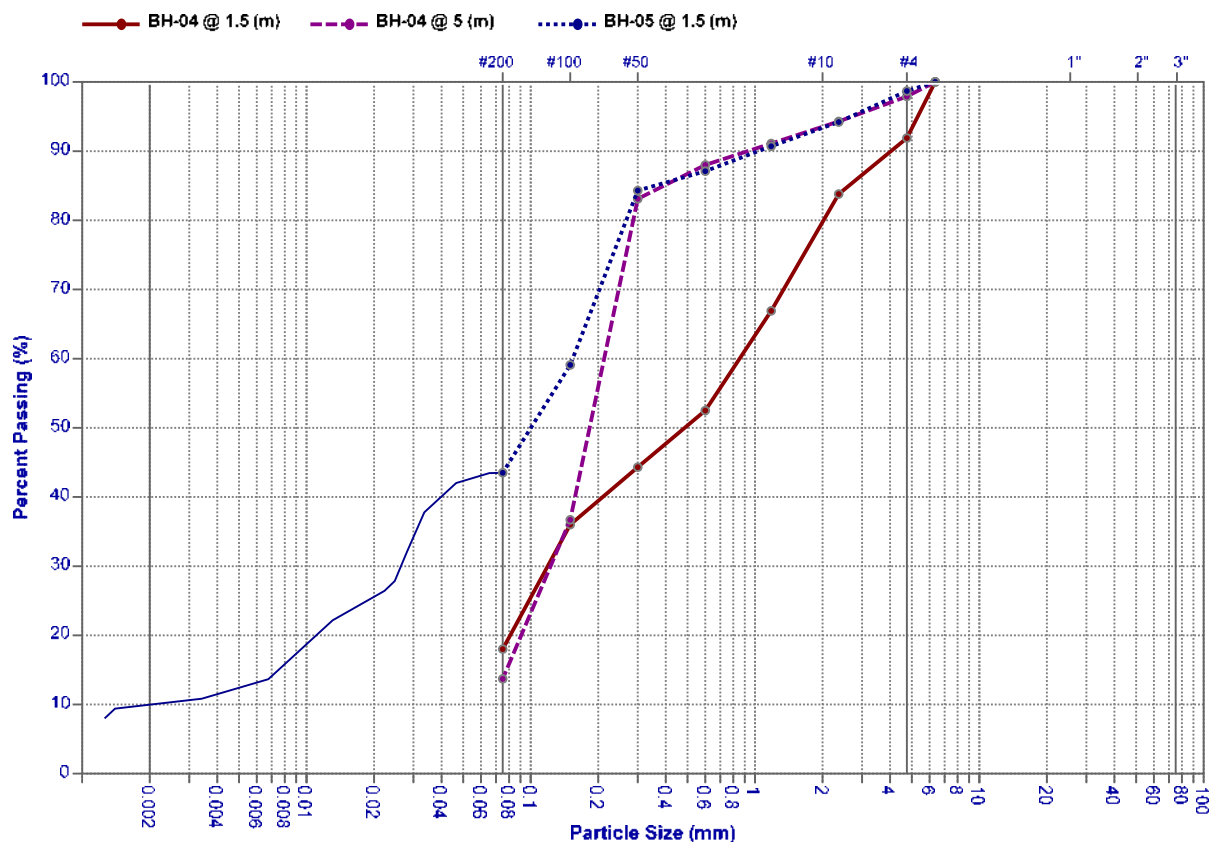
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

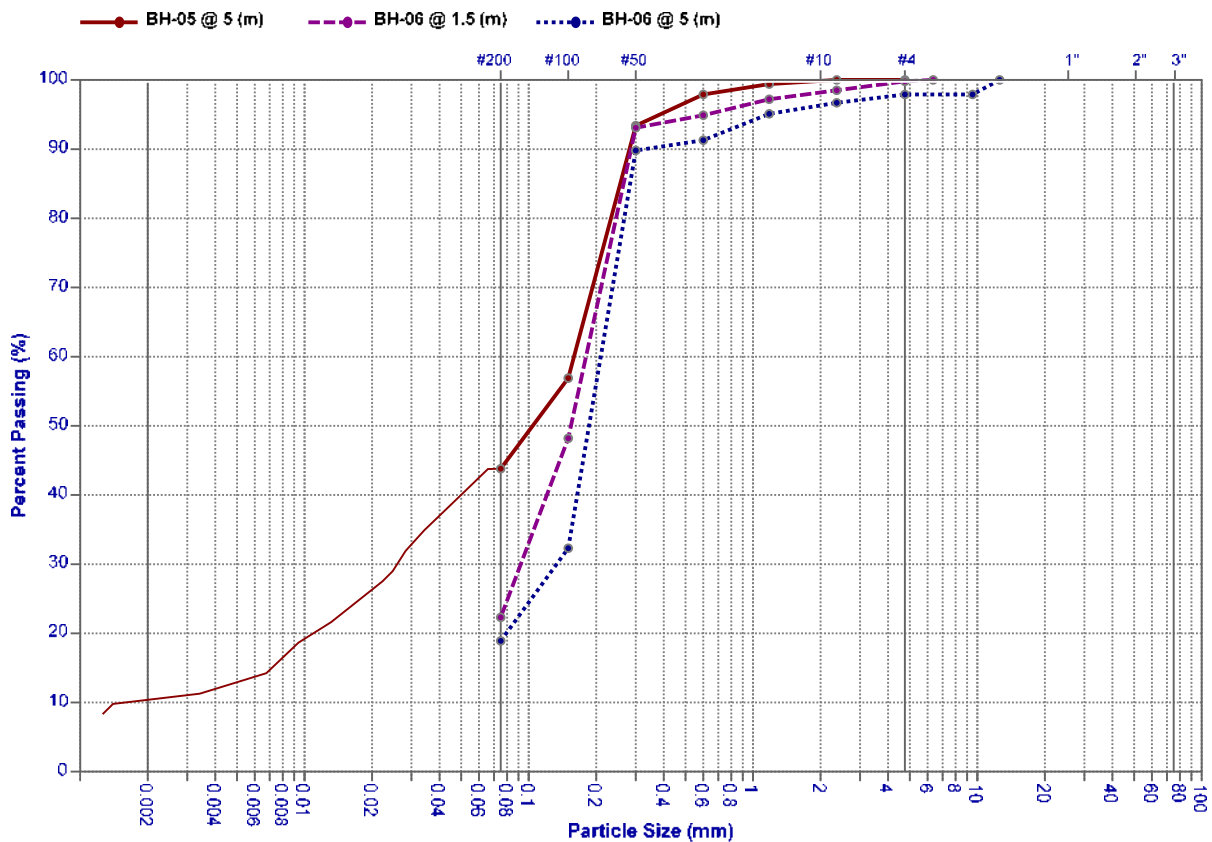
Clay	Silt	Sand	Gravel	Cobble
-	18	73.9	8.1	-
-	13.7	84.2	2.1	-
10	33.5	55.2	1.3	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-04	1.5	-	0.119	0.486	0.853	0.221	-	-	-	N/A	SM	A-2-4(0)
BH-04	5	-	0.123	0.183	0.212	0.939	-	-	-	N/A	SM	A-2-4(0)
BH-05	1.5	0.002	0.026	0.1	0.154	2.195	77	-	-	N/A	SM	A-4(0)

Location : Deh Mithaghar

ASTM C136



Particle Distribution (%)

Particle Distribution (%)				
Clay	Silt	Sand	Gravel	Cobbles
10.4	33.4	56.2	-	0.0
-	22.3	77.5	0.2	0.0
-	18.9	79	2.1	0.0

Classification

Borehole	Sample Depth (m)	Classification						LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
		D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu					
BH-05	5	0.002	0.026	0.104	0.159	2.126	79.5	-	-	N/A	SM	A-4(0)
BH-06	1.5	-	0.092	0.154	0.18	0.627	-	-	-	N/A	SM	A-2-4(0)
BH-06	5	-	0.133	0.186	0.209	1.128	-	-	-	N/A	SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

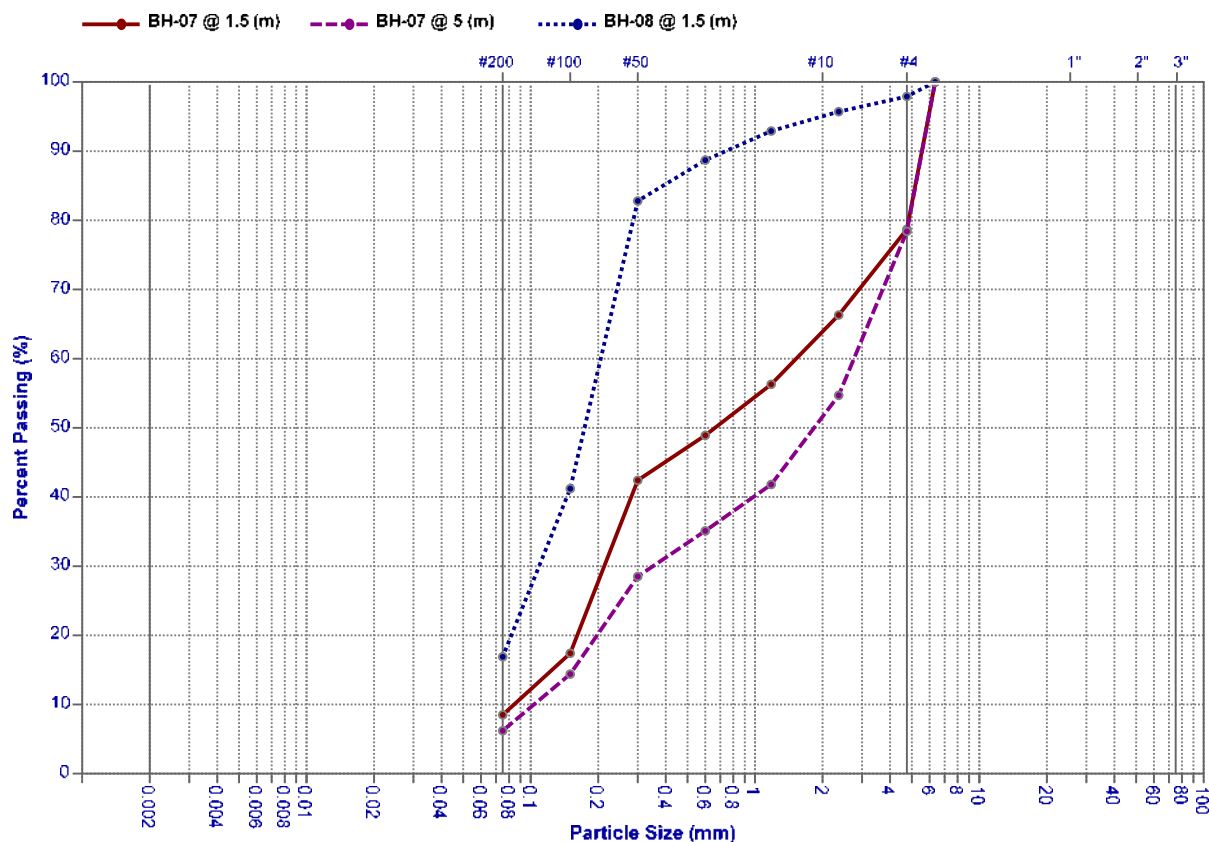
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	8.5	70.2	21.3	-
-	6.2	72.2	21.6	-
-	16.9	81	2.1	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-07	1.5	0.084	0.213	0.663	1.525	0.354	18.155	-	-	N/A	SP-SM	A-2-4(0)
BH-07	5	0.103	0.351	1.833	2.76	0.433	26.796	-	-	N/A	SP-SM	A-2-4(0)
BH-08	1.5	-	0.109	0.174	0.205	0.773	-	-	-	N/A	SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

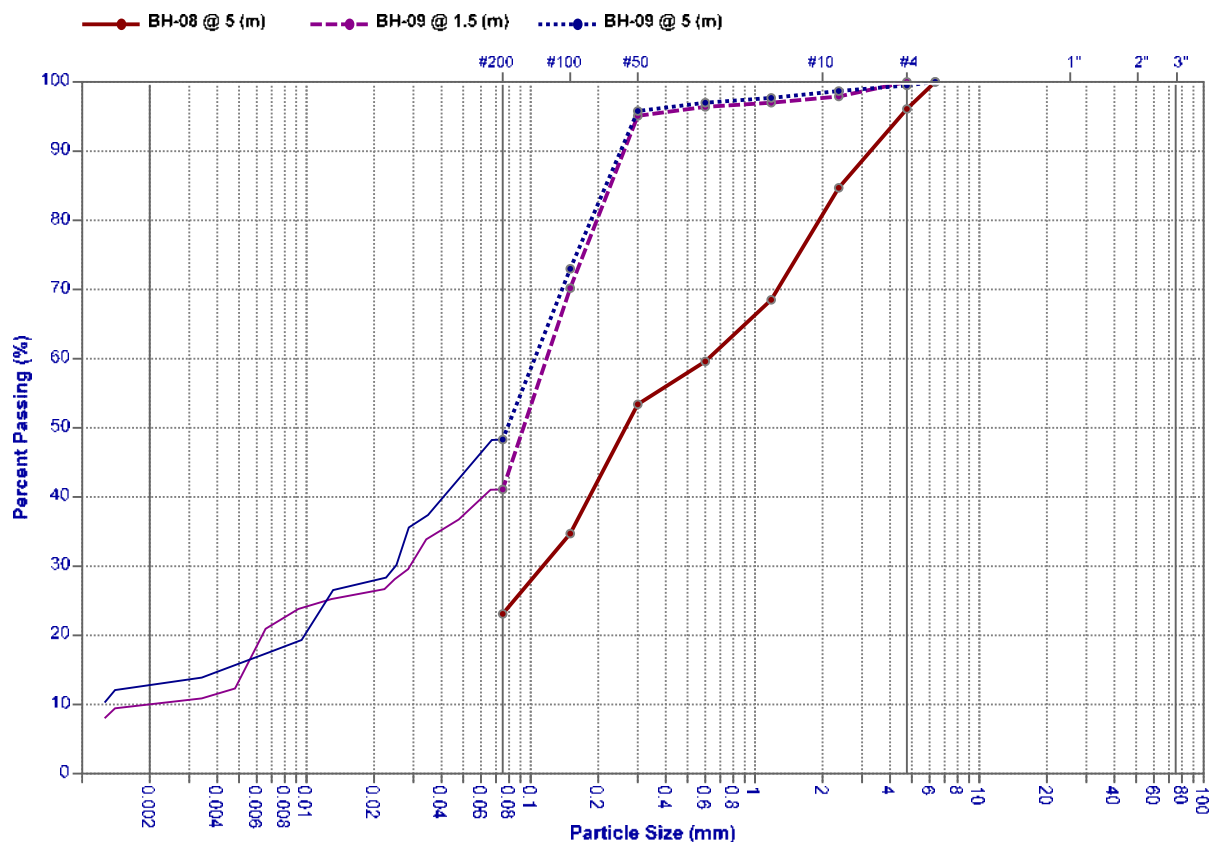
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	23.1	73	3.9	-
10	31.1	58.9	-	-
12.8	35.5	51.2	0.5	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-08	5	-	0.113	0.264	0.619	0.275	-	-	-	N/A	SM	A-2-4(0)
BH-09	1.5	0.002	0.029	0.093	0.118	3.564	59	-	-	N/A	SM	A-4(0)
BH-09	5	0.001	0.025	0.079	0.104	6.01	104	-	-	N/A	SM	A-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

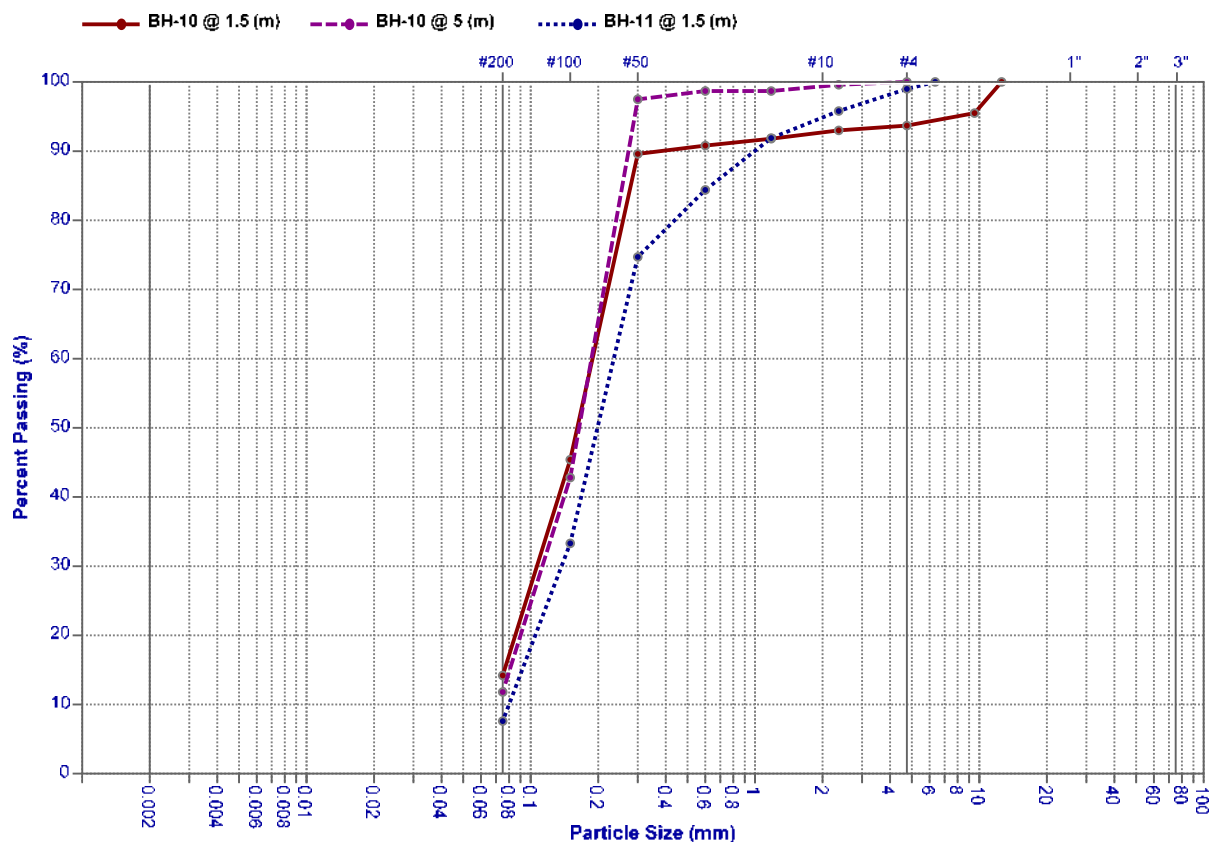
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	14.2	79.5	6.3	-
-	11.8	88.2	-	-
-	7.6	91.4	1	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-10	1.5	-	0.107	0.161	0.189	0.797	-	-	-	N/A	SM	A-2-4(0)
BH-10	5	-	0.113	0.164	0.187	0.898	-	-	-	N/A	SP-SM	A-1-b(0)
BH-11	1.5	0.08	0.137	0.198	0.235	0.998	2.938	-	-	N/A	SP-SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

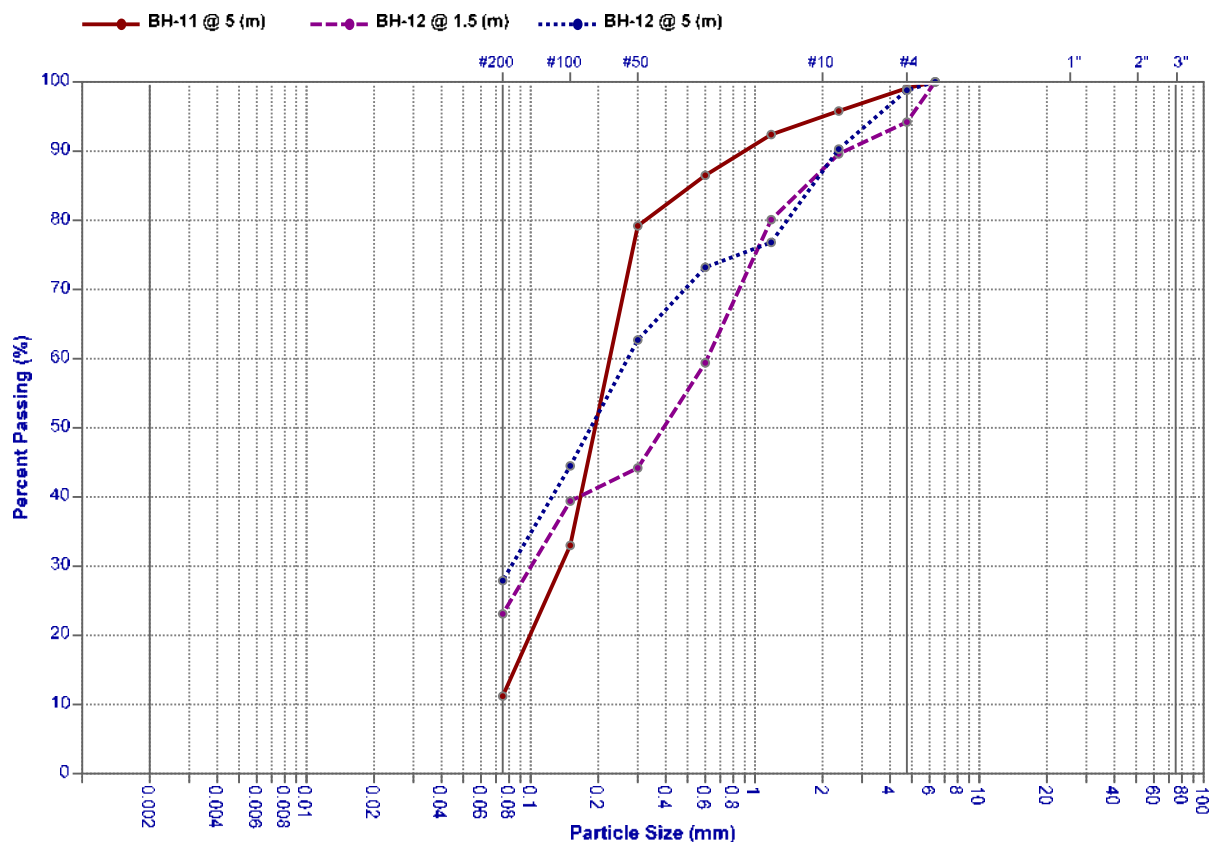
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	11.2	87.9	0.9	-
-	23.1	71.1	5.8	-
-	27.9	70.9	1.2	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-11	5	-	0.136	0.194	0.225	1.082	-	-	-	N/A	SP-SM	A-2-4(0)
BH-12	1.5	-	0.101	0.391	0.612	0.222	-	-	-	N/A	SM	A-2-4(0)
BH-12	5	-	0.082	0.185	0.271	0.331	-	-	-	N/A	SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

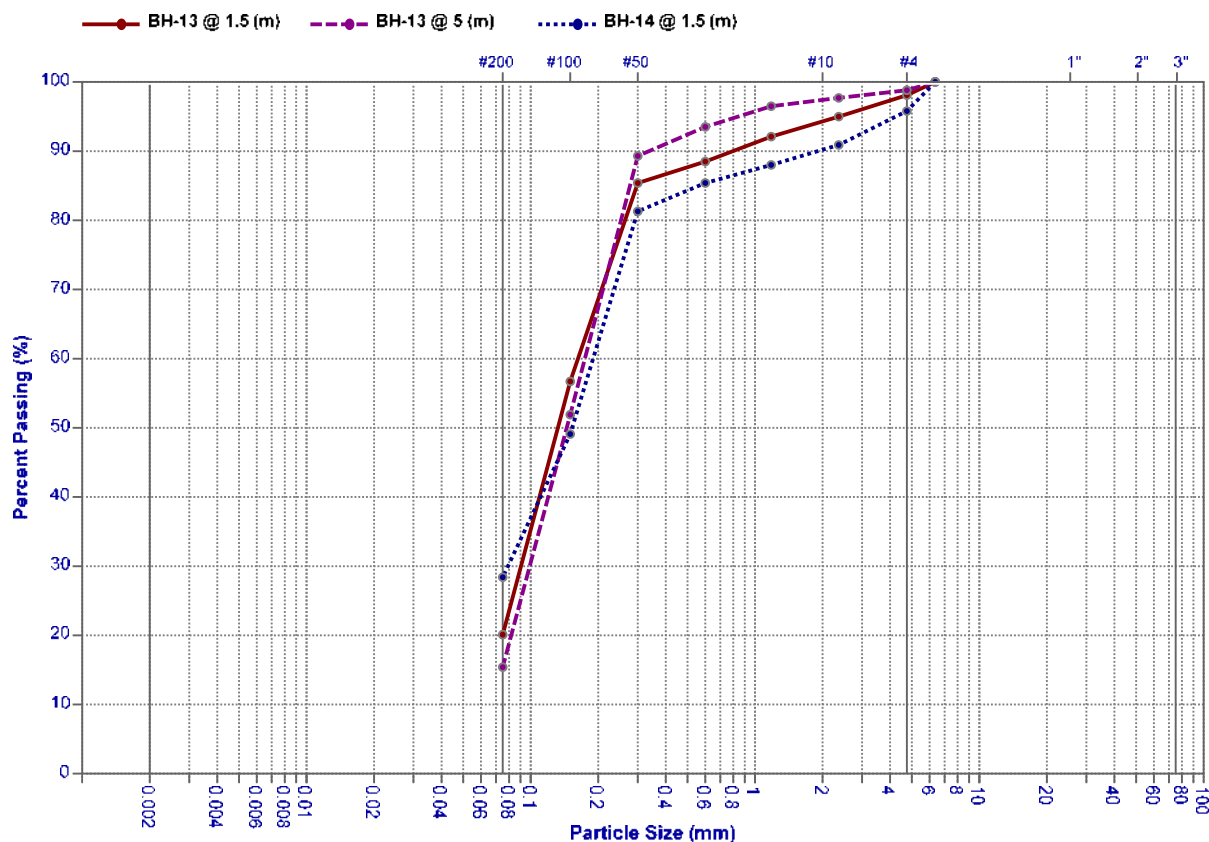
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	20.1	78	1.9	-
-	15.4	83.4	1.2	-
-	28.4	67.4	4.2	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-13	1.5	-	0.09	0.132	0.162	0.667	-	-	-	N/A	SM	A-2-4(0)
BH-13	5	-	0.099	0.145	0.174	0.741	-	-	-	N/A	SM	A-2-4(0)
BH-14	1.5	-	0.079	0.153	0.19	0.438	-	-	-	N/A	SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

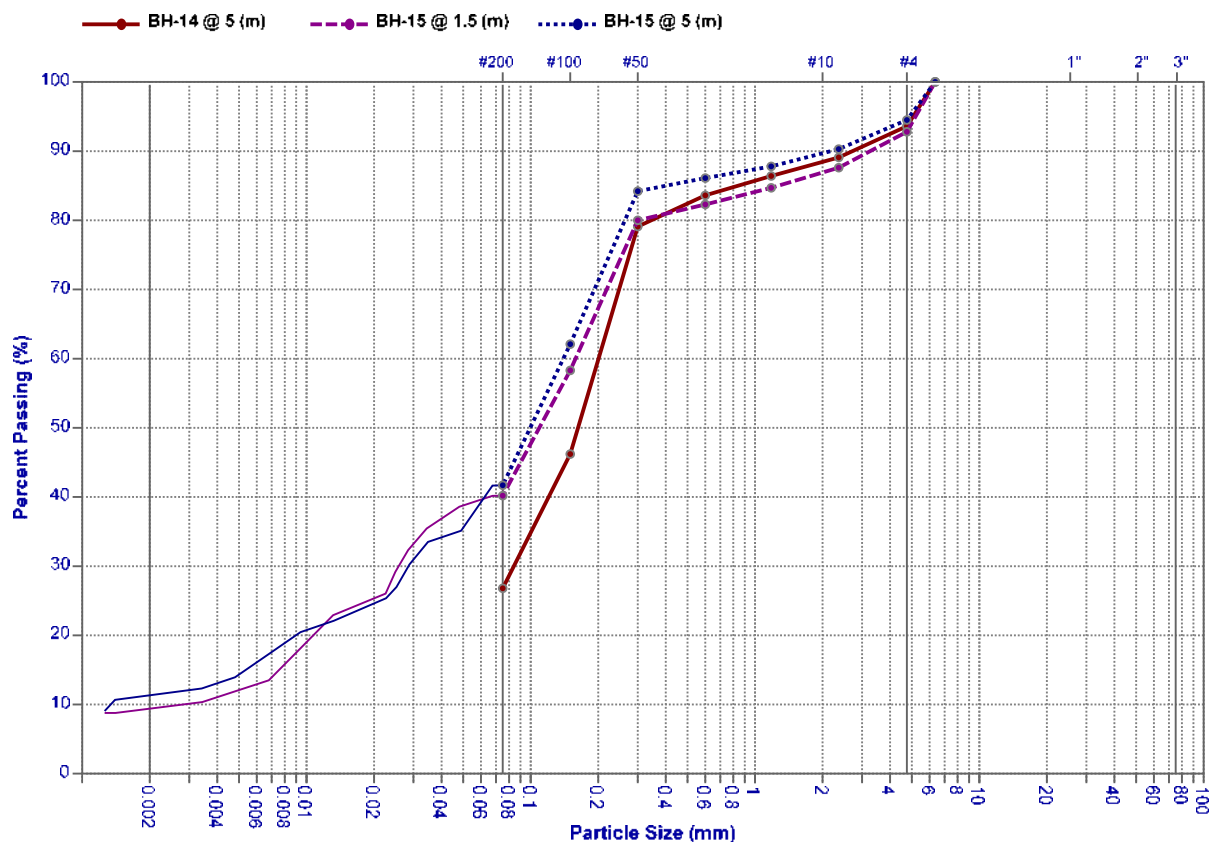
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	26.8	66.8	6.4	-
9.4	30.8	52.6	7.2	-
11.3	30.4	52.8	5.5	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-14	5	-	0.084	0.163	0.201	0.468	-	-	-	N/A	SM	A-2-4(0)
BH-15	1.5	0.003	0.026	0.109	0.158	1.426	52.667	-	-	N/A	SM	A-4(0)
BH-15	5	0.001	0.028	0.099	0.14	5.6	140	-	-	N/A	SM	A-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

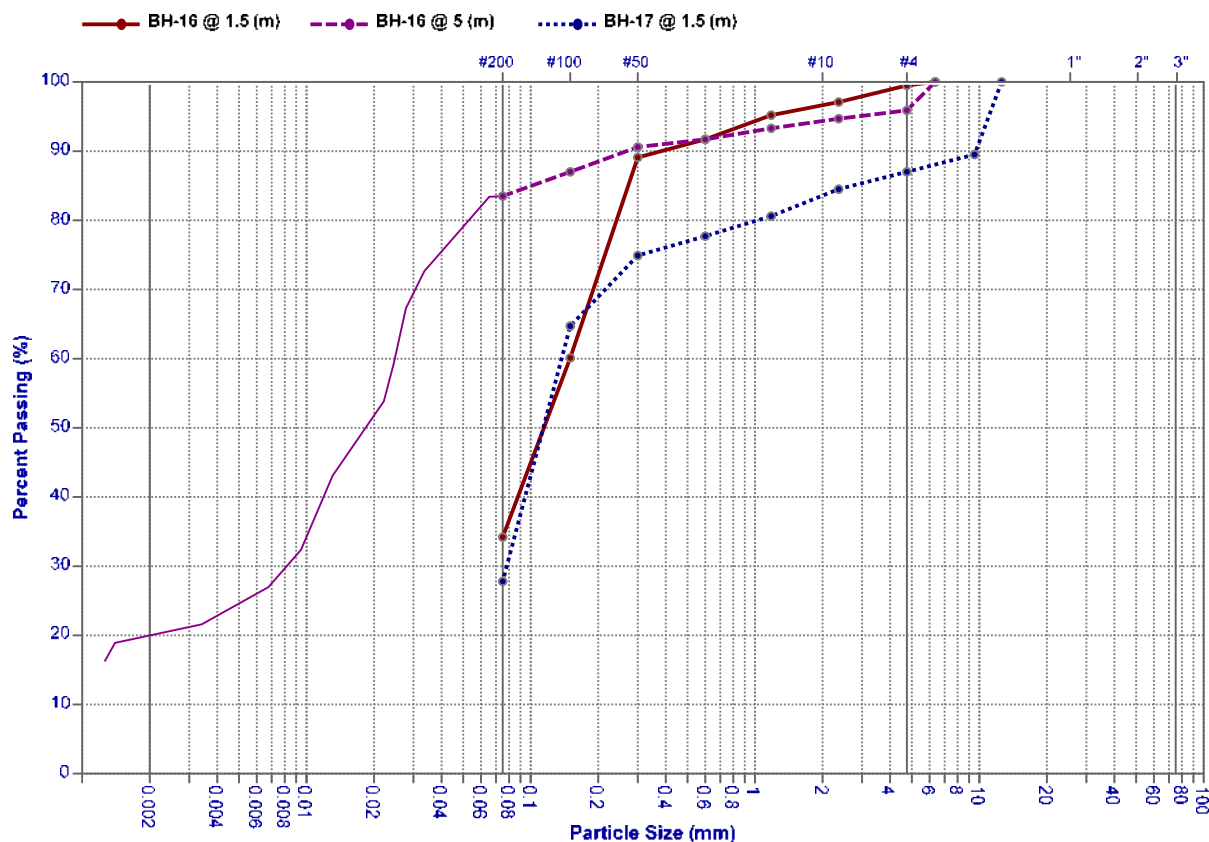
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	34.2	65.3	0.5	-
20	63.5	12.4	4.1	-
-	27.8	59.2	13	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-16	1.5	-	-	0.114	0.15	-	-	-	-	N/A	SM	A-2-4(0)
BH-16	5	0.001	0.008	0.018	0.025	2.56	25	-	-	N/A	ML	A-4(0)
BH-17	1.5	-	0.078	0.114	0.137	0.592	-	-	-	N/A	SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

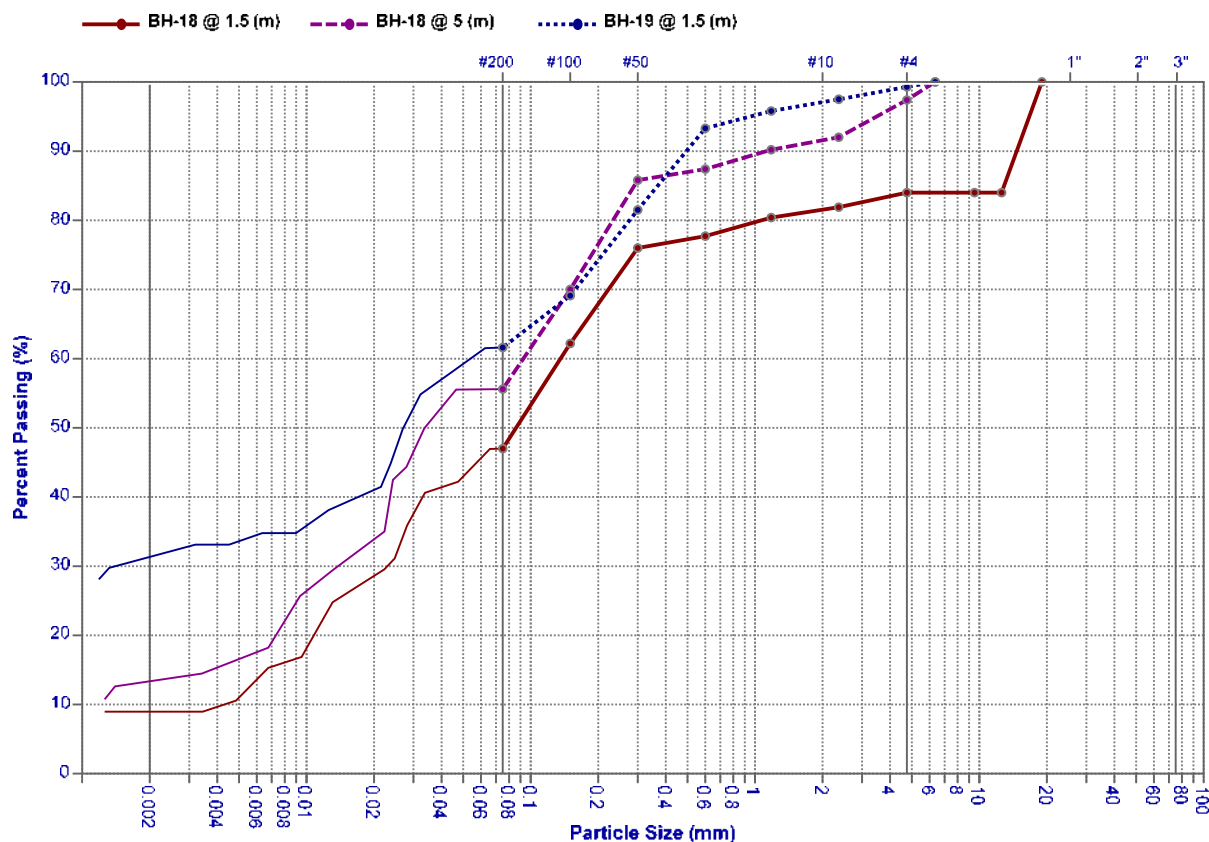
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

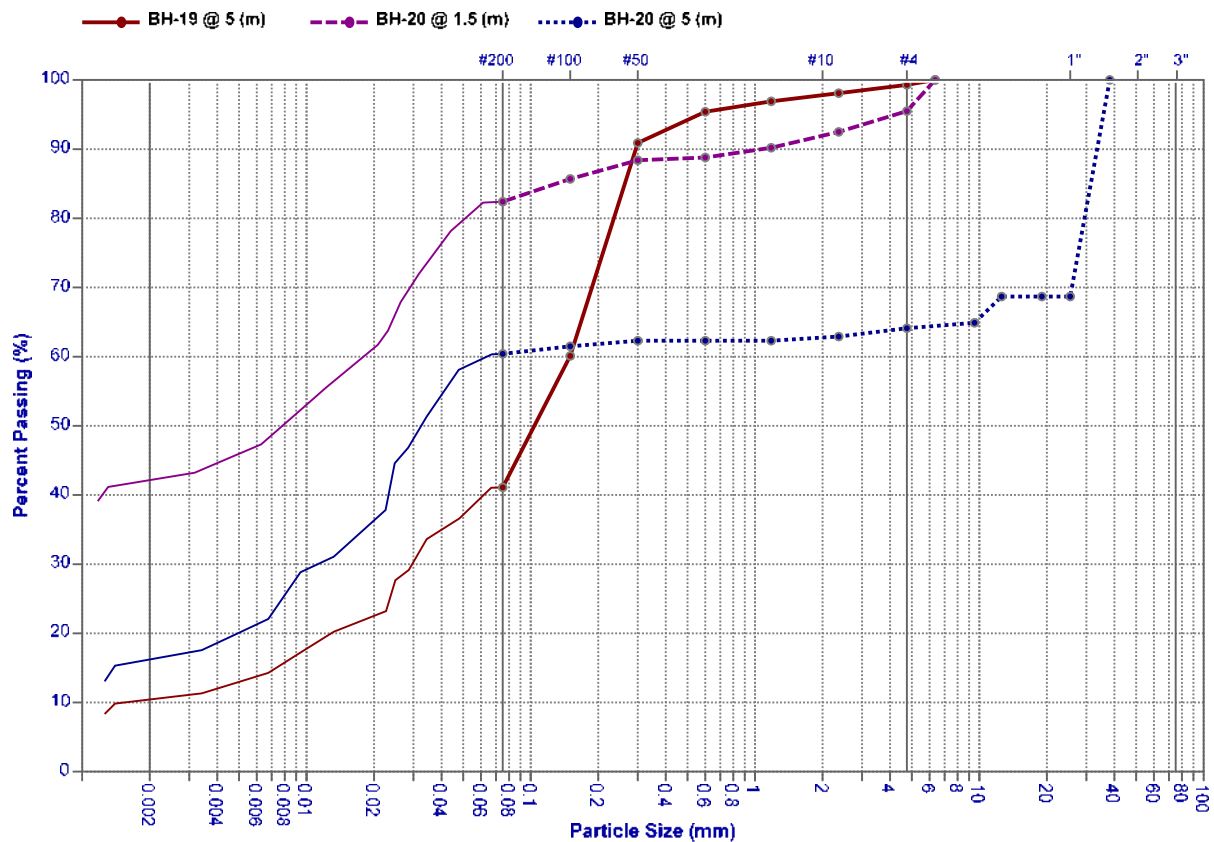
Clay	Silt	Sand	Gravel	Cobble
9	38	37	16	-
13.4	42.2	41.8	2.6	-
31.3	30.3	37.7	0.7	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-18	1.5	0.004	0.023	0.086	0.136	0.972	34	-	-	N/A	SM	A-4(0)
BH-18	5	0.001	0.014	0.034	0.093	2.108	93	-	-	N/A	ML	A-4(0)
BH-19	1.5	0.001	0.001	0.027	0.054	0.019	54	24.8	5.3	N/A	CL-ML	A-4(1)

Location : Deh Mithaghar

ASTM C136



Particle Distribution (%)

Particle Distribution (%)			
Clay	Silt	Sand	Gravel
10.4	30.7	58.2	0.7
42.1	40.3	13.1	4.5
16.2	44.2	3.7	35.9

Classification

Borehole	Sample Depth (m)	Classification						LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
		D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu					
BH-19	5	0.002	0.03	0.104	0.149	3.02	74.5	-	-	N/A	SM	A-4(0)
BH-20	1.5	0.001	0.001	0.008	0.018	0.056	18	27.1	5.5	N/A	CL-ML	A-4(3)
BH-20	5	0.001	0.011	0.032	0.064	1.891	64	-	-	N/A	ML	A-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

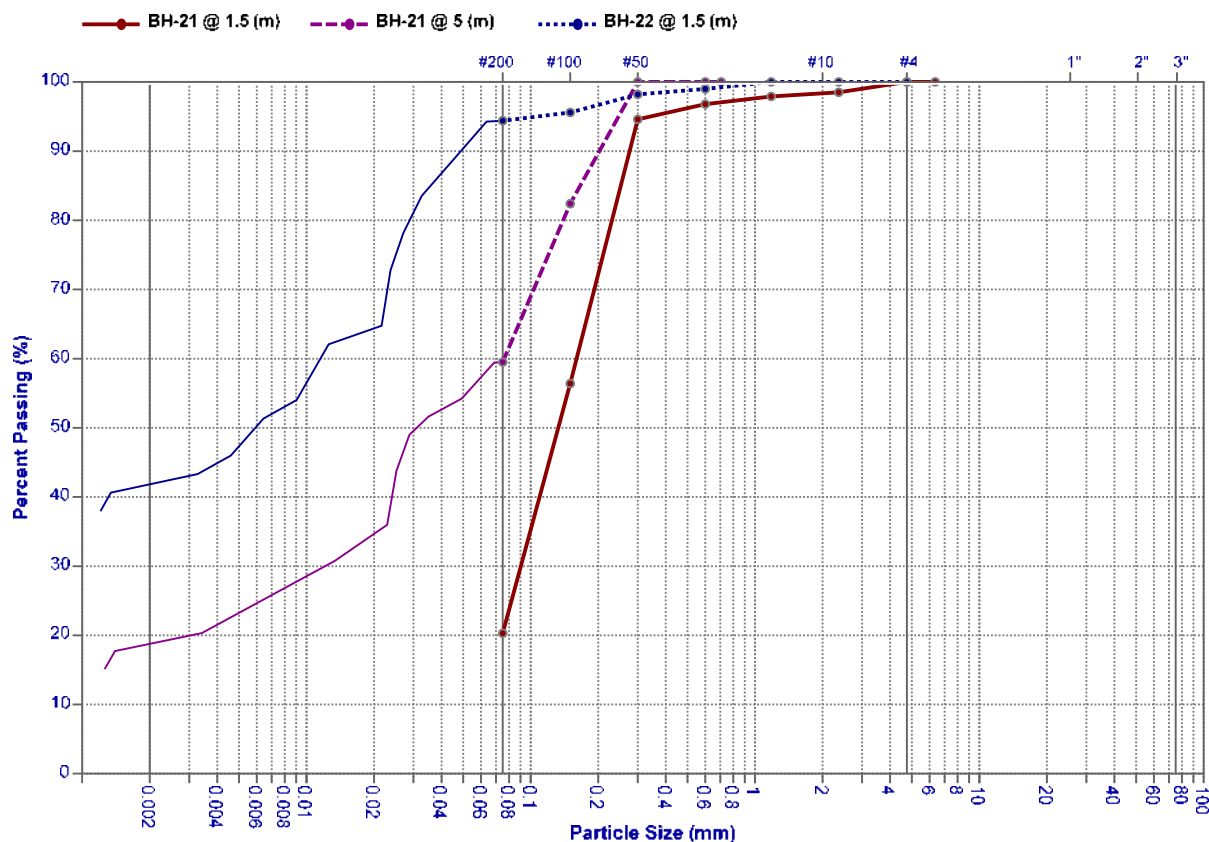
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	20.3	79.7	-	-
18.8	40.7	40.5	-	-
41.8	52.6	5.6	-	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-21	1.5	-	0.09	0.133	0.16	0.675	-	-	-	N/A	SM	A-2-4(0)
BH-21	5	0.001	0.012	0.031	0.076	1.895	76	-	-	N/A	ML	A-4(0)
BH-22	1.5	0.001	0.001	0.006	0.012	0.083	12	28.6	6.2	N/A	ML	A-4(5)

Sieve Analysis Test

Project : Geotechnical Investigation Works

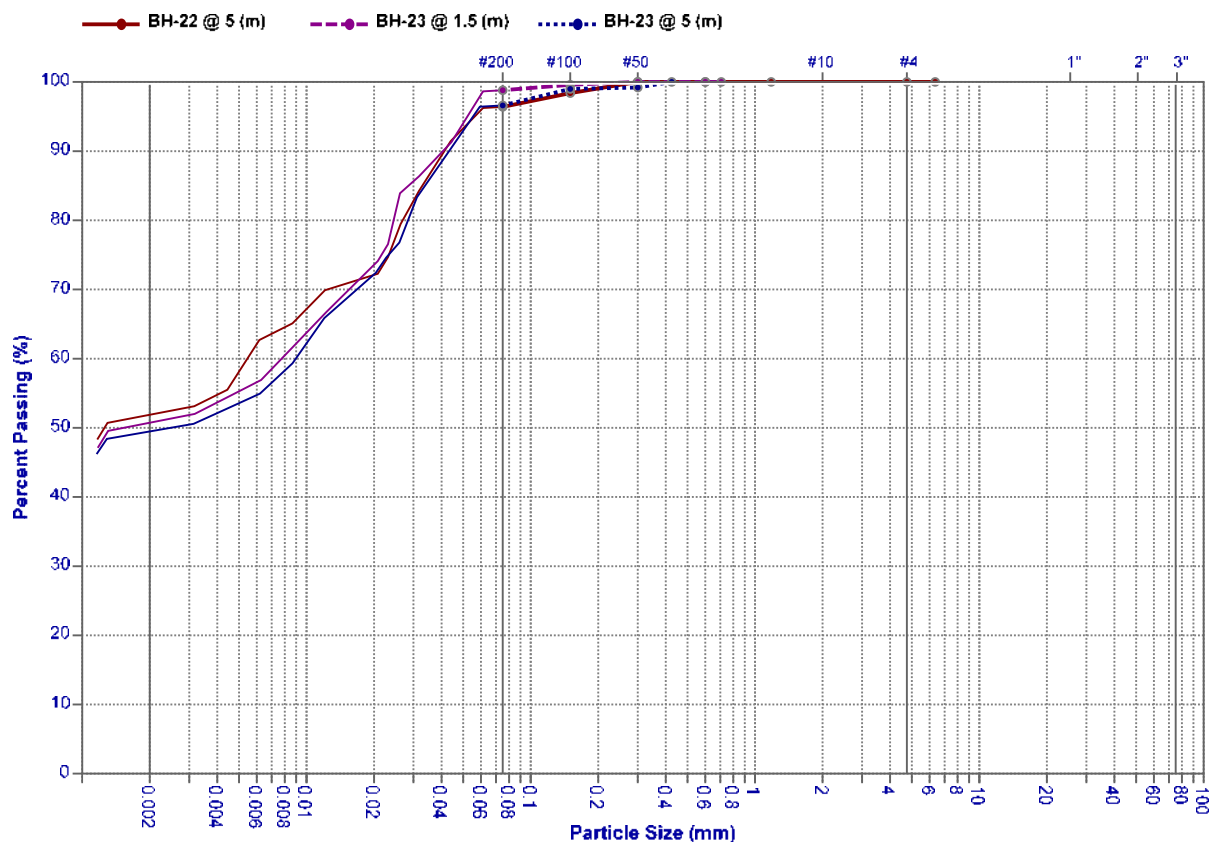
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
51.9	44.5	3.6	-	-
50.7	48.1	1.2	-	-
49.5	47.1	3.4	-	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-22	5	0.001	0.001	0.001	0.005	0.2	5	26.5	8.3	N/A	CL	A-4(7)
BH-23	1.5	0.001	0.001	0.002	0.008	0.125	8	31.1	8.2	N/A	CL	A-4(8)
BH-23	5	0.001	0.001	0.002	0.009	0.111	9	23.2	8.5	N/A	CL	A-4(6)

Sieve Analysis Test

Project : Geotechnical Investigation Works

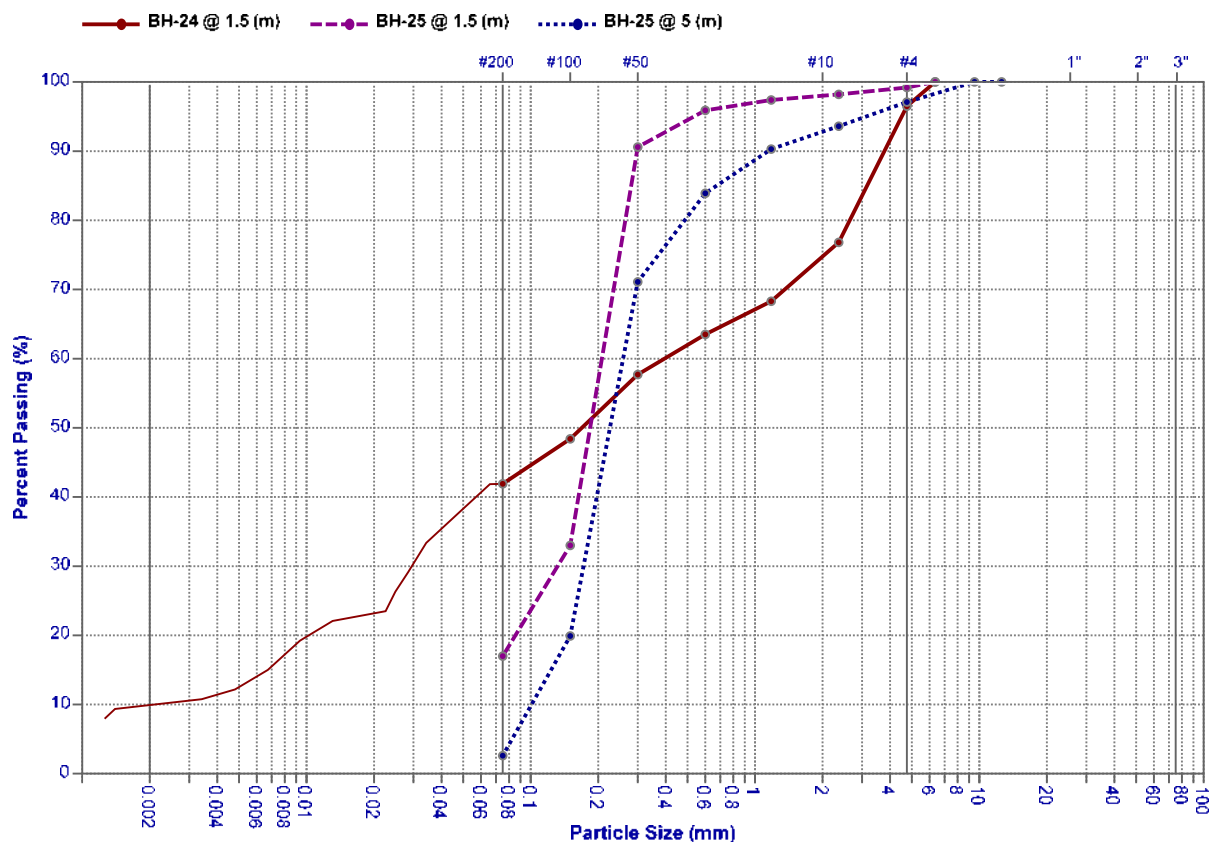
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
9.9	32	54.6	3.5	-
-	17	82.2	0.8	-
-	2.6	94.5	2.9	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-24	1.5	0.002	0.03	0.169	0.395	1.139	197.5	-	-	N/A	SM	A-4(0)
BH-25	1.5	-	0.132	0.184	0.208	1.117	-	-	-	N/A	SM	A-2-4(0)
BH-25	5	0.101	0.172	0.225	0.258	1.135	2.554	-	-	N/A	SP	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

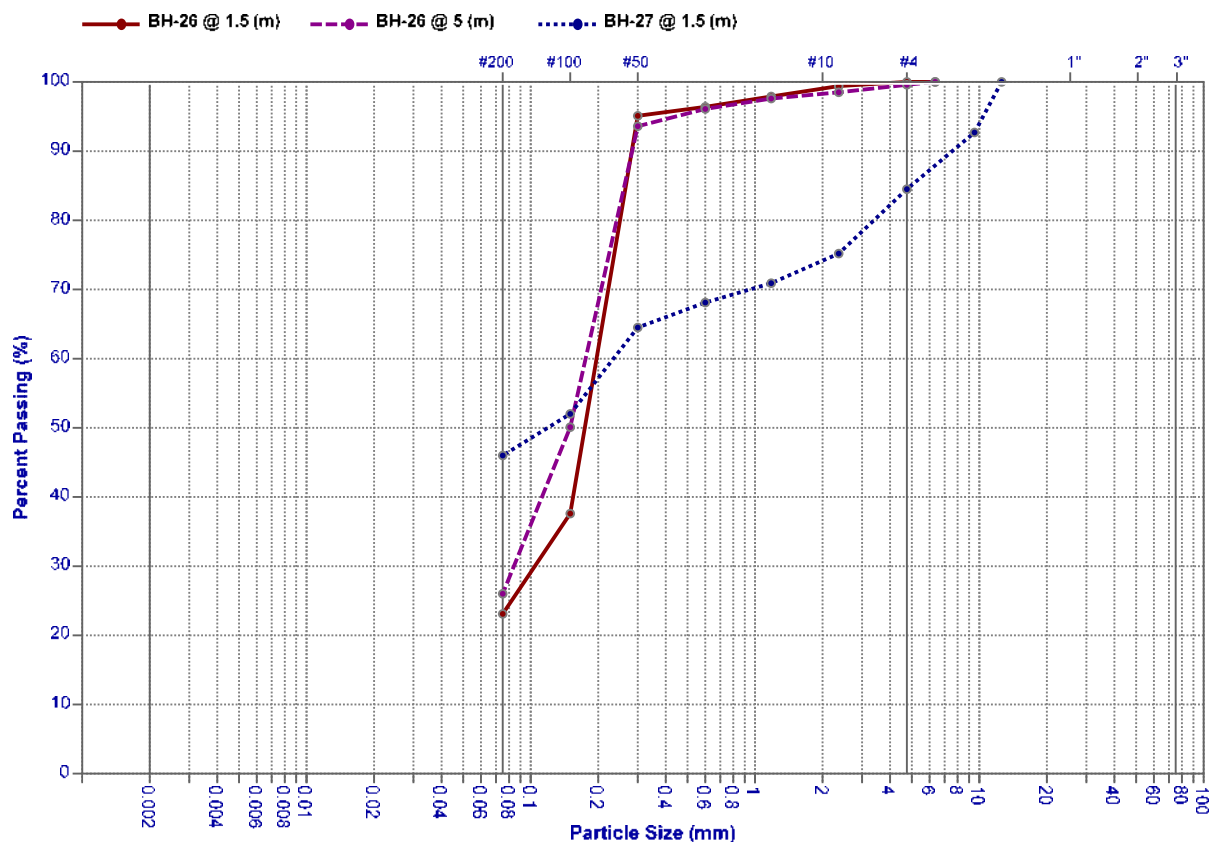
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	23.1	76.9	-	-
-	26	73.6	0.4	-
-	46	38.5	15.5	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-26	1.5	-	0.104	0.174	0.196	0.736	-	-	-	N/A	SM	A-2-4(0)
BH-26	5	-	0.084	0.15	0.176	0.535	-	-	-	N/A	SM	A-2-4(0)
BH-27	1.5	-	-	0.119	0.234	-	-	-	-	N/A	SM	A-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

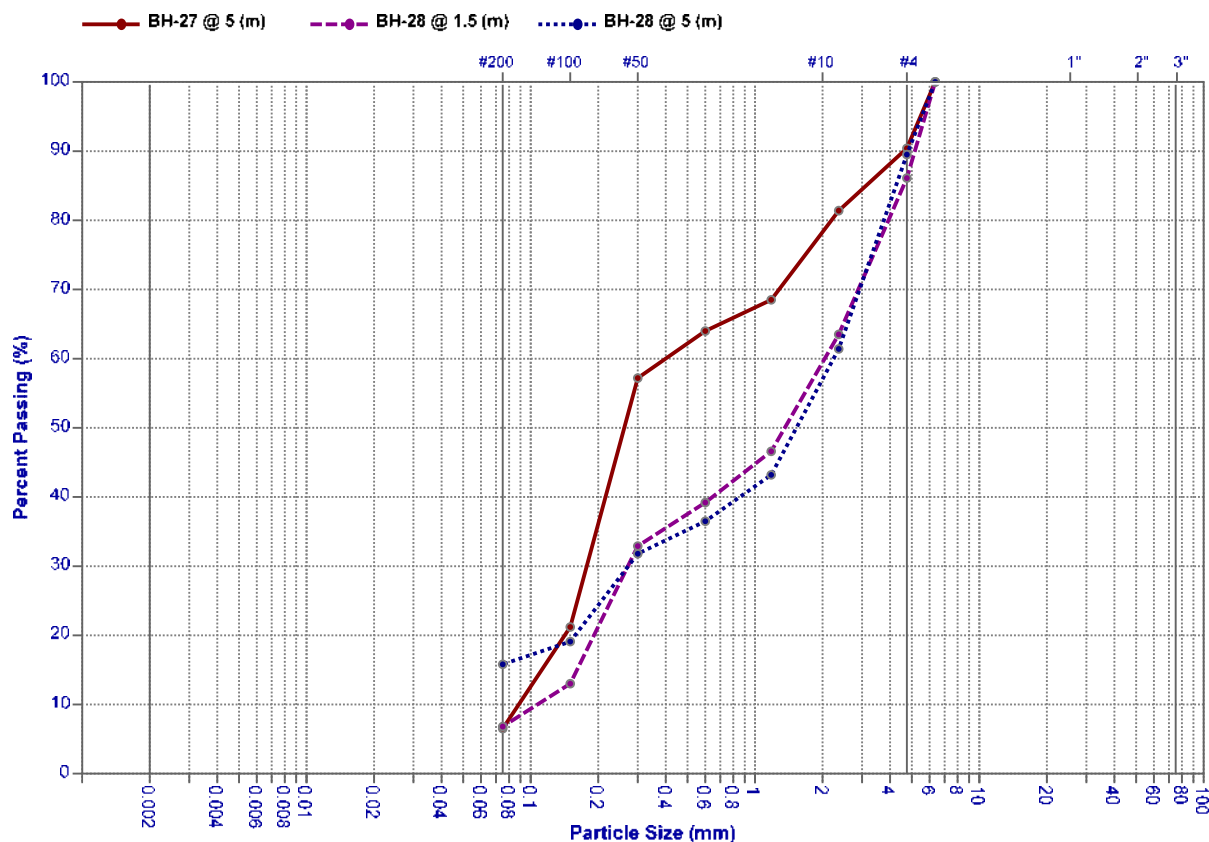
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	6.5	83.9	9.6	-
-	6.8	79.3	13.9	-
-	15.8	73.7	10.5	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-27	5	0.088	0.178	0.261	0.399	0.902	4.534	-	-	N/A	SP-SM	A-2-4(0)
BH-28	1.5	0.107	0.271	1.357	2.044	0.336	19.103	-	-	N/A	SP-SM	A-2-4(0)
BH-28	5	-	0.272	1.529	2.237	0.435	-	-	-	N/A	SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

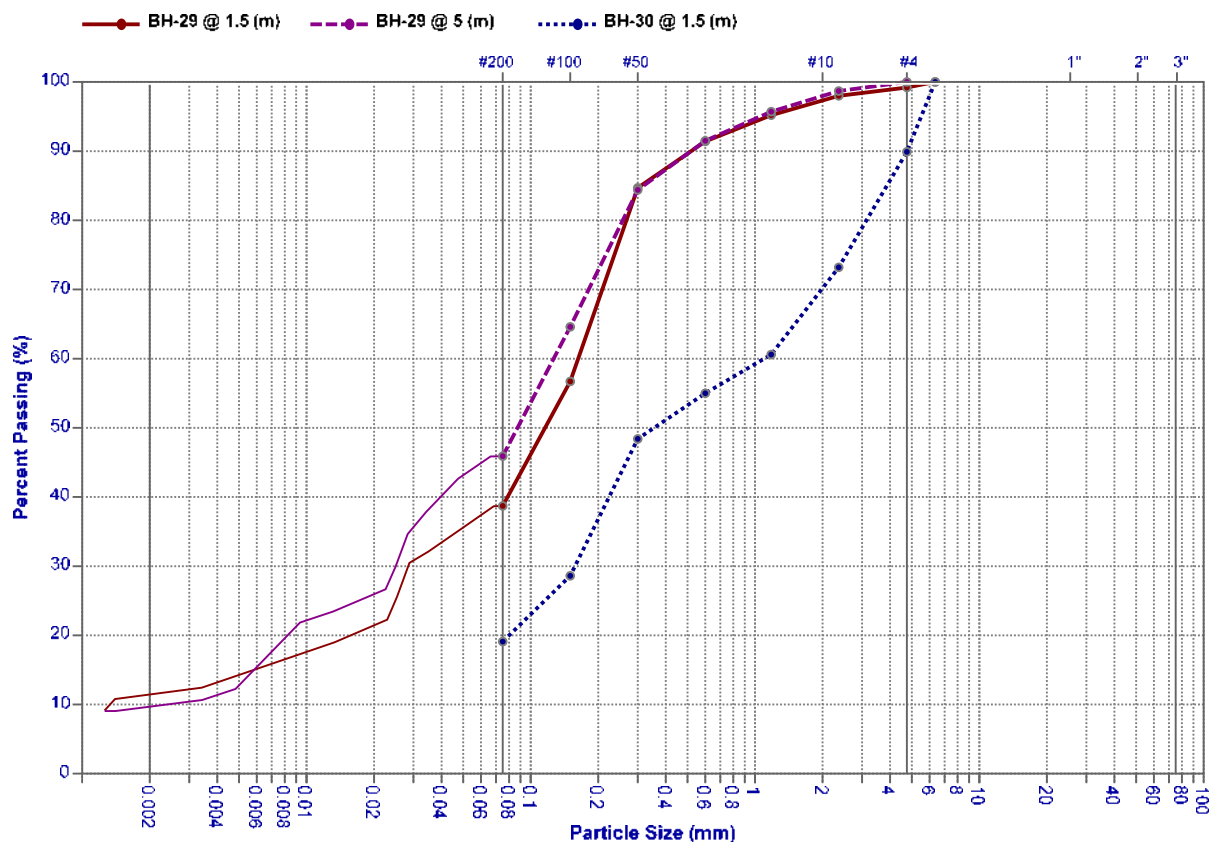
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
11.5	27.2	60.5	0.8	-
9.7	36.2	54.1	-	-
-	19.1	70.8	10.1	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-29	1.5	0.001	0.028	0.116	0.163	4.81	163	-	-	N/A	SM	A-4(0)
BH-29	5	0.002	0.025	0.087	0.126	2.48	63	-	-	N/A	SM	A-4(0)
BH-30	1.5	-	0.158	0.355	1.098	0.303	-	-	-	N/A	SM	A-2-4(0)

Sieve Analysis Test

Project : Geotechnical Investigation Works

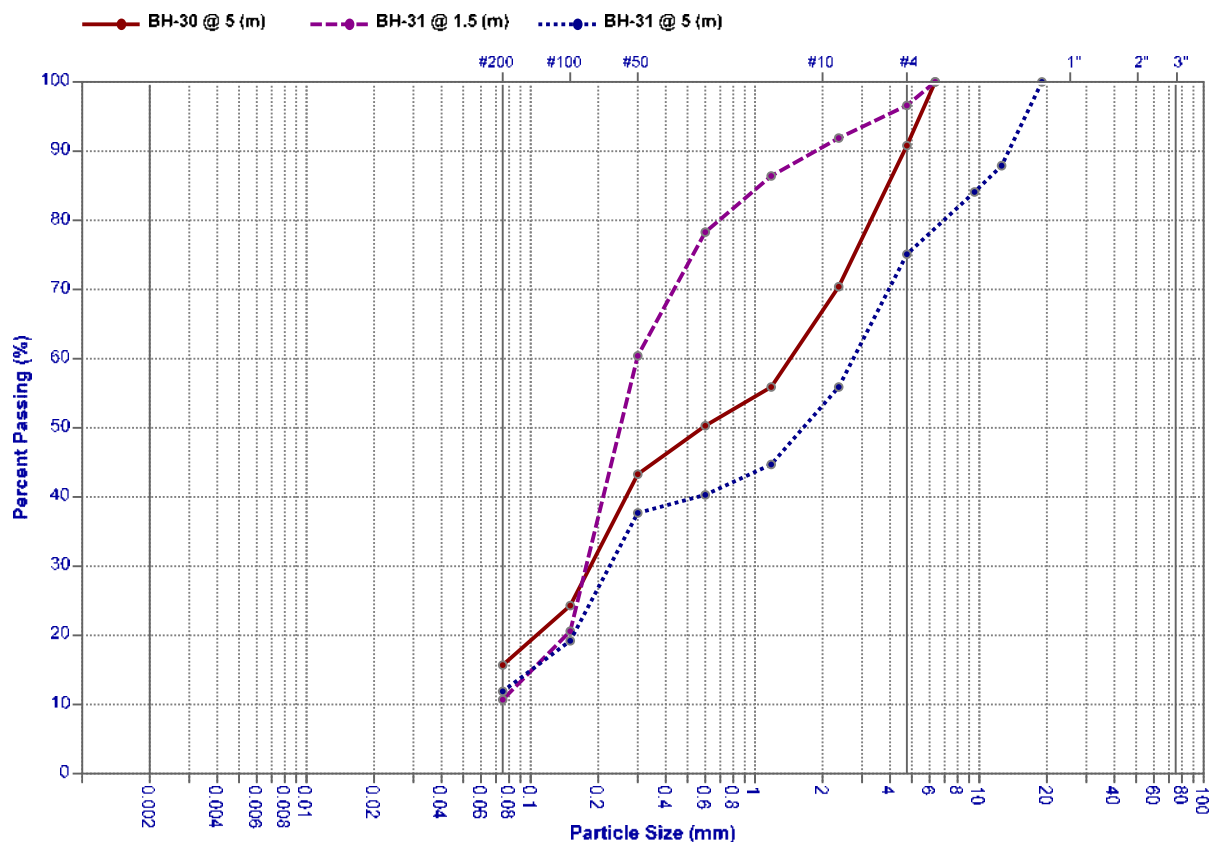
Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM C136



Particle Distribution (%)

Clay	Silt	Sand	Gravel	Cobble
-	15.7	75.1	9.2	-
-	10.7	85.9	3.4	-
-	11.9	63.2	24.9	-

Classification

Borehole	Sample Depth (m)	D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	Cc	Cu	LL (%)	PI (%)	Disp. (%)	USCS	AASHTO
BH-30	5	-	0.185	0.582	1.435	0.314	-	-	-	N/A	SM	A-2-4(0)
BH-31	1.5	-	0.177	0.25	0.298	1.383	-	-	-	N/A	SP-SM	A-2-4(0)
BH-31	5	-	0.225	1.638	2.74	0.243	-	-	-	N/A	SP-SM	A-2-4(0)

ATTERBERG LIMITS TEST

Project : Geotechnical Investigation Works

Borehole : BH-19

Client : Renewable Resources

Sample Depth : 1.5 (m)

Job No.: K22-1245-101

Classification : CL-ML | A-4(1)

Location : Deh Mithaghar

Sample Type : SPT Split Spoon



ASTM D2216-90, D854

Liquid Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	# of Blows	Moisture Content (%)
13.69	25.63	23.22	12	25.3
18.65	30.21	27.93	32	24.6
				-

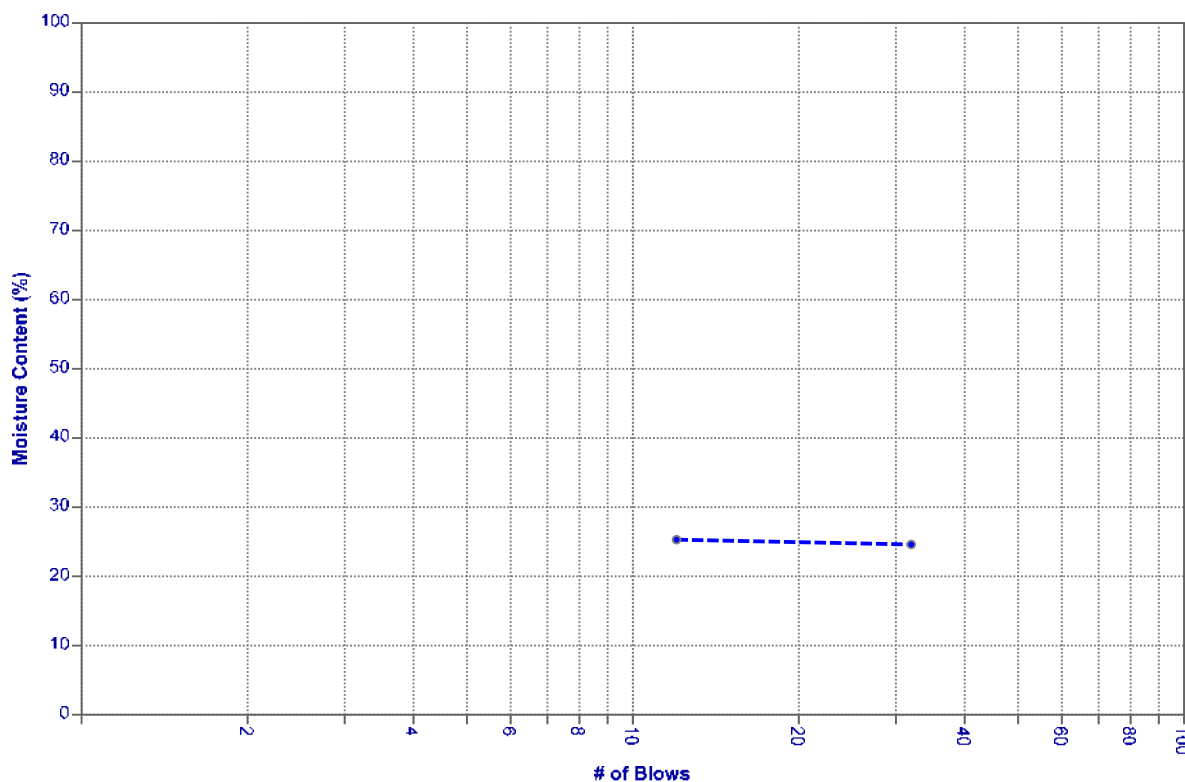
Plastic Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	Moisture Content (%)
15.32	25.43	23.78	19.5

LL = 24.8 %

PL = 19.5 %

PI=5.3



USCS Soil Description : Silty Clay With Sand
AASHTO Soil Description : A-4, Silty soils (1)

Tested By :

ATTERBERG LIMITS TEST

Project : Geotechnical Investigation Works

Borehole : BH-20

Client : Renewable Resources

Sample Depth : 1.5 (m)

Job No.: K22-1245-101

Classification : CL-ML | A-4(3)

Location : Deh Mithaghar

Sample Type : SPT Split Spoon



ASTM D2216-90, D854

Liquid Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	# of Blows	Moisture Content (%)
13.72	38.11	32.66	18	28.8
16.32	29.63	26.87	30	26.2
				-

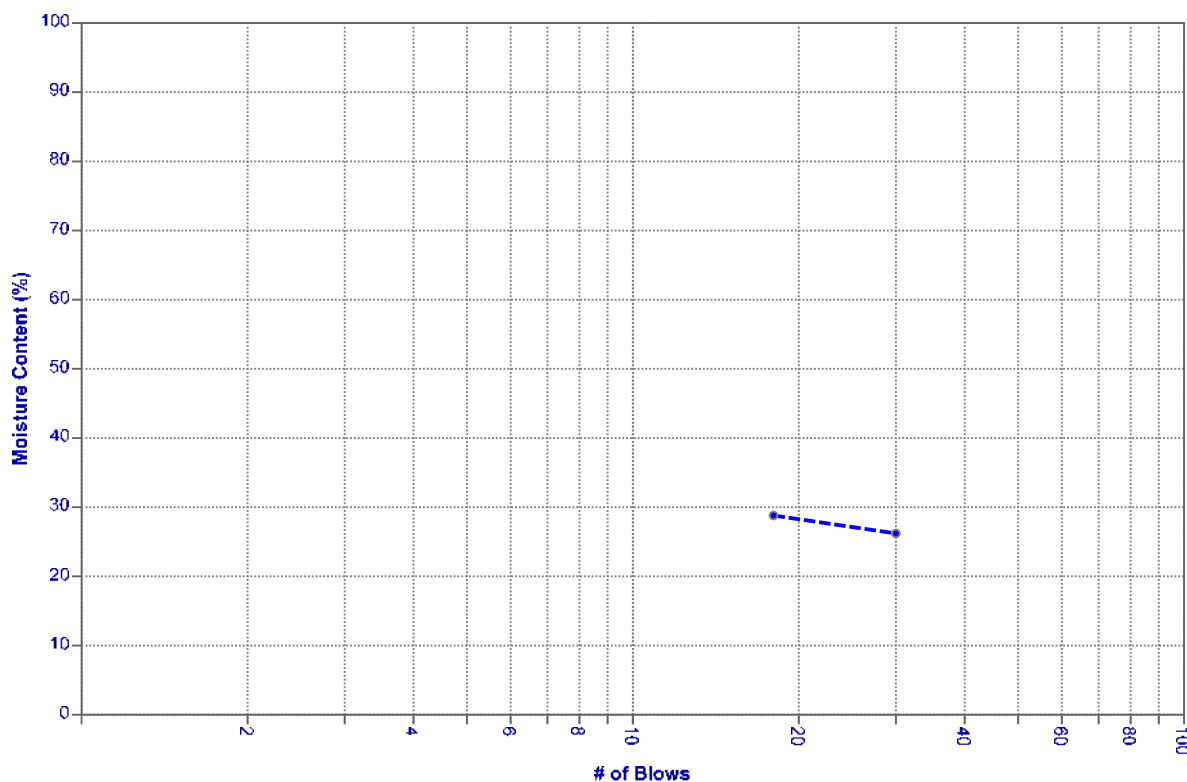
Plastic Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	Moisture Content (%)
14.15	18.77	17.95	21.6

LL = 27.1 %

PL = 21.6 %

PI=5.5



USCS Soil Description : Silty Clay With Sand
AASHTO Soil Description : A-4, Silty soils (3)

Tested By :

ATTERBERG LIMITS TEST

Project : Geotechnical Investigation Works

Borehole : BH-22

Client : Renewable Resources

Sample Depth : 1.5 (m)

Job No.: K22-1245-101

Classification : ML | A-4(5)

Location : Deh Mithaghar

Sample Type : SPT Split Spoon



ASTM D2216-90, D854

Liquid Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	# of Blows	Moisture Content (%)
18.54	30.26	27.41	11	32.1
21.06	42.52	37.81	28	28.1
				-

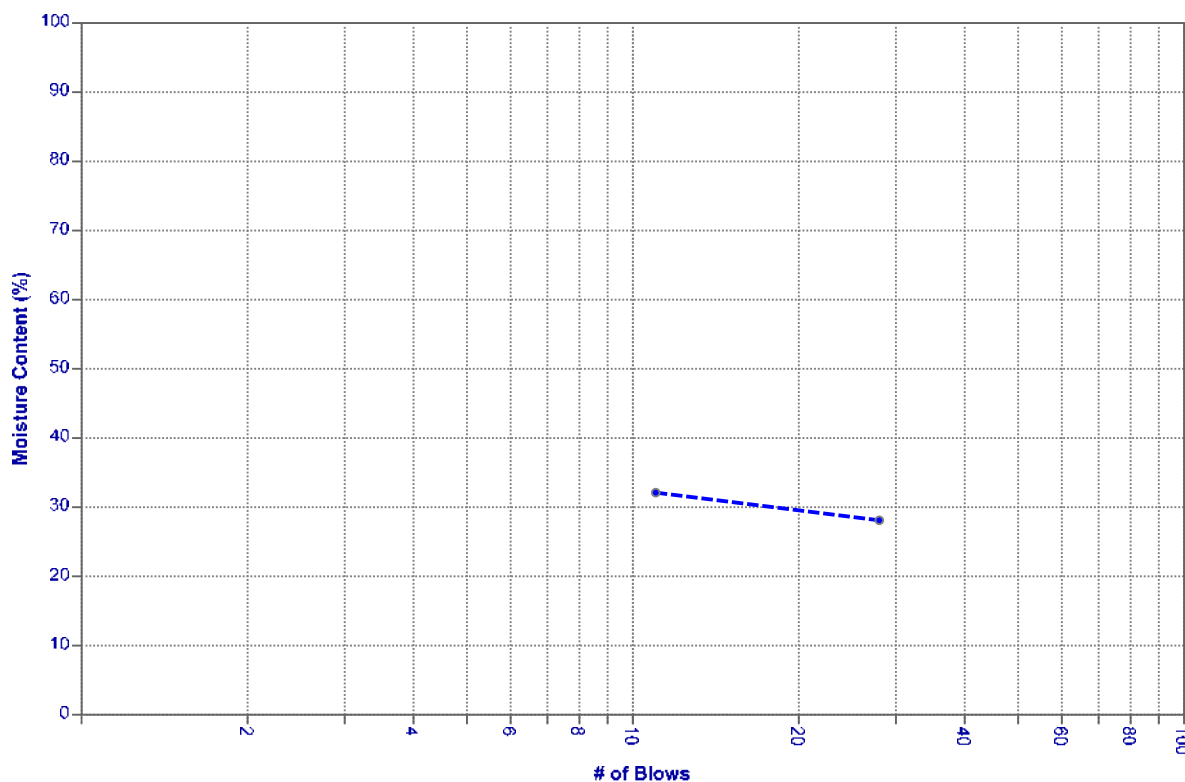
Plastic Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	Moisture Content (%)
11.01	14.51	13.87	22.4

LL = 28.6 %

PL = 22.4 %

PI=6.2



USCS Soil Description : Low Plasticity Silt With Sand
AASHTO Soil Description : A-4, Silty soils (5)

Tested By :

ATTERBERG LIMITS TEST

Project : Geotechnical Investigation Works

Borehole : BH-22

Client : Renewable Resources

Sample Depth : 5 (m)

Job No.: K22-1245-101

Classification : CL | A-4(7)

Location : Deh Mithaghar

Sample Type : SPT Split Spoon



ASTM D2216-90, D854

Liquid Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	# of Blows	Moisture Content (%)
11.36	28.98	25.08	17	28.4
18.52	31.2	28.61	29	25.7
				-

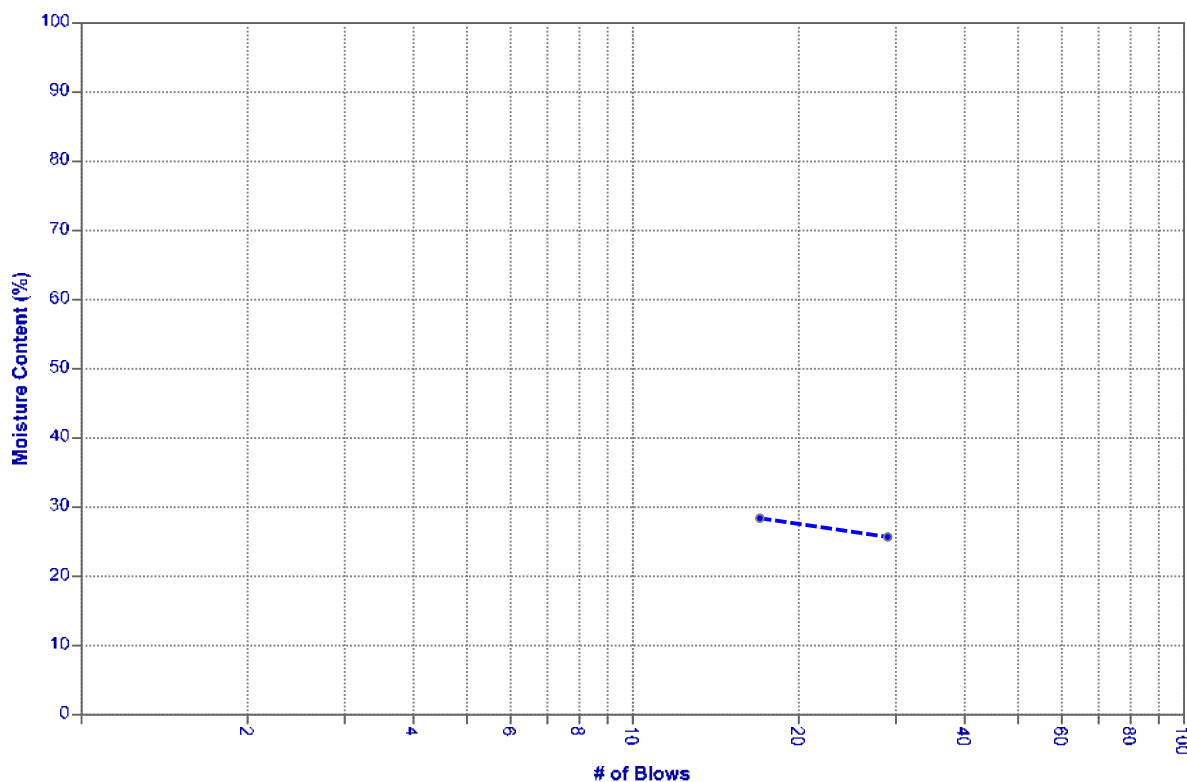
Plastic Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	Moisture Content (%)
21.96	32.33	30.73	18.2

LL = 26.5 %

PL = 18.2 %

PI=8.3



USCS Soil Description : Low Plasticity Clay With Sand
AASHTO Soil Description : A-4, Silty soils (7)

Tested By :

ATTERBERG LIMITS TEST

Project : Geotechnical Investigation Works

Borehole : BH-23

Client : Renewable Resources

Sample Depth : 1.5 (m)

Job No.: K22-1245-101

Classification : CL | A-4(8)

Location : Deh Mithaghar

Sample Type : SPT Split Spoon



ASTM D2216-90, D854

Liquid Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	# of Blows	Moisture Content (%)
13.99	30.17	26.12	19	33.4
16.87	27.11	24.78	30	29.5
				-

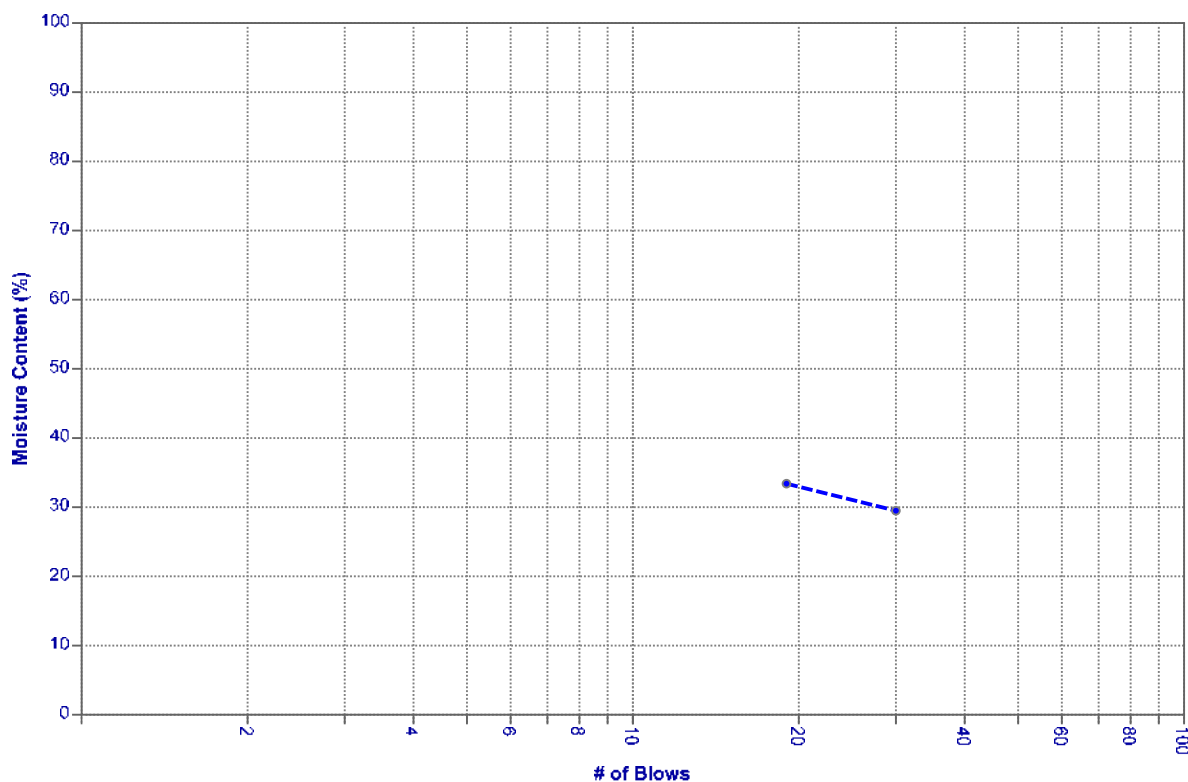
Plastic Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	Moisture Content (%)
30.84	43.61	41.23	22.9

LL = 31.1 %

PL = 22.9 %

PI=8.2



USCS Soil Description : Low Plasticity Clay With Sand
AASHTO Soil Description : A-4, Silty soils (8)

Tested By :

ATTERBERG LIMITS TEST

Project : Geotechnical Investigation Works

Borehole : BH-23

Client : Renewable Resources

Sample Depth : 5 (m)

Job No.: K22-1245-101

Classification : CL | A-4(6)

Location : Deh Mithaghar

Sample Type : SPT Split Spoon



ASTM D2216-90, D854

Liquid Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	# of Blows	Moisture Content (%)
14.25	26.52	24.03	16	25.5
11.03	31.26	27.54	29	22.5
				-

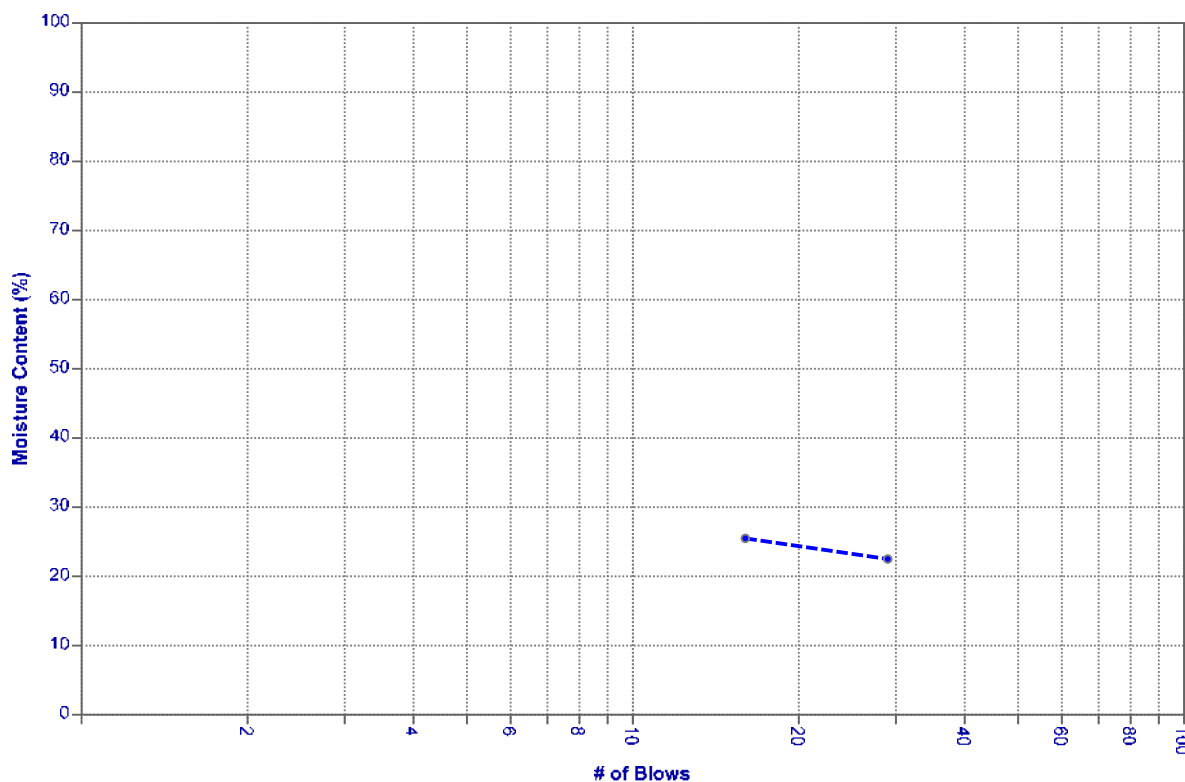
Plastic Limit

Cont. W (gr)	Cont. + Wet Soil W (gr)	Cont. + Dry Soil W (gr)	Moisture Content (%)
21.1	32.33	30.89	14.7

LL = 23.2 %

PL = 14.7 %

PI=8.5



USCS Soil Description : Low Plasticity Clay With Sand
AASHTO Soil Description : A-4, Silty soils (6)

Tested By :

Density & Moisture Test

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM D4643, D2216

Borehole	Sample Depth (m)	Moisture Content (%)	Dry Density (gr/cm3)	Wet Density (gr/cm3)
BH-01	1.5	1.6	7.88	8.01
BH-01	5	12.49	1.61	1.81
BH-02	1.5	10.33	1.6	1.77
BH-02	5	9.38	1.62	1.77
BH-03	1.5	13.2	1.6	1.81
BH-03	5	11.09	1.62	1.8
BH-04	1.5	13.22	1.62	1.84
BH-04	5	9.87	1.62	1.78
BH-05	1.5	10.85	1.6	1.77
BH-05	5	14.69	1.59	1.82
BH-06	1.5	8.23	1.65	1.78
BH-06	5	6.21	1.66	1.77
BH-07	1.5	8.56	1.69	1.83
BH-07	5	7.29	1.7	1.83
BH-08	1.5	12.14	1.65	1.85
BH-08	5	13.21	1.61	1.82
BH-09	1.5	13.67	1.62	1.84
BH-09	5	10.43	1.63	1.8
BH-10	1.5	9.07	1.62	1.77
BH-10	5	14.89	1.6	1.83
BH-11	1.5	10.09	1.64	1.8
BH-11	5	9.32	1.66	1.81
BH-12	1.5	6.33	1.67	1.78
BH-12	5	8.99	1.65	1.8
BH-13	1.5	11.54	1.61	1.79
BH-13	5	10.58	1.62	1.79
BH-14	1.5	10.49	1.63	1.8
BH-14	5	6.85	1.65	1.76
BH-15	1.5	14.97	1.59	1.83
BH-15	5	10.41	1.61	1.77
BH-16	1.5	6.99	1.65	1.76
BH-16	5	10.29	1.58	1.74
BH-17	1.5	7.32	1.66	1.78
BH-18	1.5	6.39	1.71	1.81
BH-18	5	13.2	1.68	1.91
BH-19	1.5	13.22	1.58	1.79
BH-19	5	11.06	1.61	1.79
BH-20	1.5	12.46	1.57	1.77
BH-20	5	10.14	1.68	1.85
BH-21	1.5	9.87	1.61	1.77
BH-21	5	13.08	1.63	1.85
BH-22	1.5	15.32	1.59	1.83
BH-22	5	16.98	1.61	1.88
BH-23	1.5	10.22	1.58	1.74
BH-23	5	9.87	1.59	1.75

Density & Moisture Test

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM D4643, D2216

Borehole	Sample Depth (m)	Moisture Content (%)	Dry Density (gr/cm3)	Wet Density (gr/cm3)
BH-24	1.5	12.03	1.61	1.8
BH-25	1.5	8.22	1.59	1.73
BH-25	5	9.63	1.63	1.79
BH-26	1.5	14.03	1.6	1.82
BH-26	5	12.41	1.62	1.82
BH-27	1.5	5.97	1.67	1.77
BH-27	5	8.27	1.65	1.79
BH-28	1.5	8.62	1.67	1.82
BH-28	5	10.1	1.68	1.85
BH-29	1.5	14.36	1.62	1.85
BH-29	5	16.33	1.61	1.87
BH-30	1.5	9.08	1.63	1.78
BH-30	5	7.46	1.66	1.78
BH-31	1.5	10.48	1.64	1.81
BH-31	5	9.58	1.69	1.85

Chemical Test Results

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM D516, D512,
D1293

Borehole	Sample Depth (m)	Description	Value
BH-01	1.5	pH value	6.88
BH-02	1.5		7.15
BH-03	1.5		7.3
BH-04	1.5		7.1
BH-05	1.5		7.35
BH-06	1.5		6.8
BH-07	1.5		6.85
BH-08	1.5		7.4
BH-09	1.5		7.25
BH-10	1.5		7.4
BH-11	1.5		7.14
BH-12	1.5		7.23
BH-13	1.5		6.82
BH-14	1.5		6.8
BH-15	1.5		6.9
BH-16	1.5		7.25
BH-17	1.5		7.35
BH-18	1.5		7.2
BH-19	1.5		7.13
BH-20	1.5		7.4
BH-21	1.5		6.88
BH-22	1.5		7.28
BH-23	1.5		7.2
BH-24	1.5		6.85
BH-25	1.5		7.25
BH-26	1.5		7.32
BH-27	1.5		7.3
BH-28	1.5		7.2
BH-29	1.5		7.3
BH-30	1.5		6.8
BH-31	1.5		7.28
BH-02	1.5	Sulfate Solubale in Acid (BS 1377)	0.098
BH-01	1.5		0.098
BH-03	1.5		0.01
BH-04	1.5		0.01
BH-05	1.5		0.011
BH-06	1.5		0.01
BH-07	1.5		0.099
BH-08	1.5		0.01
BH-09	1.5		0.01
BH-10	1.5		0.011
BH-11	1.5		0.01
BH-12	1.5		0.011
BH-13	1.5		0.099
BH-14	1.5		0.01

Chemical Test Results

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM D516, D512,
D1293

Borehole	Sample Depth (m)	Description	Value
BH-15	1.5		0.01
BH-16	1.5		0.01
BH-17	1.5		0.011
BH-18	1.5		0.01
BH-19	1.5		0.098
BH-20	1.5		0.011
BH-21	1.5		0.098
BH-22	1.5		0.01
BH-23	1.5		0.01
BH-24	1.5		0.098
BH-25	1.5		0.01
BH-26	1.5		0.011
BH-27	1.5		0.01
BH-28	1.5		0.01
BH-29	1.5		0.01
BH-30	1.5		0.098
BH-31	1.5		0.01
BH-01	1.5		0.38
BH-02	1.5		0.36
BH-03	1.5		0.42
BH-04	1.5		0.34
BH-05	1.5		0.42
BH-06	1.5		0.39
BH-07	1.5		0.36
BH-08	1.5		0.45
BH-09	1.5		0.4
BH-10	1.5		0.45
BH-11	1.5		0.36
BH-12	1.5		0.4
BH-13	1.5		0.39
BH-14	1.5		0.38
BH-15	1.5	Chloride Content (ASTM D1411)	0.35
BH-16	1.5		0.42
BH-17	1.5		0.44
BH-18	1.5		0.34
BH-19	1.5		0.38
BH-20	1.5		0.44
BH-21	1.5		0.33
BH-22	1.5		0.4
BH-23	1.5		0.4
BH-24	1.5		0.33
BH-25	1.5		0.37
BH-26	1.5		0.43
BH-27	1.5		0.41
BH-28	1.5		0.39
BH-29	1.5		0.42



Project : Geotechnical Investigation Works
Client : Renewable Resources
Job No. : K22-1245-101
Location : Deh Mithaghar

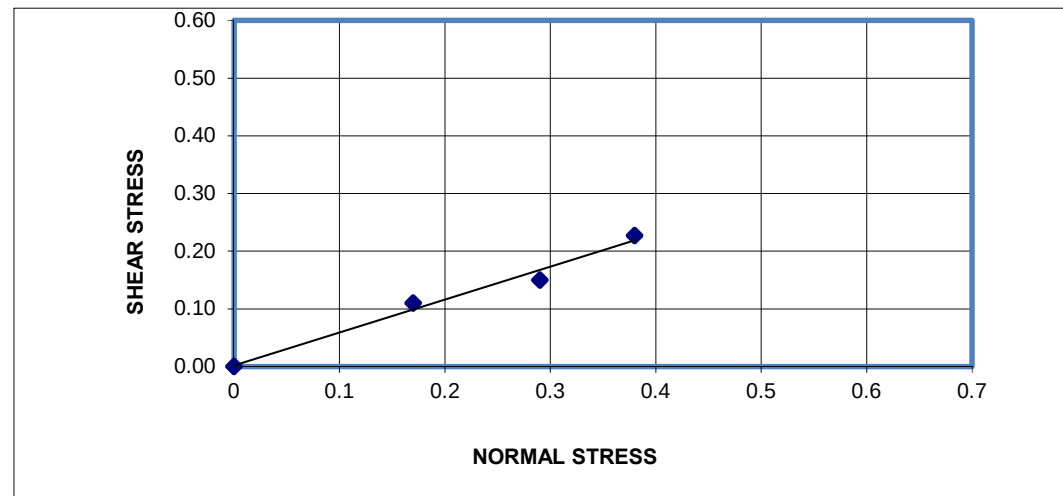
Borehole : BH-01
Sample Depth : 1.50 (m)
Classification : SM
Sample Type : SPT Split Spoon

NORMAL STRESS (kg/cm ²)	SHEAR STRESS (kg/cm ²)
0.00	0.00
0.17	0.11
0.29	0.15
0.38	0.23

Cohesion (c) 0.00

Angle of friction (Φ) 30.86

DIRECT SHEAR TEST





Project : Geotechnical Investigation Works
Client : Renewable Resources
Job No. : K22-1245-101
Location : Deh Mithaghar

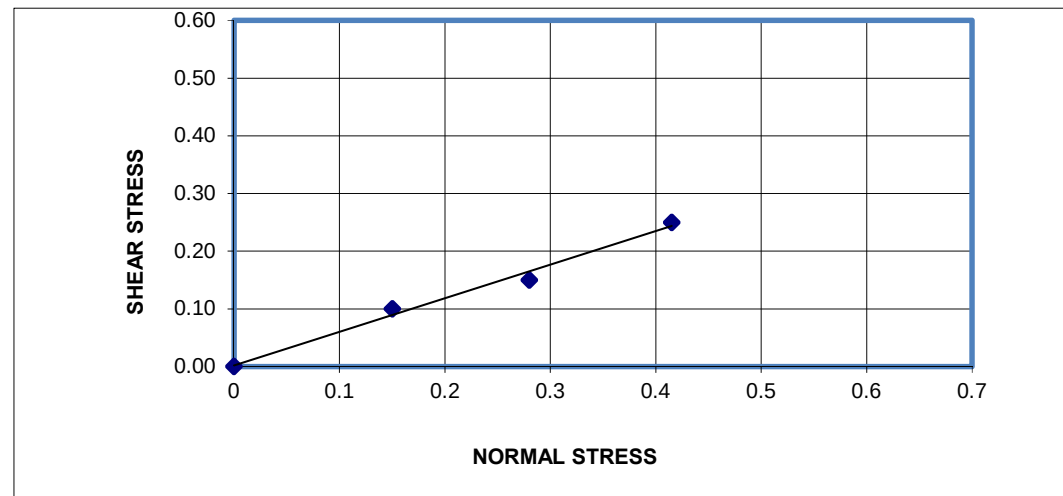
Borehole : BH-04
Sample Depth : 3.00 (m)
Classification : SM
Sample Type : SPT Split Spoon

NORMAL STRESS (kg/cm ²)	SHEAR STRESS (kg/cm ²)
0.00	0.00
0.15	0.10
0.28	0.15
0.42	0.25

Cohesion (c) 0.00

Angle of friction (Φ) 31.07

DIRECT SHEAR TEST





Project : Geotechnical Investigation Works
Client : Renewable Resources
Job No. : K22-1245-101
Location : Deh Mithaghar

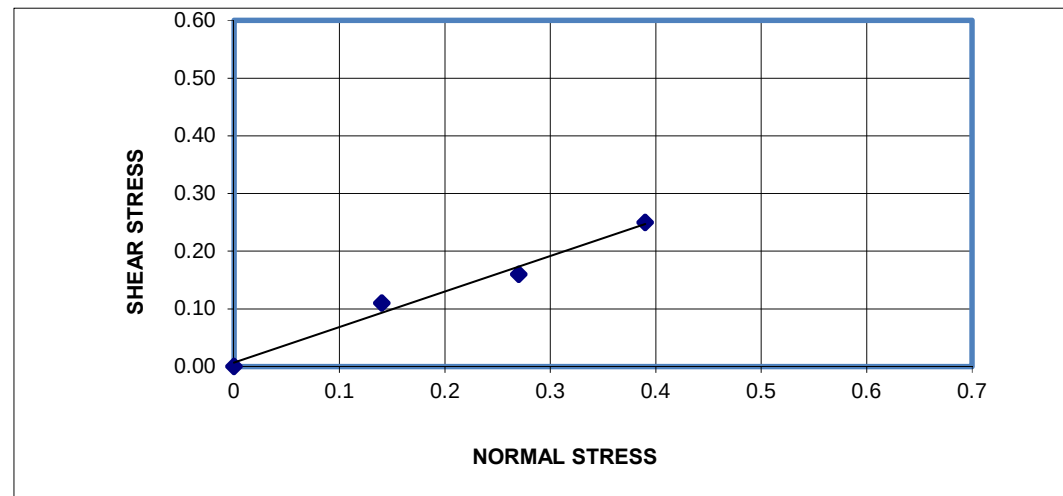
Borehole : BH-07
Sample Depth : 1.50 (m)
Classification : SM
Sample Type : SPT Split Spoon

NORMAL STRESS (kg/cm ²)	SHEAR STRESS (kg/cm ²)
0.00	0.00
0.14	0.11
0.27	0.16
0.39	0.25

Cohesion (c) 0.00

Angle of friction (Φ) 32.66

DIRECT SHEAR TEST





Project : Geotechnical Investigation Works
Client : Renewable Resources
Job No. : K22-1245-101
Location : Deh Mithaghar

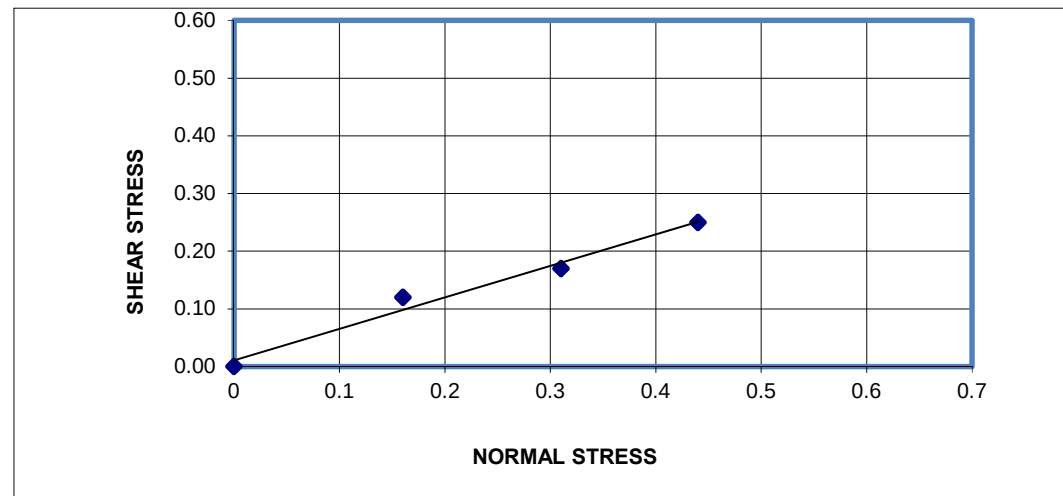
Borehole : BH-12
Sample Depth : 1.50 (m)
Classification : SM
Sample Type : SPT Split Spoon

NORMAL STRESS (kg/cm ²)	SHEAR STRESS (kg/cm ²)
0.00	0.00
0.16	0.12
0.31	0.17
0.44	0.25

Cohesion (c) 0.00

Angle of friction (Φ) 29.61

DIRECT SHEAR TEST





Project : Geotechnical Investigation Works
Client : Renewable Resources
Job No. : K22-1245-101
Location : Deh Mithaghar

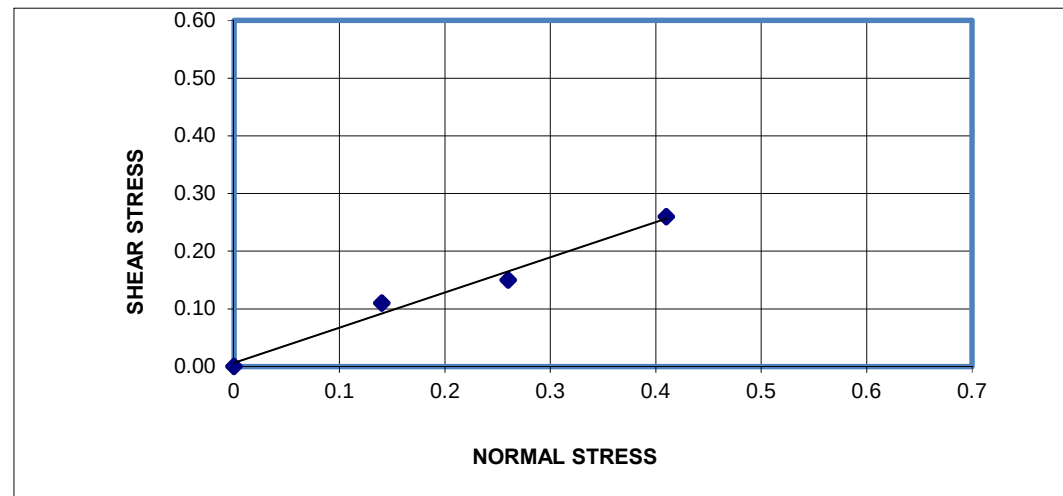
Borehole : BH-17
Sample Depth : 1.50 (m)
Classification : SM
Sample Type : SPT Split Spoon

NORMAL STRESS (kg/cm ²)	SHEAR STRESS (kg/cm ²)
0.00	0.00
0.14	0.11
0.26	0.15
0.41	0.26

Cohesion (c) 0.00

Angle of friction (Φ) 32.38

DIRECT SHEAR TEST





Project : Geotechnical Investigation Works
Client : Renewable Resources
Job No. : K22-1245-101
Location : Deh Mithaghar

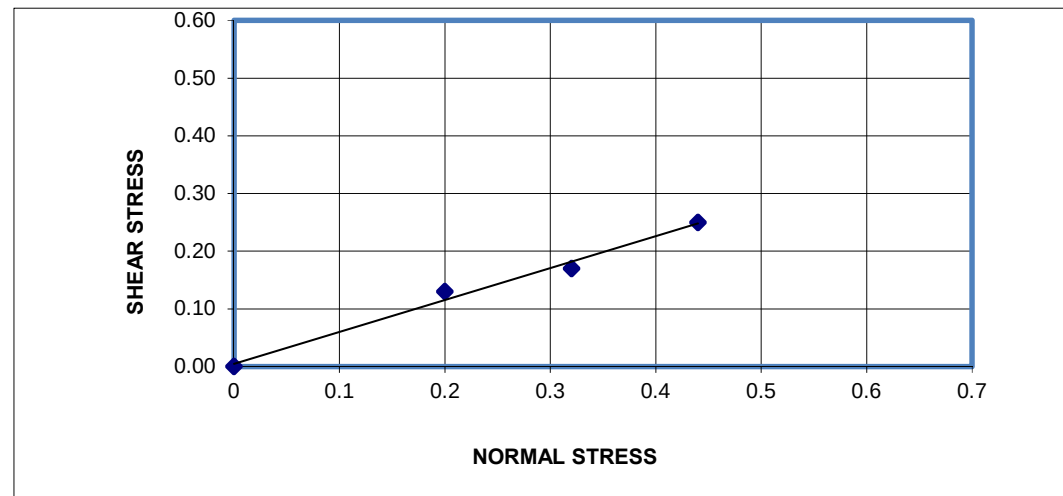
Borehole : BH-24
Sample Depth : 1.50 (m)
Classification : SM
Sample Type : SPT Split Spoon

NORMAL STRESS (kg/cm ²)	SHEAR STRESS (kg/cm ²)
0.00	0.00
0.20	0.13
0.32	0.17
0.44	0.25

Cohesion (c) 0.00

Angle of friction (Φ) 29.61

DIRECT SHEAR TEST





Project : Geotechnical Investigation Works
Client : Renewable Resources
Job No. : K22-1245-101
Location : Deh Mithaghar

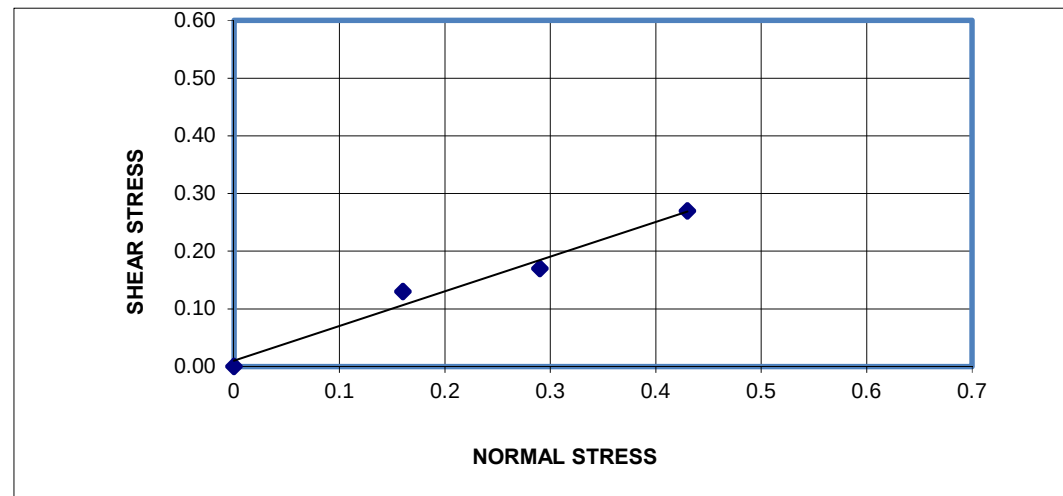
Borehole : BH-31
Sample Depth : 3.00 (m)
Classification : SM
Sample Type : SPT Split Spoon

NORMAL STRESS (kg/cm ²)	SHEAR STRESS (kg/cm ²)
0.00	0.00
0.16	0.13
0.29	0.17
0.43	0.27

Cohesion (c) 0.00

Angle of friction (Φ) 32.13

DIRECT SHEAR TEST



Chemical Test Results

Project : Geotechnical Investigation Works

Client : Renewable Resources

Job No.: K22-1245-101

Location : Deh Mithaghar



ASTM D516, D512,
D1293

Borehole	Sample Depth (m)	Description	Value
BH-30	1.5		0.35
BH-31	1.5		0.45

Appendix D

General Information on Testing Procedures

A. DRILLING, FIELD TESTING & SAMPLING

The field testing program consisted of drilling works, rock coring and in-situ testing including Standard Penetration Test (SPT), collection of soil samples using soil sampler and collection of rock samples. The following sections describe these activities in further detail.

A.1. DRILLING METHOD

All the boreholes were drilled by using rotary/wash boring method; in this method soil or rock is cut by the constant rotation of various types of bits. Drilling fluid, which is either water or bentonite slurry, is circulated through drilling rods. The returning fluid lifts loosened material.

The drilling in rock was carried out by double tube core barrels in conjunction with carbide or diamond bit. In a double tube core barrel the outer barrel is rotated by the drill rods, while, the inner barrel, which is mounted on a swivel, does not rotate during the drilling process. The core cut by the coring bit passes into the inner barrel. Core was prevented from dropping out by a steel core catcher. It was then extruded and wrapped with waxed bandage tape, to preserve the natural moisture of the recovered core.

Details of the boreholes are given in Table A.1.

Table A.1 Detail of Boreholes

Borehole No.	Borehole Depth (meters)	Water table Depth (meters)	Coordinates
BH-01	5.0	Not Encountered	303133.91 E 2782361.7 N
BH-02	5.0	Not Encountered	303451.27 E 2782778.18 N
BH-03	5.0	Not Encountered	302901.23 E 2781976.57 N
BH-04	5.0	Not Encountered	303414.48 E 2782140.53 N
BH-05	5.0	Not Encountered	303109.21 E 2784021.8 N

Borehole No.	Borehole Depth (meters)	Water table Depth (meters)	Coordinates
BH-06	5.0	Not Encountered	303280.2 E 2781809.07 N
BH-07	5.0	Not Encountered	303538.61 E 2783043.6 N
BH-08	5.0	Not Encountered	303305.8 E 2782292.86 N
BH-09	5.0	Not Encountered	302962.72 E 2782448.93 N
BH-10	5.0	Not Encountered	302943.87 E 2782121.1 N
BH-11	5.0	Not Encountered	303226.49 E 2781984.59 N
BH-12	5.0	Not Encountered	303453.78 E 2781888.55 N
BH-13	5.0	Not Encountered	303387.1 E 2781639.65 N
BH-14	5.0	Not Encountered	303021.42 E 2781805.01 N
BH-15	5.0	Not Encountered	302724.5 E 2781971.93 N
BH-16	5.0	Not Encountered	302737.42 E 2782232.94 N
BH-17	5.0	Not Encountered	302758.09 E 2782564.98 N
BH-18	5.0	Not Encountered	302793.6 E 2783305.65 N
BH-19	5.0	Not Encountered	302828.96 E 2784036.73 N
BH-20	5.0	Not Encountered	302865.08 E 2784623.03 N

Borehole No.	Borehole Depth (meters)	Water table Depth (meters)	Coordinates
BH-21	5.0	Not Encountered	303200.82 E 2784586.7 N
BH-22	5.0	Not Encountered	303011.85 E 2783523.21 N
BH-23	5.0	Not Encountered	302915.17 E 2782849.28 N
BH-24	5.0	Not Encountered	303113.21 E 2782764.0 N
BH-25	5.0	Not Encountered	303273.61 E 2782539.83 N
BH-26	5.0	Not Encountered	303524.17 E 2782321.29 N
BH-27	5.0	Not Encountered	303650.42 E 2782726.4 N
BH-28	5.0	Not Encountered	303300.26 E 2782926.29 N
BH-29	5.0	Not Encountered	303405.07 E 2783369.9 N
BH-30	5.0	Not Encountered	303816.7 E 2783439.59 N
BH-31	5.0	Not Encountered	303603.46 E 2783741.6 N



Figure A.1 Drilling works in progress

A.2. FIELD TESTING

Field testing carried out at the site includes Standard Penetration Test (SPT). Soil samples were extracted from the boreholes with the help of “SPT sampler for all types of soils”.

Following sections indicate the processes carried out in each of the field tests.

A.2.1. STANDARD PENETRATION TESTS

The standard penetration tests (SPT) were carried out at interval of 1.0 - 1.5 meter in the overburden above the bedrock. The standard penetration test was carried out by “Safety” type sliding hammer. Split-spoon sampler was used in cohesive and fine granular soils to conduct SPT.

The standard penetration test was carried out by an assembly of the following parts:

- Drive-weight assembly, consisting of a drive head and a 63.5kg impact hammer, a hammer fall guide and the drop system. The drop mechanism will ensure a constant free fall of 760mm.
- Drive rods connect the drive-weight assembly to the sampler.
- The split spoon sampler was used to carry out the test, along with retrieving disturbed samples.

The base of the borehole was made clean and reasonably undisturbed at the test elevation. Following precautions were taken during the testing sequence:

- The level of water or bentonite slurry was maintained at a sufficient level above the groundwater level, to ensure any entry of water through the bottom of the borehole.
- The casing was not driven below the level at which the test will start.

The test was executed in the following steps:

- The sampler and the drive rods were lowered in the borehole and the hammer assembly added to it.
- The sampler is penetrated over seating drive of 150mm and the numbers of blows are recorded.
- In the same way the sampler is driven over a test drive of 300mm in two increments of 150mm.
- The numbers of blows are recorded during each of the last two increments.
- The test was deemed finished when total number of blows equal to 50 was reached.

The standard penetration test was carried out in accordance with the procedure given in BS 1377-9:1990.



Figure A.2 Performance of standard penetration test

A.3. SAMPLING

Sampling forms an essential part of the geotechnical investigation process and good sampling is essential for proper laboratory testing of samples for determining strength and compressibility characteristics of soil.

A.3.1. SPT SAMPLES

Samples were recovered from standard penetration testing. The samples were recovered in split-spoon sampler and then stored in plastic bags. The storage of split-spoon samples in bags ensured retention of natural moisture of the samples which were later tested for gradation, consistency and chemical characteristics.

A.3.2. ROCK CORE SAMPLES

Rock core samples were collected from the deposits through coring. Double tube core barrel (HQ size) was used to collect these samples. The samples were recovered in core barrel, packed in aluminium foil, and then stored in rock core boxes. The storage of rock core samples in aluminium foil ensured retention of natural moisture. Unconfined compressive strength, natural moisture content, density, etc. of these samples was determined in the laboratory.

B. LABORATORY TESTING

Laboratory testing was carried out on retrieved samples. The following section enlists and gives details of relevant tests carried out on selected samples as required for determining the subsurface conditions and correlating with the information obtained from field testing and sampling.

B.1. GRAIN SIZE ANALYSIS

The purpose of grain size analysis is to determine the sizes of the assemblage of particles that make up the soil. The grain size analysis is conducted in two parts: for particles above the “# 200 US sieve”, sieve analysis is carried out by passing the selected soil sample from various sieves. For particles finer than the “# 200 US sieve”, hydrometer analysis is carried out. The combined process of determination of the size of particles is termed as the grain size analysis.

The results are appended with the report in Appendix C. Grain size analysis of soil samples was carried out as per *ASTM D-6913* & *ASTM C-136*.

B.2. NATURAL MOISTURE CONTENT

Natural moisture content is the quantity of water contained in a soil or rock sample. It is the ratio of the weight of water to the weight of solids in a given volume of soil or rock sample. Natural moisture content of soil samples was determined in accordance with *ASTM 2216-05*.

B.3. DENSITY

The weight per unit volume of the solid portion of soil is called particle (dry) density. Whereas, the oven dry weight of a unit volume of soil inclusive of pore spaces is called bulk (wet) density. The bulk density of a soil is always smaller than its particle density. Density of soil samples was determined in accordance with the procedure described in *ASTM D 7263-09*.

B.4. DIRECT SHEAR TEST

The direct shear test involves, placing a test sample in a rectangular box having two portions, the top portion can move while the lower portion is fixed. The sample is consolidated under a normal load. Also, double drainage is ensured by placing porous stones on the top and bottom of the sample. Hence, the test may be carried out under

drained conditions. The shear strength of a remoulded sample is measured by applying a horizontal force which pushes the top part of rectangular box, the sample is sheared to failure and the normal and shear stresses at the point of failure are noted down. The shear box test (or the direct shear test) suffers from various limitations the most prominent of which is the forced failure plane formed due the configuration of the apparatus; this might result in concealing the actual plane of failure. As, the tests are carried out on disturbed samples and since only the stresses at the point of failure are determined the test results cannot be reliably used in describing the strength.

B.5. CHEMICAL TESTS

Sulphate in groundwater or soil can attack concrete placed in the ground or on surface. A reaction takes place between the sulphate and the aluminate compounds present in the cement, causing crystallisation of complex compounds. The expansion, which accompanies crystallisation, induces stresses in the concrete, which results in mechanical disintegration. In moist conditions, such as exposure to seawater, the presence of chloride ion, Cl^- , presents a serious possibility of the corrosion of the reinforcement. The presence of $\text{Ca}(\text{OH})_2$ provides a strong alkaline environment in which a thin film of iron oxide is formed on the metal surface which protects it against corrosion. However, if the concrete is permeable to the extent that the soluble chlorides can reach up to the reinforcing steel, then in the presence of water and oxygen, the corrosion of the reinforcement will take place. Rust occupies more volume than the original steel, and hence the ensuing expansion of concrete, results in cracking and spalling.

Due to adverse effect of sulphates and chlorides on the quality of concrete it is essential to conduct chemical tests on soil and groundwater. This helps in quantifying the expected exposure of concrete to these chemicals and in devising precautionary measures to ensure integrity of concrete. The following chemical tests were carried out on soil samples:

- Chloride content
- Sulphate content
- pH

Chemical tests were carried out in accordance with *ASTM C 1580-09, and D 4972-01*. The selection of cement for underground concreting and is discussed in *Chapter 4*.

Table B.1 ACI standards for concrete for sulphate exposure

Sulphate Exposure	Water Soluble Sulphates in Soil (%)	Sulphate in Water (mg/L)	Cement Type
Negligible	0.00-0.10	0- 150	OPC
Moderate	0.10-0.20	150- 1500	Type II
Severe	0.20-2.00	1500-10000	Type V
Very Severe	Over 2.00	Over 10000	Type V plus pozzolan

Appendix E

Pile Capacity Calculation

(A) - CALCULATION OF ALLOWABLE SHAFT FRICTION :
Profile (02)



Depth	Strata Encountered	Diameter of Pile (m)	Length of Layer (m)	Effective σ for this layer	Effective overburden (kN/m ²)	phi	c (kN/m ²)	q _{uc} (kN/m ²)	α adhesion	α reduction- rock	β correction	δ	tan δ	k _s	FOS	Q _{Shaft} (kN)	Q _{Shaft} (Cum) (kN)
0-1	Cohesionless	0.20	1	19.0	9.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	1	1
1-2	Cohesionless	0.20	1	19.0	28.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	2	2
2-3	Cohesionless	0.20	1	19.0	47.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	3	6
3-4	Cohesionless	0.20	1	19.5	66.8	30	-	-	-	-	-	22.5	0.41	0.500	2.0	4	10
4-5	Cohesionless	0.20	1	19.5	86.3	30	-	-	-	-	-	22.5	0.41	0.500	2.0	6	16

(A) - CALCULATION OF ALLOWABLE SHAFT FRICTION :
Profile (02)



Depth	Strata Encountered	Diameter of Pile (m)	Length of Layer (m)	Effective σ for this layer	Effective overburden (kN/m ²)	phi	c (kN/m ²)	q _{uc} (kN/m ²)	α adhesion	α reduction- rock	β correction	δ	tan δ	k _s	FOS	Q _{Shaft} (kN)	Q _{Shaft} (Cum) (kN)
0-1	Cohesionless	0.30	1	19.0	9.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	1	1
1-2	Cohesionless	0.30	1	19.0	28.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	3	4
2-3	Cohesionless	0.30	1	19.0	47.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	5	8
3-4	Cohesionless	0.30	1	19.5	66.8	30	-	-	-	-	-	22.5	0.41	0.500	2.0	7	15
4-5	Cohesionless	0.30	1	19.5	86.3	30	-	-	-	-	-	22.5	0.41	0.500	2.0	8	23

(A) - CALCULATION OF ALLOWABLE SHAFT FRICTION :
Profile (02)



Depth	Strata Encountered	Diameter of Pile (m)	Length of Layer (m)	Effective σ for this layer	Effective overburden (kN/m ²)	phi	c (kN/m ²)	q _{uc} (kN/m ²)	α adhesion	α reduction- rock	β correction	δ	tan δ	k _s	FOS	Q _{Shaft} (kN)	Q _{Shaft} (Cum) (kN)
0-1	Cohesionless	0.40	1	19.0	9.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	1	1
1-2	Cohesionless	0.40	1	19.0	28.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	4	5
2-3	Cohesionless	0.40	1	19.0	47.5	30	-	-	-	-	-	22.5	0.41	0.500	2.0	6	11
3-4	Cohesionless	0.40	1	19.5	66.8	30	-	-	-	-	-	22.5	0.41	0.500	2.0	9	20
4-5	Cohesionless	0.40	1	19.5	86.3	30	-	-	-	-	-	22.5	0.41	0.500	2.0	11	31

ALLOWABLE TIP RESISTANCE :**Profile (02)**

Socket Strata	Diameter of Pile (mm)	Length of Pile (m)	N_q	Effective Overburden (kN/m ²)	FOS	Q_{tip} (kN)
Cohesionless	200	3.0	30.0	47.5	3.0	15
Cohesionless	200	4.0	30.0	66.8	3.0	21
Cohesionless	200	5.0	30.0	86.3	3.0	27
Cohesionless	300	3.0	30.0	47.5	3.0	34
Cohesionless	300	4.0	30.0	66.8	3.0	47
Cohesionless	300	5.0	30.0	86.3	3.0	61
Cohesionless	400	3.0	30.0	47.5	3.0	60
Cohesionless	400	4.0	30.0	66.8	3.0	84
Cohesionless	400	5.0	30.0	86.3	3.0	108

(A) - CALCULATION OF ALLOWABLE SKIN FRICTION:
Profile 02



Depth of pile (m)	Soil Encountered	Diameter of Pile (m)	Length of Layer (m)	Effective σ for this layer	Effective overburden (kN/m ²)	phi	c (kN/m ²)	q _{uc} (kN/m ²)	α adhesion	α reduction-rock	β correction	δ	$\tan \delta$	k _s	FOS	Q _{skin} (kN)	Q _{skin} (Cum) (kN)
0-1	Cohesive	0.20	1	18.0	9.00	-	50.00	-	0.45	-	-	-	-	-	2.0	7	7
1-2	Cohesive	0.20	1	18.0	27.0	-	50.00	-	0.45	-	-	-	-	-	2.0	7	14
2-3	Cohesive	0.20	1	18.0	45.0	-	50.00	-	0.45	-	-	-	-	-	2.0	7	21
3-4	Cohesive	0.20	1	18.0	63.0	-	50.00	-	0.45	-	-	-	-	-	2.0	7	28
4-5	Cohesive	0.20	1	18.0	81.0	-	50.00	-	0.45	-	-	-	-	-	2.0	7	35

(A) - CALCULATION OF ALLOWABLE SKIN FRICTION:**Profile 02**

Depth of pile (m)	Soil Encountered	Diameter of Pile (m)	Length of Layer (m)	Effective σ for this layer	Effective overburden (kN/m ²)	phi	c (kN/m ²)	q _{uc} (kN/m ²)	α adhesion	α reduction- rock	β correction	δ	tan δ	k _s	FOS	Q _{skin} (kN)	Q _{skin} (Cum) (kN)
0-1	Cohesive	0.30	1	18.0	9.00	-	50.00	-	0.45	-	-	-	-	-	2.0	11	11
1-2	Cohesive	0.30	1	18.0	27.0	-	50.00	-	0.45	-	-	-	-	-	2.0	11	21
2-3	Cohesive	0.30	1	18.0	45.0	-	50.00	-	0.45	-	-	-	-	-	2.0	11	32
3-4	Cohesive	0.30	1	18.0	63.0	-	50.00	-	0.45	-	-	-	-	-	2.0	11	42
4-5	Cohesive	0.30	1	18.0	81.0	-	50.00	-	0.45	-	-	-	-	-	2.0	11	53

(A) - CALCULATION OF ALLOWABLE SKIN FRICTION:**Profile 02**

Depth of pile (m)	Soil Encountered	Diameter of Pile (m)	Length of Layer (m)	Effective σ for this layer	Effective overburden (kN/m^2)	ϕ	c (kN/m^2)	q_{uc} (kN/m^2)	α adhesion	α reduction-rock	β correction	δ	$\tan \delta$	k_s	FOS	Q_{skin} (kN)	Q_{skin} (Cum) (kN)
0-1	Cohesive	0.40	1	18.0	9.00	-	50.00	-	0.45	-	-	-	-	-	2.0	14	14
1-2	Cohesive	0.40	1	18.0	27.0	-	50.00	-	0.45	-	-	-	-	-	2.0	14	28
2-3	Cohesive	0.40	1	18.0	45.0	-	50.00	-	0.45	-	-	-	-	-	2.0	14	42
3-4	Cohesive	0.40	1	18.0	63.0	-	50.00	-	0.45	-	-	-	-	-	2.0	14	57
4-5	Cohesive	0.40	1	18.0	81.0	-	50.00	-	0.45	-	-	-	-	-	2.0	14	71

ALLOWABLE END BEARING RESISTANCE :**Profile 02**

Socket	Diameter	Pile Length (m)	C	Nc	FOS	Q _{END}
Strata	of Pile (mm)	below Cut off level	kN/m ²			(kN)
Clay/Silt	200.0	3.0	50.0	9.0	3.0	5
Clay/Silt	200.0	4.0	50.0	9.0	3.0	5
Clay/Silt	200.0	5.0	50.0	9.0	3.0	5
Clay/Silt	300.0	3.0	50.0	9.0	3.0	11
Clay/Silt	300.0	4.0	50.0	9.0	3.0	11
Clay/Silt	300.0	5.0	50.0	9.0	3.0	11
Clay/Silt	400.0	3.0	50.0	9.0	3.0	19
Clay/Silt	400.0	4.0	50.0	9.0	3.0	19
Clay/Silt	400.0	5.0	50.0	9.0	3.0	19



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December, 2022

K22-1245-101

**ELECTRICAL RESISTIVITY AND THERMAL CONDUCTIVITY
TESTS FOR SOLAR POWER PROJECT AT DEH
MITHAGHAR, GADAP TOWN, KARACHI**

Client: M/s. Renewable Resource (Pvt.) Limited





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1.0 INTRODUCTION

Planning for Solar Power Project at Deh Mithaghar, Gadap Town, Karachi is underway. For this purpose, determination of the properties of subsurface deposits was essential. A program for electrical resistivity and thermal conductivity tests was, therefore, chalked out to evaluate these properties. *M/s. Soil Testing Services* were entrusted by *M/s. Renewable Resource Pvt. Limited* to carry out the tests pertaining to the determination of properties of the subsurface deposits.

Scope of fieldwork included performance of six (06) thermal conductivity tests and fifteen (15) electrical resistivity tests. This report presents a detailed account of these tests carried out at the project site.

The site conditions have been presented in Section 2 of this report. Details of thermal conductivity tests including working principle and test results have been presented in Section 3. In Section 4, working principle, details of fieldwork and test results regarding the electrical resistivity tests are discussed. Salient features of the report have been summarised in the concluding section.

2.0 SITE

The project site is located adjacent to the Hub Dam road in Gadap Town, Karachi. Nearby landmarks include Bhoola Hotel, Hub Cadet College and Hub River.

The topography of the plot is not plain with changes in elevation observed across the site. Figure 2.1 shows the google image of the site.

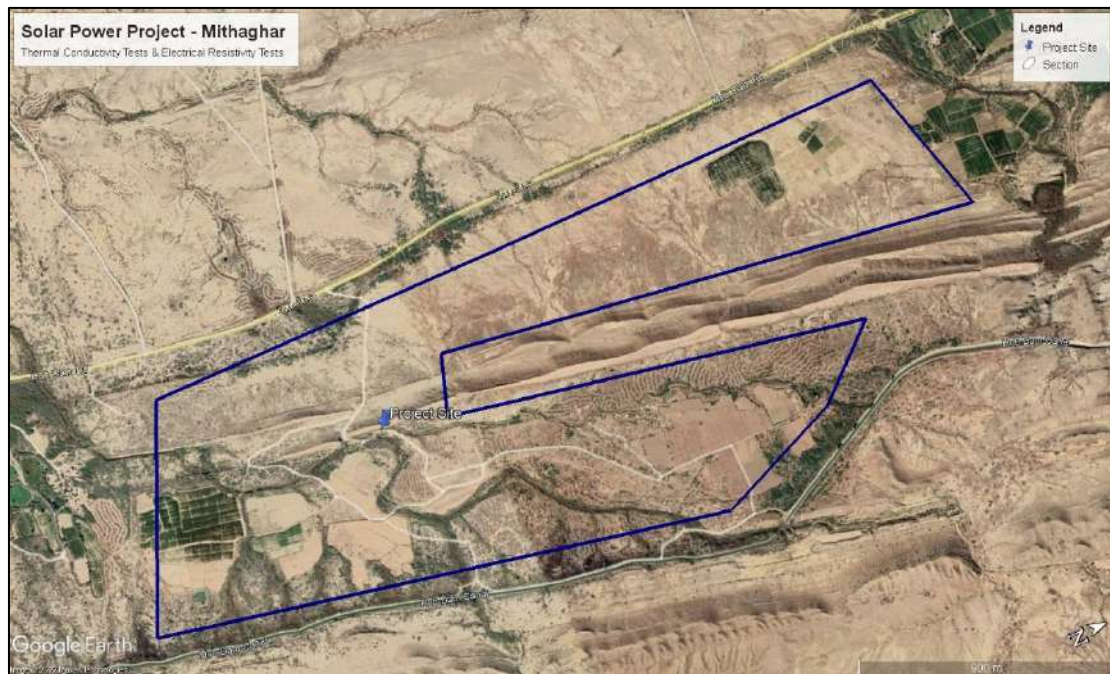


Figure 2.1: Satellite Image of site (Courtesy: Google Earth)

3.0 THERMAL CONDUCTIVITY TESTS

3.1 Equipment

The equipment used for thermal conductivity and thermal resistivity is KD2 Pro Thermal Property Analyser. The accessories of the equipment include KD2 pro portable unit, thermal sensor (TR-1), thermal grease, drill bits and pilot pins. The specifications of the equipment are listed in table 3.1.

Table 3.1 Specifications of the equipment

Accuracy	±5 to ±10% Thermal Conductivity/Resistivity
Measurement speed	1, 2, 5, & 10 min. read times depending on measurement type
Data storage	4,095 readings, flash memory
Compliance to Standards	ASTM Standard D5334-08 and IEEE Standard 442-1981
Operating environment	-50 to 150°C for sensors
Battery source	4 AA
Type	Ultra low-power 16-bit microcontroller w/ 24-bit A/D converter
Display	Liquid Crystal Display (LCD) 7.5 cm x 4 cm
Case dimensions	15.5 x 9.5 x 3.5 cm

3.2 Working Principle

The test method conforms to the transient line heat source theory. The thermal conductivity and thermal resistivity tests were performed in accordance with the ASTM D-5334.

Our test method is based on the theory that the rate of temperature rise of a line heat source depends on the thermal constants of the medium in which it is placed. A long, cylindrical, stainless steel needle sensor is used as a line heat source. The sensor (TR-1) is a 10 cm long thermal needle sensor. The sensor contains a heating element and a thermocouple and is inserted into the material to be tested. After the sensor is inserted, the heating element is turned on and kept on for 1-10 minutes (time is based on the sensor used). Sensor temperature variations are measured and analyzed by the Thermal Properties Analyzer Instrument to calculate the Thermal Resistivity and Thermal Conductivity. These readings are read directly on the LCD panel of the instrument.

3.2 Test Results

Scope of work at the site included performance of tests at six (06) locations.

Table 3.1 summarizes the results collected by KD2 pro Thermal Properties Analyzer. The values of thermal conductivity, thermal resistivity and ground temperature have been presented in the table below.

Table 3.1 Thermal Conductivity and Thermal Resistivity Values

Test No.	Nearby Borehole No.	Surface Temperature (°C)	Thermal Conductivity (K)	Thermal Resistivity (rho)	Date
			W/(m·K)	(m·K)/W	
1	BH-31	23.82	1.086	0.921	10 th December, 2022
2	BH-28	23.07	1.535	0.651	10 th December, 2022
3	BH-10	26.74	1.187	0.843	10 th December, 2022
4	BH-20	32.30	0.342	2.924	10 th December, 2022
5	BH-16	27.00	1.854	0.539	10 th December, 2022
6	BH-13	28.22	1.394	0.717	10 th December, 2022

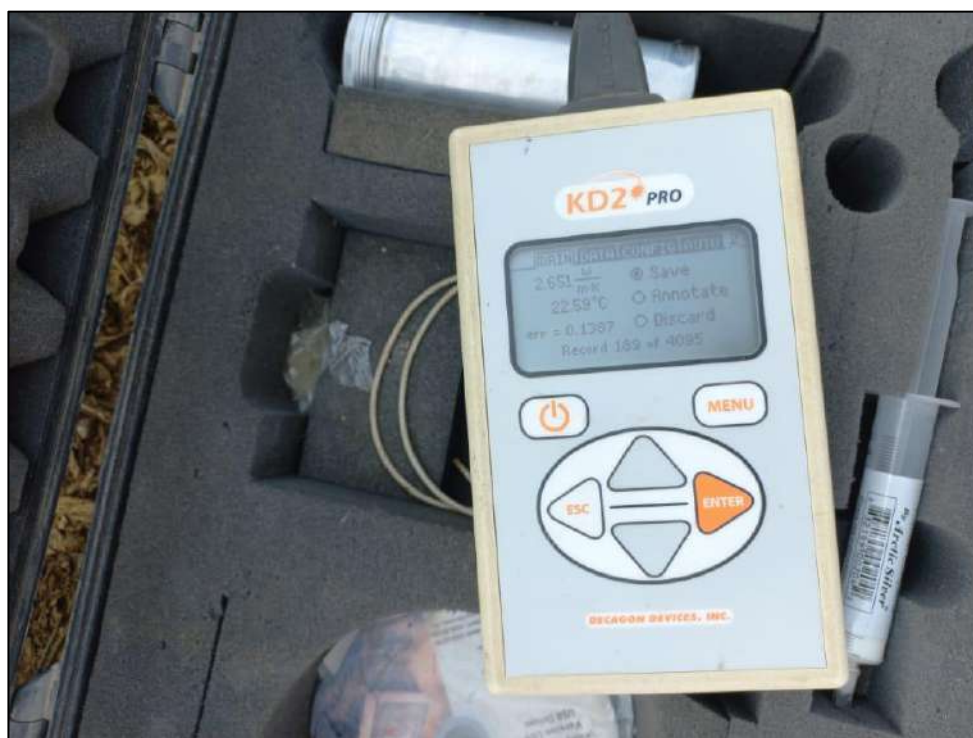


Figure 3.1 Performance of thermal Conductivity Tests

4.0 ELECTRICAL RESISTIVITY TESTS

4.1 Working Principle

Electrical resistivity tests are performed in accordance with ASTM-6431-99 and ASTM G-57. Electrical resistivity tests require inserting four probes into the test area. The probes are installed in a straight line spaced according to the type of configuration to be used during the testing. Following configurations was used to perform the tests at the site.

1. Wenner Configuration

The probes are installed in a straight line and equally spaced. The probes establish an electrical contact with the earth. The meter injects current through the ground via the tester and the outer two probes. The current flowing through the earth (a resistive material) develops a voltage / potential difference. This voltage drop resulting from the current flow is then measured between the two inner probes.

The meter then knows the amount of current that is flowing through the earth and the voltage drop across the two center probes. With this information the meter uses ohms law ($R=V/I$) to calculate and display the resistance in ohms. The product of the measured resistance and geometric factor is known as apparent resistivity.

The calculated soil resistivity is the average of the soil resistivity from the surface to a depth equivalent to the probe spacing. For example, a probe spacing of 10 meters between each probe will provide the average soil resistivity between the surface and a depth of 10 meters.

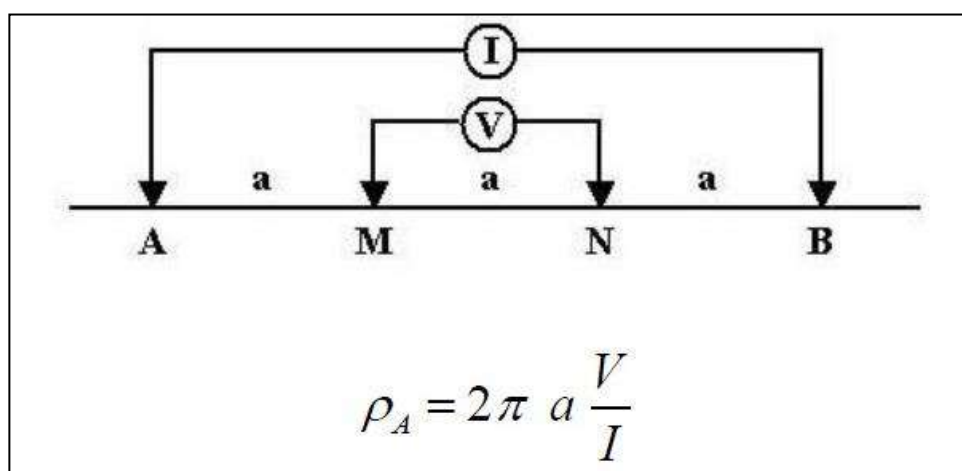


Figure 4.1 Schematic Diagram of Wenner Array

4.2 Electrical Properties of Ground

All materials, including soil and rock, have an intrinsic property, resistivity that governs the relation between the current density and the gradient of the electrical potential. Variations in the resistivity of earth materials either vertically or laterally, produce variations in the relations between the applied current and the potential distribution as measured on the surface or thereby reveal something about the composition, extent and physical properties of the subsurface materials. The various electrical geophysical techniques distinguish materials through whatever contrast exists in their electrical properties. Materials that differ geologically, such as described in a lithologic log from a drill hole, may or may not differ electrically and, therefore, may or may not be distinguished by an electrical resistivity survey. Properties that affect the resistivity of a soil or rock include porosity, water content, composition (clay mineral and metal content), salinity of the pore water, and grain size distribution.

Table 4.1 Typical electrical resistivity's of earth materials

Material	Resistivity (Ωm)
Clay	1-20
Sand, wet to moist	20-200
Shale	1-500
Porous limestone	100-1,000
Dense limestone	1,000-1,000,000
Metamorphic rocks	50-1,000,000
Igneous rocks	100-1,000,000

Table 4.1 shows some typical ranges of resistivity values for manmade materials and natural minerals and rocks, similar to numerous tables found in the literature (van Blaricon 1980; Telford et al. 1976; Keller and Frischknecht 1966). The ranges of values shown are those commonly encountered but do not represent extreme values. It may be inferred from the

values listed that the user would expect to find in a typical resistivity survey. Low resistivities for the soil layers, with underlying bedrock producing higher resistivities. Usually, this will be the case, but the particular conditions of a site may change the resistivity relationships. For example, coarse sand or gravel, if it is dry, may have a resistivity like that of igneous rocks, whereas a layer of weathered rock may be more conductive than the soil overlying it. In any attempt to interpret resistivities in terms of soil types or lithology, consideration should be given to the various factors that affect resistivity.

Table 4.2 Resistivity versus Corrosivity of Soil

Corrosivity	Resistivity (Ω -m)
Very Corrosive	Below 5
Corrosive	5-10
Moderately Corrosive	10-20
Mildly Corrosive	20-100
Generally not Corrosive	> 100

4.3 Electrical Resistivity Interpretation

Electrical resistivity tests were conducted at fifteen (15) different locations across the site up to the depth of 10.0 meters. The interpretation of resistivity values for each location is described in this section.

4.3.1 Soil resistivity for all lines

The resistivity values recorded at the site range from 0.57Ω -m to 302.59Ω -m. The underground environment is categorized as *very corrosive to non-corrosive*. Table 4.3 corresponds to the corrosivity at various depths ranges in various line lines.

Table 4.3 Corrosivity at various depths in test lines

Test Line	Depth Range (m)	Corrosivity
ERS-1	0.0 – 10.0	Mildly corrosive
ERS-2	0.0 – 3.0 3.0 – 10.0	Non-corrosive Mildly corrosive
ERS-3	0.0 – 3.0 3.0 – 5.0 5.0 – 10.0	Mildly corrosive Non-corrosive Mildly corrosive
ERS-4	0.0 – 10.0	Non-corrosive
ERS-5	0.0 – 3.0 3.0 – 10.0	Moderately corrosive Corrosive
ERS-6	0.0 – 5.0 5.0 – 10.0	Mildly corrosive Corrosive
ERS-7	0.0 – 1.0 1.0 – 10.0	Moderately corrosive Mildly corrosive
ERS-8	0.0 – 1.0 1.0 – 5.0 5.0 – 10.0	Moderately corrosive Mildly corrosive Non-corrosive
ERS-9	0.0 – 5.0 5.0 – 10.0	Very corrosive Non-corrosive
ERS-10	0.0 – 1.0 1.0 – 7.0 7.0 – 10.0	Corrosive Very corrosive Moderately corrosive
ERS-11	0.0 – 1.0 1.0 – 10.0	Mildly corrosive Non-corrosive
ERS-12	0.0 – 1.0 1.0 – 3.0 3.0 – 7.0 7.0 – 10.0	Very corrosive Mildly corrosive Very corrosive Corrosive
ERS-13	0.0 – 10.0	Very corrosive
ERS-14	0.0 – 10.0	Mildly corrosive
ERS-15	0.0 – 7.0 7.0 – 10.0	Mildly corrosive Non-corrosive



Figure 4.2 Electrical resistivity Test in progress



Figure 4.3 Electrical resistivity Test in progress

5.0 RECOMMENDATIONS & CONCLUSIONS

- Electrical resistivity and thermal conductivity tests for Solar Power Project at Deh Mithaghar, Gadap Town, Karachi were carried out in December 2022.
- Scope of work included six (06) thermal conductivity tests and fifteen (15) electrical resistivity tests.
- The values of thermal conductivity and thermal resistivity have been presented in table 3.1.
- Appropriate measures need to be taken in order to prevent the corrosion of all metallic objects and grounding of electrical equipment.

APPENDICES

APPENDIX-A

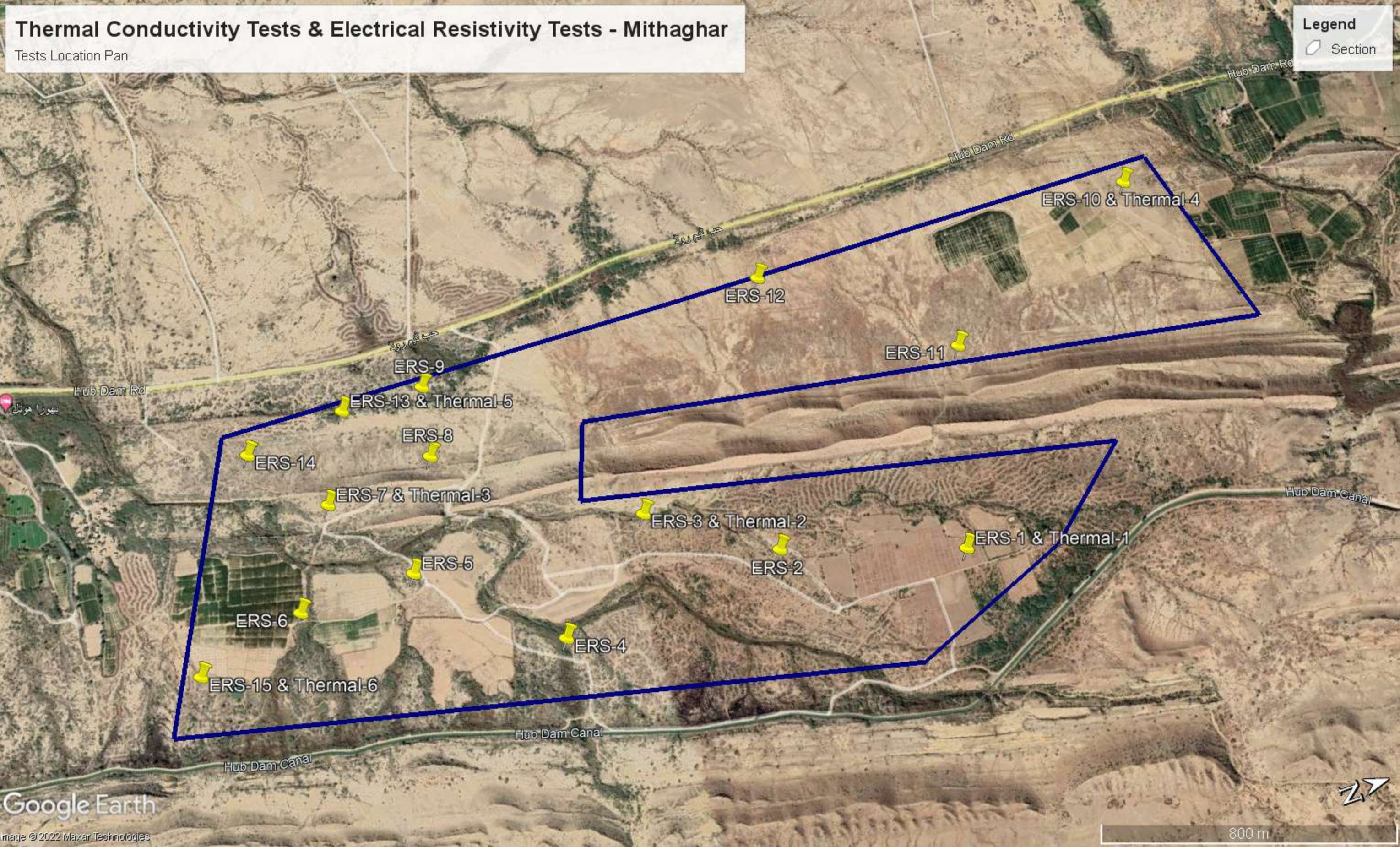
TEST LOCATION PLAN

Thermal Conductivity Tests & Electrical Resistivity Tests - Mithaghar

Tests Location Pan

Legend

Section



APPENDIX-B

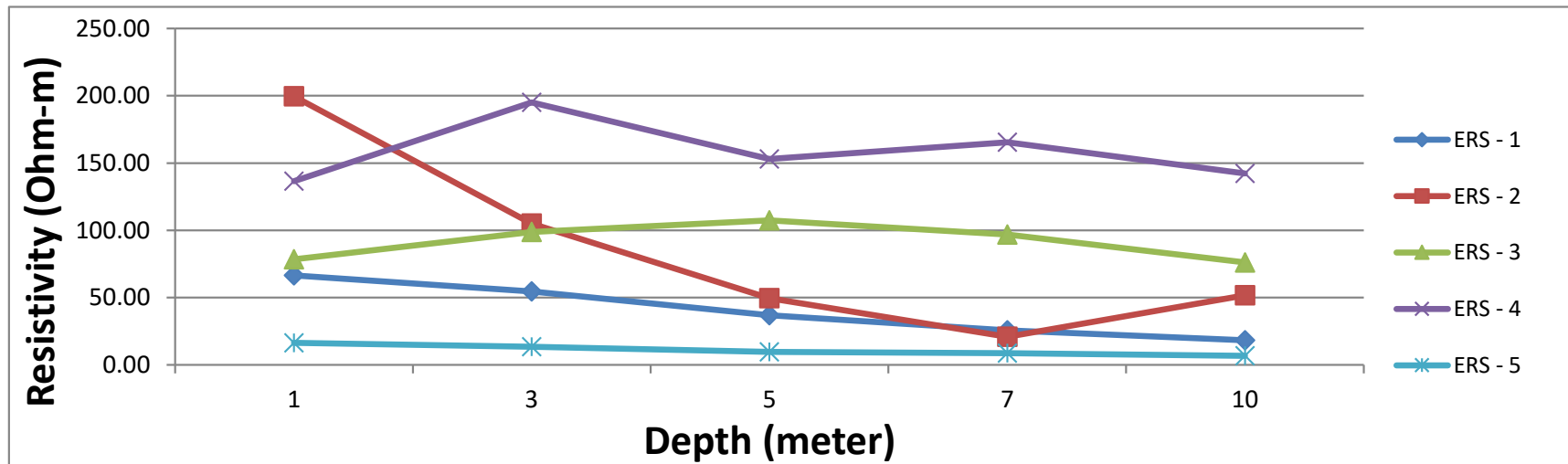
**TEST RESULTS FOR ELECTRICAL
RESISTIVITY TESTS**

K22-1245-101

Project: Solar Power Project at Mithaghar

Client: M/s. Renewable Resource Private Limited

Depth (meters)	ERS - 1	ERS - 2	ERS - 3	ERS - 4	ERS - 5
	Resistivity (Ohm-m)				
1	66.48	199.52	78.35	136.53	16.38
3	54.48	104.95	98.78	195.07	13.44
5	36.98	49.49	107.39	153.07	9.61
7	25.56	20.85	96.77	165.40	8.75
10	18.29	51.78	76.16	142.28	6.72

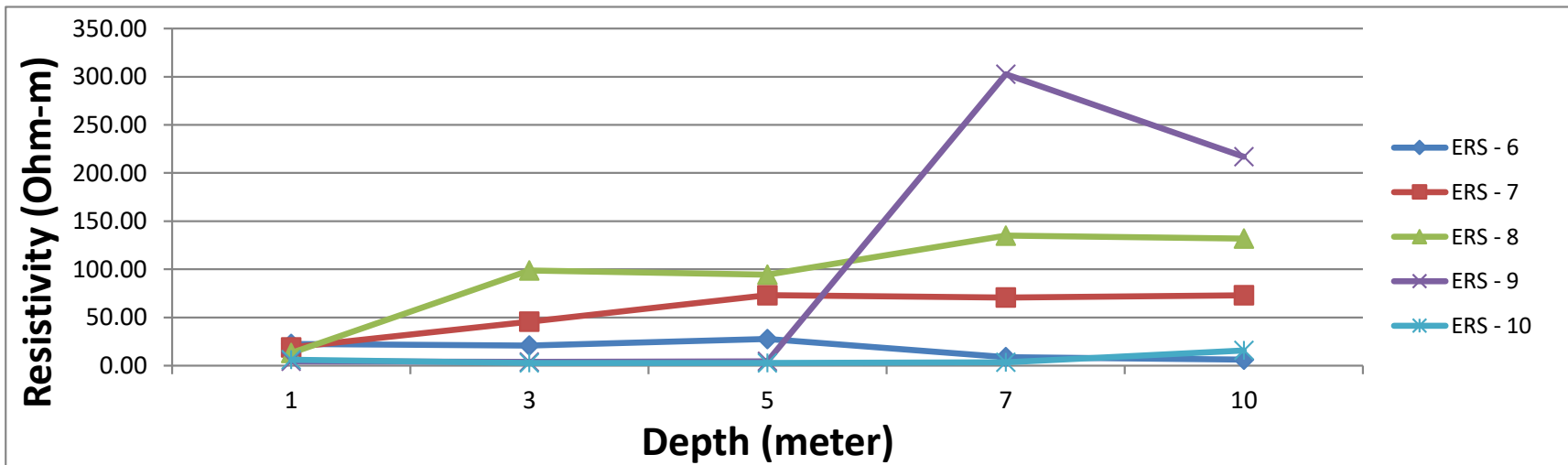


K22-1245-101

Project: Solar Power Project at Mithaghar

Client: M/s. Renewable Resource Private Limited

Depth (meters)	ERS - 6	ERS - 7	ERS - 8	ERS - 9	ERS - 10
	Resistivity (Ohm-m)				
1	22.62	18.99	13.19	4.32	6.10
3	20.94	45.49	98.78	3.92	2.75
5	27.71	73.20	94.60	4.52	2.83
7	8.93	70.80	135.04	302.59	3.56
10	6.28	72.96	132.03	217.05	15.77



K22-1245-101

Project: Solar Power Project at Mithaghar

Client: M/s. Renewable Resource Private Limited

Depth (meters)	ERS - 11	ERS - 12	ERS - 13	ERS - 14	ERS - 15
	Resistivity (Ohm-m)				
1	25.07	2.36	1.71	35.41	46.67
3	117.26	22.45	0.57	68.74	68.64
5	168.53	4.59	2.83	76.54	84.56
7	132.55	4.93	3.17	52.46	94.65
10	188.52	6.28	2.51	42.64	113.46

