JORDAN MESBAR
GEOENGINEERING CONSULTING CO. L.T.D

Project No.
S25058

Geotechnical Site Investigation Report
For

السادة وزارة الاشغال العامة والاسكان

مشروع دراسة جيوتقنية لدراسة أسباب الانهيارات و الهبوط المتكرر

الطريق الملوكي

ذيبان – الموجب

July-2025
Amman- Jordan

JORDAN MESBAR
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Date : July ,31 ,2025
Project No. S25058

Messrs. : وزارة الاشغال العامة والأسكان

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الطريق الملوكي ذيبان – الموجب

Subject : Geotechnical Site Investigation Report
Subsurface Investigation

Dear Sirs,

We are pleased to submit to you herewith the geotechnical report of the carried out geotechnical works for the above-mentioned site at Dhiban *-Wadi Al-Mujib – Jordan. The works generally consisted of drilling boreholes, Excavation test pit, sampling, Installation and laboratory testing.*
This investigation was conducted in accordance with the agreement, dated July, 6,2025.

We appreciate this opportunity to carry out this study assuring you our best services.

Ministry of Public Works & Housing
14 AUG 2025
Roads Administration

Jordan Mesbar
Geoengineering Consulting

JORDAN MESBAR **Eng. Talal Abu Baker**

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1. INTRODUCTION

These investigations were carried out according to the tender's specifications and engineer's instructions. These investigations comprised a program of carrying out drilling of boreholes, excavate trial pit, sampling, install standpipe piezometer and laboratory testing. These works were supervised by the Ministry of Public Works & Housing.

1.1 Purpose Of Study

The main purposes of the drilling boreholes and excavate trial pits works are generally to assist the slope stability analysis, identify the causes of the settlements on the road surface and determine the subsurface soil conditions at the road between Wadi Al-Mujib and Dhiban.

All drilling works carried out in accordance with the project specifications works

1.2 Scope of Work

This study was carried out according to the following sequential manner:

1. Studying all available maps and information concerning the site and the proposed project.
2. Conducting site visits to collect information regarding the geology of the site area.
3. Drilling 2 Boreholes in accordance with your requirements.
4. Install one standpipe piezometer to a depth of 30.0m.
5. Excavation one trial pit to a depth of 2.0 m in accordance with your requirements.
6. Collecting Disturbed and Undisturbed samples from boreholes.
7. Carrying out laboratory tests and presenting these tests results in attached tables.
8. Analysis of the field and laboratory test results.
9. Taking photographs for trial pit .
10. Submit full comprehensive geotechnical report.

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1.3 Project Data

Project Name	:	مشروع دراسة جيوتقنية لدراسة أسباب الانهيارات و الهبوط المتكرر الطريق الملوكي ذيبان - الموجب
Client	:	وزارة الاشغال العامة والأسكان
Geotechnical Contractor :		Jordan Mesbar Geoengineering Consulting Co LTD Amman – Wasfi Al tal Street Phone No. +962-6- 5530 0 31 Fax: +962-6-5530 0 38. Mobile :+962-79 558 2096 Email:info@jordanmesbar.com

2. GENERAL SITE DESCRIPTION

The project is located at the Kings' Highway between Dhiban and Al-Mujib Dam, between coordinates (E: 227507.088, N: 1095663.600) and (E: 227558.509, N: 1095620.561), with a total length of 60.0 m. This section suffers from slope failures and recurrent settlements in the road embankment. Geological survey works have indicated that this part of the road lies within an old landslide area. In addition, water seepage was observed at the upper part of the slope, as well as an agricultural land above the studied site where irrigation activities are being carried out. Closed drainage pipe culvert was also observed within the study.

The surface of the site have elevations ranging between 210m to 185m above sea level.

The surface layer covered by debris materials (Land slide materials) and road embankment.

The google map location of the site are attached in figure No.1 and No.2 respectively below.

Figure 1

Figure 2

3. GENERAL GEOLOGY

3. GENERAL GEOLOGY

It has been observed, based on the coordinates of the study area, that it is located near a large landslide, which represents a significant geotechnical hazard. Slope stability in the area is influenced by several factors, with the primary controlling elements being the nature of the underlying bedrock and soil, the slope configuration, and prevailing groundwater conditions.

3.1 Quaternary and Recent Sediments (S / AL)

The investigated site area is covered by wadi sediment soil (Pleistocene) . The formation of this soil, most probably, is quaternary. It is derived from carbonate rocks by processes of in-situ weathering and erosion include alluvial deposit of ephemeral wadies and associated flood plains. They consist of different fancies of moderate to unsorted , sandy silty clay matrix , gravel and cobbles of limestone and chert. They are sub rounded to sub angular and vary in composition depending on the local bed rocks.

The other parts of the site are covered by debris and colluvium materials., generally consist of different types of unsorted material of angular and subangular gravel to boulders of limestone and chert mixed with silty clay and marl.

3.2 Fuhays/ Hummar/ Shuayb (F/H/S)

These formations were encountered below debris and colluvium materials. The Undifferentiated (Cenomanian-Early Turonian) is overlying the Na'ur limestone formation and is 140 m thick. It consists of variably fossiliferous gray-green to buff marls with nodular limestone. Tow thin bedded distinctive limestone member can be distinguished and traced locally on the map where the beds are not land slipped. The lower (Karak Limestone Member) 36.0m. thick consists of alternating beds of Gryphaea rich limestone with laminated marly limestone. Bituminous base in parts. The upper (Wala Limestone Formation) 8.0m. thick comprises buff to grey fossiliferous packstone with ammonites. Above the Wala Member is distinctive green to pinkish red mudstone unit with beds (up to 3.0m thick) of laminated, fibrous and nodular gypsum, which is quarried locally . The depositinal environment ranged from open marine to supratidal.

4. SEISMOLOGY OF THE AREA

According to Jordanian Seismic Building Code volume, I, 2022, the following parameters shall be taken into consideration during design stage, the site location at the updated Jordan's seismic maps is shown in Figure 4, 5 and 6.

Type of Material	Debris materials
Site Class	S_D
0.2- Second Spectral Response Acceleration, S_s	0.64
0.2- Second Site Class Coefficient, F_α	1.31
1- Second Spectral Response Acceleration, S_1	0.22
1-Second Site Class Coefficient, F_v	1.84
Peak ground acceleration, PGA	0.26
Peak ground acceleration coefficient, FPGA	1.6
Potential damage	Moderate

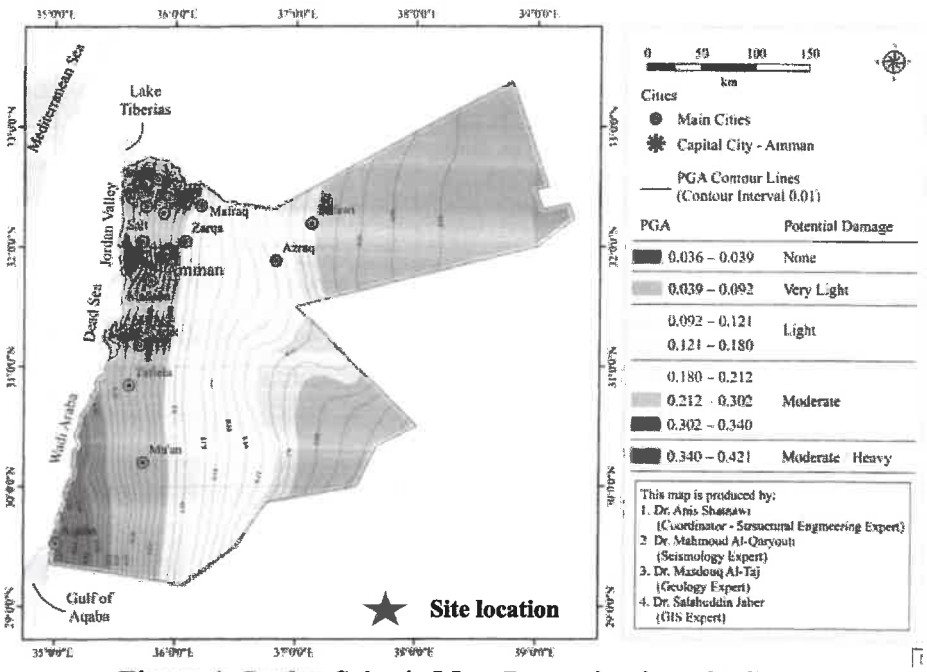


Figure 4: Jordan Seismic Map, Determination of PGA.

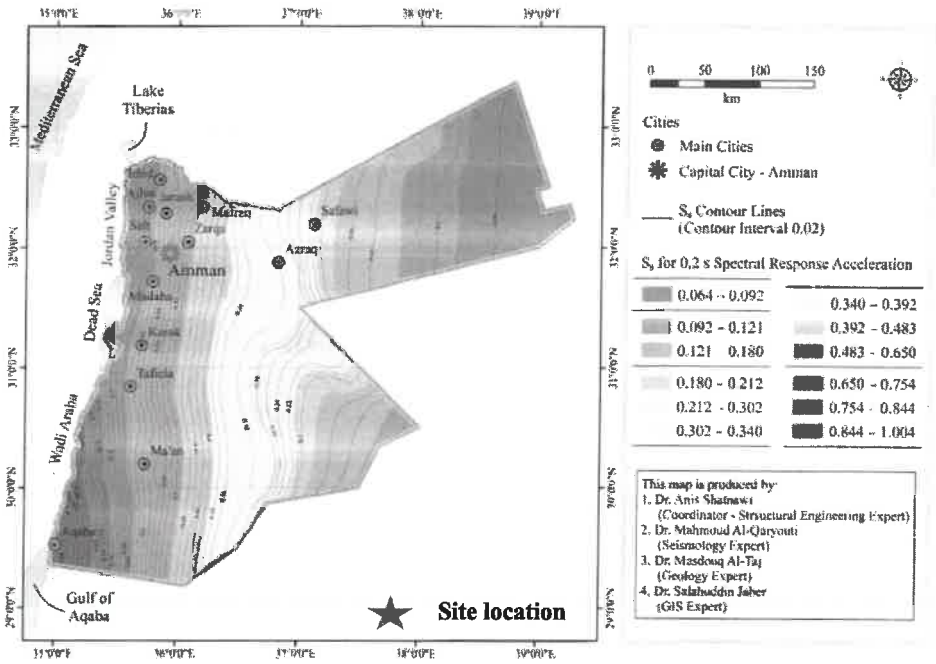


Figure 5: Jordan Seismic Map, Determination of Ss.

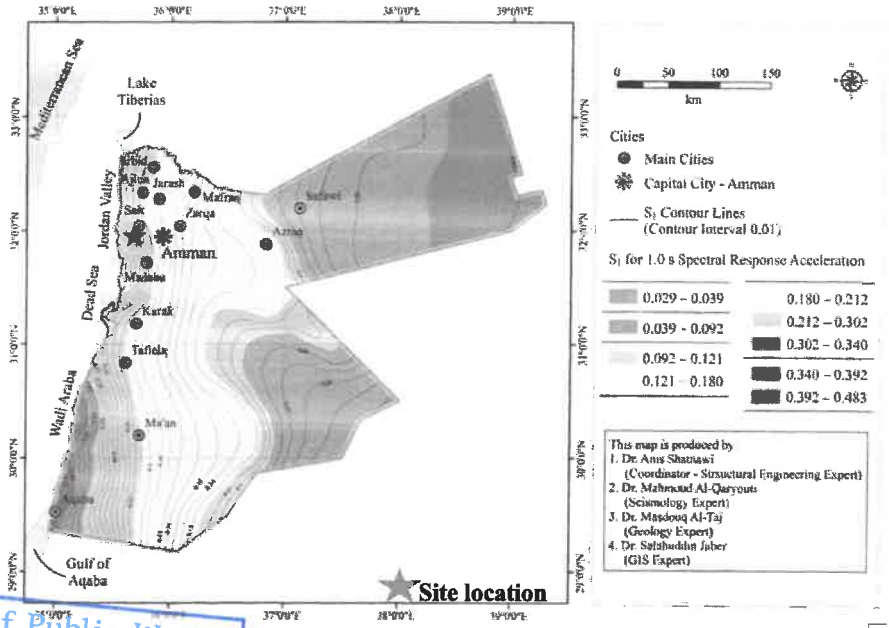


Figure 6: Jordan Seismic Map, Determination of S1.

5. FIELD INVESTIGATION

5.1 *Mobilization*

One drilling rig (Dando 51 Mounted on Mercedes truck 2544) was mobilized to the site on July, 13th, 2025 for boreholes drilling, with necessary equipment's and tools to perform the required drilling works and the field test in accordance with specifications and engineer's instructions. The field works were ended on July, 15th, 2025.

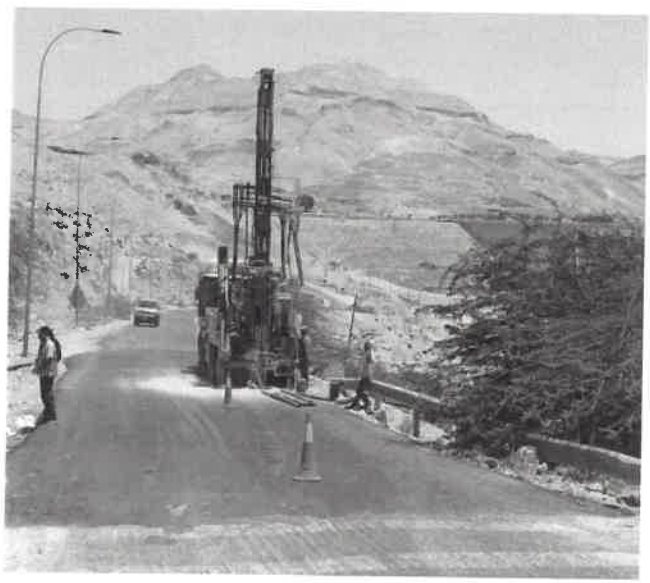
5.2 *Drilling of Boreholes*

The drilling program consists of drilling 2 boreholes to a depth of 30.0m each below the existing ground surface.

The diameter of all drilled boreholes is 100mm, Samples obtained were collected in water proof plastic. Casing with diameter of 5.0 inches was advanced with drilling as lining of the necessary depth of the boreholes.

Locations of the drilled boreholes are presented in (Figure 1) and attached in (Appendix A).

The number, co-ordinations, elevation and depth of each borehole are summarized in (Table 1) below.



The Borehole No. , coordinates, elevations, and depths of each borehole are summarized in (Table 1) below.

Table 1: Borehole number, co-ordinations, elevation and depth of each borehole:

BOREHOLE	EAST	NORTH	ELEVATION	Depth (m)
BH-1	227540	1095636	206	30.0
BH-2	227530	1095626	204	30.0
Total				60.0

5.3 Tests Pits Excavations

One exploratory excavation of test pit was carried out by manual techniques. the test pit was excavated to a depth of 2.0m. Location of the excavated test pit is presented in general site plan attached in (Appendix A).

The detailed geological description for the test pit is presented on the log of trial pit (Appendix B,B2).

5.4 Sampling

5.4.1 Sampling from Boreholes

It is our knowledge that sampling of undisturbed soil and rock samples depends on the geology and the nature of the subsurface materials encountered during drilling.

Undisturbed sampling from all materials encountered were carried by hydraulic driven rotary method utilizing double-tube swivel head type HW412-F core barrels of 76mm inner diameter and 108 mm outer diameter with tungsten carbide and PDC drilling bits. Air flush was used.

All samples were marked, placed in core boxes and covered with plastic foil and closed with a lid. Taken to our laboratories for testing and photographed.

Description of soils (Visual Manual Procedures) was carried out on the field by our geotechnical engineer in accordance with the local codes, ASTM D 2488 and BS 5930

Final boring logs give a detailed description of the various soil strata and shall include group symbol based on "Classification of Soils for Engineering Purposes" ASTM D 2487, indication of samples tested elevations of water table position.

Detailed lithological descriptions of the subsurface materials encountered in each borehole and methods of sampling are presented on logs of boring, **(Appendix B,B1).**

5.4.2 Sampling from Test Pit

Representative bulk samples of 50 kg in weight were collected from each lithological layer at trail pit. The samples were logged, marked and transported to our laboratories for testing.

Field density test was carried on each road embankment layers to determine the field density.

Detailed lithological descriptions of the subsurface materials encountered in each test pit are presented in **(Appendix B, B2)**.

4.5 Field Testing

5.5.1 Field Density

The field density test is a field control test for the compaction soil or any other pavement layer. The Field Density test by the Sand Cone Method was carried out in accordance with ASTM D1556-00 "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.

Summary of the field density test results are presented in (Table 2).

Table 4 : field density test results

T.P.No	Depth (m)	Materials Description	FIELD DENSITY	
			Moisture content %	Compaction %
TP No.1	0.0 - 0.17	Embankment layer	1.8	98.9
	0.17 - 0.35	Embankment layer	2.6	99.1

4.5.2 Instrumentations

4.5.2.1 Standpipe Piezometers Instruments Without Data logger

4.5.2.1.1 Componants

Porous Tip

(UPVC) piezometer tip, 50 mm internal diameter with varied lengths and consist of rigid plastic end fittings to fit UPVC standpipes. Slot width not greater than 2mm in an equivalent area of slots not less than 5% of the surface area.

Standpipe Tubing and Fittings

Heavy gauge rigid UPVC 3.0m in length to suit the piezometer tips. coupling, end cap and PVC cement.

Protective Cover

4" (UPVC) pipe with a length as instructed and lockable cover.

Read Out Equipment, Dipmeter

It comprises a 100 m flexible Co-axial cable, graduated each meter, mounted on winding drum incorporating 9 V battery, audio signal indicator and sensitivity control, fitted with 11 mm diam. brass PTFE probe.

4.5.2.1.2 Installation of Standpipe Piezometer

The installation shall be carried out in accordance with the specification and as follows:-

1. The borehole was drilled with a diameter of 110 mm.
2. The piezometer tip was screwed and sealed to a 3.0m length UPVC standpipe access tubing.
3. The borehole was formed to a depth 0.5m beyond the intended level of the piezometer.
4. Filter gravel then placed in the borehole to a depth of 1.0m extend above the top of the slotted, water was used for wash gravel saturate the clean gravel materials.
5. The piezometer then lowered to its intended level, jointing and sealing each length of access tubing as it is placed and ensuring it is founded in

the center of the borehole. Sufficient sand was added to the borehole to form a specified long cell of response zone.

6. Bentonite balls then added to the borehole to form a specified plug above the sand cell. Additional water may be added to the borehole to saturate the Bentonite balls.
7. A Bentonite /Cement grout was used to fill the remainder of the borehole.
8. The operation of the piezometer was checked following the completion of the grouting operation.
9. Temporary casing tubes were removed from the borehole and the grout level topped up.
10. The access tubing was then capped and terminated as detailed in the contract specification.
11. The piezometer commissioned following the stabilization of its readings.

The installation logs are illustrated in separate sheets for each borehole in (Appendix C). Base Reading of each instrument summarizes in (Table 3) below:

Table 3: Base Reading of each piezometer

Revised Borehole ID	Easting	Northing	Base Reading (m)		Top Of Pipe Level	*Water level (m)
			Date	Water Depth		
BH-1	227540	1095636	14/July/2025	No water	205.5	No water
			15/July/2025	No Water		No Water
			24/July /2025	Broken **		Broken**

*Water depth: measured water depth below the top of the extended piezometer access tube above the existing ground surface.

** During our site visit on 24, July, 2025 we noticed that the standpipe piezometer was broken and its location was backfilled by the new diversion road. As shown in the figure below.

6.0 Laboratory Testing

The laboratory testing program was designed to evaluate the pertinent physical and mechanical properties of the soil units encountered at the site. the following tests were performed according to ASTM standards as shown in (Table 4).

Table 4 : Laboratory testing program

Item	Description	Standard
Soil Mechanical Test		
1.	Moisture content	ASTM D2216
2.	Unit Weight	ASTM D7263
3.	Atterberg limits	ASTM D 4318
4.	Grain Size distribution by Sieve Analysis / or hydrometer	ASTM D 422
5.	Compaction test (Proctor)	ASTM D698/D1557
6.	Consolidation - Drained Direct Shear tests	ASTM D 3080
7.	CBR	ASTM1183
Rock Mechanical Test		
7.	Unit Weight	ISRM
8.	Uniaxial Compression test	ISRM

Physical & Mechanical laboratory test results for boreholes are Presented in (Table 5)

Physical & Mechanical laboratory test results for test pit are Presented in (Table 6

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Table 5: Physical & Mechanical laboratory test results for borehole

BH No.	Material description	Depth m	Bulk Density gm/cm³	Moisture Content %	Atterberg Limits			Sieve Analysis, %				Axial Pressure		Direct Shear tests	
					LL	PL	PI	Gravel	Sand	silt	Clay	Stress kg/cm²	Strain %	C kg/cm²	Ø°
1	Debris	1.5		6.5	Non	Non	Non							0.0	25
	Clayey marl	3.0	1.959	8.0	29	17	12	18	20	34	28	2.31	2.62		
		14.0		7.5											
	Marly limestone	6.0		6.0											
		7.5	2.121	4.0								65	--		
		9.0		4.5											
		11.0	2.221	4.5								180	--		
	Marlstone	14.0		4.1											
		17.0	2.218	4.1								75	--		
		20.0		3.9											
		22.0		3.9											
		26.0		5.7											
2	Embankment	1.0		2.5											
		2.5		5.2	Non	Non	Non	32	30	28	10				
		5.0		5.1										0.50	30
		7.5		4.9	27	18	9								
		9.5		4.9											
	Clayey marl	12.0		8.7	32	19	13	15	24	34	27			1.0	18
	Marly limestone	13.0	2.654	5.2								140	--		
	Marlstone	15.0		5.1											
		18.0		4.2											
		21.0	2.248	4.0								80	--		
		27.0		3.8											

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Table 6: Physical & Mechanical laboratory test results for test pit

TP No.	DEPTH (m)	Materials Description	Natural Moisture Content ASTM D2216	Sieve Analysis, %									Atterberg Limits (%) ASTM D 4318			Modified Proctor ASTM D1557		C.B.R ASTM D 1883-2007	
				1.5	1.0	3/4	1/2	3/8	No.4	No.10	No.40	No.200							
				37.5mm	25mm	19mm	12.5mm	9.5mm	4.75mm	2.0mm	425µm	75µm	LL	PL	PI	MDD gm/cm3	OMC%	0.1"	0.2"
T.P 1	0.0 - 0.17	Embankment layer	1.8	98.1	86.3	78.5	60.7	47.4	35.1	26.2	17.7	11.1	24	19	5	2.117	7.6	62	68
	0.17 - 0.35	Embankment layer	2.6	96.7	89.8	83.6	77.5	66.3	51.4	39.6	22.1	12.5	26	20	6	2.044	8.3	44	49

7. ENGINEERING ANALYSIS

7.1 Site Geology

The visual lithological description of the materials encountered in the boreholes drilled disclosed general similarities.

Generalized stratigraphical profile (AA') presented on (Figure 2 Appendix A) were drawn graphically to shows general trends of the subsurface materials. For more details, reference should be made to the individual logs of borings documented and presented in (Appendix B, B1). The location of this profile is shown on general site plan (Figure 1, Appendix A).

The encountered subsurface materials consist of the following materials starting from the existing ground surface: -

1. **Road embankment material** composed of Asphalted layers, base and sub base layers.

1- **Debris materials** composed of silty clay, marl with angular and sub angular gravel, cobbles and boulders of limestone.

3- Light brown to Green, Red, moist to wet, very weak **clayey marl.** (F/H/S formation).

4- Creamy , dry , slightly weathered, moderately weak **marly limestone** interbedded with thin to thick layers of marlstone and clayey marl. (F/H/S formation).

5- Light gray, dry to moist, weathered, moderately weak **Marlstone** alternated with yellow to creamy highly fractured moderately weak limestone with wet marl filling the fractures. (F/H/S formation).

7.2 *Materials properties*

Physical properties of the materials encountered were obtained from the laboratory investigation program.

7.2.1 *Materials Physical Properties*

The MOISTURE CONTENT shows the relative variation of capacity of different materials to store water. These values of moisture contents are unique to the time of sampling and significant differences are to be expected at other times.

The PLASTICITY of the encountered materials was determined by direct plotting of liquid limits against plasticity indexes on Casagrande Plasticity Chart.

The BULK DENSITY was determined by direct measurements of size and weight of the obtained undisturbed samples.

The results of the PARTICLE SIZE distribution tests of the materials show the relative proportions of the sand, silt and clay fractions in the soil mass. The percentages of these fractions had been plotted on the Textural Classification Chart for determination the TEXTURAL CLASSIFICATION of the soil. The results of the particle size distribution tests of the sand show the proportions of different fractions in the soil mass

The POTENTIAL FOR EXPANSIVENESS of the clay soil was found by plotting the plasticity indexes against the corresponding clay fractions on the WILLIAMS and DONALDSONS, Modified Chart for Expansiveness.

Physical properties obtained from the laboratory tests results for materials encountered in boreholes are summarized in (Table 7).

Table 7: Materials Physical Properties

No.	Type of Materials	Bulk Density gm/cm^3	Moisture Content %	Plasticity Index PI	Expansiveness
1.	Embankment layers	--	2.8 – 15.4	Non	--
2.	Debris materials	--	3.8	Low	Low
3.	Clayey marl	1.959	4.10 – 14.0	Low	Low
5.	Marly limestone	2.121-2.654	2.09 – 3.2	--	--
6.	Claystone	2.218-2.248	2.30 – 5.5	--	--

7.2.2 Materials Mechanical Properties

The smallest MODULUS OF DEFORMATION for the Clayey marl was obtained from the stress-strain relationship of unconfined compression tests.

STRENGTH of the Clayey marl & rock materials was determined using values of the unconfined compression tests results and referring to the Jordanian Code of Practice III, (Table 19).

All compressive strength results were corrected using the correction factor equation in accordance with ASTM D 2938.

$$C=1/[0.88+0.24(D/L)]$$

Due to the small site area, the ROCK MASS RATING (RMR) for the rock materials was determined by Bieniawski Method based on the drilling results, unconfined test results and ROCK QUALITY DESIGNATION (R.Q.D.) only.

The MODULUS OF DEFORMATION of rock material were determined by Bieniawski as follows for RMR < 50:-

$$Em = 10^{(RMR-10)/40}, GPa$$

RELATIVE DENSITY of the **Debris** materials was determined from Standard Penetration Tests (SPT) performed in the field. Interpretation of the tests results was done in accordance with Jordanian Code of Practice, Volume III, (Table 4) and of Foundation Analysis and Design, Joseph Bowles, third edition. The results of SPT tests indicate that the encountered debris materials can be classified as very dense.

The MODULUS OF DEFORMATION of the **Debris** were determined based on SPT results as follows:

$$E = (N + 6) * 1200, \text{ kpa}$$

N corrected – Number of blows from SPT results.

C&Ø for debris materials were determined in the laboratory by direct shear test according to ASTMD3080

The mechanical properties of the encountered materials are summarized in (Table 8).

Table 8: Materials Mechanical Properties

item	Type of Materials	*Modulus of deformation Kg/cm²*	*Poisons Ratio*	*C Kg/cm²*	*Ø°*	*Modified Proctor*		*CBR %*	
						MDD gm/cm³	*OMC%*	*0.1"*	*0.2"*
1.	Embankment layers	--	--	0.50	30	1.793-2.11	7.6-12.2	11-62	15-68
2.	Debris materials	636	0.25	0	25	-	-	-	-
3.	Clayey marl	250	0.25	1.0	18	1.710	13.8	6	10
4.	Marly limestone	10000	0.30	1.0	30	-	-	-	-
5.	Claystone	7500	0.30	1.0	25	-	-	-	-

7.3 *Road Embankment materials*

One tests pits was excavated along the existing road , it was excavated to a depth of 2.0 m below the existing ground level.
Laboratory tests results are shown in the below table:

Table 9 : Road Embankment materials test results

Tests		*Results T.P 1*		*Materials For Embankment MPWH for base course*
		Base course layers		
		0.0-0.17 m	*0.17-0.35 m*	
Natural Moisture Content ASTM D2216		1.8	2.6	
Seive Analysis ASTM D 422	1.5	98.1	96.7	
	1.0	86.3	89.8	
	3/4	78.5	83.6	
	1/2	60.7	77.5	
	3/8	47.4	66.3	
	No.4	35.1	51.4	
	No.10	26.2	39.6	
	No.40	17.7	22.1	
	No.200	11.1	12.5	*12.0% Max*
FIELD DENSITY (ASTM D 1556 , AASHTO T - 191) COMPACTION		98.9	99.1	*100 % Min*
Atterberg Limits (%)	LL	24	26	*25 %Max*
	PL	19	20	*6 % Max*
	PI	5	6	*PI:12 Max*
Modified Proctor ASTM D1557	MDD gm/cm3	2.117	2.044	
	OMC%	7.6	8.3	*2 %*
C.B.R ASTM D 1883-2007	0.1"	62	44	*80% Min*
	0.2"	68	49	
AASHTO		A-1-b	A-2-4	

- **Compliant with MPWH**: Gradation (mostly), Plasticity Index.
- **Non-compliant with MPWH**: Field density (slightly below), field moisture (too low), CBR (significantly low), and marginally high LL for the second layer.

7.4 Ground Water

No free or confined groundwater was encountered in any of the boreholes at the drilled depths. However, high moisture content was observed in BH-1 at depths ranging from 2.0 m to 4.0 m and from 29.0 m to 30.0 m. Seepage was also observed in the upper part of the study area.

7.5 Geological Features and Cavities

No caves or cavities were encountered in any of the boreholes to depths drilled. Generally, the area is mostly stable. No faults or other geological features were observed at the site and surrounding areas.

7.6 *Slope Stability Analysis Results.*

The slope stability analysis of the existing slope was performed based on the physical and mechanical properties of the encountered materials such as bulk density, cohesion (C) and angle of internal friction (Ø).

The slope stability analysis was carried out using Simplified Bishop's method to identify the critical slip surface at the different sections of the slope. Stratigraphical profiles of section AA', was drawn based on log data from drilled boreholes.

Results of analysis generally indicate that the existing slope is generally considered not stable as the obtained factor of safety is less than 1.2

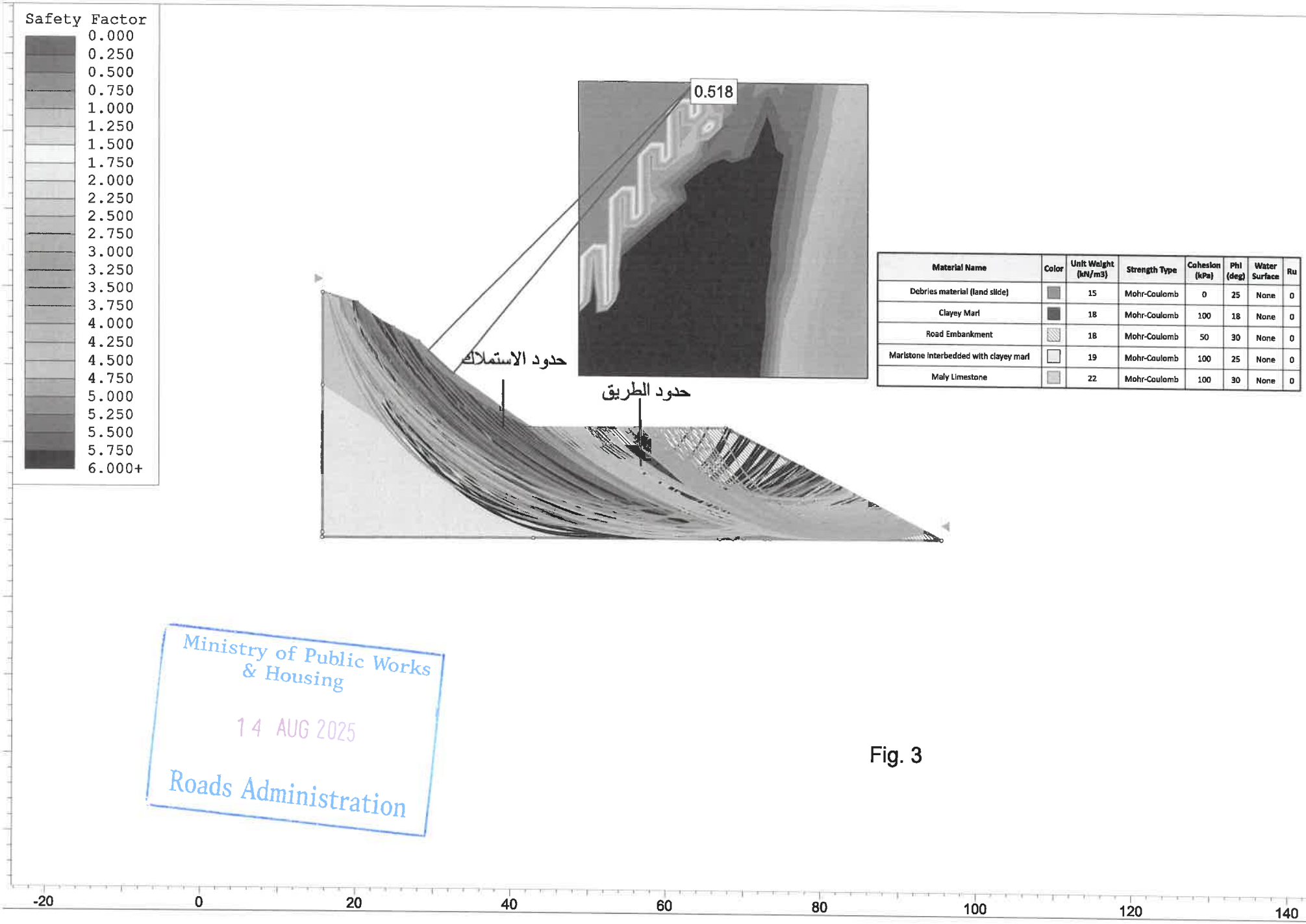
The obtained Factor of safety of the cut slopes of the road are summarized in below table 10

The calculated cut slope inclination is shown in Figure No. 3 below, based on the following criteria:

- Existing boundary loads.
- No ground water conditions.
- Existing Tension Cracks.

Table 10: Summarized Factor of safety of cut slope.

Section	Factor of Safety of the Critical Slip Surface
A-A'	0.518



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Debries material (land slide)		15	Mohr-Coulomb	0	25	None	0
Clayey Marl		18	Mohr-Coulomb	100	18	None	0
Road Embankment		18	Mohr-Coulomb	50	30	None	0
Marlstone interbedded with clayey marl		19	Mohr-Coulomb	100	25	None	0
Maly Limestone		22	Mohr-Coulomb	100	30	None	0

Fig. 3

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8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The following conclusions and recommendations are based on the results of the engineering analysis of the field and laboratory investigations and the nature of the project. If the nature of the project will be adjusted or deviated, these recommendations consequently may need adjustment. Therefore, we should be informed at once so that we can reconsider our recommendations where necessary.

8.2 Conclusions and Recommendation of the Slope Stability Analysis.

8.2.1 Conclusions of Slope Stability Analysis

Factors may cause the landslide at the project area including tension cracks and settlement which can be summarized as below:

1- The site is located at known zone described in the reference geological maps and literatures as a landslide area.

2- Presence of semi cohesive to cohesionless debris materials at the Left side (upper part) of the cut resulted from old landslide at the site and surrounding areas.

3- Presence of wet to semi-saturated clayey marl at depths of 2.0m and 11.5 m below existing ground surface. The moisture existed are resulted from upper part of landslide area where exist irrigation activities.

8.2.2 Recommendations of Slope Stability Analysis

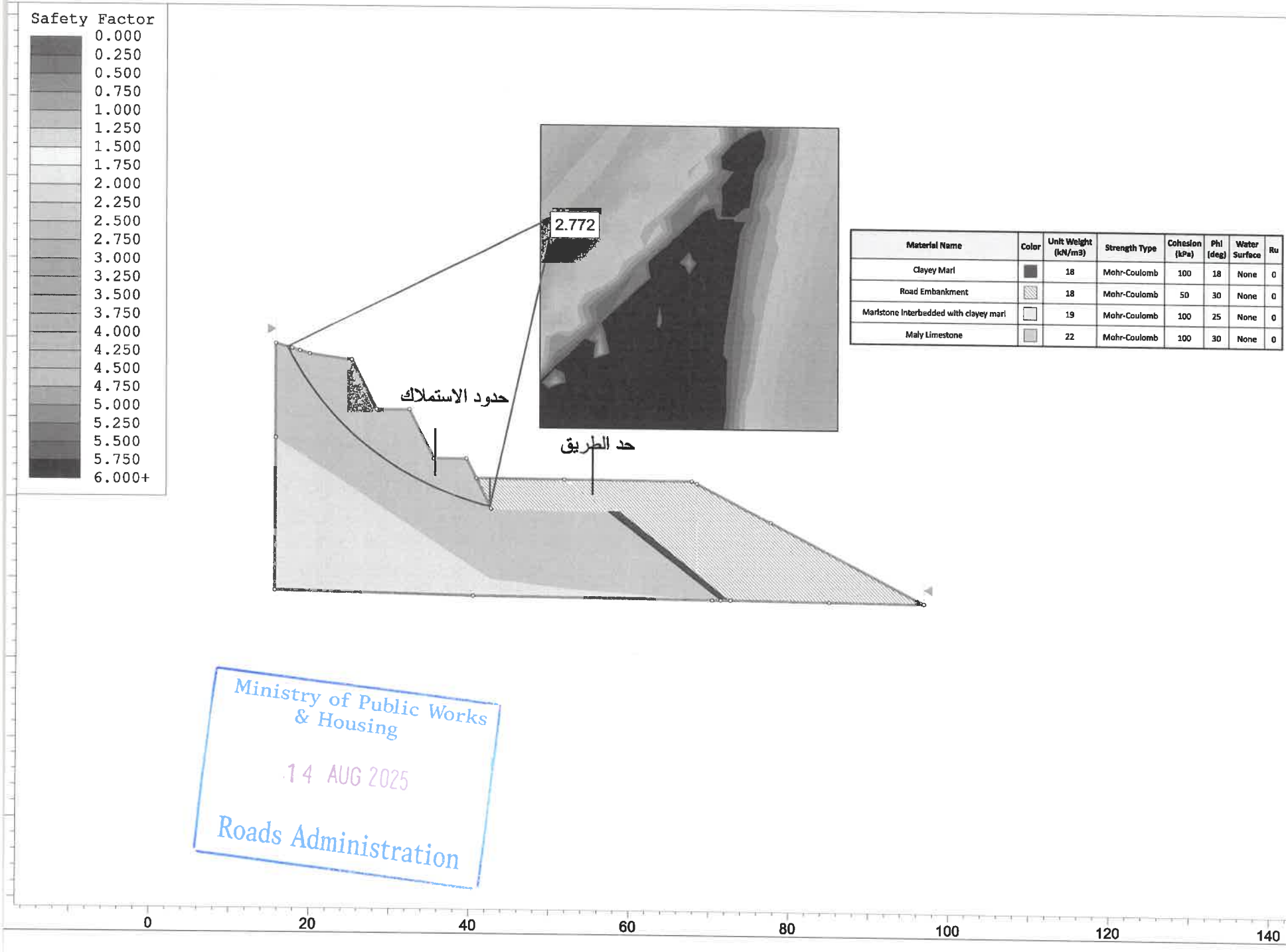
Slope Geometry Modification

Slope geometry shall be modified in the following sequences:

1- performing slope 2H :1V with a maximum berm height of 6 m and berm width of 4.0 m. to remove the debris materials and clayey marl. As shown in the slope stability analysis below.

2- Excavation shall be carried out from the highest level toward the lowest level.

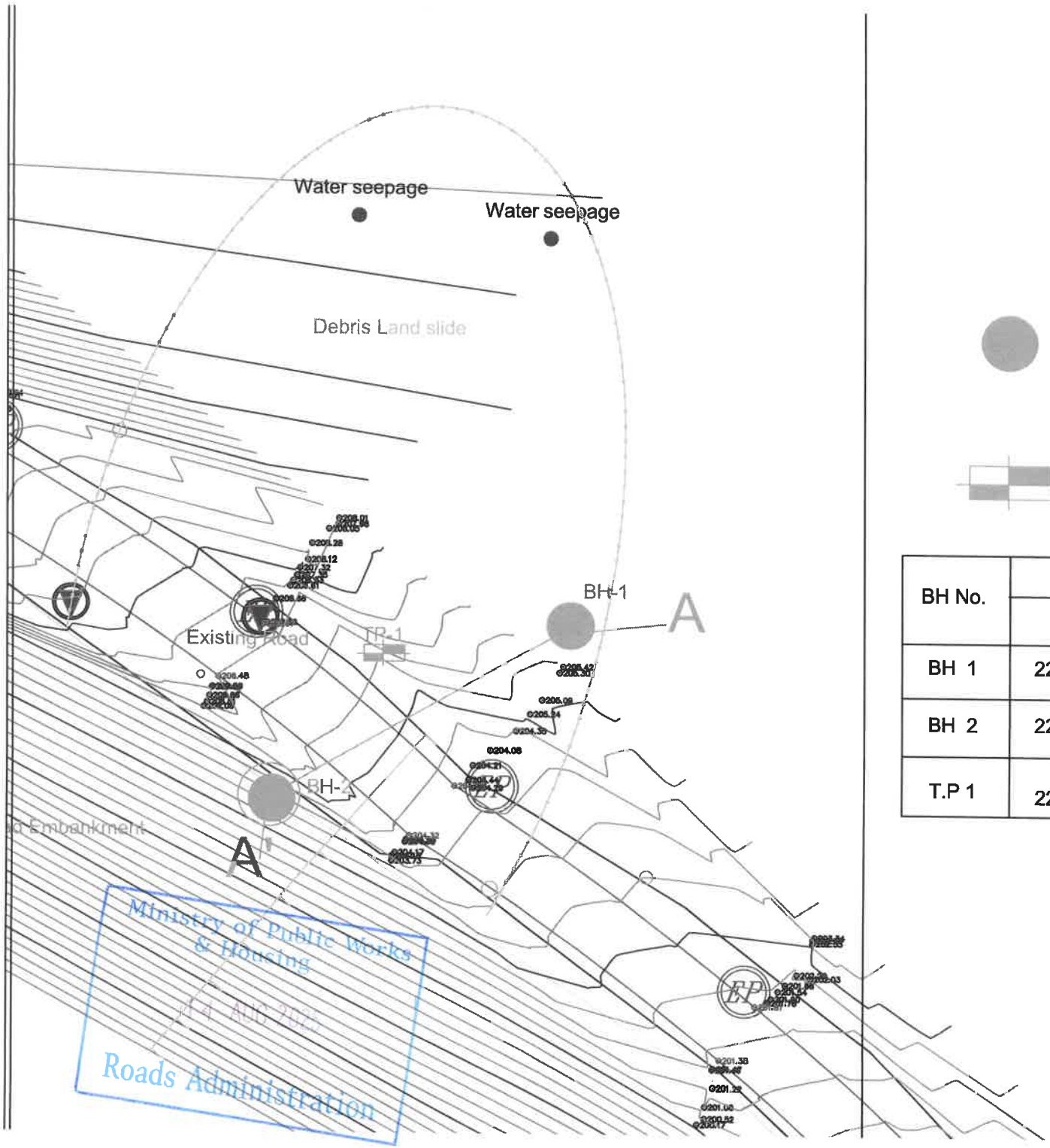
3- Over excavate existing road embankment to an approximate depth of 4.0m to remove the clayey marl materials and replace it by new road embankment materials comply with MPWH specification.



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Clayey Marl		18	Mohr-Coulomb	100	18	None	0
Road Embankment		18	Mohr-Coulomb	50	30	None	0
Marlstone Interbedded with clayey marl		19	Mohr-Coulomb	100	25	None	0
Maly Limestone		22	Mohr-Coulomb	100	30	None	0

APPENDIX A

Figure 1: General site plan
Figure 2: profiles AA'



Drilled Boreholes

Excavation Test Pit

BH No.	Coordinate		Depth (m)	Elevation
	E	N		
BH 1	227551.0	1095645.0	30.0	206.0
BH 2	227521.7	1095628.2	30.0	204.0
T.P 1	227530.9	1095641.4	2.0	206.0

Figure No. 1

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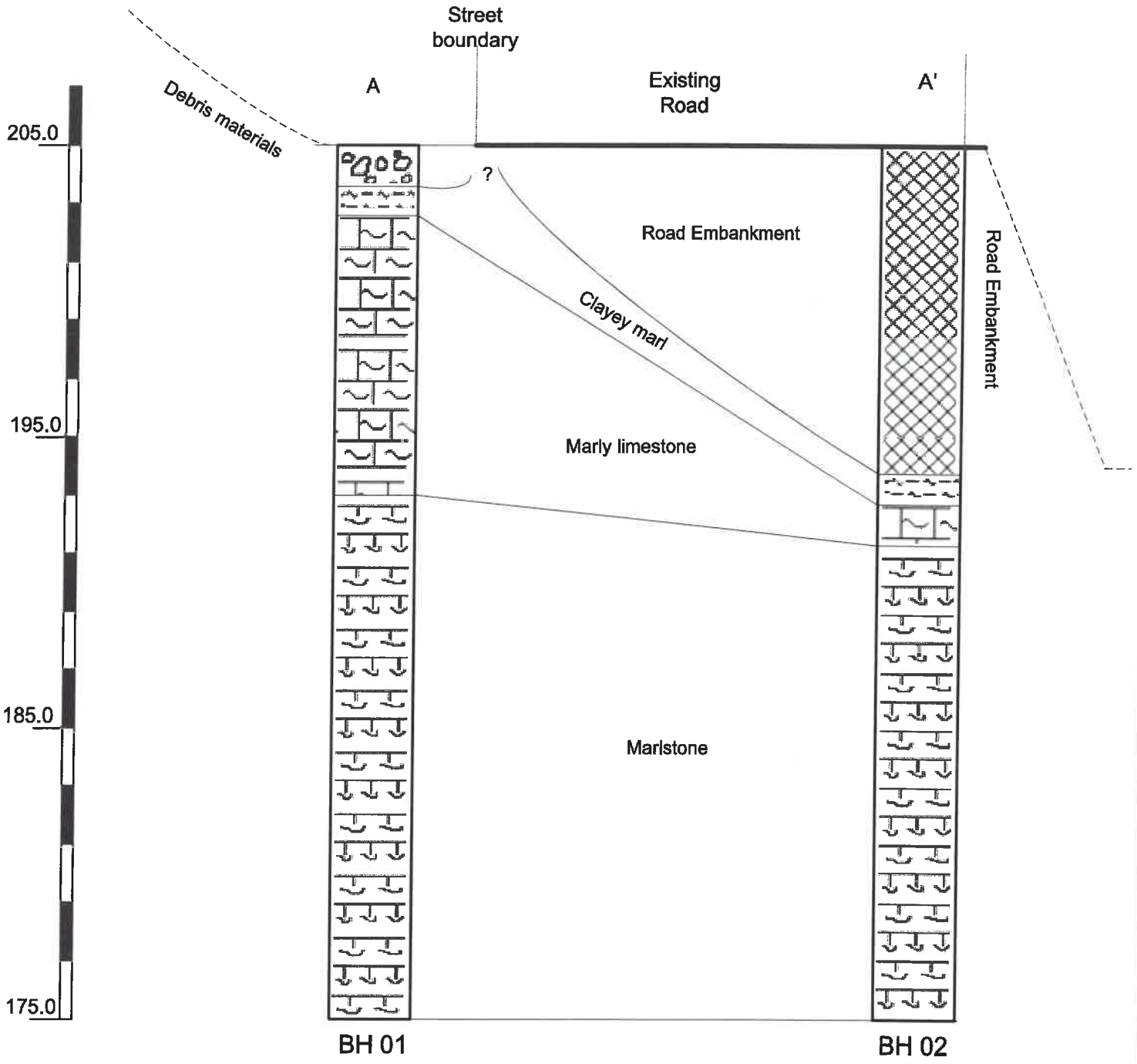

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Street level

Figure No.	2	Generalized Stratigraphical profile AA'
Report No.	S25058	
Scale	Ver 1 :100	

APPENDIX B

B1
Logs of Borings

B2
Logs of trial pit

Project : **Dead Sea Road**

Location : Al-Mujib

Drilling : **Rotary Air Flush**

Water Level : Not encountered

Coordinates :

Borehole NO. : BH-1

Date : 14-July-2025

Elevation : 206

Casing Depth :

Total Depth : 30.0m

Depth (m)	Sampling	Rock Mass Rating: TCR (%)	RQD (%)	SCR (%)	IF(mm)	Fractures	S.P.T N Blows	DESCRIPTION	Symbol	Dry Density g\cm 3	Pressure: Point Load I50	Unconfined qu	LL PLÎÜ
1								**Debris materials** Debris materials composed of silty clay, marl with angular and sub angular gravel, cobbles and boulders of limestone and chert					
2													
3		100	--					**Clayey marl** Light brown to Green, Red, moist to wet, very weak clayey marl					
4													
5								**Marly limestone** Creamy , dry , slightly weathered, moderately weak marly limestone interbedded with thin to thick layers of marlstone and clayey marl					
6													
7		95	20										
8													
9													
10													
11													
12		90	35					**Marlstone** Light gray, dry to moist, weathered, moderately weak marlstone alternated with yellow to creamy highly fractured moderately weak limestone with wet marl filling the fractures.					
13													
14													
15													

Rep. No. : S25058

Project : **Dead Sea Road**

Location : Al-Mujib

Drilling : **Rotary Air Flush**

Water Level : Not encountered

Coordinates :

Borehole NO. : BH-1

Date : 14-July-2025

Elevation : 206

Casing Depth :

Total Depth : 30.0m

Depth (m)	Sampling	Rock Mass Rating					S.P.T N Blows	DESCRIPTION	Symbol	Dry Density g\cm 3	Pressure		LL PLÎÜ
		TCR (%)	RQD (%)	SCR (%)	IF(mm)	Fractures					Point Load I50	Unconfined qu	
16													
17													
18		95	75										
19													
20													
21													
22													
23		90	15										
24													
25													
26													
27													
28													
29													
30								End of Borehole					
31													

Sheet 2 of 2

Rep. No. : S25058

Project : **Dead Sea Road**

Location : Al-Mujib

Drilling : **Rotary Air Flush**

Water Level : Not encountered

Coordinates :

Borehole NO. : BH-2

Date : 15-July-2025

Elevation : 204.0

Casing Depth :

Total Depth : 30.0m

Depth (m)	Sampling	Rock Mass Rating: TCR (%)	Rock Mass Rating: RQD (%)	Rock Mass Rating: SCR (%)	Rock Mass Rating: IF(mm)	Rock Mass Rating: Fractures	S.P.T N Blows	DESCRIPTION	Symbol	Dry Density g\cm 3	Pressure: Point Load I50	Pressure: Unconfined qu	LL PLÎÜ
1–11								**Road embankment materials** Road embankment materials composed of Asphalted layers, base and sub base layers.					
12		100	40					**Clayey marl** light brown to Green, Red, moist to wet, very weak clayey marl					
13–15													

Rep. No. : S25058

Project : **Dead Sea Road**

Location : Al-Mujib

Drilling : **Rotary Air Flush**

Water Level : Not encountered

Coordinates :

Borehole NO. : BH-2

Date : 15-July-2025

Elevation : 204.0

Casing Depth :

Total Depth : 30.0m

Depth (m)	Sampling	Rock Mass Rating: TCR (%)	Rock Mass Rating: RQD (%)	Rock Mass Rating: SCR (%)	Rock Mass Rating: IF(mm)	Rock Mass Rating: Fractures	S.P.T N Blows	DESCRIPTION	Symbol	Dry Density g\cm 3	Pressure: Point Load I50	Pressure: Unconfined qu	LL I------O------I PLÎÜ
16								**Marly limestone** Creamy , dry , slightly weathered, moderately weak **marly limestone** interbedded with thin to thick layers of marlstone and clayey marl.					
17													
18													
19								**Marlstone** Light gray, dry to moist, weathered, moderately weak Marlstone alternated with yellow to creamy highly fractured moderately weak limestone with wet marl filling the fractures.					
20													
21		95	25										
22													
23													
24													
25													
26													
27		100	75										
28													
29													
30								End of Borehole					
31													

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Roads Administration

Sheet 2 of 2

Rep. No. : S25058

Project No: S25058

Log Of T.P : T.P1

Project: Dead Sea Road

Date : 14/7/2025

Excavation Method : Manual tecniques

Coordinates: -

Ground Level : 206.0

T.P Depth : 2.0 m

Location: Dead Sea

Water level : Not encountered

SUBSURFACE PROFILE

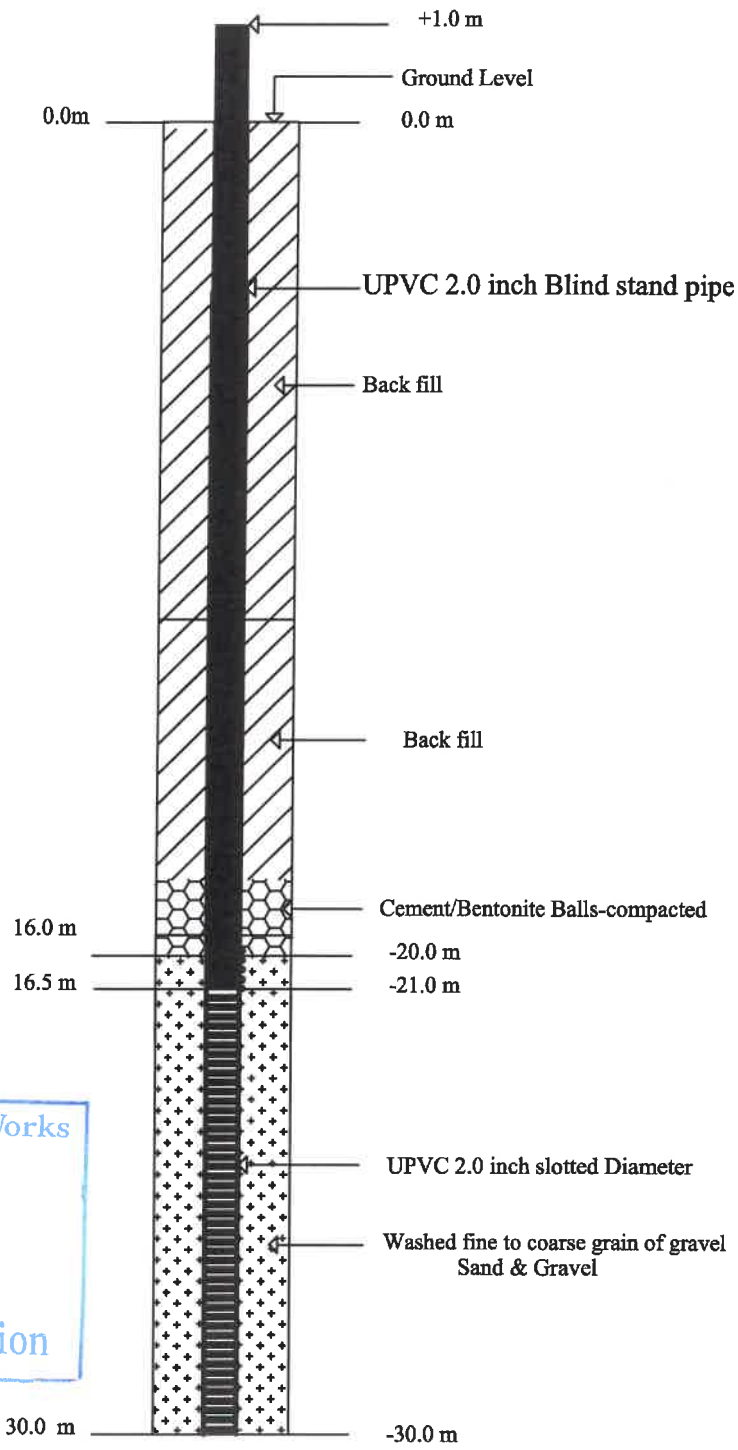
Depth	Elevation	Description	Sampler Symbol	AASHTO	USCS	L.L %	PI %	W%	Water Level	Remarks
0	0.00	Ground Surface								
0 – 1		***Road embankment materials*** Road embankment materials composed of Asphalted layers, base and sub base layers.								
	-1.70	***Clayey Marl*** light brown to Green, Red, moist to wet, very weak clayey marl								
2	-2.00	End of Test pits								
3										

Jordan Mesbar Geoengineering Consulting

APPENDIX C

Stand Pipe Piezometer Installation Log

STAND PIPE PIEZOMETER INSTALLATION LOG	
Project: :King's Highway Dhiban - Almujeb	Contractor : Jordan Mesbar
Location : Madaba	Standpipe Piezometer Number : BH.1
Installation Date : 15-07-2025	Top Level of the pipe at installation time: +1.0 m
Coordinates : E:1095645, N:227551	Ground Level at installation time: 0.0 m
Water Depth at installation time: No Water	Borehole Depth : 30.0 m



APPENDIX D

Geological Map

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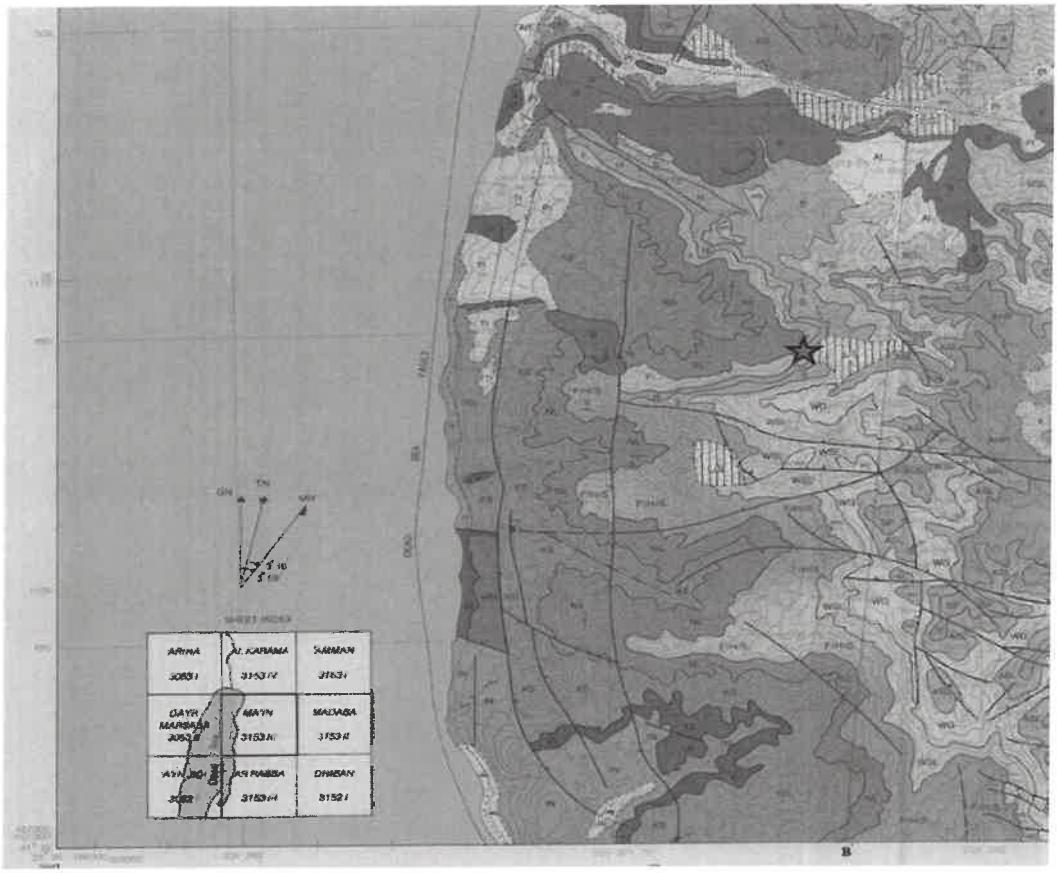

Geological Map : (Main)	Scale : 1:**50000**

Source of Map: Natural Resources Authority.

Symbol	Formation	Stage
S	Soil over bedrock	Holocene
F/H/S	Sheib, Hummar Fuheia	Campanian
NL	Naur Limestone	Neocomian albian
KS	Kurnb Sandstone	Neocomian albian
ASL	Amman Silicified Limestone	Campanian
WG	Wadi Umm Ghudran	Santonian
WSL	Wadi as Sir Lmestone	uronian

Geological Legend

Formation boundary	
Synclinal	
Anticlinal	
Fault	
Landslip	
Dip – measured	3°
Approximate site location	