DETERMINATION OF THE ROCK MASS CHARACTERISTICS AND SUPPORT SYSTEMS OF THE NEW ULUS TUNNEL, ANKARA

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES OF MIDDLE EAST TECHNICAL UNIVERSITY

BY

İREM AKSULAR

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN GEOLOGICAL ENGINEERING

DECEMBER 2008

Approval of the thesis:

DETERMINATION OF THE ROCK MASS CHARACTERISTICS AND SUPPORT SYSTEMS OF THE NEW ULUS TUNNEL, ANKARA

submitted by **İREM AKSULAR** in partial fulfillment of the requirements for the degree of **Master of Science in Geological Engineering Department**, **Middle East Technical University by**,

es

Date: 15.12.2009

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: İrem Aksular

Signature :

ABSTRACT

DETERMINATION OF THE ROCK MASS CHARACTERISTICS AND SUPPORT SYSTEMS OF THE NEW ULUS TUNNEL, ANKARA

Aksular, İrem M.Sc., Department of Geological Enginering Supervisor: Prof. Dr. Vedat Doyuran

December 2008, 148 pages

The New Ulus Tunnel will be constructed within the andesitic terrain at Hıdırlıktepe (Ankara). Excavation of the tunnel will be accomplished through blast and drill method. Emprical methods will be consulted during the design of the support systems as well as the slope of the portal rock face. Therefore it is essential to perform detailed rock mass characterization studies.

In this thesis it is aimed to determine the rock mass characteristics in order to design the rock slope of the portals and to assess the reliable support systems for the tunnel. For this purpose laboratory tests and field investigations were conducted. Field investigations involved detailed discontinuity measurements and borehole drillings. In respect of laboratory tests; point load index, unit weight and uniaxial compression strength tests were used. The field and laboratory test results were utilized in the Rock Mass Classification Systems (RMR, Q-system) in order to ascertain the rock mass characteristics. By all accounts, necessary tunnel support systems were determined. As for the portal areas, the rock face design was accomplished through kinematical analyses. Consequently, no failure is expected at the portal rock slopes.

Keyword: Rock Mass Characterization, RMR, Q, slope design, Ulus Tunnel

YENİ ULUS TÜNEL GÜZERGÂHININ (ANKARA) KAYA KÜTLESİ ÖZELLİKLERİNİN VE DESTEK SİSTEMLERİNİN BELİRLENMESİ

Aksular, İrem Yüksek Lisans, Jeoloji Mühendisliği bölümü Tez Yöneticisi: Prof. Dr. Vedat Doyuran

Aralık 2008, 148 sayfa

Altındağ Hıdırlıktepe'de yapılacak olan Yeni Ulus Tüneli, andezitlerin egemen olduğu bir sahada yer almaktadır. Tünel kazısı delme-patlatma yöntemi ile gerçekleşecektir. Tünel destek sistemlerinin ve portal şevlerinin tasarımı için ampirik yaklaşımlardan yararlanılacaktır. Bu nedenle sahada ayrıntılı kaya kütlesi karekterizasyon çalışmaları yapılması gerekmektedir.

Bu tezin amacı tünel güzergâhında kaya kütlesi karakteristiklerini belirlemek, tünel portallarında şev tasarımı yapmak ve tünel için güvenilir destek sistemlerini belirlemektir. Bu sebeple gerek saha ve gerekse laboratuar verileri kullanılmıştır. Saha çalışmaları sırasında kayaçların süreksizlik analizlerine ağırlık verilmiş olup sondaj verilerinden de yaralanılmıştır. Laboratuvar verileri olarak nokta yükleme, birim hacim ağırlık ve tek eksenli basma dayanımı verileri kullanılmıştır. Kayaç karakteristiklerini belirlemek amacıyla laboratuvar ve saha verileri sınıflama sistemlerinde (RMR, Q sistemi) kullanılmıştır. Elde edilen veriler sonucu gerekli tünel destek sistemleri belirlenmiştir. Portal şevleri kinematik analizlere göre tasarlanmıştır. Sonuç olarak portal şevlerinde herhangi bir yenilme beklenmemektedir.

Anahtar Kelimeler: Kaya Kütlesi Karakterizasyonu, RMR, Q, Şev Tasarımı, Ulus Tüneli.

To My Beloved Family

ACKNOWLEDGEMENTS

I would like to express that I feel gratitude to my supervisor Prof. Dr. Vedat Doyuran for allocating his time and also for his guidance.

I would like to thank to Prof. Dr. Tamer Topal for his invaluable supports during my thesis works. Without his precious knowledge and moral guidance this thesis would not be accomplished.

I would like to tank to Prof. Dr. Reşat Ulusay who shared his great knowledge and valuable time for this thesis.

Special tanks to Prof. Dr. Recep Kılıç who supported and encouraged me in this work.

I would like to express my appriciations to my wise bosess Serdar Aker and Şenol Sözer for their support and patience.

I am thankful to Orhan Öztekin for his helps and supports in my thesis works.

I am grateful to reasearch assistants Özgür Aktürk and Ceren Küçükuysal for their supports in this thesis.

Finally, I would like to state my deepest gratitutes to my family for their presence, supports and patience. I would not succeed this work without them.

TABLE OF CONTENTS

ABSTRACT	iv
ÖZ	.vi
DEDICATIONv	iii
ACKNOWLEDGMENTS	.ix
TABLE OF CONTENTS	.X
LIST OF TABLESx	iii
LIST OF FIGURESx	vi
CHAPTER 1.	
INTRODUCTION	1
1.1. Purpose and Scope	1
1.2. Location and Accessibility of The Study Area	2
1.3. Tunnel Characteristics	4
1.4. Physiography	5
1.4.1.Topography	5
1.4.2. Climate and Vegetataion	6
1.5. Methodology	7
1.6. Previous studies	8
1.6.1. The Relevant Literature and Researches About the Site and Its Close	
Vicinities	8
1.6.2. The Literature About The Classification Systems	9
1.6.3. Previous Reports	9
1.6.4. Maps	.10

2. GEOLOGY AND HYDROGEOLOGY	11
2.1.Geology of the Site Vicinity	11
2.2.Geology of the Study Area	15
2.2.1. Mamak Formation Andesites	16
2.2.1.1 Petrographical Analyses	16
2.2.1.2. Lithology and Discontinuity Conditions	30
2.3. Hydrogeology of the Tunnel Route	41
2.4 Structural Geology	41
2.4.1 Faults	41
2.4.2 Seismicity	41
3. GEOTECHNICAL CHARACTERIZATION OF THE ANDESITE ROCK	
MASS	43
3.1.Geotechnical Investigations	43
3.1.1 Field Studies	44
3.1.1.1 The discontinuity surveys	44
3.1.1.2 Drillings	45
3.1.2 Laboratory Tests	50
3.2. Application of the Classification Systems to the Andesites	51
3.2.1 Application of the RMR System	53
3.2.2 Q-System (NGI) Applications	70
4. ASSESSMENT OF THE SLOPE STABILITY AT THE PORTALS BY	
KINEMATICAL METHOD	77
4.1 Kinematic Analyses	77
4.1.1. Kinematic Analyses Applications	78
4.1.1.1. The New Ulus Tunnel Entrance Portal Kinematic Analyses	81
4.1.1.2. The New Ulus Tunnel Exit Portal Kinematic Analyses	85
5. SUPPORT SYSTEMS SUGGESTED FOR THE TUNNEL	91
5.1 Support System Depending On The RMR Classification	91
5.1.1 The Support Pressure	91

5.2 Support System According to the Q System	93
6. CONCLUSIONS	97
REFERENCES	
APPENDICES	104
A. The scan-line survey charts (I.S.R.M, 1981)	104
B.Classification of individual parameters used in Q System	
(Barton et. Al., 1974)	109
C. The borehole logs	112
D. The core photographs	145

LIST OF TABLES

TABLE

1.1 The physical properties of the New Ulus Tunnel	5
1.2 Average annual climatic characteristics of Ankara	6
2.1 Petrographical analysis result of the specimen (BH-1)	18
2.2 Petrographical analysis result of the speciemen (BH-2)	20
2.3 Petrographical analysis result of the speciemen (BH-3)	23
2.4 Petrographical analysis result of the speciemen (BH-4)	25
2.5 Petrographical analysis result of the speciemen (BH-7)	27
2.6 Petrographical analysis result of the speciemen (BH-8)	29
3.1 The borehole data	47
3.2 The results of uniaxial compressive strength, point load and unit weight	
Tests (after Efol. Geotechnic Services Limited.Comp.,2008)	50
3.3 Orientations of major joint sets observed at the study area	52
3.4 RMR application to andesites located between 0+100-0+200 m	54
3.5 Orientations of major joint sets at km:0+100-0+200	54
3.6 RMR application to the andesites located between km:0+200-0+300	56
3.7 The discontinuity orientations at km:0+200-0+300	56
3.8 RMR application to the andesites located between 0+300-0+400 m	58
3.9 The discontinuity orientations at km:0+300-0+400	58
3.10 RMR application to the andesites located between 0+780-0+840 m	60
3.11 The orientations of discontinuities at km:0+780-0+840	60
3.12 RMR application to the andesites located between 0+800-0+850 m	62
3.13 The orientations of discontinuities at km:0+800-0+850	62

3.14 RMR application to the andesites located between 0+840-0+950 m	64
3.15 The orientations of discontinuity sets at km:0+840-0+950	64
3.16 RMR application to the andesites located at 0+950-1+000	66
3.17 The orientations of major discontinuity sets at km:0+950-1+000	67
3.18 RMR application to andesites located at km: 0+950-1+000	68
3.19 The discontinuity sets and their orienatations at km: 0+950-1+000	68
3.20. Rock descriptions according to the RMR classification system	70
3.21 Q system Classification for the andesite located at 0+100-0+200 (in	
correlation with BH-1)	71
3.22 Q System Classification for the andesites located at 0+200-0+300	
(in correlation with BH-2)	71
3.23 Q system Classification for the andesites located at 0+300-0+400 (in	
correlation with BH-3)	72
3.24 Q system Classification for the andesites located at 0+780-0+840 (in	
correlation with BH-4)	72
3.25 Q system Classification for the andesites located at 0+800-0+850 (in	
correlation with BH-5)	73
3.26 Q system Classification for the andesites located at 0+840-0+950 (in	
correlation with BH-6)	73
3.27 Q system Classification for the andesites located at 0+950-1+000 (in	
correlation with BH-7)	74

3.28 Q system Classification for for the andesites located at 0+950-1+000	
(in correlation with BH-7)	74
3.29 Descriptions of the andesites in accordance with Q system	75
4.1 The orienatations of the major discontinuity sets observed at the	
study area	78
4.2 The orientations of major discontinuity sets at the entrance portal	81
4.3 Entrance portal slope kinematic analyses results	85
4.4 The orienatations of major discontinuity sets at the exit portal	85
4.5 Kinematic analyses results of rock slope at the exit portal	89
4.6 The results of kinematical analyses applied on slopes at both entrance and	
exit portals	90
5.1 Guidelines for excavation and support of 10 m span rock tunnels in	
accordance with the RMR system (After Bieniawski 1989)	92
5.2 .Support pressures for The New Ulus Tunnel	93
5.3 Values of excavation support ratio-ESR (Barton et al., 1974)	94
5.4 The reinforcement categories for each borehole location (according to Q	
system)	95
5.5 Maximum Unsupported Span values for variable Q indexes	96

LIST OF FIGURES

1.1 Location map of the study area is quoted from Google Map (2008)
2.1 Geological map of the close vicinity of the study area (M.T.A. 1/100000
Scale Geological Map, Ankara Sheet)12
2.2 Generalized stratigraphic columnar section of Ankara (rearranged after
Kasapoğlu, 1980)14
2.3 Geological map of the study area (1:500.000 reconaissence map of Turkey
Ankara-F-15 sheet, M.T.A, 1997)15
2.4 The photograph of the core taken from BH-117
2.5 The thin section of the sample taken from BH-1; Analyser out position under $4X$
Magnifying
2.6 Pseudomorf hornblende crystal in both analyser out (photograph on the left) and
in positions (photograph on the right)19
2.7 Plagioclase phenocryst under analyser out and in positions
2.8 The photograph of the core sample taken from BH-220
2.9 Baked biotite crystal in grain supported matrix is seen under analyser out and in
positions at thin section
2.10 Plagioclase and Biotite crystals at analyser out and in positions
2.11 Thin section showing baked Hornblende phenocryst under analyser in and out
conditions

2.12 The photograph of the core sample taken from BH-322	2
2.13 Thin section showing baked Hornblende phenocryst under analyzer in	
and out conditions	3
2.14 Thin section showing Plagioclase phenocryst in microlit supported matrix under	r
analyser in and out conditions	4
2.15 Photograph of the altered core sample taken from BH-42	4
2.16 Thin section showing Quartz phenocryst and alteration under analyzer in and ou	ut
onditions2	25
2.17 Thin section of core specimen taken from BH-4. In addition to the alteration, th	e
reddish-brown ironoxide is clearly seen under analyzer out position2	26
2.18 The photograph of the core sample taken from BH-7	26
2.19 Thin section showing flow texture and baked biotite together under analyser in	
and out positions	7
2.20 Thin section showing quartz and plagioclase phenocrysts with pseudomorf	
quartz crytal. The flow texture is seen under analyser in and out	
positions2	28
2.21 Photomicrograph of the andesite, showing the zonation of plagioclase	
phenocrystal(Plg) under analyser in position2	28
2.22 The photograph of the core sample taken from BH-82	9
2.23 Thin section view of the baked biotite crystal is seen in altered matrix under	
analyser in position	0
2.24 GoogleEarth Screen (2008) showing the locations of BH-1, BH-2 and BH-33	51

2.25 The flow structures of andesites located on the upper parts of the hill near BH-1
and BH-2
2.26 The apperance of the andesites at the upper parts of the hill, near BH-1 and
BH-2
2.27 A view of the andesites exposed near BH-3
2.28 The locations of BH-4, BH-5, BH-6
2.29 The studied andesites near BH-5
2.30 Aphanitic porphyry textured andesites
2.31 The photograph of the andesites located at km: 0+880; near BH-6
2.32 The andesites at km: 0+840, near BH-6
2.33 The colonized andesites with clay fillings
2.34 Seismic zonation map of Turkey and locations of the earthquake epicenters
occured in the vicinity of the site (www.sayisalgrafik.com/deprem)42
3.1 A satalite image acquired from Google Earth (2008). The red dash line
represents
the planned road line as the blue line shows the tunnel46
3.2 The plan view of the New Ulus Tunnel
3.3 The cross-section of the tunnel
3.4 The illustration of major discontinuity set orientations
3.5 Orientation of major discontinuity sets at km: 0+100-0+200
3.6 Orientation of major discontinuity sets at km: 0+200-0+300

3.7 Dip and dip directions of discontinuity sets observed at km: 0+300-0+40059
3.8 Illustration of major discontinuity sets
3.9 Illustration of major discontinuity sets at km: 0+800-0+850
3.10 The plot of major discontinuity sets at km: 0+90065
3.11 The plot representing the major discontinuity set orientations
3.12 The illustration of major discontinuity sets at km: 0+950-1+00069
3.13 The Correlation of classification results of RMR and Q systems
4.1 Failure envelope based on Barton failure criterion (C.Gokceoglu et al., 2000).78
4.2 The contour diagram representing general distribution of the discontinuities at the
study area
4.3 The pole consantration diagram of the discontinuities at the study area
4.4 The Rosette diagram showing the trends of discontinuities
4.5 The illustration of dip/dip direction of the discontinuity sets
4.6 The contour plot of the discontinuities at km: 0+200-0+30081
4.7 The pole plot of the discontinuities at km: 0+200-0+300
4.8 The rose diagram of the discontinuities at km: 0+200-0+30082
4.9 The orientation of major joint sets at km: 0+200-0+300
4.10 Plane failure analyses at the entrance portal rock slope
4.11 Wedge failure analyses at the entrance portal rock slope
4.12 Toppling potential analyses at the entrance portal rock slope
4.13 The contour plot of discontinuities at km: 0+900
4.14 Pole concantration of discontinuities at km: 0+900

4.15 The rosette diagram of discontinuities at km: 0+900	87
4.16 The orientations of major discontinuity sets at km: 0+900	87
4.17 Plane failure analysis forthe exit portal slope face	88
4.18 Wedge failure analyses for the exit portal slope face	88
4.19 Toppling analysis for the exit portal slope face	89
5.1. Estimated support categories based on the tunnelling quality index Q	95

CHAPTER 1

INTRODUCTION

1.1 Purpose and Scope

Since ancient times human beeing has always been interested in challenges between nature and himself. These challenges have mainly showed themselves in engineering problems and mostly resulted in the victory of human intelligence in the way of the creating magnificient engineering structures. The human capability has been accelarated in such a way that searching the convenient footpaths for transportation through mountains gave place to drillings into mountains for tunnel constructions.

Nevertheless it hasn't always been that much easy to construct structures within mountains. When compared with the other engineering issues, dealing with underground is obviously much more difficult and complex. The differentiations and constitutions of geological units that host the tunnels generally cause varying engineering problems. Therefore, making use of estimations has become the most effective way of finding solutions. Some of these estimations are used to accomplish the task of this study. There are two objectives of this study. The first objective is to determine the rock mass characteristics of the units located at the tunnel route and to decide the efficient support systems for "The New Ulus Tunnel". The second objective is to assess a reliable slope design for the tunnel portals.

In this scope previous researches associated with the tunnel site and the near vicinities were reviewed at first. Afterwards, detailed site investigations at the tunnel route were carried out. Following this stage laboratory tests were conducted on the specimens that were taken from the tunnel alignment.

By means of classification systems, the results gathered from both in-situ surveys and laboratory tests manifested the geotechnical characterization of the study area. According to the data derived from these studies, kinematic analyses were applied. Consequently the main problems that might be faced during slope construction were specified. The next step, generating the necessary support system, was carried out by benefitting the analyses' results.

1.2 Location and Accessibility of the Study Area

The study area is located between Hıdırlıktepe and Öncüler vicinities which are connected with Altındağ County in the North part of Ankara. According to the data derived from the satallite images (GoogleEarth Software, 2008) the New Ulus tunnel will take place between the longtitudes of N39°56′33 - N39°56′51 and the latitudes of E32°51′4 - E32°52′27. The location of the study area is presented in Figure 1.1.



Figure 1.1 Location map of the study area is quoted from Google Map (2008)

The hill which hosts the tunnel route is surrounded by four main transportation roads which supply the connection between Ulus-Altındağ and Plevne-Fatih districts. The access to the study area is supplied by the road nets that constitude the north branch of roadway system. This branch goes through rough topography and passes at the south side of the Ankara Cidatel. The transportation branch then goes to Hipodrom's two sides and reaches to Yenimahalle and İstanbul Highway. In the close vicinity of the investigated site the roads surrounding the Citadel, Altındağ and Yenidoğan, intersect each other at different points (Kasapoğlu, 2000).

The New Ulus Tunnel's location, Hıdırlıktepe, rises between two main roads as a part of Yenidoğan district. The road that passes among the south and the west side of Hıdırlıktepe is Bentderesi Road which connects Altındağ Road with Çankırı Road and İrfan Baştuğ Road.

1.3 Tunnel Characteristics

The New Ulus Tunnel is planned to be constructed within the scope of the renovation project of Hıdırlıktepe-Bentderesi vicinities. The project is carried out by Greater Municipality of Ankara to organize a new way for Ulus-Altındağ transportation. For that purpose, starting from Sakalar place on Bentderesi road, the new transportation route is planned to be shifted to the north, into the New Ulus Tunnel that will pass under the hill.

According to the plans, the tunnel allignment follows the topographical structure and extends nearly parallel to Bentderesi road. The 780 m long tunnel will advance in approximately 870 m elevation and end on Şehit Kaya Aldoğan Road. In consideration of the transportation route, the New Ulus Tunnel will consist of double tubes each are 9 m height. Horseshoe shape with a width of 12 m is chosen for the tunnel design. The tubes will be positioned 24 m apart from each other. Regarding to the construction method, blast and drill methods will be

applied at the construction stages. The main characteristics of the tunnel are given in the Table 1.1.

Туре	Transportation; Main Road
Location	Öncüler - Hıdırlıktepe, Altındağ in Ankara
Length	780 m
Height	8,15 m inner, 9 m outer
Width	10,6 m inner, 12 m outer
Maximum Span	12 m
Elevation	Approximately 870 m
Shape	Horseshoe shape
Number of Tube	Twin-tube tunnel with tubes 24 m apart
Construction Method	Blast and drill
Strike of Tunnel	308°

Table 1.1. The physical properties of the New Ulus Tunnel

1.4 Physiography

1.4.1 Topography

Ankara has an elevation of 960 m in average and the elevation difference between the highest and the lowest places in the city is 260 m (Kasapoğlu, 2000). The tunnel construction will take place at the south slopes of Timurlenk Hill which is formed by andesites and is one of the main rises at the close vicinity. The main construction area, Hıdırlıktepe (888 m), is located on Timurlenk Hill which has an elevation of 1003 m (Kasapoğlu, 2000). At the south, on the opposite of Hıdırlıktepe, rises another hill with an alevation of 986 m. That hill, so called Castle Hill, hosts the most famous historical structure of Ankara; the Ankara Citadel. Between Hıdırlıktepe and Citadel's hill Bentderesi Valley exists. This valley extends along East-West direction and generates a thin roadway called Bentderesi Road. Unlike the andesites that formed steep hills, the alluvium of Bentderesi stays at 850 - 870 m elevations and creates a plain.

1.4.2 Climate and Vegetation

Continental climate prevails in the study area and in its close vicinities. The main charactistic of continental climate is hot and dry summers, cold and rainy winter, and are barely dominant at the site. The highest temperatures are recorded in August and the lowest ones in January. In general, the rainfall is received at winter and spring. The mean annual rainfall for Ankara is 382,1 mm (Table 1.2).

Table 1.2. Average annual climatic characteristics of Ankara (Turkish State Meteorological Service, 2008).

Annually	Annually	Annually Mean	Annually	Annually	Annually
Mean	Mean	Evaporization	Mean	Mean	Mean
Precipitation	Temperature	and its time	Pressure	Frost Day	Snow
(mm)	(°C)	(mm-month)	(mb)		Covered
					Day
382.1	11.7	229.7/ August	913.1	83.7	32.5

Conserning the vegetation, Ankara shows a transition character between forested lands in the north and steppes in the south. Since the New Ulus Tunnel will be constructed in an urbanized field, hints of vegatation among the project area can not be easily acquired. Most of the study area is covered with artificial and concrete structures which make it difficult to observe both vegatation and geological structures that exposed on the site. At Hıdırlıktepe there are no well distributed green areas other than bushes observed here and there. Thus, as far as vegetation distribution is concerned it may be described as barren area.

1.5 Methodology

In order to achieve the purpose of this study, five stages have been carried out. In the first stage previous works related to the study area were reviewed. A database on the classification systems, tunnel support applications and slope stability was established by making use of literature surveys.

Following the first stage, detailed field investigations were performed to acquire the geological and hydrageological conditions of the study area. These investigations involved the macroscobic observations and discontinuity measurements of the exposed andesites. In respect of the discontinuity measurements, scan-line survey method (I.S.R.M, 1981) was used. Besides, eight boreholes along the tunnel route were drilled by Alkon Eng. Cons. (2008) to identify to subsurface structure. The drillings were performed in January 2008. Site investigations were accomplished by June 2008. In addition to the macroscobic observations, petrographical analyses of andesites were conducted. In order to obtain the thin sections, the core box specimens taken from the tunnel depth were used. With the help of petrographical analyses, knowledge of the mineral contents and alteration conditions were developed.

The third stage included the determination of geotechnical characterization of the andesite. In this sense, the results of scan-line surveys and laboratory tests which were applied by Efol Geotechnics Service Ltd. Co. (2008) were evaluated in the rock mass classification systems (RMR and Q system). In the context of laboratory tests, the dry unit weight, uniaxial compressive strength and point load strength index of andesites were determined. The findings of classification systems revealed the characterization of andesites that are exposed at the study area. The fourth stage involved the assessment of portal slope stability by kinematical method. The reliable slope angles for the portal rock slopes were obtained with the help of software Dips 5.1.

In the last stage, the required support systems for the tunnel were identified. In this sense, the classification system results were used.

1.6. Previous Studies

Having an opinion of the study area is advantageous when planning the site investigations. The foreknowledge of the site provides more realistic perception about the situation that is faced at the field investigations. Hence previous works are essential. In the context of previous studies reconing and compilation stages are involved. The relevant literatures, researches, case studies and maps of the site were utilized in this thesis. Moreover literature about the classification systems and their usages were reviewed. The sources that were resorted to are given in four parts which are the relevant literature and researches about the site, the literature about the classification systems, previous reports and maps.

1.6.1. The Relevant Literature and Researches about the Site and Its Close Vicinities

There are many geological and geotechnical studies that are directly or indirectly related to the invested site. Most of these studies were consulted among this thesis to reveal a sufficient characterization of the rock mass located at the study area.

Since a comprehensive knowledge of the discontinuities of andesites is very significant, researches and bulletins including in-stu investigations and discontinuity measurement were reviewed mostly. As published literature, the study of Kasapoğlu (2000) was used. The researches of Ulusay (1975), Kasapoğlu (1982) and Karacan et al. (1986) were also benefitted. The geotechnical studies of Aksoy (2004), Gökçeoğlu et. al, (2000), and Ercanoğlu (1997) were referred for the assessment of slope stability and geomechanical parameters of the andesites.

In order to obtain a general information about Mamak andesite and its weathering degree, the research of Kılıç and Bilgehan (1999), Kayışoğlu, Koçbay and Kılıç (1998), Koçbay and Kılıç (2006) were reviewed. The study of Topal et. al., (2006) on weathering effect on andesites geomechanical properties led this thesis.

In addition to geotechnical literature, many reports of General Directorate of Mineral Research and Exploration (M.T.A) were referred to assess the geology of the study area.

1.6.2. The Literature about the Classification Systems

In this thesis the rock mass classification systems used to determine the andesites' geotechnical characterization are RMR (Bieinawski, 1989), Q System (Barton et.al., 1974). The rearrangements and developments of these classification systems are also reviewed in the context of literature surveys.

1.6.3. Previous Reports

Between December 2007 and May 2008, Alkon Eng. Lim. Comp. performed detailed in-stu investigations for the project they have undertaken. The company made a report containing the results of in-stu surveys and laboratory tests which were applied by Efol Geotechnics. The results gathered from these studies were used in this thesis.

1.6.4. Maps

The maps of the study area were taken from the researches and reports mentioned above. Besides, the maps related with Hıdırlıktepe and Timurlenk Hill were gathered from different resources such as satallite images (GoogleMap, 2008) and General Directorate of Mineral Research and Exploration's (MTA, 1997) reports.

CHAPTER 2

GEOLOGY AND HYDROGEOLOGY

This chapter includes two sections. In the first section, geology of the site vicinity is mentioned by using existing literature. A general geological information including the geological phases forming the site visinity is involved. This section is followed by the second one under the name of "Geology of the Site Area" in which the geological and hydrogeological conditions of the study area are descibed in details. Both field observations and petrographical investigations are represented in this section. The revealed geological conditions of the units exposed at the site are used in the former stages of this thesis for the selection of the required parameters of the rock mass that will host the tunneling applications.

2.1 Geology of the Site Vicinity

In the close vicinity of the study area, volcanic rocks (Miocene), sedimentary sequence (Pliocene) and alluvium (Quaternery) are distinguished. The Mamak formation and Tekke Volcanics constitute the Miocene aged units. The younger unit of Pliocene is identified as Gölbaşi Formations (Akyürek et. al., 1982, 1984). The map presenting the geological units in the close vicinity of the study area is given in Figure 2.1. The geological map screen given in Figure 2.1. is a part of MTA's Geological Map of Ankara - F15 quadrangle which has a scale of 1/100000. The area limited with red borderline shows the close vicinity of the invested site.



Correlation Of Map Units

Description Of Map Units



Figure 2.1 Geological map of the close vicinity of the study area (MTA, 1/100000 Scale Geological Map, Ankara Sheet)

According to the report of MTA (1997), the gelological feature exposed at the site is named as Mamak formation (Tma). The formation involves andesite, agglomerate and tuff. Agglomerates are white, gray and partly red colored and consist of andesite, dasite and basalt blocks which are embedded within a tuffaceous matrix. Some distinct beddings are observed within agglomerates. The tuffs intercalated with agglomerates are in various colors and thin bedded. Yellowish-white volcanic breccias include various sized angular andesite pebbles. A slight bedding generated by conglomerate-tuff intercalation is observed. Altough there are white and highly weathered parts exposed in the vicinity, andesites are generally gray-pink colored. In addition to the joints, flow structures on the andesites are seen in the close vicinity. Mamak formation shows transition to Kumartaş Formation and positiones laterally to Tekke volcanics and Hançili Formation. The formation is overlain by Bozdağ Basalts. It is accepted as Late Miocene aged as the units it positiones laterally. (Akyürek et al., 1997)

As mentioned in the report (1997) of General Directorate of Mineral Research and Exploration, Tekke Volcanics (Tt), first named by Akyürek et al (1982, 1984), consists of andesites, basalts, tuff, agglomerates and dasites. Pink, red and black andesites often show flow structures. The tuffs are observed as gray-white, fine grained interlayer structures between agglomerates and andesites. The formation is mostly transitional with the Mamak formation and is seen as sills in the Kumartaş and Hançili formations. The formation is assumed to occur in Upper Miocene. The unit is a product of volcanism in the continental conditions. Basalt (β) is also observed as a sublayer of the formation. Black-dark brown colored, vesiculed basalts show flow structures. They are considered as the first products of volcanism.

The Gölbaşı formation (Tg) was first named by Akyürek et al. (1982, 1984) and constitutes gray-red, slightly cemented, various sized and origined conglomerates, sandstones and mudstones. Partly horizontal beddings are observed within the units. Conglomerates consist of basalt, limestone and gabro pebbles. Calcite and clay constitute the cementation material. The Gölbaşı formation (Pliocene) conformably overlies the Bozdağ basalts and older units.

The youngest unit exposed in the close vicinity is of Quaternery age alluvium which includes gravels and sands, silts and clays.

A generalized stratigraphical columnar section of Ankara and its close vicinities was prepared by Kasapoğlu (1980). In Figure 2.2, the modified columnar section of Ankara is given.

ERA	SUB PEF	SUB-ERA PERIOD		осн	Symbol	Descriptions		
а 1	Quaternary					Alluvium; gravel, sand, silt		
Cenozoi c	N e o g g r t i a r y l e e n Miocene	Ne	P I i o	Late		Conglomerate, red sandy-silty clay,red clay including limestone		
		₊	₊	o g	e n e	Early		Pink marl, intercalation of tuff and lava gravels
		n	Mio	cene		Clayey lacustrine limestone,marl, claystone, conglomerate, andesite,basalt,agglomerate and tuff		
			Conglomerate, sandstone, marl, gypsum					
		у	у	У I е о	Eocene			Sandy limestone with fossils and sandstone
		g e	Pale	ocene		Flysh;Conglomerate, sandstone, siltstone, limestone		

Figure 2.2 Generalized stratigraphic columnar section of Ankara (modified after Kasapoğlu, 1980).

2.2 Geology of the Study Area

The primary geological unit observed at the study area is the Mamak formation andesites (Figure 2.3). In general, the exposed andesites of Miocene age exhibit various colors and joint systems. In addition, the weathering degree of the andesites ranges between slightly and moderate. Altough the observations are so limited, the andesites showing flow structures can be identified even from a long distance. At the upper parts of the hill, these flow structures are clearly visible. In regarding to the joints, the existence of discontinuities is observable on almost all andesite outrops.



Figure 2.3 Geological map of the study area (1:500.000 reconaissence map of Turkey, Ankara-F-15 sheet, M.T.A, 1997)

2.2.1 Mamak Formation Andesites

Despite the fact that the entire hill hosting the tunnel is composed of andesites, there are very few outcrops that can be clearly observed. Most of the hill is covered with houses and artificial structures. At that point the borehole data gain significancy. In addition to the macroscobic observations, the findings of drillings were used to confirm the surface explorations. Especially at the entrance portal site there are scarcely any andesites that can be observed from the point of discontinuity measurements or assessment of macroscobic rock properties.

Under those circumstances the microscobic analyses of the andesites are consulted. For this purpose, the core boxes taken from tunnel elevation of each borehole were analized. The results are presented in the following part.

2.2.1.1 Petrographical Analyses

In addition to field investigations, microscobic survey such as thin section of the rock material is an esset to define the rock mass conditions. Thin section is a reliable method that determines the type of rock, its origin and occurence conditions. It also reveals the external facts affecting the rock material such as water or pressure. In this thesis, thin sections of andesite specimens gathered from the cores were observed. The petrographical analyses were carried out at the Mineralogical and Petrographical Laboratory of the Department of Geological Engineering of METU (2008). In terms of petrography, excluding the core specimen 1 and 3, the core samples taken from the tunnel level were analysed to determine the geology of the tunnel allignment. The definition of the rock mass based upon the site observations was confirmed according to the pethrographical analyses. Below, the results of the analyses were presented with their photomicrographs taken under Nikon branded optical microscope with 4X magnification.
Borehole 1

Since this borehole is located near the entrance portal, the borehole data were used to identify the entrance portal's geological structure. The sample benefitted in this pethrographical analysis is a piece of the core taken from the depth between 42.00 and 43.00 metres.

Despite the fact that BH-1 does not coinside the tunnel route, the depth from which the core was taken represents the the tunnel elevation. The photograph of the core specimen used for the analyses is given in Figure 2.4. Additionally, the results of petrographical analysis of the speciemen are tabulated in Table 2.1.



Figure 2.4 The photograph of the core sample taken from BH-1.

Table 2.1 Petrographical analysis result of the core specimen (BH-1).

Borehole Number	1	
Magnifying	4X	
Texture	Seriate	
Matrix	Glass+Plagioclase microlits+Clay	
Major Minerals	Biotite, Plagioclase, Hornblende	
Minor Minerals	Quartz	
	Biotite-hornblende (Figure 2.5, 2.6) and plagioclas	
	(Figure 2.7) phenocrysts are seen in highly clayey	
	matrix. Most of the plagioclase microliths	
Observations	composing the texture are altered. Baked biotite	
	and hornblende crystals shown in Figures 2.5 and	
	2.6 indicate typical andesite characteristics	



Figure 2.5 The photomicrograph of the andesite sample taken from BH-1; analyser out position under 4X Magnifying (Hb:Hornblende, B: biotite, Op: opaque, Plg: plagioclase).



Figure 2.6 The pseudomorf hornblende crystals in both analyser out (photograph on the left) and in positions (photograph on the right). (Hb:Hornblende, Q: quartz).



Figure 2.7 Plagioclase phenocryst (Plg) under analyser out and in positions.

Borehole 2

The second borehole was located on the left tube near the entrance portal. The core sample shown in Figure 2.8 was obtained from the tunnel elevation; between 36.60-36.76 m.



Figure 2.8 The photograph of the core sample taken from BH-2.

As seen in the figure, the pink colored specimen has aphanitic porphyry texture. The core has a length of 16 cm. The vesicules are clearly seen on the surface of the specimen. The petrographical analysis results of the specimen are given in Table 2.2. Moreover, the photomicrographs of the baked biotite crystal (Figure 2.9), the plagioclase and biotite crystals (Figure 2.10) and baked hornblende phenocryst (Figure 2.11) are illustrated below.

Table 2.2 The P	etrographical	analysis re	esults of the co	re specimen	(BH-2)	
-----------------	---------------	-------------	------------------	-------------	--------	--

Borehole Number	2		
Magnifying	4X		
Texture	Seriate		
Matrix	Plagioclase microlites+Clay		
Major Minerals	Biotite, Plagioclase, Hornblende		
Minor Minerals	Quartz		
	The matrix is grain supported (plagioclase		
Observations	microlites). Alteration prevails almost the whole		
	thin section. Few opaque minerals were observed.		



Figure 2.9. The baked biotite (B) crystal in grain supported matrix is seen under analyser out and in positions at thin section.



Figure 2.10. Plagioclase and biotite crystals at analyser out and in positions. (B:biotite, Plg: plagioclase, O: opaque).



Figure 2.11 The photomicrographs showing quartz (Q) and baked hornblende(Hb) phenocryst under analyser in and out conditions.

Borehole 3

The specimen was taken from the depth between 36.00 and 36.18 m at BH-3. As seen from Figure 2.12, the 19 cm long core sample has surface staining. The petrographical analysis results of the specimen are given in Table 2.3.



Figure 2.12 The photograph of the core sample taken from BH-3.

Table 2.3 The petrographical analysis results of the specimen (BH-3).

Borehole Number	3		
Magnifying	4X		
Texture	Seriate		
Matrix	Plagioclase microliths+Clay		
Major Minerals	Feldspar, Plagioclase		
Minor Minerals	Quartz, Hornblende		
Observations	High ranges of opaque minerals and dense plagioclase microliths were observed. The plagioclase phenocrystals show polysynthetic twinning and zonation.		

Furthermore, the photomicrographs of the baked hornblende phenocryst (Figure 2.13) and the plagioclase phenocryst in microlit supported matrix (Figure 2.14) are given below.



Figure 2.13 Thin section screen showing baked hornblende (Hb) phenocryst and opaque minerals (Op)under analyser in and out positions.



Figure 2.14 Thin section showing plagioclase phenocryst (Plg) in microlith supported matrix under analyser in and out conditions.

Borehole 4

The specimen was obtained from the tunnel elevation, at the depths of 17,50-17,65 m within BH-4 (Figure 2.15). In table 2.4, the results of petrographical analysis are given.



Figure 2.15 Photograph of altered core sample taken from BH-4.

Table 2.4 Petrographical analysis results of the specimen (BH-4).

Borehole Number	4		
Magnifying	4X		
Texture	Seriate		
Matrix	Plagioclase microlits+Clay		
Major Minerals	Feldspar, Plagioclase		
Minor Minerals	Quartz, Hornblende		
Observations	Highly altered (clay alteration) and oxidized andesite with vesicular structure. Baked biotites were observed. Grain supported matrix surrounds the quartz phenocrystals. Quartz phenocrystals are fissured.		

Furthermore, the photomicrographs of the quartz phenocryst (Figure 2.16) and thin section of core specimen taken from BH-4 (Figure 2.17) are illustrated below. In Figure 2.17, apart from the alteration, the reddish-brown ironoxide is clearly seen under analyser out position.



Figure 2.16 The photomicrographs of andesites showing quartz phenocryst and iron oxidation under analyser in and out conditions.



Figure 2.17 Thin section of the core specimen taken from BH-4.

Borehole 7

The specimen was obtained from the tunnel elevation, at the depths of 78,00-79,00 m within BH-7 (Figure 2.18). The results of petrographical analysis of the specimen are tabulated in Table 2.5. Additionally, the flow texture (Figure 2.19), baked biotite (Figure 2.20) crystals and plagioclase phenocrysts with pseudomorf quartz crystal are illustrated.



Figure 2.18 The photograph of the core sample taken from BH-7.

Table 2.5 Petrographical analysis results of the specimen (BH-7).

Borehole Number	7	
Magnifying	4X	
Texture	Glomeroporphyr+Flow Texture	
Matrix	Plagioclase microliths+Clay	
Major Minerals	Feldspar, Plagioclase	
Minor Minerals	Quartz, Biotite	
	Distinct flow structure generated by plagioclase microliths was determined. In addition, baked	
Observations	biotites and pseudomorph crystals were observed. Quartz and plagioclase phenocrysts are surrounded	
	by plagioclase microliths (grain supported matrix).	
	Polysynthetic twinning of plagioclase phenocrysts	
	were defined.	



Figure 2.19 The thin section screen showing flow texture and baked biotite crystals together under analyser in and out positions.



Figure 2.20. Thin section showing quartz (Q) and plagioclase phenocrysts (Plg) with pseudomorf quartz crystal (The flow texture is seen under analyser in and out positions).



Figure 2.21 Photomicrograph of the andesite, showing the zonation of plagioclase phenocrystal (Plg) under analyser in position.

Borehole 8

The specimen was obtained from the tunnel elevation, at the depths of 34.60-34.80 m of BH- 8 (Figure 2.22).



Figure 2.22 The photograph of the core sample taken from BH-8.

The petrographical analysis results of the specimen taken from BH-8 are given in Table 2.6. In addition, the photomicrograph showing baked biotite crystal in altered matrix is given in Figure 2.23.

Table 2.6 Petrographical analysis results of the specimen (BH-8).

Borehole Number	8		
Borenoie runiber	0		
Magnifying	4X		
Texture	Seriate		
Matrix	Plagioclase microlits+Clay		
Major Minerals	Feldspar, Plagioclase		
Minor Minerals	Quartz, Biotite, Hornblende		
	Existence of alteration and baked biotite crystal in		
Observations	clayey matrix were defined. Pseudomorph		
	plagioclase crystals were seen.		



Figure 2.23 The thin section view of the baked biotite (B) crystal is seen in altered matrix under analyser in position.

2.2.1.2. Lithology and Discontinuity Conditions

Considering the factors affecting the behaviour of the rock mass, lithology, anisotropy, heterogenity and discontinuity factors come to the fore. In regard to mechanical behaviour of the rock mass, the discontinuity conditions have far more importance than lithology. The factors stated here were compiled at the field investigations to enlighten the physical characterization of andesites that constitute the hill in which the tunnel construction will take place.

The term lithology includes the type of rock mass, minerological composition, grain size, texture, cementation conditions-degree of cementation and weathering conditions. Lithology can be identified by macroscobic and microscobic investigations. In this thesis, both methods were used to distinguish the lithologies that are located at the study area.

The discontinuity conditions of the andesites and their usage in the rock mass classification systems were mentioned in Chapter 3. For this reason the results of discontinuity observations are not given in details within this chapter.

In regard to survey methods, macroscobic surveys on geological units cropped out at the study area were performed at first. In order to make a correlation between borehole data and surface data, the investigations mostly consantrated on the units exposed near the borehole locations. The result of the observations including the discontinuity surveys are mentioned below.

Starting from the entrance portal's close vicinities the observations were achieved on the upper parts of the hill. The GoogleEarth view of the locations of BH-1, BH-2 and BH-3 is given in Figure 2.24.



Figure 2.24 GoogleEarth screen (2008) showing the locations of BH-1, BH-2 and BH-3.

Since the lower elevation of the hill icluding the tunnel entrance portal is completely covered by unplanned housings, most of the andesite outcrops lay under these artificial structures. Therefore, large scaled investigations on the andesites at this site couldn't be performed.

The flow structure of andesites observed on the upper parts of the hill near B-1 and BH-2 is presented in Figure 2.25. The discontinuity conditons are given in the scan-line survey forms in Appendix A. In general, the discontinuity surfaces are rough and the apertures are mostly filled with clay. Additionally, the surfaces are moderately weathered. In Figure 2.26, another vision of the andesites at the upper parts of the hill, near BH-1 and BH-2 is given.



Figure 2.25 The flow structures of andesites located on the upper parts of the hill near B-1 and BH-2.



Figure 2.26 The appearance of the andesites exposed at the upper parts of the hill, near BH-1 and BH-2

The pink andesites exposed near BH-3 are jointed and the discontinuity surfaces are moderately weathered. The spacings between the discontinuity surfaces range between 20-80 cm. A general view of the andesites studied at the site is presented in Figure 2.27. The properties of the discontinuities are defined in the scan-line survey chart given in the Appendix A.



Figure 2.27 A view of the andesites exposed near BH-3

At km: 0+840, the macroscobic observations for the andesites were carried out near BH-5. The investigated andesites will host the tunnel's right tube between km: 0+840 - 0+850. The outcrops of the andesites take place on the right side of Hoca Ahmet Yesevi Road. This easy access to the rock mass enables both the macroscobic observations and the discontinuity surveys.

In Figure 2.28 a satallite image of the investigated area derived from GoogleEarth software is given. This image is taken from Digital Globe in 2008. The eye altitude is 1,18 km and the elevation of the study area is approximately 935 m. According to the software, the coordinates are 39°56′48.84"N and 32° 51′52.2".



Figure 2.28. The locations of BH- 4, BH-5, and BH-6. The orange dash lines represent the tunnel alignment.

The photographes of the andesites studied at km: 0+840 are given in Figure 2.29.



Figure 2.29 The studied andesites near BH-5.

As seen in the photographs (Figure 2.29), the andesites are pink colored and have vesicules covering the surfaces. The constituents composing the cementation material could not be observed since they are not visiable. Big white minerals seen both on the rock faces and in fresh parts are supported by small grain sized minerals that can not be detected by macroscobic surveys. The texture is aphanitic porphyry and the visible big white cystals are sodium riched plagioclases (Figure 2.30).



Figure 2.30 Aphanitic porphyry textured andesites (White crystals seen on the surface are plagioclase crystals).

Depending on the exposed parts, the ansedites are slightly weathered and most parts are fresh. Considering that both the rock mass and the discontinuity surfaces were dry on the different days (March, May and July 2008) of the field investigations and no ground water was detected in the BH-5 (January 2008), this color change among the discontinuity surfaces appears to be the result of leakage from houses that are located on the upper part of the studied andesites. No color change was observed in the fresh parts of the rock mass which implies to the external effect of water. The field investigation on the andesites held on at the drilling site of BH-6 (Figure 2.31). According to satallite images, the coordinates of the study area are E $32^{\circ}51'50.04"$ and N $39^{\circ}56'48.12"$.



Figure 2.31 The photograph of the andesites located at km: 0+880; near BH-6.

The unit examined near BH-6 is the continuation of the andesites previously studied at BH-5. The elevation of the studied andesites is 920 m. Altough the geological unit is the same, the discontinuity oritentations and degree of weathering differ than those of andesites observed at BH-5. Most of the exposed parts of the pink andesites are fructured and moderately weathered. Big and branchy type of joints covers the intact rock masses (Figure 2.32). Clay constitutes the infilling material of these joints.



Figure 2.32. The andesites at km:0+840, near the BH-6.

The main difference of this unit is that the andesites are kaolinized mostly at the upper elevations. In regard to texture, aphanitic texture was observed.

At lower elevations of the hill (860 m) more kaolinized andesites crop out under the artificial structures. These andesites show up in dirty white color. Moreover it is hard to differentiate them from the concrete at some places. In Figure 2.33, photographs of the kaolinized andesites are given.



Figure 2.33. The kaolinized andesites with clay infillings.

Any information about the grain size or texture of the andesites could not be derieved. However, andesites can be generalized as moderately weathered. The discontinuity surfaces are rough and apertures are filled with clay. As for the dirty white color of the outcrops, kaolinization is considered. According to the research of Seyhan (1971), kaolinization was generally determined on the andesites exposed in the inner parts of West Anatolia.

2.3 Hydrogeology of the Tunnel Route

Hidirliktepe is formed by andesites that can be considered as impervious because of their low conduit capacities. At the in-stu investigations, andesites are determined as dry. According to the borehole observations carried out by Alkon Engineering Company (2008), the water table wasn't observed at any of eight boreholes. Neverthless, it would not be realistic to define the depths of 25-100 m as dry. It is convenient to except damp condition for those depths of andesites.

There is no significant stream located at the close vicinity of the project site except the arroyo of Bentderesi.

2.4 Structural Geology

Since the andesites are mostly covered with artificial structures, any effect of regional tectonic activity can not be observed. Only the flow structures and joints of andesites outcropped at the site were investigated.

2.4.1 Faults

No faults exist at Hıdırlıktepe and its close vicinities. Therefore, there are not any risks for faults cutting/coinsiding the proposed tunnel route.

2.4.2 Seismicity

According to the General Directorate of Disaster Affairs Earthquake Research Department, the New Ulus Tunnel and the study area take place in the third degree of earthquake zone (Figure 2.34) which indicates a ground accelaration of 0.3-0.2 g.



Figure 2.34 Seismic zonation map of Turkey showing the locations of earthquake epicenters which have been determined in the close vicinity of the study area. (www.sayisalgrafik.com/deprem). In this figure, the colored circles indicate the magnitudes of earthquakes that are recorded by Kandilli (2008).

The major earthquake occured in the close vicinity (Altındağ) has an instrumental magnitude of 4.2 and a depth of 33 km, and the date of its occurance is 18.06.1968. In the close visinity another earthquake with a magnitude of 3.7 (Kandilli records) and a depth of 13 km was recorded in 1980.

CHAPTER 3

GEOTECHNICAL CHARACTERIZATION OF THE ANDESITE ROCK MASS

Tunneling projects are envisioned considering the conditions of geologically controlled rock mass. This implies to the impossibility of a design stage in which geomechanical parameters are not consulted. Therefore, detailed researches related to geological situation of the site are performed. In the case of deficient geological data availability, rock mass classification systems are benefitted in both feasibility and preliminary design stages.

In this thesis, the geotechnical characterization of the andesites exposed on the site was determined by using recently developed rock mass classification systems and analytical approaches in which laboratory and in-stu test results are evaluated. The classification systems were also used to define the support systems of The New Ulus Tunnel.

3.1. Geotechnical Investigations

Site characterization tests are divided into two catergories which are field testing and laboratory testing. Site assessment is accomplished when the following informations are achieved (Bieniawski, 1989):

- 1. Types of rock invested at the study area
- 2. Overburden depth and character
- 3. Macroscobic scale discontinuities, such as faults
- 4. Conditions of groundwater
- 5. Problematic features such as swelling rock, weak ground or landslides

3.1.1 Field Studies

This stage includes observations of rock outcrops at the study area. At first the physical properties such as color, texture, macroscobic definitions of minerals, degree of weathering and wetness (in the case of water existence) were descibed. Then detailed discontinuity surveys, the most important part of the field investigation, were performed. In addition to surface surveys, eight boreholes were drilled in the context of subsurface investigations.

3.1.1.1 The discontinuity surveys

The conditions of discontinuities are very significant for engineering designs. Orientations, seperations, infillings, roughness and many of describing properties of discontinuites direct the design stages of the engineering applications. Hence ISRM (1981) developed a description system for the discontinuity conditions. The properties of discontinuities observed in andesites are mentioned within the explanations of the discontinuity attributes. In addition, scan-line survey charts depending on the suggestions of ISRM (1981) were prepared to reveal the discontinuity conditions of the andesites. The charts are given in Appendix A.

Since the tunnel portals are crucial, investigations on joint systems were consantrated on these areas. Indeed, among the tunnel alignment most of the andesite outcrops are covered with houses which prevent the measurements. For the places where no measurements are available, the previous studies of Ercanoğlu (1997) were used. Totally 175 discontinuity measurements were taken from the study area.

According to the descriptions of ISRM (1981), the discontinuities observed at the site vicinity are defined as joints. In regard to the spacing, it ranges between 0,05-1,40 m. The site surveys on andesite outcrops indicate that the persistence of the joints has an interval between 2-10 m. Besides, the outcrops that cannot be reached but seen from a distance revealed that the persistance of the discontinuities reaches more than 30 m. Also, a few toppling occurrences releated with the high persistence of the discontinuities were observed near the location of BH-5. The discontinuity surfaces of the andesites were described as rough. The measurements on discontinuities showed that the aperture values range between 0,6 to 20 mm. Especially near the exit portal, the discontinuities exhibit closer apertures contrary to the ones observed near the entrance portal. In respect of the filling material, mostly clay infillings were defined within the joints of the andesites. In addition, sand occurrence and sandy particles were also observed as the infillings. At the upper parts of the andesites, surface staining of the discontinuity surfaces was also ascertained. Altough there are slightly weathered discontinuity surfaces, the prevailing degree of surface weathering is moderate. The previous researches (Kilic et al., 2000) on Mamak formation andesites also confirm that the dominant weathering degree is moderate.

3.1.1.2 Drillings

In order to determine the geomechanical parameters of the rock mass exposed along the tunnel alignment, a total of 425 m of drilling was performed by 8 boreholes. All boreholes were drilled by Alkon Engineering Corp. (2008). For the drillings two Cralious D-500 Rotary type of drilling machines were used. At the machine NWG (single tube) and NWM (double tube) T-76 core tubes were used. The second machine worked with wire-line and used HQ (63, 5 mm dia) and NQ (47,6 mm dia) core tubes.

Determination of lithological units was accomplished with the help of borehole logs and tests applied on cores taken at drillings. In logging phase total core recovery (TCR), rock quality designation (RQD), fracture frequency and strength data were involved. Conditions of joints and weathering were also assessed by core-box surveys. The borehole logs and the core box photographs are given in Appendix C and D, respectively.

The drillings were aimed to cut the tunnel elevation to reveal the region surrounding the tunnel. The software acquired satallite image showing locations of boreholes is given in Figure 3.1.



Figure 3.1 A satalite image acquired from Google Earth (2008). The red dash line represents the planned road line as the blue line shows the tunnel.

The attributes of boreholes such as location, elevation, depth, altitude and coordinates are indicated in Table 3.1.

Borehole	Place/Km	Northing	Easting	Elevation	Depth
No		(Latitude)	(Longitude)	(m)	(m)
BH-1	0+156	39°56′33.09"	32°52′12.09"	870,264	20
	Tunnel				
BH-2	Entrance-Left	39°56′34.97"	32°52′7.93"	868,884	50
	tube /0+255				
BH-3	0+500	39°56′38.58"	32°51′58.28"	866,124	40
BH-4	Left Tube/	39°56′45.42"	32°52′7.93"	862,200	100
	0+772				
BH-5	Right Tube/	39°56′48.84"	32°51′52.2"	862,214	90
	0+840				
BH-6	Left Tube/	39°56′48.12"	32°51′50.04"	861,524	50
	0+900				
BH-7	Tunnel Exit-				
	Right Tube/	39°56′52.26"	32°51′47.88"	860,700	35
	0+970				
B.H. 8	Tunnel Exit-Left				
	Tube/ 0+962	39°59′50.82"	32°51′50.82"	860,850	40

Table 3.1. The borehole data

Based on the field surveys and drillings a cross-section and a plan view through the tunnel route were prepared. The plan view of the New Ulus Tunnel route and borehole locations appear in Figure 3.2.

At the beginning of the project BH-1 was located on the left tube at the entrance portal. Now it falls behind the left tube of the entrance portal since the tunnel was displaced approximately 35 m ahead. Of all the eight boreholes only BH-1 and BH-3 are located off the tunnel route. Except these two, all boreholes intersect the tunnel line. In Figure 3.3 the cross section of the tunnel line featuring the borehole locations is presented.







Figure 3.3. The cross-section of the New Ulus Tunnel

3.1.2 Laboratory Tests

The geomechanical parameters of the andesites are fundamental in the designs and support systems of the tunnel. In order to achieve these parameters rock mechanics tests were applied to 39 rock core samples taken from 8 boreholes. In the context of laboratory tests uniaxial compressive strength, point load and unit weight tests were performed by EFOL Geotechnic Services Limited Company (2008). The results of rock mechanic tests are given in Table 3.2.

Table 3.2 The results of uniaxial compressive strength, point load and unit weight tests (after Efol. Geotechnic Services Limited Comp., 2008)

Borehole No	Depth (m)	Dry Unit Weight (γ _s) kN/m ³	Point Load Strength Index Is ₍₅₀₎ (MPa)	Uniaxial Comp. Strenght (σ _c) MPa
BH-1	15.00-15.20	23,24	-	52,28
BH-2	6.50-6.70	23,34	-	53,5
"	14.50-15.00	22,75	-	44,42
"	18.50-18.75	23,34	-	56,06
"	23.70-24.00	23,24	-	46,11
"	32.00-32.30	23,04	-	29,60
BH-3	8.60-9.00	23,04	-	43,06
.د	9.00-19.00	_	1.82	40,04*
	15.50-16.00	_	3.17	69,74*
.د	18.00-18.30	22,75	-	45,94
.د	25.10-25.30	22,85	-	35,19
BH-4	48.50-50.00	23,43	-	53,92
"	56.30-56.50	23,04	-	18,05
.د	63.00-63.20	_	1.03	22,66*
.د	67.00-69.00	_	2.26	49,72*
.د	74.30-74.50	23,24	-	48,34
.د	80.60-80.90	23,24	-	23,92
BH-5	47.50-48.00	22,94	-	26,70
.د	51.80-52.00	22,55	-	33,45
"	60.30-60.70	22,75	-	21,80
"	70.50-71.00	22,85	-	45,54
"	71.00-79.00	_	0.61	13,42*
"	79.00-79.20	21,47	-	6,46
BH-6	14.50-14.48	22,85		38,98

"	22.00-22.50	23,14	-	47,11
"	26.00-26.20	23,04	-	39,91
"	32.40-32.60	23,04	-	21,36
"	37.20-37.50	-	0.17	3,74*
BH-7	9.00-9.40	22,65	-	51,34
"	9.50-20.00	-	2.08	45,76*
"	11.80-12.00	22,85	-	44,30
"	15.80-16.00	23,14	-	45,03
"	22.50-22.70	22,16	-	32,88
BH-8	8.50-8.70	22,45	-	40,92
"	12.00-12.26	22,16	-	40,48
"	13.00-17.00	-	1.25	27,5*
"	15.50-15.80	22,65	-	27,22
"	22.00-29.00	_	0.15	3,3*
"	27.50-28.00	23,04	-	41,57

* According to the previous studies (ISRM,1985; Bieniawski 1975; Cavagnaro 1980) that are mentioned by Topal (2000) the uniaxial compressive strength of igneous rocks is equal to 22-24 times the point load strength index. In this thesis the coefficient is selected as 22 in order to convert the Is₅₀ values to σ_c values.(σ_c =22x Point load strength index)

3.2. Application of the Classification Systems to the Andesites

In this section application of the classification systems (RMR and Q) on the geological units ascertained at the study area is under scope. In the context of classification systems, the geomechanical parameters of rock mass are assessed with the help of ratings which are built up depending on the conditions of discontinuities. Since there is a quite difference between discontinuity properties, the maximum and minimum conditions were assessed separately in the classifications. For this reason, the classification results exhibit as intervals.

According to the site investigations, four main joints sets and random joints were determined. The orientations of joint sets are given in Table 3.3

Set No	Dip	Dip Directions
Set 1	67	203
Set 2	77	350
Set 3	37	043
Set 4	66	096

Table 3.3. Orientations of major joint sets observed at the study area

Using the software Dips 5.1, the dip and dip directions of the joints were plotted. The direction of the tunnel drive is SE –NW which is represented by the arrows in the following plot (Figure 3.4).



Figure 3.4. The illustration of major discontinuity set orientations
3.2.1 Application of the RMR System

In accordance with the site observations, the borehole data were used to classify the andesites hosting the New Ulus Tunnel. In the RMR classifications (Bieniawski, 1989), borehole depths coinciding the tunnel elevations were taken into consideration to obtain reliable data for the selection of support systems. Since BH-1 and BH-3 do not intersect the tunnel line, the data obtained from these boreholes were benefitted in only classification of the rock mass. The classified andesites were divided into groups which were represented by the chainage of the planned route.

Km: 0+100-0+200 m (in accordance with BH-1)

In order to assess the RMR rating, RQD values obtained from BH-1 were used. The rest of the classification parameters depend on the site investigations of the exposed andesites located between Km:0+100-0+200 m. RMR application results are given in Table 3.4. the orientations of discontinuity sets are given in Table 3.5.

0+100- 0+200 m (BH-1)		
Parameters	Value	RMR Rating
RQD (%)	0-27	3-6
Between 0.00-20.00 m		
Uniaxial Compressive Strength	52,3 MPa	6
(σ_c)		
Conditi	on of Discontinuities	
Spacing	100-400 mm	7-10
Persistance	10-4 m	2
Aperture	15-7 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		36-42
Rating adjustment	Very unfavourable	-12
Total RMR Rating		24-30
Description		Poor Rock

Table 3.4. RMR application to andesites located between 0+100-0+200 m

Rating adjustment for discontinuity orientations

Table. 3.5. Orientations of major joint sets at km:0+100-0+200

Discontinuity Set	Dip	Dip Direction
Set 1	73	207
Set 3	68	047



Figure 3.5. The orientations of major discontinuity sets at km:0+100-0+200

Altough there are two discontinuity sets (73/207, 68/47) the most critical set is considered in the rating adjustments. Since Set 1 $(73^{\circ}/207^{\circ})$ strikes parallel to the tunnel axis, it is defined as the critical set. According to RMR rating table (Bieinawski, 1989) the orientation of discontinuity set is very unfavourable which corresponds to -12 rating.

Km: 0+200-0+300 (in accordance with BH-2)

In order to assess the RMR rating, RQD values obtained from BH-2 were used. The rest of the classification parameters depend on the site investigations of the exposed andesites. RMR application results are given in Table 3.6. The discontinuity orienatations are given in Table 3.7 and illustrated in Figure 3.6.

Km: 0+200- 0+300 m (The Entrance Portal/ BH-2)		
Parameters	Value	RMR Rating
RQD (%)	10-41	4-8
Between 25,00-36,00 m		
Uniaxial Compressive Strength	29,60- 46,11 MPa	4-6
(σ _c)		
Conditio	on of Discontinuities	
Spacing	180-550 mm	7-11
Persistance	10-3 m	2
Aperture	15-5 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		35-45
Rating adjustment	Very unfavourable	-12
Total RMR Rating		23-33
Description		Poor Rock

Table 3.6 RMR application to the andesites located between km:0+200-0+300

Rating adjustment for discontinuity orientations

Table 3.7 The discontinuity orientations at km:0+200-0+300

Discontinuity Set	Dip	Dip Direction
Set 1	73	207
Set 3	79	039



Figure 3.6. Orientation of major discontinuity sets at km:0+200-0+300

The discontinuity sets $(73^{\circ}/207^{\circ} \text{ and } 79^{\circ}/039^{\circ})$ strike parallel to the tunnel axis and dip at greater degrees than 45°. According to the RMR rating table (Bieniawski, 1989), the discontinuity orientations are very unfavourable. For this reason the adjustment rating was taken as -12.

Km: 0+300-0+400 (in accordance with BH- 3)

According to the data derieved from BH-3, the following rating table (Table 3.8) was prepared.

Table 3.8 RMR application to the andesites located between 0+300-0+400 m

Km: 0+300- 0+400 m (BH-3)		
Parameters	Value	RMR Rating
RQD (%)	0-68	3-14
Between 5,00-24,00 m		
Uniaxial Compressive Strength	40,04- 69,74 MPa	5-7
(σ_c)		
Condition of Discontinuities		
Spacing	180-600 mm	8-12
Persistance	10-5 m	2
Aperture	30-8 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Slightly weathered	5
Ground water	Damp	10
Basic RMR Rating		38-55
Rating adjustment	Very unfavourable	-12
Total RMR Rating		26-43
Descriptions		Poor-Fair Rock

Rating adjustment for discontinuity orientations

The discontinuity orienatations are given in Table 3.9 and illustrated in Figure 3.7.

Table 3.9. The discontinuity orientations at km:0+300-0+400

Discontinuity Set	Dip	Dip Direction
Set 1	74	197
Set 3	79	039



Figure 3.7. Dip and dip directions of discontinuity sets observed at km:0+300-0+400

The rose and dip/dip direction plots of the discontinuity sets revealed that there is a critical discontinuity set $(79^{\circ}/222^{\circ})$ which strikes parallel to the tunnel axis and dip at 79°. This situation denotes very unfavourable tunneling condition with a rating of -12 for the rating adjustments.

Km:0+780-0+840 (in accordance with BH- 4)

Since there are not any andesite outcrops near BH-4, the closest andesite exposures at km:0+840 were used to obtain the discontinuity conditions. Nevertheless, the borehole data of BH-4 was benefitted in the RMR applications given below. The orientations of the discontinuities are given in Table 3.10. The plots of discontinuity sets are given in Table 3.11. The illustration of major discontinuity sets is given in Figure 3.8.

Km: 0+780- 0+840 m (BH-4)		
Parameters	Value	RMR Rating
RQD (%)	0-55	3-11
Between 68,00-87,00 m		
Uniaxial Compressive Strength	23,92 -49,72 MPa	3-6
(σ _c)		
Conditio	on of Discontinuities	
Spacing	45-1400 mm	5-17
Persistance	14-2 m	1-4
Aperture	15-1 mm	0-4
Roughness	Rough	5
Infilling	Soft filling>5 - <5 mm	0-2
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		30-62
Rating adjustment	Very unfavourable	-12
Total RMR Rating		18-50
Description		Very Poor-
_		Fair Rock

Table 3.10. RMR application to the andesites located between 0+780-0+840 m

Rating adjustment for discontinuity orientations

Table 3.11. The orientations of discontinuities at km:0+780-0+840

Discontinuity Set	Dip	Dip Direction
Set 1	59	212
Set 4	75	093
Random	76	150



Figure 3.8. The illustration of major discontinuity sets near to BH-4.

The tunnel will be driven parallel to the strike of the discontinuity set 1(59°/212°). Considering both strike and dip of the discontinuity set, the orientations are defined as very unfavourable in the context of RMR rating adjustment (Bieniawski, 1989).

Km:0+800-0+850 (in accordance with BH-5)

In addition to the site investigations, the data obtained from BH-5 was used in the classifications. The results are given in Table 3.12.

Table 3.12 RMR application to the andesites located between 0+800-0+850 m

Km: 0+800- 0+850 m (BH-5)			
Parameters	Value	RMR Rating	
RQD Max.(%)	0-69	3-14	
Between 61,00-80,00 m			
Uniaxial Compressive Strength	6,46-45,54 MPa	5-1	
(σ_c)			
Conditio	Condition of Discontinuities		
Spacing	45-1400 mm	5-17	
Persistance	14-2 m	1-4	
Aperture	40-1 mm	0-4	
Roughness	Rough	5	
Infilling	Soft filling>5mm, < 5	0-2	
Weathering	Slightly weathered	5	
Ground water	Damp	10	
Basic RMR Rating		34-62	
Rating adjustment	Very unfavourable	-12	
Total RMR Rating		22-50	
Descriptions		Poor-Fair Rock	

Rating adjustment for discontinuity orientations

The discontinuity orientations (Table 3.13) and illustrations (Figure 3.9) are given below.

Table 3.13. The orientations of discontinuities at km:0+800-0+850

Discontinuity Set	Dip	Dip Direction
Set 1	59	212
Set 4	75	093
Random	76	150



Figure 3.9. Illustration of major discontinuity sets at km:0+800-0+850

The Set 1 $(59^{\circ}/212^{\circ})$ constitute the most critical discontinuity which strikes nearly parallel to the tunnel axis. Under that circumstances the tunneling condition appears to be very unfavourable with a rank of -12 for tunnel rating adjustment.

Km:0+840-0+950 (in accordance with BH- 6)

For the classifications, the RQD values obtained from BH-6 was used. The results aretabulated in Table 3.14. The discontinuity orientations (Table 3.15) and major discontinuity set plot (Figure 3.10) is given below.

Table 3.14. RMR application to the andesites located between 0+840-0+950 m

Km: 0+840- 0+950 m (BH-6)		
Parameters	Value	RMR Rating
RQD (%)	0-72	3-14
Between 31,00-50,00 m		
Uniaxial Compressive Strength	3,74-21,36 MPa	1-3
(σ _c)		
Condition of Discontinuities		
Spacing	150-600 mm	7-12
Persistance	7-12 m	2-1
Aperture	15-6 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		31-48
Rating adjustment	Very unfavourable	-12
Total RMR Rating		19-36
Descriptions		Very Poor -
		Poor Rock

Rating adjustment for discontinuity orientations

.

Table 3.15 The orientations of discontinuity sets at km:0+840-0+950

Discontinuity Set	Dip	Dip Direction
Set 1	68	205
Set3	66	036
Set 4	75	093



Figure 3.10. The plot ot major discontinuity sets at km:0+900

The critical discontinuity set observed at the locations between 0+840-0+950 m strikes parallel to the tunnel axis. Under that circumstances unstable tunneling conditions are expected. For this reason the adjustment factor was taken as -12.

Km:0+950-1+000 (in accordance with Borehole 7)

Since there are not any andesite outcrops at the close vicinities of tunnel exit portal, the related previous studies of Ulusay, 1975; Kasapoğlu, 1980 and Ercanoğlu, 1997 were used . In addition, core taken from BH-7 were also used. The cores demonstrates smilar joint orientations with the cores taken from BH-6. This can be explained by high joint persistancy of andesites. Under that circumstances, joints of andesites that will be faced at the exit portal are excepted as a continuum of the ones that are observed near BH-6. For this reason the results of site investigations near BH-6 were used (Table 3.16).

Km: 0+950-1+000 m (BH- 7)			
Parameters	Value	RMR Rating	
RQD (%)	0-63	3-12	
Between 2,00-21,00 m			
Uniaxial Compressive Strength	44,30-51,34 MPa	5-6	
(σ _c)			
Conditio	n of Discontinuities		
Spacing	100-980 mm	7-14	
Persistance	6-2 m	2-4	
Aperture	15-5 mm	0	
Roughness	Rough	5	
Infilling	Soft filling > 5 mm	0	
Weathering	Moderately weathered	3	
Ground water	Damp	10	
Basic RMR Rating		35-54	
Rating adjustment	Very unfavourable	-12	
Total RMR Rating	23-42		
Descriptions		Poor-Fair Rock	

Table 3.16 RMR application to the andesites located at 0+950-1+000 m

Rating adjustment for discontinuity orientations

Depending on the situations mentioned above, the following discontinuity sets (Table 3.17) were considered for the rating adjustments. The illustrations of discontinuity sets are given in Figure 3.11.

Table 3.17. The orientations of major discontinuity sets at km:0+950-1+000

Discontinuity Set	Dip	Dip Direction
Set 1	68	205
Set 3	66	036



Figure 3.11. The plot representing the major discontinuity set orientations

According to the rose diagram, the critical joint sets 1 (66/205) and Set 3(66/036) strike parallel to the tunnel axis. And the dips of the sets fall within the interval representing very unfavourable conditions. As a consequent, the rating adjustment is -12.

Km:0+950-1+000 (in accordance with Borehole 8)

Since BH 8 was located on the opposite of BH 7 (within a close distance), the discontinuity properties were excepted as more or less the same. For this reason the same discontinuity conditions were consided in the RMR applications (Table 3.18).

Km: 0+950 -1+000 m (BH-8)			
Parameters	Value	RMR Rating	
RQD (%)	0-67	3-14	
Between 2,51-22,51 m			
Uniaxial Compressive Strength	27,5-40,92 MPa	3-5	
(σ _c)			
Conditio	on of Discontinuities		
Spacing	100-980 mm	7-14	
Persistance	6-2 m	2-4	
Aperture	15-5 mm	0	
Roughness	Rough	5	
Infilling	Soft filling > 5 mm	0	
Weathering	ModeratelyWeathered	3	
Ground water	Damp	10	
Basic RMR Rating		35-55	
Rating adjustment	Very unfavourable	-12	
Total RMR Rating		21-43	
Descriptions		Poor-Fair Rock	

Table 3.18 RMR application to andesites located at km: 0+950-1+000

Rating adjustment for discontinuity orientations

In Table 3.19. The orienatations of major discontinuity sets are given . In addition, the illustration of these sets are represented in Figure 3.12.

Table 3.19. The discontinuity sets and their orienatations at km: 0+950 -1+000

Discontinuity Set	Dip	Dip Direction
Set 1	68	205
Set 3	66	036



Figure 3.12. The illustration of major discontinuity sets at km:0+950-1+000

As shown in the figure, the discontinuity sets strike parallel to the tunnel axis and dip between 45-90 degrees which generates very unfavourable conditions for tunneling.

The results of RMR classification system in correlation with boreholes are presented in Table 3.20.

		Description
Investigation Area/	Total RMR	of the
Borehole Number	Rating	Rock Mass
Km:0+00-0+100/BH-1	24-30	Poor Rock
Km:0+100-0+200/BH-2	23-33	Poor Rock
Km:0+300-0+400/BH-3	26-43	Poor - Fair Rock
Km:0+780-0+840 /BH-4	18-50	Very Poor - Fair Rock
Km:0+800-0+850/BH-5	22-50	Poor - Fair Rock
Km:0+840-0+950/BH-6	19-36	Very Poor - Poor Rock
Km:0+950-1+000/BH-7	23-47	Poor - Fair Rock
Kn:0+950-1+000/BH-8	21-43	Poor - Fair Rock

Table 3.20. Rock descriptions according to the RMR classification system

3.2.2 Q-System (NGI) Applications

In order to classify the individual parameters, the Q system rating tables proposed by Barton et al.(1974) were used. The descriptions of the capital letters used in the following table are also given in Appendix B. In the selection of SRF parameters, the rose diagrams and dip/dip direction diagrams of discontinuities which are shown under RMR applications were benefitted.

The classification results in correlation with each borehole are given in Table 3.21, Table 3.22, Table 3.23. Table 3.24, Table 3.25, Table 3.26, Table 3.27, Table 3.28 and Table 3.29.

Table 3.21 Q system classification for the andesites located at km:0+100-0+200 (in correlation with BH-1)

	Q-System Parameters	Description	Value
	RQD (%)	Very Poor-Poor	10*-27
BH 1	Joint Set Number (Jn)	2 sets + random	18**
	Joint Rougness Number (Jr)	Е	1,5
	Joint Alteration number (Ja)	С	2
	Joint Water Reduction (Jw)	A	1
	Stress Reduction Factor (SRF)	В	5
	Rating	0,08-0,225	5
	Description	Extremely P	oor-
		Very Poor R	ock
RMR (according to interrelations) 21,63-30,575			
	~ • • •		

*: Appendix C, Section 1, note 1 ** Appendix C, Section 2, note 1

Table. 3.22. Q System classification for the andesites located at km: 0+200-0+300 (in correlation with BH-2)

Entrance Portal	Q-System Parameters	Description	Value
	RQD (%)	Very Poor-Poor	10-41
	Joint Set Number (Jn)	2 sets	8***
BH 2	Joint Rougness Number (Jr)	E	1,5
	Joint Alteration number (Ja)	F	4
	Joint Water Reduction (Jw)	А	1
	Stress Reduction Factor (SRF)	В	5
	Rating	0,09-0,38	
Description		Extremely Poor-	
		Very Poor R	ock
RMR (according to interrelations) 22,69-35,39			

***Appendix C, Section 2, note 2

Table 3.23. Q system Classification for the andesites located at km: 0+300-0+400 (in correlation with BH-3)

	Q-System Parameters	Description	Value
	RQD (%)	Very poor- Fair	10*-68
BH 3	Joint Set Number (Jn)	2 sets	12**
	Joint Rougness Number (Jr)	Е	1,5
	Joint Alteration number (Ja)	С	2
	Joint Water Reduction (Jw)	А	1
	Stress Reduction Factor (SRF)	В	5
	Rating	0,125-0,85	5
Description		Very Poor R	ock
RMR (according to interrelations) 25,28-42,53			

*Appendix C, Section 1, note 1 **Appendix C, Section 2, note 1

Table 3.24. Q system Classification for the andesites located at 0+780-0+840 (in correlation with BH-4)

	Q-System Parameters	Description	Value
	RQD (%)	Very Poor -Fair	10*-55
BH 4	Joint Set Number (Jn)	2 sets + random	18**
	Joint Rougness Number (Jr)	Е	1,5
	Joint Alteration number (Ja)	С	2
	Joint Water Reduction (Jw)	А	1
	Stress Reduction Factor (SRF)	С	2,5
	Rating	0,16-0,916	
Description		Very Poor R	ock
RMR (according to interrelations) 27,87-43,21			

*Appendix C, Section 1, note 1 **Appendix C, Section 2, note 1

Table 3.25. Q system classification for the andesites located at km: 0+800-0+850 (in correlation with BH-5)

	Q-System Parameters	Description	Value
	RQD (%)	Very Poor -Fair	10*-69
BH-5	Joint Set Number (Jn)	2 sets + random	18**
	Joint Rougness Number (Jr)	Е	1,5
	Joint Alteration number (Ja)	С	2
	Joint Water Reduction (Jw)	А	1
	Stress Reduction Factor (SRF)	С	2,5
	Rating	0,16-1,15	
Description		Very Poor-Poor	·Rock
	RMR (according to interrelations) 27	,87- 45,25	

*Appendix C, Section 1, note 1 **Appendix C, Section 2, note 1

Table 3.26. Q system classification for the andesites located at km:0+840-0+950 (in correlation with BH-6)

	Q-System Parameters	Description	Value
	RQD (%)	Very Poor -Fair	10*-72
BH-6	Joint Set Number (Jn)	3 sets	27**
	Joint Rougness Number (Jr)	E	1,5
	Joint Alteration number (Ja)	С	2
	Joint Water Reduction (Jw)	А	1
	Stress Reduction Factor (SRF)	В	5
	Rating	0,05-0,4	
Description		Extremely Po	or-
		Very Poor R	ock
	RMR (according to interrelations) 17	,98-35,75	

**Appendix C, Section 2, note 1

Table 3.27. Q system classification for the andesites located at km:0+950-1+000 (in correlation with BH-7)

Exit Portal	Q-System Parameters	Description	Value	
	RQD (%)	Very Poor -Fair	10*-63	
BH-7	Joint Set Number (Jn)	2 sets	8**	
	Joint Rougness Number (Jr)	Е	1,5	
	Joint Alteration number (Ja)	С	2	
	Joint Water Reduction (Jw)	А	1	
	Stress Reduction Factor (SRF)	В	5	
Rating 0,18-1,18				
Description Very Poor-Poor Rock		· Rock		
	RMR (according to interrelations) 28,93-45,5			

*:Appendix C, Section 1, note 1 **:Appendix C, Section 2, note 2

Table 3.28 Q system classification for for the andesites located at 0+950-1+000 (in correlation with BH-7)

Exit Portal	Q-System Parameters	Description	Value
	RQD (%)	Very Poor -Fair	10*-67
BH-8	Joint Set Number (Jn)	2 sets	8**
	Joint Rougness Number (Jr)	Е	1,5
	Joint Alteration number (Ja)	С	2
	Joint Water Reduction (Jw)	А	1
	Stress Reduction Factor (SRF)	В	5
Rating 0,187-1,256			
Description Very Poor-Poor Rock			·Rock
RMR (according to interrelations) 29-46			

*:Appendix C, Section 1, note 1 **:Appendix C, Section 2, note 2

Andesites are characterized as very poor rocks according to the Rock Mass Qualification System. The Q index values and corresponding rock descriptions are summarized in Table 3.29.

Borehole Number	Q-System Rating	Description
BH-1	0,08-0,225	Extremely poor-
		Very poor rock
BH-2	0,09-0,38	Extremely poor-
		Very poor rock
BH-3	0,125-0,85	Very poor rock
BH-4	0,16-0,916	Very poor rock
BH-5	0,16-1,15	Very poor-poor rock
BH-6	0,05-0,4	Extremely poor-
		Very poor rock
BH-7	0,187-1,18	Very poor- poor rock
BH-8	0,187-1,256	Very poor-poor rock

Table 3.29. Descriptions of the andesites in accordance with Q system

The RMR values, obtained from the inter-relation with Q indexes generally corroborate the RMR classifications results. The correlation of the RMR and Q system results are represented in Figure 3.13.



Figure 3.13 The correlation of classification results of RMR and Q systems

As seen in Figure 3.14, the excessive difference between maximum and minimum RQD and uniaxial compressive strength values results in the variability of rock mass classes. According to the figure above (Figure 3.13), the andesites exhibit a wide range of rock quality which indicates a differentiation. This differentiation is assumed to occur depending on hydrathermal alteration.

CHAPTER 4

ASSESSMENT OF THE SLOPE STABILITY AT THE PORTALS BY KINEMATICAL METHOD

Altough gravitation is the major effect triggering the rock mass to move, other geological factors such as discontinuity conditions should not be underestimated. Especially for the structurally controlled slopes, the joint sets and their attitudes define the probability of failures. In addition to the naturely triggered ones, the slope failures are also faced in engineering applications. At the excavation stages the disturbance of rock mass may result in slope failures. The design and the construction stages of the engineering structure are developed depending on these failure conditions. Once the failure surface and the failure type are detected, reliable support design and construction system are formed as done in tunnel applications.

This chapter covers the slope stability analyses for the entrance and exit portals of the New Ulus Tunnel.

4.1 Kinematic Analyses

The kinematic analyses were performed by using the software Dips 5.1. In order to obtain the required data, scan-line surveys depending on the procedures of ISRM (1981) were conducted. Following the evaluation of survey findings, rose and contour diagrams of the joints were plotted to feature the main situation of the joint systems. The Equal Area Schmidt Projection with Lower Hemisphere selection was choosen for the plots. As for the tunnel strike, 308° was used in the analyses. Depending on the previous studies of Gökçeoğlu et al., (2000) the internal friction angle of the discontinuity surfaces was selected as 30° (Figure 4.1).



Figure 4.1. Failure envelope based on Barton failure criterion (C. Gökçeoğlu et al., 2000)

4.1.1. Kinematic Analyses Applications

According to the scan-line survey results, random discontinuities and four major discontinuity sets were determined by the software. In the context of discontinuity set selections, the familiar discontinuity orientations were groupped under individual sets (Table 4.1) and illustrated in Figure 4.2. In order to see the general distrubution of the discontinuities, the contur diagrams (Figure 4.3), pole consantrations (Figure 4.4) and rose diagrams (Figure 4.5) were plotted with the help of the software Dips 5.1.

Table 4.1. The orienatations of the major discontinuity sets observed at the study area

Set No	Dip	Dip Direction
1	67	203
2	77	350
3	67	043
4	66	096



Figure 4.2. The contour diagram representing general distribution of the discontinuities at the study area. The black arrow indicates the direction of tunnel drive.



Figure 4.3. The pole consantration diagram of the discontinuities at the study area



Figure 4.4 The Rosette diagram showing the trends of discontinuities



Figure 4.5 The illustration of dip/dip direction of the discontinuity sets

4.1.1.1. The New Ulus Tunnel Entrance Portal Kinematic Analyses

In the analyses, the dip angle for the portal rock slope was selected as 76° which is one of the steepest applicable excavation angle used in recent slope excavations. This angle denotes that the slope ratio is 1/4 (1 for horizontal and 4 for vertical). With the help of software (Dips 5.1), two major discontinuity sets revealed. The orienatation of these sets are given in Table 4.2 and represented in the dip/dip direction plot in Figure 4.9. Additionally, the plots of contour diagram (Figure 4.6), pole distrubution (Figure 4.7) and rose diagram (Figure 4.8) are given below. As for the appellation of set numbers, the familiar orientation of discontinuities were considered under the same set number.

Table 4.2 The orientations of major discontinuity sets at the entrance portal

Set Number	Dip	Dip Direction
1	73	207
3	68	047



Figure 4.6 The contour plot of the discontinuities at km: 0+200-0+300



Figure 4.7. The pole plot of the discontinuities at km: 0+200-0+300



Figure 4.8. The rose diagram of the discontinuities at km: 0+200-0+300



Figure 4.9. The orientation of major joint sets at km: 0+200-0+300

According to the kinematical analyses, there is not any potential for plane (Figure 4.10) and wedge failure (Figure 4.11) occurence. In addition toppling (Figure 4.12) is not expected at the rock slope. In the following illustrations of kinematical analyses, the yellow areas indicate the critical regions.



Figure 4.10 Plane failure analysis at the entrance portal rock slope



Figure 4.11 Wedge failure analysis at the entrance portal rock slope



Figure 4.12 Toppling potential analysis at the entrance portal rock slope

As a result, the slope orientation 76/128 is safe for the entrance portal rock slope excavations. The kinematic analyses results are given in Table 4.3.

Table 4.3 Entrance portal slope kinematic analyses results

Dip/ Dip Direction of The Slope	Internal Friction Angle (þ)	Failure Type	Problem at Rock Slope	Stable Slope Angle
		Plane	No	76/128
76/128	φ=30°	Wedge	No	76/128
		Toppling	No	76/128

4.1.1.2. The New Ulus Tunnel Exit Portal Kinematic Analyses

For the kinematic analyses of exit portal rock slope, the same tunnel strike(308°), internal friction angle (30°) and slope angle (76°) were used. Since the exit portal falls in the chainage between 0+900-1+000, the site investigations near 0+900 were benefitted. According to the scan-line surveys at km:0+900, two major discontinuity sets were determined by the software. The orientations of these major sets are given in Table 4.4. and illustrated in Figure 4.16.

Table. 4.4. The orienatations of major discontinuity sets at the exit portal

Set Number	Dip	Dip Direction
1	68	205
3	66	036

The plots of contour diagram (Figure 4.13), pole concentration (Figure 4.14) and rose diagram (Figure 4.15) are given below.



Figure 4.13. The contour diagram of discontinuities at km:0+900



Figure 4.14 Pole concetration of discontinuities at km:0+900



Figure 4.15. The rosette diagram of discontinuities at km:0+900



Figure 4.16 The orientations of major discontinuity sets at km:0+900

According to the kinematical analyses, any potential for the plane (Figure 4.17), wedge (Figure 4.18) failure and toppling (Figure 4.19) did not appear at the exit portal rock slope. Consequently the safe slope oriantation for the rock slope was determined as $76^{\circ}/308^{\circ}$. The yellow areas shown in the figures indicate the critical regions.



Figure 4.17 Plane failure analysis for the exit portal slope face



Figure 4.18 Wedge failure analysis for the exit portal rock slope face


Figure 4.19 Toppling analysis for the exit portal rock slope face

The kinematical analyses revealed that the dip angle 76 is safe for the exit portal slopes. The results of slope stability analyses for the exit portal is given in table 4.5.

Table 4.5. Kinematical analyses results of rock slope at the exit portal

Dip/ Dip Direction of the Slope	Internal Friction Angle (þ)	Failure Type	Problem at rock slope	Stable Slope Angle
		Plane	No	
76°/308°	30°	Wedge	No	76°/308°
		Toppling	No]

The safe slope orientations obtained from the kinematical analyses are given in Table 4.6. In the case of portal slopes been excavated with the following orientations, any problem will not be encountered.

Table 4.6 The results of kinematical analyses applied on slopes at both entrance and exit portals

Portal	Type Of Slope	Internal Friction Angle (D)		Problem	n	Stable Slope Angle (Dip/Dip Direction)			
		Angle (Ψ)	Plane	Wedge	Toppling				
The	Rock Face								
Entrance	Slope	30°	No	No	No	76/128			
Portal									
The	Rock Face	200							
Exit	Slope	30°	No	No	No	76/308			
Portal									

CHAPTER 5

SUPPORT SYSTEMS SUGGESTED FOR THE TUNNEL

Tunnel support systems are indispensable parts of the construction phase as well as the construction of tunnel itself. Essentially, any failure potential caused by stress distrubution around the tunnel is controlled by support systems. The only way of redusing that potential is the right selection of support systems.

For the selection of an efficent support, the stand-up time for the tunnel's unsupported span should be defined carefully. The geological unit's geomechanical properties are the key factors that determine the stand-up time for the tunnel span. In the case of tunnel drive into weak rock, a short stand - up time is expected. Under that circumstances the rock mass classifications gain importance.

5.1 Support systems depending on the RMR Classification

The appropriate rock reinforcement method is determined by making use of the guidelines that are mentioned below.

5.1.1 The Support Pressure

In the context of the excavation and support systems, guidelines in accordance with RMR system were generated. In-stu stress, shape of the tunnel and excavation method are the main factors effecting the guidelines of rock reinforcement. The support guidelines represents the permanent and not the primary support. These guidelines presented in the Figure 5.1 are applicable to tunnelings using conventional drilling blasting procedures (Bieniawski, 1989).

Table 5.1. Guidelines for excavation and support of 10 m span rock tunnels in accordance with the *RMR* system (After Bieniawski 1989)*.

Rock mass class	Excavation	Rock bolts (20 mm diameter, fully grouted)	Shotcrete	Steel sets
I - Very good rock RMR: 81-100	Full face, 3 m advance.	Generally no support re	quired except sp	ot bolting.
II - Good rock RMR: 61-80	Full face , 1-1.5 m advance. Complete support 20 m from face.	Locally, bolts in crown 3 m long, spaced 2.5 m with occasional wire mesh.	50 mm in crown where required.	None.
III - Fair rock <i>RMR</i> : 41-60	Top heading and bench 1.5-3 m advance in top heading. Commence support after each blast. Complete support 10 m from face.	Systematic bolts 4 m long, spaced 1.5 - 2 m in crown and walls with wire mesh in crown.	50-100 mm In crown and 30 mm in sides.	None.
IV - Poor rock RMR: 21-40	Top heading and bench 1.0-1.5 m advance in top heading. Install support concurrently with excavation, 10 m from face.	Systematic bolts 4-5 m long, spaced 1-1,5 m in crown and walls with wire mesh.	100-150 mm In crown and 100 mm in sides.	Light to medium ribs spaced 1.5 m where required.
V – Very poor rock <i>RMR</i> : < 20	Multiple drifts 0.5-1.5 m advance in top heading. Install support concurrently with excavation. Shotcrete as soon as possible after blasting.	Systematic bolts 5-6 m long, spaced 1-1.5 m in crown and walls with wire mesh. Bolt invert.	150-200 mm In crown, 150 mm in sides, and 50 mm on face,	Medium to heavy ribs spaced 0.75 m with steel lagging and forepoling if required. Close invert.

* Shape: horseshoe. Width: 10 m. Vertical stress: 25 MPa. Construction method: drilling and blasting.

Excluding BH-1 and BH-3, the borehole data were consulted in the support system determinations. The regions limited with red, blue and green lines represent the support catagories selected for the New Ulus Tunnel. Accordingly, for the region represented by BH 2, application of 4-5 m long rock bolts (spaced 1-1,5 m in crown) is recommended. As for the region represented by BH-4, application of systematic bolts which are 5-6 m long and spaced 1-1,5 m in crown is convenient.

With respect to the region represented by BH-6, application of systematic bolts which are 4-6 m long and spaced 1-1,5 m in crown are recommended. Regarding to the regions represented by BH-7 and BH-8, application of 4-5 m long rock bolts spaced 1-1,5 m in crown is recommended.

On the basis of coal mine studies Ünal (1983) proposed a correlation for the estimation of RMR aided support pressure of the opening with flat roof.

$$P_v = [(100 - RMR)/100] .\gamma. B$$
 Eqn.1

P_v: The support pressure, MPa

 γ : The rock density, kN/m³

B : The tunnel width, m

Borehole No	RMR Rating	Density of the Rock (γ) kN/m ³	The tunnel Width (m)	Support Pressure (P _v) MPa
BH-2	23-33	23,60	12	0,218-0,19
BH-4	18-50	23,70	12	0,23-0,142
BH-5	22-50	23,00	12	0,215-0,138
BH-6	19-36	23,40	12	0,22-0,18
BH-7	23-42	23,10	12	0,21-0,16
BH-8	21-43	23.00	12	0.218-0.157

Table 5.2 Support pressures for The New Ulus Tunnel

5.2 Support system according to the Q System

Using the Q system outputs, estimation of the stand-up time and the maximum unsupported span of the tunnel are obtained. The first step of support system determination is defining the equivalent dimension (D_e) .

According to Barton's chart (Table 5.3), the excavation support ratio (ESR) for the New Ulus Tunnel is 1. The result gathered from the equation is as follows;

$$D_e = Excavation Span/ESR$$
 Eqn. 2
 $D_e = 12/1 = 12$

Table 5.3 Values of excavation support ratio-ESR (Barton et al., 1974)

Type of Excavation	ESR
Temporary mine openings, etc.	3 - 5
Vertical shafts:	
(i) circular section	2.5
(ii) rectanular / square section	2.0
Permanent mine openings, water tunnels for hydro power	1.6
(excluding high pressure penstocks), pilot tunnels, drifts	
and headings for large excavations, etc.	
Storage rooms, water treatment plants, minor road and	1.3
railway tunnels, surge chambers, access tunnels, etc.	\frown
Oil storage caverns, power stations, major road and	1.0
railway tunnels, civil defence chambers, portals,	
intersections, etc.	\smile
Underground nuclear power stations, railway stations,	0.8
sports and public facilities, factories, etc.	

In consideration of support systems, the length of bolt (L) is determined from the equation (Barton et. al., 1974) below;

$$L=(2+0,15B) / ESR, m$$
 Eqn 3

For the andesites observed at the borehole locations the following values are used;

$$L = (2+0,15x12) / 1 = 3,8 \text{ m}$$

The relation between equivalent dimension (D_e), tunneling quality index (Q) and support bolt length is presented in Figure 5.1 and the support categories for each observation location are summarized in the Table 5.4. The support systems selected for each borehole are represented by colored points in Figure 5.1.



Figure 5.1. Estimated support categories based on the tunnelling quality index Q (After Grimstad and Barton, 1993, reproduced from Palmstrom and Broch, 2006).

Table 5.4. The reinforcement categories for each borehole location (according to Q system)

Borehole No	Q Index	De	Reinforcement
			Category
BH-2	0,09-0,38	12	8-7
BH-4	0,16-0,916	12	7-6
BH-5	0,16-1,15	12	7-6
BH-6	0,05-0,4	12	8-7
BH-7	0,18-1,18	12	7-6
BH-8	0,187-1,256	12	7-6

The reinforcement category gives the bolt spacing information in addition to the support type. According to the chart given in Figure 5.1, the following support categories were defined for the individual borehole locations. At km:0+255 and km:0+900 where BH-2 and BH-6 were drilled, 12-15 cm wide fibre reinforced shotcrete and 3,8 m rock bolting are recommended. For km:0+772 and km:0+840 where BH-4 and BH-5 were drilled, 9-12 cm or 12-15 cm wide fibre reinforced shotcrete and bolting (3,8 m rock bolt) method is advised. As for km:0+962 (BH-8) and km:0+970 (BH-7), application of 12-15 cm wide fibre reinforced shotcrete and 3,8 m long rock bolting is convenient.

Determination of the maximum unsupported span is achieved as follows:

Maximum Unsupported Span =
$$2(ESR) Q^{0,4}$$
, m Eqn. 4

For the andesites maximum unsupported span values are given in Table 5.5.

Table 5.5 Maximum unsupported span values for variable Q indexes of the andesites.

Borehole No	Q Index	ESR	Max. Unsupported Span (m)
BH-2	0,09-0,38	1	0,76-1,35
BH-4	0,16-0,91	1	0,96-1,93
BH-5	0,16-1,15	1	0,96-2,11
BH-6	0,05-0,4	1	0,6-1,38
BH-7	0,18-1,18	1	1,0-2,13
BH-8	0,18-1,25	1	1,0-2,18

CHAPTER 6

CONCLUSIONS

There are three main objectives of this thesis. The first objective involves the determination of the rock mass characteristics of the andesites that will host the New Ulus Tunnel. The second objective consists of defining the reliable support systems for the tunnel. The last objective comprises the assessment of the rock slope stabilities at the portals. In order to achieve these objectives, laboratory tests, detailed site investigations, classification systems and kinematical analyses have been utilized.

Throughout the tunnel alignment pink andesites of Mamak Formation (Miocene) constitute the main lithology. The andesites are jointed and moderately weathered. With respect to the petrographical analyses, biotite, hornblende and plagioclase minerals were defined as the major minerals whereas quartz and opaque minerals constitute the minor minerals. Futhermore, clay was observed within the microlith matrix. In addition, iron oxidation was determined which also confirms that andesites are weathered.

Depending on the scan-line surveys, four major discontinuity sets with orientations of 67/203; 77/350; 37/043; 66/096 and random joints were revealed at the study area. Since the investigated region is mostly covered with houses, site investigation results of previous studies were also benefited. In general, the discontinuity surfaces are moderately weathered and filled with clay. Moreover, sand occurences were identified within some discontinuities. Close to the surface, staining (iron oxidation) along discontinuity surfaces is noted. As for the discontinuity conditions, the spacing of the discontinuities ranges between 45 mm

and 1400 mm. Besides, the apartures of the discontinuities range between 1 mm-15 mm.

Based on the the results of empirical classification systems (RMR and Q system), the andesites exhibit very poor to fair rock qualities. This change in rock mass quality is assumed to occur due to the variaty of discontinuity conditions and alteration. Especially the fluctuation of the uniaxial compressive strengths within close distances indicates that there is a differantiation of andesites internal structure. Due to the laboratory test results, the uniaxial compressive strength of the andesites range between 6,46 Mpa and 56,06 Mpa. The dry unit weight of andesites has an interval of 21,47-23,43 kN/m³.

The kinematical analyses indicate that there is no potential for any type of failure at the entrance and exit portal rock slopes. Through the analyses, the stable slope orientations for the entrance portal was defined as 76/128 (dip/dip direction). Regarding to the exit portal rock slope, the stable orientation was defined as 76/308 (dip/dip direction).

As for the tunnel support systems, application of 9-12 cm or 12-15 cm wide fibre reinforced shotcrete and rock bolts (3,8 m long rock bolt) are recommended.

REFERENCES

Alkon Engineering Company, 2008.

- Akyürek B., 1981, Ankara melanjının kuzey bölümünün temel jeolojik özellikleri:İç Anadolu'nun Jeolojisi Sempozyumu, TJK 35. Bilimsel ve Teknik Kurultayı, 41-45, Ankara.
- AKYÜREK, B., Duru, M., Sütçü, Y., Papak, I., Şaroğlu, F., Pehlivan, N., Gönenç,
 O., Granit, S., Yaşar, T., 1:100.000 ölçekli açınsama nitelikli Türkiye
 Jeoloji Haritaları No: 55, Ankara-F15 Paftası, Maden Tetkik ve Arama
 Genel Müdürlügü Jeoloji Etütleri Dairesi, Ankara, 1997.
- Barton, N., Lien, R. And Lunde, J., 1974, Engineering classification of masses for the design of tunnel support, Rock Mechanics, Vol.6, No.4, 189-236 pp.
- Barton, N., 2002a. Some new Q-value correlations to assist in site characterisation and tunnel design, International Journal of Rock Mechanics and Mining Sciences, Vol. 39, 185-216 pp.
- Barton, N., 2002b. Deformation moduli and rock mass characterization, Tunneling & Underground Space Technology., Vol. 17, 221-222 pp.
- Bieniawski, Z.T., 1989, Engineering rock mass classifications, Wiley, Newyork, 251 pages.
- Bieniawski, Z.T., 1973, Engineering classification on jointed rock masses. Trans. South African Inst. Civil Engineering, Vol.15, 335-344 pp.

Cavagnaro, R. L., 1980. Geotechnical testing for Leigh Creek Coalfield. Proceeding 3rd. Australian and New Zealand Conference on Geomechanics., Wellington,1, 237-242pp.

Efol Geotechnics Service Ltd. Co., 2008.

- Erol, O.A, 1961, Ankara Bölgesinin tektonik gelişmesi: Turkey Geological Society Bulletin C.7, 2,57-85 pp.
- Ercanoğlu, M., 1997, Investigation of possible modes of instability and preparation of instability map of andesites in Altındağ (Ankara) settlement region. MSc Thesis, Hacettepe University (in Turkish, unpublished).
- Ercanoğlu, M., Aksoy, H., 2004, Potential instability map for rock slopes at Ankara Castle and vicinity. Yerbilimleri 29, 97–114 pp. (in Turkish).
- Ercanoglu, M., Kasmer, O., 2004. Kinematic analysis and GIS based evaluation of possible rock slope instabilities in Altindag District of Ankara City. 5th International Symposium on Eastern Mediterranean Geology, Thessaloniki, Greece, 14–20 April 2004, vol. 2, p. 695.
- Goodman, R. E., 1989, Rock Mechanics, 562 pages.
- GoogleMap, 2008, http://maps.google.com
- Gökçeoğlu, C., Sönmez, H. and Ercanoğlu, M., 2000, Discontinuity Controlled Probabilistic SlopeFailure Risk Maps of Altındağ (settlement) region (Turkey), Engineering Geology, 277/296 pp.

- Hoek, E. and Brown, E.T.,1977, Kaya Şev Stabilitesi, Maden Mühendisleri Odası Yayınları
- Hoek, E. and Brown, E.T., 1980, Underground Excavations in Rock, 528 pages National Highway Institude, U.S.
- Hoek and Bray, J.W., 1981, Rock Slope Engineering, 356 pages.
- Hunt, R. E.1984. Geotechnical engineering investigation manual, 637 pages.
- ISRM, 1972, Suggested method for determining point load strength index. ISRM Committee on field tests, document No. 1,8-12 pp.
- ISRM, 1981, Rock Characterisation, Testing and Monitoring ISRM Suggested Methods, Pergamon, Oxford.
- ISRM, 1985Suggested method for determining point load strength. International Journal of Rock Mechanics, Mining Sciences and Geomechanical Abstracts, 22, 51-60 pp.
- Kasapoğlu, K. E., 2000, Ankara Kenti Zeminlerinin Jeoteknik Özellikleri Ve Depremselliği, Jeoloji Mühendisleri Odası Yayınları:54, 162 pages.
- Karacan, E., Kasapoglu, K.E., 1986. An investigation on the fractures and joints in the Ankara andesites. Yerbilimleri 13, 63–75 pp. (in Turkish).
- Kılıç, R., Bilgehan, P., 1999, Volkanik arazilerde (Şentepe-Ankara) yerleşime yeni bir yaklaşım, Mühendislik Jeolojisi Bülteni 17,111-119.

Kılıç, R., Unified alteration index, 1999, AEG, 4, 475-483pp.

- Koçbay, A. And Kılıç, R., 2006, Enginnering Geology Assessment of Obruk Dam Site, Engineering Geology, pp. 87,141-148.
- Kayışoğlu, S., Koçbay, A. And Kılıç, R., 1998, Piroklastiklede yer seçimi, Kentleşme ve Jeoloji Sempozyumu, 18-20 Kasım 1998, 167-176 pp.
- Pamir, H. N. and Erentöz, C.,1975, M.T.A, Explanatory Text of The Geological Map of Turkey-Ankara
- Palmstrom, A. and Broch, E. 2006. Use and misuse of rock mass classification systems with particular reference to the Q-system. Tunnels and Underground Space Technology, 21, 5nd 75-593.

Rocscience/ Dips 5.1. software

Seyhan, İ., 1971, M.T.A. Volkanik Kaolinin Oluşumu Ve Andezit Problemi,

- Singh, B., and Goel, R.K.;1999, Rock Mass Classification A practical Approach in Civil Engineering, Elsevier Publications, 267 pages.
- Transportation, Training Course in Geotechnical and Foundation Engineering, 1998.
- Topal, T., Orhan, M., Işık, N.S., Özer, M. 2006, Effect of weathering on the geomechanical properties of andesite, Ankara – Turkey, Environ. Geol. (2006) 50: 85–100 DOI 10.1007/s00254-006-0189-1
- Topal, T., 2000, Problems faced in the application of the point load index test

Turkish State Meteorological Service, 2008.

- Ulusay, R. and Sönmez, H., 2002, Kaya Kütlelerinin Mühendislik Özellikleri, TMMOB Jeoloji Müh. Odası Yayınları, No: 60, Ankara, 243 p.
- Ulusay, R., 1975, Ankara kenti kuzey-orta bölgesinin jeomühendislik özellikleri, Yükseklisans Tezi, Hacettepe Üniversitesi, Beytepe-Ankara, 81 p., Unpublished material.
- USGS, Sayısal Grafik San. Ve Tic. Ltd. Şti. 2008 Türkiye Deprem Sitesi www.sayisalgrafikcom.tr
- Ünal, E., 1986, Emprical approachto calculate rock loads in coal mine roadways. Proc. 5th Conf. Ground Control Coal Mines, West Virginia University, Morgantown, 234-241 pp.

APPENDIX A

The scan-line survey charts (I.S.R.M, 1981)

PROJECT NAI	ME		-	: The Ne	ew Ulus	; Tunne'								DATE :	2	.008
PREPARED B	Υ			: İrem A	٨ksular									PAGE :	1	1/5
LOCATION				:												
KILOMETER	CUTNO	TYPE	(°) 9/0	DIP DIRECTION (⁰)	SPACING	APERTURE	PERSISTENCE		100000	FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOGY	r	
0+200		3	53	060	3-4	5-6	3	с	4	3	2	3	And	Andesite		
		3	58	064	3-4	5-6	3	с	4	3	2	3	And	Andesite		
		3	62	042	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	<u> </u>	3	45	065	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	—	3	5/	066	3-4	5-6	$\frac{3}{2}$	C C	4	3	2	3	And	Andesite		
	<u> </u>	3	52	055	3-4	5-0	3		4	3	2	3	And	Andesite		
	-	3	49	062	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	-	3	54	059	3-4	5-6	3	c	4	3	2	3	And	Andesite		
		3	62	066	3-4	5-6	3	с	4	3	2	3	And	Andesite		
		3	65	050	3-4	5-6	3	С	4	3	2	3	And	Andesite		
		3	60	056	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	<u> </u>	3	67	192	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	—	3	62	200	3-4	5-6	3	C C	4	3	2	3	And	Andesite		
	—	3	70	198	3-4	5-0	3	C C	4	3	2	3	And	Andesite		
	<u> </u>	3	68	204	3-4	5-0	3		4	3	2	3	And	Andesite		
		3	76	207	3-4	5-6	3	L c	4	3	2	3	And	Andesite		
	-	3	71	200	3-4	5-6	3	c	4	3	2	3	And	Andesite		
		3	65	202	3-4	5-6	3	с	4	3	2	3	And	Andesite		
0+300		3	70	210	3-4	5-6	3	C	4	3	2	3	And	Andesite		
		3	75	216	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	<u> </u>	3	69	211	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	<u> </u>	3	74	200	3-4	5-6	3	c	4	3	2	3	And	Andesite		
	─	3	80	205	3-4	5-6	$\frac{3}{2}$	C C	4	3	2	3	And	Andesite		
	─	3	70	218	3-4	5-0	3	U C	4	3	2	3	Anu	Andesite		
	 	3	81	214	3-4	5-6	3		4	3	2	3	And	Andesite		
		3	82	220	3-4	5-6	3	C C	4	3	2	3	And	Andesite		
	-	3	84	025	3-4	5-6	3	C C	4	3	2	3	And	Andesite		
	<u> </u>	3	78	042	3-4	5-6	3	c	4	3	2	3	And	Andesite		
		3	75	050	3-4	5-6	3	C	4	3	2	3	And	Andesite		
		3	81	038	3-4	5-6	3	C	4	3	2	3	And	Andesite		
	<u> </u>	3	85	039	3-4	5-6	3	c	4	3	2	3	And	Andesite		
		3	76	043	3-4	5-6	3		4	3	2	3	And	Andesite		
		T				DISCO		TYDES		JOIVS ()	SRW,19	381)	CD4 CW	~		
- <u>TYPE</u> 1 FAULT ZONE 2 FAULT 3 JOINT 4 CLEAVAGE 5 SCHISTOSITY 6 SHEAR 7 FRACTURE 8 BED		ROUI A STI B UNI C PLI 1 SLI 2 SM 3 SLI 4 RC 5 VE	<u>3NESS</u> EPPED DULATINO 4NAR CKENSIDEL 100TH IGHTLY R JUGH RY ROUG	э о ougн	1 EXTREMELY CLOSE 2 SURFACE STAINING 2 VERY CLOSE 2 3 SCLAY 3 CLOSE 6 4 BRECCIA 4 MODERATE 2 5 MINERAL 5 WIDE 6 4 6 CEMENTATTION 6 VERY WIDE 2 7 CHLORITE, TALC, GYPSUM 7 EXTREMELY WIDE 2 1 VERY TIGHT 9										mm <20 20-60 60-200 200-600 600-2000 2000-6000 >6000 mm	
PERSISTENCE		5 <i>VE</i> / ≞ ≤1	<u>SEEPAI</u> 1 DRY	GE		<u>WEATH.</u> 1 FRESI	<u>ERING</u> H						1 1/ 2 T/ 3 A	ERY TIGHT GHT ARTLY OPEN	3070 (<0.1 0.1-0.25 0.25-0.5
2 LOW 3 MEDIUM 4 HIGH 5 VERY HIGH		1-3 3-10 10- 20	2 DAMF 3 WET 4 DRIPI 5 FLOV	, PING VING	2 3 7	2 SLIGH 3 MODE 4 HIGHL 5 COMP	TLY WE RATELY .Y WEA: LETELY	'ARHER. 1 WEAT) THEREC 1 WEATH	ED YERED I HERED				40 504 600	PEN ODERATELY WIDE IDE	GAPPEC	0.5-2.5 2.5-10 ≽10
	6 DECOMPOSED 7 VERY WIDE > 10-100 8 AEXTREMELY WIDE 원 100-100 9 CAVERNOUS 0 >1000									10-100 100-1000 ≻1000						

	DISCONTINUITY MEASUREMENT FORM															
PROJECT NA	ME			: The Ne	ew Ulus	Tunne								DATE :	:	2008
PREPARED B	γ			: İrem A	ksular									PAGE :		2/5
KILOMETER	CUT NO	TYPE	(°)	DIP DIRECTION (°)	SPACING	APERTURE	PERSISTENCE	0037007	202000	EILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOG	Y	
0+300		3	83	040	3-4	5-6	3	с	4	3	2	3	And	Andesite		
		3	80	045	3-4	5-6	3	с	4	3	2	3	And	Andesite		
		3	70	047	3-4	5-6	3	C	4	3	2	3	And	Andesite		
		3	74	032	3-4	5-6	3	c	4	3	2	3	And	Andesite		
		3	76	035	3-4	5-6	3	c	4	3	2	3	And	Andesite		
		3	82	031	3-4	5-6	3	C A	4	3	2	3	And	Andesite		
0+400	-	3	85	224	3-4	5-0 4-6	3	C C	4	3	2	3	And	Andesite		
0.400	-	3	82	224	3-5	4-6	3	с с	4	3	2	2-3	And	Andesite		
	-	3	79	225	3-5	4-6	3	c	4	3	2	2-3	And	Andesite		
		3	75	220	3-5	4-6	3	С	4	3	2	2-3	And	Andesite		
		3	77	223	3-5	4-6	3	C	4	3	2	2-3	And	Andesite		
		3	76	220	3-5	4-6	3	c	4	3	2	2-3	And	Andesite		
		3	71	104	3-5	4-6	3	C	4	3	2	2-3	And	Andesite		
		3	73	105	3-5	4-6	3	C	4	3	2	2-3	And	Andesite		
		3	70	115	3-5	4-0	3		4	3	2	2-3	And	Andesite		
		3	81	192	2-3	1-2	3	c	4	1	1	1-2	And	Andesite		
		3	44	152	3	4	3	с	4	3	1	2	And	Andesite		
		3	72	182	3-4	6	3	C	4	3	1	3	And	Andesite		
		3	62	172	4	6	3	c	4	3	1	3	And	Andesite		
		3	74	180	3-4	6	2	C	4	3-4	1	2	And	Andesite		
	-	3	75	180	3-4	6	2	c	4	3-4	1	2	And	Andesite		
		3	80	175	3-4	6	2	L C	4	3-4	1	2	And	Andesite		
		3	72	173	3-4	6	2	c	4	3-4	1	2	And	Andesite		
		3	68	175	3-4	6	2	С	4	3-4	1	2	And	Andesite		
		3	66	171	3-4	6	2	C	4	3-4	1	2	And	Andesite		
		3	56	162	3-4	6	2	C	4	3-4	1	2	And	Andesite		
		3	50	165	3-4	6	2	c	4	3-4	1	2	And	Andesite		
		3	66	170	3-4	6	2	C .	4	3-4	1	2	And	Andesite		
	-	3	09 74	1/3	3-4	8	2	C C	4	3-4	1	2	And	Andesite		
		3	75	185	3-4	6	2	c	4	3-4	1	2	And	Andesite		
		3	80	192	3-4	4-6	3	С	4	3	2	2-3	And	Andesite		
						DISCO.	NTINUI	TY DES	CRIPT	ions (i	SRM,19	981)				
<u>TYPE</u> 1 FAULT ZONE 2 FAULT 3 JOINT 4 CLEAVAGE		ROUGNESS FILING TYPE SPACING A STEPPED 1 OPEN 1 EXTREMELY CLOSE B UNDULATING 2 SURFACE STAINING 2 VERY CLOSE C PLANAR 3 CLOY 3 CLOSE 1 SLICKENSIDED 4 BRECCIA 4 MODERATE 5 MUDE 5 MUDE 5 MUDE											<u>mm</u> <20 20-60 60-200 200-600 600-2000			
5 SCHISTOSITY 6 SHEAR 7 FRACTURE 8 BED		2 SM 3 SLI 4 RO 5 VEI	OOTH GHTLY R UGH RY ROUG	OUGH Н		5 M 6 C 7 C	INERAL SEMENT SHLORI	ATION TE, TALC	,GYPSL	iM		1	5 WIDE 6 VERY 7 EXTR. 7 EXTR. 4 PE 1 V. 2 TI	WIDE EMELY WIDE ERT TIGHT GHT	roseD	2000-2000 2000-6000 >6000 <0.1 0.1-0.25
PERSISTENCE		m	SEEPAL	<u>9E</u>	ļ	WEATH.	ERING						3 A	ARTLY OPEN	U	0.25-0.5
1 VERYLOW 2LOW 3MEDIUM 4 HIGH 5 VERYHIGH		<1 1-3 3-10 10- 20	1 DRY 2 DAMF 3 WET 4 DRIPI 5 FLOU	PING VING	1	FRESI 2 SLIGH 3 MODE 4 HIGHL 5 COMP 6 DECO	1 TLY WE RATELY Y WEA: LETELY MPOSE	ARHER. WEATI THERED WEATH D	ED HERED IERED				40 510 6W	PEN ODERATELY WIDE IDE ERY WIDE	N GAPPED	0.5-2.5 2.5-10 >10 10-100
8 AEXTREMELY WIDE ↓ 100 9 CAVERNOUS O >10									100-1000 >1000							

PROJECT NAI	ME			: The Ne	w Ulus	Tunnel	1							DATE :	2	008
PREPARED B	γ			: İrem A	ksular									PAGE :	;	3/5
LOCATION				:												
KILOMETER	CUTNO	TYPE	(°) 9/0	DIP DIRECTION (^o)	SPACING	APERTURE	PERSISTENCE			HILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOG	Y	
0+400	<u> </u>	3	86	200	3-4	4-6	3	c	4	3	2	2-3	And	Andesite		
0+600		3	61	104	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	58	107	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	66	110	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	71	105	4	5-6	3	C .	4	3	2	3	And	Andesite		
		3	69 69	114	4	5-0	3	C C	4	3	2	3	And	Andesite		
		3	60	102	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	65	011	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	62	105	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	48	067	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	64	278	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	68	083	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	82	358	4	5-6	3	L C	4	3	2	3	And	Andesite		
		3	48	076	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	85	003	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	64	352	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	68	083	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	76	240	4	5-6	3	C C	4	3	2	3	And	Andesite		
		3	77	351	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	65	352	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	85	350	4	5-6	3	C	4	3	2	3	And	Andesite		
		3	45	094	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	81	340	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	70	040	4	5-6	3	C .	4	3	2	3	And	Andesite		
		3	80	040	4	5-6	3	с С	4	3	2	3	And	Andesite		
		3	65	046	4	5-6	3	c	4	3	2	3	And	Andesite		
		3	81	165	4	5-6	3	С	4	3	2	3	And	Andesite		
		3	77	160	4	5-6	3	C	4	3	2	3	And	Andesite		
		3	78	169	4	5-6	3	C	4	3	2	3	And	Andesite		
		3	52 66	084	4	5-6	3	C C	4	3	2	3	And	Andesite		
	I		50	073	- *	DISCO.	NTINUI	TY DES	CRIPT	IONS (I	L SRM,19	381)	Loun	Andeolte		
TYPE		ROU	RESS			Ell		PF					SPACIN	<u>G</u>		mm
1 FAULT ZONE		A ST	EPPED			1 0	PEN						1 EXTR. 2 VERV	EMELY CLOSE		<20 20.60
2 FAULT 3 JOINT		C PLA	DULATINI INAR	3		2 S 3 C	URFACI LAY	E STAIN.	NG				3 CLOS	E		60-200
4 CLEAVAGE		1 SLIC	KENSIDEI	>		4 B	RECCIA						4 MODE 5 WIDE	RATE		200-600 600-2000
6 SHEAR	Y 2 SMOOTH 5 MINERAL 6 VERY WIDE 3 SUGHTLY ROUGH 6 CEMENTATION 6 VERY WIDE												WIDE		2000-6000	
7 FRACTURE	TURE 4 ROUGH 7 CHLORITE, TALC, GYPSUM 7 EXTREMELY												EMELY WIDE	~	>6000	
8 BED		5 VEF	RY ROUG	н									1 10	ERY TIGHT	DSEC	<u>nini</u> <0.1
PERSISTENCE 1 VERY LOW		<u>n</u> <1	<u>SEEPAI</u> 1 DRY	<u>3E</u>	;	WEATH. I FRESP	<u>ERING</u> 1						2 T/ 3 A	GHT ARTLY OPEN	070	0.1-0.25 0.25-0.5
2LOW		1-3	2 DAME	,	3	2 SLIGH	TLY WE		ED				4 0	PEN	ЪРЕЦ	0.5-2.5
3 MEDIUM 4 HIGH		3-10 10-	4 DRIP	NG		1 HIGHL	RATELS Y WEAT	THERED	TERED				5 /M 6 /V	UDERATELY WIDE IDE	GA.	2.5-10 >10
5 VERY HIGH		20	5 FLON	/ING	-		LETELY	WEATH	ERED				.	574 14/05		40.400
	8 AEXTREMELY WIDE 4 100 9 CAVERNOUS 0 >10										100-1000 100-1000 >1000					

PROJECT NAM	ΛE /			DISCONTINUITY MEASUREMENT FORM													
PREPARED BY	PREPARED BY : Irem Aksular PAGE : 4/5															008	
	/ BY . Irem Aksular													PAGE :		4/5	
LOCATION				:													
KILOMETER	CUT NO	TYPE	(°) <i>910</i>	DIP DIRECTION (⁰)	SPACING	APERTURE	PERSISTENCE	0037007		FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOG	Ŷ		
0+600		3	70	340	4	5-6	3	с	4	3	2	3	And	Andesite			
		3	81	354	4	5-6	3	с	4	3	2	3	And	Andesite			
		3	69	355	4	5-6	3	с	4	3	2	3	And	Andesite			
0+840		3	80	145	4	5-6	3	c	4	3	2	2	And	Andesite			
		3	78 69	152	4	5-0	3	C C	4	3	2	2	And	Andesite			
		3	64	210	2-4	4	3	c	4	3	1	2	And	Andesite			
		3	60	212	2	4-5	3	с	4	3	1	2	And	Andesite			
		3	58	209	2-4	4-5	3	С	4	3	1	2	And	Andesite			
		3	54	215	2	4-5	3	c	4	3	1	2	And	Andesite			
		3	46	215	2	4-5	3	c	4	3	1	2	And	Andesite			
		3	42	230	4-5	4	4	C C	4	3	1	2	And	Andesite			
		3	54	218	4-5	4-5	4	c	4	3	1	2	And	Andesite			
		3	52	216	4-5	5	3-4	С	4	3	1	2	And	Andesite			
		3	50	224	6	6	3-4	c	4	3	1	2	And	Andesite			
		3	75	095	5	4	2	C .	4	2	1	2	And	Andesite			
		3	78	096	5	4	2	C C	4	2	1	2	And	Andesite			
		3	69	087	5	4	2	c	4	2	1	2	And	Andesite			
		3	72	089	5	4	2	С	4	2	1	2	And	Andesite			
		3	80	095	5	4	2	С	4	2	1	2	And	Andesite			
		3	84	097	5	4	2	c	4	2	1	2	And	Andesite			
		3	70	215	5	4 6-7	2	C C	4	2	1	2	And	Andesite			
		3	55	200	4-5	6-7	3	c	4	3	1	3	And	Andesite			
		3	75	230	4-5	6	4	С	4	3	1	2-3	And	Andesite			
		3	76	235	4-5	6	4	С	4	3	1	2-3	And	Andesite			
		3	72	210	4-5	6	4	c	4	3	1	2-3	And	Andesite			
		3	70	205	4-5	6	4	c	4	3	1	2-3	And	Andesite			
		3	75	210	4-5	6	4	C C	4	3	1	2-3	And	Andesite			
		3	78	207	4-5	6	4	С	4	3	1	2-3	And	Andesite			
		3	65	200	4-5	6	4	С	4	3	1	2-3	And	Andesite			
l		3	60	192	4-5	6	4		4	3	1	2-3	And	Andesite			
						01500	111101	TT DES	CRIPI	UNIS (I	3 RW, 73	901)	SPACIN	c		1DID	
<u>IYPE</u> 1 FAULT ZONE 2 FAULT 3 JOINT 4 CLEAVAGE 5 SCHISTOSITY 6 SHEAR 7 FRACTURE 8 BED	ROUGHNESS FILLING TYPE INTERE E A STEPPED 1 OPEN 1 EXTREMELY CLOSE B UNDULATING 2 SURFACE STAINING 2 VERY CLOSE C PLANAR 3 CLAY 3 CLOSE 1 SLICKENSIDED 4 BRECCIA 4 MODERATE 7Y 2 SMOOTH 5 MINERAL 5 WIDE 3 SLIGHTLY ROUGH 6 CEMENTATION 6 VERY WIDE 4 ROUGH 7 CHLORITE, TALC, GYPSUM 7 EXTREMELY WIDE 5 VERY ROUGH 6 VERY ROUGH 6 PERTURE											<20 20-60 60-200 200-600 600-2000 2000-6000 >6000 mm					
PERSISTENCE 1 VERY LOW 2 LOW		5 <i>VEA</i> ====================================	IY ROUG <u>SEEPA(</u> 1 DRY 2 DAMP	н Э.Е	1 1 2	<u>NEATHI</u> FRESH SLIGH	<u>ERING</u> 1 TLY WE	ARHER.	ED				1 V2 2 T/ 3 P4 4 O	ERY TIGHT GHT RRTLY OPEN PEN	IBSOTO DEde	<0.1 0.1-0.25 0.25-0.5 0.5-2.5	
3 MEDIUM 4 HIGH 5 VERY HIGH		3-10 10- 20	3 WET 4 DRIPH 5 FLON	YING VING	3 4 6 6	MODE HIGHL COMP. DECO	RATELY Y WEAT LETELY MPOSEI	' WEATH THERED WEATH D	HERED				5 M 6 VM 7 V2 8 A	ODERATELY WIDE DE ERY WIDE EXTREMELY WIDE	PEN GAP	2.5-10 ≻10 10-100 100-1000	

	DISCONTINUITY MEASUREMENT FORM															
PROJECT NA	ИE			: The Ne	w Ulus	Tunne	I							DATE :	2	2008
PREPARED B	Y			: İrem A	ksular									PAGE :		5/5
LOCATION				:												
KILOMETER	CUT NO	TYPE	(°) 910	DIP DIRECTION (°)	SPACING	APERTURE	PERSISTENCE	000000	2224 2000	FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOG	Y	
		3	60	037	3	3	1	с	4	3	1	2	And	Andesite		
		3	48	205	2-4	4	3	С	4	3	1	2	And	Andesite		
		3	55	205	2-4	4	3	C	4	3	1	2	And	Andesite		
		3	64	200	2-4	4	3	c	4	3	1	2	And	Andesite		
		3	59	204	2-4	4	3	с С	4	3	1	2	And	Andesite		
	3 59 210 2-4 4 3 c 4 3 1 2 And Andesite 3 50 218 2-4 4 3 c 4 3 1 2 And Andesite															
	3 50 218 2-4 4 3 C 4 3 1 2 And Andesite 3 47 215 2-4 4 3 c 4 3 1 2 And Andesite															
		3	53	204	2-4	4	3	С	4	3	1	2	And	Andesite		
0+900		3	59	017	3-4	5-6	3	C	4	3	2	2	And	Andesite		
		3	58	033	3-4	5-6	3	C C	4	3	2	2	And	Andesite		
		3	85	020	3-4	5-6	3	c	4	3	2	2	And	Andesite		
		3	72	036	3-4	5-6	3	С	4	3	2	2	And	Andesite		
		3	64	041	3-4	5-6	3	C	4	3	2	2	And	Andesite		
		3	60	050	3-4	5-6	3	C	4	3	2	2	And	Andesite		
		3	25 89	028	3-4	5-6	3	C C	4	3	2	2	And	Andesite		
		3	66	032	3-4	5-6	3	c	4	3	2	2	And	Andesite		
		3	70	025	3-4	5-6	3	с	4	3	2	2	And	Andesite		
		3	50	026	3-4	5-6	3	С	4	3	2	2	And	Andesite		
		3	62	037	3-4	5-6	3	c	4	3	2	2	And	Andesite		
		3	68 74	046	3-4	5-6	3	c	4	3	2	2	And	Andesite		
		3	74	032	3-4	5-6	3	c c	4	3	2	2	And	Andesite		
		3	81	038	3-4	5-6	3	c	4	3	2	2	And	Andesite		
		3	54	043	3-4	5-6	3	С	4	3	2	2	And	Andesite		
		3	50	049	3-4	5-6	3	c	4	3	2	2	And	Andesite		
		3	76	208	5	6	4	C .	4	3	1	2-3	And	Andesite		
		3	67	204	5	6	4	C C	4	3	1	2-3	And	Andesite		
		3	71	215	5	6	4	c	4	3	1	2-3	And	Andesite		
		3	80	207	5	6	4	С	4	3	1	2-3	And	Andesite		
		3	59	202	5	6	4	с	4	3	1	2-3	And	Andesite		
		3	60	197	5	6	4 NT (N) / (4	3	1	2-3	And	Andesite		
			- NE					77 DE3	SMPI	, Jiro ()	-07-0W, 13	501)	SPACIM	G		mm
1 FAULT ZONE		A ST.	<u>EPPED</u>			1 C	LNG 79 IPEN	PE					1 EXTRI	EMELY CLOSE		<20
2 FAULT 3 JOINT		B UN C PL	DULATINI MAR	3		25	URFACE	E STAIN.	NG				2 VERY 3 CLOS	E E		20-60 60-200
4 CLEAVAGE		1 SLI0	CKENSIDE			4 B	RECCIA						4 MODE	RATE		200-600
5 SCHISTOSITY 6 SHEAR	TOS/TY 2 SMOOTH 5 MINERAL 5 WIDE 5 VIDE												WIDE		2000-2000	
7 FRACTURE	7 FRACTURE 4 ROUGH 7 CHLORITE, TALC, GYPSUM 7 EXTREMELY WIDE												EMELY WIDE	_	>6000	
6 BED		5 <i>VEI</i>	RY ROUG	н									<u>APE</u> 1 V3	ERY TIGHT	DSED	<u>mm</u> <0.1
PERSISTENCE		m	SEEPA	ΞE		WEATH	ERING						2 T/ 3 A	GHT ARTLY OPEN	070	0.1-0.25
1 VERY LOW		<1	1 DRY	_	1	FRES	4						377		ទ្រ	0.20-0.0
2 LOW 3 MEDIUM		1-3 3-10	2 DAMP 3 WET	,	1	2 SLIGH 3 MODE	RATEL	ARHER WEATI	ED HERED				4 О 5 М	PEN ODERATELY WINF	1,PP£	0.5-2.5 2.5-10
4 HIGH		10-	4 DRIP	NG	4	HIGH	Y WEAT	THERED					6 W	DE	G	>10
S VERY HIGH		20	5 PLUN	~//\G	6	5 DECO	MPOSE	D D	ERED				7 M	ERY WIDE	>	10-100
													8 A 9 C	EXTREMELY WIDE AVERNOUS	0PE)	100-1000 >1000

APPENDIX B

Classification of individual parameters used in Q System (Barton et. Al., 1974)

DESCRIPTION	VALUE	NOTES
1. ROCK QUALITY DESIGNATION	RQD	
A. Very poor	0 - 25	 Where RQD is reported or measured as ≤ 10 (including 0),
B. Poor	25 - 50	a nominal value of 10 is used to evaluate Q.
C. Fair	50 - 75	
D. Good	75 - 90	RQD intervals of 5, i.e. 100, 95, 90 etc. are sufficiently
E. Excellent	90 - 100	accurate.
2. JOINT SET NUMBER	Jn	
A. Massive, no or few joints	0.5 - 1.0	
B. One joint set	2	
C. One joint set plus random	3	
D. Two joint sets	4	
E. Two joint sets plus random	6	
F. Three joint sets	9	1. For intersections use $(3.0 \times J_n)$
G. Three joint sets plus random	12	
H. Four or more joint sets, random,	15	2. For portals use (2.0 × J _n)
heavily jointed, 'sugar cube', etc.		
J. Crushed rock, earthlike	20	
3. JOINT ROUGHNESS NUMBER	J _r	
a. Rock wall contact		
b. Rock wall contact before 10 cm shear		
A. Discontinuous joints	4	
B. Rough and irregular, undulating	3	
C. Smooth undulating	2	
D. Slickensided undulating	1.5	1. Add 1.0 if the mean spacing of the relevant joint set is
E. Rough or irregular, planar	1.5	greater than 3 m.
F. Smooth, planar	1.0	
G. Slickensided, planar	0.5	2. J _r = 0.5 can be used for planar, slickensided joints having
c. No rock wall contact when sheared		lineations, provided that the lineations are oriented for
H. Zones containing clay minerals thick	1.0	minimum strength.
enough to prevent rock wall contact	(nominal)	
J. Sandy, gravely or crushed zone thick	1.0	
enough to prevent rock wall contact	(nominal)	
4. JOINT ALTERATION NUMBER	J	ár degrees (approx.)
a. Rock wall contact	a	,
A. Tightly healed, hard, non-softening,	0.75	1. Values of ϕr , the residual friction angle,
impermeable filling		are intended as an approximate guide
B. Unaltered joint walls, surface staining only	1.0	25 - 35 to the mineralogical properties of the
C. Slightly altered joint walls, non-softening	2.0	25 - 30 alteration products, if present.
mineral coatings, sandy particles, clay-free		
disintegrated rock, etc.		
D. Silty-, or sandy-clay coatings, small clay-	3.0	20 - 25
fraction (non-softening)		
E. Softening or low-friction clay mineral coatings.	4.0	8 - 16
i.e. kaolinite, mica. Also chlorite, talc. ovosum		
and graphite etc., and small quantities of swelling		
clavs. (Discontinuous coatinos 1 - 2 mm or less)		
stays. (Brossianaodo oddingo, 1 - 2 min ol 1666)		

4, JOINT ALTERATION NUMBER	Ja	<i>∳</i> r degrees	(approx.)
b. Rock wall contact before 10 cm shear			
F. Sandy particles, clay-free, disintegrating rock etc.	4.0	25 - 30	
G. Strongly over-consolidated, non-softening	6.0	16 - 24	
clay mineral fillings (continuous < 5 mm thick)			
H. Medium or low over-consolidation, softening	8.0	12 - 16	
clay mineral fillings (continuous < 5 mm thick)			
J. Swelling clay fillings, i.e. montmorillonite,	8.0 - 12.0	6 - 12	
(continuous < 5 mm thick). Values of J _a			
depend on percent of swelling clay-size			
particles, and access to water.			
c. No rock wall contact when sheared			
K. Zones or bands of disintegrated or crushed	6.0		
L. rock and clay (see G, H and J for clay	8.0		
M. conditions)	8.0 - 12.0	6 - 24	
N. Zones or bands of silty- or sandy-clay, small	5.0		
clay fraction, non-softening			
O. Thick continuous zones or bands of clay	10.0 - 13.0		
P. & R. (see G.H and J for clay conditions)	6.0 - 24.0		
5. JOINT WATER REDUCTION	J _w	approx. wa	iter pressure (kgf/cm ²)
A. Dryexcavation or minor inflow i.e. < 5 I/m locally	1.0	< 1.0	
B. Medium inflow or pressure, occasional	0.66	1.0 - 2.5	
outwash of joint fillings			
C. Large inflow or high pressure in competent rock with unfilled joints	0.5	2.5 - 10.0	 Factors C to F are crude estimates; increase J_W if drainage installed.
D. Large inflow or high pressure	0.33	2.5 - 10.0	
E. Exceptionally high inflow or pressure at blasting, decaying with time.	0.2 - 0.1	> 10	Special problems caused by ice formation are not considered.
F. Exceptionally high inflow or pressure	0.1-0.05	> 10	are not considered.
6. STRESS REDUCTION FACTOR		SRE	
a. Weakness zones intersecting excavation, whi	ch may	010	
cause loosening of rock mass when tunnel is	excavated		
 Multiple occurrences of weakness zones con chemically disintegrated rock, very loose surro depth) 	ntaining clay or unding rock any	10.0	 Reduce these values of SRF by 25 - 50% but only if the relevant shear zones influence do not intersect the excavation
 B. Single weakness zones containing day, or chemical tegrated rock (excavation depth < 50 m) 	lly dis-	5.0	
C. Single weakness zones containing clay, or chemical	lly dis-	2.5	
tegrated rock (excavation depth > 50 m)			
D. Multiple shear zones in competent rock (clay free), I	oose	7.5	
surrounding rock (any depth)			
E. Single shear zone in competent rock (clay free). (de	pthof	5.0	
excavation < 50 m)			
F. Single shear zone in competent rock (clay free). (de	pth of	2.5	
excavation > 50 m)			
G. Loose open joints, heavily jointed or 'sugar cube', (a	iny depth)	5.0	

DESCRIPTION		VALUE		NOTES
6. STRESS REDUCTION FACTOR			SRF	
b. Competent rock, rock stress proble	ms			
	°c∕∽1	^o t ^o 1		2. For strongly anisotropic virgin stress field
H. Low stress, near surface	> 200	> 13	2.5	(if measured): when $5 \le \sigma_1 / \sigma_3 \le 10$, reduce σ_c
J. Medium stress	200 - 10	13 - 0.66	1.0	to 0.8 σ_c and σ_t to 0.8 σ_t . When σ_1/σ_3 > 10,
K. High stress, very tight structure	10 - 5	0.66 - 0.33	0.5 - 2	reduce σ_c and σ_t to 0.6 σ_c and 0.6 σ_t , where
(usually favourable to stability, may				$\sigma_{\rm C}$ = unconfined compressive strength, and
be unfavourable to wall stability)				$\sigma_{\rm t}$ = tensile strength (point load) and $\sigma_{\rm 1}$ and
L. Mild rockburst (massive rock)	5 - 2.5	0.33 - 0.16	5 - 10	σ_3 are the major and minor principal stresses.
M. Heavy rockburst (massive rock)	< 2.5	< 0.16	10 - 20	3. Few case records available where depth of
c. Squeezing rock, plastic flow of inc	ompetent roc	k		crown below surface is less than span width.
under influence of high rock press	ure			Suggest SRF increase from 2.5 to 5 for such
N. Mild squeezing rock pressure			5 - 10	cases (see H).
O. Heavy squeezing rock pressure			10 - 20	
d. Swelling rock, chemical swelling a	activity depen	ding on prese	nce of water	
P. Mild swelling rock pressure			5 - 10	
R. Heavy swelling rock pressure			10 - 15	
d. Swelling rock, chemical swelling a P. Mild swelling rock pressure R. Heavy swelling rock pressure	ictivity depen	ding on prese	nce of water 5 - 10 10 - 15	

ADDITIONAL NOTES ON THE USE OF THESE TABLES

When making estimates of the rock mass Quality (Q), the following guidelines should be followed in addition to the notes listed in the tables:

1. When borehole core is unavailable, RQD can be estimated from the number of joints per unit volume, in which the number of joints per metre for each joint set are added. A simple relationship can be used to convert this number to RQD for the case of clay free rock masses: $RQD = 115 - 3.3 J_V$ (approx.), where $J_V =$ total number of joints per m³ (0 < RQD < 100 for 35 > $J_V > 4.5$).

2. The parameter J_n representing the number of joint sets will often be affected by foliation, schistosity, slaty cleavage or bedding etc. If strongly developed, these parallel joints' should obviously be counted as a complete joint set. However, if there are few 'joints' visible, or if only occasional breaks in the core are due to these features, then it will be more appropriate to count them as 'random' joints when evaluating J_n.

3. The parameters J_r and J_a (representing shear strength) should be relevant to the weakest significant joint set or clay filled discontinuity in the given zone. However, if the joint set or discontinuity with the minimum value of J_r/J_a is favourably oriented for stability, then a second, less favourably oriented joint set or discontinuity may sometimes be more significant, and its higher value of J_r/J_a should be used when evaluating Q. The value of J_r/J_a should in fact relate to the surface most likely to allow failure to initiate.

4. When a rock mass contains clay, the factor SRF appropriate to loosening loads should be evaluated. In such cases the strength of the intact rock is of little interest. However, when jointing is minimal and clay is completely absent, the strength of the intact rock may become the weakest link, and the stability will then depend on the ratio rock-stress/rock-strength. A strongly anisotropic stress field is unfavourable for stability and is roughly accounted for as in note 2 in the table for stress reduction factor evaluation.

5. The compressive and tensile strengths (σ_c and σ_t) of the intact rock should be evaluated in the saturated condition if this is appropriate to the present and future in situ conditions. A very conservative estimate of the strength should be made for those rocks that deteriorate when exposed to moist or saturated conditions.

APPENDIX C

The borehole logs

PROLE CADPENDENT Nume The Revolution Tunnel DELIK CAPPRIDE Damotor 4 34 kp SCINDAL YERBROWD Location Tunnel Entence PERMINATION CONTRACTOR TO PROVIDET TO PROVIDET TO PROVIDE TO PROVIDE TO PROVIDE TO PROVIDE TO PROV						SON	IDA	JL	ogi	1/1	BO	RI	NG LOG				SONDAJ NO : Borehole No	SK-	1			SA Pi	YFA age 1 / 2	
DODDAV FEIßberging Location Tumen Entrance VERALT 3U/V/Groundwater I. Commentation Schulz VERTER-Dering Logan 1 + 95 MAH BOR CERLOCASINg Derphi 1 - 200 MMW Schulz VERTER-Dering Logan 1 - 95 MAH BOR CERLOCASINg Derphi 1 - 200 MMW Schulz VERTER-Dering Logan 1 - 200 MMW 1 - 200 MMW 1 - 200 MMW Schulz VERTER-Dering Logan 1 - 200 MMW 1 - 200 MMW 1 - 200 MMW Schulz VERTER-Dering Logan 1 - 200 MMW 1 - 200 MMW 1 - 200 MMW Schulz VERTER-Dering Logan 1 - 200 MMW 1 - 200 MMW 1 - 200 MMW Schulz VERTER-Dering Logan 1 - 200 MMW 1 - 200 MMW 1 - 200 MMW Schulz VERTER-DERING VERTER	PROJE A	D!/P	roject	Name	9	:	The	New	Ulus	Tur	nel			DELİK ÇAPI	/Hol	le Diar	neter :	4 3/4	inç		- 			
KILLOWERTERCICATING 1:0:00 MAW SOUGAD DEP, MOUST Deptition 20 m 49.49:17.1744/INSELENCTION CONTINUES 50.000 PC 1000 PC	SONDAJ	YER	i/Bori	ng Lo	cation	:	Tun	nel E	Entrar	ice				YERALTI SU	IYU	/Grour	idwater :	-						_
EXDAD LERZ.Berling Duph 20 m EAS-817 TARHINGEN-Finite Dual 15.07.2008 -17.07.12009 SIGNAL ACTONY D/BY6 AME : Cenicolas B50Retary KOORDINATCondinate(Example) International Miching International Miching DAVAAUXENTRONG D/B AVR53MWatching Note SAMULATION Condinate(Example) International Miching International Miching DAVABULACING D/B AVR53MWatching Note SAMULATION Condinate(Example) International Miching Note SAMULATION Condinate(Example) DAVABULACING D/B International Miching Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Vision Contarione Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Vision Contarione Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Vision Contarione Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Vision Contario Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Note SAMULATION Condinate(Example) Vision Contario Note SAMULATION Contarinstrumentanininininitity of	KILOMET	rre/0	Chaina	age		:	0+15	55						MUH.BOR.D	ER	/Casir	ng Depth :	12.00	мни	V I				
SCHUDULEURVEINE EXCORDINATIONATION DOMANALIZATIONE (MAIL Continued D500 Rodury MCORDINATIONATIONE (Mail III) DOMANALIZATIONE (MAIL Continued D500 Rodury MCORDINATIONATIONE (Mail III) DOMANALIZATIONE (MAIL Text and mail III) MCORDINATIONATIONE (Mail III) I - DECAMPANALIZATIONE (MAIL III) MCORDINATIONATIONE (MAIL III) MCORDINATIONATIONE (MAIL IIII) I - DECAMPANALIZATIONE (MAIL IIII) MCORDINATIONATIONE (MAIL IIIII) MCORDINATIONATIONE (MAIL IIIII) I - DECAMPANALIZATIONE (MAIL IIIII) MCORDINATIONATIONE (MAIL IIIIIII) MCORDINATIONATIONE (MAIL IIIIIIII) MCORDINATIONATIONE (MAIL IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	SONDAJ	DER	R./Bori	ng De	pth	;	20 n	n						BAŞBİT.TA	R İH	li/Star	-Finish Date :	15.01	.2008		17.01	1.200	8	
CON_NAX_AVONT Child AM. Continue (Easing) Ind DAtt (Licewase drawed bit) Ind Datt (Licewase drawed bit) Ind Datt (Licewase drawed bit) Ind Datt (Licewase drawed b	SONDAJ	KOT	U/Ele	vatior	1	:								KOORDİNA	T/Co	oordina	ate(Northing)							
Unit Note Unit Note <t< td=""><td>SON. MA</td><td>K.&Y</td><td>ONT.</td><td>D.Rig</td><td>j & Me</td><td>et. :</td><td>Crai</td><td>ious</td><td>D500</td><td>/Rot</td><td>ary</td><td></td><td>flanda.</td><td>KOORDINA</td><td>T/Co</td><td>oordina</td><td>ate(Easting) :</td><td>·</td><td></td><td></td><td>-</td><td></td><td></td><td></td></t<>	SON. MA	K.&Y	ONT.	D.Rig	j & Me	et. :	Crai	ious	D500	/Rot	ary		flanda.	KOORDINA	T/Co	oordina	ate(Easting) :	·			-			
Image: Second Processing			ALILINA	Stren	rong			TAZE		nış	WIPO V	Fi	resh	N:0-2 ÇOK	YUM	UŞAK	Very Soft	N · 0-4	RI DAI	CEVEE	oarse	Grai	ned	
U Construct U Construct <thu construct<="" th=""> <thu construct<="" th=""></thu></thu>	II DAY	YANIML TĂ	.1	M. M.	Strong Weak		B	AZ AYF	rişmiş D. Ayr.			M	lightiy W. Iod. Wealh.	N: 5-8 ORT/ N: 5-8 ORT/	A KAT	'n	Soft Moderately Stiff Very Stiff	N : 5-10 N : 11-3	GEV	ŞEK A SIKI		Loose Modera	tely De	nse
LAXA ALTEEI TANNEND CREAR ALT Commentation CREAR ALT Commentation CREAR ALT Commentation N 3.5 DECAMPORT No.5 DECAMPORT	V ÇOM	rif K Zayif	:	v.	Weak		v v	ÇOK A TÜMÜ	YR. Yle ayı	ł.		C	gniy W. omp. W.	N :16-30 COK N :>30 SERT	KATI		Stilf Hard	N:31-5 N:≻50	O SIKI ÇOK	SiKi		Dense Very D	ense	
Subject Pref Status Marked Barling Status	KAYA	KALİT	TESI T/	ANIMI/	RQD			K	RIKLA	R-30) cm/l	Fra	ctures				ORANLAF	Propo	rtions					
Base of Information The set of the the set of the set of the the set of the the set of the the set of the the set of the the set of the the set of the the set of the the set of the the set of the the set of the the set of the set of the the set of the set	% 0-25 CC % 25-50 ZA	JK ZAY MF	11-	Po	107 107		1-2	SE OF	RTA			M	oderate (M)	% 5 PEK	AZ	SB	ghtly	% 5	P)	EK AZ	s	lightly		
Is used or other Distance Distance Distance Distance Provide the state of the state state of the state of	% 50-75 CH % 75-90 [Y]	RTA L		G	ood		10-1	20 ÇO	K SIKI			In	tense (I)	% 15-35 ÇOK		Ve	ry	% 2	20 A2 3-5 Çi	ок	v	iena Very		
Bindlet Personant Tell Totalization Normalization	% 90-108 ÇO	SPT	STAP	E)	PENETR	ASYON	TEST							MUMUME			P ppret	OMETR	P Denie					
Image: Standard Februarian Tester JEOTEKNIK TANIMLAMA Image: Standard Februarian Tester Image: Standard Februarian Tester JEOTEKNIK TANIMLAMA Image: Standard Februarian Tester Image: Stan		D	Star ÖRS Dist	idard Pe ELENM urbed S	sneration S NUMU ample	n Test UNE							Undisturbed San K KAROT NUMUNE Core Sample	nple ist			VS VEYN I Vane	vremeter DENEYI Shear Te	Test st	TI				****
Solution Solution				s	TAND	ART P	ENET	RAS	ON D	ENE	ri									_	e H		ъ.	ó
Ligging and big with and offlices Campin Decort LNNIN Transmission Find Till Profile Pro	ē		,	DA	RBE S	AYISI	4 1961	l	GRA	Fik		+				t) L	PROCI	rengt	ering	0 cm	0 F		S.Co	ple N
Back of the second se	(E) (I) (I) (I) (I) (I) (I) (I) (I) (I) (I		Š.	Nut	nb. of	Blows			Graș	h		+				CDep	FROM	IK	/eath	re (3	CR)		SCR)	/Sarr
Red Red <td>JNE Depl</td> <td>Typ</td> <td>VRA</td> <td>Ë</td> <td>Ë</td> <td>Ë</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Geotechnical De</td> <td>scription</td> <td></td> <td>inL)</td> <td>Profile</td> <td>IMLI</td> <td>WAW</td> <td>Tact</td> <td>1%U</td> <td>*</td> <td>r %(S</td> <td>NO N</td>	JNE Depl	Typ	VRA	Ë	Ë	Ë							Geotechnical De	scription		inL)	Profile	IMLI	WAW	Tact	1%U	*	r %(S	NO N
Image: Solution of the second seco		ampl	ANB Zun	- 15	5 - 3(0 - 4	N	10 :	20 30	40 5	0 60				ļ	DEA		YAN	/RI\$I	IRIK/	ARO	B	ARO	RNE
0.0 nc <t< td=""><td></td><td>ω [</td><td>2 </td><td></td><td><u>.</u></td><td>(7)</td><td></td><td><u> </u></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td>Là</td><td>×.</td><td>¥</td><td><u>×</u></td><td></td><td>¥</td><td>Ö</td></t<>		ω [2		<u>.</u>	(7)		<u> </u>				1						Là	×.	¥	<u>×</u>		¥	Ö
1,0 nc <t< td=""><td>U,U I</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>i i</td><td>i</td><td>ili</td><td>N</td><td>ASPHALT</td><td></td><td>A</td><td>0,10</td><td>(</td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	U,U I								i i	i	ili	N	ASPHALT		A	0,10	(1						
1.0 ac <t< td=""><td>10_==R</td><td>c</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td>8</td><td>•</td><td></td><td>1</td></t<>	10_==R	c													1						8	•		1
2,0 Rc Rc Siightiy caolinized COLLUVIUM with andesite gravels and a few blocks. Image: Coll Coll Coll Coll Coll Coll Coll Col																		1						
2.0 RC 3.0 RC <	201									i														
3,0 RC <t< td=""><td>2,0</td><td>c </td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>015-646-5-5-58-65-51</td><td>0011110/0104</td><td></td><td></td><td>DAAA</td><td>1</td><td></td><td></td><td>34</td><td>0</td><td></td><td>2</td></t<>	2,0	c											015-646-5-5-58-65-51	0011110/0104			DAAA	1			34	0		2
3,0 RC <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>H.</td><td>11</td><td></td><td></td><td></td><td>with andesite grave</td><td>SOLLUVIUM</td><td></td><td></td><td>O_{A}^{*}</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								H.	11				with andesite grave	SOLLUVIUM			O_{A}^{*}							
4,0 RC <t< td=""><td>3,0 -</td><td>ſ</td><td></td><td></td><td></td><td></td><td></td><td></td><td>11</td><td></td><td></td><td></td><td>blocks.</td><td></td><td></td><td></td><td>S Q C S</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	3,0 -	ſ							11				blocks.				S Q C S							
4,0 RC <t< td=""><td>R</td><td>c </td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>4</td><td></td><td></td><td>3</td></t<>	R	c									1 1										4			3
5,0 RC <t< td=""><td>4,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Î</td><td>11</td><td>1</td><td>Î</td><td></td><td></td><td></td><td></td><td></td><td>000</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	4,0							Î	11	1	Î						000							
5,0 RC <t< td=""><td></td><td>⊦</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>O^{2}</td><td></td><td></td><td></td><td></td><td>_</td><td></td><td></td></t<>		⊦															O^{2}					_		
6,0 - Rc Rc Rc Pink, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, moderately weathered, signtly 6,0 Rc	5,0	c						밥	11	1														
6,0 Image: State of the state of the	1								11	÷								-			8	•		7
7,0 Rc Pink, moderately weathered, moderate weak, socialised, limonited ANDESITE with rough discontinuity surfaces. No V <t< td=""><td>6,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>11</td><td></td><td></td><td>11</td><td>¦ -</td><td></td><td></td><td></td><td>6 20</td><td></td><td></td><td></td><td>_</td><td></td><td></td><td></td><td></td></t<>	6,0							11			11	¦ -				6 20				_				
7,0 RC RC Induction and ANDESITE with rough discontinuity surfaces. 8,0 RC Induction and ANDESITE with rough discontinuity surfaces. Induction and ANDESITE with rough discontinuity surfaces. Induction and ANDESITE with rough discontinuity surfaces. 9,0 RC Induction and ANDESITE (The Andesites are and easily crumbled and sandy structure were observed.) Induction and and and and and and and and and an								11		i	ili		Pink, moderately w	eathered,		0,20		1	_					
8,0 Rc 9,0 Image: Since the set of the set	7,0 - R	°						11	11	-1	H	-	limonited ANDESI	E with rough	ı į		Ů V Ů V Ů V	1 =	Ň	2	22	0		5
8,0 RC Pink, weathered, weak Pink, weathered, weak Pink, weathered, weak 9,0 RC Pink, moderately weak Pink, moderately weak Pink, moderately weak 1,0 Pink, moderately weathered.slightly Pink, moderately Pi		ŀ].			Į.			discontinuity surfa	ices.			Ů V V V	┝						
9,0 - - - - - 6 9,0 - - - - - - - 6 9,0 - - - - - - - - 6 9,0 - - - - - - - - - 6 0,0 -	8,0 -====							1	haala 1 t		111	1	Pink, weathered, w	eak	N.		ŮVŮVŮV	1_	2	ន		-		
9,0	1	~										1	ANDESITE(The Ar and easily crumble	ndesites are d and sandv	1		Ů	/ -	>	Ň	С С	<i>r.</i>		6
0,0 RC 10,0 V V X X N 7 1,0 RC 10,00 V V X X N 7 2,0 RC 10,80 V V X X N 8 3,0 RC 10,80 V V X X N 8 4,0 RC 10,80 V V X X N 8 3,0 RC N N N N N N 8 4,0 RC N N N N N N N 4,0 RC N N N N N N N SUBeyman Erdem Orhan Öztekin Orhan Öztekin T N N N	9,0 —	ł						1	i li	-i	11		structure were ob	served.)		9,00			-					
0,0												1					Ůvůvův	÷	W4					
1,0 Rc 10,80 V V X <	10,0 - 클 R	c								1		h			X	10,00			0		ŝ	¢		7
1,0 Rc Rc Pink, moderately weak, moderately weak, moderately weak, moderately weathered-slightly weathered-slightly weathered ANDESITE 10,80 V								1			ili		·		-1		l'v'v'v		N-EN					
2,0 Rc Image: SonDÖR / Driller Pink, moderately weak, moderately weathered-slightly weathered-slightly weathered ANDESITE Image: SonDÖR / Driller Image: SonDAJ MÜHENDISI / Drilling Engineer Image: TARIH / Date Image: SonDAJ Kign	11,0 🚽	ŀ						H								10,80	Ŭ vŮ vŮ	-	-	1		-		
2,0 Image: Constraint of the second							ł				i li		Pink, moderately w	/eak.			ŮvŮvŮv		_					
$3,0 \xrightarrow{=}_{RC} \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad $	12,0 -===	~					1	H.					moderately weath	ered-slightly			ŬvŬvŬ	l ≥ i	V2-W		45	0		8
$3,0 \xrightarrow{=}_{RC} \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad $	1												weathered ANDES				Ŭvůvů	1	1					
4,0 \exists_{RC} $\begin{vmatrix} v & v & v & v \\ v & v & v & v \\ v & v &$	13,0 -=	-						H	44	H	į.	i.					$[$ \vee \vee \vee \vee	<u>}</u>						
4,0 \exists_{RC} $\begin{vmatrix} \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow$	1111																		Ŵ3					
SONDÖR / Driller SONDAJ MÜHENDİSİ / Drilling Engineer TARİH / Date IMZA / Sign Süleyman Erdem Orhan Öztekin Image: Suleyman Erdem	14,0 - 14,0						1	뉴	뷰	Ļ									W2-		Q.	9		
SONDÖR / Driller SONDAJ MÜHENDİSİ / Drilling Engineer TARİH / Date IMZA / Sign Süleyman Erdem Orhan Öztekin Image: Suleyman Erdem	- 1 R0	-					1	1:1		ι: 	:1:	. [l		IV * V * V	1 -	l	I	4)	-		9
Süleyman Erdem Orhan Öztekin		SON	DÖR	/ Drill	er			<u> </u>	SC	DND	AJN	AÜI	HENDÍSÍ / Drilling Engi	neer		T.	ARIH / Date			i	AZA I	Sigr		
		Süle	yman	Erde	m								Orhan Öztekin											

SOND	- AJ LOGU / BORING LOG		SONDAJ NO . Borehole No	SK-1				SAY Pa 2	FA je /2	
PROJE ADI/Project Name : Th	he New Ulus Tunnel	DELİK ÇAPI/Hole Dia	meter :	4 3/4 i	nç	-	4			
SONDAJ YERI/Boring Location : Tu	unnel Entrance	YERALTI SUYU/Grou	ndwater :							_
KILOMETRE/Chainage : 0+	+155	MUH.BOR.DER./Cas	ing Depth ;	12.00	MHW	!				
SONDAJ DER /Boring Depth 20	0 m	BAŞBİT.TARİHİ/Sta	rt-Finish Date :	15.01.	2008		17.01	.2008		
SONDAJ KOTU/Elevation :	ratious D500/Potory	KOORDINAT/Coordin	ate(Northing) :							
DAYANIMLILIK/Strength	AYRIŞMA/Weathering	INCE DANELI/Fin	e Grained	is		FLIC	oarse	Grain	he	
I ÇOK DAYANIMLI Strong	I TAZE Fresh II AZ AYRISMIS Slightly W.	N:8-2 COK YUMUŞAK N:3-4 YUMUŞAK	Very Saft Soft	N:0-4	çak	GEVŞE	ĸ	/ery Loc	se	
H ORTA M.Wesk IV ZAYIF Wesk	III ORTA D. AYR. Med. Weath. IV COK AYR. Highly W.	N : 5-8 ORTA KATI N : 9-15 KATI	Moderately Stiff Very Stiff	N : 0-10 N : 11-30 N : 34-50	ORT	sek Asiki	1	.oose Moderat Dence	ely Den	se
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR, Camp, W.	N : >30 SERT	Hard	N : >50	ÇOK	SIKI		Very De	ise	
% 0-25 ÇOK ZAYIF Very Poor	1 SEYREK Wide (W)	%.5 PEK A7 \$	ORANLAR/	Propor	tions					
% 25-50 ZAYIF Poor 1 % 50-75 ORTA Fair 2	1-2 ORTA Moderate (M) 2-40 SIK Close (Cl)	%5-15 AZ L	iltle	%5 %5-2	PE 10 AZ	EK AZ	S) Li	ightly ittle		
% 75-90 [Y] Good 7 % 90-100 ÇOK [Y] Excellent 7	10-20 COK SIKI Intense (I) >20 PARÇALI Crushed (Cr)	% 15-35 ÇOK V	fery	% 28-	-5 ÇC	ж	v	ery		
SPT STANDART PENETRASYON TES Standard Peneration Test D ÖRSELENNIŞ NUMUNE Disturbed Sample	SYÌ LƯ ÔR SELENMENİŞ Y Undisturbed Samı K KAROT NUMUNES Core Sample	NUMUNE Die 1	P PRESIY Pressu VS VEYN D Vane S	OMETRE remeter 1 ENEY! hear Tes!	DENE) Test	ń				
STANDART PEN	IETRASYON DENEYİ			T	<u> </u>		n2		œ	
Standard Pr	Penetration Test	(E)		ength	gui	Ê	Core		Core	le No
E Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z	GRAFIK JEOTEKNIK TA	NIMLAMA	PROFIL	K/Str	athe	e (30	TR)/T		CR)/S	Samp
C C S S S S S S S S S S S S S S S S S S	Geotechnical Des	cription Z	Profile	MLILI	AW	ractu	Ľ%		S)%	NO.
NDDA DNDA DNDA DNDA DNDA DNDA NDDA NDA N	10 20 30 40 50 60	. DERI		ANI	RIŞN	RKF	ROT	8	ROT	M
98 Z 8 Z K 0 4 8				ð	¥	Σ	3	۳	2	ő
	Bink moderately we	ak	Ŭ V Ŭ V Ŭ V						1	
5,0	moderately weathe	red-slightly	Ů VŮ VŮ V					_		
RC	weathered ANDESI	TE with	1	>	-W3		2	5		10
6,0	discontinuity surface	s.	l.v.v.v.v	_	Ň		~			10
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	evhibits								
7,0 - RC	cooling cracks at an	angle of 85		>	N3		\$			44
	degrees.			-	V 2		°			*1
8,0 -										
					8					
9,0 -=				_ ≥	W2-V		88			
	Pink, highly weather	red, weak			_					12
0.0		19,50	$\vee \vee \vee \vee \vee$	Ξ	W4					
	The end of Borehold	≥/ ^{20,00}						1		
1,0 -										
2,0 -										
3.0 -		1								
4.0										
50 - 1										
60 - E - 08										
70							ĺĺ			
8.0 1 8.0										
~1~								l.,		
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engir	leer 7		T		1-	47 .	<u></u>		
Süleyman Erdem	Orban Öztekin		Jan I Date			10	VIZA /	Sign		
		<u> </u>								

113

SONDA	J LOGU / BORING LOG		SONDAJ NO : S Borehole No	SK-2			SAYFA Page 1/4	
PROJE ADI/Project Name : The	New Ulus Tunnel	DELİK ÇAPI/Hole Dia	meter : 4	3/4 inç		- 		
SONDAJ YERI/Boring Location : Km:	0+265/ Serpme Street	YERALTI SUYU/Grou	indwater : -					
KILOMETRE/Chainage : 0+26	35	MUH.BOR.DER./Cas	ing Depth : 1	2.00 MH	w			
SONDAJ DER./Boring Depth : 40 m	n	BAŞBİT.TARİHİ/Sta	rt-Finish Date : 1	8.01.200	8	24.01	.2008	
SONDAJ KOTU/Elevation	ious D500/Rotan	KOORDINAT/Coordin	hate(Northing) :					
DAYANIMLILIK/Strength	AYRIŞMA/Weathering	INCE DANELI/Fin	e Grained	ÎRÎ DA	NELİ/C	oarse	Grained	
I ÇOK DAYANIMLI Strong I	TAZE Fresh AZ AYRIŞMIŞ Slightly W.	N: 8-2 ÇOK YUMUŞAK N: 3-4 YUMUŞAK	Very Soft N Soft N	: 0-4 ÇO	K GEVŞE	κv	ery Loose	
III CRTA M.Weak III IV ZAVIF Weak IV	ORTA D. AYR. Mod. Weath. ÇOK AYR. Highly W.	N : 5-8 ORTA KATI N : 5-15 KATI	Moderately Stiff N Very Stiff N Stiff N	: 11-30 OR	TA SIKI	Ň	loderately D	ense
	TÜMÜYLE AYR. Comp. W. KIRIKLAR-30 cm/Fractures	N : >30 SERT	Hard N	:>50 ÇO	KSIKI	v	ery Dense	
% 0-25 COK ZAYIF Very Poor 1	SEYREK Wide (W)	%5 PEKAZ S	lightly	e e	5	eu	abilu	
% 25-50 ZAYIF Poor 1-2 % 50-75 ORTA Pair 2-10	D SIK Close (CI)	% 5-15 AZ I	ittle	% 5-20 /	VZ	Lit	gnay tie	
% 75-90 IYI Goon >20 % 90-100 COK IYI Excellent >20	PARÇALI Crushed (Cr)	% 15-35 ÇOK	lery	% 20-5	ÇOK	Ve	ry	
SPT STANDART PENETRASYON TESTI Standard Peneration Test D ÖRSELENMİŞ NUMUNE Disturbed Sample	UD ÖRSELENNEMIŞ I Undisturbed Sam K KAROT NURANKI Core Sample	NUMUNE ple 1]	P PRESIVO Pressure VS VEYN DEN Vane She	METRE DEN meter Test NEY] ar Test	EYİ			
び DARBE SAYISI			PROEÌL	rength ering	0 cm)	T.Core R.	S.Core R.	ple No.
E Z S Numb. of Blows	Graph		FIGHE	Veath	nre (3	TCR)	SCR)	/Sam
	Geotechnical Des	scription	Profile	MAN	(Fract	0T %(21 %(NN N
Borin NUM NUM NUM NUM NUM NUM NUM NUM NUM Samp 15 - 3 15 - 3 20 - 1	10 20 30 40 50 60	B		AYAN	(Rik	KARG	ARC 8	ORNE
0,0			. build and a second se	<u></u>				1.0
1,0 - RC	ASPHALT	/ 0,10		- M4		33	•	1
2,0	Pink, highly weathe	red, very		4				
3,0	1 1			- >	_	32	°	2
4,0				- \$		30	0	3
5,0 -		4,30		23				
6,0 -	1 1 1 1 1 1 4 1 1 1 1 4 1 1 1 5 1 1 1 1 5 1 1 1 1 5 1 1 1 1 5 1 1 1 1	ered-fresh				75	62	4
7,0	moderate strong, A	NDESITE				90	34	5
8,0	The discontinuity survival and clean.	irfaces are				5	@	
9,0								0
0,0	1 1			N2-W1		0 56	7 14	7
			VVVVV			\vdash	-	8
RC						4	49	9
4,0						55	31	10
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drillina Enair	ieer -	rARİH / Date	1	in	17.4 /	Sion	
Süleyman Erdem	Orhan Öztekin						-1911	
Ĺ								



SOND	AJ LOGU / BORING LOG		SONDAJ NO ÷ S Borehole No	SK-2		SAYFA Page 3/4
PROJE ADI/Project Name : Th	he New Ulus Tunnel	DELİK ÇAPI/Hole Dia	ameter : 4	3/4 inc		
SONDAJ YERI/Boring Location : K	m: 0+265/ Serpme Street	YERALTI SUYU/Grou	undwater : -			
KILOMETRE/Chainage : 0+	+265	MUH.BOR.DER./Cas	sing Depth : 1	12.00 MHW		note, et .
SONDAJ DER./Boring Depth : 40	0 m	BAŞBİT.TARİHİ/Sta	art-Finish Date : 1	18.01.2008	- 24.01.2	008
SONDAJ KOTU/Elevation :		KOORDINAT/Coordi	nate(Northing)			
DAYANIMI II. IK/Strength	AYRISMA/Weathering	INCE DANEL I/Ein	e Grained		LiCourse O	rained
I ÇOK DAYANIMLI Strong	1 TAZE Fresh	N : 8-2 COK YUMUŞAK	Very Salt N	1:0-4 ÇOK GE	EVŞEK Verj	/ Loose
II ORTA M.Weak	III ORTA D. AYR. Mod. Weath.	N: 5-8 ORTA KATI N: 9-15 KATI	Moderately Stiff N Very Stiff	: 5-10 GEVŞEI I : 11-30 ORTA S	(Loo IKI Мон	se Ierately Dense
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR. Comp. W.	N :16-30 COK KATI N : >30 SERT	Hard N	l:>50 ÇOKS⊪ l:>50 ÇOKS⊪	a Ver	y Dense
% 0-25 COK ZAYIF Very Poor	1 SEYREK Wide (W)		ORANLAR/P	roportions	amelyosociation	
% 25-50 ZAYIF Poor % 50-75 ORTA Fair	1-2 ORTA Moderate (M) 2-10 SIK Close (CI)	% 5-15 AZ	Little	%5 PEK. %5-20 AZ	AZ Sligh/ Little	ly.
% 75-90 Y Good % 90-100 ÇOK Yİ Excellent	10-20 COK SIKI Intense (I) >20 PARÇALI Crushed (Cr)	% 15-35 ÇOK	Very	% 20-5 ÇOK	Very	
SPT STANDART PENETRASYON TE Standard Peneration Test	ISTI UD ÖRSELENMEMI Undisturbed Sa	\$ NUMUNE	P PRESIYO	METRE DENEY		<u></u>
D ÖRSELENMİŞ NUMUNE Disturbed Sample	K KAROT NUMUN Core Sample	EŚI	VS VEYN DEt Vane Sh	NEYI sar Test		T . T
TO DARBE SAVISI	Penetration Test		PROFIL	ering	T.Care R.	S.Core R.
Service Servic	Graph			LIK/S Veat	TCR)	SCR)
45 cm	Geotechnical De	escription	Profile	VIML SMAN	5 N N	UN NO
Son NUN NUN NUN NUN NUN NUN NUN NUN NUN NU	10 20 30 40 50 60	. 8		AYA	KAR	KARG
9,0 - 8,0	1 1 1 1 1 1 1 4 1 1 1 1 1 -19 3 -10 -10 -10 -10 -10			N1	8 8	
						- "
				W2-W1	80	
						-
2,0	1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			M		
3,0	1 1 1 1 1 1 1 1 +++++++++++++++++++++++	rered-fresh		W2 ⁻¹	8 6	19
4,0	moderate strong, /	ANDESITE				
5,0 - RC	The discontinuity s rough and clean.	urfaces are		N2-W	8 8	20
6,0 - RC				N2-W	51 25	21
7,0				N2-W1	88	22
8,0	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$. W		
9,0				N2-V	67	23
0,0		40,00		N2-V		
1,0	1 1			111 VV2-VV3	2 2	24
2,0 - _{RC}		ly weathered- ered.		III W2-W3	54	25
SONDÖR / Driller		inaar l		· · ·	1 1	۲ I
Silleumen Erdem		meel	ARIM / Uale		IMZA / Si	gn
Suleyman Erdem	Ornan Oztekin		·			

SONDALINO SK-2 SAYFA Page 4/4 PROJE ADI/Project Namo The New Ulus Tunnel DELK (APV/Hole Diameter 4.34 ling SONDAL YER/Boring Location Km. 19.256 Serme Street YERALT SUVUGroundwater - KLOMETRE/Chaininge - - - - SONDAL YER/Boring Location Km. 19.256 Serme Street YERALT SUVUGroundwater - - SONDAL KOTUEE/exiden : 40 m BA3.9 m/m - - - SONDAL KOTUEE/exiden : 40 m BA3.9 m/m - - - SONDAL KOTUEE/exiden : 1 as many street - - - - SONDAL KOTUEE/exiden : 1 as many street - - - - SONDAL KOTUEE/exiden :																						
PROJE ADI/P	roject	Name	:	The	New	Ulu	s Tu	Innel				1	DELİK CAPI/I	lole Diar	neter :	4 3/4	inc		-			*********
SONDAJ YER	İ/Borir	ng Location	:	Km:	0+2	65/ S	erp	me S	tree	et			YERALTI SUN	/U/Grou	ndwater :	-						
KILOMETRE/	Chains	ige	:	0+26	5								MUH.BOR.DE	R./Casi	ng Depth :	12.00	MHV	v				
SONDAJ DEF	R./Borin	ng Depth	:	40 m	1								BAŞBİT.TA	RİHÌ/Star	t-Finish Date ;	18.01	1.200	3	24.0	1.200	8	
SONDAJ KOT	U/Ele	vation	:										KOORDINAT	Coordin	ate(Northing)	:						
SON. MAK.&Y	ÖNT./	D.Rig & Met	t. :	Crali	ous	D50	0/R	otary	-				KOORDINAT	Coordin	ate(Easting) :							
DAYANIA	ALILIKI	Strength	_		TAZE	Α	YRI	ŞMA/V	Nea	thering			INCE DAI	VELI/Fine	Grained Very Soft		RI DA	NELI/C	Coars	e Grai	ned	
I DAYANIMI	J	M.Strong M.Weak		14	AZ AYR	rişmiş D, ayf	2.		S	Slightly W. Iod. Weath			N:3-4 ÝUMUS N:5-8 ORTA	AK KATI	Soft Moderately Stiff	N : 5-10	(UI) GE	(GEVŞA (ŞEK	211	Loose	iuse atalu De	anes
IV ZAYIF V ÇOK ZAYIF	T	Weak V.Weak		IV ç V 1	;OK A' TÜMÜ	YR. YLE A'	YR.		Hi C	lighly W. Camp. W.			N : 9-15 KATI N : 16-30 COK K.	ATI	Stiff Hard	N: 31-	ið SIKI	C RIKI		Dense Very D	ense	
KAYA KALİ	resi ta	NIMI/RQD			ĸ	RIKL	AR-	30 cm/	/Fra	actures			H. 7.0 JEKT		ORANLA	R/Propo	rtions					
% 0-25 ÇOK ZAY % 25-50 ZAYIF	ΊF	Very Poor Poor		1 1-2	SE	YREK			Wi	/ide (W) Ioderate (M)		% 5 PEK A	z Sli	ghtly	% 5	F	EK AZ	5	Slightly		
% 50-75 ORTA % 75-90 IVI		Fair Good		2-10 10-2	Sili 10 ÇD	K SIKI			C) In	lose (Cl) ntense (l)			% 5-15 AZ % 15-35 COK	LI Ve	ttle Srv	% 5 % 2	-20 А 18-5 С	Z OK	1	Little Verv		
% 90-100 COK IVI	CTAN	Excellent	NOV2	>20	PA	RÇALI			Cr	rushed (Cr)						<u> </u>	_					
5F1 D	Stan ÖRSI Distu	dard Peneration ELENMİŞ NUMUR Irbed Sample	Test							K	Undisturbe KAROT NU Core Sam	MEMIŞ I ed Sam IMUNES ple	UMUNE ple 4	1	P PRES Press VS VEYN Vane	DENEYI Shear Te	E DENI r Test ist	iYi				
Baring Depth (m) SONDAJ DERINLIĜÍ NUMUNE CINSI Sample Type	MANEVRA BOYU Run	STANDA Sta DARBE SA Numb. of B E 5 5 5 6 5 6 5 5 6 5 5 6 5 5 6 5 5 5 5	RT Pl andaro AYISI Blows E 4 4 9 8	ENETI d Pene	RASY stratic	ON E on Tes GR/ Gra	DENI st AFİK aph	EYI 50 60	5	JEC Ge	DTEKNİk otechnica	(TA I Des	NIMLAMA	DER(NLIK/Depth (m)	PROFIL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0										model with ro discor Mode ANDE	rate stron bugh and stinuity su rately we SITE	ig AN limo urface	IDESITE nited es. red, weak	45,00			B W3 W2-W3		40 71	0 44		26
0 0 0 0 0										Gray- mode mode with re discor	brown, sli rately wea rate stron ough and ough and ntinuity su nd of Bor	ightly ather ig AN limo urface	v weathered- red, IDESITE nited as.	50,00			W2-W3 W2-W		20	0 30		28
0 0 0											•			- -								and a second second second second second second second second second second second second second second second
0							1 1 1 1 1				,											
0																	-					
0								****														
U	në e	(D-1)		1						U 1075 105 ¹			T				7	-				
SON	DOR	Uniter			 		NUN	DAJ	UIVI	HENDIS	a / Drilling	Engir	ieer	Т	ARIH / Date				MZA	/ Sigr	1	
		Erdom			1					Orhan	Oztekin						1					

			-	s	SON	IDA	JL	ogu	/ E	301	RING LOG			SONDAJ NO Borehale No	: sk-	3			SA	YFA age 1/3	
PROJ	E ADI/	Project	Name	9	:	The	New	Ulus	Tun	nel		DELİK ÇAPI	Hole Dia	meter :	4 3/4	inç	<u> </u>	-		-	
SONE	AJ YE	SONDAJ LOGU / BORING L Project Name : The New Ulus Tunnel RVBoring Location : Km: 0+490 2/Chainage : 0+490 Z/Chainage : 0+490 Z/Chainage : 0+490 Z/Chainage : 0+490 Z/Chainage : 0+490 Z/Chainage : 0+490 Z/Chainage : 0+490 Z/Chainage : 0+490 IMULIK/Strength ! 172Z MM Water Water ! 0 cork Ann. YVENNLL Strength Water ! 0 cork Ann. YVENNLL Strength Water ' 1 sort Rater Water ' 1 sort Rater Water ' 1 sort Rater Water ' 1 sort Rater Water ' 2 sort Rater Gead ! 3 sort Rater Brockland Prevention Test ' 1 sort Rater DAREE SAVISI Graph Orable S Strandard Prevention Test ' 1 sort Rater DAREE SAVISI Graph Strandard Prevention Test ' 1 sort Rater DAREE SAVISI Graph Strandard Prevention Test ' 1 sort Rater Strandard Prevention Test ' 1 sort Rater Strandard Prevent										YERALTI SU	IYU/Grou	indwater :	-						
KILON	IETRE	/Chain	age		:	0+49	90					MUH.BOR.E	ER./Cas	ing Depth :	12.00	мн	N				
SONE		R./Bor	ing De	pth	:	40 n	n		·····			BAŞBIT.TA	RiHi/Sta	rt-Finish Date :	10.01	1.200	8	15.0	1.200	8	
SON.	MAK.&	YÖNT	/D.Rig	, 8 Me	. :	Cral	ious	D500/	Rot	arv		KOORDINA	r/Coordir	ate(Northing)							
	DAYAN	MLILIK	/Stren	gth				AY	RIŞI	MA/W	eathering	INCE D	NELÌ/Fin	Grained		RI DA	NELÍ	Coars	e Grai	ned	
1 11 12 12 12 12 12 12 12 12 11 11 11 11	ÇOK DA DAYANIF ORTA ZAYIF ÇOK ZAY	yanimli Ali 1F	St M. M. W	rong Strong Weak eak Weak		-=∷ ≥ >	TAZE AZ AYR ORTA I ÇOK A' TÜMÜ'	işmiş D. Ayr. (r. (le ayr			Fresh Slightly W. Mod. Weath. Highly W. Comp. W.	N:0-2 COK N:3-4 YUMI N:5-8 ORT/ N:9-15 KATI N:16-30 COK N:>30 SERT	YUMUŞAK JŞAK LKATI KATI	Very Soft Soft Moderately Stiff Very Stiff Stiff Hard	N : 0-4 N : 5-10 N : 11-3 N : 31-5 N : >50	ÇO GE 10 GE 10 OR 10 SIKI ÇO	K GEVŞI /ŞEK FA SIKI K SIKI	EK	Very Lo Loose Modera Dense Very D	iose itely De ense	inse
KA % 0-25	A KAL	TESI T	ANIMI/ Ve	RQD		-	KI	RIKLA	2-30	cm/F	ractures Wide (W)			ORANLA	₹/Propo	ortions					
% 25-50 % 50-7 % 75-80	ZAYIF ORTA		Po Fa G	ior ir aad		1-2 2-10 10-1	OR SIK	TA K SiKI			Moderate (M) Close (Cl) Intense (I)	% 5 PEK % 5-15 AZ % 15-35 COK	AZ S	lightly ittle 'erv	%5 %5- %2	-20 A 0-5 C	'EK AZ Z	5 1 1	ilightly .ittle /erv		
% 90-100	ÇOK İY SPT	STA	Ex NDART F	cellent ENETR/	SYON	TEST	PA				UD ÖRSELENMEMIS	NUMUNE		P PRES	YOMETR	FDEN	tvl	-			
	D	Sta ÖRS Disi	ndard Pe SELENM turbed S	neration Ş NUMU ample	NE						Undisturbed Sam K KAROT NUMUNE: Core Sample	ple SI		VS VEYN Vane	DENEY Shear Te	Test					
n (m) Rinliği	insi	UYOE	DAI Nur	TANDA Sta RBE SA nb. of E	ART P andar AYISI Blows	ENET d Pen	RASY etratio	ON DE n Test GRAF Grapi	NEY K	1	JEOTEKNÍK TA	NIMLAMA	Depth (m)	PROFIL	K/Strength	sathering	e (30 cm)	CR)/T.Core R.		CR)/S.Core R.	Sample No.
Boring Depti SONDAJ DE	NUMUNE C Sample Type	MANEVRA I Run	0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	10 2	0 30 4	0 50	0 60	Geotechnical Des	scription	DERÍNLÍK	Profile	DAYANIMLILI	AYRIŞMAM	KIRIK/Fractur	KAROT %(TG	ROD %	KAROT %(SC	ÖRNEK NO./
0,0	RC														ž	V4-W5		96	0		1
2,0 -	PC.										Pink, completely we weak-very weak AN Sand occurance wa	athered, IDESITE is observed.				W5		-			
3,0	RC						1 1 1 1 1	+							,	V5 V/4		3	0		2
4,0 -	RC						1 1 1		-				4,00		√ <u>-</u> √ ·	(3 W4-1	-	5	0		3
5,0 _	RC								1		_				v ≥ v	-V W2-W		5 85	38		4
6,0	RC								1						v_	N.	-	- 20	ñ		5
8,0	RC										Pink, moderately we slightly weathered, strong ANDESITE v and clean discontin surfaces.	eathered- moderate vith rough uity			× ≥	W2-W3		9	89		6
9,0	RC						+				Three discontinuity observed.	sets were			×	W2-W3		51	0		7
1,0	RC														2	W2-W3		59	12		8
2,0															1						
3,0 —	RC														_ ≥	W2-W3		80	26		Ð
4,0		NIMULLI,K/Strength AYRIAN.U Brang MAYANAL Brang I AZZ MAYANAL Brang I AZZ Miku Brang I AZZ Miku Brang I AZZ Wash Work V GRYAR Wash Work V GRYAR Wash Work V GRYAR Wash Work V GRYAR Wash Work V GRYAR Wash I GRYAR Group Herg A Fair 2-00 BK Goud 1-20 BK Close IGI Goud 1-20 BK Close IGI Goud 1-20 BK Close IGI Goud 1-20 BK Close IGI Goud 1-20 BK Close IGI Goud 1-20 BK Close IGI Goud STANDART PENETRASYON DENEYI Standard Penetration Test Numb. of Blows Graph Geote Goud STANDART PENETRASYON DENEYI Stand oci Standard Banje Stand oci Stand oci Goud Standard Graph Geote Goud Standard Standard Standard Goud Standard Standard Goud Standard									-			VVVV	1	0	-		_		
Γ	sor	DÖR	/ Drille	er.		l	********	SO	NDA	AJ MÍ	ÜHENDİSİ / Drilling Enair	ieer	T	ARİH / Date		1	ie	170	Sian		
-						_					Orhan Öztekin						u		July		
L								Die Total													

SOND	AJ LOGU / BORING LOG		SONDAJ NO . Borehole No	SK-:	3			SAY Paj 2	/FA ge /3
PROJE ADI/Project Name : Th	e New Ulus Tunnel	DELİK ÇAPI/Hole Di	ameter ;	4 3/4	inc				
SONDAJ YERI/Boring Location : Kn	n: 0+490	YERALTI SUYU/Gro	undwater :	-					
KILOMETRE/Chainage : 0+-	490	MUH.BOR.DER./Ca	sing Depth :	12.00	MHV	V			
SONDAJ DER /Boring Depth : 40	m	BAŞBİT.TARİHİ/St	art-Finish Date :	10.01	.2008		15.01	.2008	
SON MAK &YÖNT /D Rig & Met. : Cra	alious 0500/Rotary	KOORDINAT/Coord	nate(Northing) :						
DAYANIMLILIK/Strength	AYRIŞMA/Weathering	ÎNCE DANELÎ/Fi	e Grained	1	Rİ DAI	NELİ/C	parse	Grain	ed
I ÇOK DAYANIMLI Strong II DAYANIMLI M.Strong	l TAZE Fresh II AZ AYRIŞMIŞ Siightly W.	N:0-2 COK YUMUŞAK N:3-4 YUMUŞAK	Very Soft Soft	N:0-4	ÇOK	GEVŞE	< V	Very Loo	se
III ORTA SUWeak	III ORTA D. AYR. Mod. Weath.	N : 9-15 KATI N : 18-30 COK KATI	Very Stiff Stiff	N : 11-3 N : 31-5	0 ORT 0 SIKI	A SIKI	1 1	Moderati Dense	ely Dense
KAYA KALITESI TANIMI/RQD	KIRIKLAR-30 cm/Fractures	N:>30 SERT	Hard	N:>59 /Propo	çox	SIKI		Very Der)se
% 0-25 ÇOK ZAYIF Very Poor	1 SEYREK Wide (W) -2 ORTA Moderate (M)	% 5 PEK AZ	Blightly	% 5	P	EK AZ	Sli	ightly	
% 59-75 ORTA Fair 2- % 75-99 [y] Good 19	-10 SIK Close (C) 8-20 ÇOK SIKI Intense (I)	% 5-15 AZ % 15-35 COK	Little Verv	% 5- % 20	20 A2 0-5 C	: DK	Li	ttle	
% 90-100 COK IVI Excelient >	20 PARÇALI Crushed (Cr)		,						
Standard Peneration Test D ÖRSELENMİŞ NUMUNE Disturbed Sample	K KAROT NUMUNES Core Sample	lumente Ne I	P PRESP Press VS VEYN I Vane 5	OMETR Iremeter IENEYI Shear Te	E DENE Test st	vi			
TANDART PENE Standard Pe DARBE SAYISI	ETRASYON DENEYI enetration Test GRAFIK IEOTEKNİK TA		PROFIL	rength	ering	0 cm)	T.Core R.		S.Core R.
Number of Blows	Graph Geotechnical Des	cription	Profile	MLILIK/St	AWeath	racture (3	%(TCR)/		%(SCR)/ NO./Sam
Baring SONDJ NUML Sample Run 15 - 30 30 - 45 30 - 45 X	10 20 30 40 50 60	DER.		DAYANII	AYRIŞN	KIRIK/F	KAROT	RaD %	KAROT ÖRNEK
				≥	W2-W		61	4	10
				≥	V2-W		88	41	11
,o –==					_				
			Ŭ VŲ VŲ V						
,0	Pink, moderately w	eathered- noderate		1					
	strong ANDESITE.	· ·	VVVVV	≥	/2-W3		8	33	12
,0	Discontinuity surface	es are		1	>				
	discontinuity sets at	ree the angles	VVVVV			ŀ	-		
	of 30, 45 and 60 deg	grees are		1					
				≥	12-W3		64	Я	13
"					5				
,o [
					g				
,0RC				≥	W2-V		23	•	14
				<u> </u>				_	
,o —				{	9				
RC			$\left \left(v, v, v\right) \right\rangle$	≥	W2-W		8	13	15
,0			Ĭ, v, v, v						
RC			Ĭ, v, v, v	≥	2-W3		37	0	10
,0		26,00	V V V		\$	ŀ			16
	Pink, highly weather	ed, weak		1					
				5	W4		20	0	17
.0	(Sand occurence wa	IS							
		28,40		L					
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engin	eer i	FARIH / Date			ia 4	70/	Sign	
	Orhan Öztekin							Gigii	
	I					_			

		SON	IDA	JL	ogi	U/I	BOI	RING LOG			SONDAJ NO Borehole No	SK-	3			SA Pa	YFA age 3/3	
PROJE ADI/Proje	ct Name	:	The	New	Ulus	s Tu	nnel		DELÍK ÇAPI/ł	lole Dia	neter :	4 3/4	inc	~~~~				
SONDAJ YERI/B	oring Locatic	in :	Km	: 0+4	90				YERALTI SU	YU/Grou	ndwater :	-						
KILOMETRE/Cha	inage	:	0+4	90					MUH.BOR.DI	ER./Casi	ng Depth :	12.00	о мну	N				
SONDAJ DER /B	oring Depth	<u> </u>	40 r	n					BAŞBİT.TA	RIHI/Star	t-Finish Date :	10.01	1.200	8	15.0	1.200	8	
SON MAK &YON	T./D.Rig & N	Aet. :	Cra	lious	D500)/Rot	tarv		KOORDINAT	Coordin/	ate(Northing) : ate(Fasting)							
DAYANIMLI	IK/Strength		Γ		A	YRIŞ	MA/W	eathering	INCE DA	NELİ/Fine	Grained	i	RI DA	NELI	Coars	e Grair	ned	
I ÇOK DAYANIM II DAYANIMLI III ORTA IV ZAYIF V ÇOK ZAYIF	L) Strong M.Stron M.Weak Weak V.Weak	9	-=≡≥>	TAZE AZ AYI ORTA ÇOK A TÜMÜ	RIŞMIŞ D. AYR YR. YLE AY	R.		Fresh Slightly W. Mod. Weath. Highly W. Comp. W.	N:0-2 COKY N:3-4 YUMU N:5-8 ORTA N:9-15 KATI N:16-30 COKK N:>30 SERT	umuşak Şak Katı Atı	Very Soft Soft Moderately Stiff Very Stiff Stiff Hard	N:0-4 N:6-10 N:11-3 N:31-5 N:>50	CON GEV 0 OR 10 OR 10 SIKI CON	(GEVŞI /ŞEK FA SIKI (SIKI	εĸ	Very Lo Loose Modera Dense Very De	ose itely Di inse	еляе
KAYA KALİTES	TANIMI/RQD Very Po	or	-	K		AR-30	0 cm/F	ractures Wide (W)	***		ORANLAR	Propo	ortions			, í		
% 25-50 ZAYEF % 50-75 ORTA % 75-90 [Y] % 98-100 ÇOK [Y]	Poor Fair Good Excellen	t	1-2 2-1 10- >21	0 SIF 20 Ç0 0 PA	ita K siki Rçalı		_	Moderate (M) Close (Cl) Intense (I) Crushed (Cr)	%5 PEKA %5-15 AZ %15-35 ÇOK	Z SI Li Vi	lghtly Itte Yy	%5 %5- %2	P -20 AJ 0-5 Ç	ek az Z :ok	9 1 1	ilightly .ittle /ery		
SPT S	TANDART PENET itandard Penerati RSELENMİŞ NUP listurbed Sample	'RASYON ion Test AUNE	I TEST					UD ÖRSELENMEMİŞ Undisturbed Sam K KAROT NUMUNE: Core Sample	iumune ple 1		P PRES Press VS VEYN Vane	YOMETR uremeter DENEY Shear Te	E DENE Test	EY]				
(m) NSI OYU	DARBE Numb. o	Standar Standar	'ENET d Pen	(RAS)	ON D on Tes GRA Gra	ENE t FIK ph	YI	JEOTEKNÍK TA	NIMLAMA	Jepth (m)	PROFIL	/Strength	athering	(30 cm)	R)/T.Core R.		R)/S.Core R.	ample No.
Boring Depth SONDAJ DEF NUMUNE CI Sample Type MANEVRA B	0 - 15 cm. 15 - 30 cm.	30 - 45 cm.	N	10 :	20 30	40 5	50 60	Geotechnical Des	cription	DERÍNLÍKI	Profile	NITITWINEAE	AYRIŞMAWe:	KIRIK/Fracture	KAROT %(TC	RQD %	KAROT %(SC	ÖRNEK NO./S
9,0												≥	W2-W3		ŝ	0		18
	_			 				Pink moderately we	athered.	31,00		≥`	W2-W3		78	38		19
2,0 3,0								slightly weathered, i strong ANDESITE	noderate			N	W2-W3		77	67		20
4,0								The discontinuity su rough and clean.Th discontinuity sets w observed.	rfaces are ree are			2	W2-W3		53	36		21
5,0						-						2	W2-W3		33	41		22
3,0	_											≥	W2-W3		86	4		23
9,0 - Rc	-											2	W2-W3		6	13		24
0,0	-							The end of Borehold)	40,00		, ≥	W2-W3		55	14		25
SONDÖ	R / Driller				sc	OND	AJ M	DHENDISI / Drilling Engin	eer	Τλ	ARİH / Date			in	MZA /	Sian		
								Orhan Öztekin								91		



			Grinoi						Orhan Öztekin		т <i>і</i>	ARIM / Date		<u> </u>	i)	AZA I	Sign		
1	SON	DŐR /	Driller			 SOM		: AÜH	HENDÍSÍ / Drilling Ei-				1						
7,0	RC							1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					=	W2-W3		86	78		15
6,0 -	RC			and a second second									=	W2-W		100	2		14
5,0													=	A2-V		26	F		13
4,0	-								•					V3 WZ			*		12
3,0 -									5. 				 	-W3		5			
2.0 - 5	кс								of 30, 45 and 60 de observed.	grees are		$\langle v \rangle \langle v \rangle \langle v \rangle \rangle$	=	V2-W3		79	ន		11
0,0	хC								The discontinuity su rough and clean.Th	rfaces are ree			=	W2-W3		42	15		10
9,0	۶C						1 11 1 1 1 1 1 4 1						=	W2-V		67	52		9
8,0 -	×C -								Between 17,40-17,7 decomposed; sandy was observed.	'0 m weak, material]_=_	V3 W4		100	0		8
7,0 —									strong ANDESITE cracks.	with cooling			1	3					
6,0	RC								Pink, moderately we	athered-			=	12-W3		56	52		7
5,0 -										-			1						
Boring Der SONDAJ [NUMUNE	Sample Ty	MANEVK/ Run	0 - 15 cm. 15 - 30 cm 30 - 45 cm	N	10 2	0 30 4	0 50 60	,	Geotechnical Des	cription	DERINU	Profile	ITWINEAC	AYRIŞMAN	KiRIK/Fract	KAROT %(ROD %	KAROT %(ÖRNEK NO
oth (m) JERİNLİĞİ CİNSİ	be of	A BOYU	Standa DARBE SAYIS Numb. of Blow	ard Per 1 s	letratio	GRAFI Graph	K		JEOTEKNİK TA	NIMLAMA	K/Depth (m)	PROFIL	LIK/Strength	Veathering	ure (30 cm)	TCR)/T.Core		SCR)/S.Core	/Sample No
	a	Star ÖRS Dist	ELENMIS NUMUNE urbed Sample	PENET	RASY	ON DEI	NEYİ	Т	Undisturbed Sain K KAROT NUMUNEs Core Sample	ple 1		Press VS VEYN I Vane	Jremeter XENEY) Shear Te	Test st		а <u>й</u>		R	
% 75-90 Å % 90-100 ç	Yİ ÇOK İYİ SPT	STAP	Good Excellent IDART PENETRASYO	1D- >2	20 ÇOJ 0 PAI	(Siki Rçalı		Int Cri	itense (I) rushed (Cr) UD ÖRSELENMEMİS I	% 15-35 ÇOK	v	ry P PRES	% 2	0-5 Ç			/ery		
KAYA % 0-25 (% 25-50 Z	KALİT	ESİ T/ IF	ANIMI/RQD Very Poor Poor Foir	1	SE OR 0 SIK	REK TA	(-30 cm/	/Frac Wi- Mo	ictures ide (W) oderate (M) ince (CI)	% 5 PEK	AZ SI	ORANLAF Ightly	/Propo % 5	rtions	EK AZ	5	lightly		
D/ O Z# V ¢0	AYANIML RTA AYIF DK ZAYIF	1	M.Strong M.Weak Weak V.Weak	II III IV V	AZ AYR ORTA I ÇOK AY TÜMÜY	IŞMIŞ). AYR. R. LE AYR.		SI M Hij	Sightly W. Iod. Weath. ighly W. :omp. W.	N: 3-4 YUMU N: 5-8 ORTA N: 9-15 KATI N: 18-30 COKI N: >30 SERT	JSAK KATI KATI	Soft Moderately Stiff Very Stiff Stiff Hard	N:5-10 N:5-10 N:11-3 N:31-5 N:≻50	ÇO) GEV 10 OR1 10 SIKI CO1	(GEVŞI (ŞEK 'ASIKI (BIKI	EK	Very Li Loose Moder Dense Very D	nose ately Di ense	onse
D/	AYANIN	ILILIK	/Strength	Ι.	7.67#	AY	RIŞMAA	Weat	thering	INCE DA	NELÍ/Fine	Grained		Rİ DA	NEL.I/O	Coars	e Grai	ned	
SONDA	J KOT	U/Ele	/D.Rig & Met. :	Сга	lious	D500/F	Rotary			KOORDINAT	T/Coordin	ate(Northing) : ate(Easting)					•		
SONDA	JDER	./Bori	ing Depth :	100	m					BAŞBİT.TA	RİHİ/Star	t-Finish Date :	10.01	1.200	3	21.0	1.200	8	
SONDA	J YER	l/Bori Chain	ng Location :	0+7	: 0+75 55	15				YERALTI SU MUH.BOR.D	YU/Grou DER./Casi	ndwater :	-	TALIN					
PROJE	ADI/Pi	roject	Name :	The	New	Ulus 1	Tunnel			DELİK ÇAPI	/Hole Dia	neter :	4 3/4	inç					
			SO	NDA	JLO	DGU	/ BO	RI	ING LOG			SONDAJ NO Borehole No	SK-	4			SA P	YFA age 2 / 7	
											1				-	1			

	SONDAJ LOGU / BORING LOG												SONDAJ NO : SK 4					SAYFA Page 3 / 7			
PROJE ADI/Project Name : The New Ulus Tunnel										nel	••••••••••••••••••••••••••••••••••••••	DELİK ÇAPI/Hole Diameter : 4 3/4 inc									
SONDAJ YERI/Boring Location : Km: (n: 0+755 YERALTI						UYU/Groundwater : -							
KILOMETRE/Chainage : 0+7							►755 MU						MUH.BOR.DER./Casing Depth : 12.00 MHW								
SONDAJ DER./Boring Depth : 100							00 m E					BAŞBİT.TARİHİ/Start-Finish Date : 10.01.2008 21.01.2008									
S	ON MAK	VONT	/D Rig &	Me	. : t. :	Crai	ious	D500	Rot			KOORDINA	T/Coordin	ate(Northing) :							
Ľ	DAYA	IMLILIK	(/Strength	ı				A)	RIŞA	NAN	/eathering	ÍNCE D	ANELİFIN	Grained		RÎ DA	NELI	Coars	e Grai	ned	
	I ÇOK DAYANIMLI Strong II DAYANMLI M.Strong IB ORTA M.Weak IV ZAYIF Weak V COK ZAYIF Weak			I TAZE Fresh II AZ AYRIŞMIŞ Silghtly W. IB ORTA D. AYR. Mod. Weath. IV ÇOK AYR. Highly W. V. T(MUK) E AVR Comp. M					Fresh Slightly W. Mod. Weath, Highly W.	N : 0-2 COK YUMUŞAK Very Soft N : 3-4 YUMUŞAK Soft N : 5-8 ORTA KATI Moderately Sisif N : 9-15 KATI Very Stiff N :16-30 ÇOK KATI Stiff			N:8-4 ÇOK GEVŞE N:5-10 GEVŞEK N:11-30 ORTA SIKI N:31-50 SIKI			EK	K Very Loose Loose Moderately Dense Dense				
E	ΚΑΥΑ ΚΑ	LITESI T	ANIMI/RG	2D		Ė	KI	RIKLA	R-30	cm/F	ractures	N:>30 SER	<u>I</u>	Hard ORANLAF	N:>50 /Propa	ço	(SIKI		Very D	hse	·
% % %	% 0-25 ÇOK ZAYIF Very Poor % 25-50 ZAYIF Poor % 50-75 ORTA Fair % 75-90 iVI Good			1 1-2 2-1 10-3	1 SEYREK W 1-2 ORTA W 2-10 SIK C 10-20 ÇOK SIKI I				Wide (W) Moderate (M) Close (Cl) Intense (I)	(W) % 5 PEK AZ trate (M) % 5-15 AZ sse (I) % 5-35 COK			% 5 PEKAZ % 5-20 AZ % 20-5 ÇDK			5 	Slightly Little Verv				
%	90-190 ÇOKİ SP	ri STA	Excel	lent (ETR/	ASYON	TEST	- PA	RÇALI			UD ÖRSELENMEMIS	NUMUNE		P PPEel	OMETR	E DEN	D.d	·			
Blandard Paneration Text Undisturbed Sample Pesart undisturbed Sample Pesart undisturbed Sample District Rev Delawith District Rev Delawith Core Sample View Delawith Core Sample Van Shear Yest Van Shear Yest																					
eoth (m)	DERINLIĜI E CINSI VPe	A BOYU	STANDART PEN Standard F DARBE SAYISI Numb. of Blows				PENETRASYON DEN rd Penetration Test GRAFik Graph			1 		NIMLAMA	İK/Depth (m)	PROFIL	ILIK/Strength	Weathering	cture (30 cm)	(TCR)/T.Core R		(SCR)/S.Core R	O./Sample No.
Boring D	SONDAJ NUMUN Sample T	MANEVF Run	0 - 15 cn	19-20 0	30 - 45 ci	N	10 2	0 30 -	10 50	0 60	Geotechnical De	scription	DERINI	Profile	JAYANIMI	AYRIŞMA	KIRIK/Fra	KAROT %	RQD %	KAROT %	ÖRNEK N
29,0	RC															W2-W3]	100	8		16
30,0										Pink, moderately w slightly weathered,	athered- moderate			=	W2-W3		19	0		17	
32,0	RC									1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	strong limonited AN	IDESITE urfaces are			=	W2-W3		44	13		18
33,0	0									stained and partly li Some cooling crack observed.	monited. Is were				2-W3		58	27			
34,0	- The second sec						· † · =-							Ů v v v v		×					
35,0																V3 W		197	2		20
36,0	RC						1	+.							=	W2-I		10	2		21
37,0	RC														=	W2-W3		67	7		22
58,0							Ť				Pink, highly weathe	red(sandy),	38,00	VVVVVV				\square			
39,0	RC										Weak ANDESITE				=	W4		77	15		23
40,0	n												_	vvvvv							
41,0 42,0	mulum RC										Pink, moderately we slightly weathered, strong ANDESITE v cracks.	eathered- moderate vith cooling	40,30		=	W2-W3		25	89		24
43,0											The discontinuity su rough and clean.Th discontinuity sets an	rfaces are ree e observed.				~					
	SONDÖR / Driller					SONDAJ MÜHENDİSİ / Drilling Engineer						TARİH / Date				MZA / Sign					
									Orhan Öztekin												

	SONDAJ NO Borehole No	4			SAYFA Page 4 / 7							
PROJE ADI/Project Name :	The New Ulus Tunnel		DELİK ÇAPI/H	ole Dia	meter ;	4 3/4	inc					
SONDAJ YERI/Boring Location :	Km: 0+755		YERALTI SUY	U/Grou	ndwater ;							
KILOMETRE/Chainage	0+755		MUH.BOR.DER./Casing Depth : 12.00 MHW									
SONDAJ DER./Boring Depth :	100 m		BAŞBİT.TAR	HI/Star	t-Finish Date :	10.01	.2008	3	21.01.	2008		
SONDAJ KOTU/Elevation :	Cralieur DE00/Datas		KOORDINAT/	Coordin	ate(Northing) :							
DAYANIMLILIK/Strength	AYRIŞMA/W	eathering	INCE DAN	ELI/Fine	Grained		RIDA	NELİIC	0.0160.0	rainod		
I ÇOK DAYANIMLI Sirong	I TAZE II AZ AYRISMIS	Fresh Slightly W.	N : 8-2 COK YU N : 3-4 YUMUSA	Very Soft Soft	N:0-4 COK GEVSEN				Very Loose			
III ORTA M.Weak IV ZAYIF Weak	III ORTA D. AYR.	Mod. Weath. Highly W.	N:5-8 ORTAK N:8-15 KATI	ĂŤI	Moderately Stiff Very Stiff	N: 5-19 GEVŞEK N: 11-30 ORTASIKI			Loose Moderately Dense Dense			
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30 ÇOK KA N :>30 SERT	TI	Hard	N : >50	ÇOX	SIKI	Ve	ry Dense		
% 0-25 ÇOK ZAYIF Very Poor	1 SEYREK	Wide (W)	%.5 PEK A7	SI	ORANLAP	ropo	rtions					
% 25-50 ZAYIF Poor % 50-75 ORTA Fair	1-2 ORTA 2-10 SIK 10.20 COV DIVI	Noderate (M) Close (Ci)	% 5-15 AZ	Li	ttle	% 5 % 5-	20 A3	ek az Z	Silg Litt	e e		
% 75-90 [Y] Good % 90-100 ÇOK [Y] Excellent	>20 PARÇALI	Crushed (Cr)	% 15-35 ÇOK	Vi	эгу	% 2	0-5 Ç	OK	Ver	'		
SPT STANDART PENETRASYO Standard Peneration Test D ORSELENNIS NUMUNE Disturbed Sample	TESTI	UD ÖRSELENMEMİŞ ; Undisturbed Sam K KAROT NUMUNES Core Sample	RUMUNE ple I		P PRES Press VS VEYN I Vane	YOMETR uremeter DENEYI Shear Te	E DENE Tost st	Yl				
STANDART F Standa	ENETRASYON DENEYI			Ē		gth		Ê	ore R.	ore R.	ġ	
E Numb. of Blows	GRAFIK Graph	JEOTEKNIK TA	NIMLAMA	epth	PROFIL	Stren	therir	(30 °	SJT.C	3/15.0	mple	
H H H H H H H H H H H H H H H H H H H		Costoshnical Dea	a sintia a	riku	Durgh		Wea	cture	DF,	(SCI	0./5	
NDA. NDA. NDA. NDA. NDA. NDA. NDA. NDA.	N	Geolecinical Des	onpuon	ERIN	Prome	ANIM	/WŚI	KUFra	\$ I	s S	Ш	
3 12 0 N W Sar NO	10 20 30 40 50 60			<u> </u>		DAY	AYR	KIR	Υ.	KAF	Öß	
							13 W2-V W2-W3 W2-		68 95	2+ ZC	25 26 27	
		Pink, moderately we slightly weathered, r strong ANDESITE	eathered- noderate with cooling			=	12-W W2-V		92 81	ñ 	28	
ν-∰ ∏	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	The discontinuity su	rfaces are				-W3		8, 0	_	30	
) —		stained(limonited).Three discontinuity sets are observed.					3					
		-			$\langle v \rangle v \rangle \langle v \rangle \langle v \rangle \langle v \rangle \rangle \langle v $	=	V3 W2-W		8	4	31	
		· .		51,00		=	W3 W2-1		68 57	> >	32	
	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Pink-brown, modera	itely			=	W3		8 (,	33	
		weak,denselý jointe ANDESITE.	d			=	W3		\$ 4	,	35	
)	B I					=	W3		<u>6</u>		36	
						≡	W3		22 °	, 	37	
						=	W3		- 	2	38	
				57,00		=	см		4	2	39	
SONDÖR / Driller	SONDAJ MÜ	HENDISI / Drilling Engin	eer	TARÌH / Date				İMZA / Sign				
	AJ LOGU / BORING LOG		SONDAJ NO : 5 Borehole No	sk la			SAYI Pag 5	FA e / 7				
---	--	--	---	---------------------------------------	-------------------------	----------------------	----------------------------	---				
PROJE ADI/Project Name : T	ne New Ulus Tunnel	DELİK CAPI/Hole Dia	meter : 4	1 3/4 inc								
SONDAJ YER!/Boring Location : K	m: 0+755	YERALTI SUYU/Grou	indwater ; -									
KILOMETRE/Chainage : 0-	-755	MUH.BOR.DER./Cas	ing Depth : 1	12.00 MH	w							
SONDAJ DER./Boring Depth : 1	00 m	BAŞBİT.TARİHİ/Sta	rt-Finish Date : 1	10.01.20	08 80	21.0	1.2008					
SONDAJ KOTU/Elevation :		KOORDINAT/Coordin	nate(Northing) :									
DAYANIMLILIK/Strength	AYRIŞMA/Weathering	INCE DANELI/Fin	Grained I	isi n	ANELIC	Aares	Graine					
1 COK DAYANIMLI Strong	I TAZE Fresh II AZ AYRISMIS Sliahtiy W.	N : 0-2 COK YUMUŞAK N : 3-4 YUMUŞAK	Very Soft N Soft N	1:0-4 Çi	OK GEVŞE	к	Very Loos	.e				
III ORTA M.Weak WZAYIF Weak	III ORTA D. AYR. Mod. Weath. IV ÇOK AYR. Highly W.	N : 5-8 ORTA KATI N : 9-15 KATI N : 15 20 COK KATI	Moderately Stiff N Very Stiff N Stiff N	1:5-10 Gi 1:11-39 OI	EVŞEK RTA SIKI KI		Lonse Moderate Dense	ly Dense				
V ÇOK ZAYIF V.Weak KAYA KALİTESİ TANIMI/RQD	V TÜMÜYLE AYR. Comp. W. KIRIKLAR-30 cm/Fractures	N:>30 SERT	Hard N	:>50 Ço	OK SIKI		Very Den	58				
% 0-25 ÇOK ZAYIF Very Poor % 25-50 ZAYIF Poor % 50-75 ORTA Fair % 75-90 [V] Good	1 SEYREK Wide (W) -2 ORTA Moderate (M) -49 SiX Close (C) 18-20 COX SIXI Intense (I) -50 COX SIXI Intense (I)	%5 PEKAZ S %5-15 AZ L %15-35 ÇOK V	lightly ittle	% 5 % 5-20 % 20-5	PEK AZ AZ ÇOK	Si L V	lightly íttle 'ery					
% 90-190 ÇOKİYİ Excellent SPT STANDART PENETRASYON TE Standard Peneration Test D ÖRSELEYANİS NUMUNE	STI UD ÖRSELENMEMIŞ A UD ÖRSELENMEMIŞ A Undisturbed Samj K KARAT NIMININE	EUMUNE ote	P PRESIVO	METRE DER	NEY)							
Disturbed Sample	Core Sample	1	VS VEYN DEN Vane She	NEYI ear Test								
STANDART PEN Standard F DARBE SAYIS Numb. of Blows US BUILD SAYIS Numb. of Blows US BUILD SAYIS Numb. of Blows US BUILD SAYIS Numb. of Blows	ETRASVON DENEYI enetration Test GRAFIK Graph JEOTEKNİK TAI Geotechnical Des	NIMLAMA	PROFIL Profile	ANIMLILIK/Strength USMA/Weathering	IK/Fracture (30 cm)	ROT %(TCR)/T.Core R.	20%	ROT %(SCR)/S.Core r. VEK NOJSample No.				
,0 <u> </u>	10 20 30 40 50 60	athered-	لــــــــــــــــــــــــــــــــــــ	DAY.	XIX	Υ.	8	GR KA				
,0	slightly weathered, r strong ANDESITE w	noderate rith cooling		≡ §		100	- 44	40				
,o	The discontinuity su stained and rough.T discontinuity sets and	rfaces are hree e observed.		≣ 🕅		8	4	41				
,o	Between 56,00-63,5	0 m stained.		≅ 8		8	34	42				
,0	1 1 1 1 1 1 1 1 1 1 1 1 -			≡ 83		8	•	43				
,0,	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			= 8		80	27	44				
,o,				" W2-W3		82	4	45				
,0,	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	eathered-		" W4-W3		32	0	46				
,00	moderately weather ANDESITE.(Crumbi are observed) The discontinuity out	ed, weak, ing parts										
0,	rough and stained(in	monited).		" MS-W		37	0	47				
0	Pink-brown, slightly moderately weather moderately weak AN	weathered- ed, IDESITE.		HI W2-W3	-	55	4	48				
.₀ ╡ ├──┤	Pink-brown, highly w	veathered- 71,60	<u>ŇŢŇŢŇ</u>			-+	-					
SONDÖR / Driller	SONDAJ MÜHENDİŞİ / Drilling Engine	eer T	ARIH / Date		١v	IZA /	, Sign					

				_	SON	IDA	'1 I	.00	ອບ	/ B(OF	RIN	G LOG				SONDAJ NO Barehale No	sk-	4			S/ P	YFA age 6/7	
ł	PROJ	IE ADI/	Project	Name	:	The	Ne	w UI	us T	unne	el				DELİK ÇAPI/	Hole Dia	meter :	4 3/4	inc	-				
F	SONE	OAJ YE	Rİ/Bori	ing Locatio	on :	Кm	: 0+	755							YERALTI SU	YU/Grou	ndwater ;	-	,					
	KİLON	NETRE	/Chain	age	:	0+7	55								MUH.BOR.D	ER./Cas	ng Depth :	12.00	мн	N				
- F	SONE	DAJ DE	R./Bor	ing Depth	:	100	m								BAŞBİT.TA	RiHi/Sta	rt-Finish Date :	10.0	1.200	8	21.0	1.200	18	
ł	SONE	MAK		/D Rig & M	: Aet	Crai	liou	e D6	00/5	lotar					KOORDINAT	Coordir	ate(Northing)							
ŀ	0014.1	DAYAN	IMLILIK	/Strength			100	3 03	AYF	IŞMA	We	eathe	ring		INCE DA	NELI/Fin	Grained		RI DA	NELÍK	Coars	e Grai	ned	
	1 8 1V V	ÇOK DA DAYANI ORTA ZAYIF ÇOK ZAY	yanimili Vili	Strong M.Stron M.Weak Weak V.Weak	9	1 11 11 11 11 11	TAZE AZ A ORT. ÇOK TÜM	I YRIŞM A D. A' AYR. ÚYLE	IŞ YR. AYR.		1	Fresh Sligh Mod. Highly Comp	tiy W. Weath, / W.		N: 8-2 COK N: 3-4 YUMU N: 5-8 ORTA N: 8-15 KATI N: 16-39 COK H	YUMUŞAK İşak Katı Katı	Very Soft Soft Moderately Stiff Very Stiff Stiff Hard	N : 0-4 N : 5-40 N : 11-3 N : 31-4 N : 31-4	ÇOI GEV 10 ORT	k gevşi /şek Fasiki	EK	Very L Loose Moder Dense	ately D	ense
t	KA	YA KAL	ITESI T	ANIMI/RQD				KIRIK	LAR	-30 cr	m/Fr	ractu	res		N12JU SERI		ORANLA	VPropo	rtions			Very	ense	
	% 0-25 % 25-50 % 50-75 % 75-90 % 90-100	5 ÇOK ZA 3 ZAYIF 5 ORTA 8 İYİ 8 COKİYİ	AYIF I	Very Po Poor Fair Good Exceller	or it	1 1-2 2-1 10- >2	0 S 20 Ç 20 Ç	EYREI DRTA IIK IOK SII PARÇA	K KI LI			Wide (Moder Close Intens Crush	W) ate (M) (CI) :e (I) ed (Cr)		%5 PEK/ %5-15 AZ %15-35 ÇOK	12 S L V	ightiy ittlə izry	% 5 % 5 % 2	-20 A 0-5 Ç	ek az Z :ok	5 	Slightly Little Very		
ľ	1 20-100	SPT D	STA Sta ÕRS Dist	NDART PENET ndard Penerat SELENMIŞ NUR turbed Sample	RASYON Ion Test NUNE	TEST							UD ÖRSELENA Undisturbe K KAROT NU Core Sam	MEMİŞ N red Samp JMUNES sple	IUMUNE Die ł		P PRES Press VS VEYN Vane	YOMETR uremeter DENEYI Shear Te	E DENE Test	Y				
) LiĜi	70	D,	STAN	DART P Standar SAYISI	ENE1 d Pen	IRAS ietrat	GYON tion T	DEN est RAFII	ieyi K	_		JEOTEKNIK		NIMLAMA	pth (m)	PROFIL	trength	ering	30 cm)	П.Core R.		/S.Core R.	.oN siqr
	ring Depth (m NDAJ DERIN	JMUNE CINS Type	ANEVRA BOY	Numb. o . 15 cm . 30 cm	f Blows Wo St -	N		G	raph				Geotechnical	d Des	cription	DERINLIK/Der	Profile	S/NIMLILIK/S	kişMA/Weath	KVFracture (3	ROT %(TCR)	% C(ROT %(SCR)	VEK NO./San
L	88	z ő	Μŭ	9 2	8			20 3			50							Ă	AYF	Ř	¥	ŭ	¥.	ğ
72,0												m cr Ti ro	oderately wea umbling ANE ne discontinui ugh and staii	ather DESII ity su ined(ed, weak, IE. rfaces are limonited).			=	W2-W3		53	47		49
74,0 75,0	, դես հատես															74,00		=	W2-W3	-	67	0		50
76,	, nucliana					-						Pi m m	nk-brown, slig oderately wea oderately wea	ghtly ather ak Al	weathered- ed, NDESITE.			/ ≡	67-V3	-	100	30		51
77,0											- ÷								N3	-				
79,0] <u>≕</u>	9 W2-I	-	46	20		52
80,0)																	=	W2-W		71	54		53
81,() (•					=	12-W3		53	55		54
82,0) mhuuu										****		nk brown bi-		(asthorad	82,50		_	3	-				
83,0 84,0 85,0) էրություն։ Արտահատեսու											Pi Wi lin pe Th ro	nk-prown, hig sak-moderate nonitizated Af arpendicular c ne discontinui ugh and stain	only we NDES coolin ity su ned(lii	veathered, eak, SITE with g cracks. rfaces are monited).			=	W3-W4		59	40		55
86,0) 100 100											Pi m	nk-brown, slig oderately wea	ghtly athere	weathered- ed,	85,50		=	-W3	-	F	ñ		56
Γ		SON	NDÖR .	/ Driller					SON	DAJ	MÜ	ÜHE	NDİSİ / Drilling E	Engine	eer	Т	ARIH / Date			İÞ	ΛZA)	/ Sign		
												0	rhan Öztekin										•	

:	SON	IDAJ LOGU / BOI	RING LOG			SONDAJ NO Borehole No	SK-	4			SA P	YFA age 7/7	
PROJE ADI/Project	Name :	The New Ulus Tunnel		DELİK ÇAPI/H	lole Dia	meter :	4 3/4	inc					
SONDAJ YERI/Bor	ing Location :	Km: 0+755		YERALTI SUY	/U/Grou	ndwater :	-	,					
KILOMETRE/Chain	age :	0+755		MUH.BOR.DE	R./Cas	ng Depth :	12.00	MH	V				
SONDAJ DER./Bor	ing Depth :	100 m		BAŞBİT.TAF	₹İHİ/Sta	rt-Finish Date :	10.01	.200	8	21.0	1.200	8	
SONDAJ KOTU/EI	evation :			KOORDINAT/	Coordin	ate(Northing)							
SON. MAK.&YÖNT	/D.Rig & Met. :	Cralious D500/Rotary		KOORDÌNAT/	Coordin	ate(Easting)							
DAYANIMLILIK	Strength	AYRIŞMAM	leathering	INCE DAM	VELI/Fine	Grained	i	Rİ DA	NEL1/C	oars	e Grai	ned	
I ÇOK DAYANIMLI II DAYANIMLI	Strong M.Strong	I TAZE II AZ AYRIŞMIŞ	Fresh Slightly W.	N:8-2 COKYU N:3-4 YUMUŞ	JMUŞAK AK	Very Saft Soft Moderately Still	N:0-4 N:5-10	ÇO) GEV	(gevşe /sek	к	Very L Loose	aose	
IL ORTA	Weak	III ORTA D. AYR. IV ÇOK AYR.	Mod. Weath. Highly W.	N: 9-15 KATI		Very Stiff Stiff	N : 11-3	0 081	A SIKI		Moder	ately D	ND Se
V ÇOK ZAYIF	V.Weak	V TÖMÖYLE AYR.	Camp. W.	N: 530 GERT	411	Hard	N : >50	ços	(3)KI		Very L	ense	
% G-25 COK ZAYIF	Very Poor	1 SEYREK	Vide (W)			ORANLAR	VPropo	rtions					
% 25-50 ZAYIF % 50-75 ORTA	Poor Fair Good	1-2 ORTA 2-10 SIK 10-20 COK SIKI	Moderate (M) Close (Cl) Intense (I)	% 5 PEK AZ % 5-15 AZ	ះ នា ឯ	ightly ittle	%5 %5-:	P 20 A	ek az Z	s L	iightly .ittle		
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)	% 15-35 ÇOK	v	ery	% 20	1-5 Ç	юк		/ery		
SPI SIA Sta D ÖR: Dis	ndard Peneration Test ELENMİŞ NUMUNE urbed Sample		UD ÖRSELENMEMİŞ Undisturbed San K KAROT NUMUNE Core Sample	NUMUNE Iple SI		P PRES Press VS VEYN Vane	YOMETRE uremeter DENEYI Shear Te:	E DENE Test st	ev)				
	STANDART F Standar	ENETRASYON DENEYI d Penetration Test			Ē		gth	5	Ê	ore R.		ore R.	No
	DARBE SAYISI	GRAFIK	JEOTEKNÍK TA	NIMLAMA	apth	PROFIL	Stren	herin	ŝ	Ë)/S:C	mple
A BC		Ciapit	-		Š.	-	EK	Veat	en	Ľ,		SCR	/Sa
DALE PALE	0 cm 5 cm	N	Geotechnical De	scription	SINC	Profile	IML	MAN	Frac	1%	*	т %(l Š
Borin SONI Samp MAN Run	0 - 1	10 20 30 40 50 60			B		AYAN	YRIŞ	R	ARG	g	CARC	RNE ENE
			moderate weak AN	DESITE with			1-1	M2			••		<u></u>
			rougn aiscontinuity	surraces,	86,50		=	W2-W3		8	44		57
0 -			Gray ,fresh, modera ANDESITE with clu	ately strong ean and			1	W1 W2-W		28	12		58
. 1 🗖			rough discontinuity	surfaces.		Ů vůvův	\downarrow	5					
			Sandy, weak ANDE	SITE with	1	V V V	-	>		ß	Ξ		59
0			cooling cracks.	-		vvvvv	-	ÊŴ					
0 —			Gray fresh meder	taly strong	92,30		N	W		72	38		60
			ANDESITE with cli rough discontinuity	ean and surfaces.									
0							2	M1		28	4		61
	2						2	M		100	89		62
0		E Tildalalala				v v v v	1						
0						V V V V	1.1	-					0.2
							2	W.		100	8		63

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARIH / Date	İMZA / Sign
	Orhan Öztekin		

SOND			SONDAJ NO Borehole No	-5	SAYFA Page 1 / 7
SONDA	AJ LOGU / BORING LOG				
PROJE ADI/Project Name : The	e New Ulus Tunnel	DELİK ÇAPI/Hole Dia	meter : 4 3/4	1 inç	\$ ***
SONDAJ YERI/Boring Location : Km	1: 0+860 360	YERALTI SUYU/Grou MUH BOR DER /Cas	indwater : -		
SONDAJ DER /Boring Depth : 90	m	BAŞBİT.TARİHİ/Sta	rt-Finish Date : 01.0	0 WHW 1.2008 1	0.01.2008
SONDAJ KOTU/Elevation :		KOORDINAT/Coordin	nate(Northing)		
SON. MAK.&YONT./D.Rig & Met. : Cra	alious D500/Rotary	KOORDINAT/Coordin	nate(Easting) :		
t ÇOK DAYANIMLI Strong i	TAZE Fresh	N: 0-2 COK YUMUŞAK	Very Soft N : 0-4	IRI DANELI/Co	arse Grained Very Loose
H DAYANMALI M-Studing HI DAYANMALI M-Studing III ORTA M-Weak III V ZOK ZAYIF Weak V ÇOK ZAYIF V.Weak V ÇOK ZAYIF V.Weak	V ZARANGANG Sugary V. 1 ORTA D. A/R. Midd Weath. V COK A/R. Highly W. Y TÜNÜYLE A/R. Comp. W. KIEIKI A.B. 20. cm/ Comp. W.	N : 5-8 ORTA KATI N : 9-15 KATI N : 9-15 KATI N : 16-39 COK KATI N : >30 SERT	Moderately Stiff N:5-1 Very Stiff N:11 Stiff N:31 Hard N:>5	IO GEVŞEK -30 ORTASIKI -50 SIKI 0 ÇOKSIKI	Loose Moderately Dense Dense Very Dense
% 0-25 COK ZAYIF Very Poor 1 % 325-50 ZAVIF Poor 1-4 % 59-75 ORTA Fair 2 % 75-90 M Good 20	SIFVECK Vide (W) SIFVEK Wide (W) 2 ORTA (biodrate (M) SIK Close (C) SIK Close (C) PBRGI D DIstribut (C)	%5 PEKAZ S %5-15 AZ L %15-35 ÇOK V	Ightly % %	ortions 5 PEK AZ 5-20 AZ 20-5 ÇOK	Slightly Little Very
% 90-100 COK IVI Excellent *** SPT STANDART PENETRASYON TEST Standard Peneration Test	TI UD ÖRSELENMENIS N Undisturbed Sam	UMUNE Sla	P PRESIYOMET Pressuremete	RE DENEY] ar Test	
Disturbed Sample	Core Sample	I	VS VEYN DENEYI Vane Shear T	est	
STANDART PENE Standard Pa DARBE SATISI Numb. of Biows Numb. of Bio	TRASYON DENEY netration Test GRAFIK Graph JEOTEKNIK TA Geotechnical Des 10 20 30 40 50 60	NIMLAMA (L)	4YRIŞMA/Weathering KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R. RQD % . KAROT %(SCR)/S.Core R. ÖRNEK NO./Sample No.	
0,0	ASPHALT	0,10			
1,0		/		M4	<u>ଜି</u> ଦ୍ର 1
2,0	Pink-brown, highly			W4	\$ 1 9 9
	very weak-weak AN	to sand), IDESITE		W4	[₽] 0 3
3,0	$ \begin{cases} \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac$	н. 		W4	°°⊂ 4
1,0 = RC				W4	t a ⊂ 5
j,0 —	$\begin{array}{cccccccccccccccccccccccccccccccccccc$			┼─┥╴┟	
s,o	4 1 3 1 2 1 - 3 1 1 1 1 1 1 1 1 1 2 1 1			W4	⁶ 0 ک
7,0		7,00		W4	00 o 7
3,0	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $			W3	67
),0	Light pink-gray, moderat	erately e strong			
,0	The discontinuity su rough and stained. discontinuity sets and	rfaces are hree e observed.		M3	0 ² 0 9
,0				EN .	G 8 10
,0	J I				
,0RC	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		<pre>\v</pre> \v\v\v\v\v\v\v	W3	30 89 11
,0 = _{RC}			v,,v,v,v,v,v,v,v,v,v,v,v,v,v,v,v,v,v,v		12
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engine	er T	ARİH / Date	İMZ	/A / Sign
	Orhan Öztekin				

SOND	AJ LOGU / BORING LOG	Å	SONDAJ NO : SK Borehole No :	-5	SAYFA Page 2 / 7
PROJE ADI/Project Name : Th	ne New Ulus Tunnel	DELİK CARI/Hala Dia	motor · 4 24		
SONDAJ YERI/Boring Location : Kn	n: 0+860	YERALTI SUYU/Grou	indwater :-	+ my	Lega
KILOMETRE/Chainage : 0+	860	MUH.BOR.DER./Cas	ing Depth : 12.0	0 MHW	
SONDAJ DER./Boring Depth : 90	m	BAŞBİT.TARİHİ/Sta	rt-Finish Date ; 01.0	1.2008 1	0.01.2008
SONDAJ KOTU/Elevation :	-11	KOORDINAT/Coordin	nate(Northing)		
DAYANIMLILIK/Strength	AYRISMA/Weathering	INCE DANEL I/EIN	ate(Easting) :		
I COK DAYANINLI Strong II DAYANINLI M.Strong III ORTA M.Weak	I TAZE Fresh II AZ AYENSIS Slightly W. III ORTA D. AYR. Mod. Weath.	N: 0-2 ÇOK YUMUŞAK N: 3-4 YUMUŞAK N: 5-8 ORTA KATI	Very Soft Soft Moderately Stiff N : 5-1	GOK GEVŞEK	Very Loose Loose
V ZAYIF Weak J V ÇOK ZAYIF V.Weak	IV ÇOK AYR. Highly W. V TÜMÜYLE AYR. Comp. W.	N : 9-15 KATI N :16-30 COK KATI N : >30 SERT	Very Stiff N : 11- Stiff N : 31- Hard N : >50	30 ORTASIKI 50 SIKI 9 ÇOKSIKI	Moderately Dense Dense Very Dense
KAYA KALITESI TANIMIROD % 0-25 ÇOK ZAYIF Very Poor % 25-50 ZAYIF Poor 1-	KIRKLAR-30 cm/Fractures 1 SEYREK Wide (W) -2 ORTA Moderate (M)	% 5 PEKAZ S	ORANLAR/Prop	ortions 5 PEK AZ	Slightly
% 56-75 ORTA Fair 2- % 75-90 IVI Good 10 % 84-86 COK IVI Evening 2-	-19 SIK Close (Cl) 9-20 ÇOK SIKI Intense (I) 20 PARÇALI Crushed (Cr)	% 5-15 AZ L % 15-35 ÇOK V	ittle % s	5-20 AZ 20-5 ÇOK	Little Very
SPT STANDART PENETRASYON TES Standard Peneration Test Object candle and instance	TI UD ÖRSELENMEMIŞ N Undisturbed Samı	AUMUNE Sle	P PRESIYOMETE Pressuremete	RE DENEY!	
Disturbed Sample	K KAROT NUMUNES Core Sample	a 	VS VEYN DENEYI Vane Shear T	est	
DARBE SAYISI			engerin and	sting 0 cm)	Core h
LE ph Geotechnics Dec			Weaths cture (30	6(TCR)/ 6(SCR)/6	
Boring C SONDA, NUMUN NUMUN NUMUN NUMUN Run Run 15 - 30 c 15 - 30 c 15 - 30 c 15 - 30 c	10 20 30 40 50 60			YRIŞMA IRIK/Fra	AROT %
15,0	Light pink-gray, mod weathered, moderate ANDESITE. The discontinuity sur discontinuity sets are	lerately e strong rfaces are hree a observed.		W3 W3<	io 35 pb 27 pb 27 sc 13 sc 14 pb 15 nnt np sc 15 not 15 not 16 not 19 20 21 gc 21
			<u> vૻ,vૻ,vૻ,</u>		
SONDOR / Driller	SONDAJ MÜHENDİSİ / Drilling Engine	er T/	ARIH / Date	imz	A / Sign
	Orhan Öztekin	·			

SONDA	AJ LOGU / BORING LOG		SONDAJ NO Borehole No : S	K-5	SAYFA Page 3 / 7
PROJE ADI/Project Name : The	e New Ulus Tunnel	DELIK CAPI/Hole Dia	meter · 4	N/L inc	
SONDAJ YERI/Boring Location : Km	1: 0+860	YERALTI SUYU/Grou	Indwater : -	»4 niç	
KILOMETRE/Chainage : 0+8	360	MUH.BOR.DER./Cas	ing Depth : 12	.00 MHW	
SONDAJ DER./Boring Depth : 90	m	BAŞBİT.TARİHİ/Sta	rt-Finish Date : 01	.01.2008	10.01.2008
SONDAJ KOTU/Elevation :		KOORDINAT/Coordin	nate(Northing) :		
SON. MAK.&YON I ./D.Rig & Met. : Cra	Allous D500/Rotary	KOORDINAT/Coordin	nate(Easting) :		
I ÇOK DAYANIMLI Strong I	TAZE Fresh	N : 0-2 COK YUMUŞAK	Very Soft N :	IRI DANELI/C	Very Leose
II DAYANIMLI M.Strong II III ORTA M.Weak III IV ZAVIE Weak III	AZ AYANŞANŞ Signity W. L ORTA D. AYR. Mod. Weath.	N: 3-4 TUNIUŞAK N: 5-8 ORTA KATI N: 9-15 KATI	N toderately Stiff N to N to N to N to N to N to N to N	5-10 GEVŞEK 11-30 ORTA SIKI	Loose Moderately Dense
V ÇOK ZAYIF V.Weak V	/ TÜMÜYLE AYR, Comp. W.	N :18-30 COK KATI N :>30 SERT	Stiff N: Hard N:	31-50 SIKI >60 ÇOK SIKI	Dense Very Dense
KAYA KALITESI TANIMI/RQD % 0-25 COK ZAYIF Very Paor 1	KIRIKLAR-30 cm/Fractures SEYREK Wide (W)		ORANLAR/Pro	oportions	
% 25-50 ZAYIF Poor 1-2 % 50-75 ORTA Fair 2-1	2 ORTA Moderate (1/l) 10 SIK Clase (Cl)	%5 PEKAZ S %5-15 AZ L	lightly ittle	% 5 PEKAZ % 5-20 AZ	Slightly Little
% 75-90 [Y] Good 10- % 90-190 CDK Y Excellent >2	-20 ÇOK SIKI Intense (I) 20 PARÇALI Crushed (Cr)	% 15-35 СОК V	lery	% 20-5 ÇOK	Very
SPT STANDART PENETRASYON TEST Standard Peneration Test D ÖRSELENMİŞ NUMUNE Disturtuse Samote	rl UD ÖRSELENMEMİş h Undisturbed Sam K KAROT NUMUNES Coro Sample	NUMUNE ple sl	P PRESIYOM Pressurem VS VEYN DENE	EYRE DENEYÎ ¢ter Test iyî	
STANDART PENEL Standard Per	TRASYON DENEYI		Vane Shea	Test	a a o
	GRAFIK Graph JEOTEKNÍK TA	NIMLAMA	PROFIL	athering e (30 cm	R)/T.Co R)/S.Co
AJ Dept	Geotechnical Des	cription	Profile	AAMe	%(SON)
Soning Soning Soning AANE Run No. 4: So. 30 - 4: So. 4: So. 30	10 20 30 40 50 60	DER		RISA	ARO1 %
29,0	Light pink-gray, moc weathered, moderat ANDE SITE.	lerately æstrong rfaces are hree e observed.		10 M3 M3 M3 M3 M3 M3 M3 M3 M3 M3 M3 M3 M3	12 87 22 00 82 23 88 15 24 98 15 24 98 15 24 98 15 25 901 15 27 901 155 27 901 155 27 901 155 29 901 155 29 901 155 29 901 155 29 901 155 29 901 155 30 901 15 31 902 15 31
			v\`v\`v\ ` -		
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engin	eer T	ARÍH / Date	in	ZA / Sign
	Orhan Öztekin			11/2	

SONDAJ YERI/Boring Location : KILOMETRE/Chainage :	The New Ulus Tunnel	DELİK ÇAPI/Hole Dia	uneter :	SK-:	5 inç			Page 4/7	,
KILOMETRE/Chainage :	Km: 0+860	YERALTI SUYU/Grou	indwater :	-					
	0+860	MUH.BOR.DER./Cas	ing Depth :	12.00	MHW	1			
SONDAJ DER./Boring Depth :	90 m	BAŞBİT.TARİHİ/Sta	rt-Finish Date :	01.01	.2008		10.01	2008	
SONDAJ KOTU/Elevation :		KOORDINAT/Coordin	nate(Northing) :						
SON. MAK.&YÖNT./D.Rig & Met. :	Cralious D500/Rotary	KOORDINAT/Coordin	nate(Easting) :						
DAYANIMLILIK/Strength	AYRIŞMA/Weathering	INCE DANELI/Fin	e Grained	. i	Rİ DAN	IELI/Co	oarse	Grained	
I ÇOK DAYANIMLI Strong II DAYANIMLI M.Strong	i TAZE Fresh II AZ AYRIŞMIŞ Slightly W.	N : 0-2 ÇOK YUMUŞAK N : 3-4 YUMUŞAK	Very Soft Soft	N: 8-4	ÇOK	GEVŞE	K V	ery Loose	
III ORTA M.Weak IV ZAYIF Weak	III ORTA D. AYR. Mod. Weath. IV ÇOK AYR. Highly W.	N:9-15 KATI	Woderately Stiff Very Stiff	N:11-3	0 ORT	A SIKI	Ň	loderately I	Dense
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR. Comp. W.	N : >30 SERT	Hard	N : >50	ÇOK	siki	¥	ery Dense	
% 0-25 COK ZAYIF Very Poor	1 SEVREK Wide (W)		ORANLAR	Propo	rtions				
% 25-50 ZAYIF Poor % 50-75 ORTA Fair % 75-90 [Y] Good % 90-100 ÇOK [Y] Excellent	1-2 ORTA Moderate (M) 2-10 SIK Close (CI) 10-20 (CK SIKI Intense (I) >20 PARÇALI Crushed (Cr)	% 5 PEKAZ S % 6-15 AZ L % 15-35 ÇOK V	ilghtly .ittle /ery	% 5 PEK AZ Slightly % 5-20 AZ Little % 20-5 ÇOK Very					
SPT STANDART PENETRASYON Standard Peneration Test D ÖRSELENNIS NUMUNE Disturbed Sample	TESTI UD ÖRSELENMEMIS N Undisturbed Sam, K KAROT NUMUNES Core Sample	P PRESI Press VS VEYN D Vane S	YOMETRI uremeter DENEYİ Shear Tes	E DENEY Test st	rl				
Bacing Deskin (1) Bacing Deskin	NETRASYON DENEYI Penetration Test GRAFIK Graph N 10 20 30 40 50 60	NIMLAMA Detrivery (U)	PROFIL Profile	DAY ANIMLILIK/Strength	AYRIŞMAWeathering	KiRiK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD % KAROT %(SCR)/S.Core R.	ÖRNEK NO /Sample No.
				=	W3 W3	-	67 25	0	33
				=	W3		22	18	35
0	Light pink-gray, mod	lerately e strong		=	W3		62	39	36
0	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	rfaces are		=	W3	-	90	61	37
0	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	hree e observed.		Ξ	W3		95	87	38
0RC			Ŭvůvův	=	ş		8	•	39
0	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			=	6W3		92	82	40
o —									
				=	W3		100		41
	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			=	6W3		100	83	42
ב_ נ			1°., °., °.,						
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engine Orhan Öztekin	eer 7	ARİH / Date			İM	ZA / S	Bign	

Sonda	J LOGU / BORING LOG		SONDAJ NO ÷ S Borehole No ÷ S	K-5		SAYFA Page 5 / 7
PROJE ADI/Project Name : The	e New Ulus Tunnel	DELÌK ÇAPI/Hole Dia	meter : 4:	3/4 inc	<u> </u>	
SONDAJ YERI/Boring Location : Km	n: 0+860	YERALTI SUYU/Grou	indwater : -		•••	
KILOMETRE/Chainage : 0+8	360	MUH.BOR.DER./Cas	ing Depth : 12	2.00 MHW		
SONDAJ DER./Boring Depth : 90 1	m	BAŞBİT.TARİHİ/Sta	rt-Finish Date : 01	1.01.2008	10.01.3	:008
SON MAK &YONT /D Big & Met. : Cra	lious D500/Rotany	KOORDINAT/Coordin	nate(Northing) :			
DAYANIMLILIK/Strength	AYRIŞMA/Weathering	INCE DANELI/Fin	e Grained	IRI DANE	Lİ/Coarse G	irained
I ÇOK DAYANBALL Sitong I II DAYANBALI M. Sitong II III DAYANBAL M. Weak II IV ZAVIF Weak IV V ÇOK ZAVIF V. Weak V	TAZE Fresh AZ AYRIŞMIŞ Siğıhiy W. I QRTA D. AYR, Mod. Weath. ÇOK AYR. Highiy W. Y TÜMÜYLE AYR. Comp. W.	N:0-2 COK YUMUŞAK N:3-4 YUMUŞAK N:5-8 ORTA KATI N:9-15 KATI N:16-30 COK KATI N:>30 SERT	Very Soft Soft Moderately Sliff N: Very Stiff Stiff N: Hard N:	0-4 ÇOK GI 5-10 GEVŞE 11-30 ORTA S 31-50 SIKI >50 ÇOK SI	EVŞEK Va (Lo Ki Ma De (I Ve	y Loose >se iderately Dense nse ry Dense
KAYA KALITESİ TANIMIROD % 0-25 ÇOK ZAYIF Very Poor 1 % 25-50 ZAYIF Poor 1-2 % 50-75 ORTA Fair 2-1 % 75-00 M Good 10 N and conclusion 22 10	KIRIKL AR-30 cm/Fractures SEYREK Wide (M) 2 ORTA Moderate (M) 10 SiK Close (CI) -20 ORTA KOLS Intense (I) 6 PARCALL Chubled (Cr)	%5 РЕКАZ S %5-15 АZ L %15-35 ÇOK N	ORANLAR/Pr lightly ittle fery	oportions %5 PEK %5-20 AZ %20-5 ÇOK	AZ Sligi Litti Very	stiy a
SPT STANDART PENETRASYON TEST Standard Penetration Test D OrseLENNIS NUMUNE DEbuthed & Symphone	ri up örselenamenis n Undisturbed sam K KAROT NUMUNES	IUMUNE Ne I	P PRESIYOM Pressurem VS VEYN DENE	IETRE DENEYI Heter Tost EYI		
			Vane Shea	ar Test	e l	αź
Night Albert Standard Albert Nick Albert N	GRAFIK Graph Great Graph Great Graph Geotechnical Des	الله الله NIMLAMA الله cription الله	PROFIL	ANIMLILIK/Strength I\$MA/Weathering	ROT %(TCR)/T.Core i	OT %(SCR)/S.Core IEK NO./Sample No.
30 12 0 N N N N N N N N N N N N N N N N N N	10 20 30 40 50 60	°		AYR AYR	N KA	S X
58,0	Light pink-gray, mod	lerately e strong		M3	77 76	43
59,0	ANDESITE. The discontinuity su rough and stained.T discontinuity sets ar	rfaces are hree e observed.		M3	100	44
	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			≅ ≋	99	3 45
				≡ §	8 9	2 46
53,0				≅ 8	70	47
34,0 – RC – 35,0 –	Light pink-gray, high Light pink-gray, high Light pink-gray, high Light pink-gray, high Light pink-gray, high ADDESITE	ily ak		- M4	0	48
36,0 — T		÷ ·		- **	2	, 49
57,0				- W4	22	50
59,0	Light pink, moderate weathered, moderat ANDESITE.	e weak		E X	8	51
					· · ·	1 I
	Orhan Öztekin		AKIH / Date	-	İMZA / S	gn

			SON	IDA.	J LC	DGL	J / E	30F	RING	LOG			SONDAJ NO Borehole No	: SK-	5			SA P	YFA age 6/7	
PROJE A)/Project	Name	:	The	New	Ulus	Tun	nel		****	DELÍK ÇAF	1/Hole Dia	meter ;	4 3/4	inc		_			
SONDAJ	/ERÌ/Bori	ng Locatio	n :	Km:	0+86	50					YERALTI S	UYU/Grou	indwater	-						••••••
KILOMET	RE/Chain	age	:	0+86	50						MUH.BOR.	DER./Cas	ing Depth	12.0	D MH	N				
SONDAJ	DER./Bor	ing Depth	:	90 m	3						BAŞBİT.T	ARİHİ/Sta	rt-Finish Date	: 01.0	1.200	8	10.0	1.200	8	
SONDAJ	(OTU/Ele	evation	:								KOORDIN/	T/Coordi	nate(Northing)	:						
SON. MAK	&YÖNT	/D.Rig & M	let. :	Crali	ious I	D500	Rota	ary			KOORDINA	T/Coordi	nate(Easting)	:						
I COK	DAYANIMLI	Strength		1 1	TAZE	A1	raşı	AJW	Fresh		INCE DANELI/Fine Grained IRI DANELI/Coarse Gr						e Grai	ned		
II DAYA	NIMLI	M.Strong M.Weak	,	/ 旧(AZ AYRI ORTA D	işmiş D. ayr.			Slightly W Mod. Weal	th.	N: 3-4 YUMUŞAK Soft N: 5-8 ORTA KATI Moderately Stiff N: 5-10 GEVŞEK N: 5-10 GEVŞEK N: 11-30 ORTA SIKI					5N	Loose	ately D	ense	
V ÇOK	V COK ZAYIF V.Weak V YÜMÜYLE AYR. Comp. W.								N : 3-15 KATI Very Stiff N : 31-50 SKK N : 16-30 COK KATI Stiff N : 31-50 SKK N : >30 SERT Hard N : >50 COK SIKI					Dense Very E	ense					
KAYA K	KAYA KALİTESİ TANIMI/RQD KIRIKLAR-30 cm/Fractures									-	ORANLA	R/Prop	ortions	;						
% 25-50 ZAY	% 25-50 ZAYIF Poor 1-2 ORTA Moderate (M) % 25-50 ZAYIF Poor 1-2 ORTA Moderate (M) % 50-75 ORTA Fair 2-10 SIK Close (Ci)							21)	% 5 PE	(AZ S	lightly .ittle	% 6	i F	EK AZ	s	Slightly				
% 75-90 IVI	% 50-75 OKIA ran % 75-96 M Good 10-20 ÇOK SiKi intense con.100 rOK M Excellent >20 PARÇALI Crushed						Intense (I) Crushed (C	2r)	% 15-35 ÇO	۱	/ery	% 2	10-5 Ç	CK .		Very				
soniti çon	k so-too çok M Excellent 220 PAKUAL Crushed (Cr) SPT STANDART PENETRASYON TESTI UD ÖRGEL Sandard Penetration Test UD ündid D ÖRSELENIdij NUMIUNE K KAROT								ÖRSELENMEM Undisturbed S KAROT NUMUI	iş numune ampla Nesi		P PRE Pre: VS VEY	SIYOMETE ISUremete	IE DENE r Test	iy]	<u> </u>				
	Disi	or and		-						Core dample			Van	e Shear Te	est 	1			5	T
		STANC	Standar	d Pene	stration	n Test						Ê		ft	p 2	Ê	Core		Care	N
ksi (j.	0 V0	DARBE 8 Numb. of	SAYISI Blows			GRAF Grap	≓İK ∙h		JE	OTEKNİK T	ANIMLAMA	Jepth	PROFIL	/Strei	atheri	30	R)T.C		R)/S.(alume
tin Cit	RAB	ĒĒ	Ę	-		·			6	entechniczi D	escription	ILIKVE	Drofil-	רורול	Wee	acture	E %		%(SCI	0
Ind C NDA		- 30 c	- 45	N						Sociol Inical D	cachpton	ERIN	FIONE	ANIN	ISM/	IK/F ₇₈	Ğ,	% 0	ČT.	1
ây ź	5 E C	15 0	8		10 2	0.30	40 50							<u>Là</u>	Ă	Ř	Ā	Ř	¥	ĝ
o o o amhanalaan aa									Pink- (parti AND	brown, highly ly sandy), we ESITE	/ weathered ak			× × × × ×	W4		24	4		5
0									Light weat AND	pink, modera hered,modera ESITE	ately ately weak	75,00		V V E	W3		47	. 11		e
RC						i i								M			8	8		
,0 –					HH	n t	-11		Light	pink, highly	veathered	77,80		4		1	Ľ,			1
RC									AND	ESITE	very weak		Į v v v v	v -	W5		ģ	•		
,0 —								H				78,80		4-	-					ľ
RC													Ĭ, v, v,	√ =	M3		22	8		_ د
이	-				HH	-11	+	님	Pink-	brown, mode	rately		livivi	V	-					1
			-						Weat AND	hered, moder ESITE	rate weak			V. V≡	W3		32	20		5
0														ý—						
														¥ ¥ ¥	ŚŴ		16	9		5
0 - RC									-					¥ ¥	W3	-	47	19		5
ㅋ																				
	ONDÖR	Driller		T	and the second second	sc	NDA	J MÍ	HENDI	SI / Drilling Enc	lineer	7	ARIH / Data		T		47 * *	(e)	0404444900	



SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARIH / Date	İMZA / Sign
·	Orhan Öztekin		
		· · · ·	

	-	so	NDA	IJL	OG	U/	BOI	RING LO	DG			SONDAJ NO Borehole No	: SK-I	6			SA P	YFA age 1 / 4	
PROJE ADI/Proj	ject Name	э :	The	Nev	v Vlu:	s Tu	nnel		W011 - C. Manual - L	DELİK ÇAPI	Hole Dia	meter :	4 3/4	inc					-
SONDAJ YERI/	Boring Lo	cation	: Km	: 0+8	95					YERALTI SL	YU/Grou	ndwater :	-						
KILOMETRE/Ch	ainage		0+8	95						MUH.BOR.D	ER./Cas	ng Depth :	12.00	MH	N				
SONDAJ DER./	Boring De	pth	50 1	m						BAŞBİT.TA	RiHi/Sta	t-Finish Date :	22.01	.200	8 8	26.0	1.200	8	
SONDAJ KOTU	/Elevation	Not	: · ~~~~	lieur	DEO	10-1				KOORDINA	Coordin	ate(Northing)							
DAYANIMLI	LIK/Stren	qth		nous	A	YRIS	MAN	eathering		INCE DA	NELI/Fin/	Grained	1 1		NELIC	Canto	oarse Grained		
I ÇOK DAYANI	MLI St	rong Strong		TAZE AZ AY	DIGMIC			Fresh Slightly W		N:0-2 COK	YUMUŞAK	Very Soft	N : 9-4	çoi	K GEVŞI	K	Very L	pose	weitente
III ORTA	M. W	Weak eak	- iii	ORTA	D. AYR			Mod. Weath, Highly W.		N : 5-8 ORTA N : 9-15 KATI	KATI	Moderately Stiff Very Stiff	N : 5-10 N : 11-3	GEN 0 ORT	/ŞEK Fasiki		Moder	ately D	inse
V ÇOK ZAYIF	V.	Weak		TÜMÜ	YLE AY	R.		Comp. W.		N :16-30 COK KATI N : >30 SERT		Hard	N:31-5 N:>50	ÇO	K SIKI		Very D	ense	
% 9-25 ÇOK ZAYIF	-25 COK ZAYIF Very Poor 50 ZAYIF Poor -55 CRTA Fair -90 [Y] Good				INIKL	48-31	JCM/F	Wide (W)	·····			ORANLAI	R/Propo	rtions					
% 25-50 ZAYIF % 50-75 ORTA % 75-90 M	Po Fa Gi	ior ir ood	1-2 2-1 10-	0 SI -20 Ǣ	RTA K JK SIKI			Moderate (M) Close (Cl) Intense (I)		% 5-15 AZ % 15-35 COK	n∠ a L V	ittle erv	% 5 PEK % 5-20 AZ % 20-5 ÇOM		EKAZ Š Z L SOK V		Slightly Little Very		
% 90-100 ÇCK İYİ SPT	Ex STANDART F Standard Pe	cellent PENETRASY meration Te	ON TEST	1	анçаш			Crushed (Cr) VD	ÖRSELENMEMİŞ Undisturbed San	NUMUNE		P PRES	YOMETR		iyi	*)			NOTION
. a	Standard Peneration Test D ÖRSELENNİŞ NUMUNE Disturbed Sample STANDART PENETI							к	KAROT NUMUNE Core Sample	si	vs		DENEYI Shear Te	st					
I Depth (m) AJ DERINLIĜI JNE CINSI e Type VRA BOYU	STANDART PENETRASYON DENEM STANDART PENETRASYON DENEM Standard Penetration Test DARBE SAVISI GRAFIK DARBE SAVISI GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK GRAFIK							JEO Geo	TEKNİK TA technical De	NIMLAMA	İNEİK/Deptin (m)	PROFIL	MLILIK/Strength	AA/Weathering	racture (30 cm)	F %(TCR)/T.Core R.	9	* %(SCR)/S.Core R.	NO./Sample No.
Boring SOND NUMI Sample MANE	Construction Construction Geotechnical Construction State N 10 20 30 40 50 60 Construction State State N 10 20 30 40 50 60								DER		DAYANI	AYRIŞI	KIRIK/F	KAROI	RQD 9	KAROT	ÖRNEK		
,0	Image: Non-Section 1 Image: No								Τ										
,0								Pink-br weathe	rown, moder ered-highly w	ately eathered,	0,60		× = ×	W3-W4		23	80		1
	_							very we	eak -weak A	NDESITE	3.50		≣	W3-W4		24	0		2
,0			and a particular second -br modera modera ANDES	rown, slightly ately weathe ate strong, jc SITE.	weathered- red, inted	-		=	W2-W3		14	0		3					
,0								The dis limonite Perper observ 3,50-15	scontinuity se ed and roug ndicular cracl ed at the de 5,50 m	irfaces are h. (s are hths between			=	W2-W3		24	9		4
0													=	5W-2W3		32	0		5
,0										=	3 W2-W3		80	7		6			
0				ŀŀ	ŧŀ		HÌ	ł				$ \vee \ \ \ \ \ \ \ \ \ \ \ \ \$	≅	W2-W		100	έ		7
SONDÖ	R / Drille	f			so	DND	AJ M	HENDISI	/ Drilling Engir	eer	T.	ARİH / Date			in	NZA /	Sign		
								Orhan (Öztekin										

SONDA	AJ LOGU / BORING LOG		SONDAJ NO : SI Borehole No	K-6	SAYF Pag 2 /	≂A e '4
PROJE ADI/Project Name : The	e New Ulus Tunnel	DELİK CAPI/Hole Dia	meter · 4.3	3/4 inc	_	********
SONDAJ YERI/Boring Location : Km	n: 0+895	YERALTI SUYU/Grou	indwater : -			
KİLOMETRE/Chainage : 0+8	895	MUH.BOR.DER./Cas	ing Depth : 12	2.00 MHW		
SONDAJ DER./Boring Depth : 50	m	BAŞBİT.TARİHİ/Sta	rt-Finish Date : 22	2.01.2008	26.01.2008	
SONDAJ KO I U/Elevation :	alious D500/Potony	KOORDINAT/Coordin	nate(Northing) :			
DAYANIMLILIK/Strength	AYRIŞMA/Weathering	INCE DANELI/Fin	Grained	IRI DANEL IC	oarea Grainer	4
J ÇOK DAYANIMLI Strong J II DAYANIMLI M.Strong II III DAYANIMLI M.Strong II III ORTA M.Weak III IV ZAYIF Weak P. V ÇOK ZAYIF V.Weak V.	I TAZE Fresh II AZ AYRIŞKNIŞ Sliğhtiy W. III ORTA D. AYR. Mod. Weath. V Y ÇOK AYR. Highly W. V TÜMÜYLE AYR. Comp. W.	N: 0-2 COK YUMUŞAK N: 3-4 YUMUŞAK N: 5-8 ORTA KATI N: 9-15 KATI N: 16-30 COK KATI N: >30 SERT	Very Soft Soft Moderately Stifr Very Stiff Stiff Hard N:	0-4 COK GEVŞE 5-10 GEVŞEK 11-30 ORTA SIKI 31-50 SIKI >50 ÇOK SIKI	K Very Loose Loose Moderately Dense Very Dens	e y Dense ie
KAYA KALITESI TANIMI/RQD % 0-25 COK ZAYIF Very Poor 1 % 25-59 ZAYIF Poor 1 % 50-75 ORTA Fair 2- % 70-75 ORTA Fair 2- % 75-90 M Good 10	KIRIKLAR-30 cm/Fractures 1 SEYNEK Wide (W) -2 ORTA Moderate (M) -10 SIK Close (CI) -0-20 GOK SIKI Intense (I) -02 GOK SIKI Intense (I) -02 PAR-CALL Crushed (Cr)	%5 РЕКАД S %5-15 АД L %15-35 ÇOK \	ORANLAR/Pro lightly ittle	oportions %5 PEK AZ %5-20 AZ %20-5 ÇOK	Slightly Little Very	
X 90-100 COK IYI EXCELENT SPT STANDART PENETRASYON TESI Standard Peneration Tesi D ÖRSELENNIŞ NUMUNE Dicturbed Sample	TI UD ÖRSELENMENISN Undisturbed Samp K KAROT NUMUNES CODE SAMP	UMUNE le	P PRESIYOM Pressurem VS VEYN DENE	ETRE DENEYİ leter Test EYİ		
STANDART PENE Standard Per	ETRASYON DENEYI enetration Test	Ê	Vane Shear		8 8 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	No.
DARBE SAYISI Mumb. of Blows UNITED DARBE SAYISI Numb. of Blows UNITED DARBE SAYISI Numb. of Blows UNITED DARBE SAYISI Numb. of Blows	GRAFIK Graph Geotechnical Des	NIMLAMA	PROFIL Profile	Muluivoren Aweatherin racture (30 c	%(TCR)/T.C	NO./Sample
Boring SOND/ NUMU NUMU NANE Run 15 - 30 30 - 45 30 - 45	10 20 30 40 50 60	DER		AYRISM	KAROT ROD %	ÖRNEK
5,0RC				m2-W3	86 67	8
6,0		weathered		W2-W3	100	9
7,0 - RC 8,0 - RC	moderate strong, joi	ed, nted		m2-W3	62 69	10
9,0	In the discontinuity su I the	faces are		III W2-W3	46 20	11
1,0				W2-W3	22	12
3,0 - RC				W2-W3	47 47	13
4,0 — 5,0 — _{RC}				m W2-W3	50	14
6,0	Pink-brown, slighty moderate weathered weak ANDESITE	weathered- l, moderate		3-W4	0	15
8,0 —	The discontinuity su	rfaces are		W.	.* *	
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engine	er T	ARIH / Date	in	47A / Sign	
	Orhan Öztekin					

			-	SON	IDA.	J LC	GU	/ во	R	ING LOG			SONDAJ NO Borehole No	SK-	6			SA P	YFA age 3/4	
ĺ	PROJE ADI	/Project	Name	:	The	New U	Ulus T	unnel	1		DELİK ÇAPI/	Hole Dia	neter :	4 3/4	inç					
	SONDAJ YE	ERİ/Bor	ing Locatio	n :	Km:	0+89	5				YERALTI SU	YU/Grou	ndwater :	-						
	KILOMETRI	E/Chain	age	:	0+89	5					MUH.BOR.D	ER./Casi	ng Depth :	12.00	MHV	v				
	SONDAJ DI	R./Bor	ing Depth	;	50 m	1					BAŞBIT.TA	RIHI/Star	t-Finish Date :	22.01	1.2008	3	26.0	1.200	8	
	SON. MAK.	YÖNT	/D.Rig & M	et. :	Crall	ious C)500/F	lotary			KOORDINAT	Coordin	ate(Easting) :							
	DAYAN	IMLILIK	Strength				AYR	IŞMAN	Ve	athering	INCE DA	NEL!/Fine	Grained	j	Rİ DA	NELİ/C	Coars	e Grai	ned	
	I ÇOK D. II DAYAN	ayanimli Mili	Strong M.Strong		11	raze Az ayrış	şmiş		1	Fresh Slightly W.	N:0-2 COK N:3-4 YUMU N:5-8 ORTA	YUMUŞAK IŞAK	Very Soft Soft Moderately Stiff	N : 0-4 N : 5-10	Ç0) GEV	GEVŞI ŞEK	ΞK	Very Lo Loose	ose	
	IV ZAYIF V COK ZA	YIF	Weak V.Weak		N Q	ÇOK AYF	R.		ŀ	tighly W.	N:9-15 KATI N:16-30 ÇOKI	GATI	Very Stiff Stiff	N:11-3 N:31-5	0 ORT 0 SIKI	'A SIKI		Moder Dense	itely De	nse
	KAYA KA	LITESI T	ANIMI/RQD		Ľ	KIR	IKLAR	-30 cm	/Fra	actures	N : >30 SERT		ORANLAF	N:>50 /Propo	çor rtions	(SIKI		Very D	ense	
	% 0-25 ÇOK Z % 25-50 ZAYIF	AYIF	Very Poo Poor	ſ	1 1-2	SEY	rek A		N N	Vide (W) Ioderate (M)	% 5 PEK	AZ SI	ghtly	% 5	P	EK AZ	s	lightly		
	% 59-75 ORTA % 75-90 [Y]		Fair Good		2-10	U ÇOK	SIKI		C li	llose (CI) ntense (I)	% 5-15 AZ % 15-35 ÇOK	Li Vi	itle Hy	%5- %2	-20 A) 0-5 Ç	z oк	L 1	.ittle /ery		
	% 99-100 ÇOK İ SP	r sta	Excellent NDART PENET	RASYON	TESTI	FAR	GHLI			UD ÖRSELENMEMİS	KIMUNE		P Poret	/0MET0						
	a	Sta ÖRS Dis	ndard Penerate BELENMİŞ NUN turbed Sample	on Test IUNE			,		Т	Undisturbed Sam K KAROT NUMUNES Core Sample	ple 1	1	Press VS VEYN I Vane	aremeter DENEYİ Shear Te	Test st				. 1	
			STANE	DART P Standard	ENETI d Pene	RASYC stration	DN DEN Test	IEYİ				Ξ		đth		Ê	ore R		Sore R	ġ
	KINLIG ASI	٦,	DARBE S Numb. of	SAYISI Blows		(GRAF!	<		JEOTEKNÍK TA	NIMLAMA	bepth	PROFIL	/Strer	therir	(30 c	З,Т,С		3//S.C	ample
	Type	RAB	e É	H					1	Gentechnical Des	cription	1 IKVC	Drofilo		Wei	acture	ж(To		%(SC	N0./S
	UMUI UMUI	ANEV	- 15 c	- 45	N	10.20	1 20 40				or poor	DERIP	Tome	ANIA	RIŞM	BK/F c	ROT	20%	ROT	NEK
	ăŏ z ö	≥œ	0 2	8					1	and the stream of the stream o				Á	Å	Ϋ́	¥	æ	Å	ŝ
29,									Pink brown clightly	weathered			_	V3-W4		33	0		16	
30,	0 –	_						, i	i.	moderate weathere	d, moderate				Ĺ					
	m					li li			i	The discontinuity s	urfaces are		$\left(\left(
31,	₀_₫								ŀ	rough and stained.			(v,v,v)		M3					
	TI RC								i I				Ů, VŮ, VŮ, V	=	27.		9	ß		17
32,	0								÷											
									!	Pink-brown, modera	itely	32,40	VVVV			1				
33,	0					C II			İ	weathered, very we ANDESITE The spe	ak cimens are		VVVV	- 1	3-W4		4	0		
24						li li			i	crumbling into sand	size		$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	1	>					18
34,						T T				The core surfaces	are		v ^v v ^v v ^v	<u> </u>	2					
35									ļ	Imonited. (Between 35,20-35.	50 m sliahlv			1 -	W3-V		71	0		19
,						li li		i.	ij	weathered and very	weak			=	S		-			
36,						ii ¦ ¦		4.	1		-)		$ \vee \langle \vee \rangle \vee \vee \langle \vee \rangle \vee \langle \vee \rangle \vee \langle \vee \rangle \vee \langle \vee \rangle \vee \langle \vee \vee \rangle \vee \langle \vee \vee \rangle \vee \langle \vee \vee \vee \vee$]	4					
								÷	H]	W3-V		75	8		20
37,	이 클					H	4	-1-	j-			37,00								
	TUT								1	moderate strong Al	ered NDESITE.				12					
38,								1	1	٠				≡	8		100	2		21
		-							ł	Pink-brown moders	iteliv	38,60								
39,	0-10								H	weathered, very we	ak		v ^v v ^v v ^v	1_	-W4		-			
40										The core surfaces a	nd		v~v~v	1	Ň					22
40,									Ì	siscontinuity surface stained(limonitied)	es are			1		1				
41	₀_릛								4	(\ <u>``</u> v <u>`</u> v`	1						
,													\v`,v`,v`,	1_	-W4		6	5		
42.						i l i			i	Pink-brown, modera	itely		lv,`v,`v,] _	W3-		3.	Ť		23
	TITI								i I	weathered, very we ANDESITE	ak		vvv`v`							
٢	۱ د م	NDČC	10-00					1 • 1	• 1		ŕ	1	1 \ / · \ / · \ / ·	1	I 	1				
	SONDÖR / Driller						201	IDAJ N	UN	Orben Örtekin	eer	т.	ARIH / Date			ir	NZA)	Sign		

	SOND PROJE ADI/Project Name : T					٦Ľ	OGI	JT	во	R	RING LOG	-		SONDAJ NO Borehole No	SK-	6			S/ F	YFA 'age 4/4	
PRO	JE ADI/	Project	Name	:	The	New	/ Ulu:	: Tui	nnel			DELİK ÇAPI/	lole Dia	meter :	4 3/4	inç					
SON	DAJ YE	Rİ/Bori	ing Location	n :	Km:	: 0+8	95					YERALTI SU	YU/Grou	ndwater :	•						
KİLO	METRE	/Chain	age	:	0+89) 5						MUH.BOR.D	ER./Casi	ng Depth :	12.00	мнл	N				
SON		R./Bor	ing Depth	:	50 n	n						BAŞBİT.TA	RiHi/Sta	t-Finish Date :	22.01	1.200	8	26.0	1.200	8	
SON	MAK.&	YÖNT	/D.Rig & M	• et. :	Cral	ious	D500	Roi	tarv			KOORDINAT	Coordin	ate(Nonthing) :							
-	DAYAN	IMLILIK	/Strength				A	YRIŞ	MAN	Vea	athering	INCE DA	NEL!/Fine	Grained		RI DA	NELİK	Coars	e Gra	ned	
	ÇOK DA DAYANI I ORTA ZAYIF ÇOK ZAY	YANIMLI ALI YIF	Strong M.Strong M.Weak Weak V.Weak		I II IV V	TAZE AZ AYF ORTA ÇOK A TÜMÜ	RIŞMIŞ D. AYR YR. YLE AY	R.) am (F F C	Fresh Slightly W. Mod. Weath. Highly W. Comp. W.	N:9-2 ÇOKY N:3-4 YUMU N:5-8 ORTA N:9-15 KATI N:16-30 ÇOKK N:>30 ŞERT	umuşak Şak Katı Ati	Very Soft Soft Moderately Stiff Very Stiff Stiff Hard	N : 0-4 N : 5-10 N : 11-3 N : 31-5 N : >50	ÇON GEN 10 OR1 10 SIKI ÇON	(gevşi /şek (A siki (siki	EK	Very L Loose Moder Dense Very I	oose ately D kense	ense
% 0-2 % 25-5 % 50-7 % 75-5	5 ÇOK ZA Ø ZAYIF 5 ORTA 10 IYI	AYIF	Very Paos Poor Fair Good	r	1 1-2 2-11 10-1 >20	SE OF) Sil 20 ÇC) P/	YREK RTA K K SIKI IRÇALI	11-00	7 6117	W N C II C	Wide (W) Maderate (M) Elose (Ci) Intense (I) Enushed (Cr)	% 5 PEK A % 5-75 AZ % 16-35 ÇOK	z Si Li V	URANLAH Ightiy ttle ery	% 5 % 5- % 2	-20 A 9-5 Ç	EK AZ Z		llightly Little Very		
% 90-10	SPT	STA Sta	NDART PENETR ndard Peneralio	ASYON n Test	TEST					_	UD ÖRSELENMEMİŞ Undisturbed Sar	NUMUNE 1ple		P PRES Press	YOMETR	E DENE	iYl			<u> </u>	
	0	ÖRS Dis	ELENMİŞ NUMI turbed Sample	UNE			54n Januaria				K KAROT NUMUNE Core Sample	si		VS VEYN I Vane	DENEYİ Shcar Te	st	,				
ath (m) DERİNLİĞİ	cinsi pe	N BOYU	STAND S DARBE S Numb. of	ART P tandard AYISI Blows	ENET d Pen	RAS	ON D on Tes GRA Gra	ENE' t FİK ph	Yİ	_	JEOTEKNIK TA	NIMLAMA	K/Depth (m)	PROFIL	LIK/Strength	Veathering	ure (30 cm)	TCR)/T.Core R.		SCR)/S.Core R.	./Sample No.
Boring Del SONDAJ (NUMUNE Sample Ty	MANEVR/ Run	0 - 15 cm. 15 - 30 cm	30 - 45 cm	N	10 :	20 30	40 5	50 60	,	Geotechnical De	scription	DERÍNLI	Profile	DAYANIML	AYRIŞMAV	KIRIK/Fract	KAROT %(RQD %	KAROT %(ÓRNEK NO
43,0 — 44,0 —	RC										The core surfaces siscontinuity surfac stained(limonitied)	and es are			-	W3-W4		41	0		24
45,0	RC										Pink, slightly weath ,moderate strong A	ered NDESITE.	45,00			W2		89	33		25
47,0 —	RC										Pink, moderately weathered,weak A	NDESITE	46,30		-	W3-W4					26
48,0 —								1			Pink, slightly weath moderate strong A	ered, NDESITE	47,30		≡	W2		54	41		
49,0 —	RC										Pink-brown, sligthly moderately strong ANDESITE.The joi are rough, partly st	weathered, hts surfaces ained.	48,50		=	W2		83	72		27
0,0						ļļ					The end of borehol	e .	50,00				1				
51,0 —								1 1 1 1					•								
52,0 —																					
53,0 —																					
54,0 —																					
55,0 -						1															
56,0 —																					
57,0=	SONDÖR / Driller				1					1			<u> </u>		L	I	L				
	SUNDOR / Dimei							-1ND,	MJ IV		Orhan Öztekin	ieef	T.	ARIH / Date			in.	MZA ,	Sigr	1	
L																					

				SON	IDA	JL	OGI	1	BO	RI	 NG LOG			SONDAJ NO Borehole No	: SK-	7			SA P	YFA age 1/3	
PRO	E AD⊮	Projec	t Name	:	The	New	/ Ulus	s Tu	nnel			DELÍK CAPI	/Hole Dia	umeter ·	4 3/4	inc					
SON	AJ YE	Ri/Bor	ing Locati	on :	Km:	0+9	65/Ri	ght	tube			YERALTI SU	JYU/Gro	indwater :		nıç					
KIL.OF	IETRË	/Chair	age	:	0+96	65		-				MUH.BOR.D	ER./Cas	ing Depth :	12.00	MH	v				
SON	AJ DE	R./Bor	ing Depth	:	35 n	n						BAŞBİT.TA	RÍHÍ/Sta	rt-Finish Date :	25.0	1.200	3	29.0	1.200	8	
SON	DAJ KO	TU/El	evation	:								KOORDINA	T/Coordi	nate(Northing)						•••••	
SON.	MAK.&	YÖNT	./D.Rig &	Met. :	Crai	ious	D500)/Ro	tary			KOORDINA	T/Coordi	nate(Easting)							
	COK DA	MLILIP	Strength			TAZE	A	YRIŞ	şmajw	/eath Fre	sh	INCE D. N: 0-2 COK	ANELI/Fin YUMUSAK	e Grained		IRI DA	NELÍK	Coars	e Grai	ned	
	DAYANI	ALI	M.Stro M.Wea	ng k	11 . 11	AZ AYI ORTA	rişmiş D. Ayr			Slig Mo	ghtly W. d. Weath	N:3-4 ÝUM N:5-8 ORT	JŞAK X KATI	Soft Moderately Stiff	N:5-10 N:5-10	GEN GEN	(GEVŞ ŞEK A SIKI	EK	Loose	ately De	ense
v	ÇOK ZAY	1F	Weak V.Weal	<u>،</u>	v	çok a Tûmû	YR. YLE AY	R.		Higi Cor	hly W. mp. W.	N :16-30 COK	KATI	Stiff Hard	N:31-5 N:>50	50 SIK	(SIKI		Dense Very D	ense	
KA	YA KAL	ITES 1	ANIMI/RQI)		к	RIKL	4R-3	0 cm/f	Frac	tures			ORANLA	R/Prope	ortions					
% 0-2 % 25-5	5 çok ZA Di Zayıf	YIF	Very P Poor	000	1	SE	YREK			Mod	e (W) Jerate (M)	%5 PEK	AZ S	lightly	% 5	F	EK AZ	1	Slightly		
% 50-7 % 75-9	S ORTA DÎYÎ		Fair Good		10-2	20 ÇC	K SIKI			Inte	inse (l)	% 5-15 AZ % 15-35 ÇOK		_ittre /ery	% 5- % 2	-20 A 10-5 Ç	z ox		Little Very		
% 98-10	COK IV	STA	Excelle NDART PENE	nt TRASYON	TEST		RÇALI			Cru	UD ÖDERI FAMERALE				L						
	D	Sta ÖR Dis	ndard Penera SELENMİŞ NL turbed Samp i	tion Test MUNE P						1	Undisturbed San Undisturbed San K KARDT NUMUNE Core Sample	ple sl		P PRES Press VS VEYN Vane	DENEY Shear Te	E DENE r Test ist					
aring Depth (m) DNDAJ DERİNLİĞİ	Standard DARBE SAVISI NUMUNE CINE NUMUNE C				N N	RAS) etratic	(ON D on Tes GRA Gra	ENE FİK ph	50 60		JEOTEKNİK TA Geotechnical Des	NIMLAMA	DERİNLİK/Depth (m)	PROFIL Profile	/ANIMLiLik/Strength	RIŞMA/Weathering	RK/Fracture (30 cm)	ROT %(TCR)/T.Core R.	2D %	ROT %(SCR)/S.Core R.	NEK NO./Sample No.
1 0 0	< %	Σœ		8				-10 0		_					Á	¥	Ā	ž	æ	Ž.	ğ
0,0							11			1	ASPHALT		0,10	$(\land \Diamond D \lor)$	~						
1,0	22 22										Brown, completely sandy(0,10-1,50 m	weathered) ,clayey						58	0		1
2,0		ñ									COLLUVIUM	y						8	0		2
3,0		ů											3,00		=	W3		3	•		
5,0 —			-								Brownish pink, moo weathered, modera	lerately te weak			<u></u>		-	_			
6,0 —		RC								-	The discontinuity su rough and stained.	Irfaces are			, ≡ ,	W5 W		35	0		4
7,0 -		Q.						- L. - L.			Perpendicular cracl observed	(s are			ý						5
8,0									- 0	Clayey, sandy very ANDESITE at depti 5,50 m	weak ns of 6,00-				5			Ĵ			
,0	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2						-	•				· ·	W3		73	41		6			
3,0		RC													=	ev .	-	5	0		7
4,0 —					ili	t:	÷H	-				$[\wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge, \wedge$	"] ≡	ŝ		8	8		8		
	SONDÖR / Driller						SC	ONC	AJ M	ÜHI	ENDİSİ / Drilling Engir Orhan Öztekin	ieer	1	ARIH / Date			i	MZA .	/ Sign		
L																l					

	SONDAJ LOGU / BORING LOG SONDAJ LOGU / BORING LOG PROJE ADI/Project Name The New Ulus Tunnel DELIK ÇAPI/Hole Diameter									SONDAJ NO Borehole No	sk-	7			S/ P	YFA age 2/3						
Pf	ROJE ADI/	Projec	t Name	مىمىيىس :	Th	e Ne	w Uli	us T	unnel		<u> </u>	DELİK Ç	API/H	ole Dia	neter :	4 3/4	inc			ana dan bab		
s	ONDAJ YE	Rİ/Bor	ing Locati	on :	Km	1: 0+	965/F	Righ	t tube			YERALT	I SUY	U/Grou	ndwater :	-						
к	LOMETRE	/Chair	age	:	0+9	65						MUH.BO	R.DE	R./Casi	ng Depth :	12.00	MHV	v				
S	ONDAJ DE	R./Bor	ing Depth	:	35	m						BAŞBİT	T.TAR	İHİ/Star	t-Finish Date :	25.01	.200	3	29.0	1.200	18	
50	DNDAJ KU	YÖNT	/D Rin &	: Met. :	Cre	liou		10/P	otany			KOORDI	NAT/C	Coordin	ate(Northing) :						····	
	DAYAN	MLILIP	(/Strength		T			AYR	IŞMA/V	Veat	thering	INCI	E DAN	ELI/Fine	Grained]	RI DA	NELI/C	oars	e Grai	ned	
	I ÇOK DA	YANIMLI	Strong M.Stro	ng	1	TAZ AZ J	e Yrişmi	ş		Fr	esh lightiy W.	N:0-2 N:3-4	ÇOK YU YUMUŞA	MUŞAK	Very Soft Soft	N:0-4	çol	GEVŞI	к	Very L	nose	
	III ORTA IV ZAYIF		M.Wea Weak	k	N N	OR1	A D. AY	′R.		M Hij	od. Weath. ghly W.	N:9-15 N:16-30	ORTA K KATI COK KA'	ATI Ti	Noderately Stiff Very Stiff Stiff	N : 11-3 N : 31-5	9 ORT	A SIKI		Moder	ately D	ense
┢	KAYA KAL	ITESI T	ANIMI/RQI	<u>,</u>	+	TUN	KIRIK	AYR.	-30 cm/	C: Fra	omp. W.	N:>30	SERT		Hard	N : >50	ÇO	(SIK)	0- 4	Very D	ense	
	6 0-25 ÇOK Z	AYIF	Very P Poor	oor	1	, :	SEYREN	c		Wi	de (W) aderate (M)	%5	PEK AZ	ŝi	ghtiy	% 5	ruons P	FK A7		linhtly		
%	50-75 ORTA		Fair		2-	10 1	SIK ÇOK SIP	ต		Clo	tense (I)	% 5-15	AZ	Li	ttle	% 5-	20 A	Z		.ittle		
%	10-109 ÇOK İY	1	Excelle	nt	>2	20	PARÇAL	.1		Cr	ushed (Cr)	76 10-30 5	yuk	v	iry	76 Z	J-5 Ç		,	/егу		
	5P1 D	Sta ÖR: Dis	ndard Penera SELENMIS NU turbed Sampl	tion Test	N 1231						UD ÖRSELENMEMIŞ Undisturbed San K KAROT NUMUNE Core Sample	NUMUNE ple sl			P PRESh Press VS VEYN E Vane S	'OMETR remeter ENEY] Shear Te	E DENE Test st	Y				
			STAN	IDART P	PENE	TRA	SYON	DEN	iEYİ]	_					Ъ		é K	d
	- E	Þ	DARBE	SAYIS		1	GR	AFil	<	┥			1Δ	th Th	PROFIL	rengt	ering	0 cT	1,C ₀		ŝ	ple N
ti Li	CING	BO	Numb.	of Blows	s	+	Gr	aph		┦	0201210110		<i>"</i> (KDe	1 KOTIL	LIK/S	Veath	nre (3	TCR)		SCR)	//Sam
De	NUNE NUNE	EVR	5 cm. 30 cm	45 cm	N						Geotechnical De	scription		RİNLİ	Profile	IMIN	MAN	/Fract	DT %(%	0T %(N N
Borir	SON Samp	MAN Run	15-0	ŝ		10) 20 3	0 40	50 60					В		AYA	YR	ARIK	KARC	ROD	KARC	SRNE
45.0	ПШ																ĸ					
10,0	$5,0 \xrightarrow{a}$											<u> </u>	~			-		9				
16.0		х Х				H					Brownish pink, mod weathered, modera	lerately te weak			$\left(\begin{array}{c} v \\ v \\ v \\ \end{array} \right) v \\ \end{array}$	=	¥3		8	63		10
10,0	INIT										ANDESITE.		1		ŰvŰvŰv							
17.0							ЦĻ	i li			The discontinuity se	Infaces are	e		Ů, v, v, v	{						
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	7111	ų	ĺ								stained and rough.				Ů, v., v., v	-	ę					
18.0							i li	. i		Perpendicular craci	(s are			Ů, v, v, v	=	5		ъ Г	8		11	
	1111					H					opserved				Ů, v, v, v	{						
19,0					1	ļ			- i - i		14,50-15,20 m clay	ey, sandy			Ů, vů vů v							
											Very weak ANDEDI				Ů, v, v, v, v	ł						
20,0						÷	1 								Ů, v, v, v							
		R				Į.										=	8		47	14		12
21,0						+									vvvvvv		-					12
						1		li							VVVVV	1						
22,0		<u> </u>													VVVVV	<u> </u>						
		SS													$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	=	W3		83	24		13
23,0						f					Clayey, sandy, very	weak			$\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{$							
	TTT I	8				ł					ANDESITE observe	d at the			$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	≡	Ŵ		100	100		14
24,0						1					depails of 20,00-20,	50 m			$\vee^{\vee}\vee^{\vee}\vee^{\vee}$							
						1									$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	≡	ŝ					
25,0		ßC				Ì									$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	1			7	4		15
	1111	-			1										$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	1	% 2		2	e		
26,0	l l														$\vee^{\vee}\vee^{\vee}\vee^{\vee}$		[
07 C	TIT														$\vee^{\vee}\vee^{\vee}\vee^{\vee}$		-			_		
27,0							間								$\vee^{\vee}\vee^{\vee}\vee^{\vee}$							
<u></u>		2													$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	=	W3		69	47		16
28,0							間		ttt	1					$\vee^{\vee}\vee^{\vee}\vee^{\vee}$	1						
-		IDÖD	(Deller		•	1	· · · · ·						ا 			·····						!
-	SONDÖR / Driller							NON	DAJ M	UH	IENUISI / Drilling Engli	leer		T/	ARIH / Date			ÌN	NZA /	Sign		
											Ornan Oztekin											

PROJE ACIRPGIC Name The New Ulus Truncit DELIK CAPVHole Dammatr 4.34 inc GONDAV TERRItoring Location Kin: 0+4897(bpt tube YERALI SUV/ACIGURANTE - - GONDAV TERRItoring Location Kin: 0+4897(bpt tube YERALI SUV/ACIGURANTE - - GONDAV TERRItoring Die H 35 m EAS-5017 AMERISSING Supplic Suppl		-		-	, S	ON	DA	JL	oG	ະບຸ	вс	DR	RING LOG			SONDAJ NO Borehole No	SK-	7			S/ F	YFA 'age 3/3	
SONDAL YER/Romg Location Kno: 0+986 MMI-180 PER/Casing Depth 1 2.00 MINW KLOMETER/Charlong 55 m DA3_30T_TAREH/Start-Finish Data 2.801.2008 28.01.2008 SONDAL KOTLER-Infolm : KCOREDNATCoordinateRing Info.041126 2.801.2008 28.01.2008 SONDAL KOTLER-Infolm : KCOREDNATCoordinateRing Info.041126 2.801.2008 28.01.2008 SONDALKOTLER-INFORM : Castor KCOREDNATCoordinateRing Info.041126 Costores Generation SOND MAX-SOTLER-INFORM : Castores Castores Castores Generation I Costores : : Sontanda : <td>PRO</td> <td>JE ADI/</td> <td>Projec</td> <td>t Name</td> <td>÷</td> <td>:</td> <td>The</td> <td>Nev</td> <td>v Ulu</td> <td>IS T</td> <td>unne</td> <td>I</td> <td>tin and the second second second second second second second second second second second second second second s</td> <td>DELİK ÇAPI/H</td> <td>ole Dia</td> <td>meter :</td> <td>4 3/4</td> <td>inç</td> <td></td> <td></td> <td></td> <td></td> <td></td>	PRO	JE ADI/	Projec	t Name	÷	:	The	Nev	v Ulu	IS T	unne	I	tin and the second second second second second second second second second second second second second second s	DELİK ÇAPI/H	ole Dia	meter :	4 3/4	inç					
KILCARE TREEChainage : 0+85 MULH SOR DER Acting Dayh : 12.00 MWW SONADA KOTUELevolon : 36 m AAs-517 TAbilishar-Finikasharatashar-Finikas	SON	DAJ YE	Rİ/Bor	ing Lo	cation	:	Km:	0+9	65/F	tigh	t tub	е		YERALTI SUY	U/Grou	ndwater :	-						
CONDUCTOR S5 m EAS-BIT. TARHISTORIAL Flink Date: 25 0.000 in 72.0000 in 72.0000 in 72.000 in 72.000 in 72.0000 in 72.000 in 72.0000	KİLO	METRE	/Chair	nage		:	0+96	35						MUH.BOR.DE	R./Casi	ng Depth :	12.00	MH	V				
SONDA KO UZLEWRING Cralicus De00/Retary KOORDNAT/Coordinate(Sking) DAYANNELLIKGErregit 142 ONALLIKGErregit 142 ONALLIKGERregit 142 ONALLIKGERregit 143 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKGERregit 144 ONALLIKERREGIT 144 ONALLIKERREGIT 144 00 144 00 144 00 144 00 144 00 144 00 144 00 144 00 144 <td< td=""><td>SON</td><td>DAJ DE</td><td>R./Bor</td><td>ring De</td><td>pth</td><td>:</td><td>35 n</td><td>n</td><td>-</td><td></td><td></td><td></td><td></td><td>BAŞBİT.TAF</td><td>dHi/Sta</td><td>t-Finish Date :</td><td>25.01</td><td>1.200</td><td>8</td><td>29.0</td><td>1.200</td><td>8</td><td></td></td<>	SON	DAJ DE	R./Bor	ring De	pth	:	35 n	n	-					BAŞBİT.TAF	dHi/Sta	t-Finish Date :	25.01	1.200	8	29.0	1.200	8	
Scher, Monkes Touring Johnson Charlos Jobusto Portugi America Charlos Jobusto Portugi America RCURRANT Constrained Tourisment America It IDANALLICentry of the Constrained Portugi America It IDANALLICentry of the Constrained Portugi America It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) It IDANALLICENT (Constrained) IDANALLICENT (Constrained) <thidanallicent (Constrained) IDANALLICENT</thidanallicent 	SON	DAJKO	TU/EI	evation	1 	:	0					_		KOORDINAT/	Coordin	ate(Northing)							
Image: second	5014	DAYAN	MINI	UStrend	th Ne		Crai	ious	050	AVR	OTARY	Ma	athoring	KOORDINAT/	Coordin	ate(Easting) :				-			-
Is at a water water Is at a water water Is at a water water Is at a water wa		COK DA	YANIMLI	St	rong		1	TAZE			guire.	-	Fresh	N:0-2 COKYL	MUŞAK	Very Soft	N : 9-4	COL	NELI/C	Coars	e Gra Verv 1	ned	
V GWZANE V Wake V Wak		II DAYANIA III ORTA	AL1	M. M.	Strong Weak		8	AZ AY ORTA	D. AY	ş R.		1	Slightly W. Mod. Weath.	N: 5-8 ORTAN N: 5-8 ORTAN	ak Ati	Soft Moderately Stiff Very Stiff	N:5-10 N:11-3	GEN IN DRI	IŞEK A SIKI		Loose	ately D	ense
K4-24 ACALTESI TAMUNGO IRRIVAR-38 centratures ORALLARIPOPTION % 5-3 COLL % 5-3 COLL % 5-0 COLL % 7-0 COLL		/ ÇOK ZAY	1F	V.1	Weak		v	TÜMÜ	IYLE A	YR.			Comp, W.	N :16-30 COK KA N :>36 SERT	m	Stiff Hard	N:31-5 N:>50	ia siki CO)	(SIKE		Denso Very D	епзе	
15.55 COUNTY Variation Varia	K/	AYA KAL	ITESI T	ANIMI	RQD			K	IRIK	LAR-	30 cm	νFr	ractures			ORANLA	R/Propo	rtions		·			
Is best of the second process and the second procese procesecond proces and the second process and the second proc	% 0-3	25 çok 27 59 zayıf	YIP	Po	er Paor		1-2	SE	RTA			Ň	Wide (W) Moderate (M)	% 5 PEK AZ	s	ightiy	% 5	P	EK AZ	5	lightly		
s. betwork Control Call Control <t< td=""><td>% 50- % 75-</td><td>75 ORTA 98 IYI</td><td></td><td>Fa Gi</td><td>ir eod</td><td></td><td>2-10</td><td>) SI</td><td>K DK SIM</td><td>a</td><td></td><td>1</td><td>Clase (Cl) Intense (l)</td><td>% 5-15 AZ % 15-35 COK</td><td>v</td><td>iltie erv</td><td>% 5- % 2</td><td>-20 A 9-5 C</td><td>Z OK</td><td>1</td><td>little derv</td><td></td><td></td></t<>	% 50- % 75-	75 ORTA 98 IYI		Fa Gi	ir eod		2-10) SI	K DK SIM	a		1	Clase (Cl) Intense (l)	% 5-15 AZ % 15-35 COK	v	iltie erv	% 5- % 2	-20 A 9-5 C	Z OK	1	little derv		
D Description D Description D Description Performance Performance 0 <	% 90-10	OC ÇOK İY	074	Ex	cellent	NAVE	>20	P)	RÇAL				Crushed (Cr)			-							
Image: Standard Production Text Jean Standard Production Text Jean Standard Production Text Jean Standard Production Text Image: Standard Production Text Standard Production Text JEOTEKNIK TANIMLAMA Image: Standard Production Text Image: Standard Production Text Jean Standard Production Text Image: Standard Production Text JEOTEKNIK TANIMLAMA Image: Standard Production Text Jean Standard Production Text Jean Standard Production Text Image: Standard Production Text JEOTEKNIK TANIMLAMA Image: Standard Production Text Jean Standard Production Text Jean Standard Production Text Jean Standard Production Text Image: Standard Production Text JEOTEKNIK TANIMLAMA Image: Standard Production Text Jean Standard Production Text Jean Standard Production Text Jean Standard Production Text Image: Standard Production Text JEOTEKNIK TANIMLAMA Image: Standard Production Text Jean Standard Production Text Jean Standard Production Text Jean Standard Production Text Image: Standard Production Text JEOTEKNIK TANIMLAMA Image: Standard Production Text Jean Standard Production Text Jean Standard Production Text Jean Standard Production Text Image: Standard Production Text Jean Standard Production Text <t< td=""><td></td><td>SPT D</td><td>Sta</td><td>indard Pe</td><td>neration S NUMP</td><td>Test</td><td>, c9 (I</td><td></td><td></td><td></td><td></td><td></td><td>UD ÖRSELENMEMİŞ Undisturbed Sar</td><td>NUMUNE iple</td><td></td><td>P PRES</td><td>YOMETR</td><td>E DENE Test</td><td>M</td><td></td><td></td><td></td><td></td></t<>		SPT D	Sta	indard Pe	neration S NUMP	Test	, c9 (I						UD ÖRSELENMEMİŞ Undisturbed Sar	NUMUNE iple		P PRES	YOMETR	E DENE Test	M				
Image: State of the s		,	Dis	turbed S	9 NUMU ample	(vi.2							n KAROT NUMUNE Core Sample	\$1		VS VEYN Vane	DENEYİ Shaar Te	st					
Big Standard remains inst JEOTEKNIK TANIMLAMA PROFIL Big				s	TANDA	RTP	ENET	RAS	YON	DEN	EYİ						-			R.		ک	á
Image: Section of Blows Section of Blows	jū		~		Sta	andaro	Pen	etrati	on le	ACIV		4			Ē		ength	ing.	c ^m)	Core		Con	N N
add ar egy with a given and given and given and a given and a given and a given and	(C)	INS .	УQ	Nun	nb. of E	lows			Gr	aph		\downarrow	JEOTEKNIK TA	NIMLAMA	Dept	PROFIL	4St	athe	e (30	R)T		SR)/S	amp
Image: Structure of the st	C BB	NE C	/RA E	Ë	Ë	Ë							Geotechnical De	scription	R I	Profile	LEI .	AWe	actur	%ПС		%(SC	\$/O
ask if if is it i	ning (IMU	μ N N N N	15 0	-30	- 45	Ν							o o njo u o n	Ê	1 tonie	ANIN	lŞM.	KIFn	QT.	% 0	QT	剄
$\begin{array}{c c} 9,0 \\ \hline \\ 0,0 \\ \hline \\ 1,0 \\ \hline \\ 2,0 \\ \hline \\ 3,0 \\ \hline \\ 3,0 \\ \hline \\ 6,0 \\ \hline \\ 7,0 \\ \hline \\ 1,0 \\ \hline \\ 1,0 \\ \hline \\ 1,0 \\ \hline \\ 1,0 \\ \hline \\ 1,0 \\ \hline \\ 1,0 \\ \hline \\ 1,0 \\ \hline \\ 1,0 \\ \hline \\ \hline \\ \\ \hline \\ \hline \\ \hline \\ \hline \\ \hline \\ \hline \\ \hline $	89	ž ēg	₹ø.	i	92	8		10.	20.3	0 40	50 6	"					λ	AγF	R	KAI	ß	KA	ŐR
	$\begin{array}{c} 0, \\ 0, \\ 0, \\ 0, \\ 0, \\ 0, \\ 0, \\ 0, $		RCRC										Browniah pink, mod weathered, modern The discontinuity si stained and rough observed Clayey, sandy, ven ANDESITE observ depths of 31,50-32 33,00-33,50 m End Of Borehole	lerately te weak urfaces are cs are weak dat the 00 m and	35,00			W3 W5 W3 W5 W3 W3		41 3S 51	8 17 20		17
	.0 _							ļ	Ш														
	-																			•			

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		
	I		

			-	S	SON	DA	J L	OG	U/	во	RII	NG L	OG			**********		SONDAJ NO Borehole No	sĸ-	8			SA P	YFA age 1/3	
PRO.	JE ADI/	Project	t Name		:	The	Nev	v Ulu	s Tu	innel				T	DELİK CAPI	/Hole D	ian	neter	4 3/4	inc					
SONI	DAJ YE	Rl/Bor	ing Loc	ation	:	Km	: 0+9	65/L	eft t	ube					YERALTI SU	JYU/Gr	hur	ndwater :	-						
KİLO	METRE	/Chain	age		:	0+9	65								MUH.BOR.D	ER./Ca	sir	ng Depth :	12.00	MHV	v	• •••			
SON	DAJ DE	R./Bor	ing Dep	oth	:	40 r	n								BAŞBİT.T/	ARIHI/S	arl	-Finish Date :	25.01	.2008	3 8	29.0	1.200	8	
SON	DAJ KC	TU/Ek	evation		:										KOORDINA	T/Coord	ina	ate(Northing) :							
SON.	MAK.&	YONT	./D.Rig	& Me	st. :	Cra	lious	: D50	J/Ro	otary	land.			_	KOORDINA	T/Coord	ina	ate(Easting) :	~~~~~					-	
	COK DA	YANIMLI	Streng	ong		1	TAZE	<i>μ</i>	- TAIS	ŞMAQV	Fre	esh			N : 0-2 COK	YUMUŞAP	ne	Very Soft	N · 0.4	RI DA	NELI/C	Coars	e Grai	ned	
	DAYANI ORTA	ALI	M.S M.V	itrong Veak		0	AZ AY	rişmiş D. Ayf	L.		Sii Mo	ightly W. od. Weath.			N:3-4 YUM N:5-8 ORT	JŞAK A KATI		Soft Moderately Stiff Very Stiff	N : 5-10 N : 11-3	GEV 0 ORT	'ŞEK 'A SIKI	-n	Loose	ately D	ense
v	ÇOK ZAY	nF	V.W	leak		v	TOMO	IYR. IYLE AY	'n.		Hig Ce	aniy w. smp. W.			N :16-30 COK N : >30 SERT	KATI		Stiff Hard	N : 31-5 N : >50	0 SIKI ÇOP	(SIKI		Dense Very D	ense	
KA N 0.2	YA KAL	ITES T	ANIMIR	QD		-	K		AR-3	30 cm/	Frac	tures		\rightarrow				ORANLAR	Propo	rtions					
% 25-5	0 ZAYIF		Paa	91004 HT		1-2	. Ol	RTA			Mon	derate (M)			%5 PEK	AZ	Slig	ghtiy	% 5	P	EK AZ	s	lightly		
% 75-9	e M		Go	od		10-	20 ÇC	DK SIKI			Inte	ense (l) sched (Cr)			% 15-35 ÇOK		Ve	ry	% 2	20 A. 8-5 Ç	с oк	1	Jittle Very		
% 90-10	0 ÇOKIY SPT	STA	Exe NDART PE	ellent ENETR/	ASYON	TEST	·		-			UD	ÖRSELENME	MİS N	IMINE			P PPEO	OMET P	C DENG	ad a				
J	p	Sta ÖRS Dis	ndard Pen SELENMİŞ turbeci Saı İ	neration NUMU mple	NE							к	Undisturbed KAROT NUM Core Sample	Samp UNES	le			Pressi VS VEYN E Vane S	remoter ENEY) hear Te	Test					
Liği		5	ST DAR	ANDA Sta	ART PI andarc	ENET I Pen	RAS etratio	YON E on Tes GR/	ENE it	EYİ		IEO	TEKNIK	TAN		t) (J)		PROFIL	rength	aring	0 cm)	T.Core R.		S.Core R.	ple No.
Depth (m AJ DERIN	INE CINS Type	VRA BOY	Num	ib, of E	Blows			Gra	ph		+	Geo	technical I	Desc	cription	NLİK/Dep		Profile	WLLIKVS	AWeath	racture (3	«(TCR)/		%(SCR)	NO./Sam
Boring SOND/	NUML Sample	MANE	0 - 15	15 - 30	30 - 45	N	10	20 30	40	50 60						DER			DAYANII	AYRIŞN	KIRIK	KAROT	RQD %	KAROT	ÖRNEK
0,0	22						Π		E	ET						1	-	() Via	· · ·	<u> </u>					[
	Rc Rc							ili	H													2			1
1,0 -								n r	Т									$(\overline{})$							
												Pink-bi	rown, clay	ey, :	sandy,										
2,0		22						i i	Ï.	ΠÌ		DIOCKY	COLLOVI									4			2
	RC RC							111	H																
3,0 -							11	Î	TŤ.		-												_		
		ъ В							Ľ													8	0		
4,0 -							1	1 1	H																3
~ ^ ¹			1					11										N A C							
5,0 <u> </u>		ъ К																A A A A				4			
							1		ł.																4
0,0 <u> </u>			1						1							6,00									
70		ĥ						i li	1										≡	2-W3		6	9		
/,0 <u> </u>																				8					5
¹			1					i li	li							÷				-					
o,o		0					H	III				Pink, s modera	lightly we ately weat	athe bere	ered-					\$					
<u>م</u> م		ec .							i	i i	1	modera	ate strong	AN	IDESITE				≡	W2-1		8	4		6
3,0									T		•	The dis	scontinuity	sur	faces are			V V V V							
		0						ili	i			rough	and staine	d(li	monited).			V V V V		8					
5,0		α,							1									\vee \vee \vee \vee \vee	=	1-24		2	8		7
10		Ŋ							j.									\vee \vee \vee \vee \vee \vee		N3	1				
		Ľ							Ľ										=	¥2-		\ ق	4		8
o								Ш																	
1		γ,																V V V V	_	W3			5		9
3,0 —		_					Li.	ļļ.	L.										~	W2.			۳		
4,0													5	2-W3		87	67		10						
	SONDÖR / Driller SONDAJ MÜHENDİSİ / Drilling					/ Drilling En	gine	ег		TA	RİH / Date			in	170	Sign									
							<u> </u>					Orhan	Öztekin	-									Gign		
L							<u></u>																		

	SONE)AJ LOGU / BOF	RING LOG			SONDAJ NO Borehole No	SK-	3			SA Pa	YFA age 2/3	
PROJE ADI/Project	t Name : T	he New Ulus Tunnel	*****	DELİK ÇAPI/H	lole Dia	neter :	4 3/4	inç		+	-,		
SONDAJ YERI/Bo	ring Location : K	(m: 0+965/Left tube		YERALTI SUY	/U/Grou	ndwater :	-						
KILOMETRE/Chai	nage : O	+965		MUH.BOR.DE	R./Casi	ng Depth :	12.00	MHV	V				
SONDAJ DER./Bo	ring Depth : 4	0 m		BAŞBİT.TAF	RiHi/Star	t-Finish Date :	25.01	.2008		29.0	.200	8	
SON MAK &YONT		ratious D500/Rotary		KOORDINAT/	Coordin	ate(Nortning) : ate(Easting)							—
DAYANIMLILI	K/Strength	AYRIŞMA/We	eathering	INCE DAM	NELİ/Fine	Grained	j	RÍ DAI	NELI/C	oarse	Grain	ied	
I ÇOK DAYANIML II DAYANIMLI IB ORTA IV ZAYIF V ÇOK ZAYIF	strong M.Strong M.Weak Weak V.Weak V.Weak	I TAZE II AZ AYRIŞMIŞ III ORTA D. AYR. IV ÇOK AYR. V TÜMÜYLE AYR.	Fresh Slightly W. Mod. Weath. Highly W. Comp. W.	N : 0-2 COK YU N : 3-4 YUMUŞ N : 5-8 ORTA Y N : 9-15 KATI N : 16-30 COK KA N : >30 SERT	umuşak Sak Katı Atı	Very Soft Soft Moderately Stiff Very Stiff Stiff Hard	N:0-4 N:5-10 N:11-3 N:31-5 N:>50	ÇOK GEV 0 ORT 0 SIKI ÇOK	GEVŞE ŞEK A SIKI SIKI	ж	Very Lo Loose Modera Dense Very Dr	ose Itely De Inse	inse
KAYA KALITESI % 0-25 COK ZAYIF % 25-50 ZAYIF % 50-75 ORTA % 75-90 IVI	TANIMI/RQD Very Poor Poor Fair Good	KIRIKLAR-30 cm/Fi 1 SEYREK 1-2 ORTA 2-19 SIK 10-20 ÇOK SIKI	ractures Wide (W) Moderate (M) Close (Cl) Intense (I)	% 5 PEK A2 % 5-15 AZ % 15-35 ÇOK	z SI Li Vi	ORANLAR Ightly Ittle	/Propo % 5 % 5- % 20	rtions P 20 A 0-5 Ç	ek az z ok	Si L V	lightly ittle 'ery		_
% 98-105 ÇOK İYİ SPT ST.	Excellent ANDART PENETRASYON TE	>20 PARÇALI ESTÎ	Crushed (Cr)	VI BALIME		P pprel	OMETR	-			-		
St D ÖF Di	andard Peneration Test ISELENMIS NUMUNE sturbed Sample		K KAROT NUMUNES Core Sample	ple st	1	V\$ VEYN I V\$ VEYN I Vane	ITEMETR ITEMETER DENEYI Shear Te	a DENE Test st	м Г			<u> </u>	
ing Depth (m) NDAJ DERINLIĜI MUNE CINSI mple Type NEVRA BOYU n	STANDART PEE Standard F DARBE SAYISI Numb. of Blows E 5 5 9 8 4	NETRASYON DENEYI Penetration Test GRAFIK Graph	JEOTEKNİK TA Geotechnical Des	NIMLAMA	ERINLİK/Depth (m)	PROFÌL Profile	ANIMLILIK/Strength	UŞMAWeathering	K/Fracture (30 cm)	ROT %(TCR)/T.Core F	. % QI	ROT %(SCR)/S.Core F	VEK NO./Sample No.
Bor NIL MA Ru Ru	30 15 0-	10 20 30 40 50 60					DAY	AYR	В В	KA	ß	Ř	ŌŖ
15,0			Pink, slightly weath moderately weather moderate strong Al	ered- ed, NDESITE urfaces are				N3 N3		-			
17,0	-		rough and stained(limonited).	17,00		=	W24		9	35		11
18,0 - 22 19,0							=	W2-W3		51	40		12
20,0	-		Pink-dark brown(17 m) moderately weat moderate weak AN	,00-21,50 hered, IDESITE.				14					
21,0			Yellow-light pink, m weathered-highly w	oderately eahered			-	W3-M		53	13		13
22,0							-	W3-W4	-	78	99		14
24,0							-	/3-W4		50	31		15
26,0 _	-		Pink slightly wast	vered				5					
27,0 – 1 2 28,0 – 1 – –			moderate strong A The discontinuity su rough and stained(NDESITE Infaces are limonited).	28.00		-	W3-W4	-	92	79		16
			Pink-gray (28,00-35	i,50m)	1.0,00								
SONDÖF	R / Driller	SONDAJ M	ÜHENDİSİ / Drilling Engir	neer	T	ARİH / Date	0.64		Ìľ	NZA /	Sign		
			Orhan Öztekin								-		

			S	ON	DA.	JLOGU	J/B	OF	RING LOG			SONDAJ NO Borehole No	: SK-	8			S/ F	YFA Page 3/3	
h	PROJE A	Ol/Projec	t Name	:	The	New Ulus	Tunn	el		DELİK ÇAPI/	tole Dia	meter ;	4 3/4	inc			~~~~		
	SONDAJ	YERI/Bo	ing Location	:	Km:	0+965/Let	't tube	2		YERALTI SU	/U/Grou	ndwater :	-	,					
T	KILOMET	RE/Chai	nage	:	0+96	15				MUH.BOR.D	R/Cas	ing Depth :	12.00	MH	N				
3	SONDAJ	DER./Bo	ring Depth	:	40 m	ı				BAŞBİT.TA	RİHİ/Sta	rt-Finish Date :	25.0	1.200	8 8	29.0	01.200	08	
3	SONDAJ	KOTU/E	evation	:						KOORDINAT	Coordin	ate(Northing)							
1	SON. MA	K.&YÖNT	./D.Rig & Me	ł. :	Crali	ious D500	Rotar	ry		KOORDINAT	Coordin	ate(Easting)							
L	DA	YANIMLILII	(/Strength			A)	RISMA	A/We	eathering	ÍNCE DA	NELİ/Fine	e Grained		Rİ DA	NELİA	Coars	e Gra	ined	
	I ÇOI II DAY III OR' IV ZAY V ÇOP	k dayanımlı Yanımlı TA 1F K ZAYIF	Strong M.Strong M.Weak Weak V.Weak		1 A 1 A 1 A 1 A 1 A 1 A 1 A 1 A 1 A 1 A	IAZE AZ AYRIŞMIŞ ORTA D. AYR. ÇOK AYR. TÜMÜYLE AYF	<u>.</u>		Fresh Silghtly W. Mod. Weath. Highly W. Comp. W.	N:8-2 COKY N:3-4 YUMU N:5-8 ORTA N:8-15 KATI N:16-30 COKK	umuşak Şak Katı Atı	Very Soft Soft Moderately Stiff Very Stiff Stiff	N : 0-4 N : 5-10 N : 11-3 N : 31-5	ÇO GE IO OR IO SIKI	K GEVŞ /ŞEK FA SIKI	EK	Very L Loose Moder Dense	oose ately D)ense
t	KAYA I	KALİTESİ	ANIMI/RQD			KIRIKLA	R-30 c	m/Fi	ractures	N:230 SERT		ORANLA	R/Prope	rtions	K SIKI		very	Pense	
,	% 0-25 CC % 25-50 ZA % 50-75 OF % 75-90 1/1 % 90-100 CO	DK ZAYIF YIF RTA 	Very Poor Poor Fair Good Excellent		1 1-2 2-10 10-2 >20	SEYREK ORTA SIK QCK SIKI PARÇALI			Wids (W) Moderate (M) Close (Cl) Intense (I) Crushed (Cr)	%5 PEKA %5-15 AZ %15-35 ÇOK	z Si Li V	ightly ittle ery	% 5 % 5- % 2	F -20 A 0-5 C	'EK AZ Z COK	1	Slightly Little Very		
		SPT ST/ Sti D ÖR Dis	NDART PENETRA Indard Peneration SELENMİŞ NUMU furbed Sample	ASYON I Test NE	TESTI				UD ÖRSELENMEMİŞ Undisturbed Sam K KAROT NUMUNE: Core Sample	UMUNE ple N		P PRES Press VS VEYN Vane	YOMETR uremeter DENEY Shear Te	E DENG Test	EYİ	•••••			
ſ			STANDA	RTPE	ENET	RASYON DE	NEYİ	1			1		1			nż		œ	<u> </u>
	(m) RiNLIĜI NSI	ovu	DARBE S/ Numb. of E	andard AYISt Blows	l Pene	etration Test GRAF Grap	iK h		JEOTEKNÍK TA	NIMLAMA	lepth (m)	PROFIL	/Strength	thering	(30 cm)	R)/T.Core		R)/S.Core	ample No
	Boring Depth SONDAJ DEI NUMUNE CI	sample Type MANEVRA B Run	0 - 15 cm. 15 - 30 cm.	30 - 45 cm.	N	10 20 30	10 50 (60	Geotechnical Des	cription	DERINLIK	Profile	VANIMLILIK	rRişMAWe:	RIK/Fracture	AROT %(TC	20D %	AROT %(SC	SI'ON YENS
С)	<u> </u>					ii:		weathered ,very we	ak		 v ^v v ^v v [`]	<u>1</u> ≞	× ×		× ×	-	¥	17
c) malman	Sc							ANDESITE]	9-W4		91	35		
-		-	-]	5	-				18
2)	RC							-				-	W3-W4	_	64	09		19
) 0	undanuda.	ßC							Yellow (35,50-37,60 moderately weather	m) ed-highly			-	W3-W4		38	48		20
		22							ANDESITE	4K	-		1	/3-W4		8	4		21
)) Internet								Light gray, slighly w moderate strong AN	eathered, IDESITE	37,60		/ .	5		6	4		
D	, muluu	ß							very weak Andesite observed between 3 m.	was 19,00-39,40				× ×		83	65		22
0) 1111111	-							End Of Borehole		40,00		1 =	6M3					
0	uhumu																		
~	- -						111	111			1		1		í I		1 (1

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARIH / Date	İMZA / Sign
	Orhan Öztekin		
			1

APPENDIX D

The core photographs















