STATE OF NEVADA

DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

GEOTECHNICAL SECTION

GEOTECHNICAL REPORT

US 95 AT DURANGO DRIVE INTERCHANGE

LAS VEGAS

JULY 2000

E.A. 72411

CLARK COUNTY, NEVADA

Prepared by: ________________________________

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INTRODUCTION

General

This report has been prepared to characterize the subsurface soil conditions of the site and to provide geotechnical design criteria for the proposed structure. The new interchange will be built to ease the flow of traffic to and from the new housing development near Durango Drive to Las Vegas. At present, there is a two-way stop sign with the majority of traffic making a left turn onto US 95 southbound. As the housing development increases in size, the traffic is expected to increase.

Purpose and Scope

The purpose of this report is to provide information regarding the subsurface soil conditions at the proposed project location. In addition, this report provides geotechnical design and construction recommendations including the construction of a new bridge structure and retaining walls. The scope of this report consists primarily of investigation and analysis. The investigation included recent subsurface explorations, soil sampling, and analysis of field and laboratory testing data. This report describes the subsurface soil conditions, provides recommendations regarding geotechnical properties of the soil strata, and includes boring logs and summaries of test results from the field investigation.

GEOLOGY AND SEISMICITY

Geology

The site is founded in alluvium (Q_{oa})[1] deposited on the Kyle Canyon alluvial fan originating from the Spring Mountains. The Spring Mountains are within the limestone and dolostone belt of southern and eastern Nevada as shown in Figure B1. The alluvial fan deposits are pink to brown sand, gravel, and cobble size material, and are unconsolidated to locally cemented due to petrocalcic carbonate deposits (caliche). Clasts are predominately limestone and dolostone with subordinate quartzite. Sand size sediment is mainly limestone and dolomite with subordinate quartz and feldspar. Detrital gypsum occurs locally, and is an important component in these deposits. There are also active wash alluvium deposits (typically veneers) throughout the area, which is subject to flooding.

Seismicity

The site is located approximately 25 kilometers east of the La Madre fault and 10 kilometers east of the Keystone Thrust[3]. These faults are no longer considered active. The Las Vegas Valley Shear Zone lies approximately 10 kilometers northeast of the site[3] and is currently active. Other local active faults include the Frenchman Mountain Fault, the Whitney Mesa Fault, the Cashman Fault, the Valley View Fault, the Decatur Fault, the Eglington Fault, and the West Charleston Fault[4], as shown in Figure B2 map of Las Vegas Valley quaternary faults. The most prominent fault in the Las Vegas Valley is the Frenchman Mountain Fault which is capable of producing a magnitude 7 earthquake every 10,000 to 50,000 years[4]. Other faults capable of causing earthquakes could occur outside the Las Vegas Valley with strong enough ground shaking to cause damage within the valley, such as the Furnace Creek Fault in Death Valley, some 145 kilometers northwest of Las Vegas.

The site area has subsided approximately 50 mm between 1963 and 1980, probably due to dewatering[2]. See Figure B3 for a map of quaternary faults, subsidence contours, and mapped fissures related to subsidence.

The recommended effective peak acceleration coefficient is 0.15g based on a 10% probability of exceedance in 50 years (AASHTO). See Figure B4 for a map of peak acceleration contours for Nevada and California. The AASHTO ATC-6 response spectra with Type II soil is recommended. A graph with three Response Spectra curves are shown in Figure B5 including AASHTO using 0.15g Peak Ground Acceleration. The other two curves, for comparison only, are the UBC for Zone 2B and USGS using 0.1048g based on the USGS National Seismic Hazard Mapping Project.

PROJECT DESCRIPTION

Site Description

US 95 is a four lane freeway north of Las Vegas, and is oriented in a north-west to south-east direction. North Durango Drive is presently a two lane road with stop signs crossing US 95. A site map for the project is presented as Map A1 in Appendix A. A new housing development is being built to the east of the intersection resulting in a large expected increase in traffic through the intersection.

Project

The project consists of constructing an interchange to improve access to the southbound lanes of US 95 for traffic leaving the residential area located north east of the interchange. The westbound traffic on Durango Drive will be able to cross over the freeway and turn left onto the southbound on-ramp. In addition, the project includes the construction of water retention basins and improved drainage channels for control of surface water runoff.

RECOMMENDATIONS

Abutments and Piers

Based on our field investigation and laboratory testing, various foundation systems were evaluated to support the structures. The soil at the site consists of medium to very dense sandy gravel with lesser amounts of silt and clay. The site conditions indicate that the in situ soils are competent to support the proposed structures on either spread footings or drilled shafts. We recommend using spread footings for both abutments and piers. The recommended bearing capacity for the abutment footings is 192 kPa. Design soil parameters for the abutment walls are provided in Table 1. Allowable and ultimate bearing pressures as functions of footing width, settlement, and embedment length are provided in Graphs 1 through 4 for pier footings founded in native soils. Settlements are expected to occur immediately after loads are applied to the foundations. It is our recommendation that the foundation at each support be designed similar to each other, so as to minimize any differential settlement. Also, similar foundation systems will have similar responses in seismic events.

All excavations shall be performed in accordance with the NDOT "Standard Specifications for Road and Bridge Construction." All permanent slopes should be constructed to lie at a maximum of 2:1 (horizontal to vertical). It is the responsibility of the contractor to provide all necessary shorings. Caliche zones, cobbles, and/or boulders may be encountered during excavation. This may cause difficulties at any depth in the excavation of pier, retaining wall, and sound wall spread footings.

Retaining Walls

Allowable and ultimate bearing pressures are functions of footing width, settlement, and embedment length and is provided in Graph 5 for the strip footing. Estimates for construction excavation should be made on the basis of using temporary 1:1 (horizontal to vertical) slopes. Recommended design parameters for the retaining walls are presented in Table 1. The horizontal and vertical Acceleration Coefficients (A_h) and (A_v), Importance Classification (IC), Seismic Performance Factor (SPC), Soil Profile Type, and Site Coefficient (S), were all obtained using AASHTO Standard Specifications for Highway Bridges, Division 1-A, Section 3. Earth pressure coefficients (K_a, K_p, K_{ae}, and K_{pe}) were calculated using various methods.

Shrinkage Factor

The excavated materials from the proposed detention basins are acceptable for use as embankment fills. This is based on the R-value test results, as shown on Page 50, from soils taken at the site. We recommend the use of a 10% shrinkage factor for the reduction in volume of soils due to transport and compaction.

Sound Wall

Given the loading conditions provided by NDOT Bridge Division (memo from Nat Mangoba, dated March 31, 2000), 1.83 meter square spread footings are recommended to support the wall pillisters. This is based on an analysis of bearing capacity, sliding, and overturning of an eccentrically loaded square footing. The loads used in the analysis were a vertical dead load of 196.26 kN and a wind load of 193.05 kN applied at the center of a wall pillister with a height of 4.27 meters.

FIELD INVESTIGATION

The Nevada Department of Transportation (NDOT) Geotechnical Section conducted a subsurface investigation at the proposed project site approximately one year ago. Subsurface soil conditions were explored by drilling four boreholes (DURLV1 through DURLV4) to a maximum depth of 21.2 meters. The approximate locations of the boreholes are shown on Map A2 in Appendix A. Surface elevations were obtained for the borehole locations by surveying from known elevations. Drilling was accomplished using a Mobile B-80 drill rig with bentonite drilling slurry for wet drilling. Disturbed soil samples were obtained with a California Modified Split Spoon Sampler (CMS). Modified standard penetration resistance values were obtained using the CMS Sampler, based on the Standard Penetration Test (SPT) procedure (ASTM T 206-87). Uncorrected (for overburden, hammer drop system, and sampler type) blowcounts are shown in the boring logs in Appendix C. All samples were transported to the NDOT materials laboratory for testing and/or storage. All soil samples were classified using the Unified Soil Classification System (USCS). More detailed information from the soil samples is included in the boring logs, and in the test result summary sheets. Copies of the boring logs and a boring log key are presented in Appendix C; summaries of test results are in Appendix D.

LABORATORY ANALYSIS

Laboratory tests were conducted on the samples collected from the 4 boreholes. The testing program consisted of sieve and hydrometer analysis, Atterberg limits, moisture contents, and chemical analysis. Plasticity Indices (PI) obtained from testing ranged from 3 to 22, and moisture contents varied from 3.9% to 13.0%. Percent fines (less than 75 μm sieve) ranged from 7.8 to 28.3. Unit weight, direct shear, and consolidation tests were not conducted due to the disturbance of the samples, and the inability of samples to retain their shape to be placed into the testing molds. Further information is presented in the summaries of test results in Appendix D.

DISCUSSION

Borings from the subsurface investigation identified the soils to be primarily silty gravel with sand and clayey gravel with sand. There were two major layers of subsurface stratification that was apparent from the set of four borings. The contact between the two layers was at different elevations in each borehole, indicating that the layers were inclined or that the contact was not planar. Conservative design parameters have been determined by using the weakest soil strengths in calculations. The soil is very dense and contains many cobbles, as was seen on the wall of a back hoe trench (Photos 1 and 2) located approximately 30 meters south east of the interchange. The presence of boulders and caliche may occur during excavation. The presence of cobbles and possibly boulders was determined by observing the many rock fragments obtained during drilling, and several zones where the auger had difficulty in drilling into the hard soil. The presence of caliche was determined from the nature of the depositional environment of the soil (alluvial fan originating from a large mountain range composed of limestone and dolostone) and from the difficult drilling zones. Very few samples were obtained due to the refusal of the sampler to penetrate the soil during many of the SPT tests conducted in hard soil.

REFERENCES

1. United States Geological Survey "NW Las Vegas", 7 Minute (1:24,000) Quadrangle Geologic Map (Map 3Dg, 1987), Nevada Bureau of Mines and Geology (Matti, Bachhuber, Morton, Bell).

2. "Subsidence in Las Vegas Valley: Nevada Bureau of Mines and Geology" Bulletin 95, Bell, J. W. (1981).

3. United States Geological Survey "Tectonic Map of Clark County, Nevada" Bulletin 62 Plate 5, Nevada Bureau of Mines and Geology.

4. Las Vegas Review Journal article, "Valley Faults Capable of Healthy Jolt," Keith Rogers interview with Craig dePolo, research geologist with the Nevada Bureau of Mines and Geology, and Geologist Burt Slemmons, a member of the Nevada Earthquake Safety Council and professor emeritus at the University of Nevada, Reno (April 11, 1999).

Photo 1. Open trench at the Durango Interchange site showing rock size and stratification.

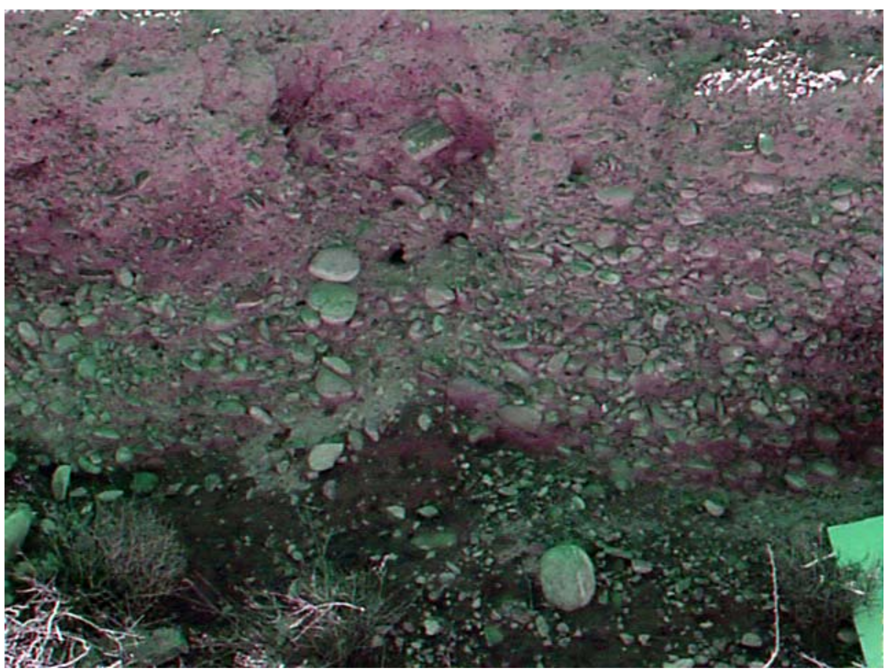


Photo 2. Alternative view of the same trench.

Table 1. Recommended Design Soil Parameters for Retaining Walls.

COEFFICIENTS	RETAINING WALL (Not Supporting Any Structures)		INTEGRAL ABUTMENT WALLS
	0^{O} BACKSLOPE	2H:1V BACKSLOPE	
K_O (At Rest Earth Pressure*)	0.47	0.47	0.47
K_a (Active Earth Pressure**)	0.30	0.56	0.30
K_p (Passive Earth Pressure**)	6.00	6.00	6.00
K_v (Design Vertical Acceleration)	0.00	0.00	0.00
K_h (Design Horizontal Acceleration)	0.15	0.15	0.15
K_{ae} (Dynamic Active Earth Pressure[+])	0.38	0.95	- [1]
K_{pe} (Dynamic Passive Earth Pressure[+])	5.49	5.49	- [1]
Base Friction for Sliding	0.32	0.32	-

Friction Angle of Embankment Soil = 32^{O}

Friction Angle of Foundation Soil = 40^{O}

* Coulomb

** Caquot and Kerisel (1948), NAVFAC (1982); use $K_{p(Design)} = K_p/1.5$

[+] Mononobe Okabe

K_p and K_{pe} = 0 for depths of less than 0.9 meters

[1] See the discussion on maximum pressure distribution and limiting effective stresses in soil behind the abutment wall (Lam and Martin, 1986).

Table 1. Notes.

For the total earth pressure (active and passive) behind an integral abutment during earthquake loading, FHWA (Lam and Martin, 1986) recommends using the sum of the following three components:

1. The static pressure due to gravity loads,

   $F_o = 1/2\ K_o \gamma_1 H^2$ Applied at 1/3 H from the wall bottom

2. The pressure induced due to displacement of the wall into the embankment backfill by bridge inertial loading,

   $F_1 = 0.425 E_s \delta_1$ Applied at 0.37H from the wall bottom

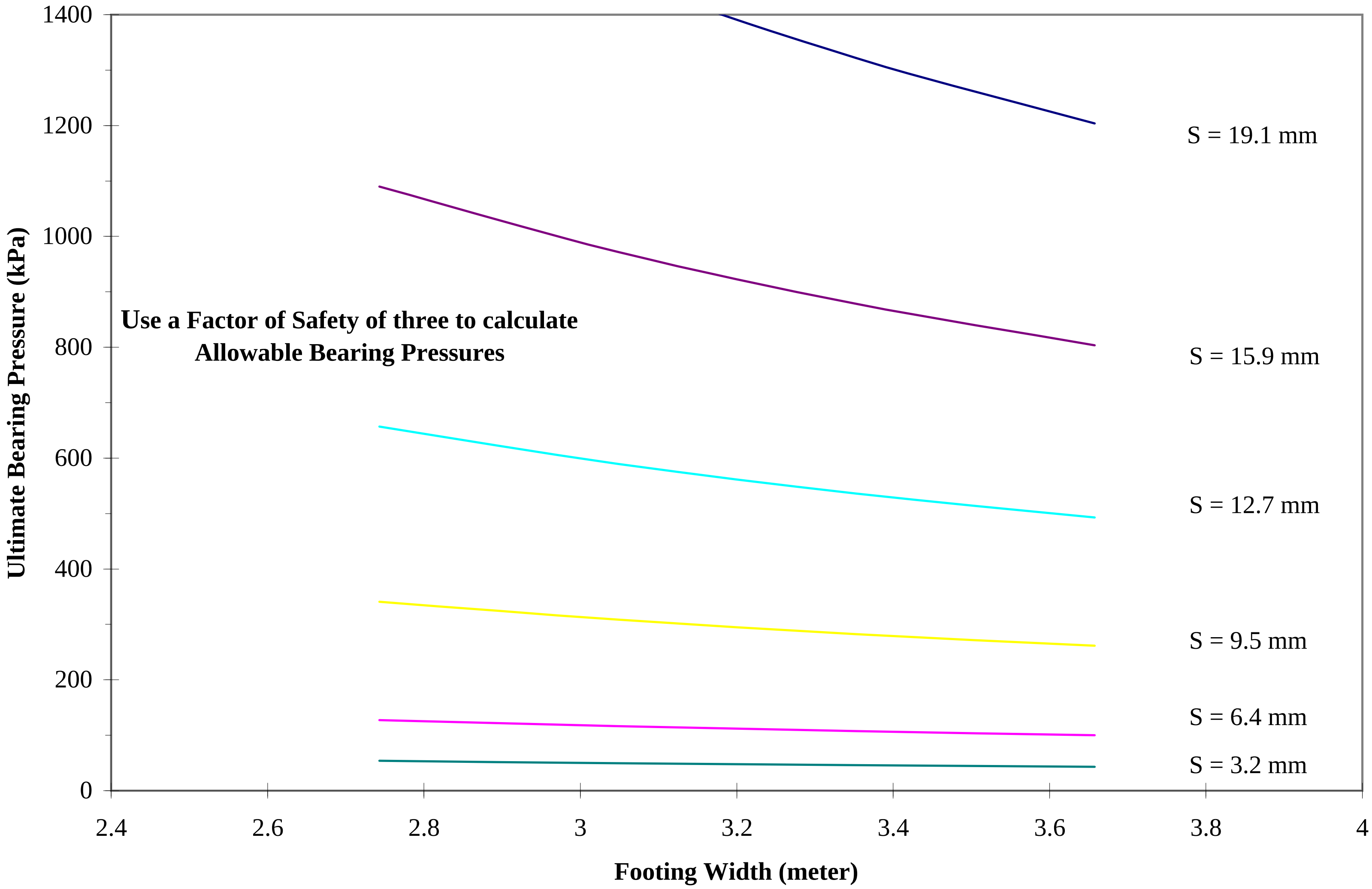
3. Additional earthquake induced dynamic pressures arising from the earthquake response of the backfill itself and its interaction with the abutment wall,

   $F_2 = 0.12\ E_s \delta_2$ Applied at 0.6H from the wall bottom

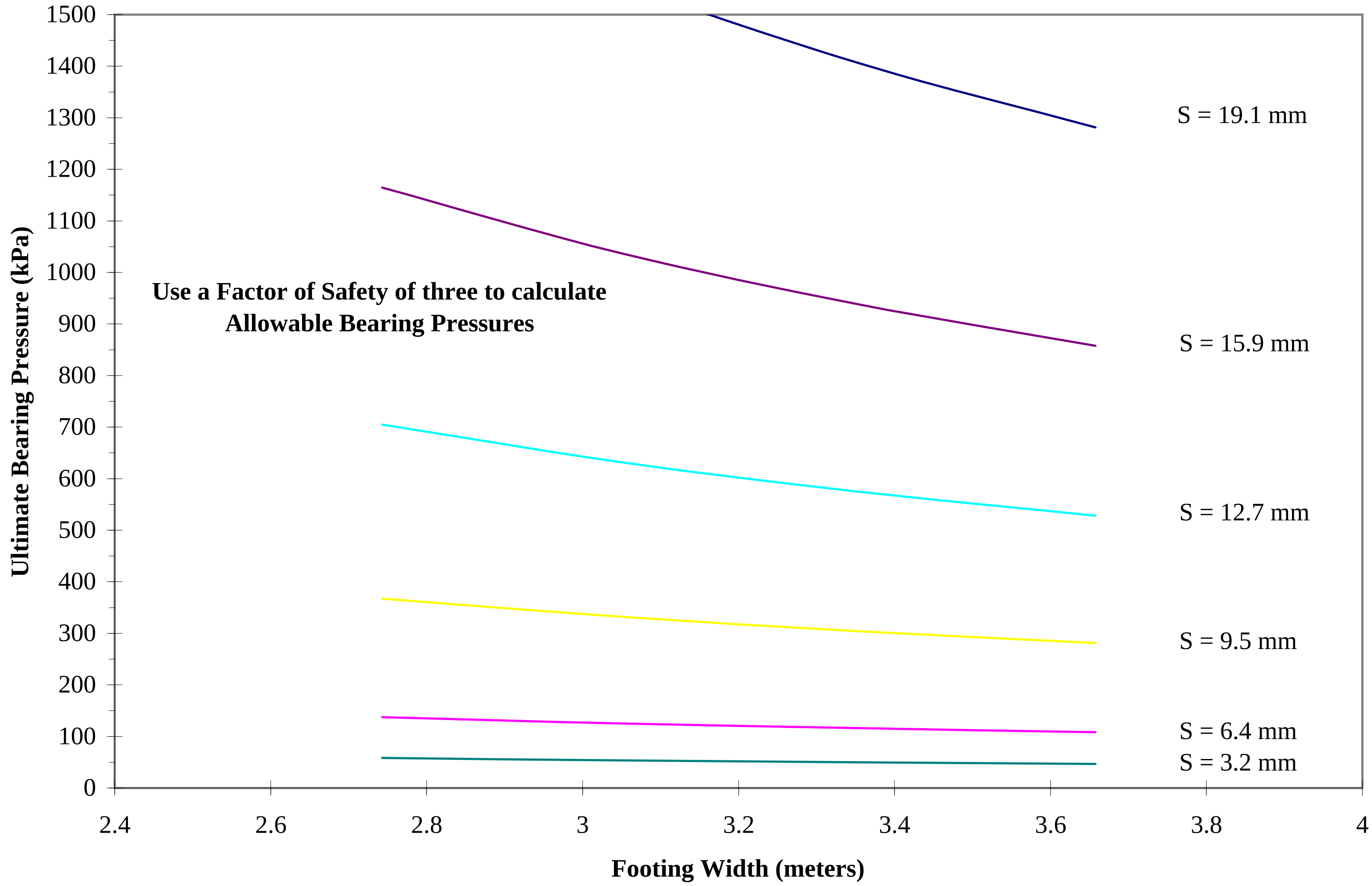
where K_o is the at-rest earth pressure coefficient, H is the abutment wall height, γ_1 (18.85 kN/m^3) is the embankment unit weight, δ_1 is the lateral translational displacement of the abutment wall, δ_2 is the rotational displacement at the top of the abutment wall, and E_s is Young's modulus for the embankment backfill. A value of 69 MPa may be used for E_s.

Abutment forces are considered excessive if the effective stress in the embankment backfill behind the abutment exceeds 369 kPa during earthquake loading. When superstructure inertia forces are transmitted directly to the embankment backfill by the integral abutment wall, adequate passive resistance must be able to restrict the displacements to a maximum of 0.1 meter.

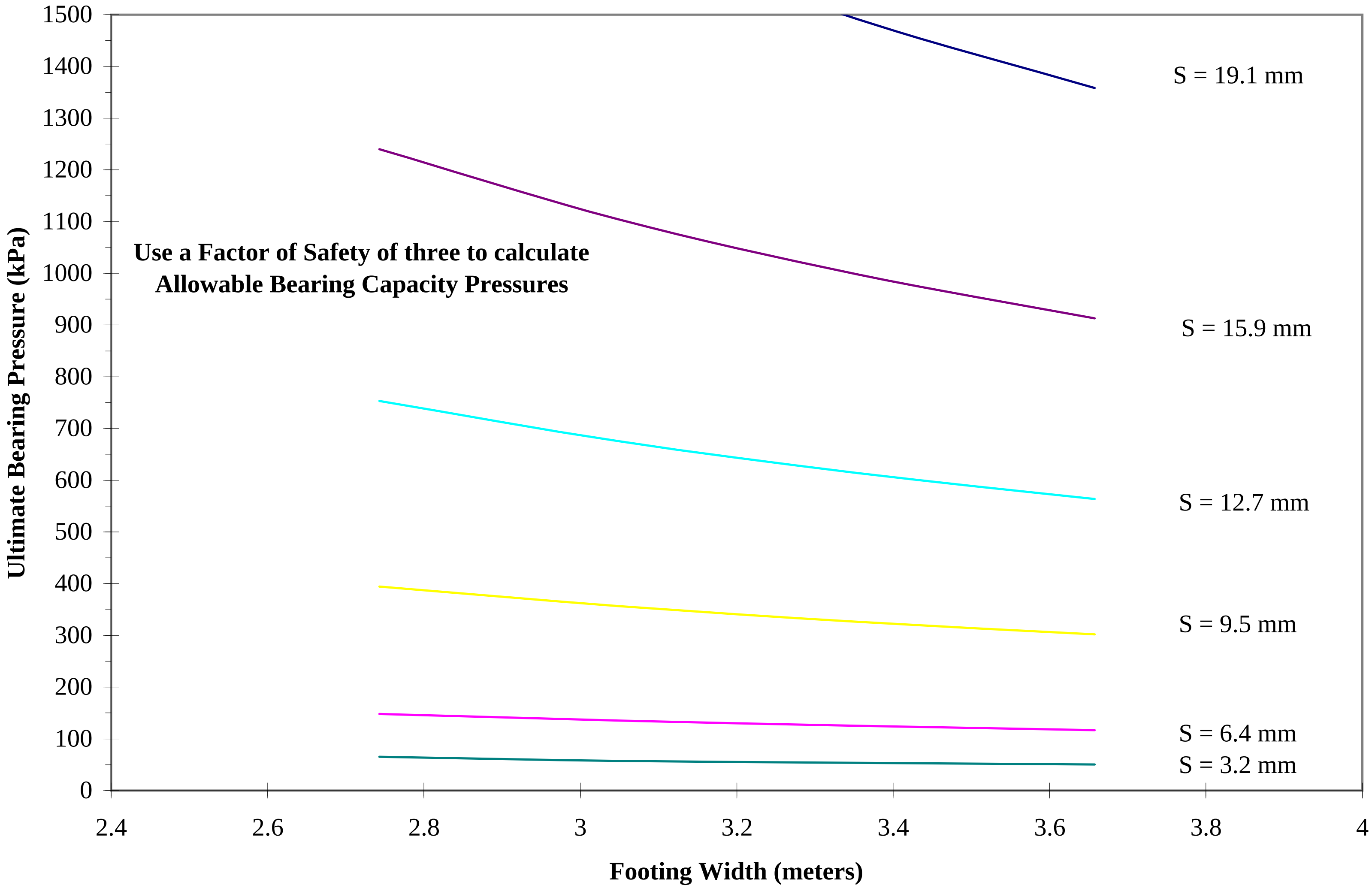
Graph 1. Settlement, S, for 1.22 meter Embedment, Square Footings



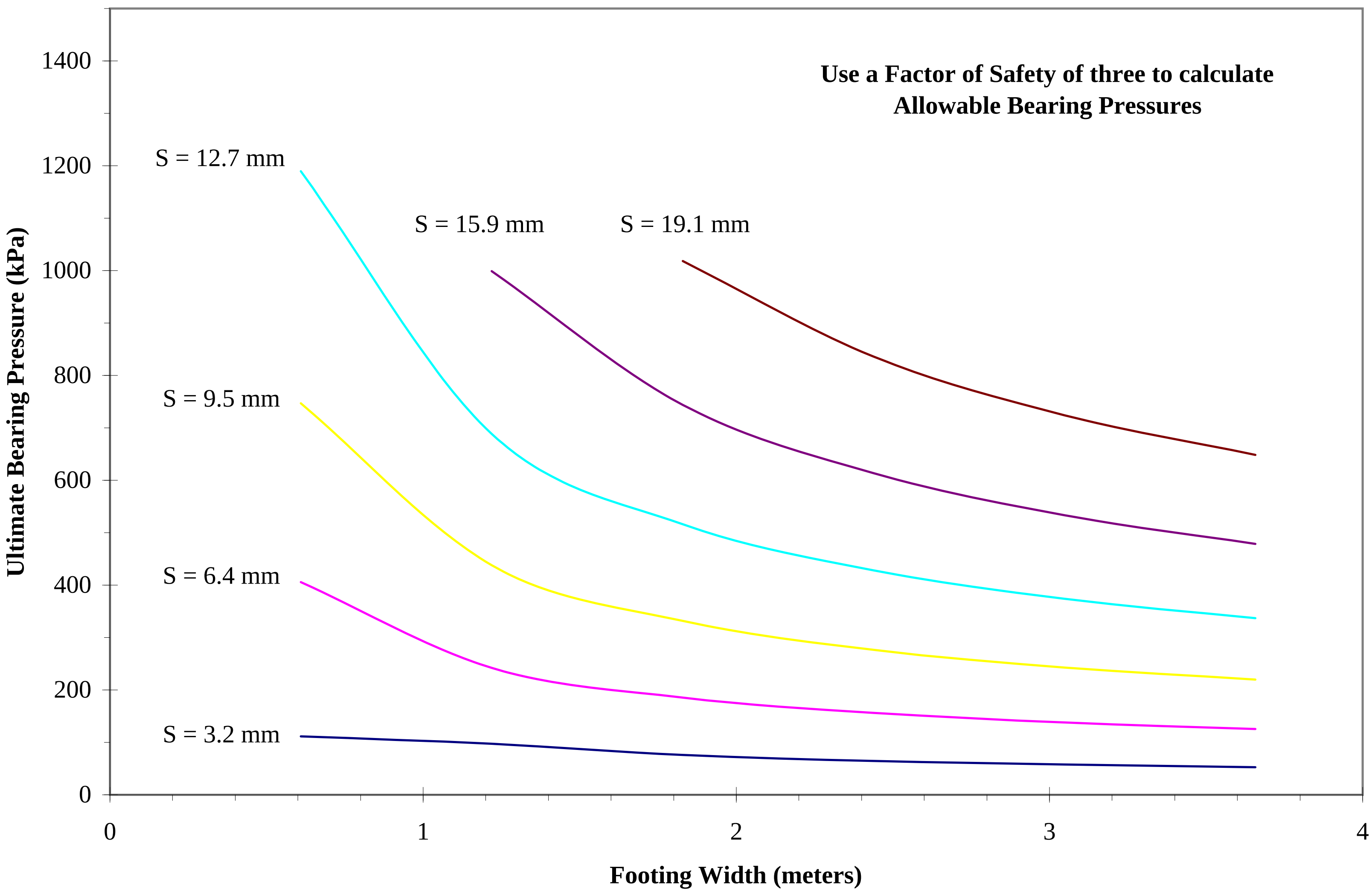
Graph 2. Settlement, S, for 1.52 meter Embedment, Square Footings



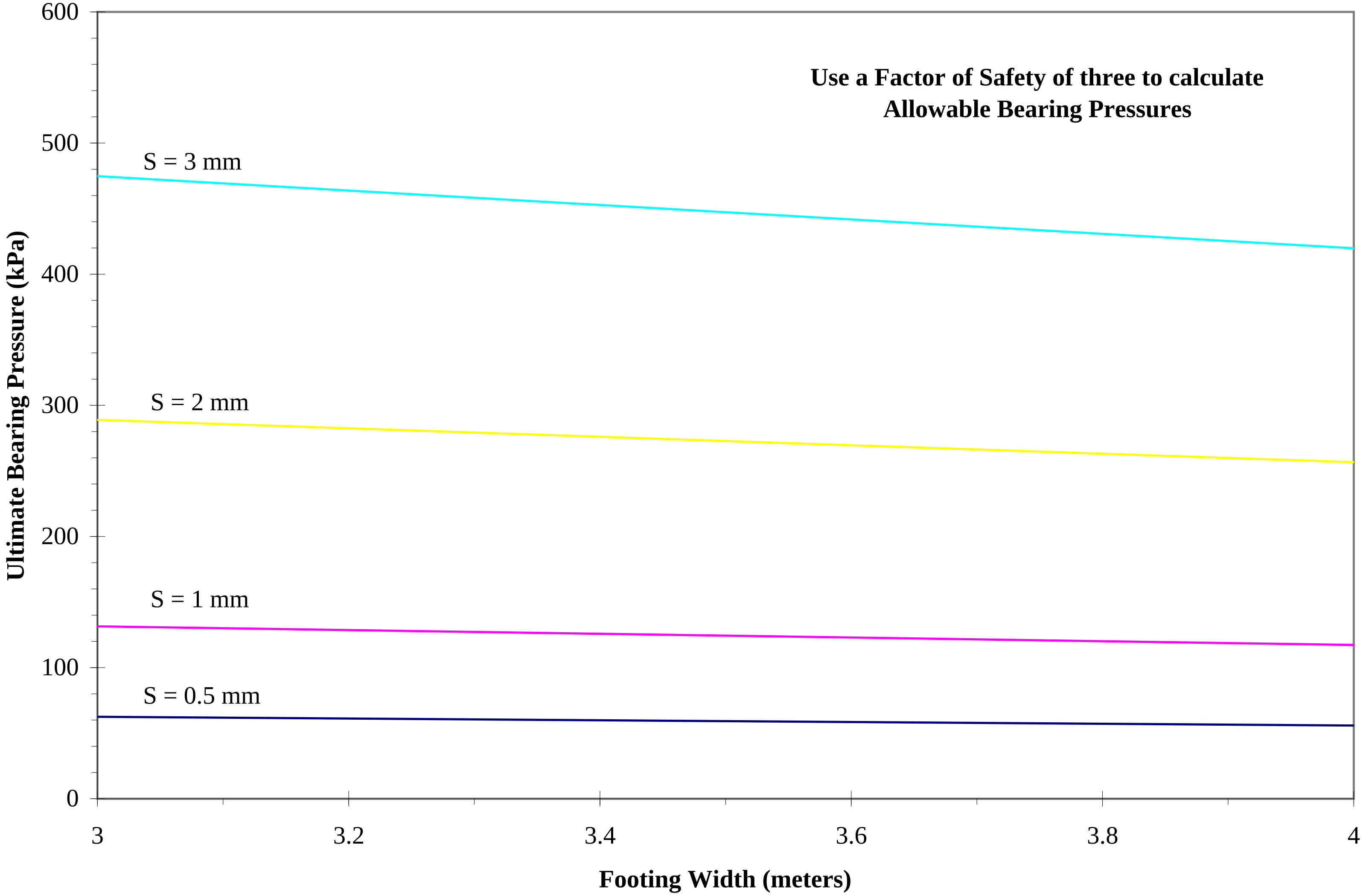
Graph 3. Settlement, S, for 1.83 meter Embedment, Square Footings



Graph 4. Settlement, S, for 1.22 meter Embedment, Strip Footings, L/W > 9



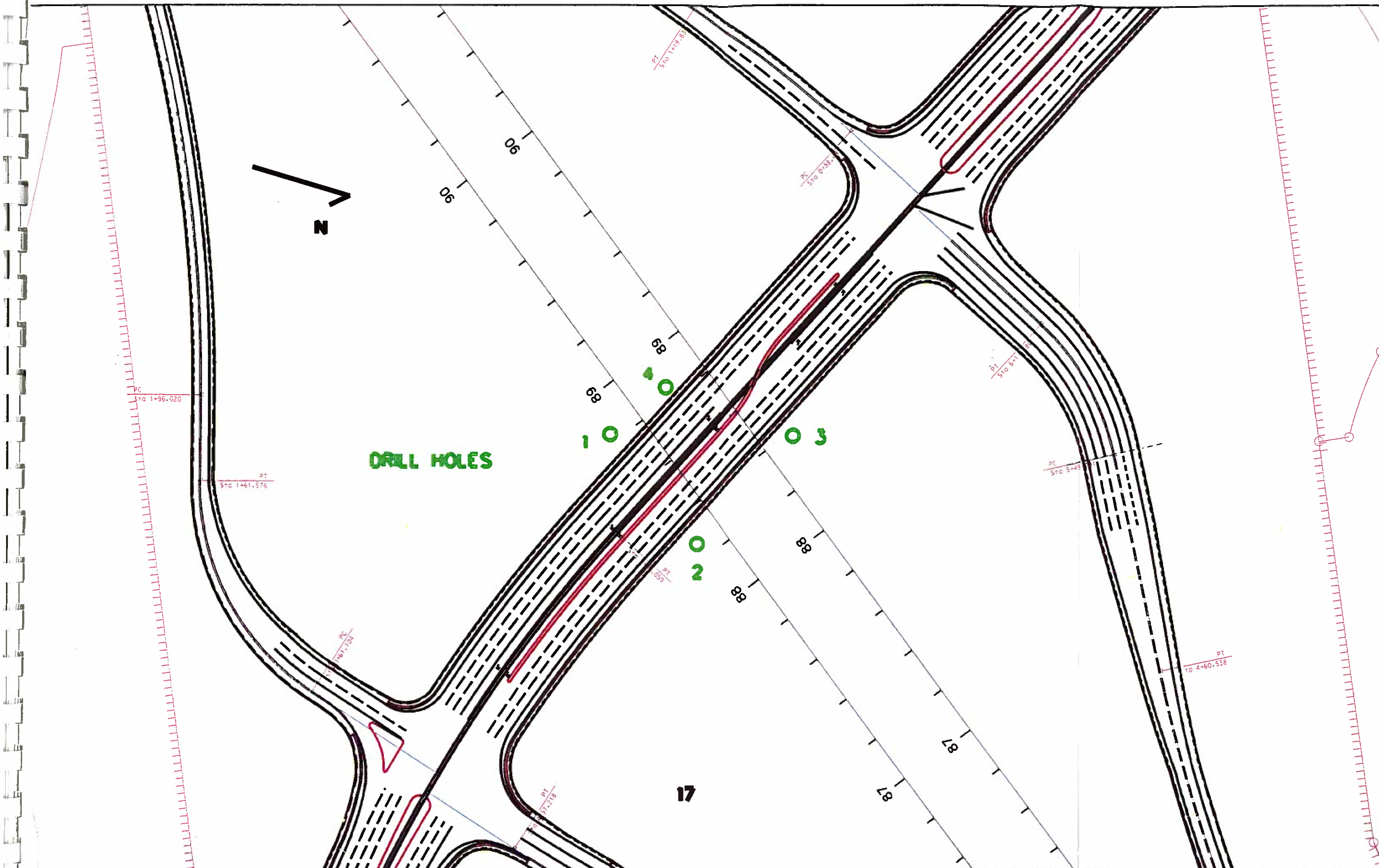
Graph 5. Settlement, S, for 1.0 meter Embedment, 5.0 meter Footing Length



APPENDIX A

LOCATION MAPS

Map A1. Site location of the new Durango Interchange.


N
DRILL HOLES
1
2
3
4
90
89
88
87
17

APPENDIX B

GEOLOGY AND SEISMICITY

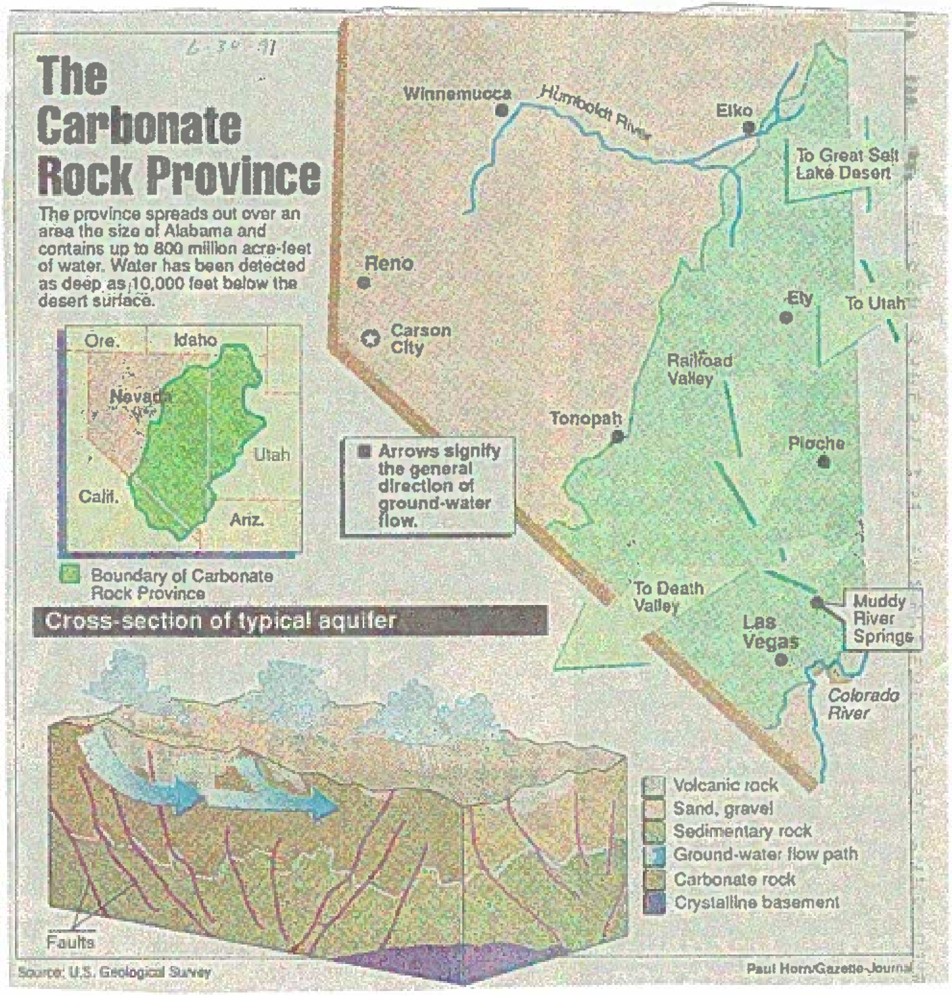


Figure B1. Limestone belt through Nevada.

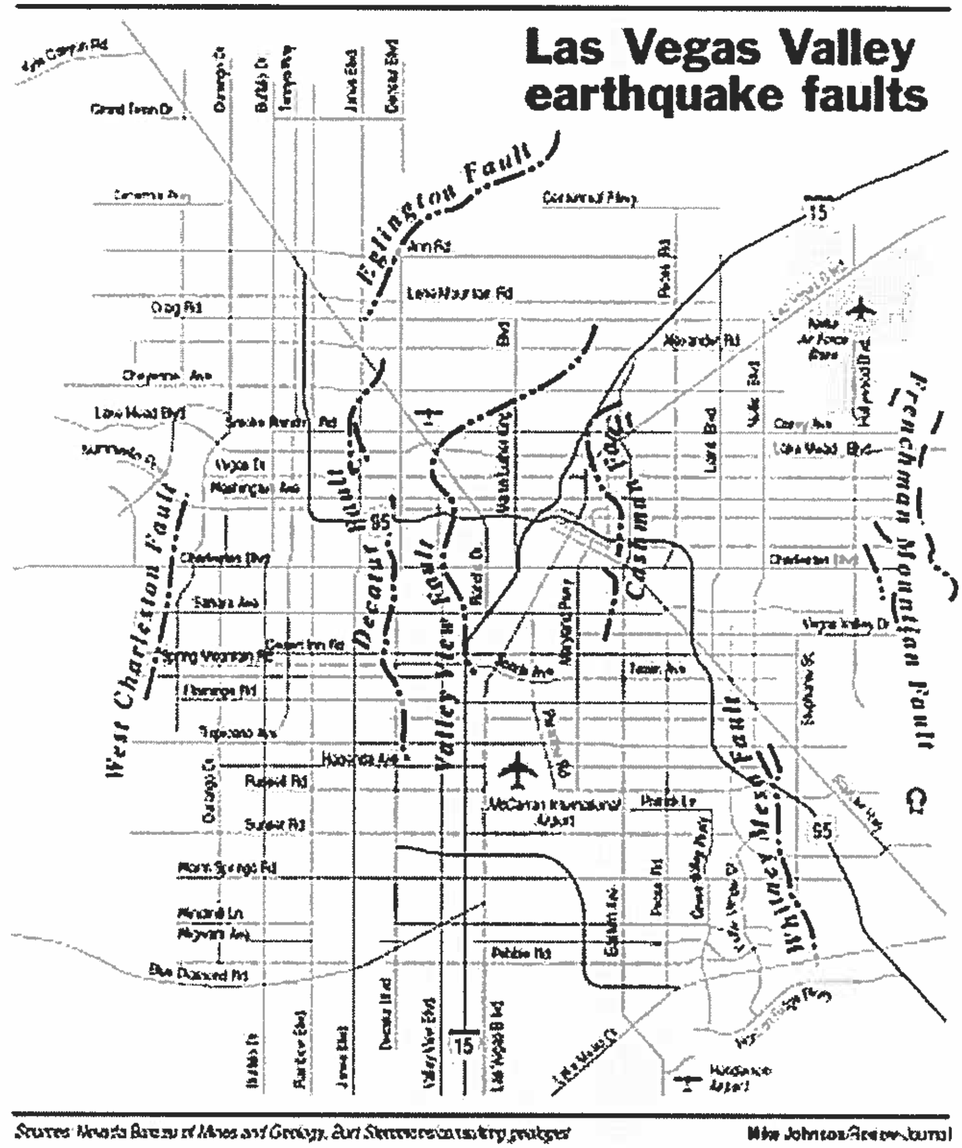


Figure B2. Significant local earthquake fault zones of Las Vegas Valley (printed in Las Vegas Review Journal, April 11, 1999).

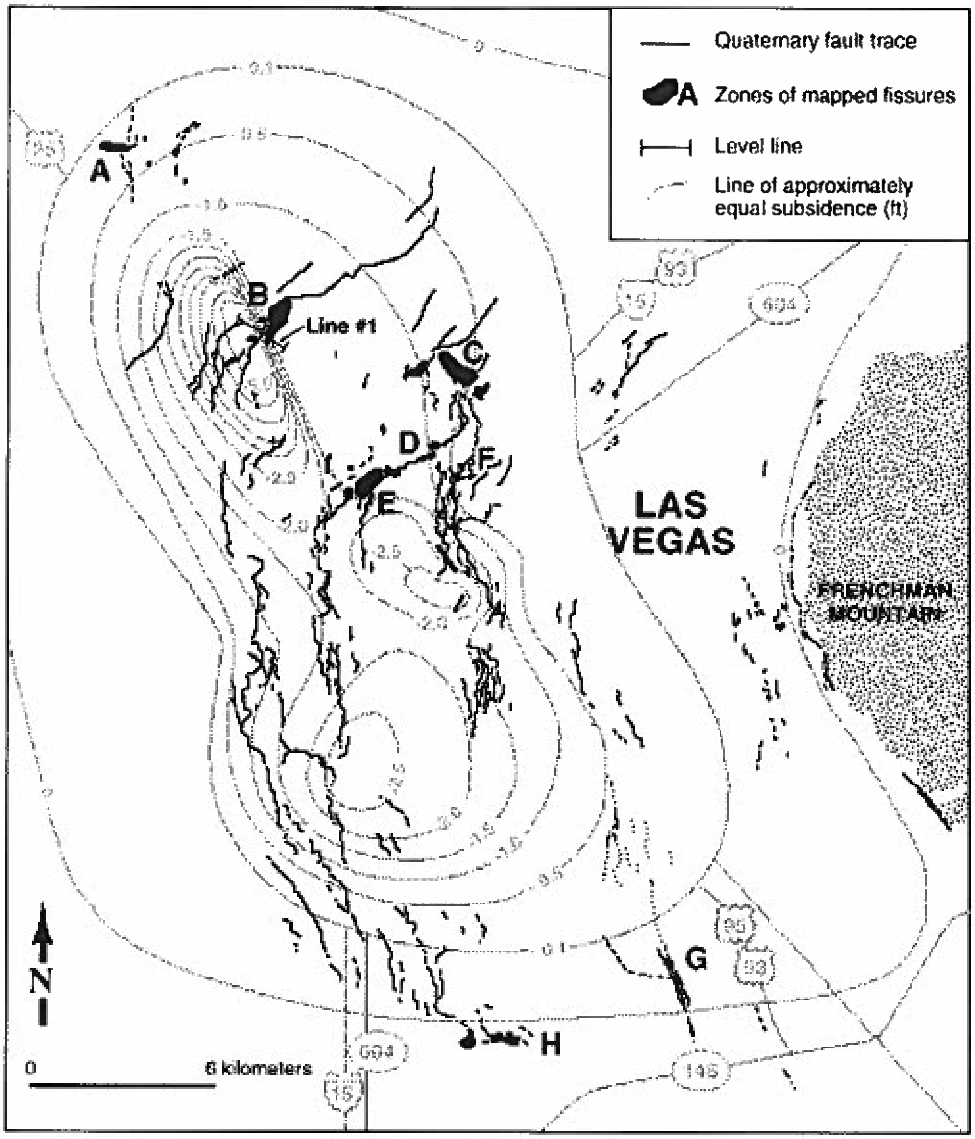


Figure B3. Zones of subsidence relative to local earthquake faults (printed in Las Vegas Review Journal).

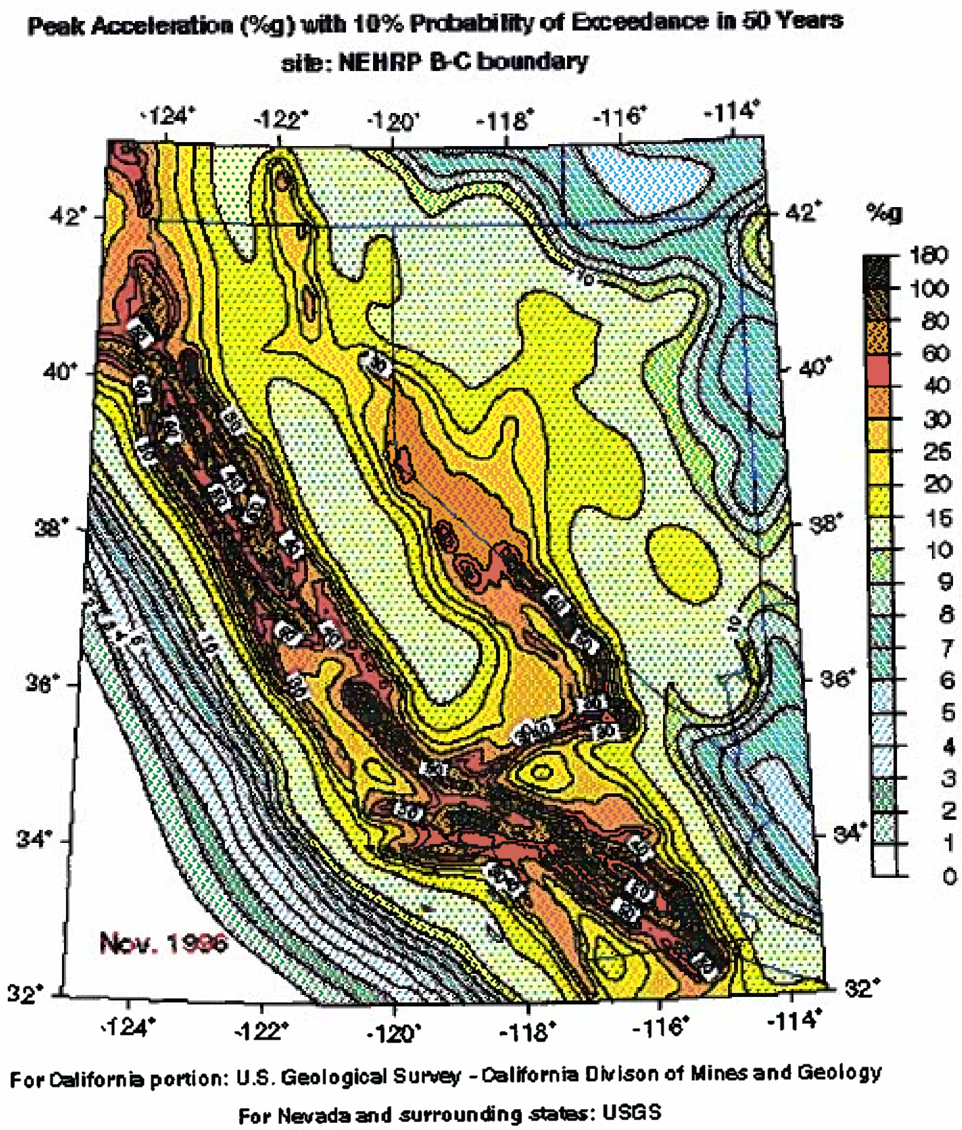


Figure B4. Seismic acceleration coefficients for Nevada and California.

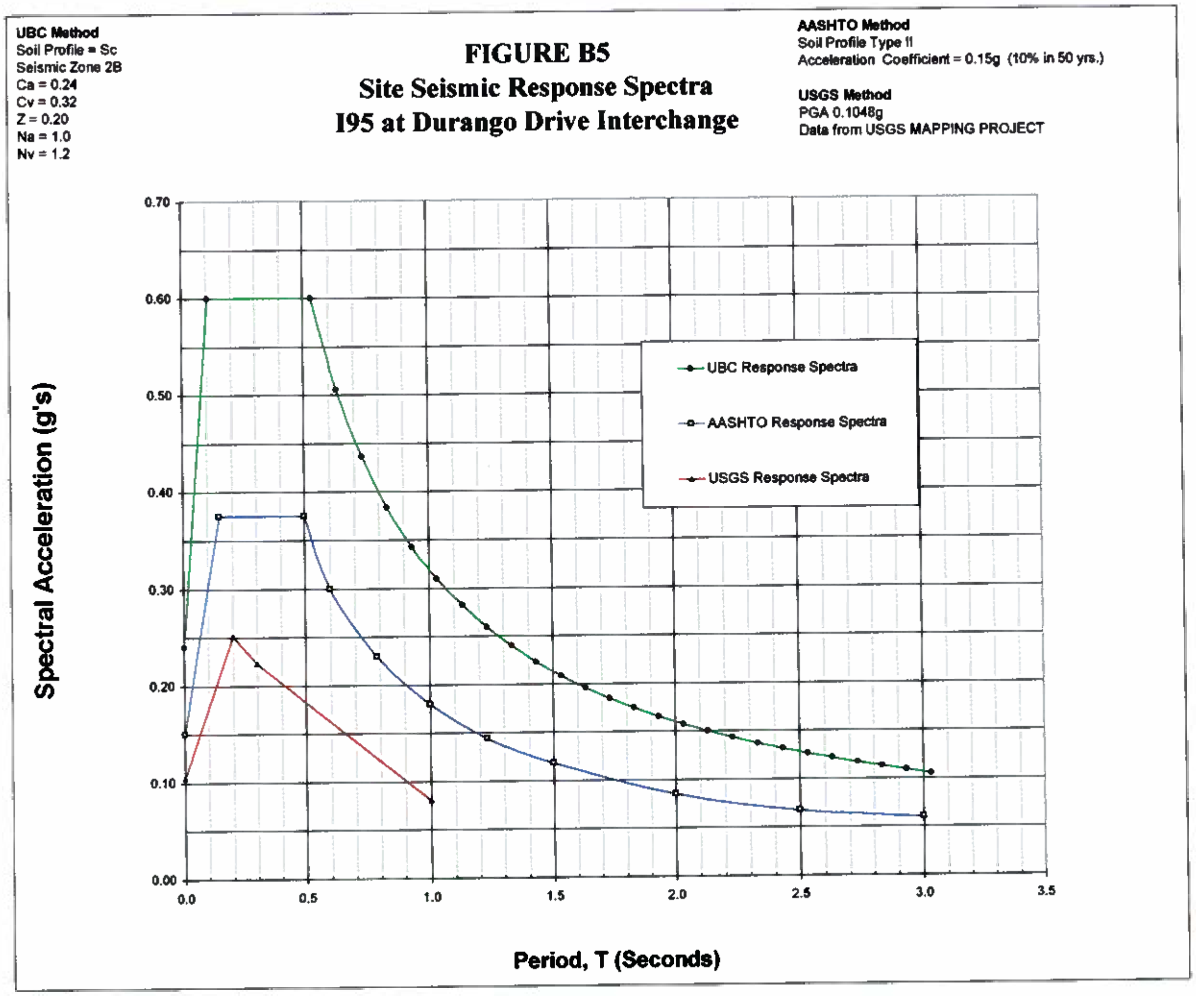


Figure B5. Response Spectra for the I15 at Durango Drive Interchange.

APPENDIX C

SUBSURFACE INVESTIGATION
BORING LOGS

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	3/1/99	STATION	"D" 35+45.8
END DATE	3/2/99	OFFSET	13.8 Meters Right
JOB DESCRIPTION	New Interchange	ENGINEER	Palmer
LOCATION	US 95 at Durango Drive, North Las Vegas	EQUIPMENT	Mobile B80 Drill Rig
BORING	DURLV1	OPERATOR	Argall, Altamirano
E.A. #	72411	DRILLING METHOD	Bentonite Slurry Wet
GROUND ELEV.	790.34 (m)	BACKFILLED	Yes DATE 5/13/99
HAMMER DROP SYSTEM	Safety Hammer		

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	REMARKS
	0.46–0.91		SPT	22 29 38	67	67	None	Down Pressure 2068 kPa (300 psi) Sample Mixed with Fill
789.3	1							
788.3	2 (1.98–2.21)	A	SPT	40 50/3"	50/3"	67	S	Refusal
	2.44–2.49		SPT	30/2"	30/2"	0	None	Refusal, Small Sample
787.3	3							
	3.51–3.59		SPT	50/3.5"	50/3.5"	57	None	Refusal, Small Sample
786.3	4							
	4.72–4.78		CMS	60/2.5"	60/2.5"	0	None	Refusal, No Recovery
785.3	5							
784.3	6							
783.3	7 (7.01–7.09)		SPT	60/3"	60/3"	0	None	Refusal, No Recovery
782.3	8							
	8.53–8.61	B	SPT	60/3"	60/3"	33	None	Refusal, Small Sample
781.3	9							

Depth to base (m)	USCS Group	MATERIAL DESCRIPTION
0.30		FILL - Sandy Gravel
4.57	GP GM	SILTY GRAVEL WITH SAND - Pale pink and contains black limestone clasts, very dense
9.14	GP GC	POORLY GRADED GRAVEL WITH SILTY CLAY AND SAND - Moderate brown with caliche coated black limestone clasts, very dense
10.00	GP GM	

NV_DOT_TEMPLTE1.GPJ NV_DOT.GDT 5/18/00

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE	3/1/99	STATION	"D" 35+45.8
END DATE	3/2/99	OFFSET	13.8 Meters Right
JOB DESCRIPTION	New Interchange	ENGINEER	Palmer
LOCATION	US 95 at Durango Drive, North Las Vegas	EQUIPMENT	Mobile B80 Drill Rig
BORING	DURLV1	OPERATOR	Argall, Altamirano
E.A. #	72411	DRILLING METHOD	Bentonite Slurry Wet
GROUND ELEV.	790.34 (m)	BACKFILLED	Yes DATE 5/13/99
HAMMER DROP SYSTEM	Safety Hammer		

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	10.06	C	SPT	60/2.3"	60/2.3"	43	S	GP GM	SILTY GRAVEL WITH SAND - Pale pink and has black limestone clasts, very dense	Refusal, Mixed With Sample D
779.3	11									
	11.58 / 11.66	D	SPT	50/3"	50/3"	100	S			Refusal, Mixed With Sample C
778.3	12									
								CE	12.19 / 12.34 ROCK OR CALICHE LAYER - White, ground to sand size by drill bit	
777.3	13									
	13.11 / 13.22	E	SPT	60/4.5"	60/4.5"	67	None	GP GC	POORLY GRADED GRAVEL WITH SILTY CLAY AND SAND - Moderate brown with caliche coated black limestone clasts, very dense	Refusal, Small Sample
776.3	14									
	14.63 / 14.72	F	SPT	60/3.5"	60/3.5"	86	None			Refusal, Small Sample
775.3	15									
774.3	16									
								CE	16.15 / 16.46 CALICHE LAYER OR ROCK	Down Pressure 4137 kPa (600 psi) From 16.0 m To 16.5 m
773.3	17									
	17.68 / 17.74	G	SPT	60/2.5"	60/2.5"	80	H	GM	SILTY GRAVEL WITH SAND - Moderate brown, very dense	Refusal, Mixed With Sample H
772.3	18									
771.3	19								20.00	

NV_DOT_TEMPLTE1.GPJ NV_DOT.GDT 5/18/00

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 3/1/99
END DATE 3/2/99
JOB DESCRIPTION New Interchange
LOCATION US 95 at Durango Drive, North Las Vegas
BORING DURLV1
E.A. # 72411
GROUND ELEV. 790.34 (m)
HAMMER DROP SYSTEM Safety Hammer

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "D" 35+45.8
OFFSET 13.8 Meters Right
ENGINEER Palmer
EQUIPMENT Mobile B80 Drill Rig
OPERATOR Argall, Altamirano
DRILLING METHOD Bentonite Slurry Wet
BACKFILLED Yes DATE 5/13/99

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	BLOW COUNT Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	20.73–20.80	H	SPT	60/4"	60/4"	75	H			
769.3	21									Refusal, Mixed With Sample G
768.3	22								SILTY SAND WITH GRAVEL - Moderate brown, very dense	
767.3	23							GM		
766.3	23.77–24.23 (24)	I	SPT	28 40 37	77	73	S		24.23	
765.3	25									Bottom of Hole at 24.23 Meters, No Water Table Encountered
764.3	26									
763.3	27									
762.3	28									
761.3	29									

NV DOT TEMPLTE1.GPJ NV DOT.GDT 5/18/00

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 3/3/99
END DATE 3/3/99
JOB DESCRIPTION New Interchange
LOCATION US 95 at Durango Drive, North Las Vegas
BORING DURLV2
E.A. # 72411
GROUND ELEV. 790.94 (m)
HAMMER DROP SYSTEM Safety Hammer

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "D" 35+45.8
OFFSET 14.0 Meters Left
ENGINEER Palmer
EQUIPMENT Mobile B80 Drill Rig
OPERATOR Argall, Altamirano
DRILLING METHOD Bentonite Slurry Wet
BACKFILLED Yes DATE 5/13/99

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.46									Down Pressure 2068 kPa (300 psi)
	0.91	A	SPT	23 27 39	66	67	H			Samples A, B, and C were Mixed for Hydrometer Test
789.9	1									
	1.37	B	SPT	38 62 58	120	73	H, CH			
	1.61	C	SPT	40 ~~60/3.5"~~	60/3.5"	33	H			Refusal
788.9	2									
787.9	3								POORLY GRADED GRAVEL WITH SILT AND SAND - Light brown with black limestone clasts, very dense	
	3.96									
786.9	4									
	4.18	D	SPT	64 ~~60/2.5"~~	60/2.5"	33	H			Refusal
785.9	5							GP GM		
784.9	6								6.40	
783.9	7									
	7.01									
	7.24		SPT	60/3"	60/3"	0	None			Refusal, No Recovery
782.9	8								CLAYEY GRAVEL WITH SAND - Light brown with black limestone clasts, very dense	
781.9	9							GC		
									10.00	

NV_DOT TEMPLTE1.GPJ NV_DOT.GDT 5/18/00

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 3/3/99

END DATE 3/3/99

JOB DESCRIPTION New Interchange

LOCATION US 95 at Durango Drive, North Las Vegas

BORING DURLV2

E.A. # 72411

GROUND ELEV. 790.94 (m)

HAMMER DROP SYSTEM Safety Hammer

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "D" 35+45.8

OFFSET 14.0 Meters Left

ENGINEER Palmer

EQUIPMENT Mobile B80 Drill Rig

OPERATOR Argall, Altamirano

DRILLING METHOD Bentonite Slurry Wet

BACKFILLED Yes DATE 5/13/99

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	[illegible]		SPT	60/3.5"	60/3.5"	0	None			Refusal, No Recovery
779.9	11									
778.9	12									
777.9	13 13.11									
	13.56	E	SPT	33 73 90	163	100	H, PI, CH			
776.9	14									
775.9	15								CLAYEY GRAVEL WITH SAND - Light brown with black limestone clasts, very dense	
774.9	16 16.15									
	16.37	F	SPT	40 60/2.5"	60/2.5"	47	H, PI			Refusal
773.9	17							GC		
772.9	18									
771.9	19									
	19.20 19.26		SPT	60/2"	60/2"	0			19.26	Refusal, No Recovery

NV_DOT TEMPLTE1.GPJ NV_DOT.GDT 5/18/00

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

SHEET 3 OF 3

START DATE	3/3/99	STATION	"D" 35+45.8
END DATE	3/3/99	OFFSET	14.0 Meters Left
JOB DESCRIPTION	New Interchange	ENGINEER	Palmer
LOCATION	US 95 at Durango Drive, North Las Vegas	EQUIPMENT	Mobile B80 Drill Rig
BORING	DURLV2	OPERATOR	Argall, Altamirano
E.A. #	72411	DRILLING METHOD	Bentonite Slurry Wet
GROUND ELEV.	790.94 (m)	BACKFILLED	Yes DATE 5/13/99
HAMMER DROP SYSTEM	Safety Hammer		

GROUNDWATER LEVEL

DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
769.9	21									Bottom of Hole at 19.26 Meters, No Water Table Encountered
768.9	22									
767.9	23									
766.9	24									
765.9	25									
764.9	26									
763.9	27									
762.9	28									
761.9	29									

NV_DOT TEMPLTE1.GPJ NV_DOT.GDT 5/18/00

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	4/26/99	STATION	"D" 33+98.9
END DATE	4/27/99	OFFSET	16.76 Meters Left
JOB DESCRIPTION	New Interchange	ENGINEER	Palmer
LOCATION	US 95 at Durango Drive, North Las Vegas	EQUIPMENT	Mobile B80 Drill Rig
BORING	DURLV3	OPERATOR	Argall, Altamirano
E.A. #	72411	DRILLING METHOD	Bentonite Slurry Wet
GROUND ELEV.	794.00 (m)	BACKFILLED	Yes DATE 5/13/99
HAMMER DROP SYSTEM	Safety Hammer		

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.15–0.61	A	SPT	5, 6, 13	19	61	H, PI	GC GM	SILTY CLAYEY GRAVEL WITH SAND - Brown with black limestone gravel, medium dense (to 0.61)	Down Pressure 2068 kPa (300 psi)
793.0	0.61–1.07	B	SPT	17, 26, 34	60	78	S, PI	GP GM	POORLY GRADED GRAVEL WITH SILT AND SAND - Brown with black limestone gravel, very dense (to 1.52)	Samples B and C Mixed For Testing Due to High Gravel Content
	1.07–1.52	C	SPT	29, 46, 36	82	89	S, PI			
792.0	1.52–1.98	D	SPT	38, 49, 74	123	89	S, PI	GP GC	POOLY GRADED GRAVEL WITH SILTY CLAY AND SAND - Tannish brown, with black limestone gravel, very dense (to 2.44)	Samples D and E Mixed For Testing Due to High Gravel Content
	1.98–2.44	E	SPT	53, 66, 84	150	94	S, PI			
	2.44–2.90	F	SPT	36, 59, 59	118	94	S, PI	GC GM	SILTY CLAYEY GRAVEL WITH SAND - Brown with black limestone gravel, very dense (to 2.90)	
791.0	2.90–3.35	G	SPT	29, 42, 74	116	83	H, PI	SC SM	SILTY CLAYEY SAND WITH GRAVEL - Brown with black limestone gravel, very dense (to 3.35)	
790.0	3.35–3.68	H	SPT	48, 94, 50/0.75"	50/0.75"	72	S, PI	SC	CLAYEY SAND WITH GRAVEL - Brown with pinkish white caliche coatings on the black limestone gravel, very dense (to 5.79)	Refusal
789.0	5.18–5.31	I	SPT	100/5"	100/5"	60	None			Refusal, Small Sample, With 50 mm Rock
788.0								GM	SILTY GRAVEL WITH SAND - Brown with broken pieces of black limestone and red sandstone rocks, and pinkish white pieces of caliche in the cuttings (to 6.40)	
	6.71		SPT	50/1"	50/1"	0	None	CE	CALICHE LAYER OR ROCK (to 6.71)	Down Pressure To 4136 kPa (600 psi) Refusal
787.0										Down Pressure To 2068 kPa (300 psi)
786.0	8.23–8.31		SPT	50/3"	50/3"	0	None	GM	SILTY GRAVEL WITH SAND - Brown with pinkish white caliche coatings on the black limestone gravel, very dense (to 10.00)	Refusal, Small Sample
785.0	9.75		SPT	50/1"	50/1"	0	None			Refusal, Small Sample

NV_DOT TEMPLTE1.GPJ NV_DOT.GDT 6/1/00

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 4/26/99
END DATE 4/27/99
JOB DESCRIPTION New Interchange
LOCATION US 95 at Durango Drive, North Las Vegas
BORING DURLV3
E.A. # 72411
GROUND ELEV. 794.00 (m)
HAMMER DROP SYSTEM Safety Hammer

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "D" 33+98.9
OFFSET 16.76 Meters Left
ENGINEER Palmer
EQUIPMENT Mobile B80 Drill Rig
OPERATOR Argall, Altamirano
DRILLING METHOD Bentonite Slurry Wet
BACKFILLED Yes DATE 5/13/99

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
783.0	11									
	~~11.28~~ ~~11.33~~		~~SPT~~	~~50/2"~~	~~50/2"~~	~~0~~	~~None~~	GM	SILTY GRAVEL WITH SAND - Brown with pinkish white caliche coatings on the black limestone gravel, very dense	Refusal, Small Sample
782.0	12									
781.0	13									
780.0	14									
	14.33 14.45	J	SPT	100/5"	100/5"	100	S		14.45	Refusal, Small Sample
779.0	15									
778.0	16									
777.0	17									
776.0	18									
775.0	19									

NV_DOT_TEMPLTE1.GPJ NV_DOT.GDT 6/1/00

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	4/26/99	STATION	"D" 33+98.9
END DATE	4/27/99	OFFSET	16.76 Meters Left
JOB DESCRIPTION	New Interchange	ENGINEER	Palmer
LOCATION	US 95 at Durango Drive, North Las Vegas	EQUIPMENT	Mobile B80 Drill Rig
BORING	DURLV3	OPERATOR	Argall, Altamirano
E.A. #	72411	DRILLING METHOD	Bentonite Slurry Wet
GROUND ELEV.	794.00 (m)	BACKFILLED	Yes DATE 5/13/99
HAMMER DROP SYSTEM	Safety Hammer		

GROUNDWATER LEVEL

DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
773.0	21									
										Bottom of Hole at 14.45 Meters, No Water Table Encountered
772.0	22									
771.0	23									
770.0	24									
769.0	25									
768.0	26									
767.0	27									
766.0	28									
765.0	29									

NV_DOT TEMPLTE1.GPJ NV_DOT.GDT 6/1/00

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 4/28/99
END DATE 4/29/99
JOB DESCRIPTION New Interchange
LOCATION US 95 at Durango Drive, North Las Vegas
BORING DURLV4
E.A. # 72411
GROUND ELEV. 791.60 (m)
HAMMER DROP SYSTEM Safety Hammer

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "D" 34+85.0
OFFSET 18.9 Meters Left
ENGINEER Palmer
EQUIPMENT Mobile B80 Drill Rig
OPERATOR Argall, Altamirano
DRILLING METHOD Bentonite Slurry Wet
BACKFILLED Yes DATE 5/13/99

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.15									
	0.56 / 0.61	A	SPT	17 45 52	97	89	S, PI	GP GM	SILTY CLAYEY GRAVEL WITH SAND - Brown, up to 50 mm diameter black limestone gravel, very dense (0.61)	Down Pressure 2068 kPa (300 psi)
790.6 (1)	1.04 / 1.07	B	SPT	29 50 80	130	94	S, PI	GP GC	POORLY GRADED GRAVEL WITH SILTY CLAY AND SAND - Brown, up to 25 mm diameter black limestone gravel, very dense (1.52)	Samples B and C Mixed For Testing Due to High Gravel Content
	1.40	C	SPT	38 68	50/2"	72	S, PI			
	1.52			50/2"						Refusal
	1.85	D	SPT	39 47	107	72	S, PI	GP GM	POORLY GRADED GRAVEL WITH SILT AND SAND - Brown, up to 38 mm diameter black limestone gravel coated with pinkish white caliche, very dense (5.79)	Samples D and E Mixed For Testing Due to High Gravel Content
	1.98			60						
789.6 (2)	2.34	E	SPT	21 46 50/3"	50/3"	78	S, PI			Refusal
788.6 (3)										
787.6 (4)										
786.6 (5)	5.18 / 5.21	F	SPT	50/2"	50/2"	6				Refusal, Small Sample
785.6 (6)										
784.6 (7)										
783.6 (8)	8.28 / 8.29	G	SPT	65/3.5"	65/3.5"	6		GC	CLAYEY GRAVEL WITH SAND - Brown, up to 25 mm diameter black limestone gravel coated with pinkish white caliche, very dense (10.00)	Refusal, Small Sample
782.6 (9)										

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 4/28/99
END DATE 4/29/99
JOB DESCRIPTION New Interchange
LOCATION US 95 at Durango Drive, North Las Vegas
BORING DURLV4
E.A. # 72411
GROUND ELEV. 791.60 (m)
HAMMER DROP SYSTEM Safety Hammer

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "D" 34+85.0
OFFSET 18.9 Meters Left
ENGINEER Palmer
EQUIPMENT Mobile B80 Drill Rig
OPERATOR Argall, Altamirano
DRILLING METHOD Bentonite Slurry Wet
BACKFILLED Yes DATE 5/13/99

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
										Samples H, I, and J Mixed For Testing Due to Low Sample Recovery
780.6	11									
	11.28 / 11.42	H	SPT	75/4"	75/4"	31	S, PI			Refusal
779.6	12									
778.6	13								CLAYEY GRAVEL WITH SAND - Brown, up to 25 mm diameter black limestone gravel coated with pinkish white caliche, also contains white and red sand and gravel, very dense	
777.6	14									
	14.33 / 14.43	I	SPT	50/4"	50/4"	22	S, PI			Refusal
776.6	15							GC		
775.6	16									
774.6	17									
	17.37 / 17.45	J	SPT	50/3"	50/3"	17	S, PI		17.45	Refusal
773.6	18									
772.6	19									

NV_DOT TEMPLTE1.GPJ NV_DOT.GDT 6/1/00

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 4/28/99
END DATE 4/29/99
JOB DESCRIPTION New Interchange
LOCATION US 95 at Durango Drive, North Las Vegas
BORING DURLV4
E.A. # 72411
GROUND ELEV. 791.60 (m)
HAMMER DROP SYSTEM Safety Hammer

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "D" 34+85.0
OFFSET 18.9 Meters Left
ENGINEER Palmer
EQUIPMENT Mobile B80 Drill Rig
OPERATOR Argall, Altamirano
DRILLING METHOD Bentonite Slurry Wet
BACKFILLED Yes DATE 5/13/99

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
770.6	21									
										Bottom of Hole at 17.45 Meters, No Water Table Encountered
769.6	22									
768.6	23									
767.6	24									
766.6	25									
765.6	26									
764.6	27									
763.6	28									
762.6	29									

NV DOT TEMPLTE1.GPJ NV DOT.GDT 6/1/00

KEY TO BORING LOGS

PARTICLE SIZE LIMITS								
CLAY	SILT	SAND			GRAVEL		COBBLES	BOULDERS
		FINE	MEDIUM	COARSE	FINE	COARSE		
.002 mm	#200	#40	#10	#4	19 mm	75 mm	300 mm	

USCS GROUP	TYPICAL SOIL DESCRIPTION
GW	Well graded gravels, gravel-sand mixtures, little or no fines
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
GM	Silty gravels, poorly graded gravel-sand-silt mixtures
GC	Clayey gravels, poorly graded gravel-sand-clay mixtures
SW	Well graded sands, gravelly sands, little or no fines
SP	Poorly graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly graded sand-silt mixtures
SC	Clayey sands, poorly graded sand-clay mixtures
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL	Organic silts and organic silt-clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity
CS	Claystone/Siltstone
PT	Peat and other highly organic soils

MOISTURE CONDITION CRITERIA

Description	Criteria
Dry	Absence of moisture, dusty, dry to touch.
Moist	Damp, no visible free water.
Wet	Visible free water,usually below groundwater table.

SOIL CEMENTATION CRITERIA

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Won't break or crumble w/finger pressure

$\underline{\nabla}$ $\underline{\blacktriangledown}$ Groundwater Elevation Symbols

STANDARD PENETRATION CLASSIFICATION*			
GRANULAR SOIL		CLAYEY SOIL	
BLOWS/FT	DENSITY	BLOWS/FT	CONSISTENCY
0 - 4	VERY LOOSE	0 - 1	VERY SOFT
5 - 10	LOOSE	2 - 4	SOFT
11 - 30	MEDIUM DENSE	5 - 8	MEDIUM STIFF
31 - 50	DENSE	9 - 15	STIFF
OVER 50	VERY DENSE	16 - 30	VERY STIFF
		31 - 60	HARD
		OVER 60	VERY HARD

*Standard Penetration Test (N) 63.5 Kg hammer 760mm free fall on 50.8mm O.D. x 35mm I.D. sampler.

Blow counts on Calif. Modified Sampler (N_{CMS}) can be converted to N_{SPT} by:
$(N_{CMS})(0.62) = N_{SPT}$

Blow counts from Automatic or Safety Hammer can be converted to Standard SPT N_{60} by:
$(N_{AUTOMATIC})(1.25) = N_{60}$
$(N_{SAFETY})(1.17) = N_{60}$

TEST ABBREVIATIONS

CD	CONSOLIDATED DRAINED	O	ORGANIC CONTENT
CH	CHEMICAL (CORROSIVENESS)	OC	CONSOLIDATION
CM	COMPACTION	PI	PLASTICITY INDEX
CU	CONSOLIDATED UNDRAINED	RQD	ROCK QUALITY DESIGNATION
D	DISPERSIVE SOILS	RV	R-VALUE
DS	DIRECT SHEAR	S	SIEVE ANALYSIS
E	EXPANSIVE SOIL	SL	SHRINKAGE LIMIT
G	SPECIFIC GRAVITY	U	UNCONFINED COMPRESSION
H	HYDROMETER	UU	UNCONSOLIDATED UNDRAINED
HC	HYDRO-COLLAPSE	UW	UNIT WEIGHT
K	PERMEABILITY	W	MOISTURE CONTENT

SOIL COLOR DESIGNATIONS ARE FROM THE MUNSELL SOIL COLOR CHART.
EXAMPLE: (7.5 YR 5/3) BROWN

SAMPLER NOTATION

CMS	CALIF. MODIFIED SAMPLER①
CPT	CONE PENETRATION
CS	CONTINUOUS SAMPLER②
CSS	CALIFORNIA SPLIT SPOON①
P	PUSHED (NOT DRIVEN)
PB	PITCHER BARREL
RC	ROCK CORE③
SH	SHELBY TUBE④
SPT	STANDARD PENETRATION TEST
TP	TEST PIT

①- I.D.= 61.5 mm
②- I.D.=82 mm with tube; 88.9mm w/o tube
③- NXB I.D.= 47.625mm
④- I.D.= 73mm

APPENDIX D

TEST RESULTS

SUMMARY OF TEST RESULTS
N.D.O.T. GEOTECHNICAL SECTION

E.A. No. 72411 Job Description SR 95 @ Durango - Clark County

Boring No. DUR4 Elevation (m) Station 35+45.8 13.8m Rt.

SAMPLE NO.	SAMPLE DEPTH (m)	SAMPLER TYPE	N BLOWS per .3m	SOIL GROUP	W%	WET UW KN/m³	% PASS #200	LL %	PL %	PI %	STRENGTH TEST TEST TYPE	STRENGTH TEST φ deg.	STRENGTH TEST C KN/m²	COMMENTS
A	0.15 - 0.61	SPT		GC-GM	6.8		13.3	22	17	5				
BC	0.61 - 1.52	SPT		GP-GC	5.5 / 7.7		9.4	20	15	5				Mixed samples
DE	1.52 - 2.44	SPT		GP-GM	3.9 / 7.1		10.6	18	15	3				Mixed samples
F	5.18 - 5.64	SPT												Visual sample - no tests
G	8.23 - 8.69	SPT												Visual sample - no tests
H	11.28 - 11.73	SPT		GC	13.0		13.8	41	22	19				Samples H,I,J combined for testing
I	14.33 - 14.78	SPT			10.9									
J	17.37 - 17.45	SPT			9.8									

CMS = California Modified Sampler 61mm ID
SPT = Standard Penetration 35mm ID
CS = Continuous Sample 82mm ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 61.5mm ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
R = Refusal
Sh = Shelby Tube 73 mm ID

U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
φ = Friction
C = Cohesion
N = No. of blows per 0.3m, sampler driven under 64kg mass dropped 760mm.
N = Field SPT N = $(N_{css})(0.62)$

H = Hydrometer
S = Sieve
G = Specific Gravity
PI = Plasticity Index
LL = Liquid Limit
PL = Plastic Limit
NP = Non-Plastic
OC = Consolidation
Ch = Chemical
RV = R - Value

CM = Compaction
E = Swell/Pressure on Expansive Soils
SL = Shrinkage Limit
UW= Unit Weight
W = Moisture Content
K = Permeability
O = Organic Content
D = Dispersive
RQD = Rock Quality Designation

SUMMARY OF TEST RESULTS
N.D.O.T. GEOTECHNICAL SECTION

E.A. No. 72411 | Job Description SR 95 @ Durango - Clark County

Boring No. DUR3 | Elevation (m) | Station 35+45.8 13.8m Rt.

SAMPLE NO.	SAMPLE DEPTH (m)	SAMPLER TYPE	N BLOWS per .3m	SOIL GROUP	W%	WET UW KN/m³	% PASS #200	LL %	PL %	PI %	STRENGTH TEST TEST TYPE	STRENGTH TEST φ deg.	STRENGTH TEST C KN/m²	COMMENTS
A	0.15 - 0.61	SPT	19	GC-GM	10.9		24.1	24	19	5				
BC	0.61 - 1.52	SPT	60/82	GP-GM	6.5 / 7.6		8.9	21	18	3				
DE	1.52 - 2.44	SPT	123/150	GP-GC	5.9 / 5.3		9.5	19	14	5				
F	2.44 - 2.90	SPT	118	GC-GM	5.7		16.6	22	15	7				
G	2.90 - 3.35	SPT	116		9.2		24.1	21	15	6				
H	3.35 - 3.81	SPT	R	SC	9.2		20.9	21	13	8				
I	5.18 - 5.64	SPT	R											Visual sample - no tests
J	14.33 - 14.78	SPT	R	GM	11		13.3							

CMS = California Modified Sampler 61mm ID
SPT = Standard Penetration 35mm ID
CS = Continuous Sample 82mm ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 61.5mm ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
R = Refusal
Sh = Shelby Tube 73 mm ID

U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
φ = Friction
C = Cohesion
N = No. of blows per 0.3m, sampler driven under 64kg mass dropped 760mm.
N = Field SPT $N = (N_{css})(0.62)$

H = Hydrometer
S = Sieve
G = Specific Gravity
PI = Plasticity Index
LL = Liquid Limit
PL = Plastic Limit
NP = Non-Plastic
OC = Consolidation
Ch = Chemical
RV = R - Value

CM = Compaction
E = Swell/Pressure on Expansive Soils
SL = Shrinkage Limit
UW= Unit Weight
W = Moisture Content
K = Permeability
O = Organic Content
D = Dispersive
RQD = Rock Quality Designation

SUMMARY OF TEST RESULTS
N.D.O.T. GEOTECHNICAL SECTION

E.A. No. 72411 Job Description SR 95 @ Durango - Clark County

Boring No. DUR2 Elevation (m) Station 35+45.8 13.8m Rt.

SAMPLE NO.	SAMPLE DEPTH (m)	SAMP-LER TYPE	N BLOWS per .3m	SOIL GROUP	W%	WET UW KN/m³	% PASS #200	LL %	PL %	PI %	STRENGTH TEST TEST TYPE	STRENGTH TEST φ deg.	STRENGTH TEST C KN/m²	COMMENTS
A	0.46 - 0.91	SPT	66											Visual sample - no tests
B	0.91 - 1.37	SPT	120	GP-GM			10.1							Ch
C	1.37 - 1.83	SPT	R	GM			12.3							
D	3.96 - 4.42	SPT	R	GP-GM			11.6							
E	13.1 - 13.6	SPT	163	GC			21.9	43	22	21				Ch
F	16.2 - 16.6	SPT	R	GC			28.3	33	14	19				

CMS = California Modified Sampler 61mm ID
SPT = Standard Penetration 35mm ID
CS = Continuous Sample 82mm ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 61.5mm ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
R = Refusal
Sh = Shelby Tube 73 mm ID

U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
φ = Friction
C = Cohesion
N = No. of blows per 0.3m, sampler driven under 64kg mass dropped 760mm.
N = Field SPT N = $(N_{css})(0.62)$

H = Hydrometer
S = Sieve
G = Specific Gravity
PI = Plasticity Index
LL = Liquid Limit
PL = Plastic Limit
NP = Non-Plastic
OC = Consolidation
Ch = Chemical
RV = R - Value

CM = Compaction
E = Swell/Pressure on Expansive Soils
SL = Shrinkage Limit
UW = Unit Weight
W = Moisture Content
K = Permeability
O = Organic Content
D = Dispersive
RQD = Rock Quality Designation

SUMMARY OF TEST RESULTS
N.D.O.T. GEOTECHNICAL SECTION

E.A. No. 72411 | Job Description SR 95 @ Durango - Clark County

Boring No. DUR1 | Elevation (m) | Station 35+45.8 13.8m Rt.

SAMPLE NO.	SAMPLE DEPTH (m)	SAMP-LER TYPE	N BLOWS per .3m	SOIL GROUP	W%	WET UW KN/m³	% PASS #200	LL %	PL %	PI %	STRENGTH TEST TEST TYPE	STRENGTH TEST φ deg.	STRENGTH TEST C KN/m²	COMMENTS
A	1.98 - 2.44	SPT	R	GP-GM			7.8							
B	8.53 - 8.99	SPT	R											
CD	10.1 - 12.0	SPT	R	GP-GM			11.1							Mixed samples
E	13.1 - 13.6	SPT	R											Visual sample - no tests
F	14.6 - 15.1	SPT	R											Visual sample - no tests
GH	17.7 - 21.2	SPT	R	GM			14.0							Mixed samples
I	23.8 - 24.2	SPT	77	GM			22.7							

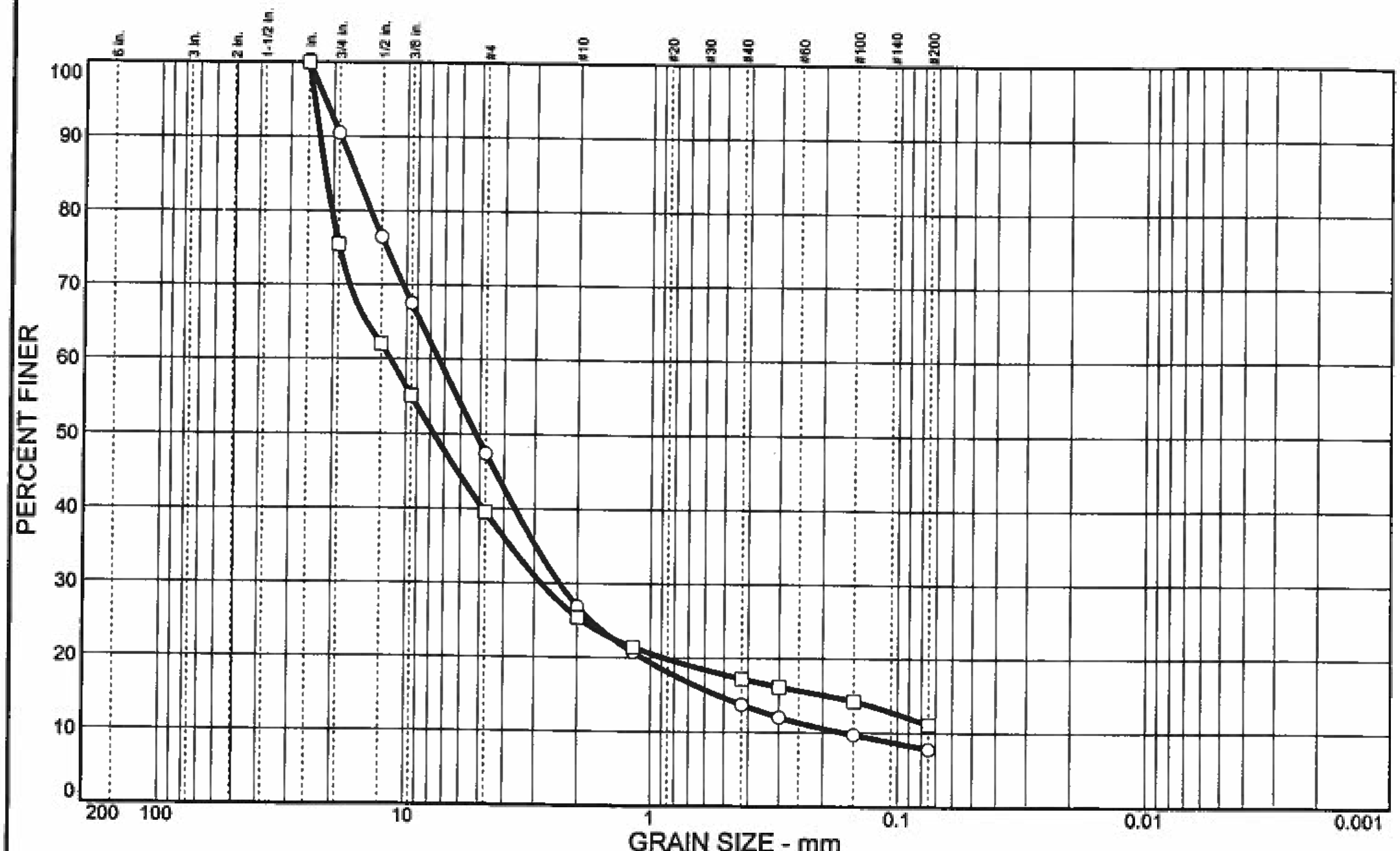
CMS = California Modified Sampler 61mm ID
SPT = Standard Penetration 35mm ID
CS = Continuous Sample 82mm ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 61.5mm ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
R = Refusal
Sh = Shelby Tube 73 mm ID

U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
φ = Friction
C = Cohesion
N = No. of blows per 0.3m, sampler driven under 64kg mass dropped 760mm.
N = Field SPT N = $(N_{css})(0.62)$

H = Hydrometer
S = Sieve
G = Specific Gravity
PI = Plasticity Index
LL = Liquid Limit
PL = Plastic Limit
NP = Non-Plastic
OC = Consolidation
Ch = Chemical
RV = R - Value

CM = Compaction
E = Swell/Pressure on Expansive Soils
SL = Shrinkage Limit
UW = Unit Weight
W = Moisture Content
K = Permeability
O = Organic Content
D = Dispersive
RQD = Rock Quality Designation
X = X-Ray Defraction

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		52.6	39.6	7.8		GP-GM			
□		60.5	28.4	11.1		GP-GM			

SIEVE inches size	PERCENT FINER ○	□	
1"	100.0	100.0	
3/4"	90.5	75.5	
1/2"	76.5	62.0	
3/8"	67.5	55.1	
	GRAIN SIZE		
D_{60}	7.39	11.6	
D_{30}	2.37	2.82	
D_{10}	0.167		
	COEFFICIENTS		
C_c	4.55		
C_u	44.31		

SIEVE number size	PERCENT FINER ○	□	
#4	47.4	39.5	
#10	26.9	25.4	
#16	20.7	21.4	
#40	13.7	17.2	
#50	12.0	16.1	
#100	9.7	14.2	
#200	7.8	11.1	

SOIL DESCRIPTION

○

□

REMARKS:

○

□

○ Location: Boring DUR1, sample: A

□ Location: Boring DUR1, sample: CD

NEVADA DEPARTMENT OF TRANSPORTATION

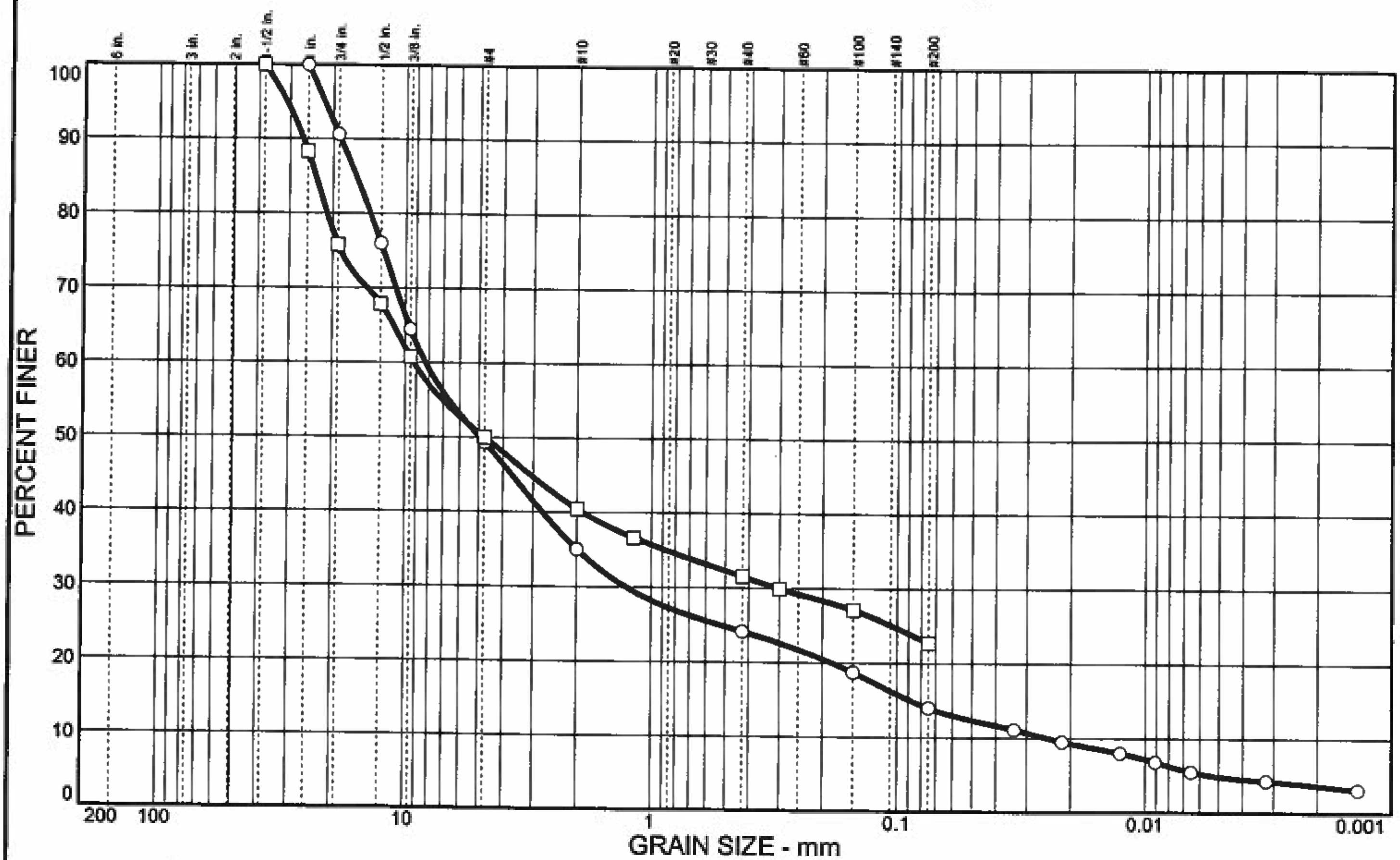
Client:

Project: Durango Interchange

Project No.: 72411-1

Plate 43

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		50.7	35.3	10.3	3.7	GM			
□		50.0	27.3	22.7		GM			

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	
1.5"		100.0	
1"	100.0	88.3	
3/4"	90.6	75.8	
1/2"	76.0	67.9	
3/8"	64.5	60.8	
	GRAIN SIZE		
D_{60}	8.25	9.21	
D_{30}	1.27	0.307	
D_{10}	0.0250		
	COEFFICIENTS		
C_c	7.81		
C_u	330.52		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	
#4	49.3	50.0	
#10	35.0	40.4	
#16		36.6	
#40	24.1	31.5	
#50		29.9	
#100	18.7	27.1	
#200	14.0	22.7	

SOIL DESCRIPTION

○ Silty gravel with sand

□

REMARKS:

○

□

○ Location: Boring DUR1, sample: GH

□ Location: Boring DUR1, sample: I

NEVADA DEPARTMENT OF TRANSPORTATION

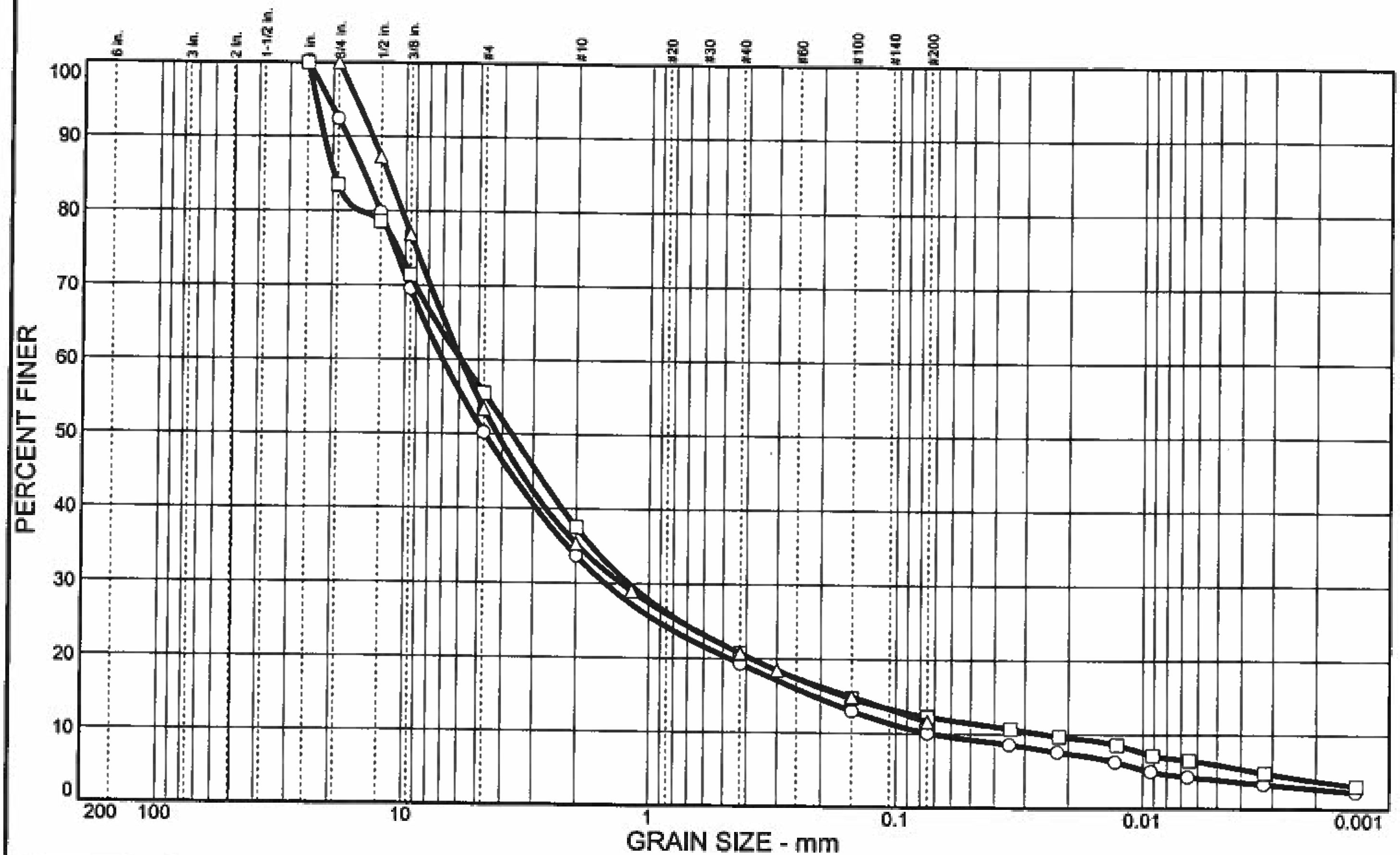
Client:

Project: Durango Interchange

Project No.: 72411-1

Plate 44

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		49.8	40.1	7.4	2.7	GP-GM			
□		44.5	43.2	8.5	3.8	GM			
△		46.6	41.8	11.6		GP-GM			

SIEVE inches size	PERCENT FINER ○	□	△
1"	100.0	100.0	
3/4"	92.4	83.5	100.0
1/2"	79.8	78.6	87.3
3/8"	69.6	71.4	76.9
GRAIN SIZE			
D_{60}	6.99	5.90	5.89
D_{30}	1.52	1.21	1.30
D_{10}	0.0723	0.0253	
COEFFICIENTS			
C_c	4.56	9.83	
C_u	96.62	232.95	

SIEVE number size	PERCENT FINER ○	□	△
#4	50.2	55.5	53.4
#10	33.7	37.5	35.3
#16			29.0
#40	19.3	20.7	20.7
#50			18.4
#100	13.0	14.7	14.9
#200	10.1	12.3	11.6

SOIL DESCRIPTION

○ Poorly graded gravel with silt and sand

□ Silty gravel with sand

△

REMARKS:

○

□

△

○ Location: Boring DUR2, sample: B

□ Location: Boring DUR2, sample: C

△ Location: Boring DUR2, sample: D

NEVADA DEPARTMENT OF TRANSPORTATION

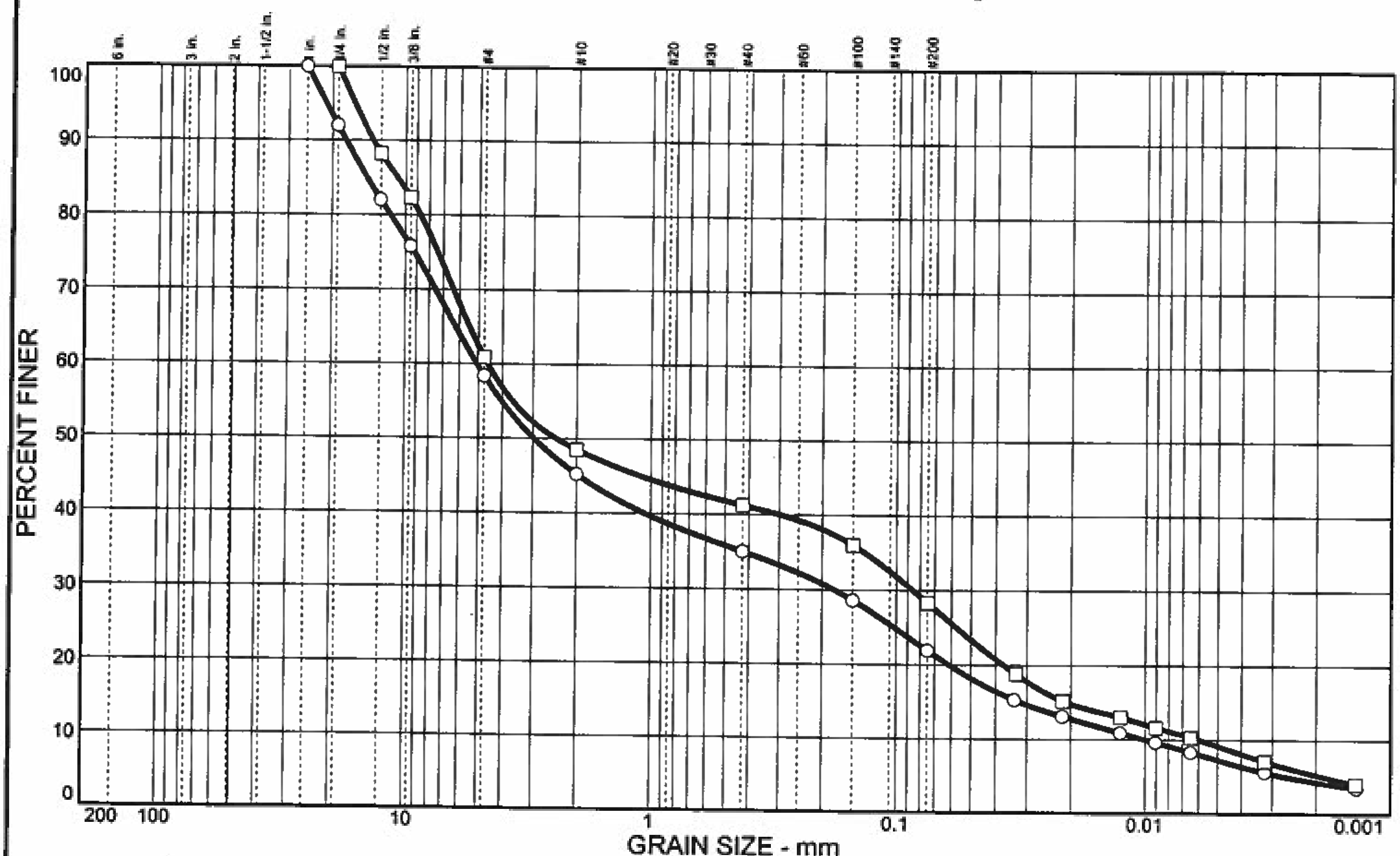
Client:

Project: Durango Interchange

Project No.: 72411-1

Plate 45

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		41.6	36.5	17.6	4.3	GC		21	43
□		39.1	32.6	23.1	5.2	GC		19	33

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	
1"	100.0		
3/4"	92.0	100.0	
1/2"	82.0	88.2	
3/8"	75.8	82.3	

	GRAIN SIZE ○	GRAIN SIZE □	
D_{60}	5.09	4.59	
D_{30}	0.179	0.0861	
D_{10}	0.0101	0.0060	

	COEFFICIENTS ○	COEFFICIENTS □	
C_c	0.63	0.27	
C_u	505.53	763.16	

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	
#4	58.4	60.9	
#10	45.2	48.5	
#40	35.0	41.2	
#100	28.6	36.0	
#200	21.9	28.3	

SOIL DESCRIPTION

○ Clayey gravel with sand

□ Clayey gravel with sand

REMARKS:

○

□

○ Location: Boring DUR2, sample: E

□ Location: Boring DUR2, sample: F

NEVADA DEPARTMENT OF TRANSPORTATION

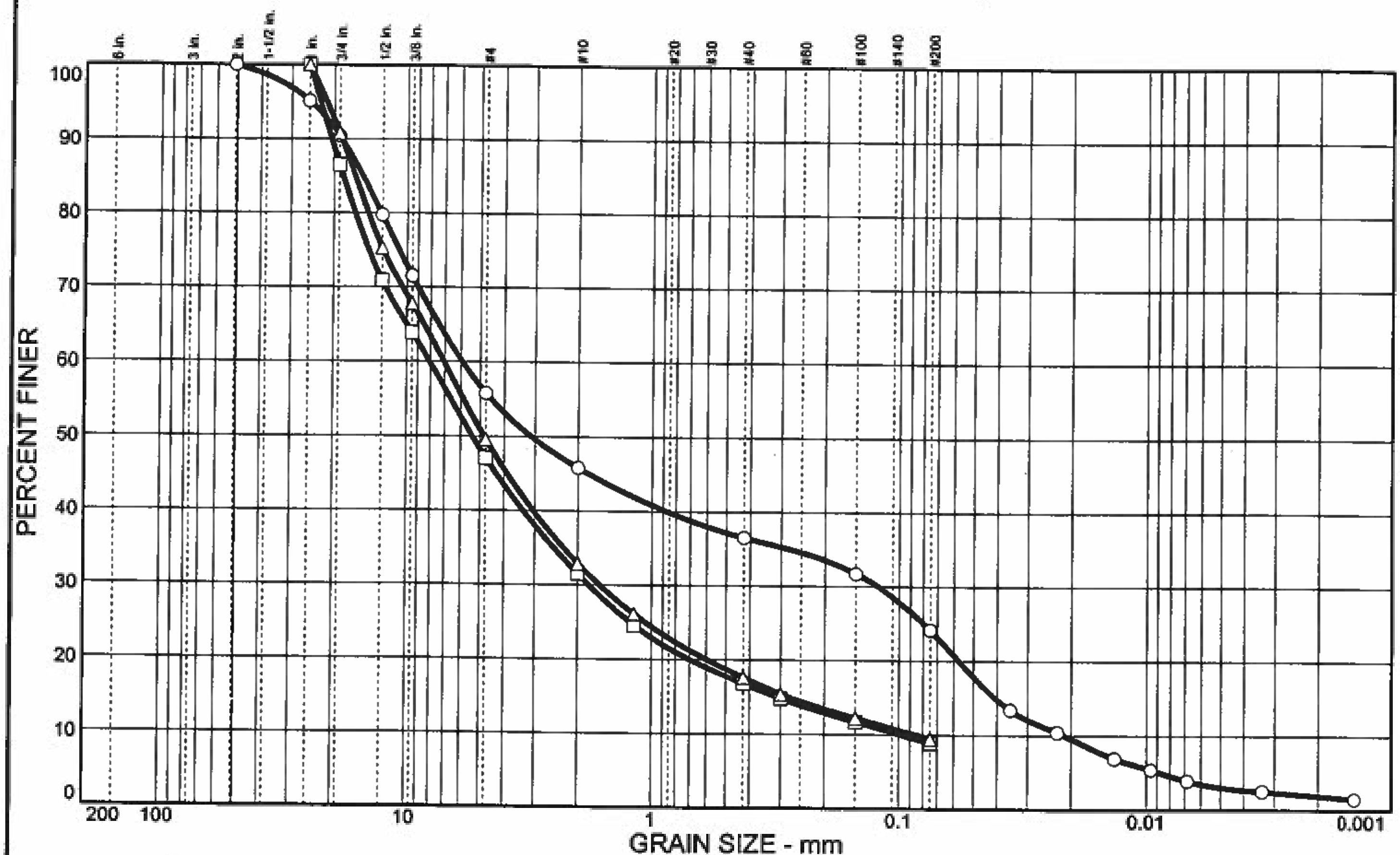
Client:

Project: Durango Interchange

Project No.: 72411-1

Plate 46

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		44.2	31.7	22.2	1.9	GC-GM		19	24
□		52.9	38.2	8.9		GP-GM		18	21
△		50.4	40.1	9.5		GP-GC		14	19

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
2"	100.0		
1"	95.1	100.0	100.0
3/4"	90.4	86.5	90.8
1/2"	79.7	70.9	75.3
3/8"	71.5	63.9	67.8

	GRAIN SIZE ○	GRAIN SIZE □	GRAIN SIZE △
D_{60}	5.93	8.08	7.05
D_{30}	0.123	1.80	1.63
D_{10}	0.0214	0.0985	0.0854

	COEFFICIENTS ○	COEFFICIENTS □	COEFFICIENTS △
C_c	0.12	4.09	4.40
C_u	277.15	81.99	82.54

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
#4	55.8	47.1	49.6
#10	45.8	31.5	32.9
#16		24.6	26.1
#40	36.5	16.8	17.6
#50		14.8	15.4
#100	31.7	11.7	12.2
#200	24.1	8.9	9.5

SOIL DESCRIPTION

○ Silty clayey gravel with sand

□ Poorly graded gravel with silt and sand

△ Poorly graded gravel with silty clay and sand

REMARKS:

○

□

△

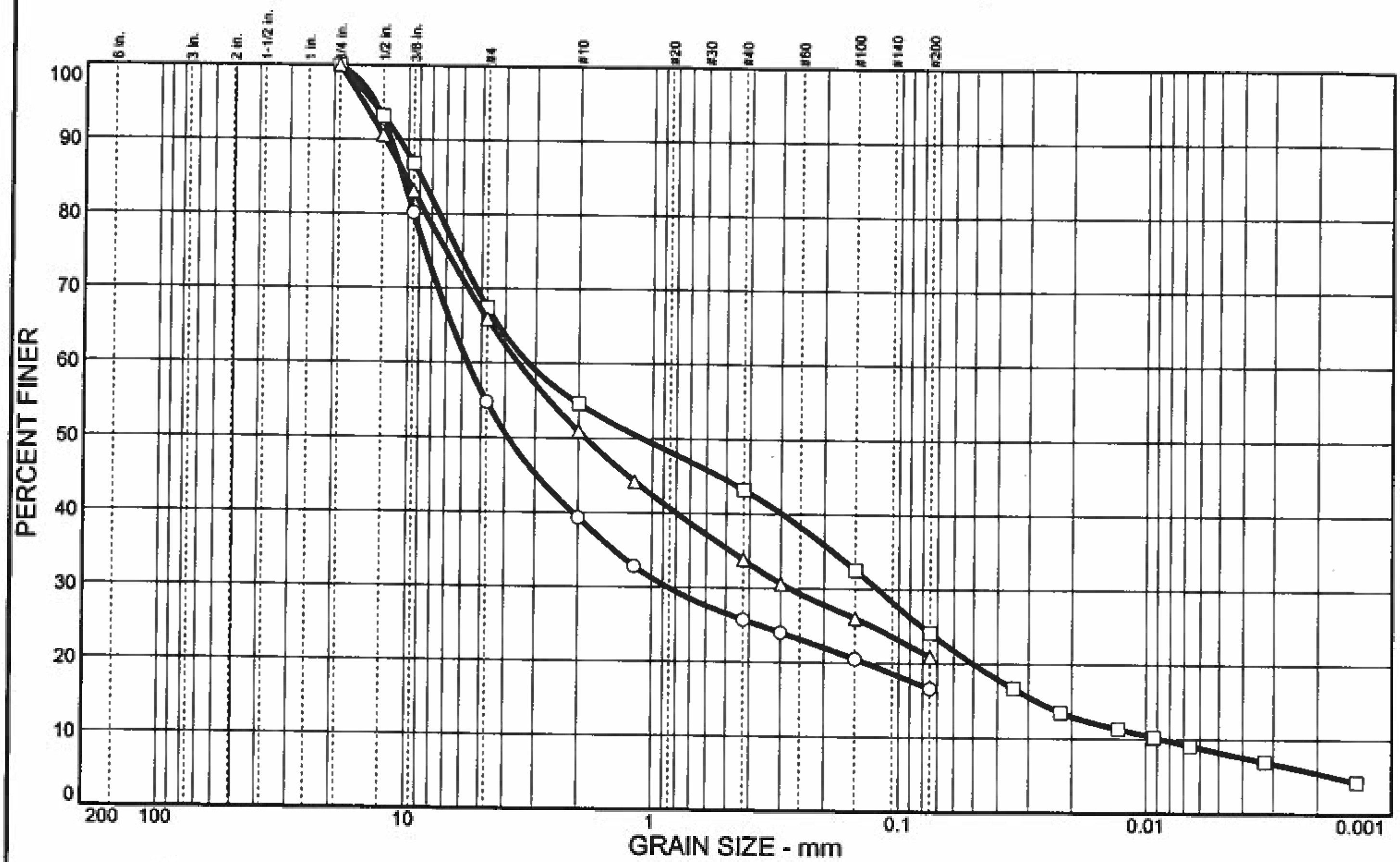
○ Location: Boring DUR3, sample: A

□ Location: Boring DUR3, sample: BC

△ Location: Boring DUR3, sample: DE

NEVADA DEPARTMENT OF TRANSPORTATION	Client: Project: Durango Interchange Project No.: 72411-1 Plate 47

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		45.2	38.2	16.6		GC-GM		15	22
□		32.6	43.3	18.6	5.5	SC-SM		15	21
△		34.1	45.0	20.9		SC		13	21

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
3/4"	100.0	100.0	100.0
1/2"	92.8	93.2	90.6
3/8"	80.2	86.8	83.1
GRAIN SIZE			
D_{60}	5.68	3.22	3.53
D_{30}	0.867	0.122	0.278
D_{10}		0.0087	
COEFFICIENTS			
C_c		0.53	
C_u		369.14	

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
#4	54.8	67.4	65.9
#10	39.3	54.6	50.9
#16	32.8		44.2
#40	25.7	43.2	33.8
#50	24.0		30.6
#100	20.5	32.5	26.0
#200	16.6	24.1	20.9

SOIL DESCRIPTION

○ Silty clayey gravel with sand

□ Silty, clayey sand with gravel

△ Clayey sand with gravel

REMARKS:

○

□

△

○ Location: Boring DUR3, sample: F

□ Location: Boring DUR3, sample: G

△ Location: Boring DUR3, sample: H

NEVADA DEPARTMENT OF TRANSPORTATION

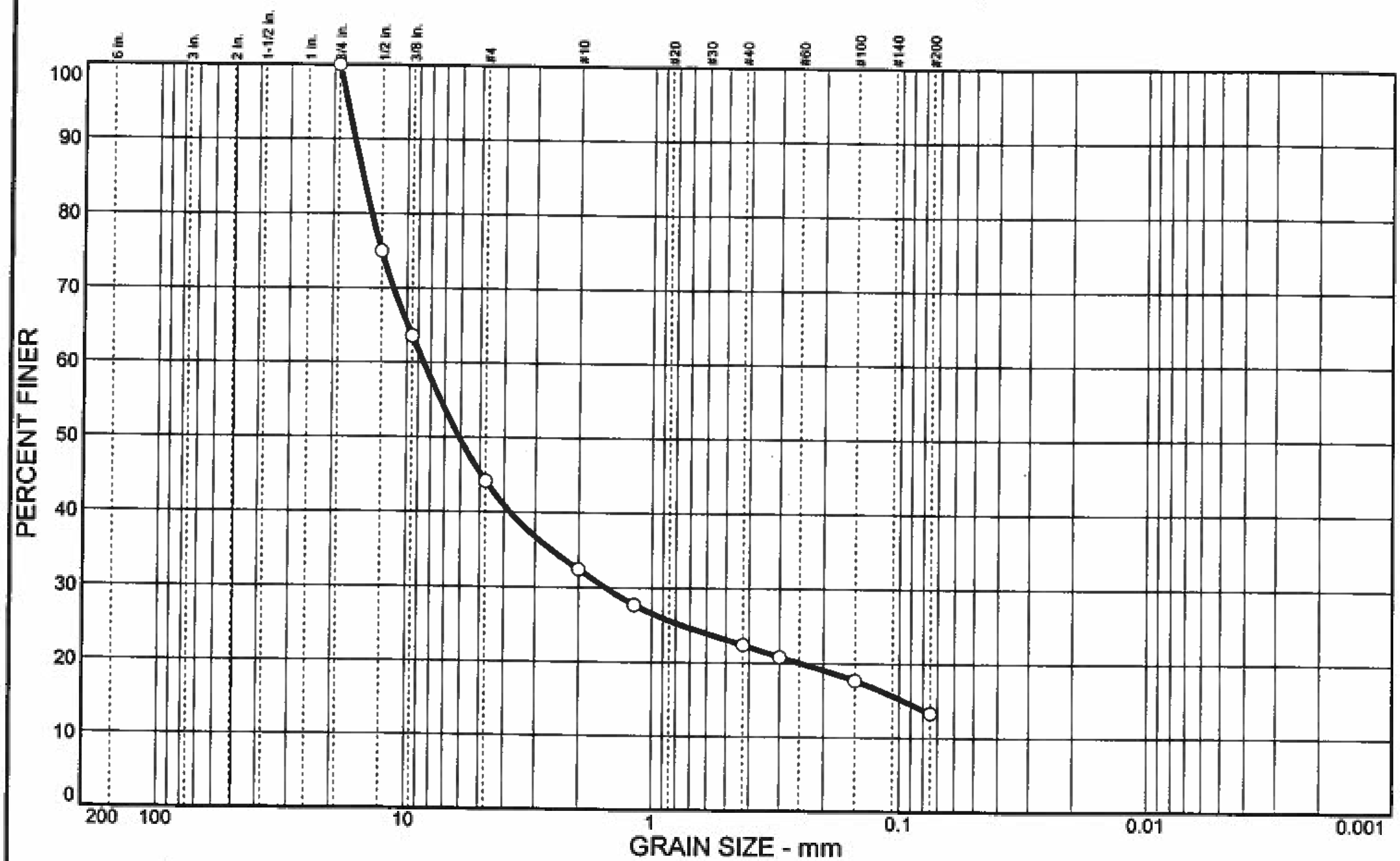
Client:

Project: Durango Interchange

Project No.: 72411-1

Plate 48

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		55.9	30.8	13.3		GM			

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
1/2"	75.0		
3/8"	63.6		

	GRAIN SIZE		
D_{60}	8.55		
D_{30}	1.55		
D_{10}			

	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	44.1		
#10	32.4		
#16	27.7		
#40	22.4		
#50	20.8		
#100	17.7		
#200	13.3		

SOIL DESCRIPTION

○ Silty gravel with sand

REMARKS:

○

○ Location: Boring DUR3, sample: J

NEVADA DEPARTMENT OF TRANSPORTATION

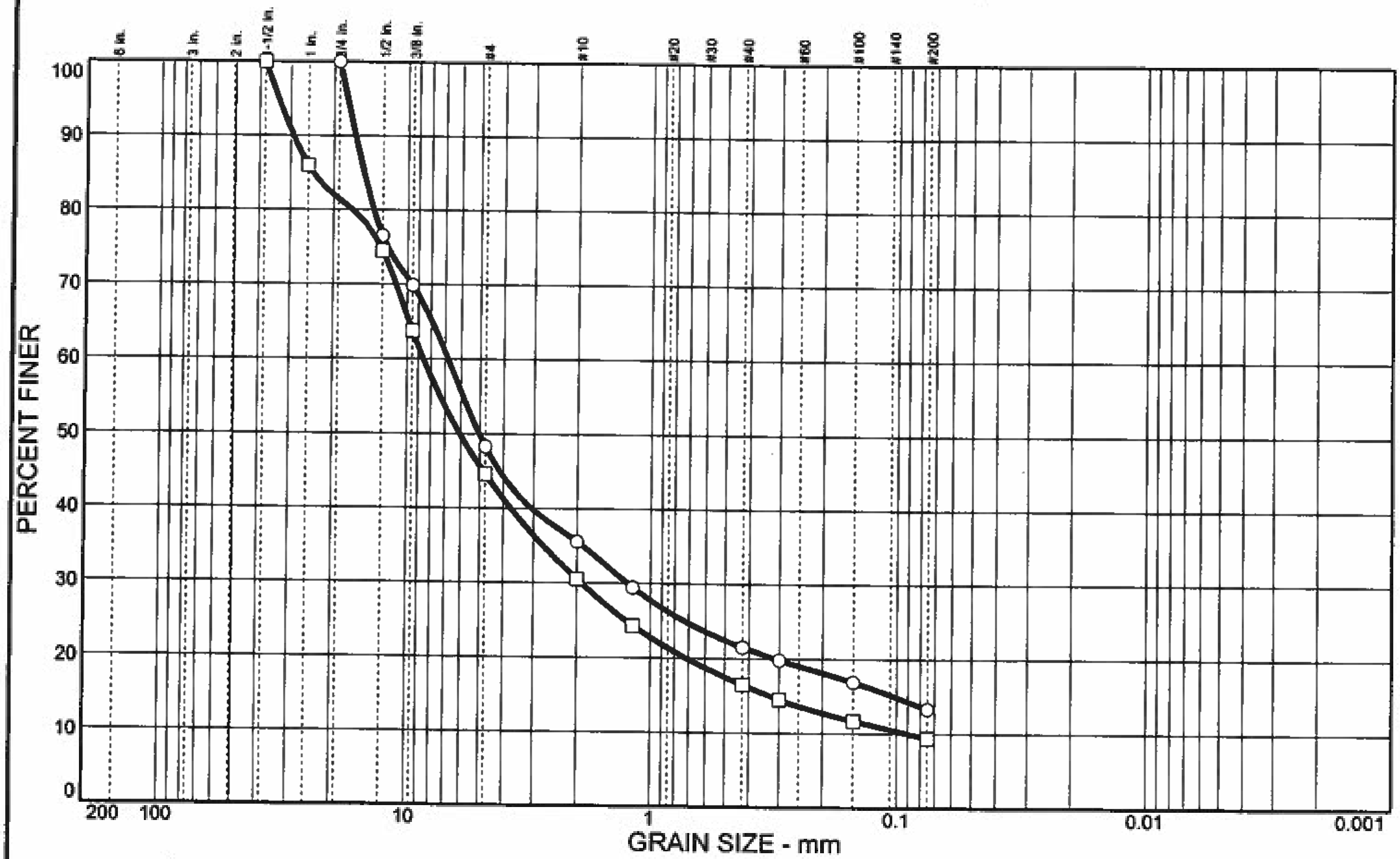
Client:

Project: Durango Interchange

Project No.: 72411-1

Plate 49

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		51.7	35.0	13.3		GC-GM		17	22
□		55.4	35.2	9.4		GP-GC		15	20

SIEVE inches size	PERCENT FINER ○	□	
1-1/2"		100.0	
1"		86.0	
3/4"	100.0		
1/2"	76.5	74.5	
3/8"	69.9	63.8	
	GRAIN SIZE		
D_{60}	6.80	8.57	
D_{30}	1.25	1.93	
D_{10}		0.0901	
	COEFFICIENTS		
C_c		4.80	
C_u		95.16	

SIEVE number size	PERCENT FINER ○	□	
#4	48.3	44.6	
#10	35.5	30.5	
#16	29.4	24.3	
#40	21.5	16.5	
#50	19.8	14.5	
#100	16.9	11.7	
#200	13.3	9.4	

SOIL DESCRIPTION

○ Silty clayey gravel with sand

□ Poorly graded gravel with silty clay and sand

REMARKS:

○

□

○ Location: Boring DUR4, sample: A

□ Location: Boring DUR4, sample: BC

NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: Durango Interchange

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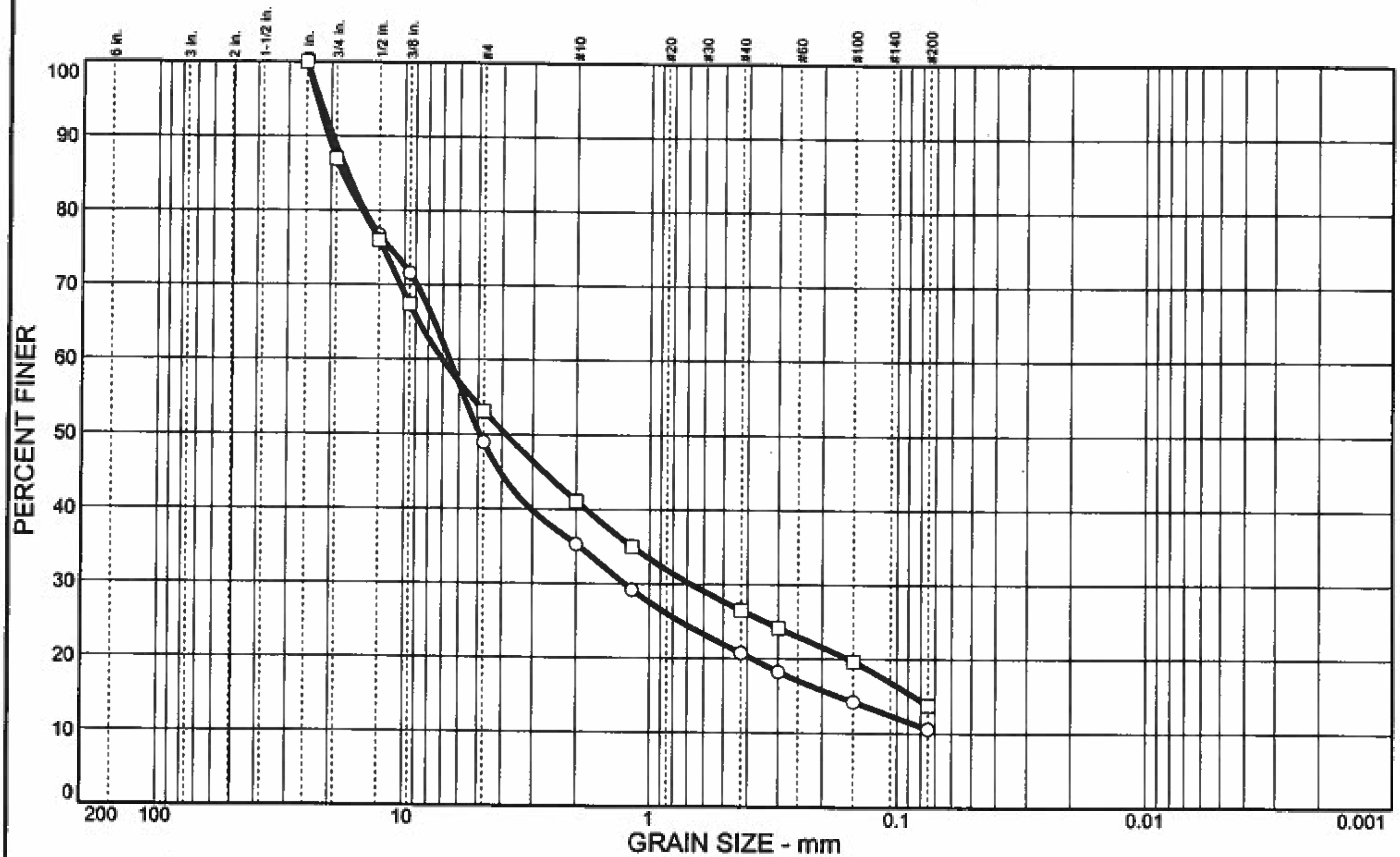
Plate 50

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		51.1	38.3	10.6		GP-GM		15	18
□		46.9	39.3	13.8		GC		22	41

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	
1"	100.0	100.0	
3/4"		87.0	
1/2"	76.7	76.0	
3/8"	71.6	67.4	
	GRAIN SIZE		
D_{60}	6.56	7.04	
D_{30}	1.27	0.679	
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	
#4	48.9	53.1	
#10	35.3	41.1	
#16	29.2	35.0	
#40	20.7	26.5	
#50	18.2	24.1	
#100	14.2	19.6	
#200	10.6	13.8	

SOIL DESCRIPTION

○ Poorly graded gravel with silt and sand

□ Clayey gravel with sand

REMARKS:

○

□

○ Location: Boring DUR4, sample: DE

□ Location: Boring DUR4, sample: HIJ

NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: Durango Interchange

Project No.: 72411-1

Plate 51

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL SECTION

CHEMICAL ANALYSIS

E.A. No. 72411

PROJECT US 95 @ Durango Interchange

BORING # DUR2

Sample No.	Chlorides ppm	Sulfates ppm	Ph	Resistivity Ohm-cm
B	50	0	8.4	3,597
E	50	0	8.5	3,676

R-Values at Durango Interchange.

STATION	LOCATION FROM CENTERLINE	DEPTH	R-VALUE
"XS1" 88+91	91.44 meters left	0 to 1.524 meters	80
"XS1" 88+91	121.92 meters right	0 to 1.524 meters	78