GEOTECHNICAL REPORT
US 93 WILDLIFE OVERCROSSING
At HD SUMMIT
North of Wells, Nevada
E.A. 73524
December 2009

NEVADA DOT
GEOTECHNICAL ENGINEERING

MATERIALS DIVISION

STATE OF NEVADA

DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

GEOTECHNICAL SECTION

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E.A. 73524
December 2009

ELKO COUNTY, NEVADA

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INTRODUCTION

General

This report has been prepared for the planned wildlife overcrossing at HD Summit on US 93 in Elko County north of Wells, Nevada (See Photo 1). This area has been identified as one of the higher areas of vehicle/animal conflicts in the state. The area is shown on the Project Location Area Map in Appendix A.

Photo 1. Looking east-southeast across US 93 at HD Summit (Note RWIS Station in background at right).

Purpose and Scope

The purpose of this report is to provide information regarding the subsurface soil conditions at the proposed project site. This report also provides geotechnical design recommendations for the construction of the structures proposed for this project. The scope of this report consists primarily of geotechnical exploration, analysis, and recommendations for both design and construction. The investigation included gathering information obtained from previous subsurface explorations, soil sampling, seismic

refraction, refraction microtremor (ReMi) analysis, and analysis of field and laboratory testing data. This report includes boring logs and summaries of test results from both the field investigations and laboratory testing, as well as information obtained during the seismic investigation. This information may be found in appendices B, C, and D respectively.

PROJECT DESCRIPTION

The project site is located north of the city of Wells in Elko County. US 93 runs roughly north/south in the area of the proposed structure. The wildlife overcrossing is planned to be located at HD Summit, at approximately milepost EL 93.5. Preliminary plans indicate the proposed structure will be constructed using prefabricated arch sections placed in a roadway cut section, then covered to create the wildlife overcrossing. Other types of prefabricated structures may also be considered.

The roadway will be lowered approximately eight feet to increase sight distance limited by the alignment's vertical and horizontal curves, as well as accommodate the roughly 24-foot high structure. Retaining walls will be attached to the structure on both ends, with a separate retaining wall protecting the NDOT RWIS station located at the site.

GEOLOGIC CONDITIONS and SEISMICITY

This area lies at an elevation of approximately 6280 feet and slopes downward to the west northwest. The site is located between the HD range to the east and the Snake Mountains to the west[1]. The four sites that were drilled are founded primarily in shallow quaternary alluvium (Qa)[2] overlaying what appears to be highly fractured bedrock. These deposits are generally light to dark brown to black silty clayey sand with gravel.

While the majority of seismic activity in Nevada occurs along the western and southwestern border of the state, the recent 6.0 magnitude earthquake 11 miles south-southeast of Wells in February of 2008[3] helps to confirm Nevada as one of the most seismically active states in the country.

FIELD INVESTIGATION

The Geotechnical Section performed site exploration in the area being considered for a wildlife overcrossing at approximately milepost EL 93.5 on US 93, north of Wells in Elko County. The purpose of this exploration was to obtain geotechnical information for the design of a structure to be built over US 93 to serve as wildlife overcrossing for local animal populations. Four boreholes were drilled on September 1st and 2nd, 2009. The four borehole locations were placed in wide shoulders in an area of embankment cut, with the roadway surface between 5 feet to 15 feet below adjacent ground. All 4 boreholes were drilled through the pavement into the native soil.

The exploration boreholes were placed near the four corners of the proposed wildlife overcrossing (See Photo 2). Drilling was accomplished with a Diedrich D-120 drill rig equipped for soil sampling, using 6-inch hollow stem auger on all boreholes. The approximate location of each borehole is shown on the Borehole Location sheet in Appendix A.

Photo 2. Drill Rig Setting Up on Borehole OC-4.

Boreholes OC-1 through OC-4 were drilled to depths between 50.2 feet and 65.3 feet. The surface elevations were obtained for the borehole locations by shooting from a known elevation point with an optical level. Soil samples and standard penetration resistance values (N-Values) were obtained utilizing the Standard Penetration Test (SPT) procedure as set forth in AASHTO test number T206. Larger samples, generally obtained with a California Modified Sampler (CMS), were not taken due to the very dense granular soil. The uncorrected blow counts are shown on the boring logs in Appendix B. All soil samples were classified, both visually and using laboratory data, using the Unified Soil Classification System (USCS) described in ASTM test number D2487.

Seismic refraction was performed at the site on October 1st, 2009. Two lines were run parallel to the roadway, one each on the east and west sides of the alignment, at the proposed location for the structure (See Photo 3). The results of the testing show acoustic velocities exceeding 10,000 feet per second (fps).

Photo 3. Seismic Refraction Run on West Side of US 93 at HD Summit.

Refraction microtremor (ReMi) analysis was used to characterize the subsurface material at the site. Results and plots from the seismic refraction and refraction microtremor are located in Appendix D.

Groundwater was found in all four boreholes at depths from 17.3 feet to 29.7 feet below the ground surface during drilling, at elevations between 6250 feet and 6260 feet. Water levels were checked one or two days later, with the water levels stabilizing between 14.4 feet and 19.1 feet below the surface, at elevations between 6260 feet and 6263 feet. See the boring logs in Appendix B for more detail.

LABORATORY ANALYSIS

Laboratory tests were performed on the samples collected from the boreholes. The testing program consisted of sieve analyses, Atterberg limits, presence of organic material, and Resistance Values (R-Values). The results of this testing program show that the soil consists primarily of silty clayey sand with gravels. Further information is presented in the summaries of test results in Appendix C.

DISCUSSION

Following the field investigation and laboratory testing, the soils were identified as silty clayey sand with gravels (See Photos 4 and 5). The shear wave velocities measured during refraction microtremor (ReMi), along with the subsurface behavior observed during drilling indicates the presence of highly fractured bedrock at 25 to 30 feet below the ground surface, at elevations ranging from approximately 6253 feet to 6258 feet. The investigation showed the subsurface material to be relatively easy to drill through, using 6” hollow stem auger. This, along with the quickly changing water levels, indicates the material is highly fractured. The presence of bedrock is also indicated by the repeated refusal of the SPT sampler. Liquefaction is unlikely to occur due to soil type and density, as well as the low seismic accelerations experienced in the region.

Photos 4 and 5. Samples OC-3 G and OC-4 G.

Settlement analysis was performed based on assumed footing sizes of 14 feet wide by 100 feet long, with an applied load of 15000 pounds per square foot (psf) and 21 feet wide by 100 feet long, with an applied load of 5000 pounds per square foot (psf). The assumed bottom of footing elevation is approximately 6265 feet. Due to the granular, non-cohesive nature of the underlying soil, the settlement should occur immediately during construction. The estimated amount of settlement is less than one inch (1"), and the estimated amount of differential settlement is less than one half inch (½").

RECOMMENDATIONS

Excavation

All excavation shall be performed in accordance with the NDOT 2001 Standard Specifications for Road and Bridge Construction[4]. All permanent slopes should be constructed to lie at a maximum of 2:1 (Horiz:Vert) slope. The contractor shall be responsible for all necessary shoring for any excavation and/or construction. All shoring must be in compliance with the Code of Federal Regulations 29 CFR part 1926. The native soils should be considered OSHA Type B for temporary excavations purposes. According to OSHA, the maximum allowable slope is 1H:1V in Type B soils for temporary excavations. The contractor should also monitor the existing paved roadway adjacent to the excavations to minimize deflection or damage to the structural section.

The anticipated excavation depth of approximately 12 feet below existing grade closely approaches the groundwater levels encountered during the field investigation. Dewatering may be required for the footing excavations. High acoustic velocities observed during seismic refraction indicate the presence of very hard bedrock, which may require substantial effort to excavate.

Foundations

Spread footings for retaining walls placed in embankments have an allowable bearing capacity of 4000 psf (4 ksf). Spread footings for the structure and retaining walls placed in native soil have an allowable bearing capacity of 15000 psf (15 ksf). The proposed structure footings are expected to be approximately 14 feet wide and 100 feet long. The assumed bottom of footing elevation is approximately 6265 feet. The contractor must perform and provide a complete settlement analysis using the actual dimensions and loads for the approved structure.

Mechanically Stabilized Earth (MSE) Walls

For this project NDOT has eliminated the requirement to use only approved Mechanically Stabilized Earth (MSE) Walls from the Qualified Products List (QPL). Also eliminated was the requirement to use inextensible reinforcement, as well as the 30 square foot maximum MSE panel size. The use of extensible (geosynthetic) reinforcement, and/or full height MSE wall panels will be allowed.

The in-situ soil parameters for MSE walls are as follows:

Cohesion (c) = 0 psf
Soil Friction Angle (φ) = 34°
Soil Unit Weight (γ)= 120 pcf

Settlement

The estimated amount of settlement of the structure footings and MSE Walls is less than one inch (1”), and the estimated amount of differential settlement is less than one half inch (½“). This settlement should be immediate, occurring during construction, and no long term consolidation settlement is anticipated due to the very dense granular soils present at the site.

Lateral Load Analysis

The following parameters are provided for seismic evaluation[5].

Horizontal Acceleration coefficient	= 0.11g*
Peak Ground Acceleration coefficient	= 0.15g†
Seismic Performance Category	= B
Soil Profile	= Type I
Site Coefficient (S)	= 1.0

* - Value provided by AASHTO Figure 1-5

† - Value recommended by NDOT Bridge Manual

REFERENCES

1. Bulletin 101, Geology of Elko County, Nevada; Nevada Bureau of Mines and Geology, 1987.

2. Geologic Map of Elko County, Nevada, Bulletin 101, Plate 1; Nevada Bureau of Mines and Geology, 1987.

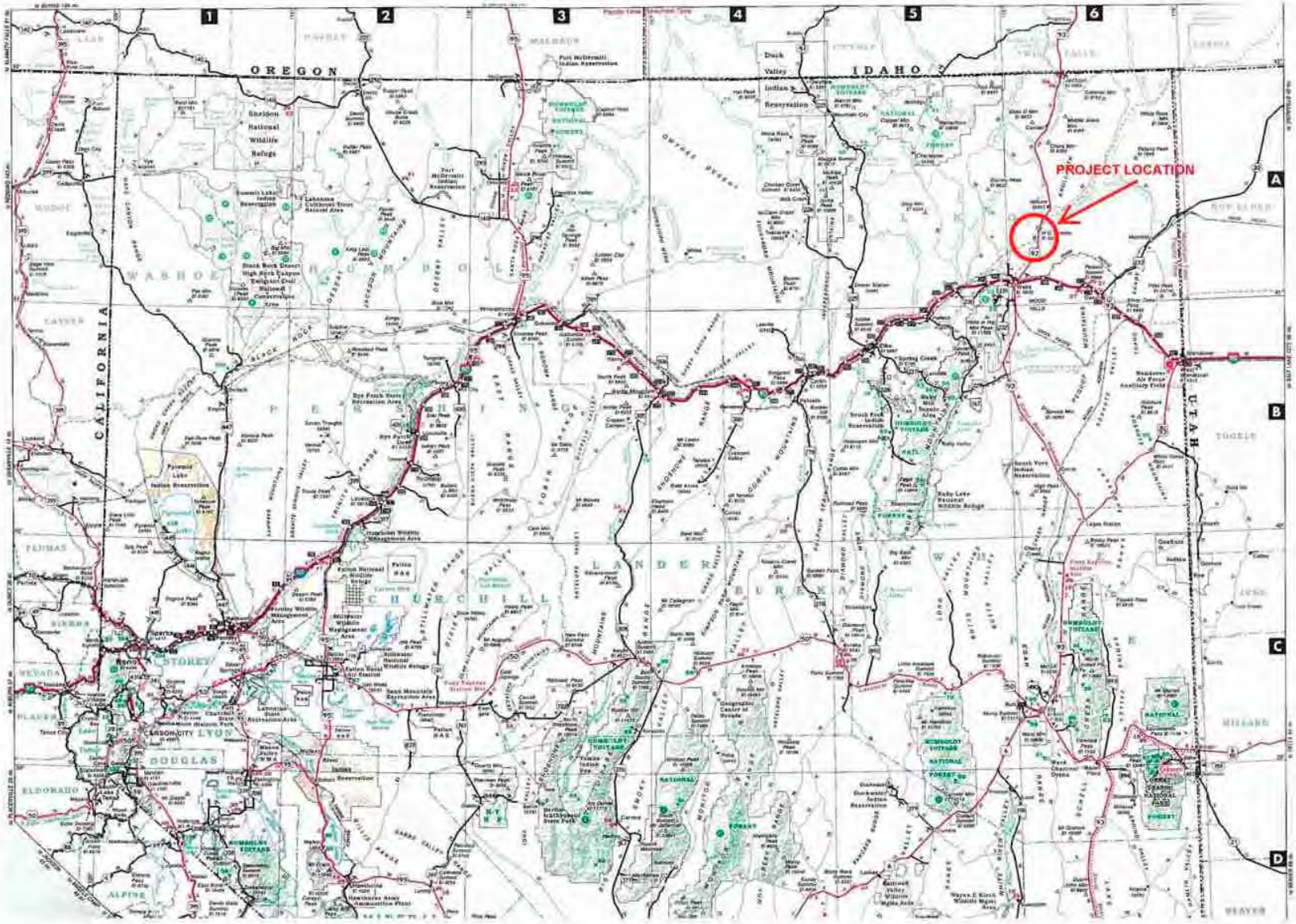
3. 6.0 quake shakes Wells, Nev. (UPDATED), Las Vegas Sun, February 21, 2008.

4. Standard Specifications for Road and Bridge Construction, State of Nevada Department of Transportation, 2001.

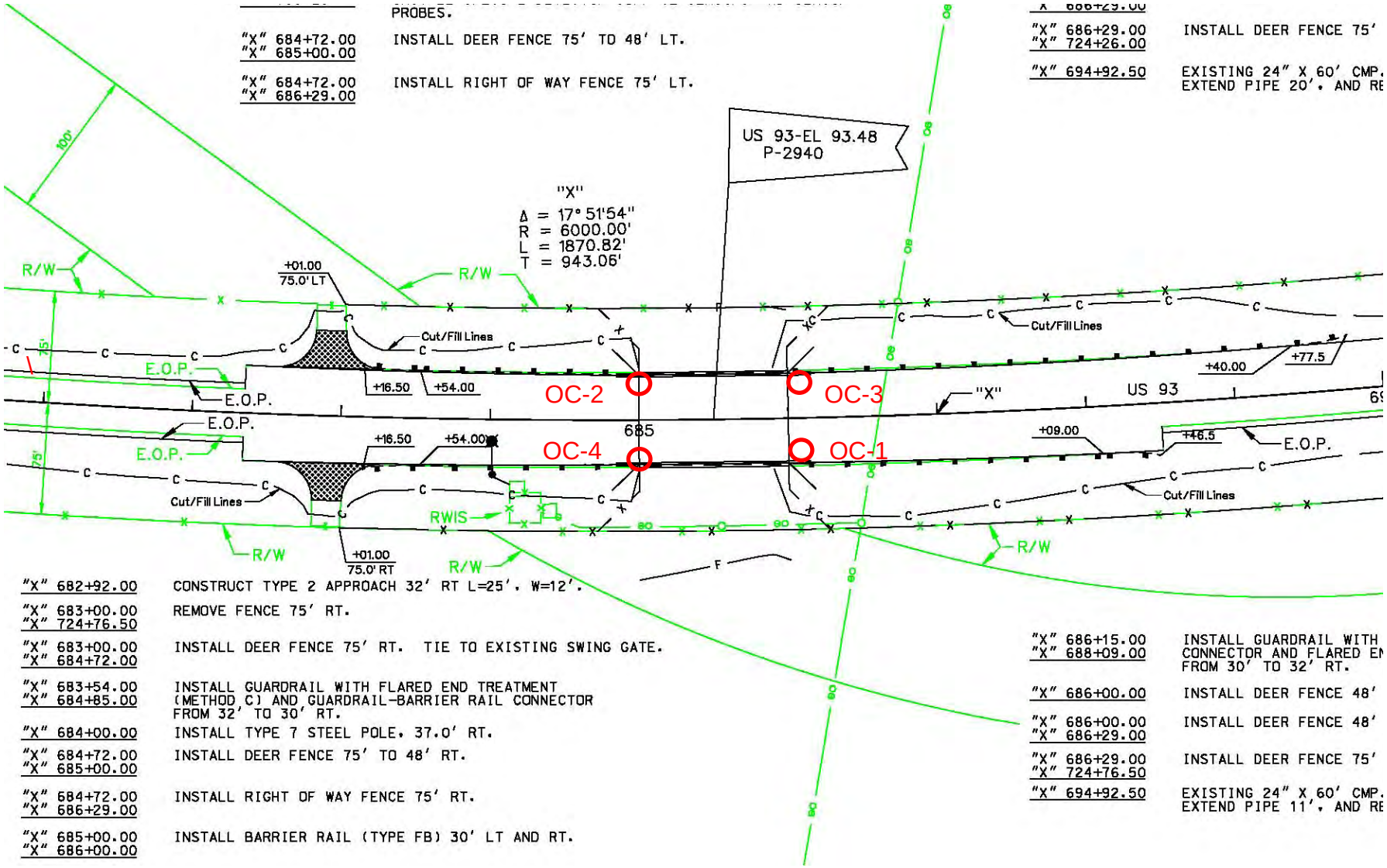
5. AASHTO Standard Specifications for Highway Bridges, 17th edition, 2002.

APPENDIX A

Project Location Area Map
Borehole Location Sheets



PROJECT LOCATION AREA MAP



BOREHOLE LOCATIONS

APPENDIX B

Boring Log Key
Boring Logs

KEY TO BORING LOGS

PARTICLE SIZE LIMITS								
CLAY	SILT	SAND			GRAVEL		COBBLES	BOULDERS
		FINE	MEDIUM	COARSE	FINE	COARSE		
.002 mm	#200	#40	#10	#4	3/4 inch	3 inch	12 inch	

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.

▽ ▼ **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) 140 lb hammer
30 inch free-fall on 2 inch O.D. x 1.4 inch 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:

$(N_{AUTOMATIC})(1.30) = N_{60}$

$(N_{SAFETY})(1.17) = N_{60}$

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 SPOON
P	PUSHED (NOT DRIVEN)
PB	PITCHER BARREL
RC	ROCK CORE③
SH	SHELBY TUBE④
SPT	STANDARD PENETRATION TEST
TP	TEST PIT

① - I.D.= 2.421 inch
② - I.D.=3.228 inch with tube; 3.50 inch w/o tube
③ - NXB I.D.= 1.875 inch
④ - I.D.= 2.875 inch

LAST MODIFIED: October 11, 2006

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION — GEOTECHNICAL ENGINEERING

START DATE 9/1/09
END DATE 9/1/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-1
E.A. # 73524
GROUND ELEV. 6278.64 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/1/09	28.70	6249.9
9/3/09	17.00	6261.6

STATION "X"686+07
OFFSET 25' Right
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.60								**ASPHALTIC CONCRETE**	
	1.50								**AGGREGATE BASE**	
	4.00	A	SPT	15/1"	15/1"	0				Bulk 1 @ 2.5'-5.0'. (A) Last 12 blows / 0.25"; No recovery
6273.6	5									
	9.00	B	SPT	10/0.25"	10/0.25"	0		SC SM		Bulk 2 @ 7.0'-9.0'. (B) Last 10 blows / 0.25"; No recovery
6268.6	10									
	13.00	C	SPT	15/1"	15/1"	0				(C) Last 10 blows / No progress; No recovery
6263.6	15									
	15.00	D	SPT	45 50/5.5"	50/5.5"	100			**SILTY CLAYEY SAND with GRAVEL** Very dark grayish brown, dry, very dense	(D) 100 psi down pressure - relatively easy drilling
	16.00									
	17.50									
	19.00									
	19.50	E	SPT	50/5.5"	50/5.5"	100		SC	**CLAYEY SAND** Medium to dark brown, dry to damp, very dense	
6258.6	20									
	22.00									
	24.50									
6253.6	25	F	SPT	34 42 25/2"	25/2"	100		SC SM	**SILTY CLAYEY SAND** Medium to dark brown, dry to damp, very dense	(F) Last 10 blows / No progress
	25.70									
	30.00									Free water @ 28.7'
	30.00									

NV_DOT US 93 WILDLIFE OVERCROSSING.GPJ NV_DOT.GDT 12/16/09

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE 9/1/09
END DATE 9/1/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-1
E.A. # 73524
GROUND ELEV. 6278.64 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/1/09	28.70	6249.9
9/3/09	17.00	6261.6

STATION "X"686+07
OFFSET 25' Right
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	30.30	G	SPT	50/3.5"	50/3.5"	0				(G) No recovery
6243.6	35									
	36.00									
	36.30	H	SPT	30/4"	30/4"	100			**SILTY CLAYEY SAND with GRAVEL** Black, wet, very dense	(H) Last 10 blows / No progress
6238.6	40							**SC SM**		
	40.00									
	40.80	I	SPT	27 30/3.5"	30/3.5"	100			**SILTY CLAYEY SAND with GRAVEL** Black, wet, very dense	(I) Last 10 blows / No progress
6233.6	45									
	50.00									
6228.6	50 50.20	J	SPT	15/1.75"	15/1.75"	0			50.20 **B.O.H.**	(J) Last 10 blows / No progress; No recovery
6223.6	55									

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION — GEOTECHNICAL ENGINEERING

START DATE 9/1/09
END DATE 9/1/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-2
E.A. # 73524
GROUND ELEV. 6278.12 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/1/09	19.50	6258.6
9/3/09	17.70	6260.4

STATION "X"685+01
OFFSET 23' Left
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
									0.60 **ASPHALTIC CONCRETE**	
									1.50 **AGGREGATE BASE**	
										Bulk 1 @ 2.5'-5.0'.
6273.1	5 5.00 / 5.70	A	SPT	19 / 19/2"	19/2"	100			**SILTY CLAYEY SAND with GRAVEL** Medium brown, dry, very dense	(A) Last 10 blows / No progress
										Bulk 2 @ 7.5'-10.0'.
6268.1	10 10.00 / 10.40	B	SPT	50/5"	50/5"	100			**SILTY CLAYEY SAND with GRAVEL** Medium brown, dry, very dense	
6263.1	15 15.00 / 16.50	C	SPT	14 / 23 / 27	50	100		SC SM	**SILTY CLAYEY SAND with GRAVEL** Light to medium brown, dry to damp, very dense	
6258.1	20 20.00 / 20.10	D	SPT	12/0.5"	12/0.5"	0				Free water @ 19.5' (D) No recovery
6253.1	25 25.00 / 25.40	E	SPT	50/4.5"	50/4.5"	100			**SILTY CLAYEY SAND with GRAVEL** Dark grayish brown to black, wet, very dense	
									30.00	

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION — GEOTECHNICAL ENGINEERING

START DATE 9/1/09
END DATE 9/1/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-2
E.A. # 73524
GROUND ELEV. 6278.12 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/1/09	19.50	6258.6
9/3/09	17.70	6260.4

STATION "X"685+01
OFFSET 23' Left
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
6243.1	35									
	35.00									
	35.60	F	SPT	26 25/1"	25/1"	100			**SILTY CLAYEY SAND** Black, wet, very dense	(F) Last 10 blows / No progress
6238.1	40							**SC** **SM**		
6233.1	45									
	45.00									
	46.30	G	SPT	33 42 50/3"	50/3"	100			**SILTY CLAYEY SAND** Black, wet, very dense	
6228.1	50									
	50.00									
	50.30	H	SPT	50/4"	50/4"	100			50.30 **SILTY CLAYEY SAND** Black, wet, very dense	
									B.O.H.	
6223.1	55									

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION — GEOTECHNICAL ENGINEERING

START DATE 9/2/09
END DATE 9/2/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-3
E.A. # 73524
GROUND ELEV. 6277.59 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/2/09	17.30	6260.3
9/3/09	14.40	6263.2

STATION "X"686+09
OFFSET 25' Left
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.60								**ASPHALTIC CONCRETE**	
	1.50								**AGGREGATE BASE**	
	2.50									
	3.40	A	SPT	26 50/4.5"	50/4.5"	100		SC SM	**SILTY CLAYEY SAND with GRAVEL** Medium brown, dry, very dense	Bulk 1 @ 4.0'-6.0'.
6272.6	5									
	8.00									
	8.40	B	SPT	50/5"	50/5"	100			**SILTY CLAYEY SAND** Medium brown, dry, very dense	
6267.6	10									
	10.70									
	13.00									Bulk 2 @ 12.0'-14.0'.
	13.70	C	SPT	39 35/2"	35/2"	100			**CLAYEY SAND** Medium brown, dry, very dense	(C) Last 10 blows / No progress
6262.6	15									
	18.00									Free water @ 17.3'
	18.30	D	SPT	50/3.5"	50/3.5"	100		SC	**CLAYEY SAND** Medium to dark brown, damp to wet, very dense	
6257.6	20									
	23.00									Hard layer @ 21.5' to 22.5'
	23.30	E	SPT	50/3"	50/3"	100			**CLAYEY SAND** Medium to dark brown, damp to wet, very dense	
6252.6	25									
	25.65									
	28.00									
	28.40	F	SPT	50/4.5"	50/4.5"	100		SC SM	**SILTY CLAYEY SAND with GRAVEL** Medium brown, wet, very dense	
	30.00									

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION — GEOTECHNICAL ENGINEERING

START DATE 9/2/09
END DATE 9/2/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-3
E.A. # 73524
GROUND ELEV. 6277.59 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/2/09	17.30	6260.3
9/3/09	14.40	6263.2

STATION "X"686+09
OFFSET 25' Left
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	33.00									
	33.90	G	SPT	60 50/4.5"	50/4.5"	100			**SILTY CLAYEY SAND with GRAVEL** Medium to dark brown, wet, very dense	
6242.6	35									
	38.00									
	38.40	H	SPT	50/3.5"	50/3.5"	100			**SILTY CLAYEY SAND with GRAVEL** Medium to dark brown, wet, very dense	
6237.6	40									
	43.00									
	43.60	I	SPT	49 20/1"	20/1"	100			**SILTY CLAYEY SAND with GRAVEL** Very dark brown to black, wet, very dense	(I) Last 10 blows / No progress
6232.6	45							**SC** **SM**		
6227.6	50									
	55.00									
6222.6	55									
	55.40	J	SPT	50/3.5"	50/3.5"	100			**SILTY CLAYEY SAND with GRAVEL** Very dark brown, wet, very dense	
									60.00	

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION — GEOTECHNICAL ENGINEERING

START DATE 9/2/09
END DATE 9/2/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-3
E.A. # 73524
GROUND ELEV. 6277.59 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/2/09	17.30	6260.3
9/3/09	14.40	6263.2

STATION "X"686+09
OFFSET 25' Left
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
								SC SM		
6212.6	65 65.00 65.30	K	SPT	50/4"	50/4"	100			65.30 **SILTY CLAYEY SAND with GRAVEL** Very dark brown, wet, very dense	
									B.O.H.	
6207.6	70									
6202.6	75									
6197.6	80									
6192.6	85									

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION — GEOTECHNICAL ENGINEERING

START DATE 9/2/09
END DATE 9/2/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-4
E.A. # 73524
GROUND ELEV. 6279.02 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/2/09	29.70	6249.3
9/3/09	19.10	6259.9

STATION "X"685+00
OFFSET 25' Right
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.60								**ASPHALTIC CONCRETE**	
	1.50								**AGGREGATE BASE**	
	2.50									
	3.20	A	SPT	34 25/2"	25/2"	100			**SILTY CLAYEY SAND with GRAVEL** Light to medium brown, dry, very dense	(A) Last 10 blows / No progress
6274.0	5									Bulk 1 @ 6.0'-8.0'.
6269.0	10									Bulk 2 @ 11.0'-13.0'.
	13.00									
	13.90	B	SPT	30 50/5"	50/5"	100			**SILTY CLAYEY SAND** Light to medium brown, dry, very dense	
6264.0	15							SC SM		
	18.00									
	19.00	C	SPT	12 60/6"	60/6"	100			**SILTY CLAYEY SAND with GRAVEL** Medium brown, dry to damp, very dense	
6259.0	20									
6254.0	25									
	28.00									
	28.30	D	SPT	50/4"	50/4"	100			**SILTY CLAYEY SAND with GRAVEL** Dark grayish brown to black, dry to damp, very dense	Free water @ 29.7'
	30.00									

NV_DOT_US 93 WILDLIFE OVERCROSSING.GPJ NV_DOT.GDT 12/16/09

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE 9/2/09
END DATE 9/2/09
JOB DESCRIPTION US 93 Wildlife Overcrossing
LOCATION HD Summit
BORING OC-4
E.A. # 73524
GROUND ELEV. 6279.02 (ft)
HAMMER DROP SYSTEM Automatic

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
9/2/09	29.70	6249.3
9/3/09	19.10	6259.9

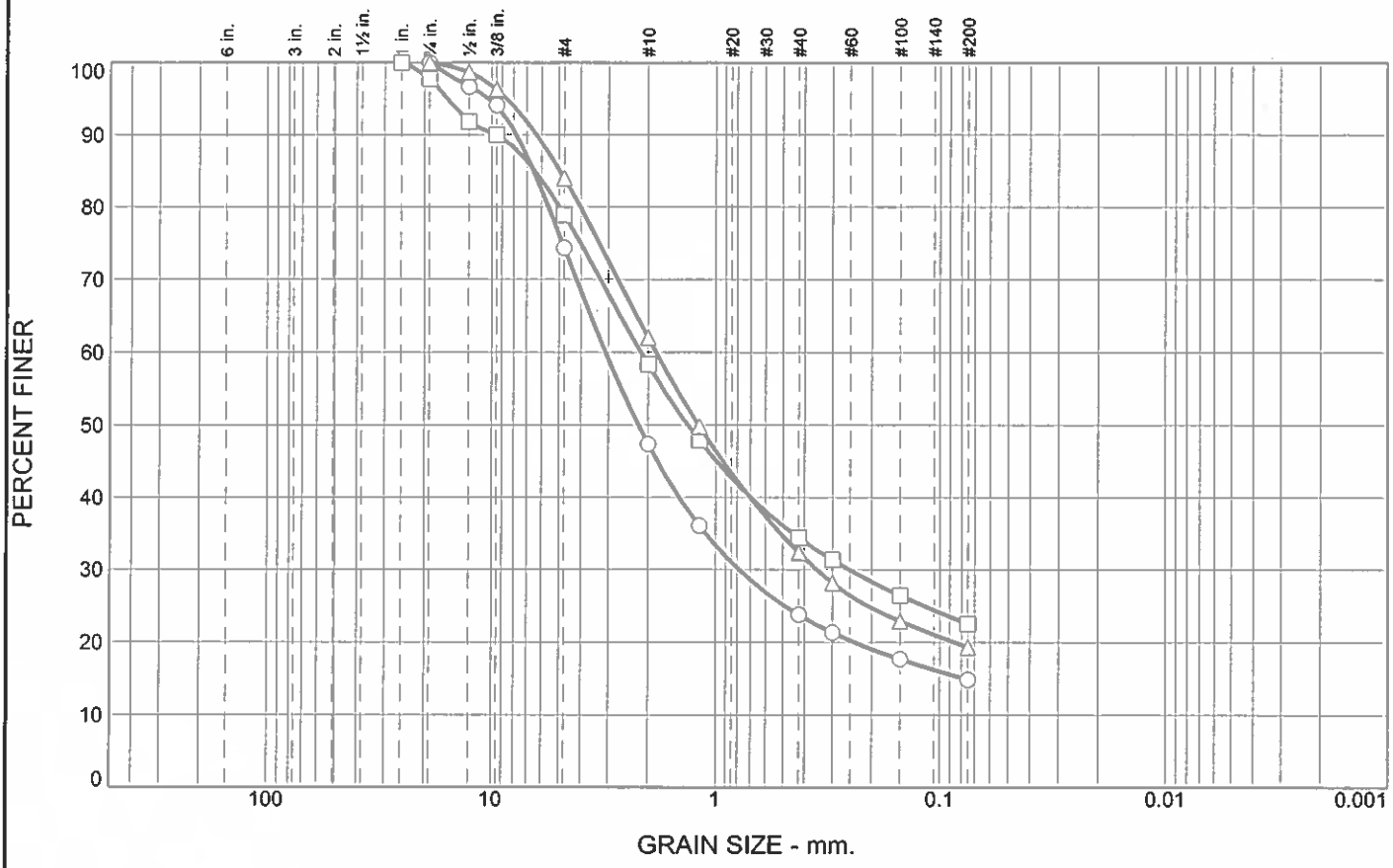
STATION "X"685+00
OFFSET 25' Right
ENGINEER Boomhower
EQUIPMENT Diedrich D-120
OPERATOR Altamirano
DRILLING METHOD 6" H.S.A.
BACKFILLED Yes DATE 9-3-09

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	33.00									
	33.70	E	SPT	28 35/2"	35/2"	100			**SILTY CLAYEY SAND with GRAVEL** Very dark brown to black, wet, very dense	(E) Last 10 blows / No progress
6244.0	35									
6239.0	40									
	42.50 42.70	F	SPT	40/2.5"	40/2.5"	0		**SC SM**		(F) Last 10 blows / No progress; No recovery
6234.0	45									
6229.0	50									
	55.00									
6224.0	55									
	55.70	G	SPT	37 25/2"	25/2"	100			55.70 **SILTY CLAYEY SAND with GRAVEL** Black, wet, very dense **B.O.H.**	(G) Last 10 blows / No progress

APPENDIX C

Soil Particle Size Distribution Sheets
Test Result Summary Sheets

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	25.6	59.5	14.9		SC-SM	A-1-a	14	18
□	0.0	21.1	56.4	22.5		SC-SM	A-1-b	14	20
△	0.0	16.0	64.7	19.3		SC-SM	A-1-b	16	21

SIEVE inches size	PERCENT FINER ○	□	△
1"		100.0	
3/4"	100.0	97.8	100.0
1/2"	96.6	91.8	98.7
3/8"	94.1	90.0	96.3
	GRAIN SIZE		
D_{60}	3.0914	2.1537	1.8430
D_{30}	0.7853	0.2517	0.3525
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	74.4	78.9	84.0
#10	47.4	58.3	62.0
#16	36.1	47.9	49.8
#40	23.8	34.4	32.4
#50	21.3	31.4	28.2
#100	17.7	26.5	22.9
#200	14.9	22.5	19.3

Material Description
○ silty, clayey sand with gravel
□ silty, clayey sand with gravel
△ silty, clayey sand with gravel

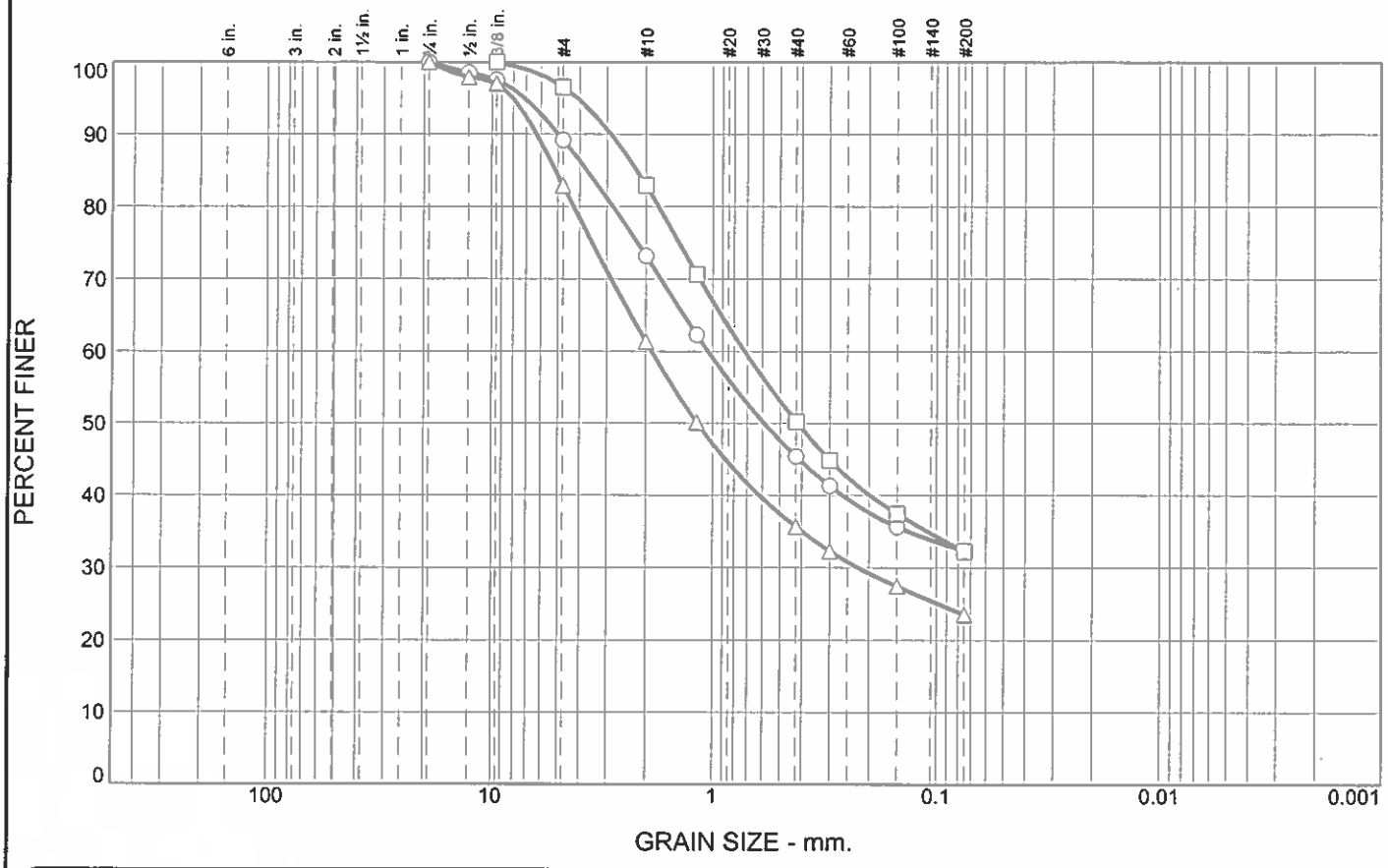
REMARKS:
○
□
△

○ Source of Sample: OC-1 Depth: 2.5 - 5.0' Sample Number: BULK 1
□ Source of Sample: OC-1 Depth: 7.0 - 9.0' Sample Number: BULK 2
△ Source of Sample: OC-1 Depth: 15.0 - 16.0' Sample Number: D

NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower
Project: US 93 Wildlife Overcrossing at HD Summit
Project No.: FL-6-09, EA 73524 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	10.8	56.8	32.4		SC	A-2-4(0)	16	25
□	0.0	3.5	64.2	32.3		SC-SM	A-2-4(0)	13	20
△	0.0	17.1	59.3	23.6		SC-SM	A-1-b	14	19

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		100.0
1/2"	98.5		97.9
3/8"	97.5	100.0	97.1
	GRAIN SIZE		
D_{60}	1.0495	0.7192	1.8843
D_{30}			0.2237
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	89.2	96.5	82.9
#10	73.2	82.9	61.4
#16	62.3	70.7	50.1
#40	45.4	50.3	35.7
#50	41.3	44.9	32.3
#100	35.6	37.5	27.5
#200	32.4	32.3	23.6

Material Description
○ clayey sand
□ silty, clayey sand
△ silty, clayey sand with gravel

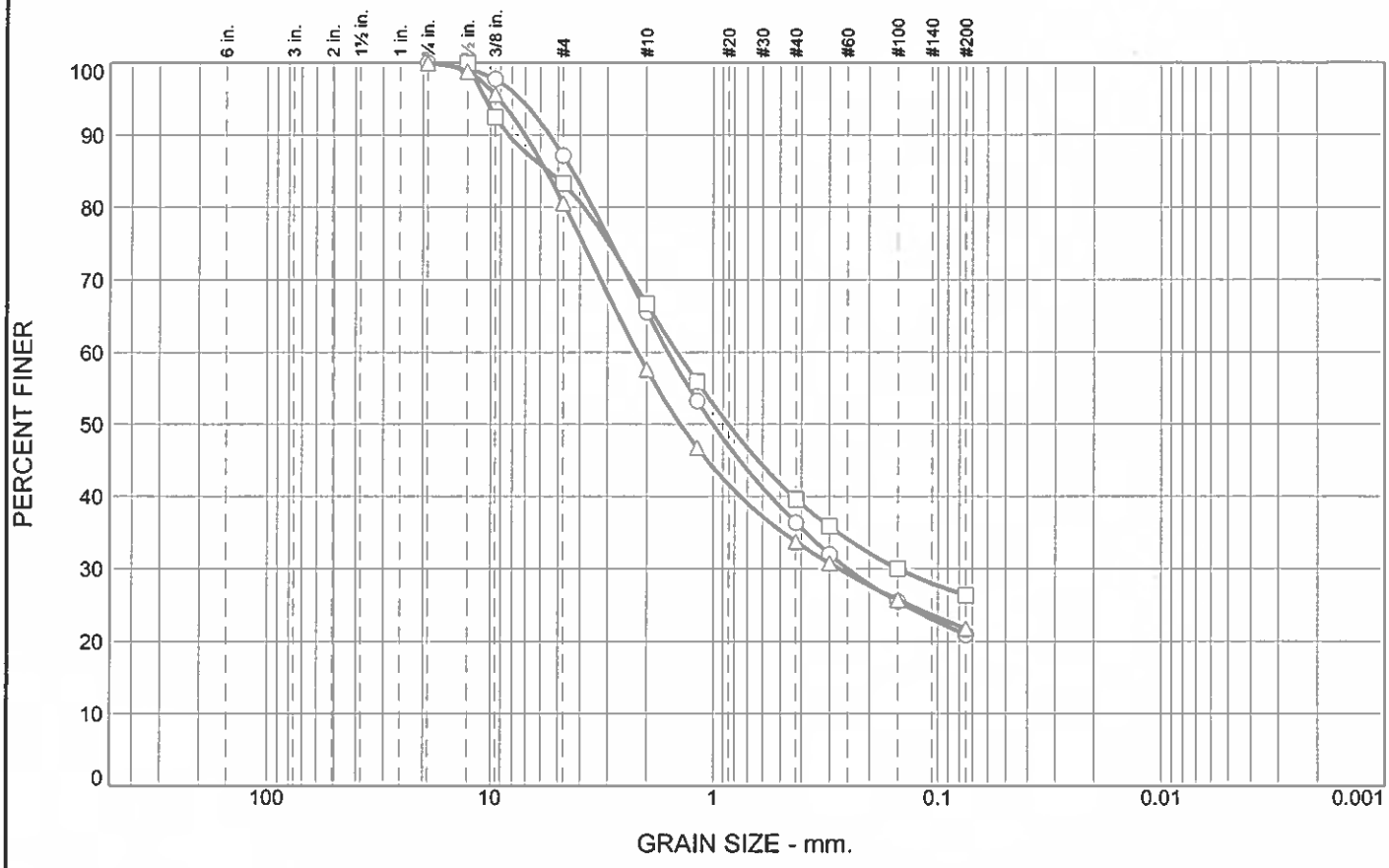
REMARKS:
○
□
△

○ Source of Sample: OC-1 Depth: 19.0 - 19.5' Sample Number: E
□ Source of Sample: OC-1 Depth: 24.5 - 25.7' Sample Number: F
△ Source of Sample: OC-1 Depth: 40.0 - 40.8' Sample Number: I

NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower
Project: US 93 Wildlife Overcrossing at HD Summit
Project No.: FL-6-09, EA 73524
Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	12.9	66.2	20.9		SC-SM	A-1-b	15	20
□	0.0	16.7	57.0	26.3		SC-SM	A-2-4(0)	19	25
△	0.0	19.4	58.9	21.7		SC-SM	A-1-b	15	21

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		100.0
1/2"	99.1	100.0	98.8
3/8"	97.8	92.4	95.6
	GRAIN SIZE		
D_{60}	1.5954	1.4532	2.2043
D_{30}	0.2499	0.1497	0.2727
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	87.1	83.3	80.6
#10	65.6	66.7	57.6
#16	53.2	55.9	46.7
#40	36.4	39.6	33.7
#50	32.0	35.9	30.8
#100	25.5	30.0	25.8
#200	20.9	26.3	21.7

Material Description

○ silty, clayey sand

□ silty, clayey sand with gravel

△ silty, clayey sand with gravel

REMARKS:

○

□

△

○ Source of Sample: OC-2 Depth: 2.5 - 5.0' Sample Number: BULK 1

□ Source of Sample: OC-2 Depth: 5.0 - 5.7' Sample Number: A

△ Source of Sample: OC-2 Depth: 7.5 - 10.0' Sample Number: BULK 2

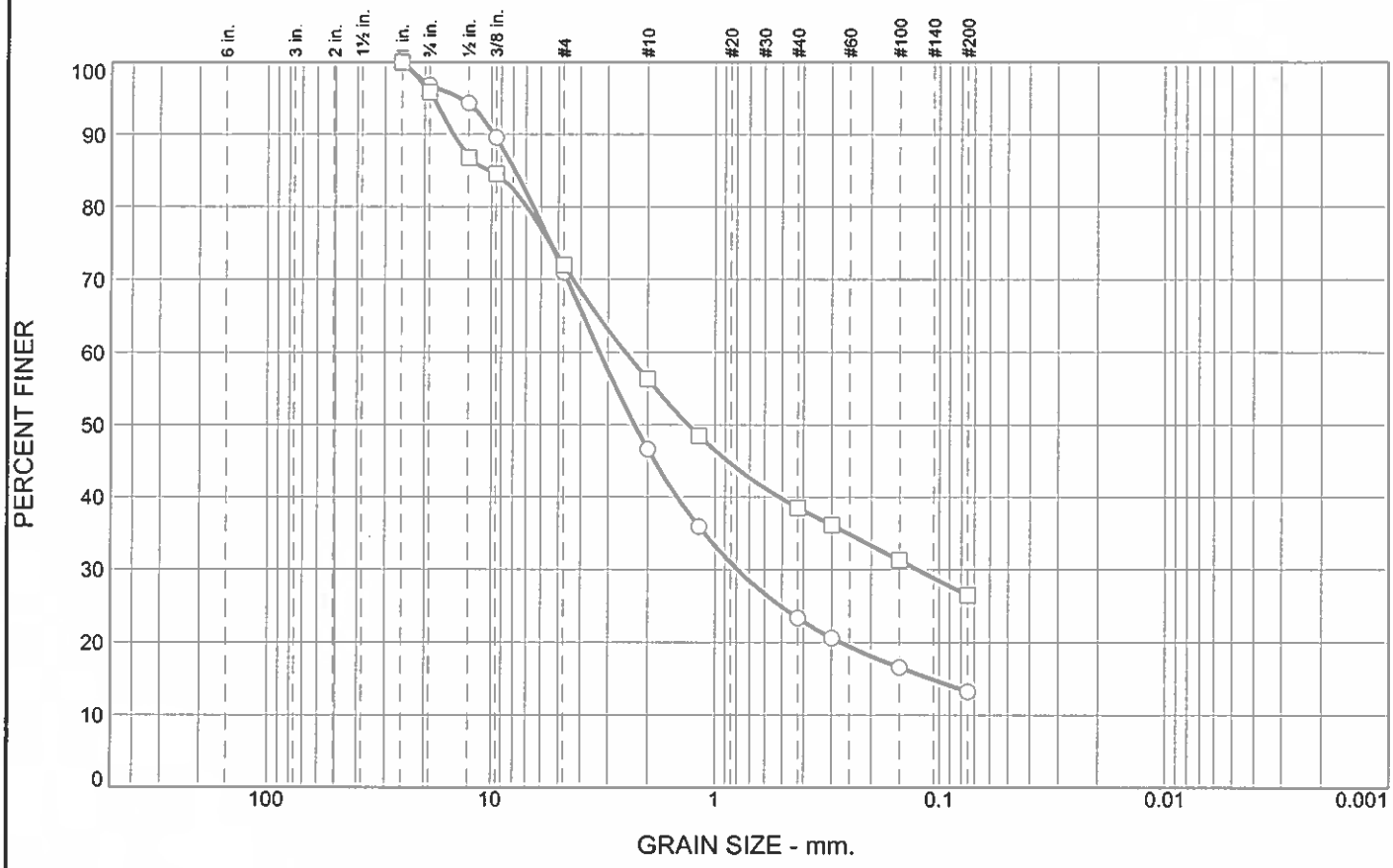
NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower

Project: US 93 Wildlife Overcrossing at HD Summit

Project No.: FL-6-09, EA 73524 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	29.0	57.8	13.2					
□	0.0	28.0	45.5	26.5		SC-SM	A-2-4(0)	19	24

SIEVE inches size	○	□	
1"	100.0	100.0	
3/4"	96.8	95.9	
1/2"	94.3	86.8	
3/8"	89.5	84.5	
	GRAIN SIZE		
D_{60}	3.2760	2.5079	
D_{30}	0.7925	0.1248	
D_{10}			
	COEFFICIENTS		
C_C			
C_U			

SIEVE number size	○	□	
#4	71.0	72.0	
#10	46.6	56.3	
#16	35.9	48.5	
#40	23.4	38.5	
#50	20.6	36.1	
#100	16.6	31.3	
#200	13.2	26.5	

Material Description

○

□ silty, clayey sand with gravel

REMARKS:

○

□

○ Source of Sample: OC-2 Depth: 10.0 - 10.4' Sample Number: B

□ Source of Sample: OC-2 Depth: 15.0 - 16.5' Sample Number: C

NEVADA DEPARTMENT OF TRANSPORTATION

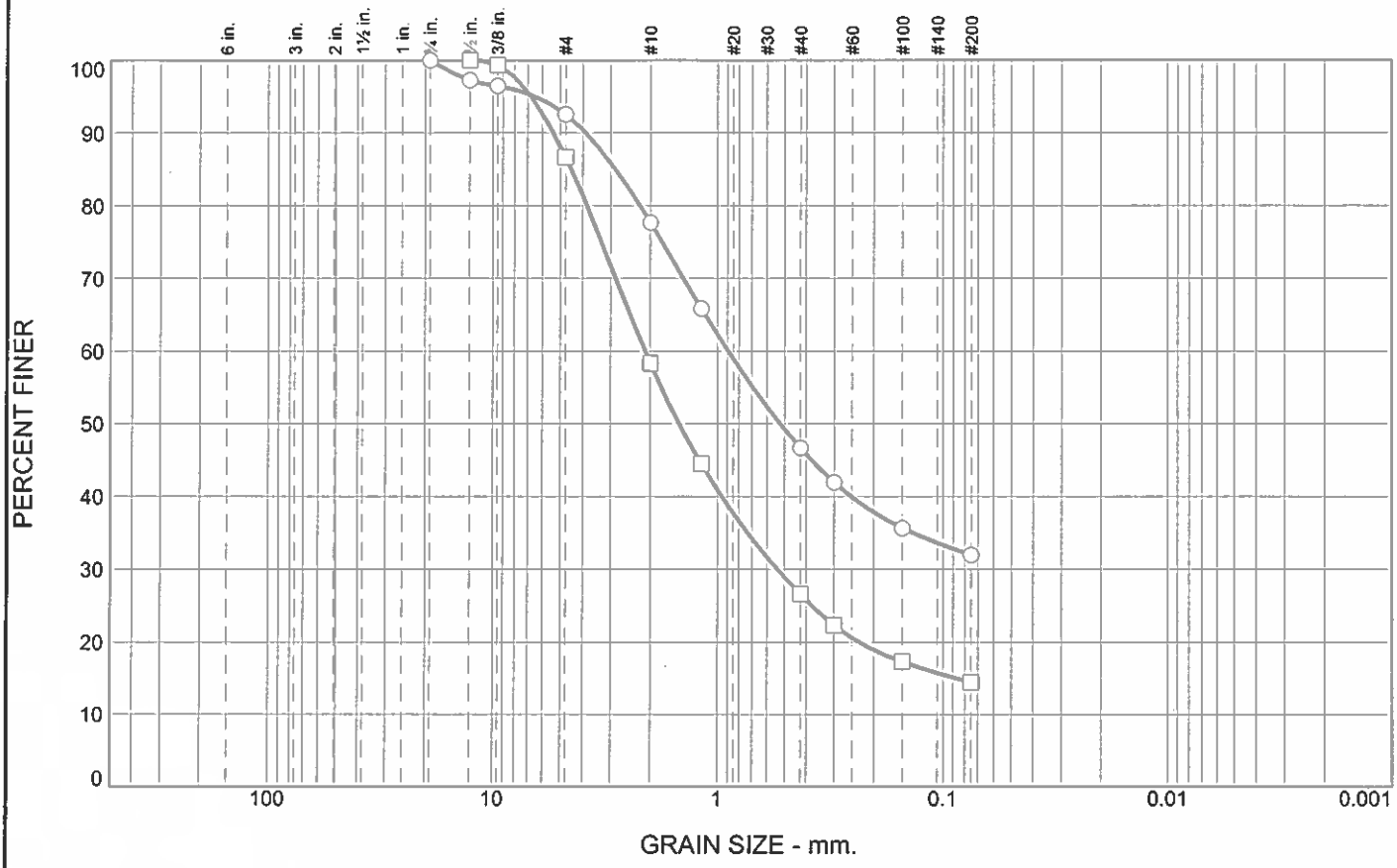
Client: D. Boomhower

Project: US 93 Wildlife Overcrossing at HD Summit

Project No.: FL-6-09, EA 73524

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	7.5	60.5	32.0		SC-SM	A-2-4(0)	21	25
□	0.0	13.3	72.2	14.5					

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/4"	100.0	
1/2"	97.2	100.0
3/8"	96.4	99.3
	GRAIN SIZE	
D_{60}	0.8963	2.1113
D_{30}		0.5367
D_{10}		
	COEFFICIENTS	
C_C		
C_U		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	92.5	86.7
#10	77.7	58.3
#16	65.8	44.5
#40	46.7	26.7
#50	41.9	22.4
#100	35.7	17.3
#200	32.0	14.5

Material Description

○ silty, clayey sand

□

REMARKS:

○

□

○ Source of Sample: OC-2 Depth: 35.0 - 35.6' Sample Number: F

□ Source of Sample: OC-2 Depth: 50.0 - 50.3' Sample Number: H

NEVADA DEPARTMENT OF TRANSPORTATION

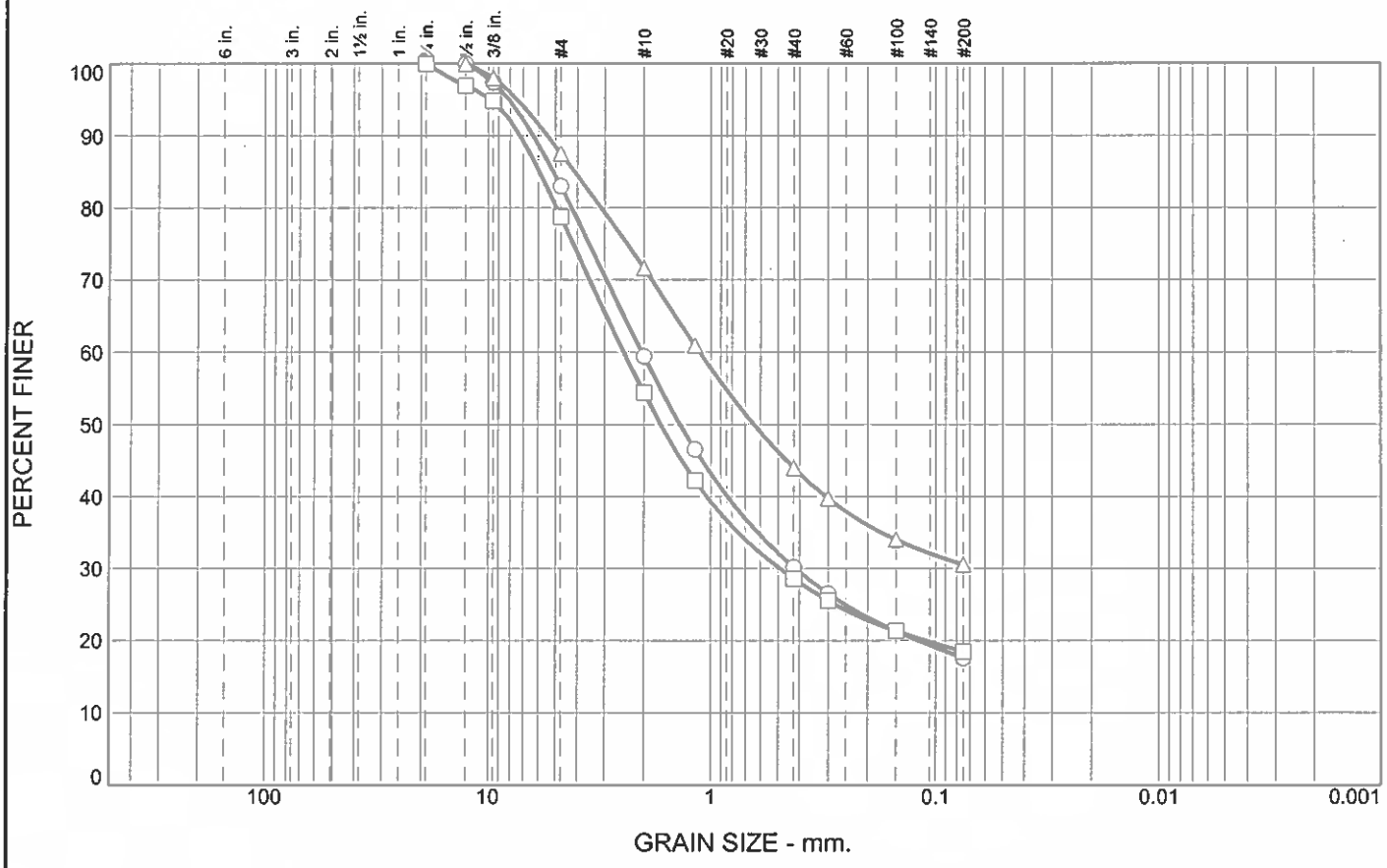
Client: D. Boomhower

Project: US 93 Wildlife Overcrossing at HD Summit

Project No.: FL-6-09, EA 73524

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	17.0	65.4	17.6		SC-SM	A-1-b	15	21
□	0.0	21.2	60.3	18.5		SC-SM	A-1-b	15	21
△	0.0	12.4	57.0	30.6					

SIEVE inches size	PERCENT FINER ○	□	△
3/4"		100.0	
1/2"	100.0	96.9	100.0
3/8"	97.4	94.8	98.0
	GRAIN SIZE		
D_{60}	2.0458	2.4652	1.1254
D_{30}	0.4170	0.4881	
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	83.0	78.8	87.6
#10	59.4	54.4	71.6
#16	46.6	42.3	60.9
#40	30.2	28.6	44.0
#50	26.6	25.5	39.8
#100	21.3	21.4	34.0
#200	17.6	18.5	30.6

Material Description

○ silty, clayey sand with gravel

□ silty, clayey sand with gravel

△

REMARKS:

○

□

△

○ Source of Sample: OC-3 Depth: 2.5 - 3.4' Sample Number: A

□ Source of Sample: OC-3 Depth: 4.0 - 6.0' Sample Number: BULK 1

△ Source of Sample: OC-3 Depth: 8.0 - 8.4' Sample Number: B

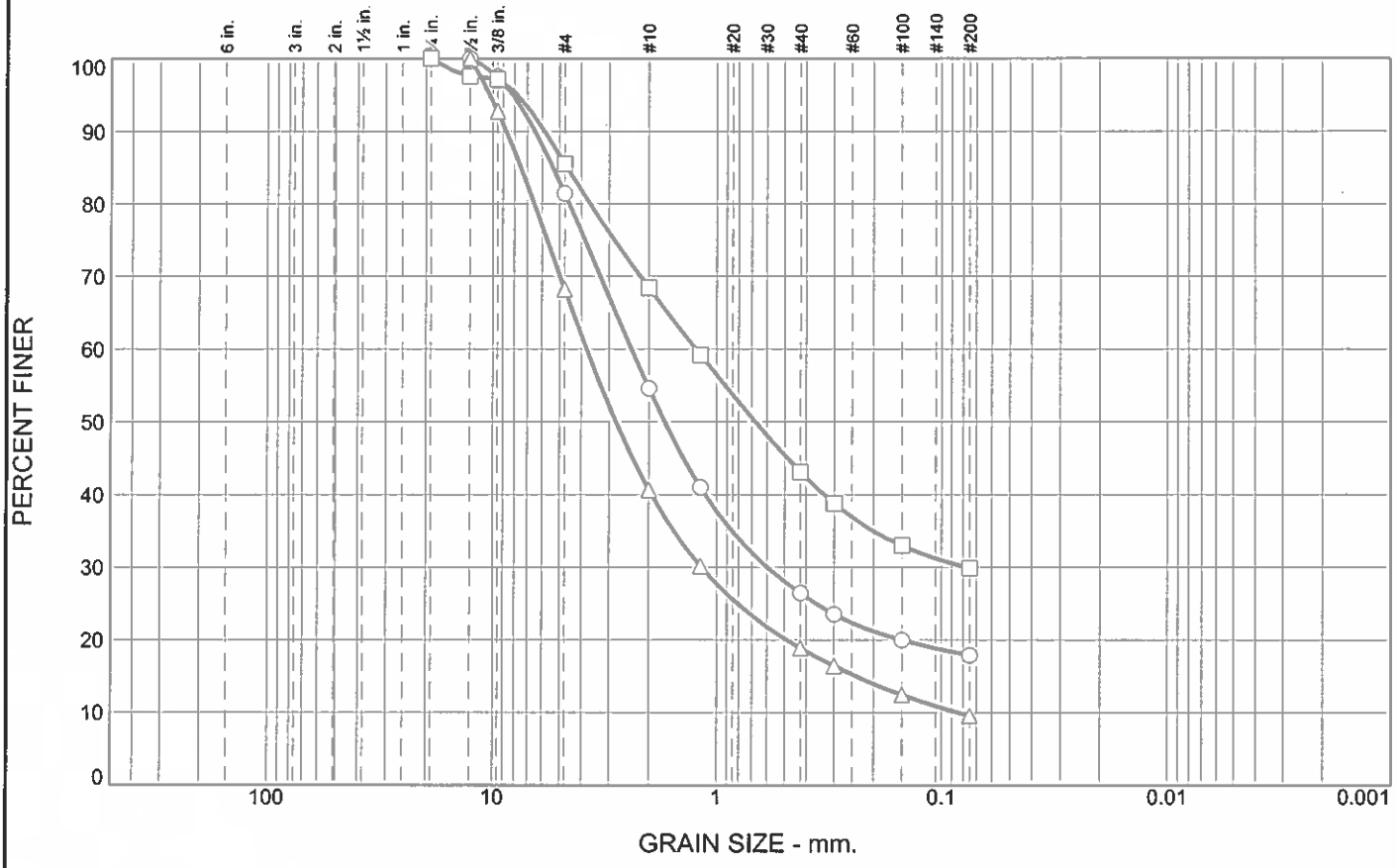
NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower

Project: US 93 Wildlife Overcrossing at HD Summit

Project No.: FL-6-09, EA 73524 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	18.5	63.6	17.9		SC-SM	A-1-b	16	22
□	0.0	14.5	55.6	29.9		SC	A-2-4(0)	16	24
△	0.0	31.8	58.6	9.6					

SIEVE inches size	PERCENT FINER ○	□	△
3/4"		100.0	
1/2"	100.0	97.6	100.0
3/8"	97.5	97.1	92.8
	GRAIN SIZE		
D_{60}	2.3911	1.2377	3.7845
D_{30}	0.5960	0.0771	1.1642
D_{10}			0.0841
	COEFFICIENTS		
C_c			4.26
C_u			45.02

SIEVE number size	PERCENT FINER ○	□	△
#4	81.5	85.5	68.2
#10	54.6	68.4	40.7
#16	41.0	59.2	30.2
#40	26.5	43.1	18.9
#50	23.6	38.8	16.4
#100	20.0	33.0	12.4
#200	17.9	29.9	9.6

Material Description
○ silty, clayey sand with gravel
□ clayey sand
△

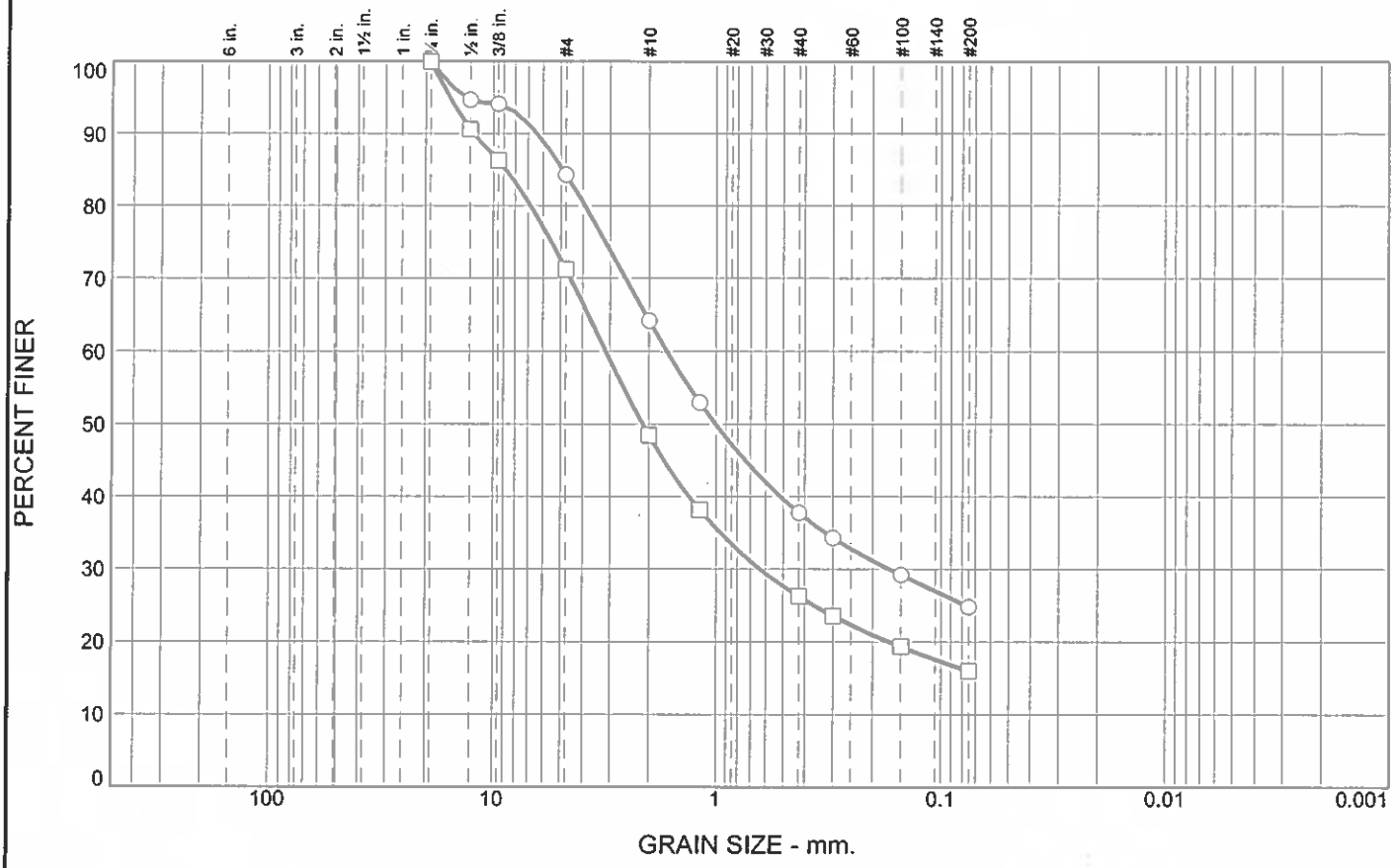
REMARKS:
○
□
△

○ Source of Sample: OC-3 Depth: 12.0 - 14.0' Sample Number: BULK 2
□ Source of Sample: OC-3 Depth: 13.0 - 13.7' Sample Number: C
△ Source of Sample: OC-3 Depth: 28.0 - 28.4' Sample Number: F

NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower
Project: US 93 Wildlife Overcrossing at HD Summit
Project No.: FL-6-09, EA 73524 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	15.7	59.5	24.8		SC-SM	A-1-b	16	21
□	0.0	28.8	55.2	16.0					

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/4"	100.0	100.0
1/2"	94.7	90.6
3/8"	94.1	86.3
GRAIN SIZE		
D_{60}	1.6590	3.1394
D_{30}	0.1687	0.6349
D_{10}		
COEFFICIENTS		
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	84.3	71.2
#10	64.2	48.5
#16	53.0	38.2
#40	37.8	26.2
#50	34.3	23.6
#100	29.2	19.3
#200	24.8	16.0

Material Description

○ silty, clayey sand with gravel

□

REMARKS:

○

□

○ Source of Sample: OC-3 Depth: 33.0 - 33.9' Sample Number: G

□ Source of Sample: OC-3 Depth: 38.0 - 38.4' Sample Number: H

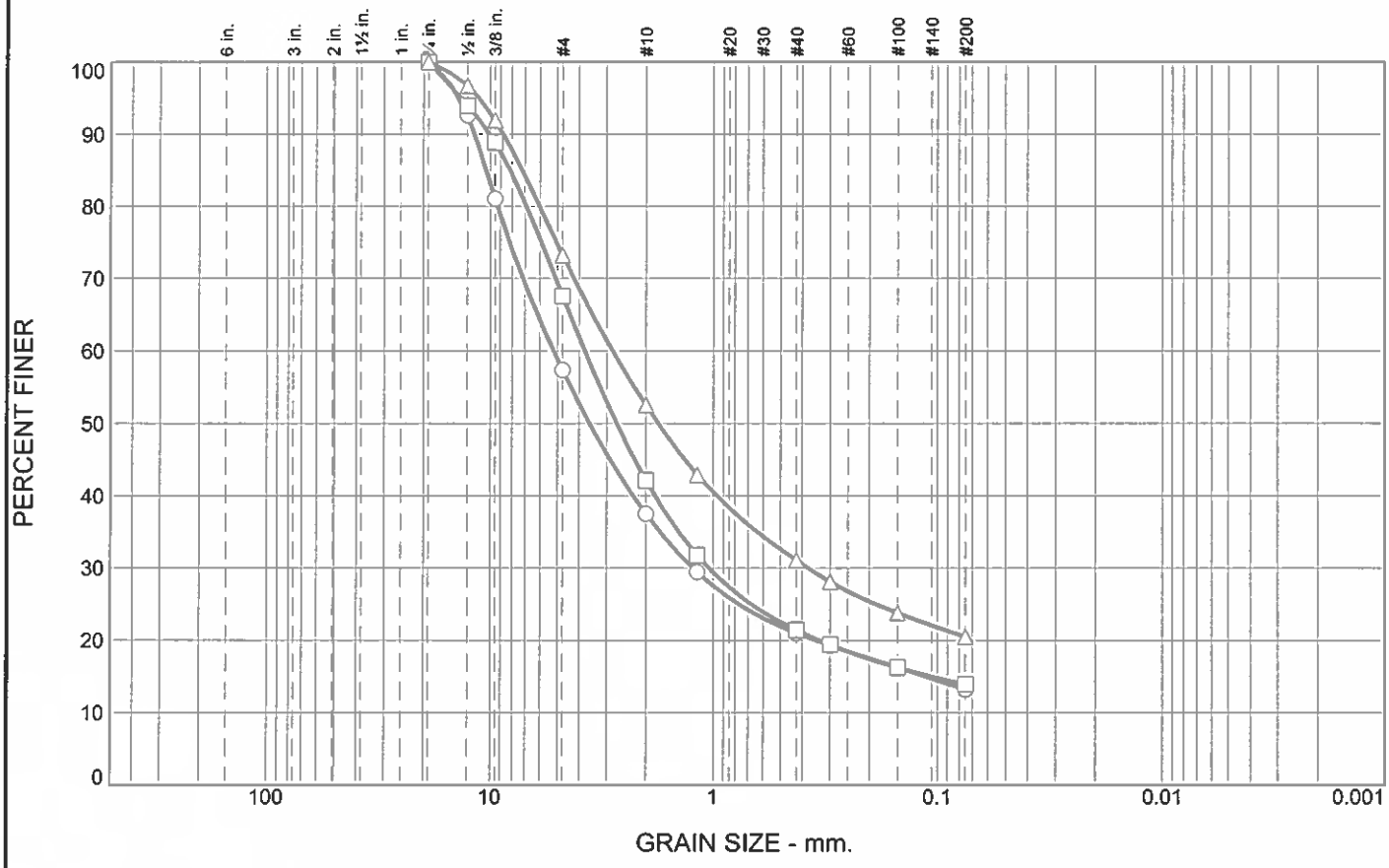
NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower

Project: US 93 Wildlife Overcrossing at HD Summit

Project No.: FL-6-09, EA 73524 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	42.7	44.1	13.2					
□	0.0	32.4	53.7	13.9		SC-SM	A-2-4(0)	15	22
△	0.0	26.8	52.7	20.5		SC-SM	A-1-b	14	19

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0	100.0	100.0
1/2"	92.6	94.0	96.7
3/8"	81.1	88.9	91.9
	GRAIN SIZE		
D_{60}	5.2128	3.7717	2.8258
D_{30}	1.2287	1.0440	0.3753
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	57.3	67.6	73.2
#10	37.6	42.2	52.5
#16	29.5	31.8	43.0
#40	21.0	21.5	31.1
#50	19.3	19.4	28.1
#100	16.3	16.3	23.8
#200	13.2	13.9	20.5

Material Description

○

□ silty, clayey sand with gravel

△ silty, clayey sand with gravel

REMARKS:

○

□

△

○ Source of Sample: OC-4 Depth: 2.5 - 3.2' Sample Number: A

□ Source of Sample: OC-4 Depth: 6.0 - 8.0' Sample Number: BULK 1

△ Source of Sample: OC-4 Depth: 11.0 - 13.0' Sample Number: BULK 2

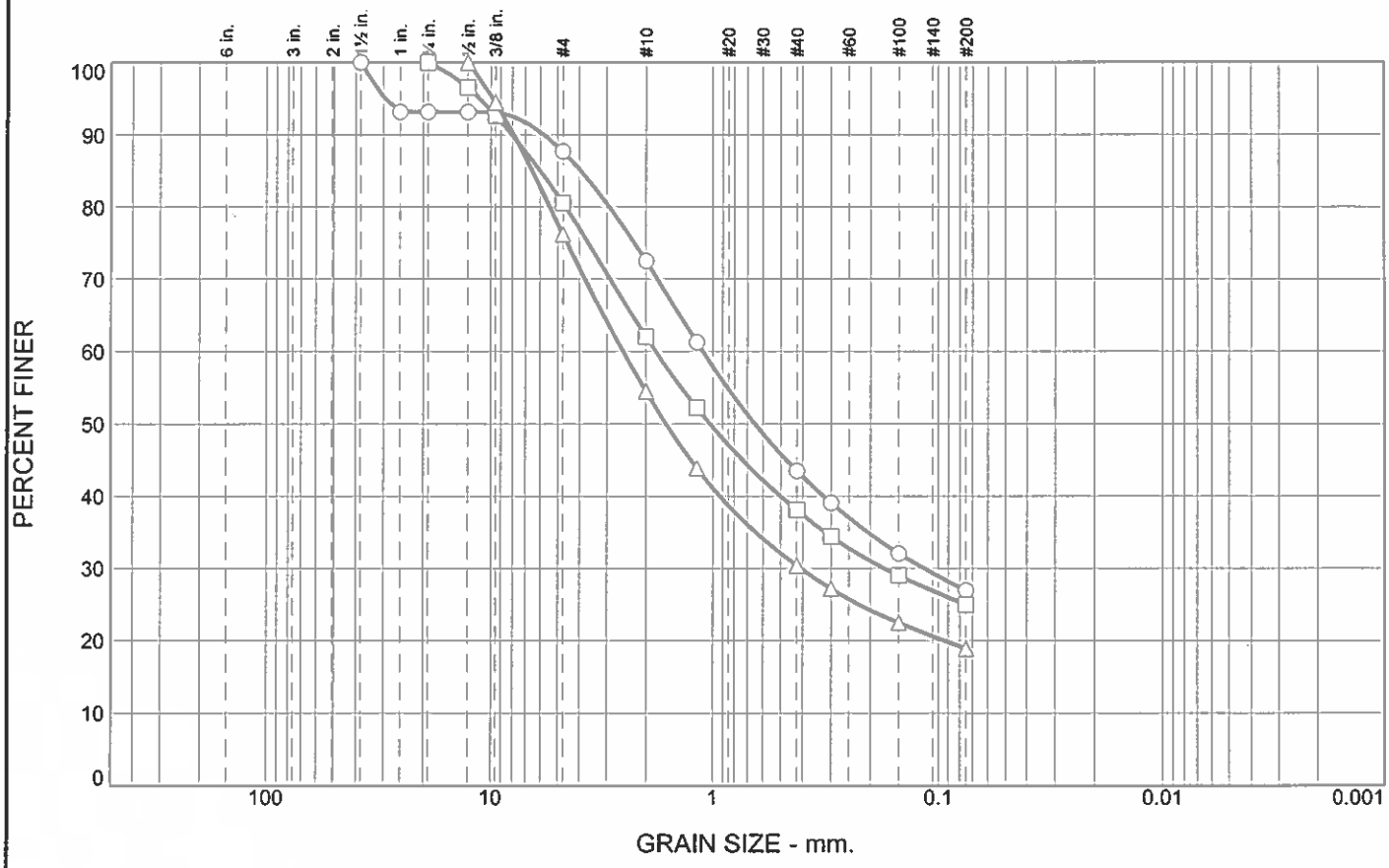
NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower

Project: US 93 Wildlife Overcrossing at HD Summit

Project No.: FL-6-09, EA 73524 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	12.3	60.8	26.9		SC-SM	A-2-4(0)	15	20
□	0.0	19.4	55.6	25.0		SC-SM	A-2-4(0)	17	24
△	0.0	23.8	57.3	18.9					

SIEVE inches size	PERCENT FINER ○	□	△
1 1/2"	100.0		
1"	93.1		
3/4"	93.1	100.0	
1/2"	93.1	96.5	100.0
3/8"	93.1	92.6	94.4
	GRAIN SIZE		
D_{60}	1.1111	1.8109	2.5372
D_{30}	0.1154	0.1734	0.4072
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	87.7	80.6	76.2
#10	72.5	62.0	54.5
#16	61.2	52.2	43.9
#40	43.5	38.1	30.4
#50	39.1	34.5	27.2
#100	32.1	29.0	22.5
#200	26.9	25.0	18.9

Material Description
○ silty, clayey sand
□ silty, clayey sand with gravel
△

REMARKS:
○
□
△

○ Source of Sample: OC-4 Depth: 13.0 - 13.9' Sample Number: B
□ Source of Sample: OC-4 Depth: 18.0 - 19.0' Sample Number: C
△ Source of Sample: OC-4 Depth: 28.0 - 28.3' Sample Number: D

NEVADA DEPARTMENT OF TRANSPORTATION

Client: D. Boomhower
Project: US 93 Wildlife Overcrossing at HD Summit
Project No.: FL-6-09, EA 73524 Figure

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

EA/Cont # 73524 **Job Description** US 93 Wildlife Overcrossing at HD Summit

Boring No. OC - 1 **Elevation (ft)** 6278.64 **Station** "X" 686 + 07, 25 ft. Rt. **Date** 9/1/2009

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST					COMMENTS
											TEST TYPE	Φ deg.	C psi	Φ deg.	C psi	
												Peak		Residual		
BULK 1	2.5 - 5.0	BULK		SC-SM			14.9	18	14	4						RV = 35
A	4.0 - 4.1	SPT	R													No Sample Recovered
BULK 2	7.0 - 9.0	BULK		SC-SM			22.5	20	14	6						RV = 7
B	9.0 - 9.1	SPT	R													No Sample Recovered
C	13.0 - 13.1	SPT	R													No Sample Recovered
D	15.0 - 16.0	SPT	R	SC-SM			19.3	21	16	5						
E	19.0 - 19.5	SPT	R	SC			32.4	25	16	9						
F	24.5 - 25.7	SPT	R	SC-SM			32.3	20	13	7						
G	30.0 - 30.3	SPT	R													No Sample Recovered
H	35.0 - 35.3	SPT	R													O = 1.6%
I	40.0 - 40.8	SPT	R	SC-SM			23.6	19	14	5						
J	50.0 - 50.2	SPT	R													No Sample Recovered

CMS = California Modified Sampler 2.42" ID
SPT = Standard Penetration 1.38" ID
CS = Continuous Sample 3.23" ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 2.42" ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
R = Refusal
Sh = Shelby Tube 2.87" 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 ft., sampler

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
MD = Moisture Density

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
HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

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

EA/Cont # 73524 **Job Description** US 93 Wildlife Overcrossing at HD Summit

Boring No. OC - 2 **Elevation (ft)** 6278.12 **Station** "X" 685 + 01, 23 ft. Lt. **Date** 9/1/2009

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST					COMMENTS
											TEST TYPE	Φ deg.	C psi	Φ deg.	C psi	
												Peak		Residual		
BULK 1	2.5 - 5.0	BULK		SC-SM			20.9	20	15	5						RV = 56
A	5.0 - 5.7	SPT	R	SC-SM			26.3	25	19	6						
BULK 2	7.5 - 10.0	BULK		SC-SM			21.7	21	15	6						RV = 43
B	10.0 - 10.4	SPT	R				13.2									
C	15.0 - 16.5	SPT	50	SC-SM			26.5	24	19	5						
D	20.0 - 20.1	SPT	R													No Sample Recovered
E	25.0 - 25.4	SPT	R					22	17	5						
F	35.0 - 35.6	SPT	R	SC-SM			32.0	25	21	4						
G	45.0 - 46.3	SPT	R					22	14	8						O = 1.5%
H	50.0 - 50.3	SPT	R				14.5									

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SPT = Standard Penetration 1.38" ID
CS = Continuous Sample 3.23" ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 2.42" ID
CPT = Cone Penetration Test
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N = No. of blows per ft., sampler

N = Field SPT N = $(N_{css})(0.62)$

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PI = Plasticity Index
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*** = Average of subsamples**

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

EA/Cont # 73524 **Job Description** US 93 Wildlife Overcrossing at HD Summit

Boring No. OC - 3 **Elevation (ft)** 6277.59 **Station** "X" 686 + 09, 23 ft. Lt. **Date** 9/2/2009

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST					COMMENTS
											TEST TYPE	Φ deg.	C psi	Φ deg.	C psi	
												Peak		Residual		
A	2.5 - 3.4	SPT	R	SC-SM			17.6	21	15	6						
BULK 1	4.0 - 6.0	BULK		SC-SM			18.5	21	15	6						RV = 69
B	8.0 - 8.4	SPT	R				30.6									
BULK 2	12.0 - 14.0	BULK		SC-SM			17.9	22	16	6						RV = 66
C	13.0 - 13.7	SPT	R	SC			29.9	24	16	8						
D	18.0 - 18.3	SPT	R					22	15	7						
E	23.0 - 23.3	SPT	R					23	15	8						
F	28.0 - 28.4	SPT	R				9.6									
G	33.0 - 33.9	SPT	R	SC-SM			24.8	21	16	5						
H	38.0 - 38.4	SPT	R				16.0									
I	43.0 - 43.6	SPT	R					20	13	7						O = 1.5%
J	55.0 - 55.4	SPT	R					20	14	6						

CMS = California Modified Sampler 2.42" ID
SPT = Standard Penetration 1.38" ID
CS = Continuous Sample 3.23" ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 2.42" ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
R = Refusal
Sh = Shelby Tube 2.87" ID

U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
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Φ = Friction
C = Cohesion
N = No. of blows per ft., sampler

N = Field SPT N = $(N_{css})(0.62)$

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G = Specific Gravity
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PL = Plastic Limit
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OC = Consolidation
Ch = Chemical
RV = R - Value
MD = Moisture Density

CM = Compaction
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UW= Unit Weight
W = Moisture Content
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RQD = Rock Quality Designation
X = X-Ray Defraction
HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

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

EA/Cont # 73524 **Job Description** US 93 Wildlife Overcrossing at HD Summit

Boring No. OC - 3 **Elevation (ft)** 6277.59 **Station** "X" 686 + 09, 23 ft. Lt. **Date** 9/2/2009

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST					COMMENTS
											TEST TYPE	Φ deg.	C psi	Φ deg.	C psi	
												Peak		Residual		
K	65.0 - 65.3	SPT	R													O = 1.3%

CMS = California Modified Sampler 2.42" ID
SPT = Standard Penetration 1.38" ID
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RC = Rock Core
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UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
Φ = Friction
C = Cohesion
N = No. of blows per ft., sampler

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
MD = Moisture Density

CM = Compaction
E = Swell/Pressure on Expansive Soils
SL = Shrinkage Limit
UW= Unit Weight
W = Moisture Content
K = Permeability
O = Organic Content
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X = X-Ray Defraction
HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

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

EA/Cont # 73524 **Job Description** US 93 Wildlife Overcrossing at HD Summit

Boring No. OC - 4 **Elevation (ft)** 6279.02 **Station** "X" 685 + 00, 25 ft. Rt. **Date** 9/2/2009

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST					COMMENTS
											TEST TYPE	Φ deg. (Peak)	C psi (Peak)	Φ deg. (Residual)	C psi (Residual)	
A	2.5 - 3.2	SPT	R				13.2									
BULK 1	6.0 - 8.0	BULK		SC-SM			13.9	22	15	7						RV = 62
BULK 2	11.0 - 13.0	BULK		SC-SM			20.5	19	14	5						RV = 40
B	13.0 - 13.9	SPT	R	SC-SM			26.9	20	15	5						
C	18.0 - 19.0	SPT	R	SC-SM			25.0	24	17	7						
D	28.0 - 28.3	SPT	R				18.9									
E	33.0 - 33.7	SPT	R					22	15	7						O = 2.2%
F	42.5 - 42.7	SPT	R													No Sample Recovered
G	55.0 - 55.7	SPT	R					21	14	7						O = 1.8%

CMS = California Modified Sampler 2.42" ID
SPT = Standard Penetration 1.38" ID
CS = Continuous Sample 3.23" ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 2.42" ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
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U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
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Φ = Friction
C = Cohesion
N = No. of blows per ft., sampler

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
MD = Moisture Density

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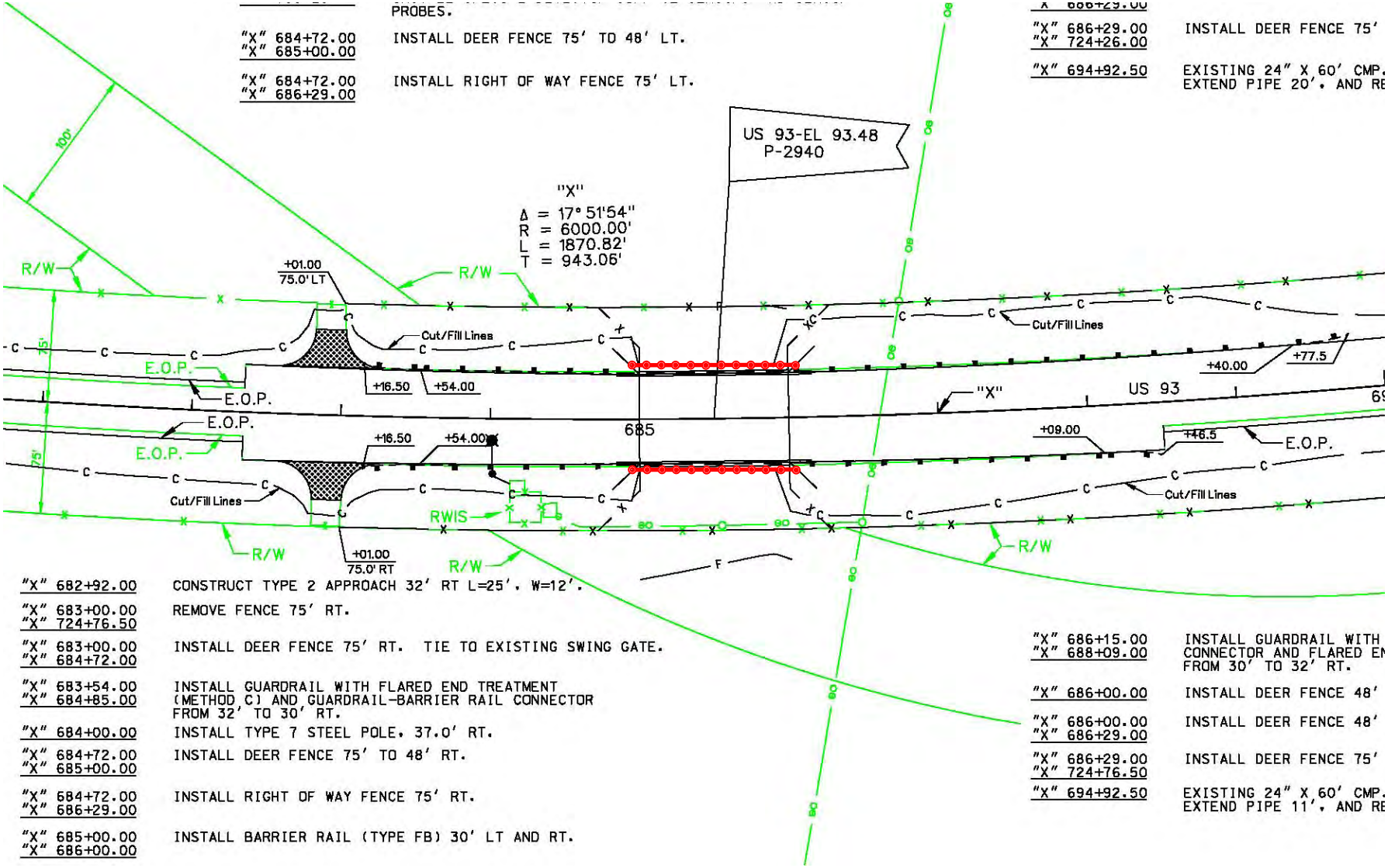
RQD = Rock Quality Designation
X = X-Ray Defraction
HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

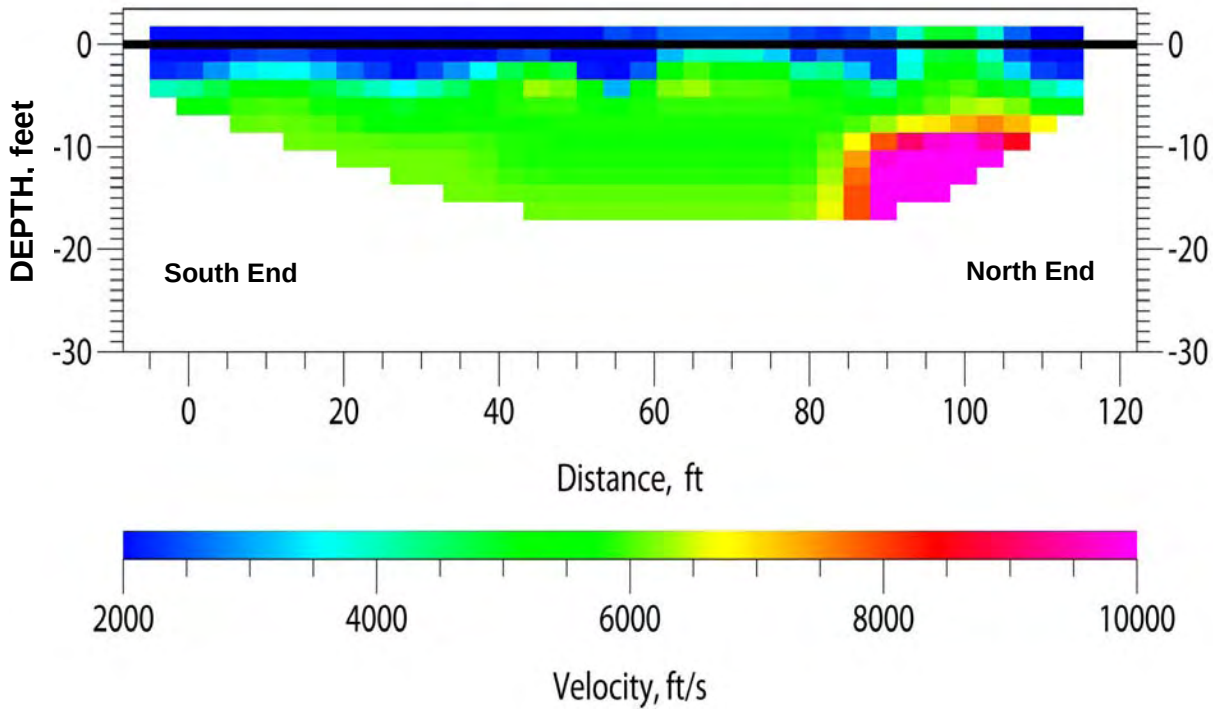
APPENDIX D

Seismic Line Location Sheet
Seismic Refraction Plots

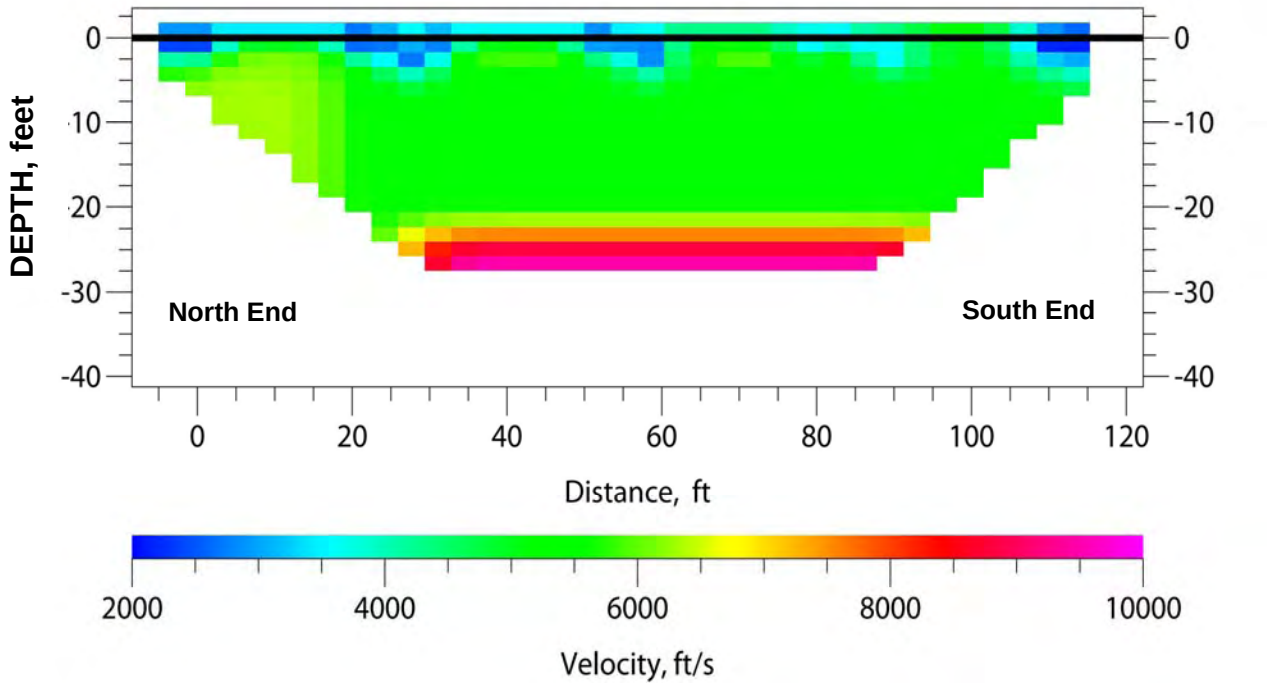


SEISMIC LINE LOCATIONS

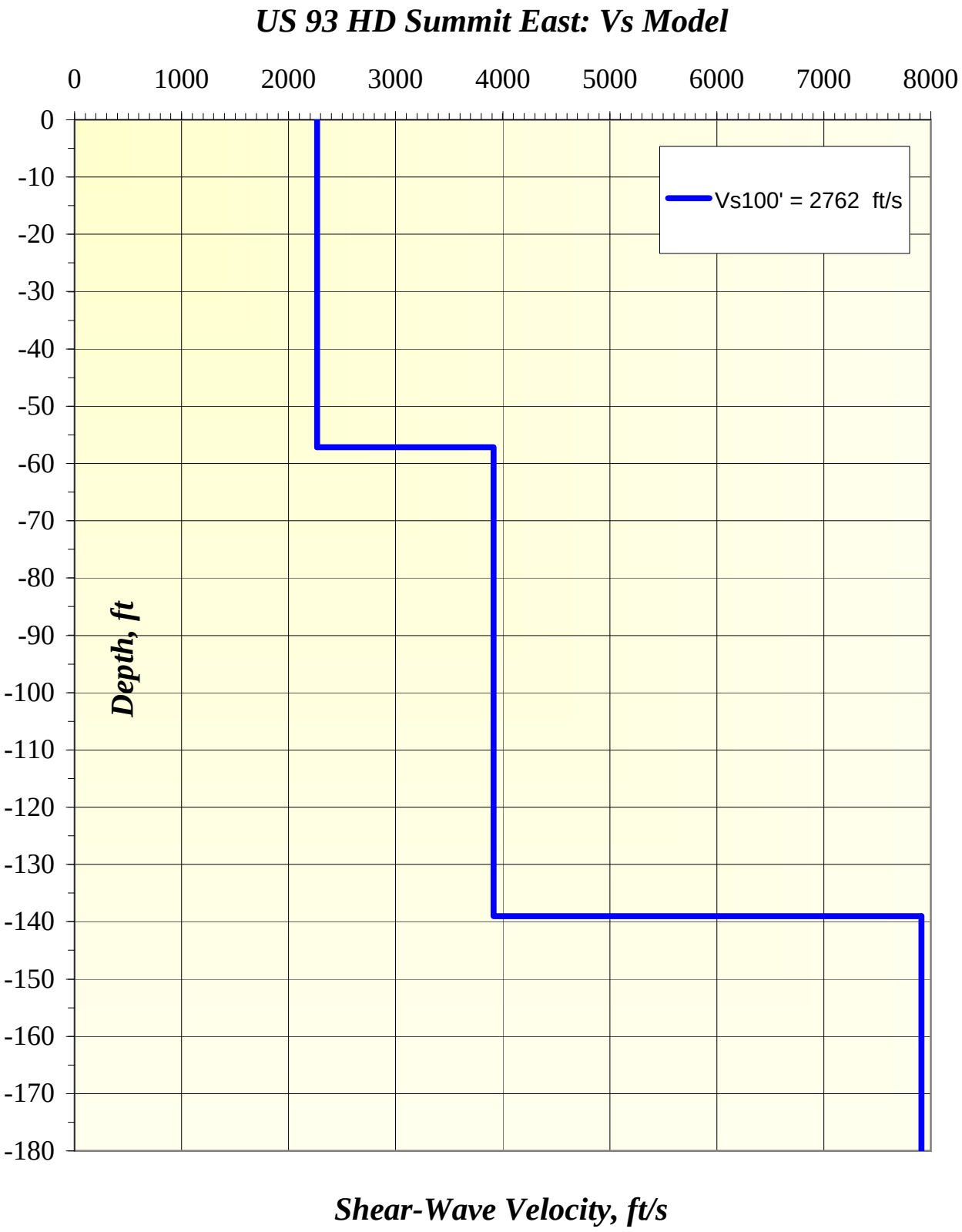
EAST SIDE – US93 at HD SUMMIT

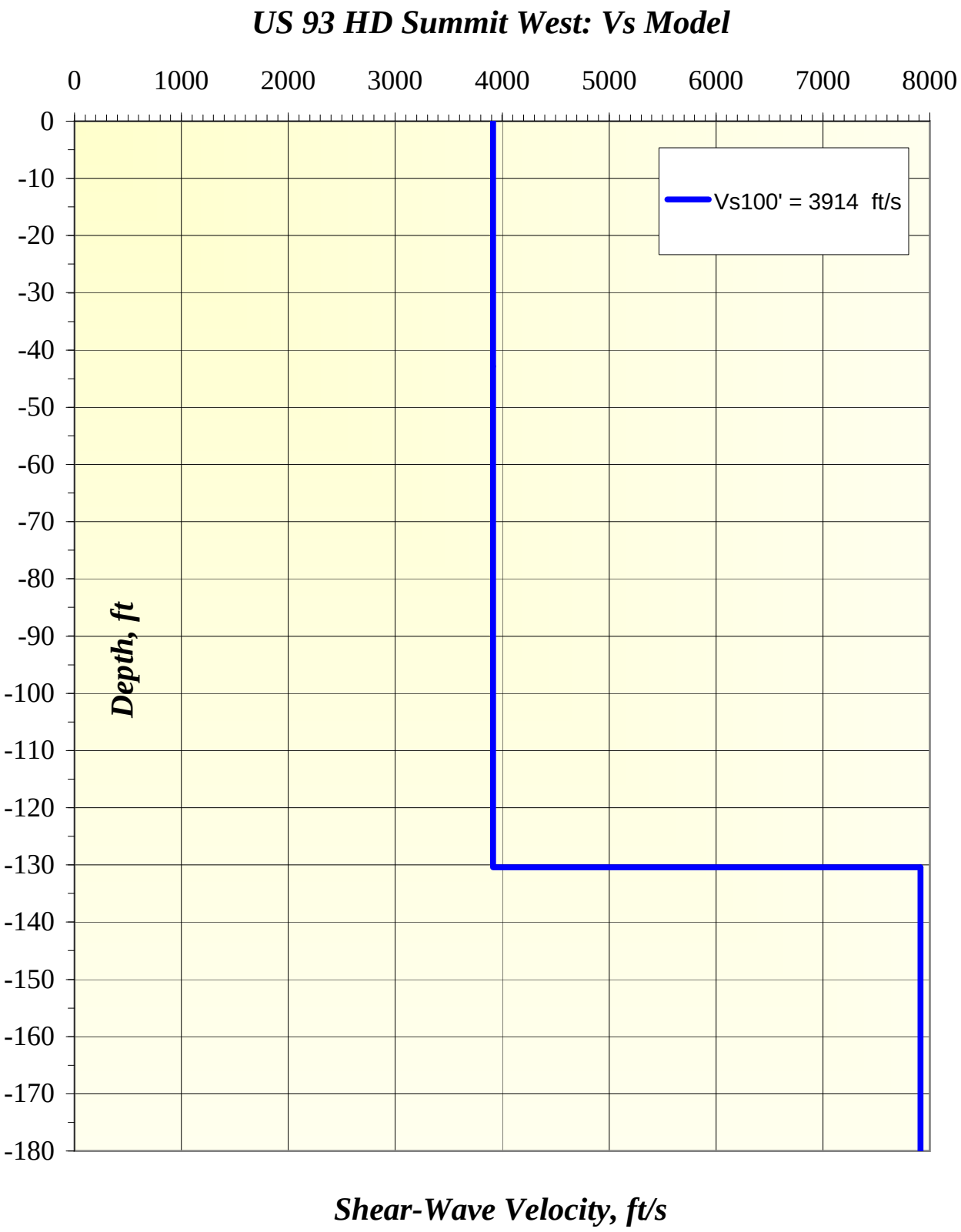


WEST SIDE – US93 at HD SUMMIT



SEISMIC VELOCITY PLOTS


US 93 HD Summit East: Vs Model
0
1000
2000
3000
4000
5000
6000
7000
8000
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
Vs100' = 2762 ft/s
Depth, ft
Shear-Wave Velocity, ft/s


US 93 HD Summit West: Vs Model
0
1000
2000
3000
4000
5000
6000
7000
8000
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
Depth, ft
Vs100' = 3914 ft/s
Shear-Wave Velocity, ft/s