GEOTECHNICAL REPORT

BRIDGE B-100 REPLACEMENT
SR 115, HARRIGAN ROAD AT L-LINE CANAL

CHURCHILL COUNTY, NEVADA

APRIL 2014

NEVADA DOT GEOTECHNICAL ENGINEERING

MATERIALS DIVISION

STATE OF NEVADA

DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

GEOTECHNICAL SECTION

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E.A. No. 73798

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INTRODUCTION

General

The Nevada Department of Transportation (NDOT) plans to replace the substandard Harrigan Road Bridge (Bridge B-100) on State Route 115/Harrigan Road over the L-Line Canal in Fallon, Churchill County, Nevada. The Site Location Map can be found in Appendix A.

Bridge B-100 is located on SR 115 which has a north-south orientation and crosses over the west-to-east running L-Line Canal. The canal is approximately 10 feet deep and is an earthen channel. SR 118/Wildes Road, a paved road, runs along the south bank of the canal, and Wood Drive, a gravel road, runs along the north bank of the canal. Several overhead and underground utilities run through the project area. The Boring Location Map in Appendix A shows an aerial photograph of the project site.

Scope

A geotechnical investigation was conducted to determine the subsurface soil and groundwater conditions at the project site. The scope of the investigation included research of available background information including geologic literature, geotechnical field exploration, laboratory testing, and analysis of field and laboratory data. The purpose of this geotechnical report is to summarize and evaluate the findings of the geotechnical investigation and to present geotechnical design criteria and construction recommendations for the new structure foundation.

PROJECT DESCRIPTION

Planned construction will consist of replacing the existing Harrigan Road Bridge over the L-Line Canal with a new structure. The existing bridge was constructed under NDOT Contract 73 in 1923 and widened under Contract 351 in 1934. The existing structure is a 2-span reinforced concrete girder bridge with vertical abutment walls with wingwalls and a center pier, all founded on spread footings. NDOT Contract 73 as-built plans indicate that the bottoms of footing elevations are 3947.5 feet for the abutments and wingwalls and 3947.0 for the center pier.

The bridge has a Sufficiency Rating of 48.2. The Sufficiency Rating is a numerical indicator of the bridge’s sufficiency to remain in service, and is measured on a scale from 0 to 100. Bridges with a Sufficiency Rating less than 50 are considered to be structurally deficient or functionally obsolete. The National Bridge Inventory (NBI) Item 113 code for the existing bridge is 3 which means that the bridge is scour critical, and the bridge foundations have been determined to be unstable for assessed or calculated scour conditions.

The planned replacement structure is a cast-in-place, 2-cell reinforced concrete box (RCB) culvert with affixed wingwalls. The RCB will be approximately 11 feet high, 43 feet wide and 41 feet long. The foundation grade of the RCB is estimated to be at an elevation of approximately 3951 feet. Current plans also include a two-directional travel way, concrete barrier rails, and scour countermeasures which are designed to resist scour within the service life of the proposed structure.

Several in-channel flow control structures exist along the L-Line Canal. These structures provide grade control and allow for diversions. There is an abandoned concrete weir about 100 feet downstream of Bridge B-100. The maximum canal operational flow is 300 cubic feet per second. Construction of the new structure is proposed to take place from December 2014 to March 2015. During this time the Truckee Carson Irrigation District (TCID) can redirect the water flow in the canal.

GEOLOGIC CONDITIONS AND SEISMICITY

Local Geology

Churchill County is located in the western portion of the Great Basin geomorphic province. The Great Basin in characterized by large normal fault-bounded valleys that are separated by large mountain ranges. The project site is located in the western part of Churchill County in the outer reaches of the broad, low valley of the Carson Sink which is underlain by deposits of Lake Lahontan. The *Geologic Map of Churchill County, Nevada* (Willden and Speed, Plate 1) shows the general map unit in the project area to be Younger Alluvium (Qya), which includes Lake Lahontan deposits, playa deposits, and young fan gravels. The younger alluvium generally is composed of fine-grained sediments, silts, and clays, but near the mountains that rim the Carson Sink it includes considerable well-sorted gravel.

Faulting and Seismicity

The Quaternary Fault and Fold Database for the United States (U.S. Geological Survey) shows several Quaternary faults within 10 miles of the project site. These geologically young and historically active faults are probable locations for near-future seismic activity and are capable of producing moderate- to large-magnitude events. However, no active faults are shown within 3 miles of the project site and no direct evidence of onsite faulting was observed.

FIELD INVESTIGATION

A geotechnical field investigation was conducted on January 22 and 23, 2014. Approximate soil borehole and geophysical survey locations are plotted on the Boring Location Map included in Appendix A. Boring locations and ground elevations provided on the Boring Logs in Appendix B were estimated using plan view alignment and mapping information and physical measurements taken in the field. Locations and elevations should be considered accurate only to the degree implied by the method used to determine locations and elevations.

Soil Borings

The subsurface soil conditions were explored by drilling 4 boreholes, identified as HBR-1, HBR-1A, HBR-2, and HBR-2A. Borehole depths ranged from 5 to 32.5 feet. Boreholes were backfilled with grout immediately after drilling operations were completed for boreholes HBR-1, HBR-2, and HBR-2A. Borehole HBR-1A was backfilled with drill cuttings. The details of subsurface conditions encountered during our exploration are shown in the Boring Logs in Appendix B. A Key to Boring Logs precedes the Boring Logs in Appendix B.

Logs of the subsurface conditions, as encountered during the field investigation, were recorded by NDOT Geotechnical Section staff. Soil samples were examined and identified in the field in accordance with ASTM D 2488. Additional soil classification was subsequently performed on soil samples using the Unified Soil Classification System (USCS) in accordance with ASTM D 2487 upon completion of laboratory testing. Where soil tests are not listed in the appropriate column of the Boring Logs, the USCS symbols and terminology are based solely on visual-manual identification (ASTM D 2488) rather than laboratory classification.

Borings HBR-1 and HBR-2 were explored using mud rotary drilling methods. Drilling was performed using an NDOT Diedrich D-120 drill rig (Drill Rig Unit #1082) equipped with a 140-pound automatic hammer. Drive samples were obtained using both a Standard Penetration Testing sampler (SPT, ASTM D1586) and a California Modified sampler (CMS, ASTM D 3550) at locations noted on the Boring Logs. The drive samples were advanced using a 140-pound automatic hammer with a drop of 30 inches. Sampler driving resistance, expressed as blow count per one foot of penetration (N-value), is presented on the Boring Logs at the respective depths. The N-value is an indication of the apparent density of coarse-grained soils and the consistency of fine-grained soils. The field blow counts presented on the Boring Logs have not been corrected for hammer efficiency, overburden pressure, rod length, etc. The energy transfer ratio from the hammer into the drill string for the NDOT Drill Rig Unit #1082 is 86%. Therefore, a factor of 1.4 (86/60) shall be applied to the field blow counts to correct for hammer efficiency.

Two supplemental boreholes, HBR-1A and HBR-2A, were explored using a mobile drill rig equipped with 6-inch solid auger. HBR-1A and HBR-2A were drilled approximately 3 feet west of HBR-1and HBR-2, respectively. Representative bulk soil samples were obtained from auger cuttings at depths indicated on the Boring Logs.

Geophysical Survey

A refraction microtremor (ReMi) survey was conducted at the project site on January 23, 2014 to develop a subsurface shear-wave velocity profile at the project site. The ReMi equipment and methods provide effective means to obtain subsurface information by estimating subsurface shear wave velocity profiles with 20% accuracy.

Data was obtained along a survey line using a cable with 12 geophones spaced 20 feet apart. The ReMi survey line ran along the Wood Drive, the gravel road north of the L-line canal, east of SR 115 as shown on the Boring Location Map in Appendix A. The ReMi survey line was set at an approximate elevation of 3959 feet.

An Optim Software and Data Solutions representative performed interpretations of the data collected at the site using the most current SeisOpt ReMi software. The results of the ReMi survey are represented by the one-dimensional shear wave velocity profile located in the

Geophysical (ReMi) Survey Data in Appendix B. This plot depicts variations in the shear wave velocity profile to a depth of 100 feet and provides the average shear wave velocity for the upper 100 feet of the soil profile, v_{s100}.

LABORATORY ANALYSES

Soil samples were tested at the NDOT Materials and Testing Laboratory in Carson City, Nevada. Soils were classified using the USCS in accordance with ASTM D 2487. Individual laboratory test results for soil samples can be found in Appendix C of this report.

The laboratory testing program for selected samples consisted of the following:

- Particle size gradations through No. 200 sieve (NV T 206)
- Atterberg Limits (NV T 210 and T 212)
- Natural Moisture Content (AASHTO T 265)
- Soil Unit Weight
- Direct Shear (AASHTO T 236)
- Resistance Value (R-value, NV T 115)

SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered during our field investigation at the project site can be found in the Boring Logs in Appendix B. Following is a summary of the subsurface conditions.

Approximately 3.5 to 6.5 inches of asphalt concrete pavement was observed in our borings on top of the fill on either side of the existing structure.

The upper 15 feet of soil encountered in our borings can be considered roadway fill material generally classified as loose to medium dense, poorly graded sand with silt, silty clayey sand, and silty sand.

Based on our subsurface explorations, the soils below the roadway fill at the project site consist predominately of sand and silt with some clay and little to no gravel. Material below the fill and to a depth of about 34 feet (the depth of our deepest boring) can be generally classified as stratified layers of medium dense to dense, poorly graded sand, poorly graded sand with silt, silty sand, and silt with varying thicknesses up to about 5 feet, and medium stiff to very stiff, sandy lean clay, sandy silty clay, and fat clay of varying plasticity and thicknesses up to of 3 feet.

The results of the ReMi survey are represented by the one-dimensional shear wave velocity profile located in the Geophysical Data in Appendix B. This plot depicts variations in the shear wave velocity profile to a depth of 100 feet. The average shear wave velocity for the upper 100 feet of the soil profile, v_{s100}, is estimated to be 810 feet per second which indicates a Site Class Definition of D as defined by Table 3.10.3.1-1 of AASHTO LRFD Bridge Design Specifications (AASHTO).

Samples to determine R-value were obtained from the fill in the upper 5 feet in borings HBR-1A and HBR-2A. R-value laboratory test results are included on the Summary of Results tables in Appendix C. The R-values were determined to be 71 to 76 in Borings HBR-1A and HBR-2A respectively. The R-value test is used by NDOT to measure subgrade strength and expansion potential, and is used in the design of flexible pavements.

Groundwater

Groundwater level was estimated during drilling to be approximately 10 feet below existing grade in borings HBR1 and HBR2. This corresponds to an elevation of approximately 3953 feet. Groundwater level was measured at a depth of 13.5 feet in borehole HBR 2A after drilling. This corresponds to an elevation of approximately 3949.5 feet. The groundwater level in the borings was approximately the same as the water level in the canal during the geotechnical investigation. Fluctuations in the level of the groundwater and soil moisture conditions as noted in this report may change due to variations in precipitation, controlled distribution of irrigation water, and other factors.

SUMMARY OF ANALYSES AND GEOTECHNICAL DESIGN CRITERIA

Seismic Design Considerations

In accordance with AASHTO Article 12.6.1, earthquake loading should only be considered where buried structures cross active faults. No seismic analysis is required since the buried RCB and wingwalls do not cross an active fault.

Scour Design Considerations

The NDOT Hydraulics Section's assessment of offsite flood flow potential determined that significant flood flows through the structure are improbable. The anticipated maximum flow through the structure is estimated to be 300 cubic feet per second which corresponds to an average depth of flow through the channel of approximately 4.6 feet. Flow in the channel is controlled upstream by several in-channel flow control structures that are managed by the TCID. The NDOT Hydraulics Section has proposed engineered scour countermeasures for the bridge replacement project, which are to be detailed in the construction plans, to resist scour for this anticipated maximum flow for the service life of the proposed structure. Therefore, the NDOT Hydraulics Section provided that design and check flood scour is not applicable at this site and they shall be taken to be zero. Hence, no changes to the foundation conditions need to be considered resulting neither from the design flood for scour at the strength and service limit states nor from the check flood for scour at the extreme event limit state in accordance with AASHTO Article 3.7.5.

Lateral Earth Pressures

The RCB and wingwalls will be backfilled with NDOT Granular Backfill material in accordance with NDOT *Standard Specifications for Road and Bridge Construction* (Standard Specifications) Section 207 and NDOT *Standard Plans for Road and Bridge Construction* (Standard Plans) Drawing R-1.1.4. Backfill beyond the limits of Granular Backfill will consist of existing or new roadway embankment fill. For our analyses, it was assumed that the properly compacted Granular Backfill will be free draining and backfill soils have the following material properties: angle of internal friction (ϕ_f) equal to 32 degrees, unit weight of soil (γ) equal to 120 pounds per cubic foot (pcf), and cohesion equal to 0. Earth pressure coefficients were calculated assuming a level backslope.

Static Lateral Earth Pressure

Static lateral earth pressures from the anticipated backfill on the sides of the culvert and wingwall sections that are fixed to the culvert to resist movement should be evaluated for drained conditions using an at-rest earth pressure coefficient, k_o, of 0.47 and a corresponding at-rest equivalent fluid unit weight of soil of 56 pcf.

Backfill soils were calculated to have a Rankine active earth pressure coefficient, k_a, of 0.31.

Vehicular Live Load Surcharge

Constant horizontal earth pressure due to vehicular live load surcharge was evaluated in accordance with AASHTO Article 3.11.6.4. Equivalent height of soil for vehicular loading, h_e, shall be taken as 2.8 feet for the culvert side walls and 2.0 feet for the wingwalls. Therefore, the constant horizontal at-rest earth pressure due to vehicular live load surcharge on the culvert side walls shall be taken as 160 pounds per square foot (psf). Constant horizontal at-rest earth pressure due to vehicular live load surcharge on the wingwalls shall be taken as 110 psf.

Other anticipated surcharge loads resulting in lateral loads on the culvert side walls and wingwalls need to be considered in the design.

Structure Loads and Bearing Pressures

Anticipated structure loads and estimated existing structure loads were provided by the NDOT Structures Division. The anticipated new structure dead loads result in a bearing pressure of 0.71 kips per square foot (ksf). The existing structure has an estimated bearing pressure from dead loads of 0.84 ksf at the abutments and 1.65 ksf at the pier. Since the existing structure has greater bearing pressures than the new structure, settlement is not expected.

Settlement

Settlement analyses for the RCB were not performed because the net bearing pressure applied at the proposed foundation elevation is estimated to be less than 0.

Foundation Soil

Based on laboratory test results along with correlation with SPT blow counts, foundation soils were analyzed using of the following soil properties: ϕ_f equal to 36 degrees, γ equal to 124 pcf, and cohesion equal to 0.

Soil Bearing Resistance

Bearing resistances for the RCB were analyzed assuming a 43 feet wide and 41 feet long box culvert founded at an approximate elevation of 3951 feet. Bearing resistances for the box culvert are summarized in Table 1 and are further explained in the following sections.

Table 1. Box Culvert Bearing Resistances

*Service Limit State		Strength Limit State		Extreme Event Limit State	
Nominal Resistance (ksf)	Factored Resistance (ksf)	Nominal Resistance (ksf)	Factored Resistance (ksf)	Nominal Resistance (ksf)	Factored Resistance (ksf)
2.0	2.0	50	23	n/a	n/a

*Note that the provided Service Limit State bearing resistances are based on *net* applied bearing pressure. Read Service Limit State section below for further explanation.

Service Limit State

The resistance factor, φ, for the service limit states shall be taken as 1.0 in accordance with AASHTO Article 10.5.5.1. Therefore, nominal and factored resistances at the service limit states are equal. For this project, the factored bearing resistance at the Service I Limit State is defined as the net bearing pressure that is estimated to produce 1 inch of total settlement. The net bearing pressure is defined as the difference between the bearing pressure applied by the new structure and the bearing pressure applied by the existing structure. Settlement analyses using computational methods based on the results of laboratory and in situ testing were performed in accordance with AASHTO Article 10.6.2.4 and FHWA *Soils and Foundations* manual.

Settlement analyses estimate that total settlement of 1 inch for the proposed RCB would occur from an applied net bearing pressure of approximately 2 kips per square foot (ksf). Therefore, factored bearing resistance at the Service I Limit State shall be 2 ksf.

Since the existing structure has greater applied bearing pressures than the proposed new RCB structure, the net bearing pressure will be less than 0.

Strength Limit State

Nominal bearing resistance at the Strength Limit State was calculated using the theoretical estimation in accordance with AASHTO Article 10.6.3.1.2a. The bearing resistance factor for the Strength Limit state, φ_b, of 0.45 used in our analysis is based on the theoretical method, in sand, using SPT from AASHTO Table 10.5.5.2.2-1.

The nominal bearing resistance at the Strength Limit State for the proposed box culvert embedded 18 inches with no eccentric loading is estimated to be 50 ksf, and the factored bearing resistance is estimated to be 23 ksf.

Extreme Event Limit State

Bearing resistances at the Extreme Event Limit States were not evaluated since seismic design is not required and check flood scour is not applicable at this site.

Foundation Embedment Depth

Section 17.2.4 of the NDOT Structures Manual requires spread footings to be embedded a sufficient depth to provide the greatest of the following:

- adequate bearing, scour and frost heave protection;
- 3 ft to the bottom of footing; or
- 2 ft of cover over the footing.

To protect against frost heave, it is recommended that spread footings be embedded at least 18 inches. Eighteen inches of embedment also provides for adequate bearing resistance.

The NDOT Hydraulics Section should be consulted to determine the embedment depth that protects against scour.

Soil Liquefaction

During a dynamic event such as an earthquake shaking, loose, saturated cohesionless soil deposits may experience a sudden loss of strength and stiffness. This phenomenon is called soil liquefaction.

Although saturated, cohesionless sands and silts are predominant at the site, they are generally medium dense to dense at and below the proposed foundation elevation which decreases the potential for soil liquefaction at the site.

Liquefaction analysis of onsite soils at and below the proposed footing elevations have been performed using the Simplified Procedure as described in the FHWA *Geotechnical Earthquake Engineering* manual. The analysis determined that there is no potential for liquefaction in the soils encountered at or below the proposed footing elevation at the project site.

CONSTRUCTION RECOMMENDATIONS

Removal of Existing Structure

Construction of the new RCB will require removal of the existing structure. The existing structure and all spread footing foundation elements shall be fully removed.

Dewatering

Construction is proposed to take place from December 2014 to March 2015. During this time the TCID can redirect the water flow in the canal so that no irrigation water will flow through the canal at the project site. However, the foundation soils will likely be saturated and water seepage will likely be encountered in excavations.

During our geotechnical investigation in January 2014, irrigation water was not flowing through the canal. Yet, there was water/ice present in the canal. Below are photos taken at the project site during our investigation that show water conditions in the L-line canal.

Photo 1. Looking East (downstream) towards Bridge B-100.

Photo 2. Looking West (upstream) at Bridge B-100.

Photo 3. Looking East (downstream) towards the weir from Bridge B-100.

Dewatering is the Contractor's responsibility and is included in the Structure Excavation item of work as stated in NDOT Standard Specifications Sub-Section 206.01.01. Additionally, we recommend that the contractor protect any subgrade from exposure to water and any unnecessary construction traffic.

Excavations

Construction of the new RCB will require soil excavation. All structure excavation shall conform in accordance with Section 206 of NDOT Standard Specifications and current OSHA safety regulations for sloping the sides of excavations, using shoring and bracing, and for using other safety features. The working area will require the contractor to shore foundation excavations due to right-of way limitations and utility conflicts. Shoring shall be designed using appropriate lateral earth pressures presented in this report and anticipated surcharge loads.

Existing fill materials and adjacent underlying native materials at the project site can generally be classified as OSHA Class C soils defined by granular soils including gravel, sand, and sandy loam; and submerged soil or soil from which water is freely seeping. Maximum allowable slopes for excavations less than 20 feet in Class C soils is 1.5H:1V. These limits and soil classifications may change based on the soil conditions exposed during construction as determined by a competent person.

Utilities

Limits of excavation will need to be confined to not interfere with existing utility infrastructure. The contractor is responsible for any necessary shoring needed for structure excavation to avoid existing utilities. As stated in Subsection 105.06 of the Standard Specifications, the contractor is responsible to take steps to ascertain the exact location of all underground facilities before doing work that may damage such facilities or interfere with their service. Locating of underground facilities is the sole responsibility of the Contractor. No reliance may be placed upon the location of underground facilities as noted on the plans.

Construction Platform

The box culvert shall be bedded on 4 inches of bedding material and backfilled in accordance with NDOT Standard Plans Drawing R-1.1.4. It is likely that unstable foundations conditions will be encountered during construction due to migration of saturated sands, seepage, and/or yielding conditions which prevent proper compaction of the foundation soils. Therefore, we recommend that both the box culvert and wingwall footings be founded on the 4 inches of bedding material and be constructed on a platform consisting of Class 150 Riprap Bedding wrapped in geotextile fabric. The recommended thickness of the Riprap Bedding is 36 inches under the RCB and 18 inches under the wingwalls. Riprap Bedding placed as part of the construction platform shall be placed in lifts and be properly compacted in accordance with Section 208 of the contract Special Provisions. The initial lift of Riprap Bedding should be approximately 12 inches, and following lifts should be no more than 8 inches. Details of the construction platform will be depicted in the construction plans.

Geotextile

Geotextile will be installed as part of the aforementioned construction platform. Additionally, geotextile will be installed for scour mitigation applications. Geotextile installation procedures and material specifications for both applications shall be in conformance with Sections 203 and 731 of the contract Special Provisions.

GEOTECHNICAL REPORT LIMITATIONS

Recommendations contained in this report are based on the information obtained from our field investigations, laboratory tests, and observations of our geotechnical engineer. If conditions are encountered during construction which differ from those described in this report, or if the scope of construction is altered significantly, the NDOT Geotechnical Section must be notified in order to provide a review of our recommendations. The nature and extent of variations may not be evident until construction takes place.

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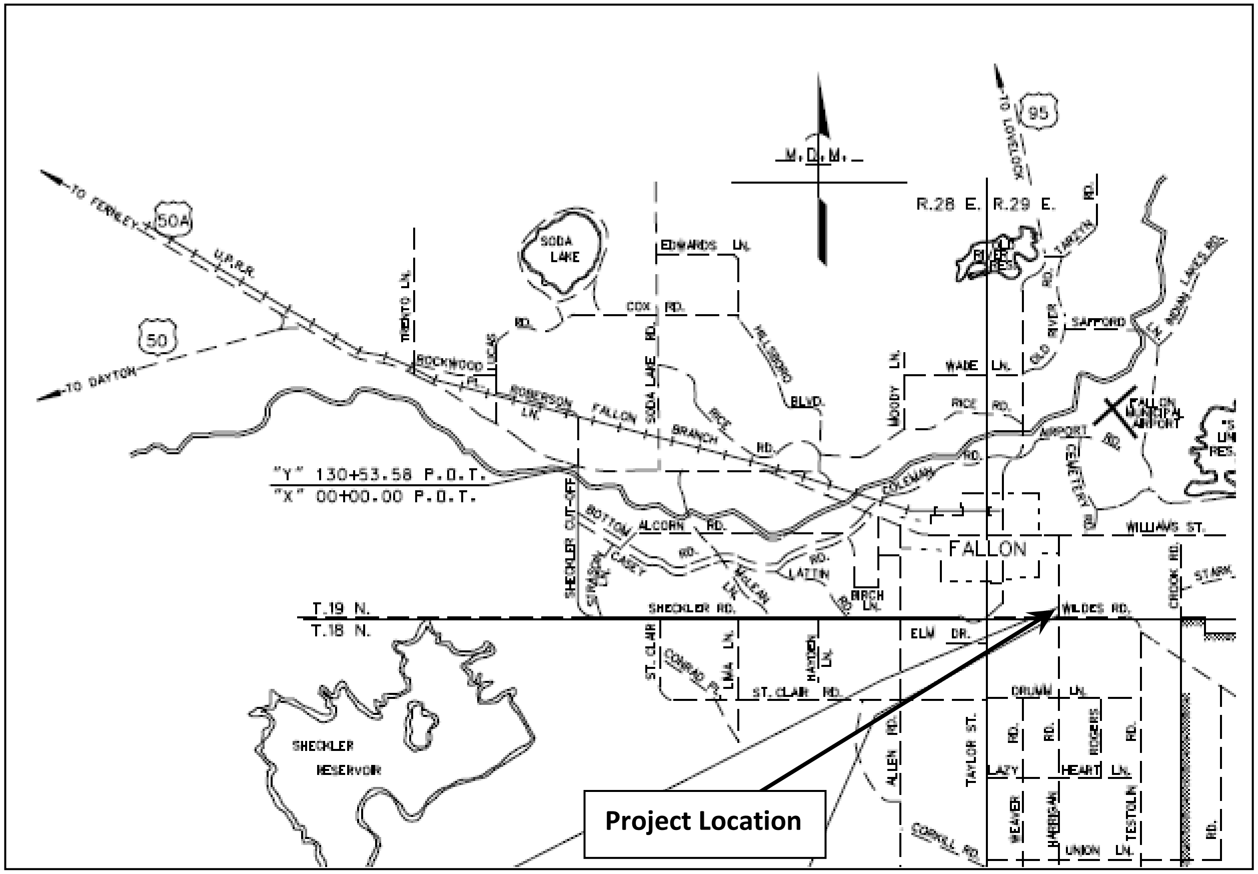
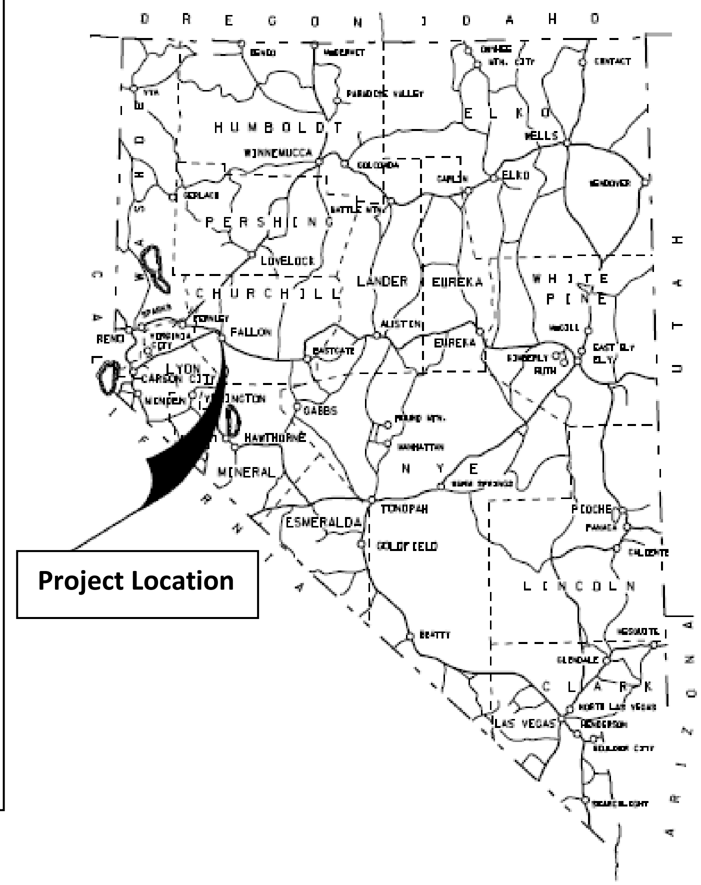
APPENDIX A:
MAPS

Site Location Map
Boring Location Map

SITE LOCATION MAP





BORING LOCATION MAP

APPENDIX B:
SUBSURFACE EXPLORATION DATA

Key to Boring Logs
Boring Logs
Geophysical (ReMi) Survey Data

KEY TO BORING LOGS

PARTICLE SIZE LIMITS								
CLAY	SILT	SAND			GRAVEL		COBBLES	BOULDERS
		FINE	MEDIUM	COARSE	FINE	COARSE		

.002 mm   #200   #40   #10   #4   ¾ 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
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
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.
∇ ▼	Groundwater Elevation Symbols

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

STANDARD PENETRATION CLASSIFICATION* (after Peck, *et al.*, 1974)

GRANULAR SOIL		CLAYEY SOIL	
BLOWS/FT N_{60}	DENSITY	BLOWS/FT N_{60}	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

* SPT N_{60}-values are only reliable for sands, and should serve only as estimates for other materials such as gravels, silts and clays.

California Modified Sampler field blow counts ($N_{CMS\ field}$) for ($6 < N_{CMS\ field} < 50$) can be converted to $N_{SPT\ field}$ by:

$(N_{CMS\ field})(0.62) = N_{SPT\ field}$

SPT field blow counts ($N_{SPT\ field}$) can be converted to N_{60} by:

$(N_{SPT\ field})(ETR/60) = N_{60}$

ETR = Energy Transfer Ratio

Field blow counts from 140 lb hammer with 30 inch free fall

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/ROCK COLOR CHARTS.

EXAMPLE: (7.5 YR 5/3) BROWN

SAMPLER NOTATION

CMS	CALIF. MODIFIED SAMPLER[1]
CPT	CONE PENETRATION TEST
CS	CONTINUOUS SAMPLER[2]
PB	PITCHER BARREL
RC	ROCK CORE[3]
SH	SHELBY TUBE[4]
SPT	STANDARD PENETRATION TEST[5]
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

5- I.D.= 1.375 inch, O.D.= 2.00 inch

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

BORING LOG

START DATE 1/22/14
END DATE 1/22/14
JOB DESCRIPTION Harrigan Road Bridge Replacement B-100
LOCATION SR 115 at L-line Canal
BORING HBR-1
E.A. # 73798
GROUND ELEV. 3963. (ft)
HAMMER DROP SYSTEM Auto, ETR=87.5%

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
1/22/14	10.0	3953.0

STATION "HR" 105+40
OFFSET 20' RT
ENGINEER Hurlbut
EQUIPMENT Diedrich D120, Rig #1082
OPERATOR Altamirano
DRILLING METHOD 3.5" Rotary Wash
BACKFILLED Yes DATE 1/22/2014

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS
	2.5–4.0	A	SPT	7 6 3	9	65	S, PI, W
3958.0	5						
	5.0–6.5	B	CMS	2 3 7	10	75	S, PI, W, DS, UW
	7.5–9.0	C	SPT	4 5 6	11	85	S, PI, W
3953.0	10						
	10.0–11.5	D	SPT	5 6 7	13	65	S, PI, W
	12.5–14.0	E	CMS	11 14 20	34	75	S, PI, W, DS, UW
3948.0	15						
	15.0–16.5	F	SPT	10 7 6	13	85	S, PI, W
	17.5–19.0	G	CMS	9 16 26	42	90	S, PI, W, DS, UW
3943.0	20						
	20.0–21.5	H	SPT	3 3 3	6	90	S, PI, W
	22.5–24.0	I	CMS	13 22 24	46	100	S, PI, W, DS, UW
3938.0	25						
	27.5–29.0	J	SPT	6 4 7	11	100	S, PI, W
3933.0	30						
	32.5–34.0	K	SPT	25 31 40	71	100	S, PI, W
3928.0	35						

Depth to bottom of layer (ft)	USCS Group	MATERIAL DESCRIPTION
1.00		Asphalt and Aggregate Base
7.00	SM	**Silty SAND** moist, mostly fine sands, about 15% to 20% nonplastic fines. Cobble at about 2' to 2.5'. Sample B: 8.0% moisture content, 98.7 pcf dry unit weight, 31 degree peak friction angle and 0.7 psi cohesion.
9.50	SC SM	**Silty, Clayey SAND** moist, mostly fine sands, about 30% fines, PI = 6.
14.50	SP SM	**Poorly graded SAND with Silt** moist to wet, mostly fine sands, about 5% to 9% nonplastic fines. Sample E1: 21.5% moisture content, 107.3 pcf dry unit weight. Sample E2: 20.0% moisture content, 98.7 pcf dry unit weight, 37 degree peak friction angle and 1.5 psi cohesion.
15.50	SP	**Poorly graded SAND** wet, mostly fine sands, <5% nonplastic fines.
17.00	CH	**Fat CLAY** wet, 90% fines, PI = 41.
18.20	SM	**Silty SAND** wet, mostly fine sands, 32% fines, PI = 2, 23.3% moisture content, 99.5 pcf dry unit weight, 21 degree peak friction angle and 8.4 psi cohesion.
19.50	SP SM	**Poorly graded SAND with Silt** wet, mostly fine sands, 6% nonplastic fines.
22.00	CL ML	**Sandy Silty CLAY** wet, 63% fines, PI = 7.
27.00	SM	**Silty SAND** wet, about 25% to 40% nonplastic fines. Sample I1: 23.0% moisture content, 100.8 pcf dry unit weight. Sample I2: 19.6% moisture content, 104.5 pcf dry unit weight, 32 degree peak friction angle and 6.6 psi cohesion.
31.00	ML	**SILT** wet, 93.5% fines, PI = 5.
34.00	SM	**Silty SAND** wet, about 20% nonplastic fines.

Bottom of hole at 34' depth.
Hole filled with grout on 1/22/14.

REMARKS

Started drilling at 10:40 am.
Used bentonite drilling mud and 3.5" tri-cone bit.
Used head pressure only for entire depth with easy penetration.
All samplers used sand catchers.
Estimated depth of free water during drilling 10'.
Finished drilling at 2:00 pm.

BORING LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE 1/23/14
END DATE 1/23/14
JOB DESCRIPTION Harrigan Road Bridge Replacement B-100
LOCATION SR 115 at L-line Canal
BORING HBR-1A
E.A. # 73798
GROUND ELEV. 3963. (ft)
HAMMER DROP SYSTEM

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
	n/a	0.0

STATION "HR" 105+40
OFFSET 20' RT
ENGINEER
EQUIPMENT Mobile Drill
OPERATOR Altamirano
DRILLING METHOD 6" Solid Auger
BACKFILLED Yes DATE 1/23/2014

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
	1.0								0.75	**3.5" Asphalt Pavement** **5.5" of Agg Base/Gravel Material.**	
		Bulk 1					RV	**SM**		**Silty SAND**	
3958.0	5 (5.0)								5.00	Bottom of hole at 5'. Hole backfilled with cuttings on 1/23/14.	
3953.0	10										
3948.0	15										
3943.0	20										
3938.0	25										
3933.0	30										
3928.0	35										

BORING LOG

SHEET 1 OF 1

START DATE	1/23/14	STATION	"HR" 106+20
END DATE	1/23/14	OFFSET	9' LT
JOB DESCRIPTION	Harrigan Road Bridge Replacement B-100	ENGINEER	Hurlbut
LOCATION	SR 115 at L-line Canal	EQUIPMENT	Diedrich D120, Rig #1082
BORING	HBR-2	OPERATOR	Altamirano
E.A. #	73798	DRILLING METHOD	3.5" Rotary Wash
GROUND ELEV.	3963. (ft)	BACKFILLED	Yes DATE 1/23/2014
HAMMER DROP SYSTEM	Auto, ETR=87.5%		

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
1/23/14	10.0	3953.0

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
									1.00 Asphalt and Aggregate Base	Started drilling at 9:45 am. Used bentonite drilling mud and 3.5" tri-cone bit. Used head pressure only for entire depth with easy penetration. All samplers used sand catchers.
	2.5–4.0	A	SPT	5 3 3	6	85	S, PI, W	SP SM	4.50 **Poorly graded SAND with Silt** moist, mostly fine sands, about 11% nonplastic fines.	
3958.0	5									
	5.0–6.5	B	SPT	1 2 2	4	75	S, PI, W	SM	9.50 **Silty SAND** moist, about 10% to 20% nonplastic fines. Sample C1: with 24% gravel, 9.2% moisture content, 119.6 pcf dry unit weight.	
	7.5–9.0	C	CMS	5 5 5	10	75	S, PI, W, UW			
3953.0	10									
	10.0–11.5	D	SPT	3 4 5	9	60	S, PI, W	SC SM	12.00 **Silty, Clayey SAND** wet, 28.3% fines, PI = 4.	Estimated depth of free water during drilling 10'.
	12.5–14.0	E	SPT	6 7 8	15	65	S, PI, W	SP	17.00 **Poorly graded SAND** wet, about 3% to 5% nonplastice fines, Sample F1: 19.1% moisture content, 107.3 pcf dry unit weight. Sample F2: 15.3% moisture content, 107.4 pcf dry unit weight, 42 degree peak friction angle and 1.6 psi cohesion.	
3948.0	15									
	15.0–16.5	F	CMS	18 19 24	43	85	S, PI, W, DS, UW			
	17.5–19.0	G	SPT	5 7 14	21	80	S, PI, W	SM	20.00 **Silty SAND** wet, 25% nonplastic fines.	
3943.0	20									
	20.0–21.5	H	SPT	9 5 4	9	80	S, PI, W	CL	23.00 **Sandy lean CLAY** wet, 70% fines, PI = 9.	
3938.0	25									
	25.0–26.5	I	SPT	19 27 28	55	95	S, PI, W	SM	26.50 **Silty SAND** wet, 26% nonplastic fines.	
									Bottom of hole at 26.5' depth. Hole filled with grout on 1/23/14.	
3933.0	30									
3928.0	35									Finished drilling at 12:00 pm.

BORING LOG

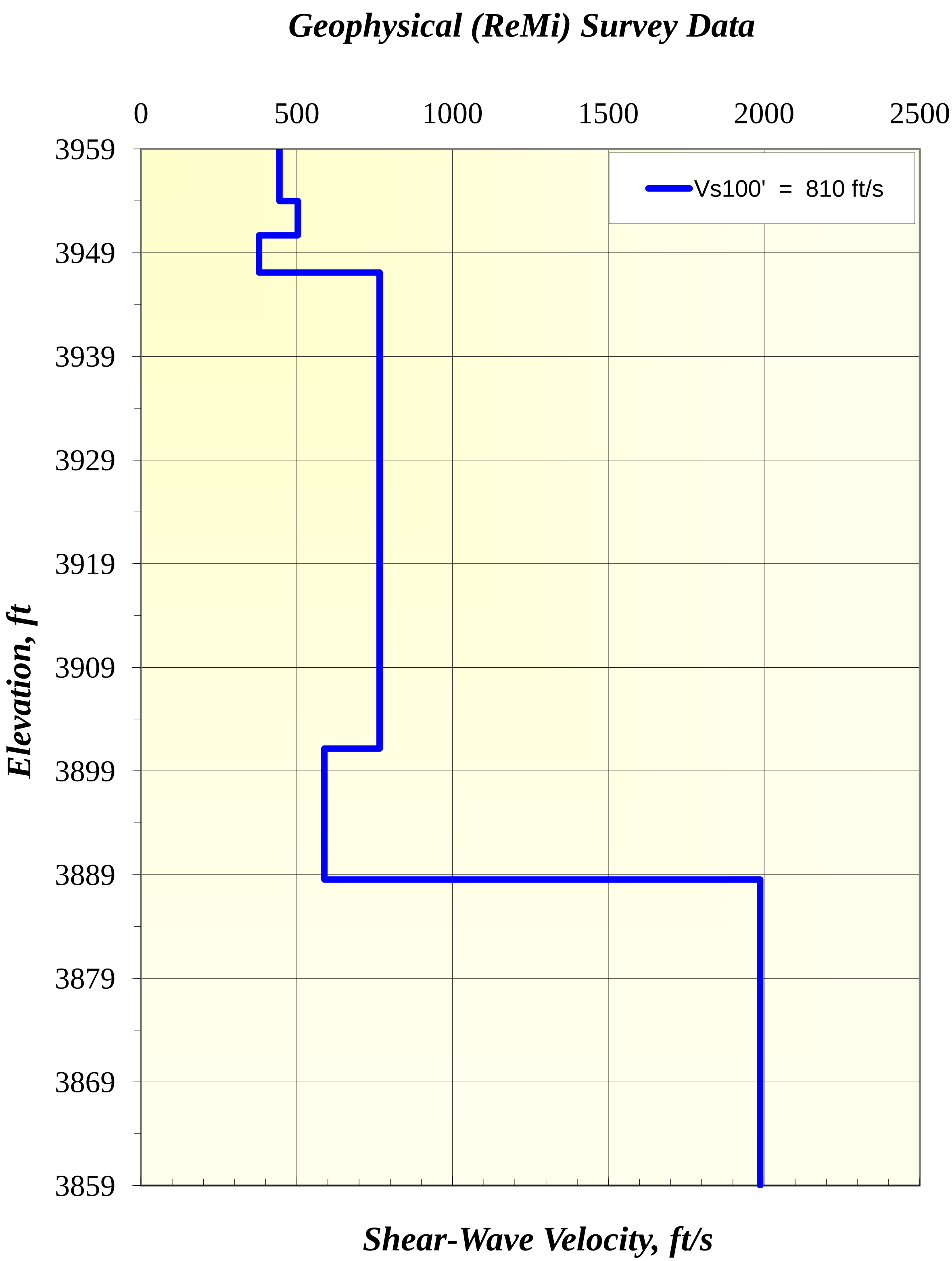
NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE 1/23/14
END DATE 1/23/14
JOB DESCRIPTION Harrigan Road Bridge Replacement B-100
LOCATION SR 115 at L-line Canal
BORING HBR-2A
E.A. # 73798
GROUND ELEV. 3963. (ft)
HAMMER DROP SYSTEM

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
1/23/14	13.5	3949.5

STATION "HR" 106+20
OFFSET 9' LT
ENGINEER
EQUIPMENT Mobile Drill
OPERATOR Altamirano
DRILLING METHOD 6" Solid Auger
BACKFILLED Yes DATE 1/23/2014

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
	1.5								1.25 **6.5" Asphalt Pavement** **8.5" of Agg Base/Gravel Material.**	
		Bulk 1					RV	SM	**Silty SAND**	
3958.0	5 (5.5)									
3953.0	10									
3948.0	15								15.00 Bottom of hole at 15'. Hole backfilled with grout on 1/23/14.	Measured ground water at a depth of 13.5'.
3943.0	20									
3938.0	25									
3933.0	30									
3928.0	35									


Geophysical (ReMi) Survey Data
0
500
1000
1500
2000
2500
3959
3949
3939
3929
3919
3909
3899
3889
3879
3869
3859
Vs100' = 810 ft/s
Elevation, ft
Shear-Wave Velocity, ft/s

APPENDIX C:
LABORATORY TEST RESULTS

Summary of Results
Particle Size Distribution Reports
Direct Shear Test Reports

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

EA/Cont # 73798 **Job Description** B-100 Harrigan Bridge Replacement, over L-line canal

Boring No. HBR - 1 **Elevation (ft)** 3963 **Station** "HR" 105+40, 20' Rt. **Date** 1/22/2014

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 TEST TYPE	Peak Φ deg.	Peak C psi	Residual Φ deg.	Residual C psi	COMMENTS
A	2.5 - 4.0	SPT	9	SM	21.2		19.7	17	NP	NP						
B	5.7 - 6.3	CMS	10	SM	8.0	98.7	16.8	17	NP	NP	DS	31	0.7	31	0.7	
C	7.5 - 9.0	SPT	11	SC-SM	21.5		30.2	23	17	6						
D	10.0 - 11.5	SPT	13	SP-SM	23.5		8.8	20	NP	NP						
E1	12.7 - 13.2	CMS	34	SP-SM	21.5	107.3	5.3	19	NP	NP						
E2	13.2 - 13.7	CMS		SP-SM	20.0	98.7	5.9	20	NP	NP	DS	37	1.5	32	0.6	
F1	15.0 - 15.5	SPT	13	SP	23.8		4.8	17	NP	NP						
F2	15.5 - 16.5	SPT		CH	34.0		88.9	61	20	41						
G1	17.7 - 18.2	CMS	42	SM	23.3	99.5	32.0	18	16	2						
G2	18.2 - 19.0	CMS		SP-SM	23.2		6.1	20	NP	NP						
H	20.0 - 21.5	SPT	6	CL-ML	33.3		63.0	26	19	7						
I1	22.7 - 23.2	CMS	46	SM	23.0	100.8	37.3	21	NP	NP						

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 # 73798 **Job Description** B-100 Harrigan Bridge Replacement, over L-line canal

Boring No. HBR - 1 **Elevation (ft)** 3963 **Station** "HR" 105+40, 20' Rt. **Date** 1/22/2014

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: TEST TYPE	Peak Φ deg.	Peak C psi	Residual Φ deg.	Residual C psi	COMMENTS
I2	23.2 - 23.7	CMS	46	SM	19.6	104.5	25.0	20	NP	NP	DS	32	6.6	32	2.2	
J	27.5 - 29.0	SPT	11	ML	37.5		93.5	31	26	5						
K	32.5 - 34.0	SPT	71	SM	25.8		19.9	22	NP	NP						

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 # 73798 **Job Description** B-100 Harrigan Bridge Replacement, over L-line canal

Boring No. HBR - 1A **Elevation (ft)** 3963 **Station** "HR" 105+40, 17' Rt. **Date** 1/22/2014

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: TEST TYPE	Peak: Φ deg.	Peak: C psi	Residual: Φ deg.	Residual: C psi	COMMENTS
BULK 1	1.0 - 5.0			SM			18.3	17	NP	NP						RV = 71

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 # 73798 **Job Description** B-100 Harrigan Bridge Replacement, over L-line canal

Boring No. HBR - 2 **Elevation (ft)** 3963 **Station** "HR" 106+20, 9' Lt. **Date** 1/23/2014

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: TEST TYPE	Peak: Φ deg.	Peak: C psi	Residual: Φ deg.	Residual: C psi	COMMENTS
A	2.5 - 4.0	SPT	6	SP-SM	21.2		10.6	19	NP	NP						
B	5.0 - 6.5	SPT	4	SM	21.4		12.5	19	NP	NP						
C1	8.2 - 8.7	CMS	10	SM	9.2	119.6	17.1	17	NP	NP						
C2	8.7 - 9.0	CMS		SM	12.6		19.9	17	NP	NP						
D	10.0 - 11.5	SPT	9	SC-SM	20.0		28.3	20	16	4						
E	12.5 - 14.0	SPT	15	SP	22.5		4.7	18	NP	NP						
F1	15.2 - 15.7	CMS	43	SP	19.1	107.3	3.1	20	NP	NP						
F2	15.7 - 16.2	CMS		SP	15.3	107.4	3.3	15	NP	NP	DS	42	1.6	35	0.0	
G	17.5 - 19.0	SPT	21	SM	24.0		25.0	18	NP	NP						
H	20.0 - 21.5	SPT	9	CL	32.1		69.7	27	18	9						
I	25.0 - 26.5	SPT	55	SM	23.8		26.0	19	NP	NP						

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 # 73798 **Job Description** B-100 Harrigan Bridge Replacement, over L-line canal

Boring No. HBR - 2A **Elevation (ft)** 3963 **Station** "HR" 106+20, 12' Lt. **Date** 1/23/2014

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: TEST TYPE	Peak: Φ deg.	Peak: C psi	Residual: Φ deg.	Residual: C psi	COMMENTS
BULK 1	1.5 - 5.5			SM			13.4	18	NP	NP						RV = 76

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

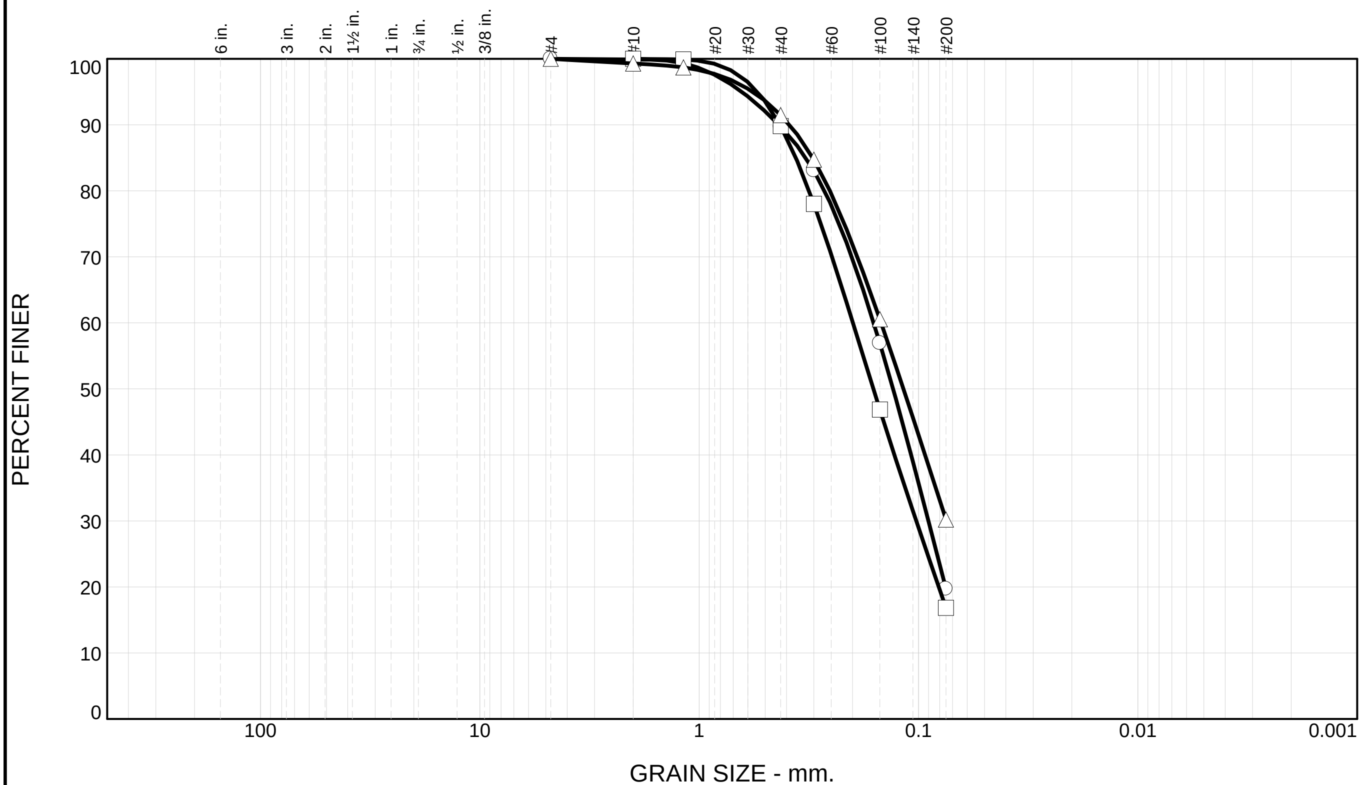
U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
Φ = Friction
C = Cohesion
N = No. of blows per ft., sampler
N = Field SPT   N = (N_{css})(0.62)

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**

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	80.3	19.7		SM	A-2-4(0)	NP	17
□	0.0	0.0	83.2	16.8		SM	A-2-4(0)	NP	17
△	0.0	0.0	69.8	30.2		SC-SM	A-2-4(0)	17	23

SIEVE inches size	PERCENT FINER ○	□	△
	GRAIN SIZE		
D_{60}	0.1600	0.1990	0.1480
D_{30}	0.0901	0.1023	
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	100.0		100.0
#10	99.9	100.0	99.3
#16	99.3	99.9	98.7
#40	89.7	89.8	91.5
#50	83.1	78.0	84.7
#100	56.9	46.9	60.5
#200	19.7	16.8	30.2

Material Description

○ silty sand

□ silty sand

△ silty, clayey sand

REMARKS:

○

□

△

○ Source of Sample: HBR-1 Depth: 2.5 - 4.0' Sample Number: A

□ Source of Sample: HBR-1 Depth: 5.7 - 6.2' Sample Number: B

△ Source of Sample: HBR-1 Depth: 7.5 - 9.0' Sample Number: C

NEVADA DEPARTMENT OF TRANSPORTATION

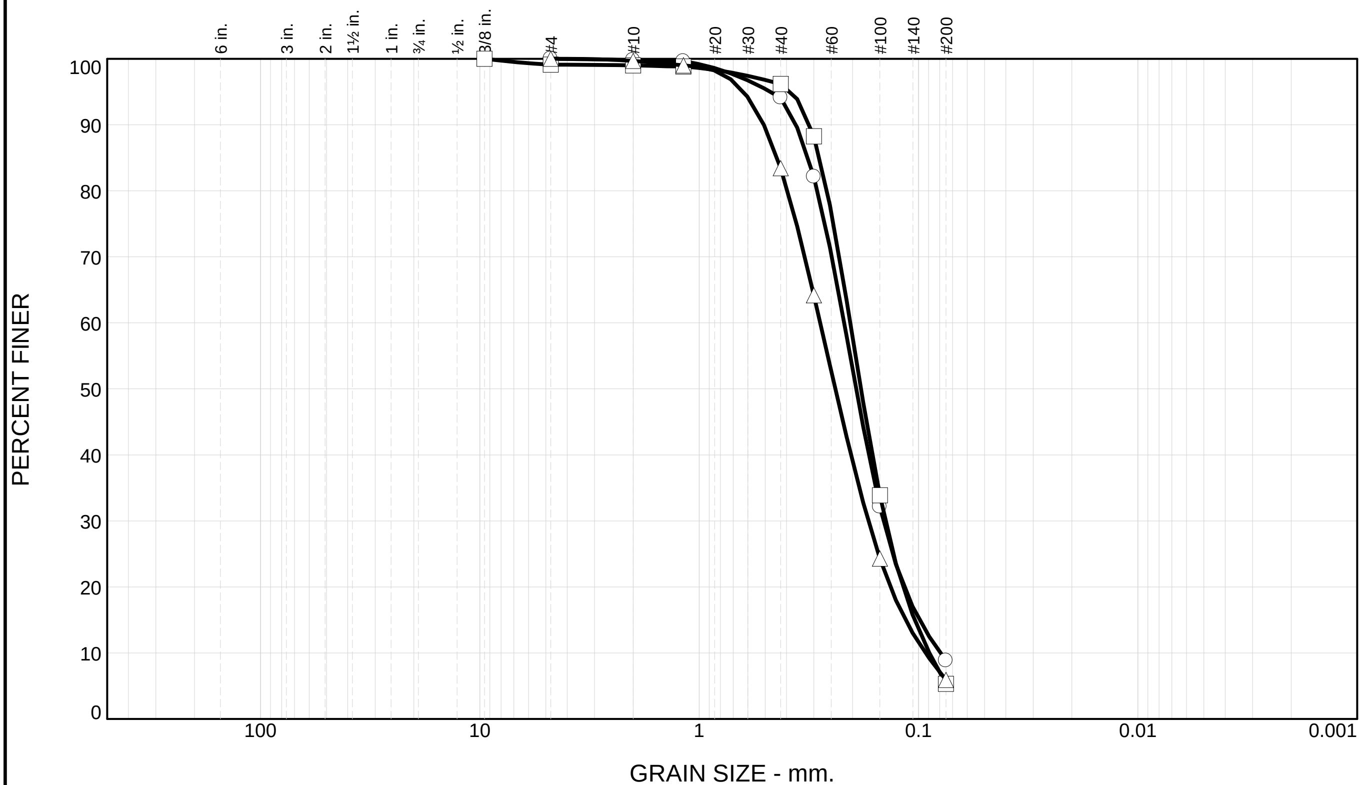
Client: A. Hurlbut

Project: B-100 Harrigan Bridge Replacement

Project No.: EA 73798

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	91.2	8.8		SP-SM	A-3	NP	20
□	0.0	0.9	93.8	5.3		SP-SM	A-3	NP	19
△	0.0	0.0	94.1	5.9		SP-SM	A-3	NP	20

SIEVE inches size	PERCENT FINER ○	□	△
3/8"		100.0	
GRAIN SIZE			
D_{60}	0.2181	0.2047	0.2807
D_{30}	0.1447	0.1416	0.1694
D_{10}	0.0795	0.0892	0.0929
COEFFICIENTS			
C_c	1.21	1.10	1.10
C_u	2.74	2.29	3.02

SIEVE number size	PERCENT FINER ○	□	△
#4	100.0	99.1	100.0
#10	99.8	99.0	99.7
#16	99.6	98.8	99.0
#40	94.1	96.2	83.4
#50	82.1	88.3	64.2
#100	32.1	33.9	24.3
#200	8.8	5.3	5.9

Material Description

○ poorly graded sand with silt

□ poorly graded sand with silt

△ poorly graded sand with silt

REMARKS:

○

□

△

○ Source of Sample: HBR-1 Depth: 10.0 - 11.5' Sample Number: D

□ Source of Sample: HBR-1 Depth: 12.7 - 13.2' Sample Number: E1

△ Source of Sample: HBR-1 Depth: 13.2 - 13.7' Sample Number: E2

NEVADA DEPARTMENT OF TRANSPORTATION

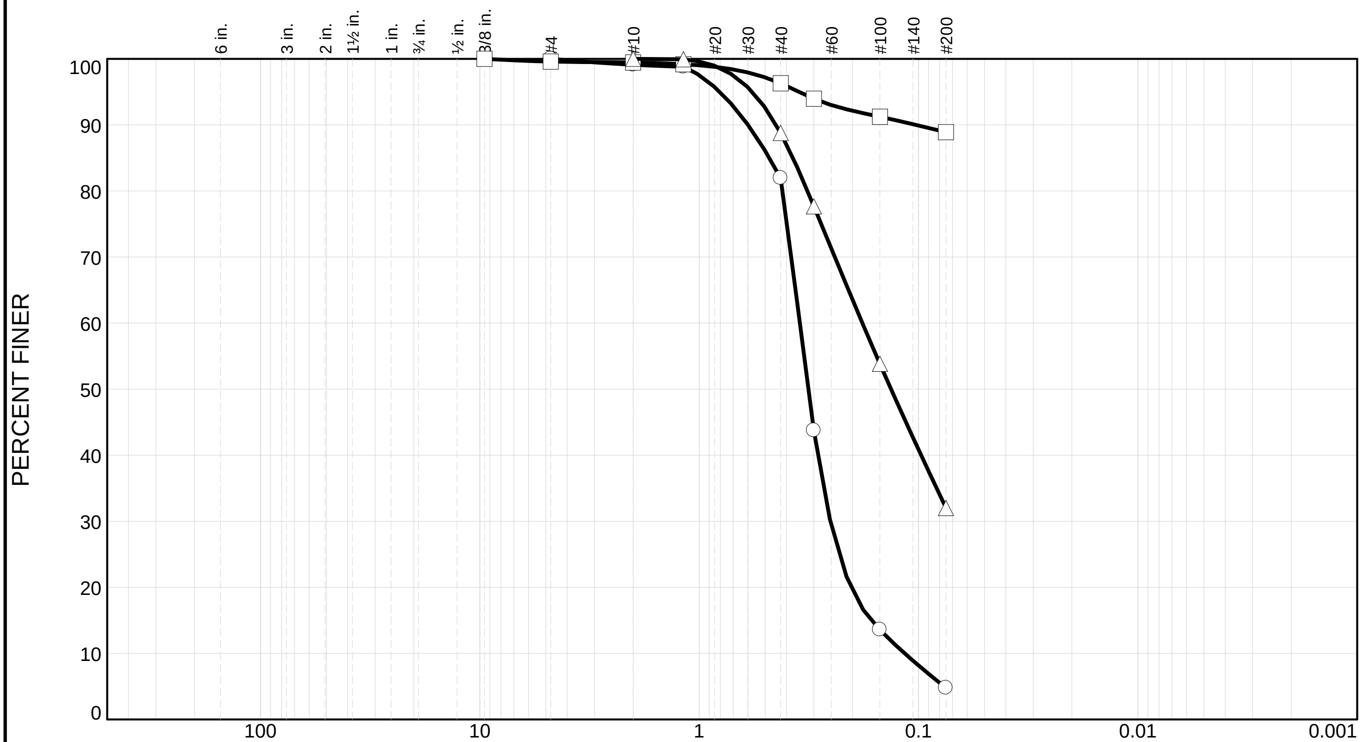
Client: A. Hurlbut

Project: B-100 Harrigan Bridge Replacement

Project No.: EA 73798

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT / % CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	95.2	4.8	SP	A-3	NP	17
□	0.0	0.4	10.7	88.9	CH	A-7-6(39)	20	61
△	0.0	0.0	68.0	32.0	SM	A-2-4(0)	16	18

SIEVE inches size	PERCENT FINER ○	□	△
3/8"		100.0	

	GRAIN SIZE ○	□	△
D_{60}	0.3480		0.1802
D_{30}	0.2524		
D_{10}	0.1156		

	COEFFICIENTS ○	□	△
C_c	1.58		
C_u	3.01		

SIEVE number size	PERCENT FINER ○	□	△
#4	100.0	99.6	
#10	99.1	99.5	100.0
#16	98.8	99.2	99.9
#40	81.9	96.3	88.8
#50	43.7	94.0	77.7
#100	13.6	91.2	53.8
#200	4.8	88.9	32.0

Material Description
○ poorly graded sand
□ fat clay
△ silty sand

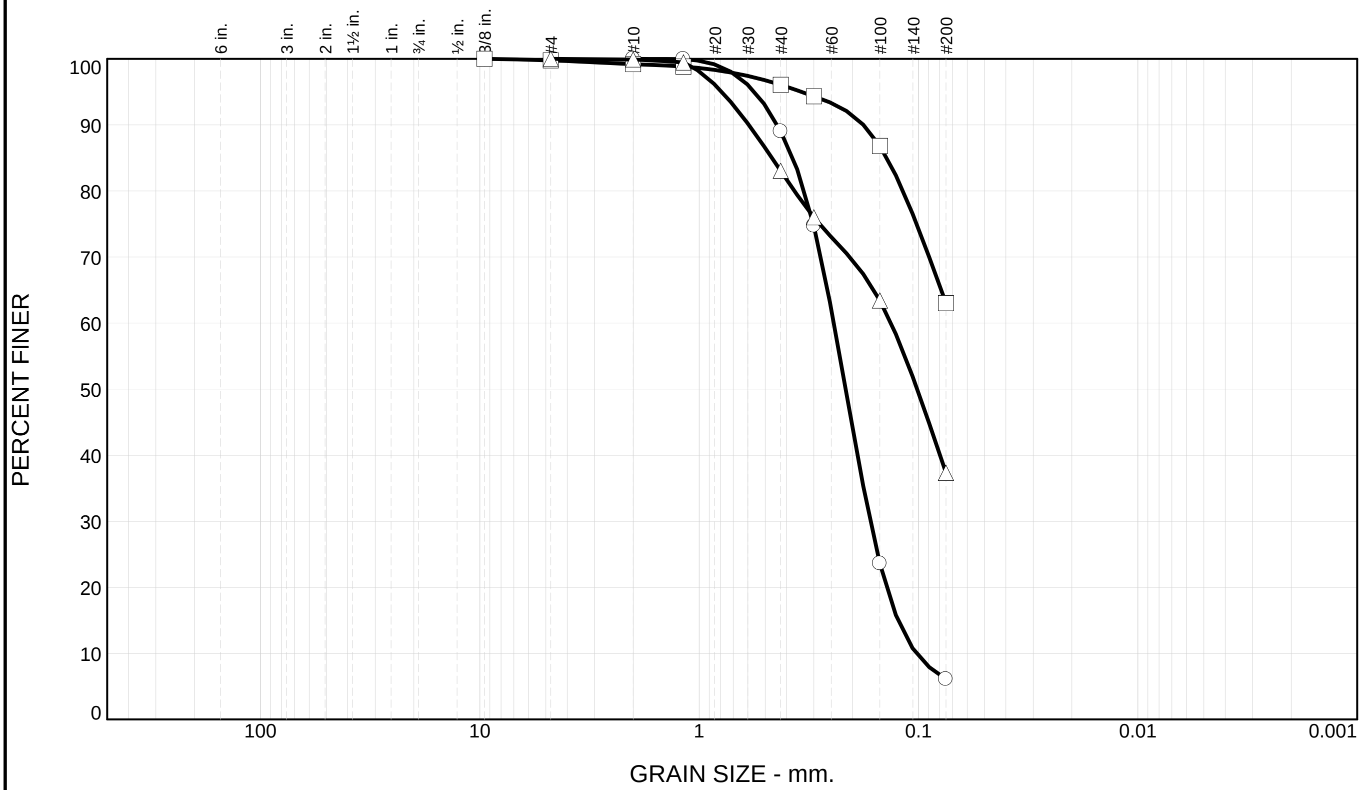
REMARKS:
○
□
△

○ Source of Sample: HBR-1 Depth: 15.0 - 15.5' Sample Number: F1
□ Source of Sample: HBR-1 Depth: 15.5 - 16.5' Sample Number: F2
△ Source of Sample: HBR-1 Depth: 17.7 - 18.2' Sample Number: G1

NEVADA DEPARTMENT OF TRANSPORTATION

Client: A. Hurlbut
Project: B-100 Harrigan Bridge Replacement
Project No.: EA 73798 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	93.9	6.1		SP-SM	A-3	NP	20
□	0.0	0.2	36.8	63.0		CL-ML	A-4(2)	19	26
△	0.0	0.0	62.7	37.3		SM	A-4(0)	NP	21

SIEVE inches size	PERCENT FINER ○	□	△
3/8"		100.0	

	GRAIN SIZE ○	□	△
D_{60}	0.2433		0.1335
D_{30}	0.1659		
D_{10}	0.1024		

	COEFFICIENTS ○	□	△
C_c	1.11		
C_u	2.38		

SIEVE number size	PERCENT FINER ○	□	△
#4		99.8	100.0
#10	100.0	99.2	99.9
#16	100.0	98.8	99.5
#40	89.0	96.1	83.1
#50	74.7	94.3	76.0
#100	23.6	86.8	63.4
#200	6.1	63.0	37.3

Material Description

○ poorly graded sand with silt

□ sandy silty clay

△ silty sand

REMARKS:

○

□

△

○ Source of Sample: HBR-1 Depth: 18.2 - 19.0' Sample Number: G2

□ Source of Sample: HBR-1 Depth: 20.0 - 21.5' Sample Number: H

△ Source of Sample: HBR-1 Depth: 22.7 - 23.2' Sample Number: I1

NEVADA DEPARTMENT OF TRANSPORTATION

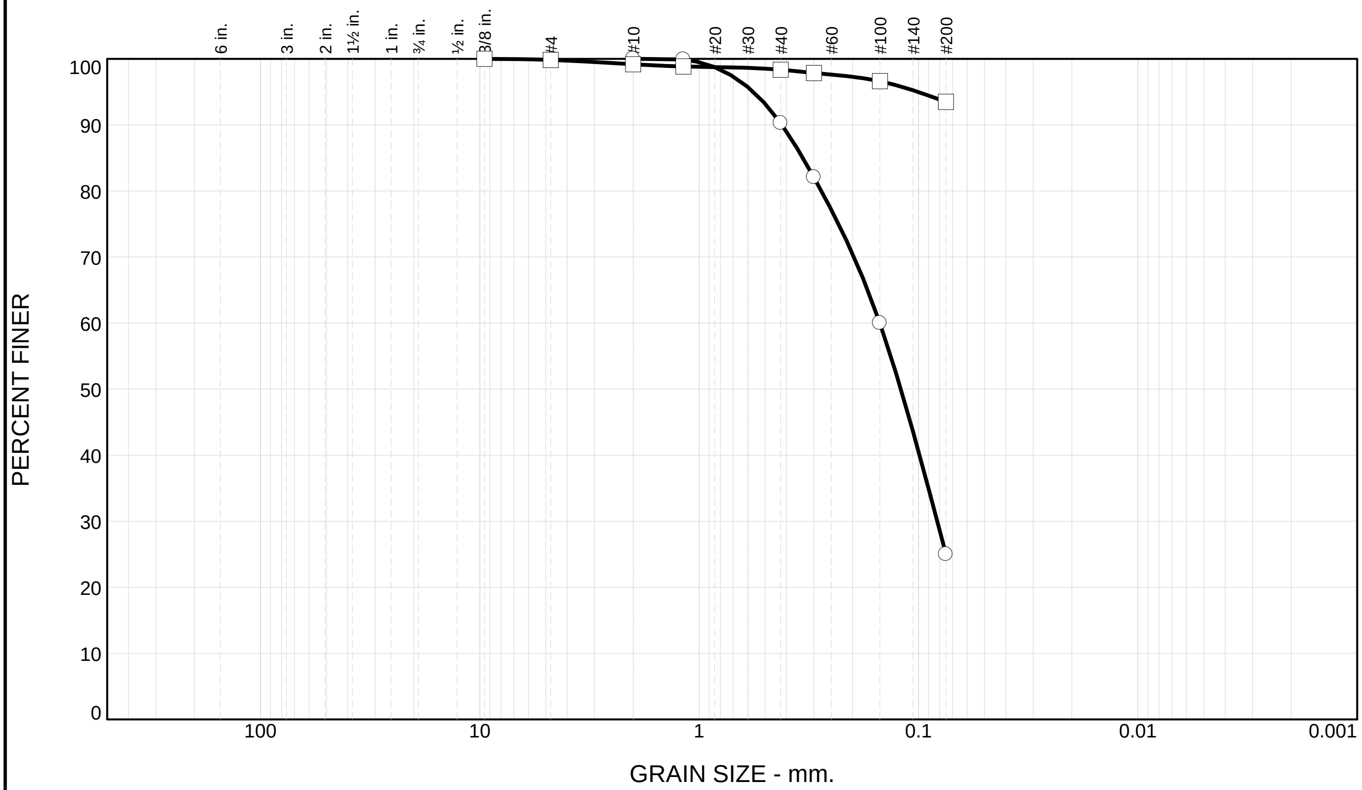
Client: A. Hurlbut

Project: B-100 Harrigan Bridge Replacement

Project No.: EA 73798

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	75.0	25.0		SM	A-2-4(0)	NP	20
□	0.0	0.2	6.3	93.5		ML	A-4(5)	26	31

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	
3/8"		100.0	
GRAIN SIZE			
D_{60}	0.1500		
D_{30}	0.0822		
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	
#4		99.8	
#10	100.0	99.2	
#16	99.9	98.8	
#40	90.3	98.4	
#50	82.1	97.9	
#100	60.0	96.6	
#200	25.0	93.5	

Material Description
○ silty sand

□ silt

REMARKS:
○

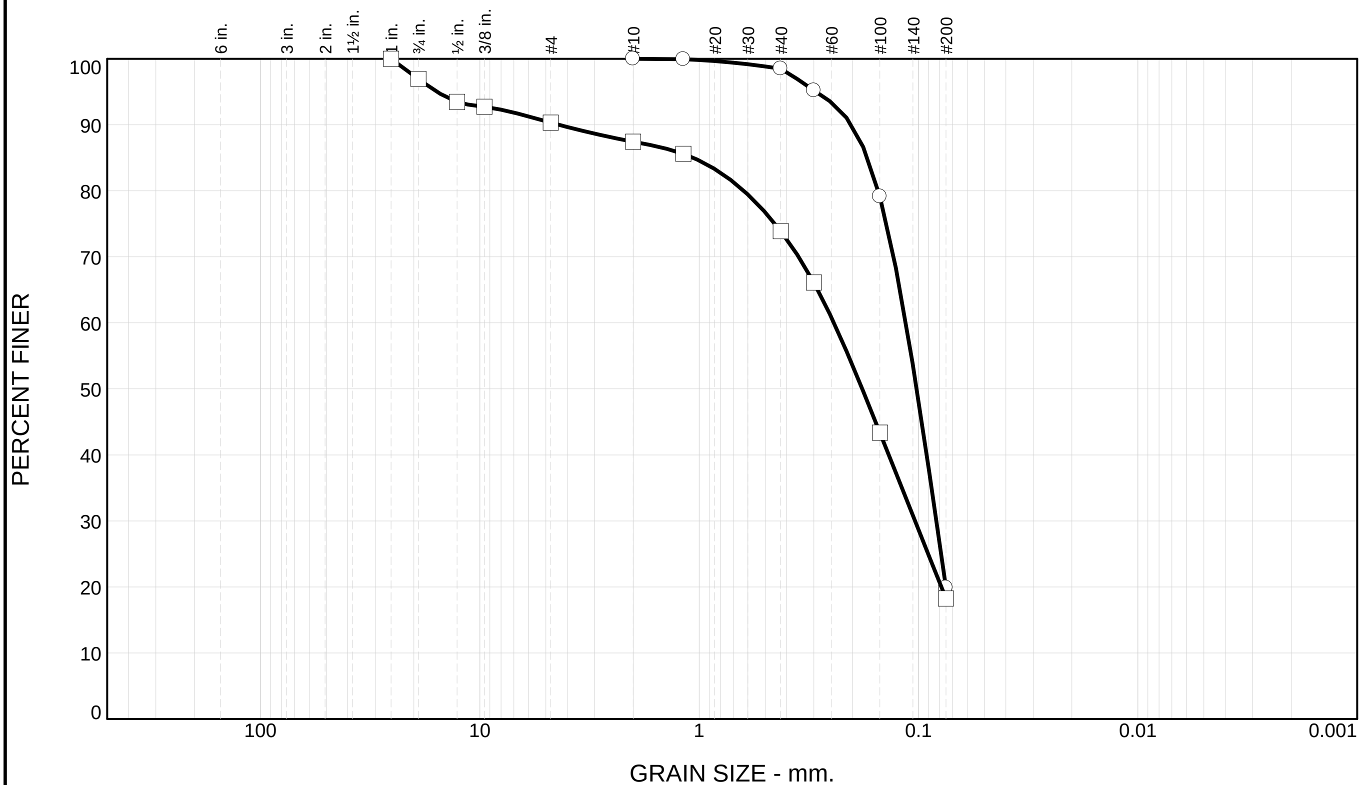
□

○ Source of Sample: HBR-1 Depth: 23.2 - 23.7' Sample Number: I2
□ Source of Sample: HBR-1 Depth: 27.5 - 29.0' Sample Number: J

NEVADA DEPARTMENT OF TRANSPORTATION

Client: A. Hurlbut
Project: B-100 Harrigan Bridge Replacement
Project No.: EA 73798 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	80.1	19.9		SM	A-2-4(0)	NP	22
□	0.0	9.7	72.0	18.3		SM	A-2-4(0)	NP	17

SIEVE inches size	PERCENT FINER ○	□	
1"		100.0	
3/4"		96.9	
1/2"		93.5	
3/8"		92.7	
	GRAIN SIZE		
D_{60}	0.1141	0.2430	
D_{30}	0.0829	0.1037	
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	
#4		90.3	
#10	100.0	87.4	
#16	99.9	85.6	
#40	98.5	73.9	
#50	95.2	66.1	
#100	79.1	43.4	
#200	19.9	18.3	

Material Description
○ silty sand

□ silty sand

REMARKS:
○

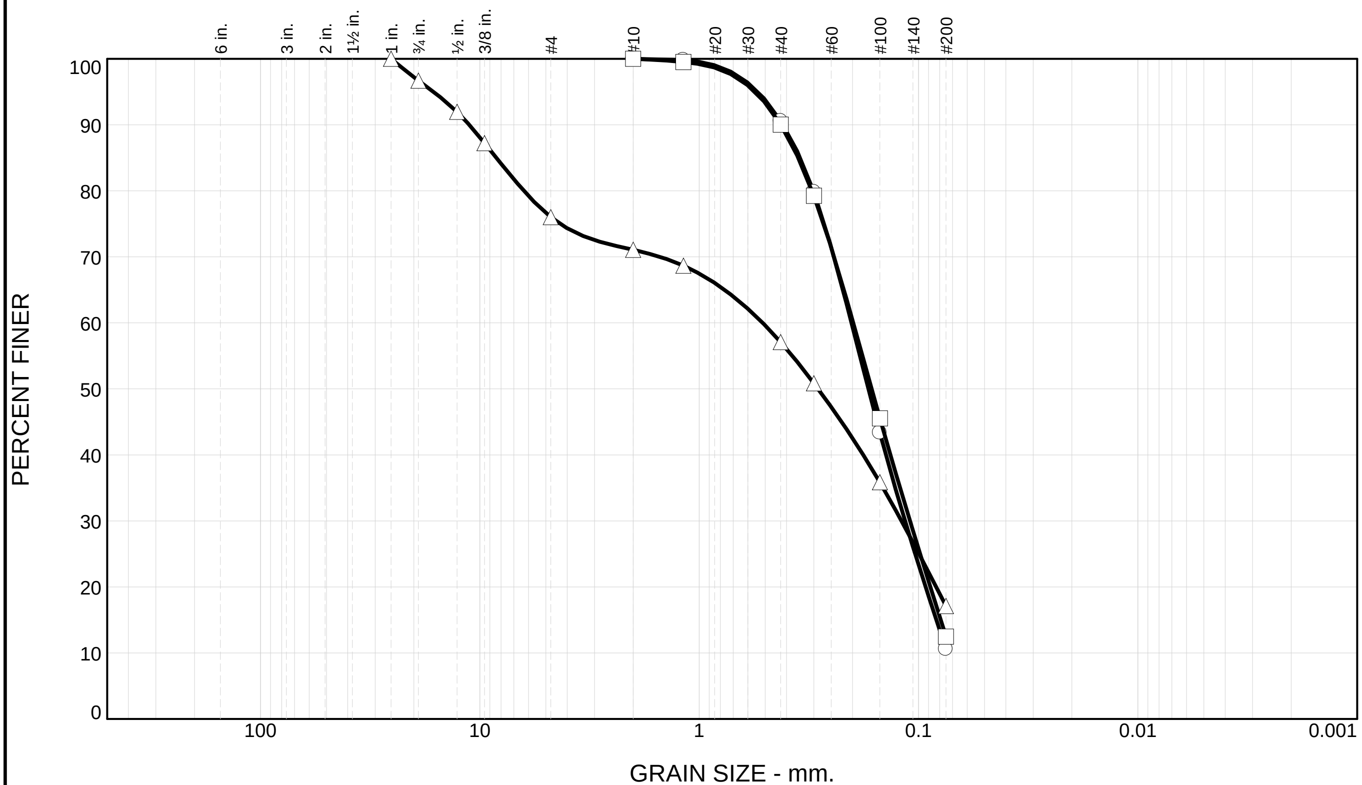
□

○ Source of Sample: HBR-1 Depth: 32.5 - 34.0' Sample Number: K
□ Source of Sample: HBR-1A Depth: 1.0 - 5.0' Sample Number: BULK 1

NEVADA DEPARTMENT OF TRANSPORTATION

Client: A. Hurlbut
Project: B-100 Harrigan Bridge Replacement
Project No.: EA 73798 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	89.4	10.6		SP-SM	A-2-4(0)	NP	19
□	0.0	0.0	87.5	12.5		SM	A-2-4(0)	NP	19
△	0.0	24.0	58.9	17.1		SM	A-2-4(0)	NP	17

SIEVE inches size	PERCENT FINER ○	□	△
1"			100.0
3/4"			96.7
1/2"			92.0
3/8"			87.2
	GRAIN SIZE		
D_{60}	0.2020	0.1983	0.5132
D_{30}	0.1152	0.1093	0.1195
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4			76.0
#10	100.0	100.0	71.1
#16	99.8	99.5	68.7
#40	90.6	90.0	57.1
#50	79.8	79.3	50.8
#100	43.3	45.5	35.9
#200	10.6	12.5	17.1

Material Description

○ poorly graded sand with silt

□ silty sand

△ silty sand with gravel

REMARKS:

○

□

△

○ Source of Sample: HBR-2 Depth: 2.5 - 4.0' Sample Number: A

□ Source of Sample: HBR-2 Depth: 5.0 - 6.5' Sample Number: B

△ Source of Sample: HBR-2 Depth: 8.2 - 8.7' Sample Number: C1

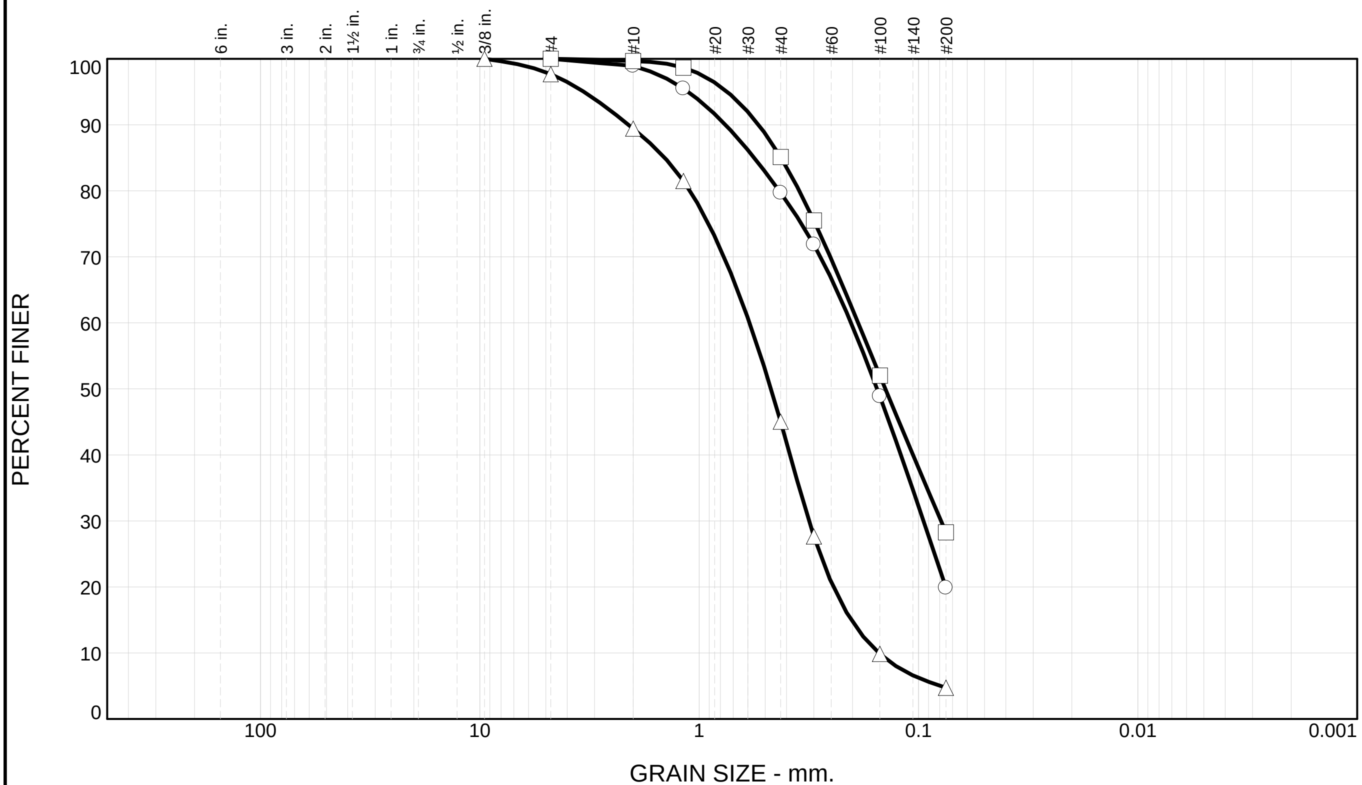
NEVADA DEPARTMENT OF TRANSPORTATION

Client: A. Hurlbut

Project: B-100 Harrigan Bridge Replacement

Project No.: EA 73798 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	80.1	19.9		SM	A-2-4(0)	NP	17
□	0.0	0.0	71.7	28.3		SC-SM	A-2-4(0)	16	20
△	0.0	2.3	93.0	4.7		SP	A-1-b	NP	18

SIEVE inches size	PERCENT FINER ○	□	△
3/8"			100.0
GRAIN SIZE			
D_{60}	0.2030	0.1884	0.5891
D_{30}	0.0949	0.0789	0.3160
D_{10}			0.1517
COEFFICIENTS			
C_c			1.12
C_u			3.88

SIEVE number size	PERCENT FINER ○	□	△
#4	100.0	100.0	97.7
#10	98.9	99.7	89.4
#16	95.5	98.7	81.5
#40	79.7	85.1	45.0
#50	71.9	75.5	27.6
#100	48.9	52.0	9.9
#200	19.9	28.3	4.7

Material Description
○ silty sand
□ silty, clayey sand
△ poorly graded sand

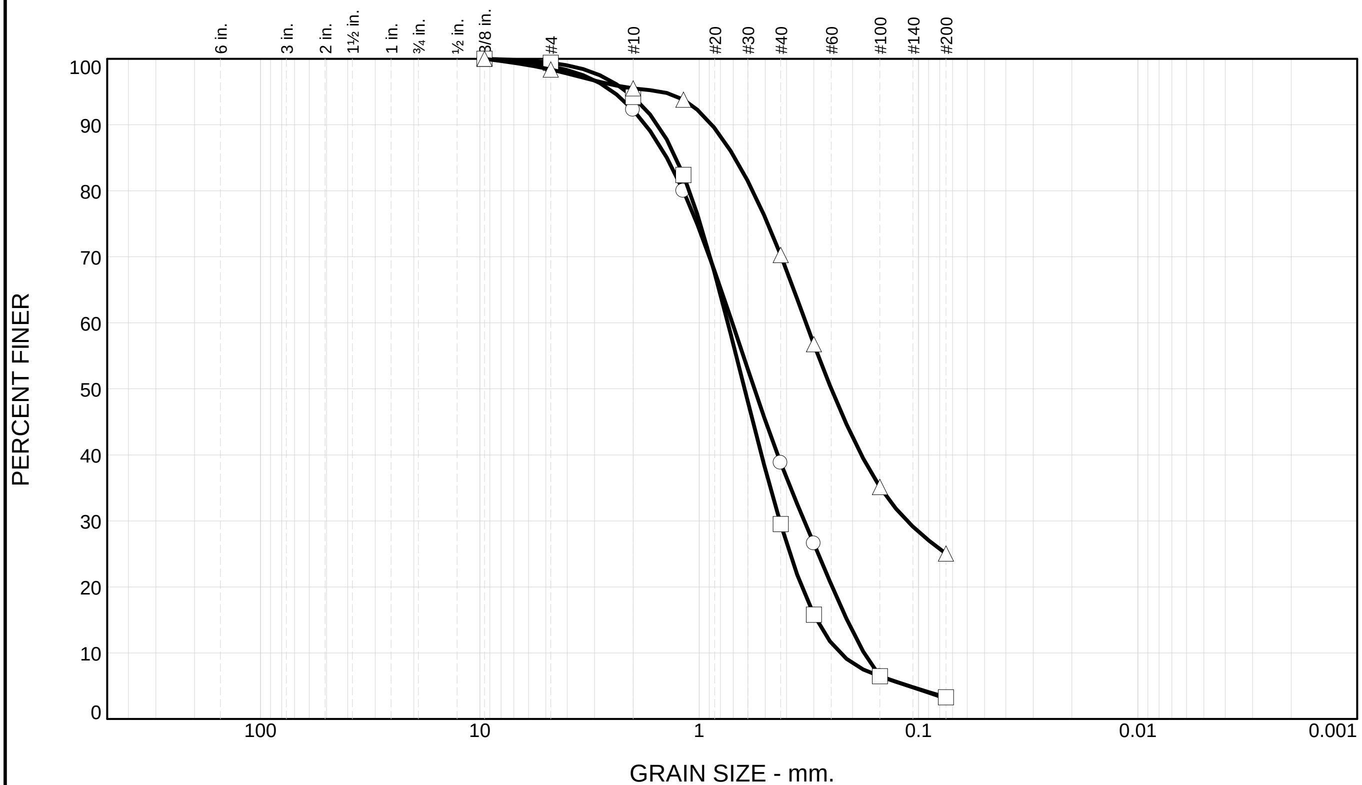
REMARKS:
○
□
△

○ Source of Sample: HBR-2 Depth: 8.7 - 9.0' Sample Number: C2
□ Source of Sample: HBR-2 Depth: 10.0 - 11.5' Sample Number: D
△ Source of Sample: HBR-2 Depth: 12.5 - 14.0' Sample Number: E

NEVADA DEPARTMENT OF TRANSPORTATION

Client: A. Hurlbut
Project: B-100 Harrigan Bridge Replacement
Project No.: EA 73798 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	1.2	95.7	3.1		SP	A-1-b	NP	20
□	0.0	0.6	96.1	3.3		SP	A-1-b	NP	15
△	0.0	1.6	73.4	25.0		SM	A-2-4(0)	NP	18

SIEVE inches size	PERCENT FINER ○	□	△
3/8"	100.0	100.0	100.0

	GRAIN SIZE ○	□	△
D_{60}	0.7060	0.7401	0.3260
D_{30}	0.3318	0.4292	0.1128
D_{10}	0.1771	0.2281	

	COEFFICIENTS ○	□	△
C_c	0.88	1.09	
C_u	3.99	3.24	

SIEVE number size	PERCENT FINER ○	□	△
#4	98.8	99.4	98.4
#10	92.2	94.2	95.5
#16	80.0	82.4	93.8
#40	38.8	29.5	70.3
#50	26.6	15.8	56.8
#100	6.5	6.5	35.1
#200	3.1	3.3	25.0

Material Description

○ poorly graded sand

□ poorly graded sand

△ silty sand

REMARKS:

○

□

△

○ Source of Sample: HBR-2 Depth: 15.2 - 15.7' Sample Number: F1

□ Source of Sample: HBR-2 Depth: 15.7 - 16.2' Sample Number: F2

△ Source of Sample: HBR-2 Depth: 17.5 - 19.0' Sample Number: G

NEVADA DEPARTMENT OF TRANSPORTATION

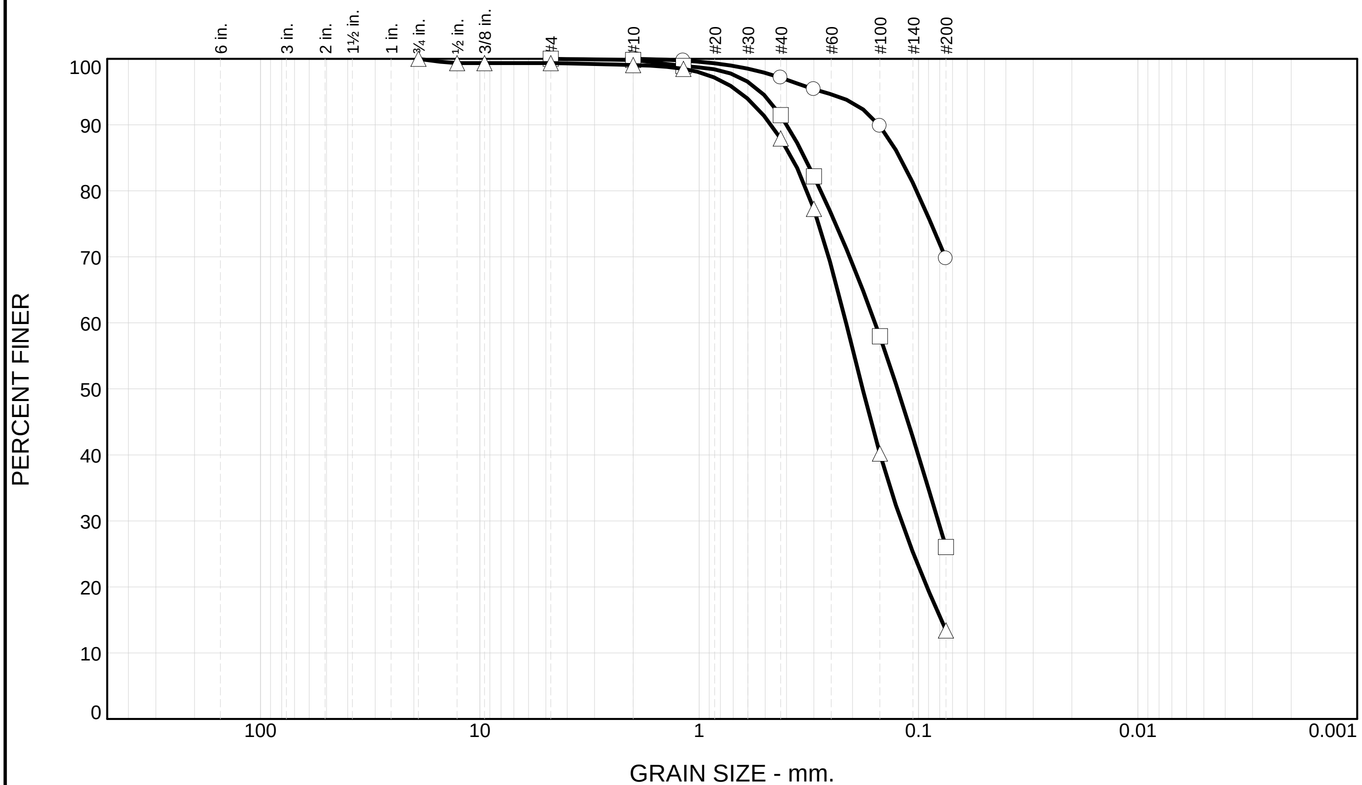
Client: A. Hurlbut

Project: B-100 Harrigan Bridge Replacement

Project No.: EA 73798

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	0.0	30.3	69.7		CL	A-4(4)	18	27
□	0.0	0.0	74.0	26.0		SM	A-2-4(0)	NP	19
△	0.0	0.7	85.9	13.4		SM	A-2-4(0)	NP	18

SIEVE inches size	PERCENT FINER ○	□	△
3/4"			100.0
1/2"			99.3
3/8"			99.3
GRAIN SIZE			
D_{60}		0.1577	0.2139
D_{30}		0.0814	0.1198
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4		100.0	99.3
#10	100.0	99.8	99.0
#16	99.7	98.9	98.5
#40	97.2	91.5	87.9
#50	95.4	82.2	77.3
#100	89.8	58.0	40.2
#200	69.7	26.0	13.4

Material Description

○ sandy lean clay

□ silty sand

△ silty sand

REMARKS:

○

□

△

○ Source of Sample: HBR-2 Depth: 20.0 - 21.5' Sample Number: H

□ Source of Sample: HBR-2 Depth: 25.0 - 26.5' Sample Number: I

△ Source of Sample: HBR-2A Depth: 1.5 - 5.5' Sample Number: BULK 1

NEVADA DEPARTMENT OF TRANSPORTATION

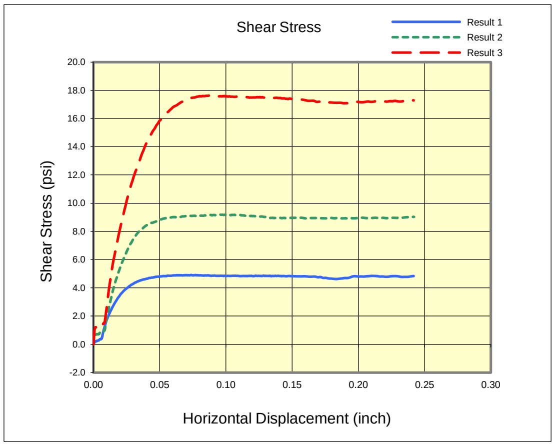
Client: A. Hurlbut

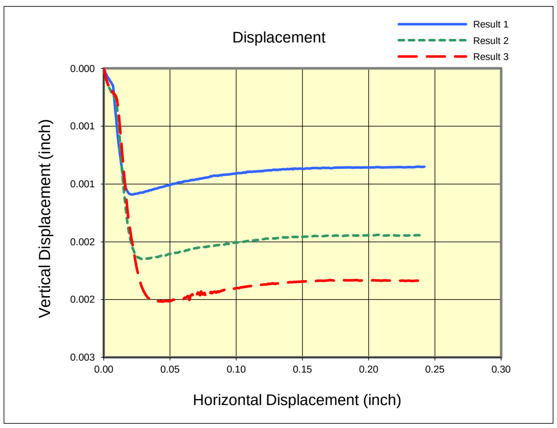
Project: B-100 Harrigan Bridge Replacement

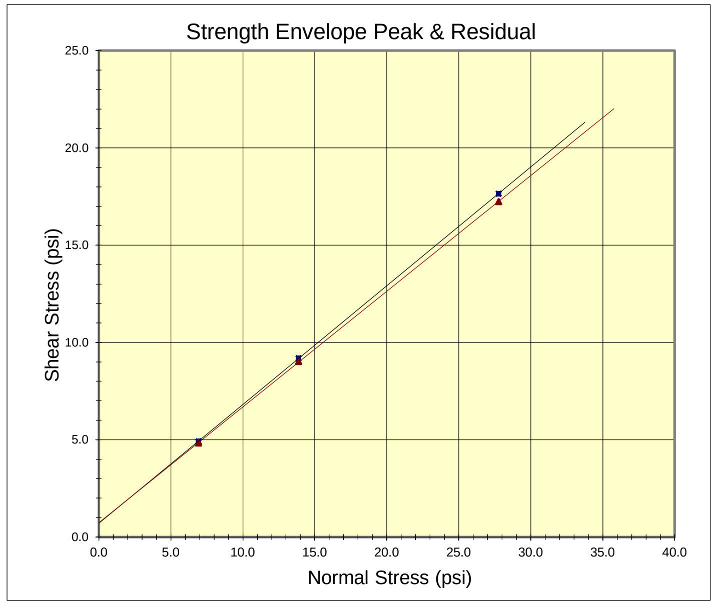
Project No.: EA 73798

Figure

DIRECT SHEAR TEST REPORT







Strength Parameters

	Peak		Residual
Friction Angle =	31	degrees	31
Cohesion =	0.70	psi	0.74

Project: FL-1-14 Boring: HBR-1 Sample: B

	Result 1	Result 2	Result 3
Specimen:	a	b	c
Date Tested	1/27/2014	1/27/2014	1/27/2014
Diameter (inch):	2.42	2.42	2.42
Height (inch):	1.00	1.00	1.00
Depth (ft):	6.20	6.20	6.20
Moisture (%)	7.4	7.6	7.3
Dry Unit Wt (pcf)	98.7	100.1	99.9
SHEAR			
Displacement Rate($^{in}/_{min}$)	0.0053	0.0056	0.0057
Normal Stress (psi)	6.93	13.88	27.77
Peak Shear Stress(psi)	4.91	9.19	17.64
Residual Shear Stress(psi)	4.8	9.0	17.2
Residual Point Picked @(in)	0.242	0.242	0.242
Time @ Peak Failure (min)	13.5	17.4	15.9

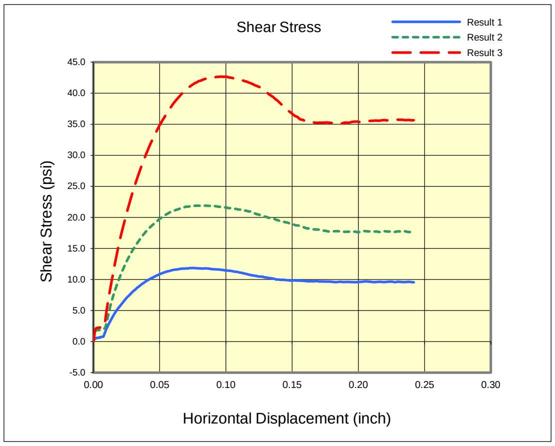
Specimen Comments

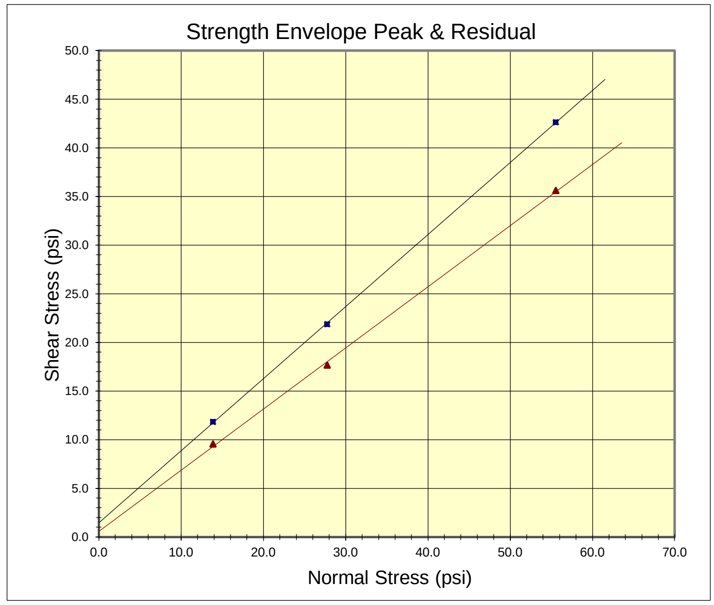
a	Medium brown silty sand shear @ 1000 psf
b	Medium brown silty sand shear @ 2000 psf
c	Medium brown silty sand shear @ 4000 psf

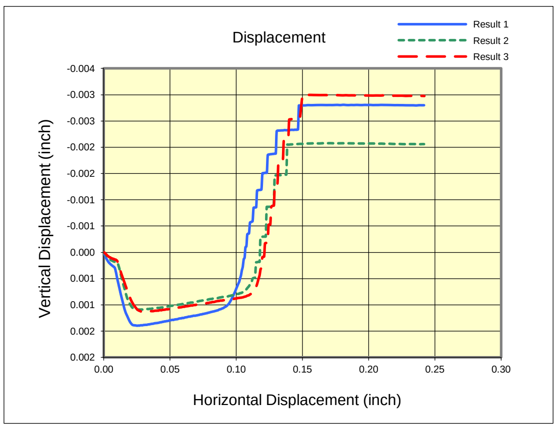
Geotechnical Section

NEVADA DOT

DIRECT SHEAR TEST REPORT







Strength Parameters

	Peak		Residual
Friction Angle =	37	degrees	32
Cohesion =	1.46	psi	0.59

Project: FL-1-14 Boring: HBR-1 Sample: E2

	Result 1	Result 2	Result 3
Specimen:	a	b	c
Date Tested	1/28/2014	1/28/2014	1/28/2014
Diameter (inch):	2.42	2.42	2.42
Height (inch):	1.00	1.00	1.00
Depth (ft):	13.80	13.80	13.80
Moisture (%)	22.1	20.9	22.4
Dry Unit Wt (pcf)	101.1	103.4	101.5
SHEAR			
Displacement Rate($^{in}/_{min}$)	0.0054	0.0055	0.0055
Normal Stress (psi)	13.87	27.75	55.54
Peak Shear Stress(psi)	11.82	21.88	42.64
Residual Shear Stress(psi)	9.6	17.7	35.6
Residual Point Picked @(in)	0.242	0.242	0.242
Time @ Peak Failure (min)	13.6	14.3	17.4

Specimen Comments

a Medium brown sand with silt shear @ 2000 psf

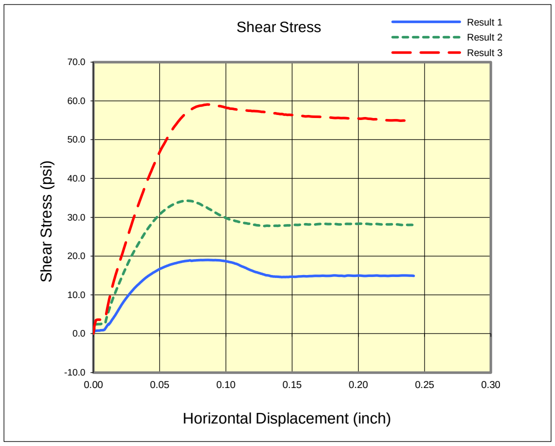
b Medium brown sand with silt shear @ 4000 psf

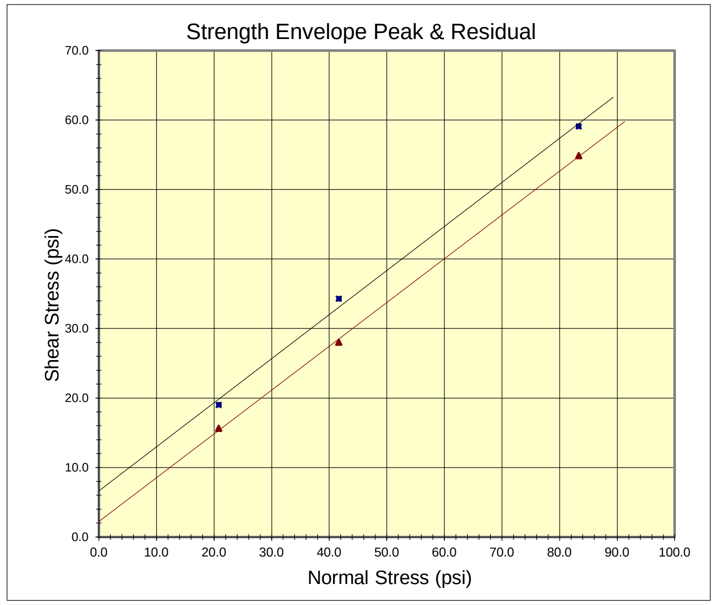
c Medium brown sand with silt shear @ 8000 psf

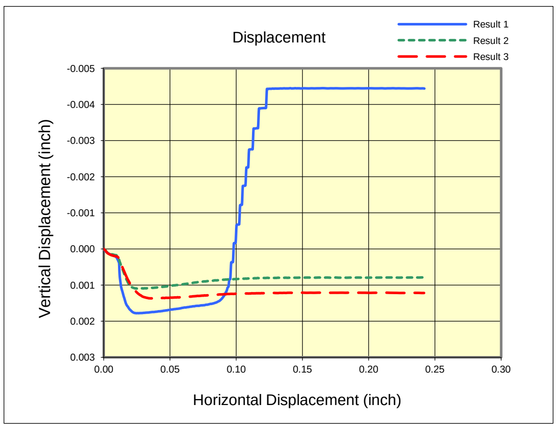
Geotechnical Section

NEVADA DOT

DIRECT SHEAR TEST REPORT







Strength Parameters

	Peak		Residual
Friction Angle =	32	degrees	32
Cohesion =	6.62	psi	2.23

Project: FL-1-14 Boring: HBR-1 Sample: I2

	Result 1	Result 2	Result 3
Specimen:	a	b	c
Date Tested	1/30/2014	1/30/2014	1/30/2014
Diameter (inch):	2.42	2.42	2.42
Height (inch):	1.00	1.00	1.00
Depth (ft):	23.80	23.80	23.80
Moisture (%)	19.1	20.0	19.2
Dry Unit Wt (pcf)	107.0	106.3	107.9
SHEAR			
Displacement Rate($^{in}/_{min}$)	0.0055	0.0054	0.0054
Normal Stress (psi)	20.80	41.65	83.32
Peak Shear Stress(psi)	19.00	34.29	59.09
Residual Shear Stress(psi)	15.6	28.0	54.9
Residual Point Picked @(in)	0.242	0.242	0.242
Time @ Peak Failure (min)	15.6	13.0	16.0

Specimen Comments

a Medium brown silty sand shear @ 3000 psf

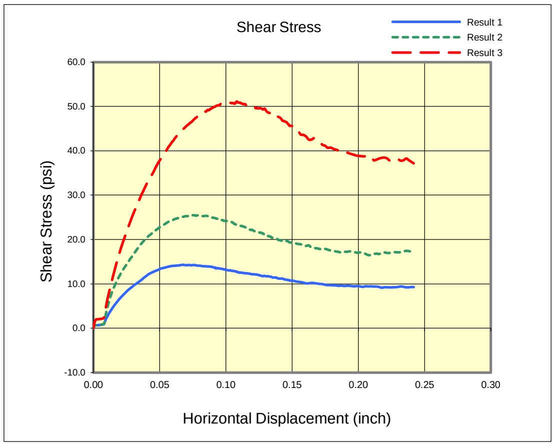
b Medium brown silty sand shear @ 6000 psf

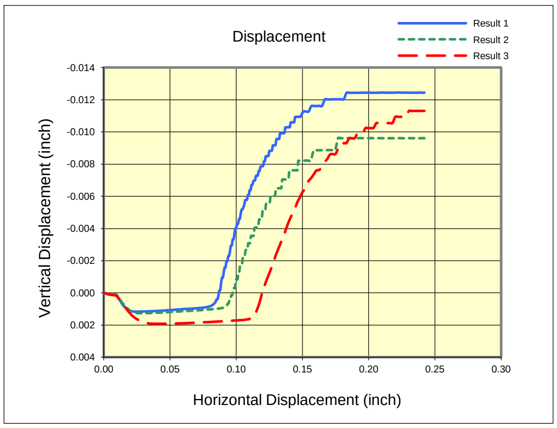
c Medium brown silty sand shear @ 12000 psf

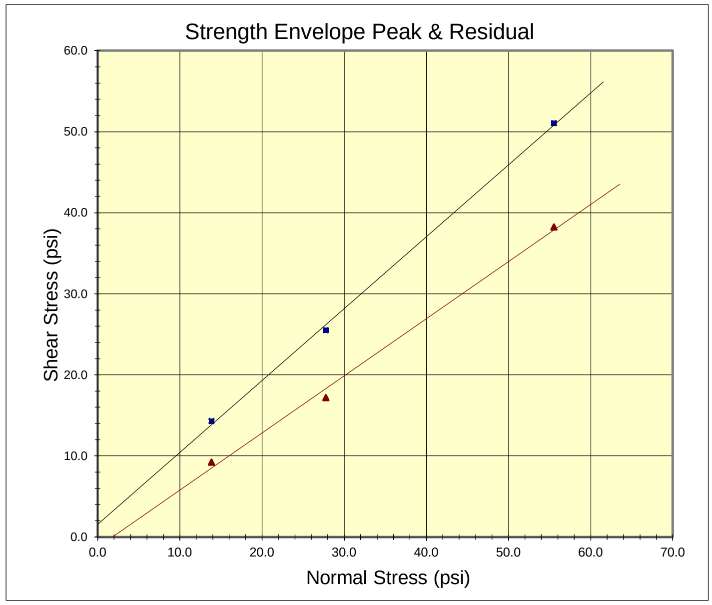
Geotechnical Section

NEVADA DOT

DIRECT SHEAR TEST REPORT







Strength Parameters

	Peak		Residual
Friction Angle =	42	degrees	35
Cohesion =	1.56	psi	-1.28

Project: FL-1-14 Boring: HBR-2 Sample: F2

	Result 1	Result 2	Result 3
Specimen:	a	b	c
Date Tested	1/31/2014	1/31/2014	1/31/2014
Diameter (inch):	2.42	2.42	2.42
Height (inch):	1.00	1.00	1.00
Depth (ft):	16.30	16.30	16.30
Moisture (%)	18.8	18.6	17.1
Dry Unit Wt (pcf)	102.9	104.3	105.7
SHEAR			
Displacement Rate($^{in}/_{min}$)	0.0056	0.0054	0.0055
Normal Stress (psi)	13.84	27.77	55.53
Peak Shear Stress(psi)	14.30	25.50	51.06
Residual Shear Stress(psi)	9.2	17.2	38.2
Residual Point Picked @(in)	0.242	0.242	0.242
Time @ Peak Failure (min)	12.3	13.8	19.8

Specimen Comments

a Medium to light sandy shear @ 2000 psf

b Medium to light sandy shear @ 4000 psf

c Medium to light sandy shear @ 8000 psf

Geotechnical Section

NEVADA DOT