Geotechnical Engineering Report

Nevada Way Sewer Line Reconstruction
Boulder City, Nevada
May 9, 2011
Terracon Project No. 64115011

Prepared for:
Nevada By Design
Las Vegas, Nevada 89120

Prepared by:
Terracon Consultants, Inc.
Las Vegas, Nevada

May 9, 2011

Terracon

Nevada By Design
5755 South Sandhill Road, Suite B
Las Vegas, Nevada 89120

Attn: Clayton L. Neilsen, P.E.

Re: Geotechnical Engineering Report
Nevada Way Sewer Line Reconstruction
Boulder City, Nevada
Terracon Project No. 64115011

Dear Mr. Neilsen:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number P64110147 authorized on March 16, 2011.

This geotechnical engineering report presents the results of the subsurface exploration and provides geotechnical recommendations concerning earthwork for the proposed project.

We appreciate the opportunity to be of service to you on this project. Materials testing services may also be provided by Terracon. We would be pleased to discuss these services with you. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

PROFESSIONAL ENGINEER STATE OF NEVADA
WALTER E. VANDERPOOL
Exp. 6-30-12
CIVIL
No. 8466
5/9/11

Walter E. Vanderpool, P.E.
Senior Associate

for Michael E. McGettigan, P.E.
Senior Associate, Office Manager

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GEOTECHNICAL ENGINEERING REPORT
NEVADA WAY SEWER LINE RECONSTRUCTION
BOULDER CITY, NEVADA

Terracon Project No. 64115011
May 9, 2011

1.0 INTRODUCTION

A geotechnical engineering report has been completed for the proposed Nevada Sewer Line Reconstruction from Fir Street to Wyoming Street, and along Fifth Street from Nevada Way to Aztec Place in Boulder City, Nevada. Four borings, designated B-1 to B-4, were performed to depths varying from 5 feet to 20 feet below the existing ground surface along the proposed alignment as directed by the Client. Logs of the borings along with a site location map and boring location plans are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to the proposed sewer line reconstruction:

- subsurface soil conditions
- groundwater observations
- pavement design
- earthwork recommendations
- seismic considerations

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Location	Nevada Way from Fir Street to Wyoming Street and Fifth Street from Nevada Way to Aztec Place in Boulder City, NV
Existing improvements	Roadway
Current ground cover	Asphalt
Existing topography	Nevada Way is relatively flat then rises approximately 20 feet towards Wyoming Street. Fifth Street drops approximately 20 feet from Nevada Way towards Aztec Place.

2.2 Site Location and Description

ITEM	DESCRIPTION
Nevada Way	Reconstruction to increase pedestrian and bicycle use. Installation of sewer line in the ROW and abandonment of existing sewer line.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The project site is located in Boulder City, Nevada. According to a geologic map of the area[1], the project site consists of quarternary age alluvial deposits and tuffaceous sedimentary rocks. Area is underlain mainly of sandstones, limestones and conglomerates.

3.2 Typical Profile

Based on the results of the borings and laboratory tests, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Consistency/Density
AC	3 to 5.5 inches	Asphalt Concrete	-
AB	9 to 17.5 inches	Aggregate Base	-
Stratum 1	To Depth Explored	Silty Sands with Gravel	Medium Dense to Very Dense

[1] *Anderson, R. Ernest, "Geologic Map of the Boulder City 15-Minute Quadrangle, Clark County, Nevada," 1977, Department of the Interior United States Geological Survey.*

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. A discussion of field sampling procedures is included in Appendix A and laboratory testing procedures and test results are presented in Appendix B.

3.3 Groundwater

Groundwater was not encountered while drilling any of the borings. However, groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the street and sewer line may be higher or lower than the levels indicated on the boring log. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The borings for the proposed sewer line and street reconstruction encountered dense to very dense granular soils. The scope of our field exploration was limited to depths of 5 to 5.5 feet in 3 of the 4 borings. The soil type and consistency encountered beneath the pavement section to a depth of 5 feet was relatively uniform throughout the alignment. These soils are suitable for support of the sewer line and pavements for the project. Our recommendations for the project are based on the assumption that the soil conditions throughout the site are similar to those disclosed by the explorations. If variations are noted during construction or if changes are made during design development, we should be notified, so we can supplement our recommendations, as applicable.

4.2 Earthwork

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of on-site backfill material and other geotechnical conditions exposed during the construction of the project.

Due to the limited depth of exploration, contractors, especially those digging utilities greater than 5 feet below the existing pavement grade, should satisfy themselves as to the hardness of materials and equipment required.

4.2.1 Site Preparation

Prior to placing any fill, all unsuitable material should be removed from the construction areas. After required removals, the existing soils should be scarified, moisture conditioned and compacted. The subgrade should be proof-rolled to aid in locating loose or soft areas. Soft, dry and low-density soil should be removed or compacted in place prior to placing fill.

If unexpected fills or underground facilities are encountered during site clearing, such features should be removed and the excavation thoroughly cleaned and backfilled. All excavations should be observed by the geotechnical engineer prior to backfill placement. Alternatively, abandoned underground facilities may be backfilled with controlled low strength material (CLSM).

4.2.2 Material Types

Engineered fill should meet the following material property requirements:

- On-site soils free of any debris, oversized material (greater than 6 inches) and organic matter may be used in required fills.
- Imported soils used as engineered fill should conform to the following:
  - **Gradation(ASTM C 136)** — **Percent Finer by Weight**
    - 3” 100
    - No. 4 Sieve 35-100
    - No. 200 Sieve 0-30
  - Maximum liquid limit (LL) 35
  - Maximum plasticity index (PI) 15
  - Maximum expansive potential (%) 4
  - Maximum sulfate content (%) 2.0
  - Maximum solubility (%) 2

4.2.3 Compaction Requirements

ITEM	DESCRIPTION
Fill Lift Thickness	8-inches or less in loose thickness
Compaction Requirements [1]	95% of the materials maximum modified Proctor dry density (ASTM D 1557)
Moisture Content On-site Soils [2]	Within the range of optimum moisture content to 4% above the optimum moisture content value as determined by the modified Proctor test at the time of placement and compaction

1. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the fill material pumping when proofrolled.

Backfill materials should be placed on a horizontal plane unless otherwise accepted by the geotechnical engineer. Flooding or jetting is not permitted as a method of compacting fill material.

4.2.4 Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. The utility trenches should be backfilled with on site materials. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill. Pipeline bedding should consist of granular, non-plastic material such Clark County Type II aggregate base or CLSM, from subgrade to a minimum of 1 foot above the pipe. Backfill to street subgrade may consist of on-site natural soils or imported soil meeting the gradation provided in Section 4.2.2.

4.2.5 Grading and Drainage

All grades must provide effective drainage away from the site during and after construction. Water permitted to pond along the alignment can result in greater soil movements than those discussed in this report. These greater movements can result in loss of subgrade support for pavements, cracking, rutting and pothole development.

After construction, we recommend verifying final grades to document that effective drainage has been achieved. Grades along pavements should also be periodically inspected and adjusted as necessary, as part of the street maintenance program.

4.2.6 Construction Considerations

Trenching and shoring operations should be conducted in accordance with Section 10 Nos. 1926.650 through 1926.652 of the State of Nevada Occupational Safety and Health Standards for the Construction Industry (with amendments as of August, 1991) and in accordance with 29 CFR Part 1926, Occupational Safety and Health Standards - Excavations; Final Rule (October 31, 1989). Safety of construction personnel is the responsibility of the contractor.

Field density tests should be conducted for each fill lift. The location of the tests in plan should be spaced to give the best possible coverage and should be taken no farther apart than 100 feet. The Engineer may require additional tests as considered necessary to check on the uniformity of compaction. In areas where sheepsfoot rollers are used, the tests should be performed in the compacted material below the disturbed surface. No additional layers of fill should be placed until the field density test results indicate that the specified density has been obtained.

Laboratory testing, observation and inspection of backfill materials should be carried out in accordance with the guidelines provided in Table 1704.7 of the Southern Nevada Amendments to the 2009 International Building Code (IBC). Based on the subsurface soil conditions encountered in the borings and the results of the laboratory tests performed for the project, we

recommend that periodic special inspections be carried out during grading operations that consist of fill placement and compaction in accordance with Item 4a of Table 1704.7.

4.3 Seismic Considerations

Code Used	Site Classification
2009 International Building Code (IBC) [1]	D [2]

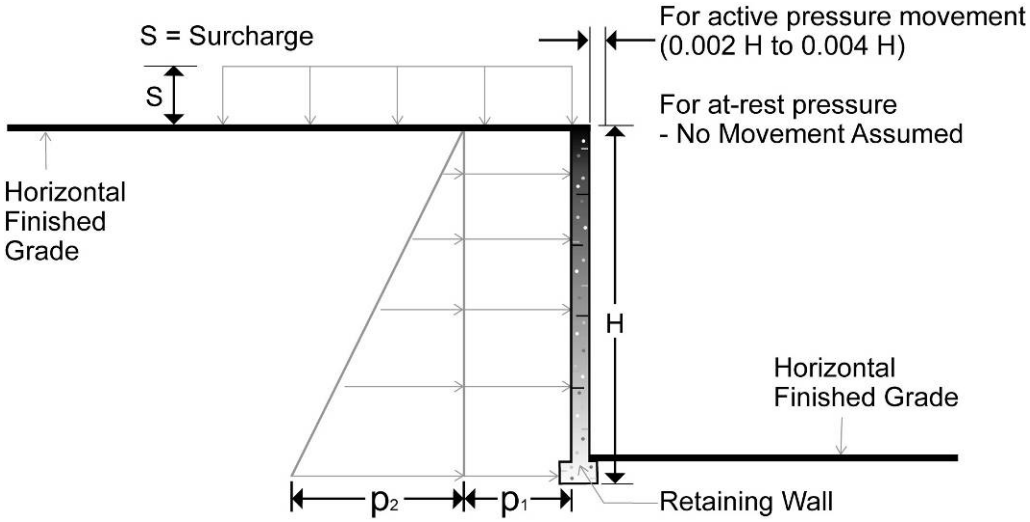
1. In general accordance with the 2009 International Building Code, Table 1613.5.2. IBC Site Class is based on the characteristics of the upper 100 feet of the subsurface profile.
2. The 2009 International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil profile determination. Borings for this project extended to a maximum depth of approximately 20 feet. Therefore, the default site class is applicable. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to justify a higher seismic site class.

We have determined the following approximate latitude and longitude of the site, along with the mapped and design spectral response accelerations:

Latitude	35.9742º
Longitude	-114.8410º
S_S	0.678
S_1	0.194
S_{DS}	0.568
S_{D1}	0.262

4.4 Lateral Earth Pressures

Trench excavation greater than 4 feet in depth should be sloped at 1:1 (Horizontal:Vertical) or shored. Trench shoring may be designed for a soil with an angle of internal friction of 35 degrees and a unit weight of 125 pounds per cubic foot. Design to resist surcharge loads may be based upon 0.3 times the surcharge gravity loads. The recommended design values assume drained soil conditions.



Earth Pressure Coefficients

Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)
Active (Ka)	0.32	38	(0.32)S	(38)H
At-Rest (Ko)	0.48	58	(0.48)S	(58)H
Passive (Kp)	3.12	375	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 **H** to 0.004 **H**, where **H** is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- In-situ soil backfill weight a maximum of 120 pcf
- Horizontal backfill, compacted between 95 percent of modified Proctor maximum dry density
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included in soil parameters

The seismic load due to lateral earth pressure may be defined in accordance with Section 1610.1.1 of the 2009 SNBCA. The dynamic component for yielding walls, $\Delta P_{AE} = {}^{3}/_{8}(k_h)H^2\gamma$; and the dynamic component for non-yielding walls is $\Delta P_E = k_h H^2 \gamma$

- k_h is equal to $S_{DS}/2.5$
- H is the height of the wall in feet
- γ is equal to the unit weight of the backfill material in pcf

The resultant dynamic force acts at a distance of 0.6H above the base of the wall.

k_h (g)	0.227
γ (pcf)	120
ΔP_{AE} (lb/linear foot of wall)	$10.2*H^2$
ΔP_E (lb/linear foot of wall)	$27.3*H^2$

The dynamic forces are considered a short-term loading condition; therefore, a one-third increase in the bearing pressure and passive resistance may be allowed for dynamic analysis.

4.5 Pavements

4.5.1 Subgrade Preparation

Based upon FHWA-DF-88-003, the field tests for penetration resistance and laboratory test results for gradation and Atterberg Limits result in an estimated R-value for pavement design of 72. Pavement reconstruction should match the existing pavement section or a minimum of 3 inches of plant mix asphaltic concrete over a minimum of 6 inches of Clark County Type II compacted to at least 95% of ASTM D1557. We recommend the moisture content and density of the top 9 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

After proofrolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in Section **4.2** of the **Earthwork** section this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.5.2 Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

4.5.3 Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

4.6 Concrete Corrosivity

Based on the results of the laboratory testing completed for the project by Atlas Chemical Testing Laboratories, Inc., the on-site soils have a “Not applicable” (S0) classification for sulfate exposure, according to Table 4.2.1 of the American Concrete Institute (ACI) 318, Section 4.2. However, moderate to severe sulfate soils exist throughout the valley, therefore, consideration should be given to using cement Type V, along with a water-cement ration of 0.45, and minimum compressive strength of 4500 psi be incorporated into the concrete mix design for this project in order to reduce sulfate attach as recommended in Table 4.3.1 of the ACI. Consideration should be given to providing protection to buried metal pipes or use of non-metallic pipes, where permitted by local building codes.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Source: Google Maps, 23 March 2011

Project Manager: MEM	Project No.: 64115011	Terracon	SITE LOCATION MAP
Drawn by: JTL	Scale: NTS	750 Pilot Road, Suite F Las Vegas, Nevada 89119	Nevada Way Sewer Line Reconstruction
Checked by: MEM	File Name: Exhibits	PH. (702) 597-9393 FAX. (702) 597-9009	BOULDER CTIY, NEVADA
Approved by: MEM	Date: 03/23/2011		Exhibit A-1

N

LEGEND:

B-1 BORING DESIGNATION AND APPROXIMATE LOCATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Source: Google Maps, 23 March 2011

Project Manager: MEM	Project No.: 64115011	Terracon	BORING LOCATION PLAN	Exhibit
Drawn by: JTL	Scale: NTS	750 Pilot Road, Suite F Las Vegas, Nevada 89119	Nevada Way Sewer Line Reconstruction BOULDER CTIY, NEVADA	A-2
Checked by: MEM	File Name: Exhibits	PH. (702) 597-9393 FAX. (702) 597-9009		
Approved by: MEM	Date: 03/23/2011			

N

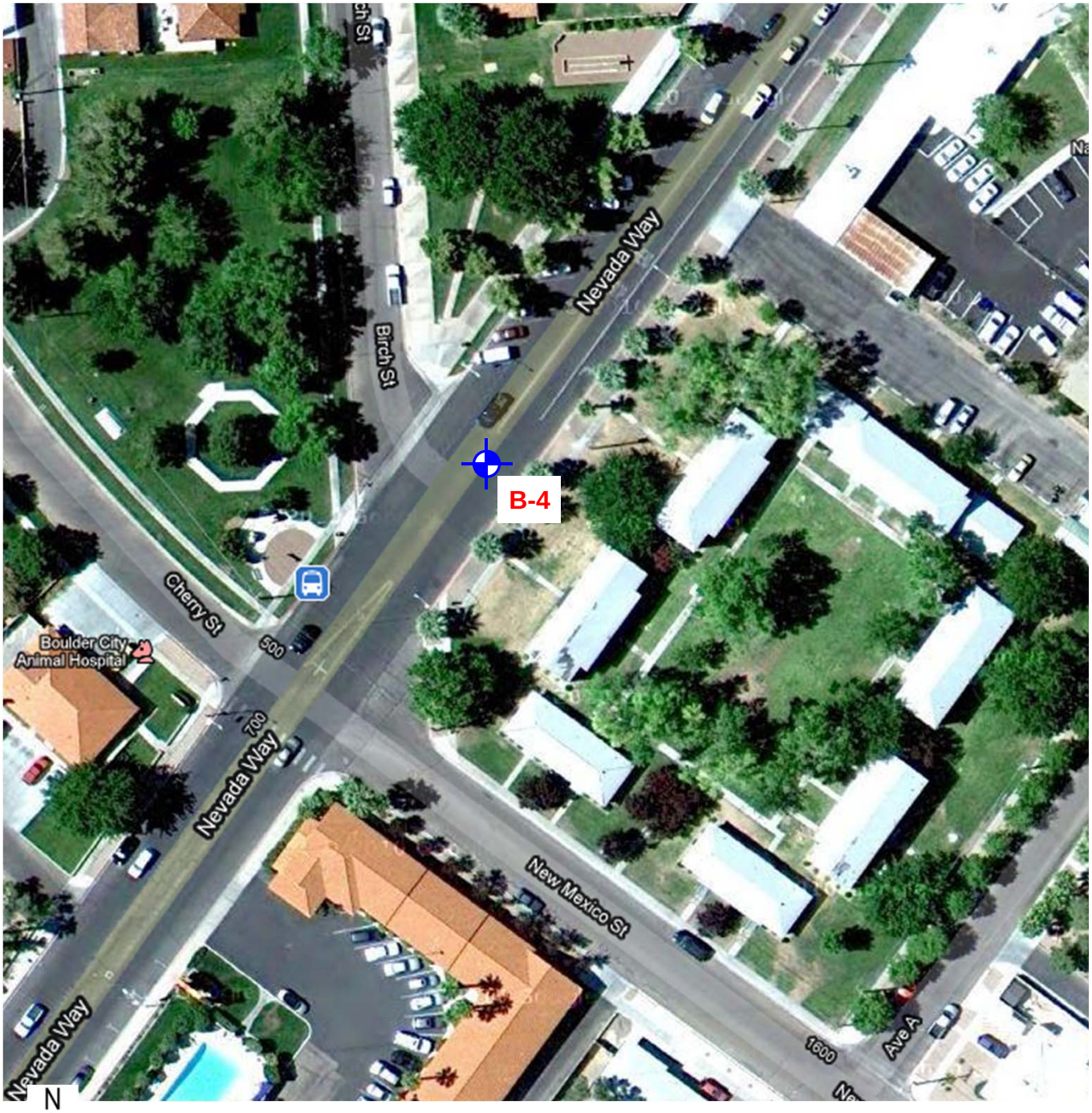
LEGEND:

B-1 BORING DESIGNATION AND APPROXIMATE LOCATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Source: Google Maps, 23 March 2011

Project Manager: MEM Drawn by: JTL Checked by: MEM Approved by: MEM	Project No.: 64115011 Scale: NTS File Name: Exhibits Date: 03/23/2011	Terracon 750 Pilot Road, Suite F Las Vegas, Nevada 89119 PH. (702) 597-9393 FAX. (702) 597-9009	BORING LOCATION PLAN Nevada Way Sewer Line Reconstruction BOULDER CTIY, NEVADA	Exhibit A-3



N

LEGEND:

B-1 BORING DESIGNATION AND APPROXIMATE LOCATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Source: Google Maps, 23 March 2011

Project Manager: MEM Drawn by: JTL Checked by: MEM Approved by: MEM	Project No.: 64115011 Scale: NTS File Name: Exhibits Date: 03/23/2011	Terracon 750 Pilot Road, Suite F Las Vegas, Nevada 89119 PH. (702) 597-9393 FAX. (702) 597-9009	BORING LOCATION PLAN Nevada Way Sewer Line Reconstruction BOULDER CTIY, NEVADA	Exhibit A-4

Field Exploration Description

Terracon personnel marked the boring locations in the field. The site was cleared for buried utilities by "One Call" prior to our arrival onsite for drilling. Ground surface elevations indicated on the boring logs were estimated from available maps, and were rounded to the nearest foot. The locations and elevations indicated on our boring logs may be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a Diedrich D120 truck-mounted drill rig using hollow stem auger techniques to advance the boreholes. Samples of the soil encountered in the borings were obtained by the Standard Penetration Test (SPT) method with standard split spoon (2-inch O. D.) sampling procedures.

In the SPT sampling procedure, the number of blows required to advance a standard 2-inch O.D. split barrel sampler the last 12 inches of the typical total 18-inch penetration or the middle 12 inches of total 24 inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N).

An automatic SPT hammer was used to advance the sampler in the borings performed on this site. A significantly improved precision and predictable efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report. However, the penetration resistance values presented on the boring logs are not adjusted for sampler diameter or calibrated hammer efficiency.

The samples obtained with the samplers were marked for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency interpretations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings prior to the drill crew leaving the site.

The Terracon staff geologist prepared a field log of each boring during drilling. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples.

Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests performed on the samples at the sampling depth. The boring logs are presented on boring logs B-1 to B-4 in Appendix A.

LOG OF BORING B-1

PROJECT ***Nevada Way Sewer Line Construction***

SITE ***Nevada Way, Boulder City***

CLIENT ***Nevada By Design***

EASTING ***875104*** NORTHING ***26693075***

STATION OFFSET

APPROXIMATE SURFACE ELEVATION (ft) ***2466.0***

GRAPHIC LOG	DEPTH (ft)	DESCRIPTION	ELEVATION (ft)	DEPTH (ft)	USCS SYMBOL	SAMPLES: SAMPLE No.	SAMPLE TYPE	RECOVERY (inch)	BLOW COUNT (blows/ft)	TESTS: WATER CONTENT, %	DRY UNIT WEIGHT (pcf)	UNCONFINED COMP. STRENGTH (psf)	NOTES
	0.5	**ASPHALT** - 5.5 inches	2465.5		AC								
					AB								
	1.5	**AGGREGATE BASE** - 12 inches	2464.5										
		SILTY SAND WITH GRAVEL - yellowish brown, slightly moist, medium dense			SM	1	SS	12	15				
						2	BS						
		- occasional clayey sand lenses											
		- with gravel				3	SS	6	50/5"	9			
	5.0		2461.0	5									
		Bottom Depth at Approximately 5 feet											

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

SAMPLE TYPES: RS = Ring BS = Bag CPT = Cone Penetration Test
SS = Standard Penetration Test C = Core ST = Shelby Tube

WATER LEVEL OBSERVATIONS, ft		
WL DEPTH ▽	NE	04-18-2011
WL DEPTH ▼	NE	04-18-2011
NOTES	Lat: 35.9742, Long: -114.8434	

Terracon

BORING STARTED	04-18-2011		
BORING COMPLETED	04-18-2011		
RIG	Diedrich D120	GEOLOGIST / ENGINEER	REE
PROJECT No.	64115011	BORING	B-1

LOG OF BORING B-2

PROJECT ***Nevada Way Sewer Line Construction***

SITE ***Nevada Way, Boulder City***

CLIENT ***Nevada By Design***

EASTING	NORTHING
875927	***26693110***
STATION	OFFSET
APPROXIMATE SURFACE ELEVATION (ft) ***2467.0***	

DEPTH (ft)	DESCRIPTION	ELEVATION (ft)	USCS SYMBOL	SAMPLE No.	SAMPLE TYPE	RECOVERY (inch)	BLOW COUNT (blows/ft)	WATER CONTENT, %	DRY UNIT WEIGHT (pcf)	UNCONFINED COMP. STRENGTH (psf)	NOTES
0.3	**ASPHALT** - 3 inches	2466.7	AC								
0.8	**AGGREGATE BASE** - 6 inches	2466.2	AB								
	SILTY SAND - trace gravel, reddish brown, slightly moist, very dense		SM	1	SS	12	56	9			
				2	BS						
	-occasional clayey sand lenses										
	- medium dense			3	SS	10	21	9			
5											
	- very dense			4	SS	12	50/6"				
				5	SS	6	50/6"	8			
10											
	SILTY SAND WITH GRAVEL - occasional cobble			6	BS						
	- occasional clayey sand lenses										
				7	SS	5	50/5"				
15.0		2452.0									
15											

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

SAMPLE TYPES: RS = Ring BS = Bag CPT = Cone Penetration Test SS = Standard Penetration Test C = Core ST = Shelby Tube

WATER LEVEL OBSERVATIONS, ft		
WL DEPTH ▽	NE	04-18-2011
WL DEPTH ▼	NE	04-18-2011
NOTES	Lat: 35.9743, Long: -114.8406	

Terracon

BORING STARTED	04-18-2011
BORING COMPLETED	04-18-2011
RIG Diedrich D120	GEOLOGIST / ENGINEER REE
PROJECT No. 64115011	BORING B-2

LOG OF BORING NO. B-2

PROJECT ***Nevada Way Sewer Line Construction***

SITE ***Nevada Way, Boulder City***

CLIENT ***Nevada By Design***

EASTING ***875927*** NORTHING ***26693110***

STATION OFFSET

APPROXIMATE SURFACE ELEVATION (ft) ***2467.0***

GRAPHIC LOG	DEPTH (ft)	DESCRIPTION	ELEVATION (ft)	DEPTH (ft)	USCS SYMBOL	SAMPLES: SAMPLE No.	SAMPLE TYPE	RECOVERY (inch)	BLOW COUNT (blows/ft)	TESTS: WATER CONTENT, %	DRY UNIT WEIGHT (pcf)	UNCONFINED COMP. STRENGTH (psf)	NOTES
		SILTY SAND			SM								
		- trace gravel and clay, reddish brown, slightly moist, very dense											
		- occasional cobble											
	19.5		2447.5			8	SS	4	50/4"	8			
		Bottom Depth at Approximately 19.5 feet											

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

SAMPLE TYPES: RS = Ring BS = Bag CPT = Cone Penetration Test
SS = Standard Penetration Test C = Core ST = Shelby Tube

WATER LEVEL OBSERVATIONS, ft		
WL DEPTH ▽	NE	04-18-2011
WL DEPTH ▼	NE	04-18-2011
NOTES	Lat: 35.9743, Long: -114.8406	

Terracon

BORING STARTED	04-18-2011		
BORING COMPLETED	04-18-2011		
RIG	Diedrich D120	GEOLOGIST / ENGINEER	REE
PROJECT No.	64115011	BORING	B-2

LOG OF BORING B-3

PROJECT ***Nevada Way Sewer Line Construction***

SITE ***Nevada Way, Boulder City***

CLIENT ***Nevada By Design***

EASTING ***876266*** NORTHING ***26692864***

STATION OFFSET

APPROXIMATE SURFACE ELEVATION (ft) ***2455.0***

GRAPHIC LOG	DEPTH (ft)	DESCRIPTION	ELEVATION (ft)	DEPTH (ft)	USCS SYMBOL	SAMPLE No.	SAMPLE TYPE	RECOVERY (inch)	BLOW COUNT (blows/ft)	WATER CONTENT, %	DRY UNIT WEIGHT (pcf)	UNCONFINED COMP. STRENGTH (psf)	NOTES
	0.3	**ASPHALT**	2454.7		AC								
	0.8	- 3 inches	2454.2		AB								
		AGGREGATE BASE			GM								
		- 7 inches, slightly moist				1	SS	11	50/6"				
	2.0	**SILTY GRAVEL WITH SAND**	2453.0										
		- brown, slightly moist, very dense			SM	2	BS						
		SILTY SAND											
		- trace gravel, reddish brown, slightly moist, very dense											
						3	SS	4	50/6"	9			
	5.0		2450.0	5									
		Bottom Depth at Approximately 5 feet											

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

SAMPLE TYPES: RS = Ring BS = Bag CPT = Cone Penetration Test
SS = Standard Penetration Test C = Core ST = Shelby Tube

WATER LEVEL OBSERVATIONS, ft		
WL DEPTH ▽	NE	04-18-2011
WL DEPTH ▼	NE	04-18-2011
NOTES	Lat: 35.9736, Long: -114.8395	

Terracon

BORING STARTED	04-18-2011		
BORING COMPLETED	04-18-2011		
RIG	Diedrich D120	GEOLOGIST / ENGINEER	REE
PROJECT No.	64115011	BORING	B-3

LOG OF BORING B-4

PROJECT ***Nevada Way Sewer Line Construction***

SITE ***Nevada Way, Boulder City***

CLIENT ***Nevada By Design***

EASTING	NORTHING
876167	***26693558***
STATION	OFFSET
APPROXIMATE SURFACE ELEVATION (ft) ***2485.0***	

DEPTH (ft)	DESCRIPTION	ELEVATION (ft)	DEPTH (ft)	USCS SYMBOL	SAMPLE No.	SAMPLE TYPE	RECOVERY (inch)	BLOW COUNT (blows/ft)	WATER CONTENT, %	DRY UNIT WEIGHT (pcf)	UNCONFINED COMP. STRENGTH (psf)	NOTES
0.4	**ASPHALT** - 5-1/4 inches	2484.6		AC								
				AB								
1.2	**AGGREGATE BASE** - 9 inches	2483.8										
				SM	1	SS	13	19				
	SILTY SAND - reddish brown, slightly moist, medium dense				2	BS						
	- trace gravel, occasional clayey sand lenses, dry				3	SS	13	65	9			
	- reddish brown		5									
5.5	- very dense	2479.5										
	Bottom Depth at Approximately 5.5 feet											

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

SAMPLE TYPES: RS = Ring BS = Bag CPT = Cone Penetration Test
SS = Standard Penetration Test C = Core ST = Shelby Tube

WATER LEVEL OBSERVATIONS, ft		
WL DEPTH ▽	*NE*	*04-18-2011*
WL DEPTH ▼	*NE*	*04-18-2011*
NOTES	*Lat: 35.9755, Long: -114.8398*	

Terracon

BORING STARTED	*04-18-2011*		
BORING COMPLETED	*04-18-2011*		
RIG *Diedrich D120*		GEOLOGIST / ENGINEER	*REE*
PROJECT No. *64115011*		BORING	*B-4*

APPENDIX B
LABORATORY TESTING

Laboratory Testing

Soil samples were tested in the laboratory to measure their natural moisture content. The test results are provided on the boring logs included in Appendix A.

Soil samples from the borings were tested for grain size distribution, Atterberg limits, direct shear strength, and water soluble sulfate (SO_4).

The laboratory test results are provided in Appendix B.

The soil samples were classified by the Unified Soil Classification System (USCS). Descriptive classifications of the soils indicated on the boring logs are in accordance with the General Notes and the USCS method presented in Appendix C. Unified Soil Classification Symbols and a brief description of this classification system are also provided in Appendix C.

Borehole	Depth (ft)	Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	%<#200 Sieve	USCS Class-ification	Water Content (%)	Dry Unit Weight (pcf)	Derived Saturation (%)	Derived Void Ratio
B-1	4.0	3	NP	NP	NP	18	SM	9.0			
B-2	1.5	1						8.9			
B-2	4.0	3						8.6			
B-2	9.0	5						8.2			
B-2	10.5	6	NP	NP	NP	14	SM				
B-2	19.0	8						7.5			
B-3	4.0	3						8.7			
B-4	4.0	3	NP	NP	NP	24	SM	9.0			

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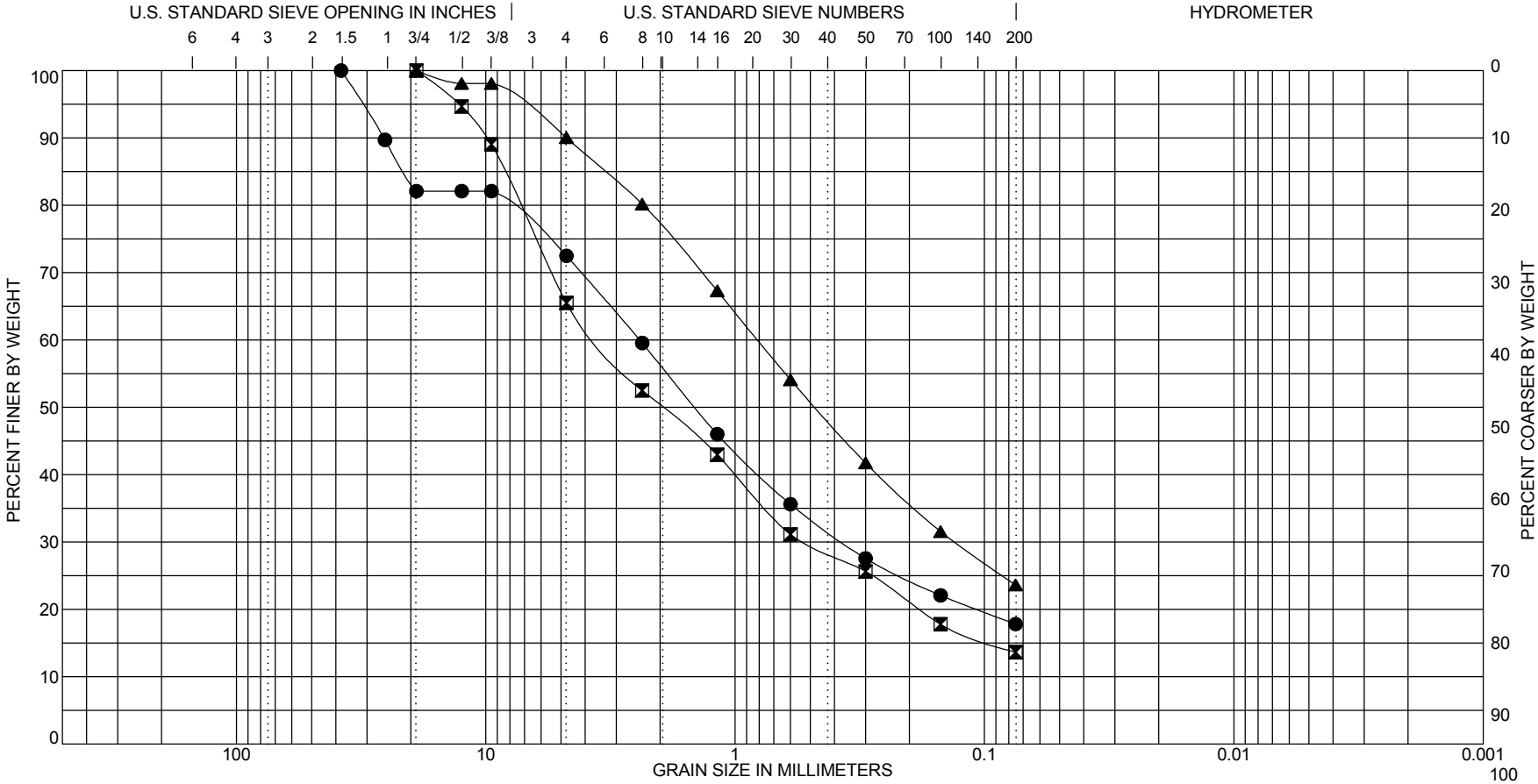
SUMMARY OF LABORATORY RESULTS

Client: Nevada By Design
Project: Nevada Way Sewer Line Construction
Site: Nevada Way, Boulder City
Project No.: 64115011 **Exhibit: B**



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	*B-1*	*@ 4.0 ft.*	*SILTY SAND with GRAVEL SM*	*NP*	*NP*	*NP*		
⊠	*B-2*	*@ 10.5 ft.*	*SILTY SAND with GRAVEL SM*	*NP*	*NP*	*NP*		
▲	*B-4*	*@ 4.0 ft.*	*SILTY SAND SM*	*NP*	*NP*	*NP*		

	Specimen Identification		D100	D85	D50	D15	%Gravel	%Sand	%Silt	%Clay
●	*B-1*	*@ 4.0 ft.*	*38.10*	*21.23*	*1.448*		*27.5*	*54.7*	*17.8*	
⊠	*B-2*	*@ 10.5 ft.*	*19.00*	*8.43*	*1.969*	*0.0942*	*34.5*	*51.9*	*13.6*	
▲	*B-4*	*@ 4.0 ft.*	*19.00*	*3.32*	*0.477*		*10.0*	*66.4*	*23.6*	

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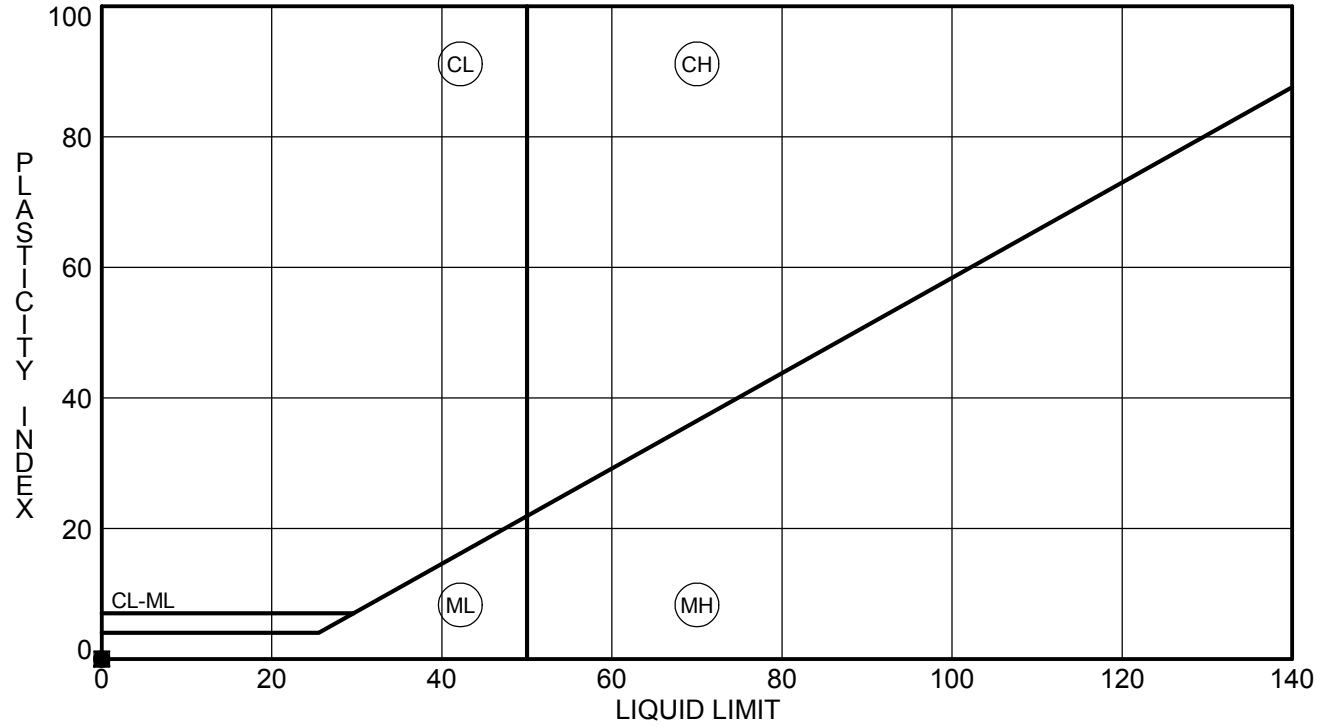
Client: *Nevada By Design*
Project: *Nevada Way Sewer Line Construction*
Project Site *Nevada Way, Boulder City*
Project No. *64115011*

SIEVE ANALYSES

Exhibit: B



Specimen Identification			LL	PL	PI	Fines, (%)	Classification
●	B-1	4.0 ft	NP	NP	NP	18	SILTY SAND with GRAVEL(SM)
⊠	B-2	10.5 ft	NP	NP	NP	14	SILTY SAND with GRAVEL(SM)
▲	B-4	4.0 ft	NP	NP	NP	24	SILTY SAND(SM)

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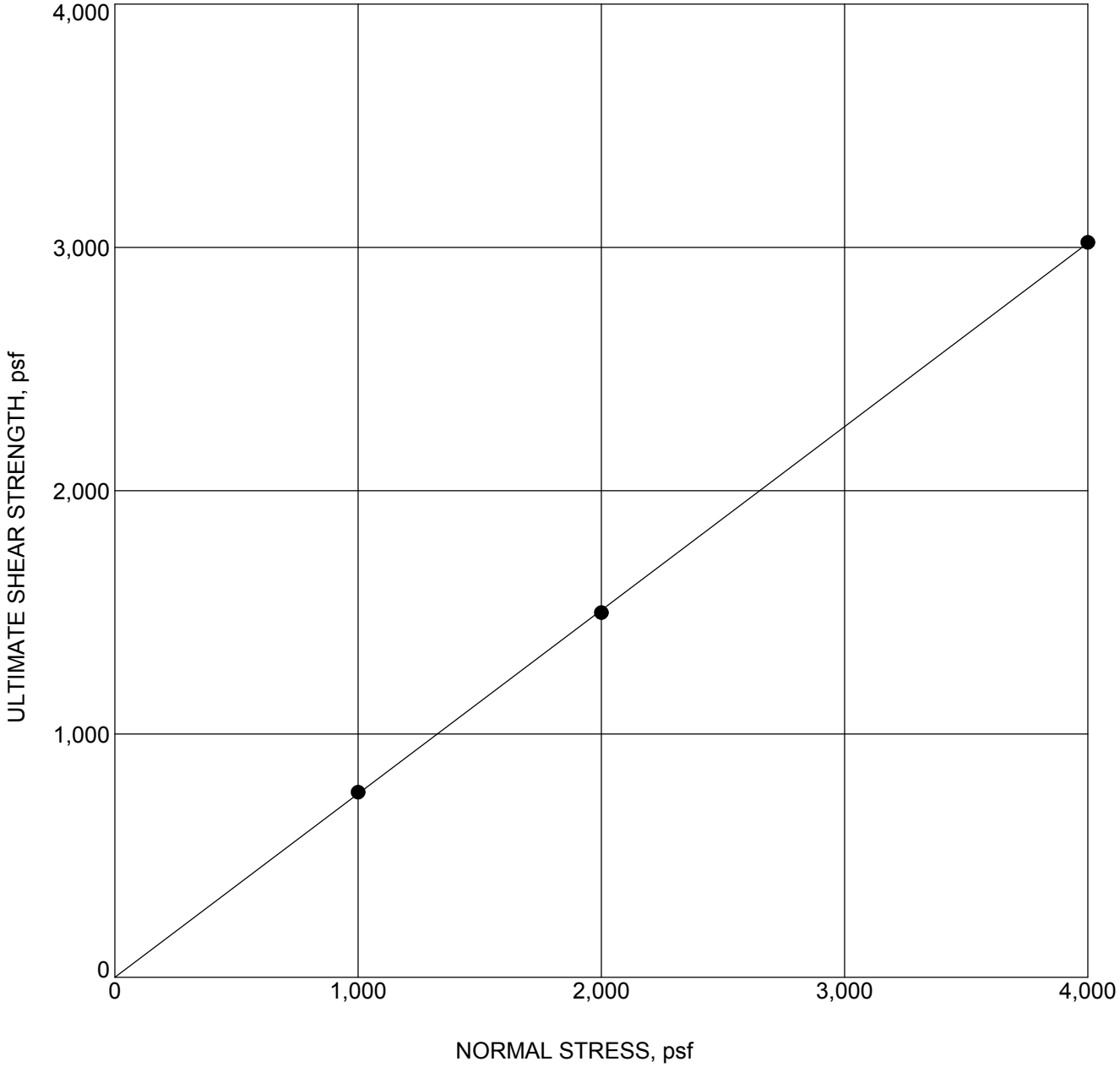
ATTERBERG LIMITS RESULTS

Client: Nevada By Design
Project: Nevada Way Sewer Line Construction
Site: Nevada Way, Boulder City
Project No.: 64115011

Exhibit: B



Specimen Identification	Final Moisture Content (%)	Initial Dry Density (pcf)	Ultimate Friction Angle	Ultimate Cohesion (psf)	Peak Friction Angle	Peak Cohesion (psf)
● B-2 @ 10.5 ft	7.1	115.9	37	0		

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DIRECT SHEAR TEST

Client: Nevada By Design
Project: Nevada Way Sewer Line Construction
Site: Nevada Way, Boulder City
Project No.: 64115011 **Exhibit: B**

DIRECT SHEAR 64115011.GPJ LV TEMPLATE.GDT 4/28/11

CHEMICAL LABORATORY TEST REPORT

Report Number: 64115011
Service Date: 04/19/11
Report Date: 04/28/11
Task:

Terracon
750 Pilot Rd.
Las Vegas NV 89119
702-597-9393

Client

Nevada By Design

Project

Nevada Way Sewer Line
Project No. 64115011

Sample Submitted By: Terracon ***Date:*** 4/27/2011
Analyzed By: **K. Ergun**

Sample Number	1	1	1
Sample Loaction	B-1	B-3	B-4
Sample Depth (ft.)	1.5	1.5	1.5
Water Soluble Sulfate (SO4), AWWA 4500 E (percent %)	0.01	0.04	0.01

Reviewed By: Kurt Ergun
Kurt Ergun
Chemist

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube – 2" O.D., 3" O.D., unless otherwise noted	PA:	Power Auger (Solid Stem)
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	BCR:	Before Casing Removal
WCI:	Wet Cave in	WD:	While Drilling	ACR:	After Casing Removal
DCI:	Dry Cave in	AB:	After Boring	N/E:	Not Encountered

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 – 1,000	2 - 4	Soft
1,000 – 2,000	4 - 8	Medium Stiff
2,000 – 4,000	8 - 15	Stiff
4,000 – 8,000	15 - 30	Very Stiff
8,000+	> 30	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 50	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	≥ 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75 to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]					Soil Classification	
					Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]		GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]		GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH		GM	Silty gravel[F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]		SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]		SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH		SM	Silty sand[G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]		CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]		ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line		CH	Fat clay[K,L,M]
			PI plots below "A" line		MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

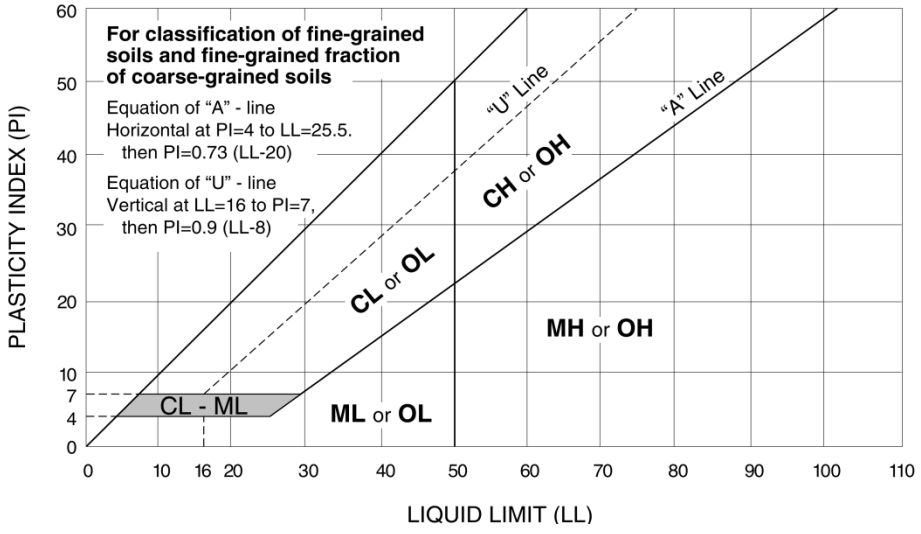

Exhibit C-2