URS

September 1, 2011

Mr. Gary Collins
Burns & McDonnell
1010 Tavern Road, Bldg.1
Alpine, CA 92901

Subject: Evaluation of Liquefaction Potential
Structure EP54-1
SDG&E Sunrise Powerlink Project
San Diego and Imperial Counties, California
URS Project No. 27661032.01001

Dear Mr. Collins:

URS Corporation Americas (URS) is submitting this letter to summarize the evaluation of the potential for liquefaction at structure EP54-1 for the Sunrise Powerlink Project. This letter addresses Mitigation Measure G-4b, which requires evaluation of the potential for liquefaction for the structure.

BACKGROUND

Liquefaction is a phenomenon where saturated coarse-grained soils (less than 50% passing the No. 200 sieve) lose their strength and acquire some mobility from strong ground motion. While not related to liquefaction, some fine-grained soils (more than 50% passing the No. 200 sieve) are vulnerable to similar liquefaction-type behavior or strength loss.

Geologic hazards, including the potential for liquefaction, were discussed in the October 1, 2010 URS report titled "Geotechnical and Geologic Hazards Investigation, Sunrise Powerlink Project, San Diego and Imperial Counties, California". The report concluded that the potential for liquefaction required additional evaluation in several areas along the alignment, including the subject tower location.

EVALUATION

To evaluate foundation conditions and liquefaction potential, URS completed a geotechnical boring at EP54-1 on August 23, 2011. The boring was drilled to a depth of approximately 50 feet. Laboratory testing was performed to evaluate grain size distribution to support the assessment of the potential for liquefaction.

The findings from the subsurface exploration and laboratory testing indicate that loose to medium dense alluvium consisting of silty sand is present to a depth of approximately 11 feet below ground

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surface (bgs), overlying completely to highly weathered granitic rock. The rock becomes slightly weathered and strong at a depth of about 40 feet bgs. Groundwater was encountered at a depth of about 9.5 feet bgs.

The potential for liquefaction in coarse grained soils was evaluated using the Standard Penetration Test blow counts (SPT N-Values) from the boring in accordance with current criteria and procedures (Youd, *et al.*, 2001; Idriss and Boulanger, 2008). The procedure for evaluating liquefaction potential is empirical and it is based on data and observations at sites that have, and have not liquefied during an earthquake.

The potential for liquefaction was assessed in terms of a factor of safety against liquefaction, FS_{liq}. The factor of safety is defined as the Cyclic Resistance Ratio required to resist liquefaction (CRR) divided by the Cyclic Stress Ratio (CSR) generated by the design ground motion. The seismic demand is a function of the anticipated peak ground acceleration (PGA). The assessment adopted a PGA of 0.23g, representative of an earthquake with a probability of exceedence of 10 percent in 50 years, and an earthquake magnitude of M7.0. The calculations conservatively assumed the depth to groundwater as 5 feet bgs. Soils were considered potentially liquefiable if the FS_{liq} was calculated to be less than about 1.1. Our analyses resulted in FS_{liq} between about 0.6 and 0.7 for the loose sand below the design groundwater level.

CONCLUSIONS AND RECOMMENDATIONS

The results of our evaluation indicate there is potential for liquefaction to occur in the shallow alluvium at structure EP54-1. To mitigate the potential for liquefaction, the foundations for the structure should be designed considering:

- A reduction in the axial and lateral soil resistances within the potentially liquefiable soils in the upper approximately 11 feet of the shaft.
- The downdrag load on the pile shaft that can develop from liquefaction-induced settlement.

If you any questions regarding the letter please contact us at (858) 812-9292.

Sincerely,

URS CORPORATION

Kelly C. Giesing, G.E. 2749
Project Geotechnical Engineer

Michael E. Hatch, C.E.G. 1925
Principal Engineering Geologist

Attachments:

Log of Boring B-EP54-1
Results of Laboratory Testing

Project: Sunrise Powerlink Project
Project Location: San Diego and Imperial Counties, California
Project Number: 27661032

Log of Boring B-EP54-1

Date(s) Drilled	**08/23/11**	Logged By	**D. Rector**	Checked By	**P. Balasubramanyam**
Drilling Method	**Coring**	Drill Bit Size/Type	**HQ-3**	Total Depth Drilled	**50.0 feet**
Drill Rig Type	**Burley 4500, Rig #2**	Drilling Contractor	**Crux**	Approx. Surface Elevation	**2332.4 ft (NAVD 88)**
Groundwater Level	**9.5 feet**	Location	**Link 1, Section 8C**	Inclination from Horizontal/Bearing	**90°**
Borehole Completion	**Bentonite seal**	Coordinate Location (NAD 83)	**32.65724 -116.61765**	Hammer Data	**140 lbs/30" automatic hammer**

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows/foot	Drill Time and Rate (ft/hr)	REMARKS AND LAB TESTS
2332	0								ALLUVIUM Medium dense, moist, brown, silty SAND (SM), medium grained, with clay, mica flakes and fine gravel				0927	
	1	1		85									75	
	2													
2330													0929	
	3										1	26	0942	WA(19), MC(10), DUW(118), LL(23), PI(4), CORR
	4	2		95									66	
2328														
	5								Loose, moist, brown, poorly graded SAND with silt (SP-SM), coarse grained, with mica flakes and fine gravel					
													0945	
	6		1								2	10	0959	MC(19)
2326														
	7	3		80									72	
	8												1001	
2324											3	6	1008	WA(8), MC(18)
	9									▽			52	
	10	4		80										
2322													1011	
	11								Medium dense, moist, brown, silty SAND (SM), coarse grained, with fine gravel		4	70	1029	SA(12), MC(14)
	12								TONALITE OF LA POSTA Light yellowish brown with black and white crystals, phaneritic, coarse grained, completely weathered, extremely weak rock. Breaks down to very dense, grayish brown, silty SAND (SM)					
2320	13													

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Log of Boring B-EP54-1

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows/foot	Drill Time and Rate (ft/hr)	REMARKS AND LAB TESTS
	13	5		100					Grades to black and white (salt and pepper colored), completely to highly weathered, with some muscovite mica flakes. Breaks down to bluish gray, well-graded SAND with silt (SW-SM)				300	
	14													
2318									Becomes very weak rock					
	15								Becomes extremely weak rock					
													1030	
	16		1						Becomes very weak rock		5	50/5"	1040	SA(9), MC(16)
2316														
	17													
	18												50	
2314		6		100										
	19								Breaks down to dark gray, poorly graded SAND with silt (SP-SM)		6			WA(6), MC(6)
	20													
2312														
													1046	
	21								Grades to highly weathered, weak to very weak rock, with few muscovite mica flakes				1053	
	22													
2310														
	23						1		With many mafic minerals				75	
		7		100	4		1		1: 45°, J, N, Fe, Sp, Pl, Sr					
	24						1							
2308							1							
	25		2						Becomes weak rock, breaks down to well-graded SAND (SW) with gravel					
							2						1057	
	26						2						1101	
2306					4		2		2: 55°, J, (set), N, Fe, Sp, Pl, Sr		7	50/5"		SA(3), MC(5)
	27						2		Breaks down to poorly graded SAND with silt (SP-SM)					
	28												60	
2304		8		100										
	29													

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Log of Boring B-EP54-1

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows/foot	Drill Time and Rate (ft/hr)	REMARKS AND LAB TESTS
	29													
	30													
2302													1106	
	31												1110	
	32						M							
2300														
	33	9		100			M M M						75	
	34						1		1: 35°, J, N, No, N, Pl, Sr					
2298					3		1 2		2: 45°, J, N, No, N, Pl, Sr					
	35													
	36		2										1114 1021	
2296														
	37													
	38								Decrease in iron oxide staining to 5-10%					
2294		10		100									60	
	39													
	40													
2292														
	41								Grades to slightly weathered, strong rock, with 0-5% iron oxide staining	X	8		1026 1130	UC
	42													
2290														
	43	11		100		100							15	
	44													
2288														
	45													

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Log of Boring B-EP54-1

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows/foot	Drill Time and Rate (ft/hr)	REMARKS AND LAB TESTS
	45								Becomes very strong rock				1150	
	46												1210	
2286														
	47		2											
	48	12		100		100							9	
2284														
	49													
	50												1238	
									Bottom of boring at 50 feet					
2282	51													
	52													
2280														
	53													
	54													
2278														
	55													
	56													
2276														
	57													
	58													
2274														
	59													
	60													
2272														
	61													

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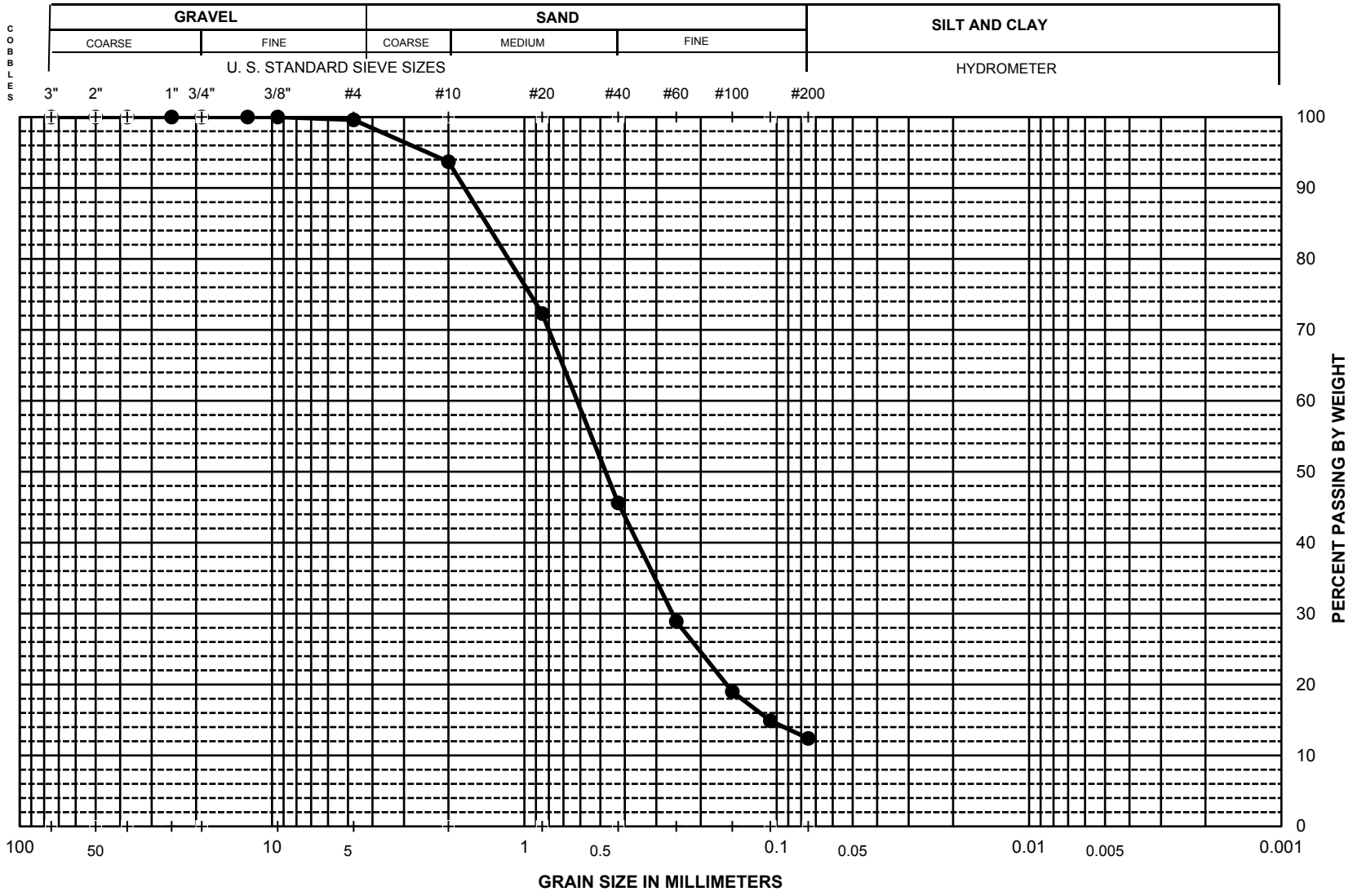
UNIFIED SOIL CLASSIFICATION



Sieve No.	Dia. mm	% Finer
3"	75.0	100.0
2"	50.0	100.0
1.5"	37.5	100.0
1"	25.0	100.0
3/4"	19.00	100.0
1/2"	12.50	100.0
3/8"	9.50	100.0
#4	4.75	99.6
#10	2.00	93.7
#20	0.850	72.3
#40	0.425	45.6
#60	0.250	28.9
#100	0.150	19.0
#140	0.106	14.9
#200	0.075	12.4
Hydrometer Analysis		

% Cobbles	XX
% Gravel	0.4
% Sand	87.2
% Fines	12.4

D_{85}	1.412
D_{60}	0.618
D_{50}	0.476
D_{30}	0.259
D_{15}	0.107
D_{10}	#N/A
C_u	XXX
C_c	XXX

Boring No.	Sample No.	Depth (ft)	SYMBOL	Wn (%)	LL	PI	% 2 μm	Description and Classification
B-EP54-1	4	10.8	●	14.2	NA	NA	NA	**Brown silty Sand (SM)**

PROJECT NAME: **Sunrise Powerlink**

PROJECT NUMBER: **27661032**

PARTICLE-SIZE DISTRIBUTION CURVES

Sieve Sunrise EP54-1 010

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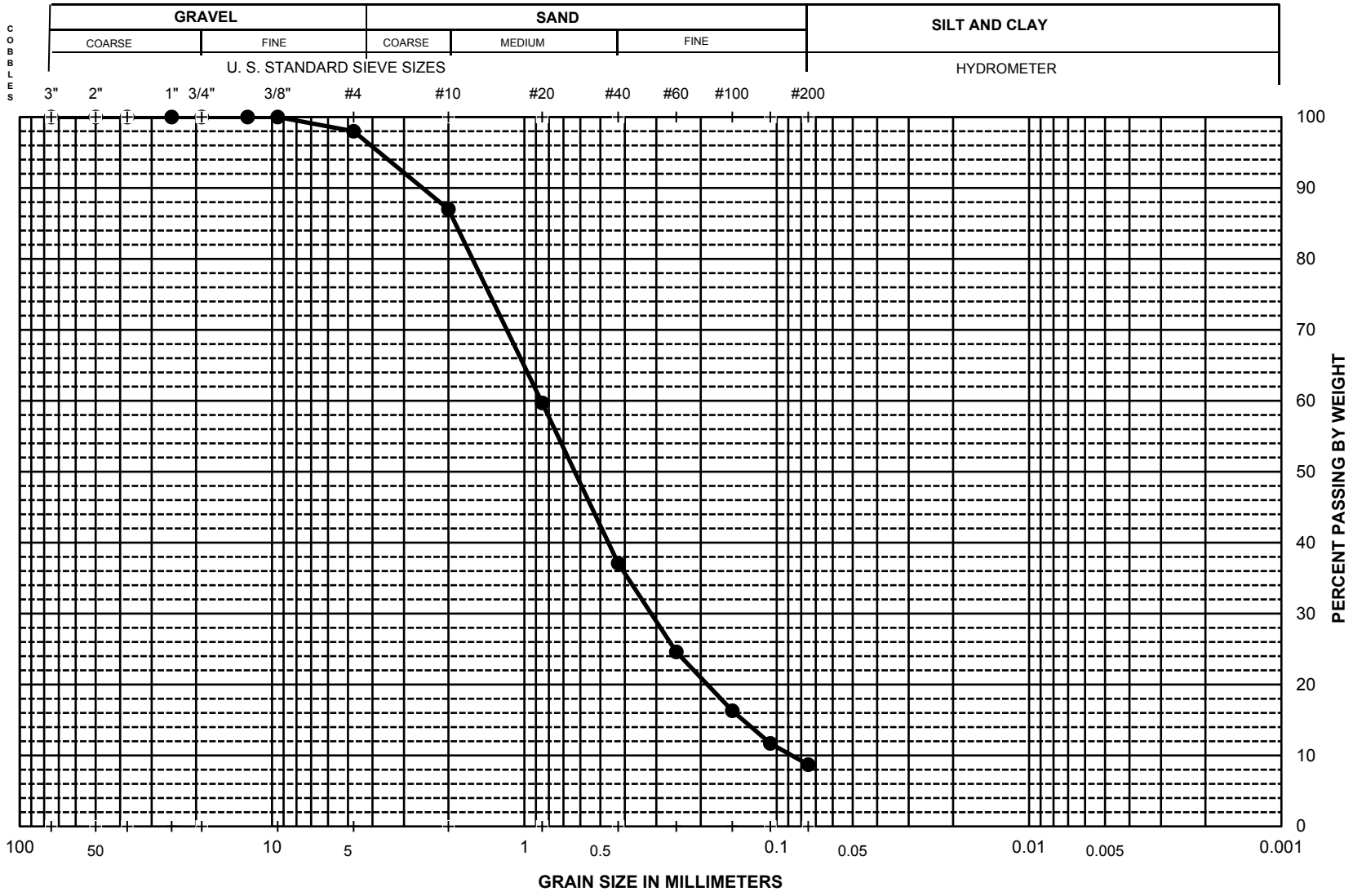
UNIFIED SOIL CLASSIFICATION



Sieve No.	Dia. mm	% Finer
3"	75.0	100.0
2"	50.0	100.0
1.5"	37.5	100.0
1"	25.0	100.0
3/4"	19.00	100.0
1/2"	12.50	100.0
3/8"	9.50	100.0
#4	4.75	98.0
#10	2.00	87.0
#20	0.850	59.7
#40	0.425	37.1
#60	0.250	24.6
#100	0.150	16.3
#140	0.106	11.7
#200	0.075	8.7
Hydrometer Analysis		

% Cobbles	XX
% Gravel	2.0
% Sand	89.3
% Fines	8.7

D_{85}	1.878
D_{60}	0.858
D_{50}	0.631
D_{30}	0.314
D_{15}	0.136
D_{10}	0.087
C_u	9.8
C_c	1.3

Boring No.	Sample No.	Depth (ft)	SYMBOL	Wn (%)	LL	PI	% 2 μm	Description and Classification
B-EP54-1	5	15.8	●	15.8	NA	NA	NA	**Bluish gray well-graded Sand with silt (SW-SM)**

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PARTICLE-SIZE DISTRIBUTION CURVES

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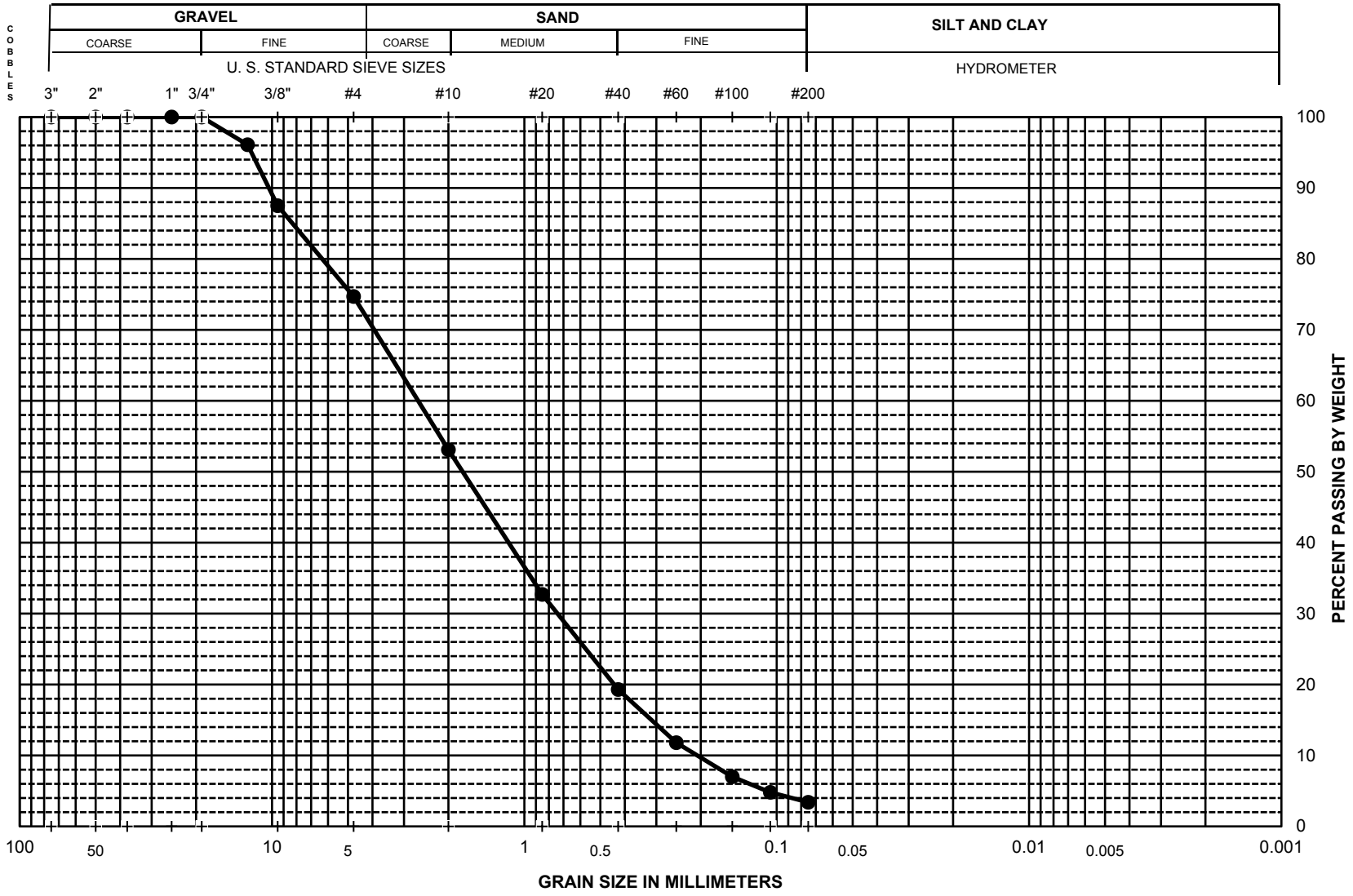
UNIFIED SOIL CLASSIFICATION



Sieve No.	Dia. mm	% Finer
3"	75.0	100.0
2"	50.0	100.0
1.5"	37.5	100.0
1"	25.0	100.0
3/4"	19.00	100.0
1/2"	12.50	96.1
3/8"	9.50	87.5
#4	4.75	74.7
#10	2.00	53.1
#20	0.850	32.7
#40	0.425	19.3
#60	0.250	11.8
#100	0.150	7.0
#140	0.106	4.8
#200	0.075	3.4
Hydrometer Analysis		

% Cobbles	XX
% Gravel	25.3
% Sand	71.3
% Fines	3.4

D_{85}	8.297
D_{60}	2.637
D_{50}	1.756
D_{30}	0.739
D_{15}	0.314
D_{10}	0.206
C_u	12.8
C_c	1.0

Boring No.	Sample No.	Depth (ft)	SYMBOL	Wn (%)	LL	PI	% 2 μm	Description and Classification
B-EP54-1	7	26.0	●	4.7	NA	NA	NA	**Dark gray well-graded Sand with gravel (SW)**

PROJECT NAME: **Sunrise Powerlink**

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PARTICLE-SIZE DISTRIBUTION CURVES

Sieve Sunrise EP54-1 026

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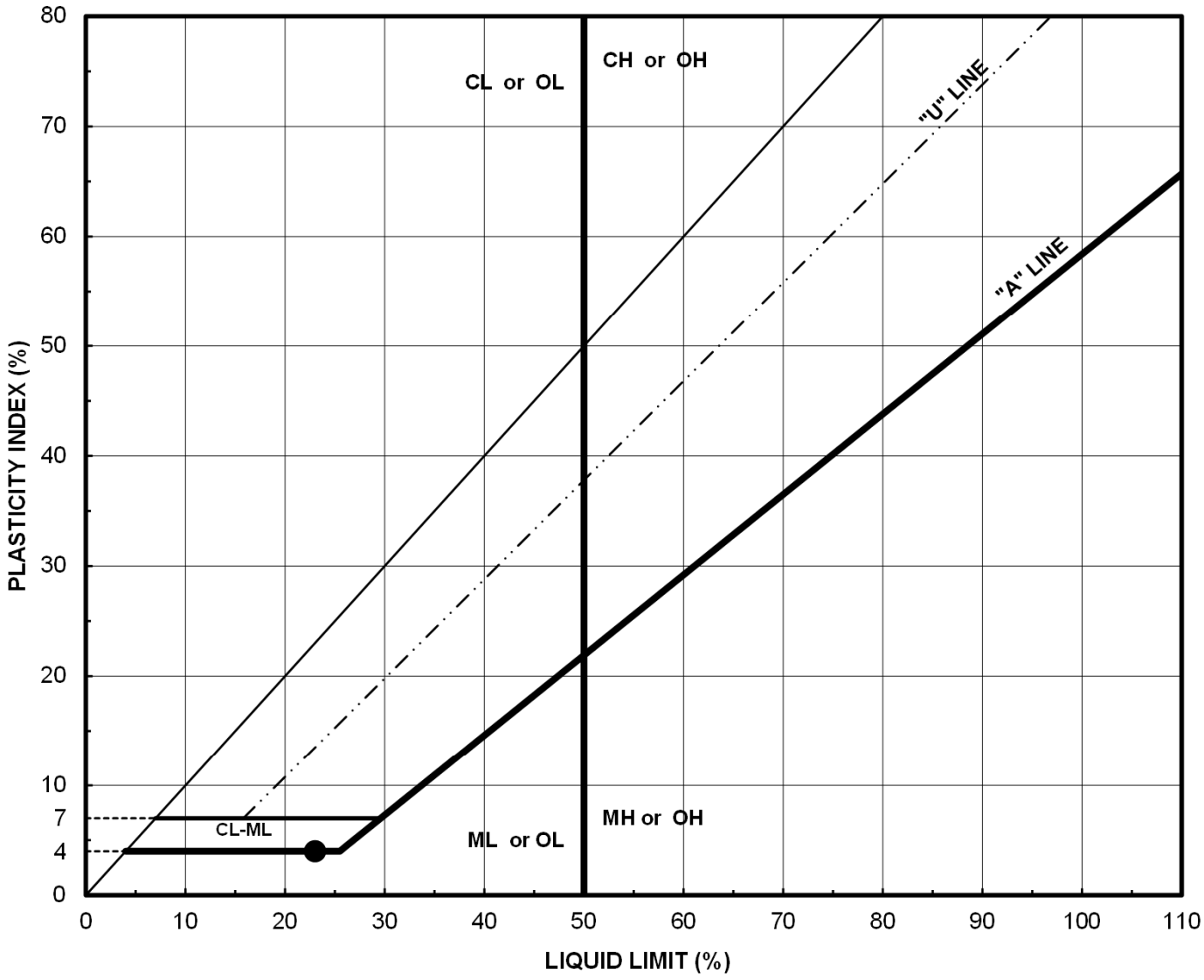

Boring Number	Sample Number	Depth (ft)	Water Content (%)	LL	PI	DESCRIPTION / CLASSIFICATION
B-EP54-1	1	2.5	NA	23	4	Brown silty SAND (SM)

Project Name: Sunrise Powerlink

Project Number: 27661032

PLASTICITY CHART

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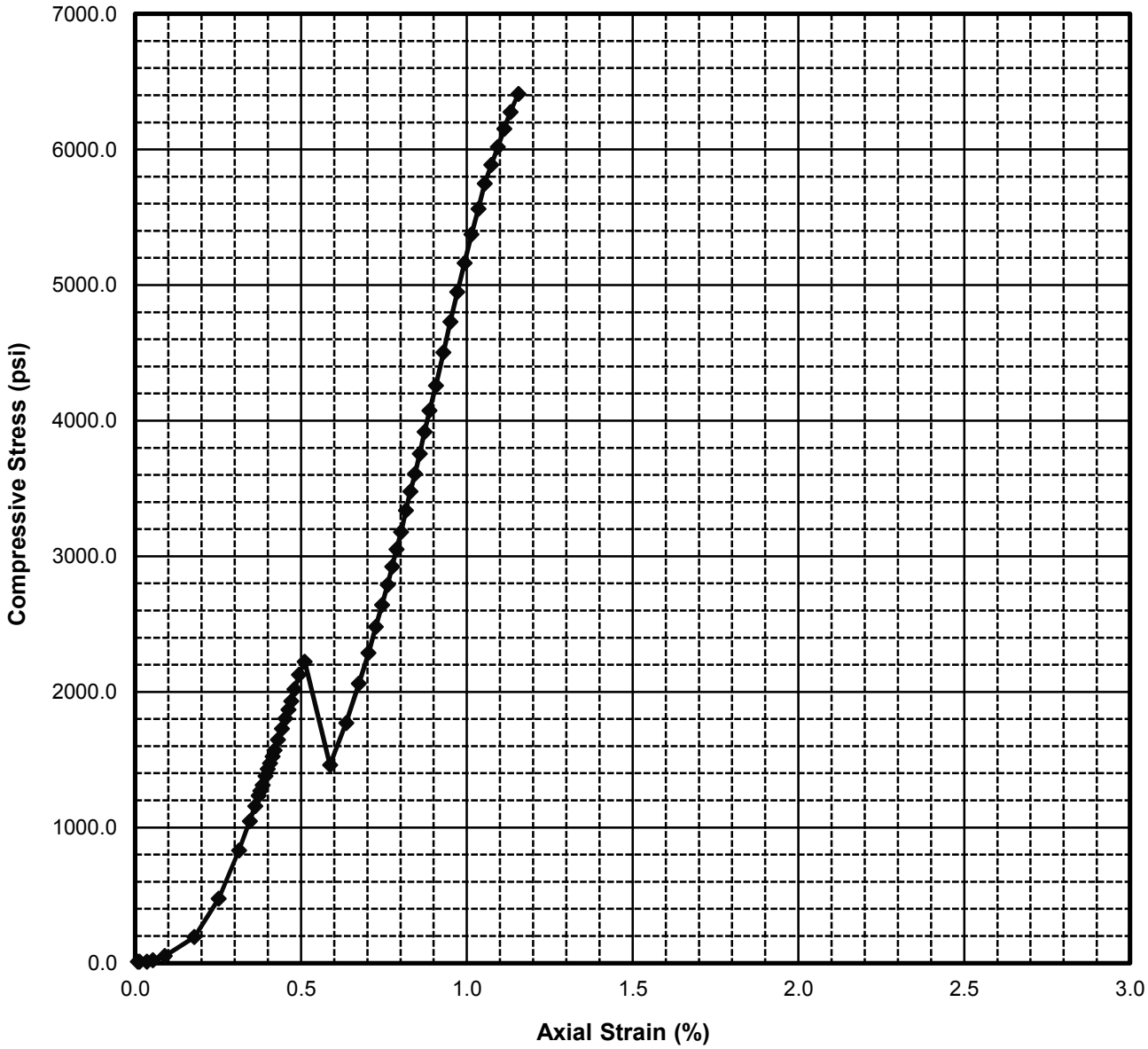
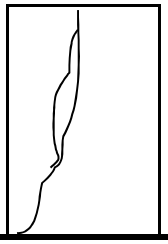


Failure Sketch



Water Content (%)	Length (in)	Diameter (in)	Wet Unit Weight (pcf)	Peak Stress (psi)
0.2	5.019	2.401	174.6	6410

Project Name: Sunrise Powerlink

Project Number: 27661030

Boring Number: B-EP54-1 **Depth (ft):** 40.8

Description and/or Classification: Bluish gray with black speckles Granite

UNCONFINED COMPRESSION TEST
ASTM D7012

CORROSIVITY TEST ANALYSIS

Project Number: 27661032
Project Name: Sunrise Powerlink
Project Engineer: KG

Boring No.: B-EP54-1
Sample No.: 1
Depth (ft): 2.5

Initial Visual Classification Symbol: SM

State of Specimen before Processing

X	Passing soil through #8 sieve
X	Moist State
	Air Dried
	Oven Dried at 60 C

Set-Up **Water Content**	Minus No. 8 or ( )
Container No.	C3
Mass Container + Wet Soil (g), M1	103.54
Mass Container + Dry Soil (g), M2	101.79
Mass Container (g), M3	71.97
Water Content, w (%)	5.87

Resistivity Test: California Test Method 643

Mininum Resistence value: 5,300 ohm-cm

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Weight of Soil in bowl (g):	428.06	446.31	455.14	464.58	473.36
Weight of mixing bowl (g):	139.25	139.25	139.25	139.25	139.25
Wet weight of Soil (g):	288.81	307.06	315.89	325.33	334.11
Amount of water added (ml):	0	20	10	10	10
Soil Box + Wet Soil (g), M5	239.01	259.07	264.42	268.31	266.66
Weight of Soil Box (g), M6	123.95	123.95	123.95	123.95	123.95
Wt. of Wet Soil for test (g), M7	115.06	135.12	140.47	144.36	142.71
Volume of Soil Box (cm^3)	79.2	79.2	79.2	79.2	79.2
Est. Saturation (%)	16.4	60.1	64.4	75.7	79.6
Resistivity Reading (ohm)	21,000	7,300	6,000	5,500	5,300
Resistence (ohm-cm)	21,000	7,300	6,000	5,500	5,300

Resistence = Soil Box Constant x Reading

pH Test : California Test Method 532

50g wet weight of soil mixed with 50 mL of de-ionized water.

pH of slurry: 9.30

Temperature : 21.6 Celsius

Sulfate Content:

100g of soil mixed with 300 mL of de-ionized water.

SO_4 (ppm) : not detected

recorded mg of SO_4 in sample, x, = 0 mg

soil / water ratio, r, = 3

number of dilutions to obtain above value, d, = _____ = _____ mg/ L = ppm

Dilution Equation, d > 0; $SO_4 = ((x / 80)* (r\ 80 * 2^{d} - r\ 80 * 2^{(d-1)})) + r\ 80 * 2^{(d-1)}$

Chloride Content:

100g of soil mixed with 300 mL of de-ionized water.

Cl^- (ppm) : 75

mg/L of Cl^- = ((A-B) x N x 35453) x 3

A = mL of $AgNO_3$ A= 5

B = 23 mL of the blank

N = 0.0493 N, normality of the titrant

Cl^- (mg/L) = A * 5 * 3

Tested By: MG Date: 8/25/2011 Checked By: TJO