Nuclear Operating Company
South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

August 10, 2009
U7-C-STP-NRC-090090

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Supplemental Response to Request for Additional Information and
Responses to Requests for Additional Information

Reference: Letter, Mark McBurnett to Document Control Desk, "Responses to Requests for Additional Information," dated July 20, 2009 (U7-C-STP-NRC-090072, ML092030132)

Attached are responses to NRC staff questions in Request for Additional Information (RAI) letters numbered 117 and 130, related to COLA Part 2, Tier 2, Subsection 2.5S.2, "Vibratory Ground Motion," and Subsection 2.5S.4, "Stability of Subsurface Materials and Foundations," and Subsection," respectively. Attachments 1 through 6 complete the responses to these letters.

Attachment 1 provides the tables and figures that supplement the changes proposed in the response to RAI letter number 117, RAI question 02.05.02-19, which was provided in the reference letter, and satisfies the commitment (09-10843-1) in that letter.

Attachments 2 through 6 provide the responses to the following NRC staff questions included in RAI letter number 130:

02.05.04-24	02.05.04-26	02.05.04-28
02.05.04-25	02.05.04-27	

RAI question 02.05.04-28 requested that STP submit, in electronic format, the input data necessary to perform shear wave velocity liquefaction analyses. This data is provided as an enclosure with this letter.

When a change to the COLA is indicated, the change will be incorporated into the next routine revision of the COLA following NRC acceptance of the RAI response.

There are no commitments in this letter.

If you have any questions regarding these responses, please contact me at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

STI 32511298 D091 NRO

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 8/10/09

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

rhb

Attachments:
1. RAI 02.05.02-19, Supplement 1
2. RAI 02.05.04-24
3. RAI 02.05.04-25
4. RAI 02.05.04-26
5. RAI 02.05.04-27
6. RAI 02.05.04-28

Enclosure:
DVD: U7-C-STP-NRC-090090, Enclosure 1, "RAI 02.05.04-28 Liquefaction Analyses Input."

cc: w/o attachments and enclosure except*
(paper copy)

Director, Office of New Reactors
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Kathy C. Perkins, RN, MBA
Assistant Commissioner
Division for Regulatory Services
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

Alice Hamilton Rogers, P.E.
Inspection Unit Manager
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

C. M. Canady
City of Austin
Electric Utility Department
721 Barton Springs Road
Austin, TX 78704

*Steven P. Frantz, Esquire
A. H. Gutterman, Esquire
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Ave. NW
Washington D.C. 20004

*George F. Wunder
*Tekia Govan
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852

(electronic copy)

*George Wunder
*Tekia Govan

Loren R. Plisco
U. S. Nuclear Regulatory Commission

Steve Winn
Eddy Daniels
Joseph Kiwak
Nuclear Innovation North America

Jon C. Wood, Esquire
Cox Smith Matthews

J. J. Nesrsta
R. K. Temple
Kevin Pollo
L. D. Blaylock
CPS Energy

RAI 02.05.02-19, Supplement 1

STP Letter U7-C-STP-NRC-090072 (ML092030132), dated July 20, 2009, provided the response to RAI 02.05.02-19, which included changes to STP COLA Part 2, Tier 2, Subsection 2.5S.2.5, “Seismic Wave Transmission Characteristic of the Site,” and Subsection 2.5S.4.7, “Response of Soil and Rock to Dynamic Loading.” This supplemental response to RAI 02.05.02-19 provides the revised Tables and Figures supporting these sections which were not provided with the original response.

Table 2.5S.2-17 Controlling Magnitudes and Distances from Deaggregation

Struct. frequency	Annual Freq. Exceed.	Overall hazard		Hazard from R>100 km	
		M	R, km	M	R, km
1 & 2.5 Hz	1E-4	7.4	600	7.6	880
5 & 10 Hz	1E-4	6.7	230	7.5	790
1 & 2.5 Hz	1E-5	7.3	380	7.7	890
5 & 10 Hz	1E-5	6.1	46	7.7	850
1 & 2.5 Hz	1E-6	6.9	122	7.8	890
5 & 10 Hz	1E-6	5.6	10	7.8	860

Shaded cells indicate values used to construct UHRS

Table 2.5S.2-18 Horizontal 10^{-4} Rock and Site Specific UHRS (in g)

Freq. (Hz)	Rock UHRS LF Sa (g)	Rock UHRS HF Sa (g)	Transfer Functions LF Amp	Transfer Functions HF Amp	Surface UHRS LF Sa (g)	Surface UHRS HF Sa (g)	Raw Envelope Sa (g)	Smooth Spectrum Sa (g)
100	3.27E-02	3.27E-02	2.190	1.556	7.17E-02	5.09E-02	7.17E-02	7.17E-02
90	3.57E-02	3.57E-02	2.009	1.427	7.17E-02	5.10E-02	7.17E-02	7.17E-02
80	4.08E-02	4.09E-02	1.759	1.249	7.18E-02	5.11E-02	7.18E-02	7.18E-02
70	4.86E-02	4.88E-02	1.479	1.050	7.19E-02	5.12E-02	7.19E-02	7.19E-02
60	5.84E-02	5.87E-02	1.232	0.876	7.20E-02	5.14E-02	7.20E-02	7.20E-02
50	6.79E-02	6.83E-02	1.063	0.759	7.22E-02	5.18E-02	7.22E-02	7.22E-02
45	7.17E-02	7.22E-02	1.010	0.724	7.24E-02	5.22E-02	7.24E-02	7.25E-02
40	7.46E-02	7.51E-02	0.976	0.704	7.28E-02	5.28E-02	7.28E-02	7.29E-02
35	7.66E-02	7.71E-02	0.959	0.698	7.34E-02	5.38E-02	7.34E-02	7.35E-02
30	7.78E-02	7.82E-02	0.958	0.711	7.46E-02	5.56E-02	7.46E-02	7.46E-02
25	7.84E-02	7.84E-02	0.977	0.748	7.65E-02	5.86E-02	7.65E-02	7.67E-02
20	7.68E-02	7.78E-02	1.041	0.823	8.00E-02	6.40E-02	8.00E-02	8.02E-02
15	7.39E-02	7.52E-02	1.170	0.982	8.65E-02	7.38E-02	8.65E-02	8.66E-02
12.5	7.16E-02	7.25E-02	1.274	1.118	9.13E-02	8.11E-02	9.13E-02	9.14E-02
10	6.84E-02	6.84E-02	1.444	1.333	9.88E-02	9.12E-02	9.88E-02	9.86E-02
9	6.79E-02	6.81E-02	1.511	1.413	1.03E-01	9.63E-02	1.03E-01	1.02E-01
8	6.71E-02	6.74E-02	1.593	1.523	1.07E-01	1.03E-01	1.07E-01	1.08E-01
7	6.59E-02	6.63E-02	1.741	1.710	1.15E-01	1.13E-01	1.15E-01	1.15E-01
6	6.44E-02	6.46E-02	1.961	1.970	1.26E-01	1.27E-01	1.27E-01	1.26E-01
5	6.20E-02	6.20E-02	2.165	2.162	1.34E-01	1.34E-01	1.34E-01	1.35E-01
4	5.94E-02	5.48E-02	2.417	2.446	1.44E-01	1.34E-01	1.44E-01	1.43E-01
3	5.66E-02	4.58E-02	2.728	2.765	1.54E-01	1.27E-01	1.54E-01	1.56E-01
2.5	5.52E-02	4.01E-02	3.059	3.123	1.69E-01	1.25E-01	1.69E-01	1.64E-01
2	5.17E-02	3.31E-02	2.862	2.852	1.48E-01	9.45E-02	1.48E-01	1.52E-01
1.5	4.73E-02	2.46E-02	3.120	3.125	1.48E-01	7.69E-02	1.48E-01	1.46E-01
1.25	4.39E-02	1.98E-02	3.146	3.133	1.38E-01	6.21E-02	1.38E-01	1.39E-01
1	4.14E-02	1.49E-02	3.061	3.070	1.27E-01	4.58E-02	1.27E-01	1.26E-01
0.9	4.08E-02	1.30E-02	2.897	2.896	1.18E-01	3.76E-02	1.18E-01	1.22E-01
0.8	3.95E-02	1.11E-02	3.026	3.031	1.20E-01	3.36E-02	1.20E-01	1.16E-01
0.7	3.75E-02	9.28E-03	2.894	2.843	1.09E-01	2.64E-02	1.09E-01	1.16E-01
0.6	3.62E-02	7.54E-03	3.292	3.319	1.19E-01	2.50E-02	1.19E-01	1.11E-01
0.5	3.41E-02	5.88E-03	3.041	3.066	1.04E-01	1.80E-02	1.04E-01	1.04E-01
0.4	2.48E-02	4.31E-03	3.124	3.059	7.73E-02	1.32E-02	7.73E-02	7.94E-02
0.3	1.57E-02	2.85E-03	3.238	3.212	5.08E-02	9.16E-03	5.08E-02	5.05E-02
0.2	7.39E-03	1.53E-03	2.842	2.756	2.10E-02	4.22E-03	2.10E-02	2.25E-02
0.15	3.92E-03	9.48E-04	2.983	2.943	1.17E-02	2.79E-03	1.17E-02	1.18E-02
0.125	2.48E-03	6.86E-04	3.358	3.331	8.34E-03	2.28E-03	8.34E-03	8.25E-03
0.1	1.33E-03	4.50E-04	3.125	3.005	4.17E-03	1.35E-03	4.17E-03	4.17E-03

Table 2.5S.2-19 Horizontal 10^{-5} Rock and Site Specific UHRS (in g)

Freq. (Hz)	Rock UHRS		Transfer Functions		Surface UHRS		Raw Envelope	Smooth Spectrum
	LF Sa (g)	HF Sa (g)	LF Amp	HF Amp	LF Sa (g)	HF Sa (g)	Sa (g)	Sa (g)
100	1.26E-01	1.26E-01	1.583	1.175	1.99E-01	1.48E-01	1.99E-01	1.99E-01
90	1.39E-01	1.39E-01	1.438	1.066	1.99E-01	1.48E-01	1.99E-01	1.99E-01
80	1.60E-01	1.61E-01	1.245	0.921	2.00E-01	1.48E-01	2.00E-01	2.00E-01
70	1.93E-01	1.95E-01	1.033	0.764	2.00E-01	1.49E-01	2.00E-01	2.00E-01
60	2.36E-01	2.38E-01	0.848	0.627	2.00E-01	1.49E-01	2.00E-01	2.00E-01
50	2.78E-01	2.82E-01	0.719	0.533	2.00E-01	1.51E-01	2.00E-01	2.00E-01
45	2.97E-01	3.01E-01	0.676	0.504	2.01E-01	1.52E-01	2.01E-01	2.01E-01
40	3.12E-01	3.16E-01	0.645	0.485	2.01E-01	1.54E-01	2.01E-01	2.01E-01
35	3.24E-01	3.28E-01	0.624	0.477	2.02E-01	1.57E-01	2.02E-01	2.02E-01
30	3.33E-01	3.37E-01	0.613	0.483	2.04E-01	1.62E-01	2.04E-01	2.04E-01
25	3.40E-01	3.40E-01	0.611	0.509	2.08E-01	1.73E-01	2.08E-01	2.08E-01
20	3.22E-01	3.29E-01	0.670	0.586	2.16E-01	1.93E-01	2.16E-01	2.16E-01
15	2.95E-01	3.03E-01	0.788	0.753	2.32E-01	2.28E-01	2.32E-01	2.33E-01
12.5	2.77E-01	2.82E-01	0.882	0.891	2.44E-01	2.51E-01	2.51E-01	2.52E-01
10	2.53E-01	2.53E-01	1.044	1.119	2.64E-01	2.83E-01	2.83E-01	2.83E-01
9	2.46E-01	2.47E-01	1.120	1.211	2.75E-01	2.99E-01	2.99E-01	2.98E-01
8	2.37E-01	2.38E-01	1.203	1.314	2.85E-01	3.13E-01	3.13E-01	3.16E-01
7	2.27E-01	2.28E-01	1.328	1.489	3.02E-01	3.40E-01	3.40E-01	3.41E-01
6	2.15E-01	2.15E-01	1.540	1.743	3.31E-01	3.75E-01	3.75E-01	3.72E-01
5	2.00E-01	2.00E-01	1.789	1.972	3.57E-01	3.94E-01	3.94E-01	3.89E-01
4	1.88E-01	1.70E-01	2.014	2.239	3.79E-01	3.81E-01	3.81E-01	3.86E-01
3	1.69E-01	1.36E-01	2.371	2.585	4.01E-01	3.52E-01	4.01E-01	4.01E-01
2.5	1.54E-01	1.16E-01	2.700	2.940	4.14E-01	3.41E-01	4.14E-01	4.13E-01
2	1.46E-01	9.26E-02	2.735	2.785	4.00E-01	2.58E-01	4.00E-01	4.04E-01
1.5	1.36E-01	6.60E-02	2.973	3.041	4.04E-01	2.01E-01	4.04E-01	3.99E-01
1.25	1.27E-01	5.20E-02	3.066	3.079	3.88E-01	1.60E-01	3.88E-01	3.85E-01
1	1.14E-01	3.82E-02	2.997	3.018	3.41E-01	1.15E-01	3.41E-01	3.48E-01
0.9	1.18E-01	3.28E-02	2.815	2.846	3.32E-01	9.34E-02	3.32E-01	3.41E-01
0.8	1.19E-01	2.77E-02	2.935	2.976	3.50E-01	8.24E-02	3.50E-01	3.37E-01
0.7	1.17E-01	2.27E-02	2.809	2.788	3.29E-01	6.34E-02	3.29E-01	3.51E-01
0.6	1.17E-01	1.81E-02	3.243	3.269	3.80E-01	5.90E-02	3.80E-01	3.54E-01
0.5	1.14E-01	1.37E-02	3.009	3.014	3.42E-01	4.12E-02	3.42E-01	3.46E-01
0.4	8.27E-02	9.61E-03	3.241	3.063	2.68E-01	2.94E-02	2.68E-01	2.70E-01
0.3	5.27E-02	5.97E-03	3.276	3.153	1.73E-01	1.88E-02	1.73E-01	1.72E-01
0.2	2.49E-02	2.89E-03	2.899	2.763	7.23E-02	7.98E-03	7.23E-02	7.72E-02
0.15	1.32E-02	1.64E-03	3.018	2.910	3.99E-02	4.76E-03	3.99E-02	4.03E-02
0.125	8.38E-03	1.11E-03	3.389	3.299	2.84E-02	3.66E-03	2.84E-02	2.81E-02
0.1	4.49E-03	6.67E-04	3.154	3.014	1.42E-02	2.01E-03	1.42E-02	1.42E-02

Table 2.5S.2-20 Input Rock Motion Durations

Set of Runs	Input Rock Spectra			
	Description	Recurrence	Magnitude	Duration [sec]
LF 10^{-4}	Low Freq.	10^{-4}	7.6	13
HF 10^{-4}	High Freq	10^{-4}	6.7	10
LF 10^{-5}	Low Freq.	10^{-5}	7.7	13
HF 10^{-5}	High Freq.	10^{-5}	6.1	7

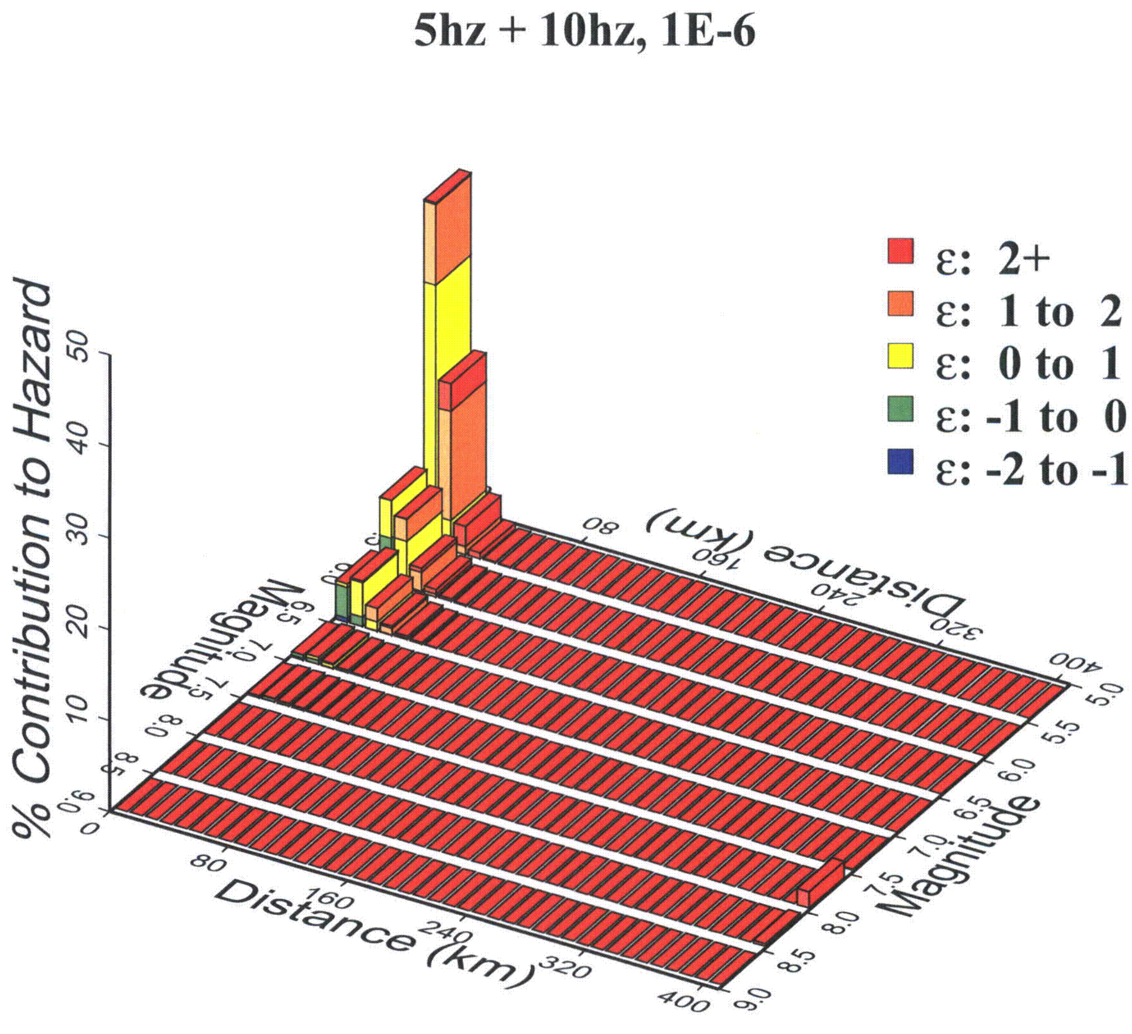
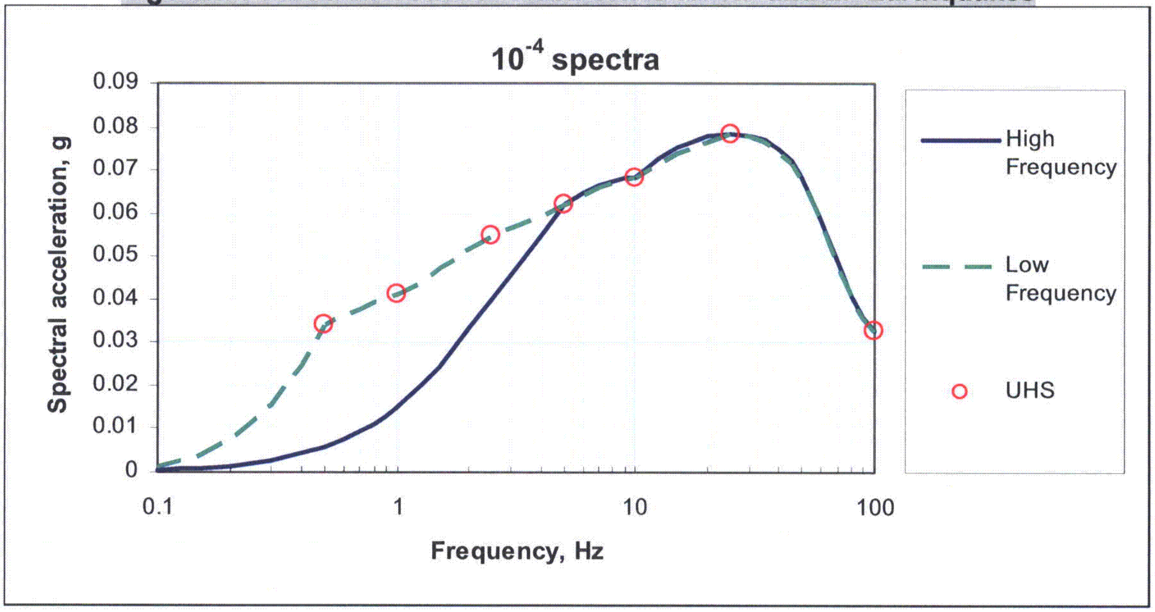


Figure 2.5S.2-32 M and R Deaggregation for 5 and 10 Hz at 10^{-6} Annual Frequency of Exceedance

Figure 2.5S.2-33 Smooth 10^{-4} Rock UHRS for HF and LF Earthquakes



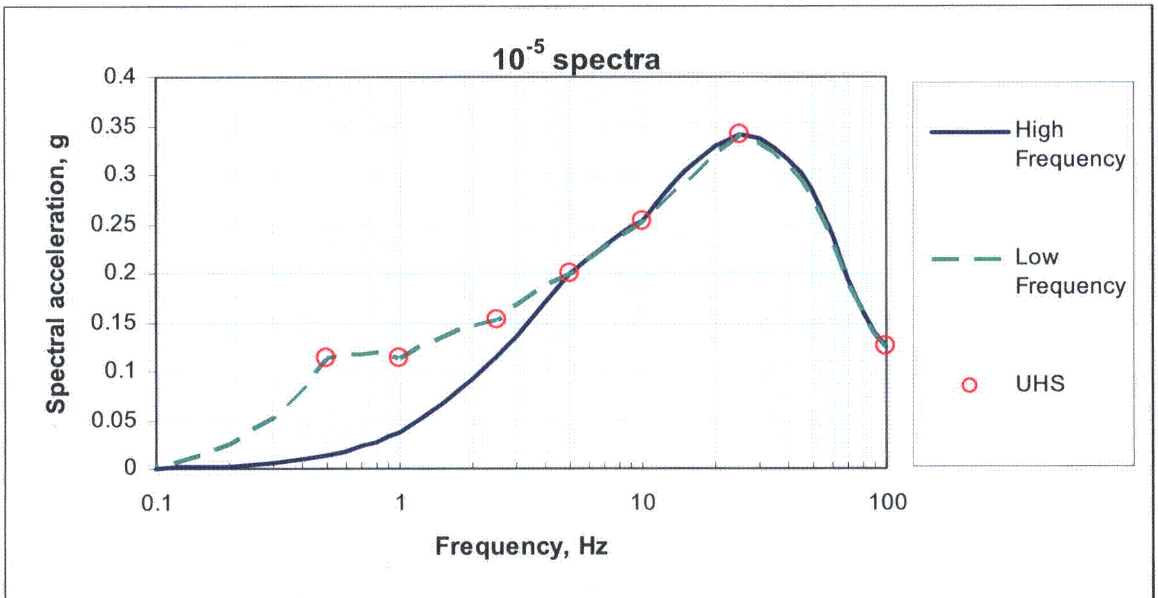


Figure 2.5S.2-34 Smooth 10^{-5} Rock UHRS for HF and LF Earthquakes

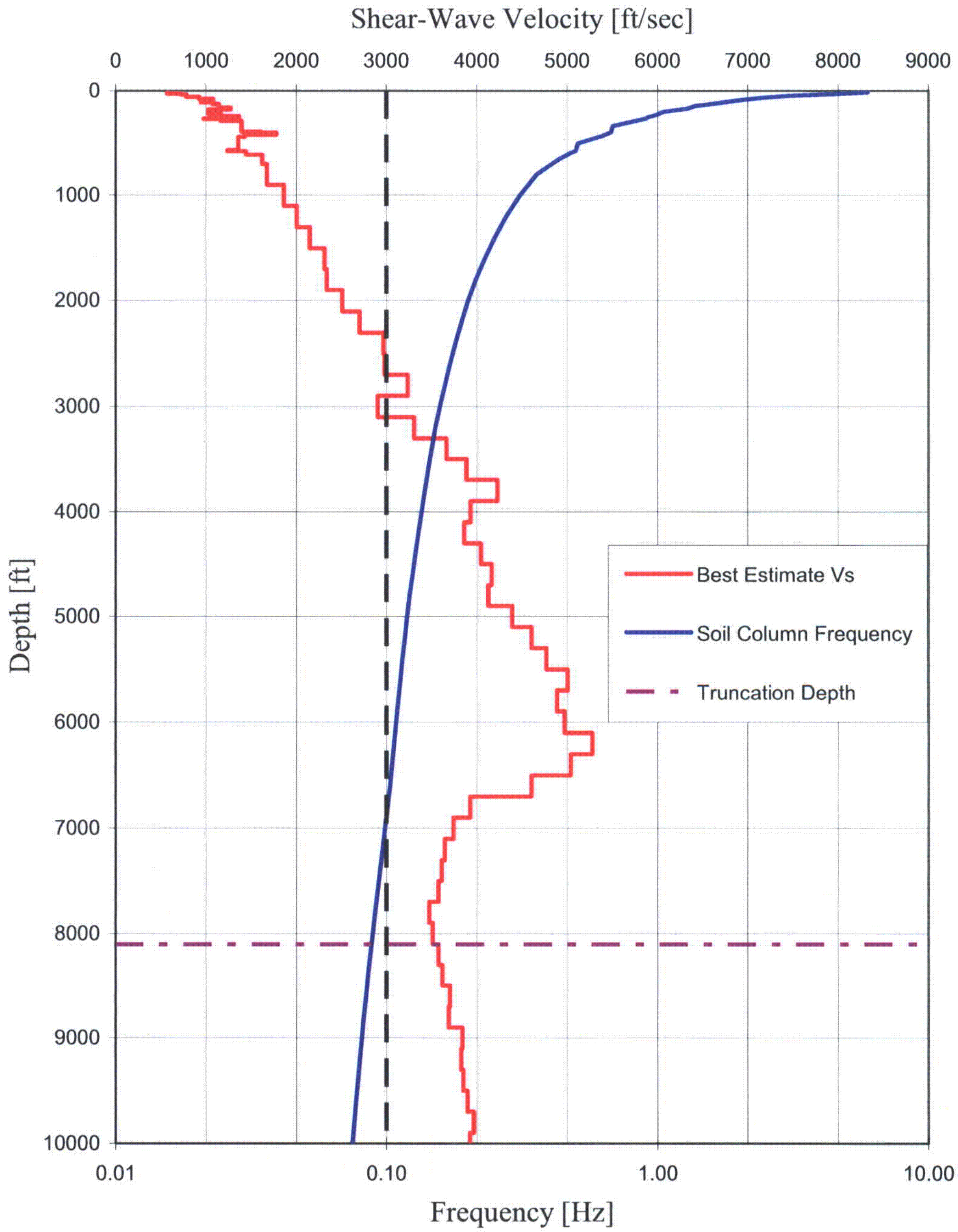


Figure 2.5S.2-35a Best Estimate Soil Column Frequency

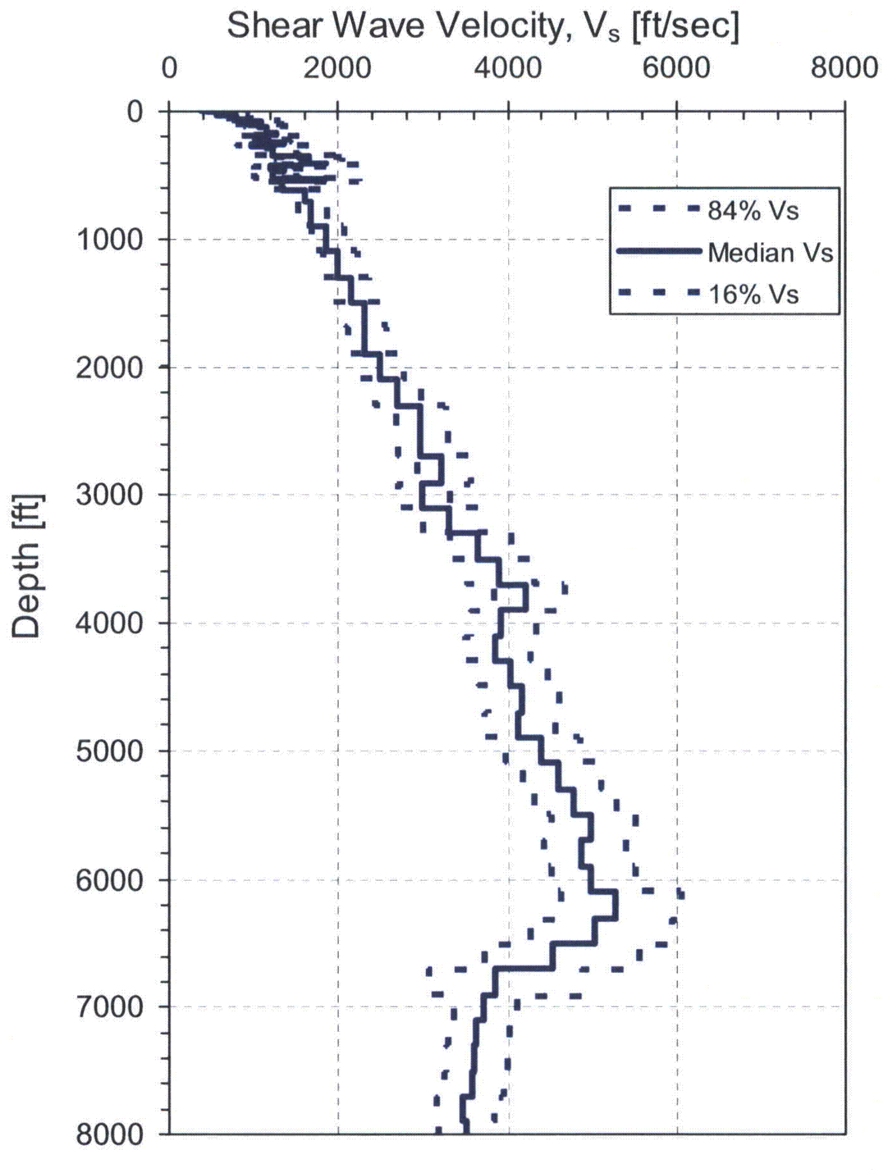


Figure 2.5S.2-35b Input Median Shear Wave Velocity Profile (+/- One Standard Deviation) for Randomization Process

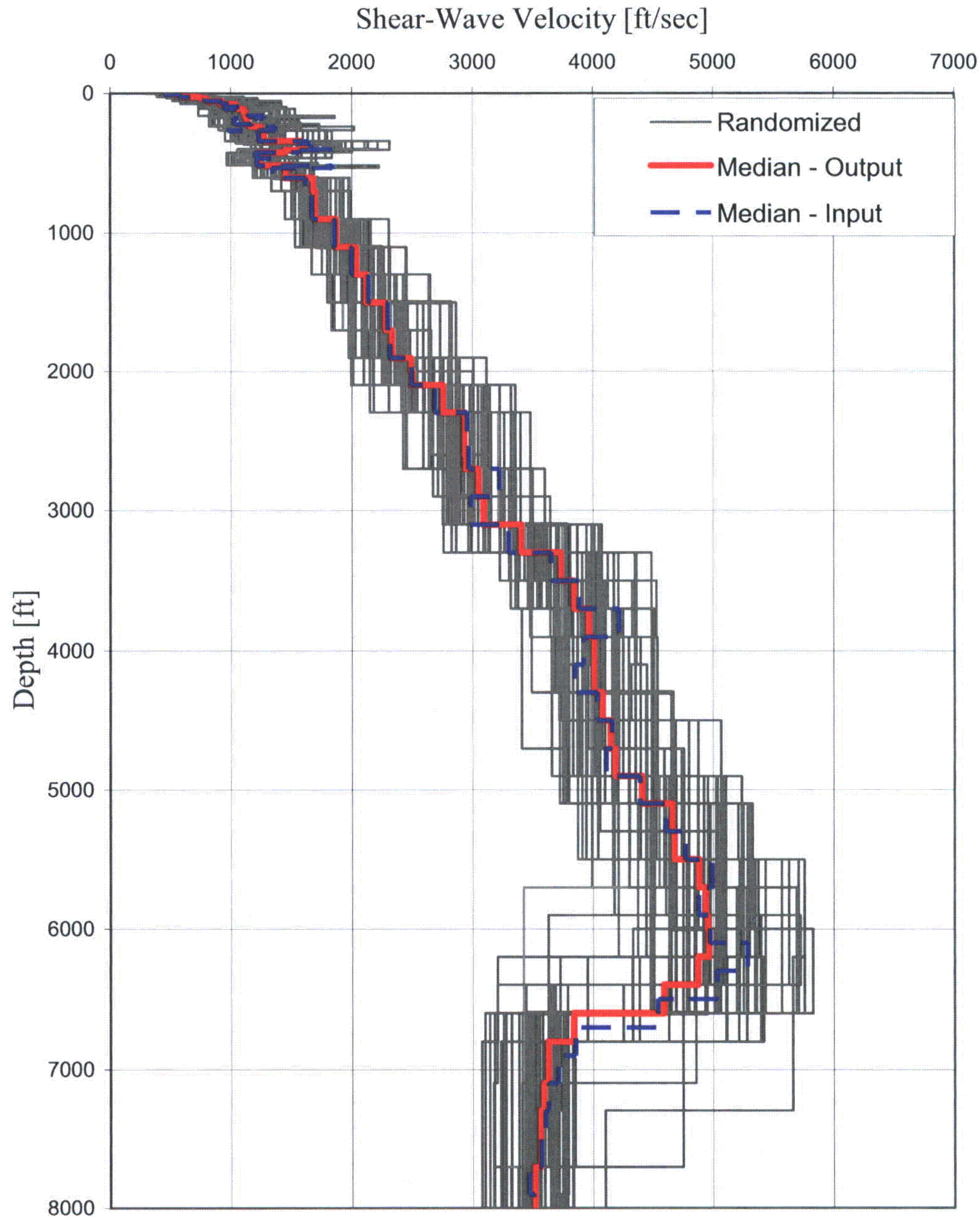


Figure 2.5S.2-36 Randomized Shear Wave Velocity Profiles, Median (Output) Shear Wave Velocity Profile and the Median (Input) Profile Used For Randomization

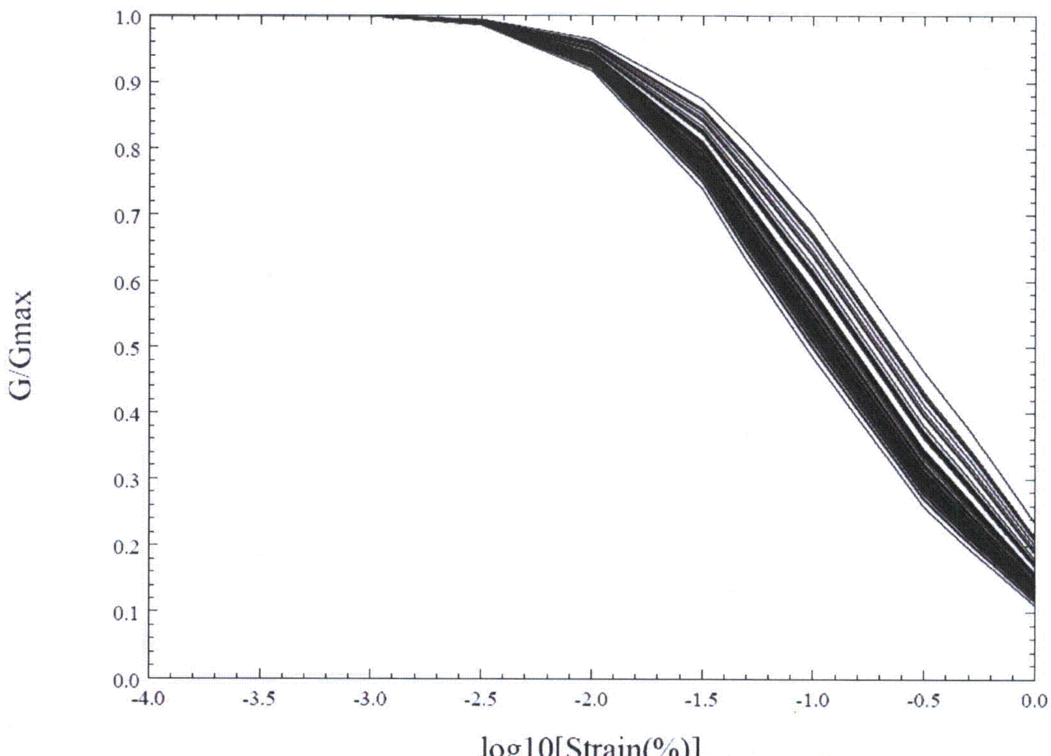


Figure 2.5S.2-37 Strain Dependent Degradation Curves for Stratum C

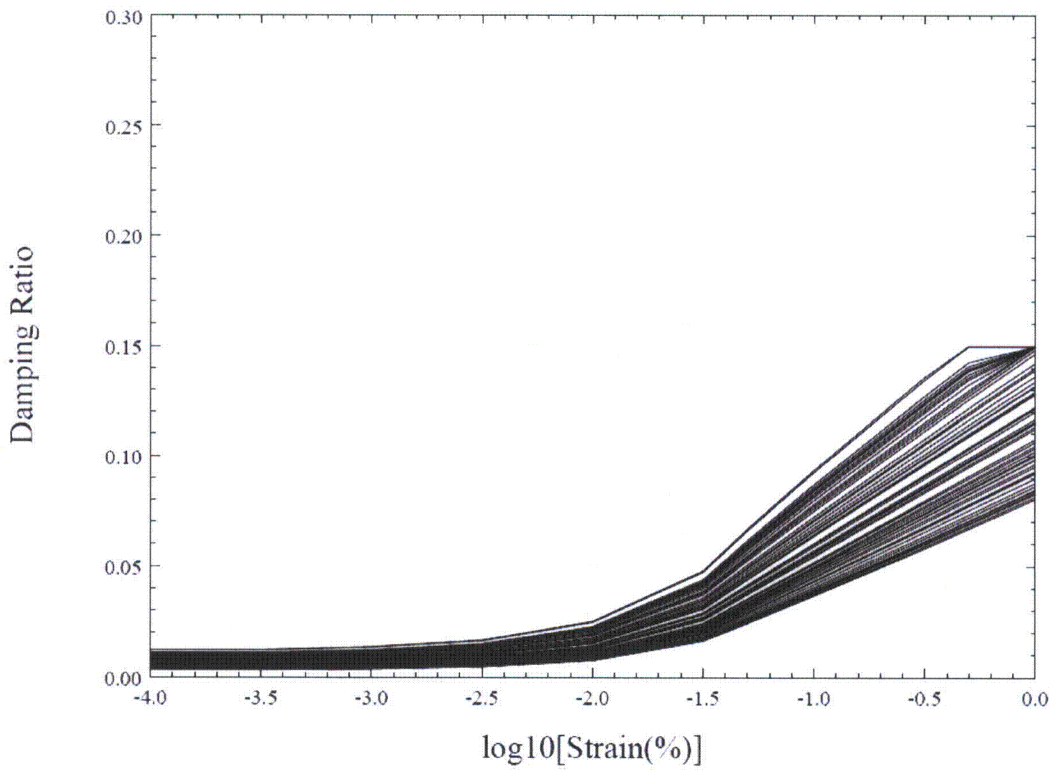


Figure 2.5S.2-38 Strain Dependent Damping Curves for Stratum C

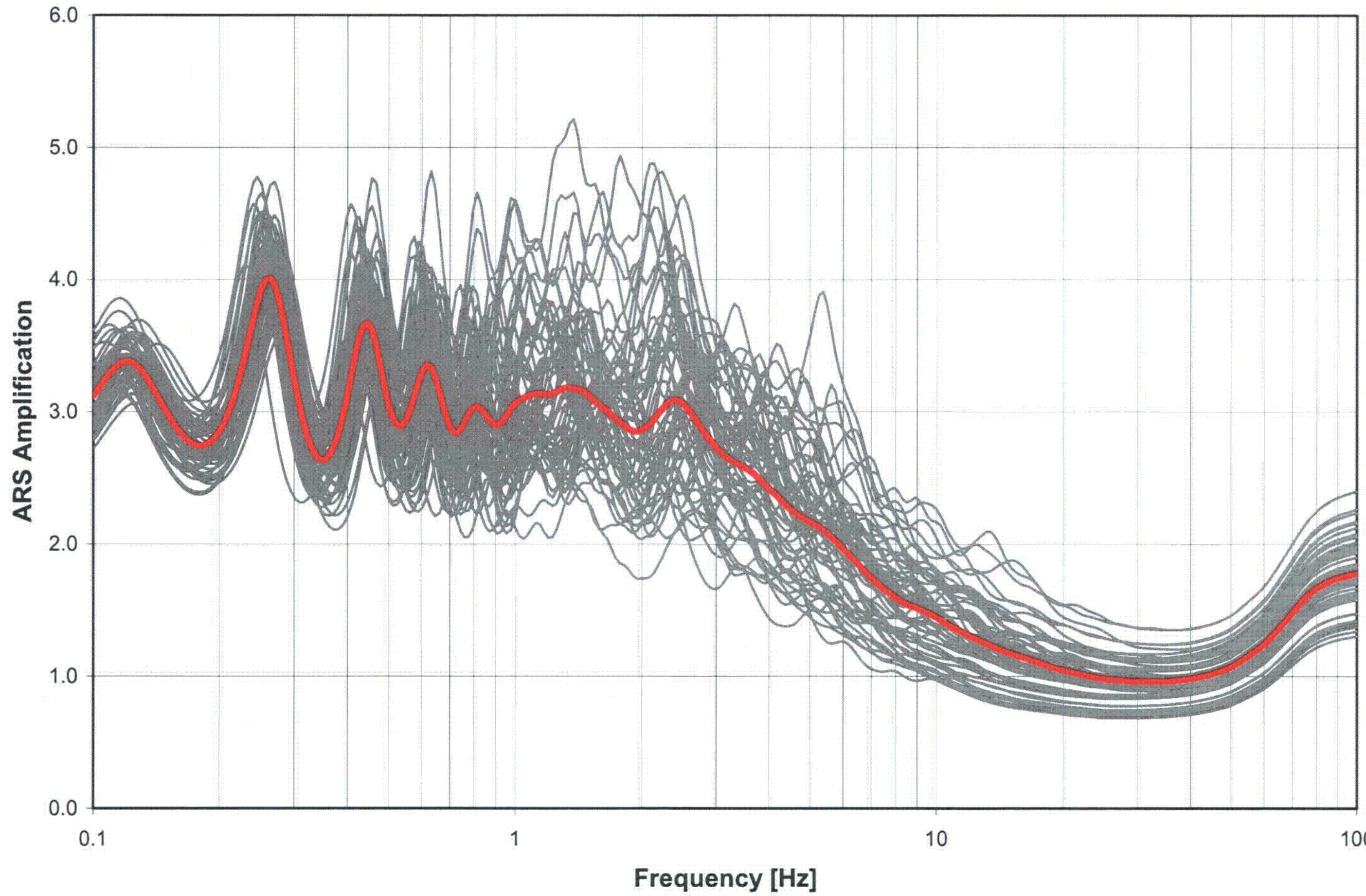


Figure 2.5S.2-39 Logarithmic Mean of Site Amplification Factors at Ground Surface from Analysis of the 60 Modified Random Profiles with the 10^{-4} LF Input Motion

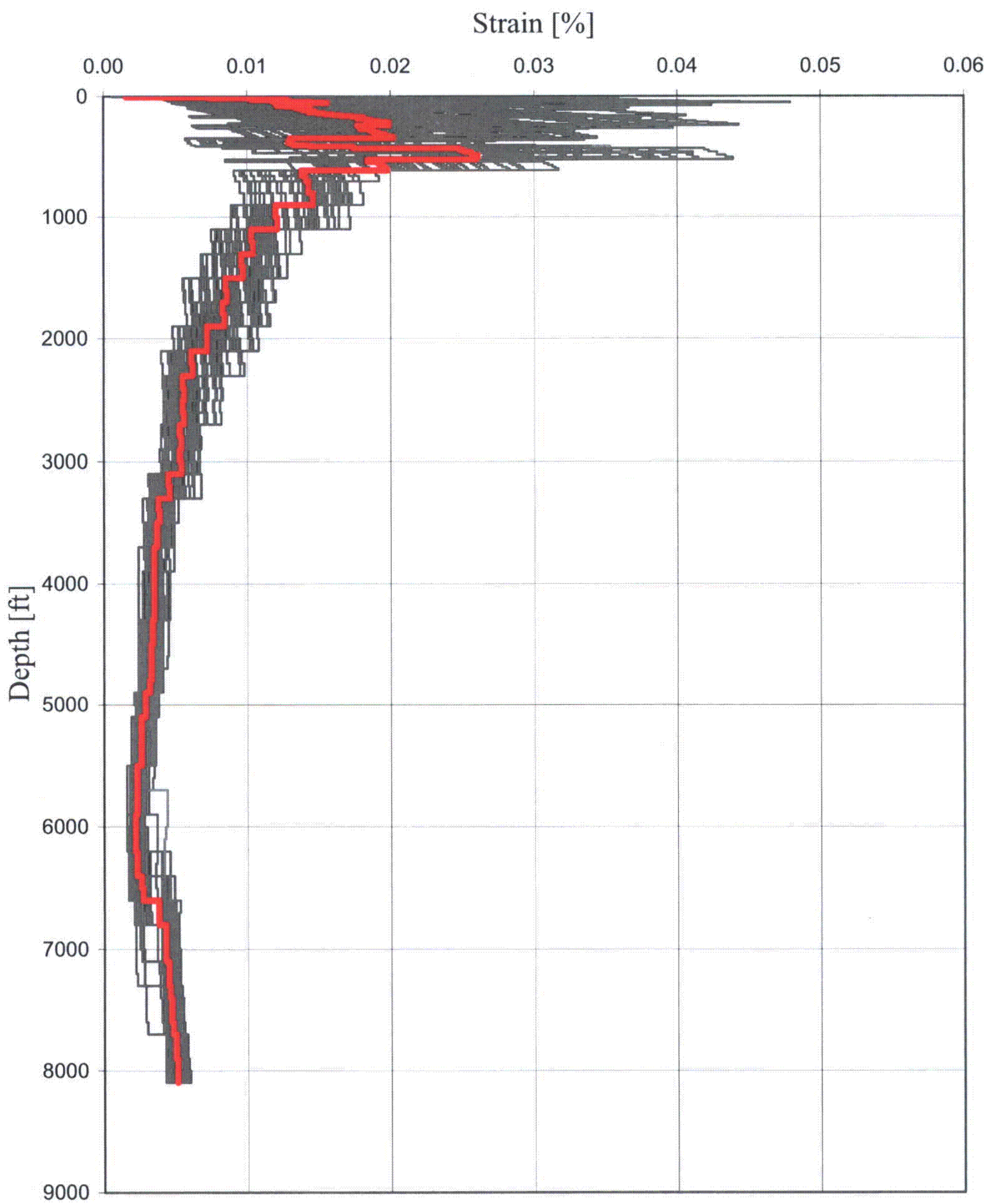


Figure 2.5S.2-40 Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the 10-4 LF Input Motion

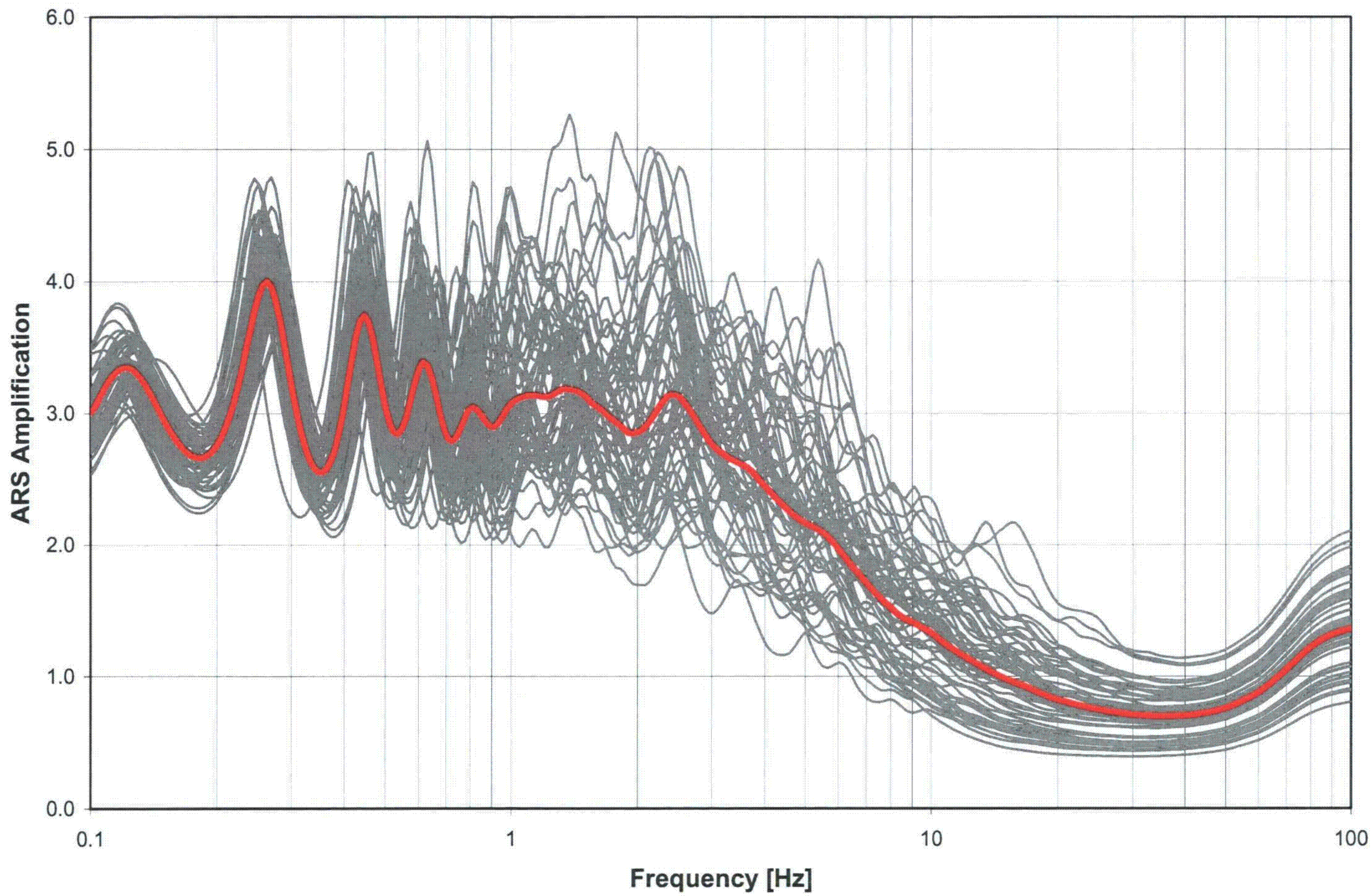


Figure 2.5S.2-41 Logarithmic Mean of Site Amplification Factors at Ground Surface from Analysis of the 60 Modified Random Profiles with the 10^{-4} HF Input Motion

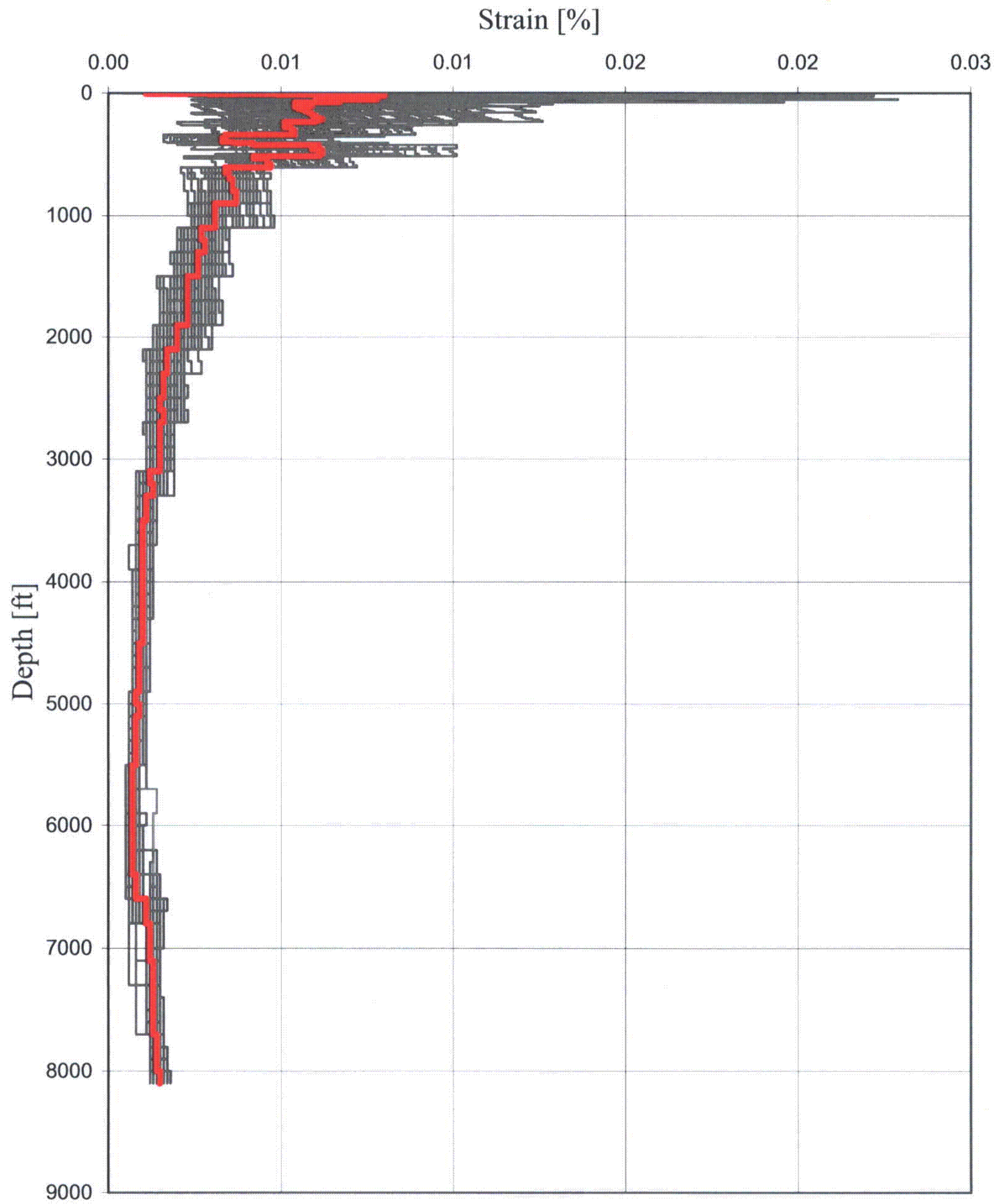


Figure 2.5S.2-42 Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the 10-4 HF Input Motion

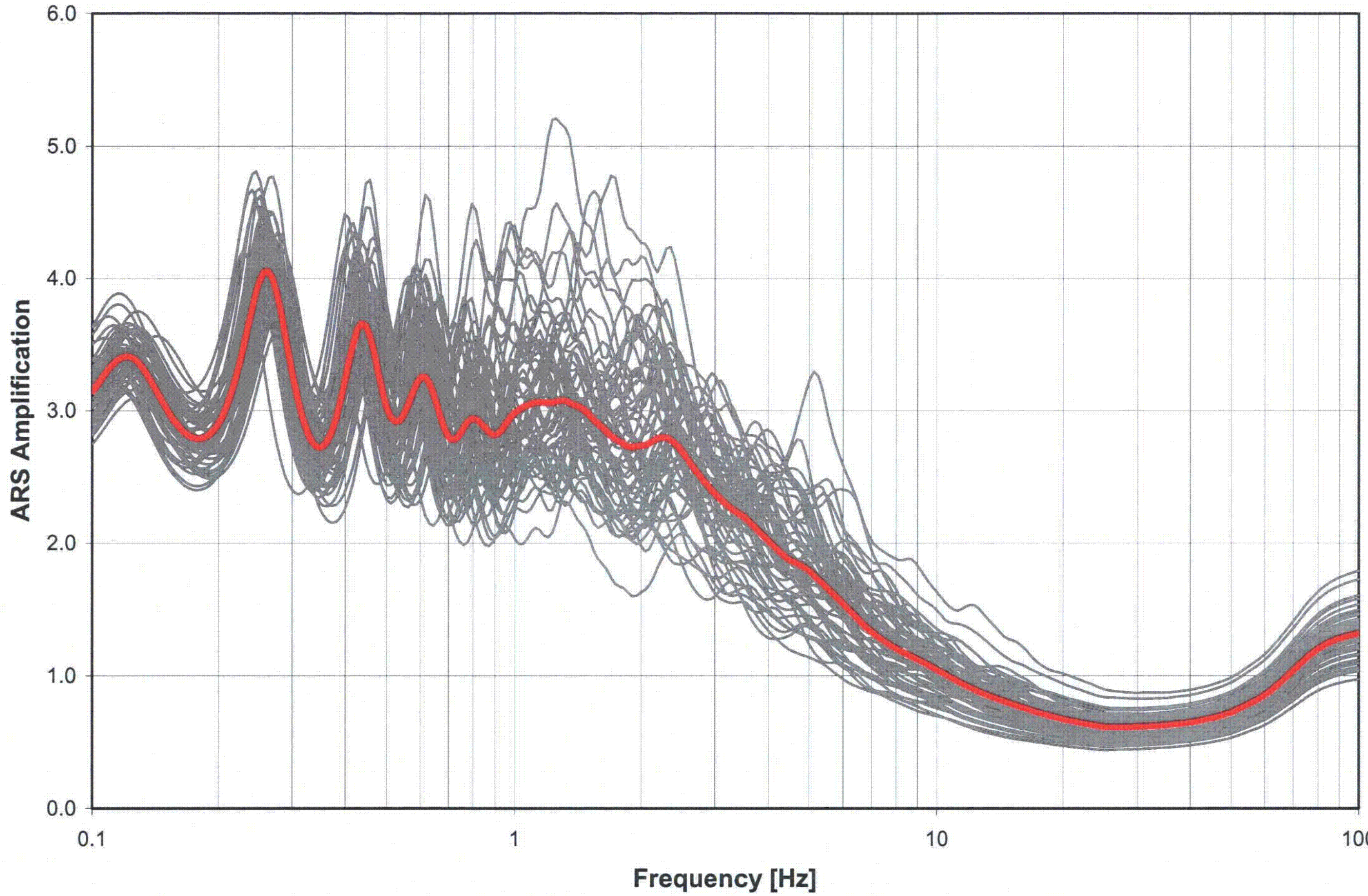


Figure 2.5S.2-43 Logarithmic Mean of Site Amplification Factors at Ground Surface from Analysis of the 60 Modified Random Profiles with the 10^{-5} LF Input Motion

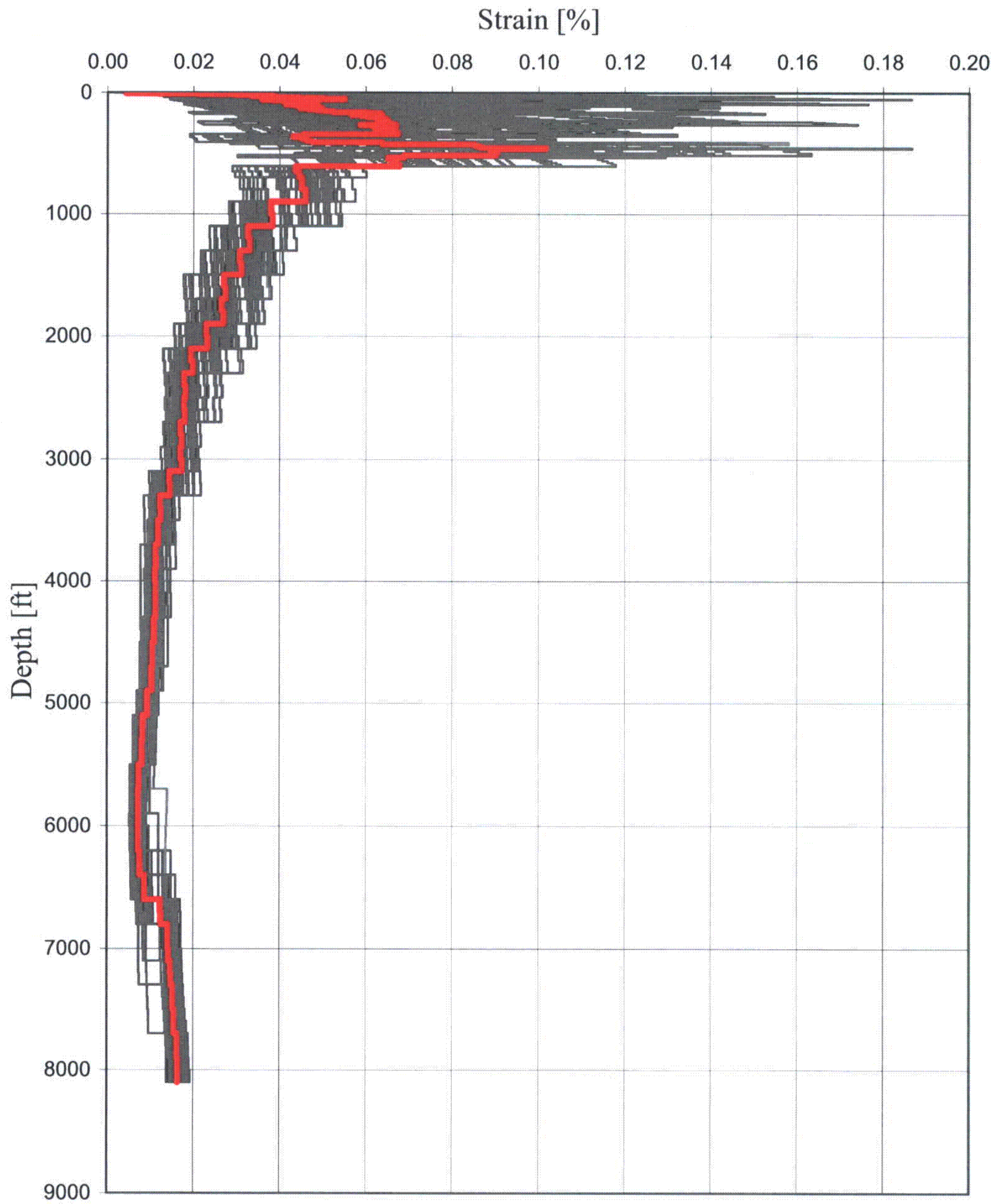


Figure 2.5S.2-44 Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the 10-5 LF Input Motion

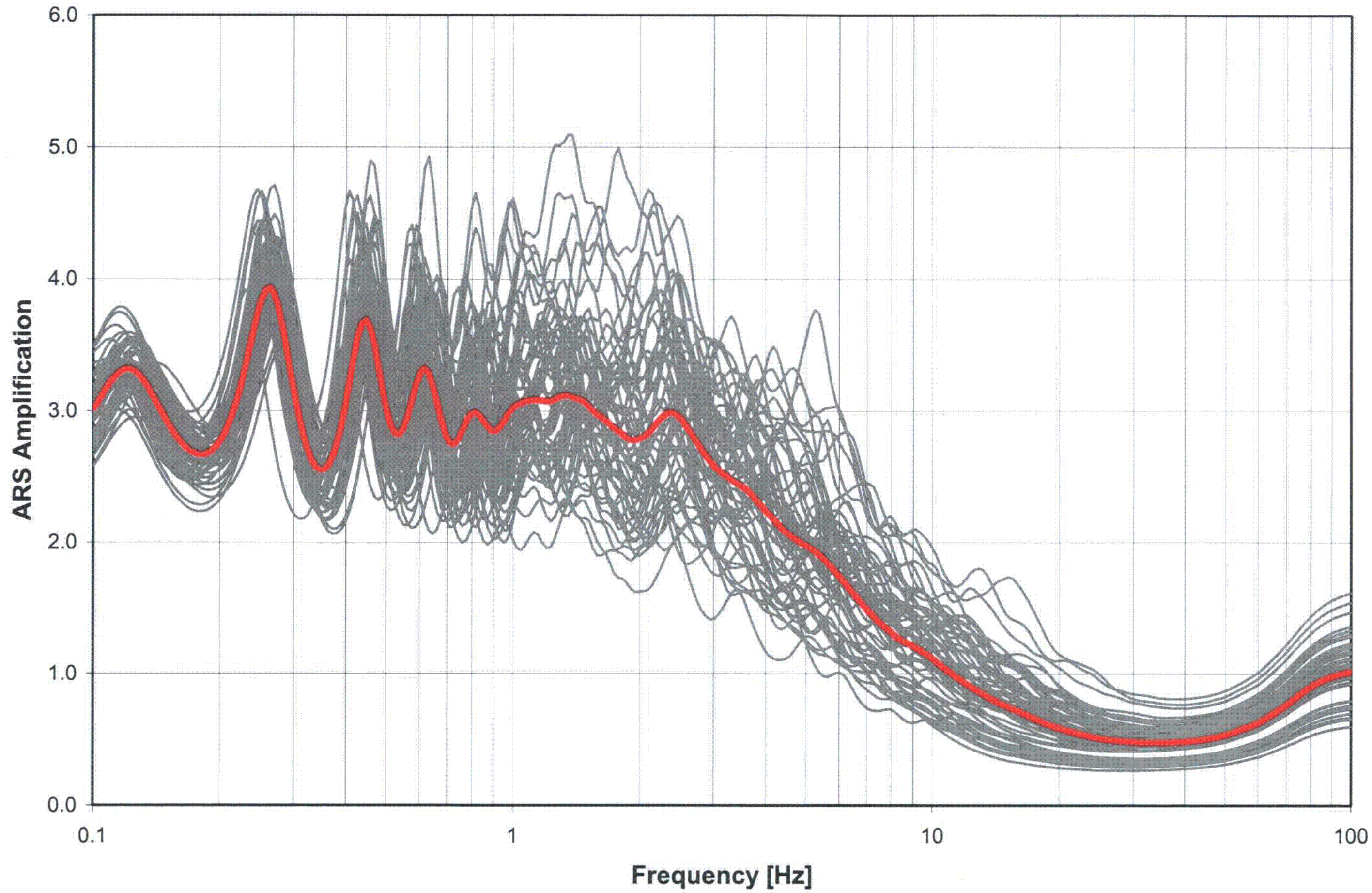


Figure 2.5S.2-45 Logarithmic Mean of Site Amplification Factors at Ground Surface from Analysis of the 60 Modified Random Profiles with the 10^{-5} HF Input Motion

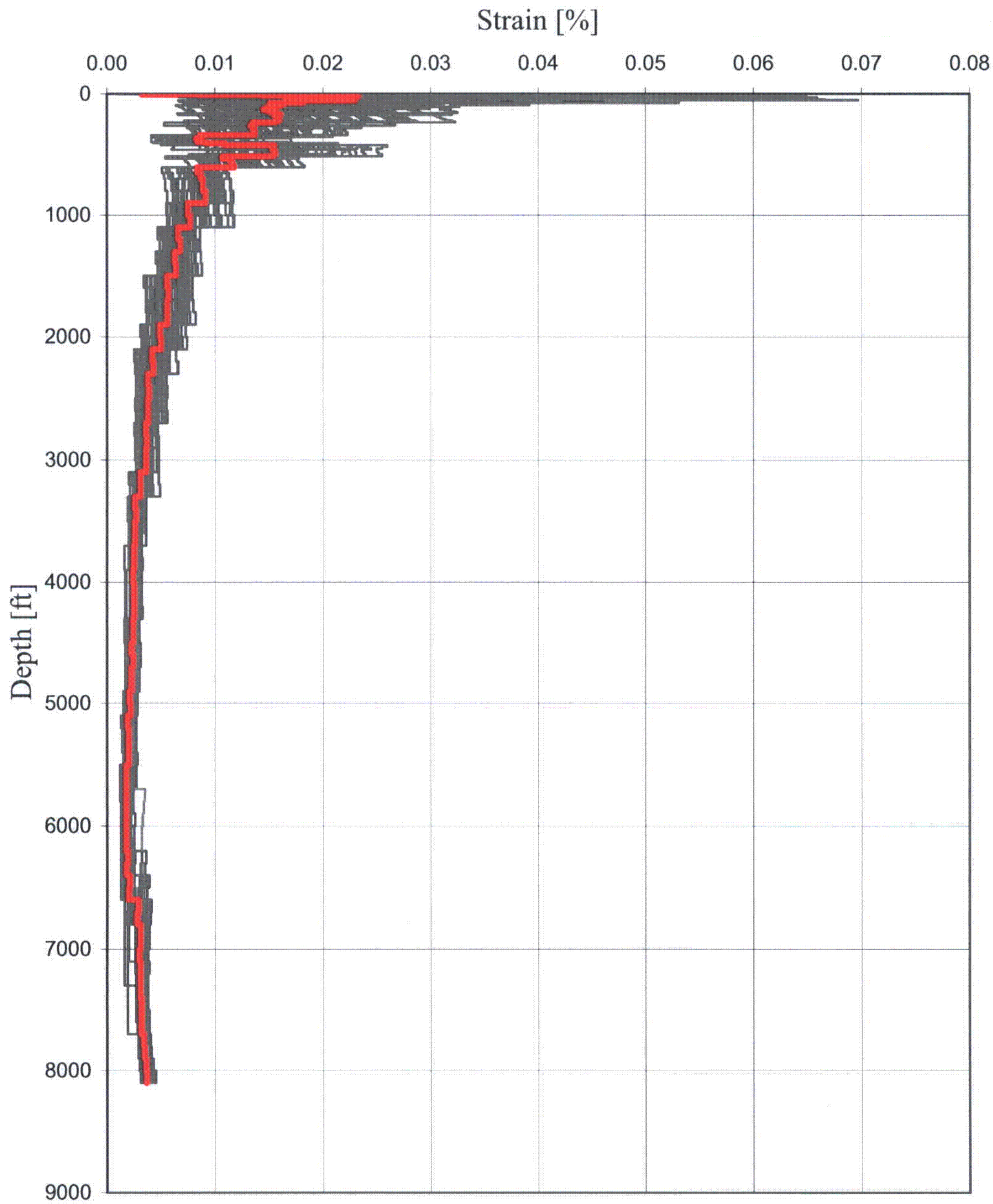


Figure 2.5S.2-46 Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the 10^{-5} HF Input Motion

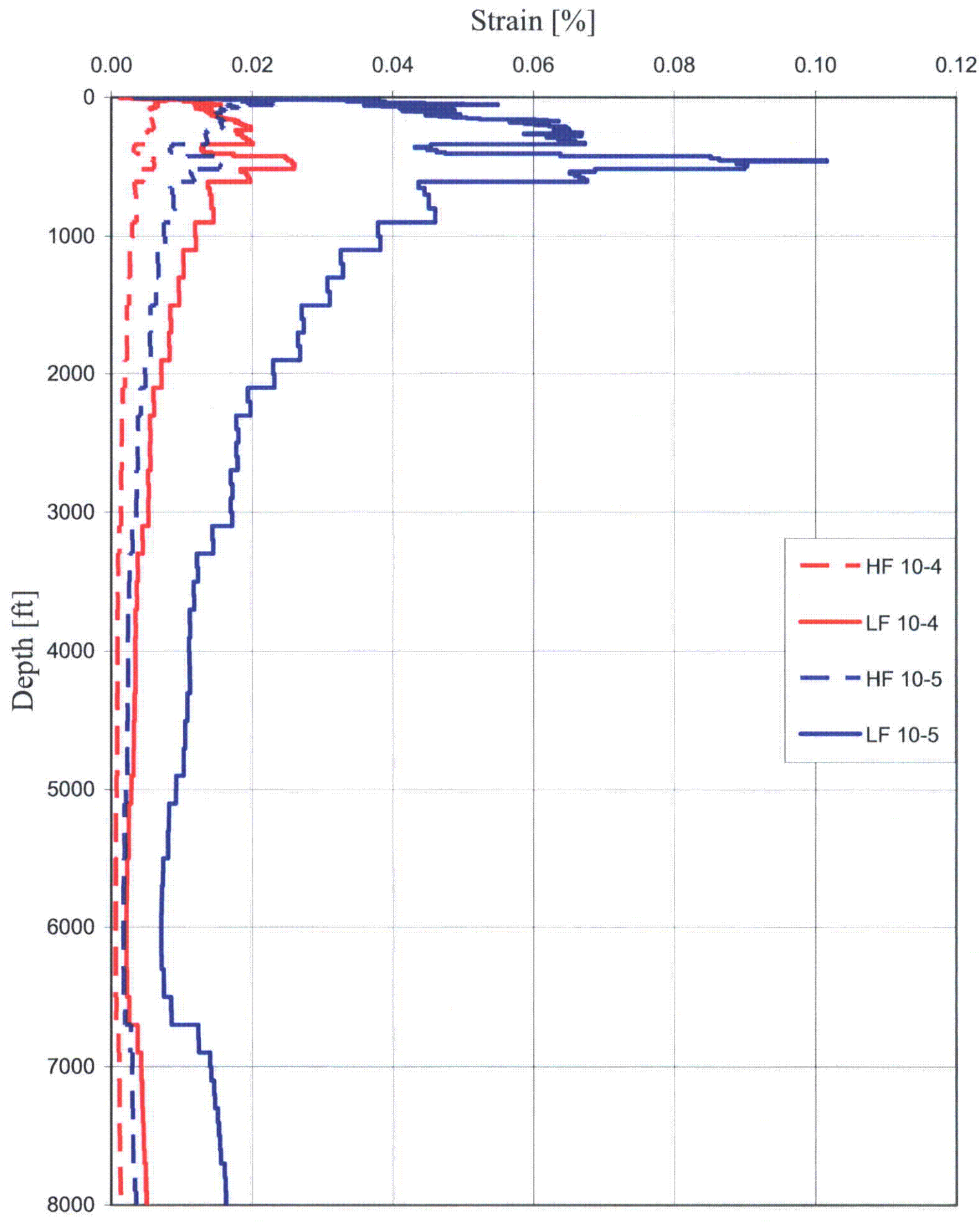


Figure 2.5S.2-47 Logarithmic Mean Maximum Strain Profiles

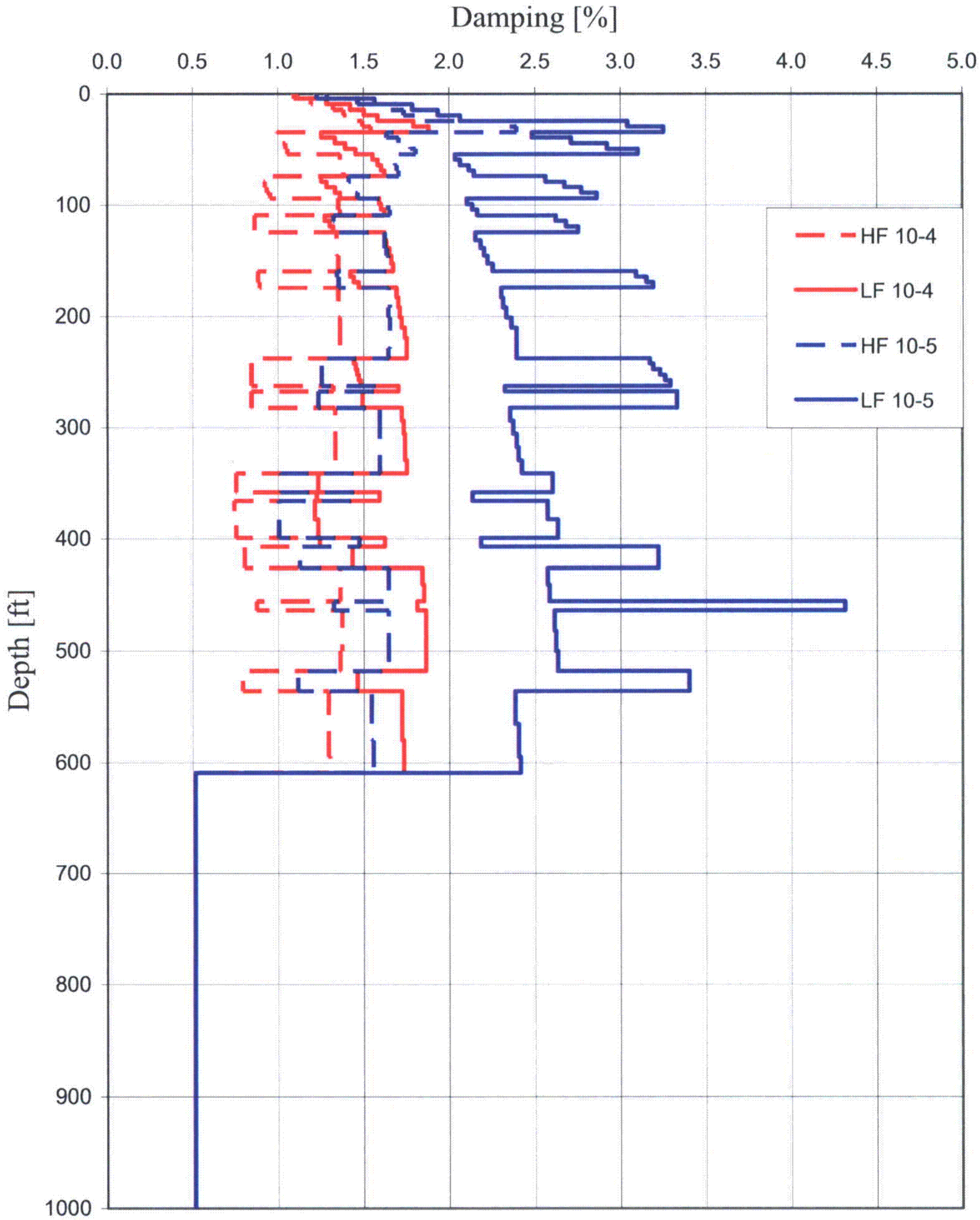


Figure 2.5S.2-48. Logarithmic Mean Profiles of Strain-Compatible Soil Damping (Top 1000 ft)

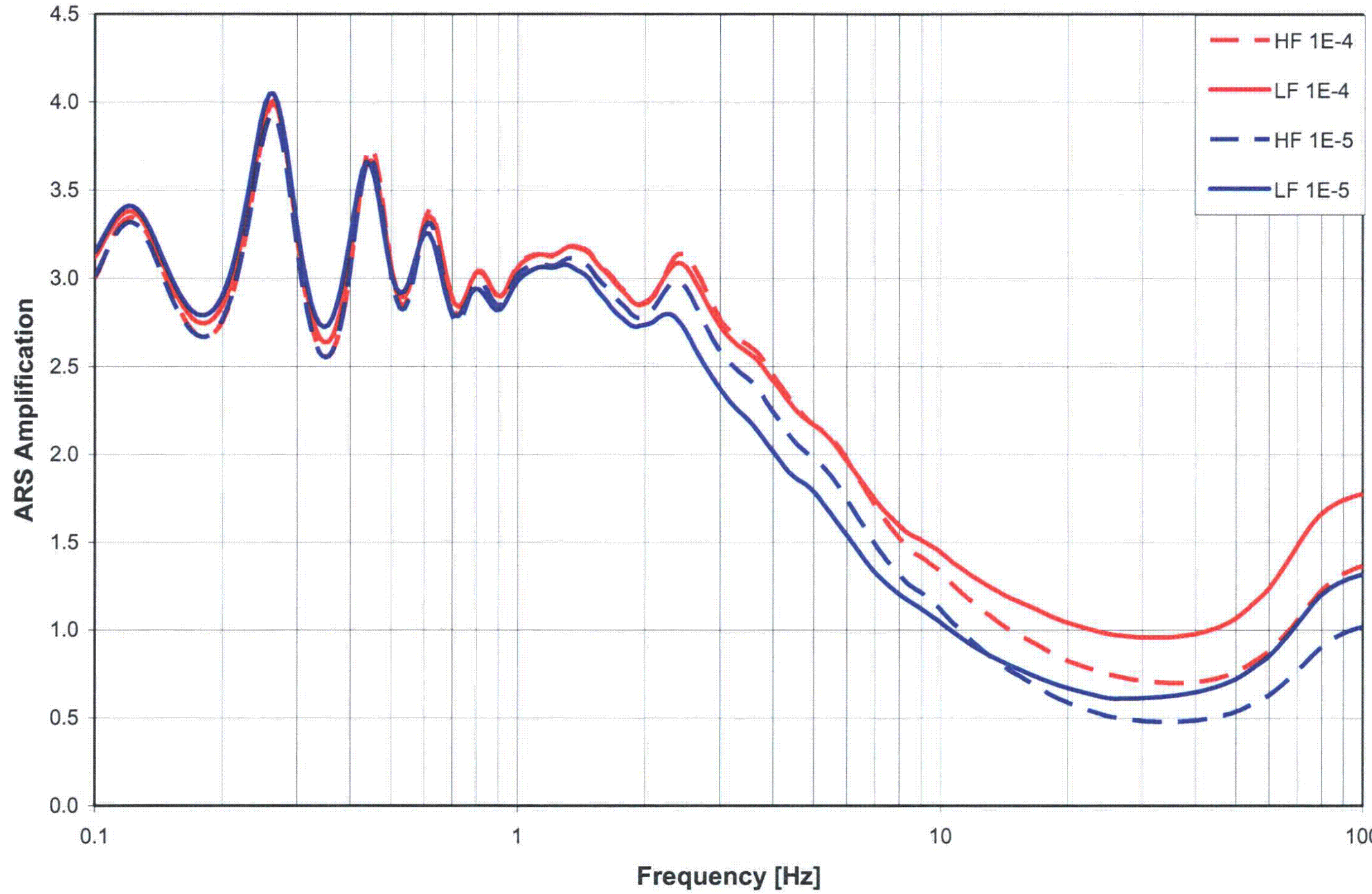


Figure 2.5S.2-49a Comparison of Log-Mean Soil amplification Factors at the Ground Surface Level for LF and HF 10^{-4} and 10^{-5} Input Motions

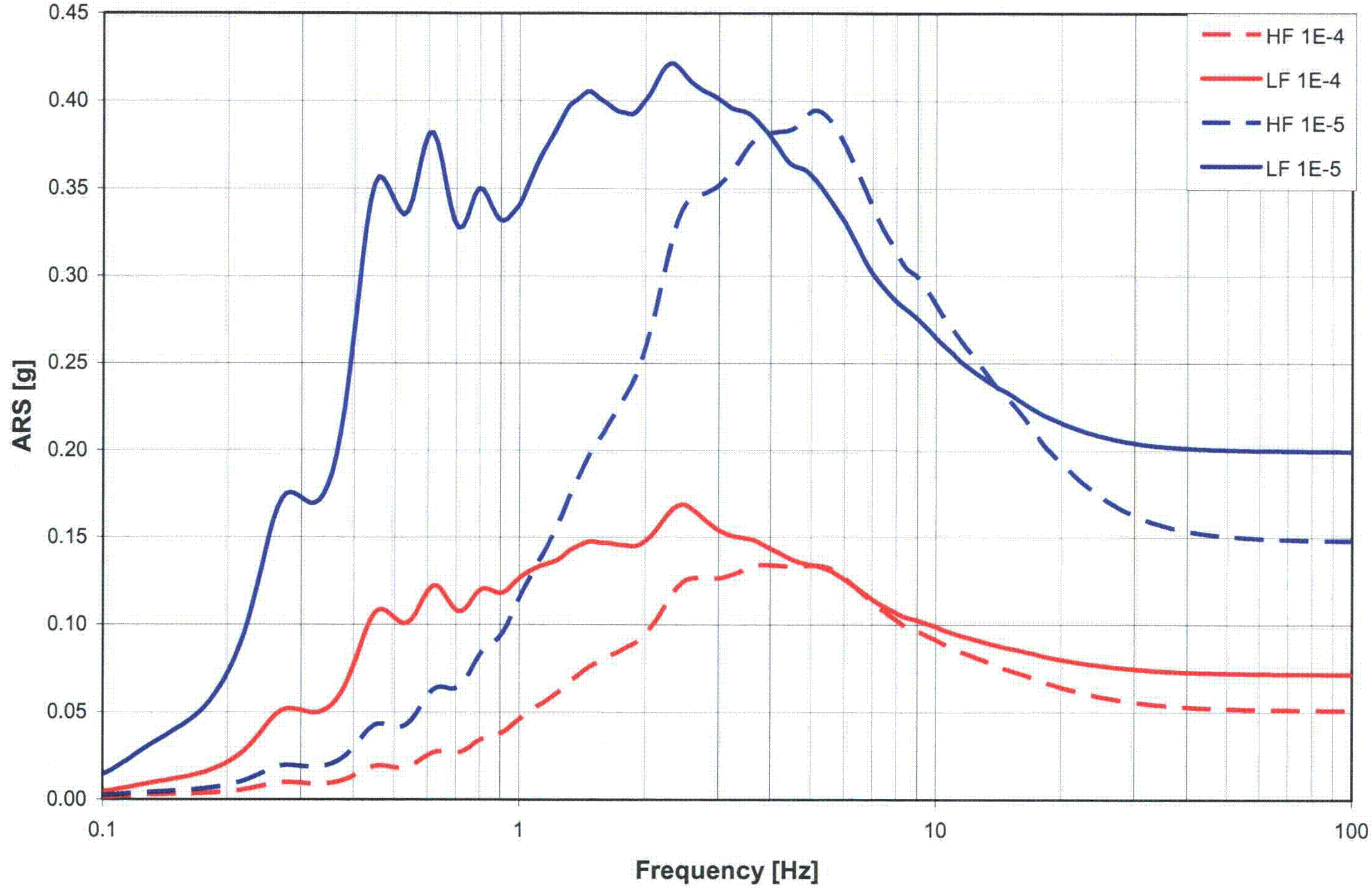


Figure 2.5S.2-49b Log-Mean ARS at the Ground Surface Level for LF and HF 10^{-4} and 10^{-5} Input Motions

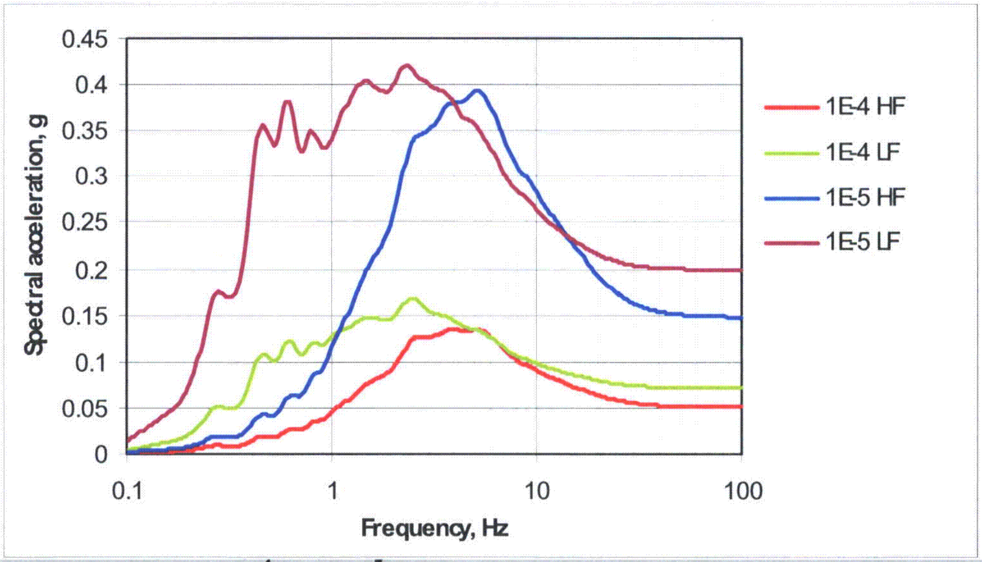


Figure 2.5S.2-50 Raw 10^{-4} and 10^{-5} Ground Surface UHRS for HF and LF Earthquakes

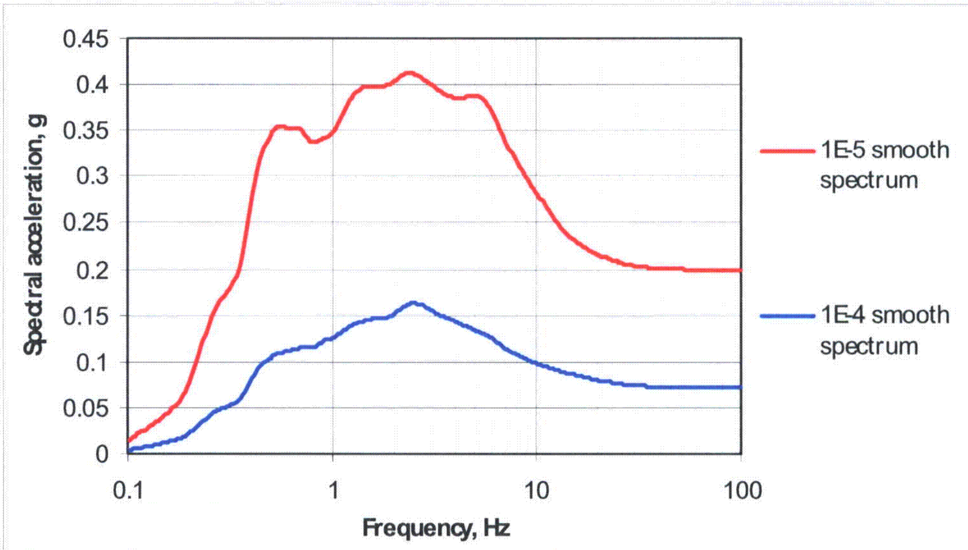


Figure 2.5S.2-51 Enveloped Smooth 10^{-4} and 10^{-5} Ground Surface UHRS for HF and LF Earthquakes

Table 2.5S.4-27 Summary of Shear Wave Velocities to 600 Feet Below Ground Surface

Stratum	Soil Type	Top El. [1] (Feet)	Bottom El. [1] (Feet)	Thickness (Feet)	Mid-Point Depth [2] (Feet)	Unit Weight (Feet)	PI (%)	Average s_u (ksf)	Maximum Vs (Ft/ sec)	Minimum Vs (Ft/ sec)	Average Vs (Ft/ sec)	Use Vs (Ft/ sec)	Average μ
A	Clay	30	10	20	14	124	~~35~~40	1.6	1,078	290	578	575	0.45
		30	25	5	6.5				670	330	451	450	0.43
		25	20	5	11.5				1,000	290	547	545	0.41
		20	15	5	16.5				1,078	370	601	600	0.47
		15	10	5	21.5				890	300	643	640	0.48
B	Silt	10	0	10	29	121	N/A	N/A	1,090	400	728	725	0.48
		10	5	5	26.5				1,060	400	707	705	0.48
		5	0	5	31.5				1,090	470	758	755	0.49
C	Sand	0	-20	20	44	122	N/A	N/A	1,430	440	786	785	0.49
		0	-5	5	36.5				1,430	440	756	755	0.49
		-5	-10	5	41.5				1,220	520	805	805	0.49
		-10	-15	5	46.5				1,070	520	828	825	0.49
		-15	-20	5	51.5				1,390	510	767	765	0.49
D	Clay	-20	-40	20	64	~~121~~ 122	40	3.0	1,550	540	929	925	0.48
		-20	-25	5	56.5				1,020	540	702	700	0.49
		-25	-30	5	61.5				1,331	580	849	845	0.49
		-30	-35	5	66.5				1,370	790	1,026	1,025	0.48
		-35	-40	5	71.5				1,550	870	1,204	1,200	0.48
E	Sand	-40	-60	20	84	~~122~~ 123	N/A	N/A	1,627	720	1,082	1,080	0.48
		-40	-45	5	76.5				1,430	940	1,196	1,195	0.48
		-45	-50	5	81.5				1,627	750	1,103	1,100	0.48
		-50	-55	5	86.5				1,250	770	1,038	1,035	0.48
		-55	-60	5	91.5				1,203	720	961	960	0.48

Table 2.5S.4-27 Summary of Shear Wave Velocities to 600 Feet Below Ground Surface (Continued)

Stratum	Soil Type	Top El. [1] (Feet)	Bottom El. [1] (Feet)	Thickness (Feet)	Mid-Point Depth [2] (Feet)	Unit Weight (Feet)	PI (%)	Average s_u (ksf)	Maximum V_s (Ft/ sec)	Minimum V_s (Ft/ sec)	Average V_s (Ft/ sec)	Use V_s (Ft/ sec)	Average μ
F	Clay	-60	-75	15	101.5	125	40	~~3.2~~3.3	1,280	720	947	945	0.48
		-60	-65	5	96.5				1,280	720	905	905	0.49
		-65	-70	5	101.5				1,260	830	956	955	0.48
		-70	-75	5	106.5				1,270	780	990	990	0.48
H	Sand	-75	-90	15	116.5	~~128~~ 125	N/A	N/A	2,190	730	1,077	1,075	0.48
		-75	-80	5	111.5				1,890	740	1,078	1,075	0.48
		-80	-85	5	116.5				2,190	730	1,081	1,080	0.48
		-85	-90	5	121.5				1,814	750	1,071	1,070	0.48
J Clay 1	Clay	-90	-125	35	141.5	125	35	~~3.5~~3.4	1,880	640	1,148	1,145	0.48
		-90	-95	5	126.5				1,350	760	981	980	0.48
		-95	-100	5	131.5				1,410	720	1,057	1,055	0.48
		-100	-105	5	136.5				1,470	640	1,068	1,065	0.48
		-105	-110	5	141.5				1,780	910	1,307	1,305	0.47
		-110	-115	5	146.5				1,880	1,000	1,337	1,335	0.47
		-115	-120	5	151.5				1,610	1,090	1,260	1,260	0.47
		-120	-125	5	156.5				1,720	680	1,178	1,175	0.48
J Sand	Sand/ Silt	-125	-140	15	166.5	125	N/A	N/A	3,210	720	1,275	1,275	0.47
		-125	-130	5	161.5				2,270	840	1,299	1,295	0.47
		-130	-135	5	166.5				2,560	840	1,277	1,275	0.47
		-135	-140	5	171.5				3,210	720	1,244	1,240	0.47

Table 2.5S.4-27 Summary of Shear Wave Velocities to 600 Feet Below Ground Surface (Continued)

Stratum	Soil Type	Top El. [1] (Feet)	Bottom El. [1] (Feet)	Thickness (Feet)	Mid-Point Depth [2] (Feet)	Unit Weight (Feet)	PI (%)	Average s_u (ksf)	Maximum V_s (Ft/ sec)	Minimum V_s (Ft/ sec)	Average V_s (Ft/ sec)	Use V_s (Ft/ sec)	Average μ
J Clay 2	Clay	-140	-185	45	196.5	125	35	~~3.5~~ 3.4	1,690	700	1,033	1,030	0.48
		-140	-145	5	176.5				1,690	930	1,235	1,235	0.47
		-145	-150	5	181.5				1,260	960	1,036	1,035	0.48
		-150	-155	5	186.5				1,390	870	1,059	1,055	0.48
		-155	-160	5	191.5				1,360	700	1,034	1,030	0.48
		-160	-165	5	196.5				1,440	830	1,037	1,035	0.48
		-165	-170	5	201.5				1,290	800	965	965	0.48
		-170	-175	5	206.5				1,330	770	966	965	0.48
		-175	-180	5	211.5				1,180	760	943	940	0.48
		-180	-185	5	216.5				1,220	670	938	935	0.48
K Clay	Clay	-185	-203	18	228.0	~~129~~ 124	25	3.0	1,650	730	1,170	1,170	0.48
		-185	-190	5	221.5				1,420	820	1,111	1,110	0.48
		-190	-195	5	226.5				1,560	810	1,117	1,115	0.48
		-195	-200	5	231.5				1,320	730	1,075	1,075	0.48
		-200	-203	3	235.5				1,650	1,430	1,510	1,510	0.47
K Sand/ Silt	Sand/ Silt	-203	-228	25	249.5	127	N/A	N/A	2,010	940	1,371	1,370	0.47
		-203	-208	5	239.5				1,630	1,140	1,341	1,340	0.47
		-208	-213	5	244.5				2,010	1,100	1,573	1,570	0.46
		-213	-218	5	249.5				1,630	1,070	1,350	1,350	0.47
		-218	-223	5	254.5				1,490	1,230	1,346	1,345	0.47
		-223	-228	5	259.5				1,620	940	1,240	1,240	0.47
L	Clay	-228	-233	5	264.5	~~129~~124	50	3.0	1,410	750	979	975	0.48

Table 2.5S.4-27 Summary of Shear Wave Velocities to 600 Feet Below Ground Surface (Continued)

Stratum	Soil Type	Top El. [1] (Feet)	Bottom El. [1] (Feet)	Thickness (Feet)	Mid-Point Depth [2] (Feet)	Unit Weight (Feet)	PI (%)	Average s_u (ksf)	Maximum V_s (Ft/ sec)	Minimum V_s (Ft/ sec)	Average V_s (Ft/ sec)	Use V_s (Ft/ sec)	Average μ
M	Sand	-233	-248	15	274.5	127	N/A	N/A	1,600	800	1,165	1,165	0.47
		-233	-238	5	269.5				1,600	1,130	1,343	1,340	0.47
		-238	-243	5	274.5				1,170	860	1,018	1,015	0.48
		-243	-248	5	279.5				1,400	800	1,110	1,110	0.48
N Clay 1	Clay	-248	-307	59	311.5	~~121~~123	45	3.0	1,760	700	1,234	1,230	0.47
		-248	-253	5	284.5				1,180	700	957	955	0.48
		-253	-258	5	289.5				1,670	1,370	1,501	1,500	0.47
		-258	-263	5	294.5				1,650	1,320	1,510	1,510	0.46
		-263	-268	5	299.5				1,760	1,010	1,293	1,290	0.47
		-268	-273	5	304.5				1,100	980	1,053	1,050	0.48
		-273	-278	5	309.5				1,200	900	1,037	1,035	0.48
		-278	-283	5	314.5				1,160	830	966	965	0.48
		-283	-288	5	319.5				1,260	1,070	1,112	1,110	0.48
		-288	-293	5	324.5				1,570	1,210	1,408	1,405	0.47
		-293	-298	5	329.5				1,640	1,470	1,522	1,520	0.46
		-298	-303	5	334.5				1,640	1,110	1,362	1,360	0.47
		-303	-307	4	339.0				1,470	940	1,140	1,140	0.48
N Sand 1	Sand	-307	-324	17	349.5	128	N/A	N/A	2,430	1,390	1,646	1,645	0.46
		-307	-312	5	343.5				1,650	1,390	1,535	1,535	0.46
		-312	-317	5	348.5				2,430	1,540	1,843	1,840	0.45
		-317	-322	5	353.5				1,720	1,560	1,618	1,615	0.46
		-322	-324	2	357.0				1,650	1,470	1,550	1,550	0.46

Table 2.5S.4-27 Summary of Shear Wave Velocities to 600 Feet Below Ground Surface (Continued)

Stratum	Soil Type	Top El. [1] (Feet)	Bottom El. [1] (Feet)	Thickness (Feet)	Mid-Point Depth [2] (Feet)	Unit Weight (Feet)	PI (%)	Average s_u (ksf)	Maximum V_s (Ft/ sec)	Minimum V_s (Ft/ sec)	Average V_s (Ft/ sec)	Use V_s (Ft/ sec)	Average μ
N Clay 2	Clay	-324	-332	8	362.0				2,220	870	1,537	1,535	0.46
		-324	-329	5	360.5	~~121~~123	45	3.0	2,220	1,460	1,704	1,700	0.45
		-329	-332	3	364.5				1,670	870	1,328	1,325	0.47
N Sand 2	Sand	-332	-365	33	382.5				2,360	1,380	1,666	1,665	0.45
		-332	-337	5	368.5				1,790	1,380	1,642	1,640	0.46
		-337	-342	5	373.5				1,810	1,630	1,685	1,685	0.45
		-342	-347	5	378.5	128	N/A	N/A	1,690	1,610	1,649	1,645	0.46
		-347	-352	5	383.5				1,750	1,580	1,638	1,635	0.45
		-352	-357	5	388.5				1,620	1,470	1,561	1,560	0.46
		-357	-362	5	393.5				1,960	1,480	1,665	1,665	0.45
		-362	-365	3	397.5				2,360	2,020	2,190	2,190	0.43
N Clay 3	Clay	-365	-373	8	403.0				2,540	1,220	1,851	1,850	0.45
		-365	-370	5	401.5	~~121~~123	45	3.0	2,540	1,220	2,053	2,050	0.43
		-370	-373	3	405.5				1,680	1,430	1,498	1,495	0.47
N Sand 3	Sand	-373	-392	19	416.5				2,060	1,360	1,572	1,570	0.46
		-373	-378	5	409.5				2,060	1,410	1,682	1,680	0.46
		-378	-383	5	414.5	128	N/A	N/A	1,710	1,460	1,577	1,575	0.46
		-383	-388	5	419.5				1,630	1,360	1,475	1,475	0.46
		-388	-392	4	424.0				1,630	1,460	1,552	1,550	0.46

Table 2.5S.4-27 Summary of Shear Wave Velocities to 600 Feet Below Ground Surface (Continued)

Stratum	Soil Type	Top El. [1] (Feet)	Bottom El. [1] (Feet)	Thickness (Feet)	Mid-Point Depth [2] (Feet)	Unit Weight (Feet)	PI (%)	Average s_u (ksf)	Maximum V_s (Ft/ sec)	Minimum V_s (Ft/ sec)	Average V_s (Ft/ sec)	Use V_s (Ft/ sec)	Average μ
N Clay 4	Clay	-392	-422	30	441.0	~~121~~123	45	3.0	1,810	910	1,207	1,205	0.47
		-392	-397	5	428.5				1,810	1,330	1,537	1,535	0.46
		-397	-402	5	433.5				1,260	1,040	1,115	1,115	0.48
		-402	-407	5	438.5				1,390	1,050	1,190	1,190	0.48
		-407	-412	5	443.5				1,400	1,040	1,260	1,260	0.47
		-412	-417	5	448.5				1,380	1,000	1,167	1,165	0.48
		-417	-422	5	453.5				1,100	910	975	975	0.48
N Sand 4	Sand	-422	-430	8	460.0	128	N/A	N/A	1,720	870	1,359	1,355	0.47
		-422	-427	5	458.5				1,720	870	1,292	1,290	0.47
		-427	-430	3	462.5				1,580	1,370	1,460	1,460	0.46
N Clay 5	Clay	-430	-484	54	491.0	~~121~~123	45	3.0	1,820	970	1,223	1,220	0.48
		-430	-435	5	466.5				1,540	1,000	1,260	1,260	0.47
		-435	-440	5	471.5				1,460	970	1,184	1,180	0.48
		-440	-445	5	476.5				1,050	1,030	1,040	1,040	0.48
		-445	-450	5	481.5				1,060	1,000	1,040	1,040	0.48
		-450	-455	5	486.5				1,460	1,080	1,273	1,270	0.48
		-455	-460	5	491.5				1,280	1,110	1,167	1,165	0.48
		-460	-465	5	496.5				1,130	1,080	1,110	1,110	0.48
		-465	-470	5	501.5				1,190	1,170	1,180	1,180	0.48
		-470	-475	5	506.5				1,280	1,110	1,180	1,180	0.48
		-475	-480	5	511.5				1,420	1,190	1,330	1,330	0.47
		-478	-484	4	516.0				1,820	1,750	1,785	1,785	0.46

Table 2.5S.4-27 Summary of Shear Wave Velocities to 600 Feet Below Ground Surface (Continued)

Stratum	Soil Type	Top El. [1] (Feet)	Bottom El. [1] (Feet)	Thickness (Feet)	Mid-Point Depth [2] (Feet)	Unit Weight (Feet)	PI (%)	Average s_u (ksf)	Maximum V_s (Ft/ sec)	Minimum V_s (Ft/ sec)	Average V_s (Ft/ sec)	Use V_s (Ft/ sec)	Average μ
N Sand 5	Sand	-484	-502	18	527.0	128	N/A	N/A	2,250	1,540	1,848	1,845	0.45
		-484	-489	5	520.5				2,250	1,790	1,972	1,970	0.44
		-489	-494	5	525.5				2,080	1,720	1,910	1,910	0.44
		-494	-499	5	530.5				2,020	1,540	1,735	1,735	0.45
		-499	-502	3	534.5				1,800	1,740	1,770	1,770	0.45
N Clay 6	Clay	-502	-575	73	572.5	~~121~~123	45	3.0	1,880	1,120	1,347	1,345	0.47
		-502	-507	5	538.5				1,880	1,620	1,750	1,750	0.45
		-507	-512	5	543.5				1,250	1,180	1,217	1,217	0.48
		-512	-517	5	548.5				1,200	1,120	1,170	1,170	0.48
		-517	-522	5	553.5				1,270	1,140	1,190	1,190	0.48
		-522	-527	5	558.5				1,330	1,320	1,323	1,323	0.47
		-527	-532	5	563.5				1,190	1,130	1,160	1,160	0.48
		-532	-537	5	568.5				1,320	1,210	1,267	1,265	0.47
		-537	-542	5	573.5				1,230	1,220	1,227	1,225	0.47
		-542	-547	5	578.5				1,560	1,160	1,363	1,360	0.47
		-547	-552	5	583.5				1,400	1,270	1,317	1,315	0.47
		-552	-557	5	588.5				1,370	1,290	1,330	1,330	0.47
		-557	-562	5	593.5				1,620	1,470	1,523	1,520	0.47
		-562	-567	5	598.5				1,800	1,280	1,508	1,505	0.47
		-567	-572	5	603.5				1,620	1,420	1,520	1,520	0.47
		-572	-575	3	607.5				1,450	1,420	1,435	1,435	0.47

[1]Elevations are referenced to NGVD 29 datum.
[2]Mid-point depth measured below El. 34 feet.

Table 2.5S.4-28 Summary of Shear Wave Velocities Deeper than 600 Feet Below Ground Surface [1]

Profile	Top Depth (Feet)	Bottom Depth (Feet)	Top El. (Feet)	Bottom El. (Feet)	Mid-Point Depth [2] (Feet)	Vs (Ft/ sec)
M1P1	609	680	-575	-646	644.5	2,050
	680	780	-646	-746	730.0	2,150
	780	880	-746	-846	830.0	2,250
	880	1,300	-846	-1,266	1,090.0	2,350
	1,300	1,930	-1,266	-1,896	1,615.0	2,550
	1,930	2,500	-1,896	-2,466	2,215.0	2,850
	2,500	3,280	-2,466	-3,246	2,890.0	9,285
M1P2	609	1,000	-575	-966	804.5	1,585
	1,000	1,300	-966	-1,266	1,150.0	2,350
	1,300	1,930	-1,266	-1,896	1,615.0	2,550
	1,930	2,500	-1,896	-2,466	2,215.0	2,850
	2,500	3,280	-2,466	-3,246	2,890.0	9,285
M1P3	609	700	-575	-666	654.5	2,650
	700	780	-666	-746	740.0	2,825
	780	850	-746	-816	815.0	2,900
	850	1,000	-816	-966	925.0	3,000
	1,000	1,060	-966	-1,026	1,030.0	3,100
	1,060	1,160	-1,026	-1,126	1,110.0	3,200
	1,160	1,250	-1,126	-1,216	1,205.0	3,325
	1,250	1,700	-1,216	-1,666	1,475.0	3,575
	1,700	2,500	-1,666	-2,466	2,100.0	4,125
	2,500	3,280	-2,466	-3,246	2,890.0	9,285

[1]Shear wave velocities and depth ranges scaled from Figure B-12, "Shear Wave Velocity Profile for the South Texas Site," Reference 2.5S.4-4
[2]Mid-point depth measured below El. 34 feet

Table 2.5S.4-29 Summary of Strata Unit Weights

Depth Below Ground Surface (feet)	Stratum and/or Soil Type	Selected Unit Weight (pcf)
Ground Surface to 20	A	124
20 to 30	B	121
30 to 50	C	122
50 to 70	D	~~121~~ 123
70 to 90	E	~~122~~ 123
90 to 105	F	125
105 to 120	H	128
120 to 215	J Clay; J Sand	125; 125
215 to 258	K Clay; K Sand/Silt	~~129; 127~~ 124;127
258 to 263	L	~~129~~ 124 [1]
263 to 278	M	127 [1]
278 to 609	N Clay; N Sand	~~121~~123; 128
609 to 680	Silt/Clay	129 [2]
680 to 780	Silty Sand	126 [2]
780 to 880	Silt/Clay	130 [2]
880 to 1,300	Silty Sand	130 [2]
1,300 to 1,930	Interbedded Sand, Clay, Silt, Claystone	130 [2]
1,930 to 2,500	Interbedded Claystone, Siltstone, Sand, Clay, Silt	135 [2]
2,500 to 3,280 +	Interbedded Claystone, Sand, Silt	140 [2]

[1] The selected unit weight for Stratum L is after Sub-stratum K Clay. The selected unit weight for Stratum M is after Sub-stratum K Sand/Silt

[2] The selected unit weights for strata deeper than approximately 600 feet below ground surface are after Reference 2.5S.4-3, Boring B-233

Table 2.5S.4-30 Summary of Strata Depths for the Selection of Shear Modulus Degradation and Damping Ratio Curves

Cohesionless Soils			
Stratum	**Mid-Layer Depth (feet)**	**Mid-Layer Depth For Curve Selection (feet)**	**Selected Peninsular Curve (feet)**
B (Silt)	29	30	< 50
C (Sand)	44	45	< 50
E (Sand)	84	85	> 50
H (Sand)	116.5	120	> 50
J (Sand/Silt)	166.5	170	> 50
K (Sand/Silt)	249.5	250	> 50
M (Sand)	274.5	250	> 50
N (Sand)	392, 427, 571	500	> 50

Cohesive Soils			
Stratum	**Depth Range (feet)**	**Average PI (%)**	**Adjusted PI (%)**
A (Clay)	< 100	35	35
D (Clay)	< 100	39	40
F (Clay)	> 100	39	60
J (Clay)	> 100	36	60
K (Clay	> 100	25	45
L (Clay)	> 100	52	70
N (Clay)	> 100	49	70

Table 2.5S.4-31 Resonant Column Torsional Shear Testing Summary

Boring No.	Sample No.	Depth (feet)	Stratum	Material
B-405	UD1	11.8	A	Clay, LL = 73, PI = 52
B-306	UD3	75.0	E	Fine Sand, 8% fines
B-405	UD4	85.0	F	Clay, LL = 60, PI = 41
B-306	UD6	104.7	H	Sand (SP-SM)*
B-405	UD6	127.0	J (clay 1)	Clay, LL = 68, PI = 50
B-405	UD8	170.0	J (clay 2 and sand/silt)	Sandy Silt, 78% fines, non-plastic
B-305	UD10	195.0	J (clay 2)	Clay, LL = 70, PI = 48
B-405	UD10	224.0	K (clay)	Clay, LL = 73, PI = 51
B-305	UD13	265.5	M	Silty Sand/Sandy Silt, 54% fines
B-405	UD13	294.7	N (clay 1)	Clay, LL = 80, PI = 60
B-405	UD16	358.5	N (clay 2)	Clay, LL = 92, PI = 65
B-305	UD18	387.5	N (sand 2)	Silty Sand, 15% fines
B-405	UD19	440.5	N (clay 4)	Clay, LL = 33, PI = 22
B-305A	UD21	455.2	N (sand 4)	Fine Sand (SP-SM)*
B-405	UD24	569.2	N (clay 6)	Clay, LL = 84, PI = 62
B-305	UD25	590.5	N (clay 6)	Clay, LL = 67, PI = 48

* Gradation tests were not performed on the two samples indicated. The descriptions above are based on visual descriptions in the field.

Table 2.5S.4-32 Summary of Shear Modulus Degradation Curves Numerical Values Prior to RCTS

Cohesionless Soil Strata

	Stratum (Mid-Point Depth in Feet)									
	B (30)	C (45)	E (85)	H (120)	J Sand (170)	K Sand/ Silt (250)	M (250)	N Sand (500)	Peninsular (<50)	Peninsular (>50)
Strain (%)	Value of G/ Gmax									
1.00E+00	0.08	0.09	0.11	0.12	0.14	0.15	0.15	0.20	0.09	0.20
3.16E-01	0.17	0.20	0.23	0.26	0.27	0.32	0.32	0.40	0.22	0.40
1.00E-01	0.37	0.40	0.46	0.49	0.51	0.56	0.56	0.64	0.43	0.64
3.16E-02	0.61	0.65	0.69	0.72	0.74	0.78	0.78	0.84	0.67	0.84
1.00E-02	0.83	0.85	0.87	0.89	0.90	0.91	0.91	0.95	0.85	0.95
3.16E-03	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.97	0.99
1.00E-03	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.16E-04	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00E-04	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Cohesive Soil Strata

	Stratum (Plasticity Index in %)						
	A (35)	D (40)	F (60)	J Clay (60)	K Clay (45)	L (70)	N Clay (70)
Strain (%)	VALUE OF G/ GMAX						
1.00E+00	0.09	0.11	0.22	0.22	0.13	0.30	0.30
3.16E-01	0.19	0.26	0.42	0.42	0.28	0.53	0.53
1.00E-01	0.45	0.49	0.70	0.70	0.52	0.78	0.78
3.16E-02	0.69	0.75	0.88	0.88	0.77	0.94	0.94
1.00E-02	0.88	0.92	0.98	0.98	0.93	1.00	1.00
3.16E-03	0.98	0.99	1.00	1.00	0.99	1.00	1.00
1.00E-03	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.16E-04	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00E-04	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2.5S.4-33 Summary of Damping Ratio Curves Numerical Values Prior to RCTS

Cohesionless Soil Strata

	Stratum (Mid-Point Depth in Feet)									
	B (30)	C (45)	E (85)	H (120)	J Sand (170)	K Sand/ Silt (250)	M (250)	N Sand (500)	Peninsular (<50)	Peninsular (>50)
Strain (%)	VALUE OF DAMPING (%)									
1.00E+00	24.5	23.2	22.1	21.0	20.5	19.4	19.4	16.6	22.8	16.5
3.16E-01	21.0	19.6	18.5	17.3	16.6	15.5	15.5	13.0		
1.00E-01	18.5	17.2	16.0	14.8	14.0	13.0	13.0	10.5	16.5	10.3
3.16E-02	12.0	10.8	9.6	8.7	8.0	7.0	7.0	5.4	10.3	5.5
1.00E-02	6.7	6.1	5.4	4.7	4.2	3.7	3.7	2.5	5.5	2.6
3.16E-03	3.8	3.4	2.7	2.4	2.2	2.0	2.0	1.4	3.0	1.4
1.00E-03	2.3	1.8	1.6	1.4	1.6	1.0	1.0	1.0	1.6	0.9
3.16E-04	1.8	1.7	1.0	0.9	0.8	0.8	0.8	0.6	1.3	0.5
1.00E-04	1.4	1.4	1.0	0.8	0.8	0.8	0.8	0.6	1.1	0.5

Cohesive Soil Strata

	Stratum (Plasticity Index in %)						
	A (35)	D (40)	F (60)	J Clay (60)	K Clay (45)	L (70)	N Clay (70)
Strain (%)	VALUE OF DAMPING (%)						
1.00E+00	18.6	18.3	15.8	15.8	18.0	13.8	13.8
3.16E-01	17.5	16.7	13.2	13.2	16.1	11.1	11.1
1.00E-01	15.3	14.7	11.1	11.1	14.0	9.3	9.3
3.16E-02	9.8	9.4	6.5	6.5	8.7	5.4	5.4
1.00E-02	5.5	5.3	3.9	3.9	4.8	3.3	3.3
3.16E-03	3.4	3.0	2.8	2.8	2.9	2.7	2.7
1.00E-03	2.4	2.0	2.6	2.6	2.5	2.6	2.6
3.16E-04	1.7	1.8	2.4	2.4	1.9	2.6	2.6
1.00E-04	1.6	1.7	2.4	2.4	1.8	2.6	2.6

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results

Appendix A Tests **Boring B-405DH** **Sample UD13**	**Resonant Column Stage** **σ_o = 87.3 psi**			**Torsional Shear Stage** **First Cycle** **σ_o = 87.3 psi**			**Torsional Shear Stage** **Tenth Cycle** **σ_o = 87.3 psi**		
Sub-Stratum N Clay 1	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**
Depth = 294.7 feet (89.9 meters)	2.09E-04	1.00	1.55	4.31E-04	1.00	1.47	4.16E-04	1.00	1.25
Total Unit Weight = 120.3 pcf	3.98E-04	1.00	1.57	8.23E-04	1.00	1.24	8.04E-04	1.00	1.33
Moisture Content = 29.0%	8.01E-04	1.00	1.74	2.00E-03	1.00	1.46	1.99E-03	1.00	1.61
Estimated In-Situ K_0 = 0.5	1.56E-03	1.00	1.74	3.84E-03	1.00	1.68	4.01E-03	1.00	1.54
Estimated σ'_{mean} = 87.3 psi	3.07E-03	1.00	1.77	9.85E-03	1.00	1.75	9.88E-03	1.00	1.88
	6.15E-03	1.00	1.93	2.02E-02	0.98	2.19	2.02E-02	0.98	2.23
	1.17E-02	0.99	2.12						
	2.11E-02	0.98	2.46						
	3.93E-02	0.94	3.06						
	7.74E-02	0.87	3.85						
	1.58E-01	0.75	4.89						
	3.55E-01	0.59	6.12						
	5.76E-01	0.50	7.18						
	8.46E-01	0.43	8.36						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix B Tests Boring B-305DH Sample UD13	Resonant Column Stage σ_o = 78.6 psi			Torsional Shear Stage First Cycle σ_o = 78.6 psi			Torsional Shear Stage Tenth Cycle σ_o = 78.6 psi		
Stratum M	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)
Depth = 265.5 feet (80.8 meters)	1.40E-04	1.00	0.95	2.58E-04	1.00	0.88	2.66E-04	1.00	0.78
Total Unit Weight = 116.0 pcf	2.86E-04	1.00	0.95	5.01E-04	1.00	0.84	4.97E-04	1.00	0.94
Moisture Content = 19.2%	5.83E-04	1.00	0.96	9.62E-04	1.00	0.84	9.67E-04	1.00	1.04
Estimated In-Situ K_0 = 0.5	1.15E-03	1.00	0.97	1.91E-03	1.00	0.83	1.94E-03	1.00	0.75
Estimated σ'_{mean} = 78.6 psi	2.25E-03	0.99	1.05	3.93E-03	1.00	0.88	3.96E-03	1.00	0.98
	4.29E-03	0.98	1.12	9.46E-03	0.91	1.53	9.45E-03	0.92	1.45
	7.96E-03	0.96	1.24	2.05E-02	0.84	2.25	2.06E-02	0.85	2.07
	1.43E-02	0.93	1.47	3.79E-02	0.76	3.98	3.51E-02	0.79	2.94
	2.54E-02	0.89	1.69						
	4.56E-02	0.82	2.15						
	8.12E-02	0.74	3.17						
	1.44E-01	0.65	4.43						
	2.55E-01	0.58	6.38						

Resonant Column Stage σ_o = 314.3 psi			Torsional Shear Stage First Cycle σ_o = 314.3 psi			Torsional Shear Stage Tenth Cycle σ_o = 314.3 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)
5.60E-05	1.00	0.77	1.04E-03	1.00	0.41	1.04E-03	1.00	0.48
1.15E-04	1.00	0.75	2.03E-03	1.00	0.59	2.05E-03	1.00	0.43
2.27E-04	1.00	0.75	6.65E-03	0.99	0.93	6.68E-03	1.00	0.71
4.49E-04	1.00	0.83	9.92E-03	0.97	1.00	9.93E-03	0.98	1.21
9.22E-04	1.00	0.90	1.34E-02	0.96	1.04	1.34E-02	0.96	1.26
3.52E-03	0.99	0.95						
6.60E-03	0.98	1.01						
1.20E-02	0.95	1.15						
2.13E-02	0.92	1.30						
3.74E-02	0.88	1.67						
6.62E-02	0.81	2.01						
1.14E-01	0.73	2.97						
1.59E-01	0.68	3.82						
2.03E-01	0.65	4.31						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix C Tests Boring B-405DH Sample UD16	Resonant Column Stage σ_o = 106.1 psi			Torsional Shear Stage First Cycle σ_o = 106.1 psi			Torsional Shear Stage Tenth Cycle σ_o = 106.1 psi		
Sub-Stratum N Clay 2	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)
Depth = 358.5 feet (109.3 meters)	3.24E-04	1.00	2.45	1.11E-03	0.95	2.76	1.09E-03	0.98	1.73
Total Unit Weight - 116.3 pcf	7.02E-04	1.00	2.50	2.15E-03	0.99	1.61	2.15E-03	0.99	1.36
Moisture Content = 29.5%	1.37E-03	1.00	2.61	4.25E-03	1.00	1.49	4.26E-03	1.00	1.31
Estimated In-Situ K_0 = 0.5	2.73E-03	1.00	2.64	9.84E-03	0.99	1.80	9.87E-03	0.99	1.61
Estimated σ'_{mean}= 106.1 psi	5.45E-03	1.00	2.74	2.00E-02	0.97	2.02	2.00E-02	0.98	1.98
	1.09E-02	0.99	2.82	4.19E-02	0.93	2.13	4.21E-02	0.93	2.10
	2.14E-02	0.99	2.88						
	4.23E-02	0.97	2.98						
	8.27E-02	0.93	3.09						
	1.64E-01	0.84	3.34						
	3.37E-01	0.71	4.34						
	7.07E-01	0.55	6.68						
	1.46E+00	0.40	11.88						

Resonant Column Stage σ_o = 424.4 psi			Torsional Shear Stage First Cycle σ_o = 424.4 psi			Torsional Shear Stage Tenth Cycle σ_o = 424.4 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)
1.84E-04	1.00	2.11	1.08E-03	0.99	1.00	1.11E-03	0.96	1.08
3.72E-04	1.00	2.1	2.16E-03	0.99	1.15	2.14E-03	1.00	0.98
7.63E-04	1.00	2.08	4.31E-03	0.99	0.98	4.29E-03	0.99	1.30
1.53E-03	1.00	2.15	9.67E-03	1.00	1.56	9.67E-03	1.00	1.22
3.06E-03	1.00	2.15	1.95E-02	0.99	1.27	1.94E-02	1.00	1.26
6.12E-03	1.00	2.17	3.11E-02	0.99	1.28	3.10E-02	0.99	1.34
1.22E-02	1.00	2.18						
2.43E-02	0.99	2.26						
4.77E-02	0.98	2.29						
9.21E-02	0.93	2.34						
1.75E-01	0.83	2.79						
3.37E-01	0.69	4.13						
4.98E-01	0.59	5.42						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix D Tests Boring B-405DH Sample UD19	Resonant Column Stage σ_o = 129.4 psi			Torsional Shear Stage First Cycle σ_o = 129.4 psi			Torsional Shear Stage Tenth Cycle σ_o = 129.4 psi		
Sub-Stratum N Clay 4	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 440.5 feet (134.3 meters)	1.01E-04	1.00	4.82	3.94E-04	0.98	0.91	3.97E-04	0.98	1.17
Total Unit Weight = 131.7 pcf	2.02E-04	1.00	4.96	9.61E-04	1.00	1.08	9.84E-04	0.99	1.34
Moisture Content = 17.4%	3.93E-04	1.00	5.09	1.99E-03	0.97	1.20	1.95E-03	1.00	1.06
Estimated In-Situ K_0 = 0.5	8.26E-04	1.00	5.09	4.06E-03	0.95	1.00	3.95E-03	0.99	1.21
Estimated σ'_{mean}= 129.4 psi	1.65E-03	1.00	5.16	9.59E-03	0.88	2.07	9.56E-03	0.89	2.05
	3.32E-03	0.98	5.28	2.15E-02	0.78	3.09	2.17E-02	0.79	3.04
	6.68E-03	0.96	5.46	3.21E-02	0.72	4.02	3.26E-02	0.72	4.10
	1.37E-02	0.91	5.62						
	2.75E-02	0.84	6.17						
	6.54E-02	0.70	6.98						
	1.73E-01	0.51	8.85						

Resonant Column Stage σ_o = 455.0 psi			Torsional Shear Stage First Cycle σ_o = 455.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 455.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
8.00E-06	1.00	4.37	3.62E-03	1.00	5.71	3.72E-03	1.00	6.20
1.60E-05	1.00	4.41	9.92E-03	0.91	5.85	9.68E-03	0.96	6.37
3.00E-05	1.00	4.47						
5.70E-05	1.00	4.62						
1.15E-04	1.00	4.66						
2.30E-04	1.00	4.79						
4.60E-04	0.99	4.76						
9.53E-04	0.99	4.73						
1.91E-03	0.99	4.83						
3.85E-03	0.98	4.85						
7.74E-03	0.95	5.05						
1.60E-02	0.90	5.49						
3.54E-02	0.79	5.82						
8.13E-02	0.65	7.10						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix E Tests Boring B-305DH Sample UD18 Sub-Stratum N Sand 2	Resonant Column Stage σ_o = 113.9 psi Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Torsional Shear Stage First Cycle σ_o = 113.9 psi Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Torsional Shear Stage Tenth Cycle σ_o = 113.9 psi Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 387.5 feet (118.1 meters)	1.11E-04	1.00	0.37	7.07E-04	1.00	0.99	7.15E-04	1.00	1.04
Total Unit Weight = 128.8 pcf	2.26E-04	1.00	0.37	8.75E-04	1.00	1.15	8.85E-04	1.00	1.07
Moisture Content = 21.2%	4.43E-04	1.00	0.47	1.74E-03	1.00	0.88	1.76E-03	1.00	0.63
Estimated In-Situ K_0 = 0.5	8.98E-04	1.00	0.47	3.59E-03	0.98	1.07	3.55E-03	1.00	1.19
Estimated σ'_{mean} = 113.9 psi	1.74E-03	0.99	0.55	7.53E-03	0.93	1.08	7.58E-03	0.93	1.08
	3.28E-03	0.98	0.63	9.71E-03	0.90	1.50	9.76E-03	0.91	1.46
	5.92E-03	0.97	0.78						
	1.04E-02	0.94	0.86						
	1.81E-02	0.92	0.99						
	3.09E-02	0.86	1.25						
	5.21E-02	0.80	1.85						
	9.01E-02	0.70	2.90						
	1.58E-01	0.61	4.28						
	2.82E-01	0.50	5.30						

Resonant Column Stage σ_o = 455.0 psi			Torsional Shear Stage First Cycle σ_o = 455.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 455.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
4.80E-05	1.00	0.22	9.10E-04	1.00	0.51	9.20E-04	0.96	0.75
8.90E-05	1.00	0.43	1.82E-03	1.00	0.54	1.81E-03	1.00	0.31
1.79E-04	1.00	0.39	3.58E-03	1.00	0.85	3.62E-03	1.00	0.74
3.57E-04	1.00	0.30						
7.28E-04	1.00	0.40						
1.41E-03	0.99	0.50						
2.68E-03	0.98	0.54						
5.02E-03	0.97	0.57						
9.22E-03	0.96	0.57						
1.57E-02	0.95	0.59						
2.56E-02	0.92	0.79						
4.24E-02	0.86	0.95						
6.77E-02	0.80	1.60						
1.05E-01	0.72	2.20						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix F Tests Boring B-305DH Sample UD25	Resonant Column Stage σ_o = 172.7 psi			Torsional Shear Stage First Cycle σ_o = 172.7 psi			Torsional Shear Stage Tenth Cycle σ_o = 172.7 psi		
Sub-Stratum N Clay 6	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 590.5 feet (180.0 meters)	7.10E-05	1.00	5.04	9.58E-04	1.00	1.55	9.57E-04	1.00	1.36
Total Unit Weight = 128.8 pcf	1.37E-04	1.00	4.99	1.74E-03	1.00	1.50	1.76E-03	1.00	1.46
Moisture Content = 20.6%	2.67E-04	1.00	5.04	3.43E-03	1.00	1.83	3.52E-03	1.00	1.85
Estimated In-Situ K_0 = 0.5	5.54E-04	1.00	5.05	9.94E-03	1.00	2.36	1.00E-02	0.98	2.17
Estimated σ'_{mean}= 172.7 psi	1.08E-03	1.00	5.12	2.08E-02	0.96	2.94	2.09E-02	0.94	3.17
	2.17E-03	1.00	5.15	4.47E-02	0.85	3.17	4.52E-02	0.84	3.30
	4.34E-03	1.00	5.23						
	8.66E-03	0.99	5.46						
	1.82E-02	0.98	5.61						
	3.89E-02	0.93	6.12						
	8.56E-02	0.83	6.69						
	2.03E-01	0.66	7.60						
	3.49E-01	0.54	10.22						

Resonant Column Stage σ_o = 455.0 psi			Torsional Shear Stage First Cycle σ_o = 455.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 455.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
2.60E-05	1.00	4.72	1.04E-03	1.00	1.40	1.03E-03	1.00	1.59
5.20E-05	1.00	4.69	2.01E-03	1.00	1.80	2.04E-03	1.00	1.80
1.03E-04	1.00	4.72	4.06E-03	1.00	1.47	4.08E-03	1.00	1.55
2.02E-04	1.00	4.72	9.41E-03	0.99	1.63	9.39E-03	1.00	1.65
3.97E-04	1.00	4.72	1.93E-02	0.97	1.79	1.93E-02	0.98	1.78
9.85E-04	1.00	4.79						
4.29E-03	1.00	4.90						
9.75E-03	0.99	5.13						
2.09E-02	0.97	5.38						
4.47E-02	0.91	5.63						
1.01E-01	0.80	6.27						
2.39E-01	0.62	7.71						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix G Tests **Boring B-405DH** **Sample UD4**	**Resonant Column Stage** **σ_o = 26.4 psi**			**Torsional Shear Stage** **First Cycle** **σ_o = 26.4 psi**			**Torsional Shear Stage** **Tenth Cycle** **σ_o = 26.4 psi**		
Stratum F	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**
Depth = 85.0 feet (25.9 meters)	8.90E-05	1.00	2.37	2.22E-03	1.00	1.04	2.27E-03	1.00	0.82
Total Unit Weight = 131.0 pcf	1.58E-04	1.00	2.39	4.21E-03	1.00	1.19	4.39E-03	1.00	1.09
Moisture Content = 22.6%	3.21E-04	1.00	2.38	1.06E-02	1.00	1.32	1.06E-02	1.00	1.62
Estimated In-Situ K_0 = 0.5	6.42E-04	1.00	2.44	2.20E-02	0.97	1.81	2.22E-02	0.99	1.72
Estimated σ'_{mean}= 26.4 psi	1.25E-03	1.00	2.43	4.60E-02	0.87	2.62	4.66E-02	0.88	2.65
	2.55E-03	0.99	2.45						
	5.06E-03	0.99	2.41						
	1.01E-02	0.98	2.45						
	2.00E-02	0.97	2.58						
	3.93E-02	0.93	2.75						
	7.61E-02	0.87	3.55						
	1.44E-01	0.76	4.44						
	2.81E-01	0.58	6.95						

Resonant Column Stage σ_o = 105.6 psi			Torsional Shear Stage First Cycle σ_o = 105.6 psi			Torsional Shear Stage Tenth Cycle σ_o = 105.6 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
1.63E-04	1.00	1.87	2.04E-03	1.00	0.89	2.05E-03	1.00	0.92
2.53E-04	1.00	1.89	4.06E-03	1.00	0.92	4.09E-03	1.00	1.02
3.85E-04	1.00	1.90	1.04E-02	0.98	1.17	1.03E-02	0.99	1.26
7.52E-04	1.00	1.95	2.14E-02	0.95	1.47	2.15E-02	0.95	1.38
1.40E-03	1.00	1.93	4.83E-02	0.84	2.47	4.89E-02	0.84	2.52
2.72E-03	1.00	2.01						
5.27E-03	1.00	2.03						
1.08E-02	0.99	2.04						
2.15E-02	0.98	2.11						
4.26E-02	0.93	2.26						
8.56E-02	0.85	2.84						
1.74E-01	0.73	3.43						
3.89E-01	0.56	5.37						
5.60E-01	0.49	6.48						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix H Tests Boring B-405DH Sample UD8	Resonant Column Stage σ_o = 51.0 psi			Torsional Shear Stage First Cycle σ_o = 51.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 51.0 psi		
Sub-Stratum J Clay 2 and sand/silt	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 170.0 feet (51.8 meters)	4.59E-04	1.00	0.73	7.04E-04	1.00	0.55	7.10E-04	1.00	0.63
Total Unit Weight = 124.4 pcf	9.74E-04	1.00	0.73	1.06E-03	1.00	0.60	1.07E-03	1.00	0.69
Moisture Content = 22.9%	1.76E-03	1.00	0.73	2.14E-03	0.99	0.85	2.15E-03	0.99	0.68
Estimated In-Situ K_0 = 0.5	3.34E-03	0.98	0.77	4.39E-03	0.96	1.33	4.36E-03	0.98	1.13
Estimated σ'_{mean}= 51.0 psi	5.97E-03	0.97	0.76	9.79E-03	0.86	1.76	9.80E-03	0.87	2.02
	1.04E-02	0.94	0.92	2.19E-02	0.77	3.01	2.20E-02	0.78	2.87
	1.75E-02	0.91	1.07	4.89E-02	0.66	4.65	4.87E-02	0.67	4.47
	2.84E-02	0.86	1.32						
	5.38E-02	0.78	1.95						
	9.68E-02	0.70	3.33						
	1.69E-01	0.62	4.68						
	3.03E-01	0.53	7.24						

Resonant Column Stage σ_o = 204.0 psi			Torsional Shear Stage First Cycle σ_o = 204.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 204.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
1.76E-04	1.00	0.60	5.56E-04	1.00	0.55	5.63E-04	1.00	0.59
3.46E-04	1.00	0.63	1.03E-03	1.00	0.41	1.02E-03	1.00	0.58
7.12E-04	1.00	0.64	2.06E-03	1.00	0.53	2.07E-03	1.00	0.65
1.39E-03	1.00	0.64	4.19E-03	0.98	0.59	4.22E-03	0.97	0.47
2.65E-03	1.00	0.64	1.00E-02	0.95	1.07	1.01E-02	0.95	1.07
4.87E-03	0.98	0.63	1.79E-02	0.92	1.51	1.79E-02	0.92	1.53
8.71E-03	0.97	0.71						
1.59E-02	0.93	0.82						
2.69E-02	0.90	0.98						
4.65E-02	0.84	1.23						
7.99E-02	0.78	1.74						
1.38E-01	0.69	2.48						
2.28E-01	0.61	3.83						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix I Tests Boring B-305DH Sample UD10	Resonant Column Stage σ_o = 58.2 psi			Torsional Shear Stage First Cycle σ_o = 58.2 psi			Torsional Shear Stage Tenth Cycle σ_o = 58.2 psi		
Sub-Stratum J Clay 2	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 195.0 feet (59.4 meters)	3.50E-04	1.00	1.25	1.03E-03	1.00	0.76	9.80E-04	1.00	0.84
Total Unit Weight = 120.0 pcf	6.71E-04	1.00	1.21	1.96E-03	1.00	0.39	1.95E-03	1.00	0.78
Moisture Content = 27.9%	1.28E-03	1.00	1.22	3.89E-03	1.00	0.72	3.87E-03	1.00	0.84
Estimated In-Situ K_0 = 0.5	2.52E-03	1.00	1.12	9.56E-03	1.00	0.84	9.50E-03	1.00	0.92
Estimated σ'_{mean} = 58.2 psi	5.07E-03	1.00	1.13	1.98E-02	1.00	0.92	1.97E-02	0.98	0.95
	1.02E-02	1.00	1.18						
	1.94E-02	1.00	1.26						
	5.06E-02	0.96	1.57						
	9.69E-02	0.90	2.04						
	1.63E-01	0.79	3.25						
	2.76E-01	0.70	5.45						

Resonant Column Stage σ_o = 233.0 psi			Torsional Shear Stage First Cycle σ_o = 233.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 233.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
1.26E-04	1.00	1.05	1.02E-03	1.00	0.76	1.02E-03	1.00	0.79
2.33E-04	1.00	1.03	2.03E-03	1.00	0.72	2.00E-03	1.00	0.68
4.76E-04	1.00	1.05	4.02E-03	1.00	0.71	4.01E-03	1.00	0.77
9.48E-04	1.00	1.09	1.00E-02	1.00	0.88	1.00E-02	1.00	0.74
1.88E-03	1.00	1.07	2.03E-02	1.00	0.84	2.03E-02	0.99	0.88
3.77E-03	1.00	1.03						
7.41E-03	1.00	1.08						
1.49E-02	1.00	1.05						
3.05E-02	0.99	1.09						
5.90E-02	0.95	1.28						
1.07E-01	0.89	1.61						
1.85E-01	0.79	2.49						
3.03E-01	0.69	3.97						
7.15E-01	0.47	7.65						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix J Tests Boring B-405DH Sample UD1 Stratum A	Resonant Column Stage σ_o = 5.2 psi			Torsional Shear Stage First Cycle σ_o = 5.2 psi			Torsional Shear Stage Tenth Cycle σ_o = 5.2 psi		
	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 11.8 feet (3.4 meters)	4.88E-04	1.00	2.31	9.24E-04	1.00	1.42	9.13E-04	1.00	1.44
Total Unit Weight = 117.9 pcf	9.37E-04	1.00	2.32	3.75E-03	1.00	1.41	3.72E-03	1.00	1.68
Moisture Content = 28.2%	1.69E-03	1.00	2.33	9.75E-03	1.00	1.50	9.73E-03	0.99	1.68
Estimated In-Situ K_0 = 0.5	3.36E-03	0.99	2.34						
Estimated σ'_{mean} = 5.2 psi	6.76E-03	0.99	2.33						
	1.33E-02	0.99	2.39						
	2.66E-02	0.98	2.50						
	5.24E-02	0.95	2.75						
	1.04E-01	0.78	3.09						
	2.36E-01	0.62	4.29						
	5.93E-01	0.45	5.57						

Resonant Column Stage σ_o = 20.9 psi			Torsional Shear Stage First Cycle σ_o = 20.9 psi			Torsional Shear Stage Tenth Cycle σ_o = 20.9 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
3.21E-04	1.00	2.10	4.42E-04	1.00	0.93	4.26E-04	1.00	0.91
6.47E-04	1.00	2.10	1.01E-03	1.00	1.03	1.00E-03	1.00	0.97
1.28E-03	1.00	2.11	2.03E-03	1.00	1.13	1.97E-03	1.00	1.18
2.55E-03	1.00	2.16	1.00E-02	1.00	1.24	1.00E-02	1.00	1.30
5.10E-03	1.00	2.20						
1.03E-02	1.00	2.23						
2.03E-02	1.00	2.26						
4.06E-02	0.97	2.28						
7.87E-02	0.92	2.51						
1.56E-01	0.83	2.88						
3.22E-01	0.68	3.49						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix K Tests Boring B-405DH Sample UD24	Resonant Column Stage σ_o = 167.0 psi			Torsional Shear Stage First Cycle σ_o = 167.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 167.0 psi		
Sub-Stratum N Clay 6	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 569.2 feet (173.5 meters)	1.71E-04	1.00	2.43	9.99E-04	1.00	1.14	1.02E-03	1.00	1.08
Total Unit Weight = 122.1 pcf	3.22E-04	1.00	2.44	2.00E-03	1.00	1.06	2.00E-03	1.00	1.14
Moisture Content = 27.2%	6.16E-04	1.00	2.52	4.02E-03	1.00	1.14	4.00E-03	1.00	1.19
Estimated In-Situ K_0 = 0.5	1.26E-03	1.00	2.58	9.90E-03	0.98	1.37	9.91E-03	0.98	1.41
Estimated σ'_{mean} = 167.0 psi	2.47E-03	1.00	2.56	2.06E-02	0.94	1.60	2.07E-02	0.94	1.65
	4.75E-03	1.00	2.64	3.83E-02	0.87	2.38	3.82E-02	0.88	2.34
	8.91E-03	1.00	2.75						
	1.75E-02	0.98	2.90						
	3.43E-02	0.95	3.02						
	6.66E-02	0.89	3.38						
	1.45E-01	0.78	4.05						
	3.05E-01	0.67	5.10						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix L Tests **Boring B-405DH** **Sample UD10**	**Resonant Column Stage** **σ_o = 67.0 psi**			**Torsional Shear Stage** **First Cycle** **σ_o = 67.0 psi**			**Torsional Shear Stage** **Tenth Cycle** **σ_o = 67.0 psi**		
Sub-Stratum K Clay	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**
Depth = 224.0 feet (68.3 meters)	3.14E-04	1.00	1.54	7.42E-04	1.00	0.97	7.49E-04	1.00	1.07
Total Unit Weight = 114.9 pcf	6.75E-04	1.00	1.54	9.80E-04	1.00	1.05	9.75E-04	1.00	1.21
Moisture Content = 34.5%	1.32E-03	1.00	1.54	1.96E-03	1.00	1.01	1.94E-03	1.00	1.06
Estimated In-Situ K_0 = 0.5	2.61E-03	1.00	1.62	3.90E-03	1.00	1.12	3.91E-03	1.00	1.11
Estimated σ'_{mean} = 67.0 psi	5.22E-03	1.00	1.70	1.02E-02	1.00	1.52	1.02E-02	1.00	1.42
	1.04E-02	1.00	1.81						
	2.08E-02	0.99	1.85						
	4.00E-02	0.98	2.03						
	7.17E-02	0.94	2.27						
	9.07E-02	0.91	2.44						
	1.85E-01	0.81	3.47						

Resonant Column Stage σ_o = 267.0 psi			Torsional Shear Stage First Cycle σ_o = 267.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 267.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
1.82E-04	1.00	1.33	1.01E-03	1.00	1.38	9.78E-04	1.00	1.39
3.27E-04	1.00	1.33	2.02E-03	1.00	1.19	2.00E-03	1.00	1.43
6.00E-04	1.00	1.33	4.00E-03	1.00	1.34	3.99E-03	1.00	1.55
1.09E-03	1.00	1.33	1.02E-02	0.98	1.29	1.02E-02	0.97	1.34
2.20E-03	1.00	1.37						
4.34E-03	1.00	1.40						
8.67E-03	1.00	1.45						
1.72E-02	1.00	1.49						
3.35E-02	0.98	1.59						
6.13E-02	0.95	1.68						
1.06E-01	0.89	2.07						
1.79E-01	0.78	2.63						
3.17E-01	0.66	3.75						
4.86E-01	0.55	5.69						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix M Tests **Boring B-405DH** **Sample UD6**	**Resonant Column Stage** **σ_o = 39.0 psi**			**Torsional Shear Stage** **First Cycle** **σ_o = 39.0 psi**			**Torsional Shear Stage** **Tenth Cycle** **σ_o = 39.0 psi**		
Sub-Stratum J Clay 1	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**Normalized Shear Modulus (G/ Gmax)**	**Damping Ratio (%)**
Depth = 127.0 feet (38.7 meters)	2.30E-04	1.00	1.62	1.03E-03	1.00	1.08	1.03E-03	1.00	1.16
Total Unit Weight = 121.8 pcf	4.50E-04	1.00	1.67	2.03E-03	1.00	1.16	2.03E-03	1.00	1.12
Moisture Content = 27.2%	9.69E-04	1.00	1.67	4.07E-03	1.00	1.26	4.08E-03	1.00	1.27
Estimated In-Situ K_0 = 0.5	1.95E-03	1.00	1.71	1.05E-02	0.98	1.26	1.05E-02	0.98	1.36
Estimated σ'_{mean} = 39.0 psi	3.92E-03	1.00	1.69						
	8.01E-03	1.00	1.78						
	1.62E-02	0.98	1.86						
	3.15E-02	0.97	2.03						
	5.99E-02	0.93	2.36						
	1.11E-01	0.85	2.67						
	2.11E-01	0.73	3.53						
	4.59E-01	0.55	5.85						

Resonant Column Stage σ_o = 267.0 psi			Torsional Shear Stage First Cycle σ_o = 267.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 267.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
9.20E-05	1.00	1.47	1.01E-03	1.00	0.67	1.01E-03	1.00	0.73
1.79E-04	1.00	1.47	2.03E-03	1.00	0.73	2.02E-03	1.00	0.67
3.69E-04	1.00	1.47	4.02E-03	1.00	0.72	4.01E-03	1.00	0.70
7.64E-04	1.00	1.47	1.01E-02	1.00	0.71	1.01E-02	1.00	0.68
1.52E-03	1.00	1.46	2.05E-02	0.98	0.84	2.05E-02	0.98	0.84
3.06E-03	1.00	1.50	3.53E-02	0.96	1.20	3.52E-02	0.95	1.21
6.11E-03	1.00	1.52						
1.23E-02	0.99	1.54						
2.39E-02	0.98	1.63						
4.53E-02	0.95	1.71						
8.21E-02	0.89	1.97						
1.51E-01	0.79	2.50						
2.69E-01	0.69	3.49						
5.26E-01	0.53	6.35						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix N Tests Boring B-306 Sample UD3	Resonant Column Stage σ_o = 24.0 psi			Torsional Shear Stage First Cycle σ_o = 24.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 24.0 psi		
Stratum E	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 75.0 feet (22.9 meters)	5.91E-04	1.00	1.08	3.61E-04	1.00	0.38	3.70E-04	1.00	0.38
Total Unit Weight = 132.6 pcf	1.21E-03	1.00	1.08	7.00E-04	1.00	0.39	7.05E-04	1.00	0.41
Moisture Content = 24.7%	2.30E-03	1.00	1.06	1.02E-03	1.00	0.42	1.01E-03	1.00	0.47
Estimated In-Situ K_0 = 0.5	4.35E-03	0.99	1.06	2.04E-03	1.00	0.57	2.05E-03	1.00	0.63
Estimated σ'_{mean} = 24.0 psi	7.86E-03	0.97	1.14	4.12E-03	0.99	0.94	4.14E-03	0.99	0.69
	1.55E-02	0.92	1.28	1.01E-02	0.92	1.40	1.01E-02	0.93	1.24
	2.56E-02	0.90	1.46						
	4.04E-02	0.85	1.82						
	5.90E-02	0.80	2.57						
	9.70E-02	0.73	3.66						
	1.69E-01	0.65	5.96						

Resonant Column Stage σ_o = 94.0 psi			Torsional Shear Stage First Cycle σ_o = 94.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 94.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
1.85E-04	1.00	0.80	3.30E-04	1.00	0.64	3.25E-04	1.00	0.46
3.63E-04	1.00	0.84	6.37E-04	1.00	0.49	6.37E-04	1.00	0.49
7.45E-04	1.00	0.84	9.82E-04	1.00	0.50	9.87E-04	1.00	0.49
1.47E-03	1.00	0.80	2.01E-03	1.00	0.73	1.99E-03	1.00	0.68
2.86E-03	0.99	0.80	4.05E-03	0.99	0.86	4.03E-03	0.99	0.90
5.33E-03	0.98	0.87	1.01E-02	0.95	1.08	1.01E-02	0.95	0.96
9.79E-03	0.96	0.92						
1.70E-02	0.94	1.09						
2.94E-02	0.90	1.32						
4.97E-02	0.86	1.68						
8.53E-02	0.79	2.24						
1.41E-01	0.71	3.15						
1.81E-01	0.67	3.96						
2.20E-01	0.64	4.94						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix O Tests Boring B-305A Sample UD21	Resonant Column Stage σ_o = 133.8 psi			Torsional Shear Stage First Cycle σ_o = 133.8 psi			Torsional Shear Stage Tenth Cycle σ_o = 133.8 psi		
Sub-Stratum N Sand 4	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 455.2 feet (138.7 meters)	1.38E-04	1.00	0.18	4.82E-04	1.00	0.12	4.81E-04	1.00	0.12
Total Unit Weight = 129.2 pcf	2.68E-04	1.00	0.16	9.65E-04	1.00	0.09	9.64E-04	1.00	0.10
Moisture Content = 18.8%	5.26E-04	1.00	0.16	1.46E-03	0.99	0.11	1.46E-03	0.99	0.14
Estimated In-Situ K_0 = 0.5	1.01E-03	1.00	0.16						
Estimated σ'_{mean} = 133.8 psi	2.02E-03	0.99	0.19						
	3.81E-03	0.99	0.21						
	6.50E-03	0.98	0.26						
	1.13E-02	0.97	0.36						
	1.86E-02	0.95	0.49						
	2.91E-02	0.91	0.74						
	4.58E-02	0.86	1.15						
	6.71E-02	0.82	1.70						
	1.00E-01	0.77	2.43						
	1.34E-01	0.73	3.40						

Resonant Column Stage σ_o = 260.0 psi			Torsional Shear Stage First Cycle σ_o = 260.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 260.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
9.34E-05	1.00	0.17	5.44E-04	1.01	0.13	5.40E-04	1.00	0.11
1.90E-04	1.00	0.16	1.09E-03	1.00	0.09	1.09E-03	1.00	0.09
3.78E-04	1.00	0.16	2.19E-03	1.00	0.10	2.19E-03	1.00	0.10
7.38E-04	1.00	0.16	3.30E-03	1.00	0.16	3.30E-03	1.00	0.15
1.45E-03	1.00	0.21	4.75E-03	1.00	0.19	4.72E-03	1.00	0.19
2.78E-03	0.99	0.09						
4.87E-03	0.99	0.24						
9.46E-03	0.98	0.25						
1.65E-02	0.97	0.47						
2.61E-02	0.94	0.53						
4.25E-02	0.92	0.71						
6.46E-02	0.88	1.00						
9.70E-02	0.81	1.59						
1.31E-01	0.76	2.18						

Table 2.5S.4-34A
Summary of RCTS Laboratory Test Results (Continued)

Appendix P Tests Boring B-306 Sample UD6 Stratum H	Resonant Column Stage σ_o = 32.2 psi			Torsional Shear Stage First Cycle σ_o = 32.2 psi			Torsional Shear Stage Tenth Cycle σ_o = 32.2 psi		
	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
Depth = 104.7 feet (31.9 meters)	2.49E-04	1.01	0.35	2.67E-04	1.00	0.26	2.71E-04	1.00	0.18
Total Unit Weight = 120.6 pcf	4.89E-04	1.00	0.29	5.41E-04	1.00	0.20	5.39E-04	0.99	0.21
Moisture Content = 19.3%	9.37E-04	0.99	0.32	1.09E-03	0.99	0.24	1.09E-03	0.99	0.21
Estimated In-Situ K_0 = 0.5	1.76E-03	0.99	0.28	2.04E-03	0.98	0.47	2.06E-03	0.97	0.49
Estimated σ'_{mean} = 32.2 psi	3.23E-03	0.97	0.37	4.20E-03	0.97	0.77	4.21E-03	0.96	0.62
	5.93E-03	0.96	0.51	1.04E-02	0.92	1.63	1.05E-02	0.91	1.26
	9.74E-03	0.93	0.72	2.05E-02	0.85	3.07	2.05E-02	0.85	2.29
	1.64E-02	0.89	0.96						
	2.65E-02	0.83	1.42						
	4.07E-02	0.75	2.03						

Resonant Column Stage σ_o = 128.0 psi			Torsional Shear Stage First Cycle σ_o = 128.0 psi			Torsional Shear Stage Tenth Cycle σ_o = 128.0 psi		
Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)	Peak Shear Strain (%)	Normalized Shear Modulus (G/ Gmax)	Damping Ratio (%)
9.41E-05	1.00	0.15	2.69E-04	1.00	0.12	2.64E-04	1.00	0.12
1.68E-04	1.00	0.24	5.07E-04	1.00	0.20	5.13E-04	1.00	0.27
3.21E-04	1.00	0.15	1.03E-03	0.98	0.18	1.03E-03	0.99	0.15
6.22E-04	1.00	0.22	1.96E-03	0.98	0.22	1.96E-03	0.99	0.22
1.17E-03	0.99	0.17	3.95E-03	0.97	0.43	3.95E-03	0.98	0.37
2.24E-03	0.99	0.22	8.68E-03	0.94	0.78	8.67E-03	0.95	0.64
4.23E-03	0.98	0.30						
7.23E-03	0.96	0.36						
1.25E-02	0.94	0.50						
2.22E-02	0.91	0.69						
3.54E-02	0.86	0.99						
5.53E-02	0.80	1.40						
7.99E-02	0.74	2.15						
1.16E-01	0.68	3.09						

Table 2.5S.4-34B G/G_{max} vs. Strain Based on RCTS Results

Strain, %	Sand at ≥ 100 ft depth (EPRI 500 ft-1000 ft)	Sand at < 100 ft depth (EPRI 250 ft - 500 ft)	Clay with PI ≥ 30 (V&D PI =100)	Clay with PI < 30 (V&D PI = 50)	Silt (EPRI PI = 50)
	G/G_{max}				
1.00E+00	0.2	0.15	0.36	0.25	0.14
0.316	0.4	0.33	0.62	0.46	0.32
1.00E-01	0.65	0.57	0.82	0.67	0.58
0.0316	0.86	0.8	0.93	0.85	0.81
1.00E-02	0.95	0.94	0.98	0.96	0.95
0.00316	1	0.99	1	1	1
1.00E-03	1	1	1	1	1
0.000316	1	1	1	1	1
1.00E-04	1	1	1	1	1

Table 2.5S.4-34c – Damping Ratio vs. Strain Based on RCTS Results

Strain, %	Sand (EPRI 500 ft-1000 ft)	Clay with PI ≥ 30 (V&D, PI = 200)	Low PI Clay and Silt (Hybrid)
	Damping Ratio (%)		
1.00E+00	16.66	8.08	15.72
0.316	10.70	4.86	10.96
1.00E-01	5.64	3.09	6.61
0.0316	2.67	2.22	3.54
1.00E-02	1.30	1.65	2.03
0.00316	0.83	1.33	1.33
1.00E-03	0.67	1.09	1.09
0.000316	0.60	1.09	1.09
1.00E-04	0.60	1.09	1.09

This figure replaces the existing Figure 2.5S.4-40 in COLA Rev 2.

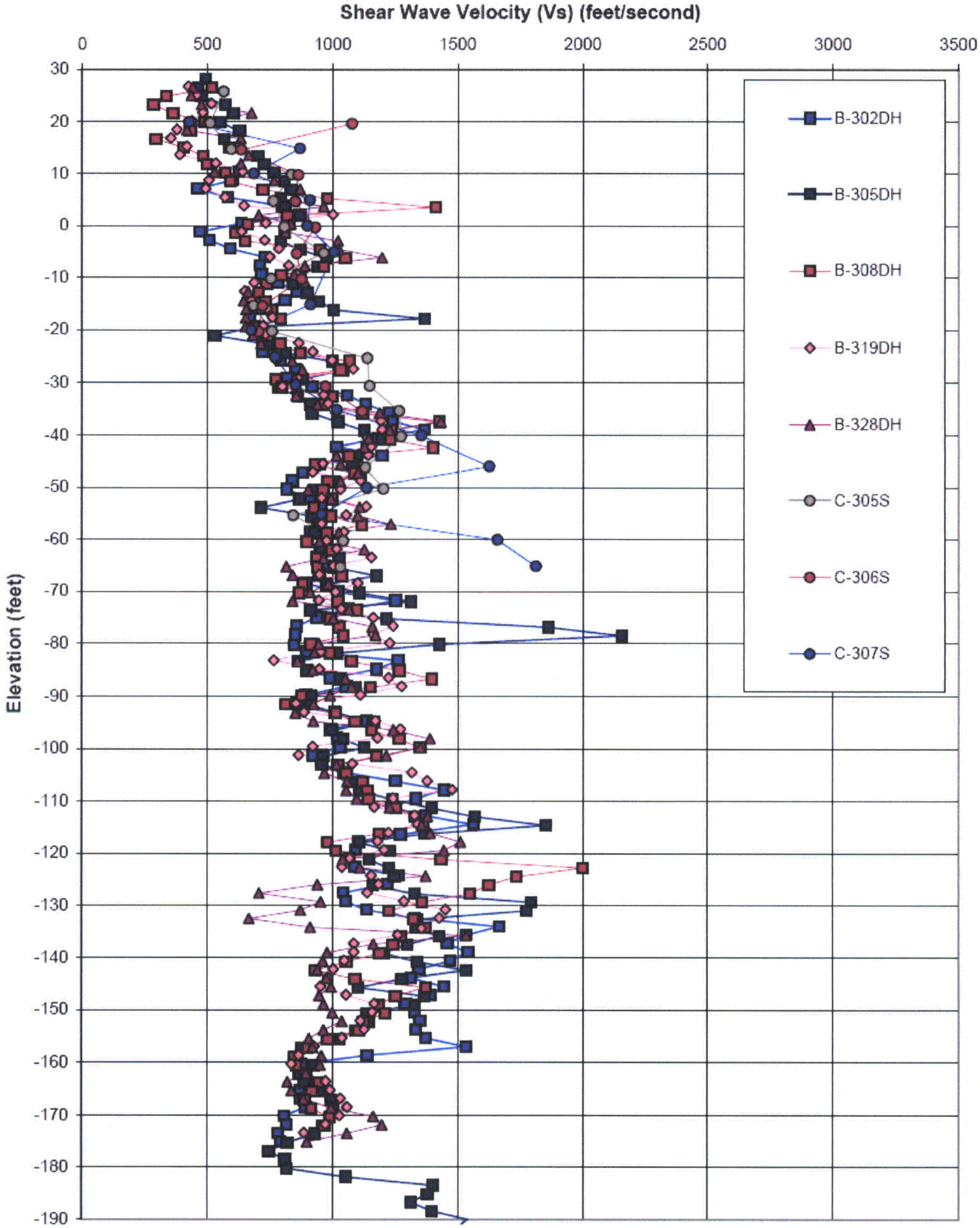


Figure 2.5S.4-40 STP 3; Shear Wave Velocity versus Depth

This figure replaces the existing Figure 2.5S.4-41 in COLA Rev 2.

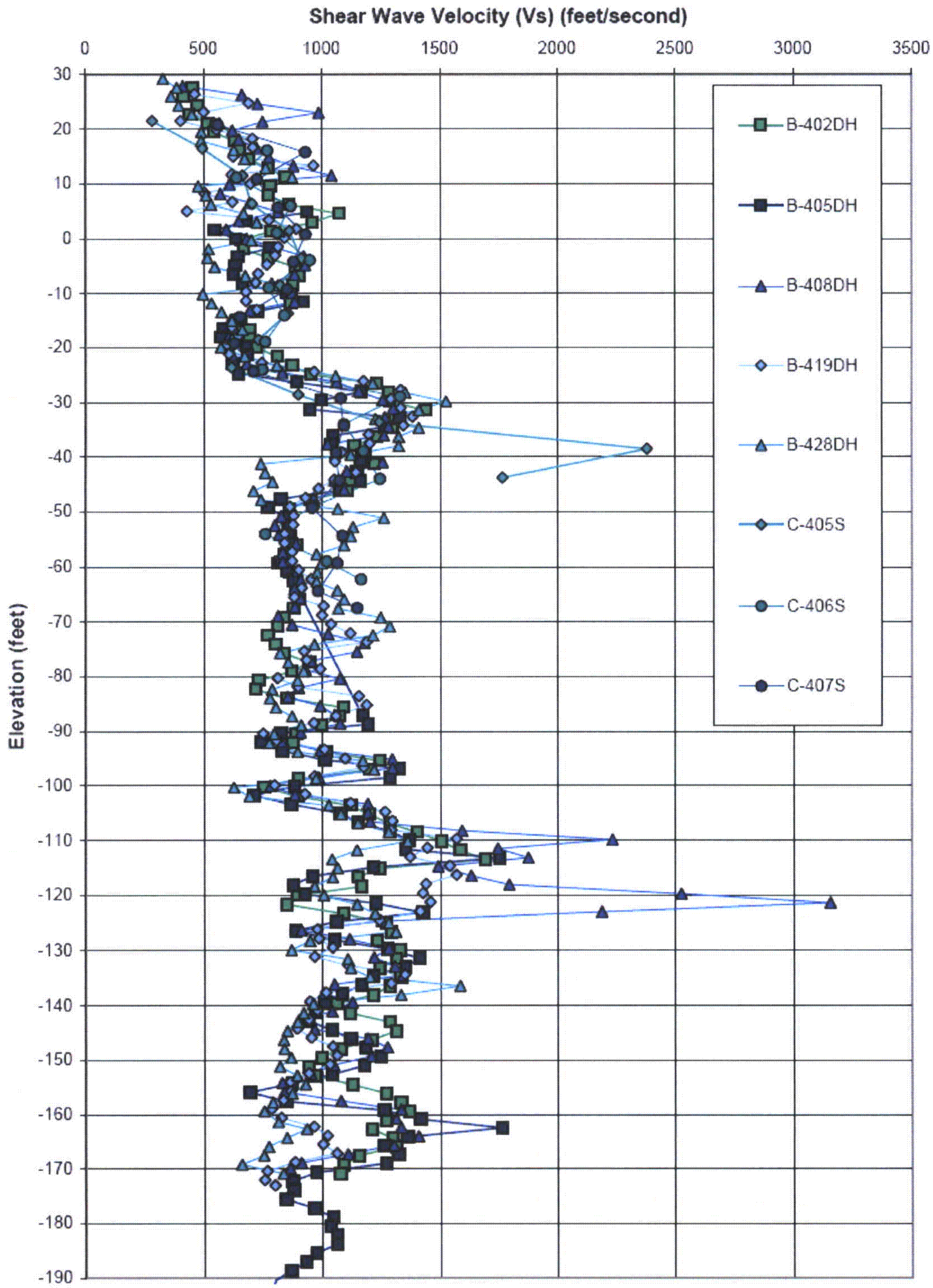


Figure 2.5S.4-41 STP 4; Shear Wave Velocity versus Depth

This figure replaces the existing Figure 2.5S.4-43 in COLA Rev 2.

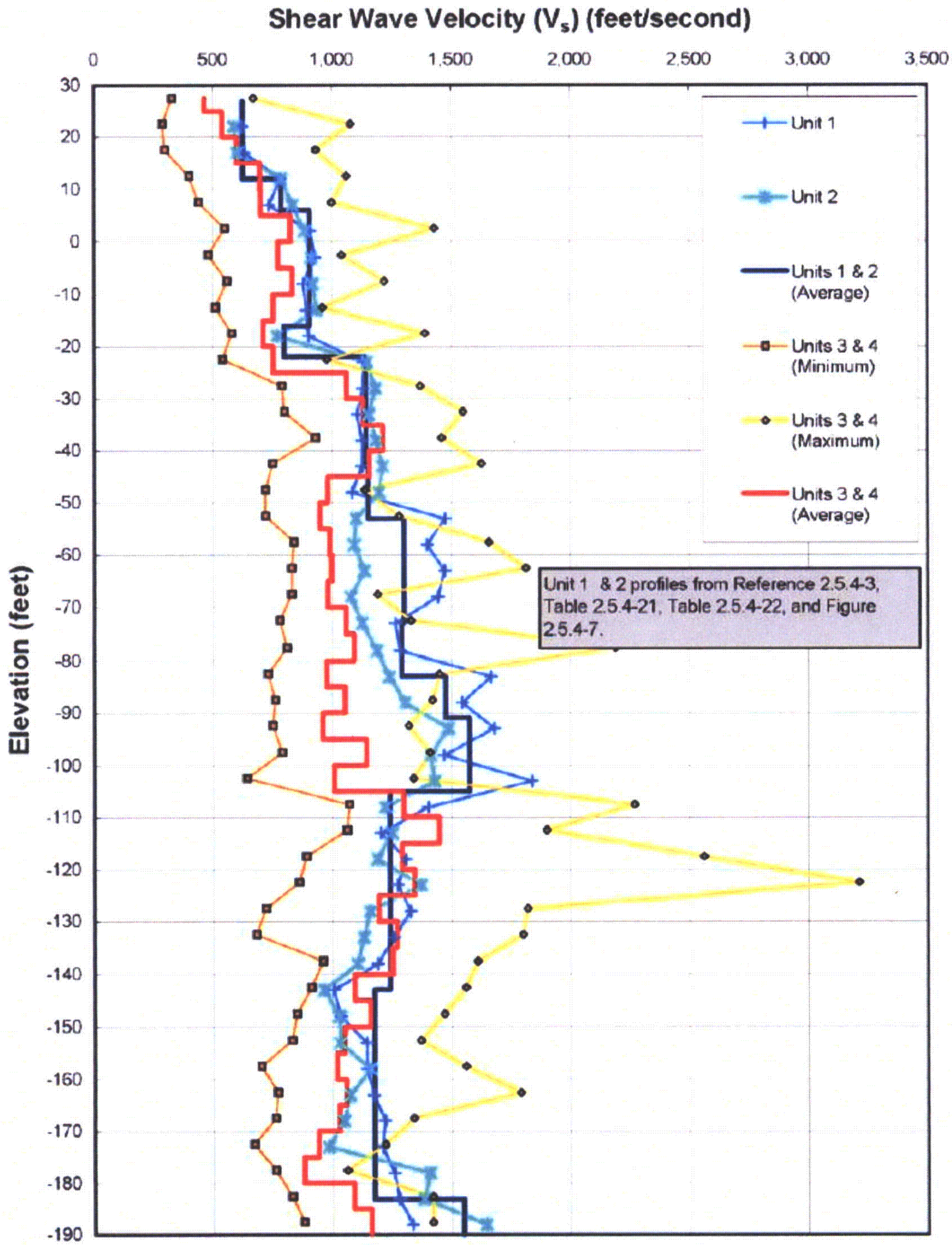


Figure 2.5S.4-43 STP 1 & 2/ STP 3 & 4; Average Shear Wave Velocity to 200 Feet Below Ground Surface

This figure replaces the existing Figure 2.5S.4-44 in COLA Rev 2.

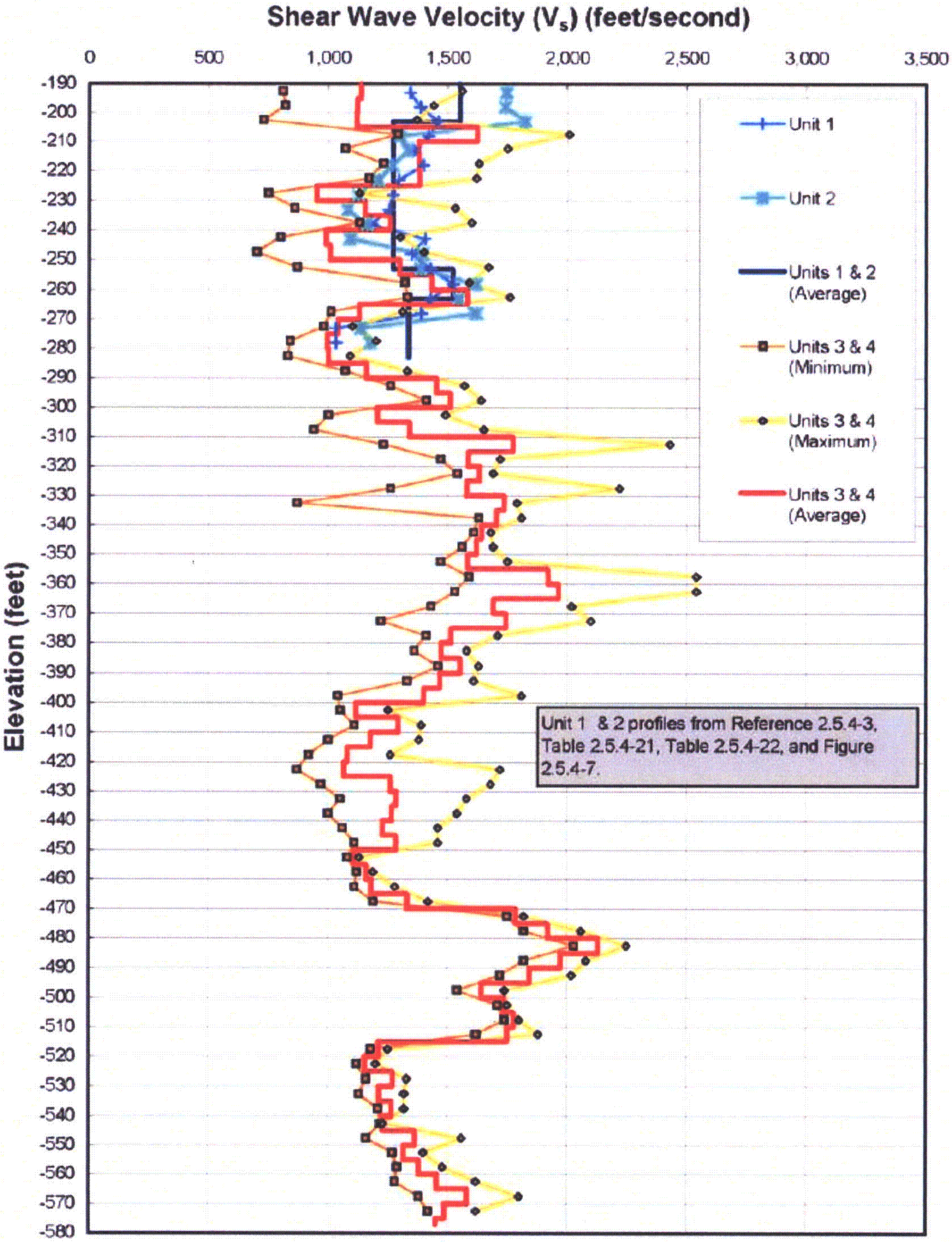


Figure 2.5S.4-44 STP 1 & 2/ STP 3 & 4; Average Shear Wave Velocity to 600 Feet Below Ground Surface

This figure replaces the existing Figure 2.5S.4-45 in COLA Rev 2.

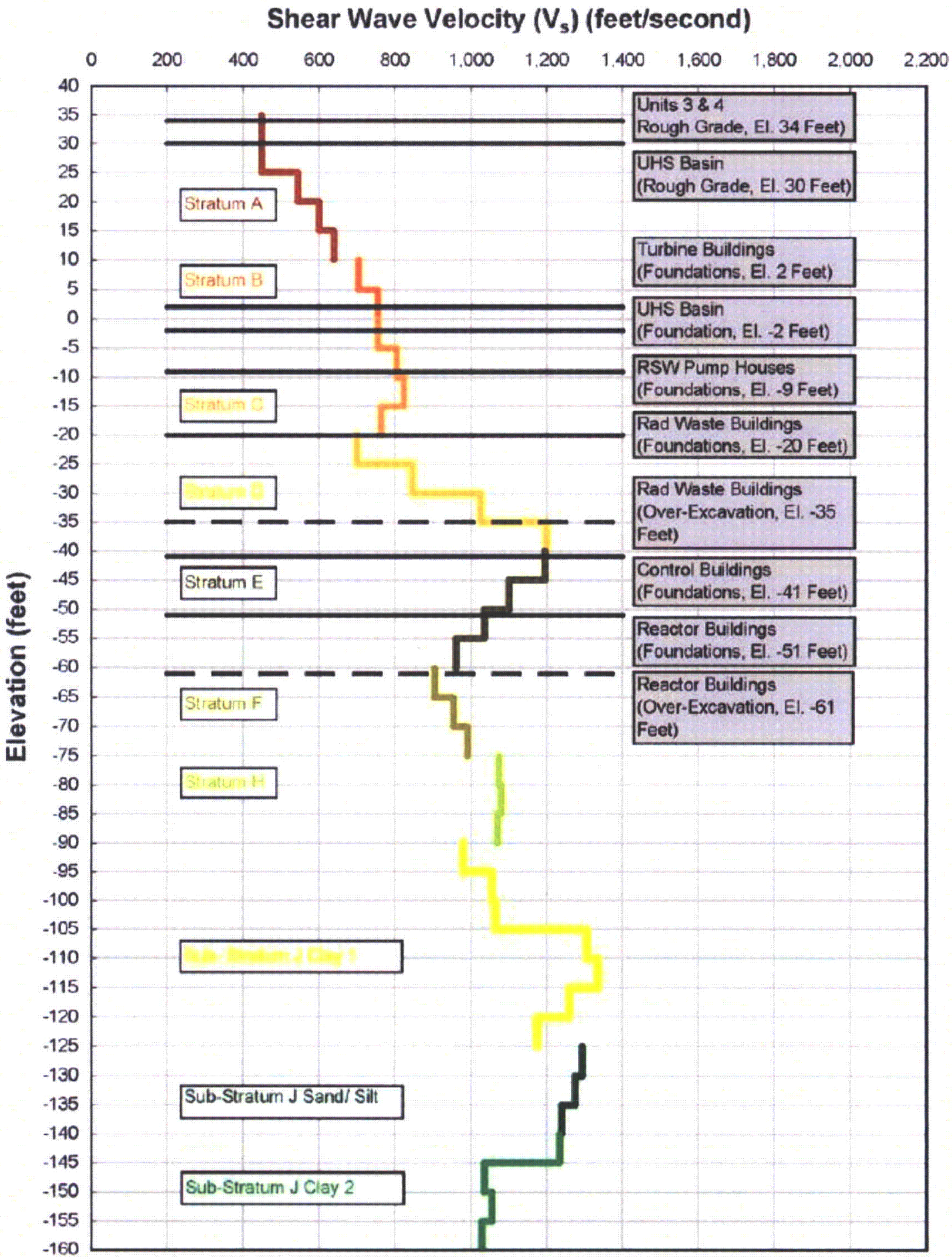


Figure 2.5S.4-45 Shear Wave Velocity –Strata A to J

This figure replaces the existing Figure 2.5S.4-46 in COLA Rev 2.

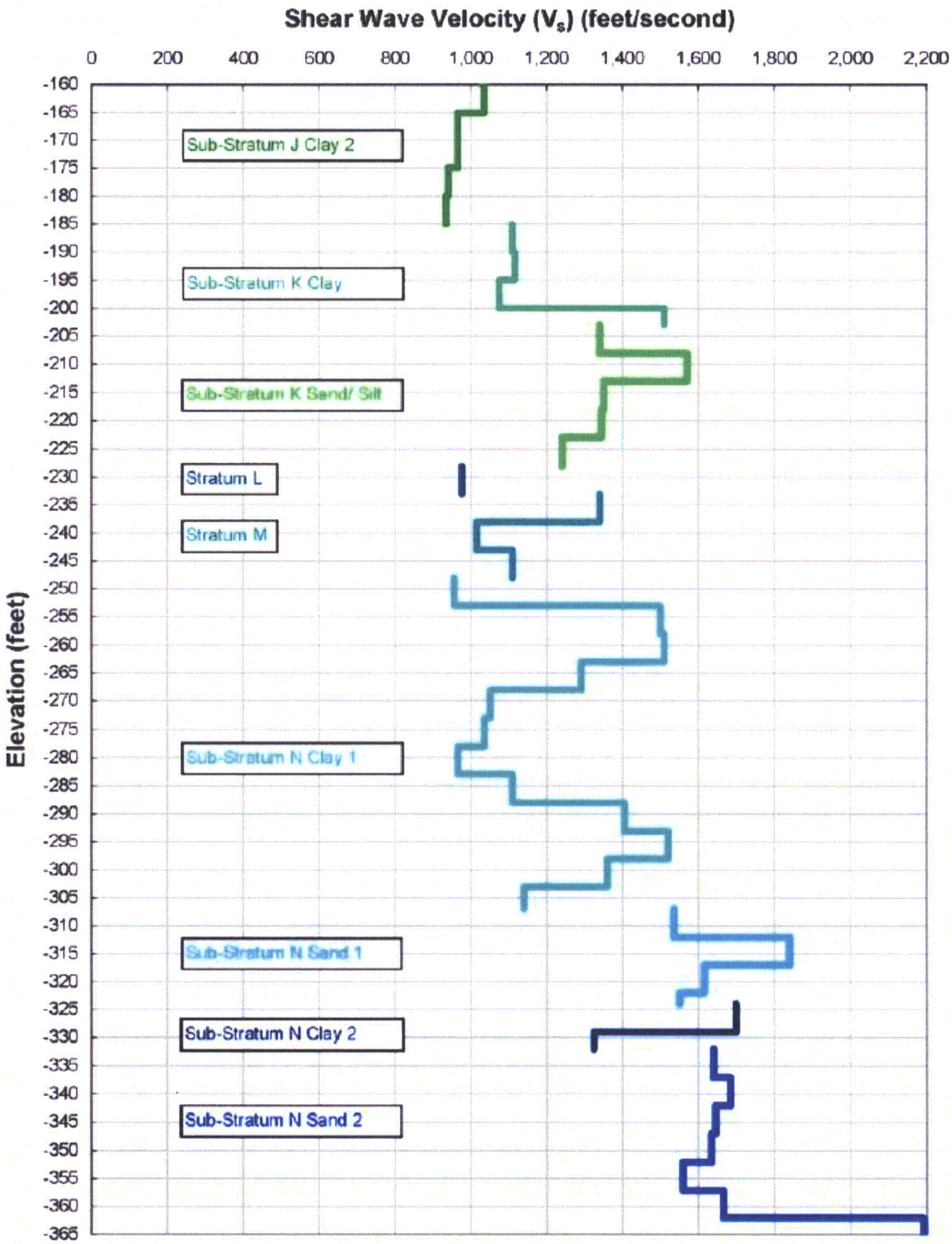


Figure 2.5S.4-46 Shear Wave Velocity –Strata J to N

This figure replaces the existing Figure 2.5S.4-47 in COLA Rev 2.

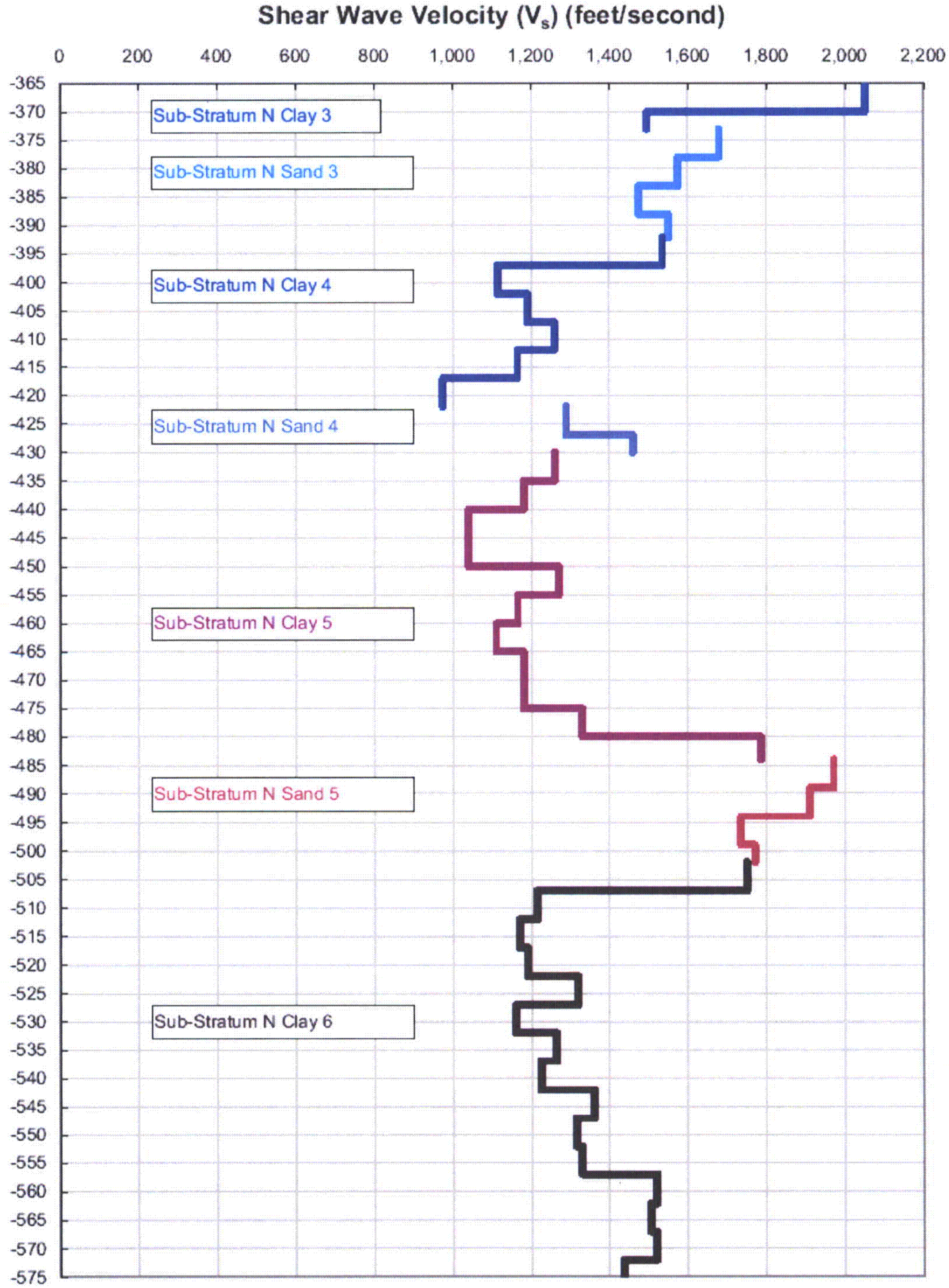


Figure 2.5S.4-47 Shear Wave Velocity Profile –Strata N to 600 Feet Below Ground Surface

This figure replaces the existing Figure 2.5S.4-57 in COLA Rev 2.

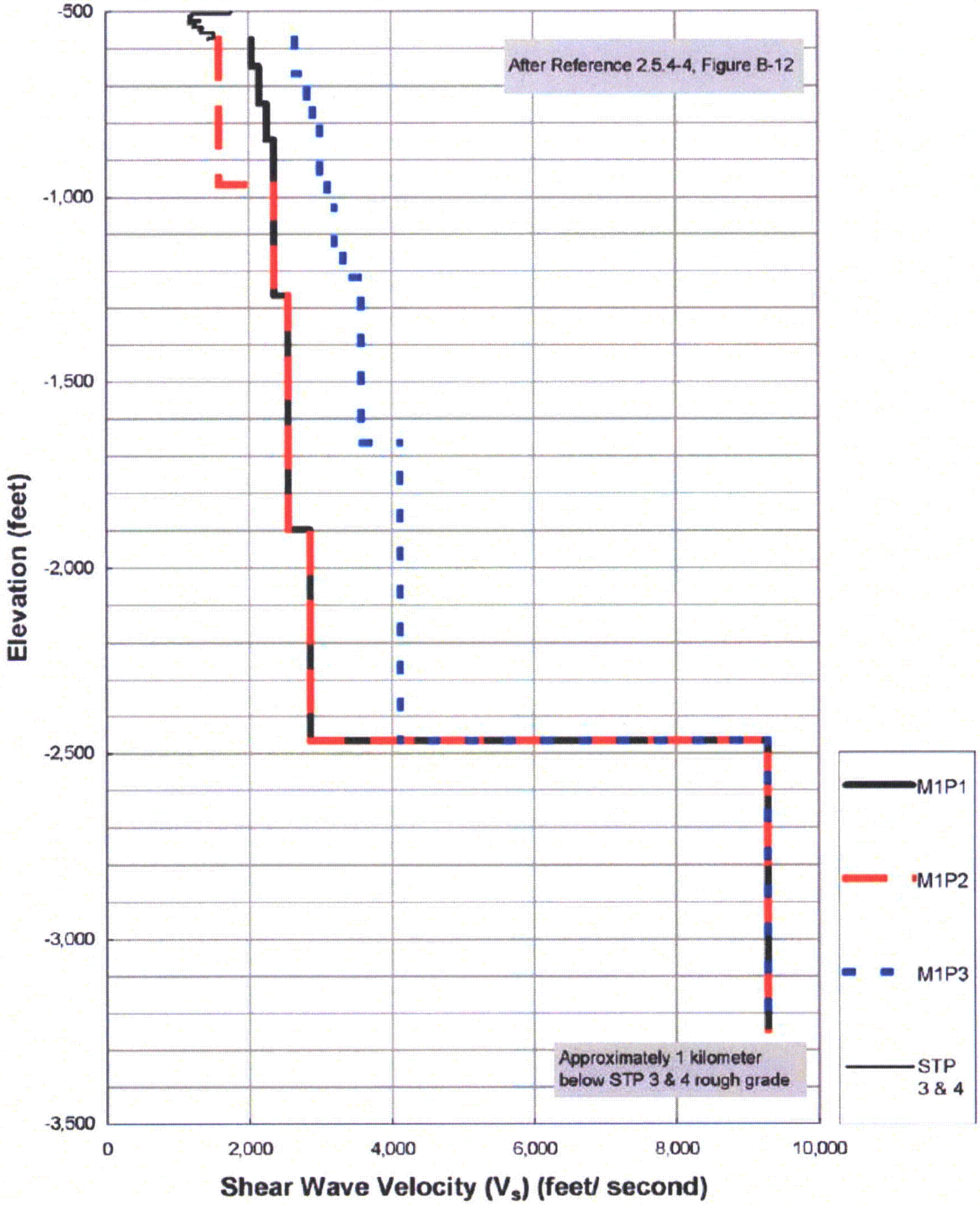


Figure 2.5S.4-57 Deep Shear Wave Velocity Profile for the STP Site

This figure replaces the existing Figure 2.5S.4-58 in COLA Rev 2.

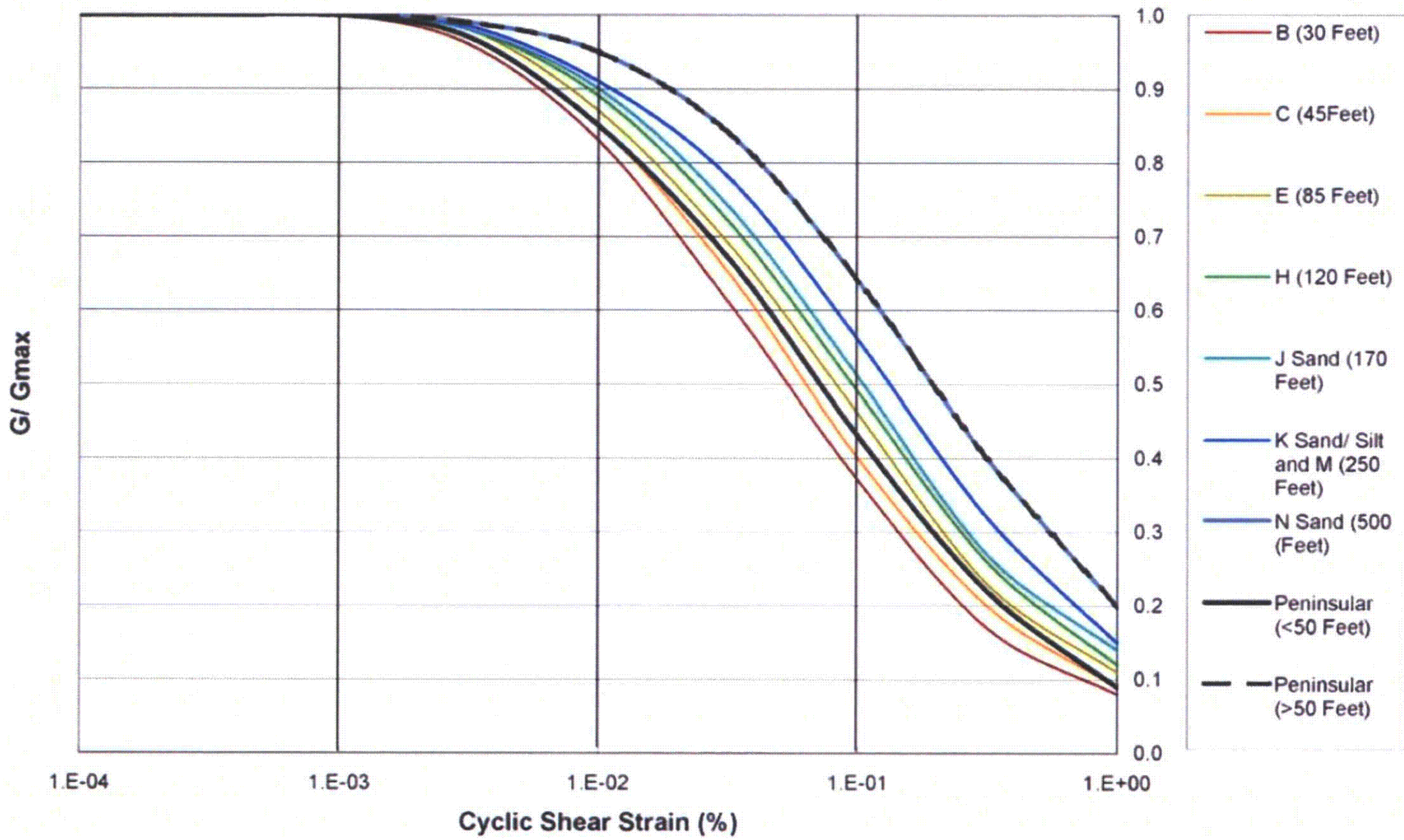


Figure 2.5S.4-58 Selected Shear Modulus Degradation Curves for Cohesionless Soil Strata

This figure replaces the existing Figure 2.5S.4-59 in COLA Rev 2.

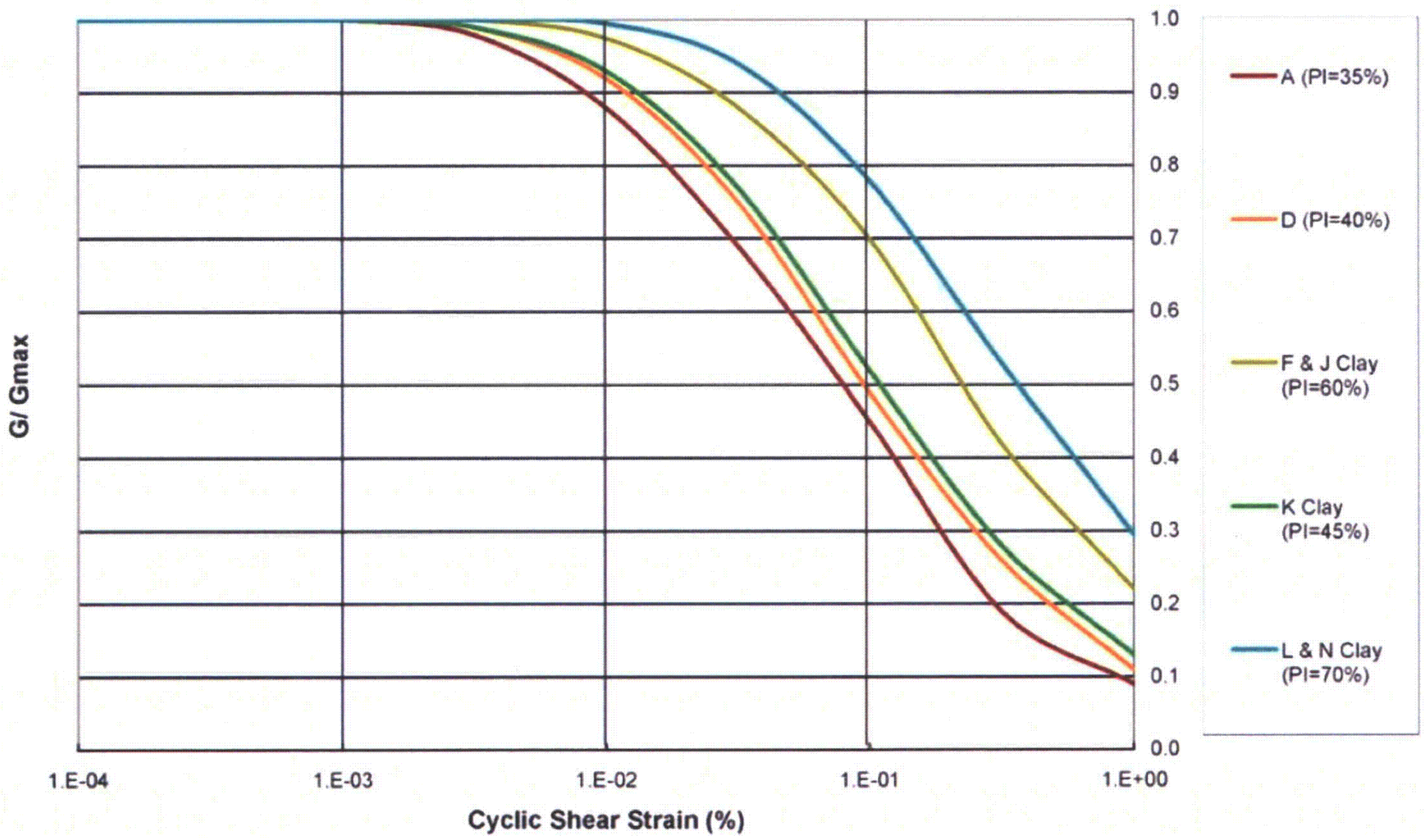


Figure 2.5S.4-59 Selected Shear Modulus Degradation Curves for Cohesive Soil Strata

This figure replaces the existing Figure 2.5S.4-60 in COLA Rev 2.

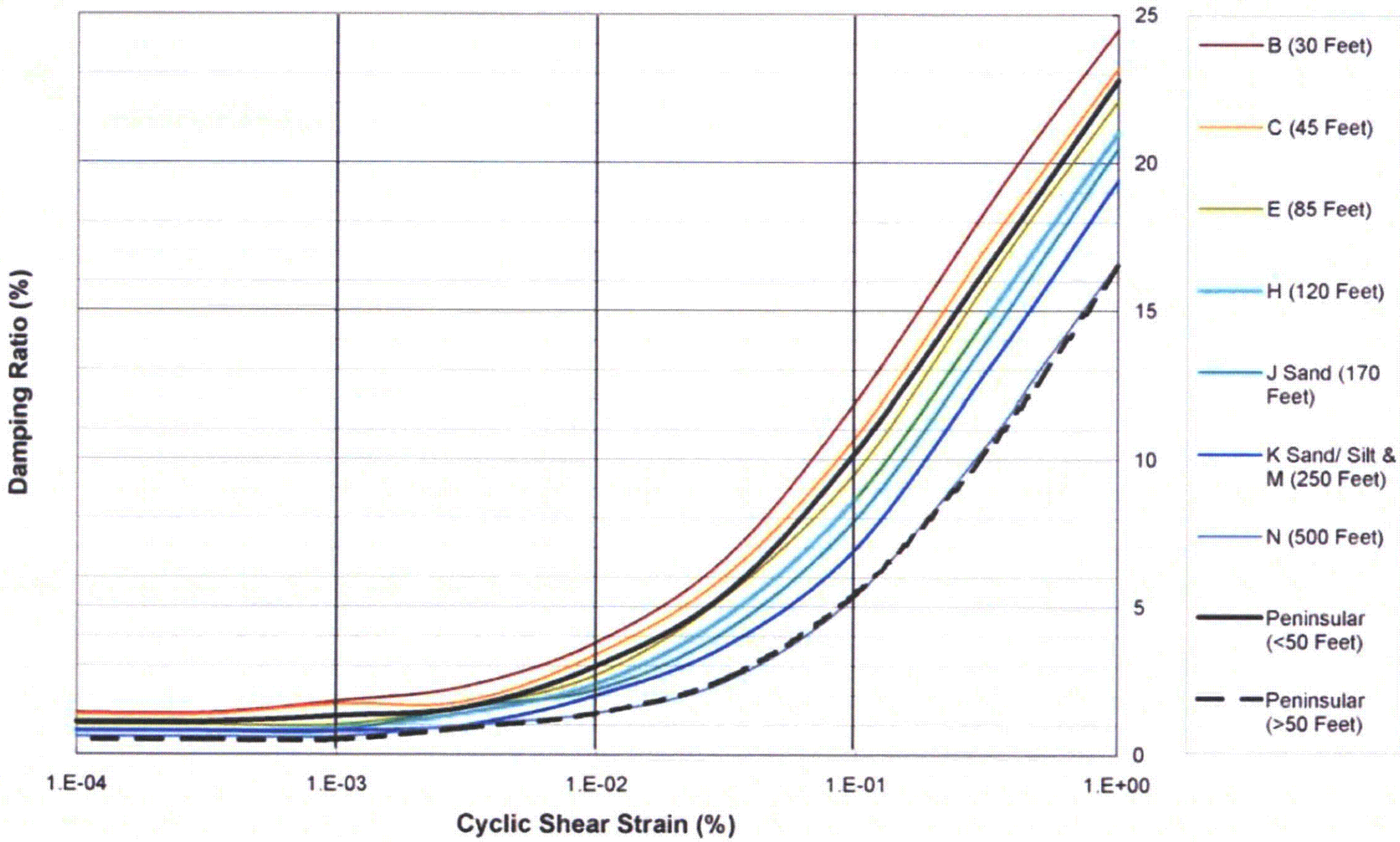


Figure 2.5S.4-60 Selected Damping Ratio Curves for Cohesionless Soil Strata

This figure replaces the existing Figure 2.5S.4-61 in COLA Rev 2.

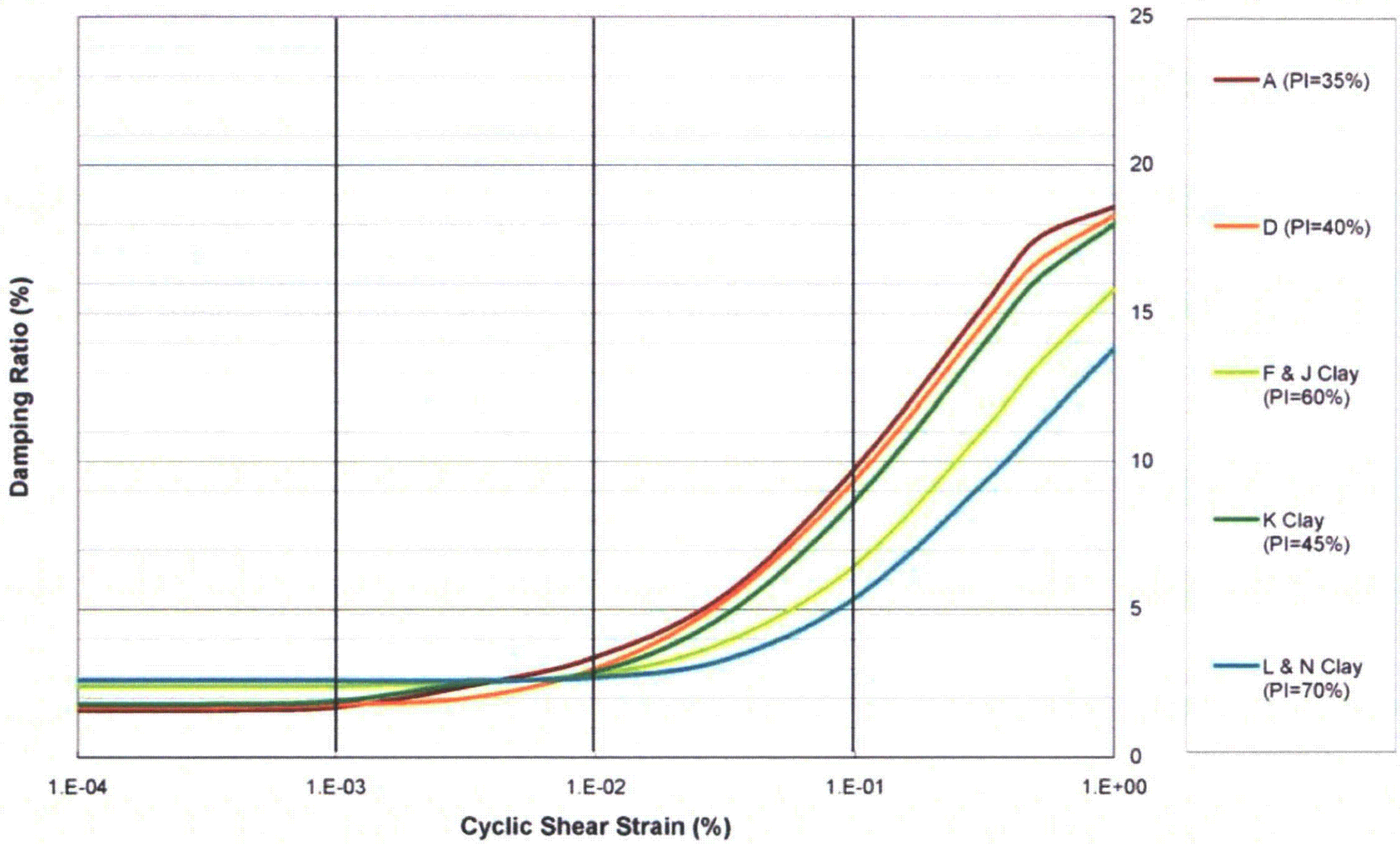


Figure 2.5S.4-61 Selected Damping Ratio Curves for Cohesive Soil Strata

This is a new figure and replaces the existing Figure 2.5S.4-62 in COLA Rev 2.

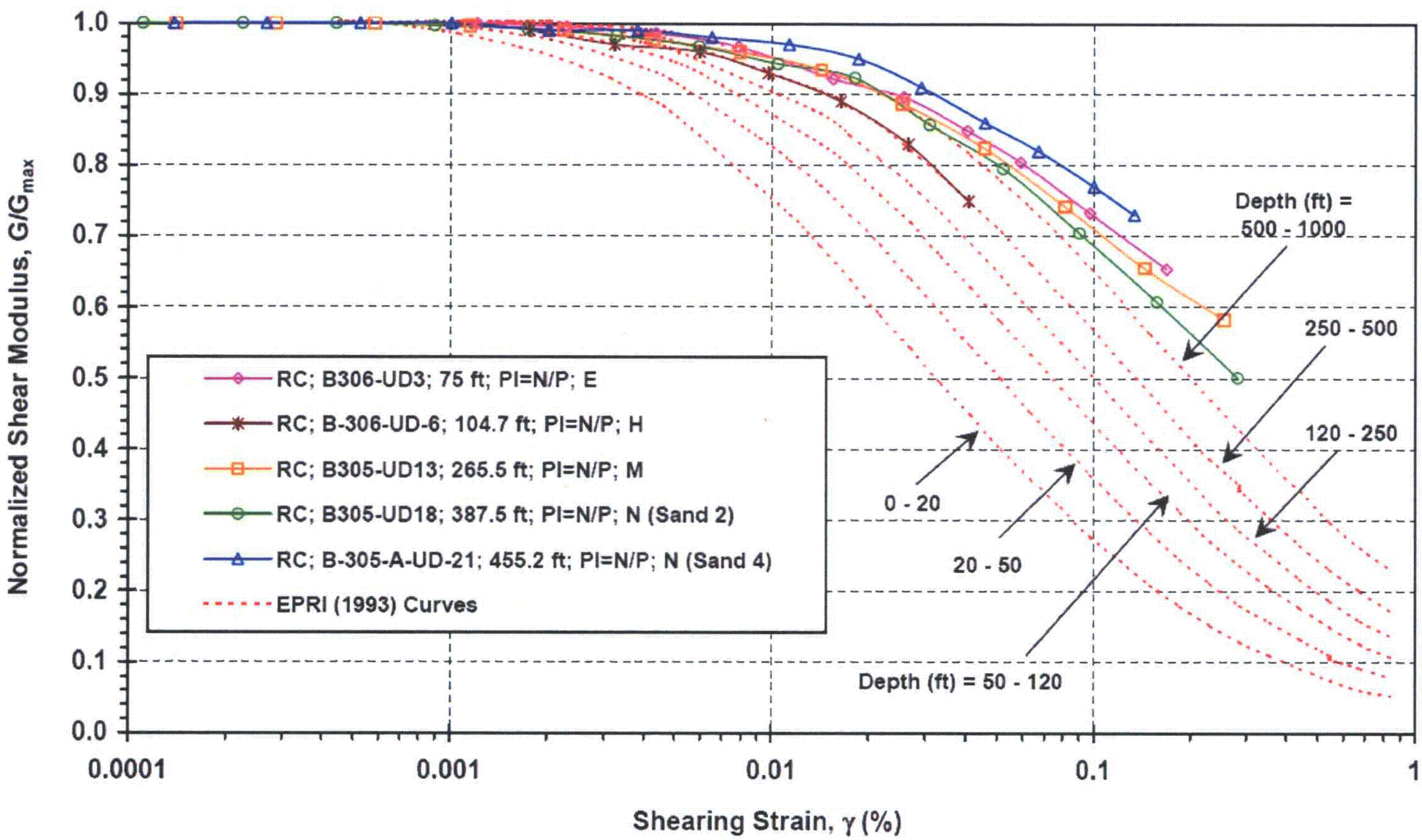


Figure 2.5S.4-62 Shear Modulus Degradation Based on RCTS Testing – All Sand Samples

This is a new figure and replaces the existing Figure 2.5S.4-63 in COLA Rev 2.

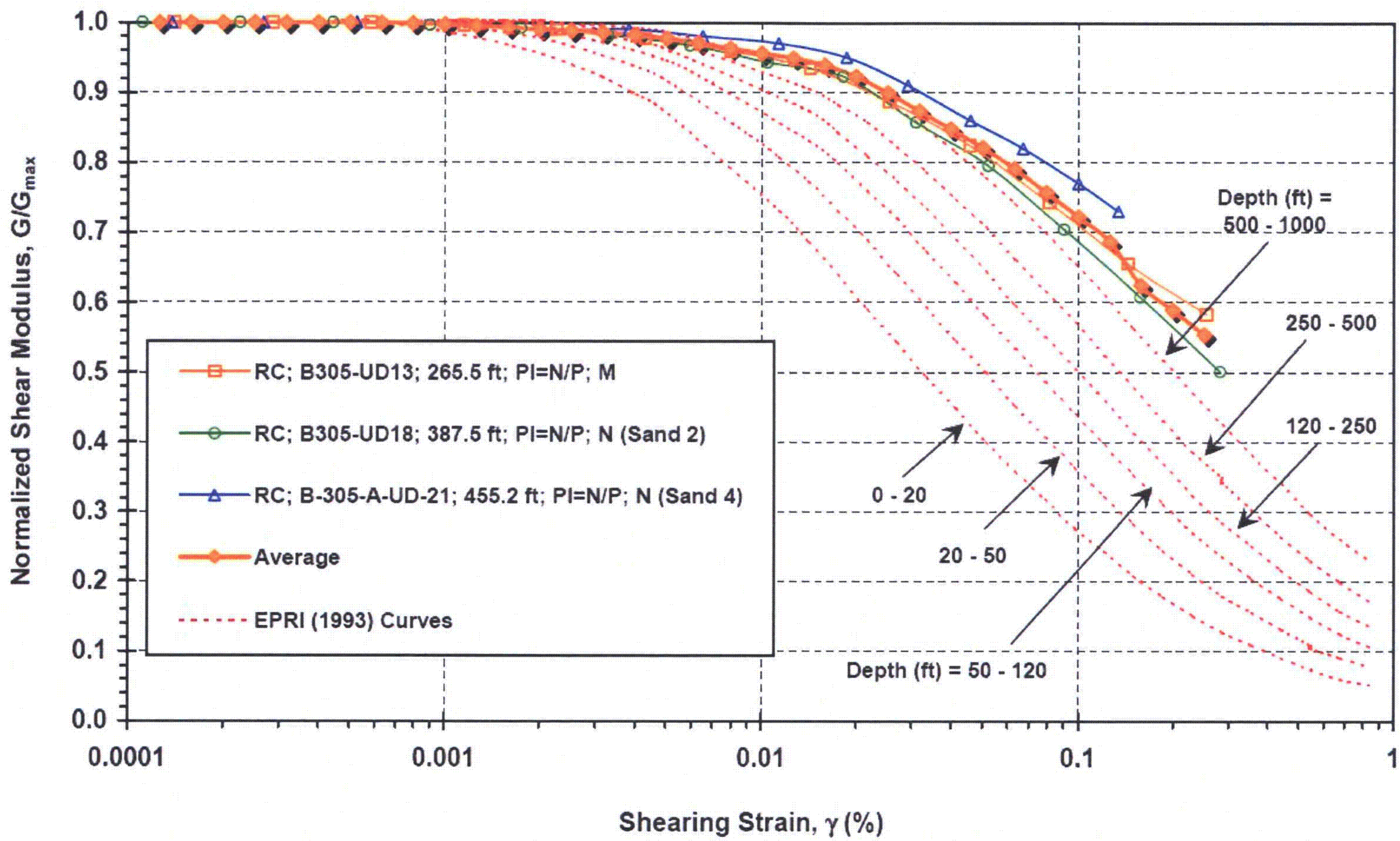


Figure 2.5S.4-63 Shear Modulus Degradation Based on RCTS Testing – Deep Sand Samples

This is a new figure and replaces the existing Figure 2.5S.4-64 in COLA Rev 2.

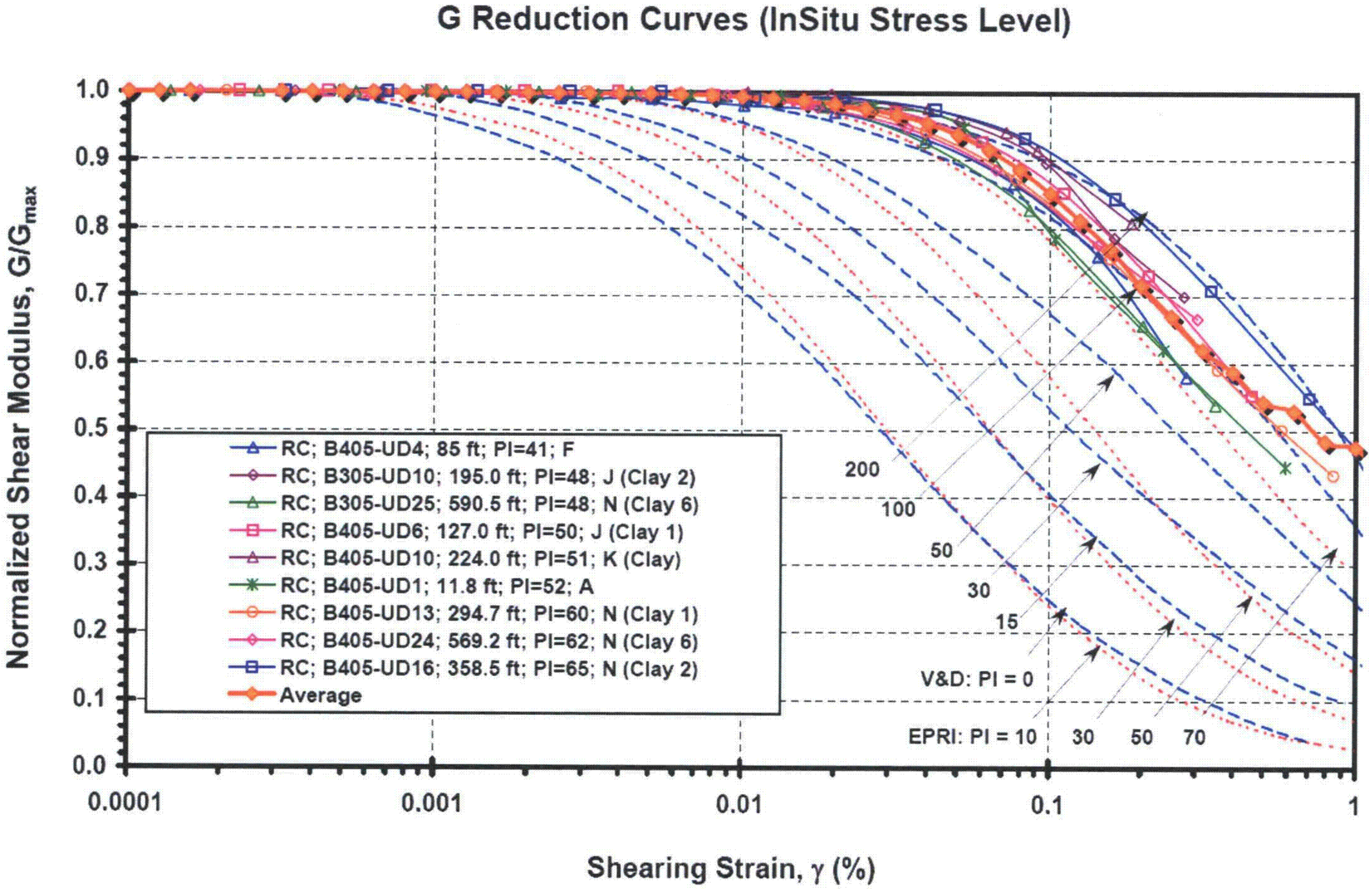


Figure 2.5S.4-64 Shear Modulus Degradation Based on RCTS Testing – High PI Clay Samples

This is a new figure and therefore Figure 2.5S.4-65 in COLA Rev 2 was renumbered.

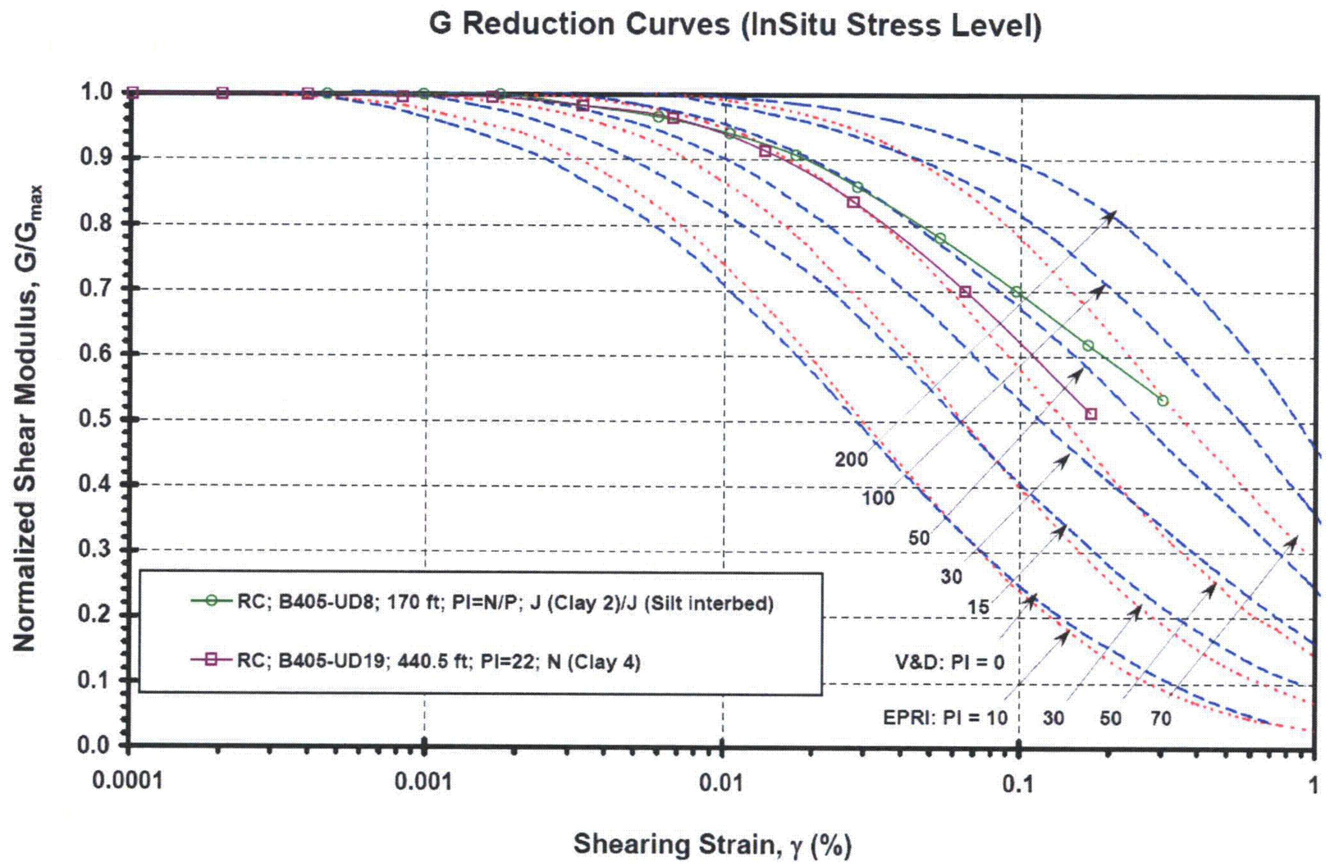


Figure 2.5S.4-65 Shear Modulus Degradation Based on RCTS Testing – Low PI Clay Samples

This is a new figure and therefore Figure 2.5S.4-66 in COLA Rev 2 was renumbered.

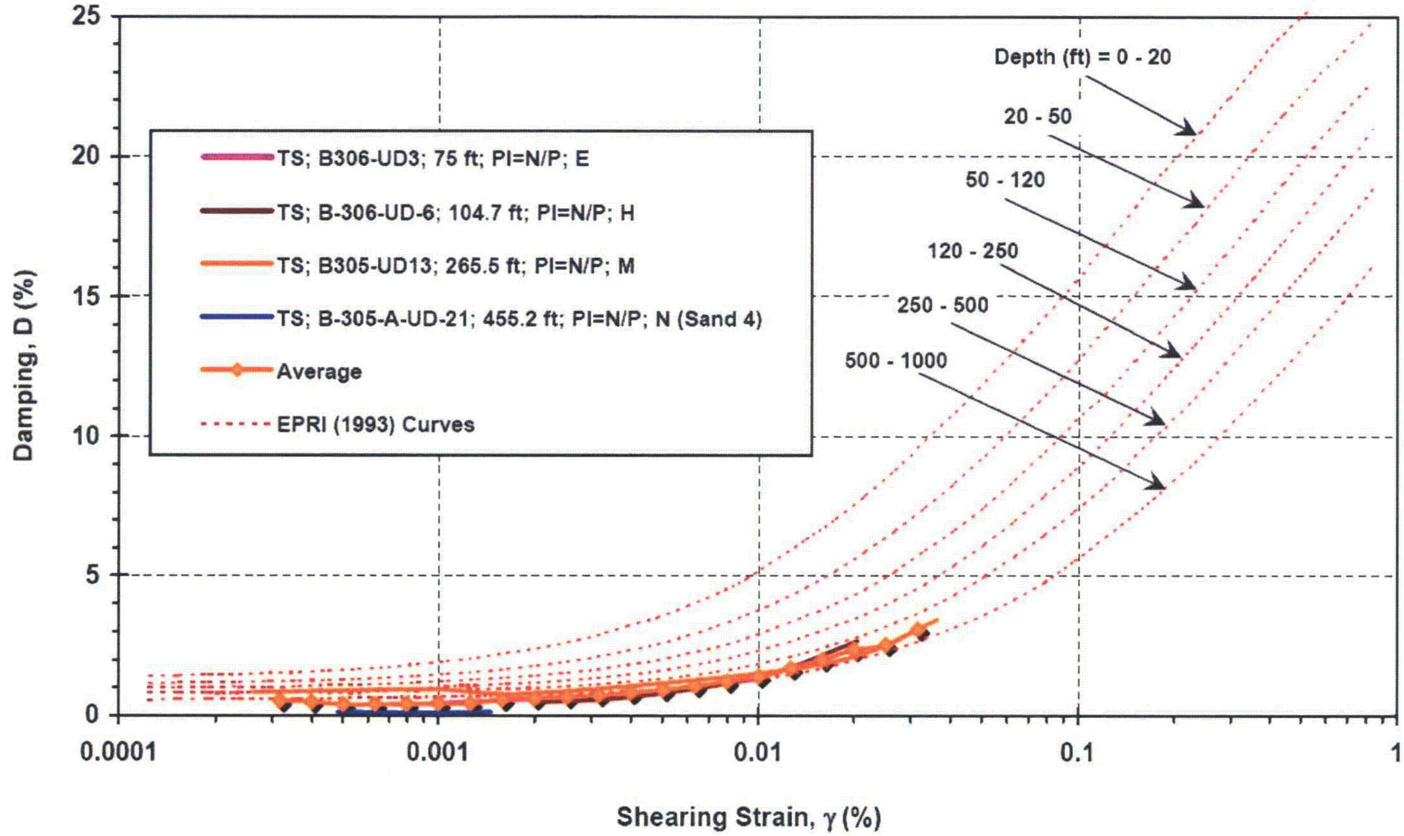


Figure 2.5S.4-66 Damping Curve Measurements Based on RCTS Testing – Sand Samples

This is a new figure and therefore Figure 2.5S.4-67 in COLA Rev 2 was renumbered.

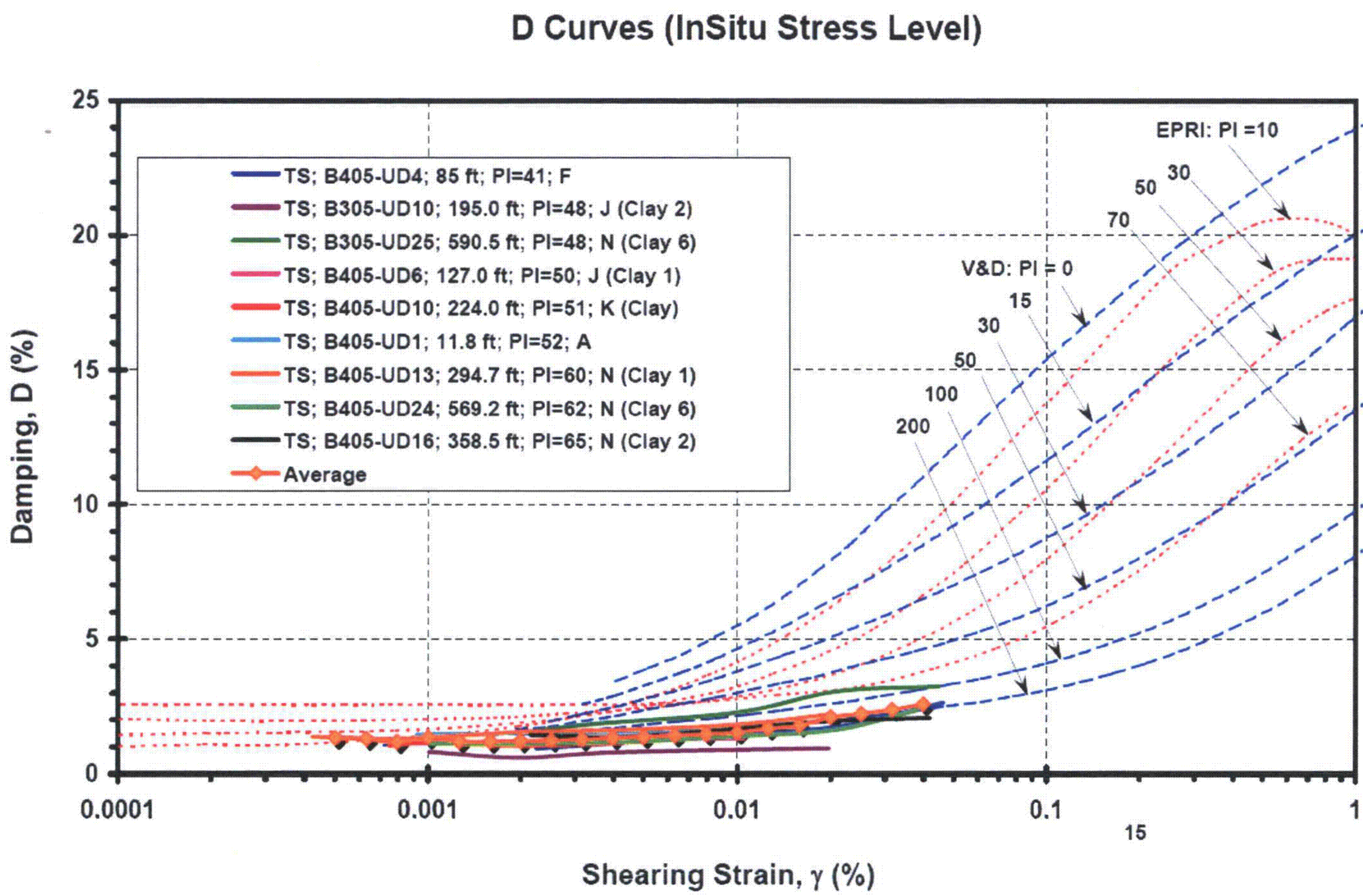


Figure 2.5S.4-67 Damping Curve Measurements Based on RCTS Testing – High PI Clay Samples

This is a new figure and therefore Figure 2.5S.4-68 in COLA Rev 2 was renumbered.

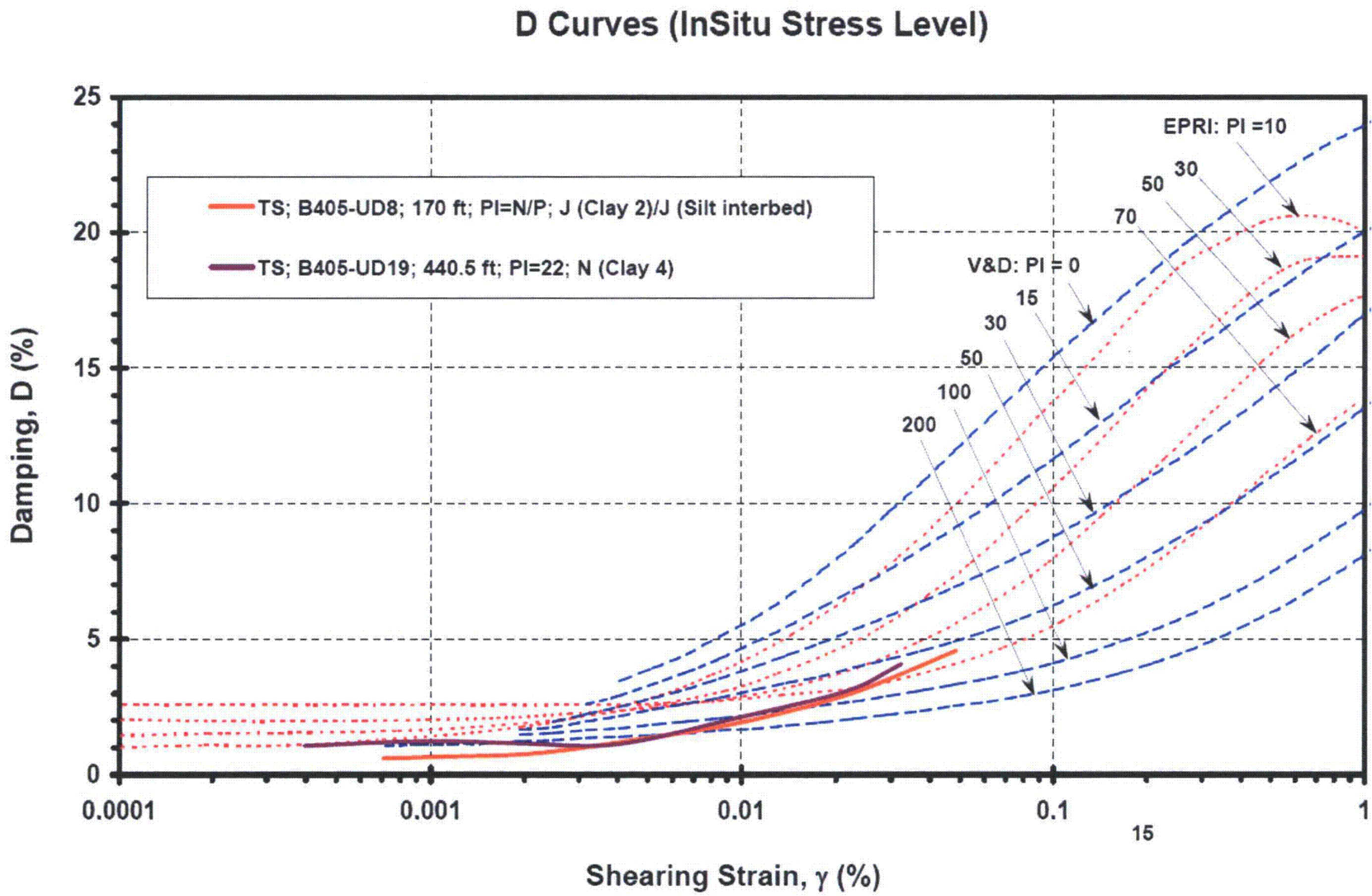


Figure 2.5S.4-68 Damping Curve Measurements Based on RCTS Testing – Low PI Samples

RAI 02.05.04-24

Question

In the response to RAI 2.5.4-2 regarding the design of the temporary slopes, you performed stability analyses for the temporary excavation and obtained acceptable factors of safety for the shear strength parameters used, phi = 25 to 28 degrees and cohesion = 300 psf. It is stated in the slope stability writeup that more information is being sought and that the shear strength parameters will be verified. Case histories document that permanent cut slopes in stiff fissured clays suffer strength loss over time, and it is generally recommended that the cohesion component of strength be set to zero for conservatism for permanent cut slopes. Given the temporary nature of the slopes, some cohesion may be operative for the duration of the open excavation. However, your write up does not address the potential for progressive failure or potential strength degradation and the staff would like you to discuss whether or not it was considered.

Please provide a discussion of your evaluation of the operational shear strength of the stiff fissured Beaumont clay for the open excavation duration. How does the duration of the open excavation for Units 1 and 2 compare with the projected construction schedule of Units 3 and 4? Are there any other long term deep excavations in the Beaumont clay that would substantiate your assumptions?

Response

Geotechnical literature reports numerous studies evaluating strength reduction in over-consolidated clay soils. One of these studies, Technical Report FHWA/TX-07/0-5202-3 by the Center of Transportation Research (CTR) University of Texas at Austin (UT) for TxDOT, evaluates the fully-softened shear strength of Eagle Ford Shale in Texas and compares the results to Beaumont clay. Beaumont clay underlies the STP project site. Although this research evaluated slopes consisting of compacted fill, the study also provides a literature study which includes studies on natural, excavated slopes. A summary of applicable research is provided in the following paragraph.

Research from Skempton (1964, 1970, 1977), Mesri and Shahien (2003), and Gulla et. al (2006) suggest causes for progressive failure and reduction in shear strength as the presence of fissures, residual strength development, and weathering (wetting, drying, freezing, thawing). Much of Skempton's research was on first-time slides in natural and excavated slopes in London Clay. Skempton's research was conducted on London Clay, a stiff and fissured over-consolidated clay. The London Clay could be characterized as having similar properties such as the stiffness and fissures as the Beaumont clay. Skempton (1970) concluded that the fully softened shear strength of natural and excavated over-consolidated natural clay slopes is numerically equal to the peak shear strength of soil in its normally consolidated state. Gulla's research (2006) also concluded that strength of highly plastic specimens approaches that of normally consolidated specimens. Although the UT report evaluates compacted subgrade, it supports previous research of a reduction in strength of high plasticity clays to the fully softened, or normally consolidated, shear strength.

As indicated, a drained cohesion value of 300 psf was used for slope stability analyses. The average drained shear strength values obtained from project laboratory testing performed on clay strata specimens, with the exception of Stratum A, ranged from 1.0 to 2.3 ksf. Shear strength testing was not performed in Stratum A, which is a relatively thin stratum at the surface. The drained cohesion value used for slope stability analyses is significantly less than the tested values in an over-consolidated state. Although a value of zero for an effective cohesion was not used, consideration was given to using a value representative of a fully softened, or normally consolidated, strength, and the potential for strength reduction and progressive failure over time. Furthermore, the slopes proposed for the Units 3 and 4 excavations, which are scheduled to be open for approximately 4 years, are similar in geometry to those used for the Units 1 and 2 excavations, which were open for approximately 4 years as well. The Units 1 and 2 slopes performed successfully during that construction, substantiating the assumptions. A literature search of any other long term deep excavations in the Beaumont clay was performed, but only limited literature was found concerning temporary, unsupported slopes with heights near the magnitude of those slopes that will occur in the STP 3 and 4 project.

No COLA revision is required as a result of this RAI response.

RAI 02.05.04-25

Question

FSAR Section 2.5S.4.2.1.1 "Stratum A" makes a statement following Equation 2.5S.4-4B that "Equation 2.5S.4-4B is indicated by Reference 2.5S.4-55 for use if the plasticity index is less than 30 or for silty or sandy clay. Strata J Clay, K Clay, L and N Clay are considered to be somewhat more sandy clays and will be characterized by Equation 2.5S.4-4B even though they have average plasticity index values greater than 30." A quick check of these soil layers in the summary tables, seems to indicate low sand percentages, typically less than 25 percent. No results were provided for layer L Clay.

Please provide additional data to support your assumption of sand-like behavior and the use of the higher value of elastic modulus applicable for cohesive soils with PI less than 30.

Response

The range in plasticity index values selected for use as shown in Table 2.5S.4-16 from RAI response U7-C-STP-NRC-090012 Attachment 3, RAI 02.05.04-13, Supplement 1 is 35 to 50 and the range of fines content is 79 to 96 (i.e., 4 to 21 percent sand/gravel) in Strata A, J, K, L, and N. Reference 2.5S4-55 indicates that Equation 2.5S4-4B is applicable to clay soils with a plasticity index values less than 30 (or sand-like behavior), but also indicates it is applicable for stiff soils. The assumption to use Equation 2.5S4-4B to obtain the higher values of elastic modulus is justified by the stiff to hard consistency of the Stratum A, J, K, L, and N clay soils. Information found in RAI response U7-C-STP-NRC-090012 Attachment 3, RAI 02.05.04-13, Supplement 1 to justify the stiff to hard consistency is summarized in the following paragraph.

As indicated in Table 2.5S.4-16, corrected SPT N_{60}-values values of Stratum A, J, K, L, and N selected for use range from 11 to 54 bpf. According to the reference Terzaghi and Peck "Soil Mechanics in Engineering Practice" 1968, corrected SPT N_{60}-values, in clays greater than 8 blows per foot are considered stiff to hard. As indicated in Table 2.5S.4-16, undrained shear strength values, S_u, values of Stratum A, J, K, L, and N selected for use range from 1.5 to 4.5 ksf. The unconfined compressive strength, q_u, is derived by multiplying the undrained shear strength, S_u, provided in Table 2.5S.4-16 by 2. The unconfined compressive strength, q_u, values of Stratum A, J, K, L, and N range from 3.0 to 9.0 ksf. According to Sowers "Soil Mechanics and Foundations" 3rd Edition and Terzaghi and Peck "Soil Mechanics in Engineering Practice" 1968, q_u values greater than 2.0 ksf are considered stiff to hard. As indicated in Table 2.5S.4-16, elastic modulus, E_s, values of Stratum A, J, K, L, and N selected for use range from 1,135 to 7,855 ksf. According to Reference 2.5S4-55, E_s values from 1,000 to 2,000 ksf are considered hard, which is consistent with SPT N_{60}-values and undrained shear strength value correlated consistencies.

The RAI response U7-C-STP-NRC-090012 Attachment 3, RAI 02.05.04-13, Supplement 1 includes fines content, liquid limit and plasticity index, strength, and elastic modulus results for Stratum L Clay as shown in Section 2.5S.4.2.1.10 and Table 2.5S.4-16.

No COLA revision is required as a result of this RAI response.

RAI 02.05.04-26

Question

Equations 2.5S.4-4A and 4B relating the elastic modulus to shear strength and OCR were obtained from Reference 2.5S.4-55. The equations offer a range of values of multipliers to be applied to the shear strength to compute the Es. From this range you selected mid-range values. The same reference also indicates that for overconsolidated soils that are excavated and may heave due to the reduction in overburden stress, the resulting Es is smaller, and perhaps very much smaller. You stated that heave on the order of 4 inches to 5 inches will occur during excavation of the overburden. The heave is expected to recompress with reloading. The staff has the following questions regarding settlement predictions based on estimated Es and the recommendations of Reference 2.5S.4-55. How is the reduction in Es due to heave accounted for in the settlement predictions?

Response

Reference 2.5S.4-55 indicates theoretically all heave should be recovered when loads are applied, but in practice may not occur. However, it is also stated in the reference that it is very difficult to predict either the amount of heave or the amount recovered. There are no currently reliable theories available for prediction of heave or settlement when heave occurs and considerable engineering judgment is required. At the completion of the settlement analyses, the predicted results of Units 3 and 4 were compared to the actual settlements reported from Units 1 and 2. The actual settlements of Units 1 and 2 compared well with the predicted settlements when considering the size, bearing level, and shape differences between the Unit 1 and 2 structures, and the Units 3 and 4 structures. This provides confidence that the selected mid-range values for Es used to determine the constrained modulus and settlement were valid.

No COLA revision is required as a result of this RAI response.

RAI 02.05.04-27

QUESTION:

FSAR Table 3.0-11 of Part 9: ITAAC, "ITAAC For Backfill Under Category I Structures," (1) does not specify the inspections, tests, or analyses that will be used to ensure that the properties of the selected backfill meet the ABWR design control document (DCD) Tier I requirements, (2) only commits to meeting minimum density values, and (3) does not provide specific acceptance criteria. The10 CFR 100.23 (d) (4) requires that "Each applicant shall evaluate all siting factors and potential causes of failure, such as the physical properties of the materials underlying the site ...," and Regulatory Guide 1.206 section C.I.2.5.4.5, "Excavations and Backfill" states that the applicant should discuss "sources and quantities of backfill and borrow, including a description of exploration and laboratory studies and the static and dynamic engineering properties of these materials." Please describe how you will ensure that (1) the field backfill meets the requirement of ABWR DCD on minimum shear wave velocity of 1000 fps as listed in the Tier I criteria, and (2) meets or exceeds the engineering properties and strength parameters assumed for the backfill in stability analyses (bearing capacity, settlement, and lateral earth pressure, liquefaction etc.).

RESPONSE:

STP COLA Tier 1, Table 5.0, "ABWR Site Parameters," Note [6], and COLA FSAR Table 2.0-2, "Comparison of ABWR Standard Plant Site Design Parameters and STP 3 & 4 Site Characteristics," Note [6a], already include the clarification:

> Shear wave velocities at multiple depths below the foundation of seismic Category I structures are less than 305 m/s (1,000 ft/sec). The deviations from the minimum shear wave velocity requirement will be justified by site-specific soil structure interaction analysis.

STP was notified by the NRC via telephone that RAI question 02.05.04-27 is being revised and will be re-issued under the same question number in recognition of the information provided in Tier 1, Table 5.0, Note [6], and FSAR Table 2.0-2, Note [6a]. A complete response to this RAI question will be provided when the revised question is issued.

No COLA changes are required in response to this RAI.

RAI 02.05.04-28

Question

In FSAR 2.5.4.8, "Liquefaction", the results of liquefaction analyses based on STP N-values, CPT tip resistance and shear wave velocities were presented in some detail for factors of safety less than or equal to 1.1. In view of the small number of data points having factors of safety of less than 1.1 that will remain after construction, you concluded that liquefaction potential was nil. In response to RAI 2.5.4-5, you stated that graphic presentation of liquefiable zones below power block safety related structures was not possible because there are no liquefaction zones. Regulatory Guide 1.198, Section 3.2, "Factor of Safety Against Liquefaction", recommends that for factors of safety less than 1.1 and factors of safety between 1.1 and 1.4, that stability and deformation analyses should be performed with assigned strength values commensurate with the amount of pore water pressure generation. Your presentation in the FSAR does not address strength degradation for factors of safety between 1.1 and 1.4. Without a detailed explanation of those results, the liquefaction and/or strength degradation issue is not fully addressed. The staff needs the following information and data to close out this issue.

a. Discussion of pore-water generation and post-earthquake strength for soils that have factors of safety less than 1.4.

b. Discussion of post-earthquake stability of safety-related structures and/or potential interaction with adjacent non-safety related structures as a result of either liquefaction or strength loss.

c. Factor of safety statistics in the form of a histogram for the results for each of the three methods used to compute liquefaction potential site-wide and structure specific.

In addition, the staff requests that you provide all the data required to perform SPT, CPT and shear wave velocity liquefaction analyses in electronic format in order for the staff to perform confirmatory analyses. The data needed to perform these independent liquefaction assessments is as follows:

- SPT, N60 values (varying with depth, for all borings used for testing) CPT, tip resistance (qc) and sleeve resistance (fs) (varying with depth, for all borings used for testing) Shear Wave Velocity (Vs) (varying with depth, for all borings used for testing)

This data has already been provided but they are in non-searchable pdf documents. It is requested that the data be provided in electronic format (for instance, on an Excel spreadsheet), to ensure the accuracy of the assessment.

Response:

The following response addresses each of the questions listed above and is followed by a markup of FSAR Section 2.5S.4.8, which will be submitted as part of STP COLA Revision 3, and additional supplemental information supporting this response that will not be incorporated into the FSAR. Additionally, Enclosure 1 contains supporting data in the requested format to enable the NRC to perform an independent liquefaction assessment.

a.) Reduction in post-earthquake strength for soils that have factors of safety (FOS) less than 1.40 is not an issue because such safety factor occurrences are not congregated as can be determined by examination of FSAR Figure 2.5S.4-79, provided as part of the FSAR markup, and supplemental Figures 39 through 49, which are also included with this response. Pore water pressure generation is assessed via estimations of post-earthquake settlement.

FSAR Figure 2.5S.4-79 depicts the spatial distribution of FOS values less than 1.10 and supplemental Figures 39 through 49 depict the spatial distribution of the FOS values between 1.10 and 1.40 for each stratum site wide for each of the three methods used to compute liquefaction potential. The plotted borings on FSAR Figure 2.5S.4-79 and supplemental Figures 39 through 49 do not illustrate a distinct pattern, congregating, or overlapping of FOS values by either CPT and V_S or SPT and V_S.

FSAR Tables 2.5S.4-35 through 2.5S.4-37 list all FOS values less than 1.10 and supplemental Tables 1 through 3 list all FOS values greater than or equal to 1.10 and less than 1.40, for each evaluation method. For each FOS value or sequence of values, its disposition is listed.

b.) Post-earthquake stability of safety-related structures and/or potential interaction with adjacent non-safety related structures as a result of either liquefaction or strength loss is evaluated by examining the distribution and depths of any localities having indicated factors of safety less than 1.40 that will remain in-place after construction and fuel load. The spatial distribution of the FOS values less than 1.40 that will remain in place after fuel load is depicted on supplemental Figure 50. COLA Tables 2.5S.4-35 through 2.5S.4-37 and supplemental Tables 1 through 3 list the locations and depths (elevations) of FOS values less than 1.40 that will remain in place after fuel load. The scattered locations and depth of the localities having FOS values less than 1.40 indicate that strength loss is not a factor and post earthquake stability is not compromised for any of the safety-related or non-safety related structures. Therefore, the potential for interaction between safety and adjacent non-safety related structures is negligible.

FSAR Revision 2 Figures 2.5S.4-48A and 2.5S.4-48B show the excavation plan for construction of Units 3 & 4, respectively. This excavation plan is used to identify the approximate excavation elevations for each boring. FOS values at elevations below the excavation will remain in place. Taking into account all the tests site wide below safety related structures, supplemental Table 4 provides a summary of FOS values less than 1.40 that will remain in place under nuclear safety-related structures after fuel load. Supplemental Tables 5 and 6 summarize FOS values that remain in place beneath non-nuclear safety-related structures adjacent to nuclear safety-related structures to remain in place after fuel load.

Compression estimates at depth resulting from pore water pressure generation related to FOS values less than 1.40 are listed in supplemental Tables 4 through 6. The liquefaction induced compressions follow Ishihara and Yoshimine's 1992 procedure for calculating volumetric strain using FOS and $(N_1)_{60CS}$ values or q_{c1} values as proxies for relative density. By multiplying volumetric strain expressed as a decimal by the layer thickness associated with the FOS less than 1.40, the liquefaction induced compression is calculated. Given the intervals below safety-related structures having FOS less than 1.40 are not laterally extensive and are at considerable depth beneath layers that are not compressing, the compressions in supplemental Table 4 would not likely propagate to the foundation level of the safety-related structures.

Of the non-safety related structures adjacent to safety-related structures, only the Turbine Building, which is adjacent to the Control, Radwaste, and Service Buildings, will have FOS values less than 1.40 to remain in place after fuel load. Supplemental Tables 5 and 6 list the FOS values to remain and summarize the possible vertical deformations associated with each FOS value for non-nuclear safety related structures. Given the size of the Turbine Building mat, the estimated settlements in supplemental Tables 5 and 6 could be absorbed by the mat foundation without disrupting plant operations.

c.) Supplemental Figures 1 through 26 are histograms illustrating the FOS distribution site wide for each stratum, and supplemental Figures 27 through 38 are histograms showing the FOS at each safety-related structure's location encountered in the borings. Examination of the histograms does not reveal a definitive stratum possessing a majority of FOS values less than 1.40 for any method evaluated.

The following changes to FSAR Section 2.5S.4.8, Liquefaction Potential, which are highlighted, are being incorporated into the FSAR as a result of FSAR Commitments COM 3H-2 and COM 2.5S-2.

2.5S.4.8 Liquefaction Potential

The following site-specific supplement addresses COL License Information Item 2.33.

The potential for soil liquefaction at STP 3 & 4 was evaluated following guidance given in RG 1.198 (Reference 2.5S.4-52). The current state-of-the-art, outlined in Reference 2.5S.4-5, was followed. The subsurface conditions and soil properties employed were those described in Subsection 2.5S.4.2. The peak horizontal ground surface acceleration and earthquake magnitude employed were those described in Subsection 2.5S.4.7.5.

2.5S.4.8.1 Liquefaction Potential of STP 1 & 2

The STP 1 & 2 UFSAR (Reference 2.5S.4-3) reports that liquefaction potential at that site was evaluated using SPT data from site-specific borings and using response analyses together with the results of cyclic triaxial laboratory tests. The site was evaluated for a peak ground surface acceleration of 0.10g and the equivalent of a Moment Magnitude 6 earthquake. The results showed that site soils either did not possess the potential to liquefy, or would not liquefy, under these seismic conditions.

2.5S.4.8.2 Liquefaction Potential of STP 3 & 4

As noted in Subsection 2.5S.4.2, subsurface stratigraphy of STP 3 & 4 is shown, in part, on the subsurface profiles, Figures 2.5S.4-5 through 2.5S.4-9. As discussed in Subsection 2.5S.1, the site soils, primarily Beaumont Formation deposits, are geologically old (Pleistocene age). Conventionally, only younger deposits, especially Holocene age and Recent age deposits are considered potentially liquefiable. To be complete and conservative, a comprehensive liquefaction analysis for all boring, CPT, and shear wave velocity data, and for all soil types, including those having high fines contents and/or predominantly fine-grained, was conducted.

For the purpose of liquefaction analysis, as well as for general subsurface stratification, each individual boring and CPT made at STP 3 & 4 was divided according to the various subsurface strata defined in Subsection 2.5S.4.2 (i.e., Strata A through N, excluding G and I). As such, the soils in the upper 600 feet of the site were evaluated for liquefaction, using the results of the STP 3 & 4 subsurface investigation. Soils deeper than 600 feet below ground surface are geologically old and are non-liquefiable, as further discussed in Subsection 2.5S.4.8.2.~~5~~ 6.

As described in Subsection 2.5S.4.7.5, the peak horizontal ground surface acceleration ~~for the site was selected at~~ of 0.10g, ~~together with~~ and a Moment Magnitude 7.7 earthquake was selected for use in liquefaction analysis. These values were used in the STP 3 & 4 liquefaction potential analysis.

2.5S.4.8.2.1 Liquefaction Evaluation Methodology

Liquefaction is defined as the transformation of a granular material from a solid to a liquefied state as a consequence of increased pore water pressure and reduced effective stress (Reference 2.5S.4-52). Soil liquefaction occurrence (or lack thereof) depends on geologic age, state of soil saturation, density, gradation, plasticity, and earthquake intensity and duration. The liquefaction analysis presented here employed state-of-the-art methods (Reference 2.5S.4-5) for evaluating the liquefaction potential of STP 3 & 4 site soils.

~~In brief,~~ Reference 2.5S.4-5 contains the so-called "Chinese Method" to assess the vulnerability to liquefaction or serious loss of strength in clayey soils. For the remaining soils, the ~~present~~ state-of-the-art (as defined in Reference 2.5S.4-5) considers an evaluation of data from SPT, CPT, and shear wave velocity (V_s) measurements, with the method employing SPT measurements being the most well-developed and well-recognized. Initially, a measure of the stress imparted to the soils by the ground motion is calculated, referred to as the cyclic stress ratio (CSR). Then, a measure of the resistance of soils to the ground motion is calculated, referred to as the cyclic resistance ratio (CRR). And finally, a factor of safety (FOS) against liquefaction is calculated as the ratio of the resisting stress, CRR, to the driving stress, CSR. Details of the liquefaction methodology and the relationships for calculating CSR, CRR, FOS, and other intermediate parameters such as the stress reduction coefficient (r_d), the magnitude scaling factor (MSF), the K_σ correction factor accounting for liquefaction resistance with increasing confining pressure, and a host of other correction factors, can be found in Reference 2.5S.4-5. Note that a MSF of 0.935 was used in the analyses, based on the selected earthquake magnitude. A review of the results of liquefaction potential analyses using the available SPT, CPT, and V_s data for the whole of STP 3 & 4 follows.

2.5S.4.8.2.2 Liquefaction Assessment of Clayey Soils

Laboratory tests and field performance data have shown that the great majority of clayey soils will not liquefy during earthquakes. Criteria to express these observations have been formulated as contained in Reference 2.5S.4-5 and are hereafter referred to as the "Chinese Method". The criteria state that clayey soils which satisfy all of the three following conditions should be judged to be vulnerable to liquefaction or serious loss of strength during a seismic event:

- Laboratory-determined water content greater than 90 percent of the laboratory-determined liquid limit;
- Liquid limit is less than 35 percent; and
- Clay content (<0.005 mm) is less than 15 percent.

The criteria are generally applicable to fine-grained soils (more than 50 percent of particles passing the No. 200 sieve). Initially, the criteria are assessed for both the fine-grained and silty and clayey sand soils below the water table (which is also a necessary condition for liquefaction to occur) for which test data are available. The liquid limit and natural water content data are assessed first, as they are the most abundant. If they indicate no liquefaction susceptibility, assessment by the clay content criterion is not necessary.

Liquid limit and natural water content for SM, SC, ML, MH, CL, and CH samples are available from References 2.5S.4-2B and 2.5S.4-2C, and are assessed to check their liquefaction potential according to the above criteria for clayey soils. The application of the criteria to the individual samples for which data are available show that the vulnerability of the clayey fine-grained soil, as well as the clayey sands (SC), to seismic liquefaction is negligible (see Figure 2.5S.4-78). Nevertheless, the clayey sand (SC) samples are also assessed by the other methods (SPT, CPT, V_s). Those samples having liquid limit = 0 (NP) on Figure 2.5S.4-78 are SM and ML samples and also are assessed by other methods (SPT, CPT, V_s) discussed later herein. All soil types except CL and CH are assessed by other methods.

A total of 299 samples for which test data are available were assessed according to the Chinese Method. Based on the liquefaction assessment by the water content and liquid limit of the 299 samples, it is judged not necessary to assess the clay content for 295 (98.7%) of the samples, as the first two conditions are sufficient to show the clay soils are not vulnerable to liquefaction or severe loss of strength (see Figure 2.5S.4-78).

For the remaining four of the 299 samples assessed:

- One sample (Boring U4-3; El. -28.8 feet; Stratum D) has water content equal to 20.9% and liquid limit equal to 23%. The sample has measured clay content equal to 27%, and thus is greater than 15%, meaning the sample is not vulnerable to liquefaction or serious loss of strength.
- One sample (Boring U4-3A; El. -54.4 feet; Stratum F) has water content equal to 26.2% and liquid limit equal to 30%. The clay content of the sample was not measured, but 14 other samples in Stratum F were tested and have an average clay content equal to 65%, with the minimum measured clay content equal to 32%. Thus, the sample is judged not vulnerable to liquefaction or serious loss of strength.

- One sample (Boring B-443; El. -133.9 feet; Sub-stratum J Clay 2) has water content equal to 26.2% and liquid limit equal to 24%. Laboratory grain-size analysis classifies the sample as ML, with the clay content equal to 15%. The sample is also assessed by the SPT method discussed later herein, from which the factor of safety against liquefaction is 3.75. Thus, the sample is not vulnerable to liquefaction or serious loss of strength.
- One sample (Boring B-306; El. -35.2 feet; Stratum E) has water content equal to 21.9% and liquid limit equal to 20%. Laboratory grain-size analysis classifies the samples as SM, with the clay content equal to 10%. The sample only marginally crosses the threshold shown on Figure 2.5S.4-78 and is judged to be an outlier. An adjacent sample at El. -31.7 feet shows a factor of safety against liquefaction equal to 3.63 when assessed by the SPT method discussed later herein.

Thus, the clay soils at the site are judged not vulnerable to liquefaction or serious loss of strength during a seismic event.

2.5S.4.8.2.~~3~~2 FOS Against Liquefaction Based on SPT Data

Uncorrected SPT N-values versus elevation are presented on Figures 2.5S.4-10, ~~and~~ 2.5S.4-~~11~~12, 2.5S.4-14, and ~~through~~ 2.5S.4-15 for the STP 3 area, the STP 4 area, the former UHS Basin/RSW area (the area west of the Power Block, now outside the Power Block), and for the remaining area outside the Power Block, respectively. Uncorrected SPT N-values verses elevation are presented on Figures 2.5S.4-11 and 2.5S.4-13 for Boring B-305DH/DHA and Boring B-405DH, respectively. SPT data from all ~~52~~ 68 borings made within the STP 3 area, all ~~41~~ 60 borings made within the STP 4 area, all ~~16~~ 26 borings made within the former UHS Basin/RSW area (west of the Power Block), and all 11 borings made within the remaining area outside the Power Block were evaluated for liquefaction potential. For completeness, all SPT N-values, including those measured in clay soils (CH, CL) and those measured in soils above the groundwater level~~, were initially included in the FOS calculation, despite their known high resistance to liquefaction~~ are identified, but the FOS is not calculated for the clay soils; clay soils (consisting of CL and CH materials) were evaluated by the Chinese Method (Subsection 2.5S.4.8.2.2) and were found to be not vulnerable to liquefaction. Of the 4944 total SPT tests, 2965 tests, or 60.0% of the total, are CL or CH samples which are not liquefiable.

The equivalent clean-sand $CRR_{7.5}$ value, based on the SPT clean sand equivalent $(N_1)_{60cs}$, was calculated following recommendations in Reference 2.5S.4-~~6~~5, (i.e., by step-wise proceeding from uncorrected SPT N value, to normalized N_1, to hammer energy corrected $(N_1)_{60}$, to clean sand equivalent $(N_1)_{60cs}$, and then calculating $CRR_{7.5}$ based on $(N_1)_{60cs}$). Refer to Figure 2.5S.4-~~65~~69 for an example of this step-wise approach from uncorrected SPT N to clean sand equivalent $(N_1)_{60cs}$. Reference 2.5S.4-5 notes that clean sands and/or clean sand equivalents, having $(N_1)_{60cs} \geq 30$ blows/foot are considered too dense to liquefy, and are classified as non-liquefiable. Note that at STP 3 & 4, ~~1250~~ 1205 tests of ~~3389~~ 4944 total tests, or approximately ~~36.9~~ 24.4% of tests, had $(N_1)_{60cs} \geq 30$ blows/foot.

Of the ~~3389~~ 4944 SPT N-values, all but ~~15~~ 11 tests were either CL and CH soils not liquefiable by the Chinese Method, or were other soil types including ML soils that had FOS ≥ 1.10 (refer to Subsection 2.5S.4.11 for discussion on the selection of an appropriate FOS). The ~~15~~ 11 tests having FOS<1.10 amounted to ~~0.4~~ 0.2% of all the

SPT tests evaluated; in other words, ~~99.6~~ 99.8% of the SPT samples were either not vulnerable or had calculated FOS values that ~~by this method~~ exceeded 1.10. For completeness, an examination of each FOS < 1.10 is provided in Table 2.5S.4-~~34~~ 35. From Table 2.5S.4-~~34~~ 35, it can be noted that:-seven of the ~~15~~ 11 tests were within areas/depths excavated for structure foundations; ~~four~~ one of the ~~15~~ 11 tests ~~were~~ was within areas where no structure~~s are~~ is placed, and where soils at similar elevations in adjoining borings had minimum FOS=~~1.41~~ 1.54; ~~of the remaining four of the 15 tests, two of those tests were made on clay soils which are unlikely to liquefy; and~~ the ~~two~~ three remaining tests are discussed separately next.

~~Of~~ For the remaining ~~two~~ three of the ~~15~~ 11 tests:

- One test (Boring B-~~350~~ 337; El. ~~12.3~~ 5.8 feet; Stratum ~~B~~ C) occurred at shallow depth at the STP 3 ~~Plant Stack~~ Machine Shop, which is not a safety-related structure~~;, and where the foundation level (likely removing Stratum B) is determined at detailed design stage (note~~ Note ~~also~~ that soils at similar elevations in adjoining borings had minimum FOS=~~1.76~~ 1.42.
- One test (Boring U3-5; El. -193.5 feet; Sub-stratum K Sand/Silt) occurred at the location of the STP 3 UHS Basin, which is a safety-related structure. Excavation plans indicate that the soil at this location will be excavated to El. 2.0 feet, thus the low-FOS soil encountered will remain below the foundation of the STP 3 UHS Basin. Other SPTs in the K Sand/Silt Sub-stratum of adjoining borings at the UHS Basin had minimum FOS = 1.38.
- One test (Boring T3-7; El. -190.6 feet; Sub-stratum K Sand/Silt) occurred at the location of the STP 3 RSW Tunnel, which is a safety-related structure. Excavation plans indicate that the soil at this location will be excavated to El. -50.0 feet, thus the low-FOS soil encountered will remain below the STP 3 RSW Tunnel. Other SPTs in the K Sand/Silt Sub-stratum of adjoining borings had minimum FOS = 1.45.
- ~~One test (Boring B-305DH/DHA; El. -348.7 feet; Sub-stratum N Sand 2) occurred at an extreme depth at the STP 3 Reactor Building and not affecting that structure (note also that Sub-stratum N Sand 2 in the STP 4 deep boring [Boring B-405DH] was "non-liquefiable" [i.e., $(N_1)_{60cs}$ ≥ 30])~~

The two SPT samples in the K Sand/Silt Sub-stratum described above have computed FOS values < 1.10. These soils are geologically old and on this basis could potentially be declared immune to liquefaction, or at least more resistant than shown by their computed FOS values, as described in Reference 2.5S.4-53 and Reference 2.5S.4-5. Reference 2.5S.4-5 notes that detailed information to assess the effect of geologic age when evaluating liquefaction behavior in terms of a quantitative FOS calculation is generally not available. Reference 2.5S.4-5 notes that sometimes the effect of geologic age is at least partially accounted for by the factor K_σ = 1 in geologically old materials that are being evaluated using SPT (or CPT) for a FOS calculation. The value of K_σ used when computing the FOS at the two SPTs being discussed was:

Boring	Elevation	K_σ
U3-5	-193.5 feet	0.632
T3-7	-190.6 feet	0.648

If K_σ were assigned as 1 to partially account for the geologic age of these two SPT samples with low FOS values, the resulting FOS would be 1.74 for boring U3-5 at El. -193.5 feet, and 1.60 for boring T3-7 at El. -190.6 feet.

Thus, if the geologic age of the Sub-stratum K Sand/Silt had been at least partially accounted for by assigning K_σ = 1, the resulting FOS values would be greater than 1.10. On the basis of its geologic age and depth below the ground surface, the low FOS calculated for two of the individual SPT samples in the K Sand/Silt Sub-stratum are judged to be of no concern.

Hence, the low FOS values from the SPT method are not significant to the safety of STP 3 & 4.

2.5S.4.8.2.3 4 FOS Against Liquefaction Based on CPT Data

CPT testing at STP 3 & 4 included the recording of both commonly-measured cone parameters (e.g., cone tip resistance, friction sleeve resistance, and pore pressure), and less-frequently-measured shear wave velocity. The evaluation of liquefaction potential based on commonly-measured cone parameters is addressed here. The evaluation of liquefaction potential based on shear wave velocity is addressed in Subsection 2.5S.4.8.2.4 5.

Corrected CPT q_t tip resistance profiles versus elevation are shown on Figure 2.5S.4-16, 2.5S.4-17, 2.5S.4-18, and 2.5S.4-19 for the STP 3 area, the STP 4 area, the area west the Power Block, (now outside the Power Block), and for the remaining area outside the Power Block, respectively. CPT data from all 10 CPTs made within the STP 3 area, all 11 CPTs made within the STP 4 area, all 10 21 CPTs made within the area west of the Power Block (C-947 was excluded due to erroneous data), and the one CPT made within the remaining area outside the Power Block were evaluated for liquefaction potential. For completeness, all CPT values, including those measured in clay soils and those measured in soils above the groundwater level, were initially included in the FOS calculation spreadsheet, despite their known high resistance to liquefaction. The CPT method identifies clay soils by their soil behavior type index, I_c, and no FOS is calculated for clay-rich soils. The spreadsheet also is set to identify soils above the water table, and no FOS is calculated for soils above the water table.

The equivalent clean-sand $CRR_{7.5}$ value, based on the CPT clean sand equivalent $(q_{c1n})_{cs}$, was calculated following recommendations in Reference 2.5S.4-5, (i.e., by step-wise proceeding from uncorrected CPT q_c value, to corrected q_t, to normalized q_{c1n}, to clean sand equivalent $(q_{c1n})_{cs}$, and then calculating $CRR_{7.5}$ based on $(q_{c1n})_{cs}$). Refer to Figure 2.5S.4-66 70 for an example of this step-wise approach from uncorrected CPT q_c to clean sand equivalent $(q_{c1n})_{cs}$. Reference 2.5S.4-5 notes that clean sands and/or clean sand equivalents, having $(q_{c1n})_{cs} \geq 160$ (dimensionless) are considered too dense to liquefy and are classified as non-liquefiable. Note that at STP 3 & 4, 751 1013 tests of 4489 6272 total tests, or 16.7 2% of tests, had $(q_{c1n})_{cs} \geq 160$ (dimensionless). Reference 2.5S.4-5 also notes that soils, having soil behavior type index $I_c \geq 2.60$, under particular conditions, are considered too clay rich to liquefy, and are also classified as non-liquefiable. Note that at STP 3 & 4 1670 2576 tests of 4489 6272 total tests, or 37.2% 41.1% of tests, had $I_c \geq 2.60$, and thus are considered too clay rich to liquefy.

Of the 4489 6272 CPT values, all but 153 176 tests had $I_c \geq 2.60$, are above the water table, or had FOS ≥ 1.10. The 153 176 tests having FOS < 1.10 amounted to 3.4 2.8% of all the tests evaluated; in other words, 96.6 97.2% of the CPT tests have $I_c \geq 2.60$, are above the water table, or had calculated FOS values by this method that exceeded 1.10. For completeness, an examination of each FOS < 1.10 is provided in Table 2.5S.4-35 36. From Table 2.5S.4-3536, it can be noted that: 35 55 of the 153 176 tests were within areas/depths excavated for structure foundations, 66 101 of the 153 176 tests were within areas where no structures are placed, and 20 of the 176 tests were made at locations where non-safety related structures are planned, but design details such as foundation elevations are unknown at this time. None of the CPT tests that had FOS < 1.10 are located where the soil will remain in-place beneath safety-related structures. 39 of the 153 tests are discussed separately next.

Of the remaining 13 of the 153 tests:

- Four tests (CPT C-310; El. -49.6 feet to -51.1 feet; Stratum E) occurred at the STP 3 Maintenance Shop, which is not a safety-related structure, and where the foundation level is determined at project detailed design stage

- One test (CPT C-408; El. -59.6 feet; Stratum H) occurred at the STP 4 Switch Yard, which is not a safety-related structure, and where the foundation level is determined at project detailed design stage

- Three tests (CPT C-410; El. 16.4 feet to 15.4 feet; Stratum B) occurred at shallow depths at the STP 4 Maintenance Shop, which is not a safety-related structure, and where the foundation level (likely removing Stratum B) is determined at project detailed design stage

- One test (CPT C-410; El. 12.4 feet; Stratum C) additionally occurred at shallow depth at the STP 4 Maintenance Shop, which is not a safety-related structure, and where the foundation level (likely removing a shallow Stratum C) is determined at project detailed design stage

- Three tests (CPT 307S; El. -10.6 to -11.6; Stratum C) occurred at the STP 3 Turbine Building, which is not a safety-related structure, and which is a very large mat-supported structure, capable of spanning limited areas with reduced subgrade support

- One test (CPT 307S; El. -52.4; Stratum E) additionally occurred at the STP 3 Turbine Building, which is not a safety-related structure, and which, as noted above, is a very large mat-supported structure, capable of spanning limited areas with reduced subgrade support

Hence, the low FOS values from the CPT method are not significant to the safety of STP 3 & 4.

2.5S.4.8.2.4 5 FOS Against Liquefaction Based on Shear Wave Velocity Data

Shear wave velocity (V_s) data from all five borings (B-302DH, B-305DH/DHA, B308DH, B-319DH, and B-328DH) and all three CPTs (C-305S, C-306S, and C-307S) made within the STP 3 area, and all five borings (B-402DH, B-405DH, B-408DH, B419DH, and

B-428DH) and ~~both~~ all three CPTs (~~C-306S and C-307S~~ C-405S, C-406S and C-407S) made within the STP 4 area were evaluated for liquefaction potential. For completeness, all V_s values, including those measured in clay soils and those measured in soils above the groundwater level, were ~~initially~~ included in the FOS calculation, despite their known high resistance to liquefaction.

Shear wave velocity measurements provide no information about the soil classifications, so it is possible that liquefaction FOS values may indicate soil liquefaction potential when, in fact, the soil in which the measurement was taken is a CL or CH material which is not vulnerable to liquefaction. For P-S logs, the shear wave velocity data are associated with soil type and fines content by examination of the SPT boring log, in the same way that fines content and soil type were determined for the SPT method. FOS values by the V_s method in the P-S logs were calculated for all soil types, including CL and CH clay soils which are not liquefiable. For the seismic CPTs, the fines content at approximately the middle of the V_s measurement interval was estimated from the CPT tip resistance and sleeve friction data, but no filter was imposed for clay-rich soil (I_c > 2.60). FOS values were calculated from the V_s in seismic CPTs without considering soil type other than estimated fines content. Low FOS values by the V_s method in the seismic CPTs were evaluated by examination of the associated I_c results to determine if they were in a soil type that is too clay-rich to be liquefiable.

The $CRR_{7.5}$ value, based on the normalized V_{s1}, was calculated following recommendations in Reference 2.5S.4-5, (i.e., by step-wise proceeding from uncorrected V_s value, to normalized V_{s1}, and then calculating $CRR_{7.5}$ based on V_{s1} and the threshold value of V_{s1}*). Note that the threshold value of V_{s1}* depends on fines content, and it varies linearly from 215 meters/second for soils having fines content of ≤5% to 200 meters per second for soils having fines content of 35%. Reference 2.5S.4-5 notes that soils having $V_{s1} \geq V_{s1}$* are considered too dense to liquefy, and are classified as non-liquefiable. Note that the V_s method is not applicable at depths exceeding about 40 feet based on the recommendation in Reference 2.5S.4-5B, page 120. Therefore, V_s data at depths more than about 40 feet are not used to evaluate liquefaction. This left a total of 287 V_s tests to be utilized. Note that at STP 3 & 4, ~~1208~~ 150 tests of ~~1687~~ 287 ~~total~~ tests utilized, or ~~71.6~~ 52.3% of tests, had $V_{s1} \geq V_{s1}$*.

Of the ~~1687~~ 287 V_s values, all but ~~76~~ 19 tests were above the water table, in clay soils, or had FOS ≥ 1.10. The ~~76~~ 19 tests having FOS < 1.10 amounted to ~~4.5~~ 6.6% of all the tests evaluated; in other words, ~~95.5~~ 93.4% of calculated FOS values by this method exceeded 1.10. For completeness, an examination of each FOS < 1.10 is provided in Table 2.5S.4-~~36~~ 37. From Table 2.5S.4-~~36~~ 37, it can be noted that: ~~13 of the 76~~ ~~tests~~ all 19 tests with FOS < 1.10 were within areas/depths to be excavated for structure foundations~~;~~. ~~53 of the 76 tests were made on clay soils which are unlikely to liquefy, and the 10 remaining of the 76 tests are discussed separately next.~~

~~Of the remaining 10 of the 76 tests:~~

- ~~One test (B-328DH; El. -127.6 feet; Sub-stratum J Sand 1) occurred at the STP 3 Turbine Building, which is not a safety-related structure, and which is a very large mat-supported structure, capable of spanning limited areas with reduced subgrade support~~

- ~~Five tests (B-428DH; El. -1.9 feet to -11.8 feet; Stratum C) occurred at the STP 4 Turbine Building, which is not a safety-related structure, and which, as noted above, is a very large mat-supported structure, capable of spanning limited areas with reduced subgrade support~~
- ~~Two Four tests (Boring B-305DH/DHA; El. -170.1 -224.2 feet to -175.1 -242.5 feet; Stratum M) occurred at extreme depths at the STP 3 Reactor Building and not affecting that structure. Note however that FOS values calculated for the same boring/same depth interval by the SPT method were FOS=1.53 at El. -168.7 feet, and FOS=1.27 at El. -188.7 feet~~
- ~~Two tests (Boring B-405DH; El. -80.7 feet to -82.3 feet; Stratum H) occurred at the STP 4 Reactor Building, with FOS=1.08. Note however that FOS values calculated for the same boring/same depth interval by the SPT method were FOS="nonliquefiable" (i.e., $(N_1)_{60cs}$ ≥ 30) at El. -77.4 feet, and FOS=2.08 at El. -87.4 feet~~

Hence, the low FOS values from the shear wave velocity method are not significant to the safety of STP 3 & 4.

2.5S.4.8.2.56 Liquefaction Resistance of Soils Deeper Than Approximately 600 Feet Below Ground Surface

Liquefaction evaluation at STP 3 & 4 focused on the soils in the upper approximately 600 feet. Site soils, however, are much deeper, with the Pleistocene Beaumont Formation extending to approximately 750 feet below ground surface. Refer to Subsection 2.5S.4.1 for a brief description of geologic conditions at depths ~~below~~ more than approximately 600 feet below ground surface, a key point being that the top depth of pre-Cretaceous bedrock ("basement rock") has been estimated to occur at approximately 34,500 feet below ground surface (Reference 2.5S.4-4).

Geologic information on soils below a depth of approximately 600 feet below ground surface was gathered from the available literature. Note that even these uppermost soils, including the Beaumont Formation, are considered geologically old (at approximately 100,000 to 24 million years for the Pleistocene, Pliocene, and Miocene deposits, as shown on Figure 2.5S.1-12). Liquefaction resistance increases markedly with geologic age, with Pleistocene soils having more resistance than Recent or Holocene soils, and pre-Pleistocene sediments being generally immune to liquefaction (Reference 2.5S.4-5). On this basis, these deeper soils are geologically too old to be prone to liquefaction. In addition, the degree of compaction and strength of these deeper soils are anticipated only to increase with depth, compared to the overlying soils which were analyzed. ~~Finally, liquefaction analyses using shear wave velocity values of approximately 1250 feet/second at a depth of 600 feet did not indicate the potential for liquefaction, with a calculated FOS=2.6. With shear wave velocities increasing below the 600 feet depth, in the range of approximately 1585 feet/second to 2350 feet/second as indicated on Figure 2.5S.4-57, h~~Higher liquefaction resistance would be expected from these deeper soils. On these bases, liquefaction of STP 3 & 4 site soils ~~below~~ more than a depth of 600 feet below ground surface was not considered possible.

2.5S.4.8.2.7 Spatial Distribution of Liquefaction FOS Values

Tables 2.5S.4-35, 2.5S.4-36, and 2.5S.4-37 summarize the low liquefaction FOS values obtained by the SPT, CPT, and V_s methods, respectively, including the layer name and the range in elevation at which low FOS values were encountered. Figure 2.5S.4-79 identifies the soil borings and CPT locations in which FOS values < 1.10 were encountered in Stratum A through K Sand/Silt. No low FOS values were encountered in strata below Stratum K Sand/Silt. The information presented in Figure 2.5S.4-79 is discussed in this subsection.

Stratum A has no low FOS values by the SPT method. Stratum A has low FOS values by the CPT method at 13 locations scattered about the site. Stratum A has low FOS values by the V_s method at three locations. Stratum A is not used for support of any safety related structures.

Stratum B has low FOS values by the SPT method in four borings. Stratum B has low FOS values by the CPT method at 13 locations scattered about the site. Stratum B has low FOS values by the V_s method in four borings. Stratum B is not used for support of any safety related structures.

Stratum C has low FOS values by the SPT method in four borings (each low FOS value occurs at a single test depth in the respective boring). Stratum C has low FOS values by the CPT method at eight locations across the site with varying thicknesses. Stratum C has low FOS values by the V_s method at three borings scattered about the site with varying thicknesses. None of the low FOS locations in Stratum C will remain in-place beneath safety-related structures.

Stratum D has no low FOS values by the SPT or V_s method. Stratum D has low FOS values by the CPT method at 17 locations scattered about the site. Stratum D is characterized as predominantly a fine grained layer and, as such, would not be expected to experience liquefaction. None of the low FOS locations in Stratum D will remain in-place beneath safety-related structures.

Stratum E has no low FOS values by the SPT method. Stratum E has a low FOS value by the CPT method at one location, within the STP-3 Turbine Building. The low FOS location will be removed by the construction excavation. The V_s method is not applicable to Stratum E soils (and deeper strata) because they occur at depths greater than the recommended depth of approximately 40 feet (per Reference 2.5S.4-5B).

Stratum F has no low FOS values by the SPT method. Stratum F has a low FOS value by the CPT method at one location, within the Machine Shop northwest of the STP-4 Power Block. The V_s method is not applicable to Stratum F soils and below.

Sub-stratum K Sand/Silt has two low FOS values by the SPT method. Sub-stratum K Sand/Silt was not penetrated by the CPT, and thus no FOS values by the CPT method are available. Sub-stratum K Sand/Silt was not penetrated by the CPT The V_s method is not applicable to Sub-stratum K Sand/Silt soils.

No layer deeper than Sub-stratum K Sand/Silt indicated low FOS values by the SPT method. No layer deeper than Sub-stratum K Sand/Silt was penetrated by the CPT. The V_s method is not applicable at these depths.

The arrangement of the soil borings and CPT locations where low FOS values were computed do not indicate spatial "clustering" of the low FOS values horizontally between adjacent borings or vertically between strata. Reference 2.5S.4-5 identifies the SPT method as the most reliable of the three methods. The SPT method indicates low FOS values at four borings in Stratum B, four borings in Stratum C, and two boring in the K Sand/Silt Sub-stratum. No other strata have low FOS values by the SPT method. The low FOS values in Stratum B and Stratum C are either to be excavated during construction, or are associated with single test depths in the borings and do not occur in adjacent borings, and are thus shown to be of limited lateral and vertical extent. Two of the low FOS locations by the SPT method will remain in-place beneath safety-related structures. These occurred in the K Sand/Silt Sub-stratum and, as discussed in Subsection 2.5S.4.8.2.3, are judged to be of no concern.

2.5S.4.8.2.~~6~~ 8 Concluding Remarks

A liquefaction analysis was performed using state-of-the-art procedures outlined in Reference 2.5S.4-5. Liquid limit, water content, and clay content data of fine grained soils were evaluated using the Chinese Method and showed that the clayey soils are not vulnerable to liquefaction or serious loss of strength. Even though the liquid limit and water content data available for clayey sands (SC) indicate that they are not vulnerable to liquefaction, all soil types other than CL and CH were evaluated for liquefaction behavior by other methods (SPT, CPT, V_s). SPT data points, ~~3389~~ 4544 total, were analyzed from ~~120~~ 165 borings, from which ~~99.6~~ 99.8% of the samples were either CL, CH, located above the water table, or had calculated FOS values that exceeded 1.10. CPT data points, ~~4489~~ 6272 total, were analyzed from ~~32~~ 43 CPTs, from which ~~96.6~~ 97.2% of the tests indicated too clay-rich to liquefy, were from above the water table, or had calculated FOS values that exceeded 1.10. Finally, shear wave velocity (V_s) data points to a maximum depth of about 40 feet, ~~1687~~ 287 total, were analyzed from 10 suspension P-S velocity logging borings and ~~five~~ six seismic CPTs, from which ~~95.5~~ 93.4% of the tests were either associated with clay-rich soil types, were from above the water table, or had calculated FOS values that exceeded 1.10. A detailed examination of the SPT, CPT, and V_s data points analyzed that had FOS < 1.10, revealed that the affected soils are not significant to the safety of STP 3 & 4.

It is also evident, from the collected subsurface investigation results, that STP 3 & 4 site soils are overconsolidated and are geologically old with respect to conventional liquefaction analysis. In the liquefaction evaluation, the effects of overconsolidation and geologic age were generally not considered, both of which tend to increase resistance to liquefaction. A very limited number of tests at isolated locations indicated potentially liquefiable soils; however, this indication could not be supported by the overwhelming percentages of the data that otherwise represent these soils as non-liquefiable. Moreover, the state-of-the-art methodology used for the liquefaction evaluation was intended to be conservative and not necessarily required to encompass every data point; therefore, the presence of a few data points beyond the CRR base curves is acceptable (Reference 2.5S.4-5). ~~Additionally, in the liquefaction evaluation, the effects of overconsolidation and geologic age were not considered, both of which tend to increase resistance to liquefaction.~~

2.5S.4.8.2.~~7~~ 9 ~~Consultation~~ Conformance with Regulatory Guide 1.198

Before and during the foregoing evaluation, RG 1.198 (Reference 2.5S.4-52) was consulted. The liquefaction evaluation presented here conforms closely to the RG 1.198 guidelines.

Under "Screening Techniques for Evaluation of Liquefaction Potential," Reference

2.5S.4-52 lists the most commonly observed liquefiable soils as fluvial-alluvial deposits, eolian sands and silts, beach sands, reclaimed land, and uncompacted hydraulic fills. The geology at the STP site includes fluvial soils and man-made fill at very limited locations. The liquefaction evaluation included all STP 3 & 4 site soils. The man-made fill (Stratum A [Fill]), which is suspected at very limited locations, is removed during site grading operations. In the same section, Reference 2.5S.4-52 indicates that clay to silt, silty clay to clayey sand, or silty gravel to clayey gravel soils can be considered potentially liquefiable. This calculation treated all STP 3 & 4 site soils as potentially liquefiable, including the fine-grained soils. Note, however, that the clayey finer-grained STP 3 & 4 site soils are not vulnerable to liquefaction or to serious loss of strength according to the Chinese Method in Reference 2.5S.4-5. contain large percentages of fines, generally greatly exceeding the soils conventionally evaluated according to the state-of-the-art method, and/or are highly plastic, and are generally considered non-liquefiable. Additionally, i In the liquefaction analyses by the SPT, CPT and V_s methods, the groundwater level for calculation purposes was selected at El. 25.5 feet for evaluating Strata A-D. This groundwater level is likely a "perched" condition within Stratum A D, as measured in the Stratum C sand (refer to Figures 2.5S.4-55 and 2.5S.4-56). Note that For evaluating Stratum E and deeper layers, a lower water level, was used as measured in the deeper Stratum E sand, occurred at an average El. 16.5 feet (El. 17.0 was used) (also refer to Figures 2.5S.4-55 and 2.5S.4-56). Despite the selected higher groundwater level, tThe calculated FOS against liquefaction overwhelmingly exceeded 1.10. Groundwater levels at STP 3 & 4 are not expected to rise in the future given the relief and topography, promoting positive drainage. Similarly, Reference 2.5S.4-52 indicates that potentially liquefiable soils may not pose a liquefaction risk to the facility if they are insufficiently thick and/or of limited lateral extent. The separately discussed SPT tests (2 of 15 tests), CPT tests (13 of 153 tests), and shear wave velocity (V_s) tests (10 of 76 tests) tests that had FOS < 1.10, detailed above, are is additionally all of limited thickness and/or lateral extent. The spatial distributions of low FOS<1.10 locations are dispersed around the site and do not define clusters or local areas of weak soil.

Under "Procedures for Evaluating Liquefaction Potential," Reference 2.5S.4-52 lists CPT, SPT, cyclic triaxial, and shear wave velocity tests as acceptable methods. The CPT, SPT, and shear wave velocity test results were used in these liquefaction potential analyses. Cyclic triaxial tests were not performed on STP 3 & 4 site soils, but were performed previously on STP 1 & 2 site soils (Reference 2.5S.4-3, Subsection 2.5S.4.8.2.4), which are similar. The CPT, SPT, and shear wave velocity test results were used in these liquefaction potential analyses.

This table replaces the existing Table 2.5S.4-34 in COLA Rev 2.

Table 2.5S.4-35 Summary of Liquefaction Potential FOS Values<1.10; SPT Method

Boring	Test El. [1] (feet)	FOS	Structure	Foundation El. [2] (feet)	Stratum (Disposition)	[3]
B-305DH/DHA	0.3	0.43	Reactor Building	-50 {-60}	Stratum C (to be excavated)	√
B-337	5.8	0.99	Machine Shop	To Be Determined	Stratum C (see note [5])	√
B-343	11.0	0.99	Radwaste Building	-19 {-39}	Stratum B (to be excavated)	√
B-422C	-3.3	0.95	Turbine Building	-8 {-10}	Stratum C (to be excavated)	√
B-424	5.8	0.98	Turbine Building	-8 {-10}	Stratum C (to be excavated)	√
B-912	-3.5	1.05	N/A	N/A	Stratum B (no structure at test location)	√
B-915	4.5	0.93	Circulating Water Pipes	To be Determined {-15 to -39} [4]	Stratum B (to be excavated)	√
T3-5	12.1	1.08	RSW Tunnel	-23 {-50}	Stratum B (to be excavated)	√
T3-5	9.6	1.03	RSW Tunnel	-23 {-50}	Stratum B (to be excavated)	√
T3-7	-190.6	1.04	RSW Tunnel	-23 {-50}	Stratum K Sand/Silt (to remain)	
U3-5	-193.5	1.10 [6]	UHS Basin	4 {2}	Stratum K Sand/Silt (to remain)	

NOTES:

[1] Elevations are referenced to NGVD 29 datum.

[2] Foundation El. shown in "{ }" symbols denote the elevations of significant over- excavation at the particular structure.

[3] √ denotes tests having FOS < 1.10, but made in strata to be excavated or areas without structures. No FOS is calculated for clay soils, as they are unlikely to liquefy according to the Chinese Method.

[4] Foundation El. of the Circulating Water Pipes is to be determined. Excavation plans indicate over-excavation to the approximate elevation indicated in "{ }" symbols.

[5] Not a safety-related structure and therefore does not affect site safety.

[6] FOS value slightly < 1.10, but which rounds up to 1.10 at two decimal places.

This table replaces the existing Table 2.5S.4-35 in COLA Rev 2.

Table 2.5S.4-36 Summary of Liquefaction Potential FOS Values<1.10; CPT Method (page 1 of 3)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3] (feet)	Stratum (Disposition)	[4]
C-301 (8)	22.2 18.3	0.80 1.04	N/A	N/A	Stratum A (no structure at test location)	√
C-301 (2)	11.9 11.4	0.91 1.04	N/A	N/A	Stratum A/B (no structure at test location)	√
C-301 (2)	-18.6 -19.1	0.82 0.89	N/A	N/A	Stratum D (no structure at test location)	√
C-302 (2)	-3.0 -3.5	1.05 1.06	N/A	N/A	Stratum C (no structure at test location)	√
C-303 (1)	16.7	1.09	N/A	N/A	Stratum A (no structure at test location)	√
C-303 (2)	-16.8 -17.3	0.83 0.89	N/A	N/A	Stratum D (no structure at test location)	√
C-304 (1)	19.3	0.98	N/A	N/A	Stratum A (no structure at test location)	√
C-305S (3)	14.4 12.5	0.95 1.04	Radwaste Building	-19 (-39)	Stratum B (to be excavated)	√
C-306S (5)	22.6 17.2	0.78 1.09	Turbine Building	-8 (-39)	Stratum A (to be excavated)	√
C-306S (4)	14.2 12.2	0.93 1.08	Turbine Building	-8 (-39)	Stratum B (to be excavated)	√
C-306S (1)	-11.9	0.87	Turbine Building	-8 (-39)	Stratum D (to be excavated)	√
C-306S (5)	-17.3 -19.8	0.84 0.93	Turbine Building	-8 (-39)	Stratum D (to be excavated)	√
C-306S (1)	-23.2	0.97	Turbine Building	-8 (-39)	Stratum D (to be excavated)	√
C-306S (1)	-32.1	0.92	Turbine Building	-8 (-39)	Stratum D (to be excavated)	√
C-306S (1)	-34.5	1.09	Turbine Building	-8 (-39)	Stratum E (to be excavated)	√
C-307S (3)	-10.6 -11.6	0.98 1.08	Turbine Building	-8 (-39)	Stratum C (to be excavated)	√
C-308 (1)	20.3	1.05	Switchyard	To Be Determined	Stratum A (see note [7])	√
C-308 (1)	-17.1	1.08	Switchyard	To Be Determined	Stratum D (see note [7])	√
C-308 (1)	-24.5	1.07	Switchyard	To Be Determined	Stratum D (see note [7])	√
C-309 (1)	17.7	1.08	Machine Shop	To Be Determined	Stratum A (see note [7])	√
C-310 (4)	-10.7 -12.7	1.01 1.06	Machine Shop	To Be Determined	Stratum D (see note [7])	√
C-401 (1)	14.6	0.98	N/A	N/A	Stratum B (no structure at test location)	√

Table 2.5S.4-36 Summary of Liquefaction Potential FOS Values<1.10; CPT Method (page 2 of 3)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3] (feet)	Stratum (Disposition)	[4]
C-401 (1)	-12.5	0.98	N/A	N/A	Stratum D (no structure at test location)	√
C-402 (1)	-11.8	1.07	N/A	N/A	Stratum D (no structure at test location)	√
C-403 (2)	-12.9 -13.4	0.99 1.04	N/A	N/A	Stratum D (no structure at test location)	√
C-404 (1)	13.4	1.06	N/A	N/A	Stratum B (no structure at test location)	√
C-405S (2)	9.5 8.9	1.02 1.08	Radwaste Building	-19 {-39}	Stratum C (to be excavated)	√
C-405S (1)	6.9	1.05	Radwaste Building	-19 {-39}	Stratum C (to be excavated)	√
C-406S (1)	-16.4	0.91	Turbine Building	-8 {-39}	Stratum D (to be excavated)	√
C-407S (1)	10.9	1.06	Turbine Building	-8 {-39}	Stratum B (to be excavated)	√
C-409 (1)	-15.2	0.97	Machine Shop	To Be Determined	Stratum D (see note [7])	√
C-410 (1)	23.7	1.07	Machine Shop	To Be Determined	Stratum A (see note [7])	√
C-410 (4)	16.4 12.4	0.97 1.09	Machine Shop	To Be Determined	Stratum B/C (see note [7])	√
C-410 (5)	-10.2 -15.6	0.90 0.98	Machine Shop	To Be Determined	Stratum D (see note [7])	√
C-410 (1)	-50.6	1.02	Machine Shop	To Be Determined	Stratum F (see note [7])	√
C-411 (1)	21.5	1.10 [5]	N/A	N/A	Stratum A (no structure at test location)	√
C-411 (1)	-18.4	0.89	N/A	N/A	Stratum D (no structure at test location)	√
C-904 (17)	24.0 16.1	0.13 0.93	N/A	N/A	Stratum A (no structure at test location)	√
C-904 (2)	8.2 7.7	0.97 1.04	N/A	N/A	Stratum B (no structure at test location)	√
C-904 (2)	-3.1 -3.6	1.07 1.09	N/A	N/A	Stratum C (no structure at test location)	√
C-904 (1)	-20.8	0.89	N/A	N/A	Stratum D (no structure at test location)	√
C-907 (2)	10.1 9.6	0.86 0.95	N/A	N/A	Stratum B (no structure at test location)	√
C-907 (6)	-9.2 -13.6	0.72 1.09	N/A	N/A	Stratum C (no structure at test location)	√
C-908 (1)	-14.1	1.01	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum D (to be excavated)	√

Table 2.5S.4-36 Summary of Liquefaction Potential FOS Values<1.10; CPT Method (page 3 of 3)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3] (feet)	Stratum (Disposition)	[4]
C-916 (1)	11.0	1.09	Control Building	-42 {-44}	Stratum B (to be excavated)	√
C-917 (8)	10.3 6.3	0.88 1.08	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum B (to be excavated)	√
C-917 (2)	-10.4 -11.9	0.96 1.05	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum D (to be excavated)	√
C-918 (13)	25.2 18.3	0.37 1.10 [5]	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum A (to be excavated)	√
C-918 (1)	-12.7	1.08	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum C (to be excavated)	√
C-940 (1)	-21.2	0.82	N/A	N/A	Stratum D (no structure at test location)	√
C-941 (1)	10.8	1.05	N/A	N/A	Stratum B (no structure at test location)	√
C-945 (1)	-18.4	0.90	N/A	N/A	Stratum D (no structure at test location)	√
C-946 (7)	20.5 18.6	0.97 1.09	N/A	N/A	Stratum A (no structure at test location)	√
C-948 (26)	25.2 15.7	0.84 1.10 [5]	N/A	N/A	Stratum A (no structure at test location)	√
C-948 (1)	8.2	1.09	N/A	N/A	Stratum B (no structure at test location)	√
C-948a (1)	10.4	1.07	N/A	N/A	Stratum B (no structure at test location)	√
C-949 (2)	23.4 23.1	1.06 1.09	N/A	N/A	Stratum A (no structure at test location)	√
C-949 (5)	-20.9 -22.2	0.70 0.77	N/A	N/A	Stratum C (no structure at test location)	√

NOTES:

[1] Elevations are referenced to NGVD 29 datum.

[2] Range of Test Els. and FOS values are given where multiple test points occur.

[3] Foundation Els. shown in "{}" symbols denote the elevations of significant over-excavation at the particular structure.

[4] √ denotes tests having FOS < 1.10, but made in strata to be excavated or areas without structures. No FOS is calculated for clay soils, as they are unlikely to liquefy according to the Chinese Method.

[5] FOS value slightly < 1.10, but which rounds up to 1.10 at two decimal places.

[6] Foundation El. of the Circulating Water Pipes is to be determined. Excavation plans indicate over-excavation to the approximate elevation indicated in "{ }" symbols.

[7] Not a safety-related structure and therefore does not affect site safety.

This table replaces the existing Table 2.5S.4-36 in COLA Rev 2.

Table 2.5S.4-37 Summary of Liquefaction Potential FOS Values<1.10: Shear Wave Velocity Method

V_s Boring or CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3] (feet)	Stratum (Disposition) [5]	[4]
B-302DH (1)	7.0	0.85	Reactor Building	-20 {-60}	Stratum B (to be excavated)	√
B-302DH (2)	-1.2 -2.8	0.73 0.84	Reactor Building	-50 {-60}	Stratum C (to be excavated)	√
B-308DH (2)	23.2 21.6	0.61 0.93	Reactor Building	-50 {-60}	Stratum A (to be excavated)	√
B-308DH (2)	16.7 15.0	0.41 0.79	Reactor Building	-50 {-60}	Stratum A/B (to be excavated)	√
B-319DH (4)	18.6 13.6	0.65 0.91	Turbine Building	-8 {-39}	Stratum A/B (to be excavated)	√
B-319DH (1)	7.1	1.02	Turbine Building	-8 {-39}	Stratum C (to be excavated)	√
B-419DH (1)	5.1	0.67	Turbine Building	-8 {-39}	Stratum B (to be excavated)	√
B-428DH (1)	9.6	0.97	Turbine Building	-8 {-39}	Stratum A (to be excavated)	√
B-428DH (3)	-1.9 -5.2	0.85 1.04	Turbine Building	-8 {-39}	Stratum C (to be excavated)	√
B-428DH (2)	-10.1 -11.8	0.79 0.92	Turbine Building	-8 {-39}	Stratum C (to be excavated)	√

NOTES:

[1] Elevations are referenced to NGVD 29 datum. Vs Method not applicable for depths greater than approximately 40 feet (Test El. below approximately -10 to -15).

[2] Range of Test Els. and FOS values and given where multiple test points occur.

[3] Foundation Els. shown in "{}" symbols denote the elevations of significant over-excavation at the particular structure.

[4] √ denotes tests having FOS < 1.10, but made in strata to be excavated or areas without structures. No FOS is calculated for clay soils, as they are unlikely to liquefy according to the Chinese Method.

[5] Where soil layers with low FOS values transcend strata breaks, both strata are noted. For example, "Stratum A/B" indicates a layer of low FOS values beginning in Stratum A and continuing into Stratum B.

This figure replaces the existing Figure 2.5S.4-5 in COLA Rev 2.

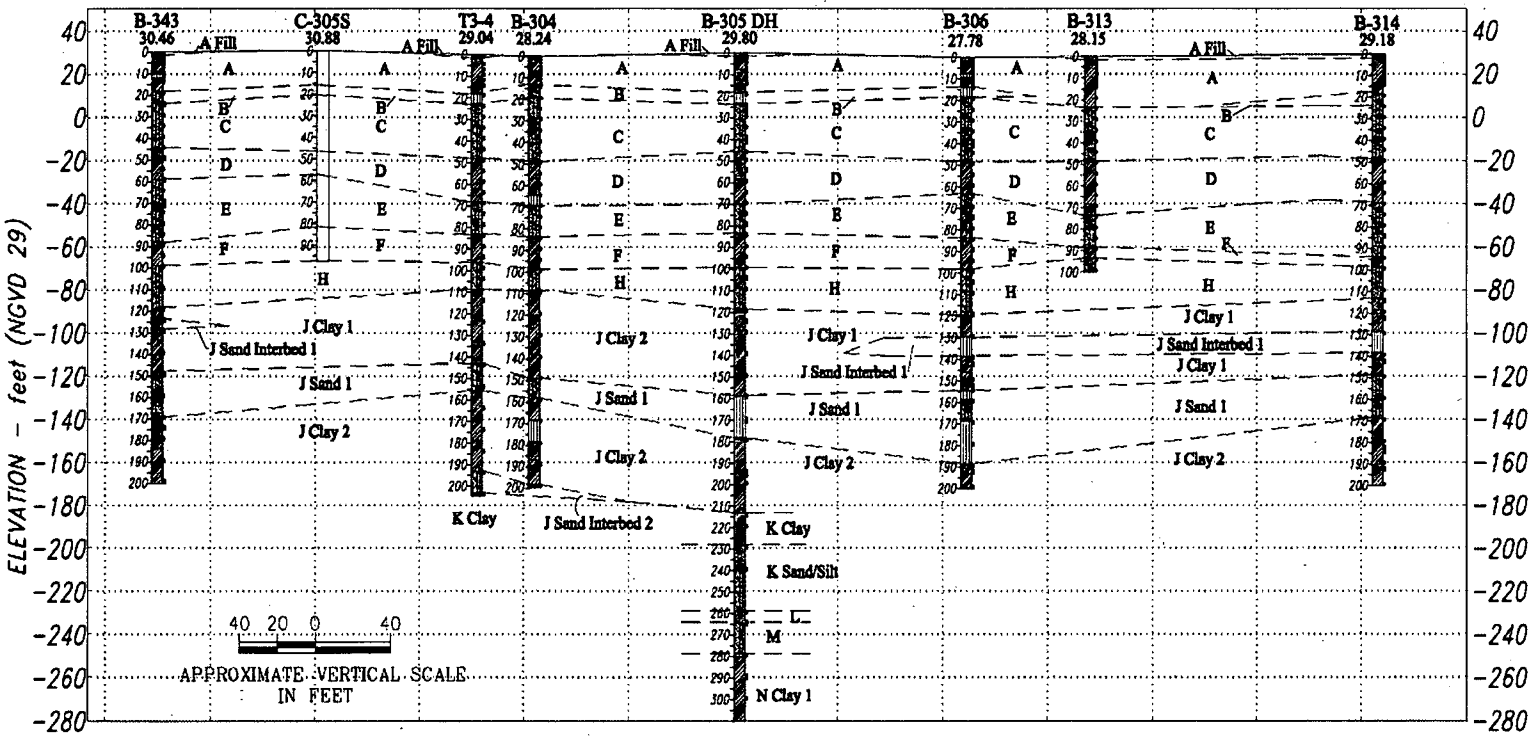


Figure 2.5S.4-5 Subsurface Profile 3EW4

This figure replaces the existing Figure 2.5S.4-6 in COLA Rev 2.

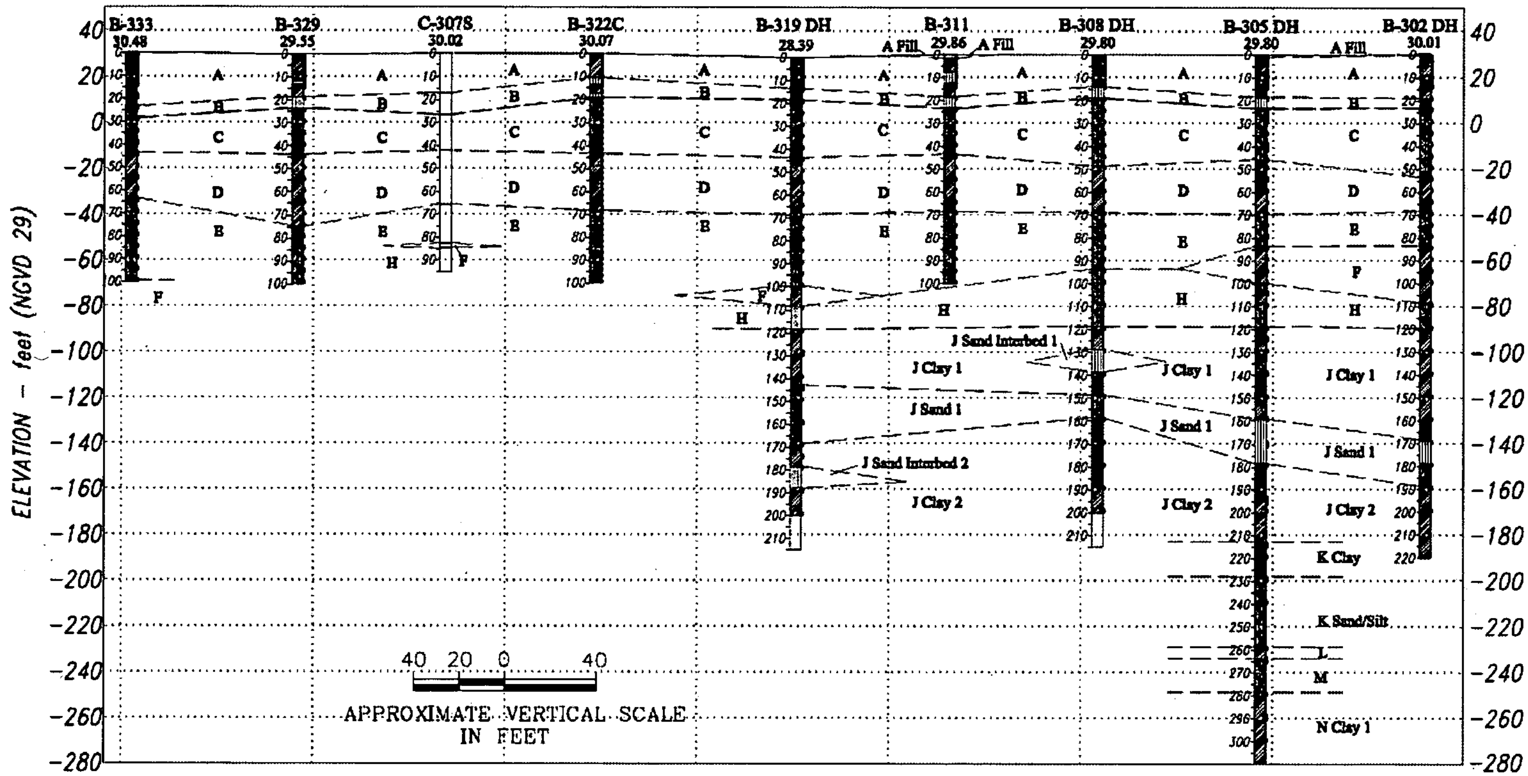


Figure 2.5S.4-6 Subsurface Profile 3NS2

This figure replaces the existing Figure 2.5S.4-7 in COLA Rev 2.

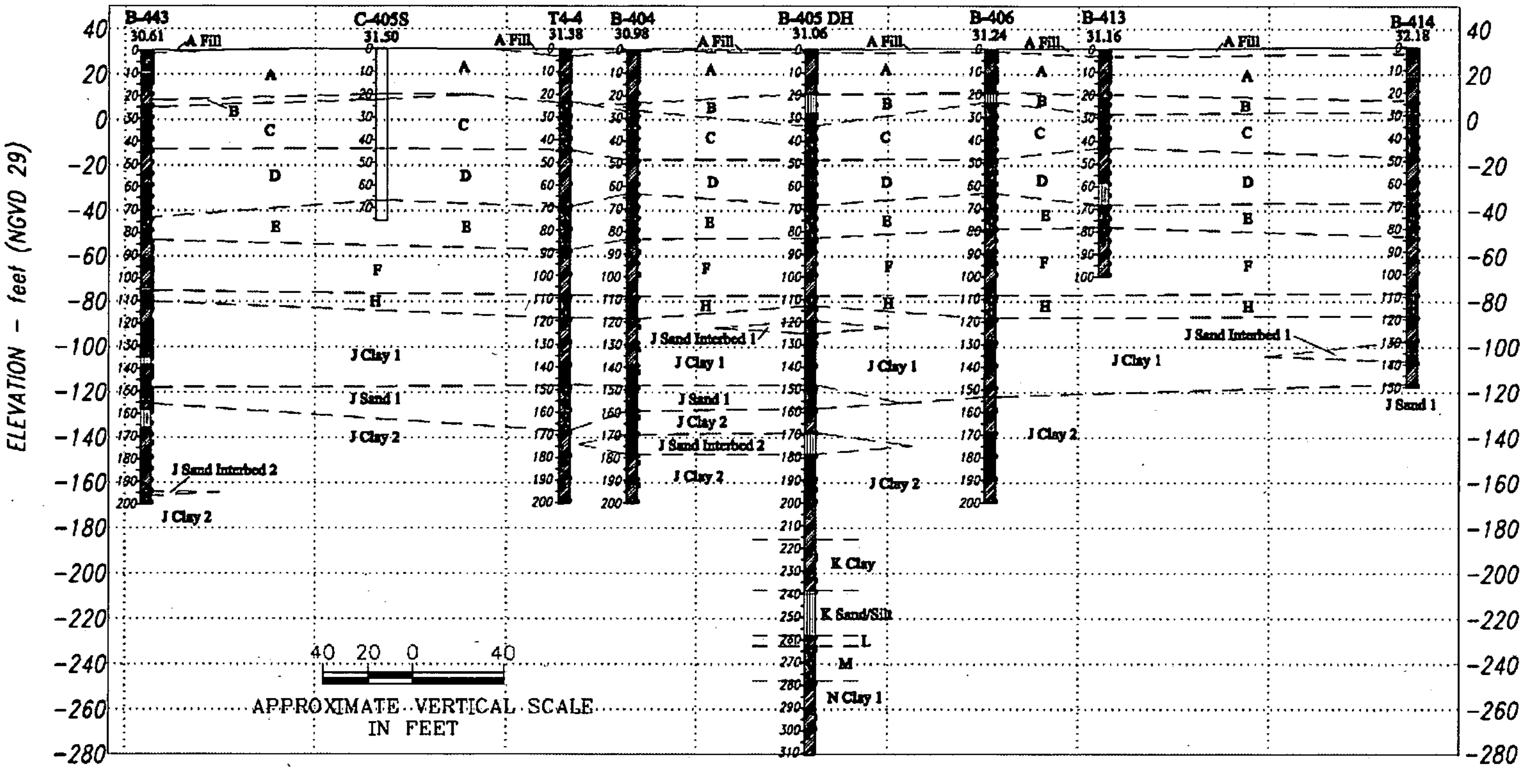


Figure 2.5S.4-7 Subsurface Profile 4EW4

This figure replaces the existing Figure 2.5S.4-8 in COLA Rev 2.

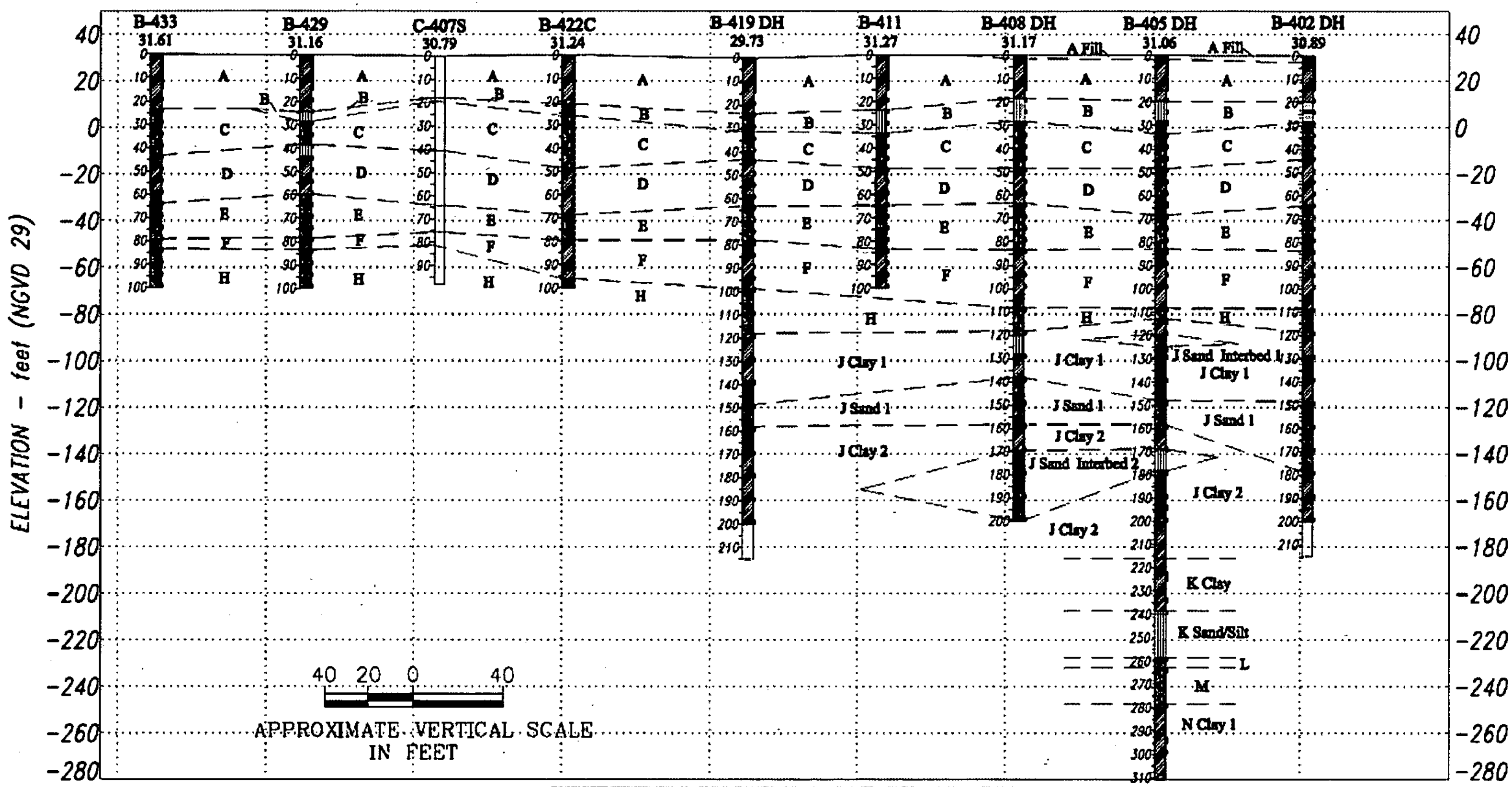


Figure 2.5S.4-8 Subsurface Profile 4NS2

This figure replaces the existing Figure 2.5S.4-9 in COLA Rev 2.

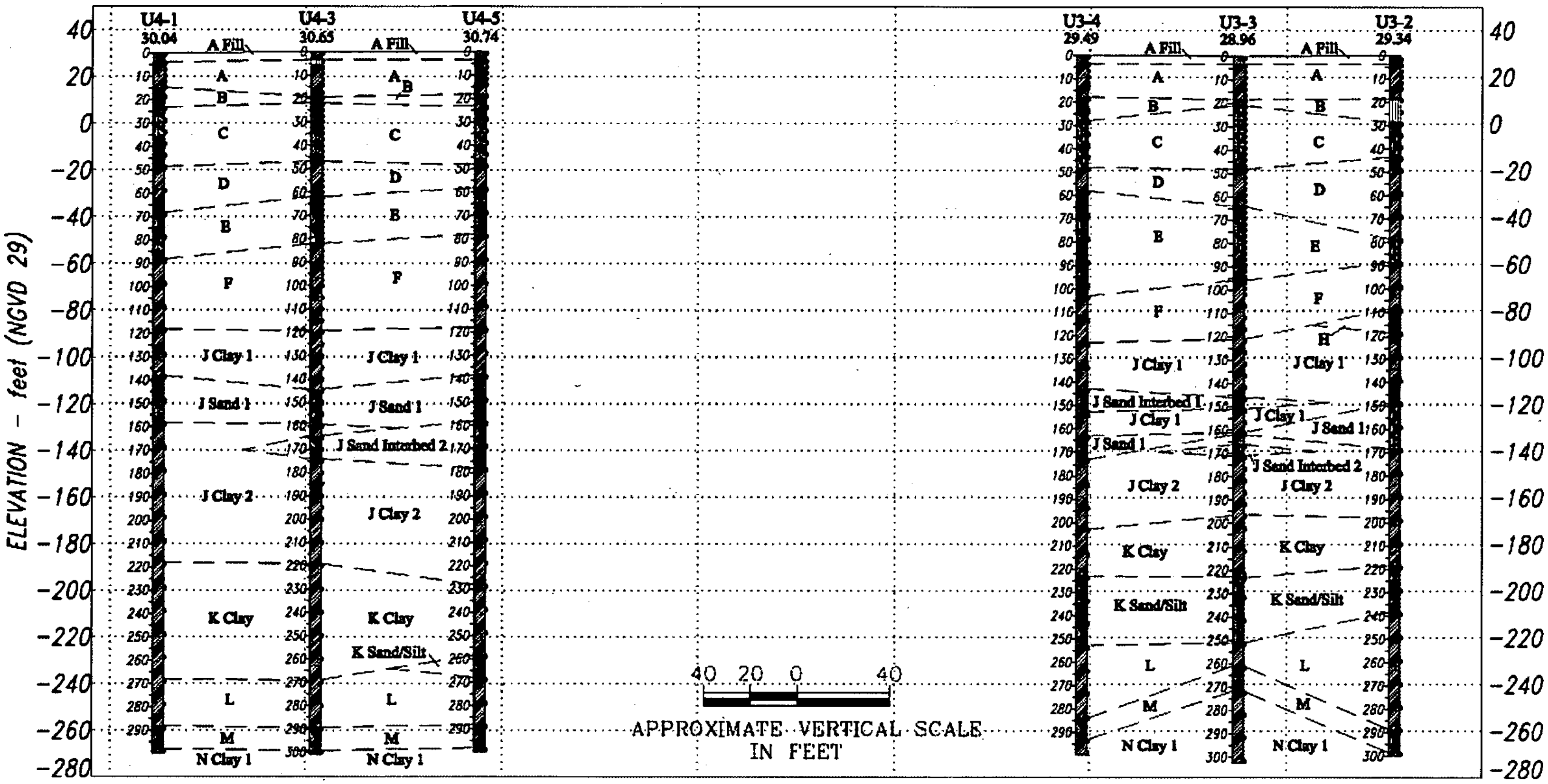


Figure 2.5S.4-9 Subsurface Profile 4UHS3

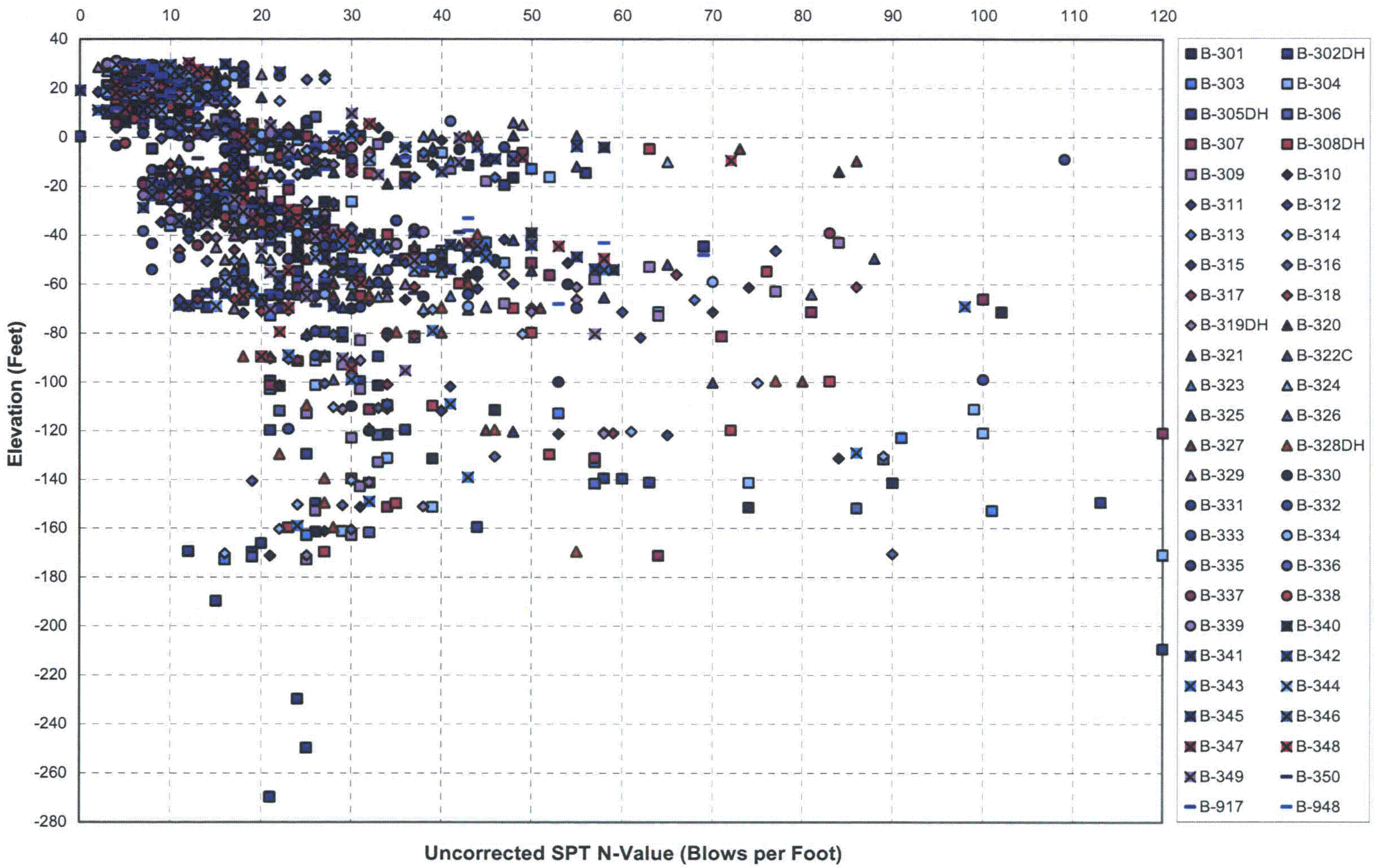


Figure 2.5S.4-10 Uncorrected SPT N-Values (STP 3) <Includes B-917>

This figure replaces the existing Figure 2.5S.4-11 in COLA Rev 2.

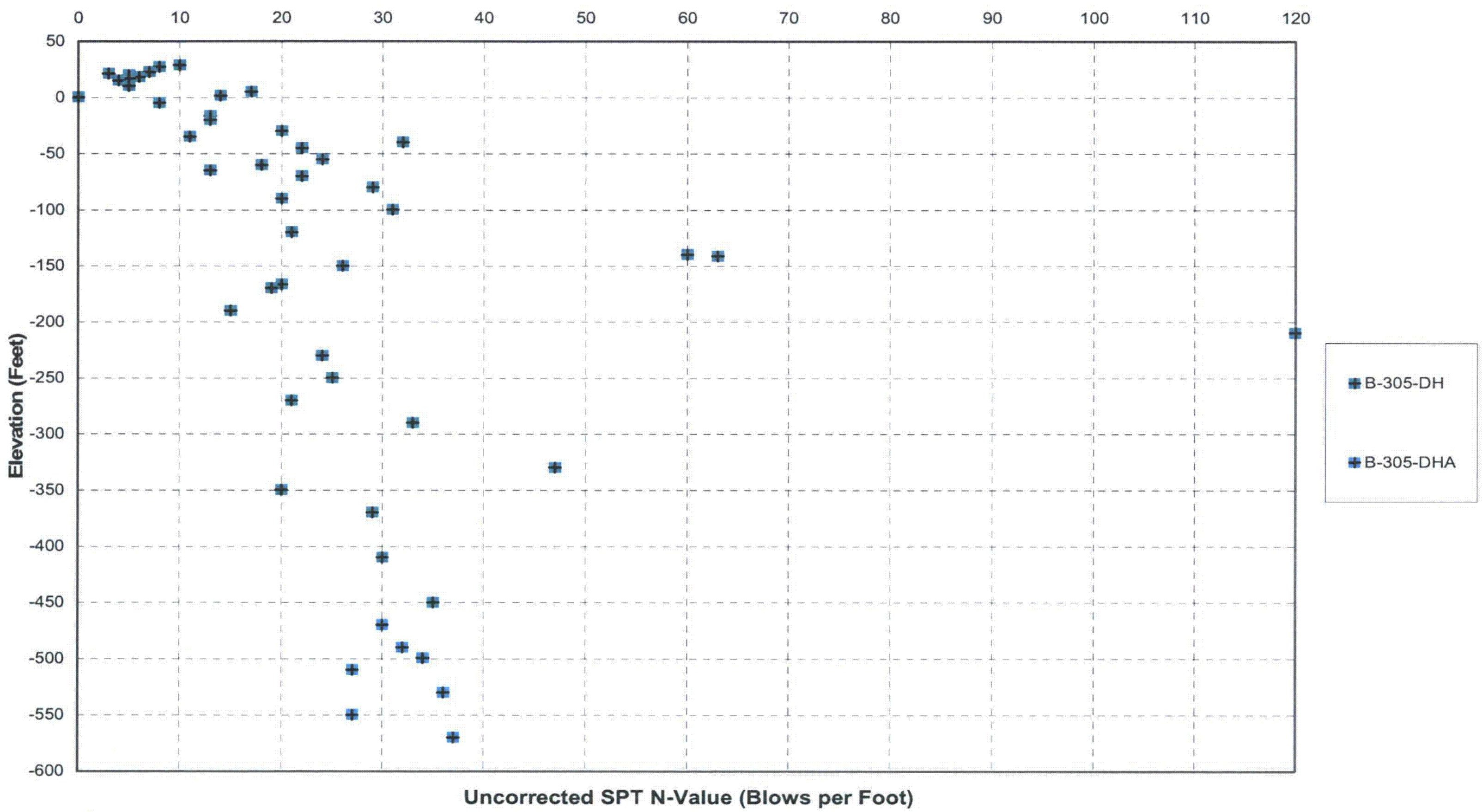


Figure 2.5S.4-11 Uncorrected SPT N-Values (STP 3; Boring B-305DH/DHA)

This figure replaces the existing Figure 2.5S.4-12 in COLA Rev 2.

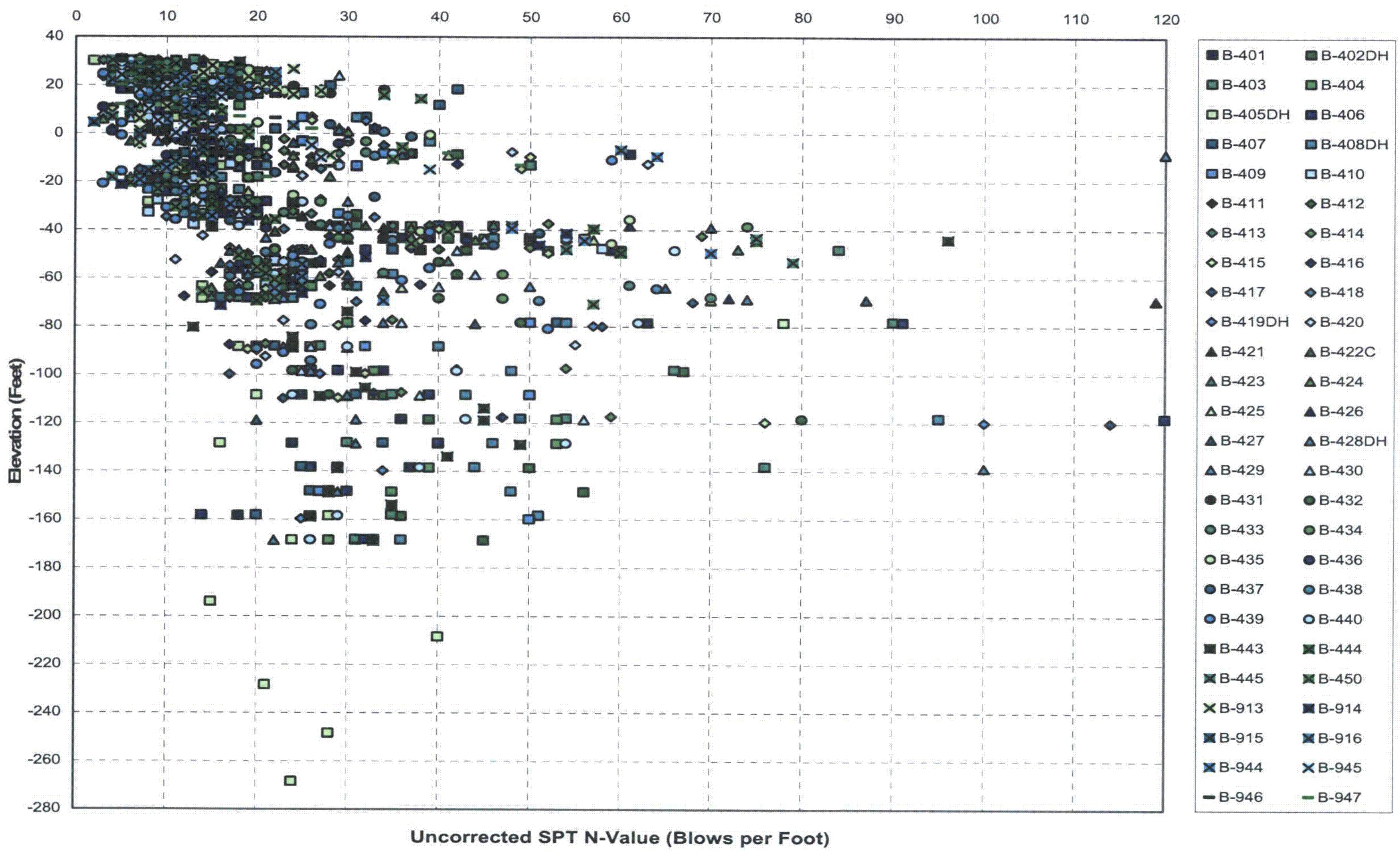


Figure 2.5S.4-12 Uncorrected SPT N-Values (STP 4)

This figure replaces the existing Figure 2.5S.4-13 in COLA Rev 2.

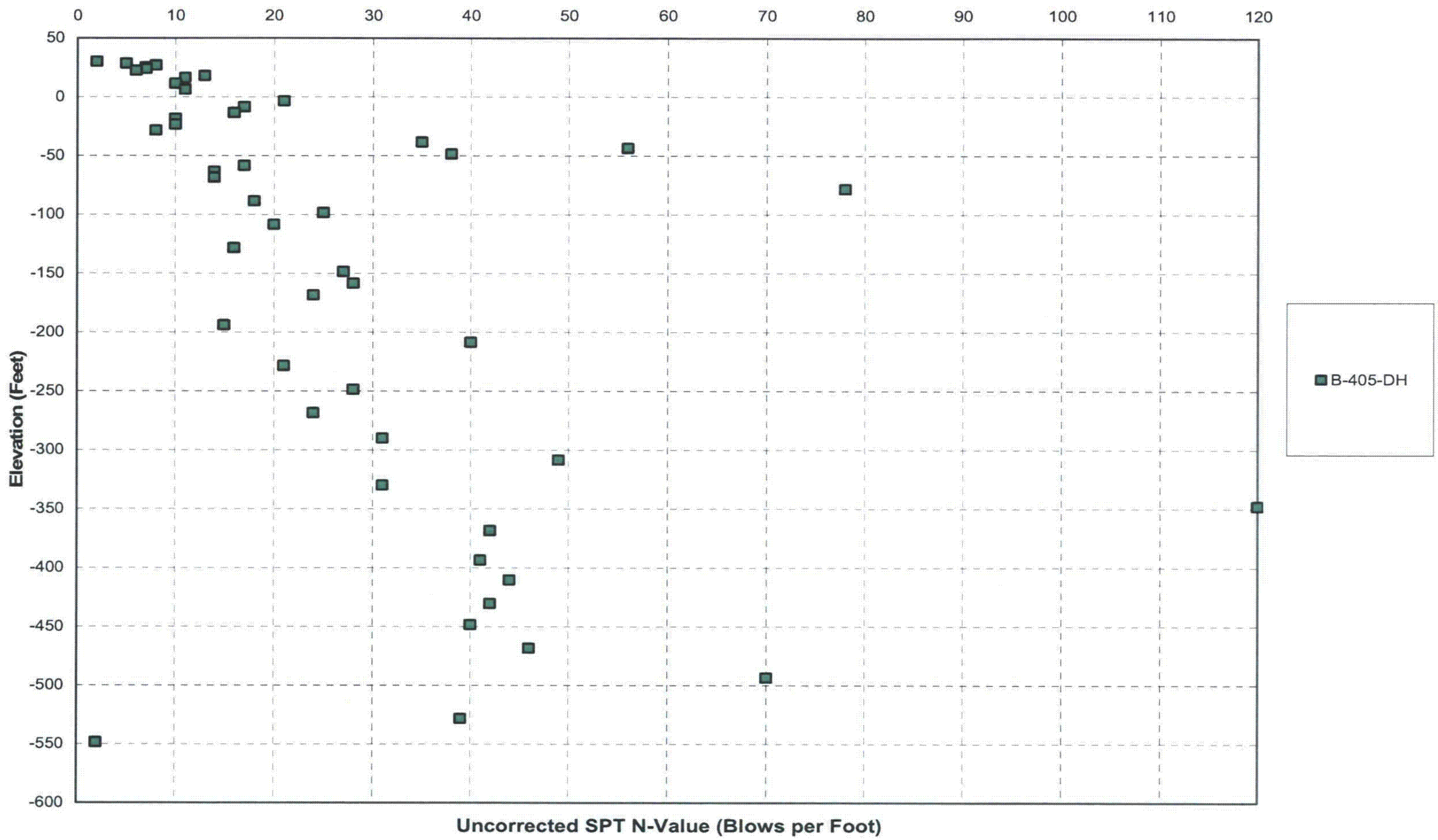


Figure 2.5S.4-13 Uncorrected SPT N-Values (STP 4; Boring B-405DH)

This figure replaces the existing Figure 2.5S.4-14 in COLA Rev 2.

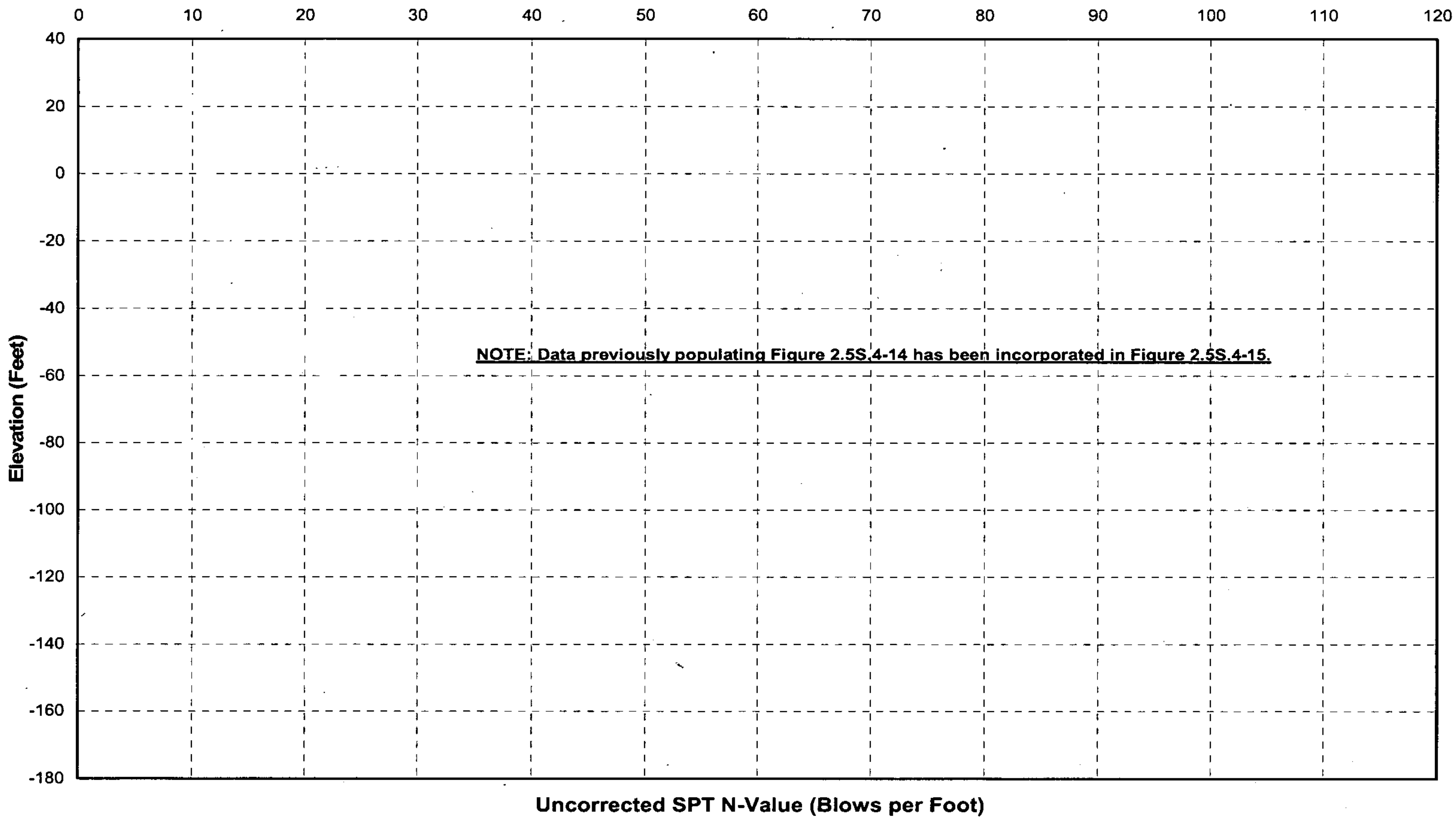


Figure 2.5S.4-14 Uncorrected SPT N-Values (UHS BASIN/RSW)<Excludes B-917>

This figure replaces the existing Figure 2.5S.4-15 in COLA Rev 2.

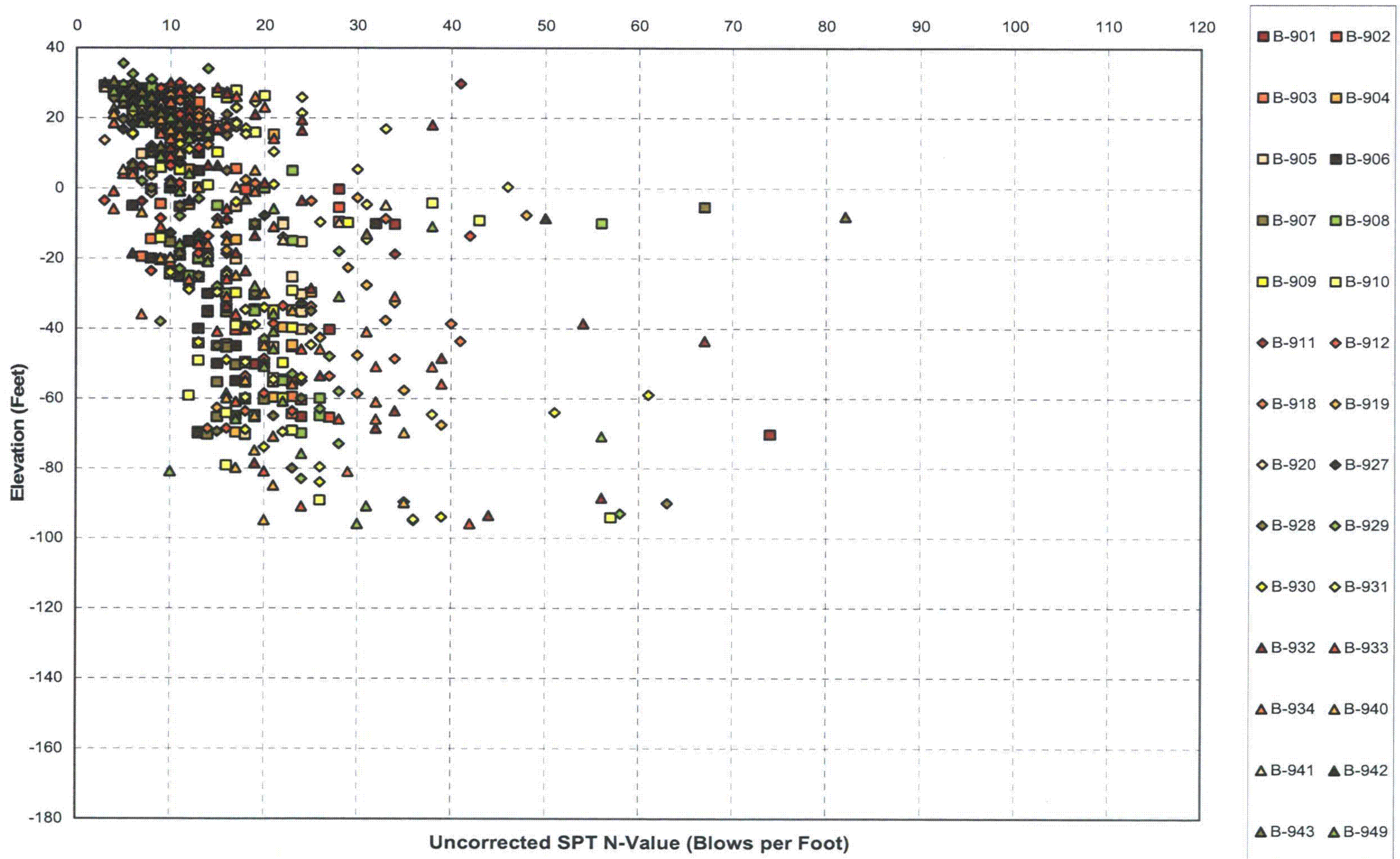
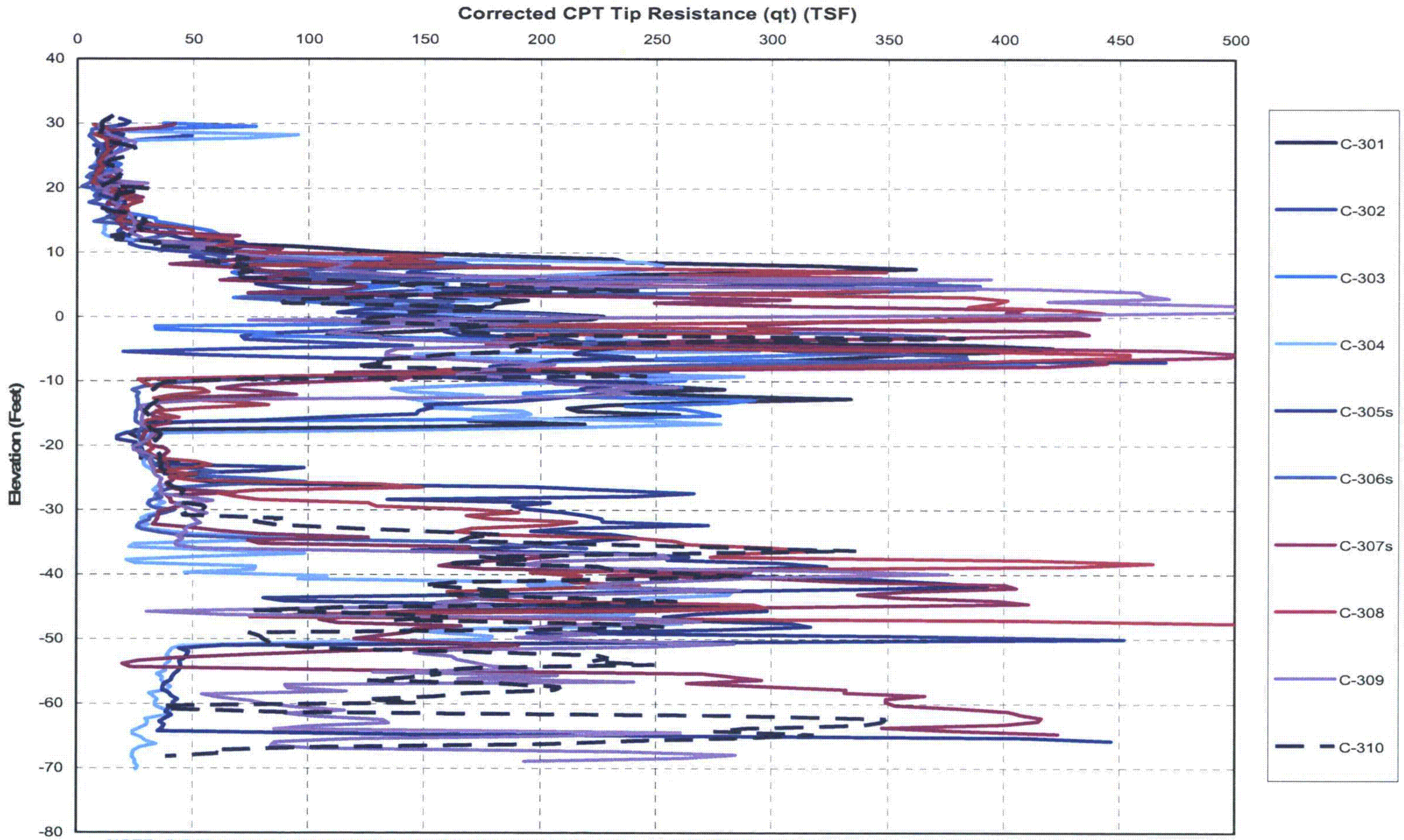


Figure 2.5S.4-15 Uncorrected SPT N-Values (Outside Power Block)

This figure replaces the existing Figure 2.5S.4-16 in COLA Rev 2.



NOTE: C-947 was not representative and therefore was not used as part of this data set.

Figure 2.5S.4-16 Corrected CPT Tip Resistance (qt)(STP3)

This figure replaces the existing Figure 2.5S.4-17 in COLA Rev 2.

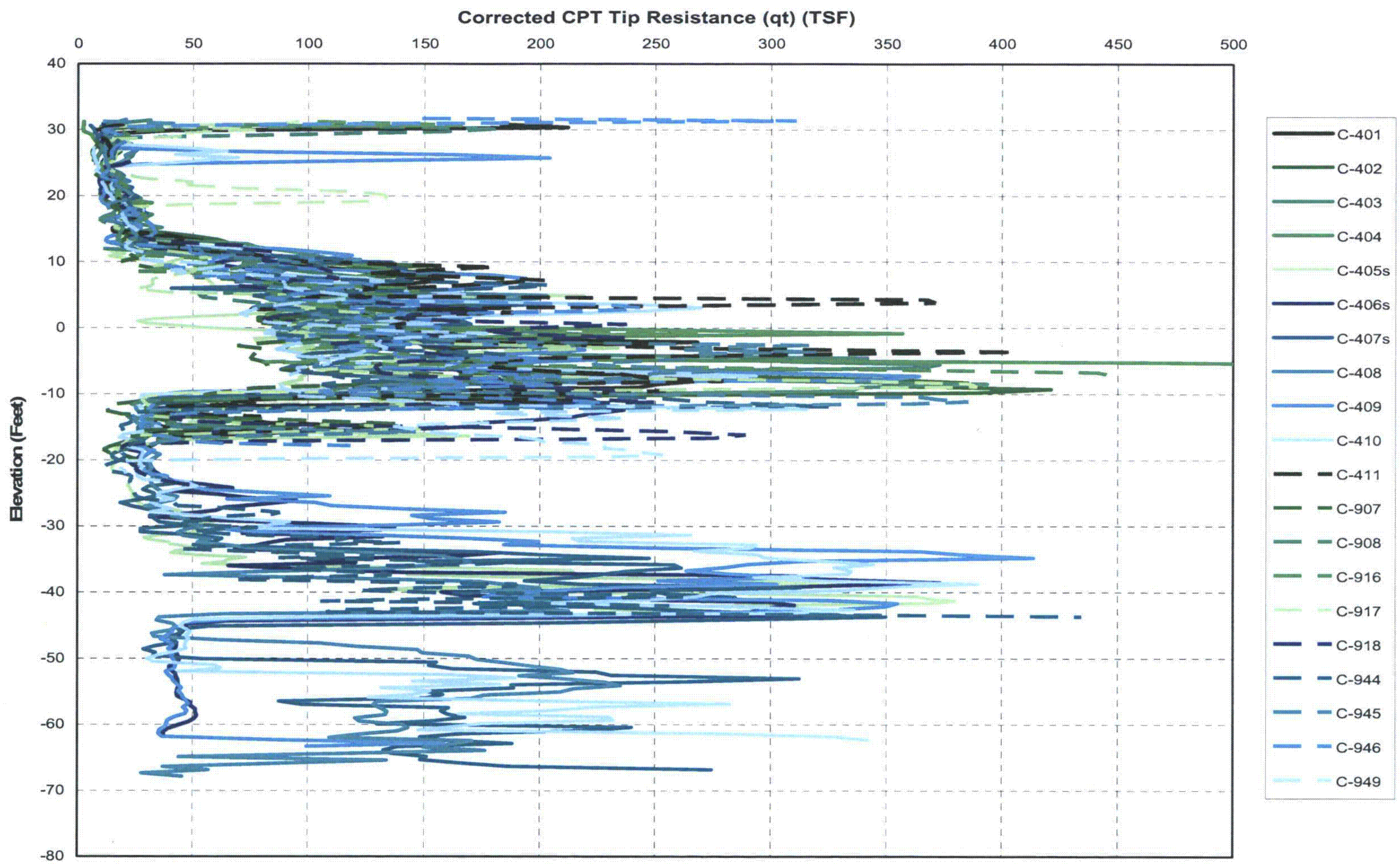


Figure 2.5S.4-17 Corrected CPT Tip Resistance (qt)(STP3)<Includes C-916>

This figure replaces the existing Figure 2.5S.4-18 in COLA Rev 2.

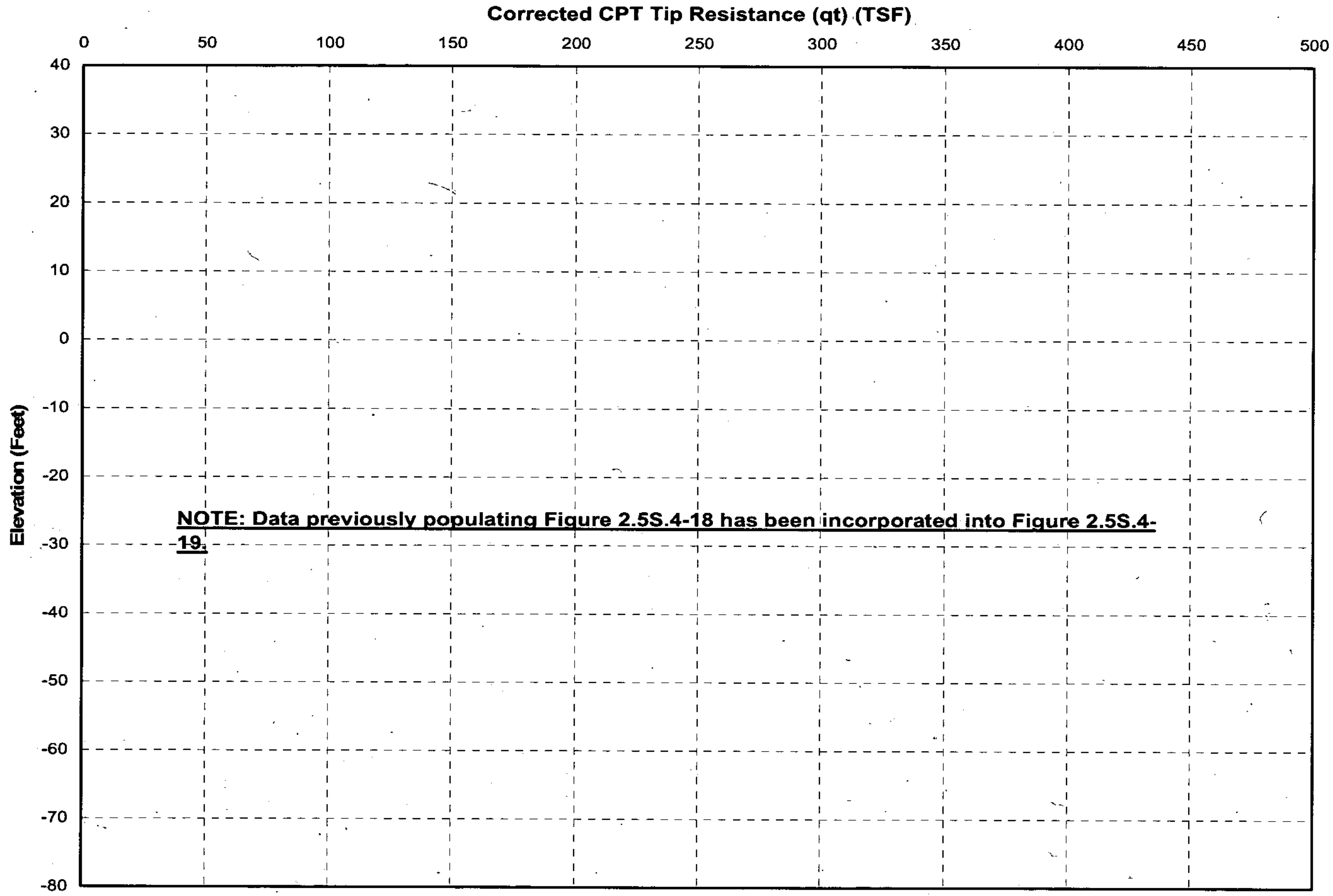


Figure 2.5S.4-18 Corrected CPT Tip Resistance (qt)(UHS Basin/RSW)<Excludes C-916>

This figure replaces the existing Figure 2.5S.4-19 in COLA Rev 2.

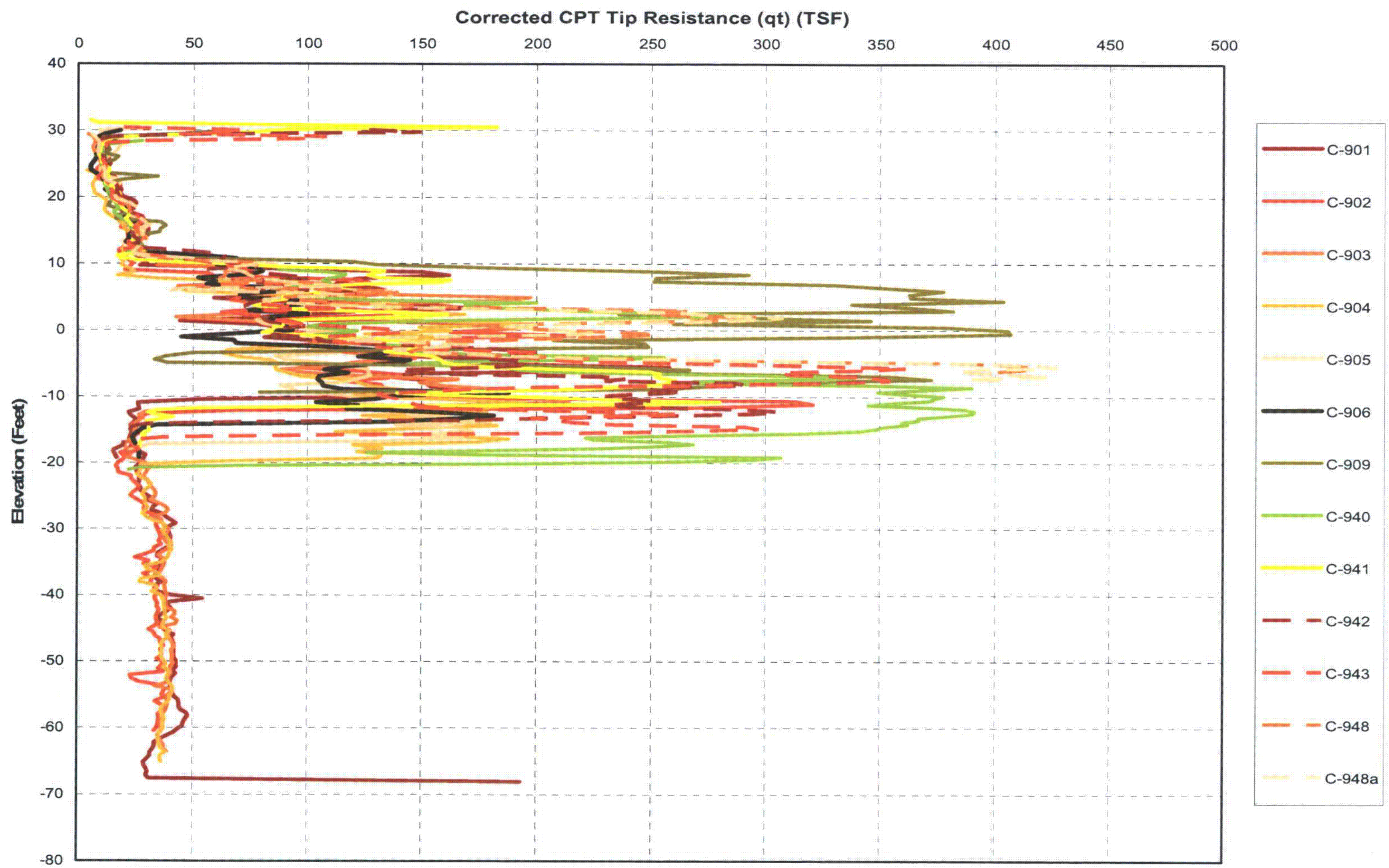


Figure 2.5S.4-19 Corrected CPT Tip Resistance (qt)(UHS Basin/RSW)<Excludes C-916>

This figure replaces the existing Figure 2.5S.4-55 in COLA Rev 2.

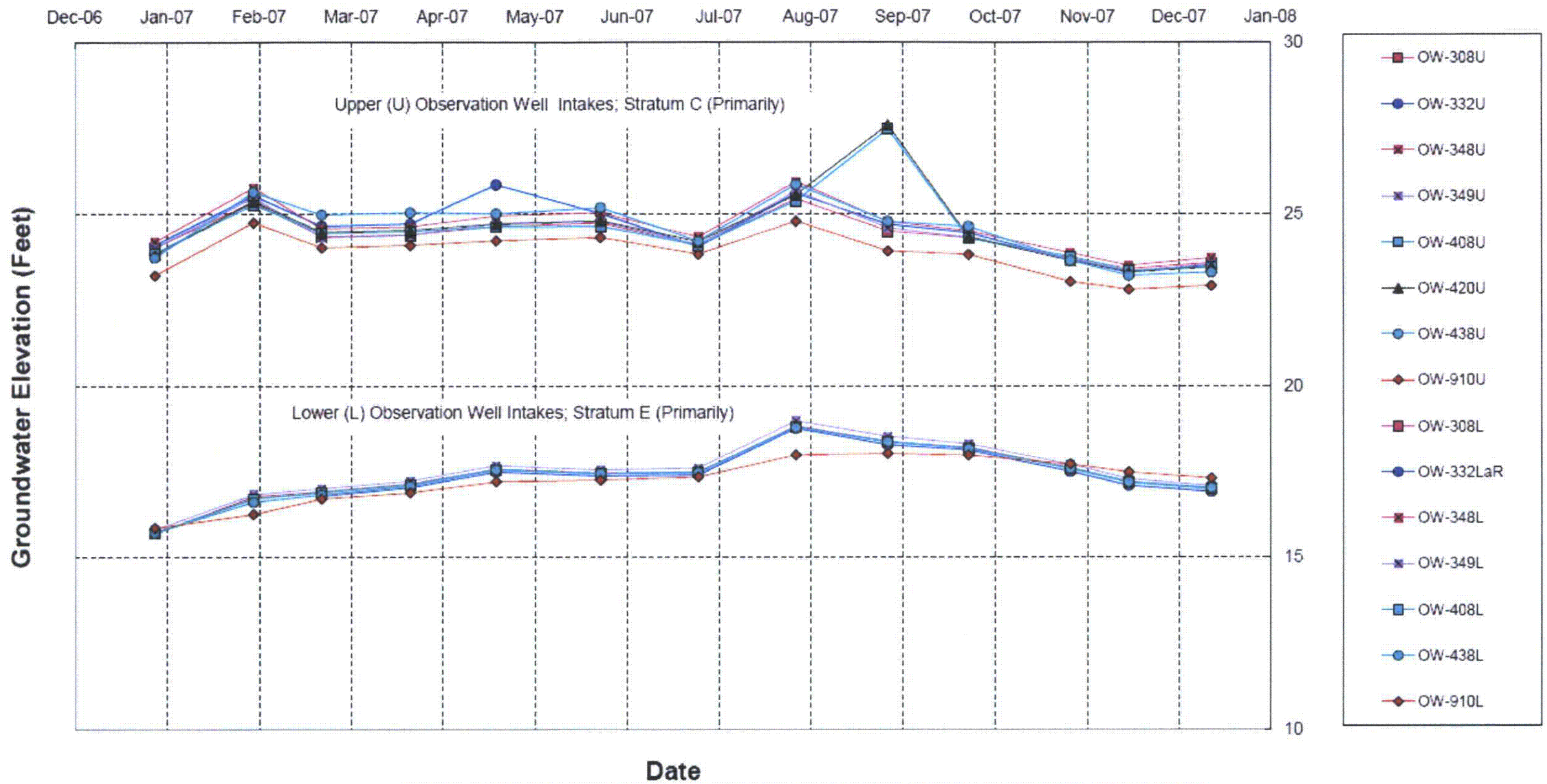


Figure 2.5S.4-55 Measured Groundwater Levels (Inside Power Block)

This figure replaces the existing Figure 2.5S.4-56 in COLA Rev 2.

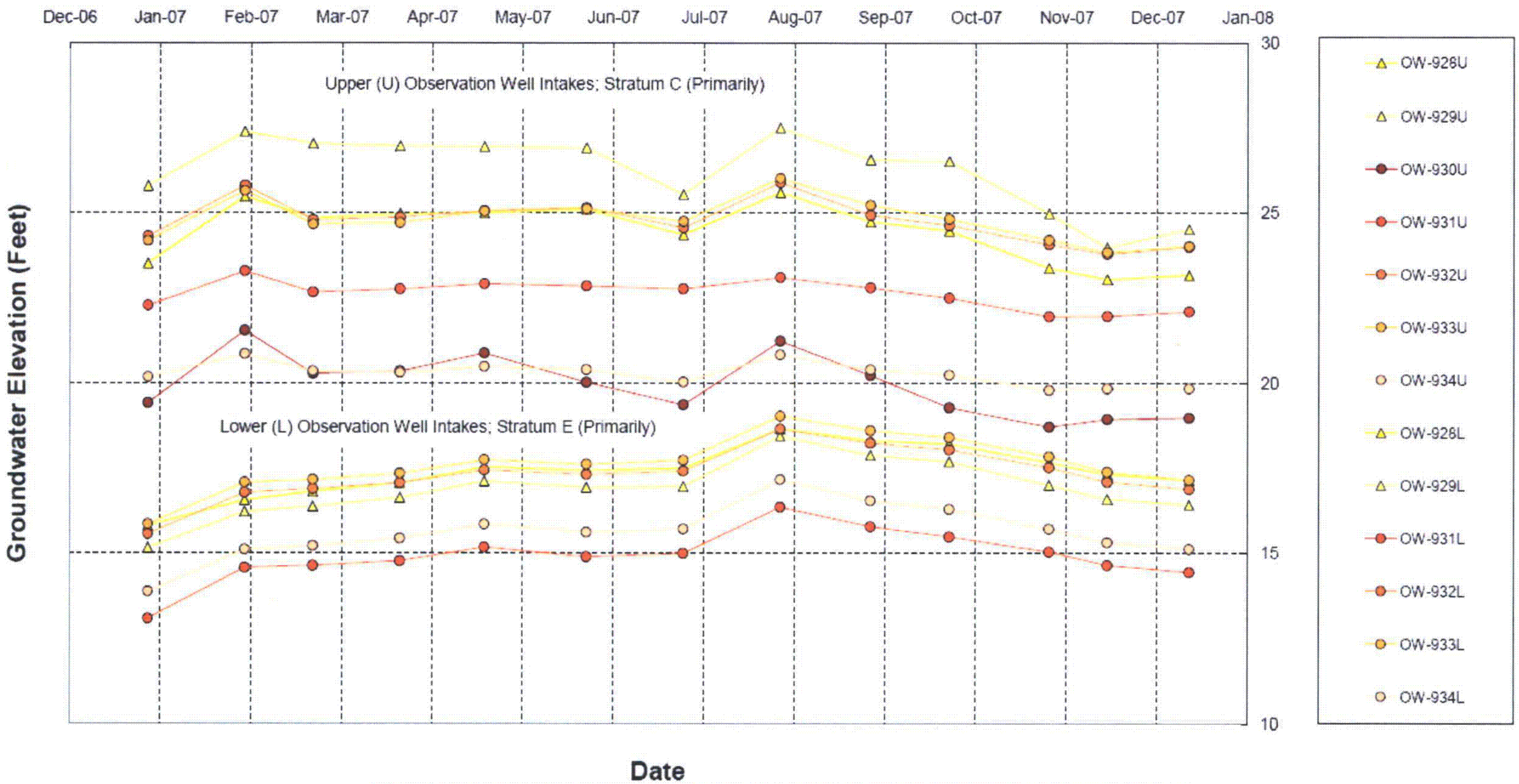


Figure 2.5S.4-56 Measured Groundwater Levels (Outside Power Block)

This figure replaces the existing Figure 2.5S.4-69 in COLA Rev 2.

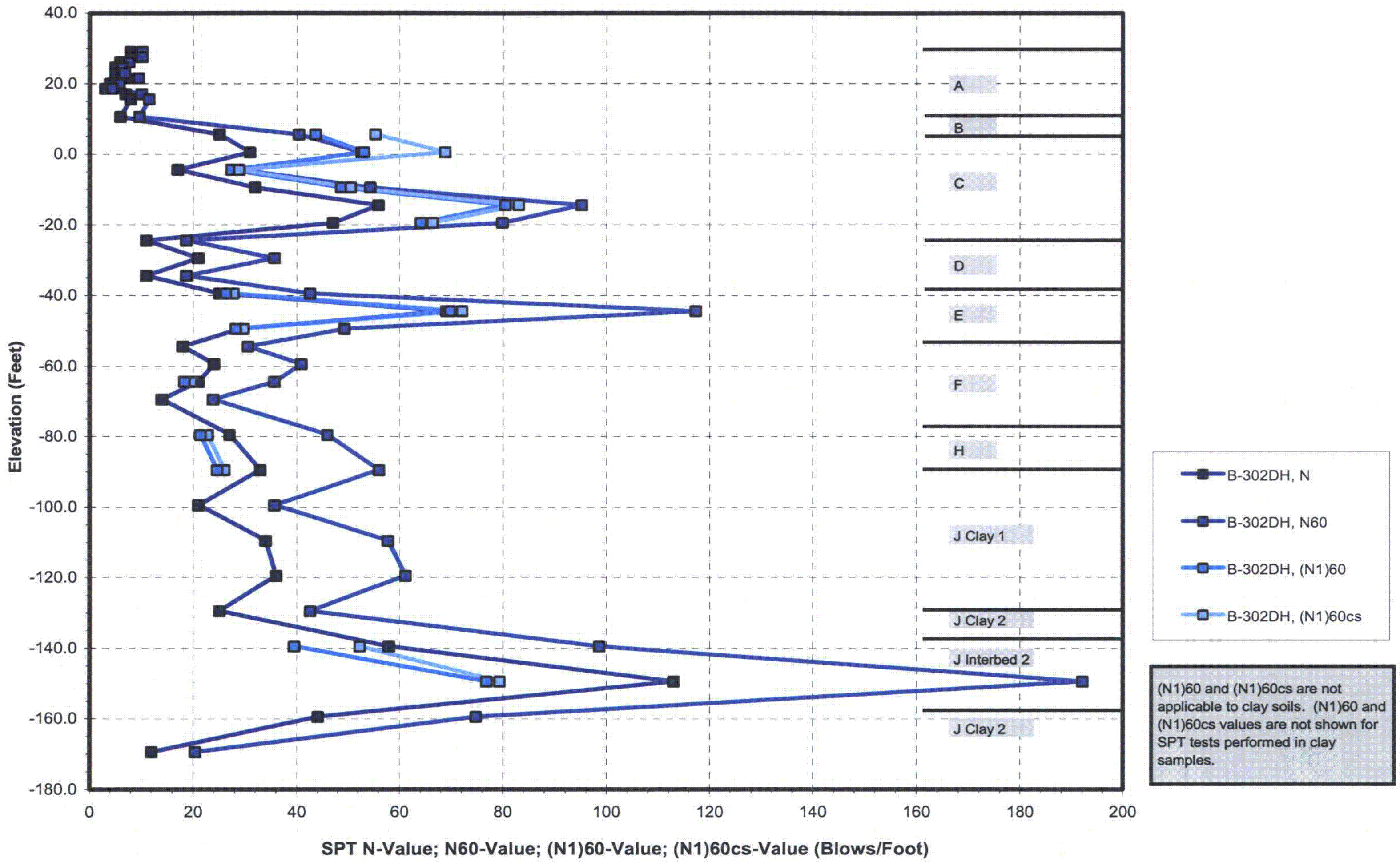


Figure 2.5S.4-69 STP 3; Example (SPT N-Value N –to- $(N_1)60$ –to- $(N_1)_{60cs}$)

This figure replaces the existing Figure 2.5S.4-70 in COLA Rev 2.

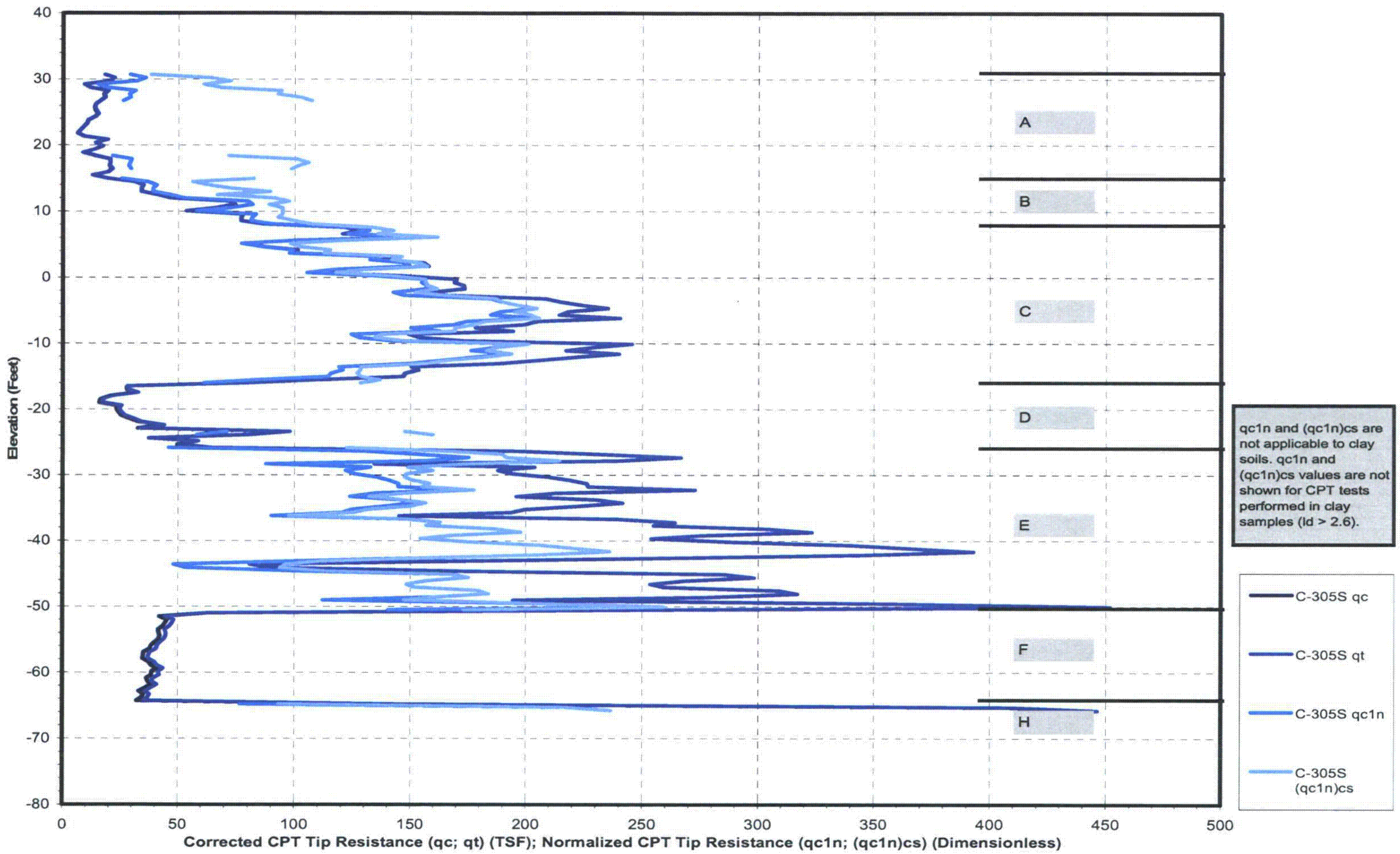


Figure 2.5S.4-70 CPT C305S (CPT 3; Example; CPT Tip Resistance q_c -to- q_t -to- q_{c1n} -to- $(q_{c1n})_{cs}$)

This figure is being added to the FSAR.

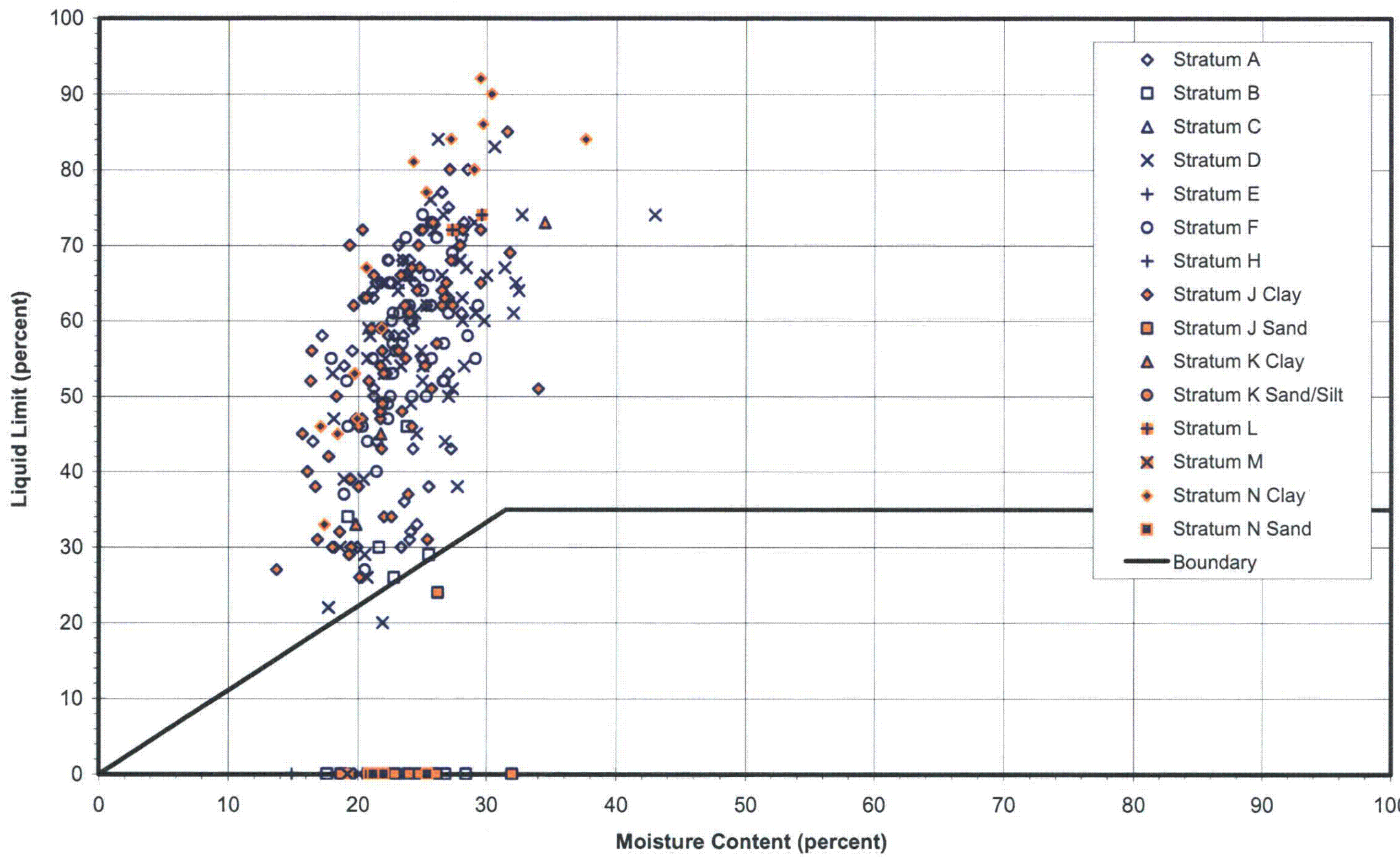


Figure 2.5S.4-78 Liquefaction Evaluation of Clayey Soils

This Figure is being added to the FSAR.

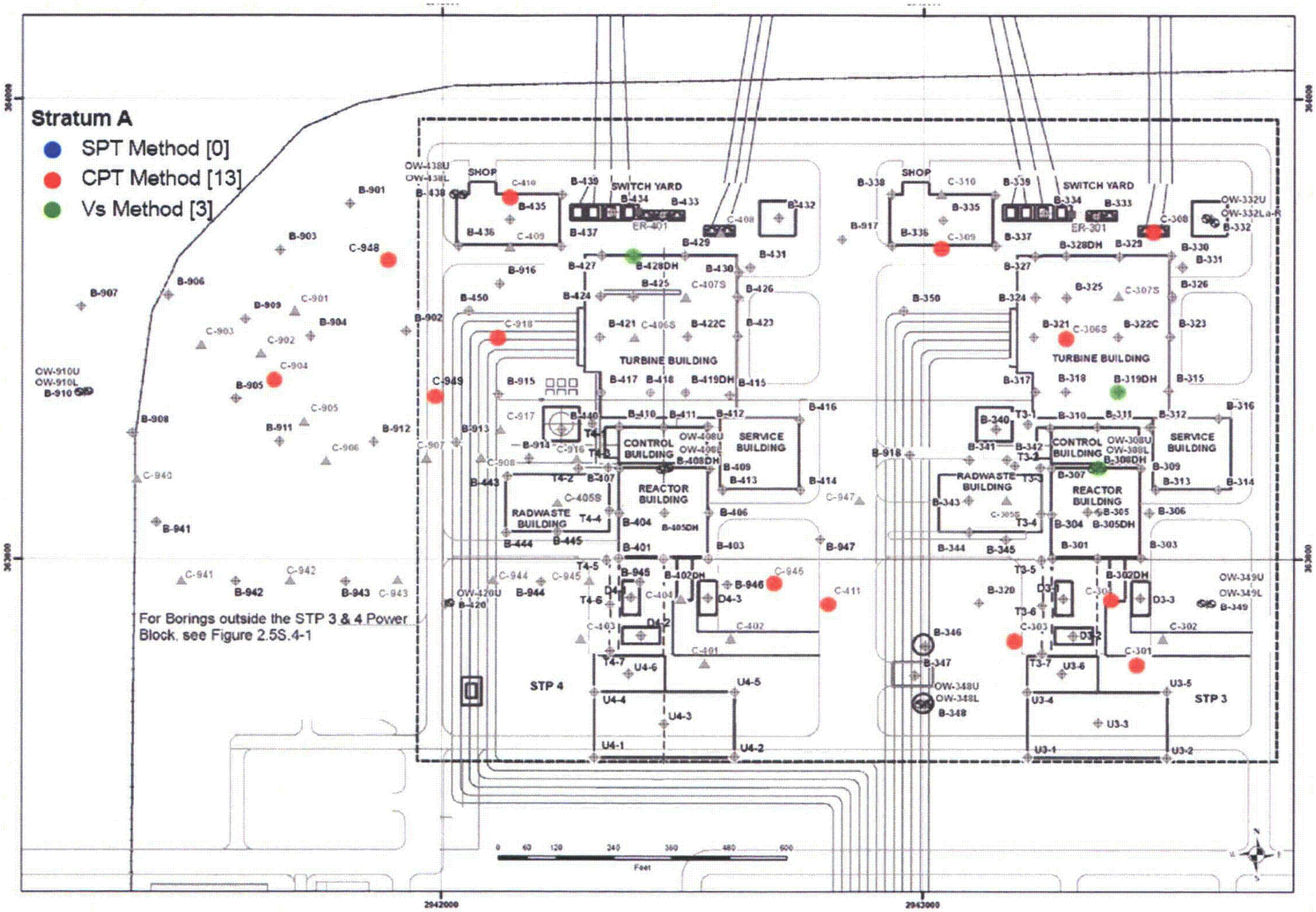


Figure 2.5S.4-79A Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum A

This Figure is being added to the FSAR.

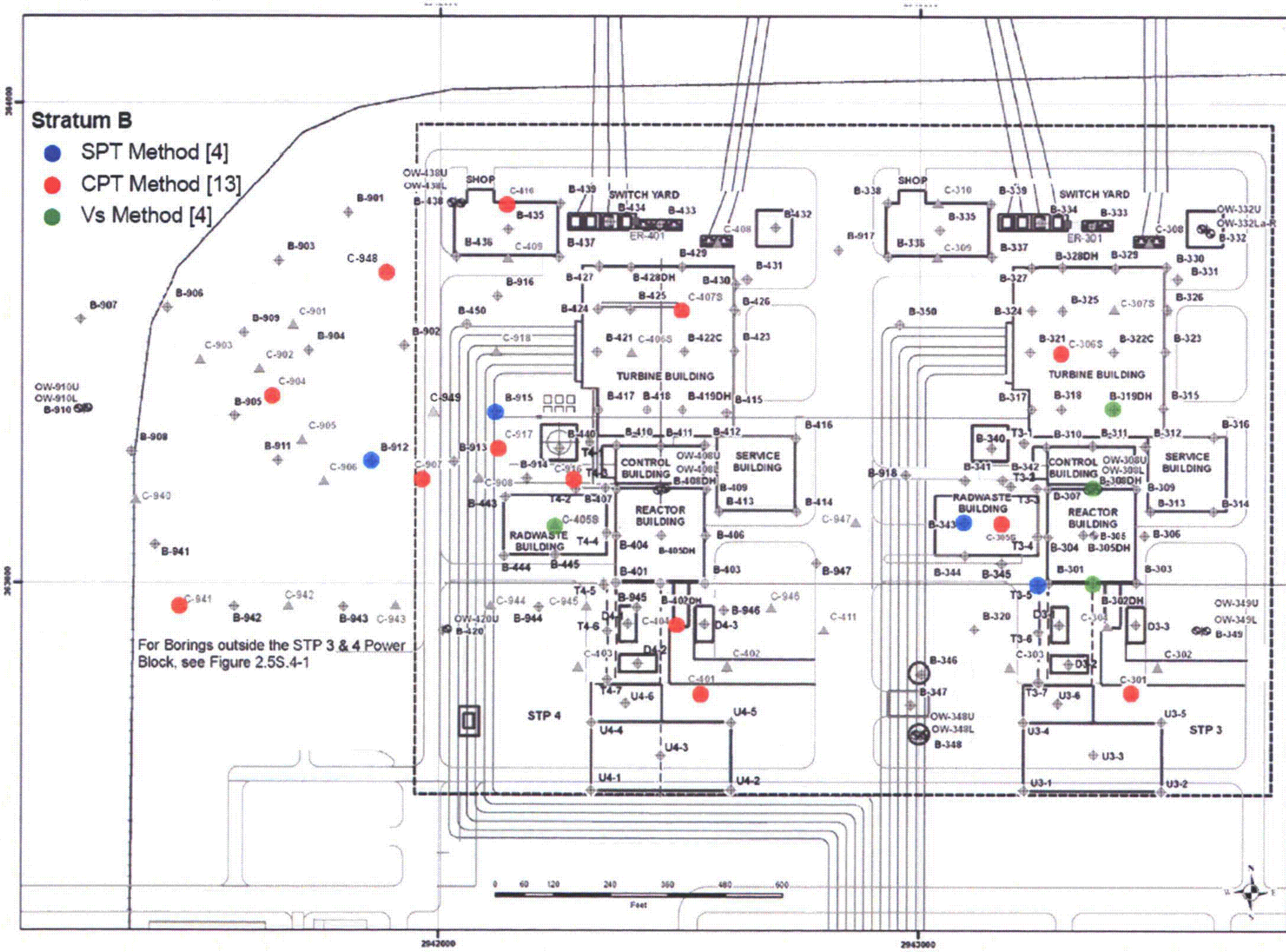


Figure 2.5S.4-79B Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum B

This Figure is being added to the FSAR.

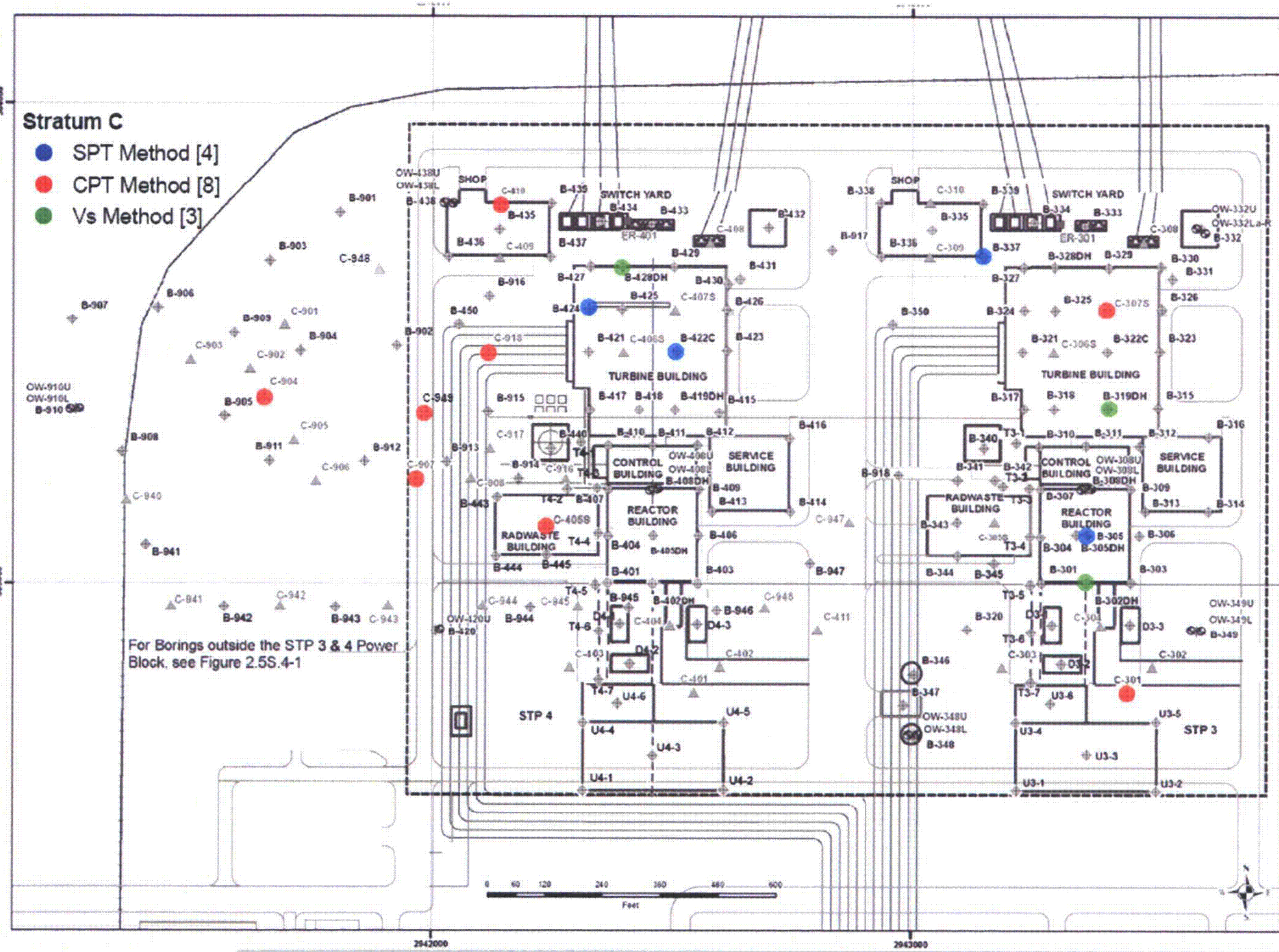


Figure 2.5S.4-79C Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum C

This Figure is being added to the FSAR.

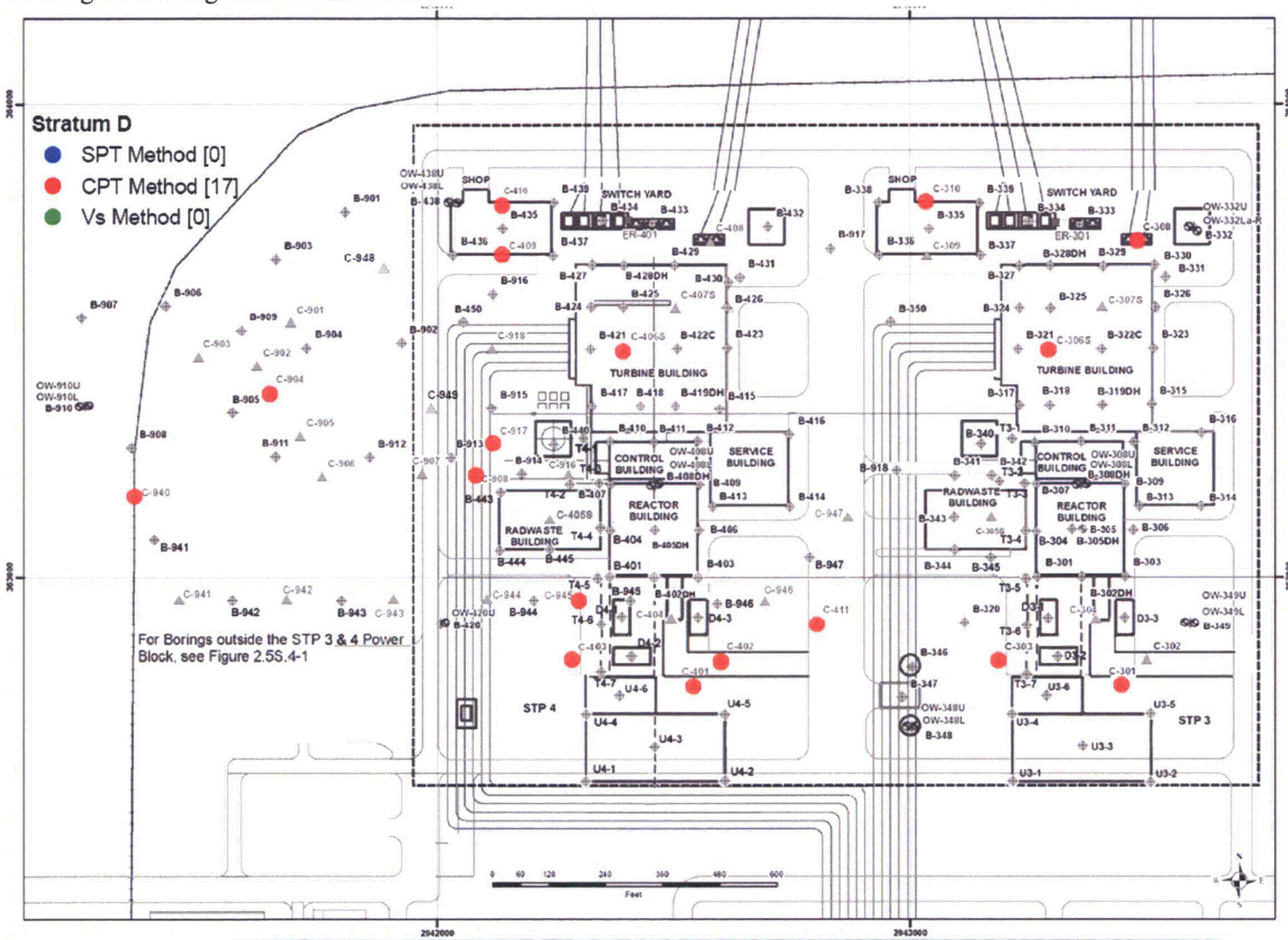


Figure 2.5S.4-79D Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum D

This Figure is being added to the FSAR.

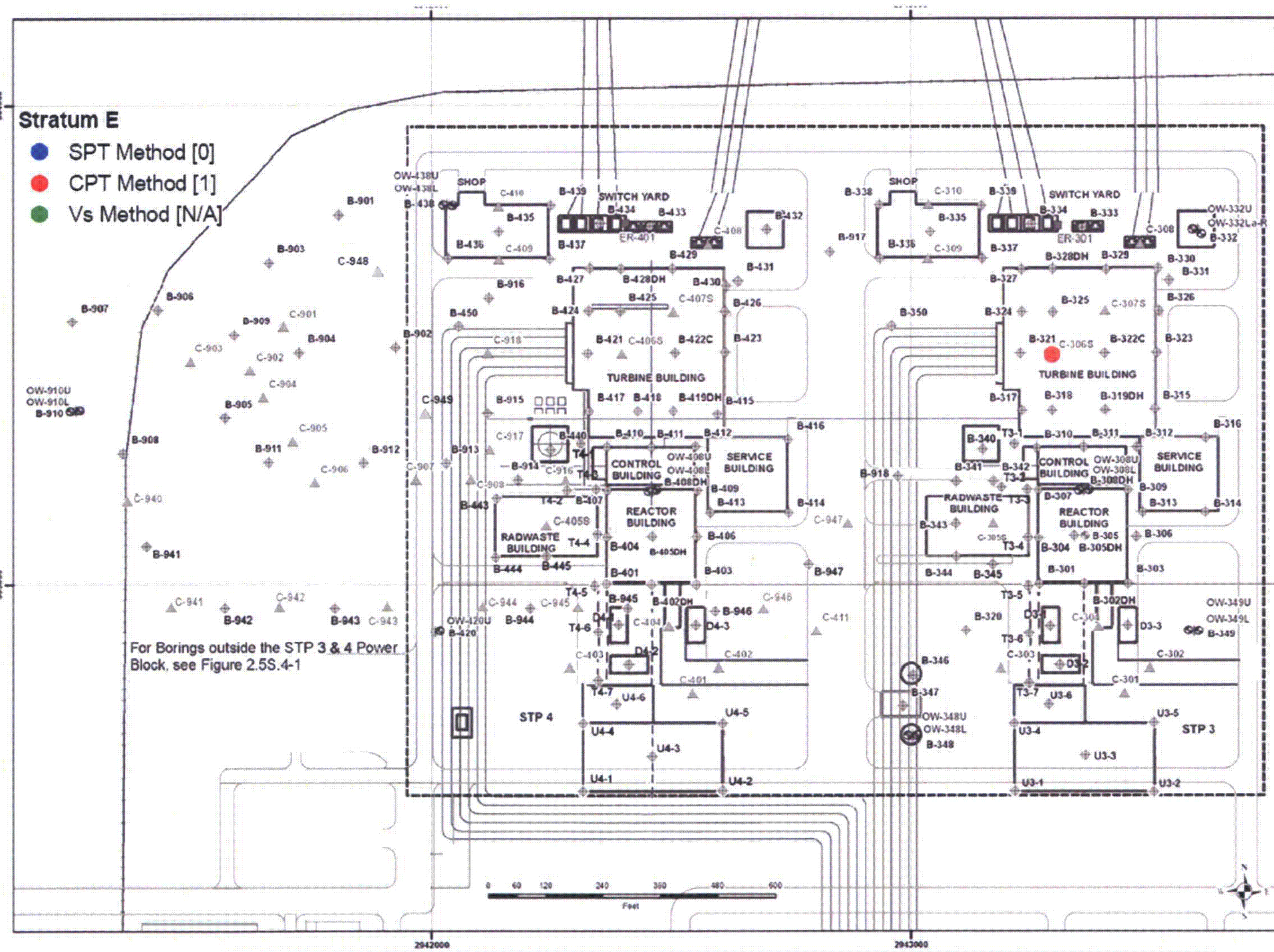


Figure 2.5S.4-79E Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum E

This Figure is being added to the FSAR.

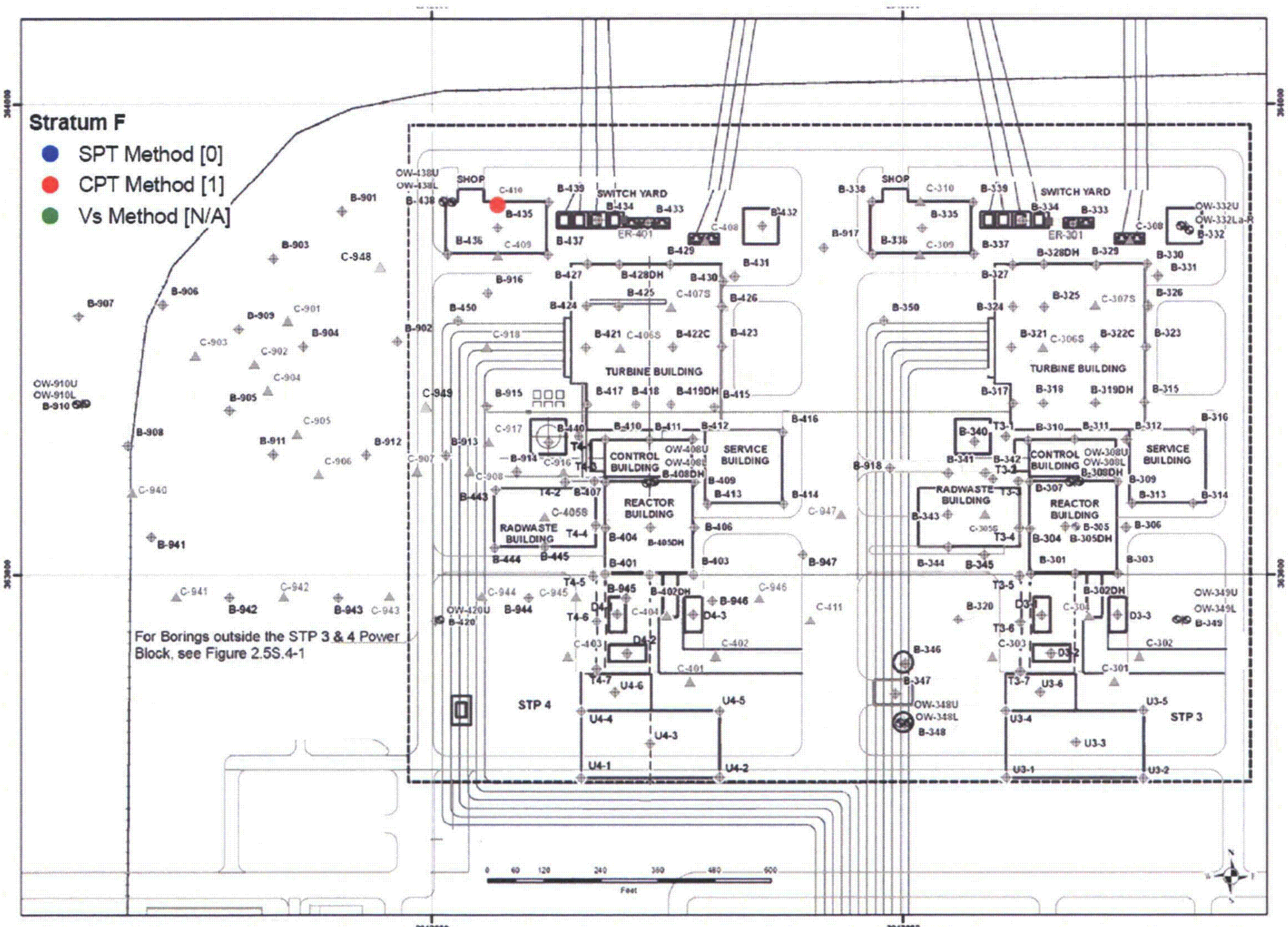


Figure 2.5S.4-79F Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum F

This Figure is being added to the FSAR.

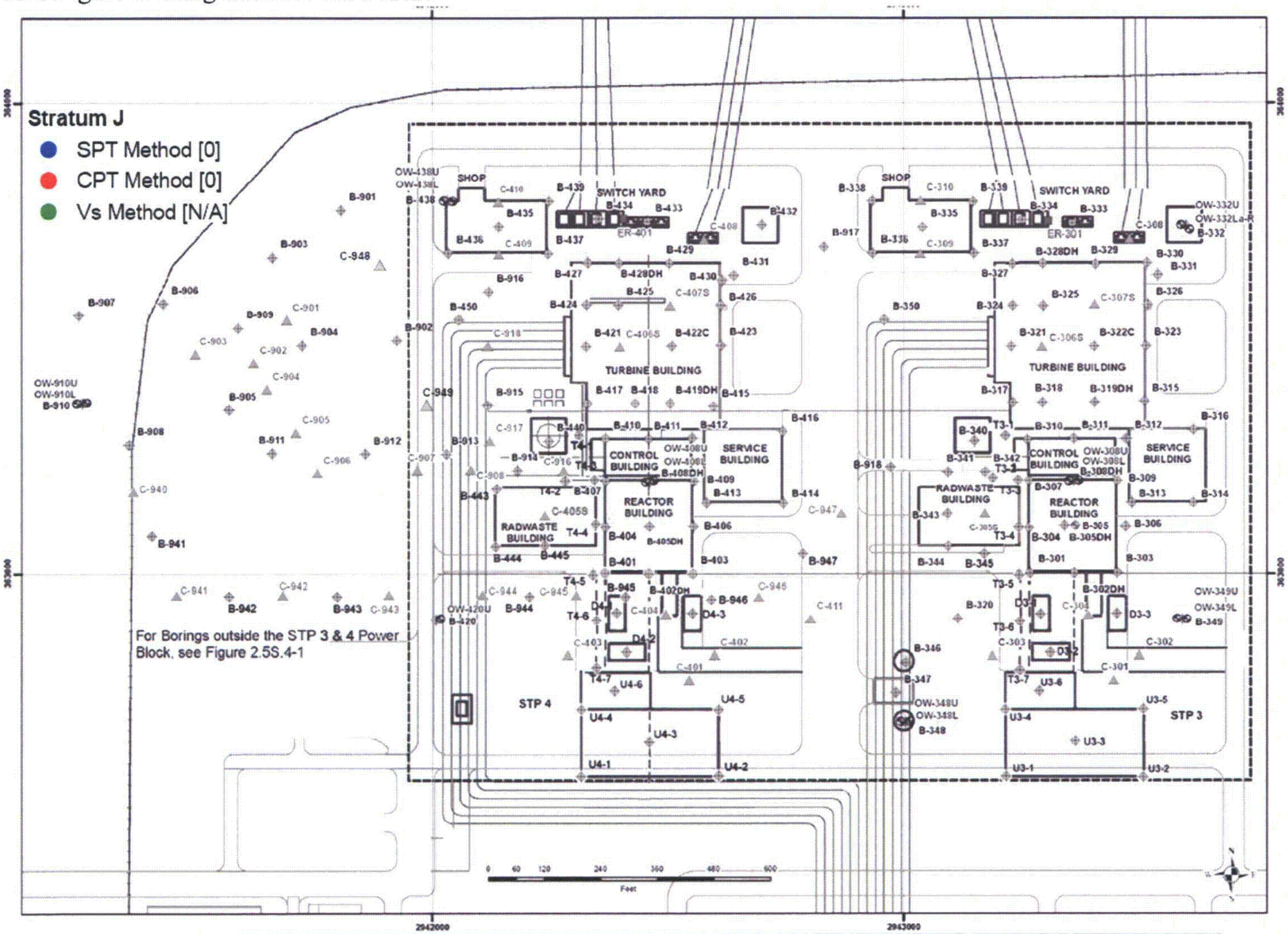


Figure 2.5S.4-79J Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum J

This Figure is being added to the FSAR.

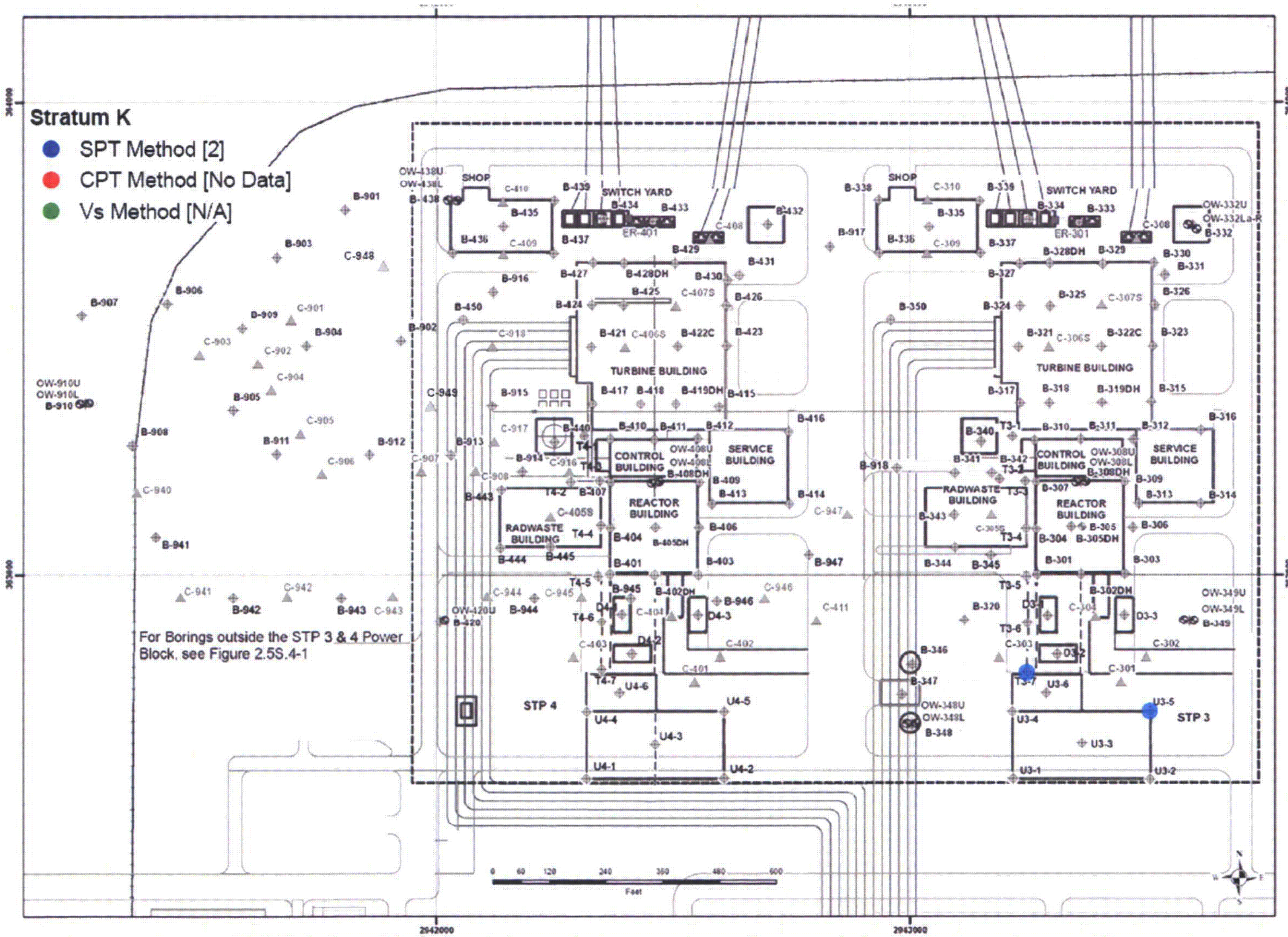


Figure 2.5S.4-79K Spatial Distribution of Low Liquefaction Factor of Safety Values, Stratum K

The following information is provided for Reference to support the response to RAI 2.5S.4-28 but will not be incorporated into the FSAR.

SUPPORTING REFERENCES:

1. "Evaluation of Settlements in Sand Deposits Following Liquefaction During Earthquakes," *Soils and Foundations*, Japanese Society of Soil Mechanics and Foundation Engineering, Vol. 32, No. 1, pp. 173–188, Ishihara, K., and Yoshimine, M., 1992.
2. "Geotechnical Earthquake Engineering," Kramer, S.L., 1996.
3. "Liquefaction Resistance of Soils From Shear-Wave Velocity", Journal of Geotechnical and Geoenvironmental Engineering, November, pp. 1015-1025, Andrus, R.D., Stokoe, K.H. II, 2000..

SUPPORTING TABLES:

SUPPORTING FIGURES

Supporting Figures (continued)

Supporting Figures (continued)

Table 1 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; SPT Method

Boring (Number of Tests)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
B-305DH (1)	-4.7	1.31	Reactor Building	-50 {-60}	Stratum C (To Be Excavated)	✓	
B-305DH (2)	-349.7 -369.7	1.16 1.38	Reactor Building	-50 {-60}	Stratum NS2 (Refer to Table 4)		✓
B-311 (1)	18.4	1.19	Control Building	-42 {-44}	Stratum A (To Be Excavated)	✓	
B-321 (1)	9.7	1.15	Turbine Building	Varies {-58}	Stratum B (To Be Excavated)	✓	
B-323 (1)	10.3	1.39	Turbine Building	Varies {6}	Stratum B (To Be Excavated)	✓	
B-326 (1)	10.9	1.39	Turbine Building	Varies {8}	Stratum B (To Be Excavated)	✓	
B-335 (1)	-3.4	1.22	Machine Shop	To Be Determined {4}	Stratum C (To Remain In Place)		✓
B-337 (1)	10.8	1.33	Machine Shop	To Be Determined {-5}	Stratum B (To Be Excavated)	✓	
B-341 (1)	11.1	1.21	N/A	N/A {-40}	Stratum B (To Be Excavated)	✓	
B-343 (1)	19.0	1.39	Radwaste Building	-19 {-39}	Stratum A (To Be Excavated)	✓	
B-350 (1)	11.3	1.11	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum B (To Be Excavated)	✓	
B-411 (1)	1.8	1.28	Control Building	-42 {-44}	Stratum B (To Be Excavated)	✓	
B-415 (1)	-4.6	1.30	Turbine Building	Varies {-14}	Stratum C (To Be Excavated)	✓	
B-420 (1)	7.4	1.18	N/A	N/A {2}	Stratum B (To Be Excavated)	✓	
B-422C (1)	-0.8	1.11	Turbine Building	Varies {-30}	Stratum C (To Be Excavated)	✓	
B-436 (1)	10.8	1.33	Machine Shop	To Be Determined {10}	Stratum B (To Be Excavated)	✓	
B-436 (1)	0.8	1.27	Machine Shop	To Be Determined {10}	Stratum C (To Remain In Place)		✓
B-445 (1)	6.8	1.31	Radwaste Building	-19 {-39}	Stratum B (To Be Excavated)	✓	
B-920 (1)	13.7	1.20	N/A	N/A	Stratum B (No Structure at Test Location)	✓	✓
B-933 (1)	-0.9	1.21	N/A	N/A	Stratum B (No Structure at Test Location)	✓	✓
B-942 (1)	30.0	1.19	N/A	N/A	Stratum A (Fill) (No Structure at Location)	✓	✓

Table 1 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; SPT Method (Continued)

Boring (Number of Tests)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
D3-1 (1)	12.6	1.22	Diesel Storage Vault	-5 {-7}	Stratum B (To Be Excavated)	✓	
D3-3 (1)	17.4	1.27	Diesel Storage Vault	-5 {-7}	Stratum A (To Be Excavated)	✓	
T3-4 (1)	10.0	1.21	RSW Tunnel	-21 {-23}	Stratum B (To Be Excavated)	✓	
T4-3 (1)	-0.4	1.14	RSW Tunnel	-21 {-23}	Stratum C (To Be Excavated)	✓	
U3-1 (1)	17.6	1.14	Ultimate Heat Sink	4 {2}	Stratum A (To Be Excavated)	✓	
U3-3 (1)	-38.0	1.38	Ultimate Heat Sink	4 {2}	Stratum E (Refer to Table 4)		✓
U3-4 (1)	5.4	1.40[5]	Ultimate Heat Sink	4 {2}	Stratum B (To Be Excavated)	✓	
U3-5 (1)	-183.6	1.38	Ultimate Heat Sink	4 {2}	Stratum K SS (Refer to Table 4)		✓
U4-6 (1)	10.8	1.35	RSW Pump House	-28 {-30}	Stratum B (To Be Excavated)	✓	
U4-6 (1)	-239.2	1.32	RSW Pump House	-28 {-30}	Stratum L (Refer to Table 4)		✓

NOTES:

[1] Elevations are referenced to NGVD 29 datum.

[2] Range of Test Els. and FOS values are given where multiple test points occur.

[3] Foundation Els. shown in "{ }" symbols denote the elevations of significant over-excavation at the particular structure or boring.

[4] ✓ denotes tests having FOS ≥ 1.10 and FOS < 1.40, but made in strata to be excavated, areas without structures, or clay soils unlikely to liquefy according to the Chinese Method.

[5] FOS value slightly < 1.40, but which rounds up to 1.40 at two decimal places.

[6] Foundation El. of the Circulating Water Pipes is to be determined. Excavation plans indicate over-excavation to the approximate elevation indicated in "{ }" symbols.

[7] ✓ denotes tests that will remain in place after fuel load.

[8} Excavation elevations interpreted from STP 3 & 4 FSAR Revision 2, Figures 2.5S.4-48A and 2.5S.4-48B are used to determine if tests will be removed during excavation.

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-301 (5)	24.7 22.7	1.13 1.33	N/A	N/A {15}	Stratum A (No Structure at Test Location)	✓	
C-301 (1)	18.8	1.38	N/A	N/A {15}	Stratum A (No Structure at Test Location)	✓	
C-301 (1)	17.3	1.30	N/A	N/A {15}	Stratum A (No Structure at Test Location)	✓	
C-301 (1)	16.3	1.36	N/A	N/A {15}	Stratum A (No Structure at Test Location)	✓	
C-301 (2)	12.9 12.4	1.17 1.20	N/A	N/A {15}	Stratum A (No Structure at Test Location)	✓	✓
C-302 (1)	-2.6	1.29	N/A	N/A	Stratum C (No Structure at Test Location)	✓	✓
C-302 (1)	-6.0	1.11	N/A	N/A	Stratum C (No Structure at Test Location)	✓	✓
C-303 (2)	16.2 15.7	1.32 1.32	N/A	N/A	Stratum A (No Structure at Test Location)	✓	
C-303 (5)	14.2 12.2	1.15 1.39	N/A	N/A {-30}	Stratum B/C (No Structure at Test Location)	✓	
C-303 (2)	8.3 7.8	1.25 1.35	N/A	N/A {-30}	Stratum C (No Structure at Test Location)	✓	
C-303 (1)	-2.0	1.20	N/A	N/A {-30}	Stratum C (No Structure at Test Location)	✓	
C-304 (1)	18.3	1.12	N/A	N/A {-35}	Stratum A (No Structure at Test Location)	✓	
C-304 (3)	11.9 10.9	1.29 1.32	N/A	N/A {-35}	Stratum A/B (No Structure at Test Location)	✓	
C-304 (1)	-34.8	1.39	N/A	N/A {-35}	Stratum D (No Structure at Test Location)	✓	
C-304 (1)	-36.3	1.31	N/A	N/A {-35}	Stratum D (No Structure at Test Location)	✓	✓
C-305S (1)	18.3	1.20	Radwaste Building	-19 {-39}	Stratum A (To Be Excavated)	✓	
C-305S (1)	14.9	1.31	Radwaste Building	-19 {-39}	Stratum A (To Be Excavated)	✓	
C-305S (1)	13.4	1.12	Radwaste Building	-19 {-39}	Stratum B (To Be Excavated)	✓	
C-305S (1)	11.0	1.38	Radwaste Building	-19 {-39}	Stratum B (To Be Excavated)	✓	
C-306S (1)	12.7	1.21	Turbine Building	Varies {-58}	Stratum B (To Be Excavated)	✓	
C-306S (1)	11.2	1.19	Turbine Building	Varies {-58}	Stratum B (To Be Excavated)	✓	

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-306S (1)	-24.7	1.21	Turbine Building	Varies {-58}	Stratum D (To Be Excavated)	✓	
C-307S (1)	21.9	1.32	Turbine Building	Varies {-30}	Stratum A (To Be Excavated)	✓	
C-307S (3)	20.4 19.4	1.13 1.37	Turbine Building	Varies {-30}	Stratum A (To Be Excavated)	✓	
C-307S (2)	18.4 17.9	1.23 1.28	Turbine Building	Varies {-30}	Stratum A (To Be Excavated)	✓	
C-307S (1)	17.0	1.12	Turbine Building	Varies {-30}	Stratum A (To Be Excavated)	✓	
C-307S (1)	8.1	1.38	Turbine Building	Varies {-30}	Stratum B (To Be Excavated)	✓	
C-307S (1)	-33.7	1.28	Turbine Building	Varies {-30}	Stratum D (To Remain In Place)		✓
C-307S (1)	-46.0	1.32	Turbine Building	Varies {-30}	Stratum E (To Remain In Place)		✓
C-307S (1)	-47.0	1.34	Turbine Building	Varies {-30}	Stratum E (To Remain In Place)		✓
C-307S (2)	-51.9 -52.4	1.26 1.31	Turbine Building	Varies {-30}	Stratum E (To Remain In Place)		✓
C-308 (1)	19.81	1.40[5]	Reserve Transformers	To Be Determined {20}	Stratum A (To Remain In Place)		✓
C-308 (1)	17.8	1.36	Reserve Transformers	To Be Determined {20}	Stratum A (To Remain In Place)		✓
C-308 (5)	14.4 17.5	1.13 1.40[5]	Reserve Transformers	To Be Determined {20}	Stratum A/B (To Remain In Place)		✓
C-308 (1)	10.9	1.36	Reserve Transformers	To Be Determined {20}	Stratum B (To Remain In Place)		✓
C-308 (1)	-11.2	1.38	Reserve Transformers	To Be Determined {20}	Stratum D (To Remain In Place)		✓
C-308 (1)	-12.2	1.39	Reserve Transformers	To Be Determined {20}	Stratum D (To Remain In Place)		✓
C-308 (1)	-13.2	1.35	Reserve Transformers	To Be Determined {20}	Stratum D (To Remain In Place)		✓
C-308 (1)	-15.6	1.35	Reserve Transformers	To Be Determined {20}	Stratum D (To Remain In Place)		✓
C-308 (1)	-23.5	1.25	Reserve Transformers	To Be Determined {20}	Stratum D (To Remain In Place)		✓
C-309 (2)	21.1 20.6	1.15 1.32	Machine Shop	To Be Determined {1}	Stratum A (To Be Excavated)	✓	
C-309 (1)	18.6	1.16	Machine Shop	To Be Determined {1}	Stratum A (To Be Excavated)	✓	

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-309 (1)	16.2	1.28	Machine Shop	To Be Determined {1}	Stratum A (To Be Excavated)	✓	
C-309 (1)	10.3	1.32	Machine Shop	To Be Determined {1}	Stratum B (To Be Excavated)	✓	
C-309 (1)	-46.3	1.32	Machine Shop	To Be Determined {1}	Stratum E (To Remain In Place)		✓
C-309 (1)	-58.1	1.35	Machine Shop	To Be Determined {1}	Stratum E (To Remain In Place)		✓
C-309 (1)	-63.5	1.35	Machine Shop	To Be Determined {1}	Stratum E (To Remain In Place)		✓
C-310 (1)	15.9	1.33	Machine Shop	To Be Determined {7}	Stratum A (To Be Excavated)	✓	
C-310 (2)	12.0 11.5	1.24 1.38	Machine Shop	To Be Determined {7}	Stratum A (To Be Excavated)	✓	
C-310 (2)	8.5 8.0	1.37 1.37	Machine Shop	To Be Determined {7}	Stratum B (To Be Excavated)	✓	
C-310 (1)	-10.2	1.36	Machine Shop	To Be Determined {7}	Stratum D (To Remain In Place)		✓
C-310 (1)	-13.1	1.13	Machine Shop	To Be Determined {7}	Stratum D (To Remain In Place)		✓
C-310 (1)	-29.9	1.35	Machine Shop	To Be Determined {7}	Stratum D (To Remain In Place)		✓
C-310 (4)	-49.5 -51.0	1.21 1.25	Machine Shop	To Be Determined {7}	Stratum E (To Remain In Place)		✓
C-310 (1)	-59.4	1.38	Machine Shop	To Be Determined {7}	Stratum E (To Remain In Place)		✓
C-401 (10)	21.0 16.6	1.10 1.31	N/A	N/A {15}	Stratum B (To Be Excavated)	✓	
C-401 (2)	15.6 15.1	1.11 1.32	N/A	N/A {15}	Stratum B (To Be Excavated)	✓	
C-401 (1)	14.1	1.28	N/A	N/A {15}	Stratum B (No Structure At Test Location)	✓	✓
C-401 (3)	13.1 12.1	1.30 1.36	N/A	N/A {15}	Stratum C (No Structure At Test Location)	✓	✓
C-401 (2)	11.2 10.7	1.24 1.30	N/A	N/A {15}	Stratum C (No Structure At Test Location)	✓	✓
C-401 (1)	-15.4	1.24	N/A	N/A {15}	Stratum D (No Structure At Test Location)	✓	✓
C-402 (2)	18.7 10.2	1.30 1.33	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-402 (1)	14.3	1.33	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-402 (1)	11.8	13.0	N/A	N/A	Stratum C (No Structure At Test Location)	✓	✓
C-402 (1)	-13.0	1.16	N/A	N/A	Stratum D (No Structure At Test Location)	✓	✓
C-402 (3)	-14.2 -15.2	1.12 1.37	N/A	N/A	Stratum D (No Structure At Test Location)	✓	✓
C-403 (3)	-14.9 -15.9	1.11 1.25	N/A	N/A {-29}	Stratum D (To Be Excavated)	✓	
C-404 (1)	13.9	1.17	N/A	N/A {-35}	Stratum A (To Be Excavated)	✓	
C-404 (3)	12.0 11.0	1.32 1.39	N/A	N/A {-35}	Stratum B (To Be Excavated)	✓	
C-405S (1)	11.2	1.12	Radwaste Building	-19 {-39}	Stratum B (To Be Excavated)	✓	
C-405S (3)	10.5 9.8	1.17 1.34	Radwaste Building	-19 {-39}	Stratum B (To Be Excavated)	✓	
C-405S (1)	9.2	1.31	Radwaste Building	-19 {-39}	Stratum B (To Be Excavated)	✓	
C-405S (5)	8.5 7.2	1.12 1.20	Radwaste Building	-19 {-39}	Stratum C (To Be Excavated)	✓	
C-405S (3)	6.6 5.9	1.10 1.25	Radwaste Building	-19 {-39}	Stratum C (To Be Excavated)	✓	
C-405S (1)	-7.2	1.40[5]	Radwaste Building	-19 {-39}	Stratum C (To Be Excavated)	✓	
C-405S (2)	-7.9 -8.2	1.38 1.40[5]	Radwaste Building	-19 {-39}	Stratum C (To Be Excavated)	✓	
C-406S (3)	16.6 15.6	1.23 1.37	Turbine Building	Varies {-58}	Stratum B (To Be Excavated)	✓	
C-406S (4)	12.6 11.2	1.17 1.36	Turbine Building	Varies {-58}	Stratum B/C (To Be Excavated)	✓	
C-406S (2)	7.7 7.2	1.24 1.39	Turbine Building	Varies {-58}	Stratum C (To Be Excavated)	✓	
C-407S (2)	11.8 11.4	1.19 1.30	Turbine Building	Varies {-30}	Stratum B (To Be Excavated)	✓	
C-407S (1)	-57.0	1.38	Turbine Building	Varies {-30}	Stratum H (To Remain In Place)		✓
C-408 (2)	19.1 18.7	1.24 1.36	Reserve Transformers	To Be Determined {20}	Stratum B (To Remain In Place)		✓
C-408 (2)	11.8 11.3	1.30 1.38	Reserve Transformers	To Be Determined {20}	Stratum B (To Remain In Place)		✓

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-408 (1)	-59.6	1.30	Reserve Transformers	To Be Determined {20}	Stratum H (To Remain In Place)		✓
C-408 (1)	-66.0	1.29	Reserve Transformers	To Be Determined {20}	Stratum J C1 (To Remain In Place)		✓
C-409 (1)	24.2	1.39	Machine Shop	To Be Determined {1}	Stratum A (To Be Excavated)	✓	
C-409 (1)	12.4	1.20	Machine Shop	To Be Determined {1}	Stratum B (To Be Excavated)	✓	
C-409 (1)	-14.7	1.19	Machine Shop	To Be Determined {1}	Stratum D (To Remain In Place)		✓
C-409 (1)	-62.4	1.25	Machine Shop	To Be Determined {1}	Stratum F (To Remain In Place)		✓
C-410 (1)	12.9	1.14	Machine Shop	To Be Determined {7}	Stratum B (To Be Excavated)	✓	
C-410 (1)	9.0	1.33	Machine Shop	To Be Determined {7}	Stratum C (To Be Excavated)	✓	
C-410 (1)	-0.9	1.31	Machine Shop	To Be Determined {7}	Stratum C (To Remain In Place)		✓
C-410 (2)	-2.84 -3.33	1.25 1.28	Machine Shop	To Be Determined {7}	Stratum C (To Remain In Place)		✓
C-410 (3)	-23.5 -24.5	1.13 1.25	Machine Shop	To Be Determined {7}	Stratum D (To Remain In Place)		✓
C-410 (3)	-44.7 -45.7	1.16 1.17	Machine Shop	To Be Determined {7}	Stratum F (To Remain In Place)		✓
C-410 (1)	-51.6	1.27	Machine Shop	To Be Determined {7}	Stratum F (To Remain In Place)		✓
C-410 (1)	-54.5	1.36	Machine Shop	To Be Determined {7}	Stratum H (To Remain In Place)		✓
C-411 (1)	20.0	1.20	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-411 (1)	18.5	1.31	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-411 (1)	14.6	1.13	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-411 (1)	12.1	1.39	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-411 (1)	-12.0	1.21	N/A	N/A	Stratum D (No Structure At Test Location)	✓	✓
C-902 (1)	9.0	1.19	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-903 (1)	7.8	1.38	N/A	N/A	Stratum C (No Structure At Test Location)	✓	✓
C-904 (4)	15.6 14.1	1.16 1.27	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓

**Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)**

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-904 (2)	13.1 12.6	1.24 1.27	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-904 (1)	-4.1	1.16	N/A	N/A	Stratum C (No Structure At Test Location)	✓	✓
C-904 (2)	-5.6 -6.1	1.37 1.38	N/A	N/A	Stratum C (No Structure At Test Location)	✓	✓
C-906 (2)	-0.6 -1.1	1.25 1.34	N/A	N/A	Stratum C (No Structure At Test Location)	✓	✓
C-906 (1)	-2.0	1.22	N/A	N/A	Stratum C (No Structure At Test Location)	✓	✓
C-907 (1)	10.5	1.20	N/A	N/A {2}	Stratum B (No Structure At Test Location)	✓	
C-907 (2)	9.1 8.6	1.15 1.36	N/A	N/A {2}	Stratum B (No Structure At Test Location)	✓	
C-907 (2)	1.2 0.7	1.33 1.38	N/A	N/A {2}	Stratum C (No Structure At Test Location)	✓	✓
C-907 (2)	-2.3 -2.8	1.15 1.40[5]	N/A	N/A {2}	Stratum C (No Structure At Test Location)	✓	✓
C-907 (3)	-3.7 -4.7	1.26 1.39	N/A	N/A {2}	Stratum C (No Structure At Test Location)	✓	✓
C-907 (2)	-5.7 -6.2	1.37 1.39	N/A	N/A {2}	Stratum C (No Structure At Test Location)	✓	✓
C-907 (1)	-9.2	1.10	N/A	N/A {2}	Stratum C (No Structure At Test Location)	✓	✓
C-907 (1)	-16.0	1.30	N/A	N/A {2}	Stratum D (No Structure At Test Location)	✓	✓
C-908 (3)	18.8 17.9	1.23 1.37	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum A (To Be Excavated)	✓	
C-908 (1)	11.5	1.13	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum B (To Be Excavated)	✓	
C-909 (1)	20.1	1.33	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-909 (2)	16.7 16.2	1.11 1.19	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-909 (1)	11.2	1.33	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-909 (3)	-4.0 -5.0	1.11 1.26	N/A	N/A	Stratum C (No Structure At Test Location)	✓	✓
C-916 (1)	15.9	1.40[5]	Control Building	-42 {-44}	Stratum A (To Be Excavated)	✓	
C-916 (1)	11.5	1.39	Control Building	-42 {-44}	Stratum B (To Be Excavated)	✓	

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-916 (2)	2.1 1.6	1.37 1.40[5]	Control Building	-42 {-44}	Stratum C (To Be Excavated)	✓	
C-917 (1)	17.7	1.40[5]	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum A (To Be Excavated)	✓	
C-917 (2)	16.7 16.2	1.15 1.28	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum A (To Be Excavated)	✓	
C-917 (1)	10.8	1.35	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum B (To Be Excavated)	✓	
C-917 (1)	8.3	1.10	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum B (To Be Excavated)	✓	
C-917 (1)	5.4	1.29	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum B (To Be Excavated)	✓	
C-917 (1)	-13.8	1.20	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum D (To Be Excavated)	✓	
C-918 (1)	18.8	1.20	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum A (To Be Excavated)	✓	
C-918 (1)	17.8	1.37	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum A (To Be Excavated)	✓	
C-918 (1)	16.8	1.35	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum A (To Be Excavated)	✓	
C-918 (1)	-13.2	1.28	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum C (To Be Excavated)	✓	
C-918 (1)	-14.2	1.33	Circulating Water Pipes	To Be Determined {-15 to -39} [6]	Stratum C (To Be Excavated)	✓	
C-940 (1)	24.4	1.31	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-940 (1)	22.8	1.39	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-940 (1)	22.1	1.29	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-940 (5)	21.1 19.8	1.18 1.32	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-940 (1)	19.2	1.37	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-940 (1)	17.2	1.37	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-940 (1)	15.3	1.30	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-940 (1)	11.0	1.39	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-940 (1)	10.0	1.33	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-941 (1)	10.5	1.32	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-942 (1)	12.4	1.32	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-942 (4)	11.4 10.4	1.33 1.38	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-943 (2)	11.7 11.3	1.11 1.29	N/A	N/A {22}	Stratum B (No Structure At Test Location)	✓	✓
C-943 (1)	10.4	1.37	N/A	N/A {22}	Stratum B (No Structure At Test Location)	✓	✓
C-943 (1)	7.1	1.38	N/A	N/A {22}	Stratum C (No Structure At Test Location)	✓	✓
C-943 (2)	4.8 4.4	1.35 1.37	N/A	N/A {22}	Stratum C (No Structure At Test Location)	✓	✓
C-943 (1)	2.2	1.34	N/A	N/A {22}	Stratum C (No Structure At Test Location)	✓	✓
C-945 (2)	12.5 12.1	1.13 1.38	N/A	N/A {-50}	Stratum B (No Structure At Test Location)	✓	
C-945 (3)	11.5 10.8	1.16 1.28	N/A	N/A {-50}	Stratum B (No Structure At Test Location)	✓	
C-945 (2)	7.5 7.2	1.29 1.37	N/A	N/A {-50}	Stratum C (No Structure At Test Location)	✓	
C-946 (1)	20.8	1.17	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-946 (1)	18.2	1.29	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-946 (2)	16.6 16.2	1.25 1.28	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-946 (5)	12.6 11.3	1.12 1.29	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-946 (1)	-17.2	1.37	N/A	N/A	Stratum D (No Structure At Test Location)	✓	✓
C-948 (4)	17.3 16.3	1.14 1.15	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-948 (9)	15.4 12.7	1.16 1.34	N/A	N/A	Stratum A (No Structure At Test Location)	✓	✓
C-948 (4)	11.1 10.1	1.17 1.40[5]	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-948 (3)	9.1 8.5	1.15 1.24	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓
C-948 (1)	7.8	1.12	N/A	N/A	Stratum B (No Structure At Test Location)	✓	✓

Table 2 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; CPT Method (Continued)

CPT (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,8] (feet)	Stratum (Disposition) [8]	[4]	[7]
C-948a (2)	11.1 10.8	1.13 1.40[5]	N/A	N/A	Stratum A/B (No Structure At Test Location)	✓	✓
C-949 (5)	25.4 23.8	1.13 1.29	N/A	N/A {3}	Stratum A (No Structure At Test Location)	✓	
C-949 (3)	22.8 22.1	1.18 1.11	N/A	N/A {3}	Stratum A (No Structure At Test Location)	✓	
C-949 (5)	21.1 19.8	1.16 1.32	N/A	N/A {3}	Stratum A (No Structure At Test Location)	✓	
C-949 (2)	10.0 9.7	1.28 1.21	N/A	N/A {3}	Stratum B (No Structure At Test Location)	✓	
C-949 (6)	2.8 1.1	1.23 1.38	N/A	N/A {3}	Stratum C (No Structure At Test Location)	✓	✓
C-949 (3)	-8.4 -9.1	1.37 1.39	N/A	N/A {3}	Stratum C (No Structure At Test Location)	✓	✓

NOTES:

[1] Elevations are referenced to NGVD 29 datum.

[2] Range of Test Els. and FOS values are given where multiple test points occur.

[3] Foundation Els. shown in "{ }" symbols denote the elevations of significant over-excavation at the particular structure or boring.

[4] ✓ denotes tests having FOS ≥ 1.10 and < 1.40, but made in strata to be excavated, areas without structures, or clay soils unlikely to liquefy according to the Chinese Method.

[5] FOS value slightly < 1.40, but which rounds up to 1.40 at two decimal places.

[6] Foundation El. of the Circulating Water Pipes is to be determined. Excavation plans indicate over-excavation to the approximate elevation indicated in "{ }" symbols.

[7] ✓ denotes tests that will remain in place after fuel load.

[8] Excavation elevations interpreted from STP 3 & 4 FSAR Revision 2, Figures 2.5S.4-48A and 2.5S.4-48B are used to determine if tests will be removed during excavation.

Table 3 Summary of Liquefaction Potential
FOS Values ≥ 1.10 and < 1.40; Shear Wave Velocity Method

V_s (Number of Test Points)	Test El. [1,2] (feet)	FOS [2]	Structure	Foundation El. [3,6] (feet)	Stratum (Disposition) [6]	[4]	[5]
B-302DH (1)	-4.4	1.23	Reactor Building	-50 {-60}	Stratum C (To Be Excavated)	✓	
B-308DH (1)	24.9	1.10	Reactor Building	-50 {-60}	Stratum A (To Be Excavated)	✓	
B-308DH (1)	18.3	1.21	Reactor Building	-50 {-60}	Stratum A (To Be Excavated)	✓	
B-308DH (2)	13.4 11.8	1.32 1.33	Reactor Building	-50 {-60}	Stratum B (To Be Excavated)	✓	
B-319DH (1)	8.7	1.19	Turbine Building	Varies {-40}	Stratum C (To Be Excavated)	✓	
B-328DH (1)	18.4	1.11	Turbine Building	Varies {-12}	Stratum A (To Be Excavated)	✓	
B-405DH (1)	1.5	1.22	Reactor Building	-50 {-60}	Stratum B (To Be Excavated)	✓	
B-419DH (1)	21.5	1.27	Turbine Building	Varies {-40}	Stratum A (To Be Excavated)	✓	
B-419DH (1)	8.4	1.20	Turbine Building	Varies {-40}	Stratum A (To Be Excavated)	✓	
B-428DH (2)	29.3	1.11	Turbine Building	Varies {-13}	Stratum A (To Be Excavated)	✓	
B-428DH (1)	7.9 6.3	1.21 1.33	Turbine Building	Varies {-13}	Stratum A/B (To Be Excavated)	✓	
B-428DH (1)	-13.4	1.15	Turbine Building	Varies {-13}	Stratum D (To Remain In Place)		✓

NOTES:

[1] Elevations are referenced to NGVD 29 datum. V_S Method not applicable for depths greater than approximately 40 feet per Andrus and Stokoe (2000) (Test El. below approximately -10 to -15 ft).

[2] Range of Test Els. and FOS values are given where multiple test points occur.

[3] Foundation Els. shown in "{ }" symbols denote the elevations of significant over-excavation at the particular structure or boring.

[4] ✓ denotes tests having FOS ≥ 1.10 and FOS < 1.40, but made in strata to be excavated, areas without structures, or having clay soils unlikely to liquefy according to the Chinese Method.

[5] ✓ denotes tests that will remain in place after fuel load.

[6] Excavation elevations interpreted from STP 3 & 4 FSAR Revision 2, Figures 2.5S.4-48A and 2.5S.4-48B are used to determine if tests will be removed during excavation.

Table 4 Summary of Liquefaction Induced Compression at Depth Beneath Nuclear Safety Related Structures

Structure	Foundation El. (ft)	Boring	Test El. [1] (ft)	Stratum	FOS [4]	$(N_1)_{60cs}$ / N_1 [2]	Layer Thickness (ft)	Volumetric Strain [3] (%)	Liquefaction Induced Compression (in)	Total Liquefaction Compression at Depth (in)	Depth Below Foundation El. to Test El. (ft)
Reactor Buliding	-50	B-305DH	-349.7	NS2	1.16	14.8 / 12.3	20.0	0.59	1.4	2.4 [5]	300 to 320
Reactor Building	-50	B-305DH	-369.7	NS2	1.37	19.8 / 16.5	30.0	0.28	1.0		
RSW Tunnel	-21	T3-7	-190.6	KSS	1.04	9.3 / 7.7	20.0	1.18	2.8	2.8 [5]	170
Ultimate Heat Sink	4	U3-3	-38.0	E	1.38	11.1 / 9.2	2.5	0.33	0.1	0.1 [5]	42
Ultimate Heat Sink	4	U3-5	-183.6	KSS	1.38	14.6 / 12.2	10.0	0.31	0.4	0.8 [5]	188 to 198
Ultimate Heat Sink	4	U3-5	-193.5	KSS	1.10	10.2 / 8.5	4.0	0.77	0.4		
RSW Pump House	-28	U4-6	-239.2	L	1.32	15.3 / 12.7	10.0	0.37	0.4	0.4 [5]	211

NOTES:

[1] Elevations are referenced to NGVD 29 datum.

[2] $(N_1)_{60CS}$ values multiplied by 0.833 to account for energy differences between Japanese and American penetration testing practices as noted by Kramer (1996).

[3] Volumetric strains interpreted from Ishihara and Yoshimine (1992) Figure 10.

[4] FOS values based on SPT method. No FOS values for CPT or V_S methods applicable to this table.

[5] Compression at depth in a laterally limited width of the indicated stratum is unlikely to propagate to the foundation elevation of the structure due to dissipation by depth below the foundation elevation.

Table 5 Summary of Liquefaction Induced Compression Beneath Non-Nuclear Safety Related Structures Adjacent to Nuclear Safety Related Structures by the CPT Method

Structure	Foundation El. (ft)	Boring	Test El. [1] (ft)	Stratum	FOS [3]	$q_{(c1N)cs}$ (tsf)	q_{c1} (kgf/cm^2)	Layer Thickness (ft)	Volumetric Strain [2] (%)	Liquefaction Induced Compression (in)	Total Liquefaction Compression (in)	Depth Below Foundation El. to Test El. (ft)
Turbine Buliding	-26	C-307S	-33.7	D	1.28	81.8	79.8	0.5	0.39	0.02	0.02	7
Turbine Buliding	-26	C-307S	-46.0	E	1.32	73.4	71.6	0.5	0.37	0.02	0.10	20 to 27
Turbine Buliding	-26	C-307S	-47.0	E	1.33	74.1	72.3	0.5	0.36	0.02		
Turbine Buliding	-26	C-307S	-51.9	E	1.30	64.7	63.1	0.5	0.42	0.03		
Turbine Buliding	-26	C-307S	-52.4	E	1.26	44.2	43.1	0.5	0.47	0.03		
Turbine Buliding	-26	C-407S	-57.0	H	1.38	75.5	73.7	0.5	0.31	0.02	0.02	31

NOTES:

[1] Elevations are referenced to NGVD 29 datum.

[2] Volumetric strains interpreted from Ishihara and Yoshimine (1992) Figure 10.

[3] Based on CPT method. No FOS values from SPT method applicable to this table.

Table 6 Summary of Liquefaction Induced Compression Beneath Non-Nuclear Safety Related Structures Adjacent to Nuclear Safety Related Structures by the Shear Wave Velocity Method

Structure	Foundation El. (ft)	Boring	Test El. [1] (ft)	Stratum	FOS [4]	V_{S1} (ft/sec) / D_R [2] (%)	Layer Thickness (ft)	Volumetric Strain [3] (%)	Liquefaction Induced Compression (in)	Total Liquefaction Compression (in)	Depth Below Foundation El. to Test El. (ft)
Turbine Building	-8	B-428DH	-13.4	D	1.15	530.8 / 90	0.8	0.29	0.03	0.03	5.4

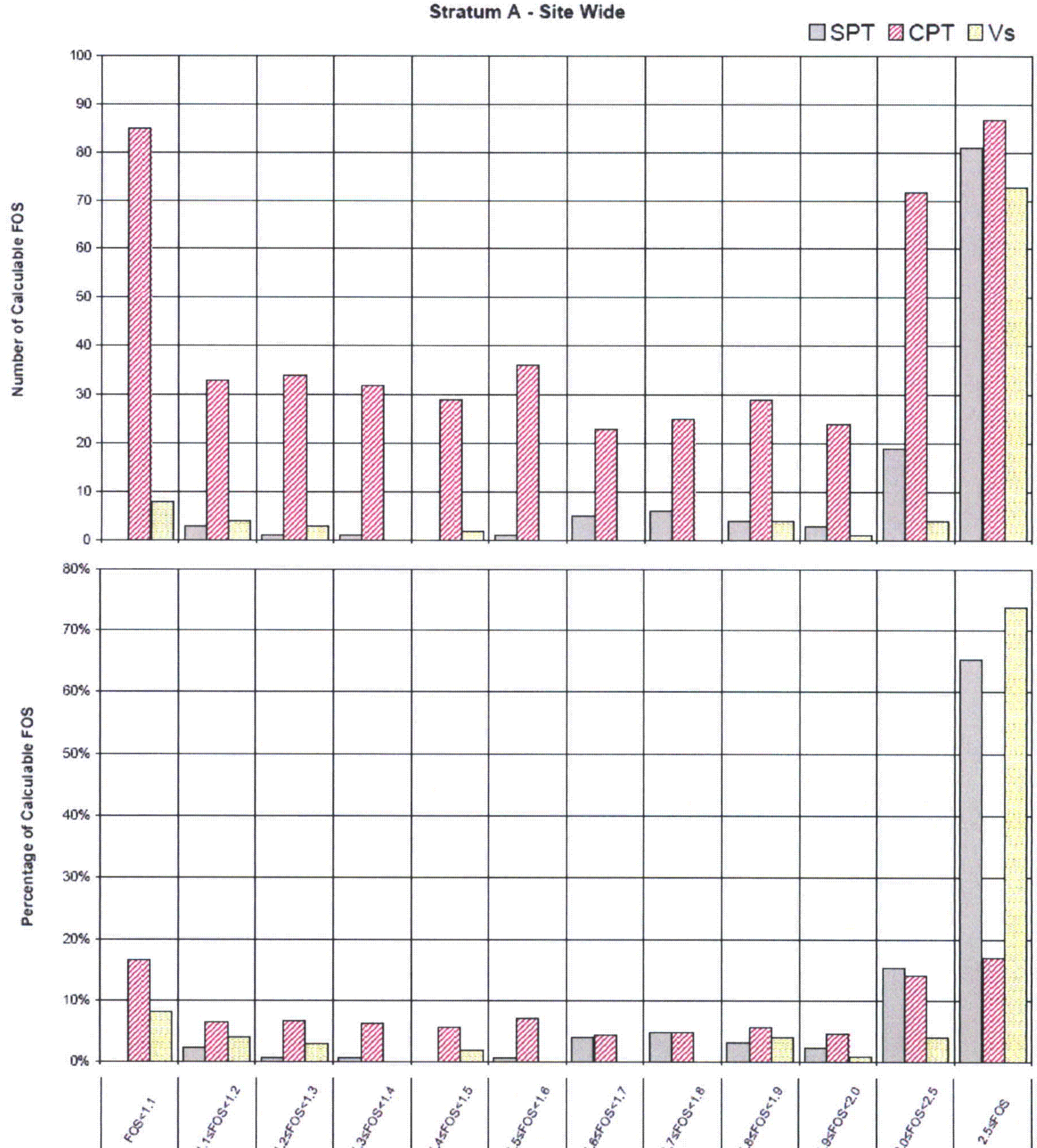
NOTES:

[1] Elevations are referenced to NGVD 29 datum.

[2] Relative density D_R estimated based on $(N_1)_{60CS}$ in boring at depth of V_S test.

[3] Volumetric strains interpreted from Ishihara and Yoshimine (1992) Figure 10.

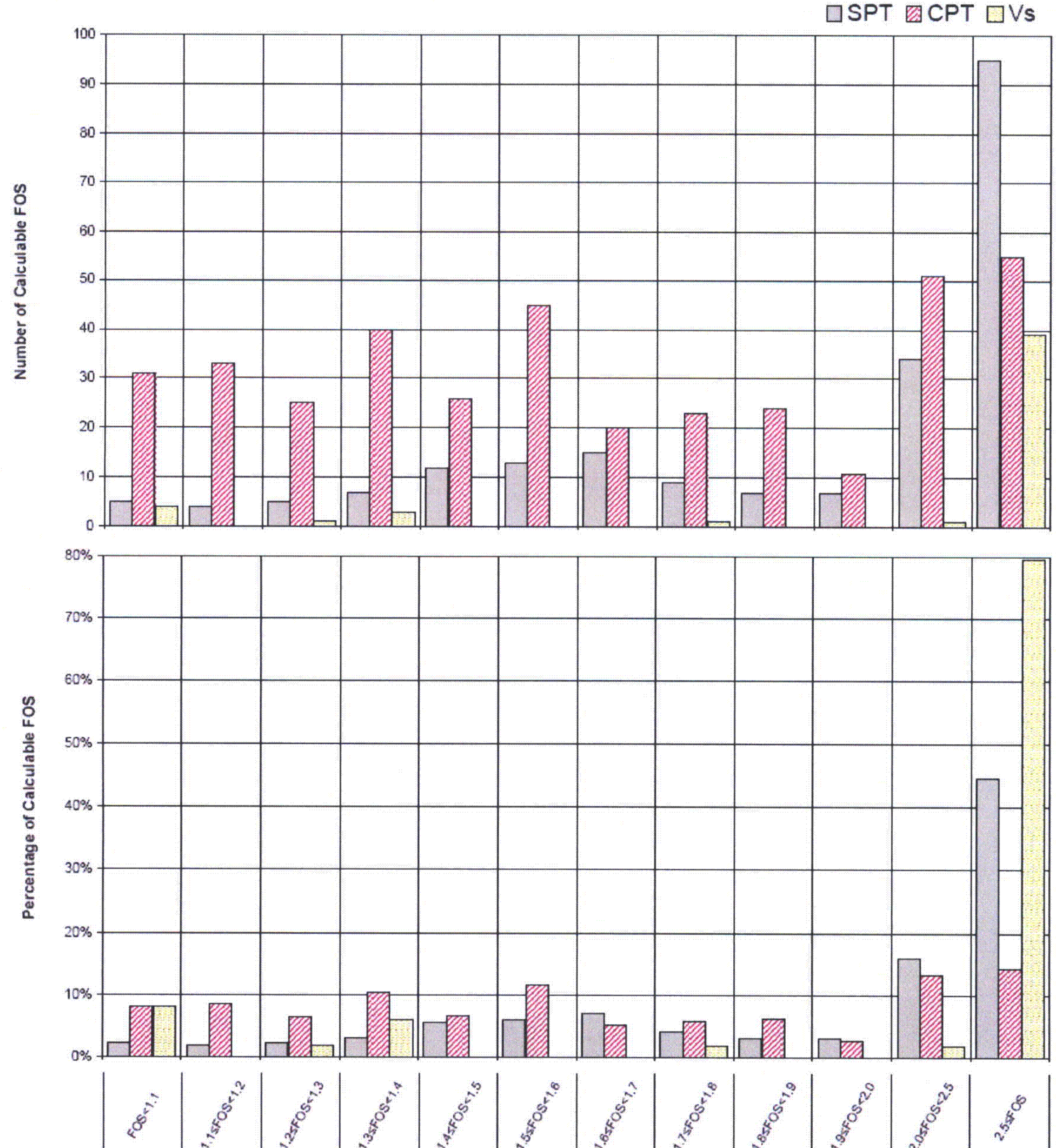
Figure 1 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum A - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	3	1	1	0	1	5	6	4	3	19	81
	% of Count	0.0%	2.4%	0.8%	0.8%	0.0%	0.8%	4.0%	4.8%	3.2%	2.4%	15.3%	65.3%
CPT	Count	85	33	34	32	29	36	23	25	29	24	72	87
	% of Count	16.7%	6.5%	6.7%	6.3%	5.7%	7.1%	4.5%	4.9%	5.7%	4.7%	14.1%	17.1%
Vs	Count	8	4	3	0	2	0	0	0	4	1	4	73
	% of Count	8.1%	4.0%	3.0%	0.0%	2.0%	0.0%	0.0%	0.0%	4.0%	1.0%	4.0%	73.7%

N/A= V_s Method not applicable at this depth

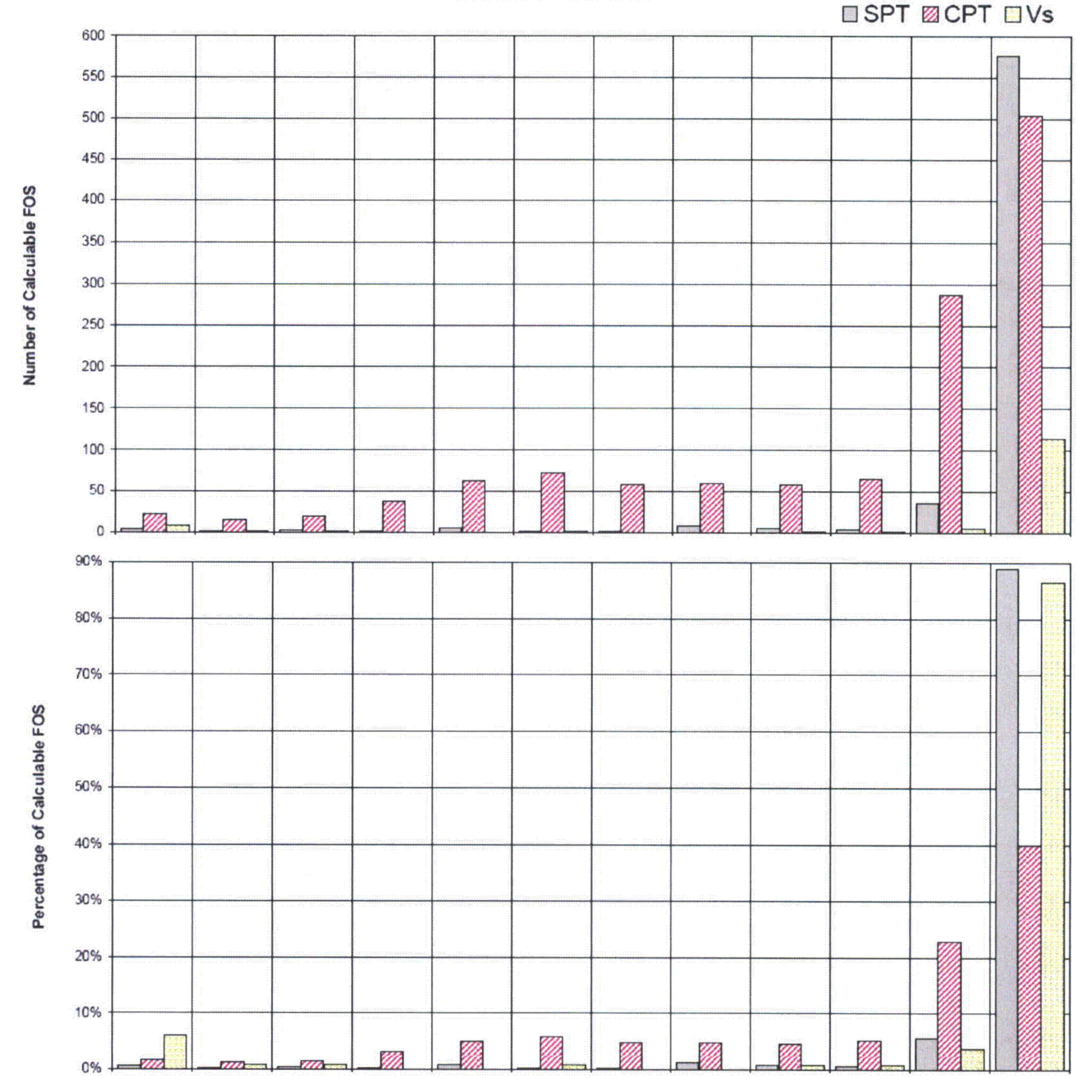
Figure 2 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum B - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	5	4	5	7	12	13	15	9	7	7	34	95
	% of Count	2.3%	1.9%	2.3%	3.3%	5.6%	6.1%	7.0%	4.2%	3.3%	3.3%	16.0%	44.6%
CPT	Count	31	33	25	40	26	45	20	23	24	11	51	55
	% of Count	8.1%	8.6%	6.5%	10.4%	6.8%	11.7%	5.2%	6.0%	6.3%	2.9%	13.3%	14.3%
Vs	Count	4	0	1	3	0	0	0	1	0	0	1	39
	% of Count	8.2%	0.0%	2.0%	6.1%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	2.0%	79.6%

N/A= V_s Method not applicable at this depth

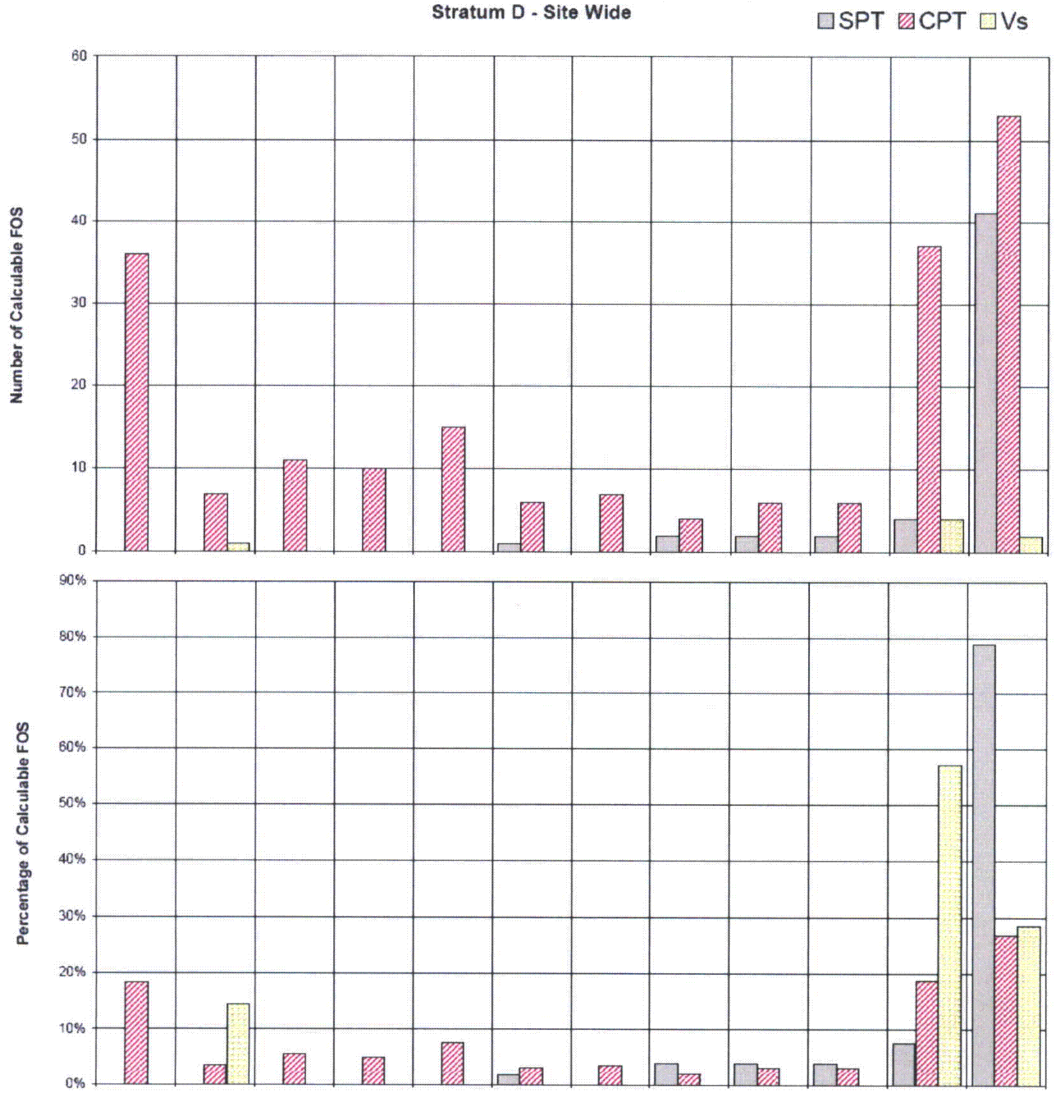
Figure 3 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum C - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	4	2	3	1	6	1	2	8	5	4	36	577
	% of Count	0.6%	0.3%	0.5%	0.2%	0.9%	0.2%	0.3%	1.2%	0.8%	0.6%	5.5%	88.9%
CPT	Count	22	15	19	38	63	73	59	60	58	65	287	505
	% of Count	1.7%	1.2%	1.5%	3.0%	5.0%	5.8%	4.7%	4.7%	4.6%	5.1%	22.7%	40.0%
Vs	Count	8	1	1	0	0	1	0	0	1	1	5	114
	% of Count	6.1%	0.8%	0.8%	0.0%	0.0%	0.8%	0.0%	0.0%	0.8%	0.8%	3.8%	86.4%

N/A= V_s Method not applicable at this depth

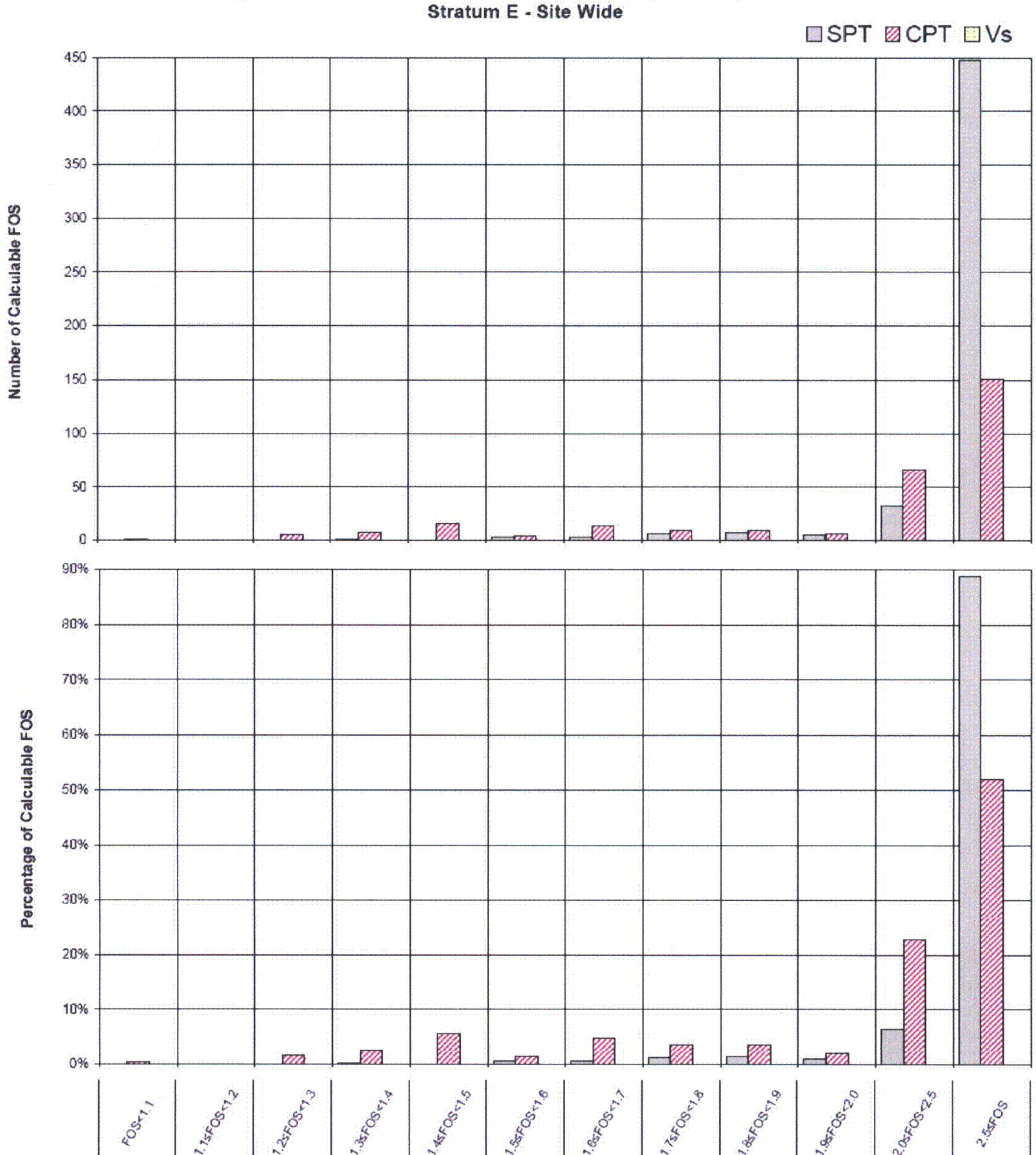
Figure 4 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum D - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	1	0	2	2	2	4	41
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	3.8%	3.8%	3.8%	7.7%	78.8%
CPT	Count	36	7	11	10	15	6	7	4	6	6	37	53
	% of Count	18.2%	3.6%	5.6%	5.1%	7.6%	3.0%	3.5%	2.0%	3.0%	3.0%	18.7%	26.8%
Vs	Count	0	1	0	0	0	0	0	0	0	0	4	2
	% of Count	0.0%	14.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	57.1%	28.6%

N/A= V_s Method not applicable at this depth

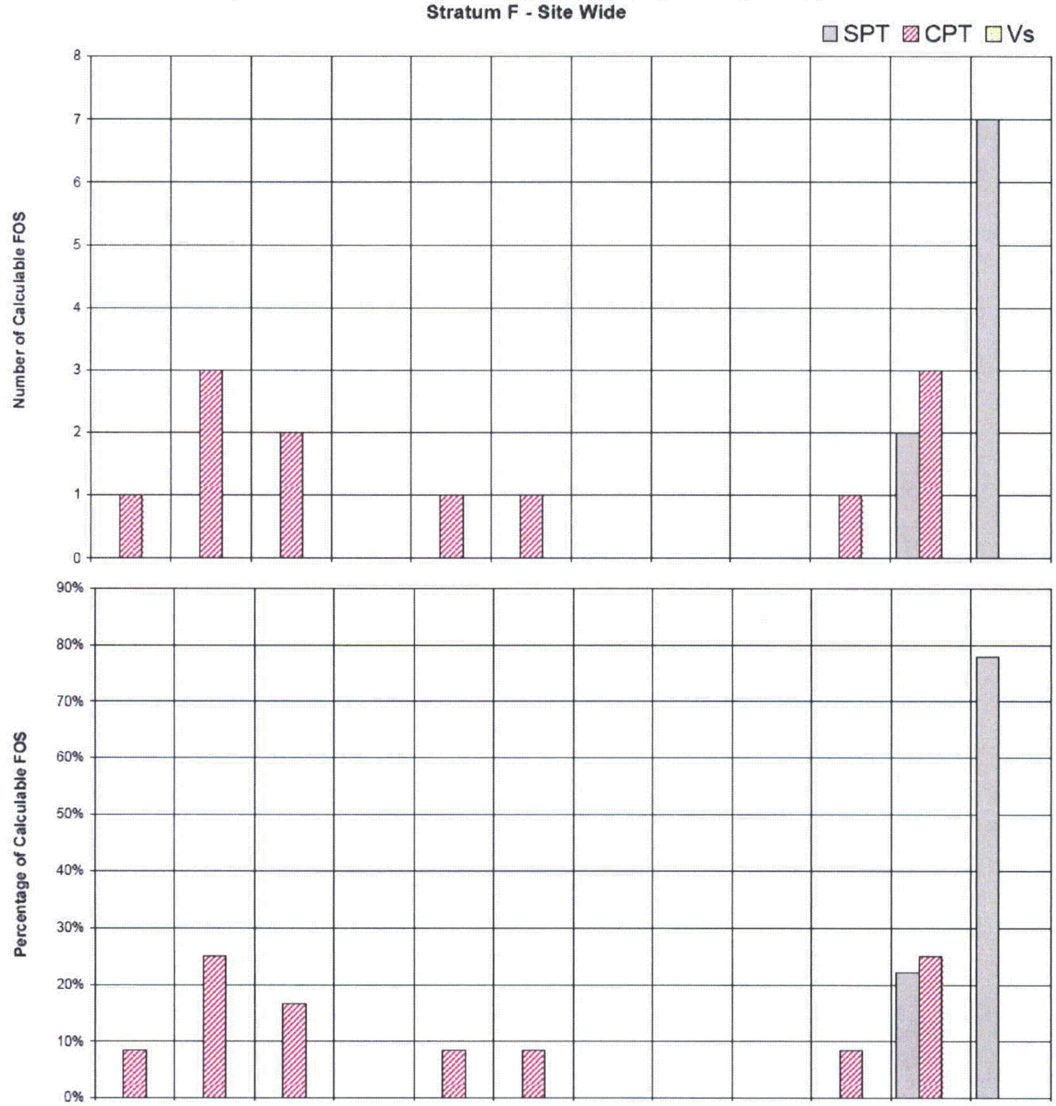
Figure 5 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum E - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	1	0	3	3	6	7	5	32	448
	% of Count	0.0%	0.0%	0.0%	0.2%	0.0%	0.6%	0.6%	1.2%	1.4%	1.0%	6.3%	88.7%
CPT	Count	1	0	5	7	16	4	14	10	10	6	66	151
	% of Count	0.3%	0.0%	1.7%	2.4%	5.5%	1.4%	4.8%	3.4%	3.4%	2.1%	22.8%	52.1%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= V_s Method not applicable at this depth

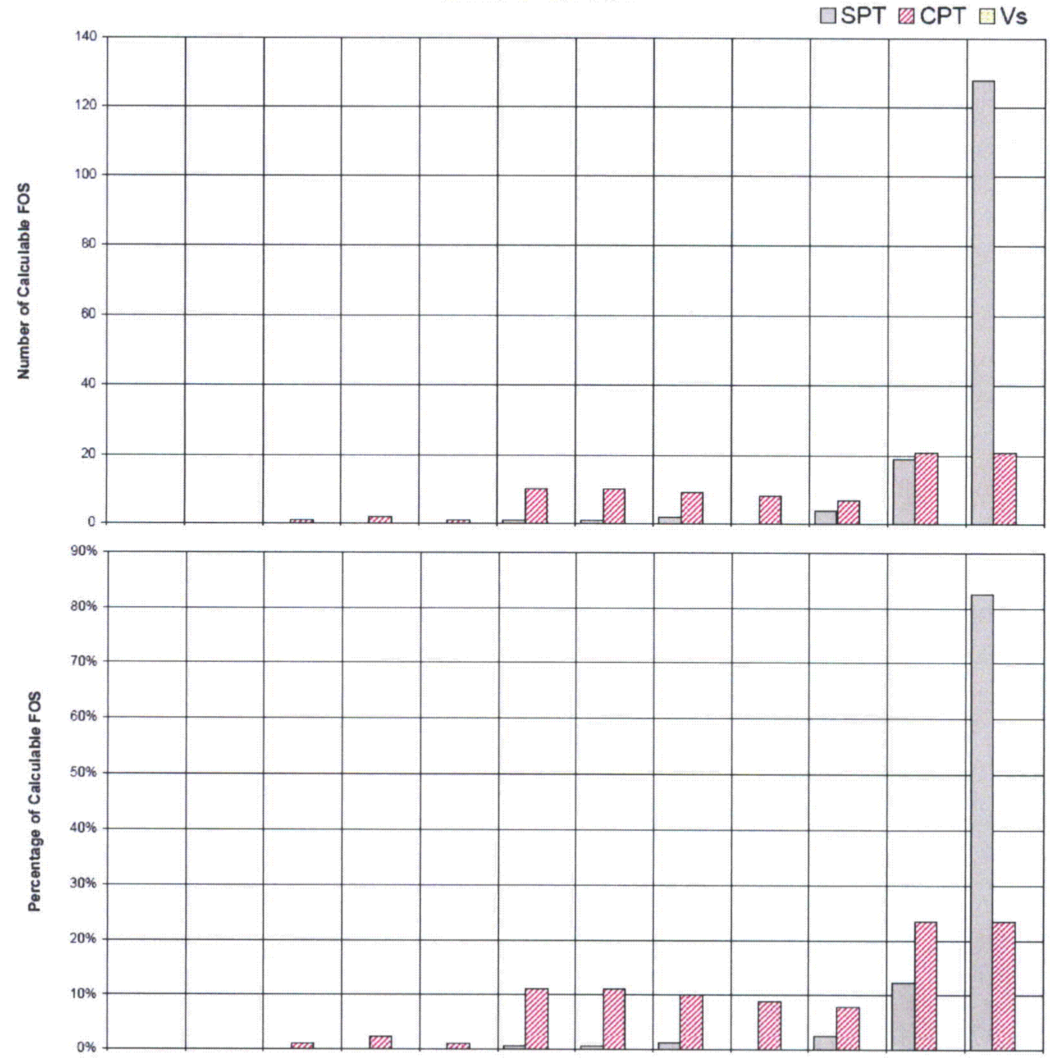
Figure 6 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum F - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	2	7
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.2%	77.8%
CPT	Count	1	3	2	0	1	1	0	0	0	1	3	0
	% of Count	8.3%	25.0%	16.7%	0.0%	8.3%	8.3%	0.0%	0.0%	0.0%	8.3%	25.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= V_s Method not applicable at this depth

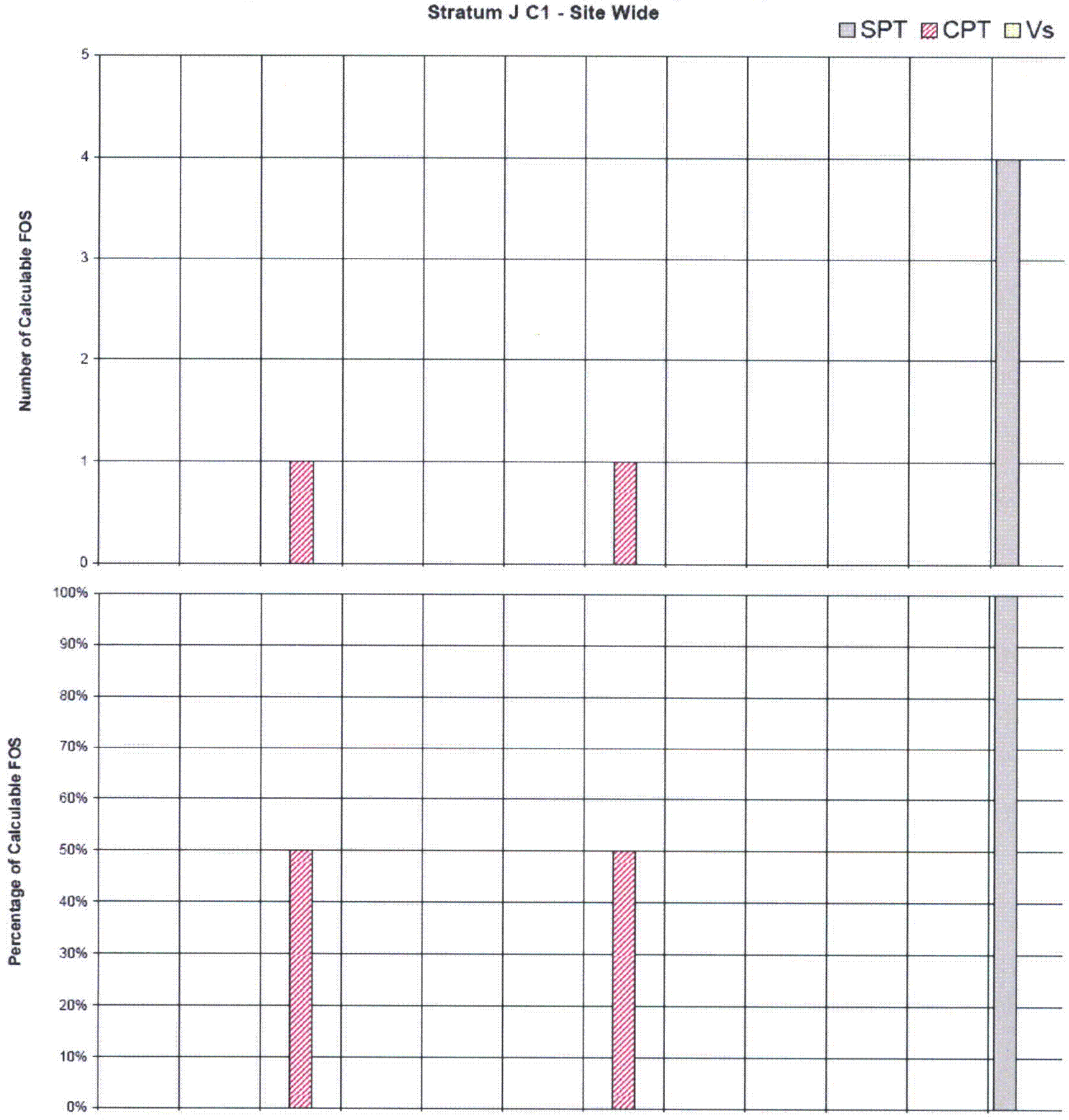
Figure 7 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum H - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	1	1	2	0	4	19	128
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.6%	1.3%	0.0%	2.6%	12.3%	82.6%
CPT	Count	0	0	1	2	1	10	10	9	8	7	21	21
	% of Count	0.0%	0.0%	1.1%	2.2%	1.1%	11.1%	11.1%	10.0%	8.9%	7.8%	23.3%	23.3%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= V_s Method not applicable at this depth

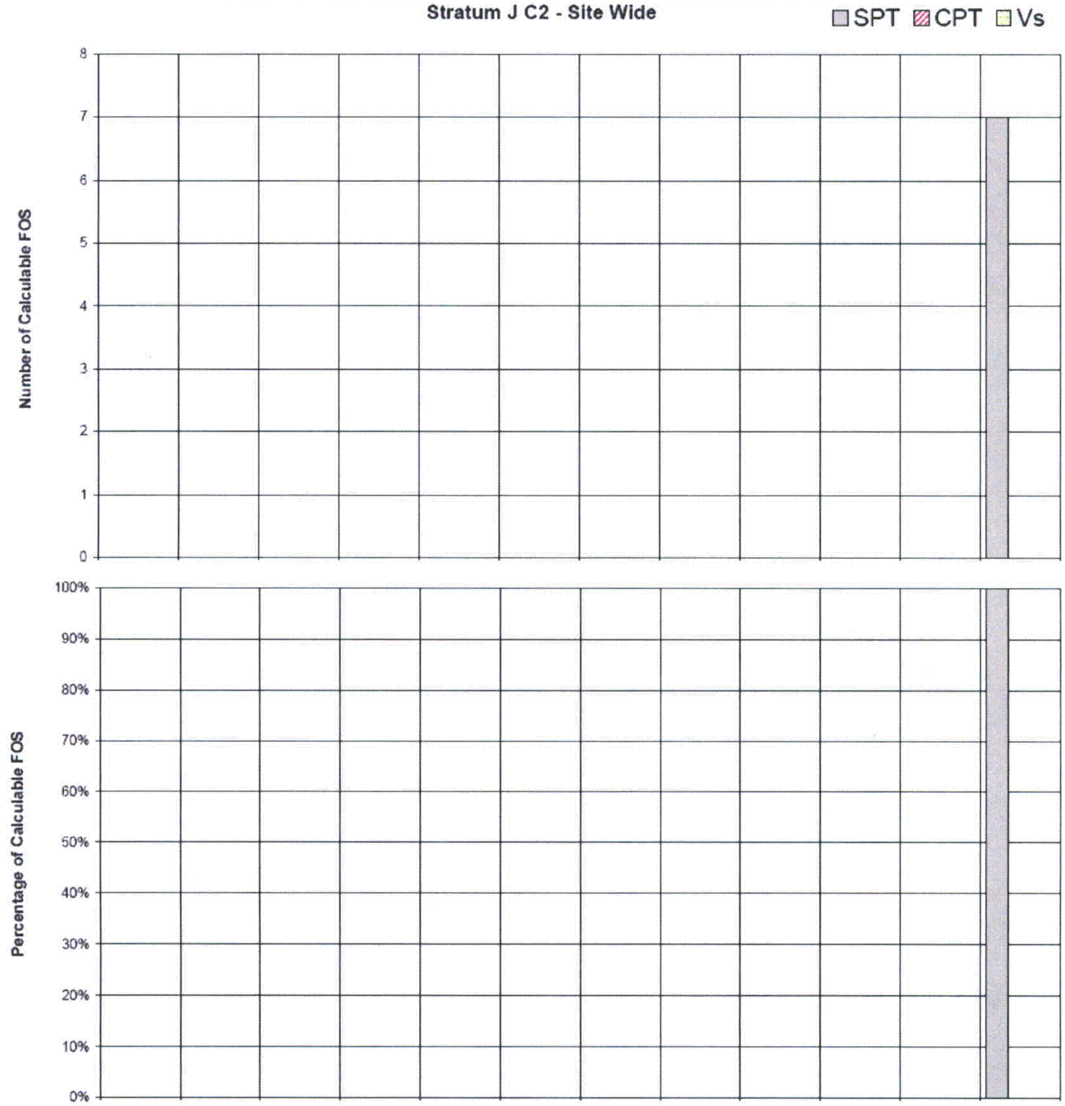
Figure 8 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum J C1 - Site Wide



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	4
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
CPT	Count	0	0	1	0	0	0	1	0	0	0	0	0
	% of Count	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= V_s Method not applicable at this depth

Figure 9 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum J C2 - Site Wide

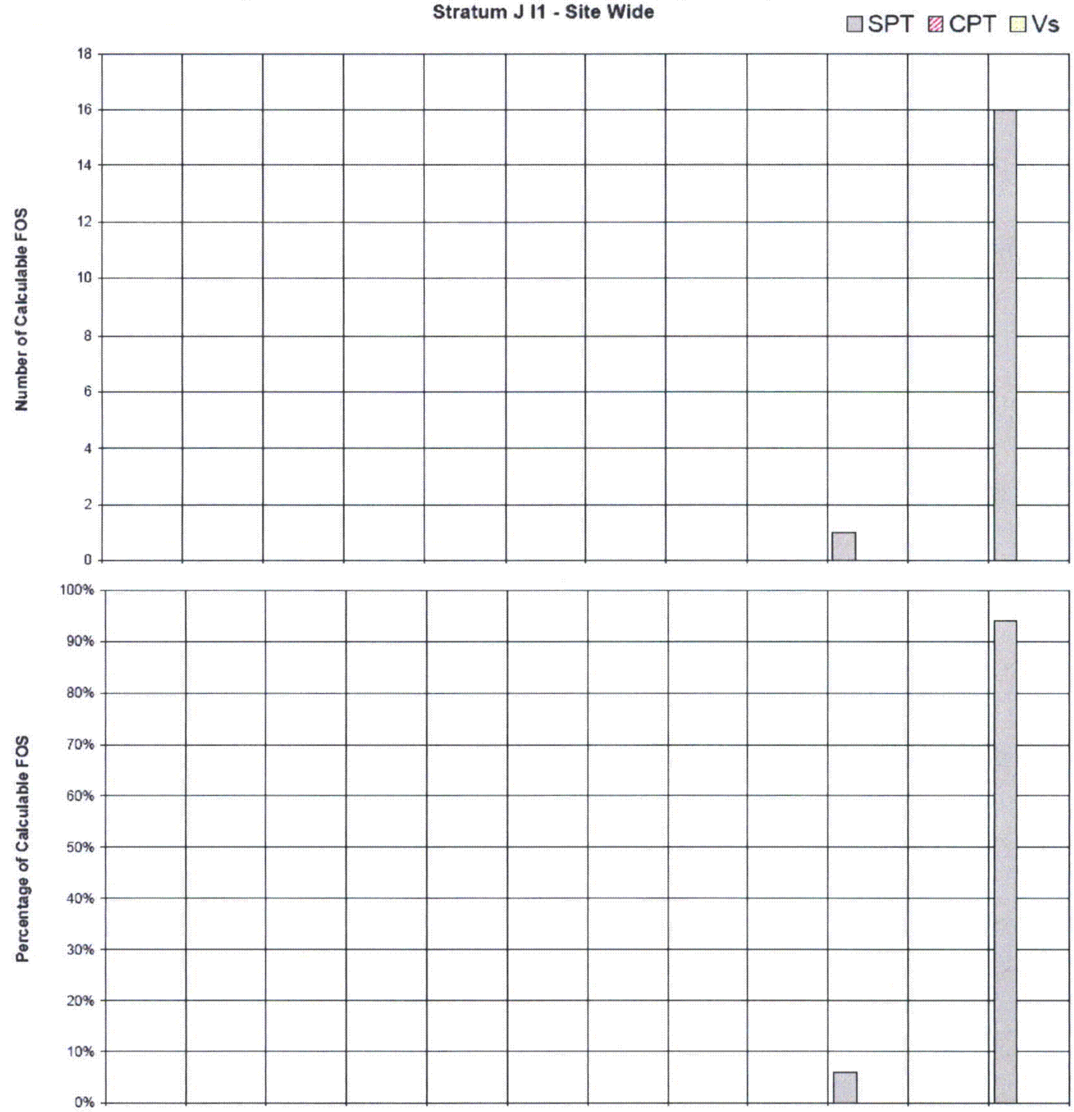


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	7
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 10 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum J I1 - Site Wide

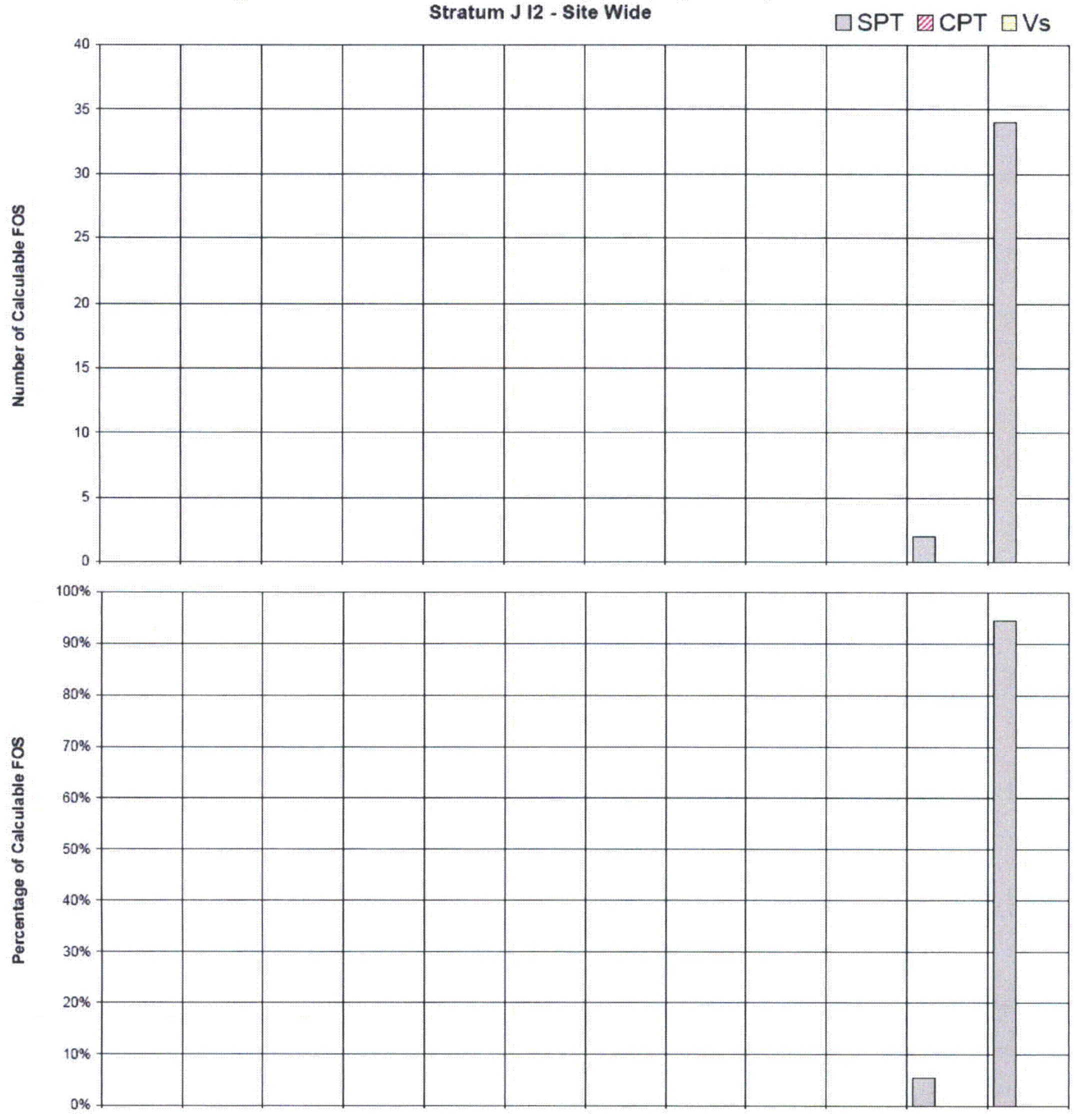


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	1	0	16
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.9%	0.0%	94.1%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 11 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum J I2 - Site Wide

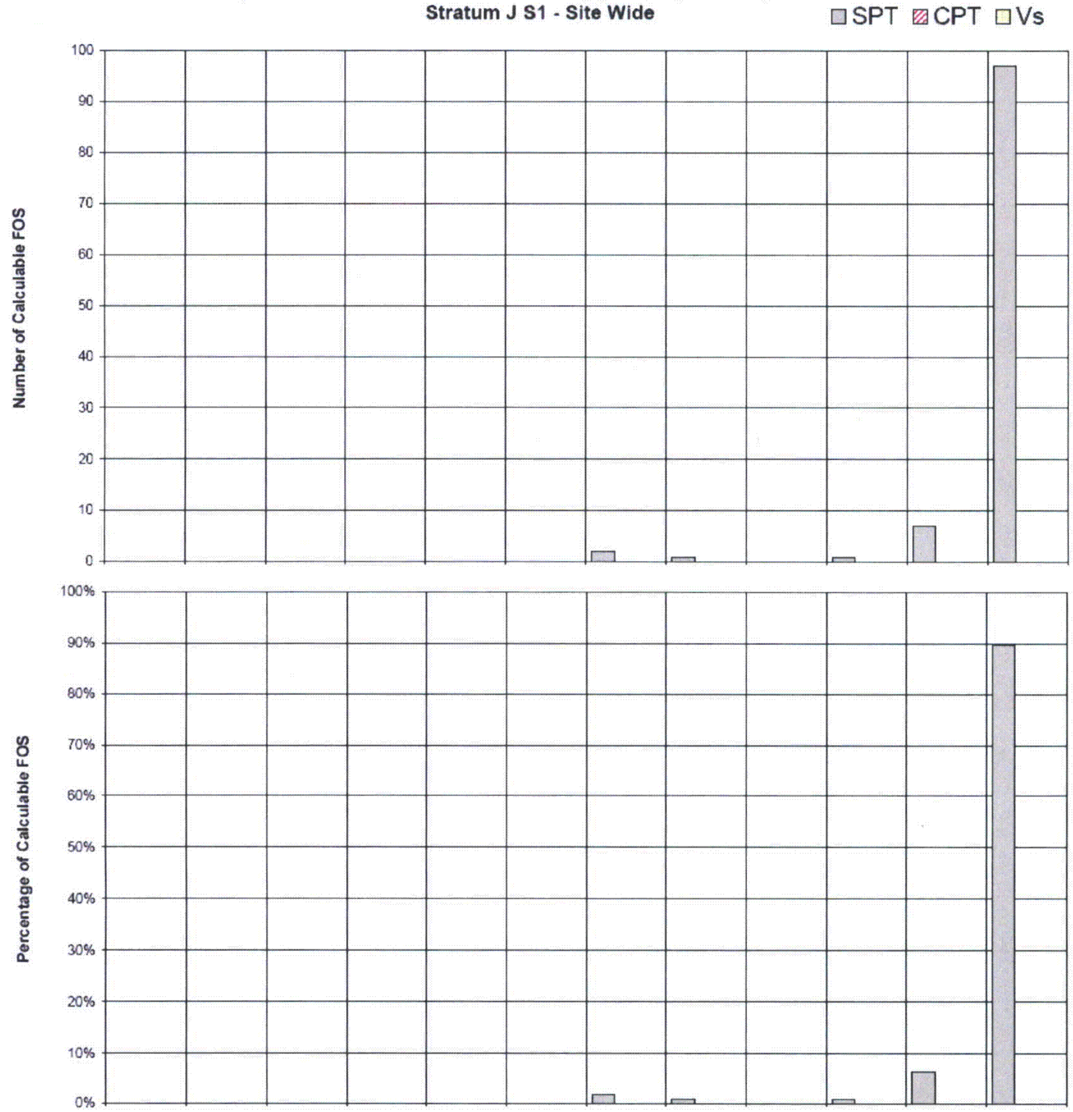


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	2	34
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.6%	94.4%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 12 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum J S1 - Site Wide

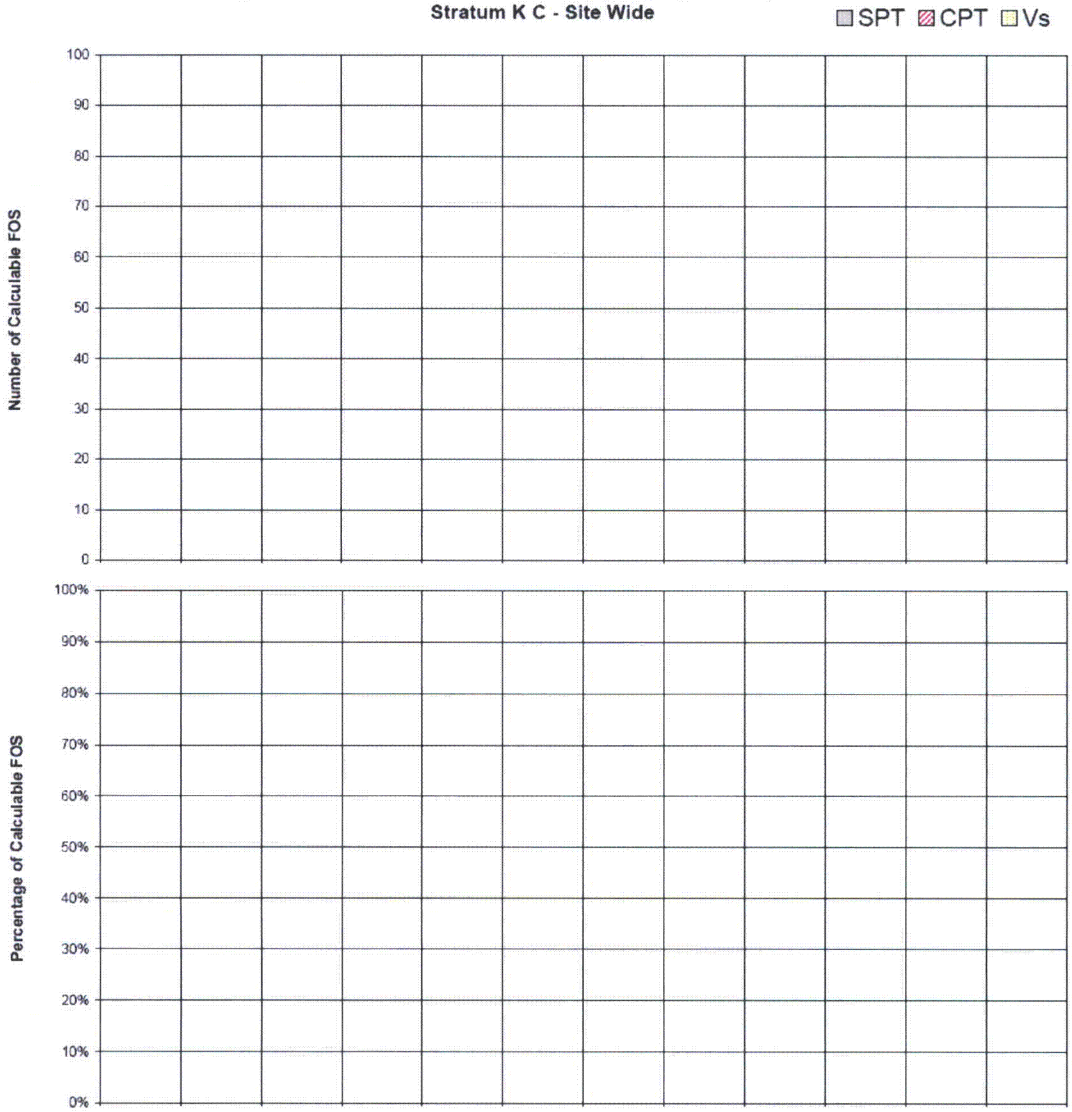


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	2	1	0	1	7	97
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.9%	0.0%	0.9%	6.5%	89.8%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 13 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum K C - Site Wide

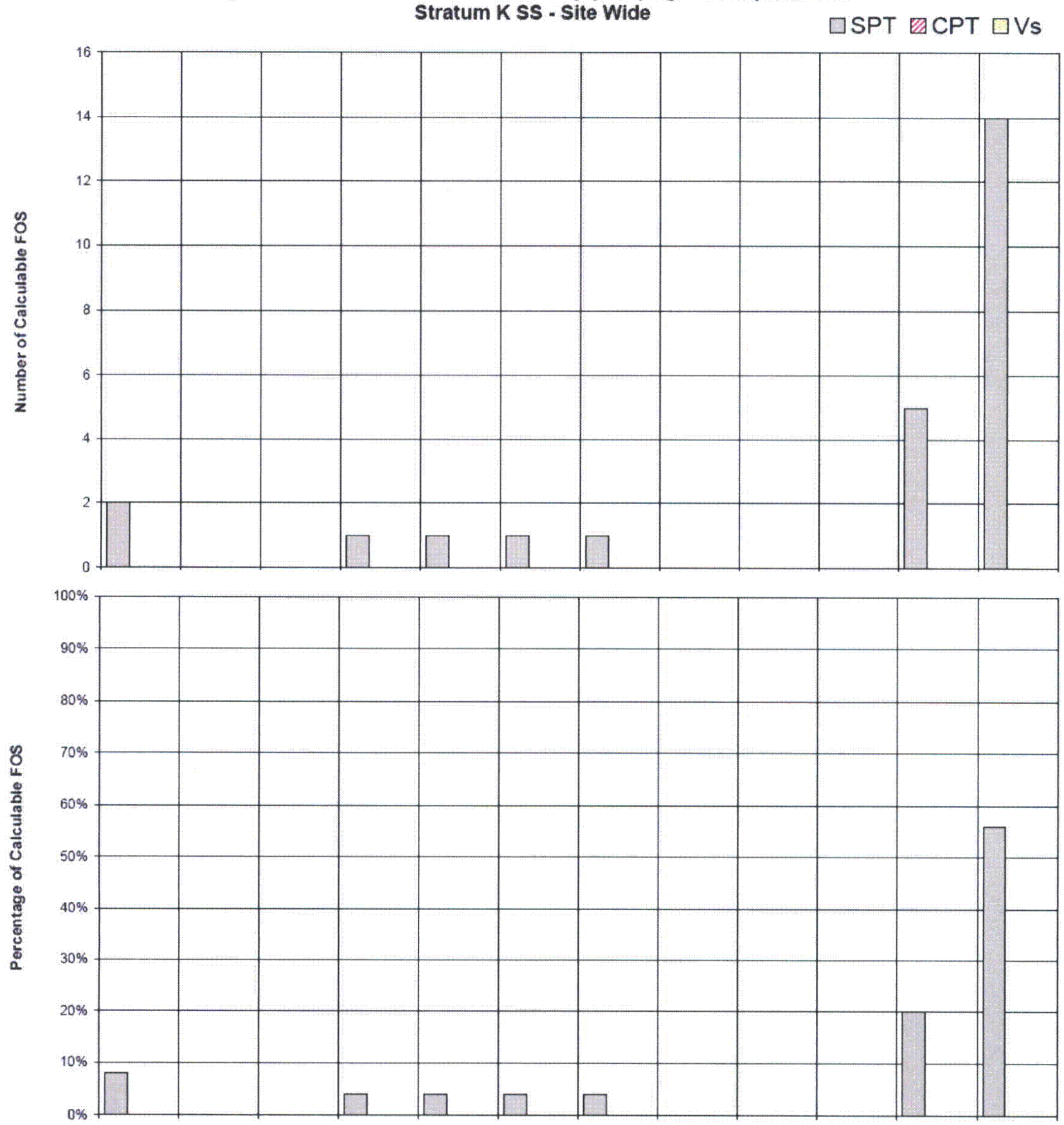


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	0
	% of Count	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 14 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum K SS - Site Wide

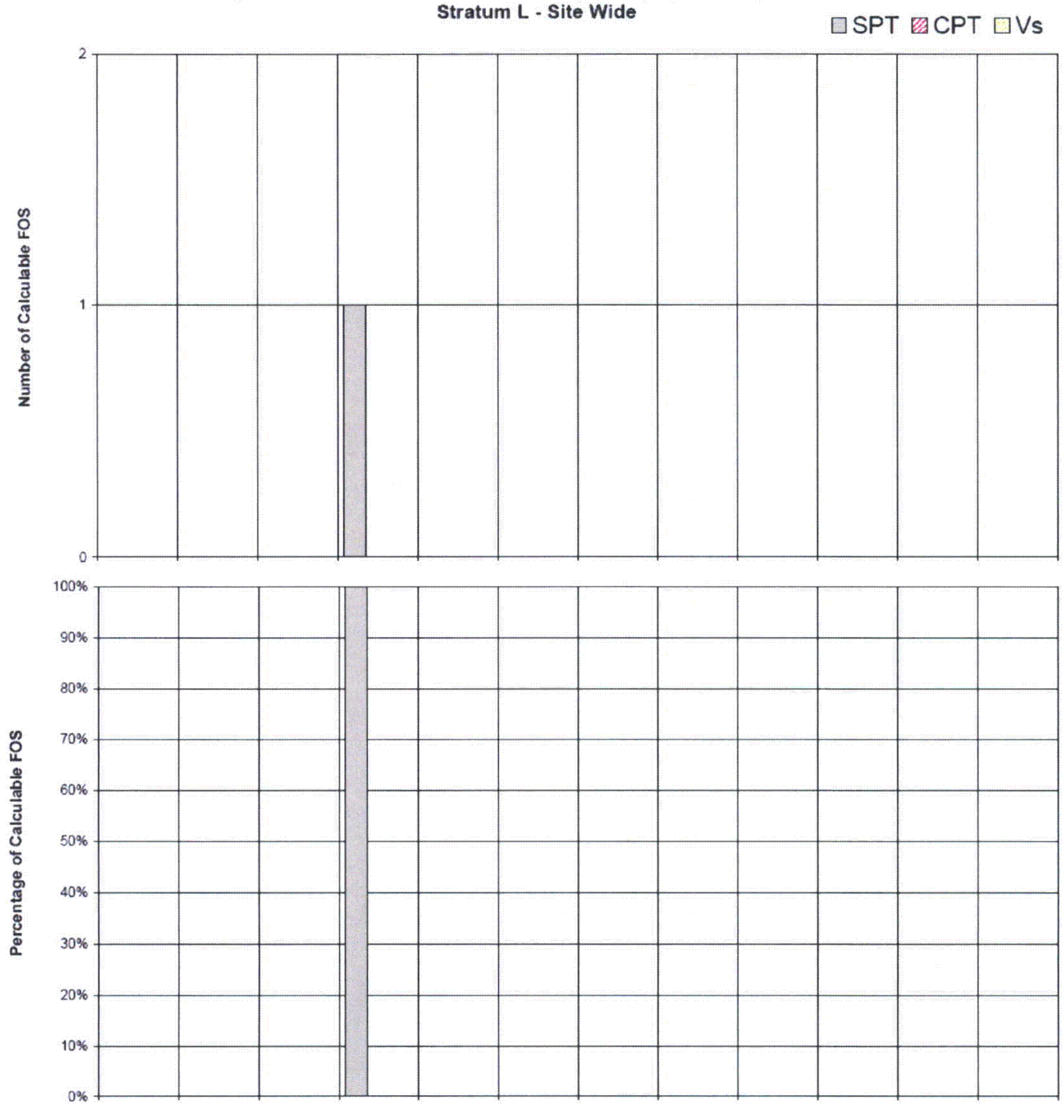


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	2	0	0	1	1	1	1	0	0	0	5	14
	% of Count	8.0%	0.0%	0.0%	4.0%	4.0%	4.0%	4.0%	0.0%	0.0%	0.0%	20.0%	56.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 15 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum L - Site Wide

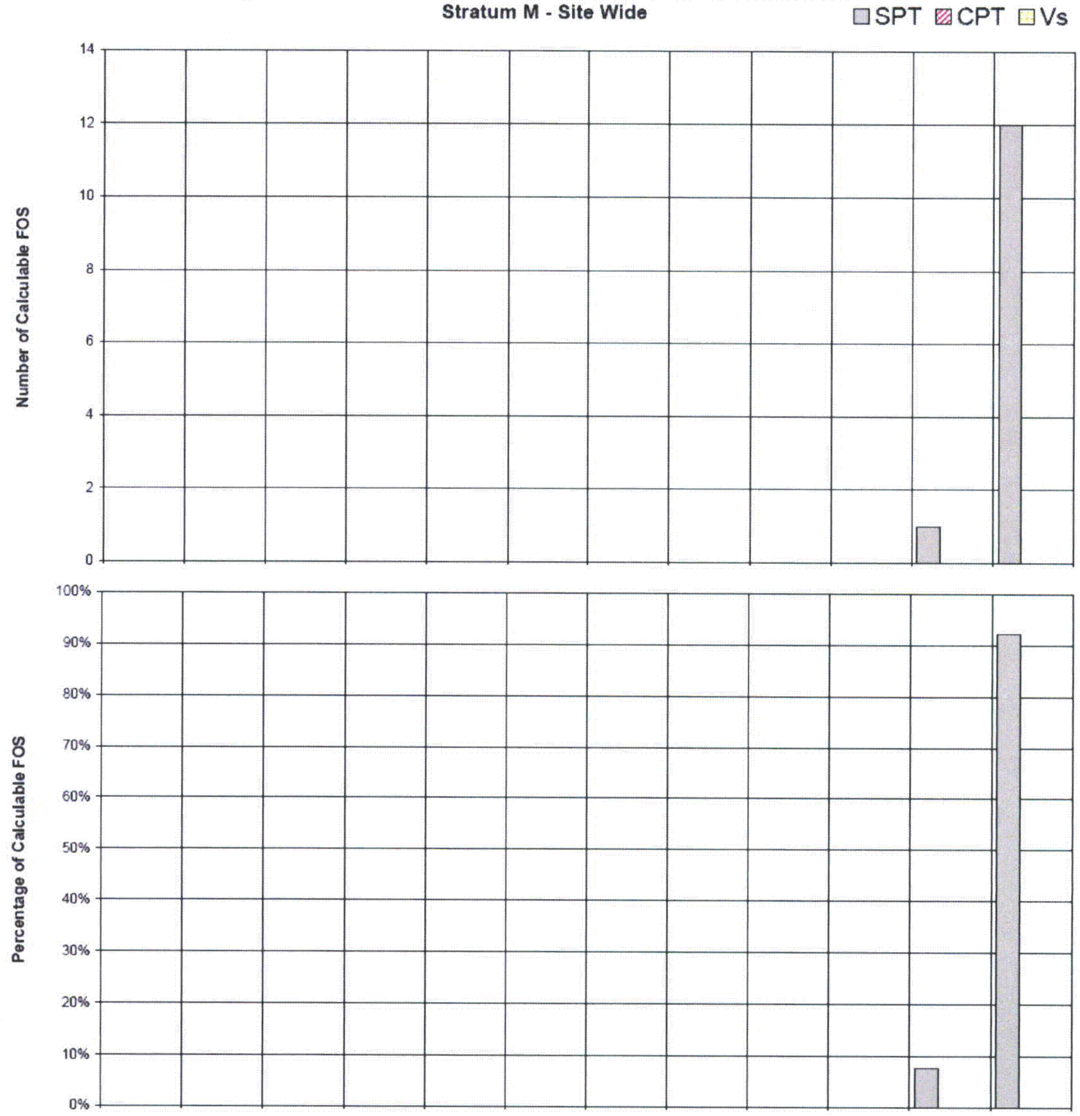


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	1	0	0	0	0	0	0	0	0
	% of Count	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 16 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum M - Site Wide

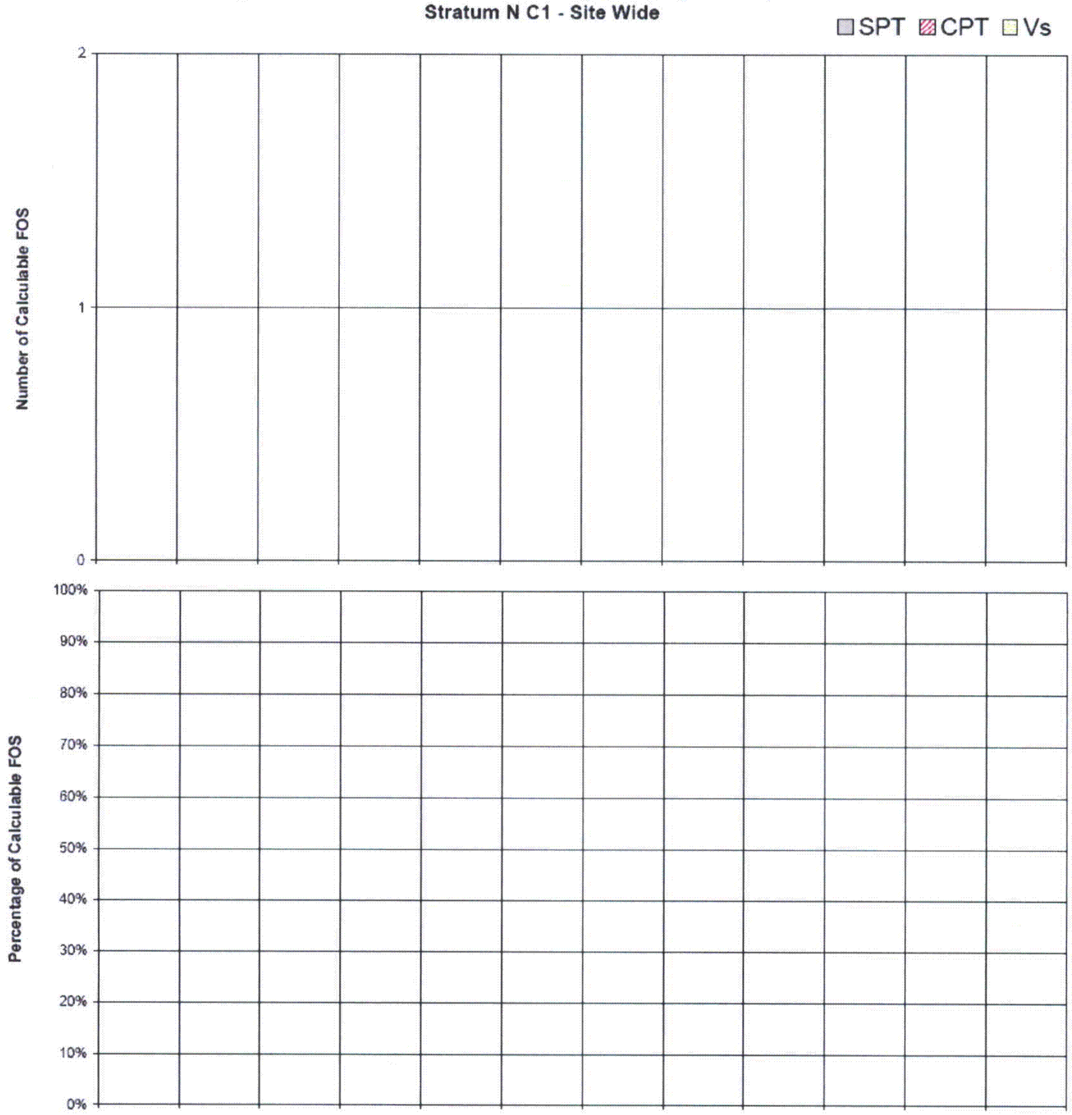


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	1	12
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	92.3%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 17 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N C1 - Site Wide

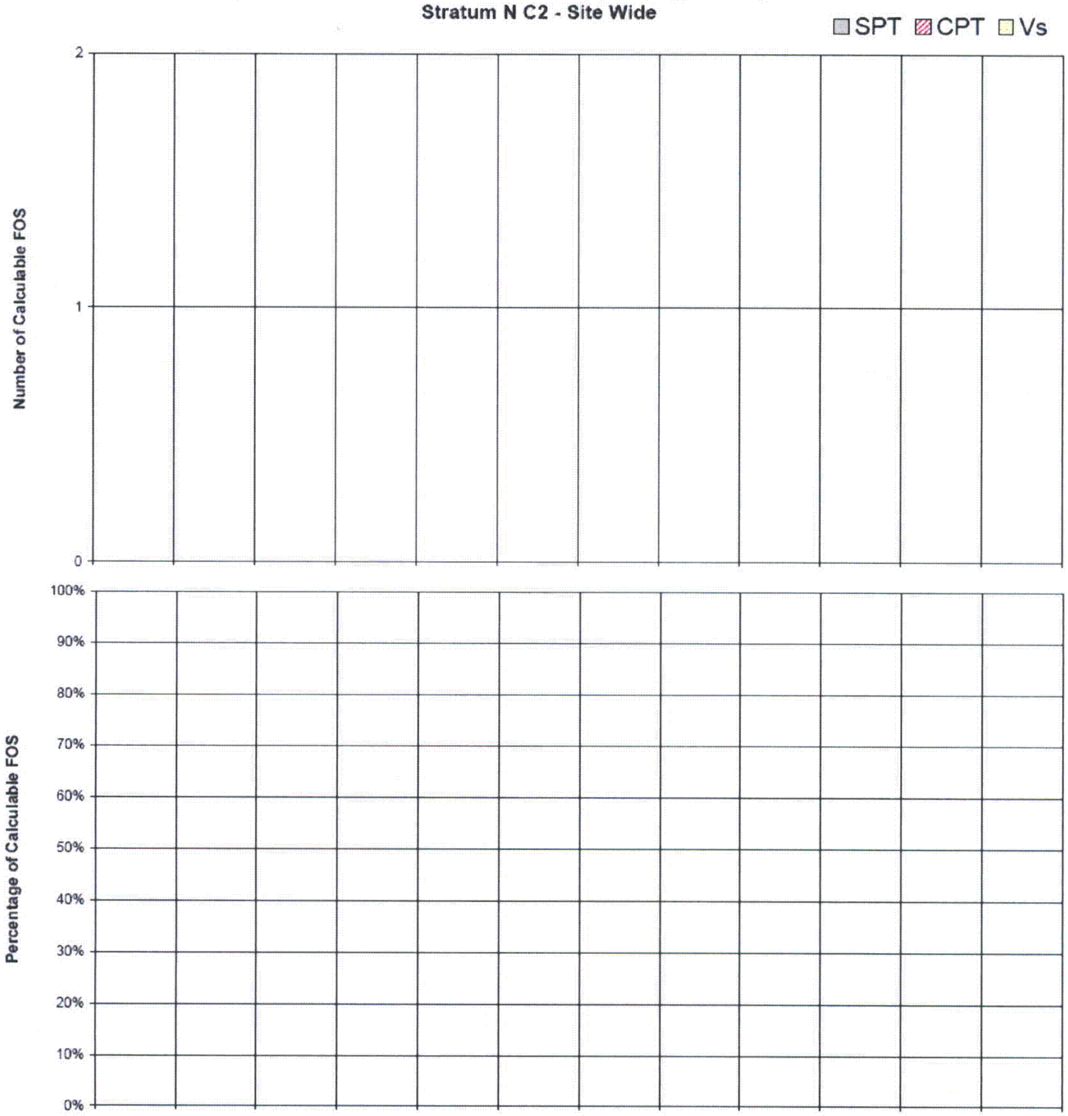


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 18 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N C2 - Site Wide

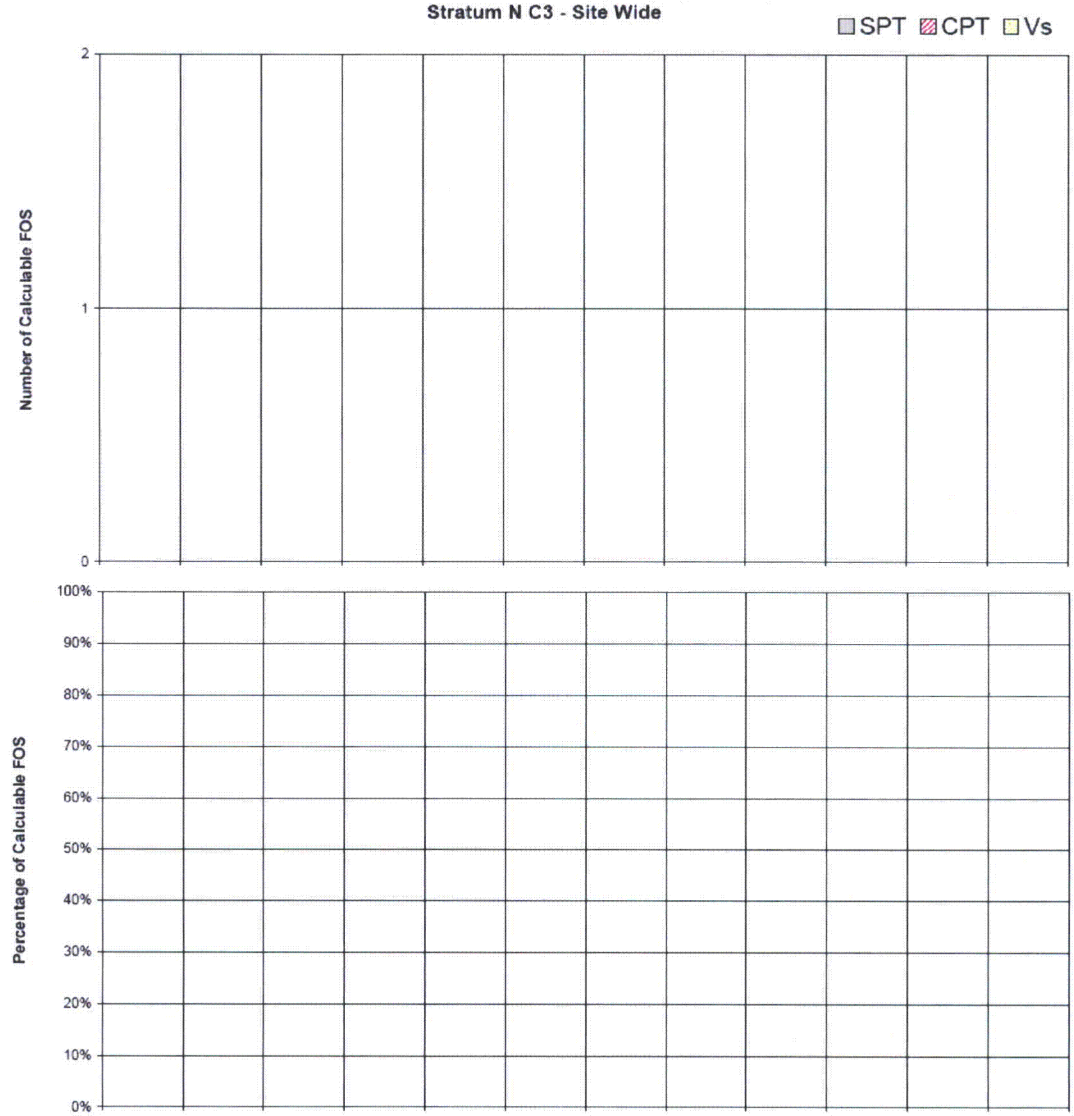


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 19 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N C3 - Site Wide

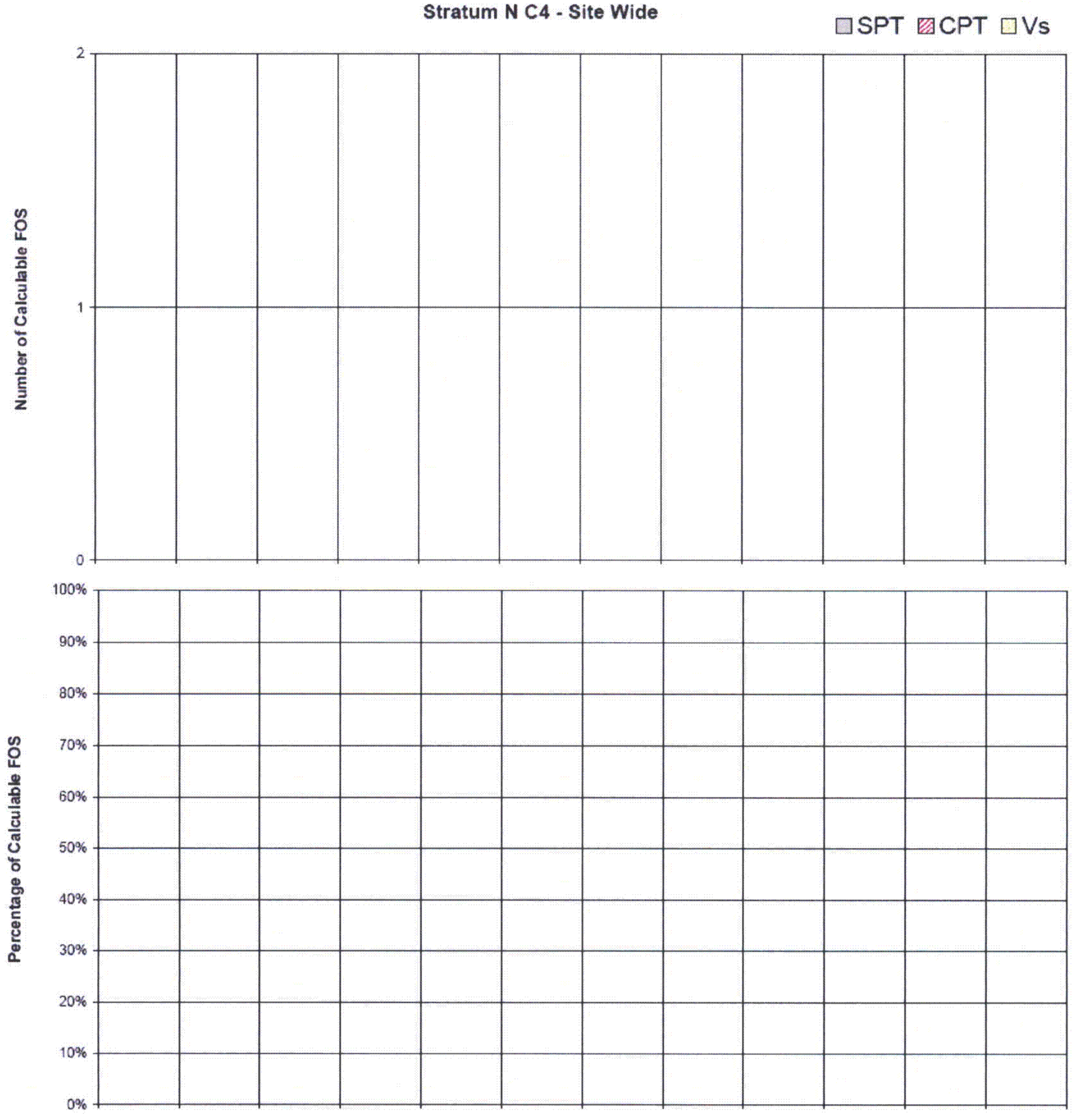


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 20 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N C4 - Site Wide

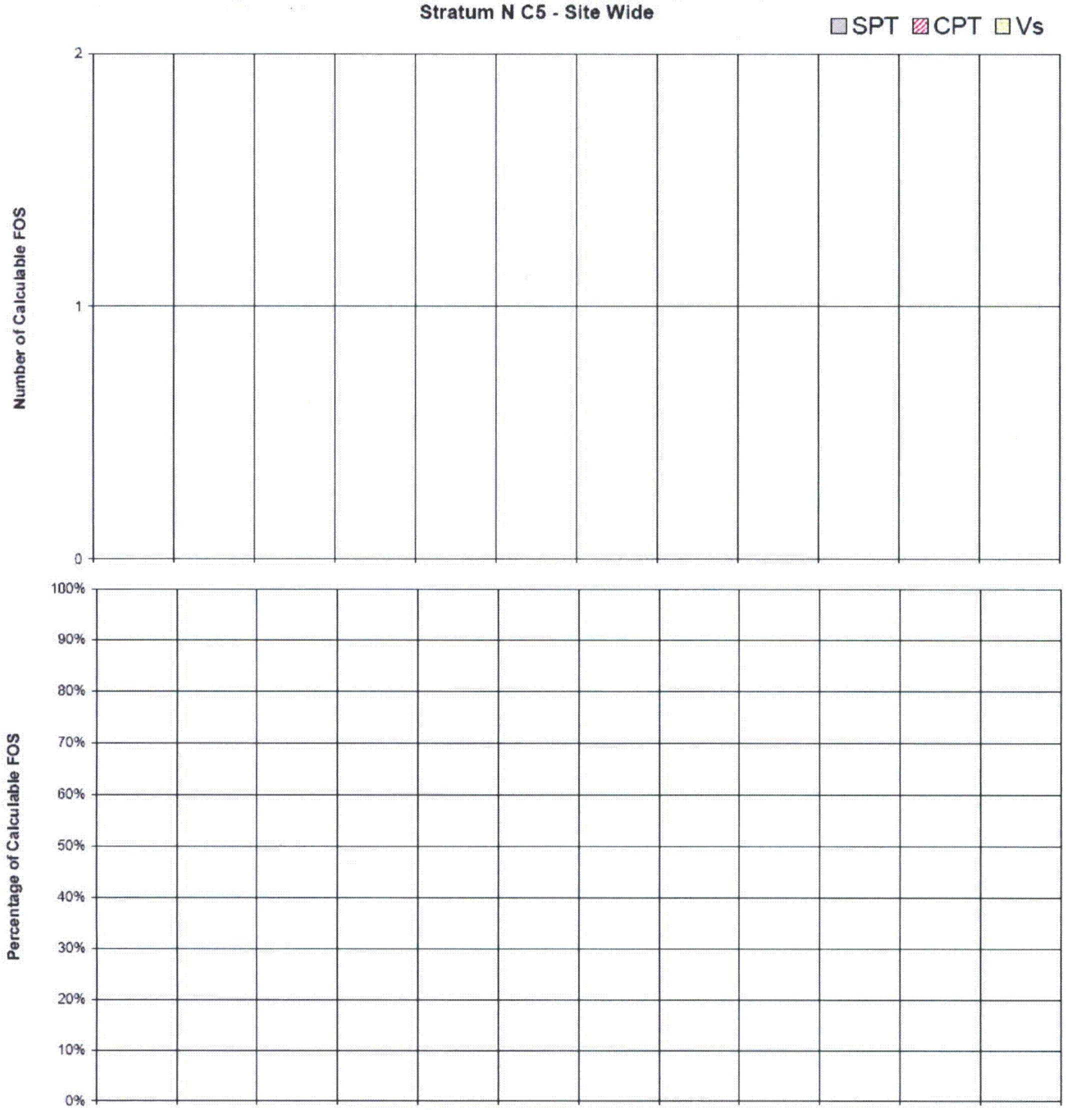


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 21 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N C5 - Site Wide

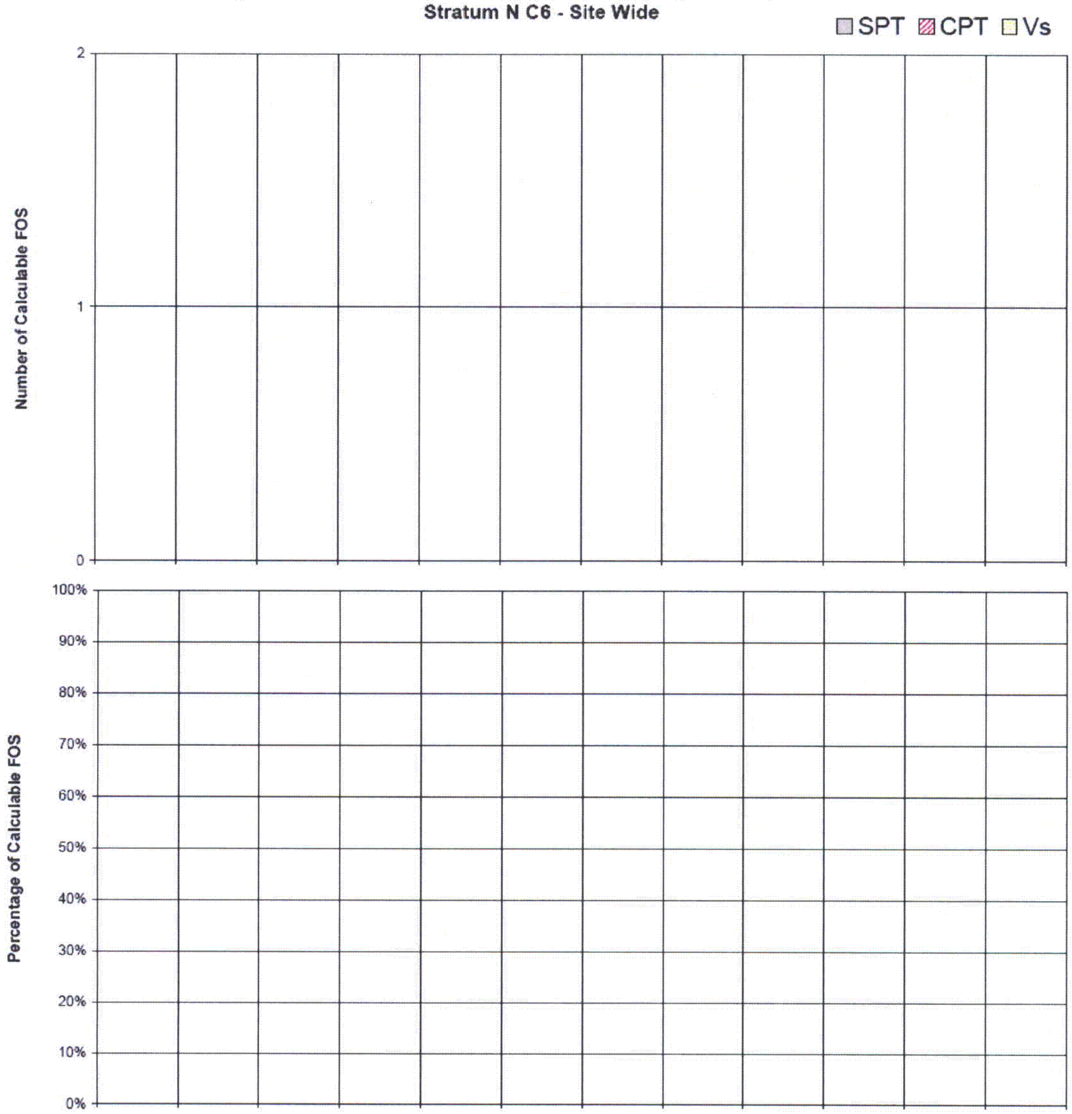


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 22 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N C6 - Site Wide

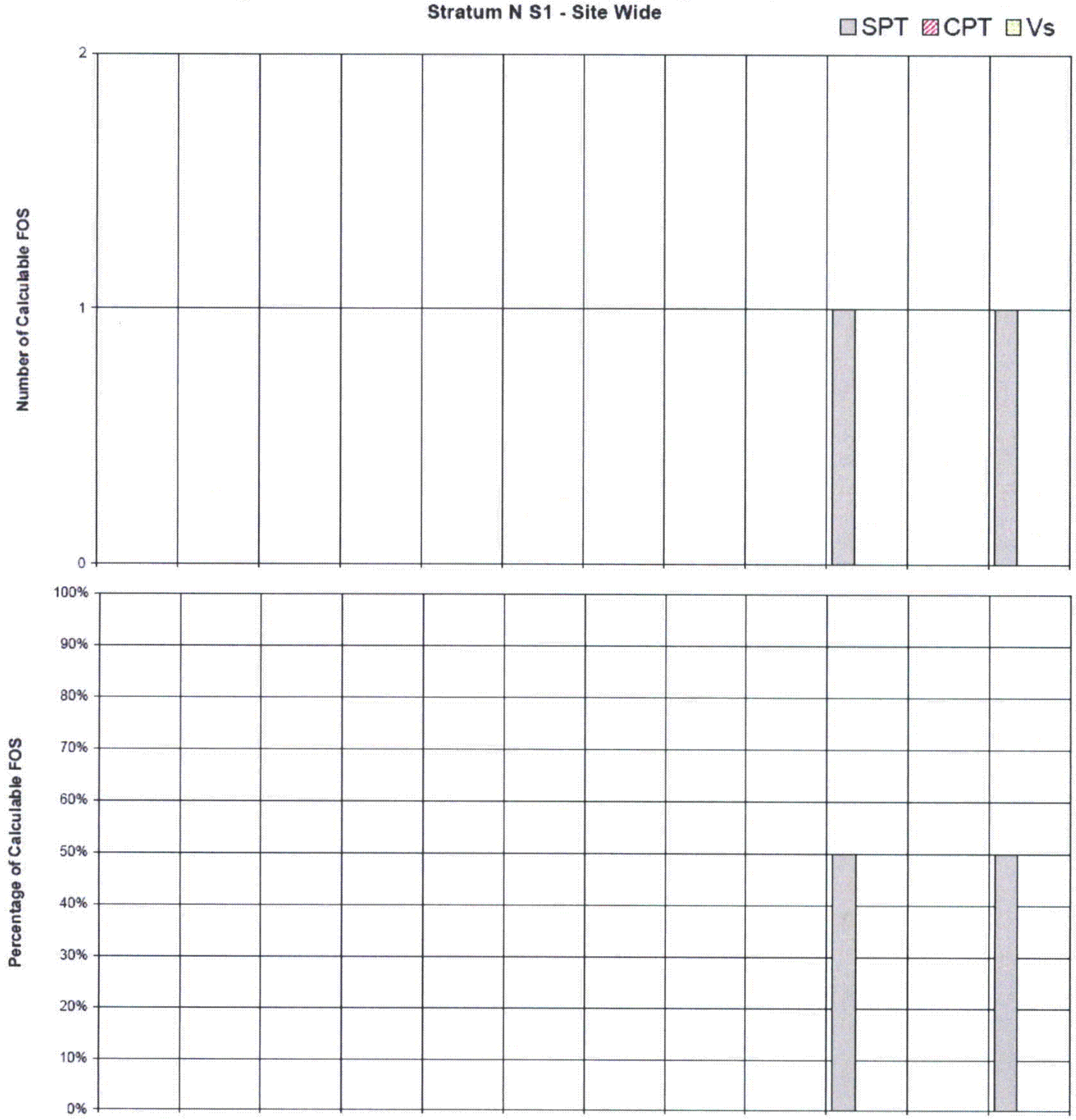


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 23 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N S1 - Site Wide

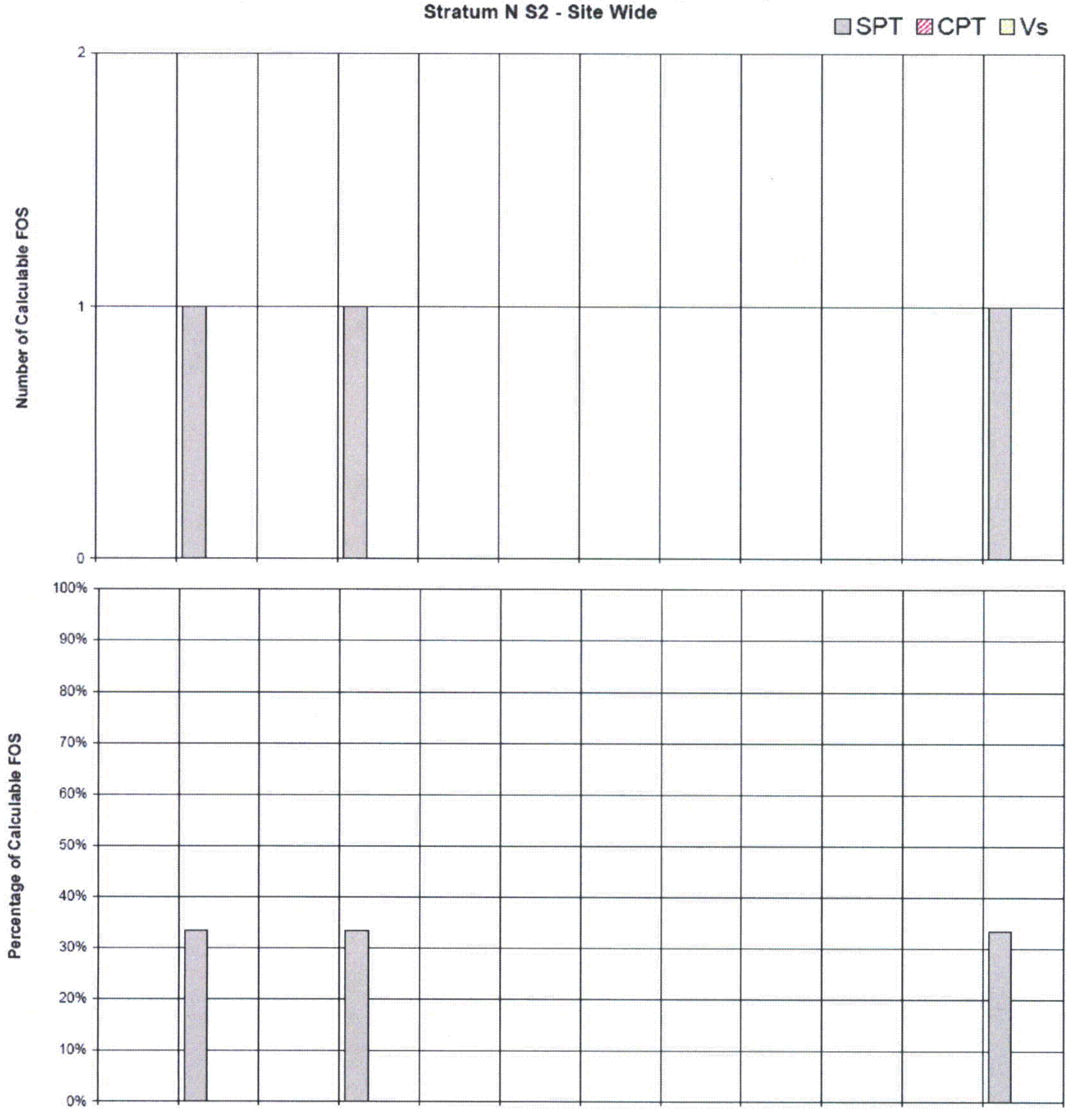


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	1	0	1
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	60.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 24 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N S2 - Site Wide

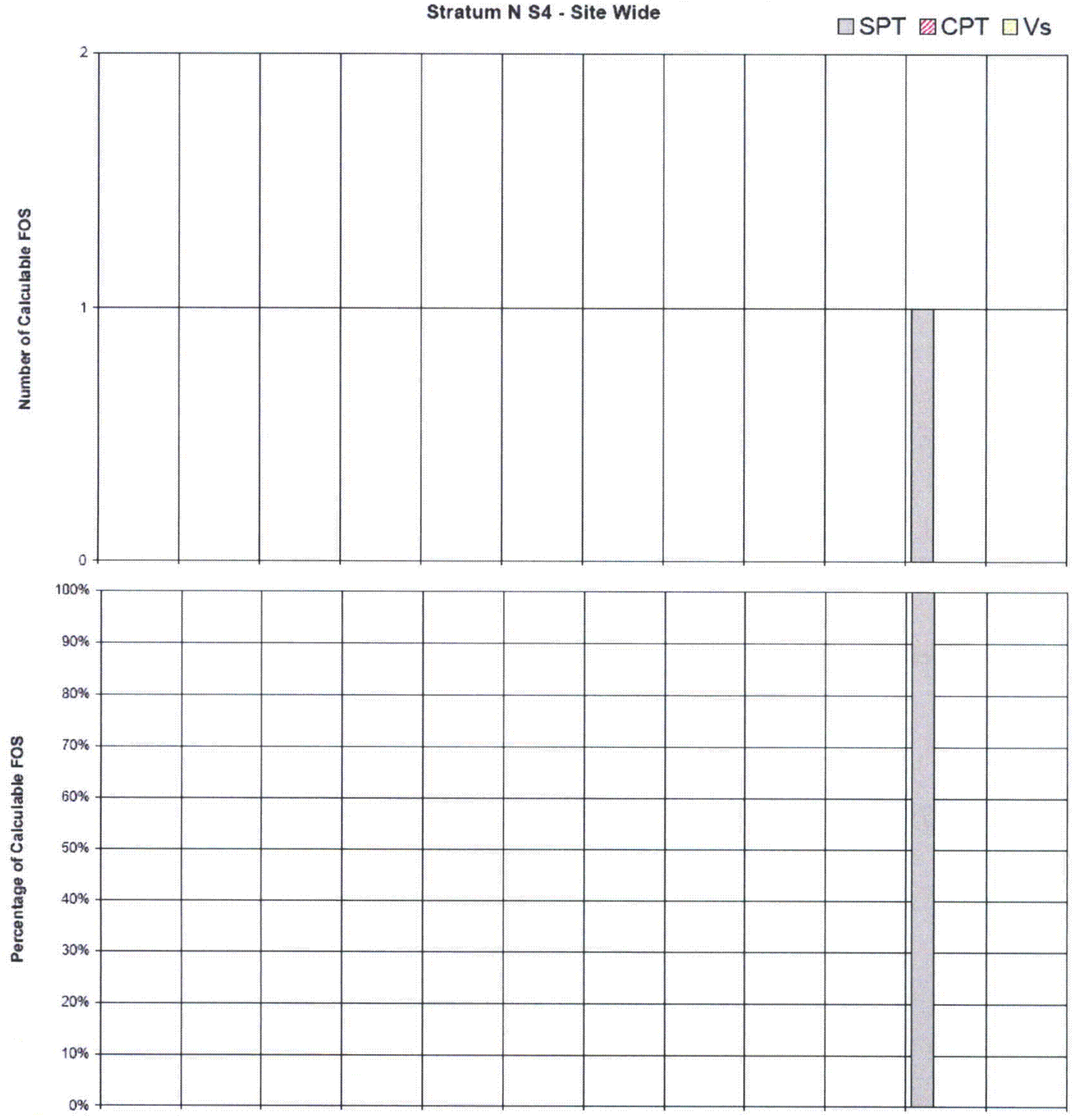


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	1	0	1	0	0	0	0	0	0	0	1
	% of Count	0.0%	33.3%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 25 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N S4 - Site Wide

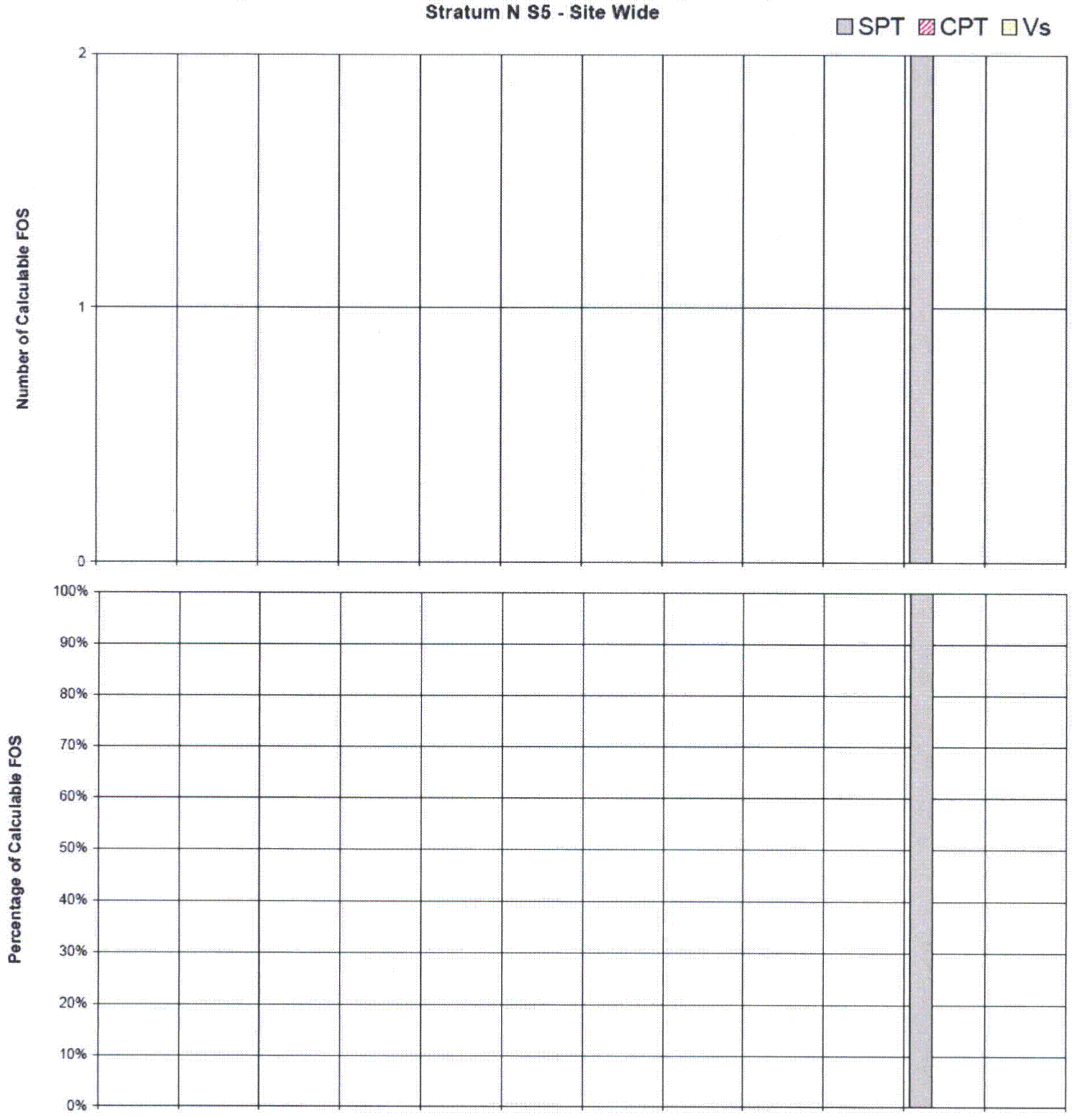


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	1	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 26 - Calculable Factors of Safety (FOS) Against Liquefaction - Stratum N S5 - Site Wide

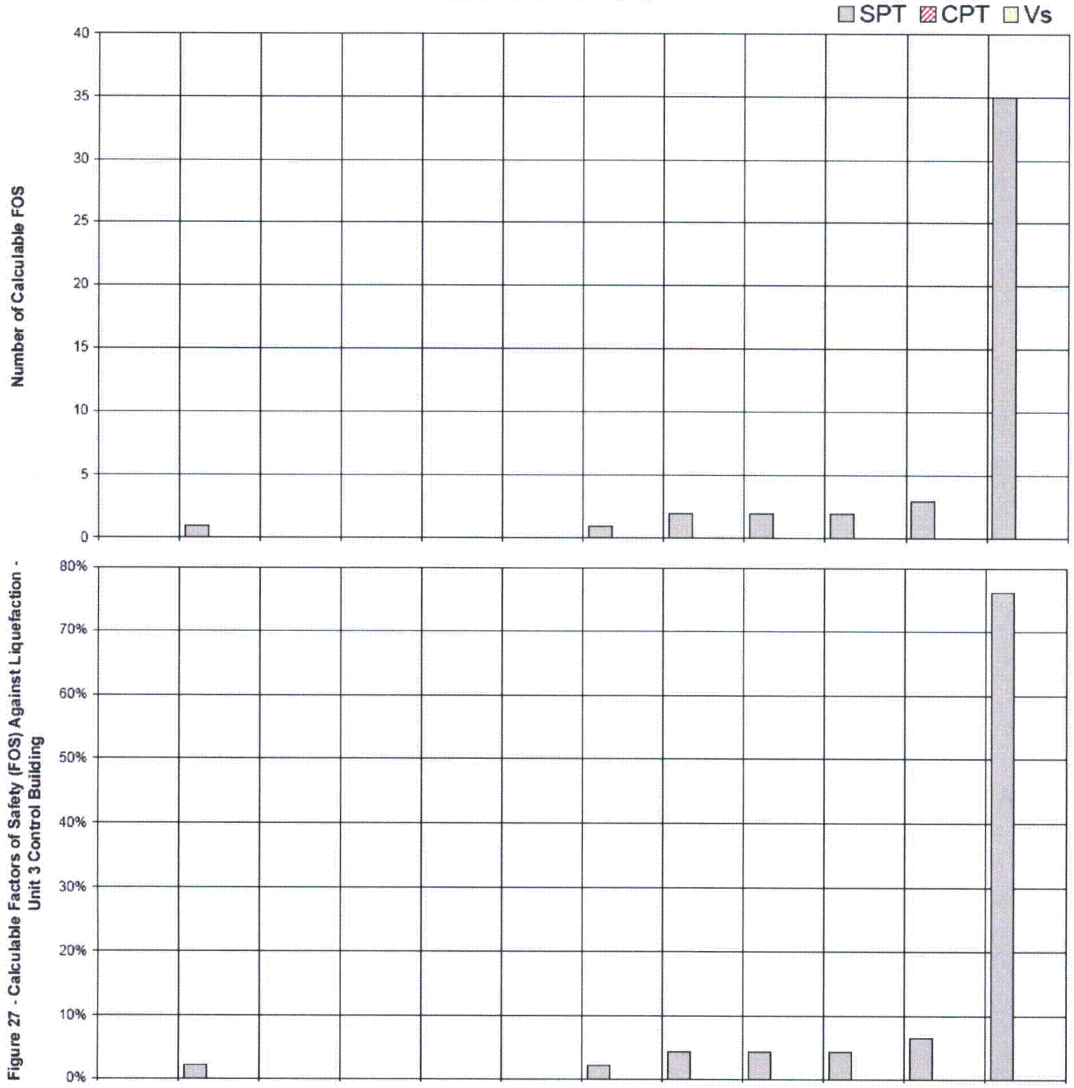


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	2	0
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data in this stratum

N/A= V_s Method not applicable at this depth

Figure 27 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 3 Control Building

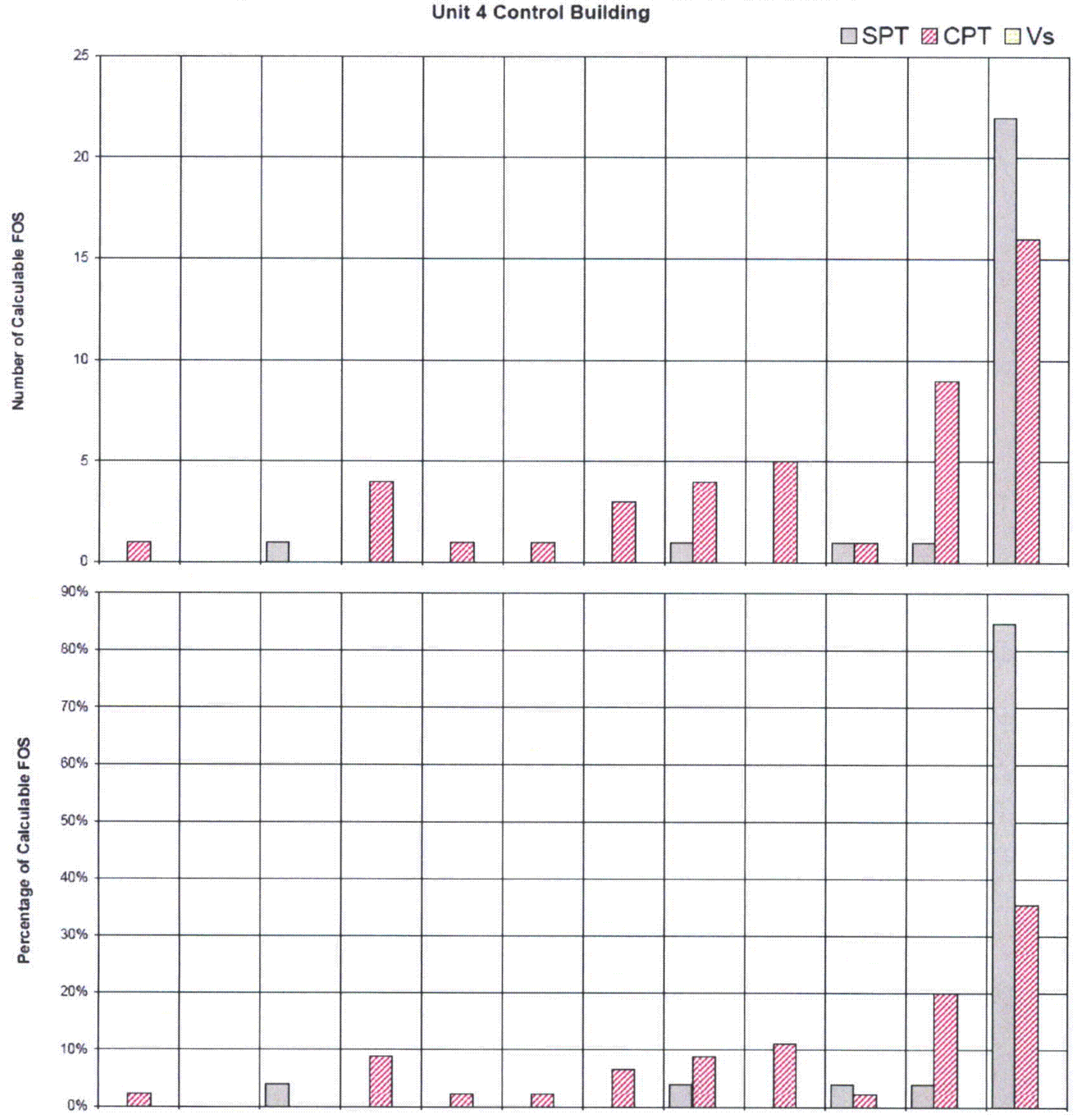


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	1	0	0	0	0	1	2	2	2	3	35
	% of Count	0.0%	2.2%	0.0%	0.0%	0.0%	0.0%	2.2%	4.3%	4.3%	4.3%	6.5%	76.1%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

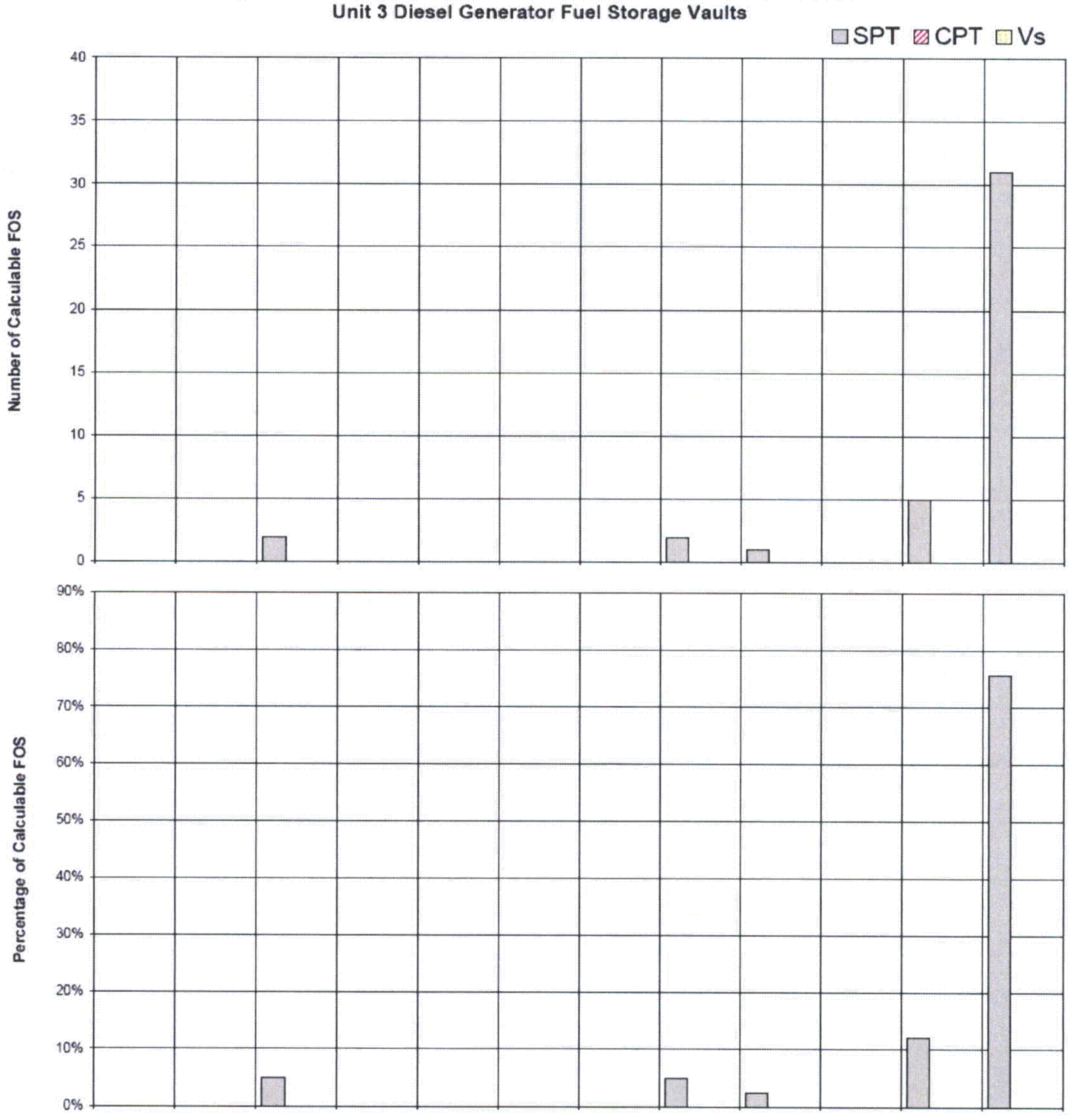
Figure 28 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 4 Control Building



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	1	0	0	0	0	1	0	1	1	22
	% of Count	0.0%	0.0%	3.8%	0.0%	0.0%	0.0%	0.0%	3.8%	0.0%	3.8%	3.8%	84.6%
CPT	Count	1	0	0	4	1	1	3	4	5	1	9	16
	% of Count	2.2%	0.0%	0.0%	8.9%	2.2%	2.2%	6.7%	8.9%	11.1%	2.2%	20.0%	35.6%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No V_s data at this structure

Figure 29 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 3 Diesel Generator Fuel Storage Vaults

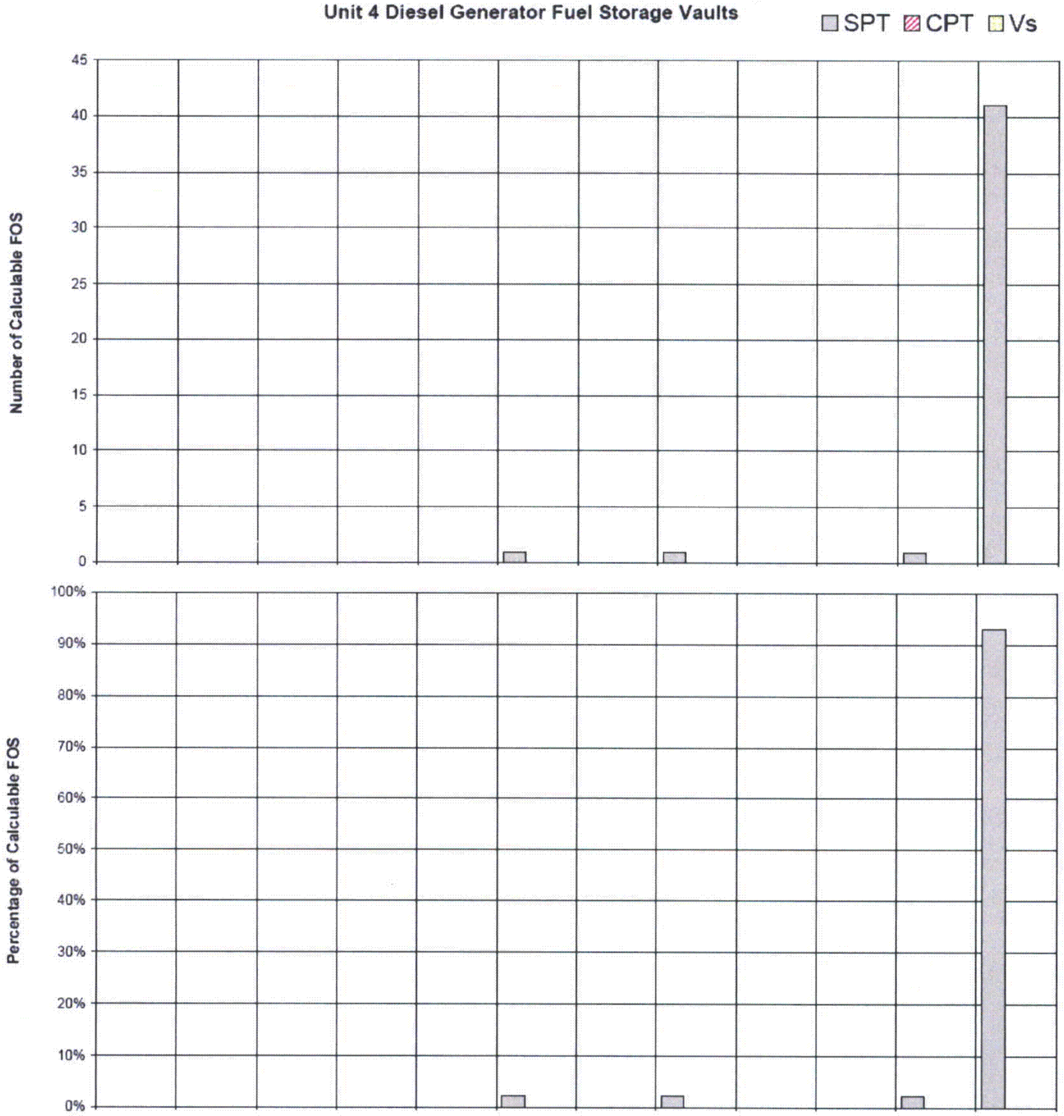


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	2	0	0	0	0	2	1	0	5	31
	% of Count	0.0%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	4.9%	2.4%	0.0%	12.2%	75.6%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

Figure 30 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 4 Diesel Generator Fuel Storage Vaults

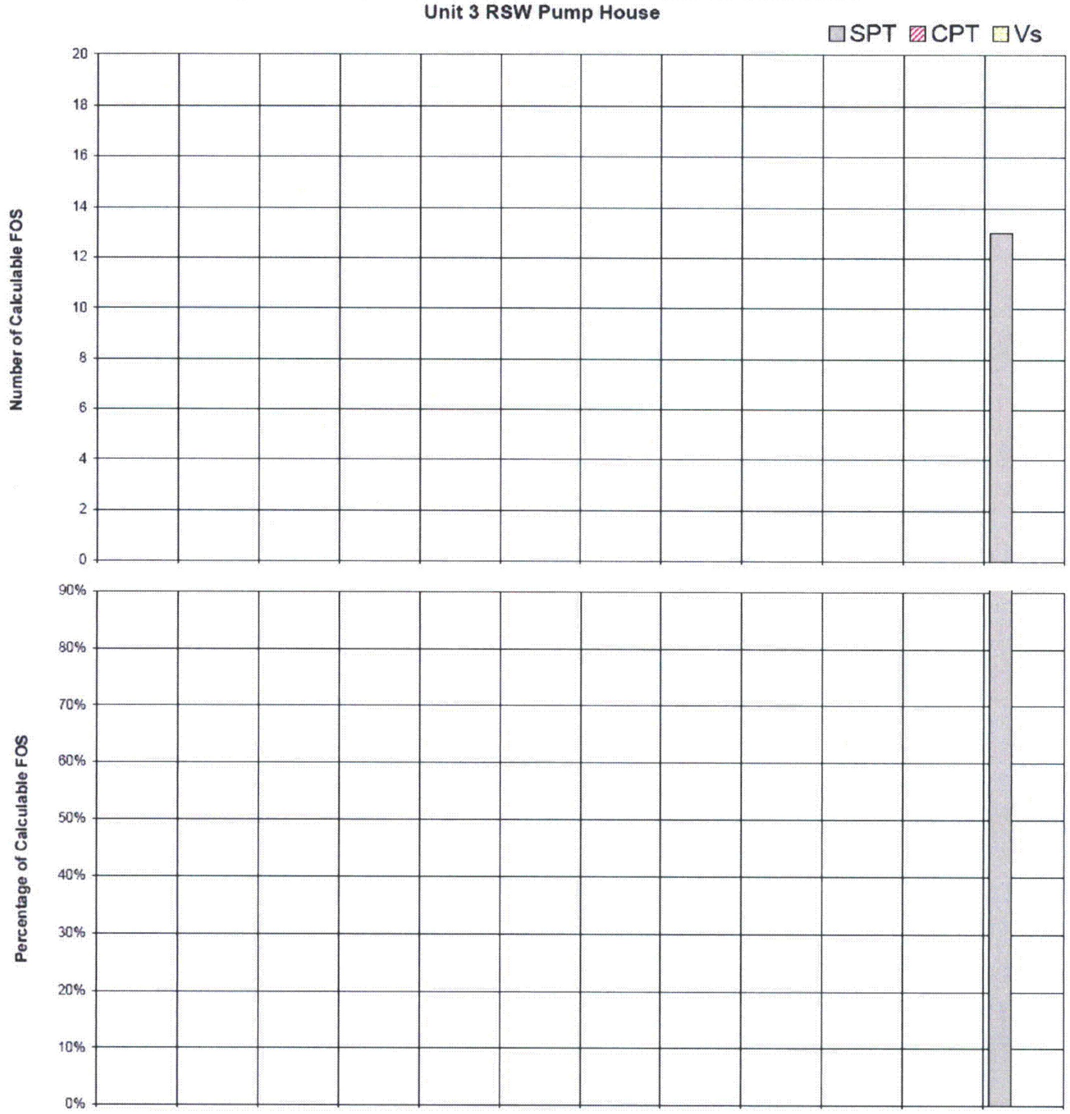


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	1	0	1	0	0	1	41
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	0.0%	2.3%	0.0%	0.0%	2.3%	93.2%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

Figure 31 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 3 RSW Pump House

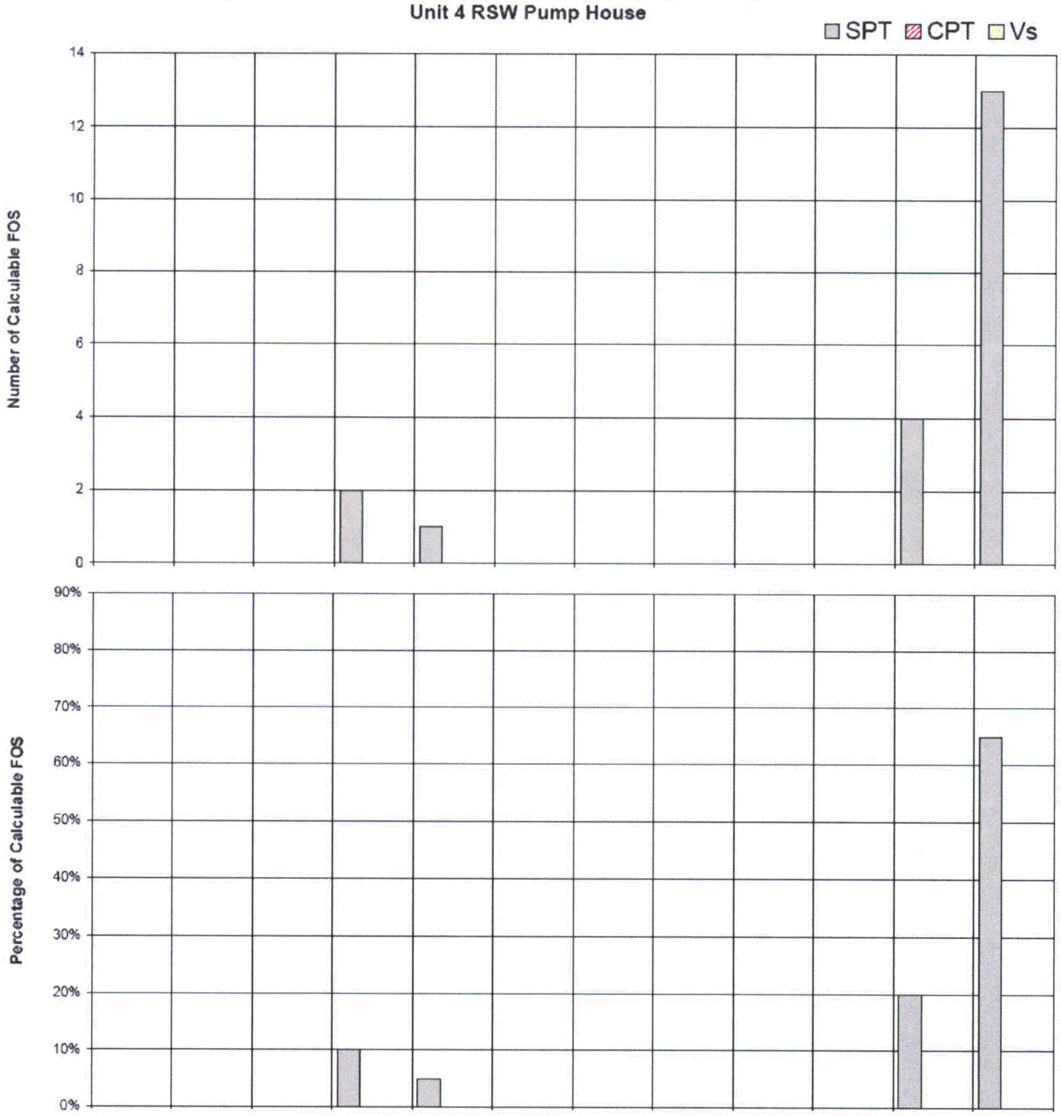


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	0	0	0	0	13
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

Figure 32 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 4 RSW Pump House

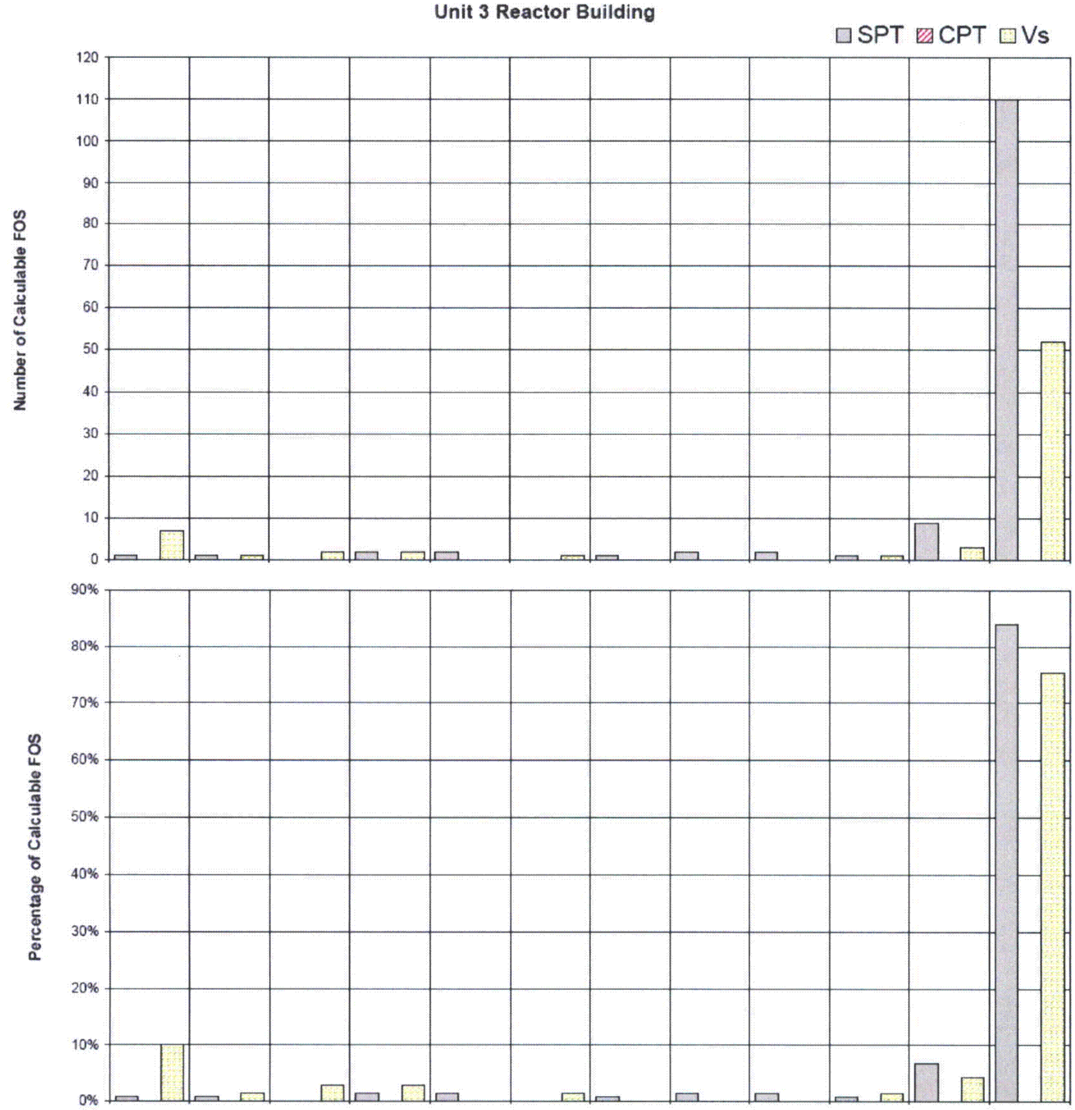


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	2	1	0	0	0	0	0	4	13
	% of Count	0.0%	0.0%	0.0%	10.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.0%	65.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

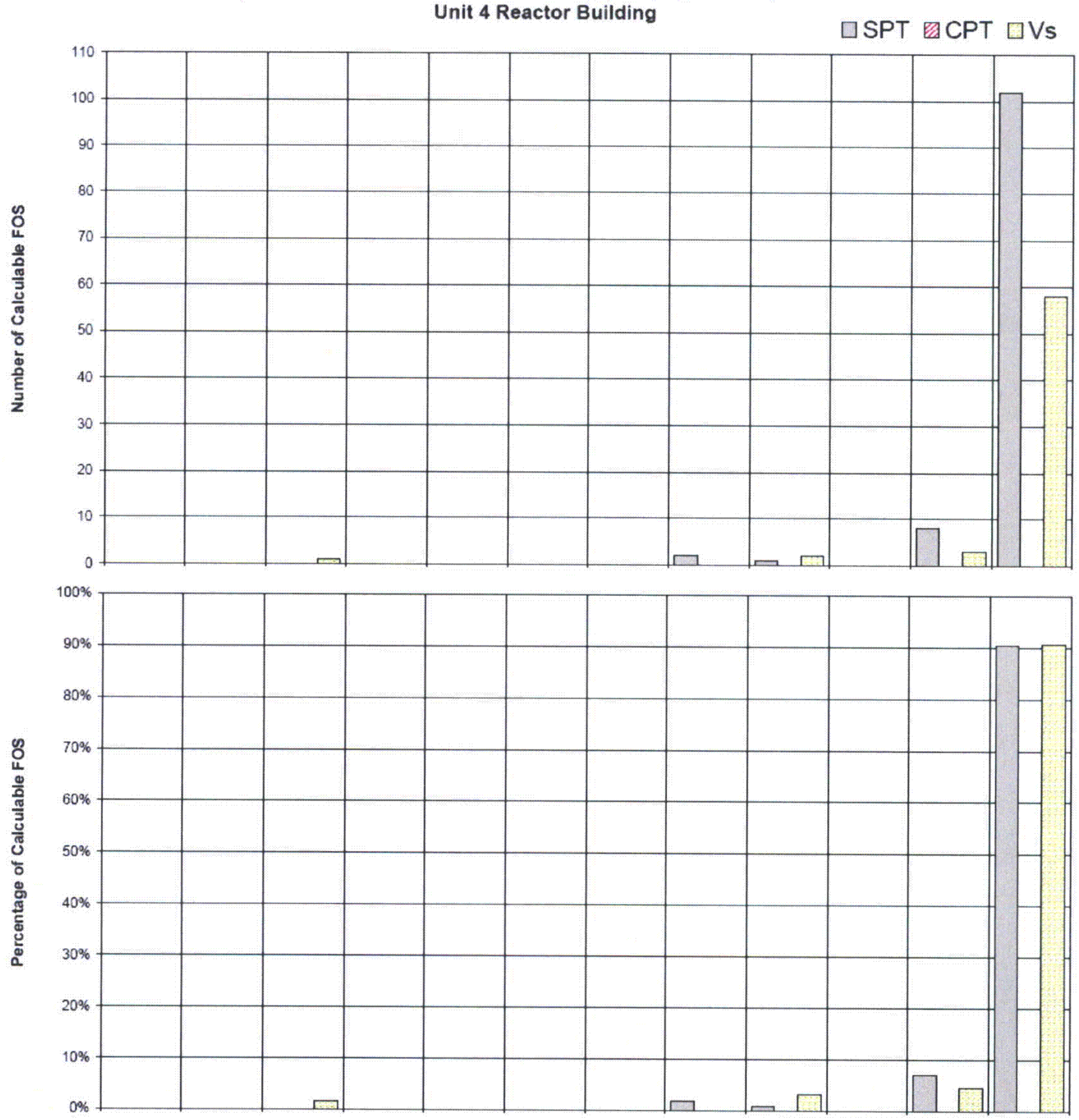
Figure 33 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 3 Reactor Building



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	1	1	0	2	2	0	1	2	2	1	9	110
	% of Count	0.8%	0.8%	0.0%	1.5%	1.5%	0.0%	0.8%	1.5%	1.5%	0.8%	6.9%	84.0%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	7	1	2	2	0	1	0	0	0	1	3	52
	% of Count	10.1%	1.4%	2.9%	2.9%	0.0%	1.4%	0.0%	0.0%	0.0%	1.4%	4.3%	75.4%

N/A= No CPT data at this structure

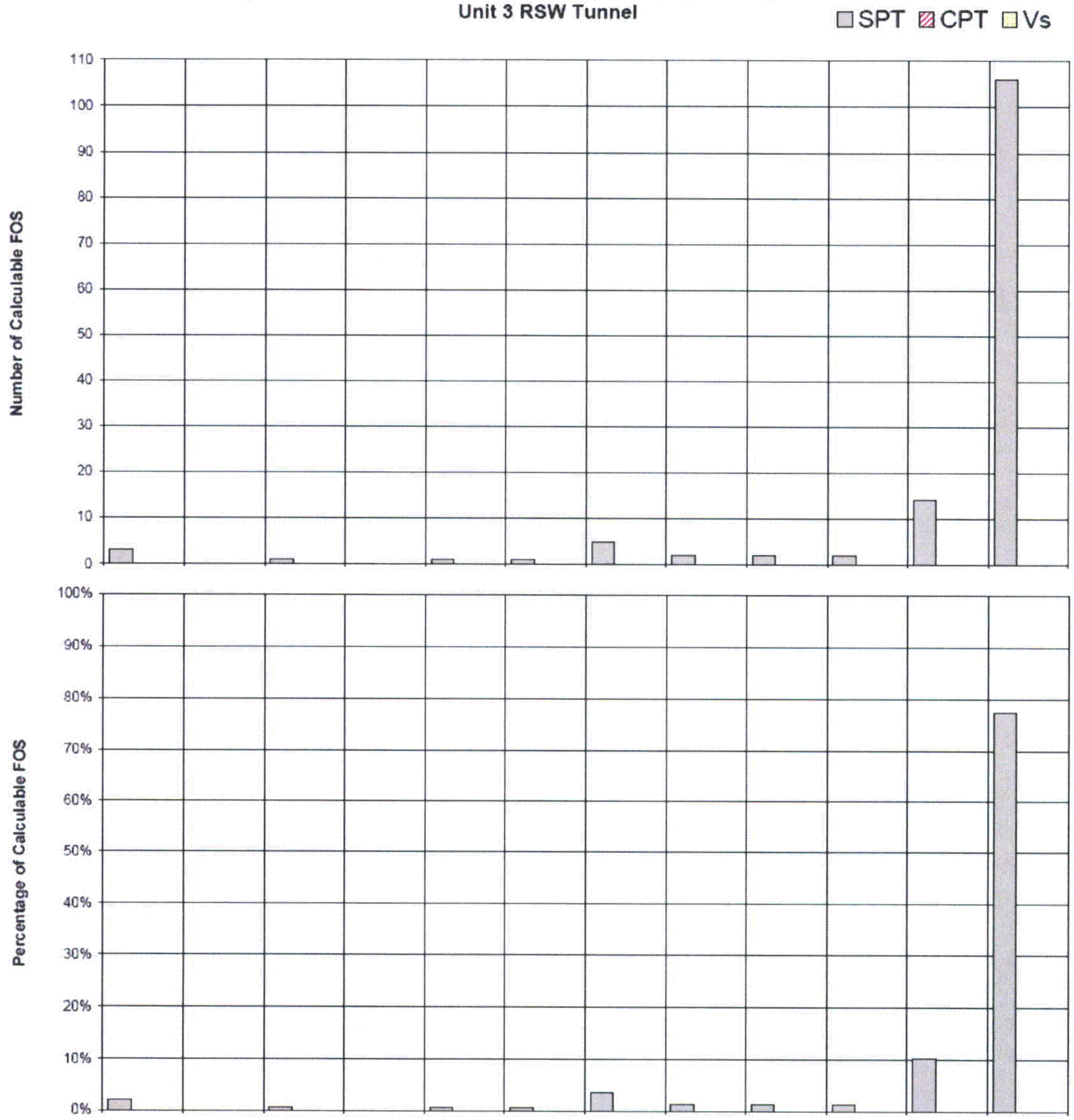
Figure 34 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 4 Reactor Building



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	0	0	0	2	1	0	8	102
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%	0.9%	0.0%	7.1%	90.3%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	0	0	1	0	0	0	0	0	2	0	3	58
	% of Count	0.0%	0.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	4.7%	90.6%

N/A= No CPT data at this structure

Figure 35 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 3 RSW Tunnel

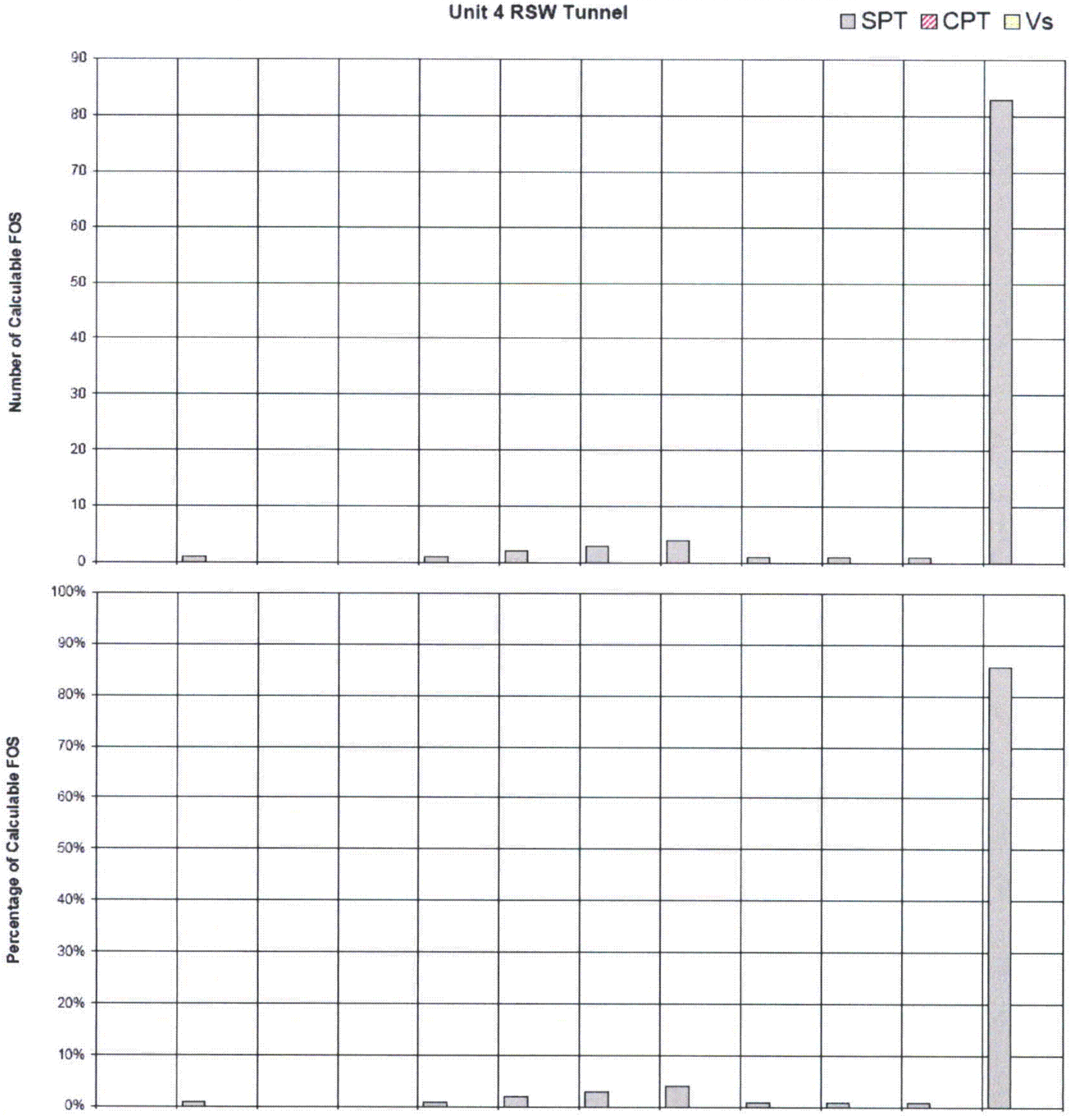


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	3	0	1	0	1	1	5	2	2	2	14	106
	% of Count	2.2%	0.0%	0.7%	0.0%	0.7%	0.7%	3.6%	1.5%	1.5%	1.5%	10.2%	77.4%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

Figure 36 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 4 RSW Tunnel

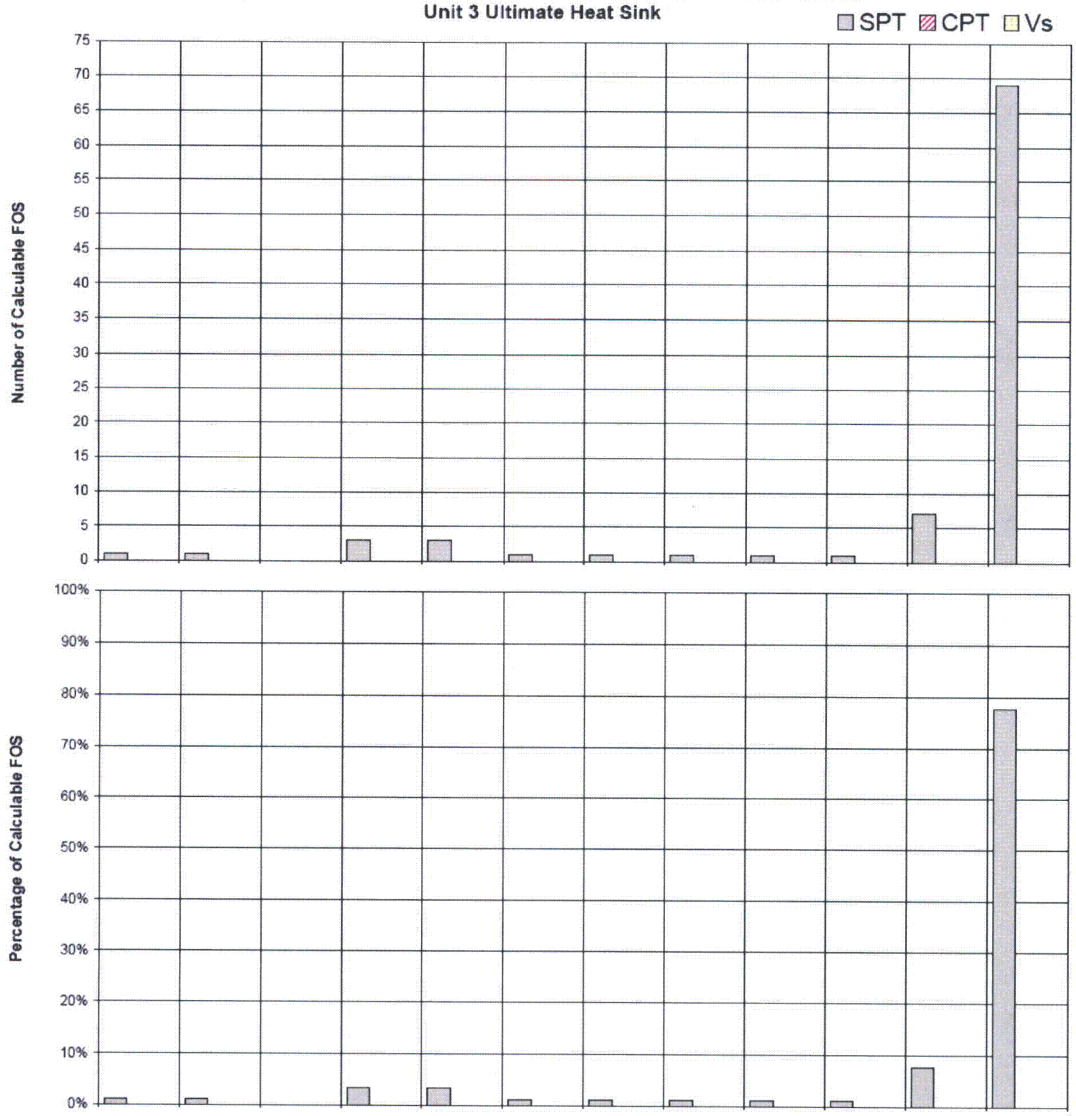


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	1	0	0	1	2	3	4	1	1	1	83
	% of Count	0.0%	1.0%	0.0%	0.0%	1.0%	2.1%	3.1%	4.1%	1.0%	1.0%	1.0%	85.6%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

Figure 37 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 3 Ultimate Heat Sink

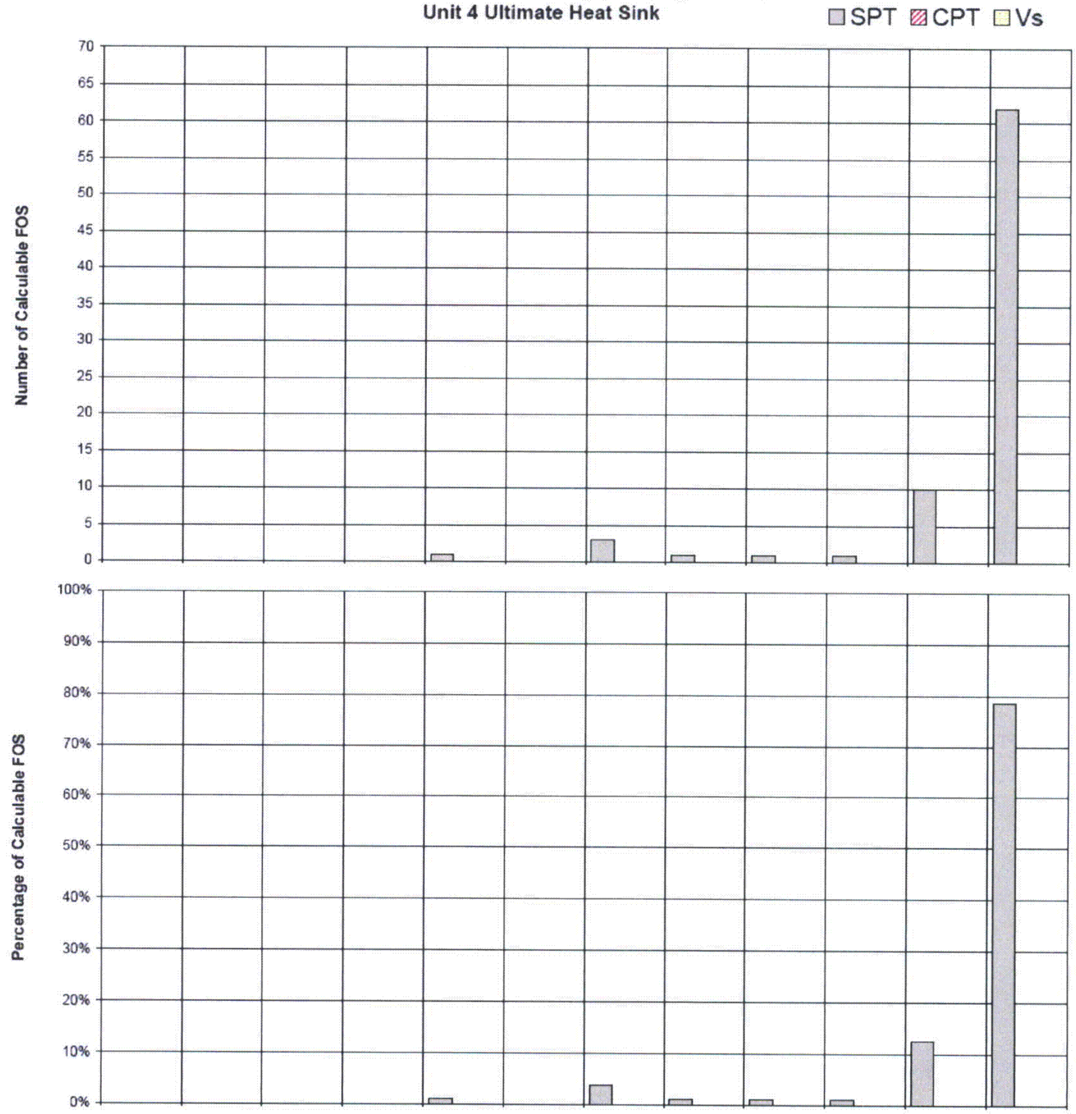


		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	1	1	0	3	3	1	1	1	1	1	7	69
	% of Count	1.1%	1.1%	0.0%	3.4%	3.4%	1.1%	1.1%	1.1%	1.1%	1.1%	7.9%	77.5%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure

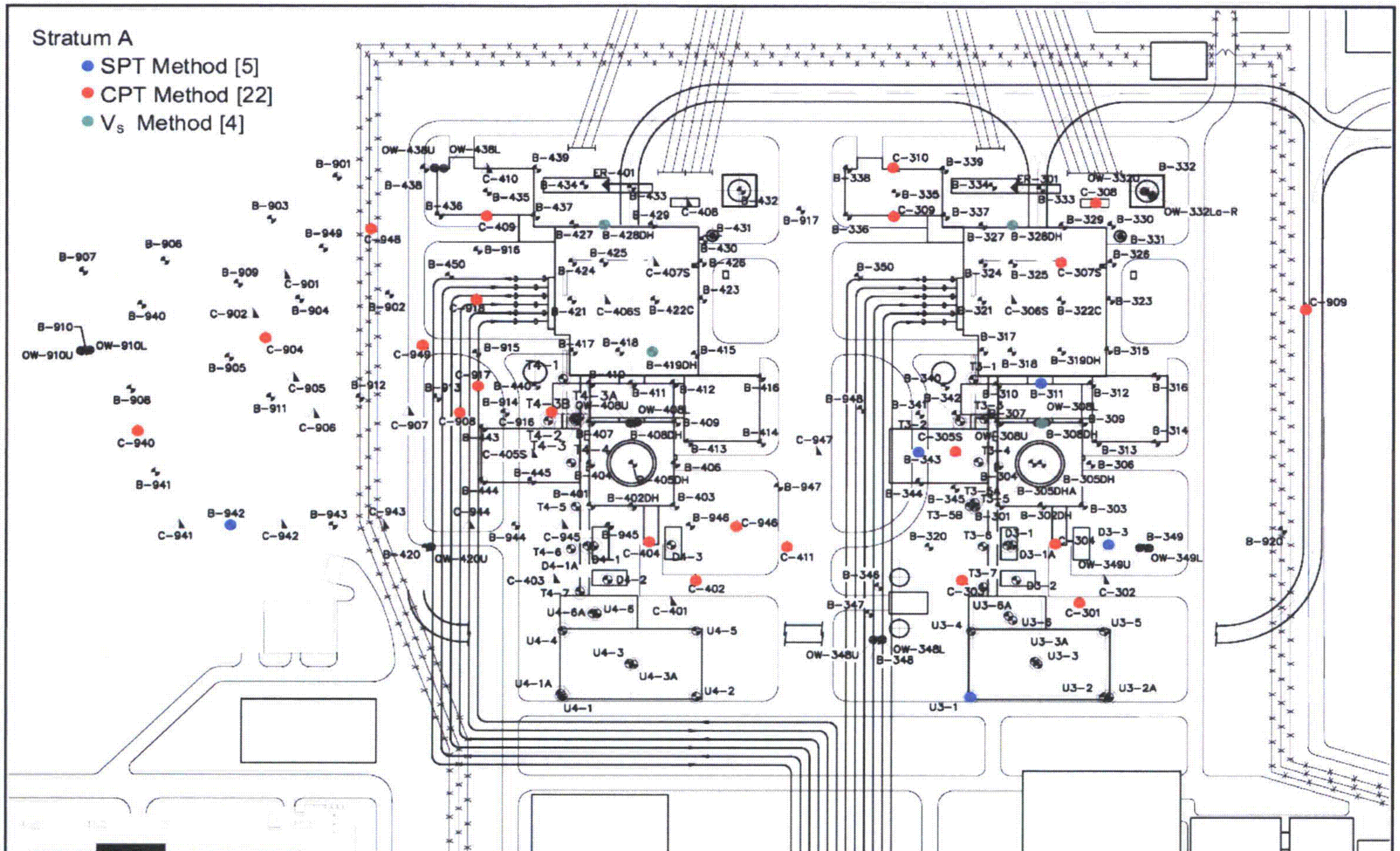
Figure 38 - Calculable Factors of Safety (FOS) Against Liquefaction - Unit 4 Ultimate Heat Sink



		FOS<1.1	1.1≤FOS<1.2	1.2≤FOS<1.3	1.3≤FOS<1.4	1.4≤FOS<1.5	1.5≤FOS<1.6	1.6≤FOS<1.7	1.7≤FOS<1.8	1.8≤FOS<1.9	1.9≤FOS<2.0	2.0≤FOS<2.5	2.5≤FOS
SPT	Count	0	0	0	0	1	0	3	1	1	1	10	62
	% of Count	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	3.8%	1.3%	1.3%	1.3%	12.7%	78.5%
CPT	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vs	Count	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	% of Count	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

N/A= No CPT data at this structure

N/A= No V_s data at this structure



APPROXIMATE SCALE IN FEET

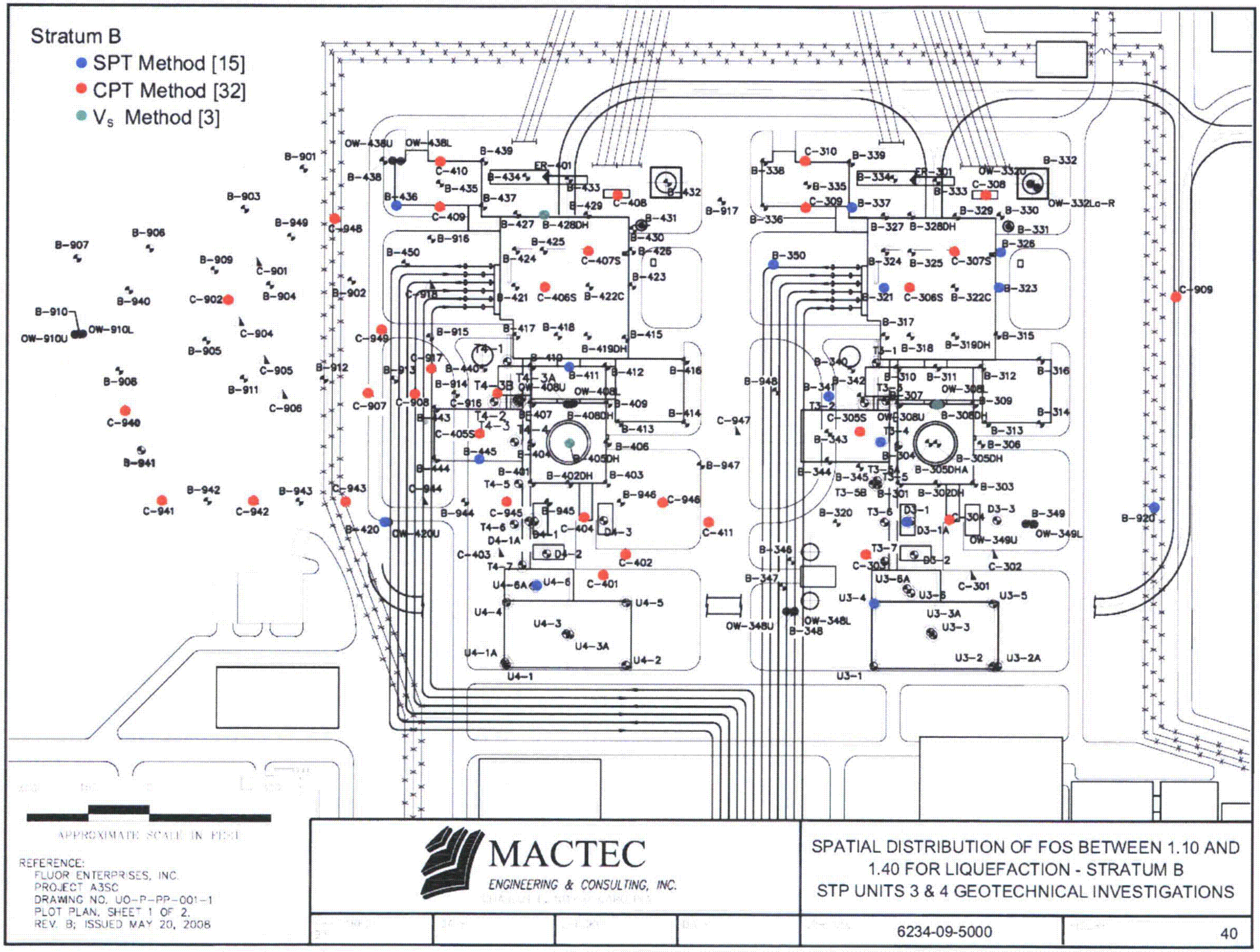
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008

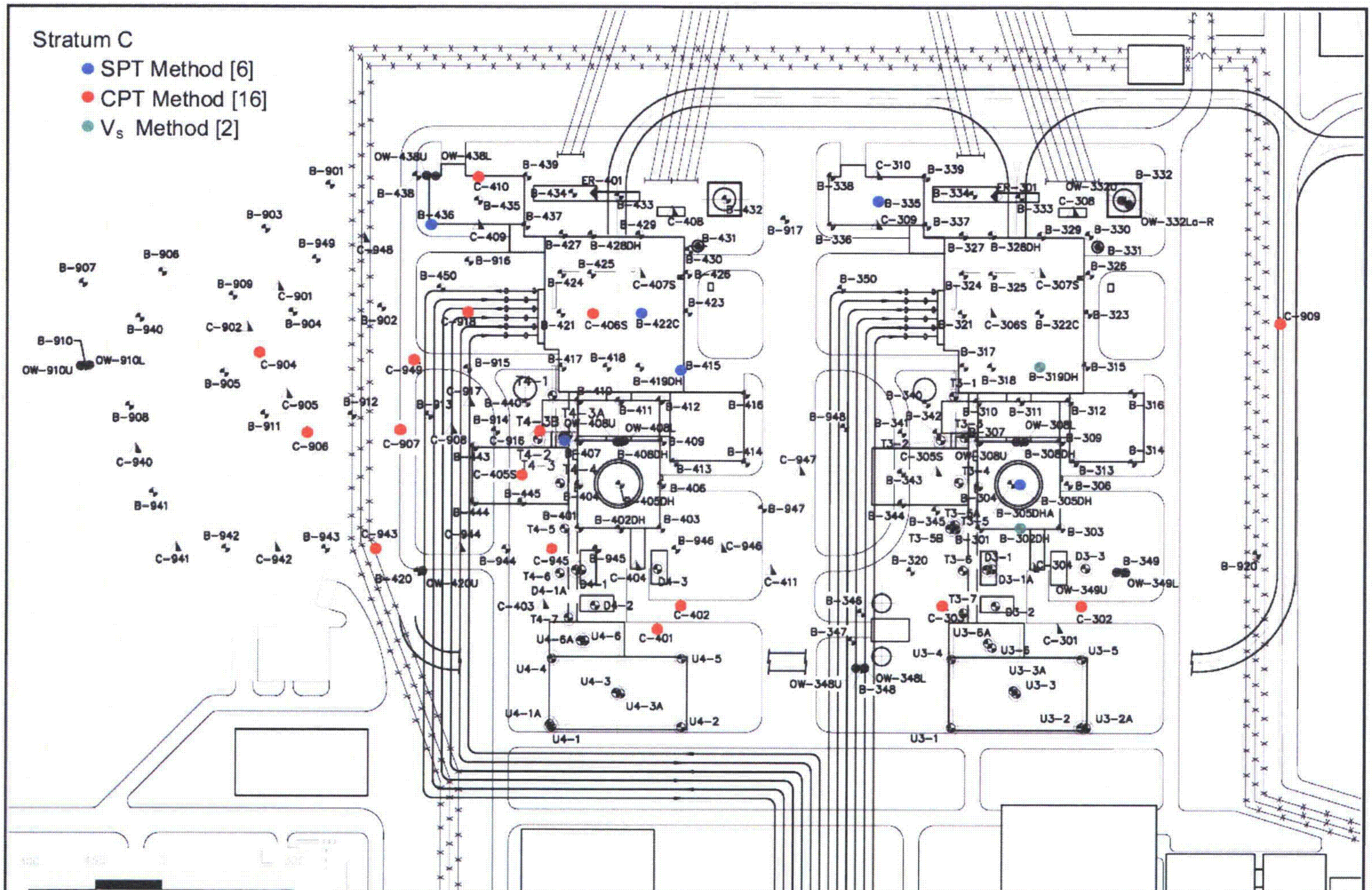
MACTEC
ENGINEERING & CONSULTING, INC.

SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM A
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000

39


Stratum B
SPT Method [15]
CPT Method [32]
V_s Method [3]
APPROXIMATE SCALE IN FEET
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2.
REV. B; ISSUED MAY 20, 2008
MACTEC
ENGINEERING & CONSULTING, INC.
SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM B
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS
6234-09-5000
40

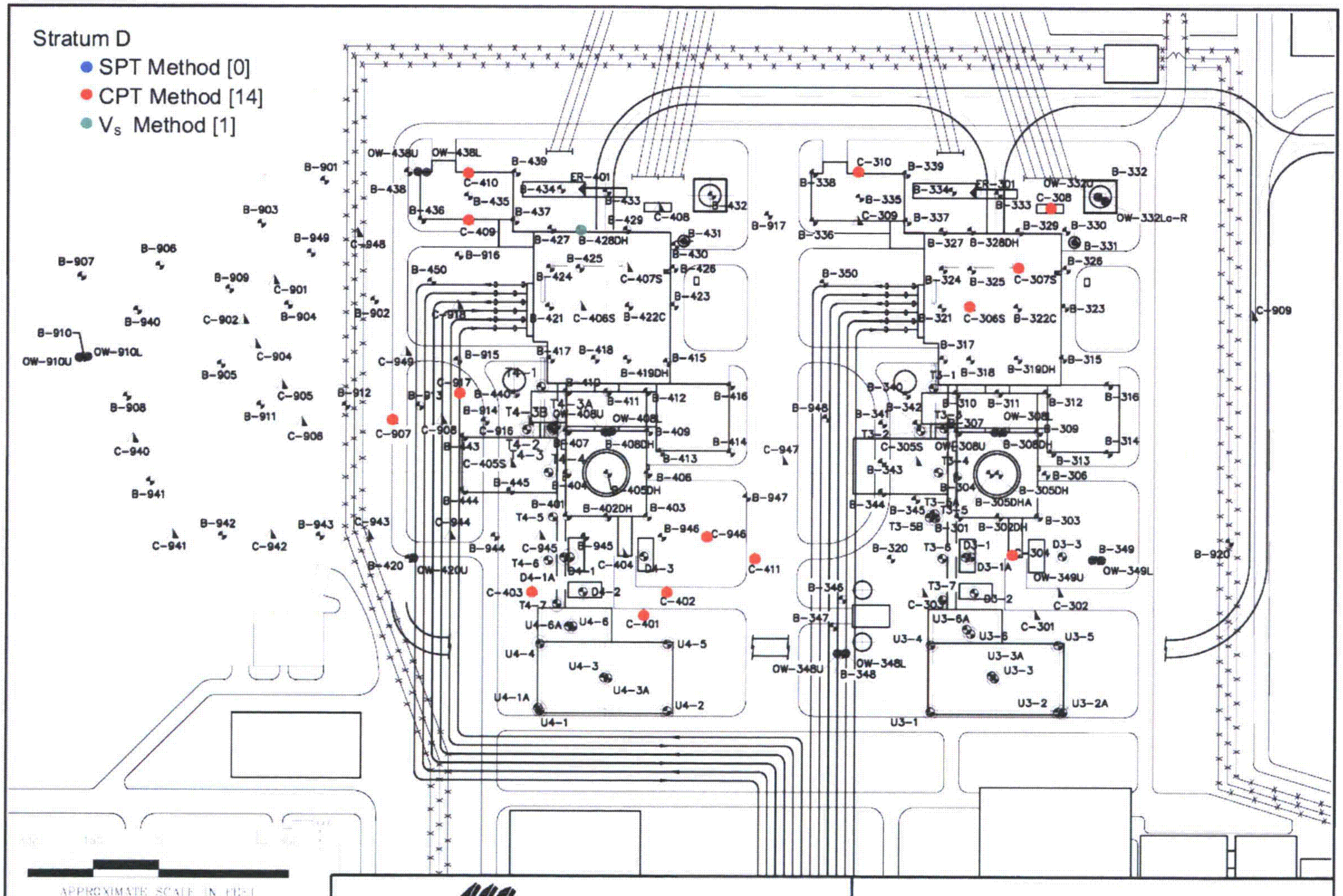


REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008

MACTEC
ENGINEERING & CONSULTING, INC.

SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM C
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000	41



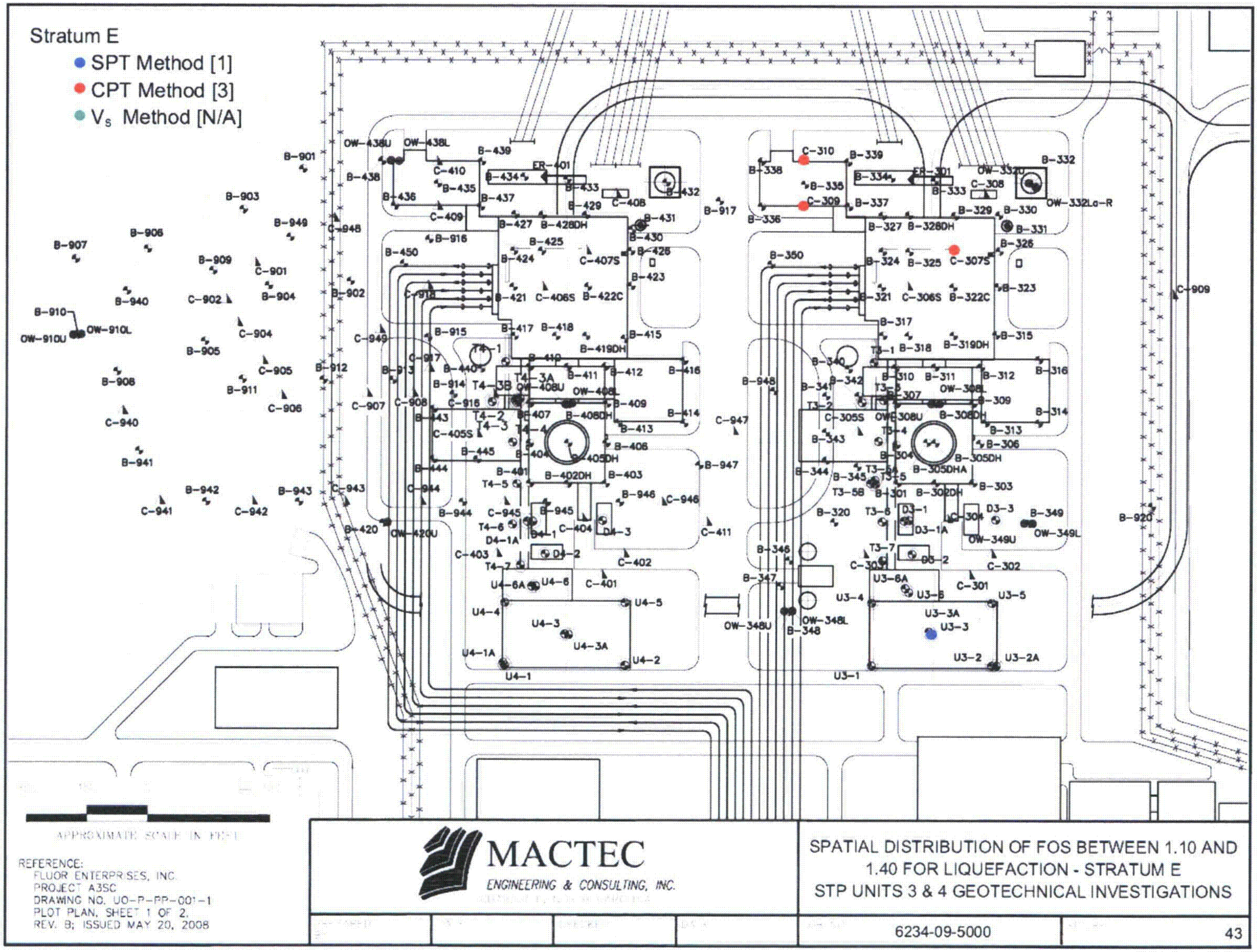
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008

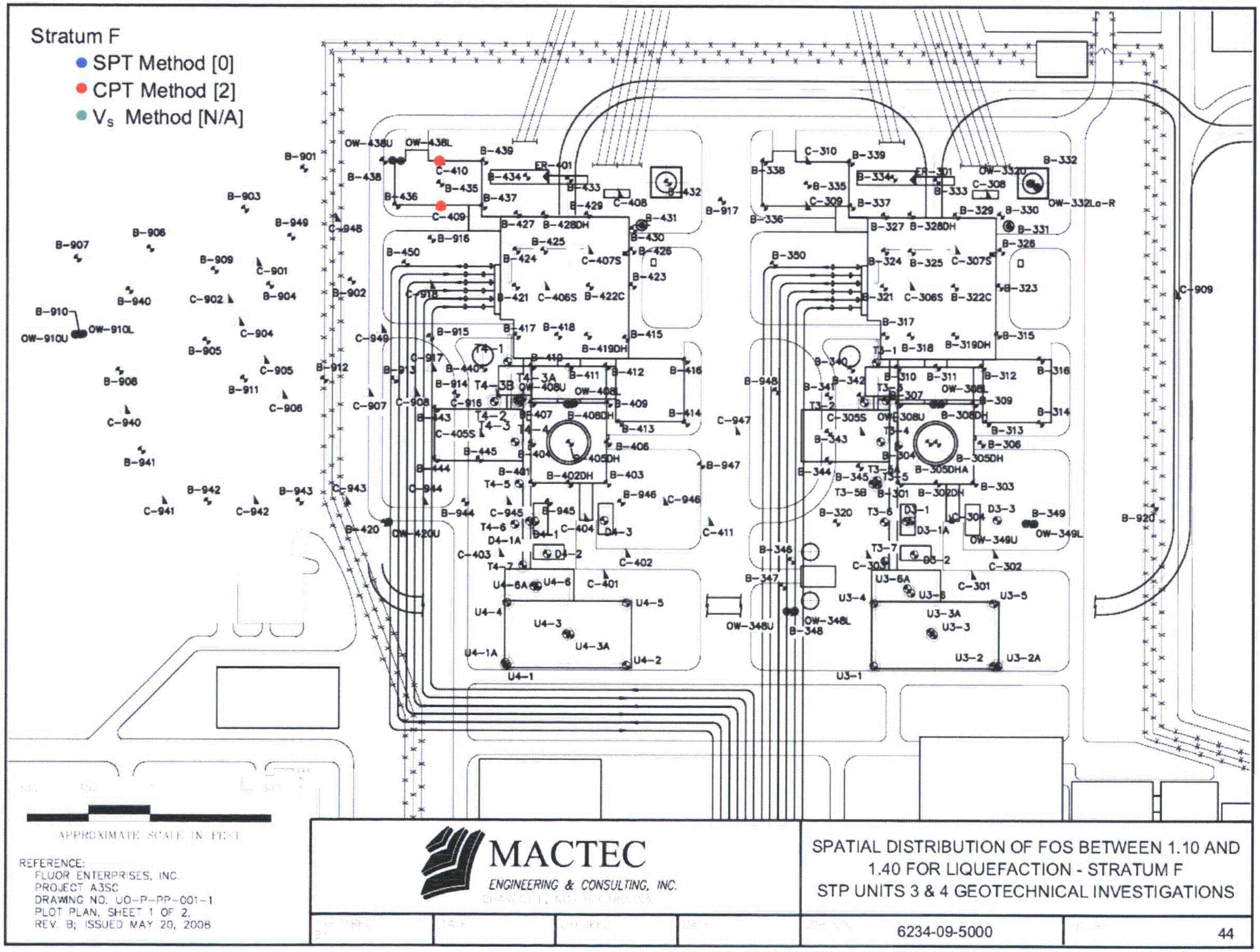
MACTEC ENGINEERING & CONSULTING, INC.

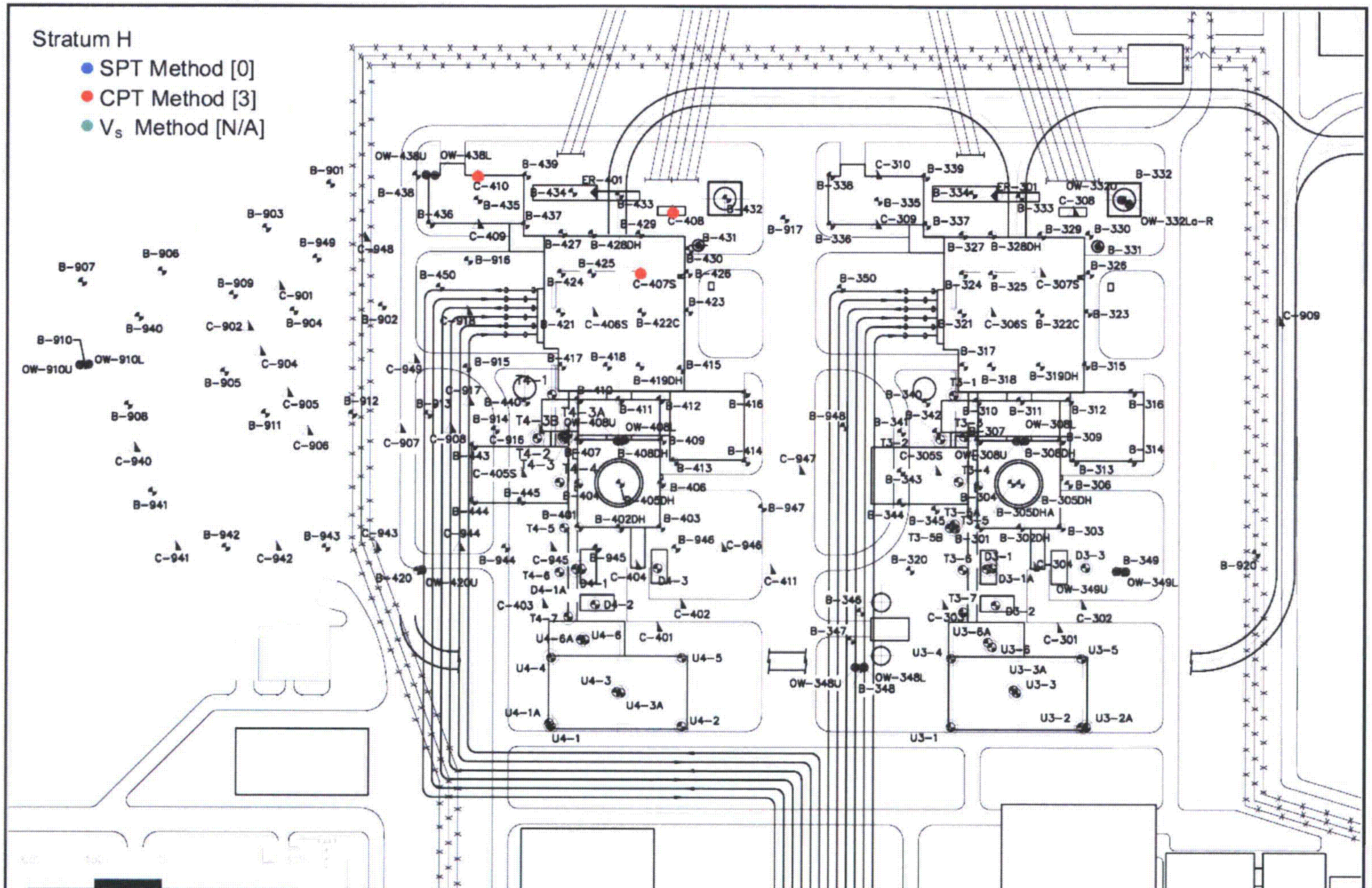
SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM D
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000

42


Stratum E
SPT Method [1]
CPT Method [3]
V_s Method [N/A]
APPROXIMATE SCALE IN FEET
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008
MACTEC
ENGINEERING & CONSULTING, INC.
SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM E
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS
6234-09-5000
43


Stratum F
SPT Method [0]
CPT Method [2]
V_s Method [N/A]
APPROXIMATE SCALE IN FEET
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008
MACTEC
ENGINEERING & CONSULTING, INC.
SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM F
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS
6234-09-5000
44



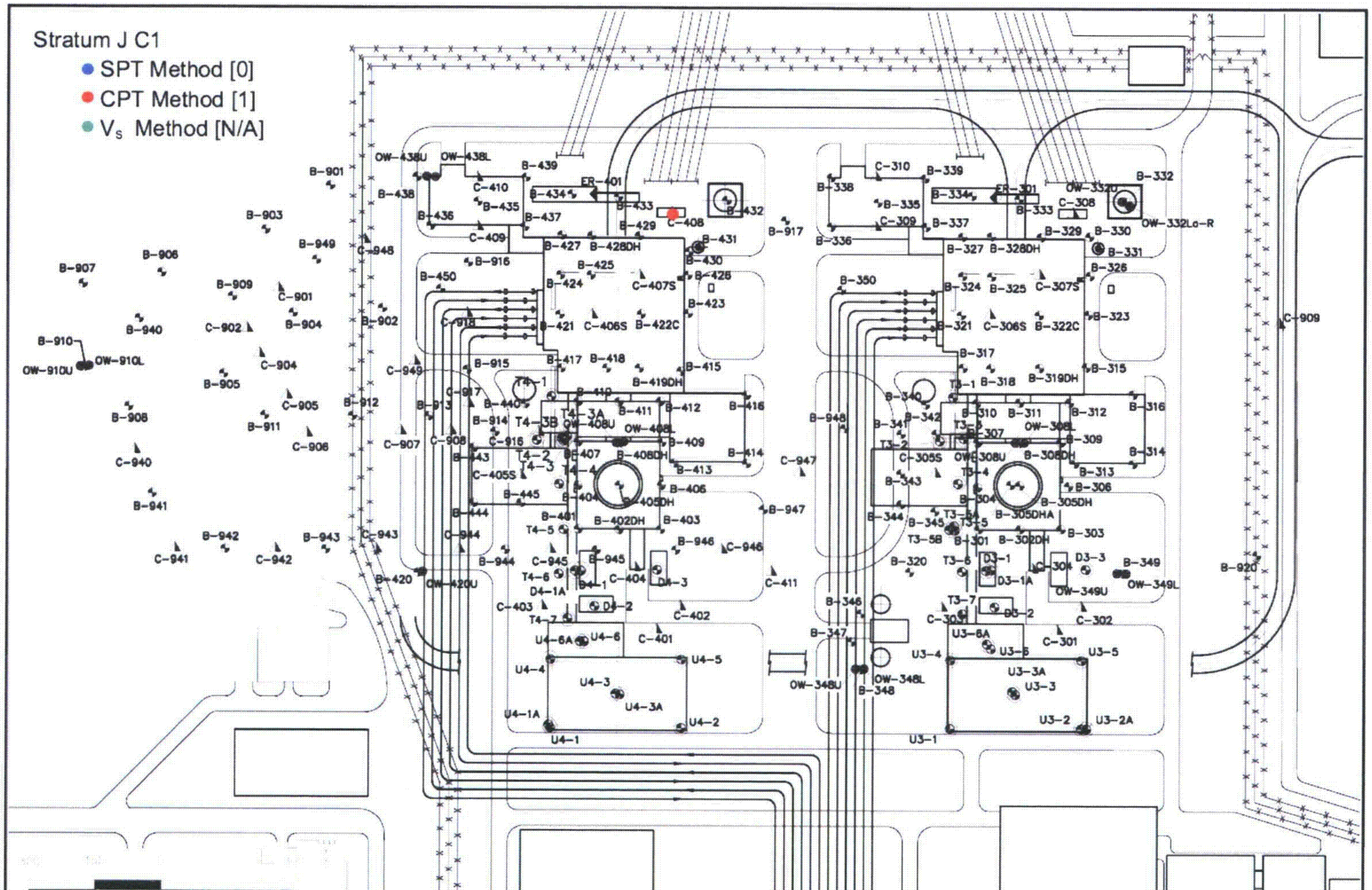
REFERENCE:
FLUOR ENTERPRISES, INC
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008

MACTEC
ENGINEERING & CONSULTING, INC.

SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM H
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000

45



APPROXIMATE SCALE IN FEET

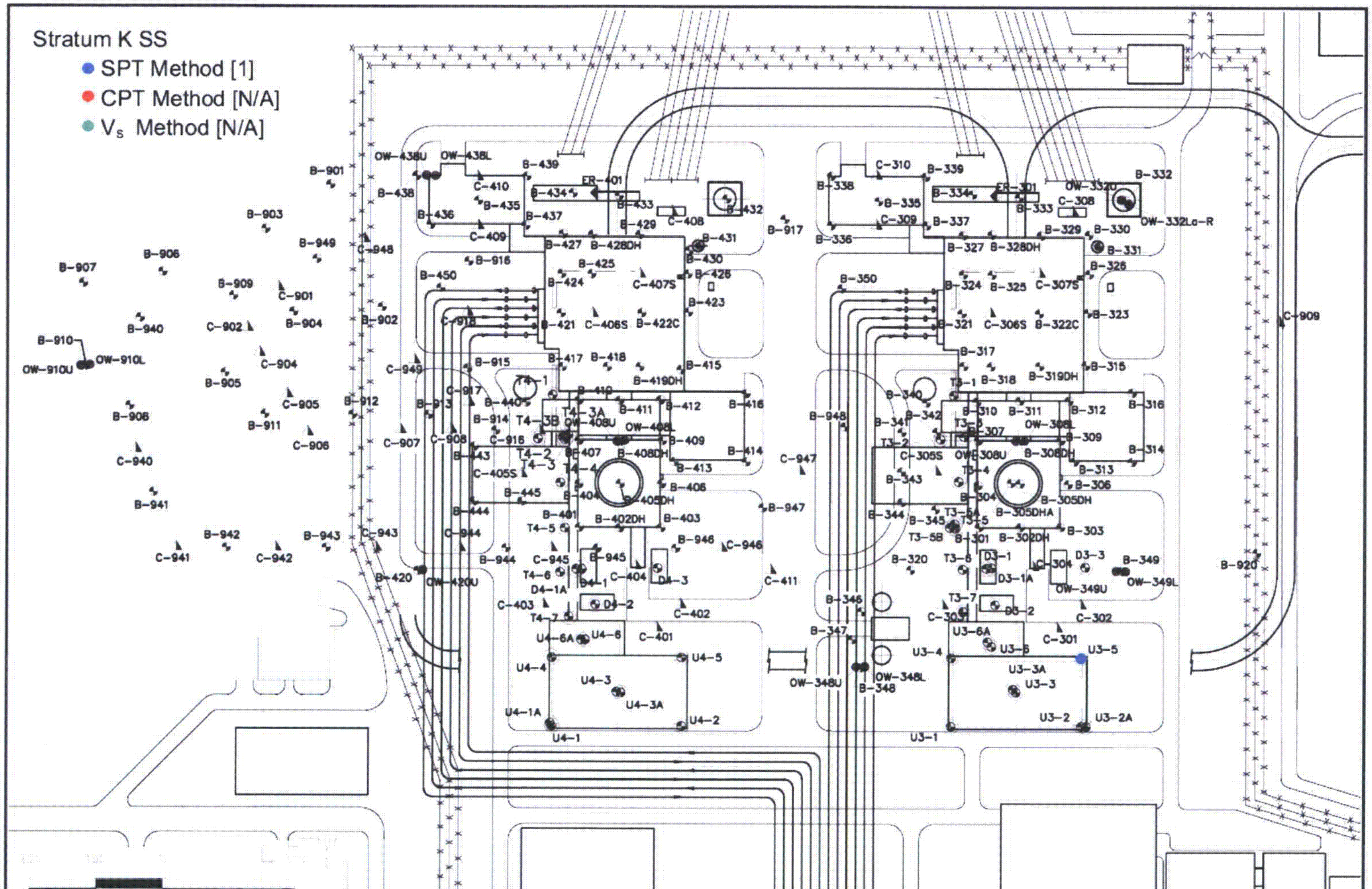
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2.
REV. B; ISSUED MAY 20, 2008

MACTEC
ENGINEERING & CONSULTING, INC.

SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM J C1
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000

46



APPROXIMATE SCALE IN FEET

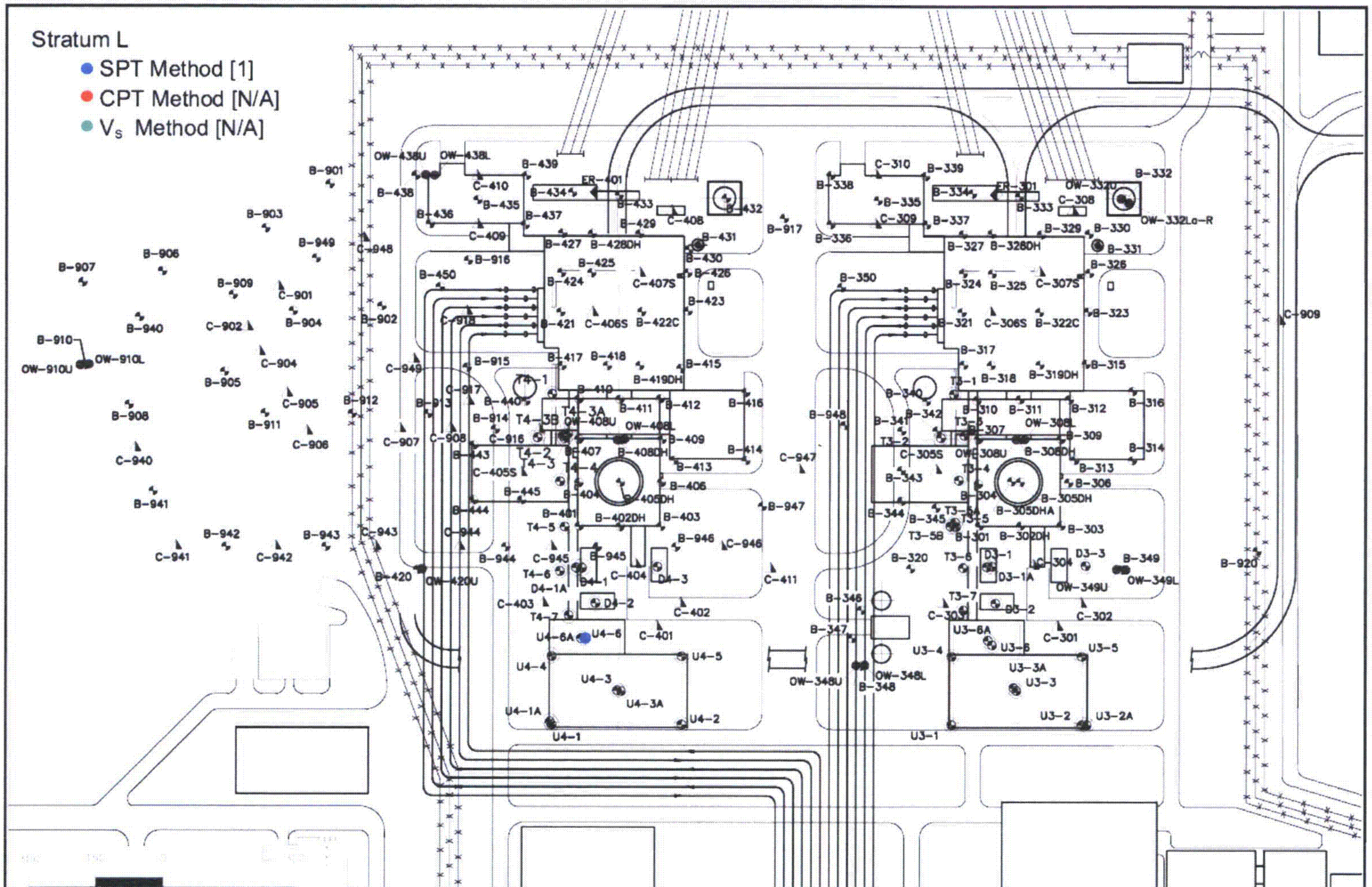
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. U0-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008

MACTEC
ENGINEERING & CONSULTING, INC.

SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM K SS
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000

47



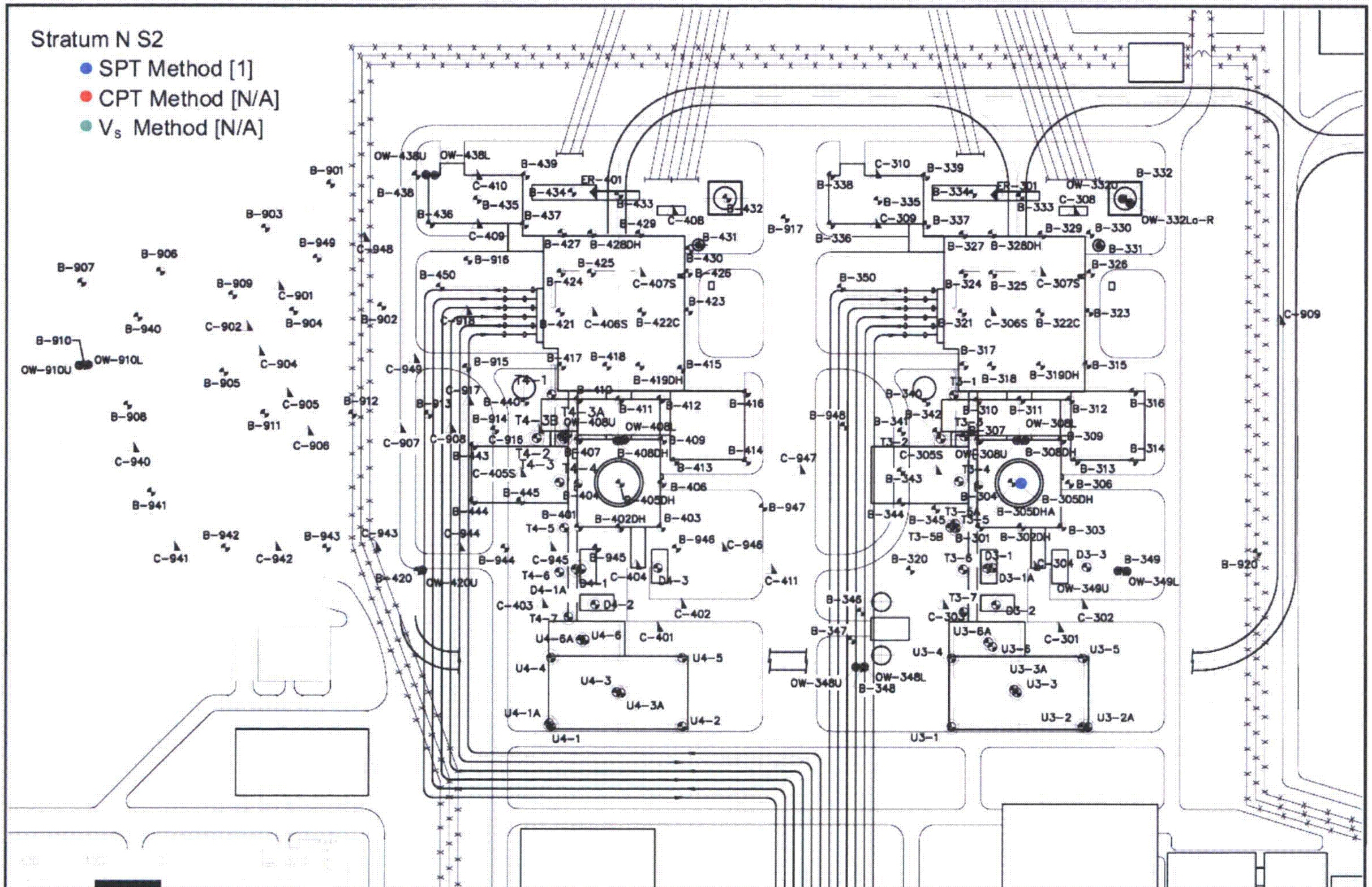
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2.
REV. B; ISSUED MAY 20, 2008

MACTEC
ENGINEERING & CONSULTING, INC.

SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM L
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000

48



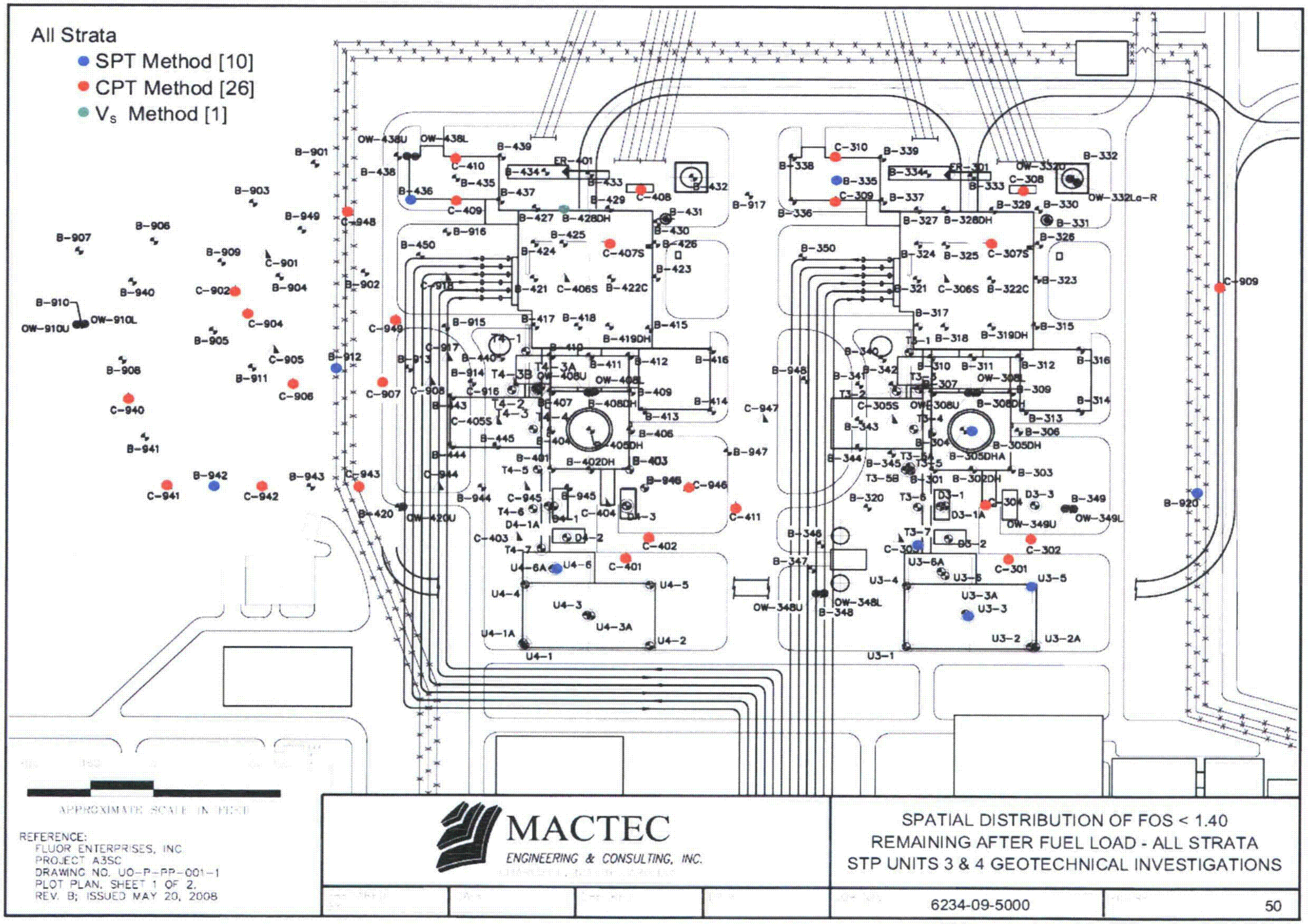
REFERENCE:
FLUOR ENTERPRISES, INC.
PROJECT A3SC
DRAWING NO. U0-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2.
REV. B; ISSUED MAY 20, 2008

MACTEC
ENGINEERING & CONSULTING, INC.

SPATIAL DISTRIBUTION OF FOS BETWEEN 1.10 AND 1.40 FOR LIQUEFACTION - STRATUM N S2
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS

6234-09-5000

49


All Strata
SPT Method [10]
CPT Method [26]
V_s Method [1]
APPROXIMATE SCALE IN FEET
REFERENCE:
FLUOR ENTERPRISES, INC
PROJECT A3SC
DRAWING NO. UO-P-PP-001-1
PLOT PLAN, SHEET 1 OF 2,
REV. B; ISSUED MAY 20, 2008
MACTEC
ENGINEERING & CONSULTING, INC.
SPATIAL DISTRIBUTION OF FOS < 1.40
REMAINING AFTER FUEL LOAD - ALL STRATA
STP UNITS 3 & 4 GEOTECHNICAL INVESTIGATIONS
6234-09-5000
50