

# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-24-2002 TIME:14:53:33.48

SOUNDING NUMBER:CPT-01

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
1.0	245.1	394.9	4.98	2.2	0.2	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 62	+ 100
1.5	132.8	202.2	3.57	1.9	0.2	-5	Very dense, Silty sand to sandy silt	40-42	80-100				39 - 65	60 - 99
2.0	101.1	147.6	4.55	4.0	0.2	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	6.12	9.10	+ 68	+ 100
2.5	87.3	123.2	4.12	4.4	-0.3	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	5.28	8.23	+ 71	+ 100
3.0	57.7	79.2	3.59	4.9	-0.4	-5	Very stiff, Sandy clay to silty clay **			30	3.83	7.18	44 - 72	60 - 99
3.5	36.1	48.3	1.92	4.3	-0.4	-5	Very stiff, Sandy clay to silty clay *			25	2.87	3.84	15 - 22	20 - 30
4.0	20.5	26.9	1.24	4.4	-0.5	-5	Very stiff, Silty clay to clay *			20	2.03	2.48	11 - 15	15 - 20
4.5	12.3	15.7	0.58	3.6	-0.5	-5	Stiff, Silty clay to clay *			15	1.60	1.16	03 - 05	04 - 06
5.0	9.9	12.5	0.37	3.6	-0.1	-5	Stiff, Silty clay to clay *			15	1.28	0.74	03 - 05	04 - 06
5.5	7.7	9.6	0.38	4.5	0.0	-5	Firm, Silty clay to clay *			15	0.99	0.76	03 - 05	04 - 06
6.0	7.8	9.6	0.36	3.8	-0.0	-5	Firm, Silty clay to clay *			15	0.99	0.72	02 - 03	02 - 04
6.5	14.4	17.3	0.53	3.6	-0.1	-5	Stiff, Silty clay to clay *			15	1.88	1.06	05 - 08	06 - 10
7.0	13.6	16.2	0.81	5.4	-0.6	-5	Stiff, Silty clay to clay *			15	1.76	1.61	05 - 08	06 - 10
7.5	9.6	11.2	0.75	4.9	-0.6	-5	Stiff, Silty clay to clay *			15	1.22	1.49	03 - 05	04 - 06
8.0	24.8	28.8	0.53	1.9	-0.0	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				05 - 09	06 - 10
8.5	27.9	32.0	0.42	1.5	-0.1	-5	Loose, Silty sand to sandy silt	27-31	20-40				05 - 09	06 - 10
9.0	29.6	33.6	0.59	1.6	-0.2	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				05 - 09	06 - 10
9.5	53.6	60.2	1.70	2.0	-0.2	-5	Dense, Silty sand to sandy silt	36-37	60-80				13 - 18	15 - 20
10.0	70.9	85.5	3.72	4.7	-0.2	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	5.09	7.44	54 - 89	60 - 99
10.5	55.7	61.2	3.84	5.8	-0.4	-5	Very stiff, Sandy clay to silty clay **			30	3.67	7.68	55 - 90	60 - 99
11.0	79.5	86.7	3.68	4.9	-0.4	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	5.26	7.37	55 - 91	60 - 99
11.5	71.9	77.6	3.67	4.9	-0.4	-5	Hard, Sandy clay to silty clay **			30	4.74	7.33	56 - 92	60 - 99
12.0	45.7	48.9	3.06	5.0	-0.4	-5	Very stiff, Sandy clay to silty clay **			25	3.60	6.12	28 - 37	30 - 40
12.5	88.2	93.7	2.70	3.8	-0.4	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	5.83	5.39	56 - 93	60 - 99
13.0	69.6	73.4	4.60	3.4	-0.5	-5	Hard, Sandy silt to sandy clay			30	4.59	9.20	38 - 57	40 - 60
13.5	151.9	158.9	3.66	2.7	-0.5	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				57 - 95	60 - 99
14.0	56.0	58.2	3.35	3.5	-0.5	-5	Hard, Sandy clay to silty clay *			25	4.42	6.70	19 - 29	20 - 30
14.5	66.1	68.1	2.83	4.6	-0.5	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	4.35	5.66	39 - 58	40 - 60
15.0	76.9	78.7	2.38	3.5	0.1	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	5.07	4.77	39 - 59	40 - 60
15.5	40.5	41.1	1.99	3.0	0.2	-5	Very stiff, Sandy silt to sandy clay			25	3.16	3.98	15 - 20	15 - 20
16.0	23.7	23.9	0.78	2.7	0.3	-5	Very stiff, Sandy clay to silty clay *			20	2.28	1.56	06 - 10	06 - 10
16.5	24.5	24.6	0.63	2.6	0.3	-5	Very stiff, Sandy silt to sandy clay			20	2.35	1.26	06 - 10	06 - 10
17.0	17.8	17.7	0.43	2.0	0.2	-5	Very stiff, Sandy silt to clayey silt			15	2.23	0.85	04 - 06	04 - 06
17.5	16.1	16.0	0.41	2.4	0.3	-5	Very stiff, Clayey silt to silty clay			15	2.00	0.82	04 - 06	04 - 06
18.0	15.3	15.1	0.52	3.0	0.3	-5	Stiff, Sandy clay to silty clay *			15	1.89	1.04	04 - 06	04 - 06
18.5	18.2	17.9	0.76	3.2	0.3	-5	Very stiff, Sandy clay to silty clay *			15	2.27	1.57	04 - 06	04 - 06
19.0	31.9	31.4	1.31	4.5	0.3	-5	Very stiff, Silty clay to clay *			25	2.46	2.61	15 - 20	15 - 20
19.5	28.0	27.5	1.48	5.0	0.3	-5	Very stiff, Silty clay to clay *			20	2.69	2.95	15 - 20	15 - 20
20.0	31.8	31.1	1.58	4.4	0.3	-5	Very stiff, Silty clay to clay *			25	2.45	3.16	15 - 20	15 - 20
20.5	39.3	38.4	2.14	4.5	0.3	-5	Very stiff, Silty clay to clay *			25	3.05	4.29	21 - 31	20 - 30
21.0	58.3	56.7	2.45	4.4	0.2	-5	Hard, Gravelly sandy clay to gravelly silty clay **			25	4.56	4.89	41 - 62	40 - 60
21.5	53.4	51.8	2.56	4.7	0.1	-5	Hard, Sandy clay to silty clay **			25	4.17	5.12	31 - 41	30 - 40
22.0	54.2	52.4	2.82	5.4	0.1	-5	Very stiff, Sandy clay to silty clay **			30	3.52	5.64	41 - 62	40 - 60
22.5	54.2	52.2	2.75	5.3	0.1	-5	Hard, Sandy clay to silty clay **			25	4.22	5.50	41 - 62	40 - 60
23.0	37.6	36.2	2.19	5.0	0.1	-5	Very stiff, Silty clay to clay *			25	2.90	4.38	21 - 31	20 - 30
23.5	41.2	39.5	2.35	4.7	0.1	-5	Very stiff, Silty clay to clay *			25	3.19	4.70	21 - 31	20 - 30
24.0	49.1	47.0	2.77	5.6	0.1	-5	Very stiff, Sandy clay to silty clay **			25	3.81	5.54	42 - 63	40 - 60
24.5	44.9	42.9	2.46	4.9	0.1	-5	Very stiff, Silty clay to clay *			25	3.48	4.92	31 - 42	30 - 40
25.0	62.8	59.7	3.74	5.0	0.1	-5	Hard, Sandy clay to silty clay **			30	4.09	7.48	42 - 63	40 - 60

\* Indicates lightly overconsolidated soil

\*\* Indicates heavily overconsolidated or cemented soil

Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT.  
Both undrained and drained parameters can be estimated for these soils.

Structure rate of loading should be considered in choosing which strength parameters to use for design.  
Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.

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Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1)
25.5	83.2	79.0	4.39	4.9	0.1	-5	Hard, Sandy clay to silty clay **			30	5.45	8.77	63 - 104	60 - 99
26.0	95.6	90.4	4.77	4.6	-0.1	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	6.27	9.54	63 - 105	60 - 99
26.5	104.8	98.9	5.21	4.9	-0.1	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	6.68	10.41	+ 106	+ 100
27.0	84.1	79.2	4.61	4.9	-0.2	-5	Hard, Sandy clay to silty clay **			30	5.50	9.23	64 - 105	60 - 99
27.5	62.7	58.9	3.69	4.7	-0.2	-5	Hard, Sandy clay to silty clay **			30	4.07	7.39	43 - 64	40 - 60
28.0	47.8	44.8	2.93	5.6	-0.2	-5	Very stiff, Sandy clay to silty clay **			25	3.69	5.86	43 - 64	40 - 60
28.5	47.5	44.4	2.50	5.3	-0.2	-5	Very stiff, Sandy clay to silty clay **			25	3.66	5.00	32 - 43	30 - 40
29.0	47.5	44.2	2.54	5.6	-0.2	-5	Very stiff, Sandy clay to silty clay **			25	3.66	5.08	32 - 43	30 - 40
29.5	44.4	41.3	2.12	4.7	-0.2	-5	Very stiff, Silty clay to clay *			25	3.41	4.24	22 - 32	20 - 30
30.0	35.0	32.5	2.13	5.4	-0.2	-5	Very stiff, Silty clay to clay *			25	2.66	4.26	22 - 32	20 - 30
30.5	30.0	27.8	1.49	4.7	-0.2	-5	Very stiff, Silty clay to clay *			20	2.82	2.98	16 - 22	15 - 20
31.0	23.0	21.2	1.11	4.3	-0.2	-5	Very stiff, Silty clay to clay *			20	2.11	2.22	11 - 16	10 - 15
31.5	18.6	17.1	0.93	4.6	-0.0	-5	Very stiff, Silty clay to clay *			15	2.23	1.87	07 - 11	06 - 10
32.0	18.2	16.7	0.97	5.0	0.5	-5	Very stiff, Silty clay to clay *			15	2.17	1.94	07 - 11	06 - 10
32.5	21.1	19.3	1.16	4.4	0.6	-5	Stiff, Silty clay to clay *			20	1.92	2.33	07 - 11	06 - 10
33.0	28.9	26.4	1.28	4.7	0.7	-5	Very stiff, Silty clay to clay *			20	2.69	2.56	16 - 22	15 - 20
33.5	15.9	14.5	0.95	4.4	0.7	-5	Stiff, Silty clay to clay *			15	1.85	1.91	07 - 11	06 - 10
34.0	11.5	10.4	0.73	4.8	1.1	-5	Stiff, Silty clay to clay *			15	1.26	1.46	04 - 07	04 - 06
34.5	11.5	10.5	0.68	5.1	2.0	-5	Stiff, Silty clay to clay *			15	1.26	1.32	04 - 07	04 - 06
35.0	13.1	11.9	0.69	5.4	4.6	-5	Stiff, Silty clay to clay *			15	1.47	1.39	07 - 11	06 - 10
35.5	11.6	10.5	0.60	4.8	4.9	-5	Stiff, Silty clay to clay *			15	1.26	1.20	04 - 07	04 - 06
36.0	11.2	10.1	0.59	4.9	5.2	-5	Stiff, Silty clay to clay *			15	1.21	1.18	04 - 07	04 - 06
36.5	12.1	10.9	0.60	5.0	6.4	-5	Stiff, Silty clay to clay *			15	1.33	1.19	04 - 07	04 - 06
37.0	12.9	11.6	0.67	5.0	6.6	-5	Stiff, Silty clay to clay *			15	1.42	1.34	04 - 07	04 - 06
37.5	14.4	12.9	0.70	4.5	7.4	-5	Stiff, Silty clay to clay *			15	1.62	1.39	04 - 07	04 - 06
38.0	16.8	15.0	0.69	4.4	4.9	-5	Stiff, Silty clay to clay *			15	1.93	1.38	07 - 11	06 - 10
38.5	14.2	12.7	0.53	3.5	7.2	-5	Stiff, Silty clay to clay *			15	1.58	1.06	04 - 07	04 - 06
39.0	14.3	12.7	0.56	3.8	8.6	-5	Stiff, Silty clay to clay *			15	1.59	1.13	04 - 07	04 - 06
39.5	16.1	14.3	0.64	3.3	8.6	-5	Stiff, Sandy clay to silty clay *			15	1.84	1.27	05 - 07	04 - 06
40.0	24.6	21.8	1.10	3.6	10.0	-5	Very stiff, Sandy clay to silty clay *			20	2.22	2.20	07 - 11	06 - 10
40.5	36.3	32.2	1.77	4.4	10.2	-5	Very stiff, Silty clay to clay *			25	2.71	3.55	17 - 23	15 - 20
41.0	47.4	41.8	2.09	4.9	11.4	-5	Very stiff, Silty clay to clay *			25	3.59	4.18	23 - 34	20 - 30
41.5	31.2	27.5	1.67	4.1	3.4	-5	Very stiff, Silty clay to clay *			20	2.67	3.34	11 - 17	10 - 15
42.0	41.9	36.9	1.78	4.2	3.8	-5	Very stiff, Silty clay to clay *			25	3.15	3.56	23 - 34	20 - 30
42.5	41.6	36.5	1.69	3.9	3.7	-5	Very stiff, Sandy clay to silty clay *			25	3.12	3.37	17 - 23	15 - 20
43.0	41.5	36.3	1.75	4.3	2.6	-5	Very stiff, Silty clay to clay *			25	3.11	3.51	23 - 34	20 - 30
43.5	28.5	24.9	1.38	4.0	2.4	-5	Very stiff, Silty clay to clay *			20	2.59	2.76	11 - 17	10 - 15
44.0	37.3	32.5	2.27	2.6	2.6	-5	Very stiff, Sandy silt to sandy clay			20	3.47	4.54	11 - 17	10 - 15
44.5	89.4	77.8	3.22	3.8	0.8	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	5.78	6.45	46 - 69	40 - 60
45.0	45.9	39.8	1.65	2.9	1.4	-5	Very stiff, Sandy silt to sandy clay			25	3.45	3.30	17 - 23	15 - 20
45.5	30.4	26.3	1.41	4.1	2.0	-5	Very stiff, Silty clay to clay *			20	2.76	2.83	12 - 17	10 - 15
46.0	21.7	18.7	0.97	4.2	2.1	-5	Very stiff, Silty clay to clay *			15	2.52	1.94	07 - 12	06 - 10
46.5	25.1	21.6	0.96	4.1	2.2	-5	Very stiff, Silty clay to clay *			20	2.23	1.93	12 - 17	10 - 15
47.0	19.1	16.5	0.71	3.3	2.4	-5	Very stiff, Sandy clay to silty clay *			15	2.17	1.42	05 - 07	04 - 06
47.5	28.5	24.5	0.90	4.1	3.0	-5	Very stiff, Silty clay to clay *			20	2.56	1.80	12 - 17	10 - 15
48.0	18.4	15.8	0.74	3.5	3.2	-5	Very stiff, Silty clay to clay *			15	2.07	1.48	05 - 07	04 - 06
48.5	19.2	16.4	0.92	3.5	3.4	-5	Very stiff, Silty clay to clay *			15	2.17	1.85	05 - 07	04 - 06
49.0	33.1	28.3	1.69	4.1	3.6	-5	Very stiff, Silty clay to clay *			20	3.01	3.38	18 - 23	15 - 20
49.5	51.7	44.1	2.62	5.3	4.5	-5	Very stiff, Sandy clay to silty clay **			25	3.90	5.23	35 - 47	30 - 40
50.0	34.5	29.4	2.07	4.3	4.1	-5	Very stiff, Silty clay to clay *			20	3.15	4.14	18 - 23	15 - 20

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50.5	28.9	24.6	1.48	4.9	4.4	-5	Very stiff, Silty clay to clay *			20	2.58	2.97	18 - 24	15 - 20
51.0	22.7	19.3	0.95	3.2	4.6	-5	Very stiff, Sandy clay to silty clay *			15	2.62	1.91	07 - 12	06 - 10
51.5	16.8	14.3	0.93	3.6	5.3	-5	Stiff, Silty clay to clay *			15	1.63	1.86	05 - 07	04 - 06
52.0	47.1	39.8	1.69	4.4	4.5	-5	Very stiff, Silty clay to clay *			25	3.52	3.38	24 - 35	20 - 30
52.5	43.2	36.4	3.45	2.6	3.8	-5	Very stiff, Sandy silt to sandy clay			25	3.20	6.91	12 - 18	10 - 15
53.0	132.0	111.2	5.77	4.5	-0.6	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	7.81	11.55	+ 119	+ 100
53.5	24.8	20.9	2.67	3.9	-0.6	-5	Very stiff, Silty clay to clay *			20	2.16	5.34	07 - 12	06 - 10
54.0	112.7	94.6	3.49	3.0	-0.6	-5	Hard, Sandy silt to sandy clay			30	7.30	6.88	48 - 71	40 - 60
54.5	107.4	90.0	6.83	5.7	-0.5	-5	Hard, Sandy clay to silty clay **			30	6.94	13.66	+ 119	+ 100
55.0	99.5	83.2	7.25	6.5	-0.5	-5	Hard, Sandy clay to silty clay **			30	6.41	14.50	+ 120	+ 100
55.5	148.4	124.0	7.85	4.9	-0.5	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	8.80	15.70	+ 120	+ 100
56.0	127.9	106.6	9.79	6.1	-0.4	-5	Hard, Sandy clay to silty clay **			33	7.55	19.58	+ 120	+ 100
56.5	69.5	57.8	4.99	5.3	-0.3	-5	Hard, Sandy clay to silty clay **			30	4.41	9.97	48 - 72	40 - 60
57.0	70.4	58.5	4.60	5.5	-0.3	-5	Hard, Sandy clay to silty clay **			30	4.47	9.20	48 - 72	40 - 60
57.5	87.5	72.6	7.08	5.5	-0.3	-5	Hard, Sandy clay to silty clay **			30	5.61	14.15	72 - 119	60 - 99
58.0	187.6	155.3	9.92	6.1	-0.3	-5	Hard, Hardpan to weak rock			33	11.16	19.84	+ 121	+ 100
58.5	145.8	120.5	11.57	7.2	-0.3	-5	Hard, Hardpan to weak rock			33	8.62	23.15	+ 121	+ 100
59.0	59.0	48.7	3.78	3.9	-0.3	-5	Hard, Sandy clay to silty clay *			25	4.43	7.55	24 - 36	20 - 30
59.5	101.6	83.6	7.21	4.0	-0.2	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	6.53	14.42	49 - 73	40 - 60
60.0	200.6	164.9	11.03	5.5	-0.2	-5	Hard, Gravelly sandy clay to hardpan **			33	11.94	22.06	+ 122	+ 100
60.5	208.7	171.3	11.37	5.5	-0.2	-5	Hard, Gravelly sandy clay to hardpan **			33	12.43	22.74	+ 122	+ 100
61.0	201.5	165.1	11.92	5.4	-0.2	-5	Hard, Gravelly sandy clay to hardpan **			33	11.99	23.83	+ 122	+ 100
61.5	286.3	217.9	9.63	3.8	-0.1	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	15.92	19.25	+ 122	+ 100
62.0	198.5	162.1	8.64	3.5	-0.1	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	11.80	17.68	+ 122	+ 100
62.5	133.7	109.1	5.53	3.8	-0.0	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	8.67	11.05	74 - 121	60 - 99
63.0	88.8	72.3	5.95	4.9	0.0	-5	Hard, Sandy clay to silty clay **			30	5.67	11.91	74 - 122	60 - 99
63.5	50.2	40.8	2.22	3.7	0.0	-5	Very stiff, Sandy clay to silty clay *			25	3.71	4.44	25 - 37	20 - 30
64.0	56.9	46.2	2.35	4.2	-0.0	-5	Hard, Sandy clay to silty clay *			25	4.24	4.70	25 - 37	20 - 30
64.5	49.1	39.8	2.01	3.6	-0.0	-5	Very stiff, Sandy clay to silty clay *			25	3.62	4.03	19 - 25	15 - 20
65.0	47.4	38.3	2.13	3.8	-0.0	-5	Very stiff, Sandy clay to silty clay *			25	3.48	4.25	19 - 25	15 - 20
65.5	71.2	57.5	2.67	2.9	-0.0	-5	Hard, Sandy silt to sandy clay			25	5.38	5.35	25 - 37	20 - 30
66.0	130.7	105.4	5.10	4.9	-0.2	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	7.68	10.20	+ 124	+ 100
66.5	45.2	36.4	2.16	2.7	-0.2	-5	Very stiff, Sandy silt to sandy clay			25	3.30	4.31	12 - 19	10 - 15
67.0	80.4	64.6	3.47	4.7	-0.2	-5	Hard, Sandy clay to silty clay **			30	5.09	6.93	50 - 75	40 - 60
67.5	60.4	48.4	2.65	3.8	-0.2	-5	Hard, Sandy clay to silty clay *			25	4.51	5.29	25 - 37	20 - 30
68.0	60.2	48.2	2.21	3.7	-0.1	-5	Hard, Sandy clay to silty clay *			25	4.49	4.42	25 - 37	20 - 30
68.5	38.3	30.7	1.66	3.4	-0.1	-5	Very stiff, Sandy clay to silty clay *			20	3.42	3.32	13 - 19	10 - 15
69.0	49.4	39.4	2.79	5.7	-0.1	-5	Very stiff, Sandy clay to silty clay **			25	3.62	5.57	38 - 50	30 - 40
69.5	43.1	34.4	1.63	3.6	-0.0	-5	Very stiff, Sandy clay to silty clay *			25	3.11	3.25	19 - 25	15 - 20
70.0	45.8	36.5	2.20	3.5	-0.0	-5	Very stiff, Sandy clay to silty clay *			25	3.33	4.40	19 - 25	15 - 20
70.5	76.8	61.1	4.47	5.5	-0.0	-5	Hard, Sandy clay to silty clay **			30	4.84	8.94	50 - 75	40 - 60
71.0	77.3	61.4	4.39	5.5	-0.0	-5	Hard, Sandy clay to silty clay **			30	4.87	8.77	50 - 76	40 - 60
71.5	67.5	53.5	3.94	5.0	0.0	-5	Hard, Sandy clay to silty clay **			25	5.05	7.87	50 - 76	40 - 60
72.0	83.9	66.4	5.12	3.0	0.0	-5	Hard, Sandy silt to sandy clay			25	6.37	10.24	38 - 51	30 - 40
72.5	225.9	178.4	7.61	3.0	0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	+100				+ 127	+ 100
73.0	307.9	242.9	6.93	1.9	-0.3	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	80-100				+ 127	+ 100
73.5	404.0	318.2	9.11	2.2	-0.3	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 127	+ 100
74.0	408.2	321.0	7.37	1.8	-0.0	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	80-100				+ 127	+ 100
74.5	392.5	308.2	6.54	1.6	0.1	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	80-100				+ 127	+ 100
75.0	291.5	228.6	3.74	1.0	0.3	-5	Dense, Sand to silty sand	42-46	60-80				51 - 77	40 - 60

\* Indicates lightly overconsolidated soil

\*\* Indicates heavily overconsolidated or cemented soil

Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT. Both undrained and drained parameters can be estimated for these soils.

Structure rate of loading should be considered in choosing which strength parameters to use for design. Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.

# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-24-2002 TIME:14:53:33.48

SOUNDING NUMBER:CPT-01

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
75.5	90.4	70.8	4.72	2.7	0.3	-5	Hard, Sandy silt to sandy clay			25	6.87	9.43	26 - 38	20 - 30
76.0	72.2	56.4	2.59	3.5	0.4	-5	Hard, Sandy clay to silty clay *			25	5.41	5.18	26 - 38	20 - 30
76.5	73.7	57.5	2.82	3.3	0.4	-5	Hard, Sandy silt to sandy clay			25	5.53	5.65	26 - 38	20 - 30
77.0	135.1	105.3	5.38	2.6	0.4	-5	Very dense, Silty sand to sandy silt	36-37	80-100				51 - 77	40 - 60
77.5	255.9	199.2	7.30	2.8	0.3	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 128	+ 100

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\*\* Indicates heavily overconsolidated or cemented soil

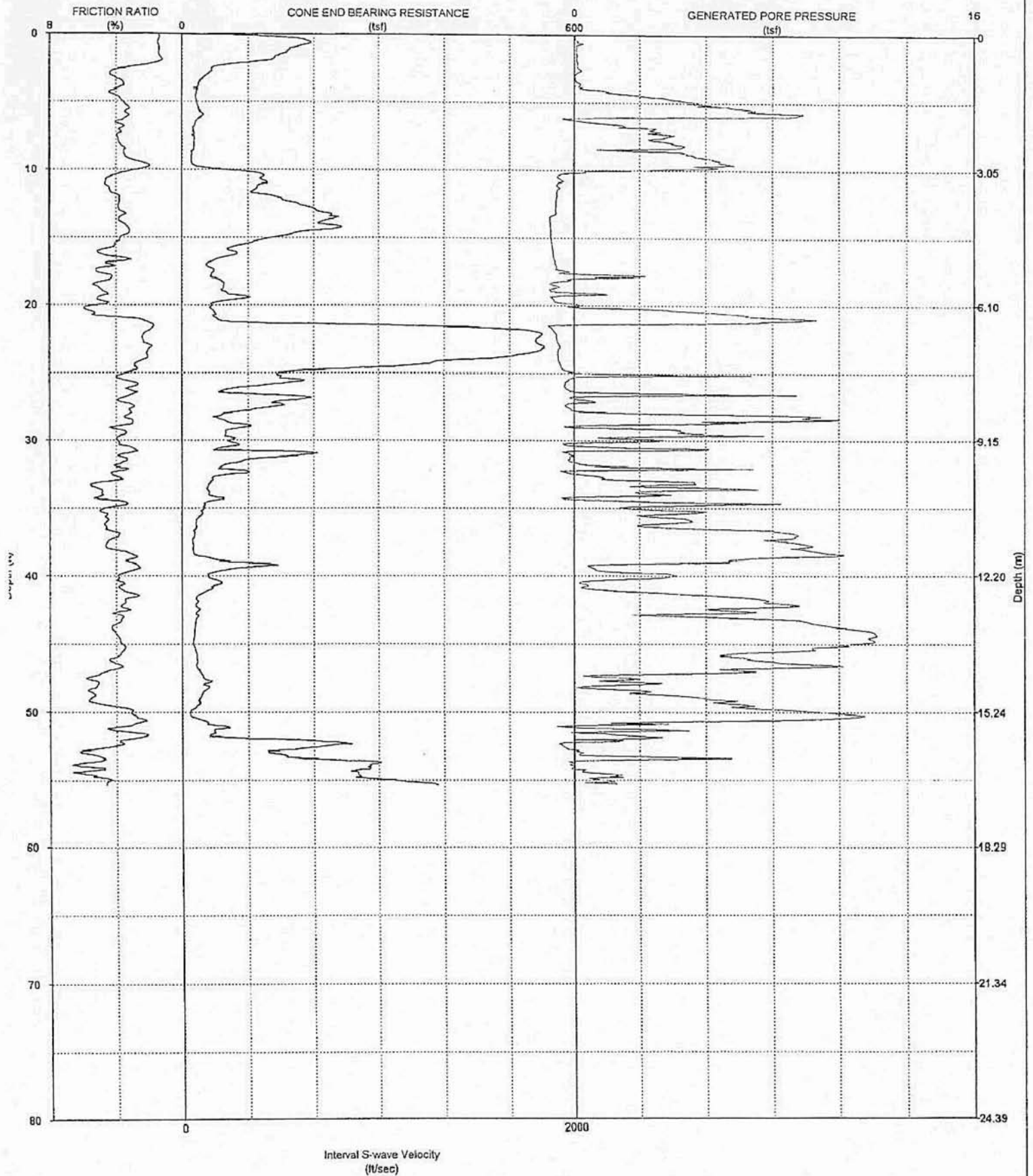
Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT.  
Both undrained and drained parameters can be estimated for these soils.

Structure rate of loading should be considered in choosing which strength parameters to use for design.

Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.



# CPTU-S LOG



REV3

# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-24-2002 TIME:12:30:47.85

SOUNDING NUMBER:CPT-02

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
1.0	166.1	267.7	2.87	1.4	0.1	-5	Very dense, Sand to silty sand	42-46	80-100				37 - 61	60 - 99
1.5	149.5	227.8	2.30	1.4	0.1	-5	Dense, Sand to silty sand	42-46	60-80				39 - 65	60 - 99
2.0	128.6	187.9	1.60	1.2	0.1	-5	Dense, Sand to silty sand	42-46	60-80				27 - 41	40 - 60
2.5	47.2	66.7	2.58	3.1	0.1	-5	Very stiff, Sandy silt to sandy clay			25	3.77	5.15	21 - 28	30 - 40
3.0	39.0	53.6	1.90	4.3	0.0	-5	Very stiff, Sandy clay to silty clay *			25	3.11	3.80	22 - 29	30 - 40
3.5	27.3	36.5	1.13	3.6	0.1	-5	Very stiff, Sandy clay to silty clay *			25	2.17	2.27	11 - 15	15 - 20
4.0	17.8	23.3	0.94	3.8	0.4	-5	Stiff, Silty clay to clay *			20	1.76	1.88	08 - 11	10 - 15
4.5	20.8	26.7	0.69	4.1	2.9	-5	Very stiff, Silty clay to clay *			20	2.05	1.77	08 - 12	10 - 15
5.0	22.6	28.5	0.85	3.6	4.6	-5	Very stiff, Sandy clay to silty clay *			20	2.23	1.70	08 - 12	10 - 15
5.5	25.2	31.3	0.89	3.2	7.2	-5	Very stiff, Sandy clay to silty clay *			20	2.49	1.78	08 - 12	10 - 15
6.0	30.9	37.7	0.86	3.2	8.6	-5	Very stiff, Sandy clay to silty clay *			25	2.44	1.72	12 - 16	15 - 20
6.5	20.8	25.0	1.01	4.0	1.0	-5	Very stiff, Silty clay to clay *			20	2.04	2.01	08 - 12	10 - 15
7.0	17.2	20.4	0.70	3.8	3.1	-5	Stiff, Silty clay to clay *			20	1.67	1.40	05 - 08	06 - 10
7.5	17.6	20.7	0.73	3.9	3.7	-5	Stiff, Silty clay to clay *			20	1.72	1.46	05 - 09	06 - 10
8.0	18.1	21.0	0.72	3.8	3.9	-5	Stiff, Silty clay to clay *			20	1.76	1.44	05 - 09	06 - 10
8.5	17.9	20.6	0.63	3.4	1.3	-5	Stiff, Sandy clay to silty clay *			20	1.74	1.26	05 - 09	06 - 10
9.0	14.6	16.5	0.53	3.5	5.0	-5	Stiff, Silty clay to clay *			15	1.87	1.07	04 - 05	04 - 06
9.5	15.3	17.2	0.64	2.3	6.2	-5	Stiff, Sandy silt to sandy clay			15	1.97	1.29	04 - 05	04 - 06
10.0	60.5	67.2	2.90	2.7	3.0	-5	Hard, Sandy silt to sandy clay			25	4.79	5.60	18 - 27	20 - 30
10.5	123.5	135.9	5.21	4.2	-0.7	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	7.45	10.42	+ 91	+ 100
11.0	125.1	136.3	5.81	4.7	-0.7	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	7.54	11.62	+ 92	+ 100
11.5	108.4	117.2	5.24	4.3	-0.7	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	6.53	10.48	+ 93	+ 100
12.0	147.4	158.0	6.08	3.8	-0.8	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	8.89	12.16	+ 93	+ 100
12.5	177.9	189.0	7.38	3.8	-0.6	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	10.74	14.76	+ 94	+ 100
13.0	206.6	217.8	8.44	3.8	-0.8	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	12.47	16.89	+ 95	+ 100
13.5	232.5	243.1	8.40	3.8	-1.0	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	14.04	16.81	+ 96	+ 100
14.0	220.3	228.7	7.70	3.5	-1.0	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	13.30	15.40	+ 96	+ 100
14.5	189.2	194.9	6.95	3.1	-1.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	+100				+ 97	+ 100
15.0	137.5	140.7	6.12	3.7	-1.0	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	8.28	12.24	+ 98	+ 100
15.5	93.4	94.8	4.59	4.1	-0.9	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	6.16	9.18	59 - 97	60 - 99
16.0	75.4	76.0	3.97	5.1	-0.9	-5	Hard, Sandy clay to silty clay **			30	4.96	7.94	59 - 98	60 - 99
16.5	60.6	60.8	2.81	3.7	-0.9	-5	Hard, Sandy clay to silty clay *			25	4.77	5.61	30 - 40	30 - 40
17.0	36.8	36.6	2.06	4.4	-0.8	-5	Very stiff, Silty clay to clay *			25	2.86	4.12	20 - 30	20 - 30
17.5	48.6	48.3	2.32	5.2	-0.3	-5	Very stiff, Sandy clay to silty clay **			25	3.81	4.64	40 - 60	40 - 60
18.0	45.5	45.1	2.50	4.2	0.4	-5	Very stiff, Sandy clay to silty clay *			25	3.56	5.00	20 - 30	20 - 30
18.5	63.1	62.2	3.37	5.3	-0.9	-5	Hard, Sandy clay to silty clay **			30	4.13	6.75	41 - 61	40 - 60
19.0	63.9	62.9	3.90	4.7	-0.7	-5	Hard, Sandy clay to silty clay **			30	4.19	7.80	41 - 61	40 - 60
19.5	96.5	94.6	4.13	5.1	-0.9	-5	Hard, Sandy clay to silty clay **			30	6.35	8.25	+ 102	+ 100
20.0	43.8	42.8	3.18	5.1	0.4	-5	Very stiff, Silty clay to clay *			25	3.41	6.36	31 - 41	30 - 40
20.5	49.1	47.6	2.70	5.4	5.0	-5	Very stiff, Sandy clay to silty clay **			25	3.83	5.40	41 - 62	40 - 60
21.0	52.7	51.2	3.21	3.1	9.4	-5	Hard, Sandy silt to sandy clay			25	4.12	6.42	21 - 31	20 - 30
21.5	311.4	301.9	7.84	1.7	-0.7	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	80-100				+ 103	+ 100
22.0	545.7	527.6	11.89	2.2	-0.8	-5	Very dense, Sandy gravel to silty gravelly sand	40-42	+100				+ 103	+ 100
22.5	541.4	522.0	13.10	2.4	-0.7	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 104	+ 100
23.0	552.4	531.1	9.66	1.9	-0.6	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	+100				+ 104	+ 100
23.5	533.0	511.1	11.64	2.1	-0.7	-5	Very dense, Sandy gravel to silty gravelly sand	40-42	+100				+ 104	+ 100
24.0	446.1	426.6	10.66	2.2	-0.7	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 105	+ 100
24.5	343.3	327.4	11.05	2.9	-0.6	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 105	+ 100
25.0	148.8	141.6	7.84	3.3	0.5	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	8.93	15.67	+ 105	+ 100

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# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-24-2002 TIME:12:30:47.85

SOUNDING NUMBER:CPT-02

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1)
25.5	181.3	172.0	5.69	3.6	-0.2	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	10.89	11.39	* 105	+ 100
26.0	101.6	96.1	4.45	3.0	-0.4	-5	Hard, Sandy silt to sandy clay			30	8.87	8.90	42 - 63	40 - 60
26.5	81.7	77.1	4.63	2.9	4.8	-5	Hard, Sandy silt to sandy clay			30	5.34	9.26	32 - 42	30 - 40
27.0	166.7	157.0	6.46	3.9	0.6	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	10.01	12.92	+ 106	+ 100
27.5	135.4	127.1	4.15	2.9	-0.3	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	80-100				64 - 105	60 - 99
28.0	62.1	58.2	3.03	3.1	3.5	-5	Hard, Sandy silt to sandy clay			25	4.84	6.06	21 - 32	20 - 30
28.5	63.3	59.2	2.43	3.0	8.4	-5	Hard, Sandy silt to sandy clay			25	4.93	4.85	21 - 32	20 - 30
29.0	98.8	92.1	3.68	4.2	-0.3	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	6.47	7.33	64 - 106	60 - 99
29.5	66.5	61.8	2.52	3.4	5.1	-5	Hard, Sandy silt to sandy clay			25	5.18	5.04	32 - 43	30 - 40
30.0	71.3	66.1	3.05	3.9	3.6	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	4.63	6.10	43 - 65	40 - 60
30.5	69.2	64.0	3.18	3.1	1.0	-5	Hard, Sandy silt to sandy clay			25	5.39	6.36	32 - 43	30 - 40
31.0	202.0	186.4	5.10	3.4	-0.2	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	12.13	10.19	+ 108	+ 100
31.5	93.3	85.9	4.96	3.4	-0.3	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	6.10	9.92	43 - 65	40 - 60
32.0	57.3	52.6	2.79	3.7	4.2	-5	Hard, Sandy clay to silty clay *			25	4.43	5.58	22 - 33	20 - 30
32.5	69.1	63.3	3.43	4.2	0.2	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	4.47	6.87	44 - 65	40 - 60
33.0	43.7	40.0	2.35	4.7	4.2	-5	Very stiff, Silty clay to clay *			25	3.34	4.69	22 - 33	20 - 30
33.5	37.3	34.1	2.04	5.1	6.5	-5	Very stiff, Silty clay to clay *			25	2.83	4.09	22 - 33	20 - 30
34.0	40.1	36.5	2.40	4.8	4.0	-5	Very stiff, Silty clay to clay *			25	3.05	4.80	22 - 33	20 - 30
34.5	41.0	37.2	1.74	3.5	2.7	-5	Very stiff, Sandy clay to silty clay *			25	3.11	3.47	17 - 22	15 - 20
35.0	33.1	30.0	1.59	4.6	2.0	-5	Very stiff, Silty clay to clay *			25	2.48	3.18	17 - 22	15 - 20
35.5	29.0	26.2	1.36	4.5	2.9	-5	Very stiff, Silty clay to clay *			20	2.68	2.72	17 - 22	15 - 20
36.0	21.2	19.2	1.12	4.6	4.8	-5	Stiff, Silty clay to clay *			20	1.91	2.24	11 - 17	10 - 15
36.5	21.1	19.0	1.00	4.6	4.3	-5	Stiff, Silty clay to clay *			20	1.89	2.01	07 - 11	06 - 10
37.0	18.7	16.8	0.74	3.8	9.0	-5	Very stiff, Silty clay to clay *			15	2.19	1.47	07 - 11	06 - 10
37.5	16.4	14.7	0.78	4.5	8.6	-5	Stiff, Silty clay to clay *			15	1.89	1.56	07 - 11	06 - 10
38.0	16.7	15.0	0.80	4.5	8.7	-5	Stiff, Silty clay to clay *			15	1.93	1.60	07 - 11	06 - 10
38.5	20.8	18.5	1.32	2.9	10.8	-5	Very stiff, Sandy clay to silty clay *			15	2.46	2.64	04 - 07	04 - 06
39.0	89.7	79.8	3.30	3.0	5.6	-5	Hard, Sandy silt to sandy clay			30	5.82	6.60	45 - 67	40 - 60
39.5	69.7	61.9	3.11	2.8	0.9	-5	Hard, Sandy silt to sandy clay			25	5.38	6.22	23 - 34	20 - 30
40.0	38.8	34.4	1.92	3.8	4.2	-5	Very stiff, Sandy clay to silty clay *			25	2.91	3.84	17 - 23	15 - 20
40.5	60.0	53.0	1.75	3.5	0.2	-5	Hard, Sandy clay to silty clay *			25	4.60	3.51	23 - 34	20 - 30
41.0	42.5	37.5	1.80	3.6	0.9	-5	Very stiff, Sandy clay to silty clay *			25	3.20	3.59	17 - 23	15 - 20
41.5	22.5	19.8	0.79	2.7	6.1	-5	Very stiff, Sandy clay to silty clay *			15	2.66	1.58	05 - 07	04 - 06
42.0	22.6	19.9	0.78	3.4	7.7	-5	Very stiff, Sandy clay to silty clay *			20	2.01	1.56	07 - 11	06 - 10
42.5	25.9	22.7	0.70	3.2	5.7	-5	Very stiff, Sandy clay to silty clay *			20	2.33	1.40	07 - 11	06 - 10
43.0	24.0	21.0	0.81	3.5	4.8	-5	Very stiff, Sandy clay to silty clay *			20	2.14	1.61	07 - 11	06 - 10
43.5	19.9	17.4	0.82	3.9	9.6	-5	Very stiff, Silty clay to clay *			15	2.31	1.64	07 - 11	06 - 10
44.0	18.5	16.2	0.79	4.1	11.6	-5	Very stiff, Silty clay to clay *			15	2.12	1.58	07 - 11	06 - 10
44.5	17.8	15.5	0.70	3.8	12.0	-5	Very stiff, Silty clay to clay *			15	2.02	1.39	07 - 11	06 - 10
45.0	16.9	14.7	0.68	3.6	11.0	-5	Stiff, Silty clay to clay *			15	1.89	1.35	05 - 07	04 - 06
45.5	20.5	17.8	0.79	3.6	8.8	-5	Very stiff, Silty clay to clay *			15	2.37	1.59	07 - 12	06 - 10
46.0	21.7	18.8	0.99	4.3	7.1	-5	Very stiff, Silty clay to clay *			15	2.53	1.98	07 - 12	06 - 10
46.5	21.7	18.7	0.87	3.6	10.4	-5	Very stiff, Silty clay to clay *			15	2.52	1.74	07 - 12	06 - 10
47.0	27.4	23.6	1.47	4.8	6.8	-5	Very stiff, Silty clay to clay *			20	2.45	2.94	12 - 17	10 - 15
47.5	34.0	29.2	2.16	5.7	2.5	-5	Very stiff, Silty clay to clay *			25	2.49	4.33	23 - 35	20 - 30
48.0	37.2	31.9	1.97	5.2	1.4	-5	Very stiff, Silty clay to clay *			25	2.75	3.94	23 - 35	20 - 30
48.5	31.5	27.0	2.01	5.5	2.9	-5	Very stiff, Silty clay to clay *			20	2.86	4.02	18 - 23	15 - 20
49.0	26.0	22.2	1.58	5.6	5.4	-5	Very stiff, Silty clay to clay *			20	2.30	3.15	18 - 23	15 - 20
49.5	22.5	19.2	1.10	4.3	7.2	-5	Stiff, Silty clay to clay *			20	1.95	2.19	07 - 12	06 - 10
50.0	11.7	10.0	0.53	3.1	10.1	-5	Stiff, Silty clay to clay			15	1.16	1.06	02 - 05	02 - 04

\* Indicates lightly overconsolidated soil

\*\* Indicates heavily overconsolidated or cemented soil

Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT. Both undrained and drained parameters can be estimated for these soils.

Structure rate of loading should be considered in choosing which strength parameters to use for design. Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.

**STRATIGRAPHICS Evaluated Properties Using Global Database**

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-24-2002 TIME:12:30:47.85

SOUNDING NUMBER:CPT-02

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
50.5	25.0	21.3	0.89	2.4	10.0	-5	Very stiff, Sandy silt to sandy clay			15	2.93	1.79	05 - 07	04 - 06
51.0	59.4	50.4	1.81	3.3	-0.2	-5	Hard, Sandy clay to silty clay *			25	4.51	3.61	24 - 35	20 - 30
51.5	50.2	42.5	1.93	3.0	0.4	-5	Very stiff, Sandy silt to sandy clay			25	3.77	3.86	18 - 24	15 - 20
52.0	158.0	133.7	7.53	3.4	-0.1	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	9.39	15.06	+ 118	+ 100
52.5	218.6	184.5	8.82	4.1	-0.5	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	13.06	17.64	+ 118	+ 100
53.0	136.9	115.3	10.51	5.9	0.3	-5	Hard, Sandy clay to silty clay **			33	8.10	21.02	+ 119	+ 100
53.5	240.4	202.2	13.58	4.9	1.3	-5	Hard, Gravelly sandy clay to hardpan **			33	14.37	27.16	+ 119	+ 100
54.0	283.3	237.8	14.69	5.4	-0.1	-5	Hard, Gravelly sandy clay to hardpan **			33	16.97	29.38	+ 119	+ 100
54.5	268.5	225.0	18.54	6.2	0.9	-5	Hard, Hardpan to weak rock			33	16.08	37.08	+ 119	+ 100
55.0	319.7	267.4	15.81	4.3	1.2	-5	Hard, Gravelly clayey sand to gravelly sandy clay			33	19.17	31.63	+ 120	+ 100

\* Indicates lightly overconsolidated soil

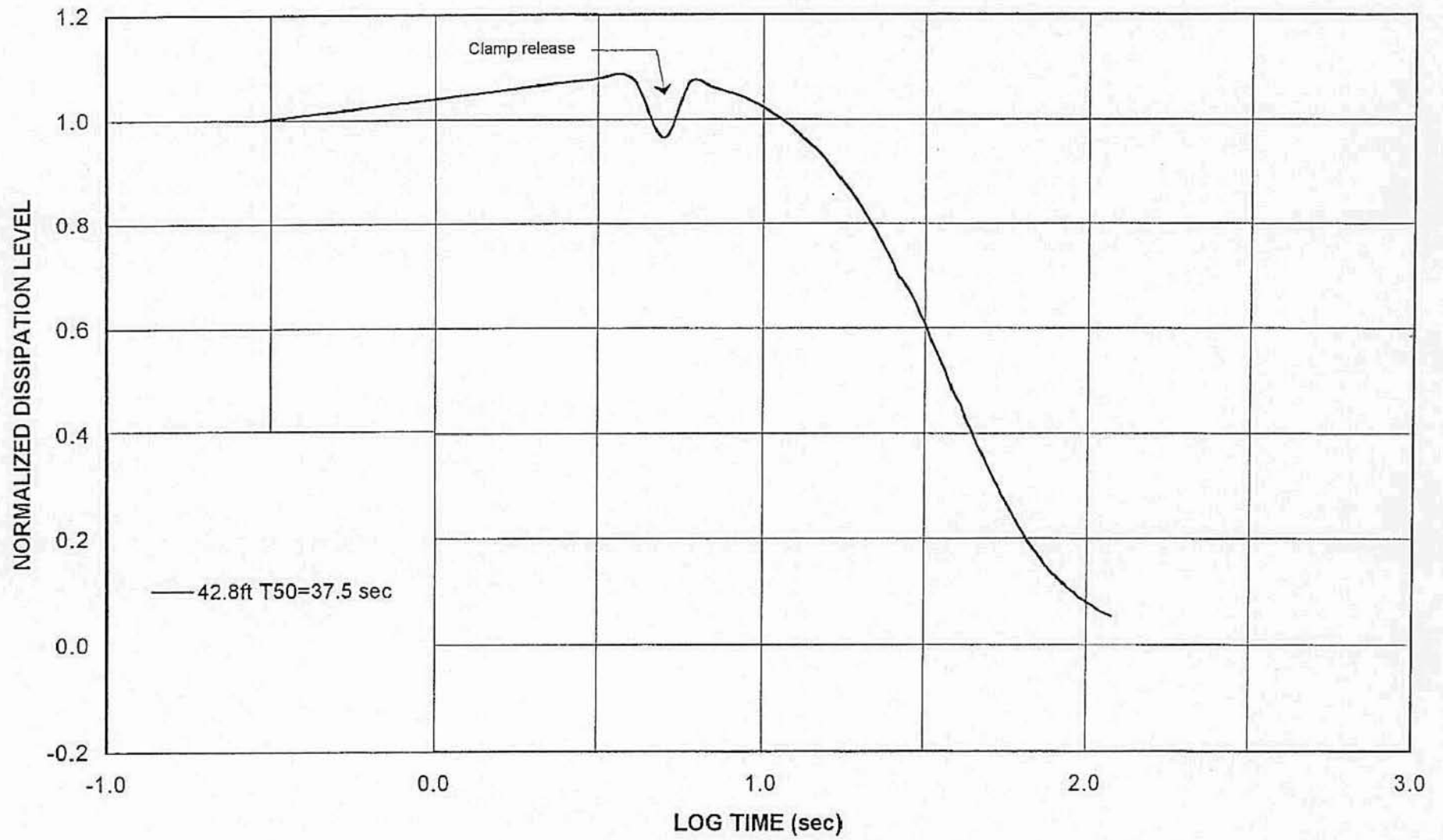
\*\* Indicates heavily overconsolidated or cemented soil

Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT.  
Both undrained and drained parameters can be estimated for these soils.

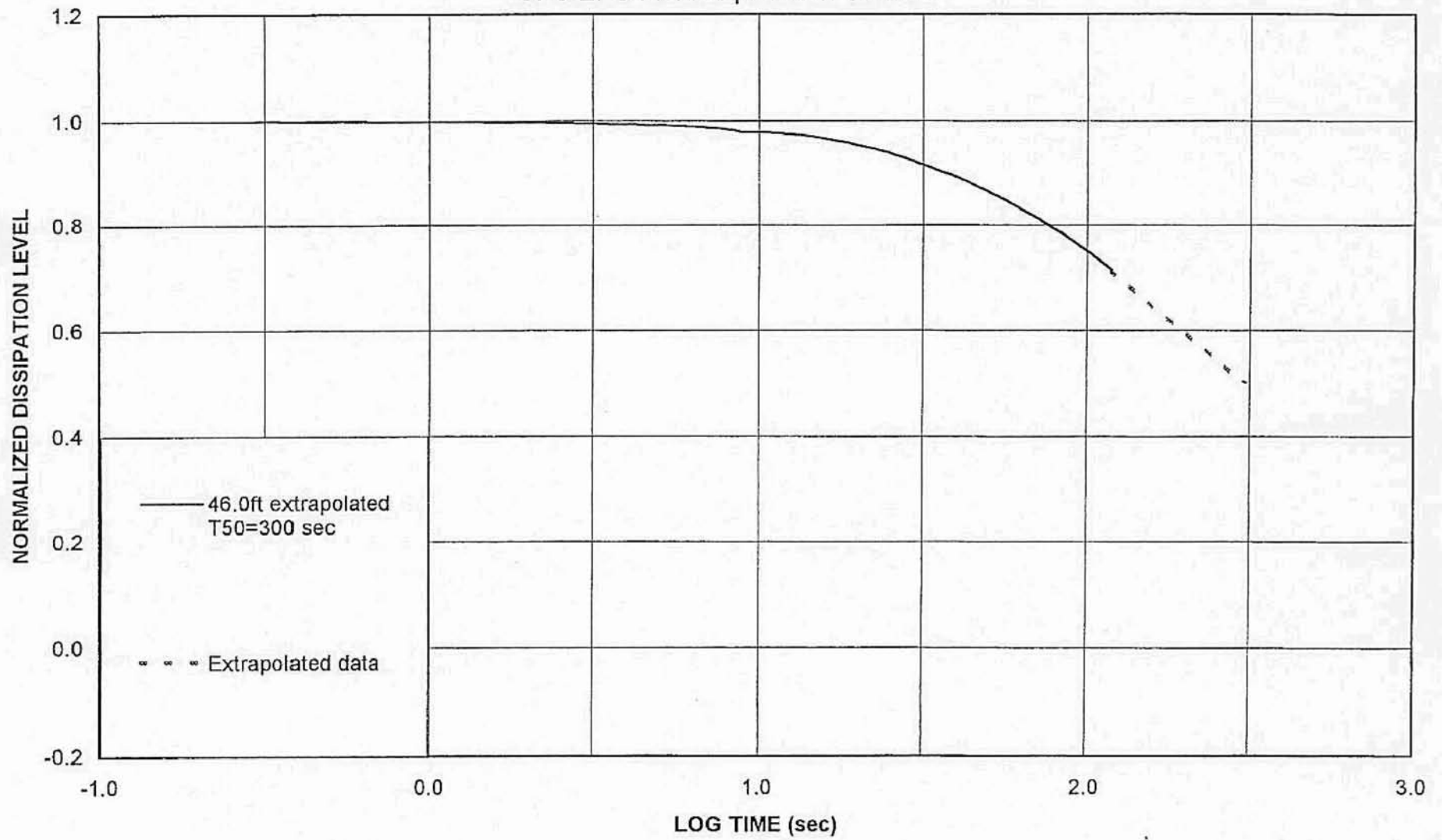
Structure rate of loading should be considered in choosing which strength parameters to use for design.  
Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.



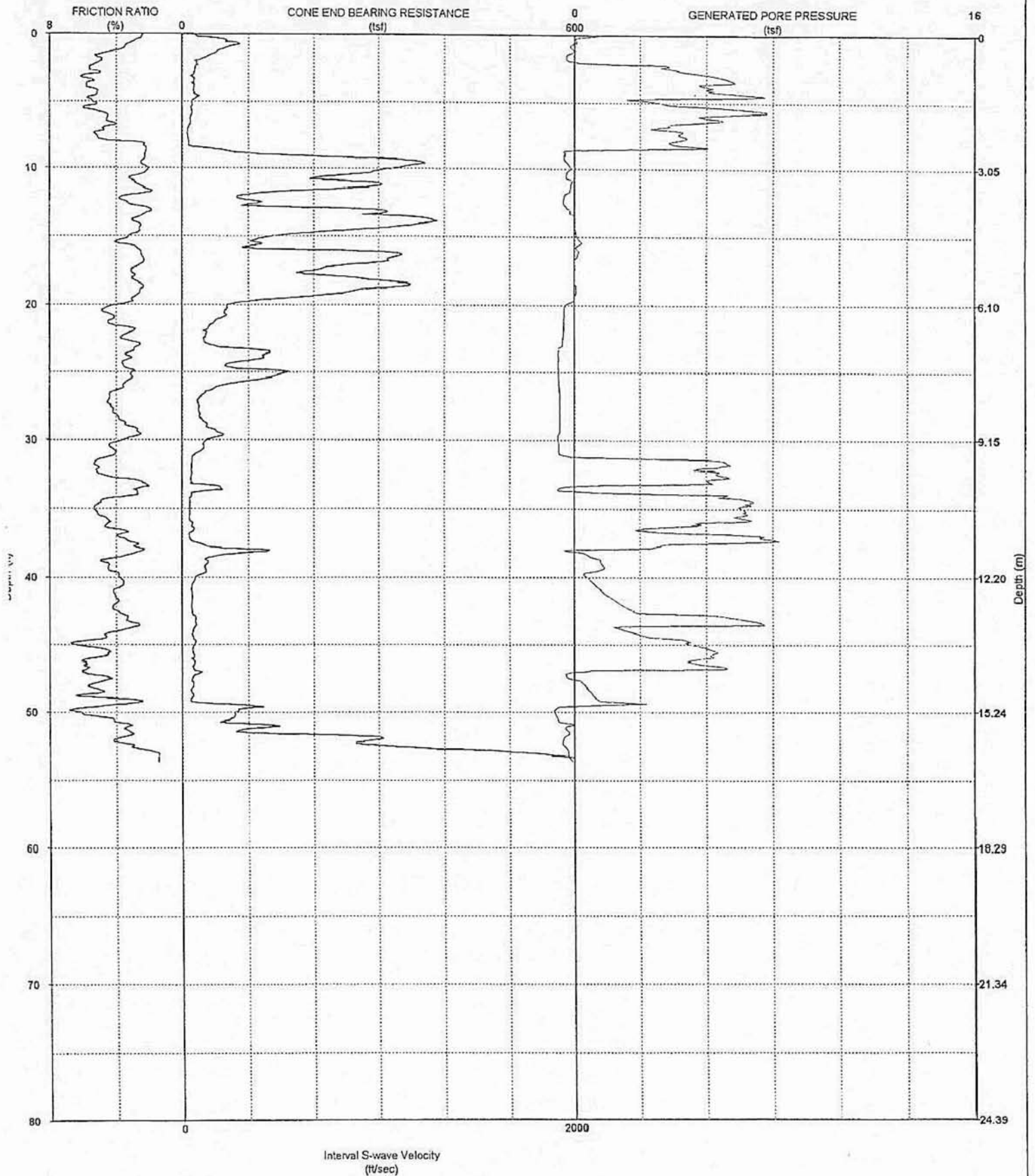
**STRATIGRAPHICS**  
**PORE WATER PRESSURE DISSIPATION TEST**  
**CPS-EPS Field Exploration CPT-02**



**STRATIGRAPHICS**  
**PORE WATER PRESSURE DISSIPATION TEST**  
**CPS-EPS Field Exploration CPT-02**



# CPTU-S LOG



REV3

# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME: CPS-EPS Field Exploration

PROJECT NUMBER: 02-120-110

R2DATE: 7-24-2002 TIME: 08:32:19.49

SOUNDING NUMBER: CPT-03

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
1.0	64.9	104.6	2.63	3.4	-0.1	-4	Hard, Gravelly clayey sand to gravelly sandy silt			30	4.32	5.26	37 - 61	60 - 99
1.5	45.0	68.5	2.70	4.9	-0.3	-4	Very stiff, Sandy clay to silty clay **			30	2.99	5.39	26 - 39	40 - 60
2.0	19.3	28.2	1.58	4.8	0.1	-4	Stiff, Silty clay to clay *			20	1.92	3.16	10 - 14	15 - 20
2.5	20.1	28.3	1.20	5.6	3.8	-4	Stiff, Silty clay to clay *			25	1.59	2.39	14 - 21	20 - 30
3.0	17.8	24.5	1.01	5.3	5.6	-4	Stiff, Silty clay to clay *			20	1.77	2.03	11 - 15	15 - 20
3.5	16.3	24.6	0.93	5.3	6.5	-4	Stiff, Silty clay to clay *			20	1.81	1.85	11 - 15	15 - 20
4.0	17.9	23.5	1.05	5.8	5.3	-4	Stiff, Silty clay to clay *			20	1.77	2.10	11 - 15	15 - 20
4.5	21.8	28.0	0.97	5.2	7.5	-4	Very stiff, Silty clay to clay *			20	2.16	1.94	12 - 16	15 - 20
5.0	14.7	18.5	1.07	5.4	3.5	-4	Stiff, Silty clay to clay *			20	1.44	2.13	08 - 12	10 - 15
5.5	14.3	17.7	0.89	5.9	7.0	-4	Stiff, Silty clay to clay *			15	1.86	1.78	08 - 12	10 - 15
6.0	14.2	17.3	0.65	4.5	5.0	-4	Stiff, Silty clay to clay *			15	1.84	1.30	05 - 08	06 - 10
6.5	13.0	15.6	0.59	4.5	5.0	-4	Stiff, Silty clay to clay *			15	1.68	1.17	05 - 08	06 - 10
7.0	8.9	10.6	0.56	4.8	3.3	-4	Stiff, Silty clay to clay *			15	1.14	1.12	03 - 05	04 - 06
7.5	8.3	9.8	0.48	5.2	4.3	-4	Stiff, Silty clay to clay *			15	1.05	0.96	03 - 05	04 - 06
8.0	10.3	12.0	0.52	3.7	3.8	-4	Stiff, Silty clay to clay *			15	1.31	1.04	03 - 05	04 - 06
8.5	36.0	41.3	1.62	2.2	2.8	-4	Medium dense, Silty sand to sandy silt	27-31	40-60				09 - 13	10 - 15
9.0	138.1	158.6	6.13	2.3	-0.4	-4	Very dense, Silty sand to sandy silt	37-40	80-100				53 - 87	60 - 99
9.5	366.4	411.1	8.60	2.5	-0.4	-4	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 89	+ 100
10.0	321.0	356.6	6.86	2.0	-0.1	-4	Very dense, Sandy gravel to silty gravelly sand	40-42	+100				+ 90	+ 100
10.5	248.0	272.9	7.16	2.5	-0.4	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 91	+ 100
11.0	274.5	299.3	8.24	2.9	-0.1	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 92	+ 100
11.5	235.2	254.2	6.33	2.2	-0.2	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 93	+ 100
12.0	89.2	95.5	4.77	3.3	-0.4	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	5.90	9.54	37 - 56	40 - 60
12.5	118.6	126.0	4.72	3.3	-0.5	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	7.66	9.44	56 - 93	60 - 99
13.0	286.3	301.8	5.73	1.9	-0.2	-5	Very dense, Sandy gravel to silty gravelly sand	40-42	80-100				+ 95	+ 100
13.5	343.1	358.8	9.13	2.5	-0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 96	+ 100
14.0	368.7	382.7	10.00	2.7	-0.1	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 96	+ 100
14.5	266.1	274.1	8.33	2.6	0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 97	+ 100
15.0	139.5	142.7	6.22	3.2	0.1	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	8.40	12.43	+ 98	+ 100
15.5	118.7	120.6	4.89	3.9	0.3	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	7.14	9.79	+ 98	+ 100
16.0	191.0	192.7	7.77	2.6	0.1	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 99	+ 100
16.5	324.5	325.2	7.57	2.4	0.1	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 100	+ 100
17.0	271.0	269.8	7.36	2.4	-0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 100	+ 100
17.5	201.3	199.8	6.89	3.1	-0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	+100				+ 101	+ 100
18.0	256.4	253.8	9.16	3.0	-0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 101	+ 100
18.5	347.9	343.3	7.79	2.5	0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 101	+ 100
19.0	257.4	253.2	7.68	2.5	0.1	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 102	+ 100
19.5	160.7	157.6	6.39	3.0	-0.0	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	+100				+ 102	+ 100
20.0	67.4	65.9	4.12	3.9	-0.4	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	4.41	8.24	41 - 61	40 - 60
20.5	63.7	62.1	3.25	4.8	-0.4	-5	Hard, Sandy clay to silty clay **			30	4.16	6.50	41 - 62	40 - 60
21.0	56.6	55.0	2.57	4.1	-0.4	-5	Hard, Sandy clay to silty clay *			25	4.43	5.15	31 - 41	30 - 40
21.5	42.0	40.8	2.07	4.2	-0.4	-5	Very stiff, Sandy clay to silty clay *			25	3.26	4.14	21 - 31	20 - 30
22.0	36.1	34.9	1.14	3.0	-0.5	-5	Very stiff, Sandy clay to silty clay *			25	2.78	2.28	10 - 16	10 - 15
22.5	31.7	30.6	1.34	3.7	-0.5	-5	Very stiff, Sandy clay to silty clay *			20	3.04	2.88	16 - 21	15 - 20
23.0	44.9	43.2	2.20	2.6	-0.5	-5	Very stiff, Sandy silt to sandy clay			25	3.48	4.40	16 - 21	15 - 20
23.5	133.1	127.6	3.91	3.1	-0.7	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	8.78	7.83	63 - 103	60 - 99
24.0	121.0	115.7	3.82	3.1	-0.7	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	7.97	7.64	63 - 104	60 - 99
24.5	65.3	62.3	3.63	3.6	-0.7	-5	Hard, Sandy clay to silty clay *			25	5.11	7.26	31 - 42	30 - 40
25.0	159.7	151.9	4.22	3.0	-0.7	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	+100				+ 105	+ 100

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\*\* Indicates heavily overconsolidated or cemented soil

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# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-24-2002 TIME:08:32:19.49

SOUNDING NUMBER:CPT-03

Page 2

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
25.5	116.9	110.9	4.39	3.1	-0.6	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	7.69	8.78	63 - 104	60 - 99
26.0	55.3	52.3	2.93	3.6	-0.8	-5	Hard, Sandy clay to silty clay *			25	4.30	5.86	21 - 32	20 - 30
26.5	34.8	32.8	1.89	4.3	-0.8	-5	Very stiff, Silty clay to clay *			25	2.65	3.79	16 - 21	15 - 20
27.0	23.5	22.1	1.25	4.4	-0.6	-5	Very stiff, Silty clay to clay *			20	2.18	2.49	11 - 16	10 - 15
27.5	25.0	23.5	1.07	4.3	-0.6	-5	Very stiff, Silty clay to clay *			20	2.33	2.14	11 - 16	10 - 15
28.0	25.6	24.0	1.12	4.2	-0.6	-5	Very stiff, Silty clay to clay *			20	2.39	2.24	11 - 16	10 - 15
28.5	30.2	28.2	1.33	3.8	-0.8	-5	Very stiff, Sandy clay to silty clay *			20	2.84	2.65	11 - 16	10 - 15
29.0	35.9	33.5	1.49	3.2	-0.6	-5	Very stiff, Sandy clay to silty clay *			20	3.42	2.98	11 - 16	10 - 15
29.5	57.5	53.4	1.31	2.5	-0.6	-5	Hard, Sandy silt to sandy clay			25	4.46	2.62	22 - 32	20 - 30
30.0	36.2	33.6	1.80	3.5	-0.7	-5	Very stiff, Sandy clay to silty clay *			25	2.76	3.60	16 - 22	15 - 20
30.5	32.7	30.2	1.45	4.4	-0.6	-5	Very stiff, Silty clay to clay *			25	2.47	2.89	16 - 22	15 - 20
31.0	21.4	19.8	1.10	4.0	-0.6	-5	Stiff, Silty clay to clay *			20	1.96	2.20	07 - 11	06 - 10
31.5	15.4	14.2	0.88	5.1	5.8	-5	Stiff, Silty clay to clay *			15	1.60	1.76	07 - 11	06 - 10
32.0	14.6	13.4	0.71	5.0	5.8	-5	Stiff, Silty clay to clay *			15	1.69	1.42	07 - 11	06 - 10
32.5	14.8	13.6	0.74	4.9	5.8	-5	Stiff, Silty clay to clay *			15	1.72	1.47	07 - 11	06 - 10
33.0	14.0	12.8	0.86	2.6	5.4	-5	Stiff, Clayey silt to silty clay			15	1.61	1.71	02 - 04	02 - 04
33.5	58.5	53.4	1.06	2.6	-0.6	-5	Hard, Sandy silt to sandy clay			25	4.52	2.12	22 - 33	20 - 30
34.0	14.9	13.6	0.80	2.7	6.2	-5	Stiff, Clayey silt to silty clay			15	1.72	1.60	04 - 07	04 - 06
34.5	12.0	10.9	0.63	4.9	7.2	-5	Stiff, Silty clay to clay *			15	1.32	1.25	04 - 07	04 - 06
35.0	11.8	10.7	0.63	5.3	6.8	-5	Stiff, Silty clay to clay *			15	1.29	1.26	04 - 07	04 - 06
35.5	11.5	10.4	0.60	5.0	6.7	-5	Stiff, Silty clay to clay *			15	1.25	1.20	04 - 07	04 - 06
36.0	15.4	13.9	0.70	4.3	5.2	-5	Stiff, Silty clay to clay *			15	1.77	1.40	07 - 11	06 - 10
36.5	18.6	16.7	0.67	4.1	2.6	-5	Very stiff, Silty clay to clay *			15	2.18	1.35	07 - 11	06 - 10
37.0	11.2	10.0	0.60	4.0	7.3	-5	Stiff, Silty clay to clay *			15	1.19	1.19	04 - 07	04 - 06
37.5	22.6	20.2	1.25	2.9	6.3	-5	Very stiff, Sandy clay to silty clay *			15	2.71	2.50	07 - 11	06 - 10
38.0	98.9	86.7	2.02	2.3	1.4	-5	Dense, Silty sand to sandy silt	36-37	60-80				34 - 45	30 - 40
38.5	51.8	46.2	3.24	3.5	0.6	-5	Very stiff, Sandy clay to silty clay *			25	3.96	6.48	22 - 34	20 - 30
39.0	38.5	34.3	1.77	4.5	1.1	-5	Very stiff, Silty clay to clay *			25	2.89	3.55	22 - 34	20 - 30
39.5	36.1	32.0	1.57	4.3	0.9	-5	Very stiff, Silty clay to clay *			25	2.69	3.14	17 - 23	15 - 20
40.0	20.1	17.8	1.07	3.8	0.5	-5	Very stiff, Silty clay to clay *			15	2.36	2.14	07 - 11	06 - 10
40.5	15.4	13.6	0.64	3.5	0.8	-5	Stiff, Silty clay to clay *			15	1.73	1.28	05 - 07	04 - 06
41.0	14.5	12.8	0.63	4.2	1.1	-5	Stiff, Silty clay to clay *			15	1.61	1.27	05 - 07	04 - 06
41.5	15.7	13.8	0.62	4.0	1.5	-5	Stiff, Silty clay to clay *			15	1.76	1.24	05 - 07	04 - 06
42.0	14.6	12.8	0.62	4.1	1.9	-5	Stiff, Silty clay to clay *			15	1.61	1.24	05 - 07	04 - 06
42.5	15.4	13.5	0.68	3.9	2.4	-5	Stiff, Silty clay to clay *			15	1.72	1.36	05 - 07	04 - 06
43.0	20.8	18.2	0.68	3.3	6.4	-5	Very stiff, Sandy clay to silty clay *			15	2.43	1.36	07 - 11	06 - 10
43.5	22.0	19.2	0.50	2.6	7.6	-5	Very stiff, Sandy clay to silty clay *			15	2.59	1.01	05 - 07	04 - 06
44.0	16.5	14.4	0.73	4.0	2.2	-5	Stiff, Silty clay to clay *			15	1.85	1.46	05 - 07	04 - 06
44.5	17.6	15.3	0.68	4.7	3.3	-5	Stiff, Silty clay to clay *			15	1.99	1.76	07 - 11	06 - 10
45.0	18.6	16.2	1.27	6.5	4.8	-5	Very stiff, Silty clay to clay *			14	2.27	2.54	12 - 17	10 - 15
45.5	15.9	13.8	0.73	4.3	5.7	-5	Stiff, Silty clay to clay *			15	1.75	1.45	05 - 07	04 - 06
46.0	15.0	12.9	1.02	5.7	5.3	-5	Stiff, Silty clay to clay *			15	1.63	2.04	07 - 12	06 - 10
46.5	17.1	14.8	1.14	5.9	5.3	-5	Stiff, Silty clay to clay *			15	1.91	2.28	07 - 12	06 - 10
47.0	27.8	23.9	1.25	5.9	0.2	-5	Very stiff, Silty clay to clay *			20	2.50	2.51	17 - 23	15 - 20
47.5	15.0	12.9	0.87	4.5	-0.1	-5	Stiff, Silty clay to clay *			15	1.62	1.74	05 - 07	04 - 06
48.0	17.1	14.7	0.94	5.7	0.4	-5	Stiff, Silty clay to clay *			15	1.90	1.88	07 - 12	06 - 10
48.5	14.3	12.3	0.72	4.8	0.6	-5	Stiff, Silty clay to clay *			15	1.52	1.44	05 - 07	04 - 06
49.0	13.2	11.3	1.14	3.4	0.9	-5	Stiff, Silty clay to clay *			15	1.37	2.28	05 - 07	04 - 06
49.5	104.2	89.0	4.70	4.7	0.7	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	6.75	9.41	70 - 116	60 - 99
50.0	79.6	67.8	5.56	6.1	-0.8	-5	Hard, Sandy clay to silty clay **			30	5.11	11.12	70 - 116	60 - 99

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Structure rate of loading should be considered in choosing which strength parameters to use for design. Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.

**STRATIGRAPHICS Evaluated Properties Using Global Database**

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-24-2002 TIME:08:32:19.49

SOUNDING NUMBER:CPT-03

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
50.5	73.0	62.1	3.48	4.2	-0.7	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	4.67	6.96	47 - 71	40 - 60
51.0	144.6	122.8	3.29	3.2	-0.2	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	9.44	6.58	71 - 117	60 - 99
51.5	95.3	80.8	6.83	3.0	-0.3	-5	Hard, Sandy silt to sandy clay			30	6.15	13.67	47 - 71	40 - 60
52.0	301.9	255.3	11.64	4.1	-0.5	-5	Hard, Gravelly clayey sand to gravelly sandy clay			33	18.11	23.28	+ 118	+ 100
52.5	306.3	258.6	12.02	3.0	-0.4	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 118	+ 100
53.0	518.4	436.8	8.21	1.5	-0.3	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	+100				+ 119	+ 100
53.5	626.8	527.2	9.46	1.4	-0.2	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	+100				+ 119	+ 100

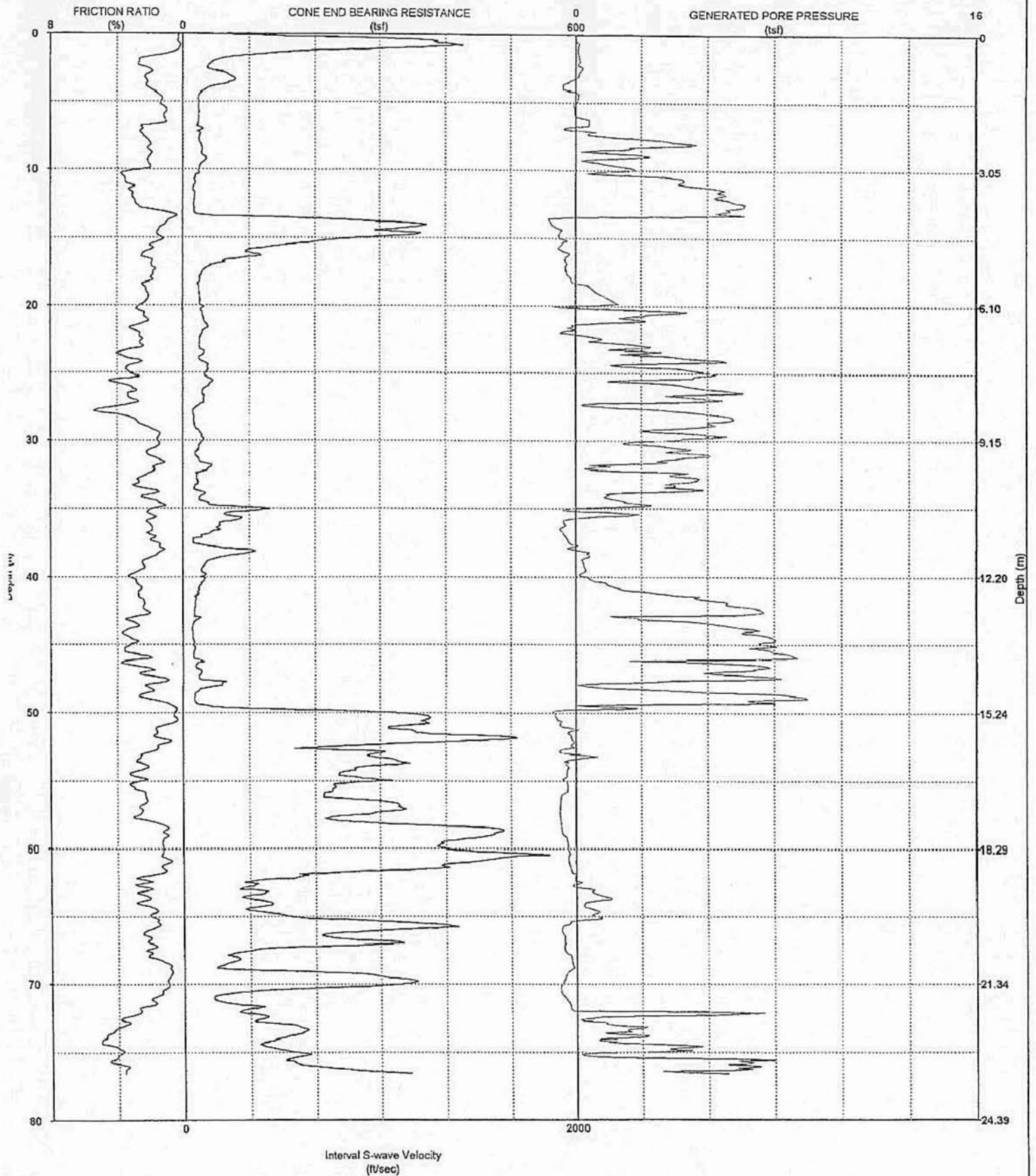
\* Indicates lightly overconsolidated soil

\*\* Indicates heavily overconsolidated or cemented soil

Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT.  
Both undrained and drained parameters can be estimated for these soils.

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Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.

# CPTU-S LOG



REV3

# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME: CPS-EPS Field Exploration

PROJECT NUMBER: 02-120-110

R2DATE: 7-23-2002 TIME: 17:32:39.15

SOUNDING NUMBER: CPT-04

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
1.0	358.6	574.5	0.92	0.2	0.1	-5	Very dense, Sandy gravel to gravelly sand	+46	80-100				37 - 61	60 - 99
1.5	127.3	193.9	1.93	0.9	0.1	-5	Dense, Sand to silty sand	42-46	60-80				26 - 39	40 - 60
2.0	49.8	72.8	2.08	2.6	0.2	-5	Dense, Silty sand to sandy silt	27-31	60-80				14 - 21	20 - 30
2.5	36.4	51.4	1.10	2.3	0.3	-5	Dense, Silty sand to sandy silt	27-31	60-80				11 - 14	15 - 20
3.0	67.5	92.6	1.61	2.1	0.1	-5	Dense, Silty sand to sandy silt	37-40	60-80				22 - 29	30 - 40
3.5	77.0	103.1	1.62	2.2	-0.3	-5	Dense, Silty sand to sandy silt	37-40	60-80				30 - 45	40 - 60
4.0	37.9	49.6	1.21	2.1	-0.5	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				11 - 15	15 - 20
4.5	24.2	31.1	0.43	1.4	0.1	-5	Loose, Silty sand to sandy silt	27-31	20-40				05 - 08	06 - 10
5.0	23.4	29.5	0.31	1.3	0.0	-5	Loose, Silty sand to sandy silt	27-31	20-40				03 - 05	04 - 06
5.5	23.2	28.8	0.23	1.0	-0.1	-5	Loose, Silty sand to sandy silt	31-36	20-40				03 - 05	04 - 06
6.0	23.6	28.8	0.28	1.2	-0.0	-5	Loose, Silty sand to sandy silt	27-31	20-40				03 - 05	04 - 06
6.5	22.7	27.3	0.24	1.0	0.5	-5	Loose, Silty sand to sandy silt	31-36	20-40				03 - 05	04 - 06
7.0	29.4	34.9	0.59	2.4	-0.5	-5	Very stiff, Sandy silt to sandy clay			20	2.90	1.18	08 - 13	10 - 15
7.5	25.2	29.6	0.63	2.4	1.1	-5	Very stiff, Sandy silt to sandy clay			20	2.48	1.25	05 - 09	06 - 10
8.0	24.9	28.9	0.55	2.0	4.4	-5	Very stiff, Sandy silt to sandy clay			20	2.44	1.10	05 - 09	06 - 10
8.5	28.7	32.9	0.62	2.1	1.8	-5	Very stiff, Sandy silt to sandy clay			20	2.82	1.25	05 - 09	06 - 10
9.0	31.0	35.1	0.65	2.0	2.8	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				05 - 09	06 - 10
9.5	29.0	32.5	0.69	2.1	1.0	-5	Very stiff, Sandy silt to sandy clay			20	2.84	1.38	05 - 09	06 - 10
10.0	23.0	25.6	0.59	2.5	2.4	-5	Very stiff, Sandy silt to sandy clay			20	2.24	1.18	05 - 09	06 - 10
10.5	18.1	19.9	0.77	3.6	3.7	-5	Stiff, Silty clay to clay *			20	1.74	1.55	05 - 09	06 - 10
11.0	18.3	20.0	0.63	3.4	4.2	-5	Stiff, Sandy clay to silty clay *			20	1.77	1.25	06 - 09	06 - 10
11.5	15.7	16.9	0.56	3.2	5.8	-5	Stiff, Sandy clay to silty clay *			15	2.00	1.11	04 - 06	04 - 06
12.0	17.3	16.5	0.54	3.1	5.6	-5	Very stiff, Sandy clay to silty clay *			15	2.21	1.08	04 - 06	04 - 06
12.5	16.1	17.1	0.48	2.8	6.8	-5	Very stiff, Sandy clay to silty clay *			15	2.04	0.96	04 - 06	04 - 06
13.0	17.1	18.0	0.57	1.4	6.1	-5	Loose, Silty sand to sandy silt	27-31	20-40				02 - 04	02 - 04
13.5	156.9	164.1	1.56	0.6	-0.9	-5	Medium dense, Sand to silty sand	42-46	40-60				29 - 38	30 - 40
14.0	371.6	385.6	3.68	1.1	-1.0	-5	Very dense, Sand to silty sand	42-46	80-100				+ 96	+ 100
14.5	303.2	312.4	5.16	1.5	-0.6	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	80-100				+ 87	+ 100
15.0	267.9	274.0	3.98	1.3	-0.7	-5	Dense, Sand to silty sand	42-46	60-80				59 - 97	60 - 99
15.5	159.8	162.3	4.19	2.0	-0.6	-5	Very dense, Silty sand to sandy silt	40-42	80-100				39 - 59	40 - 60
16.0	94.3	95.2	2.70	2.2	-0.5	-5	Dense, Silty sand to sandy silt	37-40	60-80				30 - 40	30 - 40
16.5	89.1	89.3	2.38	2.2	-0.5	-5	Dense, Silty sand to sandy silt	37-40	60-80				30 - 40	30 - 40
17.0	44.9	44.7	1.20	1.9	-0.4	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				10 - 15	10 - 15
17.5	28.7	28.5	0.66	1.8	-0.4	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				06 - 10	06 - 10
18.0	26.0	25.7	0.52	1.9	-0.2	-5	Very stiff, Sandy silt to sandy clay			20	2.49	1.04	04 - 06	04 - 06
18.5	22.9	22.6	0.58	2.4	0.5	-5	Very stiff, Sandy silt to sandy clay			20	2.18	1.16	06 - 10	06 - 10
19.0	24.2	23.8	0.54	2.2	0.6	-5	Very stiff, Sandy silt to sandy clay			20	2.31	1.08	04 - 06	04 - 06
19.5	25.6	25.1	0.56	2.1	1.4	-5	Very stiff, Sandy silt to sandy clay			20	2.44	1.11	06 - 10	06 - 10
20.0	26.2	27.6	0.76	2.7	-0.7	-5	Very stiff, Sandy silt to sandy clay			20	2.70	1.52	06 - 10	06 - 10
20.5	29.1	28.4	0.67	2.3	4.2	-5	Very stiff, Sandy silt to sandy clay			20	2.79	1.34	06 - 10	06 - 10
21.0	31.0	30.1	0.71	2.1	2.4	-5	Very stiff, Sandy silt to sandy clay			20	2.97	1.42	06 - 10	06 - 10
21.5	37.0	35.9	0.97	2.9	-0.1	-5	Very stiff, Sandy silt to sandy clay			25	2.86	1.94	10 - 15	10 - 15
22.0	29.3	28.3	0.86	2.6	-0.7	-5	Very stiff, Sandy silt to sandy clay			20	2.79	1.72	06 - 10	06 - 10
22.5	25.2	24.3	0.63	2.4	1.0	-5	Very stiff, Sandy silt to sandy clay			20	2.39	1.26	06 - 10	06 - 10
23.0	23.8	22.9	0.63	2.4	2.9	-5	Very stiff, Sandy silt to sandy clay			20	2.24	1.25	06 - 10	06 - 10
23.5	31.7	30.4	1.10	3.9	3.0	-5	Very stiff, Sandy clay to silty clay *			20	3.03	2.19	16 - 21	15 - 20
24.0	23.8	22.7	0.93	3.0	5.2	-5	Very stiff, Sandy clay to silty clay *			20	2.23	1.86	06 - 10	06 - 10
24.5	36.9	35.2	1.20	3.3	1.8	-5	Very stiff, Sandy clay to silty clay *			25	2.63	2.40	16 - 21	15 - 20
25.0	33.9	32.2	1.18	3.2	5.5	-5	Very stiff, Sandy clay to silty clay *			20	3.24	2.36	11 - 16	10 - 15

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\*\* Indicates heavily overconsolidated or cemented soil

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# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-23-2002 TIME:17:32:39.15

SOUNDING NUMBER:CPT-04

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1)
25.5	44.4	42.1	1.84	4.3	1.8	-5	Very stiff, Silty clay to clay *			25	3.43	3.68	21 - 32	20 - 30
26.0	36.0	34.0	1.24	3.1	4.7	-5	Very stiff, Sandy clay to silty clay *			25	2.75	2.48	11 - 16	10 - 15
26.5	28.7	27.1	1.05	3.3	5.8	-5	Very stiff, Sandy clay to silty clay *			20	2.71	2.09	11 - 16	10 - 15
27.0	30.9	29.0	0.86	2.8	5.7	-5	Very stiff, Sandy clay to silty clay *			20	2.92	1.72	11 - 16	10 - 15
27.5	20.0	18.8	1.14	4.2	1.3	-5	Very stiff, Silty clay to clay *			15	2.45	2.29	06 - 11	06 - 10
28.0	15.3	14.3	0.69	4.4	5.3	-5	Stiff, Silty clay to clay *			15	1.81	1.36	06 - 11	06 - 10
28.5	16.3	15.2	0.48	2.6	6.3	-5	Stiff, Sandy clay to silty clay *			15	1.95	0.95	04 - 06	04 - 06
29.0	17.9	16.7	0.48	2.2	4.9	-5	Very stiff, Sandy silt to clayey silt			15	2.16	0.95	04 - 06	04 - 06
29.5	26.6	25.0	0.40	1.4	4.9	-5	Loose, Silty sand to sandy silt	27-31	20-40				04 - 06	04 - 06
30.0	30.0	27.8	0.46	1.6	3.4	-5	Loose, Silty sand to sandy silt	27-31	20-40				04 - 06	04 - 06
30.5	23.8	22.0	0.42	1.6	3.8	-5	Loose, Silty sand to sandy silt	27-31	20-40				04 - 06	04 - 06
31.0	18.1	16.7	0.48	2.2	5.0	-5	Very stiff, Sandy silt to clayey silt			15	2.16	0.96	04 - 07	04 - 06
31.5	24.2	22.3	0.45	1.3	3.4	-5	Loose, Silty sand to sandy silt	27-31	20-40				04 - 07	04 - 06
32.0	39.8	36.6	0.64	1.8	0.8	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				07 - 11	06 - 10
32.5	21.0	19.3	0.68	2.2	4.1	-5	Very stiff, Sandy silt to sandy clay			15	2.54	1.36	04 - 07	04 - 06
33.0	22.1	20.2	0.55	2.7	4.7	-5	Very stiff, Sandy clay to silty clay *			15	2.68	1.10	04 - 07	04 - 06
33.5	17.0	15.5	0.58	2.3	4.4	-5	Stiff, Clayey silt to silty clay			15	1.99	1.17	04 - 07	04 - 06
34.0	30.6	27.8	0.62	2.2	1.3	-5	Very stiff, Sandy silt to sandy clay			20	2.85	1.24	07 - 11	06 - 10
34.5	32.1	29.1	0.89	1.5	2.0	-5	Loose, Silty sand to sandy silt	27-31	20-40				04 - 07	04 - 06
35.0	127.4	115.4	1.77	1.8	-0.1	-5	Dense, Silty sand to sandy silt	37-40	60-80				44 - 66	40 - 60
35.5	65.3	59.0	1.61	1.8	2.2	-5	Medium dense, Silty sand to sandy silt	36-37	40-60				17 - 22	15 - 20
36.0	58.7	53.0	1.70	2.2	-0.5	-5	Dense, Silty sand to sandy silt	27-31	60-80				17 - 22	15 - 20
36.5	54.1	48.7	1.02	1.8	-0.6	-5	Medium dense, Silty sand to sandy silt	36-37	40-60				11 - 17	10 - 15
37.0	27.5	24.7	0.68	1.7	-0.5	-5	Loose, Silty sand to sandy silt	27-31	20-40				04 - 07	04 - 06
37.5	15.1	13.5	0.58	1.6	-0.3	-5	Stiff, Sandy silt to clayey silt			15	1.71	1.16	00 - 02	00 - 02
38.0	78.8	70.4	0.99	1.1	-0.3	-5	Medium dense, Sand to silty sand	37-40	40-60				17 - 22	15 - 20
38.5	69.2	61.7	1.56	1.7	0.5	-5	Medium dense, Silty sand to sandy silt	36-37	40-60				17 - 22	15 - 20
39.0	34.3	30.5	1.17	2.5	0.3	-5	Very stiff, Sandy silt to sandy clay			20	3.19	2.35	07 - 11	06 - 10
39.5	27.5	24.5	0.81	2.6	0.4	-5	Very stiff, Sandy silt to sandy clay			20	2.52	1.62	07 - 11	06 - 10
40.0	25.5	22.6	0.99	3.2	0.5	-5	Very stiff, Sandy clay to silty clay *			20	2.31	1.98	07 - 11	06 - 10
40.5	27.8	24.6	0.82	2.8	1.3	-5	Very stiff, Sandy clay to silty clay *			20	2.54	1.65	07 - 11	06 - 10
41.0	23.0	20.3	0.67	2.7	2.4	-5	Very stiff, Sandy clay to silty clay *			15	2.74	1.33	05 - 07	04 - 06
41.5	20.0	17.6	0.56	2.6	4.9	-5	Very stiff, Sandy clay to silty clay *			15	2.33	1.12	05 - 07	04 - 06
42.0	18.6	16.4	0.44	2.3	6.0	-5	Very stiff, Clayey silt to silty clay			15	2.15	0.88	05 - 07	04 - 06
42.5	17.3	15.1	0.42	2.2	7.5	-5	Stiff, Clayey silt to silty clay			15	1.96	0.84	02 - 05	02 - 04
43.0	25.4	22.2	0.67	3.3	2.3	-5	Very stiff, Sandy clay to silty clay *			20	2.28	1.34	07 - 11	06 - 10
43.5	14.7	12.8	0.53	2.7	5.7	-5	Stiff, Clayey silt to silty clay			15	1.61	1.05	02 - 05	02 - 04
44.0	14.6	12.9	0.51	3.5	7.1	-5	Stiff, Silty clay to clay *			15	1.63	1.02	05 - 07	04 - 06
44.5	14.4	12.5	0.50	3.2	7.9	-5	Stiff, Sandy clay to silty clay *			15	1.56	1.00	05 - 07	04 - 06
45.0	15.9	13.8	0.53	3.2	7.5	-5	Stiff, Sandy clay to silty clay *			15	1.76	1.07	05 - 07	04 - 06
45.5	16.4	14.2	0.62	3.5	7.9	-5	Stiff, Silty clay to clay *			15	1.82	1.23	05 - 07	04 - 06
46.0	16.4	14.2	0.45	2.1	8.3	-5	Stiff, Sandy silt to clayey silt			15	1.82	0.90	02 - 05	02 - 04
46.5	18.9	16.3	0.72	3.1	7.4	-5	Very stiff, Sandy clay to silty clay *			15	2.15	1.45	05 - 07	04 - 06
47.0	27.7	23.9	0.66	2.5	5.4	-5	Very stiff, Sandy silt to sandy clay			20	2.49	1.32	07 - 12	06 - 10
47.5	26.4	22.7	0.47	1.0	7.0	-5	Loose, Silty sand to sandy silt	31-36	20-40				05 - 07	04 - 06
48.0	52.0	44.7	1.19	2.3	0.3	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				17 - 23	15 - 20
48.5	20.2	17.3	0.66	2.2	5.9	-5	Very stiff, Sandy silt to clayey silt			15	2.30	1.32	05 - 07	04 - 06
49.0	16.8	14.4	0.42	1.9	8.1	-5	Stiff, Sandy silt to clayey silt			15	1.85	0.63	02 - 05	02 - 04
49.5	41.8	35.6	0.94	0.6	0.8	-5	Loose, Sand to silty sand	36-37	20-40				05 - 07	04 - 06
50.0	324.8	276.7	2.02	0.6	-0.9	-5	Dense, Sand to silty sand	42-46	60-80				47 - 70	40 - 60

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# STRATIGRAPHICS Evaluated Properties Using Global Database

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-23-2002 TIME:17:32:39.15

SOUNDING NUMBER:CPT-04

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
50.5	368.5	313.4	1.35	0.4	-0.8	-5	Dense, Sandy gravel to gravelly sand	+46	60-80				47 - 71	40 - 60
51.0	318.8	270.6	5.41	1.5	-0.6	-5	Very dense, Sand to silty sand	42-46	80-100				71 - 117	60 - 99
51.5	368.9	312.5	7.11	1.6	-0.3	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	80-100				+ 118	+ 100
52.0	456.7	386.2	3.50	0.9	-0.2	-5	Very dense, Sand to silty sand	42-46	80-100				71 - 117	60 - 99
52.5	224.7	189.7	4.78	1.6	-0.2	-5	Dense, Sand to silty sand	40-42	60-80				47 - 71	40 - 60
53.0	295.8	249.2	7.28	2.4	-0.4	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 119	+ 100
53.5	326.3	274.4	8.98	2.6	-0.4	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 119	+ 100
54.0	263.6	221.4	6.55	2.2	-0.3	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	80-100				+ 119	+ 100
54.5	237.5	199.1	8.69	3.2	-0.4	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	+100				+ 119	+ 100
55.0	301.5	252.2	7.24	2.6	-0.4	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 120	+ 100
55.5	227.9	190.3	7.18	3.0	-0.4	-5	Very dense, Gravelly silty sand to clayey gravelly sand	36-37	+100				+ 120	+ 100
56.0	214.6	178.9	5.72	2.3	-0.6	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	80-100				72 - 119	60 - 99
56.5	305.4	254.2	7.07	2.2	-0.6	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	+100				+ 120	+ 100
57.0	336.7	279.7	8.38	2.6	-0.7	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 120	+ 100
57.5	260.2	215.6	8.18	2.7	-0.7	-5	Very dense, Gravelly silty sand to clayey gravelly sand	37-40	+100				+ 121	+ 100
58.0	256.3	212.2	6.57	1.8	-0.6	-5	Very dense, Silty sand to sandy silt	40-42	80-100				72 - 120	60 - 99
58.5	471.9	390.0	4.26	0.9	-0.6	-5	Very dense, Sand to silty sand	42-46	80-100				+ 121	+ 100
59.0	471.0	388.6	4.07	0.9	-0.5	-5	Very dense, Sand to silty sand	42-46	80-100				+ 121	+ 100
59.5	393.9	324.4	5.65	1.3	-0.4	-5	Very dense, Sand to silty sand	42-46	80-100				+ 121	+ 100
60.0	401.7	330.3	5.89	1.2	-0.3	-5	Very dense, Sand to silty sand	42-46	80-100				+ 122	+ 100
60.5	513.6	421.6	6.68	1.3	-0.3	-5	Very dense, Sandy gravel to silty gravelly sand	42-46	80-100				+ 122	+ 100
61.0	424.9	348.2	3.89	0.9	-0.3	-5	Dense, Sand to silty sand	42-46	60-80				73 - 121	60 - 99
61.5	358.4	293.2	4.57	1.2	-0.2	-5	Dense, Sand to silty sand	42-46	60-80				73 - 121	60 - 99
62.0	180.8	147.7	5.88	2.4	-0.1	-5	Very dense, Silty sand to sandy silt	37-40	80-100				73 - 121	60 - 99
62.5	97.2	79.2	2.79	2.2	0.2	-5	Dense, Silty sand to sandy silt	36-37	60-80				25 - 37	20 - 30
63.0	98.6	80.2	2.15	2.0	0.6	-5	Dense, Silty sand to sandy silt	37-40	60-80				25 - 37	20 - 30
63.5	91.8	74.6	2.48	2.2	1.1	-5	Dense, Silty sand to sandy silt	36-37	60-80				25 - 37	20 - 30
64.0	133.6	108.4	3.54	2.9	0.3	-5	Very dense, Silty sand to sandy silt	36-37	80-100				49 - 74	40 - 60
64.5	94.7	76.8	2.16	1.7	0.6	-5	Medium dense, Silty sand to sandy silt	37-40	40-60				25 - 37	20 - 30
65.0	161.4	130.5	5.00	2.0	0.8	-5	Dense, Silty sand to sandy silt	37-40	60-80				49 - 74	40 - 60
65.5	354.5	286.3	5.73	1.5	-0.3	-5	Very dense, Sand to silty sand	42-46	80-100				+ 124	+ 100
66.0	318.5	256.8	7.87	2.1	-0.6	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	80-100				+ 124	+ 100
66.5	218.2	175.6	5.55	2.1	-0.5	-5	Very dense, Silty sand to sandy silt	40-42	80-100				75 - 123	60 - 99
67.0	323.0	259.6	5.48	2.0	-0.5	-5	Very dense, Gravelly silty sand to clayey gravelly sand	40-42	80-100				+ 124	+ 100
67.5	103.7	83.2	4.62	2.3	-0.5	-5	Dense, Silty sand to sandy silt	36-37	60-80				37 - 50	30 - 40
68.0	82.2	65.8	1.64	2.0	-0.2	-5	Dense, Silty sand to sandy silt	36-37	60-80				25 - 37	20 - 30
68.5	62.8	50.2	0.76	1.0	-0.2	-5	Loose, Silty sand to sandy silt	37-40	20-40				08 - 13	06 - 10
69.0	140.5	112.2	1.76	0.7	-0.3	-5	Medium dense, Sand to silty sand	40-42	40-60				25 - 38	20 - 30
69.5	307.4	245.1	2.98	0.9	-0.5	-5	Dense, Sand to silty sand	42-46	60-80				50 - 75	40 - 60
70.0	332.6	264.8	3.27	1.0	-0.6	-5	Dense, Sand to silty sand	42-46	60-80				75 - 124	60 - 99
70.5	115.4	91.7	3.10	1.3	-0.7	-5	Medium dense, Silty sand to sandy silt	37-40	40-60				25 - 38	20 - 30
71.0	44.4	35.3	1.28	1.9	-0.5	-5	Medium dense, Silty sand to sandy silt	27-31	40-60				08 - 13	06 - 10
71.5	82.0	65.0	1.67	1.8	-0.3	-5	Medium dense, Silty sand to sandy silt	36-37	40-60				19 - 25	15 - 20
72.0	83.3	65.9	2.68	2.6	-0.2	-5	Dense, Silty sand to sandy silt	27-31	60-80				25 - 38	20 - 30
72.5	124.1	96.1	4.51	3.7	0.9	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	7.98	9.03	76 - 125	60 - 99
73.0	156.7	123.7	6.15	3.5	1.3	-5	Hard, Gravelly clayey sand to gravelly sandy silt			30	10.16	12.30	76 - 125	60 - 99
73.5	182.5	143.7	7.52	4.3	2.2	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	10.79	15.05	+ 127	+ 100
74.0	145.7	114.6	7.80	4.8	1.9	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	8.56	15.60	+ 127	+ 100
74.5	118.8	93.3	6.13	4.4	4.2	-5	Hard, Gravelly sandy clay to gravelly silty clay **			30	7.62	12.25	76 - 128	60 - 99
75.0	170.4	133.6	6.47	3.7	2.2	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	10.05	12.94	+ 128	+ 100

\* Indicates lightly overconsolidated soil

\*\* Indicates heavily overconsolidated or cemented soil

Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT.  
Both undrained and drained parameters can be estimated for these soils.

Structure rate of loading should be considered in choosing which strength parameters to use for design.  
Drained and undrained parameters must not be combined as such combination will result in significant overprediction of in situ shear strength.

# **STRATIGRAPHICS Evaluated Properties Using Global Database**

PROJECT NAME:CPS-EPS Field Exploration

PROJECT NUMBER:02-120-110

R2DATE: 7-23-2002 TIME:17:32:39.15

SOUNDING NUMBER:CPT-04

Depth (ft)	Cone (tsf)	Norm Cone (tsf)	Friction (tsf)	Averaged Friction Ratio (%)	Generated Pore Water Pressure (tsf)	Soil Conductivity (uS/cm)	Evaluated Soil Type	Drained Friction Angle (deg)	Relative Density (%)	Nc	Undrained Shear Strength (ksf)	Undrained Large Strain Shear Strength (ksf)	SPT (N)	NORM SPT (N1')
75.5	156.1	122.2	7.34	4.2	6.1	-5	Hard, Gravelly sandy clay to gravelly silty clay **			33	9.18	14.68	+ 128	+ 100
76.0	189.1	147.8	8.11	3.4	7.3	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	11.18	16.22	+ 128	+ 100
76.5	316.6	247.3	10.50	3.6	4.5	-5	Hard, Gravelly clayey sand to gravelly sandy silt			33	18.92	21.00	+ 128	+ 100

\* Indicates lightly overconsolidated soil

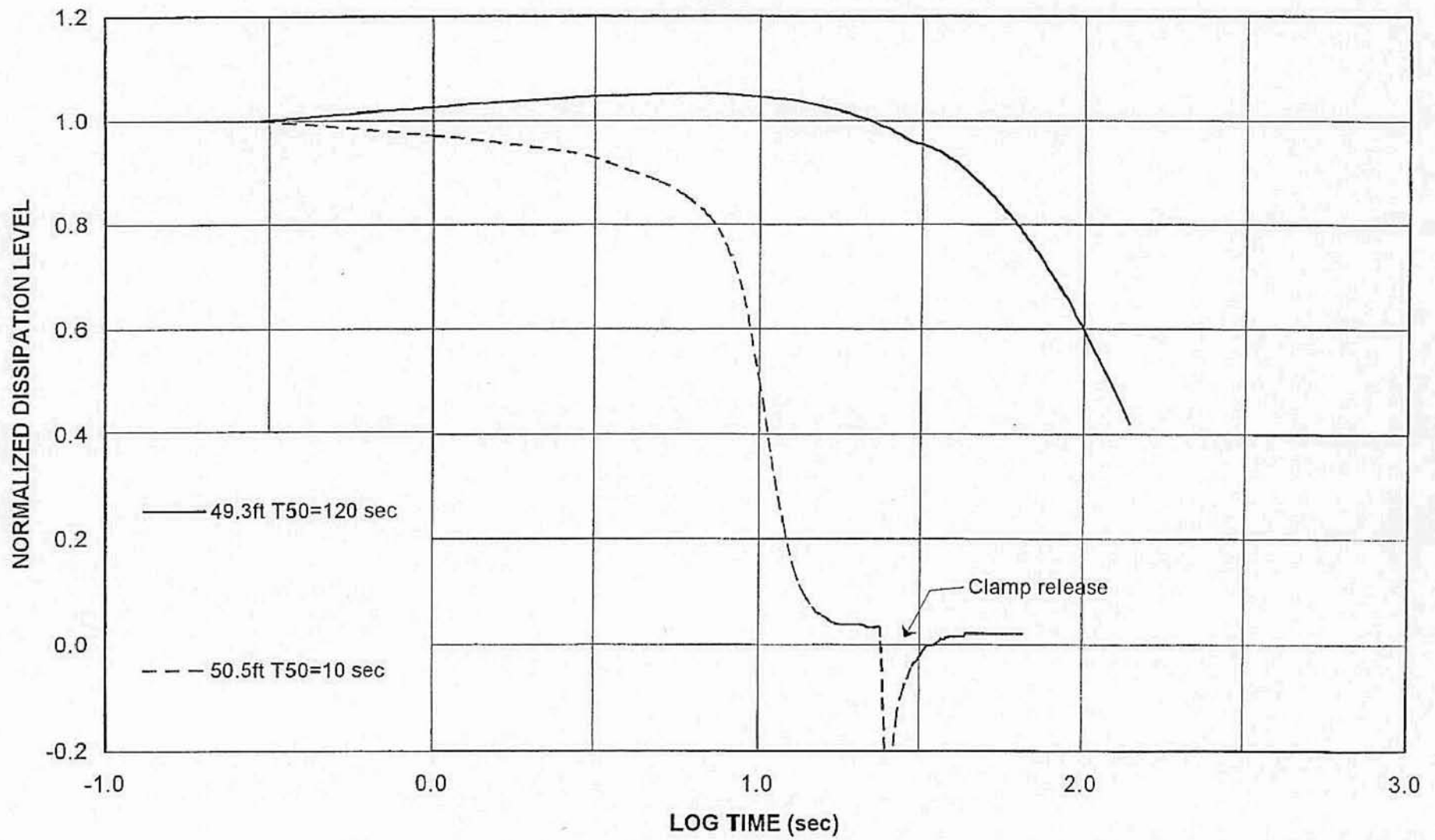
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Mixed soils containing both granular and fine grained particles (e.g. clayey sands) may undergo partial drained failure during CPT.  
Both undrained and drained parameters can be estimated for these soils.

Structure rate of loading should be considered in choosing which strength parameters to use for design.

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**STRATIGRAPHICS**  
**PORE WATER PRESSURE DISSIPATION TEST**  
**CPS-EPS Field Exploration CPT-04**





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### 1.0 EVALUATION OF GEOTECHNICAL PARAMETERS

CPT data have been correlated with soil type, drained friction angle, undrained shear strength, relative density, and equivalent SPT blowcounts, among others. Correlations have been developed by comparing CPT results to laboratory tests on drilled samples and to other in situ tests, such as vane and pressuremeter. Laboratory CPT testing on large scale samples of known composition and classical bearing capacity and cavity expansion theory have also been used. Site specific information, where available, can be used to fine tune correlations.

A two parameter correlation scheme has proved useful for CPT data evaluation. Geotechnical properties often exhibit well defined trends when plotted against the logarithm of the CPT cone end bearing resistance and friction ratio. For instance, increased grain size increases cone end bearing resistance, while increased plasticity and compressibility increase friction ratio. A chart illustrating these and other trends is presented in Figure A2. A discussion of CPT data evaluation is presented in Douglas and Olsen, 1981.

A1.1 CPT Soil Behavior Types CPT soil behavior type correlations (Figure A3) have been developed from geotechnical theory and comparisons of borehole data with CPT data (Douglas and Olsen, 1981). The CPT soil type tabulations are indicative of the response of the soil to the large shear deformations imposed on the soil during penetrometer advance. Soil shear response is not entirely controlled by grain size distribution. However, it has been found that CPT soil types generally agree with classifications based on soil grain size distribution methods such as the Unified Soil Classification System (USCS).

A1.2 CPT Relative Density Relative densities of granular soils are correlated with CPT data (Figure A4) on the basis of laboratory CPT on large scale samples of known composition (Schmertmann, 1978, and Villet and Mitchell, 1981). The effect of soil fines content has been empirically accounted for by extrapolating trends in the two parameter correlation model (Douglas and Strutynsky, 1984).

A1.3 CPT Drained Static Strength Drained friction angles have been correlated with CPT data (Figure A4) on the basis of CPT soundings and laboratory tests on drilled samples, and on theoretical analyses of the cone end bearing capacity problem (Schmertmann, 1978, Durgunoglu and Mitchell, 1974, and Villet and Mitchell, 1981). The effect of soil fines content on friction angles has been accounted for by extrapolating trends in the two parameter correlation model, as was done for the relative density correlation.

A1.4 CPT Undrained Static Strength The correlation between CPT data and undrained shear strength has been extensively studied (Douglas and others, 1984, Lunne and others, 1976, Sanglerat, 1972, and Schmertmann, 1978). The following bearing capacity equation can be used for computing undrained shear strength from CPT data:  $q_u = (S_u * N_c) + S_v$  (Eq. A1); where:  $q_u$  = ultimate bearing capacity;  $S_u$  = undrained shear strength;  $N_c$  = a dimensionless bearing capacity factor; and  $S_v$  = the estimated total vertical stress. By setting  $q_u$  equal to the cone end bearing resistance,  $q_c$ , and rearranging the equation, a value of the undrained shear strength can be computed as:  $S_u = (q_c - S_v) / N_k$  ( $N_k$  is equivalent to  $N_c$  in Eq. A1) (Eq. A2).

The primary difficulty in using this equation has been the selection of  $N_k$  applicable to cone penetration in a particular soil. Bearing capacity and cavity expansion theory and other in situ and laboratory test results performed adjacent to CPT soundings have been used to calculate  $N_k$  values. These  $N_k$  values have ranged from 5 to over 25, but are most often between about 12 and 20. Higher  $N_k$  values are typically associated with overconsolidated clays and lower plasticity clays and clayey silts.

A compilation of  $N_k$  values as a function of cone end bearing resistance and friction ratio is presented in Figure A5. This figure was developed from comparisons of CPT to results of laboratory consolidated-undrained (CU) strength tests. This is important to note as undrained shear strength is not a unique property of a soil - it is test type and stress path dependent.

Many design methodologies are based on a particular strength test on a particular type of sample. These semi-empirical design methods are successfully used by experienced designers. Engineering judgment must be applied in using the results of any type of testing to assure both adequate safety and design economy.

High Strain, Remolded Strength Another measure of the in situ undrained shear strength is provided by the CPT friction sleeve resistance. The friction sleeve interacts with soil that has already undergone bearing capacity failure induced by the tip of the penetrometer. Thus, the friction sleeve resistance is a measure of soil large strain, remolded strength. The ratio between strengths calculated from the cone end bearing and from the friction sleeve is indicative of soil sensitivity.

In moderately to highly overconsolidated, non-sensitive clays, friction sleeve resistances can indicate higher strengths than those calculated using the cone end bearing resistance. This often reflects the dilative (strain hardening) nature of shear failure in overconsolidated soils. Engineering judgment must be applied in deciding which strain level, and thus which strength, is representative for the design problem to be solved.

A1.5 Evaluation of Soil Stress History The results of penetrometer testing can often be evaluated for indication of clay soil stress history or pre-consolidation pressure. Several methods are available for this evaluation. The first method consists of computing a normally consolidated cone end bearing resistance profile, based on estimated soil unit weights, water table information, cohesion at the ground surface, and an assumed c/p ratio and cone factor  $N_k$  for the clay strata in question. This normally consolidated profile is then compared to the measured profile, and differences between the two can be assumed to be due to past stress history events (Schmertmann, 1977). A back calculation is then performed on the difference, using the assumed c/p ratio and  $N_k$ , and a pre-consolidation pressure is calculated. OCR's can then be calculated based on estimated existing stress conditions. SHANSEP procedures used during triaxial testing of clay soils may be useful in this method, especially for definition of c/p ratios.

Other methods for estimating stress history from CPT data are summarized in Mayne (1991 and 1993). These include approaches based on cavity expansion theory and critical state soil mechanics or on empirical methods based on data sets, primarily from sites in offshore oil fields. Results from each method should be compared, and engineering judgment should be used to decide which method gives the most appropriate result for the design at hand.

A1.6 Equivalent SPT Blowcount N-Values An equivalent SPT blowcount can be correlated with CPT data by using an analytical model of the SPT procedure (Douglas and Olsen, 1981). This procedure has been checked by comparison to SPT results at various sites throughout the world (Douglas and others, 1981, Douglas and Strutynsky, 1984, and Olsen and Farr, 1986) with generally good results.

The particular SPT equipment used to develop the CPT-SPT correlation chart (Figure A6) consisted of a SPT trip hammer system. This SPT hammer is characterized by reasonably repeatable, measured hammer input energy efficiencies of about 60 to 70% (Douglas and Strutynsky, 1984). This hammer input energy level is similar to that recommended (Seed and others, 1984) as the "standard" Standard Penetration Test input energy. SPT results are both equipment and operator dependent. SPT hammer efficiencies have been measured to range from 35 to over 90% of the theoretical 4200 in-lbs (30 inch fall, 140 lbs hammer) SPT input energy. Variable SPT input energy results in variable blowcounts (Douglas and Strutynsky, 1984, Seed and others, 1984). Non-uniform SPT input energy is a limitation for use of SPT for quantitative design purposes.

The approach of using the extensive SPT data base by performing CPT and then deriving equivalent SPT blowcount N-values, can result in better site characterization. This is because CPT is continuous, has higher resolution, is less expensive, and is much more consistent and repeatable than SPT. The chart that was used for correlating CPT to SPT for this study is presented in Figure A6. After determining the overburden normalized equivalent SPT N'-value, the equivalent SPT blowcount N-value was calculated by dividing the overburden normalized value by the overburden normalization factor CN, as defined in Eq. A3.

The equivalent SPT N-values reflect the higher resolution of the CPT measurements as compared to actual SPT. Performance of actual SPT includes averaging of soil resistance over about a 24 inch interval (18 inch sampler embedment and 2 to 3 sampler diameters ahead of the sampler). Equivalent SPT values have a resolution of about six inches. Rather than coarsen the 6 inch resolution equivalent SPT N-value to fit a 24 inch resolution actual SPT N-value, equivalent values are based on point by point CPT data. These high resolution, equivalent SPT values should be more useful for design purposes, especially in interlayered deposits, where thin, weak soil seams cannot be adequately characterized by actual SPT blowcount methods. The high resolution equivalent SPT values and actual SPT measurements should be similar in thick homogeneous strata.

Discrepancies between CPT equivalent SPT N-values and actual, measured SPT N-values are often due to inconsistencies in the performance of actual SPT. Poor fit of CPT equivalent and actual SPT in weak soils with very low blowcounts (0 to 3) can be due to limited accuracy of high capacity CPT loadcells used at the extreme low end of their range, but are more likely caused by extensive borehole disturbance in easily disturbed soil, and set of the SPT sampler under the self-weight of the hammer and drillrods. Discrepancies between equivalent and actual SPT values in very dense or hard soils with high blowcounts, especially in gravelly soils, can be due to both erratic penetrometer or SPT sampler interaction with large soil particles, and basic differences in modes of penetration of the two techniques. Indications of weak soils, using any method, should strongly encourage additional testing, including undisturbed sampling and sophisticated laboratory testing.

## A2.0 OVERBURDEN PRESSURE NORMALIZATION

Overburden normalization of CPT data for correlation purposes is necessary in order to remove the effects of increasing overburden pressure with depth on measured results. Cone tip resistances can be normalized to an effective vertical overburden pressure of 1 TSF by using the following equations:  $qc_1 = qc \cdot CN$  (Eq. A3); and  $CN = 1.0 - 0.5 \cdot \log(S_v')$  (Eq. A4); where:  $qc_1$  is the overburden normalized cone tip resistance, in TSF;  $qc$  is the measured cone tip resistance, in TSF;  $CN$  is the overburden normalization factor; and  $S_v'$  is the effective vertical overburden stress in TSF.

Overburden normalization curves are variable (Douglas and Martin, 1980) and were developed using laboratory CPT and SPT on large samples of clean sands. Application of these laboratory results to natural soils may be limited. The  $CN$  presented in Equation A4 is similar to that proposed (Seed and others, 1977) for the effect of overburden on SPT blowcounts.

The friction ratio is not normalized based on the assumption that overburden pressure affects friction sleeve and cone tip resistance similarly. Since the quantities are divided by each other to compute friction ratio, overburden effects should cancel. Some experience (Olsen and Farr, 1986) indicates that this assumption may oversimplify actual conditions for deep soundings. The friction resistance may be less sensitive to overburden pressure than the cone tip resistance. Thus, in soundings deeper than about 100 ft, the friction ratio may gradually decrease with increased penetration, independent of any changes in soil conditions, other than overburden pressure. Due to the variability in overburden normalization curves, no specific correction for overburden pressure on friction ratio has been recommended or used for this study. For this study, effective stresses in Equation A4 were computed using assumed water tables and soil unit weights.

## A3.0 TEST DRAINAGE CONDITION

The CPT loading rate is such that drained and undrained conditions exist during testing of sands and clays, respectively. Partial drainage may occur in mixed (granular and fine grained) soils. CPTU piezometric data indicate that minor differences in cone tip and friction ratio response can correspond with major changes in pore water pressure response (Douglas and others, 1985). The complex volumetric strain field around the penetrometer (Davidson and Boghrat, 1983) precludes reliable geotechnical effective stress analysis of CPTU results in partially drained soil.

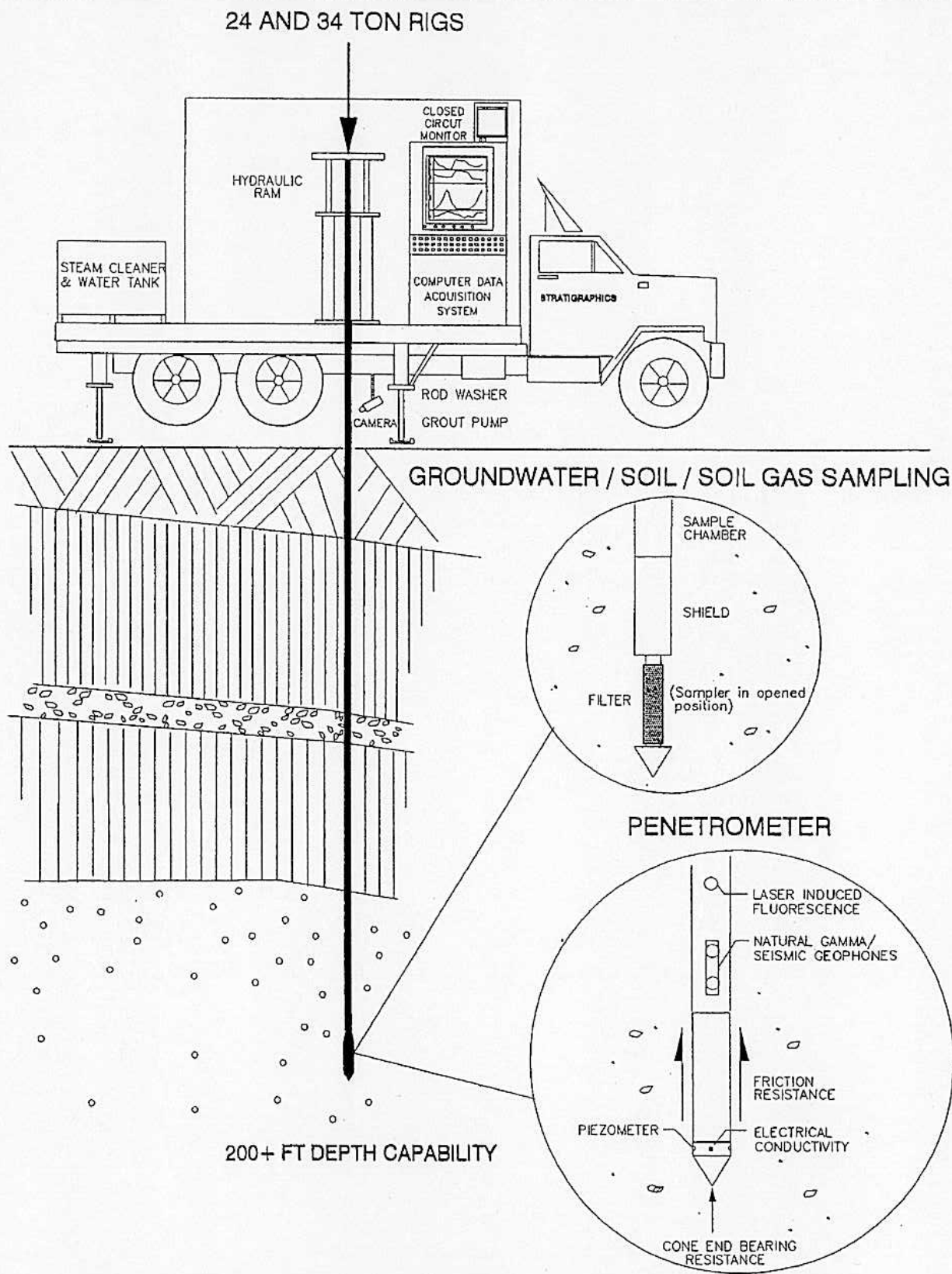
Empirical estimates of either drained or undrained parameters can be made in mixed soils. These parameters must not be combined and must be used alternatively. Combination of drained and undrained parameters will result in significant overestimation of in situ shear strength. Structure rate of loading will help determine whether drained or undrained parameters should be appropriate for design use. Depending on project needs and site conditions, geotechnical laboratory testing including consolidation and CU tests with pore pressure measurements will also be useful in assigning appropriate design parameters. Field instrumentation during construction using low volume change piezometers may be appropriate for some projects.

## A4.0 RECOMMENDED PRACTICES

The STRATIGRAPHICS data evaluation program uses a series of global correlation charts, Figures A2 through A6. Parameters are computer evaluated and tabulated at discrete intervals. Stratigraphic units should be defined on the basis of the continuous sounding logs and project requirements. The correlations are then used in evaluation of layer properties. Use of the tabulations without the review of the CPT sounding logs can lead to the choice of non-representative parameters, especially in interlayered deposits. It should be noted that taking discontinuous borehole soil samples also often provides a poor representation of subsurface conditions.

CPT correlations have been developed using empiricism. The data base is world-wide and includes decades of CPT experience. However, local conditions may differ from those in the global data base. Thus, the evaluated parameters should be viewed as indicating trends rather than as the exact equivalent of specific laboratory tests performed under boundary and drainage controlled conditions. The derived parameters are not intended to replace appropriate drilling and undisturbed sampling, other in situ and laboratory testing, and use of engineering judgment.

Review of CPT results and project requirements is used to define the need for additional information. Zones delineated by CPT (or, in fact, any other test) providing low factors of safety should be further explored. For example, high quality undisturbed sampling followed by geotechnical triaxial and consolidation testing may be indicated for low strength cohesive or partially drained mixed soil strata. Monitoring wells may be installed or groundwater samples taken in high hydraulic conductivity strata during geo-environmental exploration. Non-CPT test results can often be extrapolated across the site based on CPT evaluated stratigraphy.



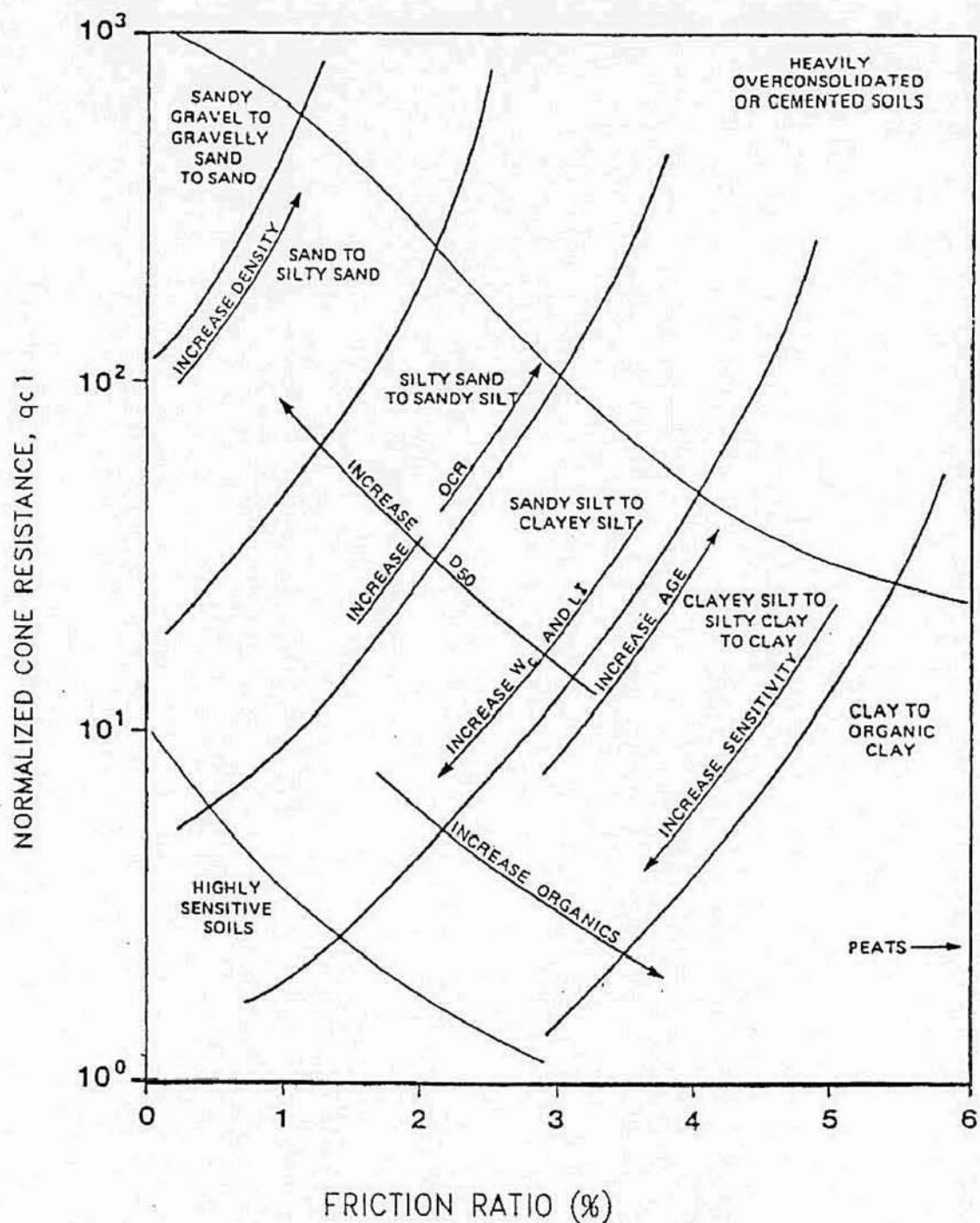
# PENETROMETER EXPLORATION SYSTEM

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REV3





SOIL BEHAVIOR TYPE CLASSIFICATION CHART

After Douglas and Olsen, 1981

**STRATIGRAPHICS**

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Figure 2

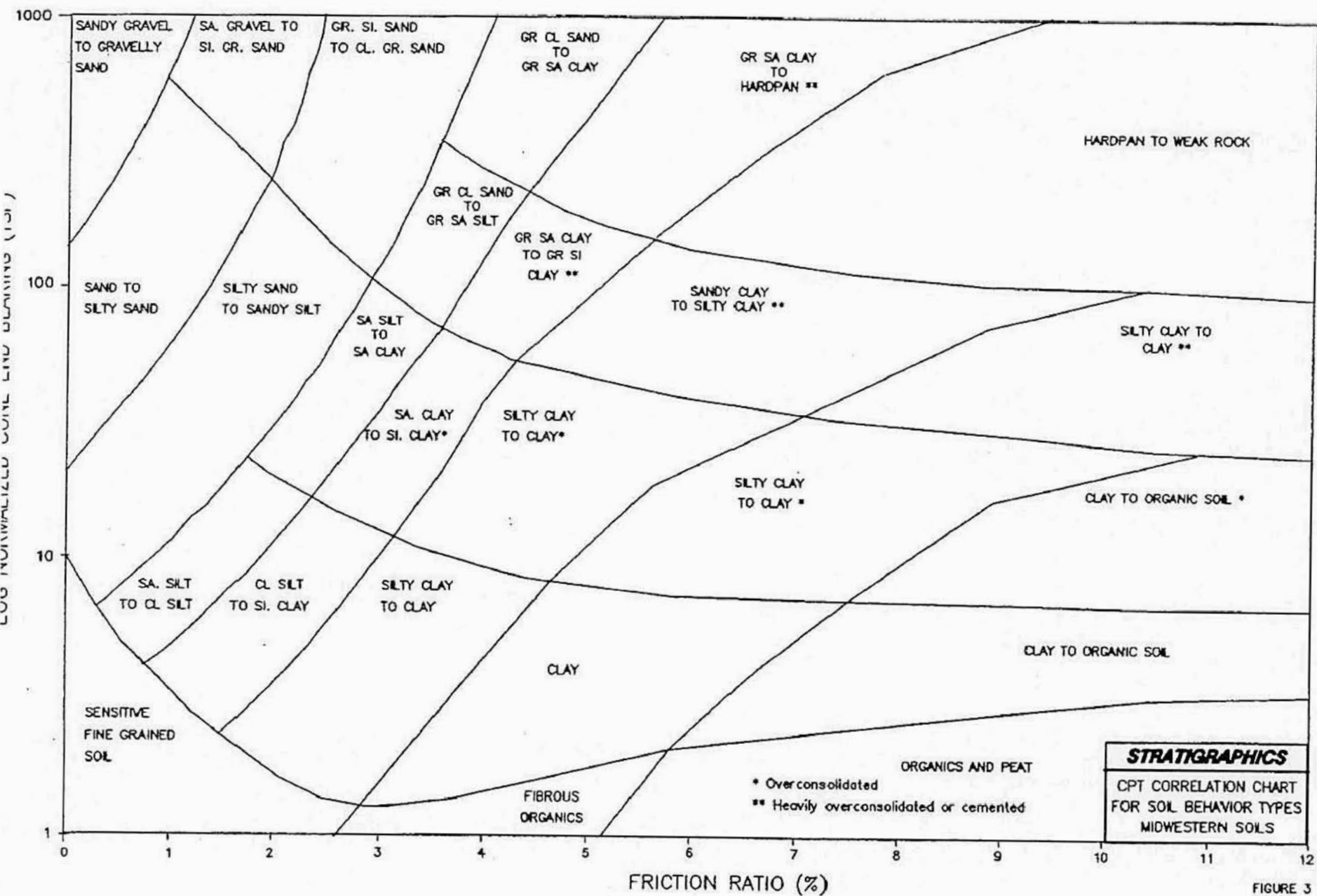
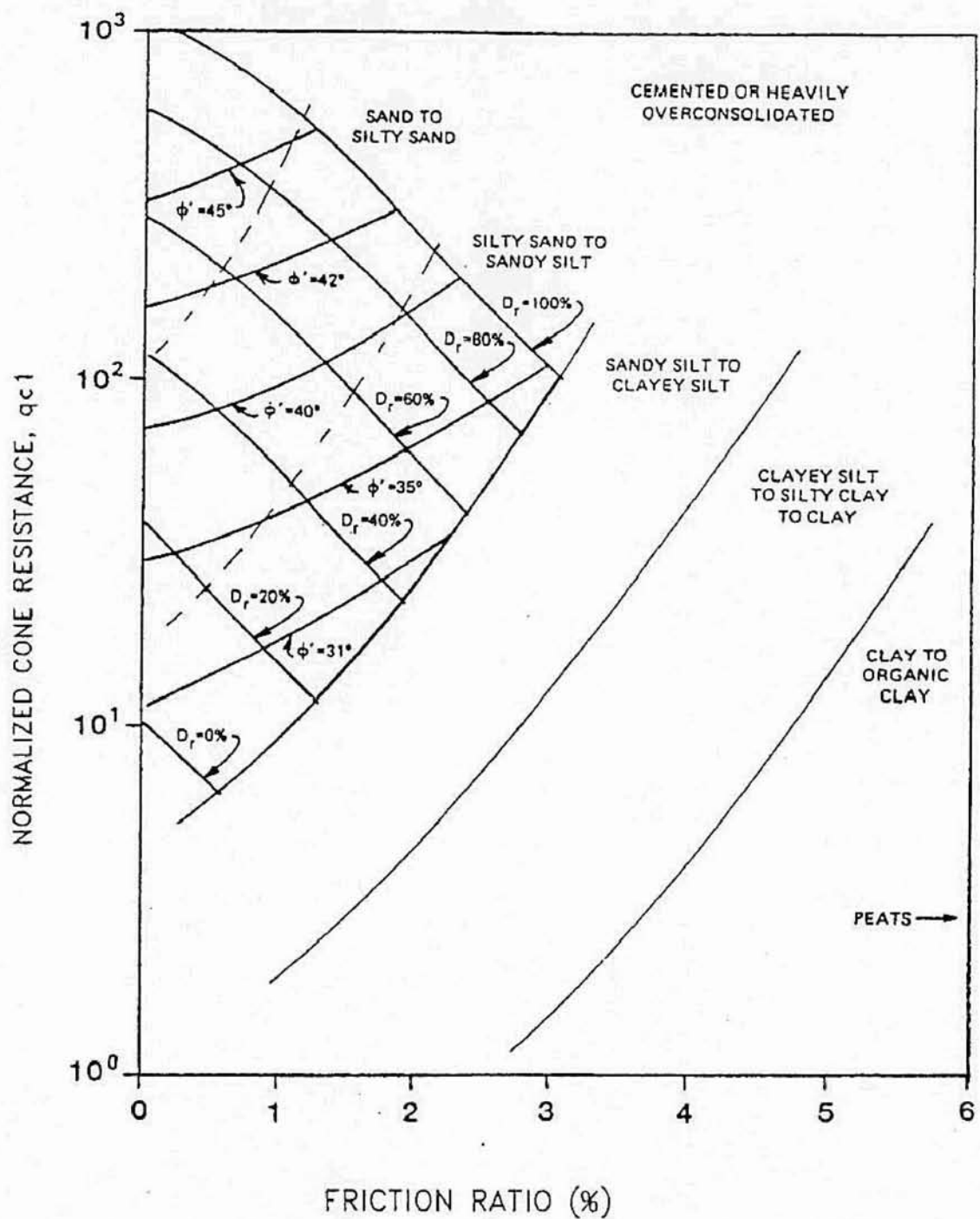


FIGURE 3

REV3



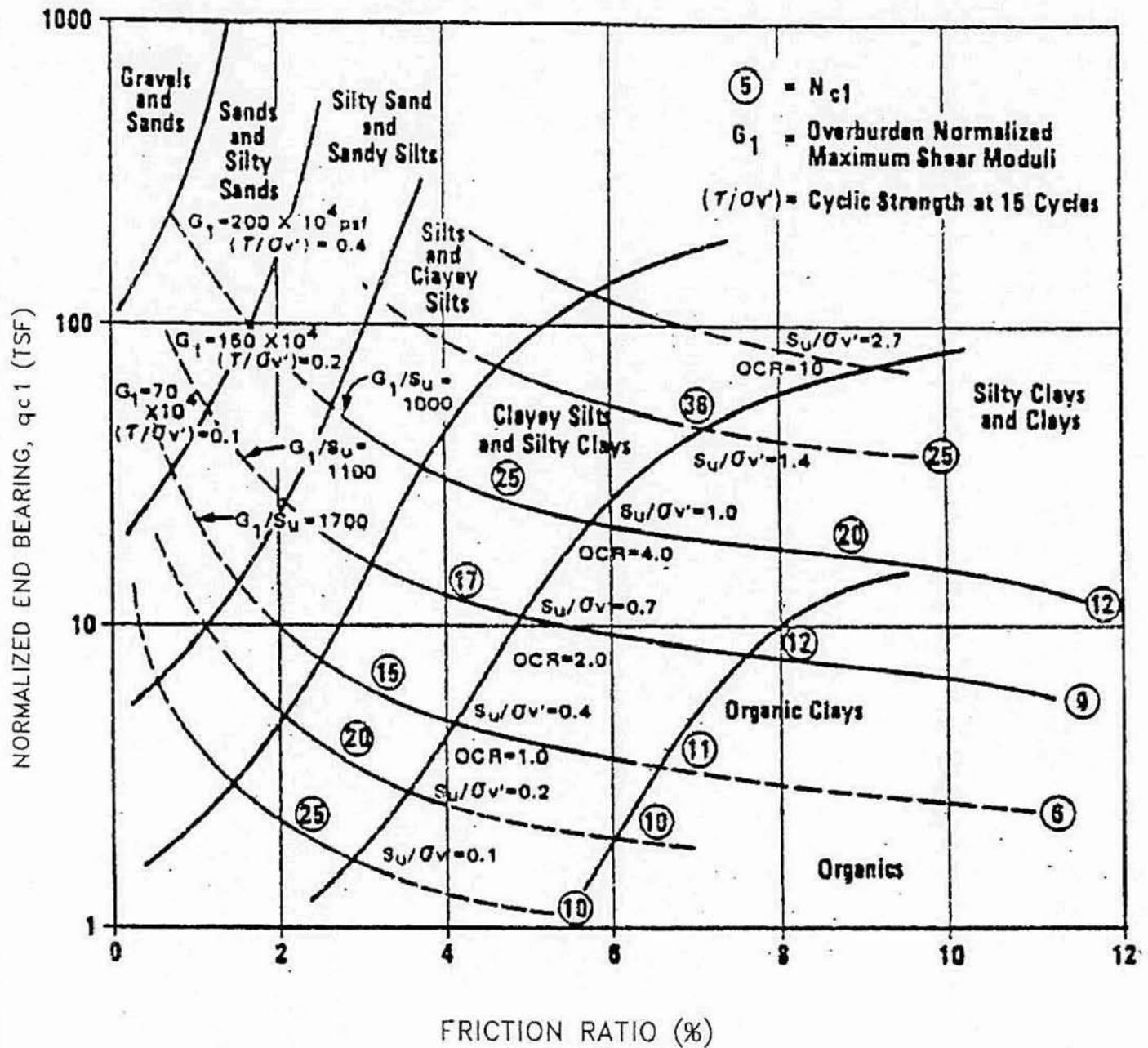
EXPANDED SOIL BEHAVIOR TYPE CLASSIFICATION CHART WITH EQUIVALENT OVERBURDEN NORMALIZED FRICTION ANGLE AND RELATIVE DENSITY TRENDS

After Douglas and Strutynsky, 1984

**STRATIGRAPHICS**

REV3

Figure 4



COMPOSITE TRENDS IN UNDRAINED SOIL PROPERTIES

After Douglas, Strutynsky, et. al., 1985

STRATIGRAPHICS

REV3



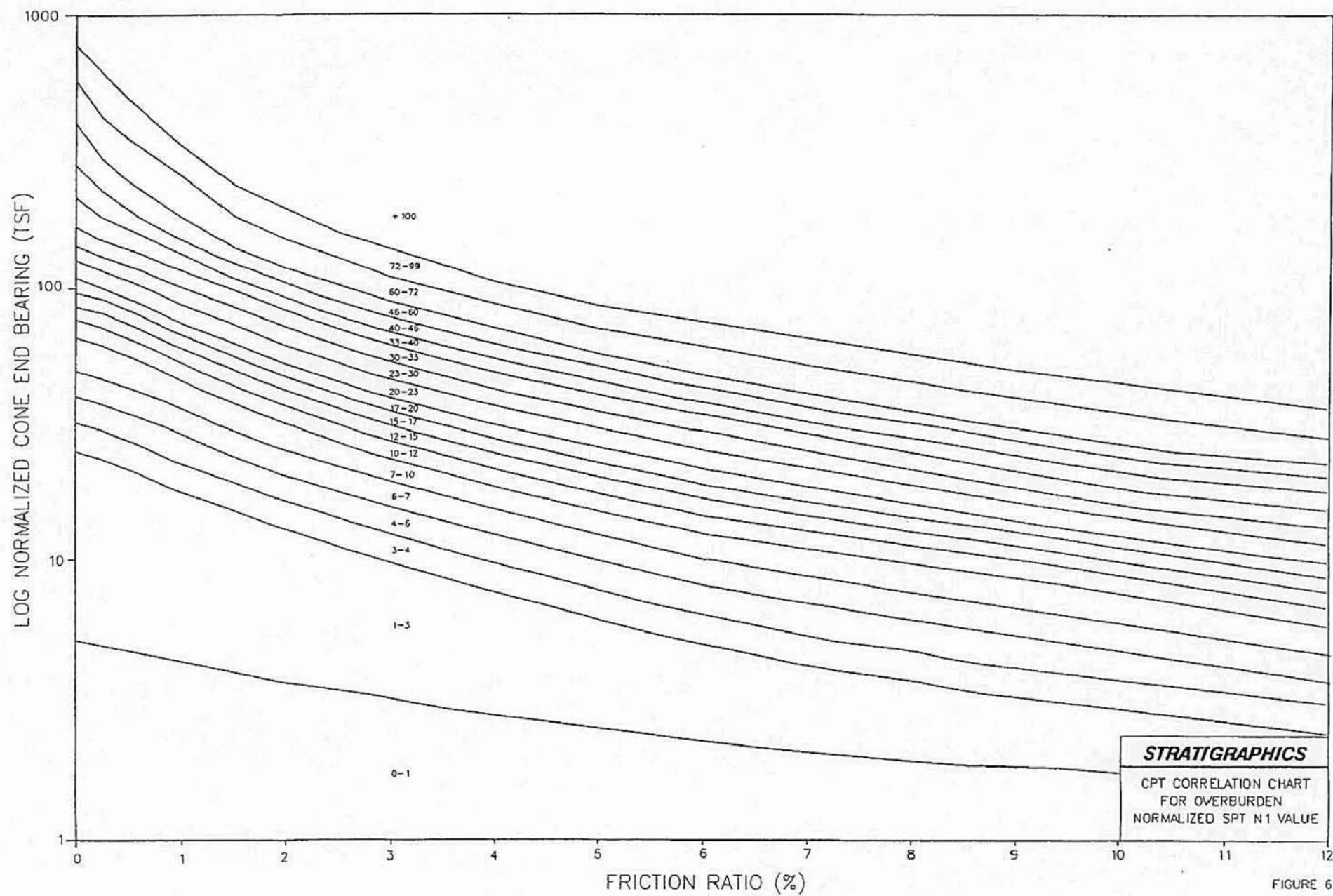


FIGURE 6

REV3

## APPENDIX B

from Baligh, M.M. and J. Levadoux, "Pore Pressure Dissipation After Cone Penetration," Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1980.

### 6.2.4 Evaluation of $c_h$ (probe)

At a given degree of consolidation, the predicted horizontal coefficient of consolidation  $c_h$  (probe) is obtained from the expression:  $c_h$  (probe) =  $R^2 T/t$  (6.2)

where  $R$  is the radius of the cone shaft,  $t$  is the measured time to reach this degree of consolidation; and  $T$  is the time factor. Table 5.1 provides values of  $T$  for different probe types at various degrees of consolidation.

An analytical method {equivalent to the graphical method described in Section 6.2.3} to check the validity of the prediction method consists of determining  $c_h$  at different dissipation stages, i.e., different  $u$ . Large differences between  $c_h$  at various degrees of consolidation indicate an inadequate initial distribution of excess pore pressure or significant coupling, or creep behavior.

The estimated values of  $c_h$  (probe) at 50% dissipation can be used in foundation problems involving horizontal water flow due to unloading or reloading of clays above the maximum past pressure. For problems involving vertical water flow in the overconsolidated range, the vertical coefficient of consolidation,  $c_v$  (probe), can be estimated from the expression:  $c_v$  (probe) =  $(k_v/k_h) c_h$  (probe) (6.3)

where  $k_v$  and  $k_h$  are the vertical and horizontal coefficients of permeability, respectively. Reliable estimates of the in situ anisotropy of clays as expressed by the ratio  $k_h/k_v$  is difficult to determine in the laboratory because of the effects of sample size, sample disturbance, ... etc. and is the subject of controversy (Rowe, 1972; Casagrande and Poulos, 1969). In situ tests to determine  $k_h/k_v$  are almost nonexistent. Table 6.2 provides rough estimates of  $k_h/k_v$  for different clays.

### 6.2.5 Prediction of $k_h$ (probe)

Approximate estimates of the horizontal coefficient of permeability,  $k_h$  (probe), can be obtained from the expression:  $k_h$  (probe) =  $(g_w/2.3s_{vo}) * RR(\text{probe}) * c_h$  (probe) (6.4)

where  $s_{vo}$  is the initial vertical effective stress ( $\text{kg/cm}^2$ );  $g_w$  is the unit weight of water ( $=10^{-3} \text{ kg/cm}^3$ ); and  $RR(\text{probe})$  is the recompression ratio during early stages of consolidation (50% dissipation, say). Results in both the upper and lower Boston Blue Clays indicate that: the average  $RR(\text{probe}) = 10^{-2}$  (6.5)

and generally  $0.5 * 10^{-2} < RR(\text{probe}) < 2 * 10^{-2}$  (6.6)

### 6.2.6 Prediction of $c_v(\text{NC})$

For foundation clays consolidated in the normally consolidated range, estimates of the coefficients of consolidation can be obtained from  $c_h$  (probe) by means of the expressions:

$$c_h(\text{NC}) = (RR(\text{probe})/CR) * c_h(\text{probe}) \quad (6.7)$$

for horizontal water flow, and  $c_v(\text{NC}) = (RR(\text{probe})/CR) * (k_v/k_h) * c_h(\text{probe})$  (6.8)  
for vertical water flow.

The compression ratio  $CR$  is the average slope of the strain vs. log effective stress plot in the appropriate effective stress range expected during consolidation of the foundation clay. Values of  $CR$  should be obtained from good quality samples carefully tested in the laboratory. Table 6.2 provides rough estimates of  $CR$  based on empirical correlation with index properties of various clays.

### Table 6.2 Empirical Correlation and Typical Properties of Clays

#### 1. Compression Ratio $CR$ (from Ladd, 1973)

$CR = C_c/(1+e_o)$  = slope of the strain vs. log stress curve

$e_o$  = initial void ratio

$C_c$  = virgin compression index = slope of  $e$  vs. log stress

$w_L$  = liquid limit

$w_N$  = natural water content

$C_c = 0.009 (w_L\% - 10\%)$

Terzaghi and Peck (1967)

$C_c = 0.54 (e_o - 0.35)$

Nishida (1958)

$C_c = 0.01 \text{ to } 0.15 (w_N\%)$

MPMR (1958)

$C_c = 0.6 (e_o - 1)$  for  $e_o < 6$

$C_c = 0.85 (e_o - 2)$  for  $6 < e_o < 14$

Kapp, (1966)

#### 2. Anisotropic Permeability of Clays (from Ladd, 1976)

Nature of Clay

1. No evidence of layering

$k_h/k_v$

1.2 +/- 0.2

2. Slight layering, e.g., sedimentary clays with occasional silt dustings to random lenses

2 to 5

3. Varved clays in northeastern U.S.

10 +/- 5