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TITLE: Determination of Liquefaction Potential at HBIP ISFSI Site

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Calculation Title: Determination of Liquefaction Potential at HBIP ISFSI Site
Calculation No.: GEO.HBIP.02.02
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Calculation Author: Karthik Narayanan (Geomatrix Consultants)
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PURPOSE

The purpose of this calculation is to evaluate the liquefaction potential of soils in the vicinity of the HBIP ISFSI Site. Liquefaction is a soil behavior phenomenon in which a loose, saturated soil loses a substantial amount of strength due to high excess pore water pressures generated by strong earthquake ground shaking. Recently deposited (in geologic terms) and relatively unconsolidated soils below the groundwater table have a high susceptibility to liquefaction. Sands and silty sands are particularly susceptible. Silts and gravels are also susceptible, and some sensitive clays have exhibited liquefaction-type strength losses.

The analyses described in this calculation package are conducted in accordance with the Work Plan GEO 2002-01 (PG&E, 2002a).

ASSUMPTIONS

The assumptions made to facilitate the analysis of liquefaction potential are:

1. Soils above the groundwater table are not liquefiable. Groundwater was assumed to be at elevation +6 feet, mean lower low water (MLLW). The groundwater elevation was evaluated based on the compression wave velocity profiles presented in PG&E (2002c) and shown on Figures 4 and 5. At elevation +6 feet, both wave velocity profiles show a rapid increase in compression wave speed (to about 5000 feet per second, the compression wave speed in water) without an accompanying increase in shear wave speed.
2. The soil profile has a constant unit weight of 125 pounds per cubic foot. This value is fairly typical for the subsurface conditions encountered in the borings (PG&E, 2002b).
3. Unless energy measurements were taken, SPT samplers driven with a safety hammer and rope and cathead arrangement were assumed to have an energy ratio of 60

percent. According to Seed et al (1985), an energy ratio of 60 percent is fairly typical for this arrangement.

INPUTS

A number of soil borings have been conducted over time in the vicinity of the ISFSI (Figure 1, as modified from PG&E, 2002d). The following screening steps were used in compiling the blowcount and laboratory data:

a) Seed et al (1985) discussed the importance of using standardized procedures for liquefaction evaluation. Only SPTs conducted with a standard sampler, and driven with a rope and cathead arrangement in borings drilled using rotary wash techniques were compiled.

b) samples classified as CL, CH, or MH were assumed not to be liquefiable, so their blowcounts were not included in the analysis.

c) Artificially high SPT blow counts occur when the sampler encounters cobbles or gravel. Blowcounts were excluded from samples where particles greater than 1-inch in diameter were reported.

d) Fines content values were taken from grain size analysis conducted on the sample collected with the SPT sampler. If such information was not available, the fines content from a nearby sample in the same lithologic unit was used for the liquefaction evaluation. If no grain size information was available, a value was assigned (consistent with the soil classification) that would result in the smallest blowcount correction.

Based on these four criteria, blowcounts from the following borings were used for the liquefaction analysis:

1) Borings 99-1, 99-2, 99-3, 99-4, and 99-5 drilled in 1999 by Geomatrix Consultants (PG&E, 2002b).

2) Borings 1, 2, 2A, 3, 4, 5, 5A, 6, 7, 8, 9, 10, and 10A drilled in 1973 by Dames and Moore (Dames and Moore, 1974).

3) Borings CH-1, CH-3, CH-4, and CH-5 drilled in 1980 by Woodward Clyde Consultants (Woodward Clyde Consultants, 1980).

The borings drilled by Geomatrix Consultants in 1999 consisted of five rotary wash borings, four of which (99-2, 99-3, 99-4, and 99-5) are in the immediate vicinity of the proposed ISFSI site (Figure 1). The data from these four borings are considered most representative of the conditions under the ISFSI site. The borings drilled by Dames and Moore and Woodward-Clyde are in the vicinity of Unit No. 3, located about 500 feet southeast of the ISFSI site (Figure 1), and were included in this analysis for comparative purposes.

Details of the drilling and sampling procedures for the borings drilled by Geomatrix Consultants in 1999 are presented in Data Report B (PG&E, 2002b). The soil descriptions, SPT blowcounts, and laboratory test results reported on the boring logs were used for this analysis.

Dames & Moore performed a number of rotary wash borings in the vicinity of Unit 3 to assess the potential for liquefaction at the site (Dames & Moore, 1974). The boring locations are shown on Figure 1. Field data such as standard penetration test (SPT) and U-type sampler blowcounts were collected, as well as laboratory-derived data such as dry densities and moisture contents.

Because Dames & Moore used the SPT sampler with a 140-pound hammer falling 30 inches, it is believed that the SPT blowcounts obtained by Dames & Moore can be reasonably compared with SPT blowcounts obtained in later investigations. However, because a number of other factors believed important in standardizing SPT blowcounts are not described, such as hammer type and release mechanism, sampler configuration, and drilling procedure, and because these SPT blowcounts were obtained prior to the time that these standardizations were in place, some variation between blowcount data sets can be expected due to differences in these factors. The U-type sampler, which was also used by Dames & Moore during their investigation, is proprietary to Dames & Moore and is significantly different in application from the SPT sampler, so the U blowcounts cannot be meaningfully compared with blowcounts obtained in later investigations and thus are not included in this evaluation.

Woodward-Clyde Consultants performed a number of additional rotary wash borings near Unit 3 to reassess site liquefaction susceptibility (Woodward-Clyde Consultants, 1980).

Approximate locations of these borings are shown on Figure 1. Field data such as standard penetration test (SPT) blowcounts were collected, as well as laboratory-derived data such as dry densities and moisture contents. it is believed that the SPT blowcounts obtained by Woodward-Clyde Consultants can reasonably be compared with SPT blowcounts obtained in later investigations.

METHODS

The method presented by Youd et al (2001) was used to evaluate liquefaction potential at the HBIP ISFSI site. The method is based on the analysis procedure outlined by Seed et al (1985) and revised by in a NCEER workshop (Youd and Idriss, 1997).

The liquefaction potential of the soils in the vicinity of the HBIP site was evaluated on the basis of standard penetration test (SPT) blowcounts. SPT blowcounts from the borings listed above ("Inputs") were compared to a limiting blowcount above which liquefaction would not occur. This limiting blowcount was based on the liquefaction susceptibility curves developed by Seed et al (1985), and adopted, with minor modifications, in a workshop on evaluation of liquefaction resistance of soils (Youd and Idriss, 1997) and was published by Youd et al (2001). The liquefaction susceptibility curves are shown on Figure 3. The liquefaction susceptibility curve for clean sands shows that at very high earthquake-induced cyclic stress ratios, values of $(N_1)_{60}$ for clean sands asymptotically approach a limiting value of 30 blows per foot.

SPT blowcounts were normalized to $(N_1)_{60}$ blowcounts. The parameter $(N_1)_{60}$ represents the blowcount (N-value) from a "standard" SPT conducted in a soil boring, normalized to an effective overburden pressure of one atmosphere. A "standard" SPT blowcount or N-value is obtained from a SPT sampler driven 18 inches into the soil by a 140-pound hammer falling 30 inches. The recorded SPT blowcount is the number of blows required to drive the sampler the final 12 inches. When soil conditions did not permit the sampler to be driven a full 18-inches (i.e., refusal), the blowcount recorded for the fraction of the final 12-inches was extrapolated to obtain an "equivalent" 12-inch blowcount.

SPT blowcounts were normalized to an effective overburden pressure of one atmosphere by multiplying the blowcount by the factor C_N, as defined by Youd et al (2001):

$$C_N = \left(\frac{P_a}{\sigma'_v}\right)^{0.5}$$

where P_a = atmospheric pressure (2116 pounds per square foot)

σ'_v = effective overburden pressure

The subscript "60" in the notation $(N_1)_{60}$ indicates that a "standard" blowcount is obtained using a hammer and a drop system that delivers 60 percent of the theoretical free-fall energy to the rods connecting the hammer to the sampler. The standard procedures were developed for blowcounts obtained with a rope and cathead system using a safety hammer and two wraps of the rope around the cathead. This "standard" system assumes an energy transfer efficiency of 60 percent. Blowcounts from borings 99-1 and 99-2 were obtained using a rope and cathead system. Energy measurements, which were taken in the upper 40 feet of boring 99-1, indicated an average energy transfer of about 50 percent (PG&E, 2002b). Therefore, blowcounts from borings 99-1 and 99-2 were multiplied by 50/60 in order to adjust to the standard energy level. Blowcounts from borings 99-3 through 99-5 were obtained with an automatic trip hammer. Automatic trip hammers typically achieve higher energy delivery than rope and cathead systems. Energy measurements obtained in previous studies for automatic trip hammers indicate an average transfer efficiency of 70 to 80 percent (Seed et al., 1985). Since no site-specific energy measurements were made during this investigation, it was conservatively assumed that the energy delivered by the automatic trip hammer was equal to about 60 percent of the theoretical energy. Therefore, no corrections were made to the blowcounts from borings 99-3 through 99-5 to adjust them to the standard energy transfer efficiency of 60 percent.

Seed et al. (1985) developed the correlation further to include the influence of fines content. The correlation shows that the penetration resistance for silty sands is less than that for clean sands, for a given cyclic resistance ratio (CRR). This is likely due to the greater compressibility and decreased permeability of silty sands, which can artificially reduce their field penetration resistance. Based on Youd et al (2001), the correction for fines content is (algebraically recast by the authors):

$$\Delta(N_1)_{60} = \alpha + (\beta - 1)(N_1)_{60}$$

where:

$\alpha = 0$, and $\beta = 1.0$ for $FC \leq 5\%$

$\alpha = \exp[1.76 - (190/FC^2)]$, and $\beta = [0.99 + (FC^{1.5}/1000)]$ for $5\% < FC < 35\%$

$\alpha = 5$, and $\beta = 1.2$ for $FC \geq 35\%$

where FC is the fines content (percent). Thus, the fines-corrected blow count, $(N_1)_{60\text{-}cs}$, is equal to $(N_1)_{60} + \Delta(N_1)_{60}$. It is noted that according to the equations listed above, $\Delta(N_1)_{60}$ is a function of not only the fines content, but also the uncorrected blowcount. Since the liquefaction curves on Figure 3 become vertically asymptotic at high CRR values, the curves imply that the fines correction is limited by the distance between the curves for a particular fines content and the clean sand curve. Such a limitation does not exist in the equations listed above, so for this analysis, a cap was imposed on the blowcount correction. The cap was calculated as the distance between the asymptotic portions of the curves on Figure 3. For example, for a fines content of 35 percent, the blowcount correction cap is 8.3 (the distance between the clean sand curve and the FC = 35 curve). Intermediate values were calculated by linear interpolation.

It is noted that soil classifications reported from the borings drilled by Dames and Moore (1974) do not appear to be consistent with ASTM Standard D2488, the current state of practice. This inconsistency should not effect the analysis when grain size test results are used either from the SPT sample or from a nearby sample in the same lithologic unit. Inconsistency in classification could effect the analysis when grain size test results are not available for the SPT sample and must be assumed on the basis of the soil classification.

SOFTWARE

The calculations for the analysis of liquefaction potential were conducted in Microsoft Excel. The spreadsheet was verified by hand calculation, as described below.

ANALYSIS

The calculations for the analysis of liquefaction potential were conducted in Microsoft Excel. The analysis spreadsheets are included in this calculation package. A hand check of the calculations was conducted for one data point and is presented in this calculation package. The hand check successfully duplicated the value in the spreadsheet.

RESULTS AND CONCLUSION

With the exception of two values (22 and 24), the $(N_1)_{60\text{-}cs}$ blowcounts from borings 99-1 through 99-5 are greater than 30 (Figure 2). As previously described, data from borings drilled during previous studies in the vicinity of Unit No. 3 (located about 500 feet southeast of the ISFSI site) were analyzed and are presented on Figure 2 for comparison purposes. Five blowcounts from the borings drilled by Dames and Moore (1974) fall below 30. No blowcounts from the borings drilled by Woodward Clyde in 1980 fall below 30. Since nearly all of the $(N_1)_{60\text{-}cs}$ blowcounts are greater than 30, it is concluded that the site is not susceptible to liquefaction.

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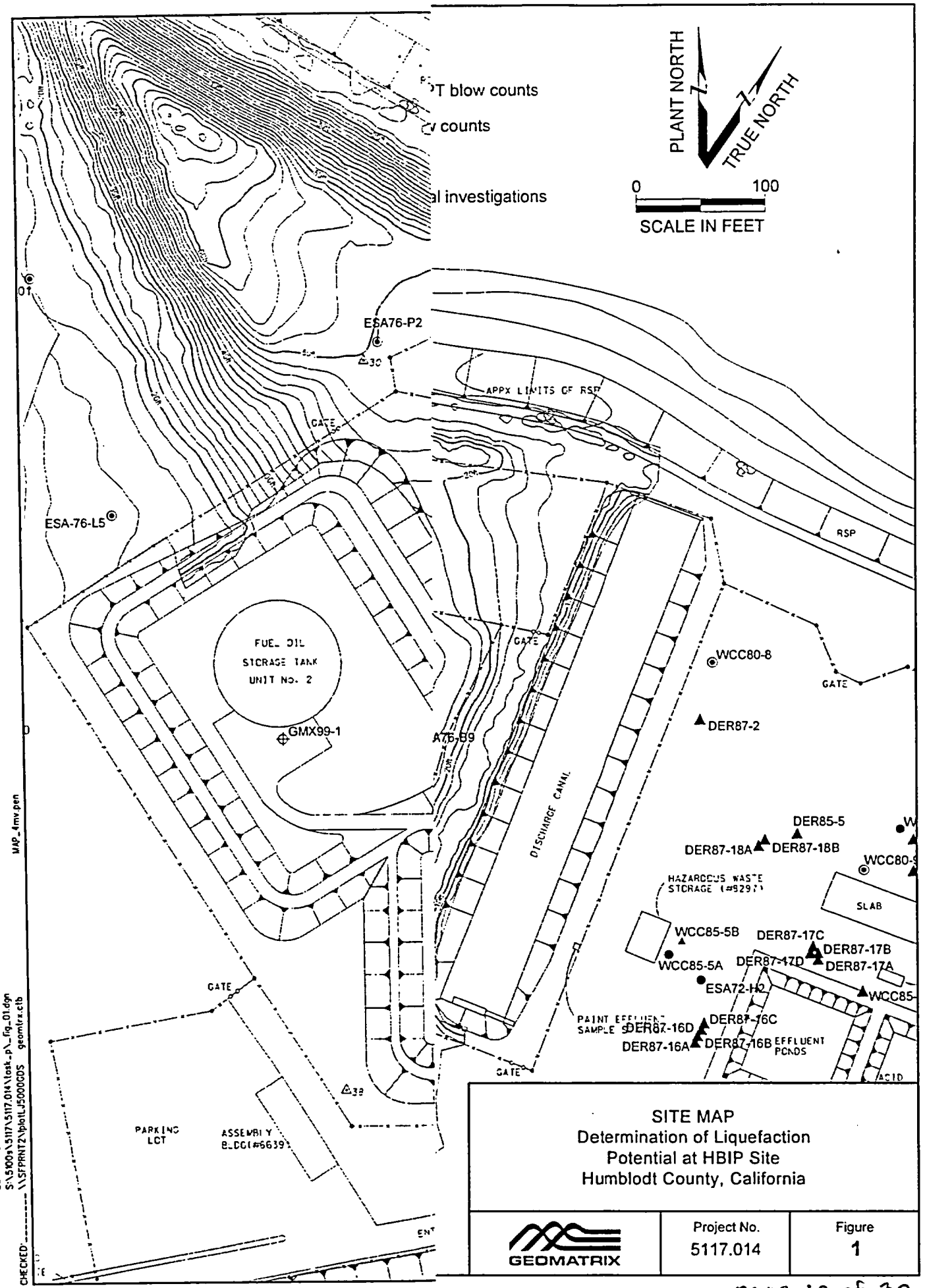


SITE MAP
Determination of Liquefaction
Potential at HBIP Site
Humblodt County, California

GEOMATRIX	Project No. 5117.014	Figure 1

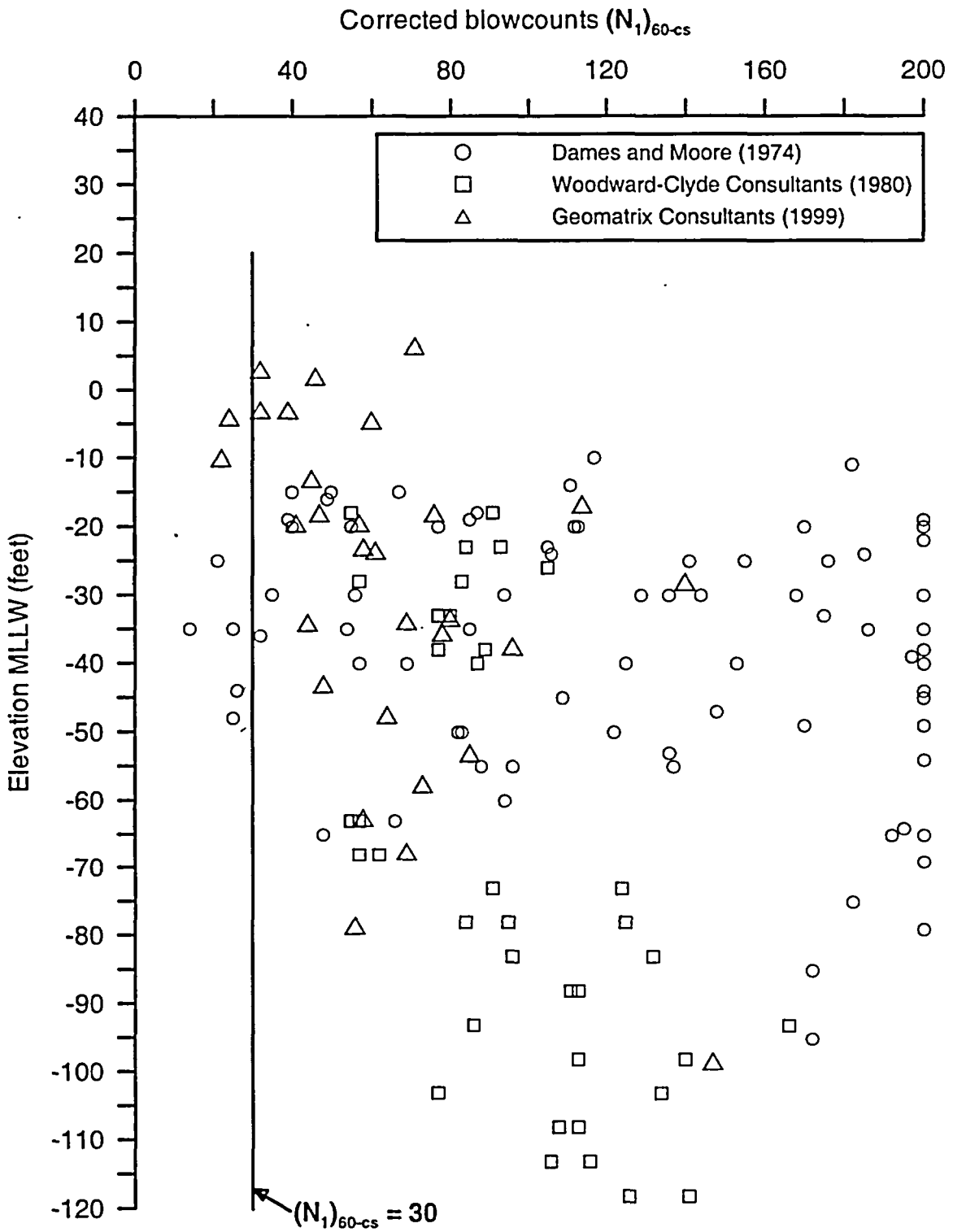
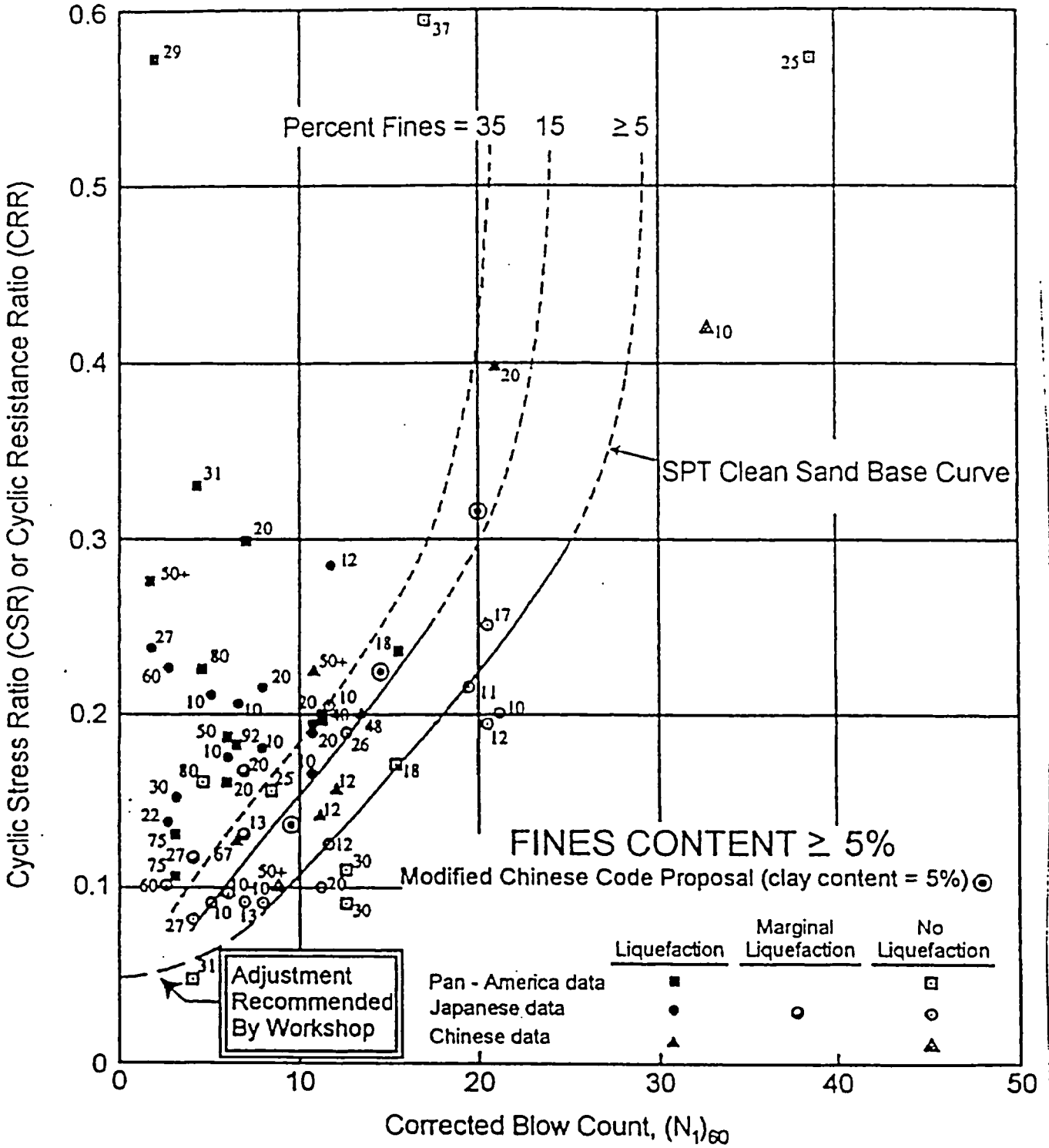


FIGURE 2 - Scatter plot of corrected SPT blowcounts

Non-GDS



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GEOMATRIX

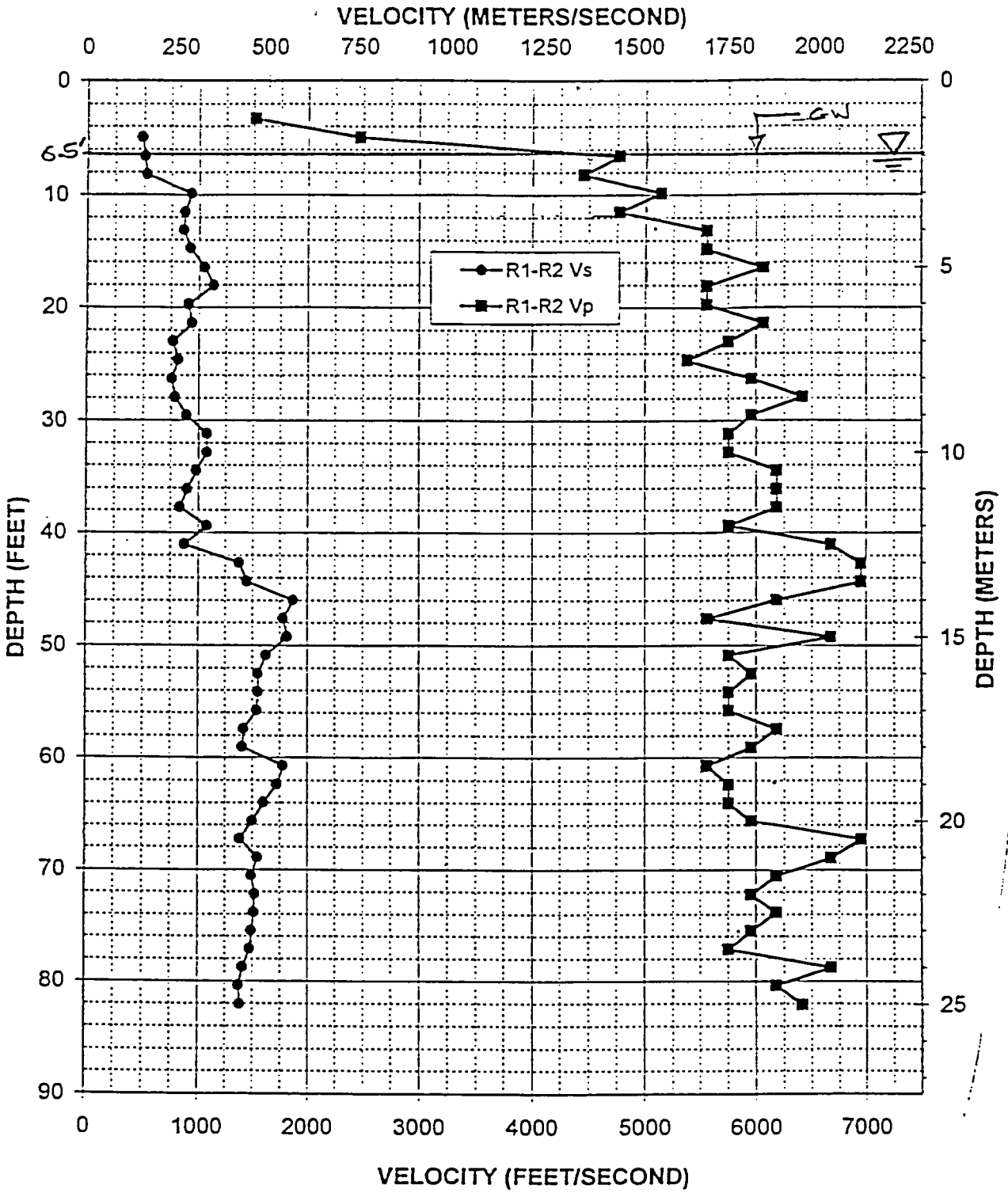
LIQUEFACTION SUSCEPTIBILITY CURVES (YOUD ET AL, 2001)
Determination of Liquefaction Potential at HBIP ISFSI Site
Humboldt County, California

Project No. 5117.014.P

Figure 3

Non-GDS

HUMBOLT BAY POWER PLANT BOREHOLE 99-1
Receiver to Receiver Analysis



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GEOMATRIX

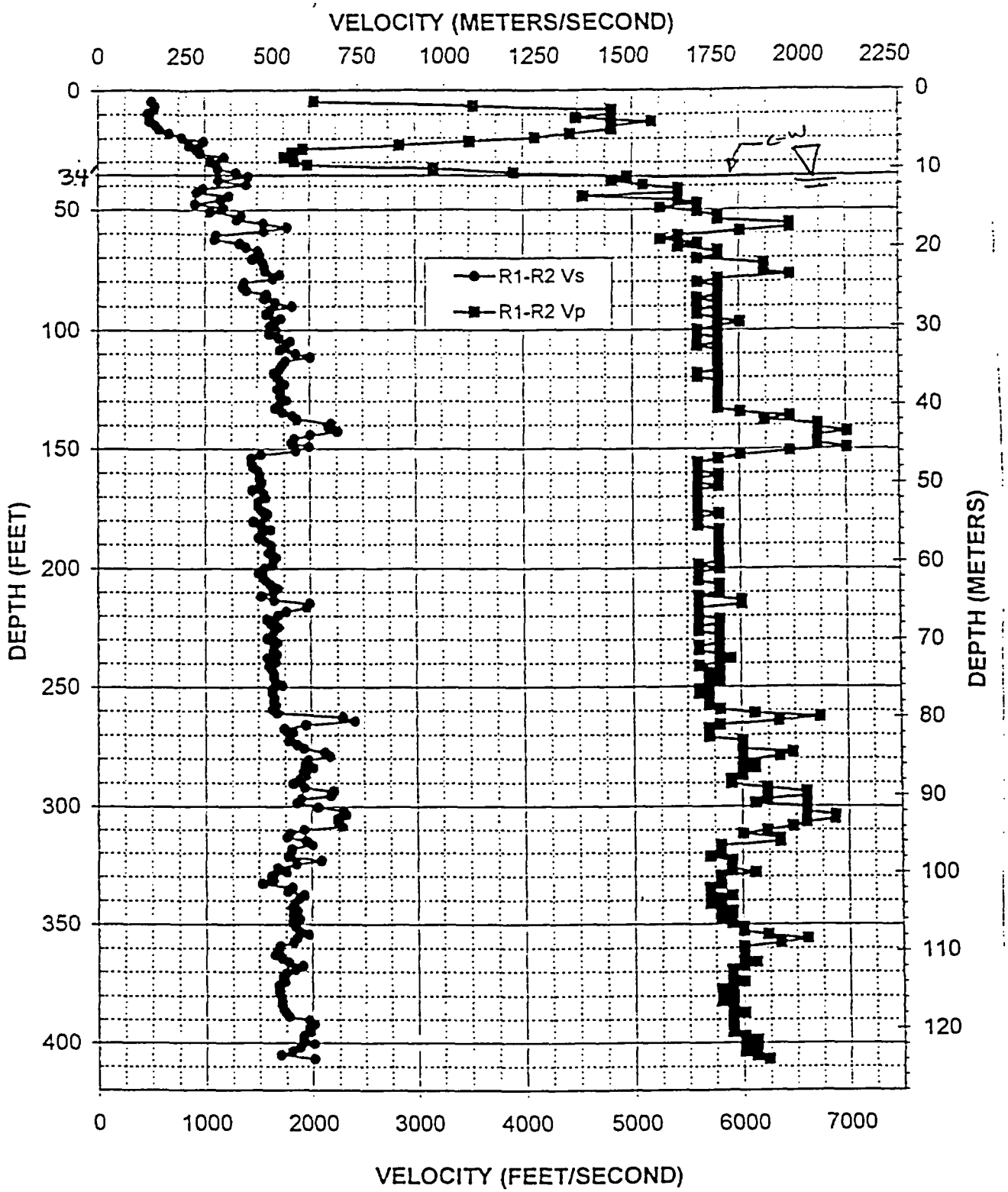
SHEAR AND COMPRESSION WAVE VELOCITY PROFILE, 99-1
Determination of Liquefaction Potential at HBIP ISFSI Site
Humboldt County, California

Project No. 5117.014.P

Figure 4

Non-GDS

HUMBOLDT BAY POWER PLANT BOREHOLE 99-2
Receiver to Receiver Analysis



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GEOMATRIX

SHEAR AND COMPRESSION WAVE VELOCITY PROFILE, 99-2
Determination of Liquefaction Potential at HBIP ISFSI Site
Humboldt County, California

Project No. 5117.014.P

Figure 5

5117.03 – HBPP ISFSI (Geomatrix 1999 Borings)

Standardized Blow Count Data Worksheet For Calculating N60 Values

(N60 Values corrected for sampler type and configuration, hammer efficiency, and rod length; no depth correction)

Key:

Sampler/Hammer Type s = small sampler (1.375-inch I D) and hammer (140#); l = large sampler (2 5-inch I D) and hammer (340#)

Rod length: C_{rods} = 0 75 to 13ft, 0 85 to 20ft, 0 95 to 33ft

Sampler w/out Liners: $C_{noliners}$ = 1.2, Borehole diameter: $C_{borehole}$ = 1.15

Boring Number	Sample Depth (ft)	Blow Count, N	Sampler/Hammer Type	Sampler Correction	N_{small}	C_{rods}	C_{energy}	N_{60}
99-1	17.5	67	SPT	1	67	0.85	0.8333	47.5
99-1	26	54	SPT	1	54	0.95	0.8333	42.8
99-1	31	60	SPT	1	60	0.95	0.8333	47.5
99-1	36	78	SPT	1	78	1	0.8333	65
99-1	41	200	SPT	1	200	1	0.8333	166.7
99-1	48.5	200	SPT	1	200	1	0.8333	166.7
99-1	50.5	150	SPT	1	150	1	0.8333	125
99-1	56	78	SPT	1	78	1	0.8333	65
99-1	60.5	109.09	SPT	1	109.09	1	0.8333	90.9
99-1	66	150	SPT	1	150	1	0.8333	125
99-1	70.5	133.33	SPT	1	133.33	1	0.8333	111.1
99-1	75.5	109.09	SPT	1	109.09	1	0.8333	90.9
99-1	80.5	133.33	SPT	1	133.33	1	0.8333	111.1
99-2	35.5	109.09	SPT	1	109.09	1	0.8333	90.9
99-2	46	44	SPT	1	44	1	0.8333	36.7
99-2	61.5	78	SPT	1	78	1	0.8333	65
99-2	65.5	120	SPT	1	120	1	0.8333	100
99-2	75.25	171.43	SPT	1	171.43	1	0.8333	142.9
99-2	75.75	150	SPT	1	150	1	0.8333	125
99-2	120.5	140	SPT	1	140	1	0.8333	116.7
99-2	140.25	400	SPT	1	400	1	0.8333	333.3
99-3	41	57	SPT	1	57	1	1	57
99-3	46	49	SPT	1	49	1	1	49
99-3	53	24	SPT	1	24	1	1	24
99-3	61	130	SPT	1	130	1	1	130
99-3	77	84	SPT	1	84	1	1	84
99-4	46	39	SPT	1	39	1	1	39
99-4	62.5	98	SPT	1	98	1	1	98
99-5	41	37	SPT	1	37	1	1	37
99-5	60.75	200	SPT	1	200	1	1	200

5117.03 -- HBPP ISFSI (Geomatrix 1999 Borings)
Standardized Blow Count Data Worksheet For Calculating (N1)60 Values

Boring Number	Groundwater Depth (ft)	Sample Depth (ft)	Standardized N_{60}	Avg Unit Wt Below Previous Sample (pcf)	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N	$(N_1)_{60}$
99-1	7	17.5	47.5	125	2188	1532	1.17513	56
99-1	7	26	42.8	125	3250	2064	1.01242	43
99-1	7	31	47.5	125	3875	2377	0.943424	45
99-1	7	36	65	125	4500	2690	0.886848	58
99-1	7	41	166.7	125	5125	3003	0.839366	140
99-1	7	48.5	166.7	125	6063	3473	0.78057	130
99-1	7	50.5	125	125	6313	3598	0.766869	96
99-1	7	56	65	125	7000	3942	0.732618	48
99-1	7	60.5	90.9	125	7563	4224	0.707768	64
99-1	7	66	125	125	8250	4568	0.680575	85
99-1	7	70.5	111.1	125	8813	4850	0.660515	73
99-1	7	75.5	90.9	125	9438	5163	0.640181	58
99-1	7	80.5	111.1	125	10063	5476	0.621616	69
99-2	34	35.5	90.9	125	4438	4344	0.69794	63
99-2	34	46	36.7	125	5750	5001	0.65046	24
99-2	34	61.5	65	125	7688	5972	0.595273	39
99-2	34	65.5	100	125	8188	6222	0.583172	58
99-2	34	75.25	142.9	125	9406	6832	0.556514	80
99-2	34	75.75	125	125	9469	6864	0.555243	69
99-2	34	120.5	116.7	125	15063	9665	0.467907	55
99-2	34	140.25	333.3	125	17531	10901	0.440575	147
99-3	37	41	57	125	5125	4875	0.658799	38
99-3	37	46	49	125	5750	5188	0.638618	31
99-3	37	(53)	24	125	6625	5627	0.5962	14
99-3	37	61	130	125	7625	6127	0.571317	74
99-3	37	77	84	125	9625	7129	0.529664	44
99-4	37	(46)	39	125	5750	5188	0.620867	24
99-4	37	62.5	98	125	7813	6221	0.566989	56
99-5	38	(41)	37	125	5125	4938	0.636426	24
99-5	38	60.75	200	125	7594	6174	0.56915	114

5117.03 – HBPP ISFSI (Geomatrix 1999 Borings)

Standardized Blow Count Data Worksheet For Calculating "Clean-Sand" (N1)60 Values

Applies correction values for sands containing fines, converting (N1)60 values to "equivalent" (N1)60 values in clean sand

Boring Number	Sample Depth (ft)	$(N_1)_{60}$	USCS	max particle size(in)	%fines (bold = sieve)	Fines Corr (Youd)	Fines Correction Cap	$(N_1)_{60\text{-}cs}$ Capped at 200	Sample Elevation (ft)
99-1	17.5	56	sm	0	**14**	4.58	4.14	60	-4.5
99-1	26	43	sw-sm	0	**11**	2.35	2.76	45	-13
99-1	31	45	sw-sm	0	**11**	2.40	2.76	47	-18
99-1	36	58	sp	0	0	0.00	0.00	58	-23
99-1	41	140	sp	0	5	0.00	0.00	140	-28
99-1	48.5	130	sp	0	5	0.00	0.00	130	-35.5
99-1	50.5	96	sp	0	5	0.00	0.00	96	-37.5
99-1	56	48	sp	0	5	0.00	0.00	48	-43
99-1	60.5	64	sp	0	3	0.00	0.00	64	-47.5
99-1	66	85	sw	0	3	0.00	0.00	85	-53
99-1	70.5	73	sw	0	**3**	0.00	0.00	73	-57.5
99-1	75.5	58	sp	0	0	0.00	0.00	58	-62.5
99-1	80.5	69	sp	0	0	0.00	0.00	69	-67.5
99-2	35.5	63	sp	0	48	17.60	8.30	71	6.5
99-2	46	24	gw	1	0	0.00	0.00	24	-4
99-2	61.5	39	sp-sm	0	**11**	2.24	2.76	41	-19.5
99-2	65.5	58	sp-sm	0	11	2.74	2.76	61	-23.5
99-2	75.25	80	sw	0	2	0.00	0.00	80	-33.25
99-2	75.75	69	sw	0	2	0.00	0.00	69	-33.75
99-2	120.5	55	sp-sm	0	8	0.99	1.38	56	-78.5
99-2	140.25	147	sp	0	**3**	0.00	0.00	147	-98.25
99-3	41	38	sm	0	**46**	12.60	8.30	46	2
99-3	46	31	sm	0	**34**	10.77	8.12	39	-3
99-3	53	14	ml	0	**88**	7.80	8.30	22	-10
99-3	61	74	sp-sm	0	**10**	2.47	2.30	76	-18
99-3	77	44	gp	0	1	0.00	0.00	44	-34
99-4	46	24	sm	0	**35**	9.80	8.30	32	-3
99-4	62.5	56	sw-sm	0	8	1.01	1.38	57	-19.5
99-5	41	24	ml	0	**56**	9.80	8.30	32	3
99-5	60.75	114	sw	0	0	0.00	0.00	114	-16.75

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)

Standardized Blow Count Data Worksheet For Calculating N60 Values Data Set:A3B1C1

(N60 Values corrected for sampler type and configuration, hammer efficiency, and rod length; no depth correction)

Key:

Sampler Type: s = standard penetrometer w/ 1.375-inch I.D.; c = California sampler w/ 2.0-inch I.D.; m = modified California sampler w/ 2.5-inch I.D

Sampler w/out Liners: y = no liners (tubes, rings); n = either sampler has no room for liners or sampler with room for liners and liners used

Hammer Configuration: rs =rope&cathead, safety hammer; ws =wireline release, safety hammr; ms =mechanical trip, safety hammr; o =other, w/ efficiency = [ ] in % (eg rs=60)

Boring Number	Sample Depth (ft)	Blow Count, N	Sampler Type	Sampler w/out Liners?	Hammer Configuration	C_{rods}	$C_{sampler}$	$C_{noliners}$	C_{energy}	N_{60}
DM73-1	31	89	s	n	rs	1	1	1	1	89
DM73-1	37	175	s	n	rs	1	1	1	1	175
DM73-1	48	41	s	n	rs	1	1	1	1	41
DM73-1	56	33	s	n	rs	1	1	1	1	33
DM73-1	62	113	s	n	rs	1	1	1	1	113
DM73-2	31	300	s	n	rs	1	1	1	1	300
DM73-2	37	198	s	n	rs	1	1	1	1	198
DM73-2	51	256	s	n	rs	1	1	1	1	256
DM73-2	67	194	s	n	rs	1	1	1	1	194
DM73-2	77	300	s	n	rs	1	1	1	1	300
DM73-2	87	300	s	n	rs	1	1	1	1	300
DM73-2A	28	48	s	n	rs	1	1	1	1	48
DM73-2A	32	119	s	n	rs	1	1	1	1	119
DM73-3	26	105	s	n	rs	1	1	1	1	105
DM73-3	31	39	s	n	rs	1	1	1	1	39
DM73-3	34	400	s	n	rs	1	1	1	1	400
DM73-3	42	42	s	n	rs	1	1	1	1	42
DM73-3	47	105	s	n	rs	1	1	1	1	105
DM73-3	52	64	s	n	rs	1	1	1	1	64
DM73-3	56	300	s	n	rs	1	1	1	1	300
DM73-3	61	400	s	n	rs	1	1	1	1	400
DM73-3	66	600	s	n	rs	1	1	1	1	600
DM73-3	76	300	s	n	rs	1	1	1	1	300
DM73-4	27	59	s	n	rs	1	1	1	1	59
DM73-4	32	300	s	n	rs	1	1	1	1	300
DM73-4	37	159	s	n	rs	1	1	1	1	159
DM73-4	42	162	s	n	rs	1	1	1	1	162
DM73-4	57	300	s	n	rs	1	1	1	1	300
DM73-5	42	59	s	n	rs	1	1	1	1	59
DM73-5	47	17	s	n	rs	1	1	1	1	17
DM73-5	52	163	s	n	rs	1	1	1	1	163
DM73-5	62	171	s	n	rs	1	1	1	1	171
DM73-5	67	128	s	n	rs	1	1	1	1	128
DM73-5	77	67	s	n	rs	1	1	1	1	67
DM73-5	107	300	s	n	rs	1	1	1	1	300
DM73-5A	45	208	s	n	rs	1	1	1	1	208

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)

Standardized Blow Count Data Worksheet For Calculating N60 Values Data Set:A3B1C1

(N60 Values corrected for sampler type and configuration, hammer efficiency, and rod length; no depth correction)

Key:

Sampler Type: s = standard penetrometer w/ 1.375-inch I.D.; c = California sampler w/ 2.0-inch I.D.; m = modified California sampler w/ 2.5-inch I.D

Sampler w/out Liners: y = no liners (tubes, rings); n = either sampler has no room for liners or sampler with room for liners and liners used

Hammer Configuration: rs =rope&cathead, safety hammer; ws =wireline release, safety hammr; ms =mechanical trip, safety hammr; o =other, w/ efficiency = [ ] in % (eg. rs=60)

Boring Number	Sample Depth (ft)	Blow Count, N	Sampler Type	Sampler w/out Liners?	Hammer Configuration	C_{rods}	$C_{sampler}$	$C_{noliners}$	C_{energy}	N_{60}
DM73-5A	50	350	s	n	rs	1	1	1	1	350
DM73-5A	60	35	s	n	rs	1	1	1	1	35
DM73-5A	65	197	s	n	rs	1	1	1	1	197
DM73-5A	75	102	s	n	rs	1	1	1	1	102
DM73-6	27	40	s	n	rs	1	1	1	1	40
DM73-6	32	82	s	n	rs	1	1	1	1	82
DM73-6	36	200	s	n	rs	1	1	1	1	200
DM73-6	42	600	s	n	rs	1	1	1	1	600
DM73-6	47	31	s	n	rs	1	1	1	1	31
DM73-6	52	400	s	n	rs	1	1	1	1	400
DM73-6	77	400	s	n	rs	1	1	1	1	400
DM73-6	91	600	s	n	rs	1	1	1	1	600
DM73-7	23	168	s	n	rs	1	1	1	1	168
DM73-7	30	86	s	n	rs	1	1	1	1	86
DM73-7	35	113	s	n	rs	1	1	1	1	113
DM73-7	42	171	s	n	rs	1	1	1	1	171
DM73-7	52	91	s	n	rs	1	1	1	1	91
DM73-7	57	149	s	n	rs	1	1	1	1	149
DM73-7	61	240	s	n	rs	1	1	1	1	240
DM73-7	67	141	s	n	rs	1	1	1	1	141
DM73-8	32	115	s	n	rs	1	1	1	1	115
DM73-8	42	149	s	n	rs	1	1	1	1	149
DM73-8	47	67	s	n	rs	1	1	1	1	67
DM73-8	59	200	s	n	rs	1	1	1	1	200
DM73-9	22	106	s	n	rs	1	1	1	1	106
DM73-9	27	49	s	n	rs	1	1	1	1	49
DM73-9	32	180	s	n	rs	1	1	1	1	180
DM73-9	42	200	s	n	rs	1	1	1	1	200
DM73-9	47	400	s	n	rs	1	1	1	1	400
DM73-10	32	52	s	n	rs	1	1	1	1	52
DM73-10	37	22	s	n	rs	1	1	1	1	22
DM73-10	42	240	s	n	rs	1	1	1	1	240
DM73-10	47	231	s	n	rs	1	1	1	1	231
DM73-10	52	300	s	n	rs	1	1	1	1	300
DM73-10	57	400	s	n	rs	1	1	1	1	400
DM73-10A	32	41	s	n	rs	1	1	1	1	41

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)

Standardized Blow Count Data Worksheet For Calculating N60 Values Data Set:A3B1C1

(N60 Values corrected for sampler type and configuration, hammer efficiency, and rod length; no depth correction)

Key:

Sampler Type: s = standard penetrometer w/ 1.375-inch I.D.; c = California sampler w/ 2.0-inch I.D.; m = modified California sampler w/ 2.5-inch I.D

Sampler w/out Liners: y = no liners (tubes, rings); n = either sampler has no room for liners or sampler with room for liners and liners used

Hammer Configuration: rs =rope&cathead, safety hammer; ws =wireline release, safety hammr; mrs =mechanical trip, safety hammr; o =other, w/ efficiency = [ ] in % (eg rs=60)

Boring Number	Sample Depth (ft)	Blow Count, N	Sampler Type	Sampler w/out Liners?	Hammer Configuration	C_{rods}	$C_{sampler}$	$C_{noliners}$	C_{energy}	N_{60}
DM73-10A	36	117	s	n	rs	1	1	1	1	117
DM73-10A	42	106	s	n	rs	1	1	1	1	106
DM73-10A	52	200	s	n	rs	1	1	1	1	200
DM73-10A	62	116	s	n	rs	1	1	1	1	116
DM73-10A	72	138	s	n	rs	1	1	1	1	138
DM73-10A	81	400	s	n	rs	1	1	1	1	400
DM73-10A	97	300	s	n	rs	1	1	1	1	300
WC80-1	38	120	s	n	rs	1	1	1	1	120
WC80-1	90	160	s	n	rs	1	1	1	1	160
WC80-3	52	114	s	n	rs	1	1	1	1	114
WC80-4	30	94	s	n	rs	1	1	1	1	94
WC80-4	35	93	s	n	rs	1	1	1	1	93
WC80-4	40	97	s	n	rs	1	1	1	1	97
WC80-4	45	98	s	n	rs	1	1	1	1	98
WC80-4	50	99	s	n	rs	1	1	1	1	99
WC80-4	75	88	s	n	rs	1	1	1	1	88
WC80-4	80	99	s	n	rs	1	1	1	1	99
WC80-4	85	204	s	n	rs	1	1	1	1	204
WC80-4	90	211	s	n	rs	1	1	1	1	211
WC80-4	95	229	s	n	rs	1	1	1	1	229
WC80-4	100	196	s	n	rs	1	1	1	1	196
WC80-4	105	300	s	n	rs	1	1	1	1	300
WC80-4	110	260	s	n	rs	1	1	1	1	260
WC80-4	115	253	s	n	rs	1	1	1	1	253
WC80-4	120	218	s	n	rs	1	1	1	1	218
WC80-4	125	209	s	n	rs	1	1	1	1	209
WC80-4	130	282	s	n	rs	1	1	1	1	282
WC80-5	30	57	s	n	rs	1	1	1	1	57
WC80-5	35	102	s	n	rs	1	1	1	1	102
WC80-5	40	66	s	n	rs	1	1	1	1	66
WC80-5	45	94	s	n	rs	1	1	1	1	94
WC80-5	50	114	s	n	rs	1	1	1	1	114
WC80-5	75	85	s	n	rs	1	1	1	1	85
WC80-5	80	91	s	n	rs	1	1	1	1	91
WC80-5	85	150	s	n	rs	1	1	1	1	150
WC80-5	90	141	s	n	rs	1	1	1	1	141

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)

Standardized Blow Count Data Worksheet For Calculating N60 Values Data Set:A3B1C1

(N60 Values corrected for sampler type and configuration, hammer efficiency, and rod length; no deptn correction)

Key:

Sampler Type: s = standard penetrometer w/ 1.375-inch I.D.; c = California sampler w/ 2.0-inch I.D.; m = modified California sampler w/ 2.5-inch I.D

Sampler w/out Liners: y = no liners (tubes, rings); n = either sampler has no room for liners or sampler with room for liners and liners used

Hammer Configuration: rs =rope&cathead, safety hammer; ws =wireline release, safety hammr; ms =mechanical trip, safety hammr; o =other, w/ efficiency = [ ] in % (eg. rs=60)

Boring Number	Sample Depth (ft)	Blow Count, N	Sampler Type	Sampler w/out Liners?	Hammer Configuration	C_{rods}	$C_{sampler}$	$C_{noliners}$	C_{energy}	N_{60}
WC80-5	95	166	s	n	rs	1	1	1	1	166
WC80-5	100	200	s	n	rs	1	1	1	1	200
WC80-5	105	155	s	n	rs	1	1	1	1	155
WC80-5	110	209	s	n	rs	1	1	1	1	209
WC80-5	115	146	s	n	rs	1	1	1	1	146
WC80-5	120	209	s	n	rs	1	1	1	1	209
WC80-5	125	229	s	n	rs	1	1	1	1	229
WC80-5	130	253	s	n	rs	1	1	1	1	253

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)
Standardized Blow Count Data Worksheet For Calculating (N1)60 Values

Boring Number	Groundwater Depth (ft)	Sample Depth (ft)	Standardized N_{60}	Avg Unit Wt Below Previous Sample (pcf)	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N	$(N_1)_{60}$
DM73-1	6	31	89	125	3875	2315	0.9561	85
DM73-1	6	37	175	125	4625	2690.6	0.8868	155
DM73-1	6	48	41	125	6000	3379.2	0.7913	32
DM73-1	6	56	33	125	7000	3880	0.7385	24
DM73-1	6	62	113	125	7750	4255.6	0.7051	80
DM73-2	6	31	300	125	3875	2315	0.9561	287
DM73-2	6	37	198	125	4625	2690.6	0.8868	176
DM73-2	6	51	256	125	6375	3567	0.7702	197
DM73-2	6	67	194	125	8375	4568.6	0.6806	132
DM73-2	6	77	300	125	9625	5194.6	0.6382	191
DM73-2	6	87	300	125	10875	5820.6	0.6029	181
DM73-2A	6	28	48	125	3500	2127.2	0.9974	48
DM73-2A	6	32	119	125	4000	2377.6	0.9434	112
DM73-3	6	26	105	125	3250	2002	1.0281	108
DM73-3	6	31	39	125	3875	2315	0.9561	37
DM73-3	6	34	400	125	4250	2502.8	0.9195	368
DM73-3	6	42	42	125	5250	3003.6	0.8393	35
DM73-3	6	47	105	125	5875	3316.6	0.7988	84
DM73-3	6	52	64	125	6500	3629.6	0.7635	49
DM73-3	6	56	300	125	7000	3880	0.7385	222
DM73-3	6	61	400	125	7625	4193	0.7104	284
DM73-3	6	66	600	125	8250	4506	0.6853	411
DM73-3	6	76	300	125	9500	5132	0.6421	193
DM73-4	6	27	59	125	3375	2064.6	1.0124	60
DM73-4	6	32	300	125	4000	2377.6	0.9434	283
DM73-4	6	37	159	125	4625	2690.6	0.8868	141
DM73-4	6	42	162	125	5250	3003.6	0.8393	136
DM73-4	6	57	300	125	7125	3942.6	0.7326	220
DM73-5	6	42	59	125	5250	3003.6	0.8393	50
DM73-5	6	47	17	125	5875	3316.6	0.7988	14
DM73-5	6	52	163	125	6500	3629.6	0.7635	124
DM73-5	6	62	171	125	7750	4255.6	0.7051	121
DM73-5	6	67	128	125	8375	4568.6	0.6806	87
DM73-5	6	77	67	125	9625	5194.6	0.6382	43
DM73-5	6	107	300	125	13375	7072.6	0.547	164
DM73-5A	6	45	208	125	5625	3191.4	0.8143	169

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)
Standardized Blow Count Data Worksheet For Calculating (N1)60 Values

Boring Number	Groundwater Depth (ft)	Sample Depth (ft)	Standardized N_{60}	Avg Unit Wt Below Previous Sample (pcf)	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N	$(N_1)_{60}$
DM73-5A	6	50	350	125	6250	3504.4	0.7771	272
DM73-5A	6	60	35	125	7500	4130.4	0.7158	25
DM73-5A	6	65	197	125	8125	4443.4	0.6901	136
DM73-5A	6	75	102	125	9375	5069.4	0.6461	66
DM73-6	6	27	40	125	3375	2064.6	1.0124	40
DM73-6	6	32	82	125	4000	2377.6	0.9434	77
DM73-6	6	36	200	125	4500	2628	0.8973	179
DM73-6	6	42	600	125	5250	3003.6	0.8393	504
DM73-6	6	47	31	125	5875	3316.6	0.7988	25
DM73-6	6	52	400	125	6500	3629.6	0.7635	305
DM73-6	6	77	400	125	9625	5194.6	0.6382	255
DM73-6	6	91	600	125	11375	6071	0.5904	354
DM73-7	6	23	168	125	2875	1814.2	1.08	181
DM73-7	6	30	86	125	3750	2252.4	0.9692	83
DM73-7	6	35	113	125	4375	2565.4	0.9082	103
DM73-7	6	42	171	125	5250	3003.6	0.8393	144
DM73-7	6	52	91	125	6500	3629.6	0.7635	69
DM73-7	6	57	149	125	7125	3942.6	0.7326	109
DM73-7	6	61	240	125	7625	4193	0.7104	170
DM73-7	6	67	141	125	8375	4568.6	0.6806	96
DM73-8	6	32	115	125	4000	2377.6	0.9434	108
DM73-8	6	42	149	125	5250	3003.6	0.8393	125
DM73-8	6	47	67	125	5875	3316.6	0.7988	54
DM73-8	6	59	200	125	7375	4067.8	0.7212	144
DM73-9	6	22	106	125	2750	1751.6	1.0991	117
DM73-9	6	27	49	125	3375	2064.6	1.0124	50
DM73-9	6	32	180	125	4000	2377.6	0.9434	170
DM73-9	6	42	200	125	5250	3003.6	0.8393	168
DM73-9	6	47	400	125	5875	3316.6	0.7988	320
DM73-10	6	32	52	125	4000	2377.6	0.9434	49
DM73-10	6	37	22	125	4625	2690.6	0.8868	20
DM73-10	6	42	240	125	5250	3003.6	0.8393	201
DM73-10	6	47	231	125	5875	3316.6	0.7988	185
DM73-10	6	52	300	125	6500	3629.6	0.7635	229
DM73-10	6	57	400	125	7125	3942.6	0.7326	293

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)
Standardized Blow Count Data Worksheet For Calculating (N1)60 Values

Boring Number	Groundwater Depth (ft)	Sample Depth (ft)	Standardized N_{60}	Avg Unit Wt Below Previous Sample (pcf)	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N	$(N_1)_{60}$
DM73-10A	6	32	41	125	4000	2377.6	0.9434	39
DM73-10A	6	36	117	125	4500	2628	0.8973	105
DM73-10A	6	42	106	125	5250	3003.6	0.8393	89
DM73-10A	6	52	200	125	6500	3629.6	0.7635	153
DM73-10A	6	62	116	125	7750	4255.6	0.7051	82
DM73-10A	6	72	138	125	9000	4881.6	0.6584	91
DM73-10A	6	81	400	125	10125	5445	0.6234	249
DM73-10A	6	97	300	125	12125	6446.6	0.5729	172
WC80-1	6	38	120	125	4750	2753.2	0.8767	105
WC80-1	6	90	160	125	11250	6008.4	0.5934	95
WC80-3	6	52	114	125	6500	3629.6	0.7635	87
WC80-4	6	30	94	125	3750	2252.4	0.9692	91
WC80-4	6	35	93	125	4375	2565.4	0.9082	84
WC80-4	6	40	97	125	5000	2878.4	0.8574	83
WC80-4	6	45	98	125	5625	3191.4	0.8143	80
WC80-4	6	50	99	125	6250	3504.4	0.7771	77
WC80-4	6	75	88	125	9375	5069.4	0.6461	57
WC80-4	6	80	99	125	10000	5382.4	0.627	62
WC80-4	6	85	204	125	10625	5695.4	0.6095	124
WC80-4	6	90	211	125	11250	6008.4	0.5934	125
WC80-4	6	95	229	125	11875	6321.4	0.5786	132
WC80-4	6	100	196	125	12500	6634.4	0.5648	111
WC80-4	6	105	300	125	13125	6947.4	0.5519	166
WC80-4	6	110	260	125	13750	7260.4	0.5399	140
WC80-4	6	115	253	125	14375	7573.4	0.5286	134
WC80-4	6	120	218	125	15000	7886.4	0.518	113
WC80-4	6	125	209	125	15625	8199.4	0.508	106
WC80-4	6	130	282	125	16250	8512.4	0.4986	141
WC80-5	6	30	57	125	3750	2252.4	0.9692	55
WC80-5	6	35	102	125	4375	2565.4	0.9082	93
WC80-5	6	40	66	125	5000	2878.4	0.8574	57
WC80-5	6	45	94	125	5625	3191.4	0.8143	77
WC80-5	6	50	114	125	6250	3504.4	0.7771	89
WC80-5	6	75	85	125	9375	5069.4	0.6461	55
WC80-5	6	80	91	125	10000	5382.4	0.627	57

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)
Standardized Blow Count Data Worksheet For Calculating (N1)60 Values

Boring Number	Groundwater Depth (ft	Sample Depth (ft)	Standardized N_{60}	Avg Unit Wt Below Previous Sample (pcf)	Total Overburden Stress (psf)	Effective Overburden Stress (psf)	C_N	$(N_1)_{60}$
WC80-5	6	85	150	125	10625	5695.4	0.6095	91
WC80-5	6	90	141	125	11250	6008.4	0.5934	84
WC80-5	6	95	166	125	11875	6321.4	0.5786	96
WC80-5	6	100	200	125	12500	6634.4	0.5648	113
WC80-5	6	105	155	125	13125	6947.4	0.5519	86
WC80-5	6	110	209	125	13750	7260.4	0.5399	113
WC80-5	6	115	146	125	14375	7573.4	0.5286	77
WC80-5	6	120	209	125	15000	7886.4	0.518	108
WC80-5	6	125	229	125	15625	8199.4	0.508	116
WC80-5	6	130	253	125	16250	8512.4	0.4986	126

HBIPLiquefaction Study - Borings of Dames and Moore (1974) and Woodward Clyde (1980)

Standardized Blow Count Data Worksheet For Calculating "Clean-Sand" (N1)60 Values

Applies correction values for sands containing fines, converting (N1)60 values to "equivalent" (N1)60 values in clean sands

Boring Number	Sample Depth (ft)	$(N_1)_{60}$	USCS	%fines	Fines Correction (Youd, et al)	Fines Correction Cap	"Clean-Sand" $(N_1)_{60\text{-}cs}$ capped at 200	Sample Elev (ft)
DM73-1	31	85	sp-sm	6	0.43	0.46	85	-19
DM73-1	37	155	sp-sm	6	0.76	0.46	155	-25
DM73-1	48	32	sw-sm	6	0.18	0.46	32	-36
DM73-1	56	24	sp	11	1.84	2.76	26	-44
DM73-1	62	80	sp	11	3.33	2.76	83	-50
DM73-2	31	287	sp	18	22.28	5.16	200	-19
DM73-2	37	176	sm	4	0.00	0.00	176	-25
DM73-2	51	197	sp	6	0.95	0.46	197	-39
DM73-2	67	132	sp	18	11.99	5.16	137	-55
DM73-2	77	191	sp	8	2.71	1.38	192	-65
DM73-2	87	181	sp	8	2.58	1.38	182	-75
DM73-2A	28	48	sp	7	0.53	0.92	49	-16
DM73-2A	32	112	sp	8	1.71	1.38	113	-20
DM73-3	26	108	sp-sm	11	4.07	2.76	111	-14
DM73-3	31	37	sp-sm	11	2.19	2.76	39	-19
DM73-3	34	368	sp	5	0.00	0.00	200	-22
DM73-3	42	35	sp	5	0.00	0.00	35	-30
DM73-3	47	84	sp	8	1.36	1.38	85	-35
DM73-3	52	49	sp	33	13.68	7.93	57	-40
DM73-3	56	222	sp	7	2.01	0.92	200	-44
DM73-3	61	284	sp	7	2.54	0.92	200	-49
DM73-3	66	411	sp	7	3.62	0.92	200	-54
DM73-3	76	193	sp	9	3.84	1.84	195	-64
DM73-4	27	60	sp-sm	29	13.41	7.19	67	-15
DM73-4	32	283	sp-sm	6	1.36	0.46	200	-20
DM73-4	37	141	sp	0	0.00	0.00	141	-25
DM73-4	42	136	sp	0	0.00	0.00	136	-30
DM73-4	57	220	sp	0	0.00	0.00	200	-45
DM73-5	42	50	sp	25	10.04	6.45	56	-30
DM73-5	47	14	sp	7	0.24	0.92	14	-35
DM73-5	52	124	sp	7	1.18	0.92	125	-40
DM73-5	62	121	sp	8	1.83	1.38	122	-50
DM73-5	67	87	sp	8	1.40	1.38	88	-55
DM73-5	77	43	sp-sm	18	6.09	5.16	48	-65
DM73-5	107	164	sp	46	37.80	8.30	172	-95
DM73-5A	45	169	sp	23	21.01	6.08	175	-33
DM73-5A	50	272	sp	8	3.73	1.38	200	-38
DM73-5A	60	25	sp	0	0.00	0.00	25	-48
DM73-5A	65	136	sp	0	0.00	0.00	136	-53
DM73-5A	75	66	sp	0	0.00	0.00	66	-63
DM73-6	27	40	sp	3	0.00	0.00	40	-15
DM73-6	32	77	sp	3	0.00	0.00	77	-20
DM73-6	36	179	sp	23	22.01	6.08	185	-24
DM73-6	42	504	sp	3	0.00	0.00	200	-30

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Standardized Blow Count Data Worksheet For Calculating "Clean-Sand" (N1)60 Values

Applies correction values for sands containing fines, converting (N1)60 values to "equivalent" (N1)60 values in clean sands

Boring Number	Sample Depth (ft)	$(N_1)_{60}$	USCS	%fines	Fines Correction (Youd, et al)	Fines Correction Cap	"Clean-Sand" $(N_1)_{60\text{-}cs}$ capped at 200	Sample Elev (ft)
DM73-6	47	25	sp	3	0.00	0.00	25	-35
DM73-6	52	305	sp	3	0.00	0.00	200	-40
DM73-6	77	255	sp	0	0.00	0.00	200	-65
DM73-6	91	354	sp	5	0.00	0.00	200	-79
DM73-7	23	181	sp	7	1.66	0.92	182	-11
DM73-7	30	83	sp	14	5.72	4.14	87	-18
DM73-7	35	103	sp	9	2.31	1.84	105	-23
DM73-7	42	144	sp	0	0.00	0.00	144	-30
DM73-7	52	69	sp	0	0.00	0.00	69	-40
DM73-7	57	109	sp	0	0.00	0.00	109	-45
DM73-7	61	170	sp	0	0.00	0.00	170	-49
DM73-7	67	96	sp	0	0.00	0.00	96	-55
DM73-8	32	108	sm	13	5.87	3.68	112	-20
DM73-8	42	125	sw	14	7.50	4.14	129	-30
DM73-8	47	54	sw	4	0.00	0.00	54	-35
DM73-8	59	144	sm	13	7.20	3.68	148	-47
DM73-9	22	117	sp	5	0.00	0.00	117	-10
DM73-9	27	50	sp-sm	0	0.00	0.00	50	-15
DM73-9	32	170	sp-sm	6	0.83	0.46	170	-20
DM73-9	42	168	sp	6	0.82	0.46	168	-30
DM73-9	47	320	sp	6	1.53	0.46	200	-35
DM73-10	32	49	sp-sm	25	9.92	6.45	55	-20
DM73-10	37	20	sp-sm	10	1.30	2.30	21	-25
DM73-10	42	201	sp-sm	10	5.22	2.30	200	-30
DM73-10	47	185	gp	7	1.70	0.92	186	-35
DM73-10	52	229	sp	0	0.00	0.00	200	-40
DM73-10	57	293	sp	0	0.00	0.00	200	-45
DM73-10A	32	39	sm	8	0.79	1.38	40	-20
DM73-10A	36	105	sm	8	1.62	1.38	106	-24
DM73-10A	42	89	sm	17	8.36	4.97	94	-30
DM73-10A	52	153	sp	0	0.00	0.00	153	-40
DM73-10A	62	82	sp	0	0.00	0.00	82	-50
DM73-10A	72	91	sm	12	4.43	3.22	94	-60
DM73-10A	81	249	sp	28	38.96	7.01	200	-69
DM73-10A	97	172	sp	0	0.00	0.00	172	-85
WC80-1	38	105	sp-sm	5	0.00	0.00	105	-26
WC80-1	90	95	sp-sm	5	0.00	0.00	95	-78
WC80-3	52	87	sp-sm	5	0.00	0.00	87	-40
WC80-4	30	91	sp-sm	5	0.00	0.00	91	-18
WC80-4	35	84	sp-sm	5	0.00	0.00	84	-23
WC80-4	40	83	sp-sm	5	0.00	0.00	83	-28
WC80-4	45	80	sp-sm	5	0.00	0.00	80	-33
WC80-4	50	77	sp-sm	5	0.00	0.00	77	-38
WC80-4	75	57	sp	0	0.00	0.00	57	-63

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Standardized Blow Count Data Worksheet For Calculating "Clean-Sand" (N1)60 Values

Applies correction values for sands containing fines, converting (N1)60 values to "equivalent" (N1)60 values in clean sands

Boring Number	Sample Depth (ft)	$(N_1)_{60}$	USCS	%fines	Fines Correction (Youd, et al)	Fines Correction Cap	"Clean-Sand" $(N_1)_{60\text{-}cs}$ capped at 200	Sample Elev (ft)
WC80-4	80	62	sp	0	0.00	0.00	62	-68
WC80-4	85	124	sp-sm	5	0.00	0.00	124	-73
WC80-4	90	125	sp-sm	5	0.00	0.00	125	-78
WC80-4	95	132	sp-sm	5	0.00	0.00	132	-83
WC80-4	100	111	sp-sm	5	0.00	0.00	111	-88
WC80-4	105	166	sp-sm	5	0.00	0.00	166	-93
WC80-4	110	140	sp-sm	5	0.00	0.00	140	-98
WC80-4	115	134	sp-sm	5	0.00	0.00	134	-103
WC80-4	120	113	sp-sm	5	0.00	0.00	113	-108
WC80-4	125	106	sp-sm	5	0.00	0.00	106	-113
WC80-4	130	141	sp-sm	5	0.00	0.00	141	-118
WC80-5	30	55	sp-sm	5	0.00	0.00	55	-18
WC80-5	35	93	sp-sm	5	0.00	0.00	93	-23
WC80-5	40	57	sp-sm	5	0.00	0.00	57	-28
WC80-5	45	77	sp-sm	5	0.00	0.00	77	-33
WC80-5	50	89	sp-sm	5	0.00	0.00	89	-38
WC80-5	75	55	sp	0	0.00	0.00	55	-63
WC80-5	80	57	sp	0	0.00	0.00	57	-68
WC80-5	85	91	sp-sm	5	0.00	0.00	91	-73
WC80-5	90	84	sp-sm	5	0.00	0.00	84	-78
WC80-5	95	96	sp-sm	5	0.00	0.00	96	-83
WC80-5	100	113	sp-sm	5	0.00	0.00	113	-88
WC80-5	105	86	sp-sm	5	0.00	0.00	86	-93
WC80-5	110	113	sp-sm	5	0.00	0.00	113	-98
WC80-5	115	77	sp-sm	5	0.00	0.00	77	-103
WC80-5	120	108	sp-sm	5	0.00	0.00	108	-108
WC80-5	125	116	sp-sm	5	0.00	0.00	116	-113
WC80-5	130	126	sp-sm	5	0.00	0.00	126	-118

CALCULATION CHECK OF LIQUEFACTION SPREADSHEET

① BORING 99-2 (GEOMATRIX, 1999)

DEPTH = 46 ft

- N = 44, SPT SAMPLER ∴ SAMPLER CORRECTION = 1.0

  DEPTH = 46 ft = 14.03 m > 10m ∴ C_{RODS} = 1.0

  PER YOUD, ET AL, 2001, p. 820, TABLE 2

- PER DATA REPORT A, ENERGY = 50%

  ∴ C_{ENERGY} = 50/60 = 0.833

- $N_{60} = N \times C_E = 44 \times 0.833 = 36.67$ ✓

- GROUNDWATER DEPTH = 34 ft (ASSUMED, SEE "ASSUMPTIONS")

- γ_{TOTAL} = 125 pcf (ASSUMED, SEE "ASSUMPTIONS")

- $\sigma_v = 125(46\text{ft}) = 5750$ pcf

  $u = 62.4(46\text{ ft} - 34\text{ ft}) = 748.8$ psf

  $\sigma_v' = 5001.2$ psf

- C_N = OVERBURDEN CORRECTION (YOUD ETAL, 2001, TABLE 2)

  $C_N = \sqrt{\frac{P_a}{\sigma_v'}} = \sqrt{\frac{2116}{5001}} = 0.650$ ✓

  $C_N \leq 2.0$ ✓ (C_N = 2.0 IS AN UPPERBOUND)

- $(N_1)_{60} = N_{60} \times C_N = 36.67 \times 0.65 = 23.83 \approx 24$ ✓

- FROM BORING LOG, SOIL IS GW. FINES CONTENT WAS NOT MEASURED, SO ASSUME FC = 0% AS A CONSERVATIVE ASSUMPTION

- PER EQUATION 5 IN YOUD ET AL, 2001

$$(N_1)_{60-CS} = \alpha + \beta (N_1)_{60}$$

FOR $FC = 0$, $\alpha = 0$, $\beta = 1.0$

$$\Rightarrow (N_1)_{60-CS} = 0 + 1.0(23.83) \cong 24 \checkmark$$

ΔN = FINES CORRECTION = $(N_1)_{60-CS} - (N_1)_{60} = 0$ ✓