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PSEG
Power LLC

ND-2011-0047
June 29, 2011

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: **PSEG Early Site Permit Application**
Docket No. 52-043
Response to Request for Additional Information, RAI No. 30, SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations

References:
1) PSEG Power, LLC letter to USNRC, Application for Early Site Permit for the PSEG Site, dated May 25, 2010

2) RAI No. 30, SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations, dated June 1, 2011 (eRAI 5726)

The purpose of this letter is to respond to the request for additional information (RAI) identified in Reference 2 above. This RAI addresses Stability of Subsurface Materials and Foundations, as described in Subsection 2.5.4 of the Site Safety Analysis Report (SSAR), as submitted in Part 2 of the PSEG Site Early Site Permit Application, Revision 0.

Enclosure 1 provides our response for RAI No. 30, Question Nos. 02.05.04-2 and 02.05.04-3. Our response to RAI No. 30, Question No.02.05.04-2 requires a revision to the SSAR. Enclosure 2 includes the proposed revisions to the SSAR. Enclosure 3 includes the new regulatory commitment established in this submittal.

If any additional information is needed, please contact David Robillard, PSEG Nuclear Development Licensing Engineer, at (856) 339-7914.

D079

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 29th day of June, 2011.

Sincerely,

David P. Lewis
Director, Nuclear Development
PSEG Power, LLC

Enclosure 1: Response to NRC Request for Additional Information, RAI No. 30, Question Nos. 02.05.04-2 and 02.05.04-3, SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations

Enclosure 2: Proposed Revisions Part 2 – Site Safety Analysis Report Subsection 2.5.4.8, Liquefaction Potential

Enclosure 3: Summary of Regulatory Commitments

cc: USNRC Project Manager, Division of New Reactor Licensing, PSEG Site (w/enclosures)
USNRC, Environmental Project Manager, Division of Site and Environmental Reviews (w/enclosures)
USNRC Region I, Regional Administrator (w/enclosures)

PSEG Letter ND-2011-0047, dated June 29, 2011

ENCLOSURE 1

RESPONSE to RAI No. 30
QUESTIONS 02.05.04-2 and 02.05.04-3

Response to RAI No. 30, Question 02.05.04-2:

In Reference 2, the NRC staff asked PSEG for information regarding the Stability of Subsurface Materials and Foundations, as described in Section 2.5.4 of the Site Safety Analysis Report. The specific request for Question 02.05.04-2 was:

> *PSEG Site ESP Application SSAR Table 2.5.4.6-1 presents ground water levels recorded between January 2009 and December 2009. 10 CFR 100.23 (d)(4) requires the evaluation and determination of siting factors for design conditions, including liquefaction potential. In accordance with this regulation, justify and discuss why the average groundwater elevation of 0.6 ft North American Vertical Datum (NAVD) was calculated from groundwater monitoring data collected between January 2009 and July 2009 instead of the complete data range (January to December, 2009). In addition, discuss any impacts to the liquefaction assessment if the complete date range of monitoring data had been used.*

PSEG Response to NRC RAI:

Depth to the groundwater table is a factor in computing the effective overburden pressure for use in correcting Standard Penetration Test (SPT) N-values and evaluating liquefaction potential. As described in SSAR Subsection 2.5.4.3.1.2, boreholes were made using a clay mineral drilling fluid. Groundwater levels at the time of drilling can be affected by the presence of the drilling fluid. All borings were completed by March 4, 2009. Water level measurements in the shallow-depth observation wells installed adjacent to the geotechnical borings (U-series) were taken in April 2009 (SSAR Table 2.5.4.6-1). These water level measurements were then used in computing overburden stresses. The groundwater elevations shown on SSAR Table 2.5.4.6-1 were subtracted from the boring ground surface elevations shown on SSAR Table 2.5.4.3-1 to obtain a depth to groundwater for each boring (rounded to the nearest 0.1 ft.).

The groundwater elevations near each specific boring location, determined in April 2009 (SSAR Table 2.5.4.6-1) were used in the calculation of the liquefaction potential for samples for that specific boring. Table RAI-30-1, created using information in SSAR Table 2.5.4.6-1, summarizes the groundwater elevations used for the liquefaction evaluation for each boring and the groundwater elevations for January through April at the observation well near that boring. Site water levels fluctuate with tidal changes and with seasons. The groundwater table used in the liquefaction evaluation is equal to or within 0.2 ft. of the average groundwater table for the winter/early spring time frame in which the borings were performed.

Table RAI-30-1
Summary of Groundwater Elevations

Boring Number	Observation Well Number	Groundwater Elevation (ft)	Groundwater Elevation (ft.) January through April, 2009		
		April 2009	Minimum	Maximum	Average
NB-1	NOW-1U	0.59	0.36	0.61	0.52
NB-2	NOW-2U	-0.17	-0.48	-0.10	-0.29
NB-3	NOW-3U	-0.19	-0.36	0.15	-0.15
NB-4	NOW-4UB	0.36	0.30	0.46	0.28
NB-5	NOW-5U	2.07	2.04	2.54	2.19
NB-6	NOW-6U	0.62	0.35	0.76	0.56
NB-7	NOW-7U	0.77	0.18	0.77	0.52
NB-8	NOW-8U	0.74	0.41	0.84	0.68

The position of the water table can affect the potential for liquefaction by changing the effective vertical stresses in the soil profile. Reference 2.5.4.8-2 recommends that, for considering liquefaction screening assessment using a water table different from that at the time of boring, the corrected N-values should not be changed. Table 2.5.4.6-1 shows that the largest change in the shallow water table observation wells over the period from January, 2009 to December, 2009 is 2.67 feet in Observation Well NOW-2U, adjacent to boring NB-2. The maximum water table elevation for Observation Well NOW-2U was Elev. 2.19 ft., which corresponds to a depth to water from the ground surface of boring NB-2 (8.2 ft.) of 8.20 – 2.19 or 6.01ft.; (use 6.0 for calculation purposes).

In response to the portion of RAI No. 30, Question 02.05.04-2 regarding the impact of changes in water level on the liquefaction assessment, factors of safety against liquefaction in Boring NB-2 were computed using a depth to water of 6 ft., instead of the original 8.4 ft. Table RAI-30-2 compares the factors of safety against liquefaction for the original depth to water to those for a shallower depth to water and shows the percent change. While there was a slight change in factors of safety for values above approximately 2, there was no change for factors of safety that were less than 1.4, and no additional samples with factors of safety less than 1.4 using the higher groundwater table and the lower bound Magnitude Scaling Factor. These results show that there is no effect on the liquefaction screening results using the simplified SPT method and the seasonal high water table.

Table RAI 30-2
Comparison of Liquefaction Safety Factors
Seasonal High Groundwater to Groundwater in Calculation

Sample Elevation (feet)	Liquefaction Safety Factor		
	Lower Bound Magnitude Scaling Factor		
	Groundwater at 8.4 feet	Groundwater at 6.0 feet	Percent Change
-68.1	N/A (1)	N/A (1)	-
-72.8	7.2	7.0	-2.78
-77.8	1.1	1.1	0.00
-82.9	1.0	1.0	0.00
-87.9	6.9	6.8	-1.45
-92.8	1.6	1.6	0.00
-97.8	1.9	1.9	0.00
-102.8	1.9	1.9	0.00
-107.8	5.6	5.4	-3.57
-112.8	1.5	1.5	0.00
-117.8	2.4	2.3	-4.17
-122.7	8.0	8.0	0.00
-127.7	9.2	9.2	0.00
-132.8	8.9	8.9	0.00
-137.8	9.6	9.6	0.00
-142.7	10.1	10.1	0.00
-147.1	11.4	11.3	-0.88
-151.8	11.6	11.4	-1.72
-157.0	11.7	11.5	-1.71
-162.0	11.8	11.8	0.00
-167.8	11.8	11.6	-1.69
-172.8	10.2	10.0	-1.96
-177.8	10.1	9.9	-1.98
-182.6	11.6	11.5	-0.86
-187.6	11.4	11.3	-0.88
-192.4	11.4	11.3	-0.88
-202.5	11.0	11.1	0.91
-212.5	10.8	10.8	0.00
-222.8	9.1	9.2	1.10
-232.8	9.0	8.9	-1.11
-242.8	3.1	3.1	0.00
-252.8	NL (2)	NL (2)	-
-262.8	3.0	3.0	0.00
-272.8	NL (2)	NL (2)	-
-282.8	8.6	8.5	-1.16
-292.8	NL (2)	NL (2)	-

1) Materials above elevation -67 ft. will be removed.

2) NL – Not liquefiable, silts and clays (USCS CL, CH, ML, MH, CL-ML, CH-MH)

Associated PSEG Site ESP Application Revisions:

SSAR Subsection 2.5.4.8 will be updated as specified in Enclosure 2 of this document.

Response to RAI No. 30, Question 02.05.04-3:

In Reference 2, the specific request for Question 02.05.04-3 was:

> *PSEG Site ESP Application SSAR Subsection 2.5.4.8 discusses liquefaction potential. 10 CFR 100.23 (d)(4) requires the evaluation and determination of siting factors for design conditions, including liquefaction potential. In accordance with the regulation:*
>
> > *a) State the method and provide the equations used to calculate $(N_1)_{60}$ and the supporting correction factor values used for each individual boring sampled. Indicate if a correction factor for overburden stress (C_N) varying with depth was used and provide equations and justification. Also, state any limiting values applied to the correction factors along with justifications for such values.*
> >
> > *b) State the method and provide the equations used to calculate Cyclic Stress Ratio ($CRR_{7.5}$), Magnitude Scaling Factor (MSF), and the correction factor for overburden stress (k_s). Provide and justify values for variables in the above equations and state any limiting or average values that were applied, along with a justification for each value.*

PSEG Response to NRC RAI:

a) **<u>Standard Penetration Test</u>**

The Standard Penetration Test (SPT) N-values for granular soils encountered in borings NB-1 through NB-8 were corrected for field variables and effective overburden pressures using the methods discussed in Regulatory Guide 1.198 and Reference 2.5.4.8-2. The methodology for determining the corrected N-values and tables of the corrected N-values are presented in detail in Calculation Number 2251-ESP-GT-001 which has been made available for review. Portions of that calculation describing the methodology are presented in this response.

N-values for granular soils were corrected for field variables and overburden stresses using the following equation:

$$(N1)_{60} = N_m C_N C_E C_B C_R C_S$$

Where:

N_m = field measured standard penetration resistance N-value
C_N = factor to normalize N_m to a common reference effective overburden stress
C_E = correction for hammer energy ratio (ER)
C_B = correction factor for borehole diameter
C_R = correction factor for rod length
C_S = correction for samplers with or without internal liners

Table RAI 30-3 is reproduced from SSAR Reference 2.5.4.8-2 and provides additional information regarding the correction factors. Text following the table discusses the approach to determining values for each of the listed correction factors.

Table RAI-30-3
Corrections to SPT (Modified from Skempton 1986) as listed by Robertson and Wride (1998)

Factor	Equipment Variable	Term	Correction
Overburden pressure	--	C_N	$(P_a / \sigma'_{vo})^{0.5}$
Overburden pressure	--	C_N	$C_N \leq 1.7$
Energy ratio	Donut hammer	C_E	0.5 - 1.0
Energy ratio	Safety hammer	C_E	0.7 - 1.2
Energy ratio	Automatic-trip Donut-type hammer	C_E	0.8 - 1.3
Borehole diameter	65-115 mm	C_B	1.0
Borehole diameter	150 mm	C_B	1.05
Borehole diameter	200 mm	C_B	1.15
Rod length	<3 m	C_R	0.75
Rod length	3-4 m	C_R	0.8
Rod length	4-6 m	C_R	0.85
Rod length	6-10 m	C_R	0.95
Rod length	10-30+ m	C_R	1.0
Sampling method	Standard sampler	C_S	1.0
Sampling method	Sampler without liners	C_S	1.1 - 1.3

Correction Factor C_N

Much of the available literature concerning C_N, the correction factor for effective overburden stress, states that the correction is limited to effective overburden stresses of 3 tons per square foot (tsf) or less. The equation recommended in Reference RAI-30-1 is presented in the above table from SSAR Reference 2.5.4.8-2 and is considered suitable for effective overburden stresses up to about 2 tsf. A maximum C_N value of 1.7

regardless of the method used is recommended in SSAR Reference 2.5.4.8-2, and this recommendation was used. For overburden stresses in excess of 2 tsf, which corresponds to approximate depths between 65 and 80 feet below the existing ground surface at the PSEG Site, SSAR Reference 2.5.4.8-2 recommended using the following equation from Reference RAI 30-2:

$$C_N = 2.2 / (1.2 + \sigma'_{vo}/P_a)$$

Where:

C_N = Overburden stress correction factor

σ'_{vo} = effective overburden stress at test depth at time of SPT boring

P_a= atmospheric pressure at site

The above equation was cited in SSAR Reference 2.5.4.8-2 as providing a better fit than the relationship in Reference RAI-30-1 for effective overburden stresses greater than 2 tsf, up to about 3 tsf.

At the PSEG Site, the overburden stresses generally exceed 3 tsf between approximate depths of 95 and 115 feet below existing grades. In order to determine the appropriate C_N equation for effective overburden stresses in excess of 3 tsf, the geotechnical literature was reviewed primarily for references dealing with liquefaction analyses. In Reference RAI-30-3, Boulanger summarized methods of estimating C_N, and discussed the estimation of liquefaction resistance in clean sands under high effective overburden stresses (defined as $\sigma'_v/P_a > 4$). By re-evaluating the existing C_N relations based on calibration chamber tests performed on clean sands by others, Reference RAI-30-3 recommended an improved C_N equation for σ'_v/P_a values up to about 7. A ratio of σ'_v/P_a of 7 is equivalent to an effective overburden stress between 7 and 8 tsf, at an approximate depth of 250 feet at the PSEG site.

Reference RAI-30-4 recommends using a lower limit C_N value of 0.4. For the area represented by borings NB-1 through NB-8, the C_N value of 0.4 occurs between approximate depths of 155 feet and 165 feet below the existing grades, and the corresponding approximate overburden stresses range from 4.5 tsf to 4.7 tsf.

Based on evaluation of the methods to estimate C_N presented in References RAI-30-1, RAI-30-2 and RAI-30-3, PSEG concluded that the proposed equation in Reference RAI-30-2, adopted in the NCEER study reported in Reference 2.5.4.8-2, should be used for SPT depths up to 100 feet, with an upper limit C_N value of 1.7. To provide information for the evaluation of liquefaction potential to the depths explored, PSEG calculated N-value corrections for the entire depth of the soil profile at each boring by extending the above equation. As recommended by Reference RAI-30-4, the lower limit C_N value was taken as 0.4. Corrections for overburden pressure were not applied to fine-grained soils (USCS classifications ML, MH, CL, or CH), or to Peat (PT), because these soil types are not considered liquefiable.

For computation of overburden stresses to be used in determining C_N, laboratory test data from SSAR References 2.5.4.2-14 and 2.5.4.2-15 were used to estimate soil unit weights for the geologic units identified from the evaluation of the geotechnical borings. In cases where data were limited, or where laboratory test data were unavailable for a particular layer, a total unit weight value of 125 pcf was used.

Depth to the water table is a factor in computing the effective overburden pressure. As described in SSAR Subsection 2.5.4.3.1.2, boreholes were made using a clay mineral drilling fluid. Groundwater levels at the time of drilling can be affected by the presence of the drilling fluid. The depth to the groundwater table at each boring location used in computing overburden stresses was estimated from water level measurements made in April, 2009 (SSAR Table 2.5.4.6-1) in the shallow-depth observation wells installed adjacent to the geotechnical borings (U-series). The groundwater elevations shown on SSAR Table 2.5.4.6-1 were subtracted from the boring ground surface elevations shown on SSAR Table 2.5.4.3-1 to obtain a depth to groundwater for each boring (rounded to the nearest 0.1 ft.).

The PSEG Site is near sea level; therefore, a standard atmosphere of 14.7 psi (2117 psf) was used to represent the barometric pressure for the PSEG Site.

Correction Factor C_E

Four drill rigs with automatic hammers were used for the subsurface exploration program and the energy ratios were measured for each drill rig and hammer combination as described in SSAR Subsection 2.5.4.3.1.2. The correction factor, C_E, is the ratio of measured energy to 60 percent. As shown in SSAR Table 2.5.4.3-3, the energy ratios of the four automatic hammers ranged between 70 and 80 percent. The energy ratio used in the calculation for each boring was based on the measured energy ratio for the drill rig that performed that boring. The resulting C_E varied between 1.17 and 1.34. Boring records in SSAR Appendix 2AA list the drill rig information for each boring.

Correction Factor C_B

Diameter of the boreholes is reported on the boring records in SSAR Appendix 2AA. For Borings NB-1 through NB-8, the borehole diameter was 4 inches. A correction factor of 1.0 was used for calculating the corrected N-values.

Correction Factor C_R

The rod length correction factor C_R, is based on the length of drill rod from the point where the SPT hammer strikes the drill rod to the sample depth. Sample depths are measured from ground surface, so the height of the drill rod stem above the ground surface needs to be added to the sample depth to determine the C_R. Although this distance varies from drill rig to drill rig and from sample to sample, the variation is over a relatively small range, approximately 3 to 5 feet. For purposes of simplicity in the calculation, a value of 4 feet was used in determining the C_R factors. While use of a constant value rather than the field-measured values may affect the corrected N-values slightly, the C_R factor only affects the corrected N-value from ground surface to a depth of 10 m (32.8 ft). Below a depth of 10 m, C_R is 1.0. Materials above 10 m are soft hydraulic fill that will be removed, and are typically clays and silts for which N-value corrections are not made. Thus, there is no effect on N-value corrections of the materials below depths of 10 m from using the constant value of 4 feet in determining the C_R factor.

Correction Factor C_S

This correction factor is for use of SPT samplers that do not include liners, which was the case for the PSEG Site exploration. A range of C_S of 1.1 to 1.3 is recommended in the table above. A mid-range value of 1.2 was used for C_S for correction of SPT N-values.

References:

RAI-30-1 Liao, S., and R. V. Whitman, (1986a). "Overburden correction factors for SPT in sand." *J. Geotech. Engrg.,*ASCE, 112(3), 373-377.

RAI-30-2 Kayen, R.E., J. K. Mitchell, H. B. Seed,A. Lodge,S.Nishio, and R. Coutinho, (1992). "Evaluation of SPT-, CPT-, and shear wave-based methods for liquefaction potential assessment using Loma Prieta data."*Proc., 4th Japan-U.S. Workshop on Earthquake-Resistant Des.Of Life-line Fac.And Countermeasures for Soil Liquefaction,* Vol. 1, 177-204.

RAI-30-3 Boulanger, R.W. (2003)."High Overburden Stress Effects in Liquefaction Analyses." Journal of Geotechnical and Geoenvironmental Engineering 129(12), 1071-1082.

RAI-30-4 G.R. Martin and M. Lew (Editors), K. Arulmoli, J.I. Baez, T.F. Blake, J. Earnest, F. Gharib, J. Goldhammer, D. Hsu, S. Kupferman, J. O'Tousa, C.R. Real, W. Reeder, E. Simantob, and T.L. Youd (Committee Members), (March 1999), "Recommended Procedures For Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California," Southern California Earthquake Center, University of Southern California.

b) Liquefaction Equations

The potential liquefaction evaluation was performed using the geologic criteria and soil characteristic criteria screening methods discussed in Regulatory Guide 1.198 and in SSAR Reference 2.5.4.8-2. The screening methods did not identify a potential for liquefaction. RAI No. 30 requests information about the method and equations used in the screening methods that use the N-values from the Standard Penetration Test. The analysis methods and results are presented in Calculation Number 2251-ESP-GT-008, which has been made available for review. This response presents a summary of material in the calculation as related to RAI No. 30, Question 02.05.04-3b.

The SPT-based liquefaction approach as discussed in SSAR Subsection 2.5.4.8.3 uses the so called "simplified procedure" methods as presented in SSAR Reference 2.5.4.8-2 to calculate the safety factor against liquefaction for each split spoon sample obtained from the estimated top of the competent layer (Vincentown Formation) and below in borings NB-1 through NB-8. Following are discussions of equations used for the liquefaction calculation.

Cyclic Stress Ratio

The Cyclic Stress Ratio (CSR) was computed using the following equation (Reference 2.5.4.8-2):

$$CSR = 0.65(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})r_d$$

Where:

a_{max}= peak horizontal acceleration at the foundation level
g = acceleration of gravity
σ_{vo} = total overburden stress at the depth of the analysis
σ'_{vo} = effective overburden stress at the depth of the analysis
r_d = stress reduction coefficient

$r_d = 1.0 - 0.00765z$ for z(depth) $\leq$ 9.15m
$r_d = 1.174 - 0.0267z$ for 9.15m $< z \leq$ 23m
$r_d = 0.744 - 0.008z$ for 23m $< z \leq$ 30m
$r_d = 0.5$ for $z >$ 30m

As noted in SSAR Subsection 2.5.4.8.3, the value for a_{max} (0.18g) was obtained from SSAR Figure 2.5.2-54. Total and effective stress values were obtained from the N-value correction performed as discussed in response to question 02.05.04-3a.

Cyclic Resistance Ratio

The Cyclic Resistance Ratio for a magnitude 7.5 earthquake ($CRR_{7.5}$) was computed using the following equation:

$$CRR_{7.5} = \{1/[34-(N_1)_{60CS}]\} + \{(N_1)_{60CS}/135\} + \{50/[10(N_1)_{60CS} + 45]^2\} - \{1/200\}$$

Where: $(N_1)_{60CS}$ = Field SPT N-value corrected for overburden stress, energy, borehole diameter, rod length sample liner, and fines content

The above equation is the same as presented in Reference 2.5.4.8-2, except the term $(N_1)_{60CS}$ has been substituted for $(N_1)_{60}$ in the reference equation to include the correction for fines content in the N-value corrections as recommended in SSAR Reference 2.5.4.8-2.

Magnitude Scaling Factor

The $CRR_{7.5}$ applies to magnitude 7.5 earthquakes. To adjust the CRR for smaller or larger earthquake magnitudes (M_w), a magnitude scaling factor (MSF) is used. An M_w value of 6.0 was obtained for the PSEG site as described in SSAR Subsection 2.5.4.8.3. Magnitude scaling factors have been proposed by several investigators. Reference 2.5.4.8-2 presents a review of available information and recommends MSF values considered as upper and lower bounds of a reasonable range. For an earthquake with a magnitude, M_w of 6.0, SSAR Reference 2.5.4.8-2 recommends a value of 1.76 for the lower bound and a value of 2.1 for the upper bound for the MSF range.

The upper bound MSF was used in the original calculations. Because the calculated Factor of Safety against liquefaction for a magnitude 7.5 earthquake is multiplied by the MSF to obtain the scaled Factor of Safety, application of the lower bound MSF will reduce the calculated Factors of Safety previously reported by a slight amount. To illustrate the effect of using the lower bound MSF, Factors of Safety were recalculated for each boring. During this recalculation, one boring (NB-2) was found to have used total overburden stresses instead of effective overburden pressures in the Factor of Safety computation. Applying the effective overburden pressures reduces the upper bound MSF Factors of Safety for boring NB-2.

Table RAI-30-4 shows the Factors of Safety for borings NB-1 through NB-8 computed using both the upper bound and lower bound MSF. The upper bound values for boring NB-2 reflect the correct effective overburden pressure. For the lower bound MSF, there are 3 calculated liquefaction safety factors less than 1.1, 9 safety factors between 1.1 and 1.4, and 245 safety factors greater than 1.4. The total of 12 samples out of 257 is less than 5 percent of the samples checked and represents isolated pockets. Thus, use of the lower bound MSF does not change the conclusion stated in SSAR Subsection 2.5.4.8 that the soils below elevation -67 ft. NAVD are not susceptible to liquefaction.

Use of the lower bound MSF provides the most conservative result for liquefaction screening by the simplified SPT method. Table 2.5.4.8-2 will be modified to show the results from the lower bound MSF use, and the text in subsection 2.5.4.8.3 will be modified accordingly.

Overburden Correction Factor K_σ

The "simplified procedure" was originally developed for cases where the overburden pressures were less than approximately 2 tsf as noted in Reference 2.5.4.8-2. To extend the use of the "simplified procedure" to higher overburden pressures, a correction factor K_σ is used. SSAR Reference 2.5.4.8-2 recommends the following equation for K_σ:

$K_\sigma = (\sigma'_{vo}/Pa)^{f-1}$

Where: σ'_{vo} = effective overburden pressure
Pa = atmospheric pressure
f = exponent that is a function of site condition, including relative density, stress history, aging and overconsolidation ratio.
= 0.8 for relative density of 40%;
= 0.7 for relative density of 60%, and;
= 0.6 for relative density of 80%.

For the PSEG Site, the value of f used was selected based on linear interpolation between the values given above, and values less than 40% or greater than 80% were taken to have the same f value as 40% and 80%, respectively, as shown in the tabulation below.

Relative Density (%)	f
0	0.8
40	0.8
60	0.7
80	0.6
100	0.6

The following equation developed from Figure 3 of Reference RAI-30-5 was used to determine relative density based on the SPT value:

$Dr = 15[(N_1)_{60CS}]^{0.5}$

Where: $(N_1)_{60CS}$ = Field SPT N-value corrected for overburden stress, energy, borehole diameter, rod length sample liner, and fines content

References:

RAI-30-5 Tokimatsu, K. and H. B. Seed, 1987.Evaluation of Settlement in Sands Due to Earthquake Shaking," Journal of Geotechnical Engineering, Volume 113, No. 8, August, pp. 861-878.

Associated PSEG Site ESP Application Revisions:

SSAR Subsection 2.5.4.8 will be updated as specified in Enclosure 2 of this document.

Table RAI-30-4 (Sheet 1 of 3)
Comparison of Liquefaction Safety Factors Using Upper and Lower Bound Magnitude Scaling Factors

Boring NB-1			Boring NB-2			Boring NB-3			Boring NB-4			Boring NB-5			Boring NB-6			Boring NB-7			Boring NB-8		
Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)
-68.2	1.3	1.1	-68.1	N/A	NA	-68.2	1.6	1.4	-69.5	3.2	2.7	-67.7	8.6	7.3	-69.6	1.7	1.4	-69.8	9.1	7.7	-66.6	2.1	1.8
-73.2	1.4	1.2	-72.8	8.5	7.2	-73.2	8.4	7.1	-72.0	1.8	1.5	-72.7	1.8	1.5	-74.3	2.2	1.9	-74.8	8.9	7.5	-71.6	8.8	7.5
-78.2	1.2	1.0	-77.8	1.3	1.1	-78.2	1.6	1.4	-74.5	8.5	7.2	-77.7	1.7	1.4	-81.3	1.8	1.5	-80.0	3.1	2.6	-76.6	8.3	7.0
-83.2	1.5	1.3	-82.9	1.2	1.0	-83.2	8.2	7.0	-77.0	8.5	7.2	-82.7	8.1	6.9	-85.5	10.9	9.2	-84.7	10.9	9.2	-80.9	11.7	9.9
-88.2	1.9	1.6	-87.9	8.1	6.9	-88.2	8.6	7.3	-79.5	1.9	1.6	-87.7	1.8	1.5	-91.3	2.7	2.3	-90.0	8.3	7.0	-86.6	10.5	8.9
-93.2	1.7	1.4	-92.8	1.9	1.6	-93.2	1.9	1.6	-82.0	1.5	1.3	-92.7	9.5	8.1	-96.3	1.8	1.5	-94.8	2.2	1.9	-91.6	2.9	2.5
-98.2	2.0	1.7	-97.8	2.3	1.9	-98.2	10.4	8.8	-84.5	11.1	9.4	-97.7	8.3	7.0	-101.3	8.0	6.8	-99.9	8.2	7.0	-96.6	9.2	7.8
-103.2	1.7	1.4	-102.8	2.3	1.9	-102.5	10.6	9.0	-87.0	1.6	1.4	-102.7	2.5	2.1	-105.5	10.5	8.9	-104.9	8.3	7.0	-100.7	10.9	9.2
-107.9	10.6	9.0	-107.8	6.6	5.6	-104.2	10.7	9.1	-89.5	1.3	1.1	-107.7	2.4	2.0	-111.3	8.7	7.4	-109.8	2.1	1.8	-106.6	14.8	12.5
-113.2	1.5	1.3	-112.8	1.8	1.5	-108.2	1.8	1.5	-92.0	1.1	0.9	-112.7	2.7	2.3	-116.3	9.5	8.1	-114.8	9.2	7.8	-111.6	8.8	7.5
-118.2	2.0	1.7	-117.8	2.8	2.4	-113.2	8.8	7.5	-97.0	1.4	1.2	-117.7	9.0	7.6	-121.3	9.3	7.9	-119.8	2.0	1.7	-116.6	3.3	2.8
-123.2	2.5	2.1	-122.7	9.4	8.0	-118.2	2.3	1.9	-99.5	10.6	9.0	-122.7	2.2	1.9	-126.3	11.0	9.3	-124.8	2.1	1.8	-121.6	2.6	2.2
-128.2	9.6	8.1	-127.7	10.8	9.2	-123.2	9.3	7.9	-102.0	8.3	7.0	-127.7	10.4	8.8	-131.3	10.4	8.8	-129.8	3.3	2.8	-126.6	10.5	8.9
-133.2	11.2	9.5	-132.8	10.5	8.9	-128.2	10.4	8.8	-104.5	1.8	1.5	-132.7	11.6	9.8	-136.3	10.6	9.0	-134.8	12.6	10.7	-131.6	10.2	8.6
-138.2	4.1	3.5	-137.8	11.3	9.6	-133.2	11.5	9.7	-106.2	10.8	9.2	-137.7	11.0	9.3	-141.3	11.8	10.0	-139.8	11.8	10.0	-136.6	10.8	9.2
-143.2	11.7	9.9	-142.7	11.9	10.1	-138.2	31.7	26.9	-109.5	1.7	1.4	-142.7	13.5	11.4	-146.3	11.9	10.1	-144.8	12.2	10.3	-141.6	12.0	10.2
-148.2	12.3	10.4	-147.1	13.5	11.4	-143.2	12.9	10.9	-111.2	11.0	9.3	-147.7	12.5	10.6	-151.0	13.8	11.7	-149.9	12.5	10.6	-146.6	13.0	11.0
-153.2	13.0	11.0	-151.8	13.7	11.6	-148.2	12.7	10.8	-114.5	2.1	1.8	-152.6	14.0	11.9	-155.4	13.9	11.8	-154.7	13.5	11.4	-151.6	12.7	10.8
-157.4	13.5	11.4	-157.0	13.8	11.7	-153.1	13.9	11.8	-117.0	2.6	2.2	-156.8	13.9	11.8	-160.4	14.0	11.9	-159.4	13.7	11.6	-156.6	13.2	11.2
-162.4	13.7	11.6	-162.0	13.9	11.8	-157.4	13.5	11.4	-119.5	2.9	2.5	-161.8	14.1	12.0	-166.2	14.5	12.3	-164.0	14.0	11.9	-161.5	NL	NL
-167.4	14.0	11.9	-167.8	13.9	11.8	-162.3	13.6	11.5	-121.6	12.0	10.2	-166.9	14.2	12.0	-171.3	13.4	11.4	-169.1	14.0	11.9	-165.7	14.6	12.4
-173.2	12.3	10.4	-172.8	12.0	10.2	-167.4	13.7	11.6	-124.5	3.7	3.1	-172.7	13.0	11.0	-176.3	12.4	10.5	-174.5	13.7	11.6	-170.8	14.4	12.2
-178.2	11.9	10.1	-177.8	11.9	10.1	-173.2	13.6	11.5	-127.0	9.6	8.1	-177.7	11.9	10.1	-181.3	12.4	10.5	-179.8	12.6	10.7	-176.2	14.1	12.0
-183.2	11.5	9.7	-182.6	13.7	11.6	-178.2	12.3	10.4	-129.5	9.8	8.3	-182.7	11.8	10.0	-186.0	13.7	11.6	-184.8	12.4	10.5	-181.6	13.4	11.4
-188.0	13.3	11.3	-187.6	13.4	11.4	-183.2	11.9	10.1	-132.0	10.5	8.9	-187.4	13.5	11.4	-190.5	13.7	11.6	-189.7	13.3	11.3	-186.6	12.7	10.8
-197.8	13.0	11.0	-192.4	13.4	11.4	-187.9	13.0	11.0	-134.5	11.7	9.9	-192.0	13.6	11.5				-194.7	13.3	11.3	-191.6	13.3	11.3

Table RAI-30-4 (Sheet 2 of 3)
Comparison of Liquefaction Safety Factors Using Upper and Lower Bound Magnitude Scaling Factors

Boring NB-1			Boring NB-2			Boring NB-3			Boring NB-4			Boring NB-5			Boring NB-6			Boring NB-7			Boring NB-8		
Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)
-207.8	12.8	10.8	-202.5	13.0	11.0	-192.8	13.2	11.2	-137.0	11.7	9.9										-201.2	13.4	11.4
-217.9	12.6	10.7	-212.5	12.8	10.8				-139.5	11.7	9.9										-211.2	13.1	11.1
-228.2	12.3	10.4	-222.8	10.7	9.1				-142.0	11.2	9.5										-221.3	12.9	10.9
-238.2	2.2	1.9	-232.8	10.6	9.0				-144.5	12.1	10.3										-231.6	12.7	10.8
-248.2	15.6	13.2	-242.8	3.6	3.1				-147.0	12.9	10.9										-241.6	12.1	10.3
-258.2	NL	NL	-252.8	NL	NL				-149.5	12.3	10.4										-251.6	11.3	9.6
-268.2	10.0	8.5	-262.8	3.5	3.0				-152.0	13.2	11.2										-261.6	NL	NL
-278.2	2.3	1.9	-272.8	NL	NL				-154.5	13.7	11.6										-271.6	1.4	1.2
-288.2	11.0	9.3	-282.8	10.1	8.6				-156.7	NL	NL										-281.6	2.2	1.9
-298.2	3.2	2.7	-292.8	NL	NL				-159.1	14.1	12.0										-291.6	NL	NL
-308.1	NL	NL							-161.1	14.3	12.1												
-318.2	NL	NL							-163.7	14.5	12.3												
-328.2	NL	NL							-166.1	14.5	12.3												
-338.2	NL	NL							-168.8	14.5	12.3												
-348.2	NL	NL							-171.9	14.5	12.3												
-358.2	NL	NL							-174.5	12.8	10.8												
-368.2	NL	NL							-177.0	12.8	10.8												
-378.2	NL	NL							-179.5	12.5	10.6												
-388.2	NL	NL							-182.0	12.4	10.5												
-398.2	NL	NL							-184.5	11.9	10.1												
-407.9	NL	NL							-187.0	12.9	10.9												
-418.2	9.0	7.6							-189.4	13.8	11.7												
-427.9	9.9	8.4																					
-438.0	9.9	8.4																					
-457.5	NL	NL																					

Table RAI-30-4(Sheet 3 of 3)
Comparison of Liquefaction Safety Factors Using Upper and Lower Bound Magnitude Scaling Factors

Boring NB-1			Boring NB-2			Boring NB-3			Boring NB-4			Boring NB-5			Boring NB-6			Boring NB-7			Boring NB-8		
Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)	Elevation (feet)	Upper Bound Safety Factor (1)	Lower Bound Safety Factor (2)
-477.2	8.9	7.5																					
-496.9	8.9	7.5																					
-517.1	8.6	7.3																					
-587.9	NL	NL																					

(1) Upper Bound Safety Factor is calculated using the Upper Bound Magnitude Scaling Factor (2.088)
(2) Lower Bound Safety Factor is calculated using the Lower Bound Magnitude Scaling Factor (1.7698)

N/A - not applicable (Kirkwood Formation material above the foundation bearing elevation)
NL - non-liquefiable silts and clays (USCS designations CL, CH, ML, MH, CL-ML, CH-MH)

	FS<1.1	1.1<=FS<1.4	1.4>=FS	Total Samples
With Upper Bound MSF	0	6	253	257
With Lower Bound MSF	3	9	245	257

PSEG Letter ND-2011-0047, dated June 29, 2011

ENCLOSURE 2

Proposed Revisions
Part 2 - Site Safety Analysis Report

Subsection 2.5.4 – Stability of Subsurface Materials and Foundations

Marked-up Pages
2.5-317
2.5-319
2.5-320
2.5-323

2.5.4.8 Liquefaction Potential

This subsection presents a discussion of liquefaction potential for the soils at the PSEG Site. RG 1.198, *Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites*, Revision 0, 2003, contains guidance on procedures for assessing soil liquefaction. The approach provides for screening using geologic criteria and soil characteristic criteria and calculation methods using field data and, if necessary, laboratory classification test data. If the screening methods conclude soils are not potentially liquefiable, the methods using laboratory cyclic strength test data are not necessary. Geologically based screening and Standard Penetration Test (SPT) based liquefaction analyses performed in accordance with RG 1.198 concluded the soils below elevation -67 ft. NAVD are not susceptible to liquefaction and more detailed analyses are not performed.

2.5.4.8.1 Site Conditions

Soil liquefaction is a process by which loose, saturated, granular deposits lose a significant portion of their shear strength due to pore pressure buildup resulting from cyclic loading, such as that caused by an earthquake. Soil liquefaction occurrence (or lack thereof) depends on geologic age, state of soil saturation, density, gradation, plasticity, and earthquake intensity and duration. Soil liquefaction can occur, leading to bearing failures and excessive settlements, when all of the following criteria are met:

- Design ground acceleration is high
- Soil is saturated (i.e., close to or below the water table)
- Site soils are sands or silty sands in a loose to medium dense condition

Replace with Insert A

The PSEG Site geology, as described in Subsection 2.5.4.1, consists of layered sediments ranging in geologic age from Quaternary to Lower Cretaceous. These sediments overlie crystalline bedrock at an elevation of approximately -1750 ft. NAVD. The uppermost 50 (+/-) ft. of sediments are recent age and consist of soft fill placed by hydraulic disposal and some artificial fill placed during previous construction activity. Quaternary age (Pleistocene) deposits of loose to medium dense sandy alluvium underlie the recent deposits and are 10 to 15 ft. thick.

Below the alluvium, Tertiary age deposits of mostly sandy soils of the Kirkwood, Vincentown and Hornerstown formations are present to depths of approximately 160 ft. below the existing ground surface. Cretaceous age sediments begin at this approximately 160 ft. depth and extend to the crystalline bedrock.

~~As described in Subsection 2.5.4.6, groundwater level monitoring between January and July 2009 shows an average groundwater elevation in the upper water bearing zone (Alluvium) of 0.78 ft. NAVD and an average groundwater elevation in the lower water bearing stratum (Vincentown Formation) of 0.43 ft. NAVD. For the liquefaction evaluation, groundwater elevations from individual boring records are used; the average of the groundwater elevations used is 0.6 ft. NAVD.~~

The Quaternary and Pleistocene deposits will be removed from the area of the safety-related structures because of their low shear wave velocity and unsuitable engineering characteristics. As discussed in Subsection 2.5.4.5, the removal is expected to extend to approximately elevation -67 ft. NAVD, or approximately 75 ft. below the present ground surface. Category 1

Soil Classification System (USCS) designations shown on the test boring logs, and the results of Atterberg limit tests and grain size analysis tests performed on selected samples.

Based on their granular composition and position below the water table, the Vincentown, Hornerstown, Navesink, Mount Laurel, Wenonah, Marshalltown, Englishtown, Magothy and Potomac formations are potentially liquefiable. The Woodbury and Merchantville formations are clayey soils containing less than 50 percent sand and are not likely to liquefy.

The field SPT results (N-values) are corrected for field variables, sampling methods and effective overburden pressures. Based on the average corrected N-value of each formation, the Hornerstown, Wenonah and Englishtown formations are potentially liquefiable. The other formations have average corrected N-values equal to or greater than 30 blows per foot and are not likely to liquefy (Reference 2.5.4.8-2).

As discussed in Reference 2.5.4.8-2, resistance of soils to liquefaction increases with age – Pleistocene sediments are more resistant to liquefaction than younger sediments, and pre-Pleistocene sediments are generally not liquefiable. All formations below the top of the competent layer are pre-Pleistocene and are not likely to liquefy based on their age.

The results of the geologically based liquefaction screening evaluation are summarized on Table 2.5.4.8-1.

2.5.4.8.3 SPT-Based Liquefaction Assessment

A liquefaction assessment using a simplified SPT-based empirical procedure is performed for the geologic formations below the top of the competent layer using the methods described in Reference 2.5.4.8-2 and as described in RG 1.198. The liquefaction potential is presented as a factor of safety which is the ratio of the cyclic resistance ratio (CRR) to the cyclic stress ratio (CSR).

The CRR is based on the SPT N-values corrected for field variables, sampling methods, overburden pressure, and fines content of the soil. The CRR is initially computed for an earthquake magnitude of 7.5 and then modified by the Magnitude Scaling Factor which is based on the earthquake magnitude for the site being evaluated.

Section 2.5.2 of NUREG-0800 states that if the controlling earthquakes for a site have magnitudes less than 6, the time history selected for the evaluation of liquefaction potential must have a duration and number of strong motion cycles corresponding to at least a magnitude 6 event. As presented in Subsection 2.5.2.6.1.2, the controlling earthquake magnitude is less than 6; therefore magnitude 6 is used in the analysis.

ADD Insert B here

The CSR is a function of the maximum acceleration at the foundation level, the total and effective overburden pressures at the sample depth, and a stress reduction factor. A stress reduction factor is used because the soil column is not rigid but deformable, and shear stresses at depth are less than at the foundation level. The Ground Motion Response Spectrum (GMRS) is developed for the top of the competent layer (Vincentown Formation) and has a mean elevation of -67 ft. Therefore, the maximum acceleration is applied at the top of the competent layer and the stress reduction factor is referenced to the top of the competent layer in the evaluation. The GMRS is shown on Figure 2.5.2-54. The maximum ground acceleration used in the analysis, 0.18 g, is the point at which the GMRS intersects the 100 Hz frequency. The use of 100 Hz to determine peak ground acceleration is standard practice and has been used on other soil sites.

Subsection 2.5.2.6 of the Hope Creek Generation Station (HCGS) UFSAR (Reference 2.5.4- 1) presents the Safe Shutdown Earthquake (SSE) and peak ac Design acceleration of 20% g is recommended at the foundatio occurrence of the SSE of Intensity VII (M ~ 5.7). These values earthquake magnitude and peak acceleration used in this liquefaction evaluation.

ADD:
", based on the lower bound Magnitude Scaling Factor."

The safety factor against liquefaction is computed for each SPT sample of granular soil obtained in borings NB-1 through NB-8 from the top of the competent layer at elevation -67 feet to the depth explored in the boring. Table 2.5.4.8-2 shows the minimum, maximum and average factors of safety against liquefaction and the distribution of safety factors for each geologic formation at the PSEG Site.

RG 1.198 states that factors of safety less than or equal to 1.1 against liquefaction are low, factors of safety between 1.1 and 1.4 are considered moderate, and factors of safety greater ~~than or equal to 1.4 are considered high. A total of 257 SPT N-values are analyzed. There are no calculated liquefaction safety factors less than 1.1, 4 safety factors between 1.1 and less than 1.4, and 253 safety factors greater than 1.4. Based on the results of the calculation of factors of safety, liquefaction of granular soils below the top of the competent layer is not likely to occur.~~

The existing total and effective overburden pressures are used in computing the safety factor against liquefaction. The Artificial and Hydraulic Fill, Alluvium and Kirkwood Formation soils will be removed and replaced with controlled fill such as concrete or compacted fill having a unit weight greater than the existing soils. The higher unit weight materials will increase the total and effective overburden pressures and will result in higher safety factors against liquefaction. Therefore the computed liquefaction safety factors shown on Table 2.5.4.8-2 are conservative using existing total and effective overburden pressures.

Replace with Insert C

2.5.4.8.4 Liquefaction Outside the Safety-Related Structure Area

The Artificial and Hydraulic Fill, Alluvium and Kirkwood Formation soils will be excavated to the top of the competent layer and replaced with Category 1 backfill material in the area of the nuclear island and other safety-related structures. Beyond this area of excavation and replacement, the Artificial and Hydraulic Fill, and Alluvium will be excavated to the Kirkwood Formation and replaced with Category 2 backfill material out to the limits of the power block excavation. Subsection 2.5.4.2 and Figure 2.5.4.5-2 discuss and illustrate details of the excavation and replacement concept.

The excavation for the power block will be bounded by a structural support system located approximately 850 ft. from the centerline of the nuclear island structures depending on the technology selected. Outside of the structural support system, the Artificial and Hydraulic Fill, Alluvium, and Kirkwood Formation soils will remain in place. Liquefaction of these soils could result in settlement and lateral spread outside the excavation support structure. As a worst case, all soil outside the excavation support structure is considered as being removed during a possible liquefaction event. If this were to occur, the structural support system could fail, and

Table 2.5.4.8-2
Summary of Liquefaction Safety Factors (FS) for each Geologic Formation

Formation No.	Formation Name	Safety Factor[a]			Distribution of Safety Factors		
		Minimum	Maximum	Average	FS<1.1	1.1<=FS<1.4	1.4<=FS
4	Vincentown	1.1	14.8	5.6	0	4	72
5	Hornerstown	1.5	12.0	5.7	0	0	33
6	Navesink	4.1	31.7	12.7	0	0	44
7	Mount Laurel	2.2	21.0	13.8	0	0	90
8	Wenonah	1.4	5.4	3.4	0	0	2
9	Marshalltown	2.2	15.0	8.3	0	0	5
10	Englishtown	3.2	3.2	3.2	0	0	1
11	Woodbury	NL	NL	NL	0	0	0
12	Merchantville	NL	NL	NL	0	0	0
13	Magothy	9.0	9.9	9.6	0	0	3
14	Potomac	8.6	8.9	8.8	0	0	3
				Total =	0	4	253

a) NL = Non liquefiable silts and clays (USCS designations CL, CH, ML, MH, CL-ML, CH-MH)

Replace with Revised Table 2.5.4.8-2

Insert A for Page 2.5-317

As described in SSAR Subsection 2.5.4.3.1.2, boreholes were made using a clay mineral drilling fluid. Groundwater levels at the time of drilling can be affected by the presence of the drilling fluid. The depth to the groundwater table at each boring location used in the liquefaction evaluation was selected from water level measurements made in April 2009 (SSAR Table 2.5.4.6-1) in the shallow-depth observation wells installed adjacent to the geotechnical borings (U-series).

Insert B for Page 2.5-319

Both lower bound and upper bound Magnitude Scaling Factors are used; the lower bound Magnitude Scaling Factor provides the lower factor of safety and thus is conservative.

Insert C for Page 2.5-320

Three calculated liquefaction safety factors less than 1.1, nine safety factors between 1.1 and less than 1.4, and 245 safety factors greater than 1.4. The results represent isolated pockets. Based on the results of the calculation of factors of safety, liquefaction of granular soils below the top of the competent layer is not likely to occur.

Revised Table 2.5.4.8-2

Table 2.5.4.8-2
Summary of Liquefaction Safety Factors (FS) for each Geologic Formation

Formation No.	Formation Name	Safety Factor [(a), (b)]			Distribution of Safety Factors		
		Minimum	Maximum	Average	FS<1.1	1.1<=FS<1.4	1.4<=FS
4	Vincentown	0.9	12.5	4.6	3	7	66
5	Hornerstown	1.3	10.2	4.6	0	1	32
6	Navesink	3.5	26.9	10.2	0	0	44
7	Mount Laurel	1.9	13.8	11.1	0	0	90
8	Wenonah	1.2	3.0	2.1	0	1	1
9	Marshalltown	1.9	9.3	5.7	0	0	5
10	Englishtown	2.7	2.7	2.7	0	0	1
11	Woodbury	NL	NL	NL	0	0	0
12	Merchantville	NL	NL	NL	0	0	0
13	Magothy	7.6	8.4	8.1	0	0	3
14	Potomac	7.3	7.5	7.5	0	0	3
				Total =	3	9	245

a) NL – Non-liquefiable silts and clays (USCS designations CL, CH, ML, MH, CL-ML, CH-MH)
b) Safety factors based on lower bound Magnitude Scaling Factor

PSEG Letter ND-2011-0047, dated June 29, 2011

ENCLOSURE 3

Summary of Regulatory Commitment

ENCLOSURE 3
SUMMARY OF REGULATORY COMMITMENTS

The following table identifies the commitment made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE	COMMITMENT TYPE	
		ONE-TIME ACTION (YES/NO)	PROGRAMMATIC (YES/NO)
PSEG will revise SSAR Subsection 2.5.4.8 to incorporate the changes in Enclosure 2 in response to NRC RAI No. 30, Question 02.05.04-2	This revision will be included in the next update of the PSEG Site ESP Application SSAR.	Yes	No