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2.5.4 Stability of Subsurface Materials and Foundations

This subsection is prepared in accordance with the applicable sections of RG 1.206 (Reference 2.5.4-201).

The details of subsurface materials present at, and foundations constructed for, the VCS site, including the safety-related power block (see Figure 2.5.4-201) and the adjoining nonsafety-related cooling basin/Guadalupe-Blanco River Authority (GBRA) storage water reservoir (see Figure 2.5.4-202), are described here.

The information presented in this subsection is based on the results of a site-specific subsurface investigation, and on an evaluation of the collected data, unless noted otherwise. The detailed data for the power block and the cooling basin/GBRA storage water reservoir collected from this site-specific subsurface investigation is contained in Appendices 2.5.4-A and 2.5.4-B, respectively, which are included with this subsection.

2.5.4.1 Geologic Features

Subsection 2.5.1 addresses the geologic setting of the VCS site, including regional and site-specific physiography and geomorphology, geologic history, stratigraphy, tectonic and neo-tectonic conditions, and potential geologic hazards, and presents related maps, cross sections, and references. The potential geologic hazards assessed in Subsection 2.5.1 include, among other things, subsidence, solutioning/karst, zones of irregular weathering, seismic sources, zones of structural weakness, and unrelieved residual stresses.

A brief summary of the geologic conditions described in Subsection 2.5.1 follows (Reference 2.5.4-202). As shown on Figures 2.5.1-201 and 2.5.1-203, the site lies within the Coastal Prairies subprovince of the Gulf Coastal Plains physiographic province. The surficial soils present at the site consist of Beaumont Formation sediments underlain by the Lissie Formation. These Pleistocene-age soils were deposited by ancestral rivers during a period of glacial recession and high sea level. The Beaumont Formation extends to a depth of approximately 400 feet below ground surface, and the Lissie Formation has a combined thickness of roughly 200 feet beneath the VCS site. These formations are underlain by deposits of Pliocene to Oligocene age, and extend to a depth of approximately 8400 feet below ground surface, where they transition to the underlying earlier tertiary sediments, with a base depth of approximately 20,000 feet below ground surface. These Cenozoic deposits are underlain by Mesozoic bedrock, and then by Proterzoic rock (basement rock), which occurs at a top depth of approximately 41,000 feet below ground surface. Refer to Subsection 2.5.1 and Figures 2.5.1-210 and 2.5.1-215 for additional detail on the stratigraphic column briefly described above. The uppermost 600 feet of Beaumont Formation and Lissie Formation (Pleistocene) sediments are the subject of the site-specific subsurface investigation described here.

Pre-loading (overconsolidation) influences on site soils, including estimates of consolidation properties, overconsolidation ratios, preconsolidation pressures, and methods used for their estimation, are addressed in Subsection 2.5.4.2. Related maps and subsurface profiles specific to the site are presented in Subsection 2.5.4.3.

The stability of site soils and their response to dynamic loading is addressed in Subsection 2.5.4.7. The stability of site soils and their response to static (foundation) loading, including the stability of foundations for seismic Category I structures, is addressed in Subsection 2.5.4.10.

2.5.4.2 Properties of Subsurface Materials

This subsection addresses the properties of subsurface materials, and the methods of determining these properties. Subsection 2.5.4.2.1 addresses the properties of subsurface materials encountered at the VCS site, while Subsection 2.5.4.2.2 describes the subsurface investigation and laboratory testing program conducted in obtaining these properties.

2.5.4.2.1 Description of Subsurface Materials

This subsection addresses the properties of subsurface materials as follows:

- Subsection 2.5.4.2.1.1 provides an introduction to the soil strata encountered at the VCS site.
- Subsection 2.5.4.2.1.2 describes each soil stratum encountered.
- Subsection 2.5.4.2.1.3 describes the evaluation of in situ properties of soil strata investigated (i.e., soils extending to a depth of approximately 600 feet below ground surface), and presents tables and figures of these properties.

- Subsection 2.5.4.2.1.4 describes the evaluation of properties of structural fill, embankment fill, and drainage sand materials, and presents tables and figures of these properties.
- Subsection 2.5.4.2.1.5 describes the subsurface materials below a depth of 600 feet (i.e., below the maximum depth of this subsurface investigation).

2.5.4.2.1.1 Summary of Soil Strata

As noted above, subsurface materials at the VCS site consist of deep Gulf Coastal Plains sediments underlain by Pre-Cretaceous bedrock (basement rock), which is estimated to occur at a depth of approximately 41,000 feet below ground surface (Reference 2.5.4-202). The uppermost 600 feet of site soils, consisting of Beaumont and older Lissie Formation soils, are the subject of this subsurface investigation. These soils are divided into 20 individual soil strata, consisting of nine predominantly clay strata and 11 predominantly sand strata. The 20 soil strata are described in Subsection 2.5.4.2.1.2, and their properties are evaluated and presented in Subsection 2.5.4.2.1.3.

Subsurface conditions deeper than 600 feet are characterized using information from the geologic literature, most notably Reference 2.5.4-203, and from deeper borings drilled in the area for oil and gas exploration (Reference 2.5.4-203). While the depth to competent bedrock (basement rock) is significant at the site (approximately 41,000 feet, as noted above), layers and lenses of sandstone, siltstone, limestone, caliche, and hard shale can be present intermittently to this depth.

Identification and characterization of the soil strata investigated is based on physical and engineering characteristics. Methods used in identification and characterization are described in detail in Subsections 2.5.4.2.2 and 2.5.4.4, and include standard penetration testing (SPT) in borings, cone penetration testing (CPT), test pits (TP), geophysical downhole P-S suspension logging to measure compression (P, V_p) and shear (S, V_s) wave velocities, field electrical resistivity testing (ER), and groundwater observation well (OW) installations and related field testing, as well as extensive laboratory testing.

The natural ground surface at and around the power block at the time of this subsurface investigation is generally level, ranging from approximately elevation +78 feet to elevation +81 feet, with an average of elevation +80 feet. Note that all references to elevations given in this subsection are to the North American Vertical Datum of 1988 (NAVD 88). During construction, the power block finish grade elevation is raised approximately 15 feet to elevation +95 feet.

The natural ground surface at the cooling basin/GBRA storage water reservoir at the time of this subsurface investigation is gently sloping downward from northwest to southeast, ranging from approximately elevation +80 feet to elevation +42 feet, with an average of elevation +70 feet. The base level of the cooling basin/GBRA storage water reservoir is elevation +69 feet. An embankment dam with crest at elevation +102 feet surrounds the cooling basin/GBRA storage water reservoir, and additionally divides the cooling basin from the adjoining GBRA storage water reservoir. The cooling basin also has interior dikes with crest at elevation +99 feet.

2.5.4.2.1.2 Description of Soil Strata

The following is a description of each soil stratum encountered in the subsurface investigation to the maximum investigated depth of 600 feet in the power block and 300 feet in the cooling basin/GBRA storage water reservoir. The stratum thickness indicated in each description for the power block is the calculated average within the two power block units (Unit 1 and Unit 2). For the cooling basin/GBRA storage water reservoir, the stratum thickness indicated in each description is the calculated average. Note that the stratum thickness at a particular boring or CPT is only included in the average calculation when the stratum is encountered and fully penetrated by the boring or CPT. The Unified Soil Classification System (USCS) (References 2.5.4-204 and 2.5.4-205) classifications included in each of the descriptions are based mainly on the results of Atterberg limit tests and grain size analyses. Most of the strata are present in each boring and CPT within the depth investigated, except as noted.

2.5.4.2.1.2.1 Stratum Clay 1

This stratum consists primarily of dark gray fat clay, or lean clay, with varying amounts of silt, sand, and gravel. It has a stiff to very stiff consistency with some weaker zones and trace organics near the ground surface. USCS classification is CL for Stratum Clay 1 (Top) and CH for Stratum Clay 1 (Bottom).

Stratum Sand 1 (described next) subdivides Stratum Clay 1 in the Unit 2 area and in the cooling basin/GBRA storage water reservoir (i.e., Stratum Sand 1 is overlain by Stratum Clay 1 [Top] and underlain by Stratum Clay 1 [Bottom]). Stratum Clay 1 (Top) is about 30 feet thick in the power block, and about 11 feet thick in the cooling basin/GBRA storage water reservoir. Stratum Clay 1 (Bottom) is about 17 feet thick in all areas investigated.

2.5.4.2.1.2.2 Stratum Sand 1

This stratum consists of pale brown, light gray, and light brown, medium dense to dense, fine poorly graded clayey and silty sand. The USCS classification is SC.

As noted above, Stratum Sand 1 subdivides Stratum Clay 1 throughout most of the Unit 2 area, except at ten borings. It also subdivides Stratum Clay 1 throughout the majority of the cooling basin/GBRA storage water reservoir, except at 20 borings. This stratum is absent in the Unit 1 area. Stratum Sand 1 is about 9 feet thick in the power block, and about 15 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.3 Stratum Sand 2

This stratum consists of light gray to brown, medium dense to very dense (occasionally loose), fine clayey sand, with varying amounts of silt and/or clay. The USCS classification is SC.

Stratum Sand 2 is present below Stratum Clay 1 within the power block, except at ten borings, and within the cooling basin/GBRA storage water reservoir, except at nine borings. Eight CPTs in the cooling basin/GBRA storage water reservoir terminate in Stratum Sand 2. This stratum is about 13 feet thick in the power block, and about 17 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.4 Stratum Clay 3

This stratum consists of pale yellow, pale brown, or yellowish brown to olive gray, stiff to hard fat clay, with varying amounts of silt and/or sand in the form of isolated seams and layers. The USCS classification is CH with some CL.

Stratum Clay 3 is present below Stratum Sand 2 at all locations investigated in the power block, but is not present in five borings in the cooling basin/GBRA storage water reservoir. One CPT in the power block and six CPTs in the cooling basin/GBRA storage water reservoir terminate in Stratum Clay 3. This stratum is about 24 feet thick in the power block, and about 19 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.5 Stratum Sand 4

This stratum consists of pale brown or light gray to pinkish gray, dense to very dense (occasionally loose), fine to medium clayey sand, mostly poorly-graded. The USCS classification is SC or SP-SC. Stratum Sand 4 contains some clay seams and layers, with some samples comprising more than 50 percent fines and indicating some plasticity.

Stratum Sand 4 is present below Stratum Clay 3 at all locations investigated in the power block and at all but one boring in the cooling basin/GBRA storage water reservoir. The remaining power block CPTs, and eight CPTs at the cooling basin/GBRA storage water reservoir area, terminate in this stratum. Stratum Sand 4 is about 26 feet thick in the power block and about 25 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.6 Stratum Clay 5

This stratum consists of light gray and brownish yellow to mottled brownish yellow or pale brown, medium to hard fat clay, with small amounts of silt and/or sand. The USCS classification is CH with some CL.

Stratum Clay 5 is present in all borings that extend below Stratum Sand 4 in the power block, but is absent in three borings at the cooling basin/GBRA storage water reservoir. Stratum Sand 5 (described next) subdivides Stratum Clay 5 (i.e., Stratum Sand 5 is overlain by Stratum Clay 5 [Top] and underlain by Stratum Clay 5 [Bottom]). One CPT in the cooling basin/GBRA storage water reservoir terminates in Stratum Clay 5 (Top). Stratum Clay 5 (Top) is about 19 feet thick in the power block, and about 14 feet thick in the cooling basin/GBRA storage water reservoir. The corresponding thicknesses for Stratum Clay 5 (Bottom) are about 16 feet and about 13 feet.

2.5.4.2.1.2.7 Stratum Sand 5

This stratum consists of pale to yellowish brown or light gray, dense to very dense (occasionally loose), fine to medium silty or clayey sand, with minor amounts of silt and/or clay. The USCS classification is SC or SM.

As noted above, Stratum Sand 5 subdivides Stratum Clay 5. For borings that extend below Stratum Clay 5 (Top), Stratum Sand 5 is not present at 17 borings in the power block and at one boring in the cooling basin/GBRA storage water reservoir. All of the remaining CPTs in the cooling basin/GBRA storage water reservoir terminate in this stratum. Stratum Sand 5 is about 13 feet thick in all areas investigated.

2.5.4.2.1.2.8 Stratum Sand 6

This stratum consists of light gray to pale brown, medium dense to very dense, fine to medium silty sand, with varying amounts of silt and/or clay. The USCS classification is SC or SM.

Stratum Sand 6 is present below Stratum Clay 5 in all the borings that extended below Stratum Clay 5. Stratum Sand 6 is about 50 feet thick in the power block and about 24 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.9 Stratum Clay 7

This stratum consists of pale yellow to pale brown and light gray, very stiff to hard clay, with minor amounts of silt and/or sand. The USCS classification is CH or CL.

In borings that extend below Stratum Sand 6, Stratum Clay 7 is present in all of the borings at the Unit 1 area, in only one boring at the Unit 2 area (i.e., it is largely absent in the Unit 2 area), and in all but two borings at the cooling basin/GBRA storage water reservoir. Stratum Clay 7 is about 45 feet thick in the power block and about 27 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.10 Stratum Sand 8

This stratum consists of pale yellow and light gray, dense to very dense, fine to medium silty or clayey sand, with varying amounts of silt and/or clay. The USCS classification is SC or SM.

Stratum Sand 8 is present below Stratum Clay 7 at the Unit 1 area and at the cooling basin/GBRA storage water reservoir, and is present below Stratum Sand 6 at the Unit 2 area. Stratum Sand 8 is about 48 feet thick in the power block and about 27 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.11 Stratum Clay 9

This stratum consists of pale brown and light gray stiff to hard fat clay, with minimal amounts of silt and/or sand. The USCS classification is CH.

Stratum Clay 9 is present below Stratum Sand 8 in all borings that extend below Stratum Sand 8. Stratum Clay 9 is about 41 feet thick in all areas investigated.

2.5.4.2.1.2.12 Stratum Sand 10

This stratum consists of light gray dense to very dense fine silty sand, with varying amounts of silt and/or clay. The USCS classification is SM.

Stratum Sand 10 is present below Stratum Clay 9 at all but one of the power block borings that extend below Stratum Clay 9. Stratum Sand 10 is about 28 feet thick in the power block and about 32 feet thick in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.2.13 Stratum Clay 11

This stratum consists of light brown to light gray stiff to hard fat clay, with minimal amounts of silt and/or sand. The USCS classification is CH.

At the power block, the five 400-foot deep borings terminate in Stratum Clay 11. The two deepest borings at the cooling basin/GBRA storage water reservoir also terminate in Stratum Clay 11. Only the two 600-foot deep power block borings fully penetrate the stratum, where Stratum Clay 11 is about 54 feet thick.

Note that the deeper Strata Sand 12 through Clay 17 are investigated and fully penetrated only in the 600-foot deep boring at the Unit 1 area and in the 600-foot deep boring at the Unit 2 area.

2.5.4.2.1.2.14 Stratum Sand 12

This stratum consists of light gray, dense to very dense, fine clayey sand, containing significant clay layers. The USCS classification is SC. Stratum Sand 12 is about 21 feet thick.

2.5.4.2.1.2.15 Stratum Clay 13

This stratum consists of light brown stiff to hard fat clay. The USCS classification is CH. Stratum Clay 13 is about 76 feet thick.

2.5.4.2.1.2.16 Stratum Sand 14

This stratum consists of olive brown, dense to very dense, fine silty sand. The USCS classification is SM. Stratum Sand 14 is about 40 feet thick.

2.5.4.2.1.2.17 Stratum Clay 15

This stratum consists of light gray stiff to hard fat clay. The USCS classification is CH. Stratum Clay 15 is about 12 feet thick.

2.5.4.2.1.2.18 Stratum Sand 16

This stratum consists of light gray dense to very dense fine silty sand, and includes some clay layers. The USCS classification is SM. Stratum Sand 16 is about 17 feet thick.

2.5.4.2.1.2.19 Stratum Clay 17

This stratum consists of pinkish gray stiff to hard clay. The USCS classification is CL. Stratum Clay 17 is about 21 feet thick.

2.5.4.2.1.2.20 Stratum Sand 18

This stratum consists of light gray dense to very dense fine silty sand. The USCS classification is SM. The 600-foot deep boring at the Unit 1 area penetrates about 14 feet, and the 600-foot deep boring at the Unit 2 area penetrates about four feet, into Stratum Sand 18.

2.5.4.2.1.3 Evaluation of Properties of In Situ Materials

Properties of in situ materials are evaluated using the results of field and laboratory testing for both the power block and cooling basin/GBRA storage water reservoir. These results, in the form of boring logs, CPT records, test pit logs, laboratory test results, etc., are contained in Appendices 2.5.4-A and 2.5.4-B, and are presented in summary tables and figures in the following subsections. The majority of the average property values for each stratum presented in the following subsections are given in the *Geotechnical Engineering Parameters Selected for Design* summary tables, namely Table 2.5.4-232 for the power block and Table 2.5.4-233 for the cooling basin/GBRA storage water reservoir.

Generally, the results from the power block and from the cooling basin/GBRA storage water reservoir are similar. Where results differ, differences can be attributed to the much larger area covered by the subsurface investigation for the cooling basin/GBRA storage water reservoir and the greater concentration of investigation work in the power block.

2.5.4.2.1.3.1 Stratum Thickness

The thickness of each stratum is estimated from borings that penetrate the particular stratum. CPTs also provide an estimate of thickness for the shallower strata. The thickness and base elevation of each stratum from all the borings and CPTs performed are averaged and presented in Table 2.5.4-203 for the power block, and in Table 2.5.4-204 for the cooling basin/GBRA storage water reservoir. Note that the thicknesses and base elevations given in Table 2.5.4-203 are for four defined areas, namely the Unit 1 area, the Unit 2 area, the area inside the power block (which is the average of the values from investigations made within the Unit 1 area and the Unit 2 area), and the area outside the power block. Note that only data from borings and CPTs that encounter and fully penetrate the stratum is considered in evaluating the stratum thickness and in selecting the stratum base elevation in Tables 2.5.4-203 and 2.5.4-204.

2.5.4.2.1.3.2 SPT N-Values

As noted in Subsection 2.5.4.2.2.3.1, 153 borings were performed for this subsurface investigation: 86 borings at the power block, seven borings at the area outside the power block (B-08, B-10, B-2185, B-2301, B-2301A, B-2307, and B-2307A), and 60 borings at the cooling basin/GBRA storage water reservoir. SPT samples were taken at approximately 2.5-foot intervals to 15 feet depth below ground surface, at 5-foot intervals from 15 feet to 100 feet depth, at 10-foot intervals from 100 feet to 200 feet depth, and at 20-foot intervals from 200 feet to the maximum depth sampled at 600 feet. To ensure that all strata were sampled, sampling intervals were decreased from 20-foot to 10-foot intervals in selected borings. Also, in the two deepest power block borings (B-2174A and B-2274A) sampling intervals from 400 feet to 600 feet below ground surface were offset (e.g., in one boring the sampling depths are 400 feet, 420 feet, 440 feet, etc., while in the other boring, the sampling depths were 410 feet, 430 feet, 450 feet, etc.).

2.5.4.2.1.3.2.1 Uncorrected N-Values

A summary of all N-values measured in the field (uncorrected) is presented in Table 2.5.4-205 for the power block and in Table 2.5.4-206 for the cooling basin/GBRA storage water reservoir. These uncorrected N-values are shown on: Figure 2.5.4-221 for borings within Unit 1, Figure 2.5.4-222 for the deep boring within Unit 1 (B-2174A), Figure 2.5.4-223 for borings within Unit 2, Figure 2.5.4-224 for the deep boring within Unit 2 (B-2274A), Figure 2.5.4-225 for borings performed outside the power block area, and Figure 2.5.4-226 for the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.3.2.2 N-Value Correction

Field SPT N-values are adjusted for overburden pressure and other factors. This adjusted N-value, N_1, is determined using the following equation (Reference 2.5.4-206):

$N_1 = N\,C_n\,C_r\,C_b\,C_s$ Equation 2.5.4-1

where, N_1 = adjusted N-value (blows per foot [bpf])
N = field SPT value (bpf)
C_r = correction factor for rod length
C_b = correction factor for boring diameter
C_s = correction factor for soil sampler
C_n = overburden correction factor which varies with depth

The correction factors for rod length, boring diameter, and soil sampler are typically close to 1.0. Additional information on each of these correction factors is provided in Reference 2.5.4-206. The correction factor for overburden pressure can vary considerably. The effective overburden pressure is determined for each SPT sample interval using the average unit weights for the individual soil strata as determined by laboratory testing, and the soil strata thicknesses at individual borings, according to the equation below (Reference 2.5.4-206):

$C_n = 2.2/(1.2 + \sigma_v')$ Equation 2.5.4-2

where, C_n = the depth correction factor, which is applied together with the other factors, above, to the uncorrected SPT N-value to yield the normalized SPT N_1-value. The value of C_n is limited to a maximum of 1.7. C_n decreases with depth, becoming less than 1.0 at $\sigma v' > 1$ ton per square foot (tsf), and has a minimum value of 0.4 (Reference 2.5.4-207)

σ_v' = the effective overburden pressure at the depth of the SPT sample interval in tsf

Note that the groundwater levels selected in Subsection 2.5.4.6.1 are used in the calculation of the effective overburden pressure.

In addition to the correction factors included in Equation 2.5.4-1, a further correction to the field-measured N-value is made for hammer energy. The SPT N-value used in correlations with engineering properties is a value traditionally based on 60% hammer efficiency. All nine of the drill rigs employed in this subsurface investigation used automatic hammers, which typically have efficiencies greater than 60%. SPT hammer energy measurements were made for each drilling rig/hammer employed, in accordance with ASTM D 6066 (Reference 2.5.4-208), and the hammer energy measurements (expressed as energy transfer ratios, or ETRs) were obtained. As shown in Table 2.5.4-207, average ETRs range from

73% to 91%. The resulting energy correction factor, C_e, (expressed as ETR/60%) ranges from 1.21 to 1.51, also as shown in Table 2.5.4-207. N_1-values (from Equation 2.5.4-1) from each boring are corrected using the appropriate C_e value. The resulting fully corrected SPT N-values are termed $(N_1)_{60}$. These fully corrected STP $(N_1)_{60}$-values are a significant factor in liquefaction evaluation (see Subsection 2.5.4.8.2).

2.5.4.2.1.3.2.3 Corrected N-Values

A summary of all $(N_1)_{60}$ values is presented in Table 2.5.4-208 for the power block and in Table 2.5.4-209 for the cooling basin/GBRA storage water reservoir. These corrected N-values are shown on: Figure 2.5.4-227 for borings within Unit 1, Figure 2.5.4-228 for the deep boring within Unit 1 (B-2174A), Figure 2.5.4-229 for borings within Unit 2, Figure 2.5.4-230 for the deep boring within Unit 2 (B-2274A), Figure 2.5.4-231 for borings performed outside the power block area, and Figure 2.5.4-232 for the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.3.2.4 Design N-Values

Table 2.5.4-210 presents $(N_1)_{60}$ values selected for design for each stratum at the power block. Note that the $(N_1)_{60}$ values shown for each stratum in the power block Geotechnical Engineering Parameters Selected for Design summary table (Table 2.5.4-232) are the same values as those shown under the heading Inside Power Block in Table 2.5.4-208. Table 2.5.4-211 presents $(N_1)_{60}$ values selected for design for each stratum at the cooling basin/GBRA storage water reservoir. These corrected N-values are also included in the cooling basin/GBRA storage water reservoir Geotechnical Parameters Selected *for Design* summary table (Table 2.5.4-233).

2.5.4.2.1.3.3 CPT Values

As noted in Subsection 2.5.4.2.2.3.2, 65 CPTs were performed for this subsurface investigation: 37 CPTs at the power block, one CPT in the area outside the power block (C-2216), and 27 CPTs at the cooling basin/GBRA storage water reservoir. These CPT results are used (among other results) to estimate the angle of internal friction of sand strata penetrated (Subsection 2.5.4.2.1.3.7) and the undrained shear strength of clay strata penetrated (Subsection 2.5.4.2.1.3.8). Seismic CPT measurements are used to calculate shear wave velocity values of both sand and clay strata penetrated (Subsection 2.5.4.2.1.3.13).

CPT corrected (q_t) and normalized (q_{c1n}) tip resistance values are also significant factors in liquefaction evaluation (see Subsection 2.5.4.8.3). Note that the terms "corrected" and "normalized" used here are as described in Subsection 2.5.4.8.3. Summaries of all of the corrected and normalized CPT tip resistance values, as well as the sleeve friction (f_s) and friction ratio (R_f) values, are given in Table 2.5.4-212 for the power block, and in Table 2.5.4-213 for the cooling basin/GBRA storage water reservoir. Figures 2.5.4-233 through 2.5.4-236 illustrate the corrected CPT tip resistance versus elevation at Unit 1, at Unit 2, in the area outside the power block, and at the cooling basin/GBRA storage water reservoir, respectively. Figures 2.5.4-237 through 2.5.4-240 illustrate the corresponding normalized CPT tip resistance versus elevation for each of the areas listed above.

2.5.4.2.1.3.4 Natural Moisture Content and Atterberg Limits

The results of natural moisture content and Atterberg limits laboratory tests on samples from all of the soil strata tested are shown in the *General Physical and Chemical Properties Test Results* summary tables, namely Table 2.5.4-216 for the power block and Table 2.5.4-217 for the cooling basin/GBRA storage water reservoir.

Atterberg limits test results (i.e., liquid limit [LL] values and plastic limit [PL] values) and natural moisture contents are plotted against elevation on Figure 2.5.4-241 for the power block and on Figure 2.5.4-242 for the cooling basin/GBRA storage water reservoir. Figures 2.5.4-243 and 2.5.4-244 show the Atterberg limit results on a plasticity chart for the power block and cooling basin/GBRA storage water reservoir, respectively.

2.5.4.2.1.3.5 Grain Size Distribution

The results of grain size distribution tests performed on all of the samples tested are shown in the *General Physical and Chemical Properties Test Results* summary tables, namely Table 2.5.4-216 for the power block and Table 2.5.4-217 for the cooling basin/GBRA storage water reservoir. These tables show the percentage (by dry weight) of gravel, sand, silt, and clay, and also the percentage fines, (i.e., the percentage passing the standard number 200 sieve; silt plus clay). Specific gravity measurements are also included.

Average fines contents are summarized for each stratum encountered at the power block and the cooling basin/GBRA storage water reservoir in Tables 2.5.4-232 and 2.5.4-233, respectively.

2.5.4.2.1.3.6 Unit Weight

Unit weight is recorded for each sample tested for shear strength and for consolidation in the laboratory. The results for all samples tested, expressed in terms of dry unit weight and natural moisture content, are included in Tables 2.5.4-218 (strength tests) and 2.5.4-222 (consolidation tests) for the power block, and in Tables 2.5.4-219 (strength tests) and 2.5.4-223 (consolidation tests) for the cooling basin/GBRA storage water reservoir.

Total unit weights recommended for use in each stratum are summarized in Table 2.5.4-232 for the power block, and in Table 2.5.4-233 for the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.3.7 Angle of Internal Friction

The drained/effective angle of internal friction (ϕ') of each sand stratum is estimated from corrected SPT $(N_1)_{60}$-values, corrected CPT tip resistances (q_t), and laboratory direct shear test results.

The empirical correlation used to obtain ϕ' from corrected $(N_1)_{60}$-value (Reference 2.5.4-209) is:

$$\phi' = 27.1 + 0.3(N_1)_{60} - 0.00054(N_1)_{60}^2 \qquad \text{Equation 2.5.4-3}$$

The empirical correlation used to obtain ϕ' from corrected CPT tip resistance (Reference 2.5.4-210) is:

$$\phi' = \text{arctangent} (\log [q_t/\sigma_v'] + 0.29)/2.68 \qquad \text{Equation 2.5.4-4}$$

where, q_t = the corrected CPT tip resistance

σ_v' = the effective overburden pressure at the depth of the CPT test interval

Values of ϕ' measured in direct shear tests on samples of the various sand strata are given in Tables 2.5.4-218 and 2.5.4-219 for the power block and for the cooling basin/GBRA storage water reservoir area, respectively.

Figure 2.5.4-261 plots ϕ' (estimated from CPT results and Equation 2.5.4-4) versus elevation for Unit 1. Figures 2.5.4-262, 2.5.4-263, and 2.5.4-264 are the corresponding plots for Unit 2, for the area outside the power block, and for the combined Unit 1, Unit 2, and the area outside the power block, respectively. Figure 2.5.4-265 is the corresponding plot for the cooling basin/GBRA storage water reservoir. Refer to Subsection 2.5.5.1.9.1.3 for a description on the selection of ϕ' for foundation sand strata in the cooling basin/GBRA storage water reservoir.

Recommended values of ϕ' derived from the different correlations/test methods (i.e., from SPT correlation, from CPT correlation, from laboratory direct shear testing), and for each stratum, are shown in Table 2.5.4-232 for the power block, and in Table 2.5.4-233 for the cooling basin/GBRA storage water reservoir.

Note that values of ϕ' for foundation clay strata in the cooling basin/GBRA storage water reservoir area are calculated from direct simple shear tests. There were 22 tests on clay samples that range in depth from 5 feet to 145 feet below ground surface. Based on these results, and as described in Subsection 2.5.5.1.9.1.2, ϕ' = 28 degrees is selected for the upper clay strata (Strata Clay 1 [Top], Clay 1 [Bottom], Clay 3, and Clay 5 [Top]).

2.5.4.2.1.3.8 Undrained Shear Strength

The undrained shear strength (s_u) of each clay stratum is estimated from laboratory unconsolidated-undrained (UU) triaxial compression test results, corrected SPT $(N_1)_{60}$-values, and corrected CPT tip resistances (q_t).

The values of s_u derived from UU triaxial tests are given in Tables 2.5.4-218 and 2.5.4-219 for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Figures 2.5.4-245 and 2.5.4-246 also plot these results against elevation for the power block and for the cooling basin/GBRA storage water reservoir, respectively. These figures identify each tested stratum.

The empirical correlation used to obtain s_u from the corrected $(N_1)_{60}$–value (Reference 2.5.4-211) is:

$$s_u = (N_1)_{60}/8 \qquad \text{Equation 2.5.4-5}$$

The empirical correlation used to obtain s_u from the corrected CPT tip resistance (q_t) (Reference 2.5.4-212) is:

$$s_u = (q_t - \sigma_v)/N_{kt} \qquad \text{Equation 2.5.4-6}$$

where, q_t = the corrected CPT tip resistance

σ_v = the total overburden pressure at the depth of the CPT test interval

N_{kt} = the cone factor

N_{kt} often falls in the range of 10 to 20 (Reference 2.5.4-211). For estimating undrained shear strength at the VCS site, correlations are made between CPT results and laboratory shear strength tests measured on undisturbed samples collected at borings close-in to the respective CPT. Making this correlation at several CPT/boring pairs, a site-specific N_{kt} = 25 is calculated.

Figure 2.5.4-247 plots s_u (estimated from CPT results and Equation 2.5.4-6) versus elevation for Unit 1. Figures 2.5.4-248, 2.5.4-249, and 2.5.4-250 are the corresponding plots for Unit 2, for the area outside the power block, and for the combined Unit 1, Unit 2, and the area outside the power block, respectively. Figure 2.5.4-251 is the corresponding plot for the cooling basin/GBRA storage water reservoir.

Table 2.5.4-220 is a summary of s_u values obtained by the various methods and contains a recommended value for each clay stratum at the power block. Table 2.5.4-221 is the corresponding table for the cooling basin/GBRA storage water reservoir.

Values of s_u for foundation clay strata (Strata Clay 1 [Top], Clay 1 [Bottom], Clay 3, and Clay 5 [Top]) at the cooling basin/GBRA storage water reservoir are calculated from direct simple shear tests. As noted above, there were 22 tests on clay samples that range in depth from 5 feet to 145 feet below ground surface. The results of these tests are contained in Table 2.5.4-219, are plotted as shear strength versus depth on Figure 2.5.4-211, and are plotted as a best-fit line of shear strength versus effective vertical stress on Figure 2.5.4-212. Refer to Subsection 2.5.5.1.9.1.2 for a description on the selection of s_u for foundation clay strata in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.3.9 Consolidation Properties

Consolidation properties and stress history of clay strata are assessed by laboratory testing and by an evaluation of CPT results. The results of laboratory consolidation tests made on selected samples are presented in Tables 2.5.4-222 and 2.5.4-223 for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Table 2.5.4-224 is a summary of consolidation test results in terms of consolidation properties, namely compression index (C_c), recompression index (C_r), void ratio (e_0), preconsolidation pressure (P_c'), and overconsolidation ratio (OCR) for each clay stratum in the power block. The corresponding summary table for the cooling basin/GBRA storage water reservoir is contained in Table 2.5.4-225.

Figures 2.5.4-252 and 2.5.4-253 plot the preconsolidation pressures of clay strata measured in laboratory consolidation tests against elevation for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Similarly, Figures 2.5.4-254 and 2.5.4-255 plot the values of OCR of clay strata measured in laboratory consolidation tests against elevation for the power block and for the cooling basin/GBRA storage water reservoir, respectively. All of these figures identify each tested stratum.

OCR can also be derived from CPT data using a correlation with undrained shear strength (s_u) and vertical effective stress (σ_v') presented in (Reference 2.5.4-210). A best-fit line for the correlation of OCR versus s_u/σ_v' from the reference (Figure 5.12 for Plasticity Index [PI] = 40%) is

$$OCR = -0.0962\,(s_u/\sigma_v')^3 + 1.009\,(s_u/\sigma_v')^2 + 2.6184\,(s_u/\sigma_v') - 0.1202$$

Equation 2.5.4-7

Figure 2.5.4-256 plots OCR (estimated from CPT results, and using Equation 2.5.4-7) versus elevation for Unit 1. Figures 2.5.4-257, 2.5.4-258, and 2.5.4-259 are the corresponding plots for Unit 2, the area outside the power block, and the combined Unit 1, Unit 2, and the area outside the power block, respectively. Figure 2.5.4-260 is the corresponding plot for the cooling basin/GBRA storage water reservoir. Table 2.5.4-226 contains a summary of the calculated OCR and selected design OCR for the power block, and Table 2.5.4-227 provides the same for the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.3.10 Elastic Modulus and Shear Modulus (High Strain)

Elastic Modulus:

For clay soils, the high strain (static) elastic modulus (E or E_H) is evaluated using the following relationship (Reference 2.5.4-213):

$$E = 600\,s_u$$

Equation 2.5.4-8

where, s_u = undrained shear strength

A second relationship pertaining to E for clay soils is based on the relationship between high strain modulus and low strain modulus derived from shear wave velocity. (Reference 2.5.4-214):

$$E = 2\,G\,(1 + \mu)$$

Equation 2.5.4-9

$G_{0.0001\%} = \gamma / g (V_s)^2$ Equation 2.5.4-10

$G_{0.0001\%} / G_{0.375\%} = 21/\sqrt{PI}$ Equation 2.5.4-11

where, E = static (or large strain) elastic modulus
μ = Poisson's ratio
γ = total unit weight of soil
g = acceleration of gravity = 32.2 feet/second/second
V_s = shear wave velocity
G = shear modulus
$G_{0.0001\%}$=small strain shear modulus (i.e., strain in the range of $10^{-4}\%$)
$G_{0.375\%}$=large strain (static) shear modulus (i.e., strain in the range of 0.25% to 0.50%)
PI = Plasticity Index

For sands, E is evaluated using the following relationship (Reference 2.5.4-213):

E = 36 N (in kips per square foot [ksf]) Equation 2.5.4-12

where, N =average corrected SPT $(N_1)_{60}$–value in bpf

A second relationship pertaining to E for sands is based on the relationship between high strain modulus and low strain modulus derived from shear wave velocity (Reference 2.5.4-214), using Equations 2.5.4-9 and 2.5.4-10, and:

$G_{0.0001\%}/G_{0.375\%} = 10$ Equation 2.5.4-13

Table 2.5.4-228 gives high strain E values for each stratum, derived from s_u (clay strata), $(N_1)_{60}$ (sand strata), and Vs (both clay strata and sand strata) for the power block. The values of E recommended for each stratum are also included in the table. Table 2.5.4-229 gives the corresponding values of E recommended for each stratum at the cooling basin/GBRA storage water reservoir.

Shear Modulus:

Shear modulus, G, is related to elastic modulus, E, as follows (Reference 2.5.4-213):

$G = E/(2 [1 + \mu])$ Equation 2.5.4-14

with the terms as defined before.

Values of G for each stratum are calculated from the E values recommended for use in Tables 2.5.4-228 and 2.5.4-229. A Poisson's ratio of 0.30 is used for sand strata, and a Poisson's ratio of 0.45 is used for clay strata. The resulting high strain G values are given in Table 2.5.4-230 for the power block and Table 2.5.4-231 for the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.3.11 Static Earth Pressure Coefficients

Active, passive, and at-rest static earth pressure coefficients, K_a, K_p, and K_0, are estimated assuming frictionless vertical walls and horizontal backfill using Rankine's theory, and based on the following relationships (Reference 2.5.4-215):

$$K_a = \tan^2 (45 - \phi'/2) \qquad \text{Equation 2.5.4-15}$$

$$K_p = \tan^2 (45 + \phi'/2) \qquad \text{Equation 2.5.4-16}$$

$$K_0 = 1 - \sin (\phi') \qquad \text{Equation 2.5.4-17}$$

where, ϕ' = drained/effective friction angle of the soil

Calculated static earth pressure coefficients are given in Table 2.5.4-232 for the power block, and in Table 2.5.4-233 for the cooling basin/GBRA storage water reservoir. Because foundations are unlikely to be constructed deeper than Stratum Sand 5, earth pressure coefficients are not calculated below this stratum. For each sand stratum, ϕ' is taken as the value recommended for use in Table 2.5.4-232 for the power block, and in Table 2.5.4-233 for the cooling basin/GBRA storage water reservoir. For all clay strata, ϕ' is taken as 20 degrees.

Coefficients used for seismic lateral earth pressure calculations are described in Subsection 2.5.4.10.4.2.

2.5.4.2.1.3.12 Coefficient of Sliding

The coefficient of sliding is termed tangent δ, where δ is the friction angle between the soil and the foundation material bearing against it, in this case concrete.

Based on Reference 2.5.4-216, tangent $\delta = 0.30$ is selected for clay strata, tangent $\delta = 0.40$ is selected for Strata Sand 1 and Sand 2, and tangent $\delta = 0.45$ is selected for Strata Sand 4 and Sand 5. Because it is unlikely that foundations are constructed deeper than Stratum Sand 5, the coefficient of sliding is not calculated below this stratum.

2.5.4.2.1.3.13 Shear Wave Velocity, Compression Wave Velocity, and Poisson's Ratio

The measurement and interpretation of shear wave velocities are described in detail in Subsections 2.5.4.4 and 2.5.4.7, respectively, and are briefly summarized here. At both Unit 1 and Unit 2, shear and compression wave velocities were measured with P-S suspension logging in four borings each (Subsection 2.5.4.4.1) and with seismic CPTs at four locations each (Subsection 2.5.4.4.2). Figures 2.5.4-269 and 2.5.4-270 are plots of all of the measured shear wave velocities to depths of 600 feet at Unit 1 and Unit 2, respectively. An analysis of the data in these plots is described in Subsection 2.5.4.7.

Table 2.5.4-251 provides recommended shear wave velocity values for each stratum in each of four areas, namely: at Unit 1; at Unit 2, inside power block, which is an average of the values at Unit 1 and at Unit 2; and the area outside the power block, which is an average of the values from the two P-S suspension logging borings (B-2301 and B-2307) made outside the power block. Note that the value of shear wave velocity for each stratum shown for the power block area in Table 2.5.4-232 is the shear wave velocity value for the inside power block area shown in Table 2.5.4-251.

Table 2.5.4-253 provides recommended shear wave velocity values for each stratum in the cooling basin/GBRA storage water reservoir.

2.5.4.2.1.3.14 Elastic Modulus and Shear Modulus (Low Strain)

The low strain shear modulus (G_L, normally assumed to be the shear modulus at 10^{-4} percent shear strain) is derived directly from the shear wave velocity using Equation 2.5.4-10. The value of low strain shear modulus for each stratum shown for the power block in Table 2.5.4-232 is derived from the shear wave velocity value for the inside power block area in Table 2.5.4-251. The value of low strain shear modulus for each stratum shown for the cooling basin/GBRA storage water reservoir in Table 2.5.4-233 is derived from the shear wave velocity value in Table 2.5.4-253.

The low strain elastic modulus (E_L) can be obtained from the low strain shear modulus (G_L) value using Equation 2.5.4-9, and applying a suitable value of low strain Poisson's ratio. Values of 0.30 for sand strata and 0.45 for clay strata are reasonable.

2.5.4.2.1.3.15 Shear Modulus Degradation and Damping Ratio

Sixteen resonant column torsional shear (RCTS) tests were performed on undisturbed samples from cohesive Strata Clay 1 (Top), Clay 3, Clay 5 (Top), Clay 7, Clay 9, Clay 11, Clay 13, and Clay 17, and from cohesionless Strata Sand 4, Sand 5, Sand 6, Sand 8, Sand 10, Sand 12, Sand 14, and Sand 18. Each of these undisturbed samples was from the power block. Two RCTS tests were also performed on recompacted composite samples representative of embankment fill at the cooling basin/GBRA storage water reservoir (see Subsections 2.5.4.2.1.4.2 and 2.5.4.5.1).

In each RCTS test, values of shear modulus (G) measured at increasing shear strain levels are compared to the value of G_{max}, the shear modulus measured at 10^{-4} percent shear strain. The shear modulus degradation (ratio of G/G_{max}) is plotted against shear strain, and a curve of G/G_{max} from the literature that best fits the test data is selected. Literature curves are used rather than an actual best-fit curve through the RCTS test data because the literature curves typically extend over a greater range of shear strain than the test data. This is described further in Subsections 2.5.4.7.3.1 and 2.5.4.7.3.2.

Tables 2.5.4-254 and 2.5.4-255 show the selected values of G/G_{max} versus shear strain for each stratum at the power block, and for the two composite samples at the cooling basin/GBRA storage water reservoir (refer to Subsections 2.5.4.2.1.4.2 and 2.5.4.5.1), respectively. Plots of G/G_{max} versus shear strain (shear modulus degradation) for each RCTS test are presented on Figures 2.5.4-293 through 2.5.4-310. Test results are also tabulated in Tables 2.5.4-258 through 2.5.4-275.

Each RCTS test also provides measured values of damping (D) at increasing shear strain levels. The same procedure used for G/G_{max} is employed to obtain a best-fit D versus shear strain curve from the literature. Tables 2.5.4-256 and 2.5.4-257 show the selected values of D versus shear strain for each stratum at the power block, and for the two composite samples at the cooling basin/GBRA storage water reservoir, respectively.} Plots of D versus shear strain for each RCTS test are presented on Figures 2.5.4-311 through 2.5.4-328. Test results are also tabulated in Tables 2.5.4-258 through 2.5.4-275. Note that damping ratio versus shear strain curves extend to a maximum 15% damping ratio.

2.5.4.2.1.3.16 Electrical Resistivity

Two field electrical resistivity test arrays were performed at the power block switch yards, with each having electrode spacings ("A") ranging from three feet to 300 feet. Test results are summarized in Table 2.5.4-234, and are further described in Subsection 2.5.4.2.2.3.5. The inferred strata noted in the table assume that the depth of the reading is approximately one-half of the "A" spacing. The minimum resistivity measured is about 120 ohm-meters and the maximum resistivity measured is about 350 ohm-meters. Guidelines for the interpretation of electrical resistivity with respect to corrosion are given in Table 2.5.4-235. Based on these guidelines, measured electrical resistivity results indicate that site soils in the uppermost 150 feet are not corrosive towards buried steel.

2.5.4.2.1.3.17 Chemical Properties

Fifty-nine sets of chemical tests, consisting of pH, chloride content, and sulphate content, were performed on samples from the power block ranging from nearly ground surface to about 160 feet depth, from Strata Clay 1 (Top), Clay 1 (Bottom), Sand 1, Sand 2, Clay 3, Sand 4, Clay 5 (Top), Clay 5 (Bottom), and Sand 5. Test results are summarized in Table 2.5.4-216 for the power block.

Measured pH values range from 7.2 to 9.0, with an average of 8.5. These results indicate the soil to be mildly corrosive based on Table 2.5.4-235 guidelines.

Measured chloride contents for the same soils tested range from about four to 680 parts per million (ppm), with an average of about 50 ppm. These results indicate the soil to be mostly mildly corrosive based on Table 2.5.4-235 guidelines, with some tests indicating a more corrosive environment.

Measured sulphate content for the same soils tested range from about seven to 4290 ppm, with an average of about 40 ppm. These results indicate the soil to be mostly non-aggressive towards concrete based on Table 2.5.4-235 guidelines, with only two tests indicating a more aggressive environment.

2.5.4.2.1.4 Evaluation of Properties of Fill Materials

Structural fill is required at the power block, and embankment fill and drainage sand are required for the embankment dams and interior dikes at the cooling basin/GBRA storage water reservoir. Laboratory test results on the various fill materials are contained in Appendices 2.5.4-A and 2.5.4-B, as described below. Fill properties are described in the following subsections, and additionally in Subsections 2.5.4.5.1 and 2.5.5.1.9.1.1.

2.5.4.2.1.4.1 Fill Materials Required in the Power Block

Although the selection of structural fill has not been finalized, it is expected to be similar to the well-graded gravel and sand with trace amounts of fines produced by a local supplier in Victoria, Texas—material processed to meet Texas Department of Transportation (DOT), Grade 4 requirements. Refer to Subsection 2.5.4.5.1 for additional detail and to Appendix 2.5.4-A for complete test results. Additional testing will be performed once the structural fill source and material have been selected. Fill properties for this material are summarized in Table 2.5.4-232, and are additionally described below.

Description: Red well-graded gravel with clay

Constituents: Gravel –50%; Sand –43%; Fines –7%

USCS Classification: GW-GC

Specific Gravity: 2.67

Unit Weight: Based on compaction to 95% modified Proctor (ASTM D 1557; Reference 2.5.4-217) maximum dry density, total unit weight (γ_t) is 138 pounds per cubic foot (pcf) at the optimum moisture content of 5.5%.

Angle of Internal Friction: Based on direct shear tests, the measured ϕ' for this material is 42°. For conservatism, the recommended ϕ' is 39° (being the lowest measured value from other similar sampled and tested materials).

Elastic and Shear Modulus: The estimated high strain elastic modulus is 1100 ksf, and the estimated low strain shear modulus is 3,300 ksf.

Shear Wave Velocity: The conservatively estimated shear wave velocity for this surficial compacted material, based on relative density, is about 700 feet per second to 850 feet per second in the upper 15 feet (refer to Subsection 2.5.4.4.1). Actual shear wave velocity depends not only on relative density, but also on confining pressure, and thus the shear wave velocity of the fill is lower at or near the ground surface, and higher with depth.

Earth Pressure Coefficients and Coefficient of Sliding:

Active, passive, and at-rest static earth pressure coefficients, K_a, K_p, and K_0, are estimated assuming frictionless vertical walls and horizontal backfill using Rankine's theory and based on the relationships below (Reference 2.5.4-215). Note that $\phi' = 39°$, except for the K_0 case, where ϕ' is conservatively assumed as 30°.

$K_a = \tan^2 (45 - \phi'/2) = 0.23$ Equation 2.5.4-15

$K_p = \tan^2 (45 + \phi'/2) = 4.4$ Equation 2.5.4-16

$K_0 = 1 - \sin (\phi') = 0.50$ Equation 2.5.4-17

For sliding against concrete, tangent $\delta = 0.55$ is recommended.

Chemical Properties:

The measured pH of 5.7 indicates that the material is mildly corrosive towards buried steel. The measured chloride content and sulphate content are both below 10 ppm, indicating the fill to be noncorrosive towards buried steel and nonaggressive towards buried concrete (Table 2.5.4-235).

2.5.4.2.1.4.2 Fill Materials Required in the Cooling Basin/GBRA Storage Water Reservoir

Excavated site soils from the cooling basin/GBRA storage water reservoir northern interior are used for construction of embankment dams and interior dikes, while imported sand is used for construction of drainage blankets (embankment dams only). Refer to Subsection 2.5.4.5.1 for additional detail and to Appendices 2.5.4-A (drainage sand) and 2.5.4-B (composite samples representative of embankment fill) for complete test results. Fill properties are summarized in Table 2.5.4-232, and are additionally described below.

Composite samples representative of embankment fill were obtained from cooling basin/GBRA storage water reservoir test pits, as described in Subsection 2.5.4.5.1. Two composite samples were tested, namely Composite "A," a sand material, and Composite "B," a clay material. For drainage sand, bulk samples are collected from a local concrete aggregate supplier in Victoria, Texas, including a material processed to meet ASTM C 33 (Reference 2.5.4-218), fine aggregate for concrete, requirements, and a material processed to meet ASTM C 144 (Reference 2.5.4-219), mortar sand requirements. The properties of the composite samples, and of the drainage sand samples, are summarized in Table 2.5.4-233.

Results of RCTS tests on the Composite "A"/Sand sample (Table 2.5.4-274, Figure 2.5.4-309, and Figure 2.5.4-327), and on the Composite "B"/Clay sample (Table 2.5.4-275, Figure 2.5.4-310, and Figure 2.5.4-328) are described in more detail in Subsections 2.5.4.7.3.1 and 2.5.4.7.3.2.

Shear Strength of Fill Materials:

Drained and undrained shear strength values of the composite samples are important in the evaluation of dam slope stability, as presented in Subsection 2.5.5. Drained/effective friction angles (ϕ') of the composite samples were obtained from a series of direct simple shear tests, while drained/effective friction angles of the drainage sand samples were obtained from a series of direct shear tests.

Refer to Subsection 2.5.5.1.9.1.1 for a detailed description on material properties derived for the composite samples. Similarly, refer to Subsection 2.5.5.1.9.2 for a detailed description on material properties derived for the drainage sand materials. For design purposes, the drained/effective friction angles derived for the tested materials are:

Embankment fill (both Composite "A"/Sand and Composite "B"/Clay):

$\phi' = 30^\circ$

Drainage sand (ASTM C 33 fine aggregate for concrete):

$\phi' = 37^\circ$

Drainage sand (ASTM C 144 mortar sand):

$\phi' = 36^\circ$

Also for design purposes, the undrained shear strength (s_u) values derived for the composite samples (both Composite "A"/Sand and Composite "B"/Clay) are based on the plot of undrained shear strength versus vertical effective stress given on Figure 2.5.5-210.

Unit Weight of Fill Materials:

For design purposes, the total unit weights (γ_t) of the tested materials are:

Embankment fill (Composite "A"/Sand):

$\gamma_t = 137$ pcf

Embankment fill (Composite "B"/Clay):

γ_t = 134 pcf

Drainage sand (ASTM C 33 fine aggregate for concrete):

γ_t = 111 pcf

Drainage sand (ASTM C 144 mortar sand):

γ_t = 108 pcf

Note that total unit weights (γ_t) for the composite samples (embankment fill materials) are based on compaction to 95% modified Proctor (ASTM D1557; Reference 2.5.4-217) maximum dry density at 4% above optimum moisture content. Total unit weights (γ_t) for drainage sand materials based on compaction to 95% modified Proctor maximum dry density at optimum moisture content.

2.5.4.2.1.5 Properties of Subsurface Materials Deeper Than Approximately 600 Feet Below Existing Ground Surface

As noted above, the maximum depth explored during this site-specific subsurface investigation is 600 feet. To perform necessary seismic ground response analyses (refer to Subsection 2.5.4.7), shear wave velocity values to appreciably greater depths are required. To accommodate this requirement, six sonic logs performed for oil field exploration borings from sites within Victoria County (Figure 2.5.4-266) were collected and analyzed. The collected sonic logs, which report compression wave velocities (V_p), begin at an upper depth of approximately 200 feet to 1,600 feet, and range in total depth from approximately 8,000 feet to 16,000 feet. Compression wave velocities from the sonic logs are converted to shear wave velocities (V_s) using the following equation (Reference 2.5.4-220):

$$V_s = V_p / [2(1 - \mu)/(1 - 2\mu)]^{1/2} \qquad \text{Equation 2.5.4-18}$$

Poisson's ratio (μ) is assumed to decrease with increasing depth as the soil becomes more confined/compressed. The value of μ is assumed to decrease linearly from a measured value of 0.46 at 600 feet depth, to a lower bound value of 0.30 at and below 5,400 feet depth. Table 2.5.4-252 provides average shear wave velocities (and related statistics) for calculated 200-foot depth intervals to the maximum sonic log depth. Figure 2.5.4-271 plots the average shear wave velocities, and the average shear wave velocities plus or minus one standard deviation, versus depth. The average shear wave velocity calculated from the six sonic logs increases from about 2090 feet per second at 800 feet depth to about 6000 feet per second at 10,000 feet depth, and then reduces slightly to about 5,000 feet per second at 15,000 feet depth. Note that the average shear wave velocities for Sand 18 at approximately 600 feet depth is measured at about 2000 feet per second at Unit 1, and about 1985 feet per second at Unit 2 (averaging 1995 feet per second between the two units).

2.5.4.2.2 Subsurface Investigation/Exploration

RG 1.132 (Reference 2.5.4-221) describes site investigation for nuclear power plants, and addresses the objectives of subsurface investigation with respect to the design of foundations and associated critical structures. Because subsurface investigations need to be site-specific, there is recognition in Reference 2.5.4-221 that flexibility and adjustments to the overall program, applying sound engineering judgment, are necessary to tailor to site-specific conditions. Consequently, adjustments are made to the subsurface investigation (including adjustments to field testing locations, and adjustments to the types, depths, and frequencies of sampling) during field operations, resulting in a more comprehensive subsurface investigation.

Subsurface investigation work at the VCS site is performed under an approved quality assurance program with site-specific work procedures, including subsurface investigation plans and technical specification, prepared by Bechtel.

Figure 2.5.4-201 for the power block and Figure 2.5.4-202 for the cooling basin/GBRA storage water reservoir show the plan locations of field tests made for this subsurface investigation.

2.5.4.2.2.1 Planning the Field Testing Program

Reference 2.5.4-221 also provides guidance on spacing and depths of borings, sampling procedures, in situ testing procedures, and geophysical investigation methods. This guidance is employed in preparing the technical specification for a particular project, addressing the bases for site-specific subsurface investigation. References to industry standards used for field testing at the VCS site are shown in Tables 2.5.4-201 and 2.5.4-202 for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Field testing details and results are also contained in Appendices 2.5.4-A and 2.5.4-B for the power block and for the cooling basin/GBRA storage water reservoir, respectively.

For the power block, the quantities of borings and CPTs for major structures (including seismic Category I structures) are based on a minimum of one boring or one CPT per structure and one boring or one CPT per 10,000-square feet of structure plan area. Reference 2.5.4-221 also includes a recommendation that borings for seismic Category I structures extend to a depth approximately equal to the width of the structure below the planned foundation level. This criterion is met at the power block for borings B-2174A, B-2174A Offset, B-2174UDR, B-2274A, B-2274A Offset, and B-2274UD made at the centers of the reactor/fuel buildings (each structure measuring 161 feet by 230 feet, or 196 feet wide on average, with planned foundation level 65.6 feet below the finish grade at elevation +95 feet). Each of these borings was advanced to 600 feet below ground surface (ground surface at the time of this subsurface investigation is elevation +80 feet). At each reactor/fuel building, 11 additional borings were made to approximately 150 feet, 200 feet, 300 feet, or 400 feet depth below ground surface. These borings were terminated in either stiff to very stiff clays or dense to very dense sands that become stronger with increasing depth. At the nonsafety-related cooling basin/GBRA storage water reservoir, 60 borings were made to approximately 60 feet to 300 feet below ground surface.

The sampling intervals employed in borings made for this subsurface investigation vary slightly from the guidance document (Reference 2.5.4-221), but are in accordance with the technical specification, and are reasonable for characterizing site subsurface conditions, as follows. The number of SPT samples taken in the uppermost 15 feet below ground surface was increased, with typically six SPT samples taken. Below 15 feet and up to a depth of 100 feet, SPT samples were taken at 5-foot intervals; from 100 feet to 200 feet depths, samples were taken at 10-foot intervals; and samples were taken at 20-foot intervals from 200 feet to the maximum depth of 600 feet below ground surface. As noted in Subsection 2.5.4.2.1.3.2, to ensure that all strata are sampled, sampling intervals were decreased from 20-foot to 10-foot intervals in selected borings. Also, in the two deepest power block borings (B-2174A and B-2274A), sampling intervals from 400 feet to 600 feet were offset (e.g., in one boring the sampling depths were 400 feet, 420 feet, 440 feet, etc., while in the other boring, the sampling depths were 410 feet, 430 feet, 450 feet, etc.). In addition, two borings (B-2177 and B-2277) were continuously sampled (at 2.5-foot centers) to a depth of 150 feet within the reactor/fuel building footprints. In the power block, undisturbed samples were taken in five borings dedicated for this purpose, namely; B-2174UD, B-2174UDR, B-2182UD, B-2269UD, and B-2274UD. Similarly, in the nonsafety-related cooling basin/GBRA storage water reservoir, undisturbed samples were taken in six dedicated borings, namely; B-2302UD, B-2304UD, B-2319UD, B-2321UD, B-2352UD, and B-2359UD. Finally, CPTs, providing continuous subsurface data to a maximum depth of 100 feet, were made at both the power block and the nonsafety-related cooling basin/GBRA storage water reservoir.

For the power block, vertical deviation surveys were conducted in the eight suspension P-S velocity logging borings, including the two deepest borings (B-2174A Offset and B-2274A Offset). Similarly, in the area outside the power block and in the nonsafety-related cooling basin/GBRA storage water reservoir, deviation surveys were performed in the two and five suspension P-S velocity logging borings, respectively, which are the deepest borings made in those areas. All borings and field tests were advanced as vertically as possible by starting the drilling rigs/field test equipment in a level position, and by regularly observing the verticality of the drilling rig masts, the drilling rods, etc., as the work progresses.

SPT samples and bulk soil samples from test pits were photographed for the VCS site subsurface investigation. Undisturbed soil samples were sealed in metal Shelby or Pitcher tubes, and could not be photographed. X-ray imaging, however, was made on undisturbed samples selected for RCTS testing.

2.5.4.2.2.2 Planning the Laboratory Testing Program

The laboratory testing for this site subsurface investigation was planned according to guidance provided in RG 1.138 (Reference 2.5.4-222). References to industry standards used for laboratory testing of collected samples are shown in Tables 2.5.4-214 and 2.5.4-215 for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Laboratory testing details and results are also contained in Appendices 2.5.4-A and 2.5.4-B for the power block and for the cooling basin/GBRA storage water reservoir, respectively.

Soil samples assigned for laboratory testing were shipped under chain-of-custody from the onsite storage area to the testing laboratories. Laboratory testing for this site subsurface investigation was performed at multiple laboratories including: MACTEC Engineering and Consulting, Inc. (MACTEC) (Atlanta, Georgia), MACTEC (Raleigh, North Carolina), Severn Trent Laboratories (St. Louis, Missouri), Fugro (Houston, Texas), and the University of Texas—Austin Soils Laboratory (Austin, Texas). Both the Fugro and the University of Texas—Austin laboratories perform specialty RCTS testing.

2.5.4.2.2.3 Field Testing

The site-specific subsurface investigation, described here, was conducted between October 2007 and February 2008. Field test locations are shown on Figures 2.5.4-201 and 2.5.4-202 for the power block and for the cooling basin/GBRA storage water reservoir, respectively. The scope of work and investigation methods used by the subsurface investigation subcontractor, MACTEC, and its subcontractors, are as follows:

- Surveying the horizontal coordinates and vertical elevations of the field testing locations.
- Evaluating the potential presence of underground utilities at the field testing locations.
- Drilling 153 borings, most with SPT sampling, and some additionally collecting undisturbed samples (207 undisturbed samples) using a Shelby push sampler or a Pitcher sampler, depending on the material sampled, to a maximum depth of 600 feet.
- Performing 65 CPTs to a maximum depth of approximately 100 feet. Seismic tests and pore water pressure dissipation tests at selected depths are performed in selected CPTs. Two CPT locations (C-2106 and C-2206) are additionally advanced intermittently to 300 feet below ground surface for qualitative evaluation.
- Excavating 20 test pits to a maximum depth of approximately 10 feet below ground surface, and collecting bulk soil samples
- Installing and developing 54 groundwater observation wells (27 well pairs, each having an upper (U) screened interval and a lower (L) screened interval) to a maximum depth of 150 feet, including slug testing each well to verify well quality and to estimate in situ hydraulic conductivity

- Performing 32 borehole permeameter tests at 16 test locations (cooling basin/GBRA storage water reservoir), and at each test location performing a shallow upper (U) test and a deeper lower (L) test to estimate hydraulic conductivity
- Installing and developing two test wells, each with four companion observation wells (cooling basin/GBRA storage water reservoir), and conducting groundwater pump testing to estimate strata transmissivity and storativity
- Performing borehole geophysical logging in 17 dedicated borings, consisting of all, or some, of the following geophysical tests: suspension P-S velocity logging, natural gamma, long and short resistivity, spontaneous potential, three-arm caliper, and deviation survey
- Conducting field electrical resistivity testing at two array locations in the switch yard (each array consisting of two orthogonal survey lines)
- Conducting SPT hammer energy measurements for each of the nine drilling rigs employed at the site

As noted earlier, this subsurface investigation was performed according to guidelines outlined in Reference 2.5.4-221. The field work was performed under an audited and approved quality assurance program and work procedures developed specifically for the project. The subsurface investigation and sample collection was directed by a site manager, who was present full-time during the investigation period. A designated project quality assurance/quality control manager regularly visited the site to audit the work and the work of the subcontractors. A Bechtel geotechnical engineer and/or geologist was also onsite full-time during the field work. Additionally, field boring logs, well logs, test pit logs, etc., were prepared by field engineers and/or geologists who were present full-time during the investigation period. A visit to the site during the subsurface investigation work was also attended by the NRC and by Exelon representatives in December 2007.

Each field test location was checked for the presence of underground utilities before work at the location begins. The locations of several field test points were revised because of their proximity to utilities or equipment inaccessibility. For environmental purposes, the ground occupied by each drilling or CPT rig was temporarily covered by plastic sheeting to prevent accidental discharge of hydraulic fluid and or oil onto the ground.

An onsite storage facility for soil sample retention was established before the subsurface investigation began. Each sample was logged into an inventory system, and samples removed from the facility were noted in an inventory log book. A chain-of-custody form was also completed for all samples removed from the facility. Material storage and handling was in accordance with ASTM D 4220 (Reference 2.5.4-223).

Complete results of this subsurface investigation were presented in Appendices 2.5.4-A and 2.5.4-B for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Additional details related to field test activities are summarized below.

2.5.4.2.2.3.1 Boring and Sampling

One hundred fifty-three borings were performed at the VCS site: 86 borings at the power block; seven borings at the area outside the power block (B-08, B-10, B-2185, B-2301, B-2301A, B-2307, and B-2307A); and 60 borings at the cooling basin/GBRA storage water reservoir.

Borings were advanced using mud-rotary drilling methods with a bentonite-based drilling mud. Nine drilling rigs were used to advance the borings, including both truck-mounted and all-terrain vehicle (ATV) rigs, with each rig employing an automatic SPT hammer. The make and model of each rig used in the work is given in Table 2.5.4-207. Boring locations are shown on Figure 2.5.4-201 for the power block and Figure 2.5.4-202 for the cooling basin/GBRA storage water reservoir. Tables 2.5.4-236 and 2.5.4-237 summarize boring locations and other details for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Boring logs are contained in Appendices 2.5.4-A and 2.5.4-B for the above noted areas. Upon completion, each boring was tremie-grouted to the ground surface with a cement-bentonite grout.

Soils were sampled using a standard SPT sampler in accordance with ASTM D 1586 (Reference 2.5.4-224). Refer to Subsection 2.5.4.2.2.1 for SPT sampling intervals. The recovered soil samples were visually described and classified by the field engineer and/or geologist in accordance with ASTM D 2488 (Reference 2.5.4-205). A representative portion of the SPT sample was placed in a moisture-sealed glass jar, which is labeled, placed in a box, and transported to the onsite storage facility.

Three-inch-diameter undisturbed tube samples were also obtained in accordance with ASTM D 1587 (Reference 2.5.4-225), using either a Shelby push sampler or a rotary Pitcher sampler depending on the material being sampled. After retrieval, any disturbed materials at the ends of the sample are removed and the ends are trimmed square to aid moisture sealing with wax. For fine-grained cohesive soils, a pocket penetrometer measurement is taken on the trimmed ends of the sample. Both ends of the sample tube are then sealed with hot wax, covered with plastic caps, and sealed once again using electrical tape and wax. The sample tubes are labeled and transported to the onsite storage facility. Table 2.5.4-238 for the power block and Table 2.5.4-239 for the cooling basin/GBRA storage water reservoir summarize the undisturbed soil samples collected during this subsurface investigation. Undisturbed sample details are also given on the boring logs contained in Appendices 2.5.4-A and 2.5.4-B for the above noted areas.

Energy measurements, in accordance with ASTM D 4633 (Reference 2.5.4-208), were made on the SPT hammer-rod systems on each of the nine drilling rigs employed in this subsurface investigation. A pile-driving analyzer (PDA) PAK model, together with calibrated accelerometers and strain gages, was used to acquire and process the data. A summary of measured hammer energies and related data is provided in Table 2.5.4-207. A minimum of three hammer energy measurements were made for each drilling rig with each size of drill rods used. Energy transfer to the PDA gauge positions is estimated using the Case Method, in accordance with ASTM D 4633 (Reference 2.5.4-226). Average energy transfer ratios range from 73% to 91%. Detailed test results are contained in Appendix 2.5.4-A for both the power block and the cooling basin/GBRA storage water reservoir.

2.5.4.2.2.3.2 Cone Penetration Testing

Sixty-five CPTs were performed at the VCS site: with 37 CPTs in the power block, one CPT in the area outside the power block (C-2216), and 27 CPTs in the cooling basin/GBRA storage water reservoir.

CPTs were advanced using an electronic seismic piezocone compression model with a 15-square-centimeter tip area and a 225-square-centimeter friction sleeve area. CPTs were performed in accordance with ASTM D 5778 (Reference 2.5.4-227). CPT equipment was mounted on a either a 25-ton truck-mounted rig, or a 15-ton track-mounted rig, each of which were dedicated to CPT work. Cone tip resistance (q_s), sleeve friction (f_s), and pore water pressure were recorded a minimum of every 2 centimeters as the cone was advanced into the ground. Shear wave velocity measurements were also made at selected CPTs using a geophone mounted above the cone. An anchored beam, struck at the ground surface with a sledge hammer, served as the vibration source. Pore pressure dissipation data was also obtained in selected CPTs.

CPTs were advanced to termination depths ranging from approximately 36 feet to 100 feet below ground surface. These include 11 seismic CPTs (C-2102S, C-2104S, C-2106S, C-2109S, C-2202S, C-2204SB, C-2206S, C-2209S, C-2301S, C-2303S, and C-2323S). Pore pressure dissipation tests are also conducted in 13 CPTs (C-2104S, C-2106, C-2203, C-2204SA, C-2206, C-2207, C-2213, C-2303S, C-2311, C-2311A, C-2213, C-2321, and C-2323S). Two CPT locations (C-2106 and C-2206) were additionally advanced intermittently to 300 feet below ground surface for qualitative evaluation. A summary of the CPT locations and other details is presented in Table 2.5.4-240 for the power block and Table 2.5.4-241 for the cooling basin/GBRA storage water reservoir. CPT locations are shown on Figures 2.5.4-201 and 2.5.4-202 for the power block and for the cooling basin/GBRA storage water reservoir, respectively. CPT logs, shear wave velocity measurements, and pore pressure dissipation test results are contained in Appendices 2.5.4-A and 2.5.4-B for the above noted areas.

2.5.4.2.2.3.3 Test Pits

Twenty test pits were performed at the VCS site: with eight test pits in the power block, and 12 test pits in the cooling basin/GBRA storage water reservoir.

Test pits were excavated to a maximum depth of 10 feet below ground surface using a mechanical excavator. Bulk samples were collected from selected soil strata for laboratory testing. A summary of test pits completed and bulk soil samples collected is included in Table 2.5.4-242 for the power block and Table 2.5.4-243 for the cooling basin/GBRA storage water reservoir. Test pits are numbered according to their adjacent boring or CPT. For example, Test Pit TP-2310 is made adjacent to boring B-2310. Appendix 2.5.4-A for the power block and Appendix 2.5.4-B for the cooling basin/GBRA storage water reservoir contain test pit records and related information.

2.5.4.2.2.3.4 Groundwater Observations and Field Testing

A series of groundwater tests were performed for this subsurface investigation. Tests include the monitoring of groundwater levels in observation wells installed at selected locations, and hydraulic conductivity tests of the various soil strata by slug tests, borehole permeameter tests, and pump tests.

2.5.4.2.2.3.4.1 Observation Wells and Slug Testing

Observation wells were installed in 54 borings (27 well pairs, each having an upper [U] screened interval and a lower [L] screened interval), with well depths ranging from 45 feet to 150 feet. Seven observation well pairs were installed at the power block; five observation well pairs were installed in the area outside the power block; and 16 observation well pairs were installed at the cooling basin/GBRA storage water reservoir. The observation wells were installed under the full-time supervision of a field geotechnical engineer and/or geologist in dedicated borings offset from SPT borings, with installation in accordance with ASTM D 5092 (Reference 2.5.4-228). Observation well borings were advanced using the rotary drilling method and a biodegradable drilling fluid, with an effective well diameter of eight inches. Each well was developed by pumping and/or flushing with clean water. Table 2.5.4-246 for the power block and Table 2.5.4-247 for the cooling basin/GBRA storage water reservoir provide a summary of the observation well locations and other details. Observation well locations are shown on Figures 2.5.4-201 and 2.5.4-202 for the power block and for the cooling basin/GBRA storage water reservoir, respectively. Complete observation well details are included in Appendices 2.5.4-A and 2.5.4-B for the above noted areas and are described further in Subsection 2.4.12.

Slug tests to measure hydraulic conductivities of in situ soil strata were performed in all installed observation wells. Slug tests were conducted using the falling head method, in accordance with Section 8 of ASTM D 4044 (Reference 2.5.4-229). Slug testing includes establishing the static water level, lowering a solid cylinder (slug) into the well to cause an increase in water level in the well, and recording the time for the well water to return to the pre-test static level. Electronic transducers and data loggers were used to measure the water levels and times during the test. Table 2.4.12-208 provides a summary of the slug test results for the power block and cooling basin/GBRA storage water reservoir. Complete slug testing details are contained in Appendices 2.5.4-A and 2.5.4-B for the above noted areas and are described further in Subsection 2.4.12.

2.5.4.2.2.3.4.2 Borehole Permeameter Testing

Borehole permeameter tests were performed at 16 test locations at the cooling basin/GBRA storage water reservoir. At each test location a shallow upper (U) test and a deeper lower (L) test was performed. The tests estimate hydraulic conductivities of the various soil strata in the unsaturated zone. The test is performed using the Guelph downhole permeameter in accordance with ASTM D 5126 (Reference 2.5.4-230). After preparation of the test hole, the test is performed in two stages. Initially, the flow rate required to maintain a 2-inch head in the test hole is measured until a constant rate is recorded. The test is then repeated with a 4-inch head.

Table 2.5.4-248 provides a summary of the borehole permeameter test locations and other test details for cooling basin/GBRA storage water reservoir. Complete borehole permeameter test details are contained in Appendix 2.5.4-B for the above noted area and are described further in Subsection 2.4.12.

2.5.4.2.2.3.4.3 Pump Testing

Aquifer pump tests were performed at two locations at the cooling basin/GBRA storage water reservoir (TW-2320U and TW-2359L) in accordance with ASTM D 4050 (Reference 2.5.4-231). The test involved pumping water from a well at a constant rate and measuring the drawdown in both the pumping well and in nearby observation wells. Four companion observation wells were installed for each pump test. After completion of the pumping phase, the recovery of the water levels was also measured. Drawdown and recovery measurements are used to calculate the transmissivity and storativity of the tested soil stratum.

Table 2.5.4-249 provides a summary of the pump test locations and other details for the cooling basin/GBRA storage water reservoir. Complete pump test details are contained in Appendix 2.5.4-B for the above noted area, and are described further in Subsection 2.4.12.

2.5.4.2.2.3.5 Field Electrical Resistivity Testing

Field electrical resistivity testing was performed at two locations in the switchyard to obtain apparent resistivity values of near-surface soil strata. Table 2.5.4-250 provides a summary of the field electrical resistivity test locations and other details. Electrical resistivity testing was conducted using a MiniRes HP earth resistivity meter, a Wenner four-electrode array, and electrode spacings ("A") of 3 feet, 5 feet, 7.5 feet, 10 feet, 15 feet, 30 feet, 50 feet, 100 feet, 200 feet, and 300 feet, in accordance with ASTM G 57 (Reference 2.5.4-232) and IEEE 81 (Reference 2.5.4-233). Test arrays were centered on each of the staked locations, namely R-2101/R-2102 and R-2201/R-2202, as shown on Figure 2.5.4-201 for the power block. Electrodes were positioned using a 300-foot measuring tape, and set on the appropriate bearings using a Brunton compass. Electrical resistivity test results are summarized in Table 2.5.4-234 for the power block. Raw electrical resistivity test data is contained in Appendix 2.5.4-A.

2.5.4.2.2.3.6 Geophysical Surveys

Geophysical logging was performed in 17 borings (eight borings in the power block; two borings in the area outside the power block (B-2301 and B-2307); and seven borings in the cooling basin/GBRA storage water reservoir), consisting of all, or some of the following geophysical tests: suspension P-S velocity logging, natural gamma long and short resistivity, spontaneous potential, three-arm caliper, and deviation survey. Detailed geophysical logging results are contained in Appendix 2.5.4-A for the power block and Appendix 2.5.4-B for the cooling basin/GBRA storage water reservoir. Suspension P-S velocity logging results are described further in Subsection 2.5.4.4.

2.5.4.2.2.4 Laboratory Testing

Laboratory testing work for this subsurface investigation was performed under an audited and approved quality assurance program and work procedures developed specifically for the project. As noted above, RG 1.138 (Reference 2.5.4-222) addresses laboratory testing of soil and rock for nuclear power plants. This guidance document describes the requirements for: laboratory equipment (including calibration), handling and storage of samples, selection and preparation of test specimens, and testing procedures for determining static and dynamic soil and rock properties. The laboratory tests listed in Reference 2.5.4-222 are common tests performed in geotechnical testing laboratories, and are covered by ASTM and related standards. Some tests not covered in Reference 2.5.4-222 were also performed for this site-specific subsurface investigation (e.g., the RCTS test method was used in lieu of resonant column tests and/or cyclic triaxial tests to obtain shear modulus degradation and damping over a range of strains).

Reference 2.5.4-221 does not provide specific guidance on the quantities of laboratory tests to conduct. The numbers of laboratory tests made for this subsurface investigation are based on engineering judgment, and on experience with similar projects, to obtain necessary data for characterizing engineering properties of materials that impact ground stability and the suitability of construction for critical foundations. Laboratory test assignments were prepared based on information developed from the subsurface investigation, such as the numbers and positions of soil strata, their thicknesses, strengths, vertical and lateral uniformity, and relevance to planned foundations, and on an understanding of plant construction at the time.

ASTM D 4220 (Reference 2.5.4-223) provides guidance on standard practices for preserving and transporting soil samples, and was adopted for use in this subsurface investigation.

Laboratory testing undertaken for this subsurface investigation included testing of soil and groundwater samples recovered from the field test locations (e.g., borings, observation wells, test pits, etc.). Laboratory testing of groundwater samples is addressed in Subsection 2.4.1.2. Laboratory testing of soil samples consists of index and engineering property tests performed on selected SPT, undisturbed, and bulk soil samples. SPT and undisturbed soil samples were recovered from borings, and bulk soil samples were recovered from test pits. Specific laboratory testing on recovered soil samples included natural moisture content, Atterberg limits, particle size analysis by sieve and hydrometer, specific gravity, unit weight, unconsolidated-undrained (UU) triaxial compression testing, consolidated-undrained (CU) triaxial compression strength testing with pore water pressure measurement, direct shear strength testing, direct simple shear strength testing, consolidation, moisture-density relationship (modified Proctor compaction), California Bearing Ratio (CBR), and chemical analyses (pH, chloride content, and sulphate content). RCTS tests were also performed on selected samples.

Laboratory tests were performed in accordance with the following standards:

- Classification and Index Testing
    - Unified Soil Classification System — ASTM D 2487 (Reference 2.5.4-204) and ASTM D 2488 (Reference 2.5.4-205)
    - Moisture Content — ASTM D 2216 (Reference 2.5.4-234)

  - Atterberg Limits — ASTM D 4318 (Reference 2.5.4-235)
  - Sieve and Hydrometer Analysis — ASTM D 422 (Reference 2.5.4-236) and ASTM D 6913 (Reference 2.5.4-237)
  - Specific Gravity — ASTM D 854 (Reference 2.5.4-238)
  - Unit Weight — (included as a part of related ASTM standards)
- Strength Testing
  - Unconsolidated-Undrained Triaxial Compression — ASTM D 2850 (Reference 2.5.4-239)
  - Consolidated-Undrained Triaxial Compression with Pore Water Pressure Measurement — ASTM D 4767 (Reference 2.5.4-240)
  - Direct Shear — ASTM D 3080 (Reference 2.5.4-241)
  - Direct Simple Shear — ASTM D 6528 (Reference 2.5.4-242)
- RCTS Testing — Stokoe, et al. (Reference 2.5.4-243)
- Compressibility Testing
  - Load Controlled Consolidation — ASTM D 2435 (Reference 2.5.4-244)
  - Constant Rate-of-Strain Consolidation — ASTM D 4186 (Reference 2.5.4-245)
- Compaction and Related Testing
  - Modified Proctor Moisture-Density Relationship — ASTM D 1557 (Reference 2.5.4-217)
  - California Bearing Ratio - ASTM D 1883 (Reference 2.5.4-246)
- Chemical Testing of Soils
  - pH — ASTM D 4972 (Reference 2.5.4-247)
  - Chloride Content — EPA 300.0 (Reference 2.5.4-248)
  - Sulphate Content — EPA 300.0 (Reference 2.5.4-248)
- Hydraulic Conductivity — ASTM D 5084 (Reference 2.5.4-249)

2.5.4.3 **Foundation Interfaces**

Subsurface profiles depicting inferred stratigraphy at the power block are presented on Figures 2.5.4-205 through 2.5.4-212. A subsurface profile legend is shown in Figure 2.5.4-203, and power block subsurface profile locations are shown on Figure 2.5.4-204. Note that subsurface profiles shown on Figures 2.5.4-205 through 2.5.4-208 illustrate typical conditions at Unit 1, and subsurface profiles shown on Figures 2.5.4-209 through 2.5.4-212 illustrate typical conditions at Unit 2.

Subsurface profiles depicting inferred stratigraphy at the cooling basin/GBRA storage water reservoir are presented on Figures 2.5.4-214 through 2.5.4-220. A subsurface profile legend is shown in Figure 2.5.4-203, and cooling basin/GBRA storage water reservoir subsurface profile locations are shown on Figure 2.5.4-213. Note that subsurface profiles shown on Figures 2.5.4-214 through 2.5.4-216 illustrate typical conditions along major north-south trending embankment dams, and subsurface profiles shown on Figures 2.5.4-217 through 2.5.4-220 illustrate typical conditions along major east-west trending embankment dams and through the cooling basin/GBRA storage water reservoir interior.

A plan and profiles illustrating power block foundation excavation geometries and the locations and depths of Unit 1 and Unit 2 major structures (including seismic Category I structures), as well as the relationship of structure foundations to the various subsurface strata, are addressed in Subsection 2.5.4.5.

Similarly, a plan and profiles illustrating cooling basin/GBRA storage water reservoir mass excavation geometry and the locations and heights of major embankment dams, as well as the relationship of embankment dam foundations to the various subsurface strata, are also addressed in Subsection 2.5.4.5.

2.5.4.4 Geophysical Surveys

This subsection provides a summary of the geophysical survey methods undertaken for this subsurface investigation. Refer to Subsection 2.5.4.7 for a description of results.

2.5.4.4.1 Suspension P-S Velocity Logging

Suspension P-S velocity logging was performed at the VCS site in 17 dedicated borings offset from SPT borings (10 borings in the power block, two borings in the area outside the power block [B-2301 and B-2307], and seven borings in the cooling basin/GBRA storage water reservoir). These 17 P-S velocity logging borings are listed as follows; B-2162A Offset, B-2174A Offset, B-2176A Offset, B-2182A Offset, B-2262A Offset, B-2274A Offset, B-2276A Offset, B-2282A Offset, B-2301, B-2302, B-2303, B-2304, B-2305, B-2306, B-2307, B-11, and

B-12. Borings B-2174A Offset and B-2274A Offset were logged to 600 feet depth, while the remaining borings were logged to 200 to 400 feet depth. During logging, borings were uncased and filled with drilling fluid. The OYO/Robertson Model 3403 unit and the OYO Model 3331A suspension logging recorder and probe were employed. Details of the equipment are described in Reference 2.5.4-250, and the velocity measurement technique used is briefly described below. Results are provided as tables and graphs in Appendix 2.5.4-A.

An ASTM standard is not available for the suspension P-S velocity logging method at this time; therefore, a brief description follows here. Suspension P-S velocity logging uses a 23-foot- (approximately 7-meter) long probe containing a source near the bottom and two geophone receivers spaced 3.3 feet (approximately one meter) apart, all suspended by a cable. The probe is lowered into the boring to a specified depth where the source generates a pressure wave in the drilling fluid. The pressure wave is converted to seismic waves (compression, P-waves, and shear, S-waves) at the boring wall. At each receiver position, the P- and S-waves are converted to pressure waves in the fluid and received by the geophones mounted in the probe, which in turn send the data to a recorder at the surface. At each measurement depth, two opposite horizontal records and one vertical record are obtained. This procedure is typically repeated every 1.6 feet (0.5 meters) as the probe is raised incrementally from the bottom of the boring to the ground surface. The elapsed time between wave arrivals at the geophone receivers is used to determine the average velocity of a 1.6-foot-high (0.5 meter) column of soil surrounding the boring. As a verification, analysis is also performed on source-to-receiver data.

P-S velocity measurements obtained are sorted by soil stratum through a review of the stratigraphic changes on the boring logs, and on the geophysical records, especially for depths where soil samples are collected less frequently, i.e., the deeper soil strata.

Compression wave velocity (P, V_p) and shear wave velocity (S, V_s) results from this subsurface investigation, including results from both the suspension P-S velocity logging method and from the seismic CPT method (refer to Subsection 2.5.4.4.2), are tabulated below.

Minimum, maximum, and average V_S values measured in the various soil strata at the power block are as follows:

Shear Wave Velocities, V_S (Power Block)

	Unit 1 Shear Wave Velocity, V_s[a]			Unit 2 Shear Wave Velocity, V_s[a]		
Stratum	**Minimum (ft/sec)**	**Maximum (ft/sec)**	**Average (ft/sec)**	**Minimum (ft/sec)**	**Maximum (ft/sec)**	**Average (ft/sec)**
Clay 1 (Top)	276	1100	737	117	1160	606
Sand 1	—	—	—	738	1350	1078
Clay 1 (Bottom)	470	1560	849	550	1300	949
Sand 2	570	1282	986	750	1470	1158
Clay 3	710	1600	1027	490	1670	960
Sand 4	687	5380	1809	900	1850	1351
Clay 5 (Top)	700	2250	1083	790	2870	1219
Sand 5	870	1290	1039	1140	2490	1498
Clay 5 (Bottom)	850	1640	1152	790	1740	1120
Sand 6	920	3120	1531	490	3400	1418
Clay 7	800	1880	1430	—	—	—
Sand 8	980	2300	1549	1140	3000	1734
Clay 9	990	1510	1260	990	1750	1250
Sand 10	1160	2220	1650	1220	2020	1637
Clay 11	820	1830	1179	910	1280	1093
Sand 12	1460	2030	1783	1410	2190	1837
Clay 13	1020	2310	1416	1050	2270	1322
Sand 14	1540	2040	1772	1370	2400	1886
Clay 15	1100	1770	1519	1360	1840	1486
Sand 16	1720	1980	1821	1540	1780	1703
Clay 17	1180	2030	1629	1630	2120	1981
Sand 18	1790	2380	1999	1940	2040	1985

a. Shear wave velocity values for strata shown "—" denote strata that are either too thin to measure at boring/seismic CPT locations, or are absent in the particular area investigated.

Minimum, maximum, and average Vs values measured in the various soil strata at the cooling basin/GBRA storage water reservoir are as follows:

Shear Wave Velocities, V_S
(Cooling Basin/GBRA Storage Water Reservoir)

	Shear Wave Velocity, V_s		
Stratum	**Minimum (ft/sec)**	**Maximum (ft/sec)**	**Average (ft/sec)**
Clay 1 (Top)	194	1045	740
Sand 1	559	1691	1015
Clay 1 (Bottom)	475	1465	903
Sand 2	559	1691	1015
Clay 3	585	2063	1019
Sand 4	866	3281	1224
Clay 5 (Top)	741	271	1134
Sand 5	894	3528	1399
Clay 5 (Bottom)	656	2038	1173

Shear Wave Velocities, V_s (Cooling Basin/GBRA Storage Water Reservoir)

	Shear Wave Velocity, V_s		
Stratum	Minimum (ft/sec)	Maximum (ft/sec)	Average (ft/sec)
Sand 6	831	2711	1349
Clay 7	877	2294	1314
Sand 8	1038	3038	1663
Clay 9	974	2412	1506
Sand 10	1193	3010	1733
Clay 11	1465	1465	1465

Minimum, maximum, and average V_p values measured in the various soil strata at the power block are as follows:

Compression Wave Velocities, V_p (Power Block)

	Unit 1 Compression Wave Velocity, V_p [a]			Unit 2 Compression Wave Velocity, V_p[a]		
Stratum	Minimum (ft/sec)	Maximum (ft/sec)	Average (ft/sec)	Minimum (ft/sec)	Maximum (ft/sec)	Average (ft/sec)
Clay 1 (Top)	3566	1498	2359	4825	1272	3121
Sand 1	—	—	—	6696	2110	4078
Clay 1 (Bottom)	6309	2187	4488	6132	3066	5545
Sand 2	6076	2448	4911	6249	5292	5829
Clay 3	6309	4345	5595	6696	5292	5841
Sand 4	9794	5167	6593	6696	5561	6008
Clay 5 (Top)	6835	5047	5816	7906	5468	6021
Sand 5	6371	5468	5838	6433	5657	5976
Clay 5 (Bottom)	6309	5249	5668	6497	5335	5799
Sand 6	9113	4934	6067	8306	5167	5896
Clay 7	6907	4934	6058	—	—	—
Sand 8	7132	5423	6148	8989	5514	6393
Clay 9	6562	5423	5798	6433	5561	5790
Sand 10	6696	5378	6068	6765	5657	6141
Clay 11	6371	5167	5598	5807	5167	5496
Sand 12	6696	5965	6290	6433	5807	6163
Clay 13	6907	5378	5954	6190	5126	5686
Sand 14	6371	5859	6048	6907	5859	6278
Clay 15	6497	5859	6107	6190	5965	6029
Sand 16	6132	5911	6027	6371	6132	6239
Clay 17	7456	5706	6418	6981	6433	6789
Sand 18	6835	6020	6394	6371	6190	6290

a. Compression wave velocity values for strata shown "—" denote strata that are either too thin at boring/seismic CPT locations, or are absent in the particular area investigated.

Minimum, maximum, and average V_p values measured in the various soil strata at the cooling basin/GBRA storage water reservoir are not evaluated.

Figures 2.5.4-267, 2.5.4-268, and 2.5.4-270 illustrate V_s measurements at Unit 1, Unit 2, and the cooling basin/GBRA storage water reservoir, respectively. Measurements are made to 600-foot depths at the power block and 300-foot depths at the cooling basin/GBRA storage water reservoir. Figures 2.5.4-271, 2.5.4-272, and 2.5.4-274 are average V_s profiles by soil stratum for the same areas and depths indicated above. These latter figures also include profiles of average V_s values plus or minus one standard deviation.

Note that Figures 2.5.4-271 and 2.5.4-272 illustrate average Vs values for Strata Clay 1 (Top) through Sand 18 at Unit 1 and Unit 2, respectively. These figures also include the 15-foot-thick structural fill layer that is required to raise the power block to finish grade (i.e., from existing ground surface at elevation +80 feet to finish grade at elevation +95 feet). The surficial structural fill layer has estimated shear wave velocity of 700 feet per second (upper fill), and 850 feet per second (lower fill): values that are considered conservative for a well-compacted granular fill material. Refer to Subsection 2.5.4.5.1 for additional details on power block structural fill. Figure 2.5.4-274, similarly illustrates average V_s values for Strata Clay 1 (Top) through Clay 11 at the cooling basin/GBRA storage water reservoir.

Poisson's ratio (μ) values (small strain) are determined for the power block based on the V_p and the V_s measurements. Average Poisson's ratios are approximately 0.44 at depths above the current groundwater level (elevation +48 feet) and approximately 0.46 below the current groundwater level. Average Poisson's ratio values are summarized as follows:

Poisson's Ratios, μ
(Power Block)

Stratum	Unit 1 Poisson's Ratio, μ^a	Unit 2 Poisson's Ratio, μ^a
Clay 1 (Top)	0.41	0.47
Sand 1	—	0.44
Clay 1 (Bottom)	0.46	0.46
Sand 2	0.47	0.48
Clay 3	0.48	0.49
Sand 4	0.45	0.47
Clay 5 (Top)	0.48	0.48
Sand 5	0.48	0.47
Clay 5 (Bottom)	0.48	0.48

Poisson's Ratios, μ
(Power Block)

Stratum	Unit 1 Poisson's Ratio, μ^{a}	Unit 2 Poisson's Ratio, μ^{a}
Sand 6	0.47	0.47
Clay 7	0.47	—
Sand 8	0.47	0.46
Clay 9	0.48	0.48
Sand 10	0.46	0.46
Clay 11	0.48	0.48
Sand 12	0.46	0.45
Clay 13	0.47	0.47
Sand 14	0.45	0.45
Clay 15	0.47	0.47
Sand 16	0.45	0.46
Clay 17	0.47	0.45
Sand 18	0.45	0.45

a. Poisson's ratio values for strata shown "—" denote strata that are either too thin at boring/seismic CPT locations, or are absent in the particular area investigated.

Note that the above V_p, V_s, and μ values (at small strain) can be assumed to reflect the VCS site subsurface profile to a depth of 600 feet below original ground surface (i.e., to approximately 600 feet below El. +80 feet, or El. –520 feet). Information available for deeper subsurface soils is described in Subsection 2.5.4.7.

2.5.4.4.2 Seismic Cone Penetration Testing

Shear wave velocity values were also measured at 11 locations at the VCS site using the seismic CPT (C-2102S, C-2104S, C-2106S, C-2109S, C-2202S, C-2204SB, C-2206S, C-2209S, C-2301S, C-2303S, and C-2323S). The maximum depth tested by seismic CPTs was 100 feet. As noted above, seismic CPT V_s results are included together with the suspension P-S velocity logging V_s results on Figures 2.5.4-267, 2.5.4-268, and 2.5.4-270, and are additionally accounted for in the average V_s profiles on Figures 2.5.4-271, 2.5.4-272, and 2.5.4-274. Seismic CPT results are typically within the range of the suspension P-S velocity logging results.

Minimum, maximum, and average V_S values measured in the various soil strata at power block seismic CPTs are as follows:

Shear Wave Velocities, V_S (Power Block)

	Unit 1 Shear Wave Velocity, V_S[a]			Unit 2 Shear Wave Velocity, V_S[a]		
Stratum	Minimum (ft/sec)	Maximum (ft/sec)	Average (ft/sec)	Minimum (ft/sec)	Maximum (ft/sec)	Average (ft/sec)
Clay 1 (Top)	275	801	547	167	702	448
Sand 1	—	—	—	738	1058	875
Clay 1 (Bottom)	598	1404	771	713	991	853
Sand 2	876	1283	970	893	1210	1026
Clay 3	806	1311	946	655	1036	834
Sand 4	687	1532	1146	948	1577	1203

a. Shear wave velocity values for strata shown "—" denote strata that are either too thin at seismic CPT locations, or are absent in the particular area investigated.

Minimum, maximum, and average V_S values measured in the various soil strata at cooling basin/GBRA storage water reservoir seismic CPTs are as follows:

Shear Wave Velocities, V_S (Cooling Basin/ GBRA Storage Water Reservoir)

	Shear Wave Velocity, V_S		
Stratum	Minimum (ft/sec)	Maximum (ft/sec)	Average (ft/sec)
Clay 1 (Top)	194	288	234
Sand 1	294	1014	623
Clay 1 (Bottom)	613	847	691
Sand 2	787	1241	1008
Clay 3	830	1111	970
Sand 4	887	1152	991
Clay 5 (Top)	741	1015	909

2.5.4.4.3 Regional/Oil Field Sonic Logging

Figures 2.5.4-269 and 2.5.4-273 illustrate Vs measurements and the average V_S profile, respectively, derived from sonic logs performed for oil field exploration borings at locations within Victoria County (Figure 2.5.4-266). Figure 2.5.4-273 also includes profiles of average V_S values plus or minus one standard deviation. Figure 2.5.4-273 is used to extend the power block average V_S profiles (Figures 2.5.4-271 and 2.5.4-272) to depths greater than 600 feet below ground surface for use in seismic ground response analyses. Note that the sonic logs collected/analyzed begin at an upper depth of approximately 200 feet to 1600 feet and range in total depth from approximately 8000 feet to 16,000 feet. Refer to Subsection 2.5.4.2.1.5 for additional description.

2.5.4.4.4 S-Wave Velocity Profile Selection

Suspension P-S velocity logging results and seismic CPT measurements are combined to develop the average V_s velocity profiles shown on Figures 2.5.4-271 and 2.5.4-272 for the power block and 2.5.4-274 for the cooling basin/GBRA storage water reservoir. The data collected at individual suspension P-S velocity logging borings and at individual seismic CPTs is sorted by soil stratum and averaged. The average thickness/base elevation of each soil stratum is also determined at each of the boring and CPT test locations, and averaged. The average V_s profiles (Figures 2.5.4-271, 2.5.4-272, and 2.5.4-274) plot the calculated average V_s values (plus or minus one standard deviation) versus the calculated average strata thicknesses/base elevations. These figures illustrate design Vs profile for site soils from ground surface to 600 feet below ground surface at the power block (i.e., to elevation -520 feet), and from ground surface to 300 feet below ground surface at the cooling basin/GBRA storage water reservoir (i.e., to elevation -220 feet).

As noted above, Figure 2.5.4-273 extends the power block average V_s profiles (Figures 2.5.4-271 and 2.5.4-272) to depths greater than 600 feet for use in seismic ground response analyses.

Tables 2.5.4-251 through 2.5.4-253 contain the numerical values that enter into the average V_s profile figures noted above.

2.5.4.4.5 Equivalent Shear Wave Velocities

Equivalent shear wave velocities (V_{eq}) for seismic Category I structures are evaluated according to the ESBWR DCD, Reference 2.5.4-251. Values of V_{eq} are calculated for each of the Unit 1 and Unit 2 reactor/fuel buildings, control buildings, and fire water service complexes, using the design V_s profiles derived above, and the statistics (especially the standard deviation) of V_s values for each stratum. From Reference 2.5.4-251, V_{eq} is calculated using lower bound V_s values and thicknesses of corresponding strata, and is evaluated to a depth equivalent to two times the largest structure dimension plus the structure embedment below power block finish grade (elevation +95 feet).

Equivalent depths calculated for seismic Category I structures are:

- Reactor/fuel building: equivalent depth of 525.6 feet (the largest foundation dimension being 230 feet, and the depth of embedment is 65.6 feet)

- Control buildings: equivalent depth of 246.9 feet (the largest foundation dimension is 99 feet, and the depth of embedment is 48.9 feet)
- Fire water service complexes: equivalent depth of 349.7 feet (the largest foundation dimension is 171 feet, and the depth of embedment is 7.7 feet)

"Lower bound V_s values" as used in Reference 2.5.4-251 are considered the average V_s values minus one standard deviation determined for each stratum. For the upper and lower structural fill layers noted above (Subsection 2.5.4.4.1), the standard deviation is taken as 25% of the estimated V_s values. "Lower bound V_s values" are further adjusted for seismic strain; preliminarily a reduction of 10% is used. Final seismic strains are determined on a site-specific basis as described in Subsection 2.5.2.5.4.

Equivalent shear wave velocities (V_{eq}) for seismic Category I structures are calculated using the equation given in Reference 2.5.4-251 (Table 2.0-201, Note 8):

$$V_{eq} = \Sigma d_i / \Sigma d_i/V_i \qquad \text{Equation 2.5.4-19}$$

where, d_i = thickness of soil stratum

V_i = lower bound V_s (reduced for seismic strain) of soil stratum

The resulting equivalent shear wave velocities (V_{eq}) for Unit 1 and Unit 2 seismic Category I structures are as follows:

Equivalent Shear Wave Velocities, V_{eq}
Seismic Category I Structures
(Power Block)

	Unit 1	Unit 2
	Equivalent Shear Wave Velocity, V_{eq}[a]	
Structure	(ft/sec)	(ft/sec)
Reactor/Fuel Building	858	882
Control Building	726	719
Fire Water Service Complex	802	809

a. Assumes 10% reduction to individual values of V_i to account for seismic strain; final reduction value to be confirmed.

VCS DEP 2.5.4-1 Because site-specific V_{eq} values fall below the minimum 1000 feet per second value required under the ESBWR DCD (Reference 2.5.4-251), a departure is taken. Refer to Section 3.7 for additional description of the V_{eq} values presented above versus the development of a site-specific soil-structure interaction model.

2.5.4.5 Excavation and Backfill

2.5.4.5.1 Sources and Quantities of Backfill

Significant earthwork is required to establish finish grades at the VCS site, especially to raise the power block to finish grade (fill to elevation +95 feet), to provide for the embedment of major power block structures (including seismic Category I structures) (deepest excavation to elevation +8 feet), to achieve cooling basin/GBRA storage water reservoir base level (excavation to elevation +69 feet), and to provide for cooling basin/GBRA storage water reservoir embankment dams (fill to elevation +102 feet) and interior dikes (fill to elevation +99 feet).

2.5.4.5.1.1.1 Power Block

At the power block, current estimates are that approximately one million cubic yards of material are excavated, one-half million cubic yards of structural fill (from offsite sources) are required to backfill major structures, and two million cubic yards of material are required to establish finish grades (of which material excavated onsite provides about one-half of the fill to finish grade requirement).

Power block area materials excavated during site grading are primarily the upper soils of Strata Clay 1 through Clay 3, consisting of clays (Strata Clay 1 and Clay 3) and clayey or silty fine sands (Strata Sand 1 and Sand 2). To evaluate the uppermost soil stratum (Stratum Clay 1) for construction purposes, eight test pits were excavated at the power block, as shown on Figure 2.5.4-201 and summarized in Table 2.5.4-242. The maximum depth of test pits was 10 feet below ground surface. The results of laboratory testing on bulk samples collected from the test pits for moisture-density (modified Proctor compaction), California bearing ratio (CBR), and other index tests are summarized in Table 2.5.4-244, with details included in Appendix 2.5.4-A. These tests show that Stratum Clay 1 soils are low to high plasticity, with an average fines content of 80%, and occur at natural moisture contents typically 4% to 6% above their optimum moisture contents. Stratum Clay 1, as well as the other upper clay stratum excavated (Stratum Clay 3), in their natural states are unsuitable for use as structural fill, but are suitable for reuse as common fill. Similarly, upper sand strata excavated (Strata Sand 1 and Sand 2) are unsuitable for use as structural fill, but are suitable for reuse as common fill. For proper reuse as common fill, clay materials and sand materials are separated during excavation, and are dried-back normally to between 2% below and 2% above optimum moisture content before placement in fill areas. Note that the upper sand strata excavated (Strata Sand 1 and Sand 2) have natural moisture contents in a similar range to those measured for Stratum Clay 1, which may similarly be higher than their respective optimum moisture contents.

For the power block, preliminary structural fill sources from local suppliers are identified as follows:

- A material processed to meet Texas DOT, Grade 4 requirements. The tested bulk sample is a well-graded gravel with trace amounts of fines (USCS classification, GW-GC)
- A material processed to meet Texas DOT, Grade 6 requirements. The tested bulk sample is a slightly finer well-graded gravel with trace amounts of fines (USCS classification, GW-GC)
- Raw material sampled at the conveyor. The tested bulk sample is a still slightly finer well-graded sand with gravel and trace amounts of fines (USCS classification, SW)

Of the above, the Texas DOT Grade 4 material is the most well-graded material and is preferred. Note that in the case of the third coarse aggregate materials, above, the local supplier of this material mainly manufactures to meet ASTM C 33 (Reference 2.5.4-218) coarse aggregate for concrete requirements, which are typically too poorly graded for structural fill. Note that the structural fill material tested from this supplier is unprocessed quarried "raw" material sampled at the conveyor, and leading directly from the pit.

The results of laboratory index tests (natural moisture content, gradation), chemical tests (pH, sulphate content, chloride content), moisture-density relationship tests (modified Proctor compaction), and strength tests (direct shear) for these materials are contained in Appendix 2.5.4-A and summarized in Subsection 2.5.4.2.1.4.1. Note, however, that once the final backfill source(s) for structural fill is determined, additional static and/or dynamic testing will be required if the materials selected are markedly different from those already tested.

Note also that structural fill below and/or surrounding major power block structures alternatively consists of lean concrete fill, or concrete fill. The selection of structural fill, lean concrete fill, and/or concrete fill is determined during detailed design.

2.5.4.5.1.1.2 Cooling Basin/GBRA Storage Water Reservoir

At the cooling basin/GBRA storage water reservoir, current estimates are that approximately 28 million cubic yards of material are moved during earthwork to establish site grades, comprising of 20 million cubic yards of clay to construct the embankment dam and dikes, 1 million cubic yards of sand (from offsite sources) for a sand drainage blanket at the outside toe of the embankment dam and 7 million cubic yards of topsoil that will be moved to a spoils area or throughout the site to reestablish vegetation in disturbed areas.

Cooling basin/GBRA storage water reservoir area materials excavated during site grading are primarily the upper soils of Strata Clay 1 and Sand 1, consisting of clays (Stratum Clay 1) and clayey or silty fine sands (Stratum Sand 1). To evaluate the uppermost soil strata (Strata Clay 1 and Sand 1) for construction purposes, 12 test pits were excavated at the cooling basin/GBRA storage water reservoir, as shown on Figure 2.5.4-202 and summarized in Table 2.5.4-243. The maximum depth of test pits was 10 feet below ground surface. The results of laboratory testing on bulk samples collected from the test pits for moisture-density (modified Proctor compaction) and other index tests are summarized in Table 2.5.4-245, with details included in Appendix 2.5.4-B. These tests show that Stratum Clay 1 soils are low plasticity, with an average fines content of 70%, and occur at natural moisture contents typically 2% to 6% above their optimum moisture contents. These tests also show that Stratum Sand 1 soils are clayey or silty, with an average fines content of 34%, and occur at natural moisture contents typically 2% below to 2% above their optimum moisture contents. Both the sand soils and the clay soils in their natural states are unsuitable for use as drainage materials, but are suitable for reuse as fill for embankment dams and for interior dikes. For proper reuse as embankment fill, clay materials and sand materials are separated during excavation, and are moisture conditioned, normally to between 2% and 6% above their optimum moisture contents, prior to placement in fill areas.

For the cooling basin/GBRA storage water reservoir, test pit bulk samples representative of the sand soils and clay soils excavated and reused for embankment fill are selected and combined for laboratory testing of recompacted specimens, as follows:

- Composite "A"/Sand: a blend of bulk samples having similar properties obtained from two test pits (test pit TP-2319, bulk sample 2 and test pit TP-2334, bulk sample 2), and representative of the coarser-grained soils used for embankment fill. The combined/tested bulk sample is a clayey sand (USCS classification, SC) with fines content of 46%
- Composite "B"/Clay: a blend of bulk samples having similar properties obtained from two test pits (test pit TP-2317, bulk sample 1 and test pit TP-2334, bulk sample 1), and representative of the finer-grained soils used for embankment fill. The combined/tested bulk sample is a lean clay with sand (USCS classification, CL) with fines content of 74%

Of the above, either material is suitable for reuse as embankment fill. Refer to Subsections 2.5.4.2.1.4 and 2.5.5.1.9.1 for additional description of the properties of cooling basin/GBRA storage water reservoir embankment fill soils.

The results of laboratory index tests (natural moisture content, gradation), chemical tests (pH, sulphate content, chloride content), moisture-density relationship tests (modified Proctor compaction), consolidation tests and strength tests (direct simple shear and triaxial compression) for these materials are contained in Appendix 2.5.4-B and summarized in Subsection 2.5.4.2.2.4. Note that recompacted specimens prepared for consolidation and strength testing from these combined/tested samples were compacted to 95% of modified Proctor (Reference 2.5.4-217) maximum dry density at 4% above optimum moisture content.

Also for the cooling basin/GBRA storage water reservoir, preliminary drainage sand sources are identified, as follows:

- A material processed to meet ASTM C 33 (Reference 2.5.4-218) fine aggregate for concrete requirements. The tested bulk sample is a poorly graded sand (USCS classification, SP)
- A material processed to meet ASTM C 144 (Reference 2.5.4-219) mortar sand requirements. The tested bulk sample is a slightly finer poorly graded sand (USCS classification, SP)

Of the above, either material is suitable for use as drainage sand (for internal drainage of embankment dams). Refer to Subsections 2.5.4.2.1.4 and 2.5.5.1.9.2 for additional description of the properties of cooling basin/GBRA storage water reservoir drainage sand materials, including an analysis of drainage sand versus foundation clay and foundation sand filter criteria.

The results of laboratory index tests (natural moisture content, gradation), chemical tests (pH, sulphate content, chloride content), moisture-density relationship tests (modified Proctor compaction), and strength tests (direct shear) for these materials are similarly contained in Appendix 2.5.4-A.

2.5.4.5.2 Extent of Excavations, Fills, and Slopes

The plan arrangement of the power block, including major structure footprints, is shown on Figure 2.5.4-201. The natural ground surface elevation at the power block ranges from approximately elevation +78 feet to elevation +81 feet, with an average of elevation +80 feet. The power block finish grade elevation is raised approximately 15 feet to elevation +95 feet, using a compacted structural fill to backfill structure excavations and below shallower founded structures, and using a common fill in non-structure areas.

Power block Unit 1 and Unit 2 reactor/fuel buildings, control buildings, and fire water service complexes are seismic Category I structures. The approximate foundation dimensions, foundation elevations, and predominant soil strata at the foundation elevations of these and other major plant structures are as follows:

Foundation Dimensions, Elevations, and Predominant Soil Strata Major Plant Structures (Including Seismic Category I Structures) (Power Block)

Structure	Approximate Foundation Dimensions (feet)	Approximate Foundation El. (feet)[a]	Predominant Soil Stratum at Foundation El. (feet)[a]
Reactor/Fuel Building (Unit 1)	161 by 230	+29.4 {+8.0}	Sand 2 {Clay 3}
Reactor/Fuel Building (Unit 2)	161 by 230	+29.4 {+8.0}	Clay 1 {Sand 2 & Clay 3}
Control Building (Unit 1)	78 by 99	+46.1 {+25.0}	Clay 1 {Sand 2 & Clay 3}
Control Building (Unit 2)	78 by 99	+46.1 {+25.0}	Sand 1 {Clay 1}
Fire Water Service Complex (Unit 1)	66 by 171	+87.3	Structural Fill over Clay 1[b]
Fire Water Service Complex (Unit 2)	66 by 171	+87.3	Structural Fill over Clay 1[b]
Radwaste Building (Unit 1)	108 by 213	+43.0	Clay 1
Radwaste Building (Unit 2)	108 by 213	+43.0	Sand 1 & Clay 1
Turbine Building (Unit 1)	194 by 377	+69.0	Clay 1
Turbine Building (Unit 2)	194 by 377	+69.0	Clay 1
Service Building (Unit 1)	105 by 157	+80.0	Clay 1
Service Building (Unit 2)	105 by 157	+80.0	Clay 1

a. Foundation elevations and soil strata designations shown in "{ }" symbols denote the elevations and soil strata at the base of significant over-excavation (to reach a suitable bearing stratum) at the particular structure (e.g., at the Reactor/Fuel Buildings [Units 1 and 2], Strata Sand 2 and Clay 3 are over-excavated approximately 21 feet below the underside of foundations, with overexcavation replaced by structural fill; at the Control Building [Unit 1], Stratum Clay 1 is overexcavated approximately 21 feet below the underside of foundations, with over-excavation replaced by structural fill; and at the Control Building [Unit 2], Stratum Sand 1 is over-excavated approximately 21 feet below the underside of foundations, with over-excavation replaced by structural fill.

b. Fire water service complexes (Units 1 and 2) bear on approximately 7.3 feet of structural fill over Stratum Clay 1 (natural ground surface at El. +80 feet prior to raising power block to finish grade).

As noted above, power block foundation excavations result in removing approximately one million cubic yards of soils. The extent of excavation, filling, temporary slopes, and the approximate limits of temporary ground support for major structures are shown in plan on Figure 2.5.4-275 and in profile on Figures 2.5.4-276 through 2.5.4-279 (note that the profiles are taken at locations identified on Figure 2.5.4-275). These figures show that the excavations for foundations result in all major structures being founded either directly on stiff to very stiff clay strata, dense to very dense sand strata, or on compacted structural fill.

The deepest excavation at the power block (i.e., the underside of overexcavation for the reactor/fuel buildings at elevation +8 feet) is approximately 87 feet below finish grade (elevation +95 feet). The subsurface investigation made at the power block (refer to Appendix 2.5.4-A) shows that the subsurface strata to support foundations are relatively horizontal. However, it should be noted that the extent of excavation to final subgrade and/or to final overexcavation level is determined during construction, based on observation of actual subsurface conditions encountered, and verification of their suitability for foundation support. Once subgrade suitability at the proposed bearing stratum is confirmed, excavations are backfilled with compacted structural fill up to the foundation level of structures. Following construction of structure foundations and other underground features, compacted structural fill is extended to the proposed finish grade, or near the proposed finish grade, as defined during detailed design. Compaction and quality control/quality assurance programs for filling are addressed in Subsections 2.5.4.5.3.

There are no permanent safety-related excavation or fill slopes created by power block site grading. Temporary excavation slopes, such as those for foundation excavation and/or overexcavation, are graded to an inclination not exceeding 2 horizontal: 1 vertical (2H:1V). Note that the excavation plan and profiles, Figures 2.5.4-275 and 2.5.4-276 through 2.5.4-279, respectively, are based on this temporary slope inclination. During detailed design, slope stability analyses are conducted to show that temporary slopes have an adequate factor of safety (typically at least 1.30 for nonsafety-related temporary slopes under static conditions), including, among other things, the effects of surcharge loading from construction equipment, and the effects of construction dewatering.

Note also on the excavation plan and sections, Figures 2.5.4-275 and 2.5.4-276 through 2.5.4-279, respectively, that the approximate limits of temporary ground support are shown along the north and west edges of the reactor/fuel building, and along the south edge of the radwaste building. At the north edge of the reactor/fuel building, there is an abrupt change in grade (from the subgrade level of the reactor/fuel building at elevation +8 feet, to the subgrade level of the turbine building at elevation +67 feet) that cannot be accommodated by a stable soil slope. Also, at the west edge of the reactor/fuel building and the south edge of the radwaste building, temporary ground support is also required to accommodate the reach of a heavy lift crane needed to place the reactor vessel. In both of these cases, temporary ground support is defined during detailed design. Note also in the case of the temporary ground support at the west edge of the reactor/fuel building and the south edge of the radwaste building that either the temporary ground support is designed to accommodate the crane loads or the crane loads are carried below the base level of the foundation excavation (i.e., by piles, piers, etc.). Temporary ground support is likely tied-back concrete slurry (diaphragm) walls, or tied-back soldier piles and lagging (with soldier piles predrilled in place). Other excavation support methods and/or configurations are evaluated during detailed design.

The plan arrangement of the cooling basin/GBRA storage water reservoir is shown in Figure 2.5.4-202. The natural ground surface elevation at the basin/reservoir area ranges from approximately elevation +42 feet to elevation +80 feet, with an average of elevation +70 feet. The base level of the basin/reservoir is elevation +69 feet, and the normal operating water level is elevation +91.5 feet. The north portion of the basin/reservoir area is mainly cut to achieve the elevation +69 feet base level, while the south and east portions of the basin/reservoir area have natural ground surface below the elevation +69 feet base level, and are neither cut nor filled. An embankment dam having crest at elevation +102 feet surrounds the basin/reservoir area, and additionally divides the cooling basin from the adjoining GBRA storage water reservoir. The basin also has interior dikes with crest at elevation +99 feet to lengthen the flow path of cooling water through the basin from outfall to intake. All embankment dams and interior dikes are constructed of compacted clay and/or clayey sand embankment fill excavated from the north portion of the basin/reservoir area.

As noted above, cooling basin/GBRA storage water reservoir excavations result in removing approximately 28 million cubic yards of soil. The extent of excavation, and filling for embankment dams and interior dikes, are shown in plan on Figure 2.5.4-280 and in profile on Figures 2.5.4-281 through 2.5.4-285 (note that the profiles are taken at locations identified on Figure 2.5.4-280). These figures illustrate a water level for the design of embankment dams at elevation +96 feet. Note, however, that the normal maximum water level in the cooling basin/GBRA storage water basin is typically elevation +91.5 feet.

Refer to Subsection 2.5.5 for description of nonsafety-related embankment fill slopes pertaining to the cooling basin/GBRA storage water reservoir.

2.5.4.5.3 Compaction of Backfill

For both the power block and the cooling basin/GBRA storage water reservoir, at initiation of earthwork, samples of the various required fill materials (i.e., power block structural fill and common fill; cooling basin/GBRA storage water reservoir embankment fill and drainage sand) are obtained and tested for index properties, chemical properties, and engineering properties (i.e., grain size and plasticity characteristics, soil pH, sulphate content, and chloride content characteristics, and moisture-density relationships). The following compaction criteria apply:

- At power block structure areas and for backfill against underground structures, structural fill is compacted to a minimum of 95% of modified Proctor (Reference 2.5.4-217) maximum dry density and within plus or minus 2% of optimum moisture content
- At power block nonstructure areas, common fill is compacted to a minimum of 92% of modified Proctor (Reference 2.5.4-217) maximum dry density and within plus or minus 4% of optimum moisture content
- At cooling basin/GBRA storage water reservoir embankment dams and interior dikes, embankment fill is compacted to a minimum of 95% of modified Proctor (Reference 2.5.4-217) maximum dry density and within plus 2% and plus 6% of optimum moisture content.
- At cooling basin/GBRA storage water reservoir embankment dam drainage blankets, drainage sand is compacted to a minimum of 95% of modified Proctor (Reference 2.5.4-217) maximum dry density and within plus or minus 2% of optimum moisture content.

Fill placement and compaction control procedures are addressed in a technical specification prepared during detailed design. The specification includes requirements for suitability of the various required fill materials, sufficient testing to address potential material variations, and in-place density and moisture content testing frequency (e.g., typically a minimum of one test per 10,000 square feet of fill placed per lift). The specification also includes requirements for an onsite testing firm for quality control to ensure specified material gradation and plasticity characteristics, the achievement of specified moisture-density criteria, fill placement/compaction, and other requirements to ensure that earthwork operations conform to design requirements. The onsite testing firm is required to be independent of the earthwork contractor and is to have an approved quality assurance/quality control program. A sufficient number of laboratory tests are required to ensure that any variations in the various required fill materials are accounted for. A materials testing laboratory is established onsite to exclusively serve the VCS site work.

A trial fill program is normally conducted for purposes of determining the optimum number of compactor passes/coverages, the maximum loose and/or compacted lift thickness, and other relevant data for optimum achievement of the specified moisture-density (compaction) criteria for power block structural fill and for cooling basin/GBRA storage water reservoir embankment fill. Refer also to Subsection 2.5.5.4.3 regarding the requirement for a surveyed trial fill established in the early construction period at the cooling basin/GBRA storage water reservoir. The need for and/or details of a trial fill for power block structural fill is determined once the material source(s) is identified.

2.5.4.5.4 **Dewatering and Excavation Methods**

Groundwater control in major power block structure excavations is required during construction. The deepest excavation level (elevation +8 feet) extends approximately 40 feet below the existing groundwater level (approximately elevation +48 feet) (refer to Subsection 2.5.4.6.1), requiring a complete construction dewatering system. Power block groundwater conditions and construction dewatering requirements are addressed in more detail in Subsection 2.5.4.6.

Groundwater control in the cooling basin/GBRA storage water reservoir excavations is not required during construction. With the deepest excavation level (elevation +69 feet) approximately 30 feet above the highest existing groundwater level (approximately elevation +39 feet) (refer to Subsection 2.5.4.6.1), an extensive construction dewatering system is not required. If minor areas of overexcavation, especially at low-lying foundation areas along the alignment of the east dam of the GBRA storage water reservoir, encounter seasonally elevated groundwater, seepage is removed from the earthwork area by localized ditching and/or sumping.

Given the subsurface conditions of the VCS site, excavations in general are made using conventional earth-moving equipment, especially self-propelled scrapers with push dozers for loading, and excavators and dump trucks in the more confined areas and for final slope trimming. Note that scrapers are ideally loaded by pushing down a slight incline in the excavation surface. This practice makes separating horizontally bedded strata (e.g., like the interlayered clay soils and sand soils present at the VCS site) more challenging, requiring close monitoring onsite (refer to Subsection 2.5.4.5.1 for additional description).

Power block excavations are primarily open cuts, with limited temporary ground support, as described above. The cooling basin/GBRA storage water reservoir excavations are open cuts excavated directly to final line, grade, and slope.

Upon reaching final excavation levels (i.e., structure foundation subgrade, embankment dam foundation subgrade, or required over-excavation level), all excavations are cleaned of loose material by either removing or compacting in-place. Final subgrades are inspected and approved prior to being covered by compacted structural fill, common fill, embankment fill, or drainage sand. Inspection and approval procedures are addressed in the foundation and earthwork technical specifications developed during detailed design. These specifications include, among other things, measures such as: proof-rolling, over-excavation and replacement of unsuitable soils, and protection of surfaces from deterioration. Excavations additionally comply with applicable OSHA regulations (Reference 2.5.4-252).

Foundation subgrade rebound (or heave) is monitored in excavations for selected major power block structures. Subgrade rebound estimates are addressed in Subsection 2.5.4.10.

Major power block structures are monitored during and following construction for:

- Groundwater levels, both interior and exterior to temporary excavations
- Horizontal and vertical movement of temporary slopes
- Loads in temporary ground support anchorages and/or struts
- Earth pressures acting on underground structures
- Foundation settlement

Cooling basin/GBRA storage water reservoir embankment dams are monitored during and following construction for:

- Groundwater levels, especially outboard of the embankment dams following construction
- Pore water pressures occurring within embankment fills
- Embankment settlements

An instrumentation and monitoring technical specification is developed during detailed design. The specification addresses issues such as the proper installation of a sufficient number of instruments to measure the parameters of interest, monitoring and recording frequency, and reporting requirements. The specification also establishes alert, action, and alarm levels for each of the parameters of interest, together with predefined plans of action in the event a reference level is met or exceeded.

2.5.4.6 **Groundwater Conditions**

Groundwater data collection is currently in progress, following-on from the installation of multiple observation well pairs during the site-specific subsurface investigation. Refer to Subsection 2.4.12 for complete details on the existing groundwater conditions at the VCS site.

Refer to Subsection 2.5.4.10 for additional detail on groundwater conditions relative to the foundation stability of seismic Category I structures.

Refer to Subsection 2.5.5.1.6 for additional detail on groundwater conditions relative to the stability of cooling basin/GBRA storage water reservoir embankment dams.

2.5.4.6.1 **Site-Specific Groundwater Measurements**

Groundwater levels at the VCS site are measured at a series of 27 observation well pairs, installed as part of this subsurface investigation, each having an upper (U) screened interval and a lower (L) screened interval. There are six observation well pairs installed at the power block, five observation well pairs installed at the area outside the power block, and 16 observation well pairs installed at the cooling basin/GBRA storage water reservoir. Measured groundwater levels, generally from the period late January 2008 through mid-July 2008 (ongoing), are shown on Figure 2.5.4-286 for the power block, Figure 2.5.4-287 for the area outside the power block, and Figure 2.5.4-288 through 2.5.4-292 for the cooling basin/GBRA storage water reservoir. Note that some observation well pairs in the area outside the power block and in the cooling basin/GBRA storage water reservoir (i.e., B-01U/B-01L through

B-10U/B-10L) were installed/monitored earlier, with groundwater level measurements reported between late October 2007 and mid-July 2008 (ongoing).

A shallow groundwater level, primarily measured in the uppermost saturated sand stratum (Stratum Sand 2), generally overlies progressively deeper hydrostatic surfaces contained within the lower sand strata (especially Strata Sand 4, Sand 5, and Sand 6). Note that a higher elevation sand stratum, Stratum Sand 1, occurs in the unsaturated zone above the current groundwater level. Also, based on the available data, the flow of groundwater at the VCS site at present is generally downward through the site subsurface profile and from west to east, towards the low-lying Linn Lake area east of the cooling basin/GBRA storage water reservoir. For engineering purposes, the following current (i.e., before the conditions expected during operation) groundwater levels are selected:

- Power Block: elevation +48 feet
- Area Outside the Power Block: elevation +48 feet
- Basin/Reservoir (West): elevation +39 feet
- Basin/Reservoir (Central): elevation +32 feet
- Basin/Reservoir (East): elevation +28 feet
- Basin/Reservoir (Linn Lake Area): elevation +15 feet

These are based on the highest groundwater levels measured in the upper (U) screened intervals of the observation well pairs at each of the noted areas.

As described in Subsection 2.4.12, the normal maximum operating water level in the cooling basin/GBRA storage water reservoir following plant construction is elevation +91.5 feet. The effect of this contained water is a general rise in groundwater levels site-wide, including a rise to approximately elevation +85 feet at the power block (i.e., slightly above the level of the original ground surface at approximately elevation +80 feet). As such, the following post-construction groundwater elevations are defined:

- Power Block: elevation +85 feet (10 feet below finish grade)
- Area Outside the Power Block: elevation +80 feet (original ground surface)

- Basin/Reservoir: elevation +91.5 feet (normal maximum operating water level)

Foundations for major power block structures are within both the shallow and the deep water-bearing soils, and as such, both the shallow and deep preconstruction groundwater conditions can impact foundation subgrade stability during construction if not properly controlled. Loss of subgrade density, bearing capacity, and equipment trafficability can result.

Foundations for major cooling basin/GBRA storage water reservoir embankment dams are generally above both the shallow and the deep water-bearing soils, and as such, preconstruction groundwater conditions are unlikely to affect foundation subgrade stability during construction.

2.5.4.6.2 Construction-Stage Dewatering

Temporary dewatering at excavations for major power block structures is required for groundwater control during construction. A detailed analysis of groundwater conditions at the VCS site is described in Subsection 2.4.12. Based on the defined subsurface groundwater conditions, groundwater control/construction dewatering measures are needed at the VCS site for excavation of major power block structures. A construction-stage dewatering specification is developed during detailed design. Construction-stage dewatering likely includes both a system of deep wells and/or well-points to dewater water-bearing sand strata in advance of excavation, and a system of shallow drains and/or ditches to collect and direct minor seepage. Generally, groundwater levels are maintained a minimum of 3 feet below final excavation levels. Additionally, water-bearing sand strata below final excavation levels (e.g., especially Strata Sand 4, Sand 5, and Sand 6) that are overlain by more impermeable clay strata are depressurized to ensure the base stability of excavations. A construction-stage dewatering design and specification is developed during detailed design.

2.5.4.6.3 Analysis and Interpretation of Seepage

As noted above, a detailed analysis of groundwater conditions at the VCS site is described in Subsection 2.4.12. During detailed design, this data is analyzed to obtain estimates of seepage into major power block structure excavations, and to design/size construction dewatering system elements.

As described in Subsection 2.4.12, a complete groundwater model was prepared for the VCS site to evaluate post-construction groundwater levels resulting from the maximum water level in the cooling basin/GBRA storage water reservoir. The effect of this contained water is a general rise in groundwater levels site-wide. Overall seepage losses from the cooling basin/GBRA storage water reservoir are estimated from the groundwater model, as described in Subsection 2.4.12. Seepage losses through cooling basin/GBRA storage water reservoir dam embankments are estimated by flow net and are described in Subsection 2.5.5.1.6.

2.5.4.6.4 Permeability Testing

The hydraulic conductivities (permeabilities) of site soils were measured in situ by slug test, by borehole permeameter test, and by pump test, as described in Subsection 2.5.4.2.2.3.4. A detailed description of test methods and test results is included in Subsection 2.4.12. Summaries of hydraulic conductivity values calculated from in situ tests are provided in Tables 2.4.12-208 (slug test), 2.4.12-210 (borehole permeameter tests), and 2.4.12-207 (pump tests).

2.5.4.6.5 History of Groundwater Fluctuations

A detailed description of groundwater conditions at the VCS site is included in Subsection 2.4.12.

2.5.4.7 Response of Soil and Rock to Dynamic Loading

Detailed descriptions of the development of the Ground Motion Response Spectrum (GMRS) and the associated Probabilistic Seismic Hazard Assessment (PSHA), as well as the geologic characteristics of the site, are addressed in Subsection 2.5.2. Refer also to Subsection 2.5.4.4 for additional descriptions on site-specific geophysical methods and results.

2.5.4.7.1 Site Seismic History

The seismic history of the area and of the site, including any prior history of seismicity and any evidence of liquefaction or boiling, is addressed in Subsection 2.5.2.

2.5.4.7.2 P- and S-Wave Velocity Profiles

Because of the extreme thickness of sediments at the site (refer to Subsection 2.5.4.1) compared to the depth of compression and shear wave velocity measurements made during the subsurface investigation (i.e., to 600 feet depth), additional information is required to complete the velocity profile for the site for use in seismic ground response analyses. Velocities in the upper 600 feet are measured at the site, and velocities deeper than 600 feet are obtained from available references. Additional descriptions follows.

2.5.4.7.2.1 Seismic Velocities in the Upper Approximately 600 Feet of Site Soils

Geophysical measurements in the upper 600 feet of site soils were obtained by suspension P-S velocity logging methods, and by seismic CPT methods, as described in Subsection 2.5.4.4.1 and , respectively. Average shear wave velocity profiles for the upper 600 feet of site soils at the power block are shown on Figures 2.5.4-271 and 2.5.4-272. The average shear wave velocity profile for the upper 300 feet of site soils at the cooling basin/GBRA storage water reservoir is shown on Figure 2.5.4-274. Average shear wave velocities (V_S) are summarized in Tables 2.5.4-251 and 2.5.4-253 for the power block and for the cooling basin/GBRA storage water reservoir, respectively.

Suspension P-S velocity logging was performed in 17 dedicated borings (eight borings in the power block, two borings in the area outside the power block [B-2301 and B-2307], and seven borings in the cooling basin/GBRA storage water reservoir), with depths ranging from 200 feet to 600 feet, and at the locations shown on Figures 2.5.4-201 and 2.5.4-202. Shear wave velocities were also measured at 11 seismic CPTs (eight seismic CPTs in the power block [four each in Unit 1 and Unit 2]; and three seismic CPTs in the cooling basin/GBRA storage water reservoir), with depths ranging from 35 feet to 100 feet, and at the locations also shown on Figures 2.5.4-201 and 2.5.4-202. The suspension P-S logging data and the seismic CPT data are contained in Appendix 2.5.4-A.

In general, comparison of measured V_S results between the power block and the cooling basin/GBRA storage water reservoir indicate relatively consistent results, ignoring variations of about 100 feet per second, except in Strata Sand 4 and Clay 9, where greater differences of the order of 300 to 400 feet per second are noted. Note that comparison between the power block and the cooling basin/GBRA storage water reservoir is only for the upper approximately 300 feet of site soils, as the cooling basin/GBRA reservoir data (shown on Figures 2.5.4-270 and 2.5.4-274) only extend to that depth. The measured V_S results between

Unit 1 and Unit 2 at the power block are also similar, except at Stratum Sand 4 which has higher shear wave velocity at Unit 1. The Unit 2 area is also slightly more sandy.

The design/average shear wave velocity (V_s) and Poisson's ratio (μ) values are summarized in Subsection 2.5.4.4.4. Note that these design/average values are developed considering the variation in strata base elevations and thicknesses from boring to boring and from CPT to CPT.

2.5.4.7.2.2 Seismic Velocities Deeper than Approximately 600 Feet Below Existing Ground Surface

Refer to Subsection 2.5.4.1 for a brief description of geologic conditions at depths greater than 600 feet, a key point being that pre-Cretaceous bedrock (basement rock) occurs at a depth of approximately 41,000 feet below ground surface (Reference 2.5.4-202). Subsurface soils at the VCS site therefore extend well below the 600 feet maximum depth investigated by this subsurface investigation. Additional subsurface data, in the form of sonic logs performed for oil field exploration borings, was obtained to characterize conditions below this depth. Six sonic logs, taken at borings drilled within the vicinity of the VCS site (Figure 2.5.4-266), were collected, having sonic data ranging in depth from approximately 200 feet to approximately 16,000 feet.

Shear wave velocities are derived from the sonic log data using the relationship given in Subsection 2.5.4.2.1.5 (Equation 2.5.4-18). Refer to Figure 2.5.4-269 for calculated values versus elevation for each of the six sonic log locations. Average shear wave velocities are calculated across all six sonic logs, and generally considering 200-foot depth intervals. These average shear wave velocity values are presented in Table 2.5.4-252 and are plotted on Figure 2.5.4-274. This figure also includes profiles of average Vs values plus or minus one standard deviation. Note that shear wave velocities of soils deeper than 600 feet below ground surface increase in the range of approximately 2090 feet per second to 6000 feet per second.

2.5.4.7.3 **Static and Dynamic Laboratory Testing**

Extensive static laboratory testing of representative soil samples obtained from this subsurface investigation was conducted, with results described in detail in Subsection 2.5.4.2.1.

Dynamic laboratory RCTS tests obtain data on shear modulus degradation and damping characteristics of site soils over a wide range of strains, and were performed on samples recovered in this subsurface investigation. Sixteen undisturbed samples from depths of 18 to 593 feet, and two re-compacted fill samples (Composite "A"/Sand and Composite "B,"/Clay as described in Subsection 2.5.4.5.1), were assigned for RCTS testing. The results of these tests are described in Subsection 2.5.4.2.1.3.15 and briefly below in Subsections 2.5.4.7.3.1 and Subsections 2.5.4.7.3.2.

2.5.4.7.3.1 Selected Shear Modulus Degradation Curves for Soils

As described in Subsection 2.5.4.2.1.3.15, 16 RCTS tests were performed on undisturbed samples from cohesive Strata Clay 1 (Top), Clay 3, Clay 5 (Top), Clay 7, Clay 9, Clay 11, Clay 13, and Clay 17, and from cohesionless Strata Sand 4, Sand 5, Sand 6, Sand 8, Sand 10, Sand 12, Sand 14 and Sand 18. Each of these undisturbed samples is from the power block. Two RCTS tests were also performed on recompacted composite samples representative of embankment fill at the cooling basin/GBRA storage water reservoir (refer to Subsection 2.5.4.2.1.4.2).

In each RCTS test, values of shear modulus (G) measured at increasing strain levels are compared to the value of G_{max}, the shear modulus measured at 10^{-4}% shear strain. The shear modulus degradation (ratio of G/G_{max}) is plotted against shear strain, and a curve of G/G_{max} from the literature that best fits the test data is selected. Literature curves are used rather than an actual best-fit curve through the test data because the literature curves typically extend over a greater range of shear strain than the test data.

The following literature curves were employed:

- Curves recommended by the Electric Power Research Institute (EPRI) for cohesive soils having plasticity indices up to 70% (Reference 2.5.4-253)
- Curves recommended by Vucetic and Dobry for cohesive soils having plasticity indices up to 200% (Reference 2.5.4-254)
- Curves recommended by Brookhaven National Laboratory for cohesionless soils ("Peninsular" range curves) (Reference 2.5.4-255)

Tables 2.5.4-254 and 2.5.4-255 show the selected values of G/G_{max} versus shear strain for each stratum in the power block, and for the composite samples in the cooling basin/GBRA storage water reservoir, respectively. The modulus degradation curves (plots of G/G_{max} versus shear strain) from RCTS tests are presented on Figures 2.5.4-293 through 2.5.4-310. Test results are also tabulated in Tables 2.5.4-258 through 2.5.4-275.

Shear modulus degradation curves for cohesive Strata Clay 1(Top), Clay 3, Clay 5 (Top), Clay 7, Clay 9, Clay 11, Clay 13, and Clay 17 are best-fit literature curves (References 2.5.4-253 and 2.5.4-254). Shear modulus degradation curves for untested cohesive Strata Clay 1 (Bottom), Clay 5 (Bottom), and Clay 15 use shear modulus degradation curves for tested Strata Clay 1 (Top), Clay 5 (Top), and Clay 13, respectively, because of similarities in properties. Note that in all cases, VCS site clay strata have plasticity indices less than the plasticity indices associated with the best-fit curves to the RCTS test data taken from the literature. This may be due to the state of overconsolidation of site clay soils, or to the advanced geologic age of the materials.

Shear modulus degradation curves from RCTS tests on cohesionless Strata Sand 4, Sand 5, Sand 6, Sand 8, Sand 10, Sand 12, Sand 14, and Sand 18 are similarly best-fit to literature curves (Reference 2.5.4-255). Shear modulus degradation curves for untested cohesionless Strata Sand 2 and Sand 16 use shear modulus degradation curves from tested Strata Sand 4 and Sand 18, respectively, because of similarities in properties. Note that in all cases, the "Peninsular" range curve having depth greater than 50 feet is best-fit to all of the RCTS test data for VCS site sand strata. The shear modulus degradation curve for Stratum Sand 1 uses the slightly more conservative "Peninsular" range curve having depth less than 50 feet. The shear modulus degradation curve for structural fill (refer to Subsections 2.5.4.2.1.4.1, 2.5.4.4.1, and 2.5.4.5.1) uses the EPRI literature curve for a depth of 10 feet (Reference 2.5.4-253). Note that the large particle sizes of the gravel/sand structural fill preclude RCTS testing of this material.

Shear modulus degradation curves from RCTS tests on the cohesionless Composite "A"/Sand material and from the cohesive Composite "B"/Clay material (materials representative of fill materials for embankment dams) are similarly best fit to literature curves (Reference 2.5.4-253), as shown on Figures 2.5.4-309 and 2.5.4-310.

2.5.4.7.3.2 Selected Damping Curves for Soils

Each RCTS test also provides measured values of damping (D) at increasing shear strain levels. The same procedure used for shear modulus degradation (G/G_{max} versus shear strain) is employed to obtain a best-fit D versus shear strain curve from the literature. Tables 2.5.4-256 and 2.5.4-257 show the selected values of D versus shear strain for each stratum in the power block, and for the composite samples in the cooling basin/GBRA storage water reservoir (refer to Subsections 2.5.4.2.1.4.2 and 2.5.4.5.1), respectively. Plots of D versus shear strain for each RCTS test are presented on Figures 2.5.4-311 through 2.5.4-328. Test results are also tabulated in Tables 2.5.4-258 through 2.5.4-275. As above, note that the damping ratio curve for structural fill (refer to Subsection 2.5.4.5) uses the EPRI literature curve for a depth of 10 feet (Reference 2.5.4-253). Again, the large particle sizes of the gravel/sand structural fill preclude RCTS testing of this material.

Note that in the referenced figures and tables, damping ratios are provided at values exceeding 15%, although damping is frequently cut off at this value. For the purpose of seismic ground response analyses, damping is limited to 15%, and the portions of the referenced figures and tables above this value are not considered.

2.5.4.7.3.3 Shear Modulus and Damping for Rock

Refer to Subsection 2.5.4.1 for a brief description of geologic conditions at depths greater than 600 feet, a key point being that pre-Cretaceous bedrock (basement rock) occurs at a depth of approximately 41,000 feet below ground surface (Reference 2.5.4-202).

Refer also to Subsection 2.5.4.7.2.2 for a description of deep shear wave velocity profiles pertinent to the site and derived from sonic logging data.

It should be noted that hard rock is considered to have damping, but is not strain-dependent. For site-specific work, damping of 1% is adopted for bedrock, and bedrock shear modulus is considered to remain constant (i.e., no degradation), in the shear strain range of 10^{-4}% to 1%.

2.5.4.7.3.4 Dynamic Properties of Structural Fill

The reactor/fuel buildings and the control buildings require overexcavation and placement of structural fill below their foundations. Refer to Subsection 2.5.4.5.1 for structural fill requirements. Refer to Subsection 2.5.4.2.1.4.1 for recommended static and dynamic properties for structural fill. Refer to Subsection 2.5.4.7.3.1 and 2.5.4.7.3.2 for shear modulus degradation and damping relationships for structural fill.

2.5.4.7.4 **Small Strain Shear Modulus Estimation**

With shear wave velocity and other parameters established, small strain shear modulus values can be calculated from Equation 2.5.4-10. Note that shear wave velocity values for use in the equation are given in Tables 2.5.4-251 through 2.5.4-253, and unit weight values for use in the equation are given in Tables 2.5.4-232 and 2.5.4-233. Refer to Subsection 2.5.4.2 for a stratum-by-stratum description of the derivation of shear modulus (G) and other geotechnical engineering parameters for use in design.

2.5.4.7.5 **Seismic Parameters for Liquefaction Evaluation**

Using the site-specific soil column extended to ground surface, the amplification factor, and the performance-based hazard methodology employed to develop the GMRS (refer to Subsections 2.5.2.5 and 2.5.2.6), a peak horizontal ground surface acceleration of 0.10 times the acceleration of gravity (g) and a moment magnitude 7.6 characteristic earthquake are selected for use in liquefaction potential analysis. Refer in particular to Subsection 2.5.2, Table 2.5.2-225 titled *Controlling Magnitudes and Distances from Deaggregation,* describe the selection of the earthquake magnitude for use in liquefaction potential analysis.

2.5.4.8 **Liquefaction Evaluation**

The potential for soil liquefaction at the VCS site is evaluated following guidance given in RG 1.198 (Reference 2.5.4-256). Current state-of-the-art deterministic methods, outlined in Reference 2.5.4-206, are followed. The subsurface conditions and soil properties employed are those described in Subsection 2.5.4.2.1. A peak horizontal ground surface acceleration of 0.10g and a Moment Magnitude 7.6 characteristic earthquake are used, as described in Subsection 2.5.4.7.5.

As noted in Subsection 2.5.4.3, subsurface stratigraphy of the VCS site is shown in part on the subsurface profiles, Figures 2.5.4-205 through 2.5.4-212 (shown in plan on Figure 2.5.4-204) for the power block, and Figures 2.5.4-214 through 2.5.4-220 (shown in plan on Figure 2.5.4-213) for the cooling basin/GBRA storage water reservoir. As described in Subsection 2.5.1, the site soils, primarily Beaumont Formation and Lissie Formation deposits, are geologically old (Pleistocene age).

Conventionally, only younger deposits, especially Holocene age and Recent age deposits, are considered potentially liquefiable. To be complete and conservative, a comprehensive liquefaction analysis for all SPT, CPT, and shear wave velocity (V_s) data is made.

For the purpose of liquefaction analysis, as well as for general subsurface stratification, each individual boring and CPT made at the VCS site is divided according to the various subsurface strata detailed in Subsection 2.5.4.2.1. As such, the soils in the upper 600 feet of the site are evaluated for liquefaction using test results from the site-specific subsurface investigation. Soils deeper than 600 feet are geologically old and are nonliquefiable, as described further in Subsection 2.5.4.8.5.

2.5.4.8.1 **Liquefaction Evaluation Methodology**

Liquefaction is the transformation of a granular soil material from a solid to a liquefied state as a consequence of increased pore water pressure and reduced effective stress (Reference 2.5.4-256). Soil liquefaction occurrence (or lack thereof) depends on geologic age, state of soil saturation, density, gradation, plasticity, and earthquake intensity and duration. The liquefaction analysis presented here employs state-of-the-art deterministic methods (Reference 2.5.4-206).

In brief, the current state-of-the-art considers an evaluation of data from SPT, CPT, and shear wave velocity (V_s) measurements, with the SPT method being the most well-developed and well-recognized. Initially, a measure of the stress imparted to the soils by seismic ground motion, referred to as the cyclic stress ratio (CSR), is calculated. Then, a measure of the resistance of the soil to seismic ground motion, referred to as the cyclic resistance ratio (CRR), is calculated. Finally, a factor of safety (FOS) against liquefaction is calculated as the ratio of resisting stress, CRR, to driving stress, CSR. Details of the liquefaction methodology and the relationships for calculating CSR, CRR, FOS, and other intermediate parameters such as the stress reduction coefficient (r_d), the magnitude scaling factor (MSF), the K_σ correction factor accounting for liquefaction resistance with increasing confining pressure, the K_α correction factor accounting for sloping ground, and a number of other correction factors, can be found in Reference 2.5.4-206.

As noted in Subsection 2.5.4.6.1, groundwater levels selected as representative of the conditions at the time of the site-specific subsurface investigation (i.e. prior to the conditions expected during operation; at the time SPT, CPT, and V_s measurements are made) are:

- Power Block: elevation +48 feet
- Area Outside the Power Block: elevation +48 feet
- Basin/Reservoir (West): elevation +39 feet
- Basin/Reservoir (Central): elevation +32 feet
- Basin/Reservoir (East): elevation +28 feet
- Basin/Reservoir (Linn Lake Area): elevation +15 feet

These conditions are used in calculating basic soil parameters and "resisting-side" factors (i.e., CRR) in liquefaction analysis (Reference 2.5.4-206).

Also as noted in Subsection 2.5.4.6.1, the effect of the contained water in the cooling basin/GBRA storage water reservoir is a general rise in groundwater levels site-wide to approximately elevation +85 feet at the power block (i.e., slightly above the level of the original ground surface at approximately elevation +80 feet). As such, in the post-construction condition, all soils are conservatively assumed as fully saturated/buoyant (i.e., groundwater level at or above the ground surface of individual borings and CPTs). These conditions are used in calculating "driving-side" factors (i.e., CSR) in liquefaction analysis.

A review of the results of liquefaction potential analysis using the available SPT, CPT, and V_s data for the whole of the VCS site follows.

2.5.4.8.2 Factors of Safety Against Liquefaction Based on SPT Data

Uncorrected SPT N-values versus elevation are presented on Figures 2.5.4-221 through 2.5.4-224, 2.5.4-225, and 2.5.4-226 for the power block, the area outside the power block, and the cooling basin/GBRA storage water reservoir, respectively. Corrected SPT $(N_1)_{60}$-values versus elevation are similarly presented on Figures 2.5.4-227 through 2.5.4-230, 2.5.4-231, and 2.5.4-232 for the power block, the area outside the power block, and the cooling basin/GBRA storage water reservoir, respectively. SPT data for all 71 SPT borings made within the power block, all five SPT borings made within the area outside the power block, and all 47 SPT borings made within the cooling basin/GBRA storage water reservoir are evaluated for liquefaction potential. For completeness, all data points are included in the FOS calculation.

The equivalent clean sand $CRR_{7.5}$ value, based on the SPT clean sand equivalent $(N_1)_{60cs}$, is calculated following recommendations in Reference 2.5.4-206 (i.e., by step-wise proceeding from uncorrected SPT N-value, to normalized N_1, to hammer energy corrected $(N_1)_{60}$, to clean sand equivalent $(N_1)_{60cs}$, and then calculating $CRR_{7.5}$ based on $(N_1)_{60cs}$). Refer to Figure 2.5.4-329 for an example of this step-wise approach from uncorrected SPT N-value to clean sand equivalent $(N_1)_{60cs}$. Reference 2.5.4-206 notes that clean sands and/or clean sand equivalents, having $(N_1)_{60cs} \geq 30$ blows per foot, are considered too dense to liquefy, and are classified as nonliquefiable. At the power block and the area outside the power block, 1159 tests of 2505 total tests (including 156 tests in the area outside the power block), or approximately 46.3% of tests, have $(N_1)_{60cs} \geq 30$ blows per foot. At the cooling basin/GBRA storage water reservoir, 520 tests of 1171 total tests, or approximately 44.4% of tests, have $(N_1)_{60cs} \geq 30$ blows per foot.

2.5.4.8.2.1 Power Block

At the power block and the area outside the power block, of the 2505 SPT N-values, all but nine tests have FOS ≥1.10 (refer to Subsection 2.5.4.11 for a description of the selection of this minimum FOS). The nine tests having FOS <1.10 amount to 0.4% of all the tests evaluated: 99.6% of calculated FOS values by this method exceed 1.10. For completeness, an examination of each FOS <1.10 is provided in Table 2.5.4-276. From the table, four of the nine tests are within areas/depths excavated for structures, three of the nine tests are in areas with no structures, and one of the nine tests is made on fine-grained soil that is nonliquefiable.

Of the remaining test:

- This single test (boring B-2277; El. –55.4 feet; Stratum Sand 5; FOS = 0.98) occurs at the Unit 2 reactor/fuel building, which is a safety-related structure. Note, however, that the FOS calculated for a test in the same stratum immediately below this test is FOS = "nonliquefiable" (i.e., $(N_1)_{60cs} \geq 30$ blows per foot). As such, the test described here represents an isolated occurrence which does not present a risk to the safety-related reactor/fuel building structure.

Therefore, the low FOS values from the SPT method are not an issue with respect to the safety-related power block.

2.5.4.8.2.2 Cooling Basin/GBRA Storage Water Reservoir

At the cooling basin/GBRA storage water reservoir, of the 1171 SPT N-values, all but 17 tests have FOS ≥ 1.10. The 17 tests having FOS <1.10 amount to 0.5% of all the tests evaluated: 99.5% of calculated FOS values by this method exceed 1.10. For completeness, an examination of each FOS < 1.10 is provided in Table 2.5.4-277. From the table, six of the 17 tests are within areas/depths excavated for mass earthwork, three of the 17 tests are interior or exterior to the basin/reservoir with no structure, and five of the 17 tests are made on fine-grained soils that are nonliquefiable.

Of the remaining three of the total 17 tests:

- One test (boring B-2336; elevation +57.0 feet; Stratum Sand 1; FOS = 0.97) occurs at the east embankment dam of the GBRA storage water reservoir. Note, however, that FOS values calculated for tests in the same stratum immediately above and below this test are FOS = 1.18 and FOS = 2.30, respectively. As such, the test described here represents an isolated occurrence.
- One test (boring B-2337; elevation +8.7 feet; Stratum Sand 4; FOS = 0.93) occurs at the east embankment dam of the cooling basin. Note, however, that the FOS value calculated for the test in the same stratum immediately below this test is FOS = 2.14. As such, the test described here represents an isolated occurrence.
- One test (boring B-2351; elevation +60.1 feet; Stratum Sand 1; FOS = 1.01) occurs at the south embankment dam of the cooling basin. Note, however, that the FOS value calculated for the test in the same stratum immediately below this test is FOS = 1.54. As such, the test described here represents an isolated occurrence.

Therefore, the low FOS values from the SPT method are not an issue with respect to the nonsafety-related cooling basin/GBRA storage water reservoir.

2.5.4.8.3 Factors of Safety Against Liquefaction Based on Cone Penetration Test Data

CPT testing at the VCS site included the recording of both commonly-measured cone parameters (e.g., cone tip resistance [q_c], friction sleeve resistance [f_s], and pore pressure), and less-frequently-measured shear wave velocity (V_s). The evaluation of liquefaction potential based on commonly measured cone parameters is addressed here. The evaluation of liquefaction potential based on shear wave velocity (V_s) is addressed in Subsection 2.5.4.8.4.

Corrected CPT tip resistance (q_t) profiles versus elevation are presented on Figures 2.5.4-233 and 2.5.4-234, 2.5.4-235, and 2.5.4-236 for the power block, the area outside the power block, and the cooling basin/GBRA storage water reservoir, respectively. Normalized CPT q_{c1n} profiles versus elevation are similarly presented on Figures 2.5.4-237, 2.5.4-238, 2.5.4-239, and 2.5.4-240 for the power block, the area outside the power block, and the cooling basin/GBRA storage water reservoir, respectively. CPT data for all 28 CPTs made within the power block, one CPT made within the area outside the power block, and all 27 CPTs made within the cooling basin/GBRA storage water reservoir are evaluated for liquefaction potential. For completeness, all data points are included in the FOS calculation.

The equivalent clean sand $CRR_{7.5}$ value, based on the CPT clean sand equivalent $(q_{c1n})_{cs}$, is calculated following recommendations in Reference 2.5.4-206 (i.e., by step-wise proceeding from uncorrected CPT q_c, to corrected q_t, to normalized q_{c1n}, to clean sand equivalent $(q_{c1n})_{cs}$, and then calculating $CRR_{7.5}$ based on $(q_{c1n})_{cs}$). Refer to Figure 2.5.4-330 for an example of this stepwise approach from uncorrected CPT q_c to clean sand equivalent $(q_{c1n})_{cs}$. Reference 2.5.4-206 notes that clean sands and/or clean sand equivalents, having $(q_{c1n})_{cs}$ ≥160 (dimensionless), are considered too dense to liquefy and are classified as nonliquefiable. At the power block and the area outside the power block, 1383 tests of 5367 total tests (including 193 tests in the area outside the power block), or approximately 25.7% of tests, have $(q_{c1n})_{cs}$ ≥160. At the cooling basin/GBRA storage water reservoir, 1463 tests of 3629 total tests, or approximately 40.3% of tests, have $(q_{c1n})_{cs}$ ≥160. Reference 2.5.4-206 also notes that soils, having soil behavior type index I_c ≥2.60, under certain conditions, are considered too clay rich to liquefy, and are also classified as nonliquefiable. At the power block and the area outside the power block, 3096 tests of 5367 total tests (including 193 tests in the area outside the power block), or approximately 57.7% of tests, have I_c ≥2.60.

At the cooling basin/GBRA storage water reservoir, 1185 tests of 3629 total tests, or approximately 32.7% of tests, have $I_c \geq 2.60$.

2.5.4.8.3.1 Power Block

At the power block and the area outside the power block, of the 5367 CPT values measured, all but 99 tests have FOS ≥1.10. The 99 tests having FOS <1.10 amount to 1.8% of all the tests evaluated: 98.2% of calculated FOS values by this method exceed 1.10. For completeness, an examination of each FOS <1.10 is provided in Table 2.5.4-278. From the table, 50 of the 99 tests are within areas/depths excavated for structures and 49 of the 99 tests are made on fine-grained soils that are nonliquefiable.

Therefore, the low FOS values from the CPT method are not an issue with respect to the safety-related power block.

2.5.4.8.3.2 Cooling Basin/GBRA Storage Water Reservoir

At the cooling basin/GBRA storage water reservoir, of the 3629 CPT values measured, all but 127 tests have FOS ≥1.10. The 127 tests having FOS <1.10 amount to 3.5% of all the tests evaluated; 96.5% of calculated FOS values by this method exceed 1.10. For completeness, an examination of each FOS <1.10 is provided in Table 2.5.4-279. From the table, 41 of the 127 tests are within areas/depths excavated for mass earthwork, 23 of the 127 tests are interior or exterior to the basin/reservoir with no structure, and 42 of the 127 tests are made on fine-grained soils that are nonliquefiable.

Of the remaining 21 of the total 127 tests:

- One test (CPT C-2301S; elevation +67.83 feet; Stratum Sand 1; FOS = 0.98) occurs at the north embankment dam of the cooling basin. Note, however, that the FOS value calculated for the test in the same stratum immediately below this test is FOS = 1.19. As such, the test described here represents an isolated occurrence.
- Nine tests (C-2308; elevation +58.02 feet to elevation +52.77 feet; Stratum Sand 1; FOS = 0.53 to 1.09) occur at the east embankment dam of the GBRA storage water reservoir. Note that the material here (uppermost 5.25 feet of soil below ground surface) is removed or recompacted as a matter of embankment dam foundation preparation.

- One test (C-2308; elevation –6.23 feet; Stratum Sand 4; FOS = 1.09) occurs at the east embankment dam of the GBRA storage water reservoir. Note, however, that the FOS values calculated for the tests in the same stratum immediately above and below this test are FOS = 1.60 and FOS = 1.14, respectively. As such, the test described here represents an isolated occurrence.
- Five tests (C-2312; elevation +52.74 feet to elevation +50.74 feet; Stratum Sand 1; FOS = 0.89 to 1.01) occur at the west embankment dam of the cooling basin. Note, however, that the FOS values calculated for the tests in the same stratum immediately above and below these tests are FOS = 1.11 and FOS = 1.23, respectively. As such, the tests described here represent an isolated occurrence.
- One test (C-2321S; elevation +54.05 feet; Stratum Sand 1; FOS = 0.99) occurs at the south embankment dam of the cooling basin. Note, however, that the FOS value calculated for the test in the same stratum immediately below this test is FOS = 2.45. As such, the test described here represents an isolated occurrence.
- Two tests (C-2321S; elevation +47.55 feet to elevation +46.05 feet; Stratum Sand 1; FOS = 1.03 to 1.08) occur at the south embankment dam of the cooling basin. Note, however, that the FOS values calculated for the tests in the same stratum immediately above and below these tests are FOS = “nonliquefiable” (i.e., $(q_{c1n})_{cs} \geq 160$) and FOS = 4.72, respectively. As such, the tests described here represent an isolated occurrence.
- One test (C-2322; elevation +18.56 feet; Stratum Sand 5; FOS = 0.95) occurs at the south embankment dam of the cooling basin. Note, however, that the FOS value calculated for the test in the same stratum immediately below this test is FOS = 1.28. As such, the test described here represents an isolated occurrence.
- One test (C-2323S; elevation +53.92 feet; Stratum Sand 1; FOS = 0.92) occurs at the south embankment dam of the cooling basin. Note, however, that the FOS value calculated for the test in the same stratum immediately below this test is FOS = 1.77. As such, the test described here represents an isolated occurrence.

Therefore, the low FOS values from the CPT method are not an issue with respect to the nonsafety-related cooling basin/GBRA storage water reservoir.

2.5.4.8.4 Factors of Safety Against Liquefaction Based on S-Wave Velocity Data

Shear wave velocity (V_s) data for all eight suspension P-S velocity logging borings and all eight seismic CPTs made within the power block, both suspension P-S velocity logging borings made within the area outside the power block, and all seven suspension P-S velocity logging borings and all three seismic CPTs made within the cooling basin/GBRA storage water reservoir is evaluated for liquefaction potential. For completeness, all data points are included in the FOS calculation.

The equivalent clean sand $CRR_{7.5}$ value, based on the normalized V_{s1}, is calculated following recommendations in Reference 2.5.4-206 (i.e., by step-wise proceeding from uncorrected V_s, to normalized V_{s1}, and then calculating $CRR_{7.5}$ based on the threshold value of V_{s1}*). Note that the threshold value of V_{s1}* depends on fines content, and varies linearly from 215 meters per second for soils having fines content of ≤5%, to 200 meters per second for soils having fines contents of 35%. Reference 2.5.4-206 notes that soils having $V_{s1} \geq V_s$* are considered too dense to liquefy and are classified as nonliquefiable. At the power block and the area outside the power block, 1683 tests of 3385 total tests (including 356 tests in the area outside the power block), or approximately 49.7% of tests, have $V_{s1} \geq V_{s1}$*. At the cooling basin/GBRA storage water reservoir, 1017 tests of 1236 total tests, or approximately 82.2% of tests, have $V_{s1} \geq V_{s1}$*.

2.5.4.8.4.1 Power Block

At the power block and the area outside of the power block, of the 2149 V_s values, all but 109 tests have FOS ≥1.10. The 109 tests having FOS <1.10 amount to 5.0% of all the tests evaluated; 95.0% of calculated FOS values by this method exceed 1.10. For completeness, an examination of each FOS <1.10 is provided in Table 2.5.4-280. From the table, 38 of the 109 tests are within areas/depths excavated for structures and 63 of the 109 tests are made on fine-grained soils that are nonliquefiable.

Of the remaining eight of the total 109 tests:

- One test (C-2102S; elevation -9.6 feet; Stratum Sand 4; FOS = 0.86) occurs at the Unit 1 turbine building, which is not a safety-related structure. Note also that FOS values calculated by the SPT method for borings surrounding this CPT at a similar depth interval are: FOS = 1.96 (boring B-2150 at elevation –8.1 feet), FOS = 2.76 (boring B-2151 at elevation –9.1 feet), FOS = 1.81 (boring B-2155 at elevation –8.1 feet), and FOS = 1.67 (boring B-2156 at elevation –9.8 feet). As such, the test described here represents an isolated occurrence.

- Five tests (B-2262A Offset; elevation –81.8 feet to elevation –88.4 feet; Stratum Sand 6; FOS = 0.29 to 0.94) occur at the Unit 2 turbine building, which is not a safety-related structure. Note also that FOS values calculated by the SPT method for the same boring/similar depth interval are: FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) at elevation –78.1 feet and FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) at elevation –88.1 feet. As such, the tests described here represent an isolated occurrence.
- Two tests (boring B-2274A Offset; elevation –82.1 feet to elevation –83.7 feet; Stratum Sand 6; FOS = 0.68 to 0.81) occur at the Unit 2 reactor/fuel building, which is a safety-related structure. Note also that FOS values calculated by the SPT method for the same boring/similar depth interval are FOS = 1.87 at elevation –80.7 feet and FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) at elevation –90.7 feet. As such, the tests described here represent an isolated occurrence.

Therefore, the low FOS values from the shear wave velocity method are not an issue with respect to the safety-related power block.

2.5.4.8.4.2 Cooling Basin/GBRA Storage Water Reservoir

At the cooling basin/GBRA storage water reservoir, of the 1236 V_s values, all but 31 tests have FOS ≥1.10. The 31 tests having FOS <1.10 amount to 2.5% of all the tests evaluated; 97.5% of calculated FOS values by this method exceed 1.10. For completeness, an examination of each FOS <1.10 is provided in Table 2.5.4-281. From the table, one of the 31 tests is within an area/depth excavated for mass earthwork, three of the 31 tests are interior or exterior to the basin/reservoir with no structure, and 21 of the 31 tests are made on fine-grained soils that are nonliquefiable.

Of the remaining six of the total 31 tests:

- Two tests (B-2302; elevation +17.3 feet to elevation +16.0 feet; Stratum Sand 2; FOS = 0.55 to 1.09) occur at the west embankment dam of the cooling basin. Note also that the FOS value calculated by the SPT method for the same boring/similar depth interval is FOS =

“nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) at elevation +16.8 feet. As such, the tests described here represent an isolated occurrence.

- One test (B-2303; elevation -108.2 feet; Stratum Sand 6; FOS = 0.97) occurs at the west embankment dam of the cooling basin. Note also that FOS values by the SPT method calculated for the same boring/similar depth interval are: FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) at elevation -103.1 feet and FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) at elevation -113.1 feet. As such, the test described here represents an isolated occurrence.
- One test (C-2301S; elevation +67.8 feet; Stratum Sand 1; FOS = 0.42) occurs at the north embankment dam of the cooling basin. Note also that the FOS values calculated by the SPT method for borings adjoining this CPT at a similar depth interval are: FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) (boring B-2302A at elevation +66.8 feet) and FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) (boring B-2317 at elevation +57.2 feet). As such, the test described here represents an isolated occurrence.
- One test (C-2303S; elevation +65.3 feet; Stratum Sand 1; FOS = 0.26) occurs at the north embankment dam of the GBRA storage water reservoir. Note also that the FOS values calculated for borings adjoining this CPT at a similar depth interval are: FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) (boring B-06 at elevation +60.3 feet); and FOS = “nonliquefiable” (i.e., $(N_1)_{60cs}$ ≥30 blows per foot) (boring B-2359 at elevation +57.8 feet). As such, the test described here represents an isolated occurrence.
- One test (C-2323S; elevation +54.2 feet; Stratum Sand 1; FOS = 0.58) occurs at the south embankment dam of the GBRA storage water reservoir. Note also that the FOS value calculated for the boring adjoining this CPT at a similar depth interval is FOS = 1.28 (boring B-2357 at elevation +54.4 feet). As such, the test described here represents an isolated occurrence.

Therefore, the low FOS values from the shear wave velocity method are not an issue with respect to the nonsafety-related cooling basin/GBRA storage water reservoir.

2.5.4.8.5 Liquefaction Resistance of Soils Deeper than Approximately 600 Feet Below Existing Ground Surface

The liquefaction evaluation described above focuses on VCS site soils in the upper 600 feet investigated. Site soils, however, are much deeper, with the Pleistocene Beaumont Formation extending to depths of approximately 400 feet below ground surface, underlain by the older Lissie Formation. The top depth of pre-Cretaceous bedrock ("basement rock") estimated at approximately 41,000 feet below ground surface (Reference 2.5.4-202). Refer to Subsection 2.5.4.1 for a brief description of geologic conditions at depths greater than 600 feet.

Geologic information on soils below 600 feet is gathered from the available literature. Note that even the uppermost soils, including the Beaumont and Lissie Formations, are geologically old (at approximately 100,000 to 24 million years for Pleistocene, Pliocene, and Miocene deposits). Liquefaction resistance increases markedly with geologic age, with Pleistocene soils having more resistance than Holocene age and Recent age soils, and pre-Pleistocene soils being generally immune to liquefaction (Reference 2.5.4-206). On this basis, deeper VCS site soils are geologically too old to be prone to liquefaction. Additionally, the degree of compaction and strength of deeper VCS site soils likely increase with depth, compared to the overlying soils which are analyzed, leading to higher liquefaction resistance. Finally, liquefaction analysis by the shear wave velocity method for soils at the maximum 600 feet depth investigated (V_s values of approximately 1995 feet per second being an average for the deepest investigated soil stratum, Stratum Sand 18) does not indicate the potential for liquefaction, with calculated FOS values = "nonliquefiable" (i.e., $V_{s1} > V_{s1}^*$). With shear wave velocities of soils deeper that 600 feet below ground surface increasing in the range of approximately 2090 feet per second to 6000 feet per second, as noted in Subsection 2.5.4.7.2.2, even higher liquefaction resistance is expected from these deeper soils. Considering the above three cases, liquefaction of VCS site soils below a depth of 600 feet below ground surface is not considered possible.

2.5.4.8.6 Concluding Remarks

A liquefaction analysis is performed using the state-of-the-art deterministic methods outlined in References 2.5.4-206. At the safety-related power block: a total of 2505 SPT data points are analyzed from 76 borings, of which 99.6% of the calculated FOS values exceed

1.10; a total of 5367 CPT data points are analyzed from 29 CPTs, of which 98.2% of the calculated FOS values exceed 1.10; and a total of 2149 V_s data points are analyzed from 10 suspension P-S velocity logging borings and eight seismic CPTs, of which 95.0% of the calculated FOS values exceed 1.10. At the nonsafety-related cooling basin/GBRA storage water reservoir: a total of 1171 SPT data points are analyzed from 47 borings, of which 99.5% of the calculated FOS values exceed 1.10; a total of 3629 CPT data points are analyzed from 27 CPTs, of which 96.5% of the calculated FOS values exceed 1.10; and a total of 1236 V_s data points are analyzed from seven suspension P-S velocity logging borings and three seismic CPTs, of which 97.5% of the calculated FOS values exceed 1.10. A detailed examination of the SPT, CPT, and V_s data points analyzed having FOS <1.10, reveals that the affected soils are not an issue with respect to the safety of the VCS site.

It is also evident from the collected subsurface investigation results and from a review of the geologic literature that VCS site soils are overconsolidated and are geologically old with respect to conventional liquefaction analysis. Moreover, the state-of-the-art methodology used for this liquefaction analysis is intended to be conservative and is not required to encompass every data point; therefore, the presence of a few data points beyond the CRR base curves is acceptable (Reference 2.5.4-206).

2.5.4.8.7 **Consultation with Regulatory Guide 1.198**

RG 1.198 (Reference 2.5.4-256) was consulted as part of this evaluation. The liquefaction evaluation presented here conforms closely to the referenced guidelines.

Under *Screening Techniques for Evaluation of Liquefaction Potential*, RG 1.198 (Reference 2.5.4-256) lists the most commonly observed liquefiable soils as fluvial-alluvial deposits, eolian sands and silts, beach sands, reclaimed land, and uncompacted hydraulic fills. The geology of the VCS site includes fluvial-alluvial soils, and the liquefaction analysis documented here includes all VCS site soils investigated. In the same section, RG 1.198 (Reference 2.5.4-256) indicates that clay to silt, silty clay to clayey sand, or silty gravel to clayey gravel soils can be considered potentially liquefiable, and the liquefaction analysis documented here treats all VCS site soils as potentially liquefiable, including the fine-grained soils. Note, however, that the finer-grained VCS site soils contain large percentages of fines, generally greatly exceeding soils that are conventionally evaluated according to the state-of-the-art method, and/or are highly plastic, and are generally considered nonliquefiable.

Additionally, in the liquefaction analysis documented here, and as noted in Subsection 2.5.4.6.1, groundwater levels selected as representative of the conditions at the time of the site-specific subsurface investigation (i.e. prior to the conditions expected during operation; at the time SPT, CPT, and Vs measurements are made) are:

- Power Block: elevation +48 feet
- Area Outside the Power Block: elevation +48 feet
- Basin/Reservoir (West): elevation +39 feet
- Basin/Reservoir (Central): elevation +32 feet
- Basin/Reservoir (East): elevation +28 feet
- Basin/Reservoir (Linn Lake Area): elevation +15 feet

These conditions are used in calculating basic soil parameters and "resisting-side" factors (i.e., CRR) in liquefaction analysis (Reference 2.5.4-206).

Also as noted in Subsection 2.5.4.6.1, the effect of the contained water in the cooling basin/GBRA storage water reservoir is a general rise in groundwater levels site-wide, including to approximately elevation +85 feet at the power block (i.e., slightly above the level of the original ground surface at approximately elevation +80 feet). As such, in the post-construction condition, all soils are assumed fully saturated/buoyant (i.e., groundwater level at or above the ground surface of individual borings and CPTs). These conditions are used in calculating "driving-side" factors (i.e., CSR) in liquefaction analysis. Despite these selected higher groundwater levels, the calculated FOS values against liquefaction overwhelmingly exceed 1.10.

Similarly, RG 1.198 (Reference 2.5.4-256) indicates that potentially liquefiable soils may not pose a liquefaction risk to the facility if they are insufficiently thick and/or of limited lateral extent. For the safety-related power block, the separately described SPT tests (one of nine tests), CPT tests (zero of 99 tests), and Vs tests (eight of 109 tests) having FOS <1.10 are all of limited thickness and/or lateral extent. Similarly, for the nonsafety-related cooling basin/GBRA storage water reservoir, the separately described SPT tests (three of 17 tests), CPT tests (21 of 127 tests), and Vs tests (six of 31 tests) having FOS <1.10 are also all of limited thickness and/or lateral extent.

Finally, under *Procedures for Evaluating Liquefaction Potential,* RG 1.198 (Reference 2.5.4-256) lists CPT, SPT, cyclic triaxial, and shear wave velocity tests as acceptable methods. All referenced methods, excepting cyclic triaxial tests (which are not performed, and which given the results of this liquefaction analysis, are not warranted), are employed in analyzing the VCS site soils.

2.5.4.9 Earthquake Site Characteristics

Refer to Subsection 2.5.2.6 for details on development of the site-specific GMRS.

2.5.4.10 Static Stability

As noted above, finish grade at the power block is approximately elevation +95 feet. Also as noted, the reactor/fuel buildings, control buildings, and fire water service complexes (FWSC) are all Seismic Category I structures. This subsection addresses the stability of foundation soils for these structures, the locations of which are shown on Figure 2.5.4-201. Other major structures, including the turbine buildings, the radwaste buildings, and the service buildings, are not seismic Category I structures, and are not evaluated further.

2.5.4.10.1 Foundations, Subsurface Conditions, and Soil Properties

VCS site Seismic Category I structures, their approximate foundation dimensions, foundation elevations, and static foundation pressures are indicated in the following table.

Structure	Approximate Foundation Dimensions (feet)	Approximate Foundation El. (feet)[a]	Gross Foundation Pressure (ksf)[b]	Net Foundation Pressure (ksf)[c]
Reactor/Fuel Buildings (Units 1 and 2)	161 by 230	+29.4 {+8.0}	14.6	11.1
Control Buildings (Units 1 and 2)	78 by 99	+46.1 {+25.0}	6.1	3.7
Fire Water Service Complexes (Units 1 and 2)[d]	66 by 171	+87.3	3.5	3.5

a. Foundation elevations designations shown in "{ }" symbols denote the elevations at the base of significant overexcavation (to reach a suitable bearing stratum) at the particular structure (e.g., at the reactor/fuel buildings [Units 1 and 2], in situ soils are overexcavated approximately 21 feet below the underside of foundations, with overexcavation replaced by structural fill; and at the control buildings [Units 1 and 2], in situ soils are overexcavated approximately 21 feet below the underside of foundations, with overexcavation replaced by structural fill.

b. Reference 2.5.4-251.

c. Net foundation pressure is the gross foundation pressure minus buoyancy, with the groundwater level at elevation +85 feet (i.e., the post-construction groundwater level).

d. Fire Water Service Complexes (Units 1 and 2) bear on approximately 7.3 feet of structural fill over in situ soils (natural ground surface at elevation +80 feet before raising power block to finish grade).

Power block subsurface conditions are described in detail in Subsection 2.5.4.2. Geotechnical engineering parameters selected for design for each of the various soil strata occurring at the site are similarly described in Subsection 2.5.4.2, and are summarized in Table 2.5.4-232. The parameters contained in this table are used as the bases for foundation analyses presented here.

For foundation analysis purposes, the specific subsurface conditions/profiles associated with each of the seismic Category I structures for both Unit 1 and Unit 2 are developed as shown on Figures 2.5.4-331 through 2.5.4-333. Associated strata depths and elevations for each of these structure-specific conditions/profiles are shown in Tables 2.5.4-282, 2.5.4-284, and 2.5.4-286. Below elevation –120 feet, strata boundary and soil property information are taken from the deeper borings (Borings B-2169, B-2173, B-2174A, B-2182A, B-2269, B-2273, B-2274A, B-2282A). Because different soil strata at times occur at the same elevation range below a particular foundation, two soil conditions/profiles are developed for calculation purposes. These are labeled "Clay Preferred" and "Sand Preferred." For soil conditions/profiles with the label "Clay Preferred," the clay stratum below the respective foundation and its characteristic undrained shear strength, s_u, represent the elevation range containing the two soil types. Similarly, for soil conditions/profiles with the label "Sand Preferred," the sand stratum below the respective foundation and its characteristic friction angle, Φ', represent the elevation range containing the two soil types. The selected clay stratum or sand stratum selected is indicated in Tables 2.5.4-282, 2.5.4-284, and 2.5.4-286. As can be seen from these tables, the "Clay Preferred" and "Sand Preferred" conditions/profiles are mostly the same or very similar given the relative uniformity of subsurface conditions at each of the structures. The two soil conditions/profiles generated through this selection process are used for calculation of structure bearing capacity and settlement.

As noted in Subsection 2.5.4.6.1, based on groundwater observation well measurements, the current (pre-construction) groundwater level at the power block is approximately elevation +48 feet, while the post-construction groundwater level at the power block is elevation +85 feet. This rise in groundwater level is a result of the contained water (to approximately elevation +91.5 feet) in the cooling basin/GBRA storage water reservoir. This latter groundwater level is used in foundation analyses.

2.5.4.10.2 Bearing Capacity Evaluations

The ultimate bearing capacity, q_{ult}, of a foundation is calculated using (Reference 2.5.4-257):

$$q_{ult} = c\, N_c\, \zeta_c + q\, N_q\, \zeta_q + 0.5\, \gamma'\, B\, N_\gamma\, \zeta_\gamma \qquad \text{Equation 2.5.4-20}$$

where, c = undrained shear strength of the soil (s_u)
q = effective overburden pressure at the foundation base
γ' = effective unit weight of the soil
B = foundation width
N_c, N_q, and N_γ are bearing capacity factors
ζ_c, ζ_q, and ζ_γ are shape factors

For rectangular foundations, the shape factors are given (Reference 2.5.4-257) as:

$$\zeta_c = 1 + (B/L)\,(N_q/N_c) \qquad \text{Equation 2.5.4-21}$$

$$\zeta_q = 1 + (B/L)\tan(\phi) \qquad \text{Equation 2.5.4-22}$$

$$\zeta_\gamma = 1 - 0.4\,(B/L) \qquad \text{Equation 2.5.4-23}$$

where, B = foundation width
L = foundation length
ϕ = friction angle of the soil

For square or circular foundations, the shape factors are given (Reference 2.5.4-257) as:

$$\zeta_c = 1 + (N_q/N_c) \qquad \text{Equation 2.5.4-24}$$

$$\zeta_q = 1 + \tan(\phi) \qquad \text{Equation 2.5.4-25}$$

$$\zeta_\gamma = 0.6 \qquad \text{Equation 2.5.4-26}$$

The allowable bearing capacity, q_a, is:

$q_a = q_{ult}/FOS$ Equation 2.5.4-27

where, FOS=the factor of safety

The above bearing capacity formulation is based assuming that the soil material within the zone of foundation deformation is uniform in terms of shear strength properties. VCS site soils, however, are inter-layered clay strata and sand strata, and as such, this interlayering of the subsurface needs to be considered in the evaluation of foundation bearing capacities. The issue of an interlayered subsurface profile is addressed by several investigators. A simplified but reasonable approach accommodates interlayering by averaging the shear strength parameters in the foundation deformation zone, as proposed in Reference 2.5.4-258 and 2.5.4-220, and uses the formulation in Reference 2.5.4-257 (Equations 2.5.4-20 through 2.5.4-27). This approach is followed for estimating foundation bearing capacities, as described below.

Figure 2.5.4-334 shows the typical wedge failure developed below a foundation, with the effective shear depth (i.e., the height of the failure wedge) as *H'*. Reference 2.5.4-220 recommends using the weighted average of cohesion (undrained shear strength), *c* (s_u), and friction angle, ϕ, as follows:

$$c = \frac{\sum c_i H_i}{\sum H_i}$$ Equation 2.5.4-28

$$\tan(\phi) = \frac{\sum \tan(\phi_i) H_i}{\sum H_i}$$ Equation 2.5.4-29

where, c_i = cohesion (undrained shear strength) of layer *i*

ϕ_i =friction angle of layer *i*

H_i = thickness of layer *i* within the effective shear depth *H'*

Equations 2.5.4-28 and 2.5.4-29 are used to derive the average shear strength properties of soils below the foundation of each seismic Category I structure. The average material properties derived for each foundation are shown in Tables 2.5.4-283, 2.5.4-285, and 2.5.4-287. Note that 21.4 feet and 21.1 feet of structural fill immediately below the bases of the reactor/fuel buildings and the control buildings, respectively, are accounted for in these tables. These depths of in situ soils are required to be removed and replaced with structural fill (thickness determined by a trial and error approach) to obtain adequate bearing capacity.

Foundation bearing capacities are estimated using the average material properties in Tables 2.5.4-283, Tables 2.5.4-285, and 2.5.4-287 and Equations 2.5.4-20 through 2.5.4-27. A summary of the allowable and ultimate bearing capacities of Seismic Category I structures is given in Table 2.5.4-288. Analysis results show that at all Seismic Category I structures, the allowable bearing capacities (using FOS = 3.0) and ultimate bearing capacities are higher than the required static design loads and dynamic design loads, respectively, specified for soft soils in Reference 2.5.4-251.

To demonstrate the effects of groundwater table on bearing capacity, Figures 2.5.4-335 and 2.5.4-336 present calculated bearing capacities (allowable and ultimate) at different groundwater levels for the reactor/fuel buildings and for the control buildings, respectively, as well as the corresponding required design load and effective design load (the effective design load is equal to the design load minus the buoyancy of the particular structure). Assuming a groundwater level varying from the base of foundation up to the post-construction level (elevation +85 feet), this comparison shows that the allowable bearing capacities are maintained higher than the static design loads for all groundwater levels considered, and the ultimate bearing capacities are also maintained higher than the dynamic design loads for all groundwater levels considered. As such, the bearing capacities of Seismic Category I structures satisfy design requirements, even considering a groundwater level varying over a wide range.

2.5.4.10.3 **Settlement Evaluations**

Foundation settlements are estimated using pseudo-elastic compression and one-dimensional consolidation. Based on a stress-strain model that computes settlement in discrete layers, the settlement, δ, of shallow foundations due to elastic compression of subsurface materials is estimated as:

$$\delta = \Sigma\,(\Delta p_i\ h_i)/E_i \qquad \text{Equation 2.5.4-30}$$

where, δ= settlement

i = 1 to n, where n is the number of layers

p_i = vertical applied pressure at the center of layer i

h_i = thickness of layer i

E_i = elastic modulus of layer *i*

The stress distribution below the corner of a rectangular flexible foundation is based on a Boussinesq-type distribution, as presented in Reference 2.5.4-259:

$$\sigma_z = (p/2\pi)\ \{\tan^{-1} [l\ b/(z\ R_3)] + (l\ b\ z/R_3)(1/R_1^2 + 1/R_2^2)\}$$

Equation 2.5.4-31

where, σ_z = calculated pressure below the corner at depth z

p = applied foundation pressure

l = length of the foundation

b = width of the foundation

z = depth below the foundation at which the pressure is calculated

$R_1 = (l^2 + z^2)^{0.5}$

$R_2 = (b^2 + z^2)^{0.5}$

$R_3 = (l^2 + b^2 + z^2)^{0.5}$

Note that to calculate σ_z values below the midpoint of an edge and the center of a rectangular foundation, the values of σ_z calculated from Equation 2.5.4-31 are multiplied by two and four, respectively.

As described in Subsections 2.5.4.2.1.3.15 and 2.5.4.7.3.1, shear modulus degradation curves for VCS site soils are developed based on the results of RCTS tests made on site-specific undisturbed soil samples (refer to Figures 2.5.4-293 through 2.5.4-308 for tests made on power block soils). For the calculation of structure settlement using the elastic method (Equations 2.5.4-30 and 2.5.4-31), the maximum principal strain is the vertical strain (i.e., $\varepsilon_1 = \varepsilon_v$), while the minimum principal strain is assumed to be zero (i.e., $\varepsilon_3 = 0$). Since the maximum shear strain, $\gamma_{max} = \varepsilon_1 - \varepsilon_3 = \varepsilon_1$ (Reference 2.5.4-259) and $E/E_{max} = G/G_{max}$, the elastic modulus reduction curves with respect to vertical strain are the same as the shear modulus degradation (reduction) curves with respect to shear strain.

To calculate structure settlement, beginning with an initial elastic modulus E_0, the corresponding vertical strain ε_{v0} is derived from the shear modulus degradation curves. Based on ε_{v0}, the settlement in the soil layer δ_0 is calculated, and in turn the vertical strain is calculated as $\varepsilon_{v1} = \delta_0/h$, where h is the thickness of the soil layer. If ε_{v1} is different from ε_{v0}, a revised elastic modulus E_1 is derived from ε_{v1} based on the shear modulus degradation curves. This iteration process continues until a compatible elastic modulus and vertical strain are found.

The settlement calculation is extended to a depth where the increase in vertical stress (Δp) due to the applied foundation pressure is less than or equal to 10% of the total applied foundation pressure. Also, applying a 1H:2V pressure distribution (refer to Figure 2.5.4-334) through the structural fill, the calculated average applied vertical stress below the foundation is compared to the preconsolidation pressures (P_c') of each of the underlying clay strata. Where more than one soil type is present at a given elevation interval below a foundation, as described previously, for settlement analysis purposes a clay stratum is selected over a sand stratum to conservatively represent the elevation interval. Results show that the preconsolidation pressures of all clay strata exceed the applied vertical stress at the midpoint of each layer, therefore, there is no virgin compression in these soils upon foundation loading. As such, consolidation of clay strata under foundation pressures is due to recompression only, and is estimated using the elastic method outlined above.

Foundation settlements are calculated based on Equations 2.5.4-30 and 2.5.4-31, and the selected subsurface profiles shown in Tables 2.5.4-282, 2.5.4-284, and 2.5.4-286. Table 2.5.4-289 presents settlement estimates for Seismic Category I structures, including total estimated settlement at the center, the edge, and the corner of each structure, as well as the allowable settlement specified in the ESBWR DCD (Reference 2.5.4-251). Comparison shows that calculated total settlements at corners of each structure foundation are within required tolerance values. Note that higher total settlements can be accommodated when critical connections to adjacent structures, utilities, and pavements are delayed.

Differential settlement can be more important in the context of structure performance than total settlement. The differential settlement within a structure is taken as the settlement difference between various points on the structure foundation. From Table 2.5.4-289:

- The maximum calculated corner of foundation settlement is 1.5 inches for the reactor/fuel buildings, 0.5 inches for the control buildings, and 0.2 inches for the fire water service complexes. These are all within ESBWR DCD tolerances.

- The maximum calculated edge of foundation to corner of foundation differential settlement is 1.2 inches for the reactor/fuel buildings, 0.4 inches for the control buildings, and 0.2 inches for the fire water service complexes. These are also all within ESBWR DCD tolerances.
- The maximum calculated differential settlement between the edge of the reactor/fuel building and the edge of the control building is 1.8 inches. The maximum calculated edge to corner differential settlement is 2.2 inches. These are both less than the limit of 3.3 inches given in the ESBWR DCD.
- The maximum calculated center of foundation settlement (again, considering flexible mat foundations) is 5.1 inches for the reactor/fuel buildings, 1.7 inches for the control buildings, and 0.6 inches for the fire water service complexes. These values are provided for reference (i.e. no ESBWR DCD criteria are stated).

Note that actual settlements are less than calculated values (described above), for two principal reasons:

- A significant amount (i.e., typically more than one-half) of foundation settlement is expected to take place by the time superstructures are ready to receive equipment and/or piping.
- Settlement estimates are based on the assumption of flexible mat foundations, and do not include the effects that thick, highly reinforced concrete mat foundations have in mitigating differential settlements. To verify that foundations perform according to estimates, and to provide the ability to make corrections if needed, major structure foundations are monitored for movement during and after construction.

Before construction of major power block structures, as noted in Subsection 2.5.4.5.2, plant-site ground surface is raised from elevation +80 feet (original ground surface) to elevation +95 feet (plant finish grade) using structural fill. The estimated settlement caused by placement of site fill is about 0.8 inches. As this settlement should occur relatively rapidly, and before construction of Seismic Category I structures, it is not included in the calculated settlements of these structures.

Also note that unloading of the soil profile results from mass excavation for power block major structures (i.e., maximum 72 feet for excavation at the reactor/fuel buildings). This unloading results in rebound/heave of the base of excavation, which is monitored/accounted for during construction. Maximum rebound/heave for excavation of major power block structures is estimated at 0.7 inches.

2.5.4.10.4 **Earth Pressure Evaluations**

The static and seismic active and at-rest lateral earth pressures acting on underground structure below-grade walls are addressed here. The analysis of seismic earth pressure is addressed generically. Passive earth pressures are not addressed. Note that active earth pressures apply to yielding walls such as steel sheet pile walls, and to a lesser extent more rigid concrete slurry (diaphragm) walls, which are used primarily as temporary ground support in construction. At-rest earth pressures occur in the case of a non-yielding walls, such as the rigid, below-grade walls of underground structures (e.g., for the reactor/fuel buildings, control buildings, etc.).

Increases in lateral earth pressures resulting from compaction close-in to below-grade structures are not considered here. These increases are controlled at the construction stage by limiting the size of compaction equipment and its proximity to below-grade walls. Note that the magnitude of compaction-induced earth pressure increases can only be assessed once a range of allowable equipment sizes and types are selected/specified.

For the seismic active earth pressure case, earthquake-induced horizontal ground accelerations are accounted for by employing the factor $k_h g$; a peak horizontal ground surface acceleration of 0.10g (refer to Subsection 2.5.4.7.5) is applied, and vertical ground accelerations (k_v g) are considered negligible (Reference 2.5.4-260).

2.5.4.10.4.1 Static Lateral Earth Pressures

The static active earth pressure, p_{AS}, is calculated using Reference 2.5.4-260:

$$p_{AS} = K_{AS} \cdot \gamma \cdot z \qquad \text{Equation 2.5.4-32}$$

where, K_{AS} = Rankine coefficient of static active lateral earth pressure

γ = unit weight of the structural fill (γ', effective unit weight when below the groundwater level)

z = depth below ground surface

The Rankine coefficient, K_{AS}, is calculated from:

$K_{AS} = \tan^2 (45 - \phi'/2)$ Equation 2.5.4-33
(which is also Equation 2.5.4-15, above)

where, ϕ' = friction angle of the structural fill, in degrees

The static at-rest earth pressure, p_{0S}, is calculated using Reference 2.5.4-215:

$p_{0S} = K_{0S} \cdot \gamma \cdot z$ Equation 2.5.4-34

where, K_{0S}= coefficient of at-rest static lateral earth pressure

The coefficient, K_{0S} is calculated from:

$K_{0S} = 1 - \sin (\phi')$ Equation 2.5.4-35
(which is also Equation 2.5.4-17, above)

Hydrostatic groundwater pressure is considered for both the active and the at-rest static conditions, calculated by:

$p_w = \gamma_w \cdot z_w$ Equation 2.5.4-36

where, p_w = hydrostatic pressure
z_w = depth below the groundwater level
γ_w = unit weight of water = 62.4 pcf

2.5.4.10.4.2 Seismic Lateral Earth Pressures

The active seismic pressure, p_{AE}, is given by the Mononobe-Okabe equation (Reference 2.5.4-260), represented by:

$p_{AE} = \Delta K_{AE} \cdot \gamma \cdot (H - z)$ Equation 2.5.4-37a

where, ΔK_{AE}=coefficient of active seismic earth pressure = $K_{AE} - K_{AS}$
K_{AE}=Mononobe-Okabe coefficient of active seismic earth thrust
H =below-grade height of the wall

The coefficient K_{AE} is calculated from:

$K_{AE} = \cos^2 (\phi' - \theta)/\{\cos^2 \theta \cdot [1 + (\sin \phi' \sin (\phi' - \theta)/\cos (\theta))^{0.5}]^2\}$
Equation 2.5.4-37b

where, $\theta = \tan^{-1} (k_h)$
k_h = 0.10, as above

Note that ΔK_{AE} can be estimated using $3/4 \cdot k_h$ for k_h values less than about 0.25g, regardless of the angle of shearing resistance of the structural fill (Reference 2.5.4-260).

Note that at-rest seismic pressure is reported at up to three times the active earth pressure when calculated by the Mononobe-Okabe equation (Reference 2.5.4-261). Recognizing the limitations of the Mononobe-Okabe method for the design of below-grade structural walls, the evaluation of below-grade walls of specific seismic Category I structures uses the Ostadan method (Reference 2.5.4-262) to estimate seismic at-rest lateral earth pressures. This method recognizes limited building wall movements due to the presence of floor diaphragms, and also the frequency content of the design motion, and uses the soil shear wave velocity and damping as input. The method is adopted for building design by the National Earthquake Hazard Reduction Program (NEHRP) (Reference 2.5.4-263). To predict lateral seismic soil pressures for below-grade structure walls resting on firm foundations, and assuming non-yielding walls, the method involves the following:

- Step 1 — perform free-field soil column analysis and obtain the ground response motion at the depth corresponding to the base of the wall in the free-field. The response motion in terms of acceleration response spectrum at 30% damping is obtained. The free-field soil column analysis may be performed using the computer program SHAKE, or similar dynamic methods, with input motion specified either at the ground surface or at the depth of the foundation mat. The choice of location of control motion is an important decision that is made consistent with the development of the design motion. The location of input motion may significantly affect the dynamic response of the building and the seismic soil pressure amplitudes.
- Step 2 — compute the total mass for a representative Single Degree of Freedom (SDOF) system using Poisson's ratio and the mass density of the soil, m:

  $m = 0.5\ \gamma/g\ H^2\ \Psi_v$ Equation 2.5.4-38

  where, γ/g = total mass density of the structural fill

  H = height of the wall

  Ψ_v = factor to account for Poisson's ratio (μ), defined by:

  $\Psi_v = 2/[(1 - \mu)(2 - \mu)]^{0.5}$ Equation 2.5.4-39
- Step 3 — obtain the lateral seismic force as the product of the total mass obtained from Step 2 and the acceleration spectral value of the free-field response at the soil column frequency obtained at the depth equal to the bottom of the wall from Step 1.

- Step 4 — obtain the maximum lateral seismic soil pressure at the ground surface by dividing the lateral force obtained from Step 3 by the area under the normalized seismic soil pressure, or 0.744 H.
- And finally, obtain the soil pressure profile by multiplying the peak pressure from Step 4 by the following pressure distribution relationship:

$$p(y) = -0.0015 + 5.05y - 15.84y^2 + 28.25y^3 - 24.59y^4 + 8.14y^5$$

Equation 2.5.4-40

where, y=normalized height ratio (Y/H)

Y = distance measured from the bottom of the wall.

Note that Y/H ranges from a value of zero at the bottom of the wall to a value of 1.0 at the top of the wall. The area under the seismic soil pressure curve is obtained from an integration of the pressure distribution over the height of the wall. The total area is $0.744H\ p_{max}$ for a wall with a height of H and a maximum pressure of p_{max} at the top of the wall.

For well-drained backfill materials (i.e., sand/gravel), seismic groundwater pressure is not considered (Reference 2.5.4-262). Since the VCS site employs granular structural fill, only hydrostatic pressure is considered, as given in Equation 2.5.4-36. Note that seismic groundwater thrust greater than 35% of hydrostatic thrust can develop for cases when $k_h > 0.30g$ (Reference 2.5.4-264). Given the relatively low seismicity of the VCS site (i.e., $k_h < 0.30g$), seismic considerations related to groundwater can similarly be disregarded.

2.5.4.10.4.3 Lateral Earth Pressures Due to Surcharge

Lateral earth pressure resulting from surcharge applied at the ground surface alongside a below-grade structure wall, p_{sur}, is calculated using

$$p_{sur} = K\ q$$

Equation 2.5.4-41

where, K = earth pressure coefficient; K_{AS} for active; K_0 for at-rest; ΔK_{AE} or ΔK_{oE} for seismic loading, depending on the nature of the loading (ΔK_{oE} = seismic at-rest coefficient).

q = uniform surcharge pressure

Note that a surcharge pressure of 500 psf is included in the earth pressure calculations summarized here. The validity of this pressure is reviewed at detailed design.

2.5.4.10.4.4 Lateral Earth Pressure Diagrams

Using the relationships outlined above and the structural fill properties summarized in Table 2.5.4-232, sample earth pressure diagrams are developed. Sample earth pressure diagrams are provided on Figures 2.5.4-337 and 2.5.4-338 for the maximum 65.6-foot wall height (reactor/fuel buildings), assuming level ground surface, and with post-construction groundwater at elevation +85 feet. Structural fill properties (granular soils) used have a unit weight (γ_t) of 138 pcf and a drained friction angle (ϕ') of 39° (refer to Table 2.5.4-232). A peak horizontal ground surface acceleration of 0.10g is employed, and a uniform surcharge load of 500 psf is included.

2.5.4.10.5 **Selected Design Parameters and Results Overview**

Field and laboratory testing results from this site-specific subsurface investigation are described in Subsection 2.5.4.2 and the parameters employed for bearing capacity, settlement, and earth pressure evaluations are based on the material characterization addressed in that subsection. The post-construction groundwater level of elevation +85 feet is selected for bearing capacity/settlement analyses and for developing sample earth pressure diagrams. For seismic earth pressure analysis, a peak horizontal ground surface acceleration of 0.10g is used, based on the site-specific seismologic and soil dynamics analyses, as described in Subsection 2.5.4.7.5.

The FOS values calculated against static bearing capacity failure of each of the foundations for Seismic Category I structures exceeds 3.0; a value of 3.0 is commonly considered adequate for ensuring foundation stability. The calculated ultimate capacities of each of the Seismic Category I structures also exceed the required dynamic bearing capacities. Finally, and considering the effects that construction time and foundation rigidity have on mitigating differential settlement, the calculated settlement of Seismic Category I structures are also within the limits specified in the ESBWR DCD (Reference 2.5.4-251).

2.5.4.11 **Design Criteria**

Geotechnical design criteria are addressed in the individual subsections, above, and also in Subsection 2.5.5, for the particular subject being considered. The design criteria summarized below are geotechnical design criteria and/or geotechnical-related design criteria that pertain to structural design. Refer to the respective subsections, above, and Subsection 2.5.5, for additional detail.

Subsection 2.5.4.8 presents the results of a liquefaction evaluation of VCS soils and presents a minimum acceptable FOS against liquefaction of 1.10. Under *Factor of Safety Against Liquefaction,* RG 1.198 (Reference 2.5.4-256) indicates that FOS <1.10 is generally considered a trigger value. This is consistent with the value selected for the analysis of VCS site soils, especially when also considering the conservatism employed in ignoring overconsolidation, the geologic age of the deposits, and other factors noted earlier.

Subsection 2.5.4.10 describes allowable bearing capacities and estimated settlement values for plant structures, and compares them to threshold values published in the ESBWR DCD (Reference 2.5.4-251).

Table 2.5.4-288 contains calculated bearing capacities, both static and dynamic, for VCS site seismic Category I structures. In the case of static bearing capacity, a minimum FOS = 3.0 is applied against the calculated ultimate bearing capacity in evaluating the static bearing capacity of a structure (i.e., the calculated ultimate bearing capacity of a structure divided by a FOS = 3.0 is not less than the minimum static bearing capacity of the structure for soft soils as per the ESBWR DCD [Reference 2.5.4-251]). In the case of dynamic bearing capacity, the calculated ultimate bearing capacity is compared directly against the dynamic bearing capacity of a structure (i.e., the calculated ultimate bearing capacity of a structure is not less than the minimum dynamic bearing capacity of the structure for soft soils as per the ESBWR DCD [Reference 2.5.4-251]).

Table 2.5.4-289 contains estimated settlement of VCS site seismic Category I structures under recommended foundation loads, and compares them against maximum post-construction total and differential settlement published in the ESBWR DCD (Reference 2.5.4-251). All DCD parameters associated with settlement are satisfied.

Subsection 2.5.4.10 also addresses criteria for static and seismic earth pressure estimation. The calculated lateral earth pressure diagrams shown on Figures 2.5.4-337 and 2.5.4-338 are best estimates, and thus contain a FOS = 1.0. In the analyses of sliding and overturning due to these lateral loads when the seismic component is included, a FOS = 1.10 is recommended.

No pile or pier foundations are used for support of seismic Category I structures. In situations where deep foundations are used for non-seismic Category I structures, as determined at detailed design:

- For axial loading, a minimum FOS = 3.0 is applied against the calculated ultimate end bearing component, and a minimum FOS = 2.0 is applied against the calculated ultimate skin friction component
- For lateral loading, the maximum allowable lateral load is taken as one-half of the load that produces 1 inch of lateral movement at the pile head, adjusted for pile spacing and for pile head fixity

Finally, Subsection 2.5.5.2.2.7 specifies and describes minimum factors of safety for stability of nonsafety-related cooling basin/GBRA storage water reservoir embankment dams, under the following conditions:

- End of Construction: 1.30
- Steady-State Seepage: 1.50
- Rapid Drawdown: 1.30
- Pseudo-static: 1.15

2.5.4.12 **Techniques to Improve Subsurface Conditions**

As noted in Subsections 2.5.4.5 and 2.5.4.10, major power block structures (including Seismic Category I structures) derive support from stiff to very stiff clay subgrade soils, dense to very dense sand subgrade soils, or compacted structural fill. Given the depths of structure foundations and the subsurface conditions that occur at those depths, as shown in part on Figures 2.5.4-275 through 2.5.4-279, special ground improvement measures are not warranted. Ground treatment is limited to localized overexcavation of unsuitable soils, such as minor zones of less competent soils occurring at foundation subgrades, and their replacement with compacted structural fill.

Overexcavations of approximately 21 feet at the reactor/fuel buildings and approximately 21 feet at the control buildings replace soils that are not adequate to directly bear the high foundation loads of these structures, with the required FOS. Overexcavations at these structures are backfilled with compacted structural fill. In addition, general overexcavations of approximately two feet, also backfilled with compacted structural fill, at the radwaste buildings, turbine buildings, and service buildings, ensure firm subgrades for construction activities. For all affected structures, structural fill is placed according to engineering specifications and quality control/quality assurance testing procedures established at detailed design stage.

As noted in Subsections 2.5.4.5 and 2.5.5, the cooling basin/GBRA storage water reservoir embankment dams mainly derive support from stiff to very stiff clay subgrade soils and dense to very dense sand subgrade soils. Given the subsurface conditions that occur along the alignment of the embankment dams, as shown in part on Figures 2.5.4-280 through 2.5.4-285, special ground improvement measures are not warranted. Ground treatment is limited to localized over-excavation of unsuitable soils, such as minor zones of less competent soils occurring at embankment dam foundation subgrades, and their replacement with compacted embankment fill. For example, the uppermost 5.25 feet of soil below ground surface described in Subsections 2.5.4.8.3.2 (CPT C-2308; elevation +58.02 feet to elevation +52.77 feet; Stratum Sand 1), is removed and replaced at the foundation of the east dam of the GBRA storage water reservoir. In addition, Subsurface Profile G shown on Figure 2.5.4-216 (also shown in plan on Figure 2.5.4-213) along the east embankment dam of the GBRA storage water reservoir shows limited areas of relatively loose granular materials having SPT $(N_1)_{60}$ less than 10 blows per foot at shallow depths below the surface; these materials are removed or recompacted as a matter of dam foundation preparation.

Ground improvement measures also include proof-rolling of structure and embankment dam foundation subgrades for the purpose of identifying any unsuitable soils for additional overexcavation and replacement. The primary focus is on maintaining the integrity of the existing stiff to very stiff clay and dense to very dense sand structure foundation subgrade soils and embankment dam foundation subgrade soils during earthwork, and continuing on to subgrade preparation to receive structure foundations and embankment fill. These measures include such steps as groundwater and surface water control, the use of appropriate measures and equipment for excavation and compaction, subgrade protection, and other similar measures.

2.5.4.13 **References**

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Table 2.5.4-201
Field Testing Summary
(Power Block)

Field Test	Industry Standard	No. of Tests[a]
Borings	Reference 2.5.4-224 Reference 2.5.4-225	93
Standard Penetration Test Hammer	Reference 2.5.4-208	42[b]
Energy Measurements	Reference 2.5.4-226	
Cone Penetration Tests	Reference 2.5.4-227	38
Observation Wells	Reference 2.5.4-228 Reference 2.5.4-229	11
Test Pits	—	8
Field Electrical Resistivity Arrays	Reference 2.5.4-232 Reference 2.5.4-233	2
Suspension P-S Velocity Logging	Reference 2.5.4-249	10

a. Includes field tests made at Unit 1, at Unit 2, and at the area Outside the Power Block.

b. Measurements made on drilling rigs/SPT hammers employed at all site areas.

Table 2.5.4-202
Field Testing Summary
(Cooling Basin/GBRA Storage Water Reservoir)

Field Test	Industry Standard	No. of Tests
Borings	Reference 2.5.4-224 Reference 2.5.4-225	60
Standard Penetration Test Hammer Energy Measurements	Reference 2.5.4-208 Reference 2.5.4-226	42[a]
Cone Penetration Tests	Reference 2.5.4-227	27
Observation Wells	Reference 2.5.4-228 Reference 2.5.4-229	16
Test Pits	—	12
Field Electrical Resistivity Arrays	Reference 2.5.4-232 Reference 2.5.4-233	—
Suspension P-S Velocity Logging	Reference 2.5.4-249	7
Borehole Permeameter Tests	Reference 2.5.4-230	16
Groundwater Pump Tests	Reference 2.5.4-231	7

a. Measurements made on drilling rigs/SPT hammers employed at all site areas.

Table 2.5.4-203 (Sheet 1 of 3)
Soil Strata Thicknesses and Base Elevations
(Power Block)

		Unit 1		Unit 2		Inside Power Block		Outside Power Block	
Stratum	**Statistics**	**Base El. (feet)[a]**	**Thickness (feet)**	**Base El. (feet)[a]**	**Thickness (feet)**	**Base El. (feet)[a]**	**Thickness (feet)**	**Base El. (feet)[a]**	**Thickness (feet)**
Clay 1 (Top)	Minimum	48.9	23.5	36.9	22.8	36.9	22.8	44.9	12.4
	Maximum	57.0	31.3	57.6	43.5	57.6	43.5	68.2	34.6
	Average	51.6	28.3	51.5	29.0	51.6	28.6	59.0	20.6
Sand 1	Minimum	Absent	Absent	28.4	0.5	28.4	0.5	Absent	Absent
	Maximum	Absent	Absent	54.2	20.0	54.2	20.0	Absent	Absent
	Average	Absent	Absent	42.8	9.0	42.8	9.0	Absent	Absent
Clay 1 (Bottom)	Minimum	11.9	7.0	12.8	2.0	11.9	2.0	32.3	8.0
	Maximum	42.9	40.0	39.3	35.0	42.9	40.0	56.4	27.5
	Average	33.1	18.5	27.3	17.4	30.5	18.0	40.2	18.8
Sand 2	Minimum	–3.0	0.5	–7.5	2.5	–7.5	0.5	13.4	7.6
	Maximum	26.5	35.5	33.1	28.5	33.1	35.5	24.9	43.0
	Average	19.3	14.2	17.9	10.8	18.6	12.6	19.0	21.2
Clay 3	Minimum	–18.3	5.0	–18.2	3.0	–18.3	3.0	–10.1	22.1
	Maximum	15.3	50.0	2.6	45.0	15.3	50.0	–2.3	35.0
	Average	–4.4	24.5	–6.4	25.1	5.4	24.8	–7.0	26.0
Sand 4	Minimum	–40.2	2.7	–39.6	19.0	–40.2	2.7	–31.2	7.0
	Maximum	–13.8	51.0	–30.5	37.8	–13.8	51.0	–15.3	28.9
	Average	–28.2	23.3	–36.1	27.3	–32.0	25.2	–23.9	16.5
Clay 5 (Top)	Minimum	–65.0	9.5	–65.6	2.2	–65.6	2.2	–50.1	5.0
	Maximum	–41.2	32.0	–41.0	31.0	–41.0	32.0	–23.6	22.0
	Average	–49.4	21.3	–52.3	16.3	–50.8	18.9	–39.7	15.8
Sand 5	Minimum	–79.2	1.0	–78.5	5.0	–79.2	1.0	–61.2	7.0
	Maximum	–48.9	28.9	–58.2	31.2	–48.9	31.2	–33.6	18.0
	Average	–60.9	11.5	–65.9	14.4	–63.9	13.2	–46.4	11.7
Clay 5 (Bottom)	Minimum	–89.0	5.7	–91.3	8.8	–91.3	5.7	–75.2	4.0
	Maximum	–54.9	40.0	–72.7	21.7	–54.9	40.0	–45.6	14.0
	Average	–70.2	17.3	–79.1	13.3	–73.4	15.8	–56.7	9.4
Sand 6	Minimum	–148.9	30.0	–139.1	11.0	–148.9	11.0	–113.2	38.0
	Maximum	–109.8	77.0	–98.3	65.5	–98.3	77.0	–112.6	67.0
	Average	–126.5	52.1	–128.6	47.6	–127.3	50.4	–112.9	52.5

Table 2.5.4-203 (Sheet 2 of 3)
Soil Strata Thicknesses and Base Elevations
(Power Block)

		Unit 1		Unit 2		Inside Power Block		Outside Power Block	
Stratum	**Statistics**	**Base El. (feet)[a]**	**Thickness (feet)**	**Base El. (feet)[a]**	**Thickness (feet)**	**Base El. (feet)[a]**	**Thickness (feet)**	**Base El. (feet)[a]**	**Thickness (feet)**
Clay 7	Minimum	–189.3	23.0	Absent	Absent	–189.3	23.0	–159.2	46.0
	Maximum	–150.8	65.5	Absent	Absent	–150.8	65.5	–159.2	46.0
	Average	–172.5	40.7	Absent	Absent	–172.5	40.7	–159.2	46.0
Sand 8	Minimum	–209.3	20.0	–221.4	40.0	–221.4	20.0	–184.2	25.0
	Maximum	–204.5	54.1	–177.9	100.1	–177.9	100.1	–161.8	49.2
	Average	–206.4	33.8	–204.0	70.3	–205.3	50.6	–173.0	37.1
Clay 9	Minimum	–268.9	37.2	–253.3	20.8	–268.9	20.8	–211.2	27.0
	Maximum	–241.7	64.0	–242.2	46.0	–241.7	64.0	–205.6	43.8
	Average	–252.4	47.7	–248.1	36.7	–249.9	41.4	–208.4	35.4
Sand 10	Minimum	–293.5	8.0	–292.7	33.9	–293.5	8.0	>–233.6	>18.0
	Maximum	–254.5	24.6	–287.2	42.0	–254.5	42.0	>–229.2	>28.0
	Average	–267.8	15.4	–289.1	39.0	–278.6	27.2	>–231.4	>23.0
Clay 11	Minimum	–327.5	72.1	–323.1	35.8	–327.5	35.8	—	—
	Maximum	–327.5	72.1	–323.1	35.8	–323.1	72.1	—	—
	Average	–327.5	72.1	–323.1	35.8	–325.3	54.0	—	—
Sand 12	Minimum	–345.6	18.1	–346.1	23.0	–346.1	18.1	—	—
	Maximum	–345.6	18.1	–346.1	23.0	–345.6	23.0	—	—
	Average	–345.6	18.1	–346.1	23.0	–345.9	20.6	—	—
Clay 13	Minimum	–421.1	75.5	–422.1	76.0	–422.1	75.5	—	—
	Maximum	–421.1	75.5	–422.1	76.0	–421.1	76.0	—	—
	Average	–421.1	75.5	–422.1	76.0	–421.6	75.8	—	—
Sand 14	Minimum	–453.9	32.8	–468.7	46.6	–468.7	32.8	—	—
	Maximum	–453.9	32.8	–468.7	46.6	–453.9	46.6	—	—
	Average	–453.9	32.8	–468.7	46.6	–461.3	39.7	—	—
Clay 15	Minimum	–465.1	11.2	–481.1	12.4	–481.1	11.2	—	—
	Maximum	–465.1	11.2	–481.1	12.4	–465.1	12.4	—	—
	Average	–465.1	11.2	–481.1	12.4	–473.1	11.8	—	—
Sand 16	Minimum	–480.1	15.0	–499.1	18.0	–499.1	15.0	—	—
	Maximum	–480.1	15.0	–499.1	18.0	–480.1	18.0	—	—
	Average	–480.1	15.0	–499.1	18.0	–489.6	16.5	—	—
Clay 17	Minimum	–506.4	26.3	–515.1	16.0	–515.1	16.0	—	—
	Maximum	–506.4	26.3	–515.1	16.0	–506.4	26.3	—	—
	Average	–506.4	26.3	–515.1	16.0	–510.8	21.2	—	—

Table 2.5.4-203 (Sheet 3 of 3)
Soil Strata Thicknesses and Base Elevations
(Power Block)

Stratum	Statistics	Unit 1		Unit 2		Inside Power Block		Outside Power Block	
		Base El. (feet)[a]	Thickness (feet)	Base El. (feet)[a]	Thickness (feet)	Base El. (feet)[a]	Thickness (feet)	Base El. (feet)[a]	Thickness (feet)
Sand 18	Minimum	>–520.3	>13.9	>–519.5	>4.4	>–519.5	>4.4	—	—
	Maximum	>–520.3	>13.9	>–519.5	>4.4	>–520.3	>13.9	—	—
	Average	>–520.3	>13.9	>–519.5	>4.4	>–519.5	>9.1	—	—

Stratum	Unit 1		Unit 2		Inside Power Block		Outside Power Block	
	Base El. (feet)[a]	Thickness (feet)	Base El. (feet)[a]	Thickness (feet)	Base El. (feet)[a]	Thickness (feet)	Base El. (feet)[a]	Thickness (feet)
Values for Use								
Clay 1(Top)	51.6	28.3	51.5	29.0	51.6	28.6	59.0	20.6
Sand 1	Absent	Absent	42.8	9.0	42.8	9.0	Absent	Absent
Clay 1 (Bottom)	33.1	18.5	27.3	17.4	30.5	18.0	40.2	18.8
Sand 2	19.3	14.2	17.9	10.8	18.6	12.6	19.0	21.2
Clay 3	–4.4	24.5	–6.4	25.1	–5.4	24.8	–7.0	26.0
Sand 4	–28.2	23.3	–36.1	27.3	–32.0	25.2	–23.9	16.5
Clay 5 (Top)	–49.4	21.3	–52.3	16.3	–50.8	18.9	–39.7	15.8
Sand 5	–60.9	11.5	–65.9	14.4	–63.9	13.2	–46.4	11.7
Clay 5 (Bottom)	–70.2	17.3	–79.1	13.3	–73.4	15.8	–56.7	9.4
Sand 6	–126.5	52.1	–128.6	47.6	–127.3	50.4	–112.9	52.5
Clay 7	–172.5	40.7	Absent	Absent	–172.5	40.7	–159.2	46.0
Sand 8	–206.4	33.8	–204.0	70.3	–205.3	50.6	–173.0	37.1
Clay 9	–252.4	47.7	–248.1	36.7	–249.9	41.4	–208.4	35.4
Sand 10	–267.8	15.4	–289.1	39.0	–278.4	27.2	>–231.4	>23.0
Clay 11	–327.5	72.1	–323.1	35.8	–325.3	54.0	—	—
Sand 12	–345.6	18.1	–346.1	23.0	–345.9	20.6	—	—
Clay 13	–421.1	75.5	–422.1	76.0	–421.6	75.8	—	—
Sand 14	–453.9	32.8	–468.7	46.6	–461.3	39.7	—	—
Clay 15	–465.1	11.2	–481.1	12.4	–473.1	11.8	—	—
Sand 16	–480.1	15.0	–499.1	18.0	–489.6	16.5	—	—
Clay 17	–506.4	26.3	–515.1	16.0	–510.8	21.2	—	—
Sand 18	>–520.3	>13.9	>–519.5	>4.4	>–519.5	>9.1	—	—

a. Elevations are referenced to NAVD 88.

Table 2.5.4-204 (Sheet 1 of 2)
Soil Strata Thicknesses and Base Elevations (Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Statistics	Base El. (feet)[a]	Thickness (feet)
Clay 1 (Top)	Minimum	–39.1	2.3
	Maximum	74.0	25.0
	Average	59.8	11.1
Sand 1	Minimum	22.0	1.7
	Maximum	64.2	31.5
	Average	47.7	14.6
Clay 1 (Bottom)	Minimum	16.7	2.5
	Maximum	58.5	45.0
	Average	31.7	16.6
Sand 2	Minimum	–5.9	4.8
	Maximum	49.0	42.0
	Average	14.4	17.7
Clay 3	Minimum	–28.5	1.5
	Maximum	15.7	83.5
	Average	1.3	19.1
Sand 4	Minimum	–49.4	1.0
	Maximum	9.2	57.0
	Average	–26.2	24.8
Clay 5 (Top)	Minimum	–68.5	0.8
	Maximum	–18.1	30.7
	Average	–40.6	14.4
Sand 5	Minimum	–80.5	1.5
	Maximum	–20.5	44.8
	Average	–56.7	12.6
Clay 5 (Bottom)	Minimum	–89.9	1.2
	Maximum	–49.4	30.0
	Average	–72.9	13.0
Sand 6	Minimum	–166.9	0.7
	Maximum	–71.2	77.0
	Average	–96.4	23.5
Clay 7	Minimum	–173.2	13.2
	Maximum	–126.7	53.6
	Average	–148.5	27.3
Sand 8	Minimum	–219.9	11.0
	Maximum	–165.5	53.0
	Average	–184.1	26.6
Clay 9	Minimum	–245.3	20.0
	Maximum	–185.5	79.0
	Average	–229.0	40.9
Sand 10	Minimum	–220.5	30.0
	Maximum	–218.3	35.0
	Average	–219.4	32.5
Clay 11	Minimum	–235.5	15.0
	Maximum	–233.3	>15.0
	Average	–234.4	>15.0

Table 2.5.4-204 (Sheet 2 of 2)
Soil Strata Thicknesses and Base Elevations
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Base El. (feet)[a]	Thickness (feet)
Values for Use		
Clay 1 (Top)	59.8	11.1
Sand 1	47.7	14.6
Clay 1 (Bottom)	31.7	16.6
Sand 2	14.4	17.7
Clay 3	1.3	19.1
Sand 4	–26.2	24.8
Clay 5 (Top)	–40.6	14.4
Sand 5	–56.7	12.6
Clay 5 (Bottom)	–72.9	13.0
Sand 6	–96.4	23.5
Clay 7	–148.5	27.3
Sand 8	–184.1	26.6
Clay 9	–229.0[b]	40.9
Sand 10	–219.4[b]	32.5
Clay 11	–234.4[b]	>15.0

a. Elevations are referenced to NAVD 88

b. Because of the broad area covered by the cooling basin/GBRA storage water reservoir, the average top and base elevations of certain strata may not be representative of the subsurface conditions present at a particular location. Refer to the detailed information contained in Appendix 2.5.4-B when considering specific subsurface conditions

Table 2.5.4-205 (Sheet 1 of 2)
Uncorrected SPT N-Values
(Power Block)

Stratum	Statistics	Unit 1 N-Value (blows/foot)	Unit 2 N-Value (blows/foot)	Inside Power Block N-Value (blows/foot)	Outside Power Block N-Value (blows/foot)
Clay 1 (Top)	No. of Tests	284	296	580	26
	Minimum	3	1	1	4
	Maximum	50	36	50	34
	Average	16	14	15	13
Sand 1	No. of Tests	Absent	52	52	Absent
	Minimum	—	12	12	—
	Maximum	—	59	59	—
	Average	—	26	26	—
Clay 1 (Bottom)	No. of Tests	146	115	261	21
	Minimum	9	10	9	10
	Maximum	50	36	50	52
	Average	16	14	15	21
Sand 2	No. of Tests	104	69	173	22
	Minimum	10	9	9	21
	Maximum	80	94	94	167
	Average	32	28	30	47
Clay 3	No. of Tests	177	186	363	26
	Minimum	11	8	8	13
	Maximum	>200	>200	>200	34
	Average	28	21	25	20
Sand 4	No. of Tests	140	143	283	14
	Minimum	10	21	10	11
	Maximum	>200	>200	>200	121
	Average	88	75	82	58
Clay 5 (Top)	No. of Tests	80	62	142	9
	Minimum	11	15	11	14
	Maximum	167	94	167	63
	Average	27	25	26	26
Sand 5	No. of Tests	19	58	77	4
	Minimum	18	7	7	25
	Maximum	87	200	200	162
	Average	48	67	62	77
Clay 5 (Bottom)	No. of Tests	49	28	77	3
	Minimum	11	10	10	24
	Maximum	89	37	89	37
	Average	27	25	26	29
Sand 6	No. of Tests	114	82	196	19
	Minimum	16	21	16	27
	Maximum	>200	>200	>200	>200
	Average	86	115	98	90
Clay 7	No. of Tests	19	2	21	3
	Minimum	16	125	16	19
	Maximum	166	>200	>200	43
	Average	53	188	66	31

Table 2.5.4-205 (Sheet 2 of 2) Uncorrected SPT N-Values (Power Block)

Stratum	Statistics	Unit 1 N-Value (blows/foot)	Unit 2 N-Value (blows/foot)	Inside Power Block N-Value (blows/foot)	Outside Power Block N-Value (blows/foot)
Sand 8	No. of Tests	12	27	39	3
	Minimum	49	33	33	57
	Maximum	>200	>200	>200	125
	Average	106	123	118	94
Clay 9	No. of Tests	14	14	28	4
	Minimum	31	30	30	35
	Maximum	58	125	125	125
	Average	45	52	50	64
Sand 10	No. of Tests	2	7	9	2
	Minimum	100	26	26	90
	Maximum	125	>200	>200	125
	Average	113	179	164	108
Clay 11	No. of Tests	13	13	26	Not Reached
	Minimum	28	19	19	—
	Maximum	125	90	125	—
	Average	45	46	45	—
Sand 12	No. of Tests	1	1	2	Not Reached
	Minimum	166	33	33	—
	Maximum	166	33	166	—
	Average	166	33	100	—
Clay 13	No. of Tests	4	4	8	Not Reached
	Minimum	33	25	25	—
	Maximum	86	46	86	—
	Average	51	38	44	—
Sand 14	No. of Tests	1	3	4	Not Reached
	Minimum	65	51	51	—
	Maximum	65	166	166	—
	Average	65	114	102	—
Clay 15	No. of Tests	2	Absent	2	Not Reached
	Minimum	52	—	52	—
	Maximum	58	—	58	—
	Average	55	—	55	—
Sand 16	No. of Tests	1	1	2	Not Reached
	Minimum	125	97	97	—
	Maximum	125	97	125	—
	Average	125	97	111	—
Clay 17	No. of Tests	1	2	3	Not Reached
	Minimum	46	68	46	—
	Maximum	46	94	94	—
	Average	46	81	69	—
Sand 18	No. of Tests	1	Not Measured	1	Not Reached
	Minimum	166	—	166	—
	Maximum	166	—	166	—
	Average	166	—	166	—

Table 2.5.4-206 (Sheet 1 of 2)
Uncorrected SPT N-Values
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Statistics	N-Value (blows/foot)
Clay 1 (Top)	No. of Tests	164
	Minimum	2
	Maximum	49
	Average	13
Sand 1	No. of Tests	131
	Minimum	4
	Maximum	80
	Average	23
Clay 1 (Bottom)	No. of Tests	158
	Minimum	5
	Maximum	>200
	Average	20
Sand 2	No. of Tests	149
	Minimum	2
	Maximum	>200
	Average	43
Clay 3	No. of Tests	168
	Minimum	7
	Maximum	97
	Average	20
Sand 4	No. of Tests	219
	Minimum	8
	Maximum	>200
	Average	50
Clay 5 (Top)	No. of Tests	63
	Minimum	12
	Maximum	>200
	Average	35
Sand 5	No. of Tests	42
	Minimum	21
	Maximum	>200
	Average	72
Clay 5 (Bottom)	No. of Tests	22
	Minimum	12
	Maximum	44
	Average	24
Sand 6	No. of Tests	36
	Minimum	18
	Maximum	>200
	Average	70
Clay 7	No. of Tests	7
	Minimum	22
	Maximum	80
	Average	37

Table 2.5.4-206 (Sheet 2 of 2)
Uncorrected SPT N-Values
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Statistics	N-Value (blows/foot)
Sand 8	No. of Tests	6
	Minimum	12
	Maximum	167
	Average	98
Clay 9	No. of Tests	6
	Minimum	25
	Maximum	73
	Average	41

Table 2.5.4-207
Energy Transfer Ratios/Hammer Energy Corrections
(Power Block; Cooling Basin/GBRA Storage Water Reservoir)

Drilling Rig	Number of Measurements	Min. ETR (%)[a]	Max. ETR (%)[a]	Average ETR (%)[a]	Hammer Energy Correction (ETR%/60%)
MACTEC Raleigh CME 55LC Track Rig (Serial No. MEC-02)[b]	7	81.1	86.0	84.4	1.41
MACTEC Atlanta CME 550 ATV Rig (Serial No. MEC-03)	4	87.1	92.0	90.7	1.51
MACTEC Atlanta CME 550x ATV Rig (Serial No. MEC-05)[b]	6	81.7	88.9	86.2	1.44
MACTEC Charlotte CME 75 Truck Rig (Serial No. MEC-09)	3	81.1	84.3	82.0	1.37
Miller Drilling CME 85 Truck Rig (Serial No. MEC-10)	3	88.6	90.6	89.3	1.49
Environmental Exploration CME 75 Truck Rig (Serial No. MEC-11)[c]	8	87.4	90.3	88.6	1.48
Mactec Charlotte CME 45 Track Rig (Serial No. MEC-12)	3	72.3	80.6	73.9	1.23
Mactec Raleigh CME 45 Track Rig (Serial No. MEC-13)	3	84.6	86.3	85.2	1.42
Environmental Exploration CME 750 ATV Rig (Serial No. 263048)	5	67.4	76.9	72.5	1.21

a. Energy Transfer Ratio (ETR) is the percent of measured SPT hammer energy versus the theoretical SPT hammer energy (350 foot-pounds)

b. Energy measurements made using both AW-J and NW-J drill rods

c. Energy measurements made using AW-J and Mayhew drill rods. Energy measurements made using Mayhew rods are not included here

Table 2.5.4-208 (Sheet 1 of 3) Corrected SPT $(N_1)_{60}$-Values (Power Block)

Stratum	Statistics	Unit 1 $(N_1)_{60}$-Value (blows/foot)	Unit 2 $(N_1)_{60}$-Value (blows/foot)	Inside Power Block $(N_1)_{60}$-Value (blows/foot)	Outside Power Block $(N_1)_{60}$-Value (blows/foot)
Clay 1 (Top)	No. of Tests	284	296	580	26
	Minimum	5	2	2	7
	Maximum	84	56	84	47
	Average	20	19	19	21
Sand 1	No. of Tests	Absent	52	52	Absent
	Minimum	—	14	14	—
	Maximum	—	69	69	—
	Average	—	29	29	—
Clay 1 (Bottom)	No. of Tests	146	115	261	21
	Minimum	9	9	9	11
	Maximum	53	37	53	64
	Average	20	19	19	21
Sand 2	No. of Tests	104	69	173	22
	Minimum	8	9	8	17
	Maximum	72	79	79	165
	Average	28	24	26	39
Clay 3	No. of Tests	177	186	363	26
	Minimum	7	7	7	8
	Maximum	173	>200	>200	27
	Average	21	17	19	15
Sand 4	No. of Tests	140	143	283	14
	Minimum	6	14	6	5
	Maximum	>200	>200	>200	66
	Average	58	52	55	35
Clay 5 (Top)	No. of Tests	80	62	142	9
	Minimum	6	10	6	9
	Maximum	96	60	96	40
	Average	16	16	16	16
Sand 5	No. of Tests	19	58	77	4
	Minimum	10	4	4	16
	Maximum	54	127	127	75
	Average	29	43	39	38
Clay 5 (Bottom)	No. of Tests	49	28	77	3
	Minimum	6	7	6	11
	Maximum	54	23	54	25
	Average	16	16	16	16

Table 2.5.4-208 (Sheet 2 of 3) Corrected SPT $(N_1)_{60}$-Values (Power Block)

Stratum	Statistics	Unit 1 $(N_1)_{60}$-Value (blows/foot)	Unit 2 $(N_1)_{60}$-Value (blows/foot)	Inside Power Block $(N_1)_{60}$-Value (blows/foot)	Outside Power Block $(N_1)_{60}$-Value (blows/foot)
Sand 6	No. of Tests	114	82	196	19
	Minimum	10	13	10	16
	Maximum	>200	>200	>200	151
	Average	51	75	61	52
Clay 7	No. of Tests	19	2	21	3
	Minimum	9	79	9	9
	Maximum	88	158	158	20
	Average	32	119	40	15
Sand 8	No. of Tests	12	27	39	3
	Minimum	31	22	22	27
	Maximum	172	>200	>200	75
	Average	66	80	76	54
Clay 9	No. of Tests	14	14	28	4
	Minimum	19	20	19	21
	Maximum	36	77	77	75
	Average	28	34	31	42
Sand 10	No. of Tests	2	7	9	2
	Minimum	60	17	17	42
	Maximum	81	>200	>200	75
	Average	71	117	107	59
Clay 11	No. of Tests	13	13	26	Not Reached
	Minimum	17	12	12	—
	Maximum	81	60	81	—
	Average	28	31	30	—
Sand 12	No. of Tests	1	1	2	Not Reached
	Minimum	100	22	22	—
	Maximum	100	22	100	—
	Average	100	22	61	—
Clay 13	No. of Tests	4	4	8	Not Reached
	Minimum	20	16	16	—
	Maximum	52	30	52	—
	Average	30	25	28	—
Sand 14	No. of Tests	1	3	4	Not Reached
	Minimum	39	33	33	—
	Maximum	39	109	109	—
	Average	39	75	66	—

Table 2.5.4-208 (Sheet 3 of 3) Corrected SPT $(N_1)_{60}$-Values (Power Block)

Stratum	Statistics	Unit 1 $(N_1)_{60}$-Value (blows/foot)	Unit 2 $(N_1)_{60}$-Value (blows/foot)	Inside Power Block $(N_1)_{60}$-Value (blows/foot)	Outside Power Block $(N_1)_{60}$-Value (blows/foot)
Clay 15	No. of Tests	2	Absent	2	Not Reached
	Minimum	31	—	31	—
	Maximum	35	—	35	—
	Average	33	—	33	—
Sand 16	No. of Tests	1	1	2	Not Reached
	Minimum	75	64	64	—
	Maximum	75	64	75	—
	Average	75	64	69	—
Clay 17	No. of Tests	1	2	3	Not Reached
	Minimum	28	45	28	—
	Maximum	28	62	62	—
	Average	28	53	45	—
Sand 18	No. of Tests	1	Not Reached	1	Not Reached
	Minimum	100	—	100	—
	Maximum	100	—	100	—
	Average	100	—	100	—

Table 2.5.4-209 (Sheet 1 of 2)
Corrected SPT $(N_1)_{60}$-Values
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Statistics	(N1)60-Value (blows/foot)
Clay 1 (Top)	No. of Tests	164
	Minimum	3
	Maximum	92
	Average	20
Sand 1	No. of Tests	131
	Minimum	6
	Maximum	97
	Average	30
Clay 1 (Bottom)	No. of Tests	158
	Minimum	7
	Maximum	>200
	Average	21
Sand 2	No. of Tests	149
	Minimum	4
	Maximum	>200
	Average	38
Clay 3	No. of Tests	168
	Minimum	5
	Maximum	72
	Average	16
Sand 4	No. of Tests	219
	Minimum	5
	Maximum	>200
	Average	34
Clay 5 (Top)	No. of Tests	63
	Minimum	7
	Maximum	>200
	Average	22
Sand 5	No. of Tests	42
	Minimum	12
	Maximum	>200
	Average	42
Clay 5 (Bottom)	No. of Tests	22
	Minimum	8
	Maximum	33
	Average	14
Sand 6	No. of Tests	36
	Minimum	9
	Maximum	>200
	Average	35
Clay 7	No. of Tests	7
	Minimum	10
	Maximum	34
	Average	17

Table 2.5.4-209 (Sheet 2 of 2)
Corrected SPT $(N_1)_{60}$-Values
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	**Statistics**	**(N1)60-Value (blows/foot)**
Sand 8	No. of Tests	6
	Minimum	4
	Maximum	60
	Average	36
Clay 9	No. of Tests	6
	Minimum	9
	Maximum	22
	Average	13

Table 2.5.4-210
Corrected SPT $(N_1)_{60}$-Values Selected for Design (Power Block)

Stratum	Average Uncorrected N-Value (blows/foot)	Average Corrected $(N_1)_{60}$-Value (blows/foot)	Selected Corrected $(N_1)_{60}$-Value (blows/foot)[a]
Clay 1 (Top)	15	19	19[b]
Sand 1	26	29	29
Clay 1 (Bottom)	15	19	19[b]
Sand 2	30	26	26
Clay 3	25	19	19
Sand 4	82	55	55
Clay 5 (Top)	26	16	16[c]
Sand 5	62	39	39
Clay 5 (Bottom)	26	16	16[c]
Sand 6	98	61	61
Clay 7	66	40	40
Sand 8	118	76	76
Clay 9	50	31	31
Sand 10	164	107	100
Clay 11	45	30	30
Sand 12	100	61	61
Clay 13	44	28	28
Sand 14	102	66	66
Clay 15	55	33	33
Sand 16	111	69	69
Clay 17	69	45	45
Sand 18	166	100	100

a. Selected $(N_1)_{60}$ values are limited to 100 blows per foot.

b. A single $(N_1)_{60}$ value for Clay 1 (Top) and Clay 1 (Bottom) is selected.

c. A single $(N_1)_{60}$ value for Clay 5 (Top) and Clay 5 (Bottom) is selected.

Table 2.5.4-211
Corrected SPT $(N_1)_{60}$-Values Selected for Design
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Average Uncorrected N-Value (blows/foot)	Average Corrected $(N_1)_{60}$-Value (blows/foot)	Selected Corrected $(N_1)_{60}$-Value (blows/foot)[a]
Clay 1 (Top)	13	20	21[b]
Sand 1	23	30	30
Clay 1 (Bottom)	20	21	21[b]
Sand 2	43	38	38
Clay 3	20	16	16
Sand 4	50	34	34
Clay 5 (Top)	35	22	20[c]
Sand 5	72	42	42
Clay 5 (Bottom)	24	14	20[c]
Sand 6	70	35	35
Clay 7	37	17	17
Sand 8	98	36	36
Clay 9	41	13	13

a. Selected $(N_1)_{60}$ values are limited to 100 blows per foot.

b. A single $(N_1)_{60}$ value for Clay 1 (Top) and Clay 1 (Bottom) is selected.

c. A single $(N_1)_{60}$ value for Clay 5 (Top) and Clay 5 (Bottom) is selected.

Table 2.5.4-212
Cone Penetration Test q_t, q_{c1n}, f_s, and R_f-Values
(Power Block)

Stratum	Statistics	Unit 1				Unit 2				Inside Power Block				Outside Power Block			
		q_t (tsf)	q_{c1n}	f_s (tsf)	R_f (%)	q_t (tsf)	q_{c1n}	f_s (tsf)	R_f (%)	q_t (tsf)	q_{c1n}	f_s (tsf)	R_f (%)	q_t (tsf)	q_{c1n}	f_s (tsf)	R_f (%)
Clay 1 (Top)	No. of Tests	898	898	898	898	685	685	685	685	1583	1583	1583	1583	62	62	62	62
	Minimum	3.5	5.6	0.0	0.0	3.1	4.9	0.0	0.1	3.1	4.9	0.0	0.0	10.8	17.3	0.1	0.5
	Maximum	136.2	173.6	6.9	8.0	128.3	146.5	6.1	8.0	136.2	173.6	6.9	8.0	57.6	77.4	2.6	8.0
	Average	43.7	45.6	2.2	5.1	35.6	38.2	1.7	4.8	40.2	42.4	2.0	5.0	40.7	41.6	1.8	4.5
Sand 1[a]	No. of Tests	—	—	—	—	189	189	189	189	189	189	189	189	—	—	—	—
	Minimum	—	—	—	—	43.3	21.2	1.5	0.6	43.3	21.2	1.5	0.6	—	—	—	—
	Maximum	—	—	—	—	820.3	555.6	13.2	8.0	820.3	555.6	13.2	8.0	—	—	—	—
	Average	—	—	—	—	211.6	142.7	4.6	2.8	211.6	142.7	4.6	2.8	—	—	—	—
Clay 1 (Bottom)	No. of Tests	465	465	465	465	439	439	439	439	904	904	904	904	35	35	35	35
	Minimum	31.0	12.9	1.1	1.7	35.6	14.1	1.3	1.2	31.0	12.9	1.1	1.2	39.3	17.5	1.3	2.1
	Maximum	194.9	119.3	8.0	7.5	182.4	108.0	8.2	8.0	194.9	119.3	8.2	8.0	168.2	101.0	6.6	8.0
	Average	50.6	23.7	2.1	4.2	65.0	29.9	2.6	4.2	57.6	26.7	2.3	4.2	75.5	34.5	2.6	3.6
Sand 2	No. of Tests	320	320	320	320	236	236	236	236	556	556	556	556	22	22	22	22
	Minimum	42.0	14.9	1.0	0.7	58.8	19.5	1.6	0.5	42.0	14.9	1.0	0.5	119.9	55.3	2.2	1.1
	Maximum	485.2	289.0	11.9	8.0	7.5	414.5	16.0	7.9	485.2	414.5	16.0	8.0	545.9	295.9	12.2	7.0
	Average	165.2	95.4	4.1	2.8	245.7	138.7	5.1	2.4	199.4	113.8	4.5	2.6	305.9	166.7	6.3	2.4
Clay 3	No. of Tests	770	770	770	770	562	562	562	562	1332	1332	1332	1332	52	52	52	52
	Minimum	26.5	8.3	0.6	0.7	30.9	8.3	0.8	1.5	26.5	8.3	0.6	0.7	32.2	8.8	1.4	2.1
	Maximum	584.2	316.3	10.4	8.0	214.3	109.5	9.4	8.0	584.2	316.3	10.4	8.0	126.7	38.6	8.3	8.0
	Average	81.6	31.7	2.6	3.6	54.3	17.2	2.0	3.8	69.4	25.5	2.4	3.7	49.6	13.8	2.4	4.9
Sand 4[b]	No. of Tests	280	280	280	280	330	330	330	330	610	610	610	610	22	22	22	22
	Minimum	35.8	9.7	0.8	0.2	45.1	11.7	1.1	0.4	35.8	9.7	0.8	0.2	147.0	42.8	1.9	1.0
	Maximum	795.4	386.5	13.2	8.0	819.8	394.7	17.3	8.0	819.8	394.7	17.3	8.0	506.2	234.9	11.4	5.4
	Average	215.2	100.8	3.7	2.3	280.6	131.8	5.1	2.4	250.6	117.6	4.5	2.3	280.8	130.7	5.7	2.1

a. Sand 1 is absent at Unit 1. Inside Power Block Stratum Sand 1 values use the Unit 2 Stratum Sand 1 values.

b. Refusal was encountered at all CPT locations within Stratum Sand 4.

Table 2.5.4-213
Cone Penetration Test q_t, q_{c1n}, f_s, and R_f-Values
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Statistics	q_t (tsf)	q_{c1n}	f_s (tsf)	R_f (%)
Clay 1 (Top)	No. of Tests	273	273	273	273
	Minimum	5.06	8.13	0.03	0.16
	Maximum	69.44	111.57	5.84	7.99
	Average	22.89	36.52	1.29	5.36
Sand 1	No. of Tests	731	731	731	731
	Minimum	3.51	5.64	0.07	0.46
	Maximum	602.30	435.68	11.63	7.99
	Average	139.45	135.48	2.78	2.67
Clay 1 (Bottom)	No. of Tests	826	826	826	826
	Minimum	5.30	8.51	0.04	0.52
	Maximum	352.31	259.72	8.98	7.99
	Average	51.80	32.87	2.23	4.51
Sand 2	No. of Tests	895	895	895	895
	Minimum	30.60	12.32	0.59	0.20
	Maximum	823.72	519.33	16.71	5.94
	Average	230.31	152.35	4.12	2.03
Clay 3	No. of Tests	334	334	334	334
	Minimum	19.25	5.75	0.58	0.83
	Maximum	228.28	165.24	7.61	6.00
	Average	63.97	25.44	2.03	3.40
Sand 4	No. of Tests	448	448	448	448
	Minimum	23.95	8.50	0.64	0.24
	Maximum	817.34	500.35	12.61	7.36
	Average	238.71	132.75	2.78	1.50
Clay 5 (Top)	No. of Tests	70	70	70	70
	Minimum	24.54	7.20	0.45	0.89
	Maximum	87.08	48.34	4.16	6.13
	Average	45.96	12.20	1.41	2.96
Sand 5	No. of Tests	52	52	52	52
	Minimum	62.90	17.08	0.38	0.37
	Maximum	639.82	356.77	8.37	4.73
	Average	298.76	161.62	3.48	1.25

Table 2.5.4-214
Laboratory Testing Summary
(Power Block)

Laboratory Test	Industry Standard	No. of Tests[a]
Natural Moisture Content	Reference 2.5.4-234	306 {3}
Atterberg Limits	Reference 2.5.4-235	306
Sieve and Hydrometer Analysis	Reference 2.5.4-236 Reference 2.5.4-237	297 {3}
Specific Gravity	Reference 2.5.4-238	86 {3}
Unit Weight	Included with Related ASTM Standards	71
Unconsolidated Undrained (UU) Triaxial Compressive Strength	Reference 2.5.4-239	31
Consolidated Undrained (CU) Triaxial Compressive Strength	Reference 2.5.4-240	5
Direct Shear Strength	Reference 2.5.4-241	9 {3}
Consolidation/Stress-Controlled	Reference 2.5.4-244	29
Moisture-Density Relationship/Modified Proctor Compaction	Reference 2.5.4-217	8 {6}
California Bearing Ratio	Reference 2.5.4-246	8
pH	Reference 2.5.4-247	59 {3}
Chloride Content	Reference 2.5.4-248	59 {3}
Sulphate Content	Reference 2.5.4-248	59 {3}
Resonant Column Torsional Shear (RCTS)	Reference 2.5.4-243	16

[a] Values shown in “{ }” symbols denote the numbers of tests made on bulk samples of structural fill materials.

Table 2.5.4-215
Laboratory Testing Summary
(Cooling Basin/GBRA Storage Water Reservoir)

Laboratory Test	Industry Standard	No. of Tests[a]
Natural Moisture Content	Reference 2.5.4-234	246 {2}
Atterberg Limits	Reference 2.5.4-235	232
Sieve and Hydrometer Analysis	Reference 2.5.4-236 Reference 2.5.4-237	232 {2}
Specific Gravity	Reference 2.5.4-238	104 {2}
Unit Weight	Included with Related ASTM Standards	52
Unconsolidated Undrained (UU) Triaxial Compressive Strength	Reference 2.5.4-239	10
Consolidated Undrained (CU) Triaxial Compressive Strength	Reference 2.5.4-240	9
Direct Shear Strength	Reference 2.5.4-241	9 {2}
Direct Simple Shear Strength	Reference 2.5.4-242	22
Consolidation/Stress-Controlled	Reference 2.5.4-244	13
Consolidation/Constant Rate-of-Strain	Reference 2.5.4-245	22
Moisture-Density Relationship/Modified Proctor Compaction	Reference 2.5.4-217	21 {2}
pH	Reference 2.S.4-248	{2}
Chloride Content	Reference 2.5.4-248	{2}
Sulphate Content	Reference 2.5.4-248	{2}
Resonant Column Torsional Shear (RCTS)	Reference 2.5.4-243	2
Hydraulic Conductivity	Reference 2.5.4-249	14

[a] Values shown in “{ }” symbols denote the numbers of tests made on bulk samples of drainage sand materials.

Table 2.5.4-216 (Sheet 1 of 4)
General Physical and Chemical Properties Test Results
(Power Block)

Stratum/ Statistics	USCS Group Symbol	Natural Moisture Content (percent)	Total Unit Weight, γ_t (pcf)	Specific Gravity, G_s	Initial Void Ratio, e_0	Liquid Limit (percent)	Plasticity Index (percent)	Gravel (percent)	Sand (percent)	Fines Content/ Silt and Clay (percent)	pH	Chloride Content (mg/kg)	Sulphate Content (mg/kg)
Clay 1 (Top)													
No. of Tests	SC-SM, CL, CH	69	9	12	7	69	69	61	61	63	17	17	17
Minimum		11.1	122.5	2.67	0.43	26	6	0.0	1.1	62.2	7.2	4.4	3.9
Maximum		43.5	134.6	2.75	0.72	84	61	1.0	56.9	98.5	8.7	683	4290
Average		19.3	130.6	2.70	0.53	50	33	0.0	19.8	79.8	8.2	—	—
Sand 1													
No. of Tests	SC	3	—	2	—	3	3	4	4	3	1	1	1
Minimum		13.4	—	2.67	—	25	8	0.0	51.3	33.8	8.9	21.6	43.8
Maximum		19.1	—	2.70	—	30	16	0.0	66.2	48.7	8.9	21.6	43.8
Average		16.0	—	2.68	—	28	13	0.0	56.6	42.3	8.9	—	—
Clay 1 (Bottom)													
No. of Tests	SC, CL, CH	34	10	6	7	34	34	22	22	28	8	8	8
Minimum		14.1	123.5	2.67	0.42	24	8	0.0	0.7	46.7	8.1	5.4	3.8
Maximum		32.6	135.0	2.75	0.78	96	61	0.1	46.8	99.3	9.0	630	573
Average		21.9	127.8	2.70	0.63	60	39	0.0	20.1	81.0	8.4	—	—
Sand 2													
No. of Tests	SM, SC, CL-ML, CL	13	1	6	—	13	13	16	16	17	4	4	4
Minimum		14.3	135.6	2.66	—	16	1	0.0	32.0	13.3	8.8	8.1	3.6
Maximum		22.8	135.6	2.68	—	47	27	12.3	86.7	48.9	9.0	39.0	59.2
Average		18.6	135.6	2.66	—	28	12	0.9	58.4	40.3	8.9	—	—
Clay 3													
No. of Tests	SC, SC-SM, CL, CH	38	6	13	4	38	38	34	34	35	10	10	10
Minimum		14.1	115.2	2.65	0.66	26	7	0.0	2.1	15.3	8.1	7.0	19.5
Maximum		36.8	123.1	2.75	0.84	96	69	18.2	85.6	97.9	8.7	223	135
Average		23.0	118.5	2.69	0.78	53	33	0.7	29.8	73.3	8.5	—	—
Sand 4													
No. of Tests	SP-SM, SP-SC, SM, SC, CL-ML, CL	21	5	14	4	21	21	27	27	26	8	8	8
Minimum		10.8	119.9	2.65	0.38	20	5	0.0	17.6	2.0	8.0	18.6	18.7
Maximum		31.7	141.0	2.73	0.68	80	56	2.0	97.7	51.9	8.8	455	108
Average		17.4	132.2	2.67	0.58	34	18	0.2	63.3	25.3	8.6	—	—

Table 2.5.4-216 (Sheet 2 of 4)
General Physical and Chemical Properties Test Results
(Power Block)

Stratum/ Statistics	USCS Group Symbol	Natural Moisture Content (percent)	Total Unit Weight, γ_t (pcf)	Specific Gravity, G_s	Initial Void Ratio, e_0	Liquid Limit (percent)	Plasticity Index (percent)	Gravel (percent)	Sand (percent)	Fines Content/ Silt and Clay (percent)	pH	Chloride Content (mg/kg)	Sulphate Content (mg/kg)
Clay 5 (Top)													
No. of Tests	SC, CL, MH, CH	17	4	5	2	17	17	13	13	13	5	5	5
Minimum		16.9	116.6	2.66	0.45	32	18	0.0	4.7	57.1	8.3	34.7	23.8
Maximum		34.9	135.1	2.76	0.52	98	72	1.8	41.1	95.3	8.6	80.3	44
Average		27.1	127.4	2.71	0.49	67	44	0.1	15.5	84.3	8.5	—	—
Sand 5													
No. of Tests	SP-SC, SC, SC-SM, CL	6	—	7	—	6	6	9	9	10	3	3	3
Minimum		13.0	—	2.65	—	19	5	0.0	55.9	9.3	8.6	38.1	17
Maximum		22.8	—	2.75	—	29	14	1.9	90.7	44.1	8.8	93.4	22.9
Average		19.7	—	2.67	—	22	9	0.2	76.6	23.2	8.7	—	—
Clay 5 (Bottom)													
No. of Tests	SP-SC, ML, CL, CH	12	4	3	2	12	12	10	10	9	3	3	3
Minimum		15.1	121	2.68	0.60	31	18	0.0	4.6	52.8	8.7	14.6	11.9
Maximum		33.0	128.4	2.72	0.65	84	62	0.0	47.2	95.4	8.9	59.2	24.2
Average		22.3	125.9	2.70	0.63	50	34	0.0	20.3	80.0	8.7	—	—
Sand 6													
No. of Tests	SP-SM, SP-SC, SM, SC	5	—	8	7	5	5	26	26	26	—	—	—
Minimum		15.3	—	2.65	0.48	14	4	0.0	51.2	7.3	—	—	—
Maximum		21.2	—	2.67	0.68	21	9	5.1	91.9	48.8	—	—	—
Average		19.0	—	2.66	0.59	18	7	0.7	83.6	15.7	—	—	—
Clay 7													
No. of Tests	CL, CH	15	1	1	—	15	15	13	13	13	—	—	—
Minimum		13.5	124.9	2.69	—	26	15	0.0	6.2	54.9	—	—	—
Maximum		31.1	124.9	2.69	—	97	67	0.0	45.1	93.8	—	—	—
Average		21.0	124.9	2.69	—	51	31	0.0	22.6	77.4	—	—	—
Sand 8													
No. of Tests	SC-SM, SC, CL, CH	12	4	3	12	12	12	13	13	13	—	—	—
Minimum		14.1	130.5	2.65	0.39	18	6	0.0	45.2	9.5	—	—	—
Maximum		30.3	132.5	2.70	0.62	60	38	0.0	90.5	48.9	—	—	—
Average		20.8	131.9	2.67	0.50	30	16	0.0	70.3	27.6	—	—	—

Table 2.5.4-216 (Sheet 3 of 4)
General Physical and Chemical Properties Test Results
(Power Block)

Stratum/ Statistics	USCS Group Symbol	Natural Moisture Content (percent)	Total Unit Weight, γ_t (pcf)	Specific Gravity, G_s	Initial Void Ratio, e_0	Liquid Limit (percent)	Plasticity Index (percent)	Gravel (percent)	Sand (percent)	Fines Content/ Silt and Clay (percent)	pH	Chloride Content (mg/kg)	Sulphate Content (mg/kg)
Clay 9													
No. of Tests	CL, MH, CH	18	12	2	7	18	18	9	9	9	—	—	—
Minimum		15.3	115.2	2.71	0.45	35	19	0.0	1.5	80.9	—	—	—
Maximum		29.1	135.2	2.72	0.82	73	51	0.0	19.1	98.5	—	—	—
Average		23.6	125.7	2.72	0.64	59	37	0.0	11.6	88.4	—	—	—
Sand 10													
No. of Tests	SM, SC	—	—	2	6	—	—	2	2	2	—	—	—
Minimum		—	—	2.69	0.46	—	—	0.0	70.1	22.5	—	—	—
Maximum		—	—	2.71	0.63	—	—	0.0	75.5	29.9	—	—	—
Average		—	—	2.70	0.57	—	—	0.0	72.8	26.2	—	—	—
Clay 11													
No. of Tests	SC, CL, MH, CH	21	11	1	6	21	21	14	14	14	—	—	—
Minimum		18.2	113.6	2.72	0.67	31	16	0.0	3.2	55.4	—	—	—
Maximum		36.7	127.5	2.72	1.00	95	66	0.0	73.6	96.8	—	—	—
Average		28.1	118.9	2.72	0.78	63	38	0.0	19.1	85.1	—	—	—
Sand 12													
No. of Tests	CL	3	—	—	—	3	3	—	—	2	—	—	—
Minimum		13.9	—	—	—	36	17	—	—	80.9	—	—	—
Maximum		14.7	—	—	—	48	30	—	—	56.8	—	—	—
Average		14.3	—	—	—	42	23	—	—	83.9	—	—	—
Clay 13													
No. of Tests	ML, CH	10	3	—	1	10	10	—	—	7	—	—	—
Minimum		20.2	122.8	—	0.76	39	13	—	—	88.0	—	—	—
Maximum		35.3	131.7	—	0.76	90	54	—	—	98.3	—	—	—
Average		27.5	126.4	—	0.76	67	40	—	—	94.3	—	—	—
Sand 14													
No. of Tests	SM, CH	2	—	—	—	2	2	—	—	3	—	—	—
Minimum		18.0	—	—	—	18	2	—	—	28.4	—	—	—
Maximum		26.1	—	—	—	52	26	—	—	36.2	—	—	—
Average		22.1	—	—	—	35	14	—	—	32.3	—	—	—

Table 2.5.4-216 (Sheet 4 of 4)
General Physical and Chemical Properties Test Results
(Power Block)

Stratum/ Statistics	USCS Group Symbol	Natural Moisture Content (percent)	Total Unit Weight, γ_t (pcf)	Specific Gravity, G_s	Initial Void Ratio, e_0	Liquid Limit (percent)	Plasticity Index (percent)	Gravel (percent)	Sand (percent)	Fines Content/ Silt and Clay (percent)	pH	Chloride Content (mg/kg)	Sulphate Content (mg/kg)
Clay 15													
No. of Tests	CH	1	—	—	—	1	1	—	—	1	—	—	—
Minimum		22.7	—	—	—	69	44	—	—	96.5	—	—	—
Maximum		22.7	—	—	—	69	44	—	—	96.5	—	—	—
Average		22.7	—	—	—	69	44	—	—	96.5	—	—	—
Sand 16													
No. of Tests	SM, SC	—	—	—	—	—	—	—	—	2	—	—	—
Minimum		—	—	—	—	—	—	—	—	19.4	—	—	—
Maximum		—	—	—	—	—	—	—	—	28.9	—	—	—
Average		—	—	—	—	—	—	—	—	24.2	—	—	—
Clay 17													
No. of Tests	CL, CH	3	1	1	—	3	3	1	1	3	—	—	—
Minimum		17.5	130.8	2.71	—	37	22	0.0	33.7	66.3	—	—	—
Maximum		19.6	130.8	2.71	—	59	40	0.0	33.7	79.4	—	—	—
Average		18.3	130.8	2.71	—	46	31	0.0	33.7	73.4	—	—	—
Sand 18													
No. of Tests	SM, CL	3	—	—	—	3	3	—	—	—	—	—	—
Minimum		12.3	—	—	—	17	2	—	—	—	—	—	—
Maximum		14.2	—	—	—	39	2	—	—	—	—	—	—
Average		13.2	—	—	—	32	2	—	—	—	—	—	—

Table 2.5.4-217 (Sheet 1 of 3)
General Physical Properties Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum/ Statistics	USCS Group Symbol	Natural Moisture Content (percent)	Total Unit Weight, γ_t (pcf)	Specific Gravity, G_s	Initial Void Ratio, e_0	Liquid Limit (percent)	Plasticity Index (percent)	Gravel (percent)	Sand (percent)	Fines Content/ Silt and Clay (percent)
Clay 1 (Top)										
No. of Tests	CH, CL, ML	76	11	23	4	42	42	45	45	45
Minimum		9.3	110.3	2.66	0.52	26	11	0.0	1.6	50.4
Maximum		31.2	131.1	2.74	0.74	81	59	0.7	49.5	98.4
Average		17.6	126.1	2.69	0.62	44	27	0.0	26.5	73.4
Sand 1										
No. of Tests	SC, SC-SM,	33	4	13	1	9	9	19	19	19
Minimum	SM, SP-SM	6.1	111.7	2.65	0.46	16	5	0.0	50.6	4.9
Maximum		24.6	133.1	2.73	0.46	37	22	0.5	95.1	49.4
Average		13.1	121.8	2.67	0.46	29	14	0.1	73.3	26.6
Clay 1 (Bottom)										
No. of Tests	CH, CL	35	5	12	1	34	34	34	34	34
Minimum		9.8	118.4	2.66	0.63	24	8	0.0	1.1	55.0
Maximum		30.2	128.5	2.78	0.63	90	58	0.0	45.0	98.9
Average		22.0	122.6	2.71	0.63	58	38	0.0	12.3	87.7
Sand 2										
No. of Tests	CL, SC,	11	4	9	2	6	6	24	24	24
Minimum	SC-SM, SM,	10.4	123.9	2.65	0.53	21	6	0.0	16.2	6.0
Maximum	ML, SP	11.8	127.8	2.72	0.63	48	35	3.8	94.0	83.8
Average		17.3	125.6	2.67	0.58	30	17	0.3	70.0	29.7
Clay 3										
No. of Tests	CH, MH, CL,	34	12	14	4	36	36	34	34	34
Minimum	SC, SP-SC,	13.7	117.8	2.66	0.56	30	13	0.0	2.5	50.3
Maximum	SM	36.6	133.0	2.78	0.88	95	66	2.7	49.7	97.4
Average		22.6	122.9	2.70	0.71	57	36	0.2	22.1	77.7

Table 2.5.4-217 (Sheet 2 of 3)
General Physical Properties Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum/ Statistics	USCS Group Symbol	Natural Moisture Content (percent)	Total Unit Weight, γ_t (pcf)	Specific Gravity, G_s	Initial Void Ratio, e_0	Liquid Limit (percent)	Plasticity Index (percent)	Gravel (percent)	Sand (percent)	Fines Content/ Silt and Clay (percent)
Sand 4										
No. of Tests	CH, CL, SC SP-SC, ML, SM, SP	16	7	12	4	6	6	32	32	31
Minimum		17.3	114.8	2.65	0.54	23	4	0.0	42.4	4.5
Maximum		30.7	129.8	2.73	0.78	68	48	8.6	94.4	57.6
Average		21.4	122.2	2.68	0.66	37	20	0.7	80.9	18.4
Clay 5 (Top)										
No. of Tests	CH, CL, SC, SM, SP-SP	19	8	10	2	17	17	15	15	15
Minimum		16.0	116.0	2.69	0.58	21	3	0.0	0.9	64.8
Maximum		26.6	133.1	2.75	0.60	77	60	4.2	35.2	99.1
Average		21.5	124.6	2.71	0.59	55	37	0.4	14.9	84.7
Sand 5										
No. of Tests	CL, SC, SC-SM, SM	7	1	3	1	6	6	12	12	12
Minimum		15.7	116.9	2.65	0.69	17	2	0.0	50.8	12.6
Maximum		24.8	116.9	2.65	0.69	36	22	0.1	87.4	49.2
Average		20.8	116.9	2.65	0.69	26	11	0.0	73.1	26.9
Clay 5 (Bottom)										
No. of Tests	CH, CL	4	—	3	—	4	4	4	4	4
Minimum		19.4	—	2.69	—	49	34	0.0	1.8	64.8
Maximum		34.0	—	2.72	—	54	38	0.0	35.2	98.2
Average		24.0	—	2.71	—	52	36	0.0	11.5	88.6
Sand 6										
No. of Tests	CH, CL, SC, SM, SP-SM	7	—	2	—	4	4	8	8	8
Minimum		14.3	—	2.65	—	27	8	2.0	65.5	8.3
Maximum		30.7	—	2.66	—	76	47	0.9	91.6	34.5
Average		21.0	—	2.66	—	47	28	0.2	78.2	21.7

Table 2.5.4-217 (Sheet 3 of 3)
General Physical Properties Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum/ Statistics	USCS Group Symbol	Natural Moisture Content (percent)	Total Unit Weight, γ_t (pcf)	Specific Gravity, G_s	Initial Void Ratio, e_0	Liquid Limit (percent)	Plasticity Index (percent)	Gravel (percent)	Sand (percent)	Fines Content/ Silt and Clay (percent)
Clay 7										
No. of Tests	CH, CL	—	—	—	—	—	—	—	—	—
Minimum		—	—	—	—	—	—	—	—	—
Maximum		—	—	—	—	—	—	—	—	—
Average		—	—	—	—	—	—	—	—	—
Sand 8										
No. of Tests	SC, SM	2	—	2	—	2	2	3	3	3
Minimum		16.8	—	2.65	—	23	10	0.0	56.7	27.4
Maximum		22.6	—	2.66	—	24	11	0.0	72.6	43.3
Average		19.7	—	2.66	—	24	11	0.0	64.0	36.0
Clay 9										
No. of Tests	CH, CL	2	—	1	—	2	2	2	2	2
Minimum		24.9	—	2.69	—	49	24	0.0	4.1	80.4
Maximum		32.1	—	2.69	—	67	40	0.0	19.6	95.9
Average		28.5	—	2.69	—	58	37	0.0	11.9	88.2

Table 2.5.4-218 (Sheet 1 of 4)
Laboratory Strength Test Results
(Power Block)

										UU Tests[a]		CIU-Bar-Tests[a]				DS Tests[a]	
Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/ Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)
Stratum Clay 1 (Top)																	
B-2174UD	UD1	10.0	69.6	130.4	16.7	37	24	CL	CU	—	—	400	22.5	40	33.5	—	—
B-2182UD	UD1	10.0	69.5	128.8	14.0	37	23	CL	UU	3920	—	—	—	—	—	—	—
B-2269UD	UD1	10.0	70.1	134.5	17.6	40	24	CL	UU	3880	—	—	—	—	—	—	—
B-2269UD	UD2	13.0	67.1	129.0	23.0	53	32	CH	UU	2460	—	—	—	—	—	—	—
B-2274UD	UD1	10.2	70.2	130.3	19.3	—	—	CL	UU	2740	0.47	—	—	—	—	—	—
Minimum, Stratum Clay 1 (Top)				128.8	14.0	37	23	—	—	2460	0.47	400	22.5	40	33.5	—	—
Maximum, Stratum Clay 1 (Top)				134.5	23.0	53	32	—	—	3920	0.47	400	22.5	40	33.5	—	—
Average, Stratum Clay 1 (Top)				130.6	18.1	42	26	—	—	3250	0.47	400	22.5	40	33.5	—	—
Stratum Clay 1 (Bottom)																	
B-2182UD	UD5	33.0	45.7	126.0	29.6	68	42	CH	UU	2860	—	—	—	—	—	—	—
B-2269UD	UD3	30.0	50.1	135.0	15.8	34	19	CL	UU	4800	0.53	—	—	—	—	—	—
B-2269UD	UD4	33.0	47.1	134.2	15.0	34	17	CL	UU	3920	—	—	—	—	—	—	—
B-2269UD	UD5	50.0	30.1	127.5	21.5	59	36	CH	UU	3060	0.22	—	—	—	—	—	—
Minimum, Stratum Clay 1 (Bottom)				126.0	15.0	34	17	—	—	2860	0.22	—	—	—	—	—	—
Maximum, Stratum Clay 1 (Bottom)				135.0	29.6	68	42	—	—	4800	0.53	—	—	—	—	—	—
Average, Stratum Clay 1 (Bottom)				130.7	20.5	49	29	—	—	3660	0.38	—	—	—	—	—	—
Stratum Clay 3																	
B-2182UD	UD7	65.0	14.5	116.6	25.0	27	10	SC	UU	3100	0.27	—	—	—	—	—	—
B-2269UD	UD7	70.0	10.1	115.2	28.3	74	44	CH	UU	2360	0.11	—	—	—	—	—	—
B-2269UD	UD8	73.0	7.1	123.1	22.4	65	40	CH	UU	4340	—	—	—	—	—	—	—
B-2274UD	UD4	67.0	13.4	119.9	28.1	79	46	CH	UU	2840	0.17	—	—	—	—	—	—
Minimum, Stratum Clay 3				115.2	22.4	27	10	—	—	2360	0.11	—	—	—	—	—	—
Maximum, Stratum Clay 3				123.1	28.3	79	46	—	—	4340	0.27	—	—	—	—	—	—
Average, Stratum Clay 3				118.7	26.0	61	35	—	—	3160	0.18	—	—	—	—	—	—

Table 2.5.4-218 (Sheet 2 of 4)
Laboratory Strength Test Results
(Power Block)

Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	UU Tests[a]		CIU-Bar-Tests[a]				DS Tests[a]	
										Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/ Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)
Stratum Sand 4																	
B-2182UD	UD11	90.5	–11.0	141.0	12.3	25	12	CL	UU	7880	0.52	—	—	—	—	—	—
B-2182UD	UD12B	95.0	–15.5	113.3	17.7	—	—	SP-SM	DS	—	—	—	—	—	—	100	39.2
Minimum, Stratum Sand 4				113.3	12.3	25	12	—	—	7880	0.52	—	—	—	—	100	39.2
Maximum, Stratum Sand4 4				141.0	17.7	25	12	—	—	7880	0.52	—	—	—	—	100	39.2
Average, Stratum Sand 4				127.2	15.0	25	12	—	—	7880	0.52	—	—	—	—	100	39.2
Stratum Clay 5 (Top)																	
B-2182UD	UD13	120.0	–40.5	131.8	18.7	38	21	SC	UU	6020	0.29	—	—	—	—	—	—
B-2269UD	UD10	123.0	–42.9	135.1	17.4	69	43	CH	UU	4120	—	—	—	—	—	—	—
Minimum, Stratum Sand 5				131.8	17.4	38	21	—	—	4120	0.29	—	—	—	—	—	—
Maximum, Stratum Sand 5				135.1	18.7	69	43	—	—	6020	0.29	—	—	—	—	—	—
Average, Stratum Sand 5				133.5	18.1	54	32	—	—	5070	0.29	—	—	—	—	—	—
Stratum Clay 5 (Bottom)																	
B-2182UD	UD15	145.0	–65.5	128.4	25.3	NV	NP	ML	UU	2900	0.16	—	—	—	—	—	—
B-2269UD	UD11	150.0	–69.9	127.9	21.8	50	28	CH	UU	5900	0.25	—	—	—	—	—	—
Minimum, Stratum Clay 5 (Bottom)				127.9	21.8	50	28	—	—	2900	0.16	—	—	—	—	—	—
Maximum, Stratum Clay 5 (Bottom)				128.4	25.3	50	28	—	—	5900	0.25	—	—	—	—	—	—
Average, Stratum Clay 5 (Bottom)				128.2	23.6	50	28	—	—	4400	0.21	—	—	—	—	—	—
Stratum Sand 6																	
B-2174UD	UD8	145.0	–65.4	118.7	17.5	—	—	SM	DS	—	—	—	—	—	—	480	34.1
B-2174UD	UD10	183.0	–103.4	127.0	15.7	—	—	SM	DS	—	—	—	—	—	—	580	35.7
B-2182UD	UD16	180.0	–100.5	123.2	15.1	—	—	SM	DS	—	—	—	—	—	—	880	36.0
Minimum, Stratum Sand 6				118.7	15.1	—	—	—	—	—	—	—	—	—	—	480	34.1
Maximum, Stratum Sand 6				127.0	17.5	—	—	—	—	—	—	—	—	—	—	880	36.0
Average, Stratum Sand 6				123.0	16.1	—	—	—	—	—	—	—	—	—	—	647	35.3

Table 2.5.4-218 (Sheet 3 of 4)
Laboratory Strength Test Results
(Power Block)

										UU Tests[a]		CIU-Bar-Tests[a]				DS Tests[a]	
Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/ Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)
Stratum Sand 8																	
B-2174UD	UD15	265.0	–185.4	129.5	19.3	26	12	SC	DS	—	—	—	—	—	—	0	33.7
B-2269UD	UD16	280.0	–199.5	127.5	18.6	26	9	SC	DS	—	—	—	—	—	—	400	34.0
B-2274UD	UD12	221.1	–140.7	126.6	10.3	—	—	SC	DS	—	—	—	—	—	—	600	31.9
B-2274UD	UD13	240.0	–159.6	131.8	15.6	32	17	CL	CU	—	—	6000	0.0	6000	0.0	—	—
Minimum, Stratum Sand 8				126.6	10.3	26	9	—	—	—	—	6000	0.0	6000	0.0	0	31.9
Maximum, Stratum Sand 8				131.8	19.3	32	17	—	—	—	—	6000	0.0	6000	0.0	600	34.0
Average, Stratum Sand 8				128.9	16.0	28	13	—	—	—	—	6000	0.0	6000	0.0	333	33.2
Stratum Clay 9																	
B-2182UD	UD25	303.0	–223.5	119.7	25.1	52	26	CH	UU	4720	0.11	—	—	—	—	—	—
B-2182UD	UD26	320.0	–240.5	133.2	15.5	35	19	CL	UU	9460	0.26	—	—	—	—	—	—
B-2182UD	UD28	330.0	–250.5	124.5	28.0	69	40	CH	UU	5840	—	—	—	—	—	—	—
B-2182UD	UD30	340.0	–260.5	135.2	15.0	43	26	CL	UU	10560	0.28	—	—	—	—	—	—
B-2182UD	UD31	343.0	–263.5	134.2	15.8	47	29	CL	UU	13460	—	—	—	—	—	—	—
B-2274UD	UD16	320.0	–239.6	119.3	25.0	58	31	CH	UU	7800	0.18	—	—	—	—	—	—
B-2274UD	UD17	380.0	–299.6	123.3	24.3	72	37	MH	UU	5740	—	—	—	—	—	—	—
Minimum, Stratum Clay 9				119.3	15.0	35	19	—	—	4720	0.11	—	—	—	—	—	—
Maximum, Stratum Clay 9				135.2	28.0	72	40	—	—	13460	0.28	—	—	—	—	—	—
Average, Stratum Clay 9				127.1	21.2	54	30	—	—	8226	0.21	—	—	—	—	—	—
Stratum Sand 10																	
B-2274UD	UD18	330.1	–249.7	126.1	14.0	—	—	—	DS	—	—	—	—	—	—	2600	30.8
B-2274UD	UD19	350.1	–269.7	126.2	20.5	—	—	—	DS	—	—	—	—	—	—	0	36.0
Minimum, Stratum Sand 10				126.1	14.0	—	—	—	—	—	—	—	—	—	—	0	30.8
Maximum, Stratum Sand 10				126.2	20.5	—	—	—	—	—	—	—	—	—	—	2600	36.0
Average, Stratum Sand 10				126.2	17.3	—	—	—	—	—	—	—	—	—	—	1300	33.4

Table 2.5.4-218 (Sheet 4 of 4)
Laboratory Strength Test Results
(Power Block)

										UU Tests[a]		CIU-Bar-Tests[a]				DS Tests[a]	
Boring Number	**Sample Number**	**Sample Top Depth (feet)**	**Sample Top Elevation (feet)[b]**	**Total Unit Weight (pounds/ cubic foot)**	**Natural Moisture Content (percent)**	**Liquid Limit (percent)**	**Plasticity Index (percent)**	**USCS Group**	**Test Type**	**Undrained Shear Strength (pounds per square foot)**	**Ratio, Undrained Shear Strength/ Preconsolidation Pressure**	**Undrained Cohesion (pounds per square foot)**	**Undrained Friction Angle (degrees)**	**Drained Cohesion (pounds per square foot)**	**Drained Friction Angle (degrees)**	**Drained Cohesion (pounds per square foot)**	**Drained Friction Angle (degrees)**
Stratum Clay 11																	
B-2182UD	UD33	380.0	–300.5	114.5	32.2	68	36	CH	UU	7800	0.18	—	—	—	—	—	—
B-2182UD	UD37	400.0	–320.5	127.4	23.6	49	24	CL	UU	5060	0.17	—	—	—	—	—	—
B-2269UD	UD18	375.0	–294.5	127.3	22.3	46	32	CL	UU	3800	—	—	—	—	—	—	—
B-2269UD	UD20	400.0	–319.5	127.5	24.1	88	32	CH	UU	4260	0.15	—	—	—	—	—	—
B-2274UD	UD20	380.0	–299.6	117.4	31.0	70	35	MH	UU	6540	0.14	—	—	—	—	—	—
B-2274UD	UD22	400.0	–319.6	121.5	25.6	56	31	CH	UU	6400	0.13	—	—	—	—	—	—
Minimum, Stratum Clay 11				114.5	22.3	46.0	24.0	—	—	3800	0.13	—	—	—	—	—	—
Maximum, Stratum Clay 11				127.5	32.2	88.0	36.0	—	—	7800	0.18	—	—	—	—	—	—
Average, Stratum Clay 11				122.6	26.5	62.8	31.7	—	—	5643	0.15	—	—	—	—	—	—
Stratum Clay 13																	
B-2174UDR	UD26	445.0	–366.1	124.6	26.2	65	40	CH	UU	6080	0.12	—	—	—	—	—	—
Minimum, Stratum Clay 11				124.6	26.2	65.0	40.0	—	—	6080	0.12	—	—	—	—	—	—
Maximum, Stratum Clay 11				124.6	26.2	65.0	40.0	—	—	6080	0.12	—	—	—	—	—	—
Average, Stratum Clay 11				124.6	26.2	65.0	40.0	—	—	6080	0.12	—	—	—	—	—	—
Structural Fill Materials																	
Fordyce Raw Material																	
3/8" sieved material			—	128.5[c]	12.4[c]	—	—	SP	DS	—	—	—	—	—	—	0	40.0
CW&A Texas DOT Grade 4 Material																	
3/8" sieved material			—	138.1[c]	5.7[c]	—	—	GW-GC	DS	—	—	—	—	—	—	0	42.0
CW&A Texas DOT Grade 6 Material																	
3/8" sieved material			—	134.6[c]	6.2[c]	—	—	GW-GC	DS	—	—	—	—	—	—	0	39.0

a. UU = unconsolidated undrained triaxial compression test. CIU-Bar = consolidated undrained triaxial compression test with pore pressures measured. DS = direct shear test.

b. Elevations are referenced to NAVD 88.

c. Compacted density and moisture content.

Table 2.5.4-219 (Sheet 1 of 5)
Laboratory Strength Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

										UU Tests[a]		CIU-Bar Tests[a]				DS Tests[a]		DSS Tests[a]			
Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Vertical Consolidation Stress (pounds/ square foot)	Horizontal Shear Stress (pounds/square foot)	Shear Strain, (%)	Effective Vertical Stress, σ_v' (pounds/square foot)
Stratum Clay 1 (Top)																					
B-2304UD	UD2	11.0	57.5	110.3	11.9	—	—	ML	DS	—	—	—	—	—	—	0	41.3	—	—	—	—
B-2321UD	UD1	3.5	68.3	119.1	18.3	42	29	CL	DSS	—	—	—	—	—	—	—	—	760	330	29.6	440
B-2321UD	UD3	10.0	61.8	126.1	16.8	51	35	CH	DSS	—	—	—	—	—	—	—	—	1460	1410	29.4	2150
B-2321UD	UD4	13.5	58.3	118.0	21.7	81	59	CH	DSS	—	—	—	—	—	—	—	—	1460	990	23.7	1690
B-2321UD	UD5	17.0	54.8	118.3	19.5	40	25	CL	DSS	—	—	—	—	—	—	—	—	2220	820	11.7	1220
B-2352UD	UD1	3.5	59.3	131.1	18.3	46	27	CL	UU	2660	0.20	—	—	—	—	—	—	—	—	—	—
B-2352UD	UD3	11.5	51.3	128.9	18.6	39	21	CL	UU	2420	0.18	—	—	—	—	—	—	—	—	—	—
B-2352UD	UD5	24.0	38.8	123.6	22.7	—	—	CH	UU	2420	—	—	—	—	—	—	—	—	—	—	—
Minimum, Stratum Clay 1 (Top)				110.3	11.9	39	21	—	—	2420	0.18	—	—	—	—	0	41.3	760	330	11.7	440
Maximum, Stratum Clay 1 (Top)				131.1	22.7	81	59	—	—	2660	0.20	—	—	—	—	0	41.3	2220	1410	29.6	2150
Average, Stratum Clay 1 (Top)				121.9	18.5	50	33	—	—	2500	0.19	—	—	—	—	0	41.3	1475	888	23.6	1375
Stratum Sand 1																					
B-2302UD	UD3	13.5	66.5	121.3	17.4	NV	NP	SM	CU	—	—	3700	29.0	0	35.0	—	—	—	—	—	—
B-2319UD	UD2	5.5	68.7	133.1	13.7	37	21	SC	UU	4320	—	—	—	—	—	—	—	—	—	—	—
Minimum, Stratum Sand 1				121.3	13.7	37	21	—	—	4320	—	3700	29.0	0	35.0	—	—	—	—	—	—
Maximum, Stratum Sand 1				133.1	17.4	37	21	—	—	4320	—	3700	29.0	0	35.0	—	—	—	—	—	—
Average, Stratum Sand 1				127.2	15.6	37	21	—	—	4320	—	3700	29.0	0	35.0	—	—	—	—	—	—
Stratum Clay 1 (Bottom)																					
B-2319UD	UD4	25.0	49.2	130.0	18.7	61	45	CH	DSS	—	—	—	—	—	—	—	—	2930	2420	20.3	4720
B-2321UD	UD6	28.5	43.3	116.6	25.0	75	55	CH	DSS	—	—	—	—	—	—	—	—	3630	1340	23.8	2490
B-2321UD	UD8	48.5	23.3	117.0	29.9	64	48	CH	DSS	—	—	—	—	—	—	—	—	5780	2900	3.9	4440
B-2359UD	UD4	35.0	42.4	128.6	22.3	68	51	CH	DSS	—	—	—	—	—	—	—	—	4350	2580	11.8	5360
B-2359UD	UD5	40.0	38.9	126.2	23.0	65	47	CH	DSS	—	—	—	—	—	—	—	—	5050	2380	8.8	5190
B-2321	UD7	38.5	33.3	122.4	14.8	60	37	CH	UU	3920	0.38	—	—	—	—	—	—	—	—	—	—

Table 2.5.4-219 (Sheet 2 of 5)
Laboratory Strength Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

										UU Tests[a]		CIU-Bar Tests[a]				DS Tests[a]		DSS Tests[a]			
Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Vertical Consolidation Stress (pounds/ square foot)	Horizontal Shear Stress (pounds/square foot)	Shear Strain, (%)	Effective Vertical Stress, σ_v' (pounds/square foot)
Stratum Clay 1 (Bottom) (continued)																					
Minimum, Stratum Clay 1 (Bottom)				116.6	14.8	60.0	37.0	—	—	3920	0.38	—	—	—	—	—	—	2930	1340	3.9	2490
Maximum, Stratum Clay 1 (Bottom)				130.0	29.9	75.0	55.0	—	—	3920	0.38	—	—	—	—	—	—	5780	2900	23.8	5360
Average, Stratum Clay 1 (Bottom)				123.5	22.3	65.5	47.2	—	—	3920	0.38	—	—	—	—	—	—	4348	2324	13.7	4440
Stratum Sand 2																					
B-2302UD	UD7	63.5	16.5	124.7	21.1	22	6	SP-SM	DS	—	—	—	—	—	—	340	37.6	—	—	—	—
B-2302UD	UD9	55.0	25.0	123.9	14.3	—	—	ML	DS	—	—	—	—	—	—	480	37.9	—	—	—	—
Minimum, Stratum Sand 2				123.9	14.3	22	6	—	—	—	—	—	—	—	—	340	37.6	—	—	—	—
Maximum, Stratum Sand 2				124.7	21.1	22	6	—	—	—	—	—	—	—	—	480	37.9	—	—	—	—
Average, Stratum Sand 2				124.3	17.7	22	6	—	—	—	—	—	—	—	—	410	37.8	—	—	—	—
Stratum Clay 3																					
B-2302UD	UD10	66.0	14.0	127.0	22.5	50	28	CH	—	—	—	—	—	0	10	—	—	—	—	—	—
B-2302UD	UD11	69.5	10.5	119.7	18.5	59	34	CH	UU	3080	0.24	—	—	—	—	—	—	—	—	—	—
B-2302UD	UD12	78.5	1.5	124.2	20.8	64	43	CH	—	—	—	—	—	—	—	—	—	7910	3950	15.1	7370
B-2304UD	UD7	73.5	–8.0	117.8	27.6	69	35	MH	UU	3280	0.18	—	—	—	—	—	—	—	—	—	—
B-2304UD	UD8	83.5	–15.0	118.9	30.9	61	35	CH	—	—	—	—	—	0	14	—	—	8660	2780	6.2	6930
B-2319UD	UD7	65.0	9.2	124.2	20.1	39	22	CL	—	—	—	—	—	0	30	—	—	7200	4460	15.7	4410
B-2321UD	UD9	58.5	13.3	127.9	20.0	49	35	CL	—	—	—	—	—	0	23	—	—	6480	2170	10.1	4800
B-2321UD	UD10	63.0	8.8	133.4	15.2	36	22	CL	—	—	—	—	—	—	—	—	—	7180	3360	14.9	6510
B-2352UD	UD8	68.0	–5.2	122.8	14.4	—	—	SM	—	—	—	—	—	—	—	1440	39.4	—	—	—	—
B-2359UD	UD10	70.0	7.4	133.0	16.6	95	61	CH	—	—	—	—	—	0	30	—	—	7220	3780	12.7	7220
Minimum, Stratum Clay 3				117.8	14.4	36	22	—	—	3080	0	—	—	0	10.0	1440	39.4	6480	2170	6.2	4410
Maximum, Stratum Clay 3				133.4	30.9	95	61	—	—	3280	0	—	—	0	30.0	1440	39.4	8660	4460	15.7	7370
Average, Stratum Clay 3				124.9	20.7	58	35	—	—	3180	0	—	—	0	21.4	1440	39.4	7442	3417	12.5	6207

Table 2.5.4-219 (Sheet 3 of 5)
Laboratory Strength Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

										UU Tests[a]		CIU-Bar Tests[a]				DS Tests[a]		DSS Tests[a]			
Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/ Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Vertical Consolidation Stress (pounds/ square foot)	Horizontal Shear Stress (pounds/square foot)	Shear Strain, (%)	Effective Vertical Stress, σ_v' (pounds/square foot)
Stratum Sand 4																					
B-2302UD	UD14	108.5	–28.5	129.8	17.8	—	—	SM	DS	—	—	—	—	—	—	1020	35.5	—	—	—	—
B-2319UD	UD8	75.0	–0.8	123.0	24.6	—	—	SP-SM	UU	12,380	—	—	—	—	—	—	—	—	—	—	—
B-2321UD	UD12	93.0	–21.2	124.2	22.7	—	—	SP-SM	—	—	—	—	—	—	—	1620	36.1	—	—	—	—
B-2359UD	UD11	77.0	0.4	122.2	19.9	23	4	SC-SM	UU	7620	0.34	—	—	—	—	—	—	—	—	—	—
B-2359UD	UD12	80.0	–2.7	124.4	19.4	26	12	SC	DSS	—	—	—	—	—	—	—	—	8010	4410	25.0	7700
B-2359UD	UD14	88.5	–11.2	121.0	25.3	—	—	ML	DS	—	—	—	—	—	—	0	34.5	—	—	—	—
Minimum, Stratum Sand 4				121.0	17.8	23.0	4.0	—	—	7620	0.34	—	—	—	—	0	34.5	8010	4410	25.0	7700
Maximum, Stratum Sand 4				129.8	25.3	26.0	12.0	—	—	12,380	0.34	—	—	—	—	1620	36.1	8010	4410	25.0	7700
Average, Stratum Sand 4				124.1	21.6	24.5	8.0	—	—	10,000	0.34	—	—	—	—	880	35.4	8010	4410	25.0	7700
Stratum Clay 5 (Top)																					
B-2302UD	UD16	120.5	–40.5	123.4	25.1	76	60	CH	DSS	—	—	—	—	—	—	—	—	10,850	5520	8.5	9620
B-2302UD	UD19	145.5	–65.5	130.3	19.4	49	34	CH	DSS	—	—	—	—	—	—	—	—	12,250	7670	10.5	9470
B-2304UD	UD11	111.0	–42.5	127.1	22.7	77	58	CH	DSS	—	—	—	—	0	17.0	—	—	10,090	5690	5.2	8330
B-2304UD	UD13	121.0	–52.5	133.1	21	62	44	CH	DSS	—	—	—	—	0	22.0	—	—	10,810	6140	7.5	8450
B-2321UD	UD15	130.5	–58.7	128.5	20.3	61	44	CH	DSS	—	—	—	—	0	45.0	—	—	11,550	5070	15.7	9410
B-2359UD	UD17	110.0	–32.7	125.5	17.4	21	3	SM	UU	5800	—	—	—	—	—	—	—	—	—	—	—
B-2359UD	UD19	114.0	–36.7	124.0	17.3	—	—	SM	—	—	—	—	—	—	—	1880	36.9	—	—	—	—
Minimum, Stratum Clay 5 (Top)				123.4	17.3	21.0	3.0	—	—	5800	—	—	—	0	17.0	1880	36.9	10,090	5070	5.2	8330
Maximum, Stratum Clay 5 (Top)				133.1	25.1	77.0	60.0	—	—	5800	—	—	—	0	45.0	1880	36.9	12,250	7670	15.7	9620
Average, Stratum Clay 5 (Top)				127.4	20.5	57.7	40.5	—	—	5800	—	—	—	0	28.0	1880	36.9	11,110	6018	9.5	9056
Stratum Sand 5																					
B-2304UD	UD15	141.0	–72.5	117	17.9	—	—	SP-SM	DS	—	—	—	—	—	—	2520	35.3	—	—	—	—
Minimum, Stratum Sand 5				117.0	17.9	—	—	—	—	—	—	—	—	—	—	2520	35.3	—	—	—	—
Maximum, Stratum Sand 5				117.0	17.9	—	—	—	—	—	—	—	—	—	—	2520	35.3	—	—	—	—
Average, Stratum Sand 5				117.0	17.9	—	—	—	—	—	—	—	—	—	—	2520	35.3	—	—	—	—

Table 2.5.4-219 (Sheet 4 of 5)
Laboratory Strength Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

										UU Tests[a]		CIU-Bar Tests[a]				DS Tests[a]		DSS Tests[a]			
Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Vertical Consolidation Stress (pounds/ square foot)	Horizontal Shear Stress (pounds/square foot)	Shear Strain, (%)	Effective Vertical Stress, σ_v' (pounds/square foot)
Stratum Clay 5 (Bottom)																					
B-2359UD	UD20	120.0	–42.7	113.1	36.3	51	36	CH	DSS	—	—	—	—	—	—	—	—	10,790	2950	2.4	8680
Minimum, Stratum Clay 5 (Bottom)				113.1	36.3	51	36	—	—	—	—	—	—	—	—	—	—	10,790	2950	2.4	8680
Maximum, Stratum Clay 5 (Bottom)				113.1	36.3	51	36	—	—	—	—	—	—	—	—	—	—	10,790	2950	2.4	8680
Average, Stratum Clay 5 (Bottom)				113.1	36.3	51	36	—	—	—	—	—	—	—	—	—	—	10,790	2950	2.4	8680
Composite "A"/Sand																					
—	A	—	—	136.3	14.5	34	22	SC	—	—	—	—	—	—	—	—	—	—	—	—	—
—	B	—	—	137.0	14.0	—	—	—	CU	—	—	1220	14.6	500	25.1	—	—	—	—	—	—
—	C	—	—	135.9	14.0	—	—	—	DSS	—	—	—	—	—	—	—	—	—	—	—	—
—	A	—	—	136.0	14.0	—	—	—	DSS	—	—	—	—	—	—	—	—	2710	1290	28.6	1980
—	B	—	—	136.4	13.9	—	—	—	DSS	—	—	—	—	—	—	—	—	4320	2780	25.2	5170
—	C	—	—	136.6	13.9	—	—	—	DSS	—	—	—	—	—	—	—	—	8750	3900	23.3	7900
—	D	—	—	137.2	14.4	—	—	—	DSS	—	—	—	—	—	—	—	—	12,890	4390	29.3	8420
—	E	—	—	136.9	14.3	—	—	—	DSS	—	—	—	—	—	—	—	—	17,480	5140	18.8	11,480
—	F	—	—	136.8	14.2	—	—	—	DSS	—	—	—	—	—	—	—	—	28,900	7650	15.6	18,110
—	G	—	—	136.8	14.1	—	—	—	DSS	—	—	—	—	—	—	—	—	2200	1860	29.8	3440
—	H	—	—	136.6	13.7	—	—	—	DSS	—	—	—	—	—	—	—	—	4400	2010	29.3	3410
—	I	—	—	136.6	14.0	—	—	—	DSS	—	—	—	—	—	—	—	—	8610	3090	21.2	6080
—	J	—	—	136.9	14.1	—	—	—	DSS	—	—	—	—	—	—	—	—	13120	4680	16.7	10,110
—	K	—	—	137.1	15.7	—	—	—	DSS	—	—	—	—	—	—	—	—	17,430	4340	11.6	10,180
—	L	—	—	136.8	14.1	—	—	—	DSS	—	—	—	—	—	—	—	—	28,950	7600	13.4	18,890
Minimum, Composite "A"/Sand				136.0	13.7	34	22	—	—	—	—	1220	14.6	500	25.1	—	—	2200	1290	11.6	1980
Maximum, Composite "A"/Sand				137.2	15.7	34	22	—	—	—	—	1220	14.6	500	25.1	—	—	28,950	7650	29.8	18,890
Average, Composite "A"/Sand				136.7	14.2	34	22	—	—	—	—	1220	14.6	500	25.1	—	—	12,480	4061	21.9	8764

Table 2.5.4-219 (Sheet 5 of 5)
Laboratory Strength Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

										UU Tests[a]		CIU-Bar Tests[a]				DS Tests[a]		DSS Tests[a]			
Boring Number	Sample Number	Sample Top Depth (feet)	Sample Top Elevation (feet)[b]	Total Unit Weight (pounds/ cubic foot)	Natural Moisture Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	USCS Group	Test Type	Undrained Shear Strength (pounds per square foot)	Ratio, Undrained Shear Strength/Preconsolidation Pressure	Undrained Cohesion (pounds per square foot)	Undrained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Drained Cohesion (pounds per square foot)	Drained Friction Angle (degrees)	Vertical Consolidation Stress (pounds/ square foot)	Horizontal Shear Stress (pounds/square foot)	Shear Strain, (%)	Effective Vertical Stress, σ_v' (pounds/square foot)
Composite “B”/Clay																					
—	A	—	—	132.8	16.3	44	29	CL	—	—	—	—	—	—	—	—	—	—	—	—	—
—	B	—	—	134.2	16.8	—	—	—	CU	—	—	740	14.4	380	26.1	—	—	—	—	—	—
—	C	—	—	134.1	16.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	A	—	—	133.4	14.0	—	—	—	DSS	—	—	—	—	—	—	—	—	2220	2080	14.6	3510
—	B	—	—	133.7	13.9	—	—	—	DSS	—	—	—	—	—	—	—	—	4350	1860	9.2	3310
—	C	—	—	133.8	13.9	—	—	—	DSS	—	—	—	—	—	—	—	—	8670	3450	17.3	6790
—	D	—	—	134.1	14.4	—	—	—	DSS	—	—	—	—	—	—	—	—	12,720	4320	12.9	9580
—	E	—	—	134.3	14.3	—	—	—	DSS	—	—	—	—	—	—	—	—	17,490	5590	11.5	13,260
—	F	—	—	133.9	14.2	—	—	—	DSS	—	—	—	—	—	—	—	—	28,710	7510	9.5	20,340
—	G	—	—	134.3	14.1	—	—	—	DSS	—	—	—	—	—	—	—	—	2190	1000	28.8	1420
—	H	—	—	134.1	13.7	—	—	—	DSS	—	—	—	—	—	—	—	—	4370	2100	18.4	3710
—	I	—	—	134.3	14.0	—	—	—	DSS	—	—	—	—	—	—	—	—	8730	3820	14.3	7640
—	J	—	—	134.1	14.1	—	—	—	DSS	—	—	—	—	—	—	—	—	12,950	3850	9.2	8250
—	K	—	—	134.3	15.7	—	—	—	DSS	—	—	—	—	—	—	—	—	17,300	5970	13.4	13,930
—	L	—	—	136.3	14.1	—	—	—	DSS	—	—	—	—	—	—	—	—	28,820	8270	11.7	21,500
Minimum, Composite “B”/Clay				132.8	13.7	—	—	—	—	—	—	740	14.4	380	26.1	—	—	2190	1000	9.2	1420
Maximum, Composite “B”/Clay				136.3	16.8	—	—	—	—	—	—	740	14.4	380	26.1	—	—	28,820	8270	28.8	21,500
Average, Composite “B”/Clay				134.1	14.6	—	—	—	—	—	—	740	14.4	380	26.1	—	—	12,377	4152	14.2	9437
Drainage Sand Materials																					
C-33	—	—	—	110.3[c]	3.0[c]	—	—	SP	DS	—	—	—	—	—	—	0	37.0	—	—	—	—
C-144	—	—	—	108.0[c]	8.1[c]	—	—	SP	DS	—	—	—	—	—	—	0	36.0	—	—	—	—

a. UU = unconsolidated undrained triaxial compression test. CIU-Bar = consolidated undrained triaxial compression test with pore pressures measured. DS = direct shear test. DSS = direct simple shear test.

b. Elevations are referenced to NAVD 88.

c. Compacted density and moisture content.

Table 2.5.4-220
Undrained Shear Strengths of Cohesive Soil Strata
(Power Block)

Values from Laboratory Tests			
Stratum	Minimum s_u (ksf)	Maximum s_u (ksf)	Average s_u (ksf)
Clay 1 (Top)	2.5	3.9	3.3
Clay 1 (Bottom)	2.9	4.8	3.7
Clay 3	2.4	4.3	3.2
Clay 5 (Top)	4.1	6.0	5.1
Clay 5 (Bottom)	2.6	5.9	4.4
Clay 7	Not Tested	Not Tested	Not Tested
Clay 9	4.7	13.5	8.2
Clay 11	3.8	7.8	5.6
Clay 13	Not Tested	Not Tested	Not Tested
Clay 15	Not Tested	Not Tested	Not Tested
Clay 17	Not Tested	Not Tested	Not Tested

Values from CPT Correlation			
Stratum	Minimum s_u (ksf)	Maximum s_u (ksf)	Average s_u (ksf)
Clay 1 (Top)	0.3	6.3	2.8
Clay 1 (Bottom)	2.3	9.4	3.7
Clay 3	1.8	13.1	4.2
Clay 5 (Top)	Not Reached	Not Reached	Not Reached
Clay 5 (Bottom)	Not Reached	Not Reached	Not Reached
Clay 7	Not Reached	Not Reached	Not Reached
Clay 9	Not Reached	Not Reached	Not Reached
Clay 11	Not Reached	Not Reached	Not Reached
Clay 13	Not Reached	Not Reached	Not Reached
Clay 15	Not Reached	Not Reached	Not Reached
Clay 17	Not Reached	Not Reached	Not Reached

Values from SPT Correlation		
Stratum	Selected Corrected $(N_1)_{60}$-Value (blows/foot)	Calculated s_u (ksf)
Clay 1 (Top)	19	2.5
Clay 1 (Bottom)	19	2.5
Clay 3	19	2.4
Clay 5 (Top)	16	2.0
Clay 5 (Bottom)	16	2.0
Clay 7	40	5.4
Clay 9	31	4.0
Clay 11	30	3.6
Clay 13	28	7.6
Clay 15	33	6.1
Clay 17	45	5.6

Values Selected for Use	
Stratum	Selected s_u (ksf)
Clay 1 (Top)	3.2
Clay 1 (Bottom)	3.2
Clay 3	3.0
Clay 5 (Top)	3.0
Clay 5 (Bottom)	3.0
Clay 7	6.0
Clay 9	4.0
Clay 11	5.0
Clay 13	6.0
Clay 15	6.1
Clay 17	5.6

Table 2.5.4-221
Undrained Shear Strengths of Cohesive Soil Strata (Cooling Basin/GBRA Storage Water Reservoir)

Values from Laboratory Tests			
Stratum	**Minimum s_u (ksf)**	**Maximum s_u (ksf)**	**Average s_u (ksf)**
Clay 1 (Top)	2.4	2.7	2.5
Clay 1 (Bottom)	3.9	3.9	3.9
Clay 3	3.1	3.3	3.2
Clay 5 (Top)	5.8	5.8	5.8
Clay 5 (Bottom)	Not Tested	Not Tested	Not Tested
Clay 7	Not Tested	Not Tested	Not Tested
Clay 9	Not Tested	Not Tested	Not Tested

Values from CPT Correlation			
Stratum	**Minimum s_u (ksf)**	**Maximum s_u (ksf)**	**Average s_u (ksf)**
Clay 1 (Top)	0.4	4.9	1.7
Clay 1 (Bottom)	0.8	9.0	3.5
Clay 3	1.2	11.8	4.0
Clay 5 (Top)	1.6	6.5	3.2
Clay 5 (Bottom)	Not Reached	Not Reached	Not Reached
Clay 7	Not Reached	Not Reached	Not Reached
Clay 9	Not Reached	Not Reached	Not Reached

Values from SPT Correlation		
Stratum	**Selected Corrected $(N_1)_{60}$-Value (blows/foot)**	**Calculated s_u (ksf)**
Clay 1 (Top)	21	2.6
Clay 1 (Bottom)	21	2.6
Clay 3	16	2.0
Clay 5 (Top)	20	2.5
Clay 5 (Bottom)	20	2.5
Clay 7	17	2.1
Clay 9	13	1.6

Values Selected for Use	
Stratum	**Selected s_u (ksf)**
Clay 1 (Top)	2.3
Clay 1 (Bottom)	3.4
Clay 3	4.0
Clay 5 (Top)	3.6
Clay 5 (Bottom)	2.5
Clay 7	2.1
Clay 9	1.6

Table 2.5.4-222 (Sheet 1 of 2)
Laboratory Consolidation Test Results
(Power Block)

Stratum/ Boring No.	Sample No.	Sample Depth (feet)	Sample Top El. (feet)[a]	LL (%)	PI (%)	USCS Group Symbol	Specific Gravity, G_s	Initial Effective Stress σ_v' (ksf)	Dry Unit Weight, γ_t (pcf)	Moisture Content (%)	P_c'[b] (ksf)	C_c[c]	C_r[d]	e_0[e]	OCR[f]
Clay 1 (Top)															
B-2269UD	UD-1	10.0-12.0	70.1	40	24	CL	2.67	1.47	109.7	17.8	17.2	0.126	0.012	0.52	11.7
B-2274UD	UD-1	10.2-11.9	70.2	33	18	CL	2.75	1.48	113.8	16.4	5.8	0.110	0.013	0.51	3.9
Clay 1 (Bottom)															
B-2182UD	UD-6	37.0-38.5	42.7	33	17	CL	2.75	4.49	111.0	16.1	8.6	0.143	0.022	0.55	1.9
B-2269UD	UD-3	30.0-32.0	50.1	34	19	CL	2.66	4.09	110.7	15.4	9.0	0.136	0.003	0.50	2.2
B-2269UD	UD-5	50.0-51.7	30.1	59	36	CH	2.70	5.48	104.9	21.5	13.7	0.159	0.060	0.61	2.5
Clay 3															
B-2182UD	UD-7	65.0-66.7	14.7	27	10	SC	2.74	6.37	95.4	20.9	11.5	0.156	0.047	0.79	1.8
B-2269UD	UD-7	70.0-71.7	10.1	74	44	CH	2.72	6.70	84.4	36.6	22.2	0.362	0.050	1.01	3.3
B-2274UD	UD-4	67.0-68.7	13.4	79	46	CH	2.76	6.74	89.2	32.6	17.1	0.252	0.039	0.93	2.5
Clay 5 (Top)															
B-2182UD	UD-13	120-121.7	–40.3	38	21	SC	2.71	9.90	104.6	20.4	21.0	0.196	0.027	0.61	2.1
Clay 5 (Bottom)															
B-2182UD	UD-15	145-147.5	–65.3	NV	NP	ML	2.70	11.52	95.4	26.8	18.4	0.156	0.032	0.77	1.6
B-2269UD	UD-11	150-151.7	–69.9	50	28	CH	2.70	11.80	103.7	21.8	23.2	0.193	0.063	0.62	2.0
Clay 7															
B-2182UD	UD-17	215-217.5	–135.3	43	26	CL	2.72	16.28	101.7	22.8	26.9	0.199	0.030	0.67	1.7
Clay 9															
B-2182UD	UD-25	303-304.2	–223.3	52	26	CH	2.79	22.30	91.3	26.5	22.1	0.209	0.032	0.91	1.0
B-2182UD	UD-26	320-321.5	–240.3	35	19	CL	2.73	23.39	115.5	14.9	35.7	0.149	0.015	0.47	1.5
B-2182UD	UD-29	333-334.7	–253.3	56	30	CH	2.72	24.21	96.9	24.7	38.3	0.276	0.037	0.76	1.6
B-2182UD	UD-30	340-341.1	–260.3	43	26	CL	2.73	24.66	116.9	15.5	38.1	0.140	0.028	0.46	1.5
B-2274UD	UD-16	300-301.8	–219.6	58	31	CH	2.76	22.29	90.9	26.8	43.0	0.309	0.037	0.90	1.9
Clay 11															
B-2182UD	UD-33	380-381.7	–300.3	68	36	CH	2.78	27.34	84.9	33.8	43.3	0.455	0.028	1.04	1.6
B-2182UD	UD-37	400-402.5	–320.3	49	24	CL	2.76	28.50	91.4	29.3	29.1	0.252	0.030	0.88	1.0
B-2269UD	UD-20	400-402.1	–319.9	63	43	CH	2.77	28.14	85.7	32.9	28.2	0.289	0.056	1.02	1.0
B-2274UD	UD-20	380-381.8	–299.6	70	35	MH	2.76	27.69	86.0	34.9	48.1	0.409	0.050	1.00	1.7
B-2274UD	UD-21	390-391.8	–309.6	73	39	CH	2.75	28.20	83.6	36.7	47.9	0.402	0.047	1.05	1.7
B-2274UD	UD-22	400-401.3	–319.6	56	31	CH	2.72	28.81	98.2	26.3	49.6	0.252	0.020	0.73	1.7

Table 2.5.4-222 (Sheet 2 of 2)
Laboratory Consolidation Test Results
(Power Block)

Stratum/ Boring No.	Sample No.	Sample Depth (feet)	Sample Top El. (feet)[a]	LL (%)	PI (%)	USCS Group Symbol	Specific Gravity, G_s	Initial Effective Stress σ_v' (ksf)	Dry Unit Weight, γ_t (pcf)	Moisture Content (%)	P_c'[b] (ksf)	C_c[c]	C_r[d]	e_0[e]	OCR[f]
Clay 13															
B-2174UDR	UD-26	445-446.0	–366.0	65	40	CH	2.78	30.91	96.2	27.6	50.0	0.233	0.038	0.80	1.6
B-2174UDR	UD-27	490-492.5	–411.0	60	43	CH	2.73	33.82	109.6	20.2	41.1	0.149	0.037	0.56	1.2
Clay 17															
B-2274UD	UD-26	580-582.5	–499.6	37	22	CL	2.70	40.63	111.0	17.8	50.7	0.126	0.020	0.52	1.2

a. Elevations are referenced to NAVD 88.

b. Preconsolidation pressure, P_c'.

c. Compression index, C_c.

d. Recompression index, C_r.

e. Initial void ratio, e_0.

f. Overconsolidation Ratio, OCR.

Table 2.5.4-223 (Sheet 1 of 2)
Laboratory Consolidation Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum/ Boring No.	Sample No.	Sample Depth (feet)	Sample Top El. (feet)[a]	LL (%)	PI (%)	USCS Group Symbol	Specific Gravity, G_s	Initial Effective Stress σ_v' (ksf)	Dry Unit Weight, γ_t (pcf)	Moisture Content (%)	P_c'[b] (ksf)	C_c[c]	C_r[d]	e_0[e]	OCR[f]
Constant Rate-of-Strain Tests															
Clay 1 (Top)															
B-2321UD	UD-1	5.2	68.31	42	29	CL	2.71	0.52	101.2	17.4	3.8	0.100	0.018	0.67	7.3
B-2321UD	UD-3	11.4	61.81	51	35	CH	2.71	1.33	105.4	15.4	6.0	0.102	0.025	0.60	4.5
B-2321UD	UD-4	15.2	58.31	81	59	CH	2.72	1.77	103.0	21.8	9.3	0.104	0.027	0.65	5.3
Clay 1 (Bottom)															
B-2319UD	UD-4	26.7	49.16	61	45	CH	2.72	3.27	109.7	19.2	30.0	0.126	0.053	0.55	9.2
B-2321UD	UD-5	18.7	54.81	40	25	CL	2.72	2.21	97.2	19.5	10.0	0.113	0.012	0.74	4.5
B-2321UD	UD-6	30.2	43.31	75	55	CH	2.72	3.65	94.8	23.9	16.0	0.125	0.040	0.79	4.4
B-2321UD	UD-8	49.8	23.31	64	48	CH	2.72	5.85	91.5	28.5	23.3	0.165	0.055	0.85	4.0
B-2359UD	UD-4	36.5	42.35	68	51	CH	2.73	4.46	103.2	21.6	43.9	0.141	0.065	0.65	9.9
B-2359UD	UD-5	41.2	37.35	65	47	CH	2.71	5.08	106.7	18.4	39.9	0.155	0.070	0.58	7.9
Clay 3															
B-2302UD	UD-12	80.2	1.50	64	43	CH	2.68	6.90	100.2	20.9	28.2	0.163	0.036	0.67	4.1
B-2304UD	UD-8	85.3	–15.04	61	35	CH	2.71	7.09	89.6	31.3	26.6	0.180	0.083	0.89	3.8
B-2319UD	UD-7	66.6	9.16	39	22	CL	2.66	6.33	103.5	18.8	19.6	0.095	0.009	0.60	3.1
B-2321UD	UD-9	59.5	13.31	49	35	CL	2.68	7.54	103.6	19.3	15.7	0.115	0.054	0.61	2.1
B-2321UD	UD-10	65.1	8.81	36	22	CL	2.67	8.15	115.4	13.7	31.0	0.110	0.029	0.44	3.8
B-2359UD	UD-10	71.6	7.35	95	61	CH	2.72	7.51	109.5	16.8	26.1	0.125	0.035	0.55	3.5
Clay 5 (Top)															
B-2302UD	UD-16	122.2	–40.50	76	60	CH	2.72	9.46	97.5	25.5	30.0	0.181	0.103	0.74	3.2
B-2302UD	UD-19	147.0	65.50	49	34	CL	2.69	11.00	103.8	21.5	30.0	0.155	0.040	0.62	2.7
B-2304UD	UD-11	112.9	–42.54	77	58	CH	2.71	8.80	103.2	21.7	33.3	0.150	0.068	0.64	3.8
B-2304UD	UD-13	123.0	–52.54	62	44	CH	2.71	9.43	107.2	18.6	28.2	0.145	0.045	0.58	3.0
B-2321UD	UD-15	132.5	–58.69	61	44	CH	2.71	10.78	100.8	21.0	13.1	0.120	0.020	0.68	1.2
Clay 5 (Bottom)															
B-2359UD	UD-20	121.3	–42.65	51	36	CH	2.72	10.56	85.0	34.0	40.0	0.273	0.064	1.00	3.8

Table 2.5.4-223 (Sheet 2 of 2)
Laboratory Consolidation Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum/ Boring No.	Sample No.	Sample Depth (feet)	Sample Top El. (feet)[a]	LL (%)	PI (%)	USCS Group Symbol	Specific Gravity, G_s	Initial Effective Stress σ_v' (ksf)	Dry Unit Weight, γ_t (pcf)	Moisture Content (%)	P_c'[b] (ksf)	C_c[c]	C_r[d]	e_0[e]	OCR[f]
Load-Controlled Tests															
Clay 1 (Top)															
B-2352UD	UD-1	3.5	59.3	46	27	CL	2.70	0.49	111.5	17.3	12.2	0.149	0.003	0.51	24.9
B-2352UD	UD-3	11.5	51.3	39	21	CL	2.71	1.49	108.8	18.4	13.4	0.156	0.020	0.56	9.0
Clay 1 (Bottom)															
B-2321UD	UD-7	38.5	33.3	60	37	CH	2.78	4.90	101.9	21.3	10.4	0.153	0.032	0.7	2.1
B-2352UD	UD-5	24.0	38.8	67	38	CH	2.67	3.05	94.4	28.0	14.8	0.189	0.010	0.77	4.8
B-2359UD	UD-3	30.8	46.6	66	36	CH	2.78	3.94	91.0	30.2	15.5	0.252	0.035	0.91	3.9
Clay 3															
B-2302UD	UD-11	69.5	10.5	59	34	CH	2.74	6.35	96.8	24.2	12.7	0.189	0.025	0.77	2.0
B-2304UD	UD-7	73.5	–5.0	69	35	MH	2.78	6.49	92.6	29.8	18.0	0.226	0.028	0.87	2.8
Clay 5 (Top)															
B-2304UD	UD-9	98.5	–30.0	62	37	CH	2.74	8.04	99.8	25.8	17.7	0.196	0.027	0.71	2.2
B-2321UD	UD-14	128.5	–56.7	58	31	CH	2.75	10.68	96.8	25.5	11.2	0.203	0.033	0.77	1.0
B-2359UD	UD-18	112.0	–34.7	27	12	SC	2.77	10.06	92.4	25.5	24.2	0.186	0.025	0.87	2.4

a. Elevations are referenced to NAVD 88.

b. Preconsolidation pressure, P_c'.

c. Compression index, C_c.

d. Recompression index, C_r.

e. Initial void ratio, e_0.

f. Overconsolidation Ratio, OCR.

Table 2.5.4-224
Summary of Laboratory Consolidation Test Properties for Cohesive Soil Strata (Power Block)

Stratum	No. of Tests	Statistics	C_r[a]	C_c[b]	P_c' (ksf)[c]	OCR[d]	e_o[e]
Clay 1 (Top)	2	Maximum	0.013	0.126	17.2	11.7	0.52
		Minimum	0.012	0.110	5.8	3.9	0.51
		Average	0.013	0.118	11.5	7.8	0.52
Clay 1 (Bottom)	3	Maximum	0.060	0.159	13.7	2.5	0.55
		Minimum	0.003	0.136	8.6	1.9	0.50
		Average	0.028	0.146	10.4	2.2	0.53
Clay 3	3	Maximum	0.050	0.362	22.2	3.3	1.01
		Minimum	0.039	0.156	11.5	1.8	0.79
		Average	0.045	0.257	16.9	2.6	0.90
Clay 5 (Top)	1	Maximum	0.027	0.196	21.0	2.1	0.61
		Minimum	0.027	0.196	21.0	2.1	0.61
		Average	0.027	0.196	21.0	2.1	0.61
Clay 5 (Bottom)	2	Maximum	0.063	0.193	23.2	1.6	0.77
		Minimum	0.032	0.156	18.4	2.0	0.62
		Average	0.048	0.175	20.8	1.8	0.70
Clay 7	1	Maximum	0.030	0.199	26.9	1.7	0.67
		Minimum	0.030	0.199	26.9	1.7	0.67
		Average	0.030	0.199	26.9	1.7	0.67
Clay 9	5	Maximum	0.037	0.309	43.0	1.9	0.91
		Minimum	0.015	0.140	22.1	1.0	0.47
		Average	0.030	0.217	35.4	1.5	0.69
Clay 11	6	Maximum	0.056	0.455	49.6	1.7	1.02
		Minimum	0.020	0.252	28.2	1.0	0.88
		Average	0.039	0.343	41.0	1.5	0.95
Clay 13	2	Maximum	0.038	0.233	50.0	1.6	0.80
		Minimum	0.037	0.149	41.1	1.2	0.50
		Average	0.038	0.191	45.6	1.4	0.68
Clay 17	1	Maximum	0.020	0.126	50.7	1.2	0.52
		Minimum	0.020	0.126	50.7	1.2	0.52
		Average	0.020	0.126	50.7	1.2	0.52

a. Recompression index, C_r.

b. Compression index, C_c.

c. Preconsolidation pressure, P_c'.

d. Overconsolidation Ratio, OCR.

e. Initial void ratio, e_0.

Table 2.5.4-225
Summary of Laboratory Consolidation Test Properties for Cohesive Soil Strata (Cooling Basin/GBRA Storage Water Reservoir)

	Constant Rate-of-Strain (CRS) Tests							Load-Controlled (LC) Tests						
Stratum	**No. of Tests**	**Statistics**	**C_r[a]**	**C_c[b]**	**P_c' (ksf)[c]**	**OCR[d]**	**e_o[e]**	**No. of Tests**	**Statistics**	**C_r[a]**	**C_c[b]**	**P_c' (ksf)[c]**	**OCR[d]**	**e_o[e]**
Clay 1 (Top)	3	Maximum	0.027	0.104	9.3	5.6	0.67	2	Maximum	0.020	0.156	13.4	16.9	0.56
		Minimum	0.018	0.100	3.8		0.60		Minimum	0.003	0.149	12.2		0.51
		Average	0.023	0.102	6.4		0.64		Average	0.012	0.153	12.8		0.54
Clay 1 (Bottom)	6	Maximum	0.070	0.165	43.9	6.6	0.85	3	Maximum	0.035	0.252	15.5	3.6	0.91
		Minimum	0.012	0.113	10.0		0.55		Minimum	0.010	0.153	10.4		0.70
		Average	0.049	0.138	27.2		0.69		Average	0.026	0.198	13.6		0.79
Clay 3	6	Maximum	0.083	0.180	31.0	3.4	0.89	2	Maximum	0.028	0.226	18.0	2.4	0.87
		Minimum	0.009	0.095	15.7		0.44		Minimum	0.025	0.189	12.7		0.77
		Average	0.041	0.131	24.5		0.63		Average	0.027	0.208	15.4		0.82
Clay 5 (Top)	5	Maximum	0.103	0.181	33.3	2.8	0.74	3	Maximum	0.033	0.203	24.2	1.9	0.87
		Minimum	0.020	0.120	13.1		0.58		Minimum	0.025	0.186	11.2		0.71
		Average	0.055	0.150	26.9		0.65		Average	0.028	0.195	17.7		0.78
Clay 5 (Bottom)	1	Maximum	0.064	0.273	40.0	3.8	1.00	—	Maximum	—	—	—	—	—
		Minimum	0.064	0.273	40.0		1.00		Minimum	—	—	—		—
		Average	0.064	0.273	40.0		1.00		Average	—	—	—		—

a. Recompression index, C_r.

b. Compression index, C_c.

c. Preconsolidation pressure, P_c’.

d. Overconsolidation Ratio, OCR.

e. Initial void ratio, e_0.

Table 2.5.4-226
Overconsolidation Ratios and Preconsolidation Pressures of Cohesive Soil Strata (Power Block)

	Average OCR			Average P'c (ksf)	
Stratum	From Consolidation Tests	From CPTs	Values for Use	From Consolidation Tests	Values for Use
Clay 1	4.5	6.0	5.3	10.9	10
Clay 3	2.6	1.9	2.1	16.9	16
Clay 5	1.9	—	1.9	20.9	20
Clay 7	1.7	—	1.7	26.9	25
Clay 9	1.5	—	1.5	35.4	35
Clay 11	1.5	—	1.5	41.0	40
Clay 13	1.4	—	1.4	45.6	45
Clay 15	—	—	1.3	—	47
Clay 17	1.2	—	1.2	50.7	50

Table 2.5.4-227
Overconsolidation Ratios and Preconsolidation Pressures of Cohesive Soil Strata (Cooling Basin/GBRA Storage Water Reservoir)

	Average OCR			Average P'c (ksf)	
Stratum	From Consolidation Tests	From CPTs	Values for Use	From Consolidation Tests	Values for Use
Clay 1	9.0[a]	5.2	7	13.3[a]	15
	6.1[b]			16.0[b]	
Clay 3	2.4[a]	2.2	3	15.4[a]	20
	3.4[b]			24.5[b]	
Clay 5	1.9[a]	1.2	2	17.7[a]	23
	3.3[b]			29.1[b]	

a. From stress-controlled consolidation tests (Reference 2.5.4-245).

b. From constant rate-of-strain consolidation tests (Reference 2.5.4-246).

Table 2.5.4-228
High Strain Elastic Moduli Values
(Power Block)

	E-Values (ksf)			
Stratum	**From $(N_1)_{60}$**	**From s_u**	**From V_s**	**Values for Use**
Clay 1(Top)	—	1920	1432	2000
Sand 1	1044	—	1267	1160
Clay 1 (Bottom)	—	1920	2765	2000
Sand 2	936	—	1230	1080
Clay 3	—	1800	2874	2340
Sand 4	1980	—	2708	2340
Clay 5 (Top)	—	1800	4761	3110
Sand 5	1404	—	1990	1700
Clay 5 (Bottom)	—	1800	4089	3110
Sand 6	2196	—	2323	2260
Clay 7	—	3600	6130	4870
Sand 8	2736	—	2929	2830
Clay 9	—	2400	5123	3760
Sand 10	3852	—	2871	3360
Clay 11	—	3000	4152	3580
Sand 12	2196	—	3504	2850
Clay 13	—	3600	6376	4990
Sand 14	2376	—	3604	2990
Clay 15	—	3660	8079	5870
Sand 16	2484	—	3354	2920
Clay 17	—	3360	10011	6690
Sand 18	3600	—	4242	3920

Table 2.5.4-229
High Strain Elastic Moduli Values
(Cooling Basin/GBRA Storage Water Reservoir)

	E-Values (ksf)			
Stratum	**From $(N_1)_{60}$**	**From s_u**	**From V_s**	**Values for Use**
Clay 1(Top)	—	1800	1531	1950
Sand 1	1080	—	616	850
Clay 1 (Bottom)	—	1800	2679	1950
Sand 2	1368	—	1048	1210
Clay 3	—	1930	3297	2610
Sand 4	1224	—	1488	1360
Clay 5 (Top)	—	2380	4177	3340
Sand 5	1512	—	1944	1730
Clay 5 (Bottom)	—	2380	4426	3340
Sand 6	1260	—	1807	1530
Clay 7	—	2370	4066	3220
Sand 8	1296	—	2747	2020
Clay 9	—	960	5767	3360
Sand 10	—	—	3201	3200
Clay 11	—	—	5433	5430

Table 2.5.4-230
High Strain Shear Moduli Values
(Power Block)

Stratum	G (ksf)
Clay 1	690
Sand 1	446
Sand 2	415
Clay 3	807
Sand 4	900
Clay 5	1072
Sand 5	654
Sand 6	869
Clay 7	1679
Sand 8	1088
Clay 9	1297
Sand 10	1292
Clay 11	1234
Sand 12	1096
Clay 13	1721
Sand 14	1150
Clay 15	2024
Sand 16	1123
Clay 17	2307
Sand 18	1508

Table 2.5.4-231
High Strain Shear Moduli Values
(Cooling Basin/GBRA Storage Water Reservoir)

Stratum	G (ksf)
Clay 1	670
Sand 1	330
Sand 2	470
Clay 3	900
Sand 4	520
Clay 5	1150
Sand 5	670
Sand 6	590
Clay 7	1110
Sand 8	780
Clay 9	1160
Sand 10	1230

Table 2.5.4-232 (Sheet 1 of 4)
Geotechnical Engineering Parameters Selected for Design (Power Block)

Parameter[a]	**Clay 1**	**Sand 1**	**Sand 2**	**Clay 3**	**Sand 4**
Average thickness, feet	47[b]	9	13.4	23.5	26
USCS symbol	CL, CH	SC	SC, SM, ML	CL, CH	SC, SC-SM
Natural moisture content (MC), %	20	16	18.5	23	17.5
Total unit weight (γ_{total}), pcf	129	135	135	119	132
Fines content, %	80	40	40	75	25
Liquid limit (LL), %	55	N/A[c]	N/A[c]	53	N/A[c]
Plasticity index (PI), %	35	N/A[c]	N/A[c]	35	N/A[c]
Uncorrected SPT N-value, bpf	15	26	30	25	82
Corrected SPT $(N_1)_{60}$-value, bpf	19	29	26	19	55
Shear wave velocity, ft/sec	782	1078	1062	990	1594
Undrained shear strength (s_u), ksf	3.2	N/A[c]	N/A[c]	3	N/A[c]
Friction angle (Φ'), degree	N/A[c]	33	33	N/A[c]	37
Elastic modulus (high strain) (E), ksf	2000	1160	1080	2340	2340
Shear modulus (high strain) (G), ksf	690	446	415	807	900
Shear modulus (low strain) (G_{max}), ksf	2502	4872	4731	3623	10,416
Earth Pressure Coefficients					
Active (K_a)	0.50	0.30	0.30	0.50	0.24
Passive (K_p)	2.00	3.40	3.40	2.00	4.00
At Rest (K_0)	0.70	0.45	0.45	0.70	0.40
Coefficient of sliding	0.30	0.40	0.40	0.30	0.45
Consolidation Properties					
C_c (C_r)	0.132 (0.021)	N/A[c]	N/A[c]	0.257 (0.045)	N/A[c]
Void ratio, e_o	0.54	N/A[c]	N/A[c]	0.90	0.48
P_c', ksf (OCR)	10.0 (5.0)	N/A[c]	N/A[c]	16.0 (2.1)	N/A[c]

Table 2.5.4-232 (Sheet 2 of 4)
Geotechnical Engineering Parameters Selected for Design (Power Block)

Parameter[a]	**Clay 5**	**Sand 5**	**Sand 6**	**Clay 7**	**Sand 8**
Average thickness, feet	35[b]	13	50	44.5	48
USCS symbol	CH, CL	SC, SC-SM	SC, SP-SM	CH, CL	SC, SC-SM
Natural moisture content (MC), %	25	20	19	21	21
Total unit weight (γ_{total}), pcf	127	132	132	125	132
Fines content, %	85	25	15	75	30
Liquid limit (LL), %	60	N/A[c]	N/A[c]	51	N/A[c]
Plasticity index (PI), %	40	N/A[c]	N/A[c]	30	N/A[c]
Uncorrected SPT N-value, bpf	26	62	98	66	118
Corrected SPT $(N_1)_{60}$-value, bpf	16	39	61	40	76
Shear wave velocity, ft/sec	1142	1367	1476	1430	1658
Undrained shear strength (s_u), ksf	3	N/A[c]	N/A[c]	6	N/A[c]
Friction angle (Φ’), degree	N/A[c]	36	39	N/A[c]	36
Elastic modulus (high strain) (E), ksf	3110	1700	2260	4870	2830
Shear modulus (high strain) (G), ksf	1072	654	869	1679	1088
Shear modulus (low strain) (G_{max}), ksf	5143	7656	8936	7935	11,263
Earth Pressure Coefficients					
Active (K_a)	0.50	0.26	N/A[c]	N/A[c]	N/A[c]
Passive (K_p)	2.00	3.80	N/A[c]	N/A[c]	N/A[c]
At Rest (K_0)	0.70	0.40	N/A[c]	N/A[c]	N/A[c]
Coefficient of sliding	0.30	0.45	N/A[c]	N/A[c]	N/A[c]
Consolidation Properties					
C_c (C_r)	0.185 (0.038)	N/A[c]	N/A[c]	0.199 (0.030)	N/A[c]
Void ratio, e_o	0.7	N/A[c]	N/A[c]	0.67	N/A[c]
P_c’, ksf (OCR)	20.0 (1.9)	N/A[c]	N/A[c]	25.0 (1.6)	N/A[c]

Table 2.5.4-232 (Sheet 3 of 4)
Geotechnical Engineering Parameters Selected for Design
(Power Block)

Parameter[a]	**Clay 9**	**Sand 10**	**Clay 11**	**Sand12**	**Clay 13**	**Sand 14**
Average thickness, feet	41	27.5	53.5	20.5	75.8	40
USCS symbol	CH, CL	SM, SC	CH, CL	SM	CH, ML	SC, SM
Natural moisture content (MC), %	23.5	N/A[c]	28	14.5	27.5	22
Total unit weight (γ_{total}), pcf	126	132	119	132	126	132
Fines content, %	90	25	85	25	95	30
Liquid limit (LL), %	59	N/A[c]	63	N/A[c]	67	N/A
Plasticity index (PI), %	35	N/A[c]	40	N/A[c]	40	N/A
Uncorrected SPT N-value, bpf	50	164	45	100	44	102
Corrected SPT $(N_1)_{60}$-value, bpf	31	107	30	61	28	66
Shear wave velocity, ft/sec	1252	1641	1147	1813	1368	1839
Undrained shear strength (s_u), ksf	4	N/A[c]	5	N/A[c]	6	N/A[c]
Friction angle (Φ’), degree	N/A[c]	38	N/A[c]	36	N/A[c]	36
Elastic modulus (high strain) (E), ksf	3760	3360	3580	2850	4990	2990
Shear modulus (high strain) (G), ksf	1297	1292	1234	1096	1721	1150
Shear modulus (low strain) (G_{max}), ksf	6132	11042	4865	13478	7328	13860
Earth Pressure Coefficients						
Active (K_a)	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]
Passive (K_p)	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]
At Rest (K_0)	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]
Coefficient of sliding	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]	N/A[c]
Consolidation Properties						
C_c (C_r)	0.122 (0.030]	N/A[c]	0.343 (0.039)	N/A[c]	0.190 (0.038)	N/A[c]
Void ratio, e_o	0.7	N/A[c]	0.95	N/A[c]	0.68	N/A[c]
P_c’, ksf (OCR)	35.0 (1.5)	N/A[c]	40.0 (1.5)	N/A[c]	45.0 (1.4)	N/A[c]

Table 2.5.4-232 (Sheet 4 of 4)
Geotechnical Engineering Parameters Selected for Design
(Power Block)

Parameter[a]	**Clay 15**	**Sand 16**	**Clay 17**	**Sand 18**	**Structural Fill (CW&A#4)**
Average thickness, feet	11.5	16.5	21.2	>9	N/A
USCS symbol	CH	SM, SC	CL, CH	SM	GW-GC
Natural moisture content (MC), %	22.5	N/A	18.5	13	6
Total unit weight (γ_{total}), pcf	126	132	131	132	138
Fines content, %	95	25	75	25	7
Liquid limit (LL), %	69	N/A[c]	46	N/A[c]	N/A[c]
Plasticity index (PI), %	45	N/A[c]	30	N/A[c]	N/A[c]
Uncorrected SPT N-value, bpf	55	111	69	N/A[c]	N/A
Corrected SPT $(N_1)_{60}$-value, bpf	33	69	45	100	30[d]
Shear wave velocity, ft/sec	1501	1774	1793	1995	700, 850[d]
Undrained shear strength (s_u), ksf	6.1	N/A[c]	5.6	N/A[c]	N/A[c]
Friction angle (Φ’), degree	N/A[c]	38	N/A	38	39
Elastic modulus (high strain) (E), ksf	5870	2920	6690	3920	1100
Shear modulus (high strain) (G), ksf	2024	1123	2307	1508	400
Shear modulus (low strain) (G_{max}), ksf	8820	12,901	13,084	16,316	3300
Earth Pressure Coefficients					
Active (K_a)	N/A[c]	N/A[c]	N/A[c]	N/A[c]	0.23
Passive (K_p)	N/A[c]	N/A[c]	N/A[c]	N/A[c]	4.40
At Rest (K_0)	N/A[c]	N/A[c]	N/A[c]	N/A[c]	0.50
Coefficient of sliding	N/A[c]	N/A[c]	N/A[c]	N/A[c]	0.55
Consolidation Properties					
C_c (C_r)	0.190 (0.038)	N/A[c]	0.126 (0.020)	N/A[c]	N/A[c]
Void ratio, e_o	0.68	N/A[c]	0.80	N/A[c]	N/A[c]
P_c’, ksf (OCR)	47.0 (1.3)	N/A[c]	50.0 (1.2)	N/A[c]	N/A[c]

a. The values tabulated above are for use as guideline only. Reference should be made to specific boring and CPT logs and laboratory test results for appropriate modifications at specific locations and for specific calculations.

b. Thicknesses of Clay 1 (Top) and Clay 1 (bottom) are combined. Thicknesses of Clay 5 (Top) and Clay 5 (Bottom) are combined.

c. N/A indicates that the property is either not measured or not applicable.

d. Conservatively estimated values for surficial structural fill.

Table 2.5.4-233 (Sheet 1 of 4)
Geotechnical Engineering Parameters Selected for Design (Cooling Basin/GBRA Storage Water Reservoir)

Parameter[a]	**Clay 1**	**Sand 1**	**Sand 2**	**Clay 3**	**Sand 4**
Average thickness, feet	27[b]	14.6	17.7	19.1	24.8
USCS symbol	CL, CH	SC	SC, SM, ML	CL, CH	SC, SC-SM
Natural moisture content (MC), %	20	16	17	23	21
Total unit weight (γ_{total}), pcf	125	126	125	123	123
Fines content, %	80	27	28	78	17
Liquid limit (LL), %	51	N/A[c]	N/A[c]	57	N/A[c]
Plasticity index (PI), %	30	N/A[c]	N/A[c]	35	N/A[c]
Uncorrected SPT N-value, bpf	16	23	43	20	50
Corrected SPT $(N_1)_{60}$-value, bpf	21	30	38	16	34
Shear wave velocity, ft/sec	821	778	1015	1019	1224
Undrained shear strength (s_u), ksf	[d, e]	N/A[c]	N/A[c]	[d,e]	N/A[c]
Friction angle (Φ’), degree	28[e]	40[e]	40[e]	28[e]	40[e]
Elastic modulus (high strain) (E), ksf	1950	850	1210	2610	1360
Shear modulus (high strain) (G), ksf	670	330	470	900	520
Shear modulus (low strain) (G_{max}), ksf	2640	2370	4030	3970	5720
Earth Pressure Coefficients					
Active (K_a)	0.36	0.25	0.25	0.36	0.25
Passive (K_p)	2.80	4.00	4.00	2.80	4.00
At Rest (K_0)	0.55	0.40	0.40	0.55	0.40
Coefficient of sliding	0.30	0.45	0.45	0.30	0.45
Consolidation Properties					
C_c (C_r)	0.148 (0.0270)	N/A[c]	N/A[c]	0.169 (0.034)	N/A[c]
Void ratio, e_o	0.638	N/A[c]	N/A[c]	0.723	N/A[c]
P_c’, ksf (OCR)	15 (8.2)	N/A[c]	N/A[c]	20 (3.0)	N/A[c]

Table 2.5.4-233 (Sheet 2 of 4)
Geotechnical Engineering Parameters Selected for Design (Cooling Basin/GBRA Storage Water Reservoir)

Parameter[a]	**Clay 5**	**Sand 5**	**Sand 6**	**Clay 7**	**Sand 8**
Average thickness, feet	27[b]	12.6	24	27.3	26.6
USCS symbol	CH, CL	SC, SC-SM	SC, SP-SM	CH, CL	SC, SC-SM
Natural moisture content (MC), %	23	21	21	21[f]	21[f]
Total unit weight (γ_{total}), pcf	125	123	123	125	123
Fines content, %	86	27	28	77	36
Liquid limit (LL), %	53	N/A[c]	N/A[c]	51[f]	N/A[c]
Plasticity index (PI), %	35	N/A[c]	N/A[c]	30[f]	N/A[c]
Uncorrected SPT N-value, bpf	32	72	69	37	98
Corrected SPT $(N_1)_{60}$-value, bpf	20	42	35	17	36
Shear wave velocity, ft/sec	1153	1399	1349	1314	1663
Undrained shear strength (s_u), ksf	[d,e]	N/A[c]	N/A[c]	[d,e]	N/A[c]
Friction angle (Φ'), degree	28[e]	40[e]	40[e]	28[e]	40[e]
Elastic modulus (high strain) (E), ksf	3340	1730	1530	3220	2020
Shear modulus (high strain) (G), ksf	1150	670	590	1110	780
Shear modulus (low strain) (G_{max}), ksf	5170	7476	6950	6700	10,560
Earth Pressure Coefficients					
Active (K_a)	0.36	0.25	N/A[c]	N/A[c]	N/A[c]
Passive (K_p)	2.8	4.00	N/A[c]	N/A[c]	N/A[c]
At Rest (K_0)	0.55	0.40	N/A[c]	N/A[c]	N/A[c]
Coefficient of sliding	0.30	0.45	N/A[c]	N/A[c]	N/A[c]
Consolidation Properties					
C_c (C_r)	0.148 (0.053)	N/A[c]	N/A[c]	0.199 (0.030)[f]	N/A[c]
Void ratio, e_o	0.85	N/A[c]	N/A[c]	0.67[f]	N/A[c]
P_c', ksf (OCR)	25.0 (2.0)	N/A[c]	N/A[c]	25 (1.6) [[f]]	N/A[c]

Table 2.5.4-233 (Sheet 3 of 4)
Geotechnical Engineering Parameters Selected for Design
(Cooling Basin/GBRA Storage Water Reservoir)

Parameter[a]	**Clay 9**	**Sand 10**	**Clay 11**
Average thickness, feet	41	32.5	>15
USCS symbol	CH, CL	SM, SC	CH, CL
Natural moisture content (MC), %	28.5	N/A[c]	28[f]
Total unit weight (γ_{total}), pcf	125	123	125
Fines content, %	88	26	85
Liquid limit (LL), %	58	N/A[c]	63[f]
Plasticity index (PI), %	37	N/A[c]	40[f]
Uncorrected SPT N-value, bpf	41	164[f]	45[f]
Corrected SPT $(N_1)_{60}$-value, bpf	13	98[f]	29[f]
Shear wave velocity, ft/sec	1506	1733	1465
Undrained shear strength (s_u), ksf	[d,e]	N/A[c]	[d,e]
Friction angle (Φ'), degree	28[e]	40[e]	28[e]
Elastic modulus (high strain) (E), ksf	3360	3200	5430
Shear modulus (high strain) (G), ksf	1160	1230	1870
Shear modulus (low strain) (G_{max}), ksf	8800	12,310	7930
Earth Pressure Coefficients			
Active (K_a)	N/A[c]	N/A[c]	N/A[c]
Passive (K_p)	N/A[c]	N/A[c]	N/A[c]
At Rest (K_0)	N/A[c]	N/A[c]	N/A[c]
Coefficient of sliding	N/A[c]	N/A[c]	N/A[c]
Consolidation Properties			
C_c (C_r)	0.122 (0.030)[f]	N/A[c]	0.343 (0.039)[f]
Void ratio, e_o	0.70[f]	N/A[c]	0.95[f]
P_c', ksf (OCR)	35 (1.5)[f]	N/A[c]	40.0 (1.5)[f]

Table 2.5.4-233 (Sheet 4 of 4)
Geotechnical Engineering Parameters Selected for Design (Cooling Basin/GBRA Storage Water Reservoir)

Parameter^a	**Drainage Sand (ASTM C33 & C144)**	**Embankment Fill (Composite “A”/Sand)**	**Embankment Fill (Composite “B”/Clay)**
Average thickness, feet	N/A^c	N/A^c	N/A^c
USCS symbol	SP/SP	SC	CL
Natural moisture content (MC), %	5 & 4	13	18
Total unit weight (γ_{total}), pcf	111 & 108	137	134
Fines content, %	1 & 2	46	74
Liquid limit (LL), %	N/A^c	34	44
Plasticity index (PI), %	N/A^c	22	29
Uncorrected SPT N-value, bpf	N/A^c	N/A^c	N/A^c
Corrected SPT $(N_1)_{60}$-value, bpf	N/A^c	N/A^c	N/A^c
Shear wave velocity, ft/sec	N/A^c	1160	950
Undrained shear strength (s_u), ksf	N/A^c	$^{g\,e}$	^{ge}
Friction angle (Φ’), degree	37 & 36	30^e	30^e
Elastic modulus (high strain) (E), ksf	N/A^c	600 x $s_u^{g,e}$	600 x s_u^{ge}
Shear modulus (high strain) (G), ksf	N/A^c	N/A^c	N/A^c
Shear modulus (low strain) (G_{max}), ksf	N/A^c	5690	3710
Earth Pressure Coefficients			
Active (K_a)	N/A^c	N/A^c	N/A^c
Passive (K_p)	N/A^c	N/A^c	N/A^c
At Rest (K_0)	N/A^c	N/A^c	N/A^c
Coefficient of sliding	N/A^c	N/A^c	N/A^c
Consolidation Properties			
C_c [C_r]	N/A^c	N/A^c	N/A^c
Void ratio, e_o	N/A^c	N/A^c	N/A^c
P_c’, ksf [OCR]	N/A^c	N/A^c	N/A^c

a. The values tabulated above are for use as guideline only. Reference should be made to specific boring and CPT logs and laboratory test results for appropriate modifications at specific locations and for specific calculations.

b. Thicknesses of Clay 1 (Top) and Clay 1 (bottom) are combined. Thicknesses of Clay 5 (Top) and Clay 5 (Bottom) are combined.

c. N/A indicates that the property is either not measured or not applicable.

d. Values are a function of effective stress (refer to Subsection 2.5.5 text and Figure 2.5.5-212).

e. Under plane strain conditions.

f. Values are carried over from the Power Block area (Table 2.5.4-232).

g. Values are a function of effective stress (refer to Subsection 2.5.5 text and Figure 2.5.5-210).

Table 2.5.4-234
Field Electrical Resistivity Test Results
(Power Block)

Resistivity (ohm-m)											
		Spacing (feet)									
		3	5	7.5	10	15	30	50	100	200	300
		Inferred Strata									
ER Test Location	Surface El. (feet)	Clay 1	Clay 1	Clay 1	Clay 1	Clay 1	Clay 1	Clay 1	Clay 1	Sand 2/ Clay 3/ Sand 4	Clay5/ Sand 5
R-2101	80.5	296	219	197	193	184	158	146	175	234	263
R-2102	80.5	326	245	210	198	184	175	146	175	292	327
R-2201	80.7	235	207	180	163	140	140	175	234	350	350
R-2202	80.7	270	213	175	158	140	123	146	175	292	245
Minimum		235	207	175	158	140	123	146	175	234	245
Maximum		326	245	210	198	184	175	175	234	350	350
Average		282	221	190	178	162	149	153	190	292	296

Table 2.5.4-235
Soil Chemistry Evaluation Guidelines
(Power Block; Cooling Basin/GBRA Storage Water Reservoir)

Potential for Attack on Buried Steel (Corrosiveness/Chlorides)					
	Range for Corrosiveness				
Property	**Little Corrosive**	**Mildly Corrosive**	**Moderately Corrosive**	**Corrosive**	**Very Corrosive**
Resistivity (ohm-m)	>100[a,b]	20-100[a] 50-100[b] >30[b,c]	10-20[a] 20-50[b]	5-10[a] 7-20[b]	<5[a] <2[b]
pH		>5 and <10[b]		5-6.5[a]	<5[a]
Chlorides (ppm)		<200[b]		300-1000[a]	>1000[a]

a. Reference A.

b. Reference B.

c. Reference B, provided 5<pH<10, chlorides <200 ppm, and sulphates <1000 ppm.

Potential for Attack on Normal Weight Concrete in Contact with the Ground (Agressiveness/Sulphates)[a]			
Concrete Exposure	**Water Soluble Sulphate (SO_4) in Soil (%)**	**Cement Type[b]**	**Water Cement Ratio (Maximum)**
Mild	0.00-0.10	—	—
Moderate	0.10-0.20	II, IP(MS), IS(MS)	0.50
Severe	0.20-2.00	V[c]	0.45
Very Severe	Over 2.00	V (with Pozzolan)	0.45

a. Reference C.

b. Per ASTM C 150 or ASTM C 595

c. Or a blend of Type II cement and a ground granulated blast furnace slag or a pozzolan that gives equivalent sulphate resistance.

References:

A American Petroleum Institute. Cathodic Protection of Above Ground Petroleum Storage Tanks, API Recommended Practice No. 651, Washington D.C., 1991

B STS Consultants, Inc. Reinforced Soil Structures, Volume 1, Design and Construction Guidelines, FHWA Report No. FHWA-RD-89-043, McLean, VA, 1990

C American Concrete Institute. Manual of Concrete Practice, Part 1, Materials and General Properties of Concrete, 1994

Table 2.5.4-236 (Sheet 1 of 3)
As-Built Boring Information
(Power Block)

Boring Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
Power Block (Unit 1)					
B-2150	13,412,560.45	2,599,590.93	80.44	150.00	–69.56
B-2151	13,412,636.54	2,599,654.12	80.41	200.00	–119.59
B-2152	13,412,705.76	2,599,720.24	80.26	150.00	–69.74
B-2153	13,412,821.99	2,599,842.54	80.23	150.10	–69.87
B-2154	13,412,450.91	2,599,619.84	80.54	150.00	–69.46
B-2155	13,412,471.13	2,599,698.69	80.36	150.00	–69.64
B-2156	13,412,548.01	2,599,760.77	80.25	201.50	–121.25
B-2157	13,412,623.72	2,599,823.05	80.07	150.00	–69.93
B-2158	13,412,749.59	2,599,928.77	80.45	100.00	–19.55
B-2159	13,412,476.54	2,599,788.95	80.40	211.50	–131.10
B-2160	13,412,180.67	2,599,627.24	80.43	200.00	–119.57
B-2161	13,412,263.42	2,599,698.18	80.49	150.00	-69.51
B-2162A	13,412,385.92	2,599,799.34	80.16	202.80	–122.64
B-2162A Offset	13,412,378.65	2,599,792.16	80.05	210.00	–129.95
B-2163	13,412,463.50	2,599,862.07	79.85	150.00	–70.15
B-2164	13,412,537.94	2,599,925.58	80.38	151.40	–71.02
B-2165	13,412,661.24	2,600,035.28	80.13	150.00	–69.87
B-2166	13,412,109.03	2,599,713.14	80.50	150.00	–69.50
B-2167	13,412,192.20	2,599,781.27	80.19	150.00	–69.81
B-2168	13,412,294.30	2,599,891.10	80.12	201.50	–121.38
B-2169	13,412,350.21	2,599,938.43	79.47	400.00	–320.53
B-2170	13,412,413.86	2,599,989.72	79.68	300.00	–220.32
B-2170R	13,412,396.19	2,599,989.32	79.18	300.00	–220.82
B-2171	13,412,488.43	2,600,092.96	80.03	81.50	–1.47
B-2171R	13,412,479.95	2,600,074.23	79.97	300.00	–220.03
B-2172	13,412,096.23	2,599,829.90	80.10	100.00	–19.90
B-2173	13,412,224.54	2,599,944.52	79.59	300.00	–220.41
B-2174A	13,412,299.46	2,600,000.64	80.11	601.00	–520.89
B-2174A Offset	13,412,316.51	2,599,991.79	79.28	617.00	–537.72
B-2174UD	13,412,276.56	2,600,005.51	78.58	301.40	–222.82
B-2174UDR	13,412,303.29	2,600,012.41	78.98	593.00	–514.02
B-2175	13,412,370.49	2,600,062.81	80.12	200.00	–119.88
B-2176A	13,412,511.69	2,600,175.17	79.81	200.00	–120.19
B-2176A Offset	13,412,522.55	2,600,178.10	79.99	210.00	–130.01
B-2177	13,412,196.92	2,600,000.49	79.61	150.00	–70.39
B-2178	13,412,315.44	2,600,107.24	79.53	151.10	–71.57
B-2179	13,412,424.96	2,600,168.71	79.78	200.00	–120.22
B-2180	13,412,247.39	2,600,062.56	78.85	200.00	–121.15
B-2181	13,412,143.28	2,600,062.56	79.24	151.30	–72.06
B-2182A	13,412,219.77	2,600,133.20	79.69	399.80	–320.11
B-2182A Offset	13,412,209.92	2,600,137.01	79.70	410.00	–330.30
B-2182UD	13,412,207.39	2,600,143.80	79.47	401.90	–322.43
B-2183	13,412,265.91	2,600,166.16	79.63	151.30	–71.67
B-2184	13,412,295.45	2,600,305.41	79.71	151.20	–71.49
B-2285	13,412,682.80	2,600,322.38	80.35	151.20	–70.85

Table 2.5.4-236 (Sheet 2 of 3)
As-Built Boring Information
(Power Block)

Boring Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
Power Block (Unit 2)					
B-2250	13,413,327.46	2,600,233.62	81.05	151.30	–70.25
B-2251	13,413,404.52	2,600,297.97	80.79	210.00	–129.21
B-2252	13,413,478.24	2,600,360.51	80.74	153.40	–72.66
B-2253	13,413,587.94	2,600,484.98	80.86	150.00	–69.14
B-2254	13,413,216.45	2,600,262.92	80.54	151.40	–70.86
B-2255	13,413,238.32	2,600,340.81	80.67	151.30	–70.63
B-2256	13,413,314.37	2,600,403.14	80.26	200.00	–119.74
B-2257	13,413,389.48	2,600,466.52	80.78	151.40	–70.62
B-2258	13,413,515.61	2,600,571.48	80.75	100.00	–19.25
B-2259	13,413,243.36	2,600,432.64	80.35	210.00	–129.65
B-2260	13,412,945.84	2,600,269.60	80.71	198.90	–118.19
B-2261	13,413,029.99	2,600,340.99	80.50	151.50	–71.00
B-2262A	13,413,146.75	2,600,442.41	80.42	200.00	–119.58
B-2262A Offset	13,413,146.80	2,600,433.53	80.57	210.00	–129.43
B-2263	13,413,227.48	2,600,506.73	80.43	151.10	–70.67
B-2264	13,413,303.45	2,600,569.40	80.51	151.00	–70.49
B-2265	13,413,424.28	2,600,677.27	80.60	154.00	–73.40
B-2266	13,412,873.85	2,600,353.67	80.67	149.50	–68.83
B-2267	13,412,957.87	2,600,424.20	80.74	149.50	–68.76
B-2268	13,413,056.37	2,600,528.54	80.58	200.00	–119.42
B-2269	13,413,117.17	2,600,582.50	80.45	403.30	–322.85
B-2269UD	13,413,092.19	2,600,593.55	80.06	402.10	–322.04
B-2270	13,413,179.24	2,600,633.41	80.62	300.00	–219.38
B-2271	13,413,253.44	2,600,735.25	80.46	301.20	–220.74
B-2272	13,412,863.17	2,600,472.73	80.22	100.00	–19.78
B-2273	13,412,991.36	2,600,585.49	80.69	399.40	–318.71
B-2274A	13,413,066.34	2,600,642.97	80.86	594.70	–513.84
B-2274A Offset	13,413,070.52	2,600,633.47	80.34	620.00	–539.66
B-2274UD	13,413,047.70	2,600,652.45	80.41	607.70	–527.29
B-2275	13,413,133.62	2,600,702.31	80.49	199.50	–119.01
B-2276A	13,413,276.30	2,600,822.55	80.53	199.50	–118.97
B-2276A Offset	13,413,289.36	2,600,817.99	80.63	210.00	–129.37
B-2277	13,412,961.61	2,600,644.66	80.60	150.30	–69.70
B-2278	13,413,084.23	2,600,745.84	80.69	151.40	–70.71
B-2279	13,413,192.06	2,600,811.88	80.28	198.80	–118.52
B-2280	13,413,014.25	2,600,704.09	80.57	198.10	–117.53
B-2281	13,412,908.71	2,600,705.43	80.42	150.00	–69.58
B-2282A	13,412,970.74	2,600,757.69	80.31	400.00	–319.69
B-2282A Offset	13,412,962.40	2,600,766.39	80.46	410.00	–329.54
B-2283	13,413,031.52	2,600,808.58	80.40	151.20	–70.80
B-2284	13,413,060.61	2,600,948.44	80.42	150.00	–69.58

Table 2.5.4-236 (Sheet 3 of 3)
As-Built Boring Information
(Power Block)

Boring Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
Outside Power Block					
B-08	13,415,809.85	2,598,937.51	81.71	150.00	–68.29
B-10	13,418,474.15	2,604,736.80	77.69	150.20	–72.51
B-2185	13,412,320.56	2,600,808.84	79.48	151.10	–71.62
B-2301A	13,414,429.68	2,596,278.37	81.23	300.00	–218.77
B-2301	13,414,414.60	2,596,251.62	80.79	310.00	–229.21
B-2307A	13,420,888.12	2,603,157.79	76.75	299.40	–222.65
B-2307	13,420,917.89	2,603,184.91	76.38	310.00	–233.62

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-237 (Sheet 1 of 2)
As-Built Boring Information
(Cooling Basin/GBRA Storage Water Reservoir)

Boring Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
B-01	13,404,257.08	2,606,680.96	71.46	150.00	–78.54
B-02	13,411,511.00	2,607,865.77	74.68	150.00	–75.32
B-03	13,414,926.74	2,609,291.47	74.89	150.00	–75.11
B-04	13,414,277.17	2,607,437.06	78.97	150.20	–71.23
B-05	13,414,770.02	2,605,821.89	77.56	150.20	–72.64
B-06	13,415,884.18	2,604,971.12	78.98	150.20	–71.22
B-07	13,418,366.17	2,606,567.82	77.39	150.20	–72.81
B-09	13,414,943.90	2,604,897.77	77.36	150.20	–72.84
B-11	13,411,479.49	2,607,866.27	74.77	310.00	–235.23
B-12	13,418,446.37	2,606,546.46	76.70	310.00	–233.30
B-2302A	13,407,371.01	2,598,389.30	80.32	150.00	–69.68
B-2302	13,407,401.61	2,598,386.93	80.00	315.00	–235.00
B-2302UD	13,407,373.35	2,598,406.10	80.00	147.30	–67.30
B-2303A	13,402,308.03	2,600,478.63	75.36	300.00	–224.64
B-2303	13,402,314.55	2,600,497.11	75.56	310.00	–234.44
B-2304A	13,396,566.48	2,608,686.75	68.33	296.50	–228.17
B-2304	13,396,541.80	2,608,710.01	68.12	310.00	–241.88
B-2304UD	13,396,571.12	2,608,693.06	68.46	143.50	–75.04
B-2305A	13,406,652.71	2,621,646.04	65.45	300.00	–234.55
B-2305	13,406,649.21	2,621,680.51	65.58	305.00	–239.42
B-2306A	13,411,450.19	2,615,249.64	64.28	100.00	–35.72
B-2306	13,411,472.15	2,615,253.03	64.68	310.00	–245.32
B-2308	13,404,197.77	2,599,333.56	76.39	100.00	–23.61
B-2310	13,406,601.70	2,601,353.57	75.95	100.00	–24.05
B-2315	13,416,228.72	2,609,409.27	47.06	101.10	–54.04
B-2316	13,413,189.22	2,608,491.76	75.17	100.80	–25.63
B-2317	13,410,598.40	2,600,511.90	76.73	101.00	–24.27
B-2318	13,401,612.98	2,601,154.61	75.31	101.50	–26.19
B-2319	13,403,601.01	2,603,048.72	74.16	151.50	–77.34
B-2319UD	13,403,595.98	2,603,062.86	74.16	115.00	–40.84
B-2320	13,407,573.79	2,606,839.75	71.46	151.50	–80.04
B-2321	13,410,953.82	2,610,037.97	71.62	150.00	–78.38
B-2321UD	13,410,937.49	2,610,017.10	71.81	132.50	–60.69
B-2322	13,413,528.90	2,612,528.69	68.53	100.00	–31.47
B-2324	13,416,308.77	2,612,208.94	24.47	151.20	–126.73
B-2331	13,409,862.54	2,612,278.74	69.37	101.10	–31.73
B-2332	13,414,435.21	2,603,735.80	78.68	100.20	–21.52
B-2333	13,398,864.77	2,603,981.87	76.07	101.50	–25.43
B-2334	13,400,634.86	2,606,130.71	71.85	61.50	10.35
B-2335	13,404,183.94	2,610,412.10	66.75	61.50	5.25
B-2336	13,409,474.40	2,616,874.85	68.00	100.00	–32.00
B-2337	13,407,263.05	2,614,846.26	67.23	100.00	–32.77
B-2338	13,398,220.80	2,606,385.80	68.15	101.70	–33.55
B-2340	13,400,762.63	2,609,812.65	68.09	61.50	6.59
B-2344	13,404,997.85	2,615,527.11	65.78	61.50	4.28
B-2346	13,407,540.56	2,618,951.51	67.09	100.00	–32.91
B-2348	13,409,626.85	2,621,653.06	50.63	150.00	–99.37

Table 2.5.4-237 (Sheet 2 of 2)
As-Built Boring Information
(Cooling Basin/GBRA Storage Water Reservoir)

Boring Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
B-2349	13,417,352.46	2,607,239.49	76.66	101.20	–24.54
B-2350	13,395,764.08	2,610,122.62	65.25	100.10	–34.85
B-2351	13,398,915.88	2,613,285.96	63.73	100.00	–36.27
B-2352	13,402,480.47	2,617,531.27	62.91	150.00	–87.09
B-2352UD	13,402,493.35	2,617,543.73	62.84	94.50	–31.66
B-2353	13,406,185.70	2,620,582.19	65.60	99.90	–34.30
B-2354	13,418,119.59	2,607,884.13	76.83	100.20	–23.37
B-2355	13,412,008.12	2,613,846.60	71.04	101.70	–30.66
B-2356	13,409,147.49	2,617,797.63	67.71	101.90	–34.19
B-2357	13,404,654.33	2,620,736.11	65.67	100.00	–34.33
B-2358	13,402,101.51	2,611,620.85	66.47	151.50	–85.03
B-2359	13,417,294.57	2,605,500.03	77.57	151.30	–73.73
B-2359UD	13,417,325.03	2,605,493.44	77.35	121.70	–44.35

[a] Northings and Eastings are referenced to NAD 83.

[b] Elevations are referenced to NAVD 88.

Table 2.5.4-238 (Sheet 1 of 3) Undisturbed Sample Details (Power Block)

Boring Number	Sample Number	USCS Group	Stratum	Sample Top Depth (feet)[a]	Sample Top Elevation (feet)[a]
Power Block (Unit 1)					
B-2174UD	UD1	CL	Clay 1 (Top)	10.0	68.6
B-2174UD	UD2	CH	Clay 1 (Bottom)	30.0	48.6
B-2174UD	UD3	CL	Clay 3	75.0	3.6
B-2174UD	UD4	CL	Sand 4	90.0	–11.4
B-2174UD	UD5	CL	Sand 4	92.0	–13.4
B-2174UD	UD6	SP-SC	Sand 4	95.0	–16.4
B-2174UD	UD7	CH	Clay 5 (Top)	115.0	–36.4
B-2174UD	UD8	SM	Sand 6	145.0	–66.4
B-2174UD	UD9	SM	Sand 6	180.0	–101.4
B-2174UD	UD10	SM	Sand 6	183.0	–104.4
B-2174UD	UD11	SM	Sand 6	206.0	–127.4
B-2174UD	UD12	SM	[Sand 6]/ Clay 7	210.0	–131.4
B-2174UD	UD13	CH	Sand 8	245.0	–166.4
B-2174UD	UD14	CH	Sand 8	245.8	–167.2
B-2174UD	UD15	SC	Sand 8	265.0	–186.4
B-2174UD	UD16	CH	Clay 9	300.0	–221.4
B-2174UDR	UD17	CH (t); SP (b)	Clay 9/ [Sand 10]	319.3	–240.3
B-2174UDR	UD18	SP	Sand 10	324.8	–245.8
B-2174UDR	UD19	CH	Clay 11	334.9	–255.9
B-2174UDR	UD20	CH	Clay 11	359.1	–280.1
B-2174UDR	UD21	CH	Clay 11	397.7	–318.7
B-2174UDR	UD22	CH	Sand 12	409.6	–330.6
B-2174UDR	UD23	CL	Sand 12	419.5	–340.5
B-2174UDR	UD24	No Recovery	Clay 13	425.0	–346.0
B-2174UDR	UD25	No Recovery	Clay 13	442.0	–363.0
B-2174UDR	UD26	CH	Clay 13	445.0	–366.0
B-2174UDR	UD27	CH	Clay 13	490.0	–411.0
B-2174UDR	UD28	SC (t); SM (b)	Sand 14	525.0	–446.0
B-2174UDR	UD29	CH	Clay 15	550.0	–471.0
B-2174UDR	UD30	CH	Clay 17	570.0	–491.0
B-2174UDR	UD31	CH (t); SM (b)	Sand 18	590.5	–511.5
B-2182UD	UD1	CL	Clay 1 (Top)	10.0	69.5
B-2182UD	UD2	No Recovery	Clay 1 (Top)	13.0	66.5
B-2182UD	UD3	CH	Clay 1 (Top)	16.0	63.5
B-2182UD	UD4	No Recovery	Clay 1 (Top)	30.0	49.5
B-2182UD	UD5	CH	Clay 1 (Top)	33.0	46.5
B-2182UD	UD6	CL	Clay 1 (Top)	37.0	42.5
B-2182UD	UD7	SC (t); SP (b)	Clay 3	65.0	14.5
B-2182UD	UD8	SC (t); CH (b)	Clay 3	68.0	11.5
B-2182UD	UD9	CH	Sand 4	85.0	–5.5
B-2182UD	UD10	CH	Sand 4	90.0	–10.5
B-2182UD	UD11	CL	Sand 4	90.5	–11.0
B-2182UD	UD12	CL (t); SP-SM (b)	Sand 4	95.0	–15.5
B-2182UD	UD13	SC	Clay 5 (Top)	120.0	–40.5
B-2182UD	UD14	ML	[Clay 5 (Top)]/ Sand 5	123.0	–43.5

Table 2.5.4-238 (Sheet 2 of 3) Undisturbed Sample Details (Power Block)

Boring Number	Sample Number	USCS Group	Stratum	Sample Top Depth (feet)[a]	Sample Top Elevation (feet)[a]
Power Block (Unit 1) (continued)					
B-2182UD	UD15	ML	Clay 5 (Bottom)	145.0	–65.5
B-2182UD	UD16	SM	Sand 6	180.0	–100.5
B-2182UD	UD17	CL	Clay 7	215.0	–135.5
B-2182UD	UD18	CH	Clay 7	218.0	–138.5
B-2182UD	UD19	SM	Sand 8	240.0	–160.5
B-2182UD	UD20	SC-SM	Sand 8	242.0	–162.5
B-2182UD	UD21	No Recovery	Sand 8	265.0	–185.5
B-2182UD	UD22	CH	Sand 8	270.0	–190.5
B-2182UD	UD23	No Recovery	Sand 8	275.0	–195.5
B-2182UD	UD24	CH	Clay 9	300.0	–220.5
B-2182UD	UD25	CH	Clay 9	303.0	–223.5
B-2182UD	UD26	CL	Clay 9	320.0	–240.5
B-2182UD	UD27	CH (t); SC (b)	Clay 9	323.0	–243.5
B-2182UD	UD28	CH	Clay 9	330.0	–250.5
B-2182UD	UD29	CH	Clay 9	333.0	–253.5
B-2182UD	UD30	CL	Clay 9	340.0	–260.5
B-2182UD	UD31	CL	Clay 9	343.0	–263.5
B-2182UD	UD32	SP-SC (t); SP (b)	Sand 10	350.0	–270.5
B-2182UD	UD33	CH	Clay 11	380.0	–300.5
B-2182UD	UD34	CH	Clay 11	383.0	–303.5
B-2182UD	UD35	CH	Clay 11	390.0	–310.5
B-2182UD	UD36	CH	Clay 11	393.0	–313.5
B-2182UD	UD37	CL	Clay 11	400.0	–320.5
Power Block (Unit 2)					
B-2269UD	UD1	CL	Clay 1 (Top)	10.0	70.1
B-2269UD	UD2	CH	Clay 1 (Top)	13.0	67.1
B-2269UD	UD3	CL	Sand 1	30.0	50.1
B-2269UD	UD4	CL	Sand 1	33.0	47.1
B-2269UD	UD5	CH	Clay 1 (Bottom)	50.0	30.1
B-2269UD	UD6	CH	Clay 1 (Bottom)	53.0	27.1
B-2269UD	UD7	CH	Clay 3	70.0	10.1
B-2269UD	UD8	CH	Clay 3	73.0	7.1
B-2269UD	UD9	CH	[Sand 4]/ Clay 5 (Top)	120.0	–39.9
B-2269UD	UD10	CH	Clay 5 (Top)	123.0	–42.9
B-2269UD	UD11	CH	Sand 5	150.0	–69.9
B-2269UD	UD12	CH	Clay 5 (Bottom)	153.0	–72.9
B-2269UD	UD13	No Recovery	Clay 5 (Bottom)	165.0	–84.9
B-2269UD	UD14	SC	Sand 8	216.0	–135.9
B-2269UD	UD15	SC	Sand 8	216.2	–136.1
B-2269UD	UD16	SC	Sand 8	280.0	–199.9
B-2269UD	UD17	SC	Sand 8	283.2	–203.1
B-2269UD	UD18	CL	Clay 11	375.0	–294.9
B-2269UD	UD19	CH	Clay 11	380.0	–299.9
B-2269UD	UD20	CH	Clay 11	400.0	–319.9
B-2274UD	UD1	CL	Clay 1 (Top)	10.2	70.2
B-2274UD	UD2	CH	Sand 1	29.8	50.6

Table 2.5.4-238 (Sheet 3 of 3)
Undisturbed Sample Details
(Power Block)

Boring Number	Sample Number	USCS Group	Stratum	Sample Top Depth (feet)[a]	Sample Top Elevation (feet)[a]
Power Block (Unit 2) (contuinued)					
B-2274UD	UD3	CH	Clay 3	64.9	15.5
B-2274UD	UD4	CH	Clay 3	67.0	13.4
B-2274UD	UD5	CL	Clay 3	89.8	-9.4
B-2274UD	UD6	No Recovery	Clay 3	94.9	–14.5
B-2274UD	UD7	SP	[Clay 3]/ Sand 4	97.4	–17.0
B-2274UD	UD8	CH	Clay 5 (Top)	120.0	–39.6
B-2274UD	UD9	SC	Clay 5 (Bottom)	146.1	–65.7
B-2274UD	UD10	CH	Sand 6	180.0	–99.6
B-2274UD	UD11	No Recovery	Sand 6	214.4	–134.0
B-2274UD	UD12	SC	Sand 8	221.1	–140.7
B-2274UD	UD13	CL	Sand 8	240.0	–159.6
B-2274UD	UD14	SC	Sand 8	265.0	–184.6
B-2274UD	UD15	SC	Sand 8	276.0	–195.6
B-2274UD	UD16	CH	Clay 9	300.0	–219.6
B-2274UD	UD17	MH	Clay 9	320.0	–239.6
B-2274UD	UD18	SM	Sand 10	330.1	–249.7
B-2274UD	UD19	SM	Sand 10	350.1	–269.7
B-2274UD	UD20	MH	Clay 11	380.0	–299.6
B-2274UD	UD21	CH	Clay 11	390.0	–309.6
B-2274UD	UD22	CH	Clay 11	400.0	–319.6
B-2274UD	UD23	CL	Sand 12	420.0	–339.6
B-2274UD	UD24	CH	Clay 13	480.0	–399.6
B-2274UD	UD25	CH	Sand 14	520.0	–439.6
B-2274UD	UD26	CL	Clay 17	580.0	–499.6
B-2274UD	UD27	SP-SC	Sand 18	600.0	–519.6
B-2274UD	UD28	SP	Sand 18	605.0	–524.6

a. Elevations are referenced to NAVD 88

Table 2.5.4-239 (Sheet 1 of 2)
Undisturbed Sample Details
(Cooling Basin/GBRA Storage Water Reservoir)

Boring Number	Sample Number	USCS Group	Stratum	Sample Top Depth (feet)[a]	Sample Top Elevation (feet)[a]
B-2302UD	UD1	CH	Clay 1 (Top)	8.5	71.5
B-2302UD	UD2	CH	Clay 1 (Top)/ [Sand 1]	11.0	69.0
B-2302UD	UD3	SP-SM (t); SM (b)	Sand 1	13.5	66.5
B-2302UD	UD4	CH	Clay 1 (Bottom)	28.5	51.5
B-2302UD	UD5	CH	Clay 1 (Bottom)	38.5	41.5
B-2302UD	UD6	CL	Clay 1 (Bottom)	48.5	31.5
B-2302UD	UD7	SC-SM	Sand 2	59.0	21.0
B-2302UD	UD8	SM	Sand 2	61.0	19.0
B-2302UD	UD9	SP-SM	Sand 2/[Clay 3]	63.5	16.5
B-2302UD	UD10	CH	Clay 3	66.0	14.0
B-2302UD	UD11	CH	Clay 3	69.5	10.5
B-2302UD	UD12	CH	Clay 3	78.5	1.5
B-2302UD	UD13	SP (t); SP-SC (b)	Sand 4	88.5	–8.5
B-2302UD	UD14	SM	Sand 4	108.5	–28.5
B-2302UD	UD15	No Recovery	Clay 5 (Top)	N/A	N/A
B-2302UD	UD16	CH	Clay 5 (Top)	120.5	–40.5
B-2302UD	UD17	CL (t); SP (b)	Clay 5 (Top)	128.5	–48.5
B-2302UD	UD18	CH	Clay 5 (Bottom)	143.5	–63.5
B-2302UD	UD19	CH	Clay 5 (Btm)/ [Sand 6]	145.5	–65.5
B-2304UD	UD1	CL	Clay 1 (Top)	6.0	62.5
B-2304UD	UD2	ML (t); SC-SM (b)	Clay 1 (Top)	11.0	57.5
B-2304UD	UD3	SM	Sand 2	28.5	40.0
B-2304UD	UD4	SM	Sand 2	32.5	36.0
B-2304UD	UD5	CH	Clay 3	53.0	15.5
B-2304UD	UD6	CL	Clay 3	63.0	5.5
B-2304UD	UD7	MH	Clay 3	73.5	–5.0
B-2304UD	UD8	CH	Clay 3/[Sand 4]	83.5	–15.0
B-2304UD	UD9	CH	Clay 5 (Top)	98.5	–30.0
B-2304UD	UD10	No Recovery	Clay 5 (Top)	N/A	N/A
B-2304UD	UD11	CH	Clay 5 (Top)	111.0	-42.5
B-2304UD	UD12	CH	Clay 5 (Top)	118.5	–50.0
B-2304UD	UD13	CH	Clay 5 (Top)	121.0	–52.5
B-2304UD	UD14	CL (t); SP (b)	Sand 5	138.5	–70.0
B-2304UD	UD15	SP-SM	Sand 5	141.0	–72.5
B-2319UD	UD1	No Recovery	Sand 1	N/A	N/A
B-2319UD	UD2	SC	Sand 1	5.5	68.7
B-2319UD	UD3	SM	Sand 1	11.0	63.2
B-2319UD	UD4	CH	Clay 1 (Bottom)	25.0	49.2
B-2319UD	UD5	ML (t); SC (b)	Sand 2	35.0	39.2
B-2319UD	UD6	ML	Clay 3	55.0	19.2
B-2319UD	UD7	CL (t); SC (b)	Clay 3	65.0	9.2
B-2319UD	UD8	SP-SM	Clay 3/ [Sand 4]	75.0	–0.8
B-2319UD	UD9	CH (t); SP-SM (b)	Sand 4	85.0	–10.8
B-2319UD	UD10	SP	Sand 4	95.0	–20.8
B-2319UD	UD11	CH	Sand 5	110.0	–35.8
B-2319UD	UD12	No Recovery	Sand 5	N/A	N/A

Table 2.5.4-239 (Sheet 2 of 2) Undisturbed Sample Details (Cooling Basin/GBRA Storage Water Reservoir)

Boring Number	Sample Number	USCS Group	Stratum	Sample Top Depth (feet)[a]	Sample Top Elevation (feet)[a]
B-2321UD	UD1	CL	Clay 1 (Top)	3.5	68.3
B-2321UD	UD2	No Recovery	Clay 1 (Top)	N/A	N/A
B-2321UD	UD3	CH	Clay 1 (Top)	10.0	61.8
B-2321UD	UD4	CH	Clay 1 (Top)	13.5	58.3
B-2321UD	UD5	CL	Clay 1 (Top)	17.0	54.8
B-2321UD	UD6	CH	Clay 1 (Bottom)	28.5	43.3
B-2321UD	UD7	CH	Clay 1 (Bottom)	38.5	33.3
B-2321UD	UD8	CH	Clay 1 (Bottom)	48.5	23.3
B-2321UD	UD9	CL	Clay 3	58.5	13.3
B-2321UD	UD10	CL	Clay 3	63.0	8.8
B-2321UD	UD11	SC	Sand 4	88.5	–16.7
B-2321UD	UD12	SP-SM	Sand 4	93.0	–21.2
B-2321UD	UD13	SC	Sand 4	118.0	–46.2
B-2321UD	UD14	CH	Clay 5 (Top)	128.5	–56.7
B-2321UD	UD15	CH	Clay 5 (Top)	130.5	–58.7
B-2352UD	UD1	CL	Clay 1 (Top)	3.5	59.3
B-2352UD	UD2	CL	Clay 1 (Top)	9.0	53.8
B-2352UD	UD3	CL	Clay 1 (Top)	11.5	51.3
B-2352UD	UD4	CL	Clay 1 (Bottom)	14.0	48.8
B-2352UD	UD5	CH	Clay 1 (Bottom)	24.0	38.8
B-2352UD	UD6	CH	Clay 1 (Bottom)	34.0	28.8
B-2352UD	UD7	CL	[Sand 2]/Clay 3	59.0	3.8
B-2352UD	UD8	SM	Clay 3	68.0	–5.2
B-2352UD	UD9	SM	Sand 4	88.0	–25.2
B-2352UD	UD10	SM	Sand 4/[Sand 5]	92.0	–29.2
B-2359UD	UD1	CL (t); SP-SM (b)	Clay 1 (Top)/[Sand 1]	13.5	63.9
B-2359UD	UD2	SP (t); CH (b)	Sand 1/Clay 1 (Btm)]	25.0	52.4
B-2359UD	UD3	CH	Clay 1 (Bottom)	30.5	46.9
B-2359UD	UD4	CH	Clay 1 (Bottom)	35.0	42.4
B-2359UD	UD5	CH	Clay 1 (Bottom)	40.0	37.4
B-2359UD	UD6	SC	Sand 2	50.0	27.4
B-2359UD	UD7	ML	Sand 2	55.0	22.4
B-2359UD	UD8	SP-SC	Sand 2	62.0	15.4
B-2359UD	UD9	SC	Sand 2	65.0	12.4
B-2359UD	UD10	CH	Clay 3	70.0	7.4
B-2359UD	UD11	SC-SM	Sand 4	77.0	0.4
B-2359UD	UD12	SC	Sand 4	80.0	–2.7
B-2359UD	UD13	SP-SC	Sand 4	85.0	–7.7
B-2359UD	UD14	ML	Sand 4	88.5	–11.2
B-2359UD	UD15	SP-SC	Sand 4	95.0	–17.7
B-2359UD	UD16	SP-SC	Sand 4	98.0	–20.7
B-2359UD	UD17	SM	Clay 5 (Top)	110.0	–32.7
B-2359UD	UD18	SC	Clay 5 (Top)	112.5	–35.2
B-2359UD	UD19	SM	Clay 5 (Top)	114.0	–36.7
B-2359UD	UD20	CH	Clay 5 (Bottom)	120.0	–42.7

a. Elevations are referenced to NAVD 88.

Table 2.5.4-240
As-Built Cone Penetration Test Information
(Power Block)

CPT Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
Power Block (Unit 1)					
C-2101	13,412,774.10	2,599,705.86	80.12	94.60	–14.48
C-2102S	13,412,550.23	2,599,702.26	80.17	91.90	–11.73
C-2103	13,412,715.32	2,599,852.09	77.68	93.40	–15.72
C-2104S	13,412,187.52	2,599,704.22	80.10	71.50	8.60
C-2105	13,412,269.09	2,599,774.92	80.19	88.00	–7.81
C-2106	13,412,291.55	2,599,955.62	79.59	296.40	–216.81
C-2106S	13,412,296.36	2,599,958.27	79.51	79.30	0.21
C-2107	13,412,304.73	2,600,042.26	79.96	95.30	–15.34
C-2108	13,412,425.89	2,600,105.91	79.78	93.30	–13.52
C-2109S	13,412,545.94	2,600,138.83	79.93	90.00	–10.07
C-2110	13,412,478.15	2,600,217.10	80.00	92.90	–12.90
C-2111	13,412,225.65	2,600,089.78	78.04	16.70	61.34
C-2111A	13,412,224.80	2,600,089.84	78.14	33.90	44.24
C-2111B	13,412,225.10	2,600,087.29	78.28	38.40	39.88
C-2111C	13,412,238.89	2,600,087.16	78.04	85.80	–7.76
C-2111D	13,412,212.18	2,600,086.06	79.22	95.50	–16.28
C-2112	13,412,358.60	2,600,185.71	79.55	99.70	–20.15
C-2113	13,412,251.45	2,600,231.11	79.31	96.80	–17.49
C-2214	13,412,587.86	2,600,280.45	79.86	93.60	–13.74
C-2215	13,412,539.13	2,600,425.19	79.83	92.60	–12.77
Power Block (Unit 2)					
C-2201	13,413,541.97	2,600,349.92	80.62	98.70	–18.08
C-2202S	13,413,315.91	2,600,345.61	80.42	93.00	–12.58
C-2203	13,413,489.00	2,600,490.16	80.56	100.00	–19.44
C-2204S	13,412,953.12	2,600,347.76	80.35	55.00	25.35
C-2204SA	13,412,954.25	2,600,354.46	80.30	91.00	–10.70
C-2204SB	13,412,963.86	2,600,351.20	80.18	90.00	–9.82
C-2205	13,413,036.37	2,600,417.96	80.39	95.00	–14.61
C-2206	13,413,081.83	2,600,615.27	80.22	247.20	–166.98
C-2206S	13,413,071.11	2,600,604.08	80.63	93.80	–13.17
C-2207	13,413,071.18	2,600,687.06	80.39	90.60	–10.21
C-2208	13,413,191.48	2,600,748.18	80.54	96.00	–15.46
C-2209S	13,413,311.92	2,600,780.51	80.27	90.00	–9.73
C-2210	13,413,244.43	2,600,858.74	80.30	33.00	47.30
C-2210A	13,413,246.80	2,600,860.38	79.87	99.60	–19.73
C-2211	13,412,992.38	2,600,730.80	80.20	93.00	–12.80
C-2212	13,413,123.28	2,600,827.18	80.44	83.00	–2.56
C-2213	13,413,017.49	2,600,874.63	80.46	97.30	–16.84
Outside Power Block					
C-2216	13,414,151.27	2,600,733.87	80.54	96.70	–16.16

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-241
As-Built Cone Penetration Test Information
(Cooling Basin/GBRA Storage Water Reservoir)

CPT Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
C-2301S	13,408,989.39	2,599,158.23	79.08	34.83	44.25
C-2301SA	13,408,982.41	2,599,162.20	78.70	30.04	48.66
C-2302	13,412,519.49	2,602,124.85	77.49	94.79	–17.30
C-2303S	13,416,428.66	2,605,405.65	76.79	97.22	–20.43
C-2304	13,418,878.70	2,607,463.62	74.85	59.96	14.89
C-2305	13,408,849.43	2,603,251.14	75.47	60.16	15.31
C-2306	13,411,148.27	2,605,179.25	77.54	59.96	17.58
C-2307	13,414,685.38	2,608,147.28	74.88	59.96	14.92
C-2308	13,415,348.90	2,610,567.73	58.02	86.26	–28.24
C-2309	13,405,587.95	2,604,945.49	72.92	53.86	19.06
C-2310	13,409,556.77	2,608,738.56	70.88	59.96	10.92
C-2311	13,413,231.26	2,613,049.76	41.70	78.13	–36.43
C-2311A	13,413,277.55	2,612,969.43	50.49	100.24	–49.75
C-2312	13,397,971.98	2,606,226.92	64.99	90.13	–25.14
C-2313	13,399,066.96	2,607,529.09	71.17	59.96	11.21
C-2314	13,402,413.42	2,608,270.67	69.45	60.16	9.29
C-2315	13,405,943.12	2,612,535.56	66.35	60.29	6.06
C-2316	13,407,731.74	2,614,700.43	68.23	60.29	7.94
C-2317	13,408,493.37	2,617,901.20	45.17	83.57	–38.40
C-2318	13,403,305.07	2,613,240.79	66.39	59.96	6.43
C-2319	13,406,689.77	2,617,807.82	65.56	59.96	5.60
C-2321S	13,397,141.61	2,611,187.71	65.80	49.86	15.94
C-2321SA	13,397,149.37	2,611,182.17	65.90	51.10	14.80
C-2322	13,400,701.15	2,615,409.91	62.19	83.90	–21.71
C-2323S	13,404,257.20	2,619,650.56	65.67	100.17	–34.50
C-2324	13,406,320.31	2,622,094.07	63.58	59.96	3.62
C-2328	13,395,274.28	2,609,720.08	65.62	60.27	5.35

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-242
As-Built Test Pit Information
(Power Block)

Test Pit Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
Power Block (Unit 1)					
TP-2101	13,412,437.27	2,599,756.15	80.43	10.0	70.4
TP-2102	13,412,124.00	2,599,818.54	80.35	10.0	70.4
TP-2103	13,411,950.60	2,600,103.92	79.70	10.0	69.7
TP-2104	13,412,451.21	2,600,288.03	80.20	10.0	70.2
Power Block (Unit 2)					
TP-2201	13,413,198.85	2,600,399.35	79.85	10.0	69.9
TP-2202	13,412,889.65	2,600,464.19	80.60	10.0	70.6
TP-2203	13,412,717.50	2,600,741.27	80.26	10.0	70.3
TP-2204	13,413,215.93	2,600,931.80	80.84	10.0	70.8

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-243
As-Built Test Pit Information
(Cooling Basin/GBRA Storage Water Reservoir)

Test Pit Number	Northing (feet)[a]	Easting (feet)[a]	Ground Surface Elevation (feet)[b]	Depth (feet)	Base Elevation (feet)[b]
TP-2310	13,406,614.56	2,601,358.66	75.57	10.0	65.6
TP-2314	13,413,935.46	2,607,799.59	74.70	10.0	64.7
TP-2317	13,410,595.30	2,600,492.45	76.76	10.0	66.8
TP-2319	13,403,607.12	2,603,037.74	74.25	10.0	64.3
TP-2320	13,407,598.78	2,606,824.54	71.41	10.0	61.4
TP-2321	13,410,972.16	2,610,031.41	70.82	10.0	60.8
TP-2332	13,414,422.39	2,603,751.85	78.22	10.0	68.2
TP-2334	13,400,632.04	2,606,110.32	72.41	10.0	62.4
TP-2335	13,404,163.77	2,610,401.63	66.82	10.0	56.8
TP-2337	13,407,266.15	2,614,864.54	66.92	10.0	56.9
TP-2351	13,398,902.07	2,613,286.15	63.91	10.0	53.9
TP-2352	13,402,479.96	2,617,531.97	62.97	10.0	523.0

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-244
Laboratory Compaction Test Results
(Power Block)

Test Pit	Sample	Depth (feet)	Top El. (feet)[a]	USCS Group Symbol	Gravel (%)	Sand (%)	Silt/ Clay (%)	Specific Gravity	Natural Moisture Content (%)[b]	Maximum Dry Density (pcf)[c]	Optimum Moisture Content (%)[c]
TP-2101	Bulk 1	8	72.4	CH	0.0	16.3	83.7	2.73	17.5	117.5	13.5
TP-2102	Bulk 1	8	72.4	CH	0.0	15.3	84.7	2.70	15.7	119.5	14.5
TP-2103	Bulk 1	8	71.7	CL	0.2	21.2	78.6	2.69	26.9	121.5	12.0
TP-2104	Bulk 1	8	72.2	CL	0.0	24.3	75.7	2.68	11.1	125.0	11.0
TP-2201	Bulk 1	5-10	74.9	CL	0.0	29.4	70.6	2.68	18.1	121.0	12.5
TP-2202	Bulk 1	8	72.6	CH	0.0	22.0	78.0	2.69	19.6	122.0	12.5
TP-2203	Bulk 1	8	72.3	CL	0.0	16.6	83.4	2.73	17.7	120.5	12.5
TP-2204	Bulk 1	5-10	75.8	CL	0.0	15.6	84.4	2.71	17.2	125.0	11.5
Fordyce[d]	Raw Material	—	—	SW	42	55	3	2.70	—	127.0[e]	8.5[e]
—	—	—	—	—	—	—	—	—	—	120.5[f]	12.5[f]
C.W.&A.[d]	TxDOT Grade 4	—	—	GW-GC	50	43	7	2.67	—	138.0[e]	5.5[e]
—	—	—	—	—	—	—	—	—	—	136.5[f]	6.0[f]
C.W.&A.[d]	TxDOT Grade 6	—	—	GP-GC	47	43	10	2.66	—	137.0[e]	6.0[e]
—	—	—	—	—	—	—	—	—	—	133.0[f]	6.5[f]

a. Elevations are referenced to NAVD 88.

b. Natural Moisture for bulk samples obtained from jar sample at same depth or within depth range of bulk sample.

c. Moisture/density testing performed in accordance with ASTM D 1557 (Modified Proctor) (Reference 2.5.4-217).

d. Possible structural fill material sampled from offsite source.

e. Test made on sample screened on 3/4” sieve.

f. Test made on sample screened on 3/8” sieve.

Table 2.5.4-245
Laboratory Compaction Test Results
(Cooling Basin/GBRA Storage Water Reservoir)

Test Pit	Sample	Depth (feet)	Top El. (feet)[a]	USCS Group Symbol	Gravel (%)	Sand (%)	Silt/ Clay (%)	Specific Gravity	Natural Moisture Content (%)[b]	Maximum Dry Density (pcf)[c]	Optimum Moisture Content[c]
TP-2310	Bulk 1	5	70.6	CL	0	42.4	57.6	2.69	13.7	123.5	12.0
TP-2310	Bulk 2	10	65.6	SC-SM	0	71.1	28.9	2.66	8.3	128.5	9.5
TP-2314	Bulk 2	5-10	64.7	CH	0	4.3	95.7	2.72	22.7	113.5	16.5
TP-2317	Bulk 1	2-5	74.8	CL	0	31.0	69.0	2.67	19.1	122.0	13.0
TP-2317	Bulk 2	5-10	71.8	CL	0	20.5	79.5	2.70	16.4	123.5	12.5
TP-2319	Bulk 2	3-10	71.3	SC	0	52.7	47.3	2.67	13.0	125.0	11.0
TP-2320	Bulk 1	4-5	67.4	CL	0	38.2	61.8	2.69	15.2	122.5	12.5
TP-2320	Bulk 2	5-10	66.4	CL	0	29.6	70.4	2.67	12.0	126.5	11.5
TP-2321	Bulk 1	4-5	66.8	CH	0	28.0	72.0	2.70	15.3	116.0	14.5
TP-2321	Bulk 2	6.5-10	64.3	CL	0	19.0	81.0	2.70	16.0	120.0	13.5
TP-2332	Bulk 2	3-10	75.2	SM	0	80.0	20.0	2.66	7.7	122.0	11.0
TP-2334	Bulk 1	2-5	70.4	CL	0	32.0	68.0	2.72	14.8	123.0	11.5
TP-2334	Bulk 2	5-10	67.4	SC	0	52.6	47.4	2.67	15.2	127.5	10.0
TP-2335	Bulk 2	4-8	62.8	CL	0	46.4	53.6	2.67	11.2	124.5	11.5
TP-2335	Bulk 3	8-10	58.8	SM	0	75.2	24.8	2.66	7.3	122.0	11.0
TP-2337	Bulk 1	4-5	62.9	CL	0	38.3	61.7	2.66	18.7	122.0	11.5
TP-2337	Bulk 2	10	56.9	CL	0	25.0	75.0	2.69	17.2	121.0	12.0
TP-2351	Bulk 2	3.5-10	60.4	SC	0	61.8	38.2	2.66	13.0	125.0	11.5
TP-2352	Bulk 1	4-5	59.0	CL	0	33.1	66.9	2.66	17.0	122.5	11.0
Composite	A/Sand[d]	—	—	SC	0	53.6	46.4	2.66	12.7	126.0	10.5
Composite	B/Clay[e]	—	—	CL	0	26.4	73.6	2.69	18.1	121.0	12.5
Fordyce[f]	C33	—	—	SP	0	99	1	2.61	4.2	112.5	3.0
Fordyce[f]	C144	—	—	SP	0	98	2	2.61	5.1	105.5	8.0

a. Elevations are referenced to NAVD 88.

b. Natural Moisture for bulk samples obtained from jar sample at same depth or within depth range of bulk sample.

c. Moisture/density testing performed in accordance with ASTM D 1557 (Modified Proctor) (Reference 2.5.4-217).

d. Composite "A"/Sand embankment fill (combined TP-2319, Bulk 2 and TP-2334, Bulk 2).

e. Composite "B"/Clay embankment fill (combined TP-2317, Bulk 1 and TP-2334, Bulk 1).

f. Possible drainage sand material (for internal embankment drainage) sampled from offsite source.

Table 2.5.4-246
As-Built Observation Well Information
(Power Block)

Investigation Station	Northing (feet)[a]	Easting (feet)[a]	Top of Concrete El. (feet)[b]	Reference El. (feet)[b]	Sand Top Depth (feet)	Sand Base/ Depth (feet)	Sand Top El. (feet)[b]	Sand Base/ El. (feet)[b]
Power Block (Unit 1)								
OW-2150U	13,412,568.08	2,599,582.77	80.91	82.78	51.0	66.2	29.9	14.8
OW-2150L	13,412,552.91	2,599,585.12	80.87	82.45	136.0	151.2	–55.1	–70.3
OW-2169U	13,412,343.77	2,599,945.85	80.11	81.77	51.0	66.0	29.1	14.1
OW-2169L	13,412,356.74	2,599,930.20	80.04	81.72	86.0	101.0	–6.0	–21.0
OW-2181U	13,412,147.38	2,600,052.86	80.01	81.31	36.0	51.0	44.0	29.0
OW-2181L	13,412,138.42	2,600,071.96	79.88	81.32	86.0	101.0	–6.1	–21.1
Power Block (Unit 2)								
OW-2253U	13,413,591.55	2,600,474.37	81.2	82.7	51.0	66	30.17	15.17
OW-2253L	13,413,584.76	2,600,494.74	81.2	82.8	131.0	146	–49.82	–64.82
OW-2269U	13,413,110.10	2,600,589.08	80.8	82.4	76.0	91.15	4.75	–10.4
OW-2269L	13,413,123.29	2,600,574.23	80.9	82.6	126.0	141.15	–45.11	–60.26
OW-2284U	13,413,055.14	2,600,956.60	81.0	82.6	61.0	76.07	19.98	4.91
OW-2284L	13,413,063.71	2,600,939.04	81.0	82.7	96.0	111.06	–15.03	–30.09
Outside Power Block								
OW-2185U	13,412,328.07	2,600,801.11	79.9	81.5	61.0	76	18.89	3.89
OW-2185L	13,412,314.47	2,600,815.69	79.8	81.4	86.0	101	–6.24	–21.24
OW-2301U	13,414,430.08	2,596,288.46	81.8	83.3	46.0	61	35.77	20.77
OW-2301L	13,414,429.77	2,596,268.29	81.9	83.2	126.0	141	–44.11	–59.11
OW-2307U	13,420,896.73	2,603,164.23	77.1	78.6	50.0	66	27.07	11.07
OW-2307L	13,420,879.09	2,603,152.12	76.9	78.6	95.0	111	–18.09	–34.09
OW-08U	13,415,801.21	2,598,934.58	82.4	83.9	86.0	101	–3.62	–18.62
OW-08L	13,415,818.85	2,598,942.49	82.6	84.1	124.0	138	–41.44	–55.44
OW-10U	13,418,474.37	2,604,768.43	78.1	79.5	45.0	59	33.09	19.09
OW-10L	13,418,486.44	2,604,760.99	78.1	79.9	123.0	138	–44.93	–59.93

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-247
As-Built Observation Well Information
(Cooling Basin/GBRA Storage Water Reservoir)

Investigation Station	Northing (feet)[a]	Easting (feet)[a]	Top of Concrete El. (feet)[b]	Reference El. (feet)[b]	Sand Top Depth (feet)	Sand Base/ Well Depth (feet)	Sand Top El. (feet)[b]	Sand Base/ Well El. (feet)[b]
OW-2302U	13,407,361.50	2,598,388.47	80.5	82.0	81.0	96	–0.48	–15.48
OW-2302L	13,407,382.11	2,598,388.94	80.5	82.0	136.0	151.15	–55.54	–70.69
OW-2304U	13,396,542.39	2,608,679.35	66.8	70.1	36.0	51	30.8	15.8
OW-2304L	13,396,528.12	2,608,678.06	68.9	69.7	81.0	96	–12.12	–27.12
OW-2319U	13,403,590.40	2,603,046.21	74.3	76.0	81.0	96	–6.67	–21.67
OW-2319L	13,403,611.30	2,603,051.83	74.7	76.1	141.0	156	–66.32	–81.32
OW-2320U	13,407,569.51	2,606,849.70	71.8	73.5	96.0	111	–24.2	–39.2
OW-2320L	13,407,580.88	2,606,834.36	71.8	73.2	136.0	151	–64.24	–79.24
OW-2321U	13,410,943.58	2,610,040.96	71.8	73.3	96.0	111	–24.21	–39.21
OW-2321L	13,410,955.46	2,610,027.59	72.0	73.5	136.0	151	–64.01	–79.01
OW-2324U	13,416,316.54	2,612,203.23	24.7	26.2	31.0	46	–6.33	–21.33
OW-2324L	13,416,300.52	2,612,217.00	24.9	26.3	110.0	126	–85.15	–101.15
OW-2348U	13,409,636.31	2,621,660.58	50.6	52.1	66.0	81	–15.44	–30.44
OW-2348L	13,409,617.75	2,621,644.36	51.2	52.7	130.0	145	–78.79	–93.79
OW-2352U	13,402,470.61	2,617,538.69	63.2	64.5	41.0	56	22.17	7.17
OW-2352L	13,402,468.45	2,617,518.54	63.3	64.6	76.0	91	–12.67	–27.67
OW-01U	13,404,253.64	2,606,666.85	72.2	73.7	42.0	61	30.16	11.16
OW-01L	13,404,252.09	2,606,686.52	72.2	73.7	96.0	111	–23.78	–38.78
OW-02U	13,411,502.39	2,607,862.19	75.3	76.7	50.0	64	25.25	11.25
OW-02L	13,411,520.51	2,607,869.30	75.1	76.5	94.0	109	–18.93	–33.93
OW-03U	13,414,934.48	2,609,294.86	75.6	77.1	40.0	54	35.6	21.6
OW-03L	13,414,918.69	2,609,286.61	75.2	76.7	84.0	98	–8.79	–22.79
OW-04U	13,414,280.51	2,607,428.57	79.6	81.1	71.0	86	8.61	–6.39
OW-04L	13,414,268.74	2,607,440.23	79.1	80.7	96.0	111	–16.87	–31.87
OW-05U	13,414,770.21	2,605,832.08	78.1	79.6	43.0	57	35.07	21.07
OW-05L	13,414,774.22	2,605,813.28	78.3	79.9	116.3	131	–38.04	–52.74
OW-06U	13,415,875.58	2,604,966.94	79.5	80.8	50.0	64	29.46	15.46
OW-06L	13,415,889.64	2,604,964.90	79.5	81.6	80.5	96	–1.01	–16.51
OW-07U	13,418,421.40	2,606,542.01	77.3	79.0	50.2	64	27.12	13.32
OW-07L	13,418,420.52	2,606,531.28	77.5	79.0	110.0	124	–32.53	–46.53
OW-09U	13,414,956.05	2,604,894.51	77.9	79.2	47.0	61	30.91	16.91
OW-09L	13,414,937.42	2,604,893.58	77.9	80.0	106.0	121	–28.14	–43.14

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-248
As-Built Borehole Permeameter Test Information (Cooling Basin/GBRA Storage Water Reservoir)

Test Number	Northing (feet)[a]	Easting (feet)[a]	Ground El. (feet)[b]	Test El. (feet)[b]	Test Hole I.D. (inches)
B-2309P-U	13,405,492.30	2,600,435.20	76.25	71.25	1.2
B-2309P-L	13,405,491.59	2,600,445.06	76.13	66.13	1.2
B-2311P-U	13,407,705.71	2,602,287.63	75.71	70.71	1.2
B-2311P-L	13,407,702.98	2,602,296.89	75.33	65.33	1.2
B-2312P-U	13,410,699.82	2,604,161.16	75.46	70.46	1.2
B-2312P-L	13,410,694.32	2,604,153.23	75.50	65.50	1.2
B-2314P-U	13,413,937.97	2,607,776.49	75.48	70.48	1.2
B-2314P-L	13,413,940.68	2,607,782.57	75.42	65.42	1.2
B-2325P-U	13,401,288.29	2,603,699.18	73.79	68.79	1.2
B-2325P-L	13,401,292.30	2,603,696.51	73.85	63.85	1.2
B-2326P-U	13,403,069.23	2,605,616.46	70.97	65.97	1.2
B-2326P-L	13,403,074.73	2,605,620.44	70.76	60.76	1.2
B-2327P-U	13,404,711.41	2,607,393.78	71.24	66.24	1.2
B-2327P-L	13,404,712.18	2,607,384.02	70.81	60.81	1.2
B-2328P-U	13,406,233.26	2,609,021.31	68.13	63.13	1.2
B-2328P-L	13,406,222.90	2,609,021.23	68.42	58.42	1.2
B-2339P-U[c]	13,399,916.45	2,608,670.14	68.75	63.75	1.2
B-2339P-L[c]	13,399,911.22	2,608,674.69	68.63	58.63	1.2
B-2341P-U	13,401,608.46	2,610,954.27	65.22	60.22	1.2
B-2341P-L	13,401,608.46	2,610,954.27	65.22	55.22	1.2
B-2342P-U	13,402,788.89	2,612,523.26	67.61	62.61	1.2
B-2342P-L	13,402,761.03	2,612,526.25	67.34	57.34	1.2
B-2343P-U	13,404,159.36	2,614,386.73	64.62	59.62	1.2
B-2343P-L	13,404,159.35	2,614,395.88	64.95	54.95	1.2
B-2345P-U	13,405,835.31	2,616,662.51	67.91	62.91	1.2
B-2345P-L	13,405,831.44	2,616,657.32	67.79	57.79	1.2

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

c. Coordinates and elevations not recorded for B-2339P-U and L. Values taken from B-2339P.

Table 2.5.4-249
As-Built Pumping Test Information
(Cooling Basin/GBRA Storage Water Reservoir)

Well Number	Drilling Method	Well Depth (feet)	Screened Interval (feet)	Northing (feet)[a]	Easting (feet)[a]	Top of Concrete El. (feet)[b]	Reference El. (feet)[b]	Well I.D. (inches)
TW-2320U	Rotary	82	55-80	13,407,428.59	2,607,105.51	72.72	71.50	6
OW-01L	Rotary	111	100-110	13,404,252.09	2,606,686.52	73.74	72.22	2
OW-01U	Rotary	61	50-60	13,404,253.64	2,606,666.85	73.65	72.16	2
OW-02L	Rotary	109	98-108	13,411,520.51	2,607,869.30	76.53	75.07	2
OW-02U	Rotary	64	53-63	13,411,502.39	2,607,862.19	76.74	75.25	2
OW-2319L	Rotary	156	145-155	13,403,611.30	2,603,051.83	76.05	74.68	2
OW-2319U	Rotary	96	85-95	13,403,590.40	2,603,046.21	75.97	74.33	2
OW-2320L	Rotary	151	140-150	13,407,580.88	2,606,834.36	73.19	71.76	2
OW-2320U	Rotary	111	100-110	13,407,569.51	2,606,849.70	73.50	71.80	2
OW-2320U1	Rotary	81	60-80	13,407,445.66	2,607,080.05	72.90	71.36	2
OW-2320U2	Rotary	81	60-80	13,407,436.76	2,607,093.25	72.92	71.36	2
OW-2320U3	Rotary	81	60-80	13,407,448.17	2,607,121.37	72.84	71.36	2
OW-2320U4	Rotary	81	60-80	13,407,466.49	2,607,138.42	72.91	71.42	2
OW-2321L	Rotary	151	140-150	13,410,955.46	2,610,027.59	73.54	71.99	2
OW-2321U	Rotary	111	100-110	13,410,943.58	2,610,040.96	73.27	71.79	2
TW-2359L	Rotary	182	150-180	13,417,241.41	2,605,450.48	79.88	77.69	6
OW-06L	Rotary	96	85-95	13,415,889.64	2,604,964.90	81.55	79.49	2
OW-06U	Rotary	64	53-63	13,415,875.58	2,604,966.94	80.77	79.46	2
OW-07L	Rotary	124	113-123	13,418,420.52	2,606,531.28	79.04	77.47	4
OW-07U	Rotary	64	53-63	13,418,421.40	2,606,542.01	79.02	77.32	2
OW-09L	Rotary	121	110-120	13,414,937.42	2,604,893.58	80.00	77.86	2
OW-09U	Rotary	61	50-60	13,414,956.05	2,604,894.51	79.24	77.91	2
OW-10U	Rotary	59	48-58	13,418,474.37	2,604,768.43	79.53	78.09	2
OW-10L	Rotary	138	127-137	13,418,486.44	2,604,760.99	79.88	78.07	2
OW-2359L1	Rotary	176	155-175	13,417,263.65	2,605,470.56	79.36	78.08	2
OW-2359L2	Rotary	176	155-175	13,417,259.76	2,605,433.37	78.93	77.56	2
OW-2359L3	Rotary	176	155-175	13,417,278.58	2,605,416.18	78.83	77.26	2
OW-2359U1	Rotary	96	85-95	13,417,252.64	2,605,460.64	79.29	77.66	2

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-250
As-Built Field Electrical Resistivity Test Information
(Power Block)

Test Number	Northing (feet)[a]	Easting (feet)[a]	Center Point El. (feet)[b]	Compass Bearing (degrees)
R-2101	13,412,470.72	2,599,460.82	80.53	300
R-2102	13,412,470.72	2,599,460.82	80.53	30
R-2201	13,413,399.51	2,600,266.58	80.66	300
R-2202	13,413,399.51	2,600,266.58	80.66	210

a. Northings and Eastings are referenced to NAD 83.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-251 (Sheet 1 of 3)
S-Wave Velocity Profile Numerical Values; Upper Approximately 600 Feet of Site Soils
(Power Block)

Stratum	Top El. (feet)[a]	Base El. (feet)[a]	Max. V_s (ft/sec)	Min. V_s (ft/sec)	Median V_s (ft/sec)	Avg. V_s (ft/sec)	Std. Dev. (ft/sec)	No. of Tests
Power Block (Unit 1)								
Fill (Upper)	95.0	87.0	—	—	—	700	—	—
Fill (Lower)	87.0	80.0	—	—	—	850	—	—
Clay 1 (Top)	80.0	52.0	1100	276	760	737	180	68
Sand 1	—	—	—	—	—	—	—	—
Clay 1 (Btm)	52.0	34.0	1560	470	765	849	272	60
Sand 2	34.0	20.0	1283	570	940	986	160	31
Clay 3	20.0	–5.0	1600	710	1020	1027	191	79
Sand 4	–5.0	–28.0	5380	687	1585	1809	938	68
Clay 5 (Top)	–28.0	–49.0	2250	700	1040	1083	263	50
Sand 5	–49.0	–61.0	1290	870	1055	1039	135	10
Clay 5 (Btm)	–61.0	–70.0	1640	850	1105	1152	241	36
Sand 6	–70.0	–125.0	3120	920	1420	1531	404	137
Clay 7	–125.0	–171.0	1880	800	1480	1430	324	33
Sand 8	–171.0	–205.0	2300	980	1430	1549	335	58
Clay 9	–205.0	–252.0	1510	990	1260	1253	117	62
Sand 10	–252.0	–268.0	2220	1160	1620	1650	280	23
Clay 11	–268.0	–328.0	1830	820	1160	1179	207	59
Sand 12	–328.0	–346.0	2030	1460	1810	1783	165	11
Clay 13	–346.0	–421.0	2310	1020	1325	1416	270	46
Sand 14	–421.0	–454.0	2040	1540	1790	1772	141	20
Clay 15	–454.0	–465.0	1770	1500	1600	1519	240	7
Sand 16	–465.0	–480.0	1980	1821	1800	1821	106	9
Clay 17	–480.0	–507.0	2030	1180	1605	1629	317	16
Sand 18	–507.0	–520.0	2380	1790	1930	1999	193	10
Power Block (Unit 2)								
Fill (Upper)	95.0	87.0	—	—	—	700	—	—
Fill (Lower)	87.0	80.0	—	—	—	850	—	—
Clay 1 (Top)	80.0	51.0	1160	167	580	606	172	71
Sand 1	51.0	43.0	1350	738	1058	1078	156	31
Clay 1 (Btm)	43.0	27.0	1300	550	965	949	200	50
Sand 2	27.0	17.0	1470	750	1190	1158	194	25
Clay 3	17.0	–7.0	1670	490	899	960	276	96
Sand 4	–7.0	–35.0	1850	900	1360	1351	235	60
Clay 5 (Top)	–35.0	–52.0	2870	790	1065	1219	401	44
Sand 5	–52.0	–66.0	2490	1140	1490	1498	270	25
Clay 5 (Btm)	–66.0	–79.0	1740	790	1110	1120	178	30
Sand 6	–79.0	–127.0	3400	490	1360	1418	402	128
Clay 7	—	—	—	—	—	—	—	—
Sand 8	–127.0	–203.0	3000	1140	1750	1734	346	83
Clay 9	–203.0	–248.0	1750	990	1250	1250	151	49
Sand 10	–248.0	–288.0	2020	1220	1660	1637	199	52
Clay 11	–288.0	–324.0	1280	910	1100	1093	101	35

Table 2.5.4-251 (Sheet 2 of 3)
S-Wave Velocity Profile Numerical Values; Upper Approximately 600 Feet of Site Soils
(Power Block)

Stratum	Top El. (feet)[a]	Base El. (feet)[a]	Max. V_s (ft/sec)	Min. V_s (ft/sec)	Median V_s (ft/sec)	Avg. V_s (ft/sec)	Std. Dev. (ft/sec)	No. of Tests
Power Block (Unit 2) (continued)								
Sand 12	–324.0	–327.0	2190	1410	1860	1837	191	14
Clay 13	–327.0	–423.0	2270	1050	1280	1322	196	47
Sand 14	–423.0	–470.0	2400	1370	1870	1886	199	28
Clay 15	–470.0	–482.0	1840	1360	1415	1486	164	8
Sand 16	–482.0	–500.0	1780	1540	1740	1703	88	6
Clay 17	–500.0	–516.0	2120	1630	2020	1981	139	14
Sand 18	–516.0	–520.0	2040	1940	1980	1985	44	4
Power Block (Units 1 & 2)								
Fill (Upper)	95.0	87.0	—	—	—	700	—	—
Fill (Lower)	87.0	80.0	—	—	—	850	—	—
Clay 1 (Top)	80.0	51.6	1160	167	665	670	187	139
Sand 1	51.6	42.8	1350	738	1058	1078	156	31
Clay 1 (Btm)	42.8	30.5	1560	470	827	895	246	110
Sand 2	30.5	18.6	1470	570	1040	1062	194	56
Clay 3	18.6	–5.4	1670	490	980	990	243	175
Sand 4	–5.4	–32.0	5380	687	1450	1594	737	128
Clay 5 (Top)	–32.0	–50.8	2870	700	1060	1147	340	94
Sand 5	–50.8	–63.9	2490	870	1360	1367	317	35
Clay 5 (Btm)	–63.9	–73.4	1740	790	1110	1137	214	66
Sand 6	–73.4	–127.3	3400	490	1380	1476	406	265
Clay 7	–127.3	–172.5	1880	800	1480	1430	324	33
Sand 8	–172.5	–205.3	3000	980	1630	1658	352	141
Clay 9	–205.3	–249.9	1750	990	1260	1252	132	111
Sand 10	–249.9	–278.4	2220	1160	1650	1641	225	75
Clay 11	–278.4	–325.3	1830	820	1130	1147	179	94
Sand 12	–325.3	–345.9	2190	1410	1830	1813	179	25
Clay 13	–345.9	–421.6	2310	1020	1310	1368	239	93
Sand 14	–421.6	–461.3	2400	1370	1850	1839	185	48
Clay 15	–461.3	–473.1	1840	1100	1470	1501	196	15
Sand 16	–473.1	–489.6	1980	1540	1740	1774	113	15
Clay 17	–489.6	–510.8	2120	1180	1935	1793	304	30
Sand 18	–510.8	–519.9	2380	1790	1965	1995	163	14
Outside Power Block								
Clay 1 (Top)	80.0	63.6	1122	583	847	841	187	12
Sand 1		—	—	—	—	—	—	—
Clay 1 (Btm)	63.6	49.6	1402	586	1172	1102	264	17
Sand 2	49.6	16.6	1783	875	1262	1292	232	40
Clay 3	16.6	–6.0	1478	741	1019	1081	207	27
Sand 4	–6.0	–24.9	3125	1135	1426	1588	509	23
Clay 5 (Top)	–24.9	–33.4	1307	877	1111	1094	128	10
Sand 5	–33.4	–47.4	2343	1048	1320	1438	388	18

Table 2.5.4-251 (Sheet 3 of 3)
S-Wave Velocity Profile Numerical Values; Upper Approximately 600 Feet of Site Soils
(Power Block)

Stratum	Top El. (feet)[a]	Base El. (feet)[a]	Max. V_s (ft/sec)	Min. V_s (ft/sec)	Median V_s (ft/sec)	Avg. V_s (ft/sec)	Std. Dev. (ft/sec)	No. of Tests
Outside Power Block (continued)								
Clay 5 (Btm)	–47.4	–60.4	1624	854	1256	1243	221	16
Sand 6	–60.4	–112.9	2232	1038	1396	1481	292	64
Clay 7	–112.9	–159.2	1754	1120	1367	1386	159	29
Sand 8	–159.2	–173.0	5965	940	1745	2093	1173	45
Clay 9	–173.0	–208.4	2044	1079	1618	1616	262	42
Sand 10	–208.4	–231.4	2076	1267	1302	1504	324	13

a. Elevations are referenced to NAVD 88

Table 2.5.4-252 (Sheet 1 of 2)
S-Wave Velocity Profile Numerical Values; Deeper Than Approximately 600 Feet Below Existing Ground Surface
(Power Block)

Top El. (feet)[a]	Base El. (feet)[a]	Max. V_s (ft/sec)	Min. V_s (ft/sec)	Avg. V_s (ft/sec)	Std. Dev. (ft/sec)	V_s Values for Use (ft/sec)	No. of Tests	Assumed Poisson's Ratio, μ
–620	–820	3126	1547	2089	219	2080	1200	0.46
–820	–1020	2985	1713	2224	340	2220	1200	0.45
–1020	–1220	3351	1863	2428	277	2420	1200	0.45
–1220	–1420	3741	2033	2491	318	2490	1200	0.44
–1420	–1620	3505	2024	2526	342	2520	1806	0.43
–1620	–1820	3477	2053	2623	274	2620	2000	0.43
–1820	–2020	3779	2071	2753	285	2750	2000	0.42
–2020	–2220	4013	2383	2836	225	2830	2000	0.41
–2220	–2420	4547	2266	2879	254	2870	2219	0.41
–2420	–2620	6242	2303	3002	277	3000	2400	0.40
–2620	–2820	4494	2268	3179	403	3170	2400	0.39
–2820	–3020	6108	2552	3418	356	3410	2400	0.39
–3020	–3220	6686	2360	3579	398	3570	2400	0.38
–3220	–3420	6300	2327	3683	523	3680	2400	0.37
–3420	–3620	7473	2751	3933	473	3930	2400	0.37
–3620	–3820	6172	2811	4004	496	4000	2400	0.36
–3820	–4020	6035	2867	4055	448	4050	2400	0.35
–4020	–4220	6007	3087	3980	377	3980	2034	0.35
–4220	-4420	5281	3193	3929	395	3920	2000	0.34
–4420	–4620	7916	3074	3930	325	3930	2000	0.33
–4620	–4820	5289	2931	3860	452	3860	2000	0.33
–4820	–5020	5629	3132	3863	291	3860	2000	0.32
–5020	–5220	5443	3035	3889	300	3880	2000	0.31
–5220	–5420	5819	2999	4002	290	4000	2000	0.31
–5420	–5620	6677	3014	3984	445	3980	2000	0.30
–5620	–5820	6225	3342	4134	421	4130	2000	0.30
–5820	–6020	6066	3289	4127	466	4120	2000	0.30
–6020	–6220	5742	3450	4102	446	4100	2000	0.30
–6220	–6420	6203	3098	4134	419	4130	2000	0.30
-6420	–6620	6217	3470	4206	372	4200	2000	0.30
–6620	–6820	5954	3659	4223	414	4220	2000	0.30
–6820	–7020	6185	3416	4234	439	4230	2000	0.30
–7020	–7220	7737	3454	4321	500	4320	2000	0.30
–7220	–7420	6298	3621	4361	469	4360	2000	0.30
–7420	–7620	6946	3586	4385	558	4380	2000	0.30
–7620	–7820	6308	3673	4421	563	4420	2000	0.30
–7820	–8020	6618	3514	4511	629	4510	2000	0.30
–8020	–8220	7056	3167	4571	734	4570	2000	0.30
–8220	–8420	6791	3026	4550	691	4550	2000	0.30
–8420	–8620	8653	3171	5090	961	5090	1702	0.30
–8620	–8820	8898	3826	5305	1027	5300	1600	0.30
–8820	–9020	8494	4239	5430	997	5430	1600	0.30
–9020	–9220	8004	4310	5512	986	5510	1600	0.30
–9220	–9420	8064	4010	5480	913	5480	1600	0.30
–9420	–9620	7352	3649	5532	857	5530	1600	0.30

Table 2.5.4-252 (Sheet 2 of 2)
S-Wave Velocity Profile Numerical Values; Deeper Than Approximately 600 Feet Below Existing Ground Surface
(Power Block)

Top El. (feet)[a]	Base El. (feet)[a]	Max. V_s (ft/sec)	Min. V_s (ft/sec)	Avg. V_s (ft/sec)	Std. Dev. (ft/sec)	V_s Values for Use (ft/sec)	No. of Tests	Assumed Poisson's Ratio, μ
–9620	–9820	8928	4485	5726	702	5720	1542	0.30
–9820	–10,020	7695	4744	5744	705	5740	1200	0.30
–10,020	–10,220	7317	4461	5507	588	5500	1200	0.30
–10,220	–10,420	6834	4481	5777	461	5770	1307	0.30
–10,420	–10,620	7451	4836	5941	466	5940	1600	0.30
–10,620	–10,820	7384	4297	5691	530	5690	1600	0.30
–10,820	–11,020	6598	4434	5379	474	5370	1600	0.30
–11,020	–11,220	7035	4404	5299	279	5290	1600	0.30
–11,220	–11,420	7467	4291	5159	337	5150	1600	0.30
–11,420	–11,620	6961	4565	5430	287	5430	1600	0.30
–11,620	—11,820	6456	4757	5425	284	5420	1638	0.30
–11,820	–12,020	7226	4644	5530	456	5530	1971	0.30
–12,020	–12,220	7166	4844	5724	409	5720	1600	0.30
–12,220	–12,420	6684	4726	5594	497	5590	1400	0.30
–12,420	–12,620	6362	4693	5318	284	5310	848	0.30
–12,620	–12,820	7165	4511	5176	496	5170	718	0.30
–12,820	–13,020	6704	4483	5140	542	5140	800	0.30
–13,020	–13,220	7282	4491	5146	519	5140	800	0.30
–13,220	–13,420	6568	4501	5122	439	5120	674	0.30
–13,420	–13,620	7075	5065	5599	336	5590	400	0.30
–13,620	–13,820	7745	5008	5729	405	5720	400	0.30
–13,820	–14,020	6845	4943	5331	261	5330	400	0.30
–14,020	–14,220	6403	4853	5420	281	5420	400	0.30
–14,220	–14,420	6784	4721	5407	396	5400	400	0.30
–14,420	–14,620	7080	4688	5331	360	5330	400	0.30
–14,620	–14,820	7538	4947	5625	450	5620	400	0.30
–14,820	–15,020	6724	5062	5598	320	5590	400	0.30
–15,020	–15,220	7941	4893	5574	404	5570	400	0.30
–15,220	–15,420	6560	4672	5150	302	5150	400	0.30
–15,420	–15,620	5396	4549	4827	155	4820	400	0.30
–15,620	–15,780	5407	4290	4987	156	4980	322	0.30

a. Elevations are referenced to NAVD 88.

Table 2.5.4-253
S-Wave Velocity Profile Numerical Values; (Cooling Basin/GBRA Storage Water Reservoir)

Stratum	Top El. (feet)[a]	Base El. (feet)	Max. V_s (ft/sec)	Min. V_s (ft/sec)	Median V_s (ft/sec)	Avg. V_s (ft/sec)	Std. Dev. (ft/sec)	V_s Values for Use (ft/sec)	No. of Tests
Clay 1 (Top)	70.0	59.8	1045	194	726	740	229	740	35
Sand 1	59.8	47.7	1204	294	800	778	230	778	25
Clay 1 (Btm)	47.7	31.7	1465	475	868	903	248	903	107
Sand 2	31.7	14.4	1691	559	991	1015	182	1015	73
Clay 3	14.4	1.3	2063	585	1013	1019	238	1019	101
Sand 4	1.3	–26.2	3281	866	1105	1224	383	1224	101
Clay 5 (Top)	–26.2	–40.6	2711	741	1035	1134	344	1134	91
Sand 5	–40.6	–56.7	3528	894	1356	1399	434	1399	78
Clay 5 (Btm)	–56.7	–72.9	2038	656	1180	1173	287	1173	53
Sand 6	–72.9	–96.4	2711	831	1339	1349	242	1349	204
Clay 7	–96.4	–148.5	2294	877	1262	1314	345	1314	113
Sand 8	–148.5	–184.1	3038	1038	1628	1663	350	1663	112
Clay 9	–184.1	–229.0[b]	2412	974	1528	1506	251	1506	104
Sand 10	–229.0	–219.4[b]	3010	1193	1628	1733	444	1733	38
Clay 11	–219.4	–234.4[b]	1465	1465	1465	1465	—	1465	1

a. Elevations are referenced to NAVD 88.

b. Because of the broad area covered by the cooling basin/GBRA storage water reservoir, the average top and base elevations of certain strata may not be representative of the subsurface conditions present at a particular location. Refer to the detailed information contained in Appendix 2.5.4-B to evaluate specific subsurface conditions.

Table 2.5.4-254
Shear Modulus Degradation Curves Numerical Values (Power Block)

Shear Strain (%)	G/G_{max} EPRI PI = 70%[a]	G/G_{max} Vucetic & Dobry PI = 200%[b]
Cohesive Soil Strata		
1.00E+00	0.30	0.47
3.16E-01	0.53	0.75
1.00E-01	0.78	0.90
3.16E-02	0.94	0.97
1.00E-02	0.99	0.99
3.16E-03	1.00	1.00
1.00E-03	1.00	1.00
3.16E-04	1.00	1.00
1.00E-04	1.00	1.00

a. Applicable to Strata Clay 1 (Top), Clay 1 (Bottom), and Clay 17.

b. Applicable to Strata Clay 3, Clay 5 (Top), Clay 5 (Bottom), Clay 7, Clay 9, Clay 11, Clay 13, and Clay 15.

Shear Strain (%)	G/G_{max} EPRI D = 10 Feet[a]	G/G_{max} Peninsular D <50 Feet[b]	G/G_{max} Peninsular D >50 Feet[c]
Cohesionless Soil Strata			
1.00E+00	0.05	0.09	0.20
3.16E-01	0.14	0.22	0.40
1.00E-01	0.30	0.43	0.64
3.16E-02	0.54	0.67	0.84
1.00E-02	0.74	0.85	0.95
3.16E-03	0.90	0.96	0.97
1.00E-03	0.99	1.00	1.00
3.16E-04	1.00	1.00	1.00
1.00E-04	1.00	1.00	1.00

a. Applicable to Fill (Upper) and Fill (Lower); refer to Table 2.5.4-251.

b. Applicable to Stratum Sand 1.

c. Applicable to Strata Sand 2, Sand 4, Sand 6, Sand 8, Sand 10, Sand 12, Sand 14, Sand 16, and Sand 18.

Table 2.5.4-255
Shear Modulus Degradation Curves Numerical Values (Cooling Basin/GBRA Storage Water Reservoir)

	G/G_{max}	
Shear Strain (%)	**EPRI PI = 40%**[a]	**EPRI PI = 70%**[b]
Composite Samples[c]		
1.00E+00	0.11	0.30
3.16E-01	0.26	0.53
1.00E-01	0.49	0.78
3.16E-02	0.75	0.94
1.00E-02	0.92	0.99
3.16E-03	0.99	1.00
1.00E-03	1.00	1.00
3.16E-04	1.00	1.00
1.00E-04	1.00	1.00

a. Applicable to Composite “A”/Sand.

b. Applicable to Composite “B”/Clay.

c. Refer to Table 2.5.4-254 for shear modulus degradation curve numerical values for in situ soil strata.

Table 2.5.4-256
Damping Curves Numerical Values
(Power Block)

Shear Strain (%)	Damping (%)		
	EPRI PI = 70%[a]	Vucetic & Dobry PI = 100%[b]	Vucetic & Dobry PI = 200%[c]
Cohesive Soil Strata			
1.00E+00	13.8	9.7	8.0
3.16E-01	9.3	6.0	4.7
1.00E-01	5.4	4.0	3.1
3.16E-02	3.3	2.9	2.2
1.00E-02	2.7	2.1	1.6
3.16E-03	2.6	1.5	1.3
1.00E-03	2.6	1.3	1.1
3.16E-04	2.6	1.2	0.9
1.00E-04	2.6	1.1	0.9

a. Applicable to Strata Clay 1 (Top), Clay 1 (Bottom).

b. Applicable to Stratum Clay 3.

c. Applicable to Strata Clay 5 (Top), Clay 5 (Bottom), Clay 7, Clay 9, Clay 11, Clay 13, Clay 15, and Clay 17.

Shear Strain (%)	Damping (%)		
	EPRI D = 10 Feet[a]	Peninsular D <50 Feet[b]	Peninsular D >50 Feet[c]
Cohesionless Soil Strata			
1.00E+00	27.0	22.8	16.5
3.16E-01	20.2	16.5	10.3
1.00E-01	13.9	10.3	5.5
3.16E-02	8.0	5.5	2.6
1.00E-02	4.5	3.0	1.4
3.16E-03	2.5	1.6	0.9
1.00E-03	1.5	1.3	0.5
3.16E-04	1.4	1.1	0.5
1.00E-04	1.4	1.1	0.5

a. Applicable to Fill (Upper) and Fill (Lower); refer to Table 2.5.4-251.

b. Applicable to Stratum Sand 1.

c. Applicable to Strata Sand 2, Sand 4, Sand 6, Sand 8, Sand 10, Sand 12, Sand 14, Sand 16, and Sand 18.

Table 2.5.4-257
Damping Curves Numerical Values
(Cooling Basin/GBRA Storage Water Reservoir)

	Damping (%)	
Shear Strain (%)	EPRI PI = 60%[a]	EPRI PI = 70%[b]
Composite Samples[c]		
1.00E+00	15.8	13.8
3.16E-01	11.1	9.3
1.00E-01	6.5	5.4
3.16E-02	3.9	3.3
1.00E-02	2.8	2.7
3.16E-03	2.6	2.6
1.00E-03	2.4	2.6
3.16E-04	2.4	2.6
1.00E-04	2.4	2.6

a. Applicable to Composite “A”/Sand.

b. Applicable to Composite “B”/Clay.

c. Refer to Table 2.5.4-254 for damping curve numerical values for in situ soil strata.

Table 2.5.4-258
RCTS Test Results; Stratum Clay 1 (Top)
(Power Block)

Boring B-2182UD **Sample UD3** **Stratum Clay 1 (Top)**	**Resonant Column Stage** **σ_o = 9 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 9 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 9 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 17.7 feet	3.74E-04		3.74E-04	4.84	9.42E-04	1.00	2.10	9.56E-04	1.00	1.90
Total Unit Weight = 125.3 pcf	7.29E-04	1.00	7.29E-04	4.83	1.89E-03	1.00	1.98	1.90E-03	1.00	2.09
Moisture Content = 21.6%	1.43E-03	1.00	1.07E-03	4.83	3.89E-03	0.98	1.96	3.92E-03	0.98	2.06
USCS Group Symbol = CH	2.84E-03	0.99	2.10E-03	4.88	9.60E-03	0.98	2.21	9.61E-03	0.94	2.21
Fines Content = 82.4%	5.76E-03	0.97	4.26E-03	5.00	2.00E-02	0.93	2.74	2.01E-02	0.94	2.76
Liquid Limit = 58%	1.15E-02	0.96	8.40E-03	5.07	—	—	—	—	—	—
Plasticity Index = 40%	2.22E-02	0.92	1.62E-02	5.23	—	—	—	—	—	—
Specific Gravity = 2.70	4.24E-02	0.88	3.01E-02	5.39	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	1.04E-01	0.78	7.14E-02	6.14	—	—	—	—	—	—
Estimated σ'_{mean} = 9 psi	2.32E-01	0.61	1.46E-01	8.18	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage **σ_o = 37 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 37 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 37 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
3.26E-04	1.00	3.26E-04	4.34	1.00E-03	1.00	1.53	9.68E-04	1.00	1.63
6.60E-04	1.00	6.60E-04	4.37	1.95E-03	1.00	1.67	1.92E-03	1.00	1.79
1.27E-03	1.00	9.53E-04	4.36	3.83E-03	1.00	1.91	3.83E-03	1.00	1.82
2.55E-03	1.00	1.96E-03	4.38	9.89E-03	0.99	2.11	9.87E-03	0.98	2.06
5.10E-03	1.00	3.87E-03	4.46	2.05E-02	0.95	2.29	2.06E-02	0.94	2.49
1.00E-02	0.98	7.61E-03	4.48	—	—	—	—	—	—
1.91E-02	0.96	1.41E-02	4.53	—	—	—	—	—	—
3.91E-02	0.90	2.93E-02	4.73	—	—	—	—	—	—
8.77E-02	0.79	6.39E-02	5.36	—	—	—	—	—	—
1.99E-01	0.66	1.33E-01	6.99	—	—	—	—	—	—
4.90E-01	0.50	2.99E-01	9.4	—	—	—	—	—	—
1.01E+00	0.35	5.68E-01	11.37	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-259
RCTS Test Results; Stratum Clay 3
(Power Block)

	Resonant Column Stage σ_o = 39 psi				**Torsional Shear Stage First Cycle; σ_o = 39 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 39 psi**		
Boring B-2182UD Sample UD9 Stratum Clay 3	**Peak Shear Strain (%)**	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 85.8 feet	1.97E-04	1.00	1.97E-04	3.61	1.01E-03	1.00	1.71	9.82E-04	1.00	1.85
Total Unit Weight = 115.0 pcf	3.86E-04	1.00	3.86E-04	3.62	1.99E-03	1.00	1.85	2.05E-03	1.00	1.77
Moisture Content = 35.1%	7.87E-04	1.00	7.87E-04	3.63	3.99E-03	1.00	1.65	3.99E-03	1.00	1.75
USCS Group Symbol = CH	1.61E-03	1.00	1.24E-03	3.68	1.02E-02	0.99	1.69	1.02E-02	0.99	1.78
Fines Content = 86.6%	3.22E-03	1.00	2.44E-03	3.76	2.07E-02	0.97	1.85	2.07E-02	0.97	1.80
Liquid Limit = 80%	6.44E-03	1.00	4.89E-03	3.75	—	—	—	—	—	—
Plasticity Index = 56%	1.28E-02	1.00	9.63E-02	3.92	—	—	—	—	—	—
Specific Gravity = 2.70	2.59E-02	0.98	1.97E-02	4.17	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	5.25E-02	0.96	3.88E-02	4.52	—	—	—	—	—	—
Estimated σ'_{mean} = 39 psi	1.05E-01	0.90	7.44E-02	5.11	—	—	—	—	—	—
	2.14E-01	0.75	1.41E-01	6.58	—	—	—	—	—	—
	4.21E-01	0.58	2.49E-01	9.28	—	—	—	—	—	—

Resonant Column Stage σ_o = 156 psi				**Torsional Shear Stage First Cycle; σ_o = 156 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 156 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
2.39E-04	1.00	2.39E-04	3.14	1.07E-03	1.00	1.21	1.08E-03	1.00	1.26
4.74E-04	1.00	4.74E-04	3.14	2.04E-03	1.00	1.40	2.03E-03	1.00	1.50
9.98E-04	1.00	9.98E-04	3.14	4.04E-03	1.00	1.46	4.06E-03	1.00	1.53
1.99E-03	1.00	1.55E-03	3.18	1.02E-02	1.00	1.50	1.01E-02	1.00	1.38
3.97E-03	1.00	3.13E-03	3.22	—	—	—	—	—	—
7.92E-03	1.00	6.26E-03	3.28	—	—	—	—	—	—
1.59E-02	0.99	1.24E-02	3.38	—	—	—	—	—	—
3.17E-02	0.98	2.44E-02	3.53	—	—	—	—	—	—
6.34E-02	0.96	4.82E-02	3.86	—	—	—	—	—	—
1.28E-01	0.88	9.58E-02	4.22	—	—	—	—	—	—
2.47E-01	0.75	1.78E-01	4.92	—	—	—	—	—	—
4.81E-01	0.60	3.42E-01	6.01	—	—	—	—	—	—
9.08E-01	0.49	5.72E-01	8.63	—	—	—	—	—	—

Table 2.5.4-260
RCTS Test Results; Stratum Sand 4
(Power Block)

Boring B-2174UD **Sample UD6** **Stratum Sand 4**	**Resonant Column Stage** σ_o **= 42 psi**				**Torsional Shear Stage** **First Cycle;** σ_o **= 42 psi**			**Torsional Shear Stage** **Tenth Cycle;** σ_o **= 42 psi**		
	Peak Shear Strain (%)	**G/G_{max}**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/G_{max}**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/G_{max}**	**Damping Ratio (%)**
Depth = 96.4 feet	1.82E-04	1.00	1.82E-04	0.39	7.94E-04	1.00	0.37	7.52E-04	1.00	0.54
Total Unit Weight = 117.7 pcf	3.57E-04	1.00	3.57E-04	0.42	1.03E-03	1.00	0.53	1.03E-03	1.00	0.41
Moisture Content = 12.9%	7.21E-04	1.00	7.21E-04	0.45	2.07E-03	1.00	0.44	2.07E-03	1.00	0.39
USCS Group Symbol = SP-SC	1.38E-03	0.99	1.33E-03	0.46	4.22E-03	0.98	0.72	4.22E-03	0.98	0.61
Fines Content = 6.8%	2.60E-03	0.98	2.44E-03	0.51	1.05E-02	0.96	0.90	1.06E-02	0.96	0.86
Liquid Limit = No Value	4.76E-03	0.97	4.47E-03	0.59	—	—	—	—	—	—
Plasticity Index = Non-Plastic	8.36E-03	0.95	7.77E-03	0.75	—	—	—	—	—	—
Specific Gravity = 2.68	1.38E-02	0.92	1.25E-02	1.03	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	2.37E-02	0.86	2.11E-02	1.51	—	—	—	—	—	—
Estimated σ'_{mean} = 42.0 psi	3.59E-02	0.81	3.05E-02	2.20	—	—	—	—	—	—
	5.51E-02	0.75	4.41E-02	3.28	—	—	—	—	—	—
	8.96E-02	0.66	6.63E-02	4.64	—	—	—	—	—	—

Resonant Column Stage σ_o **= 168 psi**				**Torsional Shear Stage** **First Cycle;** σ_o **= 168 psi**			**Torsional Shear Stage** **Tenth Cycle;** σ_o **= 168 psi**		
Peak Shear Strain (%)	**G/G_{max}**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/G_{max}**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/G_{max}**	**DampingRatio (%)**
1.51E-04	1.00	1.51E-04	0.31	1.05E-03	1.00	0.32	1.06E-03	1.00	0.39
2.97E-04	1.00	2.97E-04	0.36	2.10E-03	1.00	0.31	2.12E-03	1.00	0.31
6.09E-04	1.00	6.09E-04	0.41	4.23E-03	0.99	0.29	4.25E-03	1.00	0.30
1.18E-03	1.00	1.13E-03	0.40	8.59E-03	0.98	0.35	8.55E-03	0.99	0.48
2.25E-03	0.99	2.16E-03	0.42	—	—	—	—	—	—
4.18E-03	0.98	3.97E-03	0.44	—	—	—	—	—	—
7.33E-03	0.97	6.96E-03	0.54	—	—	—	—	—	—
1.26E-02	0.94	1.18E-02	0.70	—	—	—	—	—	—
2.12E-02	0.91	1.98E-02	0.93	—	—	—	—	—	—
3.42E-02	0.87	3.08E-02	1.44	—	—	—	—	—	—
5.33E-02	0.82	4.63E-02	2.07	—	—	—	—	—	—
8.33E-02	0.75	6.83E-02	3.17	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-261
RCTS Test Results; Stratum Clay 5 (Top)
(Power Block)

Boring B-2274UD Sample UD8 Stratum Clay 5 (Top)	Resonant Column Stage σ_o = 49 psi				Torsional Shear Stage First Cycle; σ_o = 49 psi			Torsional Shear Stage Tenth Cycle; σ_o = 49 psi		
	Peak Shear Strain (%)	G/Gmax	Avg. Shear Strain (%)	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)
Depth = 122.0 feet	7.07E-04	1.00	7.07E-04	3.42	9.92E-04	1.00	0.90	9.87E-04	1.00	0.90
Total Unit Weight = 112.6 pcf	1.53E-03	1.00	1.53E-03	3.48	1.96E-03	1.00	1.24	1.95E-03	1.00	1.02
Moisture Content = 33.5%	3.07E-03	1.00	2.40E-03	3.51	3.83E-03	1.00	1.28	3.87E-03	1.00	1.06
USCS Group Symbol = CH	6.10E-03	1.00	4.76E-03	3.58	9.66E-03	1.00	1.27	9.66E-03	1.00	1.16
Fines Content = 94.1%	1.23E-02	1.00	1.05E-02	3.66	1.96E-02	0.99	1.19	1.97E-02	0.99	1.25
Liquid Limit = 93%	2.47E-02	0.99	1.92E-02	3.72	—	—	—	—	—	—
Plasticity Index = 64%	4.90E-02	0.98	3.82E-02	3.89	—	—	—	—	—	—
Specific Gravity = 2.72	9.31E-02	0.95	7.17E-02	4.09	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	1.86E-01	0.87	1.39E-01	4.47	—	—	—	—	—	—
Estimated σ'_{mean} = 49 psi	3.87E-01	0.76	2.79E-01	5.27	—	—	—	—	—	—
	8.04E-01	0.61	4.99E-01	8.33	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Table 2.5.4-261
RCTS Test Results; Stratum Clay 5 (Top)
(Power Block)

Resonant Column Stage σ_o **= 197 psi**				**Torsional Shear Stage First Cycle;** σ_o **= 197 psi**			**Torsional Shear Stage Tenth Cycle;** σ_o **= 197 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
3.19E-04	1.00	3.19E-04	3.00	1.02E-03	1.00	1.09	1.07E-03	1.00	0.88
6.88E-04	1.00	6.88E-04	3.05	2.00E-03	1.00	0.91	2.03E-03	1.00	1.31
1.33E-03	1.00	1.07E-03	3.08	4.00E-03	1.00	0.93	4.06E-03	1.00	1.08
2.63E-03	1.00	2.13E-03	3.13	9.75E-03	1.00	1.48	9.78E-03	1.00	1.48
5.21E-03	1.00	4.16E-03	3.22	1.99E-02	0.97	1.45	2.01E-02	0.98	1.56
1.03E-02	1.00	8.27E-03	3.28	—	—	—	—	—	—
2.05E-02	0.98	1.64E-02	3.38	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
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Table 2.5.4-262
RCTS Test Results; Stratum Sand 5
(Power Block)

Boring B-2182UD **Sample UD14** **Stratum Sand 5**	**Resonant Column Stage** σ_o **= 50 psi**				**Torsional Shear Stage First Cycle;** σ_o **= 50 psi**			**Torsional Shear Stage Tenth Cycle;** σ_o **= 50 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 124.7 feet	2.07E-04	1.00	2.70E-04	0.91	1.05E-03	1.00	0.35	1.06E-03	1.00	0.40
Total Unit Weight = 124.9 pcf	5.57E-04	1.00	5.57E-04	0.97	2.10E-03	1.00	0.59	2.11E-03	1.00	0.48
Moisture Content = 22.2%	1.09E-03	1.00	1.09E-03	1.03	4.26E-03	0.98	0.72	4.27E-03	0.99	0.68
USCS Group Symbol = SC	2.14E-03	0.99	1.95E-03	1.11	1.04E-02	0.96	1.00	1.04E-02	0.97	1.00
Fines Content = 13.4%	4.12E-03	0.97	3.71E-03	1.25	—	—	—	—	—	—
Liquid Limit = No Value	7.78E-03	0.96	6.93E-03	1.34	—	—	—	—	—	—
Plasticity Index = Non-Plastic	1.40E-02	0.93	1.23E-02	1.58	—	—	—	—	—	—
Specific Gravity = 2.66	2.43E-02	0.88	2.09E-02	1.99	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	4.01E-02	0.83	3.33E-02	2.71	—	—	—	—	—	—
Estimated σ'_{mean} = 50 psi	6.54E-02	0.76	5.10E-02	3.71	—	—	—	—	—	—
	1.07E-01	0.69	7.08E-02	5.15	—	—	—	—	—	—
	1.67E-01	0.65	1.13E-01	6.32	—	—	—	—	—	—

Resonant Column Stage σ_o **= 200 psi**				**Torsional Shear Stage First Cycle;** σ_o **= 200 psi**			**Torsional Shear Stage Tenth Cycle;** σ_o **= 200 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
1.38E-04	1.00	1.38E-04	0.82	1.04E-03	1.00	0.27	1.05E-03	1.00	0.43
2.72E-04	1.00	2.72E-04	0.84	2.10E-03	0.99	0.33	2.11E-03	1.00	0.39
5.61E-04	1.00	5.61E-04	0.86	4.22E-03	0.99	0.45	4.21E-03	1.00	0.56
1.11E-03	1.00	1.11E-03	0.89	8.51E-03	0.98	0.56	8.48E-03	0.99	0.56
2.18E-03	0.99	2.03E-03	0.96	—	—	—	—	—	—
4.24E-03	0.98	3.94E-03	0.99	—	—	—	—	—	—
8.09E-03	0.97	7.44E-03	1.08	—	—	—	—	—	—
1.48E-02	0.94	1.35E-02	1.27	—	—	—	—	—	—
2.59E-02	0.91	2.31E-02	1.68	—	—	—	—	—	—
4.37E-02	0.87	3.80E-02	2.09	—	—	—	—	—	—
7.18E-02	0.80	5.96E-02	2.68	—	—	—	—	—	—
8.69E-02	0.75	7.13E-02	3.07	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-263
RCTS Test Results; Stratum Sand 6
(Power Block)

Boring B-2269UD **Sample UD15** **Stratum Sand 6**	**Resonant Column Stage** **σ_o = 77 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 77 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 77 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 216.2 feet	1.50E-04	1.00	1.50E-04	2.74	9.94E-03	0.89	2.15	9.96E-03	0.89	2.12
Total Unit Weight = 122.7 pcf	3.00E-04	1.00	3.00E-04	2.77	1.89E-02	0.85	2.81	1.89E-02	0.84	2.89
Moisture Content = 13.9%	6.19E-04	1.00	6.19E-04	2.88	—	—	—	—	—	—
USCS Group Symbol = SC	1.24E-03	0.98	1.03E-03	3.02	—	—	—	—	—	—
Fines Content = 40.1%	2.43E-03	0.97	1.99E-03	3.20	—	—	—	—	—	—
Liquid Limit = 26%	4.85E-03	0.93	3.93E-03	3.46	—	—	—	—	—	—
Plasticity Index = 12%	9.59E-03	0.89	7.57E-03	3.92	—	—	—	—	—	—
Specific Gravity = 2.66	1.82E-02	0.84	1.38E-02	4.46	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	3.83E-02	0.72	2.80E-02	5.32	—	—	—	—	—	—
Estimated σ'_{mean} = 77 psi	7.52E-02	0.61	5.19E-02	6.55	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage **σ_o = 308 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 308 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 308 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
5.10E-05	1.00	5.10E-05	2.27	9.95E-03	0.88	1.70	9.94E-03	0.88	1.65
1.01E-04	1.00	1.01E-04	2.30	—	—	—	—	—	—
2.01E-04	1.00	2.01E-04	2.32	—	—	—	—	—	—
3.98E-04	1.00	3.98E-04	2.39	—	—	—	—	—	—
8.20E-04	0.99	8.20E-04	2.44	—	—	—	—	—	—
1.61E-03	0.98	1.37E-03	2.48	—	—	—	—	—	—
3.16E-03	0.96	2.69E-03	2.61	—	—	—	—	—	—
6.20E-03	0.94	5.15E-03	2.94	—	—	—	—	—	—
1.24E-02	0.88	1.02E-02	3.33	—	—	—	—	—	—
2.42E-02	0.81	1.91E-02	3.74	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
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Table 2.5.4-264
RCTS Test Results; Stratum Clay 7
(Power Block)

Boring B-2182UD Sample UD18 Stratum Clay 7	Resonant Column Stage σ_o = 78 psi				Torsional Shear Stage First Cycle; σ_o = 78 psi			Torsional Shear Stage Tenth Cycle; σ_o = 78 psi		
	Peak Shear Strain (%)	G/Gmax	Avg. Shear Strain (%)	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)
Depth = 220.5 feet	2.66E-04	1.00	2.66E-04	2.43	1.01E-03	1.00	0.56	1.00E-03	1.00	0.46
Total Unit Weight = 115.1 pcf	5.48E-04	1.00	5.48E-04	2.46	2.02E-03	1.00	0.61	2.04E-03	1.00	0.50
Moisture Content = 35.2%	1.08E-03	0.99	1.08E-03	2.48	3.97E-03	1.00	0.59	4.00E-03	1.00	0.60
USCS Group Symbol = CH	2.18E-03	0.99	2.18E-03	2.56	1.02E-02	1.00	0.70	1.02E-02	1.00	0.79
Fines Content = 96.3%	4.39E-03	0.99	3.51E-03	2.62	—	—	—	—	—	—
Liquid Limit = 97%	8.79E-03	0.99	7.03E-03	2.74	—	—	—	—	—	—
Plasticity Index = 67%	1.76E-02	0.99	1.46E-02	2.89	—	—	—	—	—	—
Specific Gravity = 2.70	3.49E-02	0.98	2.79E-02	3.13	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	6.95E-02	0.95	5.35E-02	3.61	—	—	—	—	—	—
Estimated σ'_{mean} = 78 psi	1.34E-01	0.86	1.00E-01	4.21	—	—	—	—	—	—
	2.31E-01	0.76	1.64E-01	5.21	—	—	—	—	—	—
	3.73E-01	0.67	2.54E-01	6.38	—	—	—	—	—	—

Resonant Column Stage σ_o = 310 psi				Torsional Shear Stage First Cycle; σ_o = 310 psi			Torsional Shear Stage Tenth Cycle; σ_o = 310 psi		
Peak Shear Strain (%)	G/Gmax	Avg. Shear Strain (%)	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)
3.89E-04	1.00	3.89E-04	2.32	1.04E-03	1.00	0.63	1.01E-03	1.00	0.72
7.88E-04	1.00	7.88E-04	2.38	2.02E-03	1.00	0.68	2.06E-03	1.00	0.72
1.57E-03	1.00	1.30E-03	2.40	4.04E-03	1.00	0.72	4.04E-03	1.00	0.60
3.10E-03	1.00	2.51E-03	2.43	9.98E-03	1.00	0.62	1.00E-02	1.00	0.63
6.27E-03	1.00	5.14E-03	2.48	2.03E-02	0.99	0.75	2.02E-02	0.99	0.64
1.25E-02	1.00	1.03E-02	2.49	—	—	—	—	—	—
2.52E-02	0.99	2.04E-02	2.63	—	—	—	—	—	—
5.02E-02	0.97	4.06E-02	2.77	—	—	—	—	—	—
9.79E-02	0.94	7.73E-02	3.20	—	—	—	—	—	—
1.93E-01	0.85	1.47E-01	3.72	—	—	—	—	—	—
3.55E-01	0.74	2.56E-01	4.78	—	—	—	—	—	—
6.03E-01	0.63	4.22E-01	6.06	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-265
RCTS Test Results; Stratum Sand 8
(Power Block)

Boring B-2274UD **Sample UD14** **Stratum Sand 8**	**Resonant Column Stage** **σ_o = 91 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 91 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 91 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 267.5 feet	2.30E-04	1.00	2.30E-04	0.72	1.02E-03	1.00	0.28	1.02E-03	1.00	0.25
Total Unit Weight = 130.0 pcf	4.59E-04	1.00	4.59E-04	0.72	2.03E-03	1.00	0.33	2.05E-03	1.00	0.39
Moisture Content = 18.5%	9.58E-04	0.99	9.58E-04	0.75	4.15E-03	0.98	0.44	4.14E-03	0.99	0.46
USCS Group Symbol = SC	1.87E-03	0.99	1.70E-03	0.80	1.07E-03	0.95	0.71	1.07E-03	0.95	0.75
Fines Content = 12.0%	3.61E-03	0.98	3.35E-03	0.81	—	—	—	—	—	—
Liquid Limit = No Value	6.92E-03	0.96	6.29E-03	0.92	—	—	—	—	—	—
Plasticity Index = Non-Plastic	1.28E-02	0.94	1.16E-02	1.18	—	—	—	—	—	—
Specific Gravity = 2.65	2.22E-02	0.90	1.95E-02	1.57	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	3.75E-02	0.84	3.19E-02	2.06	—	—	—	—	—	—
Estimated σ'_{mean} = 91 psi	6.15E-02	0.76	5.04E-02	2.66	—	—	—	—	—	—
	9.52E-02	0.71	7.33E-02	3.91	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage **σ_o = 365 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 365 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 365 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
1.37E-04	1.00	1.37E-04	0.58	1.03E-03	1.00	0.33	1.04E-03	1.00	0.41
2.71E-04	1.00	2.71E-04	0.61	2.06E-03	1.00	0.39	2.06E-03	1.00	0.33
5.55E-04	1.00	5.55E-04	0.64	4.10E-03	1.00	0.37	4.12E-03	1.00	0.50
1.10E-03	1.00	1.10E-03	0.70	—	—	—	—	—	—
2.17E-03	0.99	2.04E-03	0.73	—	—	—	—	—	—
4.22E-03	0.98	3.92E-03	0.79	—	—	—	—	—	—
8.23E-03	0.97	7.57E-03	0.87	—	—	—	—	—	—
1.48E-02	0.95	1.35E-02	1.01	—	—	—	—	—	—
2.61E-02	0.91	2.38E-02	1.23	—	—	—	—	—	—
4.26E-02	0.85	3.79E-02	1.62	—	—	—	—	—	—
6.69E-02	0.78	5.68E-02	2.21	—	—	—	—	—	—
1.02E-01	0.72	8.28E-02	3.02	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-266
RCTS Test Results; Stratum Clay 9
(Power Block)

Boring B-2182UD Sample UD24 Stratum Clay 9	Resonant Column Stage σ_o = 102 psi				Torsional Shear Stage First Cycle; σ_o = 102 psi			Torsional Shear Stage Tenth Cycle; σ_o = 102 psi		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 300.6 feet	2.67E-05	1.00	2.67E-05	N/A	1.99E-04	0.99	2.69	2.13E-04	0.99	2.74
Total Unit Weight = 123.1 pcf	5.12E-05	1.00	5.12E-05	N/A	3.88E-04	0.99	2.80	3.89E-03	1.00	2.63
Moisture Content = 22.7%	1.01E-04	1.01	1.01E-05	3.41	7.67E-04	1.00	2.77	7.72E-04	1.00	2.74
USCS Group Symbol = CH	2.00E-04	1.00	2.00E-04	3.40	1.63E-03	1.01	2.76	1.64E-03	1.01	2.75
Fines Content = 93.0%	3.71E-04	1.00	3.71E-04	3.39	3.27E-03	1.01	2.74	3.27E-03	1.01	2.79
Liquid Limit = 69%	7.24E-04	1.00	7.42E-04	3.39	—	—	—	—	—	—
Plasticity Index = 49%	1.53E-03	1.00	1.53E-03	3.40	—	—	—	—	—	—
Specific Gravity = 2.72	3.04E-03	1.00	3.04E-03	3.43	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	6.02E-03	1.00	6.02E-03	3.46	—	—	—	—	—	—
Estimated σ'_{mean} = 102 psi	1.15E-02	0.99	1.15E-03	3.62	—	—	—	—	—	—
	2.26E-02	0.97	2.26E-02	3.86	—	—	—	—	—	—
	3.64E-02	0.94	3.64E-02	4.25	—	—	—	—	—	—

Resonant Column Stage σ_o = 406 psi				Torsional Shear Stage First Cycle; σ_o = 406 psi			Torsional Shear Stage Tenth Cycle; σ_o = 406 psi		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
2.34E-05	1.00	2.34E-05	N/A	3.32E-04	1.00	2.68	3.26E-04	1.01	2.62
4.49E-05	1.00	4.49E-05	N/A	6.66E-04	0.99	2.66	6.58E-04	1.00	2.63
8.84E-05	1.00	8.84E-05	3.38	1.33E-03	0.99	2.60	1.32E-03	1.00	2.51
1.76E-04	1.00	1.76E-04	3.36	2.87E-03	1.00	2.64	2.86E-03	1.00	2.62
3.27E-04	1.00	3.27E-04	3.36	—	—	—	—	—	—
6.52E-04	1.00	6.52E-04	3.35	—	—	—	—	—	—
1.35E-03	1.00	1.35E-03	3.37	—	—	—	—	—	—
2.69E-03	1.00	2.69E-03	3.37	—	—	—	—	—	—
5.33E-03	1.00	5.33E-03	3.37	—	—	—	—	—	—
9.08E-03	0.99	9.08E-03	3.50	—	—	—	—	—	—
2.03E-02	0.98	2.03E-02	3.57	—	—	—	—	—	—
3.32E-02	0.96	3.32E-02	3.8	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-267
RCTS Test Results; Stratum Sand 10
(Power Block)

Boring B-2182UD Sample UD32 Stratum Sand 10	Resonant Column Stage σ_o = 116 psi				Torsional Shear Stage First Cycle; σ_o = 116 psi			Torsional Shear Stage Tenth Cycle; σ_o = 116 psi		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 352.7 feet	1.08E-04	1.00	1.08E-04	0.40	1.06E-03	1.00	0.40	1.04E-03	1.00	0.41
Total Unit Weight = 126.8 pcf	2.19E-04	1.00	2.19E-04	0.42	2.15E-03	0.99	0.53	2.13E-03	0.98	0.43
Moisture Content = 21.1%	4.31E-04	1.00	4.31E-04	0.48	9.50E-03	0.94	0.95	9.47E-03	0.92	0.80
USCS Group Symbol = SP-SC	8.63E-04	0.99	8.63E-04	0.56	—	—	—	—	—	—
Fines Content = 8.9%	1.64E-03	0.98	1.54E-03	0.62	—	—	—	—	—	—
Liquid Limit = No Value	3.02E-03	0.97	2.84E-03	0.74	—	—	—	—	—	—
Plasticity Index = Non-Plastic	5.52E-03	0.95	5.08E-03	0.84	—	—	—	—	—	—
Specific Gravity = 2.66	9.23E-03	0.93	8.58E-03	1.02	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	1.54E-02	0.90	1.40E-02	1.23	—	—	—	—	—	—
Estimated σ'_{mean} = 116 psi	2.54E-02	0.85	2.24E-02	1.77	—	—	—	—	—	—
	4.20E-02	0.78	3.53E-02	2.52	—	—	—	—	—	—
	6.55E-02	0.73	5.18E-02	3.69	—	—	—	—	—	—

Resonant Column Stage σ_o = 455 psi				Torsional Shear Stage First Cycle; σ_o = 455 psi			Torsional Shear Stage Tenth Cycle; σ_o = 455 psi		
Peak Shear Strain (%)	**G/G_{ma}**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
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Table 2.5.4-268
RCTS Test Results; Stratum Clay 11
(Power Block)

	Resonant Column Stage σ_o = 125 psi				Torsional Shear Stage First Cycle; σ_o = 125 psi			Torsional Shear Stage Tenth Cycle; σ_o = 125 psi		
Boring B-2269UD **Sample UD19** **Stratum Clay 11**	**Peak Shear Strain (%)**	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 381.6 feet	3.80E-04	1.00	3.80E-04	2.56	1.03E-03	1.00	0.68	1.02E-03	1.00	0.70
Total Unit Weight = 114.6 pcf	7.23E-04	1.00	7.23E-04	2.57	2.04E-03	1.00	0.74	2.04E-03	1.00	0.74
Moisture Content = 33.0%	1.40E-03	1.00	1.16E-03	2.63	4.06E-03	1.00	0.59	4.05E-03	1.00	0.60
USCS Group Symbol = CH	2.77E-03	1.00	2.32E-03	2.61	9.95E-03	1.00	0.86	9.96E-03	1.00	0.69
Fines Content = 81.9%	5.46E-03	1.00	4.53E-03	2.61	—	—	—	—	—	—
Liquid Limit = 88%	1.08E-02	0.99	8.97E-03	2.62	—	—	—	—	—	—
Plasticity Index = 57%	2.14E-02	0.99	1.80E-02	2.65	—	—	—	—	—	—
Specific Gravity = 2.69	4.17E-02	0.98	3.46E-02	2.62	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	8.19E-02	0.95	6.80E-02	2.76	—	—	—	—	—	—
Estimated σ'_{mean} = 125 psi	1.54E-01	0.90	1.23E-01	3.23	—	—	—	—	—	—
	2.72E-01	0.83	2.04E-01	4.52	—	—	—	—	—	—
	4.83E-01	0.73	3.23E-01	6.92	—	—	—	—	—	—

Resonant Column Stage σ_o = 455 psi				Torsional Shear Stage First Cycle; σ_o = 455 psi			Torsional Shear Stage Tenth Cycle; σ_o = 455 psi		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
3.01E-04	1.00	3.01E-04	2.35	9.98E-04	1.00	0.90	9.95E-04	1.00	0.55
6.20E-04	1.00	6.20E-04	2.36	2.00E-03	1.00	0.79	1.99E-03	1.00	0.64
1.21E-03	1.00	1.21E-03	2.36	3.99E-03	1.00	0.89	3.97E-03	1.00	0.86
2.36E-03	1.00	2.03E-03	2.38	1.02E-02	0.98	1.06	1.02E-02	0.97	1.17
4.61E-03	1.00	4.01E-03	2.33	—	—	—	—	—	—
8.76E-03	1.00	7.62E-03	2.32	—	—	—	—	—	—
1.66E-02	1.00	1.43E-02	2.33	—	—	—	—	—	—
3.16E-02	1.00	2.72E-02	2.44	—	—	—	—	—	—
5.72E-02	0.99	4.92E-02	2.52	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-269
RCTS Test Results; Stratum Sand 12
(Power Block)

Boring B-2274UD Sample UD23 Stratum Sand 12	Resonant Column Stage σ_o = 136 psi				Torsional Shear Stage First Cycle; σ_o = 136 psi			Torsional Shear Stage Tenth Cycle; σ_o = 136 psi		
	Peak Shear Strain (%)	G/Gmax	Avg. Shear Strain (%)	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)
Depth = 422.5 feet	8.20E-05	1.00	8.20E-05	4.64	6.81E-04	1.00	0.82	6.89E-04	1.00	1.02
Total Unit Weight = 134.4 pcf	1.64E-04	1.00	1.64E-04	4.74	1.10E-03	1.00	0.90	1.09E-03	1.00	1.02
Moisture Content = 15.5%	3.28E-04	1.00	3.28E-04	4.81	2.20E-03	1.00	1.15	2.19E-03	1.00	1.00
USCS Group Symbol = CL	6.82E-04	1.00	6.82E-04	4.92	4.46E-03	0.99	1.13	4.46E-03	0.99	0.99
Fines Content = 58.3%	1.36E-03	1.00	9.94E-04	4.99	—	—	—	—	—	—
Liquid Limit = 36%	2.76E-03	0.99	2.02E-03	5.18	—	—	—	—	—	—
Plasticity Index = 21%	5.60E-03	0.96	4.09E-03	5.28	—	—	—	—	—	—
Specific Gravity = 2.68	1.14E-02	0.91	8.22E-03	5.51	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	2.36E-02	0.83	1.65E-02	6.16	—	—	—	—	—	—
Estimated σ'_{mean} = 136 psi	5.14E-02	0.70	3.34E-02	7.86	—	—	—	—	—	—
	1.23E-01	0.52	7.00E-02	10.89	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage σ_o = 455 psi				Torsional Shear Stage First Cycle; σ_o = 455 psi			Torsional Shear Stage Tenth Cycle; σ_o = 455 psi		
Peak Shear Strain (%)	G/G_{max}	Avg. Shea Strain (%)	Damping Ratio (%)	Peak Shear Strain (%)	G/G_{max}	Damping Ratio (%)	Peak Shear Strain (%)	G/Gmax	Damping Ratio (%)
3.60E-05	1.00	3.60E-05	3.59	1.02E-03	1.00	0.51	1.03E-03	1.00	0.52
7.10E-05	1.00	7.10E-05	3.62	2.04E-03	1.00	0.61	2.06E-03	1.00	0.51
1.43E-04	1.00	1.43E-04	3.64	4.10E-03	1.00	0.74	4.09E-03	1.00	0.62
2.86E-04	1.00	2.86E-04	3.68	8.29E-03	0.99	0.93	8.26E-03	0.99	0.90
5.94E-04	1.00	5.94E-04	3.80	—	—	—	—	—	—
1.19E-03	1.00	9.39E-04	3.79	—	—	—	—	—	—
2.34E-03	0.99	1.85E-03	3.92	—	—	—	—	—	—
4.77E-03	0.97	3.72E-03	4.02	—	—	—	—	—	—
1.15E-02	0.92	8.86E-03	4.34	—	—	—	—	—	—
1.90E-02	0.87	1.43E-02	4.93	—	—	—	—	—	—
3.92E-02	0.74	2.70E-02	6.56	—	—	—	—	—	—
6.12E-02	0.65	3.98E-02	7.86	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-270
RCTS Test Results; Stratum Clay 13
(Power Block)

	Resonant Column Stage **σ_o = 154 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 154 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 154 psi**		
Boring B-2274UD **Sample UD24** **Stratum Clay 13**	**Peak Shear Strain (%)**	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 481.1 feet	3.88E-04	1.00	3.88E-04	2.05	1.01E-03	1.00	1.01	1.02E-03	1.00	0.75
Total Unit Weight = 123.5 pcf	8.13E-04	1.00	8.13E-04	2.08	1.99E-03	1.00	1.01	2.00E-03	1.00	0.85
Moisture Content = 26.2%	1.65E-03	1.00	1.40E-03	2.15	3.99E-03	1.00	0.94	4.00E-03	1.00	0.89
USCS Group Symbol = CH	3.29E-03	1.00	2.79E-03	2.20	1.01E-02	0.99	0.93	1.00E-02	1.00	0.88
Fines Content = 96.1%	6.54E-03	1.00	5.62E-03	2.28	—	—	—	—	—	—
Liquid Limit = 69%	1.27E-02	0.99	1.08E-02	2.36	—	—	—	—	—	—
Plasticity Index = 42%	2.48E-02	0.99	2.08E-02	2.54	—	—	—	—	—	—
Specific Gravity = 2.71	4.72E-02	0.96	3.96E-02	2.70	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	8.93E-02	0.90	7.32E-02	2.96	—	—	—	—	—	—
Estimated σ'_{mean} = 154 psi	1.67E-01	0.80	1.30E-01	3.92	—	—	—	—	—	—
	3.22E-01	0.67	2.25E-01	5.85	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage **σ_o = 455 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 455 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 455 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
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Table 2.5.4-271
RCTS Test Results; Stratum Sand 14
(Power Block)

Boring B-2174UDR **Sample UD28** **Stratum Sand 14**	**Resonant Column Stage** **σ_o = 167 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 167 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 167 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 527.5 feet	1.06E-04	1.00	1.06E-04	1.36	1.02E-03	1.00	0.57	1.03E-03	1.00	0.43
Total Unit Weight = 126.1 pcf	2.07E-04	1.00	2.07E-04	1.34	2.11E-03	0.97	0.44	2.12E-03	0.97	0.50
Moisture Content = 20.9%	4.21E-04	1.00	4.21E-04	1.35	4.38E-03	0.93	0.62	4.41E-03	0.94	0.56
USCS Group Symbol = SM	8.60E-04	0.99	8.60E-04	1.38	9.14E-03	0.89	0.86	9.11E-03	0.91	0.87
Fines Content = 21.5%	1.70E-03	0.98	1.53E-03	1.37	—	—	—	—	—	—
Liquid Limit = 18%	3.31E-03	0.97	2.98E-03	1.45	—	—	—	—	—	—
Plasticity Index = 2%	6.32E-03	0.96	5.63E-03	1.56	—	—	—	—	—	—
Specific Gravity = 2.68	1.17E-02	0.93	1.03E-02	1.85	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	2.15E-02	0.87	1.82E-02	2.34	—	—	—	—	—	—
Estimated σ'_{mean} = 167 psi	3.74E-02	0.81	3.06E-02	3.13	—	—	—	—	—	—
	6.57E-02	0.73	5.06E-02	4.19	—	—	—	—	—	—
	8.32E-02	0.69	6.32E-02	4.58	—	—	—	—	—	—

Resonant Column Stage **σ_o = 455 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 455 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 455 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
8.00E-05	1.00	8.00E-05	1.24	1.02E-03	1.00	0.63	1.00E-03	1.00	0.51
1.59E-04	1.00	1.59E-04	1.29	1.90E-03	1.00	0.65	1.90E-03	0.99	0.63
3.17E-04	1.00	3.17E-04	1.28	—	—	—	—	—	—
6.53E-04	1.00	6.53E-04	1.30	—	—	—	—	—	—
1.29E-03	0.99	1.29E-03	1.33	—	—	—	—	—	—
2.54E-03	0.98	2.31E-03	1.35	—	—	—	—	—	—
4.89E-03	0.97	4.40E-03	1.42	—	—	—	—	—	—
9.03E-03	0.94	8.04E-03	1.67	—	—	—	—	—	—
1.68E-02	0.90	1.48E-02	1.99	—	—	—	—	—	—
2.99E-02	0.85	2.54E-02	2.66	—	—	—	—	—	—
4.42E-02	0.80	3.62E-02	3.17	—	—	—	—	—	—
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Table 2.5.4-272
RCTS Test Results; Stratum Clay 17
(Power Block)

Boring B-2174UDR Sample UD30 Stratum Clay 17	**Resonant Column Stage σ_o = 180 psi**				**Torsional Shear Stage First Cycle; σ_o = 180 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 180 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 571.6 feet	2.09E-04	1.00	2.09E-04	4.02	9.62E-04	1.00	0.93	9.38E-04	1.00	0.78
Total Unit Weight = 126.4 pcf	4.23E-04	1.00	4.23E-04	4.05	1.95E-03	1.00	1.05	1.94E-03	1.00	1.16
Moisture Content = 23.1%	8.54E-04	1.00	8.54E-04	4.09	3.87E-03	1.00	0.97	3.85E-03	1.00	0.92
USCS Group Symbol = CH	1.72E-03	1.00	1.34E-03	4.10	9.72E-03	1.00	1.12	9.69E-03	1.00	1.16
Fines Content = 68.3%	3.46E-03	0.99	2.70E-03	4.12	—	—	—	—	—	—
Liquid Limit = 59%	6.94E-03	0.99	5.41E-03	4.13	—	—	—	—	—	—
Plasticity Index = 40%	1.40E-02	0.97	1.08E-02	4.31	—	—	—	—	—	—
Specific Gravity = 2.74	2.84E-02	0.94	2.16E-02	4.53	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	5.73E-02	0.87	4.18E-02	5.22	—	—	—	—	—	—
Estimated σ'_{mean} = 180 psi	1.18E-01	0.76	8.27E-02	6.03	—	—	—	—	—	—
	2.48E-01	0.63	1.61E-01	7.80	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage σ_o = 455 psi				**Torsional Shear Stage First Cycle; σ_o = 455 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 455 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
1.44E-04	1.00	1.44E-04	3.69	9.48E-04	1.00	1.11	1.01E-03	1.00	1.19
2.88E-04	1.00	2.88E-04	3.74	1.88E-03	1.00	1.24	1.89E-03	1.00	1.43
6.00E-04	1.00	6.00E-04	3.77	3.69E-03	1.00	1.18	3.74E-03	1.00	1.00
1.20E-03	1.00	1.20E-03	3.80	7.43E-03	1.00	1.08	7.46E-03	1.00	1.09
2.40E-03	1.00	1.89E-03	3.81	—	—	—	—	—	—
4.81E-03	0.99	3.80E-03	3.82	—	—	—	—	—	—
9.69E-03	0.98	7.66E-03	3.91	—	—	—	—	—	—
1.95E-02	0.97	1.52E-02	3.91	—	—	—	—	—	—
3.93E-02	0.92	3.03E-02	4.23	—	—	—	—	—	—
7.68E-02	0.85	5.76E-02	5.01	—	—	—	—	—	—
1.18E-01	0.76	8.41E-02	5.97	—	—	—	—	—	—
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Table 2.5.4-273
RCTS Test Results; Stratum Sand 18
(Power Block)

Boring B-2174UDR **Sample UD31** **Stratum Sand 18**	**Resonant Column Stage** **σ_o = 186 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 186 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 186 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = 593.0 feet	1.74E-04	1.00	1.74E-04	0.69	1.06E-03	1.00	0.30	1.05E-03	1.00	0.31
Total Unit Weight = 125.0 pcf	3.43E-04	1.00	3.43E-04	0.68	2.18E-03	1.00	0.36	2.16E-03	1.00	0.47
Moisture Content = 14.1%	7.08E-04	1.00	7.08E-04	0.69	4.39E-03	0.98	0.54	4.39E-03	0.97	0.49
USCS Group Symbol = SM	1.39E-03	0.99	1.30E-03	0.69	8.92E-03	0.96	0.64	8.89E-03	0.96	0.55
Fines Content = 17.8%	2.69E-03	0.98	2.53E-03	0.71	—	—	—	—	—	—
Liquid Limit = 17%	5.11E-03	0.98	4.80E-03	0.77	—	—	—	—	—	—
Plasticity Index = 2%	9.41E-03	0.96	8.75E-03	0.86	—	—	—	—	—	—
Specific Gravity = 2.65	1.65E-02	0.92	1.51E-02	1.15	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	2.83E-02	0.88	2.52E-02	1.59	—	—	—	—	—	—
Estimated σ'_{mean} = 186 psi	4.73E-02	0.81	4.06E-02	2.11	—	—	—	—	—	—
	7.80E-02	0.74	6.39E-02	3.04	—	—	—	—	—	—
	9.51E-02	0.72	7.52E-02	3.67	—	—	—	—	—	—

Resonant Column Stage **σ_o = 455 psi**				**Torsional Shear Stage** **First Cycle; σ_o = 455 psi**			**Torsional Shear Stage** **Tenth Cycle; σ_o = 455 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
1.10E-04	1.00	1.10E-04	0.63	1.05E-03	1.00	0.22	1.05E-03	1.00	0.28
2.20E-04	1.00	2.20E-04	0.65	2.09E-03	1.00	0.27	2.09E-03	1.00	0.33
4.37E-04	1.00	4.37E-04	0.68	4.18E-03	1.00	0.36	4.20E-03	1.00	0.38
8.96E-04	1.00	8.96E-04	0.68	—	—	—	—	—	—
1.76E-03	0.99	1.66E-03	0.69	—	—	—	—	—	—
3.39E-03	0.99	3.18E-03	0.72	—	—	—	—	—	—
6.30E-03	0.97	5.92E-03	0.76	—	—	—	—	—	—
1.16E-02	0.94	1.08E-02	0.90	—	—	—	—	—	—
2.09E-02	0.91	1.90E-02	1.28	—	—	—	—	—	—
3.61E-02	0.86	3.22E-02	1.69	—	—	—	—	—	—
5.87E-02	0.81	4.93E-02	2.52	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Table 2.5.4-274
RCTS Test Results; Embankment Fill/Sand; Composite A Sample (Cooling Basin/GBRA Storage Water Reservoir)

Test Pits TP-2319/TP-2334 Embankment Fill/Sand Composite A Sample	**Resonant Column Stage σ_o = 19 psi**				**Torsional Shear Stage First Cycle; σ_o = 19 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 19 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = N/A feet	2.32E-04	1.00	2.32E-04	6.44	9.91E-04	1.00	2.69	1.02E-03	0.99	2.98
Total Unit Weight = 135.9 pcf	4.64E-04	1.00	4.64E-04	6.44	1.98E-03	1.00	2.58	1.99E-03	0.99	2.59
Moisture Content = 14.8%	9.63E-04	1.00	9.63E-04	6.52	4.02E-03	0.98	2.56	4.01E-03	1.00	2.76
USCS Group Symbol = SC	1.94E-03	0.99	1.32E-03	6.52	1.00E-02	0.94	3.17	1.00E-02	0.96	3.10
Fines Content = 46.4%	3.91E-03	0.98	2.62E-03	6.64	—	—	—	—	—	—
Liquid Limit = 34%	8.01E-03	0.95	5.29E-03	6.88	—	—	—	—	—	—
Plasticity Index = 22%	1.71E-02	0.87	1.11E-02	7.48	—	—	—	—	—	—
Specific Gravity = 2.66	3.92E-02	0.73	2.40E-02	9.16	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	—	—	—	—	—	—	—	—	—	—
Estimated σ'_{mean} = 19 psi	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage σ_o = 75 psi				**Torsional Shear Stage First Cycle; σ_o = 75 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 75 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
1.38E-04	1.00	1.38E-04	5.91	1.01E-03	1.00	2.90	1.01E-03	1.00	2.51
2.75E-04	1.00	2.75E-04	5.96	2.05E-03	0.99	2.64	2.01E-03	1.00	2.79
5.73E-04	1.00	5.73E-04	5.97	4.09E-03	0.99	2.48	4.09E-03	0.99	2.37
1.15E-03	1.00	8.02E-04	6.01	1.01E-02	0.96	2.90	1.01E-02	0.96	2.83
2.31E-03	0.99	1.62E-03	6.03	—	—	—	—	—	—
4.66E-03	0.98	3.26E-03	6.11	—	—	—	—	—	—
9.62E-03	0.93	6.54E-03	6.56	—	—	—	—	—	—
2.08E-02	0.83	1.37E-02	7.35	—	—	—	—	—	—
4.90E-02	0.67	3.04E-02	9.13	—	—	—	—	—	—
1.40E-01	0.45	7.58E-02	12.50	—	—	—	—	—	—
1.69E-01	0.42	8.97E-02	13.10	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
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Table 2.5.4-275
RCTS Test Results; Embankment Fill/Clay; Composite B Sample (Cooling Basin/GBRA Storage Water Reservoir)

Test Pits TP-2317/TP-2334 Embankment Fill/Clay Composite B Sample	**Resonant Column Stage σ_o = 19 psi**				**Torsional Shear Stage First Cycle; σ_o = 19 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 19 psi**		
	Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
Depth = N/A feet	3.02E-04	1.00	3.02E-04	5.40	1.04E-03	1.00	2.18	1.04E-03	1.00	2.06
Total Unit Weight = 133.0 pcf	6.23E-04	1.00	6.23E-04	5.42	2.05E-03	1.00	2.15	2.04E-03	1.00	2.14
Moisture Content = 14.8%	1.23E-03	1.00	8.96E-04	5.43	4.58E-03	1.00	2.27	4.55E-03	1.00	2.49
USCS Group Symbol = CL	2.48E-03	1.00	1.73E-03	5.49	9.52E-03	1.00	2.54	9.54E-03	1.00	2.51
Fines Content = 73.6%	4.94E-03	1.00	3.51E-03	5.54	—	—	—	—	—	—
Liquid Limit = 44%	9.95E-03	0.99	6.96E-03	5.56	—	—	—	—	—	—
Plasticity Index = 29%	2.02E-02	0.97	1.39E-02	5.69	—	—	—	—	—	—
Specific Gravity = 2.69	4.20E-02	0.90	2.90E-02	6.10	—	—	—	—	—	—
Estimated In-Situ K_0 = 0.5	9.34E-02	0.76	6.07E-02	7.40	—	—	—	—	—	—
Estimated σ'_{mean} = 19 psi	2.44E-01	0.55	1.42E-01	10.25	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

Resonant Column Stage σ_o = 75 psi				**Torsional Shear Stage First Cycle; σ_o = 75 psi**			**Torsional Shear Stage Tenth Cycle; σ_o = 75 psi**		
Peak Shear Strain (%)	**G/Gmax**	**Avg. Shear Strain (%)**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**	**Peak Shear Strain (%)**	**G/Gmax**	**Damping Ratio (%)**
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Table 2.5.4-276
Liquefaction Evaluation, SPT Method
(Power Block)

Boring (Number of Test Points)	Test El.[a,b] (feet)	FOS[b]	Structure	Foundation El.[c] (feet)	Stratum (Disposition)	[d]
B-2153 (1)	+80.2	0.95	Electrical Building	+95.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
B-2160 (1)	+76.9	0.96	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure])	√
B-2161 (1)	+80.5	1.02	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure])	√
B-2172 (1)	+79.1	0.94	General Power Block Area	N/A	Stratum Clay 1 (Top) (no structure)	√
B-2257 (1)	+80.8	0.87	Turbine Building	+69.0	Stratum Clay 1 (Top) (excavated [at structure])	√
B-2272 (1)	+76.7	0.98	General Power Block Area	N/A	Stratum Clay 1 (Top) (no structure)	√
B-2277 (1)	+76.8	0.68	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
B-2277 (1)	–55.4	0.98	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Sand 5 (isolated; refer to Subsection 2.5.4.8.2.1)	
B-2301A (1)	–27.3	1.09	Outside Power Block	N/A	Stratum Sand 4 (no structure)	√

a. Elevations are referenced to NAVD 88.

b. Range of Test Els. and FOS values are given where multiple test points occur.

c. Foundation Els. shown in “{ }” symbols denote the elevations of significant over-excavation at the particular structure.

d. √ denotes tests having FOS<1.10, but made in strata that are excavated (at structure), in areas without structures, or in fine-grained soils which are nonliquefiable.

Table 2.5.4-277
Liquefaction Evaluation, SPT Method
(Cooling Basin/GBRA Storage Water Reservoir)

Boring (Number of Test Points)	Test El.[a,b] (feet)	FOS[b]	Structure	Foundation El. (feet)	Stratum (Disposition)	[c]
B-01 (1)	+71.5	1.08	No Structure (CB Interior)	N/A	Stratum Sand 1 (excavated [at cut area])	√
B-02 (1)	+74.7	0.83	No Structure (CB Interior)	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
B-03 (1)	+74.9	1.08	No Structure (GBRA Interior)	N/A	Stratum Sand 1 (excavated [at cut area])	√
B-04 (1)	+79.0	0.83	East Dam of CB	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
B-04 (1)	+65.3	0.76	East Dam of CB	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
B-06 (1)	+79.0	0.98	North Dam of GBRA	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
B-09 (1)	+77.4	0.98	North Dam of CB	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
B-2304A (1)	–210.2	1.06	West Dam of CB	N/A	Stratum Sand 8 (fine-grained interbed; nonliquefiable)	√
B-2324 (1)	+24.5	0.81	No Structure (East of GBRA)	N/A	Stratum Sand 2 (no structure)	√
B-2336 (1)	+57.0	0.97	East Dam of GBRA	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.2.2)	
B-2337 (1)	+8.7	0.93	East Dam of CB	N/A	Stratum Sand 4 (isolated; refer to Subsection 2.5.4.8.2.2)	
B-2348 (2)	+46.4 to +44.3	0.90 to 0.93	No Structure (East of GBRA)	N/A	Stratum Clay 1 (Top) (no structure)	√
B-2350 (1)	+57.0	1.00	South Dam of CB	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
B-2351 (1)	+60.1	1.01	South Dam of CB	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.2.2)	
B-2355 (1)	–19.2	0.96	No Structure (GBRA Interior)	N/A	Stratum Sand 4 (fine-grained interbed; nonliquefiable)	√
B-2357 (1)	+65.7	0.83	South Dam of GBRA	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√

a. Elevations are referenced to NAVD 88.

b. Range of Test Els. and FOS values are given where multiple test points occur.

c. √ denotes tests having FOS<1.10, but made in strata that are excavated (at cut area), in areas without structures, or in fine-grained soils which are nonliquefiable.

Table 2.5.4-278 (Sheet 1 of 2)
Liquefaction Evaluation, Cone Penetration Test Method
(Power Block)

CPT (Number of Test Points)	Test El.[a,b] (feet)	FOS[b]	Structure	Foundation El.[c] (feet)	Stratum (Disposition)	[d]
C-2101 (2)	+80.12 to +79.37	0.54 to 0.81	Switch Yard	To Be Determined	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2102S (3)	+80.17 to +78.92	0.54 to 0.98	Turbine Building	+69.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2103 (6)	+77.68 to +73.93	0.46 to 1.02	Electrical Building	+95.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2104S (3)	+80.10 to +77.35	0.73 to 1.08	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2105 (2)	+80.19 to +79.44	0.54 to 0.80	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2106S (6)	+79.51 to +76.76	0.59 to 1.06	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2107 (3)	+79.96 to +77.71	0.46 to 1.07	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2108 (2)	+79.78 to +79.03	0.47 to 0.76	Control Building	+46.1 {+25.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2109S (3)	+79.93 to +78.68	0.44 to 0.97	Fire Water Services Complex	+87.3	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2110 (5)	+80.00 to +77.75	0.50 to 1.05	Fire Water Services Complex	+87.3	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2111D (3)	+79.22 to +77.97	0.52 to 1.08	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2112 (4)	+79.55 to +77.80	0.46 to 0.92	Service Building	+80.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2113 (4)	+79.31 to +77.56	0.45 to 1.03	Service Building	+80.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2114 (3)	+79.86 to +78.61	0.46 to +0.86	Cold Machine Shop	To Be Determined	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2115 (4)	+79.83 to +78.08	0.46 to 0.99	Cold Machine Shop	To Be Determined	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2201 (3)	+80.62 to +79.37	0.51 to 0.87	Switch Yard	To Be Determined	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2202 (2)	+80.42 to +79.67	0.60 to 1.02	Turbine Building	+69.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2203 (3)	+80.56 to +76.31	0.44 to 0.90	Electrical Building	+95.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2204SB (2)	+80.18 to +79.43	0.58 to 0.67	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2205 (9)	+80.39 to +76.14	0.47 to 1.09	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2206S (2)	+80.63 to +79.88	0.57 to 1.00	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2207 (2)	+80.39 to +79.64	0.49 to 0.78	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2208 (3)	+80.54 to +79.29	0.55 to 0.98	Control Building	+46.1 {+25.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2209S (7)	+80.27 to +76.02	0.54 to <1.10	Fire Water Services Complex	+87.3	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√

Table 2.5.4-278 (Sheet 2 of 2)
Liquefaction Evaluation, Cone Penetration Test Method
(Power Block)

CPT (Number of Test Points)	Test El.[a,b] (feet)	FOS[b]	Structure	Foundation El.[c] (feet)	Stratum (Disposition)	d
C-2210A (3)	+79.87 to +78.62	0.51 to 0.97	Fire Water Services Complex	+87.3	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2211 (3)	+80.20 to +78.95	0.51 to 0.87	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2212 (2)	+80.44 to +79.69	0.54 to 0.83	Service Building	+80.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2213 (3)	+80.46 to +79.21	0.48 to 1.08	Service Building	+80.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2216 (2)	+80.54 to +79.79	0.51 to 0.75	Spent Fuel Storage	To Be Determined	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√

a. Elevations are referenced to NAVD 88.

b. Range of Test Els. and FOS values are given where multiple test points occur.

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

d. √ denotes tests having FOS<1.10, but made in strata that are excavated (at structure), in areas without structures, or in fine-grained soils which are nonliquefiable.

Table 2.5.4-279 (Sheet 1 of 2)
Liquefaction Evaluation, Cone Penetration Test Method (Cooling Basin/GBRA Storage Water Reservoir)

CPT (Number of Test Points)	Test El.[a,b] (feet)	FOS[b]	Structure	Foundation El. (feet)	Stratum (Disposition)	[c]
C-2301S (4)	+79.08 to +77.33	0.47 to 0.77	North Dam of CB	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2301S (1)	+69.33	1.08	North Dam of CB	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2301S (1)	+67.83	0.98	North Dam of CB	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.3.2)	
C-2301SA (4)	+78.70 to +76.95	0.59 to 1.00	North Dam of CB	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2301SA (3)	+69.95 to +68.95	1.00 to 1.05	North Dam of CB	N/A	Stratum Sand 1 (excavated [at cut area])	√
C-2302 (3)	+77.49 to +76.24	0.56 to 0.98	North Dam of CB	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2303S (4)	+76.79 to +75.04	0.55 to 0.72	North Dam of GBRA	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2304 (1)	+74.60	0.62	East Dam of GBRA	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2305 (2)	+75.47 to +74.72	0.58 to 0.81	No Structure (CB Interior)	N/A	Stratum Sand 1 (excavated [at cut area])	√
C-2306 (2)	+77.54 to +76.79	0.65 to 0.84	No Structure (CB Interior)	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2307 (5)	+74.88 to +72.63	0.48 to 0.91	No Structure (GBRA Interior)	N/A	Stratum Sand 1 (excavated [at cut area])	√
C-2307 (1)	+63.63	1.01	No Structure (GBRA Interior)	N/A	Stratum Sand 1 (no structure)	√
C-2308 (9)	+58.02 to +52.77	0.53 to 1.09	East Dam of GBRA	N/A	Stratum Sand 1 (remove; refer to Subsection 2.5.4.8.3.2)	
C-2308 (1)	-6.23	1.09	East Dam of GBRA	N/A	Stratum Sand 4 (isolated; refer to Subsection 2.5.4.8.3.2)	
C-2309 (2)	+72.92 to +72.17	0.53 to 0.85	No Structure (CB Interior)	N/A	Stratum Sand 1 (excavated [at cut area])	√
C-2310 (3)	+70.88 to +69.63	0.59 to 0.92	No Structure (CB Interior)	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2311 (7)	+41.70 to +37.95	0.46 to 0.97	East Dam of GBRA	N/A	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
C-2311A (7)	+50.49 to +47.24	0.46 to 1.05	East Dam of GBRA	N/A	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
C-2312 (2)	+64.99 to +64.24	0.57 to 0.75	West Dam of CB	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2312 (5)	+52.74 to +50.74	0.89 to 1.01	West Dam of CB	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.3.2)	
C-2313 (6)	+71.17 to +68.42	0.51 to 0.97	No Structure (CB Interior)	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2314 (2)	+69.45 to +68.70	0.68 to 0.83	No Structure (CB Interior)	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2315 (5)	+66.35 to +64.10	0.49 to 0.95	No Structure (CB Interior)	N/A	Stratum Clay 1 (Top) (no structure)	√
C-2316 (3)	+68.23 to +66.98	0.47 to 0.68	East Dam of CB	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2317 (5)	+45.17 to +42.92	0.51 to 1.08	East Dam of GBRA	N/A	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√

Table 2.5.4-279 (Sheet 2 of 2) Liquefaction Evaluation, Cone Penetration Test Method (Cooling Basin/GBRA Storage Water Reservoir)

CPT (Number of Test Points)	Test El.[a,b] (feet)	FOS[b]	Structure	Foundation El. (feet)	Stratum (Disposition)	c
C-2318 (4)	+66.39 to +64.64	0.57 to 0.82	No Structure (CB Interior)	N/A	Stratum Clay 1 (Top) (no structure)	√
C-2319 (4)	+65.56 to +63.81	0.45 to 0.98	No Structure (GBRA Interior)	N/A	Stratum Clay 1 (Top) (no structure)	√
C-2319 (2)	+56.31 to +55.81	0.85 to 0.97	No Structure (GBRA Interior)	N/A	Stratum Sand 1 (no structure)	√
C-2321S (5)	+65.80 to +63.05	0.59 to 1.07	South Dam of CB	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2321S (1)	+54.05	0.99	South Dam of CB	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.3.2)	
C-2321S (2)	+47.55 to +46.05	1.03 to 1.08	South Dam of CB	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.3.2)	
C-2321SA (3)	+65.90 to +64.65	0.56 to 0.79	South Dam of CB	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2322 (5)	+62.19 to +59.95	0.56 to 0.89	South Dam of CB	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2322 (1)	-18.56	0.95	South Dam of CB	N/A	Stratum Sand 5 (isolated; refer to text)	
C-2323S (5)	+65.67 to +63.42	0.49 to 0.85	South Dam of GBRA	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2323S (1)	+53.92	0.92	South Dam of GBRA	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.3.2)	
C-2324 (4)	+63.58 to +61.83	0.47 to 1.09	No Structure (East of GBRA)	N/A	Stratum Clay 1 (Top) (no structure)	√
C-2328 (3)	+65.62 to +64.37	0.56 to 0.82	No Structure (South of CB)	N/A	Stratum Clay 1 (Top) (no structure)	√

a. Elevations are referenced to NAVD 88.

b. Range of Test Els. and FOS values are given where multiple test points occur.

c. √ denotes tests having FOS<1.10, but made in strata that are excavated (at cut area), in areas without structures, or in fine-grained soils which are nonliquefiable.

Table 2.5.4-280 (Sheet 1 of 2)
Liquefaction Evaluation, S-Wave Velocity Method
(Power Block)

V_S Boring/CPT (Number of Test Points)	Test El.[a,b] (feet)	FOS [2]	Structure	Foundation El.[c] (feet)	Stratum (Disposition)	[d]
B-2162A Offset (1)	+52.2	0.93	Turbine Building	+69.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
B-2162A Offset (5)	+45.6 to +39.8	0.52 to 1.02	Turbine Building	+69.0	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
B-2174A Offset (2)	+54.7 to +53.0	0.70 to 0.81	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
B-2174A Offset (2)	+44.8 to +43.2	0.44 to 0.88	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Clay 1 (Bottom) (excavated [at structure])	√
B-2174A Offset (2)	+25.2 to +23.5	0.61 to 1.03	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Sand 2 (excavated [at structure])	√
B-2174A Offset (2)	–30.6 to –32.3	0.84 to 0.85	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Clay 5 (Top) (fine-grained; nonliquefiable)	√
B-2174A Offset (1)	–257.0	0.77	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Clay 11 (fine-grained; nonliquefiable)	√
B-2174A Offset (8)	–286.5 to –306.2	0.64 to 0.97	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Clay 11 (fine-grained; nonliquefiable)	√
B-2174A Offset (1)	–363.6	1.08	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Clay 13 (fine-grained; nonliquefiable)	√
B-2176A Offset (1)	+42.3	0.81	Fire Water Service Complex	+87.3	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
B-2182A Offset (2)	–141.8 to –143.4	0.78 to 0.90	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Clay 7 (fine-grained; nonliquefiable)	√
C-2102S (1)	+78.2	0.61	Turbine Building	+69.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2102S (1)	+48.7	0.87	Turbine Building	+69.0	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
C-2102S (1)	–9.6	0.86	Turbine Building	+69.0	Stratum Sand 4 (isolated; refer to Subsection 2.5.4.8.4.1)	
C-2104S (3)	+75.6 to +53.6	0.57 to 0.96	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure]	√
C-2104S (2)	+48.6 to +43.6	0.78 to 1.00	Radwaste Building	+43.0	Stratum Clay 1 (Bottom) (excavated [at structure])	√
C-2106S (2)	+75.0 to +68.0	0.35 to 0.98	Reactor/Fuel Building	+29.4 (+8.0)	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2109S (3)	+75.4 to +53.4	0.60 to 0.83	Fire Water Service Complex	+87.3	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2109S (1)	+48.4	0.88	Fire Water Service Complex	+87.3	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
B-2262A Offset (5)	+64.2 to +56.0	0.60 to 0.96	Turbine Building	+69.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
B-2262A Offset (4)	+34.6 to +29.7	0.56 to 1.09	Turbine Building	+69.0	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
B-2262A Offset (4)	+16.6 to +6.8	0.43 to 0.78	Turbine Building	+69.0	Stratum Clay 3 (fine-grained; nonliquefiable)	√
B-2262A Offset (5)	–81.8 to –88.4	0.29 to 0.94	Turbine Building	+69.0	Stratum Sand 6 (isolated; refer to Subsection 2.5.4.8.4.1)	
B-2274A Offset (5)	+72.1 to +59.0	0.80 to 1.07	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√

Table 2.5.4-280 (Sheet 2 of 2)
Liquefaction Evaluation, S-Wave Velocity Method
(Power Block)

V_S Boring/CPT (Number of Test Points)	Test El.[a,b] (feet)	FOS [2]	Structure	Foundation El.[c] (feet)	Stratum (Disposition)	d
B-2274A Offset (1)	+27.9	0.70	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Bottom) (excavated [at structure])	√
B-2274A Offset (4)	+9.8 to –5.0	0.57 to 0.83	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 3 (fine-grained; nonliquefiable)	√
B-2274A Offset (2)	–82.1 to –83.7	0.68 to 0.81	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Sand 6 (isolated; refer to Subsection 2.5.4.8.4.1)	
B-2274A Offset (8)	–300.2 to –311.7	0.80 to 1.07	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 11 (fine-grained; nonliquefiable)	√
B-2276A Offset (2)	+15.0 to +13.4	0.80 to 1.07	Fire Water Service Complex	+87.3	Stratum Clay 3 (fine-grained; nonliquefiable)	√
B-2276A Offset (1)	–71.9	0.97	Fire Water Service Complex	+87.3	Stratum Clay 5 (Bottom) (fine-grained; nonliquefiable)	√
B-2282A Offset (6)	+64.1 to +55.9	0.80 to 1.03	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
B-2282A Offset (2)	+13.2 to +11.6	1.06 to 1.07	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 3 (excavated [at structure])	√
C-2202S (4)	+76.0 to +59.0	0.67 to 0.97	Turbine Building	+69.0	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2204SB (5)	+78.5 to +59.0	0.15 to 1.03	Radwaste Building	+43.0	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2204SB (2)	+24.0 to 19.0	0.75 to 1.02	Radwaste Building	+43.0	Stratum Clay 3 (fine-grained; nonliquefiable)	√
C-2206S (4)	+76.0 to +59.0	0.40 to 0.76	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 1 (Top) (excavated [at structure])	√
C-2206S (2)	+19.0 to +14.0	1.00 to 1.05	Reactor/Fuel Building	+29.4 {+8.0}	Stratum Clay 3 (excavated [at structure])	√
C-2209S (3)	+76.0 to +64.0	0.45 to 0.97	Fire Water Service Complex	+87.3	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√

a. Elevations are referenced to NAVD 88.

b. Range of Test Els. and FOS values are given where multiple test points occur.

c. Foundation Els. shown in “{ }” symbols denote the elevations of significant over-excavation at the particular structure.

d. √ denotes tests having FOS<1.10, but made in strata that are excavated (at structure), in areas without structures, or in fine-grained soils which are nonliquefiable.

Table 2.5.4-281
Liquefaction Evaluation, S-Wave Velocity Method (Cooling Basin/GBRA Storage Water Reservoir)

V_s Boring/CPT (Number of Test Points)	Test El.[a,b] (feet)	FOS[b]	Structure	Foundation El. (feet)	Stratum (Disposition)	[c]
B-2302 (2)	+52.1 to +48.8	0.97 to 1.05	West Dam of CB	N/A	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
B-2302 (2)	+17.3 to +16.0	0.55 to 1.09	West Dam of CB	N/A	Stratum Sand 2 (isolated; refer to Subsection 2.5.4.8.4.2)	
B-2302 (1)	+14.4	0.62	West Dam of CB	N/A	Stratum Clay 3 (fine-grained; nonliquefiable)	√
B-2303 (4)	+57.5 to +51.06	0.62 to <1.10	West Dam of CB	N/A	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
B-2303 (4)	+23.1 to +18.2	0.82 to 0.93	West Dam of CB	N/A	Stratum Clay 3 (fine-grained; nonliquefiable)	√
B-2303 (3)	-75.4 to -78.6	0.95 to 1.08	West Dam of CB	N/A	Stratum Clay 5 (Bottom) (fine-grained; nonliquefiable)	√
B-2303 (1)	-108.2	0.97	West Dam of CB	N/A	Stratum Sand 6 (isolated; refer to Subsection 2.5.4.8.4.2)	
B-2304 (3)	-86.1 to -89.4	0.60 to 1.07	West Dam of CB	N/A	Stratum Clay 5 (Bottom) (fine-grained; nonliquefiable)	√
B-2305 (1)	+45.9	1.06	No Structure (East of GBRA)	N/A	Clay 1 (Bottom) (no structure)	√
B-2305 (2)	-70.6 to -72.2	0.83 to 1.01	No Structure (East of GBRA)	N/A	Stratum Clay 5 (Bottom) (no structure)	√
C-2301S (1)	+74.8	0.27	North Dam of CB	N/A	Stratum Clay 1 (Top) (excavated [at cut area])	√
C-2301S (1)	+67.8	0.42	North Dam of CB	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.4.2)	
C-2303S (1)	+65.3	0.26	North Dam of GBRA	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.4.2)	
C-2303S (1)	+35.3	0.74	North Dam of GBRA	N/A	Stratum Clay 1 (Bottom) (fine-grained; nonliquefiable)	√
C-2303S (1)	-9.7	1.08	North Dam of GBRA	N/A	Stratum Clay 5 (Top) (fine-grained; nonliquefiable)	√
C-2323S (2)	+63.7 to +59.2	0.34 to 0.35	South Dam of GBRA	N/A	Stratum Clay 1 (Top) (fine-grained; nonliquefiable)	√
C-2323S (1)	+54.2	0.58	South Dam of GBRA	N/A	Stratum Sand 1 (isolated; refer to Subsection 2.5.4.8.4.2)	

a. Elevations are referenced to NAVD 88.

b. Range of Test Els. and FOS values are given where multiple test points occur.

c. √ denotes tests having FOS<1.10, but made in strata that are excavated (at cut area), in areas without structures, or in fine-grained soils which are nonliquefiable.

Table 2.5.4-282
Subsurface Conditions; Reactor and Fuel Buildings; Soil Properties (Power Block)

Simplified Soil Profile						Soil Profile for Calculation	
Top Depth (feet)[a]	**Bottom Depth (feet)[a]**	**Top El. (feet)[b]**	**Bottom El. (feet)[b]**	**Thickness (feet)**	**Stratum**	**Clay Preferred Profile**	**Sand Preferred Profile**
Unit 1							
65.6	87.0	29.4	8.0	21.4	Structural Fill	Structural Fill	Structural Fill
87.0	103.0	8.0	–8.0	16.0	Clay 3	Clay 3	Clay 3
103.0	118.0	–8.0	–23.0	15.0	Sand 4	Sand 4	Sand 4
118.0	150.0	–23.0	–55.0	32.0	Clay 5	Clay 5	Clay 5
150.0	175.0	–55.0	–80.0	25.0	Clay 5/Sand 6	Clay 5	Sand 6
175.0	220.0	–80.0	–125.0	45.0	Sand 6	Sand 6	Sand 6
220.0	255.0	–125.0	–160.0	35.0	Clay 7	Clay 7	Clay 7
255.0	300.0	–160.0	–205.0	45.0	Sand 8	Sand 8	Sand 8
300.0	337.0	–205.0	–242.0	37.0	Clay 9	Clay 9	Clay 9
337.0	350.0	–242.0	–255.0	13.0	Sand 10	Sand 10	Sand 10
350.0	422.0	–255.0	–327.0	72.0	Clay 11	Clay 11	Clay 11
422.0	440.0	–327.0	–345.0	18.0	Sand 12	Sand 12	Sand 12
440.0	516.0	–345.0	–421.0	76.0	Clay 13	Clay 13	Clay 13
516.0	549.0	–421.0	–454.0	33.0	Sand 14	Sand 14	Sand 14
549.0	560.0	–454.0	–465.0	11.0	Clay 15	Clay 15	Clay 15
560.0	575.0	–465.0	–480.0	15.0	Sand 16	Sand 16	Sand 16
575.0	600.0	–480.0	–505.0	25.0	Clay 17	Clay 17	Clay 17
Unit 2							
65.6	87.0	29.4	8.0	21.4	Structural Fill	Structural Fill	Structural Fill
87.0	110.0	8.0	–15.0	23.0	Sand 2/Clay 3	Clay 3	Sand 2
110.0	130.0	–15.0	–35.0	20.0	Sand 4	Sand 4	Sand 4
130.0	170.0	–35.0	–75.0	40.0	Clay 5	Clay 5	Clay 5
170.0	235.0	–75.0	–140.0	65.0	Sand 6	Sand 6	Sand 6
235.0	305.0	–140.0	–210.0	70.0	Sand 8	Sand 8	Sand 8
305.0	345.0	–210.0	–250.0	40.0	Clay 9	Clay 9	Clay 9
345.0	385.0	–250.0	–290.0	40.0	Sand 10/Clay 11	Clay 11	Sand 10
385.0	418.0	–290.0	–323.0	33.0	Clay 11	Clay 11	Clay 11
418.0	440.0	–323.0	–345.0	22.0	Sand 12	Sand 12	Sand 12
440.0	518.0	–345.0	–423.0	78.0	Clay 13	Clay 13	Clay 13
518.0	562.0	–423.0	–467.0	44.0	Sand 14	Sand 14	Sand 14
562.0	577.0	–467.0	–482.0	15.0	Clay 15	Clay 15	Clay 15
577.0	595.0	–482.0	–500.0	18.0	Sand 16	Sand 16	Sand 16

a. Depths measured from El. +95 feet.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-283
Subsurface Conditions; Reactor/Fuel Building; Average Properties within the Foundation Deformation Zone
(Power Block)

Structure	Soil Profile for Calculation						Shear Strength				Foundation Width, B (feet)	Effective Shear Depth H' (feet)
	Soil Profile	Stratum	Top El.[a] (feet)	Bottom El.[a] (feet)	Thickness (feet)	Total Thickness (feet)	Layer c (ksf)	Layer Φ (°)	Avg c (ksf)	Avg Φ (°)		
Reactor/ Fuel Building (Unit 1)	Clay Preferred	Fill	29.4	8.0	21.4	105.3	0.0	39.0	2.0	15.2	161.0	105.3
		Clay 3	8.0	–8.0	16.0		3.0	0.0				
		Sand 4	–8.0	–23.0	15.0		0.0	37.0				
		Clay 5	–23.0	–55.0	32.0		3.0	0.0				
		Clay 5	–55.0	–75.9	20.9		3.0	0.0				
Reactor/ Fuel Building (Unit 1)	Sand Preferred	Fill	29.4	8.0	21.4	131.0	0.0	39.0	1.1	26.9	161.0	131.0
		Clay 3	8.0	–8.0	16.0		3.0	0.0				
		Sand 4	–8.0	–23.0	15.0		0.0	37.0				
		Clay 5	–23.0	–55.0	32.0		3.0	0.0				
		Sand 6	–55.0	–80.0	25.0		0.0	39.0				
		Sand 6	–80.0	–101.6	21.6		0.0	39.0				
Reactor/ Fuel Building (Unit 2)	Clay Preferred	Fill	29.4	8.0	21.4	113.5	0.0	39.0	1.7	19.3	161.0	113.5
		Clay 3	8.0	–15.0	23.0		3.0	0.0				
		Sand 4	–15.0	–35.0	20.0		0.0	37.0				
		Clay 5	–35.0	–75.0	40.0		3.0	0.0				
		Sand 6	–75.0	–84.1	9.1		0.0	39.0				
Reactor/ Fuel Building (Unit 2)	Sand Preferred	Fill	29.4	8.0	21.4	134.0	0.0	39.0	0.9	28.0	161.0	134.0
		Sand 2	8.0	–15.0	23.0		0.0	33.0				
		Sand 4	–15.0	–35.0	20.0		0.0	37.0				
		Clay 5	–35.0	–75.0	40.0		3.0	0.0				
		Sand 6	–75.0	–104.6	29.6		0.0	39.0				

[a] Elevations are referenced to NAVD88.

Table 2.5.4-284
Subsurface Conditions; Control Building; Soil Properties (Power Block)

Simplified Soil Profile						Soil Profile for Calculation	
Top Depth (feet)[a]	Bottom Depth (feet)[a]	Top El. (feet)[b]	Bottom El. (feet)[b]	Thickness (feet)	Stratum	Clay Preferred Profile	Sand Preferred Profile
Unit 1							
48.9	70.0	46.1	25.0	21.1	Structural Fill	Structural Fill	Structural Fill
70.0	73.0	25.0	22.0	3.0	Sand 2/Clay 3	Clay 3	Sand 2
73.0	100.0	22.0	–5.0	27.0	Clay 3	Clay 3	Clay 3
100.0	120.0	–5.0	–25.0	20.0	Sand 4	Sand 4	Sand 4
120.0	170.0	–25.0	–75.0	50.0	Clay 5	Clay 5	Clay 5
170.0	215.0	–75.0	–120.0	45.0	Sand 6	Sand 6	Sand 6
215.0	255.0	–120.0	–160.0	40.0	Clay 7	Clay 7	Clay 7
255.0	300.0	–160.0	–205.0	45.0	Sand 8	Sand 8	Sand 8
300.0	337.0	–205.0	–242.0	37.0	Clay 9	Clay 9	Clay 9
337.0	350.0	–242.0	–255.0	13.0	Sand 10	Sand 10	Sand 10
350.0	422.0	–255.0	–327.0	72.0	Clay 11	Clay 11	Clay 11
422.0	440.0	–327.0	–345.0	18.0	Sand 12	Sand 12	Sand 12
440.0	516.0	–345.0	–421.0	76.0	Clay 13	Clay 13	Clay 13
516.0	549.0	–421.0	–454.0	33.0	Sand 14	Sand 14	Sand 14
549.0	560.0	–454.0	–465.0	11.0	Clay 15	Clay 15	Clay 15
560.0	575.0	–465.0	–480.0	15.0	Sand 16	Sand 16	Sand 16
575.0	600.0	–480.0	–505.0	25.0	Clay 17	Clay 17	Clay 17
Unit 2							
48.9	70.0	46.1	25.0	21.1	Structural Fill	Structural Fill	Structural Fill
70.0	73.0	25.0	22.0	3.0	Clay 1	Clay 1	Clay 1
73.0	82.0	22.0	13.0	9.0	Sand 2	Sand 2	Sand 2
82.0	105.0	13.0	–10.0	23.0	Sand 2/Clay 3	Clay 3	Sand 2
105.0	130.0	–10.0	–35.0	25.0	Sand 4	Sand 4	Sand 4
130.0	157.0	–35.0	–62.0	27.0	Clay 5/Sand 5	Clay 5	Sand 5
157.0	172.0	–62.0	–77.0	15.0	Clay 5	Clay 5	Clay 5
172.0	235.0	–77.0	–140.0	63.0	Sand 6	Sand 6	Sand 6
235.0	305.0	–140.0	–210.0	70.0	Sand 8	Sand 8	Sand 8
305.0	345.0	–210.0	–250.0	40.0	Clay 9	Clay 9	Clay 9
345.0	385.0	–250.0	–290.0	40.0	Sand 10/Clay 11	Clay 11	Sand 10
385.0	418.0	–290.0	–323.0	33.0	Clay 11	Clay 11	Clay 11
418.0	440.0	–323.0	–345.0	22.0	Sand 12	Sand 12	Sand 12
440.0	518.0	–345.0	–423.0	78.0	Clay 13	Clay 13	Clay 13
518.0	562.0	–423.0	–467.0	44.0	Sand 14	Sand 14	Sand 14
562.0	577.0	–467.0	–482.0	15.0	Clay 15	Clay 15	Clay 15
577.0	595.0	–482.0	–500.0	18.0	Sand 16	Sand 16	Sand 16

a. Depths measured from El. +95 feet.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-285
Subsurface Conditions; Control Building; Average Properties within the Foundation Deformation Zone (Power Block)

	Soil Profile for Calculation						Shear Strength					
Structure	**Soil Profile**	**Stratum**	**Top El.[a] (feet)**	**Bottom El.[a] (feet)**	**Thickness (feet)**	**Total Thickness (feet)**	**Layer c (ksf)**	**Layer Φ (°)**	**Avg c (ksf)**	**Avg Φ (°)**	**Foundation Width, B (feet)**	**Effective Shear Depth H' (feet)**
Control Building (Unit 1)	Clay Preferred	Fill	46.1	25.0	21.1	56.1	0.0	39.0	1.6	20.4	78.0	56.1
		Clay 3	25.0	22.0	3.0		3.0	0.0				
		Clay 3	22.0	-5.0	27.0		3.0	0.0				
		Sand 4	–5.0	–10.0	5.0		0.0	37.0				
Control Building (Unit 1)	Sand Preferred	Fill	46.1	25.0	21.1	58.8	0.0	39.0	1.4	22.9	78.0	58.8
		Sand 2	25.0	22.0	3.0		0.0	33.0				
		Clay 3	22.0	–5.0	27.0		3.0	0.0				
		Sand 4	–5.0	–12.7	7.7		0.0	37.0				
Control Building (Unit 2)	Clay Preferred	Fill	46.1	25.0	21.1	59.0	0.0	39.0	1.3	23.1	78.0	59.0
		Clay 1	25.0	22.0	3.0		3.2	0.0				
		Sand 2	22.0	13.0	9.0		0.0	33.0				
		Clay 3	13.0	–10.0	23.0		3.0	0.0				
		Sand 4	–10.0	–12.9	2.9		0.0	37.0				
Control Building (Unit 2)	Sand Preferred	Fill	46.1	25.0	21.1	74.6	0.0	39.0	0.1	34.8	78.0	74.6
		Clay 1	25.0	22.0	3.0		3.2	0.0				
		Sand 2	22.0	13.0	9.0		0.0	33.0				
		Sand 2	13.0	–10.0	23.0		0.0	33.0				
		Sand 4	–10.0	–28.5	18.5		0.0	37.0				

[a] Elevations are referenced to NAVD88.

Table 2.5.4-286
Subsurface Conditions; Fire Water Service Complex; Soil Properties (Power Block)

Simplified Soil Profile						Soil Profile for Calculation	
Top Depth (feet)[a]	Bottom Depth (feet)[a]	Top El. (feet)[b]	Bottom El. (feet)[b]	Thickness (feet)	Stratum	Clay Preferred Profile	Sand Preferred Profile
Unit 1							
7.7	15.0	87.3	80.0	7.3	Structural Fill	Structural Fill	Structural Fill
15.0	56.0	80.0	39.0	41.0	Clay 1	Clay 1	Clay 1
56.0	106.0	39.0	-11.0	50.0	Clay 3	Clay 3	Clay 3
106.0	123.0	-11.0	-28.0	17.0	Sand 4	Sand 4	Sand 4
123.0	168.0	-28.0	-73.0	45.0	Clay 5	Clay 5	Clay 5
168.0	215.0	-73.0	-120.0	47.0	Sand 6	Sand 6	Sand 6
215.0	255.0	-120.0	-160.0	40.0	Clay 7	Clay 7	Clay 7
255.0	300.0	-160.0	-205.0	45.0	Sand 8	Sand 8	Sand 8
300.0	337.0	-205.0	-242.0	37.0	Clay 9	Clay 9	Clay 9
337.0	350.0	-242.0	-255.0	13.0	Sand 10	Sand 10	Sand 10
350.0	422.0	-255.0	-327.0	72.0	Clay 11	Clay 11	Clay 11
422.0	440.0	-327.0	-345.0	18.0	Sand 12	Sand 12	Sand 12
440.0	516.0	-345.0	-421.0	76.0	Clay 13	Clay 13	Clay 13
516.0	549.0	-421.0	-454.0	33.0	Sand 14	Sand 14	Sand 14
549.0	560.0	-454.0	-465.0	11.0	Clay 15	Clay 15	Clay 15
560.0	575.0	-465.0	-480.0	15.0	Sand 16	Sand 16	Sand 16
575.0	600.0	-480.0	-505.0	25.0	Clay 17	Clay 17	Clay 17
Unit 2							
7.7	15.0	87.3	80.0	7.3	Structural Fill	Structural Fill	Structural Fill
15.0	43.0	80.0	52.0	28.0	Clay 1	Clay 1	Clay 1
43.0	52.0	52.0	43.0	9.0	Sand 1	Sand 1	Sand 1
52.0	71.0	43.0	24.0	19.0	Clay 1	Clay 1	Clay 1
71.0	77.0	24.0	18.0	6.0	Sand 2	Sand 2	Sand 2
77.0	105.0	18.0	-10.0	28.0	Clay 3	Clay 3	Clay 3
105.0	128.0	-10.0	-33.0	23.0	Sand 4	Sand 4	Sand 4
128.0	136.0	-33.0	-41.0	8.0	Clay 5	Clay 5	Clay 5
136.0	157.0	-41.0	-62.0	21.0	Sand 5	Sand 5	Sand 5
157.0	169.0	-62.0	-74.0	12.0	Clay 5	Clay 5	Clay 5
169.0	235.0	-74.0	-140.0	66.0	Sand 6	Sand 6	Sand 6
235.0	305.0	-140.0	-210.0	70.0	Sand 8	Sand 8	Sand 8
305.0	345.0	-210.0	-250.0	40.0	Clay 9	Clay 9	Clay 9
345.0	385.0	-250.0	-290.0	40.0	Sand 10/Clay 11	Clay 11	Sand 10
385.0	418.0	-290.0	-323.0	33.0	Clay 11	Clay 11	Clay 11
418.0	440.0	-323.0	-345.0	22.0	Sand 12	Sand 12	Sand 12
440.0	518.0	-345.0	-423.0	78.0	Clay 13	Clay 13	Clay 13
518.0	562.0	-423.0	-467.0	44.0	Sand 14	Sand 14	Sand 14
562.0	577.0	-467.0	-482.0	15.0	Clay 15	Clay 15	Clay 15
577.0	595.0	-482.0	-500.0	18.0	Sand 16	Sand 16	Sand 16

a. Depths measured from El. +95 feet.

b. Elevations are referenced to NAVD 88.

Table 2.5.4-287
Subsurface Conditions; Fire Water Service Complex; Average Properties within the Foundation Deformation Zone (Power Block)

	Soil Profile for Calculation						Shear Strength					
Structure	**Soil Profile**	**Stratum**	**Top El.[a] (feet)**	**Bottom El.[a] (feet)**	**Thickness (feet)**	**Total Thickness (feet)**	**Layer c (ksf)**	**Layer Φ (°)**	**Avg c (ksf)**	**Avg Φ (°)**	**Foundation Width, B (feet)**	**Effective Shear Depth H' (feet)**
FWSC (Unit 1)	N/A	Fill	87.3	80.0	7.3	38.5	0.0	39.0	2.6	8.7	66.0	38.5
		Clay 1	80.0	48.8	31.2		3.2	0.0				
FWSC (Unit 2)	Clay Preferred	Fill	87.3	80.0	7.3	42.1	0.0	39.0	2.1	13.8	66.0	42.1
		Clay 1	80.0	52.0	28.0		3.2	0.0				
		Sand 1	52.0	45.2	6.8		0.0	33.0				
FWSC (Unit 2)	Sand Preferred	Fill	87.3	80.0	7.3	42.1	0.0	39.0	2.1	13.8	66.0	42.1
		Clay 1	80.0	52.0	28.0		3.2	0.0				
		Sand 1	52.0	45.2	6.8		0.0	33.0				

a. Elevations are referenced to NAVD88.

Table 2.5.4-288
Calculated Foundation Bearing Capacities of Seismic Category I Structures (Power Block)

Structure	Embedment Depth, D (feet)	Groundwater Table Depth, h (feet)	Overburden Pressure, q (ksf)	Soil Profile	Ultimate Bearing Capacity, q_{ult} (ksf)	Factor of Safety,FOS	Allowable Bearing Capacity, q_a (ksf)
Reactor/Fuel Building (Unit 1)	65.6	10.0	4.4	Clay Preferred	56.5	3.0	18.8
				Sand Preferred	146.1	3.0	48.7
Reactor/Fuel Building (Unit 2)	65.6	10.0	4.4	Clay Preferred	77.4	3.0	25.8
				Sand Preferred	177.2	3.0	59.1
Control Building (Unit 1)	48.9	10.0	3.4	Clay Preferred	68.6	3.0	22.9
				Sand Preferred	78.6	3.0	26.2
Control Building (Unit 2)	48.9	10.0	3.4	Clay Preferred	85.6	3.0	28.5
				Sand Preferred	228.3	3.0	76.1
FWSC (Unit 1)	7.7	10.0	0.9	N/A	25.0	3.0	8.3
FWSC (Unit 2)	7.7	10.0	0.9	Clay Preferred	30.0	3.0	10.0
				Sand Preferred	30.0	3.0	10.0

Table 2.5.4-289
Calculated Foundation Settlements of Seismic Category I Structures (Power Block)

Structure	Soil Profile	Calculated Settlement (inches)			Allowable Settlement (inches)			
		Edge	Corner	Center	Any Corner	Average Four Corners	Differential Along Long Dimension	Center
Reactor/Fuel Building (Unit 1)	Clay Preferred	2.7	1.5	5.0	4.0	2.6	3.0	N/A
	Sand Preferred	2.7	1.5	5.0				
Reactor/Fuel Building (Unit 2)	Clay Preferred	2.7	1.5	5.0	4.0	2.6	3.0	N/A
	Sand Preferred	2.7	1.5	5.1				
Control Building (Unit 1)	Clay Preferred	0.9	0.5	1.7	0.7	0.5	0.6	N/A
	Sand Preferred	0.9	0.5	1.7				
Control Building (Unit 2)	Clay Preferred	0.9	0.5	1.7	0.7	0.5	0.6	N/A
	Sand Preferred	0.9	0.5	1.7				
FWSC (Unit 1)	N/A	0.4	0.2	0.6	0.7	0.4	0.5	N/A
FWSC (Unit 2)	Clay Preferred	0.4	0.2	0.6	0.7	0.4	0.5	N/A
	Sand Preferred	0.4	0.2	0.6				

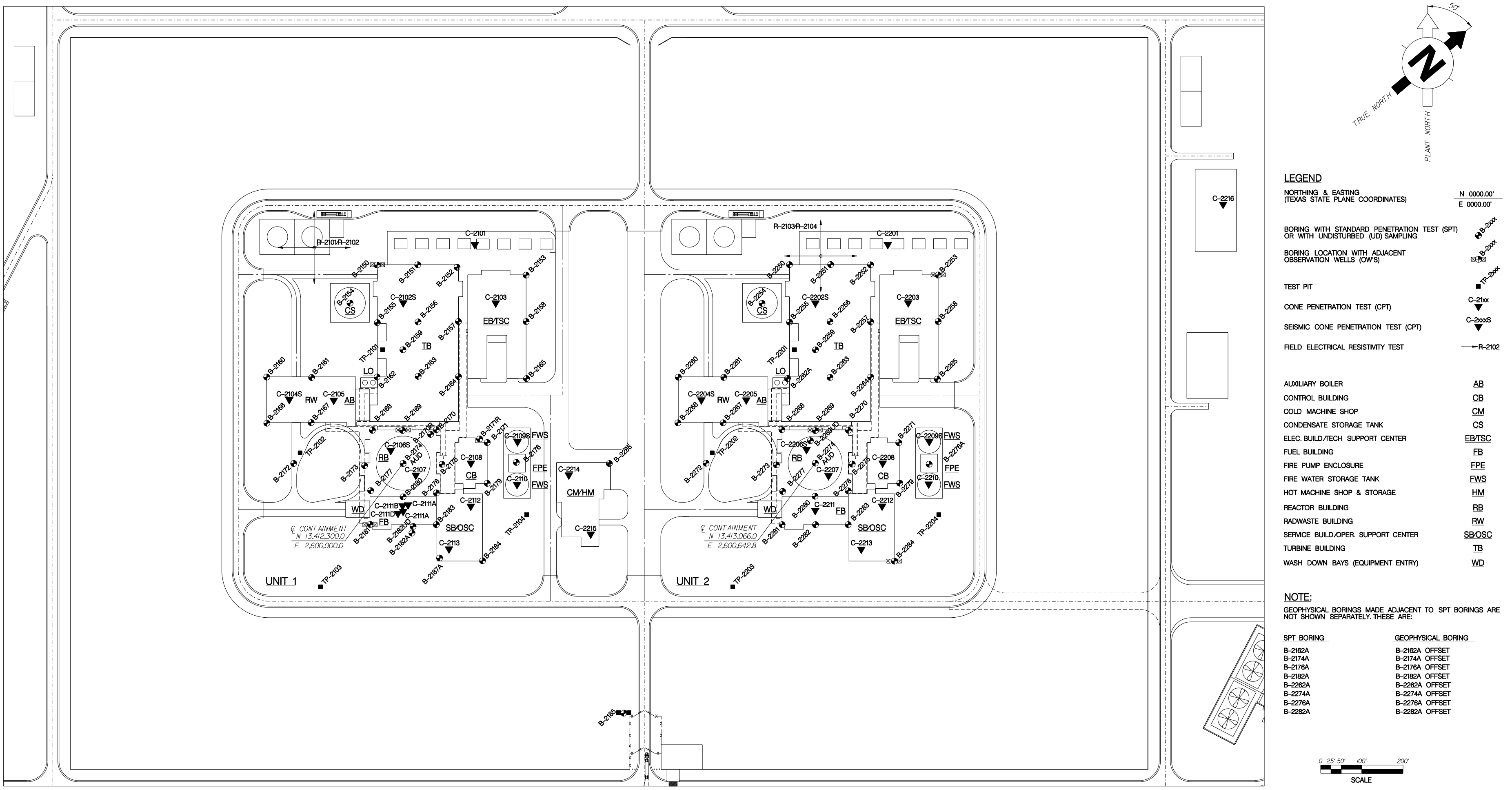


Figure 2.5.4-201 Subsurface Investigation Location Plan (Power Block)

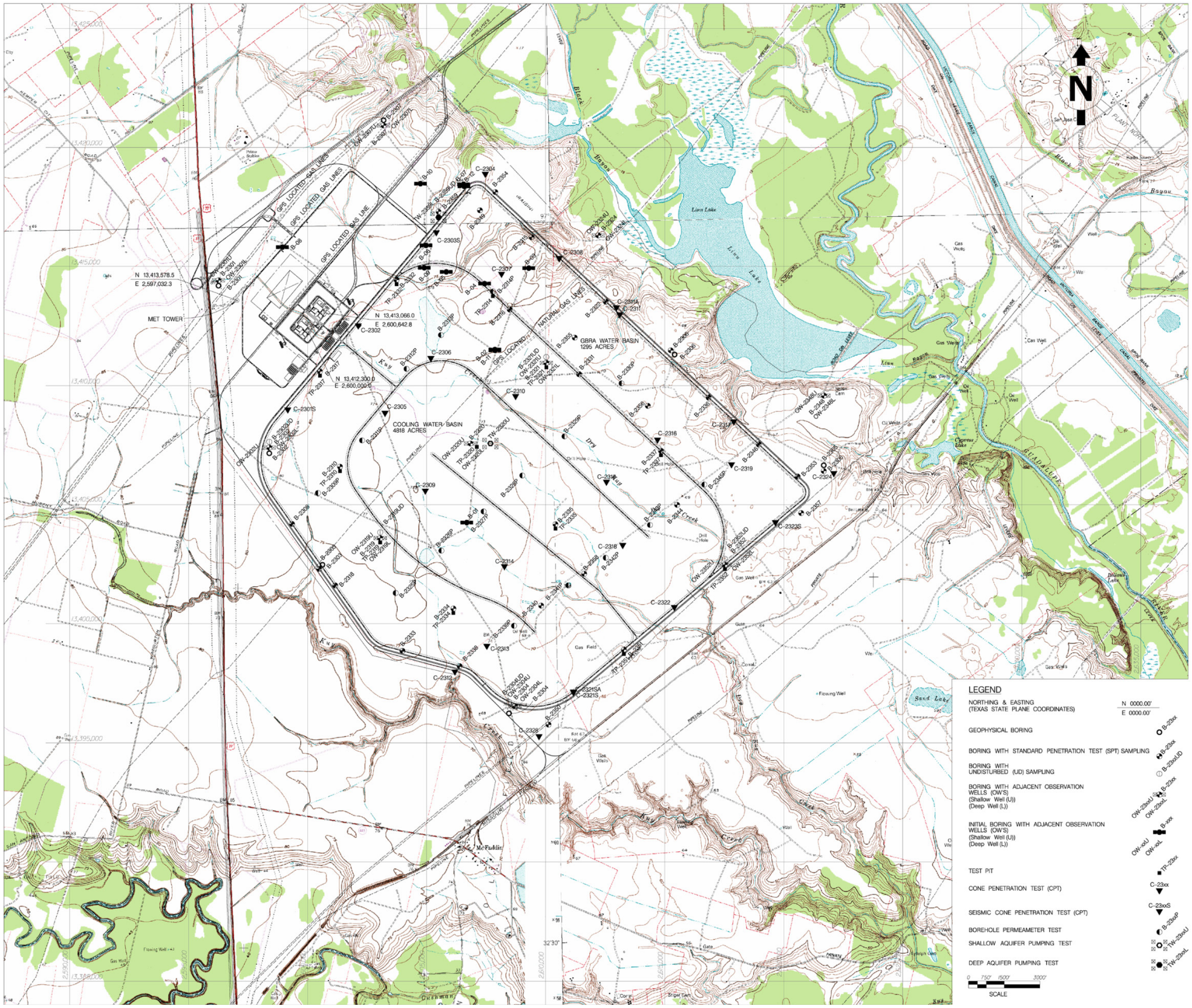
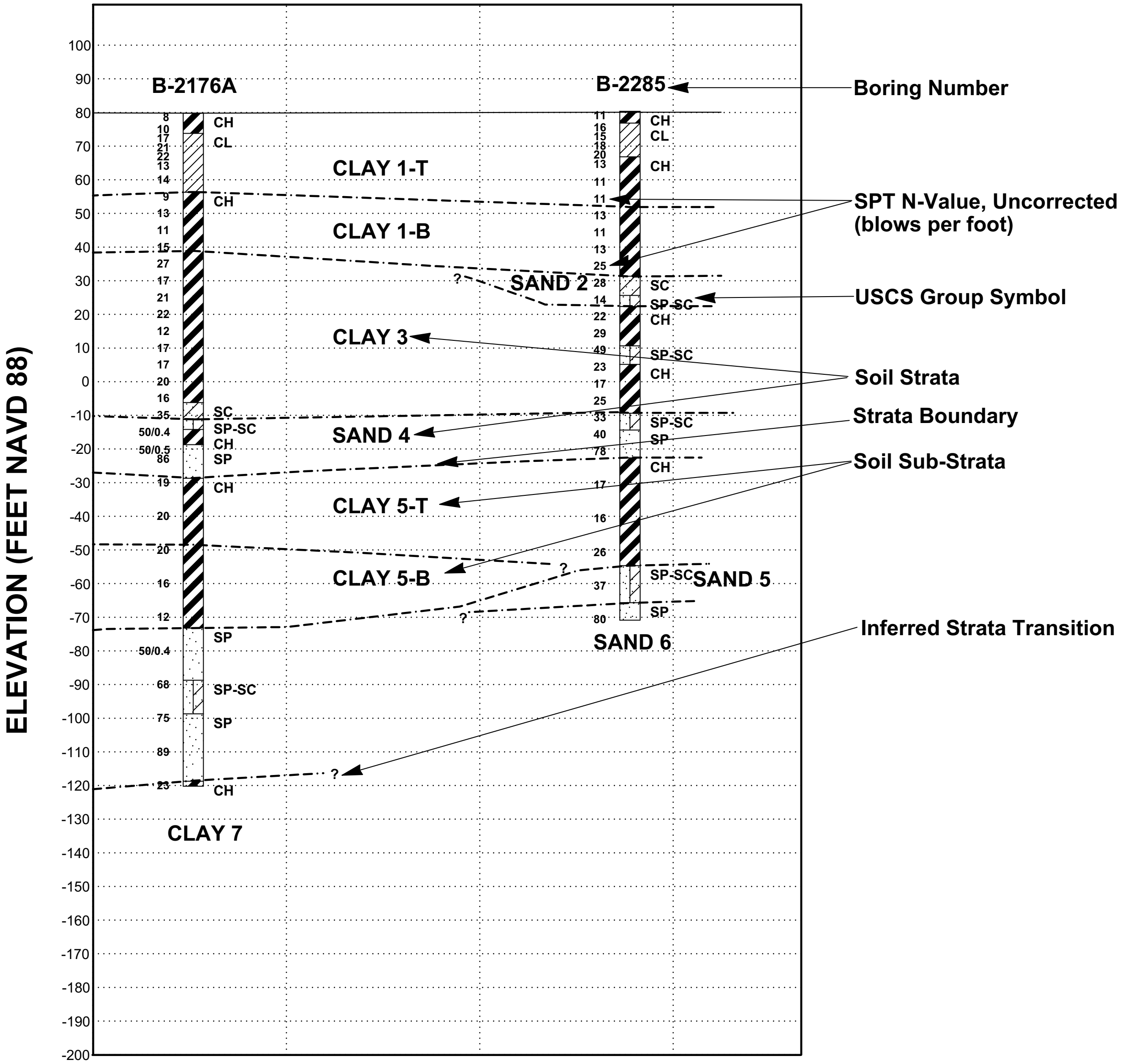


Figure 2.5.4-202 Subsurface Investigation Location Plan (Cooling Basin/GBRA Storage Water Reservoir)



NOTES:

[1] See report text for stratum descriptions.
[2] Subsurface data have been obtained only at actual boring and CPT locations. Stratification shown between borings is based on extrapolation of the data obtained from the borings. Actual stratification between borings may differ from that shown.

Figure 2.5.4-203 Subsurface Profile Legend (Power Block; Cooling Basin/GBRA Storage Water Reservoir)

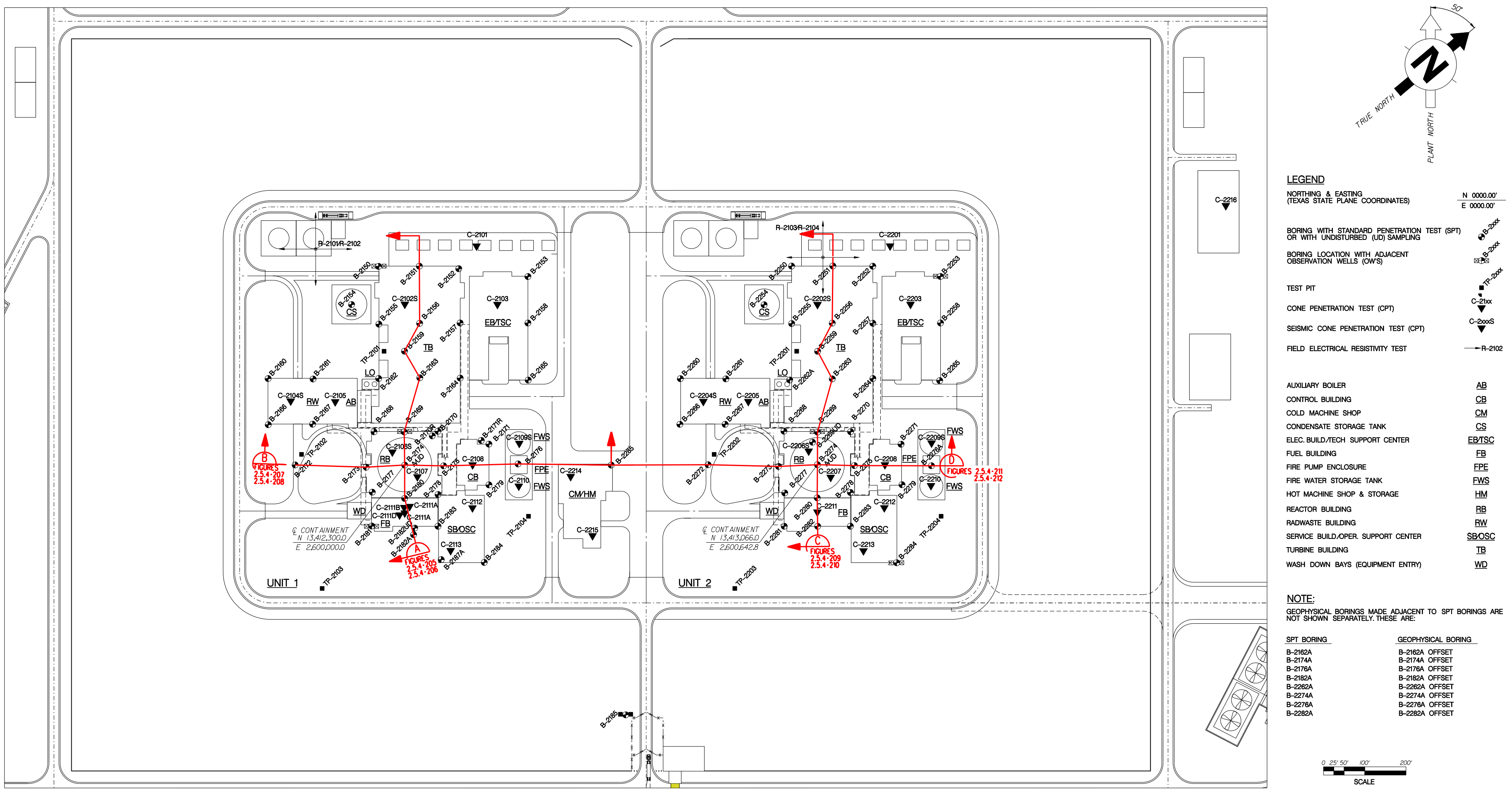


Figure 2.5.4-204 Subsurface Profile Plan (Power Block)

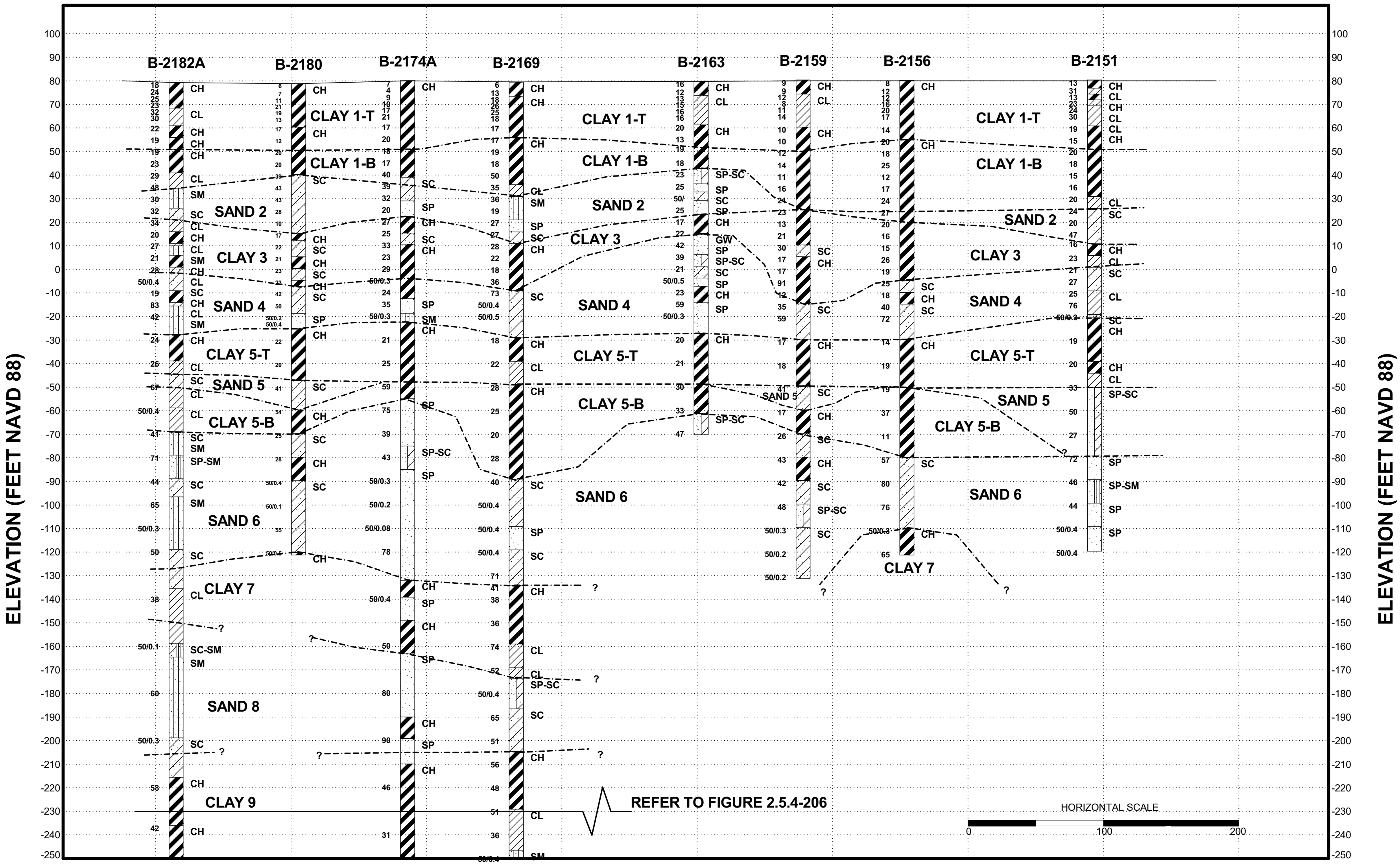


Figure 2.5.4-205 Subsurface Profile A Shallow; Unit 1 (North-South) (Power Block)

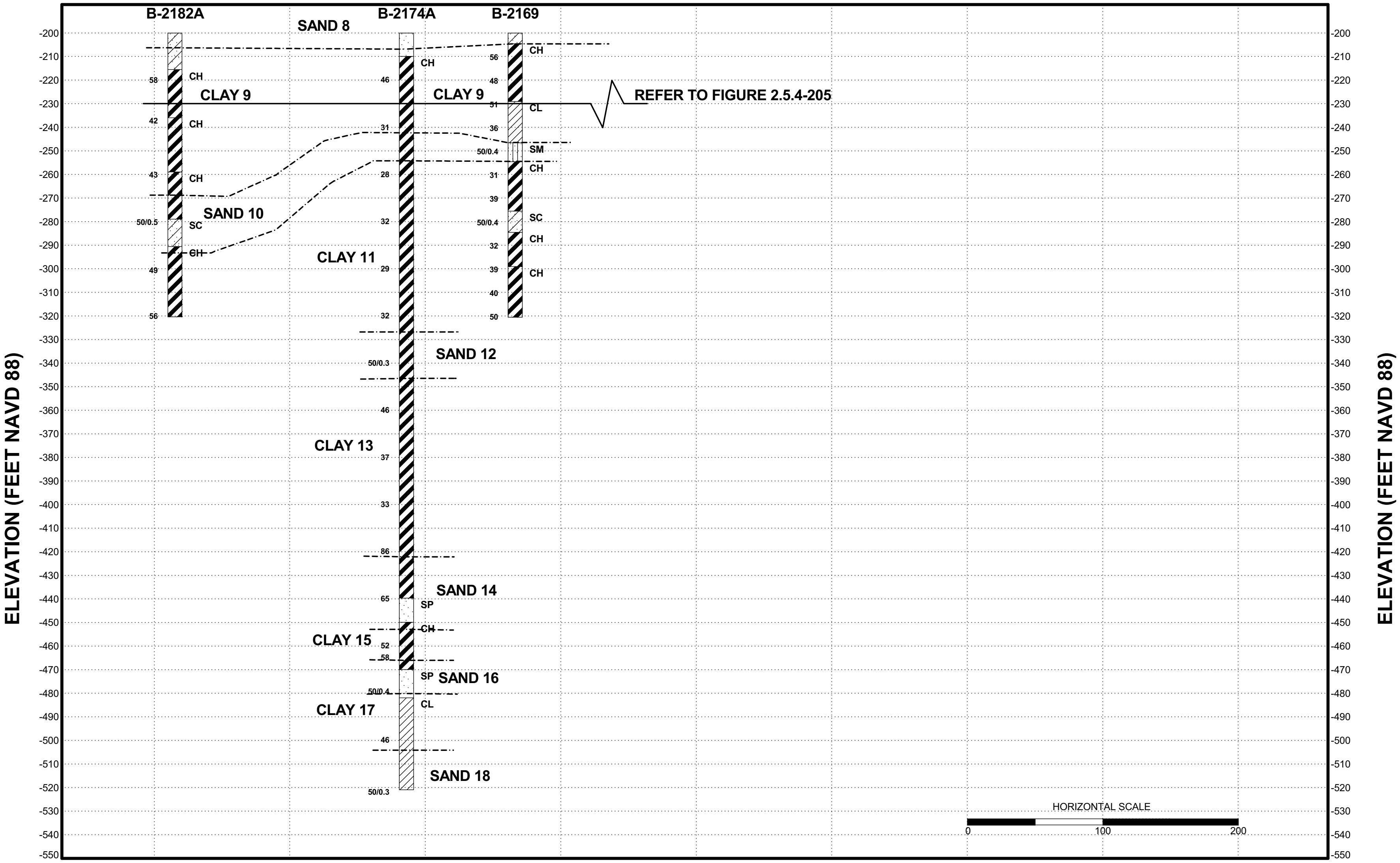


Figure 2.5.4-206 Subsurface Profile A Deep; Unit 1 (North-South) (Power Block)

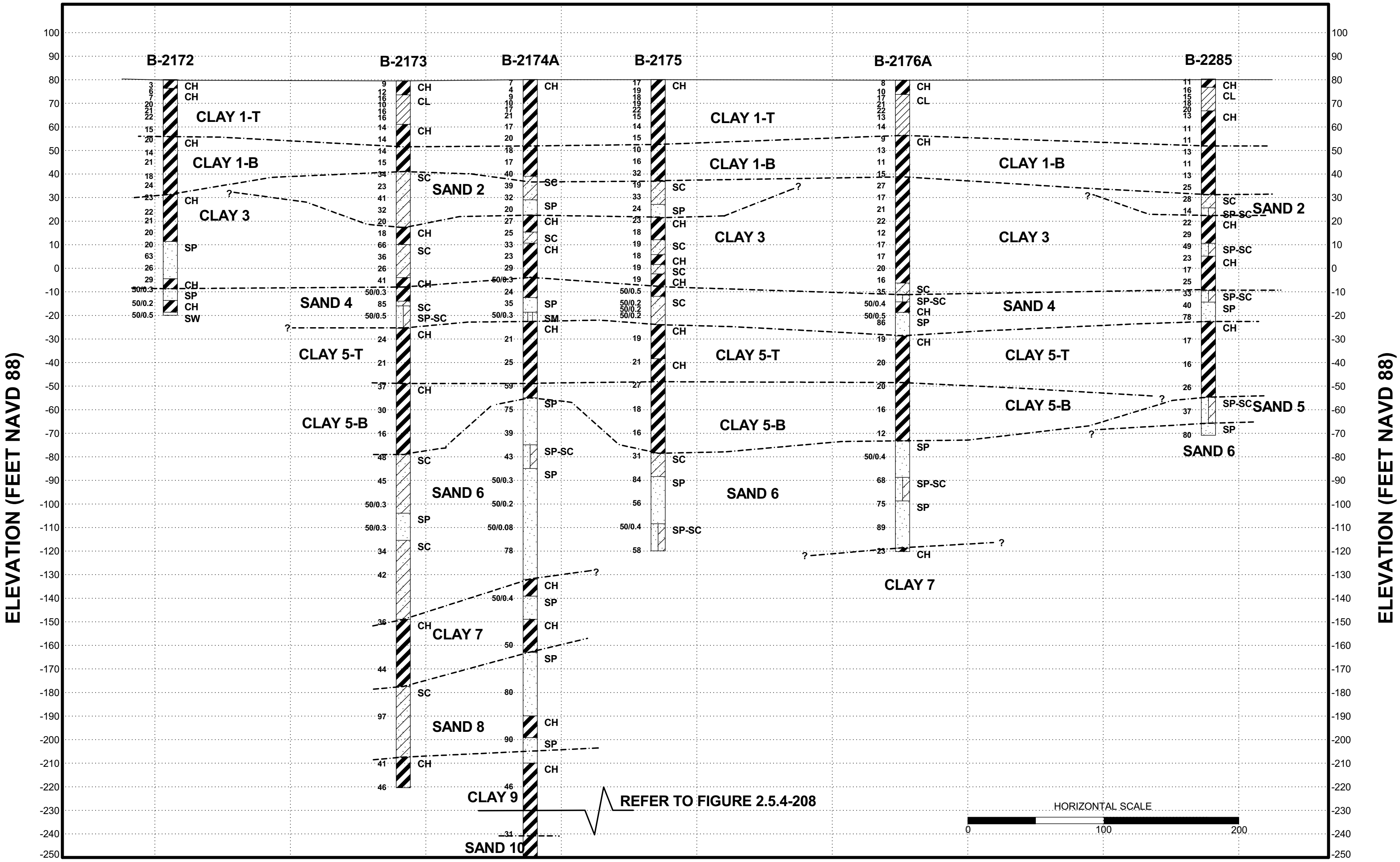


Figure 2.5.4-207 Subsurface Profile B Shallow; Unit 1 (East-West) (Power Block)

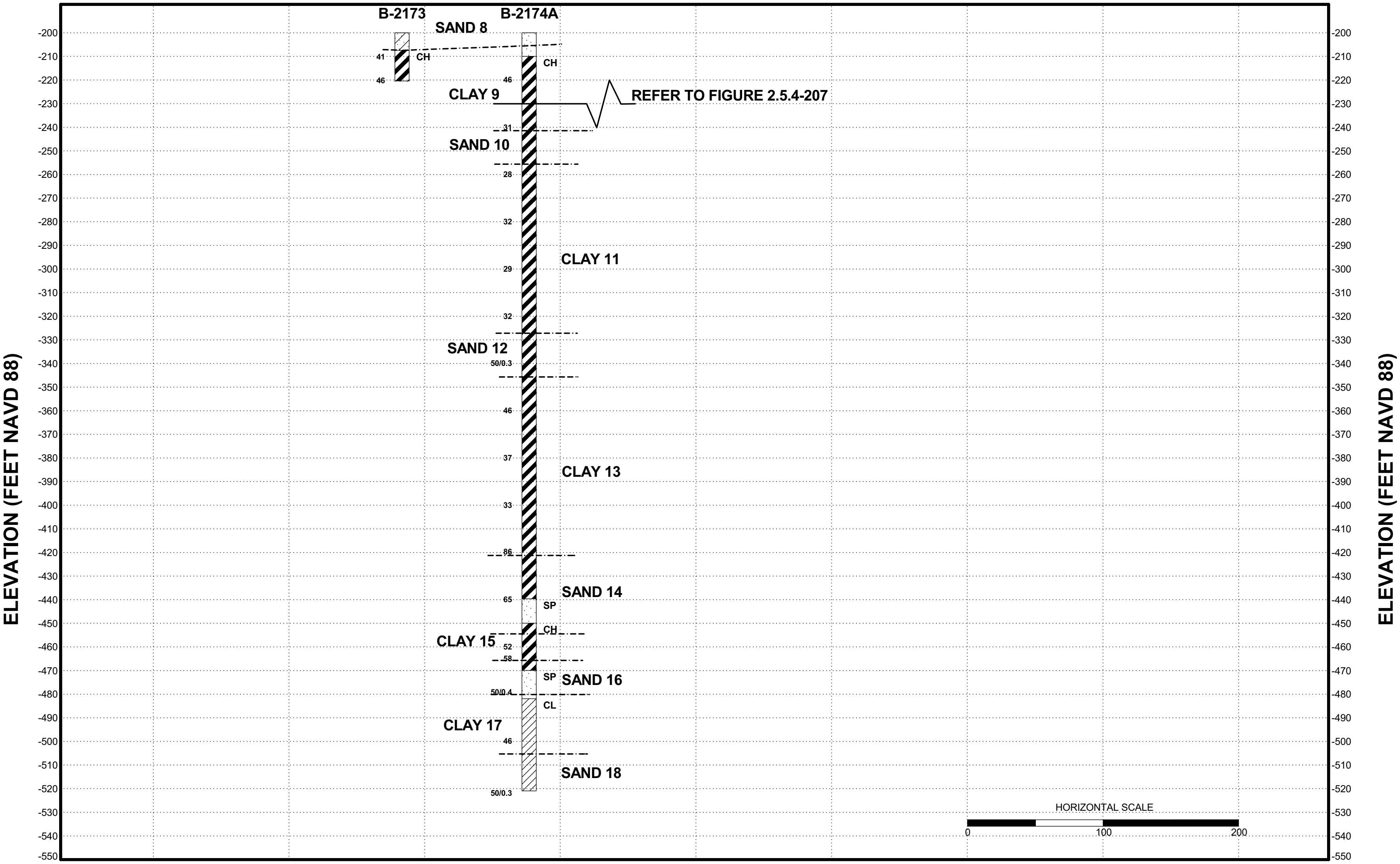


Figure 2.5.4-208 Subsurface Profile B Deep; Unit 1 (East-West) (Power Block)

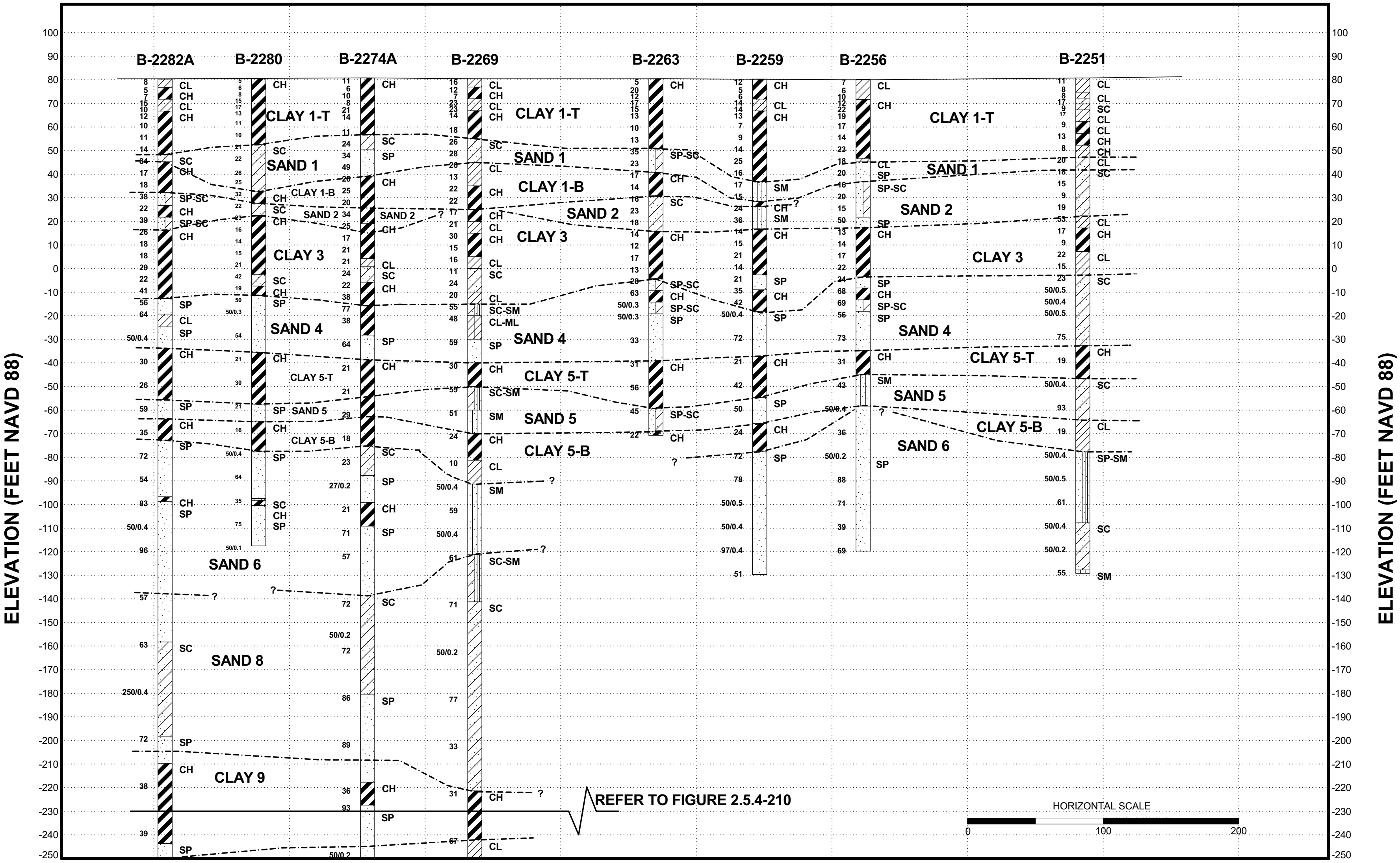


Figure 2.5.4-209 Subsurface Profile C Shallow; Unit 2 (North-South) (Power Block)

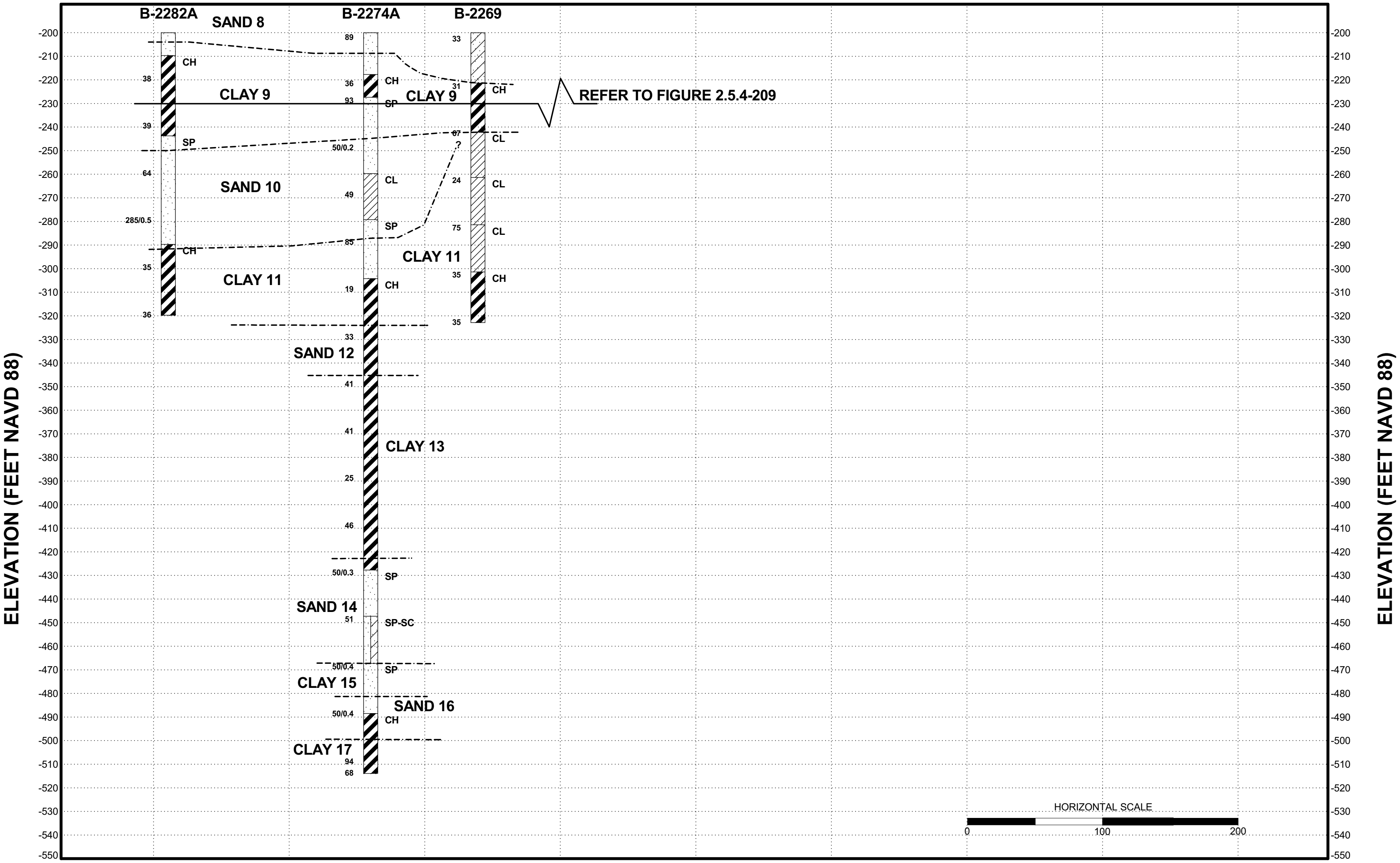


Figure 2.5.4-210 Subsurface Profile C Deep; Unit 2 (North-South) (Power Block)

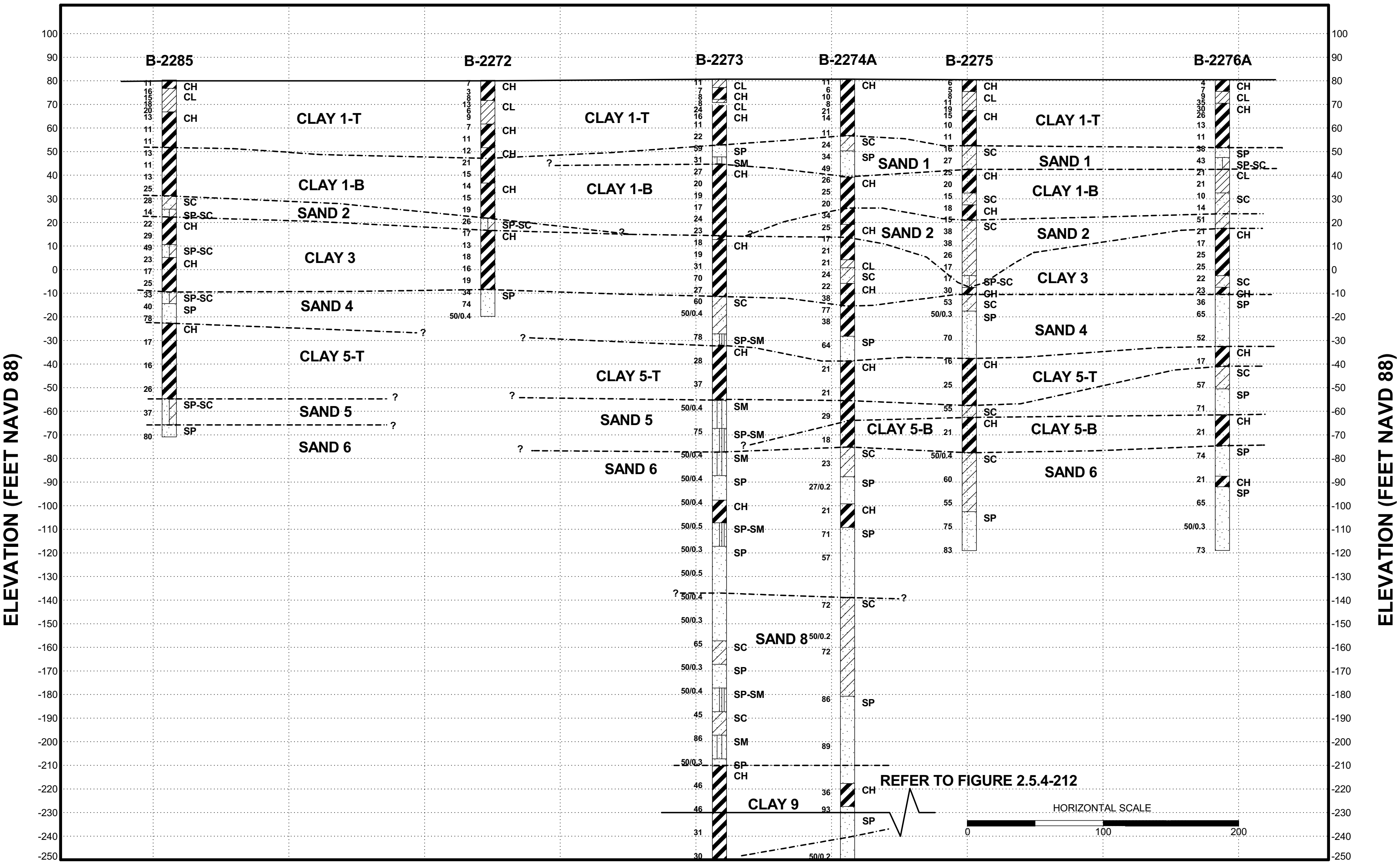


Figure 2.5.4-211 Subsurface Profile D Shallow; Unit 2 (East-West) (Power Block)

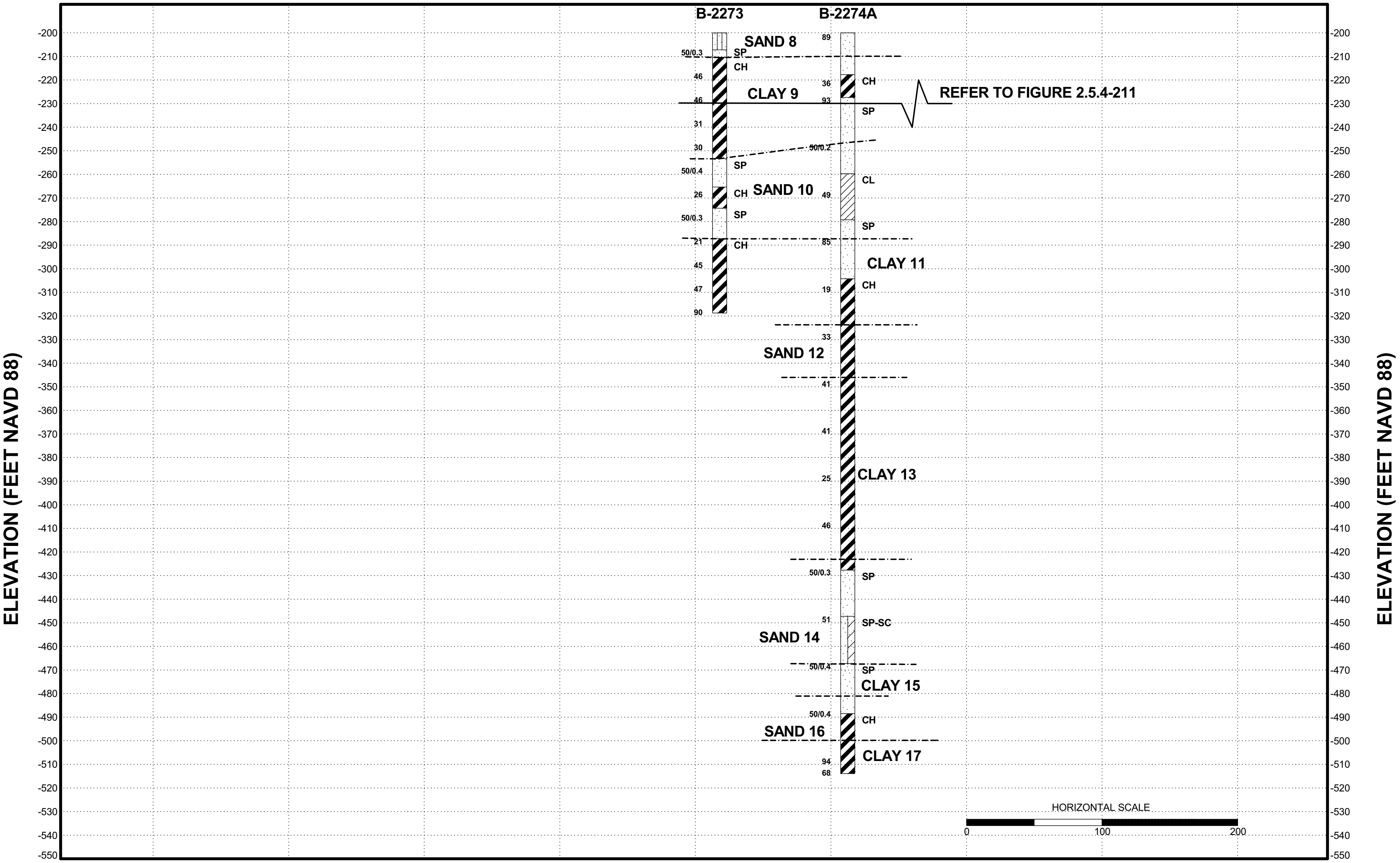


Figure 2.5.4-212 Subsurface Profile D Deep; Unit 2 (East-West) (Power Block)

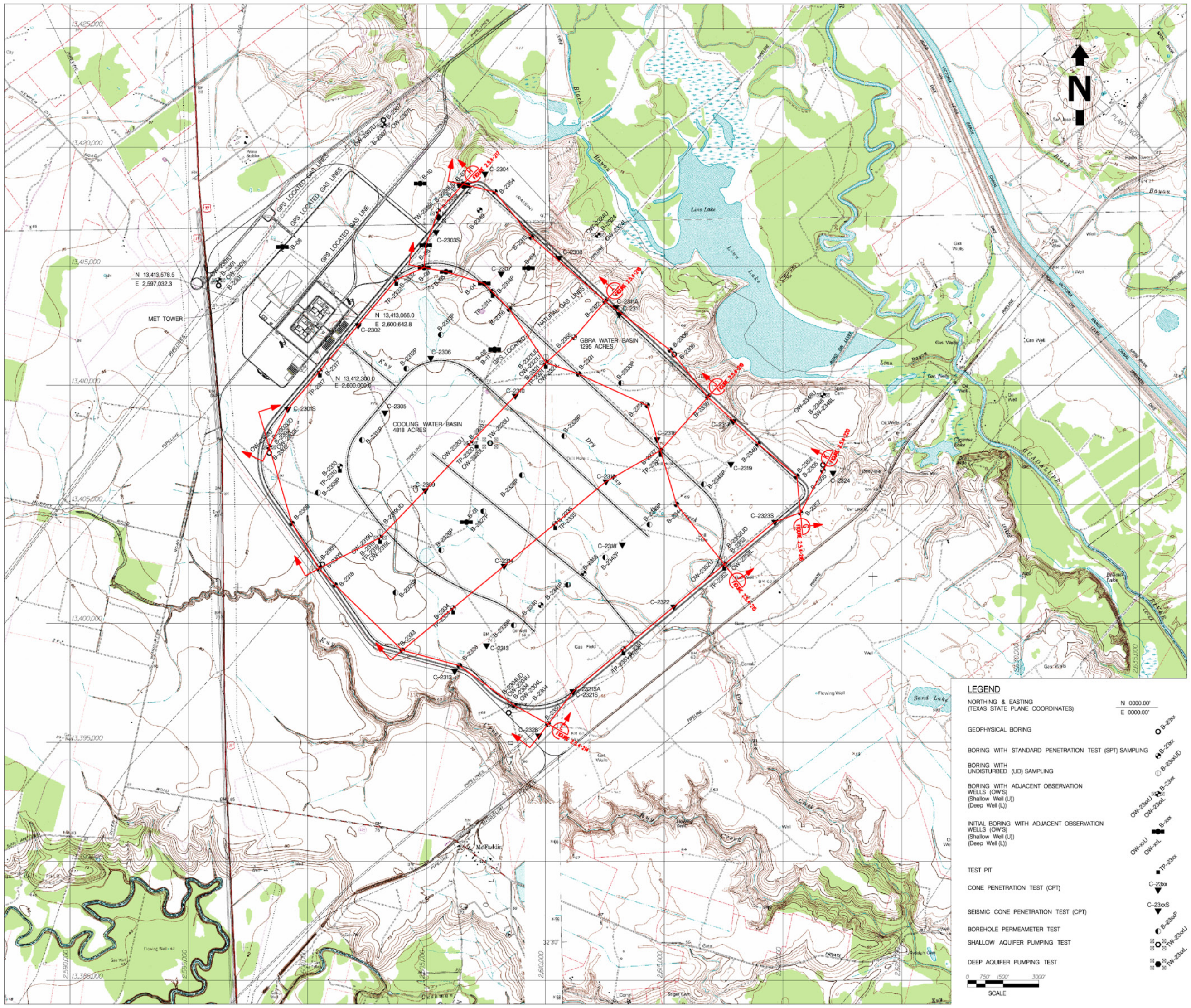


Figure 2.5.4-213 Subsurface Profile Plan (Cooling Basin/GBRA Storage Water Reservoir)

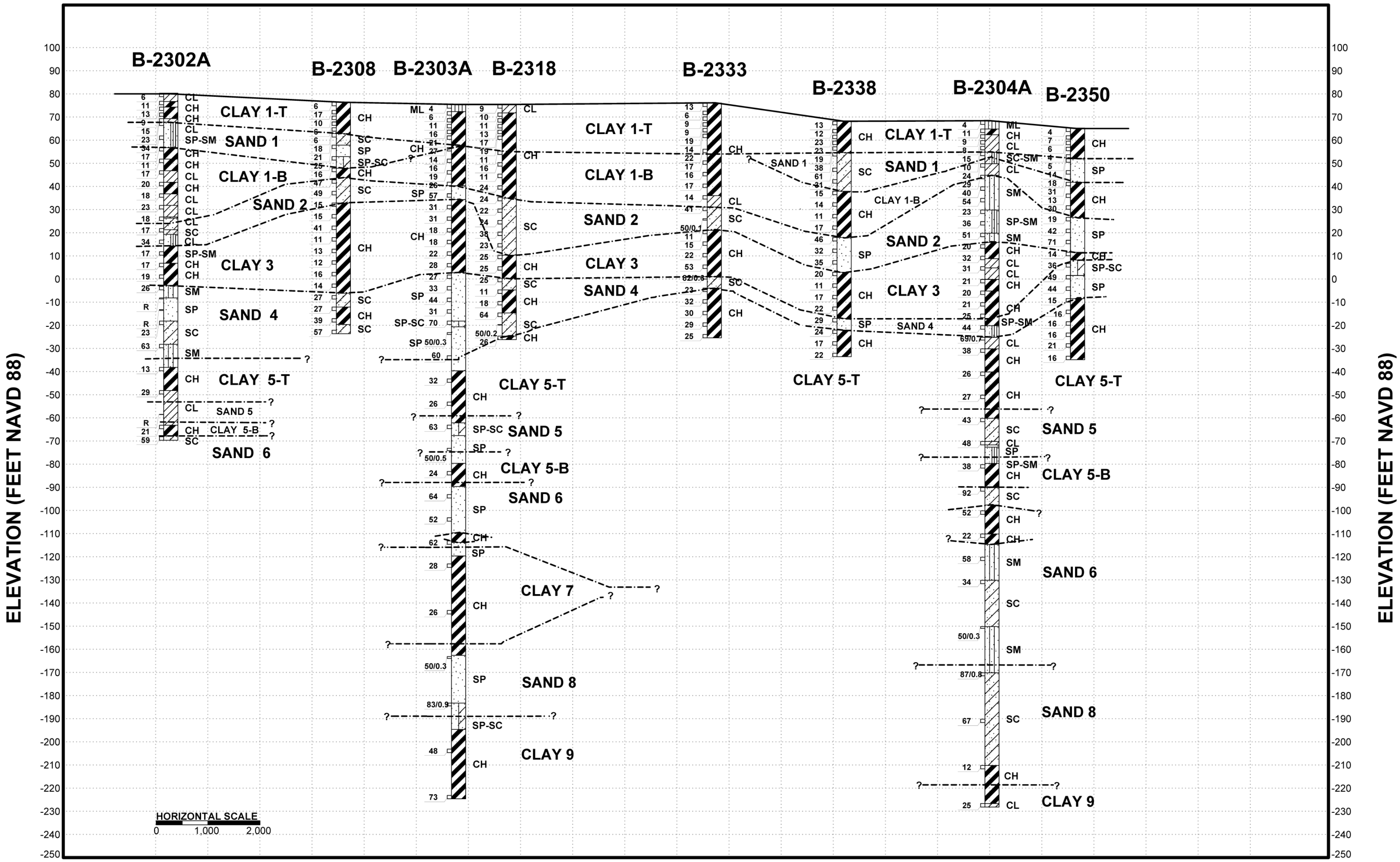


Figure 2.5.4-214 Subsurface Profile Plan E; West Embankment Dam of Cooling Basin (North-South) (Cooling Basin/GBRA Storage Water Reservoir)

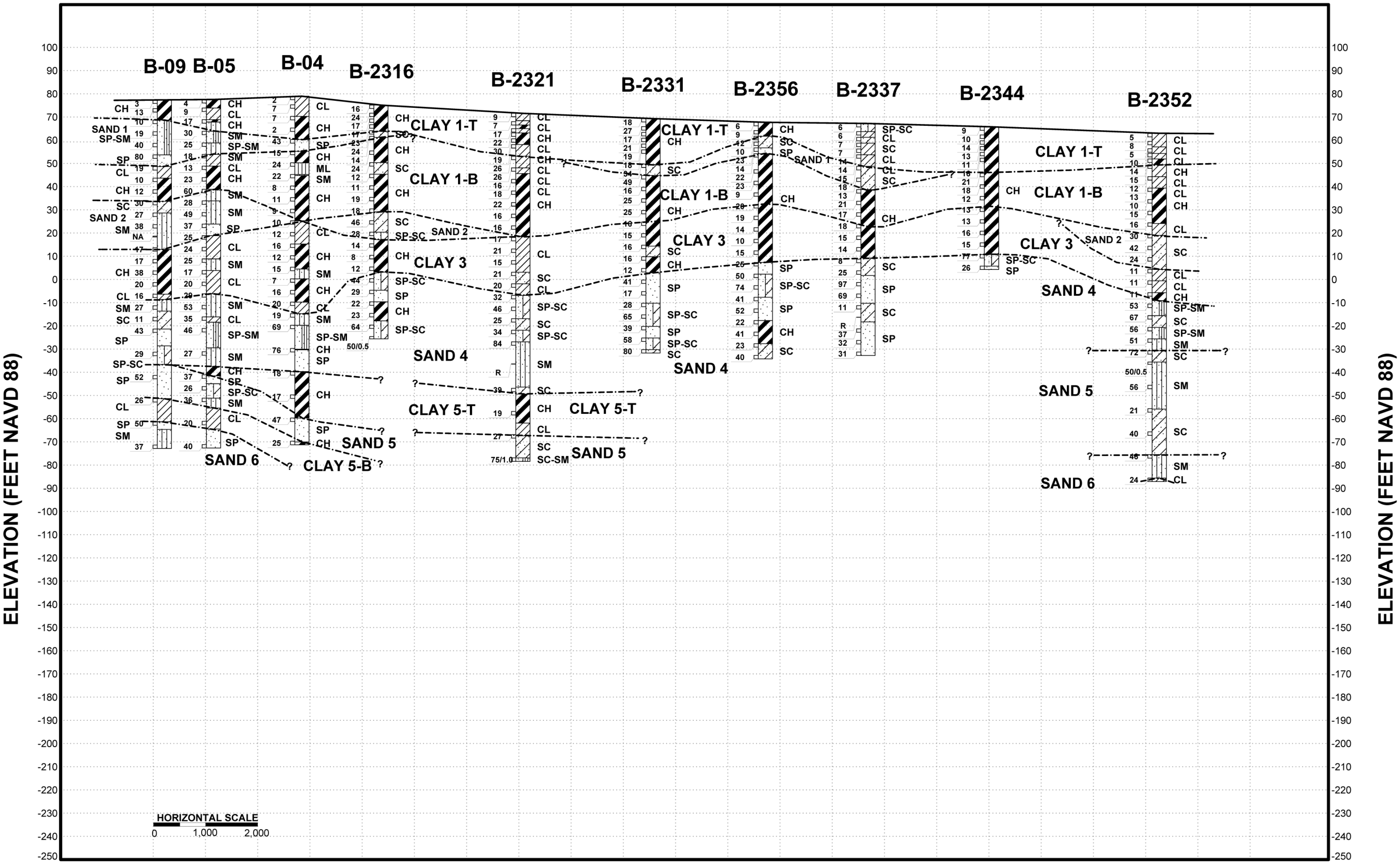


Figure 2.5.4-215 Subsurface Profile F; East Embankment Dam of Cooling Basin (North-South) (Cooling Basin/GBRA Storage Water Reservoir)

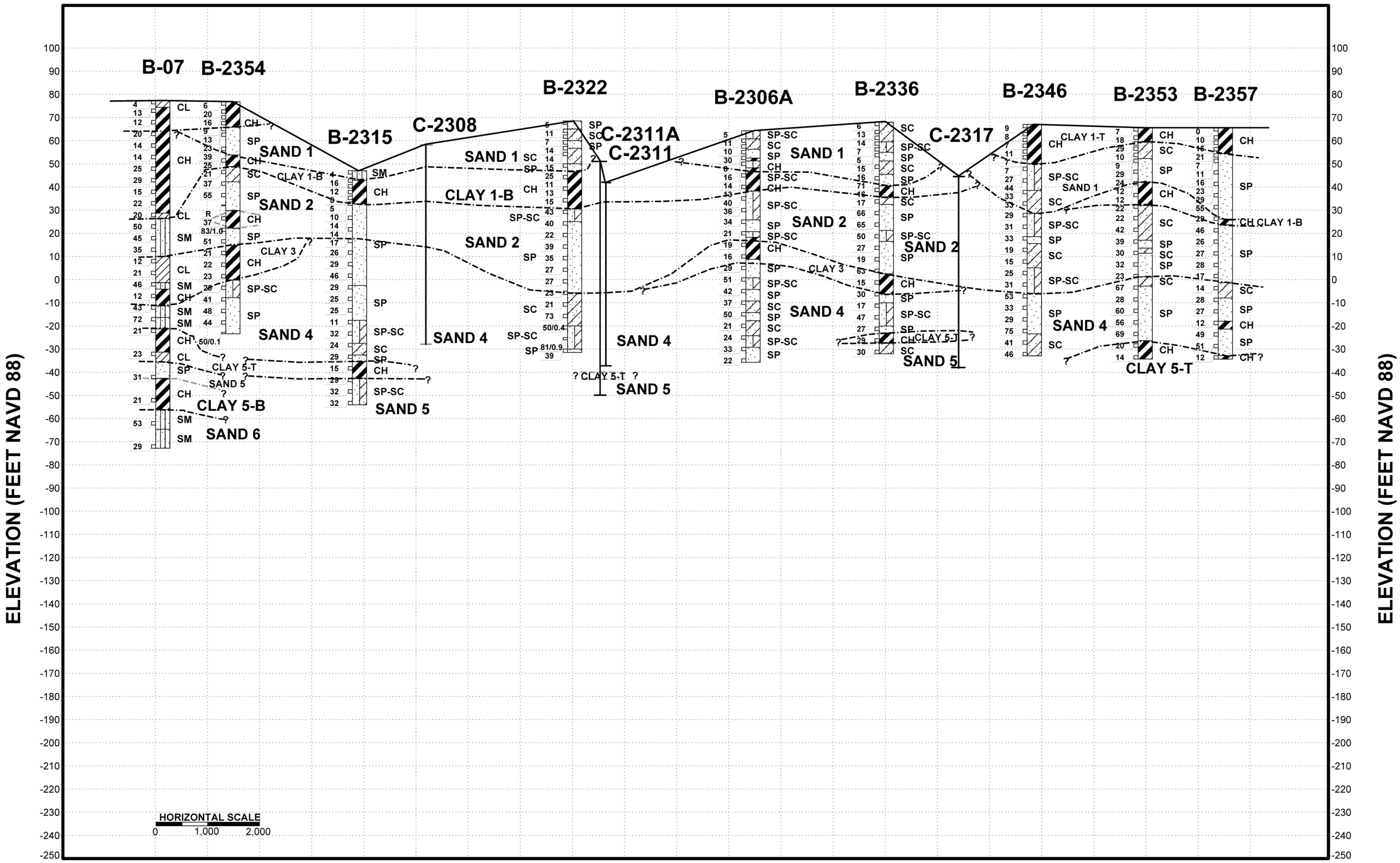


Figure 2.5.4-216 Subsurface Profile G; East Embankment Dam of GBRA Storage Water Reservoir (North-South) (Cooling Basin/GBRA Storage Water Reservoir)

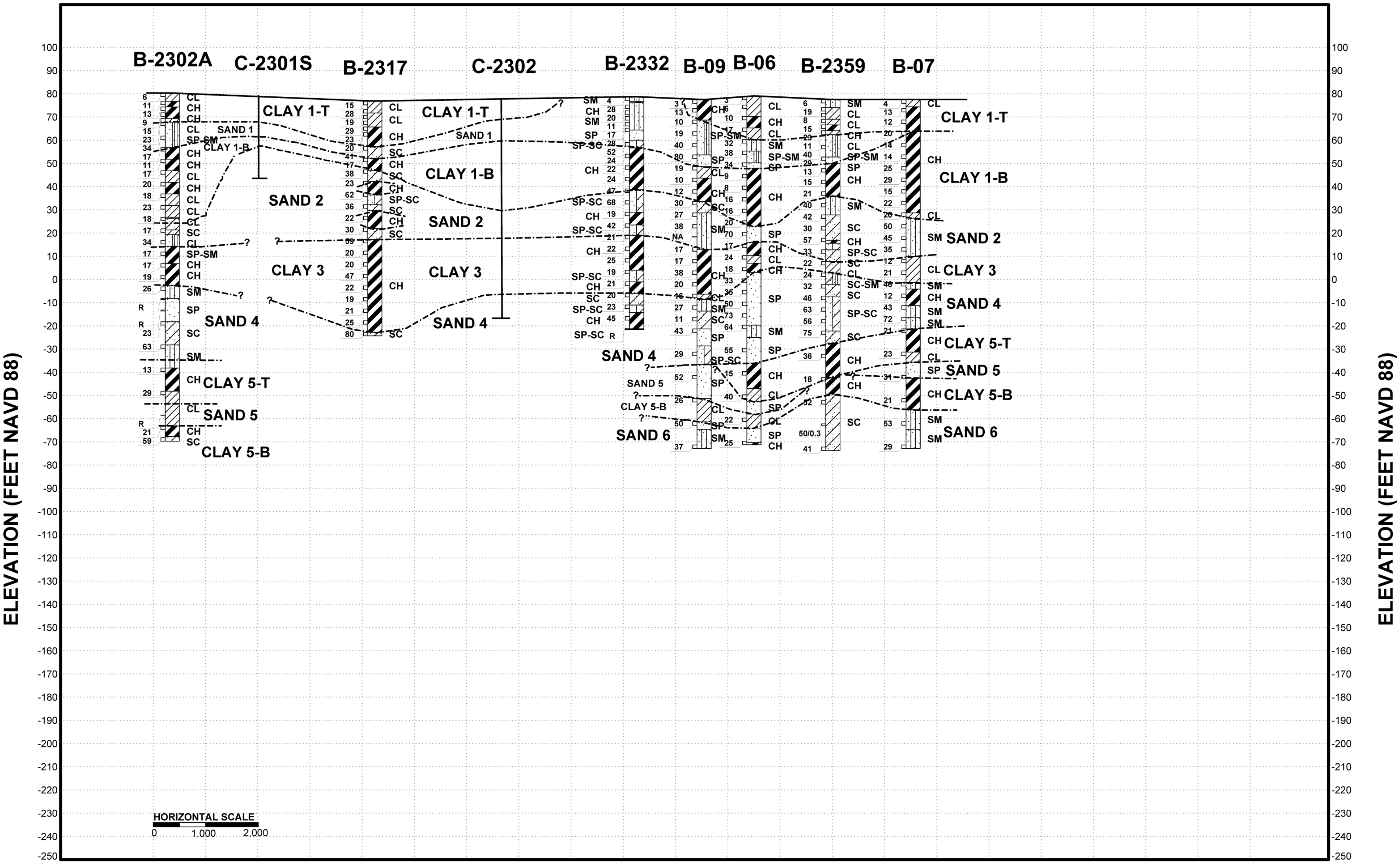


Figure 2.5.4-217 Subsurface Profile H; North Embankment Dam of Cooling Basin/GBRA Storage Water Reservoir (East-West) (Cooling Basin/GBRA Storage Water Reservoir)

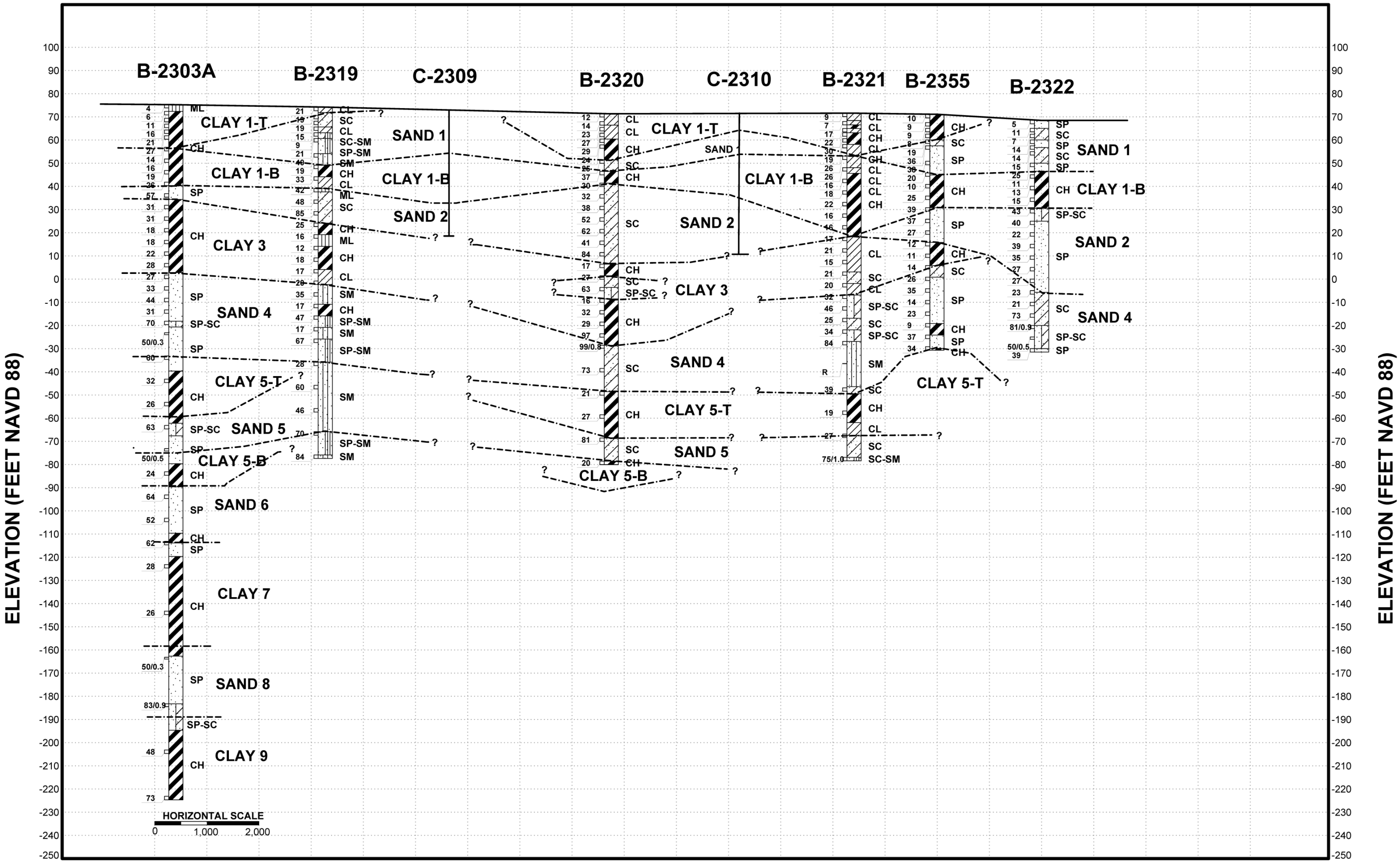


Figure 2.5.4-218 Subsurface Profile I; North-Central Area of Cooling Basin/GBRA Storage Water Reservoir (East-West) (Cooling Basin/GBRA Storage Water Reservoir)

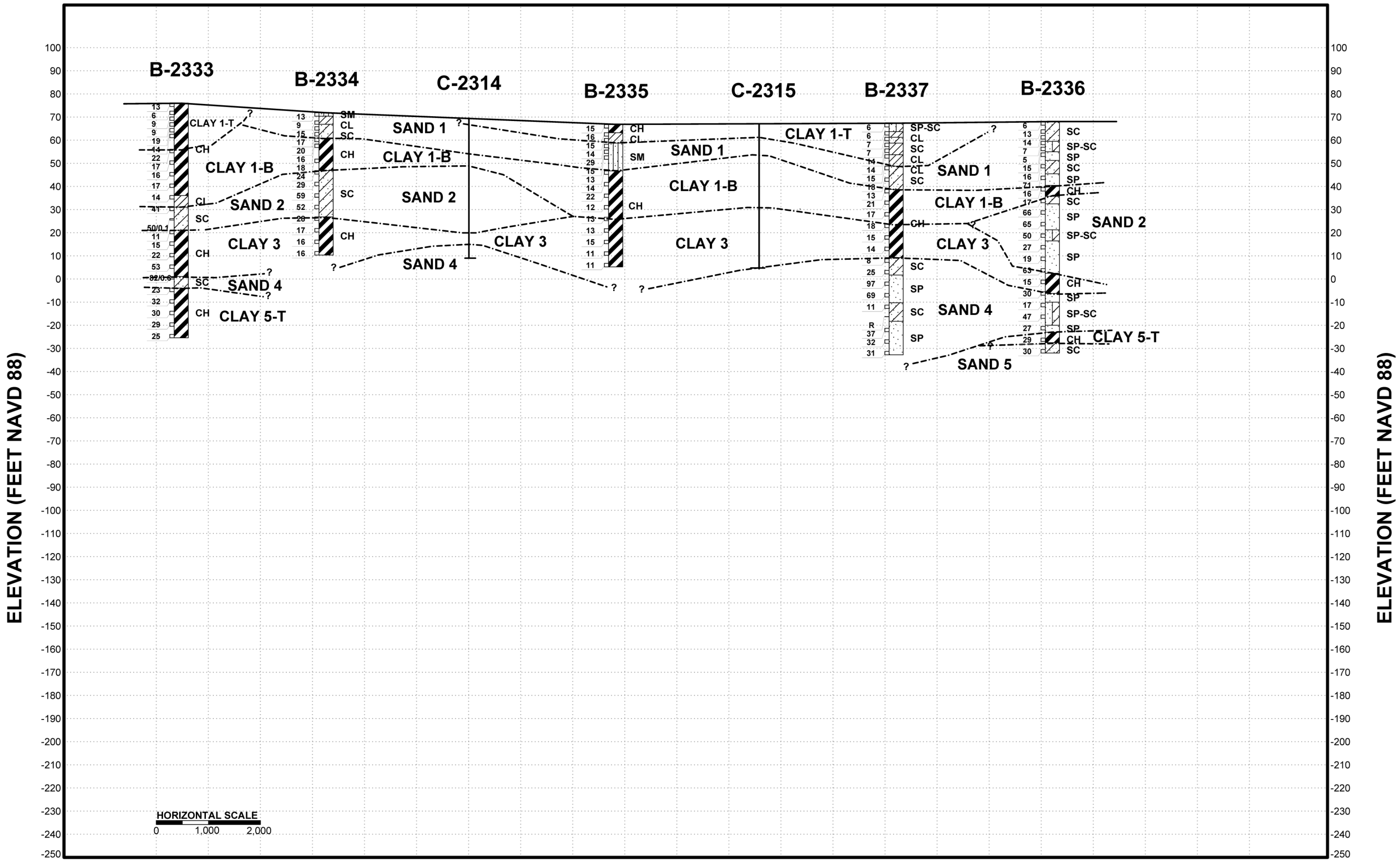


Figure 2.5.4-219 Subsurface Profile J; South-Central Area of Cooling Basin/GBRA Storage Water Reservoir (East-West) (Cooling Basin/GBRA Storage Water Reservoir)

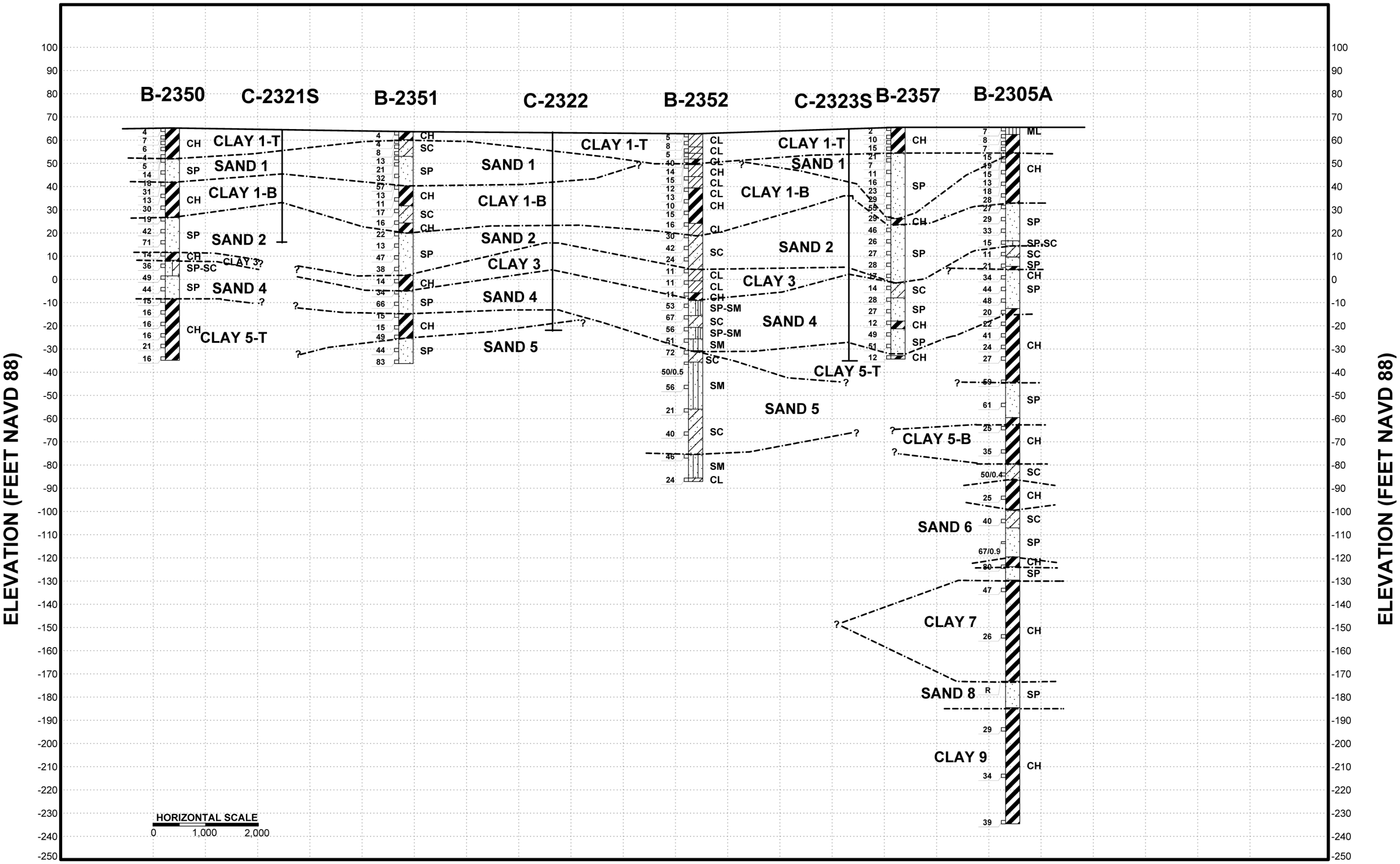


Figure 2.5.4-220 Subsurface Profile K; South Embankment Dam of Cooling Basin/GBRA Storage Water Reservoir (East-West) (Cooling Basin/GBRA Storage Water Reservoir)

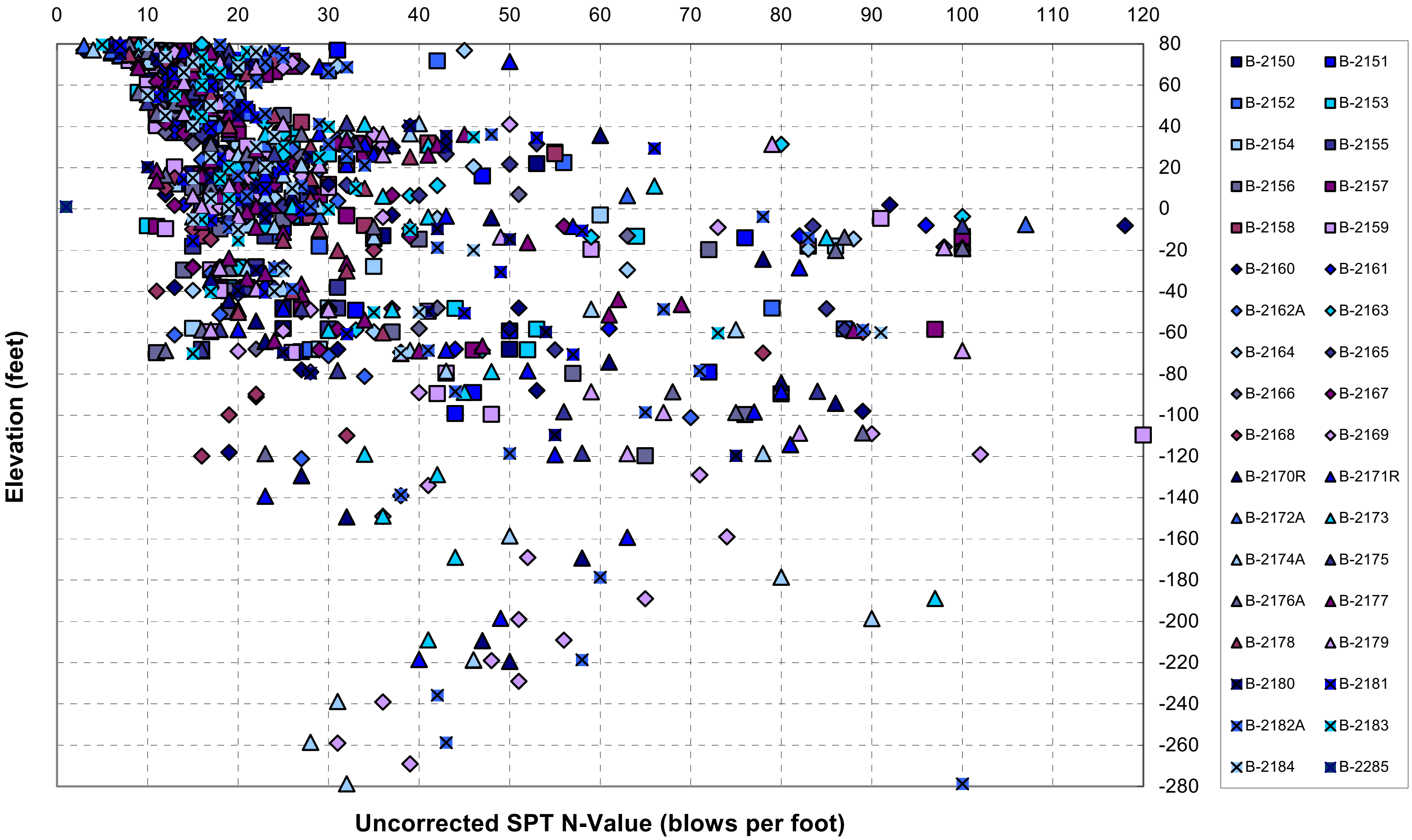


Figure 2.5.4-221 Uncorrected SPT N-Values; Unit 1 (Power Block)

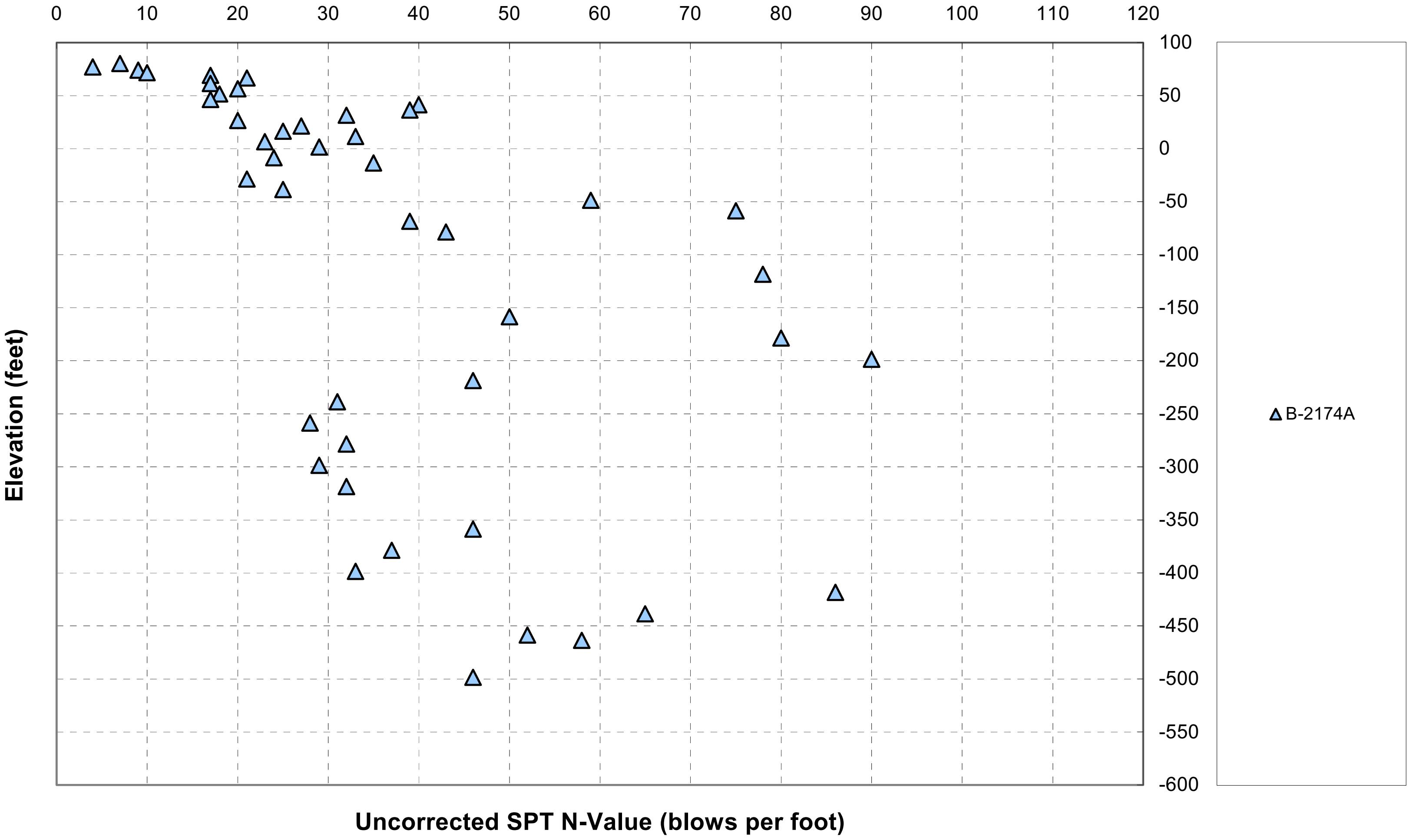


Figure 2.5.4-222 Uncorrected SPT N-Values; Unit 1; Boring B-2174A (Power Block)

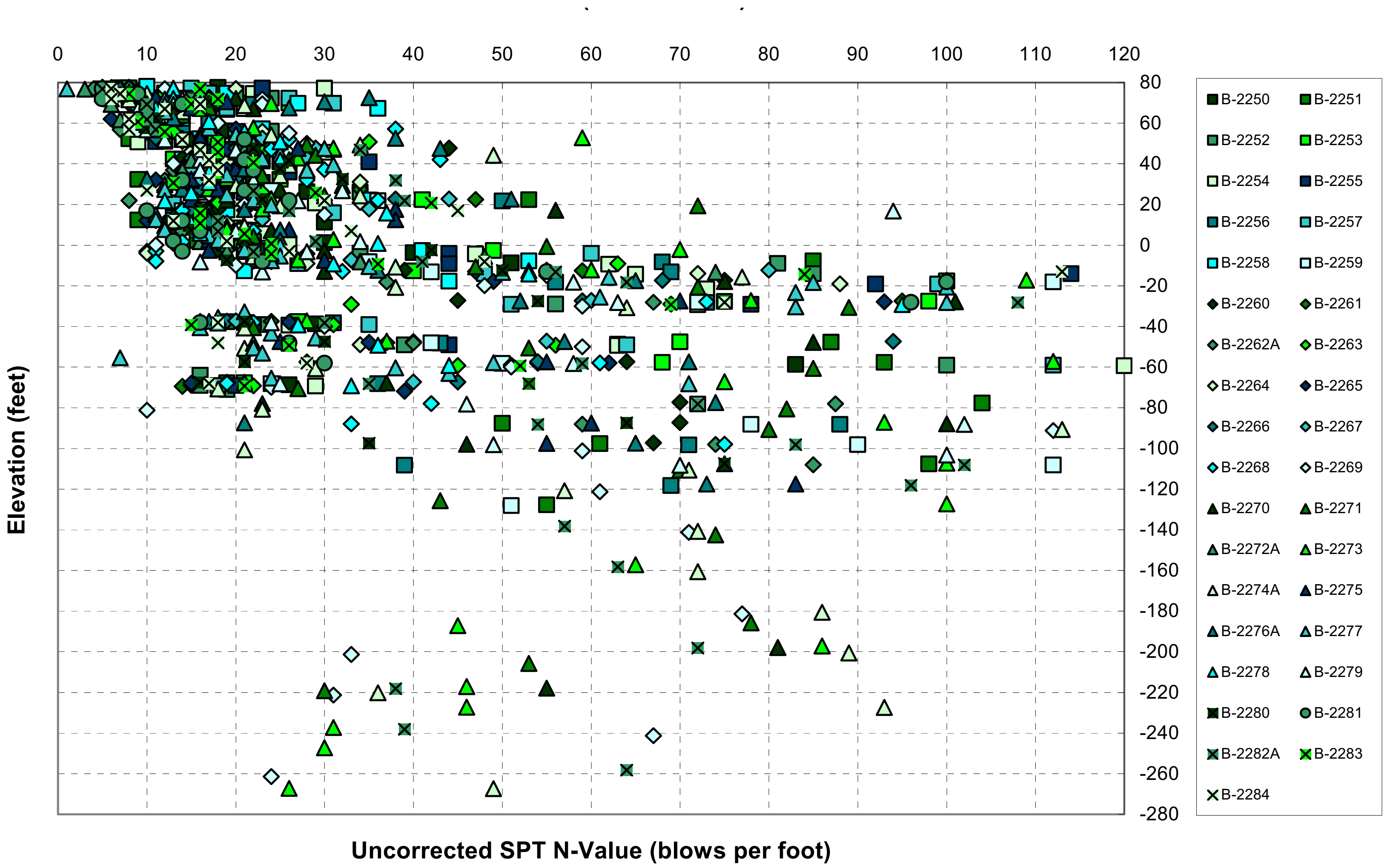


Figure 2.5.4-223 Uncorrected SPT N-Values; Unit 2 (Power Block)

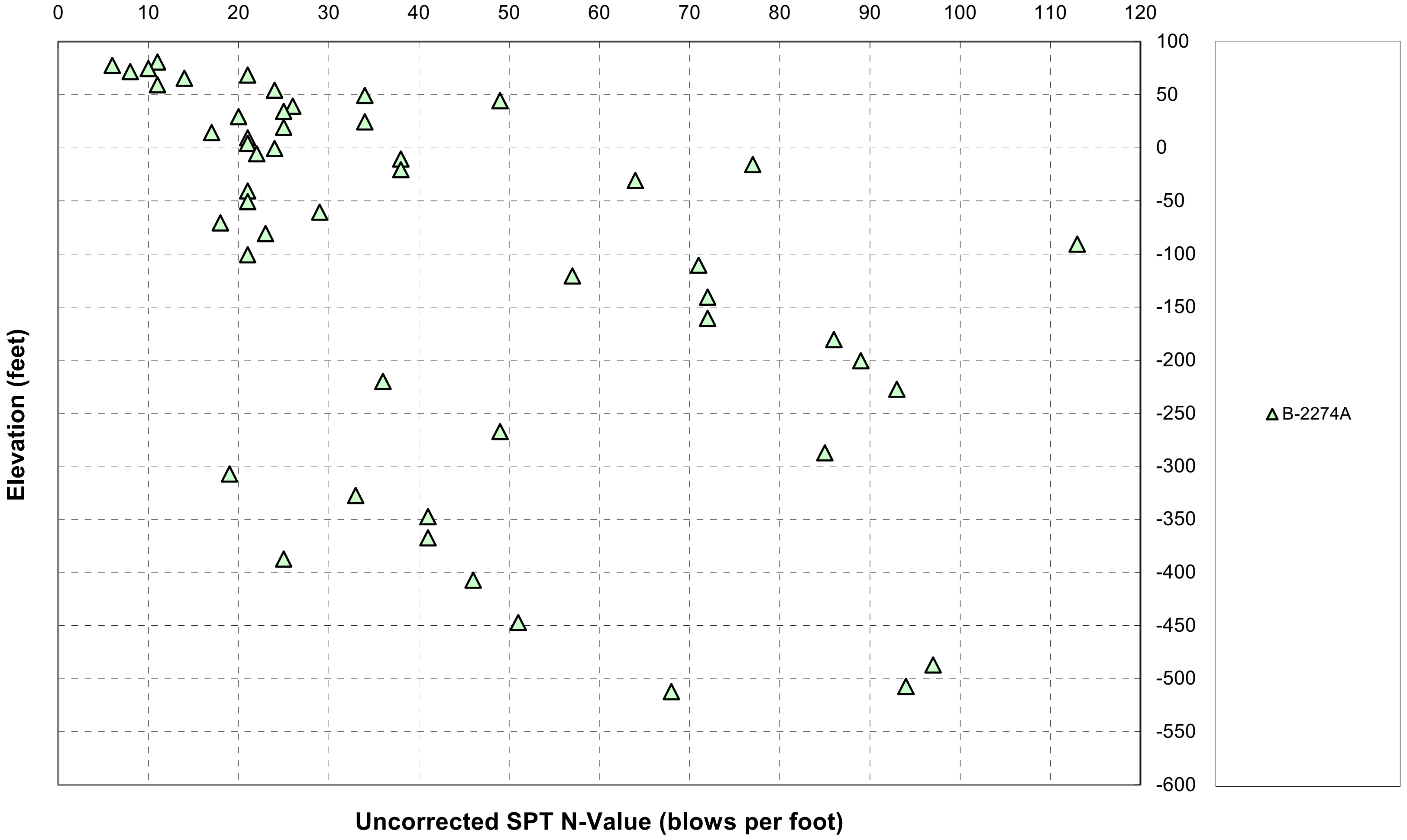


Figure 2.5.4-224 Uncorrected SPT N-Values; Unit 2; Boring B-2274A (Power Block)

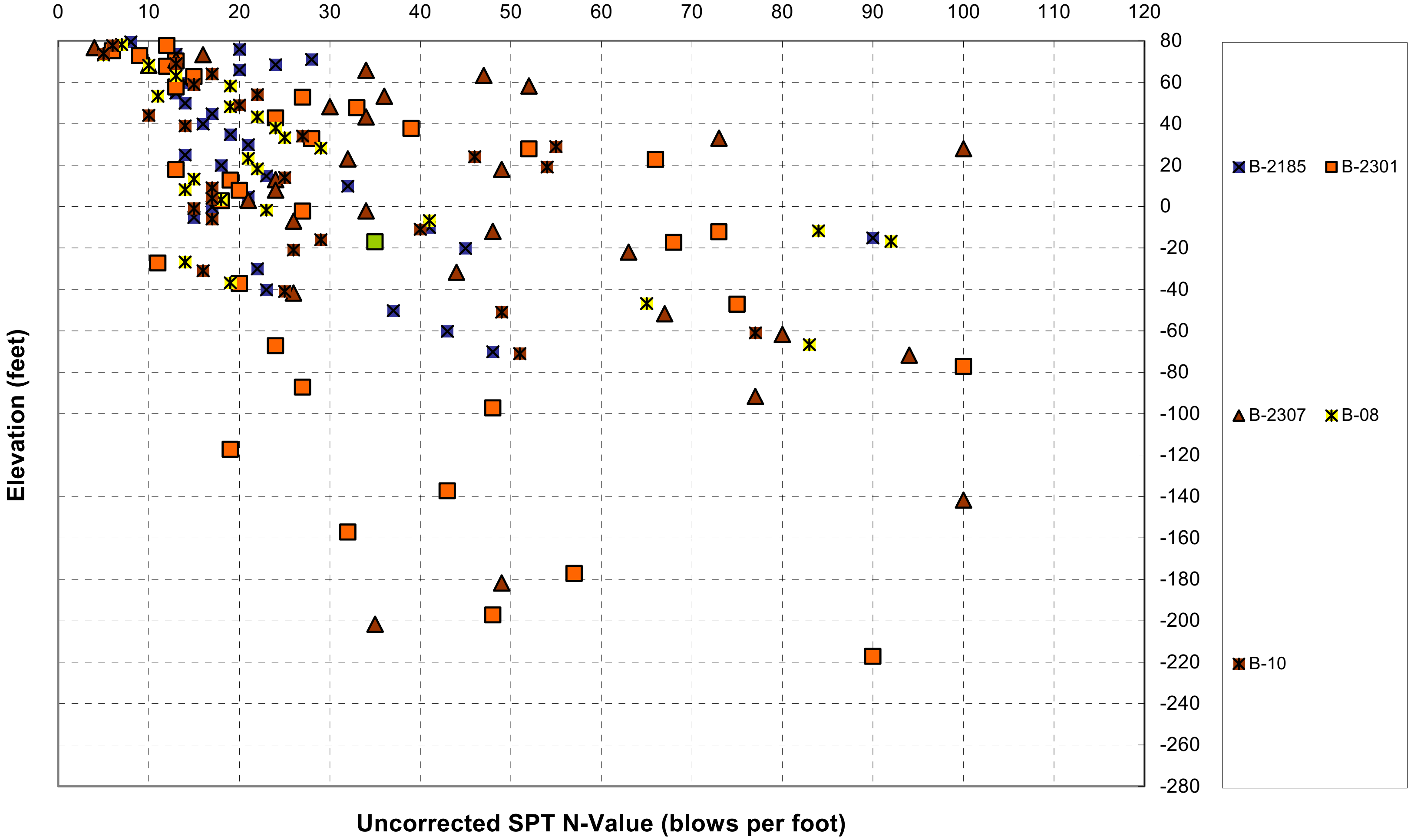


Figure 2.5.4-225 Uncorrected SPT N-Values; Investigations Outside Power Block

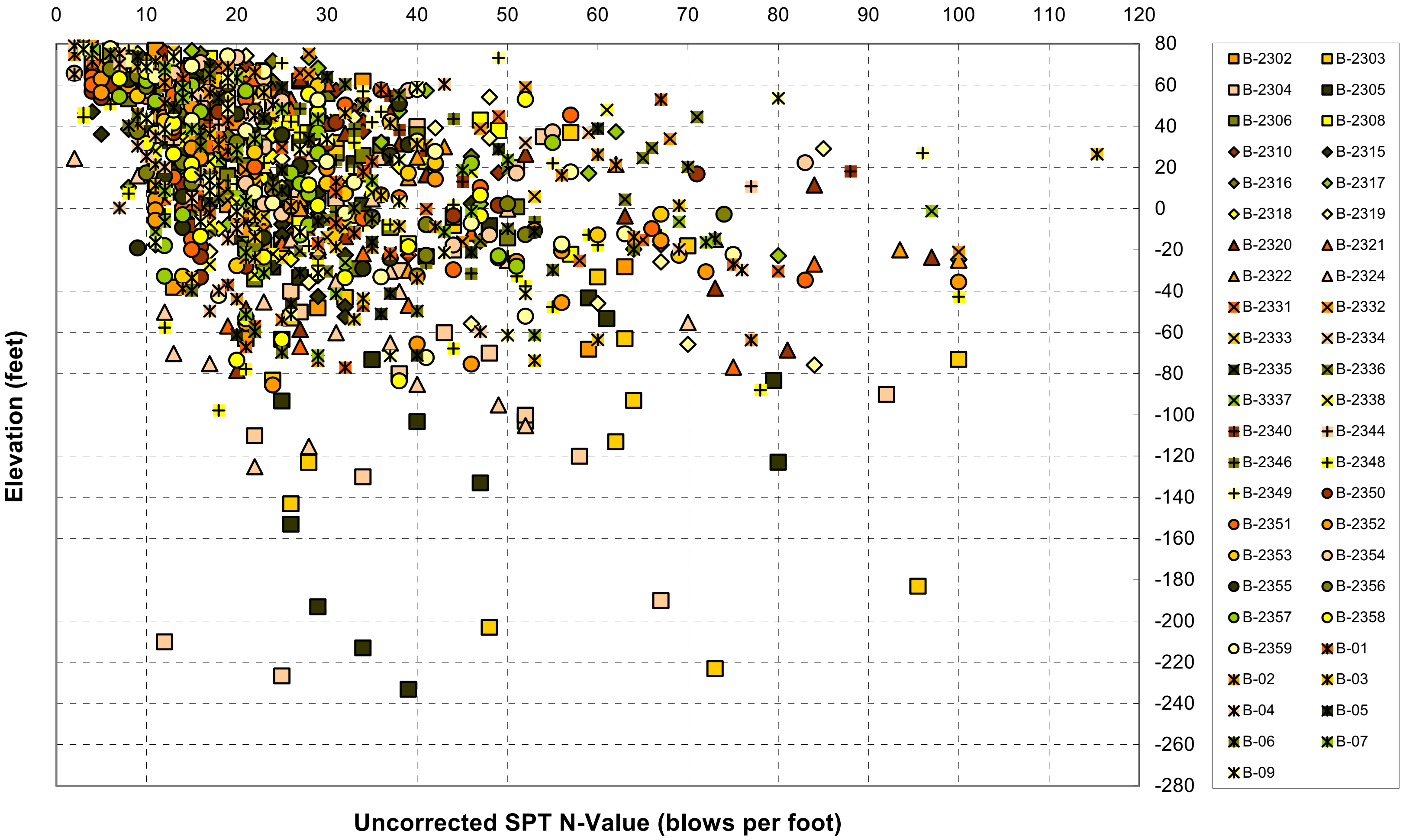


Figure 2.5.4-226 Uncorrected SPT N-Values (Cooling Basin/GBRA Storage Water Reservoir)

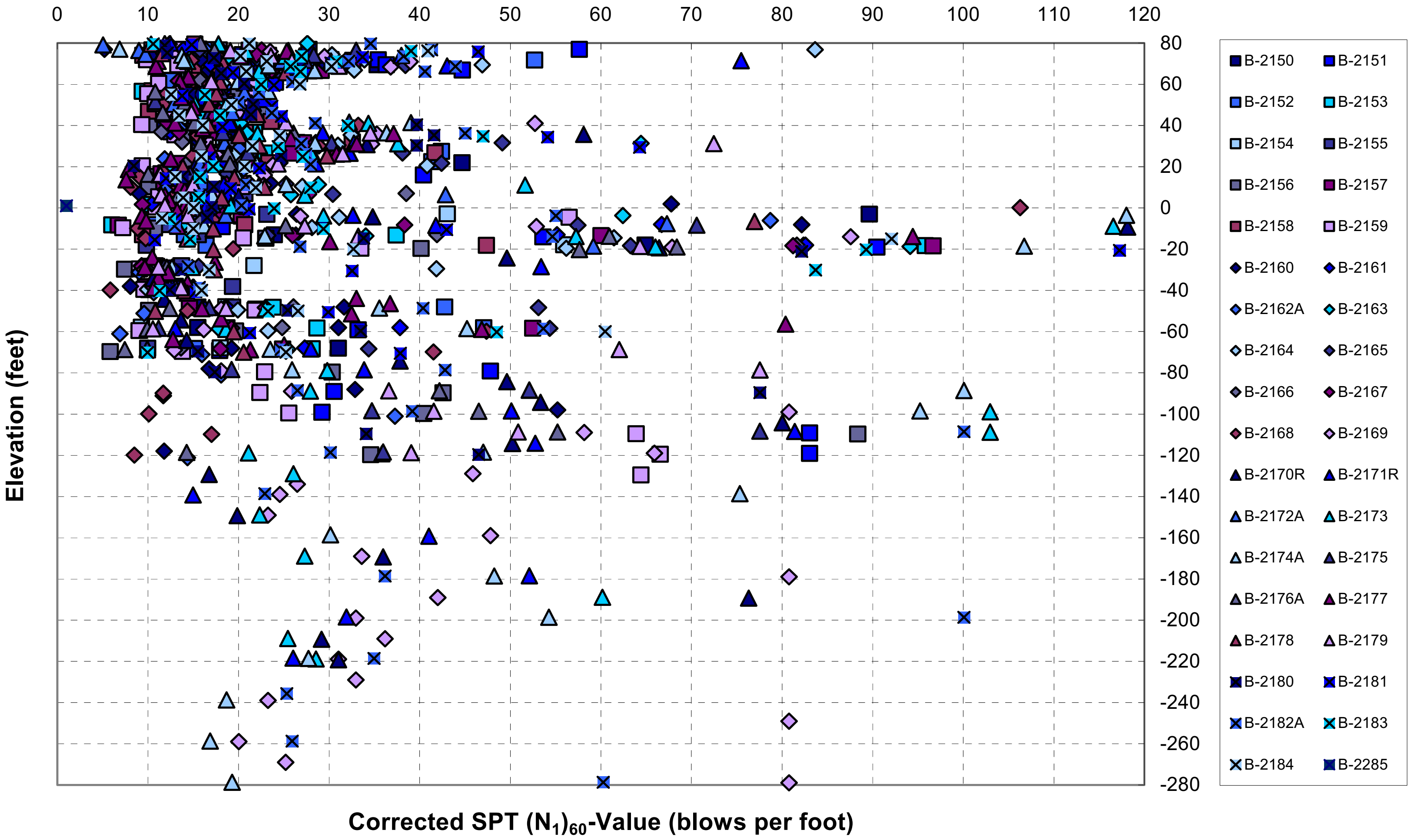


Figure 2.5.4-227 Corrected SPT $(N_1)_{60}$-Values; Unit 1 (Power Block)

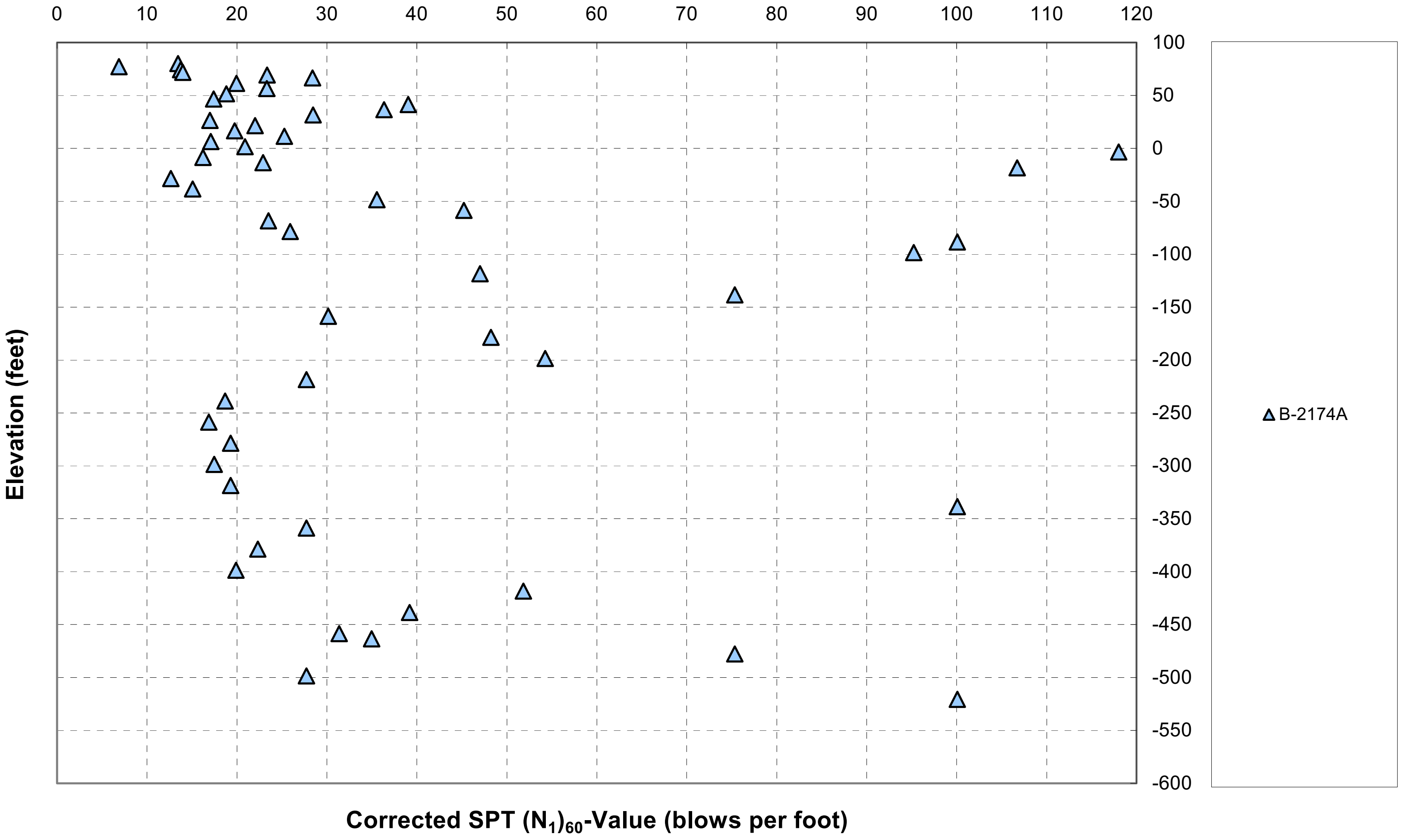


Figure 2.5.4-228 Corrected SPT $(N_1)_{60}$-Values; Unit 1; Boring B-2174A (Power Block)

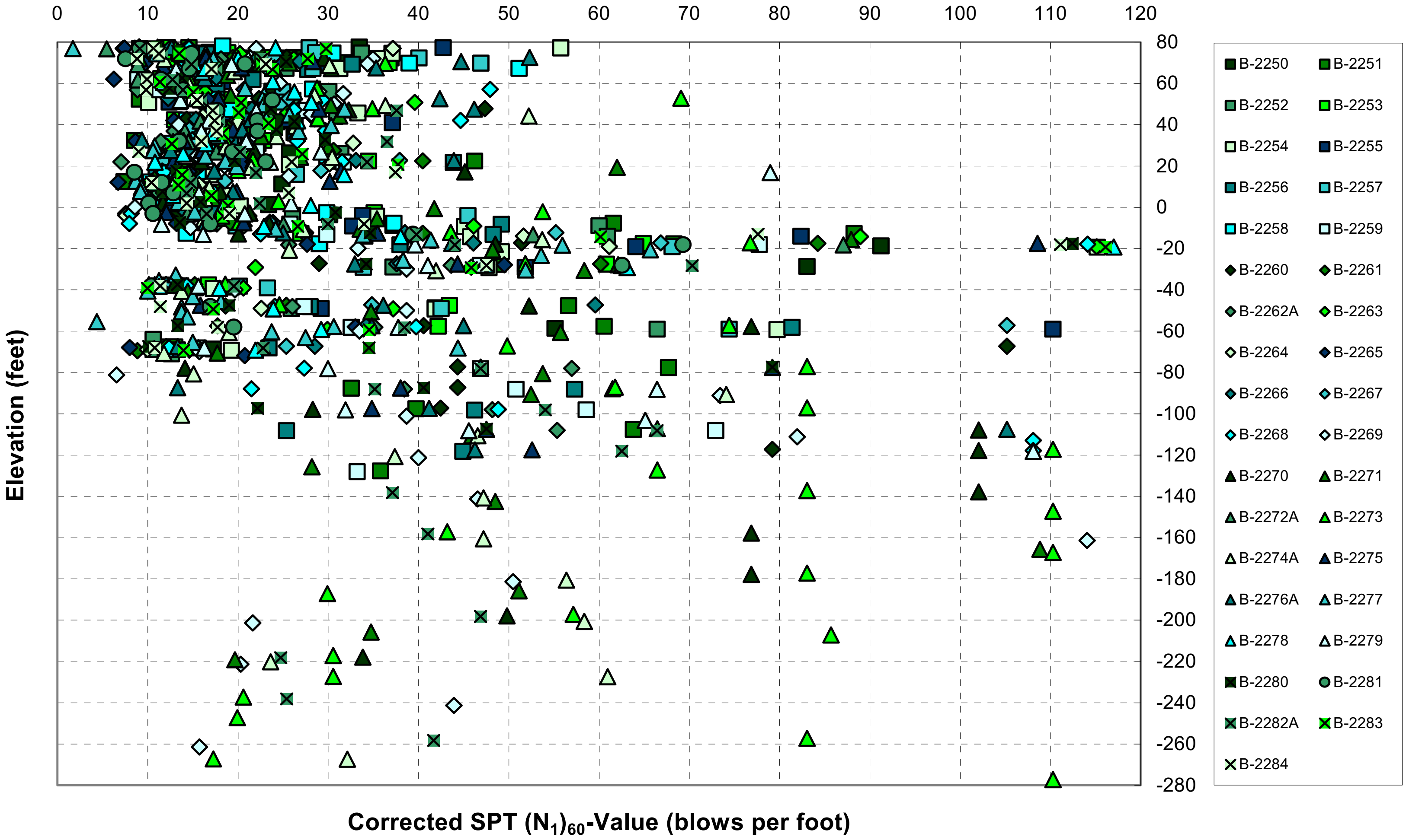


Figure 2.5.4-229 Corrected SPT $(N_1)_{60}$-Values; Unit 2 (Power Block)

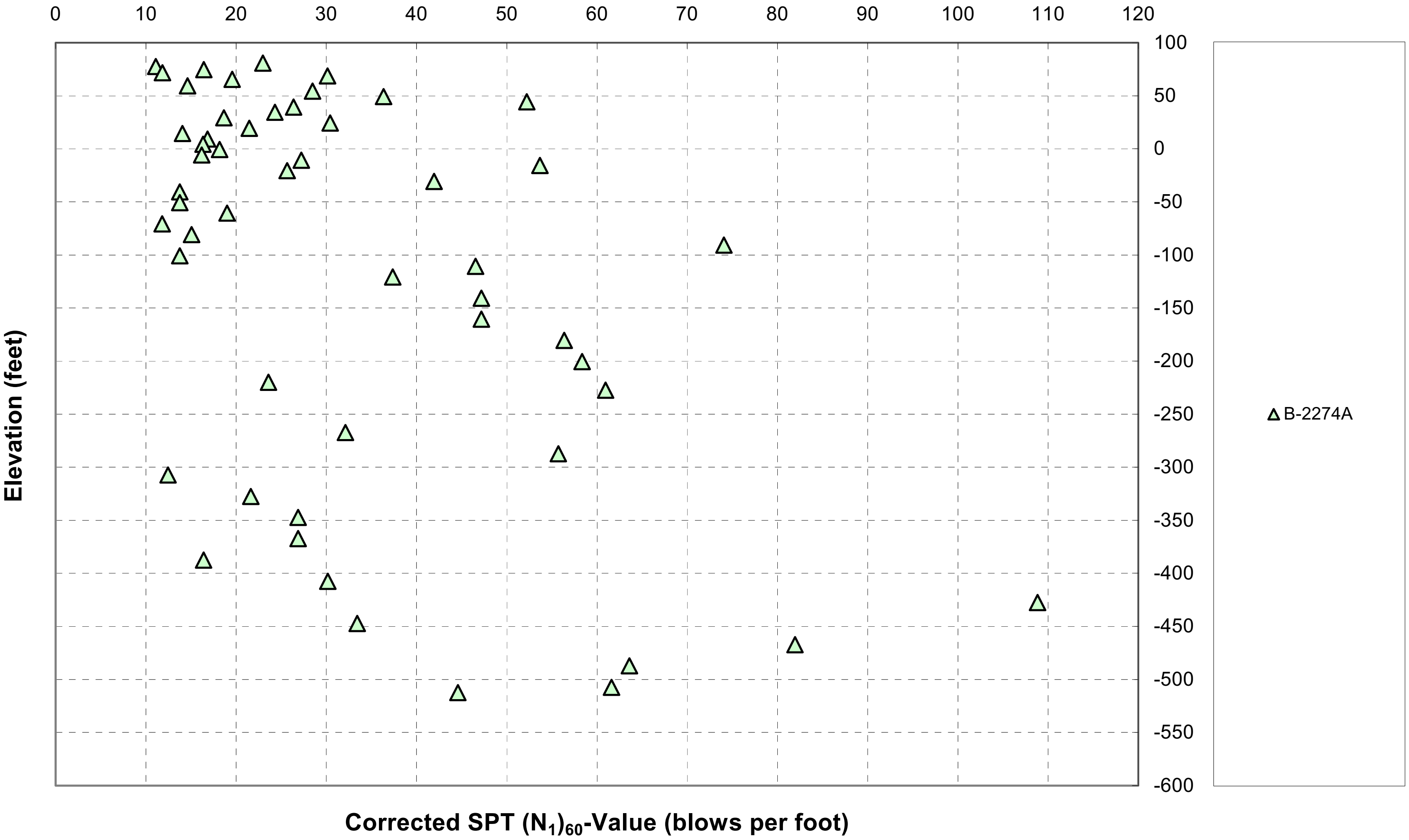


Figure 2.5.4-230 Corrected SPT $(N_1)_{60}$-Values; Unit 2; Boring B-2274A (Power Block)

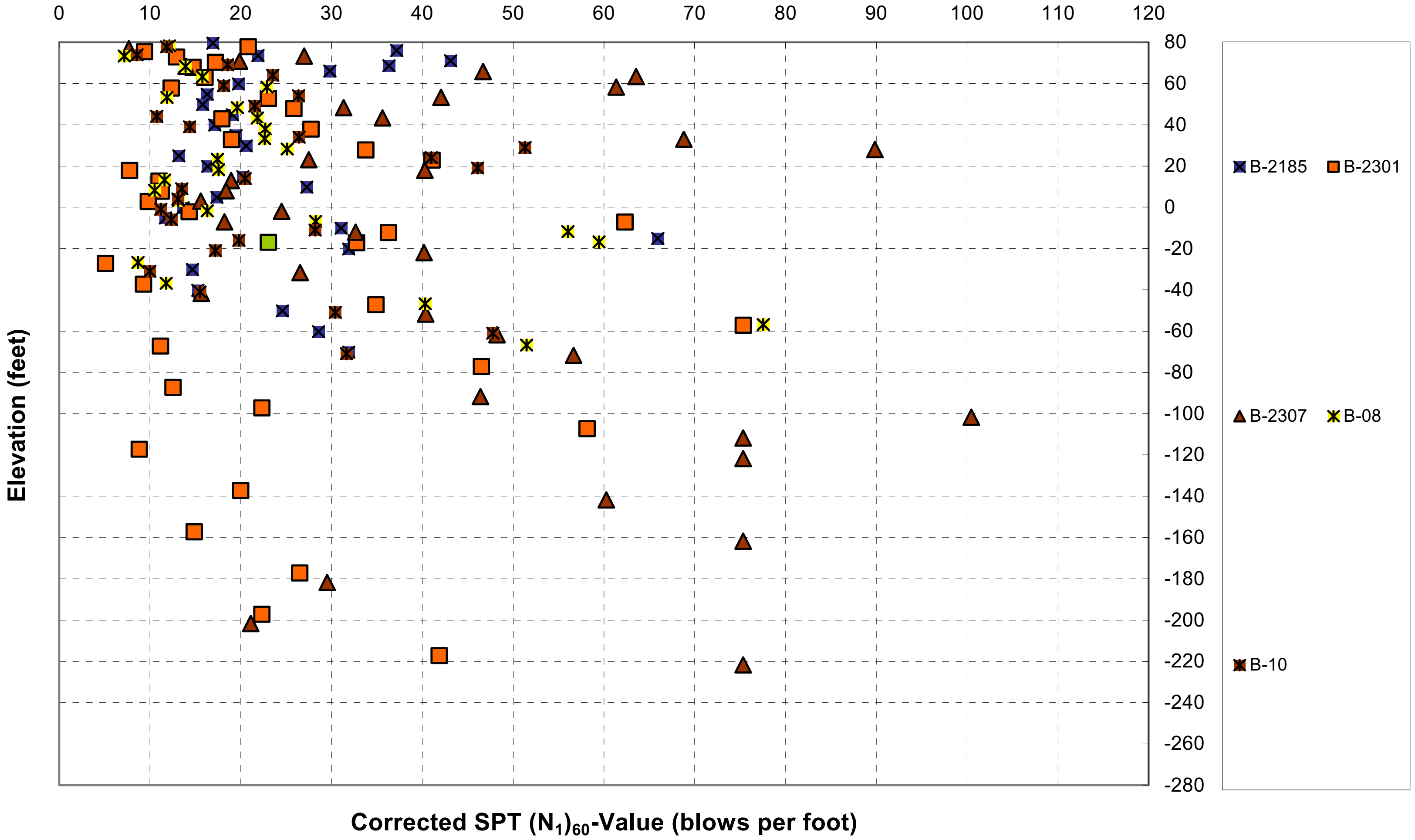


Figure 2.5.4-231 Corrected SPT $(N_1)_{60}$-Values; Investigations Outside Power Block

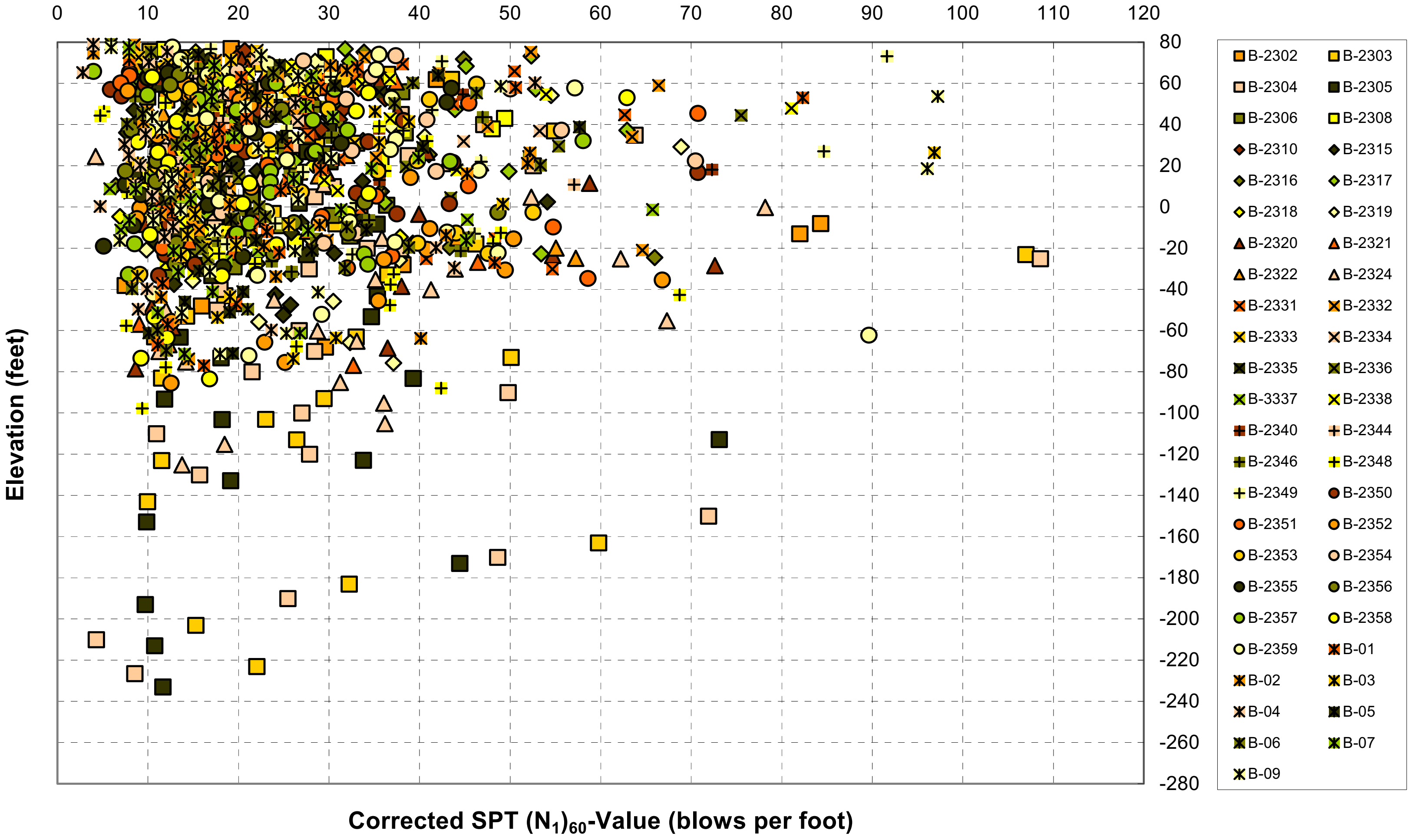


Figure 2.5.4-232 Corrected SPT $(N_1)_{60}$-Values (Cooling Basin/GBRA Storage Water Reservoir)

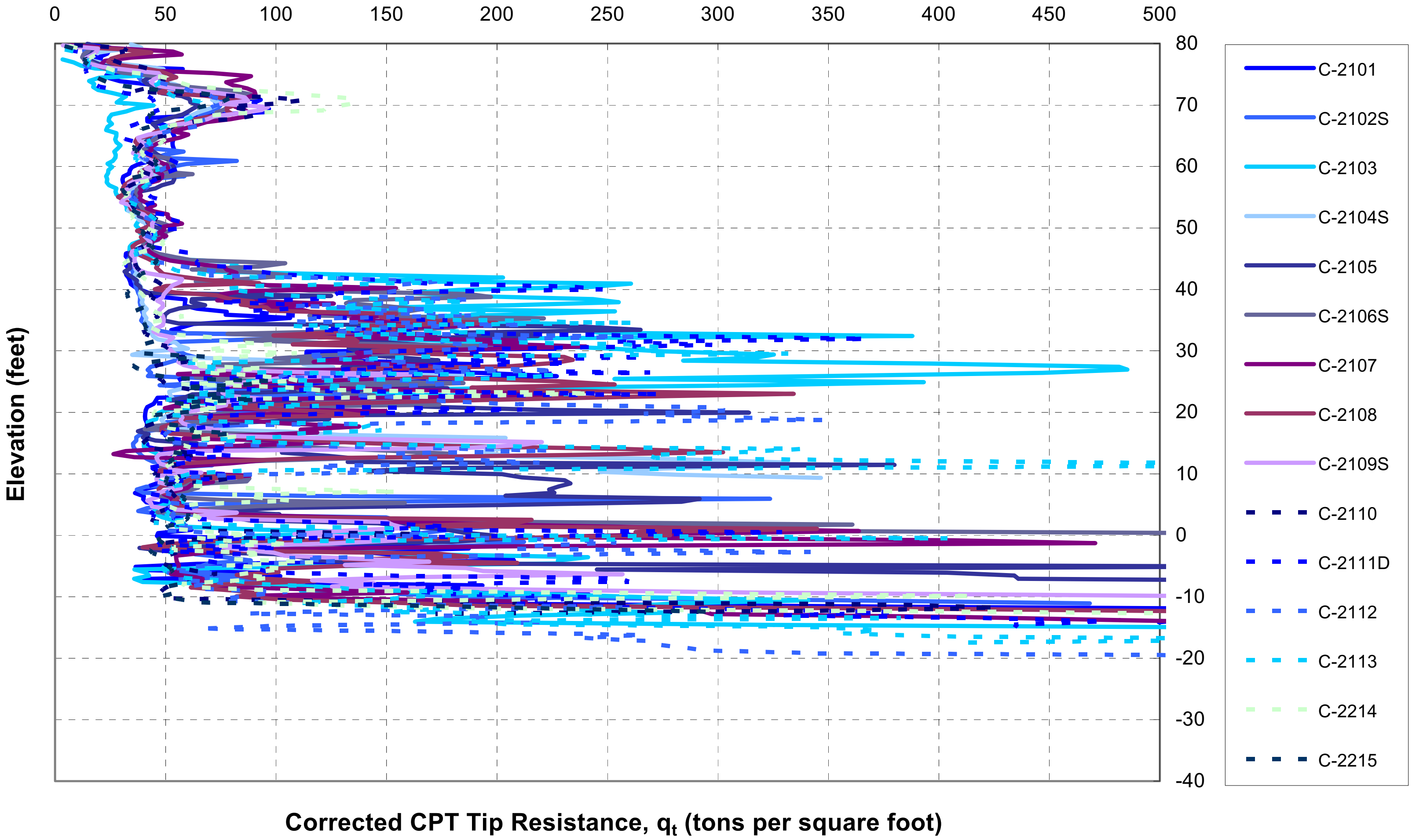


Figure 2.5.4-233 Corrected CPT q_t-Values; Unit 1 (Power Block)

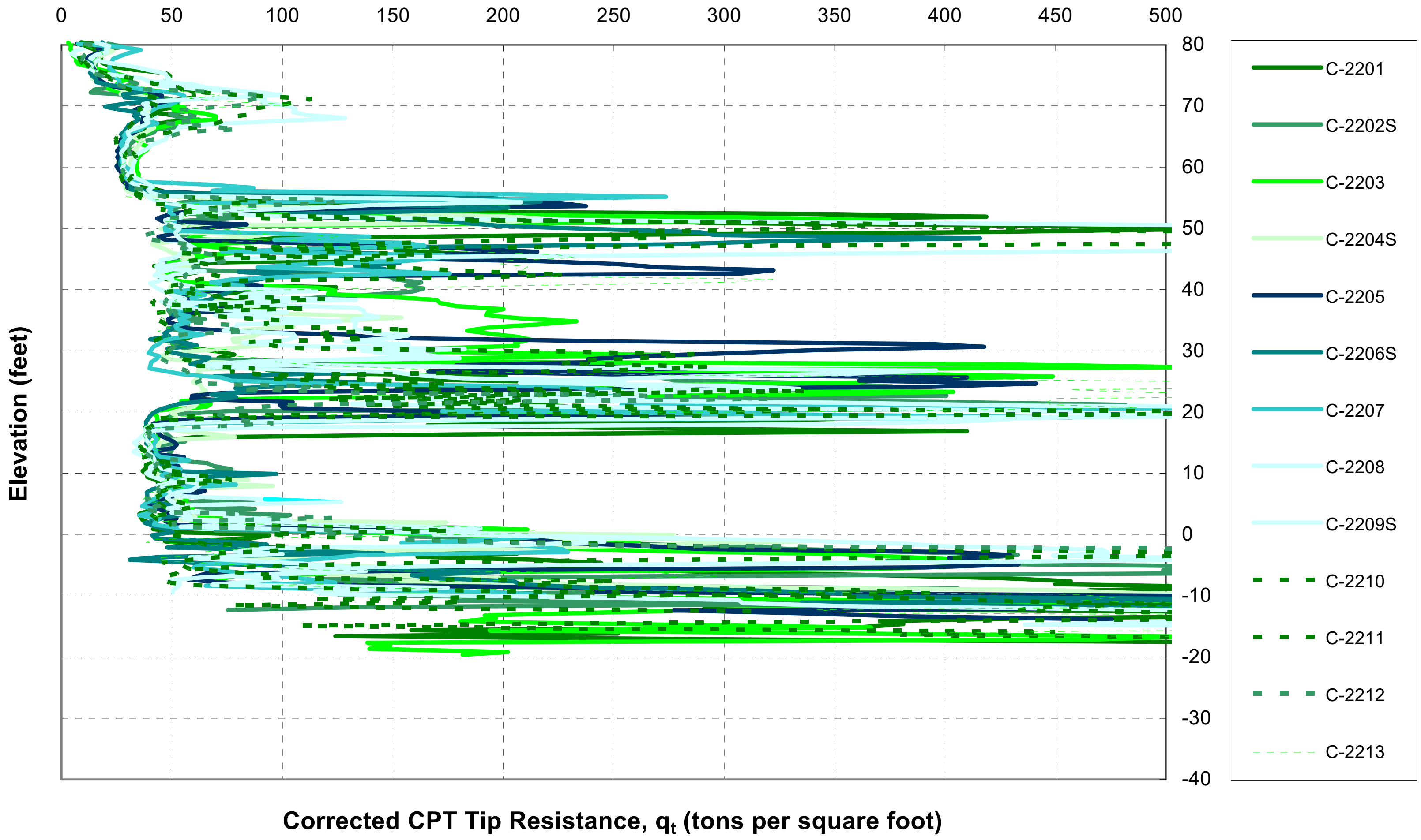


Figure 2.5.4-234 Corrected CPT q_t-Values; Unit 2 (Power Block)

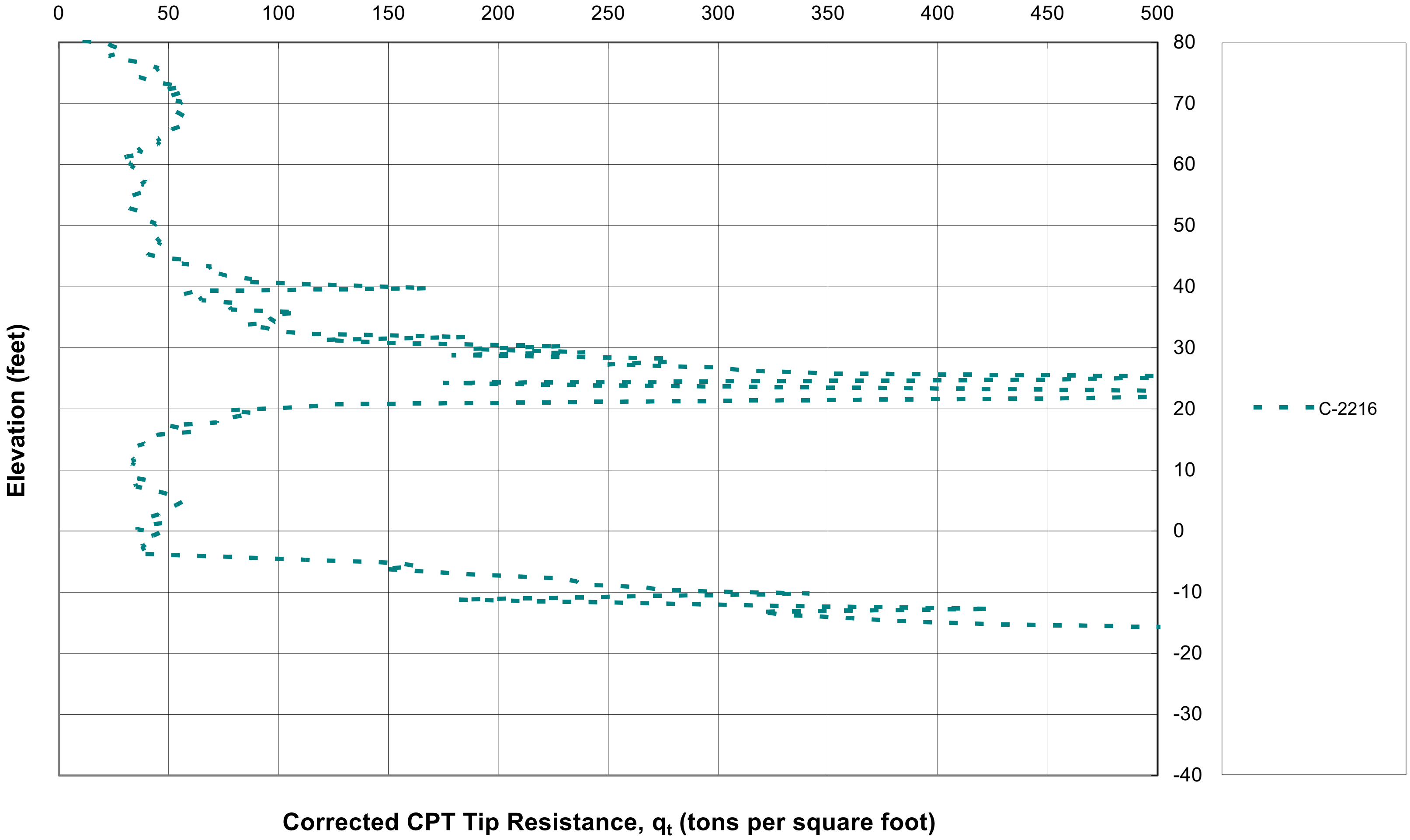


Figure 2.5.4-235 Corrected CPT q_t-Values; Investigations Outside Power Block

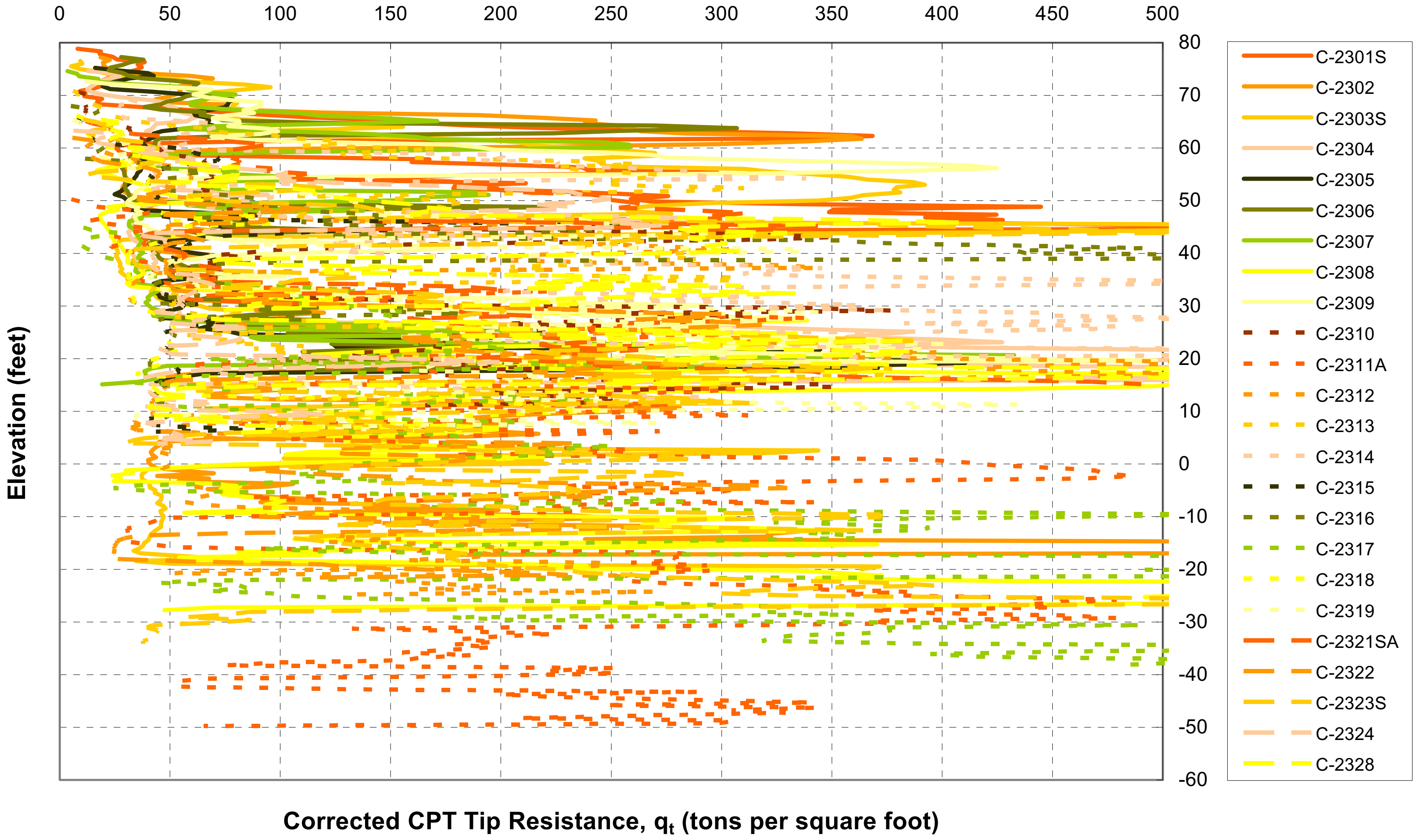


Figure 2.5.4-236 Corrected CPT q_t-Values (Cooling Basin/GBRA Storage Water Reservoir)

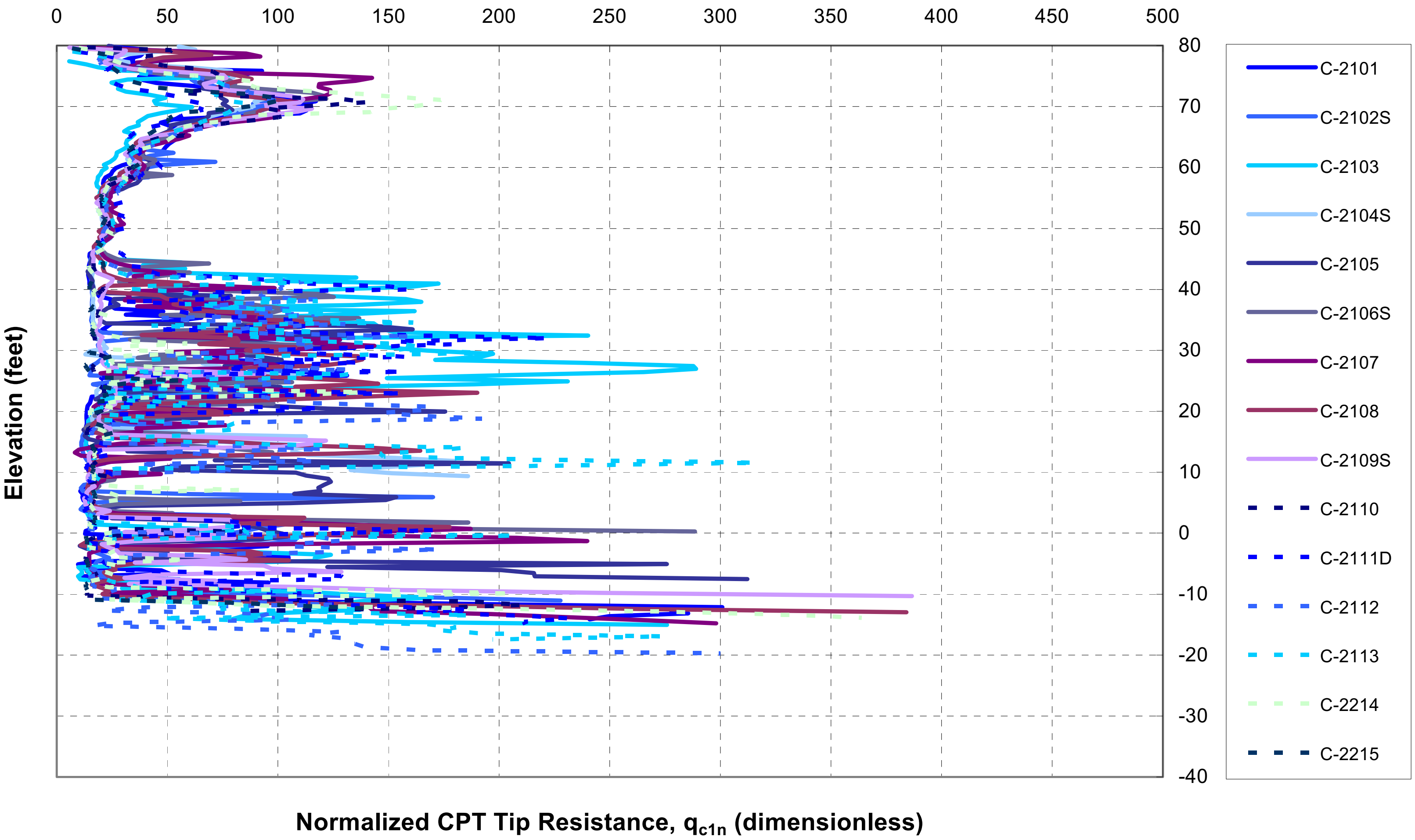


Figure 2.5.4-237 Normalized CPT q_{c1n}-Values; Unit 1 (Power Block)

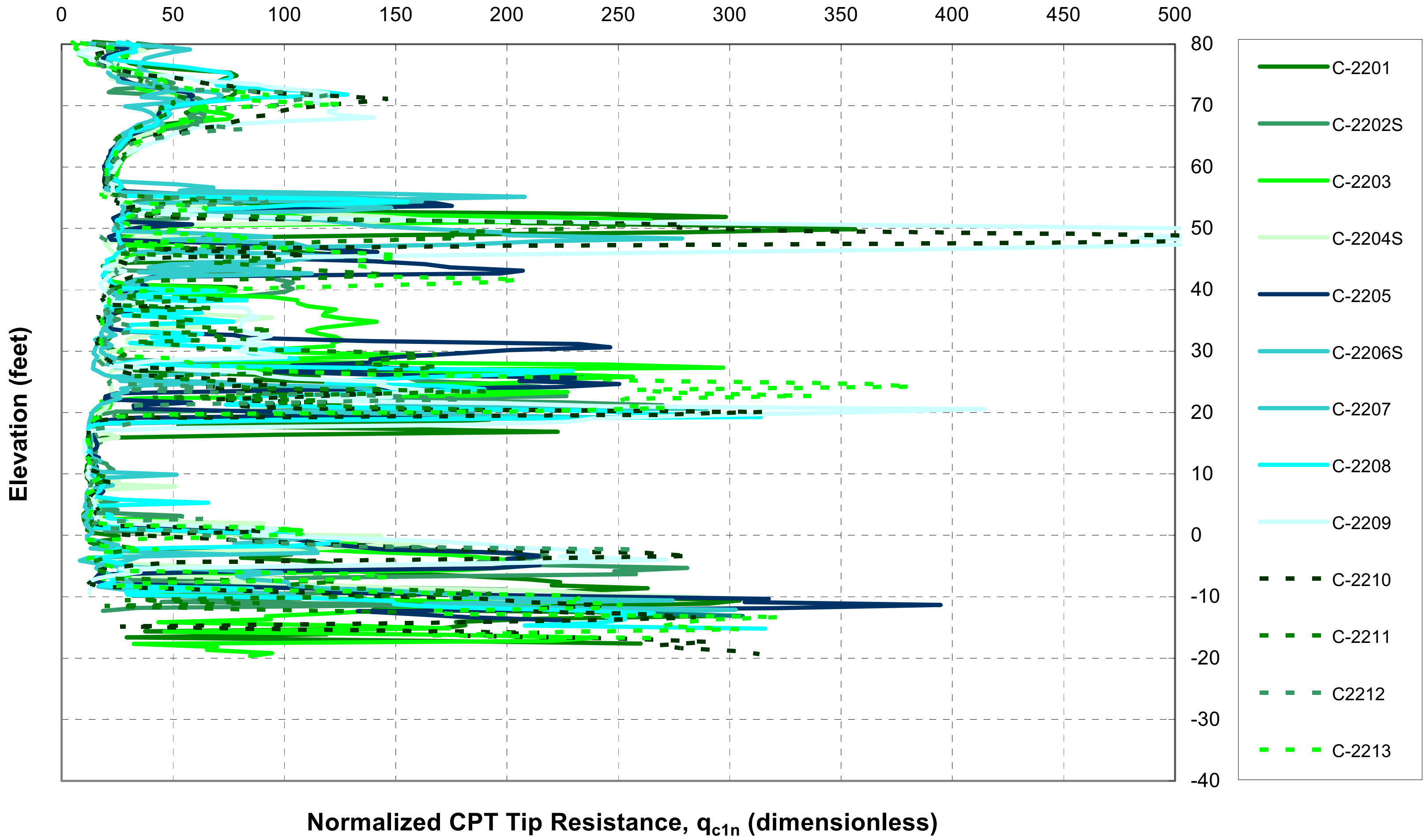


Figure 2.5.4-238 Normalized CPT q_{c1n}-Values; Unit 2 (Power Block)

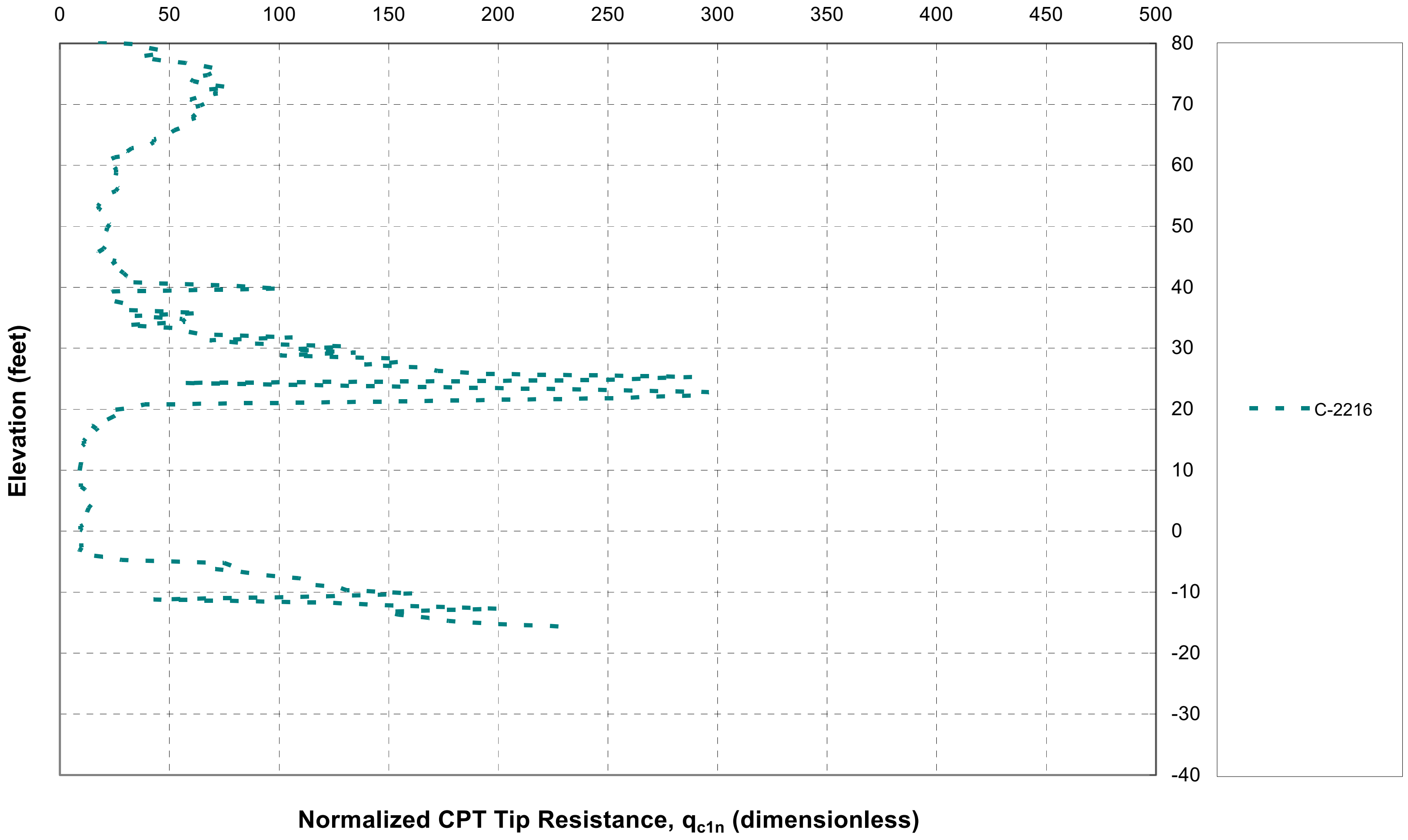


Figure 2.5.4-239 Normalized CPT q_{c1n}-Values; Investigations Outside Power Block

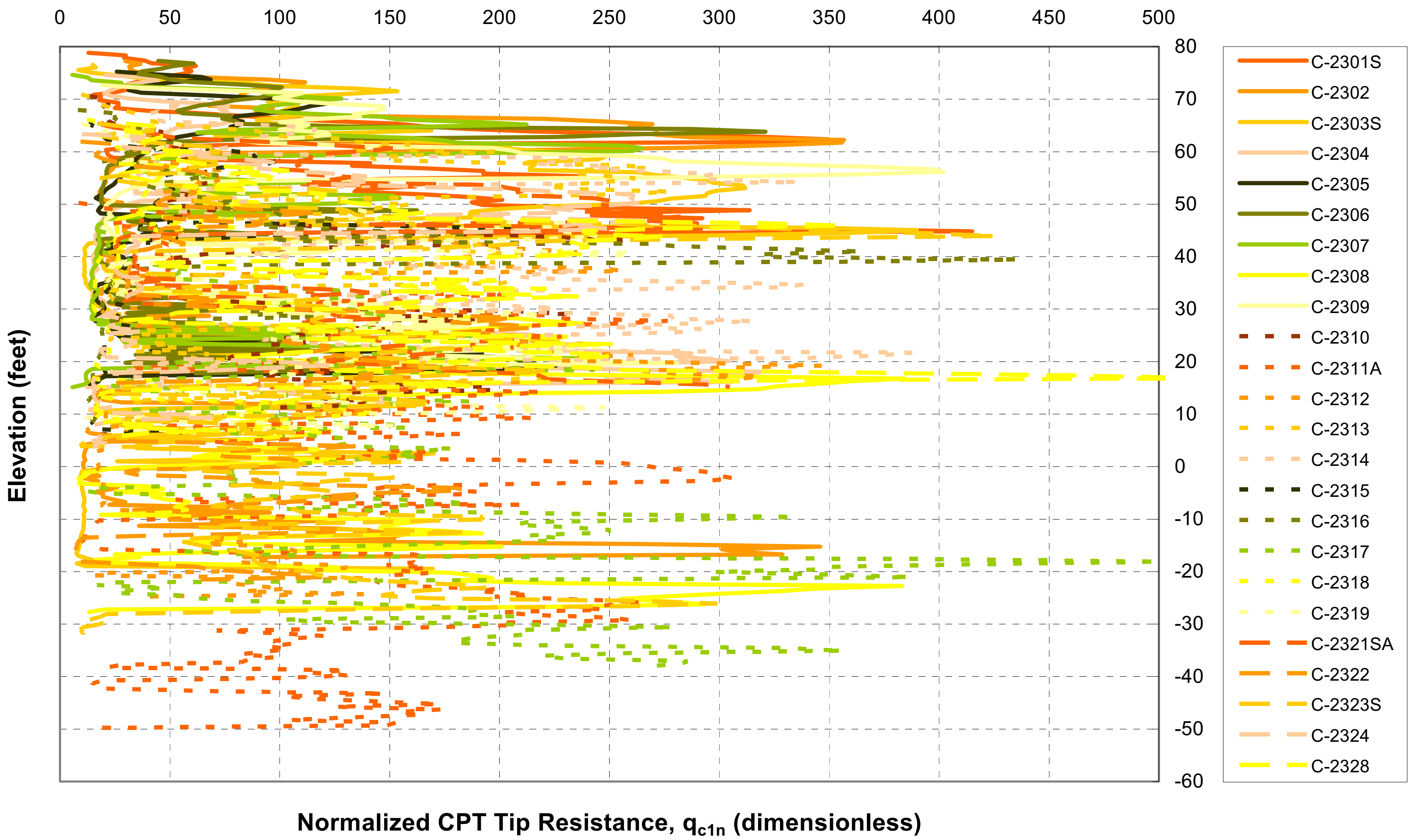


Figure 2.5.4-240 Normalized CPT q_{c1n}-Values (Cooling Basin/GBRA Storage Water Reservoir)

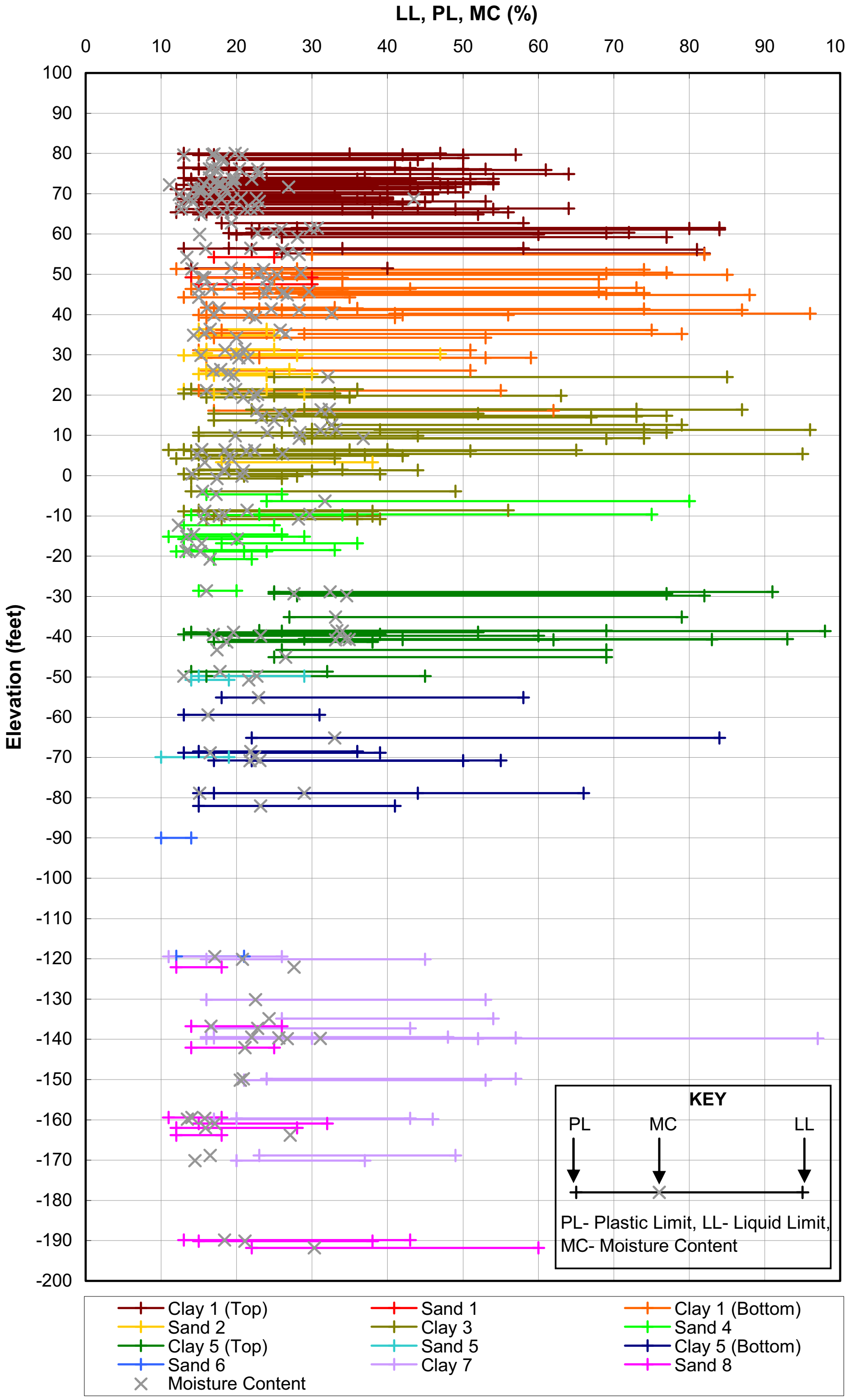


Figure 2.5.4-241 Atterberg Limits Test Results (Power Block) (Sheet 1 of 2)

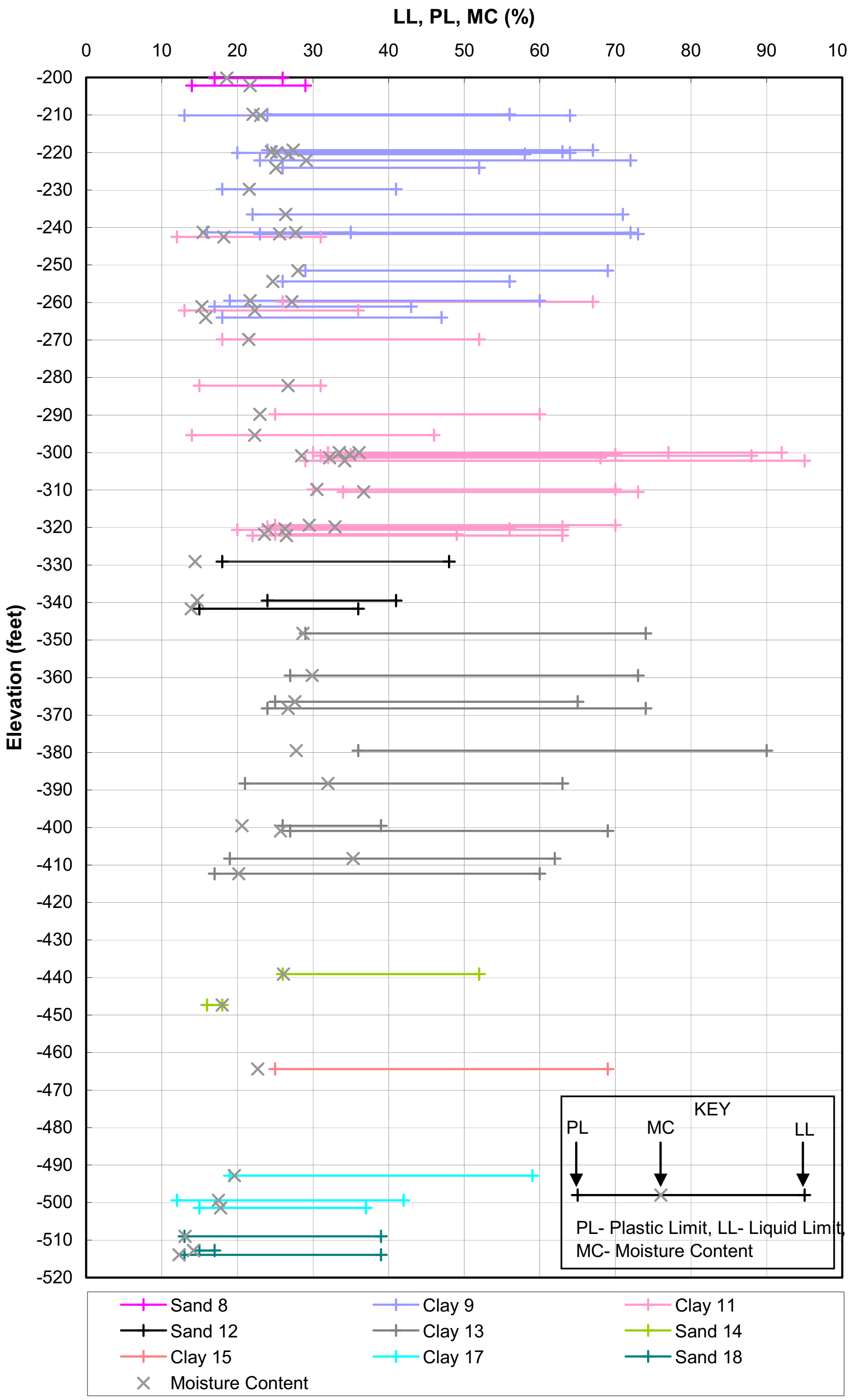


Figure 2.5.4-241 Atterberg Limits Test Results (Power Block) (Sheet 2 of 2)

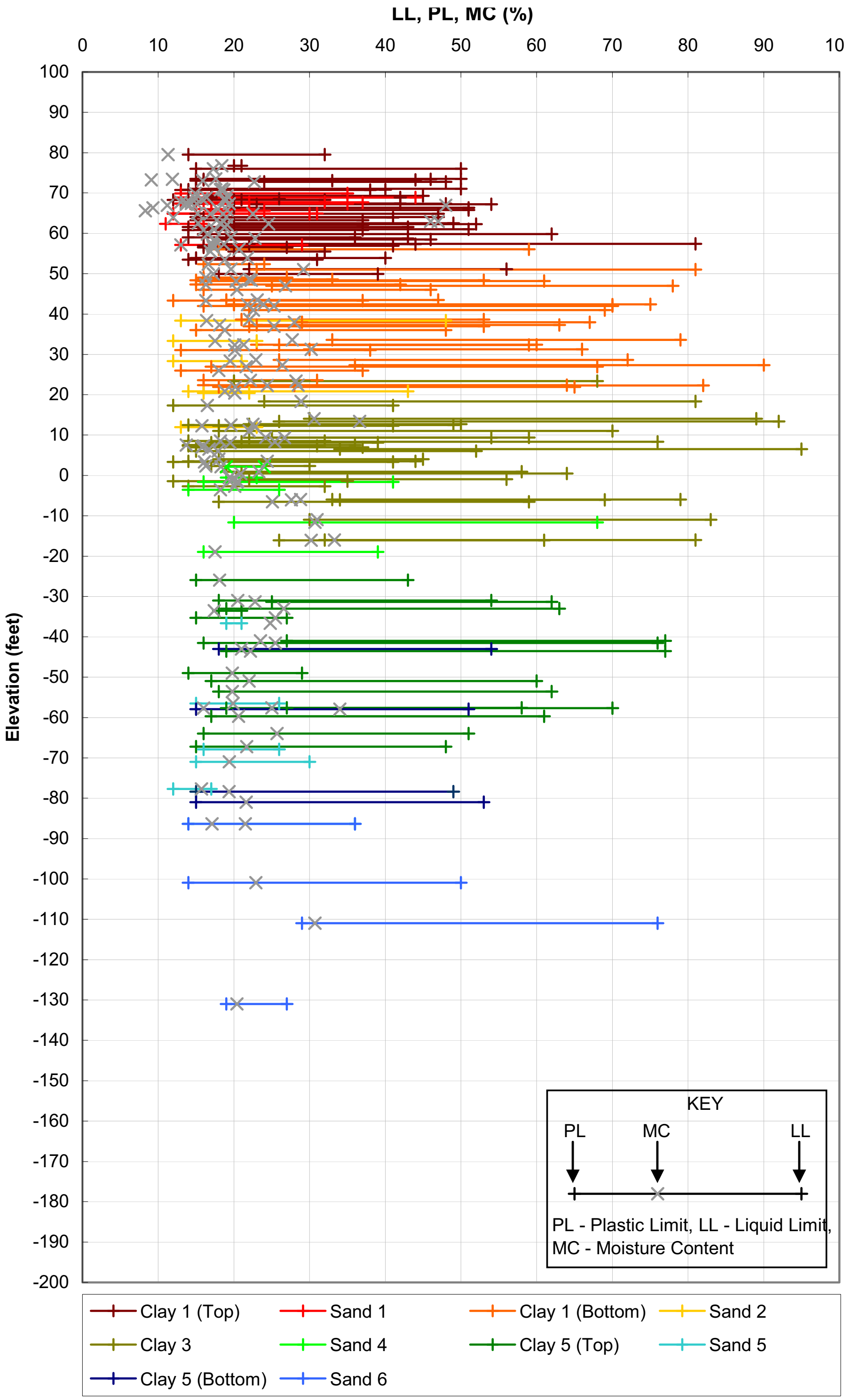


Figure 2.5.4-242 Atterberg Limits Test Results (Cooling Basin/GBRA Storage Water Reservoir)

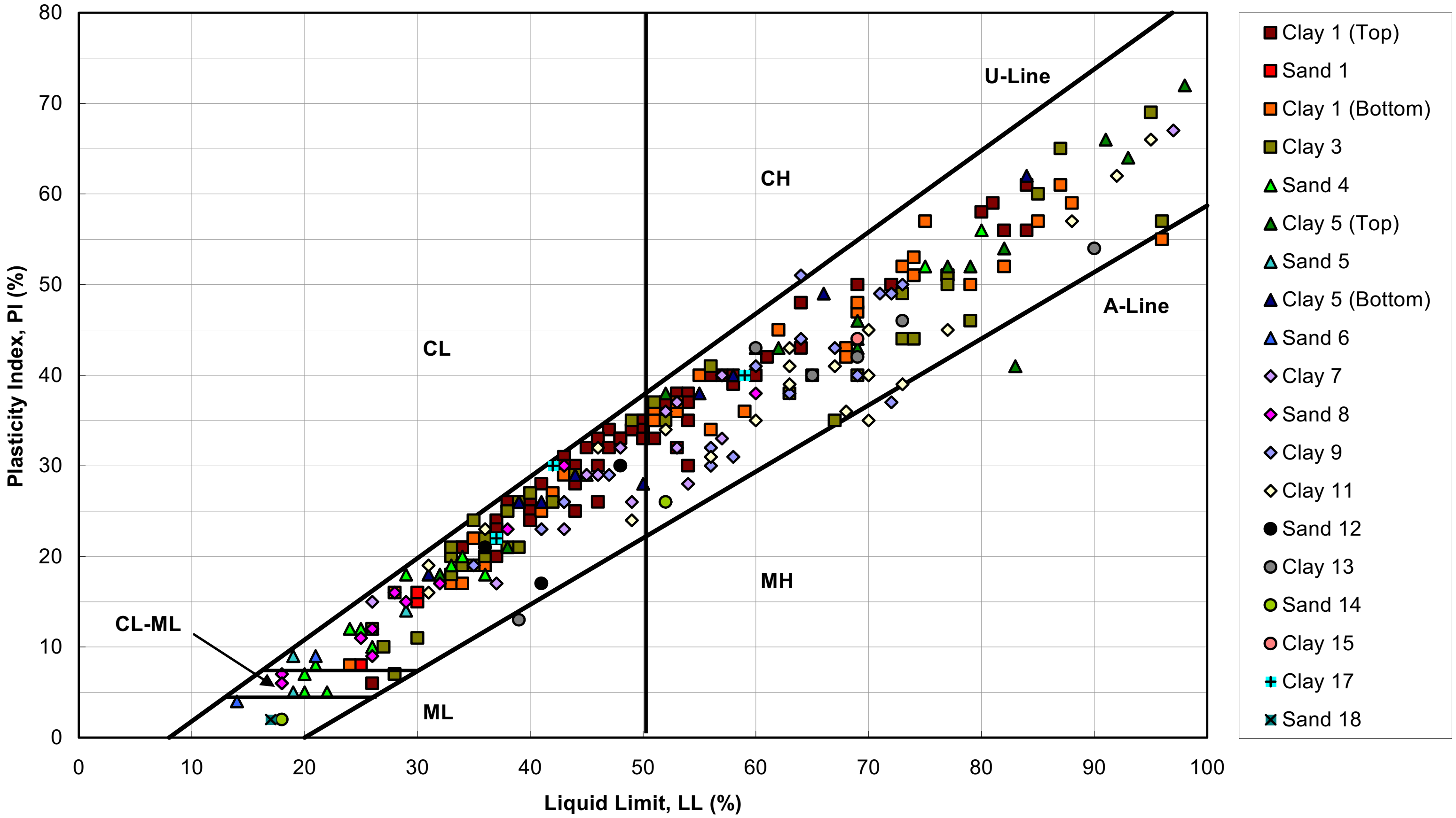


Figure 2.5.4-243 Plasticity Chart (Power Block)

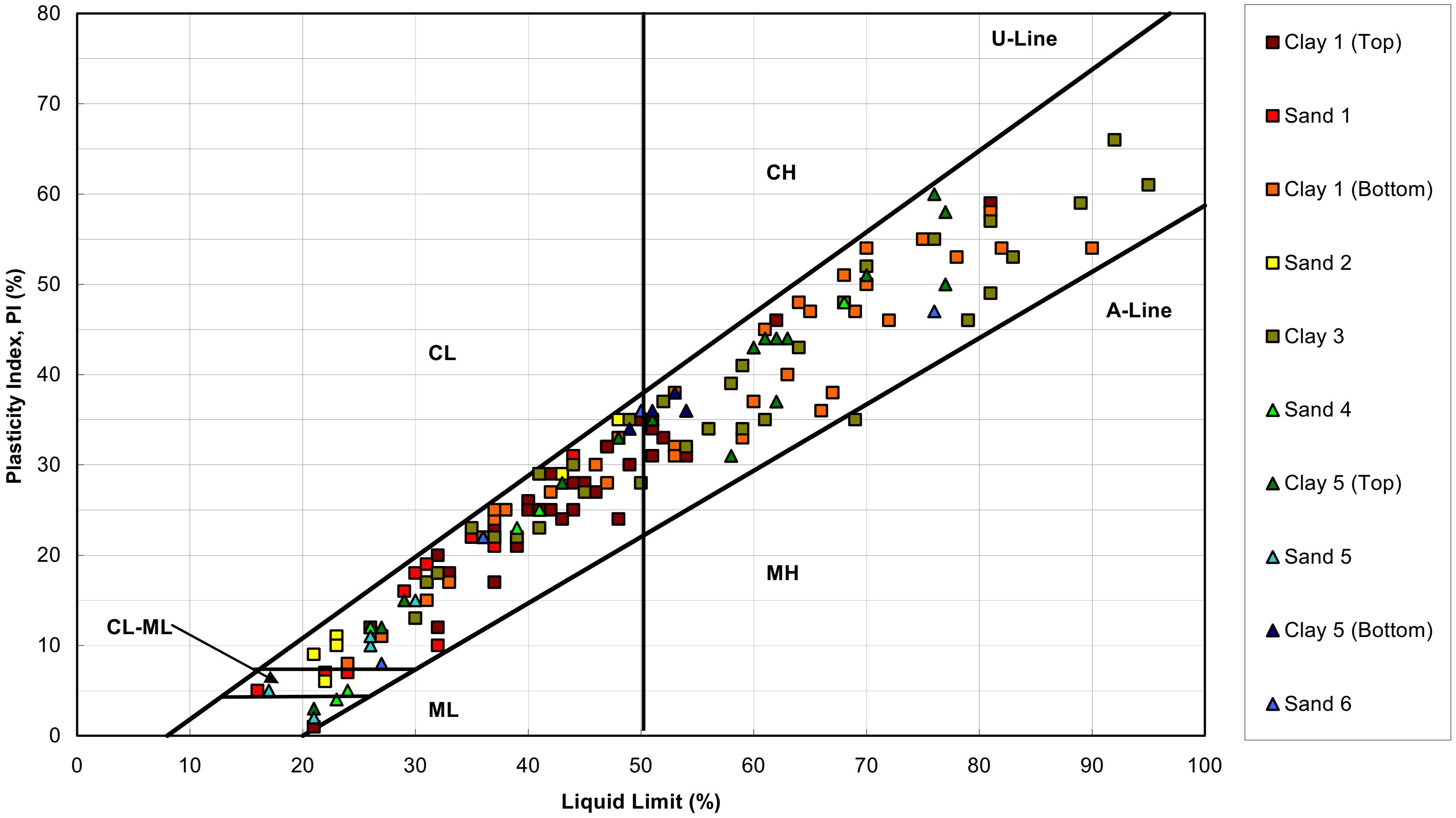


Figure 2.5.4-244 Plasticity Chart (Cooling Basin/GBRA Storage Water Reservoir)

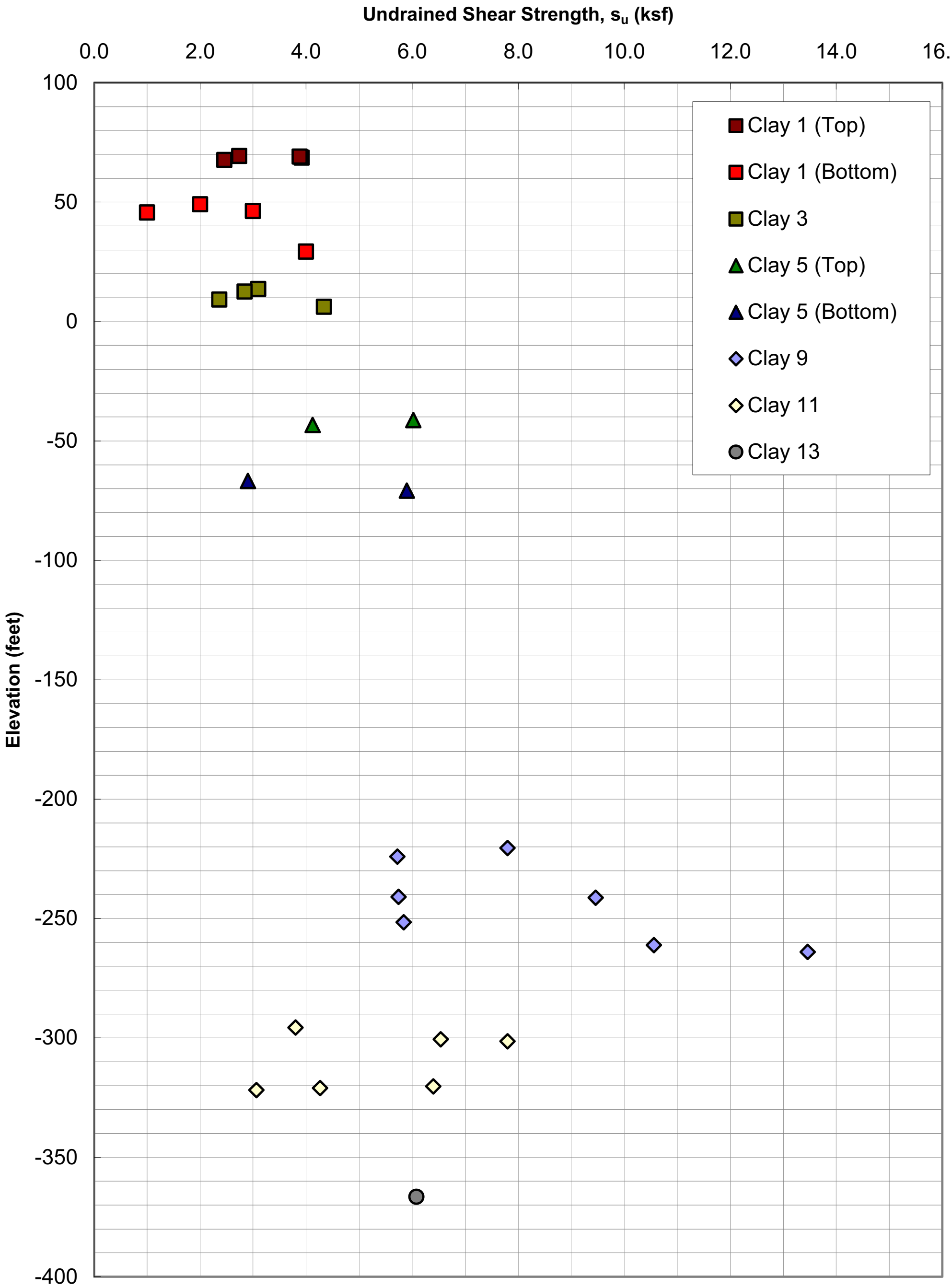


Figure 2.5.4-245 Undrained Shear Strengths of Cohesive Soil Strata from Laboratory Testing (Power Block)

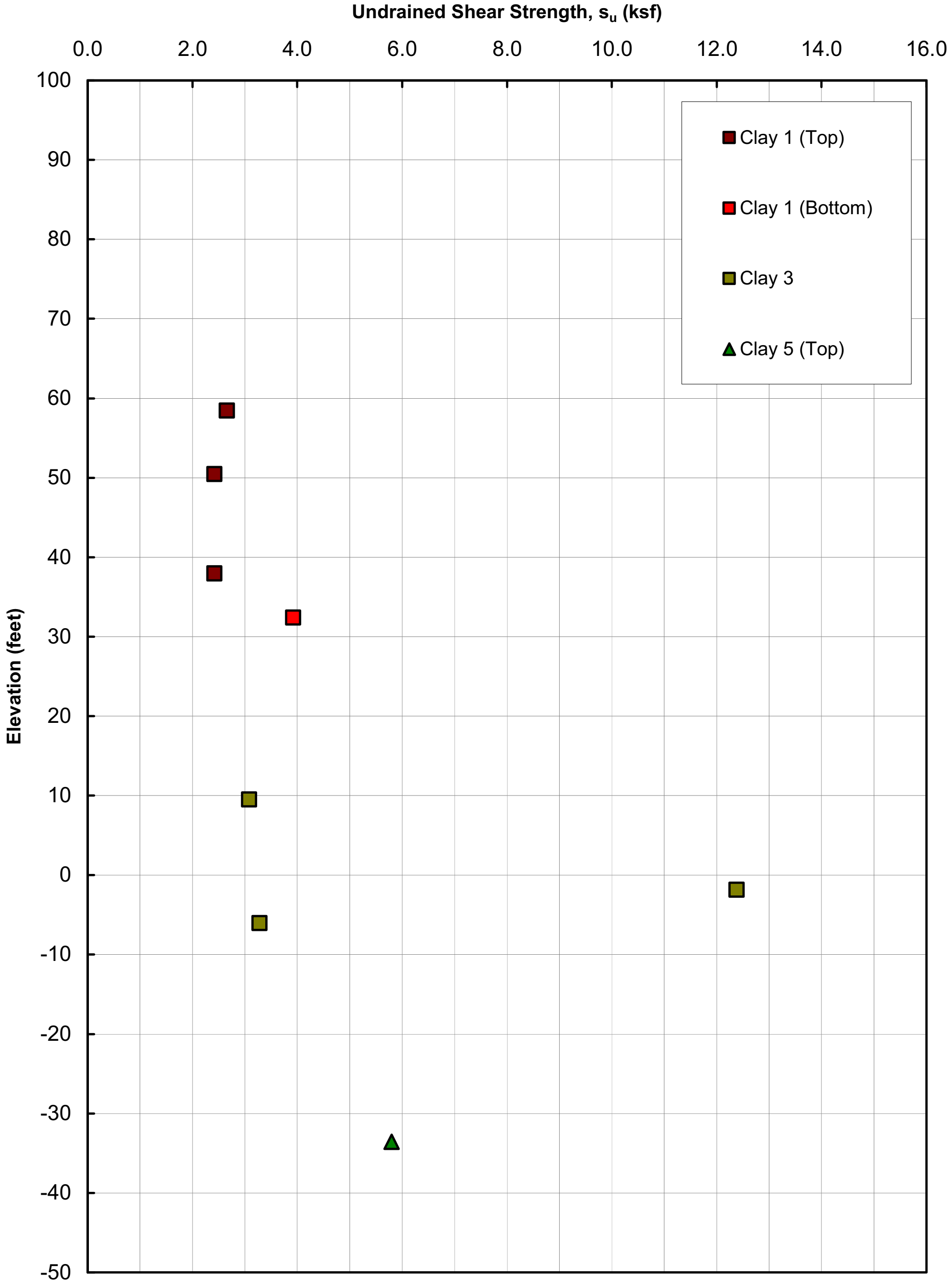
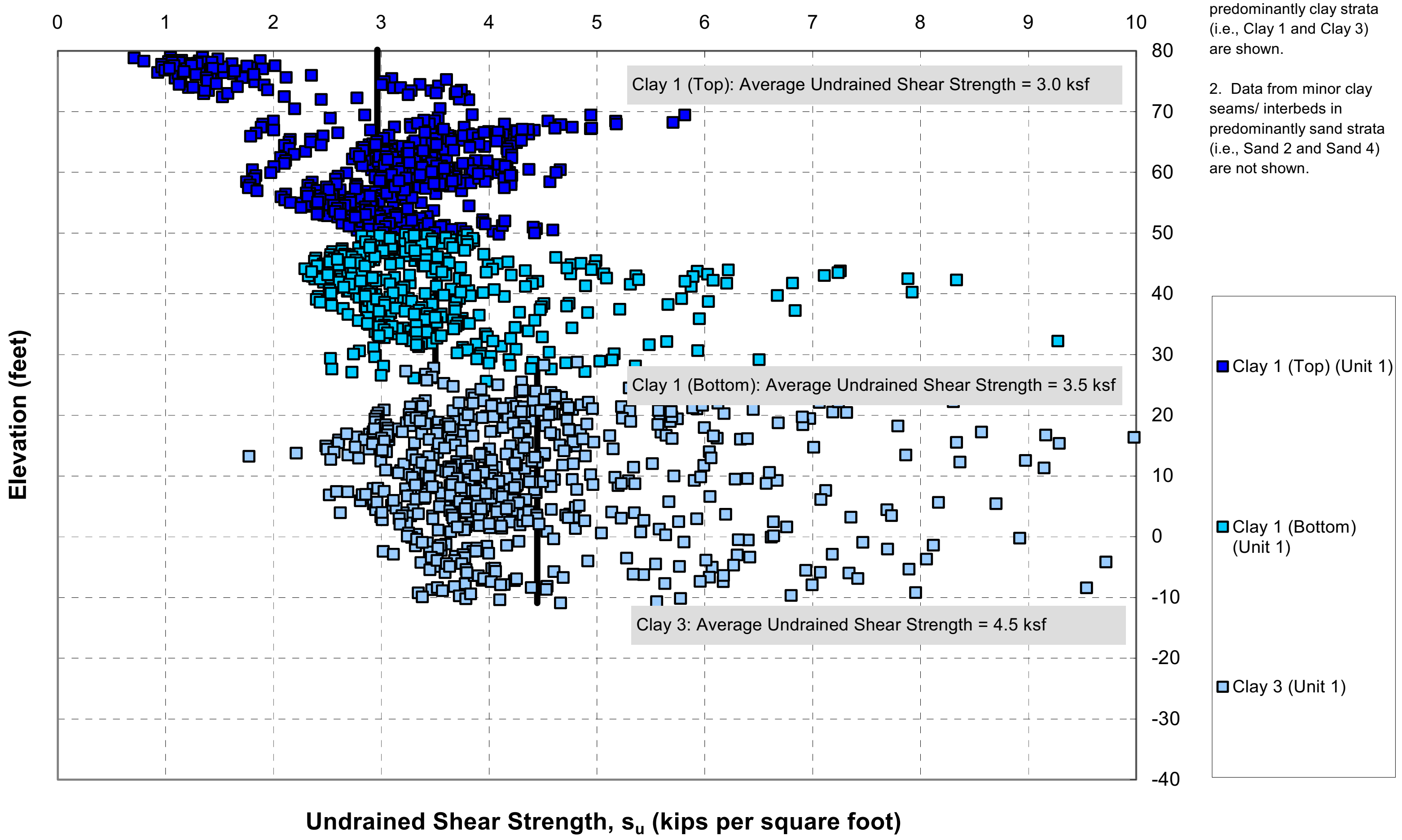


Figure 2.5.4-246 Undrained Shear Strengths of Cohesive Soil Strata from Laboratory Testing (Cooling Basin/GBRA Storage Water Reservoir)

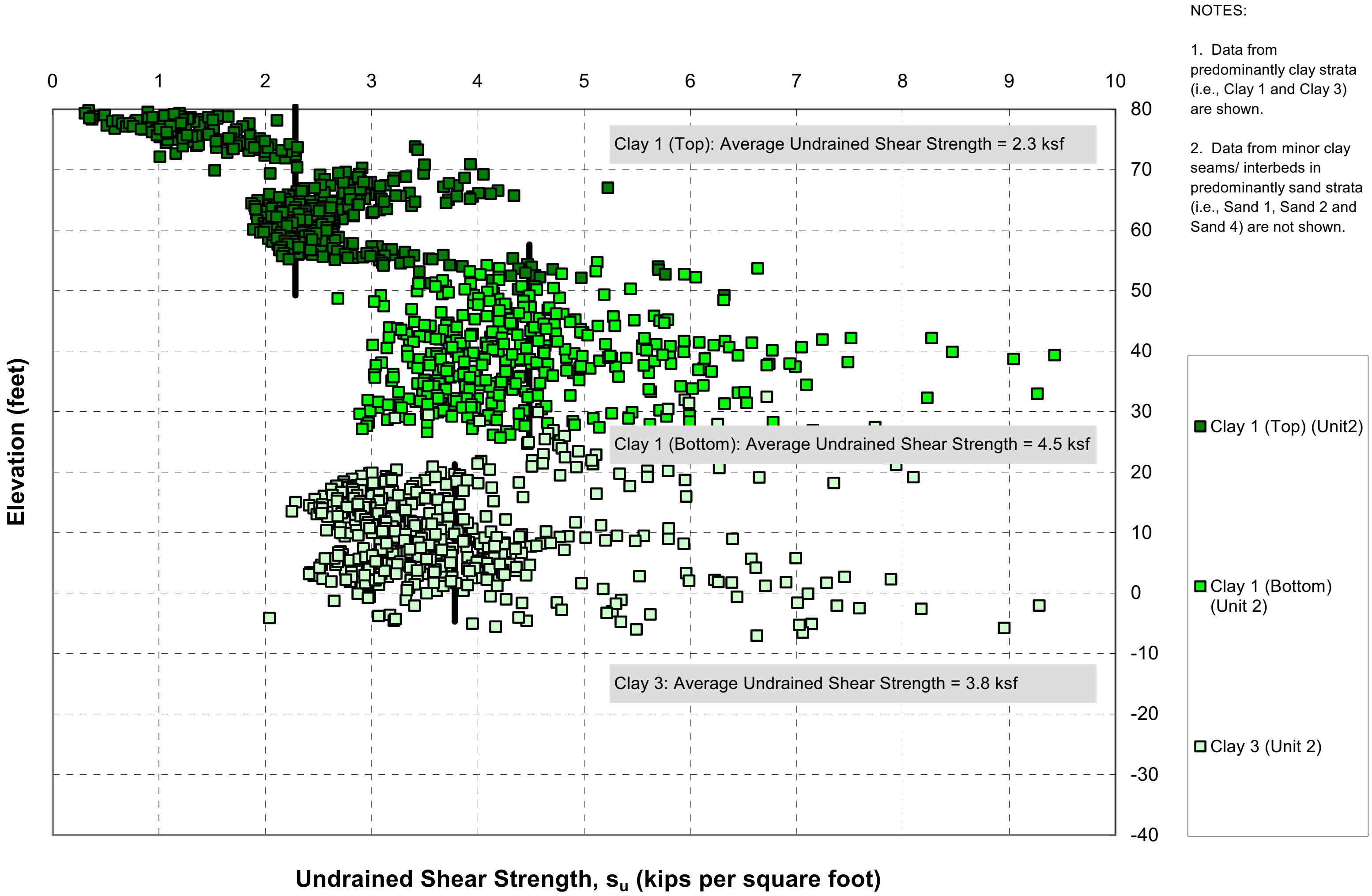


NOTES:

1. Data from predominantly clay strata (i.e., Clay 1 and Clay 3) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 2 and Sand 4) are not shown.

Figure 2.5.4-247 Undrained Shear Strengths of Cohesive Soil Strata from CPT Data; Unit 1 (Power Block)

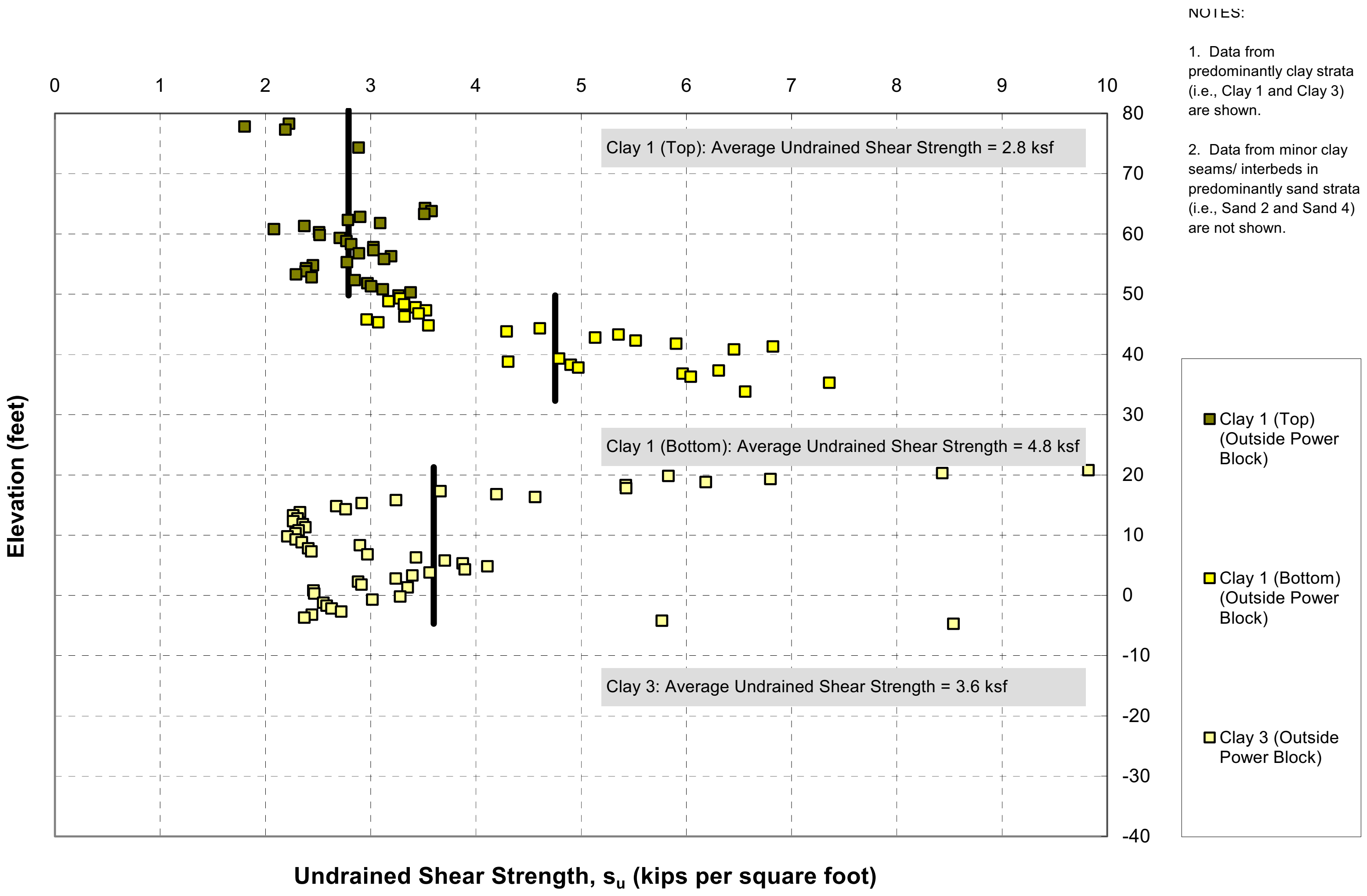


NOTES:

1. Data from predominantly clay strata (i.e., Clay 1 and Clay 3) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 1, Sand 2 and Sand 4) are not shown.

Figure 2.5.4-248 Undrained Shear Strengths of Cohesive Soil Strata from CPT Data; Unit 2 (Power Block)

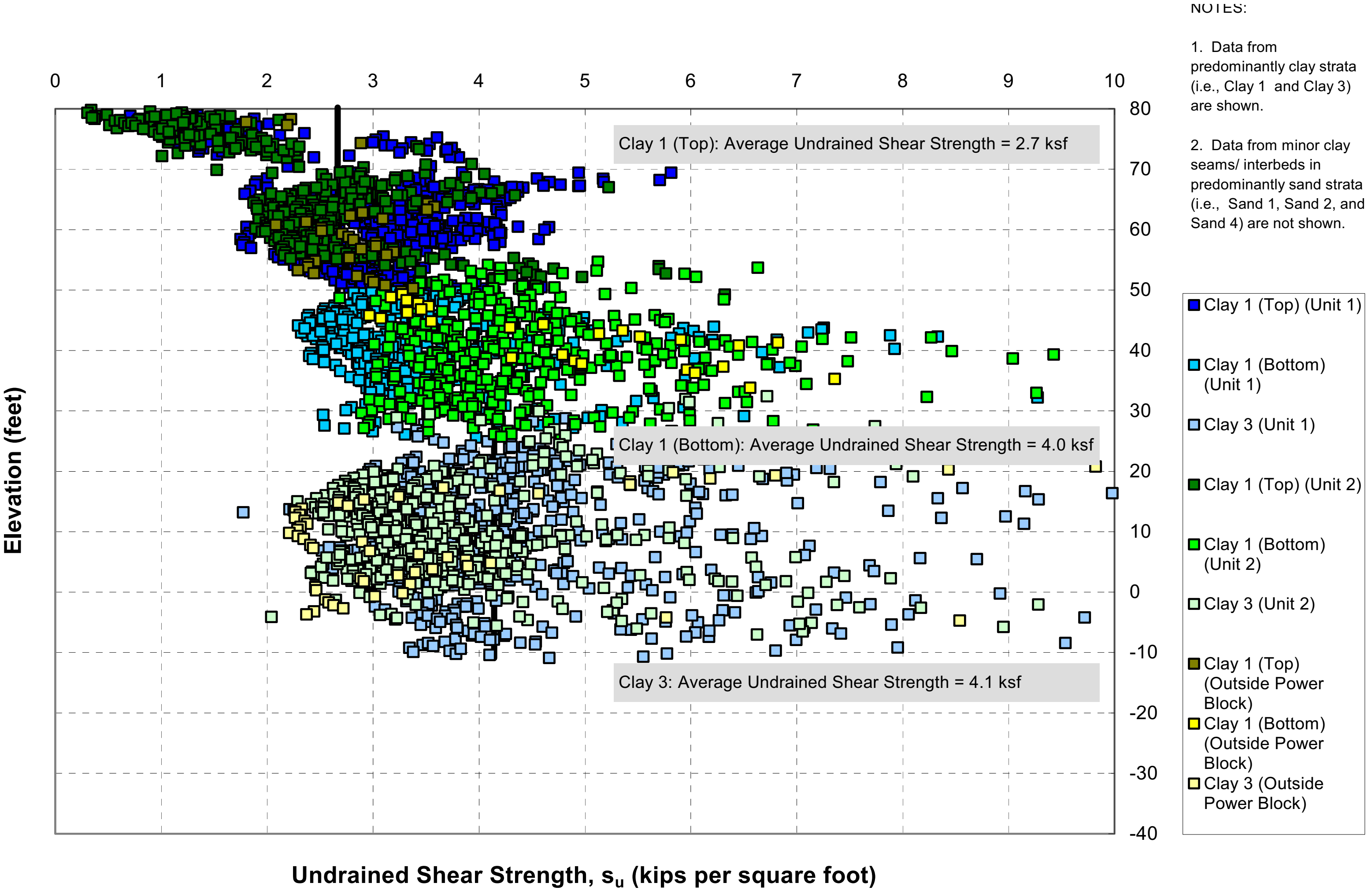


NOTES:

1. Data from predominantly clay strata (i.e., Clay 1 and Clay 3) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 2 and Sand 4) are not shown.

Figure 2.5.4-249 Undrained Shear Strengths of Cohesive Soil Strata from CPT Data; Investigations Outside Power Block

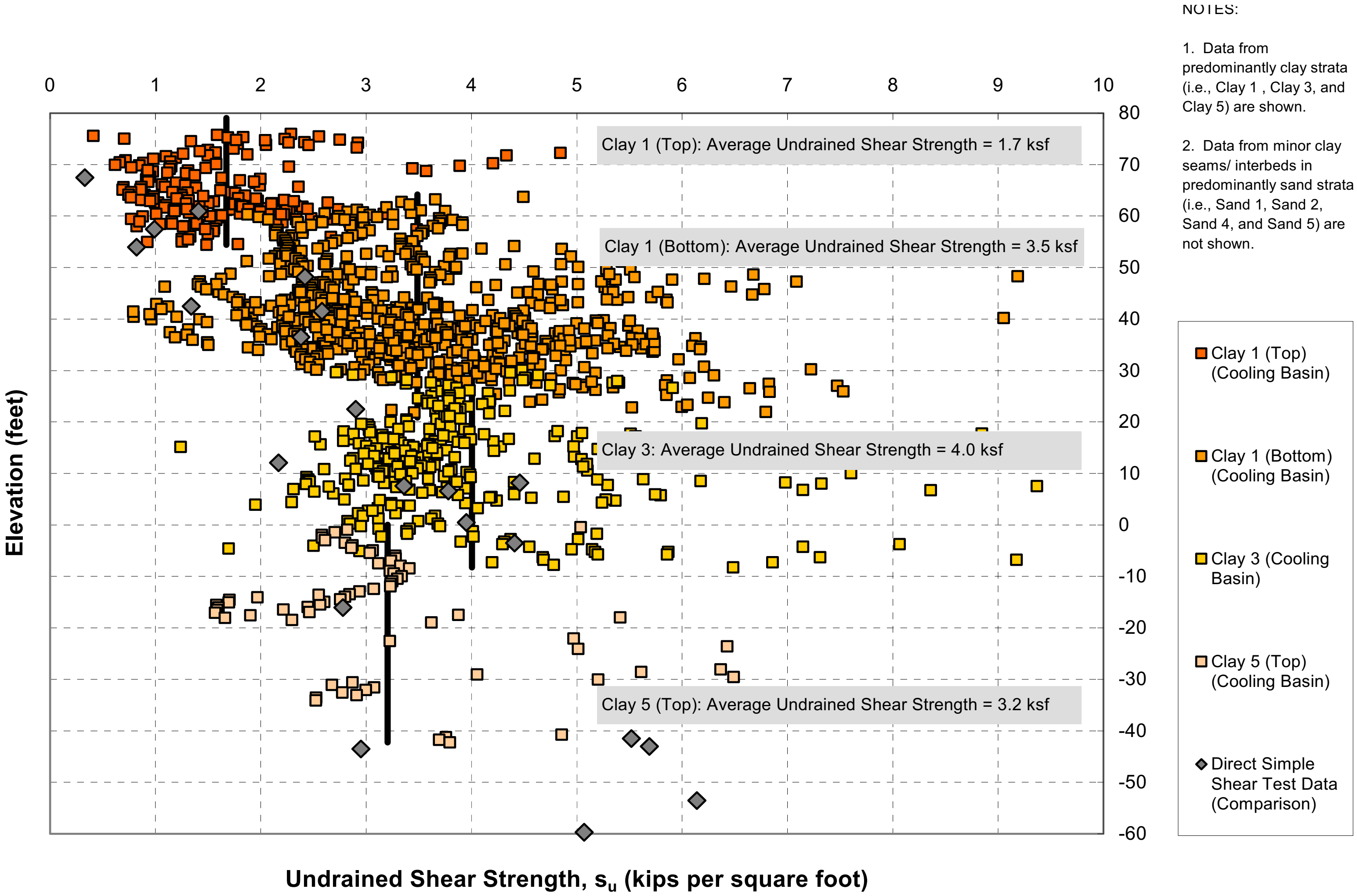


NOTES:

1. Data from predominantly clay strata (i.e., Clay 1 and Clay 3) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 1, Sand 2, and Sand 4) are not shown.

Figure 2.5.4-250 Undrained Shear Strengths of Cohesive Soil Strata from CPT Data; Unit 1, Unit 2, and Investigations Outside Power Block



Clay 1 (Top): Average Undrained Shear Strength = 1.7 ksf

Clay 1 (Bottom): Average Undrained Shear Strength = 3.5 ksf

Clay 3: Average Undrained Shear Strength = 4.0 ksf

Clay 5 (Top): Average Undrained Shear Strength = 3.2 ksf

NOTES:

1. Data from predominantly clay strata (i.e., Clay 1 , Clay 3, and Clay 5) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 1, Sand 2, Sand 4, and Sand 5) are not shown.

Figure 2.5.4-251 Undrained Shear Strengths of Cohesive Soil Strata from CPT Data (Cooling Basin/GBRA Storage Water Reservoir)

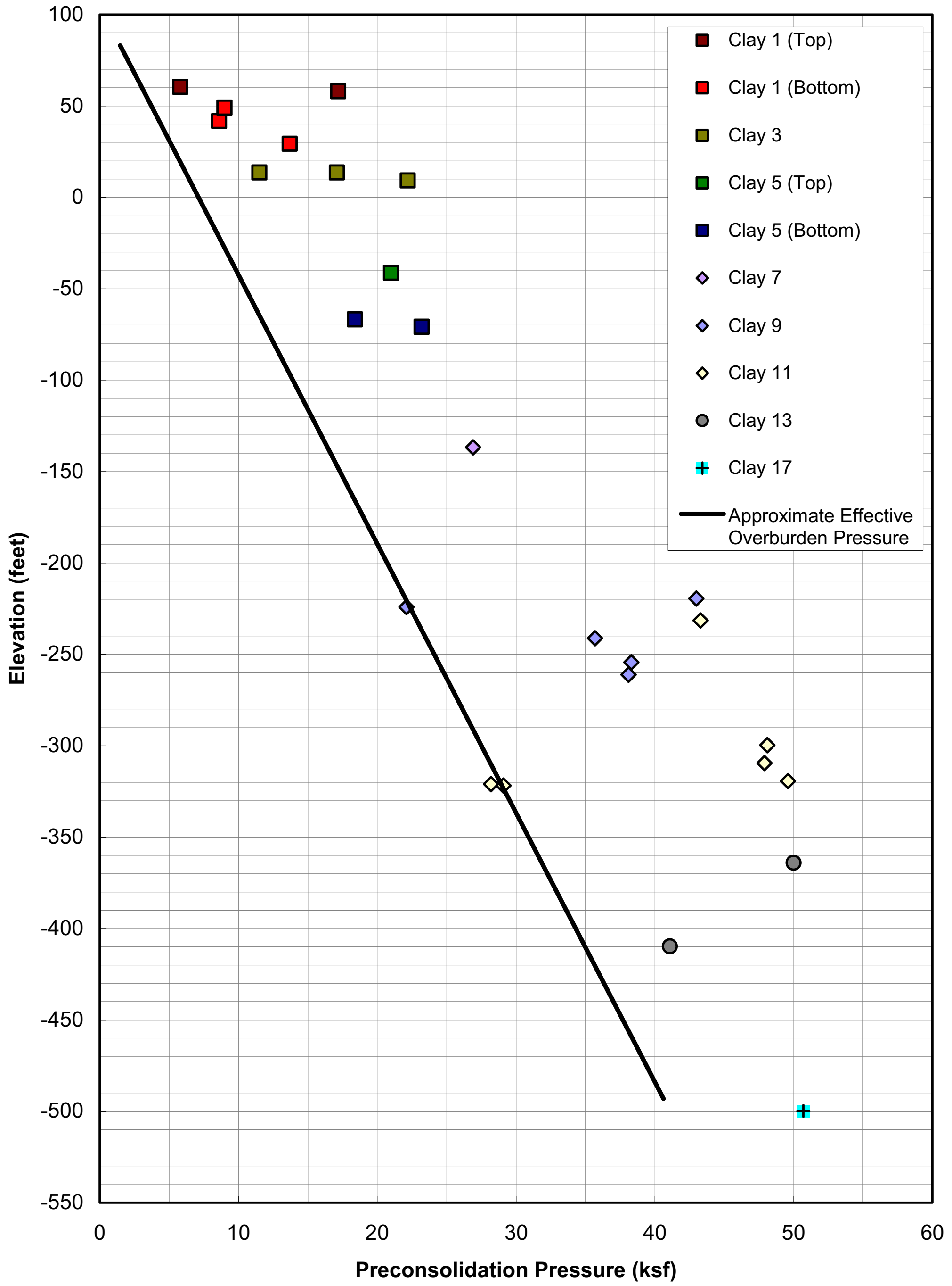


Figure 2.5.4-252 Preconsolidation Pressures (Pc') of Cohesive Soil Strata from Laboratory Testing (Power Block)

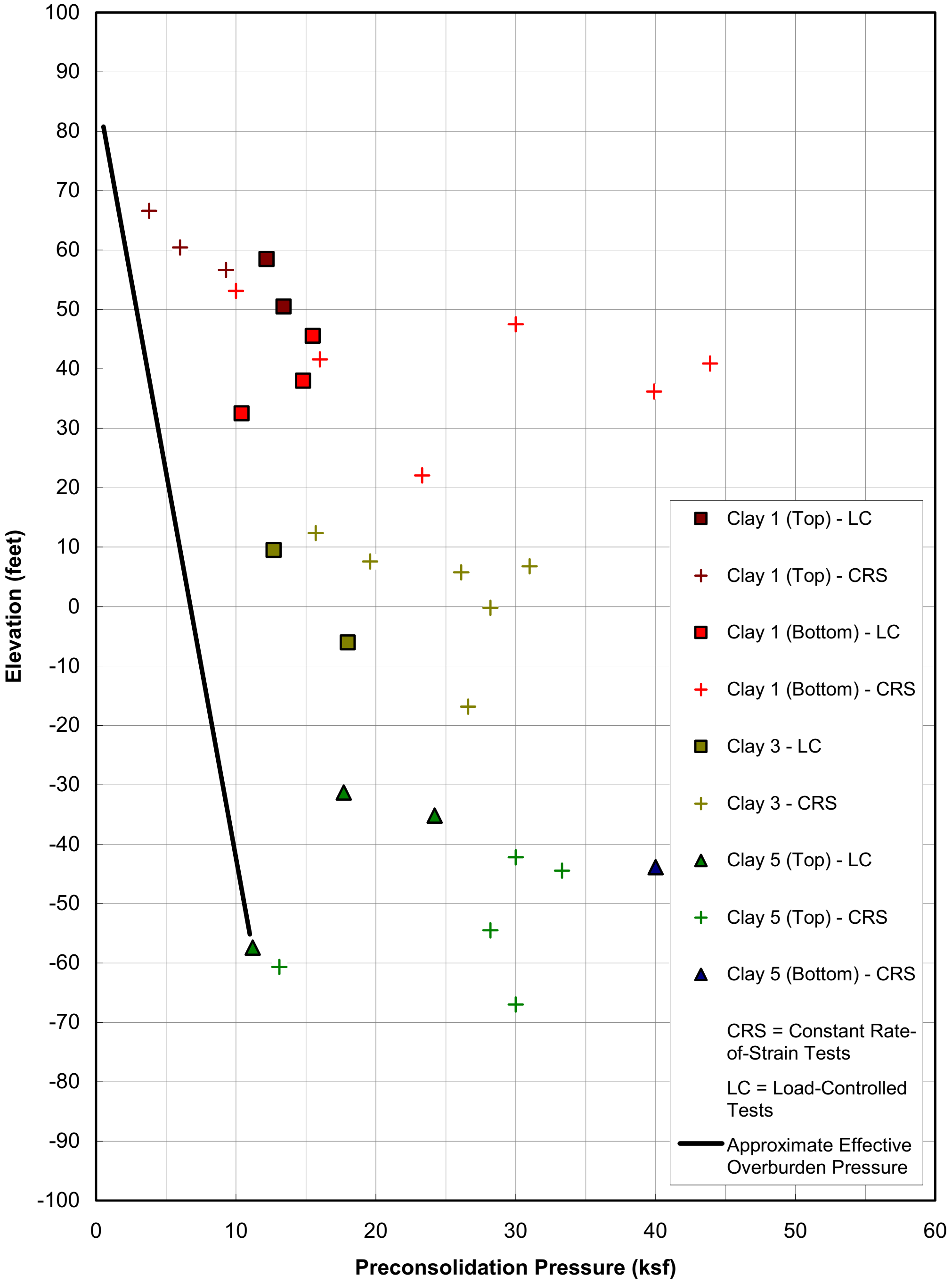


Figure 2.5.4-253 Preconsolidation Pressures (Pc') of Cohesive Soil Strata from Laboratory Testing (Cooling Basin/GBRA Storage Water Reservoir)

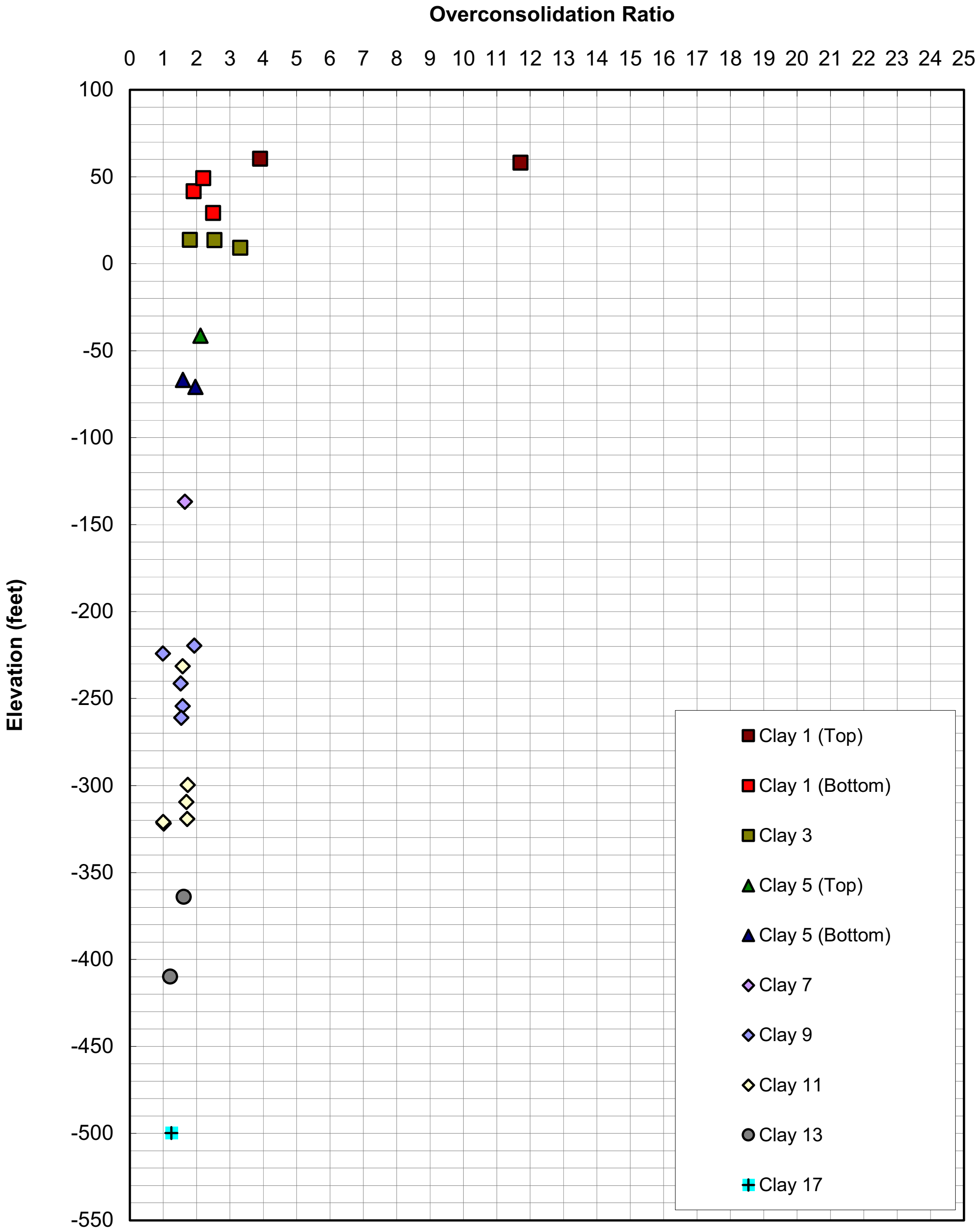


Figure 2.5.4-254 Overconsolidation Ratios of Cohesive Soil Strata from Laboratory Testing (Power Block)

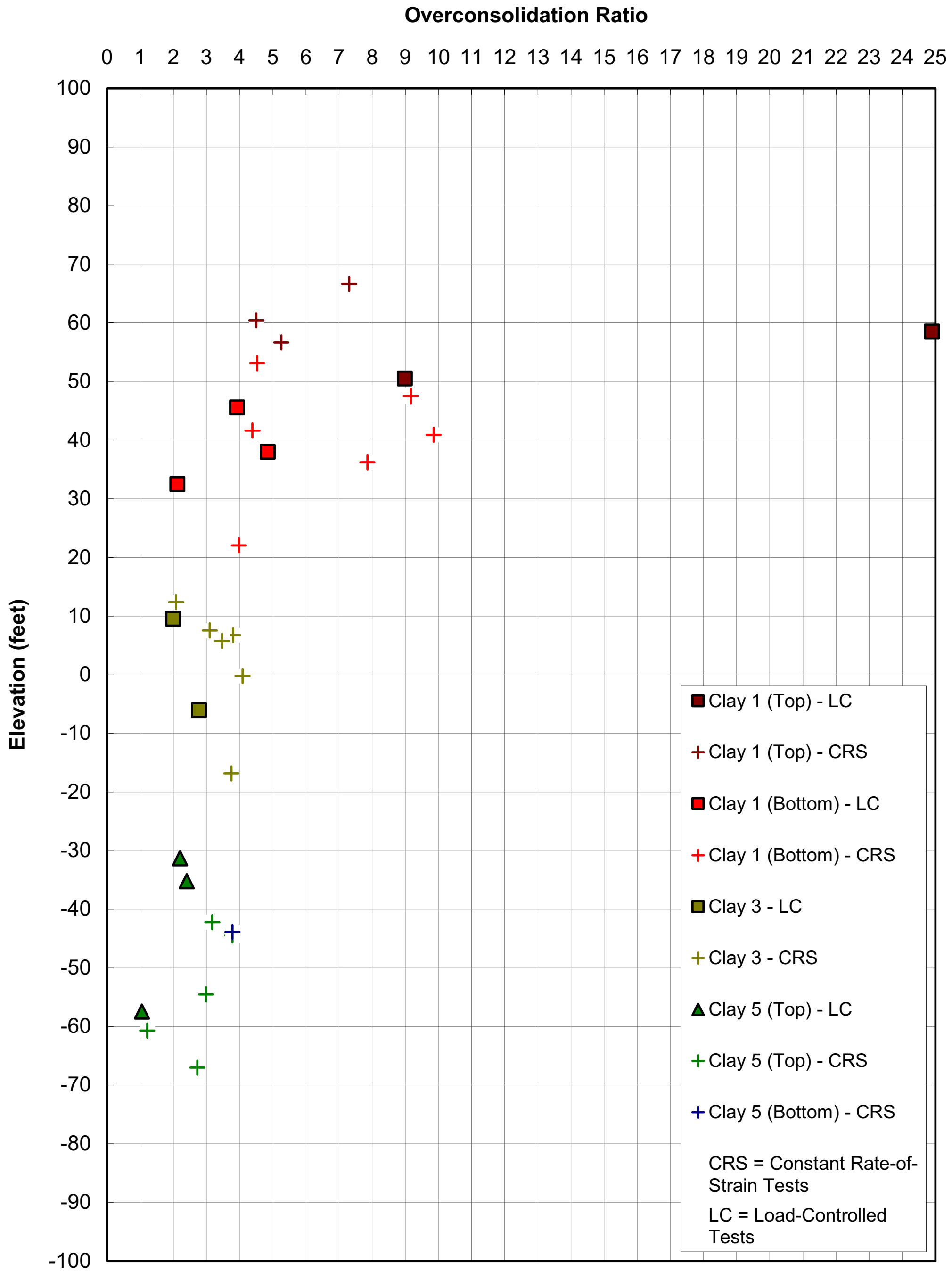
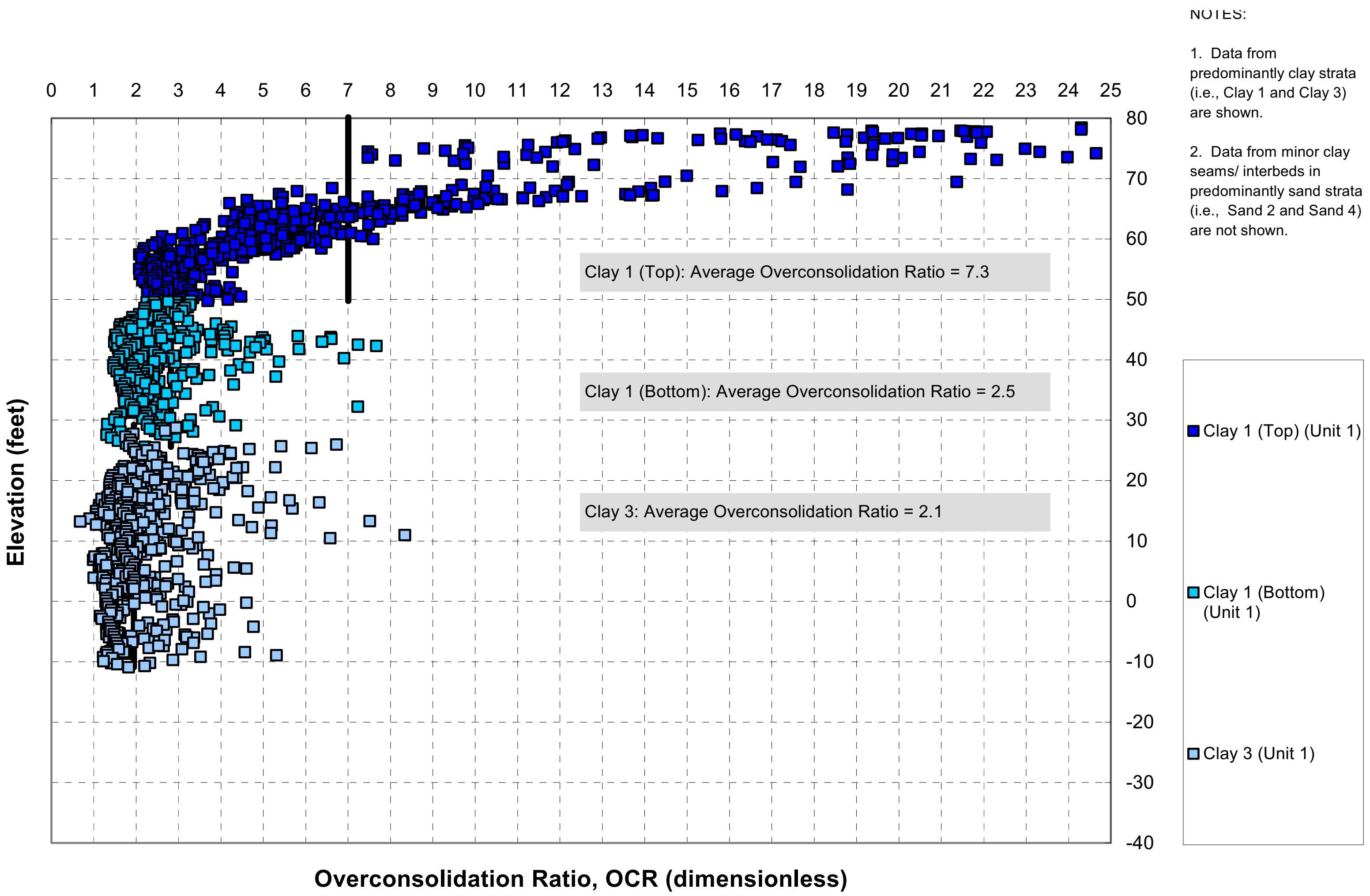


Figure 2.5.4-255 Overconsolidation Ratios of Cohesive Soil Strata from Laboratory Testing (Cooling Basin/GBRA Storage Water Reservoir)



NOTES:

1. Data from predominantly clay strata (i.e., Clay 1 and Clay 3) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 2 and Sand 4) are not shown.

Figure 2.5.4-256 Overconsolidation Ratios of Cohesive Soil Strata from CPT Data; Unit 1 (Power Block)

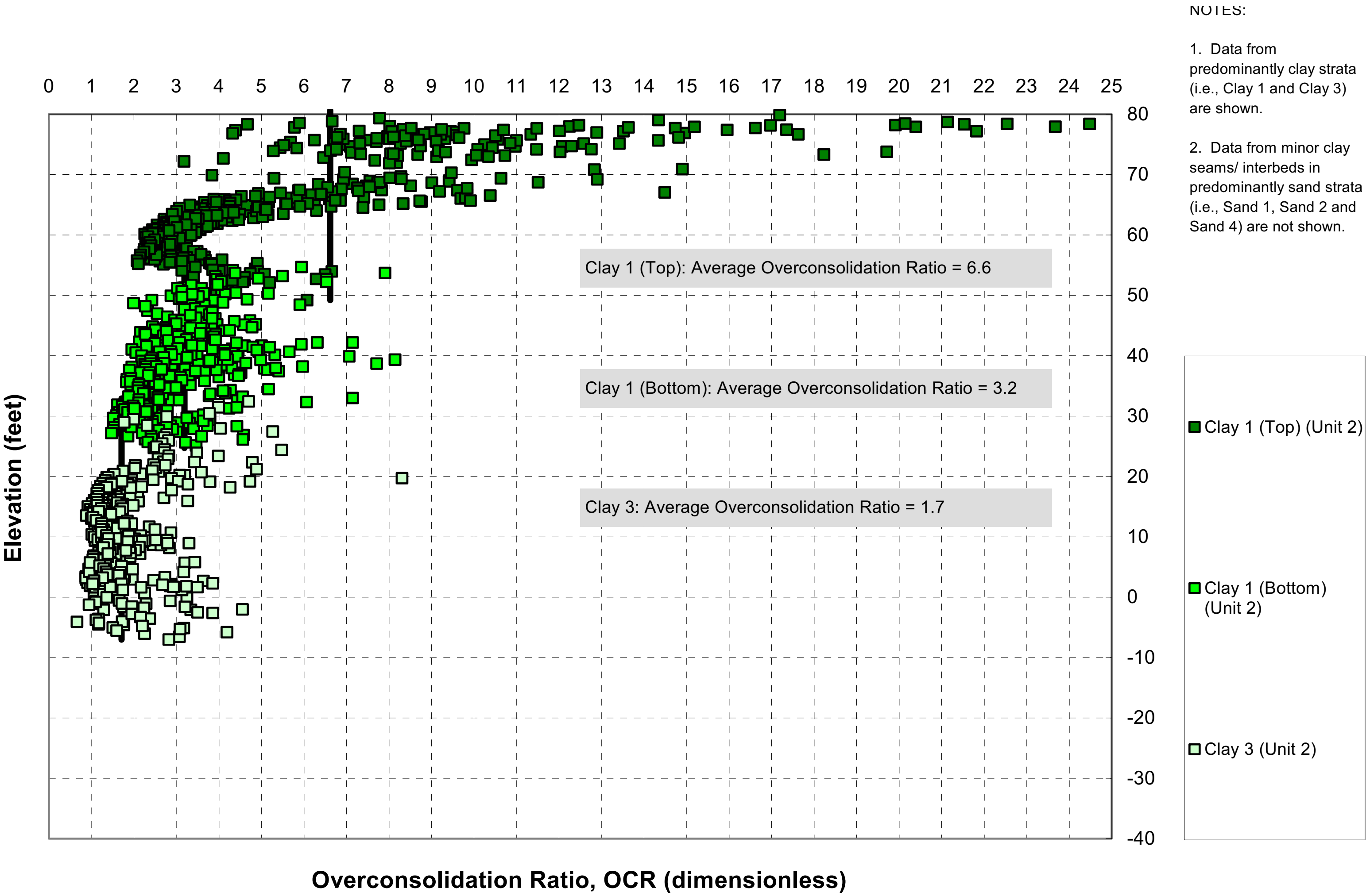
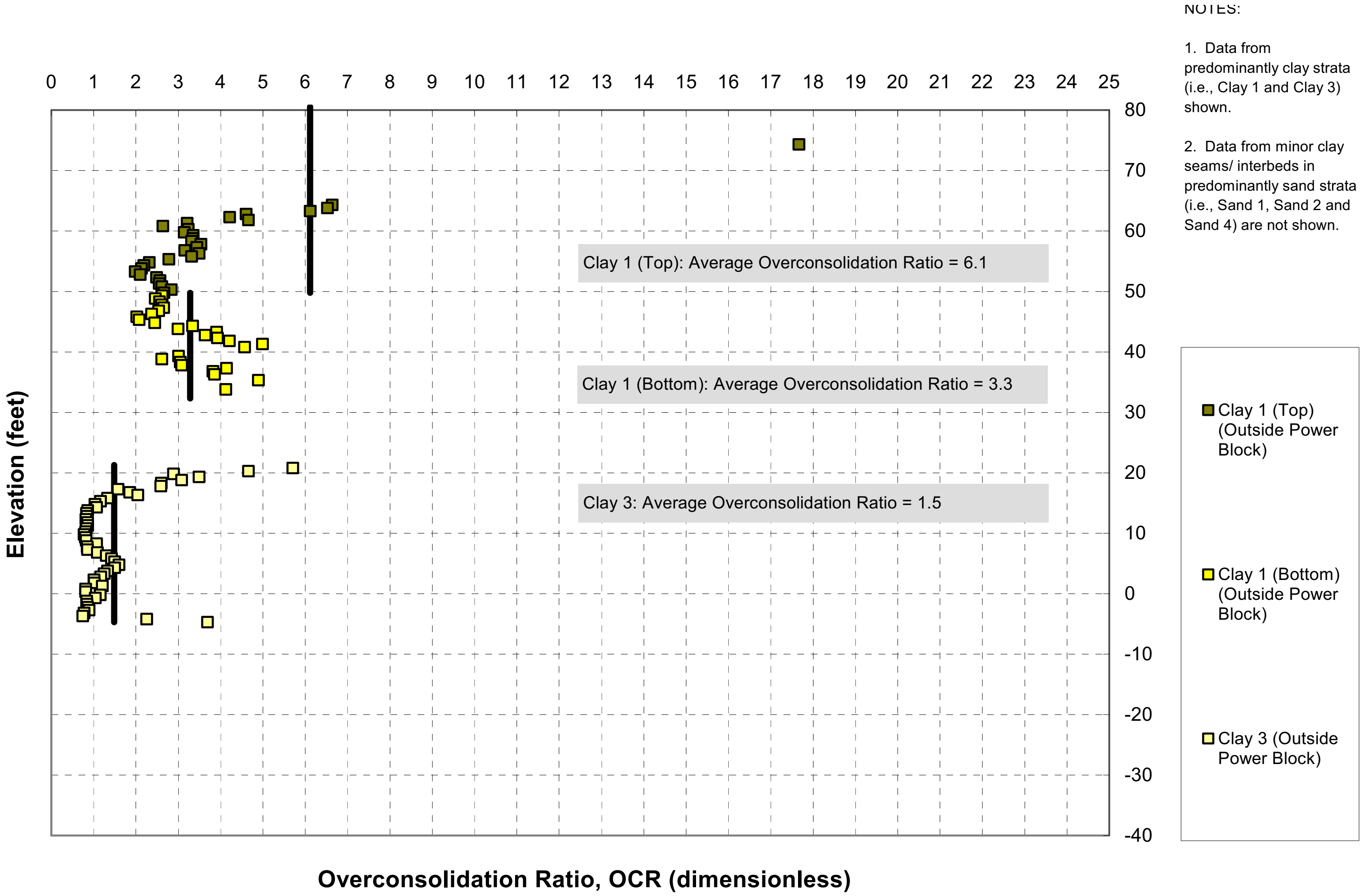


Figure 2.5.4-257 Overconsolidation Ratios of Cohesive Soil Strata from CPT Data; Unit 2 (Power Block)

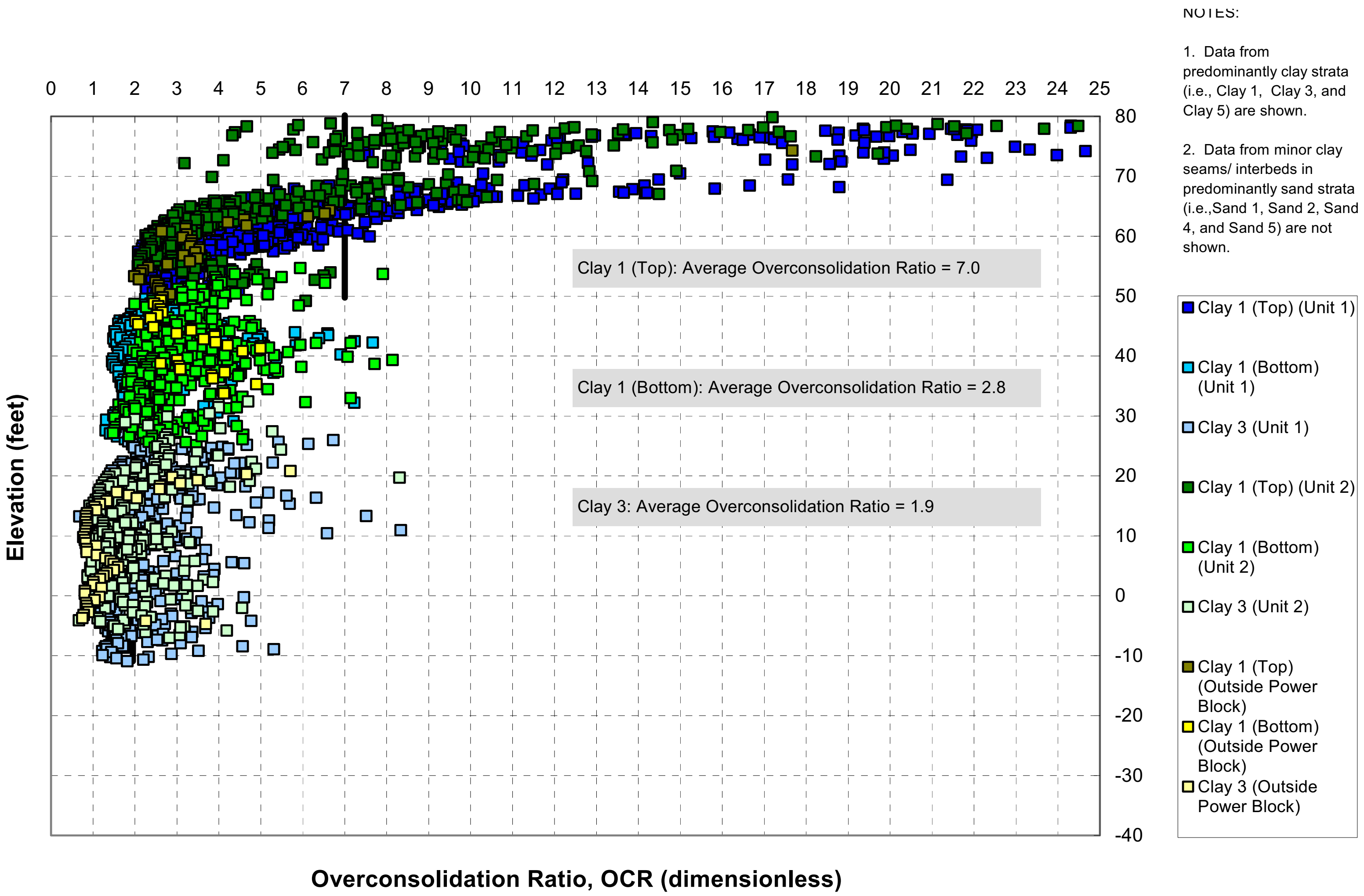


NOTES:

1. Data from predominantly clay strata (i.e., Clay 1 and Clay 3) shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 1, Sand 2 and Sand 4) are not shown.

Figure 2.5.4-258 Overconsolidation Ratios of Cohesive Soil Strata from CPT Data; Investigations Outside Power Block



NOTES:

1. Data from predominantly clay strata (i.e., Clay 1, Clay 3, and Clay 5) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e.,Sand 1, Sand 2, Sand 4, and Sand 5) are not shown.

Figure 2.5.4-259 Overconsolidation Ratios of Cohesive Soil Strata from CPT Data; Unit 1, Unit 2, and Investigations Outside Power Block

NOTES:

1. Data from predominantly clay strata (i.e., Clay 1, Clay 3, and Clay 5) are shown.

2. Data from minor clay seams/ interbeds in predominantly sand strata (i.e., Sand 1, Sand 2, Sand 4, and Sand 5) are not shown.

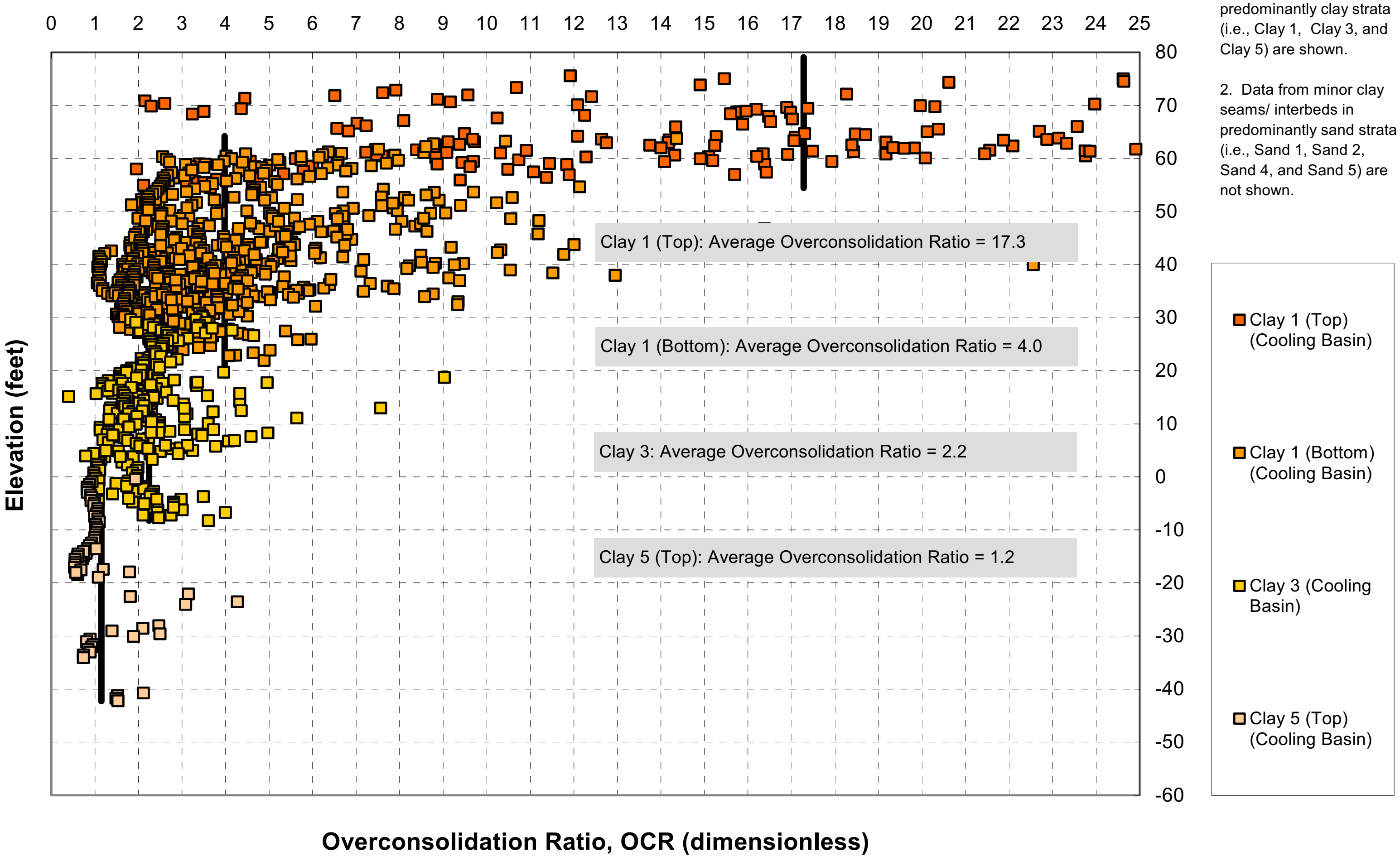


Figure 2.5.4-260 Overconsolidation Ratios of Cohesive Soil Strata from CPT Data (Cooling Basin/GBRA Storage Water Reservoir)

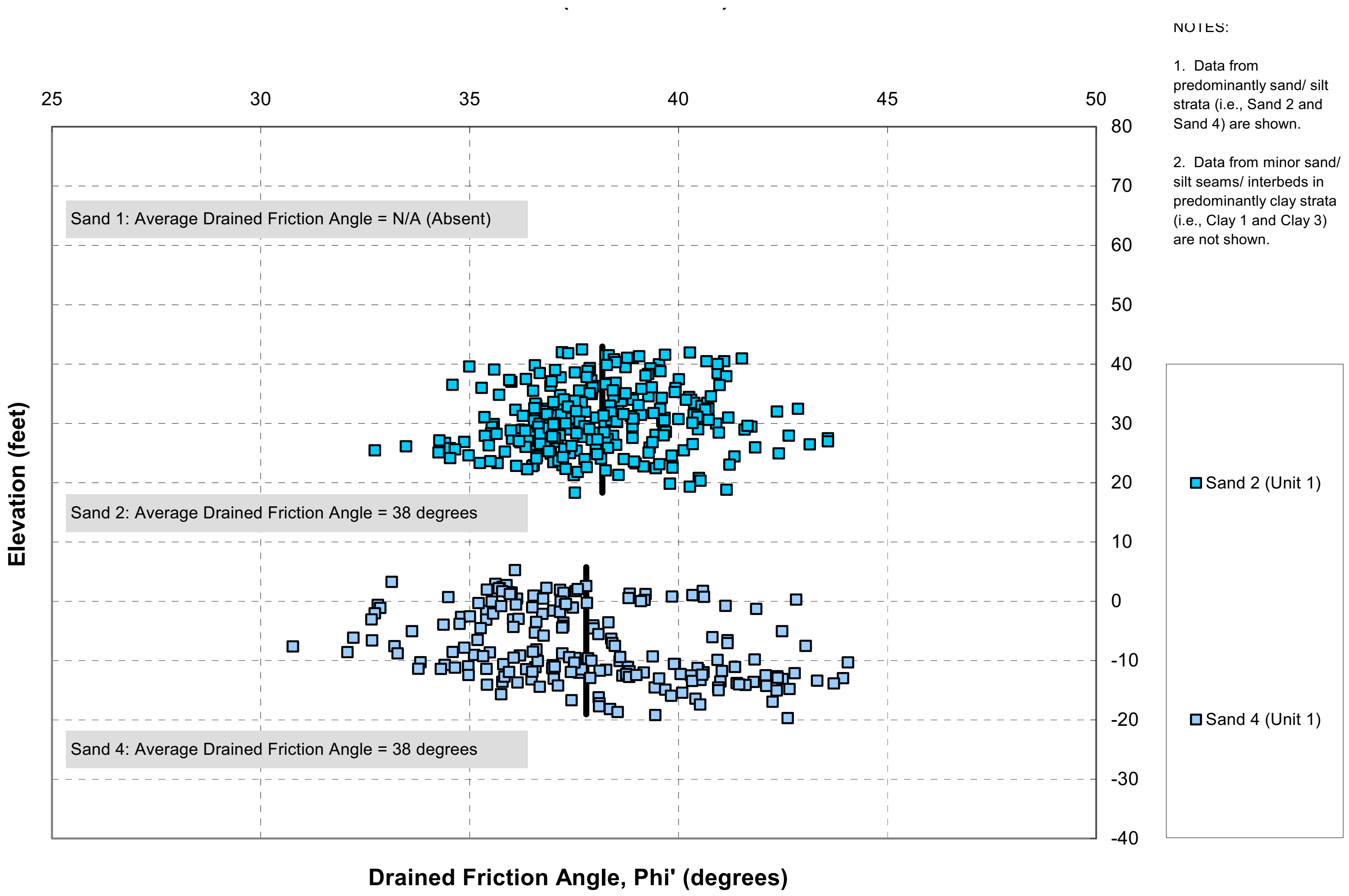
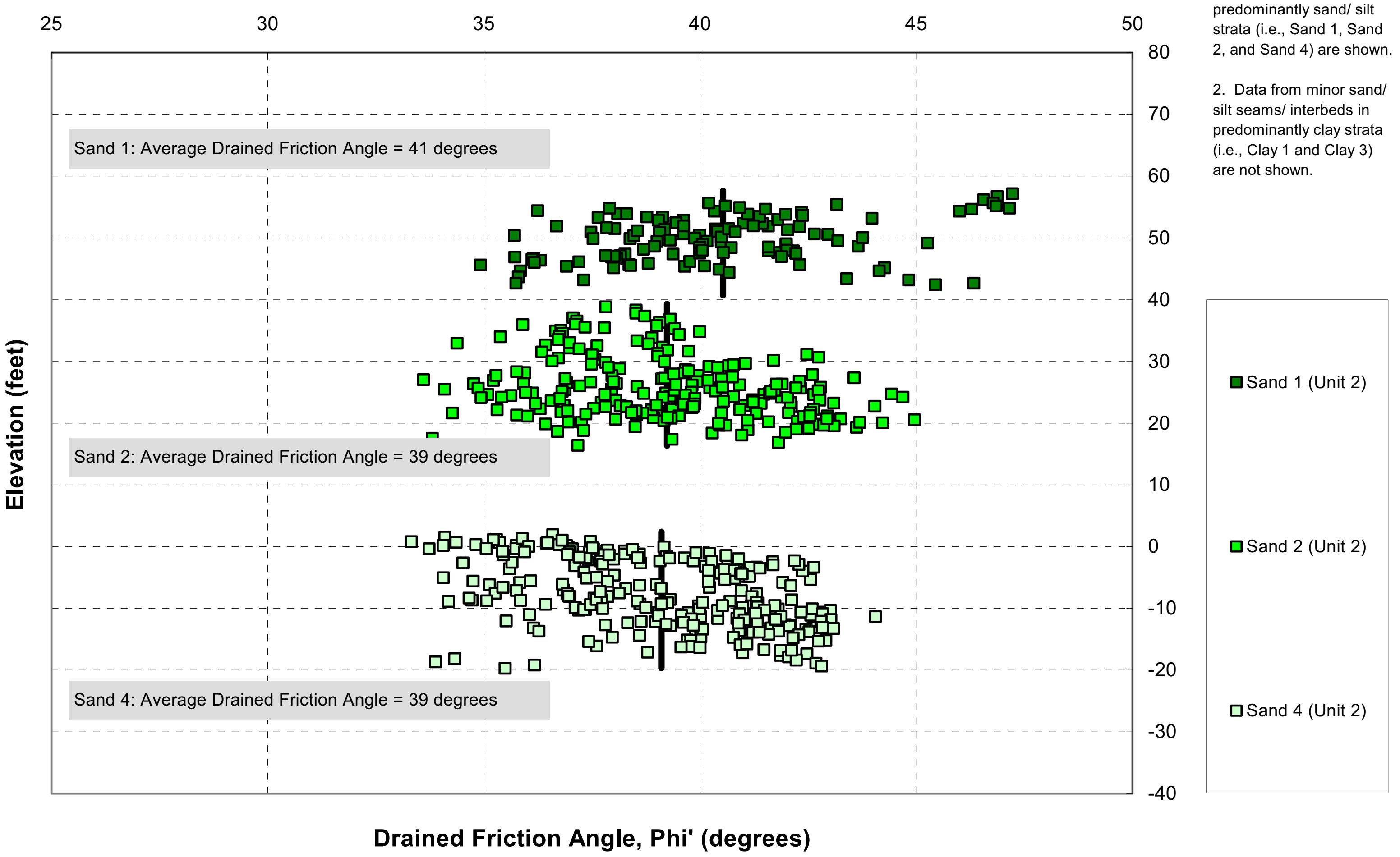


Figure 2.5.4-261 Drained Friction Angles (Phi') of Cohesionless Soil Strata from CPT Data; Unit 1 (Power Block)

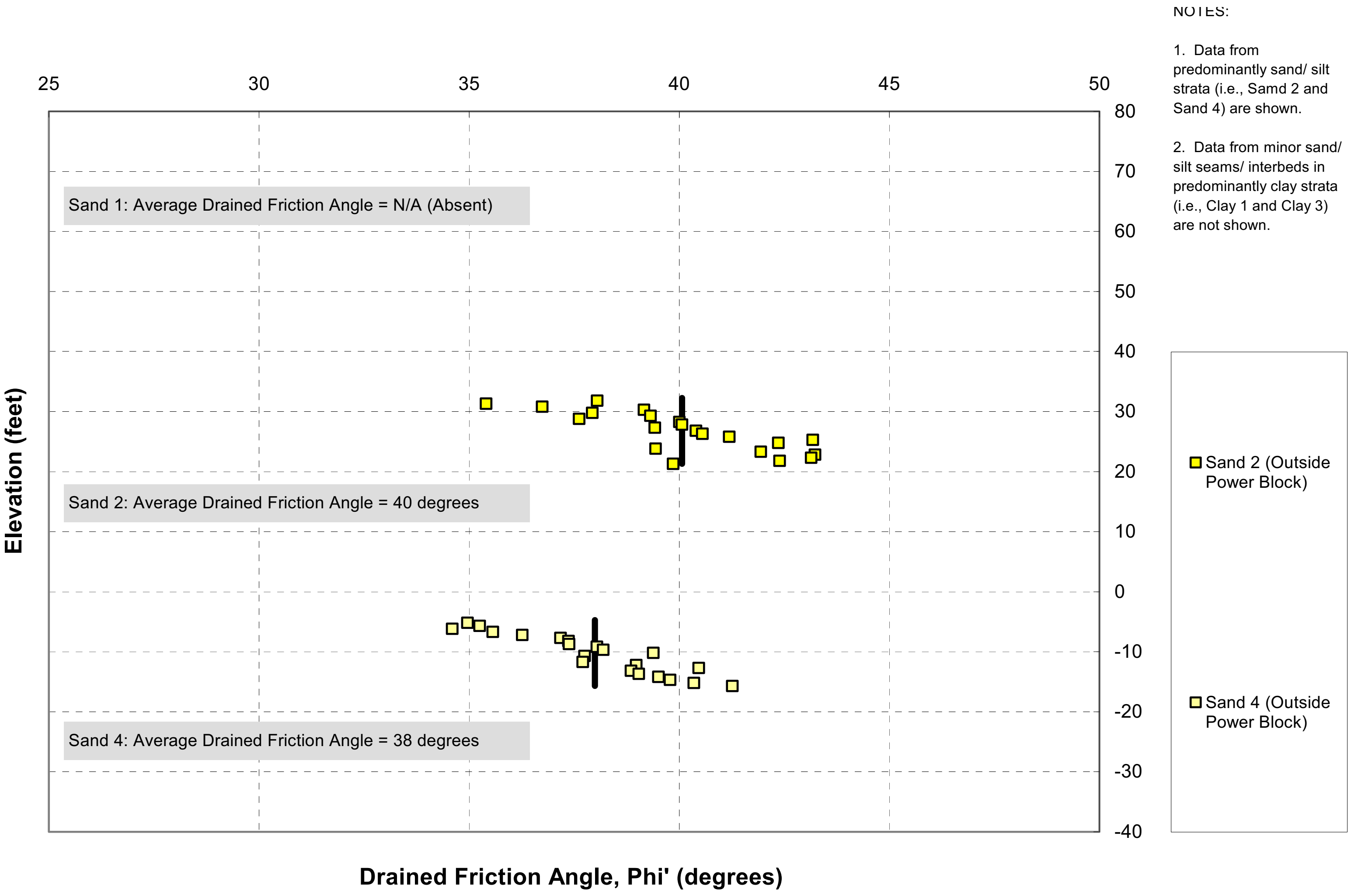


NOTES:

1. Data from predominantly sand/ silt strata (i.e., Sand 1, Sand 2, and Sand 4) are shown.

2. Data from minor sand/ silt seams/ interbeds in predominantly clay strata (i.e., Clay 1 and Clay 3) are not shown.

Figure 2.5.4-262 Drained Friction Angles (Phi') of Cohesionless Soil Strata from CPT Data; Unit 2 (Power Block)

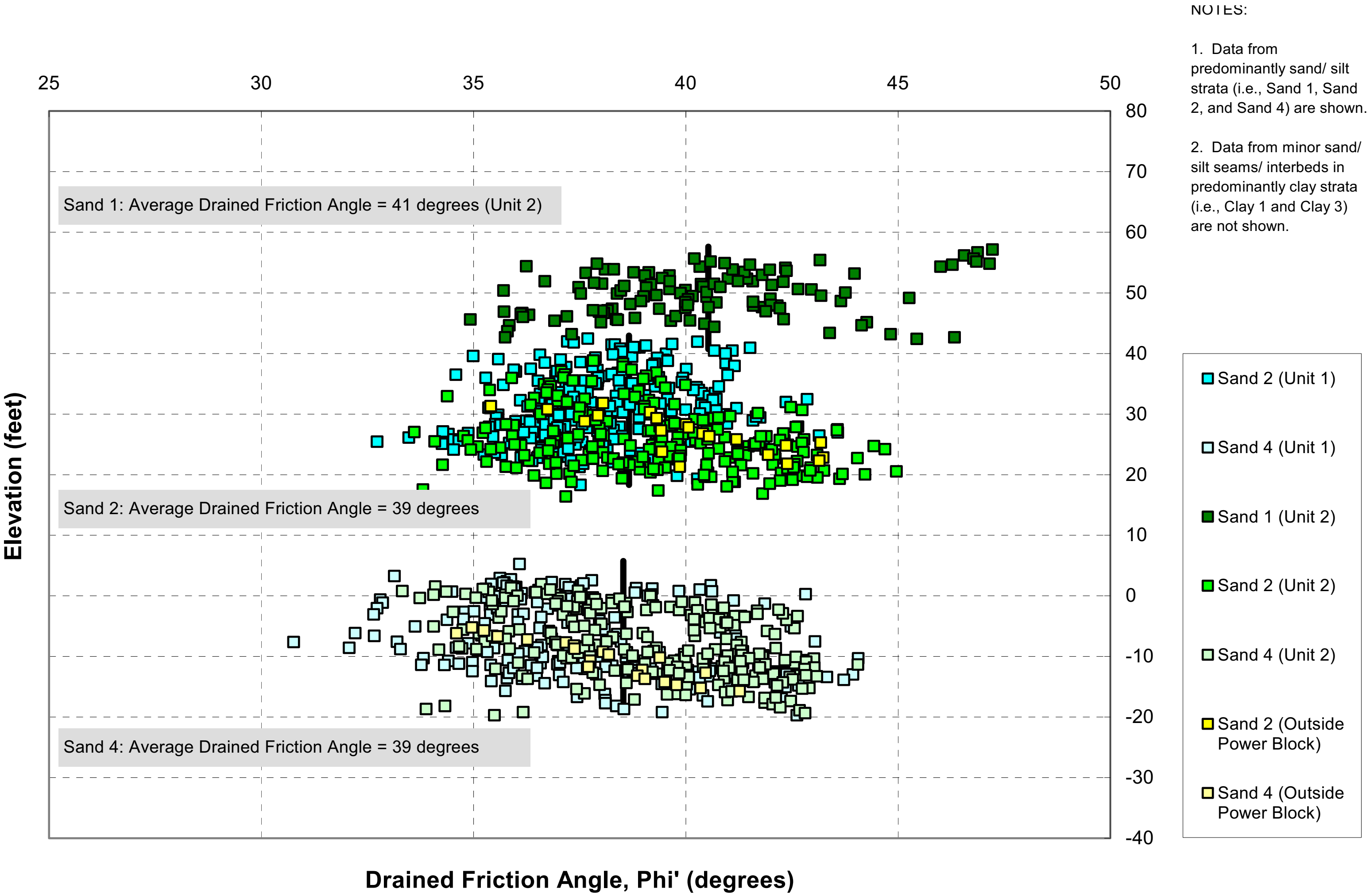


NOTES:

1. Data from predominantly sand/ silt strata (i.e., Samd 2 and Sand 4) are shown.

2. Data from minor sand/ silt seams/ interbeds in predominantly clay strata (i.e., Clay 1 and Clay 3) are not shown.

Figure 2.5.4-263 Drained Friction Angles (Phi') of Cohesionless Soil Strata from CPT Data; Investigations Outside Power Block

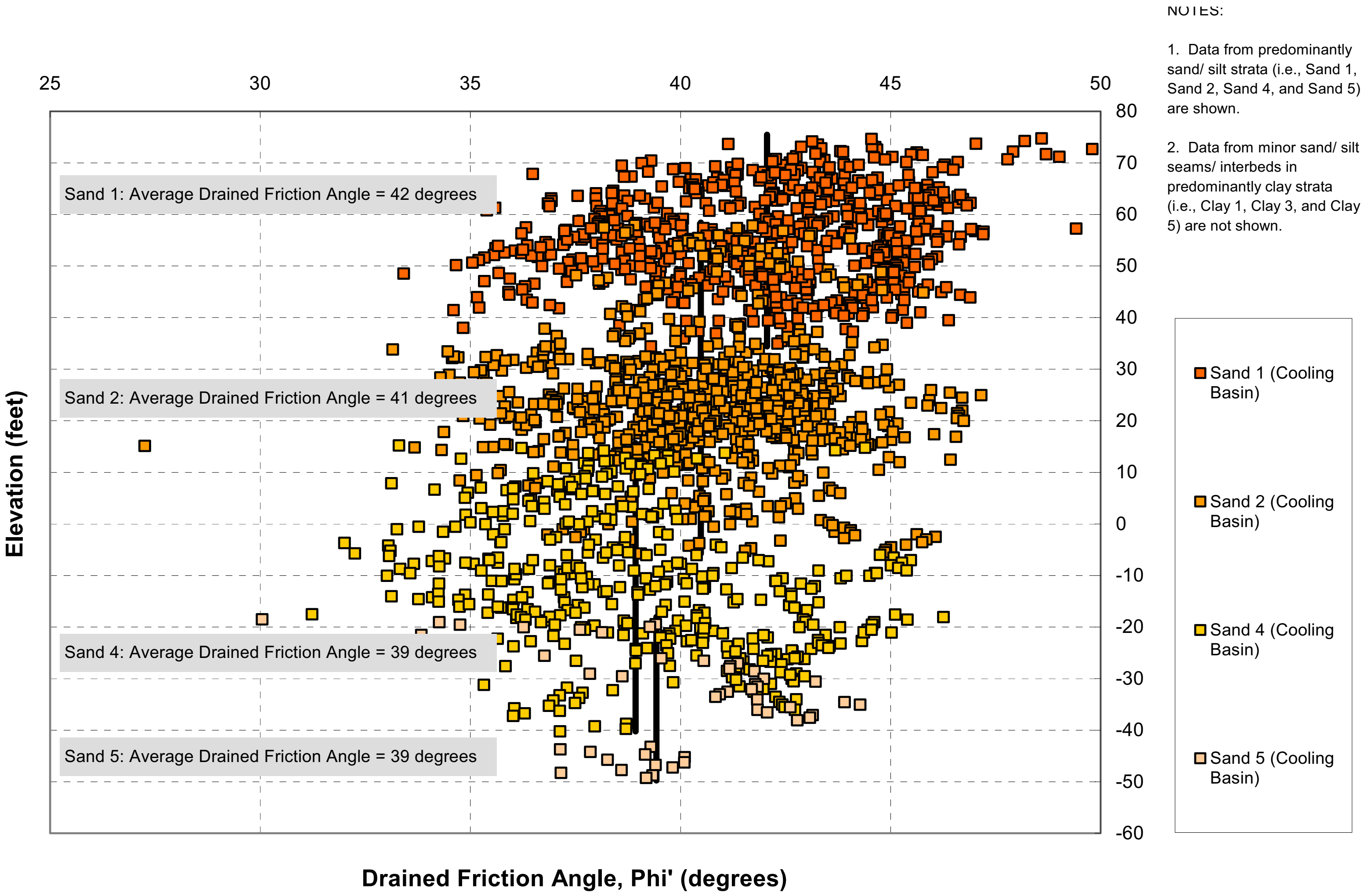


NOTES:

1. Data from predominantly sand/ silt strata (i.e., Sand 1, Sand 2, and Sand 4) are shown.

2. Data from minor sand/ silt seams/ interbeds in predominantly clay strata (i.e., Clay 1 and Clay 3) are not shown.

Figure 2.5.4-264 Drained Friction Angles (Phi') of Cohesionless Soil Strata from CPT Data; Unit 1, Unit 2, and Investigations Outside Power Block



NOTES:

1. Data from predominantly sand/ silt strata (i.e., Sand 1, Sand 2, Sand 4, and Sand 5) are shown.

2. Data from minor sand/ silt seams/ interbeds in predominantly clay strata (i.e., Clay 1, Clay 3, and Clay 5) are not shown.

Figure 2.5.4-265 Drained Friction Angles (Phi') of Cohesionless Soil Strata from CPT Data (Cooling Basin/GBRA Storage Water Reservoir)

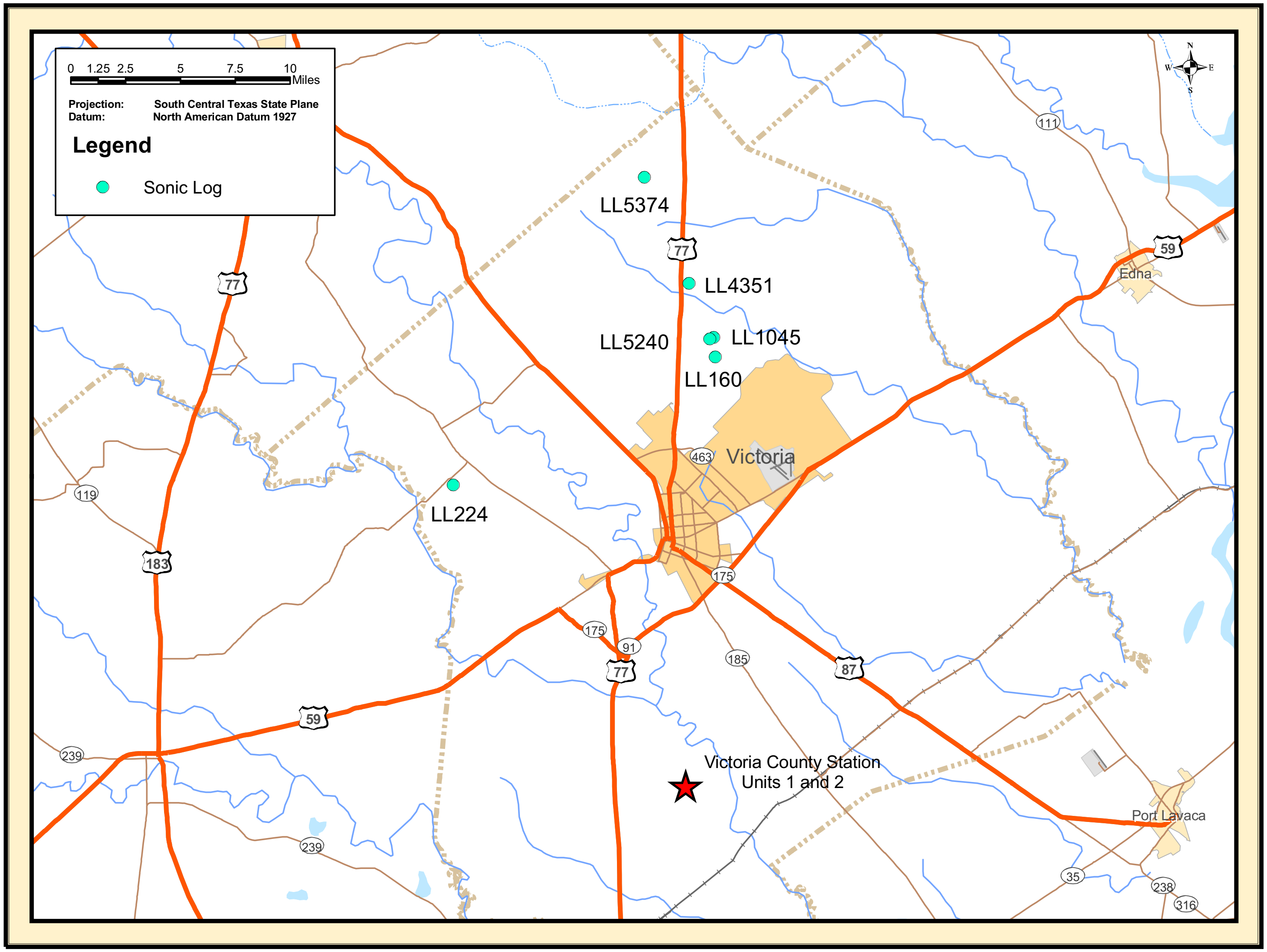


Figure 2.5.4-266 Regional/Oil Field Sonic Logging Locations (Power Block)

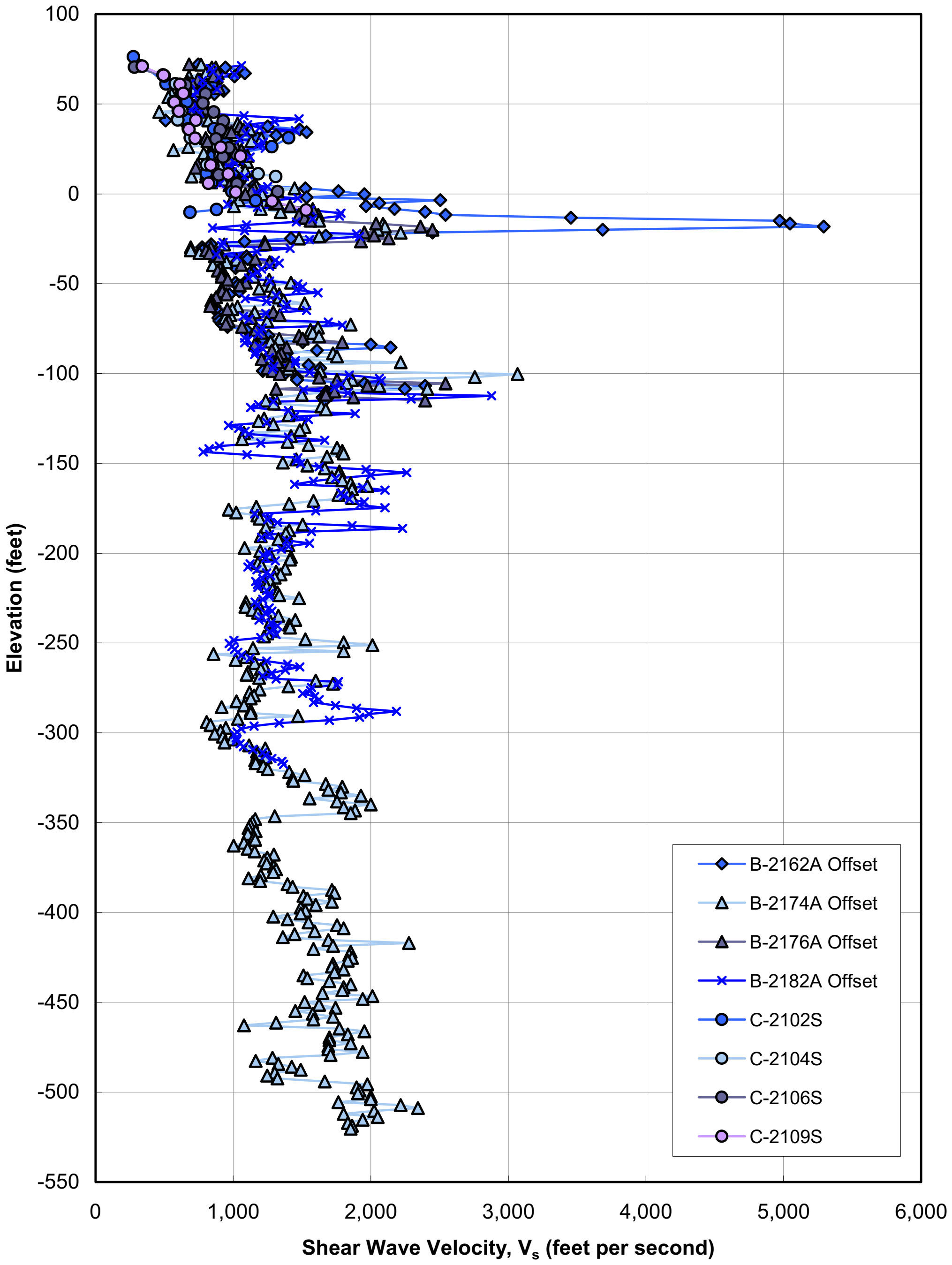


Figure 2.5.4-267 S-Wave Velocity versus Elevation; Unit 1; Upper Approximately 600 Feet of Site Soils (Power Block)

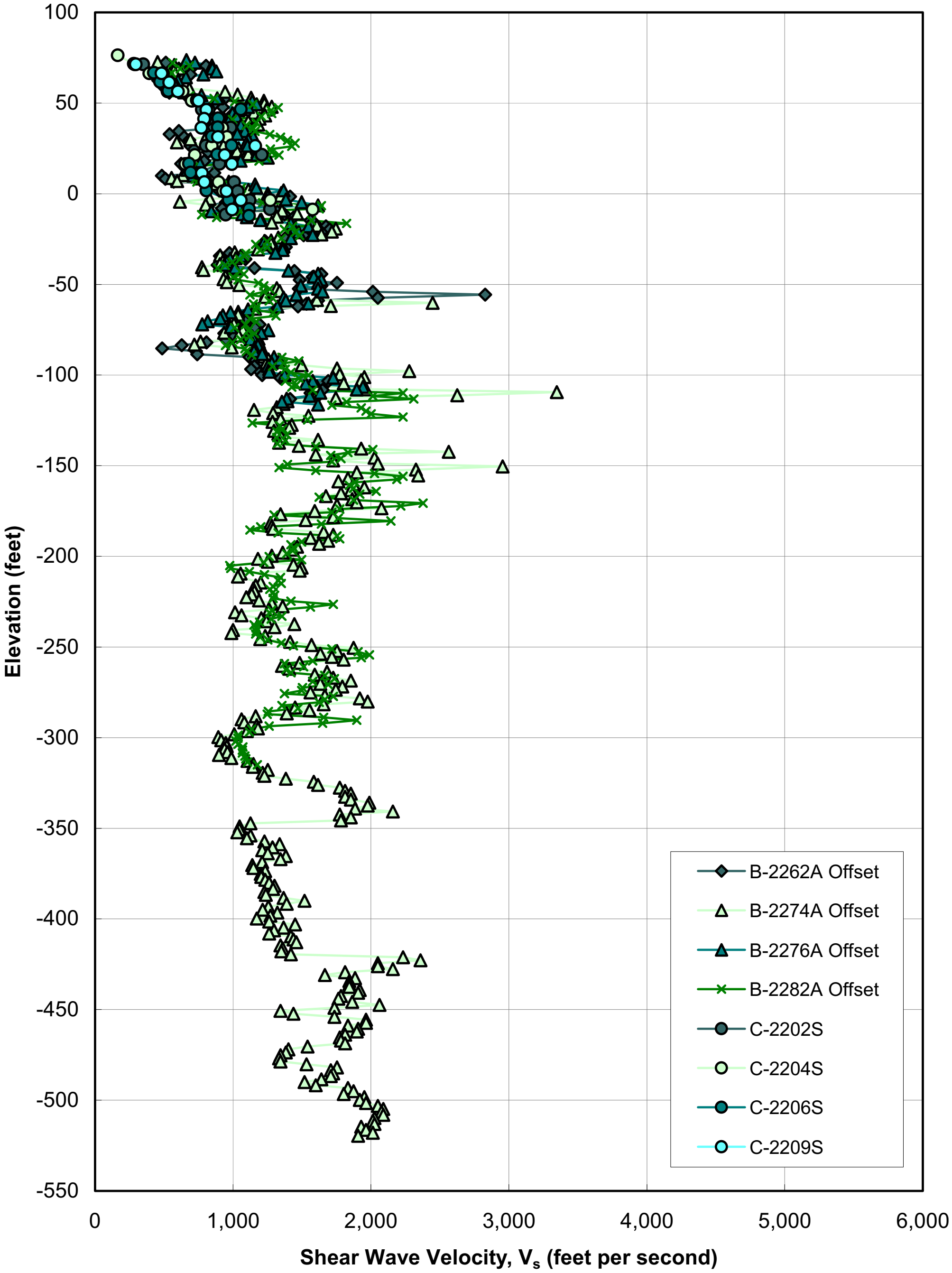


Figure 2.5.4-268 S-Wave Velocity versus Elevation; Unit 2; Upper Approximately 600 Feet of Site Soils (Power Block)

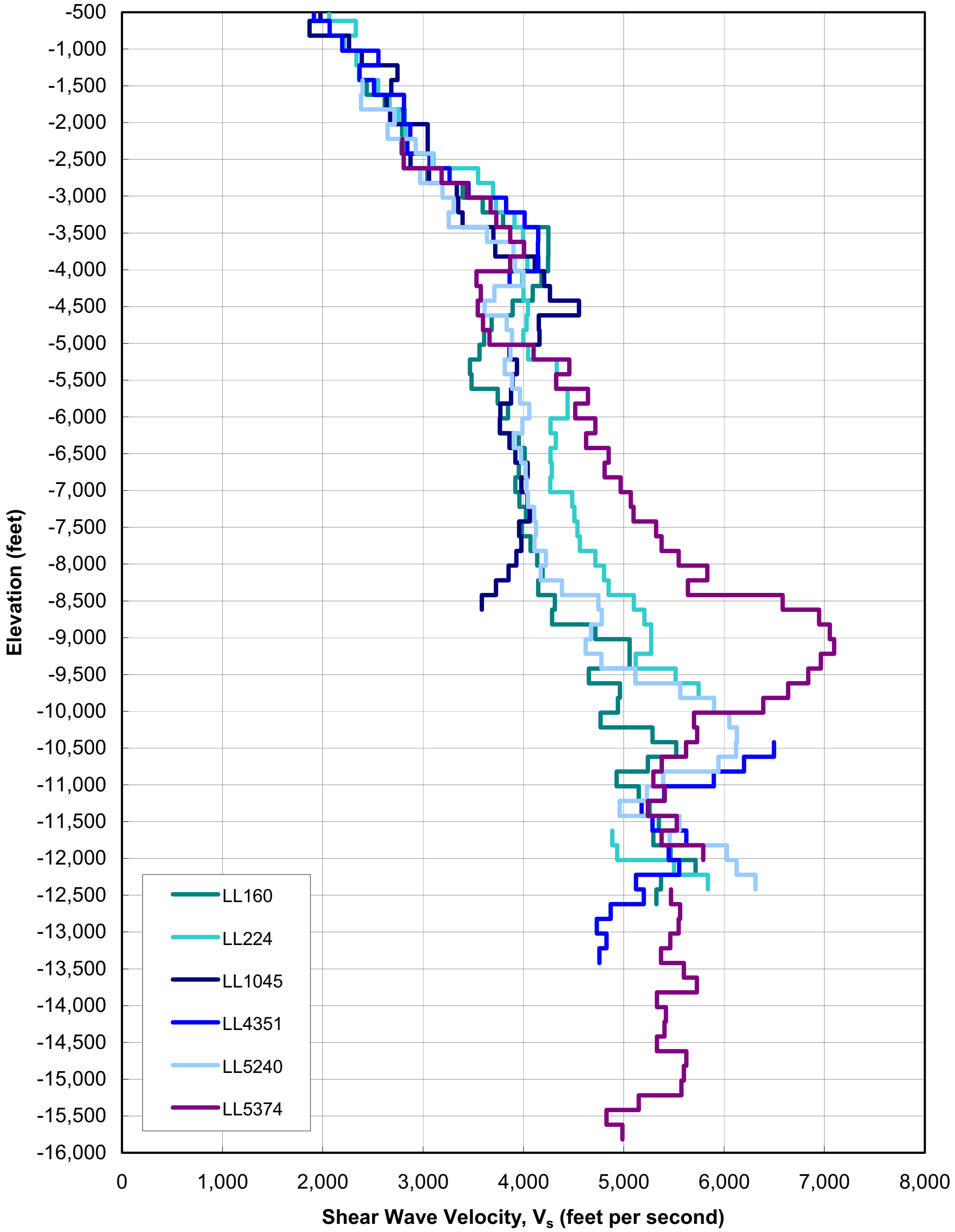


Figure 2.5.4-269 S-Wave Velocity versus Elevation; Unit 1 and Unit 2; Deeper than Approximately 600 Feet Below Existing Ground Surface (Power Block)

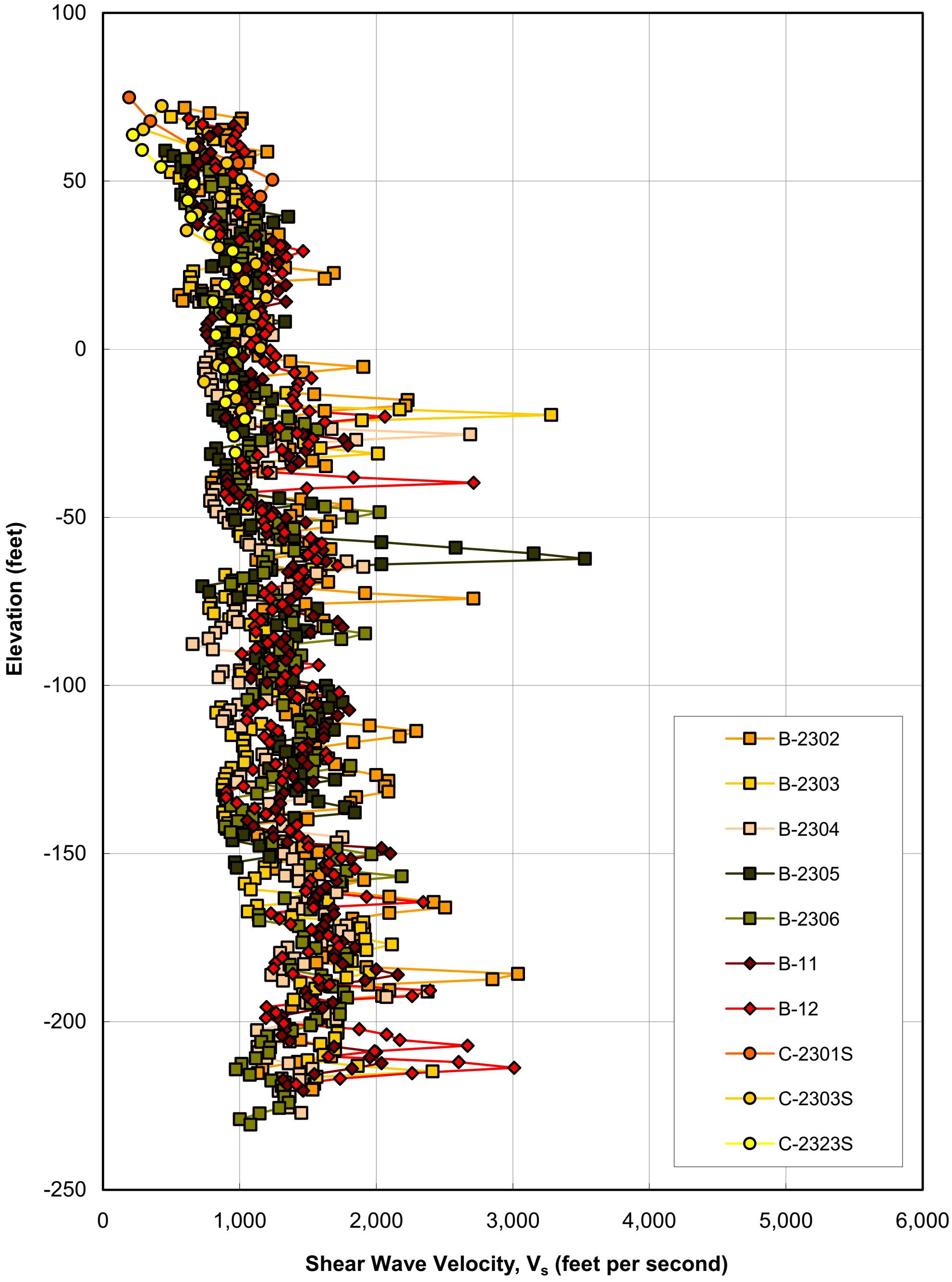


Figure 2.5.4-270 S-Wave Velocity versus Elevation (Cooling Basin/GBRA Storage Water Reservoir)

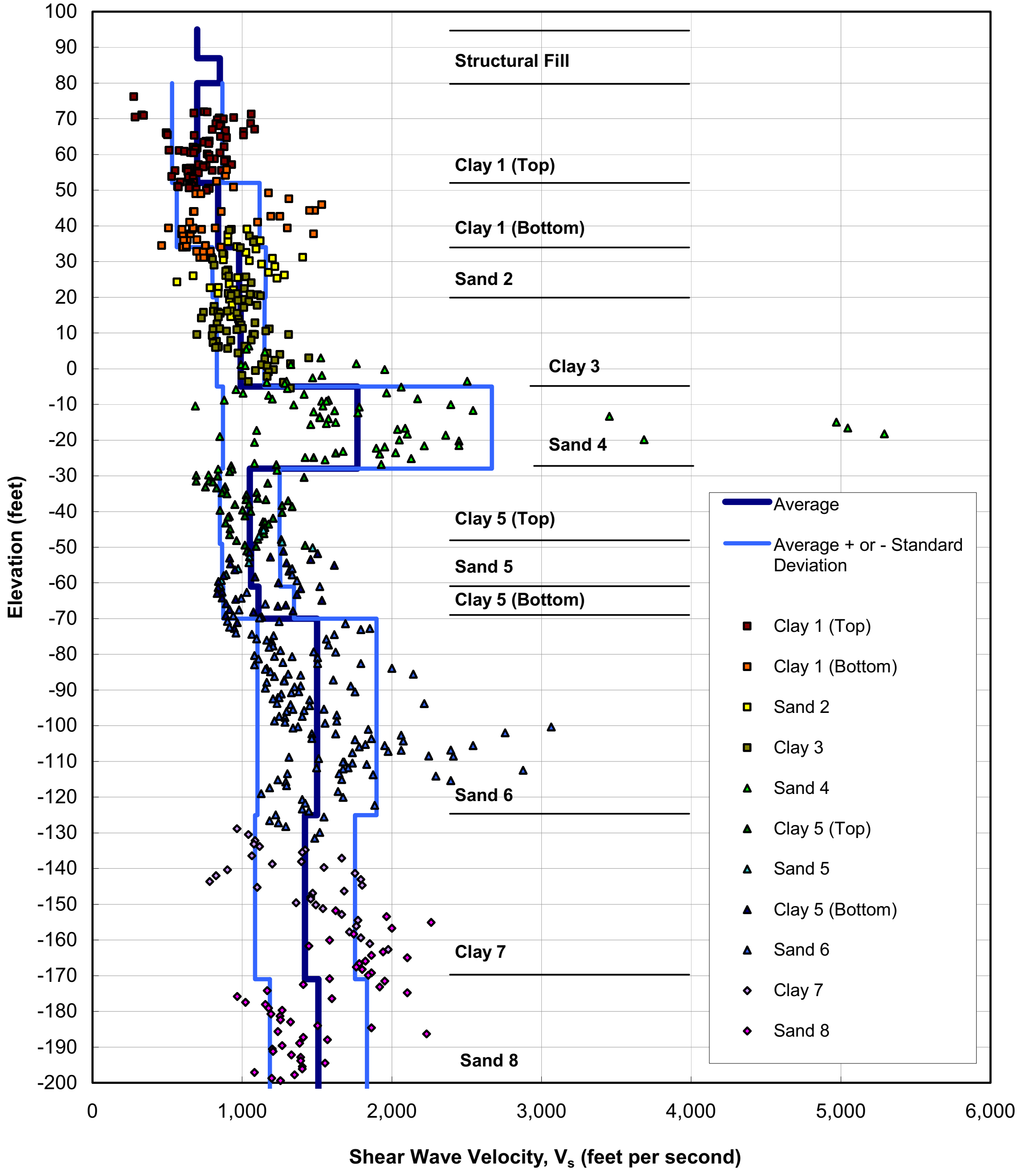


Figure 2.5.4-271 Average S-Wave Velocity Profile; Unit 1 (Power Block) (Sheet 1 of 2)

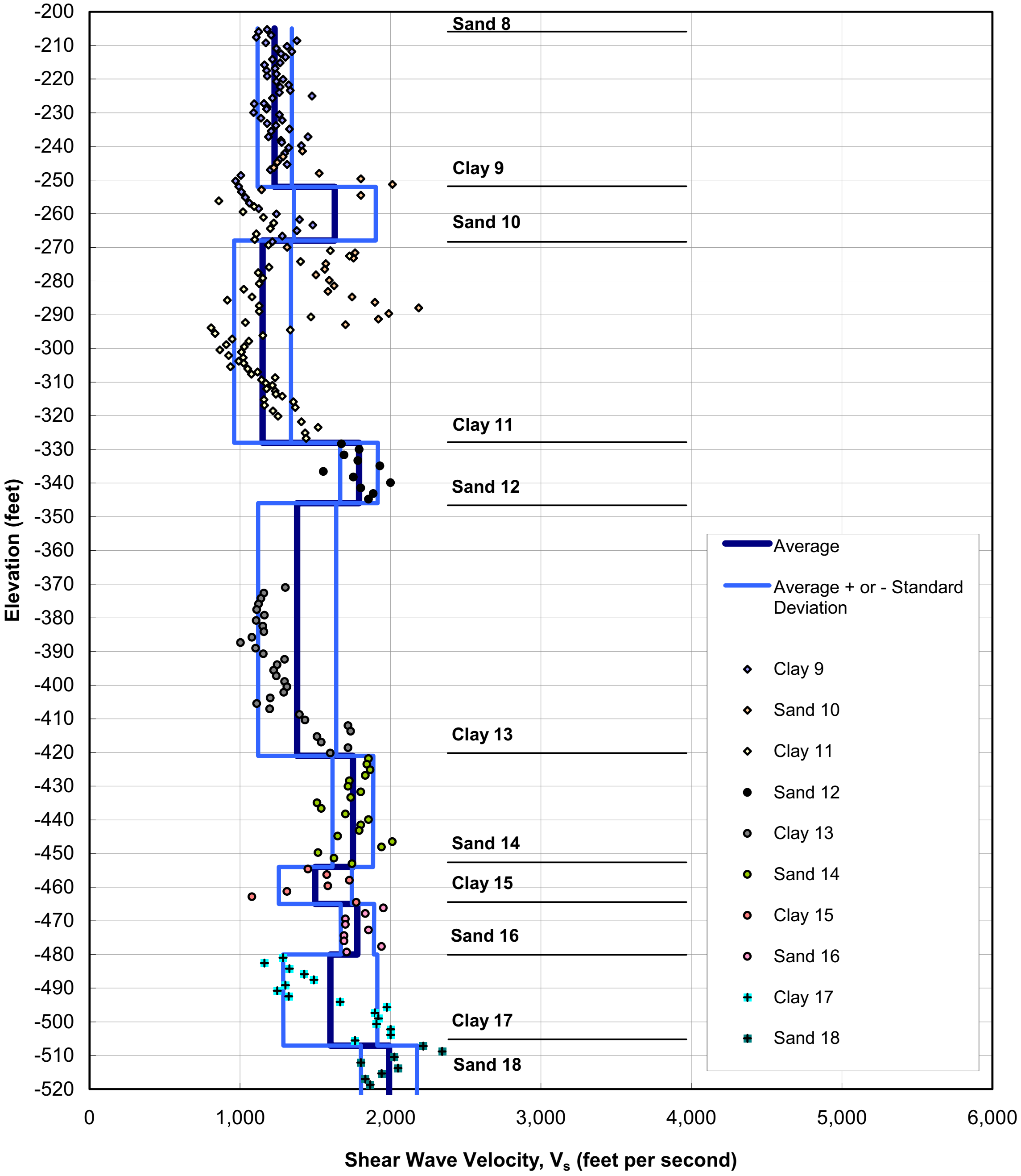


Figure 2.5.4-271 Average S-Wave Velocity Profile; Unit 1 (Power Block) (Sheet 2 of 2)

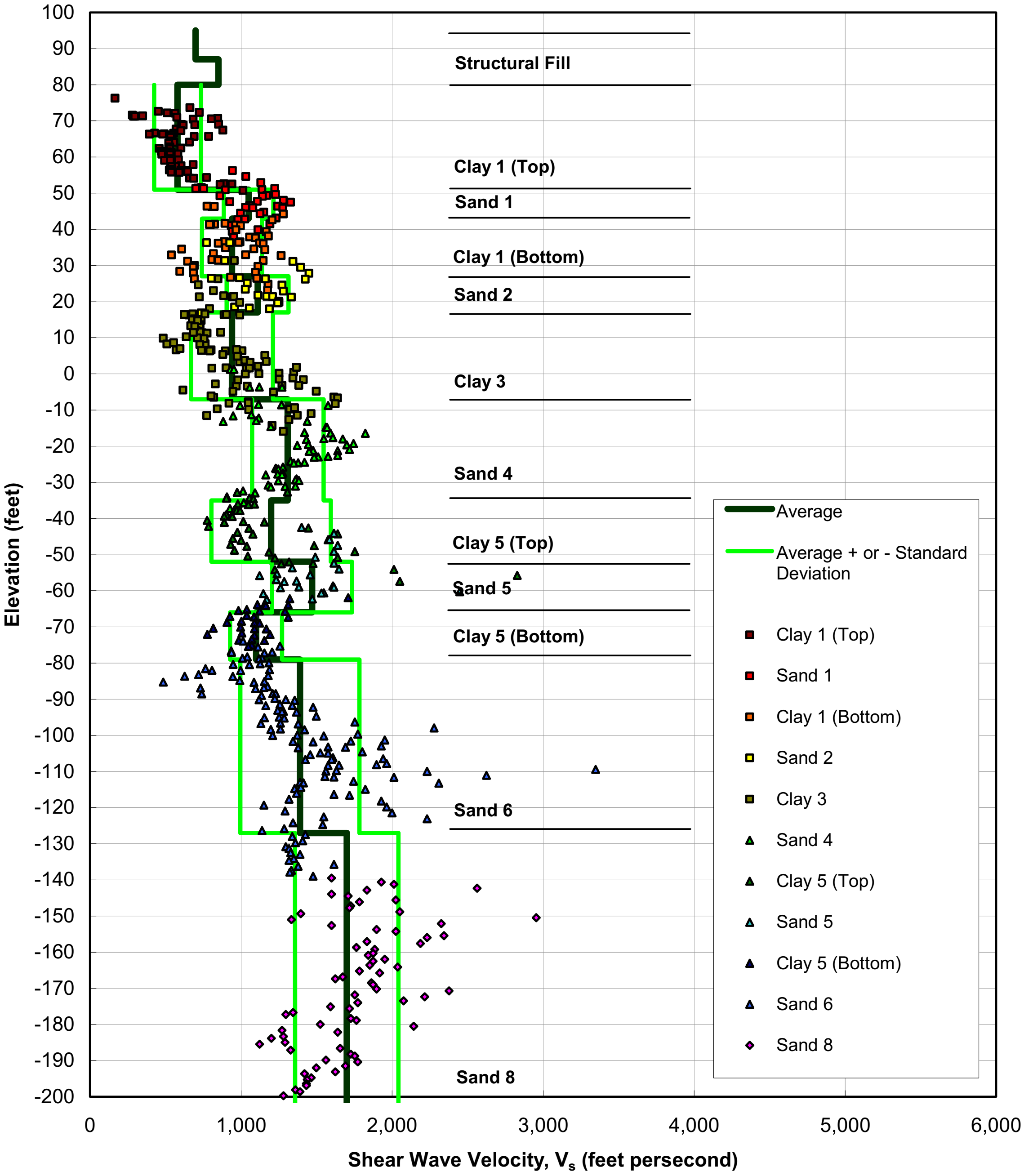


Figure 2.5.4-272 Average S-Wave Velocity Profile; Unit 2 (Power Block) (Sheet 1 of 2)

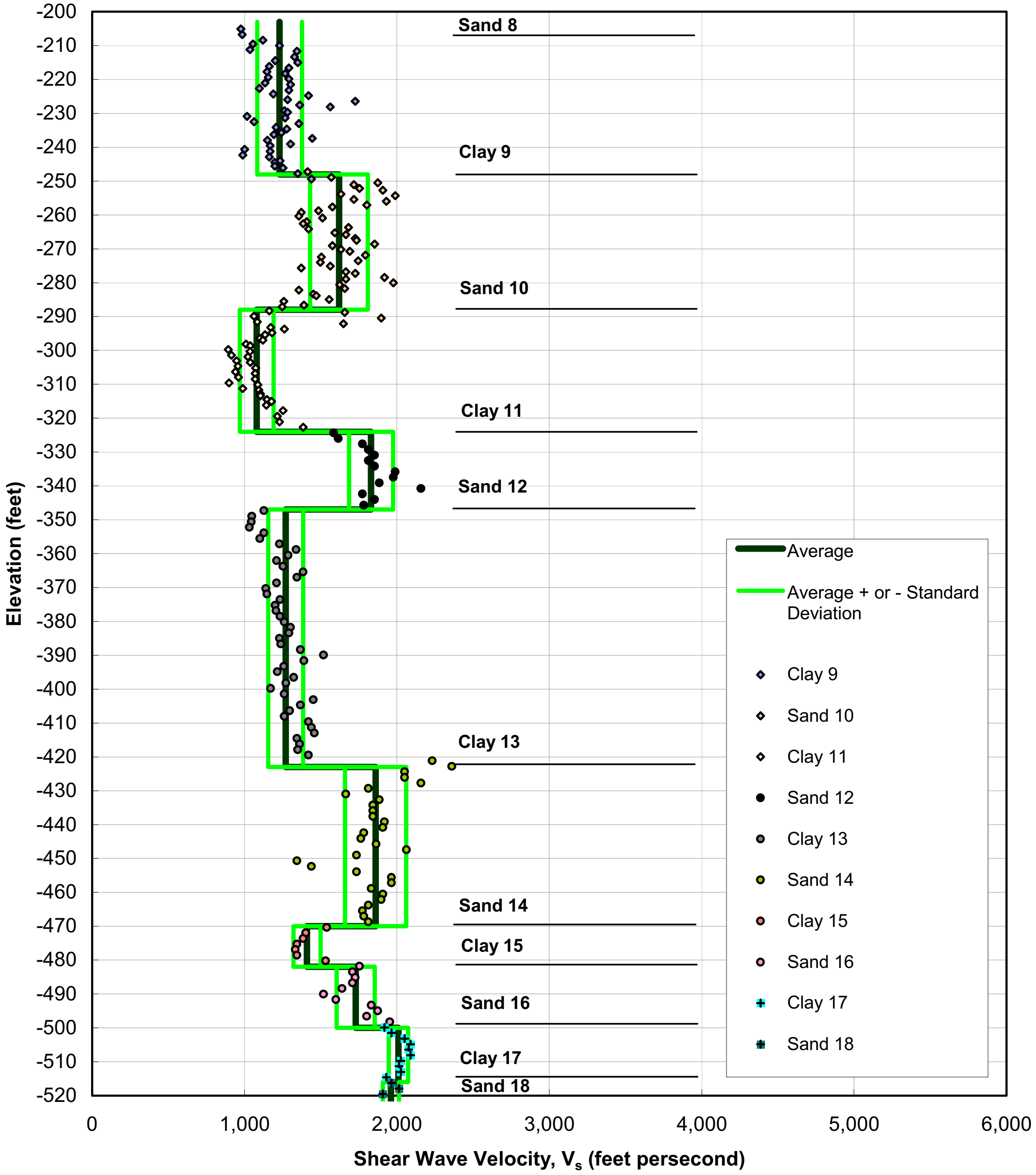


Figure 2.5.4-272 Average S-Wave Velocity Profile; Unit 2 (Power Block) (Sheet 2 of 2)

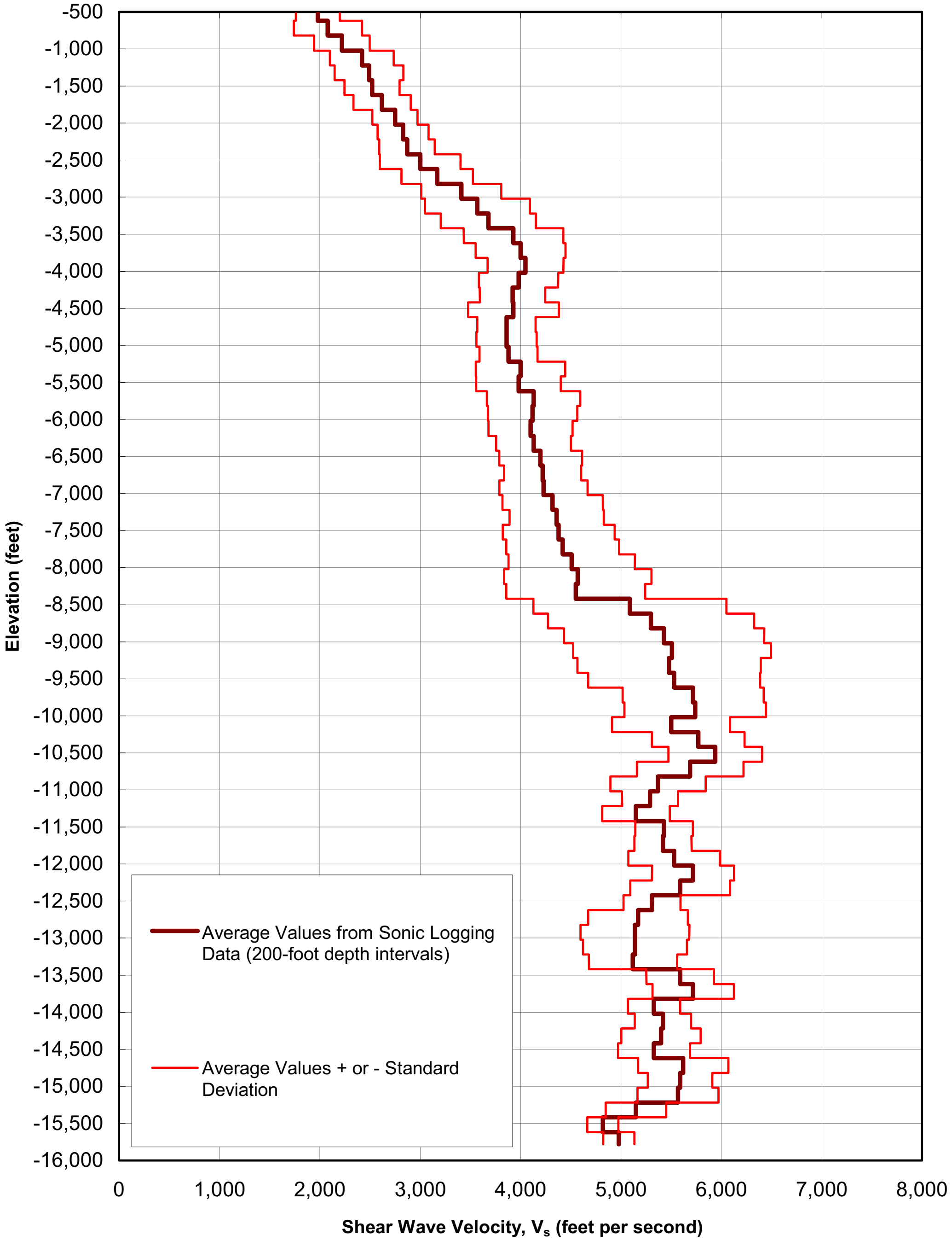


Figure 2.5.4-273 Average S-Wave Velocity versus Elevation; Unit 1 and Unit 2; Deeper than Approximately 600 Feet Below Existing Ground Surface (Power Block)

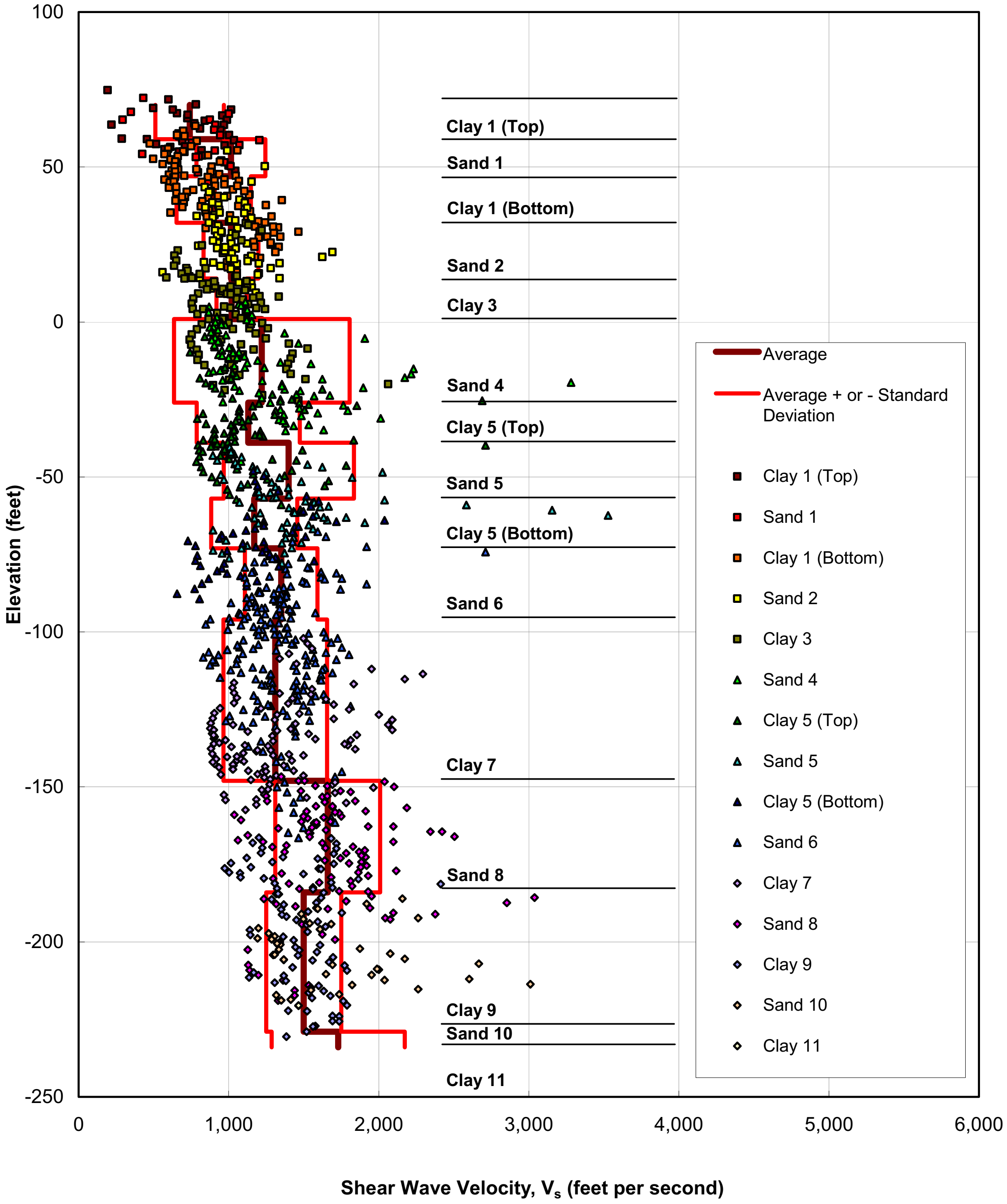


Figure 2.5.4-274 Average S-Wave Velocity Profile (Cooling Basin/GBRA Storage Water Reservoir)

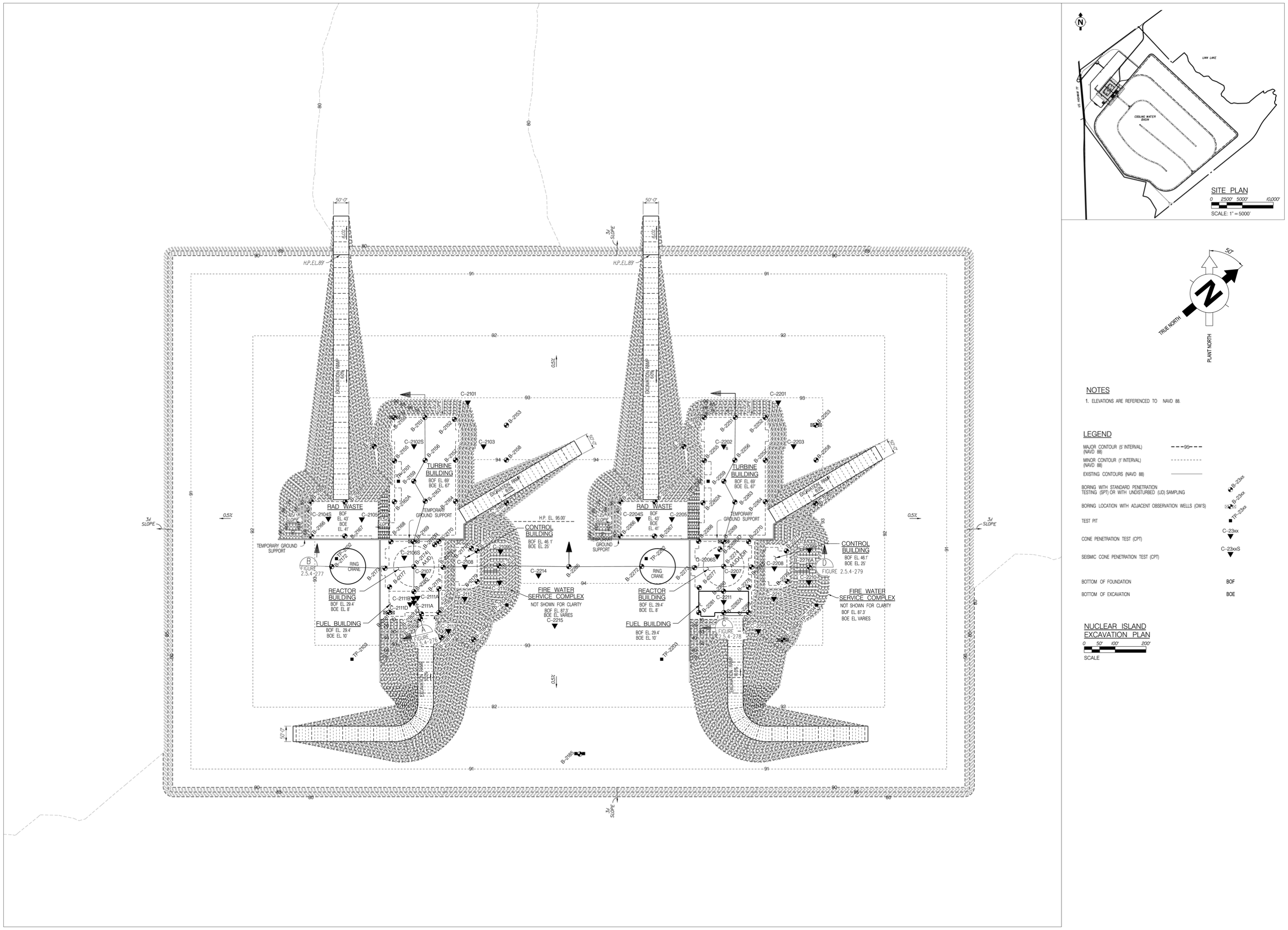


Figure 2.5.4-275 Excavation Plan (Power Block)

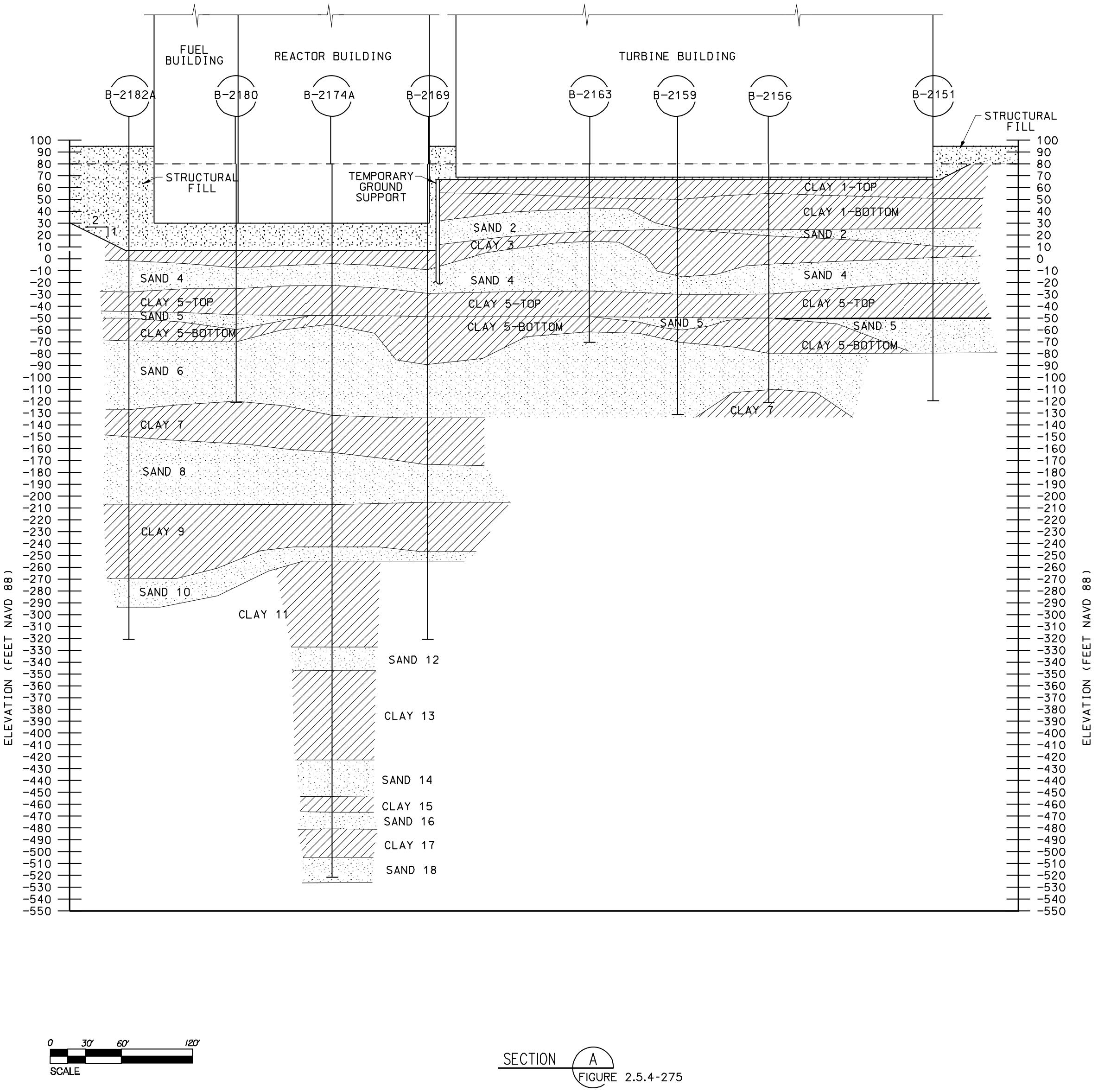


Figure 2.5.4-276 Excavation Profile A; Unit 1 (North-South) (Power Block)

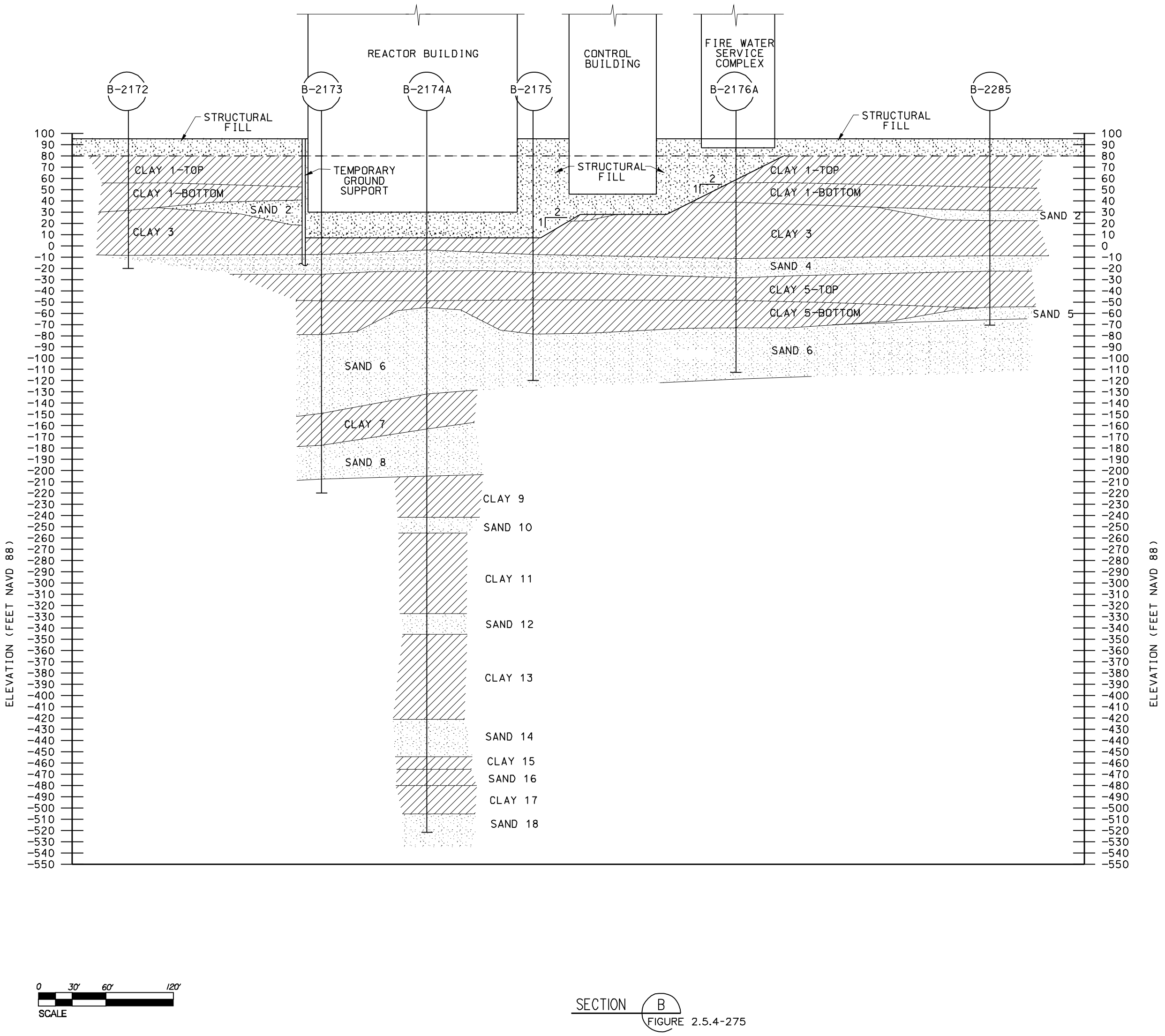


Figure 2.5.4-277 Excavation Profile B; Unit 1 (East-West) (Power Block)

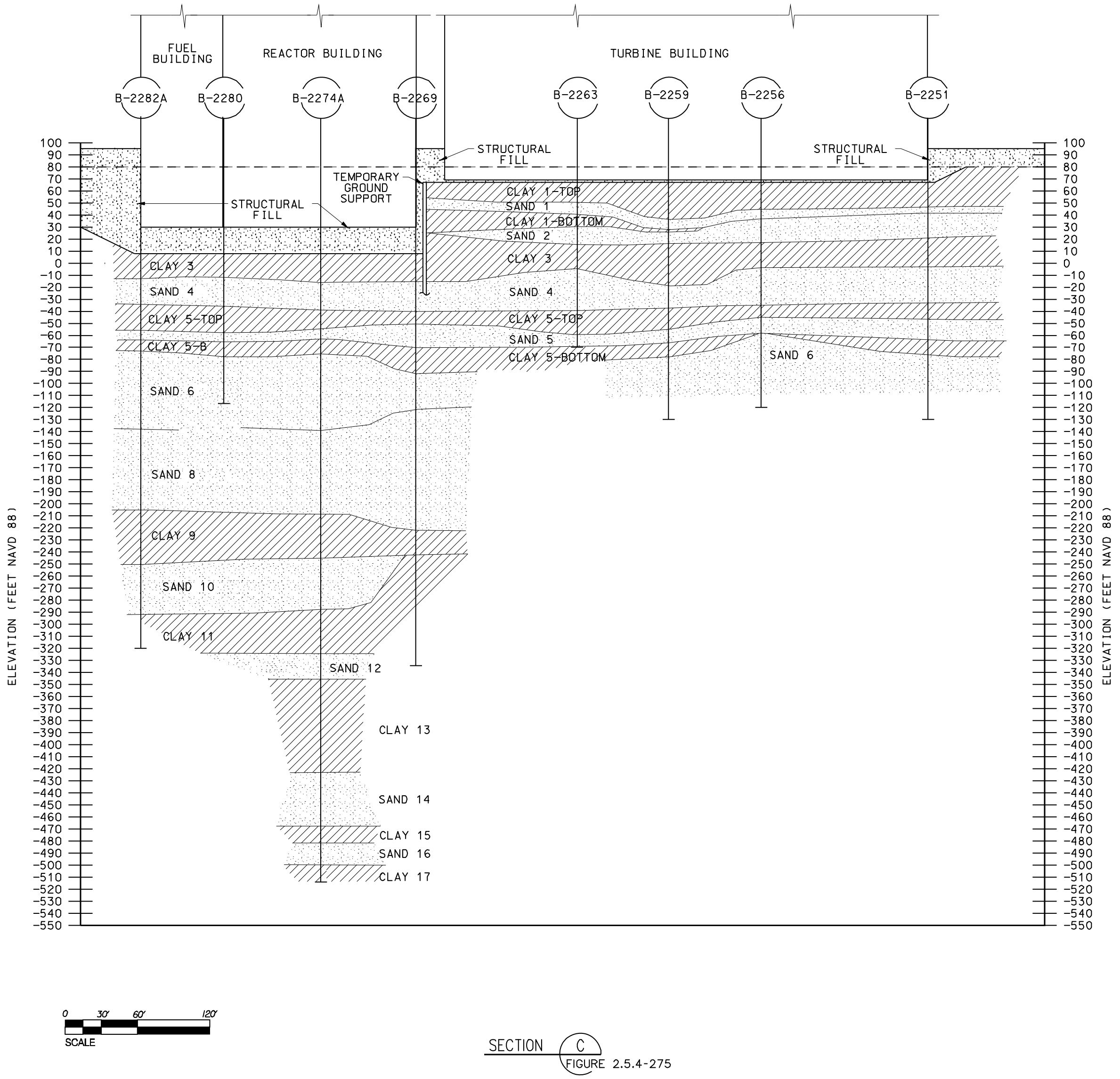


Figure 2.5.4-278 Excavation Profile C; Unit 2 (North-South) (Power Block)

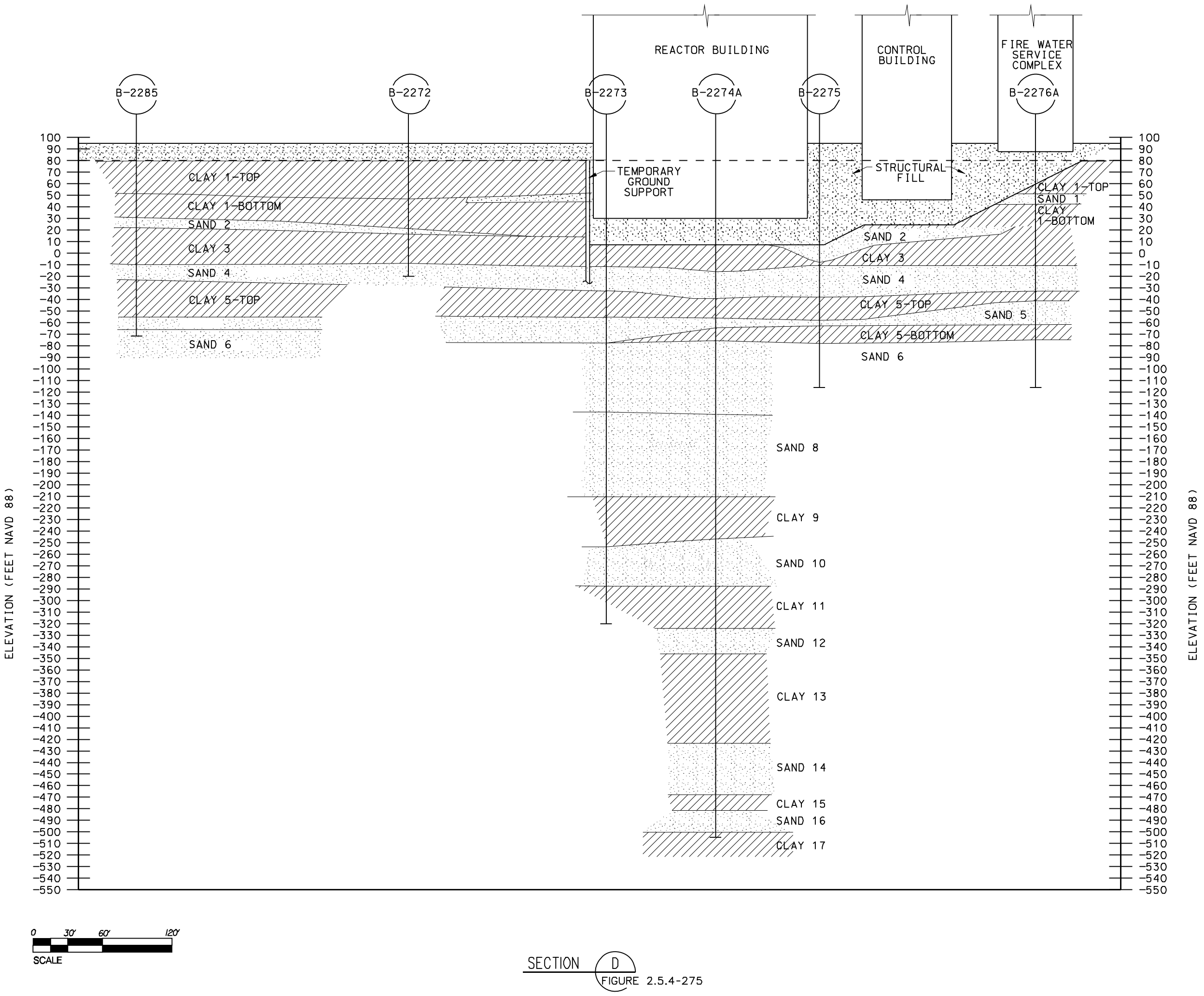


Figure 2.5.4-279 Excavation Profile D; Unit 2 (East-West) (Power Block)

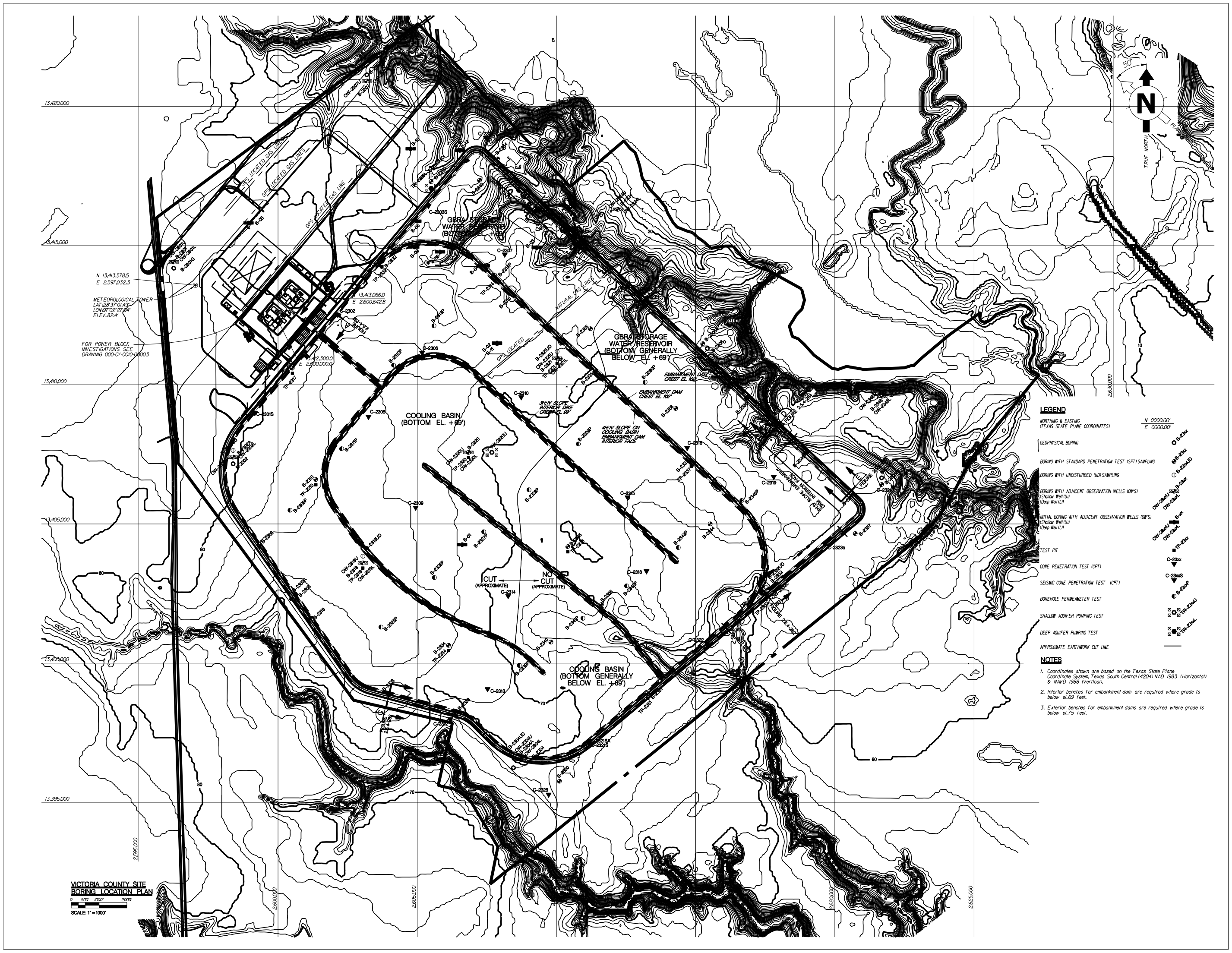


Figure 2.5.4-280 Excavation Plan (Cooling Basin/GBRA Storage Water Reservoir)

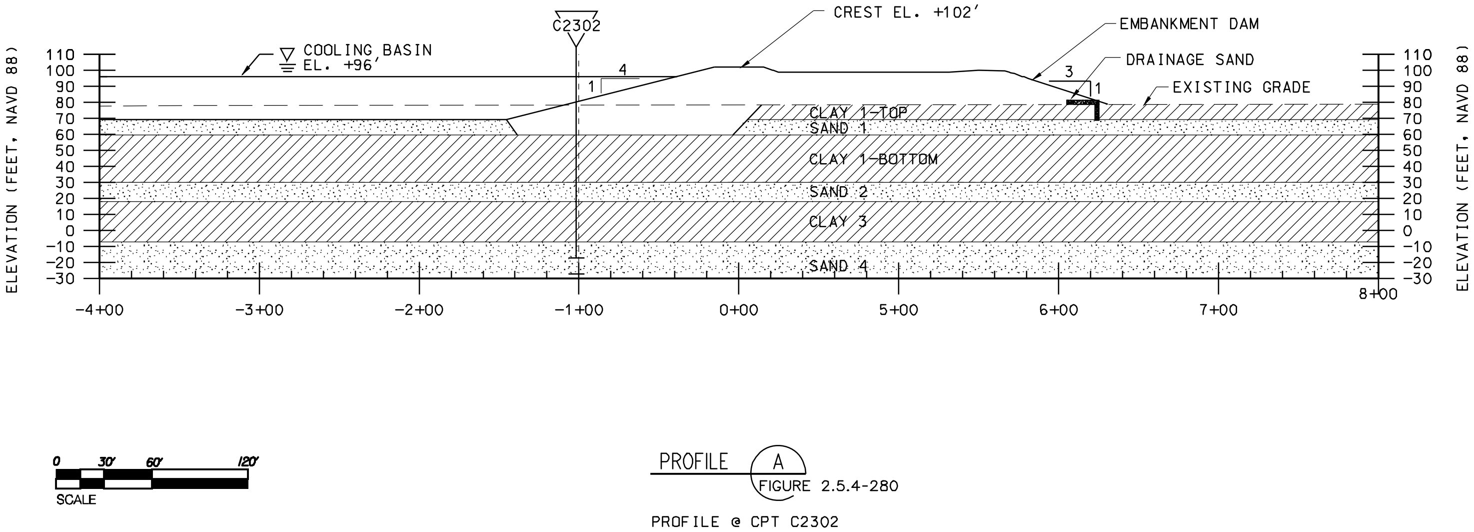


Figure 2.5.4-281 Embankment Profile A; North Embankment Dam of Cooling Basin at Cone Penetration Test C-2302 (North-South) (Cooling Basin/GBRA Storage Water Reservoir)

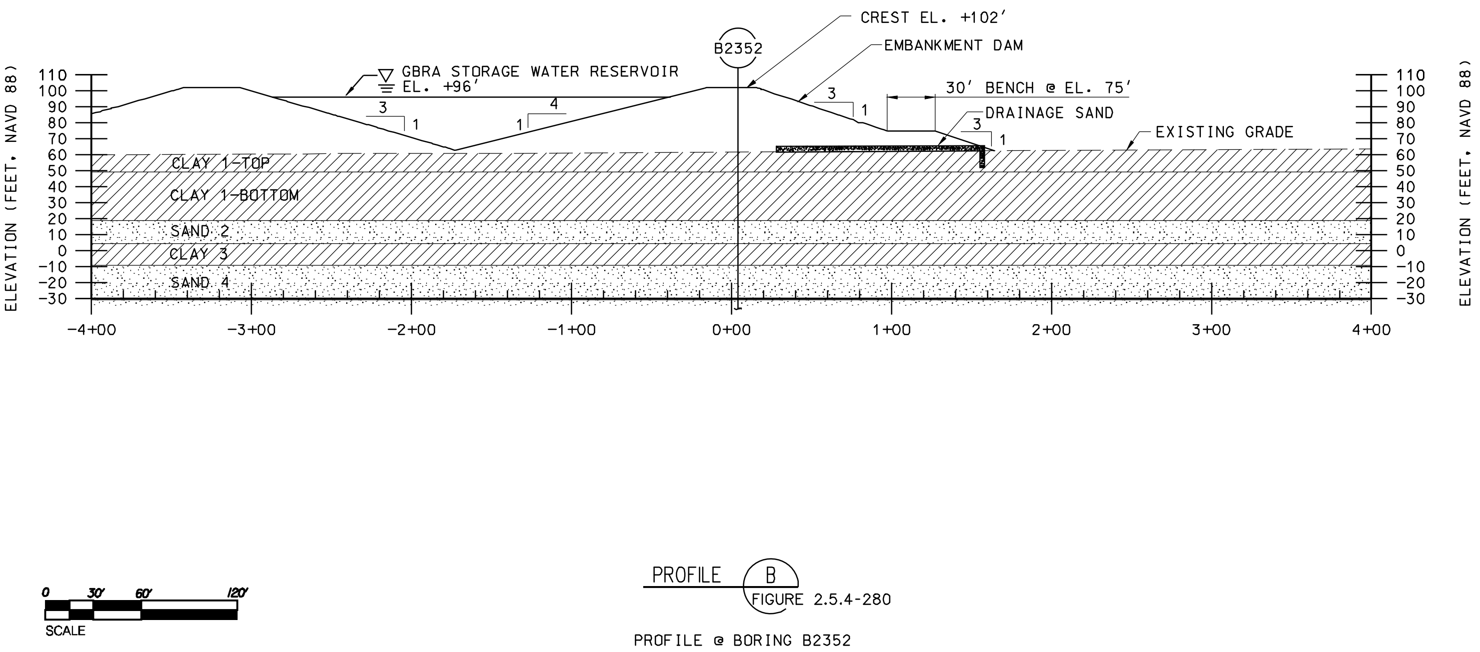


Figure 2.5.4-282 Embankment Profile B; South Embankment Dam of Cooling Basin at Boring B-2352 (North-South) (Cooling Basin/GBRA Storage Water Reservoir)

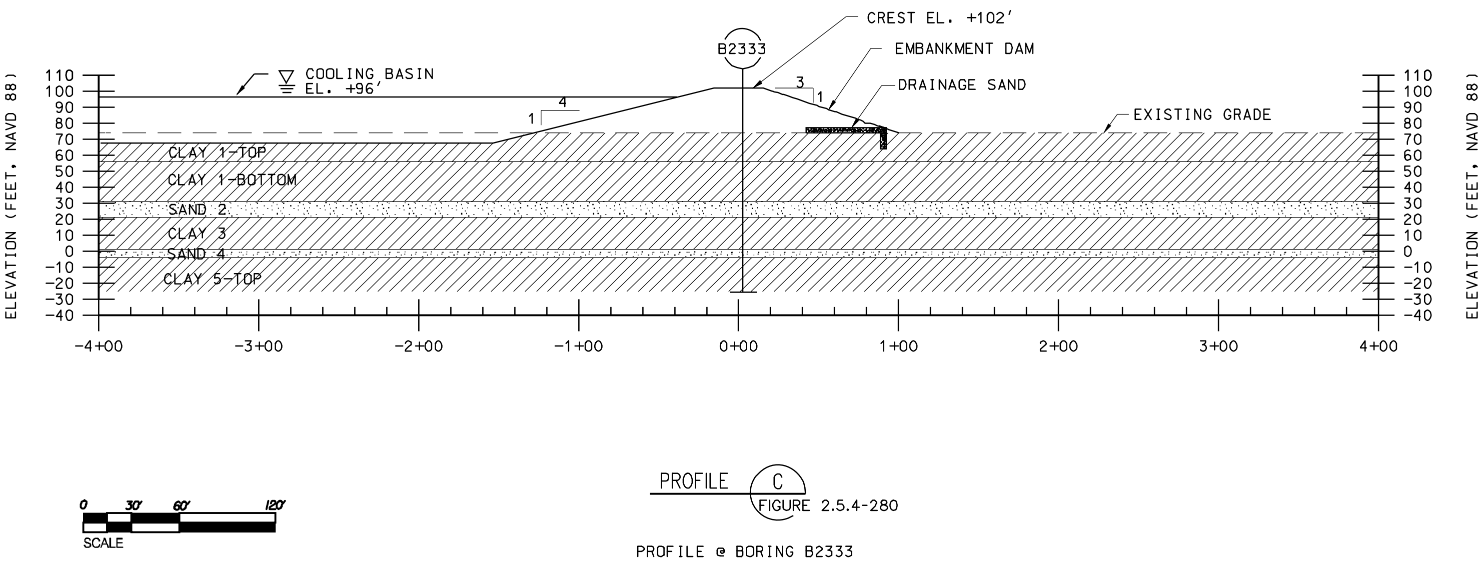


Figure 2.5.4-283 Embankment Profile C; West Embankment Dam of Cooling Basin at Boring B-2333 (East-West) (Cooling Basin/GBRA Storage Water Reservoir)

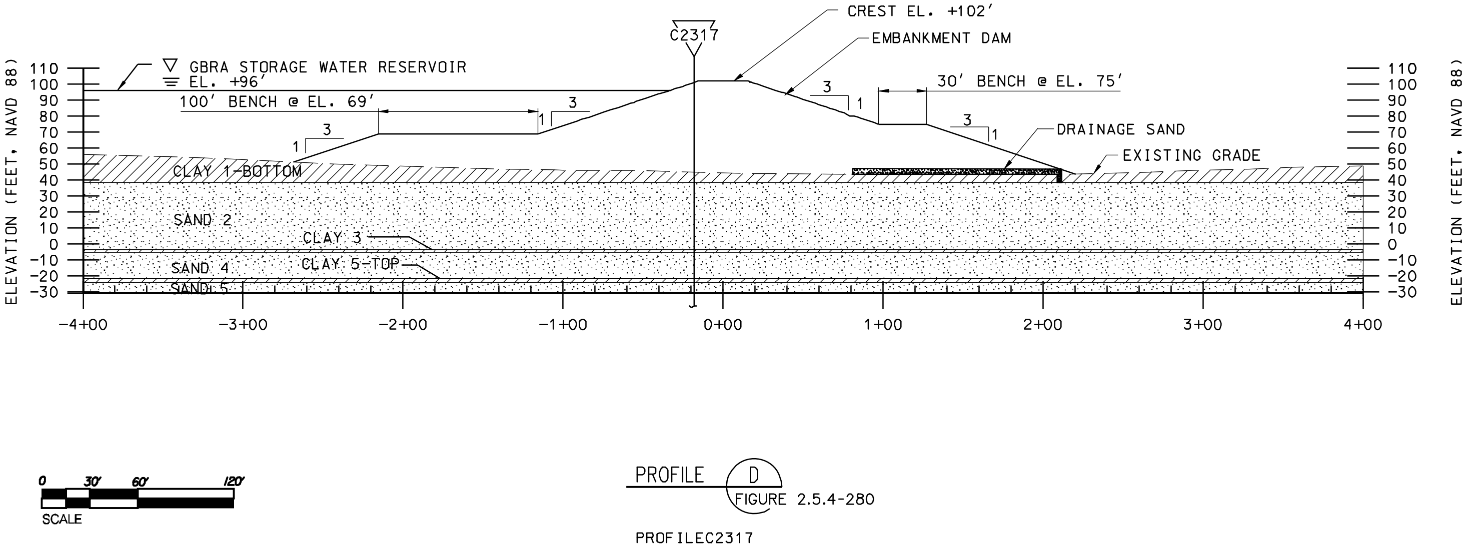


Figure 2.5.4-284 Embankment Profile D; East Embankment Dam of GBRA Storage Water Reservoir at Cone Penetration Test C-2317 (East-West) (Cooling Basin/GBRA Storage Water Reservoir)

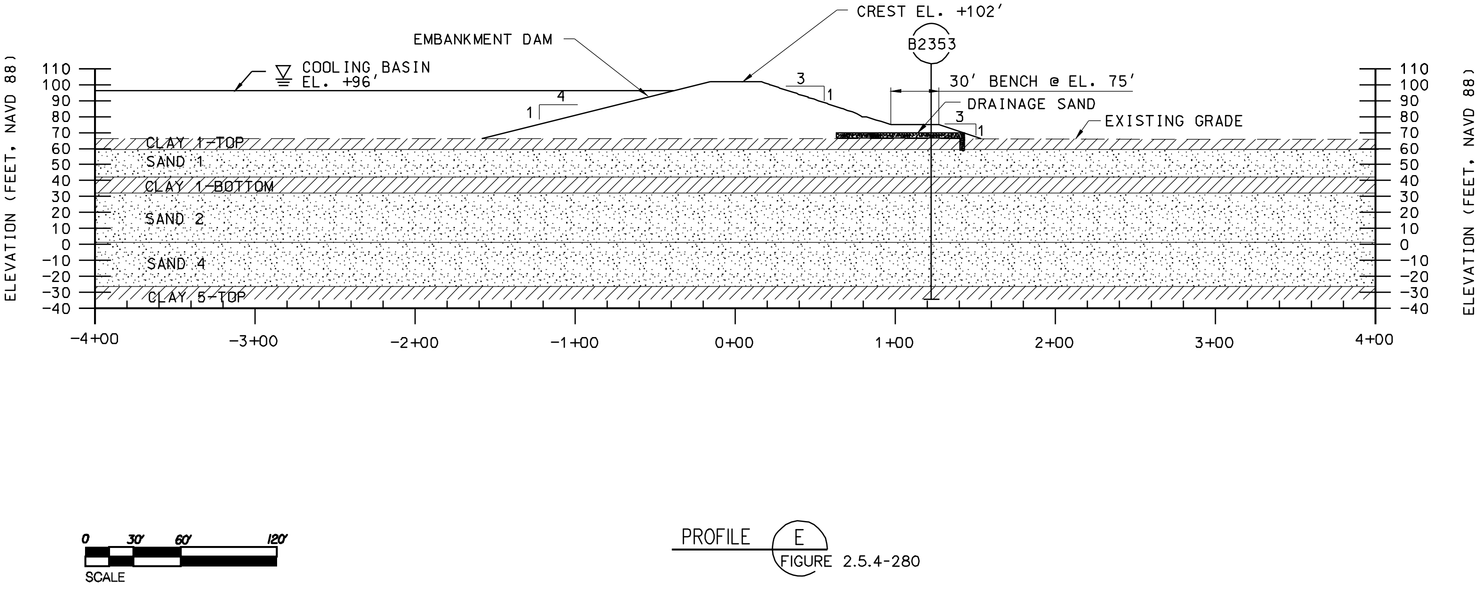


Figure 2.5.4-285 Embankment Profile E; East Embankment Dam of GBRA Storage Water Reservoir at Boring B-2353 (East-West) (Cooling Basin/GBRA Storage Water Reservoir)

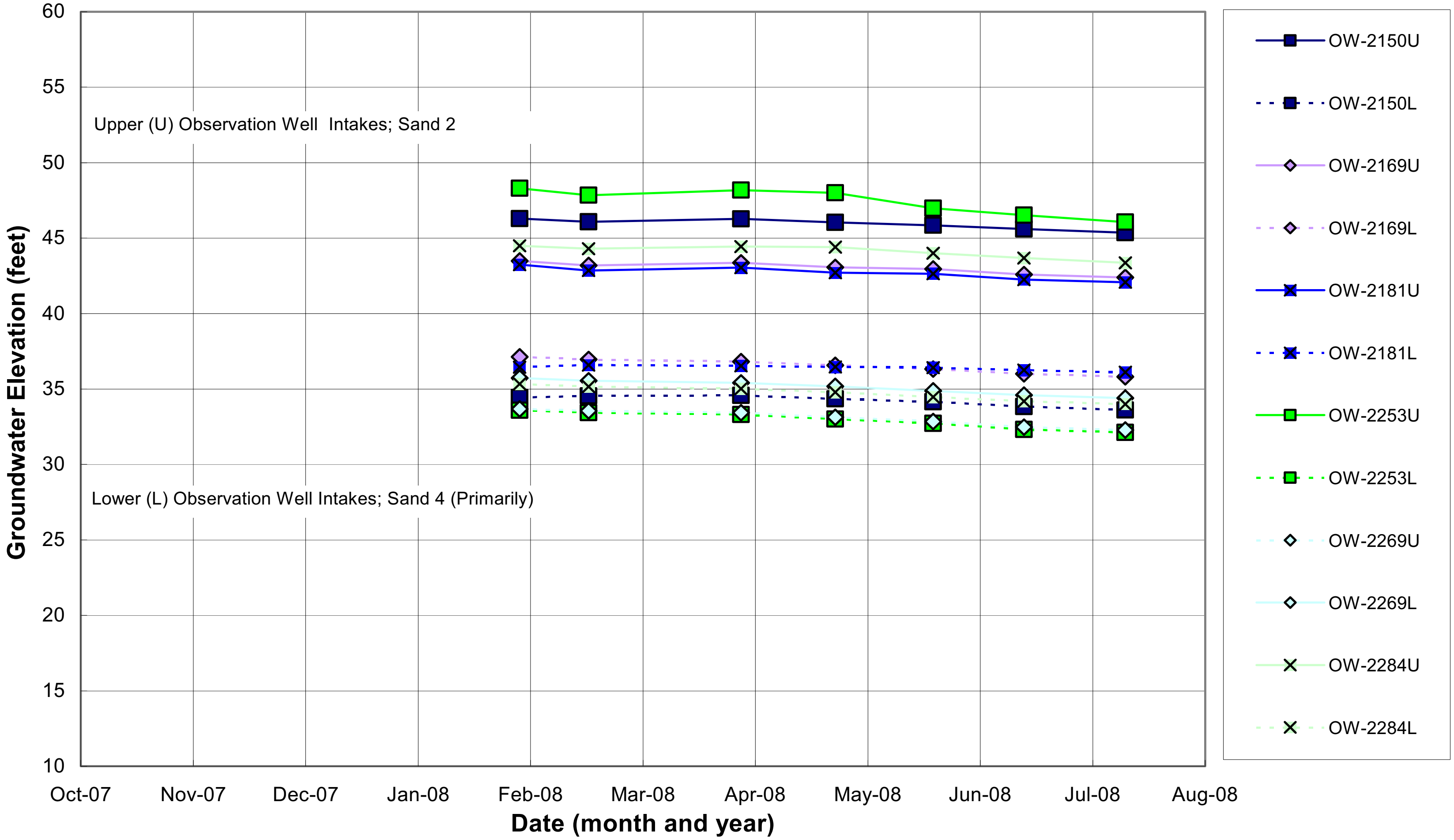


Figure 2.5.4-286 Measured Groundwater Levels; Unit 1 and Unit 2 (Power Block)

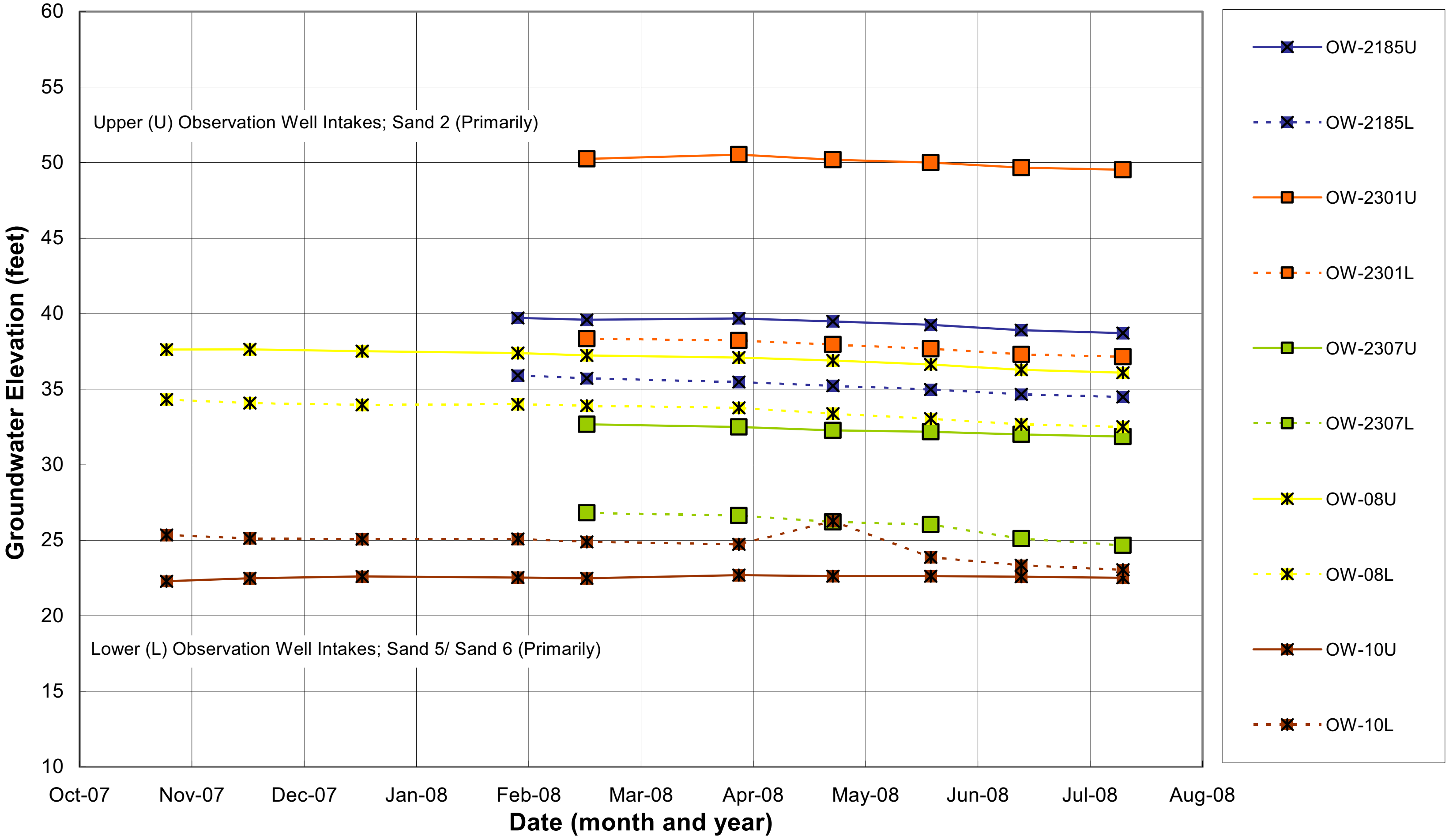


Figure 2.5.4-287 Measured Groundwater Levels; Investigations Outside Power Block

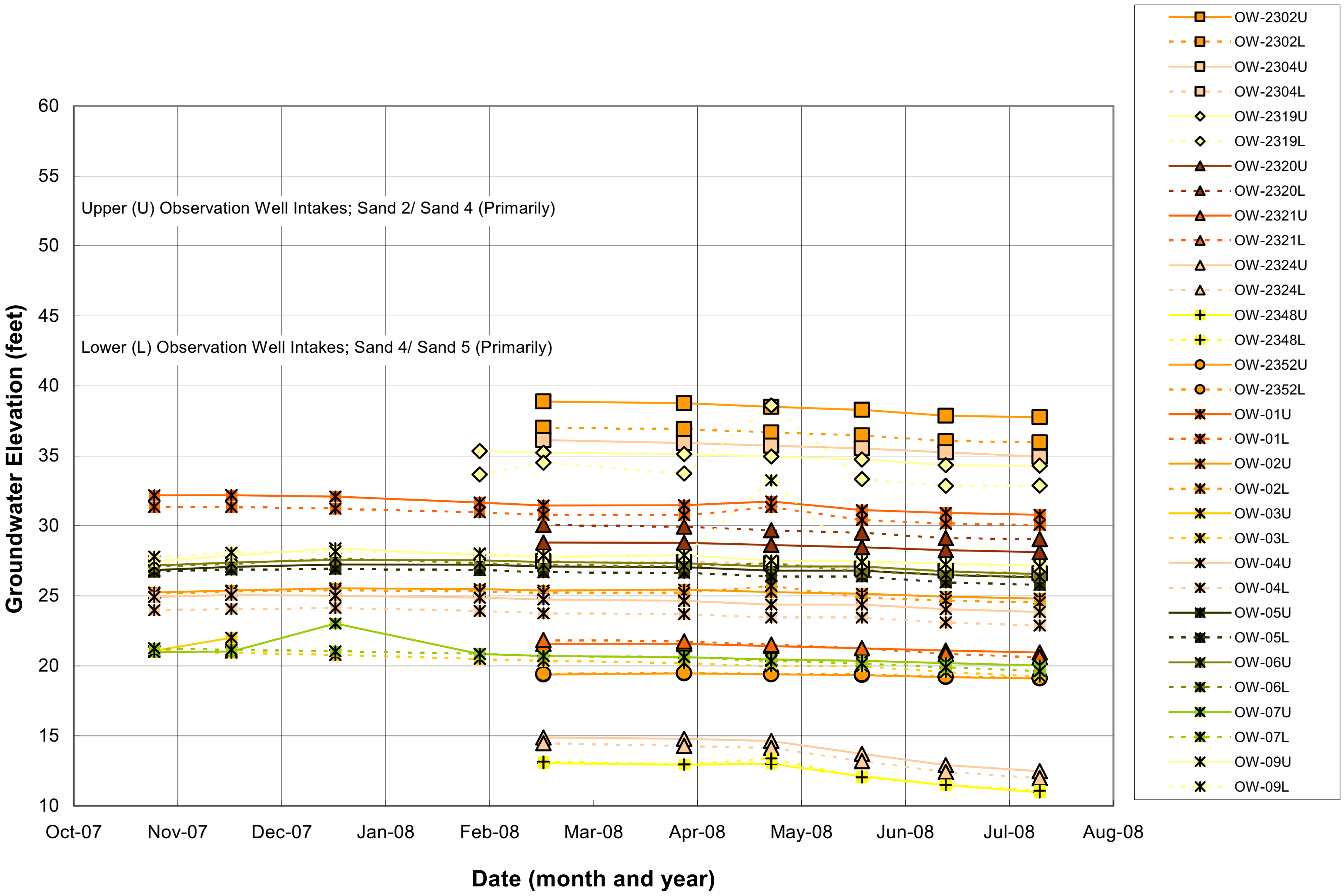


Figure 2.5.4-288 Measured Groundwater Levels; All Measurements; Cooling Basin/ GBRA Storage Water Reservoir

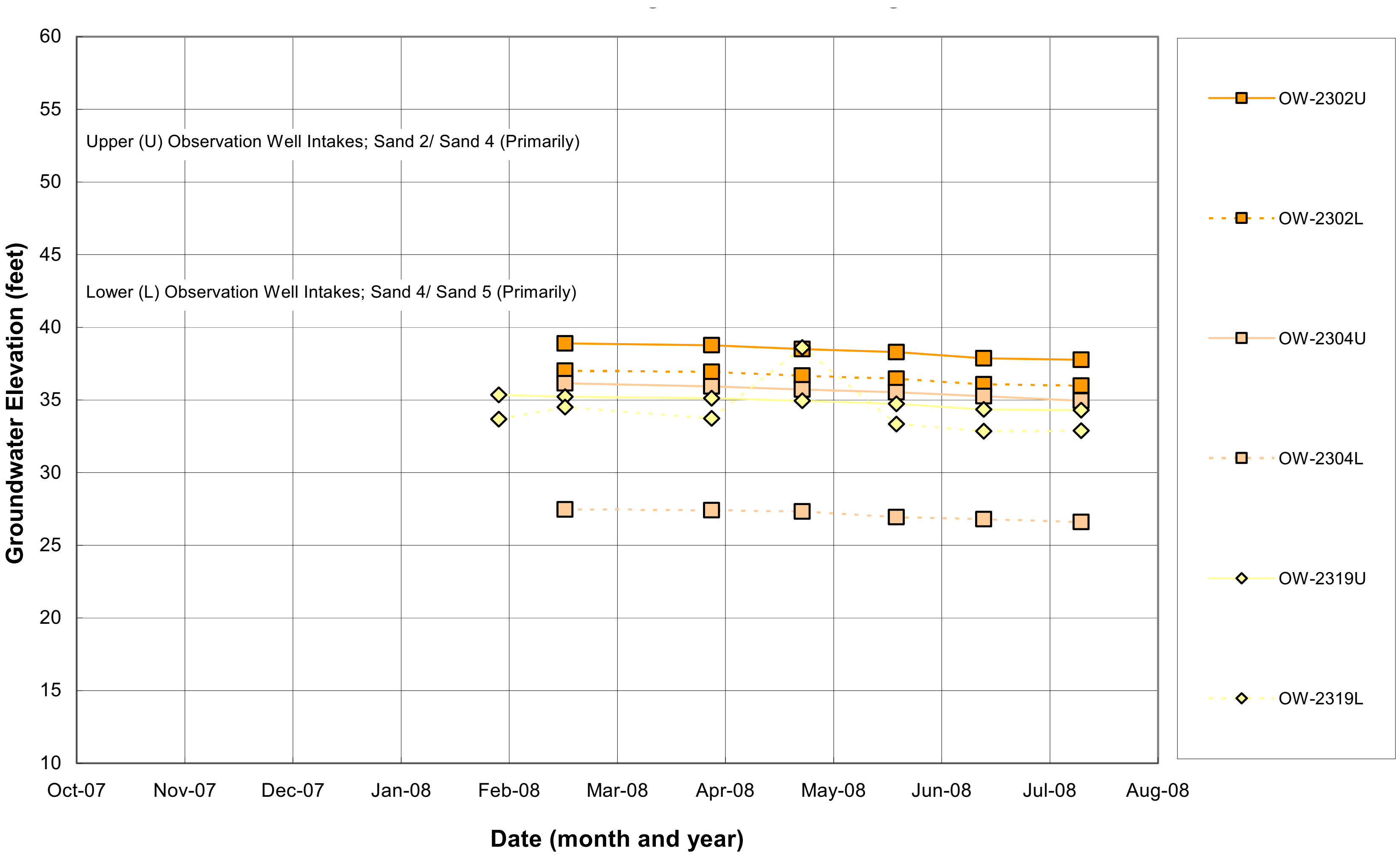


Figure 2.5.4-289 Measured Groundwater Levels; West Area Measurements; Cooling Basin/ GBRA Storage Water Reservoir

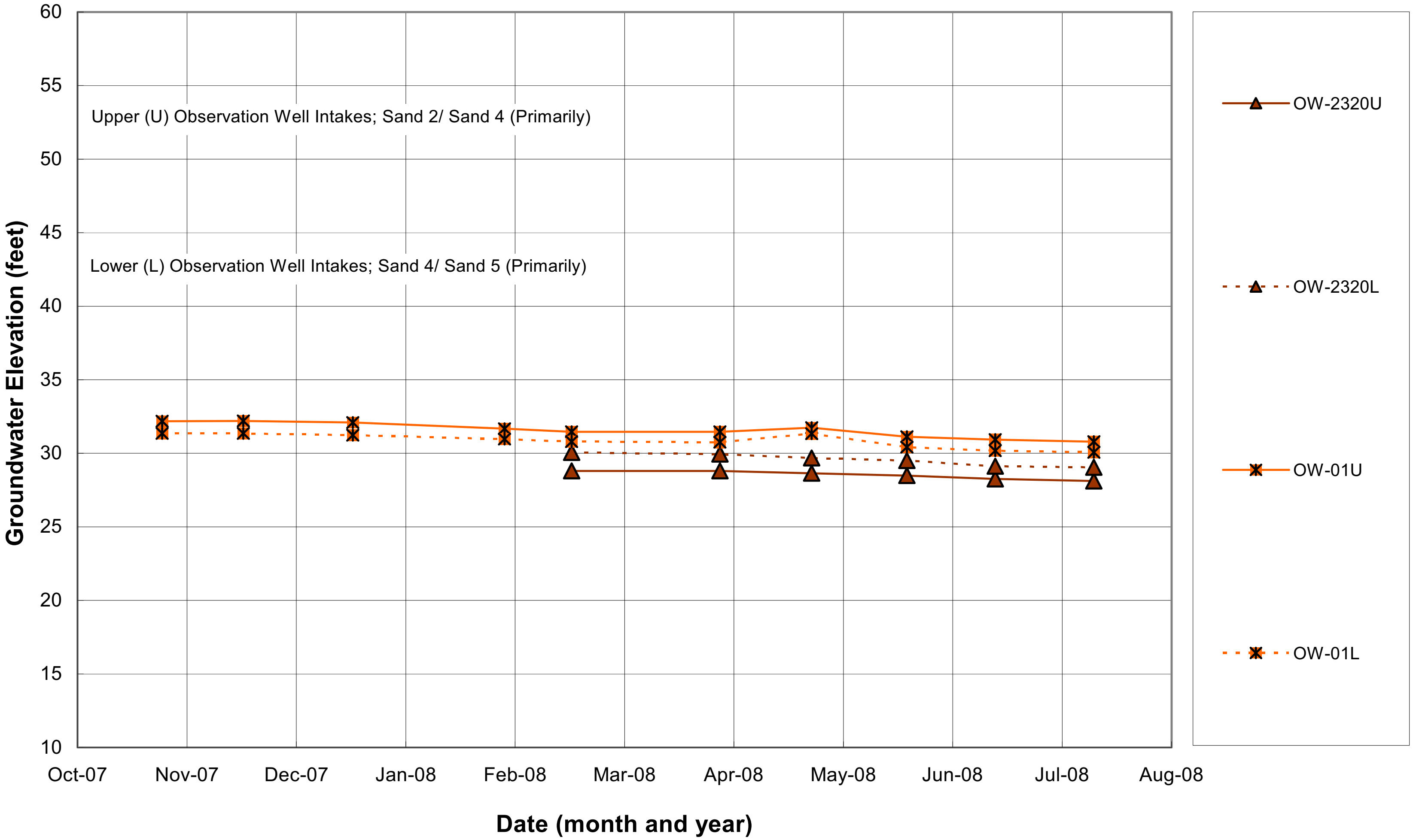


Figure 2.5.4-290 Measured Groundwater Levels; Central Area Measurements; Cooling Basin/ GBRA Storage Water Reservoir

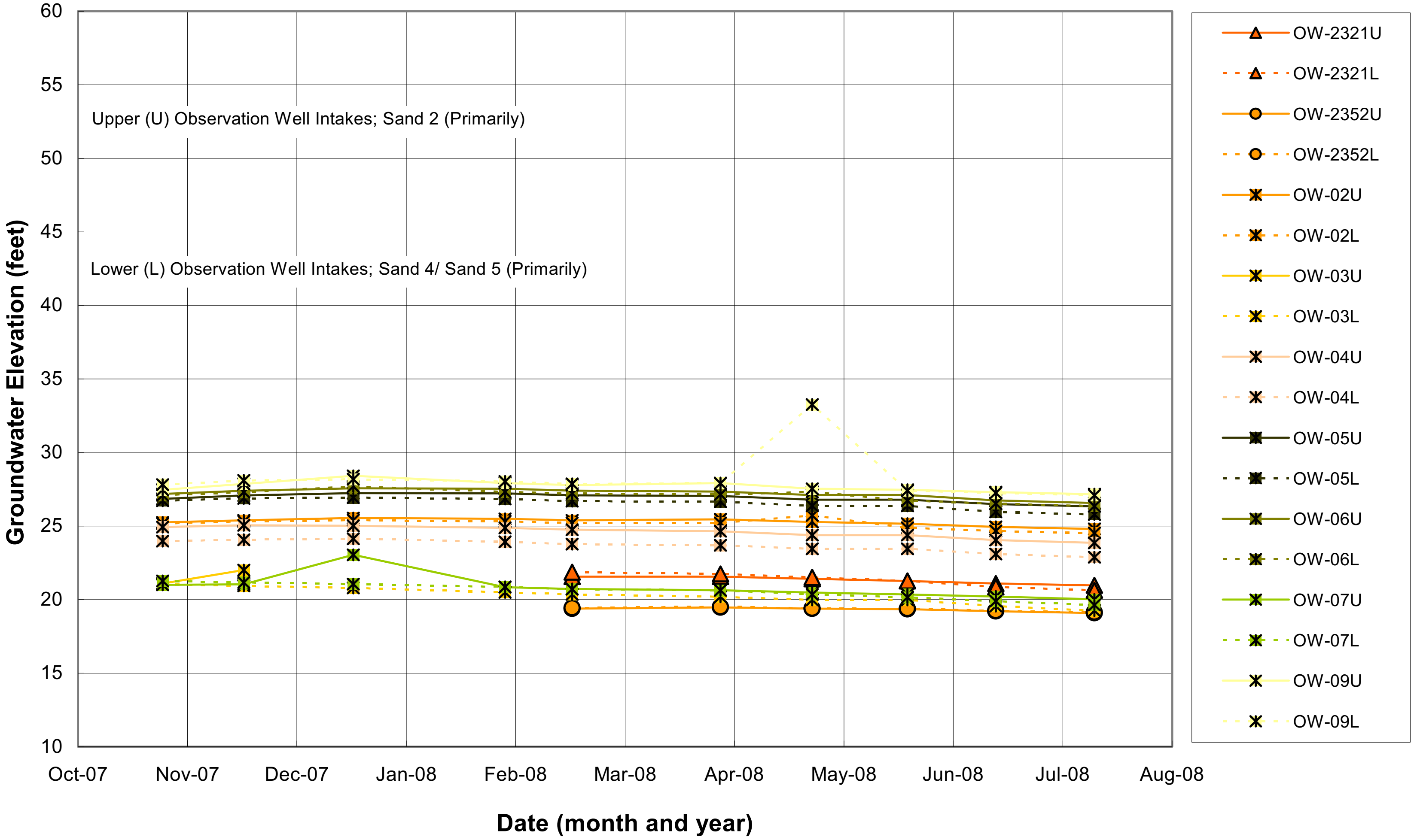


Figure 2.5.4-291 Measured Groundwater Levels; East Area Measurements; Cooling Basin/ GBRA Storage Water Reservoir

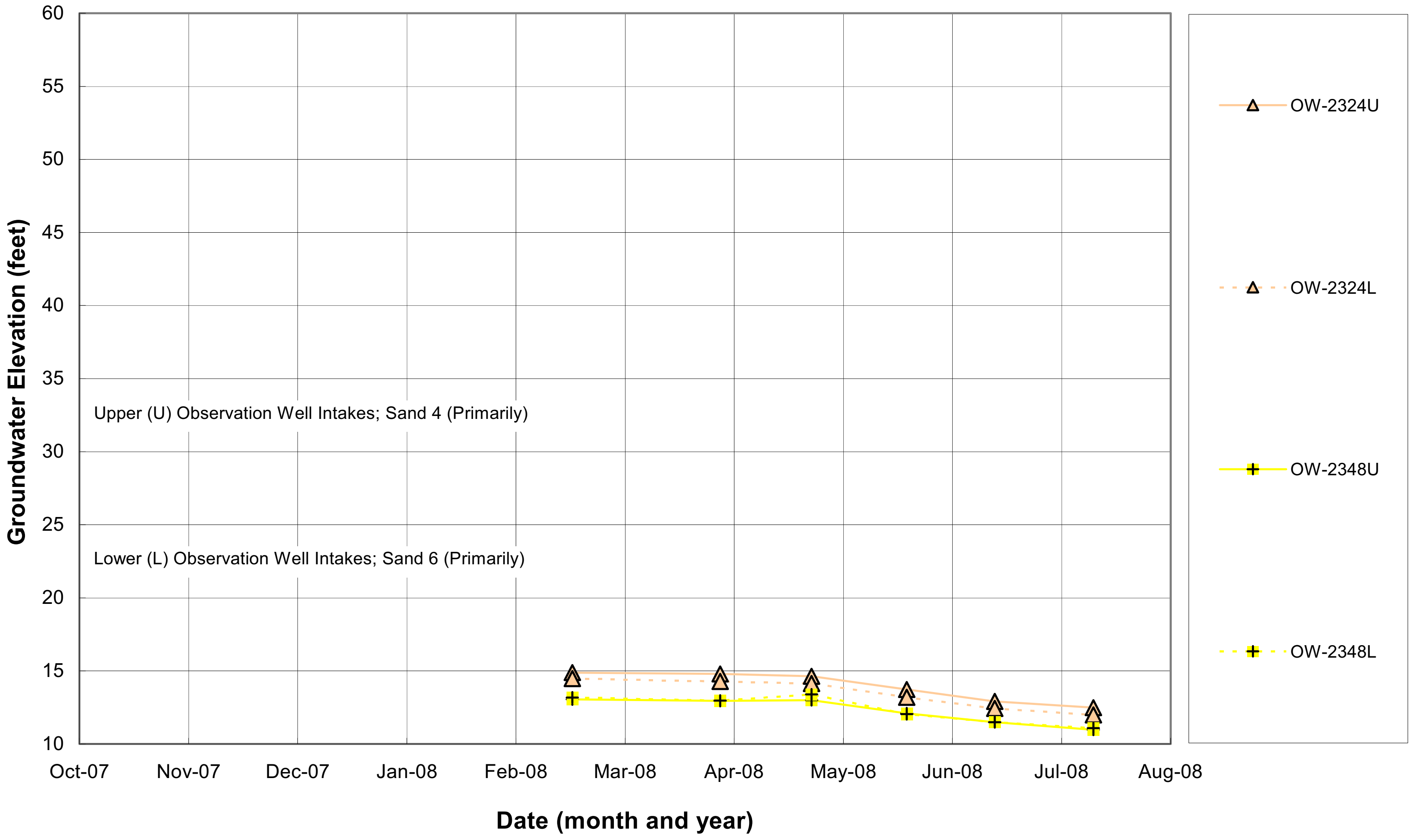


Figure 2.5.4-292 Measured Groundwater Levels; Linn Lake Area Measurements; East of Cooling Basin/ GBRA Storage Water Reservoir

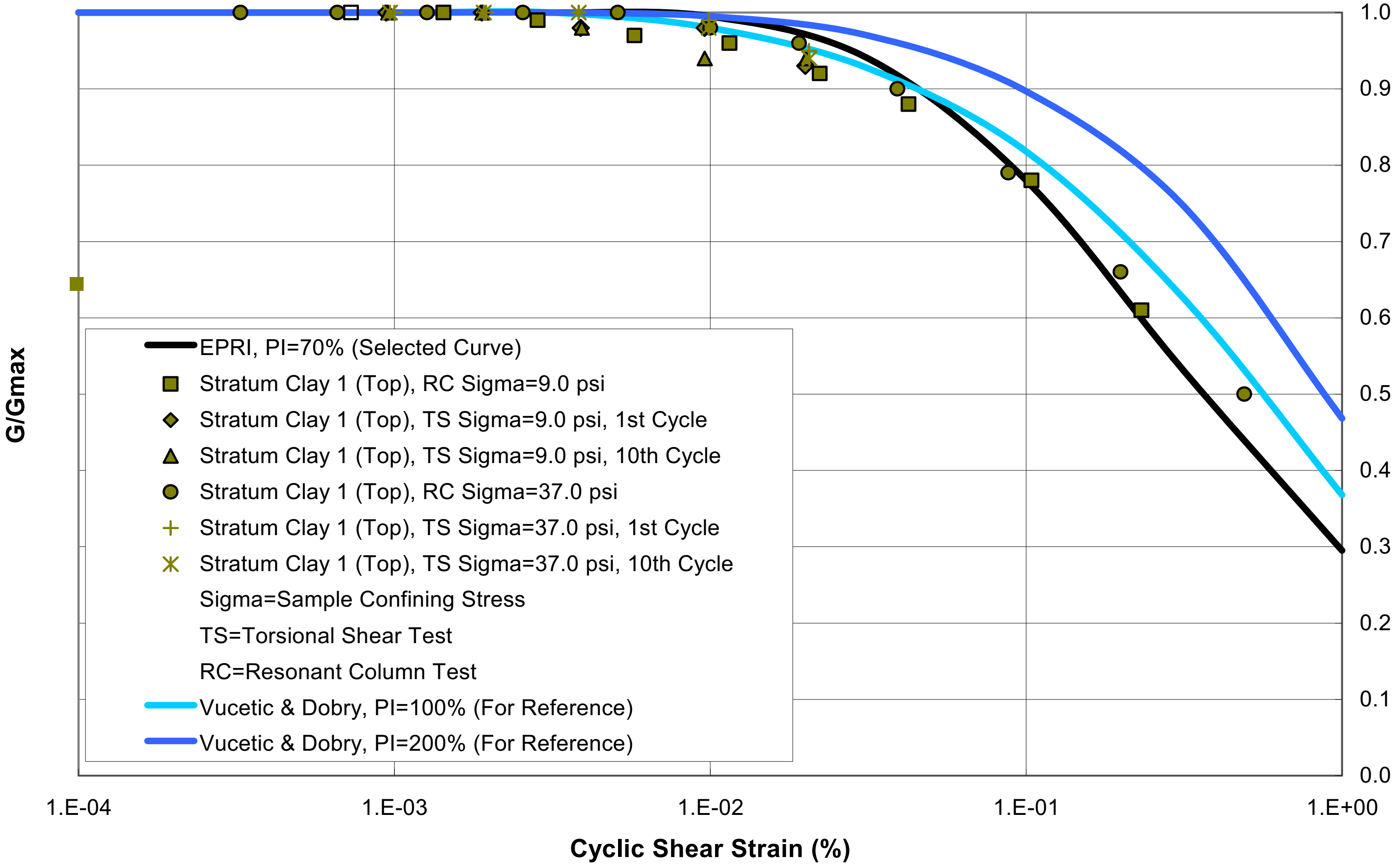


Figure 2.5.4-293 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 1 (Top) (Power Block)

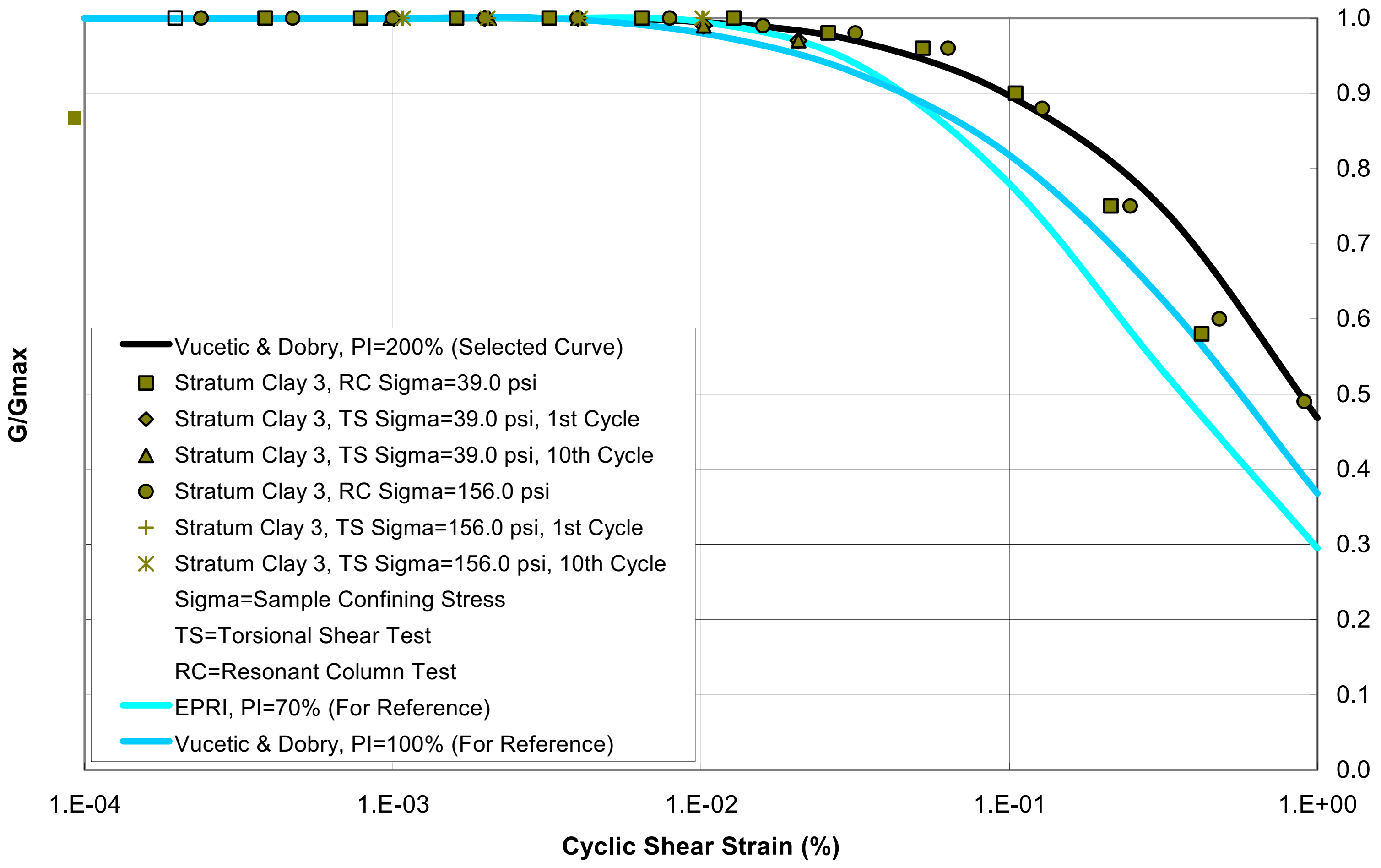


Figure 2.5.4-294 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 3 (Power Block)

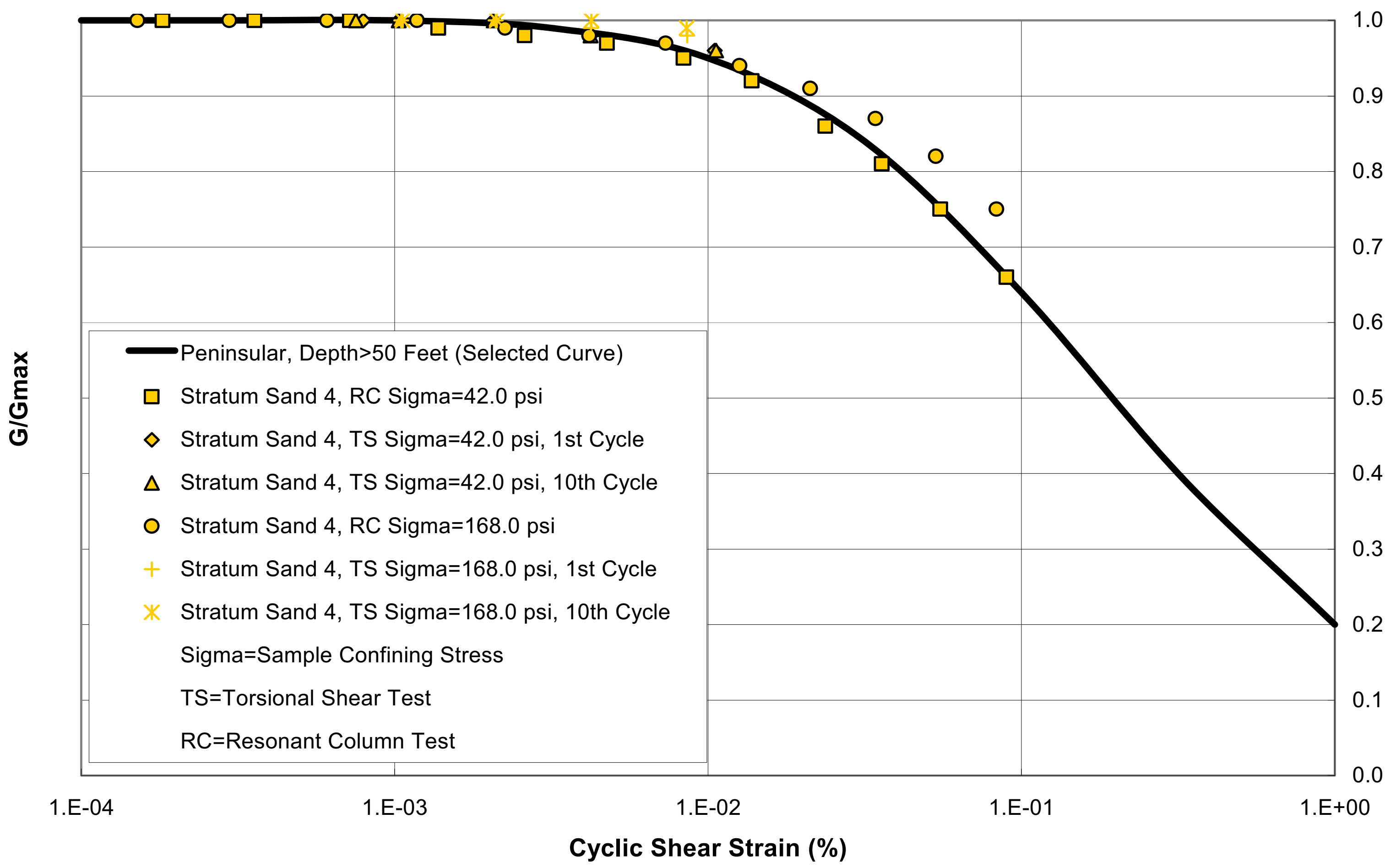


Figure 2.5.4-295 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 4 (Power Block)

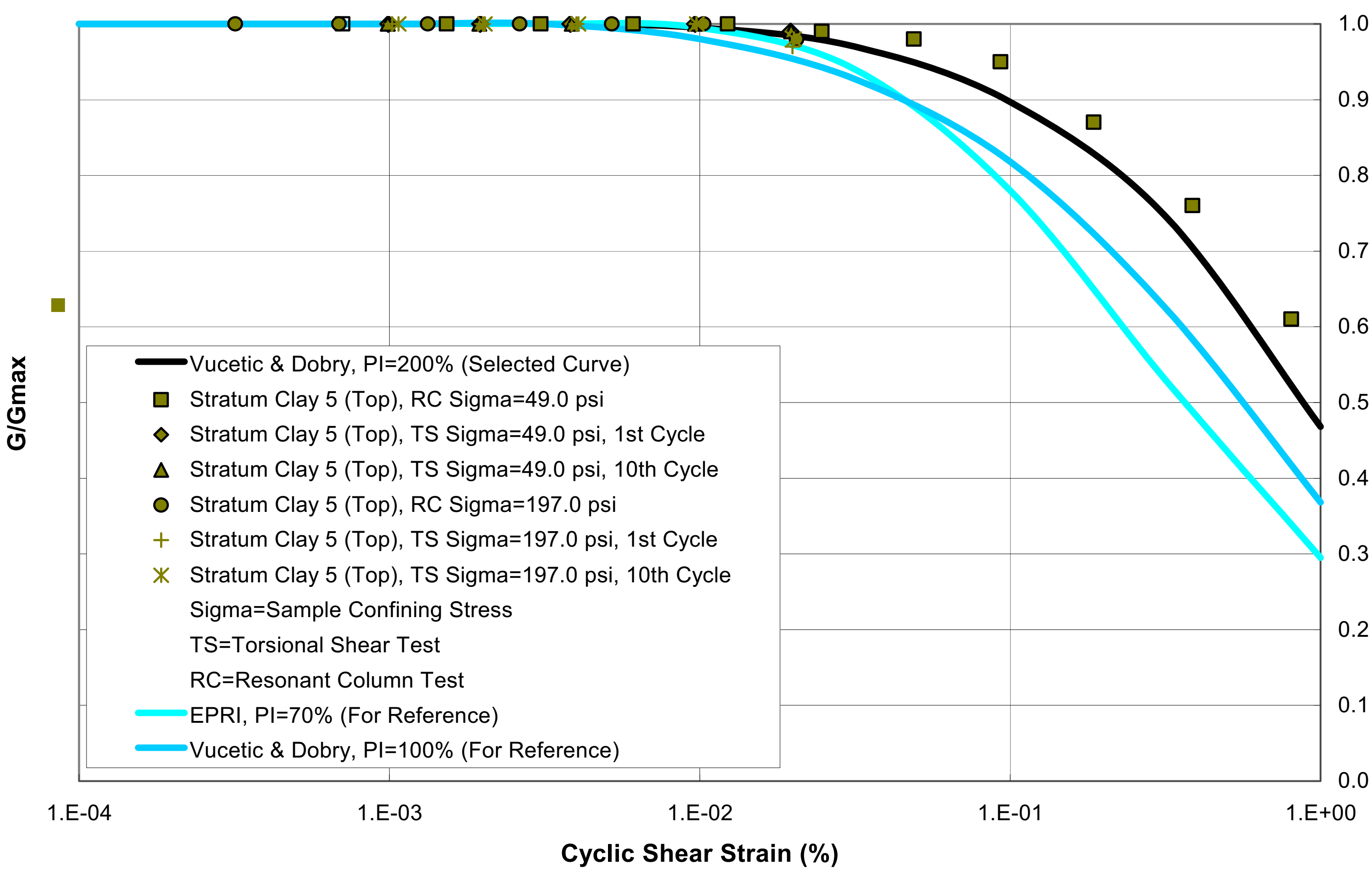


Figure 2.5.4-296 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 5 (Top) (Power Block)

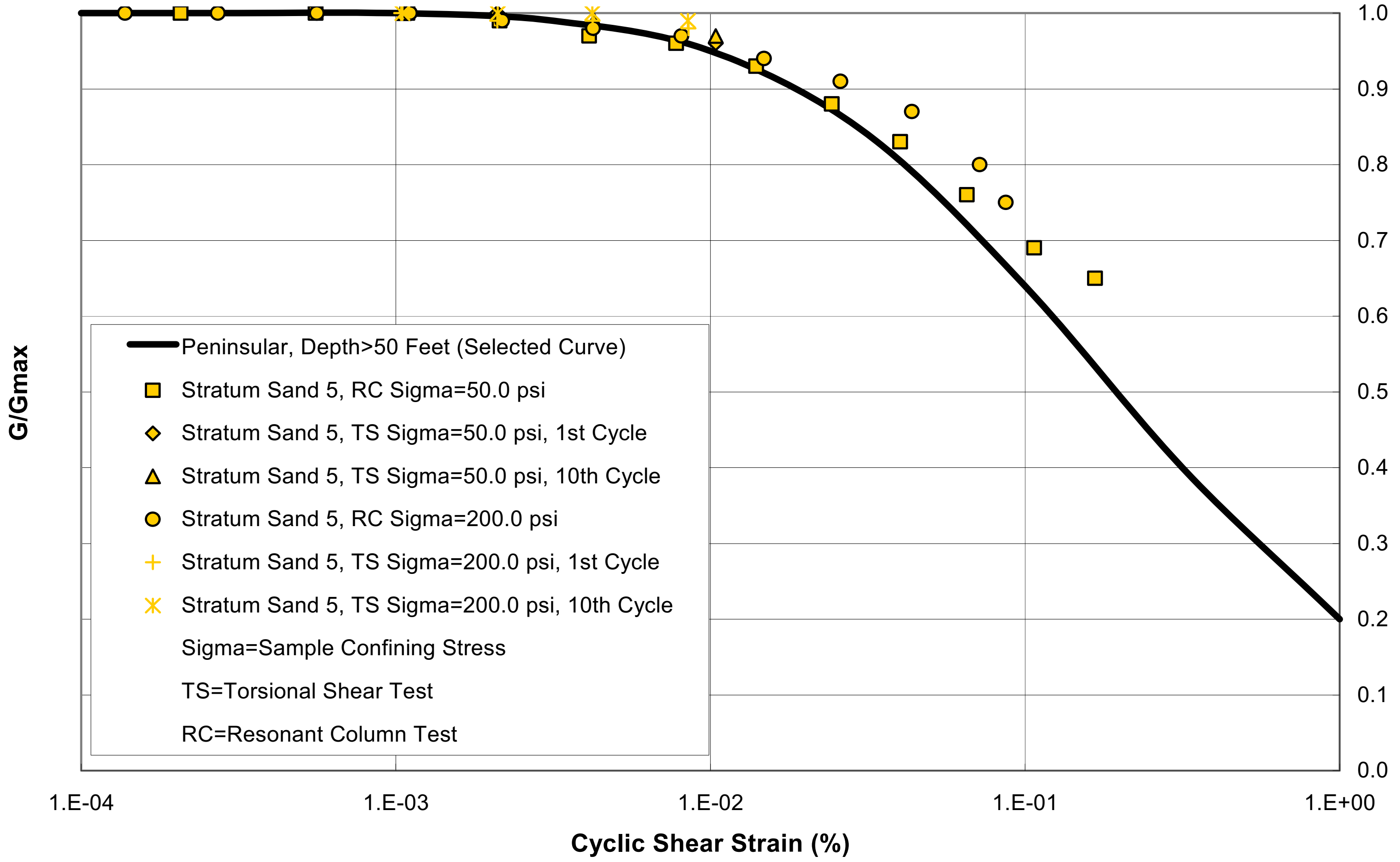


Figure 2.5.4-297 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 5 (Power Block)

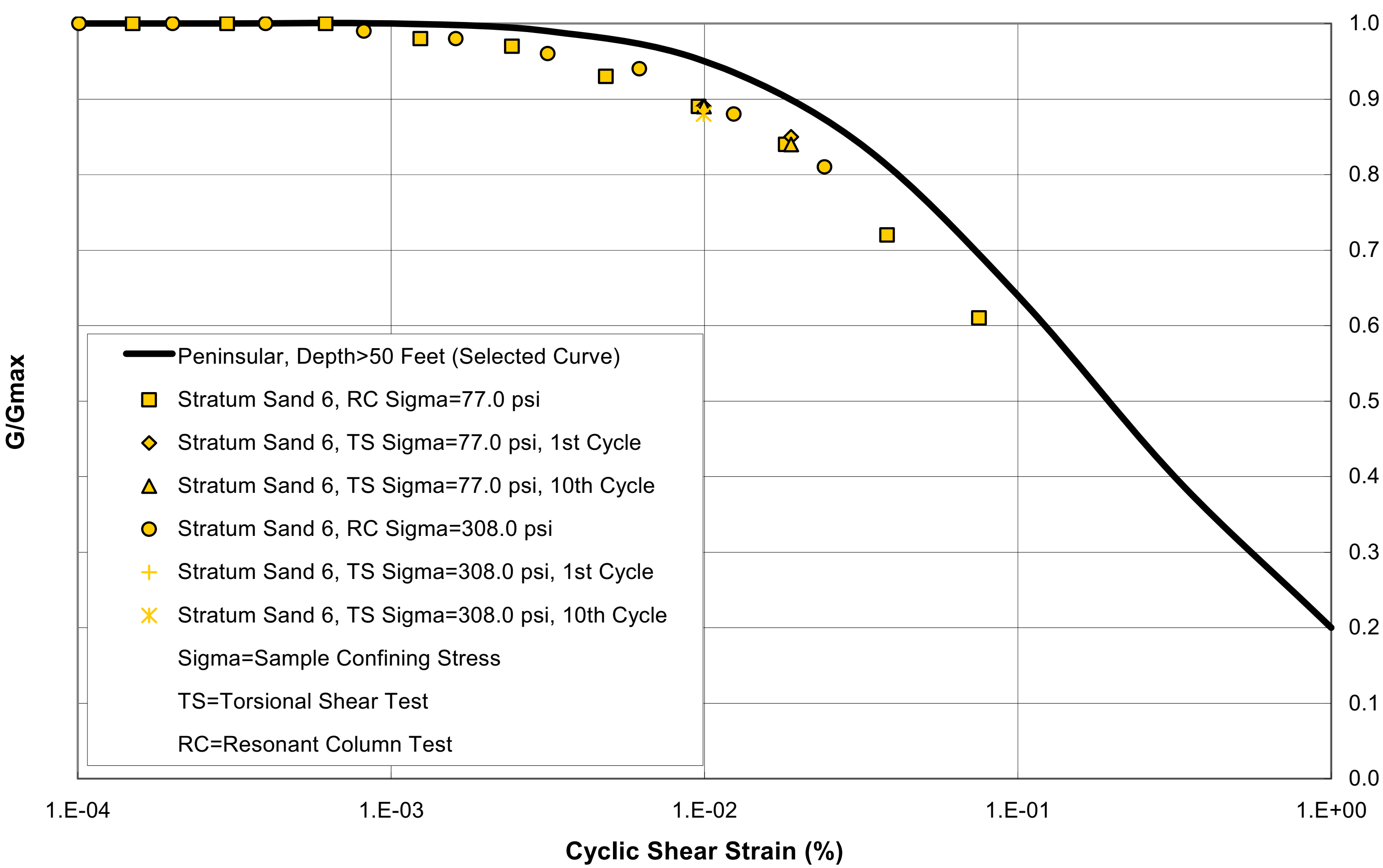


Figure 2.5.4-298 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 6 (Power Block)

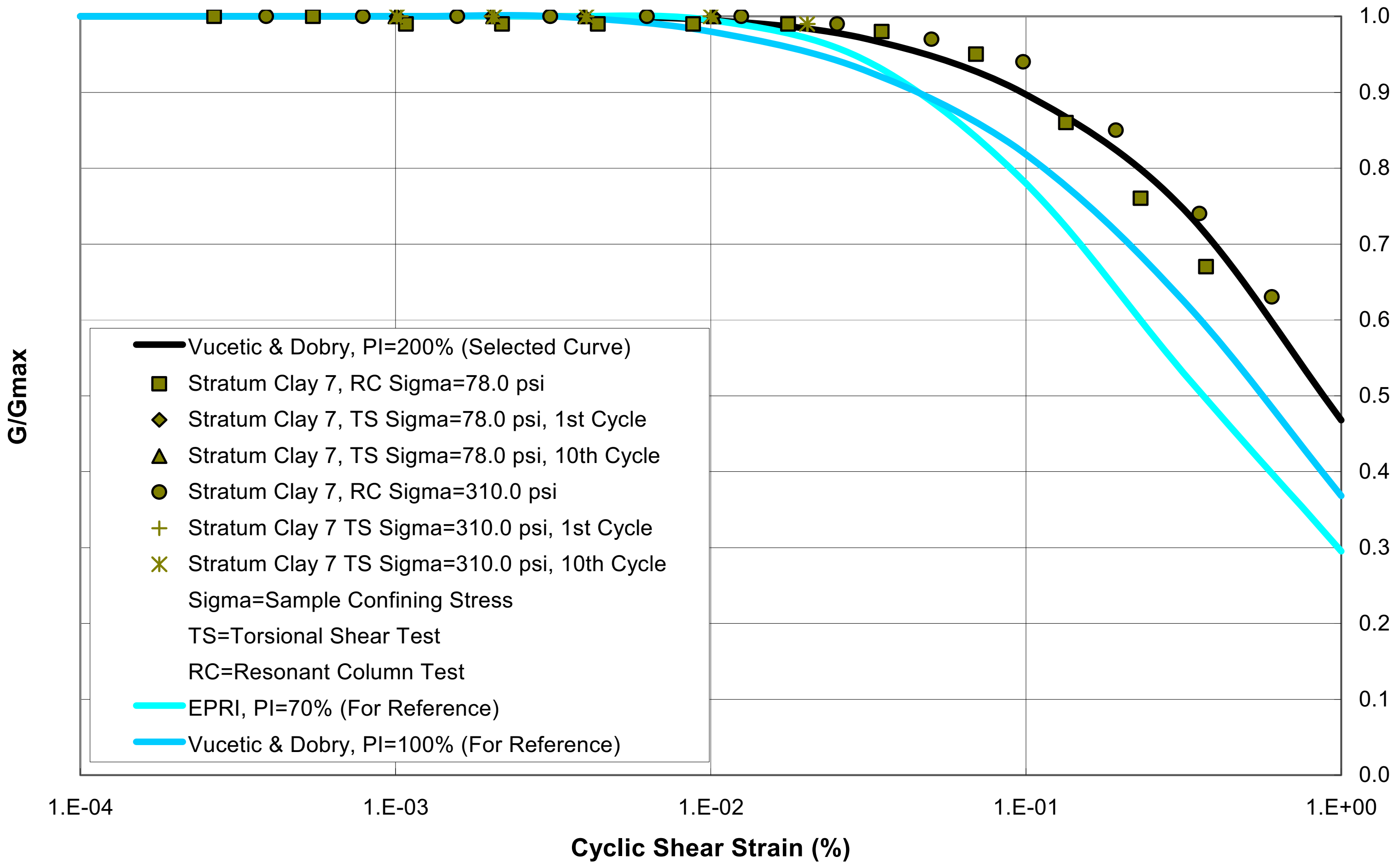


Figure 2.5.4-299 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 7 (Power Block)

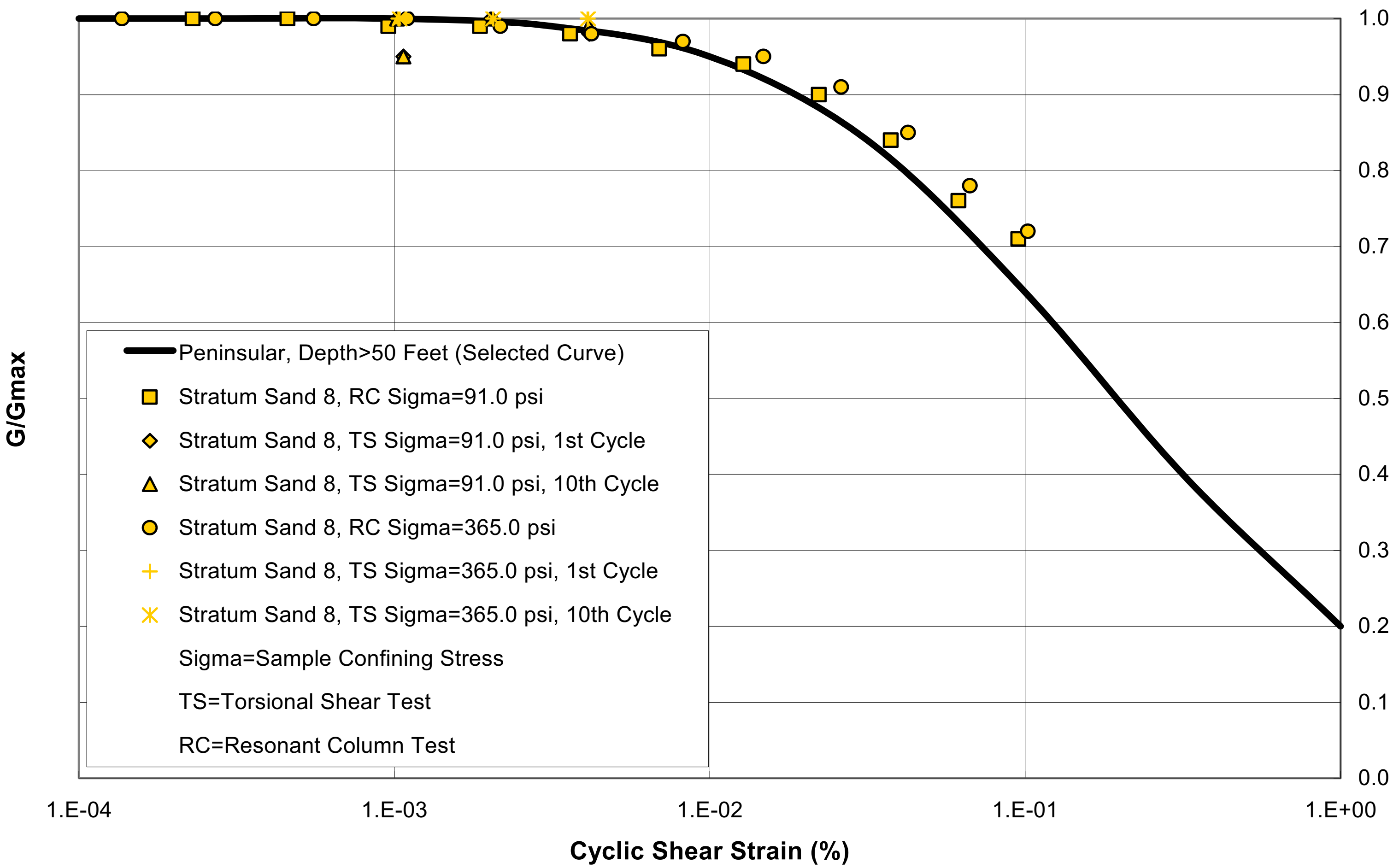


Figure 2.5.4-300 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 8 (Power Block)

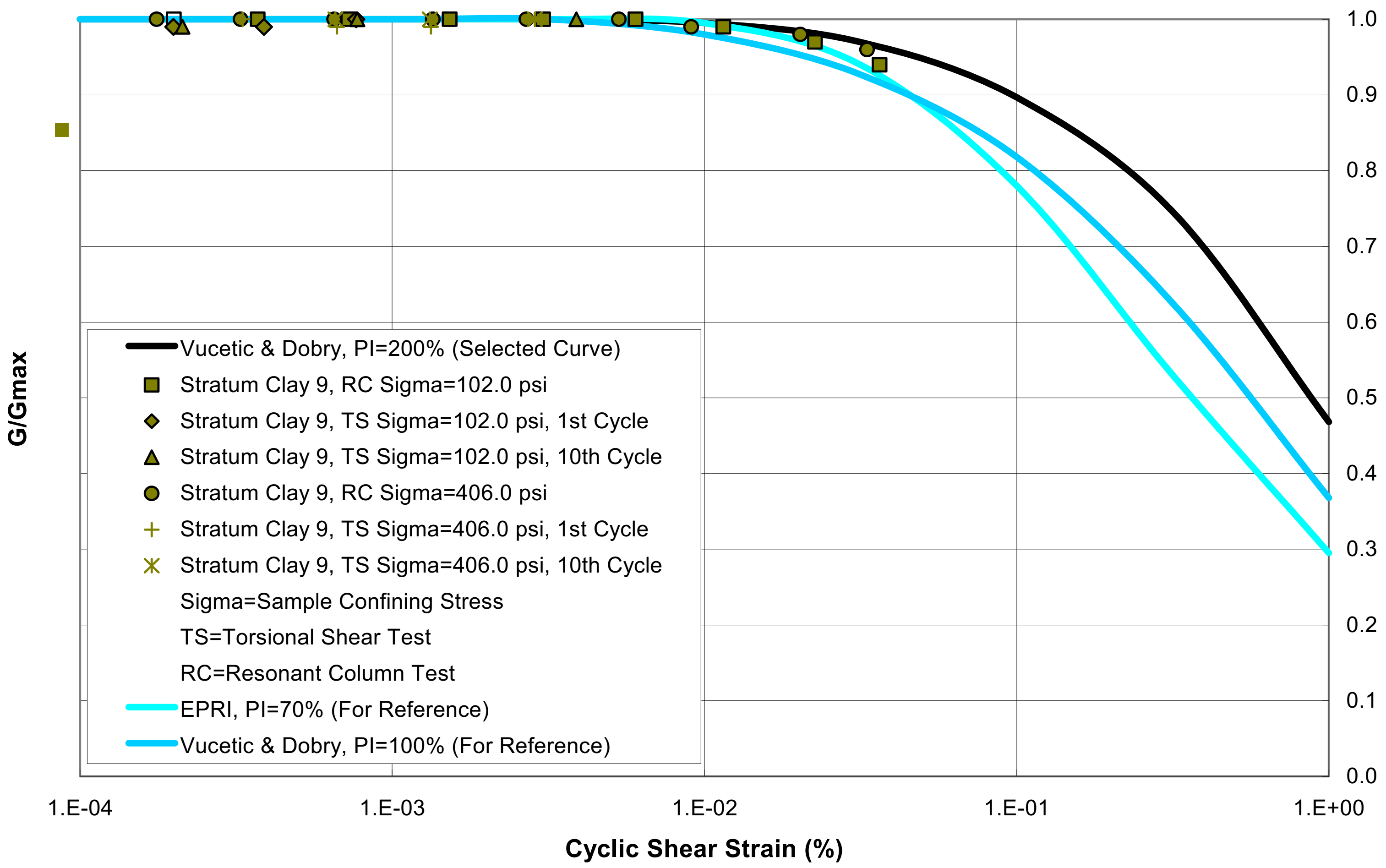


Figure 2.5.4-301 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 9 (Power Block)

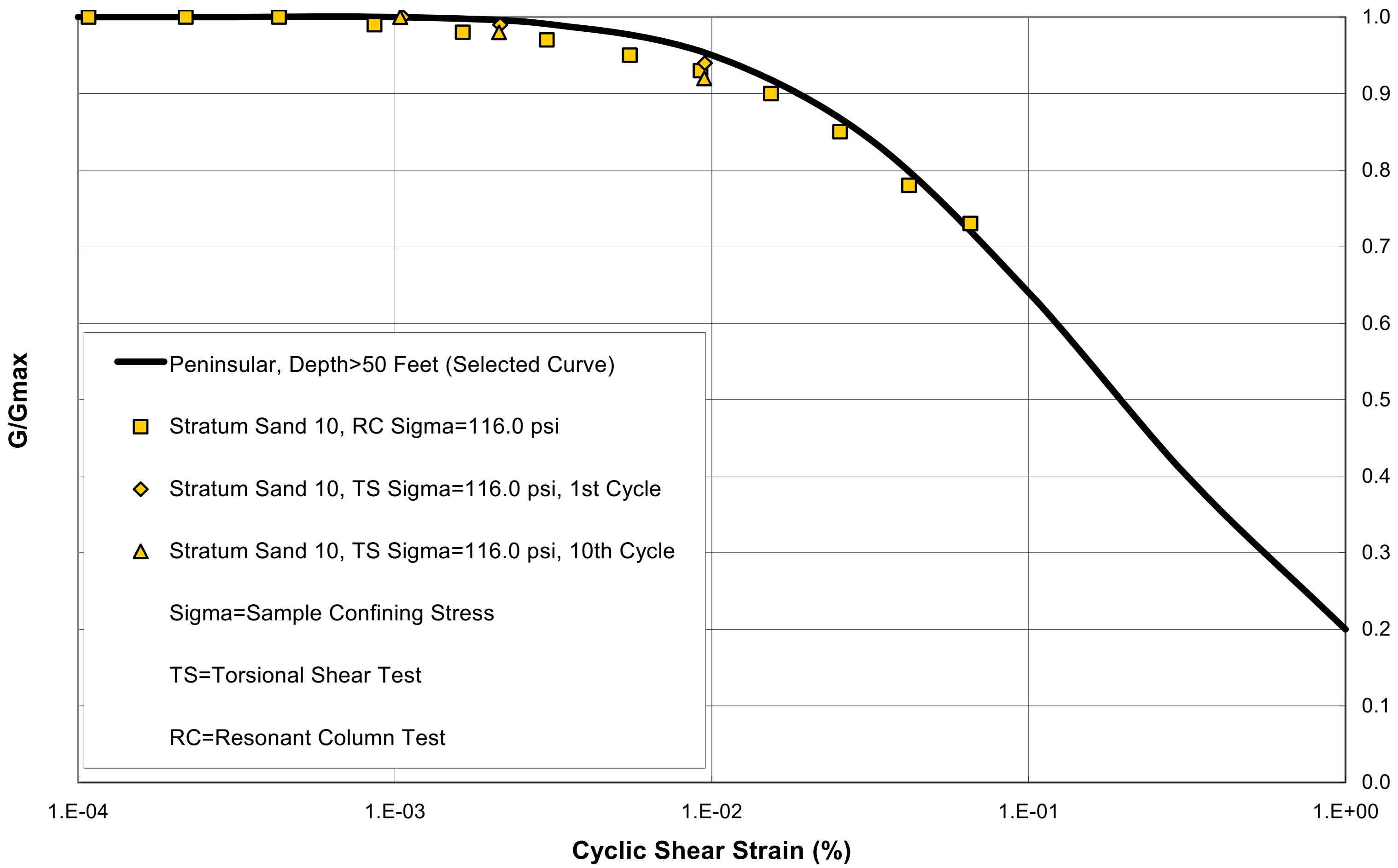


Figure 2.5.4-302 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 10 (Power Block)

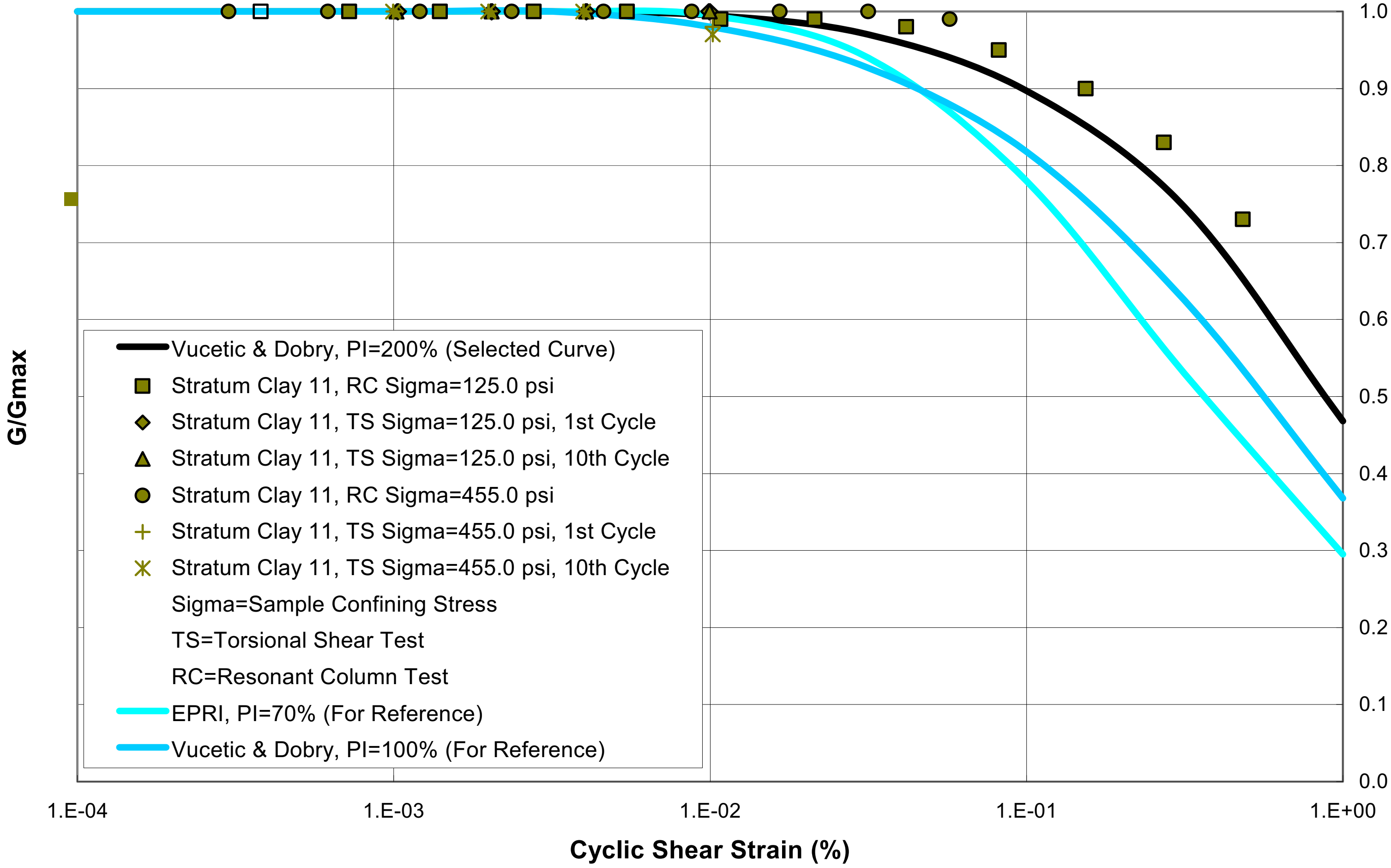


Figure 2.5.4-303 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 11 (Power Block)

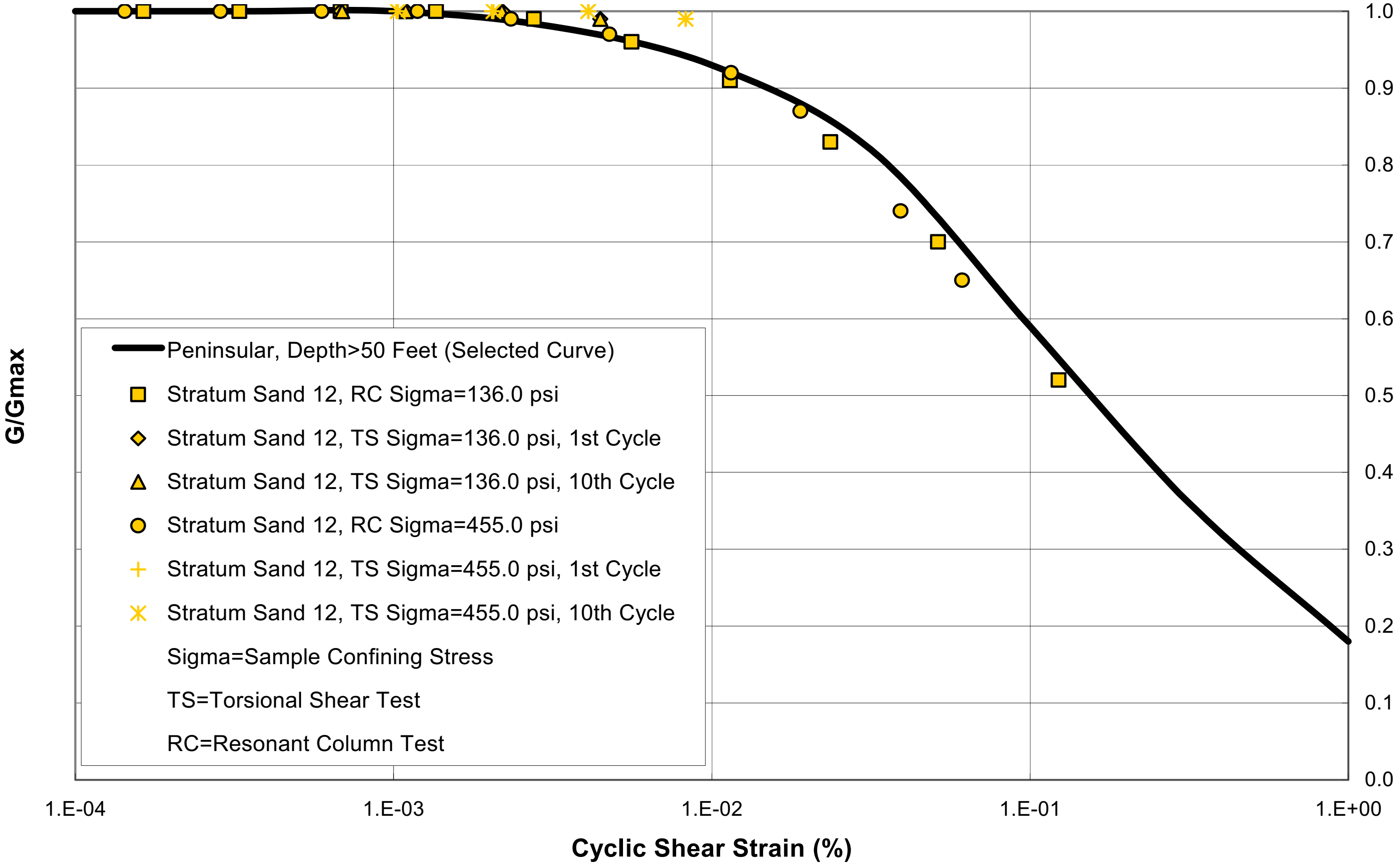


Figure 2.5.4-304 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 12 (Power Block)

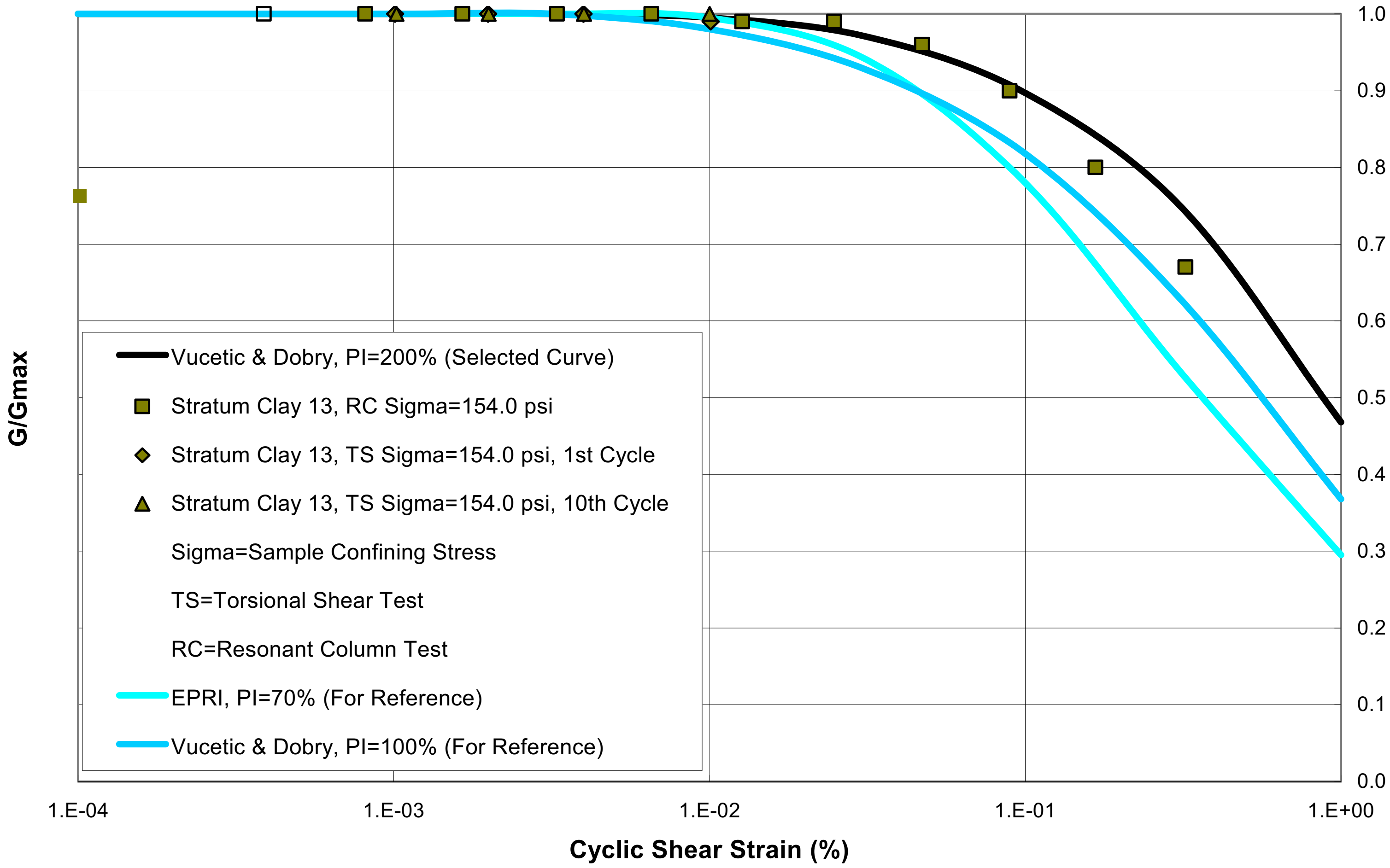


Figure 2.5.4-305 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 13 (Power Block)

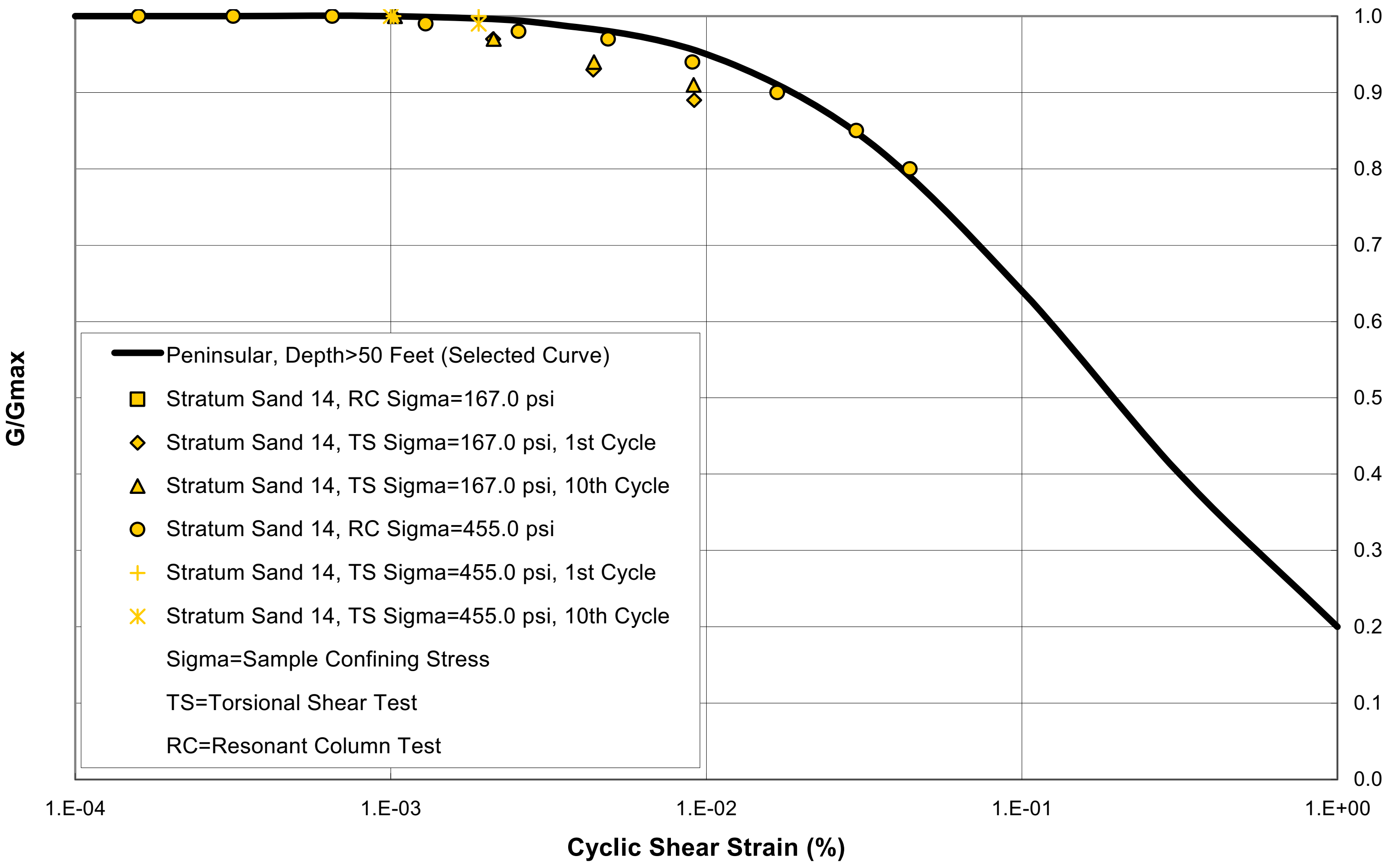


Figure 2.5.4-306 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 14 (Power Block)

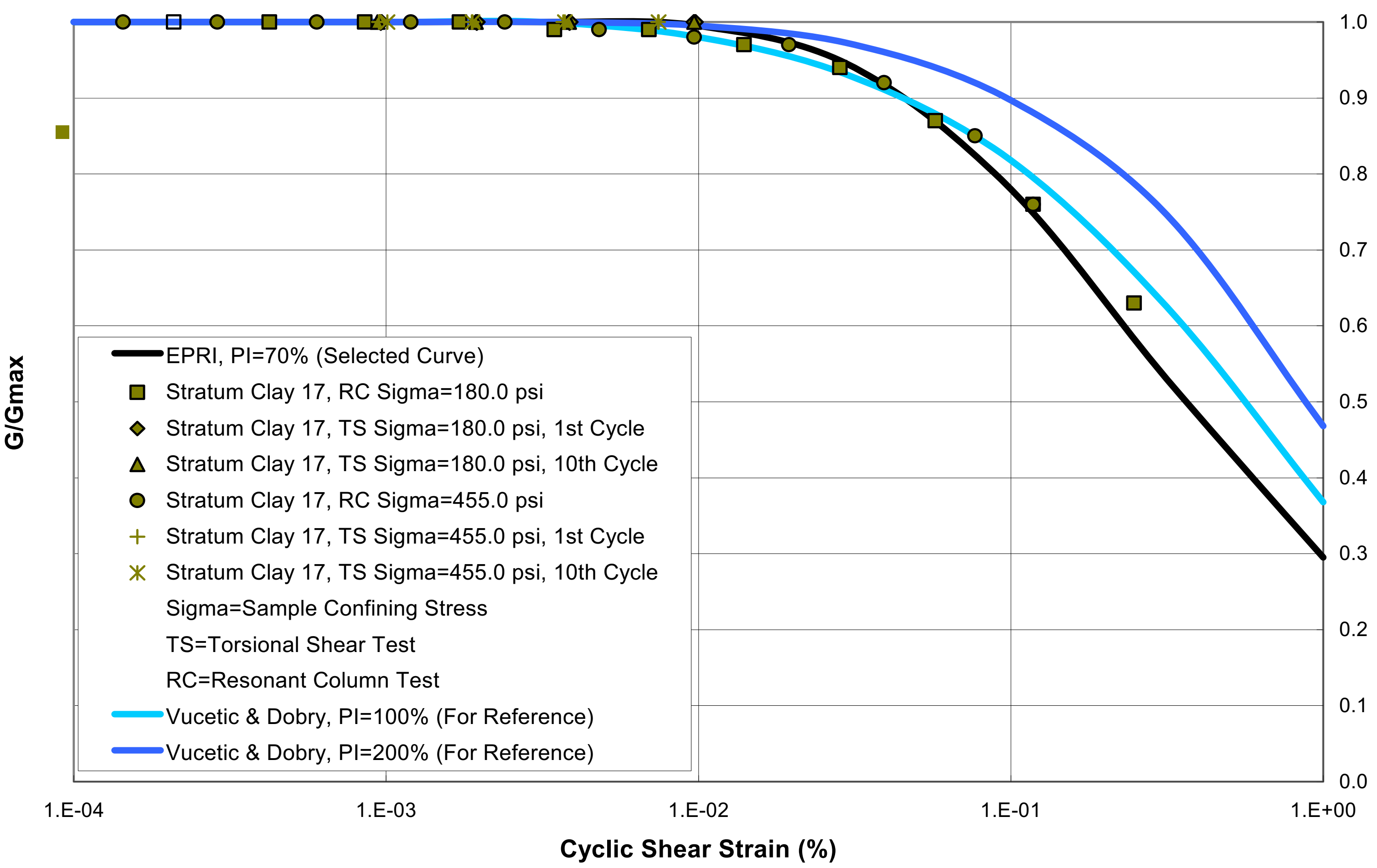


Figure 2.5.4-307 RCTS Test Results; Shear Modulus Degradation; Stratum Clay 17 (Power Block)

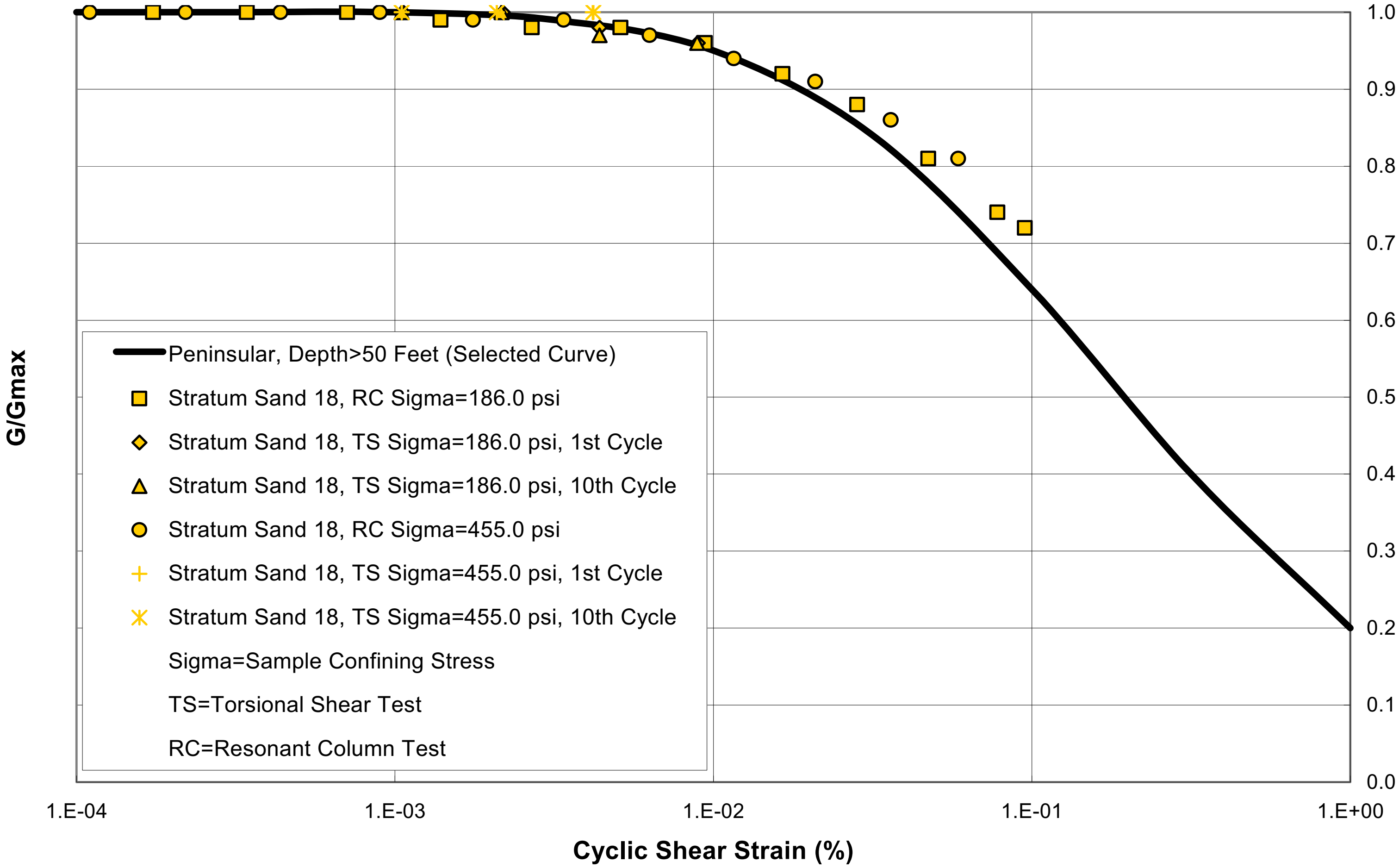


Figure 2.5.4-308 RCTS Test Results; Shear Modulus Degradation; Stratum Sand 18 (Power Block)

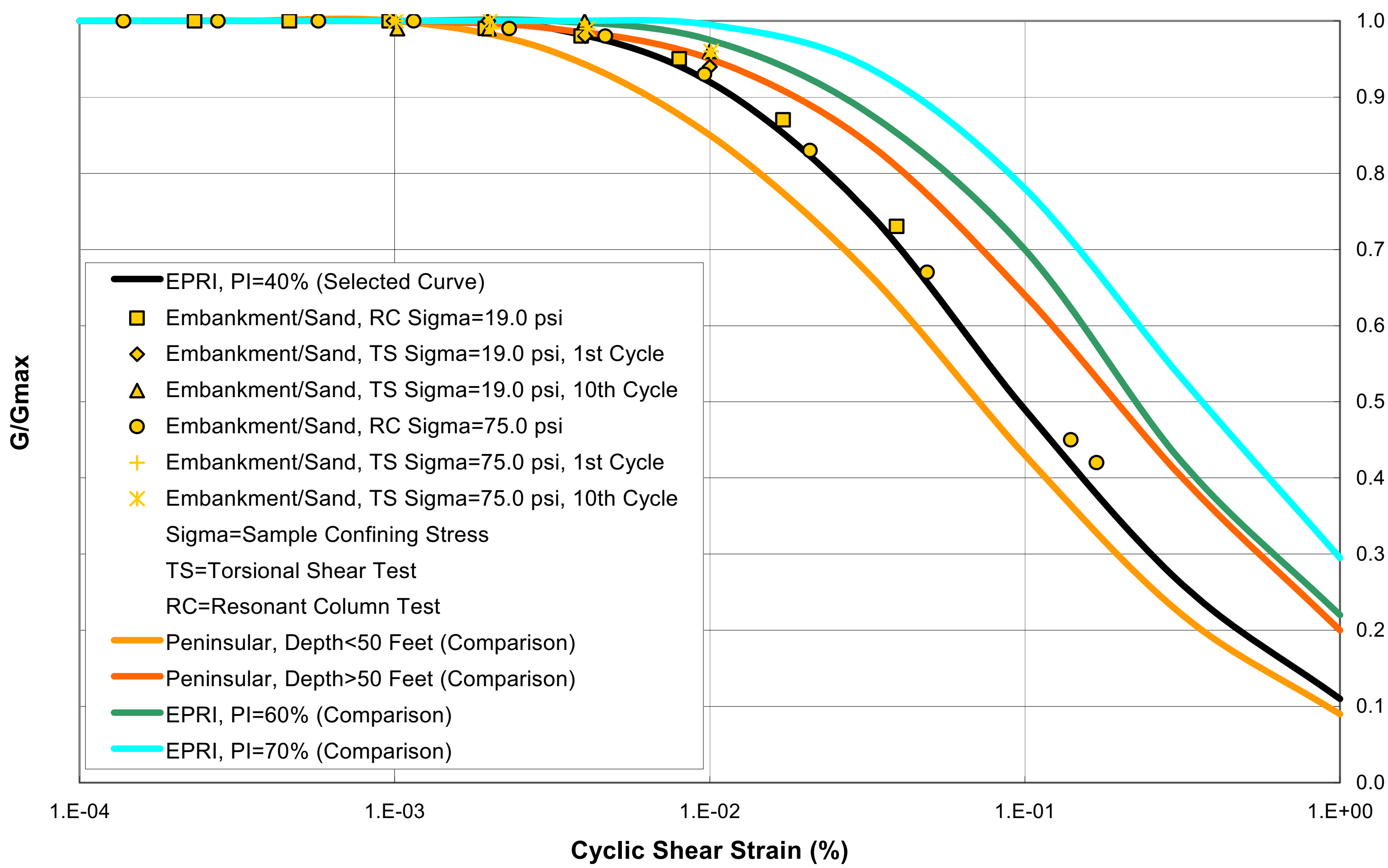


Figure 2.5.4-309 RCTS Test Results; Shear Modulus Degradation; Embankment Fill/Sand; Composite A Sample (Cooling Basin/GBRA Storage Water Reservoir)

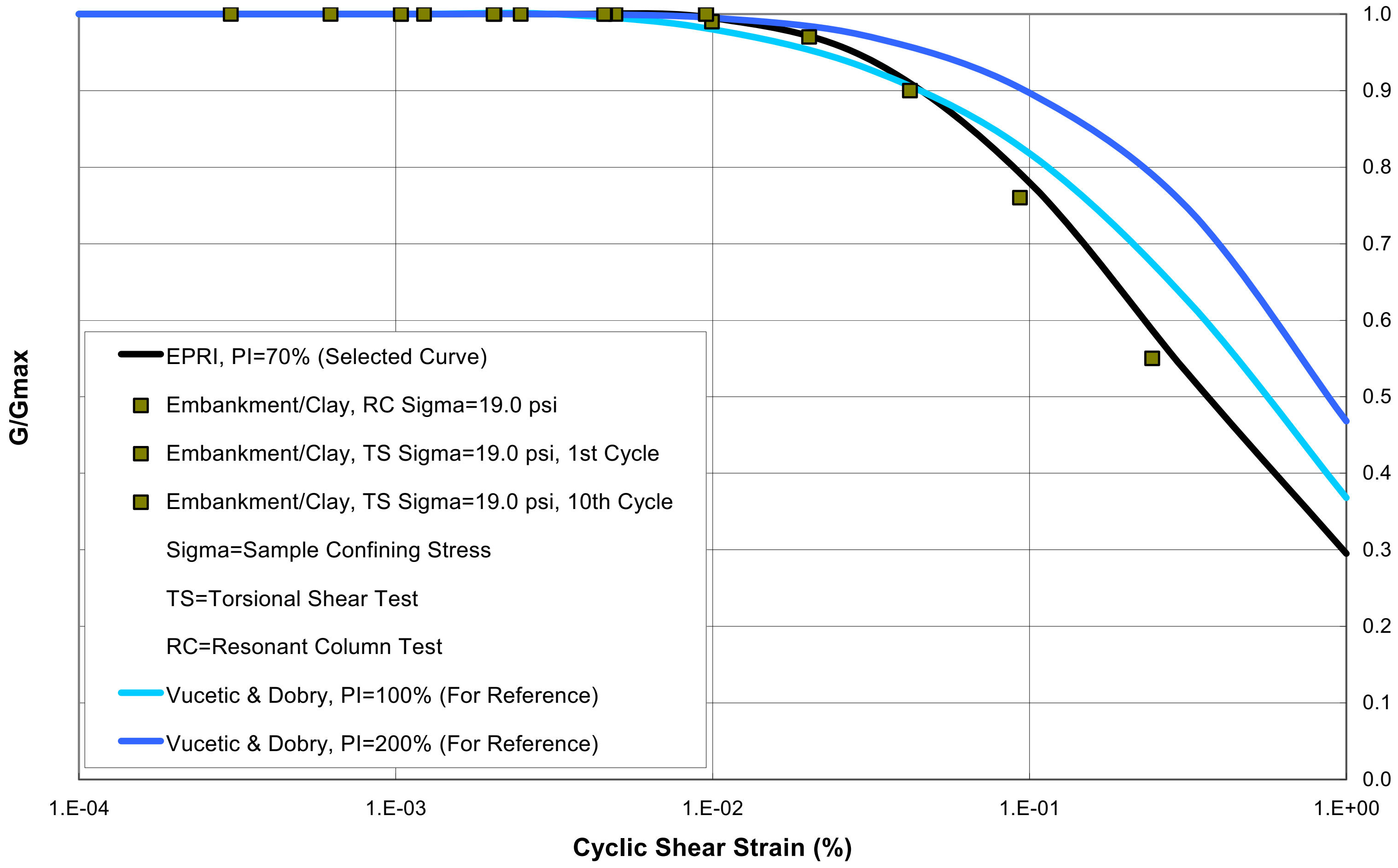


Figure 2.5.4-310 RCTS Test Results; Shear Modulus Degradation; Embankment Fill/Clay; Composite B Sample (Cooling Basin/GBRA Storage Water Reservoir)

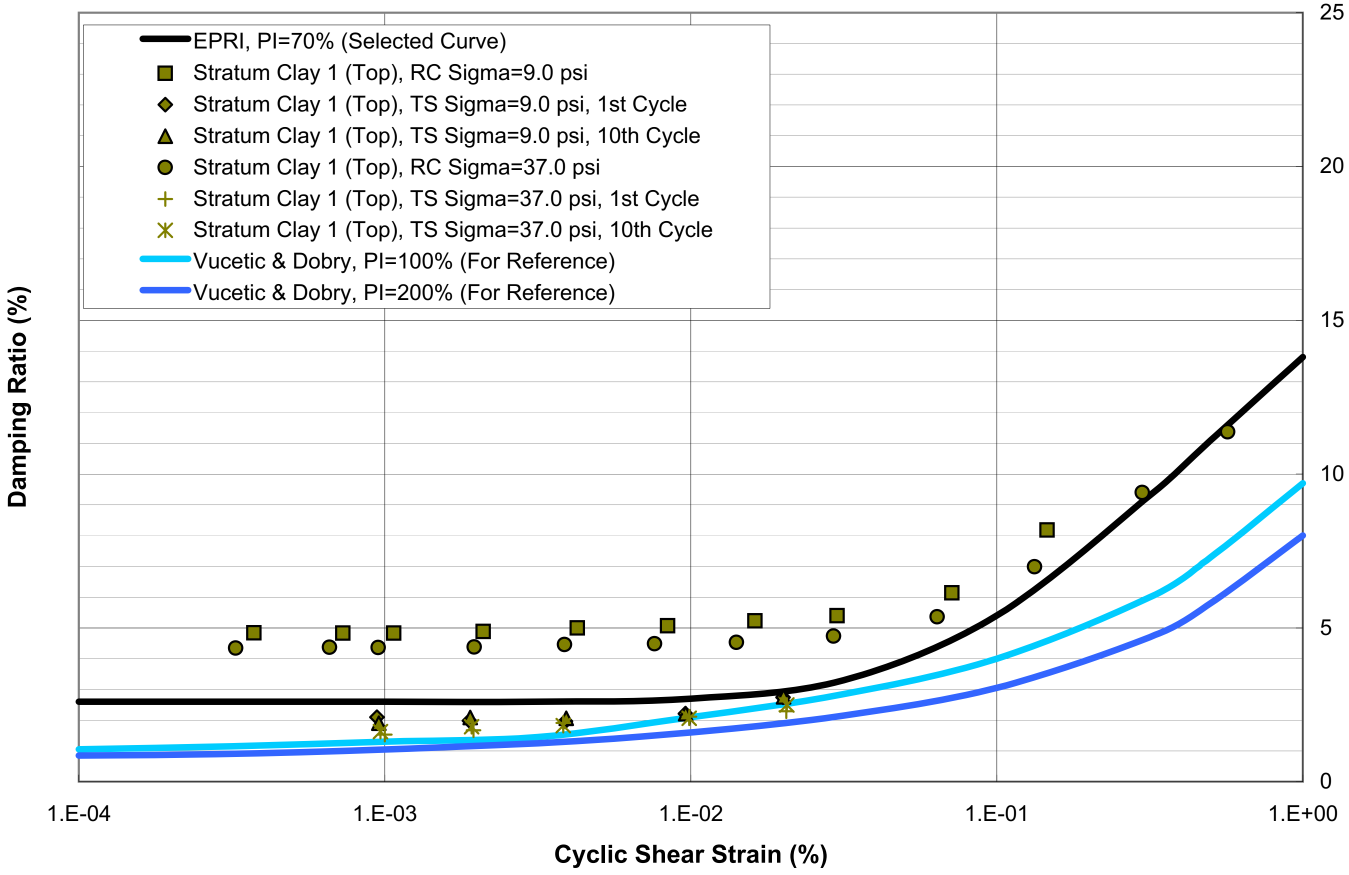


Figure 2.5.4-311 RCTS Test Results; Damping Ratio; Stratum Clay 1 (Top) (Power Block)

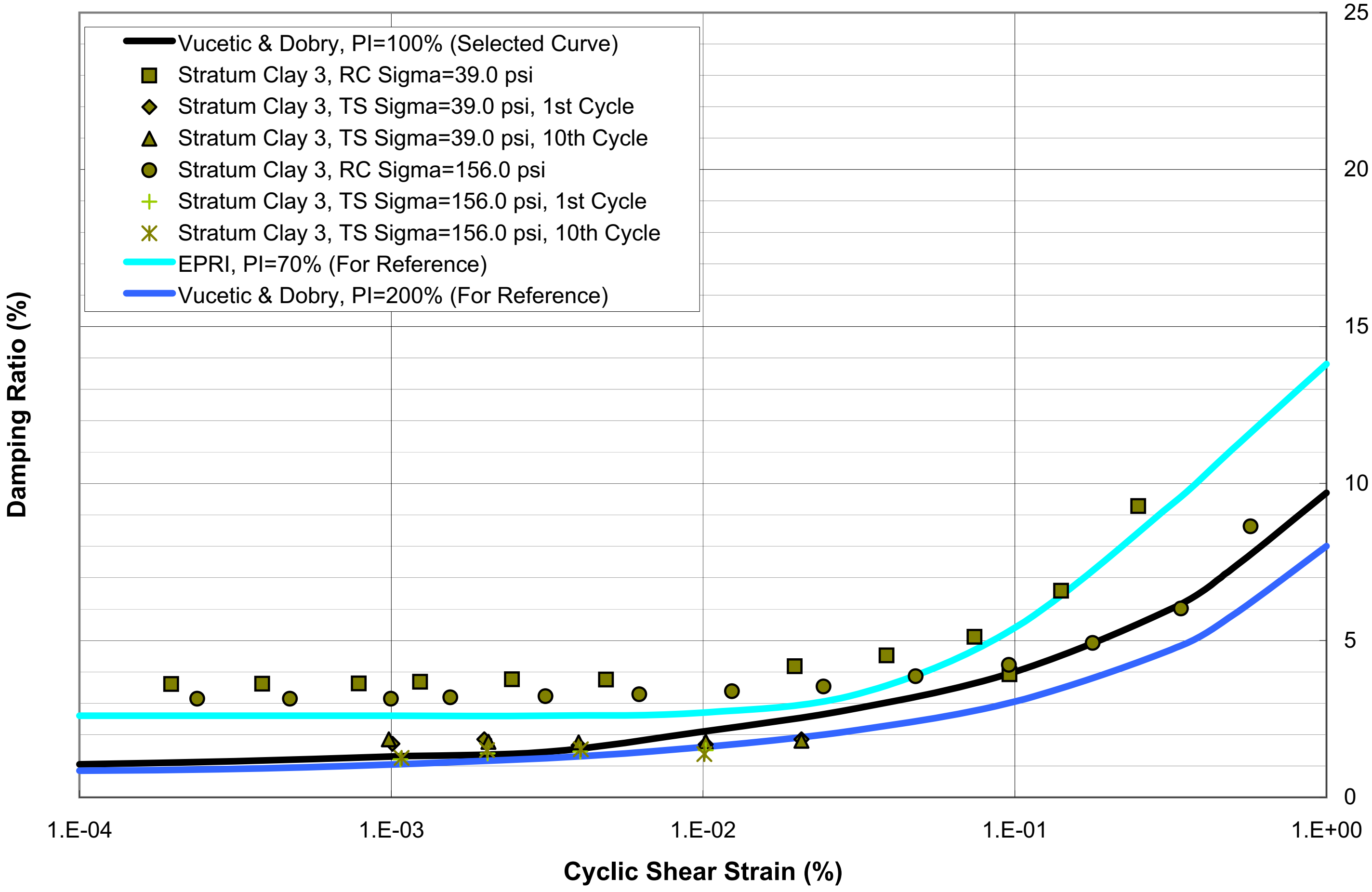


Figure 2.5.4-312 RCTS Test Results; Damping Ratio; Stratum Clay 3 (Power Block)

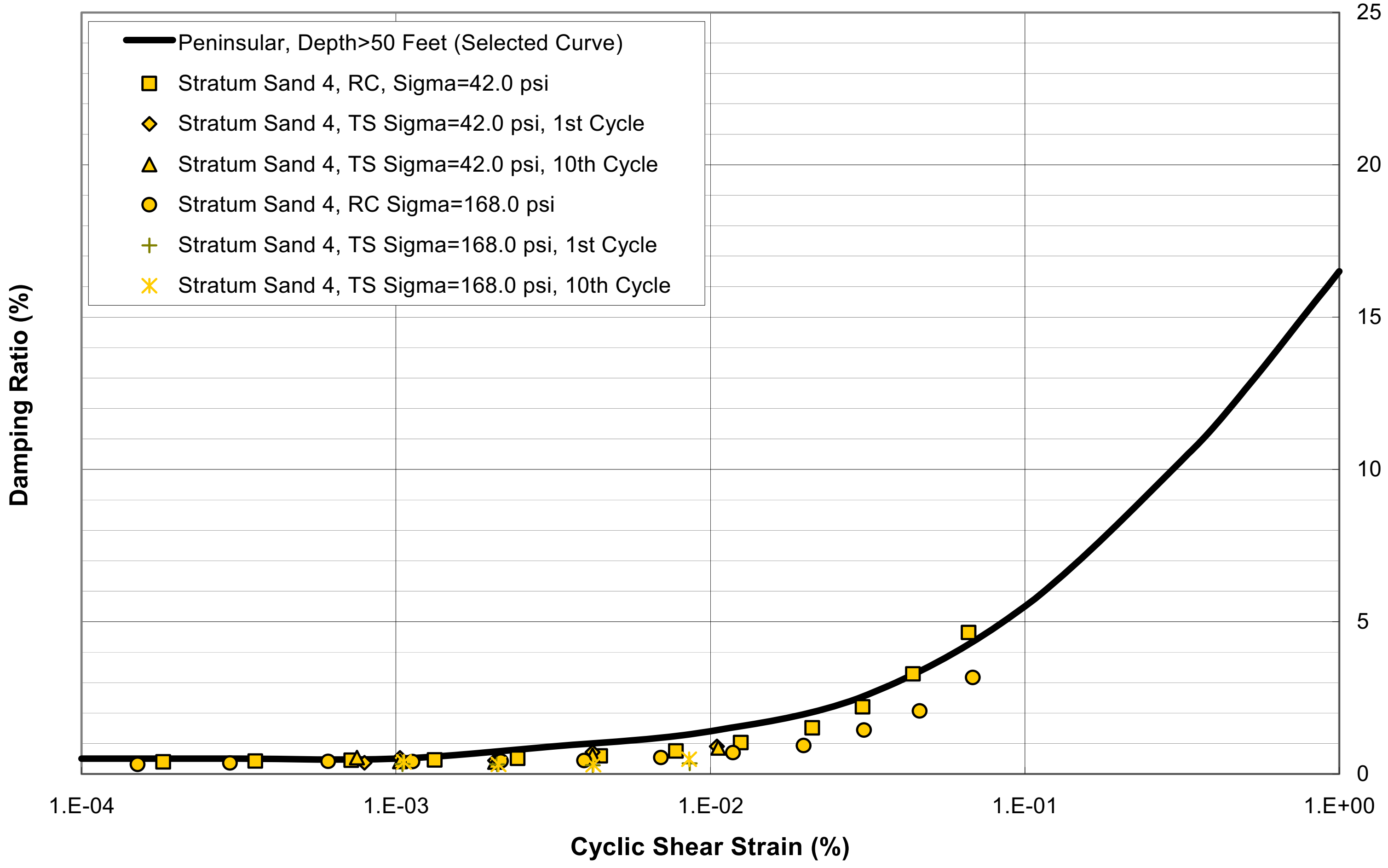


Figure 2.5.4-313 RCTS Test Results; Damping Ratio; Stratum Sand 4 (Power Block)

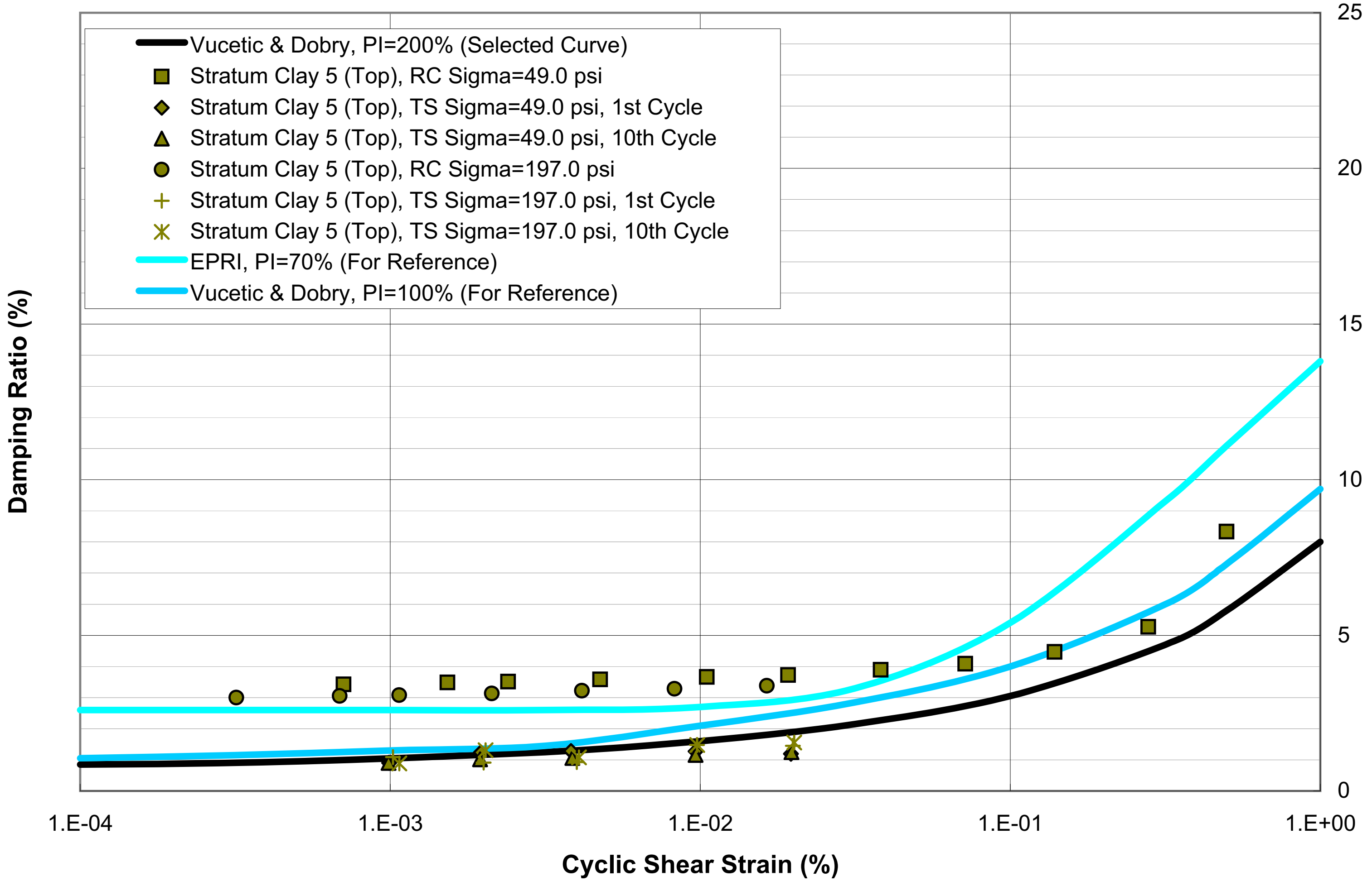


Figure 2.5.4-314 RCTS Test Results; Damping Ratio; Stratum Clay 5 (Top) (Power Block)

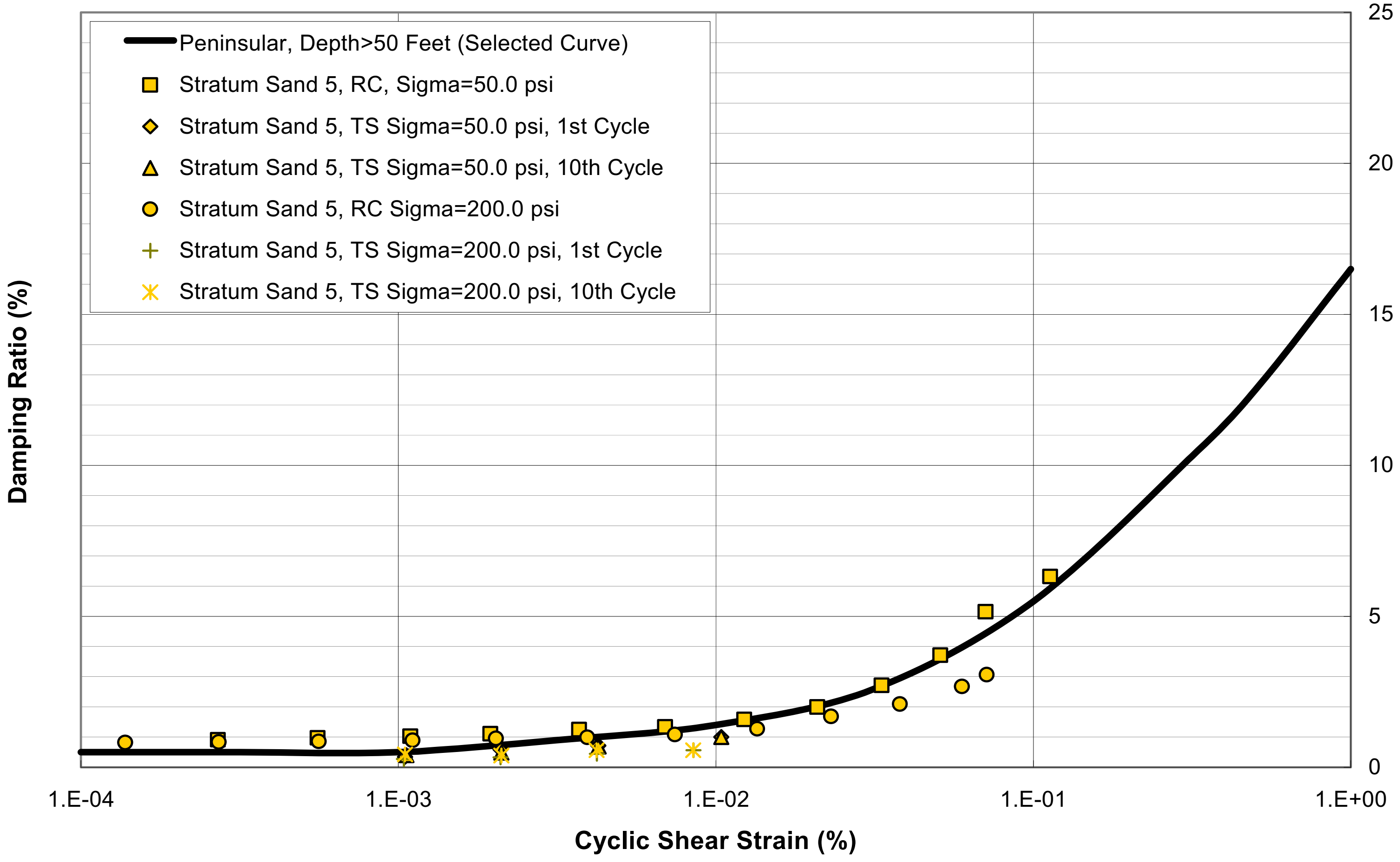


Figure 2.5.4-315 RCTS Test Results; Damping Ratio; Stratum Sand 5 (Power Block)

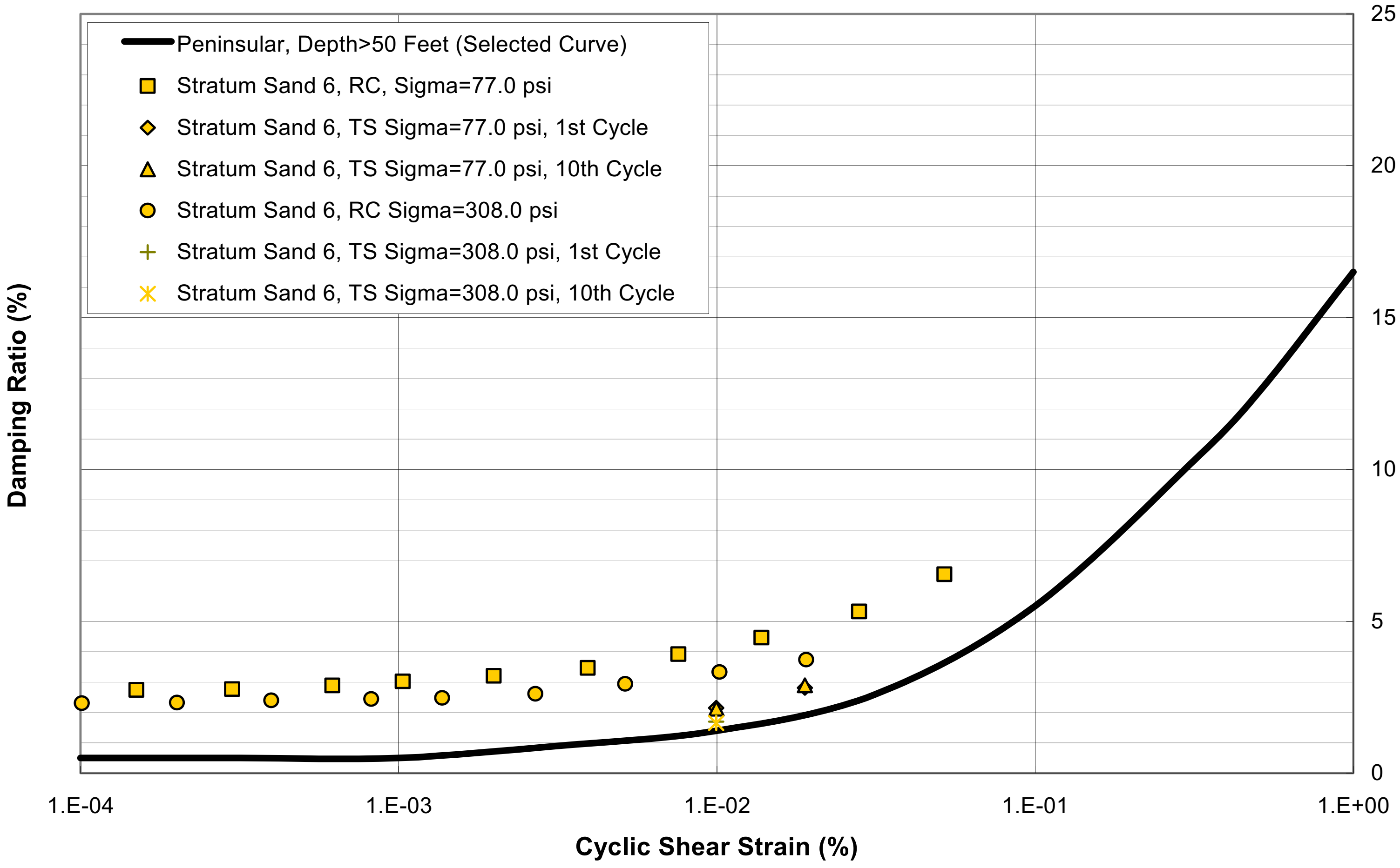


Figure 2.5.4-316 RCTS Test Results; Damping Ratio; Stratum Sand 6 (Power Block)

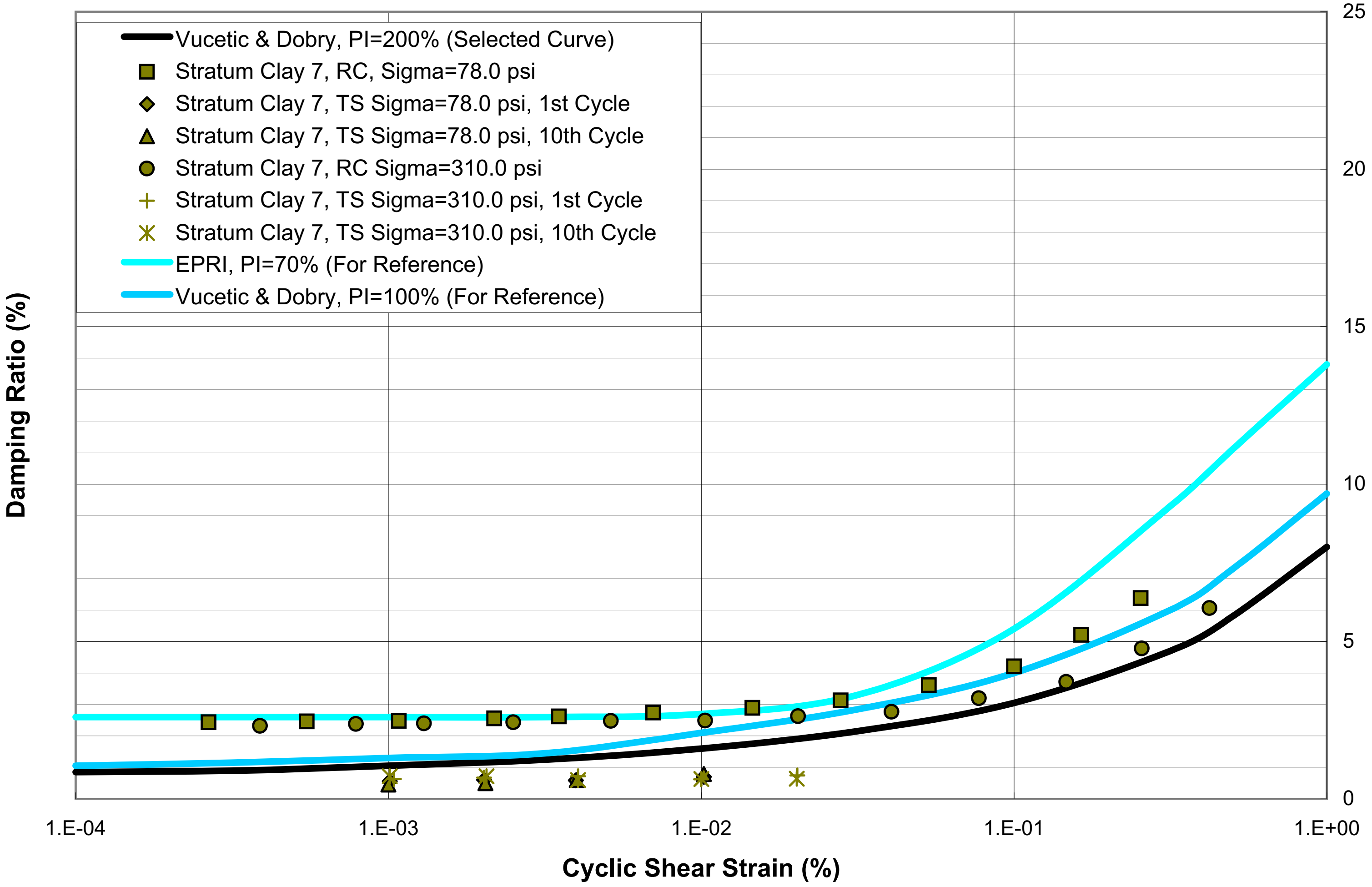


Figure 2.5.4-317 RCTS Test Results; Damping Ratio; Stratum Clay 7 (Power Block)

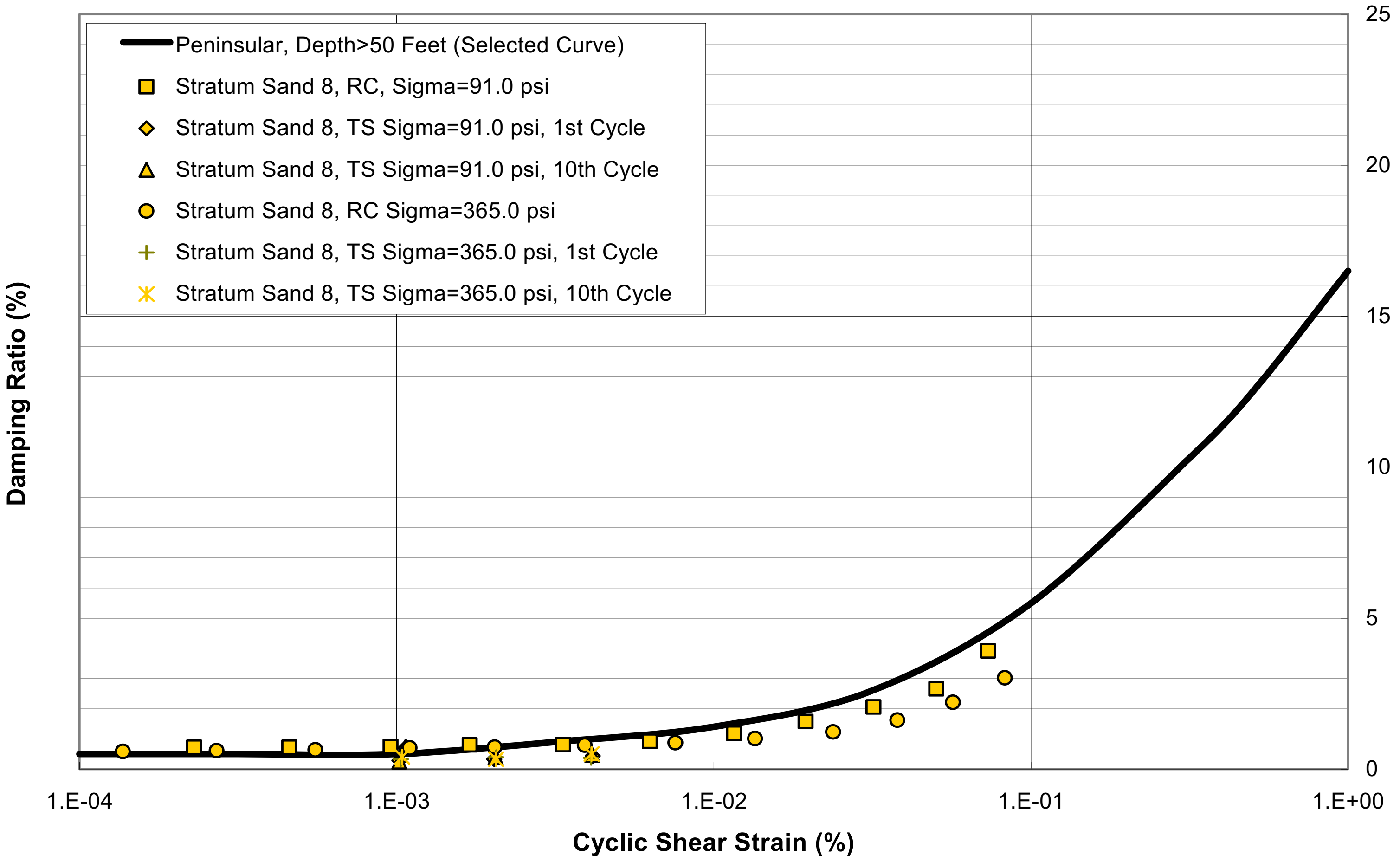


Figure 2.5.4-318 RCTS Test Results; Damping Ratio; Stratum Sand 8 (Power Block)

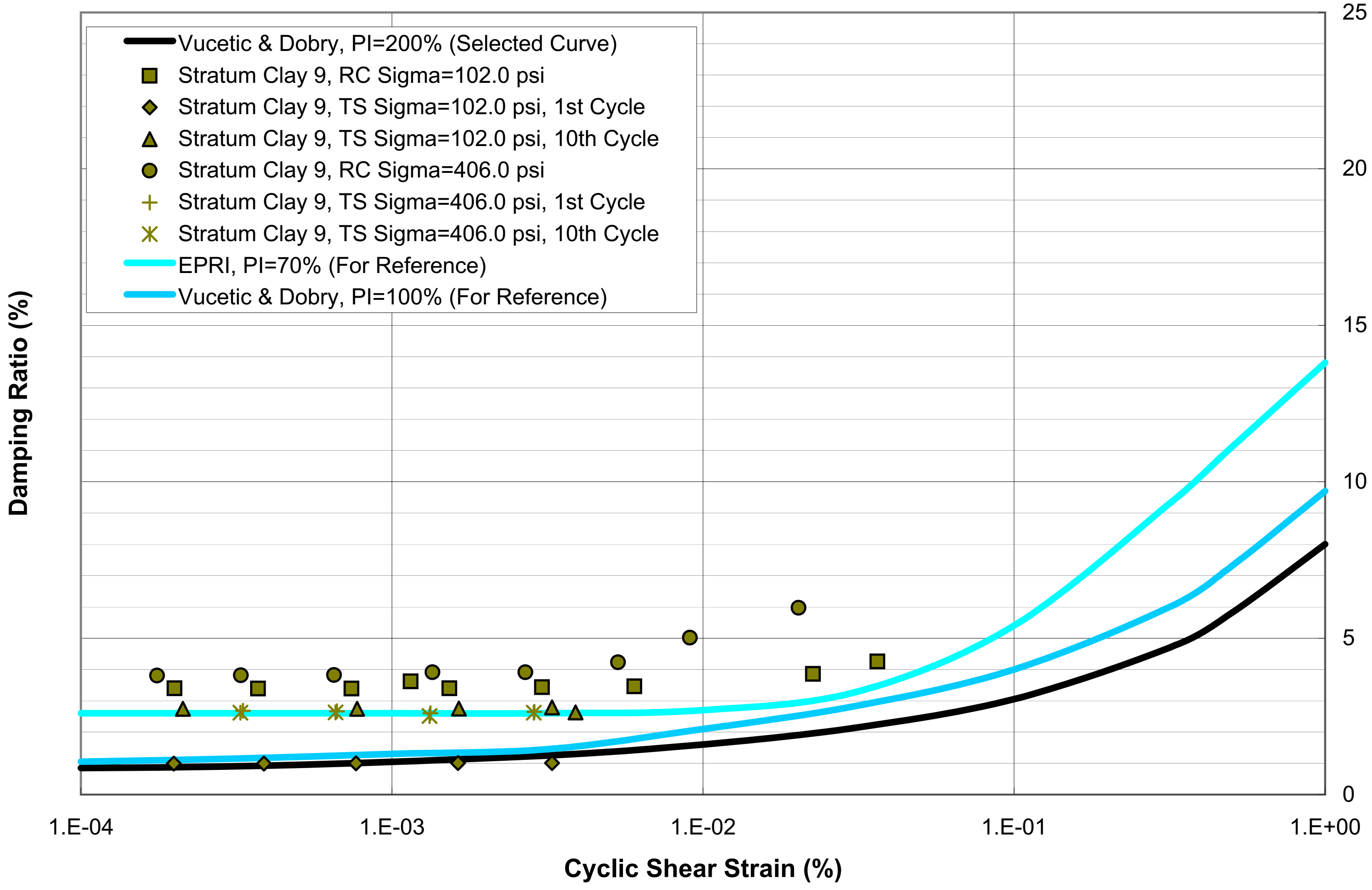


Figure 2.5.4-319 RCTS Test Results; Damping Ratio; Stratum Clay 9 (Power Block)

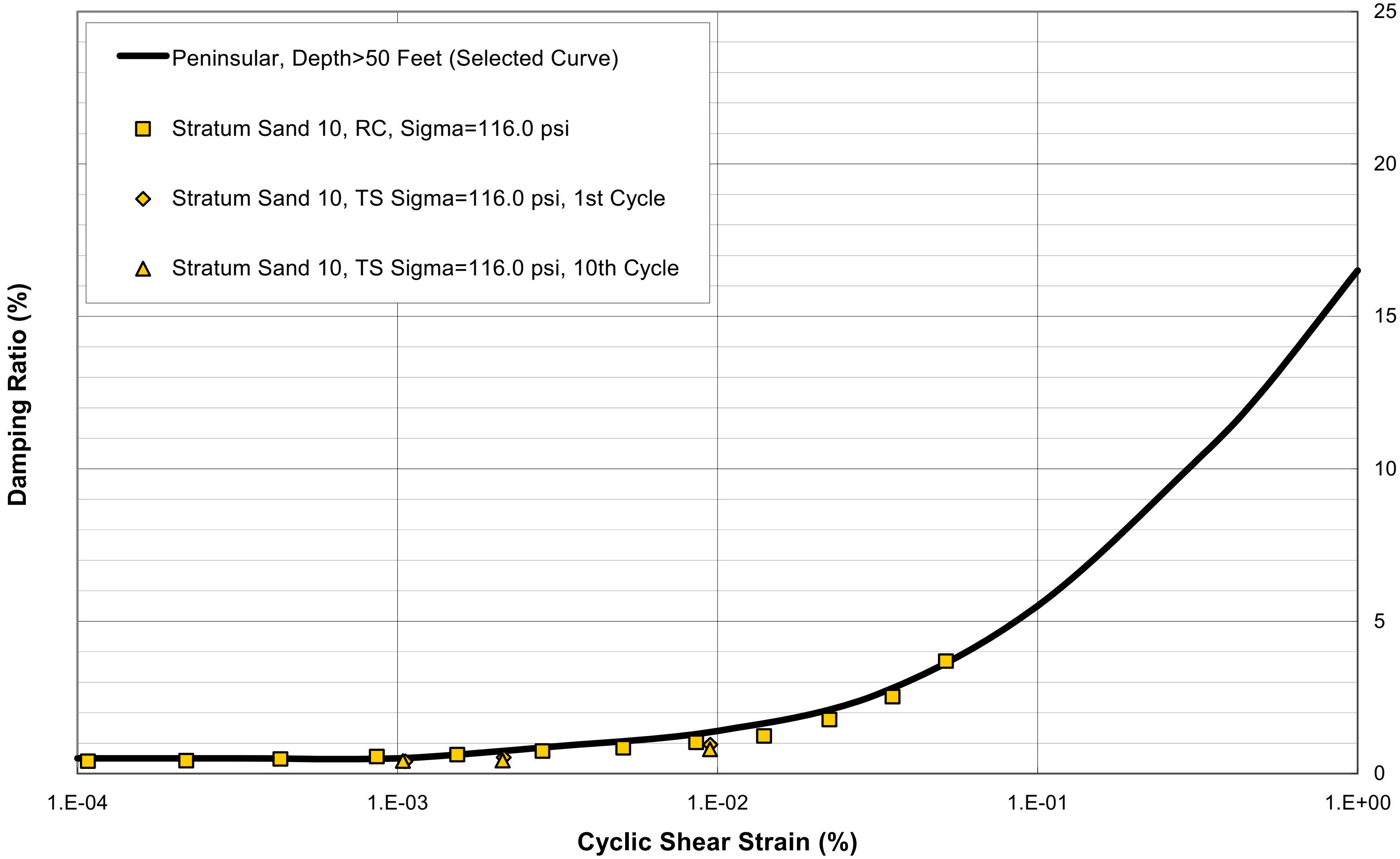


Figure 2.5.4-320 RCTS Test Results; Damping Ratio; Stratum Sand 10 (Power Block)

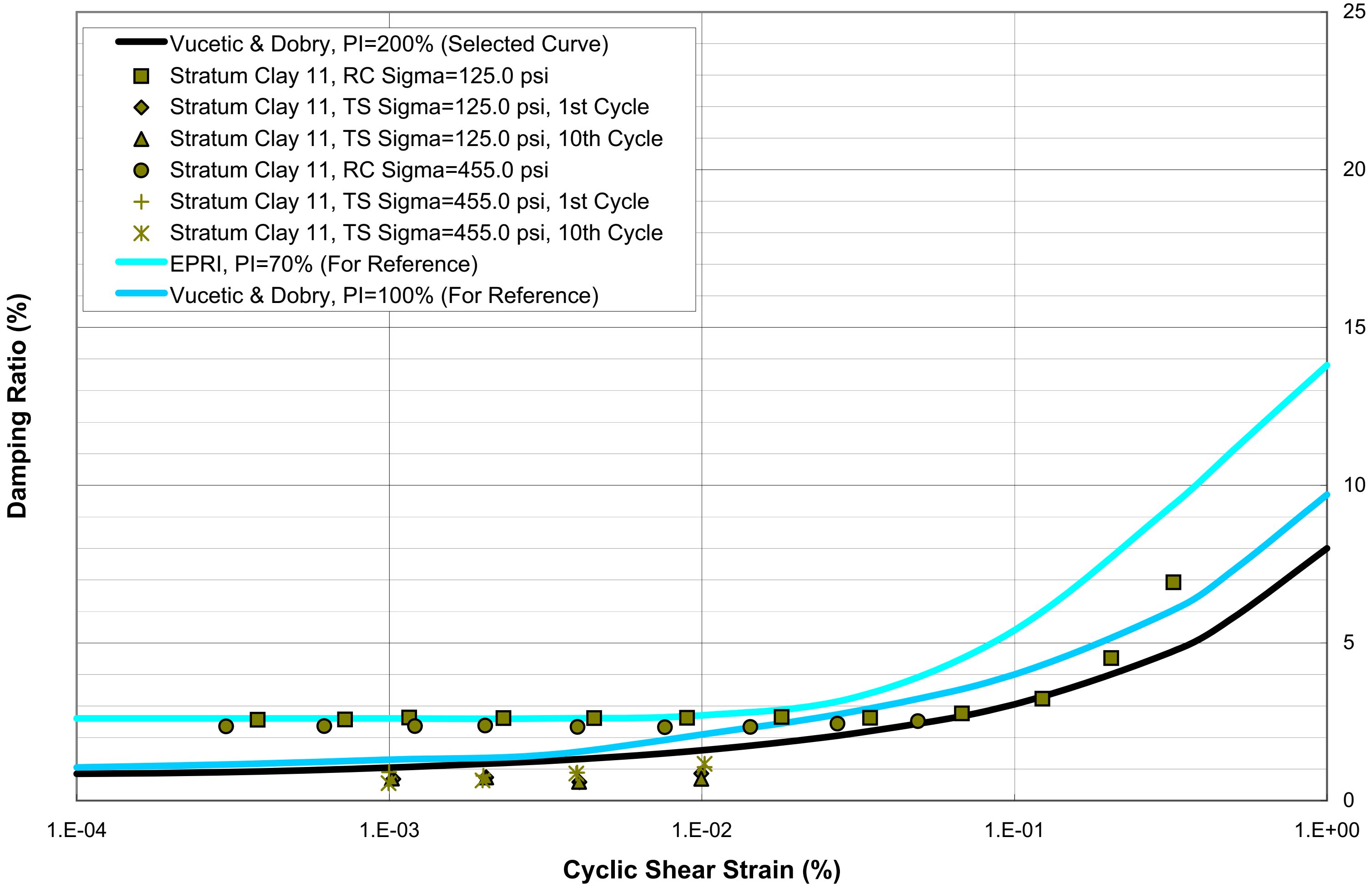


Figure 2.5.4-321 RCTS Test Results; Damping Ratio; Stratum Clay 11 (Power Block)

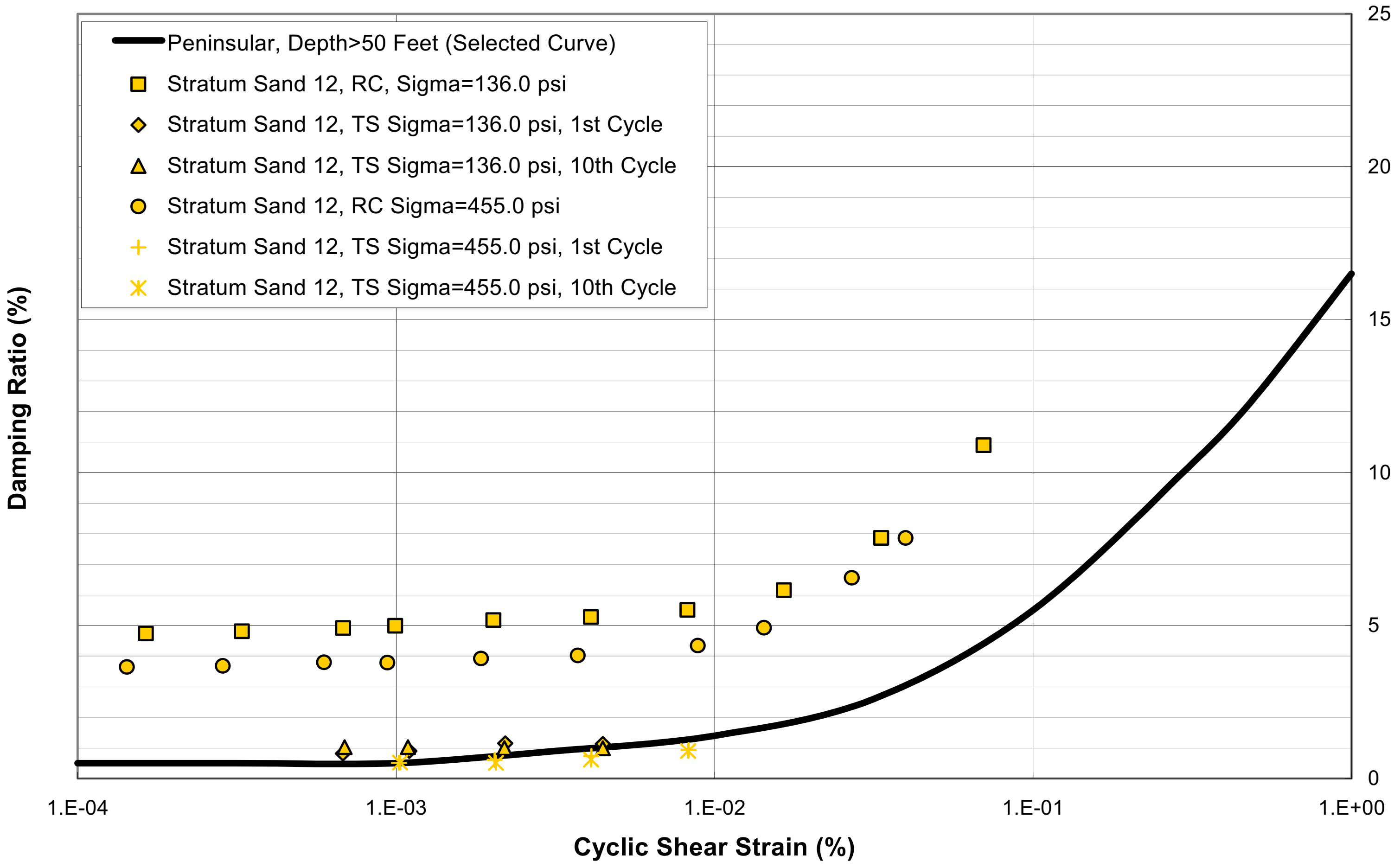


Figure 2.5.4-322 RCTS Test Results; Damping Ratio; Stratum Sand 12 (Power Block)

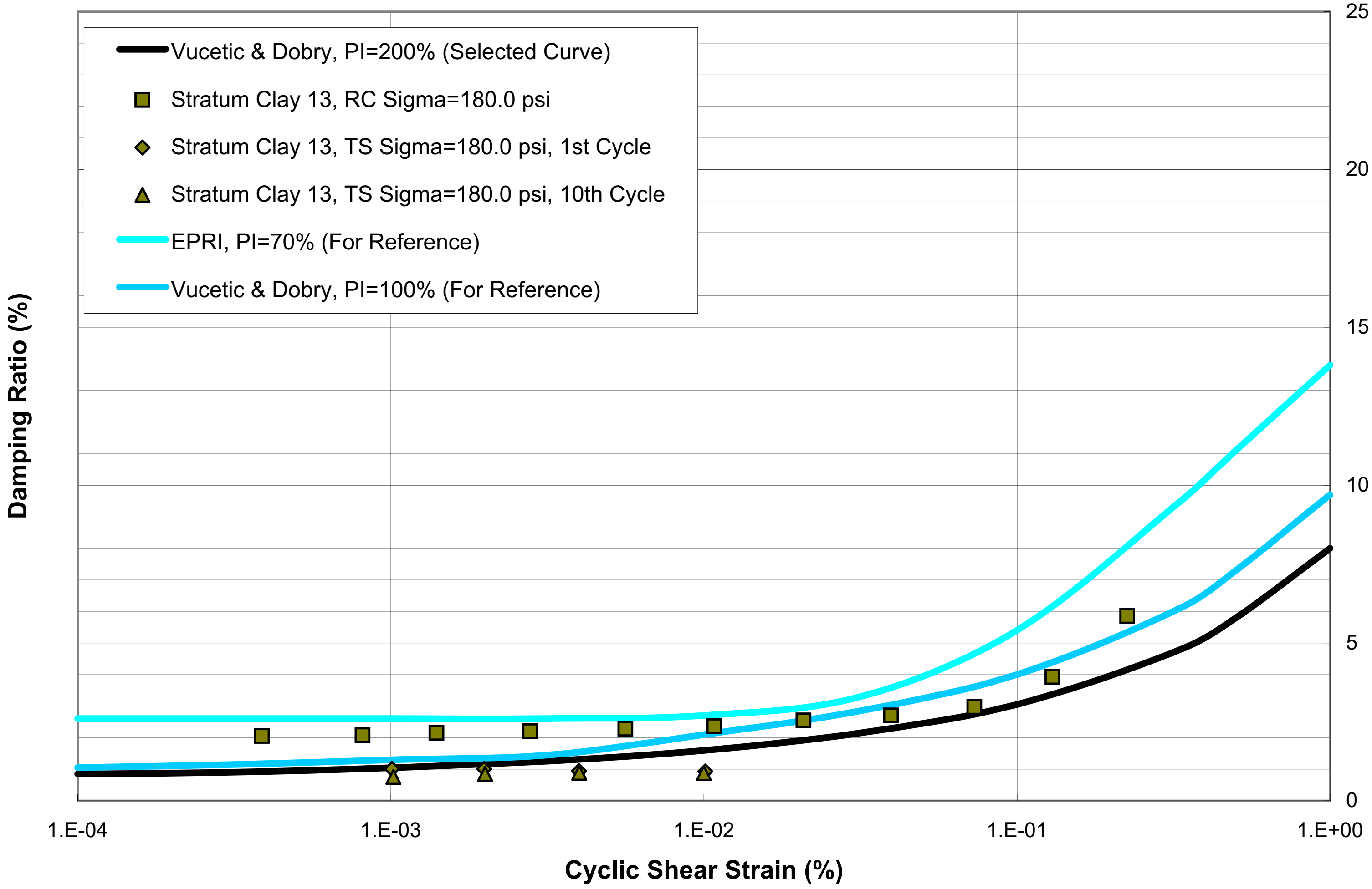


Figure 2.5.4-323 RCTS Test Results; Damping Ratio; Stratum Clay 13 (Power Block)

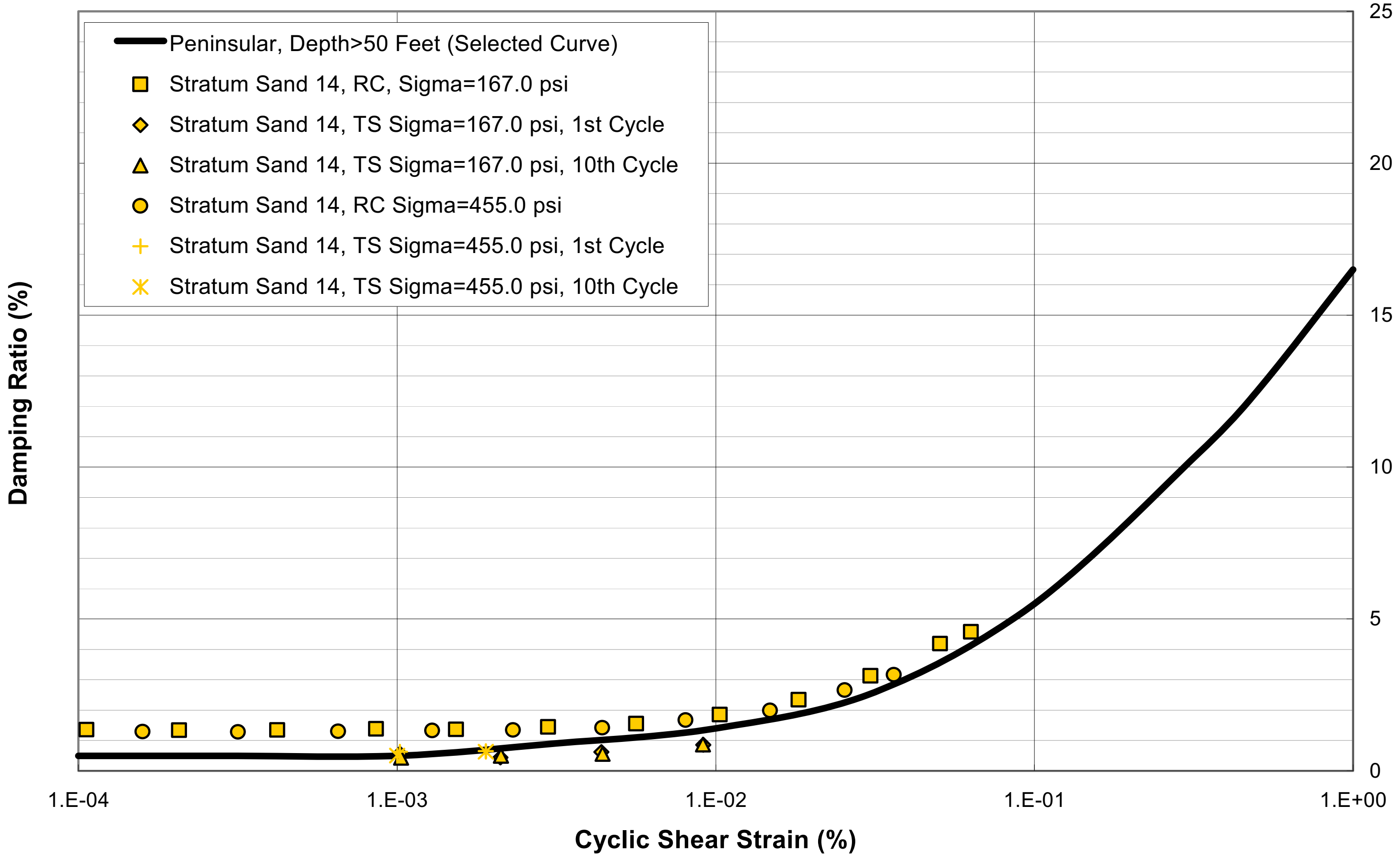


Figure 2.5.4-324 RCTS Test Results; Damping Ratio; Stratum Sand 14 (Power Block)

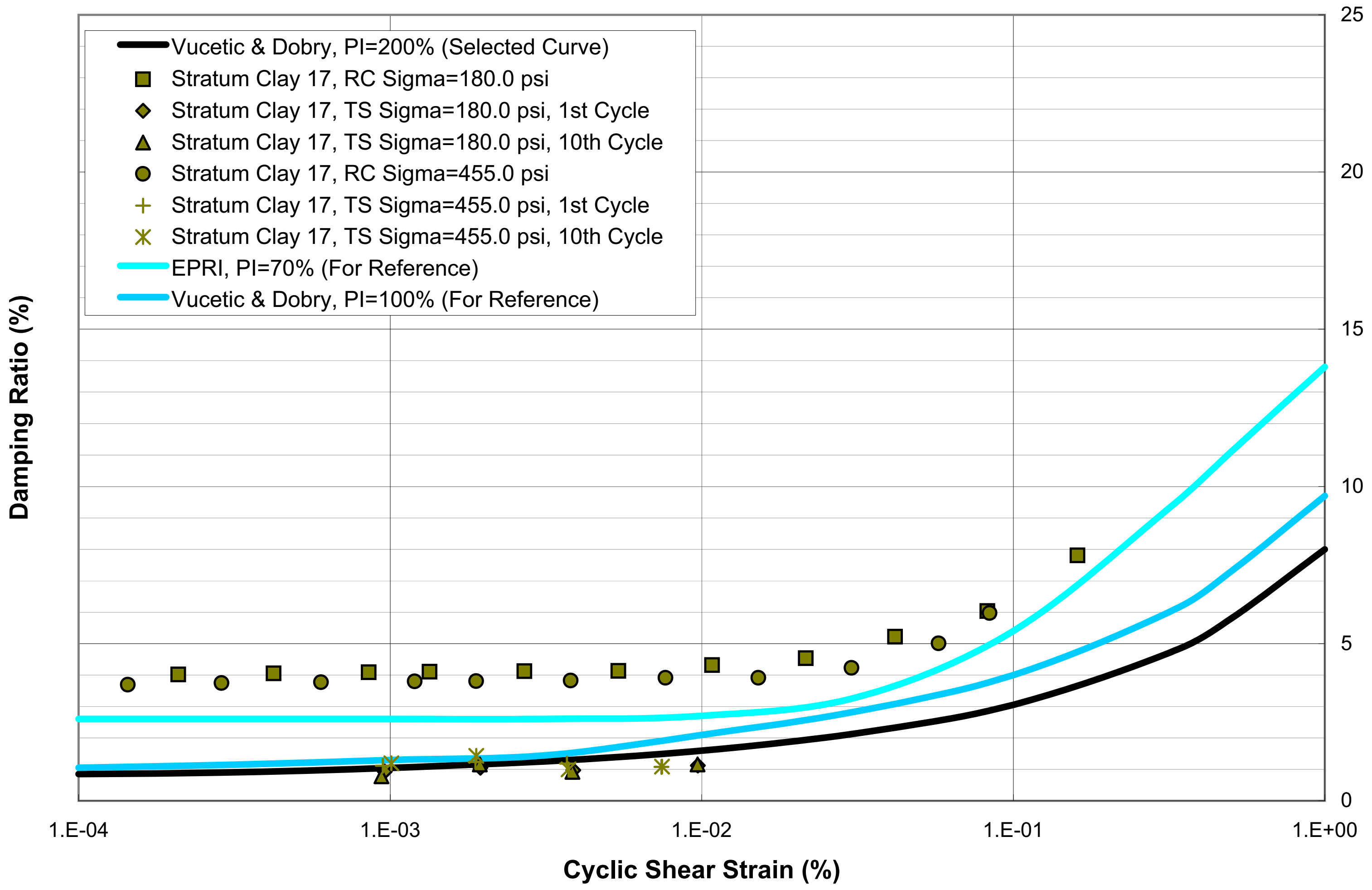


Figure 2.5.4-325 RCTS Test Results; Damping Ratio; Stratum Clay 17 (Power Block)

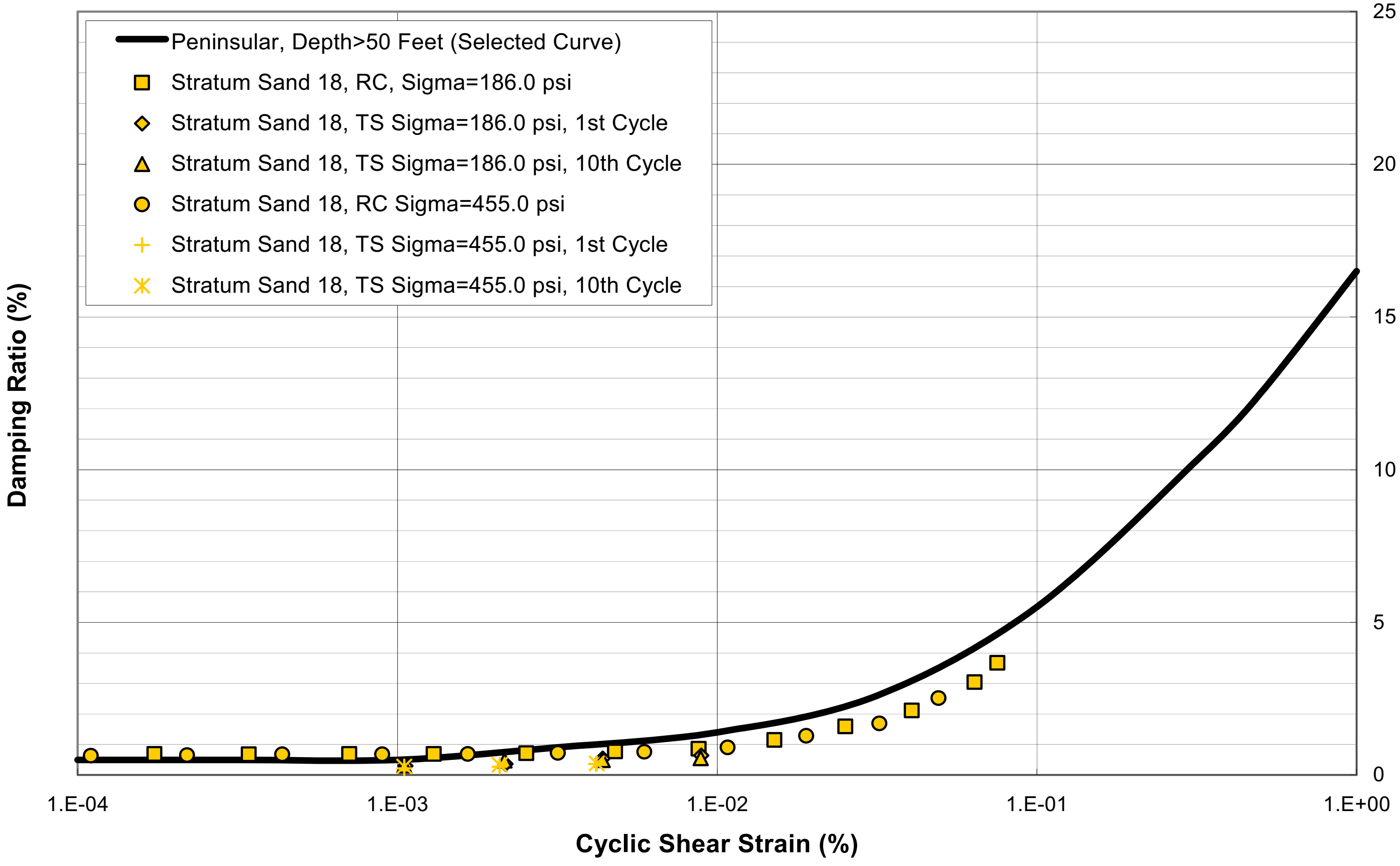


Figure 2.5.4-326 RCTS Test Results; Damping Ratio; Stratum Sand 18 (Power Block)

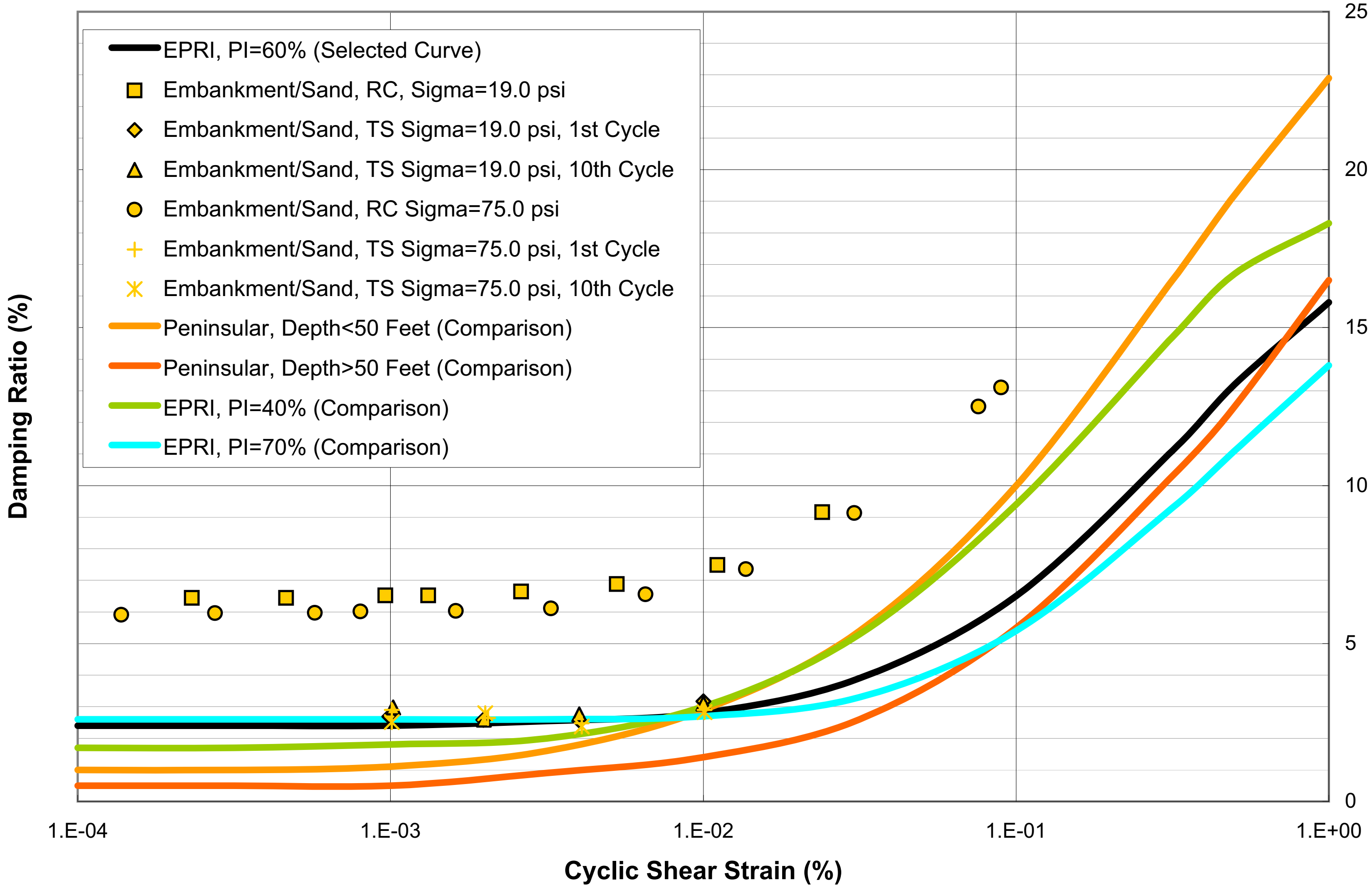


Figure 2.5.4-327 RCTS Test Results; Damping Ratio; Embankment Fill/Sand; Composite A Sample (Cooling Basin/GBRA Storage Water Reservoir)

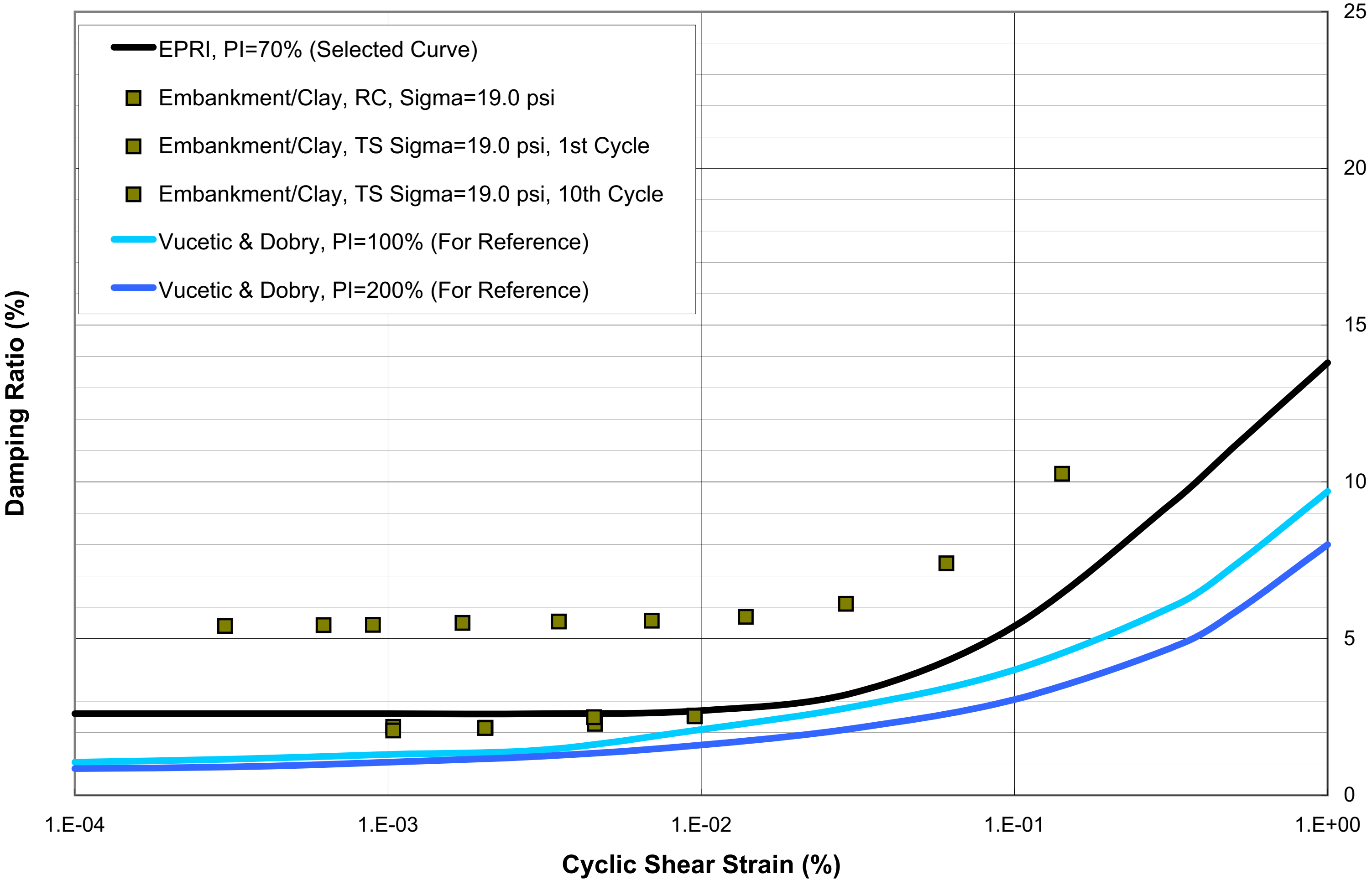


Figure 2.5.4-328 RCTS Test Results; Damping Ratio; Embankment Fill/Clay; Composite B Sample (Cooling Basin/GBRA Storage Water Reservoir)

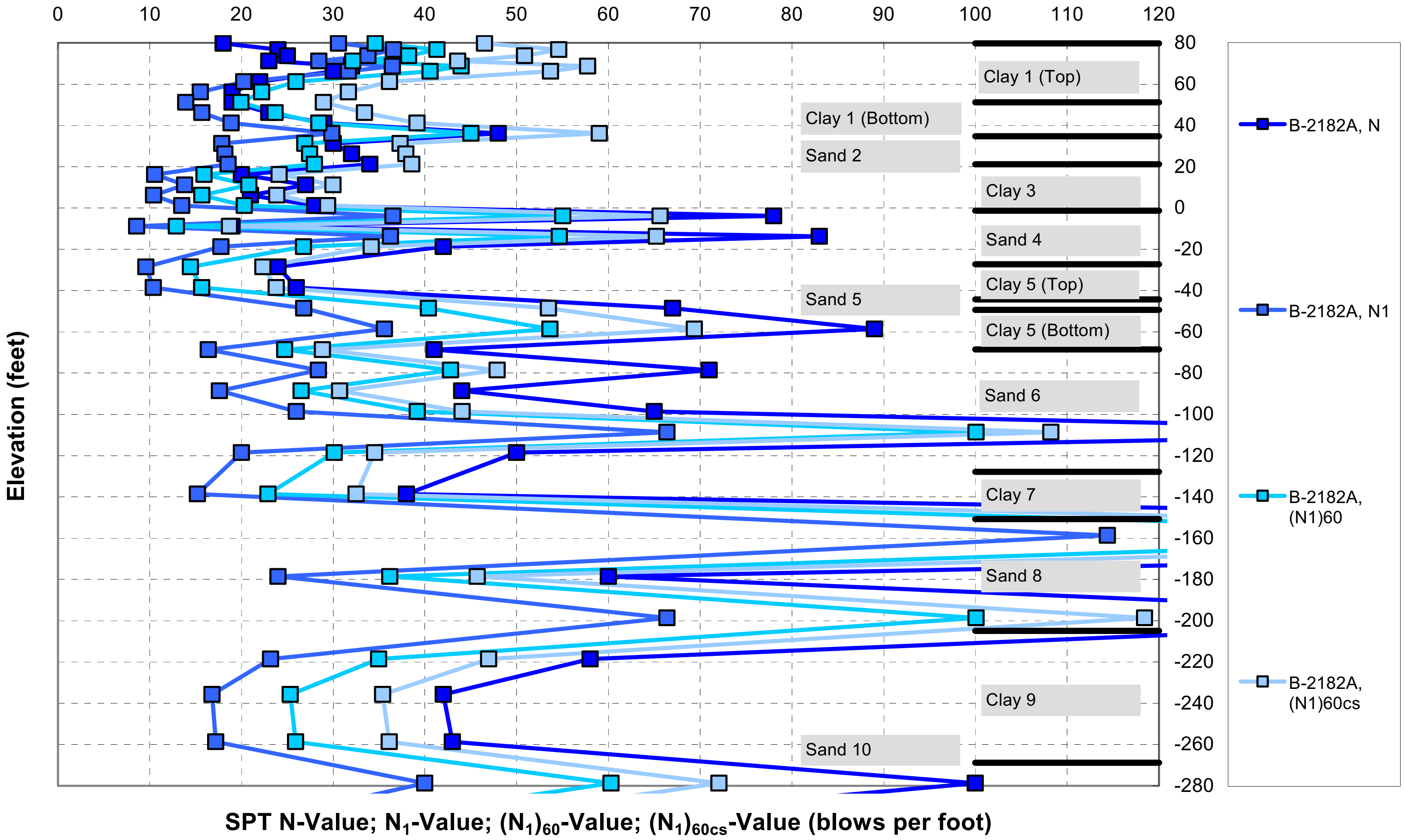


Figure 2.5.4-329 Example — SPT N- to N_1- to $(N_1)_{60}$- to $(N_1)_{60cs}$-Values; Boring B-2182A (Power Block; Cooling Basin/GBRA Storage Water Reservoir)

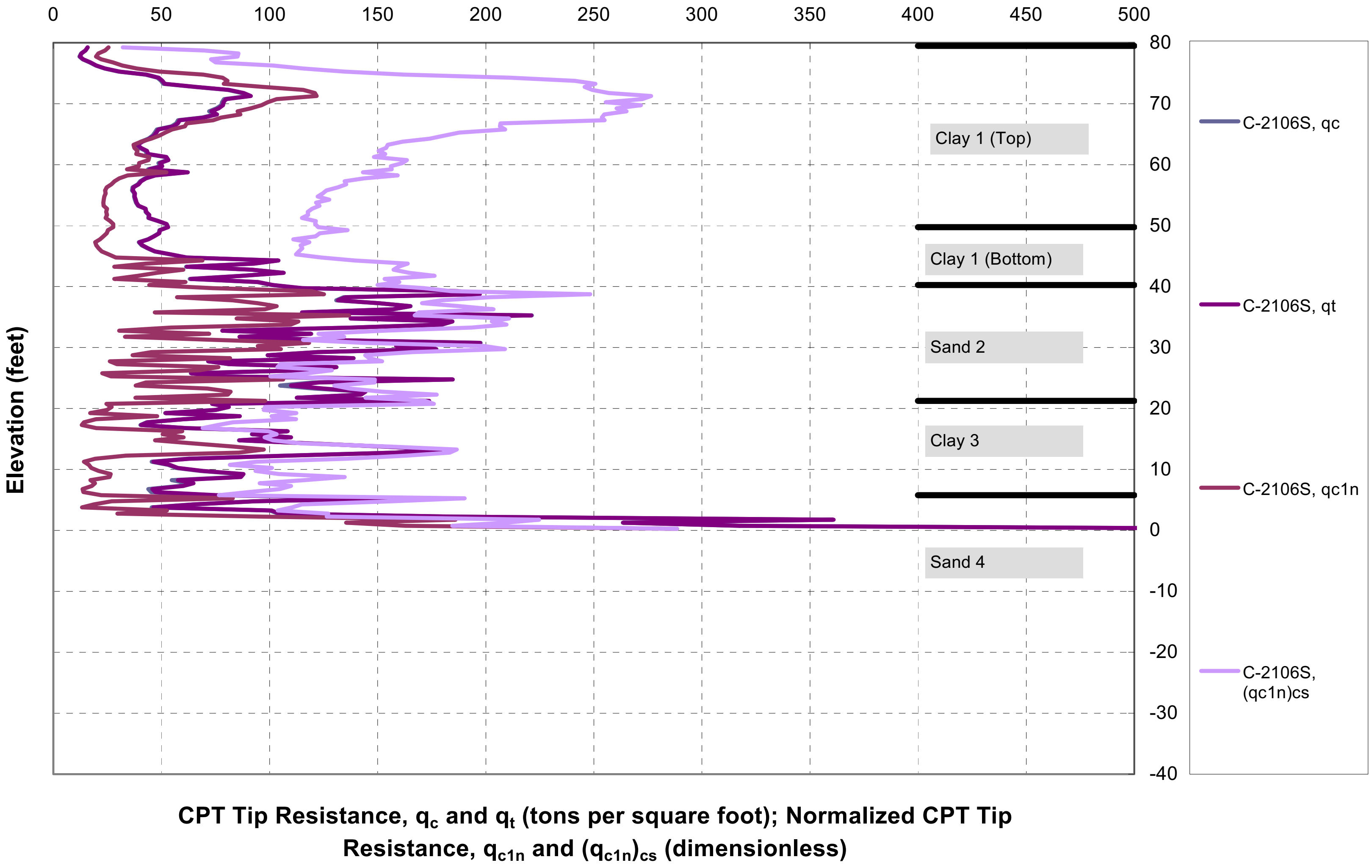


Figure 2.5.4-330 Example — CPT q_c- to q_t- to q_{c1n}- to $(q_{1n})_{cs}$-Values; Cone Penetration Test C-2106S (Power Block; Cooling Basin/GBRA Storage Water Reservoir)

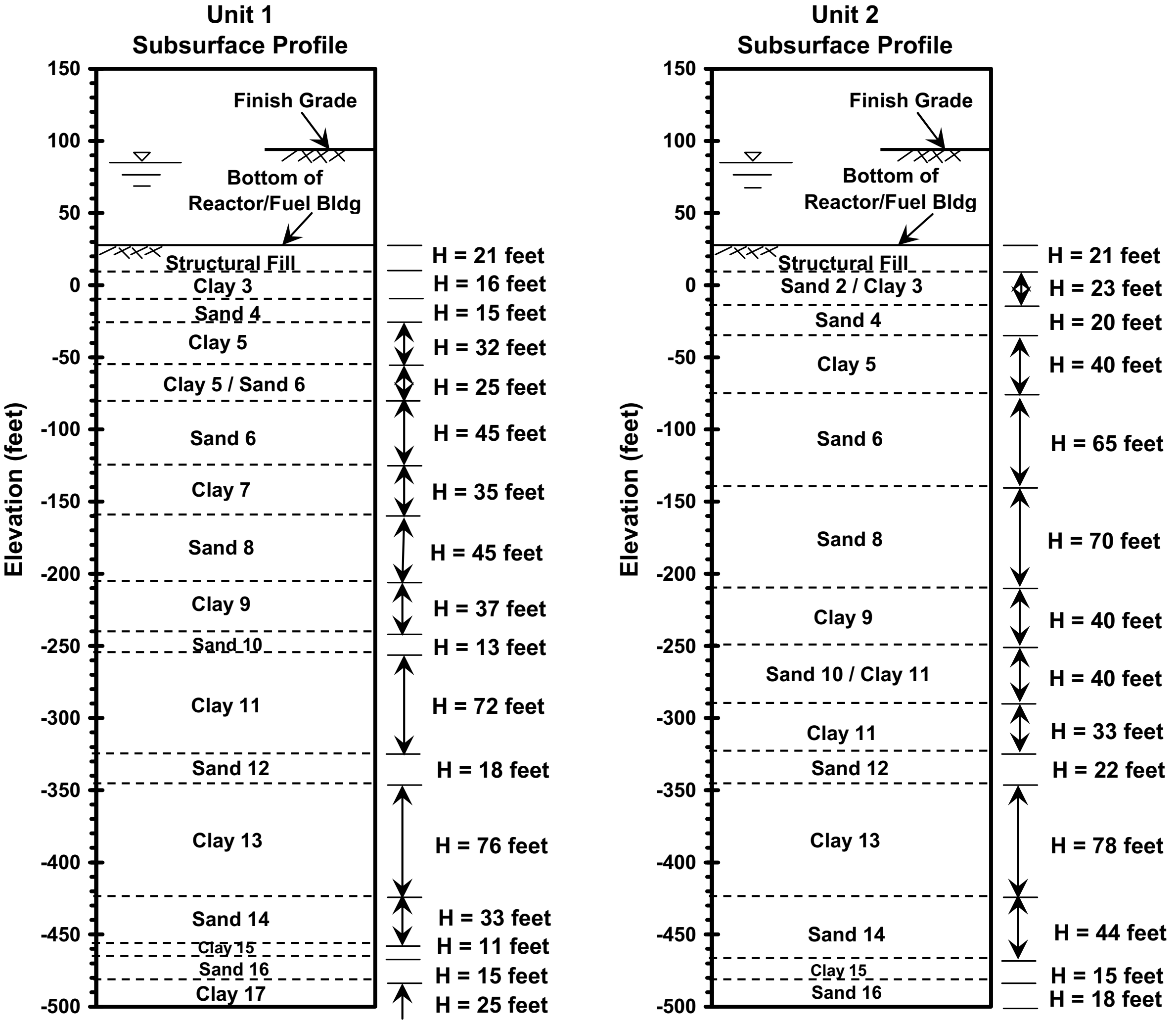


Figure 2.5.4-331 Adopted Subsurface Profiles; Reactor/Fuel Building (Power Block)

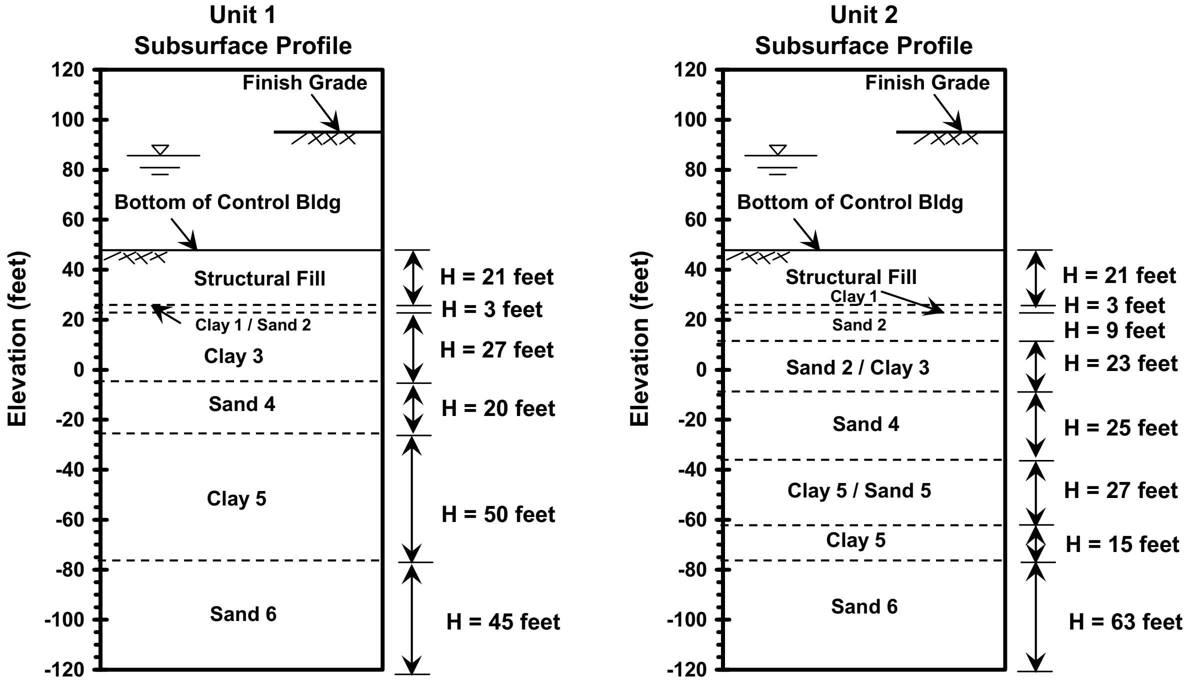


Figure 2.5.4-332 Adopted Subsurface Profiles; Control Building (Power Block)

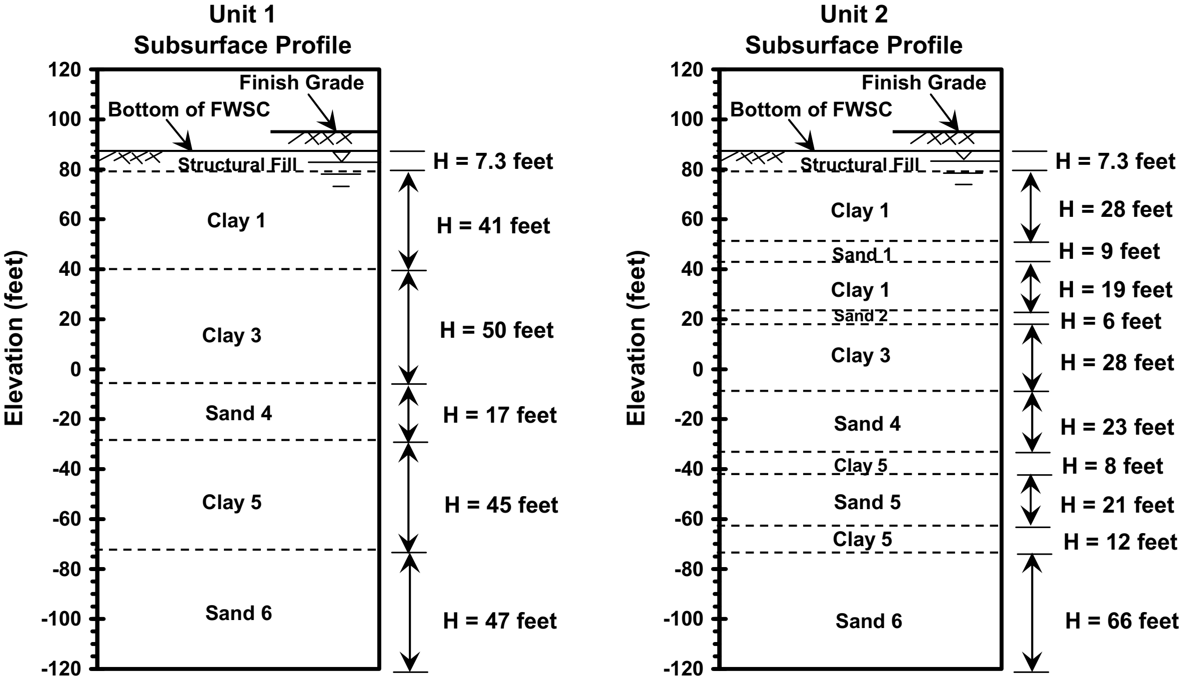
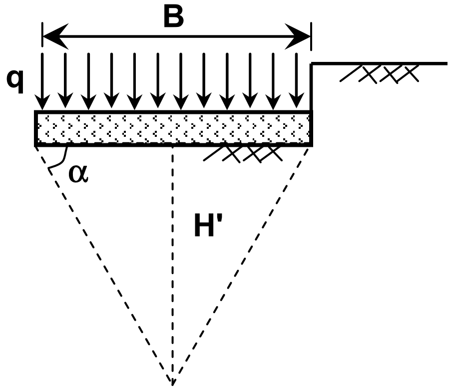


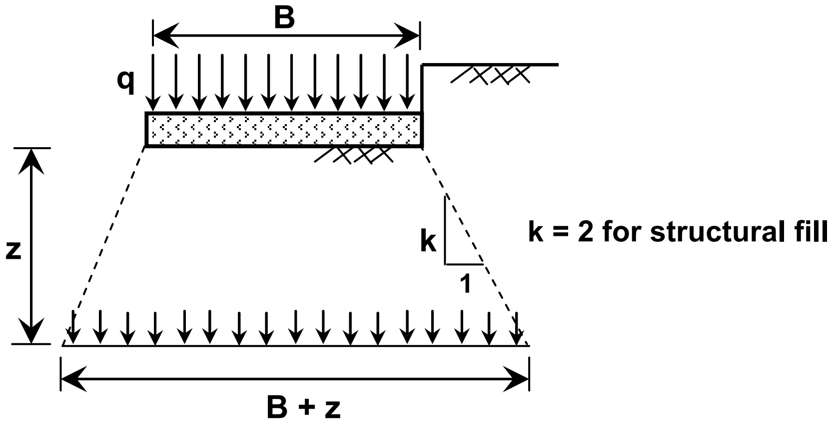
Figure 2.5.4-333 Adopted Subsurface Profiles; Fire Water Service Complex (Power Block)

FOUNDATION WEDGE



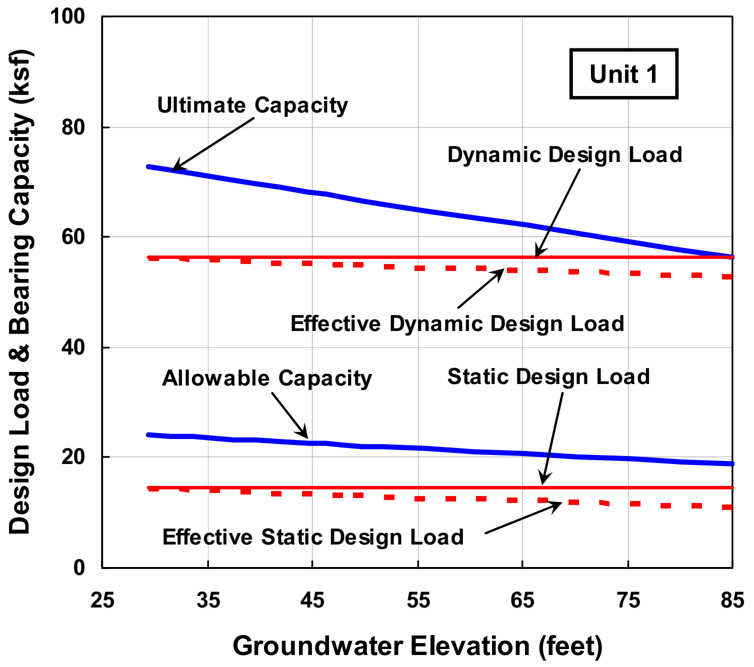
H’ = foundation deformation zone (height of the wedge), estimated as H’ = 0.5 B tan (α), where α = 45 + Φ/2, and Φ = friction angle of the soil

PRESSURE DISTRIBUTION



B = foundation width, q = foundation pressure, z = structural fill thickness, k= distribution factor

Figure 2.5.4-334 Nomenclature for Foundation Wedge and Pressure Distribution Diagrams (Power Block)



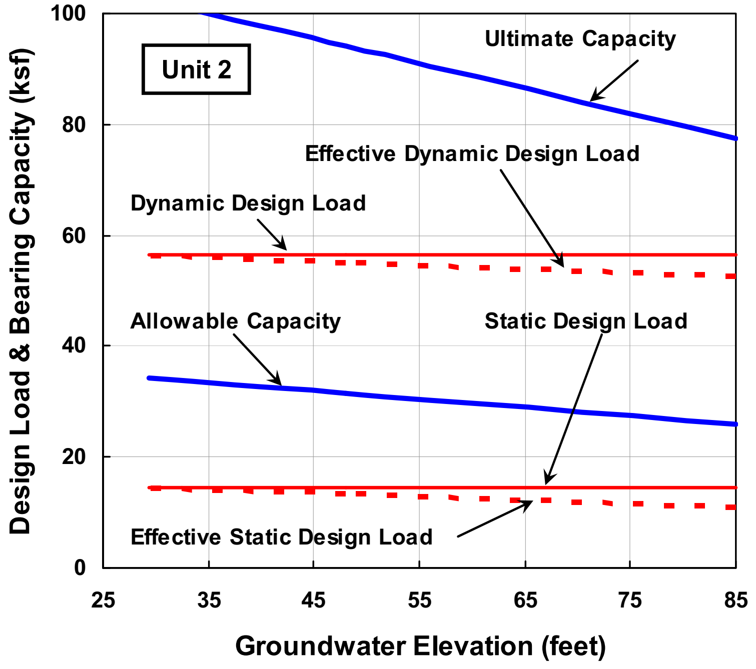
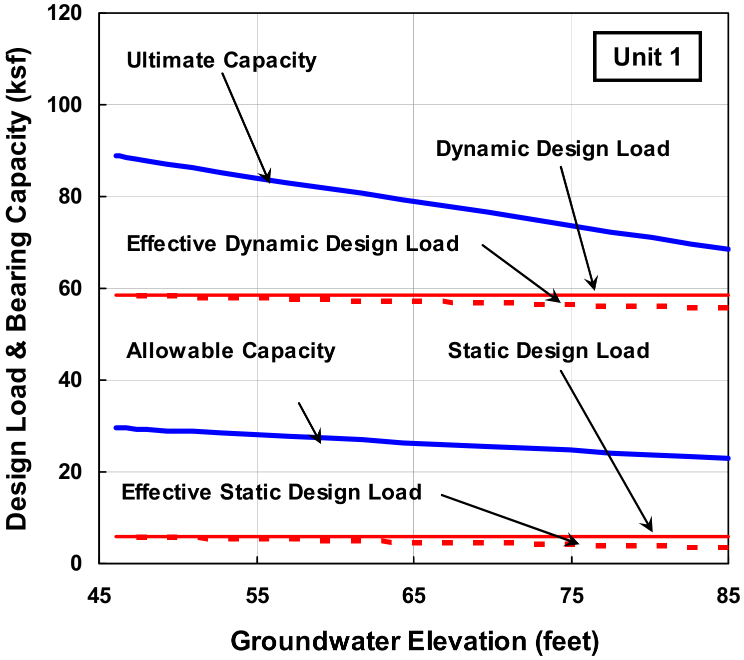


Figure 2.5.4-335 Comparison of Design Loads and Bearing Capacities versus Groundwater Table Elevations Reactor/Fuel Buildings



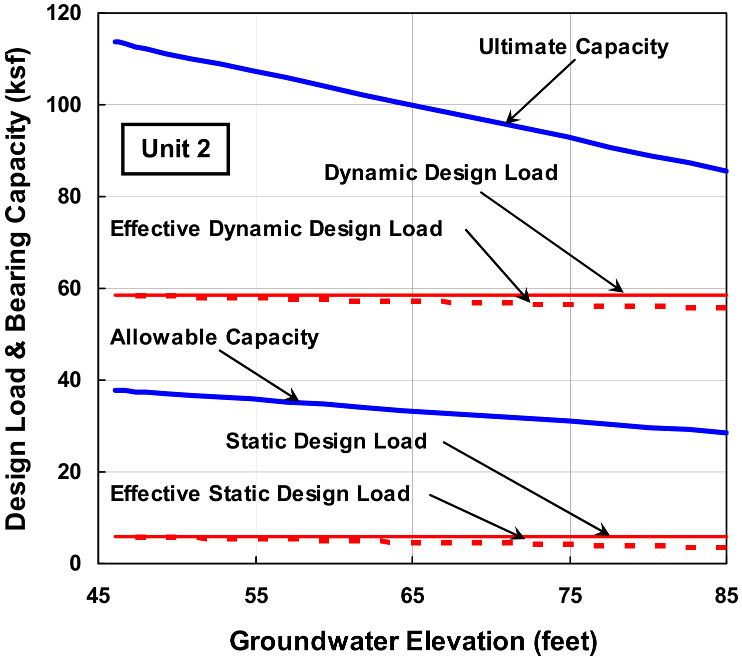


Figure 2.5.4-336 Comparison of Design Loads and Bearing Capacities versus Groundwater Table Elevations Control Buildings

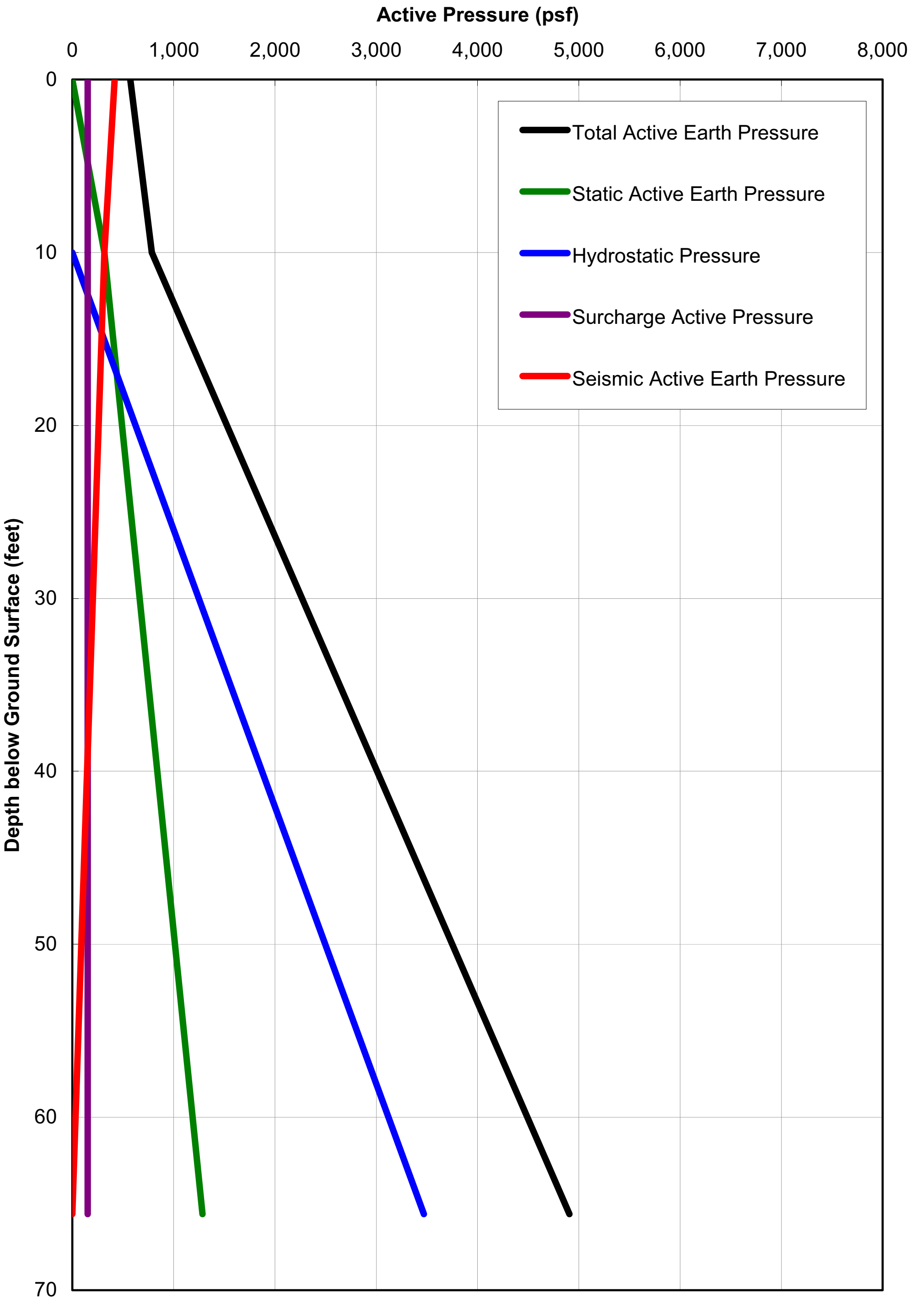


Figure 2.5.4-337 Active Lateral Earth Pressure Diagrams (Power Block)

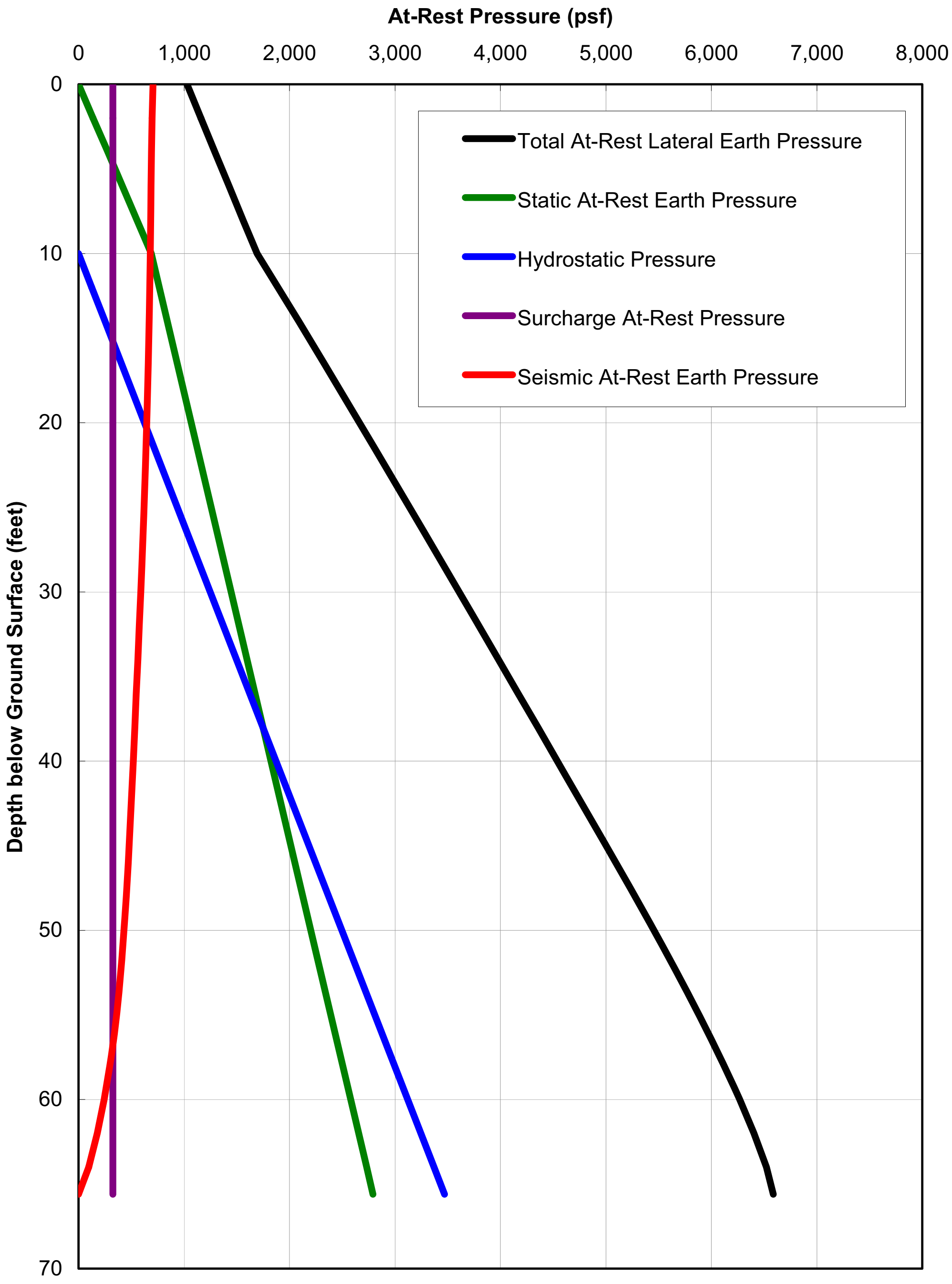


Figure 2.5.4-338 At-Rest Lateral Earth Pressure Diagrams (Power Block)

Appendix 2.5.4-A
[Refer to MACTEC Project No. 6468-07-1777, Final Data Report, Geotechnical Exploration and Testing, Exelon COL Project, Victoria County, Texas, Power Block (Volumes 1 through 4, dated July 10, 2008) included in Part 11]

Appendix 2.5.4-B

**[Refer to MACTEC Project No. 6468-07-1777,
Final Data Report, Geotechnical Exploration and Testing,
Exelon COL Project, Victoria County, Texas, Cooling Basin
(Volumes 1 through 4, dated July 18, 2008)
included in Part 11]**