ENERCON SERVICES, INC.

COMANCHE PEAK COMBINED OPERATING LICENSE APPLICATION
TXUT-001-PR-010, Revision 0

Laboratory Test Data Report

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E	1-12	0			
F	1-17	0			
G-1	1-31	0			
G-2	1-54	0			
H	1-17	0			

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS (continued)

Section **Page**

TABLES

Table **Page**

FIGURES

Figure **Page**

TABLE OF CONTENTS (continued)

Figure **Page**

APPENDICES

1.0 INTRODUCTION AND BACKGROUND

This report summarizes geotechnical laboratory test results on selected samples of soil and rock obtained during the geotechnical field exploration program for Units 3 and 4 at the Comanche Peak Nuclear Power Plant (CPNPP), for the Combined Operating License Application (COLA). Laboratory testing was performed by Fugro Consultants Inc. Laboratory of Houston, Texas. Petrographic and photomicrographic analyses were performed by Spectrum Petrographics, Inc. of Vancouver, Washington. X-Ray Diffraction Analyses were performed by the Portland State University of Portland, Oregon.

2.0 LABORATORY TESTING PROGRAM

The laboratory testing program assessed both index and strength properties of selected soil and rock samples obtained during the field exploration program. Tests were performed in general accordance with current ASTM procedures or other applicable standards, as described in the Project Instruction TXUT-001-PI-06.

The following list summarizes the type and quantities of the laboratory tests that were performed.

Soil Samples:

- Grain-Size Distribution (11)
- Grain-Size Distribution with Hydrometer (7)
- Moisture Content (8)
- Atterberg Limits (17)
- Organic Content (2)

Rock Samples:

- Moisture Content and Unit Weight (206)
- Atterberg Limits (33)
- Calcium Carbonate (28)
- Specific Gravity (13)
- Slake Durability (7)
- One-Dimensional Consolidation (5)
- One-Dimensional Swell (9)
- Unconfined Compression (64)
- Point Load Index (43)
- Consolidated-Undrained Triaxial (40)
- Unconsolidated-Undrained Triaxial (11)
- Direct Shear (7)
- Shear Wave Velocity (81)
- Petrographic Analysis (39)
- X-Ray Diffraction Analysis (14)

3.0 SAMPLE HANDLING AND SPECIMEN PREPARATION

Upon arrival at the laboratory, samples were assigned to labeled boxes and stored in secured, climate-controlled storage rooms. Samples were always kept wrapped in plastic and/or tin foil within the climate controlled storage rooms in the laboratory facility to preserve original moisture content. After test assignments, specific samples were examined and retrieved for testing. Appropriate portions of the samples were taken to complete the assigned tests. After sample examination or testing, the unused portions were properly re-sealed, placed back into their individual jars, and stored in the laboratory climate-controlled storage rooms.

Several samples were selected for testing at other facilities (Spectrum Petrographics and University of Washington) for non-safety-related applications. These samples were placed in labeled sample jars with moisture-tight lids and shipped under chain of custody to the designated testing laboratory.

All rock core specimens were prepared in accordance with ASTM D4543. This standard outlines the procedure and methods for laboratory specimen preparation and determination of the length and diameter of rock core specimens and the conformance of the dimensions with established standards. Because the dimension, shape, and surface tolerances of rock core specimens are important in determining rock properties of intact specimens, great care is exercised when preparing core samples for strength testing. The prepared cores are measured to determine the straightness of the specimen's cylindrical side, flatness of its ends, parallelism of the end platens, and perpendicularity of end surfaces to the specimen axis.

4.0 LABORATORY TEST PROCEDURES

4.1 General Information

The laboratory testing was performed in general agreement with procedures prescribed by ASTM Standards, and other standards where applicable. The following sections summarize essential procedural items. Further information can be found in the Project Instruction TXUT-001-PI-06.

4.2 Moisture Content and Density

Moisture content and density were determined in general accordance with ASTM D2216 and D2166 (Section 6). A test specimen was dried in an oven at a temperature of 110° ± 5°C to a constant mass. The loss of mass was considered water mass, and moisture content was calculated based on water mass and the mass of the dried specimen. The density was determined by means of the direct measurement of the dimensions and mass of the specimen.

4.3 Atterberg Limits

Liquid and plastic limits of selected specimens were determined in accordance with ASTM D4318. The samples were prepared by removing any material retained on No. 40 Sieve (425 μm). For shale, samples of approximately 150 g to 250 g were selected and pulverized through a grinder into powder form. Then water was added to the sample up to about the liquid limit

point. The wet sample was pushed through a No. 40 Sieve, bagged, and left overnight to slake before being tested. The liquid limit was determined by ASTM D4318 Method A.

4.4 Particle-Size Distribution

Particle-size distribution (gradation) of soils using sieve analysis and hydrometer technique was performed in accordance with ASTM D6913 and D422. The grain-size distribution of coarse-grained soils (particle sizes larger than 75 μm) is determined directly by sieve analysis, while the distribution of fine-grained soils (particle sizes smaller than 75 μm) is determined indirectly using hydrometer analysis. The grain-size distribution of mixed soils is determined by combined sieve and hydrometer analyses. Sieve analysis consists of passing a sample through a set of sieves and weighing the amount of material retained on each sieve. The hydrometer analysis is based on Stokes' law, which relates the terminal velocity of a sphere falling freely through a fluid to its diameter. The hydrometer is used to determine the percentages of clay and silt in the sample based on precipitation rates through a water column.

4.5 Specific Gravity

The specific gravity of specimens was determined in accordance with ASTM D854. This test method determines the specific gravity of soil solids that are finer than 4.75 mm (No. 4 sieve), by means of a water pycnometer. The specific gravity of solids (soil or rock) is the ratio of the weight in air of a given volume of sample at a stated temperature to the weight in air of an equal volume of distilled water at the same temperature. Rock sample porosities were calculated based on the specific gravity data and dry unit weight.

4.6 Organic Content

The organic content of specimens was determined in general accordance with ASTM D2974, with the exception that the moisture content was determined by using ASTM D2216.

4.7 Carbonate Content

The carbonate content of specimens was determined in accordance with ASTM D4373. The carbonate content (calcite equivalent) of soil is determined by treating a 1 g dried soil specimen with hydrochloric acid in an enclosed reaction cylinder. The pressure of carbon dioxide (CO_2) gas generated by the reaction between the acid and carbonate fraction of the specimen is used to determine the calcite equivalent of the specimen. Results are in terms of calcite equivalent as a percentage because different carbonate species cover a wide range of percent calcite equivalent. For example, 100 percent dolomite would be expected to yield a 108.6 percent calcite equivalent.

4.8 Slake Durability

Slake durability tests were conducted in accordance with ASTM D4644. Slake durability index is the percentage of dry mass retained for a collection of shale pieces on a 2.00 mm (No. 10) sieve after two cycles of oven drying and 10 minutes of soaking in water with a standard tumbling and abrasion action.

4.9 Petrographic Examination

Petrographic and photomicrographic analyses were performed by Spectrum Petrographics Inc. of Vancouver, Washington. These tests are typically performed on a standard thin section stained for K-feldspar plus combined carbonates, and had a permanent coverglass. Polished thin sections are used when opaque mineral analysis is required. Petrographic analysis includes: 1) rock name and interpreted protolith; 2) visually estimated modal mineralogy; 3) primary textures and structures; 4) secondary textures and structures; and 5) relative timing of formational events with emphasis on alteration and paragenesis. Standard Digital Photomicrography includes: 1) a 3X macro photo of the chip's polished surface; and 2) one or more photomicrographs at 28X to 568X to document typical appearance and important features.

4.10 X-Ray Diffraction

X-ray diffraction analyses were performed by Portland State University for clay-size fraction and bulk samples. The clay-size fraction was mounted in an oriented way onto a glass slide. This glass slide was X-rayed using a Philips Expert PW3040 theta-theta diffractometer. The X-ray diffraction patterns were analyzed both in air-dried and glycol-solvated and heated samples to evaluate changes in crystal structure ("d-spacing" and "peak intensity"). The results were used to identify the clay mineralogy and percent clay mineral. For bulk samples, whole rock specimens were ground to form a derivative sample powder smaller than 63 micrometers and packed into a random powder sample holder. The random powder was X-rayed using a Philips Expert PW3040 theta-theta diffractometer. The minerals were identified based on the d-spacing of the random powder pattern.

4.11 Consolidated-Drained Direct Shear

Direct shear tests were conducted in accordance with ASTM D3080 and ASTM D5607. Samples were treated as soils when practical, in accordance with ASTM D3080. For samples that did not fit securely into the ring, grouting was used to help secure the samples, and the resulting samples were tested according to ASTM D5607 for rock specimens. Three tests were conducted on each sample under varying normal loads to develop a shear strength envelope. When possible, different specimens of the same material were used for each pre-consolidation pressure. If three similar, undisturbed specimens were not available, the tests were conducted as "staged" tests on a single specimen, resulting in fully-softened (ultimate) or near-residual shear strength values at the three consolidation pressures.

4.12 Consolidated-Undrained Triaxial Compression with Pore Pressure Measurements

Consolidated-Undrained (CU) triaxial compression tests with pore water pressure measurement were performed in accordance with ASTM D4767 on relatively undisturbed shale and lightly cemented sandstone specimens derived from intact rock core intervals. The specimens were encased in rubber membranes and fully saturated by applying backpressure prior to the consolidation stage. Pore water in the samples was permitted to drain during the isotropic consolidation stage, but no drainage was allowed during the axial loading phase. Failure is assumed to occur when the specimens reach the maximum deviator stress, or an axial strain of 15 percent, whichever develops first. Axial load, axial displacement, chamber pressure, and excess hydrostatic pressure generated during the shearing phase are measured and recorded. The results provide total stress strength parameters if pore pressure is neglected. Effective

stress strength parameters are obtained by subtracting measured pore water pressures from the total stress results.

4.13 Consolidated-Undrained Triaxial Compression without Pore Pressure Measurements

Consolidated-Undrained (CU) triaxial compression tests without pore water pressure measurement were performed in accordance with ASTM D7012 Method A and ASTM D4767 on relatively undisturbed shale, limestone, and sandstone specimens. Specimens are trimmed in accordance with ASTM D4543 for rock core specimens. Some very soft rock specimens (e.g., soft shale, weakly cemented sandstone) are trimmed using soil-trimming techniques. The specimens are encased in rubber membrane and permitted to drain during the isotropic consolidation phase to permit consolidation under the confining pressure. No drainage is allowed during the shearing phase. Failure is assumed to occur when the specimens reach the maximum deviator stress, or an axial strain of 15 percent, whichever occurs first. Axial load, axial displacement, and chamber pressure during the shearing phase are measured and recorded. Pore pressures are not measured or recorded during shearing.

4.14 Unconsolidated-Undrained Triaxial Compression

Unconsolidated-Undrained (UU) triaxial compression tests were performed in accordance with ASTM D7012 Method A on relatively undisturbed shale, limestone, and sandstone specimens. UU triaxial compression tests were performed in a manner similar to CU triaxial compression tests without pore water pressure measurements, except that no drainage and consolidation were permitted to occur during the application of confining pressure.

4.15 Unconfined Compression of Rock

Unconfined Compression (UC) tests were performed in accordance with ASTM D7012 Methods C or D on relatively undisturbed and intact core samples of shale, limestone, and sandstone. In Method C, vertical displacement measurements are obtained based on the movement of the bottom platen during testing. These measurements incorporate movements related to equipment flex, with the result that strain cannot be used for modulus determination without correction. In Method D, the axial deformations are measured using a Linear Variable Displacement Transducer (LVDT)-Jacket Device (attach and support system) along with the platen movement, while the lateral deformations are determined using a "Chain-LVDT" Device (change in circumference system). This procedure permits obtaining estimates of materials modulus. Poisson's ratio of the specimens is obtained by measuring both axial and radial deformations during testing.

ASTM D7012 procedure requires that all specimens contain a Length (L) to Diameter (D) ratio of at least 2. However, there are published data (Obert, L. and Duvall, W.I. 1967) that allow one to correct strength data from tests in which L/D ratio is less than 2. The procedure provided by Obert et al. (1967) was used to estimate the correction factors and evaluate the results of the samples with L/D less than 2.

4.16 Point Load Strength Index of Rock

Point Load Strength Index (PLI) tests were conducted in accordance with ASTM D5731. These tests are performed using GEOTAC equipment configured to take readings close together in

order to estimate the peak load. Diametral and axial PLI tests can be rapidly performed on relatively undisturbed core specimens of sandstone and limestone, or core fragments, and are typically indexed to UC tests on the same or similar adjacent rock core specimens to develop a site-specific correlation.

4.17 Laboratory-Based Shear Wave Velocity

Laboratory measurements of shear wave (S-wave) velocity on relatively undisturbed specimens of shale, sandstone, and limestone were conducted in accordance with ASTM D2845. The velocities are measured in terms of travel time and the distance waves traveled through the rock specimen.

4.18 One-Dimensional Swell or Settlement Potential

Swell or settlement potential tests were conducted in accordance with ASTM D4546 Method C on relatively undisturbed, intact core intervals of shale. During testing, vertical load increments are applied to keep the sample from swelling after the specimen is inundated in water. A consolidation test is subsequently performed on the saturated sample, in accordance with ASTM D2435.

4.19 One-Dimensional Consolidation

One-dimensional consolidation tests were performed in accordance with ASTM D2435 Method B on relatively undisturbed core specimens of shale. Consolidation is the process of gradual transfer of an applied pressure from the pore water to the soil structure as pore water is squeezed out of the voids. For the consolidation test, a laterally confined specimen is subjected to successively increasing vertical pressure, allowing for free drainage from both the top and bottom surfaces. The samples are inundated shortly after application of seating pressure and loads are applied to contain the swelling.

5.0 LABORATORY TEST RESULTS

5.1 Moisture Content

Typical ranges of measured moisture content from selected rock samples are summarized below, and are presented in Tables 1 and 16, and on Figure 1.

Limestone: Water contents measured from limestone samples ranged from about 1 to 19 percent, with an average value of about 5 percent.

Shale: Water contents measured from shale samples ranged from about 6 to 23 percent. The average measured water content for shale was about 15 percent.

Interbedded Limestone and Shale: Samples that exhibited characteristics of limestone and shale (e.g., shaley limestone, calcareous shale), or that occurred along stratigraphic contacts between limestone and shale strata, ranged from about 9 to16 percent, with an average value of about 12 percent.

Sandstone: Water contents measured from sandstone samples ranged from about 8 to 19 percent. The average measured water content for sandstone was about 13 percent.

5.2 Unit Weight

The measured total and dry unit weights of limestone, shale, and sandstone samples are summarized below, and are presented in Tables 1 and 16, and plotted versus elevation on Figures 2 and 3.

Limestone: Measured dry unit weights of limestone samples ranged from approximately 119 pounds per cubic foot (pcf) to 160 pcf, with an average value of about 149 pcf. Measured total unit weights of limestone samples ranged from 136 pcf to 165 pcf, with an average value of about 156 pcf.

Shale: Measured dry unit weights of shale samples ranged from 99 pcf to 147 pcf, with an average value of about 120 pcf. Measured total unit weights of shale samples ranged from 118 pcf to 169 pcf, with an average value of about 137 pcf.

Interbedded Limestone and Shale: Dry unit weights of interbedded limestone and shale samples ranged between 114 pcf and 137 pcf, with an average value of 127 pcf. Measured total unit weights ranged from 132 pcf to 154 pcf, with an average value of about 142 pcf.

Sandstone: Measured dry unit weights of sandstone samples ranged from 105 pcf to 134 pcf, with an average value of about 121 pcf. Measured total unit weights of sandstone samples ranged from 124 pcf to 147 pcf, with an average value of about 136 pcf.

5.3 Grain Size Distribution

Particle size distribution analyses (including sieve and hydrometer testing) were performed primarily on soil samples of silty sand (SM), clayey sand (SC), sandy silt (ML) and sandy clay (CL). The median grain size (D50) of soil samples classifying as SM and SC typically ranges from 0.08 mm to 1.7 mm. Typical median grain size (D50) of soil samples classifying as ML and CL ranges from 0.01 mm to 0.05 mm. Grain size distribution plots are presented in Appendix A.

5.4 Atterberg Limits

Atterberg limits tests were performed on samples of residual clayey soils and shale layers within the Glen Rose Formation. Test results are summarized below, and are presented in Tables 1 and 16, and on Figure 4.

Soil Samples: Liquid limits (LL) of tested soil samples ranged between 25 and 60 percent, with an average value of 36 percent. The plasticity index (PI) ranged between 9 and 43 percent, with an average value of about 21 percent.

Shale: LL tests from shale samples ranged from 27 to 71 percent with an average value of 46 percent. The PI within these samples ranged from 14 to 48, with an average value of 28.

5.5 Specific Gravity

Specific gravity tests were performed on selected samples of limestone, shale, and sandstone. Specific gravity values are summarized as follows and are presented in Table 1 and plotted versus elevation on Figure 5.

Limestone: The specific gravities measured from limestone samples varied between 2.69 and 2.72, with an average value of about 2.71.

Shale: The specific gravities measured from shale samples ranged from 2.74 to 2.78, with an average value of about 2.76.

Sandstone: The one specific gravity test performed on a sandstone sample had a measured value of 2.65.

5.6 Porosity

Typical ranges of calculated porosity values for limestone, shale, and sandstone specimens can be summarized as follows, and are presented in Table 1 and plotted versus elevation on Figure 6.

Limestone: Estimated porosity values of limestone samples ranged from 5 to 30 percent, with an average of about 12 percent.

Shale: The porosity of shale samples was estimated to range from 13 to 42 percent, with an average value of 30 percent.

Interbedded Limestone and Shale: Porosities for interbedded limestone and shale samples were estimated to range from 19 to 33 percent. The average porosity for interbedded rock samples was about 26 percent.

Sandstone: Estimated porosity of sandstone samples ranged from 19 to 37 percent, with an average value of 27 percent.

5.7 Slake Durability

Slake durability tests were performed on selected samples of limestone and shale. The test results are summarized below, and are presented in Table 2.

Limestone: Slake durability indices of selected limestone samples ranged from 91 to 98 percent, with an average value of 95 percent. According to the Slake Durability Classification of Gamble (1971), the measured slake durability values indicate that the limestone samples are medium to highly durable.

Shale: Slake durability indices of selected shale samples range from 0.2 to 83 percent, with an average value of about 50 percent. Based on the Slake Durability Classification of Gamble (1971), measured slake durability values indicate that the shale samples have low durability.

5.8 Unconfined Compressive Strength

UC tests were performed on selected samples of limestone, shale, and sandstone between elevations 830 ft to 660 ft. Test results are presented in Tables 3 and 17, and are plotted versus elevation on Figure 7. The results are summarized below.

Limestone: UC strengths measured from limestone samples ranged from about 73 tons per square foot (tsf) to 812 tsf, with an average value of about 299 tsf. The Tangent Modulus at 50 percent of the failure load (q_u) ranged from about 310 kips per square inch (ksi) to 7,300 ksi with an average value of about 1,900 ksi.

Shale: UC strengths measured from shale samples ranged from 13 tsf to 104 tsf, with an average compressive strength of about 75 tsf. The Tangent Modulus at 50 percent of failure load (q_u) ranged from about 5 ksi to 310 ksi, with an average value of about 190 ksi.

Sandstone: Only one UC strength test was performed on a sample classified as weakly cemented sandstone. The measured unconfined compressive strength value was 10 tsf.

Detailed results of the UC tests are presented in Appendices C-1 and C-2.

5.9 Consolidated-Undrained Triaxial Tests

CU triaxial compression strength tests were performed on selected limestone, shale, and sandstone samples ranging in elevation from about 820 ft to 500 ft. Test results are presented in Tables 4 and 5, with and without pore water pressure measurements, respectively. A statistical summary is also provided in Table 17. The test results are summarized below.

Limestone: CU triaxial strength tests performed on selected limestone samples indicate compressive strength ranging from 127 tsf to 587 tsf, with an average value of about 361 tsf.

Shale: CU triaxial strength tests performed on selected shale samples resulted in compressive strengths ranging from about 10 tsf to 82 tsf, with an average value of about 30 tsf.

The p-q plots (Lambe et al. 1969) that display q $[(\sigma_1-\sigma_3)/2]$ versus p $[(\sigma_1+\sigma_3)/2]$ and the K_f-line are also shown on Figures 8, 9, and 10 for limestone peak strength, shale peak strength, and shale ultimate strength, respectively.

Detailed results of the CU tests are presented in Appendices D-1 and D-2.

5.10 Unconsolidated-Undrained Triaxial Tests

UU triaxial strength tests were performed on 11 rock samples ranging in elevation from about 824 ft to 570 ft. Test results are presented in Tables 6 and 17, and summarized below.

Limestone: UU triaxial tests performed on selected limestone samples resulted in compressive strengths ranging between 204 tsf and 498 tsf, with an average value of about 362 tsf.

Shale: UU triaxial tests performed on shale samples resulted in compressive strengths ranging from about 4 tsf to 41 tsf, with an average value of about 20 tsf.

Sandstone: Only one UU triaxial test was performed on a weakly cemented sandstone sample, and it resulted in a measured compressive strength value of 50 tsf.

Results of the UU triaxial tests are also presented as p-q plots similar to CU triaxial tests and on the same plots (Figures 8, 9, and 10).

Detailed results of the UU tests are presented in Appendix E.

5.11 Point Load Index Tests

PLI tests were performed on selected limestone samples from elevations ranging from 830 ft to 750 ft. The point load strength index ($I_{S(50)}$) values obtained from axial and diametral tests were corrected for specimen size and correlated with data obtained from UC strength tests. The PLI

test results are presented in Tables 7 and 17, and are plotted versus elevation on Figures 11 and 12. The results are summarized below.

The corrected $I_{S(50)}$ measured from axial PLI tests performed on selected limestone samples ranged from about 1 tsf to 66 tsf, with an average value of about 24 tsf. The correlated PLI compressive strength values ranged from 10 tsf to 742 tsf, with an average value of about 285 tsf.

The $I_{S(50)}$ values obtained from diametral tests performed on the same limestone samples are generally lower, ranging from about 1 tsf to 44 tsf, with an average value of about 15 tsf. The correlated PLI compressive strength values for the diametral tests range from about 14 tsf to 520 tsf, with an average value of about 180 tsf.

5.12 Direct Shear Tests

Direct shear tests were generally performed for bedding plane surfaces in selected shale samples in the elevation range from 815 ft to 780 ft. Test results are summarized in Table 8, and are presented on Figure 13. The plot shows the range of the ultimate (fully-softened) drained shear strength values. A shaded, curved envelope that includes most of the shear strength values is also presented on this plot.

Detailed results of the direct shear tests are presented in Appendix F.

5.13 One-Dimensional Consolidation Tests

One-dimensional consolidation tests were performed on selected shale samples between elevations 820 ft and 780 ft. Although sample disturbance may have obscured the pre-consolidation pressure and the resulting over-consolidation ratios (OCRs), consolidation test results were used to approximately estimate the OCRs. The estimated OCR values range from about 2 to 4, with an average of about 3. Sample disturbance has apparently occurred to some degree, even for core specimens. Sample disturbance could significantly affect the estimated OCR and compression ratios. One-dimensional consolidation test results are summarized in Table 9.

Detailed results of the one-dimensional consolidation tests are presented in Appendix B-1.

5.14 One-Dimensional Swell Tests

One-dimensional swell tests were performed on nine shale samples. The percent of wetting-induced heave measured from initially unsaturated shale samples ranged from about 0.5 to 2.2 percent for inundation pressure ranging between 2.5 kips per square foot (ksf) and 8.0 ksf, except for one sample that did not show any expansion potential. Estimated swell pressure values appear to range roughly between 11 ksf and 32 ksf. The estimated swell pressures are an order of magnitude higher than the existing overburden pressures and generally indicate a high degree of expansion potential. Based on available correlations between swell potential and the index properties (Department of the Army, 1983), the tested samples were also classified as having a medium to high degree of expansion. The results of the one-dimensional swell tests are presented in Table 10.

Detailed results of the one-dimensional swell tests are presented in Appendix B-2.

5.15 Poisson's Ratio

For selected UC tests, both the axial and lateral strains were measured to allow for estimation of the Poisson's ratio values. Estimated values for both secant and tangent Poisson's ratios at 50 percent of the maximum unconfined compression strength values are presented in Table 3 and plotted versus elevation on Figures 14 and 15.

5.16 Laboratory-Based Shear Wave Velocity

Laboratory-based S-wave velocity measurements were performed on limestone, shale, and sandstone samples between elevations 830 ft and 730 ft. Test results are summarized in Table 11, and are graphically shown versus depth on Figure 16. The results obtained from the laboratory tests are presented below.

Limestone: Measured S-wave velocities from selected limestone samples ranged from 4100 fps to 14,400 fps, with an average value of about 7260 fps.

Shale: Measured S-wave velocities from selected shale samples ranged from 1500 fps to 3900 fps, with an average value of about 2600 fps.

Sandstone: Measured shear wave velocities from selected sandstone samples ranged from 2100 fps to 5800 fps, with an average value of about 3300 fps.

5.17 Carbonate Content

Test results for calcium carbonate content of rock samples are presented in Table 12, and are also described below.

Limestone: The carbonate content measured from selected limestone samples ranged from 56 to 100 percent, with an average calcium carbonate content of about 85 percent.

Shale: The carbonate content measured from selected shale samples ranged from 3 to 77 percent, with an average value of about 37 percent.

Sandstone: The carbonate content measured from selected sandstone samples ranged from 0 to 7 percent, with an average value of about 3 percent.

5.18 Petrographic Analysis

Petrographic analysis was performed in two phases by Spectrum Petrographics Inc. of Vancouver, Washington, and is summarized in two reports dated May and August 2007. Petrographic and photomicrographic descriptions were interpreted from x-ray diffraction analysis on thin sections. The descriptions included mineralogical composition, texture, and the alteration conditions. A total of 39 rock samples were analyzed. A summary of the mineralogical compositions interpreted from the petrographic and photomicrographic analysis performed on the rock samples is presented in Table 13.

Detailed results of the petrographic analysis are presented in Appendices G-1 and G-2.

5.19 X-Ray Diffraction Analysis

X-ray diffraction analysis was performed at Portland State University in Portland, Oregon. X-ray diffraction analysis was performed on random powder from the entire rock samples and the clay size fraction from crushed samples. A total of 14 rock samples were analyzed. Table 14 presents a summary of the mineral quantification of the clay-size fraction (< 2 μm) and the mineral quantification of the random powder of the analyzed bulk sample.

Detailed results of the X-ray diffraction analysis are presented in Appendix H.

5.20 Organic Content

Test results for organic content of soil samples are presented in Table 15, and are also described below.

Organic contents were measured in two samples of fine-grained residual soils. Results indicate an organic content of 1.9 percent for a sample of sandy clay and 2.6 percent for a sample of silty clay.

6.0 REFERENCES

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Gamble, J.C., (1971), Durability-plasticity classification of shales and other argillaceous rocks, Ph.D. thesis, University of Illinois.

Lambe, T.W. and Whitman, R.V. (1969), Soil Mechanics, Series in Soil Engineering, John Wiley & Sons Inc.

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TABLE 1 (Sheet 1 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
1003-off-2	856.7	5.0	Residual Soil	20.5	-	-	-	26	12	-
1032-5	854.8	12.5	Residual Soil	-	-	-	-	25	9	-
1017-4	853.9	12.5	Residual Soil	-	-	-	-	31	17	-
1030-3	851.1	7.5	Residual Soil	21.0	-	-	-	31	16	-
1025-5	849.0	12.5	Residual Soil	-	-	-	-	44	30	-
2032-3	845.5	7.5	Residual Soil	-	-	-	-	60	43	-
2010-off-1	843.9	2.5	Residual Soil	4.8	-	-	-	36	19	-
1014-3	843.7	7.5	Residual Soil	14.4	-	-	-	50	36	-
1008-off-2	842.5	5.0	Residual Soil	11.5	-	-	-	26	12	-
2011-I-off-2	842.1	5.0	Residual Soil	11.5	-	-	-	55	38	-
1018-2	841.4	5.0	Residual Soil	17.8	-	-	-	45	30	-
1014-4	841.2	10.0	Residual Soil	-	-	-	-	27	13	-
2010-off-3	839.9	6.5	Residual Soil	-	-	-	-	26	12	-
2003-off-3	831.0	10.0	Residual Soil	14.6	-	-	-	32	16	-
2001-off-3	830.4	7.5	Residual Soil	-	-	-	-	36	20	-
2040-3	827.6	7.5	Residual Soil	-	-	-	-	32	17	-
2006-07	819.6	25.4	Residual Soil	-	-	-	-	43	26	-
1033-07	838.2	28.8	Shale	9.9	137.2	124.8	27.3	27	14	-
2004-06	829.8	20.2	Shale	12.0	141.3	126.2	26.5	33	18	-
1002-08	821.9	22.8	Shale	-	-	-	-	69	45	-
1003-09	821.8	39.9	Shale	18.3	138.1	116.7	32.1	-	-	-
2058-9	821.3	32.4	Shale	-	-	-	-	-	-	2.75
2006-07	820.6	25.4	Shale	17.5	131.7	112.1	34.7	-	-	-
1004-12	820.0	39.7	Shale	18.4	130.2	110.0	35.9	45	28	-
2036-04	818.8	14.2	Shale	17.6	131.6	111.9	34.9	-	-	-

TABLE 1 (Sheet 2 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
2000-02	817.1	26.9	Shale	21.0	130.9	108.2	37.1	-	-	-
2000a-08	815.2	28.8	Shale	18.5	118.6	100.1	41.7	-	-	-
1000-10	813.6	37.4	Shale	-	-	-	-	42	21	-
1002-10	809.3	35.4	Shale	13.4	137.7	121.4	29.3	-	-	-
2001 @ 28.9'	809.0	28.9	Shale	16.1	117.7	101.3	41.0	-	-	-
2030-07	806.9	45.1	Shale	15.6	141.4	122.3	28.9	-	-	-
2036-07	806.7	26.3	Shale	16.7	133.1	114.0	33.6	48	26	-
1003-12	806.7	55.0	Shale	-	-	-	-	51	25	-
2000-05	802.3	41.7	Shale	22.4	121.6	99.3	42.3	-	-	-
1035-13	799.5	56.6	Shale	19.7	135.9	113.5	34.0	53	34	-
1005-15	797.5	59.5	Shale	12.2	143.0	127.5	25.9	-	-	-
1038-14	797.3	46.2	Shale	17.2	130.4	111.3	35.3	56	44	-
1042-13	797.0	49.4	Shale	-	-	-	-	44	26	-
1058-12	796.8	48.4	Shale	8.5	141.6	130.5	24.0	-	-	-
1041-11	796.3	49.0	Shale	18.1	130.9	110.8	35.4	56	33	-
1003-14	796.3	65.4	Shale	17.4	135.1	115.0	33.1	-	-	-
1042-15	795.5	50.9	Shale	13.3	139.8	123.4	26.6	47	29	-
1029-13	795.2	51.7	Shale	20.4	128.3	106.3	37.8	-	-	-
1029-13	795.2	51.7	Shale	-	-	-	-	51	30	-
1041-12	795.0	50.3	Shale	19.2	132.2	110.9	35.5	-	-	-
2042a-12	794.4	36.6	Shale	19.0	130.9	110.0	36.0	-	-	-
2000-07	794.2	49.8	Shale	11.2	144.5	130.0	24.4	-	-	-
2035-10	794.0	36.0	Shale	-	-	-	-	38	23	-
2051-4	794.0	16.0	Shale	17.2	125.0	106.7	37.9	-	-	-
2042a-11	793.9	37.1	Shale	20.3	124.2	103.2	40.0	55	32	-

TABLE 1 (Sheet 3 of 11)
SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
2003-07	793.9	47.1	Shale	-	-	-	-	46	30	-
1003-15	793.4	68.3	Shale	12.8	147.5	130.8	23.9	-	-	-
2008-09	793.3	47.7	Shale	18.2	133.8	113.2	34.2	-	-	-
1003-off-18	793.3	68.4	Shale	-	-	-	-	43	25	-
1013-15	792.8	70.8	Shale	11.0	142.7	128.5	25.3	-	-	-
1006-13	792.1	55.6	Shale	-	-	-	-	50	33	-
1006-14	791.6	56.1	Shale	14.1	139.1	122.0	29.1	-	-	-
2036-10	790.7	42.3	Shale	14.4	134.0	117.2	31.7	45	29	-
2003-08	790.3	50.7	Shale	14.6	139.0	121.3	29.5	-	-	-
2029-12	789.5	54.6	Shale	15.7	137.0	118.4	31.2	-	-	-
1005-17	788.2	68.8	Shale	17.2	133.1	113.6	33.9	46	27	-
2037-13	788.0	49.0	Shale	18.2	138.4	117.0	32.0	-	-	-
1000-15	787.6	63.4	Shale	13.7	135.1	118.8	30.8	40	24	-
1042-15b	787.1	59.4	Shale	-	-	-	-	36	22	-
1042-15bb	787.0	59.5	Shale	-	-	-	-	38	24	-
1042-15c	786.3	60.1	Shale	10.4	144.1	130.6	24.1	-	-	-
1041-13	786.3	59.0	Shale	11.8	143.0	127.9	25.6	-	-	-
1038-16	785.4	58.1	Shale	12.7	141.8	125.8	27.1	38	24	-
2006-14	785.0	61.0	Shale	12.4	142.2	126.5	26.4	-	-	-
1037-12	784.8	68.0	Shale	16.3	128.8	110.8	35.5	56	35	-
2042a-14	783.9	47.1	Shale	16.5	131.7	113.0	34.3	-	-	-
1002-15	783.7	61.0	Shale	14.5	139.4	121.8	29.2	48	31	-
1005-18	783.1	73.9	Shale	12.4	136.2	121.1	29.5	46	29	-
2035-13	782.5	47.5	Shale	-	-	-	-	40	26	-
2034-16	781	58	Shale	-	-	-	-	-	-	2.77

TABLE 1 (Sheet 4 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
1041-15	777.6	67.7	Shale	6.7	156.5	146.7	13.2	-	-	-
2036-12	775.9	57.1	Shale	16.1	135.3	116.5	32.3	-	-	-
1012-21	735.0	109.0	Shale	-	-	-	-	28	16	-
2002-22	720.4	116.8	Shale	-	-	-	-	27	16	-
1041-27	716.3	129.0	Shale	-	-	-	-	65	43	-
1041-27a	715.9	129.4	Shale	-	-	-	-	71	48	-
1004-33	715.6	144.1	Shale	21.2	131.4	108.4	37.0	-	-	-
2001-22	715.0	123.0	Shale	19.1	168.5	141.5	17.7	-	-	2.78
1000-30	714.6	136.4	Shale	11.8	139.3	124.6	27.6	-	-	-
2037-28	712.5	124.5	Shale	22.5	133.1	108.7	36.8	-	-	-
2034-30	711.1	127.9	Shale	11.4	144.0	129.3	24.8	-	-	-
2006-30	705.0	141.0	Shale	8.8	151.9	139.6	18.8	-	-	-
2000-35	652.7	191.3	Shale	14.0	139.0	122.0	29.1	-	-	-
1012-34	650.0	194.0	Shale	16.4	138.3	118.9	30.9	-	-	2.75
2000-36	647.3	196.7	Shale	16.0	135.0	117.0	32.0	-	-	-
2000-37	645.2	198.8	Shale	12.5	133.5	118.7	31.0	-	-	-
1000-39	639.0	212.0	Shale	10.9	148.0	133.5	22.4	-	-	-
1004-51	599.2	260.5	Shale	20.1	131.9	109.8	36.2	-	-	-
1012-41	562.993	281.05	Shale	11.5	136.6	122.5	28.8	-	-	-
1012-42	546.093	297.95	Shale	12.8	129.8	115.1	33.1	-	-	-
1000-50	498.508	352.5	Shale	9.8	148.5	135.2	21.4	-	-	2.75
1012-51	363.493	480.55	Shale	7.4	155.1	144.4	16.0	-	-	-
1012-56	330.793	513.25	Shale	5.5	154.2	146.2	15.0	-	-	2.74
1035-07	831.5	24.6	Limestone	-	164.1	-	-	-	-	-
1005-09	828.0	29.0	Limestone	1.0	160.0	158.3	6.3	-	-	-

TABLE 1 (Sheet 5 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
1033-09	827.9	39	Limestone	-	-	-	-	-	-	2.71
1030-11	826.6	32.0	Limestone	2.4	162.4	158.6	6.1	-	-	-
2000-01	824.8	19.2	Limestone	1.6	155.4	152.9	9.5	-	-	-
1032-12	824.0	43.3	Limestone	-	164.6	-	-	-	-	-
1037-05	818.2	34.6	Limestone	7.3	150.8	140.6	16.8	-	-	-
1009-I-05	816.7	40.5	Limestone	5.3	156.8	148.9	11.9	-	-	-
2005-08	816.7	32.3	Limestone	-	164.9	-	-	-	-	-
1030-13	815.6	43.0	Limestone	5.3	155.9	148.1	12.4	-	-	-
1003-off-13	815.3	46.4	Limestone	4.3	152.9	146.7	13.2	-	-	-
1004-13	814.2	45.5	Limestone	6.8	151.2	141.6	16.2	-	-	-
2000-03	813.3	30.7	Limestone	4.4	155.6	149.0	11.8	-	-	-
1033-12	813.3	53.6	Limestone	4.0	156.9	150.9	10.7	-	-	-
1029-09	813.3	30.3	Limestone	3.5	158.45	153.14	9.4	-	-	-
1002-09	812.8	31.9	Limestone	5.3	154.2	-	-	-	-	-
1005-12	812.2	44.8	Limestone	5.3	155.0	147.2	12.9	-	-	-
2031-11	810.2	42.9	Limestone	5.3	155.0	147.2	12.9	-	-	-
2036-06	809.2	23.8	Limestone	3.8	155.9	150.2	11.1	-	-	-
1013 @ 55.5'	808.0	55.5	Limestone	3.4	152.1	147.0	13.0	-	-	-
2003-04	808.0	33.0	Limestone	4.1	157.3	151.1	10.6	-	-	2.69
1041-09	807.0	38.0	Limestone	5.8	155.7	147.1	13.0	-	-	-
1013-12	805.3	58.2	Limestone	1.7	162.9	160.3	5.2	-	-	-
1013-19	805.3	58.2	Limestone	4.4	156.8	150.1	11.2	-	-	-
1031-14	803.8	60.4	Limestone	4.6	154.8	147.9	12.5	-	-	-
1007-11	801.3	42.3	Limestone	2.9	159.8	155.3	8.1	-	-	-
2030-08	801.3	50.7	Limestone	4.7	156.2	149.1	11.8	-	-	-

TABLE 1 (Sheet 6 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
2037-10	800.3	36.7	Limestone	1.5	160.6	158.2	6.4	-	-	-
2005-11	799.4	49.6	Limestone	3.0	160.4	155.7	7.9	-	-	-
2003-06	798.5	42.5	Limestone	4.2	157.5	151.2	10.5	-	-	-
2014 @ 43.6'	797.1	43.6	Limestone	5.7	152.4	144.3	14.6	-	-	-
1009-I-09	797.0	60.2	Limestone	4.3	157.9	151.4	10.4	-	-	-
2030-11	789.2	63.4	Limestone	6.3	154.6	145.4	14.0	-	-	-
2007-13	786.1	54.9	Limestone	2.9	159.1	155.1	8.2	-	-	-
1034-18	785.1	73.4	Limestone	5.1	160.5	152.8	9.6	-	-	-
1038-17	781.1	62.4	Limestone	3.6	159.2	153.6	9.1	-	-	-
2004-16	779.6	70.9	Limestone	0.9	160.7	159.2	5.8	-	-	-
2042a-15	779.1	51.9	Limestone	2.6	163.4	159.3	5.7	-	-	-
1000-17	779.0	72.0	Limestone	-	151.0	-	-	-	-	-
2012 @ 69'	778.6	69.0	Limestone	3.5	162.3	156.8	7.2	-	-	-
2012-20	778.1	69.5	Limestone	-	157.1	-	-	-	-	-
1014-17	777.5	73.7	Limestone	3.6	154.8	149.5	11.5	-	-	-
2036-13	774.6	57.8	Limestone	4.0	155.5	149.5	11.6	-	-	-
2006-16	774.5	70.5	Limestone	4.2	154.9	148.6	12.0	-	-	-
1032-22	773.6	93.7	Limestone	3.6	157.9	152.4	9.8	-	-	-
1041-16	772.7	72.6	Limestone	6.9	153.0	143.1	15.3	-	-	-
1005-20	772.5	84.5	Limestone	-	156.3			-	-	-
2001-10	772.1	65.8	Limestone	4.6	155.0	148.2	12.3	-	-	-
1013-23	771.7	91.8	Limestone	5.9	152.1	143.6	15.0	-	-	-
1003-off-22	771.6	90.1	Limestone	5.1	154.9	147.3	10.6	-	-	-
1030-22	771.0	87.6	Limestone	4.5	157.1	150.3	11.1	-	-	-
1031-21	770.8	93.4	Limestone	4.8	155.2	148.1	12.3	-	-	-

TABLE 1 (Sheet 7 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
1034-21	768.9	89.6	Limestone	5.7	154.3	146.0	13.6	-	-	-
2041a-15	768.7	63.3	Limestone	8.0	151.9	140.7	16.7	-	-	-
2002-13R	768.2	68.8	Limestone	3.5	158.5	153.1	9.4	-	-	-
2042a-17	767.8	62.9	Limestone	5.8	152.7	144.3	14.6	-	-	-
1029-18	767.8	75.8	Limestone	6.7	155.01	145.33	14.0	-	-	-
1035-20	767.4	88.7	Limestone	6.8	149.5	140.0	17.2	-	-	-
2038-13	767.1	69.9	Limestone	5.4	153.5	145.6	13.8	-	-	-
1041-17	766.8	78.2	Limestone	4.2	157.2	150.9	10.7	-	-	-
1042-19	765.6	80.9	Limestone	4.2	157.0	150.7	10.8	-	-	-
1010-22	764.4	97	Limestone	-	-	-	-	-	-	2.72
2000-13	763.7	80.3	Limestone	4.5	154.7	148.0	12.4	-	-	-
2000-13a	763.7	80.3	Limestone	1.3	149.3	147.3	12.8	-	-	-
1034-23	761.6	99.4	Limestone	-	160.7	-	-	-	-	-
2006-19	760.8	85.2	Limestone	5.2	155.0	147.3	12.8	-	-	-
1003-off-24	760.7	101.0	Limestone	7.2	149.4	139.5	17.5	-	-	-
2030-17	759.1	93.5	Limestone	6.5	152.8	143.5	15.1	-	-	-
1037-17	757.9	94.9	Limestone	6.1	155.2	146.3	13.4	-	-	-
1042-21	757.5	88.9	Limestone	4.3	159.3	152.8	10.4	-	-	-
2037-19	757.5	79.5	Limestone	-	-	-	-	-	-	2.72
1014-21	756.9	94.3	Limestone	2.2	161.2	157.7	6.7	-	-	-
1004-25	756.0	104.0	Limestone	3.0	160.5	155.9	7.8	-	-	-
1012-17	755.0	89.0	Limestone	2.4	161.0	157.3	6.9	-	-	-
2014-16	752.4	87.0	Limestone	7.4	153.4	142.8	15.5	-	-	-
1041-20	752.0	93.0	Limestone	4.1	157.3	151.1	10.6	-	-	-
2005-21	751.6	97.1	Limestone	5.7	153.7	145.4	14.0	-	-	-

TABLE 1 (Sheet 8 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
2002-16	750.6	86.4	Limestone	4.4	156.0	149.4	11.6	-	-	-
1038-24	745.7	97.8	Limestone	5.7	154.9	146.5	13.3	-	-	-
2041a-20	745.3	86.7	Limestone	2.7	156.7	152.6	9.7	-	-	-
2000-17A	742.7	101.3	Limestone	0.8	147.4	146.2	13.5	-	-	-
2000-17	742.2	101.8	Limestone	5.1	155.3	147.8	12.5	-	-	-
2000-18	742.1	101.9	Limestone	-	162.2	-	-	-	-	-
1000-24	741.6	109.4	Limestone	-	153.5	-	-	-	-	-
2035-21	739.5	90.3	Limestone	7.8	150.9	140.0	17.2	-	-	-
2042a-23	738.4	92.6	Limestone	3.9	157.7	151.8	10.2	-	-	-
2037-23	737.7	99.3	Limestone	6.4	152.2	143.1	15.3	-	-	-
2035-22	735.9	93.9	Limestone	5.7	154.3	146.0	13.6	-	-	-
2004-25	735.3	114.7	Limestone	5.1	155.3	147.7	12.6	-	-	-
2000-19	732.9	111.1	Limestone	6.9	152.0	142.2	15.9	-	-	-
1003-off-30	731.1	130.6	Limestone	5.1	135.6	146.2	13.5	-	-	-
1012-22	730.0	114.0	Limestone	3.4	155.9	150.7	10.8	-	-	-
1000-27	728.2	122.8	Limestone	9.5	153.1	139.9	17.2	-	-	-
2000-20	726.5	117.5	Limestone	4.9	160.9	153.4	9.2	-	-	-
2002-22	720.2	116.8	Limestone	7.9	149.0	138.0	18.3	-	-	-
2000-22	718.5	125.5	Limestone	4.6	155.9	149.0	11.8	-	-	-
2002-23	716.0	121.0	Limestone	4.2	157.8	151.4	10.4	-	-	-
1002-29	714.3	130.4	Limestone	7.2	153.0	142.6	15.6	-	-	-
1002-30	710.1	134.6	Limestone	18.9	141.4	118.9	29.6	-	-	-
1012-27	705.0	139.0	Limestone	3.6	160.7	155.2	8.2	-	-	-
2000-25	704.2	139.8	Limestone	2.6	161.2	157.1	7.0	-	-	-
1012-28	700.0	144.0	Limestone	3.7	156.5	150.9	10.7	-	-	-

TABLE 1 (Sheet 9 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
1000-33	699.5	151.5	Limestone	-	-	-	-	-	-	2.72
2000-26	699.0	145.0	Limestone	3.4	157.4	152.2	10.0	-	-	-
2000-27	691.8	152.2	Limestone	5.1	156.1	148.5	12.1	-	-	-
2000-28	688.8	155.2	Limestone	8.2	147.7	137.4	18.7	-	-	-
1004-38	684.4	175.6	Limestone	3.8	157.6	151.8	10.2	-	-	-
2002-31	675.3	161.9	Limestone	3.8	156.6	150.9	10.7	-	-	-
1004-41	674.2	185.5	Limestone	2.9	152.8	148.5	12.1	-	-	-
2000-32	668.2	175.8	Limestone	3.3	158.8	153.8	9.0	-	-	-
1012-33	660.0	184.0	Limestone	3.7	157.8	152.2	9.9	-	-	-
2000-34	657.8	186.2	Limestone	3.5	158.5	153.2	9.3	-	-	2.70
2002-39	638.2	198.8	Limestone	2.8	161.0	156.5	7.4	-	-	-
1003-off-16	799.6	62.1	Limestone/Shale	9.1	146.3	134.1	21.3	-	-	-
1003-16	787.9	73.8	Limestone/Shale	13.6	140.5	123.6	27.5	-	-	-
1006-13	792.1	55.6	Limestone/Shale	15.9	141.0	121.6	28.7	-	-	-
1012-11	785.0	59.0	Limestone/Shale	9.6	142.5	130.0	23.8	-	-	-
1042-15b	786.7	59.7	Limestone/Shale	8.7	141.4	130.1	23.7	-	-	-
1042-15d	784.5	61.9	Limestone/Shale	14.8	135.6	118.1	30.7	-	-	-
1043-7	793.4	31.1	Limestone/Shale	13.8	137.0	120.4	29.5	-	-	-
1048-14	783.3	52.5	Limestone/Shale	16.1	132.3	114.0	33.3	-	-	-
2014-8	796.7	44.0	Limestone/Shale	10.4	145.6	131.8	22.7	-	-	-
2000-24	708.0	136.0	Limestone/Shale	8.5	149.0	137.4	19.4	-	-	-
1004-46	650.7	209.0	Limestone/Shale	13.2	153.6	135.6	20.5	-	-	-
1004-48	629.9	229.8	Limestone/Shale	13.1	136.7	120.8	29.1	-	-	-
2000-40	628.7	215.3	Limestone/Shale	9.0	145.0	133.0	22.0	-	-	-
2000-72	466.6	377.4	Limestone/Shale	11.7	138.2	123.7	27.4	-	-	-

TABLE 1 (Sheet 10 of 11)

SUMMARY OF INDEX PROPERTIES

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit (%)	Plasticity Index (%)	Specific Gravity
2000-76	448.9	395.1	Limestone/Shale	10.0	142.0	129.0	24.3	-	-	-
2000-43	614.8	229.2	Sandstone	17.0	132.0	113.0	31.6	-	-	-
2003-35	614.4	226.6	Sandstone	13.3	132.5	117.0	29.4	-	-	-
2003-36	613.1	227.9	Sandstone	18.8	124.4	104.7	36.7	-	-	-
1004-53	579.7	280	Sandstone	-	-	-	-	-	-	2.65
1012-40	575.0	269.0	Sandstone	13.8	133.0	116.9	29.2	-	-	-
1004-54	569.7	290.0	Sandstone	11.3	136.3	122.5	25.8	-	-	-
1000-46	568.7	282.3	Sandstone	8.4	140.8	129.8	21.4	-	-	-
2000-52	568.5	275.5	Sandstone	14.4	-	-	-	-	-	-
2002-60R	538.7	298.3	Sandstone	17.3	124.3	106.0	35.8	-	-	-
2000-60	529.7	314.3	Sandstone	18.0	131.0	111.0	32.8	-	-	-
2000-64	508.8	335.2	Sandstone	11.0	140.0	126.0	23.7	-	-	-
1012-44	506.0	338.1	Sandstone	8.2	145.4	134.4	18.6	-	-	-
2000-68	488.8	355.2	Sandstone	11.2	146.6	131.8	20.2	-	-	-
1000-51	475.3	375.7	Sandstone	9.3	145.0	132.6	19.7	-	-	-

TABLE 1 (Sheet 11 of 11)
SUMMARY OF INDEX PROPERTIES

Statistical Summary

	Material Type	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Calculated Porosity (%)	Liquid Limit	Plasticity Index	Specific Gravity
Average	Soil	14.5	-	-	-	36	21	-
	Shale	15.0	137.3	119.8	30.3	46	28	2.76
	Limestone	4.7	155.9	149.0	11.8	-	-	2.71
	Limestone/Shale	11.8	141.8	126.9	25.6	-	-	-
	Sandstone	13.2	135.9	120.5	27.1	-	-	2.65
Minimum	Soil	4.8	-	-	-	25	9	-
	Shale	5.5	117.7	99.3	13.2	27	14	2.74
	Limestone	0.8	135.6	118.9	5.2	-	-	2.69
	Limestone/Shale	8.5	132.3	114.0	19.4	-	-	-
	Sandstone	8.2	124.3	104.7	18.6	-	-	2.65
Maximum	Soil	21.0	-	-	-	60	43	-
	Shale	22.5	168.5	146.7	42.3	71	48	2.78
	Limestone	18.9	164.9	160.3	29.6	-	-	2.72
	Limestone/Shale	16.1	153.6	137.4	33.3	-	-	-
	Sandstone	18.8	146.6	134.4	36.7	-	-	2.65
Standard Deviation	Soil	5.0	-	-	-	10	10	-
	Shale	3.9	8.8	10.9	6.4	11	8	0.02
	Limestone	2.2	4.4	6.0	3.5	-	-	0.01
	Limestone/Shale	2.6	5.4	6.8	4.0	-	-	-
	Sandstone	3.5	7.4	10.1	6.1	-	-	-

TABLE 2

SUMMARY OF SLAKE DURABILITY TEST RESULTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Moisture Content (%)	Average Water Temperature (°C)	Slake Durability (%)	Classification
1000-04	840.5	10.5	Shale	7.2	22.4	83.2	Low Durability
1003-05	841.6	20.4	Limestone	5.0	22.4	91.1	Medium Durability
1003-14	796.6	65.4	Shale	17.8	22.6	0.2	Very Low Durability
1033-06	842.9	24.2	Limestone	9.8	22.5	92.0	Medium Durability
1033-09	827.9	39.0	Limestone	1.7	22.6	98.3	High Durability
2031-06	835.0	18.0	Shale	10.9	22.6	66.1	Low Durability
2031-10	816.7	36.3	Limestone	4.0	22.6	98.1	High Durability

TABLE 3 (Sheet 1 of 3)

SUMMARY OF UNCONFINED COMPRESSION TEST RESULTS

Sample No.	Elevation[1] (ft)	Depth (ft)	Material Type	L/D Ratio	Axial Failure Stress, σ_{af} (tsf)	Axial Failure Strain, ε_{af} (LVDT Jacket) (%)	Axial Failure Strain, ε_{apf} (Actuator) (%)	Secant Young's Modulus at 50% σ_{af} (psi)	Tangent Young's Modulus at 50% σ_{af} (psi)	Secant Poisson's Ratio at 50% σ_{af}	Tangent Poisson's Ratio at 50% σ_{af}
1000-39	639.0	212.0	Shale	1.7	104	--	0.57	--	--	--	--
1003-off-22	771.6	90.1	Limestone	2.0	312	--	0.91	-	--	--	--
1003-off-30	731.1	130.6	Limestone	1.7	200	--	0.65	--	--	--	--
1004-25	756.0	104.0	Limestone	1.98	218	--	0.75	--	--	--	--
1004-38	684.4	175.6	Limestone	1.9	268	--	0.69	--	--	--	--
1005-09	828.0	29.0	Limestone	2.3	371	0.085	0.38	7.2×10^6	7.0×10^6	0.22	0.42
1005-12	812.2	44.8	Limestone	2.2	221	--	0.68	--	--	--	--
1009-I-05	816.7	40.5	Limestone	2.1	255	--	0.96	--	--	--	--
1012-17	755.0	89.0	Limestone	2.0	137	--	0.96	--	--	--	--
1012-22	730.0	114.0	Limestone	2.2	291	0.32	0.37	1.6×10^6	1.2×10^6	0.02	0.05
1012-28	700.0	144.0	Limestone	1.9	311	--	0.83	--	--	--	--
1012-33	660.0	184.0	Limestone	2.2	242	0.11[3]	0.50	5.0×10^6	4.7×10^6	0.00	0.00
1012-40	575.0	269.0	Sandstone	1.9	10	--	2.40	--	--	--	--
1013 @ 55.5'	808.0	55.5	Limestone	2.2	199	0.43	0.77	6.9×10^5	6.6×10^5	0.00	0.02
1013-12	805.3	58.2	Limestone	2.0	372	0.28	0.62	1.8×10^6	2.4×10^6	0.12	0.26
1013-19	771.7	91.8	Limestone	2.2	296	0.52	0.64	7.9×10^5	9.9×10^5	0.09	0.17
1013-23	805.3	110.1	Limestone	1.9	147	--	1.05	--	--	--	--
1014-17	777.5	73.7	Limestone	2.3	271	0.48	0.53	8.6×10^5	8.5×10^5	0.17	0.23
1014-21	756.9	94.3	Limestone	2.3	595	0.24	0.43	4.0×10^6	3.9×10^6	0.12	0.27
1029-09	816.6	30.3	Limestone	2.1	323	--	0.58	--	--	--	--
1029-18	771.1	75.8	Limestone	2.0	163	0.48	0.76	6.2×10^5	5.1×10^5	0.18	0.24
1030-11	826.6	32.0	Limestone	2.0	513[2]	--	0.53	--	--	--	--
1030-22	771.0	87.6	Limestone	2.1	251	0.30	0.57	1.4×10^6	1.4×10^6	--	0.01
1031-21	770.8	93.4	Limestone	2.2	323	--	1.01	--	--	--	--
1032-22	773.6	93.7	Limestone	2.3	361	0.25	0.63	3.5×10^6	1.8×10^6	0.04	0.15

TABLE 3 (Sheet 2 of 3)

SUMMARY OF UNCONFINED COMPRESSION TEST RESULTS

Sample No.	Elevation[1] (ft)	Depth (ft)	Material Type	L/D Ratio	Axial Failure Stress, σ_{af} (tsf)	Axial Failure Strain, ε_{af} (LVDT Jacket) (%)	Axial Failure Strain, ε_{apf} (Actuator) (%)	Secant Young's Modulus at 50% σ_{af} (psi)	Tangent Young's Modulus at 50% σ_{af} (psi)	Secant Poisson's Ratio at 50% σ_{af}	Tangent Poisson's Ratio at 50% σ_{af}
1033-12	813.3	53.6	Limestone	2.1	288	0.35	1.10	1.7×10^6	1.4×10^6	0.06	0.10
1034-23	761.6	99.4	Limestone	1.9	493[2]	--	0.42	--	--	--	--
1035-07	831.5	24.6	Limestone	2.2	487[2]	--	0.44	--	--	--	--
1035-13	799.5	56.6	Shale	2.2	13	1.00	1.15	4.4×10^4	3.5×10^4	0.35	0.50
1037-05	818.2	34.6	Shale	2.3	92	0.41	0.87	4.9×10^5	2.6×10^5	0.00	0.00
1037-17	757.9	94.9	Shale	2.2	91	0.49	0.68	2.5×10^5	3.1×10^5	0.10	0.11
1038-17	781.1	62.4	Limestone	2.2	195	0.40	0.52	5.6×10^5	1.0×10^6	0.07	0.24
1038-24	745.7	97.8	Limestone	2.3	309	0.20	0.57	3.8×10^6	3.1×10^6	0.50	0.50
1041-09	807.0	38.0	Limestone	1.8	156	--	1.18	--	--	--	--
1041-17	766.8	78.2	Limestone	1.9	190	--	0.51	--	--	--	--
1041-20	752.0	93.0	Limestone	1.8	227	--	0.86	--	--	--	--
1042-19	765.6	80.9	Limestone	2.1	357	0.32	0.68	1.8×10^6	1.5×10^6	0.07	0.28
1042-21	757.5	88.9	Limestone	2.1	157	--	0.85	--	--	--	--
2000-13	763.7	80.3	Limestone	2.1	253	--	0.93	--	--	--	--
2000-13A	763.7	80.3	Limestone	2.3	366	0.76	0.76	7.4×10^5	6.7×10^5	0.07	0.13
2000-17	742.1	101.9	Limestone	2.1	250	--	0.48	--	--	--	--
2000-18	737.8	106.2	Limestone	1.7	515[2]	--	0.54	--	--	--	--
2000-20	726.5	117.5	Limestone	1.9	498[2]	--	0.35	--	--	--	--
2000-26	699.0	145.0	Limestone	1.7	287	--	0.62	--	--	--	--
2001-10	772.1	65.8	Limestone	2.1	351	--	0.87	--	--	--	--
2002-31R	675.3	161.9	Limestone	2.3	295	0.16	0.32	2.5×10^6	2.6×10^6	0.02	0.07
2004-16	779.6	70.9	Limestone	2.2	467	--	0.74	--	--	--	--
2005-21	751.6	97.1	Limestone	2.2	73	--	1.73	--	--	--	--
2006-16	774.5	70.5	Limestone	2.3	376	--	0.88	--	--	--	--
2012 @ 69'	778.6	69.0	Limestone	2.1	433	0.23[3]	0.34	2.6×10^6	2.2×10^6	0.07	0.08

TABLE 3 (Sheet 3 of 3)

SUMMARY OF UNCONFINED COMPRESSION TEST RESULTS

Sample No.	Elevation[1] (ft)	Depth (ft)	Material Type	L/D Ratio	Axial Failure Stress, σ_{af} (tsf)	Axial Failure Strain, ε_{af} (LVDT Jacket) (%)	Axial Failure Strain, ε_{apf} (Actuator) (%)	Secant Young's Modulus at 50% σ_{af} (psi)	Tangent Young's Modulus at 50% σ_{af} (psi)	Secant Poisson's Ratio at 50% σ_{af}	Tangent Poisson's Ratio at 50% σ_{af}
2012-20	778.1	69.5	Limestone	2.3	812[2]	0.15	0.23	8.0×10^6	6.9×10^6	0.05	0.15
2014 @ 43.6'	797.1	43.6	Limestone	2.3	222	0.30	0.48	1.7×10^6	8.7×10^5	0.13	0.11
2014-8	796.7	44.0	Limestone	2.2	790[2]	--	0.19	--	--	--	--
2014-16	752.4	87.0	Limestone	2.2	87	0.46[3]	0.70	2.7×10^5	3.0×10^5	0.08	0.22
2030-11	789.2	63.4	Limestone	2.2	148	--	0.65	--	--	--	--
2030-17	759.1	93.5	Limestone	2.1	118	--	0.92	--	--	--	--
2031-11	810.2	42.9	Limestone	2.1	242	0.36	0.56	1.2×10^6	1.1×10^6	0.19	0.26
2035-21	739.5	90.3	Limestone	2.1	206	--	1.04	--	--	--	--
2035-22	735.9	93.9	Limestone	2.3	268	--	0.74	--	--	--	--
2036-13	774.6	57.8	Limestone	2.1	365	0.37	0.67	1.8×10^6	1.6×10^6	0.21	0.36
2038-13	767.1	69.9	Limestone	2.1	203	0.53	0.64	7.9×10^5	5.7×10^5	0.22	0.27
2041a-15	768.7	63.3	Limestone	1.7	83	--	0.90	--	--	--	--
2042a-15	779.1	51.9	Limestone	1.5	292	--	0.63	--	--	--	--
2042a-17	767.8	62.9	Limestone	2.3	157	--	0.85	--	--	--	--

Notes:
1. Coordinate System: US State Plane 1983
   Zone: Texas North Central 4202
   Vertical Datum: NAVD88
2. Sample did not fail.
3. Only one LVDT was working.

TABLE 4

SUMMARY OF CONSOLIDATED-UNDRAINED TRIAXIAL TEST WITH PORE WATER PRESSURE MEASUREMENT RESULTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Approx. Overbdn. Pressure[1] σ_{vo} (tsf)	Consol. Pressure σ_3 (tsf)	Deviator Stress at Failure $\sigma_1-\sigma_3$ (tsf)	Axial Failure Strain ε_{af} (%)	Pore Pressure at Failure (tsf)	Failure Plane Stresses (for C=0)			p'-q Parameters at Failure[3]		Linear Shear Strength Parameters			
														Effective Stress		Total Stress	
									φ for C = 0 (deg)	Total Normal Stress σ_n (tsf)	Shear Strength s (tsf)	q (tsf)	P' (tsf)	C' (tsf)	φ' (deg)	C (tsf)	φ (deg)
Peak Strength																	
1002-30[2]	710.4	134.6	Shale	9.2	5.0	25.0	0.7	4.38	46	8.6	8.8	12.5	13.1	0.0	73	0.0	51
					10.1	70.6	1.1	8.46	51	18.0	22.2	35.3	36.9				
1029-13[2]	795.2	51.7	Shale	3.5	2.0	2.4	1.3	1.43	22	2.7	1.1	1.2	1.8	0.38	30	0.33	17
					4.0	4.8	1.2	2.65	22	5.5	2.2	2.4	3.7				
					8.0	7.2	1.2	5.11	18	10.5	3.4	3.6	6.5				
1038-16	785.4	58.1	Shale	4.0	4.2	19.0	1.9	0.44	49	7.1	6.8	9.5	13.2	--	--	--	--
2000-07	794.2	49.8	Shale	3.4	3.6	17.4	2.3	0.00	45	6.1	6.1	8.7	12.3	--	--	--	--
2003-35[2]	614.4	226.6	Sandstone	15.4	9.0	70.2	1.9	-0.32	53	16.2	21.2	35.1	44.4	21.5	20	22.9	18
					18.0	95.0	1.8	-0.49	47	31.0	32.7	47.5	66.0				
					32.4	91.2	1.7	1.99	36	51.3	37.0	45.6	76.0				
2003-36[2]	613.1	227.9	Sandstone	15.5	16.2	38.4	2.1	2.89	33	25.0	16.1	19.2	32.6	4.0	29	1.1	31
					32.4	74.0	4.4	-0.64	32	49.7	31.3	37.0	70.1				
Ultimate Strength																	
1029-13[2]	795.2	51.7	Shale	3.5	2.0	--	--	--	--	--	--	--	--	--	--	--	--
					4.0	--	--	--	--	--	--	--	--				
					8.0	7.4	9.0	4.17	15	10.0	2.7	2.7	6.5				
1038-16	785.4	58.1	Shale	4.0	4.2	13.8	8.7	0.74	38	6.8	5.4	6.9	10.4	--	--	--	--
2000-07	794.2	49.8	Shale	3.4	3.6	9.6	9.5	0.00	35	5.7	3.9	4.8	8.4	--	--	--	--

Notes:
1. Approximate overburden pressure is calculated based on an average unit weight of 145 pcf.
2. One specimen was utilized for a multistage test.
3. $q=(\sigma_1-\sigma_3)/2$, $p'=(\sigma'_1+\sigma'_3)/2$.

TABLE 5 (Sheet 1 of 3)

Summary of Consolidated-Undrained Triaxial Test without Pore Water Pressure Measurement Results

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Approx. Overbdn. Pressure[1] σ_{vo} (tsf)	Consol. Pressure σ_3 (tsf)	Deviator Stress at Failure σ_1-σ_3 (tsf)	Axial Failure Strain ε_{af} (%)	Failure Plane Stresses (for C=0)			p-q Parameters at Failure[3]	
								φ for C = 0 (deg)	Total Normal Stress σ_n (tsf)	Shear Strength s (tsf)	q (tsf)	P (tsf)
Peak Strength												
1002-15	783.7	61.0	Shale[2]	4.4	4.4	18.6	2.5	43	7.4	6.8	9.3	13.7
1041-13	786.3	59.0		4.3	8.5	38.8	1.8	44	14.4	13.9	19.4	27.9
1042-15d	784.5	61.9		4.5	2.3	12.8	2.1	48	3.9	4.3	6.4	8.6
1003-16	787.9	73.8	Shale[2]	5.4	10.0	57.4	1.7	48	17.5	19.2	28.7	38.8
1006-13	792.1	55.6		4.0	4.0	23.2	1.6	48	7.0	7.8	11.6	15.6
1006-14	791.6	56.1		4.1	2.0	24.4	2.1	59	3.8	6.3	12.2	14.3
1038-14	797.3	46.2	Shale[2]	3.4	7.0	10.2	2.2	25	9.9	4.6	5.1	12.1
1042-15a	795.5	50.9		3.7	2.0	34.8	1.6	64	3.8	7.7	17.4	19.4
2042a-12	794.1	36.6		2.7	2.7	12.2	2.8	44	4.5	4.4	6.1	8.8
1000-17A	779.0	72.0	Limestone	5.2	5.2	552.8	1.1	79	10.4	53.0	276.4	281.6
1000-24	741.6	109.4	Limestone	7.9	7.9	587.2	0.6	77	15.7	66.9	293.6	301.6
1000-27	728.2	122.8	Limestone	8.9	8.9	285.0	0.9	70	17.3	48.1	142.5	151.4
1000-51	475.3	375.7	Sandstone	27.2	27.2	124.0	0.9	44	46.2	44.5	62.0	89.4
1003-09	821.8	39.9	Shale	2.9	2.9	15.2	0.9	46	5.0	5.2	7.6	10.5
1003-14	796.3	65.4	Shale	4.7	4.7	25.2	0.9	47	8.2	8.7	12.6	17.3
1003-off-16	799.6	62.1	Shale	4.5	4.5	34.6	1.5	53	8.1	10.5	17.3	21.8
1003-off-24	760.7	101.0	Limestone	7.3	7.3	126.8	0.8	64	13.9	28.1	63.4	70.8
1004-33	715.6	144.1	Shale	10.5	5.2	10.8	11.1	31	7.9	4.7	5.4	10.6
1004-46	650.7	209.0	Shale	15.2	15.2	41.6	0.4	35	24.0	16.9	20.8	36.1
1004-51	599.2	260.5	Shale	18.9	18.9	35.6	0.7	29	28.1	15.6	17.8	36.7

TABLE 5 (Sheet 2 of 3)

Summary of Consolidated-Undrained Triaxial Test without Pore Water Pressure Measurement Results

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Approx. Overbdn. Pressure[1] σ_{vo} (tsf)	Consol. Pressure σ_3 (tsf)	Deviator Stress at Failure $\sigma_1-\sigma_3$ (tsf)	Axial Failure Strain ε_{af} (%)	Failure Plane Stresses (for C=0)			p-q Parameters at Failure[3]	
								φ for C = 0 (deg)	Total Normal Stress σ_n (tsf)	Shear Strength s (tsf)	q (tsf)	P (tsf)
Peak Strength												
1012-44	506.0	338.1	Shale	24.5	24.5	82.2	0.6	39	39.9	32.0	41.1	65.6
1013-15	792.9	70.6	Shale	5.1	5.1	26.2	1.7	46	8.8	9.1	13.1	18.2
1041-12	795.0	50.3	Shale	3.7	3.6	14.8	4.3	42	6.1	5.5	7.4	11.0
2000-17A	742.7	101.3	Limestone	7.3	7.3	536.0	0.5	77	14.5	61.5	268.0	275.4
2000-27	691.8	152.2	Limestone	11.0	11.1	240.0	1.4	66	21.2	48.2	120.0	131.0
2000-72	466.6	377.4	Shale	27.4	27.4	23.4	1.8	17	35.6	11.1	11.7	39.2
2002-16R	750.8	86.4	Limestone	6.3	6.3	200.0	1.0	70	12.2	33.8	100.0	106.2
2002-22R	720.4	116.8	Shale	8.5	8.4	70.6	2.6	54	15.2	20.8	35.3	43.7
2006-14	784.0	61.0	Shale	4.4	4.4	50.4	1.6	58	8.2	13.3	25.2	29.6
2008-09	792.9	47.7	Shale	3.5	3.5	15.8	2.9	44	5.9	5.7	7.9	11.4
2030-07	807.5	45.1	Shale	3.3	3.3	26.4	1.8	53	5.9	7.9	13.2	16.5
2036-04	818.2	14.2	Shale	1.0	2.1	11.6	2.8	47	3.6	3.9	5.8	7.8
2037-13	787.5	49.0	Shale	3.6	3.6	11.8	2.7	39	5.8	4.6	5.9	9.4
2042a-14a	779.6	51.1	Shale	3.7	3.7	10.2	3.1	35	5.9	4.2	5.1	8.8

TABLE 5 (Sheet 3 of 3)

Summary of Consolidated-Undrained Triaxial Test without Pore Water Pressure Measurement Results

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Approx. Overbdn. Pressure[1] σ_{vo} (tsf)	Consol. Pressure σ_3 (tsf)	Deviator Stress at Failure $\sigma_1-\sigma_3$ (tsf)	Axial Failure Strain ε_{af} (%)	Failure Plane Stresses (for C=0)			p-q Parameters at Failure[3]	
								φ for C = 0 (deg)	Total Normal Stress σ_n (tsf)	Shear Strength s (tsf)	q (tsf)	P (tsf)
Ultimate Strength												
1041-13	786.3	59.0	Shale[2]	4.3	8.5	28.9	5.2	39	13.8	11.2	14.4	22.9
1042-15d	784.5	61.9		4.5	2.3	7.7	4.5	39	3.7	2.9	3.8	6.1
1003-16	787.9	73.8	Shale[2]	5.4	10.0	31.0	7.2	37	16.1	12.3	15.5	25.6
1006-13	792.1	55.6		4.0	4.0	13.7	3.2	39	6.6	5.3	6.8	10.9
1006-14	791.6	56.1		4.1	2.0	11.8	3.5	49	3.5	4.0	6.0	8.0
1038-14	797.3	46.2	Shale[2]	3.4	7.0	6.5	7.7	19	9.2	3.1	3.3	10.3
1042-15a	795.5	50.9		3.7	2.0	7.4	3.4	41	3.3	2.8	3.7	5.7
2042a-12	794.1	36.6		2.7	2.7	7.6	5.3	35	4.2	3.0	3.7	6.4
1003-off-16	799.6	62.1	Shale	4.5	4.5	21.4	3.2	45	7.7	7.6	10.7	15.2
1004-46	650.7	209.0	Shale	15.2	15.2	32.4	3.2	31	22.9	13.7	15.9	31.1
1004-51	599.2	260.5	Shale	18.9	18.9	16.9	2.8	18	24.6	7.8	8.2	27.1
1013-15	792.9	70.6	Shale	5.1	5.1	14.3	4.3	36	8.1	5.8	7.1	12.2
2006-14	784.0	61.0	Shale	4.4	4.4	15.3	10.7	39	7.2	5.8	7.4	11.8

Notes:
1. Approximate overburden pressure is calculated based on an average unit weight of 145 pcf.
2. Three separate specimens from about the same elevation range were used for a 3 point test.
3. $q=(\sigma_1-\sigma_3)/2$, $p=(\sigma_1+\sigma_3)/2$.

TABLE 6

Summary of Unconsolidated-Undrained Triaxial Test Results

Sample No.	Elevation (ft)	Depth (ft)	Material Type	L/D Ratio	Confining[1] Pressure, σ_3 (tsf)	Axial Stress at Failure, σ_1 (tsf)	Deviator Stress at Failure, σ_1-σ_3 (tsf)	Axial Failure Strain, ε_{af} (%)	Failure Plane Stresses (for C=0)		$q = \frac{\sigma_1 - \sigma_3}{2}$ (tsf)	$p = \frac{\sigma_1 + \sigma_3}{2}$ (tsf)
									Normal Stress, σ_n (tsf)	Shear Strength, s (tsf)		
Peak Strength												
1000-46	568.7	282.3	Sandstone	1.9	20.5	70.5	50.0	1.5	31.8	20.9	25.0	45.5
1002-09	812.8	31.9	Limestone	2.1	2.3	206.6	204.3	0.7	4.5	21.3	102.1	104.4
1003-15	793.4	68.3	Shale	2.0	4.9	46.0	41.1	1.6	8.9	12.1	20.5	25.5
1004-41	674.2	185.5	Limestone	2.0	13.5	409.7	396.2	1.0	26.2	69.6	198.1	211.6
1005-15	797.5	59.5	Shale	1.8	4.3	26.0	21.7	2.5	7.4	7.6	10.9	15.2
1005-20	772.5	84.5	Limestone	2.2	6.1	501.1	495.0	0.9	12.1	54.0	247.5	253.6
1032-12	824.0	43.3	Limestone	1.7	3.1	569.5[2]	566.4	1.1	3.1	20.9	284.8	287.9
2000-5	802.3	41.7	Shale	2.0	3.0	7.2	4.2	13.8	4.2	1.9	2.1	5.1
2005-08	816.7	32.3	Limestone	2.1	2.4	500.1	497.7	1.2	4.7	34.3	249.0	251.3
2036-06	809.2	23.8	Limestone	2.4	2.1	220.8	218.7	0.7	4.1	21.1	109.4	111.5
2036-12	775.9	57.1	Shale	2.5	4.1	17.3	13.2	1.7	6.6	5.2	6.6	10.7
Ultimate Strength												
1000-46	568.7	282.3	Sandstone	1.9	20.5	29.6	9.1	4.9	24.2	4.5	4.6	25.1
1003-15	793.4	68.3	Shale	2.0	4.9	28.8	23.9	3.8	8.3	8.7	12.8	17.7
1005-15	797.5	59.5	Shale	1.8	4.3	20.0	15.7	4.7	7.1	6.0	7.8	12.1
2036-12	775.9	57.1	Shale	2.5	4.1	11.0	6.9	10.2	6.0	3.0	3.4	7.5

Notes:
1. Confining pressure values are approximately the same as effective overburden pressure values.
2. Sample did not fail.

TABLE 7 (Sheet 1 of 2)

SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Diametral				Axial				Strength Correlation Factors[1]
				Failure Load (lb)	PLI (psi)	Corrected PLI I_{S50} (tsf)	Estimated Uniaxial Comp. Strength q_{ud} (tsf)	Failure Load (lb)	PLI (psi)	Corrected PLI I_{S50} (tsf)	Estimated Uniaxial Comp. Strength q_{ua} (tsf)	
1000-10	813.6	37.4	Limestone	1065	188.0	14.7	144	1495	359.2	26.3	257	10
1000-17	778.4	72.6	Limestone	1121	196.9	15.5	210	1670	332.5	25.3	344	14
1000-18	772.5	78.5	Limestone	948	164.8	13.0	176	460	88.6	6.8	92	14
1000-23	748.2	102.8	Limestone	91	33.0	2.2	30	54	9.5	0.7	10	14
1000-34	686.0	165.0	Limestone	95	17.0	1.3	15	751	67.0	6.1	73	12
1000-52	457.2	393.8	Sandstone	120	22.0	1.7	35	386	90.0	6.6	136	20
1002-20	757.7	87.3	Limestone	2154	345.3	27.7	375	2128	536.7	38.8	527	14
1003-11	812.8	49.2	Limestone	1613	260.7	20.9	204	2045	430.0	32.4	317	10
1003-off-35	701.6	160.1	Limestone	1276	207.0	16.6	198	1227	220.0	17.2	206	12
1004-53	579.7	280.0	Sandstone	--	--	--	--	26	4.2	0.3	7	20
1006-10	808.2	39.8	Limestone	229	38.0	3.0	30	757	187.8	13.6	133	10
1008-17	774.3	69.7	Limestone	709	118.5	9.4	128	1611	284.8	22.3	303	14
1010-09	828.9	33.1	Limestone	--	--	--	--	2460	520.7	39.2	383	10
1010-22	826.0	35.4	Limestone	2702	471.8	37.1	363	3537	473.5	39.5	386	10
1032-15	806.5	60.5	Limestone	1627	270.1	21.5	210	3186	944.7	65.9	644	10
1033-09	828.0	39.0	Limestone	1723	285.4	22.7	222	2008	352.6	27.7	271	10
1037-14	775.7	78.3	Limestone	398	64.8	5.2	70	487	106.7	8.0	108	14
1038-13	798.7	44.3	Limestone	719	125.6	9.9	97	1457	389.4	27.8	272	10
1041-16	772.7	72.6	Limestone	417	67.7	5.4	73	330	51.0	4.1	56	14
1042-09	817.8	28.2	Limestone	1841	304.9	24.3	237	1738	325.4	25.2	246	10
1042-12	802.3	43.7	Limestone	109	17.6	1.4	14	--	--	--	--	10
2000-29	684.0	160.0	Limestone	666	107.0	8.6	102	1129	221.0	16.9	202	12
2000-31	676.1	167.9	Limestone	1488	242.0	19.2	230	1049	274.0	19.7	235	12
2000-33	663.6	180.4	Limestone	1801	289.3	23.2	277	2337	734.9	50.6	605	12
2000-34	657.8	186.2	Limestone	1798	290.9	23.3	278	1386	256.0	19.9	238	12
2001-09	779.3	58.7	Limestone	240	41.9	3.3	45	1077	269.9	19.6	265	14
2002-13	768.4	68.8	Limestone	1417	226.5	18.2	246	2058	310.5	25.2	342	14
2006-19	759.8	85.2	Limestone	977	156.6	12.5	170	1124	227.5	17.3	235	14

TABLE 7 (Sheet 2 of 2)

SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Diametral				Axial				Strength Correlation Factors[1]
				Failure Load (lb)	PLI (psi)	Corrected PLI I_{s50} (tsf)	Estimated Uniaxial Comp. Strength q_{ud} (tsf)	Failure Load (lb)	PLI (psi)	Corrected PLI I_{s50} (tsf)	Estimated Uniaxial Comp. Strength q_{ua} (tsf)	
2007-15	780.1	61.0	Limestone	3364	547.5	43.7	523	2886	478.8	38.1	455	8
2007-19	756.5	84.8	Limestone	355	57.8	4.6	63	410	66.8	5.3	72	14
2030-15	768.0	84.6	Limestone	754	131.7	10.4	140	1024	172.6	13.7	186	14
2031-10	816.7	36.3	Limestone	1308	210.2	16.8	165	2685	487.4	38.0	371	10
2031-19	770.1	83.0	Limestone	1745	281.7	22.5	306	1388	228.1	18.2	247	14
2033-19	777.1	72.9	Limestone	701	220.9	15.2	206	1144	217.9	16.8	228	14
2034-20	759.4	79.6	Limestone	1121	197.6	15.5	210	2393	557.5	41.1	557	14
2034-22	750.9	88.1	Limestone	780	138.2	10.8	147	1394	391.5	27.7	375	14
2035-14	774.0	55.8	Limestone	441	72.8	5.8	79	1319	204.8	16.5	224	14
2036-14	768.5	64.5	Limestone	809	214.2	15.3	208	516	119.8	8.8	120	14
2037-15	777.1	59.4	Limestone	1646	283.6	22.4	303	2006	294.0	24.0	326	14
2037-19	757.0	79.5	Limestone	816	141.8	11.2	151	1388	190.7	15.8	215	14
2041a-09	801.5	30.5	Limestone	1301	208.1	16.7	163	2307	353.1	28.6	280	10
2041a-20	745.4	86.7	Limestone	1660	267.3	21.4	290	2282	817.3	54.7	742	14
2042a-23	738.1	92.6	Limestone	462	81.2	6.4	86	1359	213.0	17.2	233	14

Statistical Summary (Mean ± Stdev [Count])									
Limestone	1112±726[40]	190±118[40]	15±9.4[40]	180±109[40]	1552±809[40]	319±204[40]	24±14.3[40]	284±163[40]	12.4±1.9[41]
Sandstone	120± - [1]	22± - [1]	1.7± - [1]	35± - [1]	206± - [2]	47± - [2]	3.5± - [2]	72± - [2]	20± - [2]

Notes: 1. Strength Correlation Factor was used to correlate both, diametral and axial unconfined compressive strength

TABLE 8

SUMMARY OF DIRECT SHEAR TEST RESULTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Effective Normal Stress (tsf)	Peak	Ultimate	Ultimate	
					Effective Shear Stress (tsf)	Effective Shear Stress (tsf)	Effective Cohesion (tsf)	Effective Friction Angle (degree)
1042-15b	787.1	59.4	Shale	2.2	8.3	2.6	1.40	29
				4.3	7.8	4.1		
				8.7	15.0	-		
1043-07	793.2	31.3	Shale	1.3	3.5	2.5	1.10	33
				2.6	2.7	2.3		
				5.2	4.5	4.5		
1048-14	783.3	52.5	Shale	1.7	1.4	1.2	0.80	14
				3.4	1.8	1.7		
				6.8	2.6	2.5		
1058-12	796.8	48.4	Shale	1.8	5.1	1.3	0.20	34
				3.5	2.9	2.7		
				7.0	4.9	4.9		
2000-8	815.2	28.8	Shale	1.1	1.9	0.5	0.24	15
				2.1	0.9	0.8		
				4.2	1.3	1.3		
2001C-2	809.0	28.9	Shale	1.1	1.3	0.6	0.10	26
				2.1	1.2	1.1		
				4.2	2.6	2.1		
2051-4	794.0	16.0	Shale	1.3	1.1	0.7	0.10	22
				2.6	1.0	0.9		
				5.2	2.2	2.1		

TABLE 9

SUMMARY OF ONE-DIMENSIONAL CONSOLIDATION TEST RESULTS

Sample No.	Sample Elevation (ft)	Sample Depth (ft)	Material Type (USCS)	Moisture Content (%)	Liquid Limit, LL (%)	Plastic Limit, PL (%)	Plastic Index, PI
1000-15	791.6	63.0	Shale (CL)	13.7	40	16	24
1004-12	820.0	40.0	Shale (CL)	18.4	45	17	28
1005-18	783.1	54.0	Shale (CL)	12.4	46	17	29
2003-07	793.9	47.2	Shale (CL)	13.6	46	16	30
2006-07	819.6	25.4	Shale (CL)	17.5	43	17	26

Sample No.	Effective Overburden Pressure, σ'_o (tsf)	Preconsolidation Pressure, σ'_p (tsf)	Approximate Overconsolidation Ratio, OCR	Compression Ratio, $C_{c\varepsilon}$	Recompression Ratio, $C_{r\varepsilon}$	Coefficient of Consolidation, C_v (in^2/day)
1000-15	4.8	13.0	2.7	0.065	0.025	4 to 106
1004-12	3.0	5.5	1.8	0.070	0.040	2 to 30
1005-18	5.6	21.0	3.8	0.060	0.030	2 to 93
2003-07	3.5	7.0	2.0	0.045	0.025	4 to 98
2006-07	1.9	4.5	2.4	0.065	0.035	4 to 212

Notes:

1. $C_{c\varepsilon} = C_c/(1+e_o)$, and $C_{r\varepsilon} = C_r/(1+e_o)$ where C_c and C_r are compression index and recompression index, respectively.
2. Lower and upper value of coefficient of consolidation values (C_v) correspond to higher and lower loads, respectively.

TABLE 10

SUMMARY OF ONE-DIMENSIONAL SWELL TEST RESULTS

Sample No.	Sample Elevation (ft)	Sample Depth (ft)	Material Type (USCS)	Liquid Limit, LL (%)	Plastic Limit, PL (%)	Plasticity Index, PI	Moisture Content (%)	
							Initial	Final
1002-10	809.3	35.4	Shale (CH)	69	24	45	13.4	15.3
1005-17	788.2	68.8	Shale (CL)	46	19	27	17.2	19.2
1033-07	838.2	28.8	Shale (CL)	27	13	14	9.9	12.1
1037-12	784.8	68.0	Shale (CH)	56	21	35	16.3	20.1
1041-11	796.3	49.0	Shale (CH)	56	23	33	18.1	20.9
2004-06	829.8	20.2	Shale (CL)	33	15	18	12.0	12.8
2036-07	806.7	26.3	Shale (CL)	48	22	26	16.7	18.0
2036-10	790.7	42.3	Shale (CL)	45	16	29	14.4	15.8
2042-11	793.9	37.1	Shale (CH)	55	23	32	20.3	23.5

Sample No.	Degree of Saturation (%)		Effective Overburden Pressure, σ'_v (tsf)	Inundation Pressure (ksf)	Estimated Swell Pressure (ksf)	Estimated Heave[1] (%)
	Initial	Final				
1002-10	89.6	97.4	5.1	4.0	19	1.3
1005-17	93.1	99.7	10.0	8.0	13	0.7
1033-07	72.9	88.8	4.2	4.0	4	NA
1037-12	82.0	98.4	10.0	8.0	25	2.0
1041-11	91.3	98.3	7.1	6.0	11	1.0
2004-06	92.0	99.8	3.0	2.5	11	0.5
2036-07	91.5	95.6	3.8	3.0	32	2.2
2036-10	85.4	94.8	6.1	5.0	18	1.2
2042-11	84.5	96.6	5.1	4.5	12	0.8

Notes:
1. Estimated heave at inundation pressure.

TABLE 11 (Sheet 1 of 3)

SUMMARY OF LABORATORY-BASED SHEAR WAVE VELOCITY MEASUREMENTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Shear Wave Velocity (fps)
1000-51	475.3	375.7	Sandstone	3,129
1002-09	812.8	31.9	Limestone	6,156
1002-29	714.3	130.4	Shale	8,153
1003-off-13	815.3	46.4	Limestone	11,143
1003-off-16	799.9	62.1	Shale	3,886
1004-13	814.2	45.5	Limestone	4,523
1004-33	715.6	144.1	Shale	2,325
1004-38	684.1	175.6	Limestone	6,238
1004-46	651.0	209.0	Shale	7,975
1004-54	569.7	290.0	Sandstone	2,166
1005-09	828.0	29.0	Limestone	9,223
1005-12	812.2	44.8	Limestone	6,476
1005-20	772.5	84.5	Limestone	7,892
1007-11	801.3	42.3	Limestone	7,824
1009-I-09	797.0	60.2	Limestone	6,699
1012-11	785.0	59.0	Shale	3,858
1012-22	730.0	114.0	Limestone	12,641
1012-27	705.0	139.0	Shale	6,700
1012-28	700.0	144.0	Limestone	7,840
1012-33	660.0	184.0	Limestone	14,383
1012-37	615.0	229.0	Sandstone	2,114
1013 @ 55.5'	808.0	55.5	Limestone	5,785
1013-12	805.3	58.2	Limestone	7,661
1013-19	772.1	91.4	Limestone	6,879
1014-17	777.5	73.7	Limestone	6,643
1014-21	756.9	94.3	Limestone	8,591
1030-11	826.6	32.0	Limestone	8,988
1030-13	815.6	43.0	Limestone	6,955
1030-22	771.0	87.6	Limestone	6,264
1031-14	803.8	60.4	Limestone	6,954
1032-12	824.0	43.3	Limestone	9,522
1032-22	773.6	93.7	Limestone	7,019
1033-12	813.3	53.6	Limestone	7,226
1034-10	827.8	33.2	Limestone	6,141
1034-18	785.1	73.4	Limestone	6,711
1034-21	768.9	89.6	Limestone	10,819
1035-07	831.5	24.6	Limestone	4,813
1035-17	781.7	74.4	Limestone	7,945

TABLE 11 (Sheet 2 of 3)

SUMMARY OF LABORATORY-BASED SHEAR WAVE VELOCITY MEASUREMENTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Shear Wave Velocity (fps)
1035-20	767.4	88.7	Limestone	8,683
1037-05	818.2	34.6	Limestone	4,813
1037-17	757.9	94.9	Limestone	5,830
1038-10	814.4	28.6	Limestone	5,322
1038-17	781.1	62.4	Limestone	6,331
1038-24	745.7	97.8	Limestone	6,382
1041-09	807.3	38.0	Limestone	5,295
1041-17	766.8	78.2	Limestone	6,146
1041-20	752.3	93.0	Limestone	6,515
1042-15d	784.5	61.9	Shale	1,982
1042-19	765.6	80.9	Limestone	6,553
2001-09	779.3	58.7	Limestone	6,317
2001-10	772.1	65.8	Limestone	6,290
2002-22	720.2	116.8	Shale	4,886
2002-23	716.0	121.0	Limestone	7,320
2002-31	675.1	161.9	Limestone	7,767
2002-39	638.4	198.8	Shale	8,603
2002-60	538.7	298.3	Sandstone	5,766
2003-04	808.0	33.0	Limestone	14,241
2003-08	790.3	50.7	Shale	6,590
2004-14	792.2	57.8	Shale	2,081
2004-15	786.6	63.4	Shale	2,471
2004-25	735.8	114.7	Shale	5,059
2005-11	799.1	49.6	Limestone	7,287
2007-13	786.3	54.9	Limestone	7,504
2012 @ 69'	778.6	69.0	Limestone	10,281
2014 @ 43.6'	797.1	43.6	Limestone	7,517
2029-12	789.0	54.6	Shale	1,516
2030-07	806.9	45.1	Shale	6,708
2030-08	801.9	50.7	Limestone	6,241
2030-11	789.2	63.4	Limestone	5,023
2030-17	759.1	93.5	Limestone	4,890
2031-11	810.2	42.9	Limestone	5,906
2033-12	814.0	36.7	Limestone	11,510
2035-21	739.5	90.3	Limestone	5,201
2036-06	809.2	23.8	Limestone	7,259
2036-13	774.6	57.8	Limestone	7,037
2037-10	799.8	36.7	Limestone	9,140

TABLE 11 (Sheet 3 of 3)

SUMMARY OF LABORATORY-BASED SHEAR WAVE VELOCITY MEASUREMENTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Shear Wave Velocity (fps)
2037-23	737.2	99.3	Limestone	4,485
2038-13	767.1	69.9	Limestone	5,058
2041a-15	768.5	63.3	Limestone	4,135
2042a-09	807.1	23.6	Limestone	6,880
2042a-15	778.8	51.9	Limestone	8,495

Statistical Summary

	Material Type	Shear Wave Velocity (fps)
Average	Shale	2,588
	Limestone	7,261
	Sandstone	3,294
Minimum	Shale	1,516
	Limestone	4,135
	Sandstone	2,114
Maximum	Shale	3,886
	Limestone	14,383
	Sandstone	5,766
Standard Deviation	Shale	858
	Limestone	2,086
	Sandstone	1,484

TABLE 12

SUMMARY OF CALCIUM CARBONATE TEST RESULTS

Boring No.	Sample No.	Elevation[1] (ft)	Depth (ft)	Material Type	Calcium Carbonate, $CaCO_3$ (%)
1012	1012-17	755.0	89.0	Limestone	90
1030	1030-11	826.6	32.0	Limestone	86
1032	1032-15	806.8	60.5	Limestone	91
2000	2000-01	824.8	19.2	Limestone	100
2000	2000-02	817.1	26.9	Shale	72
2000	2000-03	813.3	30.7	Limestone	56
2000	2000-13	763.7	80.3	Limestone	75
2000	2000-17	742.1	101.8	Limestone	76
2000	2000-19	732.9	111.1	Shale	77
2000	2000-22	718.5	125.5	Limestone	96
2000	2000-24	708.0	136.0	Shale	36
2000	2000-25	704.2	139.8	Limestone	94
2000	2000-28	688.8	155.2	Limestone	77
2000	2000-32	668.2	175.8	Limestone	95
2000	2000-34	657.8	186.2	Limestone	84
2000	2000-35	652.7	191.3	Shale	17
2000	2000-36	647.3	196.7	Shale	4
2000	2000-40	628.7	215.3	Shale	49
2000	2000-43	614.8	229.2	Sandstone	2
2000	2000-52	568.5	275.5	Sandstone	1
2000	2000-60	529.7	314.3	Sandstone	0
2000	2000-64	508.8	335.2	Sandstone	7
2000	2000-76	448.9	395.1	Shale	3
2002	2002-16	750.6	86.4	Limestone	83
2002	2002-23	716.0	121.0	Limestone	89
2003	2003-06	798.5	42.5	Limestone	82
2004	2004-16	779.1	70.9	Limestone	74
2041A	2041A-09	801.5	30.5	Limestone	94

Statistical Summary (Mean ± Stdev [Count])	
Shale	36.9 ± 30.6 [7]
Limestone	84.9 ± 10.9 [17]
Sandstone	2.5 ± 3.1 [4]

Notes: 1. Coordinate System: US State Plane 1983
Zone: Texas North Central 4202
Vertical Datum: NAVD88

TABLE 13 (Sheet 1 of 2)

SUMMARY OF PETROGRAPHIC AND PHOTOMICROGRAPHIC ANALYSIS

Boring No. or Location	Sample No.	Elevation[1] (ft)	Depth (ft)	Material Description	Minerals (%)						
					Quartz	Feldspar	Calcite	Dolomite	Clay	Opaques	Others
1012	1012-49	393.6	450.5	Sandstone	85		15				
1012	HS-1	828.0	16.0	Limestone			99			1	< 1
1012	HS-2	822.7	21.3	Limestone	5			88		5	2
1012	HS-3	816.2	27.8	Limestone	2		93			5	
1012	HS-4	799.5	44.5	Limestone	3		45	40	6	6	
1012	HS-5	790.9	53.1	Shale	20			12	58	10	
1012	HS-6	717.3	126.8	Limestone	4		92		2	2	
1012	HS-7	685.4	158.6	Limestone	2		90		2	6	
1012	HS-8	725.8	118.2	Limestone	5		45	45	1	4	< 1
1012	HS-9	637.4	206.7	Limestone	8		20	62		8	2
1012	HS-10	579.7	264.3	Sandstone	60				35	5	< 1
1012	HS-11	534.3	309.7	Sandstone	50				45	5	< 1
1012	HS-12	508.6	335.4	Shale	35			35	24	3	3
1012	HS-13	477.8	366.3	Shale	15				81	2	2
1012	HS-14	462.4	381.7	Sandstone	41	20		20	15	3	1
1012	HS-15	404.2	439.8	Sandstone	70	10		2	15		3
1012	HS-16	394.3	449.7	Sandstone	60	3		37			< 1
1012	HS-17	391.3	452.7	Sandstone	65	< 1		35			< 1
1012	HS-18	384.6	459.4	Shale	30		30	1	30		9
1012	HS-19	349.8	494.2	Sandstone	67	18			15		< 1
1012	HS-20	322.4	521.7	Shale	40				54	2	4
1012	HS-21	297.2	546.8	Shale	30				64	2	4
1031	1031-10	826.5	37.8	Limestone	10		63	20		6	1
1031	1031-16	795.5	68.7	Shale	20			15	55	10	
1032	1032-19	788.5	78.8	Shale	30			20	43	7	

TABLE 13 (Sheet 2 of 2)

SUMMARY OF PETROGRAPHIC AND PHOTOMICROGRAPHIC ANALYSIS

Boring No. or Location	Sample No.	Elevation[1] (ft)	Depth (ft)	Material Description	Minerals (%)						
					Quartz	Feldspar	Calcite	Dolomite	Clay	Opaques	Others
1035	1035-12	806.6	49.5	Limestone	3		87		5	5	< 1
1037	1037-18	754.2	98.6	Limestone	3		78		15	3	1
1041	1041-27	716.3	129.0	Shale	10		2		81	7	
2002	2002-06	802.6	34.6	Shale	15		5		77	3	
2004	2004-07	828.0	22.5	Shale	26			35	35	4	
2004	2004-12	803.3	47.2	Limestone	15		75		5	4	1
2031	2031-15	791.1	62.0	Shale	50			30	13	5	2
2034	2034-09	810.1	29.0	Limestone	2		89		7	2	
2034	2034-23	745.2	93.9	Limestone	3		86		5	6	
2038	2038-09	786.1	50.9	Limestone	20		51	5	15	6	3
STA 34[2]	HS-22	Note 2	NA[2]	Limestone			98			< 1	2
STA 38[3]	HS-23	Note 3	NA[3]	Limestone	3		79	15		3	
STA 42-A[4]	HS-24	Note 4	NA[4]	Sandstone	80	10			10		< 1
STA 42-A[4]	HS-25	Note 4	NA[4]	Sandstone	75	10					15

Statistical Summary (Mean ± **Stdev [Count]**)							
Shale	26.8±11.5[12]	--	3.1±8.6[12]	12.3±14.4[12]	51.3±22.7[12]	4.6±3.3[12]	2.0±2.7[12]
Limestone	5.2±5.3[17]	--	70.0±28.7[17]	16.2±26.7[17]	3.7±4.9[17]	4.2±2.1[17]	0.7±1.0[17]
Sandstone	65.3±13.4[10]	7.1±7.7[10]	1.5±4.7[10]	9.4±15.3[10]	13.5±15.6[10]	1.3±2.2[10]	1.9±4.7[10]

Notes:

1. Coordinate System: US State Plane 1983
   Zone: Texas North Central 4202
   Vertical Datum: NAVD88
2. STA 34: N32.29319, W097.80386; El. 800+/-13.2 ft (Garmin GPSmap 60X, Coordinate System: NAD27 CONUS)
3. STA 38: N32.29676, W097.79382; El. 813+/-13.9 ft (Garmin GPSmap 60X, Coordinate System: NAD27 CONUS)
4. STA 42-A: N32.30403, W097.84562; El. 1001+/-17.8 ft (Garmin GPSmap 60X, Coordinate System: NAD27 CONUS)

TABLE 14 (Sheet 1 of 2)

SUMMARY OF X-RAY DIFFRACTION ANALYSIS

Results of X-Ray Analysis on Clay-Size Fraction (< 2 µm) of Samples

Boring No.	Sample No.	Elevation[1] (ft)	Depth (ft)	Material Description	Minerals (%)				
					Expandable Illite / Smectite	Expandable Smectite	Illite	Chlorite	Kaolinite
1012	1012-49	393.6	450.5	Sandstone	5		40	10	45
1031	1031-10	826.5	37.8	Limestone	10		80		10
1031	1031-16	795.5	68.7	Shale	5		60	5	30
1032	1032-19	788.5	78.8	Shale	10		75		15
1035	1035-12	806.6	49.5	Limestone	10		85		5
1037	1037-18	754.2	98.6	Limestone	15		75		10
1041	1041-27	716.3	129.0	Shale		30	55		15
2002	2002-06R	802.6	34.6	Shale	10		80		10
2004	2004-07	828.0	22.5	Shale	10		85		5
2004	2004-12	803.3	47.2	Limestone	10		85		5
2031	2031-15	791.1	62.0	Shale	5		70	5	20
2034	2034-09	810.1	29.0	Limestone	10		90		
2034	2034-23	745.2	93.9	Limestone	10		80		10
2038	2038-09	786.1	50.9	Limestone	5		80		15

Statistical Summary (Mean ± Stdev [Count])					
Shale	6.7±4.1[6]	5.0±12.3[6]	70.1±11.6[6]	1.7±2.6[6]	15.8±8.6[6]
Limestone	10.0±2.9[7]	--	82.1±4.9[7]	--	7.9±4.9[7]
Sandstone	--	--	--	--	--

Notes: 1. Coordinate System: US State Plane 1983
Zone: Texas North Central 4202
Vertical Datum: NAVD88

TABLE 14 (Sheet 2 of 2)

SUMMARY OF X-RAY DIFFRACTION ANALYSIS

Results of X-Ray Analysis on Bulk Samples

Boring No.	Sample No.	Elevation[1] (ft)	Depth (ft)	Material Type	Minerals (%)							
					Quartz	Calcite	Ankerite	Dolomite	Phyllo-Silicates	Pyrite	Sanidine	Albite
1012	1012-49	393.6	450.5	Sandstone	65	30			5			
1031	1031-10	826.5	37.8	Limestone	5	74	13		8			
1031	1031-16	795.5	68.7	Shale	42	3	6		44	2	1	2
1032	1032-19	788.5	78.8	Shale	36		10		47		4	4
1035	1035-12	806.6	49.5	Limestone	3	92			5			
1037	1037-18	754.2	98.6	Limestone	9	85			6			
1041	1041-27	716.3	129.0	Shale	19				76		2	2
2002	2002-06R	802.6	34.6	Shale	18				82			
2004	2004-07	828.0	22.5	Shale	38	1	16		40			
2004	2004-12	803.3	47.2	Limestone	5	89			6			
2031	2031-15	791.1	62.0	Shale	65	1		26	8			
2034	2034-09	810.1	29.0	Limestone	2	92			5			
2034	2034-23	745.2	93.9	Limestone	4	83	4		9			
2038	2038-09	786.1	50.9	Limestone	21	67	3		8	1		

Statistical Summary (Mean ± Stdev [Count])								
Shale	36.3±17.3[6]	0.8±1.2[6]	5.3±6.6[6]	4.3±10.6[6]	49.5±26.9[6]	0.3±0.8[6]	1.2±1.6[6]	1.3±1.6[6]
Limestone	7.0±6.6[7]	83.1±9.5[7]	2.9±4.8[7]	--	6.7±1.6[7]	0.14±0.4[7]	--	--
Sandstone	--	--	--	--	--	--	--	--

Notes: 1. Coordinate System: US State Plane 1983
Zone: Texas North Central 4202
Vertical Datum: NAVD88

TABLE 15

SUMMARY OF ORGANIC CONTENT TEST RESULTS

Sample No.	Elevation (ft)	Depth (ft)	Material Type	Organic Content (%)
2001-off-1	835.4	2.5	Soil	1.9
2001-off-3	830.4	7.5	Soil	2.6

TABLE 16
SUMMARY OF INDEX PROPERTIES STATISTICAL DATA

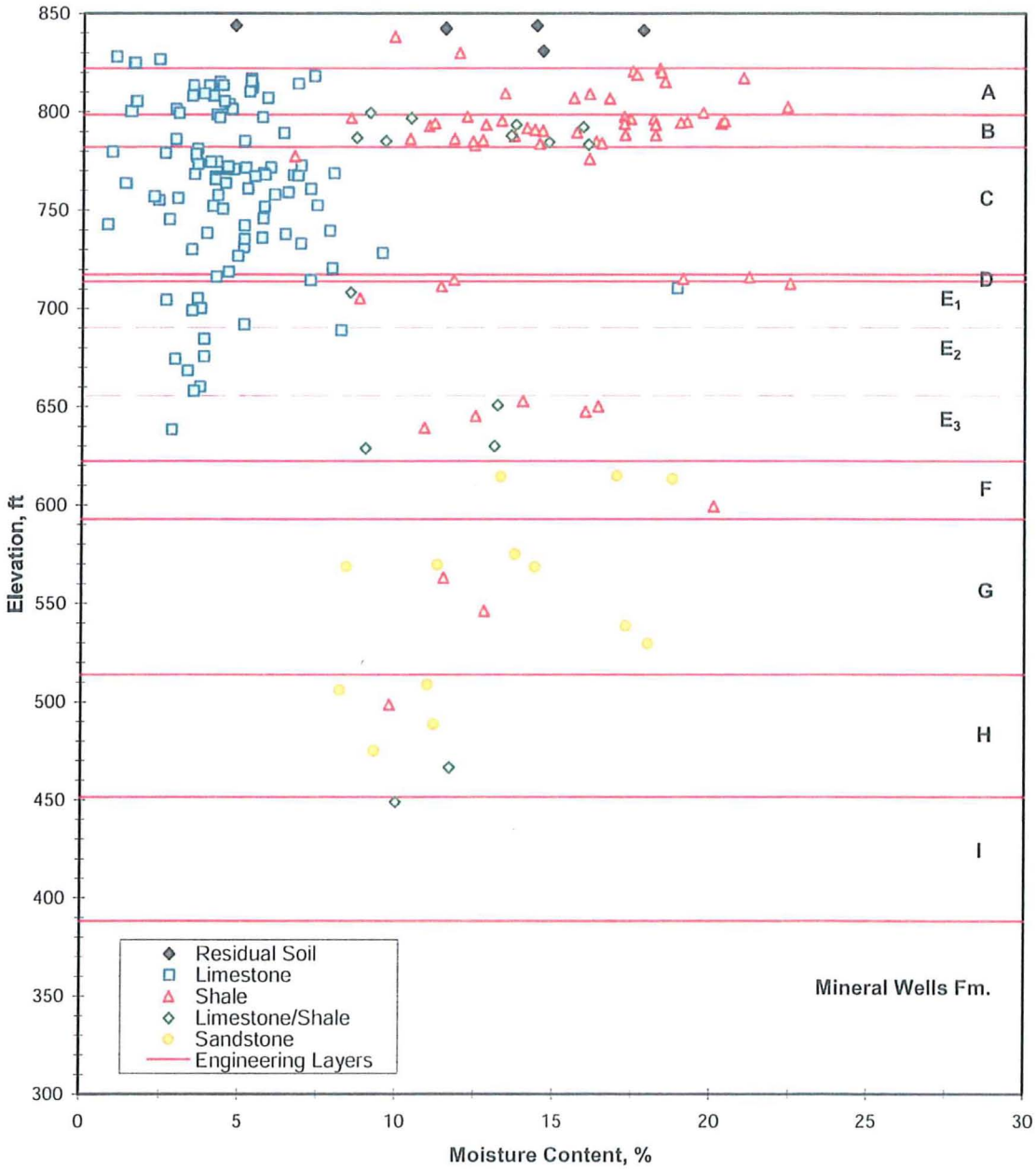
Material Type/ Engineering Layer	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits	
				Liquid Limit (%)	Plasticity Index (%)
	Mean ± Stdev [Count]	Mean ± Stdev [Count]	Mean ± Stdev [Count]	Mean ± Stdev [Count]	Mean ± Stdev [Count]
Residual Soil	14.5 ± 5.0 [8]	-	-	36 ± 10 [18]	21 ± 10 [18]
Shale	15.0 ± 3.9 [63]	137.3 ± 8.8 [63]	119.8 ± 10.9 [63]	46 ± 11 [32]	28 ± 8 [32]
Limestone	4.7 ± 2.2 [100]	155.9 ± 4.4 [109]	149.0 ± 6.0 [99]	-	-
Limestone/Shale	11.8 ± 2.6 [15]	141.8 ± 5.4 [15]	126.9 ± 6.8 [15]	-	-
Sandstone	13.2 ± 3.5 [13]	135.9 ± 7.4 [12]	120.5 ± 10.1 [12]	-	-
Layer A	8.8 ± 6.6 [37]	149.1 ± 12.8 [40]	136.7 ± 18.9 [36]	45 ± 12 [9]	26 ± 8 [9]
Layer B	13.1 ± 4.6 [46]	139.6 ± 8.8 [46]	124.0 ± 13.0 [46]	46 ± 6 [18]	29 ± 5 [18]
Layer C	5.1 ± 2.3 [56]	155.0 ± 5.0 [62]	147.8 ± 6.6 [46]	35 ± 11 [3]	21 ± 7 [3]
Layer D	13.9 ± 6.6 [7]	146.7 ± 12.6 [7]	129.5 ± 15.6 [7]	68 ± 3 [2]	46 ± 3 [2]
Layer E	8.0 ± 5.1 [24]	150.6 ± 8.8 [24]	140.1 ± 13.9 [24]	-	-
Layer F	17.3 ± 2.6 [4]	130.2 ± 3.4 [4]	111.1 ± 4.5 [4]	-	-
Layer G	13.2 ± 2.9 [9]	134.0 ± 5.2 [8]	118.7 ± 7.4 [8]	-	-
Layer H	10.0 ± 1.2 [6]	144.3 ± 3.3 [6]	131.1 ± 3.9 [6]	-	-
Layer I	6.5 ± 1.0 [2]	154.7 ± 0.5 [2]	145.3 ± 0.9 [2]	-	-

TABLE 17

SUMMARY OF STRENGTH PROPERTIES WITH STATISTICAL DATA

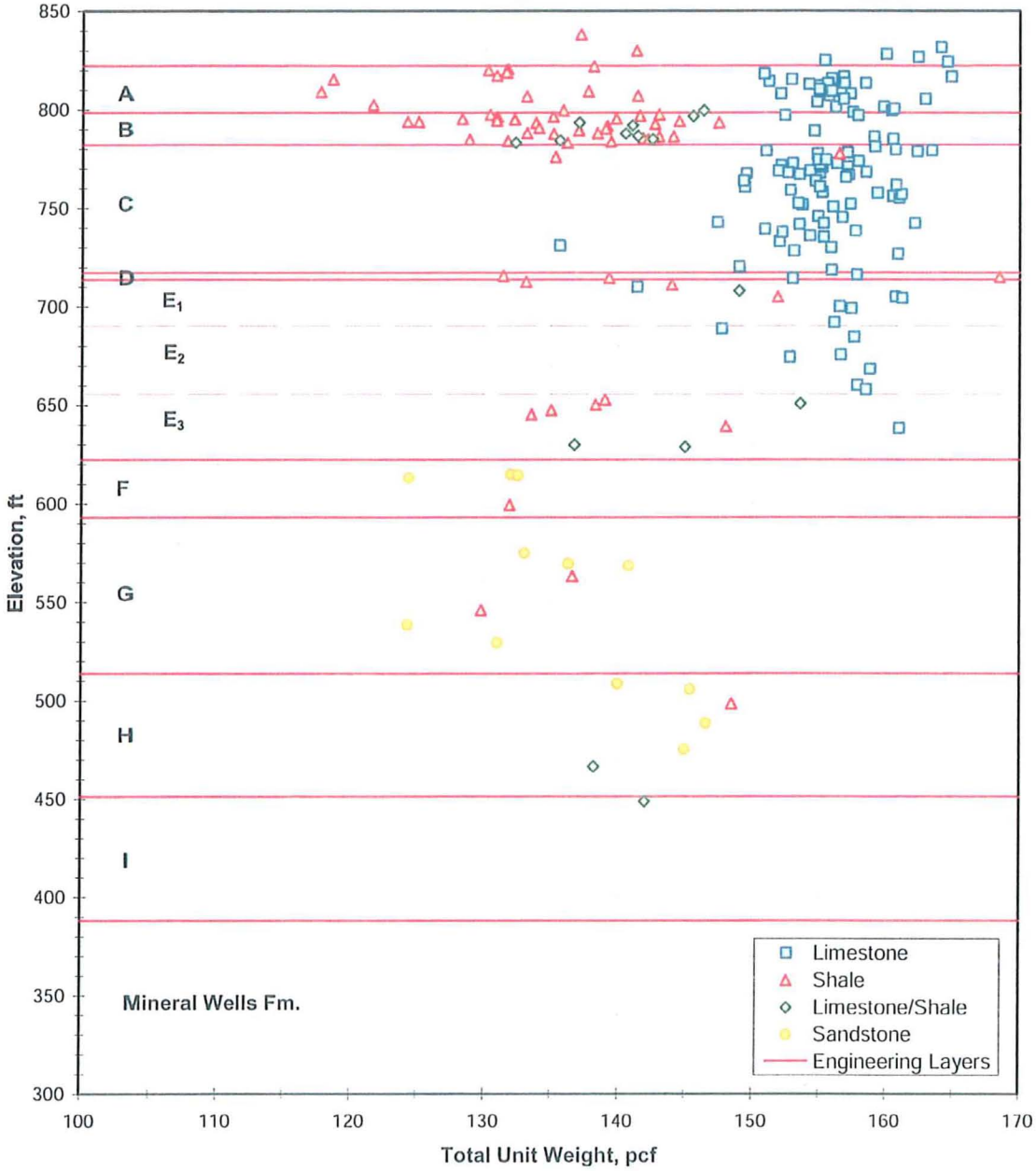
Material Type / Geologic Layer	Primary Lithology	Compressive Strength[1] (tsf) Mean ± Stdev [Count]						
		Unconfined Compression Test	Point Load Index Test		CU Triaxial Compression Test		UU Triaxial Compression Test	
			Axial	Diametral	Peak	Ultimate	Peak	Ultimate
Shale	Shale	75 ± 36 [4]	--	-	27 ± 20 [33]	15 ± 8 [16]	20 ± 14 [4]	16 ± 7 [3]
Limestone	Limestone	299 ± 149 [59]	285 ± 161 [40]	180 ± 108 [40]	361 ± 177 [7]	--	396 ± 140 [6]	--
Sandstone	Sandstone	10 ± -- [1]	71 ± 64 [2]	35 ± -- [1]	82 ± 26 [6]	--	50 ± -- [1]	9 ± -- [1]
Layer A	Limestone	281 ± 129 [11]	324 ± 123 [11]	168 ± 94 [11]	18 ± 6 [3]	--	298 ± 206 [5]	--
Layer B	Shale	291 ± 229 [7]	455 ± -- [1]	523 ± -- [1]	22 ± 14 [22]	14 ± 8 [14]	31 ± 10 [2]	20 ± 4 [2]
Layer C	Limestone	290 ± 153 [39]	264 ± 171 [22]	169 ± 93 [22]	337 ± 202 [7]	--	254 ± 241 [2]	7 ± -- [1]
Layer D	Shale	--	--	--	--	--	--	--
Layer E	Limestone	251 ± 69 [6]	260 ± 164 [6]	184 ± 96 [6]	94 ± 86 [4]	32 ± -- [1]	396 ± -- [1]	--
Layer F	Limestone with Shale and Sand interbeds	--	--	--	67 ± 23 [7]	17 ± -- [1]	--	--
Layer G	Sandstone	10 ± -- [1]	7 ± -- [1]	--	--	-	50 ± -- [1]	9 ± -- [1]
Layer H	Shale	-	136 ± -- [1]	35 ± -- [1]	77 ± 41 [3]	--	--	
Layer I	Sandstone	-	-	-	--	--	--	

Notes: 1. The compressive strength is in terms of uniaxial stress for unconfined compression and point load index tests, and in terms of deviator stress for CU and UU tests.



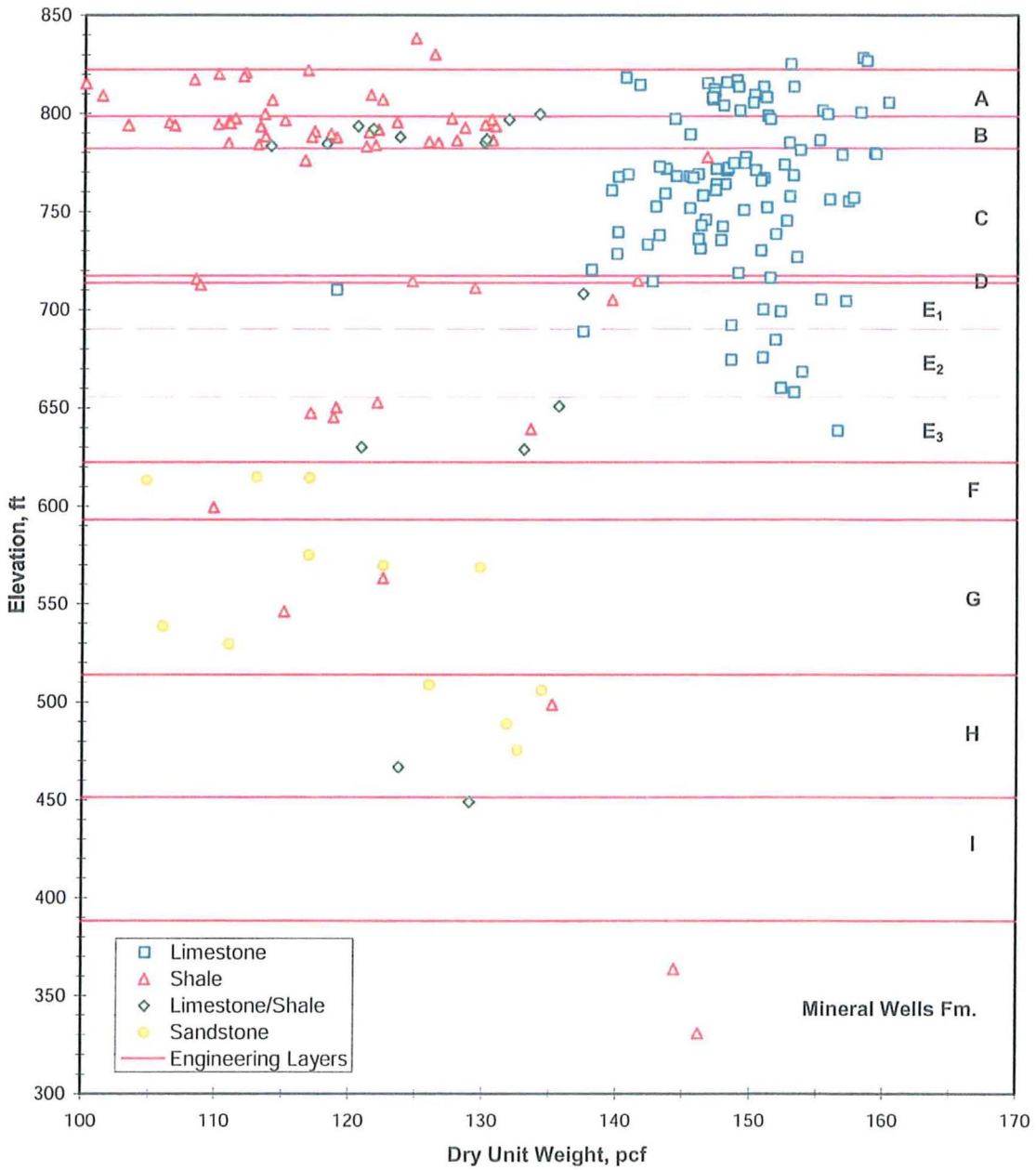
Moisture Content vs. Elevation

FIGURE 1



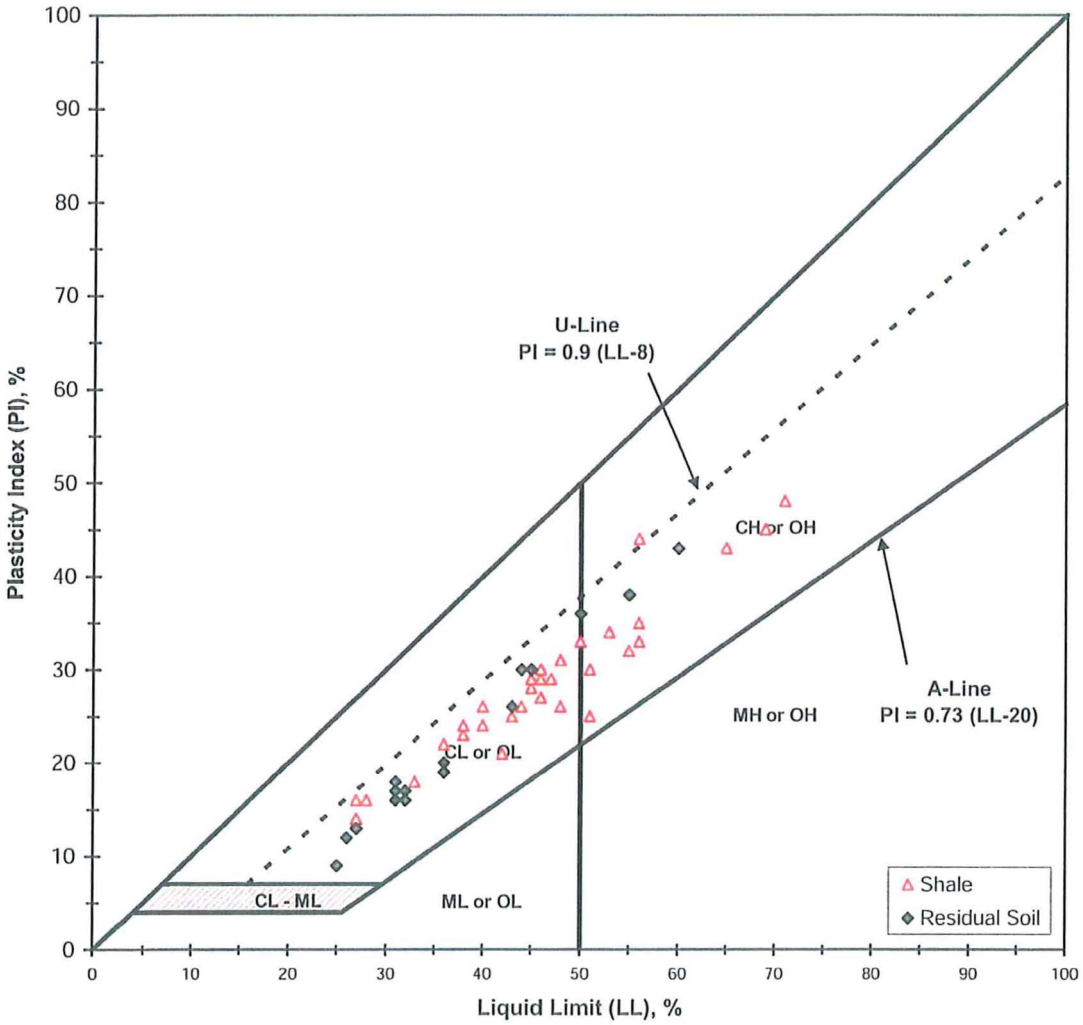
Total Unit Weight vs. Elevation

FIGURE 2



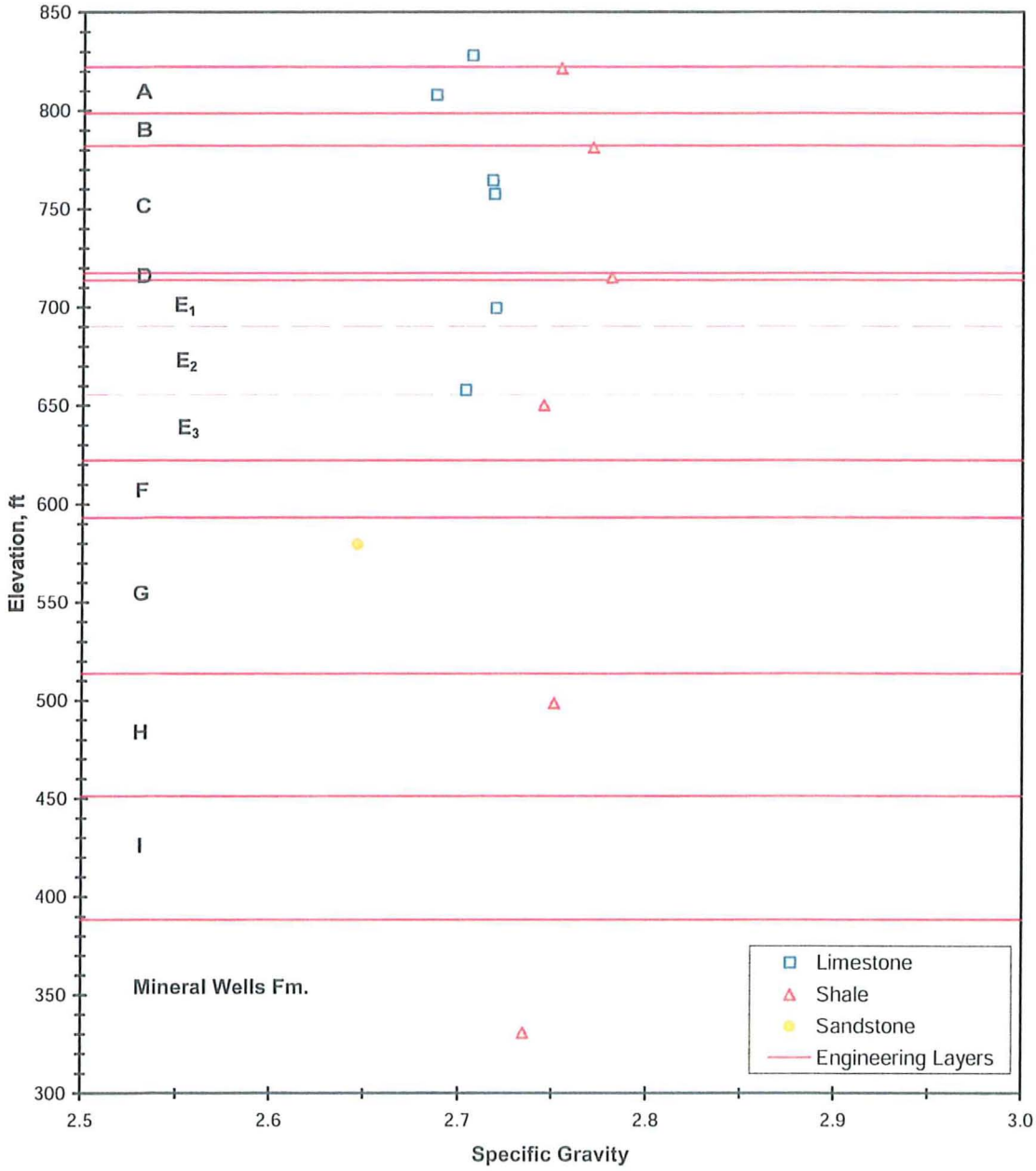
Dry Unit Weight vs. Elevation

FIGURE 3



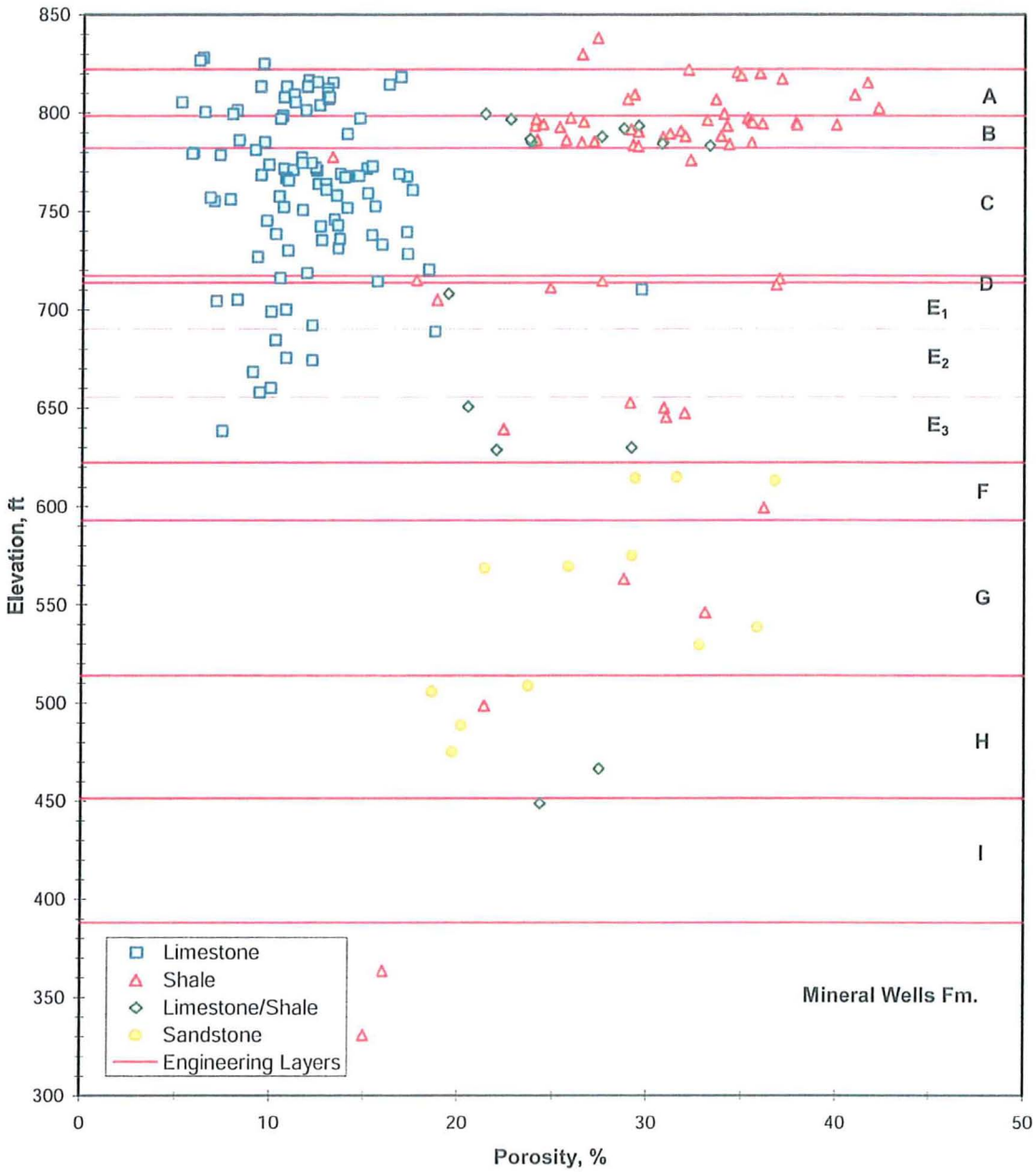
Plasticity Data

FIGURE 4



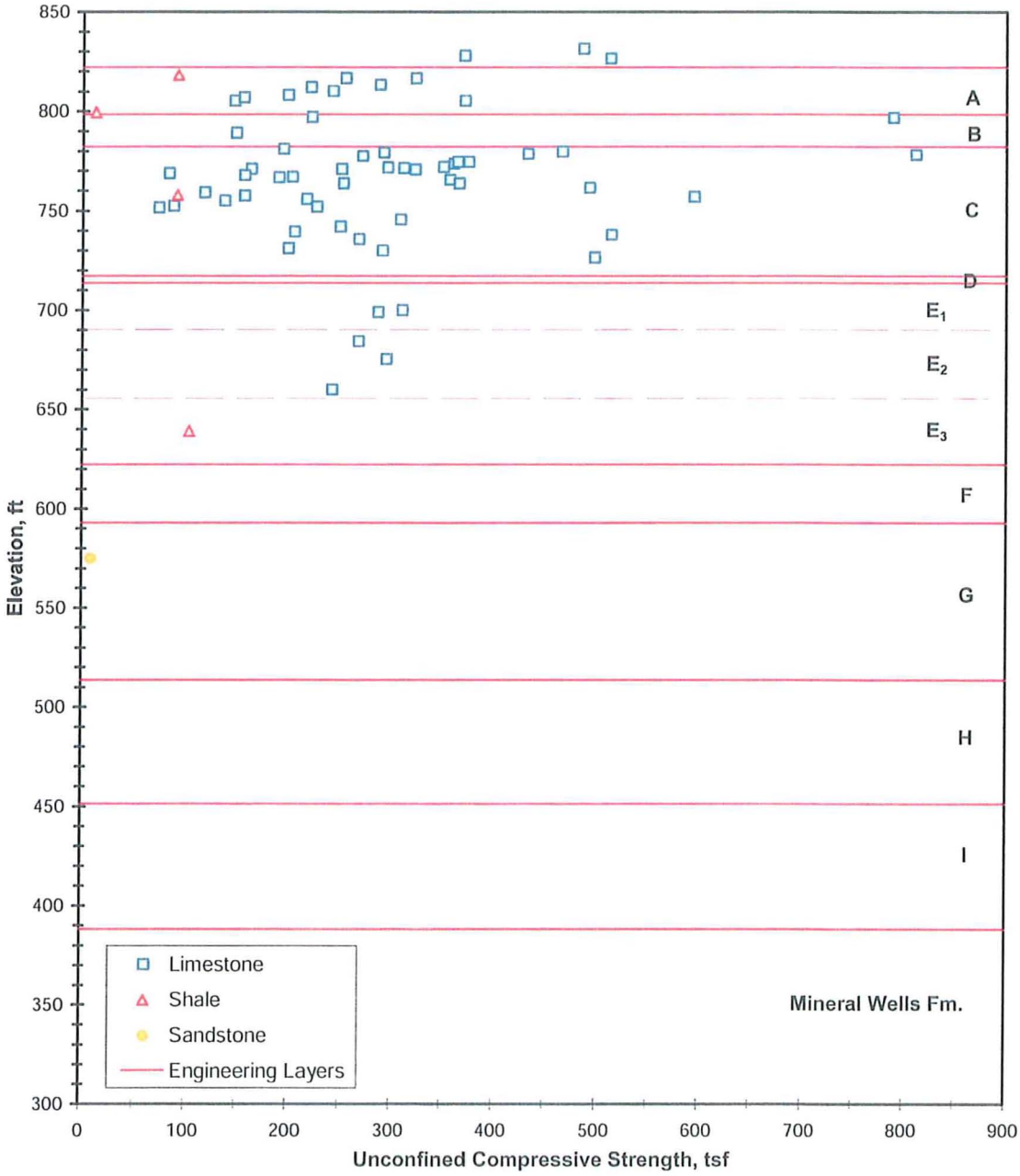
Specific Gravity vs. Elevation

FIGURE 5



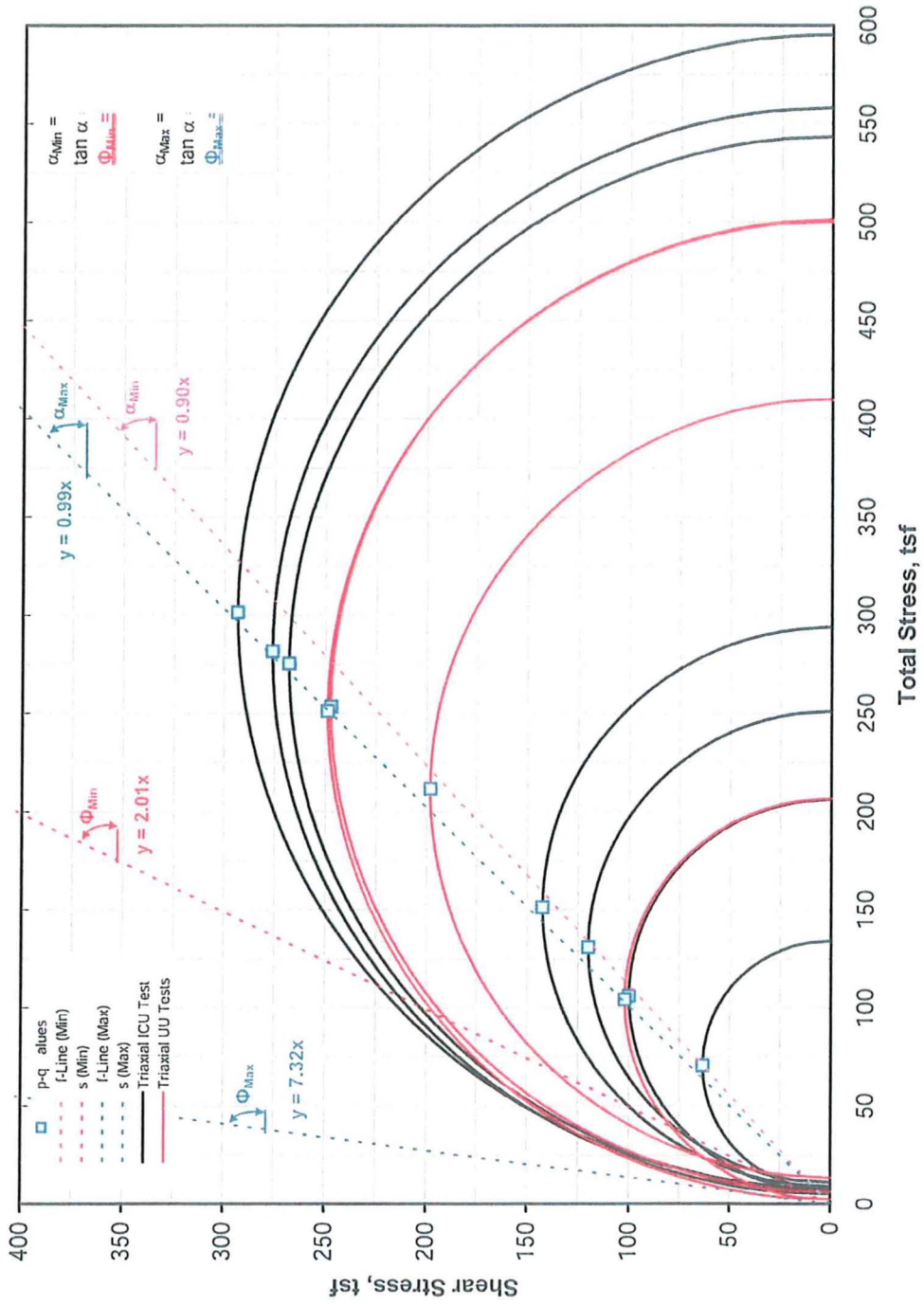
Calculated Porosity vs. Elevation

FIGURE 6



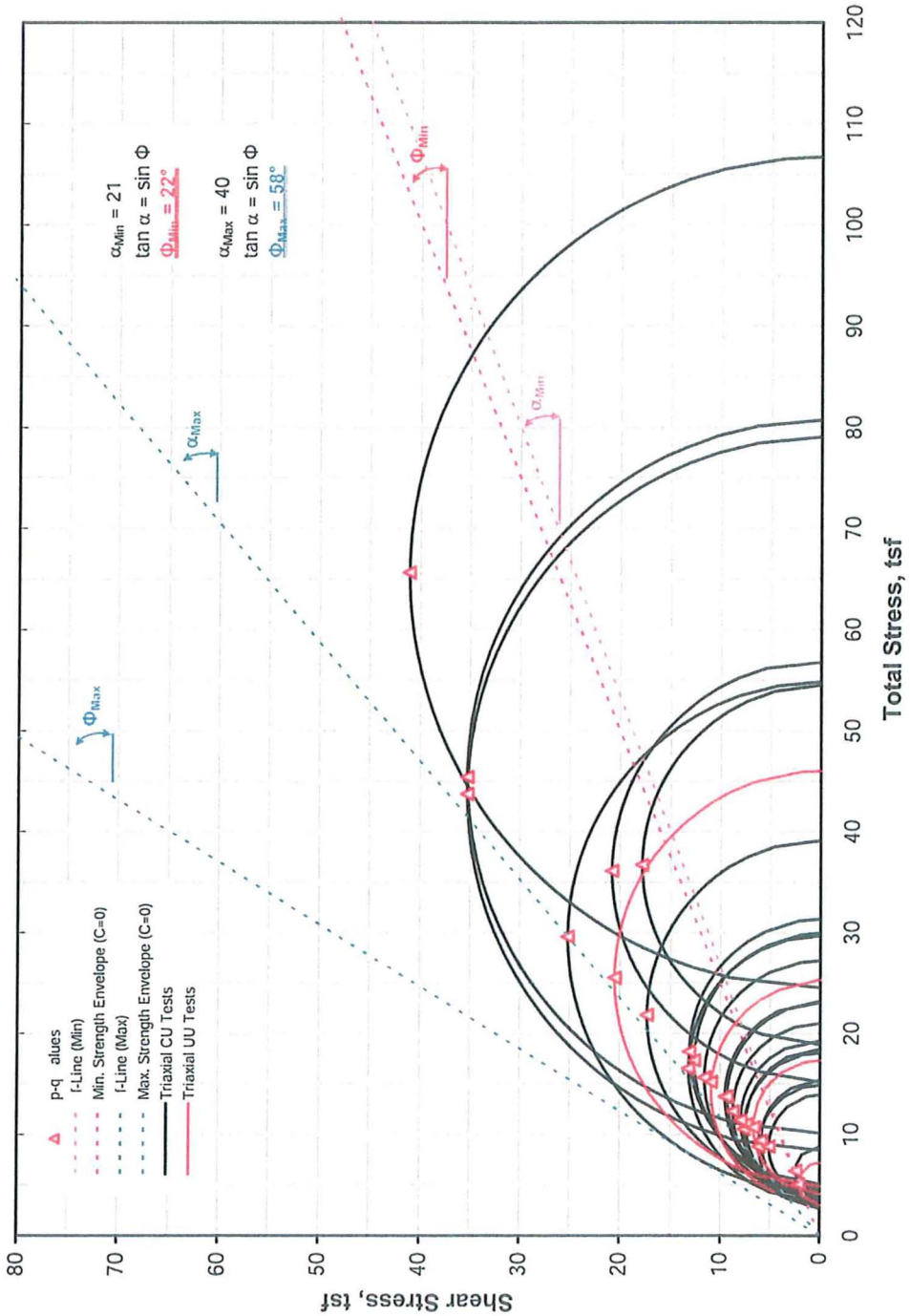
Unconfined Compressive Strength vs. Elevation

FIGURE 7



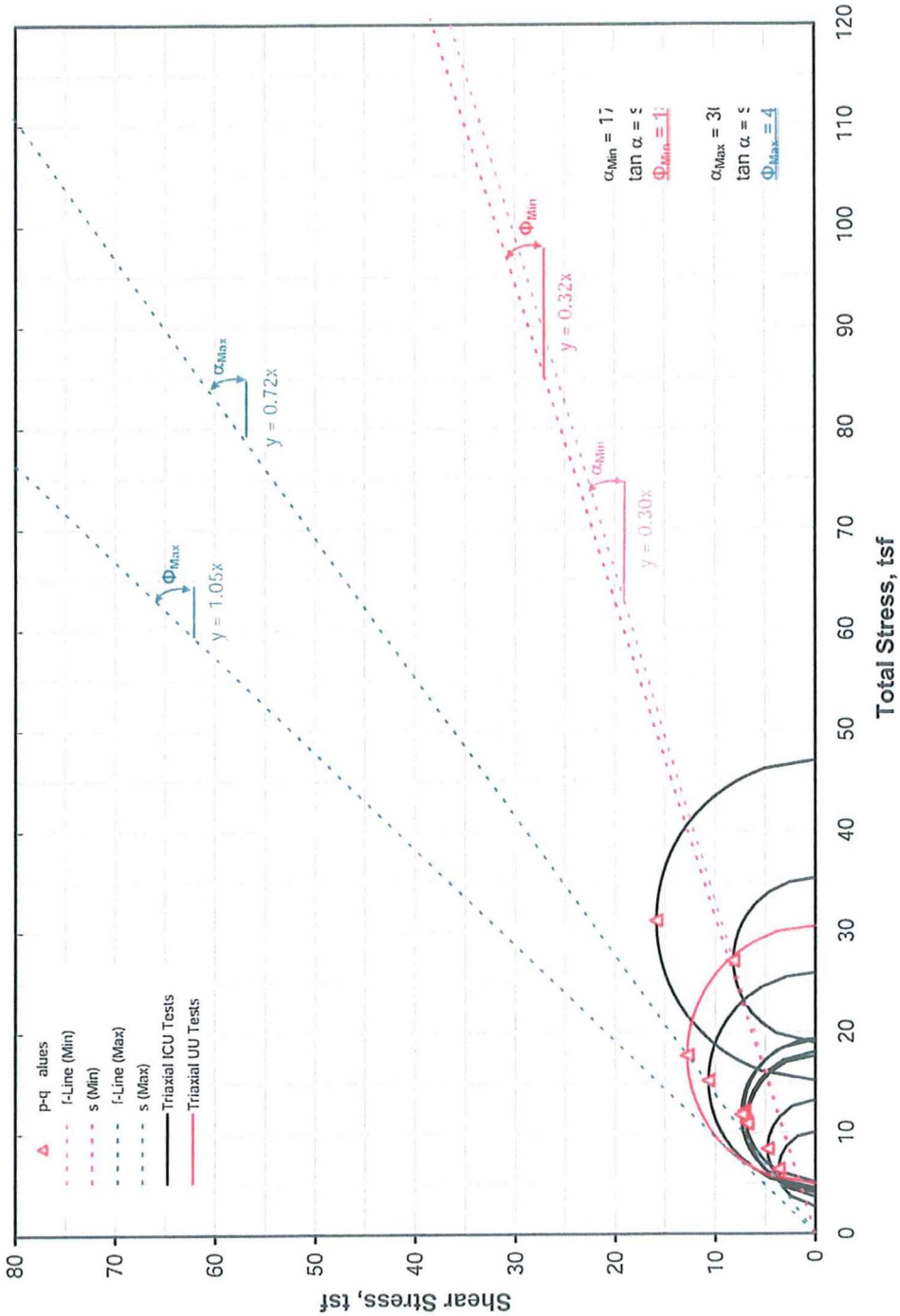
Peak Strength of Limestone from Consolidated-Undrained and Unconsolidated-Undrained Triaxial Tests

FIGURE 8



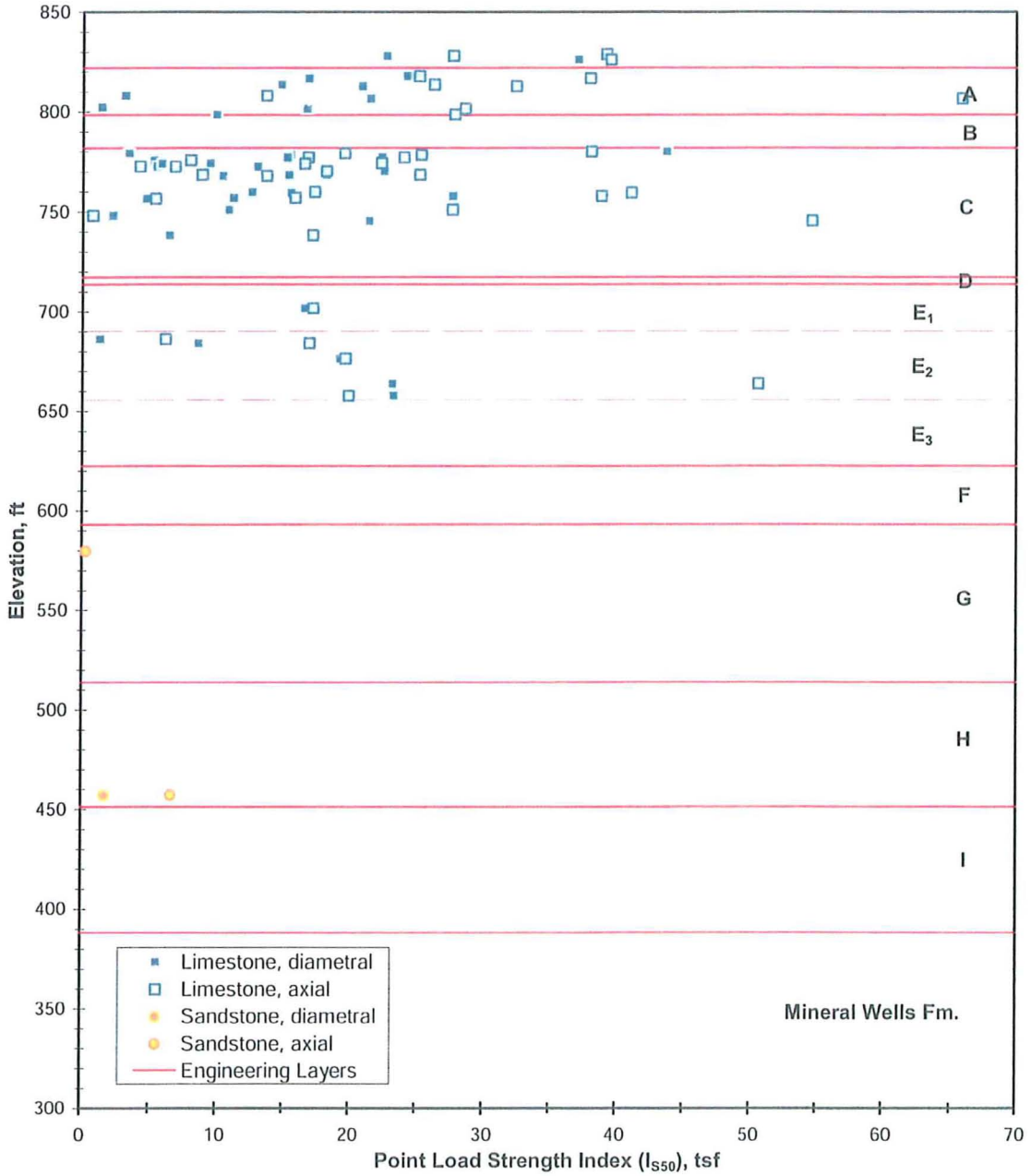
Peak Strength of Shale from Consolidated-Undrained and Unconsolidated-Undrained Triaxial Tests

FIGURE 9



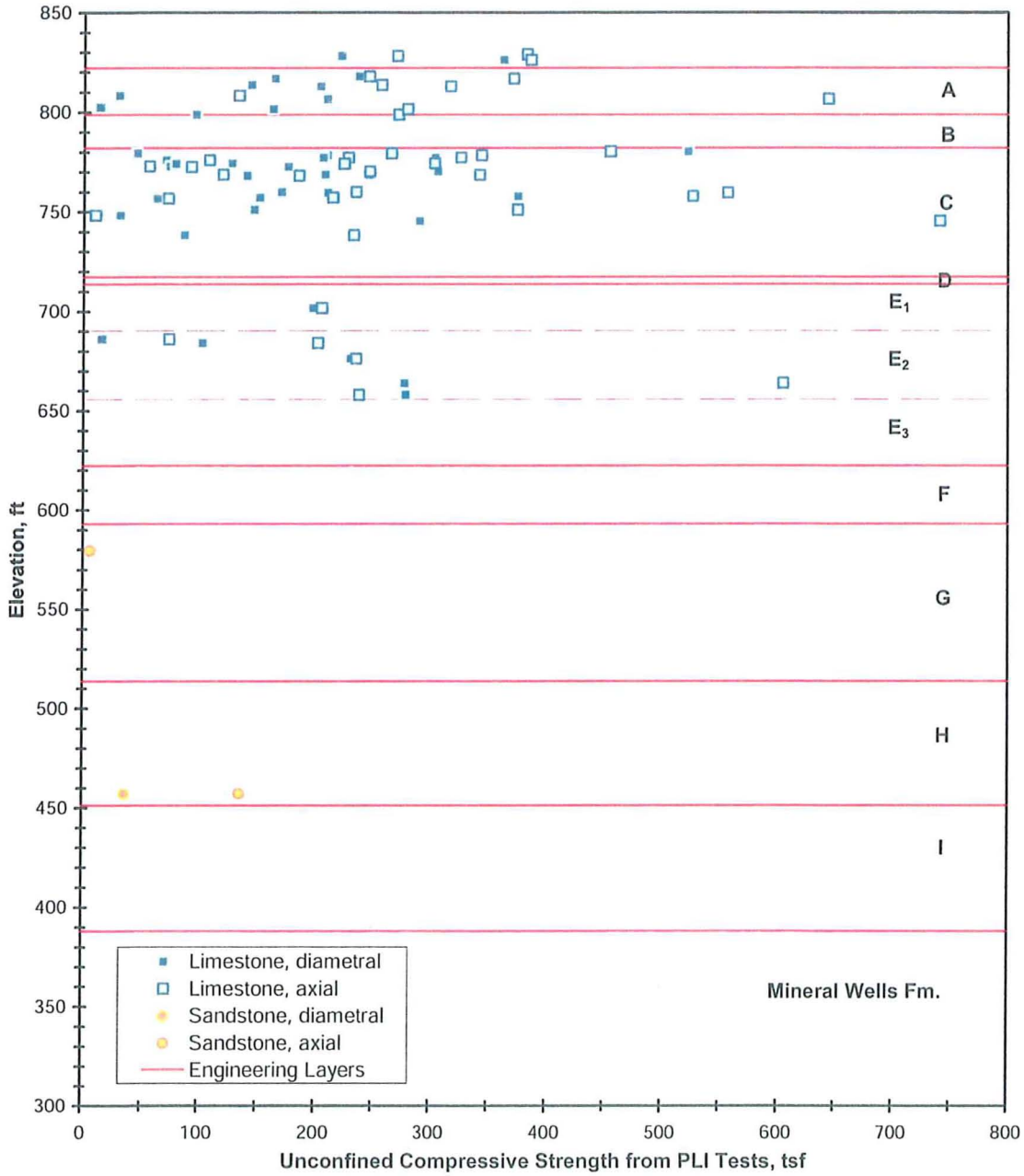
Ultimate Strength of Shale from Consolidated-Undrained and Unconsolidated-Undrained Triaxial Tests

FIGURE 10



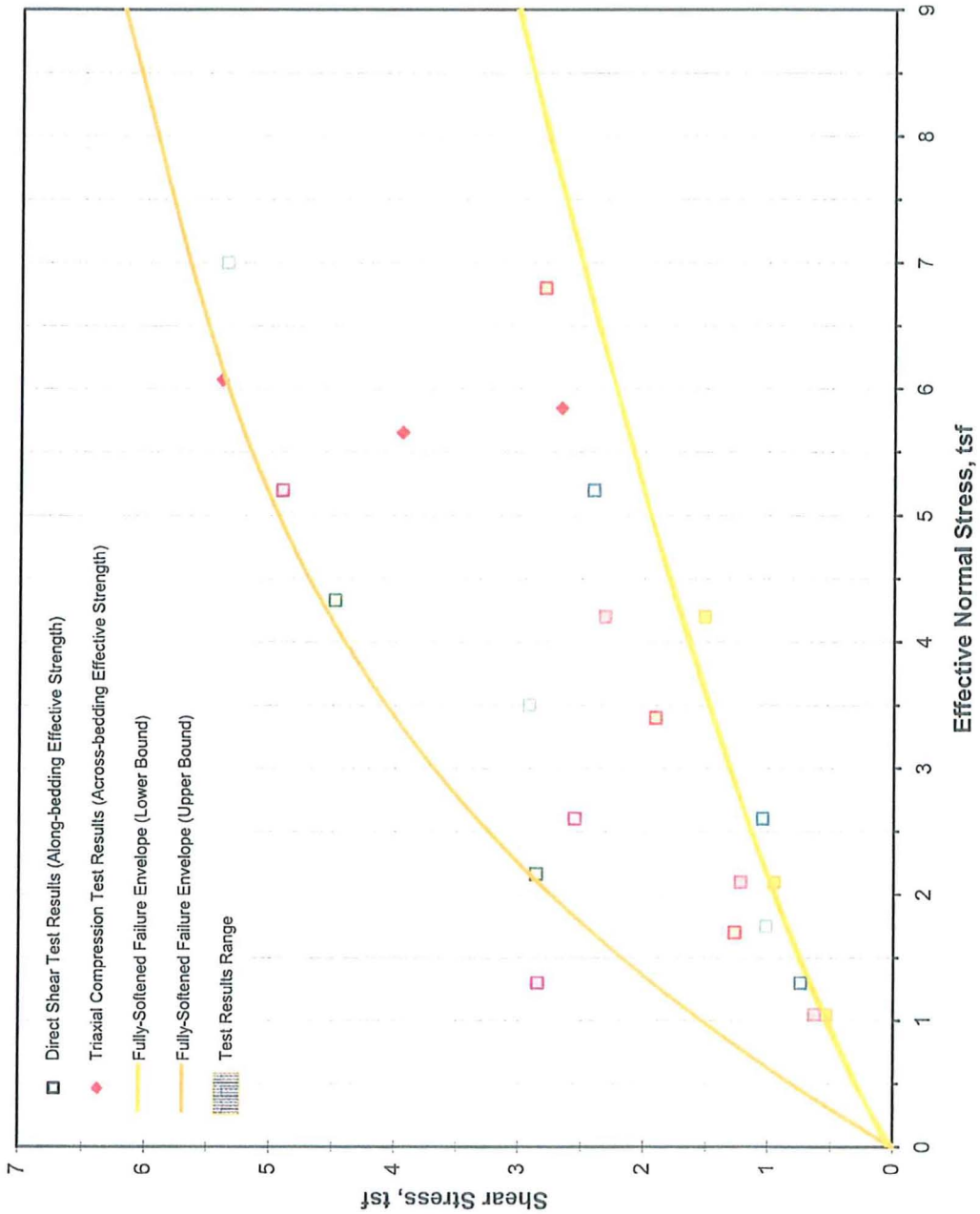
Point Load Strength Index vs. Elevation

FIGURE 11



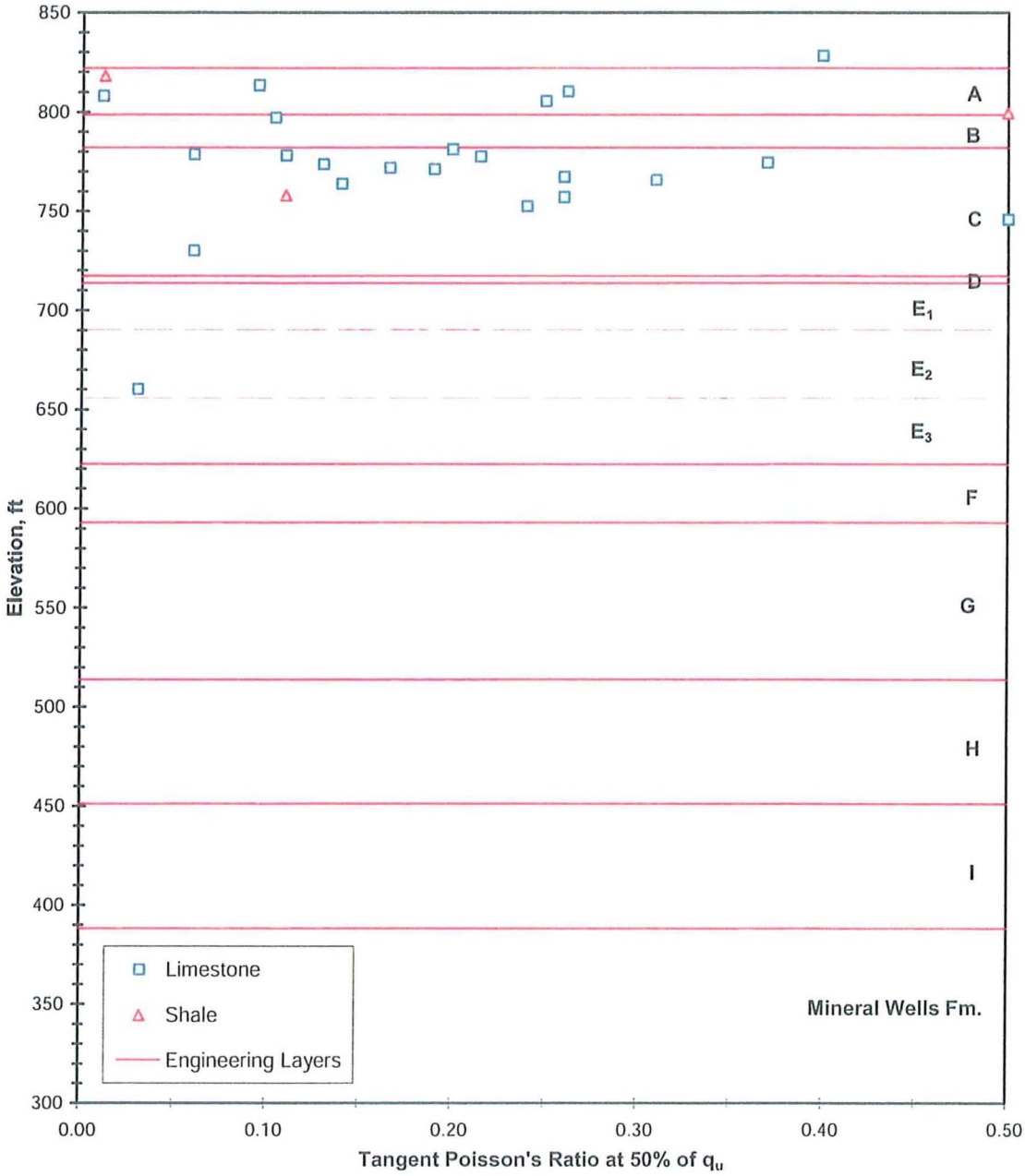
Estimated Unconfined Compressive Strength from Point Load Index Tests vs. Elevation

FIGURE 12



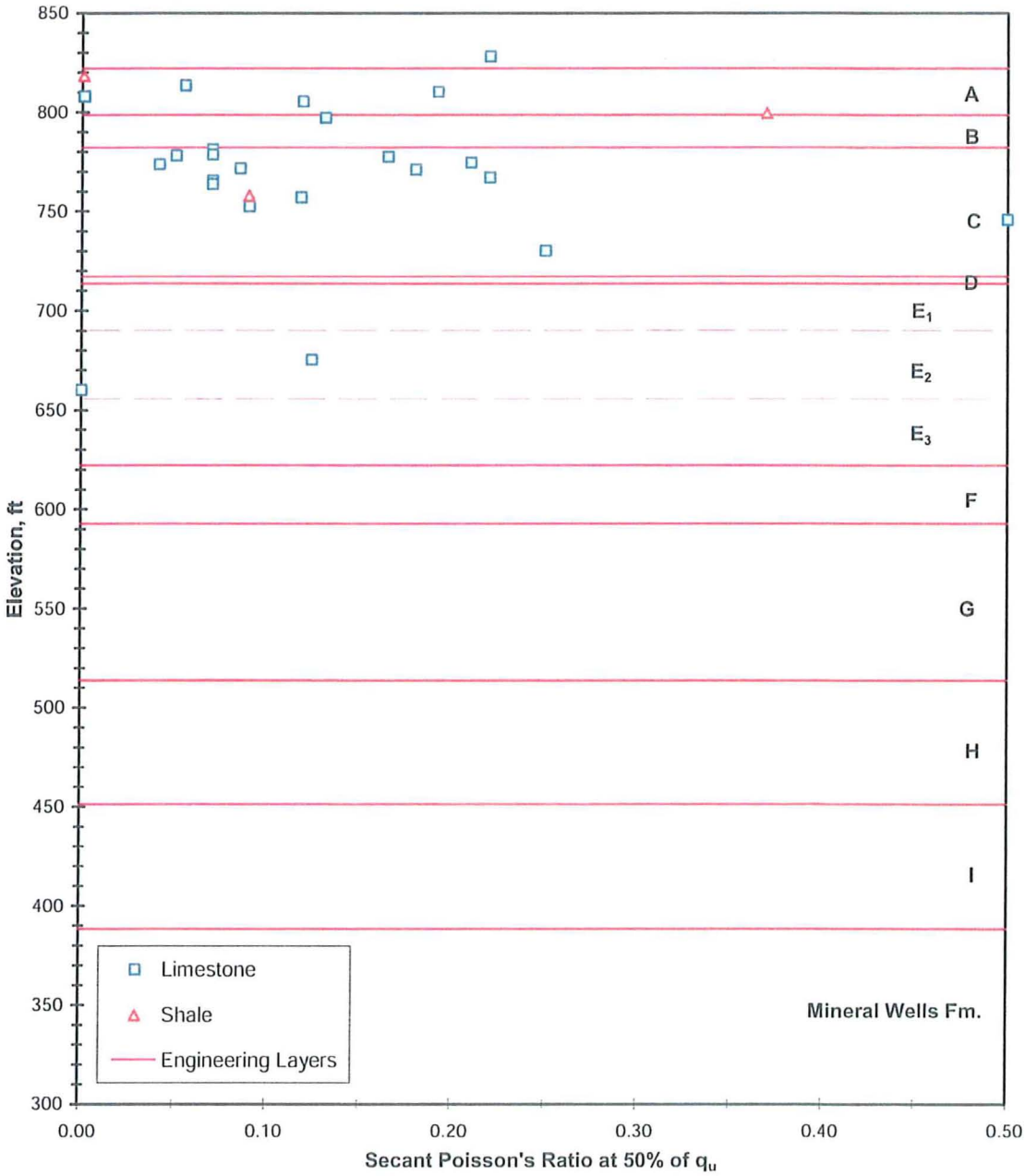
Fully-Softened Drained Shear Strength of Shale from Direct Shear and Triaxial Consolidated-Undrained Tests

FIGURE 13



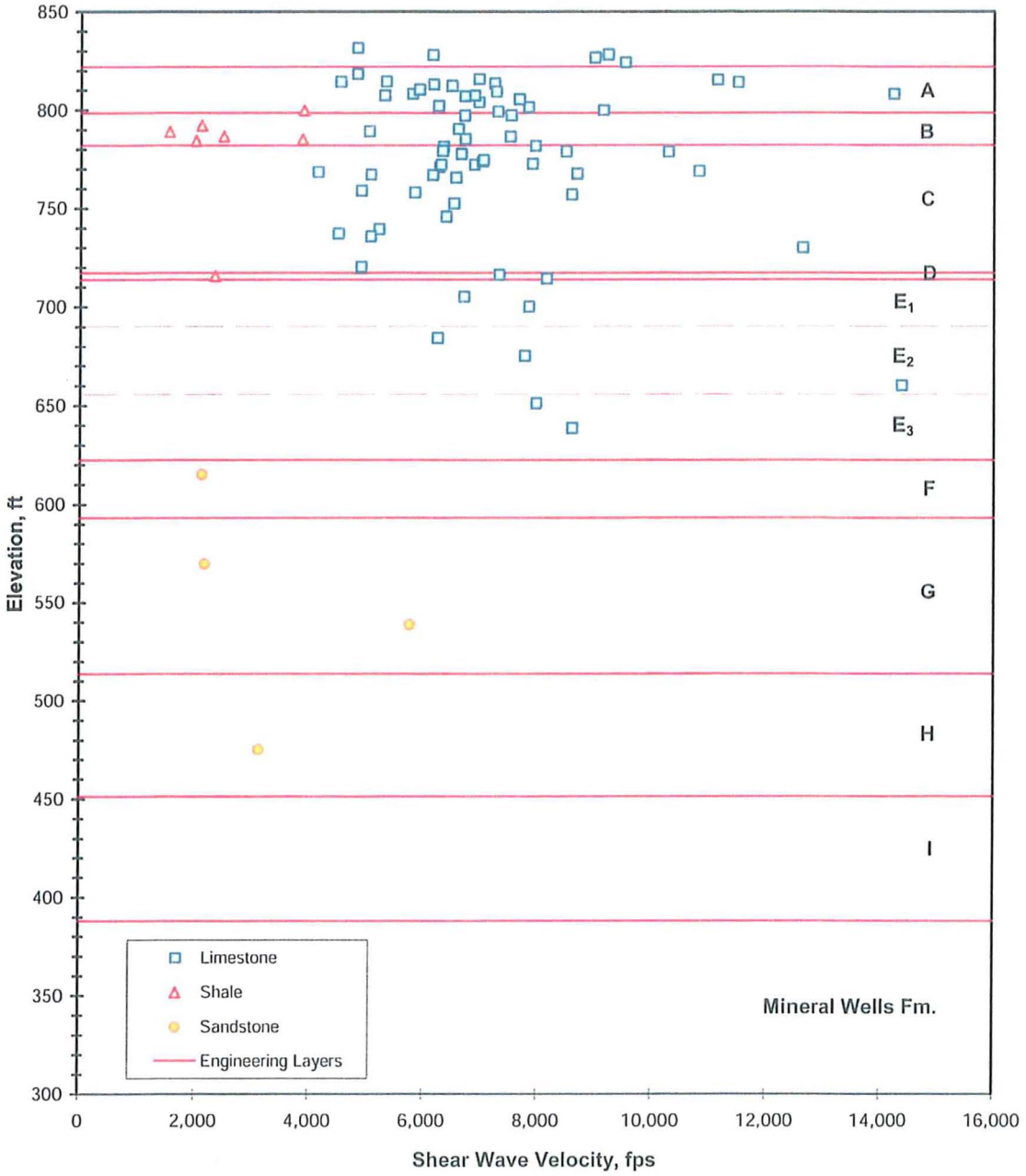
Tangent Poisson's Ratio from Unconfined Compression Tests vs. Elevation

FIGURE 14



Secant Poisson's Ratio from Unconfined Compression Tests vs. Elevation

FIGURE 15

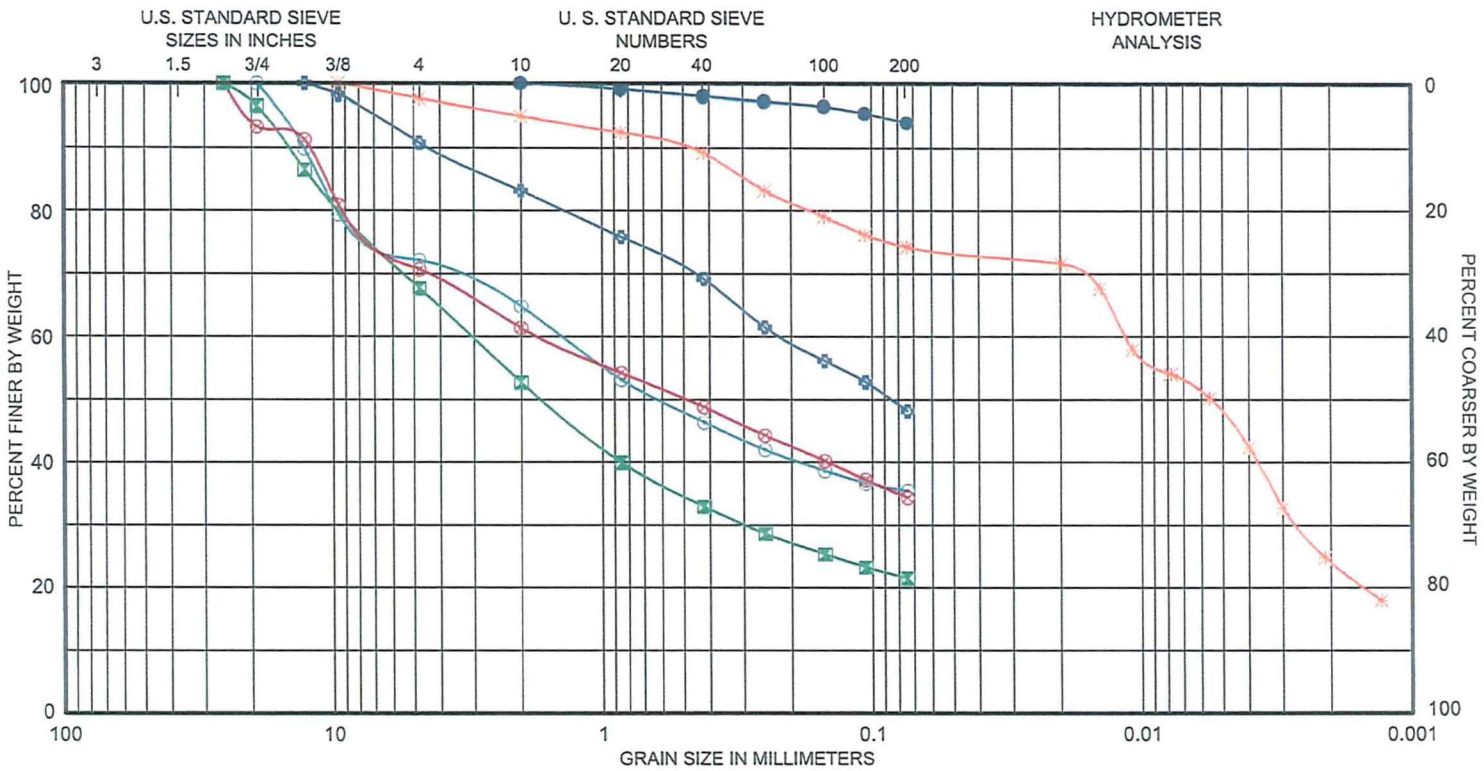


Laboratory-Based Shear Wave Velocity vs. Elevation

FIGURE 16

APPENDIX A

Particle-Size Distribution Test Results



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	SAMPLE NO.	DEPTH, FT	CLASSIFICATION
●	B-1003-2	9.5	Silt with sand (ML)
⊠	B-1008-off-1	2.5	Silty Sand (SM)
✳	B-1008-off-2	5	Lean Clay with sand (CL)
⊗	B-1012-off-2	5	Clayey Sand (SC)
⊙	B-1014-3	7.5	Clayey Sand (SC)
✿	B-1017-4	12.5	Clayey Sand (SC)

GRAIN SIZE CURVES
TXU Comanche Peak COL Project
Glen Rose, Texas

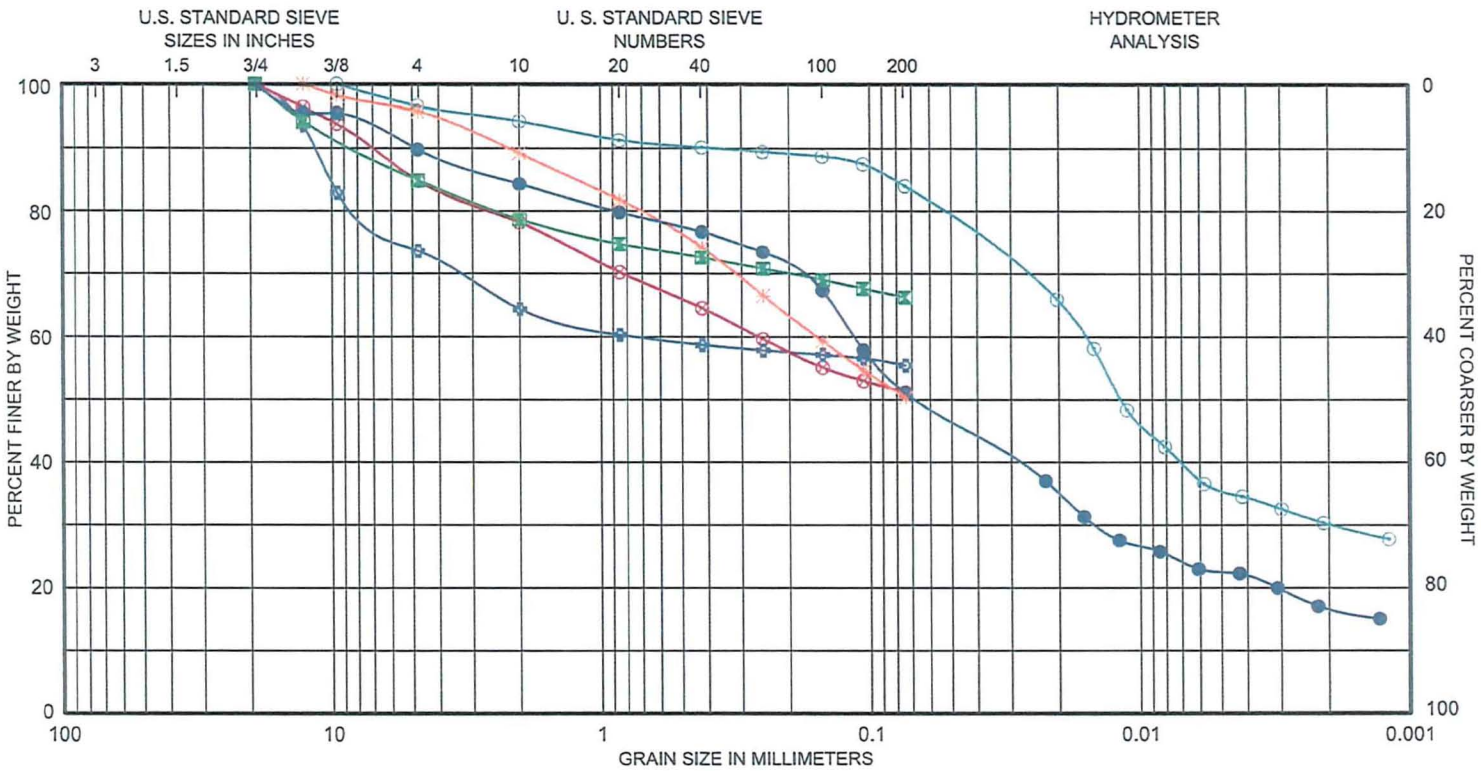
Enercon Services, Inc.

PROJECT REPORT

No.	TXUT-001-PR-010
Rev.	0
Page	2 of 4
QA File Number:	TXUT-001

APPENDIX A

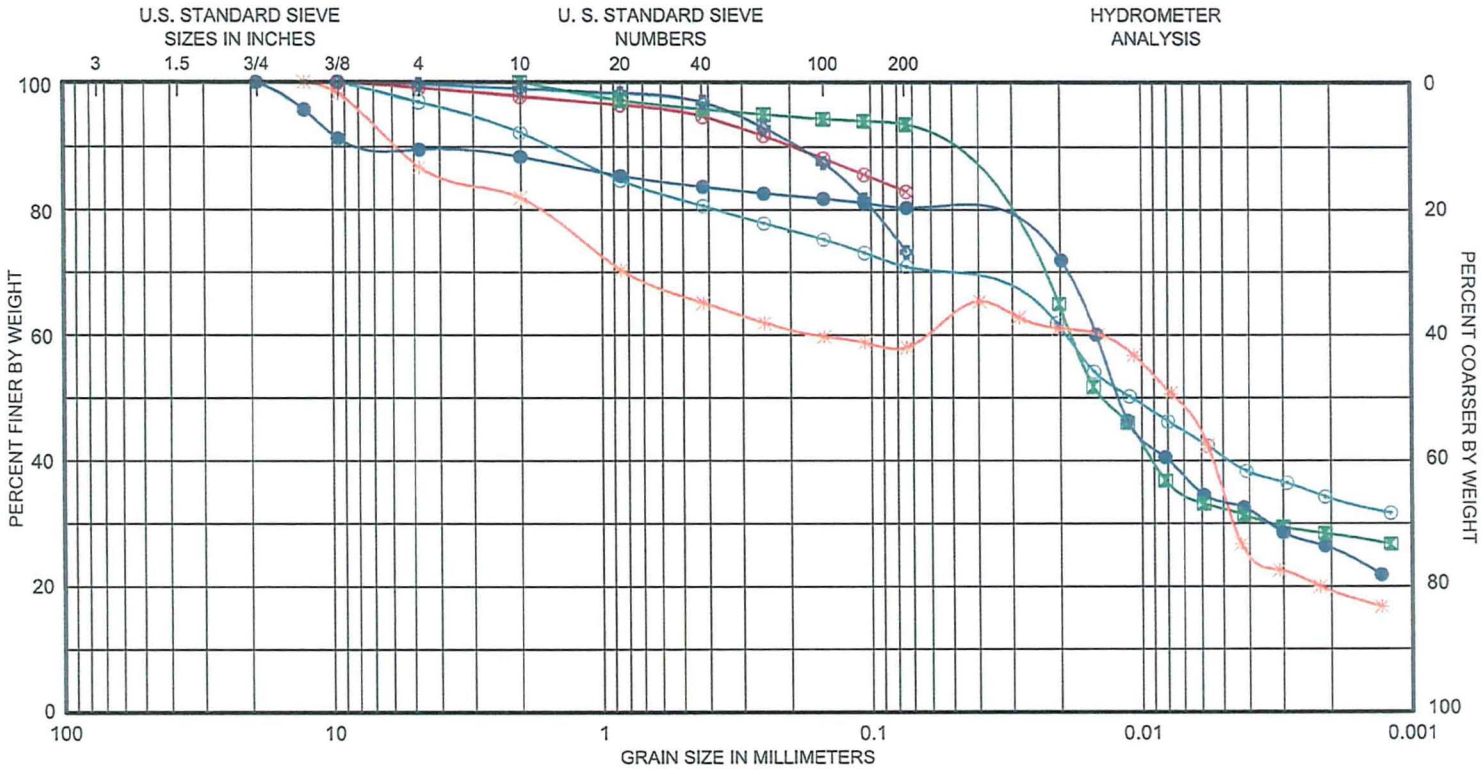
APPENDIX A



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	SAMPLE NO.	DEPTH, FT	CLASSIFICATION
●	B-1025-off-1	2.5	Sandy Silt (ML)
⊠	B-1025-off-3	7.5	Sandy Silt (ML)
✳	B-1025-off-4	10	Sandy Clay (CL)
⊗	B-1025-off-5	12.5	Sandy Clay (CL)
⊙	B-1030-3	7.5	Lean Clay with sand (CL)
✪	B-1032-2	5	Sandy Silt (ML)

GRAIN SIZE CURVES
TXU Comanche Peak COL Project
Glen Rose, Texas



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	SAMPLE NO.	DEPTH, FT	CLASSIFICATION
●	B-2001-off-3	7.5	Lean Clay with sand (CL)
⊠	B-2003-off-3	10	Lean Clay (CL)
✳	B-2010-off-1	2.5	Sandy Clay (CL)
⊗	B-2010-off-2	4.5	Sandy Clay (CL)
⊙	B-2011-l-off-2	5	Fat Clay with sand (CH)
✿	B-2032-3	7.5	Sandy Silt (ML)

GRAIN SIZE CURVES
TXU Comanche Peak COL Project
Glen Rose, Texas

Enercon Services, Inc.

PROJECT REPORT

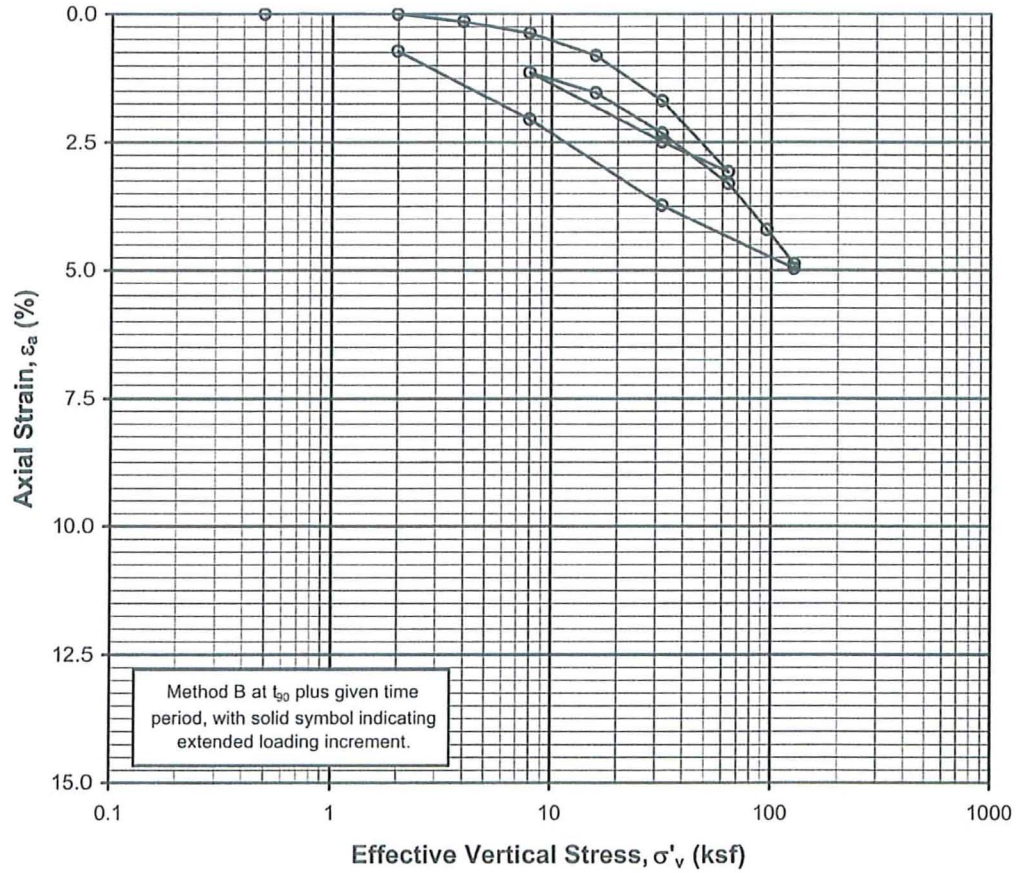
No.	TXUT-001-PR-010
Rev.	0
Page	4 of 4
QA File Number:	TXUT-001

APPENDIX A

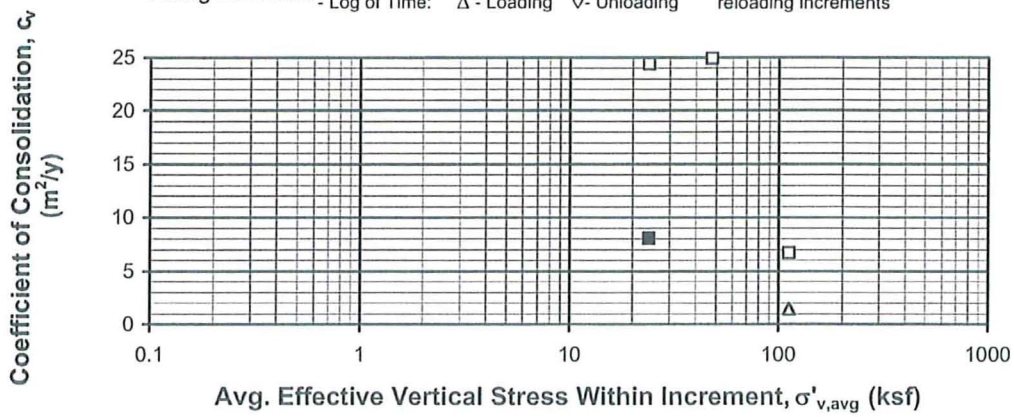
APPENDIX B-1

One-Dimensional Consolidation Test Results

APPENDIX B-1



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading with solid symbols indicating reloading increments
- Log of Time: Δ - Loading ◊- Unloading

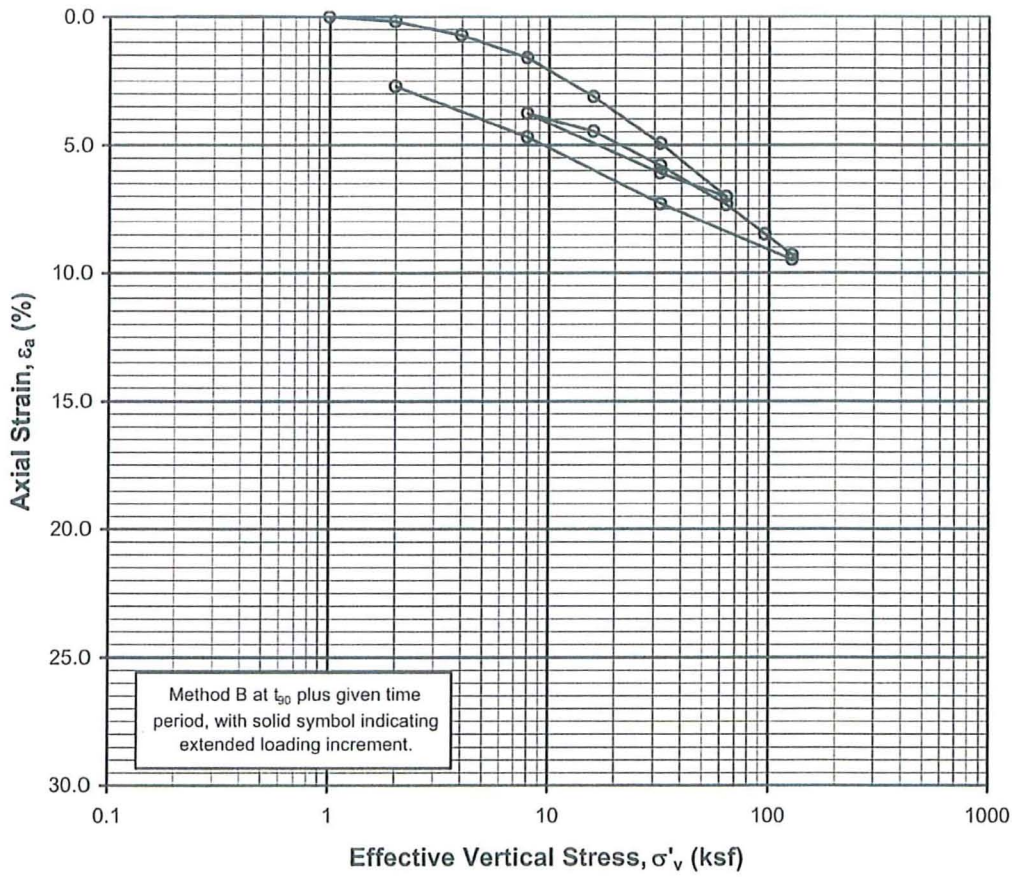


1-D CONSOLIDATION TEST

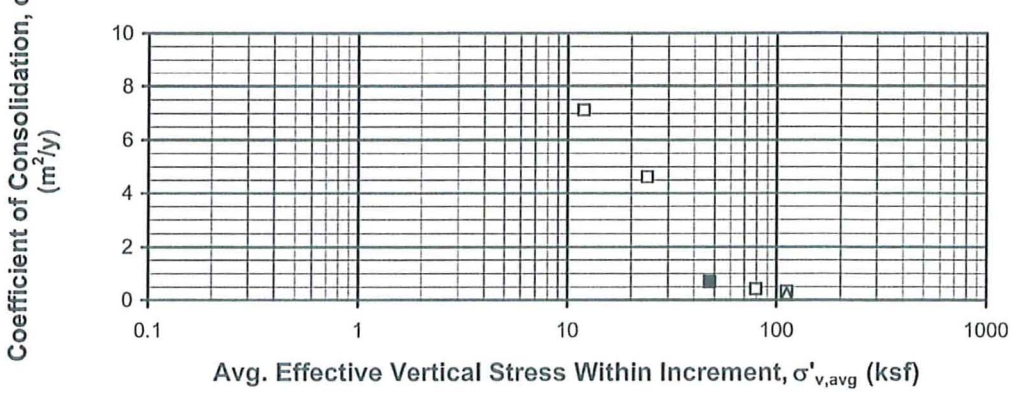
Sample No. 15 - Depth 63.40 ft

Boring B-1000

APPENDIX B-1



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

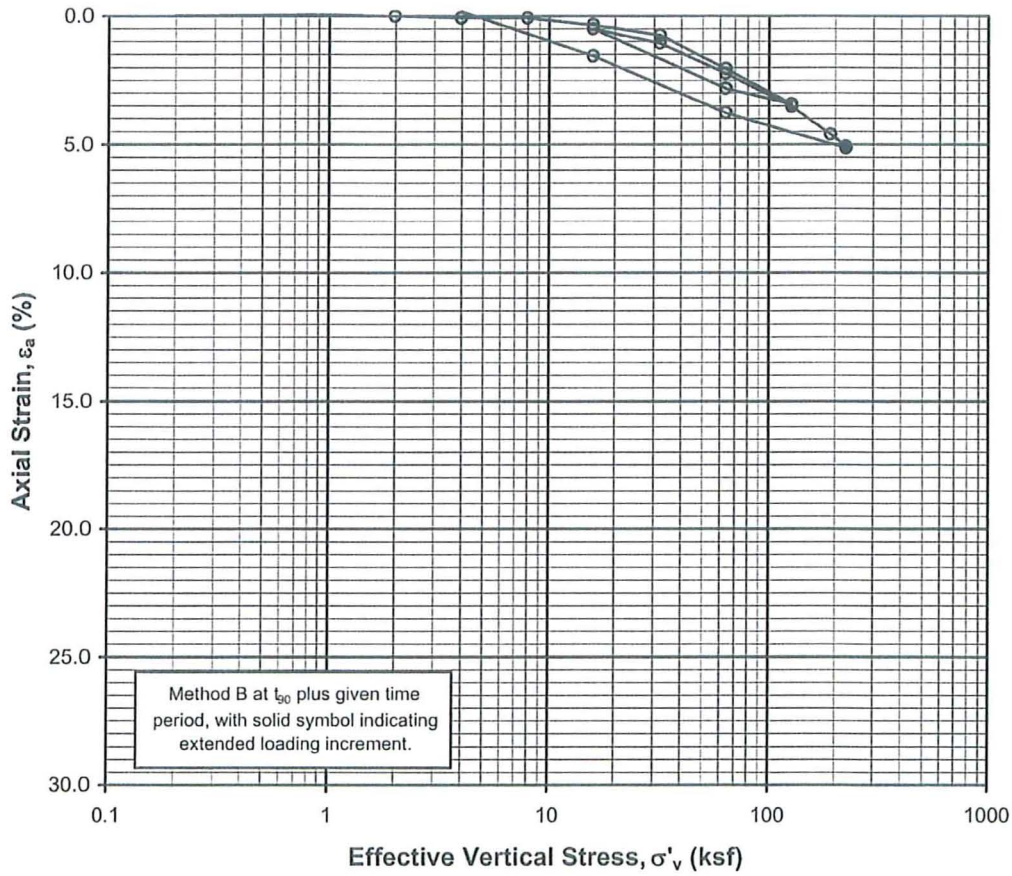


1-D CONSOLIDATION TEST

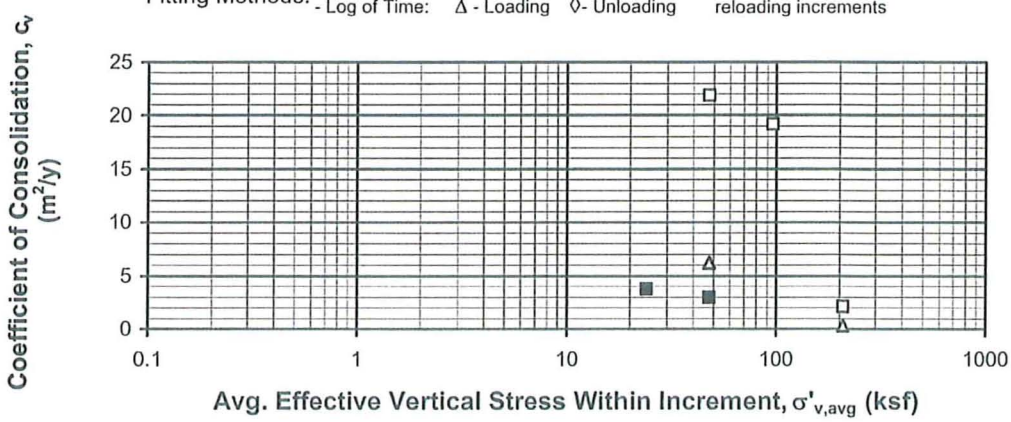
Sample No. 12 - Depth 39.70 ft

Boring B-1004

APPENDIX B-1



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

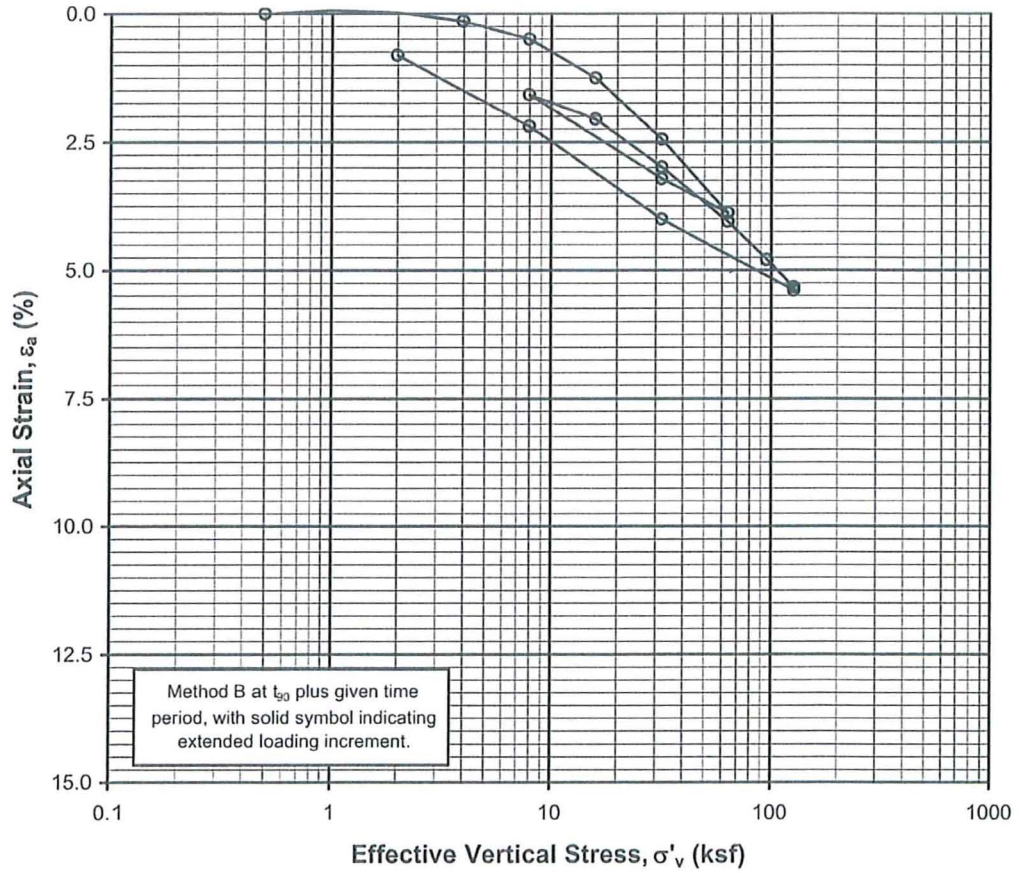


1-D CONSOLIDATION TEST

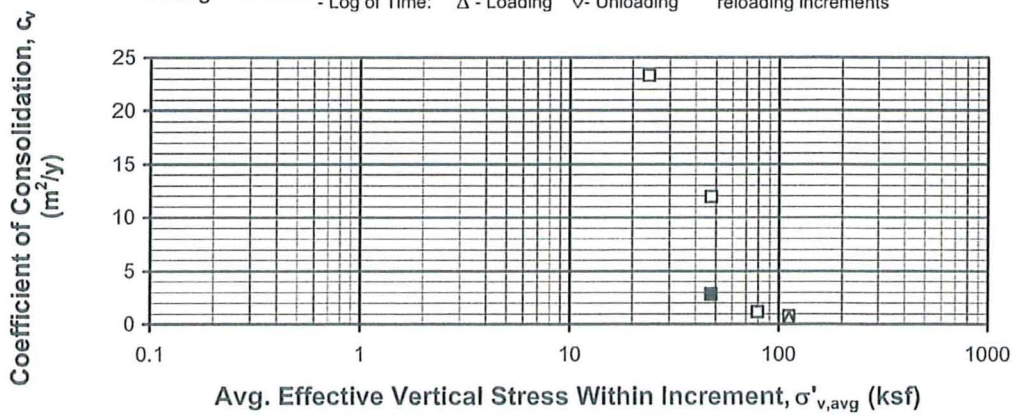
Sample No. 18 - Depth 73.90 ft

Boring B-1005

APPENDIX B-1



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

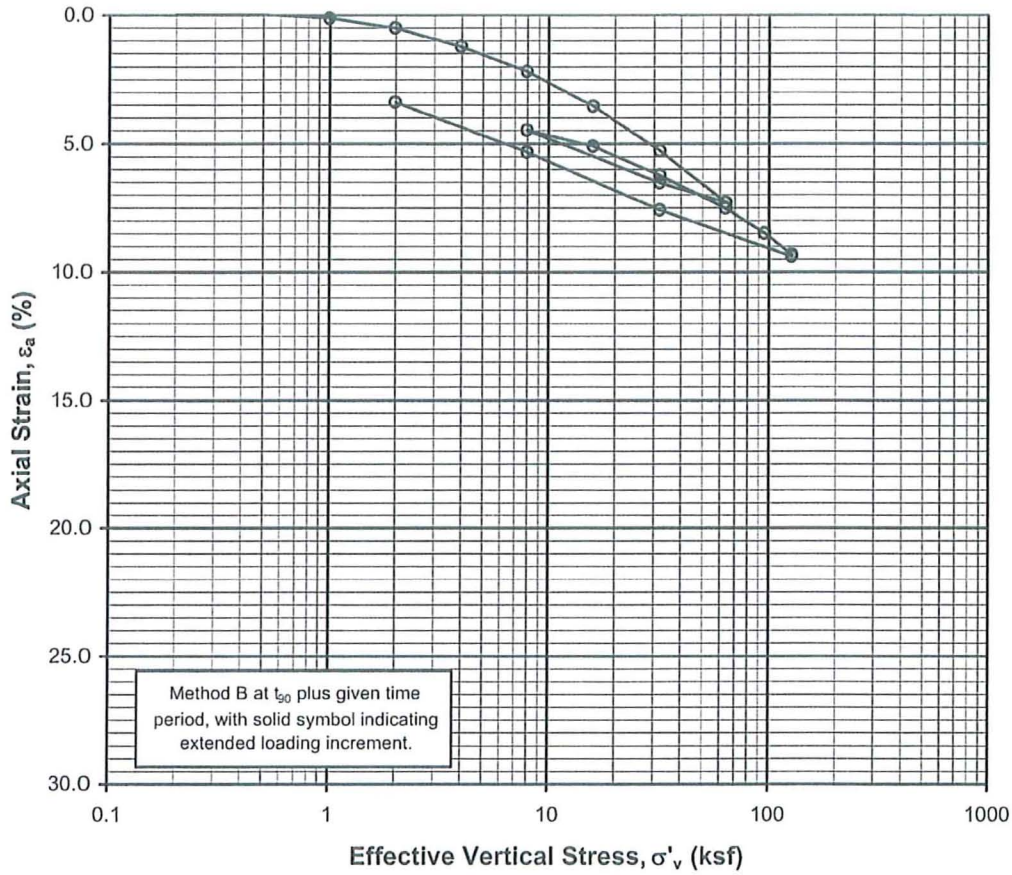


1-D CONSOLIDATION TEST

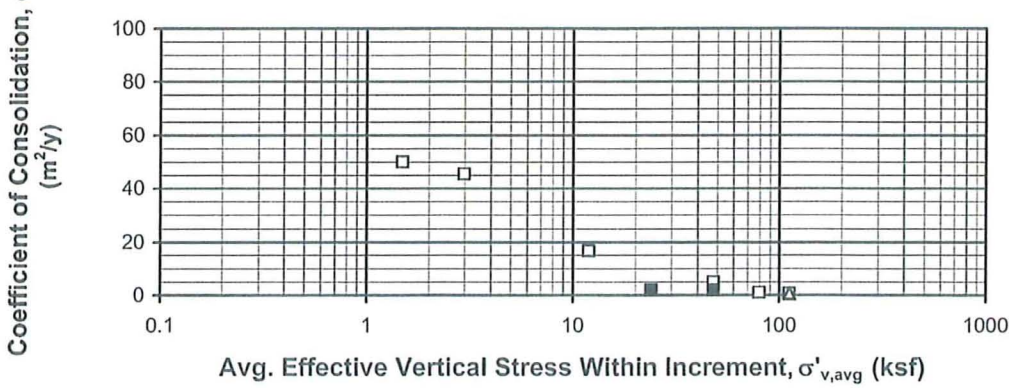
Sample No. 7 - Depth 47.10 ft

Boring B-2003

APPENDIX B-1



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments



1-D CONSOLIDATION TEST

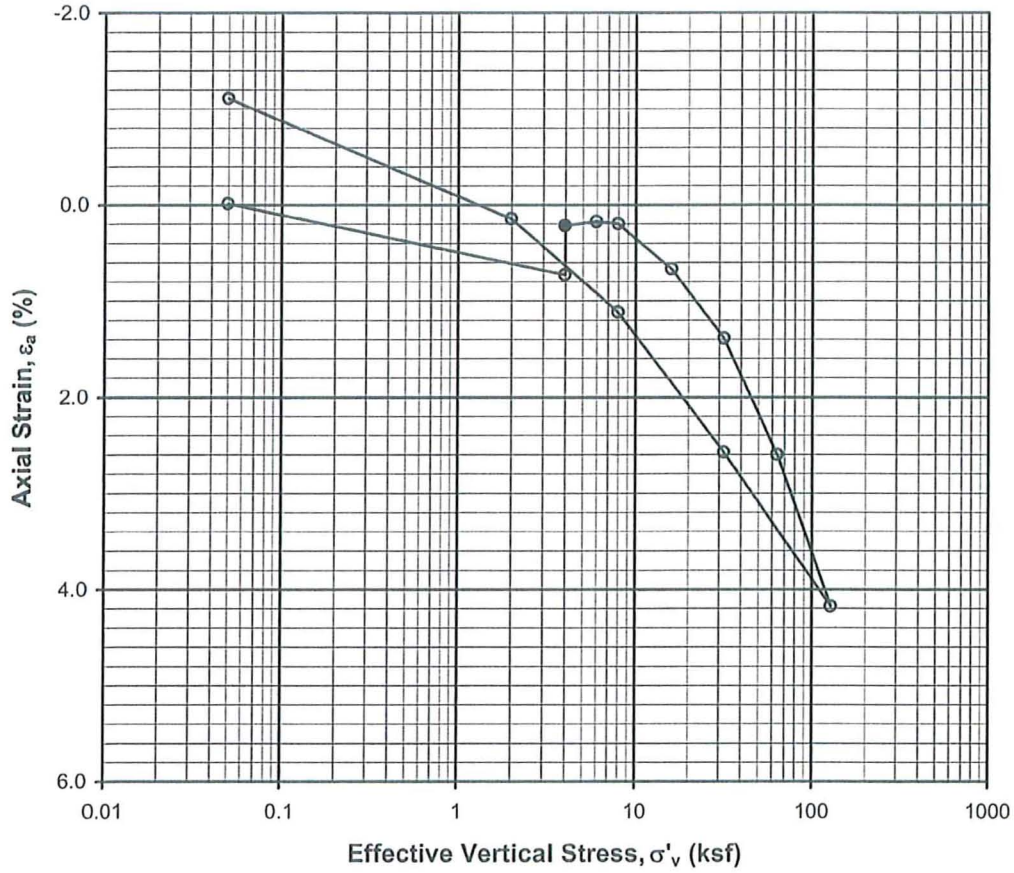
Sample No. 7 - Depth 25.40 ft

Boring B-2006

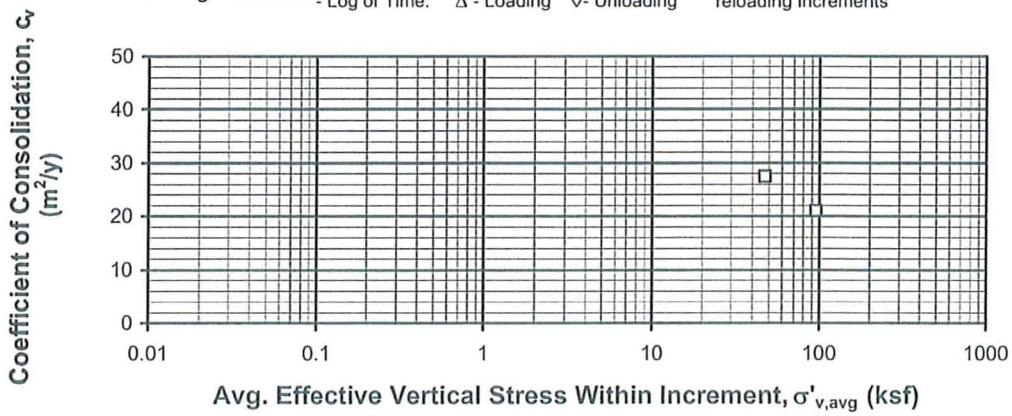
APPENDIX B-2

One-Dimensional Swell Test Results

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

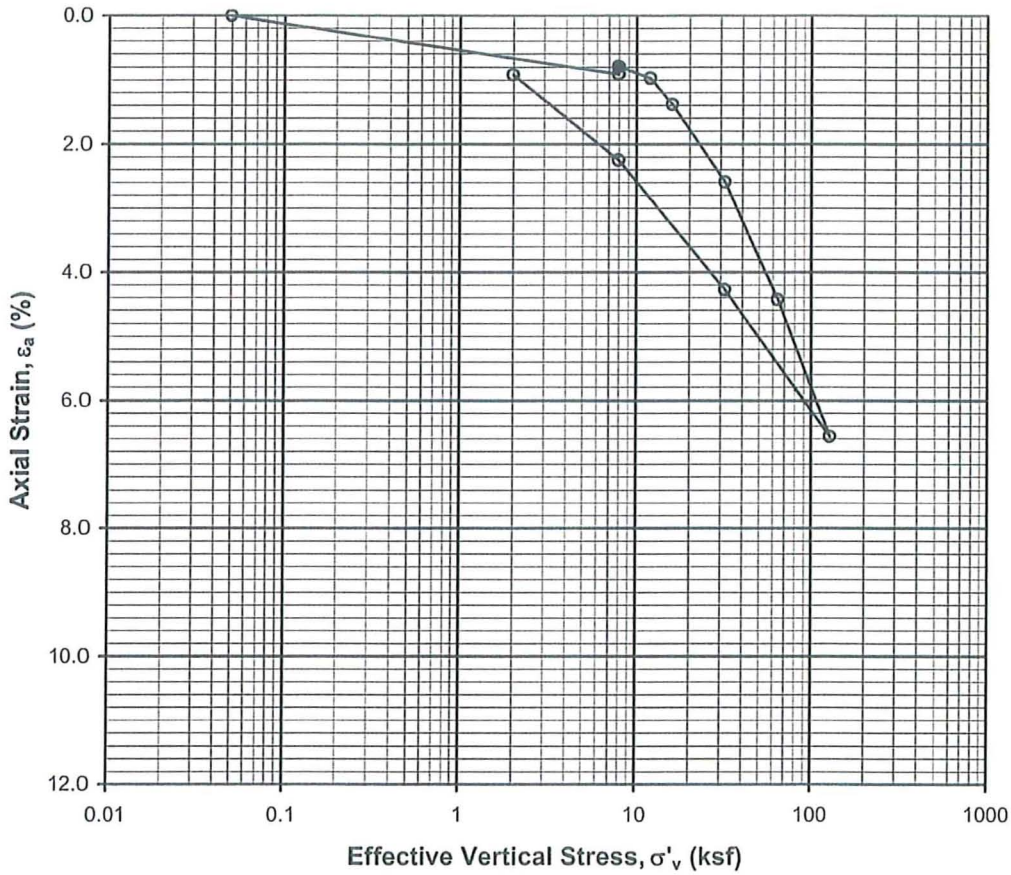


SWELL TEST

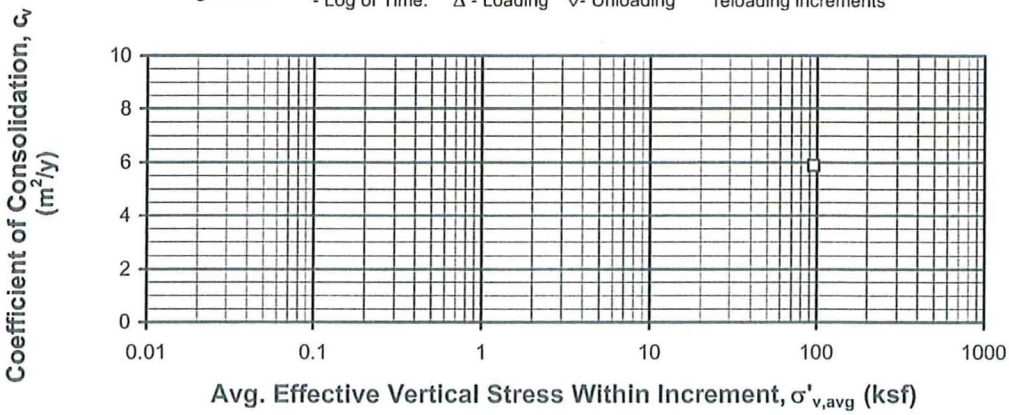
Sample No. 10 - Depth 35.40 ft

Boring B-1002

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

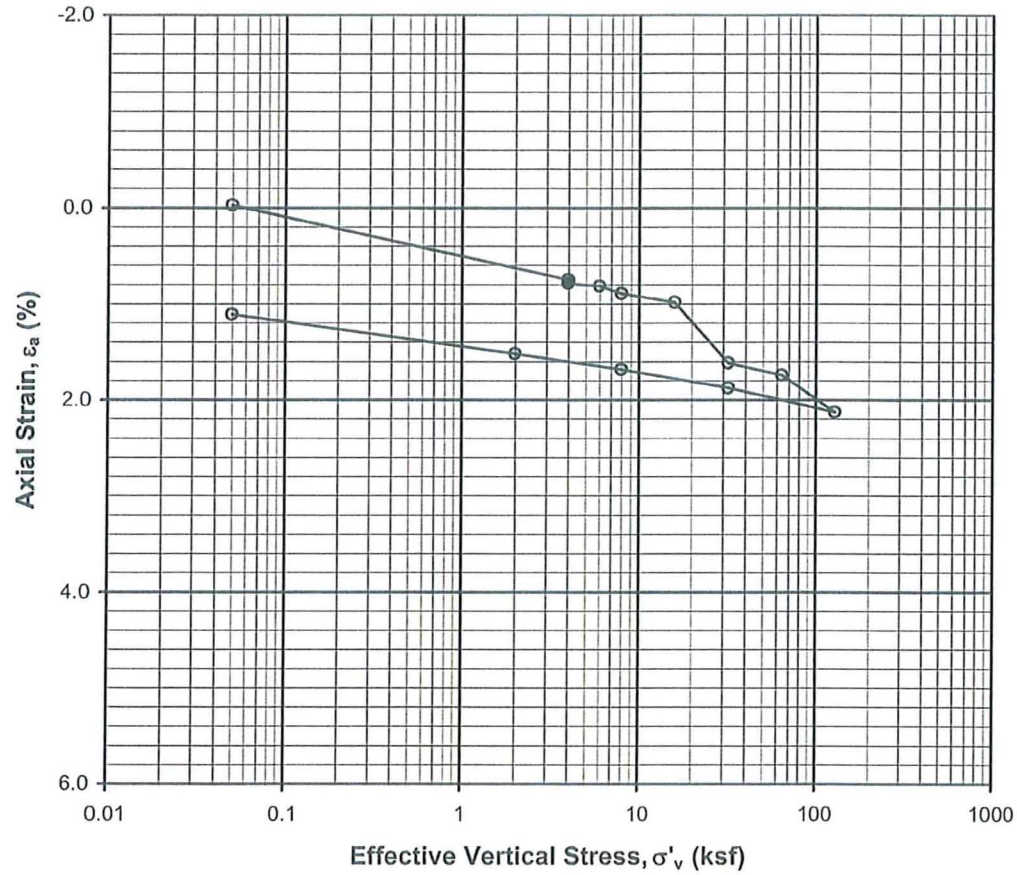


SWELL TEST

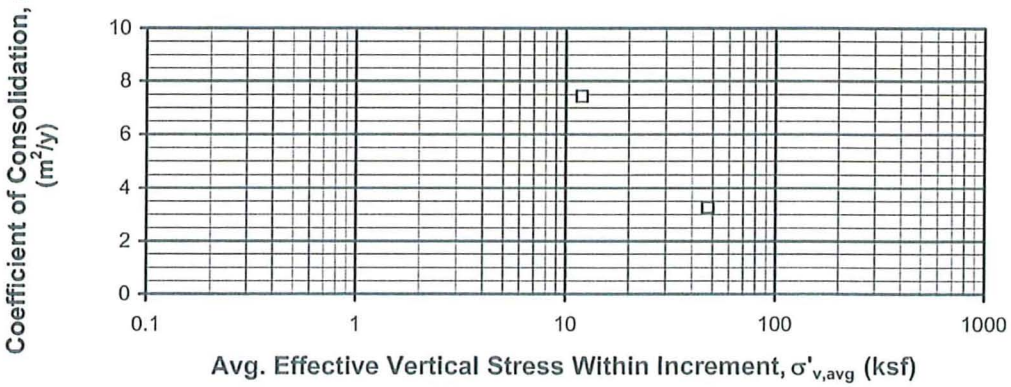
Sample No. 17 - Depth 68.80 ft

Boring B-1005

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

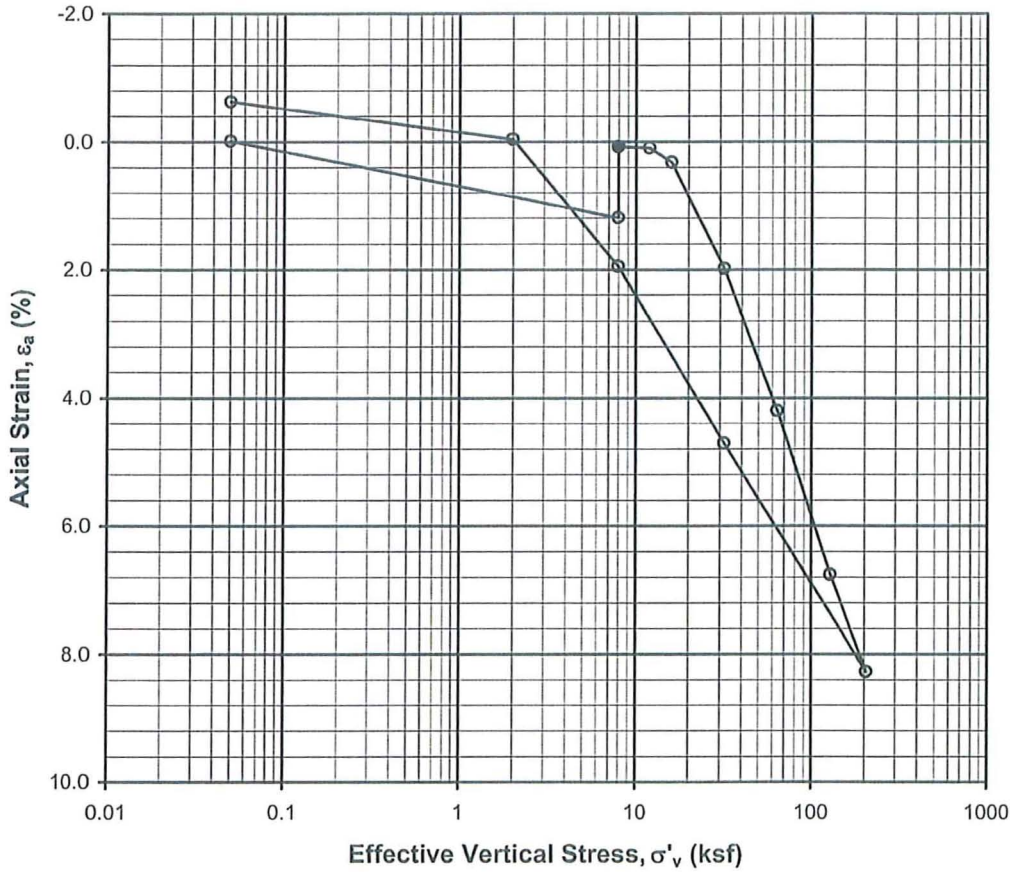


SWELL TEST

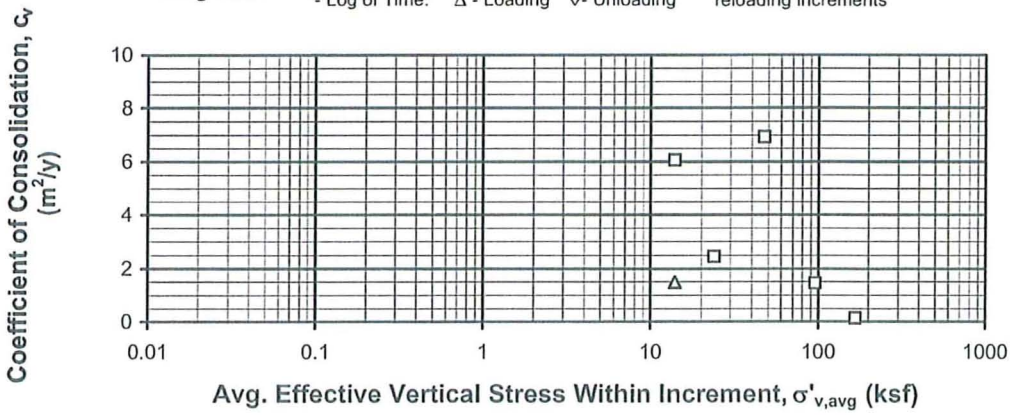
Sample No. 7 - Depth 28.75 ft

Boring B-1033

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

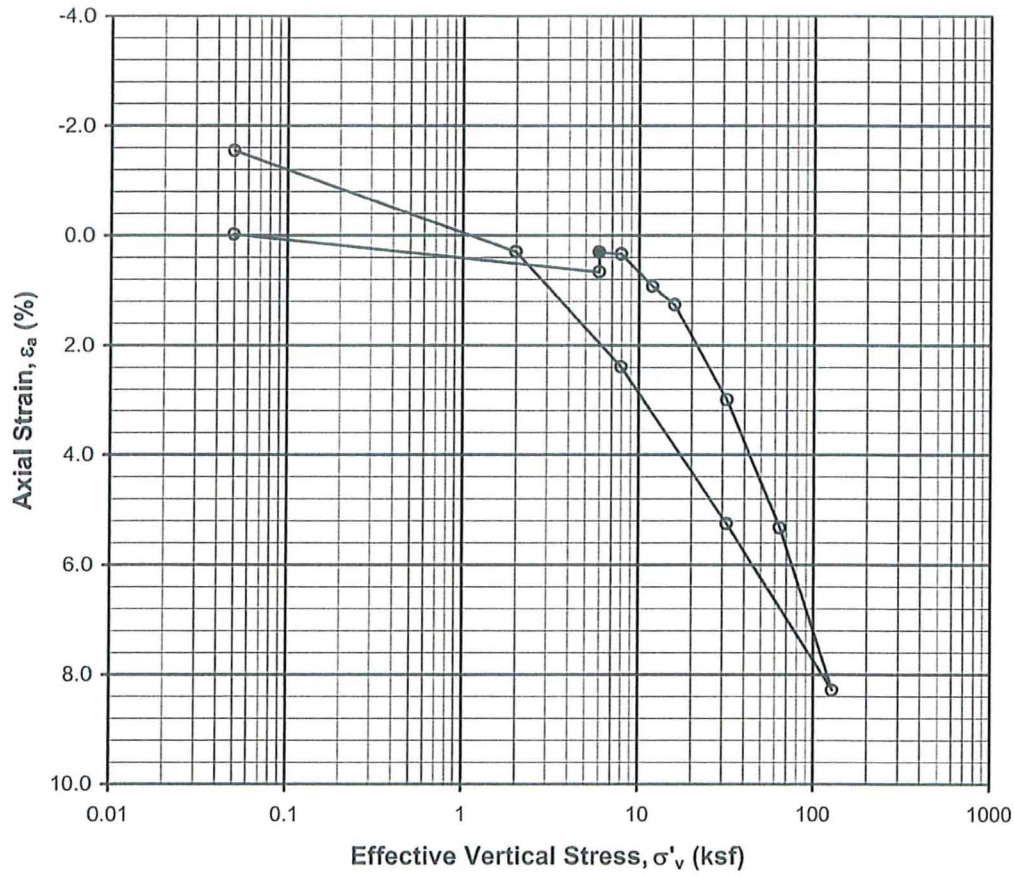


SWELL TEST

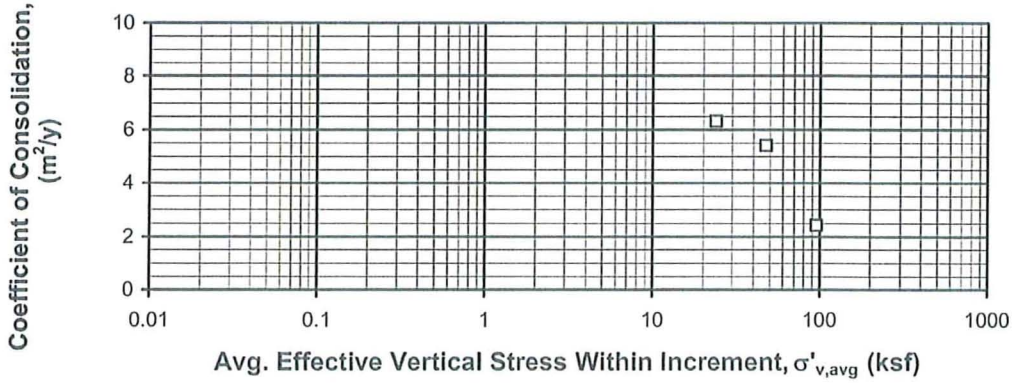
Sample No. 12 - Depth 68.00 ft

Boring B-1037

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

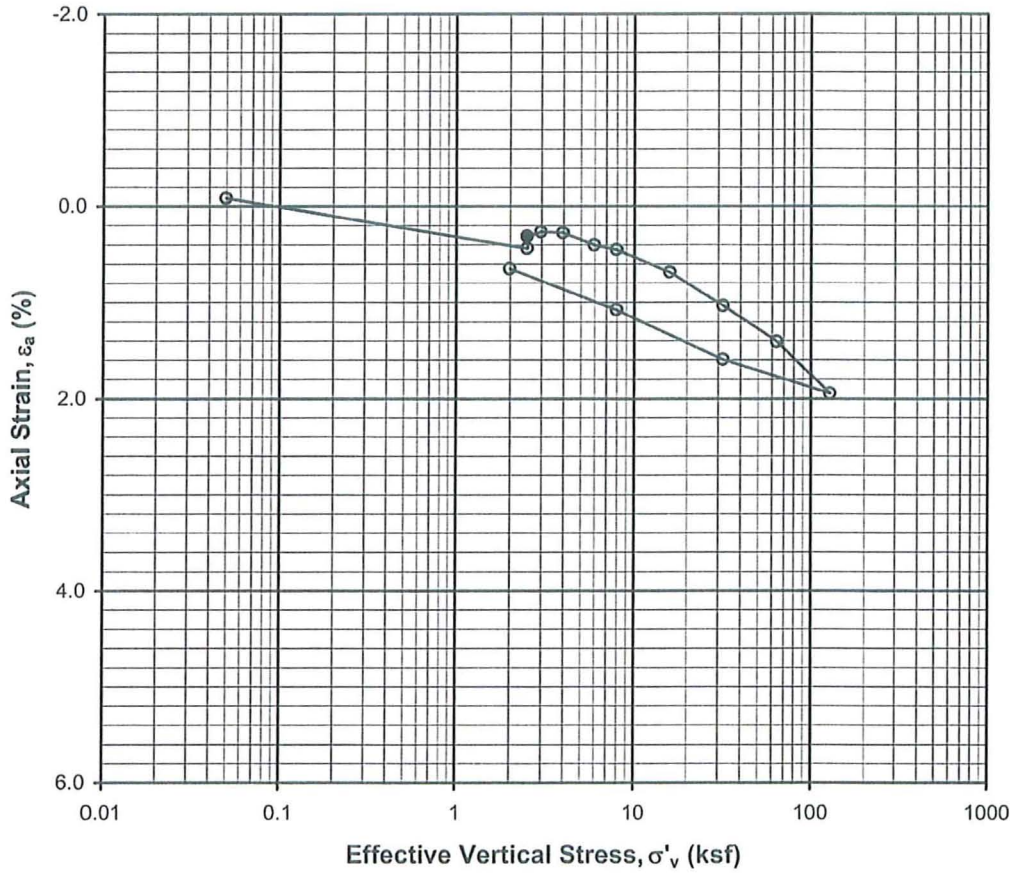


SWELL TEST

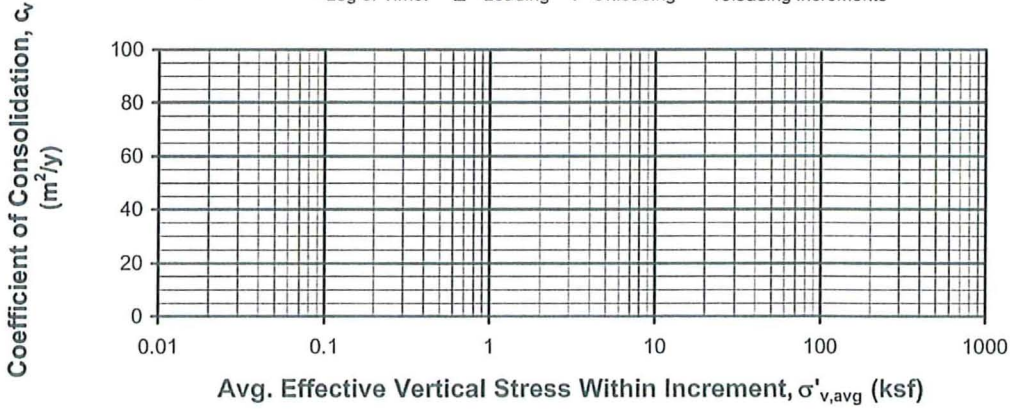
Sample No. 11 - Depth 49.00 ft

Boring B-1041

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

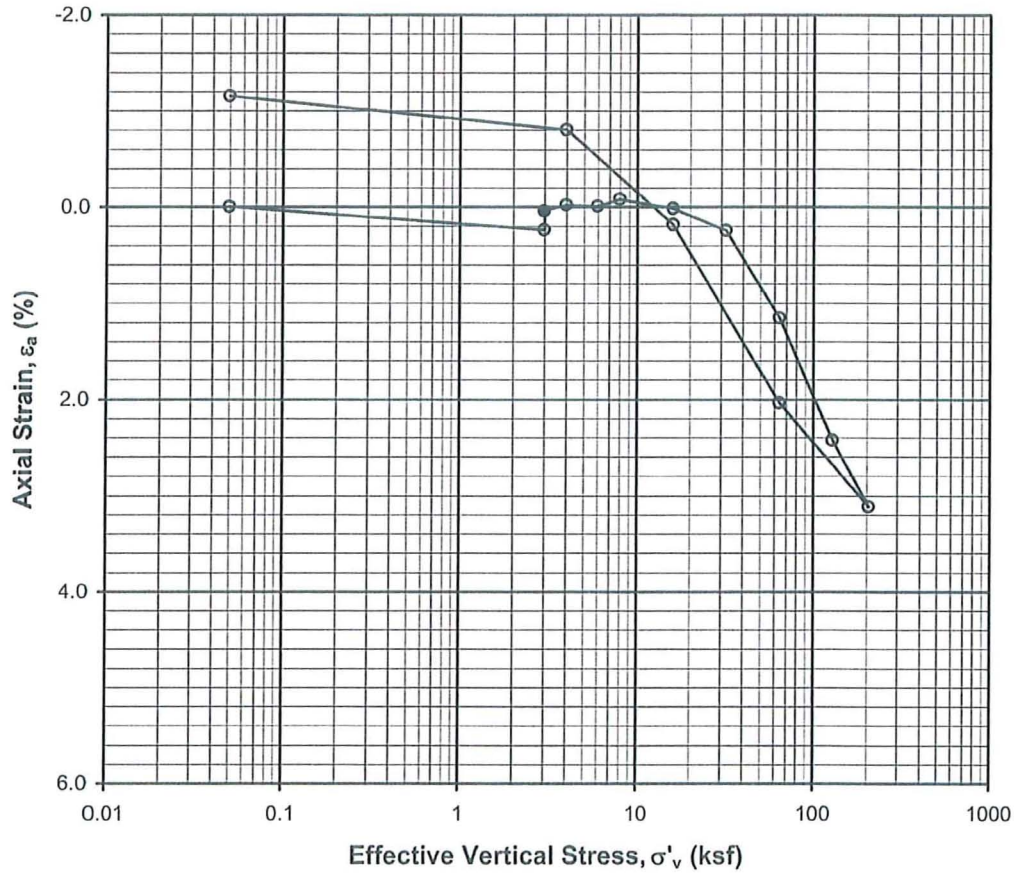


SWELL TEST

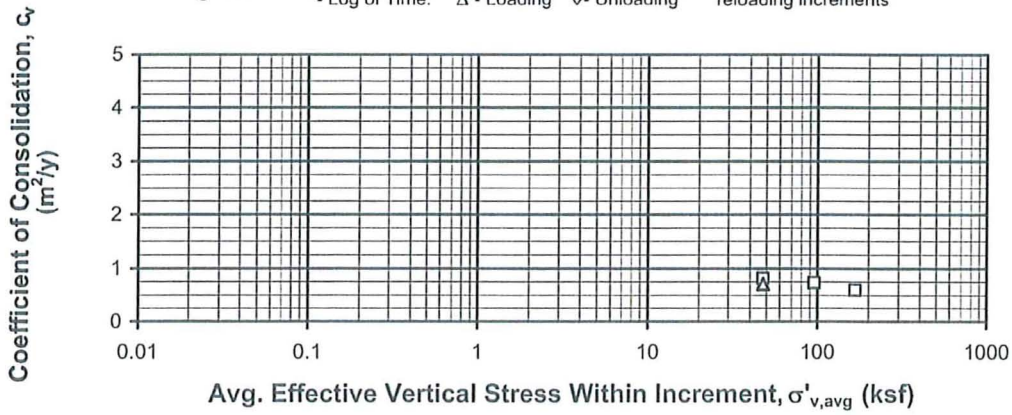
Sample No. 6 - Depth 20.20 ft

Boring B-2004

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

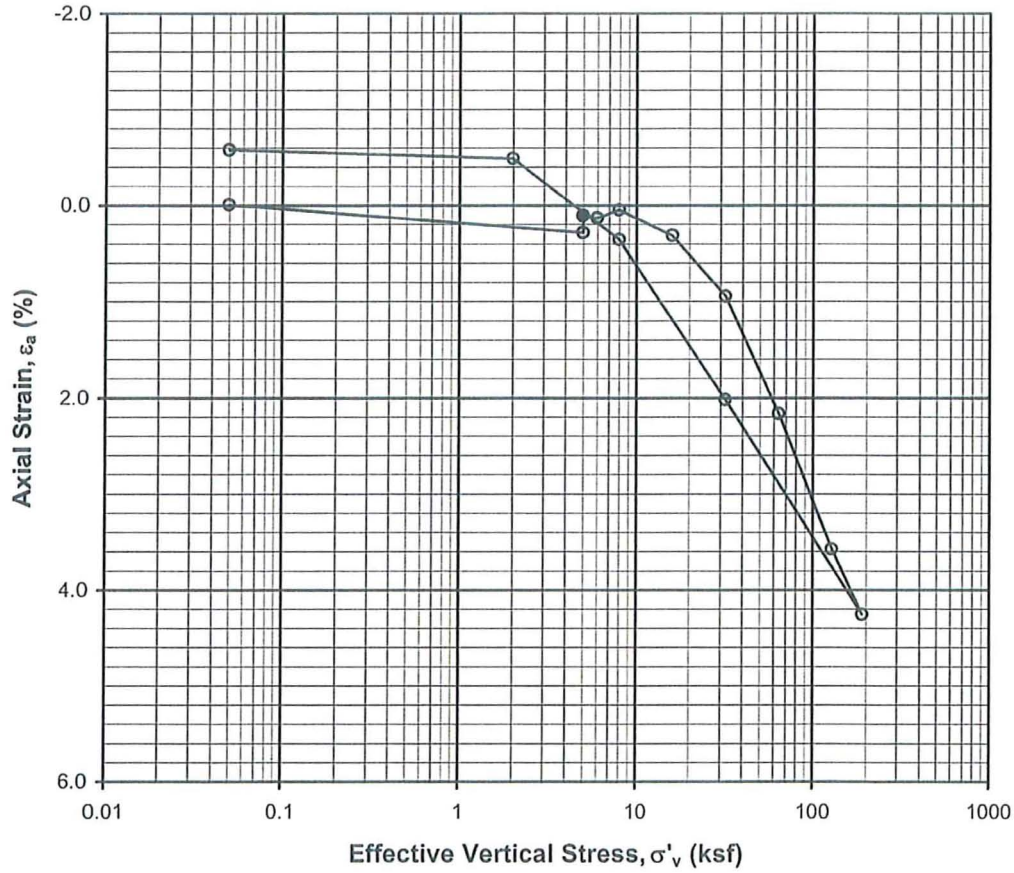


SWELL TEST

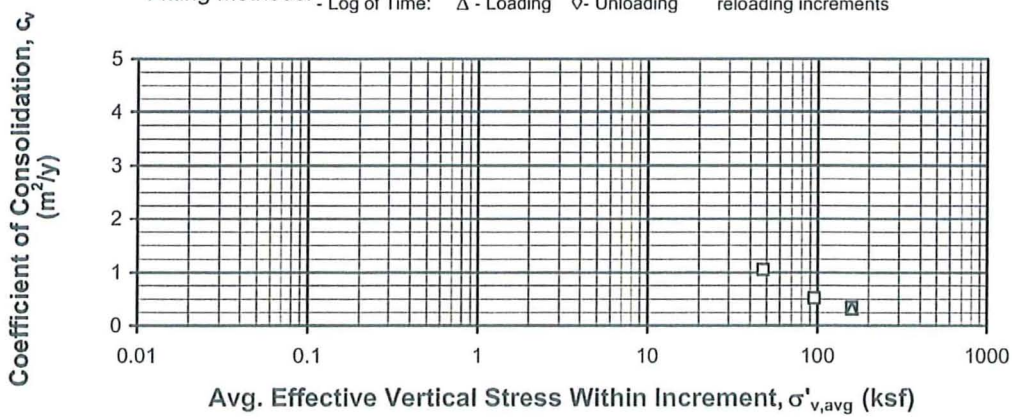
Sample No. 7 - Depth 26.30 ft

Boring B-2036

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading ○ - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments

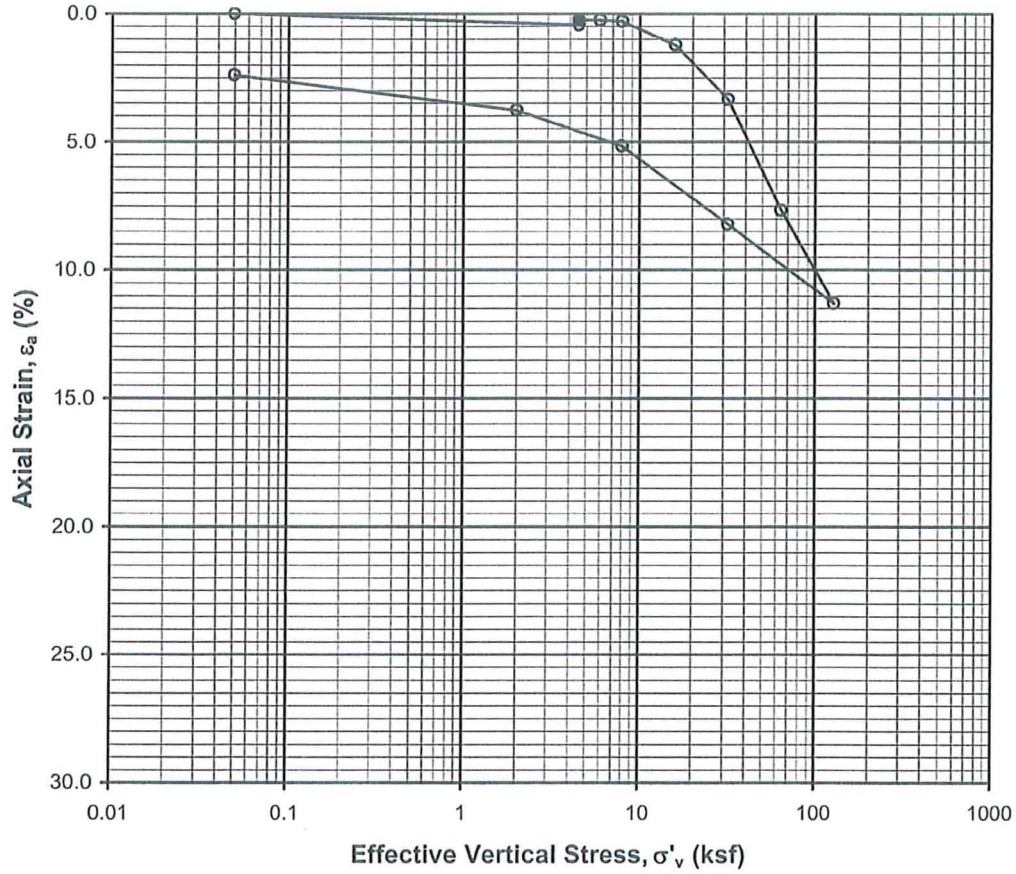


SWELL TEST

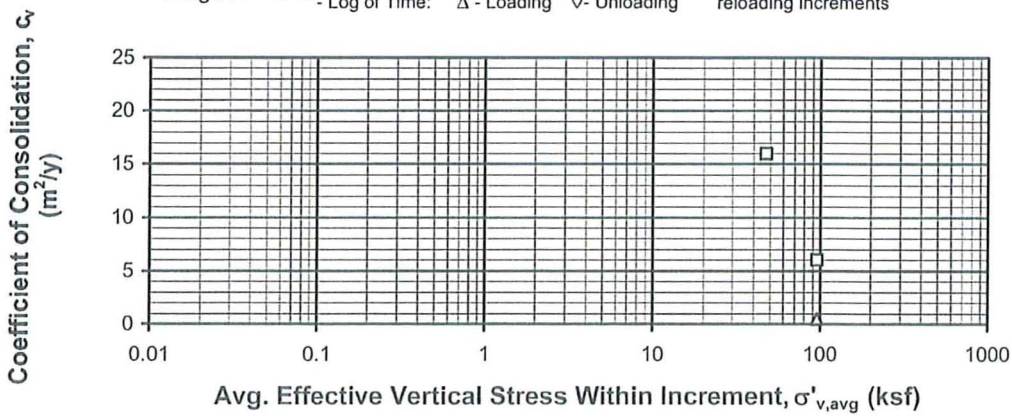
Sample No. 10 - Depth 42.30 ft

Boring B-2036

APPENDIX B-2



Fitting Methods: - Sqr. Rt. Time: □ - Loading O - Unloading
- Log of Time: Δ - Loading ◊- Unloading
with solid symbols indicating reloading increments



SWELL TEST

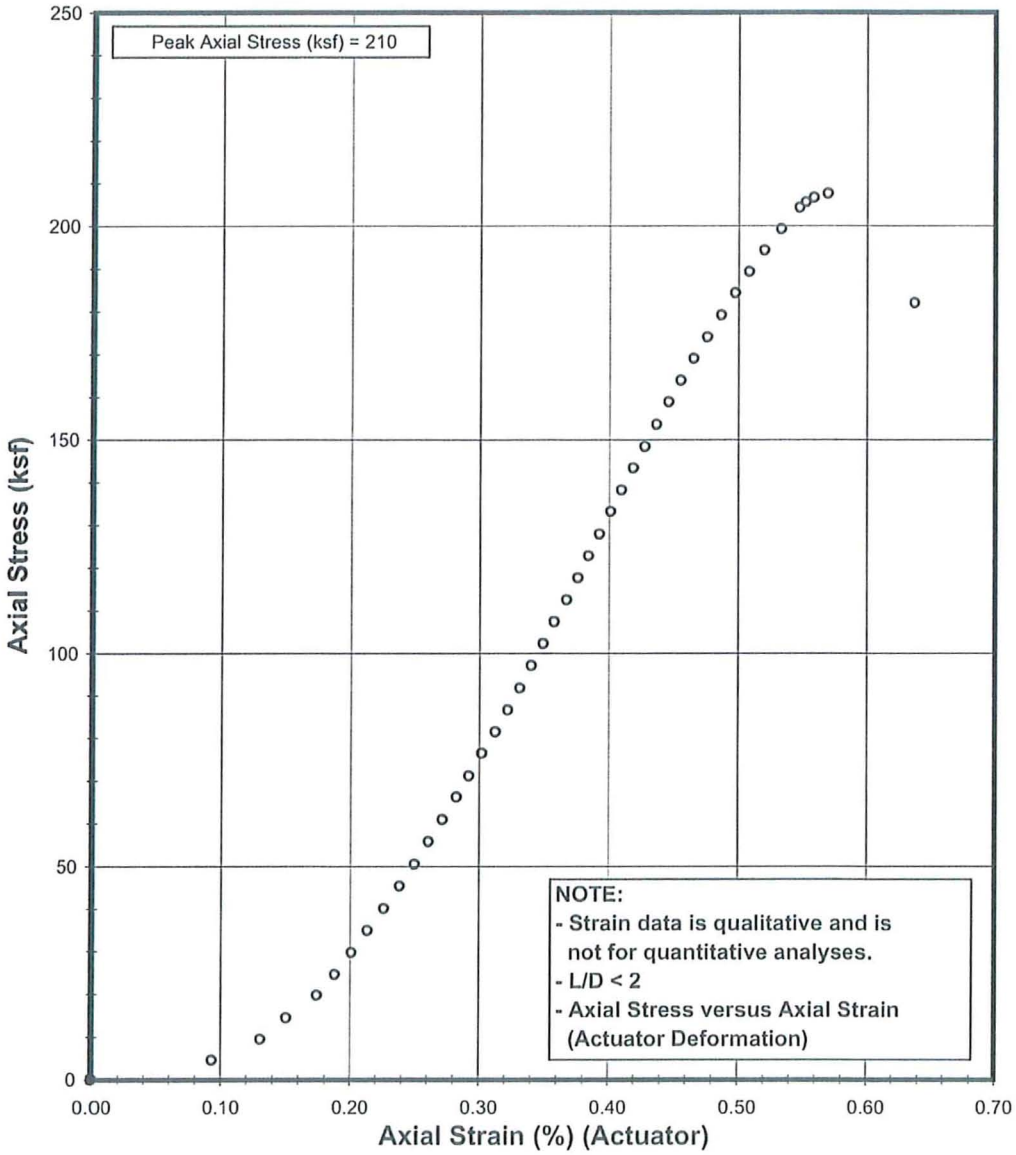
Sample No. 11 - Depth 37.10 ft

Boring B-2042a

APPENDIX C-1

Unconfined Compression Test Results

APPENDIX C-1

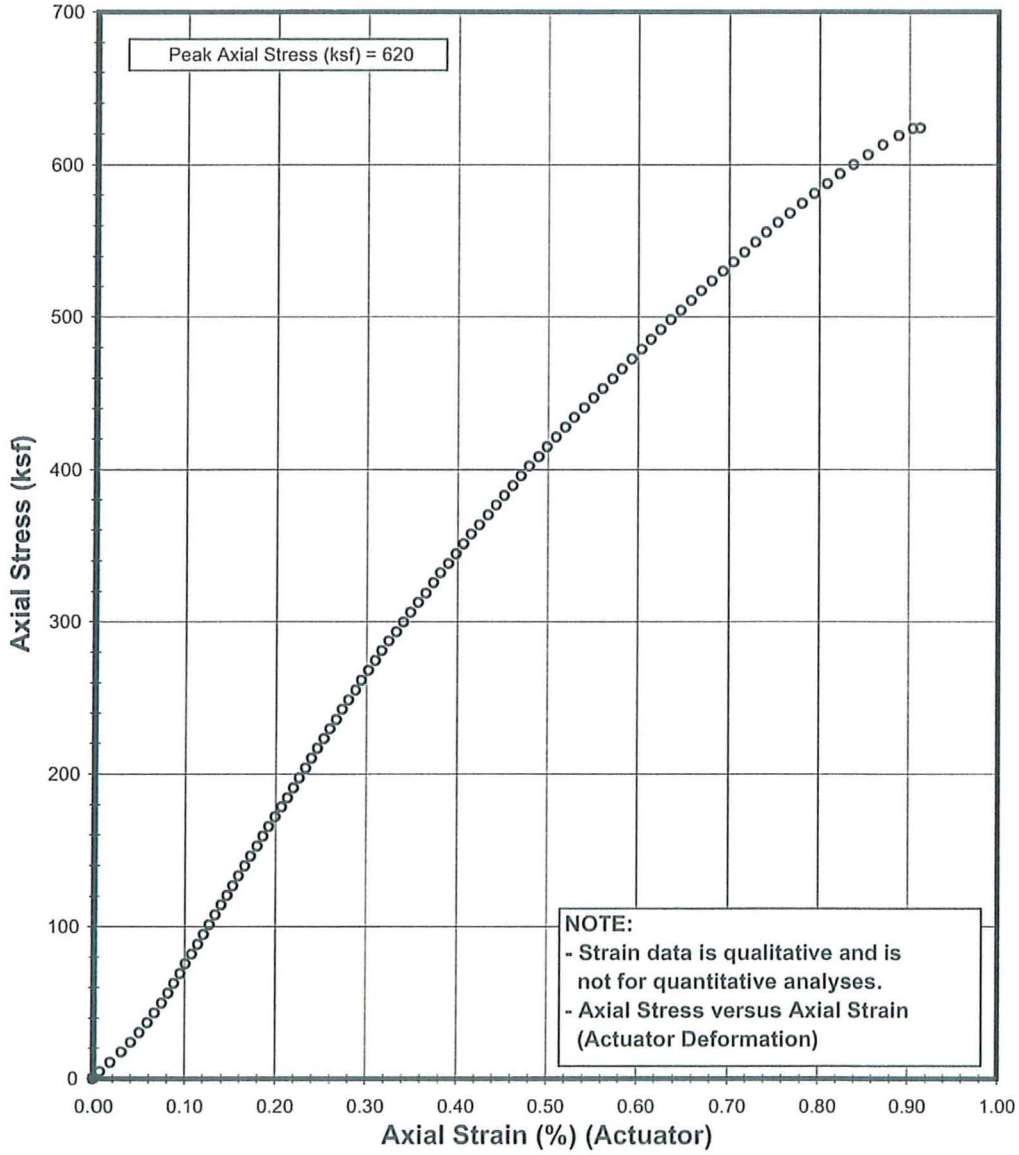


UNCONFINED COMPRESSION TEST

Sample No. 39 - Depth 212.00 ft

Boring B-1000

APPENDIX C-1

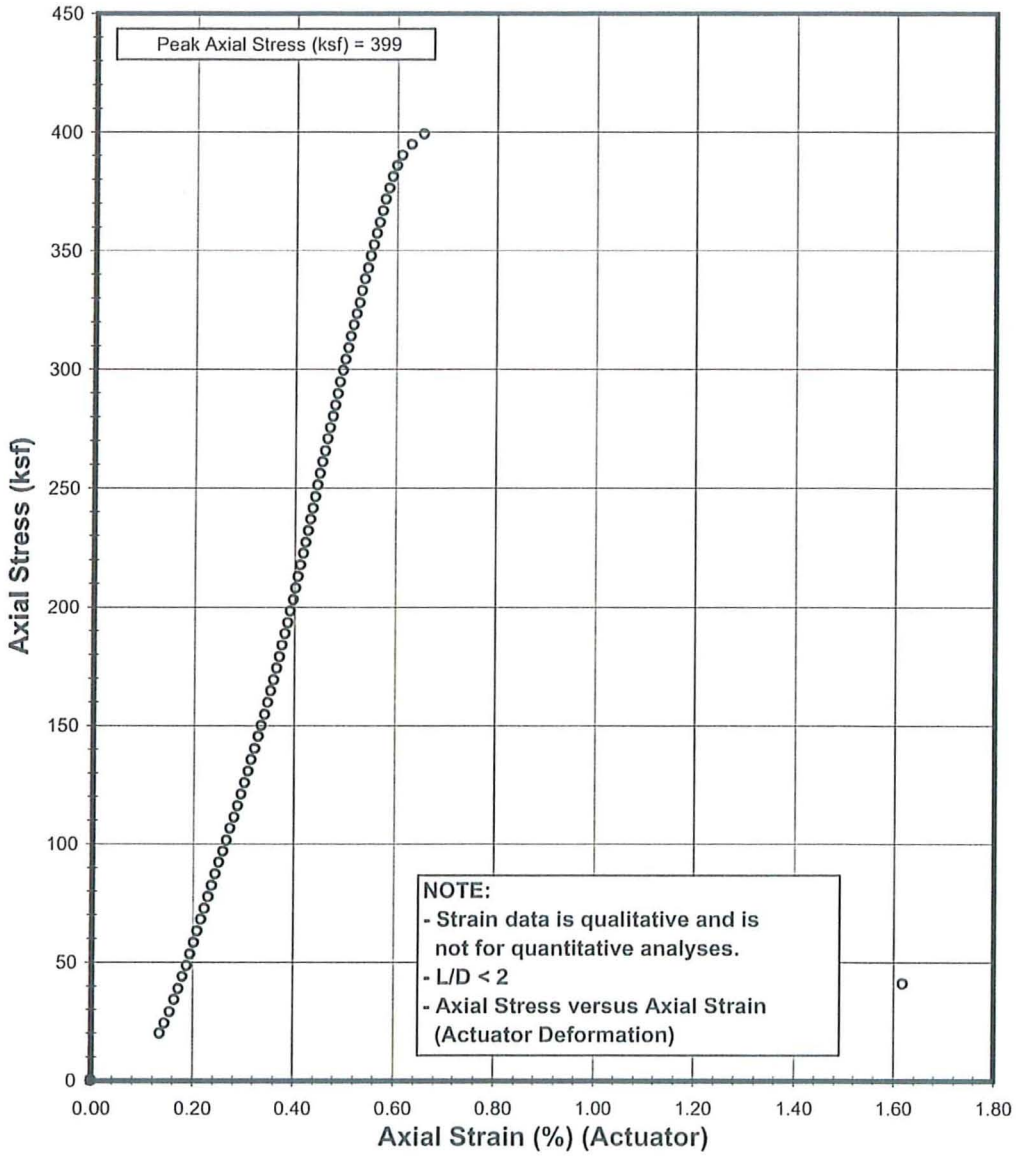


UNCONFINED COMPRESSION TEST

Sample No. 22 - Depth 89.5 - 90.1 ft

Boring B-1003-off

APPENDIX C-1

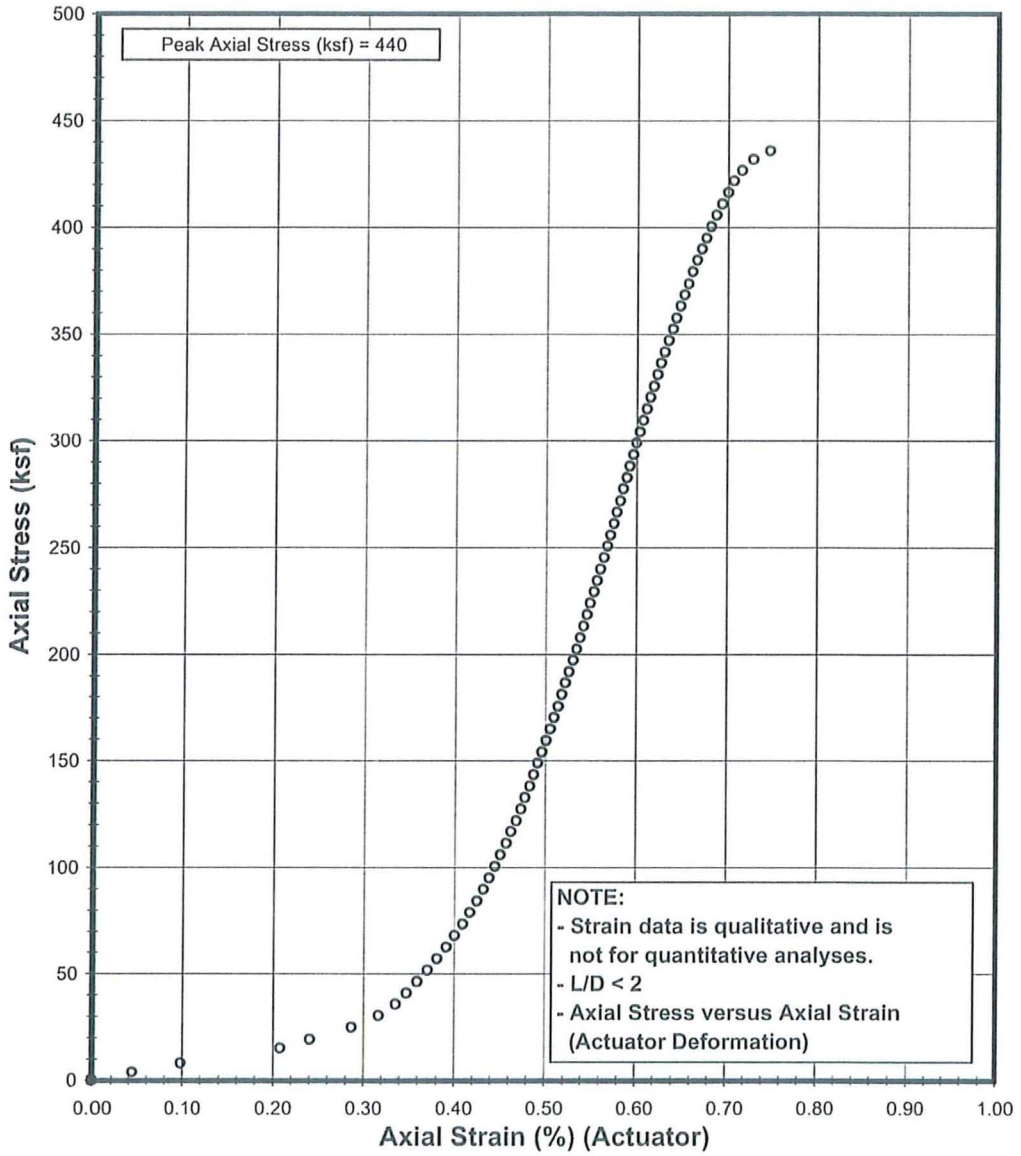


UNCONFINED COMPRESSION TEST

Sample No. 30 - Depth 130.0 ft

Boring B-1003-off

APPENDIX C-1

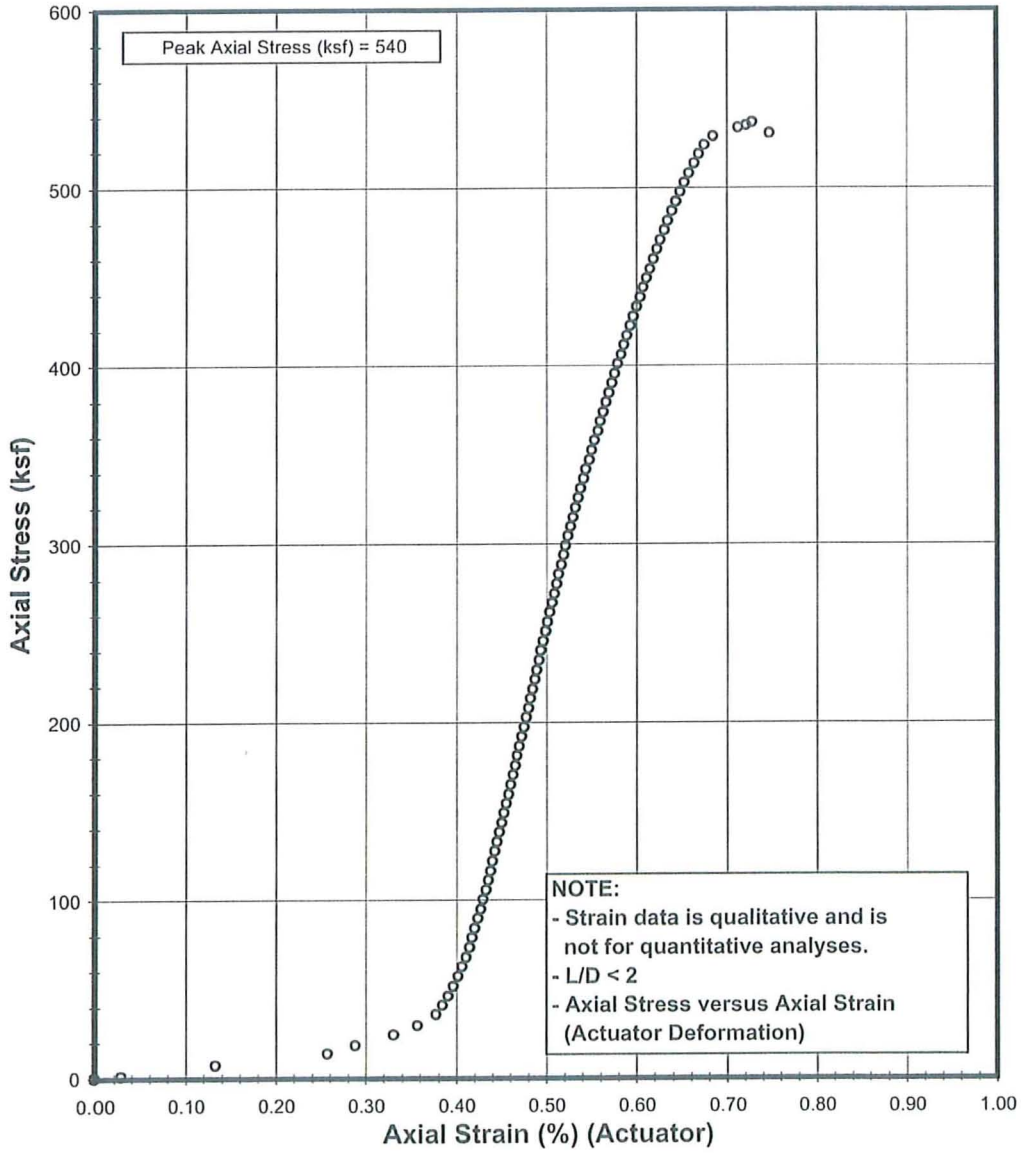


UNCONFINED COMPRESSION TEST

Sample No. 25 - Depth 103.5 - 104.0 ft

Boring B-1004

APPENDIX C-1

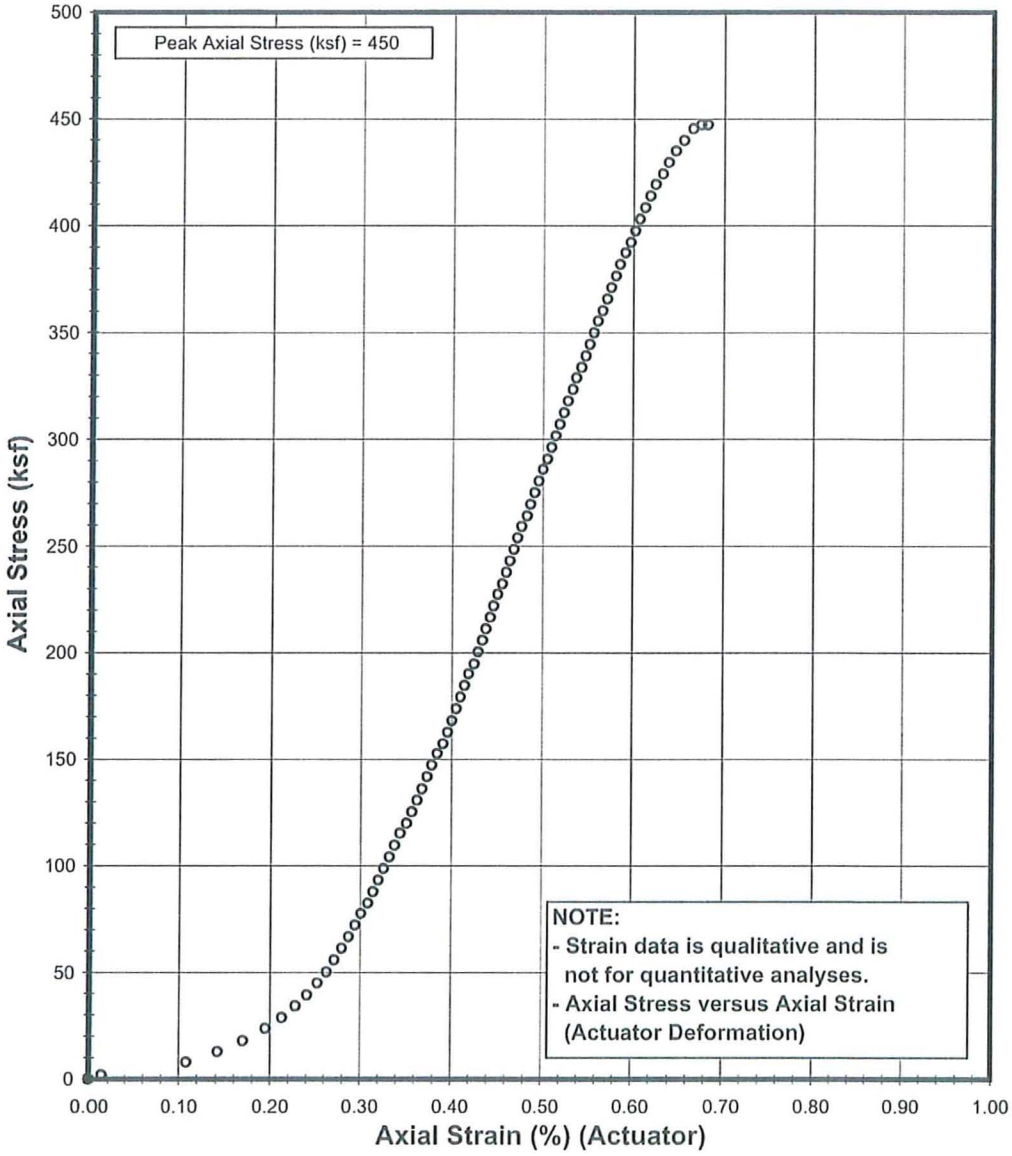


UNCONFINED COMPRESSION TEST

Sample No. 38 - Depth 175.1 - 175.6 ft

Boring B-1004

APPENDIX C-1

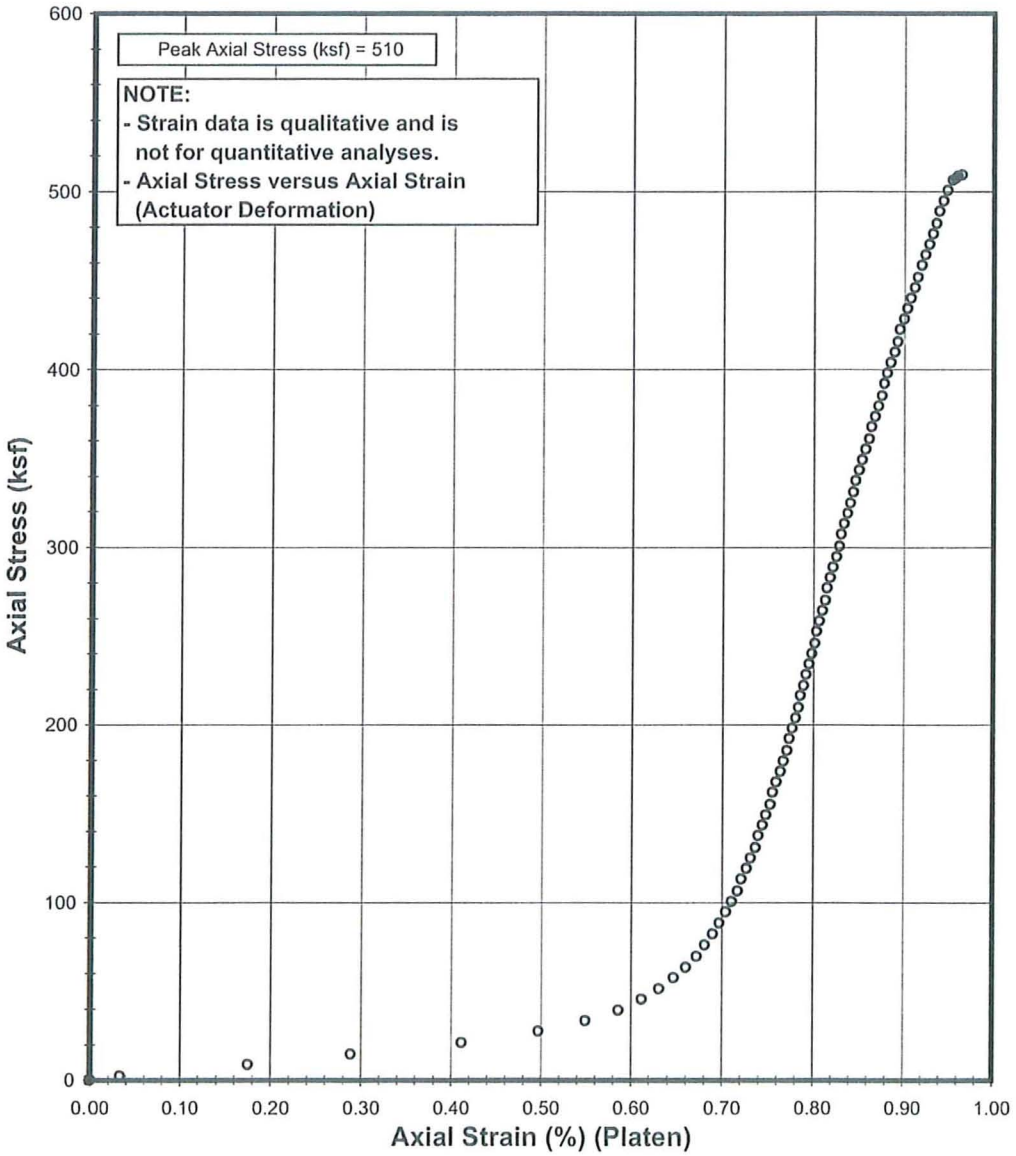


UNCONFINED COMPRESSION TEST

Sample No. 12 - Depth 44.43 - 44.80 ft

Boring B-1005

APPENDIX C-1

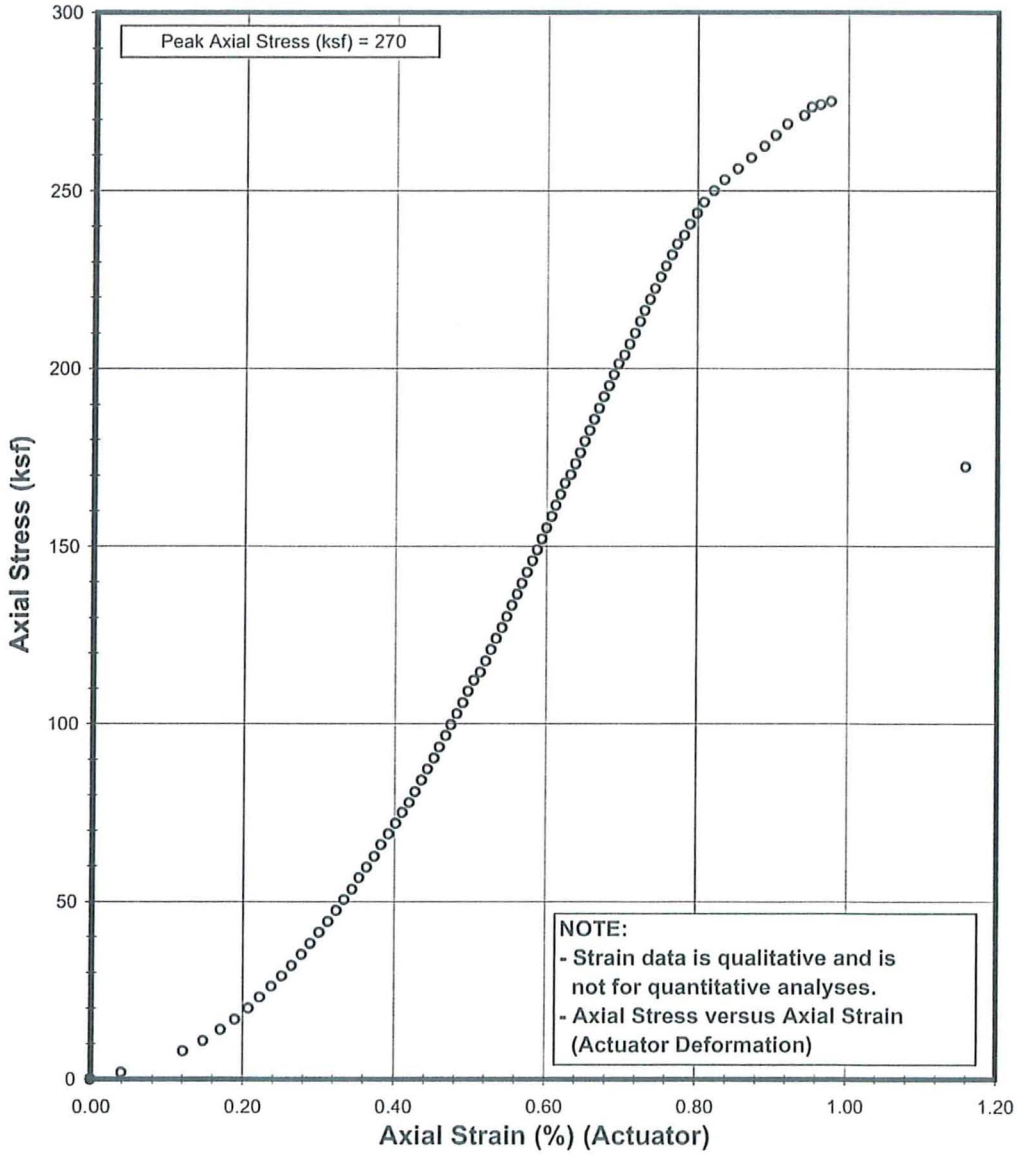


UNCONFINED COMPRESSION TEST

Sample No. 5 - Depth 40.0 - 40.5 ft

Boring B-1009-I

APPENDIX C-1

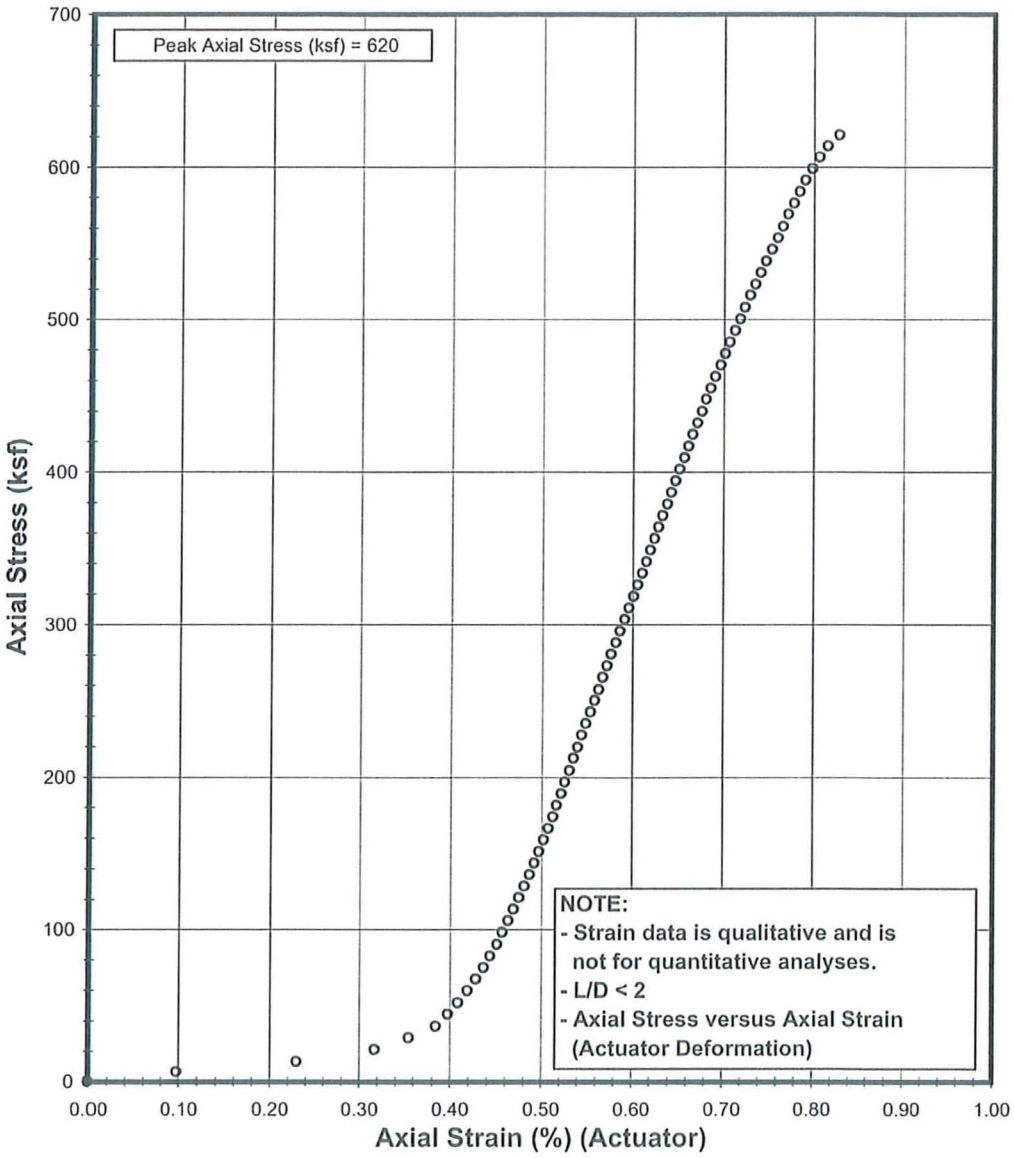


UNCONFINED COMPRESSION TEST

Sample No. 17 - Depth 84.0 - 89.0 ft

Boring B-1012

APPENDIX C-1

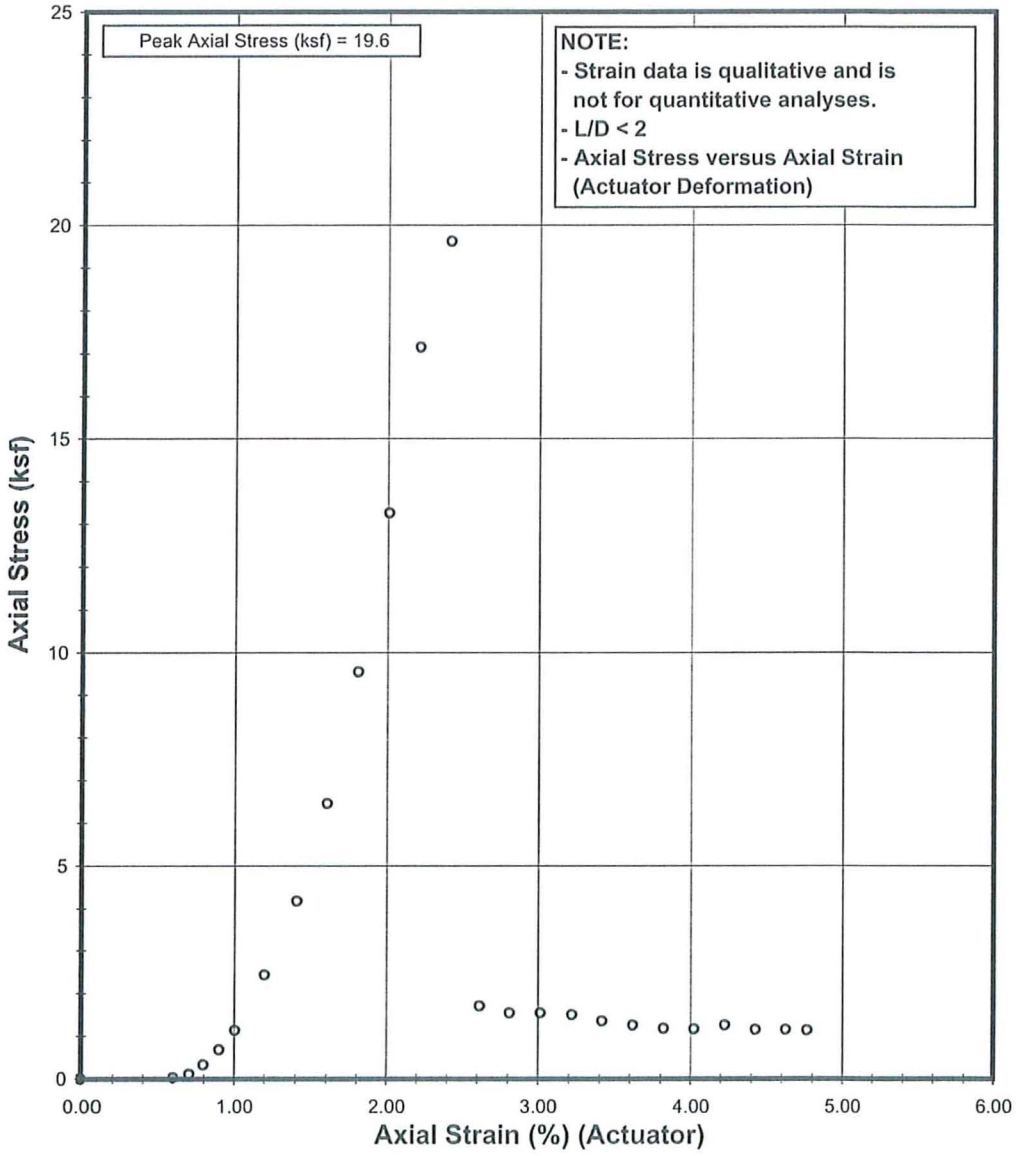


UNCONFINED COMPRESSION TEST

Sample No. 28 - Depth 139.0 - 144.0 ft

Boring B-1012

APPENDIX C-1

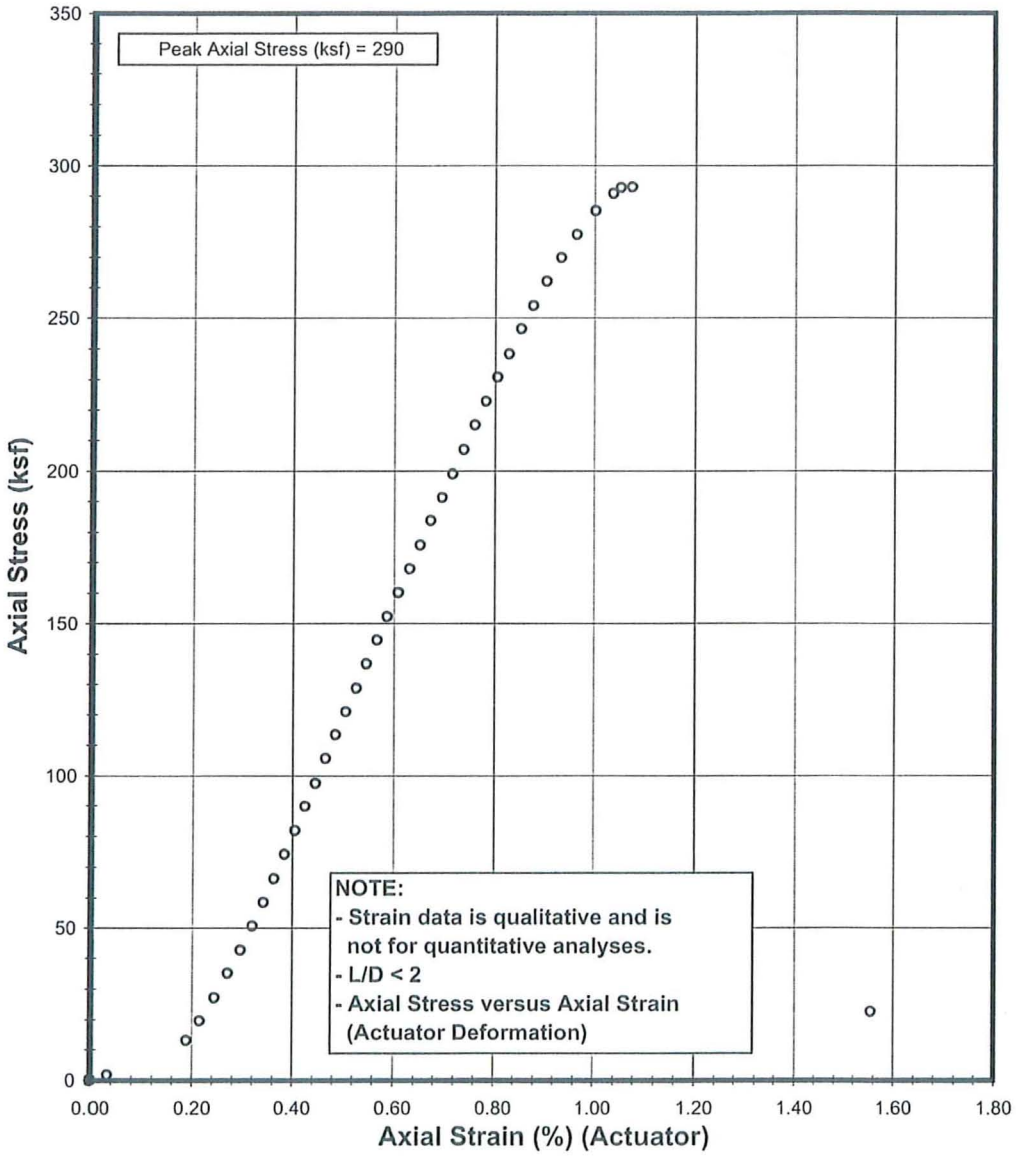


UNCONFINED COMPRESSION TEST

Sample No. 40 - Depth 269.00 ft

Boring B-1012

APPENDIX C-1

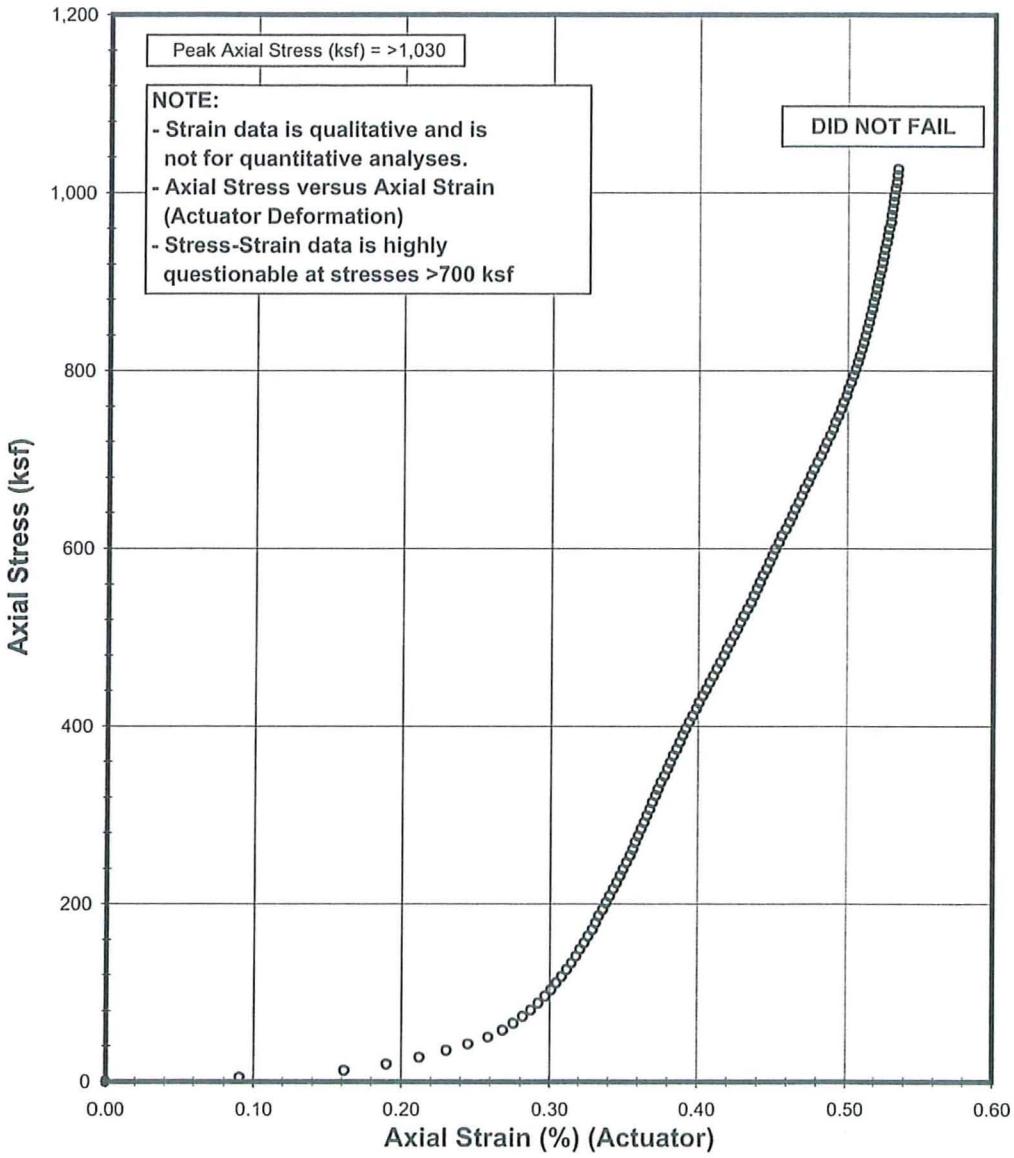


UNCONFINED COMPRESSION TEST

Sample No. 23 - Depth 110.00 ft

Boring B-1013

APPENDIX C-1

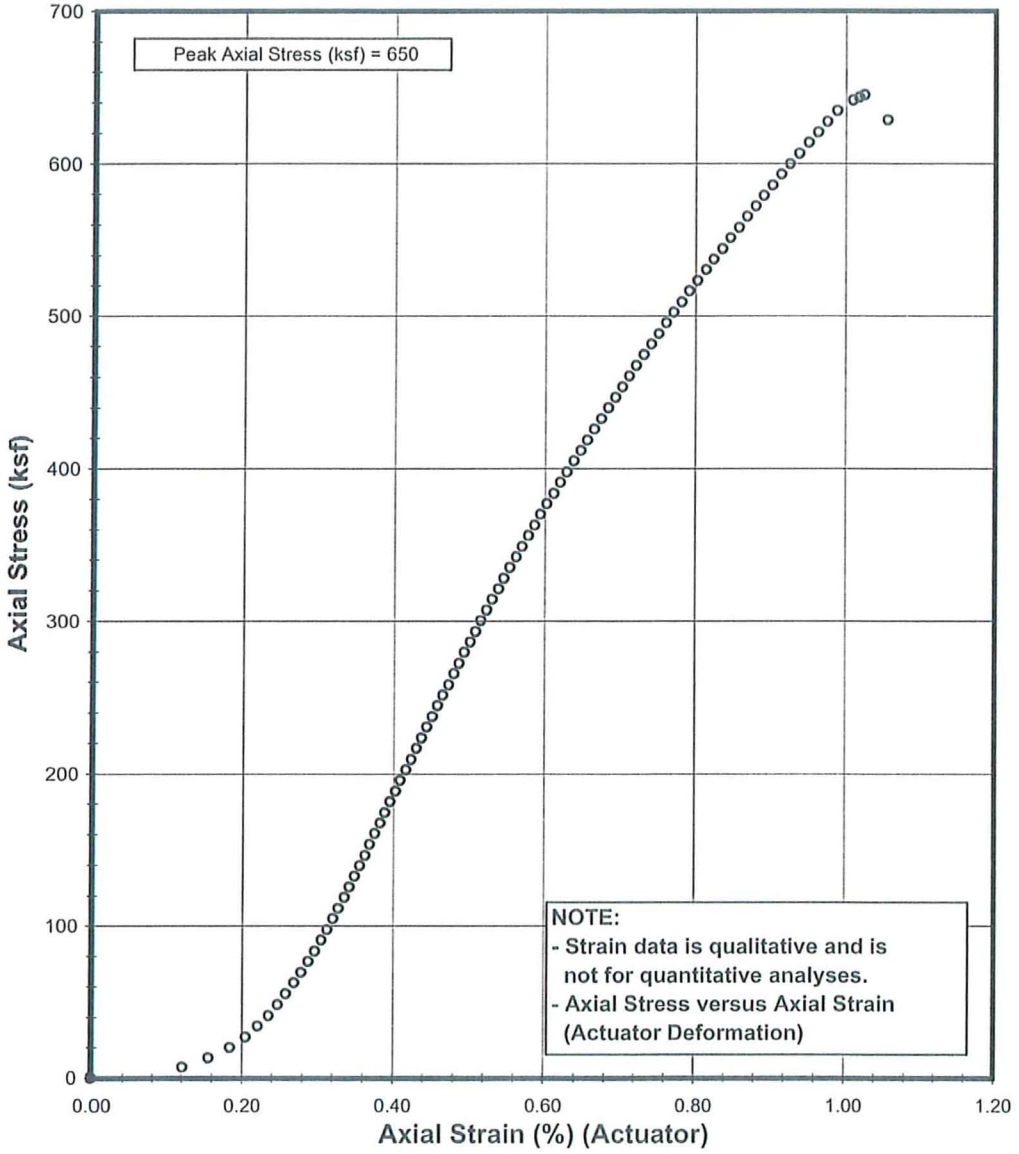


UNCONFINED COMPRESSION TEST

Sample No. 11 - Depth 31.5 - 32.0 ft

Boring B-1030

APPENDIX C-1

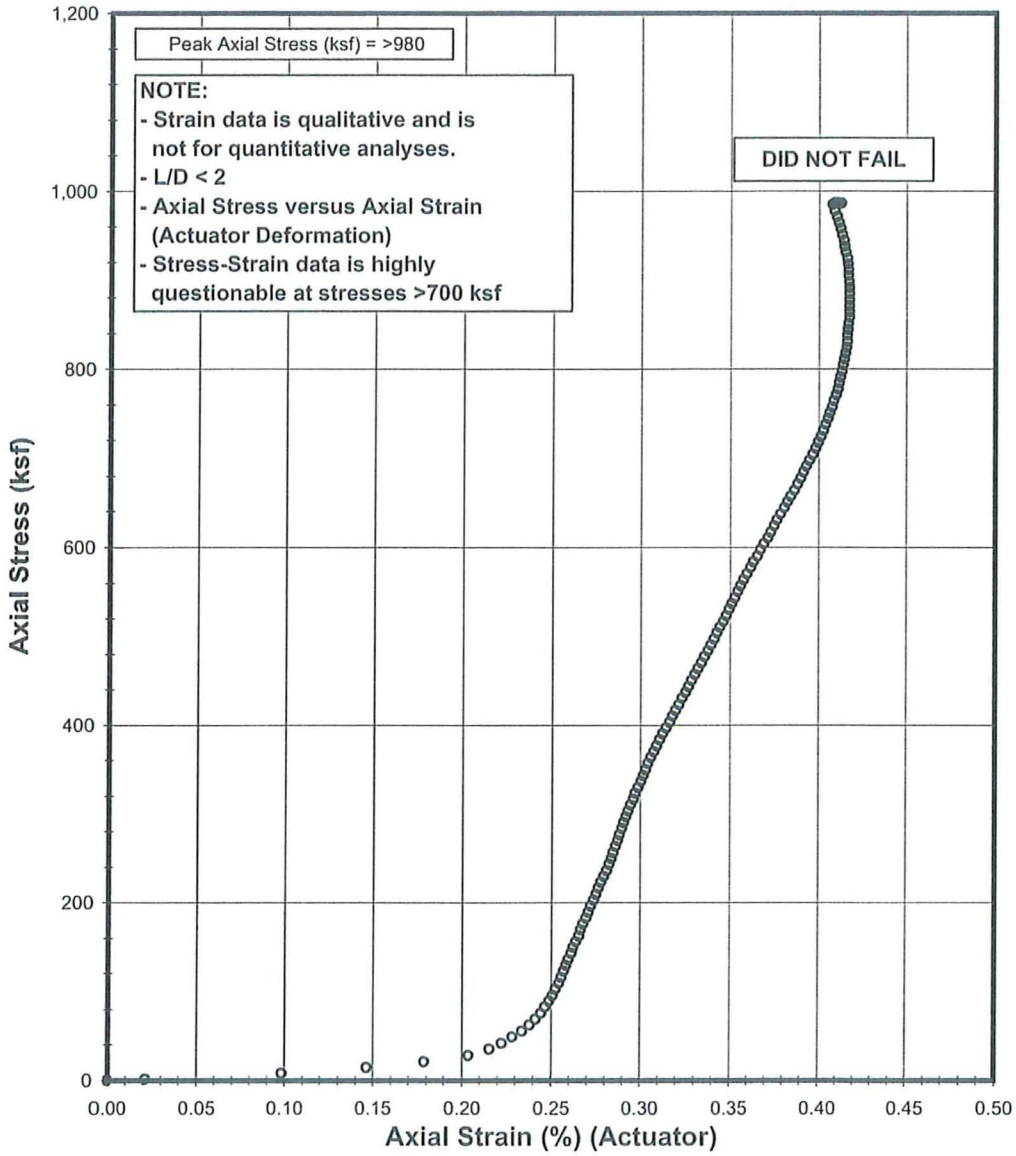


UNCONFINED COMPRESSION TEST

Sample No. 21 - Depth 92.9 - 93.4 ft

Boring B-1031

APPENDIX C-1

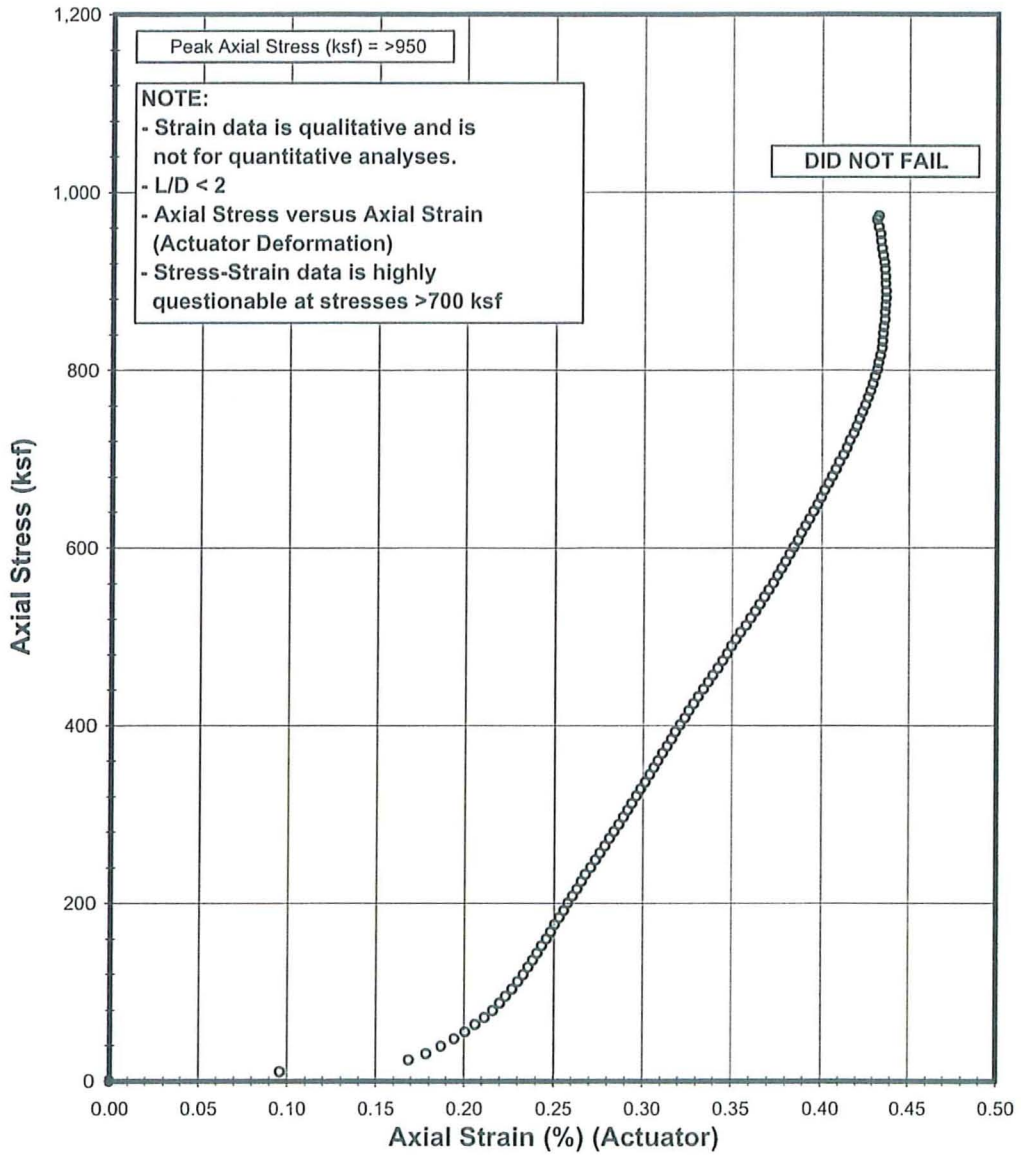


UNCONFINED COMPRESSION TEST

Sample No. 23 - Depth 98.9 - 99.4 ft

Boring B-1034

APPENDIX C-1

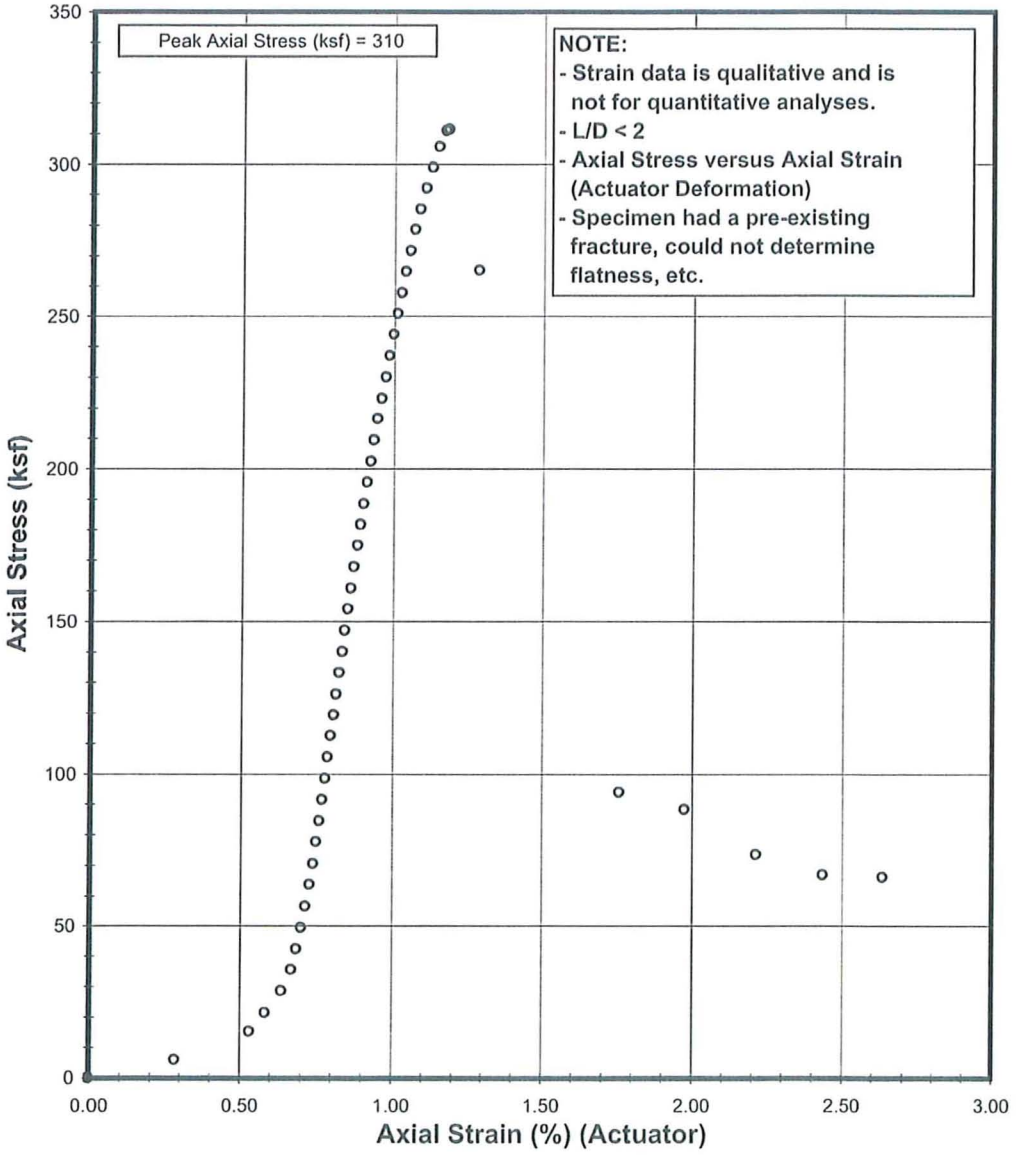


UNCONFINED COMPRESSION TEST

Sample No. 7 - Depth 24.1 - 24.6 ft

Boring B-1035

APPENDIX C-1

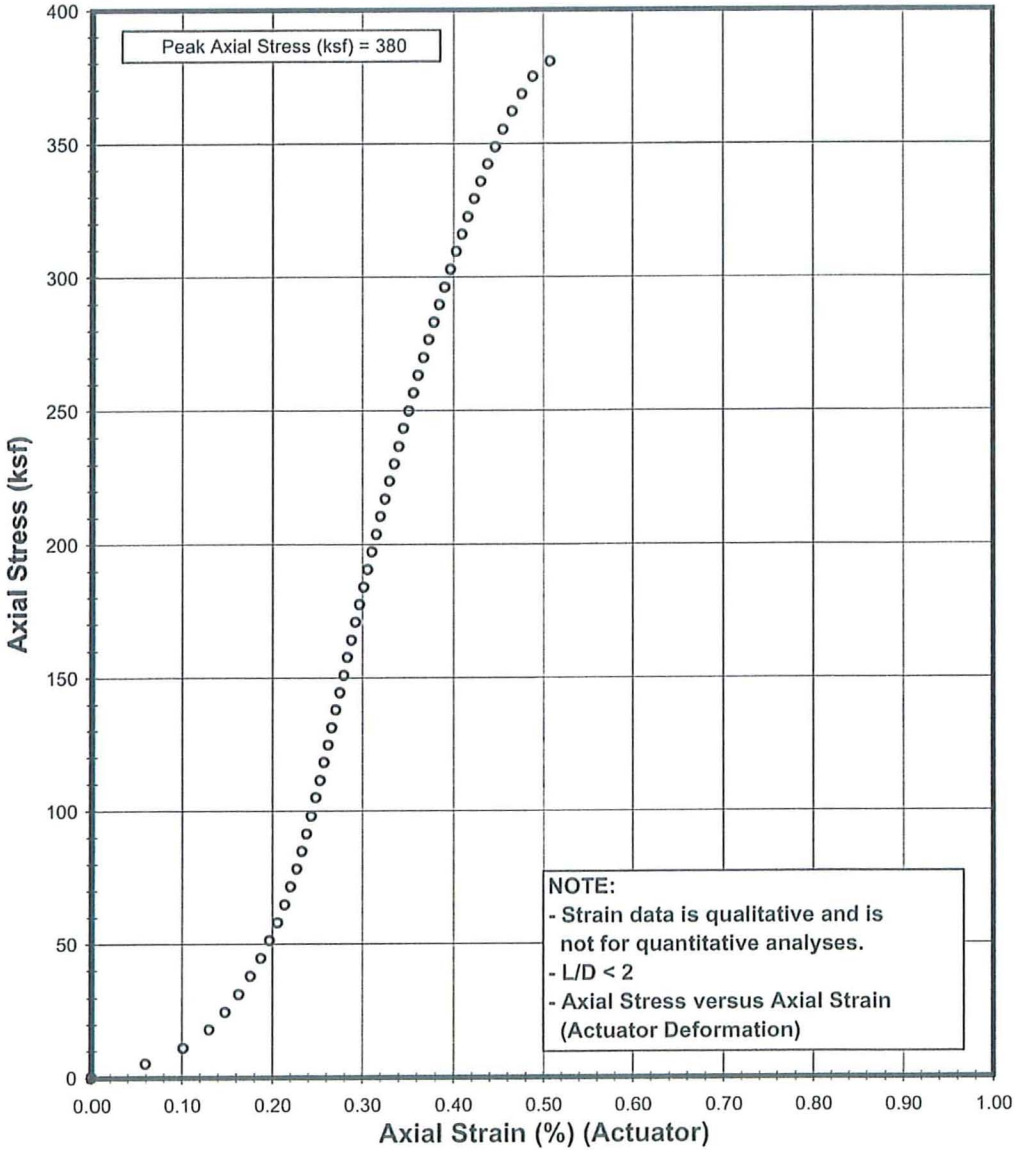


UNCONFINED COMPRESSION TEST

Sample No. 9 - Depth 37.5 - 38.0 ft

Boring B-1041

APPENDIX C-1

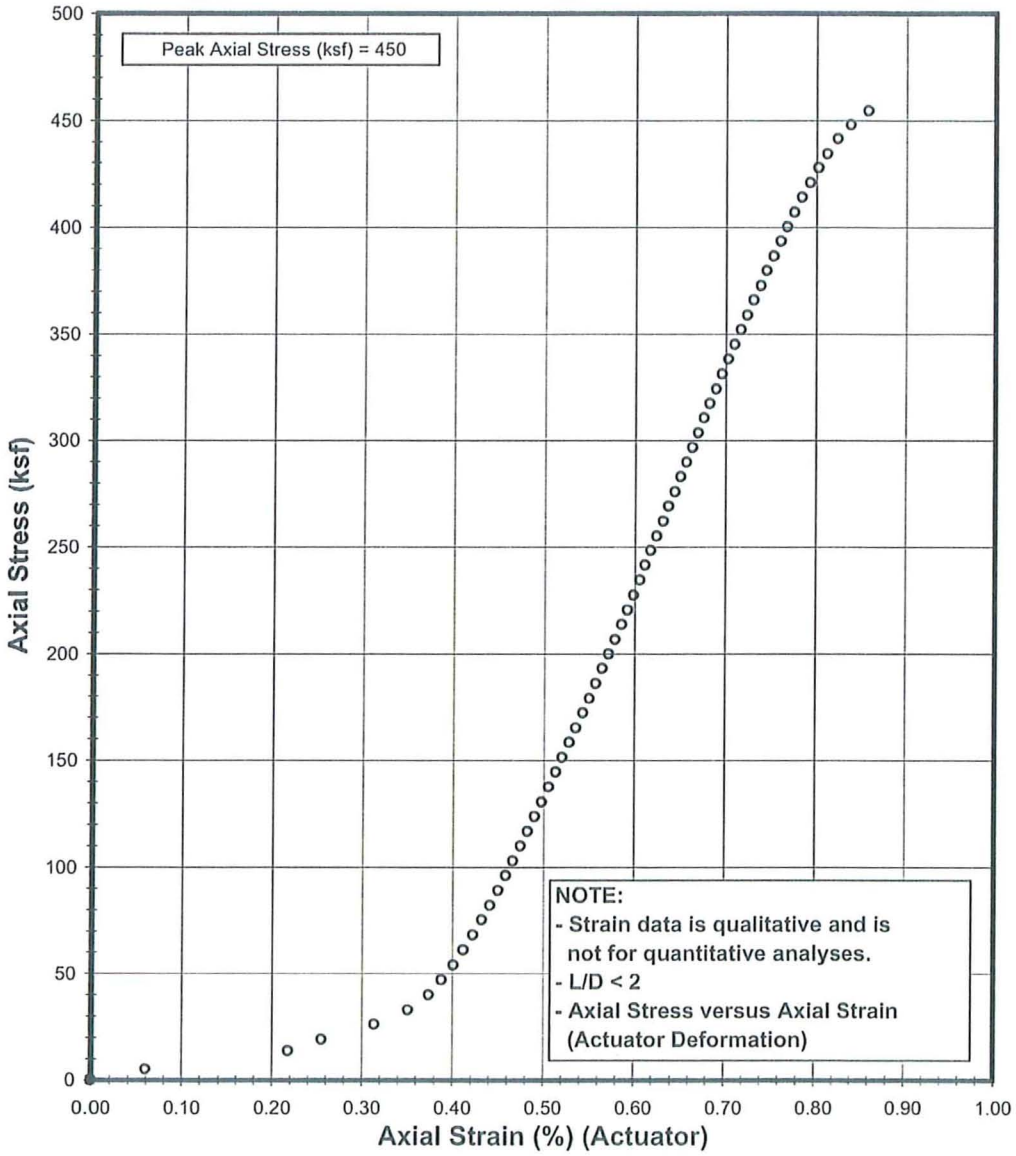


UNCONFINED COMPRESSION TEST

Sample No. 17 - Depth 77.7 - 78.2 ft

Boring B-1041

APPENDIX C-1

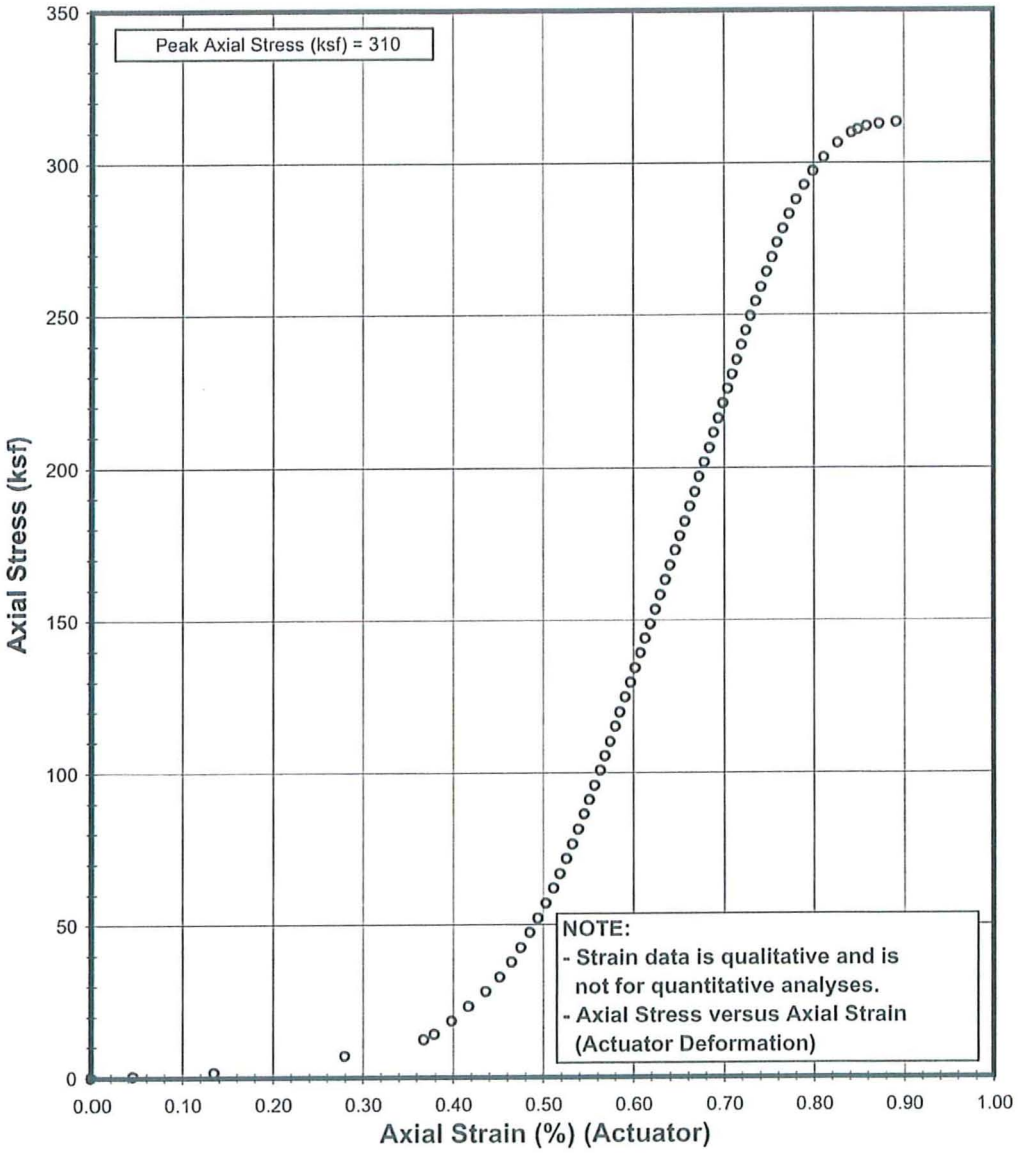


UNCONFINED COMPRESSION TEST

Sample No. 20 - Depth 92.5 - 93.0 ft

Boring B-1041

APPENDIX C-1

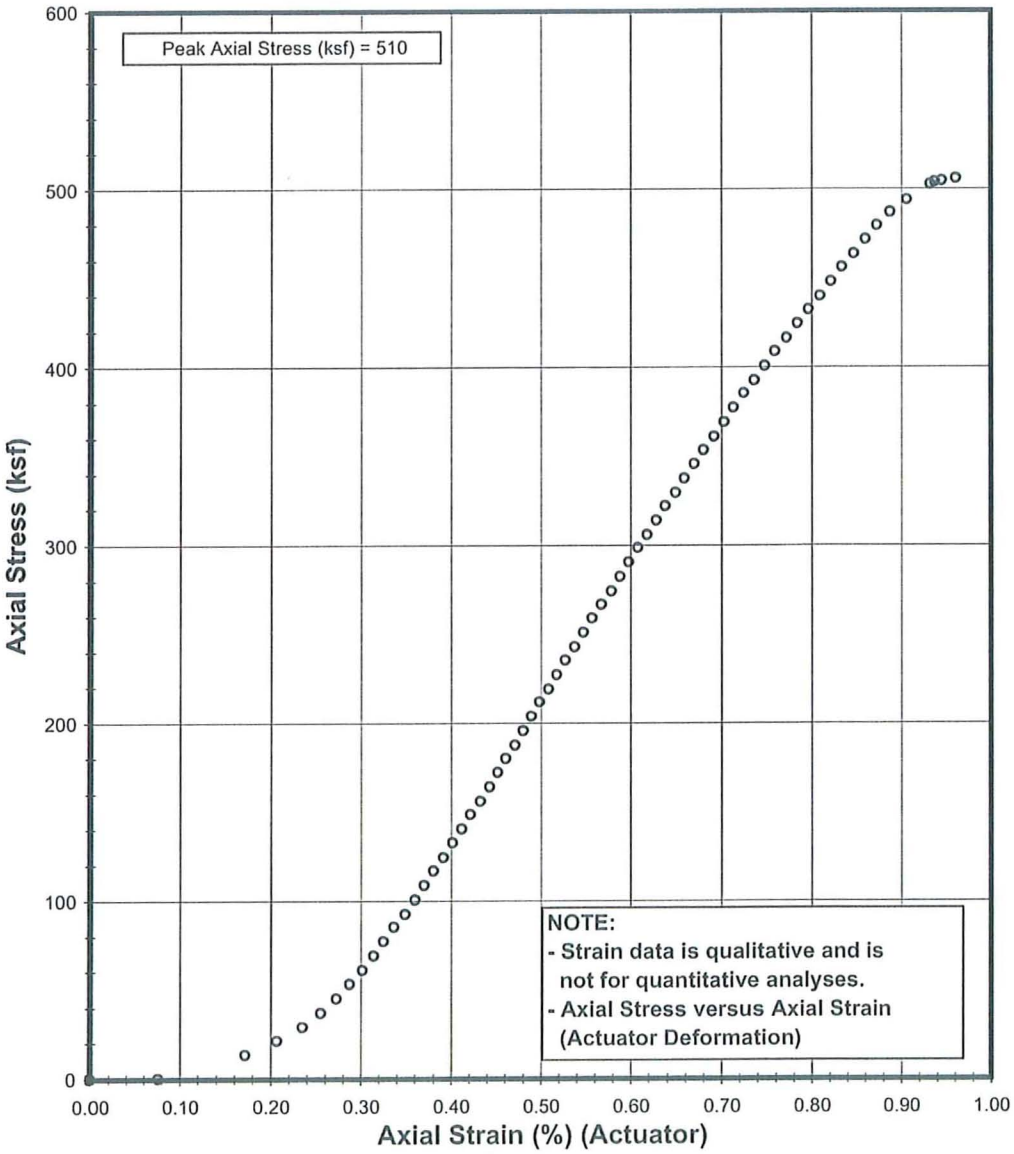


UNCONFINED COMPRESSION TEST

Sample No. 21 - Depth 88.4 - 88.9 ft

Boring B-1042

APPENDIX C-1

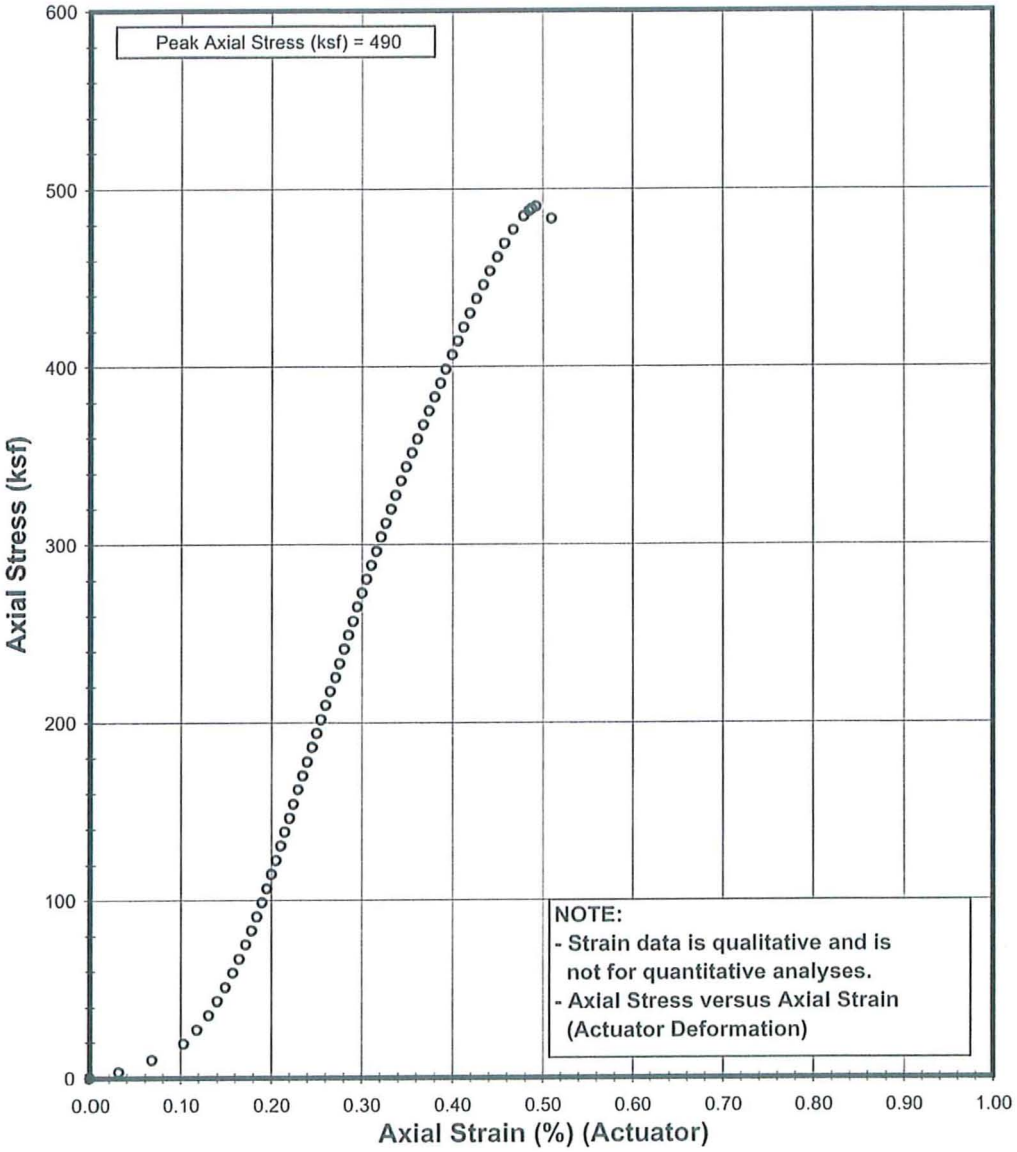


UNCONFINED COMPRESSION TEST

Sample No. 13 - Depth 79.8 - 80.3 ft

Boring B-2000

APPENDIX C-1

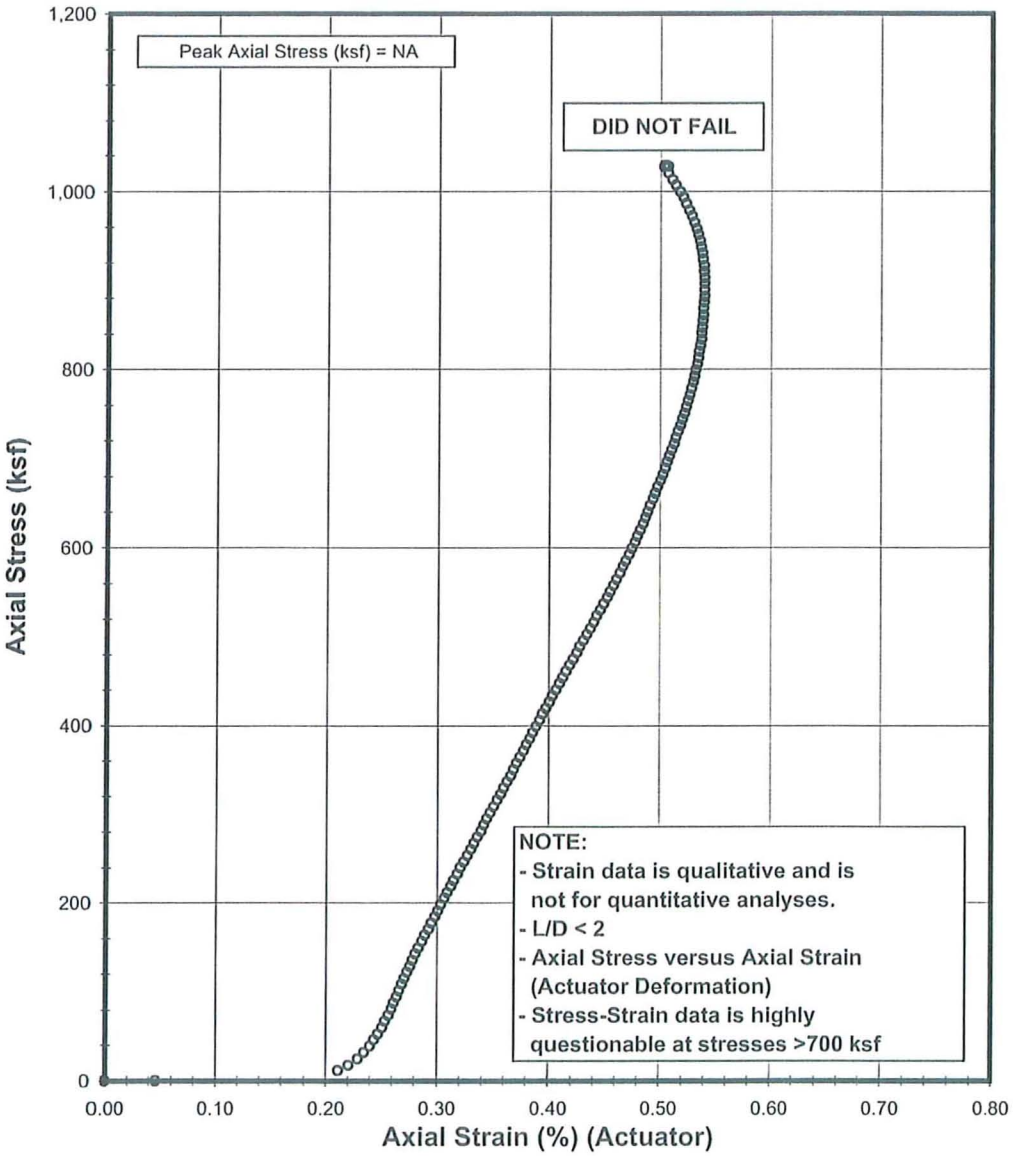


UNCONFINED COMPRESSION TEST

Sample No. 17 - Depth 101.3 - 101.8 ft

Boring B-2000

APPENDIX C-1

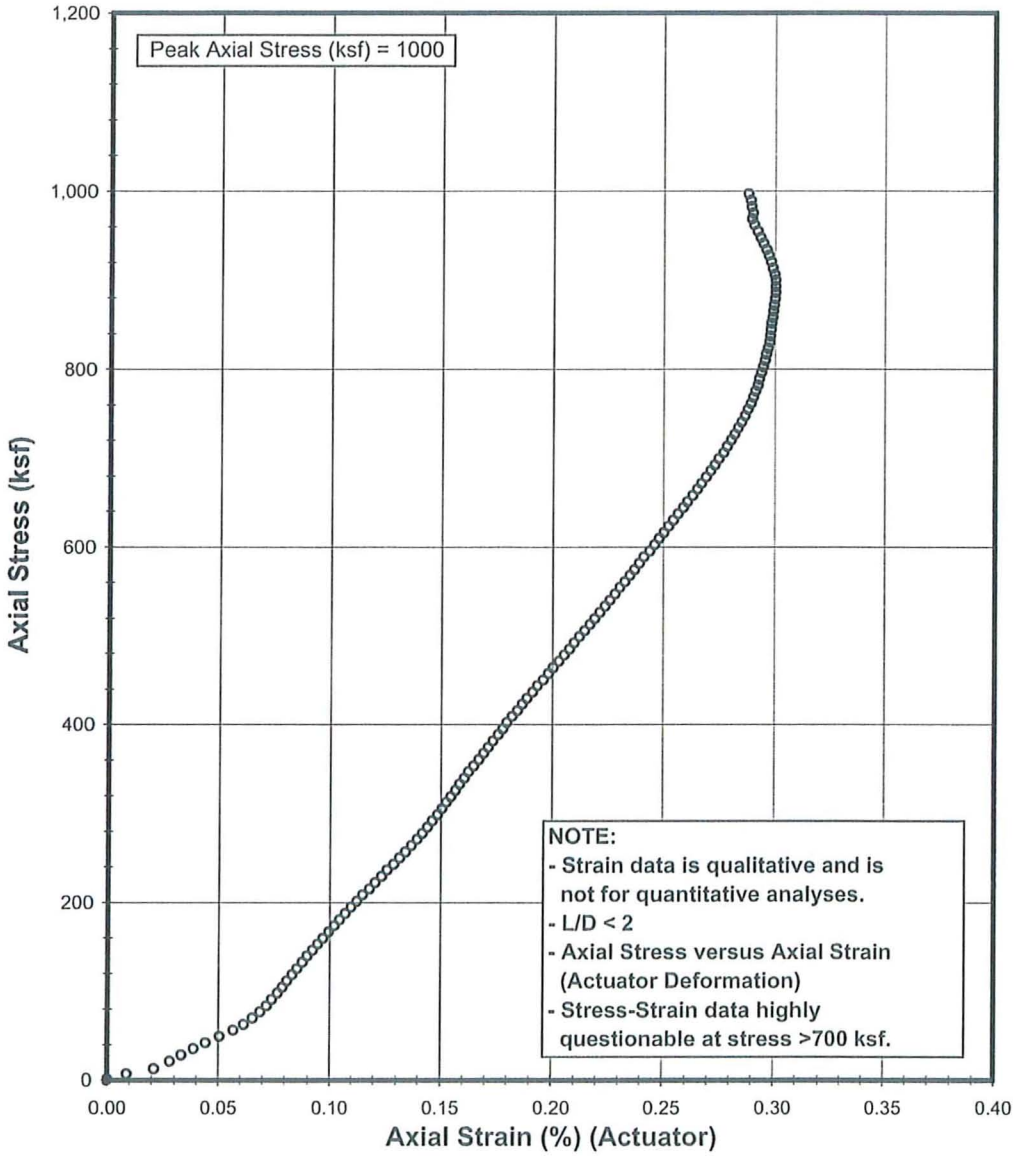


UNCONFINED COMPRESSION TEST

Sample No. 18 - Depth 106.0 ft

Boring B-2000

APPENDIX C-1

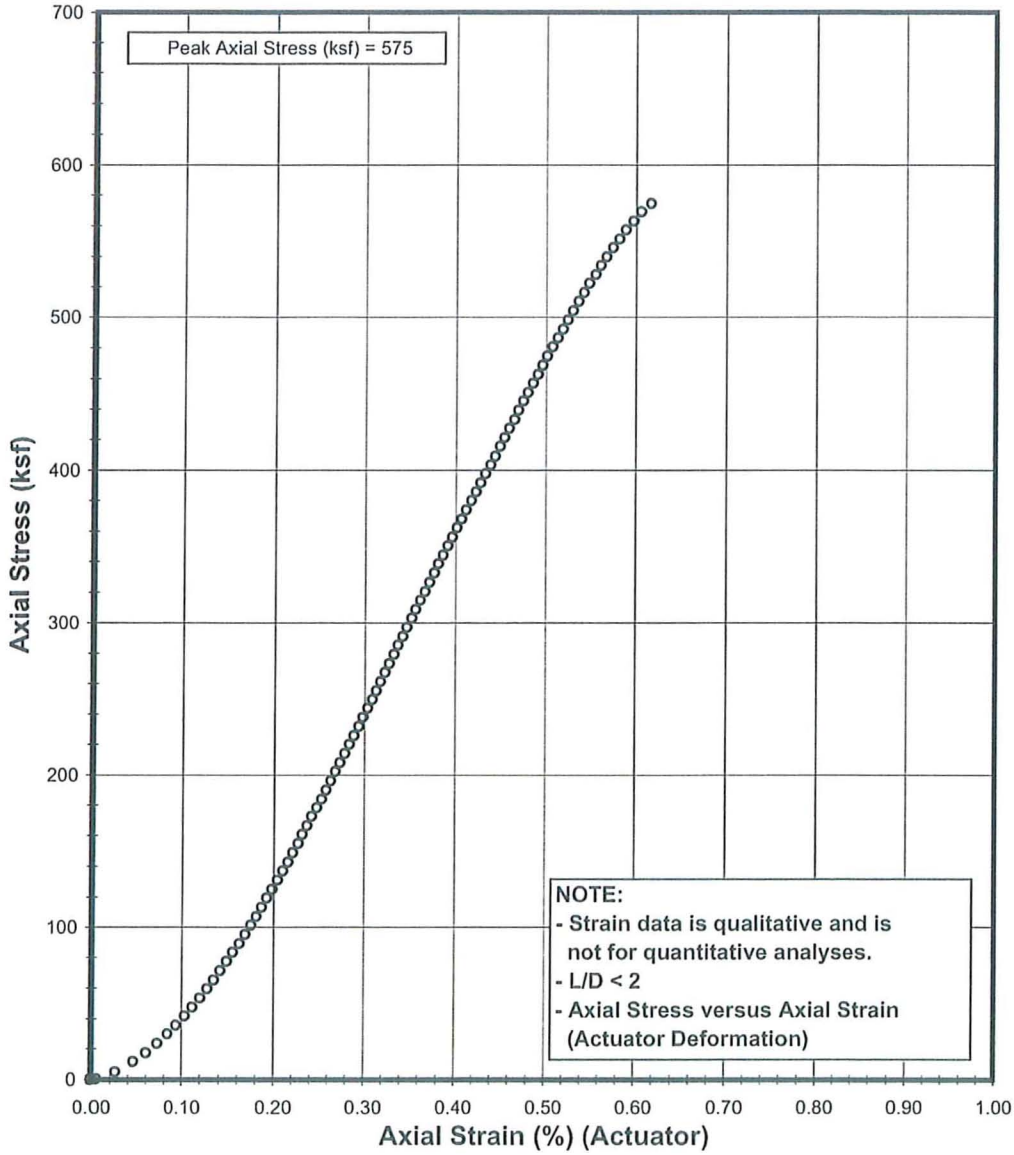


UNCONFINED COMPRESSION TEST

Sample No. 20 - Depth 118.0 ft

Boring B-2000

APPENDIX C-1

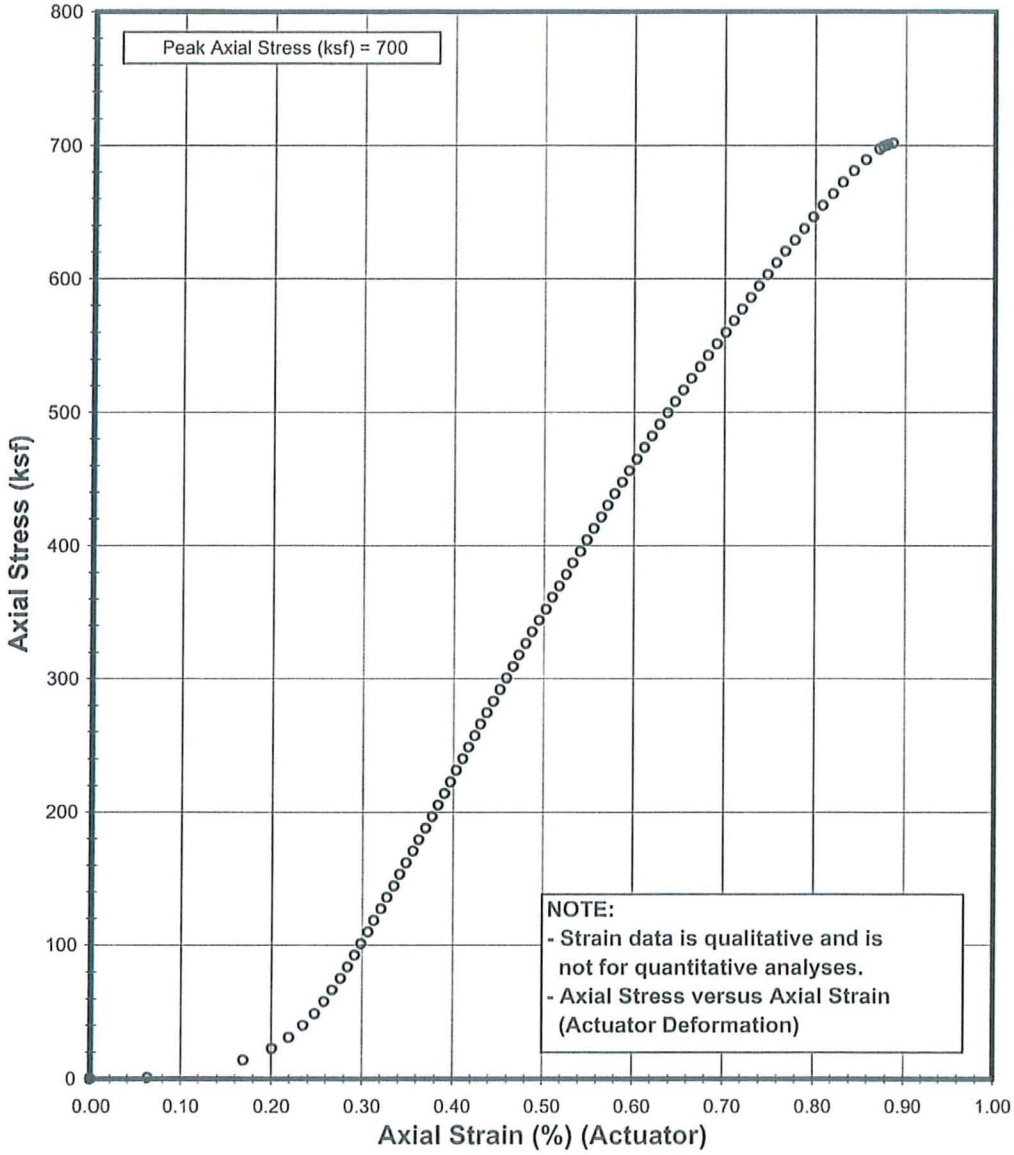


UNCONFINED COMPRESSION TEST

Sample No. 26 - Depth 144.0 ft

Boring B-2000

APPENDIX C-1

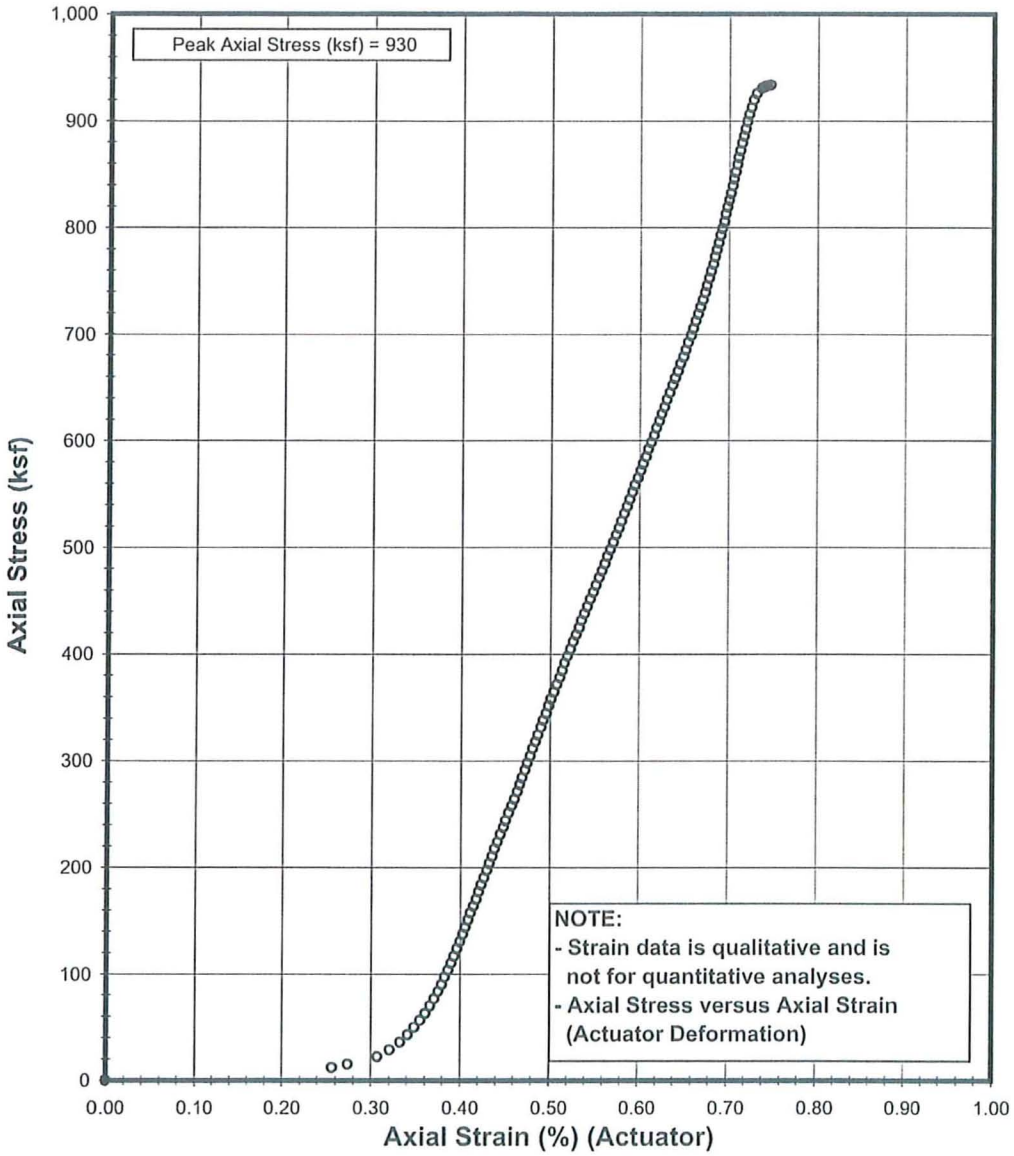


UNCONFINED COMPRESSION TEST

Sample No. 10 - Depth 65.3 - 65.8 ft

Boring B-2001

APPENDIX C-1

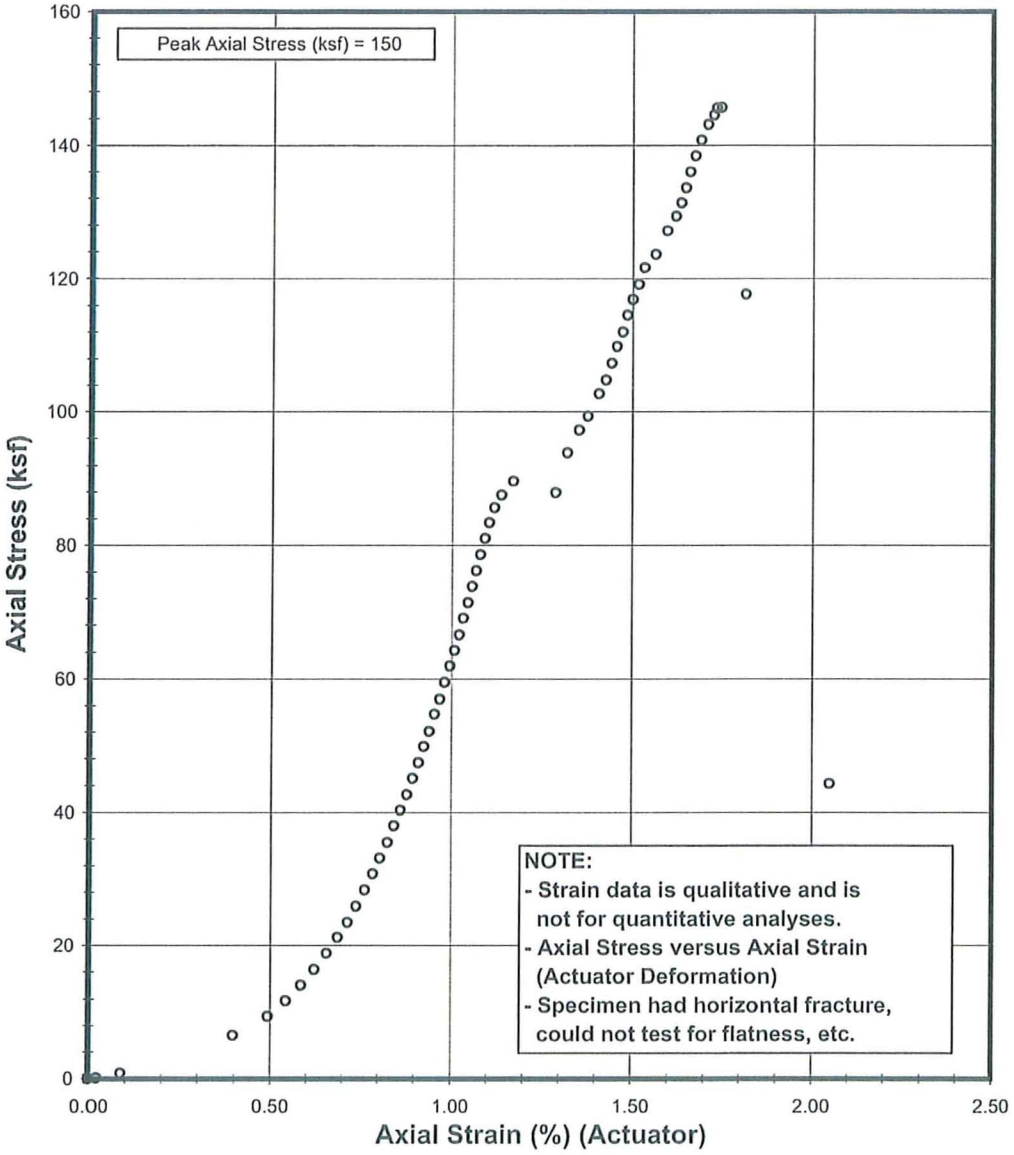


UNCONFINED COMPRESSION TEST

Sample No. 16 - Depth 70.4 - 70.9 ft

Boring B-2004

APPENDIX C-1

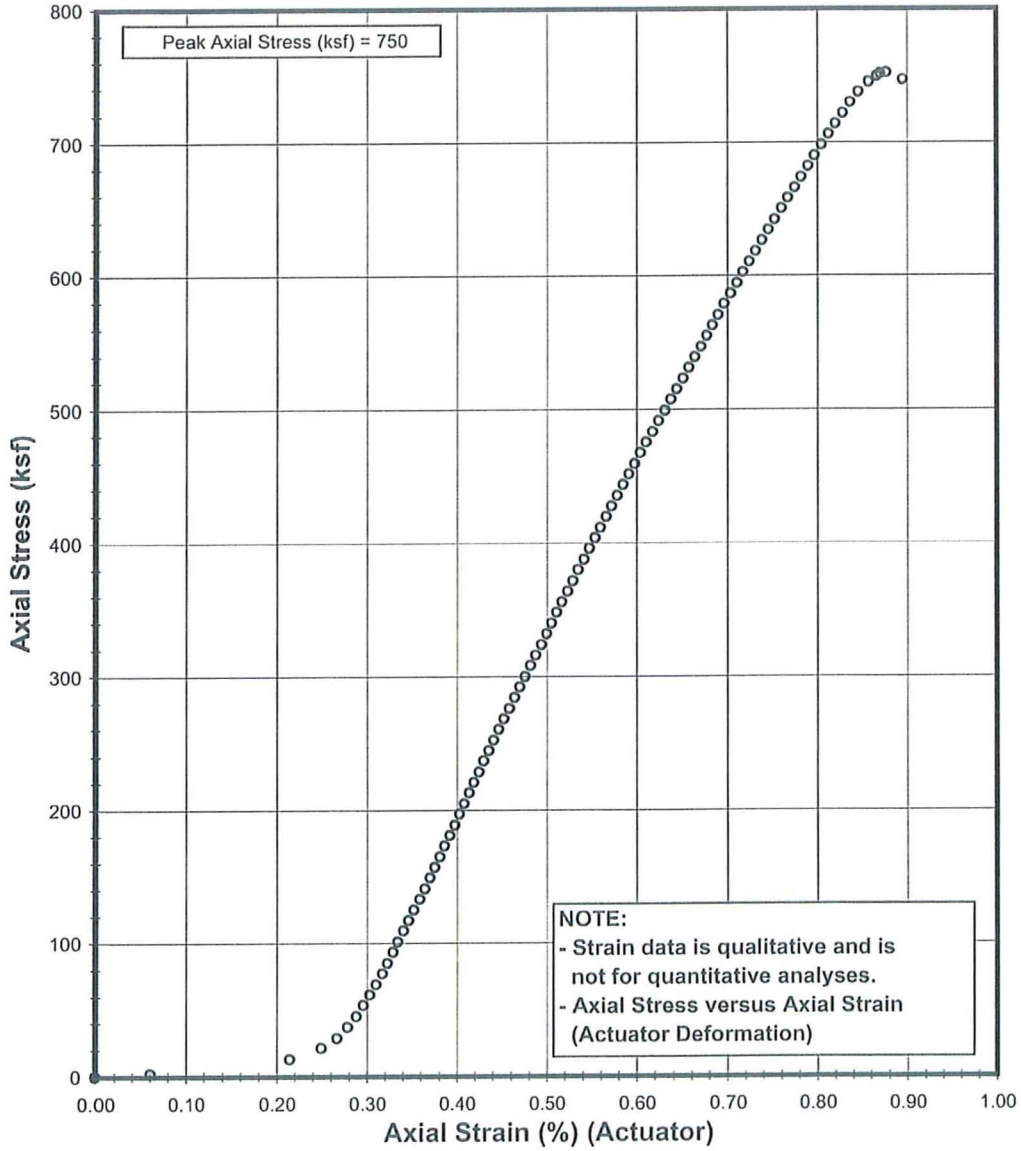


UNCONFINED COMPRESSION TEST

Sample No. 21 - Depth 96.6 - 97.1 ft

Boring B-2005

APPENDIX C-1

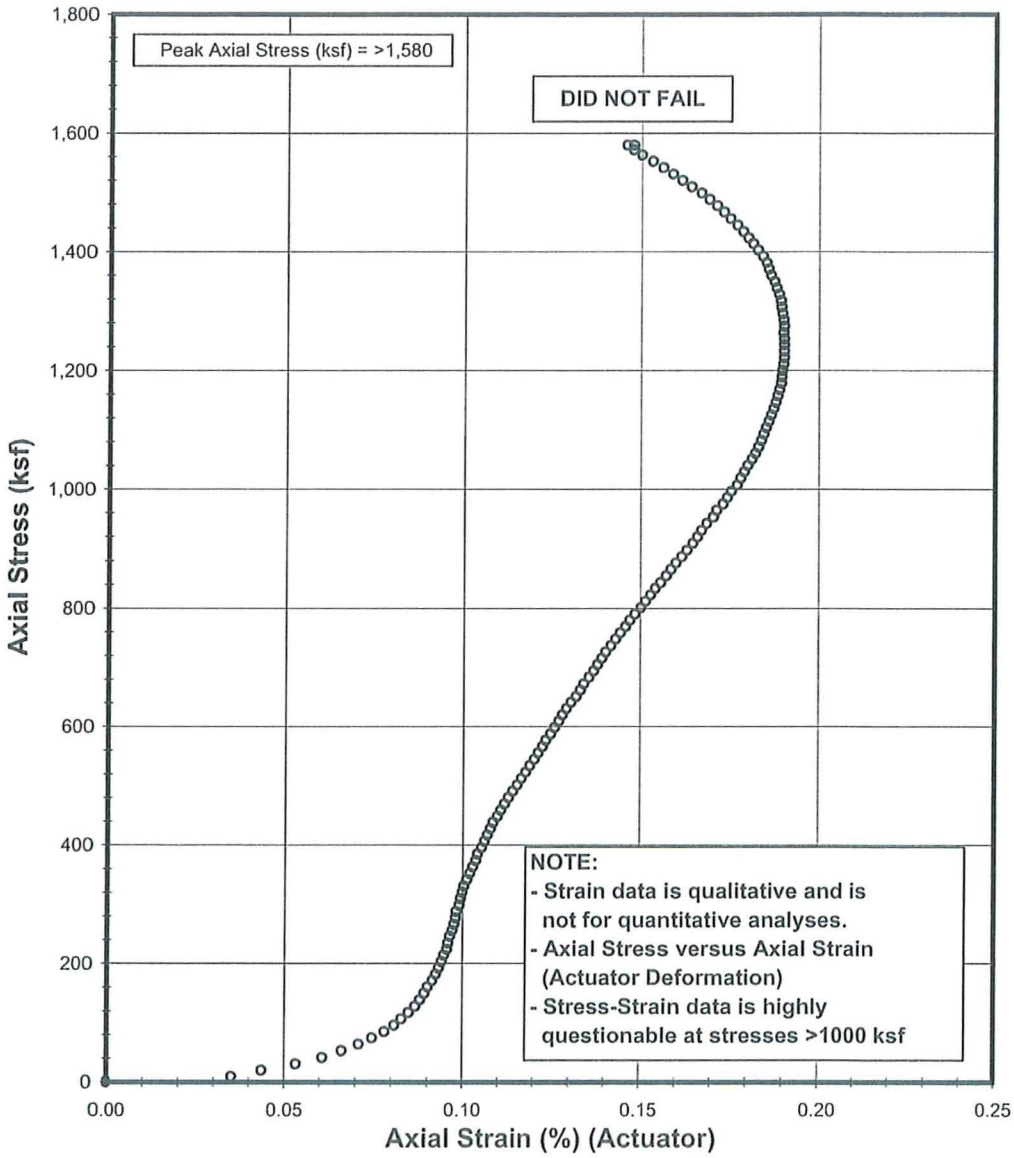


UNCONFINED COMPRESSION TEST

Sample No. 16 - Depth 70.0 - 70.5 ft

Boring B-2006

APPENDIX C-1



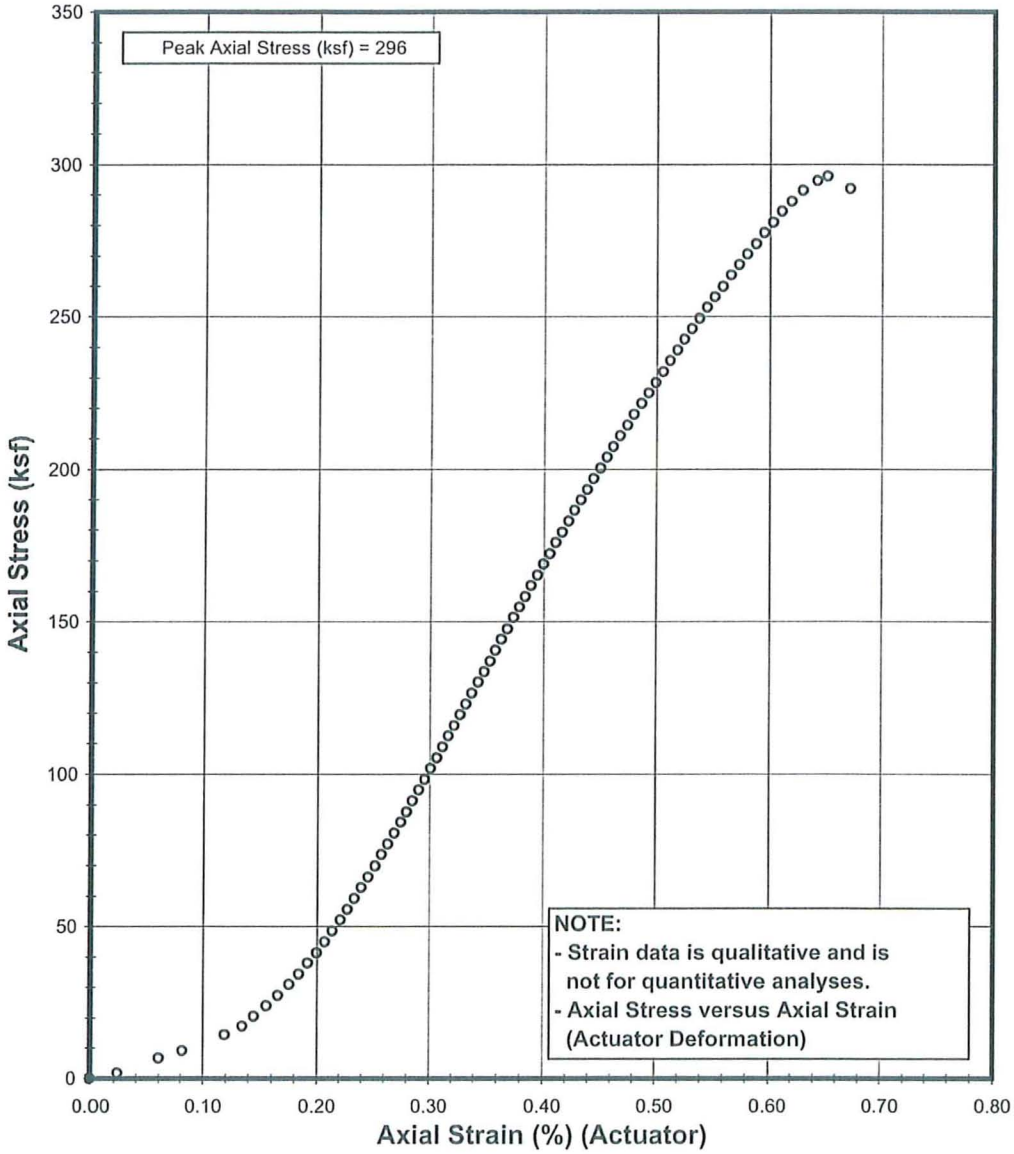
DID NOT FAIL

UNCONFINED COMPRESSION TEST

Sample No. 8 - Depth 43.6 - 44.0 ft

Boring B-2014

APPENDIX C-1

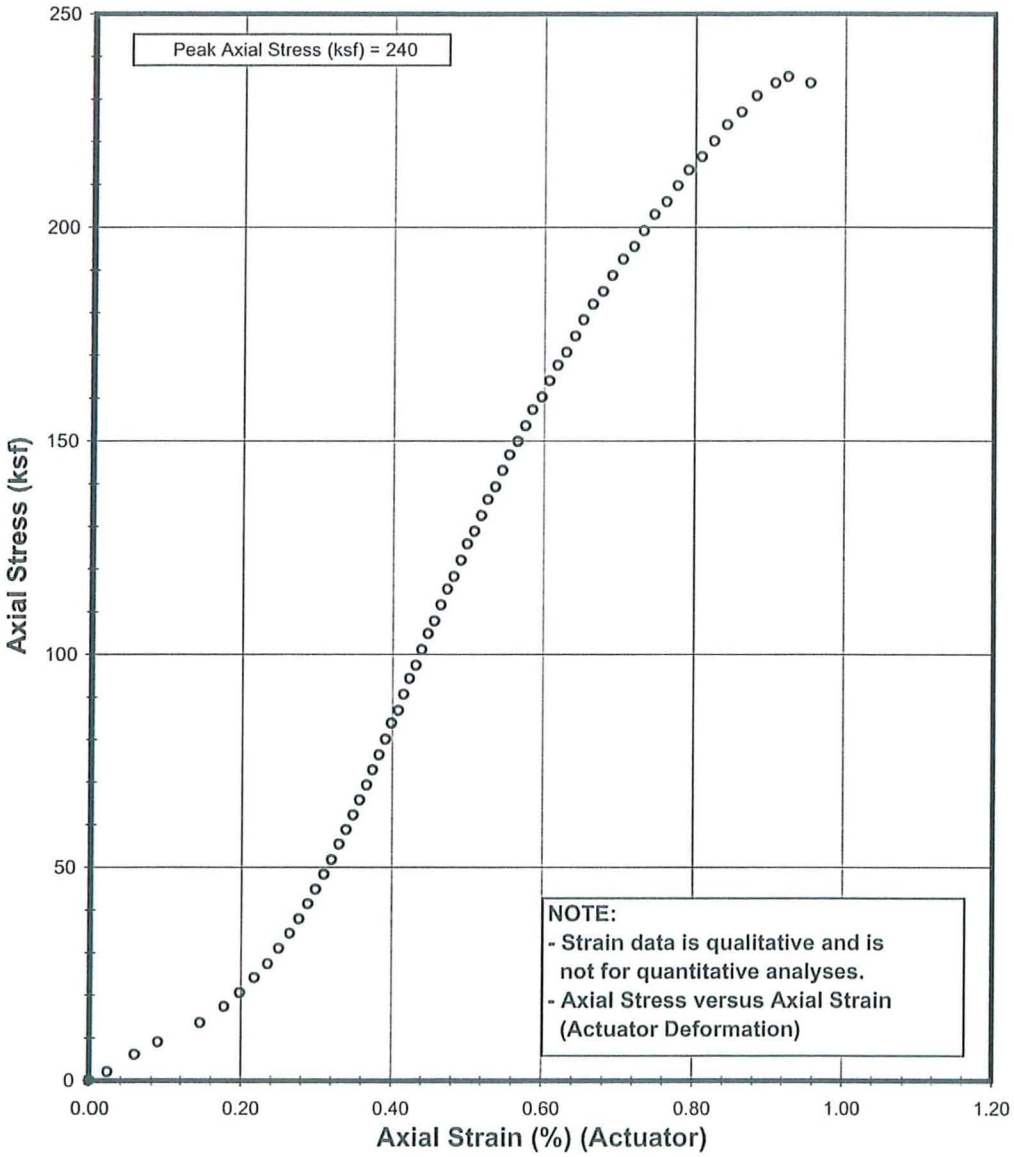


UNCONFINED COMPRESSION TEST

Sample No. 11 - Depth 62.9 - 63.4 ft

Boring B-2030

APPENDIX C-1

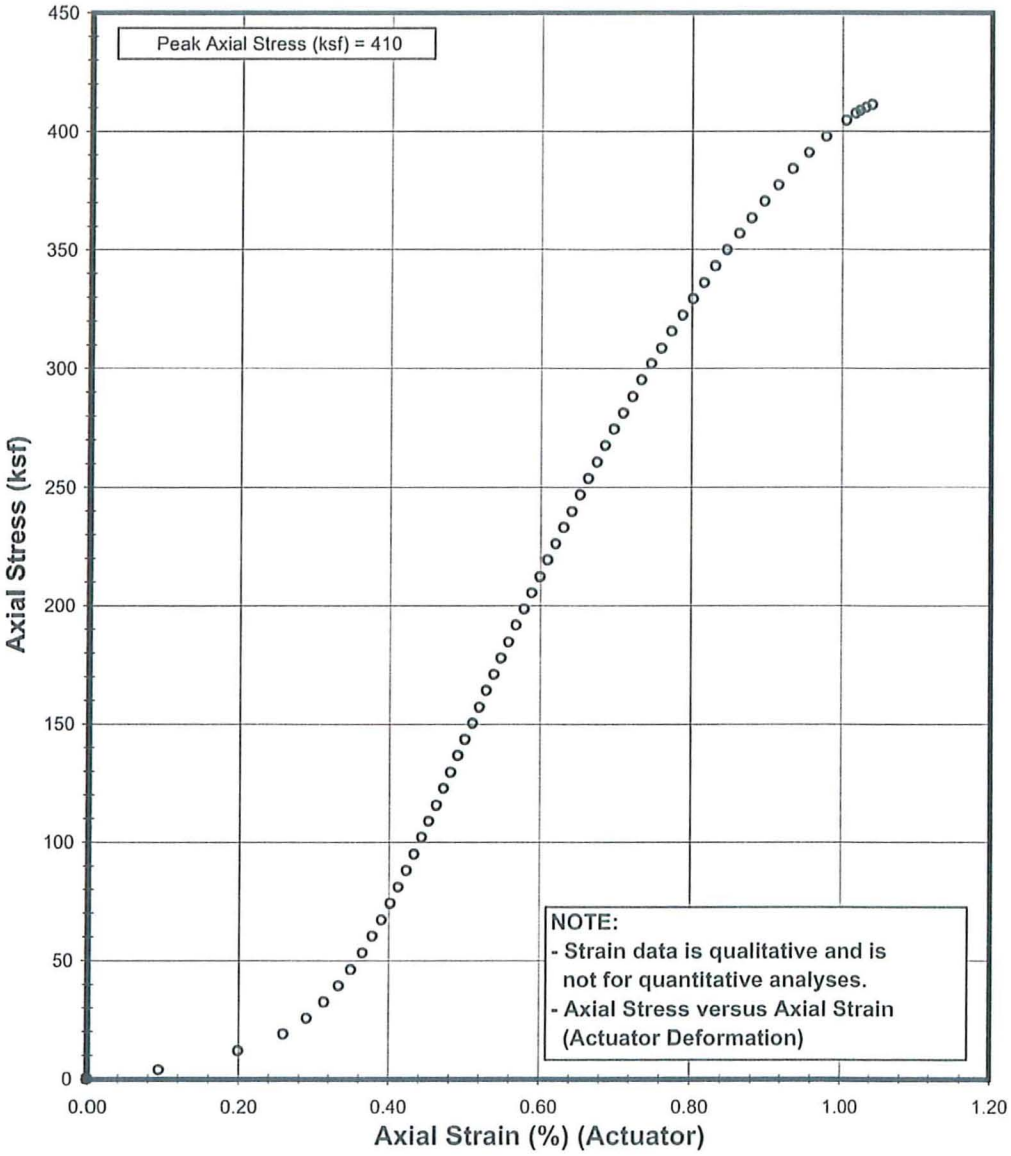


UNCONFINED COMPRESSION TEST

Sample No. 17 - Depth 93.0 - 93.5 ft

Boring B-2030

APPENDIX C-1

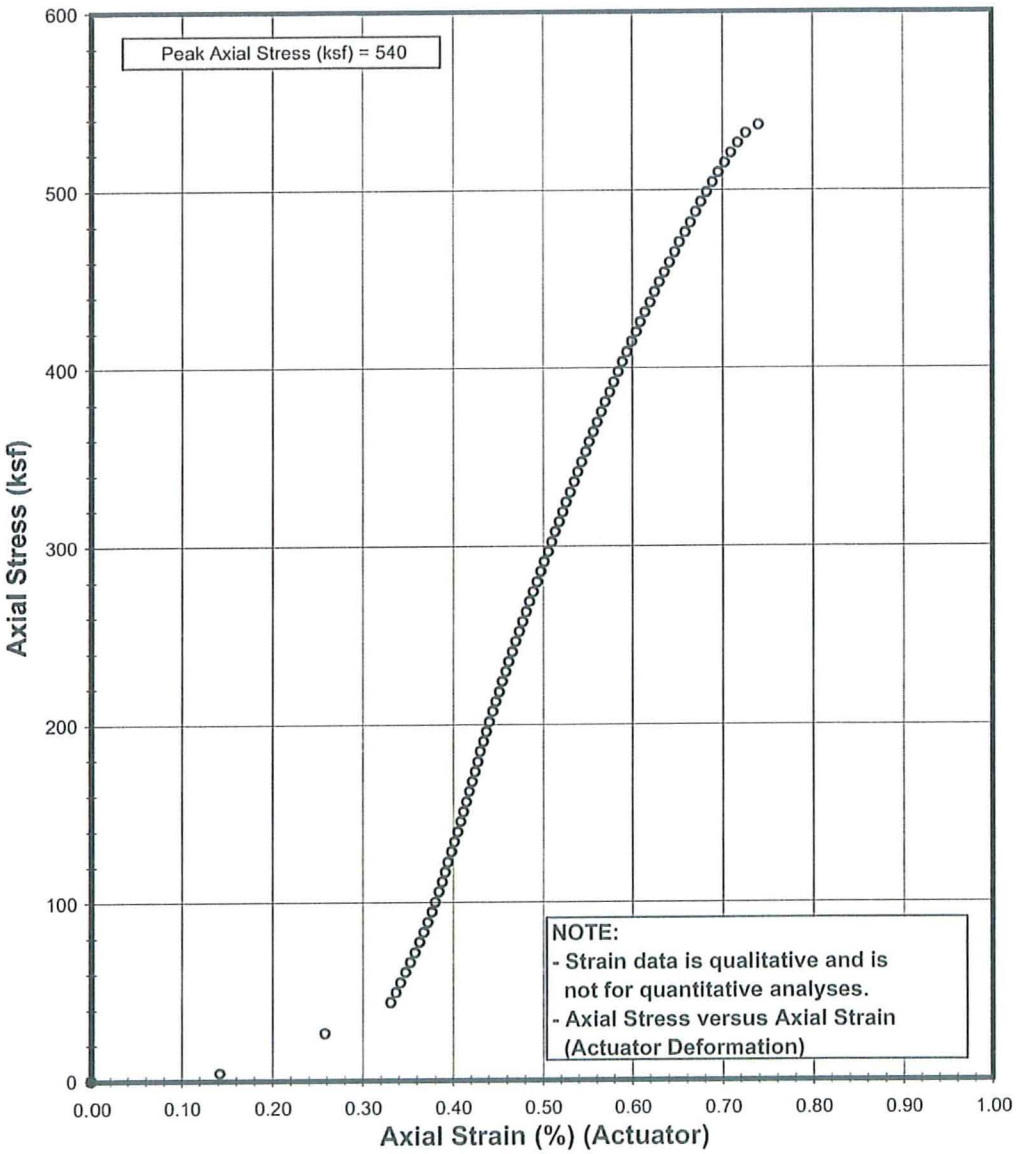


UNCONFINED COMPRESSION TEST

Sample No. 21 - Depth 89.8 - 90.3 ft

Boring B-2035

APPENDIX C-1

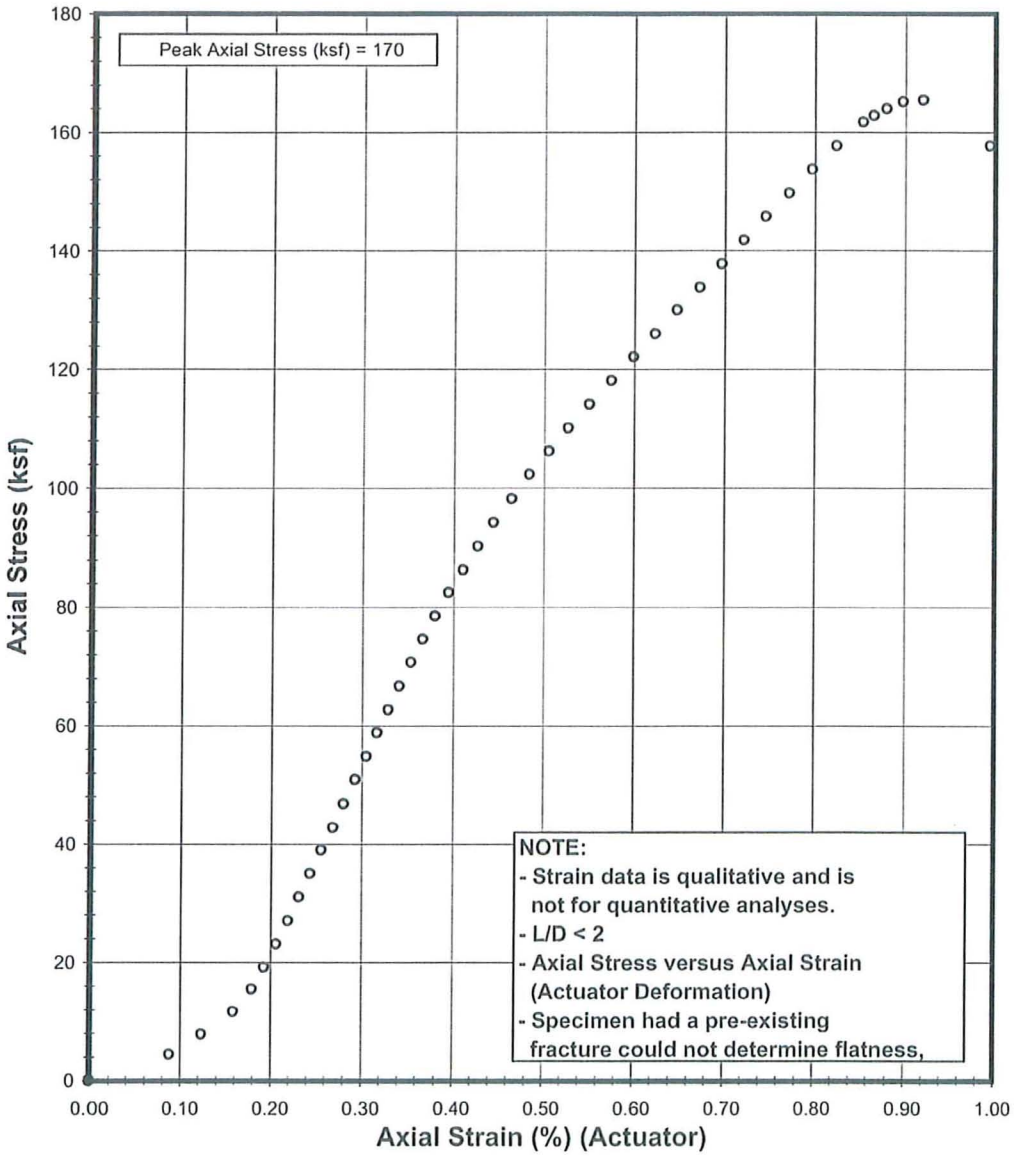


UNCONFINED COMPRESSION TEST

Sample No. 22 - Depth 93.4 - 93.9 ft

Boring B-2035

APPENDIX C-1

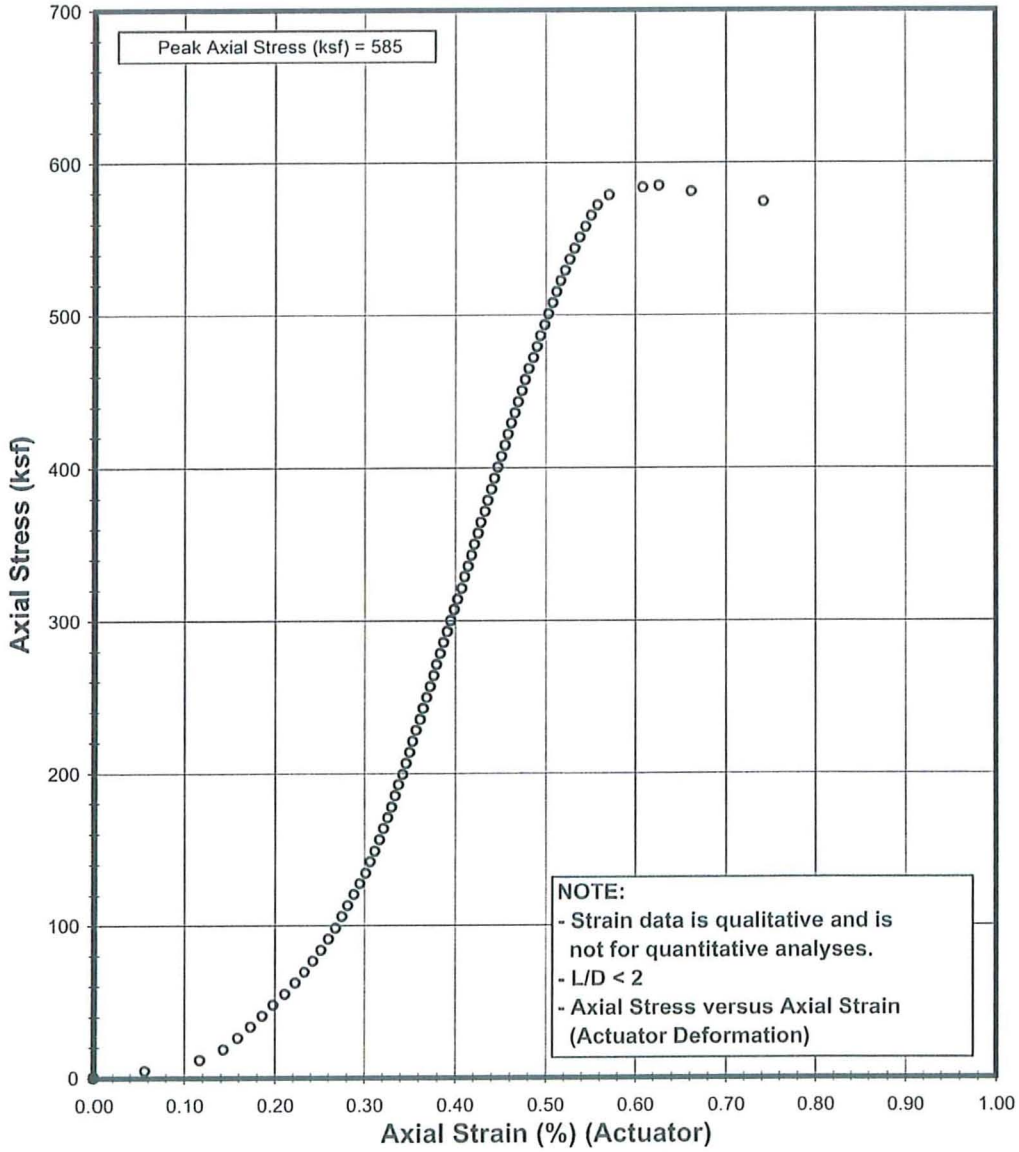


UNCONFINED COMPRESSION TEST

Sample No. 15 - Depth 62.8 - 63.3 ft

Boring B-2041a

APPENDIX C-1

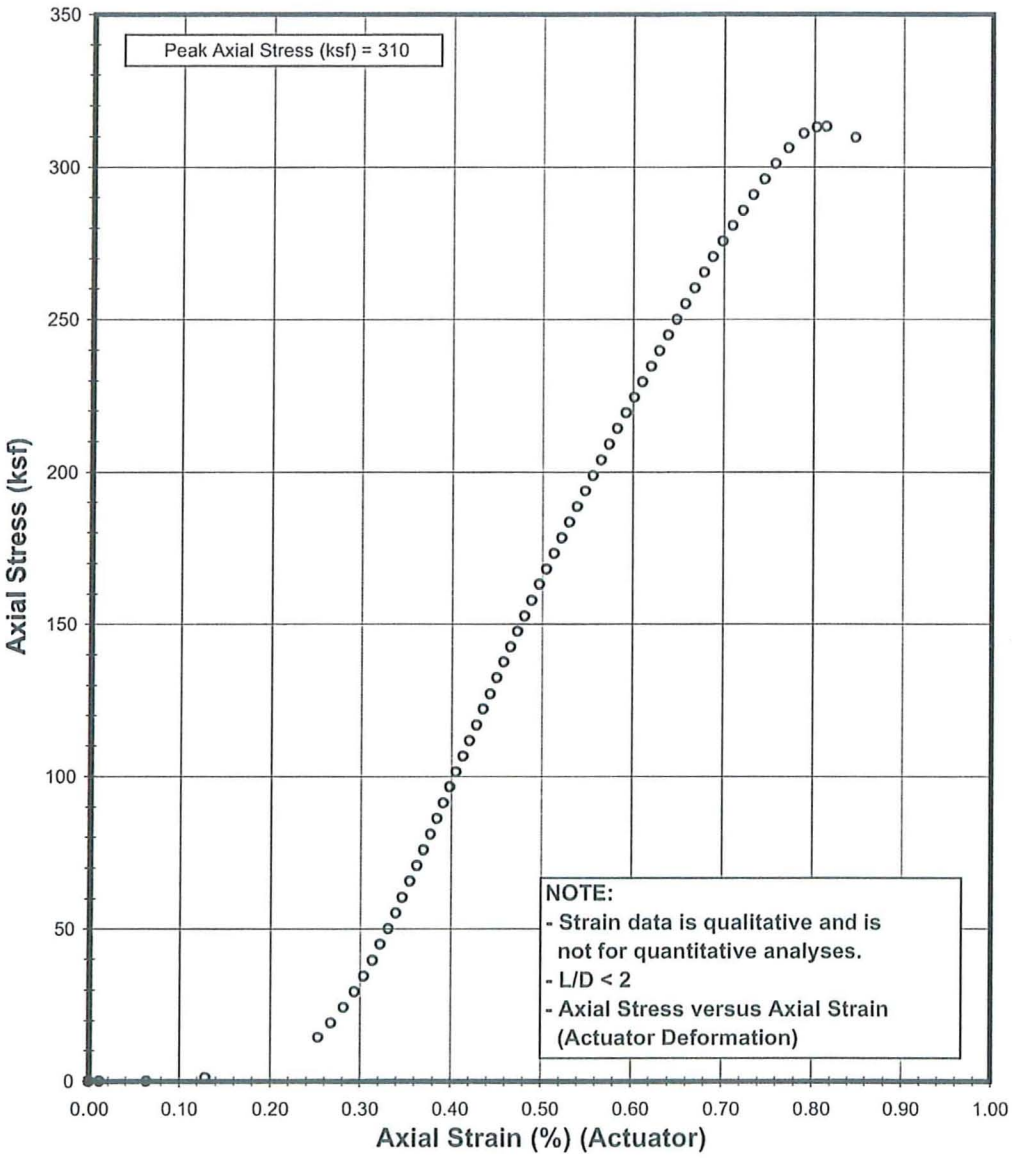


UNCONFINED COMPRESSION TEST

Sample No. 15 - Depth 51.4 - 51.9 ft

Boring B-2042a

APPENDIX C-1



UNCONFINED COMPRESSION TEST

Sample No. 17 - Depth 62.4 - 62.9 ft

Boring B-2042a