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APPENDIX E

EXCERPTS FROM DESIGN SUMMARY REPORT (BY GEI CONSULTANTS) PERTAINING TO LABORATORY MIX DESIGN TEST PROGRAM

(Added by Amendment No. 0004)

Design Summary Report

Clemson Upper and Lower
Diversion Dams
Clemson, South Carolina

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SUBMITTED TO

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May 2002
Project 01282

5.4 Soil-Cement Mix Testing Program

A soil-cement mix testing program was conducted to determine whether the target compressive strength of 400 psi proposed in the conceptual design for the soil-cement walls is reasonable and to provide information for specialty contractors to determine the field methods required to achieve the target strengths. Detailed test procedures, photographs, and test results are contained in Appendix B3.

5.4.1 Test Parameters

The main parameters affecting the strength of the in-situ soil-cement mix are the soil type and the cement content. Coarse-grained soils typically achieve higher strengths than fine-grained soils for the same cement content. Organic content can lower the strength of the soil-cement mix. Other factors that can affect strength include the water/cement ratio; addition of fly ash, gypsum or slag; addition of admixtures (water reducers, set retarders or clay dispersants); and method of mixing in the ground such as the size and number of augers, wet vs. dry injection of cement, and curing conditions.

Soil Type

We have identified five predominant soil types present in the alluvial foundation soils of the two dams. These soil types are discussed in more detail in Chapter 6. The five soil types are 1) silty sand, 2) silty sand/sandy silt, 3) low to medium plasticity silt, 4) clay, and 5) silty sand/sandy silt with organics. Batches of soil-cement for each of the soil-cement types are referred to below as Batches 1 through 5, respectively. Each soil type was tested in the soil-mix test program.

Cement Content

We used cement contents of 300, 450, and 600 pounds per cubic yard (lb/cy). The cement content is defined as the weight of cement per volume of final soil-mix (grout plus soil). Although contractors may add various admixtures to their cement (flyash or gypsum), we did not. We obtained cement from a concrete batch plant local to Clemson (see Appendix B3 for data sheet on the cement).

Water/Cement (w/c) Ratio

The water/cement ratio used in the field will depend on the contractor's requirements for pumpability and the natural moisture content of the in situ soils. For higher strength, a lower water/cement ratio is desirable. However, a stiff mix may not flow well enough to reach the bottom of the augers and, in clays, may not make the soil-cement mix workable enough to

achieve good mixing. Typically, contractors have used w/c ratios from less than 1 to greater than 2.

We used a w/c ratio of 0.7 for most of the tests and a w/c ratio of 0.9 for one set of tests on Batch 3 (low to medium plasticity silt). The results of strength tests (ASTM C 109) on 2-inch cubes of the grout (mixed at a water/cement ratio of 0.7) are included in Appendix B3. The grout achieved a strength of 3940 psi at 28 days.

The grout mix (w/c = 0.7) was also tested using the following tests: Marsh Funnel test for flowability (API procedure), Mud Balance test (ASTM D 4380-84), and Unit Weight (ASTM C 138-92). The results are presented in Appendix B3.

A summary of the soil-cement mix tests performed is presented in Table 8.

5.4.2 Test Procedures

Prior to adding the grout, we sieved the soil at its natural water content through a 3/8-inch sieve. The cement and water were mixed together in a bucket before being added to the soil. Test batches were mixed in buckets using an impeller attached to an electric drill. We mixed each batch of soil-cement for 10 minutes. A trowel was also used to make sure soil in the bottom of the bucket was mixed into the grout. Soil-cement was placed in the molds in three layers. To remove air each layer was rodded seven times, and the outside of the mold was tapped seven times with a mallet. The test specimens were approximately 3 inches in diameter and 6 inches tall. We used cardboard molds with aluminum bases. The tops were sealed with plastic-wrap and electrical tape. The samples were kept in coolers or plastic tubs while they cured. Initially, beakers of water were placed in the tubs to provide moisture. Later we placed water in the bottom of the tubs and placed the molds on pads to raise them above the water level.

We performed the following tests on the soil after it was batched from the plastic bags collected in the field but before it was mixed with grout: water content, Atterberg limits and grain size. For the silty sand/sandy silt with organics (Batch 5), we also performed organic content tests and wet/dry limits to determine the organic content. The index test results are given in Appendix B3 and are summarized in Table 10.

Cylinder-specimens of soil-cement were tested at 7, 28, and 56 days. Each specimen was made in triplicate. Specimens were tested in unconfined compression (ASTM D 1633-96). Prior to testing, each specimen was soaked for 4 hours, in accordance with ASTM D 1633. The ends of the specimens were leveled using a sulfur-capping compound prior to being placed in the testing apparatus and sheared.

Photographs illustrating the procedures used for the soil-cement mix testing are contained in Appendix B3.

5.4.3 Test Results

Appendix B3 contains the results of the soil-mix testing. The average and range of compressive strengths achieved for each test are summarized in Table 9. Plots showing the increase in strength with time for each batch are shown on Figs. 5 through 9. In a few cases the soil-cement cylinders had cracks or were so weak that the samples broke during the capping procedure.

Increasing the cement content resulted in increased strength of the soil-cement cylinders. The silty sand/sandy silt (Batch #2) and the clay (Batch #4) achieved the highest strengths. The low to medium plasticity silt (Batch #3) was difficult to mix at a cement content of 450 lb/cy and had a very low 7-day strength (< 10 psi). Increasing the w/c ratio to 0.9, in an effort to make the mix more workable, did not seem to have an effect on the 7-day strength. However, the 28-day strengths at both w/c=0.7 and w/c=0.9 were much higher (200 and 300 psi, respectively). The presence of organics in the silty sand/sandy silt with organics (Batch #5) seemed to have very little effect on the strength of the soil-cement mix at 600 lb/cy. The strengths achieved were similar to those of the silty sand/sandy silt (Batch #2). This is probably because the amount of organic material (6% or less) is relatively low. We expected the silty sand (Batch #1) to achieve higher strengths than the finer grained materials for the same cement content. However, the strength of the silty sand soil-mix was about 2/3 to 3/4 the strength achieved in the silty sand/sandy silt (Batch #2) and the clay (Batch #4) for a cement content of 450 lb/cy. Generally, strengths increased slightly between 28 and 56 days. However, this did not seem to be the case for the clay (Batch #4). It appears that some of the 56-day clay specimens had noticeable voids and/or cracks (as noted on the test sheets in Appendix B3) and that these voids and cracks weakened the specimens.

The stress-strain curves in Appendix B3 indicate that a peak strength at 28 days is reached at strains of 0.4 to 1.4%, with generally insignificant decrease in resistance for a further 0.1 to 0.6% strain. Thus, there is some degree of ductility in the soil-cement, which is highly desirable for seismic performance. However, the ductility at 56 days was usually less than at 28 days. It is likely that there would be a higher degree of ductility in the field under confinement than observed in the unconfined compression test.

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6.0 Foundation Soils Under Downstream Berms

6.1 Soils Encountered in the Borings

The soil layers encountered in the borings are described below, in order of increasing depth. The descriptions are derived from the results of the current and prior boring programs and the current and prior index testing programs. Subsurface profiles illustrating conditions found in the borings are shown on Figs. 10 through 13. The profiles are shown from a downstream perspective, looking upstream. Figures 10 and 11 show all the borings along each berm. Figures 12 and 13 are interpretive soil profiles and some of the borings were omitted for clarity. The boring elevations were those from the USACE survey in February 2002, except for the prior borings at the Lower Dam. Those borings were not surveyed so we used the elevations on the boring logs.

Embankment Fill

At all of the boring locations, a layer of embankment fill, ranging from 14 to 35.5 feet in thickness, was encountered. This fill was generally clayey sand with gravel (SC), silty sand (SM) or sandy silt (ML). Typically, the embankment fill had a distinct red or orange color. For stability analyses, we assumed the embankment fill would behave drained with a friction angle of 28° and a unit weight of 120 pcf as was used in previous analyses (GEI, 1994).

Blanket Drain Layer

A blanket drain layer ranging from 1 to 8 feet thick and typically 2 feet thick, was encountered in all of the Phase I borings except CUD-611 and CLD-601 where the borings were close to the abutments, and CUD-605 and CLD-604 where the borings were unintentionally advanced beyond the drain layer prior to sampling. The drain layer consisted of silty sand (SM) to narrowly graded sand (SP). SPT N-values (N-values) in the drain layer ranged between 7 and 94 blows per 12 inches. There were typically 20-30% non-plastic fines in the drain layer. Occasionally, some gravel was present. The drain layer was usually gray, gray/brown or gray/black. It was generally easy to distinguish the drain material from the red/orange embankment fill, but sometimes difficult to see the transition between the drain material and the underlying alluvium, which often had a similar color.

We noted that the drain layer was encountered deeper in the vicinity of the old river channels. The drain layer was not always clearly identified in the prior borings, but it was sometimes possible to estimate its depth by noting the change in color of the material described in the boring logs (Appendix A). That the drain layer would be encountered

deeper at the river channels is consistent with the drain layer being constructed at the interface between the pre-existing ground surface and the embankment. For analysis, we assumed the drain layer was part of the berm and had a friction angle of 28° and a unit weight of 120 pcf.

Alluvium

A natural deposit of alluvium was encountered in all of the borings immediately below the drain layer. The thickness of the alluvium ranged from 7 to 28 feet in thickness. The alluvium generally consists of sandy silt (ML), silty sand (SM), narrowly graded sand (SP), clay (CL), and sandy clay (SC). Organic material was noted in several samples from the Upper Dam. Organic content tests indicated that the organic content was less than 7%. N-values in the alluvium ranged from Weight of Hammer (WOH) to 84 blows per 12 inches. Most of the N-values were between 3 and 30 blows per foot. The N-values generally increased with depth, particularly in the Lower Dam.

Sand and Gravel

Underlying the alluvium is a dense sand and gravel layer overlying the bedrock. The borings were advanced three to four feet into this stratum or until sufficiently high blow counts were achieved. N-values ranged from 35 blows per 12 inches to refusal (>100 blows per 12 inches). The sand and gravel layer consists of silty sand with gravel (SM) to silty gravel with sand (GM). For design, we used the previously assigned friction angle of 35° and a unit weight of 120 pcf (GEI, 1999).

6.2 Water Levels

Data from January, 1998 indicated that water levels below the downstream berm of the Upper Dam ranged from El. 620 to 625 (USACE, 1998). Water levels below the downstream berm of the Lower Dam ranged from El. 615 to 625.

6.3 Composition of the Alluvium

The predominant materials in the alluvium are silty sand (SM) and sandy silt with non-plastic fines (ML). These comprise about 60 to 80% of the material. Sandy silt with low to medium plasticity fines accounts for about 10 to 20% of the material. A review of the gradation curves in Appendix B1 shows that the gradation curves are very steep and many lie close to the sand/silt boundary and that it is difficult to distinguish between the silty sand and the sandy silt with non-plastic fines. Elastic silt (MH), lean clay or lean sandy clay (CL) accounted for a further 10 to 30% of the samples. Samples classified by the USACE as elastic silt (MH) in prior borings were generally classified as CL by GEI. In addition, the

lean sandy clay and the sandy silt with low to medium plasticity were hard to distinguish. From a review of the plasticity data in Appendix B1, it can be seen that many of the clay and low to medium plasticity silt samples lie very close to the A-line. Fig. 14 shows plasticity data from current GEI tests, GEI tests from 1994, and USACE tests from 1980. Frequently, samples classified as clay in the field were changed to silt based on the plasticity test results and vice versa. There were only two samples classified as elastic silt based on index tests results. It appears that many of the samples classified as elastic silt (MH) or fat clay (CH) in 1980 may in fact be lean clay (CL) or medium plasticity silt (ML).

During previous analyses performed to determine liquefaction potential, it had been assumed that the looser soils (N-value <15) were more prevalent toward the bottom of the alluvium layer. However, the Phase I borings from the current study show that the looser silty soils tend to be near the top of the alluvium and that the soils near the bottom of the alluvium tend to be denser and sandier (Figs. 10 to 13). This is particularly true for the Lower Dam. For the Upper Dam there are several borings where low blow counts were recorded near the bottom of the alluvium. In general, however, blow count data recorded during the Phase I borings were similar to those recorded during prior phases of borings. Thus, it is appropriate to use the previously determined values of shear strength in the loose alluvium (S_{us} [undrained steady-state strength] and S_{up} [undrained peak strength]) (GEI, 1994) for analysis of the proposed remediation. The previously determined values of S_{us} and S_{up} were estimated from consolidated, undrained triaxial tests and laboratory vane shear tests. Values of S_{us} for the loose alluvium ranged from 70 psf under the dam toe to 1600 psf under the dam crest. Values of S_{up} in the loose alluvium ranged from 270 psf (toe) to 1600 psf (crest). For stability analyses during final design of the soil-mix walls, we conservatively assigned these values to the entire alluvium layer, rather than dividing the layer up into loose and dense layers, as had been done in previous analyses.

In the vicinity of the old river channels, no loose soils were encountered. N-values were generally greater than 20 blows/foot. The alluvium at these locations is typically silty sand or narrowly graded sand.

6.4 Soil Group Type Designations

For the purposes of selecting material types for the soil-cement testing we divided the alluvial materials into five groups:

1. Silty Sand (SM)

   This material is predominant in the alluvium and it includes material described as silty sand (SM), poorly graded sand (SP), poorly graded silty sand (SP-SM) and widely graded silty sand (SW-SP). It was typically described in the boring logs as fine sand with from 15 to 40% non-plastic or low-plasticity fines.

2. Silty Sand/Sandy Silt (SM/ML)

   This material was described in the boring logs as sandy silt with non-plastic or low plasticity fines. It contained from 10 to 40% fine sand. Gradation tests on some samples from the borings showed that some of the material was silty sand. For the batch mix we selected samples that had a plasticity index less than 9.

3. Low to Medium Plasticity Silt (ML/MH)

   This material was described in the boring logs as sandy silt with low to medium plasticity fines. It contained from about 10 to 25% fine sand. The plasticity index of the samples used for the batch mix was generally higher than 10 and the samples plotted on or just below the A-line on a plasticity chart.

4. Clay (CL)

   This material was described as a sandy lean clay or lean clay with sand in the boring logs. It typically contained 10 to 25% fine sand and was in many cases hard to distinguish from the low to medium plasticity silt. The plasticity index of the samples used for the batch mix was higher than 7 and the samples plotted on or just above the A-line on a plasticity chart.

5. Silty Sand/Sandy Silt with Organics (SM/ML-O)

   This material was similar to the silty sand/sandy silt but was black and had a slight organic odor. Frequently, roots or fibers were visible in the samples. Organic content tests showed the organic content to be less than 7%. For the soil-cement testing we selected samples with low plasticity index, so that we could see whether the organic content had any effect on the ability of the cement to strengthen the soil, without the additional factor of the higher plasticity.

Table 10 lists the samples that were mixed together for each batch mix, individual sample index test data and the index test data for the batch. Plasticity charts for the individual

samples and the batches are included in Appendix B3. Gradation curves for the batches are included in Appendix B3.

6.5 Soil-Cement Strength for Design

During conceptual design, GEI assumed that a compressive strength of 400 psi could be achieved in the soil-cement mix walls. The results of the soil-cement mix testing in the GEI laboratory show that compressive strength in excess of 400 psi can be achieved at 28 days in all soils for a cement content of 600 lb/cy and a w/c ratio of 0.7. Although we did not test the silty sand (Batch #1) at a cement content of 600 lb/cy, we expect that we would have obtained a 28-day strength greater than 400 psi.

We included a safety factor of two on the compressive strength in the conceptual design. Thus, we feel it is appropriate to continue to recommend a target compressive strength of 400 psi in the soil-mix walls for the base design.

Table 2 - Summary of Laboratory Classifications Tests - Upper Dam
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

Boring Number	Sample Number	Depth Interval for Sample (feet)	Natural Water Content (%)	Percent Fines [1] (%)	Atterberg Limits [2] LL	PI	Organic Content (%)	Sample Description and ASTM D2487 Classification Group Symbol [3]
CUD-601	S1	15.0 - 16.5	24.8	39.9	-	-	-	SILTY SAND (SM)
CUD-601	S8	25.5 - 27.0	52.1	95.2	56	24	-	ELASTIC SILT (MH)
CUD-602	S12	31.5 - 33.0	21.6	6.5	-	-	-	NARROWLY GRADED SAND WITH SILT (SP-SM)
CUD-604	S7	24.0 - 25.5	29.4	64.5	-	NP	-	SANDY SILT (ML)
CUD-605	S3	23.5 - 25.0	42.6	50.1	-	NP	-	SANDY SILT (ML)
CUD-605	S8	31.0 - 32.5	37.6	51.5	-	-	-	SANDY SILT (ML)
CUD-609	S7 (Top 12")	29.0 - 30.0	31.6	89.5	42	17	-	LEAN CLAY (CL)
CUD-610	S12	31.5 - 33.0	33.7	94.1	43	16	-	SILT (ML)
CUD-610	S15	36.0 - 37.5	33.5	30.4	25	NP	4.14	SILTY SAND (SM)
CUD-621A	T2	24.0 - 26.0	32.1	50.9	28	3	4.76	SANDY ORGANIC SOIL (OL)
				Oven Dried Limits:	-	NP		
CUD-622A	T4	21.0 - 23.0	31.2	31.1	-	NP	2.64	SILTY SAND (SM)
CUD-622A	T5 (1 of 2)	23.0 - 25.0	42.7	64.4	37	8	6.75	SANDY ORGANIC SOIL (OL)
				Oven Dried Limits:	-	NP		
CUD-622A	T6	25.0 - 27.0	42.5	74.9	33	5	-	SILT WITH SAND (ML)
CUD-622A	T7	27.0 - 29.0	30.7	48.8	-	NP	-	SILTY SAND (SM)

Note:

[1] Refer to Appendix B1 for plots of grain size distributions.

[2] Refer to Appendix B1 for plasticity charts

[3] Refer to Appendix A for ASTM D2487 soil classification group names.

Abbreviations and Symbols

LL = Liquid Limit (percent moisture)

NP = Non-Plastic

PI = Plasticity Index (percent moisture)

- = Test not performed

Table 2 - Summary of Laboratory Classifications Tests - Upper Dam
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

Boring Number	Sample Number	Depth Interval for Sample (feet)	Natural Water Content (%)	Percent Fines [1] (%)	Atterberg Limits [2] LL	PI	Organic Content (%)	Sample Description and ASTM D2487 Classification Group Symbol [3]
CUD-622A	T8	29.0 - 31.0	36.9	51.3	31	3	-	SANDY SILT (ML)
CUD-623A	T2	28.0 - 30.0	26.1	29.4	-	-	-	SILTY SAND (SM)
CUD-623A	T4 (1of 2)	32.0 - 34.0	35.3	24.4	-	-	-	SILTY SAND (SM)
CUD-624A	T1	24.0 - 26.0	18.9	41.3	27	10	-	CLAYEY SAND (SC)
CUD-624A	T2 (1 of 2, Top)	26.0 - 27.0	26.5	64.8	34	8	-	SANDY SILT (ML)
CUD-624A	T2 (2 of 2, Bot.)	27.0 - 28.0	44.9	80.0	54	23	-	ELASTIC SILT WITH SAND (MH)
CUD-624A	T3 (1 of 2, Top)	28.0 - 29.0	32.8	72.5	39	16	-	SANDY LEAN CLAY (CL)
CUD-624A	T3 (2 of 2, Bot.)	29.0 - 30.0	25.7	57.3	29	8	-	SANDY LEAN CLAY (CL)
CUD-624A	T4 (1 of 2, Top)	30.0 - 31.0	31.7	53.3	28	8	-	SANDY LEAN CLAY (CL)
CUD-624A	T4 (2 of 2, Bot.)	31.0 - 32.0	32.8	87.3	44	19	-	LEAN CLAY (CL)
CUD-624A	T6 (Top 8")	34.0 - 34.7	33.6	50.2	28	3	-	SANDY SILT (ML)
CUD-624A	T6 (Bot. 16")	34.7 - 36.0	37.5	47.5	-	NP	4.81	SILTY SAND (SM)
CUD-624A	T7	36.0 - 38.0	30.6	30.1	-	NP	3.88	SILTY SAND (SM)
CUD-624B	T1 (2 of 2)	26.0 - 28.0	63.4	78.6	43	17	-	LEAN CLAY WITH SAND (CL)
CUD-624C	T1	26.0 - 28.0	38.7	56.2	36	11	-	SANDY SILT (ML)

Note:
[1] Refer to Appendix B1 for plots of grain size distributions.
[2] Refer to Appendix B1 for plasticity charts
[3] Refer to Appendix A for ASTM D2487 soil classification group names.

Abbreviations and Symbols
LL = Liquid Limit (percent moisture)
NP = Non-Plastic
PI = Plasticity Index (percent moisture)
- = Test not performed

Table 3 - Summary of Laboratory Classifications Tests - Lower Dam
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

Boring Number	Sample Number	Depth Interval for Sample (feet)	Natural Water Content (%)	Percent Fines [1] (%)	Atterberg Limits[2] LL	PI	Organic Content (%)	Sample Description and ASTM D2487 Classification Group Symbol [3]
CLD-603	S9	42.0 - 43.5	24.0	12.0	-	-	-	NARROWLY GRADED SAND WITH SILT (SP-SM)
CLD-605	S10	33.5 - 35.0	37.1	39.1	-	-	-	SILTY SAND (SM)
CLD-605	S11	35.0 - 36.5	34.5	29.8	24	NP	-	SILTY SAND (SM)
CLD-608	S8	25.5 - 27.0	-	-	28	9	-	LEAN CLAY WITH SAND (CL)
CLD-609	S11	30.0 - 31.5	41.0	83.6	38	10	-	SILT WITH SAND (ML)
CLD-610	S6	22.5 - 24.0	29.4	76.1	37	21	-	LEAN CLAY WITH SAND (CL)
CLD-610	S10	28.5 - 30.0	33.3	60.3	30	4	-	SANDY SILT (SM)
CLD-613	T7	27.0 - 29.0	37.6	55.8	-	NP	-	SANDY SILT (ML)
CLD-621A	S1 Bot12", T2	25.7 - 29.0	28.7	51.5	-	NP	-	SANDY SILT (ML)
CLD-621A	T3 (2 of 2)	29.0 - 31.0	42.8	83.1	48	16	-	SILT WITH SAND (ML)
CLD-621A	U2, T5	34.0 - 38.0	31.7	38.9	-	NP	-	SILTY SAND (SM)
CLD-622A	S1, S2, S3	27.0 - 33.0	30.4	39.5	-	NP	-	SILTY SAND (SM)
CLD-622A	S4, S5, S6	33.0 - 39.0	34.6	35.2	-	-	-	SILTY SAND (SM)
CLD-622A	S8, S9, S10, S11	41.0 - 49.0	29.1	10.1	-	-	-	NARROWLY GRADED SAND WITH SILT (SP-SM)
CLD-622B	S1, S2, S3	27.0 - 33.0	33.4	37.6	-	NP	-	SILTY SAND (SM)
CLD-622C	T1	28.0 - 30.0	32.0	29.2	-	-	-	SILTY SAND (SM)
CLD-623A	S3, T4	24.0 - 27.0	28.4	68.1	-	-	-	SANDY LEAN CLAY (CL)
CLD-623A	S5, S6	29.0 - 33.0	28.3	61.8	33	6	-	SANDY SILT (ML)
CLD-623A	S7, S8, S9	33.0 - 39.0	28.6	41.2	-	-	-	SILTY SAND (SM)
CLD-623A	S12	43.0 - 45.0	20.8	15.8	-	-	-	SILTY SAND (SM)
CLD-623B	S2 (Top 16")	22.0 - 23.5	26.2	60.1	27	9	-	SANDY LEAN CLAY (CL)
CLD-623B	S2 (Bot 6"), S3	23.5 - 26.0	22.6	68.4	32	14	-	SANDY LEAN CLAY (CL)
CLD-623B	S5, S6	28.0 - 32.0	30.3	58.9	33	10	-	SANDY LEAN CLAY (CL)
CLD-623B	S7, S8	32.0 - 36.0	33.2	70.5	37	14	-	LEAN CLAY WITH SAND (CL)

Notes:
[1] Refer to Appendix B1 for plots of grain size distributions.
[2] Refer to Appendix B1 for plasticity charts
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PI = Plasticity Index (percent moisture)
- = Test not performed

Table 4 - Summary of Laboratory Classifications Tests - Prior Borings
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

Boring Number	Sample Number	Depth Interval for Sample (feet)	Natural Water Content (%)	Percent Fines (%)	Atterberg Limits LL	Atterberg Limits PI	Sample Description and ASTM D2487 Classification Group Symbol [1]	Source
Upper Dam								
PF-206	S5	25.5-27.0	23.6	52.0	36	6	SANDY SILT (ML)	2
PF-206	S8	42.0-43.5	11.1	14.0	NP	NP	SILTY SAND (SM)	2
nr. PF-206	S2	35.0-37.5	40.5	44.0	NP	NP	SILTY SAND (SM)	2
PF-202	S4	33.0-34.5	20	12	NP	NP	WELL-GRADED SILTY SAND (SW-SM)	2
PF-202	S5	42.0-43.5	10.1	7	NP	NP	WELL-GRADED SILTY SAND (SW-SM)	2
PF-202	S6	43.5-45.0	11.1	13	NP	NP	SILTY SAND (SM)	2
nr. PF-202	S2	35.0-35.8	-	8	NP	NP	POORLY-GRADED SILTY SAND (SP-SM)	2
nr. PF-202	S3	45.0-47.4	31.4	29	45	3	SILTY SAND (SM)	2
MW-9	S6	34.5-36.0	40.7	64	36	5	SANDY SILT (ML)	2
MW-9	S10	48.0-49.5	18.4	24	NP	NP	SILTY SAND (SM)	2
MW-10	S4	24.0-25.5	27.2	62.0	36	9	SANDY SILT (ML)	2
PW-3	S18	25.5-27.0	23.1	14	NP	NP	SILTY SAND (SM)	2
PW-3	S23	33.0-34.5	19.1	7	NP	NP	POORLY GRADED SILTY SAND (SP)	2
PW-3	S28	40.5-42.0	8.2	12	NP	NP	POORLY-GRADED SILTY SAND (SP-SM)	2
MW-11	S2	19.5-21.0	21.5	9	NP	NP	WELL-GRADED SILTY SAND (SW-SM)	2
MW-11	S5	39-40.5	9.6	8	NP	NP	POORLY-GRADED SILTY SAND (SP-SM)	2
MW-12	S4	30.0-31.5	33.5	43	NP	NP	SILTY SAND (SM)	2
PF-209	S6	31.5-33.0	27.1	63	39	12	SANDY SILT (ML)	2
PF-209	S9	43.5-45.0	9.4	12	NP	NP	WELL-GRADED SILTY SAND (SW-SM)	2
CUD-533	UF1	23.6	37	65	45	12	SANDY SILT (ML)	3
CUD-531	UF1	21.5	36	55	34	5	SANDY SILT (ML)	3
CUD-533	UF2	25.4	36	57	37	10	SANDY SILT (ML)	3
CUD-533	UF2	25.8	39	53	37	8	SANDY SILT (ML)	3
CUD-531	UF1	20.9	36	49	32	3	SILTY SAND (SM)	3
CUD-531	UF2	23.6	32	21	NP	NP	SILTY SAND (SM)	3
CUD-533	UF3	31.0	30.4	26.4	NP	NP	SILTY SAND (SM)	3
Lower Dam								
PF-131	S9	24.0-25.5	12.8	44	NP	NP	SILTY SAND (SM)	4
PF-131	S11	27.0-28.5	29.2	44	38	14	CLAYEY SAND (SC)	4
CLD-UD-8B, nr. PF-131	S1 top	28.0-30.5	20.2	68	45	11	SILT w/SAND (ML)	4
CLD-UD-8B, nr. PF-131	S1 bot.	28.0-30.5	46.6	46	28	8	CLAYEY SAND (SC)	4
PF-107	S27	39.0-40.5	19.5	26	NP	NP	SILTY SAND (SM)	4
PF-107	S30	43.5-45.0	31.2	8	NP	NP	POORLY-GRADED SILTY SAND (SP-SM)	4
PW-1	S8	43.5-45.0	8.8	4	NP	NP	POORLY GRADED GRAVEL (GP)	4
PW-1	S9	45.0-46.5	11.9	6	NP	NP	POORLY-GRADED SILTY SAND (SP-SM)	4
PF-128	S9	22.5-24.0	25.6	55	30	8	CLAYEY SAND (SC)	4
PF-128	S11	48.0-49.5	4.2	1	NP	NP	POORLY GRADED SAND (SP)	4
CLD-UD-5C, nr. PF-128	S1	44.0-43.2	7.4	2	NP	NP	POORLY GRADED SAND (SP)	4
MW-5	S9	34.0-36.0	23.8	26.0	NP	NP	SILTY SAND (SM)	4
PW-2	S9	25.5-27.0	23.7	52	30	6	SANDY SILT (ML)	4
PW-2	S12	46.5-48.0	10.8	15	NP	NP	GRAVELLY SILTY SAND (SM)	4
PF-136	S10	37.5-39.0	12.4	25	26	1	SILTY SAND (SM)	4
PF-136	S11	46.5-48.0	15.3	13	NP	NP	SILTY SAND (SM)	4
PF-136	S12	48.0-49.5	10.3	20	43	8	SILTY SAND (SM)	4
CLD-514	UF1	23.9	28.0	67	32	12	SANDY LEAN CLAY (CL)	3
CLD-518	UF1	32.9	58.0	N/A	51	16	ELASTIC SILT (MH)	3
CLD-514	UF3	30.4	N/A	64.6	27	2	SANDY SILT (ML)	3
CLD-518	UF3	32.5	N/A	63.5	30	2	SANDY SILT (ML)	3

Note:
1. Refer to Appendix A for ASTM D2487 soil classification group names.
2. USACE (1982)
3. GEI (1994)
4. USACE (1981)

Abbreviations and Symbols
LL = Liquid Limit (percent moisture)
NP = Not Plastic
PI = Plasticity Index (percent moisture)
- = Test not performed

Table 8 – Summary of Soil Cement Mix Tests

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

Batch #	Description	Cement Content for w/c = 0.7		
		300 lbs/cy	450 lbs/cy	600 lbs/cy
1	Silty sand	X	X	
2	Silty sand/sandy silt		X	X
3	Low to medium plasticity silt		X[(1)]	X
4	Clay		X	X
5	Silty sand/sandy silt w/organics			X

Note:

1. [(1)] Batch 3 also tested with w/c = 0.9 and cement content of 450 lbs/cy.

Table 9 – Summary of Results of Soil Cement Mix Testing

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

Batch #	Description	w/c[1]	Cement Content, (lbs/cy)	Average Compressive Strength (*Range of Values*), n[2] (psi)		
				7 days	28 days	56 days
1	Silty sand	0.7	300	94 (*79-103*), n=3	170 (*166-173*), n=3	206 (*204-208*), n=3
1	Silty sand	0.7	450	205 (*203-208*), n=3	318 (*311-322*), n=3	433 (*431-434*), n=3
2	Silty sand/sandy silt	0.7	450	298 (*296-301*), n=3	488 (*477-504*), n=3	545 (*526-563*), n=4
2	Silty sand/sandy silt	0.7	600	425 (*403-435*), n=4	720 (*709-732*), n=3	845 (*843-858*), n=3
3	Low to medium plasticity silt	0.7	450	11.4 (*10.6-12.4*), n=3	207 (*188-226*), n=2	232 (189-*275*), n=2
3	Low to medium plasticity silt	0.9	450	8.9 (*8.8-9.0*), n=2	316 (*306-322*), n=3	347 (*294-383*), n=3
3	Low to medium plasticity silt	0.7	600	263 (*251-270*), n=3	595 (*595*), n=1	667 (*619-721*), n=3
4	Clay	0.7	450	314 (*295-333*), n=3	424 (*341-519*), n=3	338 (*226-433*), n=4
4	Clay	0.7	600	674 (*657-690*), n=2	979 (928-*1029*), n=2	717 (*529-1040*), n=4
5	Silty sand/sandy silt w/organics	0.7	600	435 (*421-443*), n=3	705 (*610-755*), n=4	856 (*797-896*), n=3

Note:

1. [1] w/c = water/cement ratio
2. [2] n = Number of tests. Refer to test summary sheets in Appendix B3.6
3. NT = Not Tested.

Table 10 – Summary of Index Tests on Soil Mix Batches

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

Batch	Sample No.	Water Content (%)	Liquid Limit	Plasticity Index [1]	% < 200 sieve [2]	Organic Content (%)
1. Silty Sand	CUD-623A, T1	Not Tested ----------→				
	CUD-623A, T2	26.1	-- [3]	--	29.4	
	CUD-623A, T3	Not Tested ----------→				
	CUD-623A, T4 (1/2)	35.3	--	--	24.4	
	CUD-623A, T4 (2/2)	Not Tested ----------→				
	CUD-623A, T6 (2/2)	Not Tested ----------→				
	CUD-623A, S8	Not Tested ----------→				
	Batch	***29.9***	***--***	***--***	***20.1***	
2. Silty Sand/Sandy Silt	CUD-622A, T7	30.7	--	NP [4]	48.8	
	CUD-624A, T2 (1/2)	26.4	34	8	64.8	
	CUD-624A, T6 (Top 8")	33.6	28	3	50.2	
	CLD-613, T7	37.6	--	NP	55.8	
	CLD-621A, S1	28.7	--	NP	51.5	
	CLD-622C, T2	Not Tested ----------→				
	CLD-622C, T3	Not Tested ----------→				
	CLD-622C, T4	Not Tested ----------→				
	CLD-622C, T5	Not Tested ----------→				
	CLD-623A, S5&S6	Not Tested ----------→				
	Batch	***29.2***	***28***	***1***	***45.7***	
3. Low to Medium Plasticity Silt	CUD-622A, T6	42.5	33	5	74.9	
	CUD-624A, T2 (2/2)	44.9	54	23	80.0	
	CUD-624C, T1	38.7	36	11	56.2	
	CLD-621A, T3 (2/2)	42.8	48	16	83.1	
	CLD-623B, S5&S6	30.3	33	10	58.9	
	Batch	***37.9***	***40***	***15***	***68.2***	
4. Clay	CUD-624A, T1	18.9	27	10	41.3	
	CUD-624A, T3 (1/2)	32.8	39	16	72.5	
	CUD-624A, T3 (2/2)	25.7	29	8	57.3	
	CUD-624A, T4 (1/2)	31.7	28	8	53.3	
	CUD-624A, T4 (2/2)	32.8	44	19	87.3	
	CUD-624B, T1 (1/2)	Not Tested ----------→				
	CUD-624B, T1 (2/2)	63.4	43	17	78.6	
	Batch	***26.3***	***34***	***11***	***58.6***	
5. Silty Sand/Sandy Silt with Organics	CUD-621A, T2	32.1	28	3	50.9	4.76
	CUD-622A, T4	31.2	--	NP	31.1	2.64
	CUD-624A, T6 (Bot. 16")	37.5	--	NP	47.5	4.81
	CUD-624A, T7	30.6	--	NP	30.1	3.88
	Batch	***30.4***	***NV***	***NP***	***39.6***	***4.41***

Note:

1. See Appendix B3 for plasticity charts for contributing samples and batches.
2. See Appendix B3 for gradation curves for batches.
3. -- = Test not performed.
4. NV = Non-Viscous, NP = Non-Plastic

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Soil-Cement Mix Test Results - Batch 1 - Silty Sand

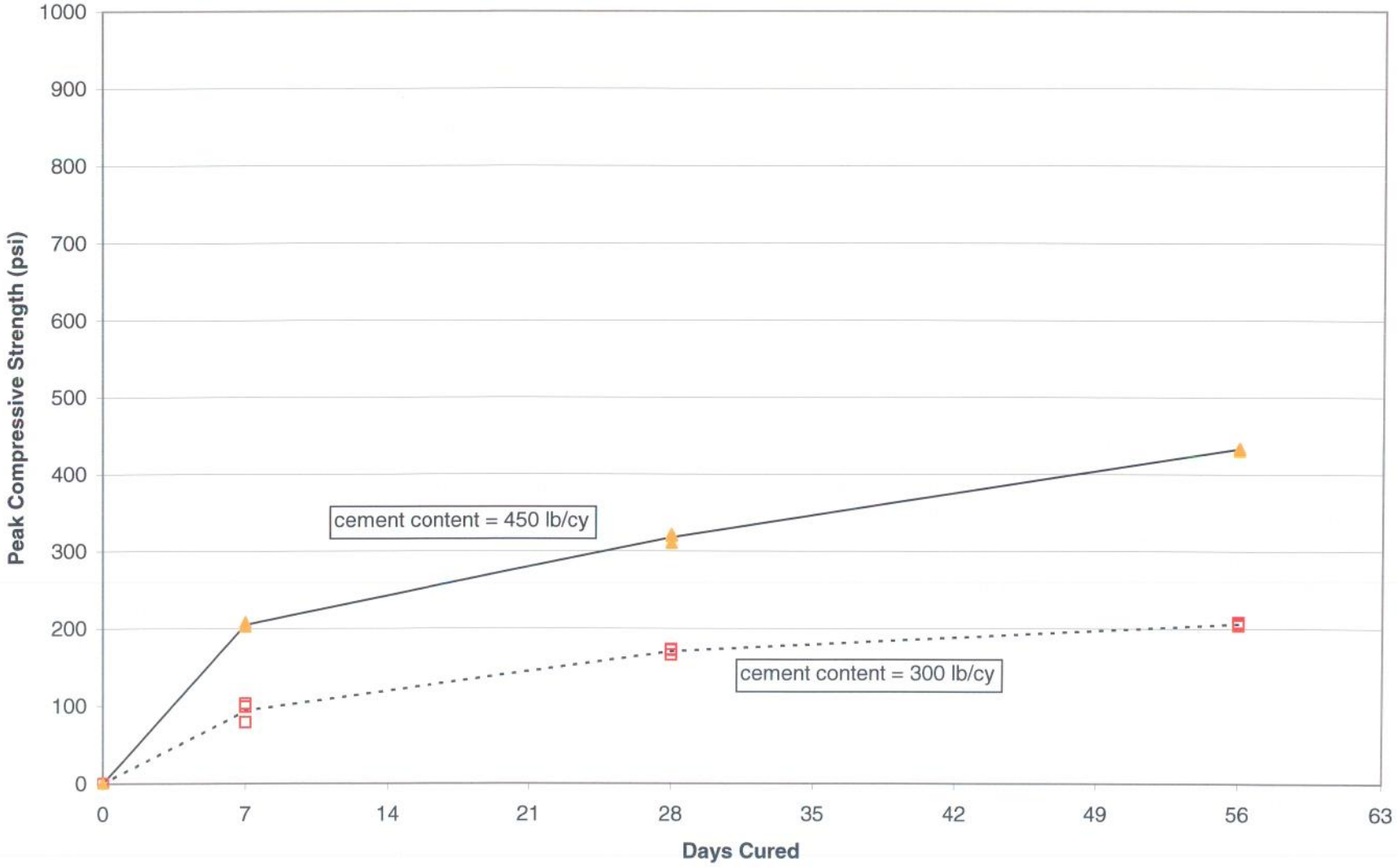

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FIGURE 5

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Soil-Cement Mix Test Results - Batch 2 - Silty Sand/Sandy Silt

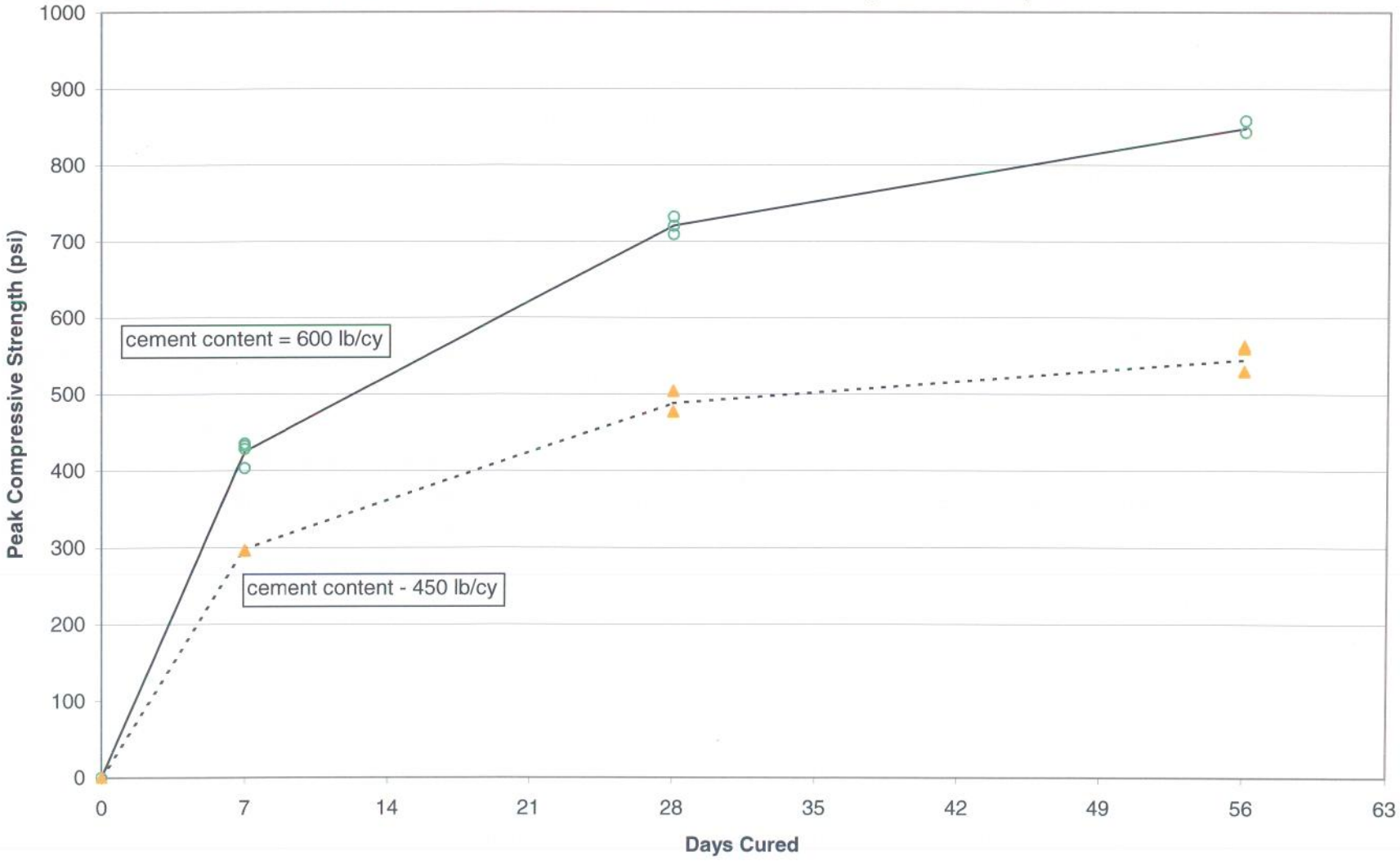

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FIGURE 6

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Soil-Cement Mix Test Results - Batch 3 - Low-Medium Plasticity Silt

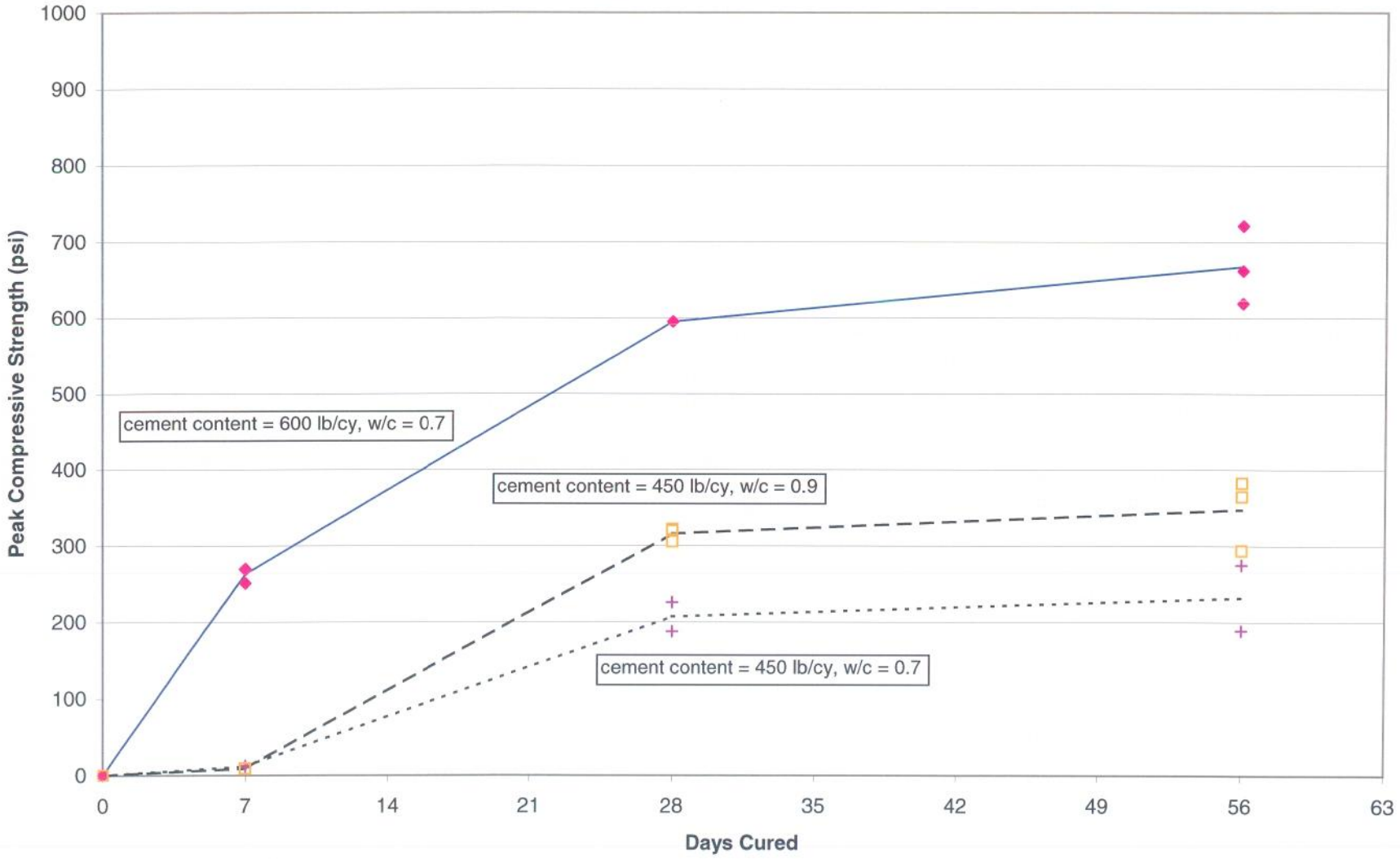

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FIGURE 7

Final Design of Seismic Remediation
Clemson Upper and Lower Dams
Soil-Cement Mix Test Results - Batch 4 - Clay

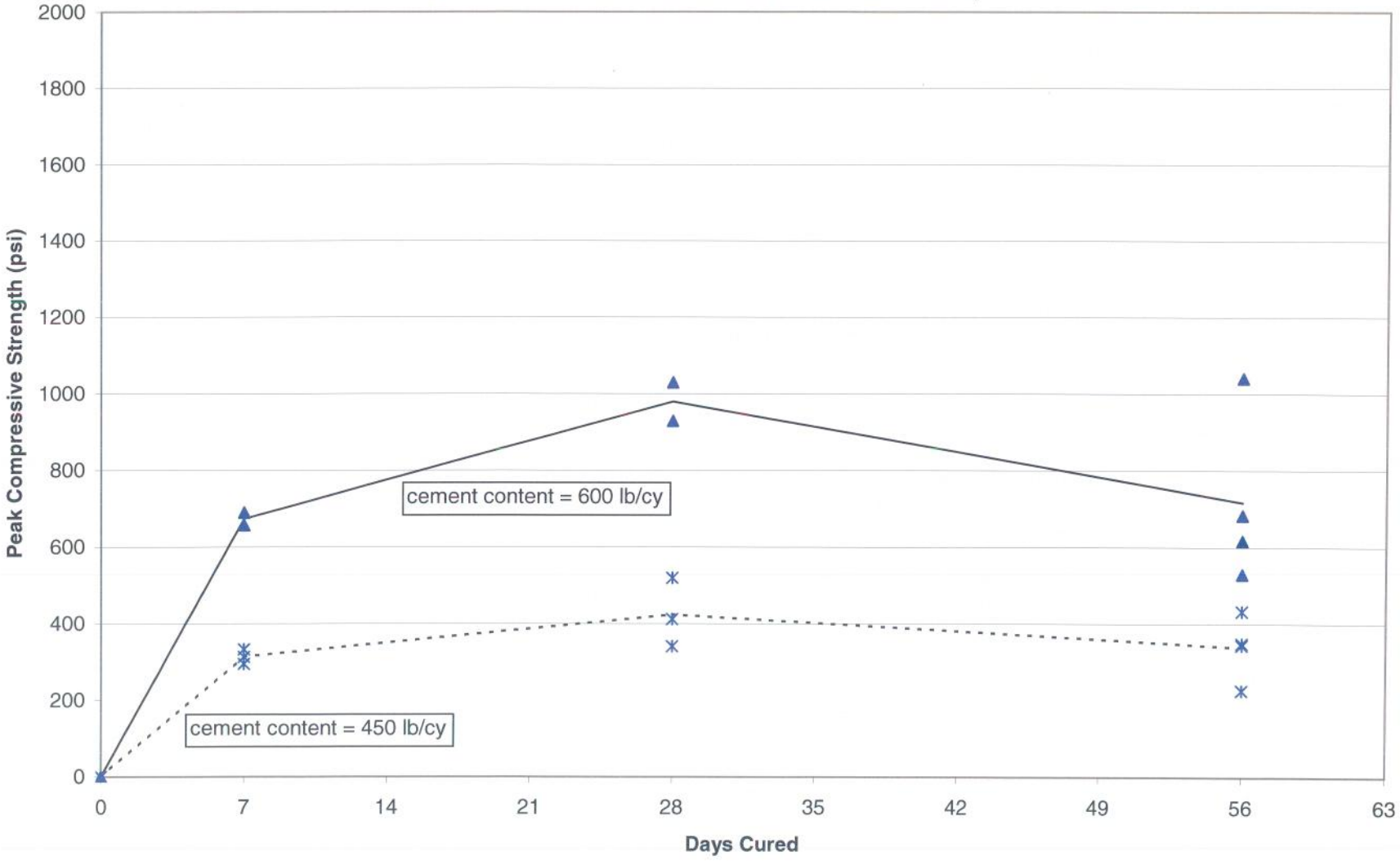

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FIGURE 8

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Soil-Cement Mix Test Results - Batch 5 - Silty Sand/Sandy Silt with Organics

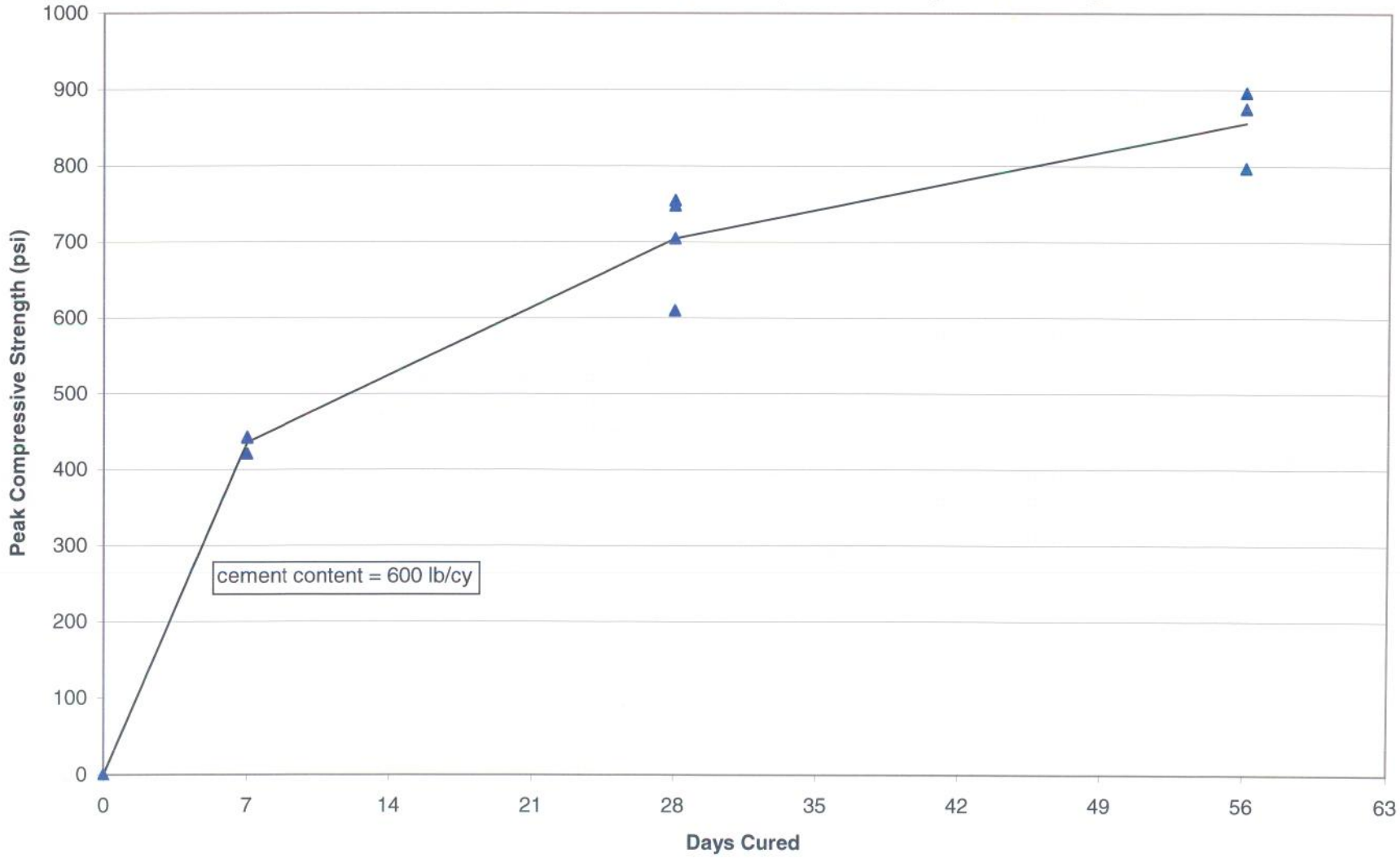

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FIGURE 9

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Plasticity Chart

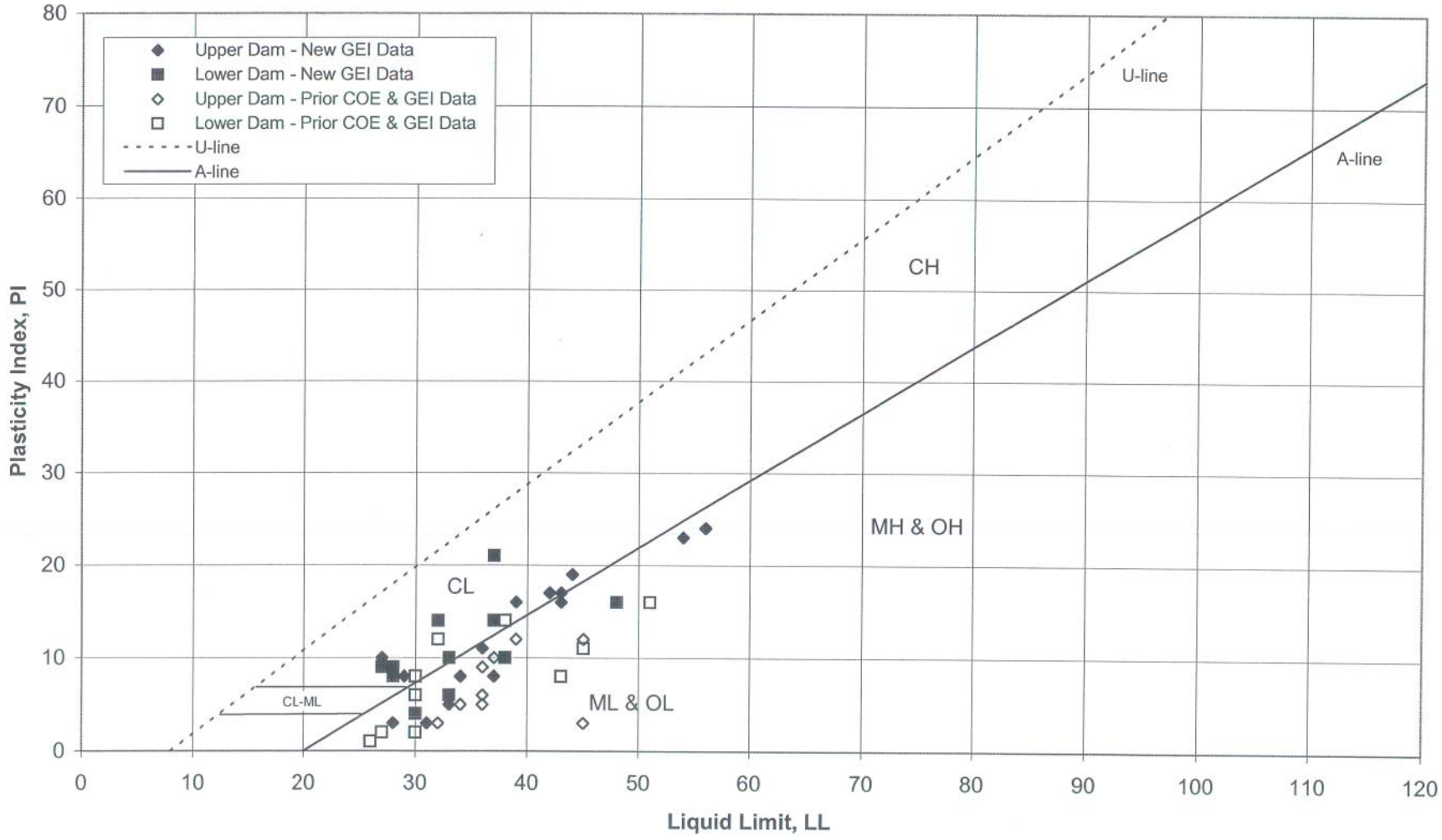

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FIGURE 14

B3 – Soil-Cement Testing

B3 – Soil-Cement Testing

B3.1 – Soil - Mix Design: Mixing and Molding Procedures

Soil-Mix Design: Mixing, Molding and Testing Procedures

Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

1. Record the ID and quantities of each contributing sample bag to the soil-mix batch. GEI identified 5 soil types based on the Unified Soil Classification System (USCS) to be batched for the Clemson Soil-Mix Design Program.
   - SM – Silty Sand
   - ML – Silty Sand/Sandy Silt
   - MLMH – Low to Medium Plasticity Silt
   - CL – Clay
   - OL – Silty Sand/Sandy Silt with Organics
2. Pass proportionate amounts of soil from each sample bag through a large 3/8" sieve simultaneously to begin the soil mixing process. Hand-push soil through sieve. Record sample weights contributing to the soil batch. [See Photo 1]
3. Perform Index Testing on the soil batch for water content (-#10 sieve = 20g; -#4 sieve = 100g; ASTM D-2216, or ASTM D-4643 when more rapid results are required or desired to expedite other phases of testing which requires 100-200g if no more than 10% of sample is retained on the #10 sieve), particle-size distribution (115g for sands; 65g for silt & clay ASTM D-422), and Atterberg Limits (200g; ASTM D-4316).
4. Calculate mix proportions using unit weights of components. Cement was determined by assuming a $G_{Cement} = 3.15$. The soil batch unit weight was determined by using the lab-determined water content for each soil batch and $G_{Soil} = 2.7$. Unit weights were used to obtain proportions for water, cement, and soil at varying cement contents (300, 450, 600 lbs/yd^3).
5. Mix water to cement for approximately 5 minutes, or until grout is thoroughly mixed, using an impeller attached to a hand drill. [See Photos 2 & 3]
6. Mix grout to soil for approximately 10 minutes using an impeller attached to a drill press. The drill press should be set at a suitable speed to induce proper mixing. The drill press in the GEI soil laboratory was set at 380 rpm. One technique to help the mixing process was to let the impeller run at the bottom of the bucket and bring it up and down while rotating the bucket around the drill press. A trowel was also used to scoop material off the bottom of the bucket. [See Photos 4 & 5]
7. Place in cardboard molds with a height of 6" and diameter of 3". Pour soil mix in 3 layers applying seven tamps with a ½" diameter rod through the sample and seven taps of a mallet to the side of the mold for each layer. Cover sample top with plastic and wrap it in place with electrical tape. [See Photos 6 & 7]
8. Cure molded samples in a moist environment in general accordance with ASTM D-1632. Samples were placed in plastic bins with cups of water around the samples or raised slightly above a thin layer of water at the bottom of the plastic bins. Water was sprayed into the bins at least once per day. [See Photo 8]
9. Remove sample molds after soil-cement cylinders have stiffened sufficiently to cure without the molds. Place each sample back in curing environment partially covered in plastic. Take samples out of the curing environment after 7, 28, and 56 days of curing for unconfined compression testing. Normally soil-cement samples were left in their molds up until the day of the unconfined compression test.
10. Weigh soil-cement cylinder prior to and after the 4-hour soak time required by ASTM D-1633. Soak cylinder for 4 hours.
11. Record the height (3 measurements at 120° angles) and diameter (once at top, middle, and bottom) of each test cylinder.
12. In general, accordance with ASTM D-1632, cap test samples with a sulfur-capping compound rather than the gypsum plaster called for in the standard. Bring the sulfur-capping compound to a temperature to about 265°F. Apply a thin film of mineral oil to the capping plate to aid in removing specimen. Perform at least one dry run with the sulfur-capping compound to warm the capping plate to slow the rate of hardening to permit the production of thin caps. [See Photo 9]
13. Set cylinder up in triaxial cell (no confining pressure) and test in accordance with ASTM D-1633 for unconfined compression testing. Load sample at a 1% strain rate (0.06 in/min). [See Photos 10 – 13]
14. Save portion of material after testing for moisture content determination (ASTM D-2216).

B3.2 – Photographs of Mixing, Molding and Testing

PHOTOGRAPHS OF SOIL MIX TESTING PROCEDURES

Photo 1 – Batch #3 after sieving through 3/8" sieve

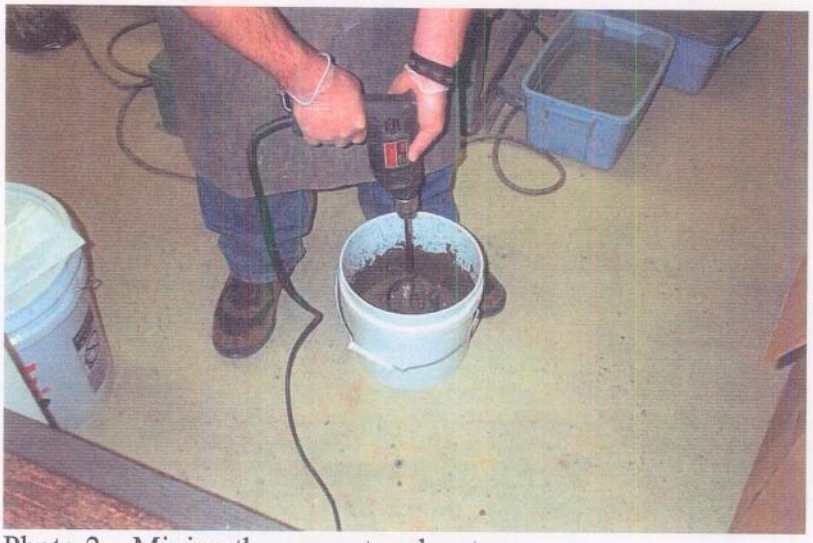

Photo 2 – Mixing the cement and water

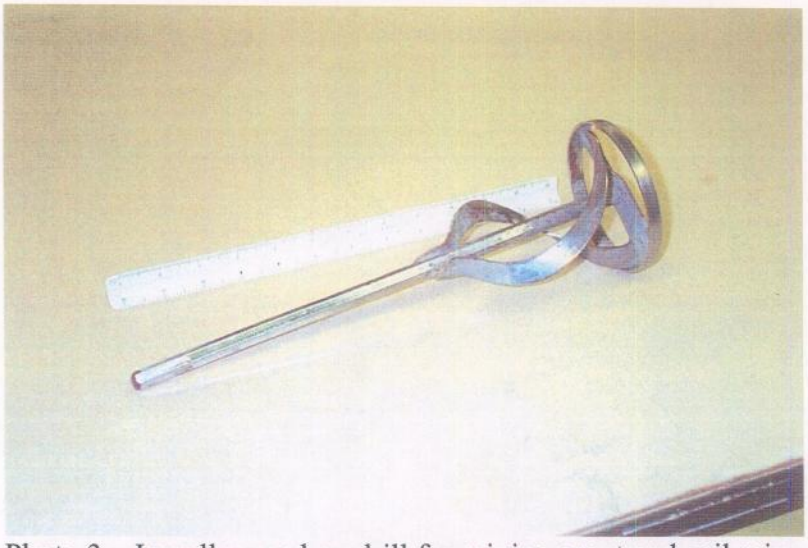

Photo 3 – Impeller used on drill for mixing grout and soil mix

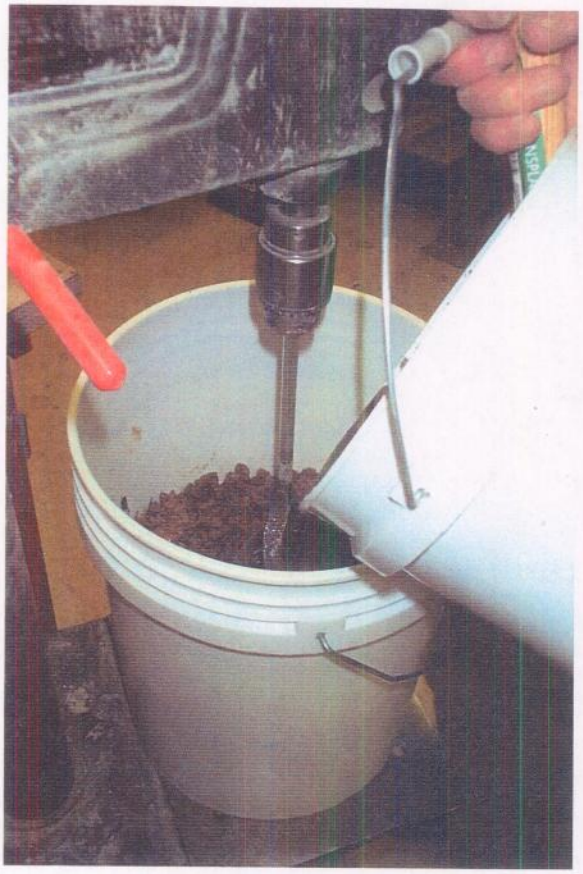

Photo 4 – Adding grout to soil batch

Photo 5 – Mix soil and grout

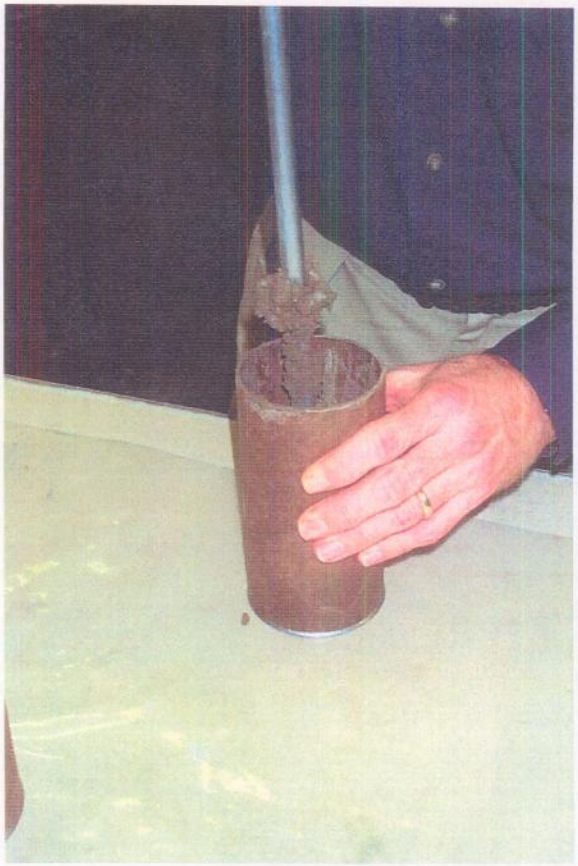

Photo 6 – Tamping soil mix in molds

Photo 7 – Sealed specimen prior to curing

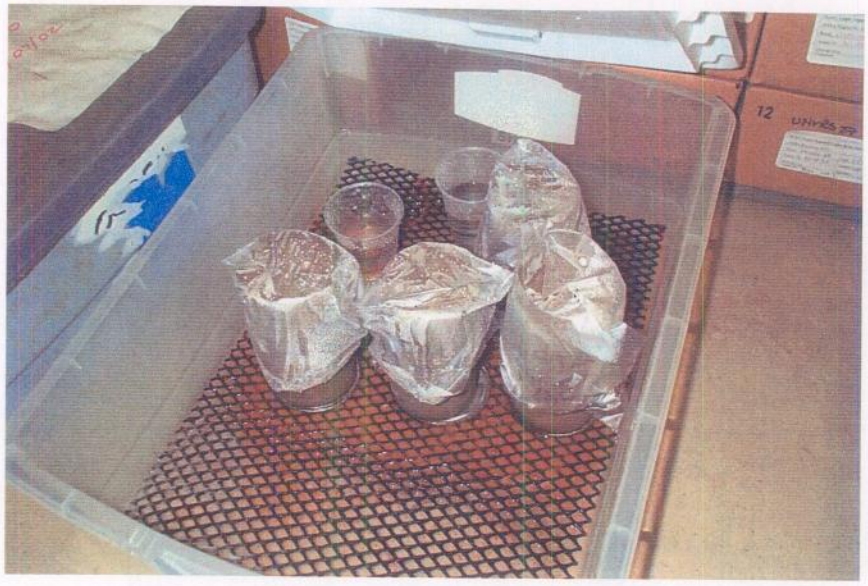

Photo 8 – Plastic tub used for curing specimens

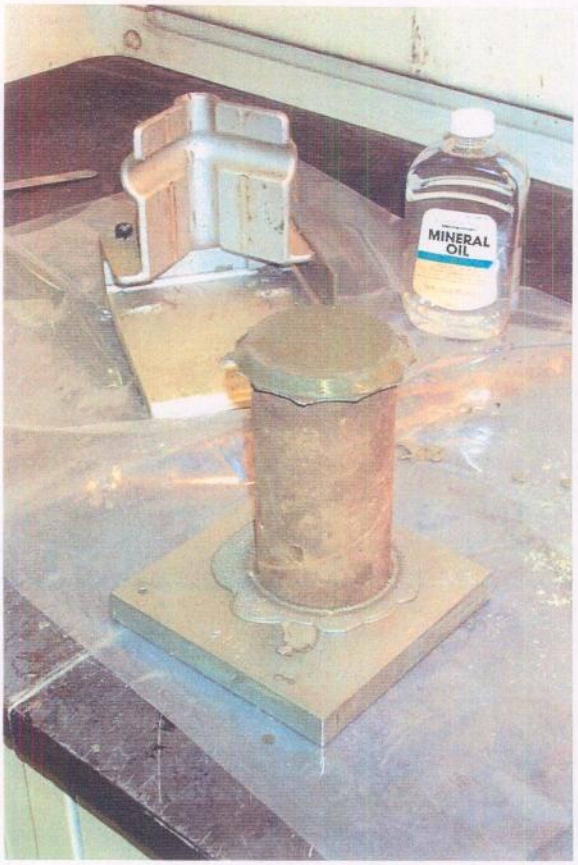

Photo 9 – Capping the specimen with sulfer

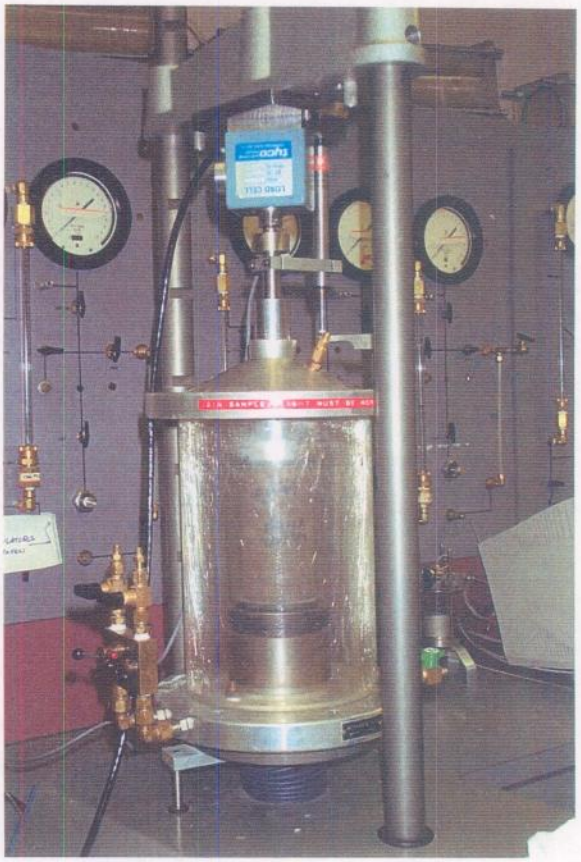

Photo 10 – Specimen set up in triaxial cell

Photo 11 – Sand specimen at failure

Photo 12 – Low to med. plasticity silt specimen

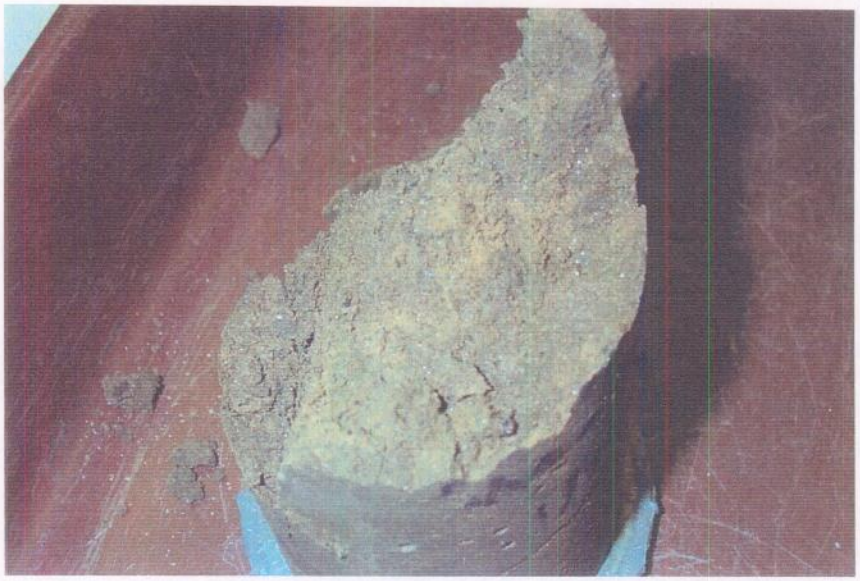

Photo 13 – Silty sand specimen

B3.3 – Grout Strength Summary

2" Grout Cubes at 0.7 w/c ratio

Batch Proportions
Wt. Cement, [lb] = 4.412
Wt. Water, [lb] = 3.120
w/c = 0.71

ASTM C109 : Compressive Strength of Hydraulic Cement Mortars (Grout)

Test ID	Cast Date	Time, [hrs]	Test Date	Weight, [g]	Dimensions			CSA, [in^2]	Peak Load, [lbs]	Compressive Strength, [psi]
					Length, [in]	Width, [in]	Height, [in]			
01282-Control-01	01/15/02	1510	01/22/02	213.469	2.00	2.00	1.83	4.00	9880	2470
01282-Control-02	01/15/02	1510	01/29/02	212.897	1.82	2.00	2.00	3.64	11721	3220
01282-Control-03	01/15/02	1510	02/12/02	212.527						3940

ASTM D4380 : Density of Bentonitic Slurries (API 13B-1 Section 3.0 : Mud Balance)

Unit Weight of Slurry, [g/cm^3]	1.67

API 13B-1 Section 4.2 : Marsh Funnel

Volume, [quart]	1
Marsh Funnel Viscosity Time, [sec]	43
Temperature of Grout, [°F]	24

ASTM C138 : Unit Weight of Concrete (Grout)
Not done by standard method

Grout Wt. + Tare, [g]	241.319
Tare ID	Grad. Cylin.
Tare Wt., [g]	117.738
Grout Wt., [g]	123.581
Measure Volume, [mL]	76
Volume, [ft^3]	0.00268
Unit Weight, [pcf]	101.48

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Tel (617) 492-2111 Fax (617) 492-5448

February 14, 2002

GEI CONSULTANTS, INC.
WINCHESTER, MASSACHUSETTS

TESTS OF GROUT CUBES

GEI PROJECT NO. 01282

Test Number — BB-916

Date Received — 1-17-02 Ages Tested — As Noted Below

Source — Submitted by your personnel, reference your P. O. #12045

Specimens — Three nominal 2" cubes identified as follows:
-- 01282 — Control-01
-- 01282 — Control-02
-- 01282 — Control-03

Test Procedure — ASTM: C 109 methods as applicable

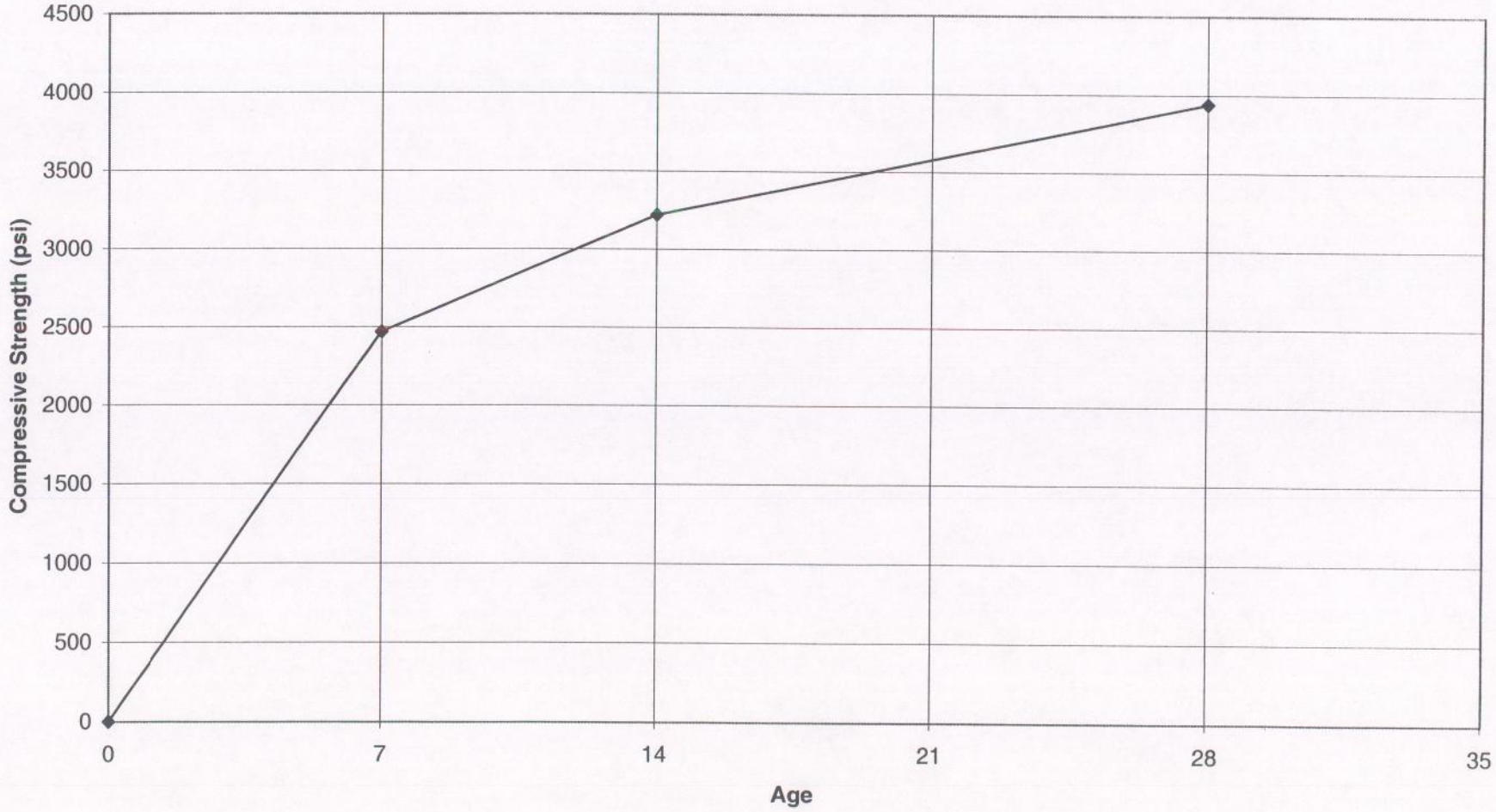
Results — The following data have been obtained:

CUBE MARK	AGE, DAYS	COMPRESSIVE STRENGTH, PSI
01282 — Control-01	7	2470
01282 — Control-02	14	3220
01282 — Control-03	28	3940

THE THOMPSON & LICHTNER COMPANY, INC.

E. Karalolos

Clemson Upper and Lower Diversion Dams
Final Design of Seismic Remediation
Grout Cube Compressive Strengths
Water/Cement Ratio = 0.7



B3.4 – Cement Analysis

RESOURCE MATERIALS TESTING, INC.
"Specialists in Fly Ash Testing"

P.O. Box 1335 -- Murphy NC 28906 1-877-217-5147

REPORT OF CEMENT ANALYSIS

TO: Thomas Cement
Attn: Mr. John Cook
2500 Cumberland Pkwy, Ste 210
Atlanta GA 30339

PROJECT NO.: RMT-392
SAMPLE NO.: 11981
DATE RECEIVED: 10-18-01
DATE REPORTED: 11-21-01

PROJECT NAME: Portland Cement Analysis
SAMPLE ID: Charleston Cement Vencemous Pertigalete M/V Thai-Ho Hold #3 10-14-01

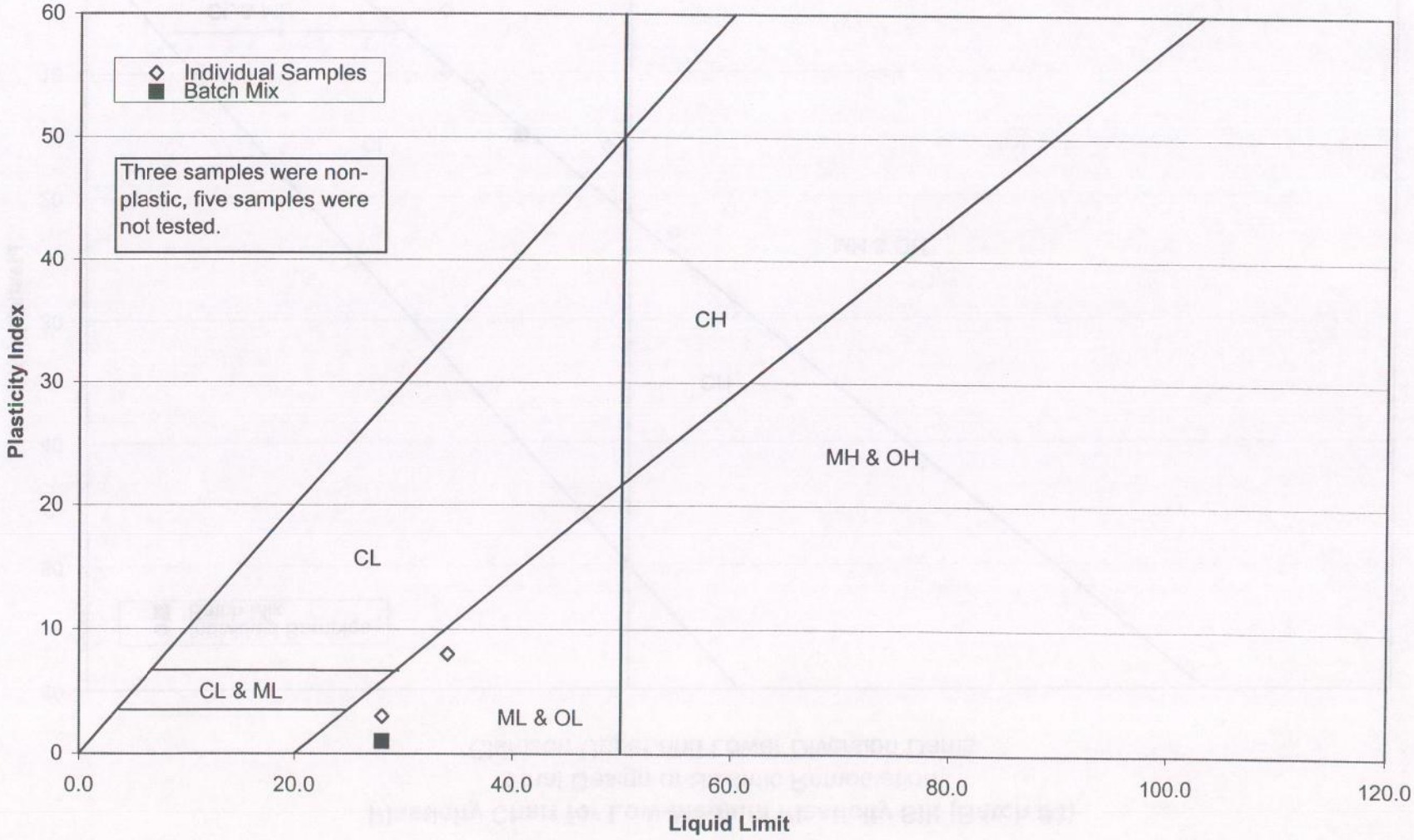
CHEMICAL ANALYSIS	RESULTS	ASTM C-150 SPEC.
Silicon Dioxide, SiO_2, %	20.30	—
Aluminum Oxide, Al_2O_3, %	5.03	—
Iron Oxide, Fe_2O_3, %	4.04	—
Calcium Oxide, CaO, %	64.65	—
Magnesium Oxide, MgO, %	0.90	6.0 Max
Sulfur Trioxide, SO_3, %	2.56	3.0 Max
Loss on Ignition, %	1.23	3.0 Max
Equivalent Alkalies as Na_2O, %*	0.43	0.60Max
Sodium Oxide, Na_2O, %	0.12	—
Potassium Oxide, K_2O, %	0.48	—
Insoluble Residue, %	0.16	0.75Max
Tricalcium Silicate, C_3S, %	62	—
Dicalcium Silicate, C_2S, %	11	—
Tricalcium Aluminate, C_3A, %	6.5	—
Tetracalcium Aluminoferrite, C_4AF %	12	—
PHYSICAL ANALYSIS		
Fineness, Blaine m^2/kg	341	280 Min
Compressive Strength, psi		
1 day	1970	—
3 day	3660	1740 Min
7 day	5260	2760 Min
28 day	6480	—
Time of Setting, Vicat		
Initial , min.	160	45 Min
Final, min.	---	375 Max
Air Content, %	6.5	12 Max
Autoclave Expansion, %	+0.00	0.80 Max
False Set*		
Initial Penetration, mm	31	—
Final Penetration, mm	25	—
Final Penetration, %	81	50 Min
Remix Penetration, mm	25	—

*Optional Requirements. This material meets the requirements of ASTM C150, GA, NC & DOT's for the parameters tested for a Type I/II low-alkali portland cement.

By Robert L Smith
Robert L. Smith, Ph.D.

B3.5 – Plasticity and Gradation Charts for Soil-Mix Batches

Plasticity Chart for Silty Sand/Sandy Silt (Batch #2)
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams

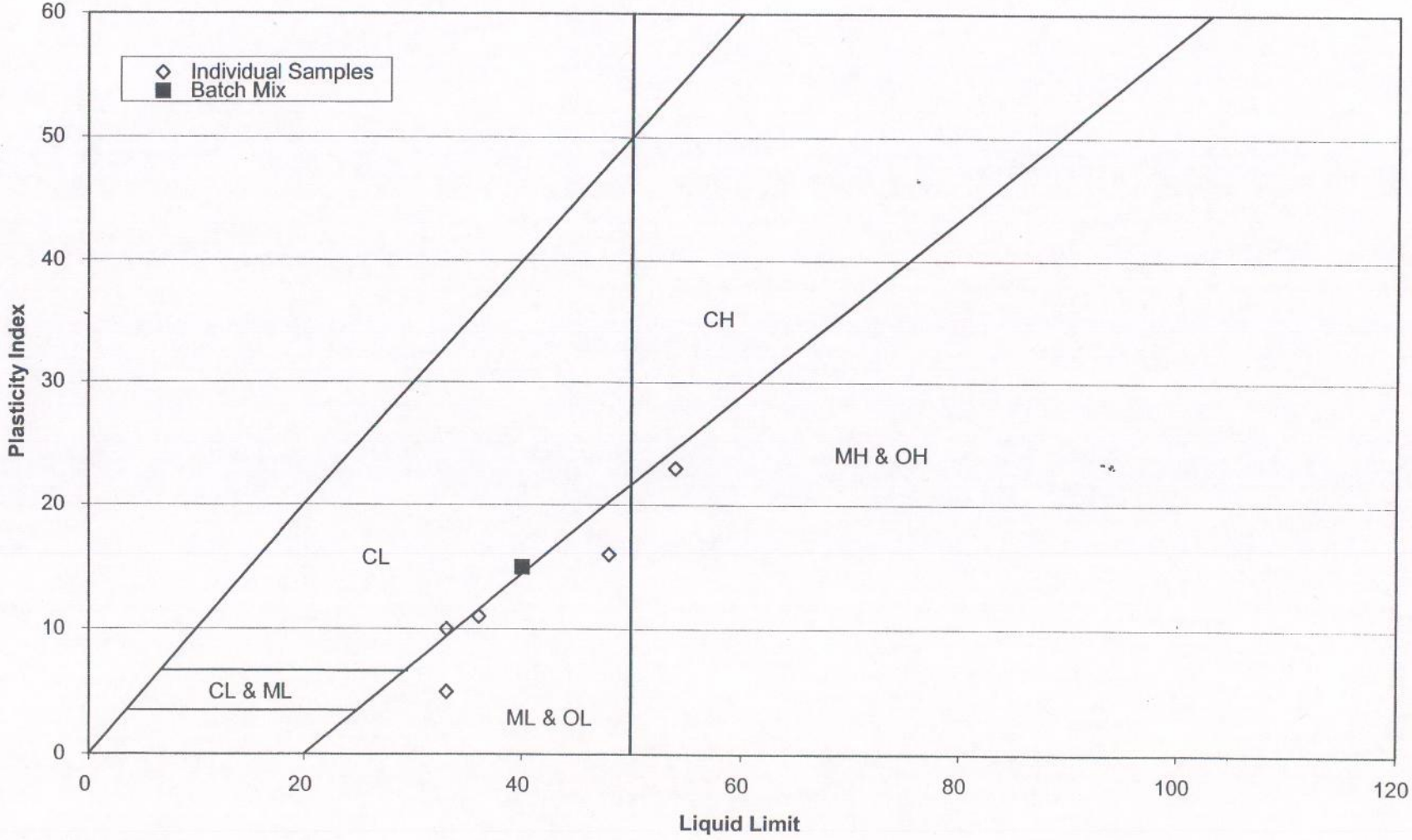


GEI Consultants, Inc.

Project 01282

3/26/02
soil mix data

Plasticity Chart for Low-Medium Plasticity Silt (Batch #3)
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams

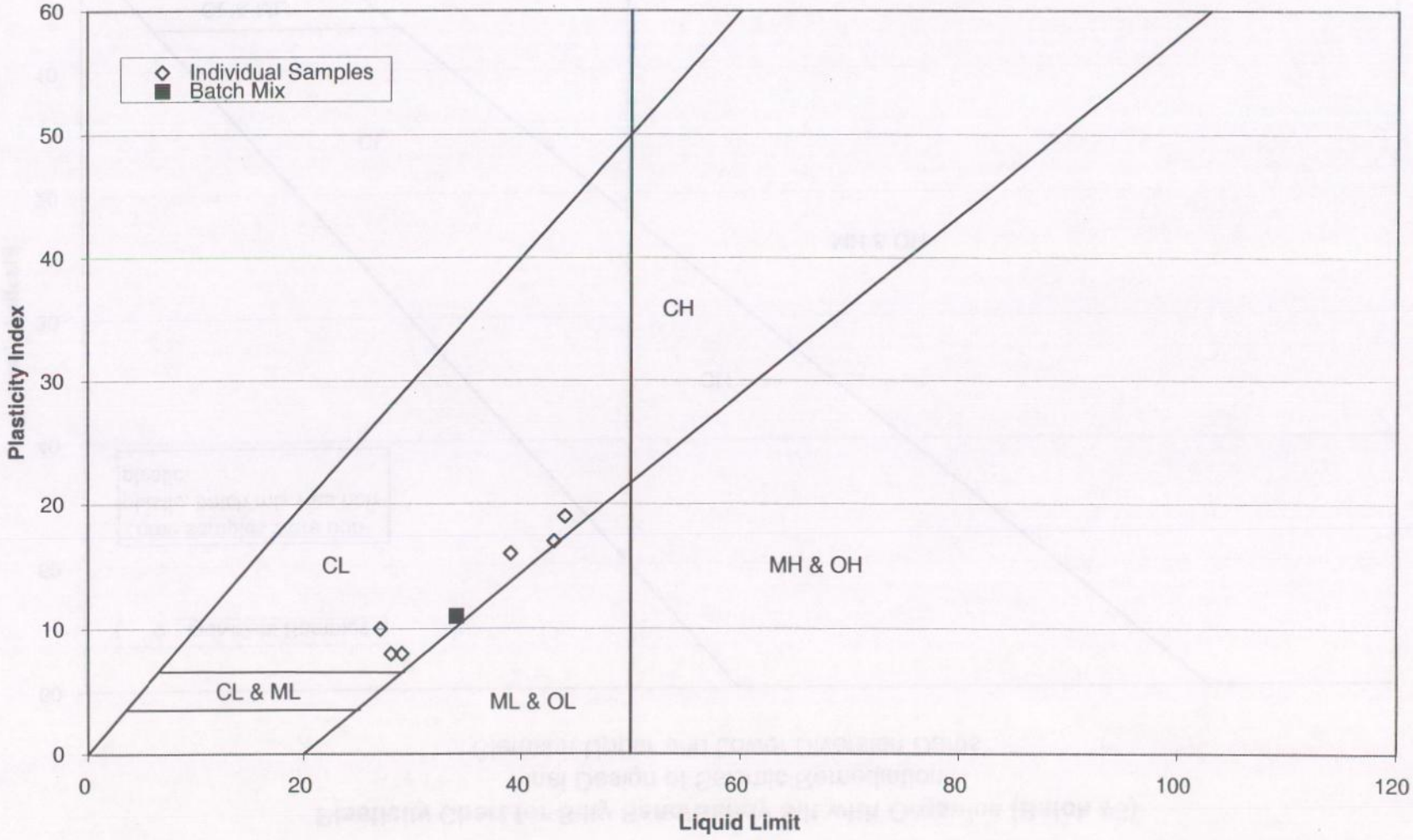


GEI Consultants, Inc.

Project 01282

3/26/02
soil mix data

Plasticity Chart for Clay (Batch #4)
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams

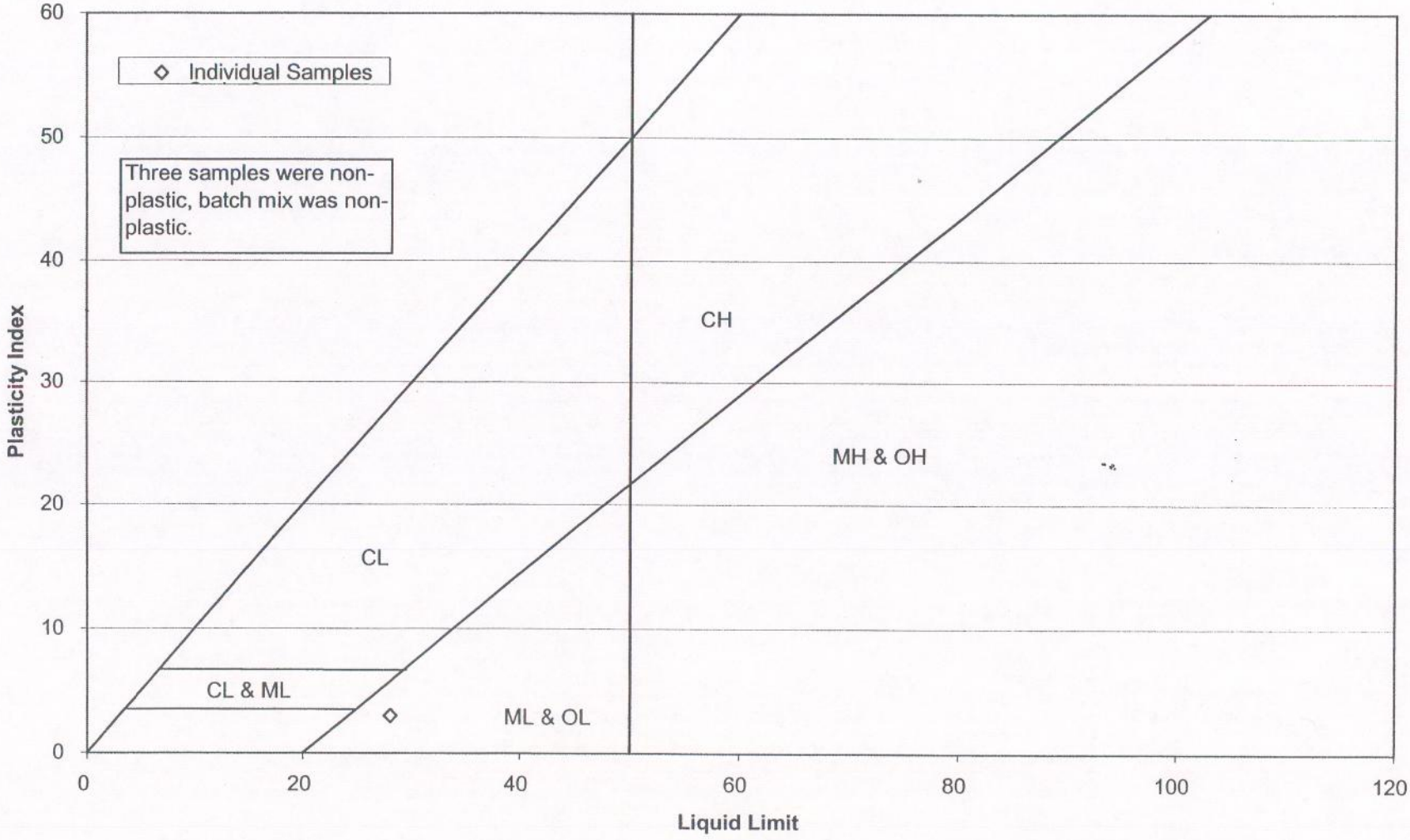


GEI Consultants, Inc.

Project 01282

4/4/02
soil mix data

Plasticity Chart for Silty Sand/Sandy Silt with Organics (Batch #5)
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams

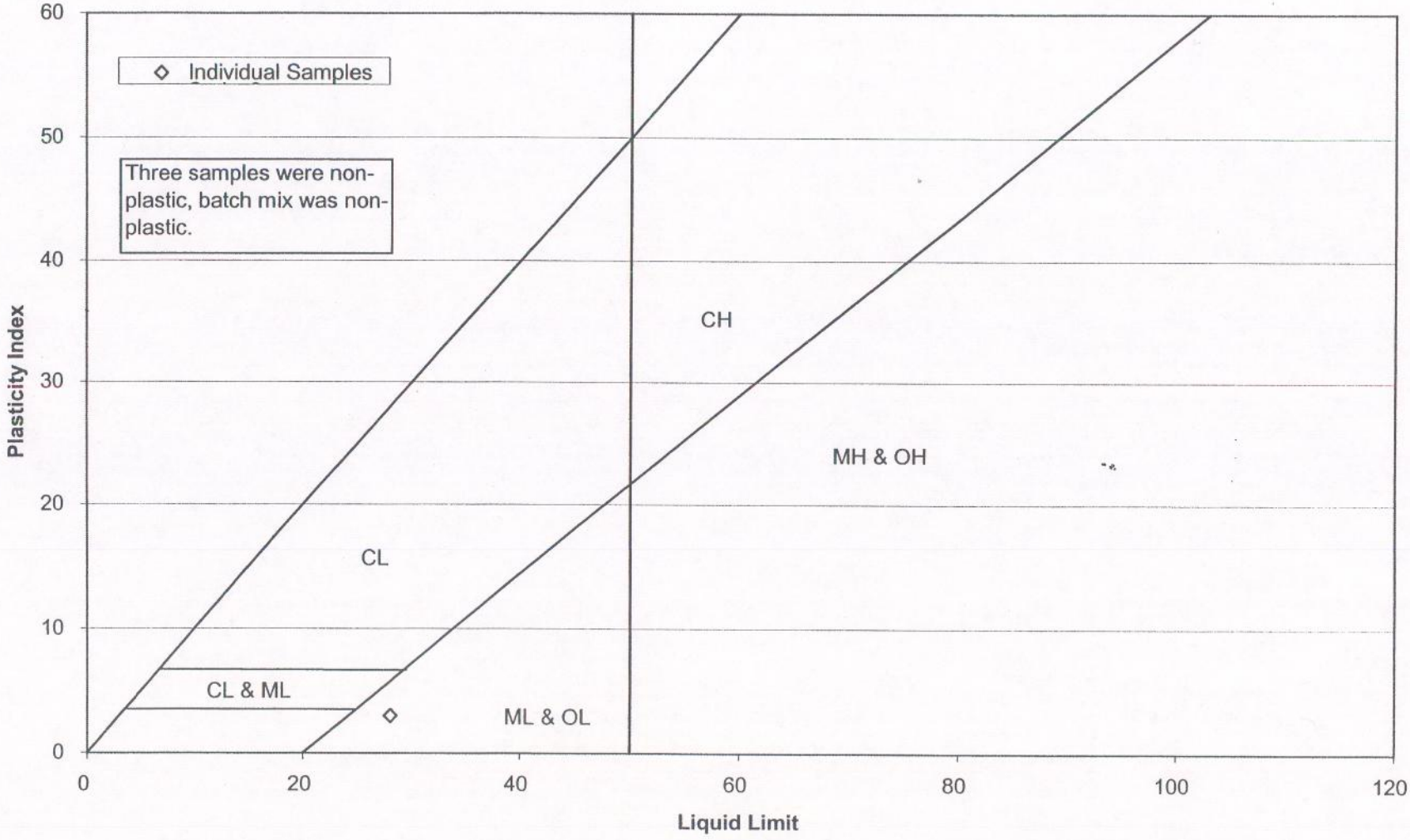


GEI Consultants, Inc.

Project 01282

3/26/02
soil mix data

Plasticity Chart for Silty Sand/Sandy Silt with Organics (Batch #5)
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams

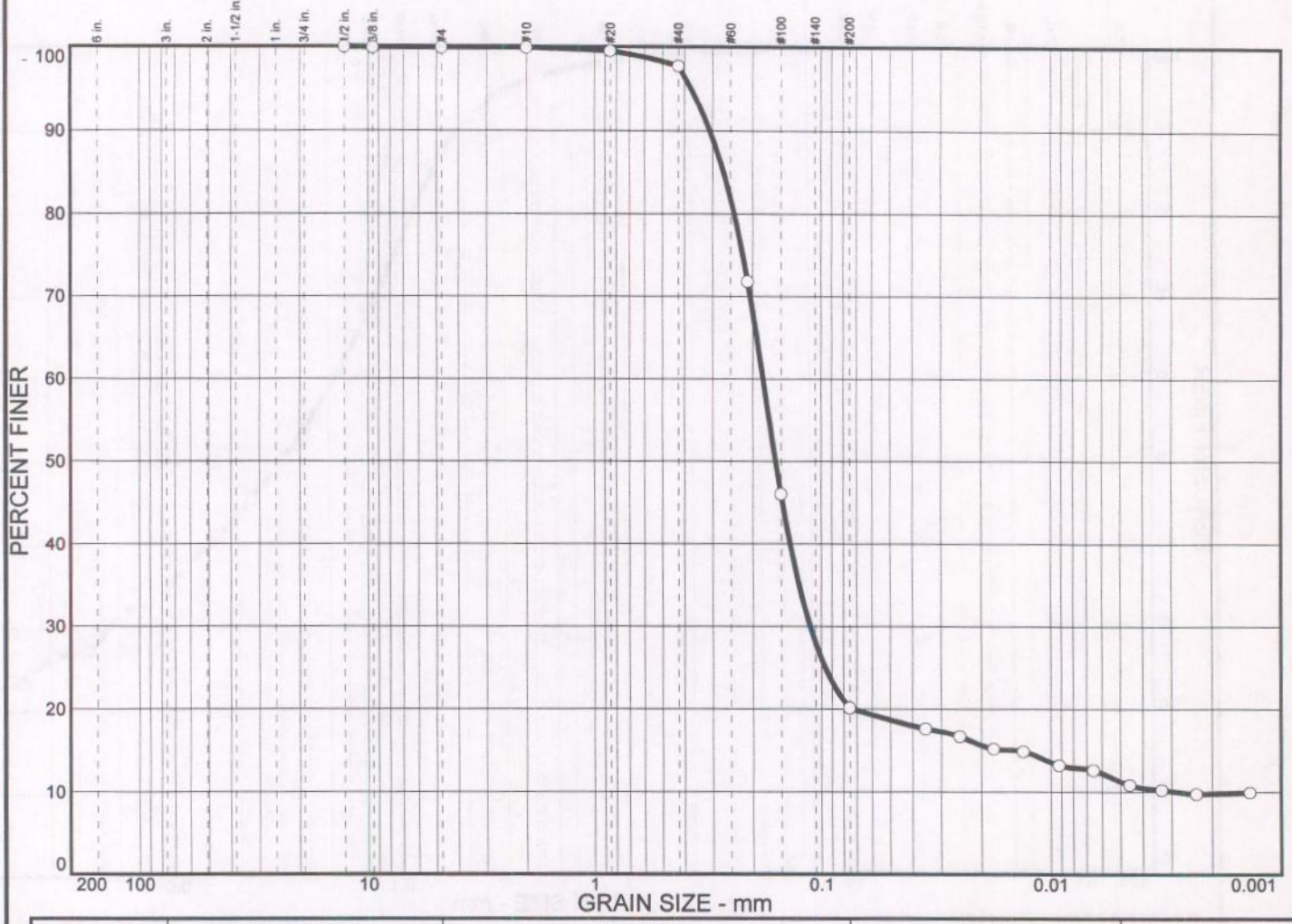


GEI Consultants, Inc.

Project 01282

3/26/02
soil mix data

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.1	79.8	20.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.268	0.180	0.158	0.112	0.0138	0.0029	24.03	62.23

MATERIAL DESCRIPTION	USCS	AASHTO
○ Silty SAND	SM	

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

○ **Source:** Soil Batch SM **Sample No.:** SM-01

Remarks:

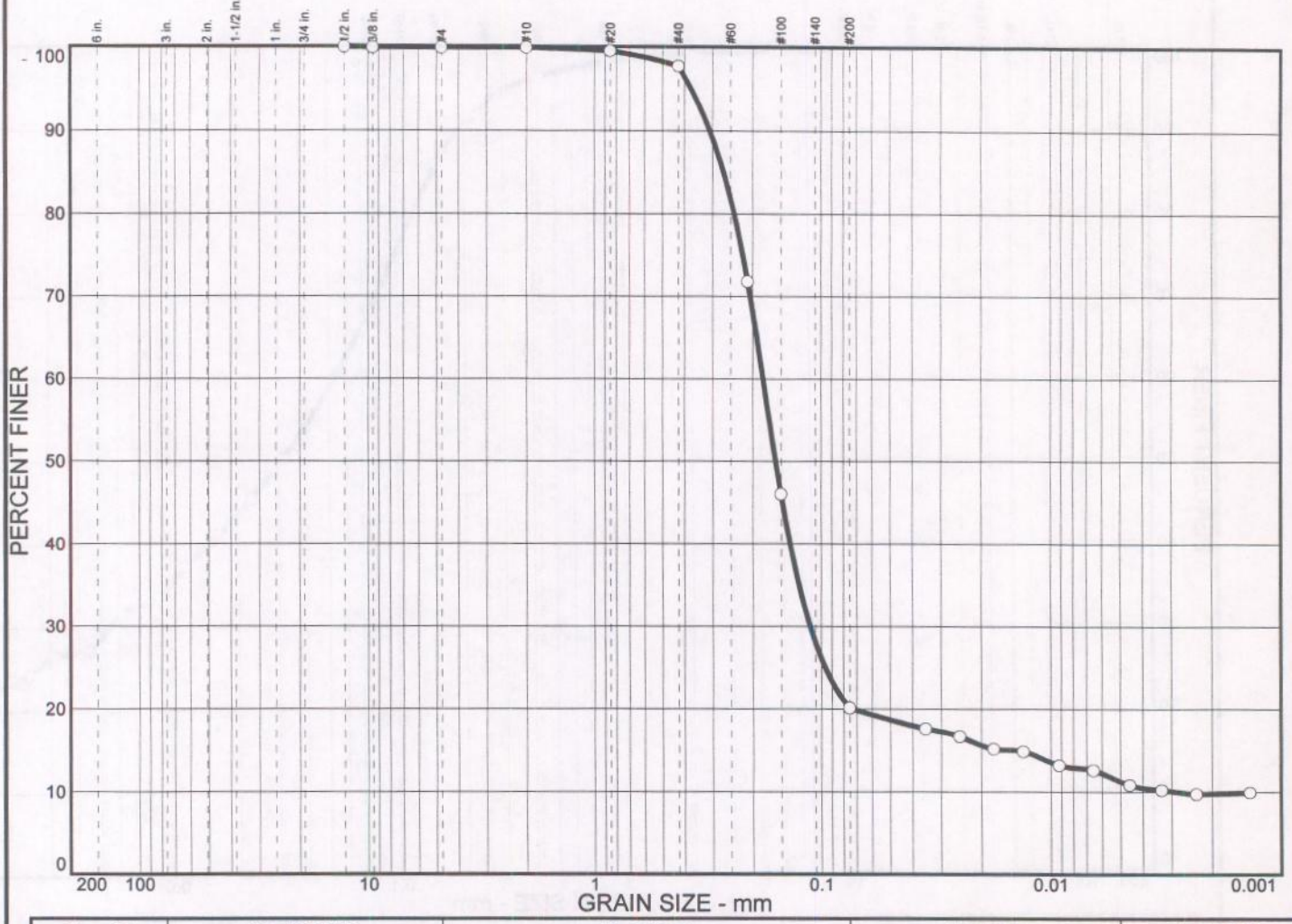
○ ASTM D422, Sample Received on 12/10/01

Tech. Responsibility: T. Moline

GEI Consultants, Inc.

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.1	79.8	20.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.268	0.180	0.158	0.112	0.0138	0.0029	24.03	62.23

MATERIAL DESCRIPTION	USCS	AASHTO
○ Silty SAND	SM	

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

○ **Source:** Soil Batch SM **Sample No.:** SM-01

Remarks:

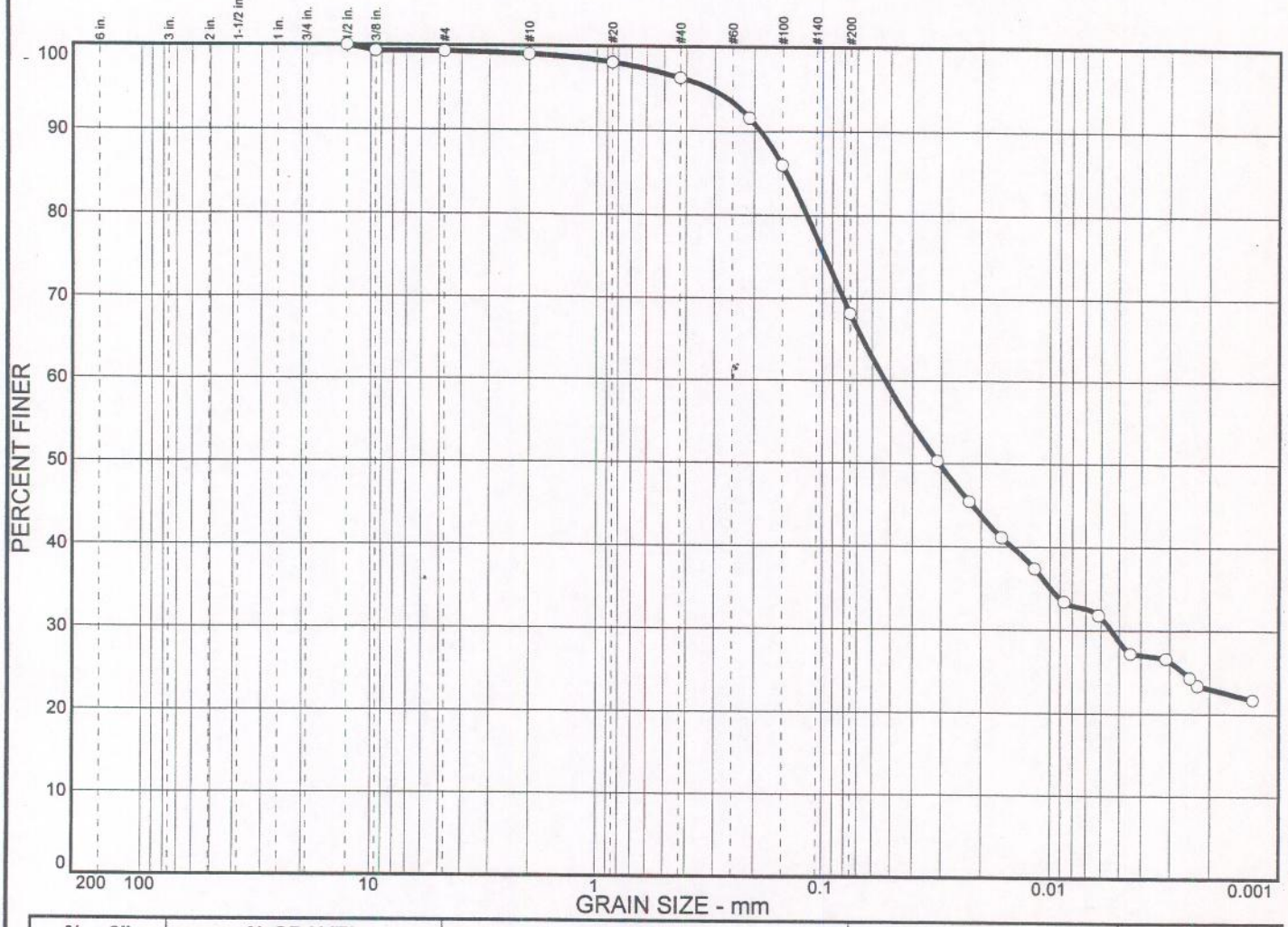
○ ASTM D422, Sample Received on 12/10/01

Tech. Responsibility: T. Moline

GEI Consultants, Inc.

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.7	31.1	68.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	40	25	0.143	0.0527	0.0306	0.0054				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Sandy Lean CLAY	CL	

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

○ **Source:** Soil Batch MLMH **Sample No.:** MLMH-01

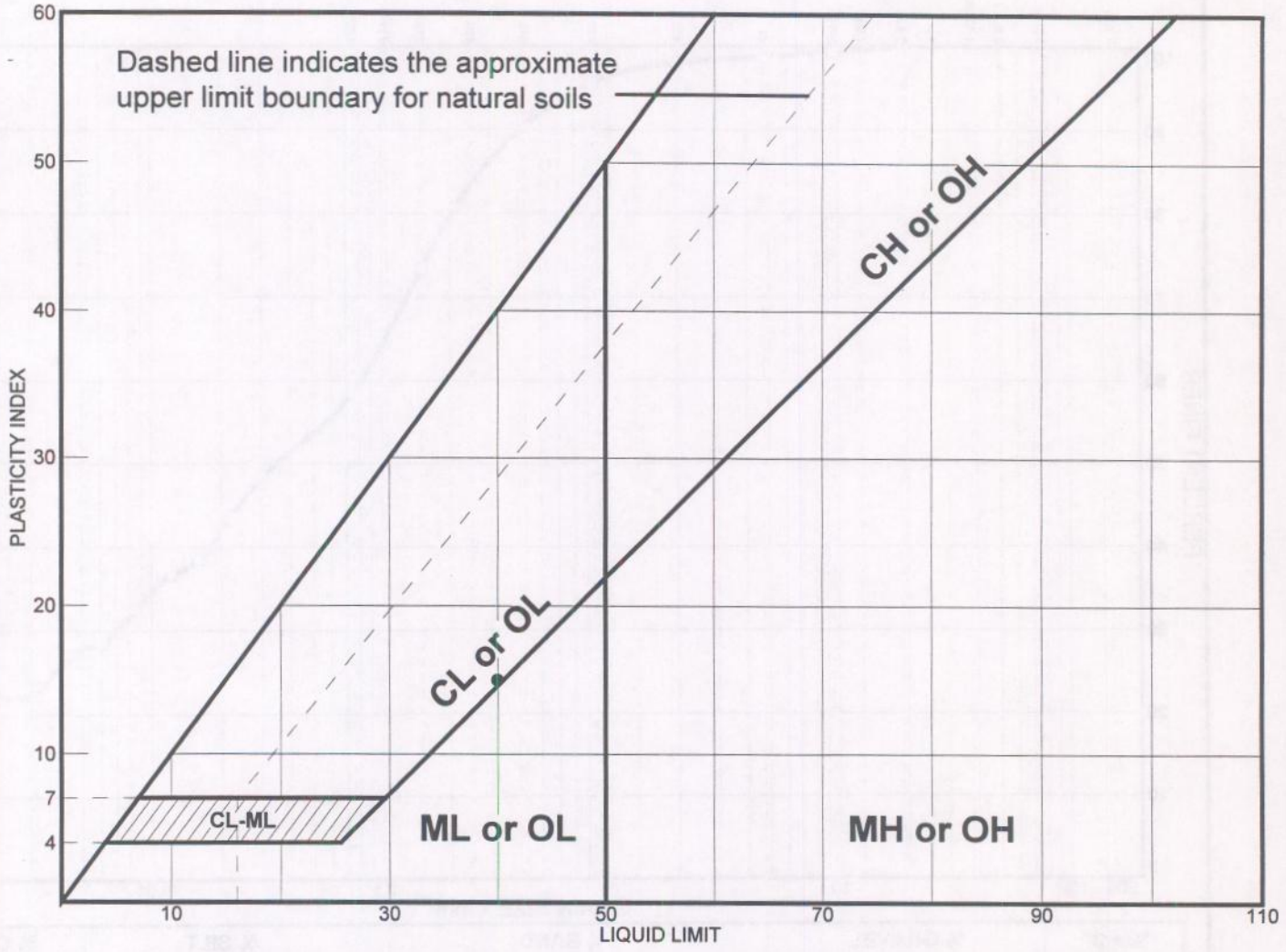
Remarks:

○ ASTM D422, Sample Recieved on 12/10/01 Tech. Responsibility. T. Moline

GEI Consultants, Inc.

Fig.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Lean CLAY	40	25	15	96.3	68.2	CL

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

● **Source:** Soil Batch MLMH **Sample No.:** MLMH-01

Remarks:

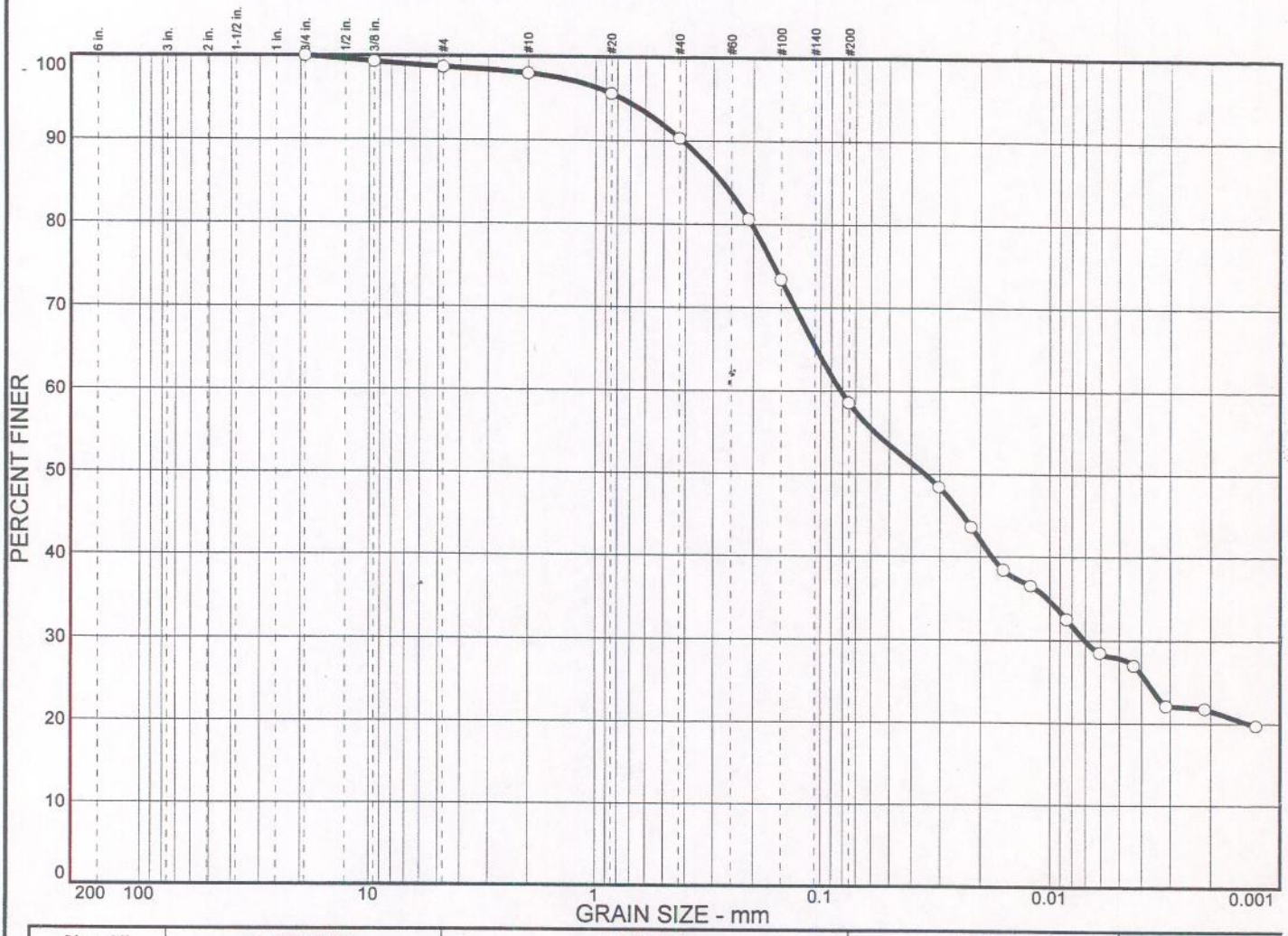
● ASTM D4318, Sample Received on 12/10/01
Tech. Responsibility: T. Moline

LIQUID AND PLASTIC LIMITS TEST REPORT

GEI Consultants, Inc.

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	1.3	40.1	58.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	34	23	0.273	0.0814	0.0349	0.0070				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Sandy Lean CLAY	CL	

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

○ **Source:** Soil Batch CL **Sample No.:** CL-01

Remarks:

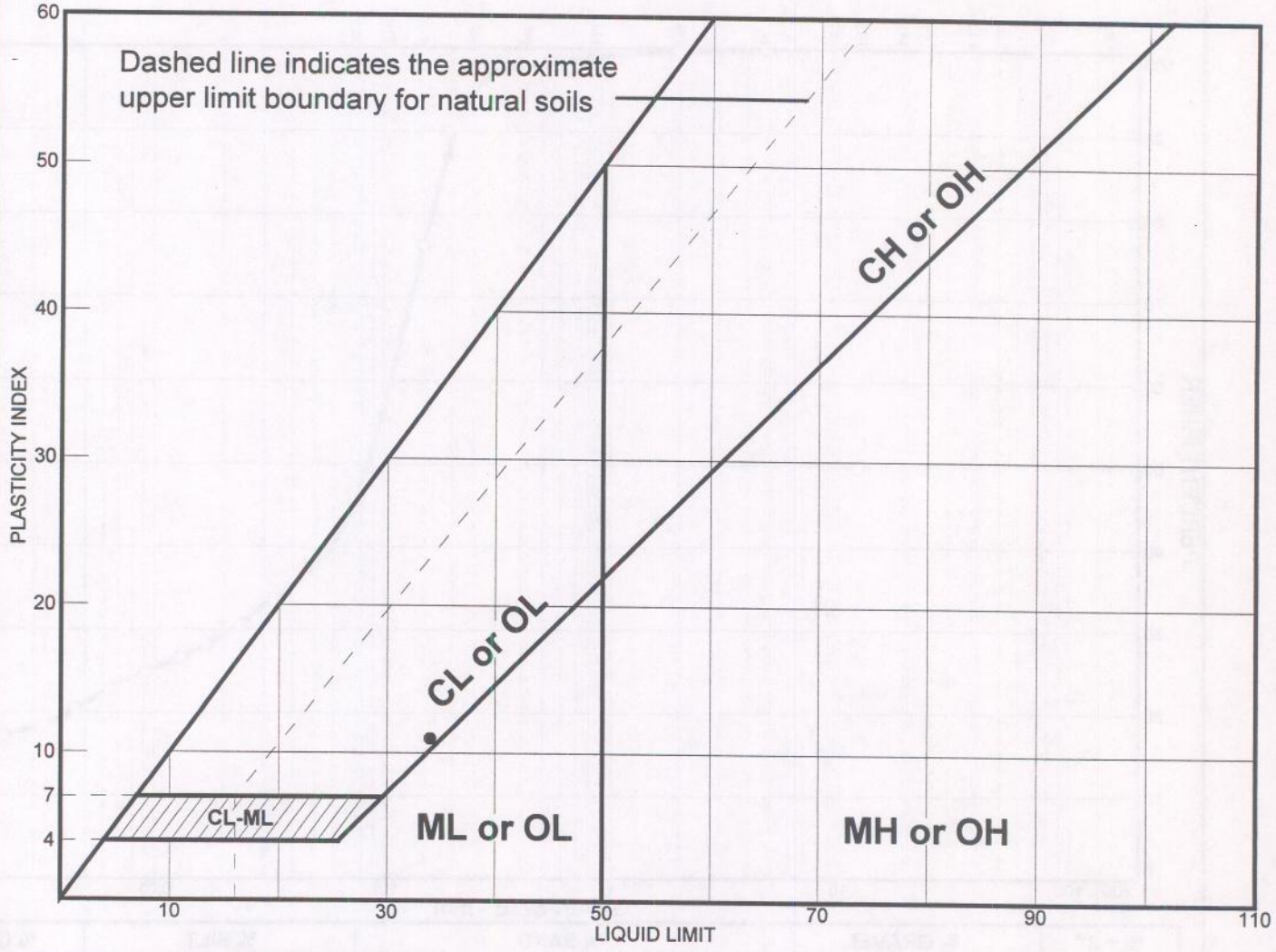
○ ASTM D422, Sample Received on 12/10/01

TTech. Responsibility: T. Moline

GEI Consultants, Inc.

Fig.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Lean CLAY	34	23	11	90.3	58.6	CL

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

● **Source:** Soil Batch CL **Sample No.:** CL-01

Remarks:

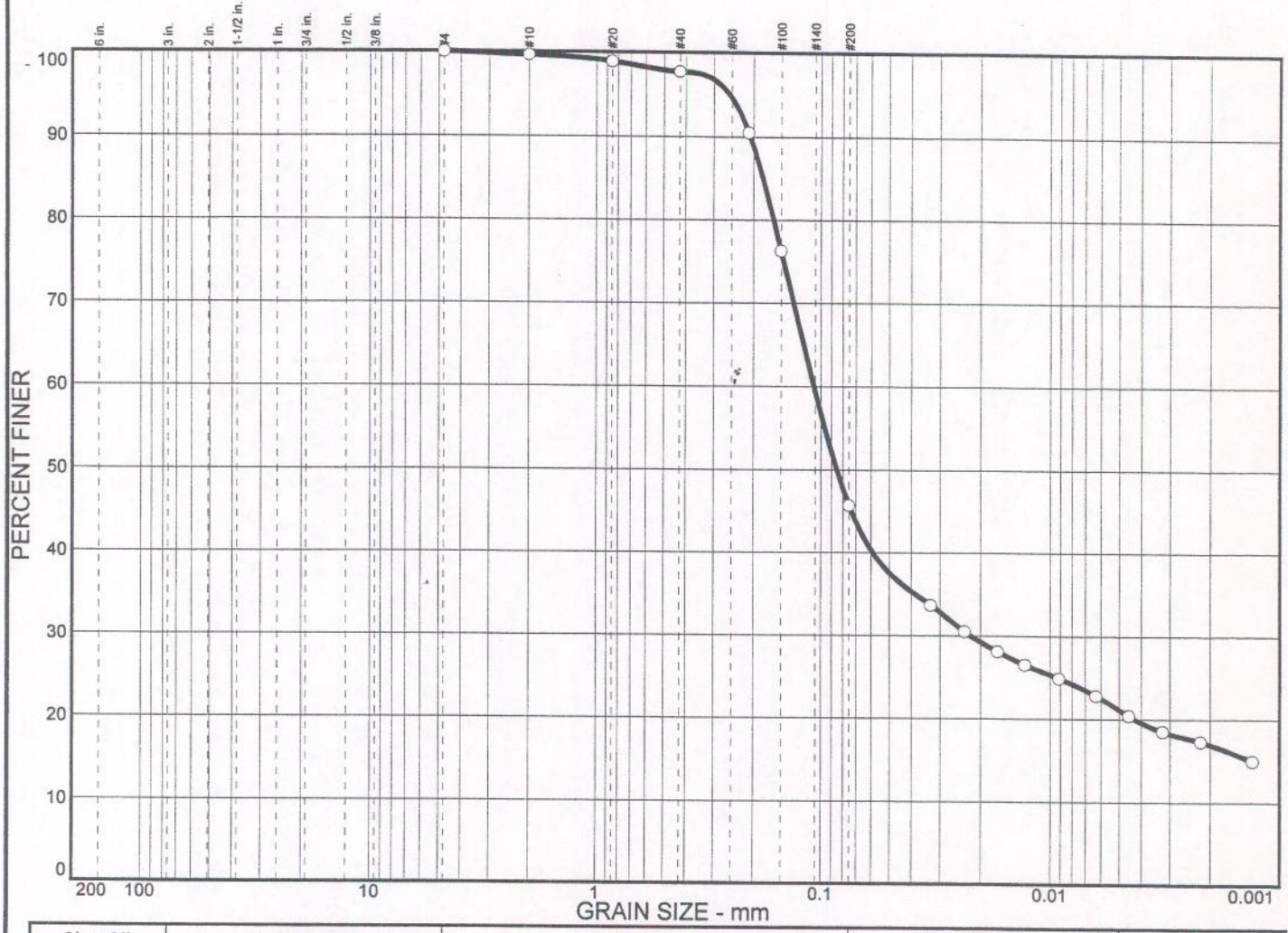
● ASTM D4318, Sample Received on 12/10/01
Tech. Responsibility: T. Moline

LIQUID AND PLASTIC LIMITS TEST REPORT

GEI Consultants, Inc.

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	54.3	45.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	28	27	0.181	0.107	0.0850	0.0221	0.0013			

MATERIAL DESCRIPTION	USCS	AASHTO
○ Silty SAND	SM	

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

○ **Source:** Soil Batch ML **Sample No.:** ML-01

Remarks:

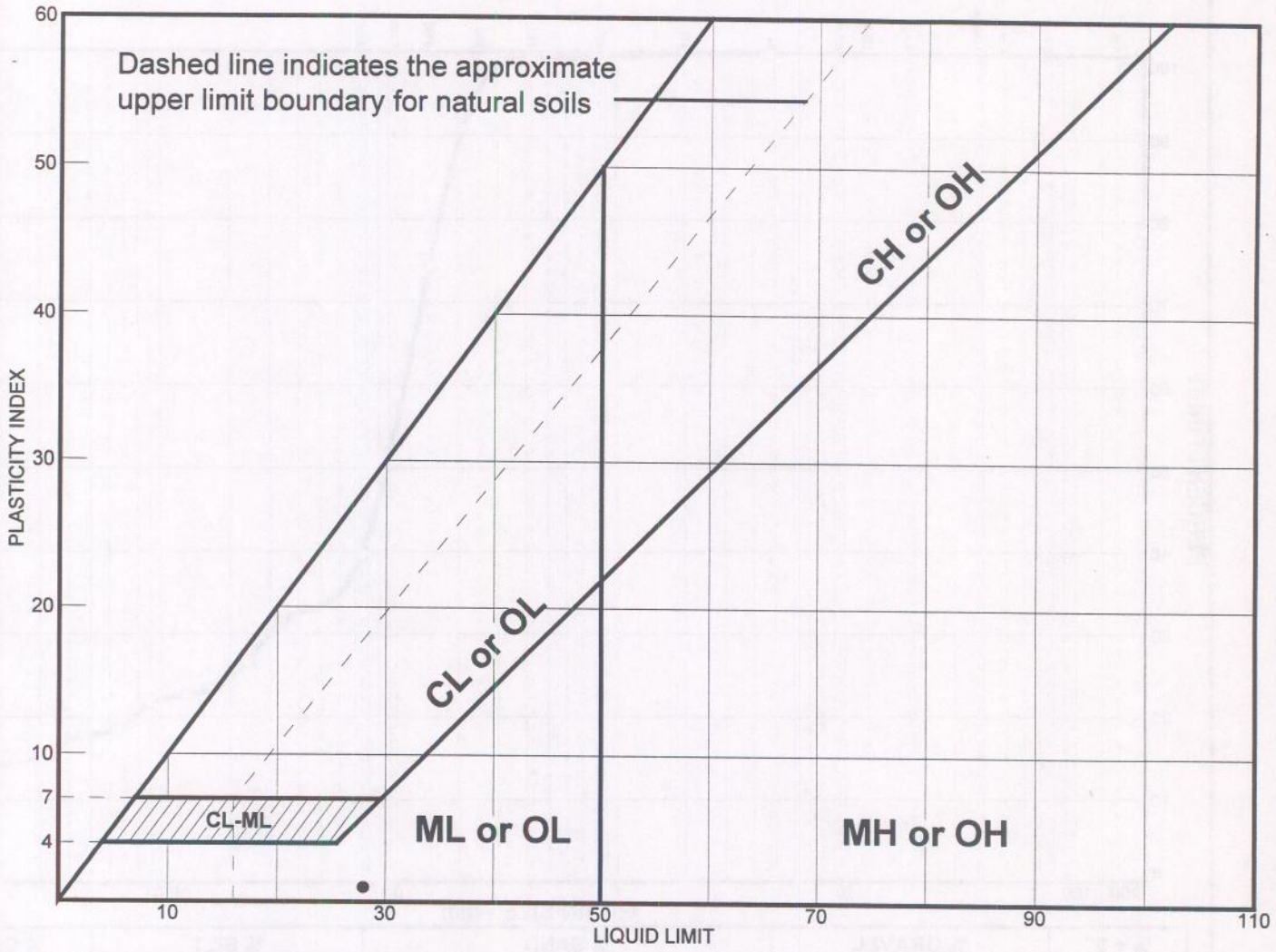
○ ASTM D422, Sample Received on 12/10/01

TTech. Responsibility: T. Moline

GEI Consultants, Inc.

Fig.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty SAND	28	27	1	97.7	45.7	SM

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

● **Source:** Soil Batch ML **Sample No.:** ML-01

Remarks:

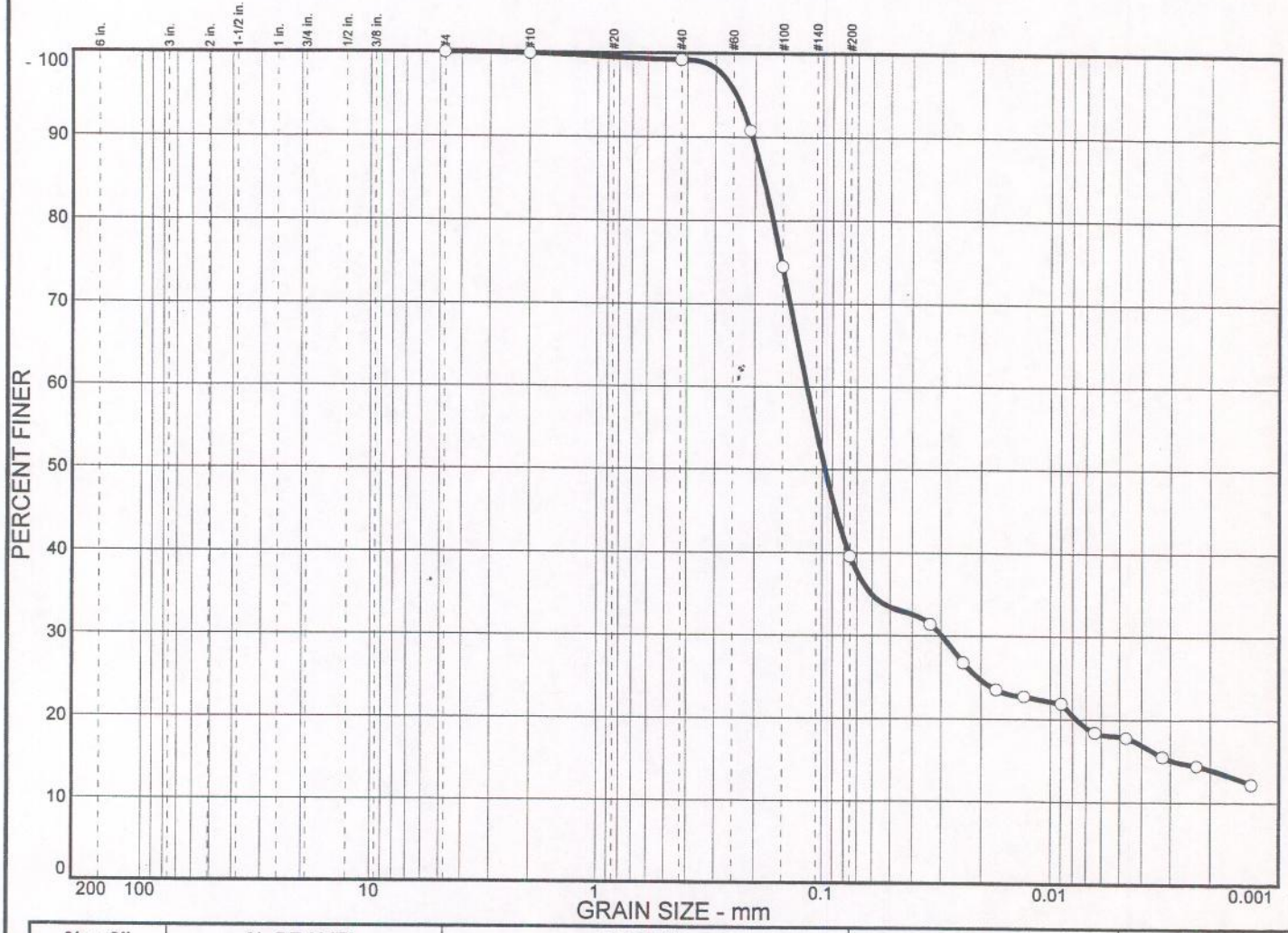
● ASTM D4318, Sample Received on 12/10/01
Tech. Responsibility: T. Moline

LIQUID AND PLASTIC LIMITS TEST REPORT

GEI Consultants, Inc.

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	60.4	39.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	0.183	0.117	0.0968	0.0297	0.0029			

MATERIAL DESCRIPTION	USCS	AASHTO
○ Silty SAND	SM	

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

○ **Source:** Soil Batch OL **Sample No.:** OL-01

Remarks:

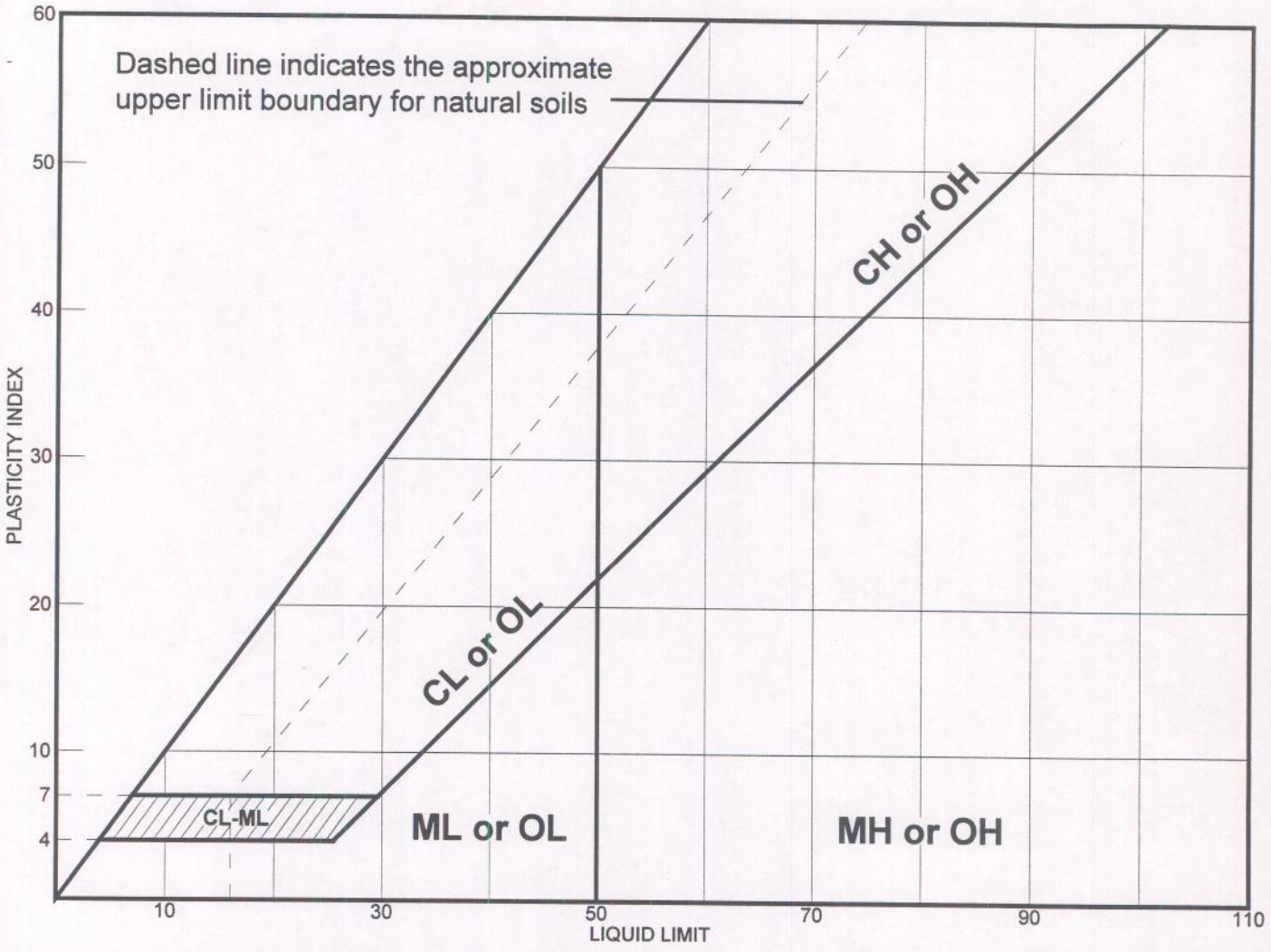
○ ASTM D422, Sample Received on 12/10/01

Tech. Responsibility: T. Moline

GEI Consultants, Inc.

Fig.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty SAND	NV	NP	NP	99.2	39.6	SM

Project No. 01282 **Client:** US Army Corps of Engineers Savannah District

Project: Design of Seismic Remediation for Clemson Diversion Dams

● **Source:** Soil Batch OL **Sample No.:** OL-01

Remarks:

● ASTM D422, Sample Received on 12/10/01
Tech. Responsibility: T. Moline

LIQUID AND PLASTIC LIMITS TEST REPORT

GEI Consultants, Inc.

Fig.

B3.6 – Summary Tables for Soil-Mix Tests

Table B3.6-1 - Unconfined Compression Testing on SM Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

450 Batch Proportions

Wt. Silty Sand, [lb] =	24.348
Wt. Cement, [lb] =	4.606
Wt. Water, [lb] =	3.224
w/c =	0.70

Batch Properties

Water Content	29.9%
Fines Content	20.1%
Liquid Limit	NT
Plasticity Index	NT

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf]	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
SM_450-01	450	02/14/02	03/14/02	28	112.21	5.773	2.994	7.040	27.11%	2249.66	319.57	1.60E+07
SM_450-02	450	02/14/02	03/14/02	28	112.92	5.807	2.992	7.029	28.31%	2264.08	322.10	1.98E+07
SM_450-03	450	02/14/02	03/14/02	28	113.44	5.831	2.995	7.046	29.04%	2191.17	310.99	1.22E+07
SM_450-04	450	02/14/02	02/21/02	7	115.45	5.764	2.994	7.041	30.12%	1432.11	203.40	1.56E+07
SM_450-05	450	02/14/02	02/21/02	7	114.19	5.765	2.988	7.012	29.75%	1420.15	202.52	9.53E+06
SM_450-06	450	02/14/02	02/21/02	7	113.25	5.782	2.988	7.014	30.03%	1455.35	207.50	1.72E+07
SM_450-07	450	02/14/02	04/11/02	56	114.44	5.818	2.991	7.026	28.56%	3050.39	434.16	3.17E+07
SM_450-08	450	02/14/02	04/11/02	56	114.73	5.781	2.992	7.029	29.05%	3030.41	431.13	2.51E+07
SM_450-09	450	02/14/02	04/11/02	56	114.37	5.766	2.992	7.032	28.19%	3048.93	433.57	2.17E+07
SM_450-10†	450	02/14/02	02/21/02	7	112.24	5.838	2.994	7.038	NT	NT	NT	NT
SM_450-11†	450	02/14/02			114.65	5.812	2.991	7.025	NT			

Notes: 1. Refer to individual test results for detailed notes
2. NT - Specimen not tested
3. † - Specimen not included in analysis

Table B3.6-2 - Unconfined Compression Testing on SM Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

300 Batch Proportions

Wt. Silty Sand, [lb] =	26.286
Wt. Cement, [lb] =	2.948
Wt. Water, [lb] =	2.068
w/c =	0.70

Batch Properties

Water Content	29.9%
Fines Content	20.1%
Liquid Limit	NT
Plasticity Index	NT

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf]	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
SM-1A†	300	01/23/02	01/30/02	7	113.69	5.828	2.985	7.000	25.88%	745.61	106.51	6.23E+06
SM_300-01	300	01/23/02	01/30/02	7	113.74	5.825	2.994	7.041	27.46%	557.50	79.18	2.05E+06
SM_300-02	300	01/23/02	01/30/02	7	113.92	5.764	2.990	7.021	29.01%	694.38	98.90	8.38E+06
SM_300-03	300	01/23/02	01/30/02	7	114.03	5.864	2.986	7.001	28.77%	718.39	102.62	9.35E+06
SM_300-04	300	01/23/02	02/20/02	28	113.90	5.848	2.987	7.009	27.58%	1164.08	166.09	1.10E+07
SM_300-05	300	01/23/02	02/20/02	28	114.19	5.756	2.990	7.020	27.00%	1209.74	172.33	1.07E+07
SM_300-06	300	01/23/02	02/20/02	28	113.77	5.822	2.988	7.010	27.03%	1211.74	172.86	1.11E+07
SM_300-07	300	01/23/02	03/20/02	56	113.60	5.822	2.986	7.005	26.70%	1454.91	207.69	1.68E+07
SM_300-08	300	01/23/02	03/20/02	56	110.96	5.820	2.985	6.996	25.78%	1441.29	206.00	1.53E+07
SM_300-09	300	01/23/02	03/20/02	56	113.49	5.801	2.988	7.010	26.60%	1432.47	204.35	1.43E+07
SM_300-10†	300	01/23/02			109.57	5.774	2.992	7.032	NT			

Notes: 1. Refer to individual test results for detailed notes
2. † - Specimen not included in analysis

Table B3.6-3 - Unconfined Compression Testing on ML Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

600 Batch Proportions

Wt. Silty Sand/Sandy Silt, [lb] =	21.440
Wt. Cement, [lb] =	6.140
Wt. Water, [lb] =	4.298
w/c =	0.70

Batch Properties

Water Content	29.2%
Fines Content	45.7%
Liquid Limit	28
Plasticity Index	1

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
ML_600-01	600	02/08/02	02/15/02	7	113.19	5.932	2.988	7.010	30.86%	3031.42	432.44	2.21E+07
ML_600-02	600	02/08/02	02/15/02	7	113.71	5.922	2.987	7.006	30.70%	2995.38	427.53	1.68E+07
ML_600-03	600	02/08/02	02/15/02	7	111.86	5.938	2.982	6.986	30.72%	3035.42	434.52	2.23E+07
ML_600-04	600	02/08/02	03/08/02	28	113.86	5.902	2.990	7.020	29.73%	5056.12	720.20	3.26E+07
ML_600-05	600	02/08/02	03/08/02	28	114.08	5.918	2.985	7.000	29.68%	5124.22	732.02	3.56E+07
ML_600-06	600	02/08/02	03/08/02	28	113.74	5.962	2.987	7.008	29.94%	4967.19	708.78	2.53E+07
ML_600-07	600	02/08/02	04/05/02	56	113.59	5.928	2.987	7.007	30.12%	6011.04	857.88	3.36E+07
ML_600-08	600	02/08/02	04/05/02	56	113.75	5.965	2.987	7.007	29.66%	5910.23	843.49	2.75E+07
ML_600-09	600	02/08/02	04/05/02	56	112.76	5.920	2.988	7.012	29.38%	5910.23	842.82	3.44E+07
ML_600-10	600	02/08/02	02/15/02	7	114.91	5.866	2.989	7.015	31.65%	2825.59	402.76	2.23E+07
ML_600-11†	600	02/08/02			113.06	5.976	2.988	7.014				

Notes: 1. Refer to individual test results for detailed notes
2. † - Specimen not included in analysis

Table B3.6-4 - Unconfined Compression Testing on ML Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

450 Batch Proportions

Wt. Silty Sand/Sandy Silt, [lb] =	24.508
Wt. Cement, [lb] =	4.604
Wt. Water, [lb] =	3.226
w/c =	0.70

Batch Properties

Water Content	29.2%
Fines Content	45.7%
Liquid Limit	28
Plasticity Index	1

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
ML_450-01	450	03/04/02	03/11/02	7	115.52	5.844	2.977	6.962	28.51%	2057.54	295.54	1.43E+07
ML_450-02	450	03/04/02	03/11/02	7	115.70	5.781	2.977	6.961	28.76%	2057.54	295.56	1.98E+07
ML_450-03	450	03/04/02	03/11/02	7	115.80	5.794	2.978	6.966	28.39%	2093.58	300.56	1.56E+07
ML_450-04	450	03/04/02	04/01/02	28	115.40	5.737	2.979	6.970	28.10%	3510.17	503.61	3.05E+07
ML_450-05	450	03/04/02	04/01/02	28	114.27	5.829	2.982	6.984	28.24%	3332.26	477.12	1.94E+07
ML_450-06	450	03/04/02	04/01/02	28	114.42	5.845	2.980	6.974	27.44%	3362.56	482.14	2.60E+07
ML_450-07†	450	03/04/02	04/01/02	28	114.32	5.791	2.977	6.962	NT	NT	NT	NT
ML_450-08	450	03/04/02	04/29/02	56	115.51	5.860	2.980	6.972	28.88%	3904.47	559.99	2.43E+07
ML_450-09	450	03/04/02	04/29/02	56	114.70	5.747	2.978	6.967	27.86%	3921.14	562.82	2.21E+07
ML_450-10	450	03/04/02	04/29/02	56	114.32	5.741	2.981	6.980	26.19%	3674.84	526.45	2.27E+07
ML_450-11	450	03/04/02	04/29/02	56	115.18	5.779	2.981	6.979	27.16%	3698.66	529.95	2.41E+07

Notes: 1. Refer to individual test results for detailed notes
2. NT - Specimen not tested
3. † - Specimen not included in analysis

Table B3.6-5 - Unconfined Compression Testing on MLMH Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

600 Batch Proportions

Wt. L. to M. Plasticity Silt, [lb] =	19.452
Wt. Cement, [lb] =	5.898
Wt. Water, [lb] =	4.126
w/c =	0.70

Batch Properties

Water Content	37.9%
Fines Content	68.2%
Liquid Limit	40
Plasticity Index	15

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf]	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
MLMH_600-01	600	01/30/02	02/06/02	7	110.57	5.801	2.973	6.942	37.95%	1876.62	270.34	1.42E+07
MLMH_600-02	600	01/30/02	02/06/02	7	110.64	5.794	2.974	6.947	37.94%	1867.42	268.82	1.31E+07
MLMH_600-03†	600	01/30/02			110.93	5.860	2.972	6.936				
MLMH_600-04	600	01/30/02	02/27/02	28	110.66	5.830	2.971	6.933	33.93%	3234.66	466.59	2.53E+07
MLMH_600-05†	600	01/30/02	02/27/02	28	110.03	5.843	2.976	6.955	NT	NT	NT	NT
MLMH_600-06	600	01/30/02	02/27/02	28	110.04	5.787	2.971	6.931	32.89%	4123.53	594.91	2.64E+07
MLMH_600-07	600	01/30/02	03/27/02	56	110.15	5.851	2.972	6.937	34.78%	4294.98	619.15	1.80E+07
MLMH_600-08	600	01/30/02	03/27/02	56	110.11	5.819	2.975	6.950	35.35%	4600.22	661.87	2.89E+07
MLMH_600-09	600	01/30/02	03/27/02	56	110.05	5.790	2.974	6.946	34.30%	5011.21	721.45	2.92E+07
MLMH_600-10	600	01/30/02	02/06/02	7	110.52	5.831	2.976	6.955	38.45%	1744.55	250.85	9.92E+06
MLMH_600-11*†	600	01/30/02										

Notes: 1. Refer to individual test results for detailed notes
2. NT - Specimen not tested
3. * - Specimen not at full height
4. † - Specimen not included in analysis

Table B3.6-6 - Unconfined Compression Testing on MLMH Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

450 Batch Proportions

Wt. L. to M. Plasticity Silt, [lb] =	23.088
Wt. Cement, [lb] =	4.602
Wt. Water, [lb] =	3.228
w/c =	0.70

Batch Properties

Water Content	37.9%
Fines Content	68.2%
Liquid Limit	40
Plasticity Index	15

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Cement Content,	Cast Date	Test Date	Day Strength	Unit Weight, [pcf]	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
MLMH_450-01	450	01/31/02	02/07/02	7	109.87	5.903	2.972	6.939	39.97%	86.07	12.40	1.72E+05
MLMH_450-02	450	01/31/02	02/07/02	7	109.49	5.928	2.971	6.931	40.11%	78.06	11.26	2.42E+05
MLMH_450-03	450	01/31/02	02/07/02	7	110.43	5.895	2.973	6.944	41.15%	73.66	10.61	9.28E+04
MLMH_450-04	450	01/31/02	02/28/02	28	109.54	5.868	2.963	6.896	33.27%	1295.88	187.90	1.19E+07
MLMH_450-05†	450	01/31/02							NT	NT	NT	NT
MLMH_450-06	450	01/31/02	02/28/02	28	109.20	5.892	2.963	6.895	32.96%	1557.86	225.93	5.98E+06
MLMH_450-07†	450	01/31/02	03/28/02	56	109.42	5.879	2.966	6.907	NT	NT	NT	NT
MLMH_450-08	450	01/31/02	03/28/02	56	109.42	5.855	2.966	6.909	33.99%	1897.93	274.69	1.18E+07
MLMH_450-09	450	01/31/02	03/28/02	56	109.62	5.845	2.963	6.895	31.53%	1305.88	189.40	1.40E+07
MLMH_450-10†	450	01/31/02	02/28/02	28	108.96	5.933	2.964	6.898	14.24%	NT	NT	NT
MLMH_450-11†	450	01/31/02	03/28/02	56	109.00	5.892	2.970	6.926	NT	NT	NT	NT
MLMH_450-12*†	450	01/31/02										

Notes: 1. Refer to individual test results for detailed notes
2. NT - Specimen not tested
3. * - Specimen not at full height
4. † - Specimen not included in analysis

Table B3.6-7 - Unconfined Compression Testing on MLMH Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

450 Batch Proportions

Wt. L. to M. Plasticity Silt, [lb] =	20.542
Wt. Cement, [lb] =	4.422
Wt. Water, [lb] =	3.982
w/c =	0.90

Batch Properties

Water Content	37.9%
Fines Content	68.2%
Liquid Limit	40
Plasticity Index	15

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Cement Content,	Cast Date	Test Date	Day Strength	Unit Weight, [pcf]	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
MLMH_450-21	450	02/14/02	02/21/02	7	108.14	5.859	2.978	6.964	43.28%	61.31	8.80	2.03E+05
MLMH_450-22†	450	02/14/02	02/21/02	7	108.83	5.820	2.971	6.934	NT	NT	NT	NT
MLMH_450-23	450	02/14/02	02/21/02	7	107.89	5.844	2.977	6.963	43.51%	62.51	8.98	3.71E+05
MLMH_450-24	450	02/14/02	03/14/02	28	107.73	5.825	2.963	6.896	36.95%	2112.66	306.34	1.18E+07
MLMH_450-25	450	02/14/02	03/14/02	28	107.67	5.799	2.963	6.894	37.13%	2218.41	321.79	9.23E+06
MLMH_450-26	450	02/14/02	03/14/02	28	107.34	5.920	2.962	6.893	36.48%	2202.39	319.52	6.93E+06
MLMH_450-27	450	02/14/02	04/11/02	56	106.75	5.895	2.954	6.856	36.18%	2018.65	294.45	6.35E+06
MLMH_450-28	450	02/14/02	04/11/02	56	107.10	5.821	2.966	6.910	38.04%	2522.75	365.09	1.90E+07
MLMH_450-29	450	02/14/02	04/11/02	56	107.13	5.841	2.962	6.892	36.51%	2638.09	382.80	1.94E+07
MLMH_450-30†	450	02/14/02			106.02	5.820	2.959	6.878				
MLMH_450-31†	450	02/14/02										
MLMH_450-32*†	450	02/14/02										

Notes: 1. Refer to individual test results for detailed notes
2. NT - Specimen not tested
3. * - Specimen not at full height
4. † - Specimen not included in analysis

Table B3.6-8 - Unconfined Compression Testing on CL Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

600 Batch Proportions

Wt. Clay, [lb] =	19.452
Wt. Cement, [lb] =	5.898
Wt. Water, [lb] =	4.126
w/c =	0.70

Batch Properties

Water Content	26.3%
Fines Content	58.6%
Liquid Limit	34
Plasticity Index	11

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf]	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
CL_600-01†	600	02/01/02	02/08/02	7	114.55	5.869	2.986	7.004	29.61%	3235.44	461.96	1.66E+07
CL_600-02	600	02/01/02	02/08/02	7	113.98	5.855	2.989	7.015	29.60%	4612.40	657.46	1.58E+07
CL_600-03	600	02/01/02	02/08/02	7	113.75	5.907	2.989	7.017	28.11%	4839.06	689.65	1.63E+07
CL_600-04	600	02/01/02	03/01/02	28	114.06	5.847	2.986	7.001	28.51%	7200.83	1028.58	2.08E+07
CL_600-05†	600	02/01/02	03/01/02	28	113.79	5.854	2.988	7.010	NT	NT	NT	NT
CL_600-06	600	02/01/02	03/01/02	28	113.77	5.939	2.985	6.998	28.46%	6494.21	928.06	2.52E+07
CL_600-07†	600	02/01/02							NT	NT	NT	NT
CL_600-08	600	02/01/02	03/29/02	56	113.32	5.874	2.988	7.010	27.90%	4790.89	683.44	3.49E+07
CL_600-09	600	02/01/02	03/29/02	56	114.03	5.903	2.986	7.004	29.00%	7282.48	1039.79	2.66E+07
CL_600-10	600	02/01/02	03/29/02	56	113.15	5.924	2.992	7.032	27.47%	3722.16	529.35	1.40E+07
CL_600-11	600	02/01/02	03/29/02	56	112.74	5.861	2.992	7.031	27.28%	4329.43	615.77	2.67E+07
CL_600-12*†	600	02/01/02										

Notes: 1. Refer to individual test results for detailed notes
2. NT - Specimen not tested
3. * - Specimen not at full height
4. † - Specimen not included in analysis

Table B3.6-9 - Unconfined Compression Testing on CL Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

450 Batch Proportions

Wt. Clay, [lb] =	23.968
Wt. Cement, [lb] =	4.42
Wt. Water, [lb] =	3.094
w/c =	0.70

Batch Properties

Water Content	26.3%
Fines Content	58.6%
Liquid Limit	34
Plasticity Index	11

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf]	Dimensions		CSA, [in^2]	w After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
						Height, [in]	Diameter, [in]					
CL_450-01	450	02/04/02	02/11/02	7	115.33	5.873	2.988	7.011	27.00%	2067.19	294.84	1.18E+07
CL_450-02	450	02/04/02	02/11/02	7	115.41	5.829	2.988	7.011	27.80%	2334.71	333.03	9.83E+06
CL_450-03	450	02/04/02	02/11/02	7	115.85	5.812	2.986	7.004	26.46%	2188.99	312.52	1.51E+07
CL_450-04	450	02/04/02	03/04/02	28	114.85	5.860	2.991	7.025	27.11%	2896.89	412.35	8.86E+06
CL_450-05	450	02/04/02	03/04/02	28	115.01	5.865	2.990	7.024	26.56%	2397.93	341.41	5.19E+06
CL_450-06	450	02/04/02	03/04/02	28	115.19	5.923	2.985	6.998	27.25%	3633.73	519.28	1.44E+07
CL_450-07	450	02/04/02	04/01/02	56	114.61	5.823	2.991	7.027	27.48%	2413.78	343.52	2.10E+07
CL_450-08	450	02/04/02	04/01/02	56	114.87	5.882	2.989	7.015	26.85%	2448.62	349.06	1.36E+07
CL_450-09	450	02/04/02	04/01/02	56	115.27	5.854	2.987	7.009	26.86%	3034.28	432.93	2.55E+07
CL_450-10	450	02/04/02	04/01/02	56	114.73	5.870	2.993	7.038	26.28%	1587.05	225.51	8.50E+06
CL_450-11†	450	02/04/02							NT	NT	NT	NT

Notes: 1. Refer to individual test results for detailed notes
2. † - Specimen not included in analysis

Table B3.6-10 - Unconfined Compression Testing on OL Soils
Final Design of Seismic Remediation
Clemson Upper and Lower Diversion Dams
Clemson, SC

600 Batch Proportions

Wt. Silty Sand/Sandy Silt with Organics, [lb] = 21.248
Wt. Cement, [lb] = 6.140
Wt. Water, [lb] = 4.300
w/c = 0.70

Batch Properties

Water Content	30.4%
Fines Content	39.6%
Liquid Limit	NV
Plasticity Index	NP
Organic Content	4.41%

ASTM C1633 : Compression Testing on Cylindrical Soil-Cement Molds

Test ID	Content, [lbs/cy]	Cast Date	Test Date	Day Strength	Unit Weight, [pcf	Dimensions Height, [in]	Dimensions Diameter, [in]	CSA, [in^2]	After Break	Peak Load, [lbs]	Compressive Strength, [psi]	Modulus of Elasticity, [psf]
OL_600-01	600	03/07/02	03/14/02	7	113.26	5.898	2.985	6.996	32.35%	2947.47	421.28	2.12E+07
OL_600-02	600	03/07/02	03/14/02	7	112.73	5.851	2.986	7.004	31.66%	3093.28	441.62	2.39E+07
OL_600-03	600	03/07/02	03/14/02	7	113.52	5.862	2.985	6.996	31.38%	3100	443.08	2.22E+07
OL_600-04	600	03/07/02	04/04/02	28	113.47	5.858	2.983	6.988	30.97%	5278.22	755.28	3.44E+07
OL_600-05	600	03/07/02	04/04/02	28	112.34	5.821	2.983	6.988	31.04%	4925.05	704.75	2.74E+07
OL_600-06	600	03/07/02	04/04/02	28	112.79	5.907	2.987	7.009	30.95%	5244.88	748.34	3.33E+07
OL_600-07	600	03/07/02	05/02/02	56	113.73	5.832	2.983	6.988	30.84%	6262.91†	896.18	3.98E+07
OL_600-08	600	03/07/02	05/02/02	56	113.22	5.876	2.986	7.001	30.07%	5579.59	797.00	3.83E+07
OL_600-09	600	03/07/02	05/02/02	56	113.79	5.892	2.986	7.001	30.32%	6128.10	875.28	3.56E+07
OL_600-10	600	03/07/02	04/04/02	28	113.41	5.780	2.991	7.028	29.95%	4284.80	609.69	2.76E+07
OL_600-11†	600	03/07/02	05/02/02	56	114.70	5.754	2.986	7.004	33.57%			

Notes: 1. Refer to individual test results for detailed notes
2. † - Specimen not included in analysis