Applied Geotechnical Engineering Consultants, Inc.

GEOTECHNICAL INVESTIGATION

PROPOSED SUBDIVISION

2700 WEST 12900 SOUTH

RIVERTON, UTAH

PREPARED FOR:

PERRY HOMES
6400 SOUTH STATE STREET
MURRAY, UTAH 84107

ATTENTION: JEFF TAYLOR

PROJECT NO. 08796

MARCH 20, 1996

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CONCLUSIONS

1. The subsurface soils encountered at the site consist of approximately 1 to 1½ feet of topsoil overlying lean clay. Sand and gravel was encountered below the clay at depths ranging from approximately 3 to 8 feet below the existing ground surface and extended the full depth investigated which was approximately 13½ feet.

2. No subsurface water was encountered to the maximum depth investigated.

3. The upper soil at the site is typically clay. The clay may result in considerable construction difficulties during periods in which the upper soils are very moist, such as in the winter and spring or at times of prolonged rainfall. Placement of gravel fill in areas of traffic will assist in accessing the property when the upper soil is very moist.

4. The proposed residences may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill and may be designed for a net allowable bearing pressure of 1,500 pounds per square foot. Footings bearing on at least 2 feet of compacted structural fill or on at least 2 feet of the undisturbed natural gravel may be designed for a net allowable bearing pressure of 2,500 pounds per square foot.

5. Geotechnical information related to foundations, subgrade preparation, pavement design and materials are included in the report.

SCOPE

This report presents the results of a Geotechnical Investigation for a proposed subdivision to be constructed at approximately 2700 West and 12900 South in Riverton, Utah. The report presents the subsurface conditions encountered, laboratory test results, and recommendations for foundations and pavement.

A field exploration program was conducted to obtain information on the subsurface conditions and to obtain samples for laboratory testing. Information obtained from the field and laboratory was used to define the conditions at the site for our engineering analysis. Results of the field exploration and laboratory tests were analyzed to develop recommendations for the proposed foundations and pavement.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

At the time of our field investigation, there were no pavement or structures on the site. The site consists of a plowed farm field. There are several drainage ditches which extend through the property and along the north property boundary.

The ground surface at the site is relatively flat with a gentle slope down toward the east.

Vegetation at the site consists of short to medium height grass and weeds.

There is a church building to the northeast of the property, a subdivision to the north, 2700 West Street on the east edge and farm fields to the south and west. There are several large drainage

basins which were empty at the time of our field investigation, along the east portion of the south property boundary.

FIELD STUDY

The field study was conducted on March 5 and 6, 1996. Eight test pits were excavated at the approximate locations indicated on Figure 1. The test pits were excavated with a rubber tired backhoe. The test pits were logged and soil samples obtained by an engineer from AGEC. Logs of the subsurface conditions encountered are graphically shown on Figures 2 and 3.

SUBSURFACE CONDITIONS

The soils at the site consist of approximately 1 to 1½ feet of topsoil overlying lean clay. Sand and gravel was encountered below the clay at depths ranging from approximately 3 to 8 feet below the existing ground surface and extend the full depth investigated, which was approximately 13½ feet.

The property is in an agricultural area. The upper soils have been plowed in the past. The thickness of the topsoil is the approximate thickness of the upper soils which contains a significant amount of roots. Plowing appears to have disturbed soils down to depths on the order of 2 to 2½ feet.

A description of the various soils encountered in the test pits follows:

Topsoil - The topsoil consists of lean clay which is moist, dark brown in color and contains roots and organics.

Clay - The clay ranges from stiff to very stiff and from slightly moist to moist. Color ranges from brown to light brown. The clay contains occasional roots.

Laboratory tests performed on samples of the clay indicate that it has natural moisture contents ranging from 19 to 49 percent and natural dry densities ranging from 66 to 97 pounds per cubic foot. Consolidation tests performed on samples of the clay indicate that it will compress a small to moderate amount with the additional light to moderate loads. Results of the consolidation tests are presented on Figures 4 and 5. Unconfined compressive strengths of 1,020 and 2,325 pounds per square foot (psf) were obtained for samples of the clay tested in the laboratory.

Silty Sand - The sand contains silt layers. It is medium dense, slightly moist and brown to gray in color.

Gravel - The gravel is poor to well graded gravel with silt and sand. Cobbles up to approximately 9 inches in size were encountered. The gravel contains occasional sandy clay layers. It is medium dense to dense, slightly moist and brown to orange brown in color.

Laboratory tests performed on a sample of the gravel indicate that it has a natural moisture content of 4 percent. Results of a gradation test performed on the sample are presented on Figure 6.

A Summary of the Laboratory Test Results is presented on Table I and on the Logs of the Exploratory Test Pits.

SUBSURFACE WATER

No subsurface water was encountered in the test pits to the maximum depth investigated which was approximately 13½ feet.

PROPOSED CONSTRUCTION

We understand that the property, which encompasses an area of approximately 26-3/4 acres, will be subdivided into residential lots. We anticipate that the houses will be one to two-story, wood frame structures with basements. We have assumed maximum wall loads of 3 kips per lineal foot and maximum column loads of 25 kips based on typical residential construction in the area.

Roads will be extended through the subdivision. We have assumed a traffic for roads consisting of 1,000 cars and 2 delivery trucks per day and 2 garbage trucks per week.

If building or traffic loads are significantly different from those described above, we should be notified so that we can re-evaluate our recommendations.

RECOMMENDATIONS

Based on the subsurface conditions encountered, laboratory test results, and the proposed construction, the following recommendations are given:

A. Site Grading

Site grading plans were not available at the time of report writing, but we anticipate that there will be only minor amounts of cut and fill required for the proposed development.

1. Excavation

We anticipate that excavation at the site can be accomplished with typical excavation equipment.

Care should be taken not to disturb the natural soil below foundations. A flat cutting edge should be used for excavation equipment when excavating for foundations in the clay.

2. Subgrade Preparation

The topsoil, organics, fill or other deleterious materials should be removed prior to placement of site grading fill.

The use of rubber tired construction equipment may cause disturbance of the natural clay soil during periods in which the upper soil is very moist, such as in the winter and spring, or at times of prolonged rain fall. If construction occurs under these conditions, placement of granular fill will assist in accessing the property and need only be placed were access is required.

Construction difficulties will vary with seasonal fluctuations in the ground moisture. The site grading contractor should be made aware of these conditions and take precautions to minimize disturbance of the natural soil, particularly in areas of buildings and roadways.

3. Materials

Listed below are materials recommended for structural fill.

Fill to Support	Recommendation
Footings	Non-expansive granular soil -200 <35%, LL < 30% Maximum size 4 inches
Floor Slabs (Upper 4 inches)	Sand and Gravel -200 <5% Maximum size 2 inches
Slab Support	Non-expansive granular soil -200 < 50%, LL < 30% Maximum size 6 inches

The upper natural soil is predominantly clay and is not suitable for use as structural fill, but may be used as fill below roads and in landscaping areas, or as utility trench backfill. The sand and gravel could be used as structural fill, if it meets the criteria

given above. Generally, it appears that the sand and gravel will meet the criteria given above.

4. Compaction

Compaction of materials placed at the site should equal or exceed the minimum densities as indicated below when compared to the maximum dry density as determined by ASTM D-1557.

Fill to Support	Compaction
Foundations	≥ 95%
Concrete flatwork and pavement	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

To facilitate the compaction process, the fill should be compacted at a moisture content within 2 percent of the optimum.

The base course should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D-1557 at a moisture content within 2 percent of the optimum.

5. Drainage

Roof down spouts and drains should discharge beyond the limits of backfill. The ground surface surrounding the proposed residences should be sloped away from the residences in all directions.

The collection and diversion of drainage away from the pavement surface is extremely important to the satisfactory performance of the pavement section. Proper drainage should be provided.

B. Foundations

1. Bearing Material

With the proposed construction and the subsurface conditions encountered, we recommend that the residences be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill. Structural fill placed below foundations should extend out and away from the edge of footings a distance equal to the depth of fill beneath footings.

2. Bearing Pressure

Spread footings bearing on the undisturbed natural soil or on compacted structural fill may be designed for a net allowable bearing pressure of 1,500 psf. Footings bearing on at least 2 feet of compacted structural fill or on at least 2 feet of undisturbed natural gravel may be designed for a net allowable bearing pressure of 2,500 psf. Footings should have a minimum width of 18 inches and a minimum depth of embedment of 10 inches.

3. Temporary Loading Conditions

The allowable bearing pressure may be increased by one-half for temporary loading conditions such as wind or seismic loads.

4. Settlement

We estimate that settlement will be less than 1 inch for foundations designed as indicated above.

5. Frost Depth

Exterior footings and footings beneath unheated areas should be placed at least 30 inches below grade for frost protection.

6. Foundation Base

The base of all excavations should be cleared of loose or deleterious material prior to fill or concrete placement.

7. Construction Observation

A representative of the geotechnical engineer should observe all footing excavations prior to structural fill or concrete placement.

C. Concrete Slab-on-Grade

1. Slab Support

Concrete slabs may be supported on the undisturbed natural soil or on compacted structural fill.

2. Underslab Gravel

A 4-inch layer of free draining gravel (less than 5 percent passing the No. 200 sieve) should be placed below the floor slabs for ease of construction and to promote even curing of the slab concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for footings placed on the natural soil or on compacted structural fill is controlled by sliding resistance between the footing and the foundation soils. A friction value of 0.3 may be used in design for ultimate lateral resistance.

2. Subgrade Walls and Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest

condition is where the wall does not move. The values listed assume a horizontal surface adjacent the wall.

Soil Type	Active	At-Rest	Passive
Sand and Gravel	40 pcf	55 pcf	300 pcf
Clay and Silt	50 pcf	65 pcf	250 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 27 pcf for active and at-rest conditions and decreased by 27 pcf for the passive condition. This assumes a horizontal ground acceleration of 0.3g which represents a 10 percent probability of exceedance in a 50 year period.

4. Safety Factors

The values recommended above assume mobilization of the soil to achieve ultimate soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Seismicity and Liquefaction

The Salt Lake County liquefaction map indicates that the site has a "very low" liquefaction potential. This means that there is a less than 5 percent probability that the soil may be subjected to seismic ground shaking great enough to result in liquefaction during a 100 year time period.

The soils encountered at the site would suggest that liquefaction is not a concern at the site.

Based on the location of the site, we recommend that the residences be designed and constructed to meet the Uniform Building Code Seismic Zone 3 criteria.

F. Water Soluble Sulfates

Two samples of the natural soil were tested in the laboratory for water soluble sulfate content. Test results indicate there is less than 0.1 percent water soluble sulfate in the natural soil. Based on the test results and published literature, the natural soil possesses negligible sulfate attack potential on concrete. No special cement type is required for concrete placed in contact with natural soil. Other conditions may dictate the type of cement to be used for the project.

G. Pavement

Based on the subsoil conditions encountered, laboratory test results and the assumed traffic, the following pavement support recommendations are given.

1. Subgrade Support

The near surface soil consist primarily of clay. A California Bearing Ratio (CBR) of 2½ percent has been assumed for the analysis.

2. Pavement Thickness

Based on the subsoil conditions, anticipated traffic, a design life of 20 years and methods presented by the Utah Department of Transportation, the following pavement sections are calculated.

Road Type	Asphaltic Concrete	Base Course
Through streets	3"	8"
Cul-de-sacs	3"	6"

If at least 6 inches of granular fill with a CBR of at least 20 percent is used below the pavement section, then the base course thickness can be reduced to 6 inches.

3. Pavement Material

Pavement materials should meet the Utah Department of Transportation Specifications for gradation and quality. The pavement thickness indicated above assumes the base course is high quality material with a CBR of at least 80 percent. Other materials may be considered for use in the pavement section. The use of other materials may result in the need for different pavement material thicknesses.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the test pits excavated at the locations indicated on the site plan and the data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until excavation is conducted. If the subsurface conditions or groundwater level are found to be significantly different from those described above, we should be notified to re-evaluate our recommendations.

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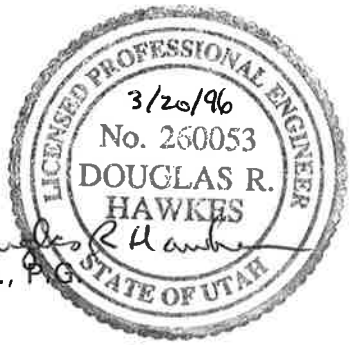

Douglas R. Hawkes, P.E., P.G.

Reviewed by James E. Nordquist, P.E.

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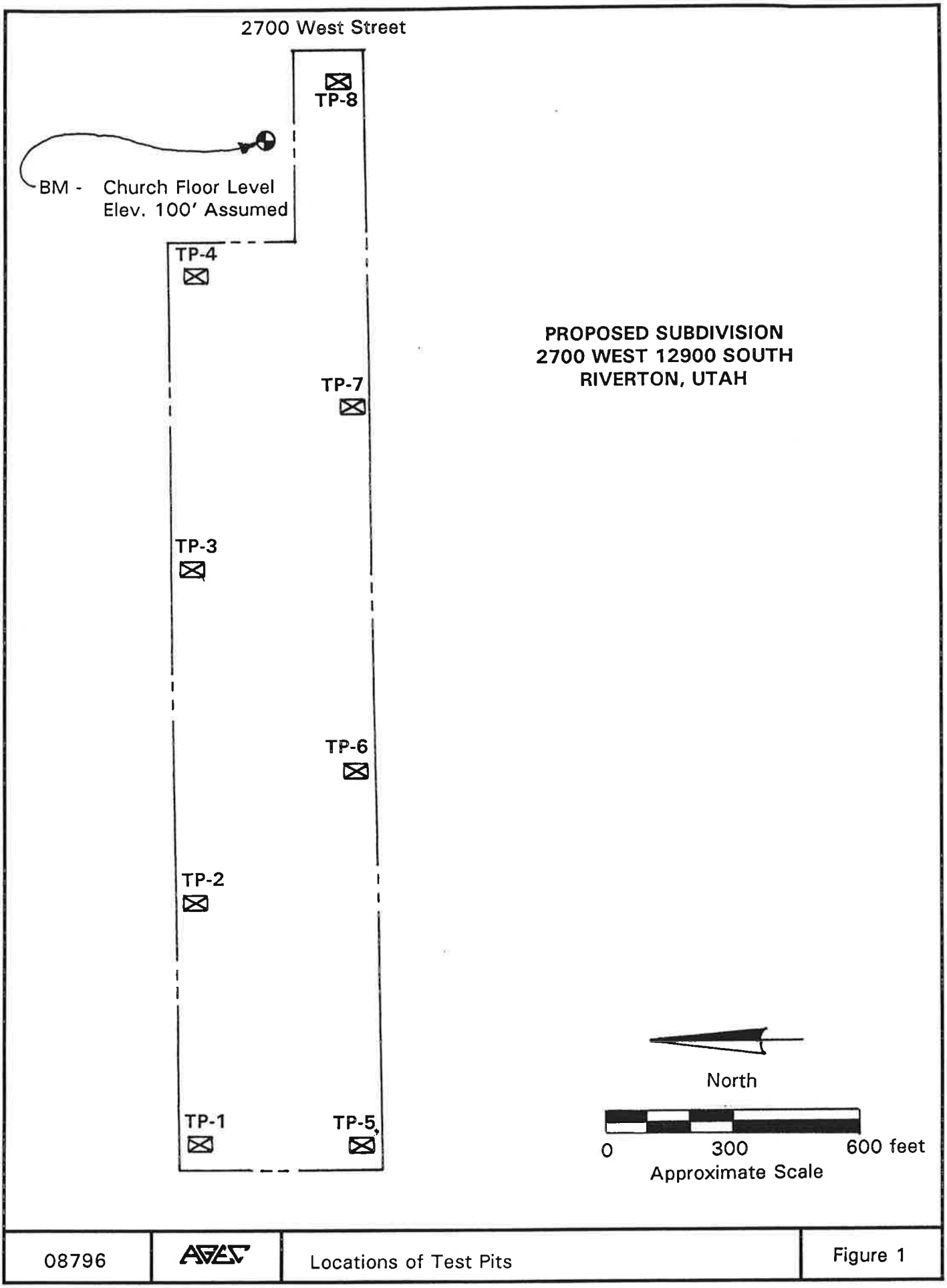
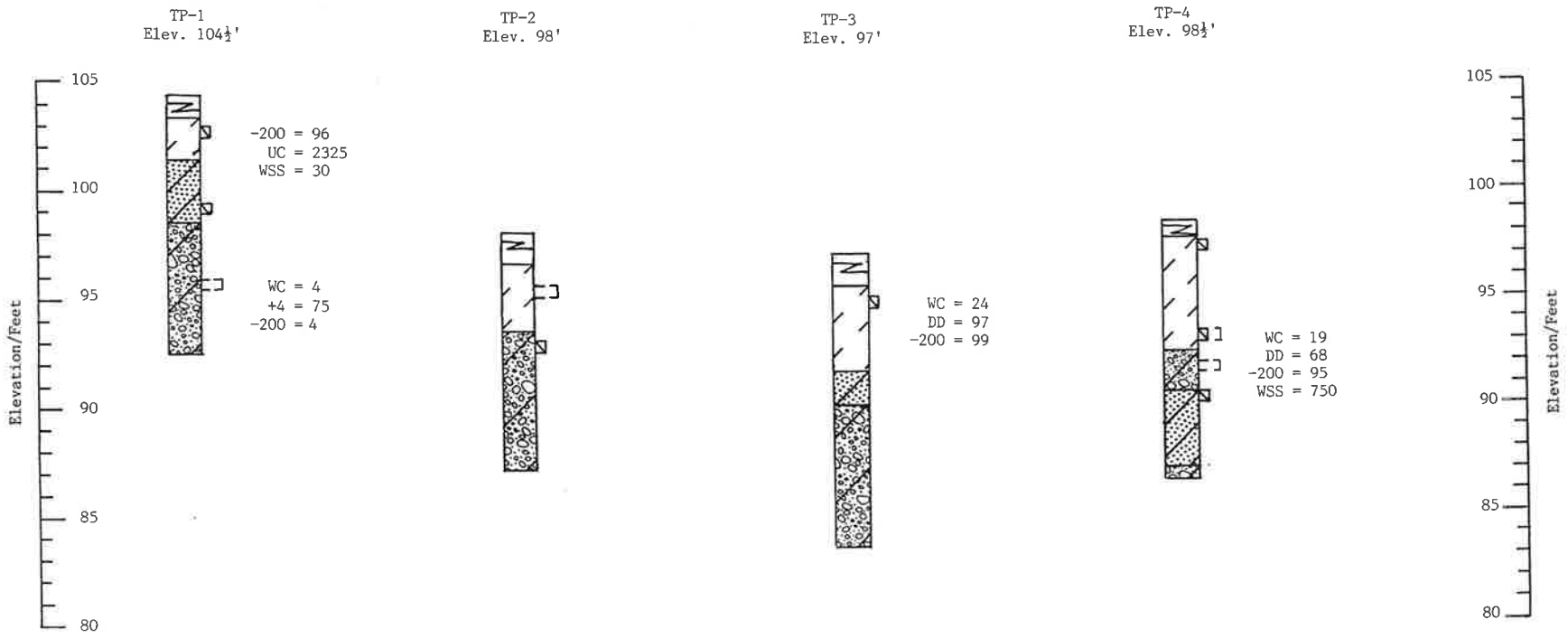


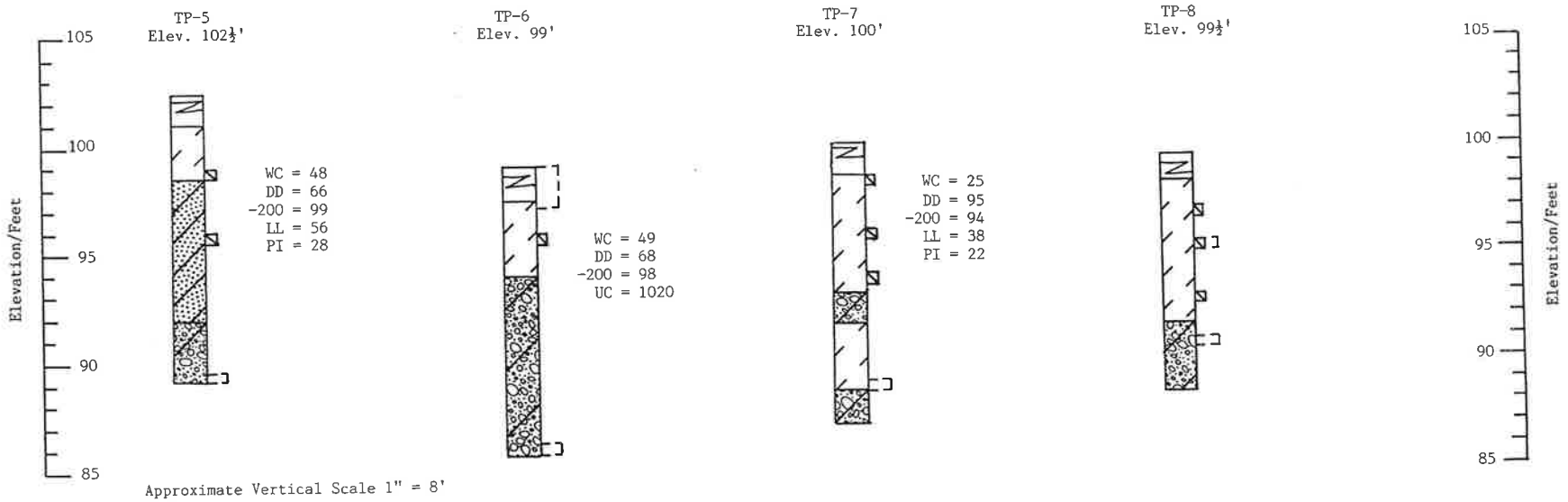
08796	AGES	Locations of Test Pits	Figure 1



Approximate Vertical Scale 1" = 8'

See Figure 3 for Legend and Notes

08796	AGES	Logs of Test Pits	Figure 2



LEGEND:

Topsoil; lean clay, moist, dark brown, roots, organics.

Lean Clay (CL); stiff to very stiff, slightly moist to moist, brown to light brown, occasional roots.

Silty Sand (SM); silt layers, medium dense, slightly moist, brown to gray.

Poor to well-graded Gravel with Silt and Sand (GP-GM/GW-GM); cobbles up to approximately 9 inches in size, occasional sandy clay layers, medium dense to dense, slightly moist, brown to orange brown.

Indicates relatively undisturbed hand drive sample taken.

Indicates disturbed sample taken.

NOTES:

1. Test pits were excavated on March 5 and 6, 1996 with a rubber-tired tractor mounted backhoe.
2. Locations of test pits were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of test pits were measured by hand level and refer to the bench mark shown on the site plan.
4. The test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the test pit logs represent the approximate boundaries between material types and the transitions may be gradual.
6. No free water was encountered in test pits at the time of excavation.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   +4 = Percent Retained on No. 4 Sieve;
   -200 = Percent Passing No. 200 Sieve;
   LL = Liquid Limit (%);
   PI = Plasticity Index (%);
   UC = Unconfined Compressive Strength (psf);
   WSS = Water Soluble Sulfates (ppm).

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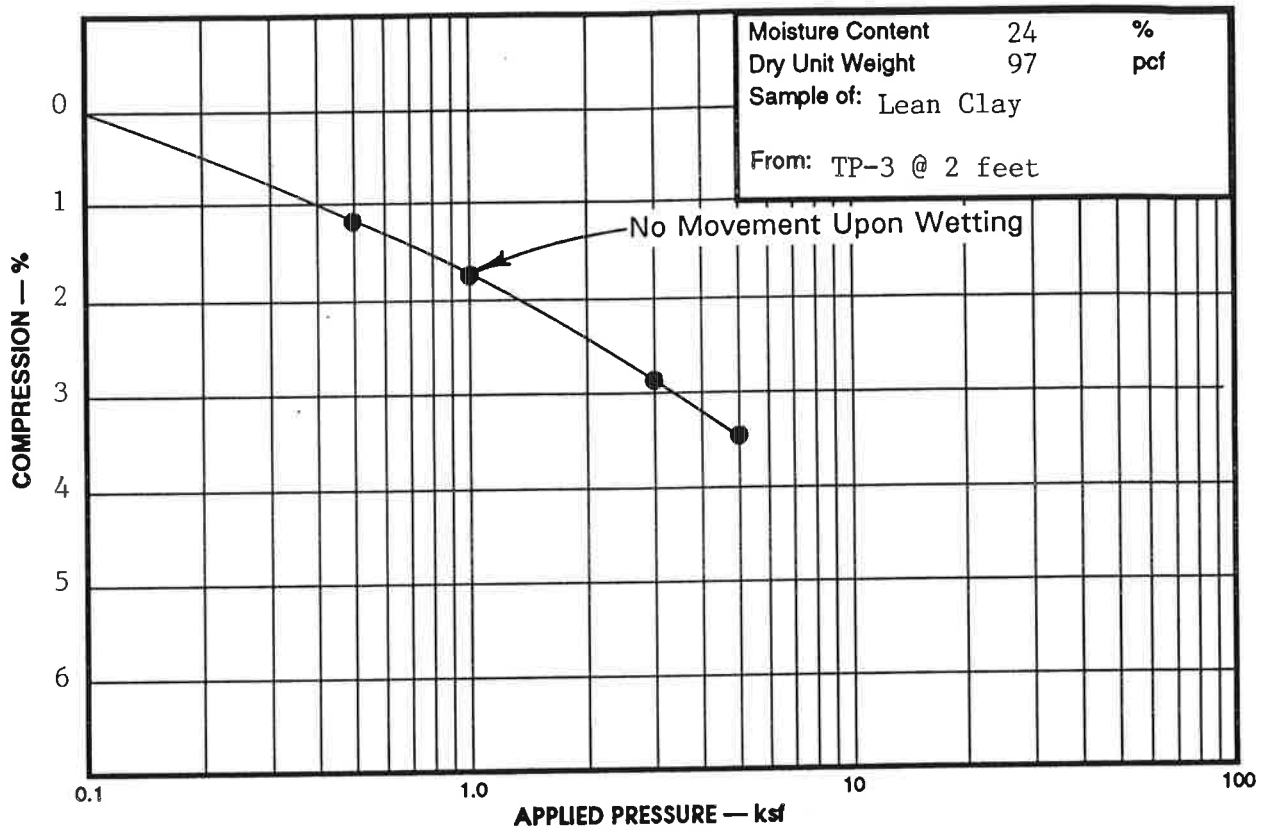

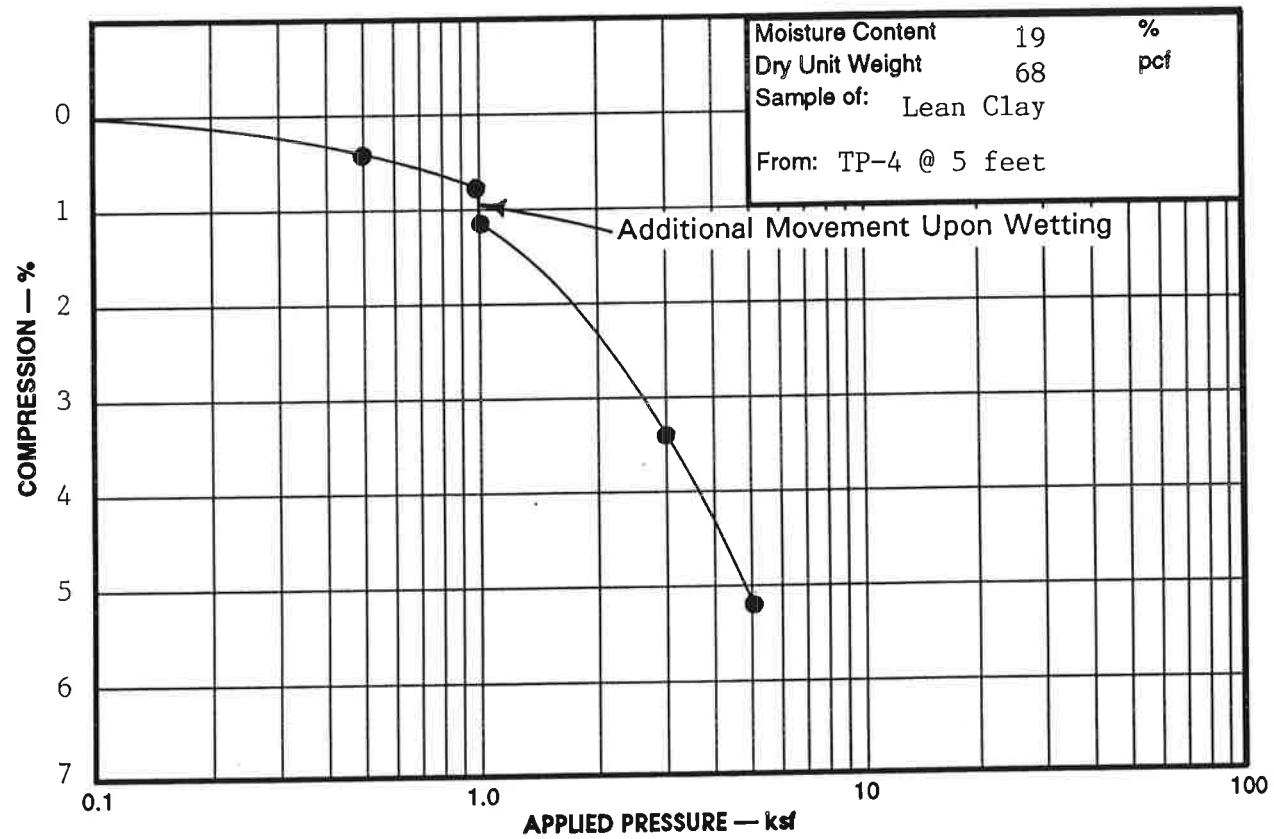

Project No. 08796 **CONSOLIDATION TEST RESULTS** Figure 4

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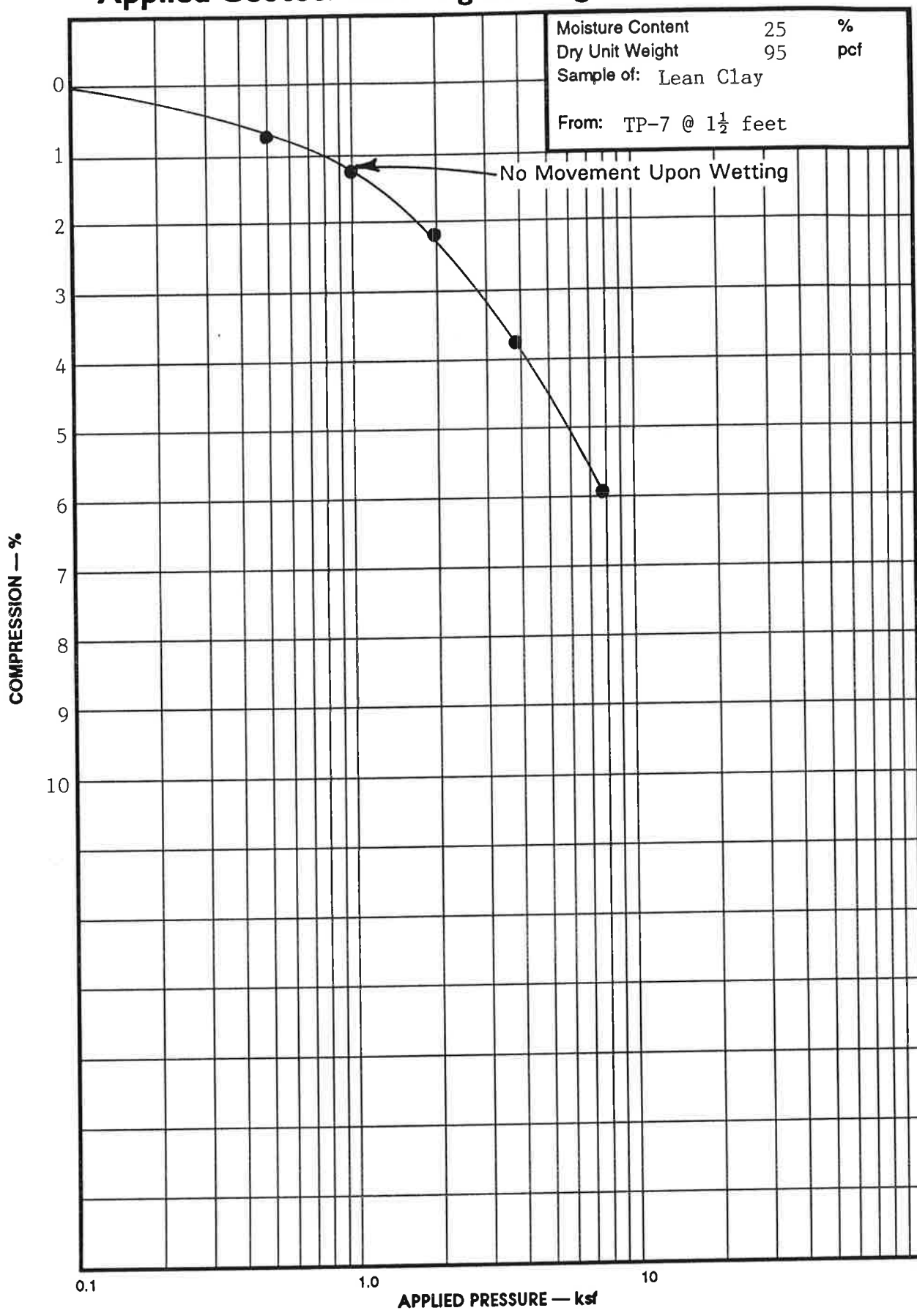
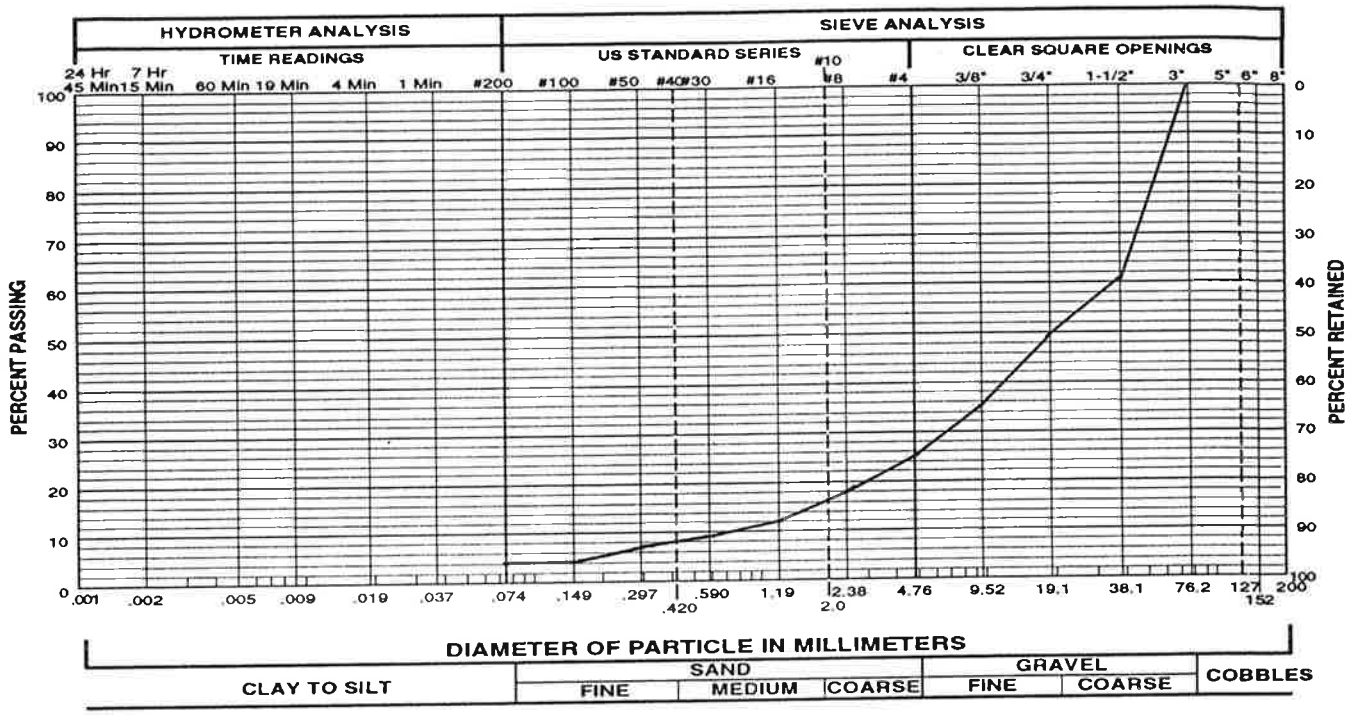


Project No. 08796 **CONSOLIDATION TEST RESULTS** Figure 5

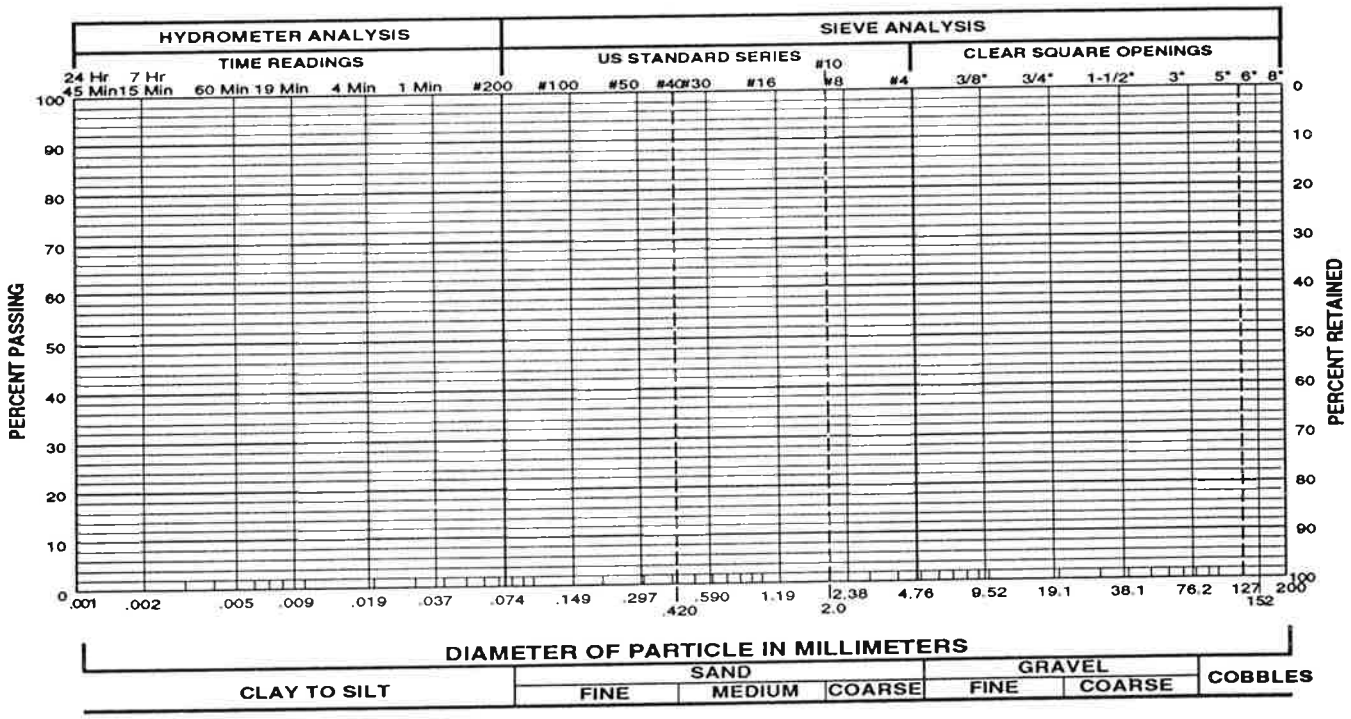
Applied Geotechnical Engineering Consultants, Inc.



Gravel 75 % Sand 21 % Silt and Clay 4 %

Liquid Limit _____ % Plasticity Index _____ %

Sample of Well-graded Gravel with Sand From TP-1 @ 8½ feet



Gravel _____ % Sand _____ % Silt and Clay _____ %

Liquid Limit _____ % Plasticity Index _____ %

Sample of _____ From _____

Project No. 08796 **GRADATION TEST RESULTS** Figure 6

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 08796

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATE (ppm)	SAMPLE CLASSIFICATION
TEST PITS	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TP-1	1½					96			2325	30	Lean Clay
	8½	4		75	21	4					Well Graded Gravel with Sand
TP-3	2	24	97			99					Lean Clay
TP-4	5	19	68			95				750	Lean Clay
TP-5	3½	48	66			99	56	28			Lean Clay
TP-6	3	49	68			98			1020		Lean Clay
TP-7	1½	25	95			94	38	22			Lean Clay