GEOTECHNICAL ENGINEERING STUDY
PRELIMINARY 47-ACRE TRACT
GRANBURY, TEXAS

Presented To:

Menard Doswell Co.

December 2005

PROJECT NO. 709-05-01

CMJ ENGINEERING, INC.

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November 30, 2005
Report No. 709-05-01

Menard Doswell Co.
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Attn: Mr. John McMackin

GEOTECHNICAL ENGINEERING STUDY
PRELIMINARY, 47-ACRE TRACT
GRANBURY, TEXAS

Dear Mr. McMackin:

Submitted here are the results of a geotechnical engineering study for the referenced project. This study was performed in general accordance with CMJ Proposal 05-1231(Revised) dated November 4, 2005. The geotechnical services were authorized by Mr. John McMackin.

Engineering analyses and recommendations are contained in the text section of the report. Results of our field and laboratory services are included in the appendix of the report. We would appreciate the opportunity to be considered for providing the materials engineering and geotechnical observation services during the construction phase of this project.

We appreciate the opportunity to be of service to you and your consultants. Please contact us if you have any questions or if we may be of further service at this time.

Respectfully submitted,
CMJ ENGINEERING, INC.

Garrett E. Will

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APPENDIX A

1.0 INTRODUCTION

1.1 Project Description

The approximate 47-acre site is located on the east side of Water's Edge Drive south of its intersection with U.S. Highway 377 in Granbury, Texas. Proposed development consists of single story commercial buildings on the northern portion of the site and single family residential construction on the southern half of the site.

Plate A.1, Plan of Borings, presents the approximate locations of the exploration borings.

1.2 Purpose and Scope

This investigation provides general information for commercial and residential development for future site development consideration. The results of this investigation should not be used for final design.

The purpose of this geotechnical engineering study has been to determine the general subsurface conditions, evaluate the engineering characteristics of the subsurface materials encountered, and develop recommendations for the type or types of foundations suitable for the project.

To accomplish its intended purposes, the study has been conducted in the following phases: (1) drilling sample borings to determine the general subsurface conditions and to obtain samples for testing; (2) performing laboratory tests on appropriate samples to determine pertinent engineering properties of the subsurface materials; and (3) performing engineering analyses, using the field and laboratory data to develop geotechnical recommendations for the proposed construction.

The design is currently in progress and the locations and/or elevations of the structure could change. Once the final design is near completion (80-percent to 90-percent stage), it is recommended that CMJ Engineering, Inc. be retained to review those portions of the construction documents pertaining to the geotechnical recommendations, as a means to determine that our recommendations have been interpreted as intended.

1.3 Report Format

The text of the report is contained in Sections 1 through 9. All plates and large tables are contained in Appendix A. The alpha-numeric plate and table numbers identify the appendix in which they appear. Small tables of less than one page in length may appear in the body of the text and are numbered according to the section in which they occur.

Units used in the report are based on the English system and may include tons per square foot (tsf), kips (1 kip = 1,000 pounds), kips per square foot (ksf), pounds per square foot (psf), pounds per cubic foot (pcf), and pounds per square inch (psi).

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

Subsurface materials at the project site were explored by eight (8) vertical soil borings. Borings B-1 through B-5 are associated with the proposed commercial structures and were drilled to depths of 20 to 25 feet. The remaining borings, B-6 through B-8, are associated with single family residential construction and were drilled to depths of 15 to 20 feet. The borings were drilled using continuous flight augers at the approximate locations shown on the Plan of Borings, Plate A.1. The boring logs are included on Plates A.4 through A.11 and keys to classifications and symbols used on the logs are provided on Plates A.2 and A.3.

Undisturbed samples of cohesive soils were obtained with nominal 3-inch diameter thin-walled (Shelby) tube samplers at the locations shown on the logs of borings. The Shelby tube sampler consists of a thin-walled steel tube with a sharp cutting edge connected to a head equipped with a ball valve threaded for rod connection. The tube is pushed into the soil by the hydraulic pulldown of the drilling rig. The soil specimens were extruded from the tube in the field, logged, tested for consistency with a hand penetrometer, sealed, and packaged to limit loss of moisture.

The consistency of cohesive soil samples was evaluated in the field using a calibrated hand penetrometer. In this test a 0.25-inch diameter piston is pushed into the relatively undisturbed sample at a constant rate to a depth of 0.25 inch. The results of these tests, in tsf, are tabulated at respective sample depths on the logs. When the capacity of the penetrometer is exceeded, the value is tabulated as 4.5+.

Disturbed samples of the noncohesive granular or stiff to hard cohesive materials were obtained utilizing a nominal 2-inch O.D. split-barrel (split-spoon) sampler in conjunction with the Standard Penetration Test (ASTM D 1586). This test employs a 140-pound hammer that drops a free fall vertical distance of 30 inches, driving the split-spoon sampler into the material. The number of blows required for 18 inches of penetration is recorded and the value for the last 12 inches, or the penetration obtained from 100 blows, is reported as the Standard Penetration Value (N) at the appropriate depth on the log of boring.

2.2 Laboratory Testing

Laboratory soil tests were performed on selected representative samples recovered from the borings. In addition to the classification tests (liquid limits and plastic limits), moisture content, unit weight, percent passing the No. 200 Sieve, and unconfined compressive strength tests were performed. Results of the laboratory tests conducted for this project are included on the boring logs.

The above laboratory tests were performed in general accordance with applicable ASTM procedures, or generally accepted practice.

3.0 SUBSURFACE CONDITIONS

3.1 Soil Conditions

Specific types and depths of subsurface strata encountered at the boring locations are shown on the boring logs in Appendix A. The generalized subsurface stratigraphies encountered in the borings are discussed below. Note that depths on the borings refer to the depth from the existing grade or ground surface present at the time of the investigation, and the boundaries between the various soil types are approximate.

The surficial soils typically consisted of two feet of brown and tan sand that visually appeared to be loose. Brown and tan sands, silty sands and occasionally clayey sands were then encountered in the borings. These sands often contained gravel below depths of 17 to 18 feet. These sands were typically medium dense to very dense in consistency, with standard penetration test values ranging from 14 to 70 blows per foot. A sample of the clayey sands encountered in Boring B-3 had a Liquid Limit (LL) of 15 and a Plasticity Index (PI) of 1.

The unit weight values in the medium dense sands and clayey sands varied from 104 to 108 pcf and unconfined compressive strengths varied from 850 to 4,590 psf, respectively. The lowest strength is reflective of a sand with minimal clay content.

Tan limestone was encountered in the bottom of Borings B-2 and B-8, at depths of approximately 21.5 and 15 feet, respectively, and in Borings B-1, B-3 and B-5 at depths of 18.5 to 19.5 feet. The limestone was hard with standard penetration test values of 0.5 to 4 inches for 50 blows.

The Atterberg Limits tests indicate the sands and clayey sands encountered at this site are generally stable with respect to moisture induced volume changes.

3.2 Ground-Water Observations

The borings were drilled using continuous flight augers in order to observe ground-water seepage during drilling. Ground-water seepage was encountered in all borings except Boring B-7 during drilling at depths of 13 to 19 feet with similar water levels at completion. No seepage was encountered in Boring B-7 during drilling and it was dry at completion.

Table 3.2-1 summarizes the observed water level data. While it is not possible to accurately predict the magnitude of subsurface water fluctuation that might occur based upon these short-term observations, it should be recognized that ground-water conditions will vary with fluctuations in rainfall. The possibility of ground-water level fluctuations should be considered when developing the design and construction plans for the project; however, seepage levels near the observed levels should be anticipated throughout the year.

Boring No.	Seepage During Drilling (ft.)	Water at Completion (ft.)
B-1	18	18
B-2	18	18
B-3	18	18
B-4	19	19
B-5	16	16
B-6	18	17
B-7	Dry	Dry
B-8	13	11

4.0 COMMERCIAL STRUCTURE FOUNDATION RECOMMENDATIONS

4.1 General Foundation Considerations

Two independent design criteria must be satisfied in the selection of the type of foundation to support the proposed structures. First, the ultimate bearing capacity, reduced by a sufficient factor of safety, must not be exceeded by the bearing pressure transferred to the foundation soils. Second, due to consolidation or expansion of the underlying soils during the operating life of the structures, total and differential vertical movements must be within tolerable limits. The foundations for the proposed buildings are discussed below.

4.2 Footing Foundations

Reinforced concrete footings may be used to support structural loads if some movement can be tolerated. Individual footings (square, round or rectangular) situated at a depth of 30 inches below finished grade may be proportioned using an allowable soil bearing capacity of 2,800 pounds per square foot (psf) while continuous footings at the same depth may utilize an allowable bearing pressure of 2,200 psf. Individual footings situated at a depth of 5 feet below finished grade may be proportioned using an allowable bearing pressure of 4,500 psf while continuous footings may utilize an allowable bearing pressure of 3,600 psf.

Individual footings should maintain a minimum width of 3 feet and continuous footings should maintain a minimum width of 18 inches, but must be wider as required, based upon allowable bearing capacities given below. Continuous spread foundations are defined as those having a length to width ratio greater than 10.

Footings will be subject to potential movements of up to one inch of total movement, and one-half inch differential movement between adjacent footings. The base of all excavated footings shall be inspected by a geotechnical engineer or geotechnician under his or her supervision to assure that the bottom is firm, level and free of loose soil material and/or debris.

The footings will resist lateral loads by a combination of friction developed between the base of the foundations and the underlying bearing materials and by the passive pressure of the soil acting on the sides of the foundation. Where foundations are placed immediately adjacent to undisturbed native soils (vertical earth formed side wall) or properly compacted backfill using native soils, allowable passive earth pressure may be taken as the pressure exerted by a fluid weighing 150 pcf. Movement on the order of 0.01 to 0.02 of the embedded portion of the footing is required to mobilize full passive pressure. Passive pressure should be neglected in the upper 2 feet due to loose sands, disturbed surface conditions and potential moisture variations. An allowable coefficient of friction factor of 0.35 may be used to calculate sliding resistance of the footings bearing on site soils.

4.3 Foundation Construction

Spread foundation construction should be monitored by a representative of the geotechnical engineer to observe, among other things, the following items:

- Identification of bearing material
- Adequate penetration of the foundation excavation into the bearing layer
- The base and sides of the excavation are clean of loose cuttings
- If seepage is encountered, whether it is of sufficient amount to require the use of excavation dewatering methods

Precautions should be taken during the placement of reinforcing steel and concrete to prevent loose, excavated soil from falling into the excavation. Concrete should be placed as soon as practical after completion of the excavating, cleaning, reinforcing steel placement and observation. Excavation for a spread foundation should be filled with concrete before the end of the workday, or sooner if required, to prevent deterioration of the bearing material. Prolonged exposure or inundation of the bearing surface with water will result in changes in strength and compressibility characteristics. If delays occur, the excavation should be deepened as necessary and cleaned, in order to provide a fresh bearing surface. If more than 24 hours of exposure of the bearing surface is anticipated in the excavations, a "mud slab" should be used to protect the bearing surfaces. If a mud slab is used, the foundation excavations should initially be over-excavated by approximately 4 inches and a lean concrete mud slab of approximately 4 inches in thickness should be placed in the bottom of the excavations immediately following exposure of the bearing surface by excavation. The mud slab will protect the bearing surface, maintain more uniform moisture in the subgrade, facilitate dewatering of excavations if required, and provide a working surface for the placement of formwork and reinforcing steel.

The concrete should be placed in a manner that will prevent the concrete from striking the reinforcing steel or the sides of the excavation in a manner that would cause segregation of the concrete.

The excavations above the footings may be backfilled with excavated on-site soils. Backfill soils should be compacted to at least 95 percent of Standard Proctor (ASTM D 698) maximum dry density, in compacted lifts not to exceed 6 inches. The soils should be compacted at a moisture near (-2% to +2%) the soil's optimum moisture content.

4.4 Floor Slabs

Floor slabs should perform satisfactorily when placed on the existing soils or compacted fill after the soils have been properly prepared. All subgrade areas should be stripped of surface organics or vegetation and any loose materials. The subgrade should be scarified to a depth of 8 inches and recompacted to a minimum density of 95 percent of Standard Proctor (ASTM D-698) near (-2% to +2%) the soil's optimum moisture content. Any fill material imported for use within the building areas should be similar to the surficial sands and clayey sands present at this site or a very sandy clay or clayey sand non-expansive select fill with a Liquid Limit less than 35 and a PI of less than 15.

A properly engineered and constructed vapor barrier should be provided beneath slabs-on-grade which will be carpeted or receive moisture sensitive coverings or adhesives

5.0 RESIDENTIAL STRUCTURE FOUNDATION RECOMMENDATIONS

5.1 General Foundation Considerations

Properly designed and constructed monolithic, slab-on-grade foundation systems should perform satisfactorily for residential structures at this site. Recommendations for this system are presented below.

5.2 Stiffened Monolithic, Slab-On-Grade

A stiffened, monolithically placed slab-on-grade foundation, either rebar or post-tensioned, used at this site must be designed with exterior and interior grade beams to provide sufficient rigidity to tolerate the differential soil movements. These differential movements will typically occur between the periphery and interior of the slab-on-grade system. Foundation movements are anticipated to occur primarily due to post construction heave of the underlying soils but also can occur due to shrinkage of the clays around the perimeter of the slab. It is recommended that all fill soils be properly placed and compacted in accordance with report Section 7 prior to foundation installation.

The foundation should be designed by a structural engineer familiar with stiffened slabs-on-grade subject to differential movement. Design parameters are presented below for effective PI, PVR and differential swell using the Post-Tensioning Institute's (PTI) slab-on-grade design method, 2^{nd} Edition.

Estimated PVR:	1.0 inch
Edge Moisture Variation -	
Approximate Center Lift:	5.5 feet
Approximate Edge Lift:	5.0 feet
Differential Swell -	
Approximate Center Lift:	1.0 inches
Approximate Edge Lift:	0.6 inches

Site grading can affect the design parameters. For example, fills using imported clays will increase the total clay thickness thereby increasing the potential vertical rise. The values presented above allow for the installation of up to 12 inches of imported clay fill, with a Liquid Limit less than 35, without affecting the design parameters. This office should be contacted for additional recommendations if clay fills in excess of 12 inches are used within the building pads.

Beams may be designed based on an allowable soil bearing pressure of 1.5 ksf within the soils. The beams should extend at least 12 inches into compacted fill or natural soils. The beam depth is given in regard to bearing capacity, and is not intended to be a structural recommendation.

A properly engineered and constructed moisture barrier should be provided beneath the slab-on-grade.

The key to the success of this foundation is proper design/construction, and providing control of the below-slab water. Providing excellent drainage away from the structure, preventing ponding water aside the slab, and proper grading in the interior courtyard enhance the slab performance.

6.0 SEISMIC CONSIDERATIONS

Based on the conditions encountered in the borings for the above referenced project the IBC-2000 site classification is TYPE D for seismic evaluation.

7.0 EARTHWORK

7.1 Site Preparation

The subgrade should be firm and able to support the construction equipment without displacement. Soft or yielding subgrade should be corrected and made stable before construction proceeds. The subgrade should be proof rolled to detect soft spots, which if exist, should be excavated to provide a firm and otherwise suitable subgrade. Proof rolling should be performed using a heavy pneumatic tired roller, loaded dump truck, or similar piece of equipment. The proof rolling operations should be observed by the project geotechnical engineer or his/her representative.

In some areas of the site non-plastic sands could be present at the surface over less permeable clayey sands. During periods of inclement weather these surface soils can become saturated and subject to pumping. In addition, the sands are difficult to compact, particularly when they are wet. This may require undercutting to a firm subgrade and blending saturated soils with more clayey site materials.

7.2 Placement and Compaction

Site grading can affect the potential movements. For example, the use of clays as fill material will increase the potential movements by increasing the total clay thickness.

Fill material should be placed in loose lifts not exceeding 8 inches in uncompacted thickness. The uncompacted lift thickness should be reduced to 4 inches for structure backfill zones requiring hand-operated power compactors or small self-propelled compactors. The fill material should be uniform with respect to material type and moisture content. Clods and chunks of material should be broken down and the fill material mixed by disking, blading, or plowing, as necessary, so that a material of uniform moisture and density is obtained for each lift. Water required for sprinkling to bring the fill material to the proper moisture content should be applied evenly through each layer.

The on-site soils are suitable for use in site grading. Imported fill material should be clean soil with a Liquid Limit less than 35 percent and no rock greater than 4 inches in maximum dimension. The fill materials should be free of vegetation and debris.

The fill material should be compacted to a density ranging from 95 to 100 percent of maximum dry density as determined by ASTM D 698, Standard Proctor. In conjunction with the compacting operation, the fill material should be brought to the proper moisture content. The moisture content for general earth fill should range from 2 percentage points below optimum to 5 percentage points above optimum (-2 to +5). These ranges of moisture contents are given as maximum recommended ranges. For some soils and under some conditions, the contractor may have to maintain a more narrow range of moisture content (within the recommended range) in order to consistently achieve the recommended density.

Field density tests should be taken as each lift of fill material is placed. As a guide, one field density test per lift for each 5,000 square feet of compacted area is recommended. For small areas or critical areas the frequency of testing may need to be increased to one test per 2,500 square feet. A minimum of 2 tests per lift should be required. The earthwork operations should be observed and tested on a continuing basis by an experienced geotechnician working in conjunction with the project geotechnical engineer.

Each lift should be compacted, tested, and approved before another lift is added. The purpose of the field density tests is to provide some indication that uniform and adequate compaction is being obtained. The actual quality of the fill, as compacted, should be the responsibility of the contractor and satisfactory results from the tests should not be considered as a guarantee of the quality of the contractor's filling operations.

7.3 Trench Backfill

Trench backfill for pipelines or other utilities should be properly placed and compacted. Overly dense or dry backfill can swell and create a mound along the completed trench line. Loose or wet backfill can settle and form a depression along the completed trench line. Distress to overlying structures, pavements, etc. is likely if heaving or settlement occurs. On-site soil fill material is recommended for trench backfill. Care should be taken not to use free draining granular material, to prevent the backfilled trench from becoming a french drain and piping surface or subsurface water beneath structures, pipelines, or pavements. If a higher class bedding material is required for the pipelines, a lean concrete bedding will limit water intrusion into the trench and will not require compaction after placement. The soil backfill should be placed in approximately 4- to 6-inch loose lifts. The density and moisture content should be as recommended for fill in Section 7.2, Placement and Compaction, of this report. A minimum of one field density test should be taken per lift for each 150 linear feet of trench, with a minimum of 2 tests per lift.

7.4 Excavation

The side slopes of excavations through the overburden soils should be made in such a manner to provide for their stability during construction. Existing structures, pipelines or other facilities, which are constructed prior to or during the currently proposed construction and which require excavation, should be protected from loss of end bearing or lateral support.

Temporary construction slopes and/or permanent embankment slopes should be protected from surface runoff water. Site grading should be designed to allow drainage at planned areas where erosion protection is provided, instead of allowing surface water to flow down unprotected slopes.

Trench safety recommendations are beyond the scope of this report. The contractor must comply with all applicable safety regulations concerning trench safety and excavations including, but not limited to, OSHA regulations.

7.5 Acceptance of Imported Fill

Any soil imported from off-site sources should be tested for compliance with the recommendations for the particular application and approved by the project geotechnical engineer prior to the materials being used. The owner should also require the contractor to obtain a written, notarized certification from the landowner of each proposed off-site soil borrow source stating that to the best of the landowner's knowledge and belief there has never been contamination of the borrow source site with hazardous or toxic materials. The certification should be furnished to the owner prior to proceeding to furnish soils to the site. Soil materials derived from the excavation of underground petroleum storage tanks should not be used as fill on this project.

7.6 Soil Corrosion Potential

Specific testing for soil corrosion potential was not included in the scope of this study. However, based upon past experience on other projects in the vicinity, the soils at this site may be corrosive. Standard construction practices for protecting metal pipe and similar facilities in contact with these soils should be used.

7.7 Erosion and Sediment Control

All disturbed areas should be protected from erosion and sedimentation during construction, and all permanent slopes and other areas subject to erosion or sedimentation should be provided with permanent erosion and sediment control facilities. All applicable ordinances and codes regarding erosion and sediment control should be followed.

8.0 PAVEMENTS

8.1 Pavement Subgrade Preparation

The surficial soils generally consisted of non-plastic sands. The sands and lower plasticity clayey sands can often be difficult to compact, particularly when they are wet. It may be desirable to blend them with more clayey soils during site grading in building or pavement areas. Consideration can also be given to mixing the sands with Portland Cement rather than replacing them with a blended material as described above. Four to 6 percent cement should improve the compaction characteristics of these materials. For significant strength gains, higher percentages of Portland Cement would be required.

Prior to compaction, the subgrade should be proofrolled with heavy pneumatic equipment. Any soft or pumping areas should be undercut to a firm subgrade and properly backfilled as described in the Earthwork section. The subgrade should be scarified to a minimum depth of 6 inches and uniformly compacted to a minimum of 95 percent of ASTM D 698 near, -2 to +4 percent, the optimum moisture content determined by that test. It should then be protected and maintained in a moist condition until the pavement is placed.

We recommend that subgrade stabilization extend to at least one foot beyond pavement edges to aid in reducing pavement movements and cracking along the curb line due to seasonal moisture variations after construction. Each construction area should be shaped to allow drainage of surface water during earthwork operations, and surface water should be pumped immediately from each construction area after each rain and a firm subgrade condition maintained. Water should not be allowed to pond in order to prevent percolation and subgrade softening, and lime should be added to the subgrade after removal of all surface vegetation and debris. Sand should be specifically prohibited beneath pavement areas, since these more porous soils can allow water inflow, resulting in heave and strength loss of subgrade soils (lime stabilized soil will be allowed for fine grading). After fine grading each area in preparation for paving, the subgrade surface should be lightly moistened, as needed, and recompacted to obtain a tight non-yielding subgrade.

Surface drainage is critical to the performance of this pavement. Water should be allowed to exit the pavement surface quickly. This can be accomplished by maintaining at least 1% slope of the finished grades and discharging the water into drainage structures. All pavement construction should be performed in accordance with the following procedures:

8.2 Pavement Sections

The project may include the construction of parking lots and/or drives. At the time of this investigation, site paving plans or vehicle traffic studies were not available. Therefore, several rigid and flexible pavement sections are presented for a 20-year design life based on our experience with similar facilities for Light Duty Parking Areas, Medium Duty Parking Areas, and Medium to Heavy Duty Drives. In general, these areas are defined as follows:

> Light-Duty Parking Areas are those lots and drives subjected almost exclusively to passenger cars, with an occasional light- to medium-duty truck (2 to 3 per week)
>
> Medium-Duty Parking Areas are those lots subjected to a variety of light-duty vehicles to medium-duty vehicles and an occasional heavy-duty truck (1 to 2 per week).
>
> Medium to Heavy-Duty Drives are those drives subjected to a variety of light to heavy-duty vehicles. These pavements include areas significant truck traffic or trash vehicles.

We recommend that rigid pavements be utilized at this project whenever possible, since they tend to provide better long-term performance when subjected to significant slow moving and turning traffic.

If asphaltic concrete pavement is used, we recommend a full depth asphaltic concrete section having a minimum total thickness of 5 inches for light-duty parking areas and 6 inches for medium-duty parking areas. A minimum surface course thickness of 2 inches is recommended for asphaltic concrete pavements.

If Portland cement concrete pavement is used, a minimum thickness of 5 inches of concrete is recommended for light-duty parking areas, 6 inches for medium-duty parking areas, and 7 inches for medium to heavy-duty areas.

A California Bearing Ratio or other strength tests were not performed because they were not within the scope of our services on this project. A subgrade modulus of 100 psi was considered appropriate for the near-surface soils. If heavier vehicles are planned, the above cross sections can be confirmed by performing strength tests on the subgrade materials once the traffic characteristics are established. Periodic maintenance of pavement structures normally improves the durability of the overall pavement and enhances its expected life.

The above sections should be considered minimum pavement thicknesses and higher traffic volumes and heavy trucks may require thicker pavement sections. Additional recommendations can be provided after traffic volumes and loads are known. Periodic maintenance should be anticipated for minimum pavement thickness. This maintenance should consist of sealing cracks and timely repair of isolated distressed areas.

8.3 Pavement Material Requirements

Reinforced Portland Cement Concrete: Reinforced Portland cement concrete pavement should consist of Portland cement concrete having a 28-day compressive strength of at least 3,500 psi. The mix should be designed in accordance with the ACI Code 318 using 3 to 6 percent air entrainment. The pavement should be adequately reinforced with temperature steel and all construction joints or expansion/contraction joints should be provided with load transfer dowels. The spacing of the joints will depend primarily on the type of steel used in the pavement. We recommend using No. 3 steel rebar spaced at 18 inches on center in both the longitudinal and transverse direction. Control joints formed by sawing are recommended every 12 to 15 feet in both the longitudinal and transverse direction. The cutting of the joints should be performed as soon as the concrete has "set-up" enough to allow for sawing operations.

Hot Mix Asphaltic Concrete Surface Course: Item 340, Type D, Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 1993 Edition.

Hot Mix Asphaltic Concrete Base Course: Item 340, Type A or B, Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 1993 Edition.

8.4 General Pavement Considerations

The design of the pavement drainage and grading should consider the potential for differential ground movement due to future soil swelling of up to 1 inch. In order to minimize rainwater infiltration through the pavement surface, and thereby minimizing future upward movement of the pavement slabs all cracks and joints in the pavement should be sealed on a routine basis after construction.

9.0 CONSTRUCTION OBSERVATIONS

In any geotechnical investigation, the design recommendations are based on a limited amount of information about the subsurface conditions. In the analysis, the geotechnical engineer must assume the subsurface conditions are similar to the conditions encountered in the borings. However, quite often during construction anomalies in the subsurface conditions are revealed. Therefore, it is recommended that CMJ Engineering, Inc. be retained to observe earthwork and foundation installation and perform materials evaluation during the construction phase of the project. This enables the geotechnical engineer to stay abreast of the project and to be readily available to evaluate unanticipated conditions, to conduct additional tests if required and, when necessary, to recommend alternative solutions to unanticipated conditions. Until these construction phase services are performed by the project geotechnical engineer, the recommendations contained in this report on such items as final foundation bearing elevations, proper soil moisture condition, and other such subsurface related recommendations should be considered as preliminary.

It is proposed that construction phase observation and materials testing commence by the project geotechnical engineer at the outset of the project. Experience has shown that the most suitable method for procuring these services is for the owner or the owner's design engineers to contract directly with the project geotechnical engineer. This results in a clear, direct line of communication between the owner and the owner's design engineers and the geotechnical engineer.

10.0 REPORT CLOSURE

The boring logs shown in this report contain information related to the types of soil encountered at specific locations and times and show lines delineating the interface between these materials. The logs also contain our field representative's interpretation of conditions that are believed to exist in those depth intervals between the actual samples taken. Therefore, these boring logs contain both factual and interpretive information. Laboratory soil classification tests were also performed on samples from selected depths in the borings. The results of these tests, along with visual-manual procedures were used to generally classify each stratum. Therefore, it should be understood that the classification data on the logs of borings represent visual estimates of classifications for those portions of each stratum on which the full range of laboratory soil classification tests were not performed. It is not implied that these logs are representative of subsurface conditions at other locations and times.

With regard to ground-water conditions, this report presents data on ground-water levels as they were observed during the course of the field work. In particular, water level readings have been made in the borings at the times and under conditions stated in the text of the report and on the boring logs. It should be noted that fluctuations in the level of the ground-water table can occur with passage of time due to variations in rainfall, temperature and other factors. Also, this report does not include quantitative information on rates of flow of ground water into excavations, on pumping capacities necessary to dewater the excavations, or on methods of dewatering excavations. Unanticipated soil conditions at a construction site are commonly encountered and cannot be fully predicted by mere soil samples, test borings or test pits. Such unexpected conditions frequently require that additional expenditures be made by the owner to attain a properly designed and constructed project. Therefore, provision for some contingency fund is recommended to accommodate such potential extra cost.

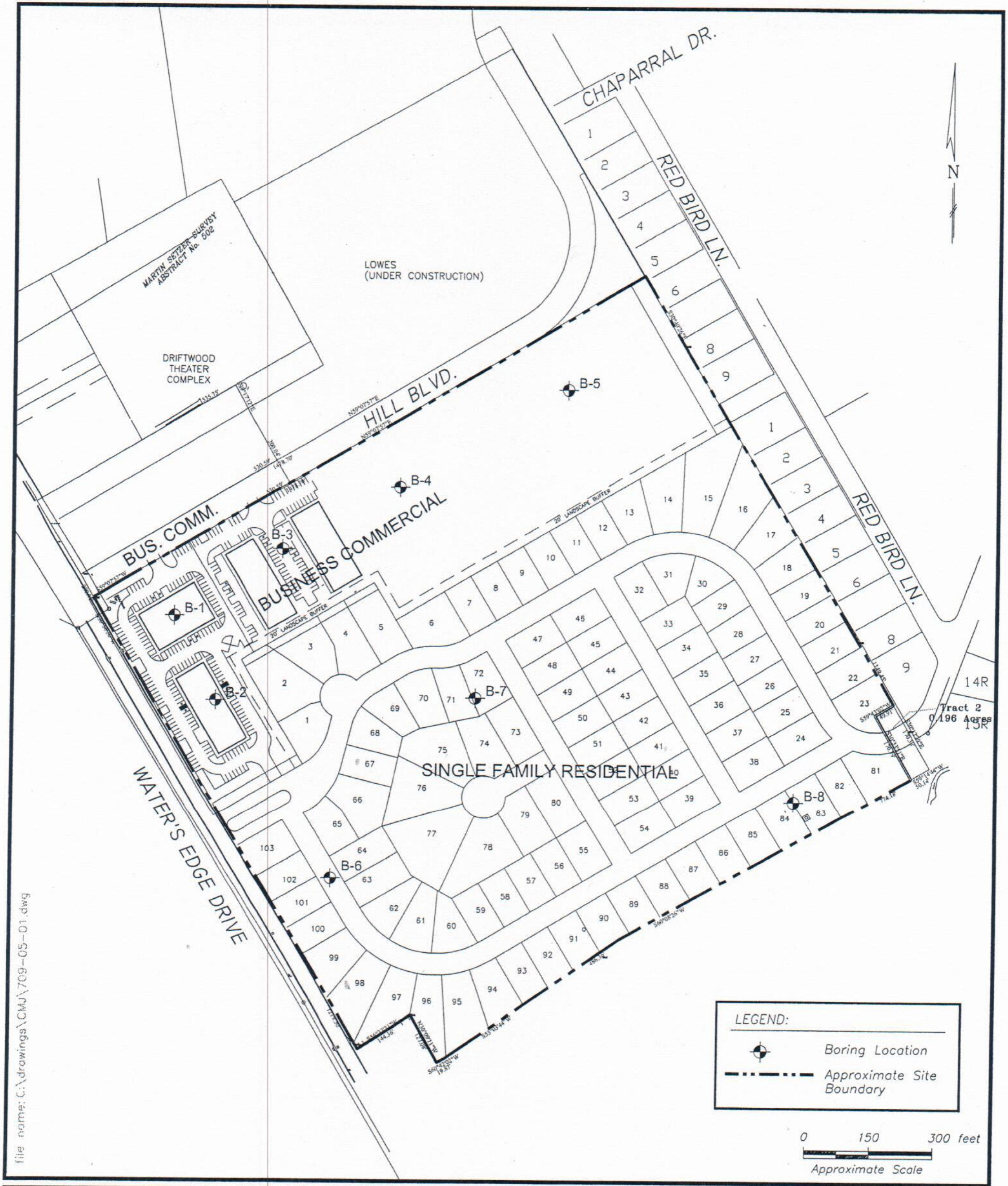
The analyses, conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our field investigation and further on the assumption that the exploratory borings are representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the borings at the time they were completed. If, during construction, different subsurface conditions from those encountered in our borings are observed, or appear to be present in excavations, we must be advised promptly so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between submission of this report and the start of the work at the site, if conditions have changed due either to natural causes or to construction operations at or adjacent to the site, or if structure locations, structural loads or finish grades are changed, we urge that we be promptly informed and retained to review our report to determine the applicability of the conclusions and recommendations, considering the changed conditions and/or time lapse.

Further, it is urged that CMJ Engineering, Inc. be retained to review those portions of the plans and specifications for this particular project that pertain to earthwork and foundations as a means to determine whether the plans and specifications are consistent with the recommendations contained in this report. In addition, we are available to observe construction, particularly the compaction of structural fill, or backfill and the construction of foundations as recommended in the report, and such other field observations as might be necessary.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, ground water or air, on or below or around the site.

This report has been prepared for use in developing an overall design concept. Paragraphs, statements, test results, boring logs, diagrams, etc. should not be taken out of context, nor utilized without a knowledge and awareness of their intent within the overall concept of this report. The reproduction of this report, or any part thereof, supplied to persons other than the owner, should indicate that this study was made for design purposes only and that verification of the subsurface conditions for purposes of determining difficulty of excavation, trafficability, etc. are responsibilities of the contractor.

This report has been prepared for the exclusive use of Menard Doswell Co. and their consultants for specific application to design of this project. The only warranty made by us in connection with the services provided is that we have used that degree of care and skill ordinarily exercised under similar conditions by reputable members of our profession practicing in the same or similar locality. No other warranty, expressed or implied, is made or intended.



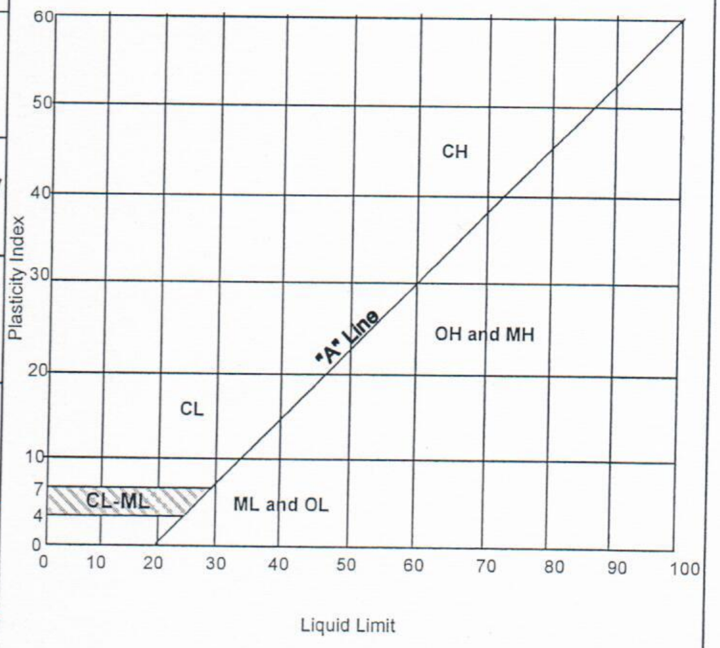
CMJ ENGINEERING, INC.

CMJ PROJECT NO. 709-05-01

PLAN OF BORINGS

PRELIMINARY - 47 ACRE TRACT
GRANBURY, TEXAS

PLATE
A.1

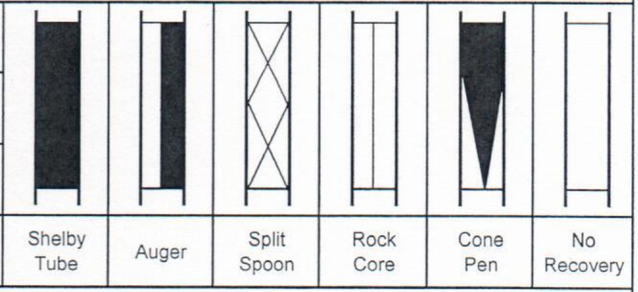
Major Divisions			Grp. Sym.	Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (more than half of the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent..........GW, GP, SW, SP More than 12 percent..........GM, GC, SM, SC 5 to 12 percent..........*Borderline* cases requiring dual symbols	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Liquid and Plastic limits below "A" line or P.I. greater than 4	Liquid and plastic limits plotting in hatched zone between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Liquid and Plastic limits above "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands; gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Liquid and Plastic limits below "A" line or P.I. less than 4	Liquid and plastic limits plotting between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Liquid and Plastic limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	 Plasticity Chart		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt	Peat and other highly organic soils			

UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE A.2

SOIL OR ROCK TYPES

⬭	GRAVEL	▨	LEAN CLAY	▦	LIMESTONE
●	SAND	●	SANDY	☰	SHALE
▥	SILT	▥	SILTY	☰	SANDSTONE
▨	HIGHLY PLASTIC CLAY	▨	CLAYEY	▦	CONGLOMERATE



TERMS DESCRIBING CONSISTENCY, CONDITION, AND STRUCTURE OF SOIL

Fine Grained Soils (More than 50% Passing No. 200 Sieve)

Descriptive Item	Penetrometer Reading, (tsf)
Soft	0.0 to 1.0
Firm	1.0 to 1.5
Stiff	1.5 to 3.0
Very Stiff	3.0 to 4.5
Hard	4.5+

Coarse Grained Soils (More than 50% Retained on No. 200 Sieve)

Penetration Resistance (blows/foot)	Descriptive Item	Relative Density
0 to 4	Very Loose	0 to 20%
4 to 10	Loose	20 to 40%
10 to 30	Medium Dense	40 to 70%
30 to 50	Dense	70 to 90%
Over 50	Very Dense	90 to 100%

Soil Structure

Calcareous	Contains appreciable deposits of calcium carbonate; generally nodular
Slickensided	Having inclined planes of weakness that are slick and glossy in appearance
Laminated	Composed of thin layers of varying color or texture
Fissured	Containing cracks, sometimes filled with fine sand or silt
Interbedded	Composed of alternate layers of different soil types, usually in approximately equal proportions

TERMS DESCRIBING PHYSICAL PROPERTIES OF ROCK

Hardness and Degree of Cementation

Very Soft or Plastic	Can be remolded in hand; corresponds in consistency up to very stiff in soils
Soft	Can be scratched with fingernail
Moderately Hard	Can be scratched easily with knife; cannot be scratched with fingernail
Hard	Difficult to scratch with knife
Very Hard	Cannot be scratched with knife
Poorly Cemented or Friable	Easily crumbled
Cemented	Bound together by chemically precipitated material; Quartz, calcite, dolomite, siderite, and iron oxide are common cementing materials.

Degree of Weathering

Unweathered	Rock in its natural state before being exposed to atmospheric agents
Slightly Weathered	Noted predominantly by color change with no disintegrated zones
Weathered	Complete color change with zones of slightly decomposed rock
Extremely Weathered	Complete color change with consistency, texture, and general appearance approaching soil

KEY TO CLASSIFICATION AND SYMBOLS **PLATE A.3**

CMJ ENGINEERING INC.

Project No.	Boring No.	Project
709-05-01	**B-1**	**Preliminary, 47-Acre Tract Granbury, Texas**

Location: **See Plate A.1**

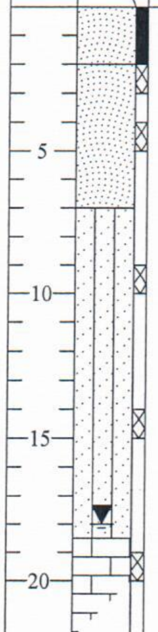
Water Observations: **Seepage at 18'; water at 18' at completion**

Completion Depth: **20.0'**

Completion Date: **11-8-05**

Surface Elevation:

Type: **Auger: B-34**



Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
SAND, tan					NP	NP	NP	2		
SAND, brown and tan, very dense, w/ trace of clay			52							
			66					6		
SILTY SAND, tan, medium dense			28							
			16							
- w/ gravel below 17'										
LIMESTONE, tan, hard			50/1"							

CMJ ENGINEERING INC.

Project No.	Boring No.	Project
709-05-01	B-2	**Preliminary, 47-Acre Tract** **Granbury, Texas**

Location: **See Plate A.1**

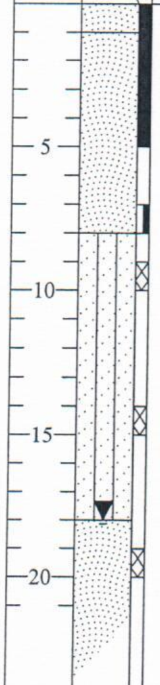
Water Observations: **Seepage at 18'; water at 18' at completion**

Completion Depth: **21.5'**

Completion Date: **11-8-05**

Surface Elevation:

Type: **Auger: B-34**



Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
SAND, tan										
SAND, brown and tan, w/ trace of clay										
								4	106	3690
					NP	NP	NP	7		
SILTY SAND, tan, medium dense										
			18							
			25							
SAND, tan, w/ gravel, medium dense										
			14							
- tan limestone at bottom of boring										

CMJ ENGINEERING INC.

Project No. **709-05-01**

Boring No. **B-3**

Project **Preliminary, 47-Acre Tract**
Granbury, Texas

Location **See Plate A.1**

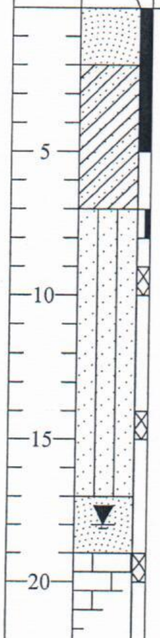
Water Observations **Seepage at 18'; water at 18' at completion**

Completion Depth **20.0'**

Completion Date **11-8-05**

Surface Elevation

Type **Auger: B-34**



Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
SAND, tan										
CLAYEY SAND, brown and tan					15	14	1	6		
								5	108	3400
SILTY SAND, tan, medium dense										
			28							
			28							
SAND, tan, w/ gravel										
LIMESTONE, tan, hard			50/1/2"							

LOG OF BORING NO. **B-3**

PLATE A.6

LOG OF BORING 709-05-01.GPJ CMJ.GDT 12/1/05

CMJ ENGINEERING INC.

Project No. **709-05-01**
Boring No. **B-4**
Project **Preliminary, 47-Acre Tract**
Granbury, Texas
Location **See Plate A.1**
Water Observations **Seepage at 19'; water at 19' at completion**
Completion Depth **20.0'**
Completion Date **11-8-05**
Surface Elevation
Type **Auger: B-34**

Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	SAND, tan					NP	NP	NP	2		
	SAND, brown and tan, w/ trace of clay, dense to very dense			49							
				64							
5											
	SAND, tan, medium dense			21					5		
10											
				16							
15											
	- w/ gravel below 18'										
				14							
20											

Project No. **709-05-01**

Boring No. **B-5**

Project **Preliminary, 47-Acre Tract**
Granbury, Texas

CMJ ENGINEERING INC.

Location **See Plate A.1**

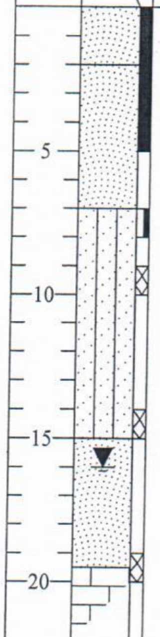
Water Observations **Seepage at 16'; water at 16' at completion**

Completion Depth **20.0'**

Completion Date **11-8-05**

Surface Elevation

Type **Auger: B-34**



Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	SAND, tan										
	SAND, brown and tan, w/ trace of clay								5	107	4590
5					15	NP	NP	NP	3		
	SILTY SAND, tan, medium dense to dense										
10				27							
15				35							
	SAND, tan, w/ gravel										
20	**LIMESTONE**, tan			50/0.5"							

CMJ ENGINEERING INC.

Project No.	Boring No.	Project
709-05-01	**B-6**	**Preliminary, 47-Acre Tract Granbury, Texas**

Location: **See Plate A.1**

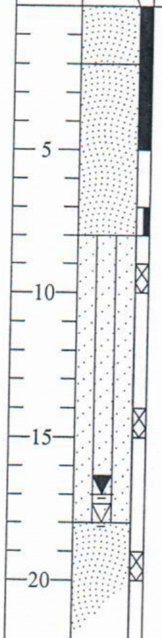
Water Observations: **Seepage at 18'; water at 17; at completion**

Completion Depth: **20.0'**

Completion Date: **11-8-05**

Surface Elevation:

Type: **Auger: B-34**



Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	SAND, tan										
	SAND, brown and tan, w/ trace of clay								5	104	850
						NP	NP	NP	5		
5											
	SILTY SAND, brown and tan, medium dense										
10				17							
15				20							
	SAND, tan, medium dense, w/ gravel										
20				21							

Project No. **709-05-01**	Boring No. **B-7**	Project	**Preliminary, 47-Acre Tract Granbury, Texas**
Location **See Plate A.1**		Water Observations	**Dry during drilling; dry at completion**
Completion Depth **20.0'**	Completion Date **11-8-05**		
Surface Elevation		Type	**Auger: B-34**

CMJ ENGINEERING INC.

Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	SAND, tan										
						NP	NP	NP	1		
	SAND, brown and tan, very dense, w/ trace of clay			49							
5				69					1		
	SAND, brown and tan, medium dense										
10				25					5		
15				20							
20				18							

Project No. **709-05-01**

Boring No. **B-8**

Project **Preliminary, 47-Acre Tract**
Granbury, Texas

CMJ ENGINEERING INC.

Location **See Plate A.1**

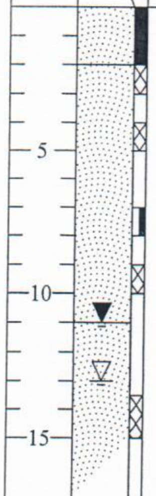
Water Observations **Seepage at 13'; water at 11' at completion**

Completion Depth **15.0'**

Completion Date **11-8-05**

Surface Elevation

Type **Auger: B-34**



Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
SAND, tan										
SAND, brown and tan, medium dense to dense, w/ trace of clay			51							
			70	18	NP	NP	NP	4		
			47							
SAND, tan, w/ gravel to very dense										
- tan limestone at bottom of boring			50/4"							