ALLIANCE ENGINEERING GROUP, INC.

- GEOTECHNICAL ENGINEERING
- ENVIRONMENTAL CONSULTING
- CONSTRUCTION MATERIALS ENGINEERING
- CONSTRUCTION MATERIALS TESTING

July 1, 2022

Bandali Builders & Estate Development
Attn: Mr. Aman Bandali
P.O. Box 27878
Austin, Texas 78755

Re: Building Pad Preparation
The Square at Crystal Falls
Leander, Texas
Alliance Engineering Group Report No. AE21-0702 – Addendum #2

Dear Mr. Bandali:

In response to a request from the contractor regarding how far soil improvements should extend beyond foundations to be constructed on the above referenced project, Alliance recommends all soil improvement measures indicated in the ***"Site Preparation and Earthwork"*** section of the above referenced report be extended a minimum of three feet (3') beyond the perimeter of the building. Additionally, soil improvement measures should extend beyond adjacent sidewalks so they bear entirely on the improved soil.

We appreciate the opportunity to be of continued service for this project and would appreciate an opportunity to provide you with a proposal for the construction phase observation and testing services. Please contact the undersigned if there are questions or comments regarding the information contained herein.

Respectfully submitted,

ALLIANCE ENGINEERING GROUP, INC.
TBPE Firm No. 11290

7/1/2022

STATE OF TEXAS
JAMES A. MCDANIEL
93622
LICENSED
PROFESSIONAL ENGINEER

James McDaniel, P.E.
Geotechnical Department Manager

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cc: File

z;data/documents/projects/engineering/2021/AE210702/Add2.doc

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ALLIANCE ENGINEERING GROUP, INC.

- Geotechnical Engineering
- Environmental Consulting
- Construction Materials Engineering
- Construction Materials Testing

Subsurface Exploration and Geotechnical Evaluation Square at Crystal Falls Leander, Texas

Prepared for:

Bandali Builders & Estate Development

Mr. Aman Bandali

Prepared by:

Alliance Engineering Group
200 Mustang Cove
Taylor, Texas 76574
(512)281-4688

Alliance Engineering Group Project # AE21-0702

August 31, 2021

ALLIANCE ENGINEERING GROUP, INC.

- Geotechnical Engineering
- Environmental Consulting
- Construction Materials Engineering
- Construction Materials Testing

SQUARE AT CRYSTAL FALLS
ALLIANCE ENGINEERING GROUP
PROJECT # AE21-0702

TABLE OF CONTENTS

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SCOPE

This report presents the results of a subsurface investigation and geotechnical evaluation for the proposed Square at Crystal Falls development located at the northeast quadrant of Crystal Falls Parkway and Bagdad Road in Leander, Texas. The site location is shown in **Figure 1**. This study was performed to evaluate subsurface conditions and provide soil-related foundation and pavement design criteria. Alliance Engineering Group performed this subsurface exploration and geotechnical evaluation in general accordance with our proposal # P21-0610E (Revised) dated July 9th, 2021.

We understand the project is to include the following:

- Two-Story tilt-wall style retail building with a footprint of approximately 17,000 sf;
- Single-story tilt-wall style retail building with a footprint of approximately 6,000 sf;
- Single-story tilt-wall style retail building with a footprint of approximately 4,000 sf;
- Approximately 27,000 sf of associated parking and pavement.

The scope of services for this study included the determination of subsurface conditions through field and laboratory testing, an evaluation of the subsurface conditions relative to the proposed construction, and the preparation of a geotechnical report. This report includes results, evaluations, and recommendations concerning earthwork, foundations, groundwater, pavement, quality control testing, and other geotechnical related aspects of the project. A summary of our conclusions is presented in the following section of this report.

The scope of services does not include an environmental assessment for the presence or absence of wetland or hazardous or toxic materials in the soil, air, surface water, or groundwater at this site. Alliance Engineering Group performed a *Phase 1 Environmental Site Assessment* (ESA) or an *EPA All Appropriate Inquiry* (AAI) under separate contract.

SUMMARY

Subsurface conditions, geotechnical engineering evaluations, and recommendations are summarized in the following paragraphs. This summary should not be considered apart from the entire text of this report. This report should be read and evaluated in its entirety prior to using our engineering recommendations for the preparation of design or construction documents. Details of our findings and recommendations are provided in subsequent sections of this report and in the attached figures.

1. A total of six (6) borings were drilled within the footprint of the proposed buildings and four (4) borings were drilled in the planned paving areas. Two (2) building borings were advanced with rock coring to depths of five (5) to twenty-five (25) feet and the other four (4) building borings were advanced to auger refusal in limestone at depths of two (2) feet below existing grades. The four (4) paving borings were advanced to auger refusal in limestone at depths of two (2) to two and a half (2½) feet below existing grades.

2. The subsurface profile consists of primarily very stiff to hard, dark brown to light brown lean clay (CL) with limestone fragments over moderately hard (rock basis), fractured weathered limestone over moderately hard, dark gray limestone (LS) with shale seams. Approximate boring locations are shown in **Figure 2.**

3. Based on the available soil information, proposed construction, and assumed structural loads, the tilt wall loads and isolated interior column load of the buildings may be supported on spread footings with a ground supported floor slab.

4. Surface drainage must be designed to provide rapid removal of water runoff away from the structure.

SITE LOCATION AND CONDITIONS

The project is located at the northeast quadrant of Crystal Falls Parkway and Bagdad Road in Leander, Texas (**Figure 1**). The site is currently undeveloped with no existing structures or roadways within the proposed site. Site vegetation consists primarily of isolated trees and unmaintained grasses and weeds. Drainage appears to run south to southwest on the property.

PROPOSED DEVELOPMENT AND CONSTRUCTION

We understand the project is to include the following:

- Two-Story tilt-wall style retail building with a footprint of approximately 17,000 sf;
- Single-story tilt-wall style retail building with a footprint of approximately 6,000 sf;
- Single-story tilt-wall style retail building with a footprint of approximately 4,000 sf;
- Approximately 27,000 sf of associated parking and pavement.

GEOLOGY MAPPING INFORMATION

According to available geologic mapping information of the United States Geologic Survey, the site lies at the interface between the Comanche Peak Limestone Formation. The Comanche Peak Limestone formation generally consists of clays with varying amounts of calcareous materials over clay marl and limestone. The clays are generally highly expansive and can undergo large volumetric changes with climatic cycles.

FIELD EXPLORATION

A total of six (6) borings were drilled within the footprint of the proposed buildings and four (4) borings were drilled in the planned paving areas. Two (2) building borings were advanced with rock coring to depths of five (5) to twenty-five (25) feet and the other four (4) building borings were advanced to auger refusal in limestone at depths of two (2) feet below existing grades. The four (4) paving borings were advanced to auger refusal in limestone at depths of two (2) to two and a half (2½) feet below existing grades.

The borings were located in the field by Alliance personnel utilizing the site location map provided by the client and measurements from existing structures. The borings were drilled on August 3rd and 4th, 2021. Drilling was performed using a truck-mounted drill rig equipped with 4-inch diameter continuous flight solid stem augers, standard penetration test and rock core sampler. The soil samples were delivered to our laboratory where they were visually classified and select samples were subjected to appropriate laboratory testing. Detailed boring logs are provided as **Figures 4** through **13**. *Standard Reference Notes for Boring Logs* is presented as **Figure 14.**

LABORATORY TESTING

Representative soil samples were selected and tested to assist the visual classifications and to determine pertinent engineering and physical characteristics. Tests were performed in general accordance with applicable ASTM standards. Testing to determine the presence of chemicals in soil samples (e.g., sulfates, chlorides) was not requested.

Laboratory testing included ASTM D2488 *(Standard Practice for Description and Identification of Soils)*, ASTM D2216 (*Standard Test Methods for Laboratory Determination of Moisture Content of Soil and Rock by Mass*), ASTM C117 *(Materials Finer than 75μ / No. 200) Sieve in Mineral Aggregates by Washing*), ASTM D422 (*Standard Test Method for Particle Size Analysis*), ASTM D4318 (*Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils*) and ASTM D 7012 *Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures*). Results of the testing are provided on the boring logs and **Figures 4** through **12**. Soil samples that remain after testing will be retained and stored for 2 months, after which time, they will be discarded unless we receive instructions on their disposition.

SUBSURFACE CONDITIONS

Information from the exploratory borings indicates that the subsurface stratigraphy may generally consist of three distinguishable strata. The characteristics of these strata are summarized in the following paragraphs.

DARK BROWN TO LIGHT BROWN, LEAN CLAY (CL) with limestone fragments: very stiff to hard, dark brown, brown and light brown lean clay (CL) was encountered from existing grade level to depths of one (1) to one and a half (1½) feet below existing grades. The laboratory test results for the silty sand soils are shown in **Table 1:**

Table 1:

Test Results for LEAN CLAY (CL)

Test Performed	Value(s)	
Atterberg Limits	Liquid Limit: 38 - 46	Plasticity Index: 16 - 19
Moisture Content (%)	9 - 13	
Percent passing #200 sieve	12 - 30	
Standard Penetration Test Values	50 blows for 5” to 0.5” of penetration	

PALE BROWN TO VERY PALE BROWN WEATHERED LIMESTONE (LS): Moderately hard (rock basis), pale brown to very pale brown weathered limestone was encountered below the lean clays and extended to depths of ten (10) feet. The laboratory test results for the weathered limestone are shown in **Table 2:**

Table 2:

Test Results for WEATHERED LIMESTONE (LS)

Test Performed	Value(s)
Core Recovery (%)	60 - 69
Core RQD (%)	0
Standard Penetration Test Values	50 blows for 0.5" to 1" of penetration

DARK GRAY LIMESTONE (LS) with shale lenses: Moderately hard (rock basis), dark gray, limestone was encountered below the weathered limestone and extended to depths of over twenty-five (25) feet. The laboratory test results for the limestone are shown in **Table 3:**

Table 3:

Test Results for LIMESTONE (LS)

Test Performed	Value(s)
Core Recovery (%)	100
Core RQD (%)	10 - 63
Unit Weight (pcf)	133.3 – 140.7
Unconfined Compression (ksf)	137.4 – 154.0

The above descriptions are of a generalized nature to highlight the major subsurface stratification features and soil and rock characteristics. The boring logs provided in the Appendix should be reviewed for specific information at each location. The stratification of the soil and rock represents our interpretation of the subsurface conditions at the boring locations based on observations by a Geotechnical Engineer of the soil and rock samples. Variations from the conditions shown on the boring logs could occur in areas in between borings or in areas around the borings.

The stratification lines shown in the boring logs represent approximate boundaries between soil and rock types and condition, and the transitions may be gradual rather than distinct. It is sometimes difficult to identify changes in stratification within narrow limits. It may also be difficult to distinguish between fill and discolored natural soil deposits if foreign substances are not present.

GROUNDWATER

Groundwater was not encountered in any of our exploratory borings at the time of drilling. Groundwater can be temporary instead of perennial, so water levels at later dates could be different from those observed during the subsurface exploration. **Although groundwater was not encountered during the drilling and sampling operation, our experience requires us to emphasize that groundwater can still appear later (e.g., during construction),** so the owner, the General Contractor, and the site Civil Engineer should not be surprised if groundwater appears in a localized area and requires the installation of a collection and removal system. Groundwater may develop after periods of rain and can develop after construction in response to landscaping irrigation. Groundwater levels may fluctuate seasonally in the project area due to variations in precipitation, runoff, evaporation, groundwater pumping, and other factors that affect groundwater recharge.

POTENTIAL MOVEMENT OF THE CLAY SOILS

The lean clay soils will experience minor changes in condition due to changes in environmental conditions (rainfall quantities and frequency, temperature, evaporation, tree roots, etc.) or man-made conditions (leaking water lines, landscape irrigation, or poor drainage) that affect the moisture content of the clay soils. The clay soil may harden, shrink, and crack when subjected to drying, swell when subjected to wetting, and soften when subjected to saturation.

The TxDOT Potential Vertical Rise (PVR) (Tex-124-E) considering existing conditions and existing overburden pressure only was calculated to be about less than 1 inch. The soils were modeled to be in an initially "dry" to "average" moisture condition and the lower clay was modeled to be in an initially "average" to "wet" moisture condition as defined by the method at the time of construction and the thickness of the active zone was assumed to be 1½ feet. Note that the TxDOT PVR method assumes limited wetting occurs and should only be used as an index tool. The TxDOT PVR value should not be considered an accurate estimate of maximum potential vertical heave.

The amount of total and differential heave or shrinkage is impossible to accurately predict because it will depend on the extent of impervious cover, seasonal changes in climate conditions, drainage conditions, presence of leaking water pipes, groundwater conditions, landscape watering, vegetation planting, and varying physical characteristics and mineralogy of the clay soils. The PVR is not a static value because it depends on how you model the soil behavior and the boundary conditions such as what changes in moisture content to consider.

BUILDING FOUNDATION RECOMMENDATIONS

Footing Foundations

Based on the subsurface conditions encountered and our experience with similar construction, the building may be supported on a ground-supported footing foundations within the weathered limestone. A net allowable bearing pressure of 8,000 psf can be used to design the footings extending at least 12 inches into the weathered limestone and extending at least 18 inches below final adjacent exterior grades.

Shallow footing foundations may resist lateral and overturning forces through a combination of sliding friction and dead weight of the structure and any overlying soil. Resistance to sliding along the footing may be calculated using the friction between the footing base and the subgrade soil. The coefficient of friction for the weathered limestone may be estimated as 0.40. The resultant force due to friction may be calculated by using the weight of the footing, plus the weight of the soil that lies above the footing (using a unit weight of 120 pcf).

Tilt wall panels are typically point loaded on rectangular footings and should not be placed on strip footing. Other types of wall loads may be placed on strip footings with a recommended minimum width of 10 inches. The depth, width and reinforcing steel requirements of the grade footings will be determined by the project Structural Engineer.

The footing foundations should be designed in accordance with the following information:

1. Footing dimensions and reinforcing steel should be observed and documented as-built. Concrete material should be sampled and tested for compressive strength, and placement operations should be monitored to record concrete slump, temperature, and age at time of placement. Concrete batch tickets should be provided by the supplier so that water-cement ratios and cement content can be checked and documented.

2. Prior to concrete placement, a representative of Alliance Engineering Group, Inc. should observe and test the footing subgrade to determine if the foundations are being placed on suitable materials and to document that loose material has been removed. Dynamic Cone Penetrometer (DCP) tests can be performed to help evaluate subgrade condition.

Ground Supported Floor Slabs

The building floor slabs may be ground-supported upon a one (1) foot flexible base over native soil and/or compacted fill soil subgrade. Flat floor slabs may be used. The floor slab subgrade should be cut or filled to one (1) foot below finished grade, to allow for the flexible base layer. The flexible base should consist of crushed limestone and generally conform to TxDOT Item 247 Type A, Grade 1. The compaction and moisture requirements for both subgrade and flexible base materials are presented in **Table 5.**

All grading fill below the flexible base shall consist of on-site lean clay or select fill. These soils shall be proof-rolled and observed by a representative of Alliance Engineering Group. The proof roll shall be performed with equipment capable of providing a minimum of a 20-ton wheel load, typically, a fully loaded 12-yard tandem axle dump truck. Any soft or pumping/rutting areas should be scarified and recompacted/tested.

A net allowable bearing pressure of 3,000 psf can be used to design the slabs, on the modified soil subgrade. A subgrade modulus of 250 pcf may be used for design.

The ground-supported floor slabs should be designed in accordance with the following information:

1. Floor coverings (carpet, tile, wood, laminate, vinyl) can be damaged or subject to mold growth by moisture penetrating the slab, therefore a moisture and vapor barrier such as a geosynthetic

geomembrane should be placed on top of the base layer or granular forming fill to limit the migration of moisture to and through the slab, and to serve as a separator between the fill and fresh concrete.

2. Slab dimensions and reinforcing steel should be observed and documented as-built. Concrete material should be sampled and tested for compressive strength, and placement operations should be monitored to record concrete slump, temperature, and age at time of placement. Concrete batch tickets should be provided by the supplier so that water-cement ratios and cement content can be checked and documented.

PAVEMENT SYSTEM

The untreated subgrade clay soils at the site are generally considered "average" subgrade materials for support of pavements. Based on the soil types encountered in the borings and previous experience with materials of this type, a modulus of subgrade reaction value of 100 pci shall be used in design of rigid pavements. Recommended pavement sections are provided in **Table 4.**

Table 4:

Recommended Pavement Sections

Traffic Conditions	Pavement Section (from top to the subgrade)
Passenger Parking Lots	• 5" Portland Cement Concrete* • 6" Flexible Base
	• 1½" Hot-Mix Asphalt Concrete (1½" TxDOT Item 340 Type D) • 8" Flexible Base
Main Drive or Delivery Truck Drive Lane	• 2" Hot-Mix Asphalt Concrete (1½" TxDOT Item 340 Type D) • 10" Flexible Base
	• 5.5" Portland Cement Concrete* • 6" Flexible Base
Dumpster Pad Area	• 6" Portland Cement Concrete* • 6" Flexible Base

*** The flexible base may be removed by adding an additional inch of concrete thickness.**

The flexible base should consist of crushed limestone and generally conform to TxDOT Item 247 Type A, Grade 1. The compaction and moisture requirements for both subgrade and flexible base materials are presented in **Table 5**

Concrete should have a minimum flexural strength of 600 psi at 28 days that corresponds to roughly 3,600-psi compressive strength. Concrete should be steel reinforced and include joints to control the formation of temperature and shrinkage related cracks. Concrete should include air entrainment to increase the resistance to temperature effects.

As a general guide, the air entrainment should vary from 3 to 6 percent. We recommend reinforcing concrete paving with grade 60, #4 deformed bars spaced at 18 inches on center each way. We recommend a maximum joint spacing of 20' x 20'. Sawcut joints should be cut to a depth of ¼ the thickness of the paving. Saw cutting should be conducted within 4 to 12 hours of initial set.

SITE PREPARATION AND EARTHWORK

All of the topsoil (soil with high organic content, e.g., >4%), tree roots, vegetation, wet soils, and any soft or loose soils must be removed from the proposed buildings and pavement areas. The stripped materials may either be wasted or stockpiled for later use in landscaping.

Prior to the addition of fill in building or paving areas, the stripped or excavated subgrade shall be proof-rolled and observed by a representative of Alliance Engineering Group. The proof roll shall be performed with equipment capable of providing a minimum of a 20-ton wheel load, typically, a fully loaded 12-yard tandem axle dump truck.

Alliance Engineering Group, Inc. recommends that select fill and backfill be placed in horizontal loose lifts of not more than 8 inches in thickness. Re-use of existing material may require some wetting or drying to produce the necessary moisture content at the time of compaction.

Appropriate laboratory tests such as Proctor moisture-density tests should be performed on samples of fill material. Field moisture-density tests and visual observation of lift thickness and material types should be performed during compaction operations to verify that the construction satisfies material and compaction requirements. Appropriate compaction testing methods and recommended density and moisture contents for material are presented below.

Fill materials should not be placed on soils that have been recently subjected to precipitation or saturation. All wet soils should be removed or allowed to dry prior to continuation of fill placement operations. Imported fill materials should not contain wet materials at the time of placement.

Select fill that is imported to the site should be classified according to the Unified Soil Classification System (USCS) as SM, SC, GM, or GC, and should meet the following criteria:

- Percent passing the No. 4 sieve: 50% to 80% (20% to 50% gravel)
- Percent passing the No. 200 sieve: 20% to 50%
- PI of soil passing the No. 40 sieve: 4 to 20
- Maximum size of gravel or rock fragments: 3 inches in any dimension

If any problems are encountered during the earthwork operations, or if site conditions differ from those encountered during our subsurface exploration, the Geotechnical Engineer should be notified immediately to determine the effect on recommendations expressed in this report. Fill compaction parameters are provided in **Table 5.**

Table 5:

Fill Compaction Parameters

Material/Use		Proctor Standard	Percent Compaction	Moisture Content
Building	Select Fill	Standard (ASTM D698)	95+	-2 to +2
	Moisture-Conditioned Subgrade/Clay Cap	Standard (ASTM D698)	92 - 98	+2 to +6
Paving	Flexible Base	Modified (ASTM D1557)	95+	-2 to +2
		TEX 113	100+	
	Moisture-Conditioned Subgrade	Standard (ASTM D698)	92 - 98	+2 to +6
	General/Utility Fill	Standard (ASTM D698)	95+	Optimum +
Non-Structural	Backfill	Standard Proctor (ASTM D698)	90	-2 to +2

CONSTRUCTION QUALITY CONTROL

Alliance Engineering Group has provided **Table 6** below as a recommendation for minimum quality control measures during the construction of new and existing structures.

Table 6:

Recommendations for Quality Control

TYPE OF WORK	ITEM	SAMPLE FREQUENCY	SAMPLE SIZE	MINIMUM TESTING
General Earthwork, Subgrade and Fill	Soil Material	1 per soil type	75 lbs.	Sieve Analysis Atterberg Limits (PI) Proctor
	Compaction	1 Per 2,500 square feet per lift or, a minimum of 3 tests per lift		Field Density Test
Flexible Base Course	Flexible Base Material	1 per material type & for each 1,000 yd^3	150 lbs.	Sieve Analysis Atterberg Limits (PI) Proctor
	Compaction	1 per 5,000 square yards per lift or, a minimum of 3 per lift		Field Density Test
Hot Mixed Asphaltic Paving	Job Mix Formula (JMF)	1 per HMAC Type		Review and Approval
	Aggregate Testing	Weekly	50 lbs.	Sieve Analysis, Sand Equivalent and FM
	Uncompacted	3 Per Day	40 lbs.	Extraction, Gradation,
	Mix			Density, Stability, Rice Gravity
	Compacted Mix on the Job	1 core per uncompacted mix sample		Laboratory testing for Core Thickness and Core Density

IBC SITE CLASSIFICATION

It is assumed that the foundation will be developed using the 2018 International Building Code. Based on the site-specific undrained soil strengths values using Table 20.3.1 of ASCE 7, Site Class B should be used. Note that the site classification is based on the upper 100 feet of the subgrade. Although the borings for this project were not advanced to this depth, our knowledge of the local geologic formations have been considered based on the results of the borings.

SURFACE DRAINAGE

Performance of foundation slabs and flatwork is influenced by changes in subgrade moisture conditions. Carefully planned and maintained surface grading can reduce the risk of wetting of the foundation soils. We recommend the following precautions be implemented and maintained during construction and throughout the life of the structure:

A. Excessive drying or wetting of clays in the open grade beam trench excavations must be avoided and no standing water is to be present. Bottoms of the beams shall be clean, firm and have no soft areas at the time of concrete placement.

B. Utility structures connecting to the building should be designed to be flexible enough to tolerate some differential movement. Water supply pipes beneath the slabs should be placed in long sections with as few joints as possible and should be of durable size and material. The structures should be designed to be relatively flexible to limit the effects of differential movement.

C. The ground surface around the building should be sloped to provide positive drainage away from the building. We recommend a minimum constructed and maintained slope of 12 inches along the first 10 feet from the edge of the foundation slab if practical. Water must not be allowed to pond adjacent to the foundation slab.

D. If roof gutters will be installed, the roof drain downspouts should be designed and placed to discharge stormwater at least 5 feet away from the edge of the building and should be concentrated on the downslope side of the foundation.

E. Downspouts must also extend horizontally beyond the width of perimeter beam backfill so that water does not seep down directly into the backfill. Downspout extensions, splash blocks, and buried outlets must be maintained by the owner.

F. Large tree species or bushes should not be planted or allowed to exist near the foundations within a horizontal distance equal to half of their mature height because of the root penetration and moisture demand that will dry underlying clay soils and cause shrinkage settlement, particularly under the perimeter beam.

G. The importance of proper owner irrigation practices cannot be over-emphasized. Irrigation should be limited to the minimum amount sufficient to maintain vegetation. Application of excess water will increase the likelihood of foundation slab movement, as will failure to water during drought summer seasons.

H. If an exterior sprinkler system is installed to water landscaping, the sprinkler lines should not be placed within 5 feet of the edge of the foundation. Instead, the lines should be placed so that sprinkler heads with sufficient capacity are used and direct water toward the structure from 5 feet away. It is the owner's responsibility to maintain constant moisture conditions in the soils around the foundation slab. Excessive watering can cause swelling of clay soils underneath the foundation slab.

I. The owner should monitor their water meter or water bills to determine if a water leak develops in the water supply system or sprinkler system (if used). Leak tests can be performed on water supply, sprinkler, and sewer systems to determine if a leak exists. Any leaking pipes should be repaired as soon as possible to stop the increase in moisture content in the underlying clay soils.

LIMITATIONS

Borings were spaced to obtain a reasonable indication of subsurface conditions. The data from the borings is only accurate at the exact boring locations. Variations in the subsurface conditions not indicated by our borings are possible. The recommendations in this report were developed considering conditions exposed in the exploratory borings and our understanding of the type of structures planned.

This report does not reflect any variations that may occur around the borings. In the performance of the subsurface exploration, specific information is obtained at specific locations at specific times. However, it is a well known fact that variations in soil conditions exist on most sites between boring locations, and conditions such as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction. If variations then appear evident, after allowing Alliance Engineering Group to perform on-site observations during the construction period and note characteristics and variations, a re-evaluation of the recommendations in this report will be necessary.

We believe that the geotechnical services for this project were performed with a level of skill and care ordinarily used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made.

The performance of foundations is primarily controlled by the quality of the construction. To prevent misinterpretation of our recommendations, and to document proper construction, Alliance Engineering Group should be retained to perform full time quality control testing, inspection, and documentation during construction of the foundations.

We appreciate the opportunity to serve as your geotechnical consultant for this project. If you have any questions, comments, or suggestions regarding the information presented herein, please contact our offices at your convenience.

Respectfully,

ALLIANCE ENGINEERING GROUP, INC.
TBPE Firm No. 11290

8/31/2021

STATE OF TEXAS
JAMES A. MCDANIEL
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LICENSED
PROFESSIONAL ENGINEER

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Project Manager

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Dist:: Bandali Builders & Estate Development - Mr. Aman Bandali

cc: File

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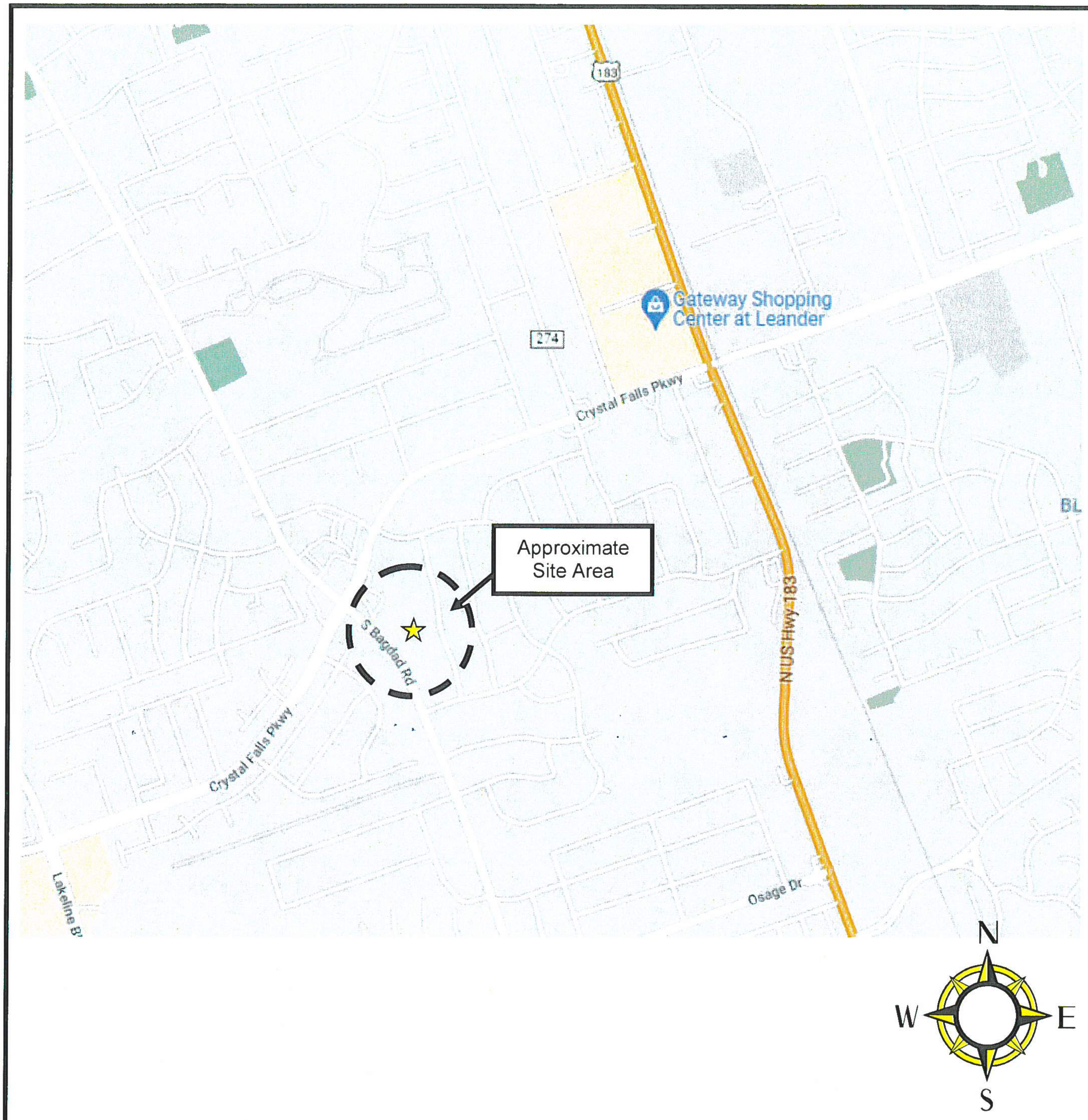
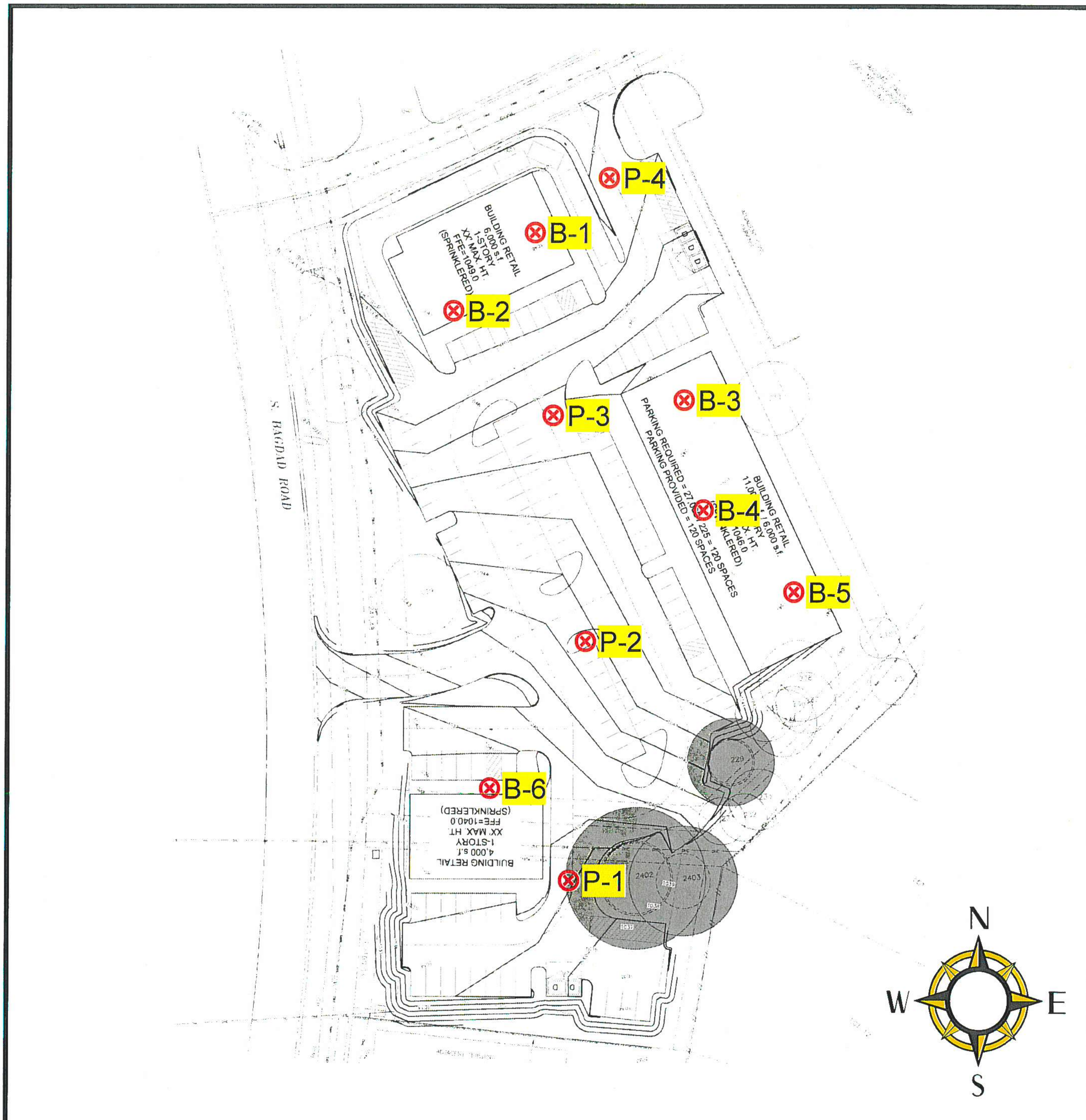


Vicinity Map

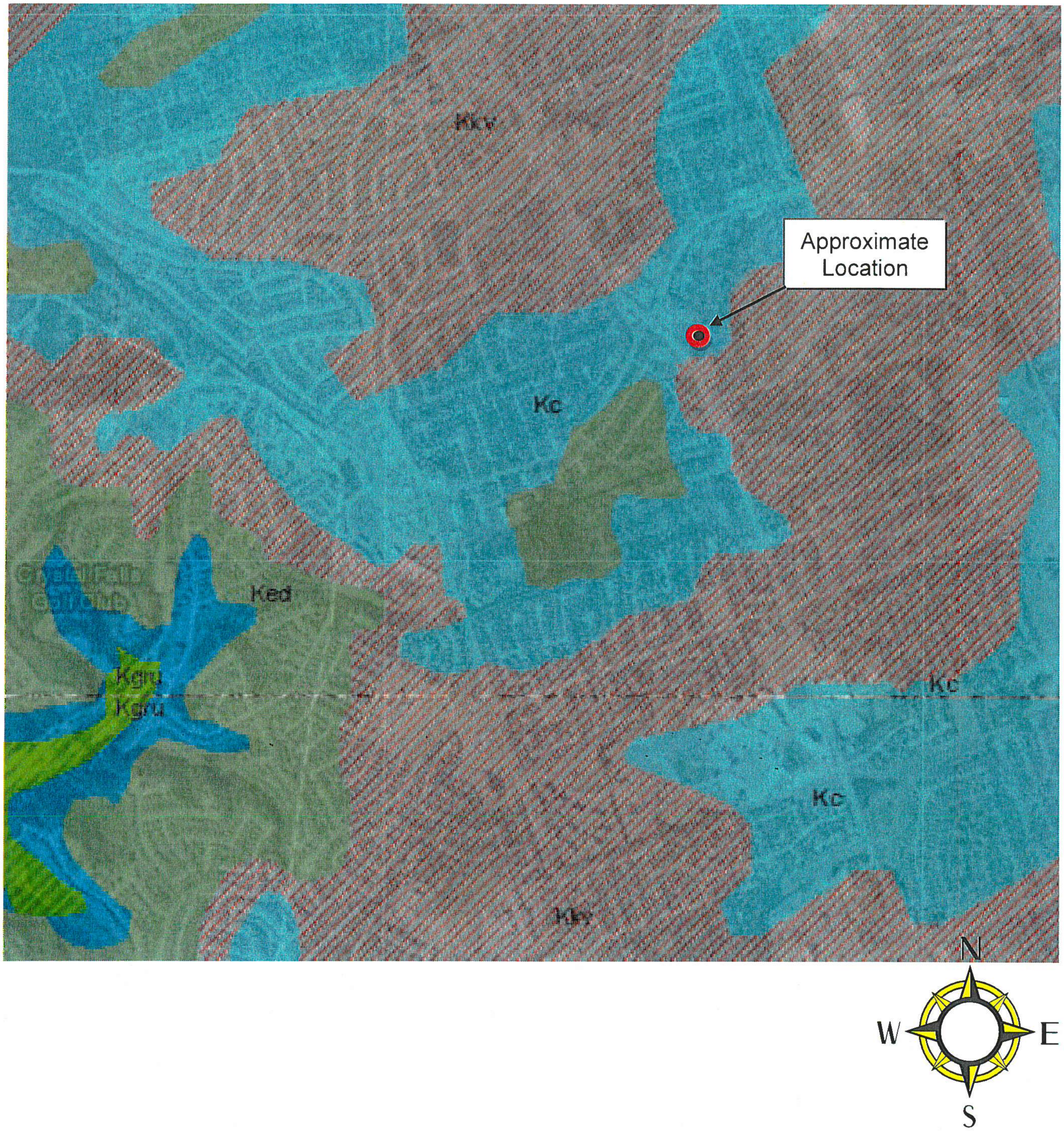
Square at Crystal Falls
Leander, Texas

ALLIANCE ENGINEERING GROUP, INC.

Prepared By: GLP	Scale: NTS	Project #: AE21-0702
Site Plan from: ArcGIS	Date: August, 2021	Figure #: 1



Approximate Locations of Borings Square at Crystal Falls Leander, Texas	ALLIANCE ENGINEERING GROUP, INC.		
	Prepared By: GLP	Scale: NTS	Project #: AE21-0702
	Site Plan from: Google	Date: August, 2021	Figure #: 2



Geology Map

Square at Crystal Falls
Leander, Texas

ALLIANCE ENGINEERING GROUP, INC.

Prepared By:	Scale:	Project #:
GLP	NTS	AE21-0702
Map By:	Date:	Figure #:
U.T. Bureau of Econ. G.	August, 2021	3

LOG OF BORING
B-1

Project: **Square at Crystal Falls**
Project #: **AE21-0702**
Date: **8-3-21** Elev.:
Location: **Leander, Texas**
Groundwater Observations: **See Below**
Logged by: **Logged by driller in field. Final log by J.M.**
Longitude:
Drilled by: **CoreTech**
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/1"	LEAN CLAY, dry, hard, brown to light brown, with limestone fragments								
1	REC=69% RQD=0%	LIMESTONE, dry, moderately hard (rock basis), pale brown, fractured, weathered								
5	REC=60% RQD=0%									
10	REC=100% RQD=10%	LIMESTONE, dry, moderately hard (rock basis), dark gray, with shale lenses								
15	REC=100% RQD=63%							140.7		137.4
20	REC=100% RQD=48%							133.3		154.0
25		- Boring Terminated at 25'								

Notes: Boring dry to 1'. Water added at 1' for coring operations.

Figure 4

LOG OF BORING
B-2

Project: **Square at Crystal Falls**
Project #: **AE21-0702**
Date: **8/4/21** Elev.:
Location: **Leander, Texas**
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Longitude:
Drilled by: **CoreTech**
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/1"	LEAN CLAY, moist, hard, dark gray and brown, with limestone fragments	13	38	22	16	30			
2		WEATHERED LIMESTONE, dry, moderately hard (rock basis), very pale brown								
		- Boring Terminated at 2'								
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										

Notes:

Figure 5

LOG OF BORING
B-3

Project: **Square at Crystal Falls**
Date: **8/4/21** Elev.:
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Drilled by: **CoreTech**

Project #: **AE21-0702**
Location: **Leander, Texas**
Longitude:
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/2"	LEAN CLAY, moist, hard, dark brown, with limestone fragments								
2		WEATHERED LIMESTONE, dry, moderately hard (rock basis), very pale brown								
		- Boring Terminated at 2'								
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										

Notes:

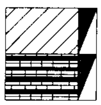
Figure 6

LOG OF BORING
B-4

Project: **Square at Crystal Falls**
Date: **8/4/21** Elev.:
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Drilled by: **CoreTech**

Project #: **AE21-0702**
Location: **Leander, Texas**
Longitude:
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/5"	LEAN CLAY, dry, hard, dark brown, with limestone fragments								
	50/0.5"	WEATHERED LIMESTONE, dry, moderately hard (rock basis), very pale brown								
2		- Boring Terminated at 2'								
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										



Notes:

Figure 7

LOG OF BORING
B-5

Project: **Square at Crystal Falls**
Date: **8/4/21** Elev.:
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Drilled by: **CoreTech**

Project #: **AE21-0702**
Location: **Leander, Texas**
Longitude:
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/0.5"	LEAN CLAY, dry, hard, dark brown, with limestone fragments	9	46	28	18	12			
	50/0.25"	WEATHERED LIMESTONE, dry, moderately hard (rock basis), very pale brown								
2		- Boring Terminated at 2'								
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										

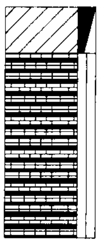
Notes:

Figure 8

LOG OF BORING
B-6

Project: **Square at Crystal Falls** Project #: **AE21-0702**
Date: **8/4/21** Elev.: Location: **Leander, Texas**
Groundwater Observations: **See Below**
Logged by: **Field log by driller. Final log by J.M.** Longitude:
Drilled by: **CoreTech** Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/3"	LEAN CLAY, dry, hard, dark brown, with limestone fragments								
1	REC=50% RQD=8%	WEATHERED LIMESTONE, dry, moderately hard (rock basis), pale brown								
5		- Boring Terminated at 5'								



Notes: Boring dry to 1'. Water added at 1' for coring operations.

Figure 9

LOG OF BORING
P-1

Project: **Square at Crystal Falls**
Date: **8/4/21** Elev.:
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Drilled by: **CoreTech**

Project #: **AE21-0702**
Location: **Leander, Texas**
Longitude:
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/1"	LEAN CLAY, dry, hard, dark brown, with limestone fragments								
2	50/0.5"	WEATHERED LIMESTONE, dry, moderately hard (rock basis), pale brown								
		- Boring Terminated at 2.5'								
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										

Notes:

Figure 10

LOG OF BORING
P-2

Project: **Square at Crystal Falls**
Project #: **AE21-0702**
Date: **8/4/21** Elev.:
Location: **Leander, Texas**
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Longitude:
Drilled by: **CoreTech**
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/5"	LEAN CLAY, dry, hard, dark brown, with limestone fragments								
	50/0.5"	WEATHERED LIMESTONE, dry, moderately hard (rock basis), very pale brown								
2		- Boring Terminated at 2'								
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										

Notes:

Figure 11

LOG OF BORING
P-3

Project: **Square at Crystal Falls**
Date: **8/4/21** Elev.:
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Drilled by: **CoreTech**

Project #: **AE21-0702**
Location: **Leander, Texas**
Longitude:
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/5"	LEAN CLAY, dry, hard, dark brown, with limestone fragments								
	50/0.5"	WEATHERED LIMESTONE, dry, moderately hard (rock basis), very pale brown								
2		- Boring Terminated at 2'								
4										
6										
8										
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										

Notes:

Figure 12

LOG OF BORING
P-4

Project: **Square at Crystal Falls**
Date: **8/4/21** Elev.:
Groundwater Observations: **N/A**
Logged by: **Field log by driller. Final log by J.M.**
Drilled by: **CoreTech**

Project #: **AE21-0702**
Location: **Leander, Texas**

Longitude:
Latitude:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI	-200 %	D.D. pcf	P.PEN tsf	UNCON. ksf
0	50/1"	LEAN CLAY, dry, hard, yellowish brown, with limestone fragments	9	42	23	19	17			
	50/1"	WEATHERED LIMESTONE,dry, moderately hard (rock basis), very pale brown								
2		- Boring Terminated at 2'								

Depth scale (feet): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28

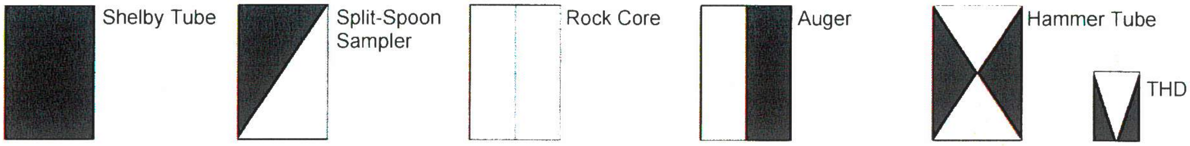
Notes:

Figure 13

STANDARD REFERENCE NOTES FOR BORING LOG

ALLIANCE ENGINEERING GROUP, INC.

I. Sampling & Testing Symbols:



II. Correlations of Penetration Resistance to Soil properties:

Relative Density of Sand and Sandy Silt		Consistency of Clay and Clayey Silt		
Relative Density	SPT N-Value	Consistency	SPT N-Value (Qualitive Measure)	Unconfined Compressive Strength (tsf)
Very Loose	0 to 4	Very Soft	0 to 3	Under 0.25
Loose	5 to 10	Soft	4 or 5	0.25 to 0.5
Medium Dense	11 to 30	Medium Stiff	6 to 10	0.5 to 1.0
Dense	31 to 50	Stiff	11 to 15	1.0 to 2.0
Very Dense	>50	Very Stiff	16 to 30	2.0 to 4.0
		Hard	>30	4.0 to 8.0

III. Unified Soil Classification Symbols:

GP – Poorly Graded Gravel
GW – Well Graded Gravel
GM – Silty Gravel
GC – Clayey Gravel
OH – High Plasiticity Organics

SP – Poorly Graded Sand
SW – Well Graded Sand
SM – Silty Sand
SC – Clayey Sand
OL – Low Plasticity Organics

ML – Low Plasticity Silt
MH – High Plasticity Silt
CL – Low to Medium Plasticity Clay
CH – High Plasticity Clay

IV. Rock Quality Designation Index (RQD):

RQD:	Description of Rock Quality: (if all natural fractures)
0% to 25%	Very Poor
25% to 50%	Poor
50% to 75%	Fair
75% to 90%	Good
90% to 100%	Excellent

V. Natural Moisture Content:

"Dry" No apparent moisture, crumbles easily
"Moist" Damp, but no visible water
"Wet" Visible Water

VI. Grain Size Terminology:

Cobble: 3-inches to 12-inches
Gravel: #4 sieve size (4.75 mm) to 3-inches
Coarse Sand: #10 to #4 sieve size
Medium Sand: #40 to #10 sieve size
Fine Sand: #200 to #40 seive size
Silt or Clay: smaller than #200 seive size

VIII. Descriptive Terms or Symbols:

"Mottled": occasional/spotted presence of that color
"-[...]": identifies change in soil characteristics
LL: Liquid Limit (moisture content as % of dry weight)
PL: Plastic Limit (moisture content as % of dry weight)
WOH: Weight of Hammer
"with [...]": item identified withing that sample only

VII. Discriptive Terms for Soil Composition:

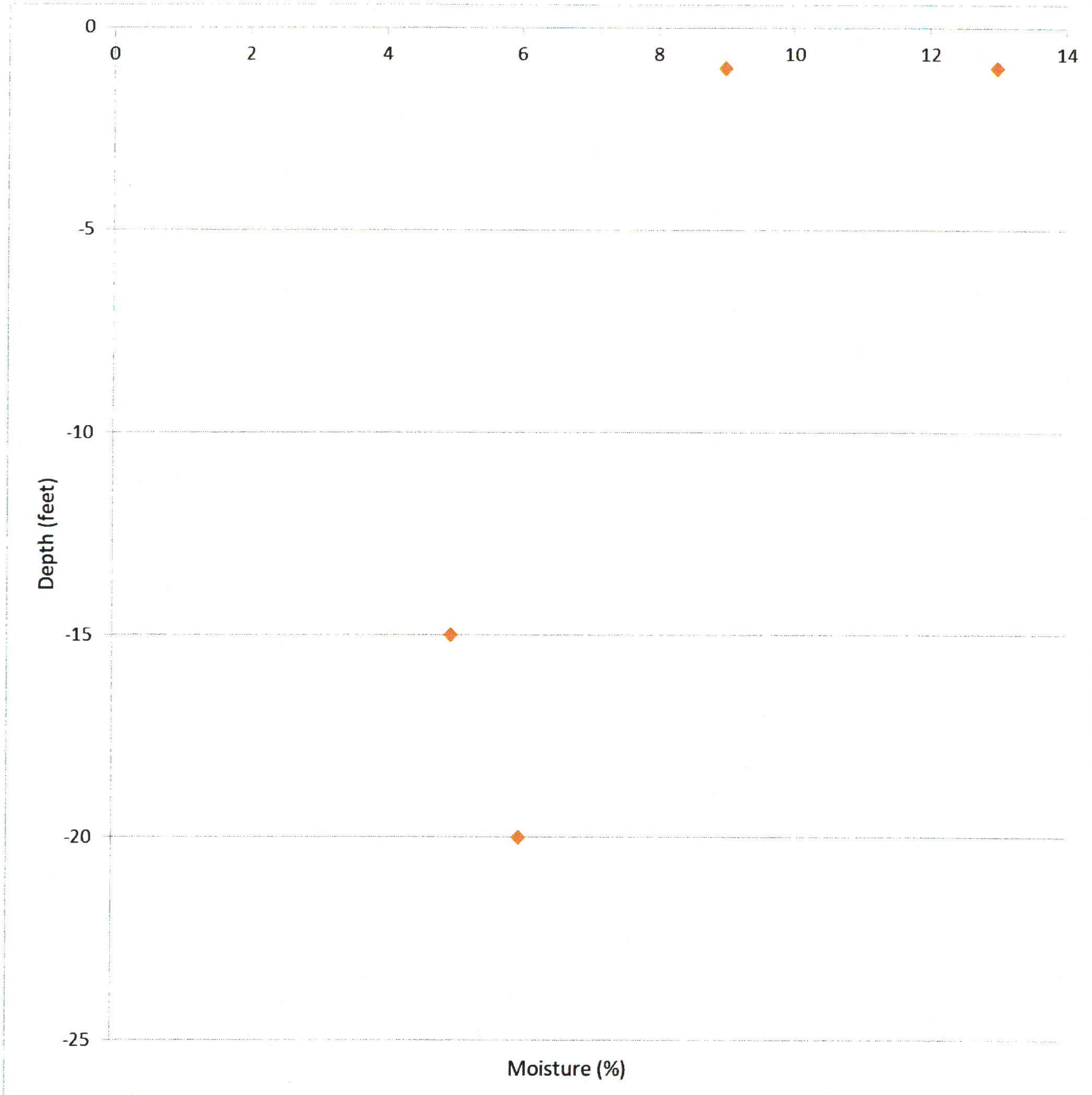
"trace" ....1% to 9%
"some"..10% to 29%
with Suffix "–y" (e.g. sandy, clayey)......30% to 49%

IX: Plasticity of Cohesive Soil:

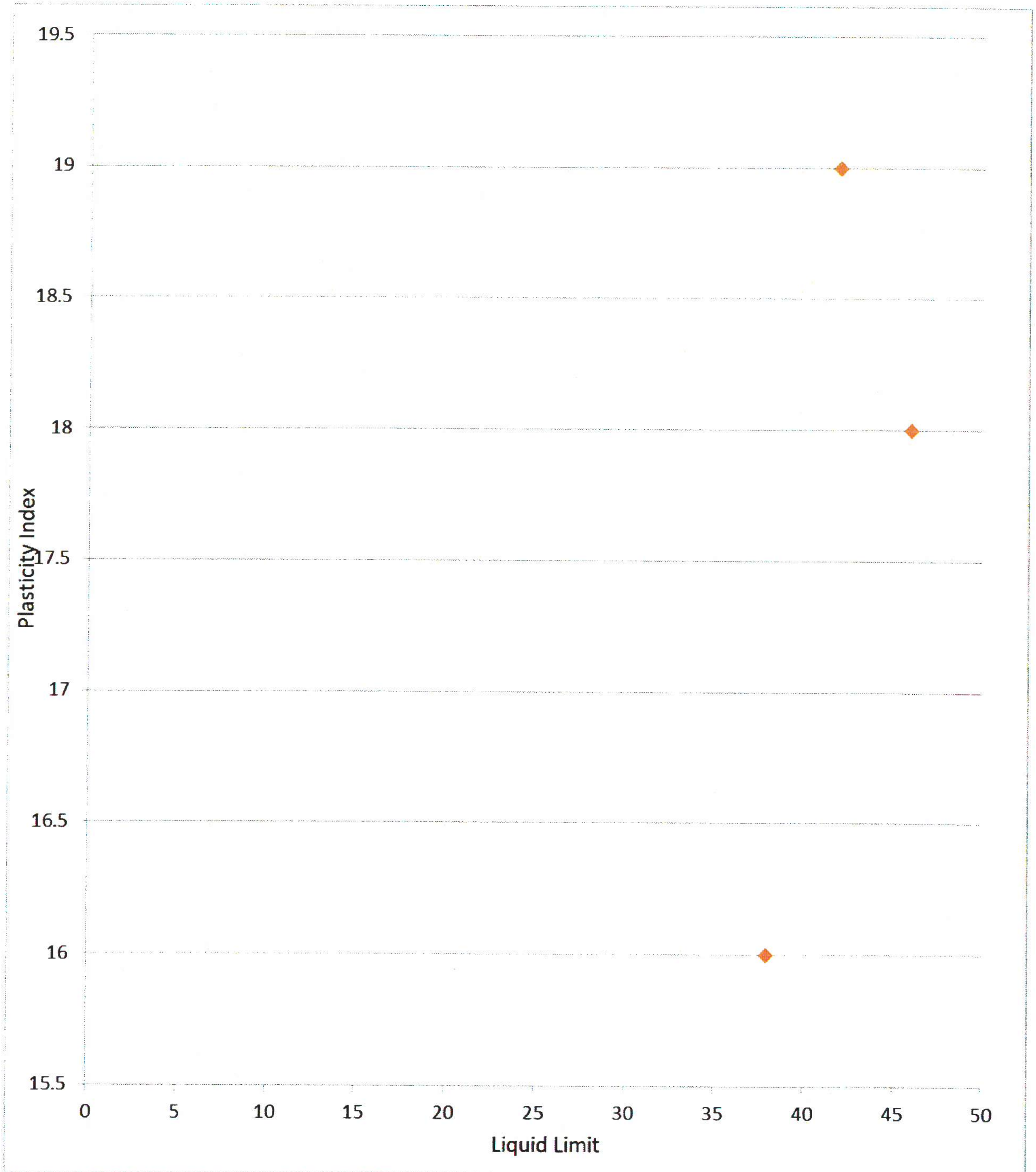
(function of PI and Clay Mineral Types)

Plasticity Index (PI):	Plasticity:
0 to 20	Low
20 to 30	Medium
30+	High

200 Mustang Cove; Taylor, Texas 76574 * Phone (512) 281-4688 * Fax: (512) 281-4191



Moisture Content Chart Square at Crystal Falls Leander, Texas	ALLIANCE ENGINEERING GROUP, INC.		
	Prepared By: GLP		Project #: AE21-0702
	Test Method: ASTM C-566	Date: August, 2021	Figure #: 15



Atterberg Limit Chart

Square at Crystal Falls
Leander, Texas

ALLIANCE ENGINEERING GROUP, INC.

Prepared By: GLP		Project #: AE21-0702
Test Method: ASTM D-4318	Date: August, 2021	Figure #: 16

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name: Square at Crystal Falls
Route: Passenger Parking Lot
Location: Leander, Texas
Owner/Agency:
Design Engineer: Typical Car and Light Truck Traffic

Flexible Pavement Design/Evaluation

Structural Number	1.94		**Subgrade Resilient Modulus**	5,500.00	**psi**
Total Flexible ESALs	15,000		**Initial Serviceability**	4.20	
Reliability	90.00	**percent**	**Terminal Serviceability**	2.00	
Overall Standard Deviation	0.35				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.16	1.00	8.00	1.28
Graded Stone Base	0.44	1.00	1.50	0.66
			Σ SN	1.94

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Rigid Design Inputs

Project Name:	Square at Crystal Falls
Route:	Passenger Parking Lot
Location:	Leander, Texas
Owner/Agency:	
Design Engineer:	Typical Car and Light Truck Traffic

Rigid Pavement Design/Evaluation

Concrete Thickness	5.00	**inches**	**Load Transfer Coefficient**	3.20	
Total Rigid ESALs	15,000		**Modulus of Subgrade Reaction**	250	**psi/in.**
Reliability	90.00	**percent**	**Drainage Coefficient**	1.00	
Overall Standard Deviation	0.45		**Initial Serviceability**	4.20	
Flexural Strength	600	**psi**	**Terminal Serviceability**	2.00	
Modulus of Elasticity	4,100,000	**psi**			

Modulus of Subgrade Reaction (k-value) Determination

Resilient Modulus of the Subgrade	0.0
Unadjusted Modulus of Subgrade Reaction	0
Depth to Rigid Foundation	0.00
Loss of Support Value (0,1,2,3)	0.0

Modulus of Subgrade Reaction	250 **psi/in.**

Figure 18

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name:	Square at Crystal Falls
Route:	Passenger Parking Lot
Location:	Leander, Texas
Owner/Agency:	
Design Engineer:	Main Drive and Fire Lane

Flexible Pavement Design/Evaluation

Structural Number	2.48		**Subgrade Resilient Modulus**	5,500.00	**psi**
Total Flexible ESALs	45,000		**Initial Serviceability**	4.20	
Reliability	90.00	**percent**	**Terminal Serviceability**	2.00	
Overall Standard Deviation	0.35				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.16	1.00	10.00	1.60
Graded Stone Base	0.44	1.00	2.00	0.88
			Σ SN	2.48

Figure 19

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Rigid Design Inputs

Project Name: Square at Crystal Falls
Route: Passenger Parking Lot
Location: Leander, Texas
Owner/Agency:
Design Engineer: Main Drive and Fire Lane

Rigid Pavement Design/Evaluation

Concrete Thickness	5.50	**inches**	**Load Transfer Coefficient**	3.20	
Total Rigid ESALs	45,000		**Modulus of Subgrade Reaction**	250	**psi/in.**
Reliability	90.00	**percent**	**Drainage Coefficient**	1.00	
Overall Standard Deviation	0.45		**Initial Serviceability**	4.20	
Flexural Strength	600	**psi**	**Terminal Serviceability**	2.00	
Modulus of Elasticity	4,100,000	**psi**			

Modulus of Subgrade Reaction (k-value) Determination

Resilient Modulus of the Subgrade	0.0
Unadjusted Modulus of Subgrade Reaction	0
Depth to Rigid Foundation	0.00
Loss of Support Value (0,1,2,3)	0.0

Modulus of Subgrade Reaction	250	**psi/in.**

Figure 20