GEOTECHNICAL INVESTIGATION

Proposed FAMILY DOLLAR STORE
Irvington Road & 9th Avenue
Tucson, Arizona

PROJECT NO. 18-DG9060

Prepared for:

7B DEVELOPMENT
Lubbock, Texas

Prepared by:

GEOSCIENCE
ENGINEERING & TESTING, INC.
Dallas, Texas

April, 2018

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Incorporated

Project No. 18-DG9060

April 4, 2018

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5709 104th Street
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GEOTECHNICAL INVESTIGATION
Proposed FAMILY DOLLAR STORE
Irvington Road & 9th Avenue
Tucson, Arizona

Attached is the Geotechnical Investigation for the above referenced project located in Tucson, Arizona. This report briefly describes the procedures employed in our subsurface exploration and presents the results of our investigation.

We appreciate the opportunity to be of assistance on this project. Please feel free to contact us if you have any questions or if we can be of further service.

Respectfully,

Geoscience Engineering & Testing, Inc.
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INTRODUCTION

Project Description

This report presents the results of a Geotechnical Investigation performed by our Firm at the referenced project located in Tucson, Arizona. It is our understanding that construction will consist of an approximate 8,300 square-foot Family Dollar Store building and the associated paved parking and drive areas. Information regarding structural loads was not available at the time of this investigation; however, we anticipate the loads will be light. It is expected that the finished floor elevation of the proposed building will be above surrounding ground surface. At the time of this investigation, grading plans and other information regarding the referenced project was not available.

Site Description

The site of the referenced project is located at northwest corner of the intersection of Irvington Road and 9th Avenue intersection in the City of Tucson, Arizona. At the time of this investigation, the site was previously occupied with a mobile home trailer park from in or around the mid-1960's until in or around the mid 1980's, however it was an undeveloped land at the time of this investigation. The general location and orientation of the site is shown in the **Illustrations** section of this report.

Purposes and Scope of Work

The scope of work was to evaluate the general soil conditions at the referenced site based on the site history, site photography and soil boring information provided by *Geoscience Engineering & Testing Inc.* The information gathered was used to develop geotechnical parameters for the design and construction of the building foundation. The principal purposes of this investigation were to

1). Develop subsurface soil and rock stratigraphy at the boring locations;

2). Evaluate soil swell potential and provide alternatives to reduce soil movement;

3). Provide recommendations for foundation design parameters;

4). Provide site preparation recommendations and

5). Provide paving recommendations

Report Format

The first sections of this report describe the field and laboratory phases of the study. The remaining sections present our engineering analysis that was used to develop geotechnical parameters for the type of foundation system proposed for this site. Boring logs and laboratory test results are presented in the **Illustrations** section of this report.

FIELD INVESTIGATION

To explore the subsurface conditions, four (4) test borings were drilled were drilled and sampled to a depth of 15 feet below ground surface in the proposed building pad. The approximate locations of the borings drilled for this study, are indicated on PLATE A – included in the **Illustrations** Section of this report.

The borings were advanced using the hollow stem drilling technique. A Standard Penetration sampler was used at selected depths in non-cohesive soils to obtain a standard penetration value (N value). An N-value is defined as the number of blows a 140-pound hammer free falling from 30 inches would require to drive a two-inch O.D. sampler one foot into undisturbed soils below the bottom of the bore hole. The N value is an indication of the relative density of non-cohesive soils. The results of the standard penetration tests, expressed as "blows per foot," are tabulated at the respective sample depths on the boring logs.

All soil samples were removed from the samplers in the field, visually classified, and placed in appropriate containers to prevent loss of moisture or disturbance during transfer to the laboratory. The borings were advanced using dry auger procedures to observe the water level at the time of the exploration. These water level observations are recorded on the boring logs.

LABORATORY TESTING

Engineering properties of the foundation soils were evaluated in the laboratory by tests performed on representative soil samples, a series of moisture contents were performed to develop soil moisture profiles at the boring locations and to aid in evaluating the uniformity of soil conditions. Plastic and liquid limit (Atterberg limits) and percentage passing number 200 sieve tests were performed on selected samples from the borings to confirm visual classification. As mentioned earlier that the relative densities of the soils were determined in the field by standard penetration method. The results of these tests are presented on the boring logs.

Review

Descriptions of subsurface materials obtained in the field at the time the boring was drilled were modified in accordance with results of laboratory tests and visual examination in the laboratory. All recovered soil samples were examined and classified in accordance with ASTM D 2487 and described as recommended in ASTM D 2488 and the Unified Soil Classification procedures. Classification of the soils and finalized material descriptions are shown on the boring logs.

GENERAL SUBSURFACE CONDITIONS

Stratigraphy

The stratification lines shown on the boring logs represent approximate locations of changes between soil types; in-situ, the transition between materials may be gradual. Based on our interpretation of the borings drilled for this study, the stratigraphy encountered in test borings drilled consisted of dark brown to tannish brown SANDY CLAY (CL)/CLAYEY SAND (SC) soils with calcareous nodules with a trace of gravel from existing ground surface elevation to the completion depth of test borings B-1 to B-4 drilled.

Detailed descriptions of the subsurface stratigraphies encountered at this site are presented on the boring logs in the **Illustrations** Section of this report.

Subsurface Water Conditions

The borings were advanced using dry auger drilling procedures in order to observe any groundwater seepage levels. At the time of this investigation, No groundwater seepage was encountered at any of the test borings drilled for this study. However, it should be noted that the depth to subsurface water can be affected by changes in atmospheric conditions and site drainage. With regard to the aforementioned, we recommend the depth to groundwater be verified prior to and during construction. Any noticeable variations in the conditions reported herein should be conveyed to this office immediately so that a thorough review of the current design recommendations can be made. Based upon short-term observations, it is not possible to accurately predict the magnitude of subsurface water fluctuations that might occur. Also, it is not uncommon for water seepage to occur with though the fractures with in the soil stratum after the period of heavy rainfall.

ANALYSIS AND RECOMMENDATIONS

Construction Consultation and Monitoring

Our interpretations of soil and groundwater conditions, described herein, are based on data obtained from the soil boring and the results of the laboratory tests performed for this study. Unknown variations in the soil and/or groundwater conditions may exist in other areas of the site.

In the event that substantial variations in the subsurface conditions are encountered during the construction phase of the project, we recommend notifying and authorized to evaluate what, if any, revisions may be necessary in our recommendations.

In addition, we suggest our firm be retained during the construction sequence phase of this project to ensure: 1). that project construction is performed in compliance with the geotechnical design concepts, specifications and recommendations and 2). that the subsurface conditions encountered are as anticipated based on the borings performed for this investigation.

Soil Movement

The near surface clay soils encountered at this site exhibited Plasticity Indices of 14 to 19. Based on the plasticity indices, these soils are considered as *low to moderately expansive* in nature. The magnitude of the moisture induced soil vertical movement was calculated using Texas Department of Transportation procedures. Based on the aforementioned method, the estimated moisture induced Potential Vertical Movement of the soils at the time of this investigation is on the order of one inch at the locations of the test borings drilled.

Considerably more movement will occur in areas where water ponding is allowed to occur during and/or after construction –or- fill soils other than select fill soils are intended for use. Site grading may also increase the potential for movement.

FOUNDATION RECOMMENDATIONS

Shallow Foundation

Based on the subsurface stratigraphy encountered at this site the structural load of the proposed "Family Dollar" can be supported by shallow foundation/spread footing.

The spread footings should be placed at a minimum depth of 2.5 feet from finished ground surface elevation installed within the compacted and tested onsite fill soils or offsite select fill soils or natural soils. The spread footings can be designed using an allowable net bearing pressure of 2,500 psf for compacted and tested natural soils or compacted and tested onsite or off-site select fill soils.

The bottom of the spread footings should be free of any loose and/or soft materials prior to concrete placement. Any soft soils in the areas of the grade beams and/or spread footings should be removed and replaced with select fill soils or flex base. Prior to placing any concrete, we recommend the spread footings be compacted with a hand compactor. Due to the nature of the subsurface soils encountered at this site, the edges of the spread footings may slough when the soils become dry. As such, we recommend the grade beams and spread-footings be widened to achieve the net bearing - or - that the allowable soil bearing capacity be reduced.

Each foundation excavation should be evaluated by a geotechnical engineer to ensure that the foundation bears within hard stratum.

Grade Beams and Floor Slab - In conjunction with a shallow foundation system, ground supported grade beam and floor slab can be used at this site. The depth of the grade beam should be at least 2 feet and width should be 12 inches. A net allowable soil bearing pressure of 2,000 psf for compacted and tested select fill and for natural soils. Any areas at the bottom of the grade beams where soft spots are noted we recommend: a) the bottom of the grade beams either be rolled or compacted by re-working with the optimum moisture with a hand compactor -Or - b) reduce the allowable soil bearing capacity. At the time of such an evaluation, it may be necessary to perform hand penetrometer probe tests in the base of the foundation excavation to ensure that the above recommendations are adhered to. All grade beams and floor slabs should be adequately reinforced to minimize cracking as normal movements occur in the foundation soils. Also, a moisture barrier of polyethylene sheeting or

similar material should be placed between the slab and the subgrade soils to retard moisture migration through the slab. Proper drainage away from the building pad is of the utmost importance. It should be understood by all parties that a soil-supported foundation system will experience movement with time.

Building Pad Preparation

Prior to placing any fill material, all existing surface vegetation, loose and fill (if any) soils and debris should be removed and disposed of off-site. Any foundation elements from previous development should be removed completely. After removal of all above mentioned items, all exposed surfaces should then be scarified to a depth of 6 inches watered as required and compacted to between 95 and 100 percent of the maximum dry density as defined by ASTM D 698 (Standard Proctor Test) at a moisture content between the optimum moisture value and 3 points above optimum.

Additional fill soil if required should consist of on-site sandy clay soils with the PI less than 16 (additional laboratory testing should be performed) or off-site select fill soils or flex base material. Low PI on-site soils or off-site select fill soils should be placed in six (6) to eight (8)-inch loose lifts at moisture contents between optimum and 3 percentage points above optimum. Each lift compacted to between 95 and 100 percent of the maximum dry density as defined in ASTM D 698. Field density tests should be taken at the rate of one test per every 2,500 square feet per lift, or a minimum of 3 tests per lift in the area of all compacted fill. For areas where hand tamping is required, the testing frequency should be increased to approximately one test per lift, per 100 linear feet of area.

The off-site flex base if is used then should be placed in 12 inches loose lifts and compacted to a minimum of 98 percent of the maximum dry density with the moisture content between -2 to +3 points of optimum moisture as per ASTM D 698.

Select Fill

"Select fill," as referred to in this report, brought in from off-site should consist of clayey sands free of organic materials with a Plasticity Index between 6 and 16, a Liquid Limit of 38 or less, and between 15 and 45 percent passing a No. 200 sieve. On-site sandy clay/clayey sand soils exhibited the characteristics of the select fill soils and can be used as fill soils however; additional laboratory testing should be performed. Placement and compaction of the select fill should be

performed in accordance with the **"Building Pad Preparation"** section of this report. It is preferable to place the select fill above the surrounding ground surface.

Flex Base

The flex base material should be either crushed aggregate or crushed limestone with passing range from the following sieves:

Sieve passing %

7/8" 10-35
3/8" 30-50
No. 4 45-65
No. 40 70-85
Max LL 35
Max PI 10

PAVING RECOMMENDATIONS

Rigid Pavement

Specific wheel loading and traffic volume characteristics were not available at the time of this investigation. However, based on assumed loading conditions, we have developed the following Portland cement concrete pavement design sections for use at this site.

	Thickness (inches)
Light Traffic	
Portland Cement Concrete	5
Compacted Subgrade	6
Medium Traffic	
Portland Cement Concrete	6
Compacted Subgrade	6

Prior to placing any fill materials, all existing surface vegetation, loose and fill (if any) soils and debris should be removed and disposed of off-site. After removal of all above mentioned items, all exposed surfaces should then be scarified to a depth of 6 inches watered as required and compacted to between 95 and 100 percent of the maximum dry density as defined by ASTM D 698 (Standard Proctor Test) at a moisture content between the optimum moisture value and 3 points above optimum. On-site soils can be used if additional fill is required and should be

placed in 6 to 8 inches loose lifts and compacted to between 95 and 100 percent of the maximum dry density as defined by ASTM D 698 (Standard Proctor Test) at moisture content between the optimum moisture value and 3 points above optimum.

Design of the concrete pavement should specify a minimum 28-day concrete compressive strength of 3,000 psi with 4 to 6 percent entrained air. The concrete should be placed within one and one half hours of batching. During hot weather, concrete placement should follow ACI 311 Hot Weather concreting. In no case should concrete temperatures exceed 95°F. Consideration should be given to limiting concrete placement to that time of day which will minimize large differences in the ambient and concrete temperature. Use of superplasticizer should be considered to improve the concrete workability without increasing water cement ratio.

Pavements with sealed joints on 15 to 20-foot spacings cut to a depth of at least one-quarter of the pavement thickness, generally exhibit less uncontrolled post-construction cracking then pavements with wider spacings. Expansion joints should be used wherever the pavement is going to abut some type of structural fixture that was designed to undergo a different level of movement than the pavement (e.g. light poles, retaining walls, existing pavement, stairways, entryway piers, building walls, or manholes). The construction and expansion joints should be inspected periodically and resealed, if necessary. The pavement should be reinforced using at least No. 3 bars, 24 inches on center, each way.

Flexible Pavement

Based on the information provided from client, we have developed the following asphalt Pavement design sections for use at this site:

Parking Area	**Thickness (inches)**
Life Expectancy ESAL's	49,700
HMAC Type D Surface Course	3.5
Flex Base	6
Compacted Subgrade	6
Driveway Area	**Thickness (inches)**
Life Expectancy ESAL's	88,000
HMAC Type D Surface Course	4.5
Flex Base	6
Compacted Subgrade	6

Prior to the placement of any fill material, all existing surface vegetation, loose and fill (if any) soils and debris should be removed and disposed of off-site. The exposed surface should then be scarified to 6 inches, watered as required and compacted to 95 to 100 percent of the maximum dry density, Moisture contents should be between optimum to 3 percentage points above optimum.

Flex base material should then be placed and compacted to a minimum of 98 percent of the maximum dry density with the moisture content between -2 to +3 of optimum moisture as per ASTM D 698.

On-site soils can be used if additional fill is required. Fill soils should be placed in 6 to 8 inches loose lifts and compacted between 95 to 100 percent with moisture content between optimum and 3 points above optimum. Flex base can also be used as fill material.

Asphalt pavement analyses were performed using the AASHTO design method and the previously stated assumed traffic characteristics. The HMAC should meet Department of Transportation specifications.

SITE GRADING AND DRAINAGE

All grading should provide positive drainage away from the proposed structures and should prevent water from collecting or discharging near the foundations. Water must not be permitted to pond adjacent to the structures during or after construction.

Surface drainage gradients should be designed to divert surface water away from the buildings and edges of pavements and towards suitable collection and discharge facilities. Unpaved areas and permeable surfaces should be provided with steeper gradients than paved areas. Pavement drainage gradients within 5 feet of buildings should be constructed with a minimum slope of one inch per foot to prevent negative drainage gradients (ponding water conditions) from developing due to differential upward pavement movements. Sidewalk drainage gradients should be along maximum slopes allowed by local codes.

Roofs should be provided with gutters and downspouts to prevent the discharge of rainwater directly onto the ground adjacent to the building foundations. Downspouts should not discharge into any landscaped bed near the foundations. Downspouts should discharge directly into storm drains or drainage swales, if possible. Roof downspouts and surface drain outlets should

discharge into erosion-resistant areas, such as paving or rock riprap. Recessed landscaped areas filled with pervious sandy loam or organic soil should not be used near the foundation. Landscaped beds should be elevated above a compacted and well-graded clay surface. Sealed planters are preferred. All trees should be a minimum of one-half their mature height away from the building or pavement edges to reduce potential moisture losses. Water permitted to pond in planters, open areas, or areas with unsealed joints next to structures can result in on-grade slab or pavement movements, which exceed those, indicated in this report.

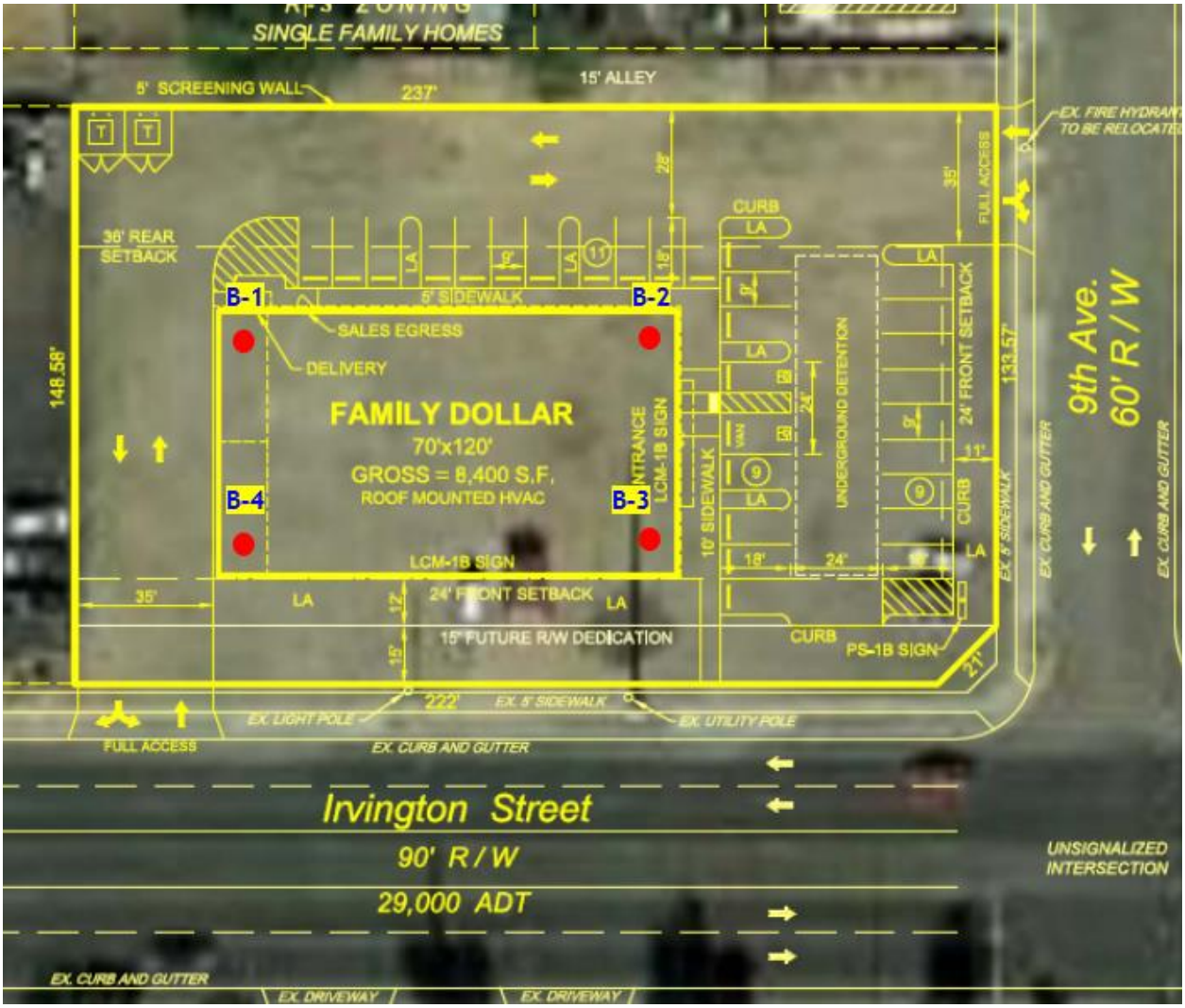
Exterior sidewalks and pavements will be subject to some post construction movement as indicated in this report. These potential movements should be considered during preparation of the grading plan. Flat grades should be avoided. Where concrete pavement is used, joints should be sealed to prevent the infiltration of water. Some post-construction movement of pavement and flatwork may occur. Particular attention should be given to joints around the building. These joints should be periodically inspected and resealed where necessary.

CLOSURE

Subsurface conditions were obtained only from the boring locations noted. It should be understood that variations in the subsurface conditions were encountered at the boring locations, and as such, further variations may exist between the boring locations. Subsurface conditions varying from those found at the boring locations may be present because of, among other factors, soil moisture variations, fill placement and naturally occurring variations in soil properties.

The soil stratigraphy described herein and on the boring logs is based on visual observations and interpretations during sampling and classification of the soil samples. Boring and laboratory data presented was developed solely for the preparation of this report. We are not responsible for interpretation or use of this data for purposes beyond the stated scope of this report.

ILLUSTRATIONS



Approximate Boring Location

BORING LOCATION PLAN
Proposed FAMILY DOLLAR STORE
Irvington Road & 9th Avenue
Tucson, Arizona

Project No. 18-DG9060

Plate A

GeoScience Incorporated

LOG OF BORING NO. B-1

Proposed "Family Dollar Store"
Irvington Road & 9th Avenue
Tucson, Arizona

Project No. 18-DG9060

Location: See Location Plan
Surface Elevation: Unknown
Drilling Method: CFA
Date Boring Drilled: 03/08/2018
Completion Depth: 15
Groundwater Information:
Seepage Encountered During Drilling: None
Upon Completion: Dry

FIELD DATA					LABORATORY DATA							
DEPTH (ft.)	SOIL & ROCK SYMBOL	SAMPLE TYPE	P: HAND PEN., TSF T: THD, BLOWS/FT. N: SPT, BLOWS/FT.	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE	SOIL SUCTION TEST (TOTAL CM. OF WATER)
0			N13		Brown and tan SANDY CLAY (CL) with calcareous nodules and occasional gravel seams	3 10							
			N18	4.5		7	30	16	14			54	
5			N25		Brown SANDY CLAY (CL) with gravel seams	5							
			N21			3							
10													
			N23	15		3							
15													
20													
25													
30													

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

REMARKS:

GeoScience Incorporated

LOG OF BORING NO. B-2

Proposed "Family Dollar Store"
Irvington Road & 9th Avenue
Tucson, Arizona

Project No. 18-DG9060

Location: See Location Plan
Surface Elevation: Unknown
Drilling Method: CFA
Date Boring Drilled: 03/08/2018
Completion Depth: 15
Groundwater Information:
Seepage Encountered During Drilling: None
Upon Completion: Dry

FIELD DATA					LABORATORY DATA							
DEPTH (ft.)	SOIL & ROCK SYMBOL	SAMPLE TYPE	P: HAND PEN., TSF T: THD, BLOWS/FT. N: SPT, BLOWS/FT.	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE	SOIL SUCTION TEST (TOTAL CM. OF WATER)
0													
			N19		Brown and tan SANDY CLAY (CL) with calcareous nodules and occasional gravel seams	5							
						13	33	15	18				
				3.5									
			N14		Brown SANDY CLAY (CL)/CLAYEY SAND (SC) with gravel seams	7						32	
5													
			N34			7							
					-brown and tan below 7.5'								
			N19			8	32	16	16				
10													
			N19			6	30	15	15			47	
				15									
15													
20													
25													
30													

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

REMARKS:

GeoScience Incorporated

LOG OF BORING NO. B-3

Proposed "Family Dollar Store"
Irvington Road & 9th Avenue
Tucson, Arizona

Project No. 18-DG9060

Location: See Location Plan
Surface Elevation: Unknown
Drilling Method: CFA
Date Boring Drilled: 03/08/2018
Completion Depth: 15
Groundwater Information:
Seepage Encountered During Drilling: None
Upon Completion: Dry

FIELD DATA						LABORATORY DATA							
DEPTH (ft.)	SOIL & ROCK SYMBOL	SAMPLE TYPE	P: HAND PEN., TSF T: THD, BLOWS/FT. N: SPT, BLOWS/FT.	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE	SOIL SUCTION TEST (TOTAL CM. OF WATER)
0						4							
			N38		Brown and tan SANDY CLAY (CL) with calcareous nodules and occasional gravel seams	10	37	18	19			58	
				3.5									
			N31		Brown SANDY CLAY (CL)/CLAYEY SAND (SC) with gravel seams -brown and tan below 5.5'	6							
5													
			N12			7							
			N15			8						47	
10													
			N43			6							
15				15									
20													
25													
30													

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

REMARKS:

GeoScience Incorporated

LOG OF BORING NO. B-4

Proposed "Family Dollar Store"
Irvington Road & 9th Avenue
Tucson, Arizona

Project No. 18-DG9060

Location: See Location Plan
Surface Elevation: Unknown
Drilling Method: CFA
Date Boring Drilled: 03/08/2018
Completion Depth: 15
Groundwater Information:
Seepage Encountered During Drilling: None
Upon Completion: Dry

FIELD DATA						LABORATORY DATA							
DEPTH (ft.)	SOIL & ROCK SYMBOL	SAMPLE TYPE	P: HAND PEN., TSF T: THD, BLOWS/FT. N: SPT, BLOWS/FT.	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE	SOIL SUCTION TEST (TOTAL CM. OF WATER)
0			N21	3.5	Dark brown SANDY CLAY (CL) with calcareous nodules and occasional gravel seams	5 12							
5			N24 N14	15	Tan and brown SANDY CLAY (CL)/CLAYEY SAND (SC) with gravel seams	7 5	30	16	14			55	
10			N16			4							
15			N17			3							
20													
25													
30													

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

REMARKS: