



**ADDENDUM NO. 2**

**PROJECT NAME: FIRE STATION # 53**

**DATE: 05/17/2016**

**ADDENDUM NO.2**

This addendum should be included in and be considered part of the plans and specifications for the name of the project. The contractor shall be required to sign an acknowledgement of the receipt of this addendum and submit with their bid.

**PROJECT NO.: 20-00045A**

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**Low Qualified Formal Invitation for Bid and Contract:**

- Geotechnical Engineering Study has been attached to this Addendum.

**Note: Addenda Acknowledgement Form for Addendum 2 is attached herein. This form must be signed and submitted with the bid package.**

Date: May 17th, 2016  
Project No. 1613

ADDENDUM NO. 02

To the drawings and specifications for:  
Fire Station 53  
14102 Donop Road, San Antonio

Beaty Palmer Architects, Inc.  
110 Broadway, Suite 600  
San Antonio, Texas 78205

GEOTECH REPORT

Item 2.1 Geotechnical Engineering Study has been attached to this Addendum.

Attachments: Firestation 53 - Geotechnical Engineering Study dated 04.18.2016

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Cory W. Hawkins, AIA, LEED AP  
Principal



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April 18, 2016

Mr. Mark Beavers  
Senior Architect  
**City of San Antonio**  
114 West Commerce  
4<sup>th</sup> Floor, Office 416  
San Antonio, Texas 78205

RE: Geotechnical Engineering Study  
**Proposed Fire Station No. 53**  
**Donop Road & Southton Road**  
**San Antonio, Texas**  
PSI Project No.: 0312-1314

Dear Mr. Beavers:

Professional Service Industries, Inc. (PSI) is pleased to submit our Geotechnical Engineering Study for the referenced project. This report includes the results of field and laboratory testing along with recommendations for use in preparation of the appropriate design and construction documents for this project.

We appreciate the opportunity to perform this Geotechnical Engineering Study and look forward to continuing participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,  
**Professional Service Industries, Inc.**

  
J.R. Eichelberger, III, P.E.  
Department Manager  
Geotechnical Services

**GEOTECHNICAL ENGINEERING STUDY**

**Proposed Fire Station No. 53  
Donop Road & Southton Road  
San Antonio, Texas**

**PSI Project No.: 0312-1314**

**PREPARED FOR**

**City of San Antonio  
114 West Commerce  
4<sup>th</sup> Floor, Office 416  
San Antonio, Texas 78205  
Attn: Mr. Mark Beavers, Senior Architect**

**April 18, 2016**

**BY**

**PROFESSIONAL SERVICE INDUSTRIES, INC.  
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**S. Peter Gonzales, P.E.  
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**Dexter Bacon, P.E.  
Chief Engineer**



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## APPENDIX

- Site Vicinity Map
- Boring Location Plan
- Boring Logs
- Key to Terms and Symbols Used on Logs



## PROJECT INFORMATION

### **Project Authorization**

Professional Service Industries, Inc. (PSI) has completed a geotechnical engineering study for the proposed Fire Station No. 53 to be located at the intersection of Donop Road & Southton Road in San Antonio, Texas. Our services were authorized via City of San Antonio Task Order "TO-460 Geotechnical Services Fire Station 53" dated March 28, 2016. This study was performed in general accordance with PSI Proposal No. 175701-R dated March 17, 2016.

### **Project Description**

Based upon information provided to us, we understand that current plans are to construct a new Fire Station over the course of two phases. The first phase will include the temporary living quarters and the permanent apparatus bay with approximate footprints of approximately 1,800 square feet and 4,500 square feet respectively. The second phase will be completed at a future time and will consist of a permanent structure with a footprint of approximately 9,500 square feet in plan area including an EMS bay. The future phase of development was not included in the scope of services authorized under TO-461. The permanent apparatus bay will be single story and will utilize a prefabricated metal building. The temporary living quarters will consist of a double wide manufactured home. Access drives and parking areas will also be constructed as part of the development may consist of an aggregate base, flexible pavement, reinforced concrete or a combination of the three.

The geotechnical recommendations presented in this report are based on the available project information, the proposed building type and location, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report as appropriate. PSI will not be responsible for the implementation of our recommendations when we are not notified of changes in the project.

### **Purpose and Scope of Services**

The purposes of this study are to evaluate the subsurface conditions at the site and develop geotechnical engineering recommendations and guidelines for use in preparing appropriate design and other related construction documents for the proposed project. The scope of services included drilling seven (7) soil borings to depths of 10 to 35 feet below existing grades, performing selected laboratory tests, and preparing this geotechnical engineering report. This report briefly outlines the available project information, describes the site and subsurface conditions, and presents our recommendations regarding the following:

- General foundation and subgrade preparation;
- Selection and placement of fill and backfill within construction limits;
- Recommendations for a shallow foundation system;
- Pavement recommendations;
- General comments regarding factors that may impact construction and performance of the proposed construction.

The scope of services for this geotechnical exploration did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. PSI did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structures, or any service that was designed or intended to prevent or lower the risk of the occurrence of the amplification of the same. Mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture.

## SITE AND SUBSURFACE CONDITIONS

### Site Description

The site for the proposed Fire Station is located off of Donop Road south of the intersection of Donop Road and Southton Road in San Antonio, Texas. The site is bordered by vacant land to the east and the south, Donop Road to the west and a commercial building to the north. The site is currently vacant and undeveloped. Based on visual observations, the project site appeared to be relatively flat. For additional information, a Site Vicinity Map and Boring Location Plan have been included in the appendix of this report.

### Site Geology

We reviewed the **San Antonio Sheet of the Geologic Atlas of Texas**<sup>1</sup> in an effort to determine the geologic setting of the project site and surrounding areas. The Geologic Atlas of Texas was developed by the Bureau of Economic Geology at The University of Texas using aerial photography, data from various oil and gas exploration companies, and very limited ground reconnaissance. Our review indicates that the project is located in the **Wilcox Group (Ewi)** of Tertiary Geologic Age. The San Antonio Sheet generally describes the **Wilcox Group** as mostly mudstone, with various amounts of sandstone, lignite, ironstone concretions, glauconitic; thickness about 1,000 ft. sand, mudstone, clay,

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<sup>1</sup> **Geologic Atlas of Texas – San Antonio Sheet**, Bureau of Economic Geology, University of Texas at Austin, 1974 (Revised 1983).

mudstone conglomerate, thickness as much as 300 ft. lower part mostly mudstone, thickness about 500 +/- ft. Total thickness roughly 1,400-1,800 ft.

### **Subsurface Conditions**

The site subsurface conditions were evaluated by drilling seven (7) soil borings within the proposed building footprint and pavement areas, as presented in the Appendix of this report. Two (2) borings were drilled within the footprint of the permanent apparatus bay to an approximate depth of 35 feet each below the existing ground surface. One (1) boring was drilled within the footprint of the temporary living quarters to an approximate depth of 35 feet each below the existing ground surface. The remaining four (4) borings were drilled to an approximate depth of 10 feet each below the existing ground surface. The number of borings, boring locations and the boring depths were selected by PSI based on the project information provided to us, our experience with similar projects in the area and the anticipated subsurface conditions at the site. The borings were located in the field by PSI personnel who measured or approximated distances from known site reference points to the boring location. Refer to the appended Boring Location Plan for details regarding the boring locations.

The borings were advanced utilizing solid flight auger drilling methods and soil samples were obtained at regular depth intervals during the drilling process. Drilling and sampling techniques were accomplished in general accordance with ASTM procedures. Selected soil samples obtained during our field exploration were transported to our laboratory where they were reviewed by geotechnical engineering personnel. Representative samples were selected and tested to determine pertinent engineering properties and characteristics for use in our evaluation of the project site. Laboratory testing and soil classification was accomplished in general accordance with ASTM procedures.

Based on the field and laboratory data, we have determined that the stratigraphy at the explored locations is generally as follows. Within the footprint of the permanent apparatus bay, soils consist of CLAYEY SAND (SC), FAT CLAY (CH) with SAND and FAT CLAY (CH). Liquid Limits for the CLAYEY SAND (SC) material, which comprised the top two (2) feet in Boring B-1 and the top six (6) feet in Boring B-2, was 47% with corresponding Plasticity Indexes between 29 and 32% and the amount of material passing the #200 Sieve was between 47 and 49%. Liquid Limits for the FAT CLAY (CH) with SAND and FAT CLAY (CH) material ranged from 65 to 73% with corresponding Plasticity Indexes between 44 and 53% and the amount of material passing the #200 Sieve between 78 and 94%. Within the pavement areas, the soils consist of SANDY LEAN CLAY (CL), CLAYEY SAND (SC), and FAT CLAY (CH). Liquid Limits for the SANDY LEAN CLAY (CL) ranged between 34 to 48% with corresponding Plasticity Indexes between 22 to 33% and the amount of material passing the #200 Sieve between 52 and 54%.

The above subsurface descriptions are of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for specific information such as soil and rock

descriptions, stratifications, penetration resistances, locations of the samples, and laboratory test data. The stratifications shown on the boring logs only represent the conditions at that actual boring location and represent the approximate boundaries between subsurface materials. The actual transitions between strata may be more gradual or more distinct. Variations will occur and should be expected at locations between and away from the boring locations. Water level observations made during field operations are also shown on the boring logs. The indicated stratum depths and any water levels are measured from the ground surface and are estimated to the nearest one-half (½) foot. Portions of any samples that are not altered or consumed by laboratory testing will be retained for 60 days from the date shown this report and will then be discarded.

### **Groundwater Information**

The borings were advanced using dry drilling techniques to their full depths, enabling the possibility of detection of the presence of groundwater during drilling operations. Groundwater was not encountered during our field operations. Upon completion of groundwater observations, the boreholes were backfilled with native soil cuttings.

Groundwater levels are influenced by seasonal and climatic conditions which generally result in fluctuations in the elevation of the groundwater level over time. In addition, perched water can exist within the overburden soils, especially following periods of rainfall. Furthermore, the CLAYEY SAND (SC) materials may readily transmit water that may not have been located or indicated by our soil borings. Therefore, the foundation contractor should check the groundwater conditions just prior to foundation excavation activities. Specific information concerning groundwater is noted on each boring log presented in the Appendix of this report.

## **EVALUATION AND RECOMMENDATIONS**

### **Geotechnical Discussion**

Based upon the information gathered at our soil borings, the clay soils encountered at this site within the seasonally active zone are moderately to highly expansive. The expansive potential (i.e. "Potential Vertical Rise" or PVR) of these soils must be addressed in the design and construction of this project in order to reduce the potential for foundation movements and foundation distress.

We understand that a shallow foundation system is preferred. A shallow soil supported slab and grade beam foundation may be considered provided the building pad is prepared to reduce the expansive potential (i.e. PVR) resulting from the shrinking and swelling actions of the onsite soils to an acceptable level. This can be accomplished by removing a portion of the expansive soil in the building area and constructing a building pad with relatively low-expansive select fill material.

The following design recommendations have been developed based on the previously described project characteristics and subsurface conditions encountered. If there are any changes in the project criteria, including project location on the site, a review must be made by PSI to determine if any modifications in the recommendations will be required. The findings of such a review should be presented in a supplemental report. Once final design plans and specifications are available, a general review by PSI is strongly recommended as a means to check that the conditions assumed in the project description are correct and that the earthwork and foundation recommendations are properly interpreted and implemented.

### **Potential Vertical Rise**

The soil profiles encountered at the soil boring locations exhibit a moderate potential to experience volumetric changes as a result of fluctuations in soil moisture content. Based on our laboratory testing results, the estimated Potential Vertical Rise (PVR) within the proposed building area is approximated to be four and one-half (4½) inches at the time of our drilling operations. This PVR value was calculated using the Texas Department of Transportation (TxDOT) Method TEX-124-E. These estimates assume a sustained surcharge load of approximately one (1) pound per square inch on the subgrade materials for a soils supported floor slab.

Any grade supported floor slabs and foundations should be expected to undergo some vertical movements, including differential, as a result of the action of expansive soils. In this general area, most structural and geotechnical engineers consider a PVR of one (1) inch or less to be within acceptable tolerances for grade supported floor slabs. The selection of a PVR value of about one (1) inch as an acceptable tolerance for a given system is generally based on the standard practice of structural and geotechnical engineers within the project area. However, some structures may require a higher level of performance. Therefore, we have developed recommendations for preparing the building pad in such a way that will result in as-built design PVR of approximately one (1) inch. Undercutting a portion of the existing soils and placing compacted select fill between the natural soils and the floor slab as discussed in the Building Pad Preparation section of this report can reduce the PVR.

The amount of movement associated with a PVR value of about one (1) inch does not take into consideration the movement criteria required or perceived by the facility owner or occupants. These “operational” performance criteria may be, and often are, more restrictive than the structural criteria or tolerances associated with a one (1) inch PVR. Therefore, we suggest the owner discuss this issue with the structural engineer, the architect, and any other appropriate members of the Design Team prior to commencement of the final design process to ensure that appropriate movement tolerances for grade supported floor slabs/foundations are developed and used for this project. If a design PVR value less than one (1) inch is desired, we recommend preparing the building pad for a design PVR value of one-half (½) inch as discussed herein. If the

risk of grade-supported foundation and floor slab movements is not acceptable, or if the required earthwork is determined excessive, structurally suspended floor slabs supported by drilled pier foundations should be used.

### **Overburden Swell Test Results**

An overburden swell test was also performed on the near-surface clays to help evaluate the shrink/swell potential of the site soils. The results of the swell test in the following table.

Table - Overburden Swell Test Results

| Boring | Depth (ft) | % Swell | Moisture content, % |     |
|--------|------------|---------|---------------------|-----|
|        |            |         | Begin               | End |
| B-1    | 8 to 10    | 8.2     | 17                  | 26  |
| B-2    | 6 to 8     | -0.6    | 17                  | 18  |

The plasticity characteristics of the soils suggest that the clay soils at the site have a relatively high potential to shrink and swell due to fluctuations in moisture content. The overburden swell test was performed to help evaluate the shrink/swell potential of the site soils. For the overburden swell test, a vertical load estimated to be equivalent to the existing in-situ weight of the soil overlying the sample depth interval was applied to the sample. The sample was then inundated in water and subsequent measurements of vertical swell are obtained for at least a 48-hour period.

### **Building Pad Preparation**

As previously noted, the estimated PVR within the area of the proposed building pad at this site is approximated to be four and one-half (**4½**) inches at the time of our drilling operations, which is above the value considered acceptable by most structural and geotechnical engineers in this area. Therefore, special measures to reduce the PVR to acceptable levels will be required for grade supported floor slabs or foundations. Two options for building pad preparation procedures are presented below for consideration. These recommendations are based on an approximate six (6) inch thick floor slab and a Finished Floor Elevation (FFE) within one (1) foot of existing grades. *PSI should be contacted once additional grading and FFE information becomes available to confirm or revise these recommendations.*

#### **Option I – Excavate and Replace**

- Topsoil, vegetation, roots, organics, loose or soft soils, and any other deleterious materials in the building pad area should be stripped from the building site and wasted. Any abandoned underground utilities and permeable backfills that may be encountered should be removed, backfilled and/or grouted a sufficient distance from the proposed improvements to prevent the conveyance of subsurface water beneath the structure.

- After stripping procedures, the subgrade soils within the proposed building footprint area should then be excavated to a depth of seven and one-half (**7½**) feet below grade at the time of our drilling operations.
- After stripping and excavating to the appropriate subgrade level, the exposed subgrade should be proof-rolled with a heavily loaded tandem axle dump truck or similar rubber tired vehicle. Soils that are observed to rut or deflect excessively under the moving load should be removed and replaced with properly compacted select fill. The proof-rolling and undercutting activities should be observed by a representative of PSI and should be performed during a period of dry weather. The subgrade soils should be scarified to a depth of at least six (6) inches and moisture conditioned to between optimum and plus four (+4) percentage points of optimum. The soils should then be compacted to a minimum of 95 percent of the standard Proctor (ASTM D698) maximum dry density.
- After subgrade preparation and observations have been completed, select fill placement may begin to achieve the final building pad elevation. The first five (5) feet of select fill should consist of a low-expansive (inert) soil materials such as pit run lean clay, lean clay with sand, sandy lean clay, or clayey sand. The select fill materials should possess a Plasticity Index (PI) between 7 and 20, and contain at least forty (40) percent material passing the No. 200 sieve by dry unit weight. The material should have a maximum particle size of less than 3 inches.
- Following the placement of the pit run select fill, a crushed limestone select fill material meeting TxDOT, Item 247, Type A, Grade 1 or 2 base material should be placed to achieve the final grade for the proposed Finished Floor Elevation (FFE).
- The minimum undercut depths and minimum select fill thicknesses provided are based on the assumption that the FFE will be approximately one (1) foot above existing grade.
- All fills made in the building pad area should be completed with the use of select pit run fill capped with at least 2 feet of crushed limestone base materials. Each layer of select fill should be placed in relatively uniform horizontal lifts with a maximum loose lift thickness of eight (8) inches. The thickness of each compacted lift should not exceed six (6) inches. Select fill should be placed and compacted to at least 95 percent of the standard Proctor maximum dry density as determined by ASTM 698 for the pit run Select Fill and ASTM D-1557 for the upper crushed limestone select fill material. The select fill should be moisture conditioned within a range of one (1) percentage point below to three (3) percentage points above the optimum moisture content value. Each lift of compacted select fill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts.

- Subgrade preparation and fill placement should extend at least five (5) feet beyond the perimeter of the structure on all sides of the building where not adjacent to existing structures and should include covered walkways and other improvements adjacent to the structure. Asphalt or concrete pavement that extends to the edge of the structure foundation or improvements and is properly sealed at the pavement/building interface is recommended.

## Option II – Water Injection

- Topsoil, vegetation, roots, organics, loose or soft soils, and any other deleterious materials in the building pad area should be stripped from the building site and wasted. Any abandoned underground utilities and permeable backfills that may be encountered should be removed, backfilled and/or grouted a sufficient distance from the proposed improvements to prevent the conveyance of subsurface water beneath the structure.
- After stripping procedures, the subgrade soils within the proposed building footprint area should then be excavated to a depth of three and one-half (3½) feet below grade at the time of our drilling operations.
- After excavating to the appropriate subgrade, proceed to modify the subgrade by water injection to a depth of 10 feet below the undercut grade.
- For water injection, only potable water should be used during the injection process. A non-ionic surfactant (wetting agent) should be added to the water according to manufacturer's recommendations; however, the surfactant proportions should not be less than one part (undiluted) per 3,500 gallons of water.
- Injections should be continued to "refusal" which is defined as until the maximum reasonable quantity of water has been injected into the soil and water is flowing freely at the surface, either out of previous injection holes or from areas where the surface soils have fractured. The amount of water flowing from the described areas will be approximately equivalent to the volume of water being pumped into the soil. As a minimum, injections should be at least 30 seconds at each injection interval, unless the interval time is altered by the Geotechnical Engineer.
- Loss of water or blow-back around injector pipes does not constitute refusal. Continued loss of water in this manner may indicate inadequate injection equipment or techniques, or in some instances, surficial soils that will not form an adequate seal to contain the water. In either instance, the owner's representative should be contacted and an on-site observation made to determine appropriate steps to achieve adequate injection.
- After completion of water injection, the injection contractor should submit records which reflect the total quantity of injection agent used. The injection contractor is

completely responsible for determining the means and methods of injecting the on-site soils such that the swell reduction criteria is met.

- Injection pipe(s) will penetrate the soil in approximately 12 to 18-inch intervals, injecting to refusal at each interval for a total depth of 10 feet or impenetrable material, whichever occurs first. If a seemingly impenetrable layer is encountered, PSI must be contacted to evaluate the significance of the lack of penetration with the injector tubes or provide alternate recommendations. A minimum of 6 injection intervals will be provided for the injection depth. The lower portion of the injection pipe will consist of a hole pattern that will uniformly disperse water throughout the entire depth.
- Injection pressures should be adjusted to inject the greatest quantity of water possible within a pressure range of 50 to 200 psi pump pressure. Slurry pumps shall be capable of pumping at least 5,400 gph.
- After injection and compaction of subgrade, place a crushed limestone base material meeting TxDOT, Item 247, Type A, Grade 1 or 2. Base material should be placed to achieve the final grade for the proposed FFE.
- The minimum undercut depths and minimum select fill thicknesses provided are based on the assumption that the FFE will be approximately one (1) foot above existing grade.
- All fills made in the building pad area should be completed with the crushed limestone select fill. Each layer of select fill should be placed in relatively uniform horizontal lifts with a maximum loose lift thickness of eight (8) inches. The thickness of each compacted lift should not exceed six (6) inches. Select fill should be placed and compacted to at least 95 percent of the standard Proctor maximum dry density as determined by ASTM 1557. The select fill should be moisture conditioned within a range of one (1) percentage point below to three (3) percentage points above the optimum moisture content value. Each lift of compacted select fill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts.
- Subgrade preparation and fill placement should extend at least five (5) feet beyond the perimeter of the structure on all sides of the building where not adjacent to existing structures and should include covered walkways and other improvements adjacent to the structure. Asphalt or concrete pavement that extends to the edge of the structure foundation or improvements and is properly sealed at the pavement/building interface is recommended.

### **General Site Preparation**

Construction areas outside of the building pad area discussed above should be stripped of topsoil, vegetation, roots, loose or soft soils, and any other deleterious materials. The stripped materials should be removed from the site and properly disposed. Upon completion of stripping operations, the site may be either excavated or filled as necessary to achieve the desired site elevation. After site stripping and excavation, or prior to placement of any fill materials, the exposed subgrade should be proof-rolled with appropriate construction equipment weighing at least 20 tons. Soils that are observed to rut or deflect excessively under the moving load should be removed and may be replaced with either properly compacted select fill materials or clean onsite soils.

Grade adjustments outside of the building pad can be made using select or general fill materials. The clean excavated onsite soils may also be reused in areas not sensitive to movement. The fill materials should be placed on prepared surfaces in lifts not to exceed eight (8) inches loose measure, or six (6) inches compacted measure. Fill materials placed outside the building pad area, should be moisture conditioned to between optimum and plus four (+4) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D698.

### **General Fill Recommendations**

General fill materials may consist of clean onsite Stratum I SANDY LEAN CLAY (CL) or CLAYEY SAND (SC) soils, select fill materials, or clean imported fill soils. The purpose of a general fill is to provide a soil material with good compaction characteristics that will provide suitable, uniform support for pavements and other facilities that are not extremely sensitive to movements. Such materials may also be used in open areas where such facilities will not be constructed. General fill material should be clean and free of any vegetation, roots, organic materials, trash or garbage, construction debris, or other deleterious materials and should contain stones no larger than three (3) inches in maximum dimension. The Plasticity Index of imported general fill material should be limited to a maximum of 35. It should be understood that it is not the intent of this recommendation to control differential soil movements due to expansive soils through the use of general fill. If differential soil movements arising from the use of general fill cannot be tolerated, select fill material should be used and should conform to the recommendations made in the following report section.

### **Slab-on-Grade Foundation Recommendations**

A shallow, grid type beam and slab foundation system may be considered to support the planned building once the building pad has been prepared as recommended herein. The intent of a stiffened slab-on-grade foundation is to allow the structure and foundation to move freely with soil movements while providing a minimum sufficient stiffness to limit differential movements.

Provided that the building pad is prepared as previously recommended and PVR movements of the magnitude as discussed earlier are reduced to an acceptable level and these movements will not impair the performance of the structure, a stiffened grid type beam and slab foundation may be utilized. Grade beams bearing into properly compacted select fill or undisturbed native materials can be designed for an allowable soil bearing capacity of **2,000 psf**. This recommended value includes a design safety factor of approximately three (3). The beams should be a minimum of 12 inches wide to prevent local shear failure. Grade beams can be widened at concentrated load locations to provide increased bearing areas. Exterior beams should penetrate at least 24 inches below the final exterior grade. A vapor barrier should be placed beneath the floor slab in order to break the rise of capillary moisture.

The design approach described in the Wire Reinforcement Institute (WRI) "Design of Slab-on-Ground Foundations" manual, 1981, may be used to design slab and grade beam foundations for this project. We have developed soil parameters for use in the WRI design method as shown in the following table. It should be understood that the WRI design method is empirical in nature. Furthermore, recommended design parameters shown below are based on our understanding of the proposed project, our interpretation of the information and data collected as a part of this study, our experience in the project area and the criteria published in the above referenced publication.

|  | <b>Option I<br/>Excavate and<br/>Replace</b> | <b>Option II<br/>Water Injection</b> |
|--|--|--------------------------------------|
| Climatic Rating, $C_w$                 | 17   | 17                                   |
| Effective Plasticity Index             | 25   | 25                                   |
| Soil/Climatic Rating Factor, $(1 - C)$ | 0.11   | 0.11                                 |

The design approach described in the Post-Tensioning Institute (PTI) "Design of Post-Tensioned Slabs-on-Ground" manual, Third Edition, 2004, may also be used to design slab and grade beam foundations for this project. We have developed soil parameters for use in the PTI design method as shown in the following table. These parameters were calculated using VOLFLO 1.5 published by Geostructural Tool Kit, Inc. It should be understood that the PTI design method is empirical in nature. Furthermore, recommended design parameters shown below are based on our understanding of the proposed project, our interpretation of the information and data collected as a part of this study, our experience in the project area and the criteria published in the above referenced publication.

|  | <b>Option I<br/>Excavate and<br/>Replace</b> | <b>Option II<br/>Water Injection</b> |
|--|--|--------------------------------------|
| Edge Moisture Variation Distance, $e_m$<br>(center lift) (ft): | 9.0  | 9.0                                  |
| Edge Moisture Variation Distance, $e_m$<br>(edge lift) (ft):   | 4.8  | 4.8                                  |
| Differential Swell (center lift), $Y_m$ (in):                  | 0.93   | 0.93                                 |
| Differential Swell (edge lift), $Y_m$ (in):                    | 1.28   | 1.28                                 |

Foundations should be excavated such that smooth, undisturbed bearing surfaces are obtained. The foundation excavations should be slightly sloped to create internal sumps for the collection and removal of water. Debris or loose material in the bottom of the excavations should be removed prior to steel placement. After excavation, the reinforcing bars and concrete should be placed as quickly as possible to avoid exposure of the excavation bottom to wetting and drying or other disturbances. Surface runoff should be drained away from the excavations and not allowed to pond. Accumulations of water in the foundation excavations should be collected and removed. The foundation concrete should be placed during the same day the excavations are made. If it is required that the foundation excavations be left open for an extended period, measures should be taken to protect the exposed subgrade from disturbances or fluctuations in soil moisture content prior to concrete placement. Masonry walls should include provisions for liberally spaced, vertical control joints to minimize the affects of cosmetic "cracking".

### **Design Measures to Reduce Changes in Soil Moisture**

The following recommended measures can reduce possible moisture fluctuations of the soils under the floor slab. Movements of the foundation soil can be effectively reduced by providing horizontal and/or vertical moisture barriers around the edge of the slab. Typically, the moisture barriers would consist of concrete flatwork or asphalt or concrete pavement placed adjacent to the edge of the building, a clay cap over plastic, and a deepened perimeter grade beam.

Although subgrade modification through excavation and replacement is recommended to reduce potential soil-related foundation movements, the design and construction of a grade-supported foundation should also include the following elements:

- *Roof drainage should be controlled by gutters and carried well away from the structure. The ground surface adjacent to the building perimeter should be sloped and maintained a minimum of 5% grade away from the building for 10 feet to result in positive surface flow or drainage away from the building perimeter. In areas adjacent to the building controlled by ADA, concrete flatwork slopes should not be less than 2% within 10 feet of the building.*

- *Hose bibs, sprinkler heads, and other external water connections should be placed well away from the foundation perimeter such that surface leakage cannot readily infiltrate into the subsurface or compacted fills placed under the proposed foundations and slabs.*
- *No trees or other vegetation over 6 feet in height shall be planted within 15 feet of the structure unless specifically accounted for in the foundation design.*
- *Utility bedding should not include gravel near the perimeter of the foundation. Compacted clay or flowable fill trench backfill should be used in lieu of permeable bedding materials between 2 feet inside the building to a distance of 4 feet beyond the exterior of the building edge to reduce the potential for water to infiltrate within utility bedding and backfill material.*
- Paved areas around the structure are helpful in maintaining soil moisture equilibrium. It will be very beneficial to have pavement, sidewalks or other flatwork located immediately adjacent to the building to both reduce intrusion of surface water into the more permeable select fill and to reduce soil moisture changes along the exterior portion of the floor due to soil moisture changes from drought, excessive rainfall or irrigation, etc. The use of a clay cap over poly sheeting (horizontal barrier) or impervious geosynthetic liner or concrete (vertical barrier) is recommended in those areas not covered with asphalt or concrete pavement or flatwork. For this project, the minimum recommended horizontal distance of relatively impervious cover from pavement, flatwork or geosynthetic liner is 7 feet. For a deepened concrete beam or other type of impervious vertical barrier, a minimum depth of 5 feet is recommended
- *Flower beds and planter boxes should be piped or water tight to prevent water infiltration under the building. Experience indicates that landscape irrigation is a common source of foundation movement problems and pavement distress.*
- *Foundation pad and pavement subgrade should be protected and covered within 48 hours to reduce changes in the natural moisture regime from rainfall events or excessive drying from heat and wind.*

### **Sidewalks and Flatwork**

**The undercutting and select fill placement operations should extend beyond the edge of the building the full width of any adjacent flatwork.**

Doweling the flatwork to the building foundation at common openings will further help to reduce the potential for differential movements and trip hazards. However, when doweling grade-supported flatwork to a structure, movements of the flatwork can cause cracking in the flatwork itself. We recommend that if grade-supported flatwork is dowelled to the foundation, the connections be designed such that they are flexible to rotate.

Proper drainage around grade-supported sidewalks and flatwork is also very important to reduce potential movements. Providing rapid, positive drainage will reduce moisture variations within the underlying soils and will therefore provide valuable benefit in reducing flatwork movements.

### **Site Seismic Design Recommendations**

For the purposes of seismic design, based on the encountered site conditions and local geology, we interpreted the subsurface conditions to satisfy the **Site Class C** criteria for use at this site as defined by the International Building Code (IBC). The site class is based on the subsurface conditions encountered at our soil borings, the results of field and laboratory testing, our experience with similar projects in this area, and considering the site prepared as recommended herein. The table below provides recommended seismic parameters for the project based on the 2012 edition of the IBC. It is likely that the Site Class could be upgraded to "B", provided that shear velocity testing is performed.

| <b>Recommended Design Seismic Parameters</b> |                 |
|--|-----------------|
| <b>Seismic Parameter</b>                     | <b>IBC 2012</b> |
| 0.2 sec ( $S_s$ )                            | 0.091g          |
| 1.0 sec ( $S_1$ )                            | 0.030g          |
| Site Coefficient 0.2sec, $F_a$               | 1.6             |
| Site Coefficient 1.0 sec, $F_v$              | 2.4             |
| 0.2 sec ( $S_{Ds}$ )                         | 0.097g          |
| 1.0 sec ( $S_{D1}$ )                         | 0.047g          |

### **Pavement Design Recommendations**

We understand that aggregate base, flexible asphaltic and rigid concrete pavements are being considered for this project. Therefore, recommendations for these types of pavements have been provided herein. Pavement design recommendations for several levels of traffic loading were developed based on assumptions of potential trafficking, drive paths or patterns and anticipated soil support characteristics of pavement subgrades. We utilized the "AASHTO Guide for Design of Pavement Structures" published by the American Association of State Highway and Transportation Officials to evaluate the pavement thickness recommendations in this report. This method of design considers pavement performance, traffic, roadbed soil, pavement materials, environment, drainage and reliability. Each of these items is incorporated into the design methodology. PSI is available to provide laboratory testing and engineering evaluation to refine the site specific design parameters and sections, upon request.

As a part of any pavement design, the strength of the underlying subgrade must be taken into consideration. This is often accomplished by performing a California Bearing Ratio (CBR) test to estimate a soil resilient modulus. We have performed a CBR test on a bulk sample of the SANDY LEAN CLAY (CL) soils present at the surface of this site within the proposed pavement areas. We have utilized a design CBR value of four (4) for the design of this pavement in consideration of the fat clay subgrade. The indicated design CBR value considers the clayey materials being compacted to a minimum of 95 percent of the maximum laboratory dry density as determined by ASTM D 698.

Specific design traffic types and volumes for this project were not available to PSI at the issuance of this report. However, we do understand that emergency firefighting vehicle traffic will make up a large portion of the drive areas. Traffic information is typically used to determine the number of 18-kip Equivalent Single Axle Loads (ESAL) that is applied to the pavement over its design life. In lieu of project specific design parameters and general trafficking, assumptions were used for this design. Based on this information, we have provided recommended pavement sections for "light duty" (automobile only), as well as increased capacity pavements constructed atop stable and properly prepared/compacted subgrades as previously recommended. Details regarding the basis for this design are presented in the table below.

| <b>Pavement Design Parameters (Rigid and Flexible)</b> |      |
|--|------|
| CBR, percent   | 4    |
| Reliability, percent                                   | 70   |
| Initial Serviceability Index, Flexible Pavement        | 4.2  |
| Initial Serviceability Index, Rigid Pavement           | 4.5  |
| Terminal Serviceability Index                          | 2.0  |
| Standard Deviation, Flexible Pavement                  | 0.45 |
| Standard Deviation, Rigid Pavement                     | 0.35 |

The presented recommended pavement sections are based on the field and laboratory test results for the project, local pavement design practice, design assumptions presented herein and our previous experience with similar projects. Light Duty pavements are presented and appropriate for areas receiving passenger vehicles and/or light truck traffic only. Higher capacity pavements are appropriate for fire-fighting vehicles, depending upon repetitions which should be selected by the project Civil Engineer. The project Civil Engineer should also verify that the ESAL values are within the expected traffic and design life of the project. PSI should be notified in writing if the assumptions or design parameters are incorrect or require modification.

| <b>Aggregate Base Pavement Sections</b> |   |
|---|---|
|   | <b>Equivalent Single Axle Load (ESAL)</b> |
| <b>Pavement Materials</b>               | Light Duty*<br>ESAL=25,000                |
| Flexible Base, in.                      | 16  |
| Lime Stabilized Subgrade, in.           | 6   |

\*automobile and light-truck traffic only.

| <b>Recommended Flexible Pavement Sections</b> |   |              |                |
|---|---|--------------|----------------|
|   | <b>Equivalent Single Axle Load (ESAL)</b> |              |                |
| <b>Pavement Materials</b>                     | ESAL=200,000                              | ESAL=500,000 | ESAL=1,000,000 |
| Asphaltic Concrete, in.                       | 2½  | 3            | 3½             |
| Flexible Base, in.                            | 9   | 10           | 10             |
| Lime Stabilized Subgrade, in.                 | 6   | 6            | 6              |

| <b>Recommended Rigid Pavement Sections</b> |   |                |
|--|---|----------------|
| <b>Pavement Materials</b>                  | <b>Equivalent Single Axle Load (ESAL)</b> |                |
|  | ESAL=1,650,000                            | ESAL=3,750,000 |
| Reinforced Concrete Thickness, in          | 7   | 8              |
| Lime Stabilized Subgrade, in.              | 6   | 6              |

PSI recommends the pavements to be utilized by the firefighting apparatus be a rigid pavement section. In areas subjected to very heavy wheel loads, heavy amounts of vehicle maneuvering or higher traffic volumes, we recommend that concrete pavements with a minimum thickness of seven (7) inches be used. The concrete pavements should be large enough to properly accommodate all vehicular traffic and loads. The concrete paving should extend beyond areas that undergo extensive turning, stopping or maneuvering. The pavement design engineer should consider this and other similar situations when planning and designing pavement areas.

We recommend that proper perimeter drainage be provided and maintained to reduce the infiltration of surface water into the pavement section from surrounding unpaved areas. We do not recommend the use of landscape beds or islands in paved areas as these features provide avenues for water to infiltrate the pavement section. The infiltration of water into the pavement section typically results in the degradation of the section with time as vehicular traffic traverses the affected area. If landscaping is desired, we recommend that above grade planter boxes that discharge water onto the top of the pavement be used.

In order to reduce potential for water/moisture infiltration into the pavement materials and pavement subgrade, we recommend designing and constructing pavement curbs that extend at least three (3) inches below the bottom of the base materials to help reduce the potential for water infiltration into the pavement section. Wick drains may also be installed behind the curbs to intercept and remove water from the pavement perimeter before the water infiltrates the pavement section. Furthermore, all concrete/asphalt interfaces should be sealed using a sealant that is compatible with both asphalt and concrete.

### **Pavement Material Specifications**

The following guidelines have been prepared for use in consideration for selection and preparation of various materials that may be used to construct the pavement sections. Submittals should be made for each pavement material and should be reviewed by the Geotechnical Engineer and other appropriate members of the design team. The submittals should provide the test information necessary to verify full compliance of the materials with the recommended or specified material properties for the project. The proposed materials to be used in construction should be approved in writing from the governing authority prior to beginning construction. Construction testing is an extension of the geotechnical exploration and pavement design. Conformance testing should be performed to document the actual field conditions at the time of construction, the observed construction practices and to assess that the materials used satisfy the project requirements. Additionally, underground utility construction may impact the pavement performance. Trench backfill above bedding and shading materials should be placed in maximum eight (8) inch loose lifts and each lift should be compacted to a minimum of 95 percent of the laboratory dry density as determined by ASTM D698 and should be observed and tested by the Geotechnical Engineer.

**Hot-Mix Asphaltic Courses** - The asphaltic concrete should be plant mixed, hot laid, Type D (fine) surface course meeting the 2004 TxDOT Standard Specification Item 340, where applicable. Based upon the TxDOT Standard Specifications, the mix should be compacted to between 92 and 97 percent of the maximum theoretical density as determined by TEX-227-F.

**Flexible Base Course** – Flexible base materials should be placed in maximum six (6) inch compacted lifts. The base materials should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557. Flexible base materials should

be moisture conditioned to between minus two (-2) and plus two (+2) percentage points of the optimum moisture content. Flexible base materials should meet all requirements specified or in 2004 TxDOT Standard Specification Item 247, Type A, Grade 1 or 2. Flexible base course should be tested to assess in-situ density and proofrolled under the observation of the geotechnical personnel to evaluate overall stability prior to asphaltic concrete placement.

In the aggregate base section, flexible base course materials will remain exposed to rain and other weather elements with unpaved sections. Therefore, grading should be performed such that the surface water freely runs off the pavement as much as possible. It should be realized that aggregate-surfaced pavements will experience some rutting as well as base material degradation due to abrasion from the traffic wheel loads. Furthermore, the surface water infiltration may soften both the subgrade and the base materials. Therefore, it is recommended that aggregate surface pavements be periodically maintained. A monthly maintenance program should include placing of additional crushed stone base materials within the potholes and other soft areas. Periodically, the maintenance program should also include the sprinkling of water on the surface to prevent dust pollution and to minimize the loss of fines from the base course materials. The maintenance program could be less frequent if the upper 1 to 2 inches of aggregates is treated with Emulsified Asphalt in accordance with Asphalt Institute MS-4 Section 8.2. Surface treatment involves spraying of a mixture of emulsified asphalt and water over the aggregate surface thus sealing or water-proofing the surface as well as preventing dust pollution and improving resistance to wheel-load abrasion. It is recommended to perform Emulsified Asphalt Surface Treatment for Aggregate surface roads and parking areas.

**Concrete** – Concrete used for paving should have a minimum compressive strength of 4,000 psi at 28 days. The air content at the point of placement should range from two (2) to four (4) percent. The concrete pavements should be reinforced, jointed and constructed per current ACI recommendations.

**Lime Treated Subgrade** – Exposed subgrade soils should be scarified and stabilized with lime to achieve a pH of 12.4 or greater. Based on the encountered expansive soils, we expect that a 6% by unit weight mixture will be required to treat the soils. A lime series pH test can be performed at the time of construction to select appropriate amount of lime mixture. Installation should be performed in general accordance with TXDOT Item 260. The degree of compaction and moisture content should be maintained until the surface is paved. Prior to lime stabilization, proofrolling with a loaded 20-ton dump truck or similar equipment under the observation of geotechnical personnel should be performed to observe that unusually soft soils are removed and replaced with compacted select fill prior to lime stabilization of the subgrade. Any select fill should have a PI in the 10 to 25 range and contain at least 35% material passing the #200 sieve.

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## CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundations, earthwork, pavements and related activities of this project. PSI cannot accept any responsibility for any conditions which deviate from those described in this report, nor for the performance of the foundations or pavements if not engaged to also provide construction observation and testing for this project.

### **Moisture Sensitive Soils/Weather Related Concerns**

Soils are sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork, foundation, and construction activities during dry weather.

### **Drainage Concerns**

Water should not be allowed to collect in foundation excavations, on foundation surfaces, or on prepared subgrades within the construction area either during or after construction. Excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff. Positive surface drainage at the site should be provided to reduce infiltration of surface water around the perimeter of the structure and beneath the structure foundation. The grades should be sloped away from the structure and the surface and roof drainage should be collected and discharged such that water is not permitted to infiltrate the building pad underlying the structure foundation.

### **Excavations**

As was discussed previously, sandy fat clay, clayey sand, and lean clay materials were encountered at this site. Typically, soils penetrated by geotechnical augers such as those encountered on this site can be removed with conventional earthmoving equipment.

It should be noted that excavation equipment varies and field conditions may vary. Generally, geologic processes (such as faulting, weathering, etc.) are erratic and large variations can occur in small vertical and/or lateral distances. Details regarding "means and methods" to accomplish the work (such as excavation equipment and technique selection) are the sole responsibility of the project contractor. The comments contained in this report are based on the observations of small diameter boreholes. The performance of large excavations may differ significantly as a result of the differences in excavation sizes.

The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926, Revised October 1989), require that excavations be constructed in accordance with the current OSHA guidelines. Furthermore, the State of Texas requires that detailed plans and specifications meeting OSHA standards be prepared for trench and excavation retention systems used during construction. We understand that these regulations are being strictly enforced, and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and Federal safety regulations.

We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties compliance with local, state, and Federal safety or other regulations.

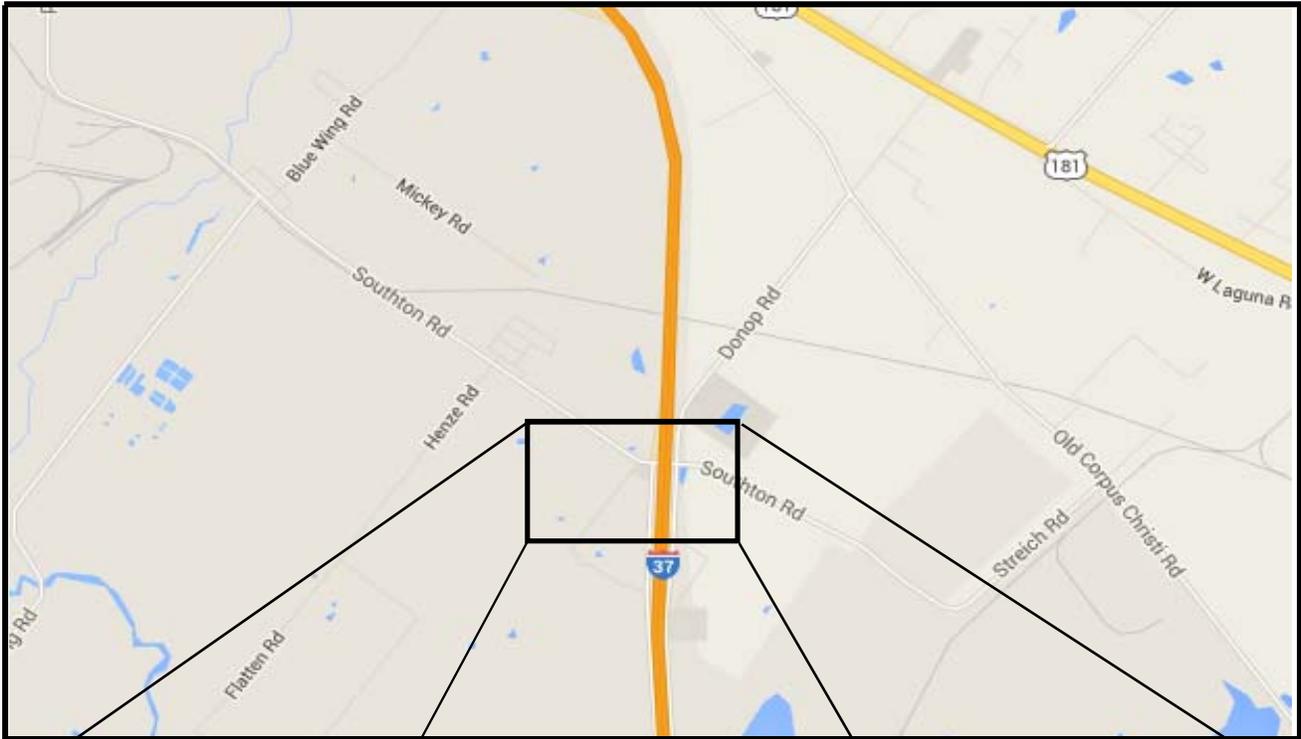
## REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by the client for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the recommendations presented in this report are required. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional Geotechnical Engineering practices in the local area. No other warranties are implied or expressed. This report may not be redistributed, copied or reproduced, except in its entirety, without the written consent of PSI.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplemental recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project. This report has been prepared for the exclusive use of the City of San Antonio for the specific application to the proposed Fire Station No. 53 to be located at the intersection of Donop Road and Southton Road in San Antonio, Texas.

# **APPENDIX**

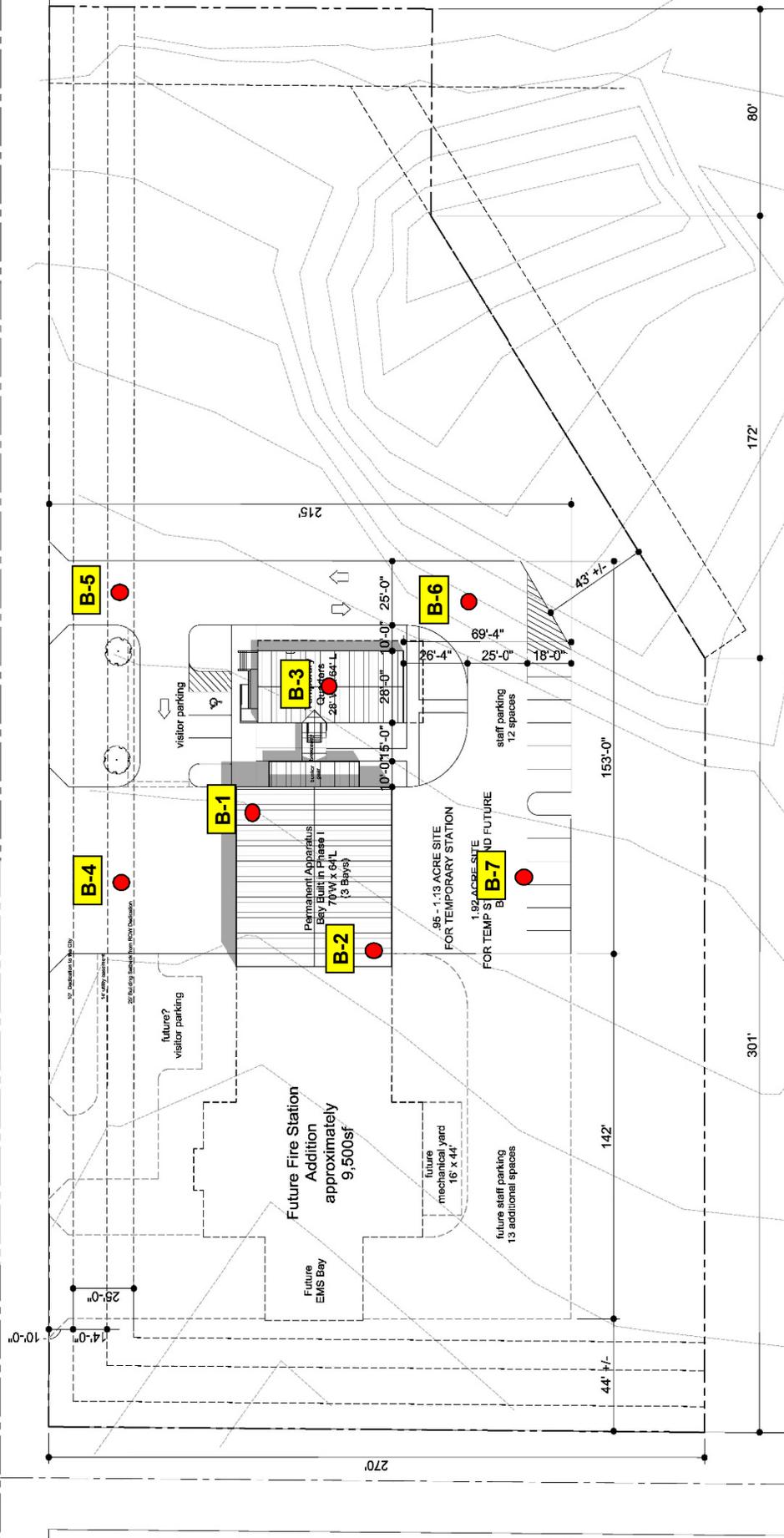


## SITE VICINITY MAP

|  |             |                        |
|--|-------------|------------------------|
| <b>Project Name and Location</b>   | <b>Date</b> | <b>PSI Project No.</b> |
| Proposed Fire Station No. 53<br>Donop Road & Southton Road<br>San Antonio, Texas | April 2016  | 0312-1314              |

***Professional Service Industries, Inc.***

DONOP ROAD



# BORING LOCATION PLAN

(Boring Locations are Approximate)

## Project Name and Location

Proposed Fire Station No. 53  
 Donop Road & Southton Road  
 San Antonio, Texas

## Date

April 2016

## PSI Project No.

0312-1314

Not to Scale

*Professional Service Industries, Inc.*

Fire Station No. 53  
Donop Road and Southton Road; San Antonio, Texas  
Project No. 0312-1314

BORING B-1

LOCATION: See Boring Location Plan

| DEPTH, FT. | SYMBOL SAMPLES | WATER | SOIL DESCRIPTION                                    | Elevation: | MOISTURE CONTENT | % RETAINED #4 | % PASSING #200 | SPT (N) & TCP (T) VALUES | % REC | %RQD | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | HAND PEN (TSF) ● UNC CMP (TSF) |     |     | UNCONF. COMP. (TSF) | UNIT DRY WT. (LB/CU FT) |
|------------|----------------|-------|---|------------|------------------|---------------|----------------|--------------------------|-------|------|--------------|---------------|------------------|--------------------------------|-----|-----|---------------------|-------------------------|
|            |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | 2.0                            | 4.0 | 6.0 |                     |                         |
|            |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | PL                             | WC  | LL  |                     |                         |
|            |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | 20                             | 40  | 60  |                     |                         |
|            |                |       | STRATUM II<br>MEDIUM DENSE. brown, CLAYEY SAND (SC) |            | 18               |               |                |                          |       |      | 47           | 15            | 32               |                                |     |     |                     |                         |
|            |                |       | STRATUM III<br>HARD, brown, FAT CLAY (CH) with SAND |            | 21               | 78            |                |                          |       |      | 66           | 16            | 50               |                                |     |     |                     |                         |
| 5          |                |       |   |            | 19               |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
|            |                |       | STRATUM IV<br>HARD, brown, FAT CLAY (CH)            |            | 19               | 94            |                |                          |       |      | 73           | 21            | 52               |                                |     |     |                     |                         |
| 10         |                |       |   |            | 18               |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
|            |                |       |   |            | 21               |               |                |                          |       |      | 71           | 22            | 49               |                                |     |     |                     |                         |
| 15         |                |       |   |            | 24               |               |                |                          |       |      |              |               |                  |                                |     |     | 3.51                | 103                     |
| 20         |                |       |   |            | 21               |               |                |                          |       |      | 66           | 18            | 48               |                                |     |     |                     |                         |
| 25         |                |       |   |            | 21               |               |                |                          |       |      |              |               |                  |                                |     |     | 5.83                | 106                     |
| 30         |                |       |   |            | 21               |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 35         |                |       | Boring terminated at 35 feet.                       |            |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |

GEO TESTS 0312-1314.GPJ RBENNETT GW.GDT 4/14/16

COMPLETION DEPTH: 35.0 Feet  
DATE: 3/31/16-3/31/16

DEPTH TO GROUND WATER  
SEEPAGE (ft.): NONE ENCOUNTERED  
END OF DRILLING (ft.): NONE OBSERVED  
DELAYED WATER LEVEL (FT): N/A



Fire Station No. 53  
Donop Road and Southton Road; San Antonio, Texas  
Project No. 0312-1314

BORING B-2

LOCATION: See Boring Location Plan

| DEPTH, FT. | SYMBOL SAMPLES WATER | SOIL DESCRIPTION                                    | MOISTURE CONTENT | % RETAINED #4 | % PASSING #200 | SPT (N) & TCP (T) VALUES | % REC | %RQD | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | HAND PEN (TSF)    UNC CMP (TSF) |     |     | UNCONF. COMP. (TSF) | UNIT DRY WT. (LB/CU FT) |
|------------|----------------------|---|------------------|---------------|----------------|--------------------------|-------|------|--------------|---------------|------------------|---------------------------------|-----|-----|---------------------|-------------------------|
|            |                      |   |                  |               |                |                          |       |      |              |               |                  | 2.0                             | 4.0 | 6.0 |                     |                         |
|            |                      | <b>Elevation:</b>                                   |                  |               |                |                          |       |      |              |               |                  | PL                              | WC  | LL  |                     |                         |
|            |                      | STRATUM II<br>MEDIUM DENSE, brown, CLAYEY SAND (SC) | 18               |               | 47             |                          |       |      | 47           | 18            | 29               | 20                              | 40  | 60  |                     |                         |
| 5          |                      |   | 16               |               |                |                          |       |      |              |               |                  |                                 |     |     |                     |                         |
|            |                      |   | 17               |               | 49             |                          |       |      | 47           | 16            | 31               |                                 |     |     |                     |                         |
|            |                      |   | 17               |               |                |                          |       |      |              |               |                  |                                 |     |     |                     |                         |
| 10         |                      | STRATUM III<br>HARD, brown, FAT CLAY (CH) with SAND | 24               |               |                |                          |       |      | 69           | 16            | 53               |                                 |     |     |                     |                         |
|            |                      |   | 20               |               |                |                          |       |      |              |               |                  |                                 |     |     |                     |                         |
| 15         |                      |   | 21               |               |                |                          |       |      |              |               |                  |                                 |     |     |                     |                         |
| 20         |                      |   | 21               |               |                |                          |       |      |              |               |                  |                                 |     |     |                     |                         |
| 25         |                      |   | 23               |               |                |                          |       |      |              |               |                  |                                 |     |     | 2.52                | 102                     |
| 30         |                      |   | 24               |               |                |                          |       |      | 65           | 21            | 44               |                                 |     |     |                     |                         |
| 35         |                      |   | 22               |               |                |                          |       |      |              |               |                  |                                 |     |     | 4.58                | 102                     |
|            |                      | Boring Terminated at 35 feet.                       |                  |               |                |                          |       |      |              |               |                  |                                 |     |     |                     |                         |

GEO TESTS 0312-1314.GPJ RBENNETT GW.GDT 4/14/16

COMPLETION DEPTH: 35.0 Feet  
DATE: 3/31/16-3/31/16

DEPTH TO GROUND WATER  
SEEPAGE (ft.): NONE ENCOUNTERED  
END OF DRILLING (ft.): NONE OBSERVED  
DELAYED WATER LEVEL (FT): N/A



Fire Station No. 53  
Donop Road and Southton Road; San Antonio, Texas  
Project No. 0312-1314

BORING B-3

LOCATION: See Boring Location Plan

| DEPTH, FT. | SYMBOL SAMPLES | WATER | SOIL DESCRIPTION                                    | Elevation: | MOISTURE CONTENT | % RETAINED #4 | % PASSING #200 | SPT (N) & TCP (T) VALUES | % REC | %RQD | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | HAND PEN (TSF)    UNC CMP (TSF) |     |     | UNCONF. COMP. (TSF) | UNIT DRY WT. (LB/CU FT) |
|------------|----------------|-------|---|------------|------------------|---------------|----------------|--------------------------|-------|------|--------------|---------------|------------------|---------------------------------|-----|-----|---------------------|-------------------------|
|            |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | 2.0                             | 4.0 | 6.0 |                     |                         |
|            |                |       | STRATUM I<br>STIFF, brown, SANDY LEAN CLAY (CL)     |            | 20               | 55            |                |                          |       |      | 48           | 16            | 31               | ●                               | ×   | ●   |                     |                         |
|            |                |       | STRATUM III<br>HARD, brown, FAT CLAY (CH) with SAND |            | 19               | 74            |                |                          |       |      | 67           | 15            | 52               | ○                               | ×   | ○   |                     |                         |
| 5          |                |       | STRATUM IV<br>HARD, brown, FAT CLAY (CH)            |            | 18               | 90            |                |                          |       |      |              |               |                  | ○                               | ×   | ○   |                     |                         |
|            |                |       |   |            | 20               |               |                |                          |       |      | 75           | 19            | 56               | ○                               | ×   | ○   |                     |                         |
| 10         |                |       |   |            | 19               |               |                |                          |       |      |              |               |                  | ○                               | ×   | ○   |                     |                         |
|            |                |       |   |            | 22               |               |                |                          |       |      |              |               |                  | ○                               | ×   | ○   |                     |                         |
| 15         |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | ○                               | ×   | ○   |                     |                         |
| 20         |                |       |   |            |                  |               |                |                          |       |      | 60           | 20            | 40               | ○                               | ×   | ○   |                     |                         |
| 25         |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | ○                               | ×   | ○   | 4.14                | 107                     |
| 30         |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | ○                               | ×   | ○   |                     |                         |
| 35         |                |       |   |            |                  |               |                |                          |       |      |              |               |                  | ○                               | ×   | ○   |                     |                         |
|            |                |       | Boring terminated at 35 feet.                       |            |                  |               |                |                          |       |      |              |               |                  |                                 |     |     |                     |                         |

GEO TESTS 0312-1314.GPJ RBENNETT GW.GDT 4/14/16

COMPLETION DEPTH: 35.0 Feet  
DATE: 3/31/16-3/31/16

DEPTH TO GROUND WATER  
SEEPAGE (ft.): NONE ENCOUNTERED  
END OF DRILLING (ft.): NONE OBSERVED  
DELAYED WATER LEVEL (FT): N/A



Fire Station No. 53  
Donop Road and Southton Road; San Antonio, Texas  
Project No. 0312-1314

BORING B-4

LOCATION: See Boring Location Plan

| DEPTH, FT. | SYMBOL | SAMPLES | WATER | SOIL DESCRIPTION                                    | MOISTURE CONTENT | % RETAINED #4 | % PASSING #200 | SPT (N) & TCP (T) VALUES | % REC | %RQD | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | <span style="color: green;">○</span> HAND PEN (TSF) <span style="color: purple;">●</span> UNC CMP (TSF) |     |     | UNCONF. COMP. (TSF) | UNIT DRY WT. (LB/CU FT) |
|------------|--------|---------|-------|---|------------------|---------------|----------------|--------------------------|-------|------|--------------|---------------|------------------|---|-----|-----|---------------------|-------------------------|
|            |        |         |       |   |                  |               |                |                          |       |      |              |               |                  | 2.0   | 4.0 | 6.0 |                     |                         |
|            |        |         |       | Elevation:  |                  |               |                |                          |       |      |              |               |                  | PL  | WC  | LL  |                     |                         |
| 18         |        |         |       | STRATUM I<br>STIFF, brown, SANDY LEAN CLAY (CL)     | 18               |               |                |                          |       |      | 47           | 16            | 31               | ●   |     |     |                     |                         |
| 19         |        |         |       |   | 19               | 52            |                |                          |       |      | 45           | 15            | 30               | ○   |     |     |                     |                         |
| 21         |        |         |       |   | 21               |               |                | 7                        |       |      |              |               |                  |   |     |     |                     |                         |
| 20         |        |         |       | STRATUM II<br>MEDIUM DENSE, brown, CLAYEY SAND (SC) | 20               | 48            |                | 10                       |       |      |              |               |                  |   |     |     |                     |                         |
| 20         |        |         |       |   | 20               |               |                | 17                       |       |      |              |               |                  |   |     |     |                     |                         |
|            |        |         |       | Boring terminated at 10 feet.                       |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |

GEO TESTS 0312-1314.GPJ RBENNETT GW.GDT 4/14/16

COMPLETION DEPTH: 10.0 Feet  
DATE: 3/31/16-3/31/16

DEPTH TO GROUND WATER  
SEEPAGE (ft.): NONE ENCOUNTERED  
END OF DRILLING (ft.): NONE OBSERVED  
DELAYED WATER LEVEL (FT): N/A



Fire Station No. 53  
Donop Road and Southton Road; San Antonio, Texas  
Project No. 0312-1314

BORING B-5

LOCATION: See Boring Location Plan

| DEPTH, FT. | SYMBOL SAMPLES WATER | SOIL DESCRIPTION                                     | MOISTURE CONTENT | % RETAINED #4 | % PASSING #200 | SPT (N) & TCP (T) VALUES | % REC | %RQD | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | HAND PEN (TSF) ● UNC CMP (TSF) |     |     | UNCONF. COMP. (TSF) | UNIT DRY WT. (LB/CU FT) |
|------------|----------------------|--|------------------|---------------|----------------|--------------------------|-------|------|--------------|---------------|------------------|--------------------------------|-----|-----|---------------------|-------------------------|
|            |                      |  |                  |               |                |                          |       |      |              |               |                  | 2.0                            | 4.0 | 6.0 |                     |                         |
|            |                      | Elevation:   |                  |               |                |                          |       |      |              |               |                  | PL                             | WC  | LL  |                     |                         |
|            |                      | STRATUM I<br>VERY STIFF, brown, SANDY LEAN CLAY (CL) | 15               |               |                |                          |       |      | 34           | 12            | 22               | ●                              | ○   | ●   |                     |                         |
|            |                      |  | 19               |               |                |                          |       |      |              |               |                  | ○                              | ○   |     |                     |                         |
| 5          |                      | STRATUM IV<br>HARD, brown, FAT CLAY (CH)             | 18               | 88            |                |                          |       |      | 63           | 19            | 44               | ●                              | ○   | ●   |                     |                         |
|            |                      |  | 17               |               |                |                          |       |      |              |               |                  | ○                              | ○   |     |                     |                         |
|            |                      |  | 16               |               |                |                          |       |      |              |               |                  | ○                              | ○   |     |                     |                         |
| 10         |                      | Boring terminated at 10 feet.                        |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 15         |                      |  |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 20         |                      |  |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 25         |                      |  |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 30         |                      |  |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 35         |                      |  |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 40         |                      |  |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |

GEO TESTS 0312-1314.GPJ RBENNETT GW.GDT 4/14/16

COMPLETION DEPTH: 10.0 Feet  
DATE: 3/31/16-3/31/16

DEPTH TO GROUND WATER  
SEEPAGE (ft.): NONE ENCOUNTERED  
END OF DRILLING (ft.): NONE OBSERVED  
DELAYED WATER LEVEL (FT): N/A



Fire Station No. 53  
Donop Road and Southton Road; San Antonio, Texas  
Project No. 0312-1314

BORING B-6

LOCATION: See Boring Location Plan

| DEPTH, FT. | SYMBOL SAMPLES WATER | SOIL DESCRIPTION  | MOISTURE CONTENT | % RETAINED #4 | % PASSING #200 | SPT (N) & TCP (T) VALUES | % REC | %RQD | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | HAND PEN (TSF) ● UNC CMP (TSF) |     |     | UNCONF. COMP. (TSF) | UNIT DRY WT. (LB/CU FT) |
|------------|----------------------|---|------------------|---------------|----------------|--------------------------|-------|------|--------------|---------------|------------------|--------------------------------|-----|-----|---------------------|-------------------------|
|            |                      |   |                  |               |                |                          |       |      |              |               |                  | 2.0                            | 4.0 | 6.0 |                     |                         |
|            |                      | Elevation:  |                  |               |                |                          |       |      |              |               |                  | PL                             | WC  | LL  |                     |                         |
|            |                      |   |                  |               |                |                          |       |      |              |               |                  | 20                             | 40  | 60  |                     |                         |
| 19         |                      | STRATUM I<br>STIFF to HARD, brown, SANDY LEAN CLAY (CL) | 19               |               |                |                          |       |      |              |               |                  | ○                              | ○   | ○   |                     |                         |
| 17         |                      |   | 17               | 54            |                |                          |       | 48   | 15           | 33            |                  | ●                              | ●   | ●   |                     |                         |
| 23         |                      |   | 23               |               |                |                          |       |      |              |               |                  | ○                              | ○   | ○   |                     |                         |
| 19         |                      |   | 19               |               |                |                          |       |      |              |               |                  | ○                              | ○   | ○   |                     |                         |
| 25         |                      |   | 25               |               |                |                          |       |      |              |               |                  | ○                              | ○   | ○   |                     |                         |
| 10         |                      | Boring terminated at 10 feet.                           |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 15         |                      |   |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 20         |                      |   |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 25         |                      |   |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 30         |                      |   |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 35         |                      |   |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |
| 40         |                      |   |                  |               |                |                          |       |      |              |               |                  |                                |     |     |                     |                         |

GEO TESTS 0312-1314.GPJ RBENNETT GW.GDT 4/14/16

COMPLETION DEPTH: 10.0 Feet  
DATE: 3/31/16-3/31/16

DEPTH TO GROUND WATER  
SEEPAGE (ft.): NONE ENCOUNTERED  
END OF DRILLING (ft.): NONE OBSERVED  
DELAYED WATER LEVEL (FT): N/A



Fire Station No. 53  
Donop Road and Southton Road; San Antonio, Texas  
Project No. 0312-1314

BORING B-7

LOCATION: See Boring Location Plan

| DEPTH, FT. | SYMBOL SAMPLES WATER | SOIL DESCRIPTION                                     | MOISTURE CONTENT | % RETAINED #4 | % PASSING #200 | SPT (N) & TCP (T) VALUES | % REC | %RQD | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | <span style="color: green;">○</span> HAND PEN (TSF) <span style="color: purple;">●</span> UNC CMP (TSF) |     |     | UNCONF. COMP. (TSF) | UNIT DRY WT. (LB/CU FT) |
|------------|----------------------|--|------------------|---------------|----------------|--------------------------|-------|------|--------------|---------------|------------------|---|-----|-----|---------------------|-------------------------|
|            |                      |  |                  |               |                |                          |       |      |              |               |                  | 2.0   | 4.0 | 6.0 |                     |                         |
|            |                      | Elevation:   |                  |               |                |                          |       |      |              |               |                  | PL  | WC  | LL  |                     |                         |
|            |                      |  |                  |               |                |                          |       |      | 20           | 40            | 60               |   |     |     |                     |                         |
| 16         |                      | STRATUM I<br>VERY STIFF, brown, SANDY LEAN CLAY (CL) | 16               |               |                |                          |       |      | 45           | 14            | 31               | ●   | ○   | ●   |                     |                         |
| 18         |                      |  | 18               |               |                |                          |       |      |              |               |                  | ○   |     |     |                     |                         |
| 21         |                      |  | 21               |               |                |                          |       |      |              |               |                  | ○   |     |     |                     |                         |
| 22         |                      |  | 22               |               |                |                          |       |      | 44           | 15            | 29               | ●   | ○   | ●   |                     |                         |
| 24         |                      |  | 24               |               |                |                          |       |      |              |               |                  | ○   |     |     |                     |                         |
| 10         |                      | Boring terminated at 10 feet.                        |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |
| 15         |                      |  |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |
| 20         |                      |  |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |
| 25         |                      |  |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |
| 30         |                      |  |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |
| 35         |                      |  |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |
| 40         |                      |  |                  |               |                |                          |       |      |              |               |                  |   |     |     |                     |                         |

GEO TESTS 0312-1314.GPJ RBENNETT GW.GDT 4/14/16

COMPLETION DEPTH: 10.0 Feet  
DATE: 3/31/16-3/31/16

DEPTH TO GROUND WATER  
SEEPAGE (ft.): NONE ENCOUNTERED  
END OF DRILLING (ft.): NONE OBSERVED  
DELAYED WATER LEVEL (FT): N/A



# Symbol Key Sheet

## Material Symbols

|  |              |  |                    |  |                   |  |                   |  |                    |
|--|--------------|--|--------------------|--|-------------------|--|-------------------|--|--------------------|
|  | "FILL"       |  | Clay (CH)          |  | Sandy Clay (CL)   |  | Silty Clay (CL)   |  | Lean Clay (CL)     |
|  | Asphalt      |  | Clayey Sand (SC)   |  | Sand (SP)         |  | Silty Sand (SM)   |  | Gravelly Sand (SP) |
|  | Base         |  | Clayey Silt (ML)   |  | Sandy Silt (ML)   |  | Silt (ML)         |  | Gravelly Silt (ML) |
|  | Concrete     |  | Clayey Gravel (GC) |  | Sandy Gravel (GP) |  | Silty Gravel (GM) |  | Gravel (GP or GW)  |
|  | Conglomerate |  | Limestone          |  | Marl              |  | Sandstone         |  | Shale              |

### Strength of Cohesive Soils

| Consistency | Undrained Shear Strength, KSF |
|-------------|-------------------------------|
| Very Soft   | less than 0.25                |
| Soft        | 0.25 to 0.50                  |
| Firm        | 0.50 to 1.00                  |
| Stiff       | 1.00 to 2.00                  |
| Very Stiff  | 2.00 to 4.00                  |
| Hard        | greater than 4.00             |

### Soil Plasticity

| Degree of Plasticity | Plasticity Index (PI) |
|----------------------|-----------------------|
| None                 | 0 to 5                |
| Low                  | 5 to 10               |
| Moderate             | 10 to 20              |
| Plastic              | 20 to 40              |
| Highly Plastic       | more than 40          |

### Density of Granular Soils

| Descriptive Term | SPT Blow Count (blows/ft) |
|------------------|---------------------------|
| Very Loose       | less than 4               |
| Loose            | 4 to 10                   |
| Medium Dense     | 10 to 30                  |
| Dense            | 30 to 50                  |
| Very Dense       | more than 50              |

## Standard Penetration Test (ASTM D 1586) Driving Record

Note: Driving is limited to 50 blows per interval, or 25 blows for 0.25 inch advancement, whichever controls. This is done to avoid damaging sampling tools.

### Blows Per Foot

### Description

|        |  |
|--------|--|
| 25     | Sampler was seated 6 inches, then 25 blows were required to advance the sampler 12 inches.   |
| 75/8"  | Sampler was seated 6 inches, 25 blows were required for the second 6 inch increment and the 50 blow limit was reached at 2 inches of the last increment. |
| Ref/2" | Sampler could only be driven 2 inches of the 6 inch seating penetration before the 50 blow limit was reached.  |

## Terms Characterizing Structure

### Soil Terms

### Description

|                   |   |
|-------------------|---|
| Blocky            | Contains cracks or failure planes resulting in rough cubes of material.   |
| Calcareous        | Contains appreciable quantities of calcium carbonate.   |
| Fissured          | Contains shrinkage cracks, which are frequently filled with fine sand or silt. The fissures are usually near vertical in orientation. |
| Interbedded       | Composed of alternating layers of different soil types.   |
| Laminated         | Composed of thin layers of varying color and texture.   |
| Nodules           | Secondary inclusions that appear as small lumps about 0.1 to 0.3 inch in diameter.  |
| Partings          | Inclusion of different material less than 1/8 inch thick extending through the sample.  |
| Pockets           | Inclusion of different material that is smaller than the diameter of the sample.  |
| Seams             | Inclusion of different material between 1/8 and 3 inches thick, and extends through the sample.                                       |
| Slickensided      | Has inclined planes of weakness that are slick and glossy in appearance. Slickensides are commonly thought to be randomly oriented.   |
| Streaks or Stains | Stains of limited extent that appear as short stripes, spots or blotches.   |

### Rock Terms

|                                |   |
|--------------------------------|---|
| Bedding Plane                  | A surface parallel to the surface of deposition, generally marked by changes in color or grain size.                      |
| Fracture                       | A natural break in rock along which no displacement has occurred.   |
| Joint                          | A natural break along which no displacement has occurred, and which generally intersects primary surfaces.                |
| % Recovery                     | The ratio of total length of recovery to the total length of core run, expressed as a percentage.                         |
| RQD - Rock Quality Designation | The ratio of total recovered length of fragments longer than 4 inches to the total run length, expressed as a percentage. |
| Weathering                     | The process by which rock is broken down and decomposed.  |

## Sampler Symbols

|  |              |  |             |  |                            |  |             |  |             |  |                              |  |            |
|--|--------------|--|-------------|--|----------------------------|--|-------------|--|-------------|--|------------------------------|--|------------|
|  | Flight Auger |  | Core Barrel |  | Disturbed Shelby Tube (3") |  | No Recovery |  | Grab Sample |  | Undisturbed Shelby Tube (3") |  | SPT Sample |
|--|--------------|--|-------------|--|----------------------------|--|-------------|--|-------------|--|------------------------------|--|------------|



CITY OF SAN ANTONIO  
TRANSPORTATION & CAPITAL IMPROVEMENTS

RECEIPT OF ADDENDUM NUMBER(S) 2 IS HEREBY ACKNOWLEDGED FOR PLANS AND SPECIFICATIONS FOR CONSTRUCTION OF FIRE STATION # 53 – 20-00045A FOR WHICH BIDS WILL BE OPENED ON TUESDAY, MAY 31, 2016 AT 2:00 P.M.

THIS ACKNOWLEDGEMENT MUST BE SIGNED AND RETURNED WITH THE BID PACKAGE.

Company Name: \_\_\_\_\_

Address: \_\_\_\_\_

City/State/Zip Code: \_\_\_\_\_

Date: \_\_\_\_\_

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Print Name/Title