BURGE • MARTINEZ CONSULTING, INC.

REPORT OF

GEOTECHNICAL ENGINEERING STUDY

FIRE STATION #2
W. VILLARET BOULEVARD & S. ZARZAMORA STREET
SAN ANTONIO, TEXAS
BMC PROJECT NO. 12-12-0103

FOR

CITY OF SAN ANTONIO – CIMS DEPARTMENT
114 W. COMMERCE STREET, 4TH FLOOR
SAN ANTONIO, TEXAS 78205

MAY 14, 2012

BURGE • MARTINEZ CONSULTING, INC.
Geotechnical Engineering • Environmental • Testing

May 14, 2012

Mr. Mark Beavers
City of San Antonio
Capital Improvements Management Services Department
114 W. Commerce Street, 4th Floor
San Antonio, Texas 78205

RE: Geotechnical Engineering Study
Fire Station #2
W. Villaret Boulevard & S. Zarzamora Street
San Antonio, Texas
BMC Project No. 12-12-0103

Dear Mr. Beavers:

Burge-Martinez Consulting, Inc. (BMC) has completed the subsurface exploration and geotechnical engineering analysis for the above-referenced project, in general accordance with BMC Proposal No. P12-12-005-R, revised April 3, 2012. Our report, which includes the results of our subsurface exploration program, laboratory testing program, and geotechnical engineering analysis, is enclosed with this letter.

Based on the results of our field exploration program, the site is considered suitable for the proposed development, provided that the recommendations enclosed in this report are followed.

We appreciate the opportunity to be of service to you during the design phase of this project. We look forward to continuing our involvement with this project during the construction phase by providing the special inspection and construction materials testing services. If you have any questions regarding the information contained in this report or if we can be of further assistance to you, please feel free to contact us.

Respectfully submitted,
BURGE•MARTINEZ CONSULTING, INC.
Texas Registered Engineering Firm F-7740
Geotechnical Engineering Services

5/14/12

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PROJECT OVERVIEW

Project Location

This report presents the results of our subsurface exploration and engineering analysis for the proposed Fire Station #2. The project site is located at the southeast corner of the W. Villaret Boulevard and S. Zarzamora Street Intersection in San Antonio, Texas. The approximate site location is illustrated on the *Site Vicinity Map* provided in the Appendix.

Scope of Work

The conclusions and recommendations contained in this report are based on eight (8) soil borings (B-1 through B-8) performed by Alpha Omega Drilling Services, Inc. on April 23, 2012. Borings B-1 through B-3 were drilled within the building footprint of the proposed structure and extended to a termination depth of 30 feet below existing ground surface elevations. Borings B-4 through B-8 were drilled in the proposed pavement areas and extended to a termination depth of 10 feet below existing ground surface elevations.

Proposed Construction

Based on information provided to us, the project will consist of the design and construction of an approximate 12,000 square-foot facility with associated parking and drive areas on the 3.286-acre property. The building is to include an EMT Apparatus Bay, a Fire Apparatus Bay, and the main Fire Station. The proposed single-story structure will have service loads of approximately 50 kips if supported by a monolithic slab-on-grade foundation system; however, the loads may be on the order of 200 kips if the structure is supported by drilled piers in conjunction with a structurally suspended floor slab. The proposed construction is shown in relation to the soil borings on the *Boring Location Plan*, provided in the Appendix.

It should be noted that BMC was not provided with detailed structural information, finished floor elevations, or proposed traffic loading conditions. Based on our understanding of the proposed construction, cut/fill requirements for grading purposes within the proposed building will be approximately 2± feet. BMC should be notified if cut/fill requirements are over two (2) feet within the building area, particularly for any grade-supported structure, as this may affect the recommendations provided herein.

The *Boring Location Plan* was developed from the conceptual site plan prepared by Ford, Powell & Carson, Inc., dated March 29, 2012. The locations of the boreholes were provided by the design team prior to our subsurface exploration activities. Elevations noted on the borings logs were estimated from the preliminary grading information provided on the Draft Topographic Survey provided by Vickrey & Associates, Inc. Furthermore, the borings were located in the field using pacing/taping procedures from existing structures/landmarks identified on the available site plans.

Purposes of Exploration

The purposes of this study were to explore the subsurface soil and groundwater conditions at the site and to develop engineering recommendations to guide design and construction of the soil supported elements of the project. We accomplished these purposes by:

1. reviewing available geologic and soil survey maps of the project area,
2. drilling eight (8) borings to explore the subsurface soil and groundwater conditions,
3. performing laboratory tests on selected representative soil samples from the borings to evaluate pertinent engineering properties, and
4. analyzing the field and laboratory data to develop appropriate engineering recommendations.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

The soil borings conducted as part of BMC's field exploration program were performed with a standard, truck-mounted drill rig, which utilized continuous solid-stem flight augers to advance the boreholes. No drilling fluid was utilized during drilling operations. Upon completion of drilling, the boreholes were backfilled with spoils generated during the drilling process and the excess spoils were mounded over the boreholes.

Representative samples of the subsurface soil were obtained employing both Shelby Tube samplers in accordance with ASTM D-1587 and split-spoon sampling procedures in general accordance with ASTM D-1586. The Shelby Tube sampler collects an undisturbed soil sample by pushing a sampler tube into the undisturbed soil and extruding the sample from the tube with a hydraulic ram. The split-spoon sampler collects relatively disturbed samples at selected depths in the borings by driving a standard two (2) inch outer diameter split-spoon sampler 18 inches into the subsurface material using a 140 pound hammer falling 30 inches. The number of blows required to drive the split-spoon sampler the final 12 inches of penetration (N-value) is recorded in the "SPT N-value" column of the boring logs. Where limited sample was recovered, grab samples were collected directly off of the flight augers.

The drilling crew maintained field logs of the soil and groundwater conditions encountered in the borings. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were then placed into plastic bags that were sealed and delivered to our laboratory for further visual examination and testing.

Laboratory Testing Program

Representative soil samples were selected and tested in our laboratory to check field classifications and to determine pertinent engineering properties. The laboratory testing program included visual classifications, moisture content tests, Atterberg Limits tests, pocket penetrometer readings, sieve analyses with hydrometer, and soluble sulfate analyses. Visual classifications conducted in the laboratory were performed by a licensed professional engineer. All data obtained from the laboratory tests are included on the respective boring logs in the Appendix.

Each soil sample was classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS). A brief explanation of the USCS is included with this report. The various soil types were grouped into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs are approximate; in situ, the transitions may be gradual.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received by the client.

EXPLORATION RESULTS

Site Conditions

At the time of our field exploration, the proposed site was undeveloped and covered with native grasses, brush, and a few trees. Prior to our exploration program, the property was shredded due to the vegetation being highly overgrown. Miscellaneous debris (asphalt, concrete, and construction debris) and fill soil from promiscuous dumping was observed spread across areas of the site, which included a large pile of fill material near the eastern property boundary.

The property had fair drainage and generally slopes downward toward the east and southeast adjacent properties. The grades on the property range from approximately 656 feet at the intersection of W. Villaret and S. Zarzamora to 648 feet at the southeast corner of the property. The adjacent properties include undeveloped land and residential developments.

Regional Geology and Soil Survey

According to the Bureau of Economic Geology at The University of Texas at Austin, Geologic Atlas of Texas, San Antonio Sheet, the proposed site is located in the Uvalde Gravel (Q-Tu) overlying the Wilcox Group (Ewi). The Uvalde Gravel deposits are found along topographically high areas and consist of caliche-cemented gravel. Thickness ranges from several feet to 20± feet. The Wilcox Group consists of mudstone with varying amounts of sandstone and lignite. Material is commonly glauconitic in the uppermost and lowermost parts. Mudstone is massive to thin-bedded, some silt and very fine sand laminae, pale brown to yellowish brown in upper part, and medium to dark gray in lower part. Sandstone in upper part is medium to fine-grained and light gray to pale yellowish brown, while lower part is fine-grained and yellowish brown to brown. Lignite is mostly found in middle part. Thickness is about 440 to 1,200 feet.

The Soil Survey of Bexar County, Texas published by the United States Department of Agriculture, National Cooperative Soil Survey, indicates that the shallow soils in the general vicinity of the site are classified as Houston Black Gravelly Clay, 1 to 3 percent slopes (HuB). These soils crack when dry and swell when wet. Runoff is slow to medium for these clays depending on the water content of the soil, so water erosion is a hazard.

The Houston Black Gravelly Clay occurs along long, smooth, convex slopes on uplands or as undulating slopes along drainageways. The surface layer is black clay that is about 38 inches thick with up to 18 percent gravel, by volume. The subsurface layer is clay or gravelly clay about 12 inches thick. The gravel in this layer is discontinuous, but where it occurs it can contain between 30 and 60 percent gravel, by volume. The underlying material is very pale brown, calcareous clay or marl and has mottles of olive brown and gray.

Soil Conditions

The natural, near surface deposits, which were studied by our field exploration program, are consistent with the regional geology and soil survey. Below any surfacing materials (topsoil, fill material, etc.), the soils encountered at our boring locations generally consisted of expansive clayey soils with an intermediate layer of sand/gravel.

Based on our observations at the time of our field exploration activities, the stratigraphy of the subsurface materials at this site can generally be described as presented in the following table:

Table 1: Subsurface Soil Conditions

Stratum	Range in Depth (ft)	Soil Description and Classification
I	0 – 6	Very stiff to hard, dark grayish brown to brown FAT CLAY (CH) with varying amounts of gravel and calcareous deposits
II	4.5 – 23	Very stiff to hard, brown to brown and tan LEAN CLAY (CL) or FAT CLAY (CH) with varying amounts of sand, gravel, and calcareous deposits or dense to very dense, brown to tan CLAYEY SAND (SC) with gravel or cemented CLAYEY GRAVEL (GC)
III	13 – 30	Hard, gray to gray and tan FAT CLAY (CH) with orange silt seams

Possible FILL: Although not specifically identified in the borings, any undocumented fill material (FILL) on the property due to past operations on the site should be evaluated during grading operations as recommended herein to determine it's suitability for re-use or for support of any pavements.

Any unsuitable fill materials encountered during grading should be removed and replaced with suitable select structural fill material or general fill material, as specified in the following sections of this report. All trash, brush, and asphalt/concrete debris encountered during grading should be removed and properly disposed of off-site.

Stratum I – This stratum was comprised of very stiff to hard, dark grayish brown to brown FAT CLAY (CH) with varying amounts of gravel and calcareous deposits. Atterberg Limits tests conducted on representative samples of this clay indicated this soil has Liquid Limits (LL's) ranging from 55 to 69 with corresponding Plasticity Indices (PI's) ranging from 34 to 46. Based on these measured indices, this clay has a high to very high potential for large changes in volume if fluctuations in the clay's moisture content occur.

Stratum II – This stratum was comprised of very stiff to hard, brown to brown and tan LEAN CLAY (CL) and FAT CLAY (CH) with varying amounts of sand, gravel, and calcareous deposits or dense to very dense, brown to tan CLAYEY SAND (SC) with gravel or cemented CLAYEY GRAVEL (GC). Atterberg Limits tests conducted on representative samples of this stratum indicated these soils have LL's ranging from 36 to 56 with corresponding PI's ranging from 18 to 36. Sieve analysis conducted on representative samples of this stratum indicated that

43 to 78 percent, by dry weight, passes the No. 200 Sieve and 11 to 31 percent, by dry weight, is retained on the #4 Sieve. Based on these measured indices, this stratum has a low to high potential for changes in volume if fluctuations in the soil's moisture content occur.

Stratum IV – This stratum was comprised of hard, gray to gray and tan FAT CLAY (CH) with orange silt seams at greater depths. Atterberg Limits tests conducted on representative samples of this clay indicated this soil has LL's ranging from 79 to 82 with corresponding PI's ranging from 56 to 57. Based on our past experience with this geology, this stratum is to continue to greater depths and will become harder with increasing depth. Since the zone of seasonal moisture fluctuations within the San Antonio area is approximately 15 feet, it is generally accepted practice by local Geotechnical Engineers to take the active zone as being 15 feet. Therefore, this stratum is not expected to undergo significant volumetric changes due to seasonal rainfall conditions.

Groundwater Observations

Groundwater was not encountered during drilling operations. Observations for groundwater were made during sampling and upon completion of the drilling operations. In dry auger drilling operations, water is not introduced into the boreholes, and the groundwater position can often be determined by observing water flowing into or out of the borehole. Furthermore, visual observation of the soil samples retrieved during the auger drilling operations can often be used in evaluating the groundwater conditions. It should be noted that groundwater conditions can fluctuate due to seasonal and climatic variations, and should be measured (checked) prior to construction activities.

ANALYSIS AND RECOMMENDATIONS

The following recommendations are based on the eight (8) borings performed at the site, laboratory test results, and the limited design information provided to us. Based on the available information, cut/fill requirements for grading purposes within the proposed building will be approximately 2± feet. We recommend that if there are any changes to the project characteristics as discussed in this report, BMC should be retained to review them so it can be determined if changes to the recommendations are necessary.

Based upon the proposed construction, this study includes recommendations for supporting the proposed structure on either a monolithic slab-on-grade foundation system or drilled piers in conjunction with either a structurally-suspended floor slab or fill-supported floor slab. The following sections discuss these foundation systems, along with recommendations for pavements and utilities.

Expansive Soil Conditions

Based on the existing subsurface soil conditions, the project site is considered to be expansive, as defined by the 2012 International Building Code (IBC) Section 1803.5.3. Although we have provided measures to reduce the magnitude of movements, these measures are not as stringent as outlined by the IBC to classify the site as non-expansive.

The potential vertical rise (PVR) for the subsurface soil stratigraphy encountered in the borings drilled at this site was calculated using the Texas Department of Transportation (TxDOT) Method TEX-124-E. These calculations indicate a potential vertical movement of approximately 2-¾ inches with a corresponding effective design plasticity index of 33. These calculations are based on the existing site conditions, an active zone of about 15 feet, and accounts for an approximate 1 psi of overburden pressure.

Due to the highly expansive soil conditions identified in the borings, we do not recommend designing any new grade-supported structure for the existing site conditions. In order to reduce the potential vertical movement associated with the expansive clays, soil movement reduction options are provided in the following section.

Soil Movement Reduction Options

As previously stated, we do not recommend designing any grade-supported structures for the existing condition. We recommend that the potential differential movements associated with the existing site conditions be reduced using cut and fill modifications (CASES I and II), as identified on Table 2 on the following page.

Table 2: Cut/Fill Modification Conditions

Building Area (Borings)	CASE	Cut/Fill Modification	PVR[1]	Effective Design PI[2]
Fire Station #2 (B-1 to B-3)	I	3 feet	1-½ inches	26
	II	4 feet	1 inch	23

Notes: (1) The PVR calculations are based on the existing clay soils being removed and replaced with select structural fill material having a maximum PI of 17. Any additional fill required for grading purposes should also consist of select structural fill material.
(2) The effective design PI is the weighted average of all PI values within the upper 15 feet utilizing a PI value no less than 15.

Typically, a PVR of one (1) inch is deemed acceptable for at-grade construction in the San Antonio area. Although the building or other at-grade improvements can be designed structurally to withstand a higher PVR, the owner would have to accept the increased probability that foundation movement will occur, plumbing leaks may occur, and aesthetic issues will develop (i.e., cracking drywall, separations on exterior siding, sticking doorways and windows, etc.). In addition, entries into the building and surrounding flatwork will be subjected to similar potential movements, unless the over-excavation operations are extended to include these areas.

The owner and design team should consider extending the over-excavation operations to include any abutting concrete flatwork in order to minimize this potential differential movement. Otherwise, special design aspects (joints, dowels, etc.) should be considered to help contend with the potential differential movement between the structure and adjacent flatwork.

Despite the design condition, this does not mean that soil-related movements are eliminated. It only means that the slab and foundation can be structurally designed for the magnitude of movement without failure of the foundation system. However, this movement does not take into account the movement criteria that is required or perceived by the building owner/occupants. These “operational” performance criteria may be, and often are, more restrictive than the structural criteria or tolerances.

The recommendations for cut and fill modifications are provided in the *Building Subgrade Preparation and Earthwork Operations* section and *Slab-on-Grade Foundation System* section. We can also provide additional soil movement reduction options, upon request, if the design team and owner feel that more or less potential movement is deemed acceptable or required of any structure. Furthermore, the recommendations presented in the study can be modified, if needed, once more detailed information of the final topography or the finished floor elevation for the proposed structure is provided by the design team.

Drilled Pier Foundation System

Based upon the soil conditions and anticipated loading conditions, the proposed building may be supported by straight-shaft drilled piers in conjunction with either a structurally-suspended floor slab or grade-supported floor slab. Additional recommendations for each of these floor systems are provided in subsequent sections of this report.

Principal column loads may be supported on straight-shaft piers bearing at a depth of at least 20 feet below existing ground surface elevations for the proposed structure. If the existing grades are elevated or lowered from that at the time of our drilling program, then the pier termination elevation should be adjusted accordingly. Actual pier depths and pier diameters should be determined by the project structural engineer and sized using the end bearing capacities and skin friction values presented herein.

The drilled pier foundation system can be designed/sized utilizing both end bearing and skin friction components. The following foundation design parameters may be utilized provided that the bearing surfaces are clean and free of both loose material and disturbed soil, and that the sidewalls of the drilled excavations are stable during both excavation and concrete placement operations.

Pier capacities provided herein were evaluated based on design methodologies presented by Lymon C. Reese and Michael W. O'Neill in the publication titled: Drilled Shafts: Construction Procedures and Design Methods prepared for the U. S. Department of Transportation Federal Highway Administration, dated August 1999.

Table 3: Drilled Pier Foundation Design Parameters

Depth (ft)	**[1] Net Allowable End Bearing Capacity (psf)**	**[2] Allowable Skin Friction (psf)**
0 – 5	---	---
5 – 8	---	630
8 – 13	---	750
13 – 20[3]	---	900
20 – 30[4]	15,000	1,100

Notes:
1. These values include a factor of safety of three (3).
2. These values include a factor of safety of two (2).
3. All piers should be bearing at a minimum depth of 20 feet below the existing grades.
4. If drilled piers are to extend below a depth of 30 feet, a deeper soil boring should be conducted to confirm actual soil conditions.

The side shear (skin friction) should be neglected for the upper five (5) feet of soil and within one (1) pier diameter above the shaft base for straight-shaft piers. We have neglected the upper five (5) feet of soil for side shear, since it is possible that the plastic clay soils may dry and shrink away from the pier shaft.

These piers will also be subjected to axial tension loads due to the expansive soil conditions and possibly due to other induced structural loading conditions. To compute the axial tension force due to the swelling soils along the pier shaft, the following equation may be used:

$$Q_u = 50\ D$$

Where: Q_u = Uplift force due to expansive soil conditions in kips (k)
D = Diameter of pier shaft in feet (ft)

This calculated force may be used to compute the longitudinal reinforcing steel required in the pier to resist the uplift force induced by the swelling clays. These additional forces should be combined with the previously noted axial uplift (tensile) loading (i.e. imposed forces from wind loading, etc.) during the design of the foundation system. However, the cross sectional area of the reinforcing steel should not be less than one-half (½) percent of the gross cross-sectional area of the drilled pier shaft. The reinforcing steel should extend from the top to the bottom of the shaft to resist these potential uplift forces.

The uplift force due to swelling soils and any other axial tension forces due to structural loading conditions can be resisted by the skin friction portion of the load developed by the drilled pier. The ultimate uplift resistance of the straight-sided pier may be evaluated using the following equation:

$$Q_r = 4.0 \cdot d \cdot D_p + W_p + P_{DL}$$

Where: Q_r = Ultimate uplift resistance of straight shaft pier in kips (k)
D_p = Founding depth of pier in natural soils in feet (ft)
d = Diameter of pier shaft in feet (ft)
W_p = Weight of the drilled pier in kips (k)
P_{DL} = Dead load acting on the drilled pier in kips (k)

We recommend that a factor of safety of at least two (2) be applied to the computed ultimate uplift resistance force.

Lateral Capacity Criteria

Lateral capacity analysis programs, such as LPile, will require the following design parameters/criteria:

Table 4: Drilled Pier Lateral Capacity Criteria

Layer	Depth to Bottom of Layer (feet)	Effective Unit Weight[1] (pcf)	Undrained Shear Strength (psf)	Soil Strain Factor (ε_0)	Friction Angle (degrees)	Adhesion Factor (α)	Subgrade Modulus, k_s (pci)
1	4	115	1,500	0.008	---	0.58	570
2	8	120	3,500	0.005	---	0.36	860
3	13	120	---	---	32	---	132
4	20	125	4,000	0.004	---	0.34	960
5	30	125	5,000	0.004	---	0.30	1,180

1 The values provided in the above table are based on the condition of the soil obtained from our borings, i.e. groundwater was not encountered during drilling operations. However, if a permanent groundwater level is encountered, then these values less 62.4 pounds per cubic foot (pcf) should be used as the effective unit weight.

Pier Spacing Criteria

Unless approved by the geotechnical engineer, pier spacing should not be less than three (3) times the largest pier diameter (center to center) for straight-shaft piers.

Settlement Criteria

Settlement of individual piers, designed and constructed as recommended in this report, is expected to be small and within tolerable limits for the proposed building. For piers bearing at or below the recommended minimum bearing depth, maximum total settlement is expected to be on the order of one (1) inch. Maximum differential settlement between adjacent columns is expected to one-half of the total settlement. These settlement values are based on our engineering experience of the soil conditions and the anticipated structural loading, and are to guide the structural engineer with the design.

Structurally-Suspended Floor Slab

If the design team and owner require a structurally suspended floor slab, then it should be either bearing on carton forms or constructed by using temporary forms in conjunction with a crawl space. Temporary forms are preferred as this method allows for a crawl space for accessing utilities.

If carton forms are used, they should be at least six (6) inches thick, and should be protected from the environment, so that they do not collapse during or prior to concrete placement. Storage and placement of carton forms should be in accordance with manufacturer's specifications. With the use of carton forms, consideration should be given to sleaving the utilities that enter the building in order to allow for potential movement associated with the clay soils.

Provisions should be made to collect and transfer any surface water that may enter into the crawl space, which is generally accomplished by constructing a three (3) inch thick "mud-mat". The mud-mat is an unreinforced concrete slab that is poured over the prepared subgrade of the crawl space. The surface of the mud-mat should be sloped to a drain or sump where the water may be collected and pumped from the crawl space. In addition, proper ventilation should be provided to help mitigate moisture build up and humidity within the crawl space.

Grade-Supported Floor Slab

For a grade-supported floor slab, the recommendations outlined in the *Soil Movement Reduction Options* section of the report should be followed in order to reduce the PVR to one (1) inch. That is, we do not recommend supporting any structure on drilled piers in conjunction with a grade-supported floor slab unless the PVR is reduced to one (1) inch or less. The design team should also consider the use of a vapor retarder (or damp-proofing) as required to meet moisture protection requirements of the interior finishing materials. However, where utilized, special consideration should be given to the surface curing of the slab in order to minimize uneven drying of the slab and associated cracking.

Pier Construction Considerations

Groundwater was not encountered during drilling operations. However, due to presence of gravels in the borings, temporary steel casing should be anticipated to keep the bottom of the excavation clean, the sidewalls stable, and to reduce the influx of groundwater, if encountered, during concrete placement operations.

As noted, the groundwater conditions observed at this site during our field study may fluctuate due to seasonal and climatic variations and should be measured (checked) prior to foundation excavation/drilling operations. Where temporary steel casing is required, we are providing the following recommendations.

> Casing Method – Temporary steel casing will provide stability of the excavation walls and will reduce water infiltration, but may not completely eliminate groundwater infiltration into the excavation. The casing should extend below the planned pier depth as required to prevent instability of the pier excavation and excessive water influx. If seepage appears in the bottom of the excavation, the casing should be extended until the excess seepage is eliminated.
>
> If this operation is not successful, or to the satisfaction of the foundation contractor, the pier excavation should be flooded with freshwater to offset the differential water pressure caused by the unbalanced water levels inside and outside of the casing. When the pier excavation depth is achieved, the bottom should be cleaned and the reinforcing steel and concrete should then be placed immediately in the excavation. The concrete should be placed completely to the bottom of the excavation with a closed-end tremie.
>
> Removal of casing should be performed with extreme care and under proper supervision to minimize mixing of the surrounding soil and water with the fresh concrete**. Rapid withdrawal of either the casing or the auger may develop a suction which could cause the soil and/or groundwater to intrude into the excavation. An insufficient head of concrete in the casing during withdrawal could also allow the soils to intrude into the freshly placed concrete.** Both of these conditions may induce "necking" (a section of reduced diameter) in the pier.

All aspects of concrete design and placement should comply with the American Concrete Institute (ACI) 318-11 Code “Building Code Requirements for Structural Concrete” and ACI 336.3R-93 (Re-approved 2006) entitled “Design and Construction of Drilled Piers”. Concrete should be designed to achieve the specified minimum 28-day compressive strength when placed at a six (6) inch slump with a plus or minus one (±1) inch tolerance. If a high range water reducer is used to achieve this slump, the span of slump retention for the specific admixture under consideration should be thoroughly investigated. Compatibility with other concrete admixtures should also be considered. A technical representative of the admixture supplier should be consulted on these matters.

Pier installation should be performed as discussed in this report and as described in the publication titled: Drilled Shafts: Construction Procedures and Design Methods prepared by Lymon C. Reese and Michael W. O'Neill for the U. S. Department of Transportation Federal Highway Administration, August, 1999. Pier construction should be carefully monitored to assure compliance of construction activities with the appropriate specifications. Particular attention to the referenced publication is warranted for pier installation. A number of items of concern for pier installation include the following:

- Pier location(s)
- Vertical alignment
- Competent bearing material
- Proper casing seal for groundwater, as required
- Reinforcing steel placement
- Concrete properties and placement
- Casing removal

The drilled pier foundation should be augered and constructed in a continuous manner. Steel reinforcement and concrete should be placed in the pier excavation immediately following drilling. The drilled pier shall be evaluated for proper bearing stratum, embedment, and cleanliness. In no circumstances should the pier excavation remain open for more than four (4) hours.

Surface runoff or groundwater seepage accumulating in the excavation in excess of three (3) inches should be pumped out and the condition of the bearing surface should be evaluated by the Geotechnical Engineer prior to placing steel reinforcement and concrete.

Slab-on-Grade Foundation System

The subsurface conditions encountered at the site are determined to be suitable for supporting the proposed structure on a monolithic slab-on-grade foundation system, provided the PVR is reduced to a level deemed acceptable by the owner and design team. The design team should also consider the use of a vapor retarder (or damp-proofing) as required to meet moisture protection requirements of the interior finishing materials. However, where utilized, special consideration should be given to the surface curing of the slab in order to minimize uneven drying of the slab and associated cracking.

Based on the anticipated structural loading and SPT values, as monitored during drilling of our borings, we recommend that any monolithic slab-on-grade foundation system be designed for a maximum net allowable end bearing capacity of 2,500 psf into compacted select structural fill. At beam intersections, or as required at column locations, the grade beams may be widened to support additional loads. At these areas, the bearing capacity may be increased to 2,800 psf; however, the beams must be at least 30 inches in the smallest dimension and poured monolithically with the slab.

We recommend that the beams have a minimum width of 10 inches and extend a minimum of 18 inches below finished grade and into compacted select structural fill material. Exterior grade beams should extend a minimum of 24 inches below the finished exterior grade. These recommendations are for proper development of bearing capacity for the continuous beam sections of the foundation system and are NOT based on structural considerations. Grade beam widths and depths for structural considerations may need to be greater than recommended herein and should be properly evaluated and designed by the structural engineer.

The following table presents the design criteria published by the Building Research Advisory Board (BRAB), Wire Reinforcement Institute (WRI), and the Post-Tensioning Institute (PTI), 3rd Edition. These values were based on our understanding of the proposed project, our interpretation of the information and data collected as part of this study, the criteria publications, and on our past experience with similar projects.

Based on the soil conditions, the structure may be supported using a Type III reinforced slab-on-grade foundation system in accordance with BRAB.

Table 5: Slab-on-Grade Design Criteria

Recommended BRAB, WRI, & PTI Criteria For Slab-on-Grade Foundation	Modified Conditions	
Design Criteria	**CASE I**	**CASE II**
Minimum Over-excavation	3 feet	4 feet
Minimum Select Fill Pad Thickness	3 feet	4 feet
Potential Vertical Rise (PVR)	1-½ inches	1 inch
Effective Design Plasticity Index (PI) / BRAB PI	26	23
Slope Correction Coefficient	1.0	1.0
Constant Soil Suction, pF	3.8	3.8
Climatic Rating (C_w)	17	17
Unconfined Compressive Strength (tsf)	2.0	2.0
Soil Support Index, c	0.88	0.91
Edge Distance Penetration, e_m, Center	8.2 feet	8.8 feet
Edge Distance Penetration, e_m, Edge	4.3 feet	4.5 feet
Thornthwaite Index (I_m)	-14	-14
Center Lift	0.6 inch	0.4 inch
Edge Lift	1.2 inches	0.8 inch

Following any over-excavation and site preparation processes and if required by final grade elevations, any proposed building pads can be built-up and leveled using additional select structural fill material, as detailed in the *Building Subgrade Preparation and Earthwork Operations* section.

For a monolithic slab-on-grade foundation system, designed and constructed as recommended in this report, post construction settlements should be one (1) inch or less. Settlement response of a fill supported slab is influenced more by the quality of construction than by soil-structure interaction. Therefore, it is essential that the recommendations for both the foundation and the building pad construction be strictly followed throughout the construction phase of the proposed building's foundation.

Seismic Considerations

According to the IBC (Section 1613.3.2), the site shall be classified in accordance with Chapter 20 of ASCE 7-10: Minimum Design Loads for Buildings and Structures. According to the ASCE 7-10 and 2009 IBC documents, the site classification is based on the subsurface soil/rock profile to a depth of 100 feet. Since the maximum depth explored for this study was 30 feet, we have assumed that the geologic formation condition extends to a depth of at least 100 feet. Based on the soil/rock profile encountered and these assumptions, the Site Class is "D" as defined by ASCE 7-10, Table 20.3-1 (or 2009 IBC, Table 1613.5.2). Additional seismic site parameters are as follows:

- Mapped 0.2 second spectral response acceleration (S_S) = 0.084g,
- Mapped 1.0 second spectral response acceleration (S_1) = 0.027g, and
- Site coefficients of F_A = 1.6 and F_V = 2.4.

Building Subgrade Preparation and Earthwork Operations

After grading operations are completed, the exposed subgrade surfaces should be observed by the Geotechnical Engineer or authorized representative. The following site preparation would be necessary for a grade-supported floor slab or monolithic slab-on-grade foundation system:

1) Existing vegetation, topsoil, any existing loose materials, or unsuitable fill should be stripped and removed from the proposed building footprint. Any tree roots and stumps should be grubbed and removed from the site.

2) Following stripping operations, the floor slab area should be over-excavated to the depth as discussed in the previous sections, depending on the level of performance that the design team selects. The over-excavation area should extend a minimum of five (5) feet beyond the horizontal limits of the proposed building footprint. A qualified geotechnical engineer, or representative, should be on-site during earthwork operations to observe and approve any cut areas prior to fill placement.

3) Following excavation, the exposed subgrade soils should be scarified to a depth of six (6) inches, moisture conditioned between 0 and +4 percentage points above optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D698.

4) Following approval of the subgrade, the select fill (or general fill if slab is structurally suspended) should be placed up to the desired final building pad elevation. All fill material should be placed in eight (8) inch maximum thick loose lifts. The select fill should be moisture conditioned between -3 and +3 percentage points of optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698, Standard Proctor Method. One nuclear density test should be performed for each 5,000 square feet, or a minimum of three (3) nuclear density tests per lift, whichever results in more tests.

When placing the select fill, care should be taken to avoid water ponding in the select fill layer. This could cause post-construction movements, which exceed the estimated values. Care must be taken to prevent landscape watering, surface drainage, leaking utility lines or other sources of water from entering the select fill.

For a grade-supported foundation system, we suggest placing a clay cap outside the limits of the building. The final 18 to 24 inches of the pad, outside the limits of the building, should consist of cohesive clay with a plasticity index between 15 and 25. This procedure will help to reduce the potential for water migrating into the building pad. Where concrete flatwork or pavements abut the structure, the clay cap may be eliminated. The clay cap should be placed in eight (8) inch maximum thick loose lifts, moisture conditioned between 0 and +4 percentage points above optimum moisture content, and compacted to 95 percent of the maximum dry density as determined in accordance with ASTM D698.

Any import or select fill should be an approved inorganic material, free of debris. The select fill material should be approved by the Geotechnical Engineer prior to importing on site. Any on-site soils should be approved of as select fill prior to use during construction. Select fill material should be placed in lifts not exceeding eight (8) inches in loose thickness, moisture conditioned to within ±3 percentage points of the optimum moisture content, and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698, Standard Proctor Method. Select fill material should have a maximum Plasticity Index (PI) ranging between 7 and 17 and have a maximum particle size of three (3) inches.

General fill material, which includes on-site soil, may be placed if the structure is to be supported by a structurally-suspended foundation system. General fill materials should have a maximum particle size of four (4) inches and be placed in lifts not exceeding eight (8) inches in loose thickness. Coarse-grained soils (SC, GC, or more granular) should be moisture conditioned to within ±3 percentage points of the optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698. Fine-grained soils (CH, CL, ML, or MH) should be moisture conditioned between 0 and +4 percentage points above optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698.

Pavement Design

General parking areas and drive areas will be provided primarily for general automobile traffic, emergency vehicles, and some heavy truck traffic for deliveries and trash pick up. No detailed information regarding the expected traffic loads were known at the time of our report preparation. Therefore, assumptions were made regarding the anticipated traffic conditions.

Our pavement analysis was generally based on the design procedure developed by AASHTO's *Guide for Design of Pavement Structures*, 1993. Based on the site location and facility type, we utilized an effective pavement life of 20 years. Also for this analysis, we estimated a CBR (California Bearing Ratio) value of three (3) percent for the Stratum I soils, which will likely be the predominant subgrade materials following rough grading operations. We estimated this CBR value since evaluation of CBR values by either field or laboratory testing was not included in the scope of our services. We selected this value based on our knowledge and experience with similar soil. We suggest that additional testing, including CBR testing and Atterberg Limits, be conducted on the actual subgrade materials at the time of construction in order to verify the assumptions in this report.

The following design parameters and criteria were considered in our analyses:

- Resilient Modulus: 4,500 psi (CBR = 3)
- Modulus of Soil Reaction, k value: 75 pci
- Reliability: 80 percent for flexible pavement and 90 percent for rigid pavement
- Overall Standard Deviation: 0.45 for flexible pavement and 0.35 for rigid pavement
- Initial Serviceability: 4.2
- Terminal Serviceability: 2.0

The minimum recommended thicknesses for flexible pavement sections (asphaltic concrete) are presented in the following tables. Entrances to the new development as well as areas expected to require excessive maneuvering, such as dumpster areas, should consists of a rigid (concrete) pavement system. Areas that are subjected to heavy truck traffic, including fire tanker vehicles should consist of a heavy-duty pavement section. Minimum thicknesses for rigid pavement sections are also provided.

Table 6: Flexible Pavement Design Sections

	Light-Duty Options			**Heavy-Duty Options**		
Pavement Material	**Thickness (in)**			**Thickness (in)**		
Type D, Hot Mix Asphaltic Concrete	1.5	1.5	1.5	2.5	2.5	2.5
Crushed Limestone Base	11	7	---	16	13	---
Lime-Stabilized Subgrade	---	6	---	---	6	---
Mechanically Stabilized Layer[1]	---	---	7			11
Compacted Subgrade	6	---	6	6	---	6
Estimated Total ESAL Count	**33,000**	**26,000**	**40,000**	**500,000**	**563,000**	**622,000**

Note 1.) The use of a geogrid within the base section is provided as an option in lieu of lime-stabilized subgrade due to the limited areas considered for paving.

Table 7: Rigid Concrete Pavement Design Sections

	Medium-Duty Options		**Heavy-Duty Options**	
Pavement Material	**Thickness (in)**		**Thickness (in)**	
Reinforced Concrete	5	6	6	7
Crushed Limestone Base[1]	---	---	---	---
Lime-Stabilized Subgrade	6	---	6	---
Compacted Subgrade	---	6	---	6
Estimated Total ESAL Count	**228,000**	**273,000**	**525,000**	**650,000**

Note 1.) Although not required as a structural layer, crushed limestone base may be used as a level-up course.

Soluble sulfate testing was conducted on two composite samples of the Stratum I clay, which showed concentrations of 269 ppm and 1,430 ppm (see attached results). Based on the National Lime Association's *Lime-Treated Soil Construction Manual* (January 2004), sulfate concentrations less than 3,000 ppm are unlikely to cause problems when soils are treated with lime. Therefore, lime-treatment is a viable alternative for the Stratum I clays.

For the above pavement sections, we have calculated traffic loading conditions equal to or greater than the noted 18-kip equivalent single-axle loads (ESALs) for the light-duty, medium-duty, and heavy-duty pavement sections. Typically, the light-duty and medium-duty sections will meet the requirements for the parking spaces, while the heavy-duty sections will meet the requirements for the drive lanes, including fire lanes due to the frequency of the heavy loading. If our assumptions or the traffic loading conditions do not meet the intended use or if further information comes available, we would be happy to provide further design recommendations.

The following paragraphs specify the pavement materials to be used to construct the proposed pavement areas:

Hot Mix Asphaltic Concrete Surface Course - The asphaltic concrete surface course should be plant mixed, hot laid Type D (Fine Graded Surface Course) meeting the 2004 Texas Department of Transportation (TxDOT) specification, Item 340 and specific criteria for the job mix formula. The mix should be designed for a stability of at least 40 and should be compacted to between 91 and 95 percent of the maximum theoretical density as determined in accordance with Tex-207-F. The asphalt cement content by percent of total mixture weight should fall within a tolerance of $\pm$ 0.3 percent asphalt cement from the specific mix design. In addition, the mix should be designed so that 75 to 85 percent of the voids in the mineral aggregate (VMA) are filled with asphalt cement.

Crushed Limestone Base - Base material should be composed of crushed limestone meeting the requirements of TxDOT Item 247, Grade 1, Type A. The base should be compacted to a minimum of 95 percent of the maximum dry density as determined by the modified moisture-density relationship (ASTM D 1557) at -2 to +2 percentage points of optimum moisture content. Base material should be placed in maximum loose lifts of eight (8) inches in thickness.

Reinforced Concrete - Concrete should be designed to exhibit a flexural strength (third point loading) of at least 580 psi at 28 days (approximate compressive strength of 4,000 psi at 28 days). The flexural strength (M_r) may be approximated by the following formula from ACI 330R: $M_r=2.3\ (f_c')^{2/3}$, where f_c' is the average compressive strength of the concrete test cylinders. The actual relationship between flexural and compressive strength for the proposed mix should be evaluated in the laboratory.

Lime-Stabilized Subgrade - The clay subgrade should be stabilized with hydrated lime in accordance with TxDOT Items 260 and 264. The lime should be blended with a mixing device such as a Pulvermixer, sufficient water added, and be allowed to cure for at least 48 hours. Based on the plasticity index of the soils tested across the site, it is expected that five (5) percent lime, by dry weight, will be required to adequately stabilize the subgrade soils at this site. This is approximately 22 pounds per square yard for a six (6) inch deep treatment. However, the actual percentage required should be determined by laboratory tests on samples of the subgrade soil utilizing lime from the actually source prior to construction. After curing, the lime-soil blend should be remixed and compacted to at least 95 percent of the maximum dry density as determined in accordance with TEX-114-E at moisture contents ranging from 0 to +4 percentage points of optimum moisture content. The elapse of time after mixing of the lime and soil has an effect on the maximum dry density, which decreases with time. For any mixture older than three (3) days, a new moisture-density relationship is required.

Mechanically Stabilized Layer – A Mechanically Stabilized Layer (MSL) is defined as a composite layer consisting of base course material that is confined by geogrid which promotes interlocking of the two materials. A Mechanically Stabilized Layer is designed in accordance with 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures and is specifically governed by AASHTO R 50-09. The MSL shall be incorporated into the pavement design by utilizing modified layer coefficients. Modified layer coefficients shall be calibrated and validated with the results of full scale laboratory, field and/or accelerated pavement testing where actual geogrids are tested in-soil and in representative conditions. A Mechanically Stabilized Layer has a defined thickness and structural number and contributes to the overall section's ESAL count. In-air index testing of geogrid properties, or explanations of performance based on in-air index testing of geogrid properties is not sufficient to understand the complex mechanisms involved in soil/geogrid interaction and/or the performance of MSLs. Therefore, no acceptance of alternates based on material property comparisons or explanations of performance based on in-air testing of geogrid properties will be allowed. The proposed pavement design options include placing **Tensar TX5 Triaxial Geogrid** on the prepared (compacted) subgrade then adding base material to form a Mechanically Stabilized Layer. The geogrid manufacturer should be contacted so that they can answer any questions during the installation of the geogrid. The properties of a MSL are project specific. Alternative materials will need to be approved by BMC prior to installation, which could result in an increase in the overall thickness of the mechanically stabilized layer.

Compacted Subgrade - The subgrade should be moisture conditioned between optimum and plus four (+4) percentage points above optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D-698.

General fill materials, whether coarse-grained or fine-grained, should have a maximum particle size of four (4) inches and be placed in lifts not exceeding eight (8) inches in loose thickness. Coarse-grained soils (SC, GC, or more granular) should be moisture conditioned to within ±3 percentage points of the optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698. Fine-grained soils (CH, CL, ML, or MH) should be moisture conditioned between 0 and +4 percentage points above optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698.

Proper perimeter drainage in and around pavement sections is very important, and should be provided so that infiltration of surface water from unpaved areas surrounding the pavement areas is minimized. We do not recommend installation of landscape beds or islands in the pavement. Such features provide an avenue for water to enter into the pavement section and the underlying subgrade soil. Water penetration usually results in degradation of the pavement section with time, and as vehicular traffic traverses the area of moisture infiltration. Above grade planter boxes, with drainage discharging onto the top of the pavement, or directed into storm sewers, should be considered if landscape features are desired.

Curbs will help reduce migration of groundwater into the pavement base course from adjacent areas, provided they are properly constructed and backfilled so water is not allowed to store behind the curb. A crack sealant compatible to both asphalt and concrete should be provided at all concrete-asphalt interfaces, and at all interfaces of existing/new pavement areas.

Cracking, particularly longitudinal cracking within one (1) to three (3) feet of the pavement edges, should be expected of any asphalt pavements constructed on this site. Although not common, this longitudinal cracking may even occur near the middle of pavements. The cracking occurs as the expansive soils adjacent to and below the pavements shrink and swell with seasonal moisture fluctuations. Therefore, proper maintenance, including sealing all cracks on a timely manner, should be conducted throughout the life of the asphalt pavements.

Utility Trench Recommendations

It is vital that all backfill being placed into utility trenches be moisture conditioned and compacted to a degree that meets or exceeds the compaction of the adjacent areas, so that no settlement will occur. Additionally, it is important that proper backfill material be used. Generally, the material that is excavated from the trenches is stockpiled on site and subsequently used as backfill material in the trenches.

Additionally, it is our recommendation that all backfill material used in the utility trenches be moisture conditioned to within three (3) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D-698. Furthermore, it is our recommendation that the backfill material be placed in six (6) inch lifts. The backfill material should be tested for moisture content and compaction for each six (6) inch lift at a minimum frequency of one (1) test per 100 linear feet. For narrow trenches that would be too confined to sufficiently compact the backfill materials, it is our recommendation that a flowable fill material be used to backfill the trench.

General Retaining Wall Recommendations

No specific information regarding any retaining walls was provided to us during the preparation of this study. We are providing these recommendations in the event that concrete retaining walls are used on this project. The foundation of the retaining wall(s) may be designed/sized using a maximum net allowable end bearing capacity of 2,000 psf. All foundations should be bearing at least 12 inches below the finished grade in front of the walls. Additionally, a coefficient of friction of 0.35 may be used for the base of the foundation if bearing into native soils or 0.50 if bearing on to a pad of base material or clean gravel that is at least eight (8) inches thick to resist sliding.

Although the following soil properties are recommended, the wall designer may utilize more conservative values in their design as an additional factor of safety. It is our recommendation that free draining gravel be used directly behind any retaining walls. As such, we are only providing design criteria for free draining gravel. ASTM C33, No. 57 or No. 67 crushed stone provides size distribution requirements for free draining gravel that would be suitable for this application. The table below presents the equivalent hydrostatic earth pressures exerted from the free draining gravel onto the retaining wall(s).

Table 8: Retaining Wall Design Parameters

Material Type	Condition	Equivalent Hydrostatic Earth Pressure (psf per foot depth)	Earth Pressure Coefficient
Free Draining Gravel	Active	30	Ka = 0.28
	At-Rest	50	Ko = 0.45
	Passive	390	Kp = 3.54

These equivalent fluid densities do not include any lateral components due to ether hydrostatic or surcharge loads. Any retaining walls designed at this site should include a drainage system to prevent the build up of hydrostatic forces behind the wall. This may include weep holes and/or a perforated drain pipe located at the base of the retaining wall to allow stored water to drain from the backfill material. If a drain system is not provided, then an additional 62.4 psf per foot depth should be added to the lateral forces acting on this wall.

We strongly discourage the use of high plasticity clays (CH material) as backfill of any retaining walls, as this material will contribute additional lateral forces on the wall systems. However, a 12 to 24 inch layer of clay (CL or CH) may be placed at the top of the backfill in order to minimize the amount of surface water infiltration into the granular backfill, thereby reducing the water to be handled by the drainage system.

Heavier earthwork equipment should maintain a minimum horizontal distance away from the retaining walls of one (1) foot per foot of vertical wall height. Lighter compaction equipment should be utilized near the walls.

The above equivalent fluid densities do not include a factor of safety; however, we recommend that a minimum factor of safety of at least one and one-half (1-½) be utilized. Surcharge loads, such as the floor slab loads or parking areas will add additional horizontal components of lateral earth pressure to the retaining walls. The magnitude of these components will depend on the loads and the locations of these loads relative to the retaining walls. We can assist with the analysis of these loads, as they contribute to the retaining wall's lateral loads, if we are provided with this information. For design purposes, a live load surcharge of 125 psf and 250 psf should be utilized for standard traffic loading and fire lane loading, respectively.

In addition to analyzing the internal and external stability of the wall systems, global stability analyses (GSA) should be performed by the retaining wall designer or Geotechnical Engineer of Record. We can assist further with the GSA, upon request, once final grading is provided.

General Construction Considerations

The site should be graded such that surface water runoff is directed away from any excavations during construction. In addition, site grading should allow for surface and roof drainage away from the structures during their design lives. Roof drains and downspouts should discharge water on adjacent pavements or extend at least five (5) feet beyond the building edge. We suggest verifying final grades around the structures to document that effective drainage has been achieved. Typically, the slope around a building should be a minimum of five (5) percent for the first 10 feet.

For grade-supported structures, planters and landscaping are not recommended within six (6) feet of the building areas, as they can allow for moisture infiltration into the building pad and underlying subgrade. If planters are installed, we suggest that they be self-contained to prevent water migrating into the building pad. An impermeable liner could be placed under the landscaping bed with drainage collected and discharged onto adjacent pavement areas or directed into the stormwater drainage system.

The surface soils in this vicinity are extremely moisture sensitive, and so any uncontrolled surface flow across the site could result in undesired infiltration and future difficulties with swell. For this reason, it is strongly urged that fill operations be performed in such a manner as to enhance natural water flow and control erosion.

Exposure to the environment may weaken the soils at the foundation bearing level if the excavations remain open for extended periods of time. Therefore, foundation concrete should be placed as soon as possible after the excavations are completed. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If rainfall becomes imminent while the bearing soils are exposed, we recommend that a 1-to 3-inch thick "mud-mat" of "lean" concrete be placed on the bearing soils.

In a dry and undisturbed state, the surficial soil at the site will provide sufficient subgrade support for fill placement and construction operations. However, when wet, these soils will degrade quickly with disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations which will help maintain the integrity of the soil.

Limitations

This report has been prepared to aid in the evaluation of subsurface conditions at this site and to assist design professionals in the geotechnical related design of this project. It is intended for use with regard to the specific project as described in this report. Any substantial changes or differences in assumed building loads or building layout should be brought to our attention so that we may determine any effect on the recommendations provided in this report.

The scope of our study did not include an environmental assessment of the soil, rock, or water conditions either on or adjacent to the site. As such, no environmental opinions are presented in this report.

The opinions and conclusions expressed in this report are those of BMC and represent interpretation of the subsurface conditions based on tests and the results of our analyses. BMC is not responsible for the interpretation or implementation by others of recommendations provided in this report. This report has been prepared in accordance with generally accepted principles of geotechnical engineering practice and no warranties are included, expressed, or implied, as to the professional services provided under the terms of our agreement.

The analysis and recommendations submitted in this report are based upon the data obtained from the borings performed at the locations indicated in the *Boring Location Plan*, and from other information described in this report. This report does not reflect any variations that may occur between the borings. In the performance of the subsurface exploration, specific information is obtained at specific locations and times. However, it should be noted that variations in soil conditions, such as depth of FILL, exist on most sites between the boring locations, and groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction.

If variations appear evident, BMC should be allowed to perform on-site observations during the construction period and note characteristics and variations to determine if a re-evaluation of the recommendations in this report will be necessary.

Closing

We recommend that the construction activities be monitored on a call-out basis by a qualified Geotechnical Engineer, or representative. We also recommend that once the plans are prepared, BMC be retained to review them so it can be determined if changes to the recommendations are necessary or if additional recommendations are required.

APPENDIX

Figure 1: Site Vicinity Map

Figure 2: Boring Location Plan

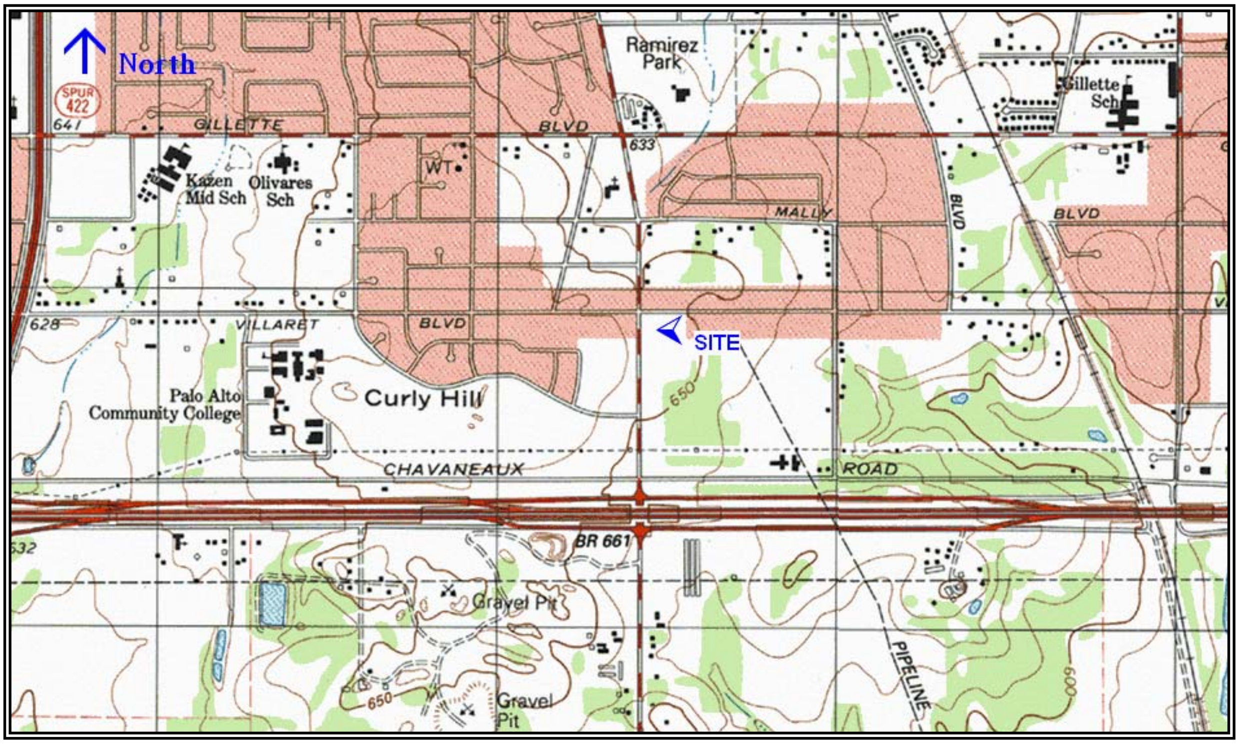
Boring Logs (B-1 through B-8)

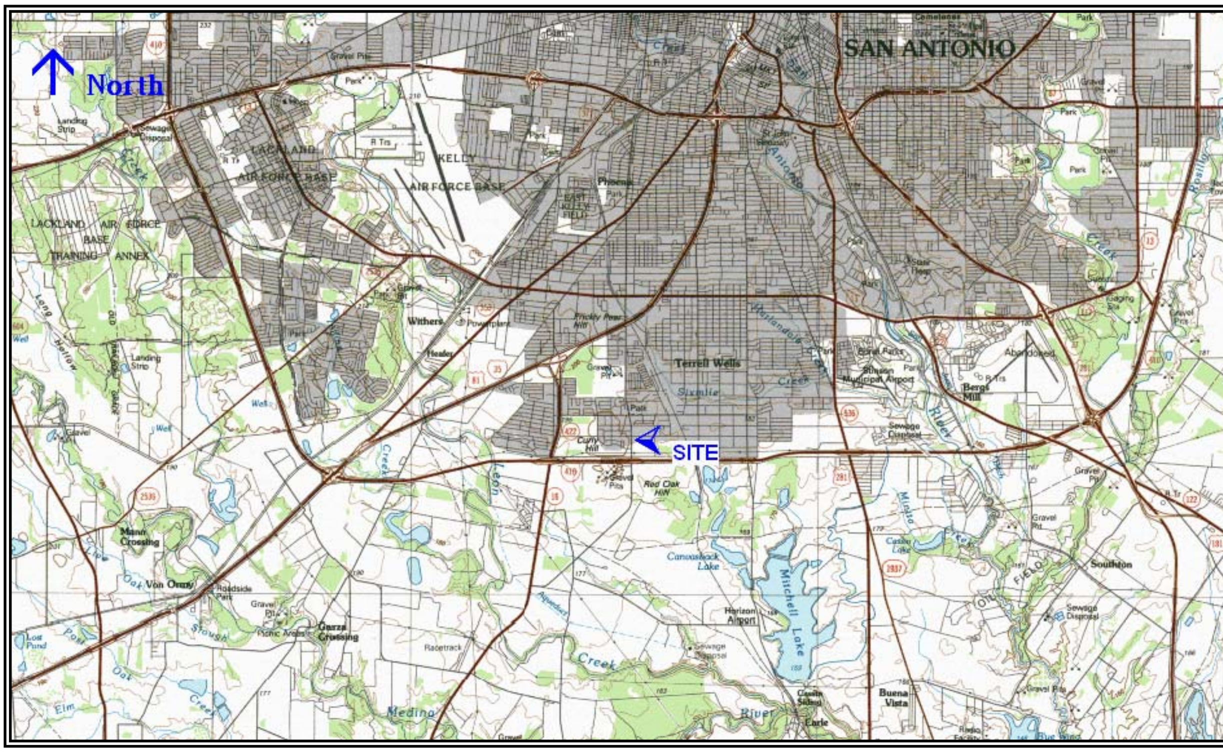
Laboratory Test Report Graphs (2)

Soil Classification Chart

Soluble Sulfate Analytical Report

Laboratory and Field Test Procedures





Geotechnical Engineering Study
Fire Station #2
W. Villaret Blvd. & S. Zarzamora St.
San Antonio, Texas
BMC Project No. 12-12-0103

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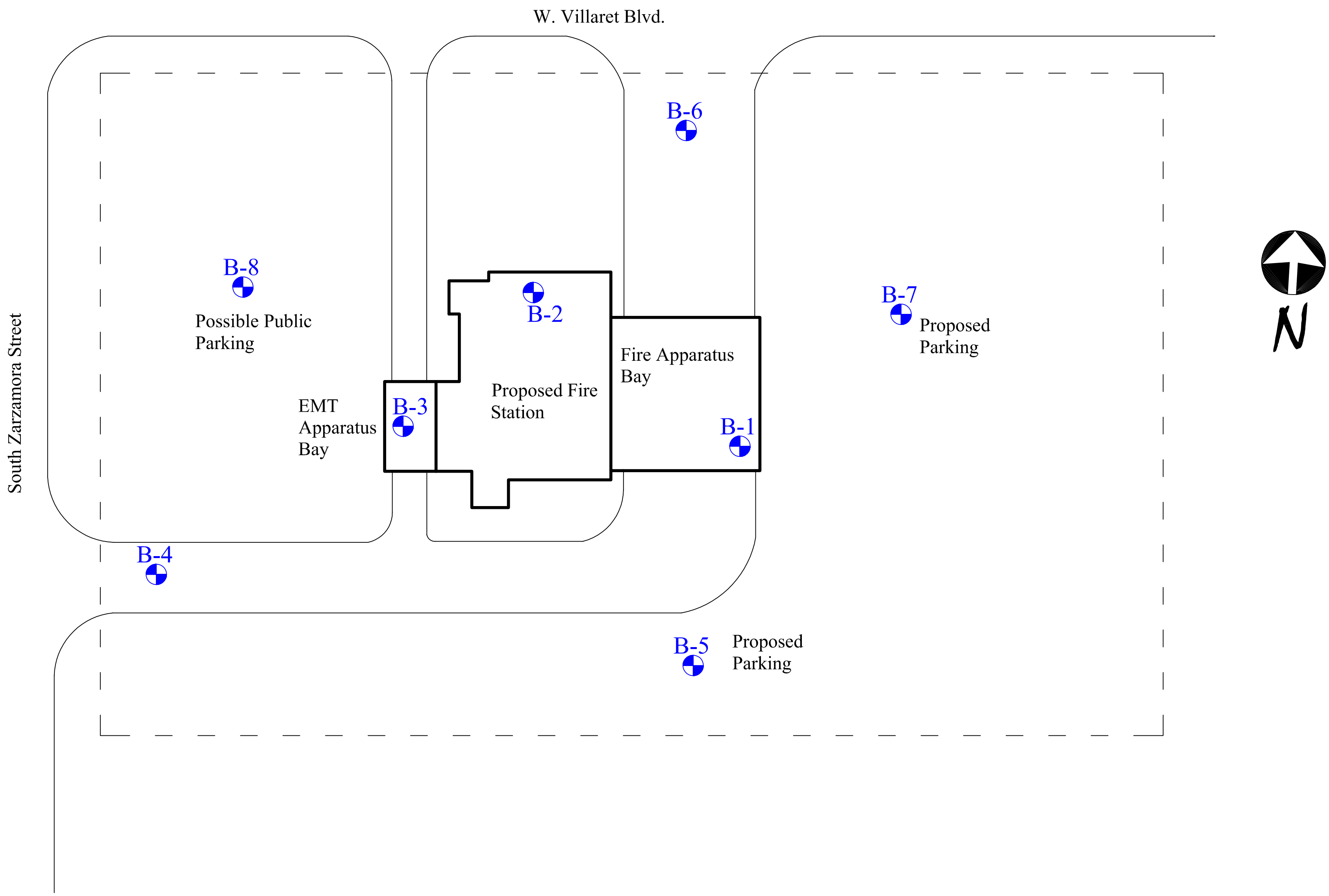
FIGURE 1

SITE VICINITY MAP



Note: Not drawn to Scale

Geotechnical Engineering Study
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San Antonio, Texas
BMC Project No. 12-12-0103

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FIGURE 2
BORING LOCATION PLAN

Burge-Martinez Consulting, Inc.
3453 North Pan Am Expressway, Suite 201
San Antonio, Texas 78219
Telephone: 210-646-8566
Fax: 210-590-7476

BORING NUMBER B-1

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 652.5 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff to hard, dark grayish brown FAT CLAY (CH) with gravel	SS 1		4-6-11 (17)			12				
			SS 2		7-11-13 (24)			18	65	24	41	
5		- grades to brown below 4.5 feet with trace calcareous nodules and gravel	SS 3		14-16-20 (36)			14				
		Stratum II: Hard, brown, calcareous LEAN CLAY (CL), trace gravel	SS 4		17-19-25 (44)			11	49	20	29	
10		- increase in sand and gravel below 8.5 feet	SS 5		15-26-37 (63)			12	40	20	20	64
15		- becomes cemented CLAYEY GRAVEL (GC) with greater depth (grab samples collected of auger cuttings)	SS 6		50/2"			6				
20			SS 7		50/2"			5				
25		Stratum III: Hard, gray to gray and tan FAT CLAY (CH)	SS 8		15-26-29 (55)			18				
30			SS 9		19-21-23 (44)			19				
		Bottom of hole at 30.0 feet.										

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San Antonio, Texas 78219
Telephone: 210-646-8566
Fax: 210-590-7476

BORING NUMBER B-2

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 654.5 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff, dark grayish brown FAT CLAY (CH), trace gravel	SS 1		4-6-10 (16)			15	66	27	39	
			SS 2		9-11-14 (25)			17				
5		Stratum II: Very stiff to hard, brown, SANDY FAT CLAY (CH), trace gravel	SS 3		10-13-14 (27)			11	56	20	36	51
			SS 4		11-12-12 (24)			17				
10		- becomes cemented CLAYEY GRAVEL (GC) below 8.5 feet (grab sample collected of auger cuttings)	SS 5		50/3"			5				
15		Stratum III: Hard, gray to gray and tan FAT CLAY (CH)	SS 6		11-13-19 (32)			25	79	22	57	
20			ST 7			4.5+		23				
25			SS 8		10-17-18 (35)			25				
30		- orange silt seams below 28 feet	SS 9		16-19-21 (40)			23				
		Bottom of hole at 30.0 feet.										

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Telephone: 210-646-8566
Fax: 210-590-7476

BORING NUMBER B-3

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 654.5 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff to hard, dark grayish brown FAT CLAY (CH) with gravel	SS 1		5-9-11 (20)			20				
			SS 2		13-12-14 (26)			14	58	21	37	
5		- grades to brown below 4.5 feet with trace calcareous nodules and gravel	SS 3		14-17-21 (38)			7	59	20	39	
		Stratum II: Hard, brown, calcareous SANDY LEAN CLAY (CL), trace gravel (11% retained on #4 Sieve)	SS 4		16-18-21 (39)			8				64
10		- becomes cemented CLAYEY GRAVEL (GC) below 8.5 feet (grab samples collected of auger cuttings)	SS 5		50/3"			3				
15		- grades to tan in color with increased sand content below 13.5 feet	SS 6		50/1"			7				
20		Stratum III: Hard, gray to gray and tan FAT CLAY (CH)	SS 7		17-19-26 (45)			24	82	26	56	
25		- orange silt seams below 23 feet	SS 8		19-19-21 (40)			24				
30			SS 9		19-24-38 (62)			24				
		Bottom of hole at 30.0 feet.										

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Telephone: 210-646-8566
Fax: 210-590-7476

BORING NUMBER B-4

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 655.3 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff, dark brown FAT CLAY (CH), trace gravel	SS 1		7-7-10 (17)			13	55	21	34	
			SS 2		8-11-11 (22)			15				
5		Stratum II: Hard, brown GRAVELLY LEAN CLAY (CL) with sand (31% retained on #4 Sieve)	SS 3		16-19-24 (43)			11				50
		- becomes cemented CLAYEY GRAVEL (GC) below 6.5 feet (grab samples collected of auger cuttings)	SS 4		50/1"			3				
			SS 5		50/1"			4				
10		Bottom of hole at 10.0 feet.										

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BORING NUMBER B-5

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 653.0 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff to hard, dark brown FAT CLAY (CH), trace gravel	SS 1		5-7-10 (17)			13				
			SS 2		7-7-11 (18)			17	62	25	37	
5		- grades to brown in color below 5 feet with trace calcareous nodules	SS 3		8-14-21 (35)			14				
		Stratum II: Very stiff to hard, brown and tan, calcareous LEAN CLAY (CL) with sand	SS 4		11-14-22 (36)			6	36	18	18	78
10		- increase in calcareous deposits below 8.5 feet	SS 5		11-14-15 (29)			13				
		Bottom of hole at 10.0 feet.										

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BORING NUMBER B-6

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 653.1 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff, dark brown FAT CLAY (CH), trace gravel	SS 1		6-9-11 (20)			14	69	23	46	
			SS 2		13-13-15 (28)			14				
5		Stratum II: Hard, brown and tan, calcareous LEAN CLAY (CL) with sand and trace gravel	SS 3		19-21-24 (45)			6				
		- becomes cemented CLAYEY GRAVEL (GC) below 6.5 feet (grab samples collected of auger cuttings)	SS 4		50/1"			11				
			SS 5		50/3"			6				
10		Bottom of hole at 10.0 feet.										

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BORING NUMBER B-7

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 652.0 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff to hard, dark brown FAT CLAY (CH), trace gravel and calcareous deposits	SS 1		7-8-8 (16)			16				
			SS 2		9-14-19 (33)			14	59	24	35	
5		- grades to brown in color below 4.5 feet	SS 3		12-16-25 (41)			10				
		Stratum II: Dense, brown CLAYEY SAND (SC) with gravel (23% retained on #4 Sieve)	SS 4		21-19-19 (38)			7				43
10			SS 5		15-25-23 (48)			8				
		Bottom of hole at 10.0 feet.										

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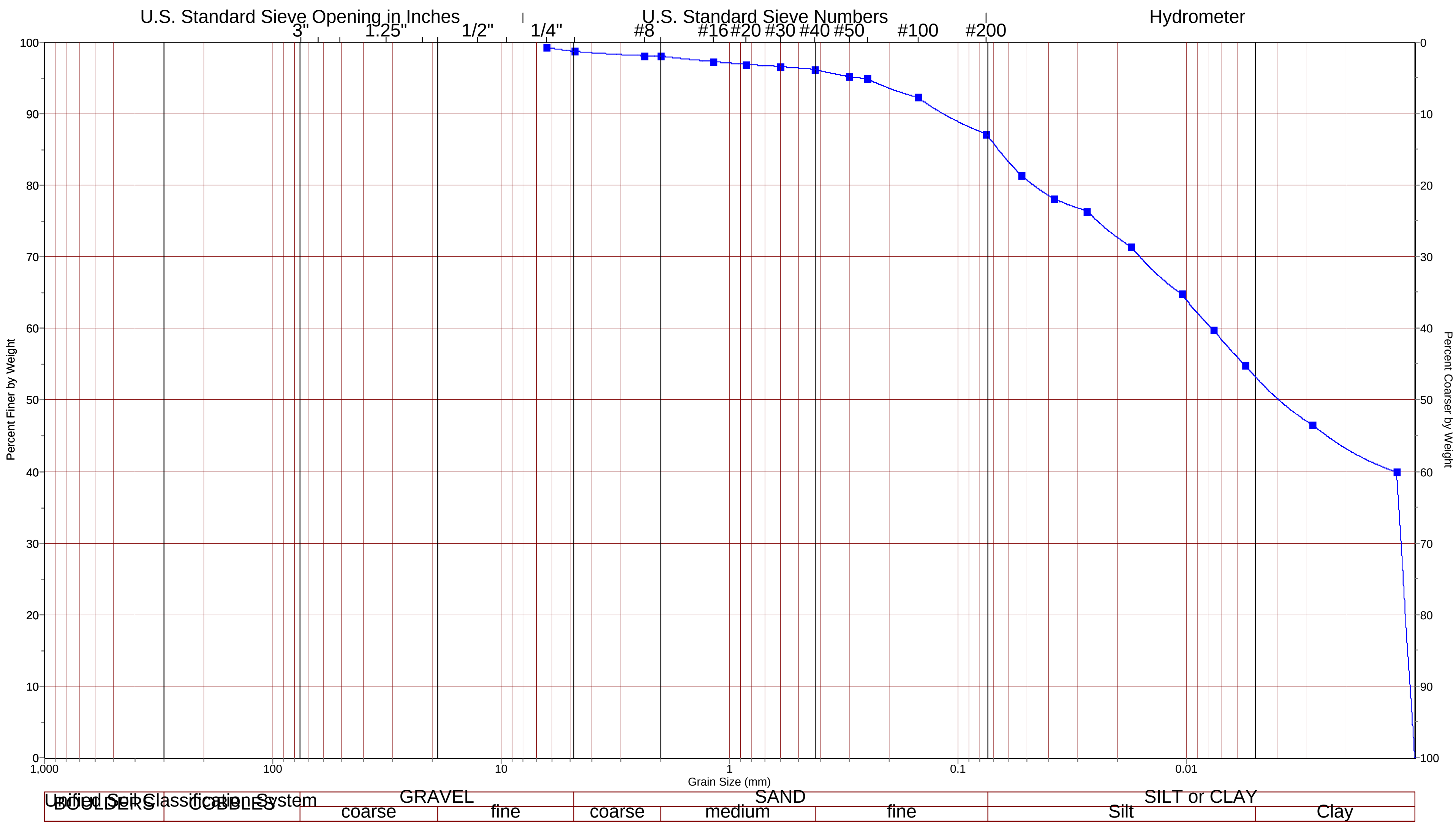
BORING NUMBER B-8

CLIENT City of San Antonio - CIMS Department
PROJECT NAME Fire Station #2
PROJECT NUMBER 12-12-0103
PROJECT LOCATION San Antonio, TX
DATE STARTED 4/23/12 **COMPLETED** 4/23/12
GROUND ELEVATION 655.2 ft **HOLE SIZE** 5"
DRILLING CONTRACTOR Alpha Omega Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY Andrew **CHECKED BY** B. Krieger
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Stratum I: Very stiff, dark grayish brown FAT CLAY (CH), trace gravel	SS 1		5-7-11 (18)			16	58	21	37	
			SS 2		9-9-11 (20)			17				
5		Stratum II: Hard, brown and tan FAT CLAY (CH) with sand, trace gravel and calcareous deposits	SS 3		8-13-19 (32)			11	56	22	34	
		- becomes cemented CLAYEY GRAVEL (GC) below 6.5 feet (grab samples collected of auger cuttings)	GB 4					2				
			GB 5					4				
10		Bottom of hole at 10.0 feet.										

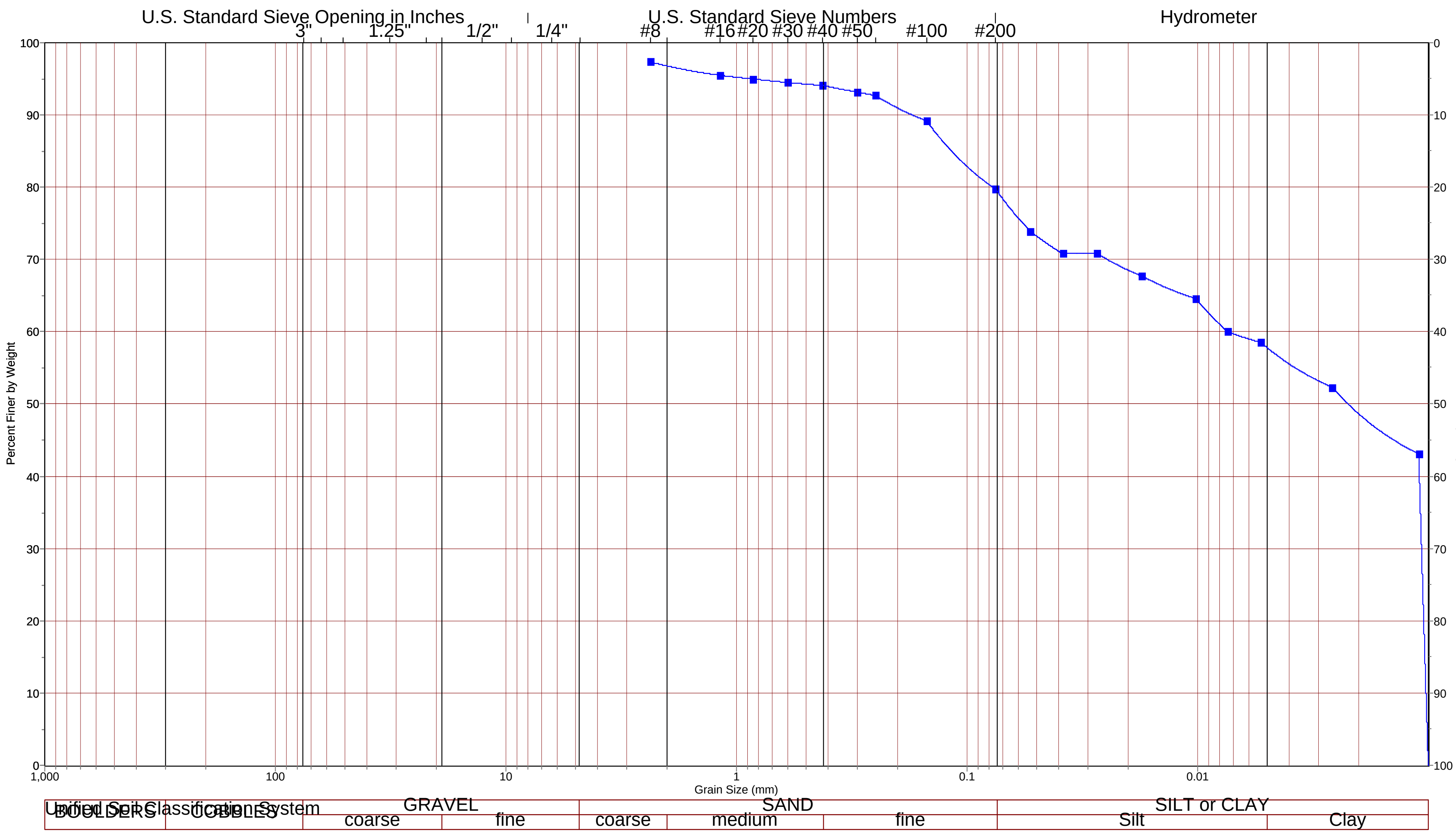
ACME	Project No.: 12-12-0103	GRAINSIZE DISTRIBUTION GRAPH
	Project Name: COSA Fire Station #2	Tested By: BMC
	Client: COSA CIMS Dept.	Test Date: 5/9/2012

Symbol	Sample No.	% Clay	% Silt	% Fine Sand	% Medium Sand	% Coarse Sand	% Fine Gravel	% Coarse Gravel	% Cobbles
▪	B-2 6.5'-8'	53.3	33.8	9.2	2.0	0.8	0.5	0	0



ACME	Project No.: 12-12-0103	GRAINSIZE DISTRIBUTION GRAPH
	Project Name: COSA Fire Station #2	Tested By: BMC
	Client: COSA CIMS Dept.	Test Date: 5/9/2012

Symbol	Sample No.	% Clay	% Silt	% Fine Sand	% Medium Sand	% Coarse Sand	% Fine Gravel	% Coarse Gravel	% Cobbles
▪	B-3 4.5'-6'	57.9	21.7	14.7	2.8	0.7	0	0	0



SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

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REPORT NARRATIVE 5/14/2012

Benny Krieger
BMC Consulting
3453 N PanAm Expressway
Ste 212
San Antonio , TX - 78219
TEL: (210) 646-8566 Email: Benny@burgemartinez.com
FAX: (210) 590-7476

RE: 12-12-0103 Fire Sation #2

Dear Benny Krieger: Order No.: 1205007

Enclosed please find the analytical report for the sample/s received on 5/2/2012.

HOLDING TIMES: All samples were analyzed within prescribed holding times and/or in accordance with the Sample Acceptance Policy unless otherwise noted in the report.
DATA: Sample were prepared, analyzed and reported using the methods outlined in the following references: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition
QA/QC: All method blanks, laboratory spikes, and/or matrix spikes met quality assurance objectives, except as noted in the report with data qualifiers.
SUBCONTRACTED: No analyses were subcontracted to an outside laboratory.
COMMENTS: No significant observations were made.

The reported results apply to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions regarding these test results call (210) 340-8121.

Thank you,

Reddy Gosala, Ph.D
Laboratory Director

Report of Laboratory Analysis

San Antonio: NELAP Certificate# T104704367-11-4

ALAMO ANALYTICAL LABORATORIES, LTD.
10526 Gulfdale • San Antonio, Texas 78216-3601 • (210) 340-8121

Date: 14-May-12

Analytical Results Report

CLIENT: BMC Consulting
Lab Order: 1205007
Project: 12-12-0103 Fire Sation #2

Alamo Lab ID	Client ID	Collection Date	Analyses	Matrix	Result	Rpt Limit	Units	DF
TestName: TEX-620-J		**TestNo:** TX620J	**Date Analyzed** 5/5/2012 10:00:00 AM				Initials: FR	
1205007-01A	B-6/S-1 Boring B-6 DBC	4/23/2012	Sulfate	Soil	269	250	mg/Kg	10
1205007-02A	B-8/S-2 Boring B-8 DBC	4/23/2012	Sulfate	Soil	1430	1250	mg/Kg	50

Approved by:

Report of Laboratory Analysis

San Antonio: NELAP Certificate# T104704367-11-4

Date: *14-May-12*

ALAMO ANALYTICAL LABORATORIES, LTD.

QC SUMMARY REPORT

CLIENT: BMC Consulting
Work Order: 1205007 **Project:** 12-12-0103 Fire Sation #2

Analyte	BLK	SPK value	%REC LCS	LCSD	RPD %	RPD Limit	%REC MS	Low - High Limit	Parent	DUP	RPD %	RPD Limi
Batch ID: TX620J-5/4/2012	**TestName:** TEX-620-J											
Run ID: UV1_120504A	**Test Code:** TX620J				**Units:** mg/Kg		**Analysis Date:** 5/5/2012 10:00:00 AM		**Prep Date:** 5/4/2012 12:00:00			
Sulfate	<25	25	107.2%					80 - 120	1430.0	1380.0	4.000	30.0

Approved by: [signature]

Laboratory QC Report

San Antonio: NELAP Certificate# T104704367-11-4

CHAIN OF CUSTODY RECORD

COC #: 06519

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San Antonio, Texas 78216
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www.alamoanalytical.com
admin@alamoanalytical.com

NELAP Certificate # T104704367-08-TX

MUST BE COMPLETED BY CLIENT

Alamo's Client: BMC	Client's P.O. #:
Project Manager: Benny Krieger	Phone #: 646-8566
Address: 3453 N. Panam Exp.	Fax #: 590-7476
Project Number: 12-12-0103	Project Name: Fire Station #2
Project Location: San Antonio, TX	Sampler Signature: [signature]

Turnaround time: Standard (7) ☒ (in working days)
RUSH: 1☐ 2☐ 3-5☐ Days (additional charges)
TRRP 13 Report: Yes ☐ No ☐ (additional charges)
Analysis for Permit Compliance: Yes ☐ No ☐
DMR Form Required: Yes ☐ No ☐

LAB ID# (Do not use)	Sampling Date	Sampling Time	Composite	Grab	Matrix	FIELD ID #	FIELD DESCRIPTION	No. of Containers	ANALYSIS: Tex 620 Soluble Sulfates							REMARKS (Preservation, Size/Amount, Etc.)
1205007-01	4/23/12		X		Soil	B-6/S-1	Boring B-6 DBC	1	X							
↓ 02	4/23/12		X		〃	B-8/S-2	Boring B-8 DBC	1	X							

Relinquished by: (Signature / Print Name)	Date	Time	Received by: (Signature)
[signature] Benny Krieger	5/2/12	8:39	
Relinquished by: (Signature / Print Name)	Date	Time	Received by: (Signature)
Relinquished by: (Signature / Print Name)	Date	Time	Received by: (Signature)
Relinquished by: (Signature / Print Name)	5/2/12	8:39	Received for laboratory by: (Signature) [signature]

Headspace ☐ ☐ If Yes, Amt. ______
Properly Sealed ☐ ☐ If No, Explain ______
Chilled ≤4° C ☐ ☐ If No, Temp. ______

Comments: Email Results To Benny@burgemartinez.com

ALAMO ANALYTICAL LABORATORIES LTD.

10526 Gulfdale • San Antonio, Texas 78216-3601 alamo_labs@sbcglobal.net • www.alamoanalytical.com

Sample Log-In Checklist

DATE: 5/02/12 TIME: 8.45 INITIALS: [initials]

CLIENT: BHC PROJECT: W.O# 1205007

1. Is a Chain of Custody present? **(Yes)** No
2. Is a Chain of Custody properly completed? **(Yes)** No
3. Are custody seals present? Yes **(No)**
   If yes, are they intact? Yes No
   Are they on: Sample ____ or on Shipping Container ____
4. Are all samples tagged or labeled? **(Yes)** No
   If yes, do the labels match the Chain of Custody? **(Yes)** No
5. Do all shipping documents agree (i.e., number of coolers arrived vs. on tickets)
   If not, describe below. Yes No **(N/A)**
6. Are samples preserved properly? *If not*, describe below. **(Yes)** No
7. Are all samples within holding times on arrival? **(Yes)** No
   If not, describe below.
8. Condition of shipping container: Intact ✓ or Other ______
9. Condition of samples: Intact ✓ or ______
10. Temperature of samples: 6°C
11. Delivery agent: Client ✓ UPS ___ Fed-Ex ___ Lone Star ___ Alamo P/U ___ Other ______
12. Sample disposal: Return to client ______ Alamo Analytical Disposal ✓

Comments: (Reference checklist item number from above, or for comments on resolution below):

[signature]

Record of contacting client for resolution of sample discrepancies (first and retry contact)

Contacted How?

Name: ______ Phone ___ Fax ___ Date: ___/___/___ Time: ______
Name: ______ Phone ___ Fax ___ Date: ___/___/___ Time: ______

LABORATORY AND FIELD TEST PROCEDURES

Soil Classification per ASTM D2487
This soil testing standard was used for classifying soils according to the Unified Soil Classification System. The soil classifications of the earth materials encountered are as noted in the attached boring logs.

Soil Water Content per ASTM D2216
This test determines the water content of soil or rock expressed as a percentage of the solid mass of the soil. The test results are listed under Moisture Content in the attached boring logs.

Soil Liquid Limit per ASTM D4318
The soil Liquid Limit identifies the upper limit soil water content at which the soil changes from a moldable (plastic) physical state to a liquid state. The Liquid Limit water content is expressed as a percentage of the solid mass of the soil.

Soil Plastic Limit per ASTM D4318
The soil Plastic Limit identifies a lower limit soil water content at which the soil changes from a moldable (plastic) physical state to a non-moldable (semi-solid) physical state. The Plastic Limit water content is expressed as a percentage of the solid mass of the soil.

Plasticity Index per ASTM D4318
This is the numeric difference between the Liquid Limit and Plastic Limit. This index also defines the range of water content over which the soil-water system acts as a moldable (plastic) material. Higher Plasticity Index (PI) values indicate that the soil has a greater ability to change in soil volume or shrink and swell with lower or higher water contents, respectively.

Standard Penetration Test (SPT) and Split Spoon Sampler (SS) per ASTM D1586
This is the standard test method for both the penetration test and split-barrel (spoon) sampling of soils. This sampling method is used for soils or rock too hard for sampling using Shelby Tubes. The method involves penetration of a split spoon sampler into the soil or rock through successive blows of a 140 pound hammer in a prescribed manner.

Blow Counts (N) per ASTM D1586
This is the number of blows required to drive a Split Spoon Sampler by means of a 140 pound hammer for a distance of 12 inches in accordance with the variables stated in the test procedures.

Thin-walled Tube Sampling (Shelby Tube - ST) per ASTM D1587
This is the standard test method for sampling fine-grained soils using a thin-walled metal tube. Relatively undisturbed samples are recovered for laboratory testing of physical properties.

Pocket Penetrometer (PP): This test method is an accepted modification of ASTM D1558 test method for establishing the moisture-penetration resistance relationships of fine-grained soils. The test results are measured in tons per square foot, tsf. The strength values provided by this method should be considered qualitatively.

Minus No. 200 Sieve per ASTM D1140
This test method covers determination of the amount of material finer than a #200 (75 µm) sieve by washing. The results are stated as a percentage of the total dry weight of the sample.

Boring Logs: This is a summary of the above described information at each boring location.