PART 1 - GENERAL

1.1 Related Documents:

Drawings and general provisions of Contract.

1.2 DESCRIPTION OF WORK:

Contract documents indicate the Work of the contract and related requirements and conditions.

The Work includes, briefly and without force and effect upon the contract documents, work necessary to facilitate the installation of a prefabricated Magazine building (to be furnished and installed by others and NIC) as follows. Contractor may, at his discretion, alter the sequence of construction activities outlined below.

Relocate four existing 20' Conex containers from the proposed location of the Magazine to another location on-site to be selected by Williamson County. Proposed locations are within 300' of existing locations and consist of areas of previously graded and compacted roadbase.

Install silt fence as shown on Sheet C101 and specification section 015713.

Clear and grub project site area per specification section 311000.

Excavate and remove 36 inches of existing soil within the Magazine footprint and 3 feet beyond the perimeter to provide building pad for Magazine.

Prepare subgrade and place the fill pad for the Magazine per notes on Sheet C101 and Balcones Geotechnical Report Addendum 1.

Coordinate installation of Magazine on pad prepared by Contractor. Costs of purchase, delivery and installation of Magazine shall be borne by Williamson County and are NIC.

Prepare subgrade for flatwork at perimeter of Magazine.

Install flatwork as detailed on Sheet C102.

Restore all disturbed areas of vegetation with hydromulch.

Remove silt fence.

1.3 SUBMITTALS

Provide material submittals and other information as required for coordination of the work.

1.4 CONTRACTOR'S USE OF CONSTRUCTION SITE

CONTRACTOR shall not unreasonably encumber the construction site with materials or equipment. CONTRACTOR shall assume reasonable responsibility for protection of construction site.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

1.1 Testing

Contractor shall retain the services of a qualified third-party testing agency, acceptable to Williamson County, to provide testing services described in Specification Section 321313 3.9 and on Pages 8 and 9 of the *Geotechnical Investigation [for the] Williamson County Sheriff's Office Training Center*, consisting of two proctor Compaction tests (TEX 113E), one for subgrade and one for select fill, with densities run on subgrade and on each lift of select fill placed.

End

SECTION 015713

TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted November 1, 2014.

1.2 SUMMARY

A. Section includes specifications for the following temporary erosion and sedimentation controls:
   1. Silt fence

B. Related Sections:
   1. Section 311000 “Site Clearing”.

1.3 SUBMITTALS

A. Silt Fence
   1. Source, manufacturer, characteristics and test data for the silt fence fabric
   2. Manufacturer, characteristics and test data for the posts and wire fence

PART 2 - PRODUCTS

2.1 Stabilized construction entrance

A. Silt fence
   1. Fabric
      a. The silt fence fabric shall be of nonwoven polypropylene, polyethylene or polyamide thermoplastic fibers with non-raveling edges. The silt fence fabric shall be non-biodegradable, inert to most soil chemicals, ultraviolet resistant, unaffected by moisture or other weather conditions, and permeable to water while retaining sediment. The silt fence fabric shall be supplied in rolls a minimum of 36 inches (0.9 meter) wide.
      b. The fabric shall meet the requirements presented in Table 1, when sampled and tested in accordance with the methods indicated herein.
   2. Posts
      a. Posts shall be steel Tee or Y-posts, not less than 4 feet (1.22 meters) in length with a minimum weight of 1.25 pounds per foot (1.86 kilograms per meter) with a minimum Brinell Hardness of 143. Hangers shall be adequate to secure fence and fabric to posts. Posts and anchor plates shall conform to ASTM A-702. Caps are required.
   3. Wire Fence

a. Wire fence shall be welded wire fabric 2 in. x 4 in. 12.5 SWG, wire diameter 0.099 in (±0.005 in.).

Silt Fence Fabric Requirements		
Physical Properties	Method	Requirements
Fabric Weight in ounces per square yard	TEX-616-J	5.0 minimum
Equivalent Sieve Opening Size: US Standard	CW-02215	40 to 100
Mullen Burst Strength: lbs. per sq. inch (psi)	ASTM D-3786	280 minimum
Ultraviolet Resistance; % Strength Retention	ASTM D-1682	70 minimum

PART 3 - EXECUTION

3.1 Silt Fence

A. The silt fence fabric shall be securely attached to the posts and the wire support fence with the bottom 12 inches (300 mm) of the material buried in a trench a minimum of 6 inches (150 mm) deep and 6 inches (150 mm) wide to prevent sediment from passing under the fence. When the silt fence is constructed on impervious material, a 12-inch (300-mm) flap of fabric shall be extended upstream from the bottom of the silt fence and weighted to limit particulate loss. No horizontal joints will be allowed in the silt fence fabric. Vertical joints shall be overlapped a minimum of 12 inches (300 mm) with the ends sewn or otherwise securely tied.

B. The silt fence shall be a minimum of 24 inches (0.6 meter) high. Posts shall be embedded a minimum of 12 inches (300 mm) in the ground, placed a maximum of 8 feet (2.4 meters) apart and set on a slight angle toward the anticipated runoff source. When directed by the Engineer, posts shall be set at specified intervals to support concentrated loads.

C. Per OSHA §1926.701, "all protruding reinforcing steel, onto and into which employees could fall, shall be guarded to eliminate the hazard of impalement". Caps must be large enough to dissipate the forces of impact to prevent impalement from a reasonably foreseeable fall distance. It should be noted that the use of impalement protection caps is but one method of protection; covers or wooden troughs can be another means of meeting the guarding requirement.

D. The silt fence shall be repaired, replaced, and/or relocated when necessary or as directed by the Engineer. Accumulated silt shall be removed when it reaches a depth of 6 inches.

END OF SECTION 015713

SECTION 311000

SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. Section includes specifications for the removal and disposal of all trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish and other objectionable material.

B. Related Sections:

1. Section 015713 “Temporary Erosion and Sedimentation Control".
2. Section 312000 “Earth Moving” for subgrade preparation, excavation, and backfill.

1.3 SUBMITTALS

A. General
1. A plan for removal and deposition of all clearing and grubbing materials and debris

PART 2 - PRODUCTS

2.1 Not used.

PART 3 - EXECUTION

3.1 General

A. Prior to commencement of this work, all required erosion control and tree protection measures indicated on the Drawings shall be in place. The existing utilities shall be located and protected as specified in the General and Supplementary Conditions and Division 01 Specification Sections and/or indicated on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way.

B. Areas within the construction limits indicated on the Drawings shall be cleared of all trees, stumps, brush, etc.; except trees or shrubs scheduled for preservation which shall be carefully trimmed as directed, and shall be protected from scarring, barking or other injuries during construction operations. All exposed cuts over 2 inches (50 millimeters) in diameter, exposed ends of pruned limbs or scarred bark shall be treated with an approved asphalt material within 24 hours of the pruning or injury.

C. Construction equipment shall not be operated, nor construction materials stockpiled, under the canopies of trees, unless otherwise indicated on the Drawings and/or specified in the Contract Documents. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

D. Within the construction limits or areas indicated, all obstructions, stumps, roots, vegetation, abandoned structures, rubbish and objectionable material shall be removed to the following depths:
   1. Any foundations from existing structures (such as light poles) should be demolished and completely removed from all proposed construction areas, to a depth of at least 24 inches below final grade.
   2. Roots of trees to be removed within construction areas should be grubbed to full depths, including the dry soil around the roots.
   3. All utilities and associated bedding materials that are planned to be abandoned/demolished should be removed from within the construction areas. If not possible, the abandoned utility lines should be thoroughly grouted and plugged with flowable fill.

E. Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc. shall be backfilled with select embankment material and compacted by approved methods. All cleared and grubbed material shall be disposed of in a manner satisfactory to the Engineer. Unless otherwise provided, all materials as described above shall become the property of the Contractor and removed from the site and disposed of at a permitted disposal site.

END OF SECTION 311000

SECTION 312000

EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted November 1, 2014.

1.2 SUMMARY

A. Section includes specifications for the following:
1. Excavation
2. Subgrade preparation
3. Borrow
4. Embankment
5. Proof rolling
6. Base
7. Pipe trenching, bedding, and backfill

B. Related Sections:

1. Section 015713 “Temporary Erosion and Sedimentation Control"
2. Section 311000 “Site Clearing”

1.3 SUBMITTALS

A. General
1. Plan for removal and deposition of all waste materials
2. Blasting permit if blasting is required and allowed on the project
3. Plan identifying source, material type, classification and characteristics (P.I., optimum moisture-density, etc.) of embankment layers, in-situ subgrade soils, proposed borrow material
4. Type and size of equipment proposed to produce the required compaction
5. The manufacturer, model and description of the proposed dust control equipment
6. The sprinkling plan including application rate, pattern of sprinkling and scheduled times of application
7. Source, gradation, and test results for the crushed limestone material
8. Field density test results for in-place compacted subgrade, embankment, and base

PART 2 - PRODUCTS

2.1 BORROW

A. Borrow will be used only when indicated on the Drawings or directed by the Engineer and shall only be acquired from approved sources.

B. Borrow for paving areas shall have a PI less than 30.

2.2 EMBANKMENT

A. General
   1. Excavated on-site processed limestone and Stratum Ia/I/II soils, if free of organics, debris, and rocks larger than 4 inches, may be considered for use as fill in pavement, landscape, or other general areas.

B. Rock Embankments
   1. The maximum dimension of any rock used in embankment shall be less than the thickness of the embankment layer and in no case shall any rock over 2 feet (600 mm) in its greatest dimension be placed in the embankment, unless otherwise approved by the Engineer.
   2. All oversized rocks, which are otherwise suitable for construction, shall be broken to the required dimension and utilized in embankment construction where indicated. When preferred by the Contractor and acceptable to the Engineer, oversized rocks may be placed at other locations where the embankment layer is of greater depth, thus requiring less breakage.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to commencement of this work, all required erosion control and tree protection measures shall be in place. The existing utilities shall be located and shall be protected as specified in the General and Supplementary Conditions and Division 01 Specification Sections and/or indicated on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way.

B. Construction equipment shall not be operated, nor construction materials stockpiled, under the canopies of trees, unless otherwise indicated on the Drawings. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

C. No material shall be stockpiled within the banks of a waterway.

3.2 DUST CONTROL

A. Materials
   1. Water shall be furnished by the Contractor and shall be clean and free from industrial wastes and other objectionable matter.

B. General

1. It shall be the Contractor's continuous responsibility at all times, including nights, holidays and weekends until acceptance of the project by the Owner, to maintain the specified areas relatively free of dust in a manner that will cause the least inconvenience to the public.

3.3 EXCAVATION

A. General
   1. All excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed.
   2. All excavation shall be performed as specified herein and shall conform to the established alignment, grades and cross sections indicated on the Drawings. Suitable excavated materials shall be utilized, insofar as practical, in constructing required embankments.
   3. Unsuitable excavated materials or excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor. Unsuitable material encountered below the subgrade elevation in pavement cuts, when declared "Waste" by the Engineer, shall be replaced with material from the pavement excavation or with other suitable material as approved by the Engineer. It shall become the Contractor's responsibility to dispose of this material in an environmentally sound manner at a permitted disposal site.
   4. All blasting shall conform to the Provisions of the General and Supplementary Conditions and Division 01 Specification Sections. In all cases, a Blasting Permit must be obtained in advance from the regulating authority.
   5. Adequate dewatering and drainage of excavation shall be maintained throughout the time required to complete the excavation work.
   6. Stump holes or other small excavations encountered within the limits of the embankments shall be backfilled with suitable material and thoroughly tamped by approved methods before commencement of the embankment construction.

3.4 SUBGRADE PREPARATION

A. General
   1. The subgrade shall be prepared sufficiently in advance to ensure satisfactory prosecution of the Work.
   2. The Contractor shall set blue tops for the subgrade at maximum intervals of 50 feet (15 meters) in each direction.
   3. The surface of the subgrade shall be scarified and shaped in conformity with the typical sections and the lines and grades indicated on the Drawings; by the removal of existing material or addition of approved material as established by the Engineer. Any deviation in the subgrade cross section which exceeds ½ inch in a length of 10 feet (12 mm in a length of 3 meters), measured longitudinally, shall be corrected by loosening, adding or removing material, and then reshaping and compacting by sprinkling and rolling.

B. Proofrolling
   1. Once final subgrade elevations have been achieved, the exposed subgrade shall be carefully proofrooled with a 20-ton (minimum weight) pneumatic roller or a fully loaded dump truck to detect weak zones in the subgrade, in accordance with the requirements in this Section.
   2. All unsuitable material shall be removed and replaced with soils exhibiting similar classification, moisture content, and density as the adjacent in-situ soils.

C. Density
   1. It is the intent of this specification to provide the required density and moisture control for the subgrade based on the plasticity characteristics of the approved materials. The subgrade materials shall be sprinkled as required and compacted to the extent necessary

to provide the density specified below, unless otherwise indicated on the Drawings. The Plasticity Index (P.I.) will be established in accordance with TxDOT Test Methods Tex-104-E, Tex-105-E and Tex-106-E. The density determination will be made in accordance with TxDOT Test Method Tex-114-E and field density measurements will be made in accordance with TxDOT Test Method Tex-115-E.

Description	PI	Density, Percent	Range or Moisture Contents for Compaction
Subgrade and Paving Fill	Less than 25	Not less than 95	-3% minimum +3% maximum
Subgrade and Paving Fill	Greater than 25	Not less than 95	Optimum minimum +4% maximum
Crushed Limestone Base		Not less than 95	-3% minimum +3% maximum

2. Subgrade materials on which planting or turf will be established shall be compacted to a minimum of 85 percent of the density as determined in accordance with TxDOT Test Method Tex-114-E. Field tests for density in accordance with TxDOT Test Method Tex-115-E will be made as soon as possible after compaction operations are completed. If the material fails to meet the density specified, it shall be reworked as necessary to obtain the density required.
3. Prior to placement of any base materials, the in-place density and moisture content of the top 6 inches (150 mm) of compacted subgrade shall be checked. If the tests indicate that the relative density and moisture do not meet the limits specified in the table above, the subgrade shall be reworked as necessary to obtain the specified compaction and moisture content. All initial testing will be paid for by the Owner. All retesting shall be paid for by the Contractor.

3.5 BORROW

A. General
1. The Contractor shall arrange for borrow from one of the following sources:
   a. Existing borrow pit
   b. New borrow pit
   c. Surplus excavated material from a site, with a site development permit
2. The Contractor shall notify the Engineer 3 weeks prior to opening a pit or any other borrow source to allow necessary testing for approval of materials. All borrow sites shall comply with the requirements of the site development permit.
3. During construction, borrow sources shall be kept drained to permit final cross sections to be measured, when required.
4. Borrow sites shall be managed and maintained to minimize the impact of the appearance of the natural topographic features and at no time create a potential hazard to the public.

3.6 EMBANKMENT

A. General
1. The area of embankment placement shall be proof rolled and any unstable or spongy areas shall be undercut and backfilled with suitable material or otherwise mechanically manipulated and compacted by approved methods. Where shown on the Drawings or

required by the Engineer, the ground surface thus prepared shall be compacted by sprinkling and rolling. The surface of the ground, including those plowed and loosened or roughened by small washes, shall be restored to approximately its original slope and the ground surface thus prepared shall be compacted by sprinkling and rolling.

2. Unless otherwise indicated on the Drawings and with the exception of rock, the surface of the ground of all unpaved areas, which are to receive embankment, shall be loosened by scarifying or plowing to a depth of not less than 4 inches (100 mm). The loosened material shall be re-compacted with the new embankment as hereinafter specified.
3. The surface of hillsides, which are to receive embankment, shall be loosened, by scarifying or plowing, to a depth of not less than 4 inches (100 mm) and benches constructed before the embankment materials are placed. The embankment shall then be placed in layers, as hereinafter specified, beginning at the low side with partial width layers and increasing the widths of the layers as the embankment is raised. The material, which has been loosened during preparation of the original ground surface, shall be re-compacted simultaneously with the embankment material placed at the same elevation.
4. Where embankments are to be placed adjacent to or over existing pavements, the pavement slopes shall be plowed or scarified to a depth of not less than 6 inches (150 mm) and the embankment along the pavement slopes shall be built up in successive layers, as hereinafter specified, to the elevation of the old pavement. Then, if specified, the top surface of the old pavement shall be scarified to a minimum depth of 6 inches (150 mm) and re-compacted along with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible layer depth, specified hereinafter.
5. Trees, stumps, roots, vegetation or other unsuitable materials shall not be placed in embankment.
6. All embankment shall be constructed in layers approximately parallel to the finished grade.
7. The embankment shall be continuously maintained at its finished section and grade until that portion of the work is accepted. After completion of the embankment to the finished section and grade, the Contractor shall proof roll the subgrade or finished grade. Any unstable or spongy areas shall be undercut and backfilled with suitable material or otherwise mechanically manipulated and compacted by approved methods. After acceptance of the embankment, re-vegetation activities shall commence immediately to minimize the soil loss and air pollution.

B. Rolling
   1. The embankment layer shall be sprinkled.
   2. Rolling with a power roller shall start longitudinally at the sides of the designated area and proceed towards the center, overlapping on successive trips by at least 1/2 the width of the rear wheel of the power roller.
   3. The rollers, unless otherwise directed by the Engineer or designated representative, shall be operated at a speed between 2 and 3 miles (3 and 5 kilometers) per hour.

C. Earth Embankment
   1. Earth embankments shall be defined as embankments composed of soil material other than rock and shall be constructed of acceptable material from approved sources.
   2. Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8 inches (200 mm) or less in loose measure, for the full width of the individual cross section and in a length that is best suited to the sprinkling and compaction methods utilized.
   3. Minor quantities of rocks with a maximum dimension of 4 inches (100 mm) may be incorporated in the earth embankment layers, provided that the rock is not placed immediately adjacent to structures.
   4. Each layer of embankment shall be uniform as to material type and classification, density and moisture content before beginning compaction.
   5. Where layers of unlike materials abut each other, each layer shall be feathered on a slope of 1:20 or the materials shall be so mixed as to prevent abrupt changes in the soil.

6. Any material placed in the embankment by dumping in a pile or windrows shall not be incorporated in a layer in that position. All such piles or windrows shall be incorporated in an embankment layer by blading and mixing or by similar methods.
7. Clods or lumps of material shall be broken down into smaller sizes and the embankment material in a layer shall be mixed by blading, harrowing, discing or similar methods to ensure that a uniform material of uniform density is secured in each layer.
8. The water required in sprinkling the layers, to obtain the moisture content necessary for optimum compaction, shall be evenly applied. It shall be the responsibility of the Contractor to secure uniform moisture content throughout the layer by such methods as may be necessary.
9. All earth cuts, whether full width or partial width side hill cuts and which are not required to be excavated below the subgrade elevation, shall be scarified to a uniform depth of at least 6 inches (150 mm) below grade. The material shall be mixed and reshaped by blading, sprinkled and rolled in accordance with the requirements outlined above for earth embankments to the same density required for the adjacent embankment.
10. Each layer shall be compacted to the required density by any method, and/or type and size of equipment, which will produce the required compaction. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.
11. It is the intent of this specification to provide the required density and moisture control for each layer of earth embankment and select material based on the plasticity characteristics of the embankment soil. Each layer shall be sprinkled as required and compacted to the extent necessary to provide the density specified below, unless otherwise indicated.

Description	PI	Density, Percent	Range or Moisture Contents for Compaction
Subgrade and Paving Fill	Less than 25	Not less than 95	-3% minimum +3% maximum
Subgrade and Paving Fill	Greater than 25	Not less than 95	Optimum minimum +4% maximum
Crushed Limestone Base		Not less than 95	-3% minimum +3% maximum

12. The Plasticity Index (PI) will be established in accordance with TxDOT Test Methods Tex-104-E, Tex-105-E and Tex-106-E and the density determination will be made in accordance with TxDOT Test Method Tex-114-E, "Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade and Embankment Soil". Field density measurements will be made in accordance with TxDOT Test Method Tex-115-E, "Field Method for Determination of In-Place Density of Soils and Base Materials".
13. After each layer of earth embankment or select material is complete, tests, as necessary, will be conducted as directed by the Engineer. If the material fails to meet the density specified, the course shall be reworked as necessary to obtain the specified compaction.

D. Rock Embankments
1. Rock embankments shall be defined as those composed principally of rock and shall be constructed of accepted material from approved sources. Rock embankments shall not be placed immediately adjacent to structures.
2. Except as otherwise indicated on the Drawings, rock embankments shall be constructed in successive layers of 18 inches (450 mm) or less in thickness for the full width of the cross section. When, in the opinion of the Engineer, the rock sizes necessitate a greater

thickness of layer than specified, the layer thickness may be increased as necessary, but in no case shall the thickness of layer exceed 2½ feet (750 mm).

3. Each layer shall be constructed by starting at one end and dumping the rock on top of the layer being constructed then pushing the material ahead with a bulldozer in such a manner that the larger rock will be placed on either the ground or the preceding embankment layer. Each layer shall be constructed in such a manner that the interstices between the larger stones are filled with small stones and spalls which have been created by this operation and from the placement of succeeding layers of material.
4. Each layer shall be compacted to the required density as outlined for "Earth Embankments", above, except in those layers where rock will make density testing difficult, the Engineer may accept the layer by visual inspection or proof rolling.
5. Unless otherwise indicated, the upper 3 feet (1 meter) of the embankment shall not contain stones larger than 4 inches (100 mm) in their greatest dimension and shall be composed of material so graded that the density and uniformity of the surface layer may be secured in accordance with TxDOT Test Method Tex-114-E.
6. Exposed oversize material shall be broken up or removed.

3.7 PROOF ROLLING

A. Equipment

1. The proof rolling equipment shall have a loading platform or body suitable for ballast loading that is supported on a minimum of two (2) axles with not more than two (2) pneumatic tired wheels per axle. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces. Pneumatic proof rolling equipment with multiple pivotal axles and more than two tires along the front or rear axle axis shall have articulating axle supports to equally distribute the load to all tires over uneven surfaces.
2. The proof roller unit, under working conditions, shall have a minimum contact width of 7½ feet (2.3 meters) and shall be so designed that the gross roller weight may be varied uniformly from 25 tons to 50 tons (23 megagrams to 45 megagrams) by ballast loading. The tires shall be capable of operating under various loads with variable air pressures up to 145 psi (up to 1000 kiloPascals). The tires shall be smooth tread and shall impart a minimum ground contact pressure of 75 pounds per square inch (520 kiloPascals). Tires shall be practically full of liquid (i.e. when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The operating load and tire pressure shall be within the range of the manufacturer's chart as directed by the Engineer.
3. The proof roller shall be drawn by a power train of adequate tractive effort or may be of a self-propelled type. The proof rolling equipment shall be equipped with a reverse mode transmission or be capable of turning 180 degrees in a street width. When a separate power train is used to draw the proof roller, the power train weight shall not be considered in the weight of the proof roller. The power train shall be rubber-tired when rolling subgrade and base materials. A cleated or track-type power train may be used on earth and rock embankments.

B. Execution

1. The entirety of prepared surfaces to be tested shall be proof rolled by a minimum of two passes of the proof roller tires. Each succeeding trip of the proof roller shall be offset by not greater than one tire width.
2. Proof rollers shall be operated at speeds between 2 and 6 miles per hour (3 and 10 kilometers per hour) or as directed by the Engineer.
3. Acceptable limits of elastic and plastic deformation of prepared subgrade courses shall be established by proof rolling test sections of representative soil conditions, previously tested and approved for density and moisture requirements of the governing subgrade and earth embankment items. Proof rolling of first course base over a plastic subgrade may be

SECTION 321313

CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted November 1, 2014.

1.2 SUMMARY

A. Section includes specifications for construction of the following:
   1. Concrete sidewalks

B. Related Sections:
   1. Section 312000 “Earth Moving” for subgrade preparation, excavation, and backfill.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Concrete
   1. Mix design for each class of concrete required on the project
   2. Supplier and type of mixing equipment
   3. Supplier current TCEQ and EPA authorizations to operate the facility.
   4. Appropriate mortar and grout mix designs
   5. Admixtures:
      a. Type of admixtures to be used with the concrete mixes
      b. Certification that proposed admixture meet the requirements of this specification, ASTM C260 and ASTM C494
   6. Evaporation retardants:
      a. Type and manufacturer of proposed evaporation retardant
      b. Confirmation that the evaporation retardant meets the requirements of test results for TxDoT DMS-4650
   7. Epoxies and/or adhesives:
      a. Type and manufacturer of proposed epoxy and/or adhesives
      b. Confirmation that it meets the requirements of test results for TxDoT DMS-6100

B. Reinforcing Steel
   1. Evidence that the steel reinforcement producer is included on the TxDoT list of approved producing mills
   2. Listing of the size, grade, type and quantity of reinforcing steel proposed for the project

3. If welding of reinforcing steel is proposed:
    a. Evidence that carbon equivalent (C.E.) of the proposed steel is at least 0.55% with a report of chemical analysis showing the percentages of elements necessary to establish C.E.
4. When mechanical splices are proposed:
    a. The types of couplers proposed for use

C. Fibrous Concrete
1. Concrete Type, Supplier and Design
2. Fiber Type, Supplier and product properties
3. Proposed proportioning of material, including adjustment for slump requirements
4. Fiber documentation of compliance with applicable building codes, this specification item, and ASTM C 1116/C 1116 M-08

D. Joints and Joint Sealant
1. Type and manufacturer of all joint materials proposed for use
2. Technical data indicating that proposed products meet the requirements specified herein
3. Sealant Type (Rubber-Asphalt, Polymer Modified Emulsion, Low Modulus Silicone or Polyurethane), Class and method of application (crack sealing, joint sealing, etc)
4. Manufacturer recommendations concerning the use of primer and backer rod
5. Manufacturer recommended equipment and procedures for preparation, dispensing, application, curing etc of the sealant
6. Manufacturer certification that the product to be supplied meets or exceeds the specifications

E. Curing
1. Proposed curing methods and procedures
2. Type and manufacturer for all membrane curing materials proposed
3. Type and manufacturer for all polyethylene firm curing materials proposed

PART 2 - PRODUCTS

2.1 BASE

A. General
1. Subbase or base materials shall be per the Drawings and in accordance with Section 312000, “Earth Moving”.

2.2 FORMS

A. General
1. Forms shall be of metal, well-seasoned wood or other approved material of a section satisfactory to the Engineer.
2. Wood forms shall not be less than 2 inches (50 mm) nominal thickness for straight runs and 1-inch (25-mm) nominal thickness for curved runs. Forms shall be clean, straight, free from warp and of a depth equal to the thickness of the finished work.
3. Metal forms shall be as required to maintain the true shape without warping or bulging. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms, which do not present a smooth surface or line up properly, shall not be used. Metal shall be kept free from rust, grease or other foreign materials.

4. Flexible or curved forms shall be used for curves of 100-foot (30 meter) radius or less.
5. Form or form lumber that will be reused shall be maintained clean and in good condition. Lumber that is split, warped, bulged, or marred or that has defects that will produce inferior forms shall not be used but shall be removed from the work.

2.3 REINFORCEMENT

A. General
1. Steel reinforcing shall be open-hearth, basic oxygen or electric-furnace new billet steel.
2. Unless indicated otherwise on the drawings, bar reinforcement shall be Grade 60 and must conform to ASTM A615/615M.
3. The nominal deformed bar size of reinforcing steel bars shall be designated in 1/8 inches.
4. Smooth, round bars shall be designated by size number through a No. 4. Smooth bars above No. 4 shall be designated by diameter in inches.

B. Chairs and Supports
1. Chairs and Supports shall be steel, precast mortar or concrete blocks cast in molds of sufficient strength to position the reinforcement as indicated on the drawings when supporting the dead load of the reinforcement, the weight of the workers placing concrete and the weight of the concrete bearing on the steel. Chairs shall be plastic coated when indicated on the drawings.
2. Steel chairs shall have a base with 9 inch^2 (58 cm 2) minimum area or sufficient area to prevent the chair from sinking into fill or subgrade. Precast mortar or concrete blocks meeting the requirements of this item may be used.

C. Bending
1. The reinforcement shall be bent cold, true to the shapes indicated on the drawings. Bending shall preferably be done in the shop. Irregularities in bending shall be cause for rejection. Improperly fabricated, damaged or broken bars shall be replaced at no additional expense to the Owner. Damaged or broken bars embedded in a previous concrete placement shall be repaired using a method approved by the Engineer.
2. Unless otherwise indicated on the drawings, the inside diameter of bar bends, in terms of the nominal bar diameter (d), shall be as follows:

Bar Number in 1/8 inches (mm)	Diameter
3, 4, 5 (10, 13, 16)	4d
6, 7, 8	6d
9, 10, 11 (29, 32, 36)	8d
14, 18 (43, 57)	10d

D. Tolerances
1. Fabricating tolerances for bars shall not be greater than as follows:
   a. Bar length, 1 inch
   b. Any bend, ½ inch
   c. Spiral or circular tie, ½ inch
   d. Stirrup or tie, ½ inch

E. Splices
1. Splicing of bars, except when indicated on the drawings or specified herein, will not be permitted without written approval of the Engineer.
2. Any splicing shall conform to the requirements in the Table below.

Minimum Lap Requirements		
Bar Number in 1/8 inches (mm)	**Uncoated Lap Length**	**Coated Lap Length**
3 (10)	1 foot 4 inches (0.4 meters)	2 foot 0 inches (0.610 meters)
4 (13)	1 foot 9 inches (0.533 meters)	2 foot 8 inches (0.813 meters)
5 (16)	2 foot 2 inches (0.660 meters)	3 feet 3 inches (0.991meters)
6 (19)	2 foot 7 inches (0.787 meters)	3 feet 11 inches (1.194 meters)
7 (22)	3 feet 5 inches (1.041 meters)	5 feet 2 inches (1.575 meters)
No. 8 (25)	4 feet 6 inches (1.372 meters)	6 feet 9 inches (2.057 meters)
No. 9 (29)	5 feet 8 inches (1.727 meters)	8 feet 6 inches (2.591 meters)
No. 10 (32)	7 feet 3 inches (2.210 meters)	10 feet 11 inches (3.327 meters)
No. 11 (36)	8 feet 11 inches (2.718 meters)	13 feet 5 inches (4.089 meters)

3. Welded wire fabric shall be spliced using a lap length that includes an overlap of at least 2 cross wires plus 2 inches (50 mm) on each sheet or roll. No splice of less than 6 inches (150 mm) will be permitted. Splices in the #3 (10M) bars shall have a minimum lap of 12 inches (300 mm).
4. End preparation for butt-welding reinforcing bars shall be done in the field, except Bar No. 6 and larger shall be done in the shop. Delivered bars shall be of sufficient length to permit this practice.
5. Unless otherwise indicated on the drawings, dowel bars transferring tensile stresses shall have a minimum embedment equal to the minimum lap requirements shown in the table above. Shear transfer dowels shall have a minimum embedment of 12 inches (300 mm).

F. Mechanical Couplers
1. When mechanical splices in reinforcing steel bars are indicated on the drawings, the following types of couplers may be used:
   a. Sleeve-filler
   b. Sleeve-threaded
   c. Sleeve-swaged
   d. Sleeve-wedge

G. Storage of Materials
1. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel indicated on the drawings.

H. Fiber Reinforcement
1. Reinforcement shall be in accordance with ASTM C 1116/C 1116 M-08. Fibers shall conform to section 4.1.2 Type 2 Glass Fiber-Reinforced Concrete, or 4.1.3 Type 3 Synthetic Fiber-Reinforced Concrete, or 4.1.4 Natural Fiber-Reinforced Concrete.
2. Reinforcement shall be 100% virgin polypropylene fibrillated fibers specially manufactured for use as concrete reinforcement and meeting the requirements of ASTM C-1116 (Fiber-Reinforced Concrete and Shotcrete). The fibrous material shall not contain reprocessed

olefin. Each container of fibrous material shall bear the manufacturer's name and/or trademark and the net weight (mass) of fibrous material in the package.

3. The fiber manufacturer shall provide documentation of a minimum of 5-year performance history of the fiber and confirm compliance with applicable building codes, this specification item and ASTM C-1116.
4. The specific gravity of the fibrous material shall be 0.91 plus or minus .05. The tensile strength shall be 80 to 110 ksi (550 to 750 MPa). The lengths of the fibrous material shall be ½, ¾, 1½ and 2 inches (12.7, 19, 38 and 51 mm) in length.
5. Unless otherwise shown on the drawings, each cubic yard of concrete shall contain no less than 1½ pounds of fibrous material (0.9 kg per cubic meter). The fibrous material shall be added to the concrete mix at the time the mix is batched.

2.4 JOINTS

A. Asphalt Board
1. Preformed asphalt board shall be formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder and meeting the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete (Bituminous Type), ASTM D 994.
2. Boards shall be smooth, flat and straight throughout and shall be sufficiently rigid to permit easy installation.
3. Boards that crack or shatter during installing and finishing operations will not be acceptable.
4. When tested in accordance with TxDOT Test Method Tex-524-C the asphalt boards shall not deflect from the horizontal more than ¾ inch in 3½ inches (19.3 cm in 90 cm).

B. Non-bituminous Fiber Material
1. Preformed non-bituminous fiber material shall meet the requirements of the Standard Specifications for the Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM D 1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

C. Boards
1. Board shall be obtained from Redwood, Cypress, Gum, Southern Yellow Pine or Douglas Fir timber. They shall be solid heartwood and shall be free from sapwood, knots, clustered birdseye, checks and splits. Occasional sound or hollow birdseye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler.
2. With the exception of Redwood and Cypress, all boards shall have a creosote or pentachlorophenol treatment of 6 pounds per cubic foot (96 kg/m3).
3. When oven dried at 230°F (110°C) to a constant weight, the weight of the board per cubic foot (minus treatment), shall not be less than 20 pounds nor more than 35 pounds (not less than 320 nor more than 561 kgs per cubic meter).

D. Joint Sealer
1. Unless otherwise indicated on the drawings a Class 4, 5 or 7 low-modulus silicone sealant shall be provided that conforms to the requirements of TxDoT DMS-6310, "Joint Sealants and Fillers".
2. The joint sealer shall adhere to the sides of the concrete joint or crack and shall be an effective seal against infiltration of water and incompressibles. The material shall not crack or break when exposed to low temperature.

E. Backer Rod
1. Backer Rod shall be expanded closed cell polyethylene foam compatible with sealant. No bond or reaction shall occur between rod and sealant. Backer Rod shall be of sufficient width to be in compression after placement and shall be used with joint sealer.

F. Rebonded Recycled Tire Rubber

1. This material shall consist of granular particles of rubber, made by grinding automobile and truck tires, securely bound together by a synthetic resin or plastic binder. The filler must be molded into sheets of the required dimensions, which meet the testing requirements of both ASTM D 1751 and ASTM D 1752, except that the requirements for asphalt content and expansion are waived. The density of the material must be at least 30 lb/ft 3 (440kg/m3).

G. Load Transmission Devices for Expansion and Control Joints

1. When indicated, one end of each dowel bar shall be encased in an approved cap having an inside diameter of 1/16 inch (16 mm) greater than the diameter of the dowel bar. The cap shall be of such strength, durability and design as to provide free movement of the dowel bar and shall be approved by the Engineer prior to use. One end of the cap shall be filled with a soft felt plug or shall be void in order to permit free movement of the dowel bar for a distance equivalent to 150 percent of the width of the expansion joint used. The dowel caps and dowel bars shall be held securely in place by bar ties as indicated on the drawings. Mechanical methods of implanting dowel bars in the plastic concrete may be used when approved by the Engineer.
2. Where required, dowel bars shall be coated with a plastic material meeting the requirements indicated.
3. Where red lead and oil bar coating is indicated, the red lead may be of any standard commercial grade and the oil shall be clean and no lighter than Standard No. 30 SAE grade. Approved thinner and dryer may be added to the red lead, but the material upon application shall be of such consistency that will provide a uniform and heavy coating on the bar. Where asphalt bar coating is indicated, the material may be any standard grade of oil asphalt and shall be applied hot. Cutback asphalt will not be permitted for bar coating.

H. Cleaning and Sealing Joints and Cracks in Concrete Pavement

1. Joints and/or cracks shall be sealed with the type and/or class of materials indicated on the Drawings.
2. The materials shall conform to the requirements of TxDOT Departmental Materials Specification No. DMS-6310, "Joint Sealants and Seals".
3. Primers, if required, shall be as recommended by the manufacturer of the sealant. Backer rods, when required, shall be compatible with the sealant and shall not react with or bond to the sealant.
4. The sealing compound shall be delivered in the manufacturer's original sealed containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the sealer, the manufacturer's batch number or lot, the pouring temperature, and the safe heating temperature.
5. All equipment shall be in accordance with the sealant manufacturer's recommendations. Air compressors shall be equipped with appropriate filters for removing oil and water from the air.
6. Any equipment, that damages dowels, reinforcing steel, concrete, base, subbase or subgrade in the process of cleaning the joints and/or cracks, shall be discontinued and the joint and/or crack shall be cleaned by other methods approved by the Engineer, which do not cause such damage.

2.5 CONCRETE

A. General

1. Concrete shall be composed of hydraulic cement or hydraulic cement and supplementary cementing materials, water, aggregates (fine and coarse), and admixtures proportioned and mixed as hereinafter provided to achieve specified results.
2. Fine and coarse aggregates, mineral filler, bulk cement and fly ash shall be weighed separately. Allowances shall be made in the water volume and aggregate weights during

batching for moisture content of aggregates and admixtures. Measurement of materials in non-volumetric and volumetric mixers shall conform to Section 421.4.D of TxDOT Specification Item 421, "Hydraulic Cement Concrete".

B. Cementitious Materials
   1. Portland cement shall conform to ASTM C 150, Type I (General Purpose) or Type III (High Early Strength).
   2. If the use of high early cement is not specified on the Drawings and the Contractor desires to use it, the Contractor shall obtain written permission from the Engineer prior to its use and shall assume all additional costs incurred by the use of such cement. All cement shall be of the same type and from the same source for a project unless written permission if first received from the Engineer.
   3. Bulk or sacked cement may be used and a bag shall contain 94 pounds (42.6 KG) net. All bags shall be in good condition at the time of inspection.
   4. Fly ash (denoted by Texas DOT designations Type A and Type B) may replace 20 to 35 percent of a mix design's Portland cement content by absolute volume. Fly ash shall not be used in mix designs with less than 5 sacks of portland cement per cubic yard.

C. Admixtures
   1. General
      a. Concrete admixtures conforming to the requirements below may be used when approved by the Engineer to minimize segregation, improve workability, reduce the amount of mixing water and to provide normal hot weather concreting provisions. The use of admixtures shall not alter the approved mix designs, except for water content.
      b. The Contractor shall submit the name of the admixture proposed and manufacturer's certification that the selected admixtures meet the requirements of this item and of ASTM C 260 and C 494 as applicable. Admixtures for a mix design shall be of the same brand. If more than one admixture is proposed in the concrete mix, a statement of compatibility of components shall accompany certification. Manufacturer's product literature shall specify when in the batching/mixing operation the admixture must be added.
      c. No admixture shall be chloride-based or have chloride(s) added in the manufacturing process.
      d. Admixtures must be pretested by the Texas Department of Transportation (TXDOT) Materials and Tests Engineer and be included in the State's current approved admixture list.
   2. Air Entraining Admixture:
      a. An "Air Entraining Admixture" is defined as a material which, when added to a concrete mixture in the proper quantity, will entrain uniformly dispersed microscopic air bubbles in the concrete mix.
      b. The admixture shall meet the requirements of ASTM Designation: C 260 modified as follows:
         1) The cement used in any series of test shall be either the cement proposed for the specific work or a "reference" Type I cement from one mill.
         2) The air entraining admixture used in the reference concrete shall be Neutralized Vinsol Resin.
   3. Water-reducing Admixture:
      a. A "Water-reducing Admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a given consistency and required strength.
      b. This admixture shall conform to ASTM C 494, Type A.
   4. Accelerating Admixture:
      a. An "Accelerating Admixture" is defined as an admixture that accelerates the setting time and the early strength development of concrete.

b. This admixture shall conform to ASTM C 494, Type C. The accelerating admixture will contain no chlorides.

5. Water-reducing, Retarding Admixture:
   a. A "Water-reducing, Retarding Admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a given consistency and retard the initial set of the concrete.
   b. This admixture shall conform to ASTM C 494, Type D.
6. High-range Water Reducing Admixtures:
   a. A "High-range Water Reducing Admixture", referred to as a superplasticizer, is defined as a synthetic polymer material which, when added to a low slump concrete mixture increases the slump without adversely affecting segregation, impermeability or durability of the mix.
   b. This admixture shall conform to ASTM C 494, Type F or G.
7. Fly Ash:
   a. Fly ash used in Portland cement concrete as a substitute for Portland cement or as a mineral filler shall comply with TXDOT Materials Specification D-9-8900 and be listed on TXDOT's current list of approved fly ash sources. Fly ash obtained from a source using a process fueled by hazardous waste (30 Texas Administrative Code, Section 335.1) shall be prohibited. This applies to any other specification concerning the use of fly ash. Contractor shall maintain a record of source for each batch. Supplier shall certify that no hazardous waste is used in the fuel mix or raw materials.

D. Coarse Aggregate
1. Coarse aggregate shall consist of durable particles of crushed or uncrushed gravel, crushed blast furnace slag, crushed stone or combinations thereof; free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material either free or as an adherent coating. Quality shall be reasonably uniform throughout.
2. When white hydraulic cement is specified, the coarse aggregates used in the concrete shall be light colored.
3. The coarse aggregate from each source shall not contain more than 0.25 percent by weight of clay lumps, nor more than 1.0 percent by weight of shale nor more than 5 percent by weight of laminated and/or friable particles when tested in accordance with TXDOT Test Method TEX-413-A.
4. The coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with TXDOT Test Method TEX-410-A.
5. Unless otherwise indicated on the drawings, the coarse aggregate from each source shall be subjected to 5 cycles of the soundness test conforming to TXDOT Test Method TEX-411-A. The loss shall not be greater than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used.
6. Coarse aggregate shall be washed. The Loss by Decantation (TXDOT Test Method TEX-406-A), plus allowable weight of clay lumps, shall not exceed 1 percent or the value indicated on the drawings or in the project manual, whichever is less. If material finer than the # 200 (75 micrometer) sieve is definitely established to be dust of fracture of aggregates made primarily from crushing of stone, essentially free from clay or shale as established by Part III of TXDOT Test Method TEX-406-A, the percent may be increased to 1.5. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1% but not more than 3% if the material finer than the #200 (75 micrometer) sieve is determined to be at least 67% calcium carbonate in accordance with TxDoT Test Method Tex-406-A, Part III.
7. The coarse aggregate factor may not be more than 0.82; however, when voids in the coarse aggregate exceed 48 percent of the total rodded volume, the coarse aggregate factor shall not exceed 0.85. The coarse aggregate factor may not be less than 0.68 except for a Class I machine extruded mix that shall not have a coarse aggregate factor lower than 0.61.

8. When exposed aggregate surfaces are required, the coarse aggregate shall consist of particles with at least 40 percent crushed faces. Uncrushed gravel, polished aggregates and clear resilient coatings are not acceptable for exposed aggregate finishes.
9. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.
10. The use of recycled crushed hydraulic cement concrete as a coarse aggregate shall be limited to Concrete Classes A, B and D.
11. When tested by approved methods, the coarse aggregate including combinations of aggregates when used, shall conform to the grading requirements shown in the table below.

Coarse Aggregate Gradation Chart (Percent Passing)										
Grade	**Nom. Size**	**2½″ (62.5mm)**	**2″ (50mm)**	**1½″ (37.5mm)**	**1″ (25mm)**	**¾″ (19mm)**	**½″ (12.5mm)**	**3/8″ (9.5mm)**	**No. 4 (4.75mm)**	**No. 8 (2.36mm)**
1	2″ (50 mm)	100	80—100	50—85		20—40			0—5	
2 (467)*	1½″(37.5 mm)		100	95—100		35—70		10—30	0—5	
3	1″ (50 mm)		100	95—100		60—90	25—60		0—5	
4 (57)*	1″ (50 mm)			100	95—100		25—60		0—10	0—5
5 (67)*	¾″ (19 mm)				100	90—100		20—55	0—10	0—5
6 (7)*	½″ (12.5 mm)					100	90—100	40—70	0—15	0—5
7	3/8 ″ (9.5 mm)						100	70—95	0—25	
8	3/8 ″ (9.5 mm)						100	95—100	20—65	0—10

E. Fine Aggregate
1. Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. Quality shall be reasonably uniform throughout.
2. When white hydraulic cement is specified, the fine aggregates used in the concrete shall be light colored.
3. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by weight of clay lumps in accordance with TEX-413-A. When subjected to color test for organic impurities per TXDOT Test Method TEX-408-A, it shall not show a color darker than standard.
4. Unless indicated otherwise on the drawings the acid insoluble residue of fine aggregate used in slab concrete subject to direct traffic shall not be less than 60 percent by weight (mass) when tested conforming to TXDOT Test Method TEX-612-J.
5. Unless indicated otherwise on the Drawings, fine aggregate shall be blended, when necessary, to meet the acid insoluble residue requirement.
6. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.
7. The use of recycled crushed hydraulic cement concrete as a fine aggregate shall be limited to Concrete Classes A, B and D.

8. When tested in accordance with TxDoT Test Method Tex-401-A, the fine aggregate, including mineral filler and combinations of aggregates, when used, shall conform to the grading requirements shown in the table below.

Fine Aggregate Gradation Chart (Grade 1 - Percent Passing)							
3/8 (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18mm)	No. 30 (600 µm)	No. 50 (300 µm)	No. 100 (150 µm)	No. 200 (75 µm)
100	95—100	80—100	50—85	25—65	10—35[1]	0—10	0—3[2]
1. 6 to 35 when sand equivalent value is greater than 85. 2. 0 to 6 for manufactured sand.							

9. Sand equivalent per TXDOT Test Method TEX-203-F shall not be less than 80 nor less than otherwise indicated on the drawings, whichever is greater.
10. The fineness modulus will be determined by adding the percentages by weight retained on sieve Nos. 4, 8, 16, 30, 50 and 100 (4.75 mm, 2.36 mm, 1.18mm, 600 µm, 300 µm, and 150 µm) and dividing the sum of the six sieves by 100. For all classes of concrete, the fineness modulus shall be between 2.30 and 3.10.

F. Mineral Filler
1. Mineral filler shall consist of stone dust, clean crushed sand or other approved inert material. When tested in accordance with TxDoT Test Method Tex-401-A, it shall conform to the following gradation:

Passing the No. 30 (600 µm) Sieve	100 percent
Passing the No. 200 (75 µm) Sieve	65 to 100 percent

G. Mixing Water
1. Water for use in concrete and for curing shall be potable water free of oils, acids, organic matter or other deleterious substances and shall not contain more than 1,000 parts per million of chlorides as Cl or sulfates as SO4.
2. Water from municipal supplies approved by the State Health Department will not require testing. Contractor shall sample and test water from other sources and submit test results to the Engineer for approval 10 days prior to proposed use. Tests shall be made in accordance with "Standard Method of Test for Quality of Water to be used in Concrete," AASHTO Method T-26.
3. Water shall be accurately metered.

H. Evaporation Retardants
1. Evaporation retardants shall conform to the requirements of TxDoT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants". The evaporation retardant must be a commercially available monomolecular film compound. The evaporation retardant shall have no adverse effect on the cement hydration process or the concrete and shall reduce surface moisture evaporation from the concrete when performing concrete operations in direct sun, wind, high temperatures, or low relative humidity. The producer of the evaporation retardant shall certify that it meets these specified requirements.

I. Air Entrainment
1. Unless indicated otherwise on the drawings, all concrete classes with the exception of Class B shall be air entrained in accordance with the table below. If the air content is more than 1½ percentage points below or 3 percentage points above the required air, the load

of concrete will be rejected. If the air content is more than 1½ but less than 3 percentage points above the required air, the concrete may be accepted based on strength test results.

Air Entrainment		
Nominal Maximum Aggregate Size, Inches (mm)	**% Air Entrainment**	
	Moderate Exposure	**Severe Exposure**
3/8 (9.5)- Grades 7 & 8	6	7½
½ (12.5)- Grades 6	5½	7
¾ (19)- Grades 5	5	6
1 (25)- Grades 4	4½	6
1½ (37.5)- Grades 2 & 3	4½	5½
2 (50)- Grades 2	4	5

J. Epoxy
1. Unless indicated otherwise on the drawings, epoxy materials shall conform to TxDoT DMS-6100, "Epoxy and Adhesives".

K. Mortar and Grout
1. Mortar and grout shall consist of 1 part hydraulic cement and 2 parts sand with sufficient water to provide the desired consistency.
2. Mortar shall be provided with a consistency that can be handled easily and spread by a trowel.
3. Grout shall be provided with a consistency that will flow into and completely fill all voids.

L. Storage of Materials
1. Cement, Supplementary Cementing Materials and Mineral Filler
   a. All cement, supplementary cementing materials and mineral filler shall be stored in separate and well ventilated, weatherproof buildings or approved bins, which will protect the material from dampness or absorption of moisture. Storage facilities shall be easily accessible and each shipment of packaged cement shall be kept separated to provide for identification and inspection.
   b. The Engineer may permit small quantities of sacked cement to be stored in the open for a maximum of 48 hours on a raised platform and under waterproof covering.
2. Admixtures
   a. Admixtures shall be stored in accordance with manufacturer's recommendations and shall be protected against freezing.
3. Aggregates
   a. The method of handling and storing concrete aggregates shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and shall be level. Aggregates shall be stockpiled in sizes to facilitate blending. If the aggregate is not stockpiled on a hard, non-contaminant base, the bottom 6-inch (150 mm) layer of the stockpile shall not be used without recleaning the aggregate.
   b. When conditions require the use of 2 or more grades of coarse aggregates, separate stockpiles shall be maintained to prevent intermixing. Where space is limited, stockpiles shall be separated by walls or other appropriate barriers.
   c. Aggregate shall be stockpiled and protected from the weather a minimum of 24 hours prior to use to minimize free moisture content. When stockpiles are too large to protect from the weather, accurate and continuous means acceptable to the Engineer shall be provided to monitor aggregate temperature and moisture.

Aggregates shall be stockpiled and handled such that segregation and contamination are minimized.

d. The stockpiles shall be sprinkled to control moisture and temperature as necessary. A reasonably uniform moisture content shall be maintained in aggregate stockpiles.

2.6 CONCRETE MIX

A. Mix Design

1. The Contractor shall furnish a mix design acceptable to the Engineer for the class of concrete required in accordance with the table below. The mix shall be designed by a qualified commercial laboratory and signed/sealed by a registered Professional Engineer, licensed in the state of Texas to conform with requirements contained herein, to ACI 211.1 or TXDOT Bulletin C-11 (and supplements thereto). The maximum water-to-cementitious material ratio identified in the table for specific classes of concrete shall not be exceeded.

Classes of Concrete						
Class	Cement Sacks Per CY	Minimum Strength, psi (MPa)		Maximum W/C Ratio, by weight	Coarse Aggr. Grade	Air Entrain.
		28 Days	7 Days			
A	5.0 (280 kg/m ^{3})	3000 (20.6)	2100 (14.5)	0.6	2,3,4,8	Yes
B	4.0 (225 kg/m ^{3})	2000 (13.8)	1400 (9.7)	0.6	2,3,4,5,6,7	No
C	6.0 (335 kg/m ^{3})	3600(24.8)	2520 (17.4)	0.45	2,3,4,5,6	Yes
D	4.5 (252 kg/m ^{3})	2500 (17.2)	1750 (12.1)	0.6	2,3,4,5,6,7	No
J	2.0 (112 kg/m ^{3})	800 (5.5)	560 (3.9)	N/A	2,3,4,5	No
S	6.0 (335 kg/m ^{3})	4000 (27.6)	2800 (19.3)	0.45	2,3,4,5	Yes

2. A higher-strength class of concrete with equal or lower water-to-cementitious-material ratio may be substituted for the specified class of concrete.
3. The mix design shall be over-designed in order to account for production variability and to ensure minimum compressive strength requirements are met.
4. The Contractor shall perform, at the Contractor's expense, the work required to substantiate the design, including testing of strength specimens.
5. Approved admixtures that are included in the prequalified concrete admixtures list maintained by TxDOT's Construction Division may be used with all classes of concrete at the option of the Contractor provided that specific requirements of the governing concrete structure specification are met.
6. Water reducing and retarding agents shall be required for hot weather, large mass, and continuous slab placements.
7. Air entraining agents may be used in all mixes but must be used in the classes indicated. Unless approved by the Engineer, mix designs shall not exceed air contents for extreme exposure conditions as recommended by ACI 211.1 for the various aggregate grades.

B. Mix Design Options

1. For class of concrete designed using more than 520 lbs. of cementitious material per cubic yard (310 kgs per cubic meter), one of the mix design options presented below shall be used.
2. For class of concrete designed using less than 520 lbs. of cementitious material per cubic yard (310 kgs per cubic meter), one of the mix design options presented below will be used, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3 and 4 unless a sulfate-resistant concrete is required.

a. Option 1: Twenty (20) to thirty-five (35) percent of the cement may be replaced with Class F fly ash.
b. Option 2: Thirty-five (35) to fifty (50) percent of the cement may be replaced with ground granulated blast-furnace slag.
c. Option 3: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class F fly ash, ground granulated blast-furnace slag or silica fume. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.
d. Option 4: Type IP or Type IS will be used and up to ten (10) percent of the cement may be replaced with Class F fly ash, ground granulated blast-furnace slag or silica fume.
e. Option 5: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class C fly ash and at least six (6) percent of silica fume, ultra fine fly ash or metakaolin. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.
f. Option 6: A lithium nitrate admixture will be added at a minimum dosage of 0.55 gal. of thirty (30) percent lithium nitrate solution per pound of alkalis present in the hydraulic cement.
g. Option 7: When hydraulic cement only is used in the design, the total alkali contribution from the cement in the concrete does not exceed 4.0 lbs. per cubic yard.

C. Consistency
1. Concrete shall be workable, cohesive, possess satisfactory finishing qualities and of stiffest consistency that can be placed and vibrated into a homogeneous mass within slump requirements specified in the table below without the development of segregation or honeycombing. No concrete will be permitted with a slump in excess of the maximums shown unless water-reducing admixtures have been previously approved. Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected. Slump values shall be conducted in accordance with TXDOT Test Method TEX-415-A.

Slump Requirements		
Type of Construction	**Slump, inches (mm)**	
	Maximum	**Minimum**
Heavy Duty Pavements and Driveways	6½ (165)	4 (100)
Sidewalks and Medium Duty Pavement and Driveways	4 (100)	2 (50)
Curbs and Gutters, Hand-vibrated	3 (75)	1 (25)
Curbs and Gutters, Hand-tamped or spaded	4 (100)	2 (50)
High Strength Concrete	4 (100)	3 (75)

2. Consistency and quality of concrete should allow efficient placement and completion of finishing operations before initial set. Re-tempering (i.e. addition of water and reworking concrete after initial set) shall not be allowed. When field conditions are such that additional moisture is needed for final concrete surface finishing operation, the required water shall be applied to surface by fog spray only and shall be held to a minimum. Excessive bleeding shall be avoided and in no case will it be permissible to expedite finishing and drying by sprinkling the surface with cement powder.
3. Since the slump of a fiber-reinforced concrete is less than the slump of an otherwise identical concrete without fiber and since the magnitude of difference depends upon the amount and type of fibers, trial mixtures representing the amount and type of fibers to be used for the work shall be prepared and tested to ensure that the specified slump requirements are met.

2.7 CONCRETE MIXING

A. General
   1. Concrete may be provided by one of the following:
      a. Batched and/or mixed at a plant and delivered by a transit-mix truck
      b. Batched and mixed by a mobile volumetric batching and mixing unit
      c. Batched and mixed by hand
   2. All equipment necessary for construction of this item shall be on the Project and shall be approved by the Engineer before the Contractor will be permitted to begin construction operations on which the equipment is to be used.
   3. All equipment, tools and machinery used for hauling materials and performing any part of the work shall be maintained in such condition to insure completion of the work without excessive delays for repairs and replacement.
   4. Mixing equipment shall be capable of producing sufficient concrete to provide required quantities.
   5. Improperly mixed concrete shall not be placed.
   6. An adequate water supply and an accurate method of measuring the water shall be provided.

B. Transit-Mix (Ready-Mix) Concrete
   1. The central batching plant and mixer trucks meet the requirements of ASTM C 94, Ready-mixed Concrete.
   2. Mixing shall be done in a mixer that will produce uniform distribution of material throughout the mass and shall be capable of producing concrete meeting. The concrete shall be delivered to the project in a thoroughly mixed and uniform mass and shall be discharged with a satisfactory degree of uniformity. Additional mixing at the job site, at the mixing speed designated by the manufacturer, may be allowed by the Engineer as long as the concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.
   3. Additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to each batch to coat the mixer drum. This shall be required for every load of concrete. The mixing speed shall be attained as soon as all ingredients are in the mixer.
   4. A ticket system will be used that includes a copy for the Inspector. Ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.
   5. Sufficient trucks will be available to support continuous placements.
   6. When the concrete contains silica fume, mixing times and batching operations shall be adjusted as necessary to ensure that the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix shall be verified in trial batches.
   7. Mixing and agitating speed shall be as designated by the mixer manufacturer. All revolutions after prescribed mixing shall be at agitating speed. Except for short periods of time during discharge, the drum shall be kept in continuous motion from the time the mixing is started until the discharge is completed.
   8. A portion of mixing water required by the mix design to produce the specified slump may be withheld and added at the job site, but only with permission of the Engineer and under the Inspector's observation. When water is added under these conditions, the drum or blades shall be turned at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. When water is added, the mix design water-cementitious-material ratio shall not be exceeded. Water or chemical admixtures shall not be added to the batch after any concrete has been discharged.
   9. Additional cement shall not be added at the job site to otherwise unacceptable mixes.
   10. A metal plate shall be attached in a prominent place on each truck mixer plainly showing the various uses for which it was designed. The data shall include the drum's speed of rotation for mixing and for agitating and the capacity for complete mixing and/or agitating only.

11. The loading of the transit mixers shall not exceed capacity as shown on the manufacturer's plate attached to the mixer or 63 percent of the drum volume, whichever is the lesser volume. The loading of transit mixers to the extent of causing spill-out in route to delivery will not be acceptable.
12. Excess concrete remaining in the drum after delivery and wash water after delivery shall not be dumped on the project site unless approval of the dump location is first secured from the Engineer.

C. Volumetric Batching and Mixing Concrete
1. The batching and continuous mixing operations shall conform to ASTM C 685, "Concrete Made by Volumetric Batching and Continuous Mixing". This type concrete shall be made from materials continuously batched by volume, mixed in a continuous mixer and delivered to the site in a freshly mixed and unhardened state. Tests and criteria for batching accuracy and mixing efficiency shall be as specified in ASTM C 685.
2. These mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging.
3. For continuous volumetric mixers, the materials delivered during a revolution of the driving mechanism or in a selected interval, will be considered a batch and the proportion of each ingredient will be calculated in the same manner as for a batch type plant.
4. Mixing time shall conform to recommendations of manufacturer of mixer unless otherwise directed by Engineer.
5. A ticket system will be used that includes a copy for the Inspector. The ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.
6. Each batching or mixing unit, or both, shall carry in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed and the weight-calibrated constant of the machine in terms of a revolution counter or other output indicator. The mixer shall produce a thoroughly mixed and uniform concrete.
7. The batcher-mixer unit shall contain in separate compartments all the necessary ingredients needed for the manufacture of concrete. The unit shall be equipped with calibrated proportioning devices to vary the mix proportions and it shall produce concrete as required by the Work and ASTM C 685.
8. Entire contents of the drum shall be discharged before any materials are placed therein for a succeeding batch.

D. Hand-Mixed Concrete
1. Hand mixing of concrete may be permitted for small placements or in case of an emergency and then only on authorization of the Engineer.
2. Hand-mixed batches shall not exceed a 4 cubic foot (0.113 cubic meters) batch in volume.
3. Material volume ratios shall not be leaner than 1 part cement, 2 parts large aggregate, 1 part fine aggregate and enough water to produce a consistent mix with a slump not to exceed 4 inches (100 mm).
4. Admixtures shall not be used unless specifically approved by the Engineer.

E. Admixtures
1. All admixtures used shall be liquid except high-range water reducers which may be a powder. Liquid admixtures shall be agitated as needed to prevent separation or sedimentation of solids; however, air agitation of Neutralized Vinsol Resin will not be allowed.
2. No admixture shall be dispensed on dry aggregates. Admixtures shall be dispensed at the batching site separately, but at the same time as the mixing water. Only high range water reducers may be introduced into the mix at the job site.

3. When other admixtures are used with fly ash, the amount of the other admixture to be used shall be based on the amount of Portland cement only and not the amount of Portland cement and fly ash.
4. When high-range water reducers are to be added at the job site, transit mixers shall be used. Admixture manufacturer literature shall indicate recommended mixing methods and time for the specific equipment and mix design used. The transit mix equipment shall not be loaded in excess of 63 percent of its rated capacity to ensure proper mixing of the admixture at the site. If during discharging of concrete a change in slump in excess of 30% is noted, the remaining concrete shall be rejected unless prior approval was given by the Engineer to retemper a load with a second charge of admixture. Retempering with water shall not be allowed.
5. All mixes with air entrainment shall have a minimum relative durability factor of 80 in accordance with ASTM C 260. Dosage of air entrainment admixtures may be adjusted by the Contractor to stay within the specified tolerances for air entrainment of Standard Specification Item No. 403S, "Concrete for Structures".

F. Transporting Time
1. The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall not exceed the following:

Allowable Transportation Times		
Air or Concrete Temperature whichever is higher	Maximum Time w/o Retarder	Maximum Time with Retarder
Non-agitated Concrete		
35℉ to 79℉ (2℃ to 26℃)	45 minutes	45 minutes
Over 80℉ (Over 25℃)	30 minutes	45 minutes
Agitated Concrete		
90℉ (32℃) or above	45 minutes	105 minutes
75℉ to 89℉ (24℃ to 32℃)	60 minutes	120 minutes
35℉ to 74℉ (2℃ to 23℃)	90 minutes	150 minutes

2.8 CURING

A. Liquid Membrane
1. The liquid forming membrane curing compound shall comply with the "Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete", ASTM C 309, Type 1-D clear or translucent, with fugitive dye or Type 2 white pigmented. The material shall have a minimum flash point of 80℉ (26.7℃) when tested by the "Pensky-Martin Closed Cup Tester", ASTM D 93.
2. It shall be of such consistency that it can be satisfactorily applied as a fine mist through an atomizing nozzle by means of approved pressure spraying equipment at atmospheric temperatures above 40℉ (4.4℃).
3. It shall be of such nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete or its components. Type 1 compound shall contain a fugitive dye that will be distinctly visible not less than 4 hours nor more than 7 days after application.
4. Type 2 compound shall not settle out excessively or cake in the container and shall be capable of being mixed to a uniform consistency by moderate stirring and shall exhibit a daylight reflectance of not less than 60 percent of that of magnesium oxide when tested as indicated.

5. The compound shall produce a firm, continuous, uniform moisture impermeable film, free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. When applied to the damp concrete surface at the rate of coverage indicated, the compound shall dry to the touch in not more than 4 hours and shall not be tacky or track off concrete after 12 hours.
6. It shall adhere to horizontal and vertical surfaces in a tenacious film and shall not run off or show an appreciable sag, disintegrate, check, peel or crack during the required curing period.
7. Under traffic, the compound shall not pick up or peel and shall gradually disintegrate from the surface.
8. The compound shall be delivered to the job only in the manufacturer's original containers, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.
9. The water retention test shall be in accordance with the following table. Percentage loss shall be defined as the water lost after the application of the curing material was applied. The permissible percent moisture loss shall not exceed 2 percent after 24 hours and 4 percent after 72 hours.

B. Polyethylene Film
1. Polyethylene film shall be opaque pigmented white in color and shall be manufactured from virgin resin without additives or scrap. It shall be sufficiently strong and tough to permit its use under the conditions existing on street paving work without being torn or otherwise rendered unfit for the purpose during the curing period.
2. The film shall have a minimum thickness of 4 mils (0.004 inch), shall have a minimum tensile strength of 1,700 psi at 77°F (11,720 kPa at 25°C) in the longitudinal direction and 1,200 psi at 77°F (8,275 kPa at 25°C) in the transverse direction and shall have a minimum elongation of 200 percent at 77°F (25°C) in the longitudinal direction and 150 percent at 77°F (25°C) in the transverse direction.
3. The permissible percent moisture loss shall not exceed 2 percent after 24 hours and 4 percent after 72 hours. Tests for tensile strength and elongation will be conducted in accordance with ASTM Designation: D 882, Method A. Tests for moisture retention will be conducted in accordance with ASTM Designation: C 156.

C. Cotton Mats
1. Cotton mats shall consist of a filling material of cotton "bat" or "bats" [at least 12 oz. Per square yard (400 grams per square meter)] completely covered with unsized cloth [at least 6 oz. Per square yard (200 grams per square meter)] stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in. (100 mm), or tuft both longitudinally and transversely at intervals less than 3 in. (75 mm).
2. The cotton mats shall be free from tears and in good general condition. A flap at least 6 in. (150 mm) wide with two (2) thicknesses of the covering that extends along one side of the mat shall be provided.

D. Burlap-Polyethylene Mats
1. The burlap-polyethylene mats shall be made from burlap impregnated on 1 side with a film of opaque white-pigmented polyethylene, free from visible defects. The laminated mats shall have at least 1 layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and shall be free of visible defects.

PART 3 - EXECUTION

3.1 PREPARATION

A. General
1. The subgrade, subbase or base course shall be shaped to the lines, grades and cross sections as indicated on the Drawings and shall be thoroughly compacted in accordance with Section 312000, “Earth Moving”.
2. No equipment or hauling shall be permitted on the prepared subgrade, except by special permission of the Engineer.
3. Any unsuitable material encountered in the subgrade shall be removed and replaced by a suitable material and compacted to a uniform grade.
4. If the subgrade is undercut or natural ground is located below the top of subgrade, the necessary backfill material shall conform with Section 312000, “Earth Moving”, and shall be compacted with a mechanical tamper. Hand tamping will not be permitted.
5. The subgrade or foundation shall be moist before placing on grade. If dry the subgrade shall be lightly sprinkled.

B. Sidewalks
1. A granular cushion of a minimum thickness of 2 inches (50 mm) but maximum thickness of 5 inches (125 mm), composed of crusher screenings, gravel and sand, crushed rock or coarse sand, shall be spread, wetted thoroughly, tamped and leveled. The granular cushion shall be moist at the time the concrete is placed. Where the subgrade is rock or gravel, 70% of which is rock; the 2-inch (50 mm) cushion need not be used.

3.2 FORMS

A. Placing Forms
1. Permission to place concrete will not be given until all work is complete to the satisfaction of the Engineer.
2. The subgrade under the forms shall be firm and cut true to grade so that each form section when placed will be firmly in contact for its whole length and base width and exactly at the established grade. Any subgrade under the forms below established grade shall be corrected, using suitable material, placed, sprinkled and rolled as directed.
3. All forms areas shall be cleaned of any extraneous matter before placing concrete. Forms shall be cleaned and oiled each time they are used.
4. Forms shall be staked with at least 3 pins for each 10-foot (3-meter) section. A pin shall be placed at each side of every joint. Form sections shall be tightly joined and keyed to prevent relative displacement.
5. All forms on which concrete will be placed shall be thoroughly wetted before the placement of concrete. Puddles of excess water shall be removed before placing the concrete. The various surfaces shall be in a moist, saturated surface dry condition when concrete is placed on or against them.
6. If, at any stage of the work, the forms show signs of bulging or sagging, the portion of the concrete causing such condition shall be removed immediately, if necessary and the forms shall be reset and securely braced against further movement.

B. Removing Forms
1. Unless otherwise indicated on the drawing, forms for vertical surfaces may be removed when the concrete has aged 12 hours after initial set, provided it can be done without damage to the concrete.
2. Forms for inside curb faces may be removed in approximately 3 hours provided it can be done without damage to the curb.

3. If all test cylinders made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of 14 curing days.
4. All metal appliances used inside forms for alignment shall be removed to a depth of at least ½ in. (13 mm) from the concrete surface. The appliances shall be manufactured to allow the removal without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Rods, bolts and ties shall not be burned-off.
5. All forms shall be removed unless indicated otherwise on the drawings.

3.3 STEEL REINFORCEMENT

A. Placement

1. Reinforcement shall be placed as near as possible in the position indicated on the drawings. Unless otherwise indicated on the drawings, dimensions shown for reinforcement are to the centers of the bars. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than ¼ inch (6 mm). Cover of concrete to the nearest surface of steel shall be as follows:

Condition	Minimum Cover, Inches (mm)
Concrete cast against and permanently exposed to earth, all sizes	3 (76 mm)
Concrete exposed to earth or weather, bar No. 6 (19) through No. 18 bars (57)	2 (51 mm)
Concrete exposed to earth or weather, bar No. 5 (16), W31 (W200) or D31 (D200) wire and smaller	1½ (38 mm)

2. All reinforcement shall be accurately placed at slab mid-depth, equidistant from the top and bottom of the concrete and held firmly in place by means of bar supports of adequate strength and number that will prevent displacement and keep the steel at its proper position during the placement of the concrete. In no instance shall the steel be placed directly on the subgrade or sand cushion layer.
3. All reinforcing steel shall be tied at all intersections, except that where spacing is less than 1 foot (300 mm) in each direction, alternate intersections only need be tied. Mats of wire fabric shall overlap each other 1 full space as a minimum to maintain a uniform strength and shall be tied at the ends and edges.
4. Where prefabricated deformed wire mats are specified or if the Contractor requests, welded wire fabric may be substituted for a comparable area of steel reinforcing bar plan, subject to the approval of the Engineer.
5. Individual bar supports shall be placed in rows at 4-ft (1.22 meters) maximum spacing in each direction. Continuous type bar supports shall be placed at 4-ft (1.22 meters) maximum spacing.
6. Prior to placement of the concrete, the reinforcement installation shall be inspected by the Engineer to ensure conformance with the drawings, specifications and this item.
7. Care shall be exercised to keep all steel in its proper position during placement of the concrete. If during placement of the concrete, the reinforcement is observed to lose bar support, float upward or move in any direction, the placement shall be stopped until corrective action is taken.

B. Sidewalks

1. Reinforcement for sidewalks shall consist either of polypropylene fibrillated fibers or 6″ × 6″ × W1.4 × W1.4 (150mm × 150mm × MW9 × MW9) welded wire fabric or one layer #3 (10M) reinforcing bars, placed no more than 18 inches (450 mm) on center both directions.
2. Where driveways cross sidewalks, additional reinforcing shall be placed in the sidewalk as indicated on the Drawings.

3.4 JOINTS

A. General
1. The Contractor shall install concrete joint materials which will function as a compatible system.
2. Care shall be exercised during the construction of all joints to ensure that the concrete sections are completely separated by an open joint or by the joint materials and to ensure that the joints will be true to the outline indicated on the drawings.
3. Joint sealer shall not be placed where a bond breaker is present.
4. Asphalt, Redwood board or other materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face.
5. All joints shall be shaped to conform to the contour of the finished section in which they are installed.

B. Expansion Joints
1. All open joints and joints to be filled with expansion joint material shall be constructed using forms adaptable to loosening or early removal.
2. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete.
3. Where preformed fiber joint material is used, it shall be anchored to the concrete on one side of the joint by light wire or nails to prevent the material from falling out.
4. Finished joints shall conform to the drawing details with the concrete sections completely separated by the specified opening or joint material.
5. Soon after form removal and where necessary after surface finishing, all projecting concrete shall be removed along exposed edges to secure full effectiveness of the expansion joints.

C. Control Joints
1. Control joints shall be formed or sawed joints perpendicular to the surface of the pavement.
2. Where sawed joints are used, controls joints shall be sawed as soon as sawing can be accomplished without damage to the pavement, and within 24 hours of concrete placement. All joints shall be completed before permitting traffic to use the pavement.
3. Concrete saws shall be power driven, shall be manufactured especially for the purpose of sawing concrete and shall be capable of performing the work. Saw blades shall be as indicated. Tracks adequately anchored, chalk, string line or other approved methods shall be used to provide true alignment of the joints. The concrete saw shall be maintained in good operating condition and the Contractor shall keep a standby power saw on the project at all times when concrete operations are under way.
4. If membrane curing is used, the portion of the seal which has been disturbed by sawing operations shall be restored by the Contractor by spraying the areas with additional curing seal.

D. Construction Joints
1. Intentional stoppage of the placing of the concrete shall be at either an expansion joint or at a control joint.
2. Construction joints shall be square and normal to the forms.
3. Bulkheads shall be provided in the forms for all joints, of sufficient cross-sectional area to prevent deflection, accurately notched to receive the load transmission devices or dowels, and shaped accurately to the cross section of the pavement.

4. The hardened concrete surface shall be thoroughly cleaned of all loose material, laitance, dirt or foreign matter and saturated with water so it is moist when placing fresh concrete against it. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Forms shall be drawn tight against the existing concrete and the joint surface flushed with grout just prior to placing the fresh concrete.
5. The joint surface shall be coated with bonding mortar, grout, epoxy or other material as indicated on the drawings or other items. A Type V epoxy shall be provided in accordance with TxDoT DMS-6100, "Epoxies and Adhesives" for bonding fresh concrete to hardened concrete. The epoxy shall be placed on a clean dry surface and the fresh concrete shall be placed while the epoxy is still tacky. Bonding mortar or grout shall be placed on a surface that is saturated surface dry and the concrete shall be placed before the bonding mortar or grout dries. Other bonding agents shall be placed in accordance with the manufacturer's recommendations.
6. Immediately upon any unintended stoppage of the placing of concrete, the Contractor shall place the available concrete to a line and install the above-described bulkhead at right angles to the centerline of the pavement, perpendicular to the surface and at the required elevation. Concrete shall be placed and finished to this bulkhead. Any concrete remaining on the subgrade ahead shall be removed and disposed of as directed by the Engineer. When placing of concrete is resumed before the concrete has set to the extent that the concrete will stand on removal of the bulkhead, the new concrete shall be rodded with the first. An edge created by a construction joint of this type shall have a joint seal space and shall be sealed as required for control joints. The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. The term monolithic placement shall be interpreted to mean that the manner and sequence of concrete placing shall not create construction joints.

E. Installation of Dowels and Anchor Bolts
1. Dowels and anchor bolts shall be installed by casting them in place or by grouting with grout, epoxy, or epoxy mortar unless indicated otherwise on the drawings.
2. Holes for grouting shall be formed or drilled. Holes for anchor bolts shall be drilled to accommodate the bolt embedment required on the drawings. Holes for dowels shall be made at least 12 in. (300 mm) deep unless indicated otherwise on the drawings. When grout or epoxy mortar is specified the diameter of the hole shall be at least twice the dowel or bolt diameter but shall not exceed the dowel or bolt diameter plus 1 ½ in (38 mm). When epoxy is specified the hole diameter should be 1/16 to ¼ in. (1.6 to 6.35 mm) greater than the dowel or bolt diameter.
3. The holes shall be thoroughly cleaned of all loose material, oil, grease or other bond-breaking substance and blow them clean with filtered compressed air. When an epoxy type material is used the holes shall be in a surface dry condition. When hydraulic cement grout is used the holes shall be in a surface moist condition. The void space between the hole and the dowel or bolt shall be completely filled with grouting material. The requirements for cleaning outlined in the product specification for prepackaged systems shall be followed exactly.

F. Sidewalks
1. Expansion joint material ¾ inch (19 mm) thick, shall be provided where the new construction abuts an existing structure, sidewalk or driveway. Similar expansion material shall be placed around all obstructions protruding through the sidewalk. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete.
2. Maximum spacing of expansion joints shall be 40 feet (12 meters) as indicated on the Drawings or as directed by the Engineer.
3. Control joints shall be spaced at 5 feet (1.5 meters) on center. Normal dimensions of the control joints shall be ¼ inch wide and ¾ inch deep (6 mm wide and 19 mm deep).
4. All joints shall be constructed perpendicular (90 degrees) to the centerline of walk and shall match any previously placed concrete joints.

5. For sidewalks with widths exceeding 6 feet (1.83 meters), longitudinal control joints shall be provided as indicated on the Drawings or as directed by the Engineer.

G. Cleaning and Sealing Joints and Cracks
   1. General
      a. Equipment, tools and machinery recommended for proper prosecution of the Work shall be on the project and shall be approved by the Engineer prior to the initiation of the joint and/or crack cleaning and sealing operations.
   2. Joint and Crack Preparation
      a. The bonding surface of cracks and joints shall be cleaned of infiltrated material, saw cuttings or other foreign material. All material removed from joints and cracks shall be removed.
      b. No sealing of any joints or cracks shall be done when the joints or cracks are damp, unless drying of the joints and cracks with compressed air can be demonstrated.
      c. Joints shall be cleaned with filtered compressed air.
      d. Hand tools, air guns, power routers, abrasive equipment or other equipment may be used to clean the joints. The joint sealant space shall be resized by sawing to the width and depth shown on the Drawings to accommodate the type of sealant specified.
      e. Cracks shall be grooved initially at the surface so that a reservoir of rectangular cross section is provided for the sealant. The grooves shall be cut to the dimensions shown on the Drawings. The devices that are used for grooving, such as diamond blade random cut saws, random-crack grinders, etc., shall be capable of following the path of the crack without causing excessive spalling or other damage to the concrete.
   3. Joint and Crack Sealing
      a. The sealant shall be installed in accordance with the manufacturer's recommended procedure. The joint and/or crack surfaces shall be surface dry unless recommended otherwise by the manufacturer of the sealant.
      b. The surface temperature at the time of the sealing operation shall not be less than 40℉ (4.5℃).
      c. The minimum depth of sealant shall be ½ inch (12.5 mm) or a depth recommended by the sealant manufacturer and the top of the sealant shall be located 1/8 to ¼ inch (3 to 6.5 mm) below the adjacent pavement surface.
      d. If required, the primer shall be applied as soon as possible after cleaning is accomplished. The primer shall be applied uniformly at the rate recommended by the sealant manufacturer. The primer shall be applied to exposed metal surfaces before new corrosion begins and shall be allowed to cure for a minimum of thirty (30) minutes, but no longer than eight (8) hours prior to the application of the sealant, unless sealant manufacturer recommendations indicate otherwise.
      e. Backer rods shall be used to prevent a fluid type sealant from flowing through the joint and crack and to retain the sealant at its required elevation. The application and use of backer rod shall be as recommended by the sealant manufacturer and approved by the Engineer.

3.5 PLACING CONCRETE

A. General
   1. The Contractor shall give the Engineer sufficient advance notice before placing concrete to permit the review of forms, reinforcing steel placement and other preparations. Concrete shall not be placed prior to the completion of formwork and placement of reinforcement therein.
   2. When mixing, placing and finishing concrete is scheduled during non-daylight hours; the entire placement site should be illuminated to the satisfaction of the Engineer.

B. Weather Conditions
   1. Concrete may be placed when the ambient temperature is not less than 35°F (2°C) in the shade and rising or above 40°F (4°C). Concrete shall not be placed when the ambient temperature in the shade is below 40°F (4°C) and falling unless approved by the Engineer. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32°F (0°C).
   2. Concrete shall not be placed when impending weather conditions would impair the quality of the finished work.
   3. If changes in weather conditions require protective measures after work starts, adequate shelter shall be provided to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. Operations during rainfall shall only be continued if approved by the Engineer.
   4. Aggregate stockpiles shall be covered to the extent necessary to control the moisture conditions in the aggregates. Aggregates shall be free from ice, frost and frozen lumps.
   5. The Contractor is responsible for the protection of concrete placed under any and all weather conditions and is responsible for producing concrete equal in quality to that placed under normal conditions. Permission given by the Engineer to allow placement of the concrete during adverse weather does not relieve the Contractor of the responsibility for producing concrete equal in quality to that placed under normal conditions. Concrete placed under adverse weather conditions that proves to be unsatisfactory shall be removed and replaced at Contractor' expense.

C. Admixtures
   1. All admixtures used shall be liquid except high-range water reducers which may be a powder. Liquid admixtures shall be agitated as needed to prevent separation or sedimentation of solids; however, air agitation of Neutralized Vinsol Resin will not be allowed.
   2. No admixture shall be dispensed on dry aggregates. Admixtures shall be dispensed at the batching site separately, but at the same time as the mixing water. Only high range water reducers may be introduced into the mix at the job site.
   3. When other admixtures are used with fly ash, the amount of the other admixture to be used shall be based on the amount of Portland cement only and not the amount of Portland cement and fly ash.
   4. When high-range water reducers are to be added at the job site, transit mixers shall be used. Admixture manufacturer literature shall indicate recommended mixing methods and time for the specific equipment and mix design used. The transit mix equipment shall not be loaded in excess of 63 percent of its rated capacity to ensure proper mixing of the admixture at the site. If during discharging of concrete a change in slump in excess of 30% is noted, the remaining concrete shall be rejected unless prior approval was given by the Engineer to retemper a load with a second charge of admixture. Retempering with water shall not be allowed.
   5. All mixes with air entrainment shall have a minimum relative durability factor of 80 in accordance with ASTM C 260. Dosage of air entrainment admixtures may be adjusted by the Contractor to stay within the specified tolerances for air entrainment of this specification.

D. Concrete Temperature
   1. Minimum Temperature
      a. The minimum temperature of all concrete at the time of placement shall not be less than 50°F (10°C).
      b. The aggregate and/or the water may be heated uniformly, so that the temperature of the mixture of aggregates and water is between 50°F(10°C) and 85°F(29°C) before introduction of the cement.
   2. Maximum Temperature
      a. The maximum temperature of any concrete, unless otherwise indicated on the drawings, shall not exceed 95°F (35°C) when placed. The maximum temperature of

cast-in-place concrete in curbs and sidewalks, and for precast bumper curbs, shall not exceed 85℉ (30℃) when placed.

b. If the concrete mix temperature is expected to exceed 90℉ (32℃) (or 100℉ (38℃) in mixes with high range water reducers) ice may be utilized to lower the concrete mix temperature. Ice may be added to the concrete mix as a portion by weight of the mix water. However, the addition of ice shall not exceed 50% of the total mix water weight.

E. Transporting Time

1. The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall not exceed the following:

Allowable Transportation Times		
Air or Concrete Temperature whichever is higher	**Maximum Time w/o Retarder**	**Maximum Time with Retarder**
		All others
Non-agitated Concrete		
35℉ to 79℉ (2℃ to 26℃)	45 minutes	45 minutes
Over 80℉ (Over 25℃)	30 minutes	45 minutes
Agitated Concrete		
90℉ (32℃) or above	45 minutes	105 minutes
75℉ to 89℉ (24℃ to 32℃)	60 minutes	120 minutes
35℉ to 74℉ (2℃ to 23℃)	90 minutes	150 minutes

F. Material Proportions

1. Proportioning of all material components shall be checked prior to discharging. Excluding mortar material for pre-coating of the mixer drum and adjustment for moisture content of admixtures and aggregates, material components shall fall within the range of + 1% for water, + 2% for aggregates, + 3% for cement, +2% for fly ash and within manufacturer recommended dosage rates for admixtures except that air entrainment shall be within + 1½ percentage points of the mix design requirements.

G. Handling and Placing

1. The method of handling, placing and consolidation of concrete shall minimize segregation and displacement of the reinforcement and produce a uniformly dense and compact mass.
2. Concrete shall not have a free fall of more than 5 feet (1.5 meters).
3. Any hardened concrete spatter ahead of the plastic concrete shall be removed.
4. Each part of the forms shall be filled by depositing concrete as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point and running or working it along the forms will not be allowed.
5. Cold joints in a monolithic placement shall be avoided. The sequence of successive layers or adjacent portions of concrete shall be such that they can be vibrated into a homogeneous mass with the previously placed concrete without a cold joint. Not more than 1 hour (1 ½ hours if a normal dosage of retarding admixture is used) shall elapse between adjacent or successive placements of concrete.

H. Consolidation

1. All concrete shall be carefully consolidated and the mortar flushed to the form surfaces by continuous working with immersion type vibrators. Vibrators which operate by attachment

to forms or reinforcement will not be permitted, except on steel forms. At least 1 standby vibrator shall be provided for emergency use in addition to the ones required for placement. For lightweight concrete, vibrators of the high frequency type, which produce a minimum of 7000 impulses per minute, will be required.

2. The concrete shall be vibrated immediately after deposition. Prior to the beginning of work, a systematic spacing of the points of vibration shall be established to insure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points 18 to 30 inches (450 to 750 mm) apart and slowly withdrawn. The vibrator may only be inserted in a sloping or horizontal position in shallow slabs. The vibrator shall not be used to move the concrete to other locations. In addition, the vibrator shall not be dragged through the concrete. Concrete along construction joints shall be thoroughly consolidated by operating the vibrator along and close to but not against the joint surface. The vibration shall continue until thorough consolidation and complete embedment of reinforcement and fixtures is produced, but not long enough to cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

3.6 FINISHING

A. Equipment

1. The Contractor shall provide a strike template and a tamping template both of 4 by 10 inch (10 by 25 cm) lumber or equivalent metal section and at least 2 feet longer than the width of the pavement. Both templates to conform to the crown section of the pavement and the tamp, if of wood, shall have a steel face not less than 3/8 inch (9.5 mm) in thickness. The Contractor shall also provide a longitudinal float of approved design and not less than 14 feet (4.25 meters) in length.
2. The Contractor shall furnish and maintain at least two standard 10-foot (3.05 meter) steel straightedges on the work site at all times during the paving operations.
3. The Contractor shall furnish a sufficient number of bridges to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints. All necessary finishing and edging tools shall be furnished as may be required to complete the pavement as indicated.

B. Fogging

1. The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand operated fogging equipment.
2. From the time of initial strike off until final finish is completed and required interim curing is in place, the unformed surfaces of concrete slabs shall be kept damp, not wet, to offset the effects of rapid evaporation of mixing water from the concrete due to wind, temperature, low humidity or combinations thereof. Fogging equipment capable of applying water in the form of a fine fog mist, not a spray, will be required. Fogging will be applied at the times and in the manner directed by the Engineer.
3. Fogging equipment may be either water pumped under high pressure or a combination of air and water, either system in combination with a proper atomizing nozzle. The equipment shall be sufficiently portable for use in the direction of any prevailing winds. The equipment shall be adapted for intermittent use to prevent excessive wetting of the surfaces.

C. Floating

1. Concrete shall be struck off with an approved strike off screed to such elevation that when consolidated and finished the surface of the pavement to conform to the required section and grade. The strike template shall be moved forward with a combined transverse and

longitudinal motion in the direction work is progressing, maintaining the template in contact with the forms and maintaining a slight excess of material in front of the cutting edge. The concrete shall then be tamped with an approved tamping template to compact the concrete thoroughly and eliminate surface voids and the surface screed to required section.

2. After completion of a strike off, consolidation and transverse screeding, a hand-operated longitudinal float shall be operated to test and level the surface to the required grade.
3. Workers shall operate the float from approved bridges riding on the forms and spanning the pavement. The longitudinal float shall be held in contact with the surface and parallel to the centerline and operated with short longitudinal strokes while being passed from one side of the pavement to the other. If contact with the pavement is not made at all points, additional concrete shall be placed, if required and screed and the float shall be used to produce a satisfactory surface. Care shall be exercised to keep the ends of the float from digging into the surface of the pavement. After a section has been smoothed so that the float maintains contact with the surface at all points in being passed from one side to the other, the bridges may be moved forward half the length of the float and the operations repeated.

D. Broom Finishing
1. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a broom or wood float to a gritty texture unless otherwise indicated on the Drawings.
2. The outer edges and joints shall be rounded with approved tools to a ¼-inch (6.3 mm) radius. Care shall be exercised to prevent loss of dummy joints or rounded edges when applying the broom finish.

E. Exposed Aggregate
1. When exposed aggregate surfaces are required for sidewalks, driveways and/or medians, the coarse aggregate shall consist of particles with at least 40 percent crushed faces. Uncrushed gravel, polished aggregates and clear resilient coatings are not acceptable. Grade 5 coarse aggregates shall be used for exposed aggregate finishes for sidewalks, driveways and/or medians.

3.7 CURING

A. General
1. At least 1 day of curing shall be allowed after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.
2. All concrete pavement shall be cured by protecting it against loss of moisture for a period of not less than 72 hours from the beginning of the curing operations. Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered and cured in accordance with the requirements specified for whichever of the following methods the Contractor may elect.
3. Failure to provide sufficient cover material of the type the Contractor elects to use, failure to maintain saturation in wet curing methods, lack of water to adequately take care of both curing and other requirements or other failures to comply with curing requirements shall be cause for immediate suspension of concreting operations.
4. The covering material used in curing shall be removed as necessary to saw joints or to comply with the requirements for "Surface Test."
5. The concrete surface shall be maintained wet with a water spray if indicated and the covering material replaced immediately on completion of sawing and testing and any required surface correction.
6. The storing of reinforcing or structural steel on completed pavement slabs is prohibited.

B. Membrane Curing
1. Immediately after the finishing of pavement has been completed and after the free surface moisture has disappeared, the pavement shall be sprayed uniformly with a Type 2 white

pigmented curing compound. Should the film of compound be damaged from any cause before the expiration of 72 hours after original application, the damaged portions shall be repaired with additional compound.

C. Polyethylene Film Curing
   1. Immediately after the finishing of the surface has been completed and the concrete has taken its initial set, it shall be wetted with water applied in the form of a fine spray and covered with the polyethylene film so placed and weighted as to cause it to remain in intimate contact with the surface. The polyethylene film covering shall be maintained in place continuously for not less than the specified curing period.
   2. The film shall be prepared to form blankets of sufficient width to cover the entire surface and both edges of the pavement slab. All joints in the blankets occasioned by joining film sheets shall lap not less than 12 inches (30.5 cms). All joints shall be sealed in a manner acceptable to the Engineer to provide a moisture-proof lap.
   3. The polyethylene film blankets shall be adequately weighted to prevent displacement or billowing due to wind and the film folded down over the side of the pavement shall be secured by a continuous bank of earth. Plowing of this windrow into place not to be permitted.
   4. All tears or holes appearing in the polyethylene film during the curing period shall be immediately repaired by placing acceptable moisture proof patches over such defects or by replacing the blankets. It shall be the Contractor's responsibility to prevent damage to the film blankets, which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected by the Engineer at any time if it appears they do not provide an airtight covering.
   5. Polyethylene film blankets rejected on account of pinholes or minor tears may be continued in service when repaired to an airtight condition. All polyethylene film blankets rejected by the Engineer shall be immediately marked by the Contractor for identification and then destroyed or stored entirely separate from approved blankets.
   6. Should the film blanket be damaged or torn for any cause during the first 72 hours of the curing period such damage shall be repaired immediately.

D. Cotton Mats
   1. Wet cotton mats placed in direct contact with the slab shall be maintained for the required curing time. If needed damp burlap blankets made from 9-ounce (255 gm) stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats, which may be placed dry and wetted down after placement.
   2. The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time. Surfaces, which cannot be cured by contact, shall be enclosed with mats, anchored positively to the forms or to the ground, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

E. Sidewalks
   1. The sides of the concrete shall be cured in the forms. If the forms are removed during the curing process, the curing shall be continued by the placement of fill against the exposed concrete edges.

3.8 PROTECTION

A. Opening to Traffic
   1. The pavement shall be closed to traffic, including vehicles of the Contractor, until the concrete is at least 14 days old and has attained an average compressive strength acceptable to the Engineer. This period of closure to traffic may be extended if, in the

opinion of the Engineer, weather or other conditions make it advisable to provide an extension of the time of protection.

2. Prior to opening any section of the pavement to traffic, all joints shall be sealed, the pavement cleaned, and topsoil placed against the pavement edges or behind the curb where turf or vegetation is to be established before permitting vehicles thereon.
3. At the end of the 14-day period and as long thereafter as ordered by the Engineer and if so desired by the Contractor, the pavement may be opened for use by vehicles of the Contractor provided the gross weight (vehicle plus load) of such vehicles does not exceed 14,000 pounds (6,350 KGs). Such opening, however, shall in no manner relieve the Contractor from responsibility for the Contractor's work.
4. When High Early Strength Concrete, resulting from the use of Type III cement, is used, the pavement may be opened to all traffic after the concrete is 7 days old or as long thereafter as ordered by the Engineer, subject to the same provisions governing the opening after 14 days as above indicated.

B. Cold Weather

1. The temperature of all concrete placed on or in the ground, shall be maintained above 32°F(0°C) for a period of 72 hours from time of placement.
2. Protection shall consist of providing additional covering, insulated forms or other means and if necessary, supplementing such covering with artificial heating. Avoid applying heat directly to concrete surfaces. Curing shall be provided during this period until all requirements for curing have been satisfied.
3. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before permission is granted to begin placement.
4. Sufficient extra test specimens will be made and cured with the placement to ascertain the condition of the concrete as placed prior to form removal and acceptance.

3.9 FIELD QUALITY CONTROL

A. Testing Agency

1. Contractor will engage a qualified testing agency to perform tests and inspections.
2. The Contractor shall provide sufficient notice to the Engineer of each concrete placement to allow for scheduling of tests and inspections, and shall provide access to each concrete placement as needed to perform tests and inspections.

B. Compressive Strength

1. At least one set of test cylinders shall be obtained from each day’s concrete placement, or for each 100 cubic yards, whichever is less.
2. A minimum of four test cylinders shall be prepared; two each to be tested at 7 and 28 days. Specimens will be tested conforming to TXDOT Test Method TEX-418-A. A strength test shall be defined as the average breaking strength of 2 cylinders.
3. Test specimens shall be cured using the same methods and under the same conditions as the concrete represented. Design strength cylinders shall be cured conforming to TXDOT Bulletin C-11 (and supplements thereto).
4. When control of concrete quality is by 28-day compressive tests, job control testing will be by 7-day compressive strength tests. The minimum strength requirement for seven (7) day test will be 70 percent of the specified minimum 28-day compressive strength. If the required 7-day strength is not obtained, changes in the mix design shall be made and resubmitted for approval. For an occasional failure of the seven-day compressive test, the concrete may be tested at 28 days for final evaluation.

C. Slump

1. At least one slump test will be performed for each day’s concrete placement.
2. Slump tests will be performed in accordance with TxDoT Test Method Tex-415-A.

D. Entrained Air
   1. At least one entrained air test shall be performed for each day's concrete placement.
   2. Entrained air tests will be performed in accordance with TxDoT Test Method Tex-416-A.

E. Temperature
   1. At least one temperature test shall be performed hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above.
   2. Temperature tests will be performed in accordance with ASTM C 1064/C 1064M.

F. Pavement Surface Testing
   1. After the concrete has been placed 12 hours or more, the Engineer will test the surface of the pavement with a 10-foot (3.05 meter) straightedge. Unless specified otherwise, the surface shall not vary from the straightedge by more than 1/16 inch per foot (5 mm per meter) from the nearest point of contact and in no case shall the maximum ordinate from a straightedge to the pavement be greater than 1/8 inch (3 mm). Any high spots causing a departure from the straightedge in excess of that specified shall be ground down by the Contractor to meet the surface test requirements.

G. Accessibility
   1. Sidewalks, ramps, and pavements designated on the Drawings as accessible routes may be inspected by a Registered Accessibility Specialist (RAS). Any deficiencies noted by the RAS shall be repaired or replaced at the expense of the Contractor.

3.10 REPAIRS AND ACCEPTANCE

A. Defective Work
   1. Any defective work discovered after the forms have been removed shall be repaired or replaced as soon as possible at the expense of the Contractor.

B. Cost Adjustments for Pavement
   1. It is the intent of this specification that the pavement be constructed in strict conformity with the thickness, strength and typical sections indicated on the drawings. Where any pavement is found not so constructed, the Owner may elect to apply the following rules relative to adjustment of payment in lieu of repair and replacement, based on pavement thickness and compressive strength.
   2. Thickness
      a. The pavement will be core drilled after any grinding operations have been completed for surface corrections prior to final acceptance. Locations of core tests may be selected by the Engineer; however, spacing interval for core tests, as specified herein, shall be maintained. The thickness of the pavement will be determined by measurement of the cores in accordance with TxDOT Test Method Tex-424-A.
      b. For the purpose of establishing an adjusted price for pavement, each concrete placement less than 1,000 square yards in area shall be considered a unit. For concrete placements greater than 1,000 square yards in area, the Engineer shall delineate the concrete placements into approximately equivalent units.
      c. One core will be taken at the location selected by the Engineer or at random in each unit.
      d. When the measurement of the core from any unit is not deficient more than 0.2 inches from the plan thickness, full payment will be made.
      e. When the measurement of the core from any unit is deficient more than 0.2 inch but not more than 0.75 inch from the plan thickness, 2 additional cores will be taken from the unit and the average of the 3 cores determined. The 2 additional cores from any unit will be taken at locations such that the pavement in the unit will be well represented. If the average measurement of these 3 cores is not deficient more than 0.2 inches from the plan thickness, full payment will be made. If the average

thickness of the 3 cores is deficient by more than 0.2 inch but not more than 0.75 inch from the indicated thickness, an adjusted unit price as provided below will be paid for the areas represented by these cores.

Concrete Pavement Deficiency	
Deficiency in Thickness Determined by Cores, Inches	**Proportional Part of Contract Price Allowed**
0.00 to 0.20	100 percent
0.21 to 0.30	80 percent
0.31 to 0.40	72 percent
0.41 to 0.50	68 percent
0.51 to 0.75	57 percent

f. Irrespective of an acceptable overall project average for any or all of the Pay-Adjustment Acceptance Factors, limited substandard portions of the work, as determined by the Engineer, shall be remedied or removed and replaced to the satisfaction thereof.

g. Any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch or 1/8 of the indicated thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants removal, the area shall be removed and replaced at the Contractor's entire expense, with concrete of the thickness indicated on the drawings.

h. Any area of pavement found deficient in thickness by more than 1 inch or more than 1/8 of the indicated thickness, whichever is greater, shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness indicated on the drawings.

i. No additional payment over the Contract unit price will be made for any pavement of a thickness exceeding that indicated on the drawings.

3. Compressive Strength

a. If the average compressive strength based on concrete test cylinders at 28 days is less than the specified minimum strength of the concrete, then payment will be made at an adjusted price as specified in the following table.

Pay Adjustment Factor for Deficient Compressive Strength	
Ratio of Average Strength from Test Cylinders to Specified Minimum Compressive Strength both at 28 Days	**Proportional Part of Contract Price Allowed**
More then 0.95	100 percent
0.90 to 0.95	85 percent
0.85 to 0.90	70 percent
0.80 to 0.85	60 percent
Less than 0.80	0 percent (Remove & Replace)

b. When, in the opinion of the Engineer, the compressive strength test results appear unrepresentative, additional testing of field cores may be authorized. To be considered acceptable for consideration the field cores shall be acquired, properly handled and tested in accordance with ASTM C 42/C 42M, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete" within 45 days of the original concrete placement date. The retesting will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original test results were erroneous in the opinion of the Engineer, the original test results will be discarded. In the instance of erroneous original test results the subsequent first set of retests will be at the expense of the Owner.

c. When, in the opinion of the Engineer, the concrete compressive strength is deemed unacceptable for the intended use of the pavement, the concrete shall be removed and replaced to the limits indicated by test results.

3.11 WARRANTY

A. Pavement

1. If cracks develop in the pavement surface within the one-year warranty period, the Contractor shall seal the cracks in accordance with the requirements of this specifications, or perform other corrective measures as directed by the Engineer, at the expense of the Contractor.

END OF SECTION 321313

waived by the Engineer if it is determined that the prepared first course base will be damaged by the proof roller.

C. Subgrade
   1. The subgrade shall be tested by proof rolling prior to placement of the first course of base material. Any unstable or spongy subgrade areas identified by proof rolling shall be corrected either by additional re-working, drying and compaction, or by removal and replacement of unsuitable materials. When specifically directed by the Engineer, the Contractor shall re-work the subgrade as follows:
      a. Remove the unstable subgrade to the full depth of the unstable insitu material or to a minimum depth of 6 inches (150 mm), whichever is greater.
      b. Spread the material over a sufficient area to allow reworking of the excavated material.
      c. Disc, scarify or otherwise breakup the excavated material and allow to dry (Note: If approved by the Engineer, the addition of lime or other additive may be used to aid in the drying process or to stabilize the unstable material).
      d. Fill the excavated area with the re-worked material and compact to specified densities.
      e. Proof roll the re-worked area.
   2. Unstable organic subgrade soils shall not be reworked but shall be permanently removed and replaced with materials approved by the Engineer.
   3. All suitable material removed by excavation may be utilized in the subgrade with the approval of the Engineer. All other material required for completion of the Subgrade, shall also be subject to approval by the Engineer.

D. Embankment Construction
   1. All embankment courses shall be proof rolled, unless otherwise directed by the Engineer.
   2. If required by the Engineer, stability testing of embankments constructed to the finished elevation shall either be conducted with a standard proof roller or alternate equipment, which can be proven to impart a horizontal and vertical pressure distributions equivalent to or greater than those induced by a standard proof roller.

END OF SECTION 312000

GEOTECHNICAL INVESTIGATION
WILLIAMSON COUNTY
SHERIFF'S OFFICE TRAINING CENTER
WILLIAMSON COUNTY, TEXAS

Williamson County
Georgetown, Texas

Balcones
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Job 0115-041
March 25, 2016

Report of Geotechnical Investigation
Williamson County Sheriff's Office Training Center
Williamson County, Texas

Submitted herewith is our Report of Geotechnical Investigation for the above referenced project. In brief, the report includes a plan of borings, boring logs, laboratory test results and descriptions of subsurface conditions. Based on the findings, recommendations are set forth for the design and construction of foundations, and for earthwork.

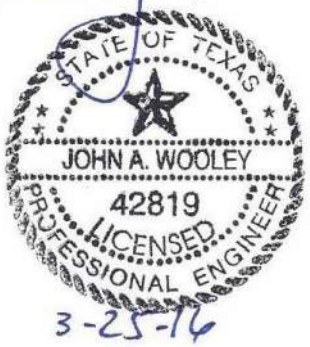
Balcones Geotechnical, PLLC (Balcones) appreciates the opportunity to provide these geotechnical engineering services to Williamson County and looks forward to our continued association throughout final design and construction phases.

Sincerely,

BALCONES GEOTECHNICAL, PLLC
TBPE Firm Registration No. F-15624

Rebecca A. Russo, P.E.
Senior Geotechnical Engineer

John A. Wooley, P.E.
Principal



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INTRODUCTION

The Williamson County Sheriff's Office Training Center is a new facility to be constructed near the northwest quadrant of the intersection of Chandler Road and FM 1660 near Hutto, Texas. The project will include construction of a new one-story building, ancillary garage structure, at-grade parking and driveways, and screen wall and waterline along Chandler Road. The project site location is shown on the Vicinity Map presented on Plate 1.

The architectural design services are being provided by Brinkley Sargent Wiginton (BSW) Architects. Structural design services are being provided by Datum Engineers, Inc. (Datum). We have received the Request for Geotechnical Recommendations letter dated October 7, 2015 by Datum which describes the proposed project. Balcones Geotechnical, PLLC (Balcones) was retained by Williamson County Transportation and Infrastructure to provide geotechnical engineering services.

AUTHORIZATION

The investigation was authorized on December 1, 2015 by Mr. Robert Daigh, P.E. with issuance of a formal Notice to Proceed and acceptance of our Contract for Geotechnical Engineering Services which was signed by the Honorable Judge Dan Gattis on December 3, 2016. The contract outlines the agreed upon scope of services.

PURPOSE AND SCOPE

Balcones was retained by Williamson County to perform the geotechnical investigation for this project and to provide foundation design recommendations to guide design and construction of the facility. This report contains all the data developed for that purpose.

The scope of the investigation included 1) drilling of 17 borings to determine subsurface conditions within the structure and pavement areas for obtaining representative samples for laboratory testing; 2) laboratory testing to determine classification and index properties of site soils, and 3) preparation of this report to provide foundation design recommendations.

Field sampling and laboratory testing were in general accordance with methods, procedures, and practices set forth by the American Society for Testing and Materials, latest version of Annual Book of ASTM Standards, where applicable.

FIELD INVESTIGATION

Borings drilled for this investigation included 17 borings, designated W-1 through W-6 for the proposed screen wall and waterline, B-7 through B-11 for the proposed building, and P-12 through P-17 for the proposed parking and driveway areas. Borings were drilled to depths of 10 to 35 feet below existing grade. Boring locations are shown on the attached Boring Location Plan, Plates 2a and 2b. Boring locations were surveyed and staked by Halff & Associates prior to our mobilization to the site.

Detailed descriptions of subsurface materials encountered at the boring locations are presented on the Logs of Borings, Appendix A. A Generalized Subsurface Profile within the building footprint precedes the boring logs in Appendix A. Keys to Terms and Symbols used on the logs are set forth in Appendix A, following the boring logs.

Pocket penetrometer values in tons per square foot (tsf), and Standard Penetration Test N-values in blows per foot (bpf), are shown on the logs of borings at the respective test depth. Groundwater and/or drilling fluid observations made during drilling are presented on the boring logs. Latitude and longitude GPS coordinates were obtained at boring locations using a hand-held GPS device accurate to about 3 horizontal meters, are shown at the top of the boring logs and should be considered approximate. Boring elevations were provided by Halff and are presented on the boring logs.

The borings were drilled with a truck-mounted drill rig equipped with 1) continuous flight augers for advancing the holes dry and recovering disturbed samples (ASTM D 1452), 2) seamless push tubes for obtaining relatively undisturbed soil samples of cohesive strata (ASTM D 1587), 3) split-barrel samplers and drive weight assembly for obtaining representative samples and measuring the penetration resistance (N values) of non-cohesive soil strata (ASTM D 1586), and 4) double-tube wireline core barrels equipped with diamond bits for obtaining 2-inch diameter rock cores (ASTM D 2113).

LABORATORY INVESTIGATION

The laboratory testing program included identification and classification testing of strata encountered in the subsurface. Soil classification tests, including Atterberg limit determinations (ASTM D 4318) and partial grain-size analyses (ASTM D 422), were conducted on representative samples of the soil strata. Unconfined compression tests on soil (ASTM D 2166) were conducted on clay samples. The classification and compressive strength tests included natural water content determinations (ASTM D 2216). The compressive strength tests also included unit dry weight

determinations. The results of the tests are tabulated on the boring logs at the sample recovery depths.

Two pressure swell tests were conducted on representative clay samples obtained from the borings. In this test method, the soil specimen is restrained laterally and axially drained while subjected to an applied vertical seating load. The sample is inundated, and a vertical load is applied to maintain zero change in height, referred to as the "swell pressure". Once the swell pressure is determined, the weights are removed and the percent swell (change in vertical height) is recorded. The results are summarized in the table below, and presented graphically in Appendix B.

Summary of Pressure Swell Test Results					
Boring Number	**Sample Depth**	**Initial Water Content, %**	**Final Water Content, %**	**Percent Swell**	**Swell Pressure, psf**
B-8	2 – 4 ft	30	33	0.3 0	100 170
B-9	4 – 6 ft	26	27	0.4 0	100 165

Measured swell was relatively low most likely due to the high initial moisture content. The on-site clay soils have measured and recognized swell potential, and provisions should be made in foundation design to account for potential shrink/swell movements associated with moisture change. Recommendations for such provisions are provided in the Foundation Recommendations section of this report.

Seven soluble sulfate content tests (Tex-145-E Part II) were conducted on representative soil samples obtained from the pavement borings. The tests were performed to evaluate soils with regard to the phenomenon known as "sulfate induced heave." The results of the soluble sulfate content tests are presented on the boring logs at the respective sample depth, and summarized in the following table.

Soluble Sulfate Content Test Results		
Boring	**Sample Depth (ft)**	**Soluble Sulfate Content (ppm)**
P-12	2 ft	180
P-13	4 ft	160
P-14	6 ft	200
P-15	4 ft	180

Soluble Sulfate Content Test Results		
Boring	**Sample Depth (ft)**	**Soluble Sulfate Content (ppm)**
P-16	2 ft	180
ppm – parts per million		

Descriptions of strata made in the field at the time the borings were drilled were modified in accordance with results of laboratory tests and visual examination. All recovered soil samples were classified in general accordance with ASTM D 2487 and described as recommended in ASTM D 2488. Classifications of the soils and finalized descriptions of soil strata are shown on the boring logs.

SITE AND SUBSURFACE CONDITIONS

Physiography

The proposed Sheriff's Office Training Center will be located on undeveloped land currently used for agricultural purposes. The building site and pavements are located east of Mustang Creek. The proposed waterline will extend about 3,000 ft to the west towards FM 130 along the southern property boundary, and will cross Mustang Creek. An existing Williamson County Sheriff Facility is located to the west, and is fronted by a partial CMU privacy wall which is to be rebuilt. The proposed configuration and alignment of the new wall is unknown at this time.

The site relief across the proposed building area is relatively flat and gently slopes down to the south towards Mustang Creek. The USGS Topographic Map is presented on Plate 3. According to the Halff survey data, ground surface elevations within the proposed main building footprint vary from about 691.4 to 692.3 feet. Based on a proposed Finished Floor Elevation (FFE) for this building of 694.75 ft, the building will require a net fill of about 2 to 3½ feet. The proposed specialty storage garage has a reported FFE of 694 feet, and with existing site grades of 693 to 694, 1 foot or less of site grading will be requiring to achieve final grade.

Geology

According to published geologic mapping[1] and our experience in the vicinity, the Sheriff's Office Training Center site is mapped as being underlain by highly plastic, potentially expansive clays of the Taylor Group. Specifically, the Ozan Formation of the Taylor is mapped across most

[1] Fisher, W.L. (1974), "Geologic Atlas of Texas, Austin Sheet," Bureau of Economic Geology, The University of Texas at Austin, map and accompanying bulletin.

of the site, with upper high gravel terrace deposits mapped in the eastern portion of the building site. A fault is present near the western end of the site, where surficial outcropping of the Austin limestone is mapped further west. A Geologic Map of the site is presented on Plate 4.

The high gravel terrace deposits typically consist of surficial high plasticity clay with increasing sand and gravel content with depth. The Ozan formation of the Taylor Group consists of highly plastic clay soils with significant shrink swell potential. Where present in abundance, the calcareous material within the clay stratum will mitigate some swell potential otherwise attributed to the clay soils.

Stratigraphy

In general, the borings encountered surficial dark brown to brown fat clay underlain by tan to reddish tan lean and fat clay, further underlain by tan and gray fat clay of the Taylor Group to the boring termination depths. A brief description of subsurface conditions and engineering properties at the proposed building area, pavements, and wall and waterline are provided in the following sections.

Building Borings. Borings B-7 through B-11 were drilled within the proposed building area. The borings encountered surficial fat clay, underlain by fat and lean clay, further underlain by fat clay, clayey gravel, and clayey sand. A Generalized Subsurface Profile is presented in Appendix A, preceding the boring logs.

Measured plasticity indices ranged from 17 to 54 with an average of 40 in the upper 15 feet of soil strata. Beneath the upper 15 feet, the subgrade conditions varied somewhat, ranging from clayey gravel (B-9) to fat clay (B-11) with a PI of 55. The clayey gravel and clayey sand strata in borings B-9 and B-10 may be associated with the high gravel terrace deposits mapped across the site.

Pavement Borings. Borings P-12 through P-17 were drilled within proposed pavement and driveway areas. The borings encountered surficial dark brown fat clay underlain by grayish tan to reddish tan fat clay to the boring termination depth of 10 feet. Measured plasticity indices ranged from 15 to 48 with an average of 35 (5 tests). Percent fines (material passing the No. 200 sieve) ranged from 84 to 93.

Wall and Waterline Borings. Borings W-1 through W-6 were drilled along the proposed wall and waterline along the north easement of Chandler Road. The borings encountered surficial dark brown fat clay underlain by grayish tan to reddish tan fat clay to the boring termination depths of 25 feet.

Boring W-1 encountered calcareous lean clay from the 4 to 15 ft depth, likely associated with weathered soil remnants of the Austin Group limestone. Two of the borings (W-4, W-6) encountered 2-ft of surficial fill soil, although it was sometimes difficult to discern fill material from re-worked native soils.

Measured plasticity indices ranged from 14 to 65 with an average of 51 (6 tests). Discounting boring W-1, the average plasticity index is 60. Percent fines (material passing the No. 200 sieve) ranged from 93 to 99.

Groundwater

Groundwater was encountered in 5 of the borings at depths of 4 to 18 feet below existing grade, at the time of drilling. Of the 5 borings where groundwater was encountered, 3 of the borings are building borings where groundwater was measured at depths of 6.5 to 15 feet. This groundwater condition is likely perched water in the upper sandy lean clay and clayey sand layers atop less pervious fat clay. Calcareous pockets were noted on the boring logs and the presence of which are generally indicative of the previous passive of groundwater.

Groundwater conditions are dependent upon and affected by antecedent rainfall conditions, and may be different at the time of construction. Oftentimes, groundwater can be found within the upper sandy lean clay layers, perched atop the underlying, less pervious fat clay of the Taylor Group. Groundwater seepage may also be encountered in seams, partings and sandy layers and discontinuities within the clay strata. The presence of groundwater will need to be considered in the final building design. If encountered in excavations, groundwater, more likely than not, can be handled by sumping and pumping.

FOUNDATION RECOMMENDATIONS

Although design plans are preliminary at this time, we understand that the proposed construction of the main building will consist of a 23,400 sf tilt-wall training facility. The structure will be steel-framed, possibly with site-cast loading-bearing tilt wall exterior panels. Reported column loads will range from 25 to 150 kips, and bearing wall loads will range from 1 to 5 kips per linear foot. Potential vertical movements of the slab and foundations are required to be limited to ¾ inch; however, a foundation improvement option for ½ inch PVR has also been requested. In addition, a specialty storage garage facility is proposed at the northeast corner of the parking lot. We understand that this facility will be relatively lightly loaded with metal veneer. Potential vertical movement of this structure is less critical; and we have been requested to provide foundation options for movements of 1” and 2” for this structure.

Based on anticipated structural loading, and our experience with similar construction, support of the structures on foundations consisting of grid-beam stiffened slabs atop a select fill pad would be acceptable. An alternative foundation for the main building, consisting of deep foundation support with a structurally suspended, cast free of grade, ground floor slab is also given in the following section, for consideration by the owner, should he have little tolerance for the magnitude of estimated vertical movements presented herein. The following sections provide recommendations for the select fill pad options, grid-beam stiffened slab, and deep foundation system alternative.

Potential Vertical Rise

The upper 15 feet of soil consists of mostly fat clay with intermittent sandy and gravelly clay layers. Accordingly, we have modeled the site conditions to consist of 5 feet of surficial fat clay, underlain by 5 feet of lean clay, further underlain by 5 feet of fat clay. The potential vertical movements were estimated using the results of swell tests and the McDowell[2] procedure commonly known as Potential Vertical Rise (PVR), also known as TxDOT test method TEX-124-E. These methods, while estimates only, allow the calculation of potential soil heave magnitudes using different contributory thicknesses of swelling soil. Using these methods, we offer the following select fill pad thicknesses and potential vertical movement estimates. Significantly greater movements will occur if ponding water and/or leaking utility lines are allowed to occur during or after construction.

Estimated Potential Vertical Movements		
Select Fill Pad Thickness (feet)	**PVR**	**Minimum Excavation Depth***
5	2”	3
6	1½”	4
7	1”	5
8	¾”	6
9	½”	7
* Below existing or final grade, whichever is deeper.		

Movements due to shrink swell behavior of the subgrade are often not uniform and are more severe near the edges of the structure where soil moisture is more readily affected with

[2] McDowell, C. (1956), “Interrelationships of Loads, Volume Change, and Layer Thickness of Soils to the Behavior of Engineering Structures,” Highway Research Board, Proc., 35th Annual Meetings, Publ. No. 426, Transportation Research Board, Washington, D.C., 754-772.

climatic changes. Therefore, we recommend that a minimum select fill pad of at least 7 feet be used for design of the more critical structures. The following suggestions will help mitigate foundation movements and related potential structure distress.

1. A select fill pad of uniform thickness, as much as practical, under the structure;
2. Incorporation of flexible connections and/or provisions in the foundation to reduce the effects of potential differential movement;
3. Positive drainage away from the structure, such as 1.5 to 2.0% for areas with impervious cover, and 10% for areas with pervious cover; and
4. Clay cap and/or possibly concrete flat work around the perimeter of the building to help protect the subgrade from future moisture variations. If a clay cap is used, we recommend a minimum thickness of 18 inches to provide an increased barrier to moisture migration into the select fill zone. The clay material used for the cap should have a maximum particle size of ½ inch, no more than 80% passing the No. 200 sieve, and a minimum plasticity index of 30. The clay cap material should be compacted to at least 95% of the maximum dry density as determined using TxDOT Test Method TEX-114-E at a moisture content within ±3% of the optimum water content.

Preparation of The Building Pad

1. Within the structure footprint and at least 3 ft outside the footprint, remove and dispose of all surficial vegetation, any deleterious materials, and any additional depth required to provide a select fill pad of uniform thickness as determined by allowable movement criteria beneath the structure. Based on existing grades, the thickness of the select fill pad may vary, and a minimum excavation depth has been given herein.
2. Scarify the excavated, pre-fill subgrade at least 12 inches and recompact to at least of 95% of the maximum dry density as determined using the Texas Department of Transportation (TxDOT) Test Method TEX-114-E. Hold water contents within -1 to +3 percent of optimum.
3. Bring the structure pad to grade with crushed limestone derivative base material (select fill) conforming to the following:

Retained on 2-1/2” screen	0%
Retained on 7/8” screen	5% - 50%
Retained on 3/8” screen	25% - 65%
Retained on No. 4 mesh	35% - 75%
Retained on No. 40 mesh sieve	60% - 90%

Material passing the No. 40 sieve shall meet the following plasticity requirements:

Passing No. 40 Sieve	Maximum Plasticity Index	Minimum Plasticity Index
25% - 40%	15	3
10% - 25%	20	4

Other locally available materials generally complying with these requirements, having a low PI (between 5 and 20), not open graded to a degree to create a ponding problem beneath the slab, containing no more than 40% passing the # 200 sieve, and able to maintain excavations and support construction traffic during inclement weather may be submitted for review by the geotechnical engineer. If an alternative select fill is proposed and approved, the upper 2 ft of the select fill pad should consist of more durable base material meeting the requirements specified above.

4. Place the select fill in maximum 10 inch lifts and compact to 98% of the maximum dry density as determined by TxDOT Test Method TEX 113-E. Maintain the moisture content within 2% of optimum.

5. Outside of the structures, the select fill pad should be capped, or covered, with a site-generated clay cap, as recommended in Item 4 in the previous section.

6. To preclude moisture vapor migration through the floor slabs, on top of the compacted, select fill, place a capillary moisture barrier/drainage layer (minimum thickness 4 inches) of free-draining, clean, crushed stone with sizes ranging mostly between ½ and ¾ inch and no more than 5% passing the No. 200 sieve. Durable crushed stone aggregate, ASTM C-33 Size No. 57 or 67 gradation, is suggested since it is readily available in the central Texas area.

7. On top of the free-draining, clean, crushed stone layer, or on top of the select fill layer for the upper slab, place a vapor barrier of sufficient strength and durability to resist puncture during reinforcing steel and concrete placement. Typical thickness should be greater than 12 mils. Placement of the vapor barrier should be in accordance with manufacturer's recommendations.

Shallow Spread Footings

Shallow spread footings may be used to support column loads associated with any structures, provided they are supported on a minimum thickness of at least 4 feet of compacted select fill. Footings may be sized in accordance with the following:

1. Spread footings may be sized using an allowable net bearing pressure of 3,000 psf, provided a minimum thickness of 4 feet of compacted select fill as described in the previous section is in place.
2. The minimum depth of footing should be at least 2.5 feet and the minimum footing width should be at least 3 feet for an isolated footing, and 2 ft for a continuous footing.
3. Settlement or heave of footings designed using these parameters should be about ¾ inch.

Stiffened Slab on Ground

The stiffened grid beam slab-on-ground foundation alternative, if used, may be designed using the slab thickness, beam spacing, depth and reinforcement, and soil parameters presented herein.

1. Grid beams generally should be placed along the exterior building perimeter and beneath load bearing walls. The grid should be as regular as wall and any concentrated load locations permit.
2. Beams should be founded in the compacted select fill and sized for an allowable bearing pressure of 1,500 psf. Beam widths and depths should be at least 12 inches and 24 inches, respectively. The perimeter beam may be sized for an allowable bearing pressure of 2,500 psf, and should be at least 30 inches deep.
3. Assure that any concentrated structural loads are centered at the intersection of beams. Beam intersections carrying concentrated loads may be widened and sized for a bearing pressure of 3,000 psf if founded on at least 4 feet of select fill.
4. If the design requires a modulus of subgrade reaction, use 100 pci.
5. Settlement of grid-beam stiffened slabs bearing atop a select fill pad designed and placed in accordance with the recommendations included herein could be on the order of ¾ inch, with differential settlement between two points approaching half that amount.

Structurally Suspended Slab on Grade Option

For the structurally suspended ground floor option, a permanent void space of at least 12 inches should be maintained beneath all interior and perimeter beams, floor slabs, and pier caps. A preferred void space would consist of a well-ventilated (forced draft and/or air conditioned if necessary) crawl space on the order of 48 to 60 inches.

The ground surface beneath the structure should be sloped to drain to a collection point and a sump and pump underslab drainage system. This might be achieved with placement of a mud mat or asphaltic concrete surfacing of the crawl space floor and sloping to drainage collection points and piping to sumps. The sump should be equipped with a submersible pump which will cycle “on” and “off” to discharge water which accumulates in the sump. Balcones can provide supplemental recommendations if underslab drainage is planned.

An alternative sometimes used in lieu of a crawl space is to construct the slab and beams atop void boxes. Void boxes are susceptible to collapse during concrete placement, which often goes unnoticed and renders this method problematic. If void boxes are used, observations should be made during construction to verify that the void boxes are not compromised and do not collapse during construction. Further, if void boxes are used to create the void space, an underslab drainage system is recommended which is sometimes incompatible with void box manufacturer’s recommendations. Placement of an underslab drainage system and location of the vapor barrier should be thoroughly discussed with the void box manufacturer prior to design of the below grade slab. These factors are critical and should be considered in evaluating HVAC requirements and possible impact on indoor air quality due to poor floor slab penetration control.

Crawl or void box spaces should be sloped to drain to drop inlets and ultimately to a sump and pump or to daylight. Soil retainers should be used to prevent soil from entering the void beneath the perimeter grade beam. Flexible connections may need to be incorporated into plumbing entering the crawl or void space from potentially swelling subgrade. Further, utility pipe penetrations beneath the slab should be backfilled with flowable fill for a distance of 2 feet beneath the slab, and 4 feet outside the slab to limit groundwater that may enter beneath the slab through pervious pipe bedding stone.

Drilled Shaft Foundations

If drilled shafts are selected as the foundation alternative, shafts should be designed in accordance with the following:

1. Straight drilled shafts should penetrate to a depth of at least 25 ft below existing or final grade, whichever is deeper, to embed the shaft deep enough to resist potential uplift forces due to soil heave in the zone of seasonal moisture change (upper 15 ft).
2. Shafts tipped at least 25 feet below existing or final grade may be designed using an allowable end bearing of 10 ksf (including a factor of safety of 3).
3. An additional component of 0.5 ksf skin friction may be used for that portion of the shaft below the upper 15 ft of embedment. The upper 15 ft is neglected due to shrink/swell potential.

4. The diameter of straight drilled shafts carrying structural column loads should not be less than 24 inches. Shaft reinforcement extending from top to bottom should not be less than 1.5% of the gross area of the shaft. Actual tensile stress in the shaft may be calculated as 75D kips, where D is the shaft diameter, in feet.

5. The following LPILE parameters are recommended for use by the structural engineer for lateral load analyses and drilled shaft design.

Recommended LPILE Parameters					
Depth	**Soil Type (PY curve)**	**γ' (pcf)**	**k (pci)**	**UC (psi)**	**ε_{50} (in/in)**
0 – 10 ft	Neglect	---	---	---	---
10 – 35 ft	Stiff Clay with water	58	1,250	75	0.005
γ' = Effective (buoyant) Unit Weight UC = Undrained Cohesion (clay)			*k* = Soil-Modulus Parameter ε_{50}=strain at 50% of maximum stress		

6. Maintain a minimum clear spacing between drilled shafts of at least three shaft diameters. If the minimum spacing cannot be maintained, the geotechnical engineer should be retained to consider the group effect of the closely spaced shafts.

7. Settlement of individual drilled shafts should be less than one inch. Differential settlement between adjacent drilled shafts designed as recommended herein should not be greater than ½ inch.

Drilled Shaft Construction

Drilled shafts should be installed in accordance with the following:

1. Contract documents should provide for the possible use of temporary casing for proper installation of drilled shafts should detrimental groundwater conditions and/or collapsing soils be encountered. A separate unit price for the use of casing should be identified on the bid tabulation form in the contract documents such that the contractor will be paid for casing only if it is actually used. No more than 2 inches of water should be in the bottom of the shaft excavation prior to the placement of concrete.

2. If casing is used, when it is extracted, the head of the concrete must be maintained at a level well above the bottom of the casing. To facilitate casing extraction, the slump of the concrete and the cleanness of the inside of the casing are critical items that the

contractor must control. The top 10 feet of the shaft concrete should be vibrated following placement.

3. In order to promote shaft-to-soil bonding, drilled-shaft concrete should be specified as a high slump concrete (7- to 8-inch slump, preferably superplasticized), which still has the proper characteristics of normal concrete such as workability, durability, cohesiveness, and strength.
4. To prevent deterioration of the sides and bottoms of shaft excavations, reinforcement and concrete should be placed the same day drilling operations are completed. Before placement, shafts should be inspected to assure bottoms and sidewalls are free of deleterious spall and free water.
5. Centralizing chutes, tremies, and/or concrete pumps may be necessary to prevent the concrete from striking the sides of reinforcement and thus segregating. The desired maximum free fall of concrete should be about 10 ft, but greater heights are allowable if segregation can be eliminated and if the shaft excavation is dry.
6. The drilled shaft operations should be inspected, on a full-time basis, by a qualified representative of the geotechnical engineer to a) verify desired penetration into the bearing stratum, b) verify shaft dimensions and proper reinforcement, c) monitor cleanness of the shaft sidewalls and bottom and amount of water in shaft excavations, d) monitor placement of concrete and use of tremie or pumps, e) monitor the extraction of casing, if used, and f) maintain accurate records.
7. As the design of any foundation relies heavily on generalizations drawn from subsurface conditions determined at a limited number of boring locations, verification of these generalizations at any given location should not be dictated by criteria based on depth or drilling resistance. Instead, the sides and bottoms of shafts should be examined by the geotechnical engineer of record to assure that shaft bottoms bear in the desired stratum.
8. In addition to construction recommendations contained herein, the shafts should be constructed in general accordance with ACI 336.3R, Chapters 4 and 5.

Site Drainage

Grading around the structures should be such that future ponding or standing water around the structures does not occur. All surface drainage measures should be designed to direct water well away from the buildings and pedestrian areas.

Seismic Design

Referring to Section 1613 of the International Building Code (2012), we assign a site classification based on the soil profile encountered in the borings and extrapolated to 100-foot depth as Site Class D.

Seismic design coefficients were determined using the on-line software, Seismic Hazard Curves and Uniform Response Spectra, version 5.1.0, dated February 10, 2011 accessed at (http://earthquake.usgs.gov/designmaps/us/application.php). Analyses were performed considering the 2012 International Building Code. Input included coordinates (30°35'46.24"N, 97°32'32.18"W) and Site Classification D. Seismic design parameters for the site are summarized in the following table.

IBC Site Classification and Seismic Design Parameters				
Site Classification	**Fa**	**Fv**	**Ss**	**S1**
D	1.6	2.4	0.065 g	0.036 g

Where: Fa = Site coefficient
Fv = Site coefficient
Ss = Mapped spectral response acceleration for short periods
S1 = Mapped spectral response acceleration for a 1-second period

ADDITIONAL CONSIDERATIONS

Flatwork Outside Building Footprints

Potential differential movements between the planned structure and abutting flatwork should be expected for flatwork supported on unimproved subgrade soil conditions. Thus, we recommend that undercut (or partial undercut) and select fill replacement be extended to include adjacent movement-sensitive flatwork such as entry sidewalks. Movement-sensitive exterior flatwork should be undercut a minimum of 3 feet and backfilled with select fill meeting the plasticity, gradation and compaction requirements set forth herein. This undercut depth should extend some distance from the building and may be transitioned to depths of 2 and 1 foot. This suggested transition should be in areas where flatwork (sidewalks, pavements, etc.) abut the building and serves as the impervious “cap” over the select fill pad beneath the building.

The flatwork and abutting sidewalks should be designed and constructed to allow for positive drainage to be maintained away from the building foundation. The planned site grading should allow for potential future differential movements, and should never be allowed to reach a level condition or negative slope that promotes drainage toward the foundation. This reversal in drainage can direct moisture into the building envelope and can become a constant nuisance and maintenance issue.

Measures to Reduce Changes in Soil Moisture

The following measures are suggested to reduce potential soil moisture fluctuations beneath flatwork and pavements in close proximity to the building footprint. These measures will also serve to reduce potential water migration into the select fill pad beneath the building (in addition to the clay cap recommended in the Potential Vertical Rise section of this report). These concepts should be taken into account for design and construction of a grade-supported slabs outside the building footprint:

- Roof drainage should be controlled by gutters and carried well away from the structure.
- Hose bibs, sprinkler heads, and other external water connections should be placed well away from the movement sensitive ancillary structures such that surface leakage cannot readily infiltrate into the subsurface or compacted fills placed beneath slabs.
- No trees or other vegetation over 6 feet in height should be planted within 15 feet of the structure unless specifically accounted for in the foundation design.
- Utility bedding should not include gravel within 4 feet of 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 equilibrium within the soil water content. If possible, pavement and sidewalks should be located immediately adjacent to the building.
- Flower beds and planter boxes should be piped, or should be 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.
- Site work excavations should be protected and backfilled without delay to reduce changes in soil moisture.
- Utilities which penetrate the building should be designed with some flexibility to allow free movement in the lines as a result of potential soil shrinkage or swelling.
- Flatwork supported on unimproved, natural soil conditions could result in differential movement. We recommend that flatwork include details that limit these potential

differential movements without resulting in vertical separations. Control joints should include reinforcing steel to prevent joint displacement.

OTHER FACILITIES

Screen Wall

As previously mentioned, the county plans to replace the partially failing CMU Screen Wall that runs parallel to Chandler Road along the front of the existing facility. It is our understanding that this existing wall was constructed after 2009 and consists of CMU wall blocks founded on a shallow spread footing of unknown depth, width and reinforcement. Inspection of the failed section indicates that there is little reinforcement extending from the footing into the wall and that there does not appear to be adequate vertical reinforcement and grout within vertical CMU cells. We assume that the new wall will be close in proximity to the existing wall.

Soil conditions along the existing wall, and presumably the future wall, may be understood by review of borings W-2, W-3 and W-4. The Plasticity Index (PI) in these borings ranges from 55 to 65 with an average of 61. The surficial moisture contents in these borings ranges from 31 to 39 with an average over 35. These high moisture contents correlate well with the relatively low undrained shear strength of about 1 to 2 ksf.

Support of the wall loads may be achieved by means of a shallow continuous spread footing or by a deep foundation system with drilled shafts and grade beams. Significant foundation movement should be anticipated if the shallow continuous foundation is considered. The shallow continuous footing may be designed using an allowable net bearing pressure of 1500 psf, assuming a depth of 2 ft and a minimum width of 2 ½ ft. As stated, because of the high PI of subgrade soils, there is potential for vertical shrink swell movement of the shallow foundation system. We estimate the potential vertical rise (PVR) to be about 4.5 inches if the foundation were to be placed at a depth of 2 ft below grade. If the foundation is over-excavated to 4 ft and placed on 2 ft of compacted select fill, the PVR would be reduced to about 3.2 inches. If over-excavated to 6 ft and founded on 4 ft of compacted select fill, the PVR would be reduced to about 2 inches. Reducing the PVR of a spread footing to the desired 1 inch total and ½ inch differential would require over-excavation to about 8 ft and seems impractical. If this approach is used, the select fill should be extended beyond the footing width by at least 1 ft on both sides. Select fill selection and placement criteria are presented in the “Preparation of the Building Pad” section on page 8 of this report.

To resist lateral loads, the shallow foundation system will develop friction along the base of the footing. This ultimate force (un-factored) may be estimated using a sliding coefficient of

friction of 0.55 if the footing is in contact with compacted select fill, and 0.37 if in contact with natural clay subgrade.

For the shallow foundation alternative, the amount of excavation and select fill necessary to limit PVR to 2 inches is significant, and to reduce it to 1 inch seems excessive. Performance expectations of a shallow foundation system could be compromised in an effort to offset cost of construction. Alternatively, use of a drilled shaft and grade beam system could be considered. Drilled shafts for this application should extend to a depth of at least 20 ft and may be sized on the basis of an allowable net end bearing of 7 ksf, and a skin friction of 500 psf for that portion of the shaft deeper than 15 ft. Lateral load design parameters and other design and construction recommendations are provided in the previous Drilled Shaft Design and Construction sections of this report.

Water Line

An off-site water line runs parallel to Chandler Road near borings W-1 through W-6. Subsurface conditions are similar to those discussed previously for other portions of this facility. Size of water line and depth of burial are unknown at the time of this report. Excavation conditions in this area should be achieved with a medium-sized excavator, depending on depth and diameter. No rock will be encountered in excavations less than 25 ft deep. Groundwater should be anticipated in these CH and CL clay soils in excavations deeper than about 5 ft. If dry, these soils would classify as Type B according to OSHA 29 CFR Part 1926, but because of the groundwater, they will classify as Type C.

Detention Pond

A stormwater detention pond is planned at the west end of the proposed development. We understand that the pond will be roughly 3 or 4 ft deep and will have a concrete outlet structure which can only tolerate 2 inches of total PVR and 1 inch differential PVR. Borings W-5 and W-6 were drilled in the vicinity of the detention pond and outlet structure. Soil conditions consist of dark brown to grayish brown, stiff to very stiff CH clay soil.

The design of the detention pond is in the preliminary stages. The following sections present geotechnical recommends for site preparation earthwork, construction of embankments, permanent slope configurations, and foundations for outlet structure.

Stripping and Surface Preparation. The ground surface within the pond footprint, particularly beneath the proposed embankments, will require preparation prior to the start of construction. All trees, stumps, roots, brush and surficial soils should be grubbed and removed from the embankment areas.

Embankments and Cut Slopes. Based on the subgrade conditions encountered at the site, measured plasticity indices and anticipated embankment construction, slope configurations of 4H to 1V or flatter are typically adequate with regard to slope stability, provided the embankment materials and construction are carried out as recommended herein. Slopes of this configuration will avoid any slope instability issues.

Embankment Materials. All material used for embankment construction should be non-dispersive, and should be free of organic material (trees, stumps and roots), debris, or other deleterious matter and should be processed before placement on the embankment so it is reasonably uniform in composition and moisture content. On site materials with a maximum particle size of 3 inches may be used for embankment construction. The surficial topsoil containing organic materials should be stripped, stockpiled and used to promote vegetative slope protection for the outer slope faces of the embankment.

Slope Protection. In areas of proposed earthwork, the surficial 6 to 8 inches of dark brown surficial soils containing organic materials should be removed from within the pond footprint and borrow areas. This material may be stockpiled and used to promote vegetative slope protection for the embankments and regraded pond slopes.

All permanent slope faces should be protected from erosion by placement of at least 8 inches of topsoil with vegetative cover. Alternate slope protection systems such as concrete lining, stone riprap, or erosion-control geotextiles, should be considered in critical areas depending on water velocities and design aesthetics. Embankment slopes protected by vegetation should be periodically inspected and repaired if necessary. Some minor, shallow sloughing and gullying should be expected and planned for in the owner's maintenance budget.

Outlet Structure Foundation Recommendations. The following is recommended for foundations of proposed outlet structures.

1. To achieve a Total PVR of 2 inches, the foundations supporting the outlet structure will need to be over-excavated 6 ft and the excavation backfilled to a depth of 2 ft below grade with compacted select fill selected and compacted as previously recommended for select pad fill. Footings should be founded at least 24 inches below final grade and bear on the compacted select fill pad.
2. Footings may be sized for an allowable bearing pressure of 2,500 psf.
3. Horizontal loads acting on the foundations will be resisted by friction between the foundation material and the base of the foundation. For design purposes, the resistance due to passive soil pressure in front of the footing should be neglected due to potential shrinkage of the soil away from the foundation. For concrete foundations

poured in good contact with the compacted select fill an allowable coefficient of friction of 0.55 may be used for sliding resistance. Another alternative for increasing the sliding resistance is by installing a shear key. Passive resistance at the shear key located beneath the footing may be sized using an allowable equivalent fluid pressure of 300 pcf.

4. Any concrete slabs intended to serve as an overflow weir over constructed embankments should include upstream and downstream turn-downs at least 18 inches below grade, and open-graded gravel such as ASTM C33 No. 57 stone and filter fabric beneath the overflow slab.

Lateral Earth Pressures. Lateral pressures transmitted to the overflow weir wing walls can be evaluated by using the equivalent fluid density (EFD) values given in the following tables for "active" and "at-rest" conditions, respectively. Where there is sufficient wall movement, deflection, and/or rotation, the walls can be designed for the "active" condition. However, when rigid walls are restricted from moving, the walls should be designed for the "at-rest" condition.

The "EFD - undrained condition" should be used if there is a chance for hydrostatic forces to develop and a drainage system is not provided behind the walls; otherwise, the "EFD – drained condition values" can be used. If free-draining backfill is provided behind the walls, we recommend that a positive slope grade coupled with pavement or the use of a clay cap, be provided to help reduce the chances for surface water infiltration behind the walls.

Surcharge loads including equipment loads, traffic, and soil stockpiles should also be considered in the analysis of below-grade walls. Use a coefficient of horizontal earth pressure of 0.50 for any uniform surcharge on the backfill adjacent to the wall.

Lateral "Active" Pressures for Below-Grade Walls

Backfill Type	Estimated Total Soil Unit Weight, (pcf)	Effective Soil Unit Weight, (pcf)	Active Earth Pressure Coefficient, (k_a)	Equivalent Fluid Density (EFD)	
				Drained Condition, (pcf)	Undrained Condition, (pcf)
On-site Soils	120	58	0.45	55	95
Open-Graded Gravel (ASTM C33 No.57 or 67)	105	43	0.30	35	75
TxDOT Item 247, Type A, Grade 3, or Select Fill	125	63	0.33	45	85

Lateral "At-Rest" Pressures for Below-Grade Walls

Backfilll Type	Estimated Total Soil Unit Weight, (pcf)	Effective Soil Unit Weight, (pcf)	At-Rest Earth Pressure Coefficient, (k_o)	Equivalent Fluid Density (EFD)	
				Drained Condition, (pcf)	Undrained Condition, (pcf)
On-site Soils	120	58	0.62	75	105
Open-Graded Gravel (ASTM C33 No.57 or 67)	105	43	0.45	50	80
TxDOT Item 247, Type A, Grade 3, or Select Fill	125	63	0.50	65	95

The equivalent fluid unit density (EFD) values are for triangular distribution of lateral earth pressures on the wall; surcharge loads impose a rectangular stress distribution. Heavy compaction rollers should operate no closer than 5 feet from the wall. Hand operated compaction equipment, such as vibratory plates, should be used directly behind the wall.

Fill Placement and Compaction. Soils to be used in embankment should be constructed in lifts such that all lifts are bonded together, the specific densities are met throughout each lift, the moisture content is uniform throughout the fill, and clods are broken down and bonded into the rest of the lift without nesting and voids. The embankment material should be compacted to at least 95 percent of the maximum dry density as determined by TEX-114-E compaction test. Hold moisture contents to within -1 to +3% of optimum and compacted lift thicknesses to 6 inches. Borrow soils more than 3 percent dry of optimum should be prewetted in the borrow area, and should not be placed on the fill until their moisture contents have equilibrated.

PAVEMENT DESIGN PARAMETERS

New pavement drives and parking areas are planned as part of the facility improvements. At this time, we understand pavement thicknesses with be designed by others. Accordingly, below is a summary of pertinent geotechnical data from the pavement borings.

Pavement Data Summary	
Borings	P-12 through P-17
Water Contents, %	17 to 33 (average 28)
Liquid Limits, %	30 to 72 (average 55)
Plasticity Indices, %	13 to 48 (average 34)
Minus No. 200, %	84 to 93 (average 89)
Soluble Sulfates, ppm	160 to 200 (average 180)

It should be noted by the pavement designer that without significant undercut and replacement of the highly plastic CH clay soils, the pavement structure will be subject to shrink/swell behavior that could result in pavement cracking and/or undulations which may impact surface drainage. Careful consideration should be given to methods to maintain a constant soil moisture content beneath the pavements to help mitigate these expansion problems. This may be achieved with edge barriers, frequent crack repair/fill maintenance program, and rapid placement of soil and flatwork around pavements, to name a few.

Pavement Drainage and Groundwater Control

It should be noted that control of surface drainage and groundwater is important to the performance and life of pavements. Infiltration of water into the pavement subgrade and pavement structure will result in premature loss of serviceability. Adequate drainage provisions should be included in the pavement design. Additionally, the placement of curbs, islands and irrigation systems should be carefully planned in a manner that will not lead to ponding and saturation of pavement base materials that extend into island areas.

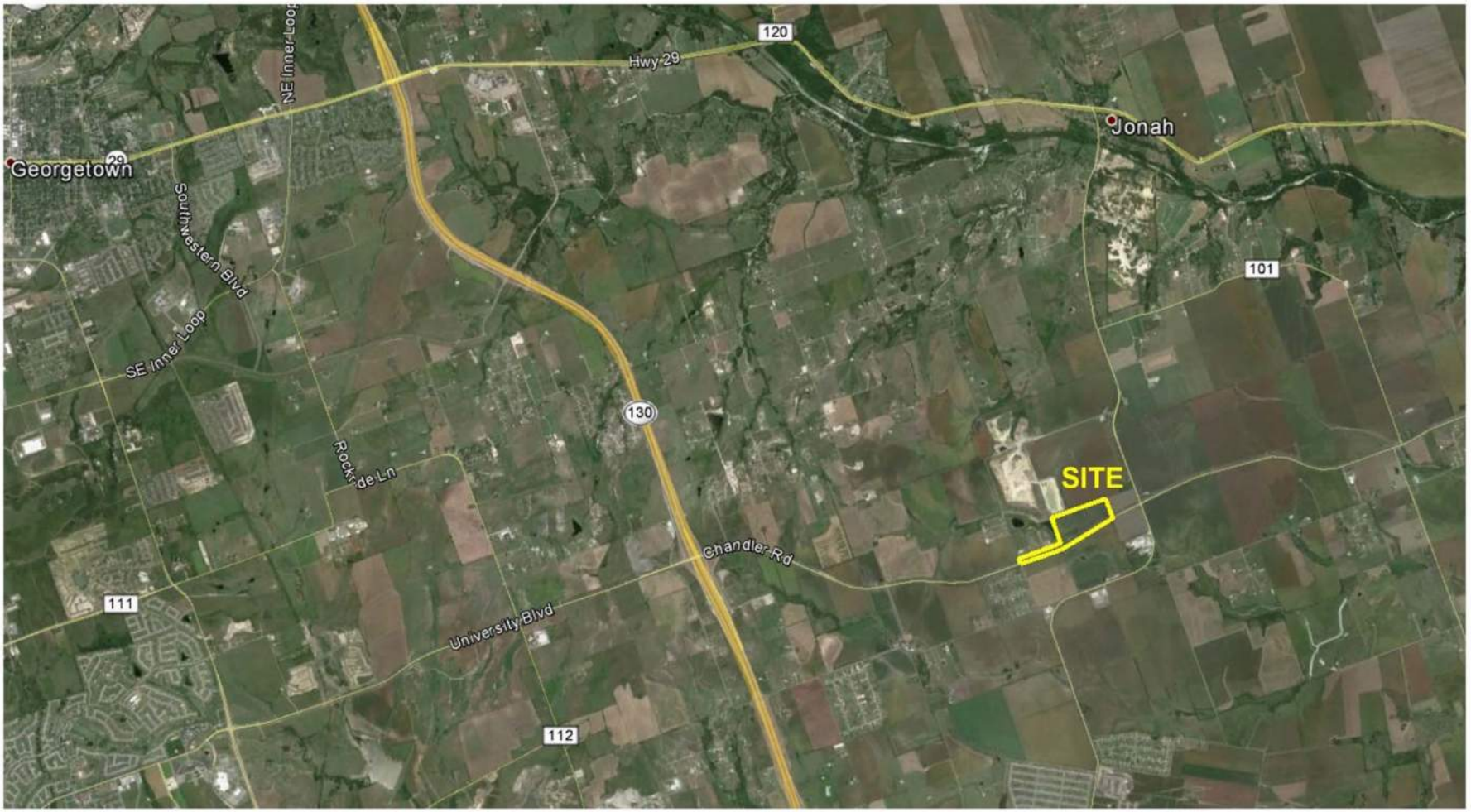
CONDITIONS

Since some variation was found in subsurface conditions at boring locations, all parties involved should take notice that even more variation may be encountered between boring locations. Statements in the report as to subsurface variation over given areas are intended only as estimations from the data obtained at specific boring locations.

The professional services that form the basis for this report have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in the same locality. No other warranty, expressed or implied, is made as the professional advice set forth. The results contained in this report are directed at, and intended to be utilized within, the scope of work contained in the agreement executed by Balcones Geotechnical, PLLC and client. This report is not intended to be used for any other purposes.

* * *

FIGURES

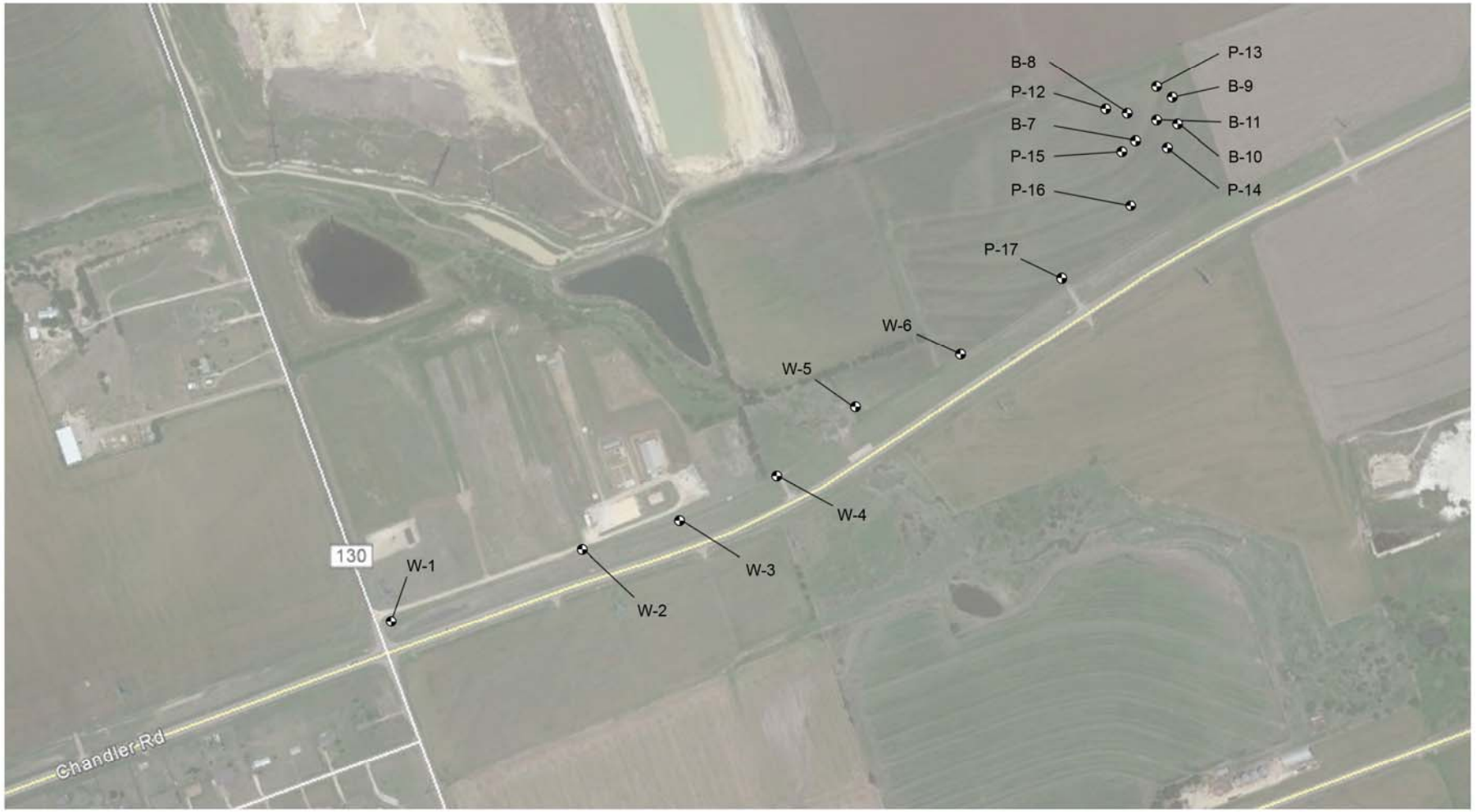


VICINITY MAP

Williamson County Sheriff's Office Training Center
Williamson County, TX

Balcones Geotechnical
Austin, TX 78731
512.451.8600

Plate 1



PLAN OF BORINGS

Williamson County Sheriff's Office Training Center
Williamson County, TX

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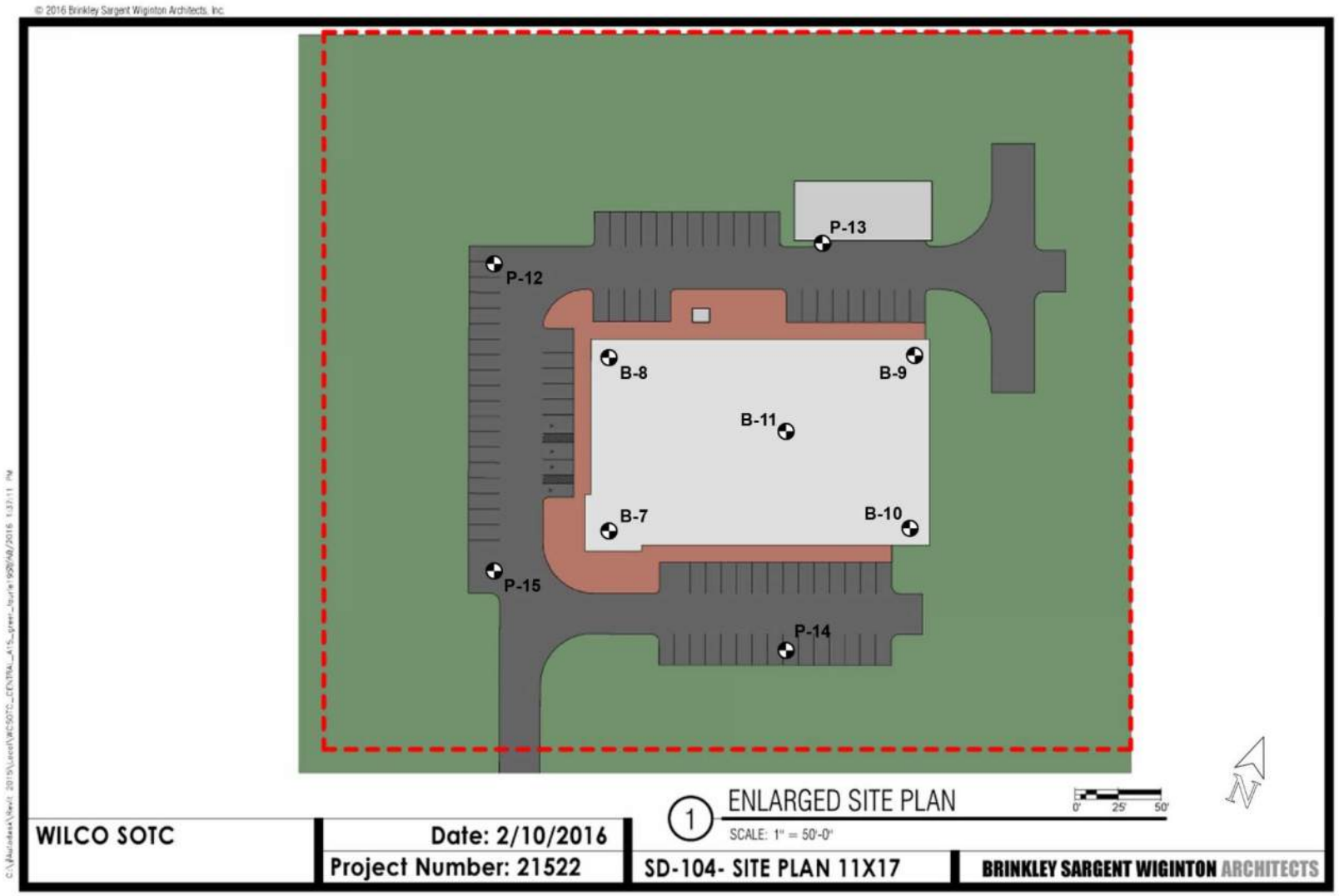
512.451.8600

Plate 2a



SITE PLAN

Williamson County Sheriff's Office Training Center
Williamson County, TX

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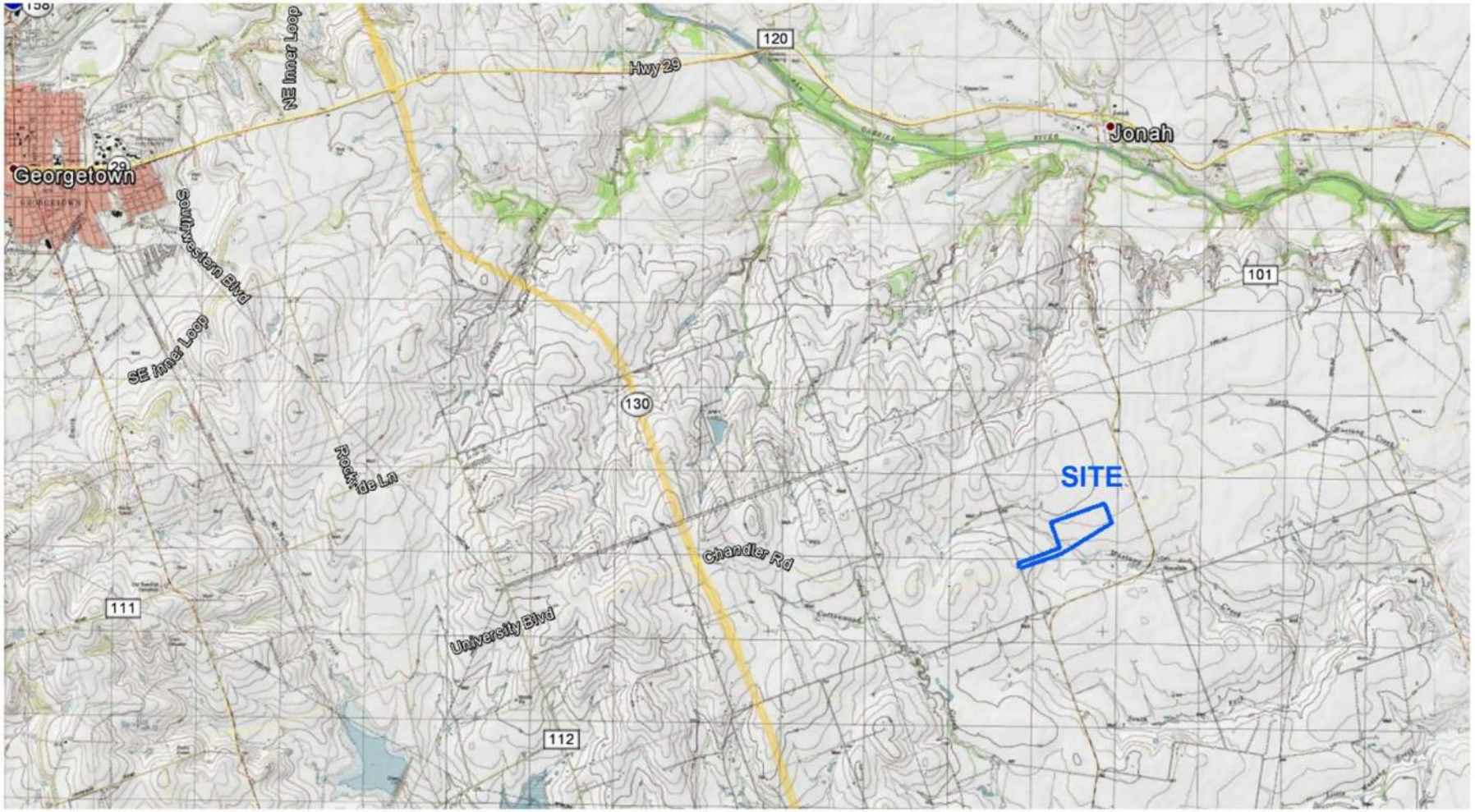
Austin, TX 78731
512.451.8600

Plate 2b



USGS TOPOGRAPHIC MAP

Williamson County Sheriff's Office Training Center
Williamson County, TX

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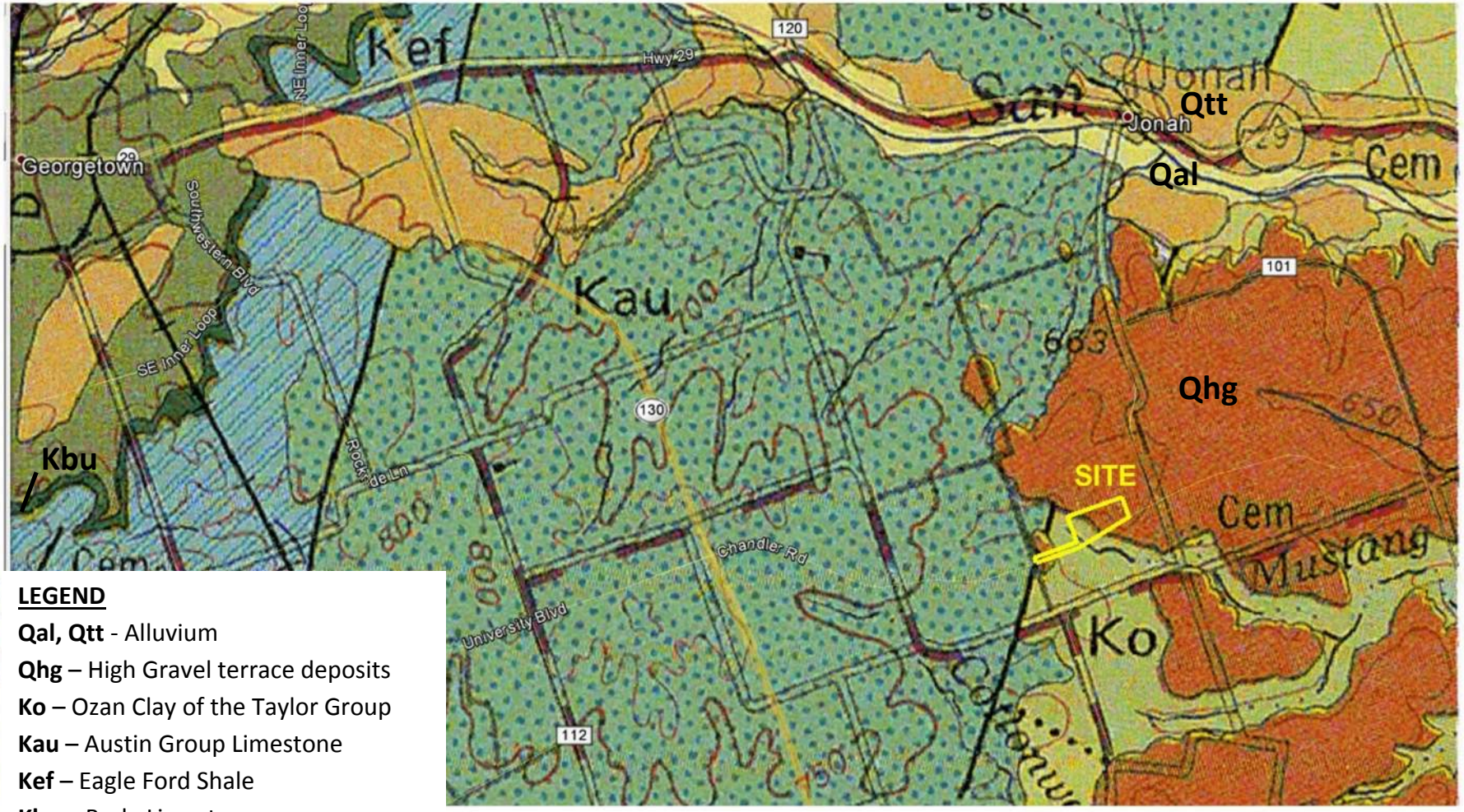
Plate 3



LEGEND

Qal, Qtt - Alluvium
Qhg – High Gravel terrace deposits
Ko – Ozan Clay of the Taylor Group
Kau – Austin Group Limestone
Kef – Eagle Ford Shale
Kbu – Buda Limestone

Source: Geologic Atlas of Texas, Austin Sheet, 1981

GEOLOGIC MAP

Williamson County Sheriff's Office Training Center
Williamson County, TX

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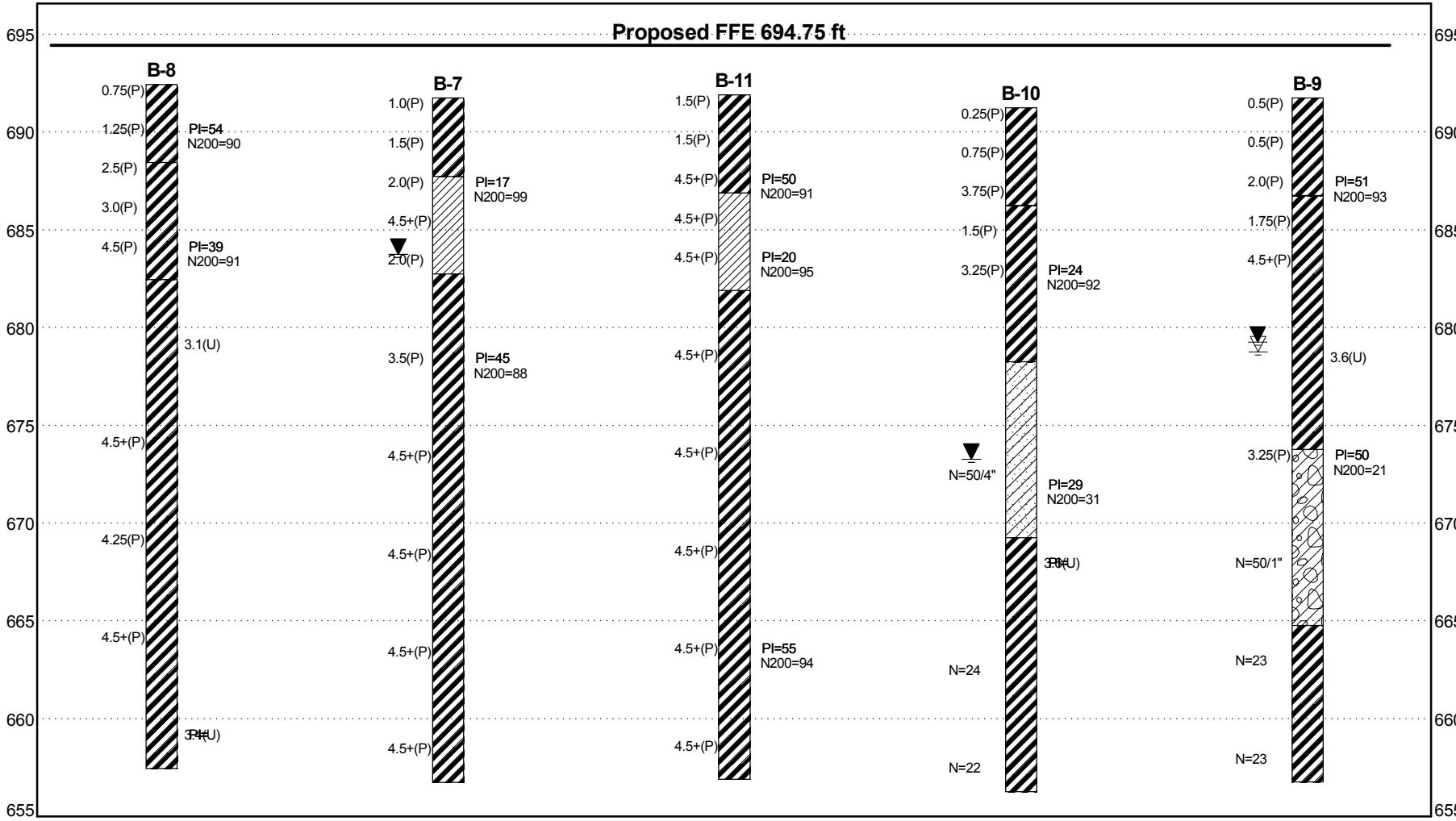
Plate 4

APPENDIX A



Balcones Geotechnical

Sheriff's Office Training Center

Williamson County, Texas

GENERALIZED SUBSURFACE PROFILE

Project No. 0115-041

PLATE 1

SIMPLE FENCE BG 0115-041 SOTC.GPJ 0115-036 NORTH CAMPUS2.GPJ 03/24/16 18:46

LOG OF BORING NO. B-7

LATTITUDE: 30.596179
LONGITUDE: -97.542273

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 691.7 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								1.0(P)
												1.5(P)
					687.7							
5				Tan LEAN CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CL	4.0	18	31	17	100	99		2.0(P)
												4.5+(P)
					682.7							2.0(P)
10				Reddish tan and gray FAT CLAY, stiff to hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	9.0							
						20	65	45	100	88		3.5(P)
15												
												4.5+(P)
20												
												4.5+(P)
25												
						13						4.5+(P)
30												
												4.5+(P)
					656.7							
35				NOTES:	35.0							
				1. Boring was advanced dry to the 35-ft depth and groundwater was encountered at the 8-ft depth.								
				2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								

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COMPLETION DEPTH: 35.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE: 8.0
UPON COMPLETION: 8.0

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 2

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. B-8

LATTITUDE: 30.596492
LONGITUDE: -97.542382

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 692.5 FT								
				Dark brown FAT CLAY, firm, w/calcareous nodules and sand. CH								0.75(P)
						28	75	54	98	90		1.25(P)
					688.5							
				Reddisn tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	4.0							2.5(P)
5												
												3.0(P)
						16	54	39	100	91		4.5(P)
					682.5							
10				Reddish tan and gray FAT CLAY, hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	10.0							
						16					115	3.1(U)
15												
												4.5+(P)
20												
												4.25(P)
25												
												4.5+(P)
30												
						26					98	3.4(U)
					657.5							
35				NOTES:	35.0							
				1. Boring was advanced dry to the 35-ft depth and groundwater was not encountered.								
				2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								

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COMPLETION DEPTH: 35.0
DATE DRILLED: 1-22-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 3

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. B-9

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

LATTITUDE: 30.596673
LONGITUDE: -97.541794

SURF. ELEVATION: 691.8 FT

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				Dark brown FAT CLAY, firm, w/calcareous nodules and sand. CH								0.5(P)
												0.5(P)
				- grayish brown from 4 to 5 ft	686.8	30	75	51	100	93		2.0(P)
5				Reddisn tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	5.0							1.75(P)
						14						4.5+(P)
10												
						19					119	3.6(U)
15												
					673.8							
				Reddish tan CLAYEY GRAVEL with SAND, medium dense to very dense, calcaerous, wet, w/cemented layers. GC	18.0		69	50	49	21		3.25(P)
20												
			N=50/1"	*- cemented from 23 to 27 ft*								
25					664.8							
				Reddish tan and gray FAT CLAY, hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	27.0							
			N=23									
30												
			N=23									
35					656.8							
				NOTES: 1. Boring was advanced dry to the 35-ft depth and groundwater was encountered at the 13-ft depth. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.	35.0							

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COMPLETION DEPTH: 35.0
DATE DRILLED: 1-22-16
WATER LEVEL / SEEPAGE: 13.0
UPON COMPLETION: 12.5

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 4

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. B-10

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

LATTITUDE: 30.596372
LONGITUDE: -97.541715

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 691.3 FT								
				Dark brown FAT CLAY, firm, w/calcareous nodules and sand. CH								0.25(P)
												0.75(P)
				- grayish brown from 4 to 5 ft	686.3							3.75(P)
5				Reddisn tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	5.0							
												1.5(P)
				- calcareous LEAN CLAY at 8 ft		17	38	24	100	92		3.25(P)
10												
					678.3							
				Reddish tan CLAYEY SAND with GRAVEL, medium dense to very dense, calcaerous, wet, w/cemented layers. SC	13.0							
15												
			N=50/4"	*- gravel from 18 to 22 ft*		10	43	29	67	31		
20												
					669.3							
				Reddish tan and gray FAT CLAY, hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	22.0	23					101	3.6(U)
25												
			N=24	*- samples wet below 28 ft*								
30												
			N=22									
35					656.3							
				NOTES: 1. Boring was advanced dry to the 35-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.	35.0							

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COMPLETION DEPTH: 35.0
DATE DRILLED: 1-21-16
WATER LEVEL / SEEPAGE: 18.0
UPON COMPLETION: 18.0

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 5

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. B-11

LATTITUDE: 30.596415
LONGITUDE: -97.541993

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 691.9 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								1.5(P)
												1.5(P)
				- grayish tan from 4 to 5 ft	686.9	31	74	50	96	91		4.5+(P)
5				Tan LEAN CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CL	5.0							
												4.5+(P)
						12	33	20	100	95		4.5+(P)
					681.9							
10				Reddish tan and gray FAT CLAY, hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	10.0							
												4.5+(P)
15												
												4.5+(P)
20												
												4.5+(P)
25												
						22	81	55	99	94		4.5+(P)
30												
												4.5+(P)
					656.9							
35				NOTES:	35.0							
				1. Boring was advanced dry to the 35-ft depth and groundwater was encountered at the 8-ft depth.								
				2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								

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COMPLETION DEPTH: 35.0
DATE DRILLED: 1-22-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 6

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. P-12

LATTITUDE: 30.596542
LONGITUDE: -97.542674

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 692.6 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								1.5(P)
				Soluble sulfates=180 ppm at 2 ft		30	72	48	100	91		1.5(P)
					688.6							
				Reddish tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	4.0							4.5+(P)
5												4.5+(P)
												4.5+(P)
					682.6							
10					10.0							
				NOTES: 1. Boring was advanced dry to the 10-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.							
15												
20												
25												
30												
35												

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COMPLETION DEPTH: 10.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 7

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. P-13

LATTITUDE: 30.596796
LONGITUDE: -97.541995

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 692.2 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								1.5(P)
												1.5(P)
					688.2							
				Reddish tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	4.0	28	72	48	99	93		3.0(P)
5				**Soluble sulfates=160 ppm at 4 ft**								
												4.5+(P)
												4.5+(P)
					682.2							
10					10.0							
				NOTES: 1. Boring was advanced dry to the 10-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								
15												
20												
25												
30												
35												

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COMPLETION DEPTH: 10.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 8

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. P-14

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

LATTITUDE: 30.596098
LONGITUDE: -97.541856

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 691.2 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								1.5(P)
												2.0(P)
5				*- grayish brown from 4 to 6 ft*								1.5(P)
					685.2							
				Reddish tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	6.0	33	30	16	100	89		4.5+(P)
				Soluble sulfates=200 ppm at 6 ft								4.5+(P)
10					681.2							
					10.0							
				NOTES: 1. Boring was advanced dry to the 10-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								
15												
20												
25												
30												
35												

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COMPLETION DEPTH: 10.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 9

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. P-15

LATTITUDE: 30.596049
LONGITUDE: -97.542454

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

SURF. ELEVATION: 692.0 FT

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								1.5(P)
												2.0(P)
					688.0							
				Reddish tan LEAN CLAY with SAND, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CL	4.0	17	30	13	95	84		1.0(P)
5				**Soluble sulfates=180 ppm at 4 ft**								
												4.5+(P)
												2.5(P)
					682.0							
10					10.0							
				NOTES: 1. Boring was advanced dry to the 10-ft depth and groundwater was encountered at the 6.5-ft depth. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								
15												
20												
25												
30												
35												

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COMPLETION DEPTH: 10.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE: 6.5
UPON COMPLETION: 6.5

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 10

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. P-16

LATTITUDE: 30.595439
LONGITUDE: -97.542347

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 690.0 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								0.5(P)
				Soluble sulfates=180 ppm at 2 ft		31	72	44	95	84		2.0(P)
				- grayish brown from 4 to 6 ft								1.5(P)
5					684.0							
				Grayish tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	6.0							2.0(P)
												2.5(P)
10					680.0							
				NOTES: 1. Boring was advanced dry to the 10-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.	10.0							
15												
20												
25												
30												
35												

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COMPLETION DEPTH: 10.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 11

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. P-17

LATTITUDE: 30.594604
LONGITUDE: -97.543237

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 687.2 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and sand. CH								1.25(P)
				- large gravel at 2 ft								1.25(P)
				- grayish brown from 4 to 7 ft								1.0(P)
5												
					680.2							1.5(P)
				Reddish tan FAT CLAY, very stiff to hard, calcareous, w/silt and sand partings, calcareous pockets, and ferrous staining. CH	7.0							
												2.5(P)
10					677.2							
					10.0							
				NOTES: 1. Boring was advanced dry to the 10-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								
15												
20												
25												
30												
35												

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COMPLETION DEPTH: 10.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 12

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. W-1

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

LATTITUDE: 30.590698
LONGITUDE: -97.552135

SURF. ELEVATION: 705.6 FT

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				Dark brown FAT CLAY, very stiff, w/calcarous nodules and scattered organics. CH								1.0(P)
												2.0(P)
					701.6							
				Tan LEAN CLAY, hard, calcareous, w/sand and silt partings, and ferrous staining. CL	4.0	18	30	14	100	97		4.5+(P)
5				*- sample moist at 4.5 ft*								
												4.5+(P)
												4.5+(P)
10												
												4.5+(P)
					690.6							
15				Tan FAT CLAY, hard, calcareous, w/silt and sand partings, and ferrous staining. CH	15.0							
			N=50	*- sample wet at 18.5 ft*								
20												
			N=50									
					680.6							
25				NOTES:	25.0							
				1. Boring was advanced dry to the 25-ft depth and groundwater was encountered at the 4-ft depth.								
				2. Boring was backfilled with a mixture of auger cuttings and bentonite pellets.								
30												
35												

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COMPLETION DEPTH: 25.0
DATE DRILLED: 1-21-16
WATER LEVEL / SEEPAGE: 4.0
UPON COMPLETION: 4.0

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 13

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. W-2

LATTITUDE: 30.591504
LONGITUDE: -97.549571

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 692.8 FT								
				Dark brown FAT CLAY, stiff, w/calcareous nodules and pockets, sand and gravel. CH								1.0(P)
					690.3							
					2.5	31					95	1.9(U)
				Reddish tan and gray FAT CLAY, very stiff to hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH								
												1.75(P)
5												
						33	87	62	100	99		2.0(P)
												2.5(P)
10												
												4.5+(P)
15												
												4.5+(P)
20												
												4.5+(P)
25					667.8							
					25.0							
				NOTES: 1. Boring was advanced dry to the 25-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.								
30												
35												

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COMPLETION DEPTH: 25.0
DATE DRILLED: 1-18-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 14

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. W-3

LATTITUDE: 30.591847
LONGITUDE: -97.548307

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 683.8 FT								
				Dark brown to grayish brown FAT CLAY, stiff, w/calcareous nodules and pockets, sand and gravel. CH								1.0(P)
												1.25(P)
					679.8							
5				Reddish tan and gray FAT CLAY, very stiff to hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	4.0	36	90	65	100	94		1.25(P)
												2.25(P)
												3.0(P)
10												
												4.0(P)
15												
												4.5+(P)
20												
												4.5+(P)
					658.8							
25				NOTES: 1. Boring was advanced dry to the 25-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.	25.0							
30												
35												

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COMPLETION DEPTH: 25.0
DATE DRILLED: 1-18-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 15

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. W-4

LATTITUDE: 30.592347
LONGITUDE: -97.547019

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 678.6 FT								
				Grayish tan and brown FAT CLAY, stiff, w/sand and gravel. CH	676.6							1.0(P)
				Dark brown to grayish brown FAT CLAY, stiff, w/calcareous nodules and pockets, sand and gravel. CH	2.0	39	82	55	100	96	82	1.3(U)
						38						1.75(P)
5												
												2.5(P)
				- with large gravel and cobbles at 8 ft	670.6							
				Reddish tan and gray FAT CLAY, very stiff to hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	8.0							1.75(P)
10												
												4.5+(P)
15												
												4.5+(P)
20												
												2.25(P)
25					653.6							
				NOTES: 1. Boring was advanced dry to the 25-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.	25.0							
30												
35												

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COMPLETION DEPTH: 25.0
DATE DRILLED: 1-18-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 16

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. W-5

LATTITUDE: 30.593136
LONGITUDE: -97.545975

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 674.3 FT								
				Dark brown to grayish brown FAT CLAY, stiff, w/calcareous nodules and pockets, sand and gravel. CH		29	66	45	100	93		1.0(P)
												2.5(P)
												1.5(P)
5					668.3							
				Grayish tan FAT CLAY, stiff, w/calcareous pockets and nodules, ferrous staining. CH	6.0							1.5(P)
												1.5(P)
10					661.3							
				Reddish tan and gray FAT CLAY, very stiff to hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	13.0							3.0(P)
15												
												4.5+(P)
20												
												4.5+(P)
25					649.3							
				NOTES: 1. Boring was advanced dry to the 25-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.	25.0							
30												
35												

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COMPLETION DEPTH: 25.0
DATE DRILLED: 1-23-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 17

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

LOG OF BORING NO. W-6

LATTITUDE: 30.593717
LONGITUDE: -97.544573

Sheriff's Office Training Center
Williamson County, Texas
PROJECT NO. 0115-041

SURF. ELEVATION: 678.4 FT

DEPTH, FT	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO.4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
	Reddish brown FAT CLAY, stiff, w/calcareous nodules and gravel. CH	676.4							2.0(P)
	Dark brown to grayish brown FAT CLAY, stiff, w/calcareous nodules and pockets, sand and gravel. CH	2.0	34	89	65	100	98	85	
		674.4							
5	Grayish tan FAT CLAY, stiff, w/calcareous pockets and nodules, ferrous staining. CH	4.0							4.5+(P)
									3.75(P)
									3.25(P)
10		668.4							
	Reddish tan and gray FAT CLAY, very stiff to hard, blocky, w/calcareous pockets, ferrous staining, and silt partings. CH	10.0							4.5+(P)
15									
									4.5+(P)
20									
									4.5+(P)
25		653.4							
	NOTES: 1. Boring was advanced dry to the 25-ft depth and groundwater was not encountered. 2. Boring was backfilled with a mixture of auger cuttings and bentonte pellets.	25.0							
30									
35									

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COMPLETION DEPTH: 25.0
DATE DRILLED: 1-18-16
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)

Plate 18

BALCONES_STD_N AND P 0115-041 SOTC.GPJ 0115-041 SOTC.GPJ 03/24/16 18:18

TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

SOIL TYPES

CLAY (CH)

SHALY CLAY (CH)

CLAY (CL)

SANDY CLAY (CL)

Well-Graded **SAND (SW)**

Poorly-Graded **SAND (SP)**

SILTY SAND (SM)

CLAYEY SAND (SC)

Well-Graded **GRAVEL (GW)**

Poorly-Graded **GRAVEL (GP)**

SILTY GRAVEL (GM)

FILL Material

SOIL GRAIN SIZE

U.S.STANDARD SIEVE

12"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

304	76.2	19.1	4.76	2.00	0.420	0.074	0.002

SOIL GRAIN SIZE IN MILIMETERS

STRENGTH OF COHESIVE SOILS (2)

CONSISTENCY	UNDRAINED COMPRESSIVE STRENGTH Tons Per Sq. Ft.
Very Soft	Less Than 0.25
Soft	0.25 to 0.50
Firm	0.5 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

DENSITY OF GRANULAR SOILS (2)

NUMBER OF BLOWS PER FT., N	RELATIVE DENSITY
0-4	Very Loose
4-10	Loose
10-30	Medium
30-50	Dense
Over 50	Very Dense

DESCRIPTIVE TERMS FOR SOIL (1)

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick.
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusions of small pockets of different soils.

MOISTURE

Dry	No water evident in sample; fines less than plastic limit.
Moist	Sample feels damp; fines near the plastic limit
Very Moist	Water visible on sample; fines greater plastic limit and less than liquid limit
Wet	Sample bears free water; fines greater than liquid limit.

INCLUSIONS (1)

Parting	Inclusion <1/8" thick extending through sample
Seam	Inclusion 1/8" to 3" thick extending through sample.
Layer	Inclusion >3" thick extending through sample.
Trace	<5% of sample.
Few	5% to 10% of sample.
Little	15 to 25% of sample.
With	15% to 29% of sample.

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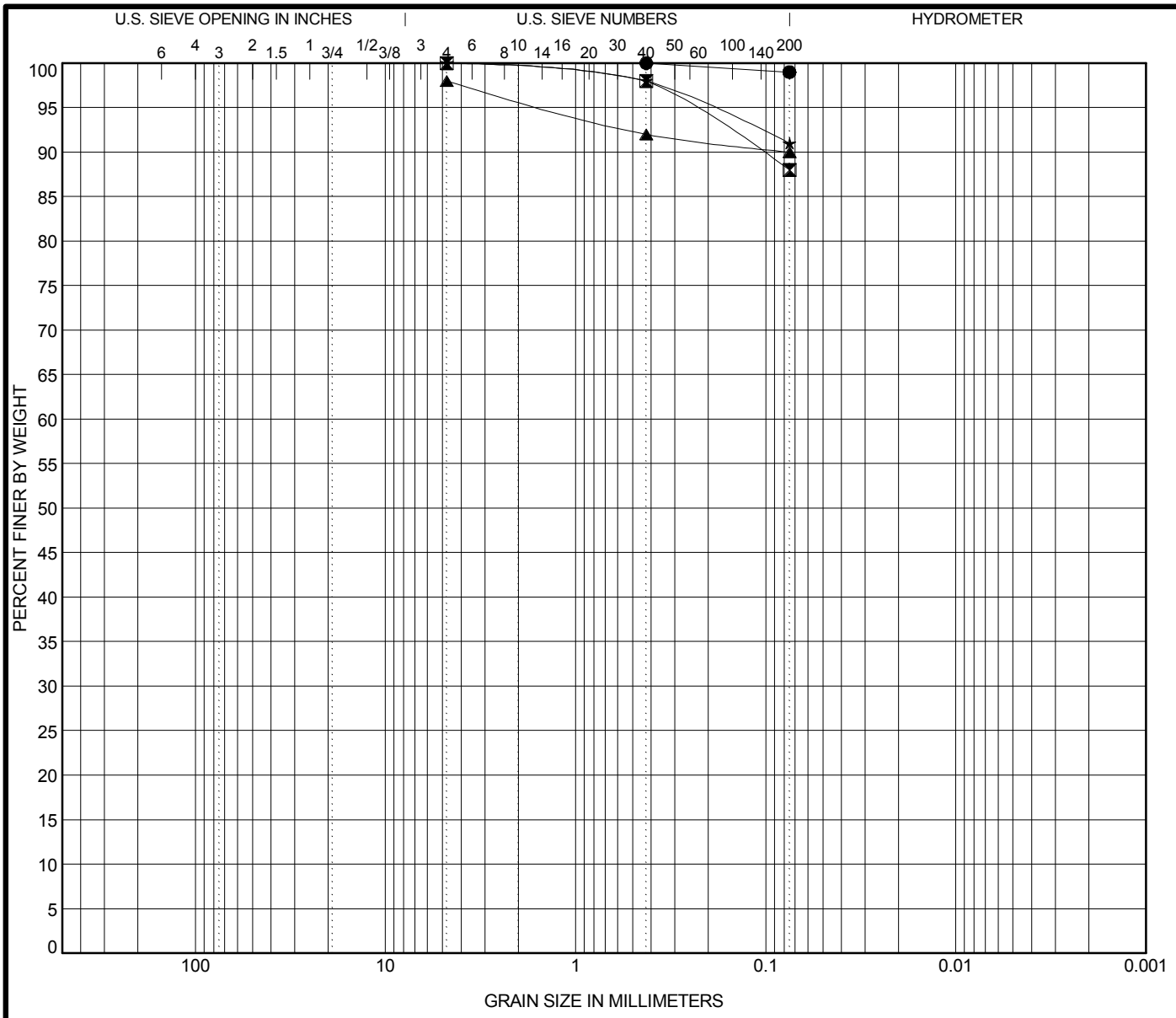
NOTE: Information on each boring log is a compilation of subsurface conditions and soil and rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted from commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

REFERENCES: 1) ASTM D 2488 2) Peck, Hanson and Thornburn, (1974), Foundation Engineering.

PLATE 19

APPENDIX B



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**B-7**		**4.0**	**LEAN CLAY (CL)**	**31**	**14**	**17**		
⊠	**B-7**		**13.0**	**FAT CLAY (CH)**	**65**	**20**	**45**		
▲	**B-8**		**2.0**	**FAT CLAY (CH)**	**75**	**21**	**54**		
★	**B-8**		**8.0**	**FAT CLAY (CH)**	**54**	**15**	**39**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-7**	**4.0**	**0.425**				**0.0**	**1.0**	**99.0**	
⊠	**B-7**	**13.0**	**4.75**				**0.0**	**12.0**	**88.0**	
▲	**B-8**	**2.0**	**4.75**					**8.0**	**90.0**	
★	**B-8**	**8.0**	**4.75**				**0.0**	**9.0**	**91.0**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

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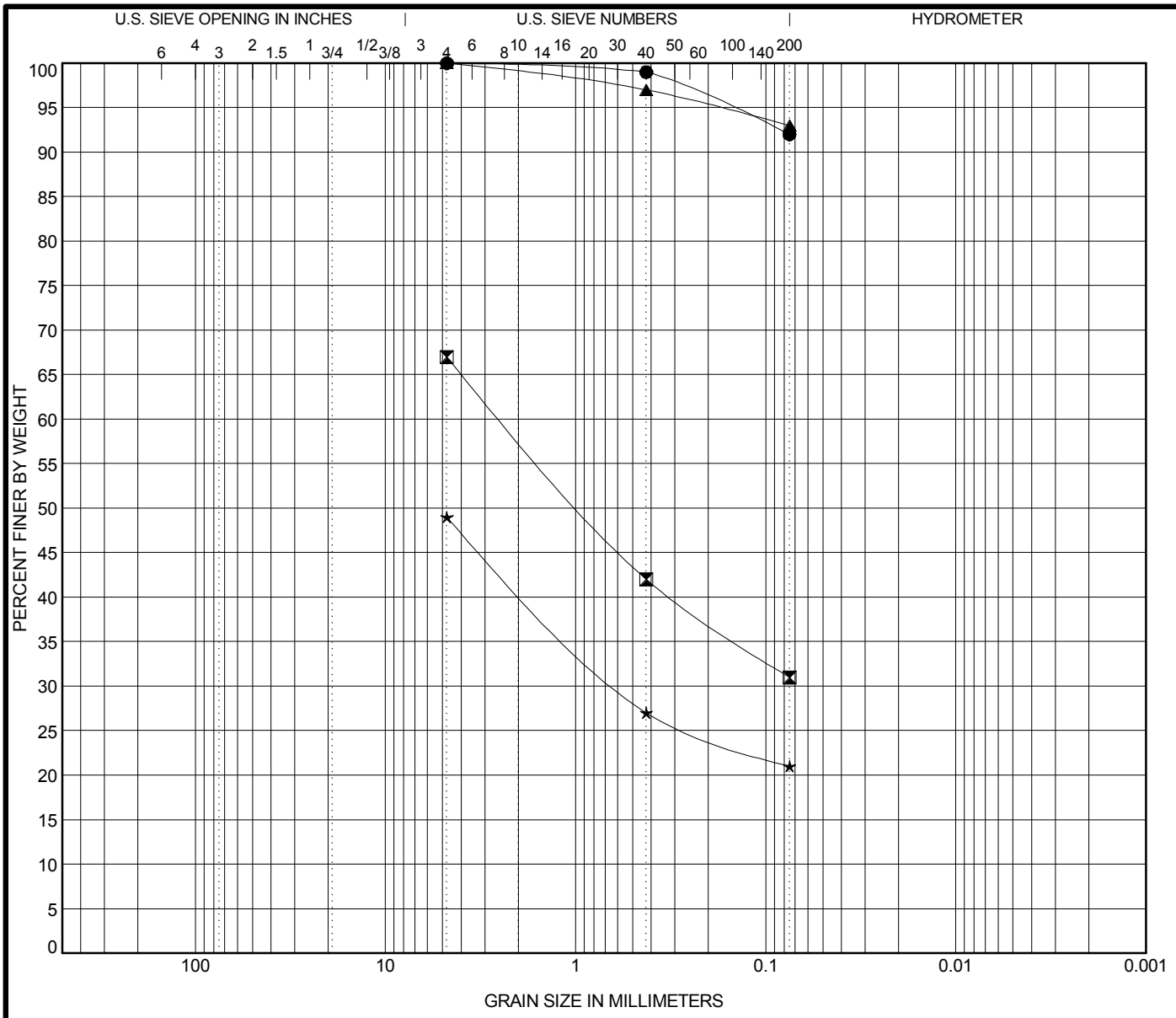
GRAIN SIZE DISTRIBUTION

Project: Williamson County SOTC

Location: See Boring Location Plan

Job No.: 0115-041



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**B-10**		**8.0**	**LEAN CLAY (CL)**	**38**	**14**	**24**		
⊠	**B-10**		**19.0**	**CLAYEY SAND with GRAVEL (SC)**	**43**	**14**	**29**		
▲	**B-9**		**4.0**	**FAT CLAY (CH)**	**75**	**24**	**51**		
★	**B-9**		**18.0**	**CLAYEY GRAVEL with SAND (GC)**	**69**	**19**	**50**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-10**	**8.0**	**4.75**				**0.0**	**8.0**	**92.0**	
⊠	**B-10**	**19.0**	**4.75**	**2.416**				**36.0**	**31.0**	
▲	**B-9**	**4.0**	**4.75**				**0.0**	**7.0**	**93.0**	
★	**B-9**	**18.0**	**4.75**		**0.591**			**28.0**	**21.0**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

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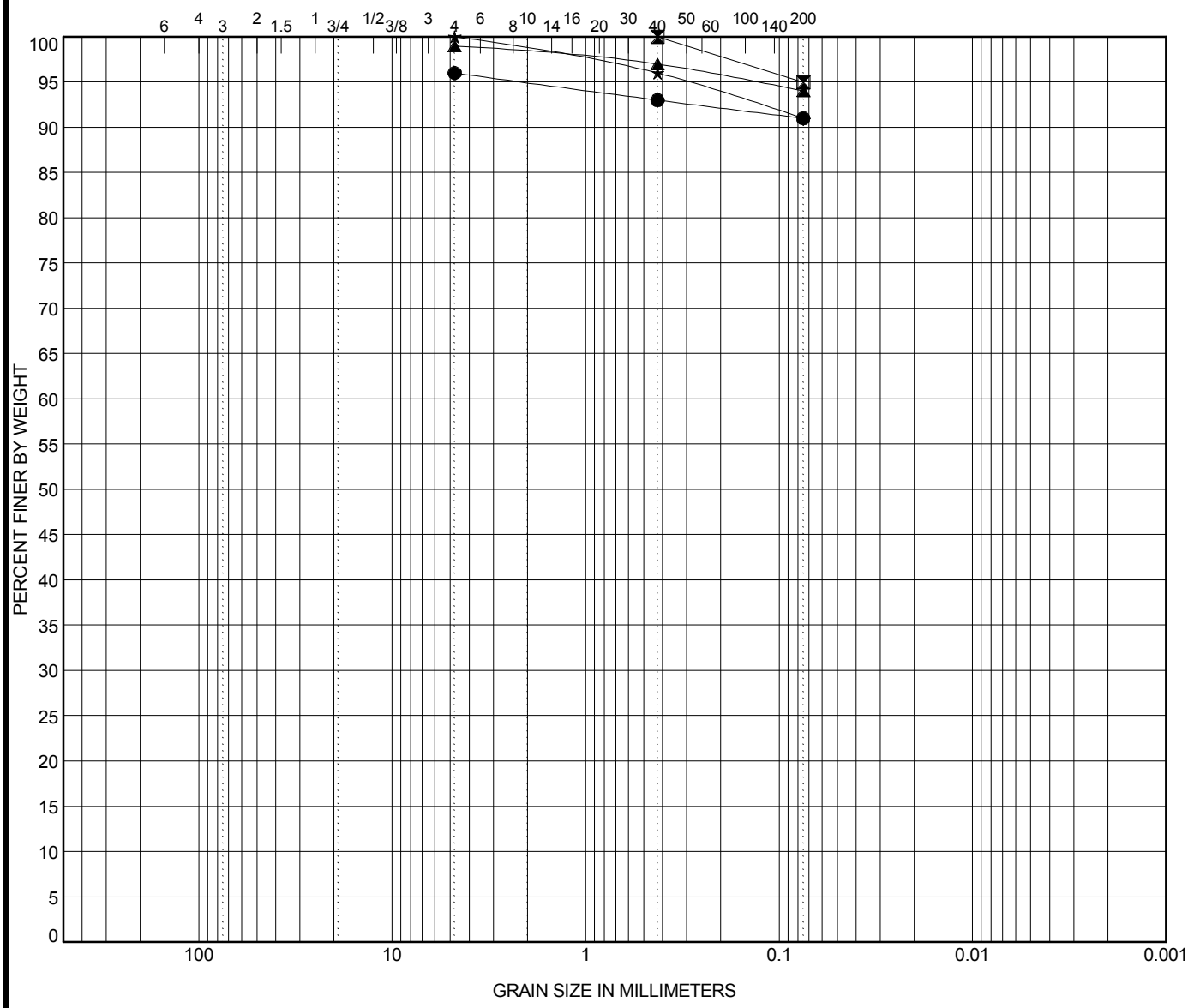
GRAIN SIZE DISTRIBUTION

Project: Williamson County SOTC

Location: See Boring Location Plan

Job No.: 0115-041



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**B-11**		**4.0**	**FAT CLAY (CH)**	**74**	**24**	**50**		
⊠	**B-11**		**8.0**	**LEAN CLAY (CL)**	**33**	**13**	**20**		
▲	**B-11**		**28.0**	**FAT CLAY (CH)**	**81**	**26**	**55**		
★	**P-12**		**2.0**	**FAT CLAY (CH)**	**72**	**24**	**48**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-11**	**4.0**	**4.75**					**5.0**	**91.0**	
⊠	**B-11**	**8.0**	**0.425**				**0.0**	**5.0**	**95.0**	
▲	**B-11**	**28.0**	**4.75**					**5.0**	**94.0**	
★	**P-12**	**2.0**	**4.75**				**0.0**	**9.0**	**91.0**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

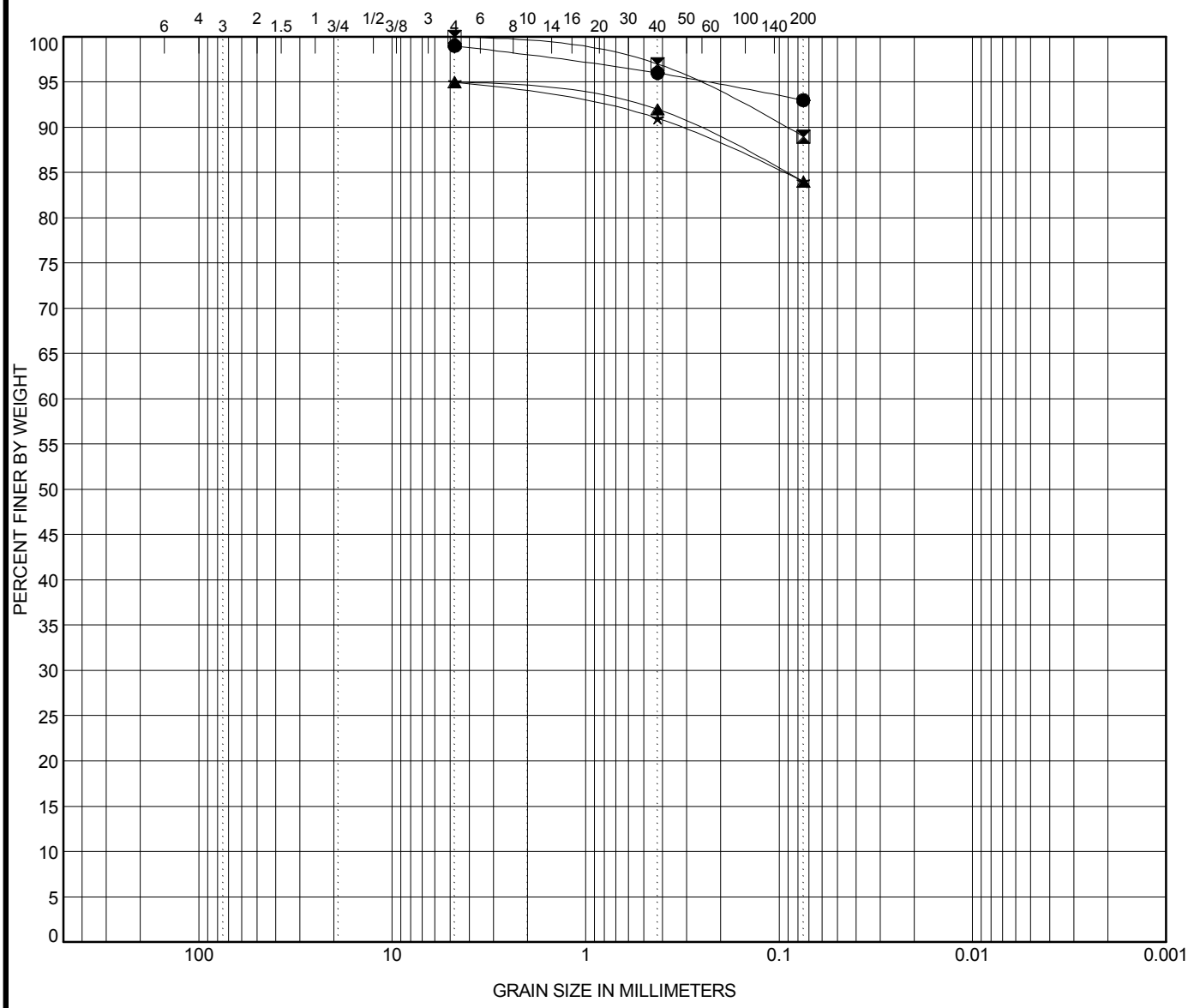
Balcones Geotechnical
Austin, TX 78731
512.451.8600

GRAIN SIZE DISTRIBUTION

Project: Williamson County SOTC

Location: See Boring Location Plan

Job No.: 0115-041



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**P-13**		**4.0**	**FAT CLAY (CH)**	**72**	**24**	**48**		
⊠	**P-14**		**6.0**	**LEAN CLAY (CL)**	**30**	**14**	**16**		
▲	**P-15**		**4.0**	**LEAN CLAY with SAND (CL)**	**30**	**17**	**13**		
★	**P-16**		**2.0**	**FAT CLAY with SAND (CH)**	**72**	**28**	**44**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**P-13**	**4.0**	**4.75**					**6.0**	**93.0**	
⊠	**P-14**	**6.0**	**4.75**				**0.0**	**11.0**	**89.0**	
▲	**P-15**	**4.0**	**4.75**					**11.0**	**84.0**	
★	**P-16**	**2.0**	**4.75**					**11.0**	**84.0**	

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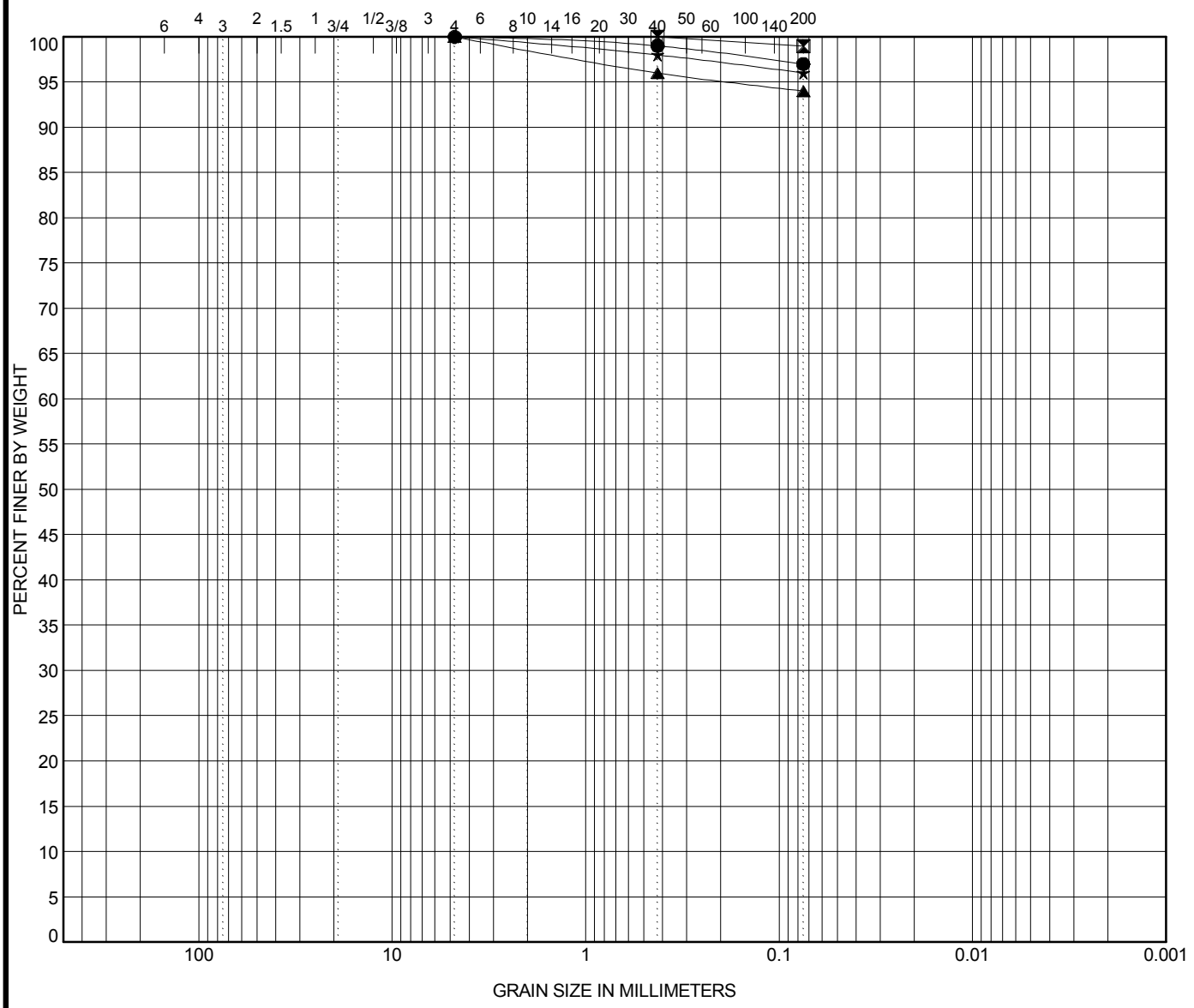
GRAIN SIZE DISTRIBUTION

Project: Williamson County SOTC

Location: See Boring Location Plan

Job No.: 0115-041



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**W-1**		**4.0**	**LEAN CLAY (CL)**	**30**	**16**	**14**		
⊠	**W-2**		**6.0**	**FAT CLAY (CH)**	**87**	**25**	**62**		
▲	**W-3**		**4.0**	**FAT CLAY (CH)**	**90**	**25**	**65**		
★	**W-4**		**2.0**	**FAT CLAY (CH)**	**82**	**27**	**55**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**W-1**	**4.0**	**4.75**				**0.0**	**3.0**	**97.0**	
⊠	**W-2**	**6.0**	**0.425**				**0.0**	**1.0**	**99.0**	
▲	**W-3**	**4.0**	**4.75**				**0.0**	**6.0**	**94.0**	
★	**W-4**	**2.0**	**4.75**				**0.0**	**4.0**	**96.0**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

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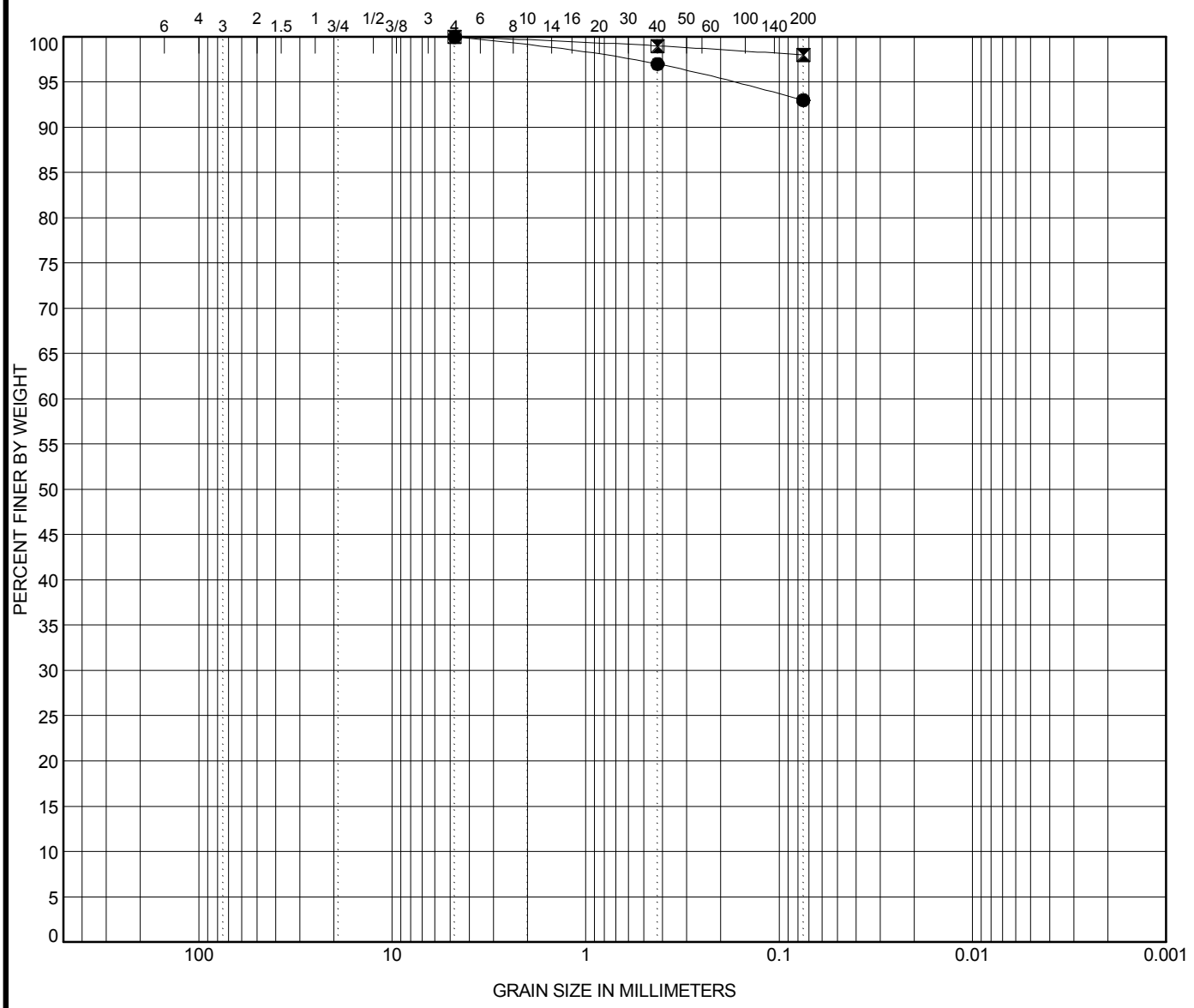
GRAIN SIZE DISTRIBUTION

Project: Williamson County SOTC

Location: See Boring Location Plan

Job No.: 0115-041



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**W-5**		**0.0**	**FAT CLAY (CH)**	**66**	**21**	**45**		
⧓	**W-6**		**2.0**	**FAT CLAY (CH)**	**89**	**24**	**65**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**W-5**	**0.0**	**4.75**				**0.0**	**7.0**	**93.0**	
⧓	**W-6**	**2.0**	**4.75**				**0.0**	**2.0**	**98.0**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

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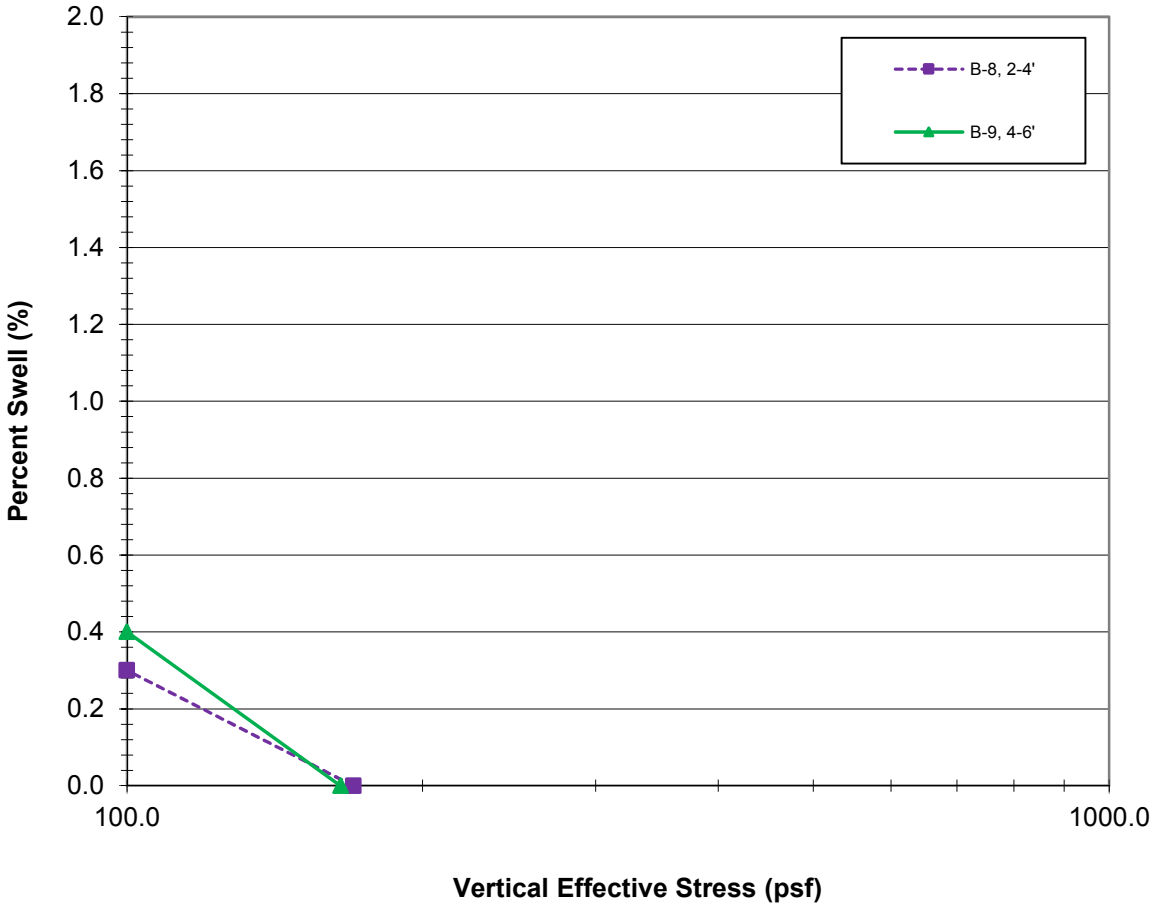
Austin, TX 78731
512.451.8600

GRAIN SIZE DISTRIBUTION

Project: Williamson County SOTC

Location: See Boring Location Plan

Job No.: 0115-041



Boring	Sample Depth	Initial Moisture (%)	Final Moisture (%)	Percent Swell (%)	Swell Pressure (psf)	Test Description
B-8	2-4'	30	33	0.3	170	Pressure Swell
B-9	4-6'	26	27	0.4	165	Pressure Swell

PERCENT SWELL VERSUS LOG PRESSURE CURVE

Williamson County Sheriff's Office Training Center
Williamson County, Texas

Balcones Geotechnical
5926 Balcones Drive, Suite 230 Austin, Texas 78731 Phone: 512-380-9969
TBPE Firm Registration F-15624

Mr. W. Owen Harrod, PhD, AIA
MWM Design Group
305 East Huntland, Suite 200
Austin, Texas 78752

Job No. 0115-041-1
July 26, 2019

Addendum 1 – Report of Geotechnical Investigation
Williamson County Sheriff's Office Training Center
Williamson County, Texas

Submitted herewith is our Addendum 1 to the geotechnical investigation for the above referenced project. The purpose of this addendum is to provide geotechnical engineering support to MWM Design Group for their design of the foundation for a Magazine Bunker associated with the WILCO Sheriff's Office Training Facility (SOT). This addendum is intended to supplement recommendations presented in our report for the SOT Facility (Report Number 0115-041 dated March 25, 2016). This addendum should be reviewed in conjunction with the referenced report. This addendum does not alter or change any of the recommendations included in the original report.

It is our understanding that the Bunker will be a pre-manufactured structure 20 ft by 30 ft in plan dimension and that the current design intent is to support the structure directly on a prepared crushed limestone building pad. The location of the Bunker will be generally between borings W-3 and W-4 which were drilled as part of our original investigation and report referenced above. To accomplish the geotechnical scope of services, we will rely on this referenced report and the borings stated above. No additional borings or lab testing have been performed.

Performance Criteria

Based on our understanding of the pre-fabricated building, it would be supported directly on a prepared select fill pad. We assume that there would be some sort of pedestal footings where concentrated loads would occur. From our discussions with you, the building would be able to tolerate some vertical movement, but it would be best to limit differential movements which would rack the structural frame. No specific guidance has been provided from the manufacturer as to allowable total or differential movements. Based on this limitation, we off the recommendations that follow which we believe will provide a somewhat robust foundation for the structure but will result in some movement of the structure.

Recommendations

Borings W-3 and W-4 indicate highly plastic, potentially expansive clay soils extending to at least the 20-ft deep. Measured Plasticity Indices were 55 and 65. Based on these conditions,

the Potential Vertical Rise (PVR) of the ground could be on the order of 5 to 6 inches. Reducing the PVR to a typical value of one inch is not practical for a structure of this type. The Estimated Potential Vertical Movement table on page 7 of our report would indicate 7 ft of select fill would be required to satisfy a PVR of one inch. Rather than achieve a 1" PVR, we recommend a limited removal and replacement approach combined with acceptance of greater vertical movements. For the proposed bunker structure, we recommend the following.

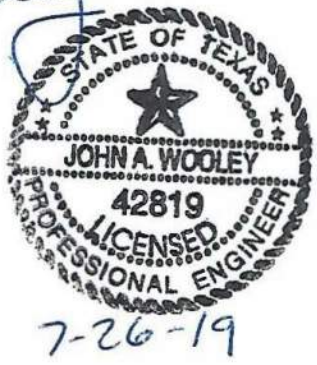
1. For a distance of 3 ft beyond the perimeter of the structure, remove at least 36 inches of the dark brown fat CH clay and replace with compacted select fill as indicated below.
2. Prior to placement of the select fill, scarify, moisture condition and compact the top 12 inches of subgrade to 95% of the dry density determined by Test Method TEX 114 E. Hold moisture contents to 1 to 3 % wet of optimum.
3. After moisture-conditioning and compacting the subgrade, place the select fill. The select fill should conform to requirements on Pages 8 and 9 of our report as far as gradation, compaction and lift thicknesses are concerned.
4. Vertical movements on the order of 2 to 3 inches could occur and should be anticipated. We would expect the differential movement from one end of the structure to the other to be about one-half of this magnitude.
5. Promotion of good surface drainage is important. We suggest that the ground should be graded to slope away from the structure with at least a 3% grade for the first 20 ft, and that the pad subgrade be set at least 6 inches above surrounding grade.
6. Surrounding the structure with a 4 to 6-ft wide impermeable barrier, such as concrete sidewalk or apron, would support the goal of limiting soil moisture variation and deterring water entry into the subgrade.

* * *

We appreciate the opportunity to provide these consulting services to MWM. Please contact the undersigned if you have any questions.

Sincerely,
Balcones Geotechnical, LLC
TBPE Firm Reg. F-15624

John A. Wooley, P.E.
Founder and Principal



Copy: Bob Lubecker, WILCO