11 GEOLOGY AND SOILS STATEMENT (30 TAC §330.957(K))

Based on the available geologic map of the area and the contents of the borings completed by Langerman Foster, the site is located within terrace deposits below the existing fill material.

Terrace deposits are derived from ancient meandering paths and flood events of the Brazos River. Due to the inconsistent means of deposition, the deposits vary both horizontally and vertically in content and engineering properties. From a geologic perspective, alluvial deposits are considered recent.

The underlying Austin Chalk Formation consists of relatively soft limestone based on universal rock classification system, but is considered relatively hard rock in Central Texas. It is comprised of chalk, limestone and marl, and is over 100 feet thick in this area. The unweathered chalk is a gray color.

12 GROUNDWATER AND SURFACE WATER STATEMENT (30 TAC §330.957(L))

12.1 GROUNDWATER STATEMENT

Based on soil borings performed by Langerman Foster in 2020 groundwater was encountered at depths ranging between 22 feet and 25.5 feet below ground surface.

Groundwater levels are expected to rise and fall on a seasonal basis, and are influenced by rainfall and the level of the Brazos River. The water observations conducted for this investigation are short-term and should not be interpreted as a groundwater study. However, the presence of groundwater will affect construction and long-term performance of the proposed foundations and pavements.

12.2 SURFACE WATER STATEMENT

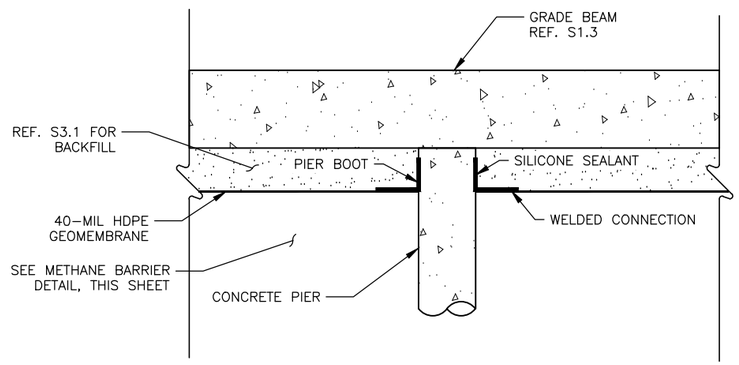
Surface water will generally sheet flow away from the building into the paved areas around the building and be collected in the storm drainange system that will outfall into the existing drainage channels and inlet to the Brazos River.

The site is located outside the 100-year flood plain for the Brazos River according to FEMA Flood Insurance Map of McLennan County, Texas Map Number 48309C0390D dated December 20, 2019.

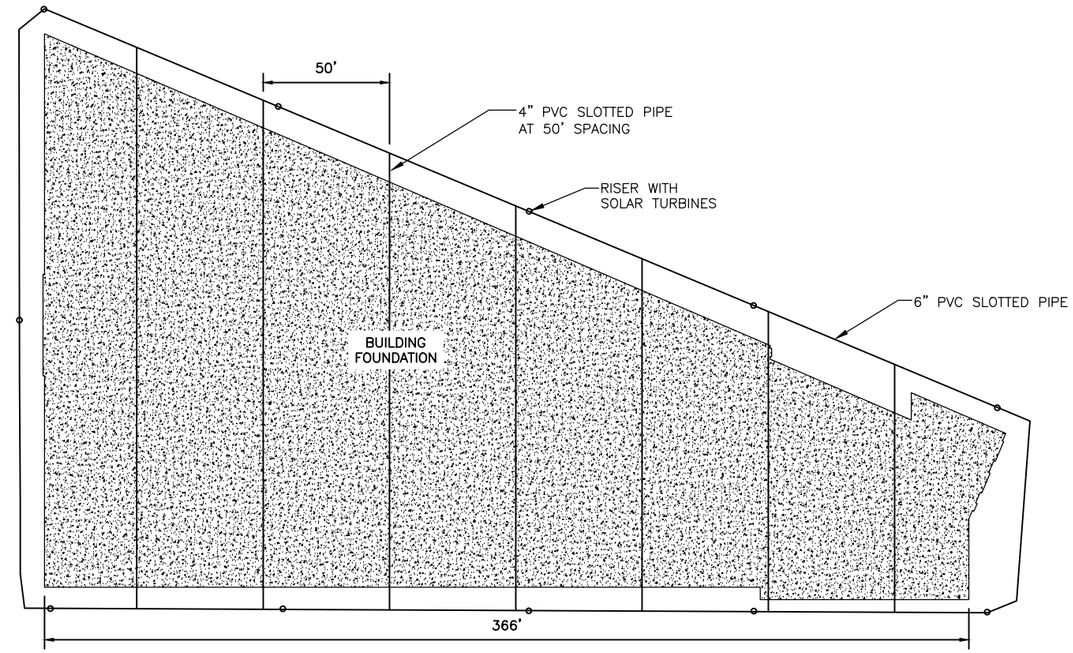
13 FOUNDATIONS PLANS (30 TAC §330.957(M))

The foundation plan for the Operations Center, which was developed by AECOM, is included in this section. The foundation consists of a reinforced concrete slab supported by grade beams that bear directly on concrete pier caps. The entire structure is supported by drilled shaft piers that extend below the landfill waste layer into the underlying shale formation. Drawing SE.00.01 in Appendix B provides a foundation plan with sections and details.

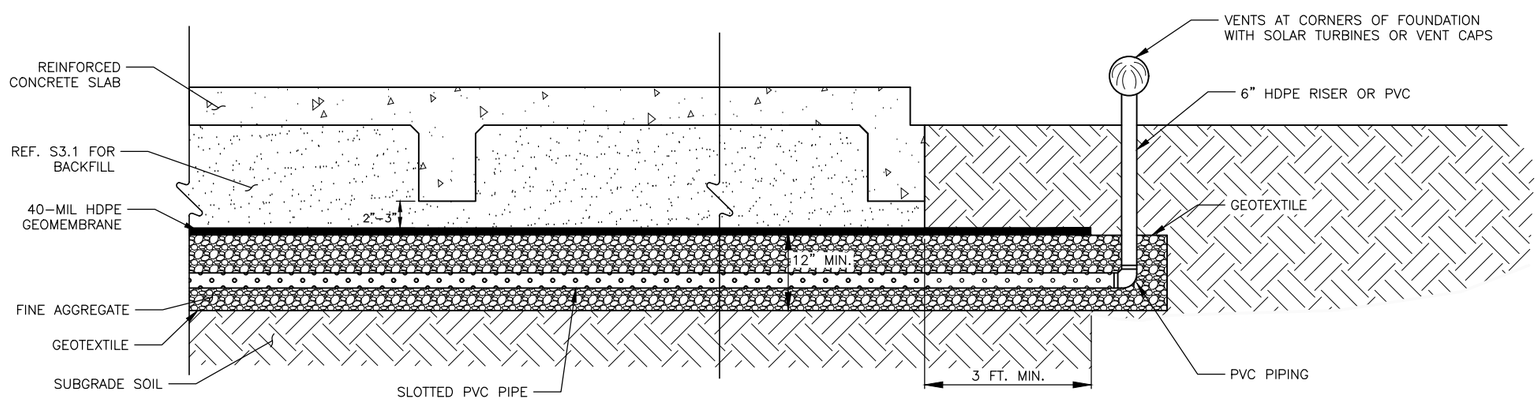
Drawing 13.1 is a layout and typical section of the subsurface methane barrier and gas ventilation system that will be installed beneath the structural slab and beams. To comply with the requirements of 30 TAC 330.957(M)(1)(A) and (B), the system includes a 40 mil HDPE liner underlain by a one foot thick layer of drainage aggregate and a non-woven geotextile. The liner will be installed around the concrete peers using pipe boots or collars to seal the annual spacing between the drilled shafts and liner material. Perforated PVC piping will be installed within the aggregate layer to extend beneath the structure and around the building. Riser vents will provide points to allow surface venting of gas collected by the piping to comply with the requirements of 30 TAC 330.957(M)(1)(C) and (D) .



PIER BOOT DETAIL
NTS



PIPING PLAN
NTS



NOTE:

1. FINE AGGREGATE SHALL BE COARSE SAND OR FINE GRAVEL WITH 0% PASSING #200 SIEVE
2. SLOTTED PIPING SHALL EXTEND AROUND THE BUILDING PERIMETER AND BENEATH SLAB AS SHOWN ON PLAN.
3. PROVIDE FITTED HDPE BOOTS FOR A1C FOUNDATION PIERS (SEE PIER BOOT DETAIL, THIS SHEET)
4. CONTINUOUS METHANE MONITORS SHALL BE INSTALLED IN THE VENT PIPE RISERS. REFER TO DRAWING 2 FOR SENSOR SPECIFICATIONS.

METHANE BARRIER DETAIL
NTS

06/06/2022

FOR INFORMATION PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
METHANE BARRIER AND GAS VENTILATION PLANS

PROJECT TITLE
BAYLOR UNIVERSITY - FUDGE FOOTBALL DEVELOPMENT CENTER

CLIENT
BAYLOR UNIVERSITY
ONE BEAR PLACE
WACO, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 162221105.00 | DSN. BY: JAA | DWN. BY: BGC | CHK. BY: JAA | Q/A RVW BY: JAA | APP. BY: JAA

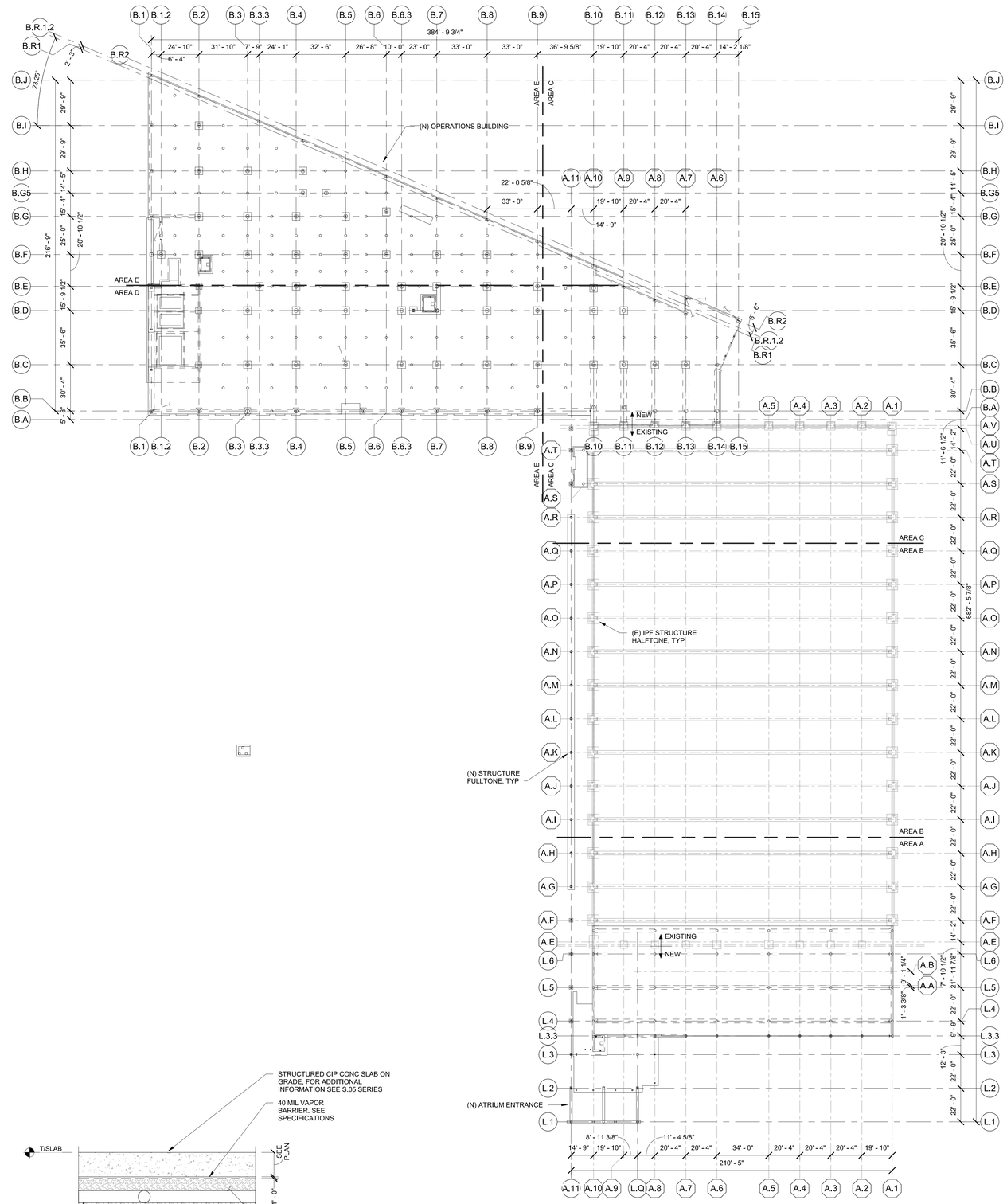
CADD FILE: METHANE BARRIER DETAIL

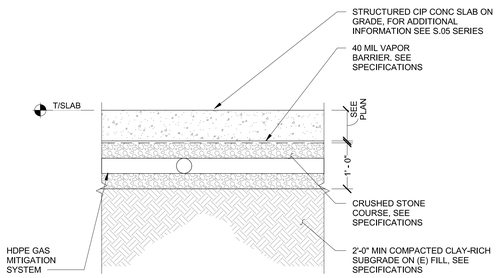
DATE: 05/2022

SCALE: AS SHOWN

DRAWING NO. 13.1

6/8/2022 2:12 PM G:\BAYLOR\METHANE BARRIER DETAIL





5A TYPICAL SOG CONSTRUCTION
Scale: 3/4" = 1'-0"

1A LEVEL 100 OVERALL FOUNDATION GAS MITIGATION PLAN
S.03.01 Scale: 1/32" = 1'-0"

SCALE: 1/32" = 1'-0"
0 16 32 64

NOT FOR CONSTRUCTION - ISSUED FOR INFORMATION AND PERMITTING ONLY

AECOM

BAYLOR UNIVERSITY - FUDGE FOOTBALL DEVELOPMENT CENTER
1504 S UNIVERSITY PARKS DRIVE
WACO, TX 76798

CLIENT
BAYLOR UNIVERSITY
ONE BEAR PLACE
WACO, TX 76798
HTTP://baylor.edu

AECOM TECHNICAL SERVICES, INC
ARCHITECTURE

JENSEN HUGHES
CODE COMPLIANCE / LIFE SAFETY

WALKER PARTNERS
CIVIL / SITE UTILITIES

OJB LANDSCAPE ARCHITECTURE
LANDSCAPE / SITE DESIGN

AECOM TECHNICAL SERVICES, INC
STRUCTURAL

CAMPISE CONSULTING AND INSPECTIONS, LLC
VERTICAL TRANSPORTATION

IDIBRI a SALAS O'BRIEN COMPANY
AV / TELECOM / IT / SECURITY / ACOUSTIC ISOLATION

AECOM TECHNICAL SERVICES, INC
MECHANICAL / ELECTRICAL / PLUMBING / FIRE PROTECTION

DOWNSTREAM
SIGNAGE / GRAPHICS / BRANDING

REGISTRATION

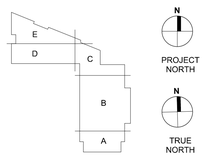
STATE OF TEXAS
SANTOSH VANGALA
133250
LICENSED PROFESSIONAL ENGINEER

Vangala, Santosh
Digitally signed by Vangala, Santosh
Date: 2022.06.02 16:45:01-06'00'

Each Construction Issue prepared by the Architect describes a portion of the Work required for the total Project. Each Construction Issue may contain one or more Bid Packages or Work Categories as defined by the Owner. A Construction Issue may modify a previously issued document & when issued, supersedes all previous Construction Issues & Modification Documents containing the same document. Individual Construction Issues by their nature are partial Contract Documents & based in part on preliminary or otherwise incomplete information. It is the Contractor's responsibility to augment each Construction Issue *using techniques, including unit pricing, allowances, & alternates*, to provide a complete scope of work. Due to the refinement & detailing necessary from time to time in order to develop the final Contract Documents, the Contractor shall review all Construction Issues & coordinate the information given in subsequent Construction Issues with that given in earlier Construction Issues.

TCEQ Permit Set

KEY PLAN



ISSUE/REVISION

I/R	DATE	DESCRIPTION
	June 2, 2022	TCEQ Permit Set

PROJECT NUMBER 60619826 **DATE** June 2, 2022

SHEET TITLE
LEVEL 100 OVERALL FOUNDATION GAS MITIGATION PLAN

SHEET NUMBER
SE.00.01

Designer: Designer Checker: Checker Approved: Approver Approver: Approver ANSI D 22"x34"
Project Management Initials:
Last Plotted: 6/2/2022 4:44:13 PM
Name: BW-SO2025-SHEET-USA1 M100581-Baylor University Football Operations Facility\60619826-ACM-419-FUDGE FBOPS-STRUCT.rvt
Printed on ___% Post-Consumer Recycled Content Paper

14 OTHER PLANS (30 TAC §330.957(N))

14.1 GRADING, PAVING AND UTILITY PLANS (30 TAC §330.957(N)(1))

Proposed grading, paving, and utility plans were prepared by Walker Partners. All sitework including grading, paving, drainage and utilities were detailed in the approved Authorization to Disturb Final Cover.

Architectural, structural, and MEP plans were prepared by AECOM. Civil engineering plans, which were developed by Walker Partners and detailing the proposed site improvements, were previously submitted as stated above. The architectural, structural and MEP plans provide information on the proposed building construction as well as the building for the Fudge Football Operations Center. The drawings are contained in Appendix B. The following list provides general content descriptions of the applicable plan sheets for this permit:

Baylor University Fudge Football Operations Center Building Plans

Civil Construction Plans were included in the recently approved Authorization to Disturb Final Cover (TCEQ approval letter date: 04/19/2022)

A.02.00D – A.02.03E Building Floor Plans

These drawings provide overall floor plans for each floor of the Football Operations building.

A.05.01 – A.05.05 Building Elevations

Building elevations are provided for the Football Operations building.

SE.00.01

This is the overall foundation plan for the building.

PS,PD, P.02 Plumbing Drawings

These drawng detail the plumbing layout for the building

Landscaping

The proposed landscaping turf grass was approved with the previous authorization request. No additional landscaping is proposed other than possible plantings adjacent to the building. Any new plantings will be installed with root bottoms a minimum of 2 feet above the waste layer.

Excavated Material Disposal and Water Management

The contractor will manage any contaminated water or solid waste material excavated during construction in accordance with the approved Authorization Request dated April 2022.

Construction Safety Issues

The contractor and all subcontractors will be required to follow safety procedures outlined in this document and the specifications, and will be expected to be prepared to encounter waste and adhere

to provisions of this plan. The contractor will be required to address, at a minimum, the following safety issues:

- **Landfill gas safety issues** – Workers will follow the safety procedures that are contained in the Site Safety Plan (SSP) required for construction and procedures contained in this document. Construction of this project will be performed in and near buried wastes. As these buried materials decompose, they will generate landfill gas, which normally consists of carbon dioxide, methane, and occasionally hydrogen sulfide, as well as other trace gases, depending on the composition of the buried materials. These gases usually vent to the atmosphere through the cover soil, but may also migrate laterally to adjacent areas depending on site and weather conditions. Landfill gases may cause an oxygen deficiency in underground trenches, vaults, conduits, and structures. The contractor and/ or the University will conduct air monitoring in excavation areas and other locations of construction activity where landfill gas is likely to accumulate. Monitoring equipment shall be calibrated to detect small amounts of methane and be recalibrated periodically in accordance with manufacturers' recommendations and the SSP. Monitoring of air for methane gas (and other gases, as determined by the SSP) shall be performed during working hours whenever open trenches, excavations, or waste handling/disposal is taking place, when the contractor is working on or near exposed refuse, or when landfill gas is likely to be present.

- In addition, the SSP to be developed for the project by the selected contractor will address construction workers safety. Also, the selected contractor will be advised of the possibility of landfill gas and to take the necessary precautions associated with construction activities at this site. To monitor concentrations of methane, an on-site representative of the contractor will be required to continuously wear a personal gas monitor which will detect concentrations of methane and emit an audible alarm when methane concentration reaches 20 percent of the lower explosive limit. If this were to happen, the representative will immediately advise all personnel to vacate the area of concern and not return until methane concentrations have returned to acceptable levels. While such conditions that would allow methane to accumulate to levels of concern are not anticipated, the representative will, nonetheless, monitor the excavation process on a routine basis to provide suitable oversight of methane concentrations.

  The University will designate a Professional Engineer to oversee the methane monitoring program during construction. Consistent with the Site Safety Plan, the responsible individual will determine the appropriate levels of monitoring for the proposed construction activities.

- **Potential fire control and management** – Fires and explosions may occur from the presence of methane gas. Methane is explosive in approximate concentrations of 5 to 15 percent by volume in air and will be present in landfill gas at the site. Soil shall be stockpiled adjacent to work space in areas of exposed refuse for firefighting purposes and water will be available all times on-site for potential fire suppression. Fire extinguishers with a rating of at least A, B, and C will be available at all times on the site. Welding, smoking, and startup and shutdown of equipment will not be permitted in areas of exposed refuse and smoking will not be allowed at any time within the construction area. The local fire department will be notified prior to the commencement of construction and its contact information will be kept available by all supervising project personnel, one of which will be on-site during all working hours.

- Procedures for working with municipal solid waste – Landfill materials (solids and liquids) have the potential to contain pathogens, fungus, viruses, infectious materials, sharp, puncturing,

and cutting objects, and other hazards. Dust control during waste excavation is important with respect to controlling dust-borne transmission of harmful elements. Preventing dermal contact with waste by workers, including unnecessary walking over, or in, exposed waste, will also reduce the risks of worker exposure. Dust control and worker exposure during excavation will be addressed in the contractor's health and safety plan, as will be required by the bid documents for this project.

The project construction is scheduled to begin in the second quarter of 2022 and is expected to be completed by the end of 2023.

14.2 IRRIGATION SYSTEM PLANS (30 TAC §330.957(N)(2))

No Irrigation System is proposed to be installed at the landfill with this permit application.

15 SOIL TESTS (30 TAC §330.957(O))

Geotechnical investigation is included in Appendix A.

16 CERTIFIED COPES OF REQUIRED NOTICES (30 TAC §330.957(P))

A copy of the previously filed notice is included in this section.

NOTICE 2007031886
4 PGS

NOTICE TO REAL PROPERTY RECORDS, BUYERS, LESSEES, AND OCCUPANTS REGARDING LAND WHICH OVERLIES A CLOSED MUNICIPAL SOLID WASTE LANDFILL

In accordance with the provisions of Chapter 361, Subchapter R, Health and Safety Code (the "Code") and the rules of the Texas Commission on Environmental Quality ("TCEQ", formerly the Texas Natural Resource Conservation Commission) published in Subchapter T, "Use of Land over Closed Municipal Solid Waste Landfills" (30 TAC, Section 330.951-330.964) (the "TCEQ Rules") requiring the preparation and filing of a Notice to Real Property Records of McLennan County, Texas, with respect to land overlying a closed municipal solid waste landfill; Baylor University, the undersigned owner (the "Owner") of the land (the "Land") described in Exhibit A attached hereto and incorporated herein by reference does hereby state the following:

1. Prior Use of the Land or Tract as a Municipal Solid Waste Landfill

   Owner has determined through site investigations that the Land was used for the disposal of municipal solid waste by a previous owner and/or operator.

2. Legal Description of the Portion of the Land or Tract that Contains a Closed Municipal Solid Waste Landfill

   Exhibit A is a legal description of the portion of the tract of land containing the closed municipal solid waste landfill.

3. Provisions with Respect to Development or Lease of this Property

   Provisions with respect to development or lease of this property exist in the Code and the TCEQ Rules (30 TAC, Section 330.962-330.964).

4. Name of Owner

   Baylor University
   One Bear Place #97110
   Waco, Texas 76798-7110

   ATTN: Karl H. McNair, Director of Real Estate Services

Baylor University

By: Reagan M. Ramsower
Reagan M. Ramsower
Vice President for Finance and Administration

August 29, 2007
Date

Attest: Marsha J. Duckworth
Marsha J. Duckworth
Assistant Secretary

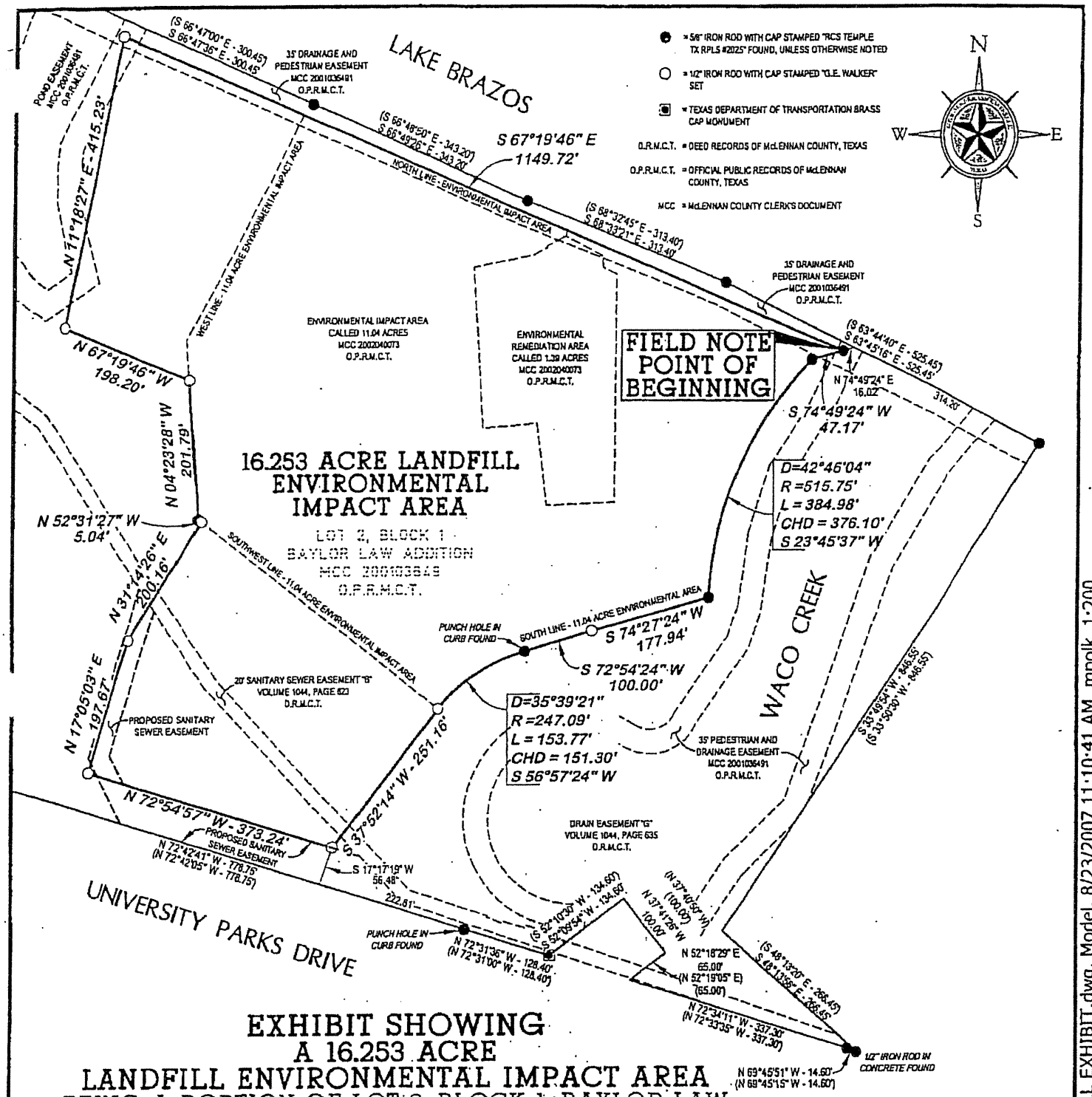


EXHIBIT SHOWING
A 16.253 ACRE
LANDFILL ENVIRONMENTAL IMPACT AREA

BEING A PORTION OF LOT 2, BLOCK 1, BAYLOR LAW ADDITION RECORDED IN McLENNAN COUNTY CLERK'S DOCUMENT 200103649 OF THE OFFICIAL PUBLIC RECORDS OF McLENNAN COUNTY, TEXAS

FIELD NOTES ATTACHED HERETO, MADE A PART HEREOF AND TITLED: 16.253 ACRE LANDFILL ENVIRONMENTAL IMPACT AREA LOCATED IN THE T.J. CHAMBERS SURVEY, ABSTRACT 7, CITY OF WACO, McLENNAN COUNTY, TEXAS

NOTE: BEARINGS BASED UPON TEXAS STATE PLANE COORDINATE SYSTEM, NAD 83, TEXAS CENTRAL ZONE, ACQUIRED FROM GLOBAL POSITIONING SYSTEM OBSERVATIONS.

G. E. WALKER & ASSOCIATES, L.L.C.
ENGINEERS ✯ SURVEYORS
TEXAS
600 AUSTIN AVENUE, SUITE 20 • WACO, TEXAS 76701 • PHONE: 1-254-714-1402

0 100 200 400

REVISIONS

PLAT NO. A1-0172 DRAFT DATE 08/22/08 FB/PG 49/41

PROJ. NO. 1-01086 TAB NO. NA FIELD NOTE NO. 01

G. E. WALKER & ASSOCIATES, L.L.C.
ENGINEERS ★ SURVEYORS

16.253 ACRE LANDFILL ENVIRONMENTAL IMPACT AREA LOCATED IN THE T.J. CHAMBERS SURVEY, ABSTRACT 7 CITY OF WACO, McLENNAN COUNTY, TEXAS

FIELD NOTES FOR A 16.253 ACRE TRACT OF LAND LOCATED IN THE T.J. CHAMBERS SURVEY, ABSTRACT 7, IN THE CITY OF WACO, McLENNAN COUNTY, TEXAS AND BEING A PORTION OF LOT 2, BLOCK 1, BAYLOR LAW ADDITION, RECORDED IN McLENNAN COUNTY CLERK'S DOCUMENT 2001036491 OF THE OFFICIAL PUBLIC RECORDS OF McLENNAN COUNTY, TEXAS. SAID 16.253 ACRES BEING FURTHER DESCRIBED BY METES AND BOUNDS WITH BEARINGS BASED UPON STATE PLANE COORDINATE SYSTEM, NAD 83, TEXAS CENTRAL ZONE, ACQUIRED FROM GLOBAL POSITIONING SYSTEM OBSERVATIONS AS FOLLOWS:

BEGINNING AT A 5/8" IRON ROD WITH CAP STAMPED "RCS TEMPLE TX RPLS #2025" FOUND MARKING THE NORTHEAST CORNER OF A "LANDFILL ENVIRONMENTAL IMPACT AREA", AS DESCRIBED AS AN 11.04 ACRE TRACT AND RECORDED IN McLENNAN COUNTY CLERK'S DOCUMENT 2002040073 OF THE OFFICIAL PUBLIC RECORDS OF McLENNAN COUNTY, TEXAS, FROM WHICH THE NORTHEAST CORNER OF THE ABOVE MENTIONED LOT 2, BLOCK 1 AND THE NORTHWEST CORNER OF LOT 1, BLOCK A OF THE FERRELL SPECIAL EVENTS CENTER ADDITION, RECORDED IN CABINET A, SLIDE 640 OF THE McLENNAN COUNTY PLAT RECORDS BEARS N 74°49'24" E – 16.02' AND S 63°45'17" E – 314.20';

THENCE THROUGH THE INTERIOR OF LOT 2, BLOCK 1 WITH THE EAST LINE OF THE "LANDFILL ENVIRONMENTAL IMPACT AREA" THE FOLLOWING 5 CALLS:

1) **S 74°49'24" W – 47.17'** TO A 5/8" IRON ROD WITH CAP STAMPED "RCS TEMPLE TX RPLS #2025" FOUND,
2) **AN ARC DISTANCE OF 384.98'** WITH A CURVE TO THE LEFT, HAVING A RADIUS OF 515.75' AND A CHORD OF S 23°45'37" W – 376.10' TO A 5/8" IRON WITH CAP STAMPED "RCS TEMPLE TX RPLS #2025" ROD FOUND,
3) **S 74°27'24" W – 177.94'** TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET,
4) **S 72°54'24" W – 100.00'** TO A PUNCH HOLE FOUND IN THE CURB MARKING A POINT OF CURVATURE,
5) **AN ARC DISTANCE OF 153.77'** WITH A CURVE TO THE LEFT, HAVING A RADIUS OF 247.09' AND A CHORD OF S 56°57'24" W – 151.30' TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET MARKING THE SOUTHEAST CORNER OF THE "LANDFILL ENVIRONMENTAL IMPACT AREA,"

THENCE LEAVING SAID LINE OF "LANDFILL ENVIRONMENTAL IMPACT AREA," CONTINUING THROUGH THE INTERIOR OF LOT 2, BLOCK 1 THE FOLLOWING 4 CALLS:

1) **S 37°52'14" W – 251.16'** TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET FOR THE SOUTHEAST CORNER OF THE HEREIN DESCRIBED TRACT,
2) **N 72°54'57" W – 373.24'** TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET FOR THE SOUTHWEST CORNER OF THE HEREIN DESCRIBED TRACT;
3) **N 17°05'03" E – 197.67'** TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET FOR AN ANGLE POINT IN THE WEST LINE OF THE HEREIN DESCRIBED TRACT,
4) **N 31°14'26" E – 200.16'** TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET IN THE SOUTH LINE OF THE "LANDFILL ENVIRONMENTAL IMPACT AREA" FOR AN ANGLE POINT IN THE WEST LINE OF THE HEREIN DESCRIBED TRACT,

600 AUSTIN AVENUE, SUITE 20 • WACO, TEXAS • 76701
PHONE: 254-714-1402 • FAX: 254-714-0402

THENCE N 52°31'27" W – 5.04' CONTINUING THROUGH THE INTERIOR OF LOT 2, BLOCK 1 WITH THE SOUTH LINE OF THE "LANDFILL ENVIRONMENTAL IMPACT AREA" TO A 5/8" IRON ROD WITH CAP STAMPED "RCS TEMPLE TX RPLS #2025" FOUND MARKING ITS SOUTHWEST CORNER AND AN ANGLE POINT IN THE WEST LINE OF THE HEREIN DESCRIBED TRACT,

THENCE N 04°23'28" W – 201.79' CONTINUING THROUGH THE INTERIOR OF LOT 2, BLOCK 1 WITH THE WEST LINE OF THE "LANDFILL ENVIRONMENTAL IMPACT AREA" TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET FOR AN ANGLE POINT IN THE WEST LINE OF THE HEREIN DESCRIBED TRACT,

THENCE N 67°19'46" W – 198.20' CONTINUING THROUGH THE INTERIOR OF LOT 2, BLOCK 1 LEAVING SAID WEST LINE OF THE "LANDFILL ENVIRONMENTAL IMPACT AREA" TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET FOR AN ANGLE POINT IN THE WEST LINE OF THE HEREIN DESCRIBED TRACT,

THENCE N 11°18'27" E – 415.23' CONTINUING THROUGH THE INTERIOR OF LOT 2. BLOCK 1 TO A ½" IRON ROD WITH CAP STAMPED "G.E. WALKER" SET FOR THE NORTHWEST CORNER OF THE HEREIN DESCRIBED TRACT,

THENCE S 67°19'46" E – 1149.72' CONTINUING THROUGH THE INTERIOR OF LOT 2, BLOCK 1 TO THE POINT OF BEGINNING.

RELEASED: AUGUST 23, 2007

KEVIN R. HESSEL, R.P.L.S. 5344

STATE OF TEXAS
REGISTERED
KEVIN R. HESSEL
5344
PROFESSIONAL
LAND SURVEYOR

FILED AND RECORDED
OFFICIAL PUBLIC RECORDS

J.A. Andy Harwell

August 31, 2007 10:18:42 AM 2007031886
FEE: $23.00
J.A. "Andy" Harwell County Clerk
Mclennan County TEXAS

PROJ NO. 1-01086
PLAT NO. A1-0172
FIELD NOTE NO. 1-01086-FN-01
MAP CHECKED BY MPP

17 CLOSURE PLAN (30 TAC §330.957(Q))

Site grading activities will be performed as described in approved Authorization to Disturb Final Cover dated April 19, 2022. Any other future disturbances to the final cover shall be approved prior to performing the activities. All disturbed landfill cap areas associated with the site grading activities shall be restored to a minimum of 2 foot thick as described in the Authorization to Disturb Final Cover approved in April 2022.

The proposed construction associated with this development permit application is not expected to result in significant removal of existing landfill cap material with the exeption of a portion of the building foundation construction. A minimum of 2 foot of cap material will be restored in those areas. Incidental cap disturbance shall be repaired in accordance with this section and the referenced Authorization Request.

18 OPERATIONAL REQUIREMENTS PLAN (30 TAC §330.957(R)) AND (30 TAC §330.961)

18.1 OPERATIONAL REQUIREMENTS PLAN GENERAL INFORMATION (30 TAC §330.961(A))

The Site Operating Plan, Structures Gas Monitoring Plan (Section 20), Closure Plan and Safety, and Evacuation Plan will be considered part of the operating record for the development permit. A copy of this information will be maintained in an office at the Football Operations Center throughout the life of the facility. The permit holder will notify the executive director and other entities that have requested notification in the event of any incident involving the facility related to the development permit for remediation.

18.2 LANDFILL GAS CONTROL (30 TAC §330.961(B))

The Structures Gas Monitoring Plan, in Section 20 of this application, provides detailed requirements and procedures for the monitoring systems to be installed and maintained in the Operations Center building. The plan details the type and number of monitoring equipment as well as the locations and frequency of monitoring for the building. The plan will be updated as needed to reflect modifications to the building that may warrant changes to the monitoring plan.

18.3 REPORTING (30 TAC §330.961(B)(2))

Methane sampling will be performed on a monthly basis. All monthly sampling results will be placed in the operating record of the Football Operations Center in accordance with 30 TAC §330.125(b)(3) and will be available for inspection by the executive director. If methane gas levels exceed the limits specified in the monitoring plan, the owner will notify the TCEQ in accordance with 30 TAC §330.371(c).

18.4 AIR CRITERIA (30 TAC §330.961(C))

No open burning will be allowed at this facility and Baylor University will comply with all federal, state, and local regulations related to air pollution and the state implementation plan.

18.5 PONDED WATER (30 TAC §330.961(D))

The proposed grading and drainage plans adjacent to the Opeartions Center building will promote positive drainage and will not result in any ponding of water over the closed MSW landfill.

18.6 WATER POLLUTION CONTROL (30 TAC §330.961(E))

Stormwater runoff from the building and parking area will be routed into the existing and proposed drainage system and discharge into the adjacent creek and inlet to the Brazos River. All wastewater will be collected and discharges into manholes that convey wastewater to the wastewater treatment facility operated by the Brazos River Authority.

18.7 GROUNDWATER MONITORING (30 TAC §330.961(F))

The closed MSW landfill unit does not have a groundwater monitoring system and no groundwater monitoring is proposed with this application.

18.8 CONDUITS (30 TAC §330.961(G))

All waterline extensions serving the building located over waste will be constructed of dual containment piping as required by 330.9561(g). All utilities for the football operations will be constructed in accordance with the approved authorization to disturb final cover for this facility.

18.9 RECORDKEEPING REQUIREMENTS (30 TAC §330.961(H))

Baylor University will record and retain the following information:

- All gas monitoring results and any remediation plans associated with landfill gases.
- All design documentation for the landfill gas monitoring and venting system.
- All operations and maintenance documents pertaining to systems as they relate to this development permit.
- All other documents required by the permit or the executive director.

19 SITE OPERATING PLAN (30 TAC §330.957(S))

19.1 SITE OPERATING PLAN OVERVIEW (30 TAC §330.957(S)(1) AND (2))

The Football Operations Center building structure consists of a two story building with offices, conference rooms, locker rooms and training areas. The building is equipped with multiple methane sensors that will produce both an audible and visual alarm if concentrations of methane exceed 1% BV or 20% of the LEL. In the event of this alarm the procedures in this section shall be implemented by designated safety coordinators. This plan is intended to fulfill the requirements of 30 TAC §330.957(s).

The following equipment is expected to be used at the Operations Center:

Description	Procedures and Function	Maintenance Schedule
General Office	Power down on daily basis	Periodic updates and checks
Cleaning Equipment	General Housekeeping	As needed repairs and replacement.
HVAC	Maintain adequate interior climate control	Semi-annually
Electric Water Heaters	hot water service	Annually
Lighting	Provide interior illumination	Periodic checks and repairs
Training Equipment	Used for workouts and instruction	As needed for proper function
IT/Network Equipment	Used for data telephone, security cameras, etc.	As needed for proper function function

The equipment list will be periodically reviewed and updated as needed if new equipment is added or changes are made.

20 STRUCTURES GAS MONITORING PLAN (30 TAC §330.957(T))

20.1 STRUCTURES GAS MONITORING PLAN GENERAL INFORMATION (30 TAC §330.957(T)(1))

This Structures Gas Monitoring Plan fulfills the requirements of the 30 TAC §330.957(t) and will be considered part of the operating record for the development permit. A copy of this information will be maintained in an office at the Football Operations Building throughout the life of the facility. The permit holder will notify the executive director and other entities that have requested notification in the event of any incident involving the facility related to the development permit for remediation.

The Structures Gas Monitoring Plan includes two key components. The first is a gas ventilation system with an impermeable barrier installed below the building foundation with vent risers located adjacent to the building. This system will allow methane that migrates though the landfill cap and fill soil to be collected and vented outside of the structure. This system is detailed in Section 13. The second component is a monitoring system inside the building that includes controller units and remote sensors on each floor that are capable of detecting methane and other explosive gases at concentrations below 1% BV or 20% of LEL. This system will have audible and visual alarms that will trigger in the event that methane concentrations exceed 1%. The monitoring system is intended to confirm that the concentration of methane gas within the facility structure does not exceed 20% of the LEL.

20.2 FACILITY CHARACTERISTICS AND POTENTIAL MIGRATION PATHWAYS (330.957(T)(2)A)

The Football Operations Center structure is a two story building constructed over a reinforced concrete slab that is supported by grade beams and drilled shaft piers. The piers will extend below the waste layer into the underlying chalk formation. The existing final cover elevations at the building footprint range from approximately 395.0 to 398.0. The final cover in this area is approximately two feet deep. The proposed finished floor elevation of the building is 398.5 feet. Approximately 2 to 3 feet of engineered fill will be placed over the final cover in the vicinity of the building to establish the proposed elevations for the building slab and paving.

The nature and age of the waste are discussed in detail in Section 3 of the permit. The age of the waste and the preliminary field measurements indicate that the landfill is in the later stages of decomposition and gas production is very limited. However the due to the potential presence of landfill gas various protective measures have been incorporated into the design of the structure. These are described in the following section.

The building will be used as offices and training facility for the Baylor football team and coaching staff. There are several offices and training bays as well as locker room facilities and a workout area. The expected occupancy of the structure will range from less than 10 to 50 people during training and workouts. The typical duration of occupation will be less than 8 hours for most individuals and up to 8 hours for some full time personnel.

The potential routes of entry for methane gas include pipe penetrations trough the slab as well as joints and cracks that may occur in the future. The foundation design and underlying methane barrier system will greatly reduce the potential for gas migration into the structure. Potential ignition sources include water heaters, HVAC units, static or sparking associated with exercise equipment. The facility will be a smoke free environment with smoking prohibited inside and outside the building.

20.3 BUILDING DESIGN CHARACTERISTICS RELATED TO LANDFILL GAS ACCUMULATION PREVENTION (330.957(T)(2)(B))

The design of the Football Operations Center structure includes several features that will prevent or eliminate the accumulation of landfill gas within the building structure. As previously discussed, the addition of a soil fill layer over the landfill cap provides additional separation and protection from potential landfill gas migration. The methane barrier and ventilation system consists of a 40 mil HDPE membrane liner underlain with a 12 inch aggregate layer and PVC gas collection piping that vent into solid PVC risers outside of the building. The additional fill, methane barrier, and ventilation system provide the primary systems to prevent LFG migration into the structure and eliminate gas accumulation through the subsurface ventilation system. The HDPE liner will be installed around the concrete piers using preformed boots or collars that will be fuse welded to the liner. Flexible sealant will be utilized around the piers to seal the annular space between concrete and liner material.

All conduits into the building that penetrate the liner will be installed with pipe boots and sealant as described above. Any pipe penetrations through the slab will be installed as indicated on the mechanical drawings and shall include a pipe sleeve and compression seals that accommodate some movement and may be mechanically adjusted to maintain proper seals at pipe entries.

The methane monitoring system inside the building will provide continuous monitoring for methane through the building to provide early detection and warning in the event of gas accumulation inside the Operations Center. In addition to the monitoring equipment, periodic methane monitoring will be conducted in the gas ventilation system to monitor the concentration of methane within the subsurface ventilation system. The frequency of methane monitoring in the vent risers will be at least once annually. Drawings 20.3A and 20.3B in Appendix B are gas sensor plan that show proposed locations of the gas sensors as well as the controller units and notes.

20.4 LANDFILL GAS COLLECTION AND VENTILATION SYSTEM DESCRIPTION (330.957(T)(2)(C))

The landfill gas collection and ventilation system consists of two components. The first is an impermeable methane barrier layer consisting of a 40 mil HDPE liner. The barrier layer is underlain with a one foot thick layer of aggregate material with slotted PVC piping embedded in the aggregate and vented outside the structure through risers. The PVC risers will have sampling ports to facilitate methane monitoring. Drawing 13.1 in Appendix B provides a layout and details of the proposed ventilation system. The barrier and ventilation layer will be installed below the level of the perimeter concrete grade beams to minimize the foundation penetrations through the liner material. The liner material will be installed as described above adjacent to the piers to minimize the potential for gas migration at these locations.

20.5 LANDFILL GAS MONITORING EQUIPMENT (330.957(T)(2)(D))

As previously described the methane gas monitoring system includes:

One controller and four sensors will be installed on the second floor of the building. A second controller unit with five sensors will be installed on the first floor of the building. Drawing 20.1 in Appendix B provides a plan for the location of the methane monitoring equipment. The O & M manual for the monitoring equipment is included in Appendix C. Calibration will be performed at least twice annually or every six months.

20.6 IMPLEMENTATION SCHEDULE FOR MONITORING EQUIPMENT (330.957(T)(2)(E))

The gas monitoring equipment will be installed and tested prior to completion of the building construction. The monitoring equipment shall be in continuous operation at least one week prior to building occupation to verify that measurable methane concentrations are not present within the building.

20.7 SAMPLING AND ANALYSIS PLAN (330.957(T)(2)(F))

Gas samples will be taken initially prior to occupancy from the four riser pipes connected to the gas ventilation system. The samples will be collected and analyzed in accordance with this section and the following section.

The risers shall be capped and the sampling port valve closed for 24 hours prior to sampling. Four samples will collected from the gas collection system at the four risers using four separate "Summa" canisters. The selected analytical laboratory will provide canisters and chain of custody forms for the sampling activities. It should be noted that only four of the five canisters will be analyzed (the fifth is a spare in the event any issues were encountered with the other three).

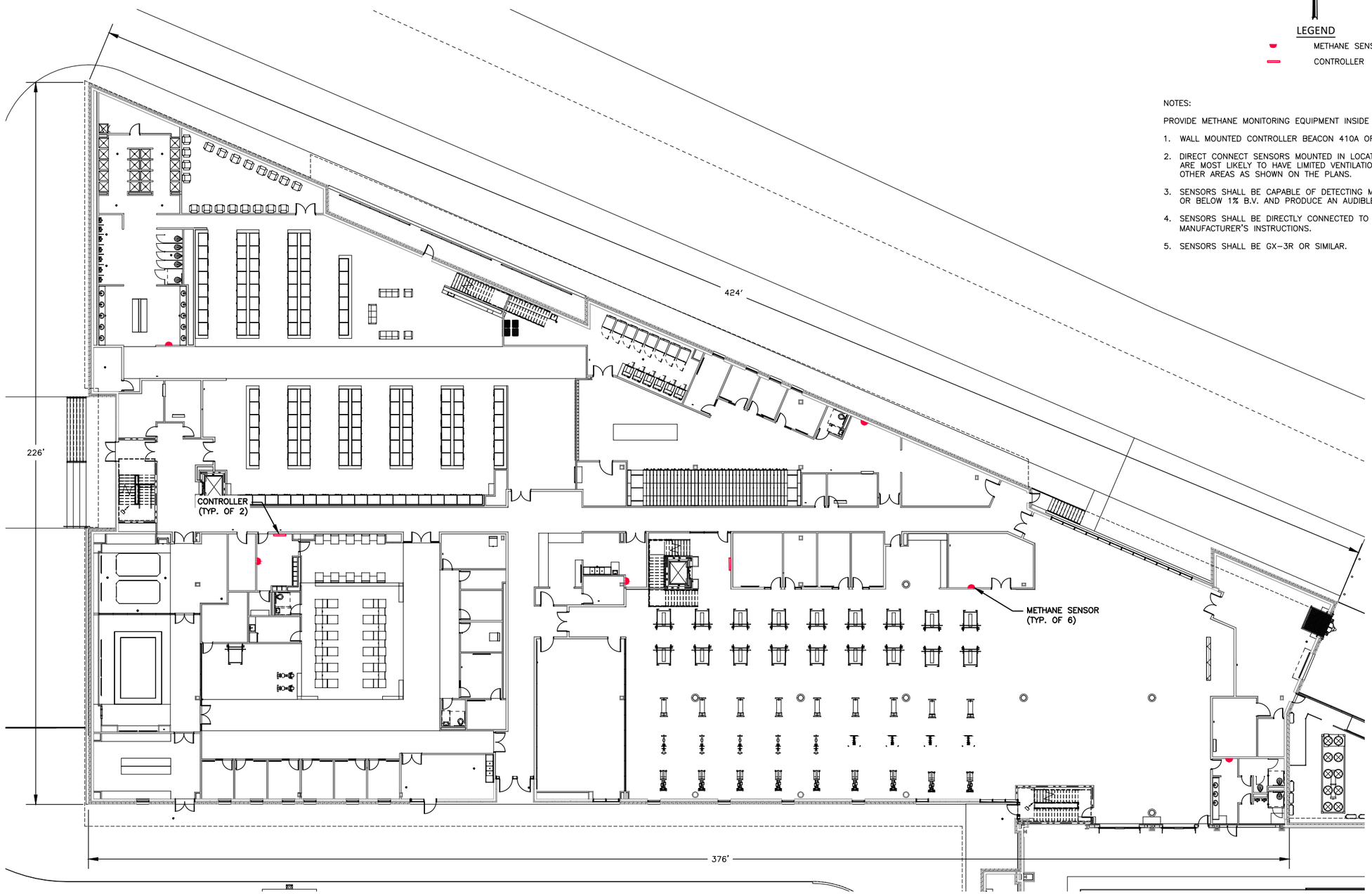
The following method shall be used to collect the samples from the active collection system. Teflon tubing was first connected to a sampling port at the riser pipe. The closed canister will then be connected to the line which containing a pressure gauge and a flow controller. The flow controller will be set to a flow rate of approximately 500 ml/min. The line will then be purged and a field analyzer was used to sample the gas and make sure that air intrusion into the line was not detected. The evacuated canister will then be opened and allowed to fill until its pressure reaches just above 0 mm Hg.

20.8 ANALYSIS OF LANDFILL GAS (330.957(T)(2)(G))

The four gas samples collected from the riser pipes will be analyzed for the following constituents and compounds. The samples of gas will be shipped to an accredited laboratory offsite that can perform the approved EPA test methods:

- Methane and other light hydrocarbons, carbon dioxide and water vapor
- Hydrogen Sulfide, mercaptans, ammonia
- VOCs

Laboratory QA/QC procedures will be provided by the laboratory chosen to perform the analysis and will be included with the test results.



N

LEGEND

METHANE SENSOR

CONTROLLER

NOTES:

PROVIDE METHANE MONITORING EQUIPMENT INSIDE THE BUILDING CONSISTING OF:

1. WALL MOUNTED CONTROLLER BEACON 410A OR EQUIVALENT.
2. DIRECT CONNECT SENSORS MOUNTED IN LOCATIONS OF THE BUILDING THAT ARE MOST LIKELY TO HAVE LIMITED VENTILATION INCLUDING RESTROOMS AND OTHER AREAS AS SHOWN ON THE PLANS.
3. SENSORS SHALL BE CAPABLE OF DETECTING METHANE CONCENTRATIONS AT OR BELOW 1% B.V. AND PRODUCE AN AUDIBLE ALARM AT 1% B.V.
4. SENSORS SHALL BE DIRECTLY CONNECTED TO THE CONTROLLER UNIT PER MANUFACTURER'S INSTRUCTIONS.
5. SENSORS SHALL BE GX-3R OR SIMILAR.

STATE OF TEXAS
JEFFREY ARRINGTON
61895
LICENSED
PROFESSIONAL ENGINEER
06/06/2022

FIRST FLOOR SENSOR PLAN
NTS

FOR INFORMATION PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY
△			
△			
△			
△			
△			
△			

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
GAS SENSOR LOCATION PLAN - 1

PROJECT TITLE
BAYLOR UNIVERSITY - FUDGE FOOTBALL DEVELOPMENT CENTER

CLIENT
BAYLOR UNIVERSITY
ONE BEAR PLACE
WACO, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221105.00 | DSN. BY: JAA | DWN. BY: RGC | CHK. BY: JAA | Q/A RVW BY: | APP. BY: JAA

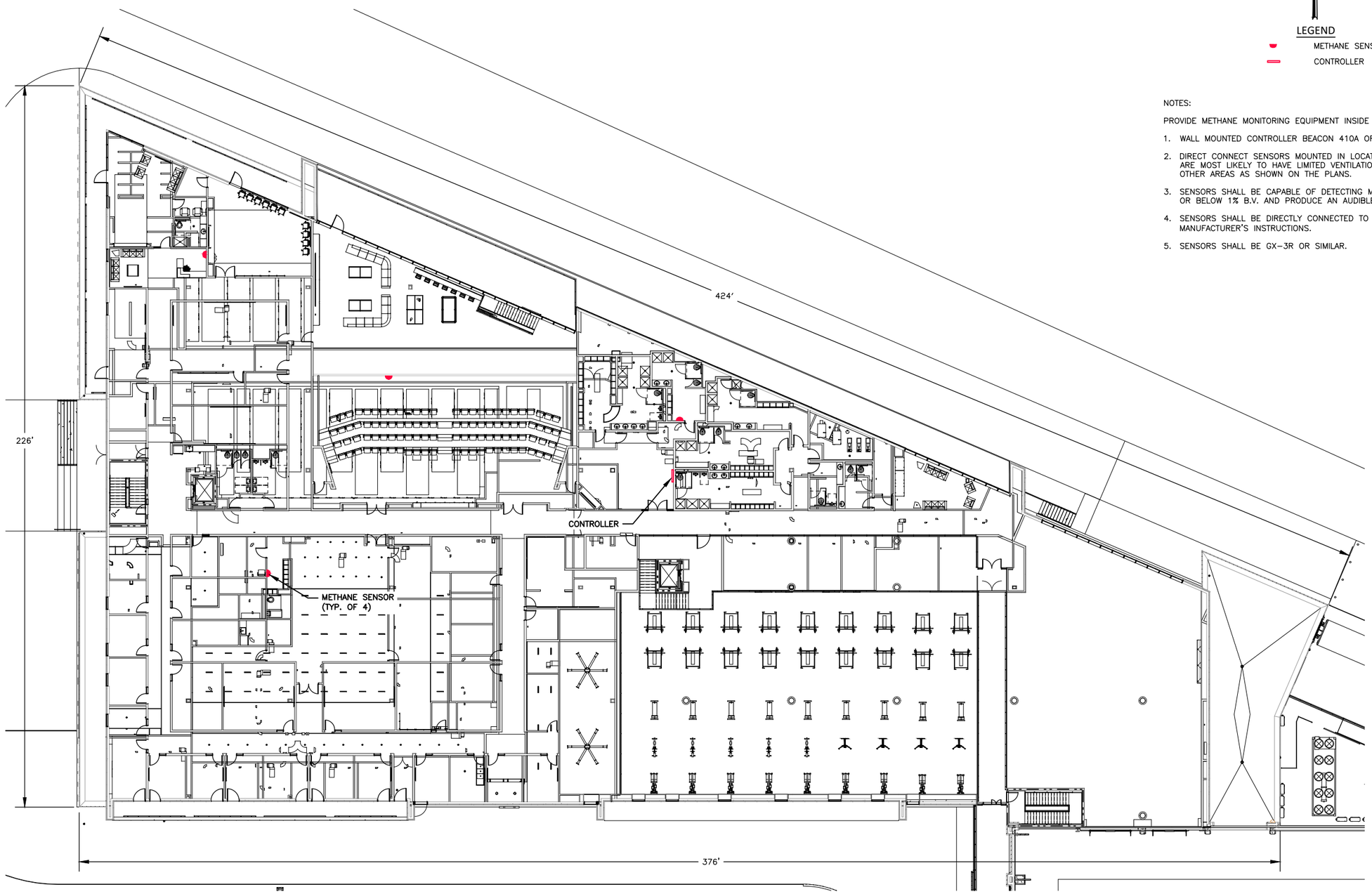
CADD FILE: SENSOR PLAN

DATE: 05/2022

SCALE: AS SHOWN

DRAWING NO. **20.3A**

6/6/2022 2:13 PM G:\BAYLOR\SENSOR PLAN



N

LEGEND

METHANE SENSOR

CONTROLLER

NOTES:

PROVIDE METHANE MONITORING EQUIPMENT INSIDE THE BUILDING CONSISTING OF:

1. WALL MOUNTED CONTROLLER BEACON 410A OR EQUIVALENT.
2. DIRECT CONNECT SENSORS MOUNTED IN LOCATIONS OF THE BUILDING THAT ARE MOST LIKELY TO HAVE LIMITED VENTILATION INCLUDING RESTROOMS AND OTHER AREAS AS SHOWN ON THE PLANS.
3. SENSORS SHALL BE CAPABLE OF DETECTING METHANE CONCENTRATIONS AT OR BELOW 1% B.V. AND PRODUCE AN AUDIBLE ALARM AT 1% B.V.
4. SENSORS SHALL BE DIRECTLY CONNECTED TO THE CONTROLLER UNIT PER MANUFACTURER'S INSTRUCTIONS.
5. SENSORS SHALL BE GX-3R OR SIMILAR.

STATE OF TEXAS
JEFFREY ARRINGTON
61895
LICENSED
PROFESSIONAL ENGINEER
06/06/2022

SECOND FLOOR SENSOR PLAN
NTS

FOR INFORMATION PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY
△			
△			
△			
△			
△			
△			

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
GAS SENSOR LOCATION PLAN - 2

PROJECT TITLE
BAYLOR UNIVERSITY - FUDGE FOOTBALL DEVELOPMENT CENTER

CLIENT
BAYLOR UNIVERSITY
ONE BEAR PLACE
WACO, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221105.00 | DSN. BY: JAA | DWN. BY: RGC | CHK. BY: JAA | Q/A RVW BY: JAA | APP. BY: JAA

CADD FILE: SENSOR PLAN

DATE: 05/2022

SCALE: AS SHOWN

DRAWING NO. **20.3B**

6/6/2022 2:13 PM G:\BAYLOR\SENSOR PLAN

21 SAFETY AND EVACUATION PLAN (330.957(U))

21.1 PLAN OVERVIEW

The Football Operations Center structure consists of a two story building with offices, conference rooms and locker rooms. The first floor also has driving bays or rooms. The building is equipped with multiple methane sensors that will produce both an audible and visual alarm if concentrations of methane exceed 1% BV or 20% of the LEL. In the event of this alarm the procedures in this section shall be implemented by designated safety coordinators. This plan is intended to fulfill the requirements of 30 TAC §330.957(u).

21.2 SAFETY AND EVACUATION PROCEDURES

In the event of an audible or visual alarm is triggered by one of the methane sensors in the building the following procedures shall be implemented:

1. Designated safety coordinators for each floor shall walk through the office and inform all occupants that they should immediately evacuate the building by the stairs or through the nearest exit door.
2. All occupants of the building at the time of evacuation shall proceed to the designated location for evacuation which will generally be the south end of the parking area. Safety coordinators shall determine if all occupants have exited the building.
3. After evacuation is complete the safety coordinator shall call 911 to notify the local fire department and inform him of the emergency. The coordinator will also notify Baylor Environmental Health and Safety Manager to provide details of the evacuation.
4. The safety coordinators should wait for the emergency response personnel and inform them of the reasons for evacuation.
5. After emergency response personnel have determined it is safe to re-enter the building the safety coordinators may allow people back into the Operations Center.

The locations of stairways and exits marked on Drawings A.00.01, A.00.02, A.02.01A, A.02.01B A.02.02A, A.02.02D and A.02.02E of the building plans contained in Appendix B. Building occupants will be notified by posting notice in common areas and by email or other similar forms of communication that the building is located over a former MSW landfill, and that controls are in place to minimize the potential danger posed by a closed MSW landfill.

Appendix A

Site Investigation

- Geotechnical Investigation – February 2022

LANGERMAN FOSTER
ENGINEERING COMPANY

April 6, 2020

Baylor University
Hankamer Academic Center
1428 South 5th Street, Suite H330
Waco, Texas 76706

Attention: Mr. J.D. Dethrow
Senior Project Manager

Reference: Geotechnical Investigation
Baylor Football Operations Center
Waco, Texas
LFE Project No. W20-014

Dear Mr. Dethrow:

This letter transmits our geotechnical report, which has been electronically produced. We appreciate the opportunity to provide geotechnical engineering services for Baylor University.

We understand that SCS Engineers will be evaluating the environmental impacts of the existing fill materials. Because there are both geotechnical and environmental concerns on this site, we anticipate that further geotechnical input will be required as the project plans are developed.

Once the project plans and specifications are completed, we would be pleased to review those portions that pertain to this report. We would also appreciate the opportunity to provide construction phase services such as materials testing as a part of the success of the project. If you have any questions regarding our report, please call me at (254) 235-1048.

Best Regards,
LANGERMAN FOSTER ENGINEERING COMPANY
Texas Registered Engineering Firm No. F-13144

Scott M. Langerman, P.E.
Principal / Geotechnical Engineer

Distribution List:

1. Baylor University- Mr. J.D. Dethrow (JD_Dethrow@Baylor.edu)

GEOTECHNICAL INVESTIGATION

Baylor Football Operations Center
Waco, Texas

LFE Project No. W20-014

Report Prepared For:

Baylor University
Waco, Texas

Report Prepared By:

Scott M. Langerman, P.E.
Principal / Geotechnical Engineer

STATE OF TEXAS
SCOTT MILES LANGERMAN
82700
LICENSED
PROFESSIONAL ENGINEER

April 6, 2020

LANGERMAN FOSTER ENGINEERING COMPANY

2000 South 15th Street, Waco, Texas 76706
Ph: 254/235-1048 www.LFEctx.com

GEOTECHNICAL INVESTIGATION
BAYLOR FOOTBALL OPERATIONS CENTER
WACO, TEXAS

1.0 INTRODUCTION

Purpose: The purpose of this geotechnical investigation is to provide geotechnical design and construction criteria for a new Football Operations Center on the campus of Baylor University. The project location is shown on Plates 1 and 2 in the Appendix. Geotechnical data and recommendations are provided in a brief, and hopefully user friendly manner.

There are existing fill materials across most of the project area that are remnants of previous landfill activities. Environmental studies are currently being conducted that may require changes in the recommendations contained in this report.

Authorization: Services were performed in general accordance with LFE Proposal No. GEO20-013, dated January 21, 2020. Authorization to proceed was provided by Mr. Brett A. Dalton, Vice President and Chief Business Officer at Baylor University on February 13, 2020.

2.0 SUBSURFACE EXPLORATION

Boring Types: A total of thirteen borings were drilled for subsurface exploration as shown in Table 2.1 on the next page. Our drilling program consisted of using both conventional drilling techniques and electric cone penetrometer technologies.

Drilling Dates: Electric cone borings were drilled on March 10, 2020. Conventional borings were drilled from March 9 through 17, 2020. Dates of each boring are shown on the individual logs in the Appendix.

Boring Layout: The borings were staked in the field by LFE personnel using a sketch provided by Baylor University. If precise location and elevation data are desired, then a registered professional land surveyor should be retained to locate the borings and determine the ground surface elevations.

Sampling Methods: Samples were generally obtained with Standard Penetration Tests (SPT's) in most soils, and NX-size core drilling in limestone bedrock materials. Push-tubes were used for a few samples. SPT N-values, rock core information, and other field tests data are recorded on the boring logs in the Appendix. Sampling was not performed in the electric cone borings.

TABLE 2.1: BORING TYPES AND DEPTHS		
Structure	***Boring Nos.***	***Depth and Type***
Football Operations Building	B-1 B-2, B-3, B-4, and B-5 C-1 through C-3	100-ft, Conventional[(1)] 60-ft to 70-ft Conventional[(1)] ≈60-ft , CPT[(2)]
Allison Practice Facility Addition	B-6 C-4	100-ft, Conventional[(1)] ≈60-ft, CPT[(2)]
Driveways and Parking	T-1 through T-3	10-ft, Conventional[(1)]

[(1)]Conventional drilling was performed with a truck-mounted rig using traditional sampling tools. Limestone bedrock was cored. Two conventional borings extended to a depth of 100-ft to evaluate seismic criteria for structural design in accordance with building code requirements. The depth was also needed to evaluate whether any deeper geologic concerns will impact support of the Football Operations Building.

[(2)]CPT drilling consisted of pushing a piezometric cone into the ground until refusal occurred, usually at the top of limestone bedrock. The CPT cone was instrumented, and data were used to evaluate design criteria for auger-cast piles and drilled piers. Refusal occurred at depths of 56 to 59 feet.

3.0 LABORATORY TESTS

Test Results: Laboratory test results are shown on Plate 3 in the Appendix and selected tests are shown on the boring logs.

Test Procedures: Laboratory tests were conducted in general conformance with the standards noted in Table 3.1.

TABLE 3.1: LABORATORY TESTS

Test Name	***Test Method***
Atterberg Limits	ASTM D 4318
-#200 Mesh Sieve	ASTM D 1140
Moisture Content	ASTM D 2216
Soil Classification	ASTM D 2487
Unconfined Compression (soil)	ASTM D 2166
Unconfined Compression (rock)	ASTM D 2938

4.0 SITE OBSERVATIONS

Site Observations: The Football Operations Center will be situated in a relatively flat area, most of which is currently occupied by an outdoor practice field with turf. The adjoining Allison Indoor Practice Facility was constructed in 2009.

Landfilling activities occurred on the site, probably in the 1950's and 1960's, although exact dates are unknown. At that time, landfill materials were burned, and there were few regulations. Depths of landfill materials were 13.5 to 22 feet at the boring locations.

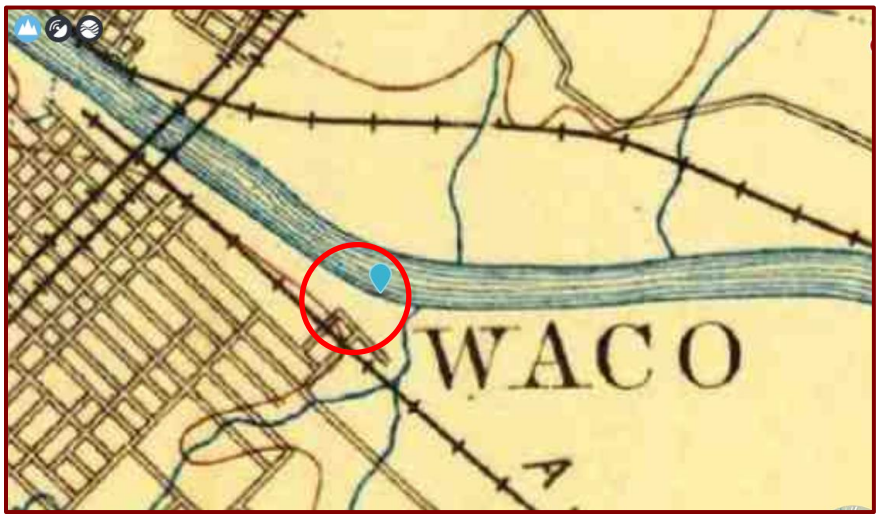


Figure 4.1: USGS 1892

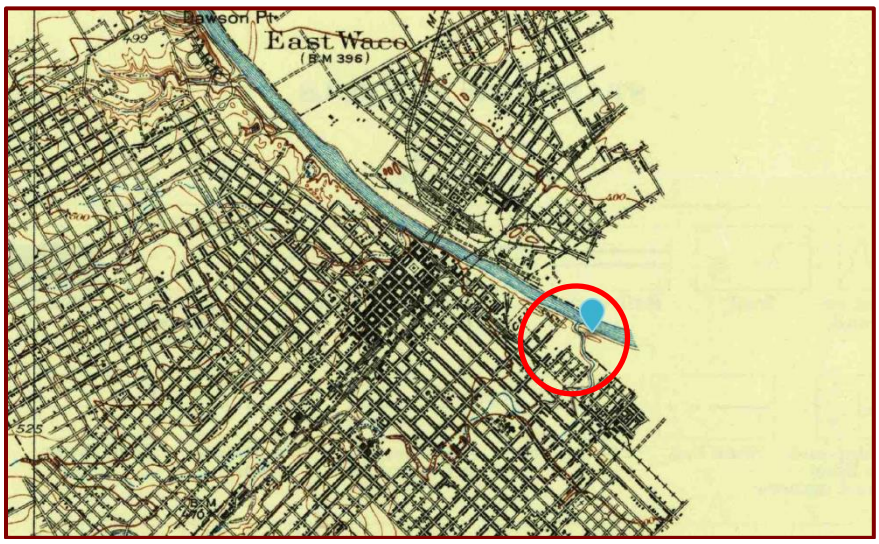


Figure 4.2: USGS 1931

Figure 4.3: USGS 1957

Figure 4.4: Google Earth 1995

Figure 4.5: Google Earth 2003

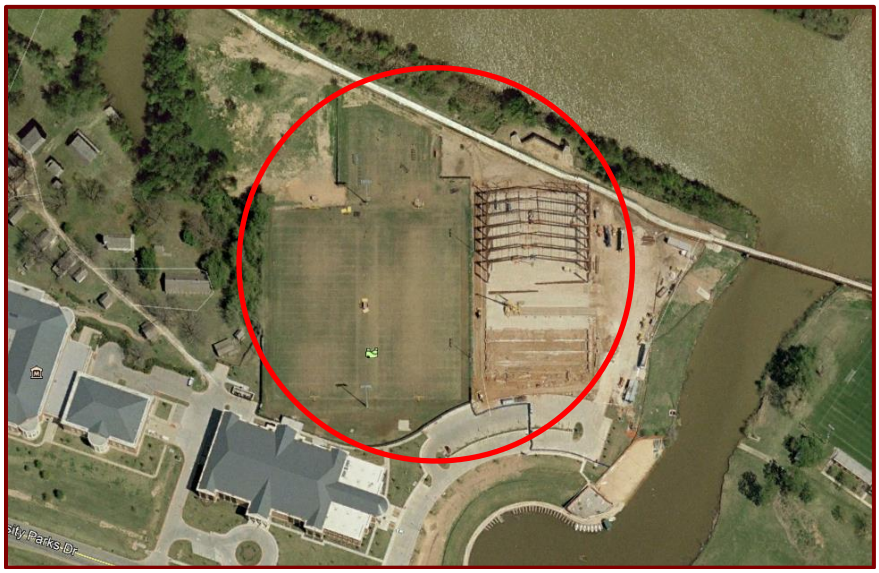


Figure 4.6: Google Earth 2009

Figure 4.7: Google Earth 2019

5.0 SUBSURFACE MATERIALS

Stratigraphy: Major strata types for the deeper conventional borings are listed in Table 5.1, and individual boring logs are contained in the Appendix. Material descriptions are general and range of depths approximate because boundaries between different strata are seldom clear and abrupt in the field.

TABLE 5.1: MAJOR STRATA TYPES

Strata	Depth to Top of Strata (ft)	Depth to Base of Strata (ft)	General Description
I	0	13.5 to 22	***EXISTING FILL-*** Sandy Lean Clay, Lean Clay, Clayey Sand, and Clayey Sand/Gravel; dark gray, dark brown, red-brown, and brown, with various proportions of glass, brick, plastic, metal, wood, and paper fragments
II	13.5 to 22	54.5 to 59	***TERRACE DEPOSITS (NATIVE SOILS)-*** Sandy Lean Clay, Lean Clay, Silty Sand, Silty Sand/Gravel, and Sand; dark brown, brown, and dark gray
III	54.5 to 59	100+	***AUSTIN FORMATION (BEDROCK)-*** Limestone; gray, with marly seams
Strata changes are approximations, and in-situ transitions are usually gradual			

Geology: Based on the available geologic maps[1,2] of the area, and the contents of the borings, the site contains Existing Fill in the top 13.5 to 22 feet followed by *Terrace Deposits* overlying the primary *Austin Formation*.

The Existing Fill contains a mixture of clay and sand with various proportions of trash such as glass, brick, plastic, metal, wood, and paper fragments. These materials were placed by previous landfilling operations on the site. The depths of existing fill shown on the logs are approximate because the fill is similar to the native soils.

Terrace Deposits below the existing fill are derived from meandering paths and flood events of the Brazos River. Due to the inconsistent means of deposition, the deposits vary both horizontally and vertically in

content and engineering properties. At this site, most of the soils consist of clay, silt, and sand to depths of roughly 55 to 60 feet. From a geologic perspective, terrace deposits are considered recent.

The underlying Austin Chalk is considered a relatively soft limestone based on universal rock classification systems, but is considered relatively hard rock in the Central Texas area. Although the Austin Chalk is usually described as limestone, it is comprised of chalk, limestone, and marl (marl is calcareous clay). The unweathered Austin Chalk is gray in color.

Table 5.2 includes the depths of limestone for each boring.

TABLE 5.2: DEPTHS TO LIMESTONE

Boring	Depth to Top of Limestone (ft)
B-1	58.5
B-2	54.5
B-3	57
B-4	59
B-5	58
B-6	57

Groundwater: Water level measurements were made in the borings prior to using water for coring limestone bedrock. Groundwater was encountered at depths ranging from 22 to 25.5 feet at the time of drilling. Depth measurements are shown on the individual boring logs.

The water observations conducted for this investigation are short-term and should not be interpreted as a groundwater study. We expect the groundwater elevation will fluctuate within a few feet of the Brazos River elevation, except in a condition of rapidly rising or rapidly falling water such as during a flood.

The electric cone tests shown in the Appendix indicate water much deeper than was revealed by the conventional borings. For that reason, the water readings with the electric cone do not appear reliable.

6.0 GEOTECHNICAL FOUNDATION RECOMMENDATIONS

Project Information:

The project consists of a new Football Operations Center. It will be located beside the Allison Indoor Practice Facility along the Brazos River. The overall project will include the Football Operations Center, an addition to the Allison Indoor Practice Facility, and new Driveways and Parking Areas.

Details concerning the configurations of the facilities and structural design loads were in the planning stage when this report was issued. We anticipate that additional geotechnical design data will be needed as the project progresses.

Recommendations for the Foundations and Retaining Walls are presented in Section 6, 7, and 8 of this report. Pavements are addressed in Section 9.

Figure 6.1: Exterior (Courtesy Baylor University)

Figure 6.2: Exterior South Side (Courtesy Baylor University)

Figure 6.3: Exterior River Side (Courtesy Baylor University)

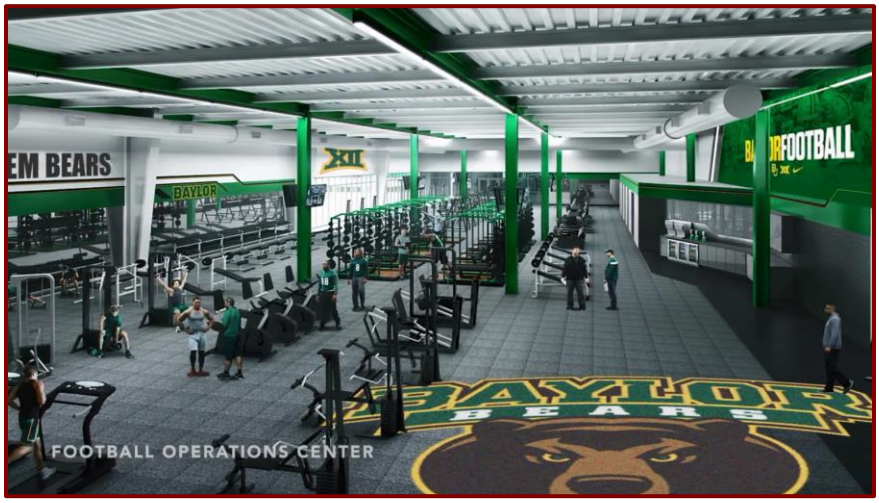


Figure 6.4: Interior (Courtesy Baylor University)

Existing Fill: Existing fill was present to depths of 13.5 to 22 at the boring locations. It generally consists of a mixture of clay and sand with varying proportions of brick, wood, plastic, metal, paper, and glass fragments.

We understand that environmental evaluations are being made by SCS Engineers. The results of the environmental studies will impact the design of the foundation system. We anticipate that the existing fill under the new buildings will either be removed, and then replaced with select fill, or a vapor extraction system will be employed to evacuate landfill gases. Additional geotechnical recommendations will likely be necessary as the design progresses.

Dewatering: Due to the proximity of the project to the Brazos River, as well as proposed elevations of the improvements, groundwater and possibly flood water, will impact design and construction. An independent dewatering expert should been retained by the design team to address these issues. Construction dewatering and flood water issues are addressed in only a general fashion herein.

Expansive Soil: Clay soils in the Central Texas area are subject to expansive soil movements, which include swelling under moist conditions and shrinking under dry conditions. The moisture fluctuations occur due to seasonal wet and dry cycles, but are also influenced after construction by site grading, drainage, landscaping, and groundwater. Actual soil movement is difficult to determine due to the many unpredictable variables involved.

At the Football Operations Center, most of the soils consist of sandy soils that do not exhibit expansive movement potential. However, there are occasional layers or pockets of clay soils that are expansive, and these layers are mainly near the ground surface. Any expansive soils that are below permanent structures should be removed.

Silty Sand: Clayey/Silty Sand and other unstable subgrade soils are prevalent throughout the site. Earthwork in silty soils is often problematic because small changes in moisture content will cause a rapid loss of strength. Rutting often occurs with heavy equipment, especially with repetitive loads. Over-working of silty soils, especially with vibratory equipment, will exacerbate problems. Depending on the actual conditions encountered during construction, it may be necessary to use woven filter fabrics, geogrids, clean stone, or cement treatment of the soils in order to improve the subgrade. The most effective procedure will depend upon the soil conditions and time of year stabilization is needed.

Silty sands are also easily eroded. Small cracks in utilities, such as sewer pipes, will draw silt and fine sand into the line, and this creates voids. In this particular area of Waco, sinkholes have occurred due to silts and sands washing into sewer lines. The City of Waco has completed major restoration of a sewer line and several sinking manholes that cracked and created major voids along the Brazos River. We highly recommend that sewer lines be designed and constructed in a manner such that breaks in sewer lines do not create voids.

Foundation Types: The Football Operations Center is in the conceptual process, and the structural design has not commenced. Based on the geologic conditions, as well as the anticipated loads, deep foundations will be needed. Several foundation options may be considered for support of the structural loads, namely drilled shafts, driven piles, or auger-cast piles.

Drilled Shafts: Although drilled shafts are the most common deep foundation system in the Central Texas area, this site is not favorable from an installation standpoint. Drilled shafts will require casing to bedrock, and the slow installation process will likely be cumbersome for the project schedule. Even with these challenges, drilled shafts may be viable on a cost basis.

Driven Piles: Installing driven pipe or H-piles is a viable alternative for this site; however, this is not a common foundation system in the area. The piles could easily be driven through the sandy soils to refusal in bedrock, and high capacities are achievable. The piles could be either driven or vibrated to bedrock, and then driven to refusal. At this time, we do not believe this foundation system will be the best alternative, but it is certainly an option. The sandy soils at the site may be sensitive to vibration that could potentially cause damage to nearby structures. If driven piles are determined to be viable, then we will need to provide additional geotechnical recommendations.

Auger-cast Piles: Auger-cast piles (ACP's) are constructed by advancing a continuous hollow-stem auger to refusal in limestone bedrock. Fluid cement grout is then pumped under pressure through the center of the auger shaft as it is withdrawn, leaving a continuous concrete pile. Pile diameters generally range from 16 to 24 inches, and reinforcing can be placed in the piles.

ACP's have been successfully used on 3 previous Baylor projects- McLane Stadium, the Ferrell Center Addition, and the Highers Simpson Athletic Building. On all of these projects, ACP's were rapidly constructed and were able to achieve significant load bearing. ACP's must be load tested during construction to verify capacity. One drawback to ACP's is that a

significant quantity of piles will need to be installed to make the system cost-competitive with drilled shafts. This is because mobilization of ACP equipment is costly, and load testing of the piles is costly.

With the above in mind, we believe that either Drilled Shafts or Auger-cast piles will offer a positive deep foundation system. Geotechnical criteria for design are contained in the following sections.

AUGER CAST PILES

ACP Description: ACP's are constructed by advancing a continuous hollow-stem auger to refusal in limestone bedrock. Fluid cement grout is then pumped under pressure through the center of the auger shaft as it is withdrawn, leaving a continuous concrete pile. Pile diameters generally range from 16 to 24 inches, and reinforcing can be placed in the piles.

Capacities of ACP's: For the Football Operations Center, ACP's must extend to practical refusal in limestone bedrock. The capacity of ACP's bearing in rock is controlled by two items- the strength of the grout relative to requirements in the building codes, and the strength of the rock.

The International Building Code has limiting capacity requirements. In this case, the allowable end-bearing capacity of the limestone bedrock is lower than the capacity based on the ultimate grout strength. We anticipate penetration of the auger into limestone will be limited to about 1 to 2 feet, depending on the contractor's equipment.

Design capacities for ACP's are provided in Table 6.1, and must be verified during construction with load tests.

TABLE 6.1: ACP CAPACITIES

ACP Diameter (inches)	Capacity (Tons)
16	55
18	70
24	125
30	190

Based on an Allowable End-Bearing Capacity in Limestone Bedrock of 40 tons per square foot. Factor of Safety is approximately 2.5 to 3. Overburden soils are neglected.

Grout Strength must be at least 3,000 PSI

Capacities must be verified by field load tests

Side Friction: Table 6.2 contains allowable tensile side friction values for auger-cast piles. The side friction for piles spaced horizontally between 2 and 6 diameters (center to center) should be multiplied by a reduction factor varying linearly as shown in Table 6.3.

TABLE 6.2: ALLOWABLE TENSILE SIDE FRICTION		
Depth (feet)	**Stratum Description**	**Allowable Side Friction[1] (psf)**
0 to 5	Clay or Sand	Neglect
5 to Top of Limestone	Sand / Silt / Clay	250
[1] Tensile only. Do NOT use as additive to compressive strengths from Table 6.1. Factor of safety is about 3.		

TABLE 6.3: REDUCTION FACTORS FOR SIDE FRICTION	
Pier Spacing	**Reduction Factor (percent)**
< 2 diameters	50
3 diameters	67
4 diameters	78
5 diameters	89
≥ 6 diameters	100
Multiply the calculated side friction by the appropriate reduction factor	

Lateral Loads: ACP's may be subject to lateral loads that must be resisted by the soil. One common software package to design for lateral loads is the L-Pile computer program. Geotechnical input parameters for L-Pile Version 2018 are listed in Table 6.4.

TABLE 6.4: LATERAL LOAD DESIGN PARAMETERS (L-PILE VERSION 2018)

Depth (feet)	*L-Pile Soil Type*	*Soil Type*	*Cohesion (psf)*	*φ (deg)*	*ε50 (Soil) or k_{rm} (Rock)*	*Unit Wt (2) (pcf)*	*Modulus, k_s (pci)*	*Initial Modulus of Rock Mass (psi)*	*Uniaxial Comp. Strength (psi)*
0 to 5	Neglect	Silt, Sand, and Clay	300 (1)	---	0.015	115	---	---	---
Varies	Sand (Reese)	Existing Fill	--	28	--	100	60	--	--
Varies	Stiff Clay w/out Free Water	Native Soil-Clay	500	--	0.008	110	--	--	--
Varies	Sand (Reese)	Native Soil-Sand	--	34	--	110	75	--	--
Varies	Weak Rock	Limestone	---	---	0.0005	140	---	40,000	2,000

(1) Minor cohesion, unit weight, and ε50 as listed above may be used to account for the effect of the overburden soils.

(2) Unit weights listed above represent total unit weights. For soils below the water table, the unit weight of water (62.4 pcf) must be subtracted. It would be conservative to assume that the water level will rise to the top of ground for calculation purposes.

Although L-Pile parameters have been provided for Limestone, ACP's will likely attain practical refusal with a 1 to 2 ft penetration into Limestone. Straight-shaft Drilled Piers can be drilled into Limestone, with limiting depths depending on the length of the Kelly bar on the rig.

DRILLED SHAFTS

Description: Drilled straight-shaft piers are installed by using an auger to drill into Limestone. Steel reinforcement is placed in the excavation, and concrete is poured up to a specified elevation. Drilled shafts are the most common foundation type in the Waco area.

Risk: Installing drilled shafts at this site will be difficult from a constructability standpoint. Temporary casing must be seated into Limestone to seal out groundwater and prevent caving. Often, casing in this situation is vibrated to the top of Limestone, but at this site vibrations may cause liquefaction of the sand soils that would impact surrounding structures.

If casing is vibrated, then vibration monitoring will be required, and must be interpreted by an engineer that specialized in vibration analysis. In addition, installing cased drilled piers is a slow process as compared to installing ACPs. There will be a schedule impact.

Bearing Stratum: Gray LIMESTONE (Logged at 54.5 to 59 feet below the existing grade)

End Bearing: Straight-shaft drilled piers may be designed using an allowable end-bearing of 80,000 psf with a penetration of at least 5 feet into LIMESTONE. This capacity may be increased if confirmed with load tests; however, load tests are not required. Drilled shafts must be specified to terminate on a hard layer after the required penetration is achieved. This may require penetrating more than 5 feet, and would be determined on a pier by pier basis.

Side Friction: An allowable tensile side friction value of 250 psf may be used in the overburden soils, but the top 5 feet should be neglected. Compressive side friction support is not recommended above limestone. An allowable tensile and compressive side friction value of 5,000 psf can be used after an initial 2-ft penetration into Limestone.

Settlement: Properly designed and constructed drilled shafts are expected to have a settlement of ½ inch or less.

Casing: Temporary casing and/or slurry drilling techniques will be required to properly install the drilled shafts. As discussed above, using temporary casing will be problematic and will require special monitoring if the casing is vibrated. Slurry drilling may be used instead, but will require a drilling company that specializes in this method.

There are numerous pitfalls to slurry drilling, such as the bearing stratum cannot be visually confirmed, and the concrete must be poured from the bottom up using a tremie. It may not be possible to create a thick enough slurry to prevent the sand soils from caving. With either method, several test piers would need to be installed to confirm the drilling methods.

Pier Spacing: The ***side friction*** for piers spaced horizontally less than 6 diameters (center to center) should be multiplied by a reduction factor as listed in Table 6.3 in the auger-cast pile recommendations.

Lateral Loads: Geotechnical parameters for lateral load resistance are shown in the previous Table 6.4 in the auger-cast pile recommendations.

INTERIOR SLABS

Interior Slabs: Slab on grade construction can be used at this site. However, the slab and grade beams system must be designed to be fully supported by the deep foundation system. If the existing landfill materials are left in place, these materials will be subject to adverse settlement. If instead the landfill materials are removed and replaced with select fill, settlement will still occur due to the depth of the select fill as it settles under its own weight.

One alternative is to replace all the landfill materials with select fill, and then place a surcharge load of fill on top of the select fill to accelerate settlement. This alternative can be further evaluated as the design progresses, if it is considered viable.

The slab and grade beams must be designed to span between and be completely supported by the deep foundation elements. It can be constructed on grade without void boxes. The intent of a structural slab is to design it to be completely supported by the deep foundations to avoid downward movement of the slab in the event that the soils settle over time.

MISCELLANEOUS GEOTECHNICAL PARAMETERS

Flatwork: This site is on relatively loose soils that will be subject to settlements. Be aware that flatwork such as sidewalks, drainage features, plazas, and utilities will be subject to adverse soil movements. The owner should be prepared to repair and even replace these items over time, depending on the magnitude of movement that actually occurs.

Where the ground is intentionally sloped and graded to provide positive drainage, the ground may settle sufficiently over time to reverse the intended drainage, and must be remediated when necessary. Cracks in ground-supported flatwork should be anticipated.

Smaller Structures: There will be various small structures or equipment pads at the site that can be supported with stiffened slab-on-grade construction. An allowable bearing pressure of 2,500 psf can be used for spread or continuous footings provided that at least 12 inches of clean stone is placed below the footings. The clean stone should extend laterally at least 12 inches past the edge of the footings, where practical. This will help to strengthen the soils at the site to provide a relatively uniform base for supporting the footings. The clean stone should be angular with particles

of about 3 to 5 inches in size. If constructed over existing fill materials, the slabs will be subject to settlement of an unknown amount.

Light Poles: We understand that small light poles will be installed and supported with drilled straight-shaft piers. Groundwater was encountered at depths of 22 to 25.5 feet below the existing grade, and will impact the depth to which piers can be drilled. The piers can only be effectively drilled to the depth in which groundwater is encountered. Depending on antecedent rainfall, the depth to groundwater will vary. From a design and constructability standpoint, we suggest that piers only extend about 18 feet below the existing grade. This may result in larger diameter piers than are used for typical light poles.

An allowable side friction value of 250 psf may be used for piers. The top 5 feet must be neglected for side friction calculations. End-bearing must also be neglected. Casing of the piers will likely be necessary due to caving soils. L-Pile parameters for lateral loads are provided in Table 6.4. For larger light poles, ACP's or Drilled Shafts must extend to limestone using the recommendations for the buildings.

Subgrade Improvement: Many of the onsite soils will be subject to pumping of the subgrade, and we should be contacted if this situation occurs. Clean crushed stone may be placed at the base of the excavations to create a firm working surface where needed and/or specified. We expect that a layer of about 8 to 10 inches in thickness will be needed if soft and/or wet subgrade conditions are present, but field conditions may dictate an increased thickness. If more than about 10 inches is needed, then a filter fabric may be needed on top of the stone to avoid migration of fines.

The crushed stone must be clean, and should generally range in size from 3 to 6 inches. Compaction specifications do not apply; however, the stone should be placed in such a manner that will stabilize the bottom of the excavations. This type of clean stone is normally used to stabilize construction entrances, and should be readily available.

Be aware that plumbing and other features that require trenching will be difficult to install if the trenches extend into clean stone.

Seismic: For structural designs based upon the 2012 IBC, the Site Class is D. The Mapped Spectral Response Acceleration at short periods (SS) is about 0.10g, and the Mapped Spectral Response Acceleration at a 1 second period (S1) is about 0.04g. Site Coefficients are as follows: Fa= 1.6 and Fv= 2.4.

Hazards associated with slope stability, soil liquefaction, surface rupture, and lateral spreading are not considered an issue with this site due to the study area being in a seismically inactive area and the site being underlain by bedrock.

Vapor Barriers: The need for vapor barriers, and where to place them, must be determined by the design team based on the proposed floor treatment, building function, concrete properties, placement techniques, and the construction schedule. When moisture barriers are used, precautions should be taken during the initial floor slab concrete curing period to reduce differential curing and possible curling of the slabs.

Review by MEP: We recommend that this report be provided to the project Mechanical, Electrical, and Plumbing engineers (MEP's). Their designs should account for adverse settlement within existing fill material. We are available to help with questions they may have about soil movements.

Connection to the Existing Structures: The addition to the Allison Indoor Practice Facility will connect to the existing building. Care must be exercised in all excavations to avoid undermining the existing foundations. Sheeting or shoring of excavations may be needed, and must be evaluated by an engineer specializing in excavation stability.

The new addition should be structurally isolated, to the extent practical, from the existing structure to avoid cracking at the interface. The existing foundation consists of footings over cement-treated base. We expect that differential movements will occur between the new/old structures because the existing foundations have settled over time.

Existing Foundations: It is critical that excavations near the existing foundation do not cave and create voids. Figures 6.5 and 6.6 show two usual methods of excavating for select fill placement. When the wedge method is used, special care must be taken during rain events to avoid erosion of the wedge. It is desirable to place the select fill promptly after the excavation is complete.

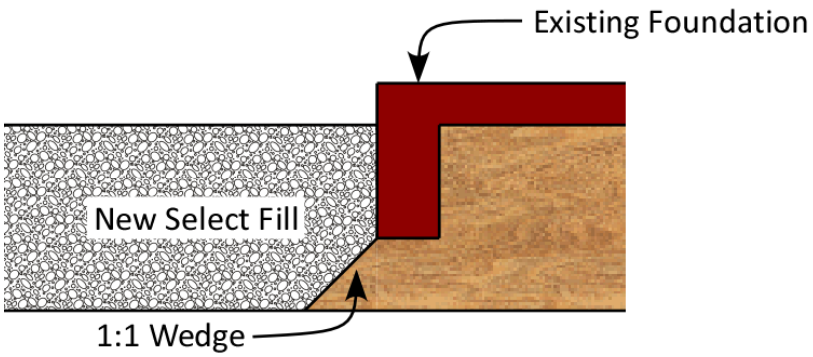


Figure 6.5: Create a 1:1 Wedge

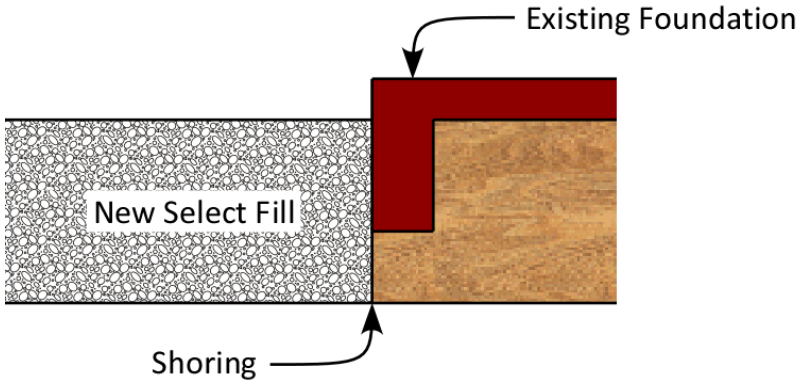


Figure 6.6: Install Shoring (designed by competent professional)

Excavations: The following paragraphs contain general comments regarding below grade excavations. Excavation characteristics, design of temporary support systems, and dewatering methods are the sole responsibility of the contractor. Accordingly, the following statements should be regarded only as opinions.

The upper sand and clay soils within roughly the top 55 feet are materials that can easily be excavated with conventional earth moving equipment.

The design of temporary excavation support systems, trench safety systems, and slope stability for temporary open cut excavations were not included our scope of services. The contractor is solely responsible for designing and constructing stable, temporary excavations and must shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations must comply with applicable local, state, and federal safety regulations including current OSHA Excavation and Trench Safety Standards. Construction site safety is generally the sole responsibility of the contractor, who shall also be responsible for the means, methods, and sequencing of construction operations. We are providing information in this report solely as a service to our client. Under no circumstances

should the provided information be interpreted to mean that LFE is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and must not be inferred.

In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Specifically, the current OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926 must be followed. The contractor's "responsible person" as defined in 29 CFR Part 1926, must evaluate the materials exposed in the excavations as part of the contractor's safety procedures. If an excavation, including a trench, is extended to a depth of more than twenty (20) feet, it will be necessary to have the side slopes designed by a professional engineer licensed in the State of Texas. The contractor's "responsible person" must establish a minimum lateral distance from the crest of the slope for vehicles, spoil piles, or other surcharge loads. Likewise, the contractor's "responsible person" shall establish protective measures for exposed slope faces.

The contractor must include the proximity to adjacent features when planning their method of excavation and support. These features include, but are not limited to, adjacent structures and utility lines. The contractor must also be prepared to manage varying amounts of subsurface water. Dewatering quantities will depend on drainage features, any groundwater, and rainfall prior to and during construction.

7.0 SITE RETAINING WALL RECOMMENDATIONS

Project Information: Retaining walls will be used throughout the site for various applications. Exterior walls will be used to accommodate changes in grade, and are expected to be less than 10 feet in height.

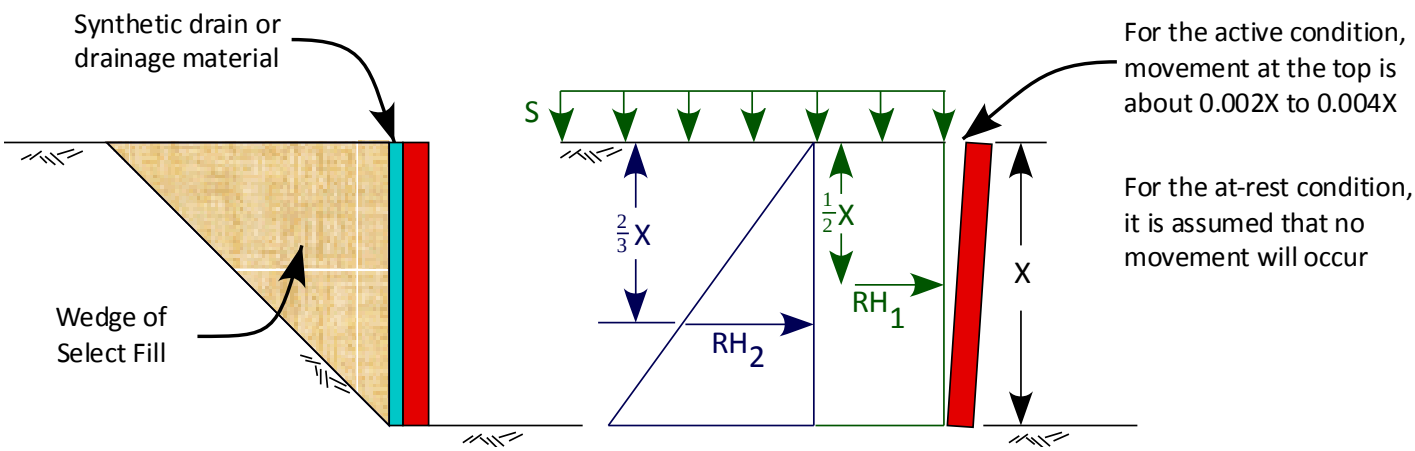


Figure 7.1: Sketch of Retaining Wall (not to scale, for illustrative purposes only)

TABLE 7.1: EARTH PRESSURE PARAMETERS

Earth Pressure	Coefficient	Equivalent Fluid Pressure (pcf)	Surcharge Pressure, P_1 (psf)	Earth Pressure, P_2 (psf)
At-Rest (K_0)	0.50	60	(0.50)S	60X
Active (K_A)	0.33	40	(0.33)S	40X
Passive (K_P)	3.0	360	--	--

- Values assume a 1H:1V wedge of select fill behind the wall with a unit weight of 120 pcf.
- Values assume that the wall is drained. Hydrostatic pressures must be added for an undrained condition
- Earth pressure parameters do not include a factor of safety
- Drainage material: ASTM C-33, Size 67 gravel aggregate, uniformly compacted
- Base sliding resistance: 500 psf or an ultimate coefficient of friction of 0.3
- Footing bearing pressure: 2,500 psf
- Resultant Horizontal Forces per linear foot:
  - R_{H1}= (P_1)(X), where R_{H1} is acting at ½X from the top of the wall
  - R_{H2}= (0.5)(P_2)(X), where R_{H2} is acting at ⅔X from the top of the wall

Footing Support: For the footing bearing pressure listed above, at least 12 inches of clean stone must be placed directly below the base of the footing. This will help to strengthen the sand soils at the site to provide a relatively uniform base for supporting the footing. The clean stone should be angular with particles of about 3 to 6 inches in size. Compaction specifications do not apply. Instead the stone must simply be installed in a manner that increase the firmness and stabilize the subgrade. This type of clean stone is normally used to stabilize construction entrances, and should be readily available. If constructed over existing fill materials, the slabs will be subject to settlement of an unknown amount.

8.0 GEOTECHNICAL CONSTRUCTION RECOMMENDATIONS

Site Preparation: Surficial vegetation, root systems, pavements, utilities, and any other underground structures must be removed. The stripping depth must be based on field observations with attention given to old drainage areas, uneven topography, and wet soils. Proof-rolling should be used to detect soft spots or pumping subgrade areas. Proof-rolling should be performed using a heavy pneumatic tired roller, loaded dump truck, or similar piece of equipment weighing at least 25 tons.

As discussed in this report, removal of existing fill materials will be subject to environmental studies and TCEQ requirements that have not yet been completed. Further geotechnical input will likely be required, depending on the results of the environmental studies.

Grading: Grading, landscaping, and drainage pose a significant risk factor for future performance of foundation systems. Preventing water from ponding around the foundation is critical. We suggest the following general guidelines for perimeter drainage:

1. The building pad or the finished floor elevation must be elevated above the exterior finished grade to assist in draining the surface water away from the structure.

2. Where possible, extend paved surfaces up to the building line to serve as a barrier to soil moisture evaporation and infiltration. These surfaces must slope away from the building.

3. Outlets for gutter systems must rapidly discharge water away from the foundation.

4. Roots from trees and decorative vegetation remove moisture from soils, which causes soil shrinkage (settlement). Trees should have root blockers near the foundation or be located as far away from the foundation as practical.

5. Sprinkler systems must be properly maintained and over-watering of the soils should be avoided.

Subgrade: The subgrade soils and on-site fill should be compacted to at least 95 percent of ASTM D698 (or TEX-113-E) maximum dry density at 0 to +3% of the optimum moisture content. A maximum compacted lift thickness of six inches must be specified, with each lift tested for compliance prior to the addition of subsequent lifts. The placement and compaction of fill material must be observed, monitored, and tested by LFE on a full-time

basis. Proof-rolling may be used in lieu of compaction testing of the subgrade, but will require approval by LFE on a case-by-case basis.

Select Fill: Fill should meet the requirements of 2004 TxDOT Item 247, Type A, Grade 3 or better. If another local source of select fill is desired, the following specification may be used as a guide:

Maximum Aggregate:	3 inches
Percent Retained on #4 Sieve:	25 - 50
Percent Retained on #40 Sieve:	50 - 75
Plasticity Index:	5 - 15
Non-Organic	

The select fill material should be compacted to at least 95 percent of ASTM D698 (or TEX-113-E) maximum dry density at 0 to +3% of the optimum moisture content. A maximum compacted lift thickness of six inches must be specified, with each lift tested for compliance prior to the addition of subsequent lifts. The placement and compaction of fill material must be observed, monitored, and tested by LFE on a full-time basis.

If existing fill soils are removed in accordance with environmental recommendations, and then replaced with select fill, it may be necessary to increase the compaction requirements for select fill. Additional geotechnical input will be required.

Foundations: Foundation construction recommendations for **drilled piers** and **footings** are listed below. **Auger-cast piles** are usually installed with a performance based specification, and should be constructed in a manner to meet or exceed the design capacities.

1. A minimum pier shaft diameter of 24 inches is normally specified to allow for cleaning, minimum construction tolerances, and conventional concrete mix designs.

2. Foundation construction must be observed by LFE to determine that the proper bearing material has been reached in accordance with the recommendations given herein.

3. Prior to the placement of concrete, water must be removed from foundation excavations. Prolonged exposure or inundation of the bearing surface with water may result in changes in bearing strength and compressibility characteristics. If delays occur, the drilled shaft and/or footing excavations should be deepened and cleaned, in order to provide a fresh bearing surface.

4. Concrete must be placed promptly after the excavations are completed, cleaned, and observed. Drilled piers must be concreted before the end of the work day.

5. The reinforcement steel cage placed in the shaft must be designed from the standpoint of meeting at least the following two requirements: (1) the structural requirements for the imposed loads; and (2) stability requirements during the placement of concrete.

6. Groundwater was encountered at depths of 22 to 25.5 feet during our field exploration. Drilled shafts will require temporary steel casing to seal out groundwater and prevent the pier holes from caving. Special concrete design and construction procedures as described in ACI 336.1 and ACI 336.3R should be specified in order to properly extract the casing during concrete placement. ACI requires placing concrete at a minimum slump of 6 inches when temporary steel casing is used.

   Slurry drilling may be used as an alternative, but will require a drilling company that specializes in this method. There are numerous pitfalls to slurry drilling, such as the bearing stratum cannot be visually confirmed, and the concrete must be poured from the bottom up using a tremie. It may not be possible to create a thick enough slurry to prevent the sand soils from caving.

   With either method, several test piers would need to be installed to confirm the drilling methods.

9.0 PAVEMENT RECOMMENDATIONS

Design Basis: We understand that there are three basic types of pavement that will be installed for the Football Operations Center:

Light duty pavement will be used for parking of passenger vehicles and light trucks.

Medium-duty pavement will consist primarily of drive lanes for light vehicles as well as *occasional* delivery trucks or buses.

Heavy-duty pavement will be accessed by semi-trailer trucks, trash trucks, and buses.

Risk: Pavement design methods are intended to provide an adequate thickness of structural materials over the subgrade to support the wheel loads. Design methods do not account for shrink and swell movements of expansive clays, nor do design methods account for settlement of existing fill materials. *The pavement may be adequate from a structural standpoint, yet still experience cracking due to movement of the subgrade.* It is critical to minimize moisture changes in the subgrade to reduce shrink/swell movements.

The pavement and adjacent areas must be well drained. Proper maintenance must be performed on cracks in the pavement surface to prevent water passing through to the base or subbase material. Extending the base material out about 2 feet from the edge of the pavement curb will also aid in reducing edge related cracking. Even with these precautions, some movements and related cracking may still occur. Routine maintenance is essential.

Using geogrids will help reduce damage from existing fill soils, but will usually increase the cost of the initial pavement installation. In the long-term, it has been our experience that using geogrids reduces maintenance costs and extends the pavement life.

Pavement "islands" often provide a means of water infiltration into the base and subgrade materials below the pavement. If islands are used, then we recommend that a synthetic lining or clay soils be used to limit infiltration of water into the base and subgrade. Water entry into the base and subgrade will cause softening of the materials, and will cause potholes and/or ruts to form.

The presence of trees and vegetation adjacent to paved areas will exacerbate the formation of cracks in pavements due to moisture loss in the subgrade from transpiration to the root systems of the vegetation. Soil moisture loss from vegetation can extend a distance from the vegetation about equal to its height. ***In general, concrete pavements perform better than asphalt pavements, especially in areas where trucks will start/stop and make turns.***

Traffic Loads: For pavement design purposes, traffic volumes are expressed as the number of Equivalent 18-kip single axle load applications (ESAL) over a 20 year theoretical pavement design life. We have summarized values for three primary traffic conditions.

We have computed the approximate types and volumes of different vehicles to aid in the design team's evaluation of the intended uses of the pavements.

TABLE 9.1: TRAFFIC ESTIMATES

Traffic Area	Typical Traffic	ESAL's	Reference Table
Light Parking Light Duty	Light cars and pickups, occasional medium delivery trucks, no heavy vehicles, similar to a low volume residential street.	20,000	Table 9.2A
Drive Lanes Medium Duty	Light cars and trucks, few heavy vehicles, similar to a moderate volume residential street.	60,000	Table 9.2B
Service Trucks and Buses Heavy Duty	Delivery Trucks, Buses, and Trash Trucks	100,000	Table 9.2C

TABLE 9.2A: ESTIMATED TRAFFIC CHARACTERISTICS (20,000 ESAL'S – LIGHT DUTY VEHICLE PARKING)		
Vehicle Type	***Gross Vehicle Weight (lbs)***	***Vehicles per Day***
Cars / Pickups	4,000	2,000
Medium Delivery Trucks	20,000	10
Heavy Trucks	60,000 to 80,000	1 per week

TABLE 9.2B: ESTIMATED TRAFFIC CHARACTERISTICS (60,000 ESAL'S – MEDIUM DUTY DRIVE LANES)		
Vehicle Type	***Gross Vehicle Weight (lbs)***	***Vehicles per Day (per lane)***
Cars / Pickups	4,000	4,000
Medium Delivery Trucks	20,000	20
Heavy Trucks	60,000 to 80,000	1

TABLE 9.2C: ESTIMATED TRAFFIC CHARACTERISTICS (100,000 ESAL'S – TRUCK AREAS)		
Vehicle Type	***Gross Vehicle Weight (lbs)***	***Vehicles per Day (per lane)***
Cars / Pickups	4,000	2,000
Medium Delivery Trucks	20,000	20
Heavy Trucks	60,000 to 80,000	4