GEOTECHNICAL ENGINEERING SERVICES REPORT

LAMAR COUNTY EMERGENCY FACILITY
2805 N MAIN ST
PARIS, TEXAS

Prepared For:
WA CIVIL, LLC

Prepared By:
EST, Inc.

EST PROJECT NUMBER
23-03666

December 8, 2023

3522 Sam Rayburn Hwy
Melissa, Texas 75454
Tel: (469) 907 5500
Texas Firm Reg.# F-10777

December 8, 2023

WA Civil, LLC
350 N. Collegiate Street, Suite 100
Paris, Texas

Attn : Larry H. Walker, PE, PMP

RE: Geotechnical Engineering Services Report
Lamar County Emergency Facility
2915 N Main St
Paris, Texas
EST Project Number: 23-03666

Mr. Walker:

EST has completed the geotechnical engineering services for the proposed Lamar County emergency facility building to be located at 2805 N Main St, in Paris, Texas.

The purpose of the subsurface exploration was to evaluate the geotechnical engineering properties of the near surface soils for the above referenced project. This report provides the information and geotechnical recommendations needed for the design and construction of the proposed building.

We appreciate the opportunity to work with you on this project. If you have any questions regarding the information contained in this report, please call us at (469) 907-5500.

Respectfully,
EST, Inc.

Ahmad Souri, Ph.D., P.E.
Geotechnical Engineering Manager
Eds@estinc.com

STATE OF TEXAS
AHMAD SOURI
137340
LICENSED
PROFESSIONAL ENGINEER

Digitally signed by Ahmad Souri, PhD, PE
Date: 2023.12.08 14:30:12 -06'00'

TABLE OF CONTENTS

APPENDICIES

1.0 Introduction

Project Description. The project is located at 2805 N Main St, in Paris, Texas. The project consists of a proposed metal building (footprint approximately 19,000 SF) and associated parking areas. The general location and layout of the project site are provided in Appendix A.

Project Authorization. This geotechnical investigation was authorized by Mr. Larry Walker with WA Civil, LLC and performed in accordance with EST Proposal dated October 16, 2023.

Report Specificity. This report was prepared to meet the specific needs of the client for the specific project identified. Recommendations contained herein should not be applied to any other project at this site by the client or anyone else without the explicit approval of EST.

2.0 Subsurface Exploration

The subsurface exploration was completed on October 20, 2023. The table below summarizes the soil borings performed. The boring location plan is provided in Appendix A.

Summary of Soil Borings			
Boring ID	Depth (feet)	Date Drilled	General Location
B-01	25	10/20/2023	Building Area
B-02	25	10/20/2023	
B-03	5	10/20/2023	Parking and Driveways
B-04	5	10/20/2023	

The project was accessed with a CME-55 track-mounted, rotary drilling rig equipped with 4-inch hollow stem augers. Representative soil samples were obtained using the Shelby Tube sampling procedure in general accordance with ASTM Specification D1587 and using Standard Penetration Test (SPT) sampling procedures in general accordance with ASTM Specifications D1586. Texas Cone Penetration (TCP) test was performed to evaluate the strength characteristics of rock materials and according to TxDOT Tex-132-E procedure and TxDOT geotechnical manual.

The SPT sampling process utilizes a split-barrel (two-piece) sampling tube to obtain soil samples. A 2-inch outside diameter sampling tube is hammered, using an automatic drive hammer, into the bottom of the boring with a 140-pound weight falling 30 inches. The number of blows required to advance the tube the last 12 inches of an 18-inch sampling interval or portion thereof is recorded as the standard penetration resistance value, SPT-N value. The in-situ relative density of granular soils and the consistency of cohesive soils can be estimated from the SPT-N value. The uncorrected, SPT-N values recorded for each test are shown on the attached boring logs at their relative sampling depths.

TCP test was performed by driving a 3-inch outside diameter steel cone with a 170-pound weight falling 24 inches. The number of blows for 12 inches of penetration, or the inches of penetration due to 100 blows of the hammer, whichever occurs first, are recorded. The TCP blow counts and penetration values recorded for each test are shown on the attached boring logs at their relative test depths.

The soil borings were located in the field by an EST representative using handheld GPS device with horizontal accuracy of 20 feet. The approximate boring locations and depths are provided in the boring location diagram included in Appendix A of this report.

As part of the drilling operations, the drill crew prepared field boring logs. The drill crew examined the samples retrieved during drilling operations and recorded a soil description on the field boring logs. The split-barrel samples were packaged in plastic bags to reduce moisture loss and tagged for identification. The Shelby tube and split-barrel samples were transported to our laboratory for further evaluation. The field boring logs also include the visual classifications of the auger sample materials encountered during drilling and the engineer's interpretation of the subsurface conditions between samples. This report contains the final boring logs that represent some modifications based on the engineer's evaluation and the laboratory test results of the soil samples.

3.0 Site Conditions

3.1 Seismic Site Classification

Based on the subsurface materials encountered during our investigation and the 2018 International Building Code (IBC), the site class is "C". This site class should be used when designing the foundation systems for this project. The following seismic design parameters based on the 2018 IBC may be used.

Seismic Site Classification and Parameters		
Site Class	C	
Seismic Design Category	A	
Approximate Site Coordinates	Latitude	33.690652° N
	Longitude	95.555256° W
S_s – MCE_R Acceleration (Short period)	0.135g	
S_1 – MCE_R Acceleration (1.0s period)	0.069g	
S_{MS} – Site Modified MCE_R Acceleration (Short period)	0.176g	
S_{M1} – Site Modified MCE_R Acceleration (1.0s period)	0.104g	

Seismic Site Classification and Parameters	
S_{DS} – Design MCE_R Acceleration at 5% Damping (Short period)	0.117g
S_{D1} – Design MCE_R Acceleration at 5% Damping (1.0s period)	0.069g
F_a – Site Amplification Factor (Short period)	1.3
F_v – Site Amplification Factor (1.0s period)	1.5
*MCE_R = Maximum Considered Earthquake Ground Motion Response.	

3.2 Historical Aerial Photographs Review

Historical aerial photographs of the site were reviewed for potential past alterations to the site which could impact our geotechnical recommendations. Specifically, aerial photographs were reviewed to visually assess obvious areas of significant past fill on site. Aerial photographs reviewed for this study are identified below and are included in Appendix C.

Year	Observations Since Prior Aerial Photograph
1995	The site areas were part of truck parking. Concrete pavement was noted at parts of the site.
2005	No visible changes.
2008	No visible changes.
2013	No visible changes.
2021	No visible changes.

Our review of past aerial photographs revealed no obvious areas of fill onsite. Due to previous site use (truck parking) we anticipate disturbance of near surface soil in those areas.

Limitations. Due to the intermittent nature, relatively low resolution of aerial photographs, and lack of detailed information regarding the past site use, our review should not be considered a thorough and complete review of the site history. Therefore, significant activities including undocumented fills may be missed from our review.

3.3 Topography

A topographic map of the site is provided in Appendix C. The map indicates the site generally slopes to the west and southwest.

3.4 Geology

Based on available surface geology maps, it appears this site is located in the Bonham Formation. A geologic map and USGS formation description are provided in Appendix D. Soils associated with the Bonham Formation generally consists of high plasticity clays overlying Marl.

3.5 Stratigraphy

Descriptions of the soil layers (per ASTM Unified Soil Classification System, USCS) encountered and their approximate depths are provided in the boring logs included in Appendix B. A summary of the stratigraphy indicated by the borings is provided below.

<table>
<tr><th colspan="4">Generalized Subsurface Conditions at Proposed Building Area
(Borings B-01 and B-02)</th></tr>
<tr><th colspan="2">Depth from Existing Ground Surface (feet)</th><th rowspan="2">Soil/Rock Description</th><th rowspan="2">Detailed Description of Soils/Rock Encountered</th></tr>
<tr><th>Top of Layer</th><th>Bottom of Layer</th></tr>
<tr><td>0</td><td>25</td><td>FAT AND LEAN CLAY</td><td>Stiff to very stiff FAT CLAY WITH SAND (CH) / FAT CLAY (CH), stiff to very stiff SANDY LEAN CLAY (CL) / LEAN CLAY WITH SAND (CL).

Exception:
• GRAVEL / SAND at 0 to 11in. at Boring B-02.
• Stiff CLAYEY SAND (SC) at 4 to 6-feet at Boring B-02.</td></tr>
<tr><td colspan="4">* Boring Termination Depth = 25 feet from ground surface.</td></tr>
</table>

3.6 Groundwater Conditions

Groundwater was not encountered in any of the borings during or immediately after the completion of drilling operations. Groundwater level fluctuations and/or perched water conditions may occur due to seasonal variations in the amount of rainfall and other factors such as drainage characteristics. To obtain more accurate groundwater level information, long-term observations in a monitoring well or piezometer that is sealed from the influence of surface water would be needed. The possibility of groundwater level fluctuations should be considered during the preparation of construction plans.

3.7 Corrosion Potential and Cement Type

The corrosion potential (for concrete and steel) of on-site soils was evaluated using the United States Department of Agriculture's (USDA) Web Soil Survey maps, which are provided in Appendix F. According to the USDA Web Soil Survey maps, the on-site materials present a high risk of corrosion to steel and a moderate exposure of concrete to sulfate containing solutions. Therefore, we recommend that preventative measures against steel corrosion be considered. In many cases, polyethylene encasement or epoxy-coated resin have been used to protect buried ferrous metals or ductile iron pipes.

For concrete elements at this site, we recommend using ASTM C150, Type I/II Portland cement (or equivalent type) with a maximum water to cement ratio (w/c) of 0.50 and a minimum compressive strength of 3,000 psi.

4.0 Laboratory Testing

All samples obtained from the project site were transferred to our laboratory for processing and/or testing. Laboratory tests were performed on select soil samples in agreement with the applicable ASTM testing procedures. Laboratory testing included estimation of the natural moisture content (ASTM D2266), Atterberg limits (ASTM D4318), sieve analysis (ASTM D2487), one-dimensional swell of soils (ASTM D4546), and soluble sulfate content in soils (Tex-145-E). The results of moisture content, Atterberg limits, and sieve analysis tests can be found in the boring logs provided in Appendix B.

4.1 Swell Potential Based on Atterberg Limits

Atterberg limits for 6 soil samples within the top 10 feet were used to evaluate the swell potential of onsite soils. The plasticity index (PI) of the samples was between 26 and 49 with an average of 36 indicating that the soils have a high potential for shrinking and swelling with changes in soil moisture content.

4.2 One Dimensional Swell Tests

One dimensional swell tests (ASTM D4546) were performed on select clay soil samples. Detailed swell test results are provided in Appendix B. The results of these tests are summarized below.

Boring ID	Sample Depth (feet)	Initial Moisture Content (%)	Liquid Limit (LL)	Plasticity Index (PI)	Applied Load (tsf)	Swell (%)
B-01	6-8	29.3	71	49	7/16	2.39
B-02	0-2	28.4	59	42	1/16	0.87
B-02	4-6	24.2	37	26	5/16	2.25

4.3 Soluble Sulfate Tests

Soluble sulfate tests (Tex-145-E) were performed on select soil samples. Detailed sulfate test results are provided in Appendix B. The results of these tests are summarized below.

Boring ID	Depth (feet)	Soluble Sulfate Concentration (ppm)
B-01	2-4	<100
B-02	0-2	<100
B-03	0-2	<100

5.0 Evaluation and Recommendations

5.1 Potential for Vertical Rise (PVR)

TxDOT Tex-124-E method was used to evaluate the potential for vertical rise (PVR) of onsite soil materials. The calculated PVR is an empirical estimate of a soil's potential for swell based upon the soil's plasticity, applied loading (due to structures or overburden), and antecedent moisture content. The wetter a soil's antecedent moisture content, the lower its calculated PVR will be for a given plasticity index and load. However, soils with a higher antecedent moisture content will be more susceptible to shrinkage due to drying. Maintaining a consistent moisture content in the soil is the key to minimizing both swell- and shrink-related structural problems. The calculated PVR values below should not be considered as absolute values that will occur, but rather an approximate estimate based on industry standard practice and local experience. Extreme changes in soil moisture may occur in events such as but not limited to ponding water, leaking water lines, inadequate drainage and nearby trees causing soil desiccation. Thus, movements that exceed those calculated below may be encountered. Regular maintenance should be provided to address any potential detrimental issues that may affect the soil moisture during the lifespan of the structure.

<u>Estimated PVR Using Tex-124-E Method</u>. We estimated a PVR value of about 2.5 to 3.0 inches for onsite soils assuming dry to average antecedent moisture condition. A 10 feet zone of seasonal moisture change was used in our PVR estimate.

<u>Estimated PVR From Swell Tests</u>. We estimated a PVR value of about 2.0 to 2.5 inches using the swell test results. It should be noted that the PVR from the swell tests is dependent on the samples' moisture content at the time of testing. A 10 feet zone of seasonal moisture change was used in our PVR estimate.

5.2 Short-Term Construction Excavations

<u>Sloped (un-supported) Excavations</u>. On-site sloped (un-supported) short-term construction excavations should be designed in accordance with Occupational Safety and Health Administration (OSHA) excavation standards. Based on our investigation, the on-site soils may be classified as Type B (per OSHA classification system) from the ground surface to a depth of 10-feet. Short-term construction excavations in Type B soils may be constructed with a maximum slope of 1H:1V (horizontal to vertical)

to a depth of 10-feet. If excavations are to be deeper than 10-feet, EST should be contacted to evaluate the excavation. Recommendations provided herein are not valid for any long-term or permanent slopes on-site.

Shored Excavations. Vertical short-term construction excavations may be used in conjunction with trench boxes or other shoring systems. Shoring systems should be designed using an equivalent fluid weight of 85 pounds per cubic foot (pcf) above the groundwater table and 105 pcf below the groundwater table excluding the effect from surcharge loads. If present, lateral pressure from surcharge loads (dead and live) at the ground surface should be added to the lateral earth pressures calculated. Lateral pressures from surcharge can be estimated using a lateral earth coefficient of 0.5 and assumed to act as a uniform pressure along the upper 10-feet of the excavation. Surcharge loads located at a horizontal distance (from the edge) equal to or greater than the excavation depth may be ignored. We recommend a maximum of 200 feet of unshored excavation be open at any one time to prevent the possibility of failure and excessive ground movement. Unshored excavations should not remain open for a period longer than 24-hours.

Limitations. Recommendations for short-term construction excavations assume there are no nearby structures or other improvements that might be detrimentally affected by the construction excavation. If there are nearby structures or improvements, EST should be contacted before proceeding in construction to evaluate the construction excavations.

Excavation Monitoring. Excavations should be monitored to confirm site soil conditions consistent with those encountered in the borings drilled as part of this study. Discrepancies in soil conditions should be brought to EST attention for review and revision of recommendations, as appropriate.

5.3 General Site Development

Site Preparation. We recommend removing all existing structures, trees, pavements, vegetation, topsoil, and any other unsuitable materials from the construction areas. We also recommend removing any existing stumps, roots larger than 2 inches in diameter, rocks larger than 3 inches in diameter, and any matted roots from the proposed construction area. After removing all vegetation and unsuitable materials, the exposed surface should be proofrolled.

Proofroll. We recommend proof-rolling the exposed subgrade for building and paving areas. Proof-rolling should be performed in overlapping passes and in mutually perpendicular directions using equipment with minimum subgrade loadings of 25 tons. The proofroll should be performed after the final grade is established in areas to be cut. In areas to be filled, the proofroll should be performed prior to fill placement. Areas of loose or soft subgrade encountered in the proofroll should be removed and replaced with engineered fill and compacted in place as per our recommendations in section 5.5 - "Fill and Compaction". The Geotechnical Engineer or his representative should be present to witness the removal of the unsuitable materials and the proof-rolling process.

Subgrade Scarification. After proofroll and prior to any fill placement, subgrade in building and paving areas should be scarified to a minimum depth of 6 inches, moisture conditioned and compacted to 92 to 98 percent of the material's maximum dry density and at a workable moisture level at least 4 percentage points above optimum per ASTM D698.

Grading and Drainage. Standard construction practices of providing good surface water drainage should be used. A positive slope of the ground for drainage away from any foundation should be provided. Ditches or swales should be provided to carry the run-off water both during and after construction. Stormwater runoff should be collected by gutters and downspouts and should discharge away from the buildings.

Trees and Plants. Root systems from trees and shrubs can affect soil moisture causing subgrade soils to dry and shrink. Soil drying and shrinking leads to settlement beneath grade slabs such as floors, sidewalks and paving. If shrubs or bushes are placed next to building slabs, an impervious membrane should be used to separate the slabs from the shrubs to limit any infiltration of water under the slab. Trees and large bushes should be located a distance equal to at least one-half their anticipated mature height away from grade slabs. Lawn areas should be watered moderately, without allowing the clay soils to become too dry or too wet.

5.4 Demolition Considerations

Based on our review of the historical site aerial photos, there are existing facilities present on the site and expected to be demolished. We recommend the demolition and removal operations be carefully performed for existing floor slabs, foundations, utilities, and pavements to minimize disturbance to the subgrade. Excessive disturbance of subgrade soils from demolition activities can have detrimental effects on any planned foundation and flatwork elements for the new development. Our guidelines presented herein should be followed during demolition activities.

Existing Foundations. Existing foundations can be slabs, shallow footings, or drilled piers. Slabs or shallow footings should be completely removed. Drilled piers should be cut off to an elevation at least 24-inches below proposed bottom of slabs, grade beams, footings, utility lines, or final subgrade, whichever is deeper. The remainder part of the drilled pier should remain in place. Foundation elements left in place should be surveyed and superimposed on the proposed plans for the new development to determine the potential for obstructions to the planned construction. If drilled piers are planned to be completely removed, EST should be contacted to review the removal procedures and provide additional recommendations, as necessary.

Existing Utilities. Existing utilities and bedding from previous development should either be completely removed or may be abandoned in place if they do not interfere with the new planned development. Abandoned utility piping should be properly pressure-grouted and completely filled.

Backfill. Any soil material resulting from the removal of existing foundations and utilities should be backfilled according to our recommendations in Section 5.5 – "Fill and Compaction" of this report, as appropriate.

5.5 Fill and Compaction

Select Fill. Select fill consists of low PI material with at least 25 percent passing the No. 200 sieve, having a liquid limit less than 35, and a plasticity index between 8 and 20. Select fill should be placed in lifts not exceeding 8 inches in loose thickness and compacted to at least 95 percent of the material's maximum dry density and at a moisture content between optimum and +4 percent of the optimum moisture content per ASTM D698. Select fill soils placed during construction should be checked routinely to verify its conformance with the requirements.

Lime Treatment for Native Soil. Onsite soils treated with hydrated lime may be used in lieu of importing select fill. We estimate a minimum of 7 percent hydrated lime based on the maximum dry density of the unmodified materials will be required to adequately lower the PI of onsite soils. We recommend "Lime series" test be performed to determine the proper percentage of hydrated lime required to adequately lower the PI of the native material to below 15. Lime treated soils should be placed in loose lifts not exceeding 8 inches and should be uniformly compacted to a minimum of 95 percent maximum dry density and within ±2 percent of the optimum moisture content per ASTM D698. We recommend the Geotechnical Engineer or a qualified testing firm be hired to perform routine laboratory testing to verify the treated on-site materials are suitable for construction. Further, we recommend that routine sulfate screening be performed to verify sulfate concentrations are within acceptable ranges for lime modification to prevent sulfate-induced heave.

General Fill. General fill may be used in areas outside of the building pad. General fill should consist of clean onsite material or other import material as approved by the Geotechnical Engineer. General fill should be placed in loose lifts not exceeding 8 inches and should be uniformly compacted to a minimum of 95 percent maximum dry density and within -1 and +3 percent of the optimum moisture content per ASTM D698.

Unsuitable Materials. Materials considered unsuitable for use as select fill or general fill include low and high plasticity silt (ML and MH), silty clay (CL-ML), organic clay and silt (OH and OL) and highly organic soils such as peat (Pt). Such materials may be used for site grading and in unimproved areas as approved by the Geotechnical Engineer. Soils placed in unimproved areas should be placed in loose lifts not exceeding 10-inches and should be compacted to at least 90 percent maximum dry density and at a moisture content within ±3 percentage points of optimum per ASTM D698.

Fill Testing. During compaction operations, the exposed subgrade and each lift of compacted fill should be tested for moisture and density and reworked as necessary until that surface is approved by the Geotechnical Engineer's representative prior to the placement of additional lifts. We recommend the scarified surface and each lift of fill be tested for density and moisture content at a rate of:

- One test per 2,500 square feet for building areas, or a minimum of two tests per compacted lift.
- One test per 5,000 square feet for paving areas, or a minimum of two tests per compacted lift.
- One test per 150 linear feet of utility trench backfill, or minimum of two tests per compacted lift.

5.6 Subgrade Treatment for Slab-on-Grade

Based on our investigation, a slab constructed on grade in this site will be subjected to a PVR up to 3.0 inches. We recommend performing subgrade treatment for the building pad to reduce the PVR to the allowable post construction PVR value of 1.0 inch. Subgrade treatment may be performed by using select fill or moisture conditioning of existing soils.

Subgrade Treatment Using Select Fill. We recommend subgrade treatment to the depths shown in the table below for select fill option.

Subgrade Treatment Using Select Fill		
Allowable PVR (inches)	Minimum Thickness of Select Fill (feet) [1, 2]	Thickness of Compacted Subgrade below Select Fill (inches) [3]
1.0	10	6

Notes:

1. Depth measured below bottom of the slab-on-grade.
2. Select fill material should meet the requirements and placed as discussed in section 5.5 – "Fill and Compaction" of this report.
3. The subgrade to receive select fill soil should be scarified to a depth indicated above. The scarified subgrade should be compacted to 92 to 98 percent of the material's maximum dry density and at a workable moisture level at least +4 percentage points above optimum per ASTM D698.

Subgrade Treatment by Moisture Conditioning. We recommend subgrade treatment to the depths shown in the table below for moisture conditioning option.

Subgrade Treatment Using Moisture Conditioning		
Allowable PVR (inches)	Thickness of Moisture Conditioned Soil and Cap (feet) [1, 2, 3]	Thickness of Cap (inches) [4, 5]
1.0	10	8

Notes:

1. Depth measured below bottom of the slab-on-grade.
2. Moisture conditioned native clay soil should be compacted to 92 to 98 percent of the material's maximum dry density and at a workable moisture level at least +4 percentage points above optimum (ASTM D698) and placed in loose lifts not exceeding 9 inches.
3. The cap material must be placed above the moisture conditioned soils in a reasonable period of time (within 48 hours) following completion of the moisture conditioning process to prevent the loss of soil moisture. If the surface of the moisture conditioned soils is allowed to dry and crack prior to placement of the cap, the dry soils should be reworked and placed in a moisture conditioned state.
4. Lime should be applied at a minimum rate of 42 pounds per square yard for a depth of 8 inches. Lime stabilization should be performed in accordance with TxDOT Standard Specifications Item 260 "Lime Treatment", or local equivalent. Lime treated soils should be uniformly compacted to a minimum of 95 percent maximum dry density and within ±2 percent of the optimum moisture content per ASTM D698
5. In lieu of lime stabilized soil cap, flexible base may be used for the cap. The flexible base should meet the requirements of TxDOT Standard Specifications Item 247, Grade 1-2, Type A or D, or equivalent. Flexible base should be compacted to at least 95 percent maximum dry density (per ASTM D698) and within ±2 percent of the optimum moisture content.

Building Pad Construction Recommendations. The extent of the pad preparation area should extend at least 5 feet laterally from the building slab edges. Subgrade treatment should also extend beneath abutting sidewalks and exterior doorways to prevent differential heaving between exterior sidewalks and doorways resulting in doors being stuck or difficult to open.

The ground surface should be sloped away from the building on all sides to prevent water from collecting near the building. Water should not be allowed to pond near the building during or after construction. In addition, the moisture content of the soil should be maintained until the slab is constructed. Therefore, the building pad should always contain enough moisture so that surface cracks do not develop. We recommend the moisture content of the building pad be evaluated just before concrete for the slab is placed.

Moisture/Vapor Retarder. We recommend placing vapor barrier (10-mil minimum thickness) underneath the slab for areas to be covered with flooring such as wood, tile, and/or carpeting. The designer may refer to ACI 302 and ACI 360 standards for procedures and cautions regarding the use and placement of a vapor retarder.

5.7 Foundation System

Assumed Maximum Cut Depth. Recommendations provided herein assume that the finish grade for the building pad is within 1 foot of existing site grade. In the event the finish grade requires more than 1 foot of cut or fill, we should be contacted to review the design and assess the suitability of the foundation recommendations provided.

Foundations Adjacent to Slopes. Foundation recommendations provided herein assume the foundations are not adjacent to slopes in excess of 5:1 (H:V). Foundations located in close vicinity to slopes steeper than 5:1 may experience reduced bearing capacities and/or excessive settlement. Any foundations closer than 5 times the depth of adjacent slopes or excavations in excess of 5:1 should be brought to our attention so that we can review the appropriateness of our recommendations.

Slab-on-Grade

A reinforced slab may be used to support the building additions. The slab should be adequately designed with exterior and interior grade beams to sustain the vertical soil movements (PVR of 1.0in.). We recommend the slab be designed using a net dead load plus sustained live load of 1,500 psf or a net total load pressure of 2,250 psf, whichever results in a larger bearing surface. These bearing pressures are based on a safety factor of 3 and 2, respectively, against shear failure of the foundation bearing soils. Grade beams should be found at a minimum of 18 inches below surrounding grade (supported on select fill or moisture conditioned soils, depending on the subgrade treatment implemented). The bottom of the beam trenches should be free of any loose or soft material prior to the placement of the concrete.

Underreamed Drilled Piers

Underreamed drilled pier foundations bearing in native soil may be utilized at this site for the proposed building. For slab-on-grade supported by drilled piers option, our recommendations in section 5.6 – “Subgrade Treatment for Slab-on-Grade” for 1-inch allowable PVR should be followed. For suspended structural slab option, our recommendations are presented in Section 5.8 – “Suspended Structural Slab”.

Foundation Depth and Bearing Capacity. We recommend that underreamed piers should be found at a depth of 17 feet beneath the existing grade. The piers may be proportioned using a net dead load plus sustained live load bearing pressure of 4,000 psf or a net total load pressure of 6,000 psf, whichever condition results in a larger bearing surface. These bearing pressures are based on a safety factor of 3 and 2, respectively, against shear failure of the foundation bearing soils.

Settlement. Foundation settlement for drilled piers constructed as described above should be less than 1 inch.

Lateral Capacity. We recommend soil resistance to lateral loads on drilled piers be ignored in the upper 3-feet of the soil profile. The following LPILE design parameters are recommended for use in lateral load pier design.

Depth (feet)	Soil Type	LPILE Model	Effective Soil Unit Weight (pcf) [1]	Undrained Shear Strength (psf) [2]	Strain at 50% of Peak Strength, ε_{50}	Soil Modulus of Horizontal Subgrade Reaction, k (pci)
0 - 3	Native Soil / Clay Fill	Soft Clay (Matlock)	125	50	0.02	10
3 - 10	Moisture Conditioned / Fill Soil	Soft Clay (Matlock)	125	400	0.01	100
3 - 18	Native Untreated Soil	Stiff Clay w/o water (Reese)	125	1000	0.007	400

Notes:
1. Effective soil unit weight based on assumed groundwater depth greater than 25-feet.
2. Based on Factor of safety of 2.

Uplift. The uplift force on the piers due to swelling of the active clays can be approximated by assuming a uniform uplift pressure of 800 psf for moisture conditioned soil or select fill or 1500 psf for untreated native soil acting over the perimeter of the shaft to a depth of 10 feet. The shafts should contain sufficient full length reinforcing steel to resist uplift forces.

Uplift Resistance. The uplift resistance provided by an underreamed drilled pier is the sum of resistance provided by the shear strength of the soil, the weight of the soil above the bell and the weight of the drilled pier itself. The following equation may be used to calculate the allowable uplift resistance:

$$F_a = R_F c N_u A_u + \frac{W_s}{FS_1} + \frac{W_c}{FS_2}$$

Where:

F_a is allowable uplift resistance (lb),

c is allowable soil cohesion (psf),

N_u is bearing capacity factor = $3.5([D_b - 10]/B_b) \leq 8.0$

R_F is reduction factor for closer pier spacings (see below),

D_b is depth to base of bell (ft),

B_b is diameter of the bell (ft),

A_u is projected area of bell outside the shaft = $\pi(B_b^2 - B_s^2)/4$,

B_s is diameter of straight portion of pier (ft),

W_s is weight of soil above the bell (lb),

W_c is weight of drilled pier (lb),

FS_1, FS_2 are factors of safety for soil weight and weight of pier, respectively. We recommend FS_1 value of 1.2 and FS_2 value of 1.1.

An allowable cohesion c = 600 psf (using factor of safety of 3) may be used and is appropriate for sustained loading conditions. The allowable cohesion value may be increased for transient loading conditions by multiplying the value by 1.5.

Shaft/Diameter Ratio. The piers should be provided with an underream diameter to shaft diameter ratio not less than 2.5 to 1 and not greater than 3 to 1.

Pier Spacing. Piers should not be spaced closer than two underream diameters (edge to edge) based on the diameter of the larger bell. Closer pier spacings may result in reduced uplift capacity and increased settlements. We should be contacted to review closer pier spacings on a case-by-case basis.

Reduction Factor (R_F) for Closer Pier Spacings. A reduction in uplift resistance will be required for piers spaced closer than two bell diameters (edge to edge). The reduction factor is dependent on the number of piers in close proximity to the pier in question. The following table shows the recommended Reduction Factor (R_F) values based on number of piers in close proximity to the pier in question:

Numbers of Piers in Close Proximity to a Given Pier	Reduction Factor (R_F)
Piers Spaced Greater than 2x Diameters Edge-to-Edge Spacing	1.0
1	0.6
2	0.4
3	0.2
Greater than or equal to 4	0

There will be no reduction in uplift resistance contribution from the weight of soil above the bell and weight of drilled pier.

Construction Observation. Construction of piers should be observed by qualified engineer representative/inspector to ensure:

1. The bearing stratum and penetration depth are per the design.
2. The bell/underream size is per design.
3. The removal of all cuttings and loose materials.
4. That groundwater seepage, if encountered, is handled correctly.
5. The shafts are vertical (within acceptable tolerance).
6. That the top of the shafts in contact with clay are not enlarged (i.e., mushroomed).

Groundwater. Groundwater was not encountered during our subsurface investigation. However, groundwater may be encountered during pier excavation and the risk of groundwater seepage is increased during or after periods of precipitation. Submersible pumps may be capable of controlling seepage in the pier excavation to allow for concrete placement.

Recommended Construction Specifications. Drilled shaft foundations construction specifications are found in TxDOT Item 416 (Drilled Shaft Foundations), or ACI 336.3 (Design and Construction of Drilled Piers). These specifications include requirements for construction using casing or the slurry displacement method, as appropriate.

Concrete Placement. Concrete should be placed in the shafts immediately after excavation to reduce the risk of significant groundwater seepage, deterioration of the foundation-bearing surface and underream collapse. *In no event should a pier excavation be allowed to remain open for more than 8 hours*. Concrete should have a slump of 5 to 7 inches and should not be allowed to strike the shaft sidewall or steel reinforcement during placement.

5.8 Suspended Structural Slab

A suspended structural slab supported on underreamed drilled piers may be used for the proposed building. If a structural floor slab is to be installed, a minimum of 6-inch void space between the bottom of the slab or grade beams and the underlying ground surface should be maintained. This can be provided by crawl space or using void forms. Any fill placed within the building areas for grading or backfill around grade beams/pier caps should be moisture conditioned soil. Moisture conditioned soil should consist of clean material free of debris or organics and compacted to 92 to 98 percent of the material’s maximum dry density and at a workable moisture level at least +4 percentage points above optimum (ASTM D698) and placed in loose lifts not exceeding 8 inches.

Grade Beams and Pier Caps. Where applicable, all grade beams supported by piers and pier caps should be formed and not cast against earthen trenches. Grade beams and pier caps should be formed with a minimum 6-inch void at the bottom. Structural cardboard forms should extend to the full length and width of the grade beams and pier caps. Soil retainers should be provided to prevent soils adjacent to grade beams and pier caps from sloughing into the void space. Soil retainers should extend at least 4 inches above the bottom of the grade beam and the same distance below the bottom of void space. Backfill soils placed adjacent to grade beams and pier/pile caps must be moisture conditioned and compacted to 92 to 98 percent of the maximum dry density at a moisture level at least +4 percentage points above the optimum moisture content (ASTM D698).

Utility Lines Under Slab. Provisions should be made to protect utility lines under the slab from differential movement from swelling soils. For utilities passing through grade beams, sleeves allowing a minimum of 4 inches of void space above and below the utility line can be utilized.

5.9 Pavement

Rigid pavement (concrete) may be used for parking areas and driveways. Traffic data indicating the number and type of vehicles on which to base the pavement design was not provided. Therefore, our recommendations are based upon our experience and assuming normal vehicular loading. Any unusual loading conditions should be brought to our attention prior to finalizing the pavement design so that we assess and modify our recommendations as necessary.

Reinforced Concrete Pavement. Portland cement concrete with a minimum 28-day compressive strength of 4,000 pounds per square inch (psi) should be used. Grade 60 reinforcing steel should be used in the transverse and longitudinal directions. The following pavement thicknesses and reinforcing are recommended.

Pavement Use	Thickness (inches)[1]	Steel Reinforcing
Light Duty Pavement Passenger Cars and Light Trucks	5	No. 3 bars spaced at 18-inch intervals each way
Heavy Duty Pavement Heavy Trucks and Dumpsters	7	No. 3 bars spaced at 18-inch intervals each way
Notes: 1. Thickness based on design life of 20 years and reliability of 90%.		

Concrete pavement thicknesses provided above can be increased an extra 1-inch in lieu of lime stabilization of the pavement subgrade.

The maximum control joint spacing should be 15 feet. Saw cut control joints should be cut within 6 to 12 hours of concrete placement. Where not specified herein, concrete pavements should comply with TxDOT Item 360 - "Concrete Pavement", or local equivalent.

Pavement Subgrade. Based on our investigation, the onsite subgrade soils consist of high plasticity clay. The pavement subgrade should be placed in loose lifts not exceeding 8-inches and should be uniformly compacted to a minimum of 95 percent maximum dry density and within ±2 percent of the optimum moisture content per ASTM D698. We recommend the subgrade be stabilized using lime treatment as shown below.

Reagent	Application Rate (pounds per square yard)[1]	Application Depth (inches)
Lime	32	6
Notes: 1. Based on 7% lime by dry weight of soil.		

Lime stabilization should be performed in accordance with TxDOT Item 260 - “Lime Treatment”, or local equivalent.

6.0 Closing and Limitations

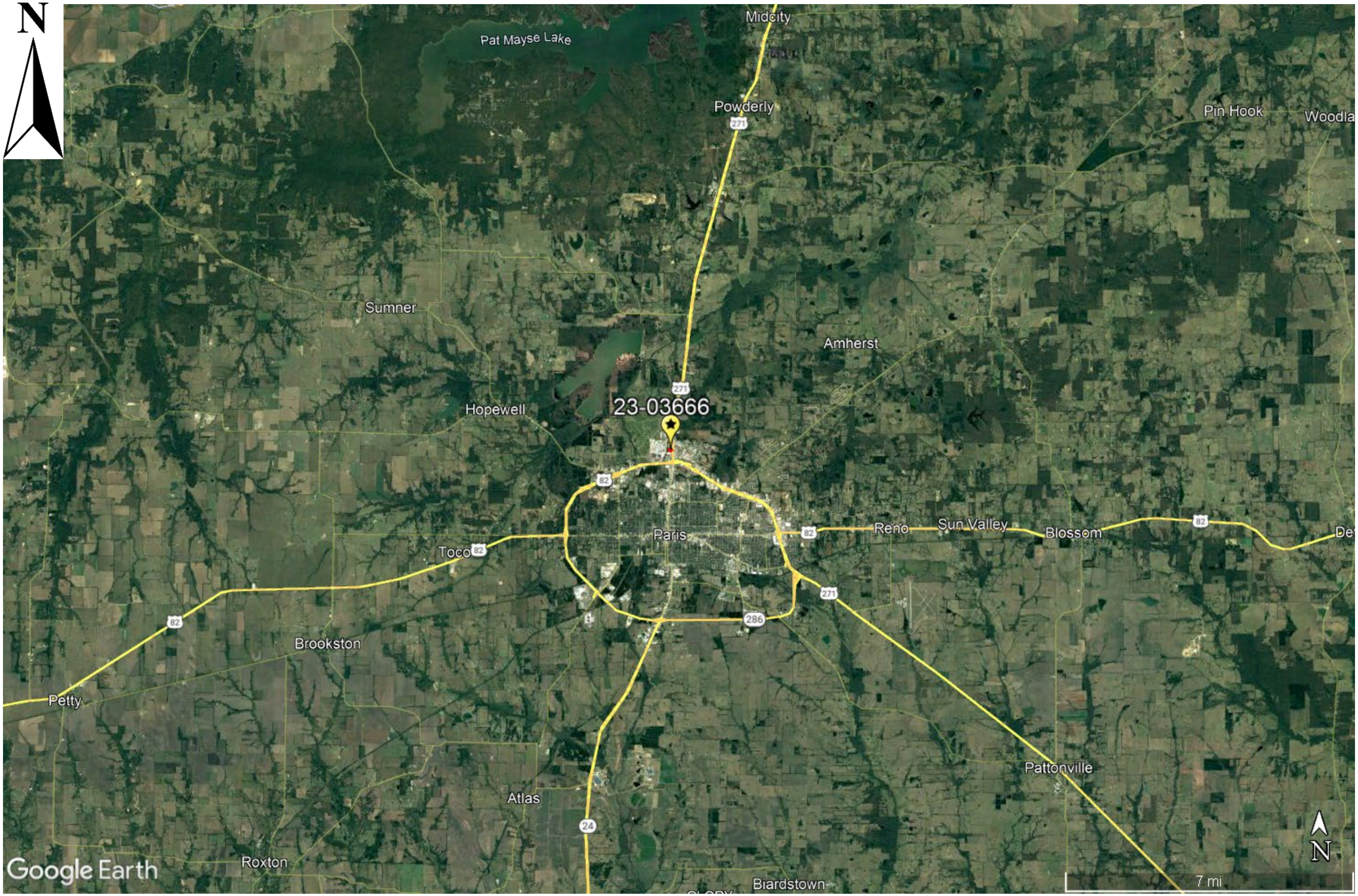
This report was prepared for WA Civil, LLC in reference to the proposed Lamar County Emergency Facility building located at 2805 N Main St, in Paris, Texas. This report provides geotechnical recommendations based on the subsurface conditions encountered in the borings. It is not practical or economical to perform enough subsurface investigation borings to identify all conditions at the site. Subsurface conditions may vary with distance away from the borings completed for this report. Conditions that may affect the recommendations contained within the geotechnical report may exist and may not become known until construction. If variations appear during construction, it may be necessary to revise the recommendations contained in this report. Therefore, monitoring of subsurface conditions during construction should be performed by a geotechnical engineer or his representative to verify that conditions are consistent with the geotechnical report.

EST warrants that the findings and recommendations contained herein have been made with generally accepted professional geotechnical practices in the local area. No other warranties are implied or expressed. The scope of services and recommendations contained in this report do not include any environmental assessment or identification of contaminated or hazardous materials. Any statements in this report or in the boring logs concerning suspicious odors, colors, irregular textures or abnormal conditions are for informational purpose only and have not been verified by testing.

Appendix A

Project Location and Boring Location Diagrams

PROJECT LOCATION - GENERAL



EST Project No. 23-03666 Metal Building at 2805 N Main St

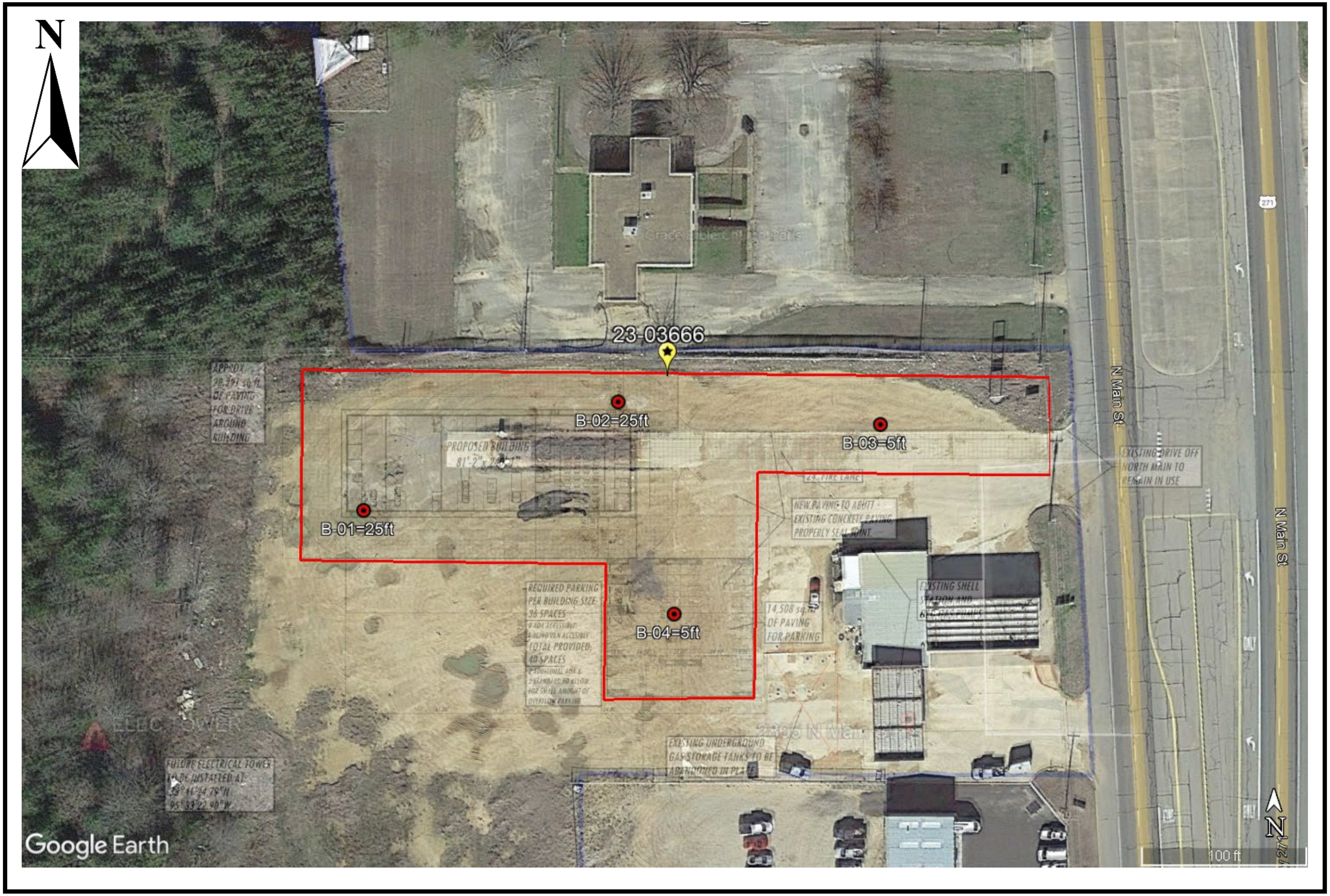
PROJECT LOCATION - LOCAL

EST Project No. 23-03666

Metal Building at 2805 N Main St

EST

BORING LOCATION PLAN



EST Project No. 23-03666

Metal Building at 2805 N Main St

EST

Appendix B

Boring Logs and Laboratory Test Results

BORING NUMBER B-01

EST, Inc
3522 Sam Rayburn Hwy
Melissa, Texas 75454
Tel: 469-907-5500

CLIENT WA Civil, LLC
PROJECT NAME Metal Building at 2805 N. Main St.
PROJECT NUMBER 23-03666
PROJECT LOCATION Paris, Texas
DATE STARTED 10/20/23 **COMPLETED** 10/20/23
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
INITIALLY ENCOUNTERED Not Encountered
LOGGED BY TL **CHECKED BY** A.S
AFTER 15 Min. ---
NOTES
AFTER hrs ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	POCKET PEN. (tsf)	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	TCP (BLOWS/PENET.)	CONF. PRESSURE (psi)	COMP. STRENGTH (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	PERCENT PASSING SIEVE #200 (%)
0		SANDY LEAN CLAY (CL) - Stiff to very stiff, dark brown.	ST	2.25							17				
			ST	4.50							15	46	14	32	51
5		FAT CLAY (CH) - Stiff to very stiff, brown and gray.	ST	3.00							30				
			ST	4.25							29	71	22	49	97
10		Fissured below 8-feet.	ST	4.25							30				
15			ST	4.50							28				
20			ST	2.25											
			TCP				36/12"								
25			SS			8-13-14 (27)									
		Bottom of borehole at 25.0 feet.	TCP				59/12"								

EST, Inc
3522 Sam Rayburn Hwy
Melissa, Texas 75454
Tel: 469-907-5500

BORING NUMBER B-02

CLIENT WA Civil, LLC		**PROJECT NAME** Metal Building at 2805 N. Main St.	
PROJECT NUMBER 23-03666		**PROJECT LOCATION** Paris, Texas	
DATE STARTED 10/20/23	**COMPLETED** 10/20/23	**GROUND ELEVATION**	**HOLE SIZE** 4 inches
DRILLING CONTRACTOR		**GROUND WATER LEVELS:**	
DRILLING METHOD Hollow Stem Auger		**INITIALLY ENCOUNTERED** Not Encountered	
LOGGED BY TL	**CHECKED BY** A.S	**AFTER 15 Min.** ---	
NOTES		**AFTER hrs** ---	

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	POCKET PEN. (tsf)	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	TCP (BLOWS/PENET.)	CONF. PRESSURE (psi)	COMP. STRENGTH (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	PERCENT PASSING SIEVE #200 (%)
0		GRAVEL / SAND - 11in.	AU												
		FAT CLAY WITH SAND (CH) - Very stiff, dark brown and brown.	ST	4.25							28	59	17	42	74
			ST	3.25							31				
5		CLAYEY SAND (SC) - Stiff, brown.	ST	3.00							28	37	11	26	44
		FAT CLAY (CH) - Very stiff, brown and gray.	ST	3.50							34				
10			ST	3.25							35				
15			ST	4.50											
			SS			21-20-18 (38)					30				
20			TCP				22/12"								
			SS			20-22-20 (42)									
25		Bottom of borehole at 25.0 feet.	TCP				45/12"								

EST, Inc
3522 Sam Rayburn Hwy
Melissa, Texas 75454
Tel: 469-907-5500

BORING NUMBER B-03

CLIENT WA Civil, LLC
PROJECT NAME Metal Building at 2805 N. Main St.
PROJECT NUMBER 23-03666
PROJECT LOCATION Paris, Texas
DATE STARTED 10/20/23 **COMPLETED** 10/20/23
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
INITIALLY ENCOUNTERED Not Encountered
LOGGED BY TL **CHECKED BY** A.S
AFTER 15 Min. ---
NOTES
AFTER hrs ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	POCKET PEN. (tsf)	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	TCP (BLOWS/PENET.)	CONF. PRESSURE (psi)	COMP. STRENGTH (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PERCENT PASSING SIEVE #200 (%)
0		LEAN CLAY WITH SAND (CL) - Very stiff, brown.													
1			ST	3.50							32	48	17	31	73
2		FAT CLAY (CH) - Very stiff, brown and gray.													
3			ST	4.50							24				
4															
			ST	4.50											
5															

Bottom of borehole at 5.0 feet.

EST, Inc
3522 Sam Rayburn Hwy
Melissa, Texas 75454
Tel: 469-907-5500

BORING NUMBER B-04

CLIENT WA Civil, LLC
PROJECT NAME Metal Building at 2805 N. Main St.
PROJECT NUMBER 23-03666
PROJECT LOCATION Paris, Texas
DATE STARTED 10/20/23 **COMPLETED** 10/20/23
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
INITIALLY ENCOUNTERED Not Encountered
LOGGED BY TL **CHECKED BY** A.S
AFTER 15 Min. ---
NOTES
AFTER hrs ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	POCKET PEN. (tsf)	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	TCP (BLOWS/PENET.)	CONF. PRESSURE (psi)	COMP. STRENGTH (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	PERCENT PASSING SIEVE #200 (%)
0		FAT CLAY WITH SAND (CH) - Very stiff, brown.													
1			ST	3.25							15	53	16	37	73
2															
3			ST	4.00							13				
4															
5			ST	3.00											

Bottom of borehole at 5.0 feet.

Project Name:	Metal Building at 2805 N Main St	EST Project Number:	23-03666
Project Location:	Paris, Texas	Date:	10/3/2023

Absorption Swell Test Results (ASTM D4546)

Boring No.	B-01	B-02	B-02	
Average Sample Depth (ft)	6-8	0-2	4-6	
Sample Height (in)	0.8	0.8	0.8	
Sample Diameter (in)	2.5	2.5	2.5	
Initial Sample Volume (in^3)	3.93	3.93	3.93	
Initial Sample Weight (g)	122.9	124.7	128.0	
Initial Moisture (%)	29.3%	28.4%	24.2%	
Final Moisture (%)	33.3%	30.6%	26.3%	
Initial Wet Unit Weight (pcf)	119.0	120.8	124.0	
Initial Dry Unit Weight (pcf)	92.1	94.0	99.8	
Applied Load (tsf)	7/16	1/16	5/16	
Initial Dial Reading (in)	0.30120	0.22550	0.28260	
Final Dial Reading (in)	0.32030	0.23250	0.30060	
Swell (%)	2.39%	0.87%	2.25%	

Project Name:	Metal Building at 2805 N Main St	EST Project Number:	23-03666
Project Location:	Paris, Texas	Date:	11/3/2023

Soluble Sulfate Content Test Results (Tex-145-E)

Sample ID	Sample Depth (feet)	Dilution Ratio (1:X)	Colorimeter Readings			Sulfate Concentration (ppm)
B-01, S2	2-4	20	BDL	BDL	BDL	<100
B-02, S1	0-2	20	BDL	BDL	BDL	<100
B-03, S1	0-2	20	BDL	BDL	BDL	<100

*BDL= Below Detection Limit

Appendix C

Historical Aerial Photographs

HISTORICAL AERIAL PHOTOS – 2021

EST Project No. 23-03666

Metal Building at 2805 N Main St

HISTORICAL AERIAL PHOTOS – 2013

EST Project No. 23-03666

Metal Building at 2805 N Main St

EST

HISTORICAL AERIAL PHOTOS – 2008

EST Project No. 23-03666

Metal Building at 2805 N Main St

EST

HISTORICAL AERIAL PHOTOS – 2005

HISTORICAL AERIAL PHOTOS – 1995

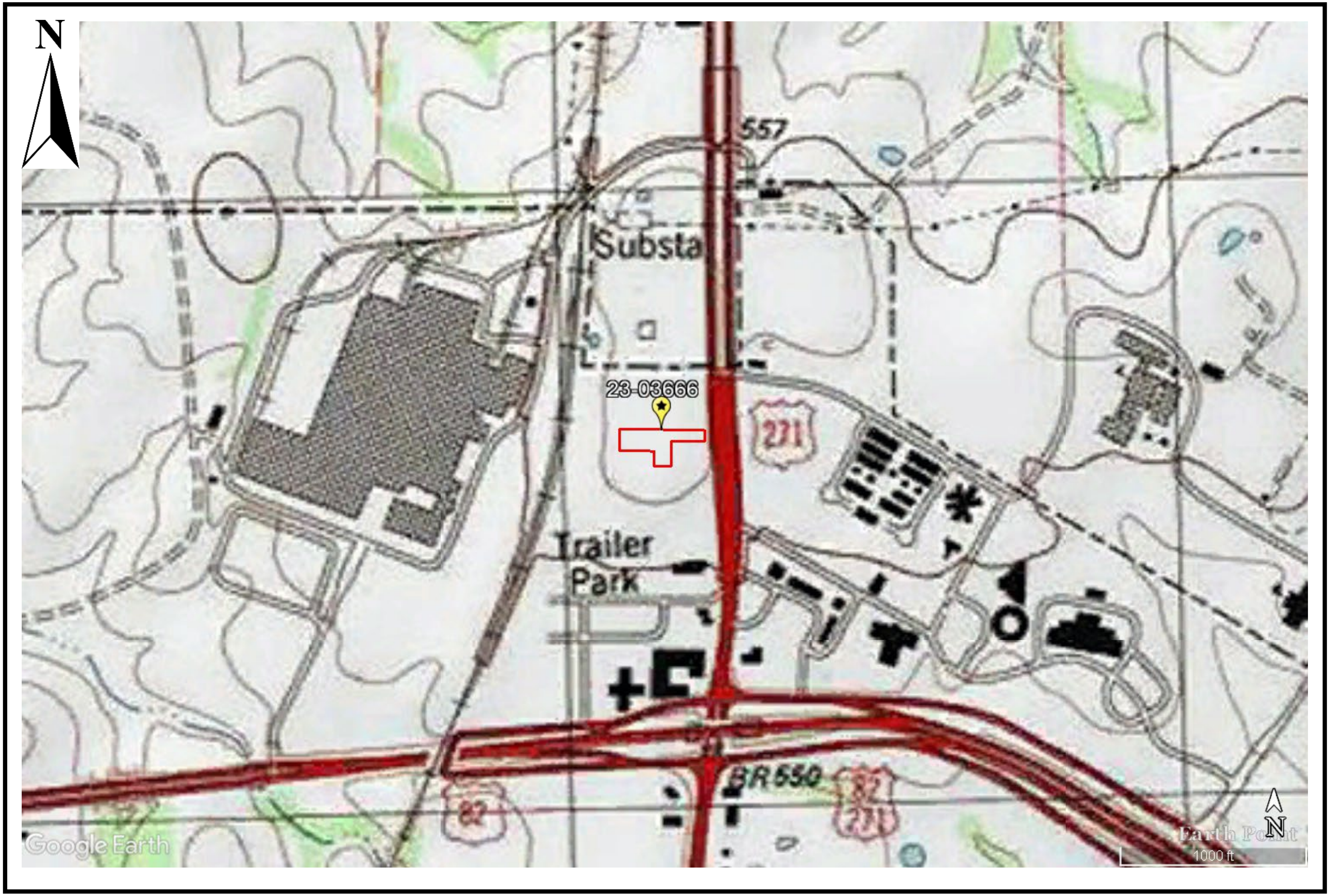
EST Project No. 23-03666

Metal Building at 2805 N Main St

Appendix D

Topographic Map

TOPOGRAPHIC MAP



EST Project No. 23-03666

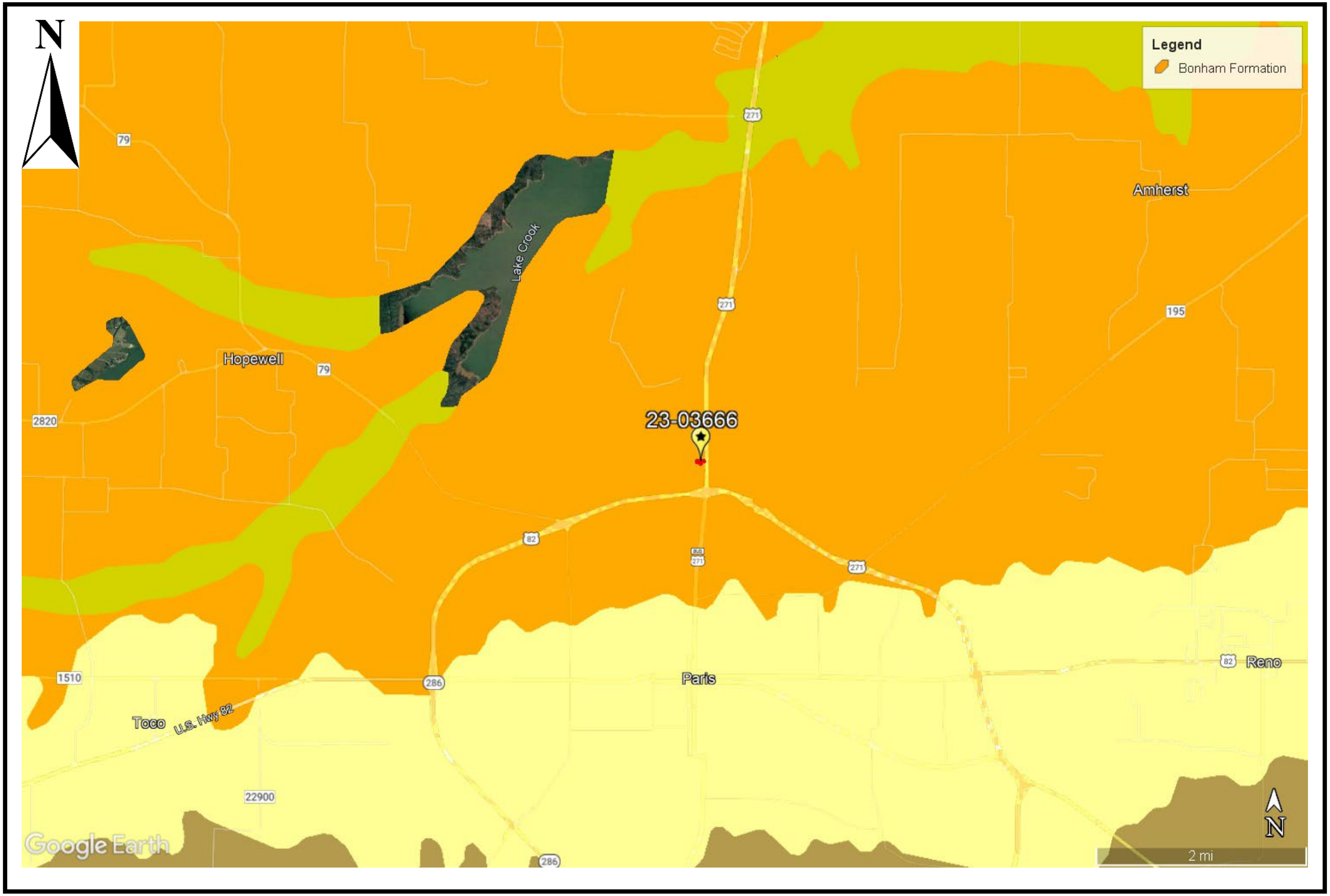
Metal Building at 2805 N Main St

EST

Appendix E

Geologic Information

GEOLOGIC MAP



EST Project No. 23-03666

Metal Building at 2805 N Main St

Bonham Formation

XML JSON

Bonham Formation

State	Texas
Name	Bonham Formation
Geologic age	Late Cretaceous; Gulfian Series
Lithologic constituents	Major Sedimentary > Carbonate > Marlstone *(Bed)* Sedimentary > Clastic > Mudstone > Claystone *(Bed)*
Comments	marl and clay, silty, glauconitic, most abdt near middle, poorly to thinly bedded, med to lt gray; weathers lt gray to yell-gray; marine megafossils, thickness 400 +- ft.
References	Bureau of Economic Geology, 1967, Sherman Sheet, Geologic Atlas of Texas: University of Texas at Austin, Bureau of Economic Geology, scale 1:250,000. Bureau of Economic Geology, 1992, Geologic Map of Texas: University of Texas at Austin, Virgil E. Barnes, project supervisor, Hartmann, B.M. and Scranton, D.F., cartography, scale 1:500,000.
NGMDB product	NGMDB product page for 68390
Counties	Fannin - Grayson - Lamar - Red River

Appendix F

Web Soil Survey Corrosion Maps

Map Scale: 1:1,160 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 15, 30, 60, 90

Feet: 0, 50, 100, 200, 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

High

Moderate

Low

Not rated or not available

Soil Rating Lines

High

Moderate

Low

Not rated or not available

Soil Rating Points

High

Moderate

Low

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lamar and Delta Counties, Texas
Survey Area Data: Version 20, Sep 5, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Nov 30, 2021—Dec 6, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Corrosion of Steel

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10	Crockett loam, 1 to 3 percent slopes	High	5.9	100.0%
Totals for Area of Interest			**5.9**	**100.0%**

Description

ENG

Engineering

AGR

Agronomy

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Rating Options

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

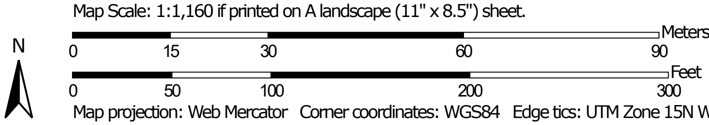
Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Map Scale: 1:1,160 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

High

Moderate

Low

Not rated or not available

Soil Rating Lines

High

Moderate

Low

Not rated or not available

Soil Rating Points

High

Moderate

Low

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lamar and Delta Counties, Texas
Survey Area Data: Version 20, Sep 5, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Nov 30, 2021—Dec 6, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Corrosion of Concrete

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10	Crockett loam, 1 to 3 percent slopes	Moderate	5.9	100.0%
Totals for Area of Interest			**5.9**	**100.0%**

Description

ENG

Engineering

AGR

Agronomy

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Rating Options

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Appendix G

Supporting Information

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) AND SOIL CONSISTENCY DESCRIPTION

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

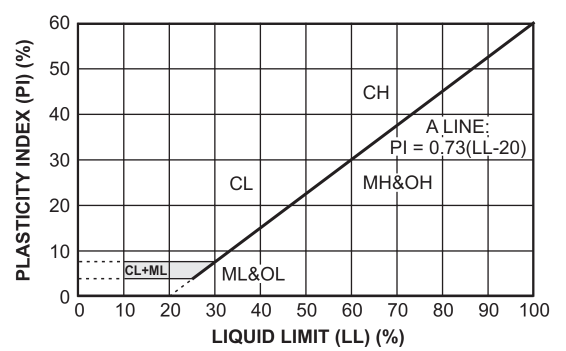
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



TERMS DESCRIBING SOIL CONSISTENCY

Fine Grained Soils		Coarse Grained Soils		
Description	Penetrometer Reading (tsf)	Penetration Resistance (blows/ft)	Description	Relative Density
Soft	0.0 to 1.0	0 to 4	Very Loose	0 to 20%
Firm	1.0 to 1.5	4 to 10	Loose	20 to 40%
Stiff	1.5 to 3.0	10 to 30	Medium Dense	40 to 70%
Very Stiff	3.0 to 4.5	30 to 50	Dense	70 to 90%
Hard	4.5+	Over 50	Very Dense	90 to 100%