Leeville VOR Facility Replacement Project

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Fugro USA Land, Inc. (Fugro) is pleased to present our geotechnical study report for the Leeville VOR Facility Replacement project. We performed our services in accordance with Fugro Proposal dated August 17, 2023. Our services were authorized on November 20, 2023, through the issuance of Professional Services Task Order No. 148049283. Additional services were requested by Jacobs for the access road expansion and the services were authorized through the issuance of revision to Professional Services Task Order No. 148049283, November 1, 2024.

We appreciate the opportunity to be of service to Jacobs and look forward to working together in the future. Please feel free to call us if you have any questions or comments concerning this report or when we may be of further assistance.

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Abbreviations

FOS	factor of safety
SPT	standard penetration test

1. Introduction

1.1 Project Description

Fugro understands that Jacobs is assisting the Federal Aviation Administration (FAA) in the design and construction of a new structure located in Lafourche Parish, Louisiana. Based on the information provided by Jacobs, the project consists of the installation of a Very High Frequency Omni-Directional Range (VOR) tower, a storage tank, condensers, a control room, and other facility equipment. In addition, pavement recommendations for roadway expansion were requested by Jacobs. Jacobs provided Fugro with the proposed boring locations and requested Fugro perform a geotechnical investigation to support the project. A *Vicinity Map* is included on Plate 1.

1.2 Scope of Work

The purposes of our geotechnical study were to 1) explore and evaluate the subsurface soil and groundwater conditions at the proposed exploration locations, and 2) provide geotechnical recommendations to assist Jacobs in the design and construction of foundations for the proposed facility structures and pavements.

We accomplished these purposes by:

- Drilling a total of five (5) soil borings. Two (2) soil borings to a depth of 75-ft each below existing site grade and three (3) soil borings to a depth of 10-ft below existing site grade at locations provided by Jacobs.
- Performing field and laboratory tests on selected soil samples to assess pertinent geotechnical engineering soil properties.
- Analyzing field and laboratory test results to develop engineering recommendations for this project.
- Preparing this report, summarizing our findings and recommendations.

Environmental assessment, compliance with state and federal regulatory requirements, assessment of potential migration, and/or environmental analyses, including those associated with biological agents, were beyond the scope of this study. We were neither asked nor authorized to evaluate the environmental conditions at the site. A geologic fault study was also beyond the scope of this project.

1.3 Applicability of Report

The explorations and analyses for this study and the conclusions and recommendations presented in this report were selected or developed based on our understanding of the project, as described above and in later sections of this report. If pertinent details of the project have

changed or otherwise differ from our descriptions, we request notification and authorization to review the changes and modify our conclusions and recommendations if needed.

We have prepared this report exclusively for Jacobs to use as a guide for the design's geotechnical aspects and construction of proposed structures. We have conducted this study using the standard level of care and diligence normally practiced by recognized engineering firms performing similar services under similar circumstances at the same time and locality. We intend for this report, including all illustrations and appendices, to be used in its entirety. Fugro makes no claim or representation concerning any activity or condition falling outside the specified purposes to which this report is directed. The observations, conclusions, and recommendations presented in this report may not apply to locations not explored by our borings or areas outside the project boundaries. This report should be made available for information only and not as a warranty of subsurface conditions.

1.4 Variations in Subsurface Conditions

Our interpretations of soil and depth-to-water conditions, as described in this report, are based on data obtained from our sample borings, laboratory tests, and our experience. Although we have allowed for minor variations in the subsurface conditions, our recommendations may not be appropriate for subsurface conditions other than those reported herein. It is possible that some undisclosed variations in soil or groundwater conditions might occur outside the boring locations, especially the extent and depth of any surficial conditions and possible fill materials. We recommend careful observations during construction to verify our interpretations. Should variations from our interpretations be found, we recommend that we be notified and authorized to evaluate what, if any, revisions should be made to our recommendations.

2. Field Exploration

This section includes information relating to our field exploration activities for this project. We have included a general discussion on drilling methods, sampling methods, depth-to-water observations, and borehole completion.

2.1 General

Five (5) soil borings, designated as B-1, B-2, and P1 through P-3, were performed for the project. The boring target locations and depths were provided by Jacobs. The soil boring locations were located in the field by Fugro onsite personnel using a handheld GPS. Borings B-1 and B-2 were drilled on December 5 and December 6, 2023, with an ATV-mounted drilling rig using a combination of dry-auger and wet-rotary drilling techniques. Borings P-1 through P-3 were drilled on December 12, 2024, with an ATV-mounted drilling rig using dry-auger drilling techniques. The as-drilled boring locations are presented on the *Exploration Plan* on Plate 2. The boring logs for this study are presented on Plates 3 through 7 with a key identifying the terms and symbols used on Plates 8a and 8b. The coordinates for the explorations are indicated on the logs.

2.2 Soil Sampling Methods

Soil samples from soil borings were generally taken continuously from the existing grade to a depth of about 16 feet and at 5-ft intervals thereafter to the boring completion depths. Borings were logged in general accordance with the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* (ASTM D2488).

Our field procedure for cohesive soil sampling was conducted in general accordance with the *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes* (ASTM D1587). Undisturbed samples of cohesive soils were generally obtained by hydraulically pushing a 3-inch-diameter, thin-walled tube a distance of about 24 inches. The samples were extruded in the field and visually classified by one of our geotechnical personnel. Field estimates of the undrained shear strength of the recovered samples were obtained by using a hand penetrometer and/or torvane. Portions of each recovered soil sample were placed into appropriate containers for transportation to our laboratory.

Our field procedure for sampling cohesionless and select cohesive soils was conducted in general accordance with the *Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586). A description of the SPT tests is presented on Plate 8b. An automatic hammer was used to obtain the hammer blows for each SPT sample. Our geotechnical personnel recorded the hammer blows for each sampling interval. The SPT N-value, described on

Plate 8b, is recorded on the boring logs and is uncorrected. The soil samples obtained from the split barrel sampler were visually classified and packaged for transportation to our laboratory.

2.3 Short-Term Depth-to-Water Observations

Each boring was initially drilled using dry-auger techniques in an effort to determine depth-to-water levels at the project site. Once water was encountered, drilling was temporarily stopped and water level readings were obtained. Drilling then continued to the boring completion depth using the wet-rotary method. The interpreted depth-to-water conditions are discussed further in Section *4.3* and are noted on the boring logs (Plates 3 through 7).

2.4 Borehole Completion

The soil borings performed for this study were backfilled upon completion with cement-bentonite grout from the bottom up. When grout returned to the surface, the excavations were topped off by pouring grout from the surface.

3. Laboratory Testing

The laboratory testing program for this study was directed primarily toward evaluating the classification properties and undrained shear strength characteristics of the foundation soils. Our laboratory tests were performed in general accordance with the appropriate standards as shown in Table 3.1.

Table 3.1: Summary of Tests Performed and Methods

Test Type	Test Destination
Moisture Content	ASTM D2216
Atterberg Limits	ASTM D4318
Percent Finer than a No. 200 Sieve	ASTM D1140
Sieve Analysis	ASTM D6913
UU-Triaxial Compression	ASTM D2850

3.1 Classification Tests

The classification tests included tests for natural moisture content, liquid and plastic limits (collectively termed Atterberg Limits), sieve analysis, and percent finer than a No. 200 sieve. These tests aid in classifying the soils and are used to correlate the results of other tests performed on samples taken from different borings and/or different depths. The results of the classification tests are presented on the boring logs on Plates 3 through 7, in Appendix A, *Summary of Test Results*, and in Appendix B, *Grain Size Curves*.

3.2 Undrained Shear Strength Tests

We measured the undrained shear strength of select undisturbed samples of cohesive soils by performing unconsolidated undrained triaxial compression tests. Natural moisture contents and dry unit weights were determined as routine parts of the compression tests. The results of the laboratory shear strength tests, along with the field estimates of shear strengths, are presented on the boring logs on Plates 3 through 7, and in Appendix A, *Summary of Test Results*.

4. General Site Conditions

This section contains interpreted site and subsurface conditions based on our field exploration and our laboratory testing programs. This section also includes a discussion and interpretation of the depth-to-water conditions encountered at the site during our field exploration.

4.1 Site Description

The project area is located at an FAA facility off of Louisiana Highway 1 in the Lafourche Parish Sec 38; Township 22S; Range 23E, Louisiana. As mentioned previously, Jacobs provided Fugro with the boring locations. The project site was located within an elevated berm south of Louisiana Highway 1. The project site was surrounded by marsh land and open water and connected to Louisiana Highway 1 by an 8 feet wide access road to the north. A *Vicinity Map* provided on Plate 1, depicts the site's general location in reference to Louisiana Highway 1. Boring B-1 was located to the northwest corner of the elevated berm. Boring B-2 was located along the eastern boundary of the elevated berm. Borings P-1 through P-3 were located along the existing access road connecting the project site to Highway 1. The site was generally flat and all debris had been removed at the time of our field exploration. The *Exploration Plan*, provided on Plate 2 shows the approximate locations of the boring, however Fugro did not survey the boring locations.

4.2 Subsurface Conditions

A generalized subsurface profile across the site is presented on Plates 9a and 9b. Based on the review of laboratory test results, Boring B-1 generally consisted of a fill layer from the existing ground surface to depth of 2.5 ft, followed by alternating layers of silty sand and poorly graded sand to a depth of 48.5 ft, underlain by a layer of sandy silt to a depth of 53.5 ft, followed by layers of lean and fat clays to the completion depth of the boring. Boring B-2 generally consisted of a fill layer from the existing ground surface to depth of 2.5 ft, followed layers of poorly graded sand and poorly graded sand with silt to a depth of 18.5 ft, underlain by a layer of sandy lean clay to a depth of 23.5 ft, followed by a layer of silty sand to a depth of 53 ft, and by layers of sandy lean clay and fat clay to the completion depth of the boring. Borings P-1 through P-3 generally consisted of a limestone fill layer from existing ground surface to a depth of 0.5 ft, underlain by alternating layers of poorly graded sand and poorly graded sand with silt to the completion depth of the borings. Borings B-1 and B-2 were drilled to a depth of 75 ft and Borings P-1 through P-3 were drilled to a depth of 10-ft below existing site grade.

The strength tests conducted on cohesive materials generally indicated a soft to very stiff consistency. The N-values in the cohesionless layer indicated a very loose to dense consistency. Detailed information relating to the subsurface conditions encountered at the site is presented

on the boring logs on Plates 3 through 7. A key identifying the terms and symbols used on the boring logs is presented on Plates 8a and 8b.

4.3 Depth-to-Water Conditions

In an effort to estimate the depth-to-water at the project site, soil borings for this study were initially drilled using dry auger drilling techniques. A summary of the groundwater measurements are presented in Table 4.1.

Table 4.1: Summary of Groundwater Measurements

Boring ID	Depth to Initial Groundwater (ft)	Depth of Groundwater After 15-minute waiting period (ft)
B-1	4.0	1.3
B-2	3.0	1.3
P-1	4.0	1.0
P-2	4.0	1.0
P-3	4.0	1.0

It should be noted that short-term water levels recorded in the open boreholes should not be considered to represent a long-term condition. It is possible that the water levels in the open boreholes may not have had enough time to completely stabilize. More accurate determinations of groundwater levels are usually made from long-term standpipe piezometer readings; however, the water level is likely to be consistent with the adjacent marsh.

4.4 Seismic Design Parameters

In accordance with the 2021 International Building Code (IBC) and ASCE 7-16, the design of structures must consider dynamic forces resulting from seismic events. These forces are dependent upon the magnitude of the earthquake event as well as the properties of the soils that underlie the site. As part of the procedure to evaluate seismic forces, the code requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristics of the subsurface profile within the upper 75-ft of the ground surface. The site classification for seismic design was based on correlations with the shear strength values obtained from the soil borings. Site specific dynamic soil properties were not obtained as part of our study. We recommend a Site Classification “D” be applied for this project.

5. General Foundation Recommendations

As mentioned previously, the project consists of the installation of a Very High Frequency Omni-Directional Range (VOR) tower, a storage tank, condensers, a control room, and other facility equipment. Based on the information provided by Jacobs, we understand that a structural mat supported on deep foundations will be utilized on the project. For deep foundation alternatives,12-inch square precast concrete piles and 12-inch diameter auger cast-in-place (ACIP) piles were evaluated.

Recommendations for mat foundations are presented in Section 6, *Floor Slabs*. Recommendations for deep foundations are presented in Section 7, *Deep Foundation Recommendations*.

5.1 Existing Pile Foundations

Fugro understands that existing piles are present at the project site. Detailed information of the existing piles including pile locations and pile abandonment methods were not provided at the time of this report. However, we recommend that any existing piles be cutoff and not extracted. We recommend pile cutoff for existing piles to be 2 ft below the proposed mat foundation. It should be noted that excavations deeper than 2 ft will potentially encounter difficulties due to shallow groundwater depth. In addition, the new piles should be spaced at least 5 pile diameters center-to-center from the existing pile foundations.

6. Floor Slabs

Proper design and installation of floor slabs is an essential aspect of construction. Failure to properly design and install floor slabs can contribute to the development of significant foundation distress. Foundation distress can lead to serviceability problems including, but not limited to, structural distress, floor slab movements, and various aesthetic concerns. This section provides recommendations for the design and construction of conventional mat foundations.

6.1 Mat Foundation

The subgrade below the mat foundation should be properly prepared including stripping all significant organic and other deleterious materials. The moisture content at the time of construction should be monitored. If the moisture content is dry of optimum, moisture conditioning may be required. Before grade is raised, the exposed subgrade should be observed for areas that appear to be soft, wet, weak, or containing deleterious materials. The exposed subgrade should then be brought to design grade using properly placed and compacted structural clay fill.

Moisture content fluctuations resulting from the presence of vegetation may significantly affect the performance of the clay soils at the site thereby affecting the performance of the structure. As such, trees and other vegetation that require large amounts of water from the subsurface to survive should be kept away from the proposed structure. The water demand of such vegetation may contribute to significant moisture content fluctuations within near surface cohesive soils thus increasing the potential for shrink/swell movements.

The following design details are also recommended:

1. Maintain uniform moisture conditions in the exposed subgrade soils prior to construction of the floor slab. The exposed subgrade soils should not be allowed to dry out or to become wet during construction.
2. Backfill all utility trenches or potential conduits of water underneath floor slabs using structural clay fill within a distance of 5 ft outside and adjacent to floor slabs. Utility trenches have been identified as conduits that permit the migration of moisture under slabs. Where utility trenches extend out from underneath the floor slabs, we recommend that a bentonite clay plug be placed in the trench to restrict exterior water from migrating beneath the slab.

7. Deep Foundation Recommendations

As discussed in Sectio*n 5, General Foundation Recommendations*, we understand that structural mats supported on deep foundations will be utilized on the project. Recommendations for 12-inch square precast concrete piles and 12-inch diameter ACIP piles are provided in this section. The following paragraphs include our recommendations for Axial Capacity, Factors of Safety and Verification, Lateral Load Analysis, Group Effects, and Estimated Settlement.

7.1 Axial Capacity

The ultimate axial capacity of individual, isolated deep foundations was computed using the static method of analysis. In this method, the ultimate compressive capacity for a given penetration is computed as the sum of the skin friction on the pile wall and the end bearing on the pile tip. We neglected the end-bearing in our analyses for auger cast-in-place piles because the movement associated with mobilizing the end bearing is typically beyond tolerable structural limits.

The ultimate compressive and tensile capacity was computed for 70-ft long, 12-inch square prestressed precast concrete (PCPS) piles using the computer program APILE (Reese et al, 2015).

Ultimate axial capacity curves for cast-in-place piles were computed for 70-ft long, 12-inch diameter ACIP piles using the computer program SHAFT (Reese et al, 2017a and 2017b).

The ultimate axial pile capacity curves are presented in Appendix C, *Ultimate Axial Capacity Curves*. The penetration should be referenced from the natural ground surface at the time of our exploration.

7.2 Factors of Safety and Verification

The recommended factors of safety for the deep foundations are as follows:

- We recommend a factor of safety of 3.0 be applied to the ultimate axial capacity for piles loaded in sustained and transient compression and tension with no verification testing.
- A factor of safety of 2.5 may be applied if dynamic testing using the Pile Driving Analyzer (PDA) is performed on a long-term restrike (greater than 3 days) on at least 5% of the production piles for capacity verification.
- A factor of safety of 2.0 may be applied provided at least one load test is performed (to failure or to a load exceeding the estimated axial capacity by 50%), and the site and subsurface conditions are reasonably uniform and do not pose difficult construction conditions. We recommend sonic integrity testing of drilled foundations as described below to provide quality assurance of drilled foundations.

- The reported axial capacities included herein are geotechnical capacities. The structural capacity of the reinforced concrete should be checked by the Structural Engineer.

7.3 Lateral Load Analysis

We performed a simplified evaluation of the lateral resistance for 12-inch square precast concrete piles and 12-inch diameter auger cast-in-place (ACIP) piles for the soil conditions encountered at the site. We performed our lateral load analyses using the computer program LPILE, developed by Ensoft. The following assumptions were made in our lateral load analyses of single, isolated pile:

- Young's Modulus equals 3,600 ksi for straight-sided concrete piles (f'_c = 4,000 psi);
- Lateral loads only were applied at the top of the pile; and
- No axial loads or external moments were applied at the top of the pile.

We assumed in our analyses that the piles are installed to a penetration of at least 40 feet below the existing ground surface. We analyzed both free-head and fixed-head conditions with lateral loads applied at the ground surface. We performed our analyses using limiting deflections (at the ground surface) of ¼, ½, and 1 inch. We also evaluated the maximum bending moment in the pile section. We analyzed each case using both "uncracked" and "cracked" stiffness (EI). A "cracked" stiffness of 35 percent of the actual stiffness (EI) was used for our calculations as recommended by ACI 318 08. The computed lateral loads applied at the ground surface and the maximum internal bending moments for isolated, individual pile installed at least 40 ft below final grade, are provided in the table below.

Table 7.1: Lateral Load Resistance and Resulting Maximum Bending Moment

Pile Section	Pile Top Fixity	Stiffness	Top Deflection ¼ inch		Top Deflection ½ inch		Top Deflection 1 inch	
			Lateral Load (kips)	Max Moment (in-kips)	Lateral Load (kips)	Max Moment (in-kips)	Lateral Load (kips)	Max Moment (in-kips)
12-Inch-Square Precast Concrete Pile	FREE-HEAD	CRACKED	1.4	76.0	2.4	141.5	4.3	263.2
	FIXED HEAD	CRACKED	4.1	217.9	7.2	403.9	12.4	738.7
	FREE-HEAD	UNCRACKED	2.4	149.4	4.2	282.5	7.4	529.6
	FIXED HEAD	UNCRACKED	6.9	435.5	12.4	816.2	21.4	1,498.6
12-inch Diameter Auger Cast-In-Place Pile	FREE-HEAD	CRACKED	1.1	53.9	1.8	99.1	3.2	184.7
	FIXED HEAD	CRACKED	3.1	153.6	5.5	282.7	9.4	515.8
	FREE-HEAD	UNCRACKED	1.8	106.1	3.2	199.5	5.6	372.6
	FIXED HEAD	UNCRACKED	5.3	307.5	9.4	572.9	16.3	1,050.2

7.4 Group Effects

The overall allowable load carrying capacity of a group of piles may, in some cases, be less than the sum of the individual allowable capacities. A reduction in the individual pile capacity, to allow for group effects, is usually not necessary for piles having a center-to-center spacing of 3 or more piles width/diameter for axial loads, and 5 or more diameters for lateral loads. The reduction in individual capacity depends on many factors including the configuration of the group, number of piles in the group, piles size, the depth of installation, and the piles spacing. If piles are spaced closer than 3 to 5 diameters or if groups larger than about 5 by 5 are planned, we recommend that we be retained to review the final design and comment on group effect.

7.5 Estimated Settlement

A detailed settlement analysis was beyond the scope of this study. Based on our experience and the results of index tests performed on soil samples collected at the site we estimate post-construction settlements for properly installed individual isolated piles to be less than about 1/2 inch.

8. Aggregate Surfacing Recommendations

We understand that aggregate surfacing is planned for the construction of the access roads, lateral extension and parking areas for this project. This section presents discussions and recommendations on subgrade preparation as well as an aggregate surfacing section.

8.1 Subgrade Preparation

For the roadway extension, proper subgrade preparation will be imperative to a successful widening project. *Within the existing roadway and planned parking areas (gravel pad)*, subgrade preparation should consist of stripping all significant vegetation, organic materials, debris, fill materials, silty soils and other deleterious materials and extending at least 3 ft beyond the edges of the proposed roadway. We anticipate that approximately 6- to 12 inches of stripping from existing mudline in roadway expansion areas and should be confirmed during site grading activities. Stripped areas should be proof rolled with fully loaded dump truck or heavy rubber-tired equipment (20 tons) to expose any zones of soft or loose material. Proof-rolling should be performed under the observation of a representative of the geotechnical engineer. Soft, loose, or porous soils, or other unsuitable materials present within the excavation subgrade should be removed to competent native materials.

If the adjacent grade in the roadway widening consists of submerged marsh material, site clearing activities should include the removal of the upper 1 foot of soils. The upper foot of soil is generally expected to consist of organic matter, including peat, wood fragments and roots, and native organic clay. Considering the depth-to-water and depth thickness of surficial organic soils, over-excavations should generally be limited to a depth of 1 foot below existing grade where possible. The subgrade should be free of large wood fragments and debris that could compromise installation of geotextile. Proof-rolling the subgrade is not required prior to fill placement. Detailed steps after removing the upper foot of marsh material is included below:

- Place nonwoven geotextile, Mirafi 180N or equivalent, on the stripped subgrade. A heavy-duty fabric such as 180N, or equivalent, should be used to provide additional resistance to punctures and tearing from organic matter left from site clearing activities. Due to the very soft ground conditions, the fabric should be overlapped a minimum of 2 feet between rolls, or as recommended by the geotextile manufacturer.

- Place a lift of structural sand fill on top of the geogrid reinforcement to achieve grade 1-ft above adjacent water levels, or 1-ft, whichever is greater. We recommend the sand be placed in maximum 12-inch thick lifts and track walked by a dozer, or similar tracked equipment, during spreading of material to provide a means of compactive effort.

8.2 Aggregate Surfacing – Gravel Pad, Parking Area and Road Widening Sections

The following table provides a typical section based on our experience with similar projects and subsurface conditions as those encountered within the borings performed for this project. This section is not based on a specific loading condition (e.g. equivalent single axle load) or life expectancy.

Table 8.1 Gravel Pad/Parking Area, Existing Road and Road Widening Section Recommendations

Types and Recommended Use	Material	Thickness	Reference or Specification
Aggregate (light-duty parking and traffic)	Crushed Limestone Over Separation Fabric Over	10 inches	LADOTD Section 1003.05.1
	Compacted Structural Sand Fill	Raise to Grade	See Text

A separation fabric such as Mirafi 180N, or equivalent, should be placed at the interface of the compacted structural sand fill and crushed stone. Compacted structural sand fill should be raised to grade and extend 3 feet beyond the edges of traffic. The crushed stone surfacing for the aggregate section should be in accordance with Section 1003.05.1 of the 2016 edition of the LADOTD *Standard Specifications for Roads and Bridges*. The stone should be placed in 6- to 8-inch-thick loose lifts and uniformly compacter to at least 95 percent of the maximum dry density as determined by ASTM D698 (Standard Proctor) within 0 to +3 percent of optimum moisture. Prior to the start of fill placement, representative samples of the stone fill material should be collected and classified. The compaction properties of the stone fill should be determined during this testing.

9. Construction Considerations

The following sections provide our construction considerations for recommendations regarding site preparation, ACIP piles installation, sonic integrity logging, driven piles installation, fill selection, quality control and field testing, and quality assurance testing.

9.1 Site Preparation

Initial site preparation within the footprint of the structure should consist of stripping all significant surface vegetation, organic materials, debris, fill materials, silty soils and other deleterious materials below the footprint of the structure and extending at least 5 ft beyond the edges of the proposed structure. We anticipate that approximately 6- to 12 inches of stripping from existing grade will be needed within the footprint of the structures. Any existing utilities and other underground obstructions should be identified and relocated as necessary to facilitate construction activities.

Stripped subgrades in the building pad areas should then be moisture conditioned as necessary to achieve a moisture content wet of the optimum moisture content as defined by the soil's field compaction curve. The moisture content at the time of construction should be monitored. If the moisture content is dry of optimum, the upper 8 inches of soil should be scarified, followed by moisture conditioning within 0% and 4% points of the optimum moisture content and recompacted in accordance with Section 9.4 of this report.

Stripped areas should be proof rolled with fully loaded dump truck or heavy rubber-tired equipment (20 tons) to expose any zones of soft or loose material. Proof-rolling should be performed under the observation of a representative of the geotechnical engineer. Soft, loose, or porous soils, or other unsuitable materials present within the excavation subgrade should be removed to competent native materials.

If proof rolling cannot affect a firm and unyielding condition, i.e., displacements beneath wheel passages are less than ¼ to ½ inch, ruts do not form, soft spots are not apparent, then subgrades should be treated, with either cement or lime, and constructed in accordance with LaDOTD (2016) Section 305.

At those locations where cutting is required to achieve design rough grade, the area should be cut prior to proofrolling. The proofrolled subgrade should then be brought to design grade using properly placed and compacted structural clay fill.

A majority of subgrade problems are attributable, at least in part, to poor site drainage. We recommend that an effective "site drainage plan" be devised by others prior to commencement of construction to provide positive drainage away from the planned limits of construction and

off the site, both during and after construction. This drainage plan should consist of sloping the subgrade and structural fill in conjunction with the use of lateral ditches to transmit water away from the foundations and construction areas and offsite. If the foundation sublayers do become saturated, the bearing capacity will be greatly reduced, and the useful life of the structures will be decreased.

9.2 ACIP Pile Installations Considerations

The proper installation of augered cast-in-place piles (ACIP) is dependent upon the Contractor's experience, construction procedures, and equipment. Installation factors have a greater affect on the performance of ACIP piles compared to any other type of deep foundation. Detailed pile installation specification specifically addressing the special concerns of ACIP piles should be prepared as part of the construction package. The pile specifications should be in general accordance with Deep Foundation Institute (2010). We should also be given an opportunity to review the proposed specifications prior to construction.

9.2.1 Contractor Experience and Equipment

The selected contractor should have relevant project experience with augering and pumping equipment, installation of similar sized augered piles in similar subsurface soil conditions, placement of reinforcing steel, as well as experience handling the special grout mixes and admixtures. The contractor's crane should generally be equipped with a torque converter to allow the auger to be withdrawn at a slow continuous rate without sudden jerking. **Our experience indicates that not all contractors have the specialized equipment and experience required to successfully install ACIP piles and particularly for the installation of piles with diameters greater than 24-inches**. We strongly recommend that the contractor's qualifications and experience records be reviewed as part of the selection process.

9.2.2 Grout Mix

The pile contractor should be able to demonstrate that a grout mix can be furnished to meet this project's requirements. The results of a test mix design are generally required to be submitted prior to approval of the grout mix for construction. During construction, the fluidity of the grout mix should be frequently tested using a ¾ inch diameter flow cone. Flow rates of 10 to 25 seconds are typically specified. Compressive strength of the grout mix should be checked by making at least six, 2-inch square cubes for each day of pile installation. Test cubes should be cured and tested in accordance with ASTM C109/C109M and may be restrained from expansion as described in ASTM C942. The Deep Foundation Institute recommends testing two grout cubes at 7 days, two at 28 days, and keeping two on hold.

9.2.3 Pile Installation and Monitoring

The installation process makes it inherently difficult to verify the integrity of the installed ACIP piles, yet the integrity is essential to the load carrying capacity of ACIP piles. A comprehensive construction monitoring and record keeping program is recommended to help reduce the risks associated with improper construction techniques. Construction monitoring should be performed in accordance with Deep Foundation Institute (2010). We recommend that construction monitoring be performed by qualified personnel independent of the contractor.

There are several aspects of the installation procedure that can be monitored to aid in assessing whether the ACIP is being installed properly. These aspects are: 1) viscosity of the grout mixture to be pumped, 2) initial grout placement prior to raising the augers and resulting grout head observed upon completion of pile installation, 3) incremental grout factor (volume of grout pumped relative to the theoretical volume) computed over intervals of 5 foot or less as the auger is withdrawn, 4) uniformity of grout placement and computed grout factor along the length of the completed pile, 5) continuous grout placement and auger withdrawal without delays or grout pressure fluctuations, and 6) unobstructed and successful reinforcing steel placement in a timely manner following completion of grout placement. Records kept during construction monitoring should include these aspects of the pile installation.

The incremental volume of grout pumped as the auger is withdrawn is one of the more important installation controls. Common practice is to have the contractor calibrate the grout pump at the start of the work. The number of pump strokes are then computed to provide an initial grout head of 5-ft to 10-ft and at least 15% greater than the theoretical volume for each 5-ft increment of auger withdrawal. Typically, the actual volume of grout pumped is in the range of 15% to 60% greater than the theoretical volume. The required grout volume to obtain a uniform pile will vary depending on the soil type and consistency. An independent observer should continually monitor and document the number of pump strokes pumped over each 5-ft interval.

9.2.4 Reinforcing Steel Placement

The placement of reinforcing steel cages and tension steel can be improved significantly by using a second crane or cherry picker. If a second crane is possible, the benefits of using a second crane to place the reinforcing steel are: 1) the pile installation crane can be more productive drilling and grouting piles, 2) the second crane has a better reach to pick up reinforcing steel away from the congested pile location, 3) there is better control of cage alignment within the grouted pile, and 4) placement time is reduced by allowing the reinforcing steel to be lowered into the pile as soon as the auger is removed and the grouted pile top is cleaned.

9.2.5 Construction Sequence

The Contractor's installation plan should be reviewed prior to the start of construction. The installation plan should address the allowable spacing between piles to be grouted the same day. In general, previously cast piles should achieve their initial set (at least 6 hours and preferably 1 day) prior to augering adjacent piles. We strongly recommend installing ACIP piles spaced closer than about 6-ft (clear spacing) on alternate days to reduce the risk of interference between adjacent piles. A drop in the grout level of a completed pile when installing an adjacent pile is an indication of a possible "blow-out" condition and should be addressed. As such, providing sufficient time at this site for individual piles to achieve their initial set before installing adjacent piles is essential.

9.2.6 Sonic Integrity Logging

A non-destructive technique currently available to observe completed ACIP piles is the Sonic Integrity Logger. We believe it is essential that a qualified Geotechnical Engineer observe the installation of ACIP piles using sonic integrity logging to provide a higher degree of confidence that the piles are properly installed. Defects such as caving, necking or soil inclusions in the pile can be detected using sonic integrity logging. The use of the Sonic Integrity Logger at the start of construction to evaluate alternate installation procedures and to help establish an acceptable production pile installation procedure is particularly beneficial. We can provide literature and/or a demonstration of the sonic integrity logging equipment if requested.

9.3 Driven Pile Installation Considerations

Recommendations for driven pile installation are included in this subsection. We have included discussions of pile driving specifications, pile driving equipment, installation methods, and pile driving records.

9.3.1 Pile Driving Specifications

Detailed pile driving specifications should be prepared by the design engineer in conjunction with the geotechnical consultant. The specifications should cover the project requirements for furnishing and installing the piles including the scope of work, necessary submittals, piling details, equipment requirements, installation requirements and tolerances, capacity evaluation, and construction records. The specification should require the contractor to submit a complete package detailing the proposed piling equipment and installation procedures for approval prior to mobilization to the site. The complete package should also include the results of a wave equation analysis to evaluate the proposed pile driving hammer and cushion system prior to approval for mobilization to the site.

We recommend that the specification establish a pile driving criterion to clearly define the required pile capacities, pile penetrations, and/or final driving resistance for acceptance. The

results of the wave equation analysis should be used to establish the pile driving criterion. Requirements for pile load tests and capacity evaluation should be stated.

The specification should require the contractor to notify the engineer of any changes to the pile driving equipment and methods so that the pile driving criterion can be adjusted, if necessary. Remedial measures should be presented to address piles not achieving the specified criterion, out of tolerance piles, or piles with questionable driving records. We would be pleased to provide sample specifications or to review the specifications for the project.

It is recommended that static pile load tests be performed to verify the recommended pile capacities in the field. The pile load tests should be performed in accordance with ASTM D1143. The pile load tests should be performed under the guidance of the geotechnical engineer of record so that the data may be interpreted, and the recommended pile capacities adjusted, if necessary, according to the load test results.

9.3.2 Pile Driving Equipment

Foundation piles should be driven using a hammer of adequate size in as nearly a continuous operation as feasible, without interruption, if possible. Pile driving hammers may be diesel, steam, or air operated. The use of a drop hammer, with a light ram and a large stroke, is discouraged since this type of hammer can produce exceedingly high and damaging stresses.

The required energy rating for the hammer will vary depending on the ultimate capacity required, the depth of installation, and the pile type. Once these specifics are known, a wave equation analysis should be performed to aid in the hammer selection. As previously stated, we recommend that the contractor perform a wave equation analysis to evaluate the proposed pile driving hammer and cushion system prior to approval for mobilization to the site. The results of the wave equation analysis should be used to demonstrate that the proposed hammer has sufficient energy to install the piles to the required capacity and/or penetration, and that the hammer is properly cushioned to avoid structurally damaging the piles. To avoid damaging the pile and/or pile driving equipment, refusal criteria should be determined and agreed upon by all parties involved prior to the start of actual pile driving.

9.3.3 Driven Pile Installation

Driven pile installation should be in general accordance with LaDOTD (2016), Section 804. Production piles for this site should be installed to a blow count criterion utilizing the wave equation and curves presented in Appendix C, as applicable. We recommend retapping selected production piles periodically to determine if the driving resistance and pile capacity increase or decrease with time.

In addition, we recommend surveying the production piles to detect possible vertical and/or horizontal movement (commonly referred to as heave), which can result from soil displacement

when driving adjacent piles. Piles which heave after driving adjacent piles should be redriven to at least their original penetration and final driving resistance. Pilot holes (Pre-drilling) will reduce heave, if unacceptable pile and ground movements are experienced. However, the diameter of the pilot hole should be limited to no greater than 2/3 of the pile tip diameter and should extend no deeper than 50 percent of the planned pile depth. Following this guideline for pre-drilling, the presented capacities may be used for design. We have based our computed capacities on the assumption that piles will be driven to the desired penetration without any additional supplemental drilling techniques. If supplemental techniques are selected in installation of the piles, in addition to the recommended pre-drilling procedure, we should be retained to evaluate their influence on our computed capacities. Use of jetting to aid pile installation should not be used.

9.3.4 Pile Driving Records

An accurate and detailed driving log should be kept by an independent inspector during production driving operations. The log should provide a complete record of hammer blows per foot of penetration from the initial to the final blow for each pile installed. The record for each pile should also include the driving date, pile information, hammer information, cushion information, hammer and compressor operation information, ground and pile tip elevations, records of retapping, and notes on installation delays, problems, or unusual occurrences.

9.4 Fill Selection

The type of backfill used and the amount of effort used to place the backfill will depend on the purpose of the backfill. The following subsections present our recommendations for filling operations, including placement and compaction.

9.4.1 Structural Clay Fill

Structural clay fill should be placed as required to attain rough grade elevations in foundation areas and to backfill over-excavated areas. Structural clay fill should be free from organic material, hazardous materials, unsuitable fill debris, and any other deleterious materials. Fill materials should not contain rocks, blocky material, debris, or lumps over 3 inches in maximum dimension, nor more than 15 percent material larger than 2 inches, and should classify as a lean clay (CL) with a liquid limit no greater than 45 nor a plasticity index greater than 25.

In general, structural clay fill should be placed in loose lifts not more than 6 to 8 inches thick and uniformly compacted to at least 95 percent of the maximum dry density, as determined by ASTM D698. The moisture content at the time of placement should be optimum to 3 percent wet of optimum. Structural clay fill shall be compacted with a sheepsfoot or padfoot roller.

If wet weather or extended dry periods deteriorate the surface whereby a good bond cannot be formed between successive lifts, the earthwork Contractor should prepare the surface as

necessary. This preparation may include removing or scarifying the top couple of inches of the underlying material before placing the next lift.

9.4.2 Structural Sand Fill

Structural sand fill should consist of a clean sand fill with less than 12 percent material passing the No. 200 sieve. Structural sand fill should be approved by the Geotechnical Engineer-of-Record. Structural sand fill should be compacted to at least 70 percent of the maximum dry density, as determined by ASTM D4253/D4254 using a smooth drum vibratory roller. We recommend using hand-operated compaction equipment in confined areas and immediately adjacent to shallow foundations.

9.5 Quality Control and Field Testing

Fill material index properties and compaction control curves must be obtained upon each change in soil properties, soil color or texture, compactor, or lift thickness, and at minimum frequencies recommended by the Geotechnical Engineer of Record based on each fill and source soil property ranges and variations expected. For preliminary planning purposes, minimum frequencies of at least every 1,000 loose cubic yards can be estimated. Fill soil sampling should be planned and coordinated to fit the construction production goals, and generally at least two days in advance of the compaction of corresponding fill lifts, depending on confirmation of other process controls and source soil ranges and variations.

The Geotechnical Engineer of Record should perform field moisture-density tests at appropriate frequencies on compacted lifts to ensure that the compaction control specifications are achieved. Field testing volumes and frequencies will depend on confirmation of other process controls and fill soil ranges and variations. Typically for mass fills, such tests would be performed every 2,500 square feet of compacted lift or fraction thereof. For trench backfill and small areas of filling, field moisture content/density testing should be performed for every 200 cubic yards of backfill placed for each lift or for every 200 linear feet of trench, whichever represents the greater frequency of testing. The Geotechnical Engineer of Record or his representative shall determine the acceptability of each compacted lift based on this regime of field moisture content/density testing. Field density gauge probes must be deployed to measure the average properties of the compacted lift.

The Geotechnical Engineer of Record will develop a QC/QA work plan designed to fit the contractors fill construction production goals with effective process controls.

9.6 Quality Assurance Testing

It is recommended that the Geotechnical Engineer of Record conduct periodic spot testing of certain select clay fills (for example with the collection of Shelby tube samples), for laboratory testing to verify compaction controls and that compacted strength and stability properties are as

expected for the design of the fills. This spot testing combined with the compaction control reports used in construction will enable both direct data verifications for best practicable construction controls, and volume representation of compacted engineering properties for long term strength and stability. This spot testing will be defined in the QC/QA work plan.

10. Geotechnical Design Review and Construction Monitoring

Following the final design, we should be given the opportunity to review the drawings and specifications to verify that our design recommendations were adhered to and interpreted as we have intended. We strongly recommend that the Geotechnical Engineer-of-Record, or their qualified representative, be present on-site during site preparation, earthwork, and construction to observe and monitor construction activities. Construction monitoring performed by qualified personnel independent of the Contractor is recommended because the performance of foundations and other structures constructed during this project will be directly related to the Contractor's adherence to the recommendations presented in this report and to the specifications prepared by the Designer. Additionally, the geotechnical aspects of construction contain inherent uncertainties that can result in unanticipated soil and/or groundwater conditions being encountered during construction. Qualified geotechnical personnel observing construction on-site can monitor construction activities and may aid in recognizing unanticipated subsurface conditions and reconciling these conditions with design recommendations.

Construction monitoring should be performed during:

- Foundation Installation: The installation of foundations should be monitored to verify the suitability of the exposed foundation soils, the stability of the foundation excavation, and the placement of foundation concrete.

11. References

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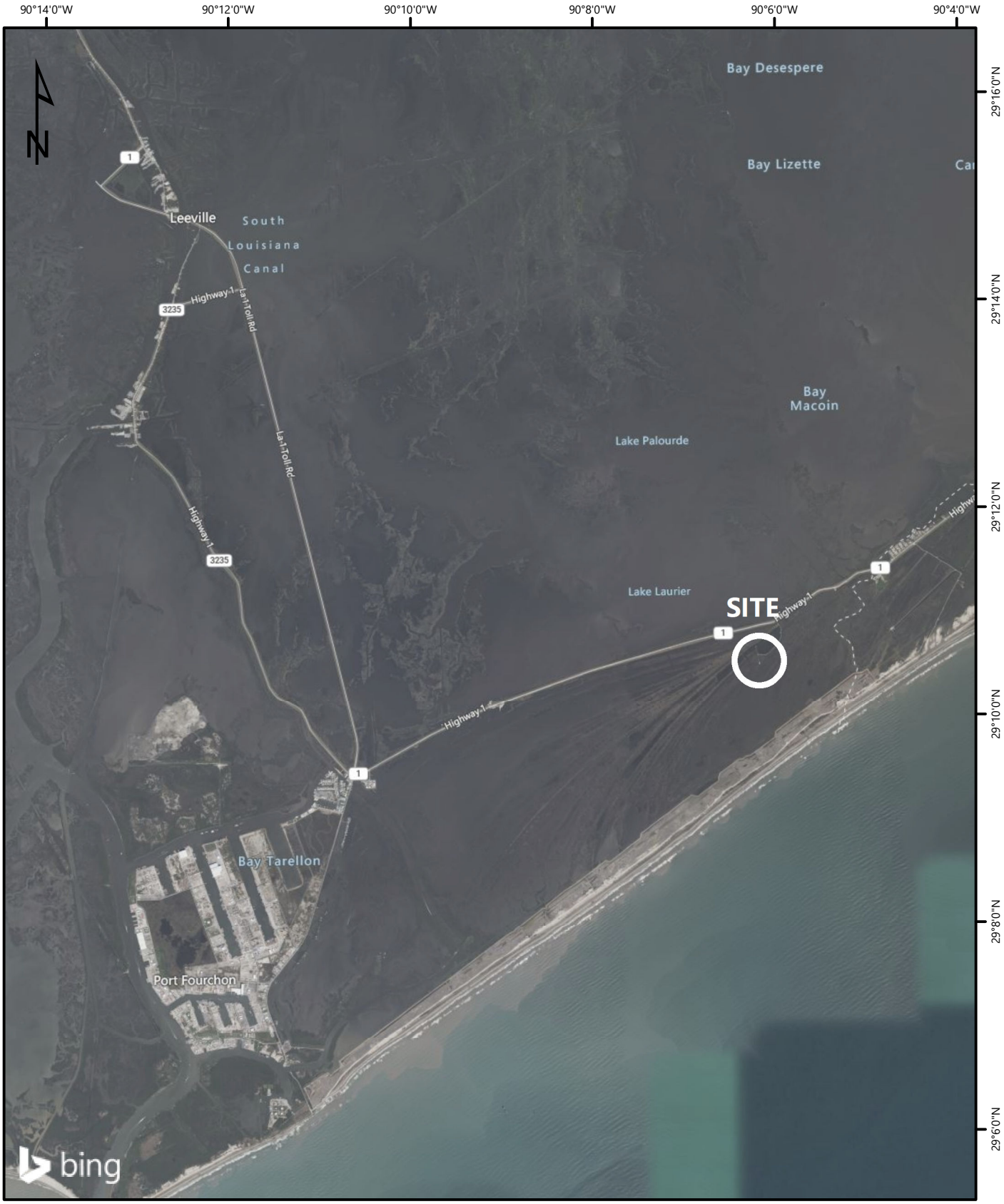
Plates

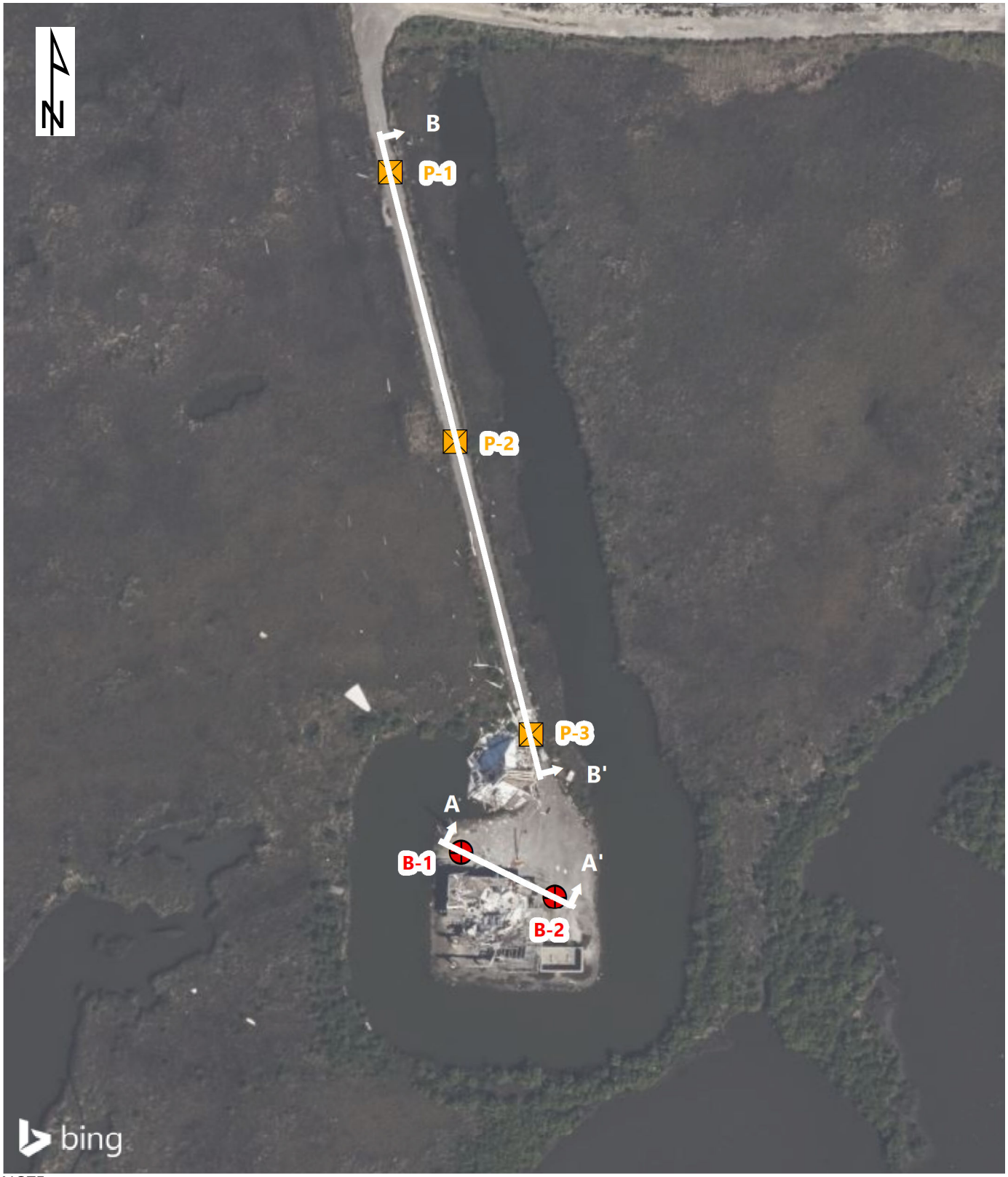


Service Layer Credits: Sources: Esri.

0 0.5 1 2 mi

0 0.75 1.5 3 km

PLATE 1: VICINITY MAP



NOTE:
Borings were located in the field and the locations are approximate.

Service Layer Credits: © 2023 Microsoft Corporation.

0 50 100 200 ft
0 15 30 60 m

Legend

SOIL BORING LOCATION

SUBSURFACE PROFILE LOCATION

PAVEMENT BORINGS

PLATE 2: EXPLORATION PLAN

LOCATION: See Plate 2

COORDINATES: N 29° 10' 31.21"
W 90° 06' 14.67"

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	▼			N=9	**FILL**: **SILTY SAND (SM)**, dark brown, with crushed stone and shell fragments							
	▽			N=5	**POORLY GRADED SAND (SP)**, loose to medium-dense, gray	2.5		3	27			
5				N=5								
				N=17	- with shell fragments at 6.5'			4	25			
				N=12								
10				N=12	**POORLY GRADED SAND WITH SILT (SP-SM)**, medium-dense, gray, with shell fragments	10.5		6	26			
				N=14								
15				N=12				10	28			
				N=3	**SILTY SAND (SM)**, very loose to medium-dense, gray, with clay pockets - with shell fragments from 18.5' to 28.5'	18.5		39	28			
20												
				N=9				36	26			
25												
				N=15								
30												
				N=21	**POORLY GRADED SAND WITH SILT (SP-SM)**, medium-dense, gray, with traces of shell fragments	33.5		10	26			
35												
				N=11								

CLASSIFICATION

SHEAR STRENGTH

☐ Penetrometer ◇ Torvane △ Hand Vane

Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:

1. ▽: Water First Noticed. ▼: Depth To Water after 15 minutes.
2. Terms and symbols defined on Plates 8a and 8b.

COMPLETION DATE: December 7, 2023
TOTAL DEPTH: 75.0'
CAVED DEPTH: Not Applicable
DRY AUGER: 0' to 4'
WET ROTARY: 4' to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: M. Allen
DRILL RIG: Ardco
HAMMER TYPE: Automatic

FUGRO

Leeville VOR Facility Replacement Project

LOG OF BORING NO. B-1

Leeville, Louisiana

Project No. 04.00247190

PLATE 3a

FCBR_LOG (FINAL) 2016 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

LOCATION: See Plate 2

COORDINATES: N 29° 10' 31.21"
W 90° 06' 14.67"

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					POORLY GRADED SAND WITH SILT (SP-SM), medium-dense, gray, with traces of shell fragments							
45				N=10	**SILTY SAND (SM)**, medium-dense, gray, with clay pockets	43.5		24	26			
50				N=22	**SANDY SILT (ML)**, gray	48.5		56	30			
55					**LEAN CLAY (CL)**, firm, gray, with silt seams and pockets	53.0	94		31			
60												
65					**FAT CLAY (CH)**, firm, gray	63.0						
70					- with sand seams below 68'							
75						75.0	73		50			

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Hand Vane

Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:

1. ▽: Water First Noticed. ▼: Depth To Water after 15 minutes.
2. Terms and symbols defined on Plates 8a and 8b.

COMPLETION DATE: December 7, 2023
TOTAL DEPTH: 75.0'
CAVED DEPTH: Not Applicable
DRY AUGER: 0' to 4'
WET ROTARY: 4' to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: M. Allen
DRILL RIG: Ardco
HAMMER TYPE: Automatic

FUGRO

Leeville VOR Facility Replacement Project

LOG OF BORING NO. B-1

Leeville, Louisiana

Project No. 04.00247190

PLATE 3b

FCBR_LOG (FINAL) 2016 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

LOCATION: See Plate 2

COORDINATES: N 29° 10' 30.95"
W 90° 06' 14.07"

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (☐ Penetrometer, ◇ Torvane, △ Hand Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
	▼			N=5	**FILL**: **SILTY SAND (SM)**, dark brown, with crushed stone and shell fragments	2.5							
	▽			N=7	**POORLY GRADED SAND WITH SILT (SP-SM)**, loose to medium-dense, gray, with traces of shell fragments			10	24				
5				N=14		6.5							
				N=12	**POORLY GRADED SAND (SP)**, medium-dense, gray, with shell fragments			3	28				
10				N=15		10.5							
				N=12	**POORLY GRADED SAND WITH SILT (SP-SM)**, medium-dense, gray, with shell fragments			9	30				
				N=12									
15				N=12				10	27				
				N=2	**SANDY LEAN CLAY (CL)**, soft, dark gray, with shell fragments	18.5		58	43				
20													
				N=5	**SILTY SAND (SM)**, loose to medium-dense, gray, with clay pockets and shell fragments	23.5							
25													
				N=7				16	32				
30													
				N=7									
35													
				N=5				14	28				

NOTES:
1. ▽: Water First Noticed. ▼: Depth To Water after 15 minutes.
2. Terms and symbols defined on Plates 8a and 8b.

COMPLETION DATE: December 7, 2023
TOTAL DEPTH: 75.0'
CAVED DEPTH: Not Applicable
DRY AUGER: 0' to 4'
WET ROTARY: 4' to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: M. Allen
DRILL RIG: Ardco
HAMMER TYPE: Automatic

FUGRO

Leeville VOR Facility Replacement Project

LOG OF BORING NO. B-2

Leeville, Louisiana

Project No. 04.00247190

PLATE 4a

FCBR_LOG (FINAL) 2016 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

LOCATION: See Plate 2

COORDINATES: N 29° 10' 30.95"
W 90° 06' 14.07"

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					SILTY SAND (SM), loose to medium-dense, gray, with clay pockets and shell fragments							
45				N=14								
50				N=17				34	26			
					SANDY LEAN CLAY (CL), stiff to very stiff, gray, with silt seams and pockets	53.0						
55							99		28			
60							100		26			
					FAT CLAY (CH), soft to stiff, gray, with silt and sand pockets	63.0						
65							76		46			
70							75		47			
75						75.0						

CLASSIFICATION

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Hand Vane

Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:

1. ▽: Water First Noticed. ▼: Depth To Water after 15 minutes.
2. Terms and symbols defined on Plates 8a and 8b.

COMPLETION DATE: December 7, 2023
TOTAL DEPTH: 75.0'
CAVED DEPTH: Not Applicable
DRY AUGER: 0' to 4'
WET ROTARY: 4' to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: M. Allen
DRILL RIG: Ardco
HAMMER TYPE: Automatic

FUGRO

Leeville VOR Facility Replacement Project

LOG OF BORING NO. B-2

Leeville, Louisiana

Project No. 04.00247190

PLATE 4b

FCBR_LOG (FINAL) 2016 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

LOCATION: See Plate 1

COORDINATES: N 29° 10' 35.07"
W 90° 06' 15.08"

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					FILL: **LIMESTONE**, gray, with sand traces							
	▼			N=11	**POORLY GRADED SAND WITH SILT (SP-SM)**, loose to medium-dense, dark brown, with shell fragments	0.5		9	19			
2				N=5				8	20			
4	▽											
				N=19	**POORLY GRADED SAND (SP)**, medium-dense, dark brown	4.5		5	22			
6												
				N=35	**POORLY GRADED SAND WITH SILT (SP-SM)**, dense, dark gray, with shell fragments	6.5						
8												
				N=33				6	22			
10						10.0						
12												
14												
16												
18												

CLASSIFICATION

SHEAR STRENGTH

☐ Penetrometer ◇ Torvane △ Hand Vane

Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:

1. ▽: Water First Noticed. ▼: Depth To Water after 15 minutes.
2. Terms and symbols defined on Plates 8a and 8b.

COMPLETION DATE: December 12, 2024
TOTAL DEPTH: 10.0'
CAVED DEPTH: Not Applicable
DRY AUGER: 0' to 10'
WET ROTARY: Not Applicable
BACKFILL: Cement-Bentonite Grout
LOGGER: J. Suter
DRILL RIG: Ardco
HAMMER TYPE: Automatic

FUGRO

Leeville VOR Facility Replacement Project

LOG OF BORING NO. P-1

Leeville, Louisiana

Project No. 04.00247190

PLATE 5

FCBR_LOG (FINAL) 2016 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

LOCATION: See Plate 1

COORDINATES: N 29° 10' 33.54"
W 90° 06' 14.68"

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					FILL: **LIMESTONE**, gray							
	▼			N=14	**POORLY GRADED SAND WITH SILT (SP-SM)**, medium-dense, dark brown, with shell fragments - with clay traces from 0.5' to 6.5'	0.5		9	22			
2				N=8								
4	▽			N=12				11	25			
6				N=29								
8						8.5						
				N=36	**POORLY GRADED SAND (SP)**, dense, dark gray			4	22			
10						10.0						
12												
14												
16												
18												

CLASSIFICATION

SHEAR STRENGTH

☐ Penetrometer ◇ Torvane △ Hand Vane

Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:

1. ▽: Water First Noticed. ▼: Depth To Water after 15 minutes.
2. Terms and symbols defined on Plates 8a and 8b.

COMPLETION DATE: December 12, 2024
TOTAL DEPTH: 10.0'
CAVED DEPTH: Not Applicable
DRY AUGER: 0' to 10'
WET ROTARY: Not Applicable
BACKFILL: Cement-Bentonite Grout
LOGGER: J. Suter
DRILL RIG: Ardco
HAMMER TYPE: Automatic

FUGRO

Leeville VOR Facility Replacement Project

LOG OF BORING NO. P-2

Leeville, Louisiana

Project No. 04.00247190

PLATE 6

FCBR_LOG (FINAL) 2016 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

LOCATION: See Plate 1

COORDINATES: N 29° 10' 31.87"
W 90° 06' 14.21"

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					FILL: **LIMESTONE**, gray, with sand traces							
				N=12	**POORLY GRADED SAND WITH SILT (SP-SM)**, loose to medium-dense, dark gray, with shell fragments	0.5		8	19			
2					- dark brown below 2.5'							
				N=9				6	24			
4					**POORLY GRADED SAND (SP)**, medium-dense to dense, dark brown	4.0						
				N=21	- with shell fragments at 4'							
6					- gray below 6.5'							
				N=32				3	24			
8												
				N=32								
10						10.0						
12												
14												
16												
18												

CLASSIFICATION

SHEAR STRENGTH

☐ Penetrometer ◇ Torvane △ Hand Vane — Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT: 0.5 1.0 1.5 2.0 2.5

NOTES:

1. ▽: Water First Noticed. ▼: Depth To Water after 15 minutes.
2. Terms and symbols defined on Plates 8a and 8b.

COMPLETION DATE: December 12, 2024
TOTAL DEPTH: 10.0'
CAVED DEPTH: Not Applicable
DRY AUGER: 0' to 10'
WET ROTARY: Not Applicable
BACKFILL: Cement-Bentonite Grout
LOGGER: J. Suter
DRILL RIG: Ardco
HAMMER TYPE: Automatic

FUGRO

Leeville VOR Facility Replacement Project

LOG OF BORING NO. P-3

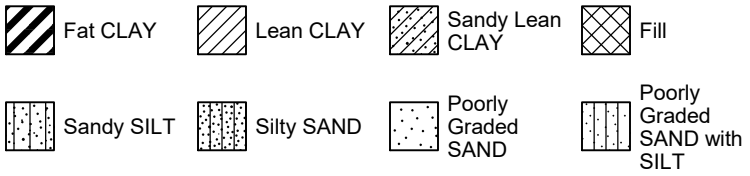
Leeville, Louisiana

Project No. 04.00247190

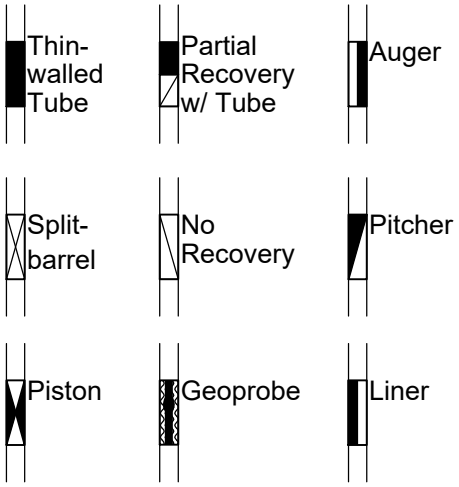
PLATE 7

FCBR_LOG (FINAL) 2016 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

SOIL TYPES



SAMPLER TYPES



SOIL GRAIN SIZE

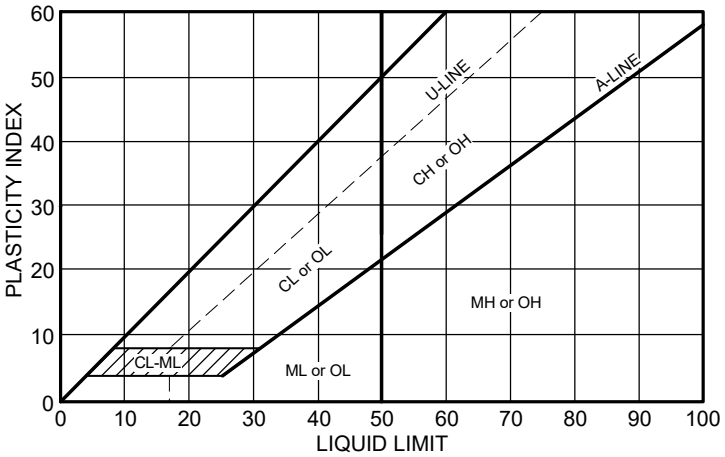
U.S. Standard Sieve

Boulders	Cobbles	Gravel		Sand			Silt	Clay
		Coarse	Fine	Coarse	Medium	Fine		

6" 3" 3/4" 4 10 40 200

152 75.0 19.0 4.75 2.00 0.425 0.075 0.005 (mm)

PLASTICITY CHART



SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

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TERMS AND SYMBOLS USED ON BORING LOGS

SOIL CLASSIFICATION (1 of 2)

Project No. 04.00247190

PLATE 8a

TERMS 1 2021 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/24/25

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

DENSITY OF GRANULAR SOILS

Descriptive Term	*Relative Density, %	**Blows Per Foot (SPT)
Very Loose	< 15	0 to 4
Loose	15 to 35	5 to 10
Medium Dense	35 to 65	11 to 30
Dense	65 to 85	31 to 50
Very Dense	> 85	> 50

*Estimated from sampler driving record.
**Requires correction for depth, groundwater level, and grain size.

STRENGTH OF COHESIVE SOILS

Term	Undrained Shear Strength, ksf	Blows Per Foot (SPT) (approximate)
Very Soft	< 0.25	0 to 2
Soft	0.25 to 0.50	2 to 4
Firm	0.50 to 1.00	4 to 8
Stiff	1.00 to 2.00	8 to 16
Very Stiff	2.00 to 4.00	16 to 32
Hard	> 4.00	> 32

SHEAR STRENGTH TEST METHOD

U = Unconfined Q = Unconsolidated - Undrained Triaxial

P = Pocket Penetrometer T = Torvane V = Miniature Vane F = Hand Vane

HAND PENETROMETER CORRECTION

Pocket penetrometer (PP) strength measurements reported on the boring logs are estimated undrained shear strengths from unadjusted PP readings so that end-users can apply adjustments based on their experience and risk. Fugro generally adjusts the PP strength measurements to account for the small PP test size compared to the larger laboratory test specimen. For Gulf Coast cohesive soils (with PP readings greater than about 1 tsf), our experience indicates that multiplying the raw PP readings (in tsf) by 0.6 provides estimated undrained shear strengths (in ksf) which correlate better with laboratory tests.

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

Legend

SOIL BORING

5 FIELD SPT N-VALUE

Soil Description

- Lean CLAY (CL)
- Sandy Lean Clay (CL)
- Fat CLAY (CH)
- Sandy SILT (ML)
- Poorly-Graded SAND (SP)
- Poorly-Graded SAND with Silt (SP-SM)
- Silty SAND (SM)
- Fill

NOTE:
Conditions may vary laterally between explorations.

10 ft
10 ft
Vertical Exaggeration = 1.0X

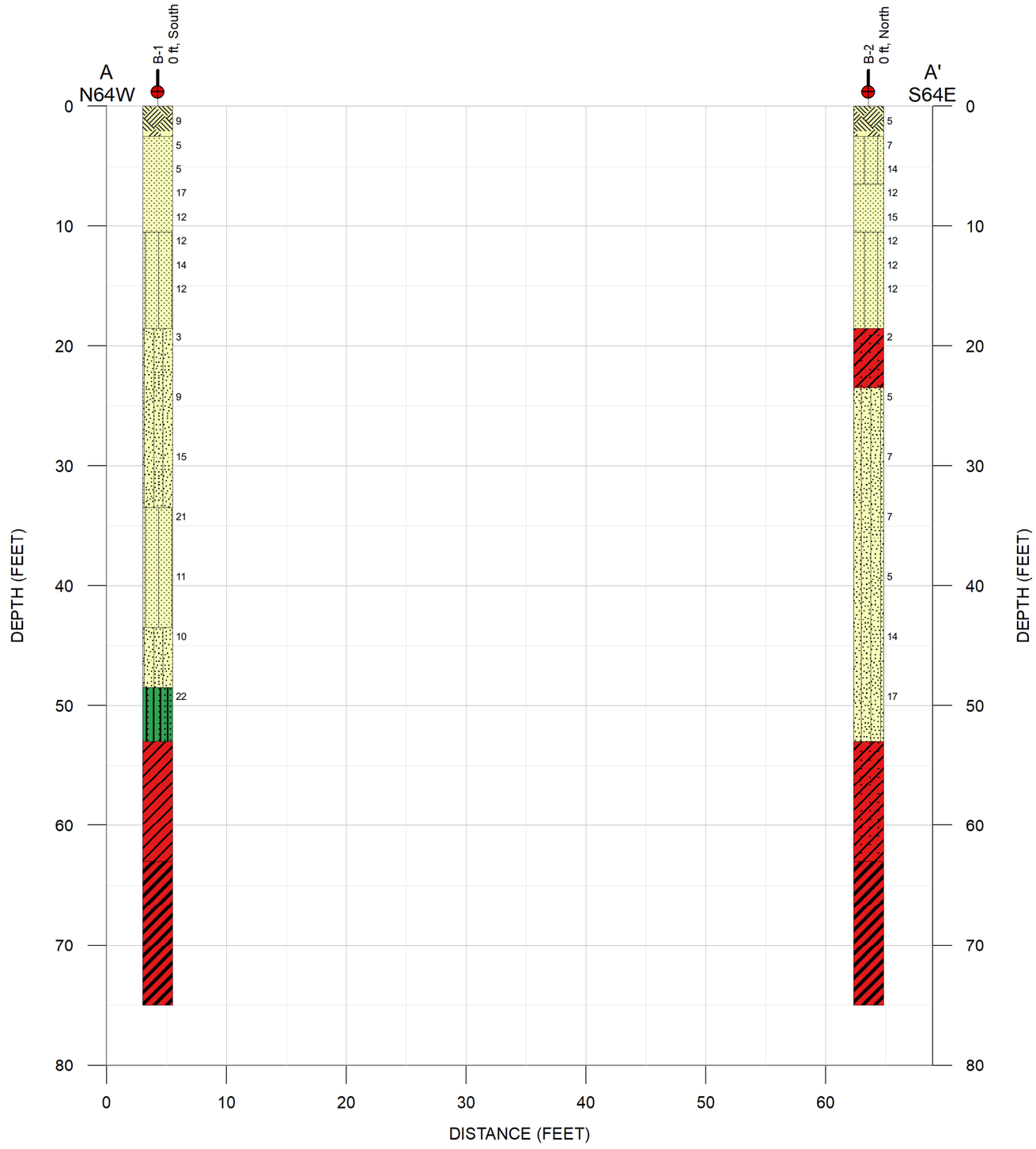
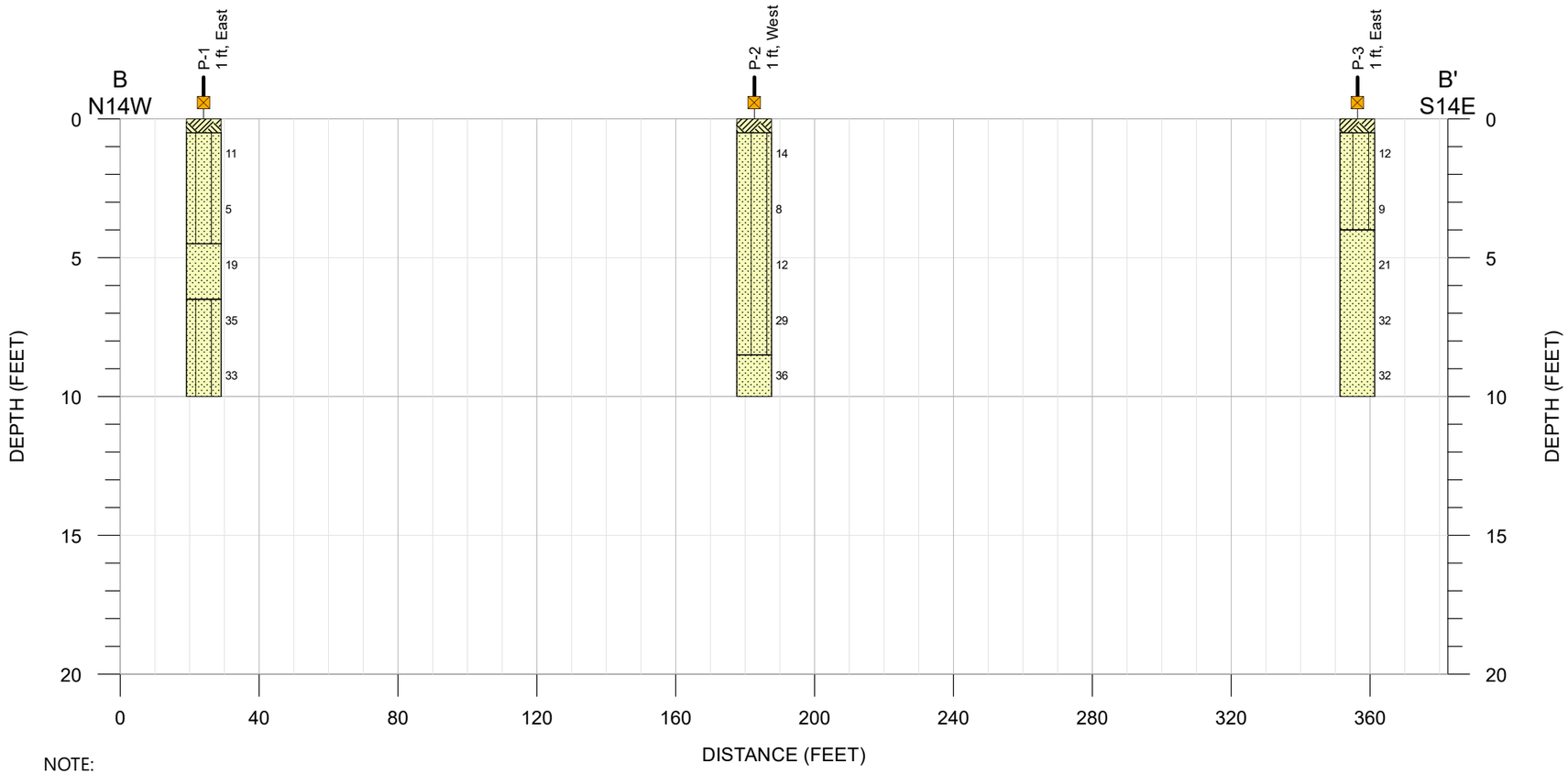
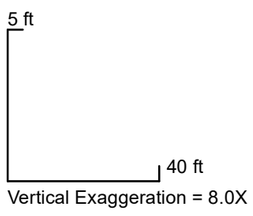


PLATE 9a: GENERALIZED SUBSURFACE PROFILE A-A'



NOTE:
Conditions may vary laterally between explorations.



Soil Description

- Poorly-Graded SAND (SP)
- Poorly-Graded SAND with Silt (SP-SM)
- Fill

Legend

- PAVEMENT BORING
- 5 FIELD SPT N-VALUE

PLATE 9b: GENERALIZED SUBSURFACE PROFILE B-B'

Appendix A

Summary of Test Results

Sample No.	Depth (ft)	Identification Tests						Field Shear Strength Estimate		Miniature Vane Tests		Compression Tests								
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (PI)	Moisture Content (%)	Dry Unit Weight (pcf)	Passing No. 200 Sieve (%)	Penetrometer (ksf)	Torvane (ksf)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	Type Test	Moisture Content (%)	Confining Pressure (psi)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	ε_{50} Strain (%)	Dry Unit Weight (pcf)	Failure Strain (%)	Type of Failure
2	2.5-4.0				27		3.2													
4	6.5-8.0				25		4.1													
6	10.5-12.0				26		5.6													
8	14.5-16.0				28		10.3													
9	18.5-20.0				28		38.7													
10	23.5-25.0				26		35.9													
12	33.5-35.0				26		10.3													
14	43.5-45.0				26		24.4													
15	48.5-50.0				30		56.0													
16	53.0-54.0							0.25												
17	54.0-55.0				31	94		0.5				UU	31	43	0.87		5.9	94	15.0	A
18	58.0-59.0							0.5												
19	59.0-60.0							0.5												
20	63.0-64.0							0.5												
21	64.0-65.0							0.5												
22	68.0-69.0							0.5												
23	69.0-70.0							0.5												
24	73.0-74.0							0.5												
25	74.0-75.0				50	73		0.5				UU	50	58	0.68		1.0	73	8.8	B

Notes:

NP = Non-Plastic Material

TYPE OF TEST
U - Unconfined Compression
UU - Unconsolidated - Undrained Triaxial
CU - Consolidated - Undrained Triaxial

TYPE OF FAILURE
A - Bulge
B - Single Shear Plane
C - Multiple Shear Plane
D - Vertical Fracture
E - Slickensides

FUGRO

Leeville VOR Facility Replacement Project

SUMMARY OF TEST RESULTS - BORING B-1

LELAP Lab ID #10001

Leeville, Louisiana

Project No. **04.00247190**

PLATE A-1

Sample No.	Depth (ft)	Identification Tests						Field Shear Strength Estimate		Miniature Vane Tests		Compression Tests								
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (PI)	Moisture Content (%)	Dry Unit Weight (pcf)	Passing No. 200 Sieve (%)	Penetrometer (ksf)	Torvane (ksf)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	Type Test	Moisture Content (%)	Confining Pressure (psi)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	ε_{50} Strain (%)	Dry Unit Weight (pcf)	Failure Strain (%)	Type of Failure
2	2.5-4.0				24		9.8													
4	6.5-8.0				28		3.0													
6	10.5-12.0				30		9.0													
8	14.5-16.0				27		9.7													
9	18.5-20.0				43		58.4													
11	28.5-30.0				32		16.2													
13	38.5-40.0				28		14.0													
15	48.5-50.0				26		34.4													
16	53.0-54.0							0.25												
17	54.0-55.0				28	99		0.5				UU	28	43	1.58		7.5	99	15.0	A
18	58.0-59.0							0.5												
19	59.0-60.0				26	100		0.5				UU	26	47	2.65		6.5	100	15.0	A
20	63.0-64.0							0.5												
21	64.0-65.0				46	76		0.5				UU	46	51	0.30		3.3	76	14.6	A
22	68.0-69.0							0.5												
23	69.0-70.0				47	75		0.75				UU	47	55	1.06		1.6	75	8.6	A,B
24	73.0-74.0							0.75												
25	74.0-75.0							0.75												

Notes:

NP = Non-Plastic Material

TYPE OF TEST
U - Unconfined Compression
UU - Unconsolidated - Undrained Triaxial
CU - Consolidated - Undrained Triaxial

TYPE OF FAILURE
A - Bulge
B - Single Shear Plane
C - Multiple Shear Plane
D - Vertical Fracture
E - Slickensides

FUGRO

Leeville VOR Facility Replacement Project

SUMMARY OF TEST RESULTS - BORING B-2

LELAP Lab ID #10001

Leeville, Louisiana

Project No. **04.00247190**

PLATE A-2

FCBR SUMMARY OF TESTS 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/29/25

Sample No.	Depth (ft)	Identification Tests						Field Shear Strength Estimate		Miniature Vane Tests		Compression Tests								
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (PI)	Moisture Content (%)	Dry Unit Weight (pcf)	Passing No. 200 Sieve (%)	Penetrometer (ksf)	Torvane (ksf)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	Type Test	Moisture Content (%)	Confining Pressure (psi)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	ε50 Strain (%)	Dry Unit Weight (pcf)	Failure Strain (%)	Type of Failure
2	0.5-2.0				19		9.0													
3	2.5-4.0				20		8.2													
4	4.5-6.0				22		4.9													
6	8.5-10.0				22		5.6													

Notes:

NP = Non-Plastic Material

TYPE OF TEST
U - Unconfined Compression
UU - Unconsolidated - Undrained Triaxial
CU - Consolidated - Undrained Triaxial

TYPE OF FAILURE
A - Bulge
B - Single Shear Plane
C - Multiple Shear Plane
D - Vertical Fracture
E - Slickensides

FUGRO

Leeville VOR Facility Replacement Project

SUMMARY OF TEST RESULTS - BORING P-1

LELAP Lab ID #10001

Leeville, Louisiana

Project No.
04.00247190

PLATE A-3

FCBR SUMMARY OF TESTS 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/29/25

Sample No.	Depth (ft)	Identification Tests						Field Shear Strength Estimate		Miniature Vane Tests		Compression Tests								
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (PI)	Moisture Content (%)	Dry Unit Weight (pcf)	Passing No. 200 Sieve (%)	Penetrometer (ksf)	Torvane (ksf)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	Type Test	Moisture Content (%)	Confining Pressure (psi)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	ε_{50} Strain (%)	Dry Unit Weight (pcf)	Failure Strain (%)	Type of Failure
B2A	0.5-2.0				22		8.6													
B4A	4.5-6.0				25		10.9													
B6A	8.5-10.0				22		3.6													

Notes:

NP = Non-Plastic Material

TYPE OF TEST
U - Unconfined Compression
UU - Unconsolidated - Undrained Triaxial
CU - Consolidated - Undrained Triaxial

TYPE OF FAILURE
A - Bulge
B - Single Shear Plane
C - Multiple Shear Plane
D - Vertical Fracture
E - Slickensides

FUGRO

Leeville VOR Facility Replacement Project

SUMMARY OF TEST RESULTS - BORING P-2

LELAP Lab ID #10001

Leeville, Louisiana

Project No.
04.00247190

PLATE A-4

Sample No.	Depth (ft)	Identification Tests						Field Shear Strength Estimate		Miniature Vane Tests		Compression Tests								
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (PI)	Moisture Content (%)	Dry Unit Weight (pcf)	Passing No. 200 Sieve (%)	Penetrometer (ksf)	Torvane (ksf)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	Type Test	Moisture Content (%)	Confining Pressure (psi)	Shear Strength (ksf)	Remolded Shear Strength (ksf)	ε_{50} Strain (%)	Dry Unit Weight (pcf)	Failure Strain (%)	Type of Failure
B2A	0.5-2.0				19		8.5													
B3A	2.5-4.0				24		5.5													
B5A	6.5-8.0				24		3.2													

Notes:

NP = Non-Plastic Material

TYPE OF TEST
U - Unconfined Compression
UU - Unconsolidated - Undrained Triaxial
CU - Consolidated - Undrained Triaxial

TYPE OF FAILURE
A - Bulge
B - Single Shear Plane
C - Multiple Shear Plane
D - Vertical Fracture
E - Slickensides

FUGRO

Leeville VOR Facility Replacement Project

SUMMARY OF TEST RESULTS - BORING P-3

LELAP Lab ID #10001

Leeville, Louisiana

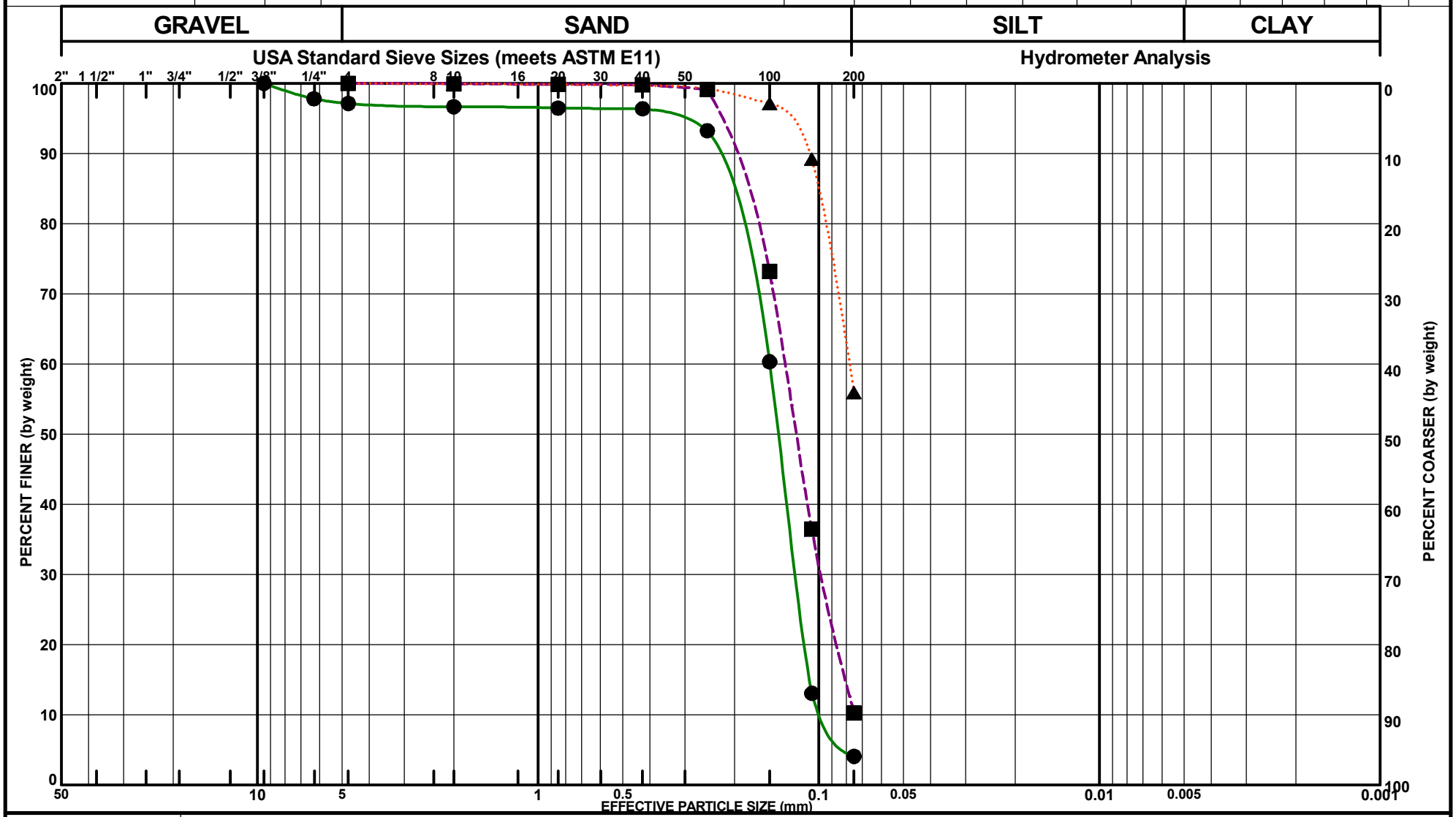
Project No.
04.00247190

PLATE A-5

Appendix B

Grain Size Curves

Boring Number	Sample Number	Depth (ft)	Material Description	%Gravel	%Sand	%Silt	%Clay	D100	D60	D30	D10	Cc	Cu	LL	PL	PI
● B-1	4	6.5-8	POORLY GRADED SAND (SP), gray, with shell fragments	2.9	93.1			9.5	0.15	0.12	0.094	1.02	1.59			
■ B-1	12	33.5-35	POORLY GRADED SAND WITH SILT (SP-SM), gray, with traces of shell fragments	0.0	89.7			4.75	0.132	0.097						
▲ B-1	15	48.5-50	SANDY SILT (ML), gray	0.0	44.0			4.75	0.078							



FCBR GSA LANDSCAPE 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/29/25

FUGRO

Leeville VOR Facility Replacement Project

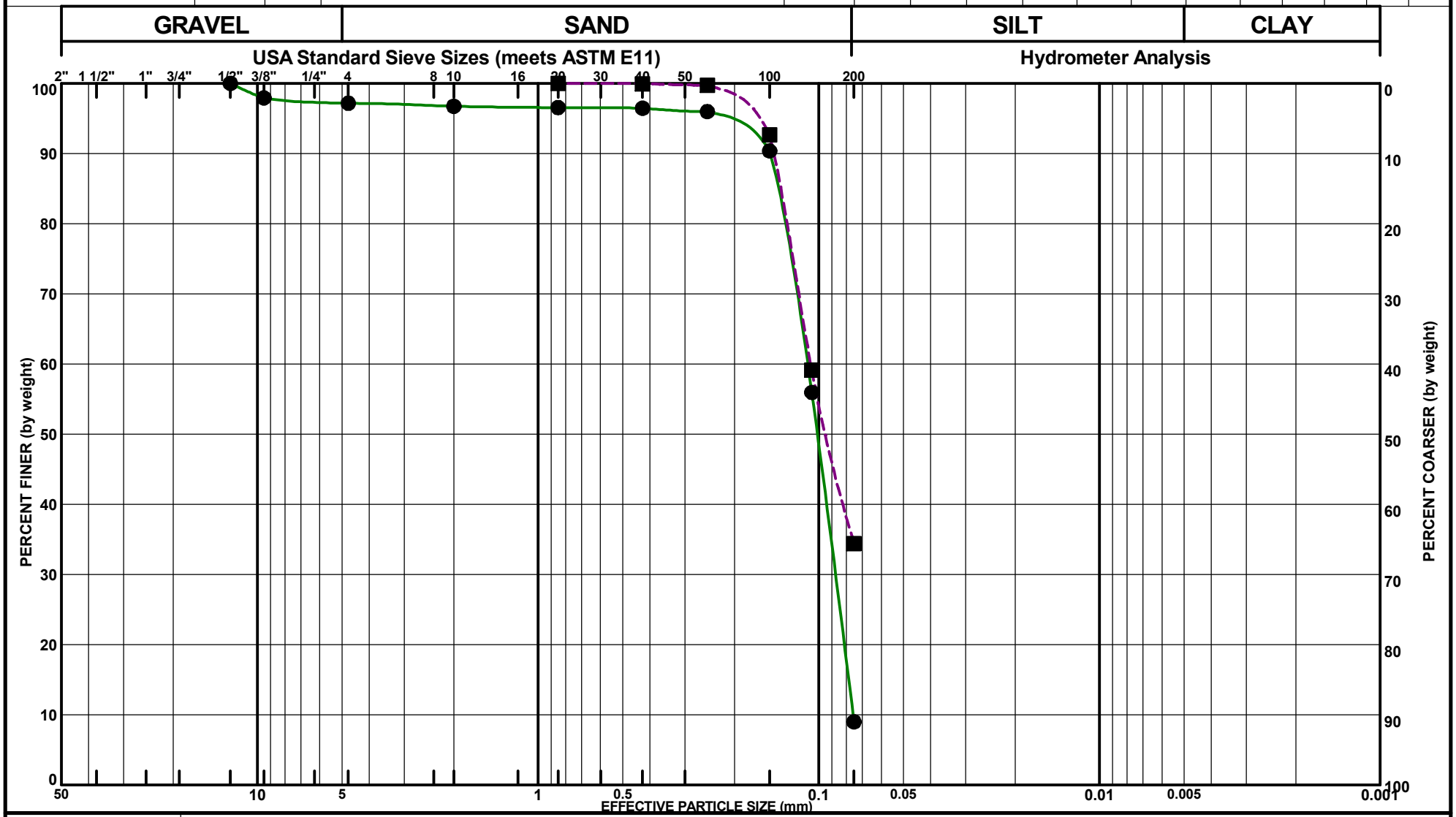
Leeville, Louisiana

PARTICLE-SIZE ANALYSIS

ASTM D422/D6913/C136

Tested By:	Date Tested:	Reviewed By:	Date Reviewed:	Project No.	
James Suter	12/18/2023	Deborah Meyer-Sayer	12/20/2023	04.00247190	PLATE B-1

Boring Number	Sample Number	Depth (ft)	Material Description	%Gravel	%Sand	%Silt	%Clay	D100	D60	D30	D10	Cc	Cu	LL	PL	PI
● B-2	6	10.5-12	POORLY GRADED SAND WITH SILT (SP-SM), gray, with shell fragments	2.8	88.2			12.5	0.11	0.088	0.076	0.92	1.46			
■ B-2	15	48.5-50	SILTY SAND (SM), gray, with clay pockets and shell fragments	0.0	65.6			0.85	0.107							
▲																



FUGRO

Leeville VOR Facility Replacement Project

Leeville, Louisiana

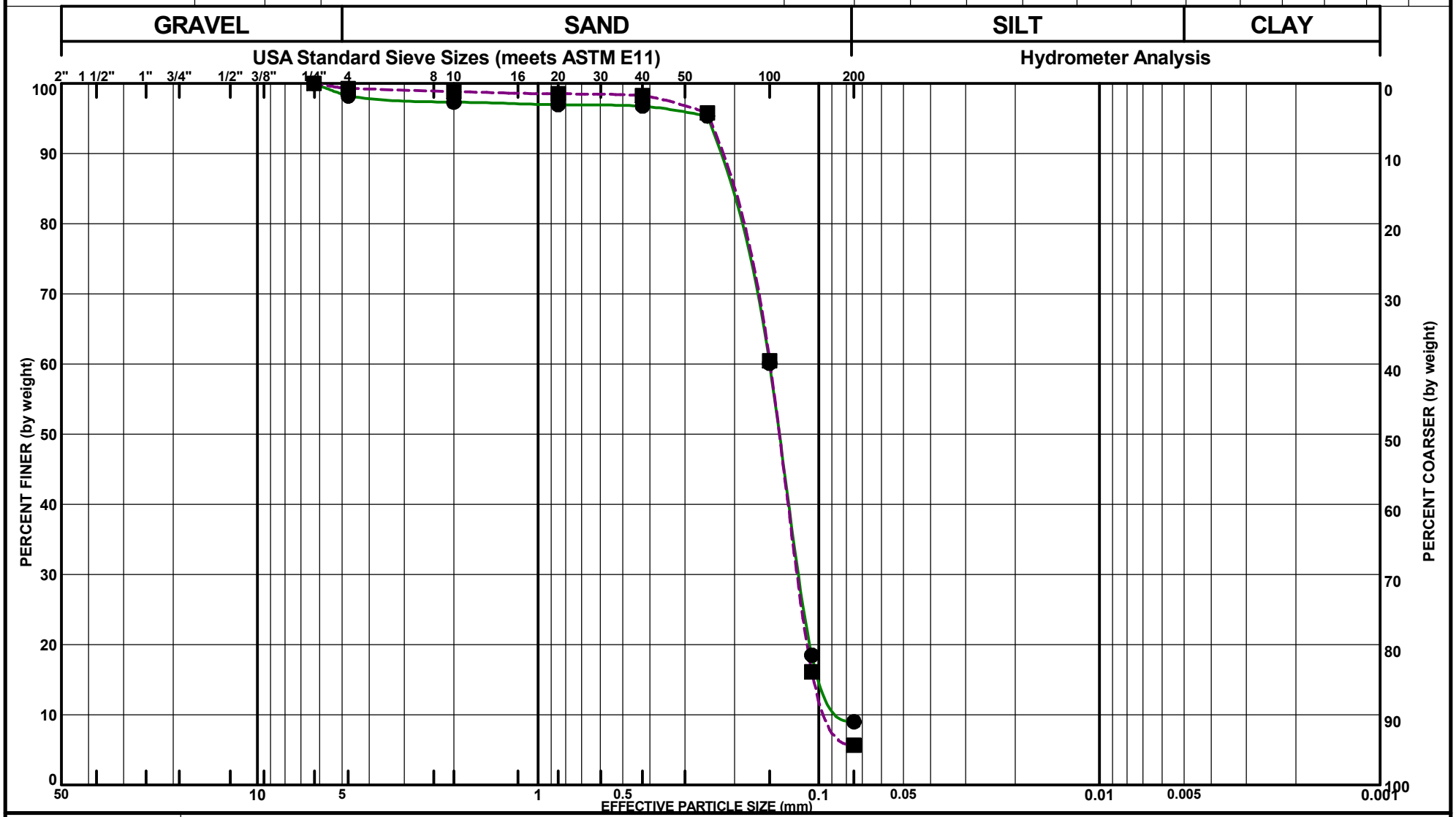
PARTICLE-SIZE ANALYSIS

ASTM D422/D6913/C136

Tested By:	Date Tested:	Reviewed By:	Date Reviewed:	Project No.	
James Suter	12/18/2023	Deborah Meyer-Sayer	12/20/2023	04.00247190	PLATE B-2

FCBR GSA LANDSCAPE 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/29/25

Boring Number	Sample Number	Depth (ft)	Material Description	%Gravel	%Sand	%Silt	%Clay	D100	D60	D30	D10	Cc	Cu	LL	PL	PI
● P-1	B2A	0.5-2	POORLY GRADED SAND with SILT (SP-SM), dark brown, with shells	1.8	89.2			6.3	0.15	0.117	0.078	1.17	1.93			
■ P-1	B6A	8.5-10	POORLY GRADED SAND WITH SILT (SP-SM), dark gray, with shell fragments	0.8	93.6			6.3	0.149	0.118	0.087	1.08	1.72			
▲																



FCBR GSA LANDSCAPE 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/29/25

FUGRO

Leeville VOR Facility Replacement Project

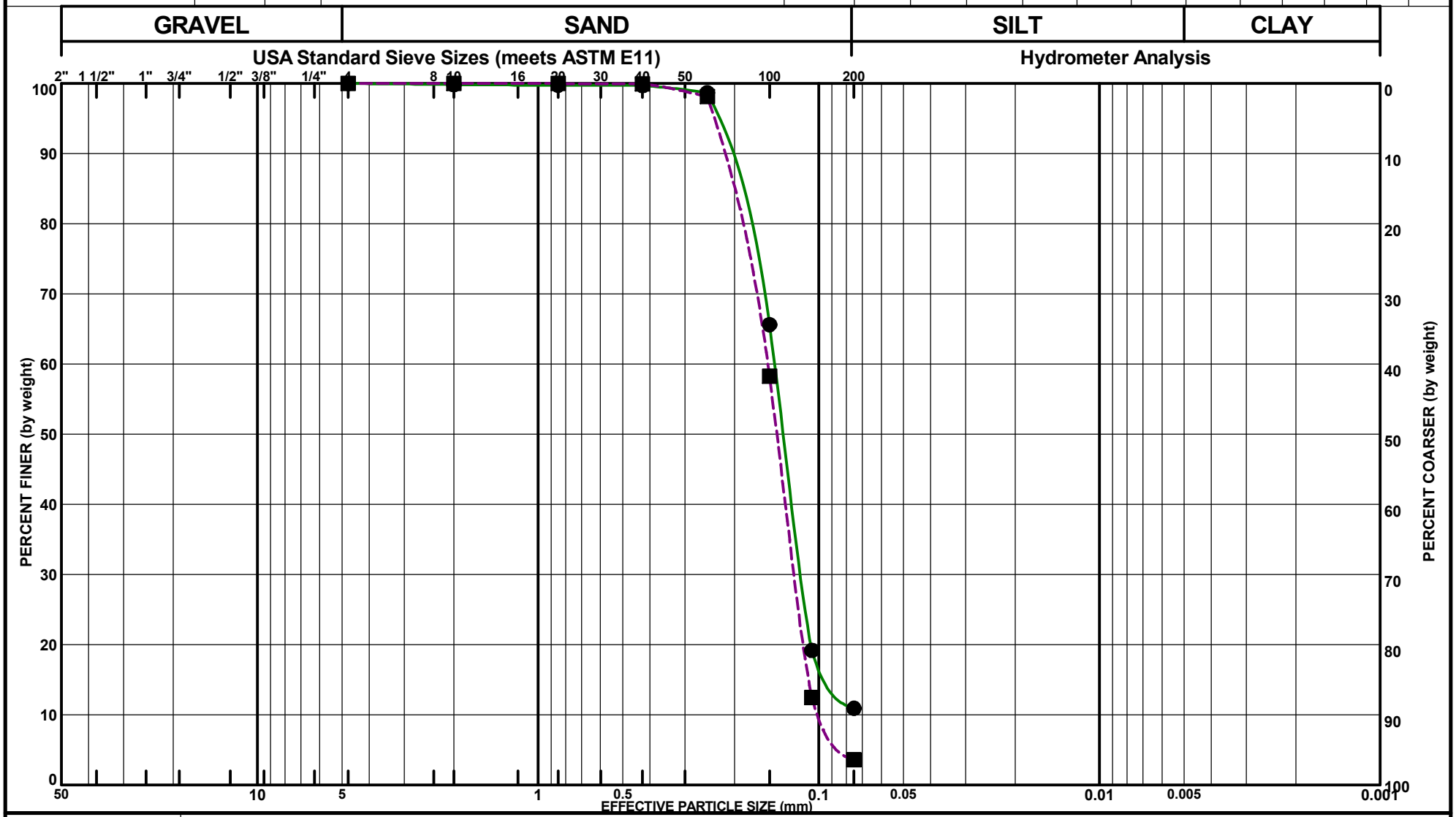
Leeville, Louisiana

PARTICLE-SIZE ANALYSIS

ASTM D422/D6913

Tested By:	Date Tested:	Reviewed By:	Date Reviewed:	Project No.	
Paul Nash	1/14/2025			04.00247190	PLATE B-3

Boring Number	Sample Number	Depth (ft)	Material Description	%Gravel	%Sand	%Silt	%Clay	D100	D60	D30	D10	Cc	Cu	LL	PL	PI
● P-2	B4A	4.5-6	POORLY GRADED SAND WITH SILT (SP-SM), dark brown, with shell fragments	0.0	89.1			4.75	0.144	0.115						
■ P-2	B6A	8.5-10	POORLY GRADED SAND (SP), dark gray	0.0	96.4			4.75	0.153	0.121	0.096	0.99	1.59			
▲																



FUGRO

Leeville VOR Facility Replacement Project

Leeville, Louisiana

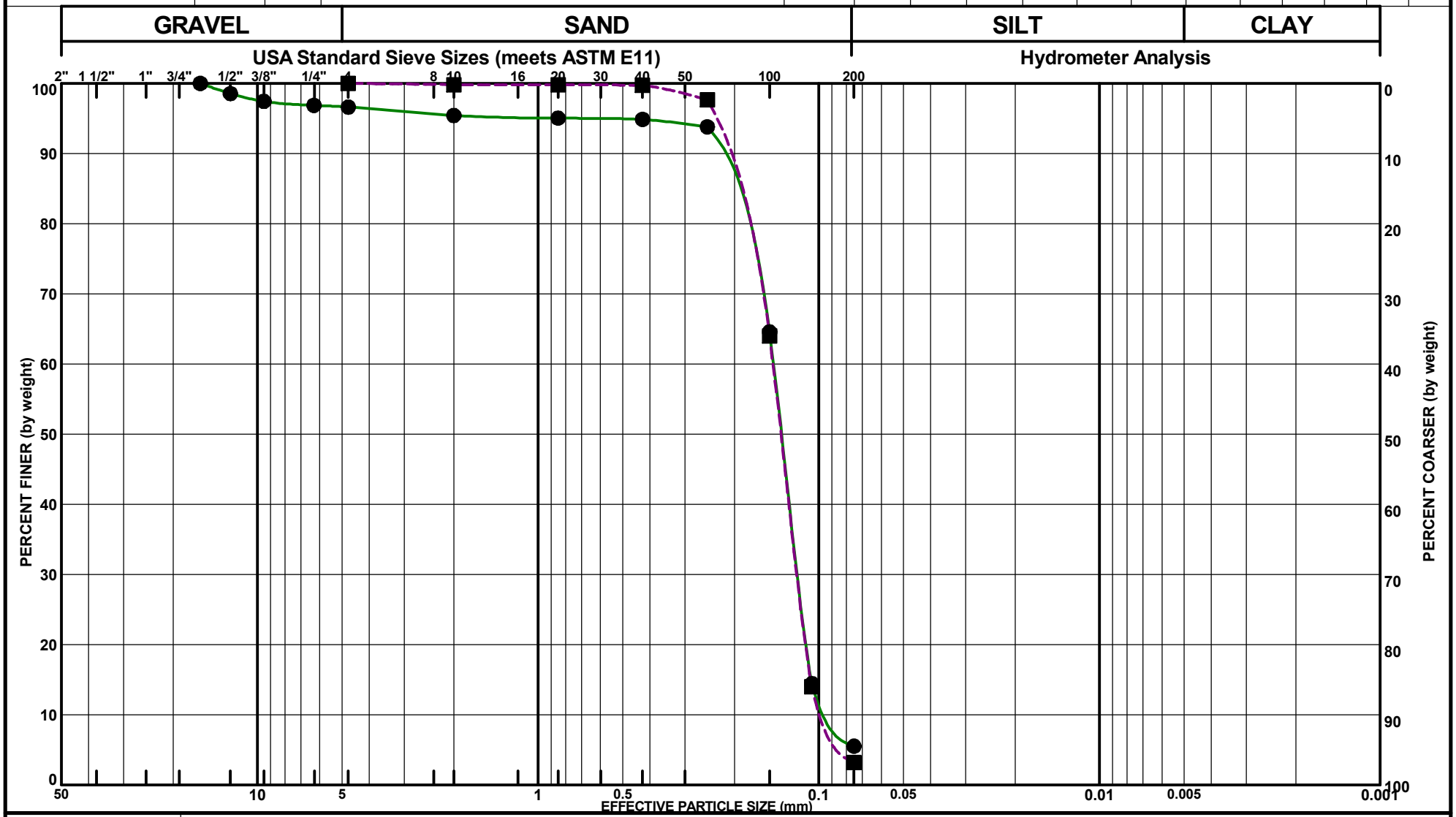
PARTICLE-SIZE ANALYSIS

ASTM D422/D6913

Tested By:	Date Tested:	Reviewed By:	Date Reviewed:	Project No.	
Paul Nash	1/15/2025			04.00247190	PLATE B-4

FCBR GSA LANDSCAPE 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/29/25

Boring Number	Sample Number	Depth (ft)	Material Description	%Gravel	%Sand	%Silt	%Clay	D100	D60	D30	D10	Cc	Cu	LL	PL	PI
● P-3	B3A	2.5-4	POORLY GRADED SAND WITH SILT (SP-SM), dark brown	3.4	91.1			16	0.145	0.118	0.089	1.07	1.63			
■ P-3	B5A	6.5-8	POORLY GRADED SAND (SP), greenish gray	0.0	96.8			4.75	0.146	0.118	0.093	1.03	1.56			
▲																



FCBR GSA LANDSCAPE 247190.GPJ FUGRO DATA TEMPLATE 042610.GDT 01/29/25

FUGRO

Leeville VOR Facility Replacement Project

Leeville, Louisiana

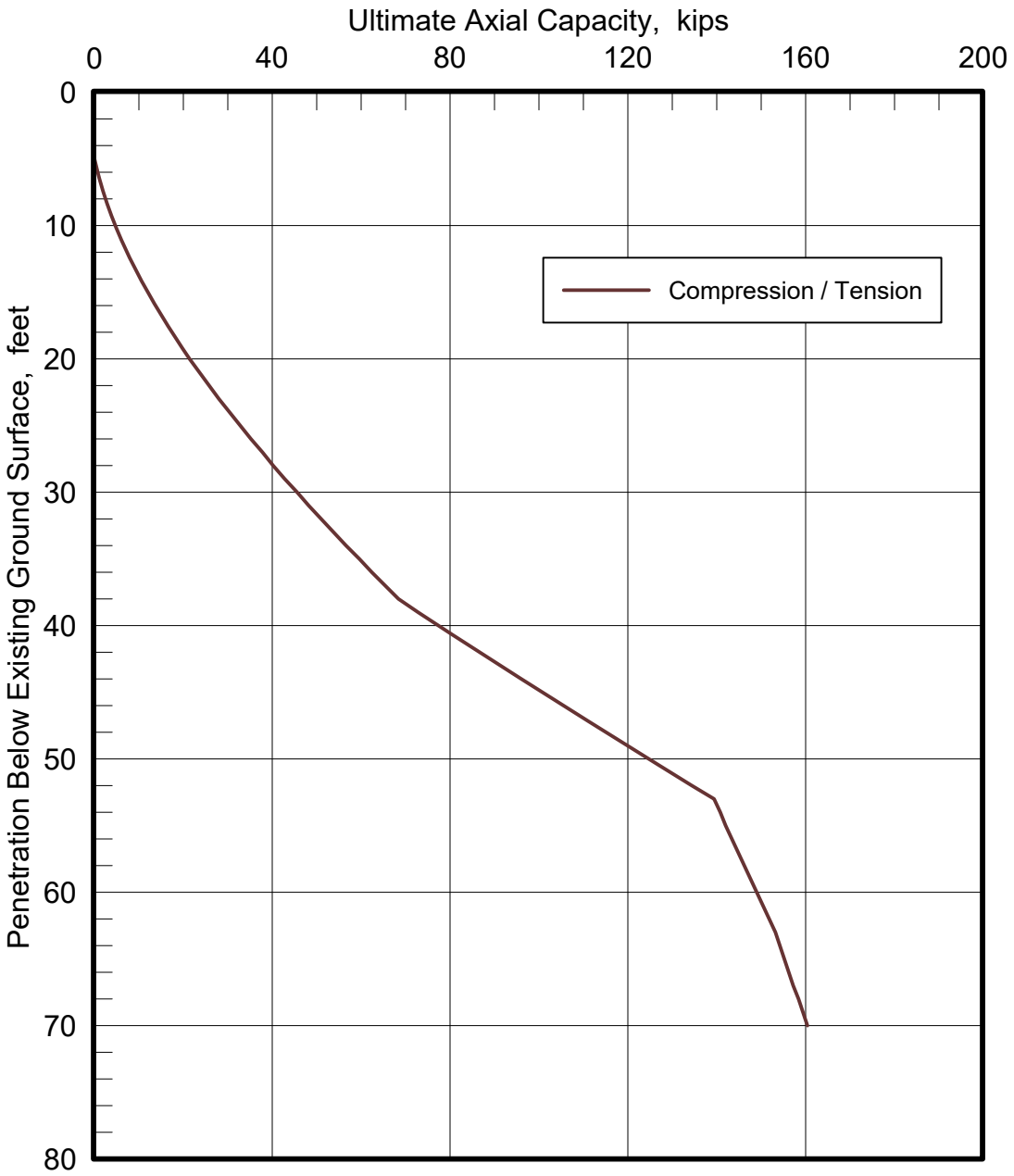
PARTICLE-SIZE ANALYSIS

ASTM D422/D6913

Tested By:	Date Tested:	Reviewed By:	Date Reviewed:	Project No.	
Paul Nash	1/14/2025			04.00247190	PLATE B-5

Appendix C

Ultimate Axial Capacity Curves



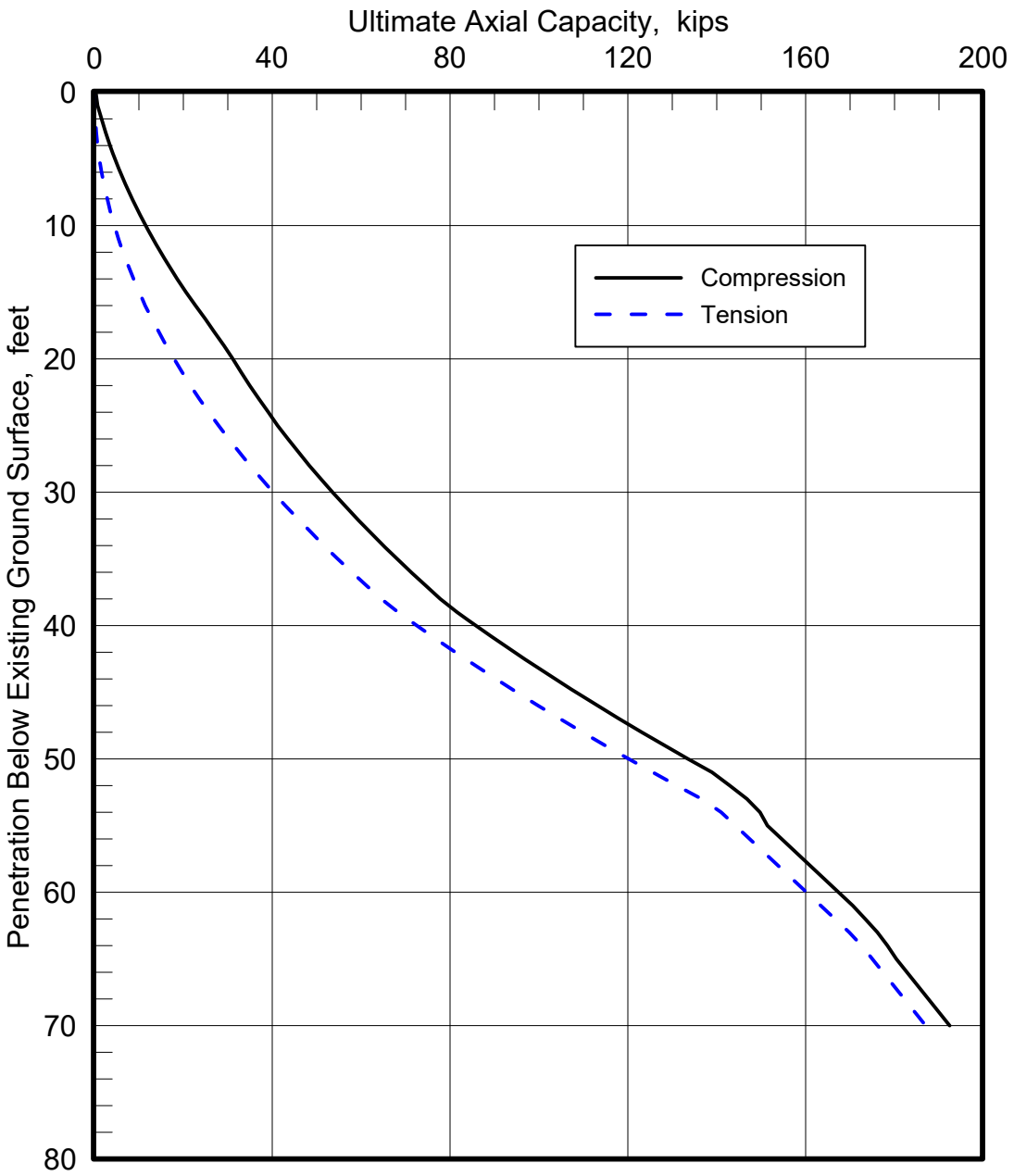
NOTES:

1. This curve represents ***ultimate*** values of a 12-inch diameter ACIP Pile for compression without end bearing and tension.
2. The curve should be used for design of individual, isolated pile as discussed in the report text.
3. See report text for recommended safety factors and other discussions on the use of this curve.
4. Tension capacity should be limited to the depth of steel reinforcement that can developed proposed tensile loads.

ULTIMATE AXIAL CAPACITY CURVE
12-INCH DIA. AUGERED CAST-IN-PLACE (ACIP) PILE
LEEVILLE VOR FACILITY REPLACEMENT PROJECT - JACOBS
LEEVILLE, LOUISIANA

Project No.: 04.00247190

Reviewed by: Viet Le	Date: 01/16/24	Approved by: Eric Marx	Date: 01/16/24	PLATE C-1



NOTES:
1. This curve represents **ultimate** values of axial capacity for compression (with end bearing) and tension (without end bearing). Factors of safety and installation guidelines are discussed in the text.
2. This curve is for a single isolated pile. Group effects are discussed in the text.
3. Tension capacity should be limited to the depth of steel reinforcement that can develop proposed tensile loads.
4. This curve includes geotechnical axial capacity. Structural capacity should be checked by designer.

ULTIMATE AXIAL CAPACITY CURVE
12-INCH SQUARE PRECAST CONCRETE PILE
LEEVILLE VOR FACILITY REPLACEMENT PROJECT - JACOBS
LEEVILLE, LOUISIANA

Project No.: 04.00247190

Reviewed by: Viet Le	Date: 01/16/24	Approved by: Eric Marx	Date: 01/16/24	PLATE C-2