SPI SCHAUMBURG & POLK, INC.

Eagle Landing Homeowners Association, Inc.

Eagle Landing Lake Outfall Channel Erosion

Preliminary Engineering Report

JEFFREY C. SIMMONS
96748

, P.E.

3-22-22

March, 2022

Summary

The Eagle Landing Lake, constructed in 1956, was formerly known as Simpson Lake. The lake is located approximately 3 miles west of Avinger, Tx in Cass County. The lake's dam is located on the west end of the lake with the primary and emergency spillways located on the south end of the dam. The principal spillway consists of a 7.2-foot diameter steel pipe spillway. County Road 1596 runs along the top of the lake dam. The emergency spillway is an approximately 150-foot-wide open channel spillway located above the primary spillway. Flow from the lake travels east to west through the spillway structures. Immediately downstream of the spillways, the outfall channel turns south and then quickly turns west again. At approximately 180 feet downstream of the spillways, the channel has eroded so that flow drops vertically approximately 25 feet to the channel below. The sudden increase in velocity at the drop and erosive energy of the falling flow has degraded the streambed significantly. The side slopes of the lower channel section are fairly vertical. Water flows from several areas of the lower channel walls. The erosion of the channel that has created the waterfall is commonly called headcutting. Headcutting continues to progress upstream until it is stopped by a stable structure (e.g. stable soil, rock, concrete, etc.). In this case, erosion will continue until it reaches the spillway/road structure and possibly the lake if no stable structure is found or created. There are building structures located approximately 60 feet south of the current waterfall location. As the erosion continues to migrate upstream, the buildings will be in danger of being affected. See the following site pictures.

The Geotechnical Engineer's (ETTL) report (See Appendix A), shows that the surface soils are very loose silty sand with minor clay layers. The clay exists within the silty sand and is determined to be dispersive. Due to this dispersion, the clay particles are a cohesionless material. For these reasons, only low flow velocities are required to erode these soils.

The following sections provide two solution options for these erosion issues.

Option 1 – Drop Structure

The construction of a stable drop structure, in the existing outfall channel, would be a way to stop the channel erosion. The structure would need to be constructed of a material that is stable at the high flow velocities. Concrete would be the best choice of material due to its strength, erosion resistance, stability, and constructability. The structure would begin at the elevation of the upstream channel and end at the elevation of the downstream channel (downstream of the drop). The upstream end of the structure would need to be toed into the existing channel sufficiently to prevent flow from undermining the structure. The structure would need to be sufficiently sized to carry the maximum flow from the lake. The structure would have a fairly flat top section followed by a steep (3 horizontal : 1 vertical) section that would be approx. 75’ long, and finally a flat lower section. The downstream end of the structure, would be constructed of concrete followed by large rock riprap. The rock would extend to the limits of the erosive flow velocities. Construction would require access by large equipment for excavation and grading and delivery of materials (e.g. concrete trucks, rock). It’s estimated that construction of this option would take 4 months. See the preliminary estimated construction costs below.

Eagle Landing HOA
Option 1 - Concrete Drop Structure
Engineer's Opinion of Probable Construction Cost

Item No.	Description	Quantity	Units	Unit Price	Unit Total
1	Mobilization	1	LS	$ 26,375.00	$ 26,375.00
2	Construction Staking	1	LS	5,000.00	5,000.00
3	Concrete Spillway Structure	1	LS	125,000.00	125,000.00
4	8-24" Rock Riprap	150	CY	325.00	48,750.00
5	Grading and Excavation	1	LS	50,000.00	50,000.00
6	Embankment Material	1000	CY	30.00	30,000.00
7	SWPPP - Erosion Control	1	LS	5,000.00	5,000.00
				Subtotal	$ 290,125.00
				20% Contingency	58,025.00
				Total	***$ 348,150.00***

Option 2 – Outfall Channel Realignment

The spillway outfall channel could be realigned to the north. This would require a berm to be constructed immediately downstream of the spillway blocking the existing channel to the south. A new channel would be constructed to carry flow to the north. This outfall channel would be positioned beyond the backside slope of the dam and be aligned fairly parallel to the top of dam. In order to not affect the dam stability, we would want to position the channel as far away from the toe as is feasible. This flow path would route the water to the original creek channel location and elevation on the backside of the dam. To take flow from the spillway elevation down to the original creek elevation, channel protection will be required in the form of channel lining and/or protected drop structures. If the adjacent access drive (on the north side of the spillway) is required, then flow would be carried under that drive via a drainage structure (e.g. pipes, box culvert). The channel and any drainage structures would have to be sized to not restrict flow leaving the lake spillway, in order to not act as the lake spillway. Material around any drainage structures would need to be imported or cement treated in order to avoid seepage around the exterior of the structure. In the steepened sections of the channel, material (e.g. rock, concrete) would be needed to protect from erosion of the channel. In flatter sections, the channel would need to either be lined with an imported select fill material or the native soils would need to be treated with cement. Some trees would be removed in order to construct the channel and drop structures. TCEQ wouldn't have a problem with this proposed channel as long as the dam is not disturbed. It's estimated that construction of this option would take 3 months. See the preliminary estimated construction costs below.

Eagle Landing HOA
Option 2 - Outfall Channel Realignment
Engineer's Opinion of Probable Construction Cost

Item No.	Description	Quantity	Units	Unit Price	Unit Total
1	Mobilization	1	LS	$ 12,575.00	$ 12,575.00
2	Construction Staking	1	LS	5,000.00	5,000.00
3	Drop Structures	3	EA	17,500.00	52,500.00
4	8-24" Rock Riprap	50	CY	325.00	16,250.00
5	Grading and Excavation	1	LS	12,000.00	12,000.00
6	Cement Treatment of Soils	1	LS	10,000.00	10,000.00
7	Tree Removal	1	LS	10,000.00	10,000.00
8	Drainage Structure (under driveway)	30	LF	500.00	15,000.00
9	SWPPP - Erosion Control	1	LS	5,000.00	5,000.00
				Subtotal =	$ 138,325.00
				20% Contingency	27,665.00
				Total =	***$ 165,990.00***

Recommended Improvements

According to Cass County Appraisal District's online mapping, neither the existing outfall channel nor the proposed channel's alignments are on HOA property. The total right-of-way for the county road is approx. 40'. The property owners for both locations are Jeffery and Trina Vaughn. Construction of either option would require a construction easement from the property owners. Due to the benefits of both options, it would be expected that the property owners would welcome the improvements.

It's estimated that a drop structure, as described in Option 1, would need to be 115' long and 35' wide. Due to the loss of soil from the channel, the structure would need to be constructed into the existing embankment. Construction of this structure would require a significant amount of earthwork. Underdrains would be needed due to the flow from the channel walls. Preliminary construction costs are estimated to be approximately $348,000.

It's estimated that the outfall channel realignment, as described in Option 2, would involve the creation of 375' of new channel. The channel would be a combination of steepened sections protected by rock riprap and flatter sections with stabilized soil. Preliminary construction costs are estimated to be approximately $166,000.

For either option if construction doesn't affect the lake's spillway or dam, submission of plans to TCEQ will not be required.

Based on the estimated costs and disturbance required for a drop structure, it is the Engineer's recommendation that Option 2 of re-routing the channel be pursued.

APPENDIX A

Location Map

Source: Esri, USDA FSA, Esri Community Maps Contributors, Texas Parks & Wildlife, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc., METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Eagle Landing Homeowners Association
Location Map

1" = 400'

0 250 500 1,000 Feet

APPENDIX B

ETTL Geotechnical Report

ETTL | Engineers & Consultants

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

March 4, 2022

Jeff Simmons
Schaumburg & Polk, Inc.
320 S. Broadway Ave., Suite 200
Tyler, Texas 75702

SUBJECT: Eagle Landing Erosion Study
Avinger, Texas
Geotechnical Investigation
ETTL Job No. G 5846-225

Dear Mr. Simmons:

Submitted herein is the report summarizing the results of a geotechnical investigation conducted at the site of the above-referenced project.

If you have any questions concerning this report, or if we can be of further assistance during construction, please contact us. We are available to perform any construction materials testing and inspection services that you may require. Thank you for the opportunity to be of service.

Sincerely,
ETTL Engineers & Consultants Inc.

Evan Felker

Evan Felker, E.I.T.
Project Manager

Robert M. Duke, P.E.
Senior Engineer

STATE OF TEXAS
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Geotechnical Investigation

Eagle Landing Erosion Study

Avinger, Texas

Jeff Simmons
Schaumburg & Polk, Inc.
Tyler, Texas

Prepared by

ETTL Engineers & Consultants Inc.
Tyler, Texas

March 2022

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1.0 INTRODUCTION

This study was performed at the request and authorization to proceed granted by Jeff Simmons with Schaumburg & Polk, Inc. in Tyler, Texas, in accordance with our proposal dated January 19, 2022. The field operations were conducted on February 15, 2022.

The purpose of this investigation was to define and evaluate the general subsurface conditions of the proposed site located at within the Eagle Landing HOA in Avinger, Texas. A site map depicting the location is included in **Appendix A**. Specifically, the study was planned to evaluate the following:

- Subsurface stratigraphy within the limits of exploratory borings;
- Classification and dispersive properties of soil samples taken from the site; and
- Recommendations for modifications of soils properties.

The investigation was carried out in three phases: 1) field exploration, sampling, and testing; 2) laboratory testing; and 3) engineering evaluation of data, the details of which are set forth in the following sections.

A variety of tests were performed on selected soil samples to provide the data used to form the basis for the conclusions and recommendations of this study. The conclusions and recommendations that follow are based on limited information regarding site grading. Using a handheld GPS unit, ETTL located the boring on the ground based on a site meeting with the client's representative. ETTL did not confirm by a survey that the locations indicated on the Plan of Boring or the elevations stated herein, accurately reflect the locations on the ground.

2.0 PROJECT DESCRIPTION

This project is focus on the south west section of the Simpson Lake dam/spillway within the Eagle Landing HOA. The current downstream waterway west of the spillway is experiencing substantial erosion. The purpose of this project is to investigate the erodibility and dispersity of onsite soils for a new spillway to relieve the current eroding waterway.

3.0 SITE DESCRIPTION

The site is located near the spillway located at the south west corner of Simpson Lake. There are dense trees to the west and south. The current water way runs WSW from the spillway.

4.0 FIELD OPERATIONS

Subsurface conditions of the proposed project were defined by one (1) sample core borings. The field boring logs were prepared as drilling and sampling progressed. The final boring logs are also included in **Appendix A**. Descriptive terms and symbols used on the logs are in accordance with the Unified Soil Classification System (ASTM D 2487). A reference key is provided on the final page of this report.

A track-mounted drill rig utilizing dry auger drilling procedures was used to advance the borings. Soils were sampled by means of a 1 3/8-inch I.D. by 24-inch-long split-spoon sampler driven into the bottom of the borehole in accordance with ASTM D 1586 procedures. In conjunction with this sampling technique, the Standard Penetration Test was conducted by recording the N-value, which is the number of blows required by a 140-pound weight falling 30 inches to drive a split-spoon sampler 1 foot into the ground. For very dense strata, the number of blows is limited to a maximum of 50 blows within a 6-inch increment. Where possible, the sampler is "seated" six inches before the N-value is determined. The N-value obtained from the Standard Penetration Test provides an approximate measure of the relative density that correlates with the shear strength of the soil. The disturbed samples were removed from the sampler, logged, packaged, and transported to the laboratory for further identification and classification.

All boreholes were backfilled with cuttings after collecting final groundwater readings. Samples obtained during our field studies and not consumed by laboratory testing procedures will be retained in our Tyler office free of charge for 60 days. To arrange storage beyond this point in time, please contact the Tyler office.

Table 4.0 – Boring Identification

Boring	Depth (ft.)	Structure/Location	[1] G.W. Depth (ft.)
B-1	15	New Waterway	10.0

Table Notes:

1) G.W. = highest groundwater observation during the drilling activities measured from the depth the existing ground.

5.0 LABORATORY TESTING

Upon return to the laboratory, a geotechnical engineer visually examined all samples and several specimens were selected for representative identification of the substrata. By determining the Atterberg liquid and plastic limits (ASTM D 4318) and the percentage of fines passing the No. 200 sieve (ASTM D 1140), field classification of the various strata was verified. Also conducted were natural moisture content tests (ASTM D 2216). These results are presented on the individual logs of boring provided in **Appendix A**.

5.1 Identification and Classification of Dispersive Clay Soils by Crumb Test

This test is conducted on a small cube specimen that is placed in a jar full of distilled water. Observations are made over time regarding the characteristics of cloudiness that may form. This test provides a preliminary indication regarding the possibility of soil erosion due to dispersion. The tests indicate that the samples were dispersive.

5.2 Hydrometer and Mechanical Analysis of Soil Binder

This test was performed to characterize the gradation of native soils and to determine the percentage of the sample that consists of fine clay particles (<0.002mm). This information is sometimes needed to specify an appropriate geotextile to help prevent fines from washing out of the native soil as water is drained out of it into a coarser drainage medium. This data is also used to help predict the shear strength of clay following degradation of many cycles of shrink/swell, especially where it comprises slopes.

5.3 Dispersive Characteristics of Soils by Double Hydrometer

One test was conducted on a soil sample to provide an indication regarding the possibility of soil erosion due to dispersion. The tests indicate that the samples of near surface soils at boring B-1 were dispersive.

6.0 FOUNDATION SOIL STRATIGRAPHY AND PROPERTIES

6.1 Site Geology

According to the Bureau of Economic Geology at the University of Texas at Austin, Geologic Atlas of Texas, Tyler Sheet, the proposed site is located near the contact point of the Queen City Sand Formation (Eqc) and Alluvium Deposits (Qal).

The Queen City Sand formation is described as fine-grained to locally medium-grained quartz sand found in a series of laminated or thinly stratified white and red sands and sandy clays, frequently merging into one another and forming a mottled sandy clay or clayey sand. Ironstone concretions, sometimes occurring as ledges, are common within the formation. Upper sands rest on a series of black, blue, and gray micaceous sands, blue, brown, and gray clays with thin strata of sandstones and limestone. Thickness of the formation in ranges from 100 to 400 feet and is generally thinning southeastward. The age is Eocene and can found mapped throughout the Tyler Sheet

For more information, please refer to the National Geologic Map Database and the Geologic Atlas of Texas:

http://ngmdb.usgs.gov/Geolex

6.2 Site Stratigraphy

The soils at the site generally consist of very loose silty sand (SM) with minor clay layers from existing grade surface to 5 feet followed by medium dense silty sand (SM) with minor clay layers to boring termination depth. What clay exists within the silty sand is determined to be dispersive.

The classifications are based on weathering, depositional environment, mineralogy, color change, lithology, and structure. Detailed on the boring logs in **APPENDIX A** are the specific types and depths of the various soil strata encountered. The logs show defined boundaries between various soil types, but in reality, the transition between types is generally gradual.

6.2.1 Erosion Mechanics of Dispersive Soils

The erosion mechanism of dispersive soils is different than for non-dispersive soils. Dispersion happens when the clay particles deflocculates so they are no longer electro-chemically bound to each other and makes the clay almost like an ultra-fine cohesionless material. For this to happen very little velocity is needed. Usually occurs with water flow within cracks or silty sand seams where permeability is high and can create deep gullies on slopes as well as tunnels.

6.2.2 Erosional Piping

Erosional piping is a phenomenon related to soil properties and layering characteristics together with groundwater or seepage flow (there must be a head to induce the flow) through the soil that exits the soil mass at some point. Where the groundwater exits it can begin an erosion process if appropriate measures are not taken to prevent the erosion.

One common example of the process is often observed in backfill of jointed, precast concrete storm drain pipe. If the backfill is not compacted properly, infiltration of surface water is facilitated. The surface water percolates through the loose backfill and can exit through joints in the pipe that are not properly sealed (or which have opened up since placement). The water exiting through the joints takes particles of soil with it and begins to erode the soil locally around the exterior of the pipe. Over time the void grows, which process can eventually lead to collapse of the ground into the void.

Anywhere that groundwater or seepage water is induced to flow into a collection system, the potential for erosional piping exists. Some examples of potential problem situations include:

1. Granular embedment of subsurface piping where the embedment can be drained at an outlet such as a manhole or exterior headwall. In this instance fines from the soil are eroded into the void spaces of the granular aggregate. If conditions are right the fines can also be carried through the void spaces by the water flow to the exit.
2. Buried pipes where the backfill around the pipe is not properly compacted and/or consists of dispersive (soils with a highly erodible clay fraction). In this instance flow can follow the outside contact of the backfill and the pipe to an exit where the erosion process begins and then works its way back into the soil along the pipe, creating a “pipe” in the soil.
3. Seepage through and/or under embankment dams. Under certain conditions, the pressure of flow through the soil mass exits the soil downstream of the dam. Where the groundwater exits under pressure, erosion can begin (if the properties of the soil at the exit make it susceptible to erosion). Once the erosion process begins, it works its way back through the soil mass from the exit creating a void, or “pipe” as it progresses.
4. Groundwater or seepage water that flows from a less permeable zone to a more permeable zone such as where seepage through an embankment dam moves from the clay core to an interceptor drain.

These examples are given as an overview of the kinds of situations where piping could be a problem and are not intended to be a comprehensive list. A detailed analysis of the potential for erosional piping for this project was beyond the scope of our study. However, ETTL is available to assist in further evaluation of specific situations once they are identified by project designers. In general, solutions for mitigating the risk entail one or more of the following (not an exhaustive list):

1. Elimination of situations that induce the flow of groundwater or seepage through soil.
2. Precluding the use of highly erodible soils in situation where the flow of groundwater cannot be prevented.
3. Specialized treatment of zones where groundwater exits a soil mass using filtration devices (graded aggregate, geotextiles) that controls the quantity and size of erodible material that can pass through to the exit.

7.0 GROUNDWATER OBSERVATIONS

Seepage was observed at 8 feet below the existing grade during flight auger drilling. After the completion of drilling activities, water was observed 10 feet below the existing ground surface, as noted in **Table 4.0** above.

Data regarding the groundwater level was obtained by observations in open boreholes. At best this provides only an approximation of the phreatic surface at the time of drilling. *The phreatic surface that should be considered for the design of this project may vary significantly from that which was observed in the borings due to the following factors*:

- The characteristics of the soil profile may have prevented the water level in the boring from rising to the phreatic level during the time period of observation
- A given boring may not intercept groundwater bearing zones (i.e., the groundwater is perched or travels in seams or fissures that are not continuous over the entire site)
- Groundwater may only be perched in pockets above local aquicludes, but the distribution of borings is not generally adequate to confirm this with a high level of certainty
- Groundwater level varies seasonally and with rainfall
- Rotary wash drilling methods introduce fluid into the boring that often makes it impossible to distinguish between groundwater and drilling fluid

If the designer believes that the level of groundwater could significantly impact the project, then ETTL should be contacted to develop a plan for piezometer installation and monitoring to more accurately assess the groundwater levels at the site.

8.0 RECOMMENDATIONS FOR EROSION CONTROL

The following recommendations are given to reduce the potential for new erosion associated with the new spillway and to reduce the effects of erosion associated with the current waterway.

8.1 Backfilling the Current Channel

Preparation prior to backfilling the channel will require clearing and grubbing the areas in proximity of the channel. Strip the subgrade over the entire channel to remove any vegetation and loose debris to prevent the formation of voids. Stripping of surface soils should be to a minimum depth of 1 foot. A greater depth of stripping will be required in the immediate vicinity of slope failures, if encountered. Since the new face will need to be placed in a level platform, benching of the embankment face will be required. A minimum construction width of 7 to 8 feet is typical. However, all soils that have been displaced during a slip must be removed down to competent, undisturbed material.

All stripped areas should be inspected by qualified personnel to determine if additional excavation is required to remove weak or otherwise objectionable materials that would adversely affect stability of the embankment. After completion of stripping, the exposed soils should be scarified, the moisture content adjusted, and then recompacted to 95% of standard proctor (ASTM D698) at a moisture content of optimum or above.

For recommendations on placement of select fill please refer to **Section 9.3, Select Fill.** As an added measure of protection after the slope has been constructed Shoreblock and Pryamat should be installed in accordance with the manufacture's recommendations.

8.2 New Channel

Given the highly erodible and dispersive characteristics of the soils on site, proper measures should be taken to mitigate the effects of erosion caused by flowing water. After removing the surficial vegetation and organic topsoil and cutting to finished grade it is recommended that the native soils be remediated via cement treatment or replaced with select fill prior to constructing the new channel, see **Sections 9.3 and 9.4.** There should be a minimum buffer of **12 inches** of select fill or cement treated soils between the native subgrade and channel.

To lower the risk of further erosion, the hydraulic structure should be designed to reduce the energy of water and help protect the underlying soils. Viable options include (but not limited to) riprap, Shoreblock and Pryamat, or a concrete channel. Sheet piles or drop-down walls can be considered but, more information would be needed. Contact ETTL for details.

9.0 SITE EARTHWORK

9.1 Site Preparation

Remove the surficial vegetation and organic topsoil. Tree root zones (typically 3 to 5 feet deep) and abounded utilities should be completely removed and replaced by select fill. Any areas disturbed by site preparation/demolition should be undercut and replaced with select fill.

9.2 New Channel Subgrade Preparation

9.2.1 Select Fill

- Over-excavate to provide a minimum of **12 inches** of select fill or cement treated soil beneath the channel. Extend this over-excavation a minimum of 5 feet beyond the channel lines.

- After cutting to grade and/or before adding fill, the exposed subgrade should be proof rolled with a fully loaded dump truck. Any areas that show signs of significant deflection (as determined by a member of this firm) should be further evaluated and repaired.

- Scarify the exposed subgrade to a depth of 12 inches, adjust the moisture content to, and maintain it within a range of optimum to optimum +2% and recompact to a density of at least 95%

9.3 Select Fill

Fill shall consist of homogeneous soils (i.e., not sand with clay lumps) free of organic matter and rocks larger than 6 inches in diameter. Fill should possess an Atterberg PI of 15 to 40, and with a percentage passing the #200 sieve >40. Atterberg limits testing of the fill at a rate of 1 test per 500 cubic yards of fill (minimum 1 test per fill area and as visual change occur) placed in the recommended to verify that fill specifications are met. The material should be placed in the following manner;

- Prepare the subgrade in accordance with the recommendations above. Sites that slope more than about 15% should be benched with minimum 7-foot wide benches prior to placing fill.

- Place subsequent lifts of fill in thin, loose layers not exceeding nine inches in thickness to the desired rough grade and compact to a minimum of 95% of the maximum density defined by ASTM D 698. Maintain moisture within a range of optimum to optimum +3%.

- Conduct in-place field density tests at a rate of one test per 3,000 square feet for every lift with a minimum of 2 tests per lift. *Density testing is essential to assure that the soil is properly placed.*

- Prevent excessive loss of moisture during construction.

9.4 Cement Stabilization

This option consists of deep mixing (12-inch lift) of cement. The mixing operation and compaction need to be in accordance with standard recommendations for cement treatment (see below).

Mixing and compaction need to be completed no later than 2 hours following first mixing. There is a possibility that construction traffic on this stabilized lift will cause a break in the "crust" (in spots) and cause some deterioration of the stabilized subgrade at that location. If this happens the subgrade will need additional repair work. All traffic should be kept off the area during the curing period of at least 7 days. In order to improve the chances of satisfactory performance, construction traffic on the stabilized areas should be kept to a minimum after the initial cure.

9.4.1 Cement Treatment

Treatment of the subgrade should be in accordance with Item 275, "Portland Cement Treated Materials (Road Mixed)," Texas Department of Transportation Standard Specifications for Construction of Highways, Streets and Bridges with the following exceptions:

- Under Section 4.3, "Application of Cement," the rate of cement to be applied is 80# per square yard worked into the top 1 foot of subgrade being worked. A thorough blend using pulverizer mixers is important.

- Each lift of the modified subgrade should be compacted under Section 4.5.2, "Density Control," using drum rollers, except that it shall be compacted to a minimum density of 95% of Standard Proctor Density (ASTM D698) or to the maximum extent achievable based on observations of ETTL personnel.

9.5 Temporary Excavations

The Federal Register, Volume 54, No. 209 (Revised July 1992), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) contain the “Construction Standards for Excavations, 29 CFR, part 1926, Subpart P”. The contractor is solely responsible for designing and constructing stable, temporary excavations in accord with these standards and should shore, slope or bench the sides of the excavations as required to maintain the stability of both the excavation sides and bottom. ETTL has not performed stability analyses of any kind. The contractor’s “responsible person”, as defined in CFR Part 1926, should evaluate the soil exposed in the excavation as part of the contractor’s safety procedure. In no case should the height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Contractors should review the boring logs in **Appendix A** to demine the appropriate soil type per the aforementioned OSHA regulations.

10.0 GENERAL CONSTRUCTION CONSIDERATIONS

10.1 Subgrade Stability

During wet periods of the year especially, the native subgrade and areas where cuts into the native subgrade are required are likely to be unstable. This will necessitate specialized construction procedures to be able to achieve a subgrade that is sufficiently stable to serve as a base to adequately compact fill. The most appropriate method is best determined based on an evaluation of the conditions by the geotechnical engineer of record at the time of construction.

11.0 LIMITATIONS

Geotechnical design work is characterized by the presence of a calculated risk that soil and groundwater conditions may not have been fully revealed by the exploratory borings. This risk derives from the practical necessity of basing interpretations and design conclusions on a limited sampling of the subsoil stratigraphy at the project site. The number of borings and spacing is chosen in such a manner as to decrease the possibility of undiscovered anomalies while considering the nature of loading, size, and cost of the project. The recommendations given in this report are based upon the conditions that existed at the boring locations at the time they were drilled. The term "existing groundline" or "existing subgrade" refers to the ground elevations and soil conditions at the time of our field operations.

It is conceivable that soil conditions throughout the site may vary from those observed in the exploratory borings. If such discontinuities do exist, they may not become evident until construction begins or possibly much later. Consequently, careful observations by the geotechnical engineer must be made of the construction as it progresses to help detect significant and obvious deviations of actual conditions throughout the project area from those inferred from the exploratory borings. Should any conditions at variance with those noted in this report be encountered during construction, this office should be notified immediately so that further investigations and supplemental recommendations can be made.

Construction plans and specifications should be submitted to ETTL for review prior to issuance for construction to help verify that the recommendations of this report have been correctly understood and implemented.

This company is not responsible for the conclusions, opinions, or recommendations made by others based on the contents of this report. The recommendations made in this report are applicable only to the proposed scope of work as defined in **SECTION 2.0 PROJECT DESCRIPTION** and may not be used for any other work without the express written consent of ETTL Engineers. The purpose of this study is only as stated elsewhere herein and is not intended to comply with the requirements of 30 TAC 330 Subchapter T regarding testing to determine the presence of a landfill. Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. No warranties are either expressed or implied.

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will <u>not</u> likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will <u>not</u> be adequate to develop geotechnical design recommendations for the project.

Do <u>not</u> rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do <u>not</u> rely on an executive summary. Do <u>not</u> read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GBA GEOPROFESSIONAL
BUSINESS
ASSOCIATION

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APPENDIX A

Plan of Borings and Boring Logs

0 50 100
SCALE IN FEET

ETTL Engineers & Consultants

EAGLE LANDING
EROSION STUDY
AVINGER, TEXAS

PLATE 1 - PLAN OF BORINGS
JOB NO.: G5846-225
SCALE: AS SHOWN
DATE: MARCH 2022

ETTL | **Engineers & Consultants**

LOG OF BORING B-1

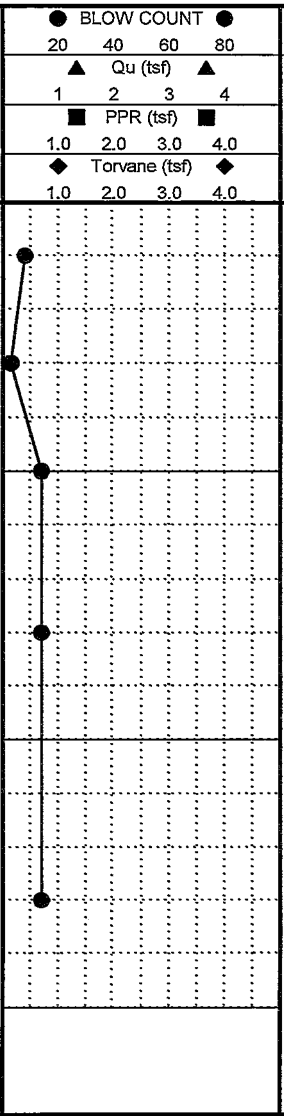
PROJECT: Eagle Landing Erosion Study
Avinger, Texas

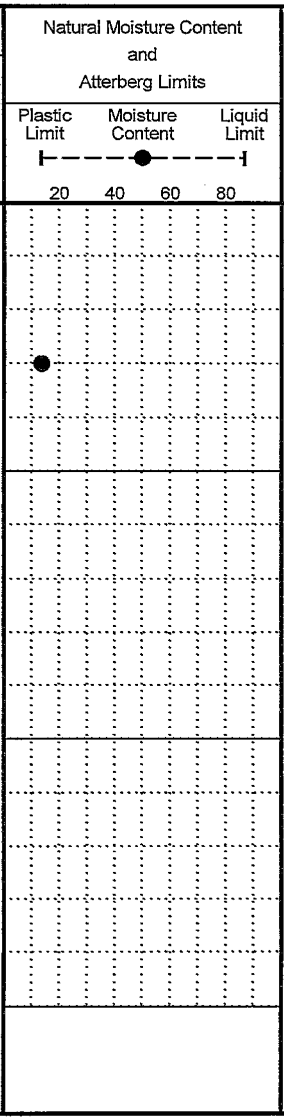
PROJECT NO.: G 5846-226

DRILL RIG: D-50 Track Rig
BORING TYPE: Flight Auger

DATE 2/15/22
SURFACE ELEVATION Not Available

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421





DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	COMPRESSIVE STRENGTH: DRY DENSITY (pcf)	COMPRESSIVE STRENGTH: COMPRESSIVE STRENGTH (tsf)	COMPRESSIVE STRENGTH: MOISTURE CONTENT (%)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%): LIQUID LIMIT LL	ATTERBERG LIMITS(%): PLASTIC LIMIT PL	ATTERBERG LIMITS(%): PLASTICITY INDEX PI	SIEVE ANALYSIS: MINUS #200 SIEVE (%)	SIEVE ANALYSIS: PLUS #40 SIEVE (%)	SIEVE ANALYSIS: PLUS #4 SIEVE (%)	SWELL TEST: DRY DENSITY (pcf)	SWELL TEST: FREE SWELL (%)	SWELL TEST: ZERO SWELL PRESSURE (ksf)	SWELL TEST: MOISTURE CONTENT (%)
0		SM																		
					SILTY SAND(SM) loose; brown; moist; with minor clay	N=8														
					-- very loose	N=3				14	NP	NP	NP	22	14	12				
5		SM			SILTY SAND(SM) medium dense; light brown; moist; with minor clayey sand layers	N=14														
		SM			SILTY SAND(SM) medium dense; dark brown; very moist; with minor lean clay partings	N=14														
10				▼																
		SM			SILTY SAND(SM) medium dense; light gray with light brown; very moist	N=14														
15					Bottom of Boring @ 15'															

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 8 feet while drilling. Water @ 10 feet and open to 10.5 feet upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
This is a preliminary boring log.

GPS Coordinates:	Driller:	Logger:
N32.888770°, W94.612126°	Mike D.	Evan F.

Boring Log Descriptive Terminology

Key to Soil Symbols and Terms

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO 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 (APPRECIABLE AMOUNT OF FINES)	▨	GM	Silty gravels, gravel-sand-silt mixtures.
			▨	GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	▨	SW	Well-graded sands, gravelly sands, little or no fines.
			▨	SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	▨	SM	Silty sands, sand-silt mixtures.
			▨	SC	Clayey sands, sand-clay mixures.
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	▨	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			▨	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			▨	OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	▨	MH	Inorganic silts, micaceous or diatomaceous fine 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.

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Notes

SPT (Standard Penetration Test-ASTM D1586):
The number of blows of a 140 lb (63.6 kg) hammer falling 2.5 ft (750 mm) used to drive a 2 in (50 mm) O.D. Split Spoon sampler for a total of 1.5 ft (0.45 m) of penetration.
Written as follows:
first 0.5 ft (0.15 m) - second 0.5 ft (0.15 m) - third 0.5 ft (0.15 m) (ex: 1-3-9)
Note: if the number of blows exceeds 50 before 0.5 ft (0.15 m) of penetration is achieved, the actual penetration follows the number of blows in parentheses (ex: 12-24-50 (0.09 m), 34-50 (0.4 ft), or 100 (0.3 ft)).
WR denotes a zero blow count with the weight of the rods only.
WH denotes a zero blow count with the weight of the rods plus the weight of the hammer.

Soil Classifications are Based on the Unified Soil Classification System, ASTM D2487 and D2488. Also included are the AASHTO group classifications (M145). Descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.

Order of Descriptors

- Group Name
- Consistency or Relative Density
- Moisture Condition
- Color
- Particle size descriptor(s) (coarse grained soils only)
- Angularity of coarse grained soils
- Other relevant notes

Criteria For Descriptors

Consistency of Fine Grained Soils

Consistency	N-Value (uncorrected)
Very Soft	< 2
Soft	2 - 4
Medium Stiff	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	> 30

Apparent Density of Coarse Grained Soils

Relative Density	N-Value (uncorrected)
Very Loose	< 4
Loose	4 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

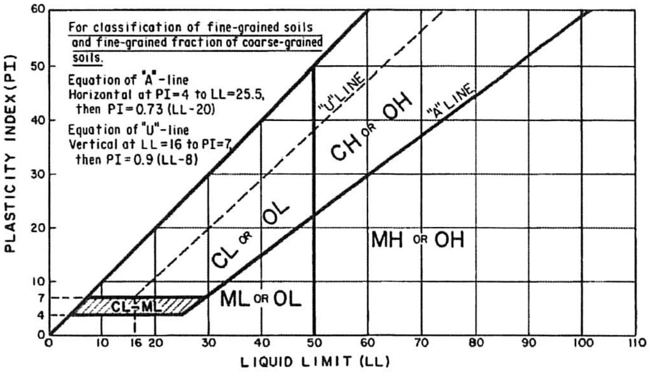
Moisture Condition

Dry	-Absence of moisture, dusty, dry to the touch.
Moist	-Damp, but no visible water.
Wet	-Visible free water.

Definition of Particle Size Ranges

Soil Component	Size Range
Boulder	> 12 in (300 mm)
Cobble	3 in (75 mm) - 12 in (300 mm)
Gravel	No. 4 Sieve (4.75 mm) to 3 in (75 mm)
Sand	No. 200 (0.075 mm) to No. 4 Sieves (4.75 mm)
Silt	< No. 200 Sieve (0.075 mm)*
Clay	< No. 200 Sieve (0.075 mm)*

*Use Atterberg limits and chart below to differentiate between silt and clay.



Angularity of Coarse-Grained Particles

Angular	-Particles have sharp edges and relative plane sides with unpolished surfaces.
Subangular	-Particles are similar to angular description, but have rounded edges.
Subrounded	-Particles have nearly plane sides, but have no edges.
Rounded	-Particles have smoothly curved sides and well-rounded corners and edges.

APPENDIX B
Laboratory Testing Reports

Identification and Classification of Dispersive Clay Soils By Crumb Test
ASTM D 6572

Project Information

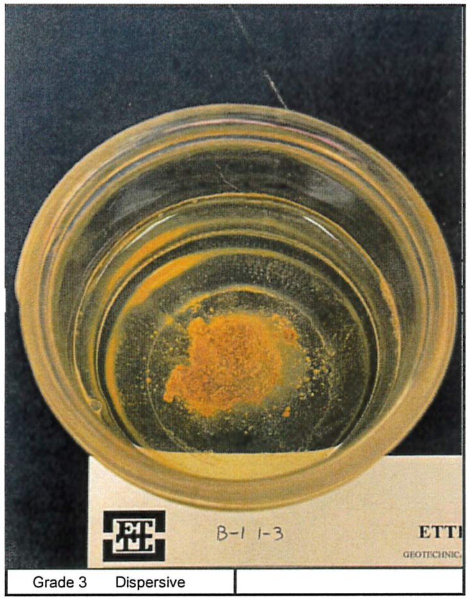
Project: Eagle Landing HOA
Client/Arch./Engr.: SPI
Contractor or Project Location: Avinger, Texas
ETTL Job No.: G 5846-225

Sample Information

Material Origin: Geotechnical Boring
Sampling Info. provided By: Evan Felker
Sampled By: ETTL Drilling Date Sampled: 2/15/2022
Testing Technicia Evan Felker Test Date: 2/21/2022

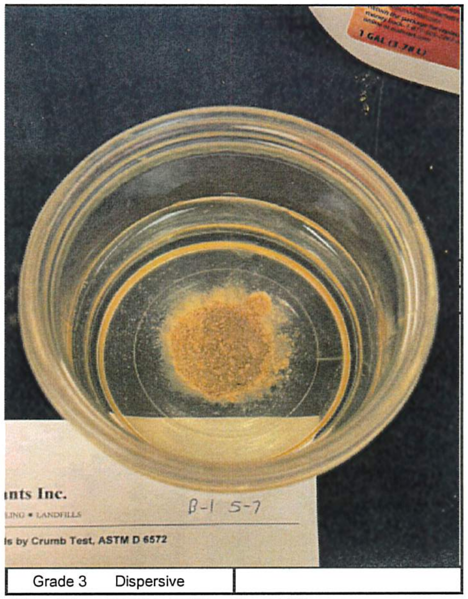
Test Data

B-1 1.0'-3.0'



Grade 3 Dispersive

B-1 5.0'-7.0'



Grade 3 Dispersive

*** Note 1 from ASTM D 6572 Section 5.2:**

The crumb test is a relatively accurate positive indicator of the presence of dispersive properties in soils. **The crumb test, however, is not a reliable negative indicator that soils are non-dispersive.** The crumb test can seldom be relied upon as the sole test method for determining the presence of dispersive particles. The Double Hydrometer (D4221) and Pinhole (D4647) tests provide a higher reliability of the dispersive behavior of soils.

*** Note 2 from ASTM D 6572 Section 11.9.2:**

Grade 2, (Intermediate) - Slight reaction; this is the transition grade. A faint, barley visible colloidal suspension causes turbid water near portions of the soils crumb surface. If the cloud is easily visible, assign Grade 3 (Dispersive). If the Could is faintly seen in only one small area, assign Grade 1 (Non-Dispersive).

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GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

Particle-Size Distribution of Fine-Grained Soils (Hydrometer ASTM D 7928)

Mechanical Sieve Analysis (ASTM D 6913)

Project: Eagle Landing HOA

Client: SPI

Job Location: Avinger, Texas

ETTL Job No.: G 5846-225

Boring / Sample Location: B-1

Sample No.: Depth (ft.): 3-5

Description: Brown Silty Sand (SM)

Material Origin: Geotechnical Boring

Date Sampled: 2/15/2022

Sampled By: ETTL Drilling

Sample Info. Provided By: ETTL Engineers

Testing Technician: Evan F

Test Date: 2/21/2022

Starting Mass and Sample Preparation	
Dispersion Device:	Device A
Dispersion Time:	1 min
Dispersion Agent:	5.0 (g) Na-Hex
Soaking Time:	Min. 16hrs.
Hydrometer Type:	152H
Sample Condition:	Moist
Starting Mass of (whole) sample (g):	371.57
M_d - Dry Mass (whole) sample (g):	326.51
Starting Mass Sedimentation Sample (g):	91.16
Dry Mass Sedimentation Sample (g):	80.11
Separation Sieve:	No. 10
Estimated Specific Gravity:	2.67
Sedimentation Cylinder: I/HC #:	G145

M.C. of Whole Sample	
Pan No.:	193
Tare Mass (g):	30.07
Tare + Wet Mass (g):	64.70
Tare + Dry Mass (g):	60.55
M.C.%	13.62%

M.C. of Sedimentation Sample	
Pan No.:	196
Tare Mass (g):	30.12
Tare + Wet Mass (g):	47.40
Tare + Dry Mass (g):	45.30
M.C.%	13.8%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Sieve Analysis of Material Retaining on No. 10 (Sepration D6913)				
2"	0.00	0.0	50.0	100.0
1"	0.00	0.0	25.0	100.0
3/4"	5.54	1.7	19.0	98.3
3/8"	24.66	7.6	9.50	92.4
No 4	39.51	12.1	4.75	87.9
No 10	45.79	14.0	2.00	86.0
Sieve Analysis of Material Retaining on No. 200 (Hydrometer Wash)				
40	0.23	14.3	0.425	85.7
60	1.70	15.8	0.250	84.2
100	26.98	43.0	0.150	57.0
140	48.54	66.1	0.106	33.9
200	59.55	77.9	0.075	22.1

Particle Uniformity		
D 10 (mm)=	N/A	
D 15 (mm)=	0.0096	
D 30 (mm)=	0.0946	
D 50 (mm)=	0.1350	
D 60 (mm)=	0.1587	
D 85 (mm)=	0.3326	
Cu =	N/A	
Cc =	N/A	
Per USDA Soil Texture		
% Gravel =	12.1	> 4.75 mm
% Sand =	68.0	4.75 < >0.05 mm
% Silt =	8.1	0.05 < > 0.002mm
%Clay =	11.8	< 0.002 mm
PTI Clay Fration:	53	

Hydrometer Analysis of Material Passing No. 10 Sieve						
Time (min)	Hydrometer Reading	Temperature Deg. (C)	Offset Reading - r_{dm}	Effective Depth - Hm	Particle Diameter - Dm	Percent Finer - Nm
1	22.5	22.6	6.6	12.7	0.048	19.7
2	22.0	22.6	6.6	12.8	0.034	19.1
4	20.0	22.6	6.6	13.1	0.025	16.6
15	19.5	22.7	6.6	13.2	0.013	16.0
30	18.5	22.8	6.5	13.4	0.009	14.8
60	18.0	22.9	6.5	13.5	0.006	14.3
120	17.5	23.0	6.4	13.5	0.005	13.7
240	17.0	23.2	6.4	13.6	0.003	13.2
1440	16.0	21.2	7.1	13.8	0.001	11.0

Atterberg Limits		
LL	PL	PI
NP	NP	NP

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

Dispersive Characteristics of Clay Soils By Double Hydrometer (ASTM D 4221)

Project: Eagle Landing HOA
Client: SPI
Job Location: Avinger, Texas
ETTL Job No.: G 5846-225
Boring / Sample Location: B-1
Sample No.: Depth (ft.): 3-5
Description: Brown Silty Sand (SM)

Material Origin: Geotechnical Boring
Date Sampled: 2/15/2022
Sampled By: ETTL Drilling
Sample Info. Provided By: ETTL Engineers
Testing Technician: Evan F
Test Date: 2/21/2022

Starting Mass and Sample Preparation		
Soaking Time:	Min. 16hrs.	
Hydrometer Type:	152H	
Sample Condition:	Moist	
Time on Vacuum	10 mins	
Filtering Flask No.:	G123	
Starting Mass of (whole) sample (g):	371.57	
M_d - Dry Mass (whole) sample (g):	326.51	
Starting Mass Sedimentation Sample (g):	28.45	
Dry Mass Sedimentation Sample (g):	25.00	
Separation Sieve:	No. 10	
Estimated Specific Gravity:	2.67	
Sedimentation Cylinder: I/HC #:	G145	
Atterberg Limits		
LL	PL	PI
NP	NP	NP

M.C. of Sedimentation Sample (Double Hydrometer)	
Pan No.:	171
Tare Mass (g):	30.23
Tare + Wet Mass (g):	44.91
Tare + Dry Mass (g):	43.13
M.C.%	13.8%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Sieve Analysis of Material Retaining on No. 200 (Hydrometer Wash)				
40	0.35	1.4	0.425	98.6
60	0.89	3.6	0.250	96.4
100	9.37	37.5	0.150	62.5
140	16.31	65.2	0.106	34.8
200	19.56	78.2	0.075	21.8

Time (min)	Hydrometer Reading	Temperature Deg. (C)	Offset Reading - r_{dm}	Effective Depth - Hm	Particle Diameter - Dm	Percent Finer - Nm
1	3.0	22.6	0.4	16.0	0.054	10.5
2	3.0	22.6	0.4	16.0	0.038	10.5
4	3.0	22.6	0.4	16.0	0.027	10.5
15	3.0	22.7	0.3	16.0	0.014	10.6
30	3.0	22.8	0.3	16.0	0.010	10.8
60	2.9	22.9	0.2	16.1	0.007	10.5
120	2.8	23.0	0.2	16.1	0.005	10.3
240	2.5	23.2	0.1	16.1	0.004	9.4
1440	2.0	21.2	0.9	16.2	0.001	4.5

Percent Passing 2-µm Double Hydrometer Test:	**5.8**	
Percent Passing 2-µm Standard Hydrometer Test D 422:	**11.8**	
Double Hydrometer Ratio - DHR (Percent Dispersion):	**50%**	**Dispersive**

ASTM D 4221, Section 5.0 - 5.4 & Section 12.1

When the percent dispersion equals 100, indicates Completely Dispersive, when dispersion equals 0, indicates Completely Non-dispersive.

*The Double Hydrometer test has about 85% reliance in predicting dispersive performance, (about 85% of dispersive soils show more than 35% dispersion)

Percent Despersion	Dispersiveness
30%	Non-Dispersive
30 to 50%	Intermediate
>50%	Dispersiveness

USACE, EM 1110-2-1906 Appendix XIII Sec. 2-b-2

% Dispersion < 35, Dispersion Not a Problem

% Dispersion > 50, Dispersion Will be a Problem

35 < % Dispersion > 50, Dispersion May or May Not Occur

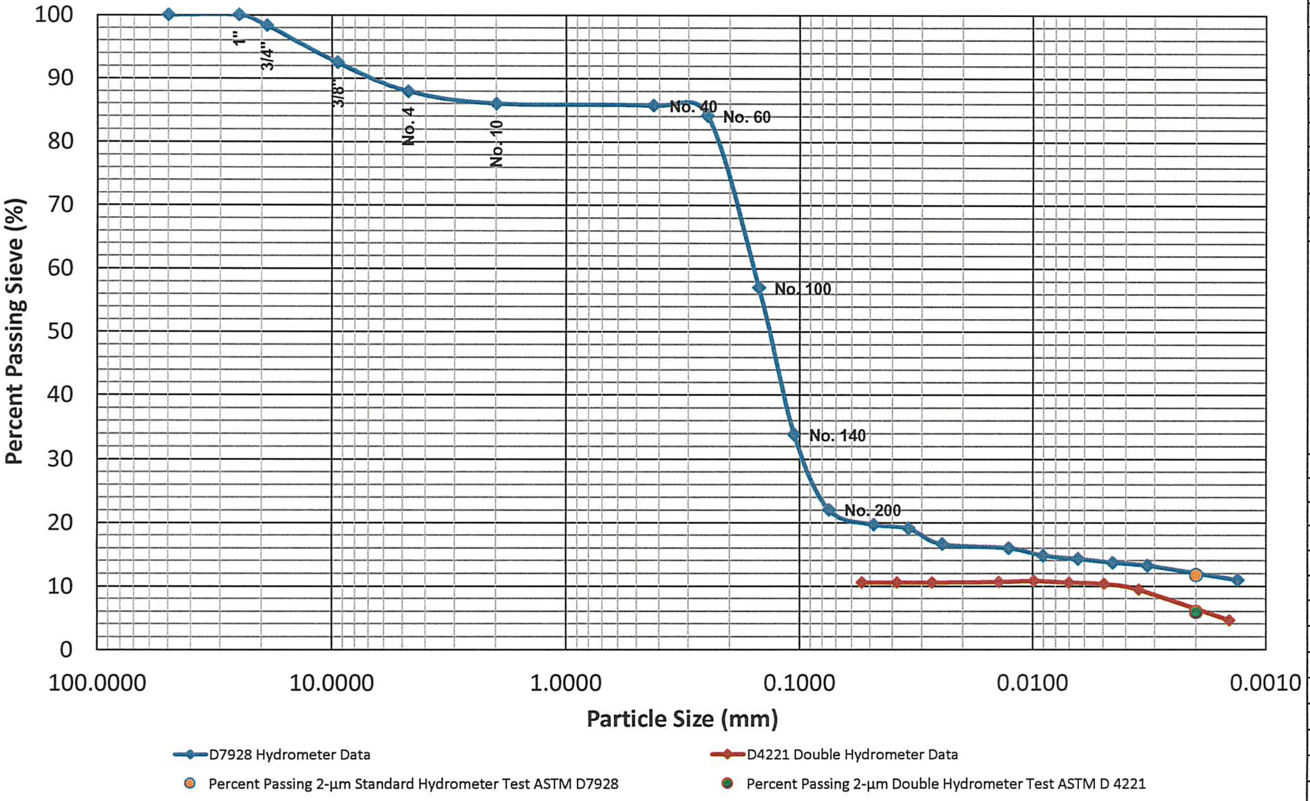
NRCS Hand Book, Part 633.1302 (b3) Dispersive Classification for Double Hydrometer

% Dispersion < 30, Probably Not Dispersive

% Dispersion > 60, Probably Dispersive

30 < % Dispersion > 60, Other tests are need to determine if sample is dispersive

Particle Size Distribution Curve By Hydrometer (ASTM D 7928)
Dispersive Characteristics of Clay Soils By Double Hydrometer (ASTM D 4221)



Hydrometer Analysis			D. Hydrometer Analysis		
Sieve No.	Dia. (mm)	% Finer	Sieve No.	Dia. (mm)	% Finer
2"	50.0	100.0			
1"	25.0	100.0			
3/4"	19.0	98.3			
3/8"	9.50	92.4			
No. 4	4.75	87.9			
No. 10	2.00	86.0			
No. 40	0.425	85.7	No. 40	0.425	98.6
No. 60	0.250	84.2	No. 60	0.250	96.4
No. 100	0.150	57.0	No. 100	0.150	62.5
No. 140	0.106	33.9	No. 140	0.106	34.8
No. 200	0.075	22.1	No. 200	0.075	21.8
Hydrometer Analysis	0.0483	19.7	Double Hydrometer Analysis	0.0543	10.5
	0.0342	19.1		0.0384	10.5
	0.0245	16.6		0.0271	10.5
	0.0127	16.0		0.0140	10.6
	0.0090	14.8		0.0099	10.8
	0.0064	14.3		0.0070	10.5
	0.0046	13.7		0.0050	10.3
	0.0032	13.2		0.0035	9.4
	0.0013	11.0		0.0014	4.5

L.L.	NP
P.L.	NP
P.I.	NP
% Sand	68.0
% Silt	8.1
% Clay	11.8
D_{85}	0.3326
D_{60}	0.1587
D_{50}	0.1350
D_{30}	0.0946
D_{15}	0.0096
D_{10}	N/A
C_u	N/A
C_c	N/A

5.8	11.8	50.0%
Percent Passing 2-µm Double Hydrometer Test ASTM D 4221	Percent Passing 2-µm Standard Hydrometer Test ASTM D7928	Doubel Hydrometer Ratio - DHR (Percent Dispersion)

Project Name:	Eagle Landing HOA	Boring Location	Sample No.	Depth (ft)	Description and Classification	Estimated SG	Technician
Client:	SPI				Brown Silty Sand (SM)		Evan F
ETTL Inc. Job #	G 5846-225	B-1		3-5		2.67	Date: 02/21/22