Geotechnical Engineering Report

City of Sylvania - Waste Water Treatment Plant Upgrades
624 Friendship Road, Screven County, GA
June 25, 2021
Project No. 6-25-21-2

Prepared For:
City of Sylvania
Screven County, GA

Prepared By:
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June 25, 2021

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Referencing: Report of Geotechnical Evaluation Services
City of Sylvania – Waste Water Treatment Plant Upgrades
624 Friendship Road, Screven County, Georgia
Report No.: 6-25-21-2

Dear Stacy,

As requested, WHITAKER LABORATORY, INC. has conducted a geotechnical evaluation at the above referenced site. Authorization to perform this evaluation was provided by your acceptance of our proposal dated May 13, 2021. Our findings and recommendations for design and construction are attached and it is important that you read the report in its entirety.

It is a pleasure to provide our services to you and we look forward to further opportunities to assist you on this and other projects.

Respectfully submitted,
WHITAKER LABORATORY, INC.

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REPORT OF GEOTECHNICAL EVALUATION

City of Sylvania – Waste Water Treatment Plant Upgrades
624 Friendship Road, Screven County, Georgia

I. INTRODUCTION / SCOPE

WHITAKER LABORATORY, INC. has completed an evaluation of the surface and subsurface conditions at this site. The preliminary conditions found, and how those conditions could affect the design and construction of foundations for the structures planned, form the basis for this report. Regardless of the thoroughness of any geotechnical evaluation, there are limitations, and deviations from the conditions found in this evaluation could be subsequently disclosed. We recommend that this report be provided to all parties involved in the planned development to include but not necessarily limited to the Owner, Architect, Design Engineers, General Contractor and sub-contractors. Unanticipated circumstances often arise during sitework, earthwork and foundation construction. Accordingly, we recommend that our firm be retained to provide the construction surveillance, inspection, and testing on the project, thereby being readily available to assist in the evaluation of any conditions encountered that differ from those anticipated.

The existing WWTP site is located at 624 Friendship Road in Screven County, GA. We understand that upgrades are planned for construction at the existing WWTP facility. Improvements will consist of a Cascade Aeration Structure, Digester Tank and Aeration Tank. In an effort to evaluate subsurface soil conditions and their impact on the design and construction of the planned upgrades, a total six standard penetration test (SPT) borings were performed. The borings were advanced within the planned construction areas and extended to depths reaching 15 to 35 feet below the ground surface.

Please note that this evaluation only applies to the structures planned for construction within the areas of the site where SPT borings were performed. This evaluation does not apply to any future improvements, which may be made to the site. In particular, if at any time should additional fill be placed, adjacent to or nearby the structures referenced in this report, additional geotechnical borings and a follow up geotechnical analysis will be required. Standard billing rates will apply for this work.

II. EXECUTIVE SUMMARY

The following recommendations shall be considered a summary of the recommendations contained within this report and utilized as such. This report shall be read in its entirety.

- The encountered subsurface soils on this site can be made suitable for support of the planned structures utilizing shallow spread pier and/or strip footing foundations with slab-on-grade (or mat foundation system) if our foundation loading & site grading assumptions are not exceeded and the recommendations contained within this report are performed and verified during construction.

- Please note that organic soils, rubble debris and uncontrolled fill were encountered at the ground surface and extending to depths reaching 6 to 13 feet below existing grades within the B-1 through B-4 areas of this site. All organic materials and/or debris shall be removed from below all structural areas. In addition, all uncontrolled fill shall be removed and replaced in a compacted condition within the B-1 through B-4 areas of the site. Undercutting and replacement shall be expected to be required within the B-1, B-2, B-3 and B-4 areas of the site. Undercutting and replacement will extend to depths reaching 6 to 13 feet below existing grades.

- Groundwater was encountered at depths ranging from 9 to 15 feet below existing grades on this site. Depending upon the required depth of excavation, dewatering may be required in areas of this site during foundation construction and/or during undercutting and backfilling processes deemed necessary. Groundwater levels should be maintained at least 2 feet below finished subgrade elevations to property compact and/or stabilize exposed subgrade soils. Due to the clayey nature of in-situ subsurface soils on this site, perimeter rim ditches with sump pits and pumps should suffice as an adequate dewatering technique.

At any time, we will be glad to discuss the contents of this report. This includes insuring that you fully consider potential problems for design and construction procedures in respect to interpretations of the data.

III. PROJECT INFORMATION & DESCRIPTION

We understand the following related to each structure:

- **Digester (B-3 and B-4 area of site):** The digester will consist of a 40-foot diameter tank that is 20 feet tall. The tank will be full of water. A ring wall foundation system is planned to be utilized for support of the digester structure. Tank bottom will reside about 4 ft below existing grades. This will produce an approximate 1000 psf increase in pressure on soils residing immediately below the bottom of the tank.

- **Aeration Tank (B-4 and B-5 area of site):** Aeration tank will be 52 ft long x 30 ft wide and 16 ft deep. Tank will be full of water. Bottom of tank will reside 12 feet below existing grades throughout the entire area of the structure. Top of tank walls will reside 4 feet above existing grades. Tank will likely utilize a mat foundation for tank bottom with perimeter cast-in-place concrete walls. Fill soil will not be placed around this structure to elevate the ground surface above existing grades. With this design, soils residing below the bottom of the tank will not experience an increase in pressure.

All above grade (16') with base +/- 2' above ex. grade

- **Cascade Aeration Structure (B-2 area of site):** The cascade aeration structure will be 5 ft wide x 14 ft long and 5 ft deep. The structure will reside entirely below existing grade elevations. This structure will never be full of water. With this design, soils residing below the bottom of the tank will not likely experience any significant increase in pressure.

Partially above grade

If our understanding of the project or assumptions are incorrect, we should be contacted immediately, provided the correct information and allowed an opportunity to change and/or modify the recommendations contained within this report if necessary.

IV. SITE LOCATION & DESCRIPTION

Item	Description
Location	624 Friendship Road, Screven County, GA
Existing Structures	Existing WWTP structures are present
Current ground cover	Predominately grassed within individual planned construction areas
Existing topography	Generally flat within individual planned construction areas

At the time of our site visit, the planned construction areas consisted of open grassed areas. Ground surface topography was generally flat within each individual planned construction area.

V. AREA GEOLOGY

This project is located in Screven County, Georgia. The overall project area is centrally located within the South Atlantic Coastal Plain. This broad, gently sloping region extends southeastward from the Fall Line (Chesterfield - Columbia - Augusta - Macon - Columbus) to the Atlantic Ocean. The soils encountered are sedimentary in origin, and consist of layered marine deposits of sands, silts, and clays. These deposits have since been subjected to successive erosion and re-deposition, by fluctuations of sea levels, storm tides, and winds. Many of the surface sands are the result of depositional forces along ancient beaches, which formed during the changing shoreline and river conditions. Intermittent deposits of shells occur within the strata at irregular intervals. The surface soils in a majority of this Coastal Plain area were deposited during the Pleistocene Era, however surface soils near the coast are likely of the Holocene Era.

VI. TEST BORINGS AND SUBSURFACE CONDITIONS

The field exploration to determine the characteristics of the subsurface materials included a reconnaissance of the project site, and the drilling of exploratory borings. Standard penetration test borings were performed using rotary head drilling equipment and advancing hollow stem augers. Sampling and Standard Penetration Testing, (SPT), was performed in accordance with ASTM D-1586. SPT samples were taken at 2.5 foot intervals of depth for the first 10 feet, and at 5.0 foot intervals thereafter. Standard Penetration testing is done with a 140 pound hammer falling 30-inches and a two inch diameter sampling spoon. Results of Standard Penetration Testing (SPT N values) provide an indication of the relative consistency, density and in-situ strengths of the tested soils.

Soil samples from SPT testing and from the auger cuttings have been used for identification and visual classification. The subsurface stratification and the profile as presented in the boring logs, represent approximate boundary lines between the strata and materials encountered. These boundary lines are usually gradual and not clearly defined, and it is sometimes difficult to record changes in stratification precisely. It should be noted that underlying soil conditions can, and do, vary considerably within short lateral distances. It is possible that conditions may be revealed between boring locations that are different from those found by our borings and used for our analysis.

The approximate locations of the borings are shown on the attached BORING LOCATION PLAN. Our drilling crews, based on landmarks and features available at the time of drilling, have estimated the locations of the borings in the field. If the precise location of the boreholes is critical, this can be determined by employing a land surveying firm to plot the true locations. Such survey should be completed promptly and before any disturbance to the area has occurred. If desired, Whitaker Laboratory, Inc. will be glad to coordinate surveying arrangements for an additional fee.

Below approximately 6 to 8 inches of organic topsoil, the near surface soils on this site consist of backfill/fill soil (uncontrolled sand backfill/fill, organic sands and/or rubble) within areas of borings B-1 through B-4 extending to depths reaching 6 to 13 feet below existing grades. Below this uncontrolled fill or backfill and/or below the topsoil within area of borings B-5 and B-6, the in-situ soils on this site predominately consist of stiff sand clays (SC), stiff clays (CL) and firm silty sands (SM) extending to the termination depth of the deepest soil test boring at 35 feet below existing grades.

The above description of the subsurface profile should be considered a general description intended to highlight the major strata encountered. More detailed profiles can be observed within the attached logs. Please note that boring logs are only representative of their location. Stratification transitions should be expected to occur outside and between boring locations. Taking into account that sampling was not performed on a continuous basis within SPT borings, lines drawn representing elevations of stratification changes shown on the SPT boring log were estimated.

VII. GROUNDWATER TABLE

The apparent groundwater table was measured for each boring location at the time of boring. Groundwater levels were measured to range from 9 to 15 feet below the ground surface at the time of boring. The groundwater elevation should be expected to fluctuate with the season of the year, surrounding ground surface conditions, and with recent rainfall amounts. Thus, groundwater elevations shown on the boring logs should be considered valid only for the date of observation. WHITAKER LABORATORY, INC. recommends that the contractor determine a groundwater levels just prior to site work begins.

Typically, the groundwater level needs to be 24 inches below subgrade elevations to properly compact and/or stabilize the subgrade and successfully compact backfill materials.

Due to requirements for undercutting & replacement within area of borings B-2, B-3 and B-4 and deep excavation requirements for foundation construction within area of boring B-5 and B-6, dewatering efforts will likely be required during earthwork and/or during foundation construction on this site.

Although dewatering techniques consisting of well point systems, sump pits with pumps, and/or drainage ditches are typically effective methods to lower groundwater, the means and methods for dewatering should ultimately be the responsibility of the contractor.

Due to the silty and/or clayey nature of subsurface soils residing at bottom of undercut excavation elevations (area of borings B-2 through B-4) and/or bottom of foundation excavation elevations (area of borings B-5 and B-6), the use of deep drainage ditches/trenches (and/or rim ditches) with sump pits & pumps should prove to be a successful dewatering strategy.

Please note that lowering the groundwater table can negatively impact existing foundations of adjacent structures. In an effort to minimize this potential impact, dewatering measures on this site shall not lower the groundwater table below adjacent structures by more than 10 feet. Temporary piezometers should be installed to monitor groundwater levels adjacent to nearby existing structures. Injection wells should be installed if necessary to maintain groundwater levels if deemed necessary.

VIII. SEISMIC SITE CLASSIFICATION AND COEFFICIENTS

Liquefaction Potential:

Liquefaction typically occurs when very loose to loose non-cohesive soils encountered below the groundwater table experience a significant loss of shear strength due to the increase in porewater pressure resulting from seismic vibrations.

Based upon the design earthquake (Charleston, SC earthquake with magnitude 7.3 and a 2% probability of exceedance in 50 years) combined with subsurface soil conditions encountered (stiff sand clays & clays), liquefaction induced settlement should not be of concern in the design of the structures.

Seismic Parameters:

This site would be defined as a Site Class "D". The classification is determined by average soil properties in the top 100 feet of the soil profile, including standard penetration test N values, shear wave velocities, in-situ shear strengths and moisture contents, as specified by IBC 2018 / ASCE 7-16.

Ss = 0.288
S1 = 0.107
SMS = 0.453
SM1 = 0.256
SDS = 0.302
SD1 = 0.171

A summary report is attached in Appendix III of this report. If the size and design of any of the structures justifies additional investigation, a Site Specific Geotechnical Investigation and dynamic site response analysis shall be performed. Our firm has the ability to provide our clients such testing and evaluation, and we will be available to discuss the cost, and potential benefit, if any, of such if you desire.

IX. EARTHWORK AND FOUNDATION DESIGN CONSIDERATIONS

The encountered subsurface soils on this site can be made suitable for support of the planned structures utilizing shallow spread pier and/or strip footing foundations with slab-on-grade (or mat foundation system) if our foundation loading & site grading assumptions are not exceeded and the recommendations contained within this report are performed and verified during construction.

Please note the following concerns:

- Please note that organic soils, rubble debris and uncontrolled fill were encountered at the ground surface and extending to depths reaching 6 to 13 feet below existing grades within the B-1 through B-4 areas of this site. All organic materials and/or debris shall be removed from below all structural areas. In addition, all uncontrolled fill shall be removed and replaced in a compacted condition within the B-1 through B-4 areas of the site. Undercutting and replacement shall be expected to be required within the B-1, B-2, B-3 and B-4 areas of the site. Undercutting and replacement will extend to depths reaching 6 to 13 feet below existing grades.

- Groundwater was encountered at depths ranging from 9 to 15 feet below existing grades on this site. Depending upon the required depth of excavation, dewatering may be required in areas of this site during foundation construction and/or during undercutting and backfilling processes deemed necessary. Groundwater levels should be maintained at least 2 feet below finished subgrade elevations to property compact and/or stabilize exposed subgrade soils. Due to the clayey nature of in-situ subsurface soils on this site, perimeter rim ditches with sump pits and pumps should suffice as an adequate dewatering technique.

Earthwork:

The following shall be performed to establish finished subgrade elevations for the structures:

- We recommend that all structural areas be cut to finished subgrade elevations.
- Area of borings B-1, B-2, B-3 and B-4 shall be further undercut to remove all organic materials and/or uncontrolled backfill/fill. Undercut depths shall be expected as follows:
    - 6 feet below existing grades within the B-1 area of the site.
    - 9 feet below existing grades within the B-2 area of the site.
    - 12 to 13 feet below existing grades within the B-3 & B-4 areas of the site.
- Each construction area shall be dewatered as required. As mentioned above, the use of deep drainage ditches/trenches (and/or rim ditches) with sump pits & pumps should prove to be a successful dewatering strategy.
- In an effort to provide a stable working surface in structural areas where finished subgrade elevations reside below existing grades, Whitaker recommends placement of a #57 stone mat (minimum 12 inches thick) wrapped in filter fabric. This #57 stone mat shall be tied into the dewatering system (rim ditches with sump pits & pumps).
- Once each construction area is cut to finished subgrade elevations (as within area of borings B-5 and B-6) or cut to bottom of undercut elevations (as within area of B-1 through B-4), all exposed subgrade soils shall be thoroughly compacted in-place to 95% of ASTM-D-1557 and pass proof-rolling inspections prior to backfilling/filling operations begin and/or foundation construction begins. Areas found to pump or deflect should be further dewatered and compacted in-place and/or undercut to a competent material and backfilled with an approved compacted material.
- Exposed subgrade soils shall be inspected, tested and approved by Whitaker Laboratory personnel prior to backfilling/filling placement begins and/or foundation construction begins.
- Backfill and fill material required to achieve finished subgrade elevations, should consist of granular soils and meet the requirements for material type and placement as outlined within the SITE WORK RECOMMENDATIONS section of this report.
- Uncontrolled fill that is required to be undercut (areas of borings B-1 through B-4) can be stockpiled and later utilized as backfill as long as the material is organic free, consists of sandy type soil and moisture contents are controlled.

- Compaction efforts on exposed subgrade soils and backfill/fill soils shall be made with a large vibratory smooth drum roller (Cat CS 74 or equivalent - centrifugal force range of 37,300 – 74,600 lb).

Foundation Recommendations:

Cascade Aeration Structure & Digester
B-2 through B-4 areas of the site
(Ring wall and/or spread footings)

Once the above Earthwork recommendations are accomplished, footings can be excavated. Bottom of footing excavations shall be thoroughly compacted to meet or exceed 95% of the soils modified proctor maximum dry density in accordance with ASTM-D-1557. Footing inspections shall be conducted at this time by performing dynamic cone penetrometer (DCP) testing within bottom of footing excavations to verify adequate bearing material is present.

DCP testing shall be performed within hand auger borings at one-foot intervals and extending to depths reaching at least 3 feet below bottom of footing elevations.

Subsurface bearing soils deemed unsuitable based upon dynamic cone penetrometer testing should be undercut to a competent material and backfilled with an approved material.

After the above is completed and verified by Whitaker personnel during construction, spread footings may be designed for safe soil bearing pressures of 2,000 PSF. Our technicians, prior to placing steel and concrete, should approve all footing excavations.

Bottom of footing elevations shall reside at least 12 inches below the ground surface. Overall settlements on the order of one inch should be anticipated. Differential settlement is anticipated to be on the order of ½ the overall settlement. Floor slabs can be designed utilizing a modulus of subgrade reaction “k” value of 150 pci.

Lateral loads can be resisted by passive earth pressure due to compacted structural fill placed against the sides of the footings. The upper 1-foot of resistance should be neglected unless the fill is confined by a pavement or floor slab. A soil unit weight of 110 pcf and passive earth pressure coefficient of 3.0 can be utilized in the analysis. Additionally, a friction coefficient of 0.35 between the concrete footings and underlying soil can be used in combination with passive earth pressures to resist lateral loads. The coefficient of friction should be applied to dead normal loads only.

Aeration Tank
B-5 and B-6 areas of the site
(Mat Foundation)

We understand that the aeration tank structure will have bearing elevations approximating 12 feet below existing grades. Settlement of the structure is anticipated to be minimal since the pressure exerted by the structure at the planned bearing elevation is assumed to be less than what existed prior to excavation (structure exerting less PSF at the structures bearing elevation than the overburden pressure at the bearing elevation prior to construction). Based upon this information, the mat foundation can be designed utilizing bearing pressures of 1500 psf. A modulus of subgrade reaction "k" value of 75 pci can be utilized in the mat foundation design.

Please note that, loosening and softening of subgrade soils during construction could lead to settlement. Careful groundwater control and subgrade preparation will be required. Past experience indicates that insufficient groundwater control combined with insufficient excavation support, could cause the subgrade soils to yield during excavation resulting in heave and disturbance of the bearing soils. If heaving/disturbance of the bearing soils go undetected, potentially damaging settlements could occur to the structures.

Groundwater was encountered as shallow as 9 feet below the ground surface at the time of drilling within the B-5 area of this site. Due to the depth of excavation required for construction of the aeration tank, dewatering will be required. Although dewatering will be the responsibility of the contractor, we recommend the use of deep drainage ditches/trenches (rim ditches) with sump pits & pumps. In addition, Whitaker recommends installing a minimum 12-inch thick, compacted, #57 stone mat below the bottom of mat foundation elevation to provide a stable working surface. This stone mat shall be wrapped in filter fabric and tied into the rim ditch dewatering system.

Buoyant forces acting on the structure during and after construction are of concern. Typical design features to mitigate the impact of buoyant forces include increased mass and/or wider mat foundations that projects beyond the perimeter of the structures to engage the weight of the surrounding backfill. All grades should be sloped away from the structure and surface water should be collected and discharged such that water is not permitted to infiltrate the construction excavation.

The structure must be capable of resisting the lateral earth pressures that will be imposed on them during and after construction.

Earth pressure coefficients should be selected by the designer based on the type of wall, whether the wall is braced or un-braced and other conditions. For "worst case" design conditions where positive drainage is not provided or is temporarily interrupted, the hydrostatic pressure will have to be added to the earth pressure on the wall. For this design groundwater should be assumed to reside within close proximity to the existing ground surface elevation.

Based upon SPT borings performed, Whitaker Laboratory, Inc. is providing the following soil parameters for your use in the design and construction of the planned aeration tank structure and associated retaining structures:

The below parameters were estimated from SPT borings B-5 and B-6:

Depth (ft, below ground surface)	SPT "N" Range	Soil Behavoir	Approximate Soil Unit Weight (pcf)		Internal Friction Angle (degrees)	Cohesion (psf)	Earth Pressure Coefficients		
			Sat	Submerged			Active K_a	Passive K_p	At Rest K_o
0 – 4	8 - 11	Sand	115	52.6	30	0	0.33	3.0	0.45
4 - 17	15 - 20	Clay	120	57.6	0	1000	1	1	1
17 – 25	15 - 22	Sand	117	54.6	32	0	0.307	3.25	0.45

Soil parameters provided in the below table should be used for the design of the structures if the structures are constructed utilizing an open excavation (excavation is sloped back on a minimum 1.5H : 1V slope from the top perimeter edge of the footings and later backfilled with select sandy type soils (maximum 15% fines) up against the foundation walls. Please note that the coefficients given below are based on the use of select granular sand backfill meeting compaction requirement provide below.

Soil Classification For Backfill	Approximate Soil Unit Weight (pcf)		Internal Friction Angle (degrees)	Cohesion (psf)	Earth Pressure Coefficients		
	Sat	Submerged			Active, K_a	Passive, K_p	At Rest K_o
SP-SM & SM	115	52.6	30	0	0.33	3.0	0.45

All backfill and/or fill should be placed in 8 to 10 inch thick, loose lifts and compacted by conventional compaction equipment to 95% density in accordance with ASTM D-1557. All of the backfill for this project should consist of a clean, free draining granular soil. The fill should be free of objectionable roots, clay lumps, organics and other debris. Soils classified as SW, SP, SM, or SM-SP with a maximum of 15% passing a #200 sieve may be acceptable.

Note: Effective, or buoyant unit weights should be used for soils below the groundwater table plus hydrostatic pressure.

Shoring or Bracing design should consider vibrations caused by installation of retaining system. The existence of nearby structures exposes the new construction owners and the foundation contractor to the risk of potential vibration damage form the installation of those systems requiring pile driving or vibration ramming operations. Regardless of the shoring or bracing system utilized, Whitaker Laboratory recommends performing pre and post structure surveys of nearby structures (photo documentation of preexisting visual structural deficiencies) and continuous vibration monitoring.

Please note that lowering the groundwater table can negatively impact existing foundations of adjacent structures. In an effort to minimize this potential impact, dewatering measures on this site shall not lower the groundwater table below adjacent structures by more than 10 feet. Temporary piezometers should be installed to monitor groundwater levels adjacent to nearby existing structures. Injection wells should be installed if necessary to maintain groundwater levels if deemed necessary.

X. SITE WORK RECOMMENDATIONS

We will be pleased to discuss these recommendations with the owner and the site work contractor selected to do the work. We believe it will be beneficial to the project, for the owner and the contractor to have a clear understanding of our recommendations.

1. Prior to construction, all building areas, plus at least 10 feet on each side and all areas to be paved, should be stripped of all vegetation, topsoil and root systems. Site drainage during construction should be considered prior to this clearing and stripping. Preventing the ponding of storm water is of particular importance.

2. Topsoil, organics, root-mat and other surface materials will likely vary across the site. Individual test borings may not accurately reflect the presence of, or the thickness of such materials due to site variability and/or surfacing clearing to facilitate access for drilling equipment. Site clearing and grubbing, when unsupervised, and particularly in areas of wet soils and times of wet weather, may push organic debris into otherwise stable soils. Undercutting and clearing with a track hoe in lieu of bulldozers can minimize this.

3. Any stump holes or other depressions should be cleared of loose material and debris, and should then be back-filled with approved fill. The backfill should be placed in 6-inch thick lifts and compacted to 95% density in accordance with ASTM D-1557.

4. Any existing utilities that underlie the site should be relocated and their trenches back-filled with approved soil. The backfill should be placed in 6-inch lifts and compacted to 95% density according to ASTM D-1557.

5. Prior to fill placement, the subgrade should be proof rolled with a loaded dump truck to locate unstable or soft areas. Any unstable areas should then be investigated to determine the cause of the instability. If due to unsuitable soils, such as highly organic soils or soft clays, the areas should be undercut to firm soil and replaced with approved fill compacted in 6-inch lifts to minimum density of 95% in accordance with ASTM D-1557. If the instability is due to excess moisture in otherwise stable soil, the area should be drained and compacted to 95% density.

6. Any fill or backfill required to level or raise the site should be placed in 8 to 10 inch thick, loose lifts and compacted by appropriate compaction equipment to 95% density in accordance with ASTM D-1557.

7. All of the fill and backfill (including utility line backfill) for this project should consist of clean, free draining granular soils. The fill should be free of objectionable roots, clay lumps, organics and other debris. The fill should be readily compactable during placement. Soils classified as SW, SP, SP-SM or SM with a maximum of 15% passing a #200 sieve may be acceptable. Soils with the minus #200 fraction classified as MH, CH, OH, ML, CL or SC may be rejected. Soils with a maximum plasticity index of 25 and a maximum liquid limit 40 may be acceptable for use only beneath building pads which are situated well above the groundwater table with approval from the geotechnical engineer. Soils classified as SC or CL, exhibiting moisture sensitivity, soils with excessive clay content, or excessive moisture should not be used without approval from the geotechnical engineer. Approved sands will also need to be moisture conditioned as necessary to facilitate proper compaction throughout its entire depth. If utility trenches cannot be sufficiently dewatered to readily allow compaction of the specified pipe bedding material, then a class I (ASTM-D-2321) gravel or gravel mixture will be required.

8. To assist in reducing moisture beneath the structure, and to reduce the potential for mold growth, the site shall be graded and filled as necessary to direct drainage away from the structure. If sub drains are installed, these alone may not prevent moisture vapor beneath the structure that can cause mold growth. (Also refer to paragraph 10 below). Care must be taken to not place concrete on top of wet soils. For example, if fill or natural soils experience heavy rain, the soils should be properly drained and dried, prior to placement of concrete. Otherwise moisture migration through the slab will occur.

9. Compact all footing excavations and slab subgrades to a minimum density of 95% in accordance with ASTM-D-1557, prior to placement on concrete. The footing excavations, and all prepared slab subgrade, should be maintained in a dry and compacted condition until the concrete is placed. Areas that are softened by water or that are disturbed by construction activity should be re-worked, re-compacted, or appropriately repaired to the required bearing and density. If necessary, stone backfill or other corrective measures may be implemented to stabilize footings.

10. All slabs-on-grade should be supported on a minimum of 4-inches of granular, free-draining gravel or coarse grained sand (less than 5% fines) to reduce moisture migration by capillarity. A vapor retarding membrane, overlying this granular base, is recommended to further reduce moisture migration into finished areas of the structure. Note that the use of these measures will not totally prevent moisture under or on top of slabs or beneath structures. (Also refer to paragraph 8 above).

11. Any footing excavations that are directly adjacent to the existing foundations should be done in small increments to avoid undermining them and causing a loss of support to the existing structure. If necessary, the excavations should be sheeted and braced or grouting should be performed to stabilize the soil in the immediate area.

XI. QUALITY CONTROL AND TESTING

Documented inspections and/or testing performed by Whitaker Laboratory personnel, at the following critical milestones during construction, will be required for the recommendations contained within this report to be validated:

Earthwork:

- Verify adequate dewatering measures are being implemented.
- Verify all organics and uncontrolled backfill/fill have been removed/undercut from below structures residing within the B-1 through B-4 areas of the site. Undercutting shall be expected to extend to depths reaching 9 to 13 feet below existing grades within the B-2 through B-4 areas of the site.
- Perform density testing and proofrolling on all exposed subgrade soil (after stripping, excavating to finished subgrade elevations and/or undercutting) to verify exposed subgrade soils are compacted and stable enough to begin foundation construction and/or receiving backfill / fill.

- Collect sample of proposed backfill & fill material, perform laboratory testing and determine suitability for use (approve or disapprove).
- During backfill & fill placement: Perform density testing on each lift of backfill and/or fill soil.

Footings:

- Once footings are excavated: Perform footing inspections on bearing subgrade soils within bottom of footing excavations prior to placement of reinforcing steel or concrete.
- Footing inspection shall consist of performing DCP testing within hand auger borings at one-foot intervals extending to depths reaching 3 feet below bottom of footing elevations.
- Provide recommendations for undercutting and replacement where deemed necessary to achieve recommended bearing capacity and/or reduce settlement.

At the appropriate time, please contact Whitaker Laboratory, Inc. for budgetary and scheduling purposes for the performance of the above required inspection and testing services.

We further offer concrete, asphalt, masonry, and structural steel inspections and testing. Whitaker Laboratory, Inc. also performs observational services for mold mitigation, including observation of installation of vapor retarding membranes, subdrains, overall site drainage, and regularly scheduled observations after construction of site and landscape drainage, and monitoring of humidity and moisture in slabs and basement walls.

XII. QUALIFICATIONS OF REPORT

Any recommendations or opinions offered in this report are based on our interpretation of the data obtained from this investigation. It should be noted that underlying subsurface and soil conditions can, and do, vary considerably within short lateral distances. Regardless of the thoroughness of any subsurface investigation, it is possible that conditions may be revealed between boring locations that are different from those found by our borings and used for our analysis. For this reason, we recommend that the site preparation and foundation construction for this project be monitored closely. If deviations of the soil conditions from those presented in this report appear, we will be glad to furnish any additional analyses and recommendations that may be required.

This report was made to investigate subsurface properties of the site and is not intended to serve as a wetlands survey, toxic mold assessment, or environmental site assessment. No effort has been made to define, delineate, or designate any area as wetlands or an area of environmental concern or contamination. Any references to low areas, poorly drained areas, etc. are related to geotechnical applications. Any recommendations regarding drainage and earthwork are made on the basis that such work can be permitted and performed in accordance with the current laws pertaining to wetlands, storm water runoff, and environmental contamination.

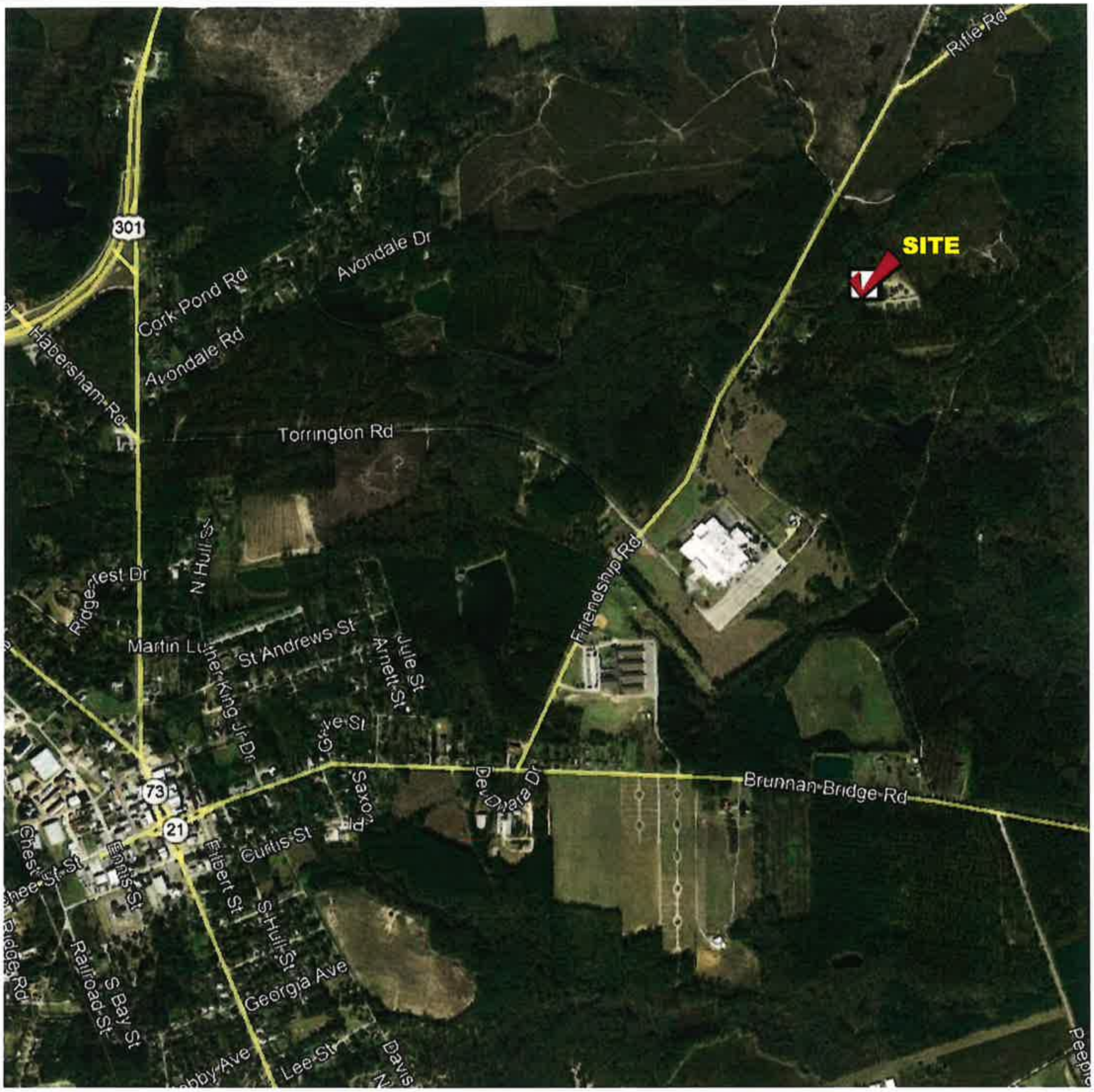
This report does not attempt to define or represent any FEMA, or otherwise designated, flood, erosion, scour, or other hazardous zones; nor does it presume to reflect that governmental or other authorities will grant approval of the project and issue appropriate permits.

WARRANT: WHITAKER LABORATORY, INC. and its professional engineers strive to perform all services in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession practicing in the same locality and under similar conditions. No other warranty or representation, expressed or implied, is included or intended in this agreement, in any report, opinion, document, or otherwise. We carry commercial general liability insurance, including completed operations, and professional liability insurance in aggregate amounts deemed adequate, and we comply with the statutory requirements for workmen's compensation insurance. Accordingly, by accepting and relying on the contents of this report, the liability of WHITAKER LABORATORY, INC. and its professional engineers, to the client, owner, or any other party, for any loss or damage, resulting from any cause, including professional acts, errors, omissions, negligence, toxic mold and other environmental claims, breach of warranty or breach of contract, shall not exceed the total compensation received by us for services related to this project; and client will defend, settle, and discharge any claims or allegations of liability for same against us by others. If client desires higher monetary limits of our liability, we will be pleased to discuss such higher limits and the impact on liability and fees. In the event the client makes a claim against us, at law or otherwise, for any alleged act, error, omission, negligence, breach of warranty or breach of contract, arising from the performance of our services, it is mutually agreed that initially, the client and Whitaker Laboratory, Inc. will attempt to resolve such dispute through direct negotiations between the appropriate representatives of each party. Secondly, if such negotiations are not fully successful, the parties agree to resolve any remaining disputes by formal nonbinding arbitration mediation in accordance with the rules and procedures to be agreed upon by the parties. Mediation is a pre-condition to litigation. The exclusive venue for any disputes relating to Whitaker Laboratory's service shall be in Chatham County, GA. Furthermore, if the client fails to prove such claim, then client shall pay all costs accrued by us in defending ourselves.

TITLE: The ownership of opinions, technical ideas, methods and means, drawings, calculations, and other data developed by us during the course of preparing proposals or rendering engineering services remains exclusively with us. It is a condition of this report or proposal that the client agrees not to use the opinions, technical ideas, methods and means, drawings, calculations or any other data for projects or locations, other than those specifically addressed in the report, and that no one other than the client may use this report, without the written permission of WHITAKER LABORATORY, INC.

APPENDIX I

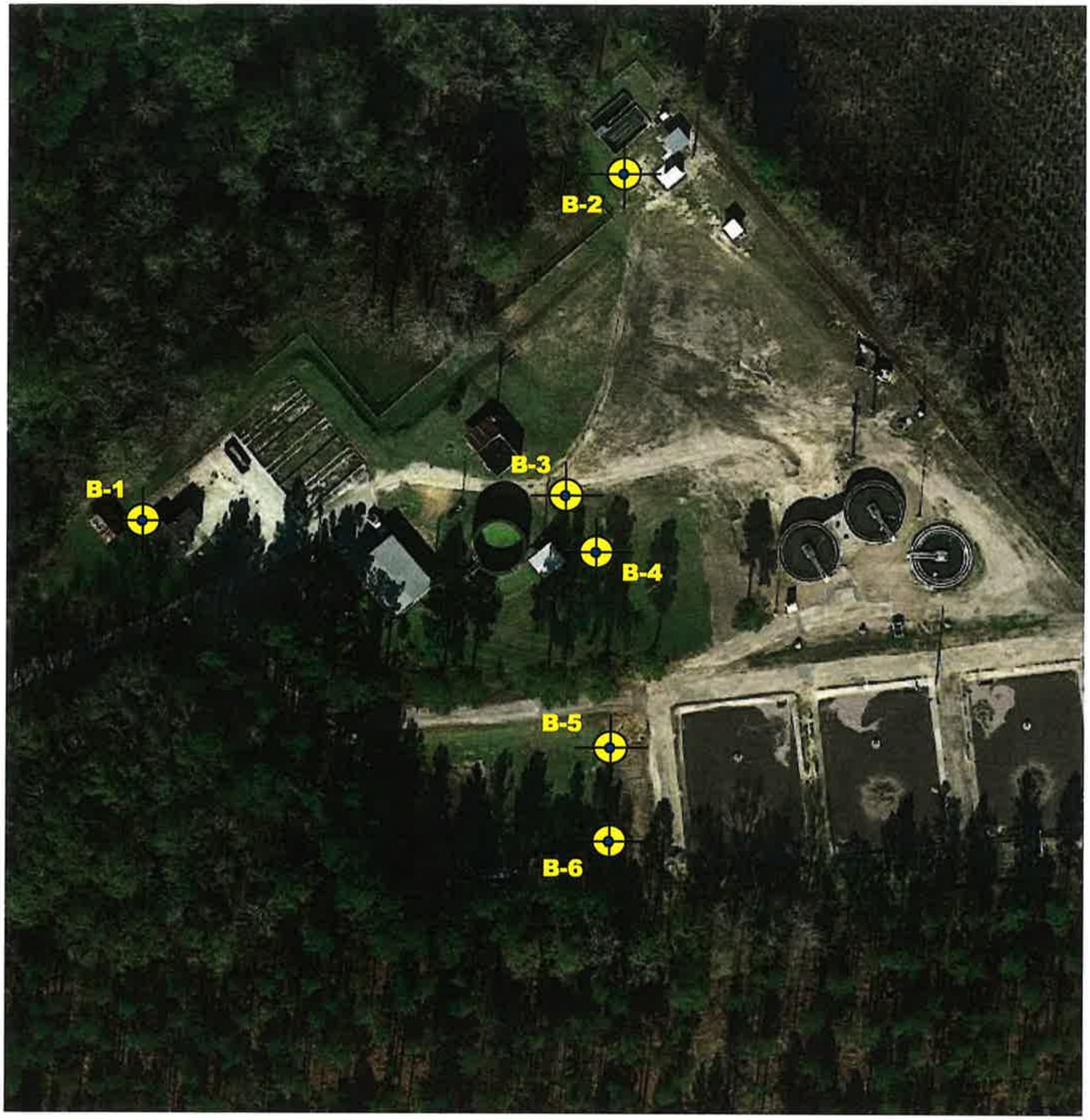
SITE VICINITY & BORING LOCATION PLANS



Site Vicinity Map

Waste Water Treatment Plant Upgrades
624 Friendship Road
Screven County, Georgia

N



Boring Location Plan

Waste Water Treatment Plant Upgrades
624 Friendship Road
Screven County, Georgia

ALL BORING LOCATIONS ARE APPROXIMATE, & ARE BASED ONLY ON FIELD ESTIMATES.

W LAB

WHITAKER LABORATORY, INC.

APPENDIX II

BORING RECORDS

Client: City of Sylvania

Boring No. 1

Project: Waste Water Treatment Upgrades

Date: 6/17/21

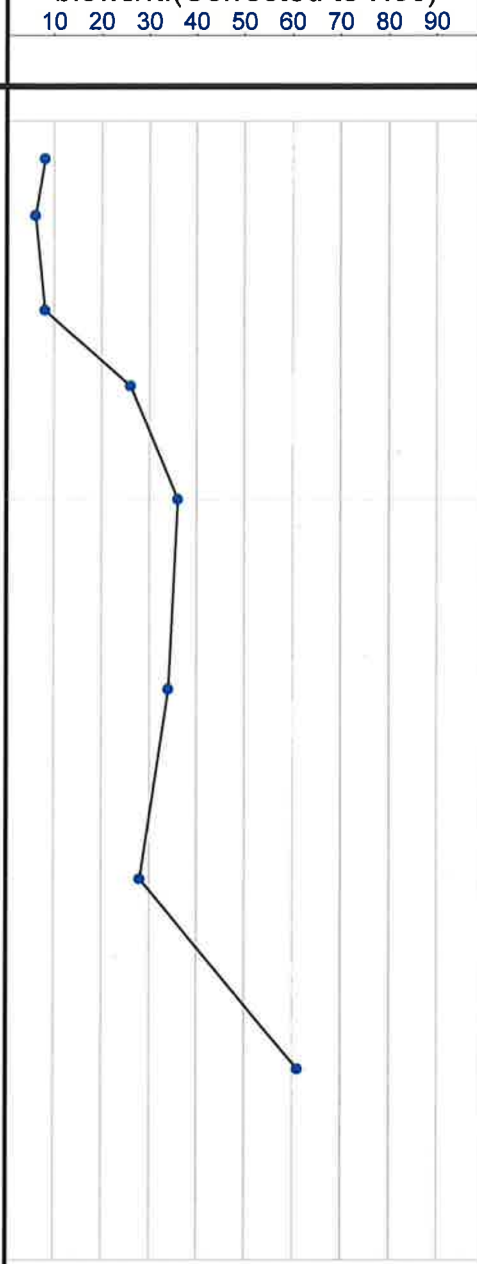
Location: 624 Friendship Road - Screven County, GA

Engineer: Follo

SUBSURFACE PROFILE

Depth	Description	Sample Depth	Number	Blows/ft
0	Ground Surface	0		
0–2	**SM-PT** Topsoil		1	8
2–3.5	**SC-CL** Firm, orange fine sand clay		2	6
3.5–6	**SP-SM** Loose, tan medium to fine sand	5	3	8
6–13	**SC** Stiff to hard, orange-tan fine sand clay		4	26
		10	5	36
13–18	**SC** Hard, orange-tan-gray fine sand clay	15	6	34
18–25	**SC** Stiff to hard, orange-tan fine sand clay	20	7	28
25	End of Borehole	25	8	61

Standard Penetration Test blows/ft.(Corrected to N60)



Water Table | Remarks

Drilled By: Wilkerson (B48)

Drill Method: H. S. Auger

Drill Date: 6/17/21

WHITAKER LABORATORY, INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: City of Sylvania

Boring No. B-2

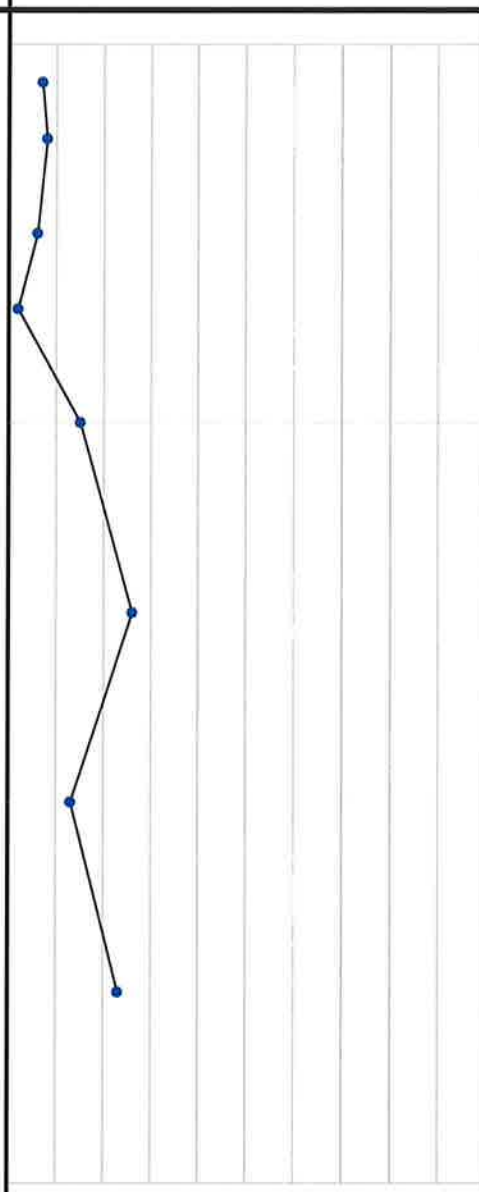
Project: Waste Water Treatment Upgrades

Date: 6/17/21

Location: 624 Friendship Road - Screven County, GA

Engineer: Follo

SUBSURFACE PROFILE		Sample			Standard Penetration Test blows/ft.(Corrected to N60)	Water Table	Remarks
Depth	Description	Depth	Number	Blows/ft	10 20 30 40 50 60 70 80 90		
0	Ground Surface	0					
	SM-PT Topsoil		1	7			
	SC Firm, tan-brown fine sand clay		2	8			
5	**SC-PT** Firm to soft, gray-brown medium to fine sand clay with organics	5	3	6			
			4	2			
10	**SC** Stiff, orange-tan fine sand clay	10	5	15			
						▼	
15		15	6	26			
20	**SC** Stiff, yellow-tan fine sand clay	20	7	13			
25	End of Borehole	25	8	23			
30		30					



Drilled By: Wilkerson (B48)

Drill Method: H. S. Auger

Drill Date: 6/17/21

WHITAKER LABORATORY, INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: City of Sylvania

Project: Waste Water Treatment Upgrades

Location: 624 Friendship Road - Screven County, GA

Boring No. B-3

Date: 6/17/21

Engineer: Follo

SUBSURFACE PROFILE

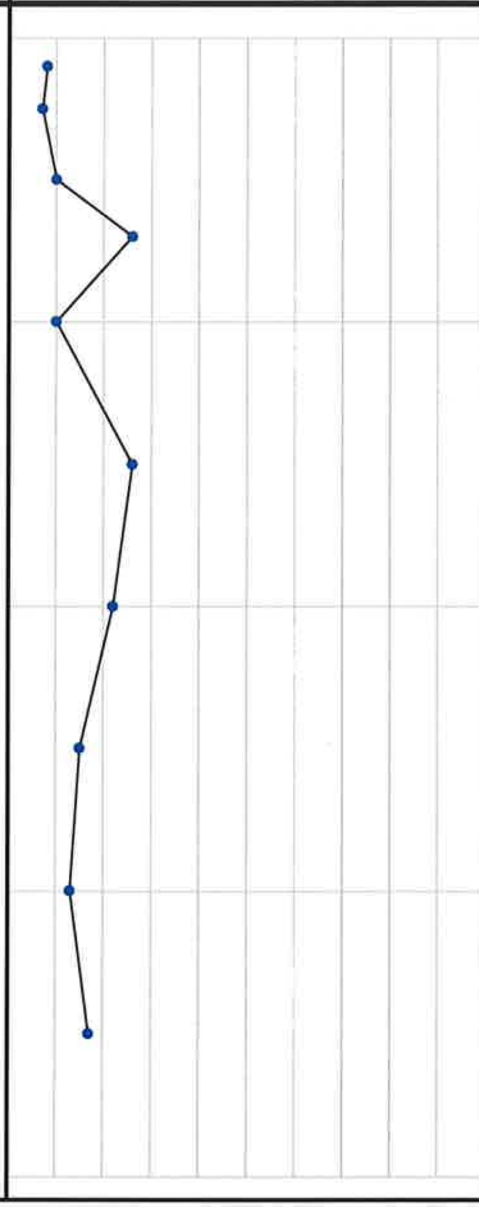
Depth	Description
0	Ground Surface
0	**SM-PT** Topsoil
	SP-SM Loose, brown fine sand
5	**SC-PT** Stiff, gray brown sand clay with organics and rubble
12	**SC** Stiff, orange-tan medium to fine sand clay
22	**SC** Stiff, orange-tan fine sand clay
35	End of Borehole

Sample

Depth	Number	Blows/ft
	1	8
	2	7
5	3	10
	4	26
10	5	10
15	6	26
20	7	22
25	8	15
30	9	13
35	10	17

Standard Penetration Test blows/ft.(Corrected to N60)

10 20 30 40 50 60 70 80 90



Water Table

Remarks

Drilled By: Wilkerson (B48)

Drill Method: H. S. Auger

Drill Date: 6/17/21

WHITAKER LABORATORY, INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: City of Sylvania

Project: Waste Water Treatment Upgrades

Location: 624 Friendship Road - Screven County, GA

Boring No. B-4

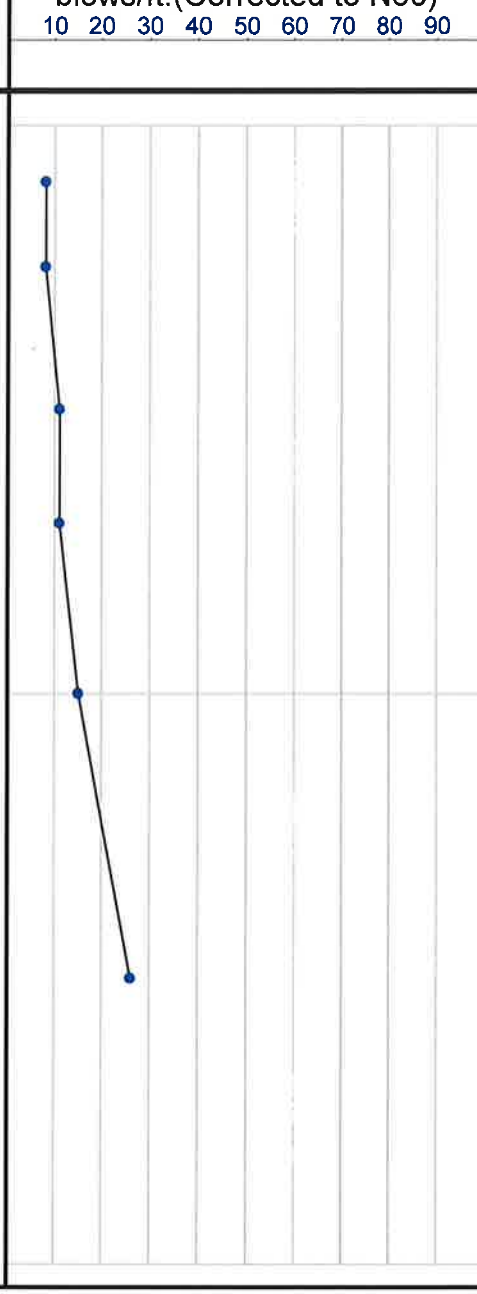
Date: 6/17/21

Engineer: Follo

SUBSURFACE PROFILE

Depth	Description	Sample Depth	Number	Blows/ft	Water Table	Remarks
0	Ground Surface	0				
	SM-PT Topsoil		1	8		
	SM Loose, brown fine silty sand		2	8		
5	**SP-SM** Firm, tan medium to fine sand	5	3	11		
			4	11		
10		10	5	15		
	SC Stiff, orange-tan fine sand clay				▼	
15	End of Borehole	15	6	26		
20		20				

Standard Penetration Test blows/ft.(Corrected to N60)



Drilled By: Wilkerson (B48)

Drill Method: H. S. Auger

Drill Date: 6/17/21

WHITAKER LABORATORY, INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: City of Sylvania

Project: Waste Water Treatment Upgrades

Location: 624 Friendship Road - Screven County, GA

Boring No. B-5

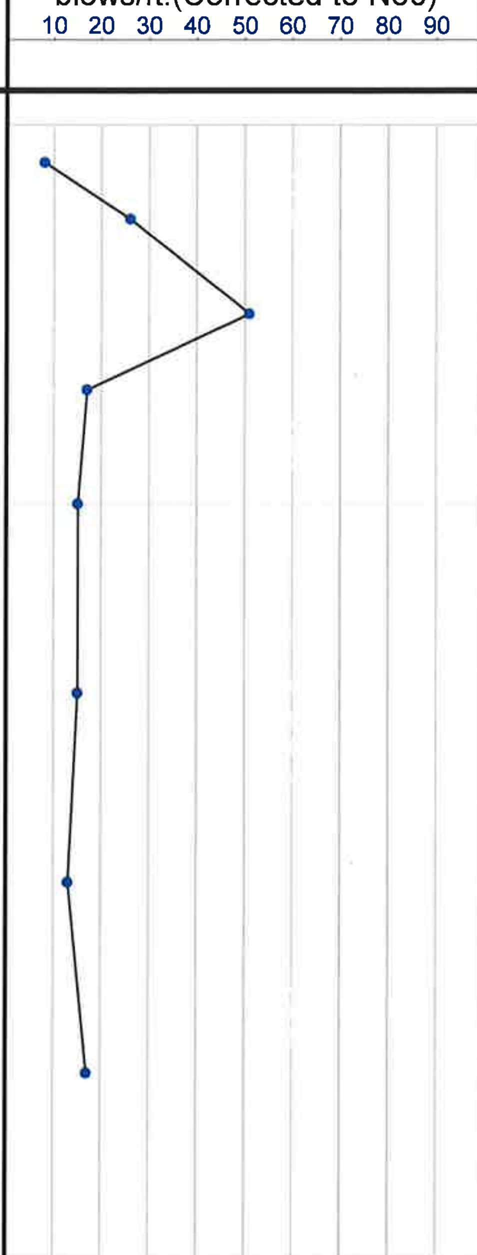
Date: 6/17/21

Engineer: Follo

SUBSURFACE PROFILE

Depth	Description	Sample Depth	Number	Blows/ft	Water Table	Remarks
0	Ground Surface	0				
	SM-PT Topsoil		1	8		
	SM Loose, brown fine silty sand		2	26		
5	**SC** Stiff to hard, orange-tan medium to fine sand clay	5	3	51		
	CL Stiff, tan-orange silty clay		4	17		
10	**CL** Stiff, tan-gray silty clay	10	5	15	▼	
15		15	6	15		
	SM Firm, tan medium to fine silty sand					
20		20	7	13		
25	End of Borehole	25	8	17		
30		30				

Standard Penetration Test blows/ft.(Corrected to N60)



Drilled By: Wilkerson (B48)

Drill Method: H. S. Auger

Drill Date: 6/17/21

WHITAKER LABORATORY, INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: City of Sylvania

Boring No. B-6

Project: Waste Water Treatment Upgrades

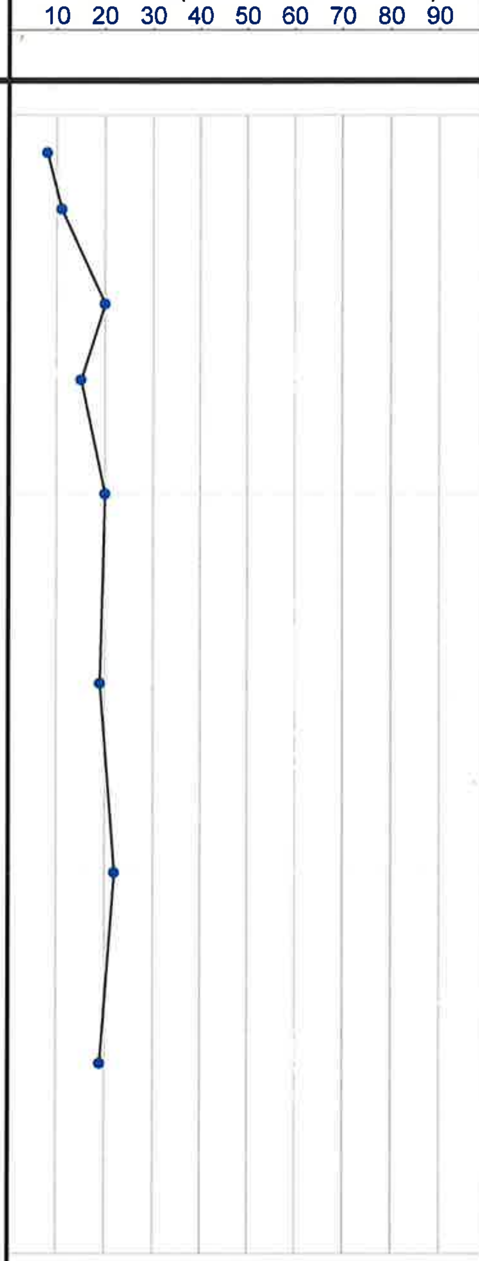
Date: 6/17/21

Location: 624 Friendship Road - Screven County, GA

Engineer: Follo

SUBSURFACE PROFILE		Sample				
Depth	Description	Depth	Number	Blows/ft	Water Table	Remarks
0	Ground Surface	0				
	SM-PT Topsoil		1	8		
	SP-SM Loose, brown fine sand		2	11		
5	**SC** Stiff, orange-brown medium to fine sand clay	5	3	20		
	CH Stiff, orange-gray clay		4	15		
10		10	5	20		
	SM Firm, white fine silty sand					
15		15	6	19	▼	
	SC Stiff, yellow-tan fine sand clay					
20		20	7	22		
25	End of Borehole	25	8	19		
30		30				

Standard Penetration Test blows/ft.(Corrected to N60)



Drilled By: Wilkerson (B48)

Drill Method: H. S. Auger

Drill Date: 6/17/21

WHITAKER LABORATORY, INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

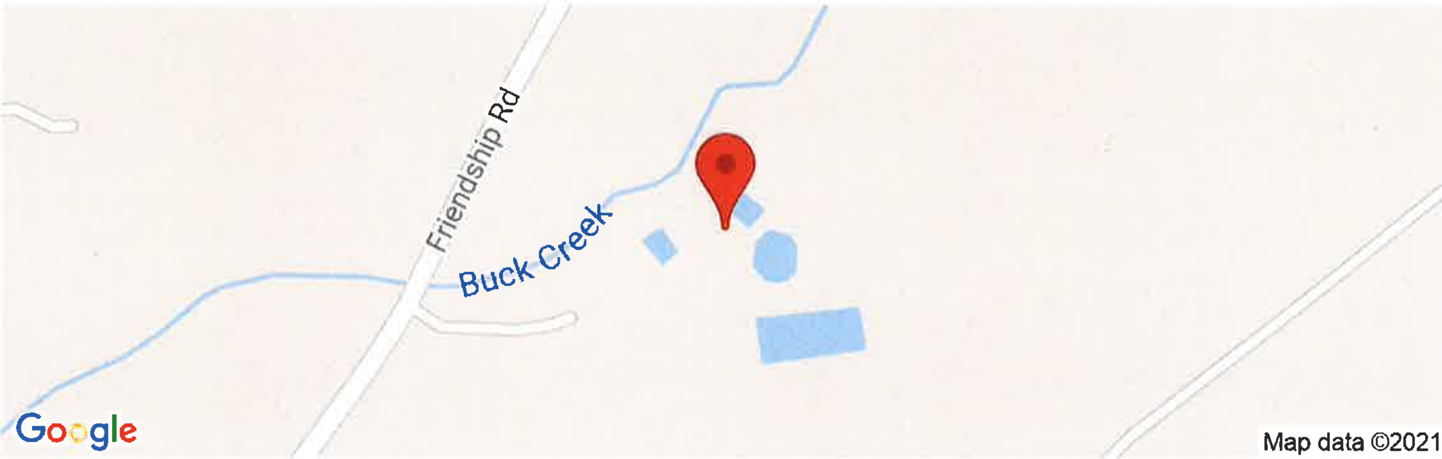
APPENDIX III

LIQUEFACTION & SEISMIC PARAMETERS

OSHPD

624 Friendship Road, Sylvania, GA

Latitude, Longitude: 32.765, -81.614



Date	6/28/2021, 8:12:33 AM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	D - Default (See Section 11.4.3)

Type	Value	Description
S_S	0.288	MCE_R ground motion. (for 0.2 second period)
S_1	0.107	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.453	Site-modified spectral acceleration value
S_{M1}	0.256	Site-modified spectral acceleration value
S_{DS}	0.302	Numeric seismic design value at 0.2 second SA
S_{D1}	0.171	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	C	Seismic design category
F_a	1.569	Site amplification factor at 0.2 second
F_v	2.386	Site amplification factor at 1.0 second
PGA	0.155	MCE_G peak ground acceleration
F_{PGA}	1.489	Site amplification factor at PGA
PGA_M	0.231	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	0.288	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.328	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.107	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.122	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.879	Mapped value of the risk coefficient at short periods
C_{R1}	0.879	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

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APPENDIX IV

IMPORTANT GENERAL NOTES

GENERAL NOTES

The "standard" penetration resistance is an indication of the density of cohesion less soils and of the strength of cohesive soils. The "standard" penetration test is measured with a 1.4 inch I.D., 2 inch O.D., sampler driven one (1) foot with a 140 pound hammer falling 30 inches.

RELATIVE DENSITY OF SOIL THAT IS PRIMARILY SAND

Number of Blows	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 20	Firm
21 - 30	Very firm
31 - 50	Dense
Over 51	Very dense

CONSISTENCY OF SOIL THAT IS PRIMARILY SILT OR CLAY

Number of Blows	Consistency
0 - 2	Very soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very stiff
Over 31	Hard

While individual test boring records are considered to be representative of subsurface conditions at the respective boring locations on the dates shown, it is not warranted that they are representative of subsurface conditions at other locations and times.

The subsoil stratification shown on these profiles is not warranted but is estimated based on accepted soil engineering principles and practices and reasonable engineering judgment.

Unless notified, samples will be disposed of after 60 days.

GROUP

MAJOR DIVISIONS	SYMBOLS	TYPICAL NAMES
		COARSE-GRAINED SOILS More than 50% retained on No. 200 Sieve*
GRAVELS 50% or more of coarse fraction retained on No. 4 sieve		
CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silty mixtures
	GC	Clayey gravels, gravel sand clay mixtures
SANDS More than 50% of coarse fraction passes No. 4 sieve		
CLEAN SANDS	SW	Well graded sand and gravelly sands, little or no fines
	SP	Poor graded sands and gravelly sands, little or no fines
SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand clay mixtures
		FINE GRAINED SOILS 50% or more passes No. 200 Sieve*
SILTS AND CLAYS Liquid Limit 50% or less		
	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
	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 sands or silts, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	PT	Peat, muck and other highly organic soils

*Based on the material passing the 3 in. (75 mm) sieve.